

# Instruction to build WRAQ

For materials to build WRAQ, refer to the bills of materials as below.

<https://github.com/neurobio-hiroshima/WRAQ/blob/main/BOM.xlsx>

PCB board will be made according to the design files made on Autodesk eagle.

<https://github.com/neurobio-hiroshima/WRAQ/tree/main/pcb/WRAQ/eagle>

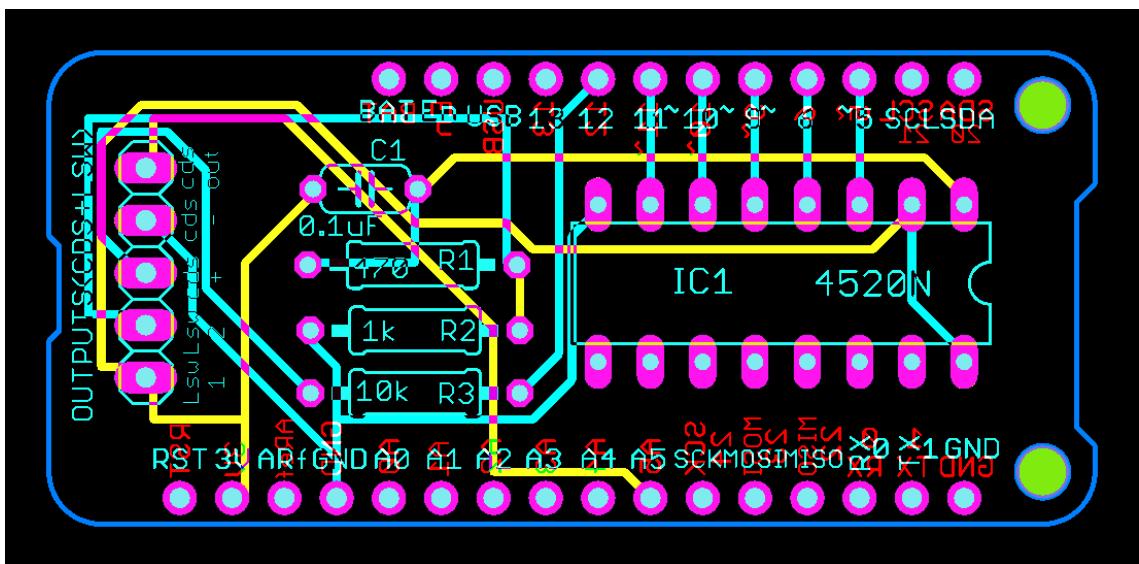
If you use Seeed fusion to fabricate PCB, the following gerber files might be useful.

[https://github.com/neurobio-hiroshima/WRAQ/tree/main/pcb/WRAQ/gerber\\_seeed](https://github.com/neurobio-hiroshima/WRAQ/tree/main/pcb/WRAQ/gerber_seeed)

Instructions to build WRAQ hardware

## 1. Soldering parts to the PCB

- Since line drawings on PCB indicate where to put each part, please place them at the indicated position and wire them with soldering to the pads PCB. Parts needs to be on PCB are as below.
  - Resistor, 470 Ohm, 1/4 w
  - Resistor, 1k Ohm, 1/4 w
  - Resistor, 10k Ohm, 1/4 w
  - 0.1uF ceramic capacitor
  - 4 bit binary counter (TC4520BP, place it with correct direction according to the notch)



- Solder the female header set (e.g., Header Kit for Feather - 12-pin and 16-pin Female Header Set, Adafruit Product ID: 2886) as receptacles to the pads on PCB board.

2. Modifying flying saucer and wiring with cables

- Flying saucer consists of the wheel and main body. In case, you may disassemble it by hitting the central bearing part from the bottom by hammer, which might make it easy to place the magnet and reed switch (see below). First of all, the reed switch is placed next to the central bearing part as in Figure 1. Use drill driver to make two holes with diameter of 1 mm through which the two feet of the reed switch come out to the bottom. The reed switch was fixed in position with epoxy glue such as Alardite or Devcon 30 minutes epoxy. Flying saucer has four wing supporting the bearing part at the center (found from the bottom). Removal of them might make it easy to do the above manipulation (see Figure 3).
- Position cylindrical neodymium magnet (0.25"DIA X 0.1"H) on the back surface of saucer with help of the epoxy glue so that it sweeps over the body of reed switch upon revolution of the wheel (Figure 2).
- Upon securing the neodymium magnet and reed switch (maybe making the epoxy glue hardened by keeping it overnight), CdS photoresistor is placed at the back side of the central bearing part with a support of a 20 mm-long silicone tube (5 and 9 mm for inner and outer diameters, respectively).
- Cut five 50 mm-long 28 AWG cables and exposed both ends with wire stripper followed by preparatory soldering. Wire one end of the cables to the CdS photoresistor and feet of reed switch, then wire another end of the cables to the pad on PCB board according to the labels on it with referring to Figure 3.

3. Upload the firmware to the adalogger

- Solder the pin headers to the pads on adalogger.
- Compilation of the firmware <https://github.com/neurobio-hiroshima/WRAQ/blob/main/firmware/WRAQ/WRAQ.ino> using ArduinoIDE needs RTCZero library (ver. 1.5.2) as indicated in the comments in firmware. Please install this library in advance of firmware upload.
- Please follow the instruction (<https://learn.adafruit.com/adafruit-feather-m0-adalogger>) by Adafruit to upload the firmware to the adalogger, Before uploading, correct the time and date (lines 26-34 in WRAQ.ino). Now you can let it run driven by Lithium polymer battery.
- Cover the bottom of the flying saucer bottom by 3D-printed cover using stl file given on the github (<https://github.com/neurobio-hiroshima/WRAQ/blob/main/stl/cover2.stl>).



Figure 1

A picture of the bottom view of WRAQ showing locations of CdS (center) from which three wires come from (green, yellow and red) and the feet of reed switch connected with two wires (white and red). The last two wires were from two holes made to keep the reed switch in position. Wiring between CdS (green, yellow and red on left) / reed switch (white and red on the right) and PCB connected to the adalogger. This is helpful to find the position of holes you need to make for the feet of reed switch.



Figure 2

This also tells where the magnet and reed switch need to be placed with epoxy glue. Notice that feet of reed switch were inserted into two holes made in advance, then epoxy glue fixed the switch in position. The wheel and main body were disassembled for demonstration. Indeed, if you hit the exposed bearing part from the bottom of the main body by hammer, you can disassemble the flying saucer.



Figure 3

This is to show the cables with red and yellow were connected to one of the pins on cdS, while another cdS pin was connected with singly green cable. Three cables (red, yellow and green from the left at the center of the panel) are for cdS photoresister. White and red (invisible since it is hidden behind the adalogger) cables in Fig. 1C are wiring between reed switch and adalogger. Lithium polymer battery or AA battery box is connected directly to the adalogger through JST PH 2 pin connector. Lithium polymer battery from the adafruit is with this connector (e.g., <https://www.adafruit.com/product/328>).