OPTOBLE - OPTOGENETICS SYSTEM BUILD INSTRUCTIONS

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CONTROLLER UNIT

BILL OF MATERIALS

Component	**Supplier**
Raspberry Pi 3 Model B+	Adafruit (3775)
Micro-USB Power Cord	Amazon (B00MARDJZ4)
USB Numberpad	Amazon (B078MZQWPP)
M3 x 0.5 x 6M screws (x8)	Albany County Fasteners (1011-1006-0012)
#2-56 3/8 machine screws (x4)	Amazon (B000MN6P90)
8" Raspberry Pi Display Cable	Adafruit (1647)

INSTRUCTIONS

This controller unit was taken from the Adafruit website, follow instructions found in the "7-portable-raspberry-pi-multitouch-tablet.pdf". Note that the battery and "PowerBoost" components are not necessary if a wired connection is sufficient. After unit fabrication, upload the code to the Raspberry Pi and plug in the number pad to the USB.

OPERATION

Open the controller python script with root or sudo privileges in the terminal (*sudo python optoble.py*). Adjust the TkInter window to full screen. Search for devices by using the "Scan" button, which will trigger listening for 15 seconds. The "Devices" listbox will display discovered implants, and the "RSSI" listbox will show the connection strength of each device. Connect to a device by selecting the device in the "Devices" listbox and selecting the "Connect" button. Temperature data will start to display within the first 20 seconds, a "X" will appear in the "C" listbox next to the connected device, and the "Connect" button text will turn green while the connection is active. If the connection is lost, try connecting again. To send parameters to the implant, enter the parameters and select the "Send" button. After the stimulation pattern is complete, the temperature display will show "Completed!". To troubleshoot, check the terminal, which will show more verbose output to help trace the bug.

IMPLANT

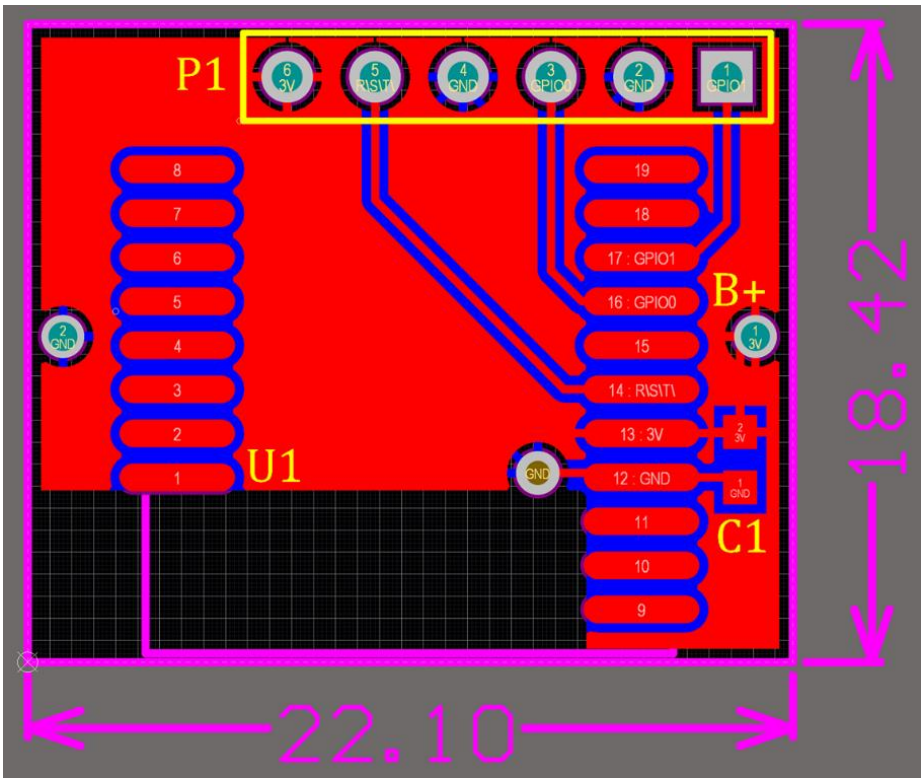
BILL OF MATERIALS

Component	**Supplier**
RFduino 22301	Obsolete – can be found on Alibaba
Printed Breakout Board	Printed via OSH Park
CR2032 Battery	Digi-Key (P666-ND)
6-pin PCB Header	Mouser (855-M22-2010605)
0.1 µF Capacitor	Digi-Key (1276-1004-2-ND)
LED1 (470 nm)	Mouser (720-LBT67CP2S135Z)
LED2 (625 nm)	Mouser (720-GRDASP123A5692)
28 Gauge Insulated Wire	Amazon (B01M7TA276)
Silicone Tubing (1.016 mm ID)	A-M Systems, Inc. (807300)
PDMS	Sigma-Aldrich (423785)
Kwik-Sil	World Precision Instruments
Solder Paste	Amazon (B017RSGPI8)
Lead-free Solder	Amazon (B01B61TWGY)
Wire-Wrapping Tool	OK Industries (WSU-30)
Implant Case Mold	3D Printed

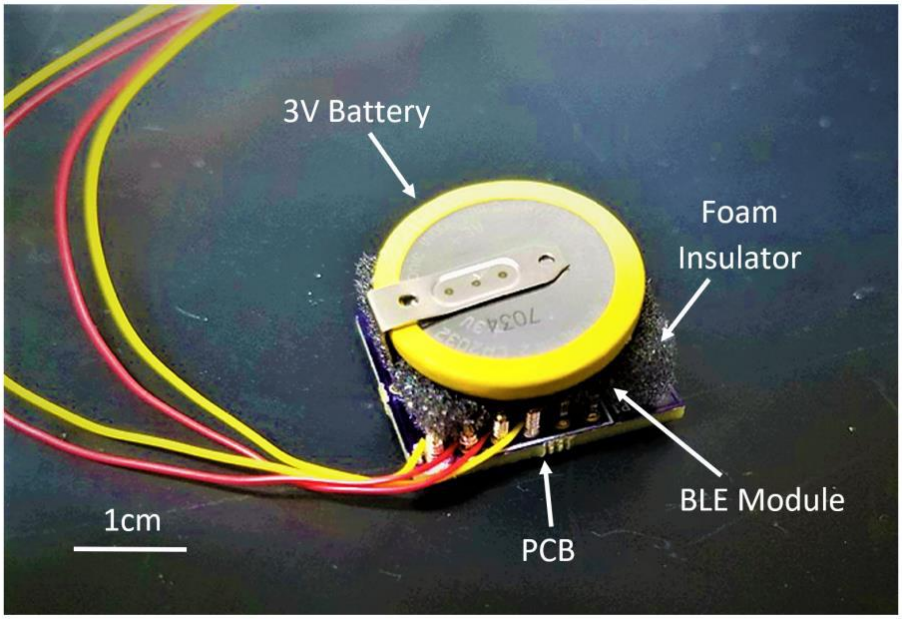
INSTRUCTIONS

CIRCUIT BOARD

Use unleaded solder paste and a vacuum pump to apply paste to all exposed copper pads. The pads are very small; therefore, the smallest tip should be used with the syringe. Using the smallest tip also means that the vacuum pump must be used to apply solder paste. Use fine-point tweezers to place the surface mount Bluetooth module and the capacitor on the board. Do not use a PCB oven to reflow the solder as the temperature may damage the BLE module. Instead, use a heat gun on a low temperature (< 300 ºC) or a regular soldering iron to melt the solder. With a soldering iron, place the tip onto each pad just long enough to melt the solder. To confirm successful fabrication, use a multimeter to ensure that the solder made contact will the appropriate SMD components, and more importantly, no pins on the BLE module are shorted together.



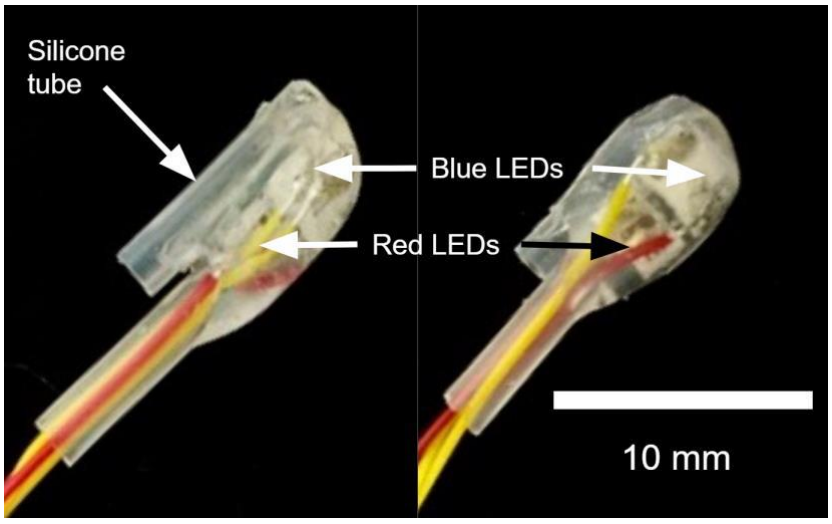
Following the PCB fabrication, solder the battery onto the PCB. The battery should be kept away from high amounts of heat to maintain its power capacity. Next, solder the six-pin-header to the PCB and trim off excess height from the bottom and top of the board not needed for attaching the LED wires.



During the implantation surgery, attach the nerve cuff to the rat's sciatic nerve. Use a wire wrapping tool to attach the LED wires to the wrapping posts on the PCB. Notice that the LED is polarized, and each lead must be attached correctly to either the power or ground post.

NERVE CUFF

Solder two 28-gauge wires onto each of the LEDs and place them through a 1 cm segment of silicone tubing to stabilize the wires. Adhere the light-emitting side of both LEDs to another 1 cm segment of silicone tubing with Kwik-Sil. Orient the wires parallel to the longitudinal axis of the tubing. Use Kwik-Sil to ensure full isolation of all electronic components. The cuff can then be wrapped around the nerve by slicing the outer layer of the second segment of silicone tubing longitudinally.



CASE

First obtain the mold and assemble the two shell components. To minimize leakage from the mold, hot glue the region where the two components meet. While applying the glue, ensure that the two components are pushed together tightly to promote a good seal. Once the glue is dry, wrap the mold securely with parafilm. The best way to wrap the mold is to first wrap transverse to the insert. After this is completed, wrap the mold again axially without the insert in the mold. The axial wrap will close off the hole for the insert, but it can easily be cut out. Next, mix a 1:9 curing agent to polymer ratio in a weigh boat or other disposable container. For the mold described in this paper, add roughly 5.4 mL of the polymer mix to the weight boat first. This material is very viscous, so use wide brim tips if available. Next, add 600 µL of the curing agent dropwise to the polymer. Mix the two components thoroughly, or until bubbles form. Pop larger bubbles, however, as to avoid vacancies in the cured case. Once this is done, transfer the mixture into the well formed by the two shell components. After the mixture is completely transferred, slowly slide in the mold's insert component. Leave the mold for 48-72 hours if curing at room temperature. Curing is faster at higher temperatures, so refer to the PDMS data sheet for a more descriptive list of curing times.