

# Remo<sup>2</sup>hbo Soldering, Programming, and Assembly How-To for all Sensor Hardware Components



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# HOW-TO SOLDER

To prepare a part for soldering, check how it will fit through the circuit board. This means that you might have to bend its metal attachments to fit through the correct holes as shown in Figure 1:

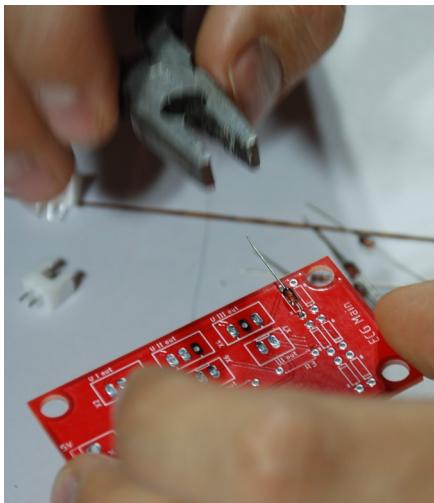


Figure 1: bend to fit

Then, bend the metal attachments to make the part stay in place as shown in Figure 2, 3, and 4:

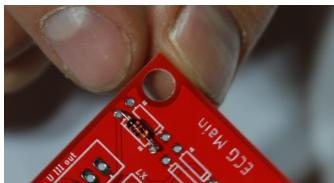


Figure 2: bend to stay



Figure 3: bend to stay



Figure 4: bend to stay



Now you can clip off the excessive metal as shown in Figure 5:



Figure 5: clip off

Now solder the pieces in place using a soldering iron and lead-free tin as shown in Figure 6:

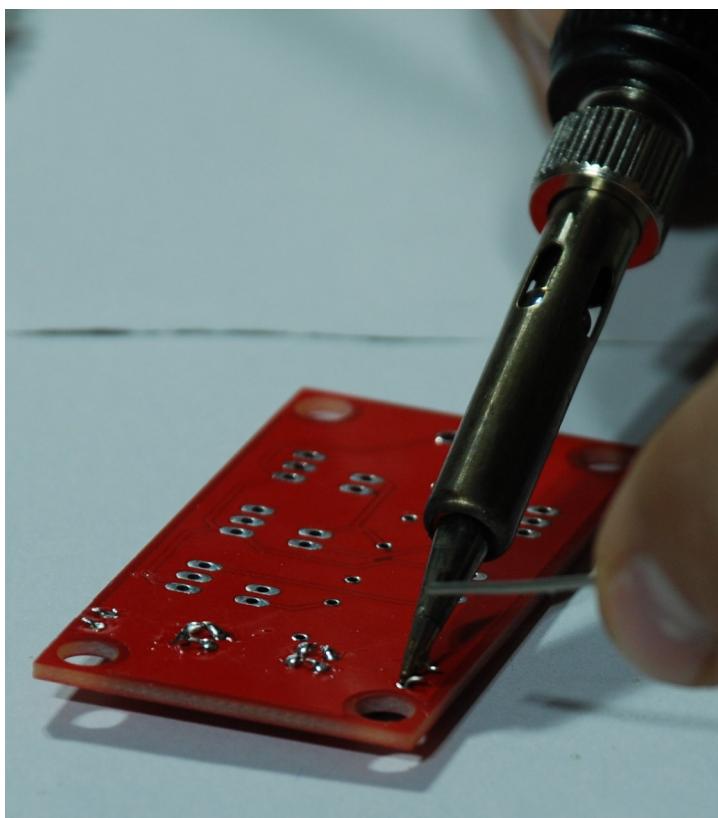


Figure 6: solder



# HOW-TO PROGRAM THE MICRO-CONTROLLERS

## Programming the ATMEL Micro-controllers of the Heart Rate & ECG and PTT boards

In order to program the micro-controllers, you need an Arduino Uno and a computer with Microsoft Windows or a Linux operating system. This guide is based on a tutorial available online at <https://www.arduino.cc/en/Tutorial/ArduinoToBreadboard>.

Once the micro-controllers, the 16 MHz crystal, the 10k resistor, and two 18 to 22 picofarad (ceramic) capacitors are mounted to the soldered board, attach the Arduino Uno to the board as shown in Figure 7

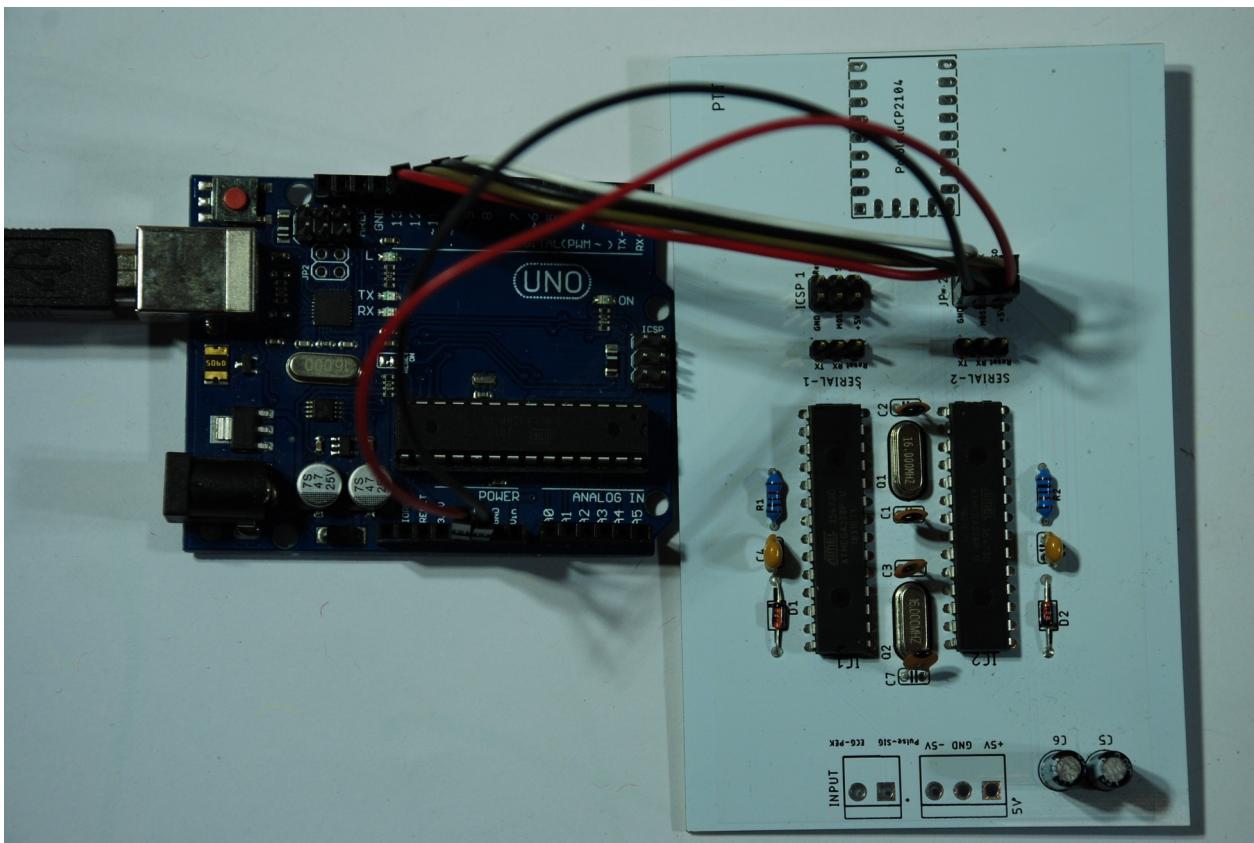


Figure 7: attaching the Arduino Uno to the board for burning boot loader



*Side note: using a Linux OS*

If you are using a Linux computer, make sure that you are using the LATEST Arduino IDE, i.e. Arduino 2.

Even so, you have to add your user to the group that has access to the port that is talking to the Arduino when you attach it to your computer via USB. To do this, attach the Arduino. Open a terminal, and enter the following:

```
$ sudo usermod -a -G tty [USERNAME]
```

```
$ sudo usermod -a -G dialout [USERNAME]
```

*dialout is the usergroup that has access to the port (port /dev/ttyACM0)*

Now change the attachments between Arduino Uno and Board to program the ATMEL as shown in Figure 8:

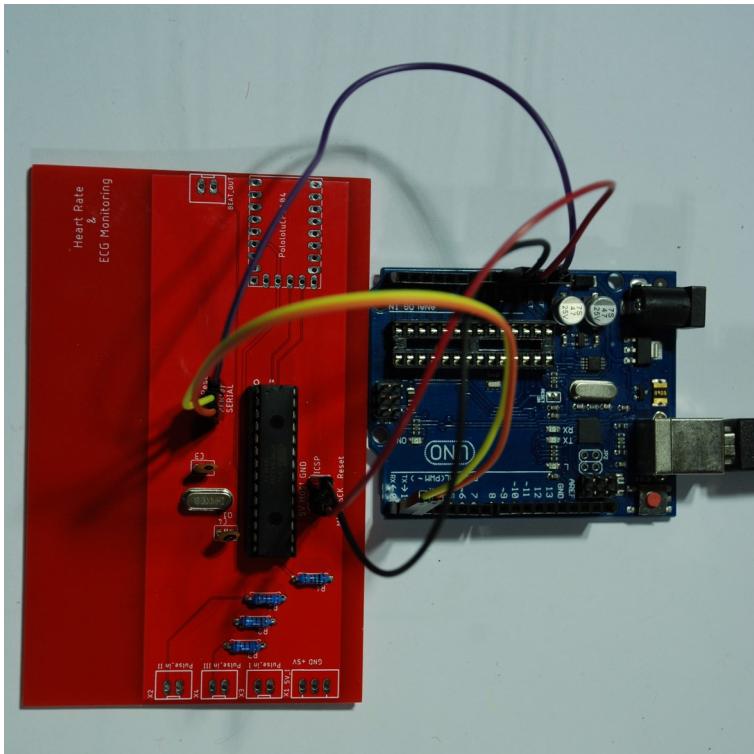


Figure 8: attaching the Arduino Uno to the board for programming



OR

Attach the ATMEL micro-controller to the controller socket DIP28 on the Arduion Uno and program.

First, try to upload a basic "Blink" program to the Arduino. You can find this in "File" >> "Examples" >> "01. Basics" >> "Blink"

*Side note: ATMEL micro-controller on PTT Board*

*For the PTT board, you have to use a Microsoft Windows OS with ATMEL Studios as the files for the PTT board are a ATMEL Studios project stored in the github repository ([https://github.com/cadus/Vital-parameter-modules/tree/master/Source\\_codes/SPO2](https://github.com/cadus/Vital-parameter-modules/tree/master/Source_codes/SPO2)).*

*Also, use these instructions <https://cutmywire.wordpress.com/2013/07/21/arduino-und-co-mit-atmel-studio-nutzen/> to add functionalities to ATMEL studios that you need.*



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## CIRCUIT BOARD ASSEMBLY

The Remo<sup>2</sup>hbo patient monitor consists of an ECG, heart rate, temperature, blood oxygen saturation through pulse oximetry, and blood pressure monitors. For these values, we require a total of 10 circuit boards that filter signals, send signals, or provide adequate power. The [Biosignal Circuit Boards Repository](#) contains a list of these including links to a few online stores most of which are located in Germany.

The end of each section of each board contains a larger PDF schema of the board. This is included as it is searchable. The searchability may be helpful to find where small parts are located on each board.



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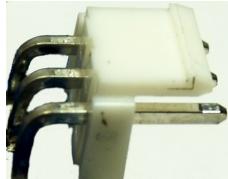
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# POWER SUPPLY

Parts:

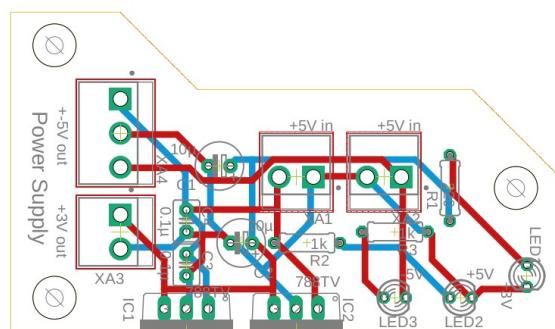
Description	Image	Number of parts
Power supply printed circuit board		1
220 Ohm resistor		1
1 K Ohm resistor		2
10µ capacitor		2
0.1µ capacitor		2



3.3V voltage regulator TO220 LF33		2
LED 3mm		3
JST B3P VH plug		1
JST B2P VH plug		3

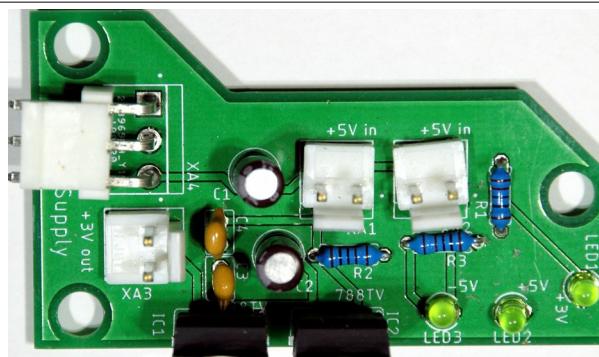


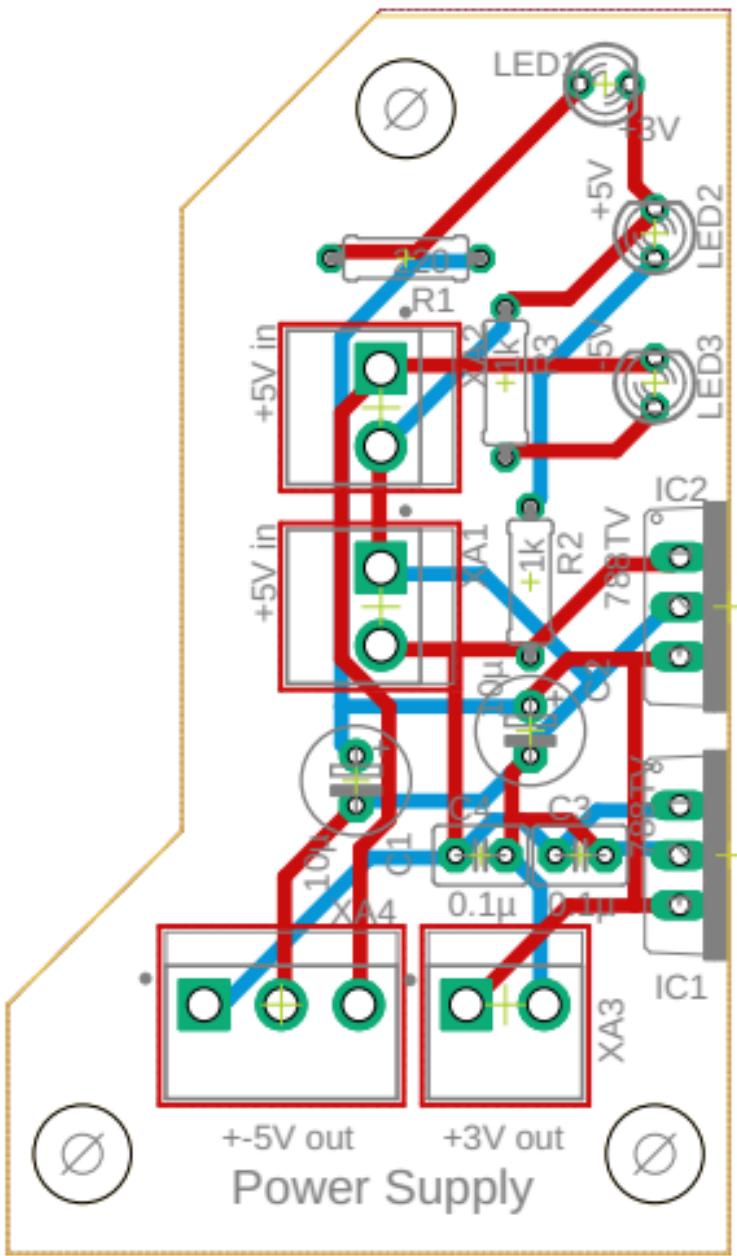
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See enlarged PDF at the end of the section for searchable version of schema

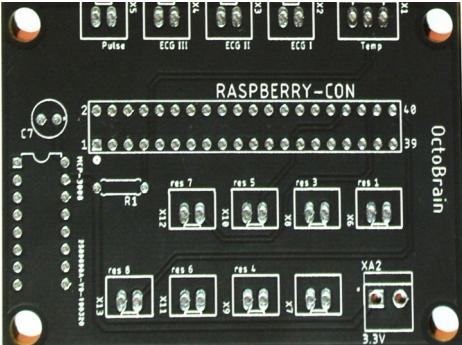
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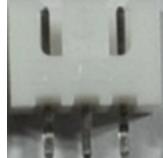


# OCTOBRAIN

Parts:

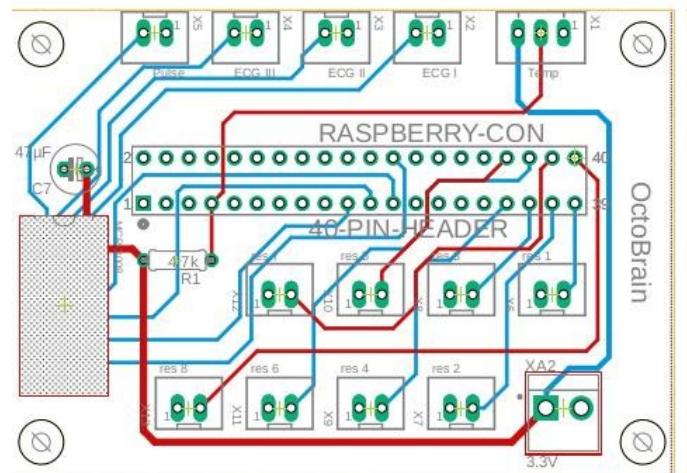
Description	Image	Number of parts
Octobrain printed circuit board		1
4.7 K Ohm resistor		1
47µ capacitor		1
A-D converter MCP-3008		1
2x20 pinhead		1



JST XH 02 plug		12
JST XH 03 plug		1
JST VH2P or JST B2P VH plug		1

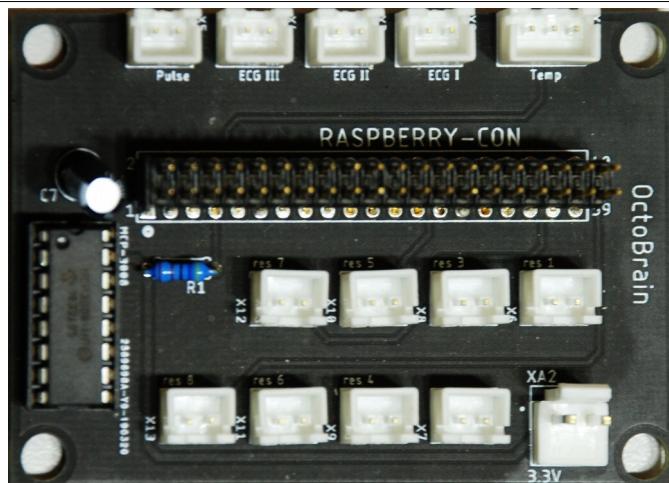


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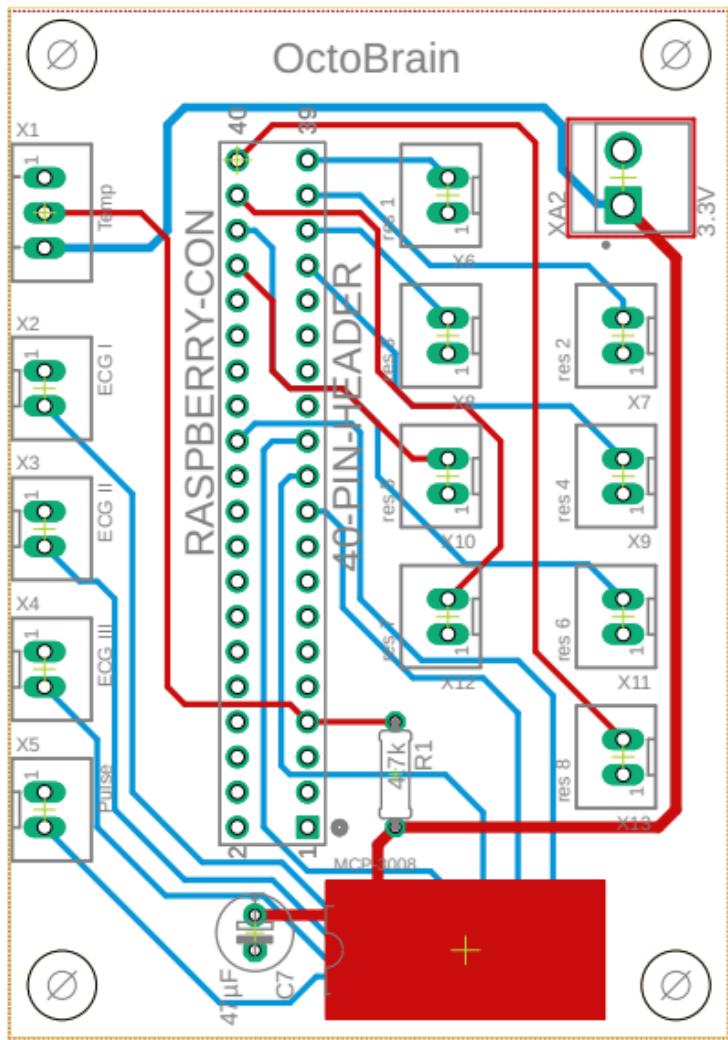


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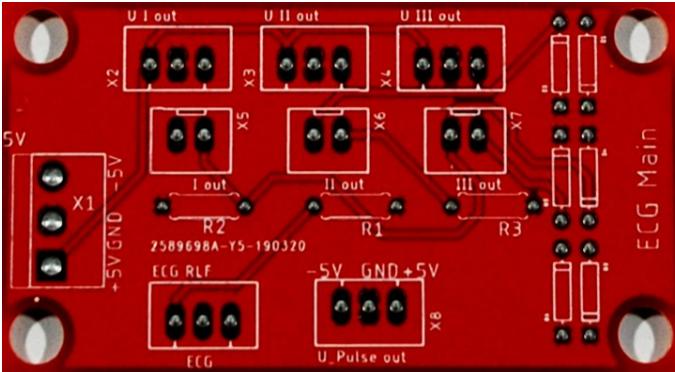
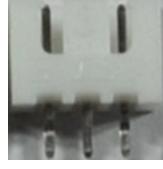


# OctoBrain



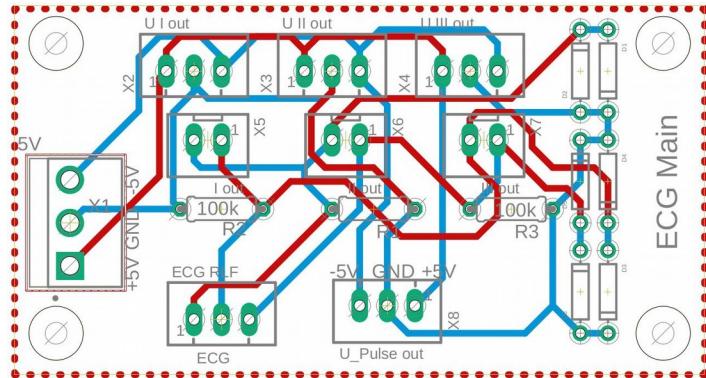
# ECG MAIN

Parts:

Description	Image	Number of parts
ECG main printed circuit board		1
100 K Ohm resistor		3
1N4148 Diode		6
JST XH 02 plug		3
JST XH 03 plug		6

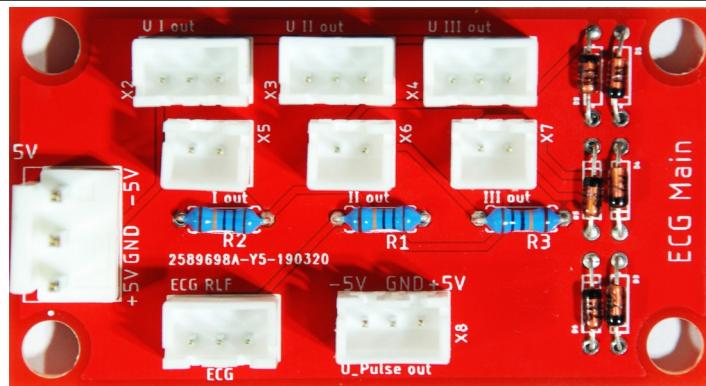


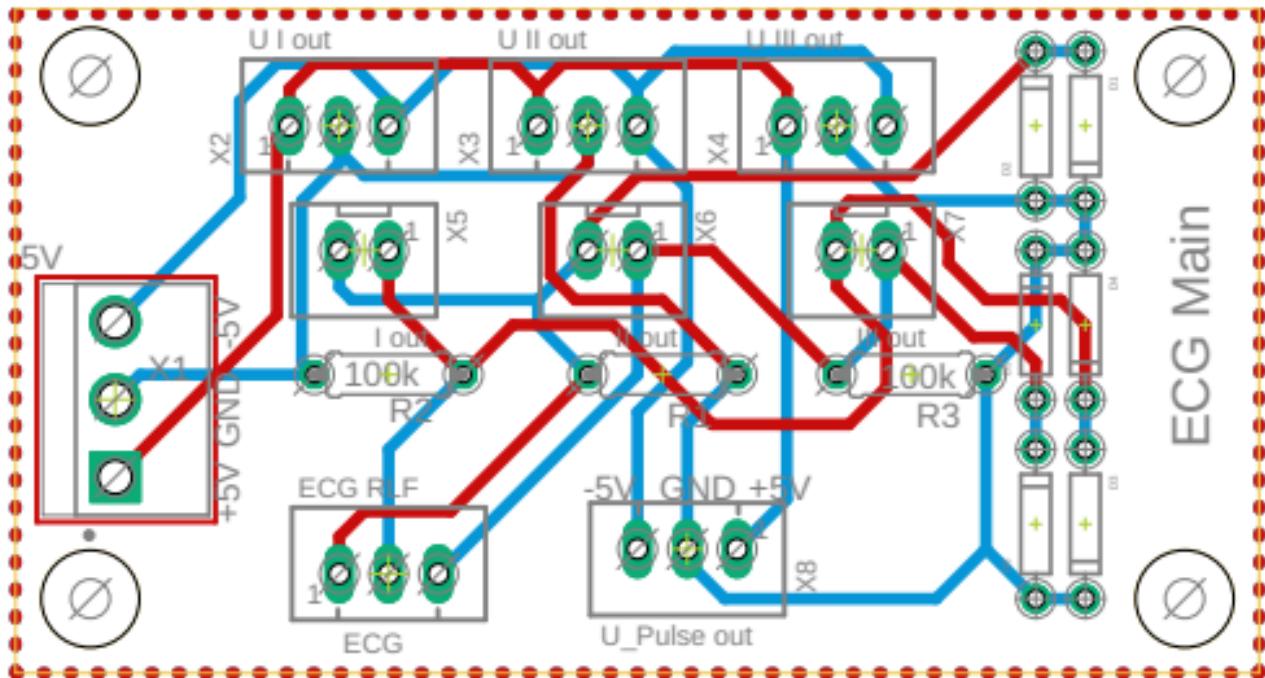
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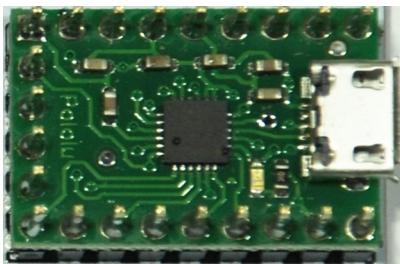
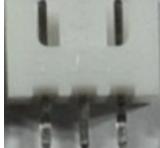


# ECG HEART RATE & MONITORING

Parts:

Description	Image	Number of parts
ECG heart rate & monitoring printed circuit board		1
22 K Ohm resistor		3
10 K Ohm resistor		1
22p capacitor		2
DIL28 socket for ATmega 328P		1
ATmega 328P		1



16MHz crystal		1
USB to serial - Pololu CP2104		1
JST XH 02 plug		3
JST XH 03 plug		1
1x3 pinhead		1

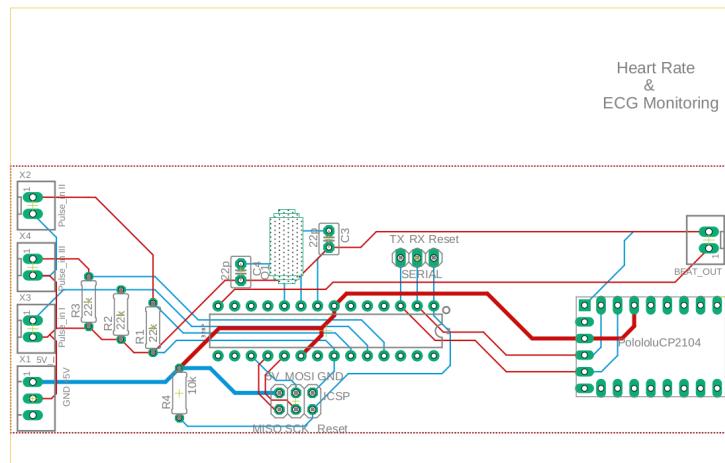


2x3 pinhead



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Schema



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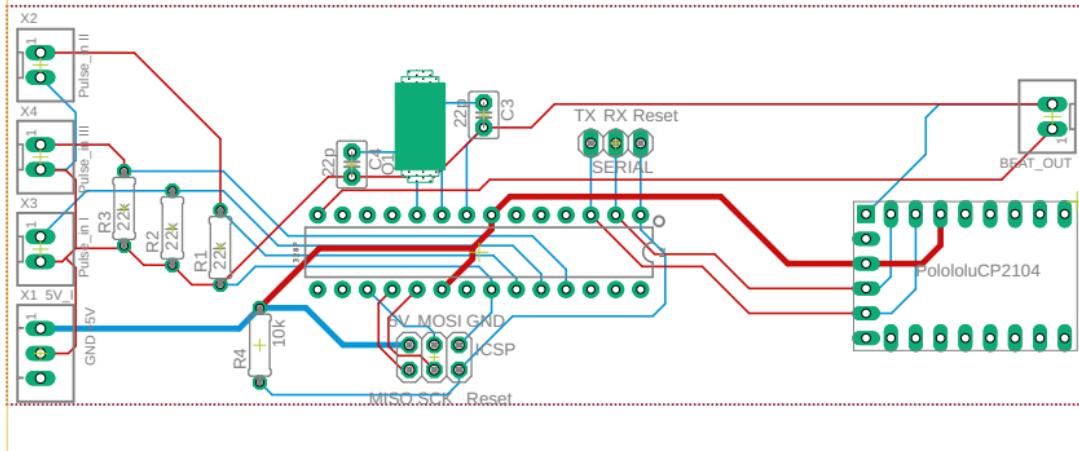


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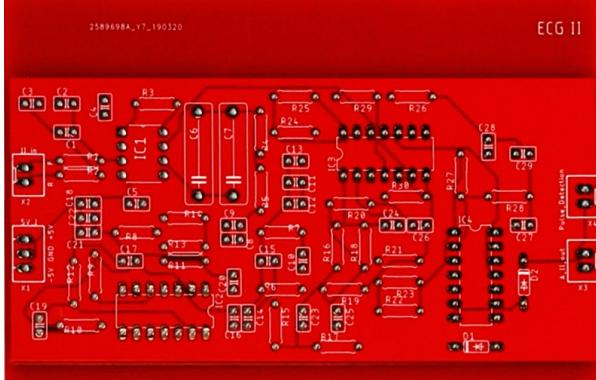
## Heart Rate & ECG Monitoring



## ECG I, II, III

All are identical!! This indicates the number of parts for one of the ECG units.

Parts:

Description	Image	Number of parts
ECG I, II, or III printed circuit board		1
100 K Ohm resistor		3
330 Ohm resistor		1
8.2 K Ohm resistor		1
10 K Ohm resistor		7
22 K Ohm resistor		1
27 K Ohm resistor		4



33 K Ohm resistor		1
47 K Ohm resistor		3
390 K Ohm resistor		1
500 K Ohm resistor		2
1 M Ohm resistor		8
2.2p capacitor		2
10p capacitor		1

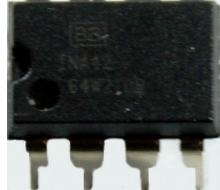


100p capacitor		1
150p capacitor		2
470p capacitor		2
680p capacitor		1
1.5n capacitor		5

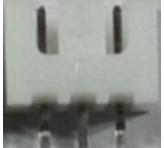


2.2n capacitor		2
4.7n capacitor		2
15n capacitor		2
33n capacitor		1
68n capacitor		3
100n capacitor		1



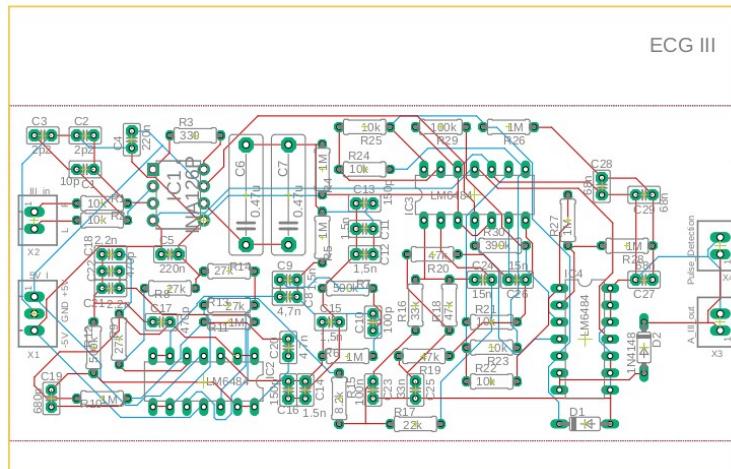
220n capacitor		2
0.47μ capacitor		2
1N4148 Diode		1
1N5819 Schottky diode		1
INA126P instrumentation amplifier		1
DIL8 socket/base for INA126P		1
LM6484 Quad OP Amp		3



DIL14 socket/base for Quad OP Amp		3
JST XH 02 plug		3
JST XH 03 plug		6

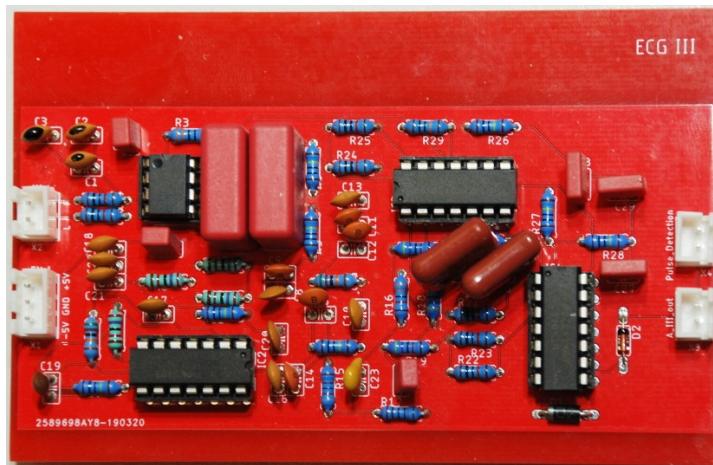


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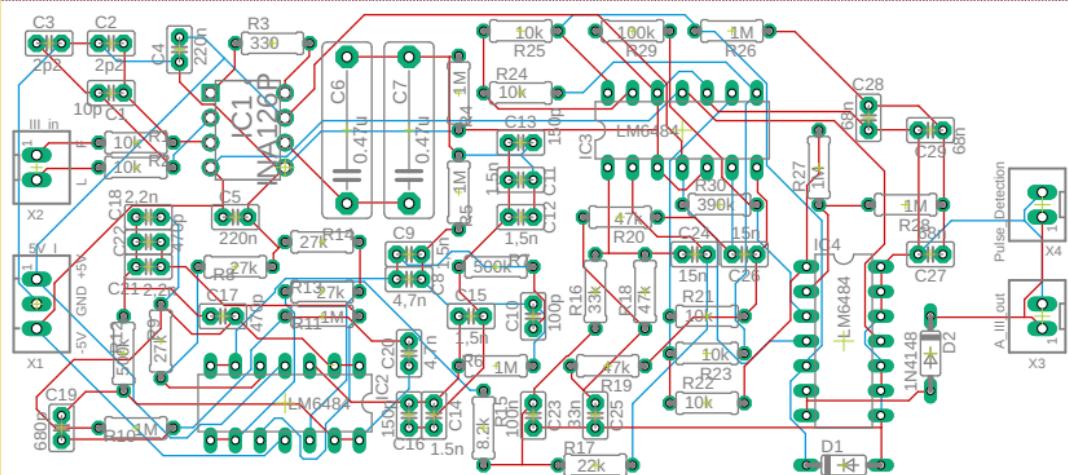


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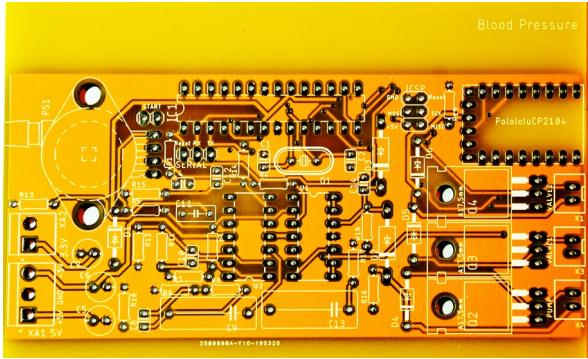


### ECG III



# BLOOD PRESSURE

Parts:

Description	Image	Number of parts
Bloodpressure printed circuit board		1
1.5 K Ohm resistor		1
10 K Ohm resistor		2
22 K Ohm resistor		1
100 K Ohm resistor		8
220 K Ohm resistor		2
1 Meg Ohm resistor		2

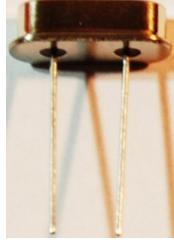
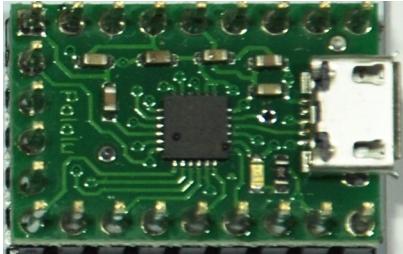


1.5 Meg Ohm resistor		1
22p capacitor		2
10n capacitor		1
100n capacitor		2
220n capacitor		2
330n capacitor		1



680n capacitor		1
1μ capacitor		1
47μ capacitor		3
1N5819 Schottky diode		2
1N4148 diode		4
ATMega 328P		1
OWN_MPX53GP pressure sensor		1



16MHz crystal		1
IRF540 To220 transistor		3
LM6484 Quad OP Amp		1
MCP6024 Quad OP Amp replaced with TLC2264		1
USB to serial - Pololu CP2104		1



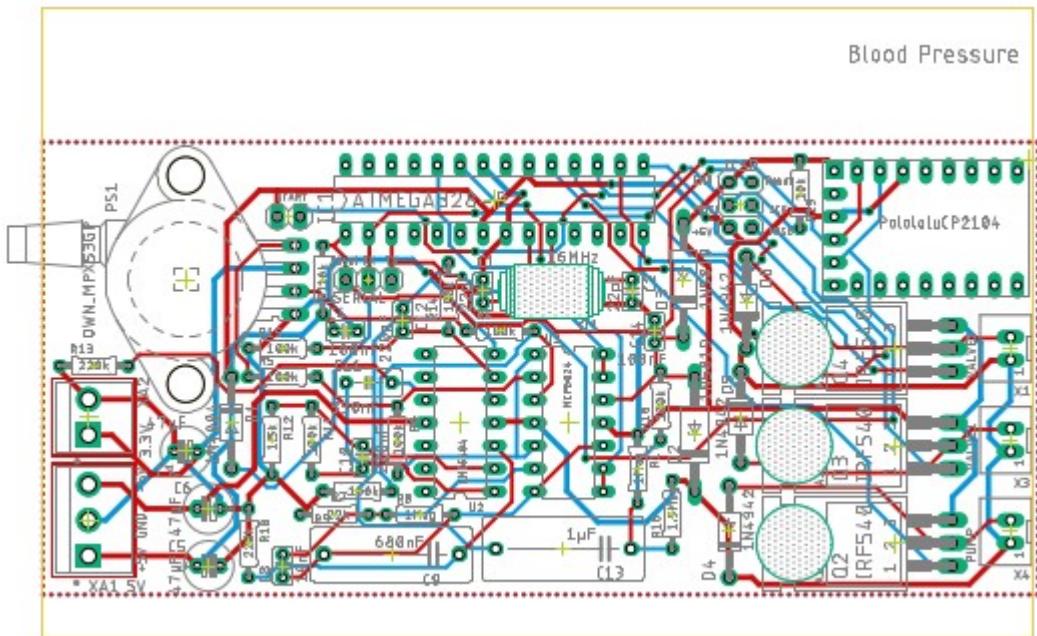
JST XH 02 plug		3
JST B3P VH plug		1
1x3 pinhead		1
1x2 pinhead		1
2x3 pinhead		1
DIL14 socket for LM6484 Quad OP Amp		3



DIL28 socket for ATMega 328P		1
DC E-Pump		1
Micro valve		2
Tube		1
Tube attachment		1
T-piece		2
Blood pressure cuff		1

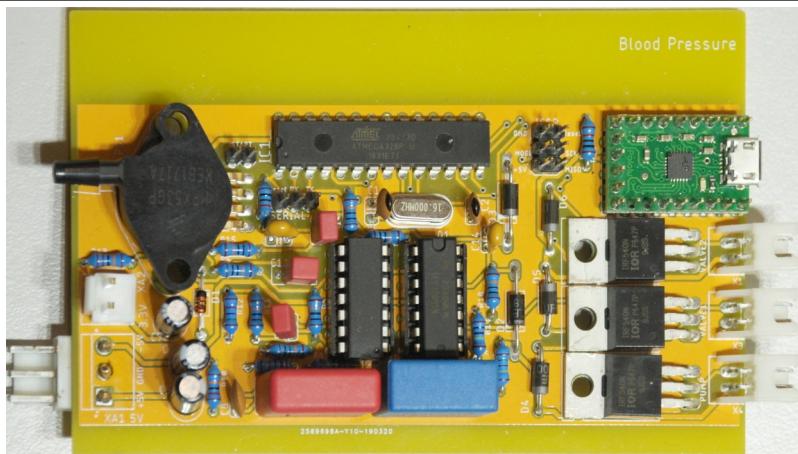


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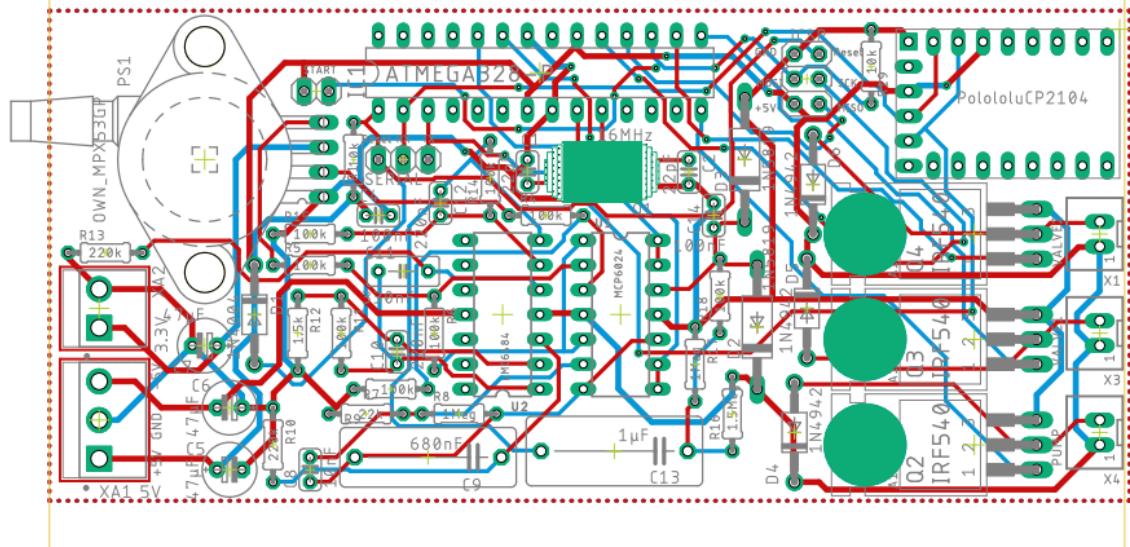


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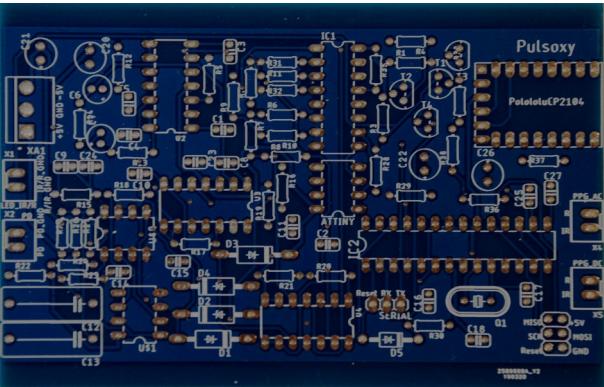


# Blood Pressure



# PULSOXY

Parts:

Description	Image	Number of parts
Pulsoxy printed circuit board		1
68 Ohm resistor		1
100 Ohm resistor		1
1 K Ohm resistor		6
4.7 K Ohm resistor		2
10 K Ohm resistor		9
100 K Ohm resistor		6

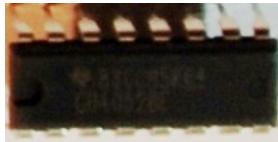
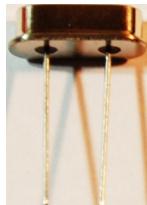


180 K Ohm resistor		1
220 K Ohm resistor		2
1 Meg Ohm resistor		9
2.2p capacitor		2
22p capacitor		2
150p capacitor		1
470p capacitor		2

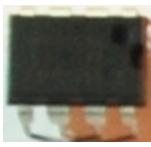
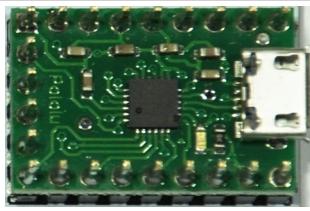


10n capacitor		2
22n capacitor		2
47n capacitor		2
100n capacitor		5
1μ capacitor		2
4.7μ capacitor		2

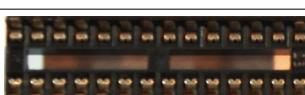


47µ capacitor		4
1N5819 Schottky diode		4
1N4148 diode		1
CD 4052 B multiplexer		1
ATMega 328P		2
16MHz crystal		1
BC547 TO92 transistor		4



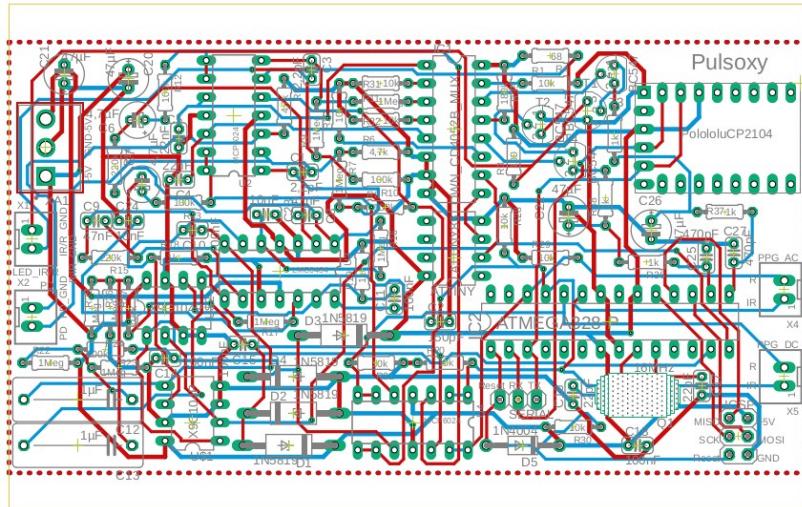
X9C104P DIL8 DigitalPoti		2
LM6484 Quad OP Amp		1
MCP6024 Quad OP Amp replaced with TLC2264		2
USB to serial - Pololu CP2104		1
JST XH 02 plug		4
JST B3P VH plug		1



1x3 pinhead		1
2x3 pinhead		1
DIL8 socket for X9C104P DIL8 DigitalPoti		2
DIL14 socket for LM6484 Quad OP Amp		3
DIL16 socket for CD 4052 B multiplexer		1
DIL28 socket for ATMega 328P		1

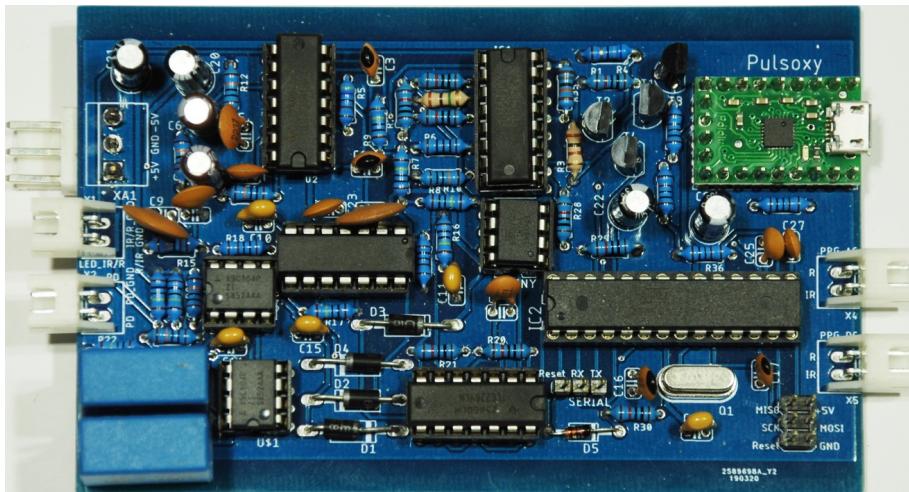


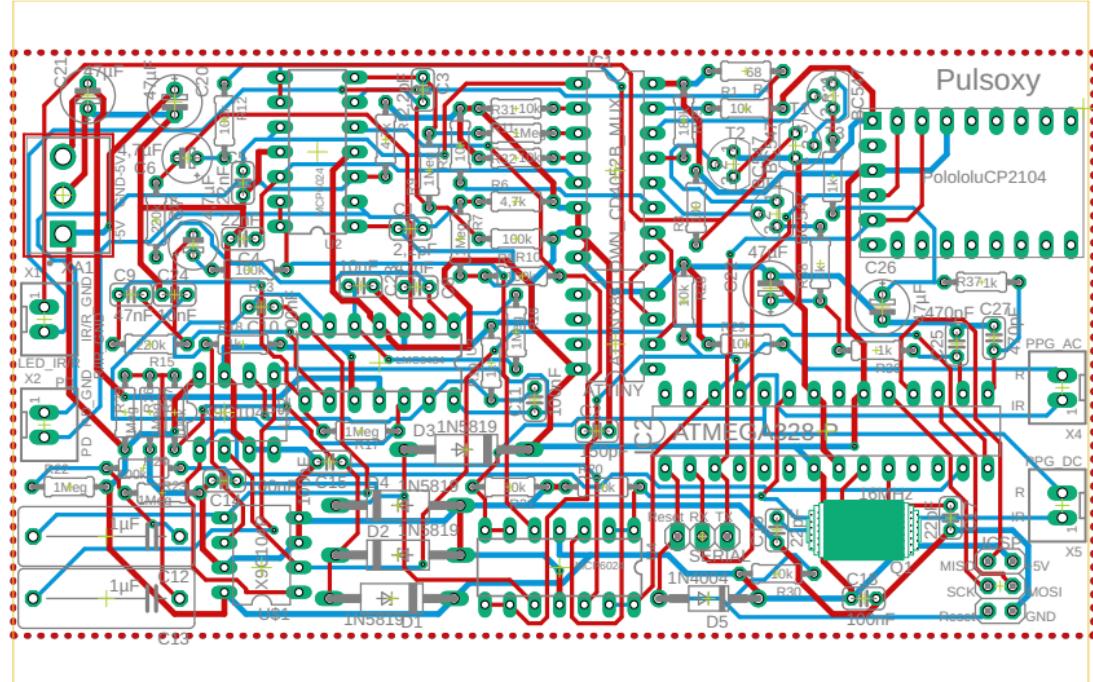
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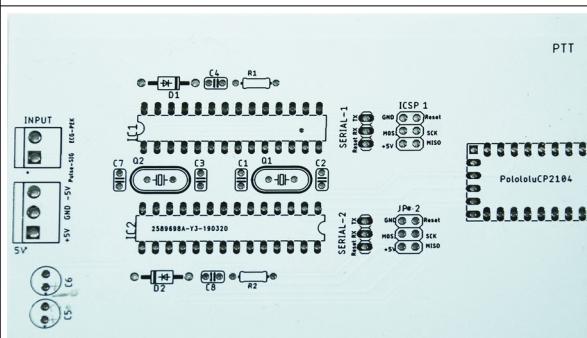
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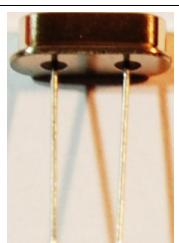
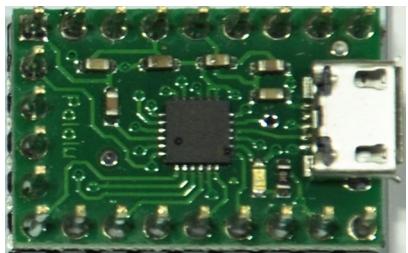


# PTT – Pulse Transit Time

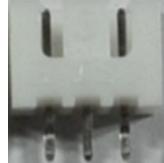
Parts:

Description	Image	Number of parts
PTT printed circuit board		1
10 K Ohm resistor		2
22p capacitor		4
100n capacitor		2
47µ capacitor		2



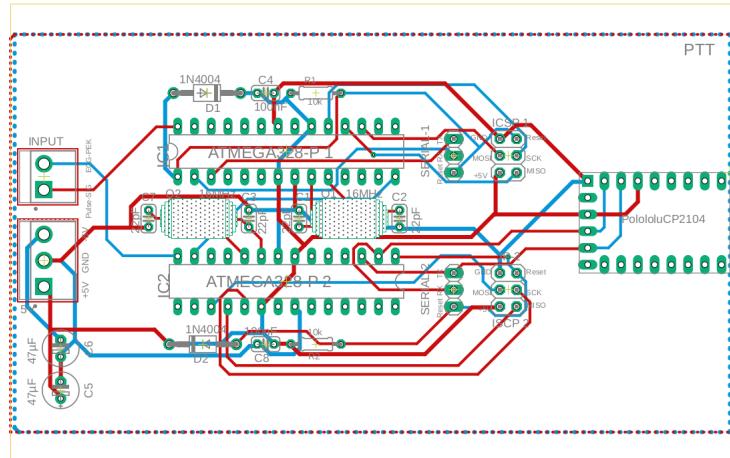
1N4148 diode		2
DIL28 socket for ATMega 328P		2
ATMega 328P		2
16MHz crystal		1
USB to serial - Pololu CP2104		1
JST XH 02 plug		1



JST XH 03 plug		1
1x3 pinhead		2
2x3 pinhead		2

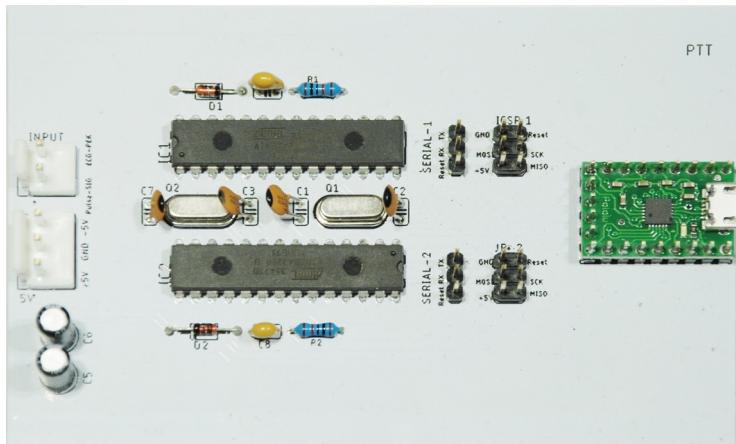


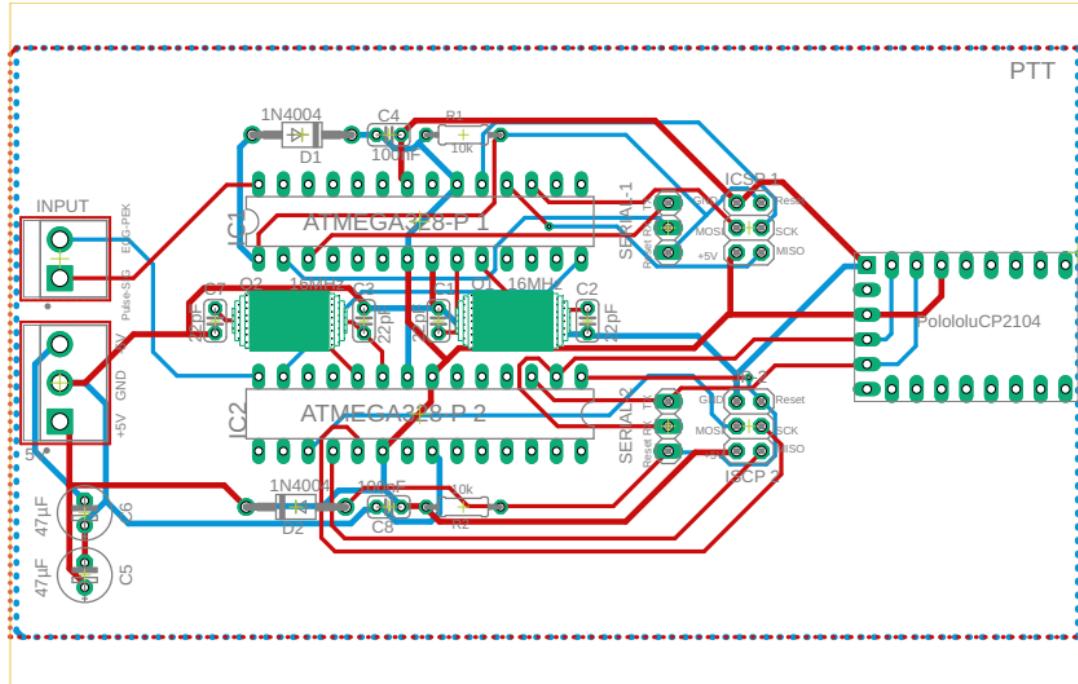
## Schema



See enlarged PDF at the end of the section for searchable version of schema

## Finished





## HOW-TO ASSEMBLE THE REMO2HBO

Once all the components are soldered and the micro-controllers have been programmed, all the boards can be attached for testing. The following schema shows how all the boards are attached to each other.



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