Tactile Cube Project

Electronics assembly manual

# Schematics location:

PCB - Project\_Masters project - PCB\_2021-08-15\_14-50-25.zip  
Cube - Project\_Masters Project - Cube schematic\_2021-08-15\_14-50-16.zip

# Printed circuit boards:

The designs have been made using EasyEDA circuit and PCB designer application. It is a free online IDE where you can order from JLCPCB directly.

## Components needed for one PCB:

* 1 \* MCP3004 – Quad Channel 10-bit ADC - SOIC-14 Package – **MCP3004-I/SL - Farnell**
* 5 \* 10nF Multilayer Capacitor 50V – 0603 Size – **06035C103JAT2A - Farnell**
* 1 \* Zener Single Diode 2V 200mW – SOD-323 Package – **BZT52C2V0S-7-F - Farnell**
* Design wise 1 is needed, I used 2 in parallel – 536 Ohm resistor – 0603 Size – **WR06X5360FTL - Farnell**
* 4 \* WS2812B Addressable RGB LED (I’d redesign the PCB and use APA102 LEDS, which work on a one-way SPI protocol) - **https://proto-pic.co.uk/product/rgb-ws2812b-smd-led-strip-of-10/**
* 4 \* Analogue 1-axis Hall Effect Sensor – SOT-23-3 Package – **DRV5053PAQDBZR – Digikey**

## What I’d improve:

It is untested, but the heat of the LEDs can affect what the measured magnetism looks like. A little 1mm cut on the PCB between the LEDs and hall effect sensors could prevent or slow down this effect.

Assembly of this cube is literal hell with having to solder the SPI lines on some PCBS to 3 time as these lines are shared. I’d design the splitting SPI rails onto the PCB with having SPI breakouts on all four sides.

Finally, I’d add some more cut-outs to the edges of the PCBs where wires could be pulled through to be soldered from the outside making this project much more pleasing to assemble.

Due to the 3D printing, I’d also move any components or connection out of the central cross of the PCB to allow for a better fit later during the mechanical assembly.

Add battery detection circuitry for voltage, temperature and take the battery charger circuit LEDs information to know if the batteries are charging correctly. Even current measurement and power measurements would be lovely to know.

You can maybe add a buzzer or speaker into the cube to add some musical tones to the game.

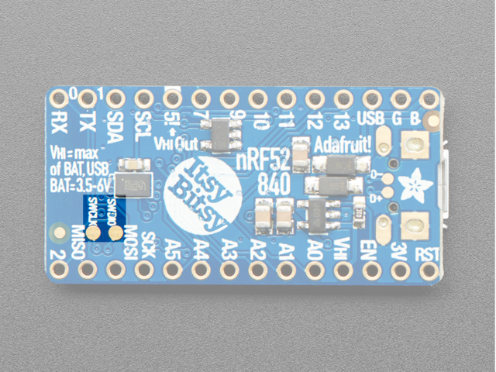
# The whole cube schematic:

This is where things might get a little complicated. (Especially for me since I have not made one prior to making this document.)

## Components:

* Adafruit ItsyBitsy nRF52840 Express – Microcontroller
* JLINK or NRF52832/NRF52840 development kit boards for programming (we will ditch the original bootloader)
* TP4056 5V 1A MicroUSB 18650 Lithium Battery Charging Board Module - <https://www.amazon.co.uk/gp/product/B07BSVS842/ref=ppx_yo_dt_b_asin_title_o04_s00?ie=UTF8&psc=1>
* 2 \* (supposedly) 2Ah Lithium batteries <https://www.amazon.co.uk/gp/product/B08TQSC5G9/ref=ppx_yo_dt_b_asin_title_o04_s00?ie=UTF8&psc=1> (Be extremely careful with these, they have protection boards but still dangerous and explosive)
* 1 \* GY-521 MPU-6050 Accelerometer Module <https://www.amazon.co.uk/gp/product/B00PIMRJX6/ref=ppx_yo_dt_b_asin_title_o03_s00?ie=UTF8&psc=1>
* 1 \* Slide Switch (just in case I added one as an afterthought to be able to turn the cube on-off) <https://www.amazon.co.uk/gp/product/B01N367QLZ/ref=ppx_yo_dt_b_asin_title_o01_s00?ie=UTF8&psc=1>
* 1 \* USB micro breakout board. (Sorry I could not find where and when I got mine I used, but most tiny boards should do, like these) <https://www.amazon.co.uk/Yosoo-Health-Gear-Breakout-Converter-default/dp/B08FDDMM55/ref=sr_1_1_sspa?dchild=1&keywords=usb+micro+breakout&qid=1629035403&sr=8-1-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExR1kySlFTQkhTUjdYJmVuY3J5cHRlZElkPUEwMjA0ODc3VE04NFdZT0U4RDhPJmVuY3J5cHRlZEFkSWQ9QTAyMDczNzQzSUVBM09OSUc1VFE0JndpZGdldE5hbWU9c3BfYXRmJmFjdGlvbj1jbGlja1JlZGlyZWN0JmRvTm90TG9nQ2xpY2s9dHJ1ZQ==>
* 1 \* LDO 3.3V voltage regulator – **LD39150DT33-R – Farnell**
* 1 \* 1uF ceramic capacitor
* 1 \* 2.2uF ceramic capacitor

## Wiring the microcontroller:

 We will need JTAG access to this microcontroller so we will need a very thin wire to be soldered on the SWCLK and SWDIO pins which can be located on the bottom of the microcontroller. (Figure 1)

The other 2 of these tiny connections we will need is the D+ D- pins for the USB protocol. (Figure 1, red outline)

Figure https://learn.adafruit.com/adafruit-itsybitsy-nrf52840-express?view=all - Location of the debug pins and the USB data pins.

Personally, I have used 30 AWG wires to make these connections and be very careful not to short or de-solder any other components while doing so.

## Charge controller:

The R3 resistor must be replaced, 1A charging current is too much. I’ve replaced it with a 3.3K Ohm resistor.