EmotiGlass Build Intructions

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Documents Referenced

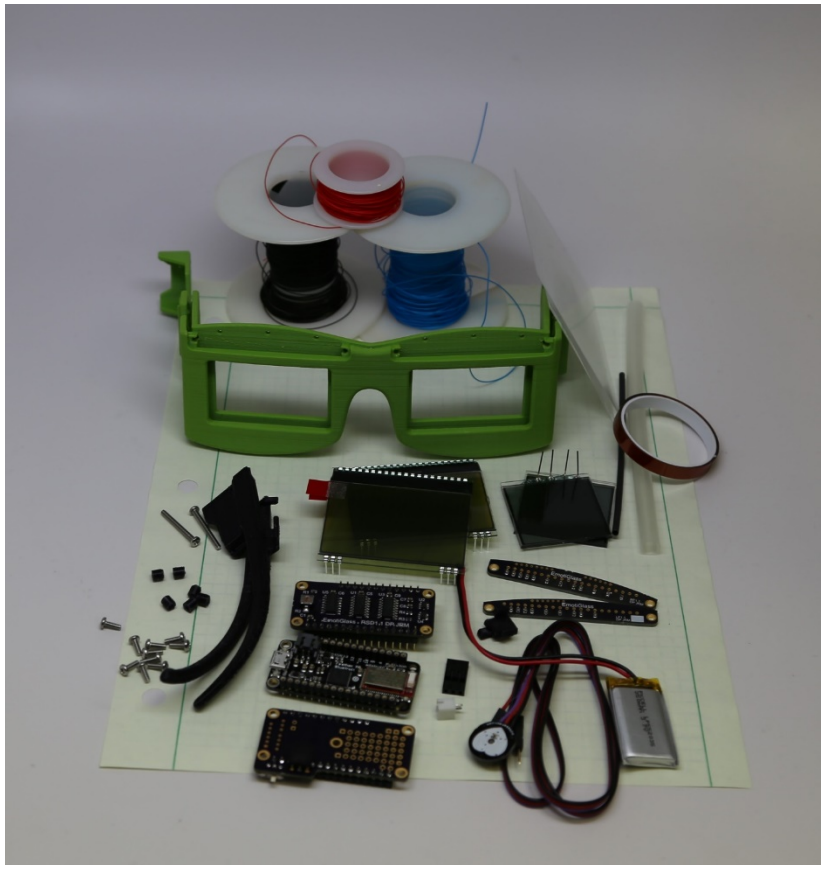
- Bill of Materials Rev 1.2
  - Contains listing of all components needed to build one EmotiGlass prototype
- PCB Drawings and Assembly Notes Rev 1.1
  - Contains diagrams and notes needed to assemble the EmotiGlass PCBs
- Wiring Info 1.2
  - Contains pinouts needed to wire together all components of the EmotiGlass prototype

This document contains instructions to build an EmotiGlass wearable prototype. Photos of most steps are included. Please gather the documents referenced above before proceeding.

All files and documentation can be found at https://hackaday.io/project/160615-emotiglass

Steps

Collect and Prepare Components



Order electronic components

All electronic components used are readily available from a number of retailers. For convenience, the BOM includes DigiKey part numbers – all components were in stock at the time of writing. Passive component values are not critical, so similar parts may be substituted.

Order PCBs

The PCBs were designed to be fabricated on a standard 1/16” (1.6mm) 2-layer process and were designed to meet typical design rules. They can be ordered from Osh Park or most other PCB fabricators. A zip file containing the Gerbers can be found on the project page. This file contains 4 zip files, each of which may be directly uploaded to the fabricator.

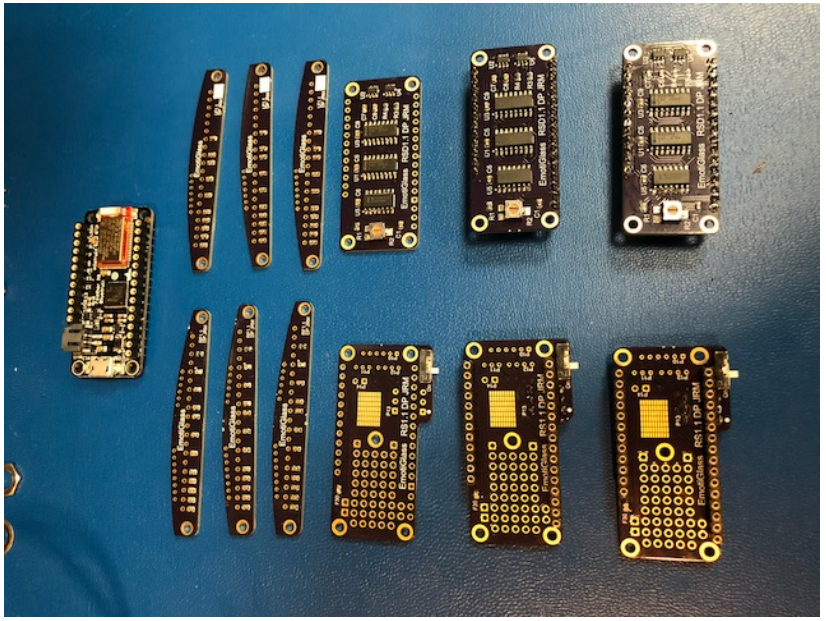
Gather tools and supplies

In addition to the components, some tools and supplies will be needed. These include:

- Safety Equipment
  - Safety glasses
- Supplies
  - Wire wrap wire (red, black, and one additional color preferably)
    - 30AWG with Kynar (PVDF) insulation is recommended (ex. DigiKey K394-ND)
  - Heatshrink – 1/16” for wires and (optional) 1/4” for
  - Kapton tape
    - Used to fix damaged wire insulation and for temporarily holding components
  - Hot Glue
- General assembly tools
  - Pliers,
  - Tweezers
  - Screwdrivers
    - Small Philips and flat head
  - Dental pick, wire director, or similar
  - Scissors
- Electronic assembly tools and supplies
  - Wire cutters and strippers
  - Soldering iron
  - Solder, flux, flux remover, solder wick
  - Solder paste (optional)
- 3D Print finishing tools
  - Xacto knife
  - Flush cutters
  - Sandpaper (180-320 grit works best)

Assemble PCBs

Refer to the “PCB Drawings and Assembly Notes” document for the details needed to assemble the PCBs. Components can be mounted using a standard soldering iron. If available, solder paste and a reflow oven may speed the process. The displays should not be mounted to the front left and front right PCBs until later in the process, but all other components should be installed. Photo below shows the assembled boards.



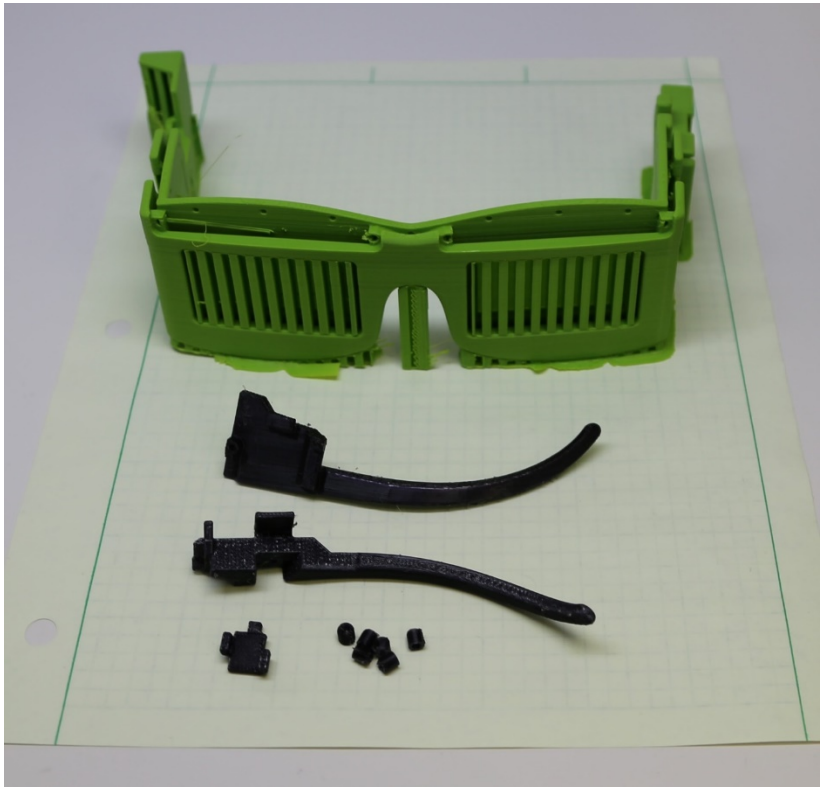
3D Print frame components

There are 5 unique 3D Printed parts in the EmotiGlass design. Most filament extrusion-type 3D printers with a common .4mm nozzle should be able to print these without issue.

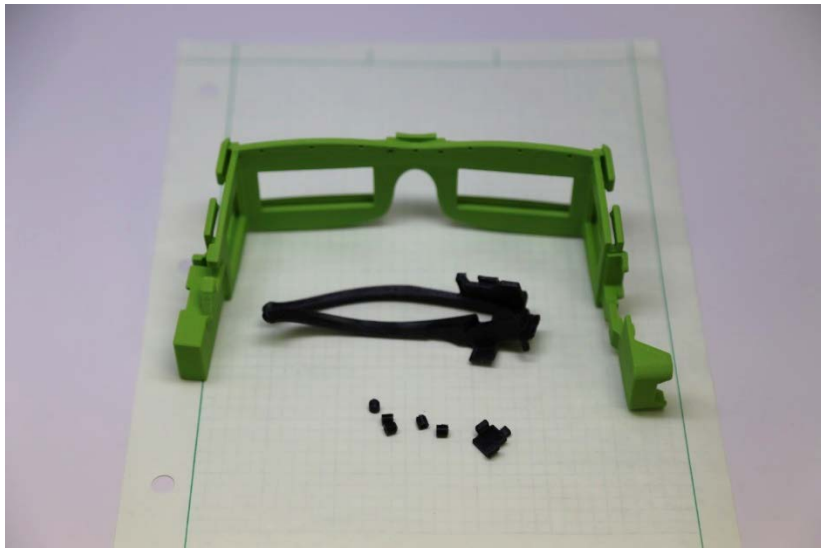
The frame is the largest piece, and should be printed from a stiff material such as PLA so that it can protect the glass components. The prototype in the pictures was printed in green Ultimaker PLA on an Ultimaker 2+. It is necessary to print with support material, and we suggest using a .4mm nozzle so that the support material can reasonably be removed. The prototype shown used .15mm layers, which work well for this part, although .1mm will give slightly smoother curves if print time is not critical.

The two side pieces should be printed from a less stiff plastic. The prototype shown used Taulman 645 nylon printed by a Cetus MK2, using a .4mm nozzle and .15mm layers. Other nylons or comparable materials should also work. Note that nylon must be dried before use for good print results.

The key and spacers can be printed from any convenient material. The ones shown below were printed in the same batch as the side pieces. I suggest printing extra spacers as they are tiny and easily lost.



The next step is to remove support material, strings, and brims/rafts from the printed parts. All of the parts other than the frame will require minimal cleanup. The frame will have a rough surface on the bottom curves, which can be cleaned up with a knife and some sandpaper. It is critical to remove all support material from the display grooves to prevent assembly problems.



Install Firmware and GUI

In order to test and control the EmotiGlass prototype, the Adafruit Feather will need to have the firmware installed, and the GUI will need to be installed on a phone or tablet. The firmware must be installed on the Feather before final electronic assembly.

Install Firmware

Firmware for EmotiGlass is loaded via the Arduino IDE. Besides the standard libraries available to the Arduino v1.8.2 IDE, support libraries for the Adafruit Feather M0 Bluefruit LE need to be installed. Detailed instructions are available at: https://cdn-learn.adafruit.com/downloads/pdf/adafruit-feather-m0-bluefruit-le.pdf

The driver library for the LCDs also needs to be installed. Download and unzip the package from: https://www.lcd-module.com/fileadmin/downloads/development%20service/Arduino/Arduino%20meets%20EA%20DOGM132-5%20DOGM128-6%20DOGL128-6.zip. After that, follow the instructions available at: Arduino meets EA DOGM132-5 DOGM128-6 DOGL128-6\Documentation\ReadMe.pdf.

After that, install the source files for EmotiGlass from https://hackaday.io/project/160615-emotiglass) and compile/verify. Make sure that the board selected under the Arduino IDE's "Tools" is "Adafruit Feather M0." Select the serial port assigned to your board and upload the compiled firmware.

Install GUI

The GUI files may be downloaded from the project page. For Android only, a compiled application may be installed. For Android or iOS, the GUI may be installed via Evothings Studio

Android App Install

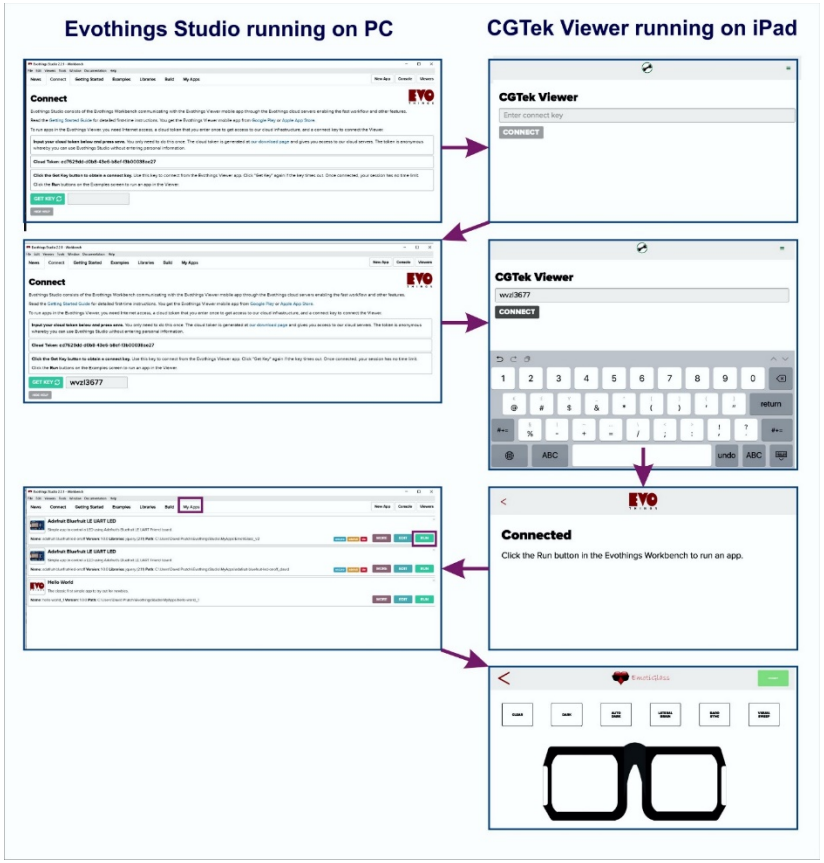
Open the file manager on any Android device that supports BLE and install the EmotiGlass.apk.

Evothings Studio PC Install

Evothings Studio 2.0 needs to be installed on a computer used if using an iOS device or developing the APP. Windows, Mac OS X and Linux installers are available for free at: https://evothings.com/download/. A starter guide is available at: https://evothings.com/doc/starter-guides/evothings-studio-starter-guide.html.

After installing Evothings Studio, a new project named "EmotiGlass" should be started, and the unzipped contents of EmotiGlassGUI.zip copied into the project's directory.

Evothings Studio and the Evothings player then need to be connected. This is done by getting a key and sharing it with the app as shown in the following imade. The BLE-enabled device running the client should be able to control EmotiGlass without any further setup.



Evothings Studio iOS Install

Install the free CGTek Viewer app from the App Store, and load the GUI through Evothings Studio.

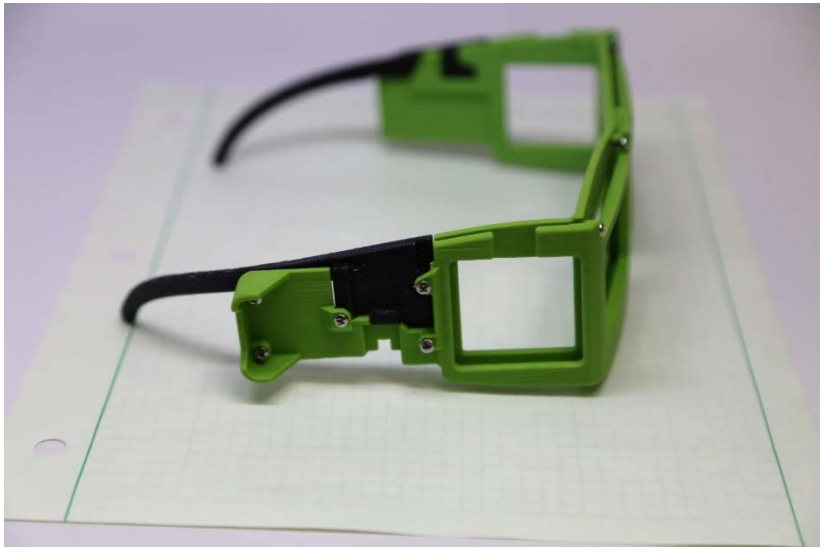
Evothings Studio Android Install

Download and install Evothings Viewer from the Google Store

Wearable Prototype Assembly

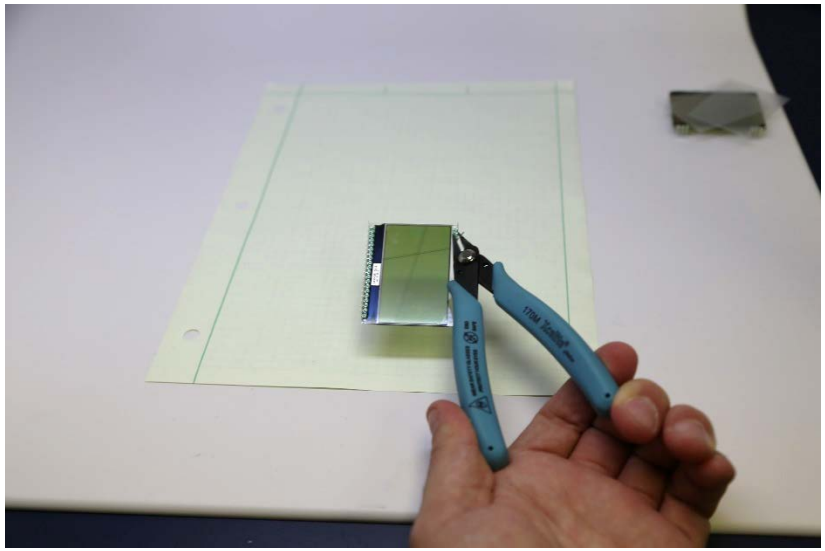
Pre-assemble Frame

After the 3D printed parts have been finished, the threads need to be cut for the screws, which should be done before any electronics are installed. In these parts, it is sufficient to simply let the screws cut their own threads when initially installing them. Unless specified, use either #2-56x1/4” or M2x6 screws. Be careful to keep the screws straight during the initial installation. This is also a good time to check the fit of the side pieces into the frame. After this is complete, remove all screws.

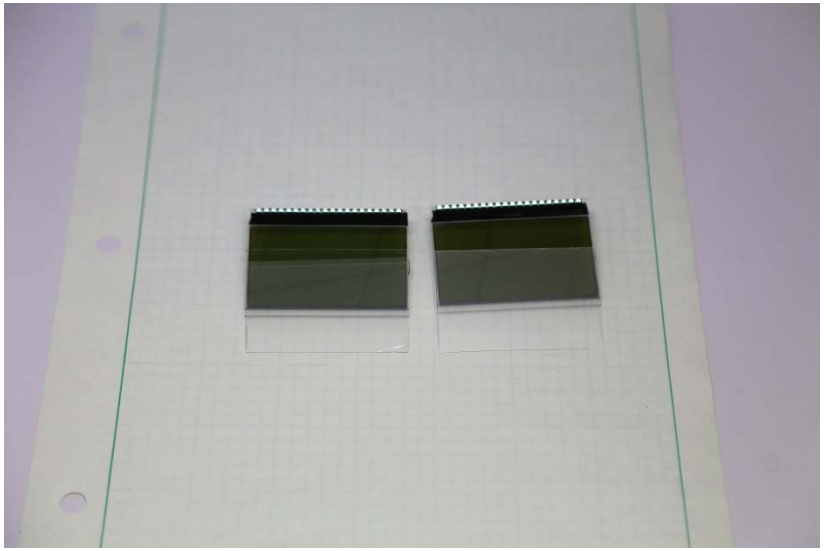


Prepare Front Displays

Some of the pins on the LCD Displays need to be removed (pins 1-3 and 18-20). These pins were installed by the manufacturer by crimping them onto the base glass and then putting some potting compound over them. To remove, they can be bent away from the display and then any excess potting compound can be scraped off. A wire cutter can be used for this. One of the cutting edges is inserted under edge of the metal pin, and the cutter is closed only enough to keep it in place as the cutter is rotated to bend the pin away from the glass. Be careful!



After the displays have had the bottom pins removed, cut pieces of polycarbonate film to match the size of these displays. Also cut pieces to match the side LCD shutters (not shown in photo). This film is intended to provide extra protection to the wearer in case the displays are somehow broken while the device is being worn.

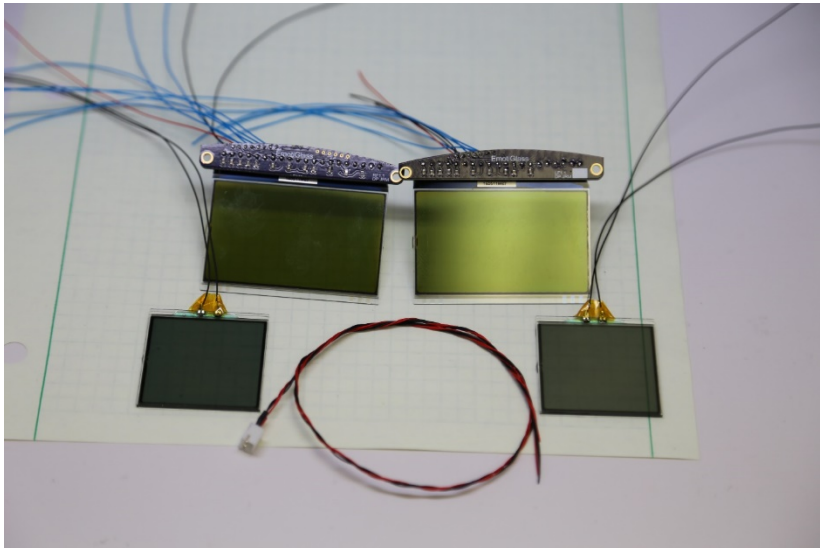


Complete front PCB assembly

Next, install the displays and the polycarbonate film into the frame. The film should be on the inside (wearer side) of the displays. The front PCBs can then be installed and screwed into place. Once the front PCBs are secured, the display can be soldered into the board. The spacing between the PCB and display is critical, so it must be assembled in place. Once the displays are soldered to the PCBs, remove the complete assemblies from the frame.

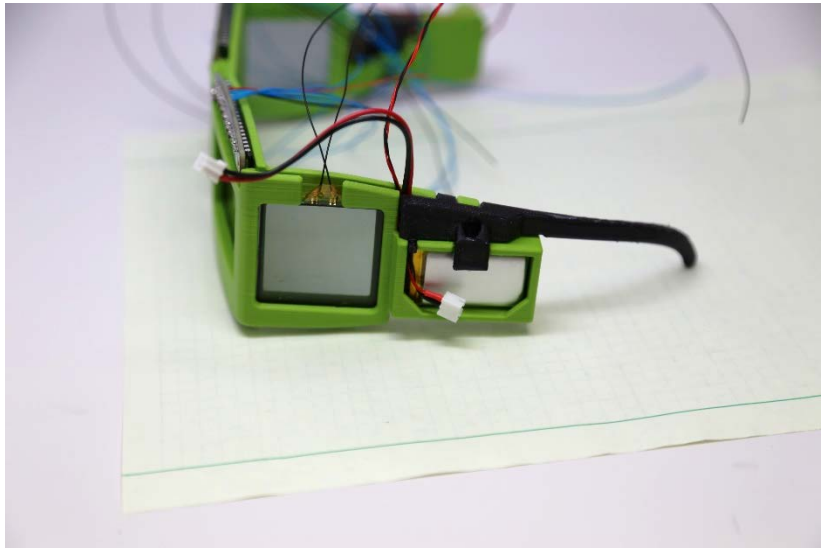
Pre-wiring

Next, attach wires to the side shutters and to the headers which send wires towards the right side (P20 and P30). The wires should exit the rear of the PCBs as shown. Be sure that the insulation comes close enough to the boards to prevent shorts. You may want to put some Kapton tape on the connections for the side shutters. The battery pigtail can also be assembled at this time by attaching wires to the male JST connector. Be sure to leave a lot of extra length on the wires. The battery connections and board to board ground connections should be doubled or use thicker wire. The battery pigtail should be twisted together.



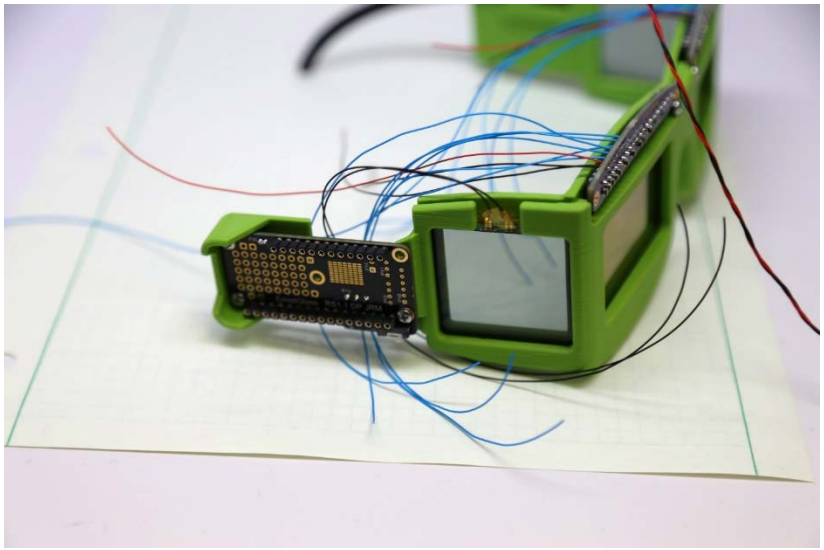
Install components in frame

The battery should be installed with the lead proceeding up the channel provided in the frame. Install the left side piece, being careful not to pinch the battery wire. The pigtail can also be routed down this channel to place the connection point in front of the battery. Do not plug in the battery yet. (Note: the frame was designed for the battery to be hard wired, but we are leaving it connectorized until thorough testing is complete so we can easily unplug it if we have any issues.)

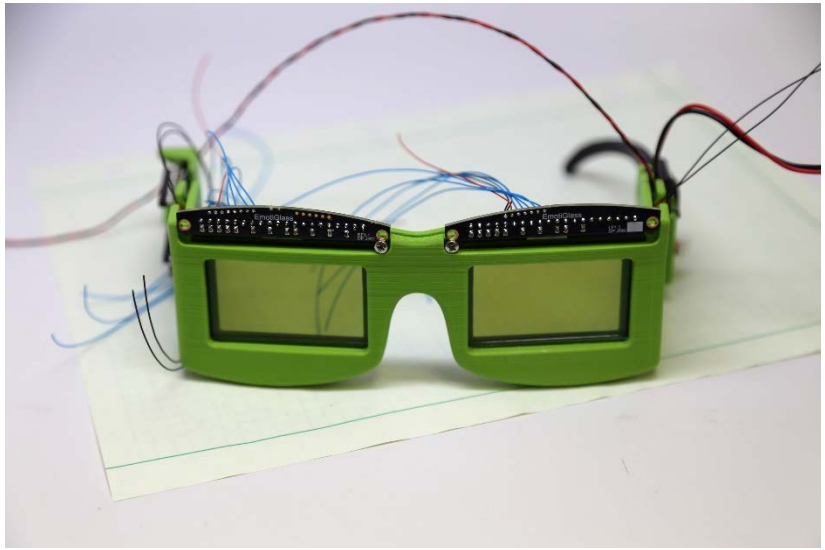


The side shutters now can be installed. The protective film on the shutters and on the polycarbonate film will need to be removed before they are installed. Be sure to clean the faces of the shutter and film that touch each other as they will not be accessible after assembly. It is helpful to use a screwdriver to pull the edge of the frame locking tabs forward slightly during the installation.

The right side PCB can also be installed. It should be installed with 3 screws as shown. Once wiring begins, this PCB should not ever be removed from the frame. The frame provides access for wiring when the right side piece is not installed.

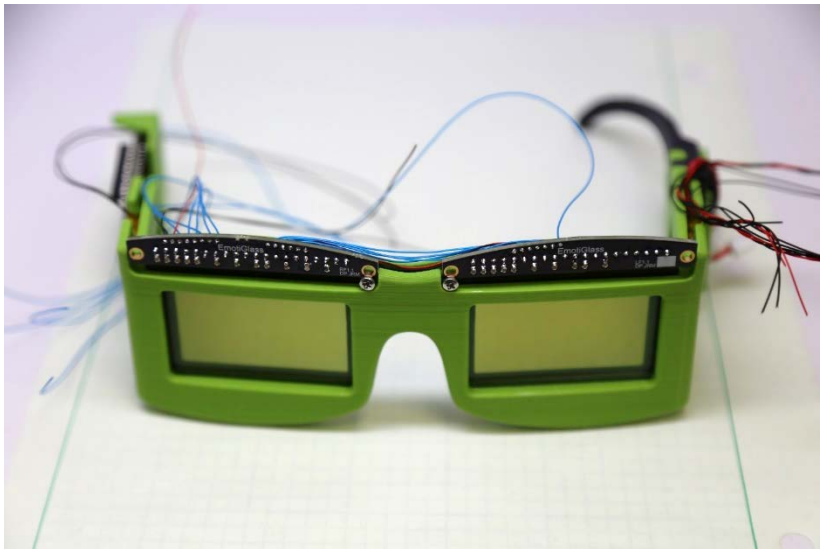


The front displays should be installed, but should remain slightly above their nominal positions. They can be rested on a screw placed in one of the mounting holes (this can be tightened to hold these PCBs in place if needed)

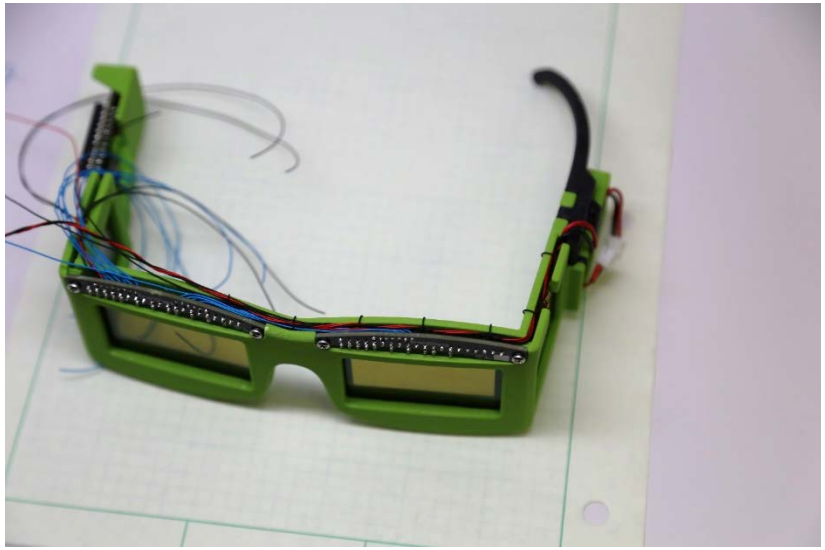


Wiring

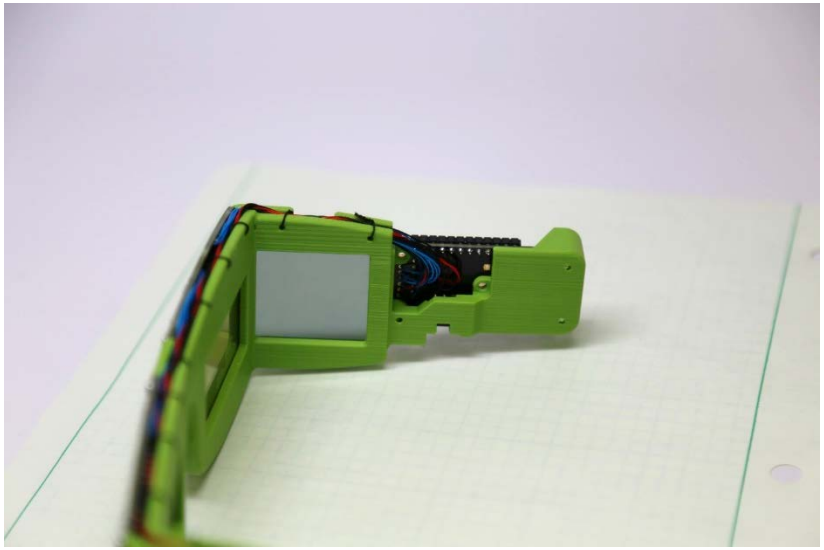
Begin wiring by making the connections between the two front PCBs. Reference the wiring info diagram for connection info.



Once these connections are complete, the front PCBs may be dropped into their final positions and secured with their mounting screws. Next, dressing of the wires can begin. A number of holes are provided thorough which a tie can be installed. The prototype used offcuts of wire wrap wire for the ties, but thread of twine would probably work even better. Starting from the end with the battery, dress the wires into the groove and secure. A tool such as a wire director or dental pick or similar (a bent tiny screwdriver could also work) is extremely helpful for manipulating the wires. We suggest not tying around all wires, but rather letting some wires remain below the tied bundle and only tying around the battery lead and a few additional wires as needed.

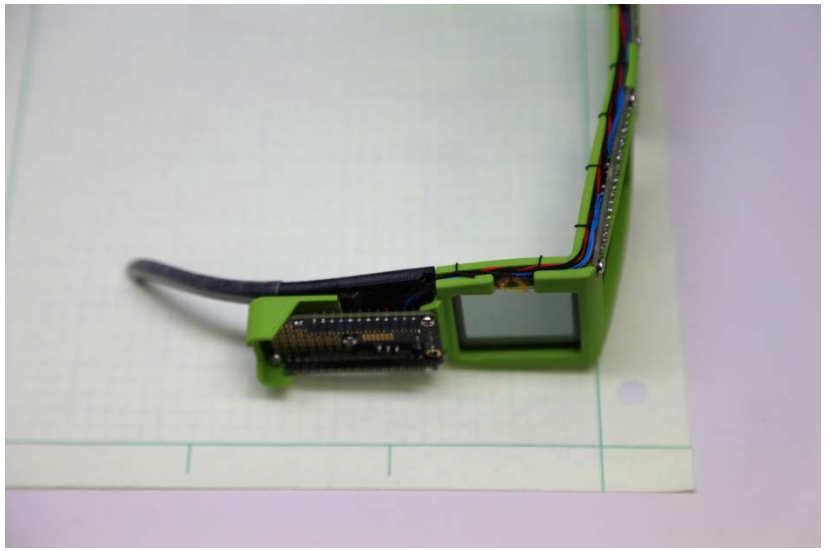


Finish the wiring by trimming all of the wires and soldering them into the headers in the right side PCB. After that, finish dressing the wires.



Complete frame

Next, the right side piece can be installed. Be careful not to pinch any wires. The right side piece is secured by two screws. After installing the side piece, remove the screws in the top left and bottom right positions.

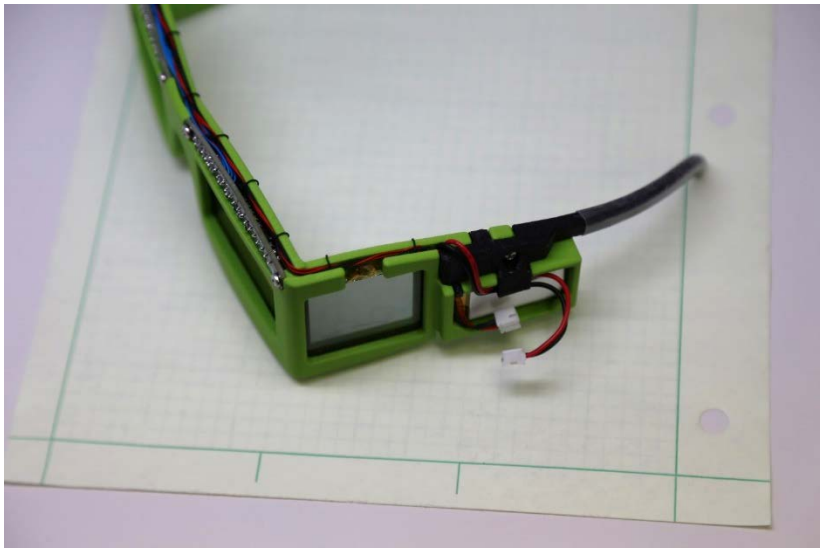


PCB Stack assembly

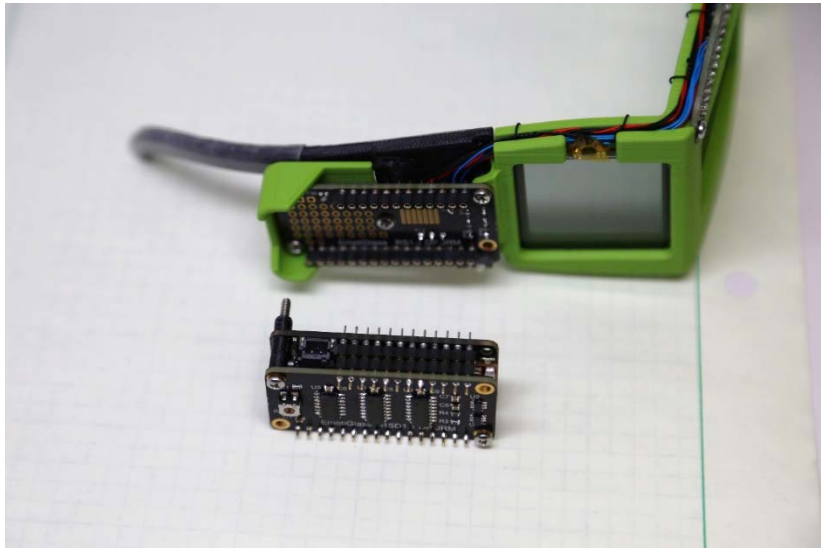
Before proceeding ensure that:

1. The Feather has been flashed with EmotiGlass firmware

2. The battery is still unplugged

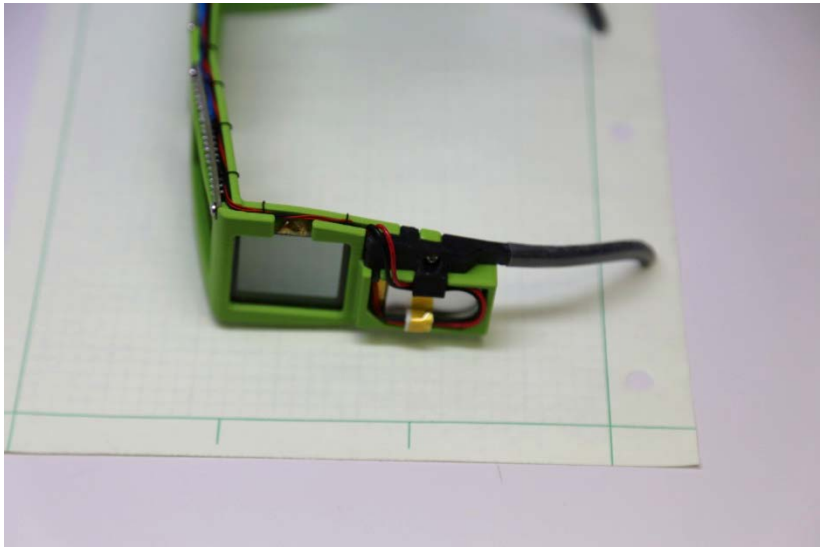


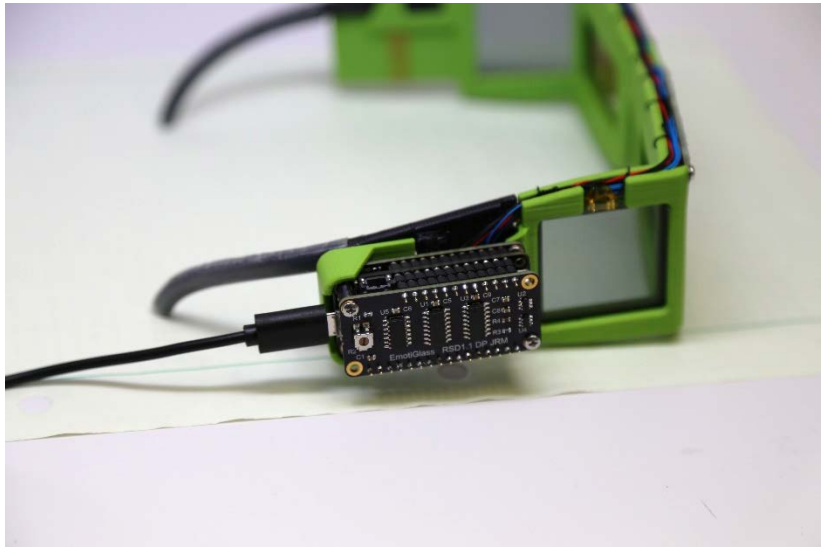
The Right Side Dev PCB stacks onto the Feather, which stacks onto the Right Side PCB. Initially, these can be plugged together for testing. Once complete, 2 #2-56x7/8” secure the stack. 2 of the 3D printed spacers go between the top two boards, and 1 goes between the lower two boards (on each screw).



Power on

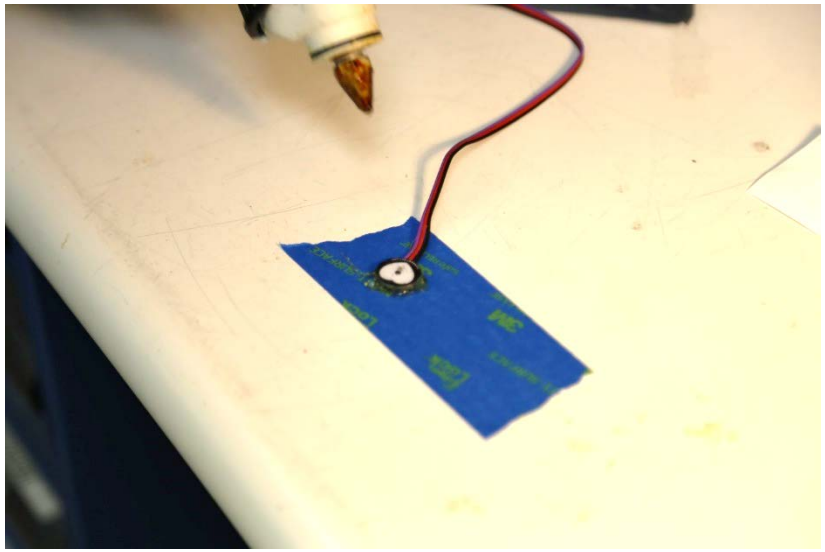
Before powering on, measure the resistance between the two terminals of the battery connector to ensure there is no short. EmotiGlass can be powered via a USB connection or from the battery (USB power will charge the battery when both are connected). If a current-limited power supply is available, it is best to initially power the device from that. This is a good point to test basic functionality (connect the GUI via Bluetooth and click ‘Dark’ and ‘Clear’). The battery connector can be held to the battery with a piece of tape as shown.



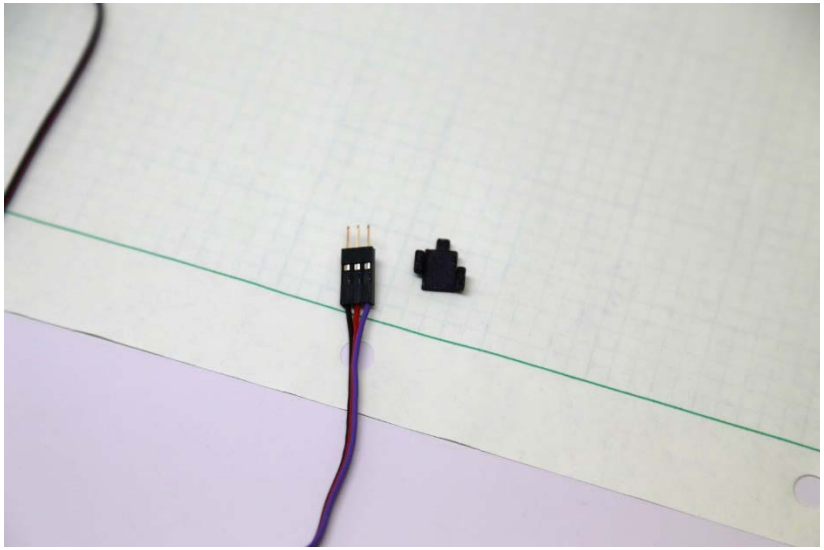

EmotiGlass
RSD1.1 DIP_REV

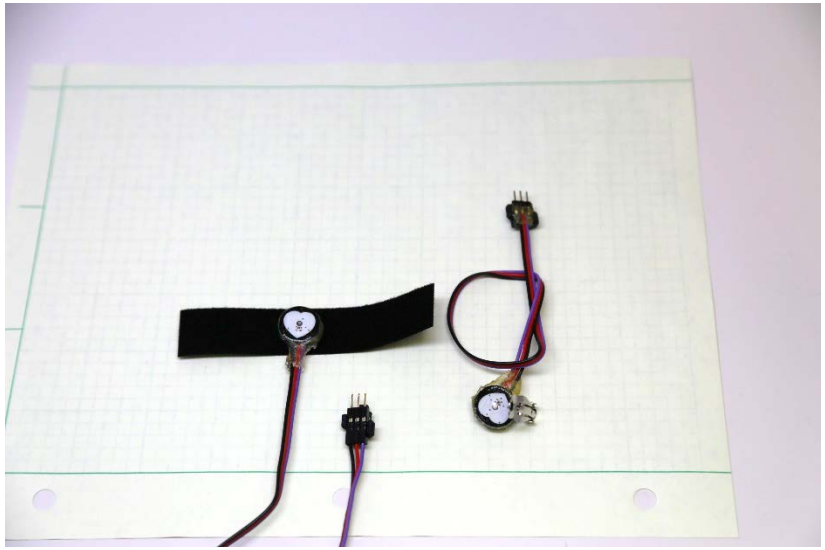
Assemble Pulse Sensor

EmotiGlass uses an open-source plethysmography sensor from pulsesensor.com (see site for more information). This sensor can be hot glued to an ear clip, Velcro finger strap, or other mounting arrangement. Following the suggestions of the manufacturer, the sensor is encapsulated in hot glue as part of the mounting.



Lastly, a 3D printed key is added to the connector to prevent the sensor from being inserted backwards, which may damage the circuitry. Remove the three single pin connector housings, and replace with the 3 position connector housing (pins in same order as cable, black is pin 1). Then, with pin 1 (black) to the left, glue the key piece underneath the connector (see photos). The front face of the key should sit flush or slightly behind the front of the connector housing. If you desire to trim the cable and don't have the crimp on pins available, the wire can be soldered to 3 positions of a standard header strip, which can then be glued to the key. Both options are shown in following photos.





Complete EmotiGlass

Plug the pulse sensor in and the EmotiGlass wearable prototype build is complete.