Pic of kb

This all started with a review I found from Switch and Click when they looked at the Kumara Red Dragon K552 keyboard. Priced at $35 US it is surprisingly inexpensive. I also wanted a project where I could experiment with modding and not cry when things went wrong. I also like the ten key less form factor.

If you want to look at unboxing and review-like things, that's been done. We will be going in a bit of a different direction.

The board arrived, and to borrow a phrase from the EE Vblog, "Don't just turn it on. Take it apart."

Analysis

* Key caps

The Key caps are made out of an ABS plastic and the oil from the plastic release was present on EVERYTHING. I believe it is a crude doubleshot cap in that there is a black piece of plastic for the cap and a semi-translucent plastic for the stem.

Show underside of a cap.

Of course there is shine through lettering. You may have noticed the font and how it's perhaps a 'Gamer font'. I suspect something a little different here. It was something I caught when watching Glarses review the Pewdiepie board.

To quote:

They have a lot of the same problem that a lot of these cheap doubleshot key caps have in terms of the connecting ' O ' type letters and numbers where you can see it doesn't connect properly and you get these dark spots which can look kind of inconsistent when you shine those LED through them.

End quote.

What I think the manufacturer did was a pretty smart workaround. They embraced that weakness in the manufacturing process and made it work by intentionally splitting the font characters to make manufacturing easier.

* Aside

You may have noticed me pointing out various youtubers, that's because citing your references is good practice. References aren't just for an English paper you hoped the teacher wouldn't read.

* Stabilizers

I want to make a joke here about these stabilizers being from a region where there is constant fighting and refugees stream out in a mass exodus to find a place where they can live and prosper with hope and most importantly, stability in their futures. Unfortunately, that hits too close to reality and we'll have to settle with saying that these must have been made by a baby because there is so much rattle.

*Switches

The unit I ordered came with ... Out-tea-moo(?) Ode-e-mu(?) *Oh-teh-moo* Red switches.

These switches are almost compatible with the entire Cherry MX style lineup. The difference lies in their pins.

Find Outemu Mechanical drawing. Show that and the MX switch pin side by side.

Outemu switches use a slightly smaller and narrower pin compared to other Cherry MX class switches. It's not a huge difference, but the Outemu hot swap sockets are too small for the more common MX pin. These switches are generally in the budget bin. I don't particularly like linear switches. At this point there are two choices:

1) Stick with Outemu brand switches and have hot swap capabilities. Your choices of switch are Red and Black (both linear), Brown (tactile), or Blue (clicky)

OR

2) Pick a switch, remove those sockets, and solder in some MX compatible switches.

There is a third option of sanding or trimming leads to make them fit in the sockets. Just… no. That's a horrible plan.

*Plate and PCB

Normally, you might think these are two separate things. Normally, you would be right. However, in this case, the plate is electrically part of the PCB design. I am also going to spend a bit of time here for two reasons:

- The first is that this is somewhat my wheelhouse and I'm going to be critiquing the PCB design choices.
- Second, folks seem to just gloss over the PCB. I think this component deserves a bit more attention.

The PCB, (Printed Circuit Board) and steel plate, verified by using a magnet, are held together with four plastic spacer rivets and several screws. The spacer rivets hold onto only the plate and PCB. The screws go through the plate into plastic standoffs located inside the tray to hold everything in place. There are additional posts to help support the assembly and brace up against the steel plate. For the most part that seems pretty reasonable. If that were it, I might say ' Good job. Design is straightforward and makes sense. Keep doing that.'

Here's where it gets weird. I'm going to make it weird.

There are two springs and two bare spots on the steel plate where the springs make electrical contact. My guess is that this is a crude ground plane or EMI (Electromagnetic Interference) shield. What I do know is that there are two springs that make sandwiching this together a bit of a pain.

The PCB is also a single sided design, and I think it's made of phenolic paper. Translation: They put traces and solder pads on one side of the board only. Phenolic paper is the insulating material used in this PCB. Most of the time you see something called FR4. FR4 is a fiberglass based insulator and is a good general purpose material. Phenolic paper is cheap. So the cost cutting measures rear their head. There is some bowing or curvature at the center of the PCB. I don't think that's supposed to happen. There are also a significant number of jumpers on the top side of the PCB where the switches go. I haven't gone through and checked every jumper, but there are at least a few that are making a crude ground plane.

The microcontroller is a BYK901-0001. I tried locating a datasheet for this part so I could at least speak about features, and internal architecture. My attempt to get this information from an Alibaba vendor resulted in a quote ~$1.55 US ea / 1000 unit minimum order, but they couldn't get me documentation on how it worked. If you can help, leave a comment. I want to know more about this part. I did find this device mentioned in some other budget mechanical keyboard designs, but nothing about how the chip works.

The microcontroller has pads left behind for a JTAG connector. This is usually used for in circuit programming and debugging purposes. Again, there's some odd things happening where the silkscreen – AKA the white-ish paint that you see – appears to be covering specific solder pads. I'm not sure what's being done here, and I don't want to desolder the chip to investigate. Risk -

reward and all that. Honestly, I think a proper data sheet might tell me most of what I want to know.

The board is connected to the outside world via a cable with an iron choke bead and a simple header. Remember when I mentioned this is a single sided board? Well, since that header is through-hole, it goes through the PCB, That means that it needs to be soldered on the same side as the rest of the components. Essentially, this is a mechanically weak point on this board because there's not a lot of support for that connector. They did put a glob of glue down to help provide support, but this is where a 2-sided board would not have an issue because there would be solder gripping the connector on both sides of the PCB.

Speaking of the USB header, I had a moment of scope creep when I watched Switch and Click modify this same keyboard by adding a USB C connector to the back. I thought that was brilliant and ordered the headers to do the same thing to this board.

Show Sparkfun part and Schematic

I then abandoned that idea based on how cheaply made this PCB is. So apparently ESD (electrostatic discharge) protection is a suggested part of the USB interface. Those features are not part of these sparkfun USBC breakout boards.

Show TI application note

Depending on the implementation, there may be an inductor (coil) used in conjunction with diodes to prevent voltage spikes from destroying the USB interface on the board (AKA: the microcontroller I have no documentation for). The solution that I would prefer is to have the protection diodes as part of the USB C breakout board. At some point in the future I think I'm going to make my own version of that breakout board with those features included. For now, I'm going to leave the cable and this part of the board alone.

* Bottom Tray

This is probably the least interesting aspect of this board. It's a plastic tray. The cable is secured with two bolts to hold it in place. There is some cable strain relief to reduce the risk of damage to the cable. There are scuffs inside the tray from manufacturing that you will never see unless you take it apart. The feet on the bottom are very small and don't provide a lot of grip on flat surfaces. The flip out feet aren't too bad though and is a reasonable addition to modify the typing angle.

*Time to Modify!

Fixing the Tray

The tray is overall okay, but a few things can be improved. The feet need to be bigger to keep the board from slipping. I bought a 6” square sheet of 1/16” thick rubber from McMaster Carr. Whoo! It has a smell. The outgassing on this is surprisingly strong. I cut some of the sheet into strips and then glued those strips onto the bottom using a clear Gorilla Glue. I roughed up the gluing surface of the case and rubber feet so that the glue has something to hold onto with a bit of fine grit sandpaper. Next the contact surfaces were cleaned up to remove any loose particles. Finally I tried to line them up as much as possible when gluing.

Next, we want to deaden that hollow sound from the plastic tray. With some information from Stupid Bullets in hand, I filled the tray up with a pourable two-part silicone material to add weight and sound dampening to the case. It will also help deaden the hollow sounds you would get otherwise.

This worked well, but there’s some room for improvement we’ll talk about at the end.

Fixing the PCB

There’s conveniently a single pad where they opted to not install a decoupling capacitor on the board. So for fun, I soldered on a couple of 1uF ceramic capacitors. This probably won’t change anything, but it can’t hurt. You’ll notice I ‘tombstoned’ the capacitors. Not a recommended practice for the record.

Second, the Outemu sockets have to go. They are thankfully easy to remove. This will pave the way for when I install the switches. Apply heat, use the solder plunger, repeat. This is the one case where the single sided PCB was actually a boon. Doing this with a 2-sided board can be more difficult.

Fixing the stabilizers

These have been pulled out and aggressively lubed with silicone grease. Probably too much grease to be honest. I am still working out my preferences for doing much nicer builds. I added some tape to help brace the stabilizers in the plate. For the most part, they hold reasonably still.

For the space bar, I tried something a little different. I also added a bit of clear plastic packing tape on the plate under the wire before installing the stabilizer. The thought is that if it’s going to vibrate, it will hit the plastic tape first and help deaden the sound. This step was not needed and was more of an experiment.

Fixing the Switches

The Outemu switches probably aren't that horrible if lubed and filmed. I'm more a fan of tactile switches. So to replace the ones that came with it, I selected a set of Kailh Polia switches. I also want to minimize vibration as much as possible. So to improve things a little bit, I cut up a bit of foam to go between the plate and the board. There are much nicer solutions available, but this should do the job.

I tried using a sheet of laser cut foam From Stupidfish that would work with a TKL unit in place of my homemade foam. The problem is that the foam was about 1mm too thick. I had to abandon this and go back to my homemade foam.

I replaced the four plastic clip in spacers with proper screws and an insulating washer between the nut and PCB. I was able to use some scraps from the laser cut foam to act as spacers. The screw heads are countersunk and while not completely flush with the plate there's enough clearance to keep caps from making contact with the screw or plate.

Fixing the Key Caps

The keycaps aren't really something I can 'fix'. But we can replace them with a better set. I have a Tai-Hao PBT set I bought from WASD that will fit the bill. The caps are shine-through and is an attractive black and sky blue color set. PBT is a more rugged plastic than ABS, so it'll hold up a little better over time.

Cosmetics

I removed the Red Dragon logo using an eraser similar to what Switch and Click did. However, I could still see the logo at just the right angles so I took a fine grit sandpaper and tried that too. It was better, but now the badge and the bottom of the tray were roughed up in spots. I tried to make this better by applying a layer of clear coat to these external parts of the board. It's still not the best paint job after two coats, but it is presentable.

Room for improvement

A good design project should look back and ask 'what could be better'? We met the goal of modding and improving the overall sound and feel of the board, but the lessons learned should be talked about.

Plate foam was one that I did not expect to be an issue. 3mm foam between the plate and PCB is probably the way to go. You are still going to have to slice that piece up a lot since there isn't a premade template available for the Kumara Red Dragon that I know of.

An ESD protection circuit built into the USB interface would be the only way I'd be willing to remove the cable that came with the keyboard. The circuit might be on the PCB hiding under a blob of glue, but since the manufacturer is cost conscious I wouldn't risk it. A second protection circuit wouldn't hurt anything if it already exists.

I added too much silicone to the tray. This is proven because I'm actually pressing into the silicone dampener with the unit assembled. I made sure not to over tighten any screws since they are just being held in with plastic standoffs that could easily strip. The result is a very firm typing experience with just a hint of flex. I also learned that silicone is really tough to cut.
I can dig into it with a razor blade, but if I wanted to effectively fillet a bit of the gasket away, it would look really bad as the material flexes and binds while cutting.

The Kailh Polia switches probably have been over lubed since these were done when I was a lot less experienced greasing switches. This series of switches also have a lot of stem wobble to them – a function of the manufacturer, and has nothing to do with what I did or did not do. It's still a better switch than what was in there.

Keycaps are pretty subjective, and while the Tai-Hao set isn't perfect, I think they are a much better solution than the ABS key caps that were included.

The stock plate mount stabilizers were - are pretty horrible, I did what I could to make these work. That included clipping the feet. I suspect these were Cherry knockoff stabilizers. A better set might help a little.

I did not focus on preserving the cosmetic look of the board while working. I'd probably put more focus into preserving surfaces if I were to do this again. The clear coat solution made it better, but it is imperfect.

It might be possible to make the board mount a lot more flexible by modifying the posts and replacing the top of each one with a rubber washer or spacer. It would still be a tray mount, but there would be inherent flex because of the rubber between the plate and case standoffs.

Cost

This is a rough estimate that includes everything used. The estimate excludes items I bought that were ultimately not used in the rebuild process. The laser cut foam for example. Overall, it was around $150 US. That includes the purchase of the keyboard. Switches and keycaps were around

$50 each. The miscellaneous items make up the rest of the cost. (Silicone mix, paint, hardware, rubber sheet, glue, etc.)

That's the mod. I did realize after I started planning this project that Glarses and Switch and Click modded the same board in their own way. You should check those videos out.

And now, here's an obligatory sound test…