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# **Muscle BioAmp Biscuite**

**Upside Down Labs**

**May 13, 2024**

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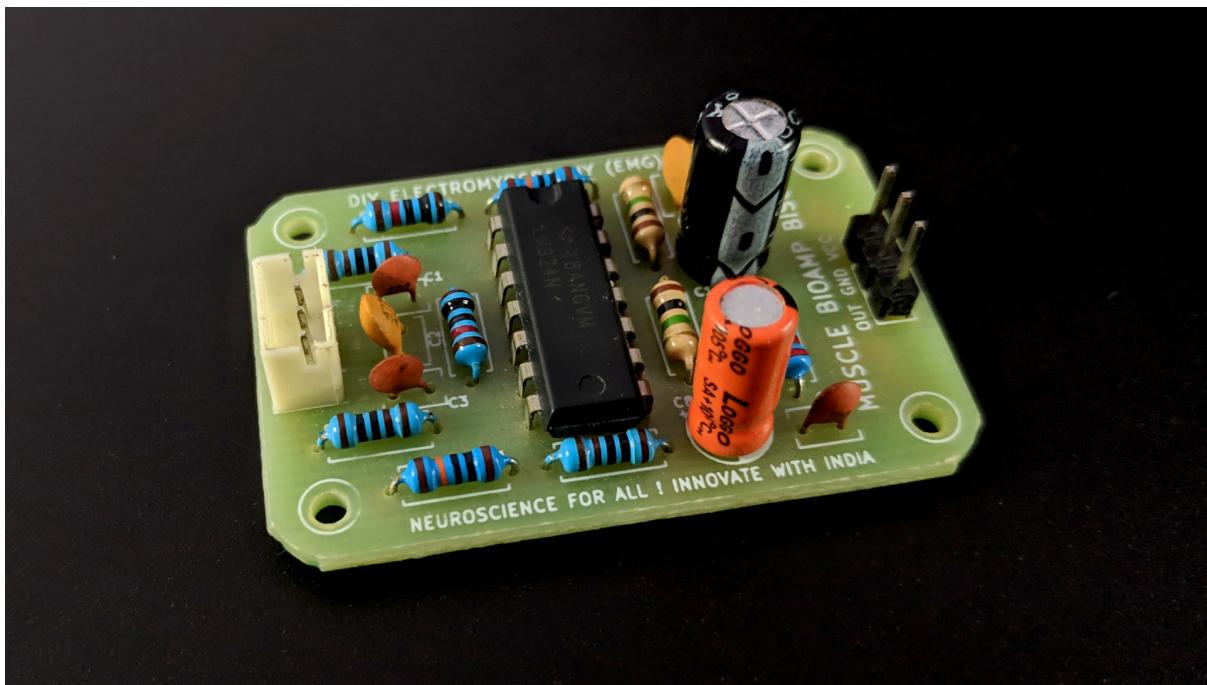
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**CHAPTER  
ONE**

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**OVERVIEW**

Muscle BioAmp BisCute is the most affordable DIY ElectroMyography (EMG) sensor in the world that allows you to create a Human-Computer Interface (HCI) projects with ease. In the process of building your own BisCute, you learn what goes into making a functional biopotential amplifier that can be used for amplifying sub mV signals generated by muscles inside your body to a level a microcontroller unit (MCU) can understand.



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**CHAPTER  
TWO**

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## **FEATURES & SPECIFICATIONS**

Minimum Input Voltage	3.3-30 V
Input Impedance	$10^{11}$ ohm
Fixed Gain	x2420
Bandpass filter	72 – 720 Hz
Compatible Hardware	Any development board with an ADC (Arduino UNO & Nano, Adafruit QtPy, STM32 Blue Pill, BeagleBone Black, Raspberry Pi Pico, to name just a few) or any standalone ADC of your choice
BioPotentials	EMG (Electromyography)
No. of channels	1
Electrodes	3 (Positive, Negative, and Reference)
Dimensions	3.0 x 4.5 cm
Open Source	Hardware + Software

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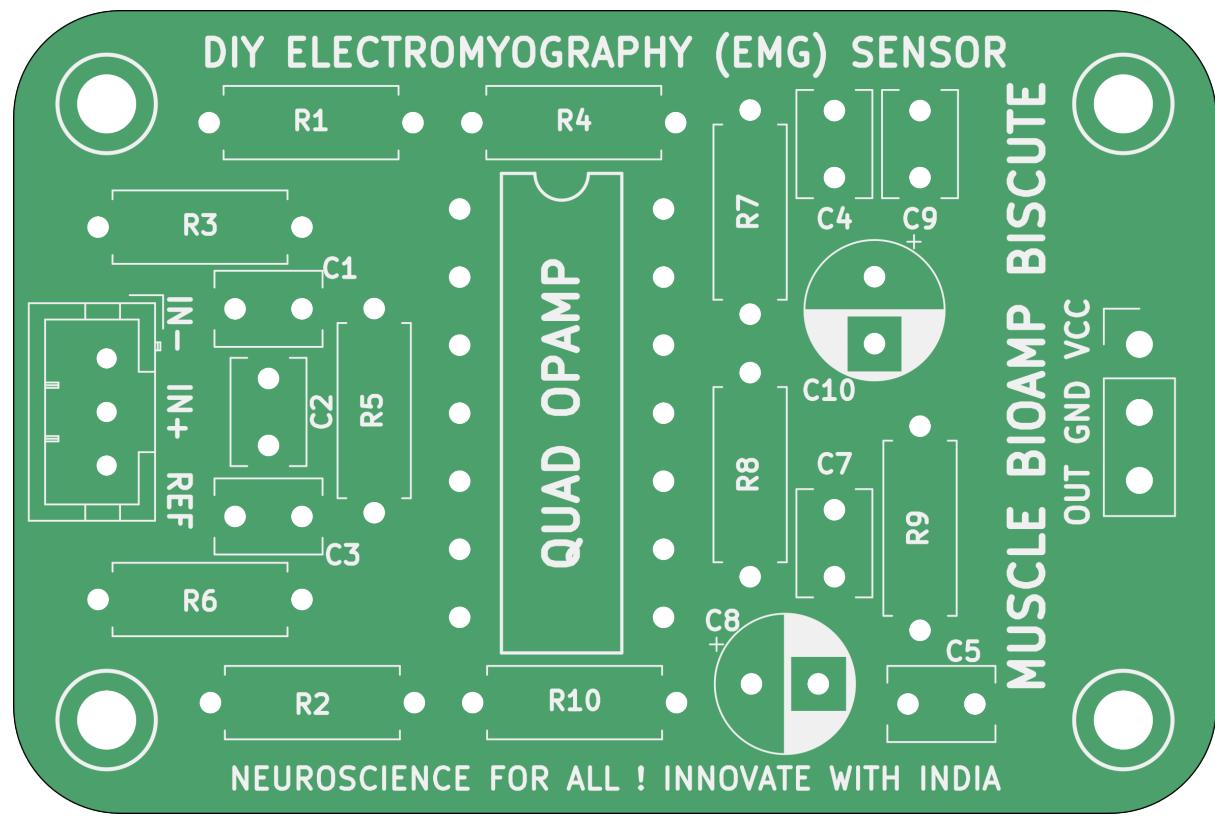
CHAPTER  
THREE

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## HARDWARE

Images below shows a quick overview of the hardware design.

PCB Front



PCB Back

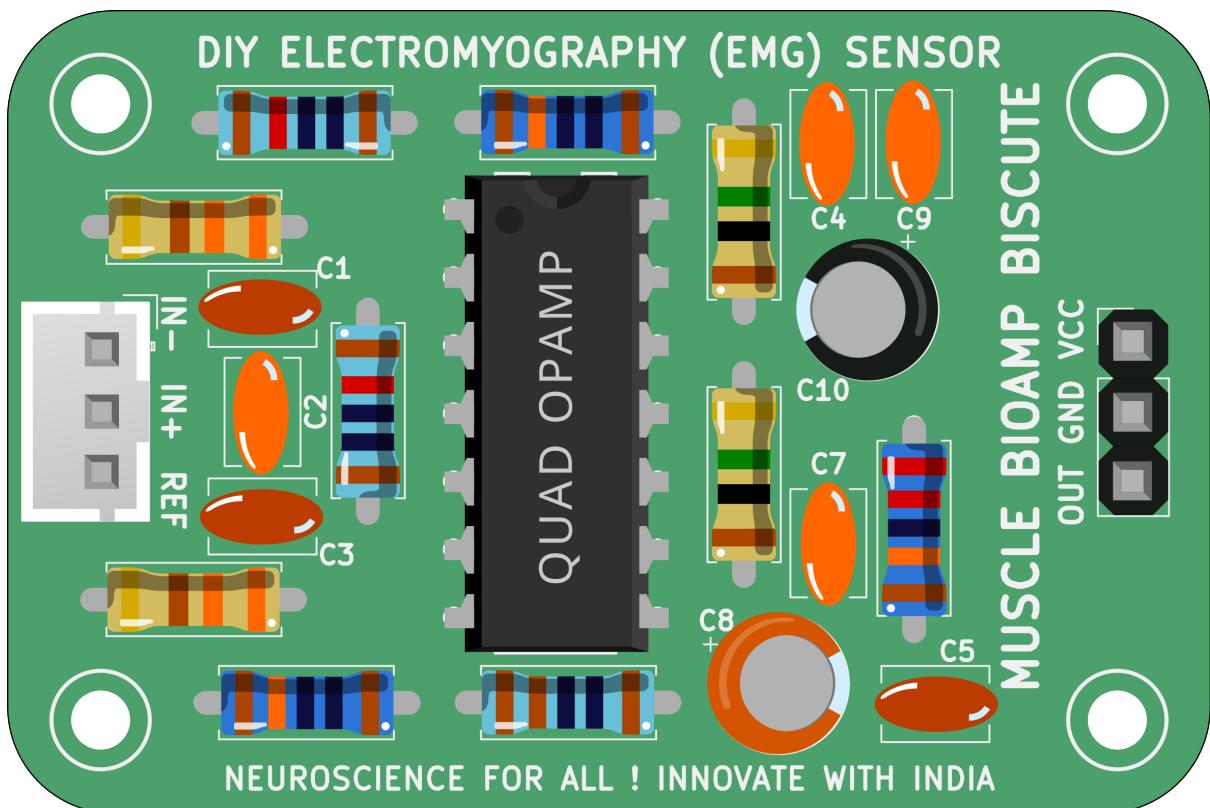
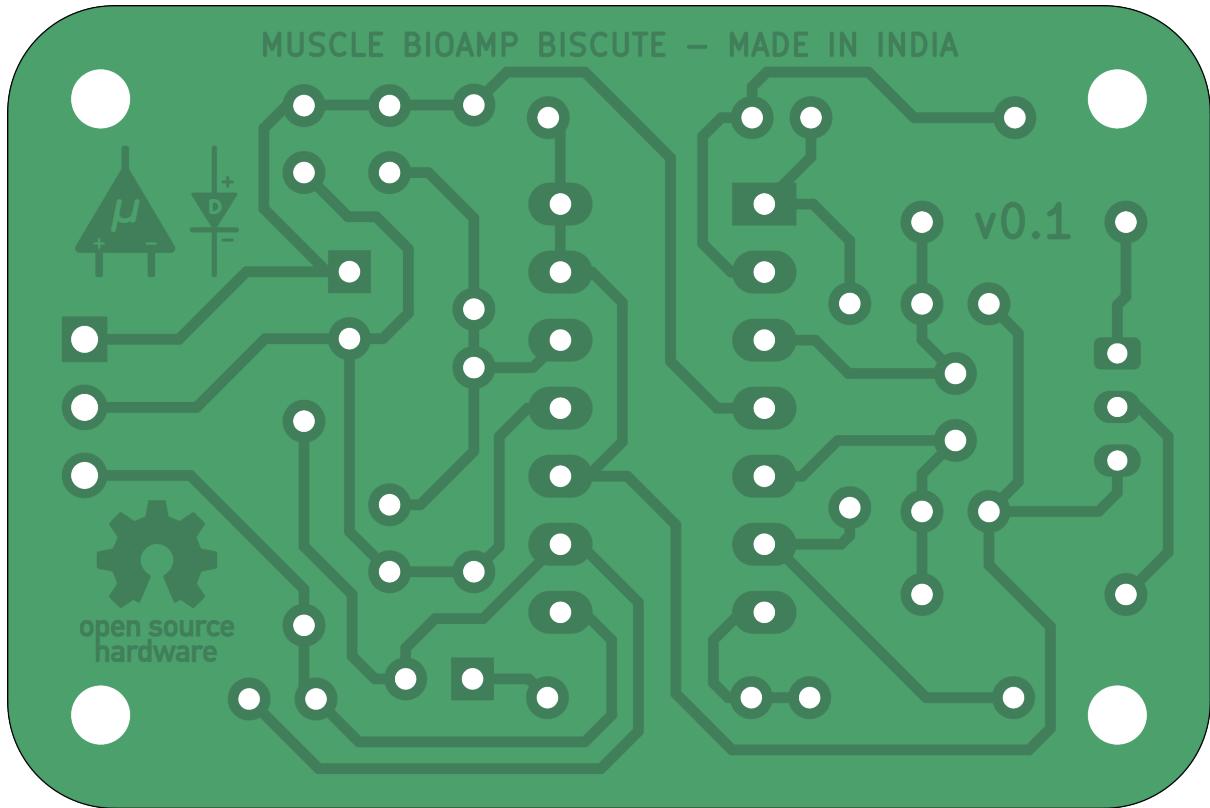


Fig. 1: Assembled PCB



Fig. 2: PCB Layout

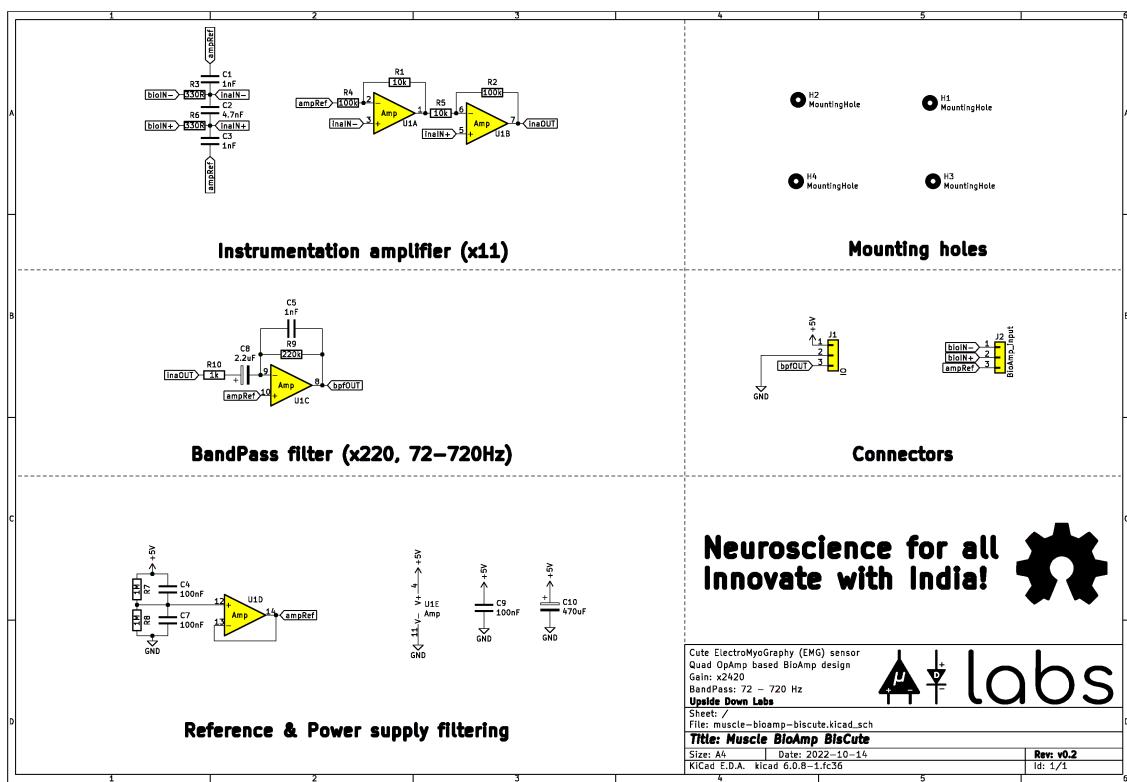


Fig. 3: Schematic Diagram

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**CHAPTER  
FOUR**

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**CONTENTS OF THE KIT**



BisCute bare PCB

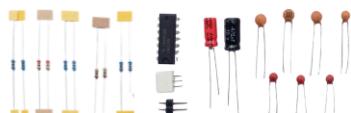


BioAmp cable v3 (50 cm)



x 3

Boxy Gel electrodes



Components



Jumper Cables (pack of 3)



Muscle BioAmp Band

*\*Each pack comes with a bunch of surprise goodies!!*

## SOFTWARE REQUIREMENTS

- Before you start using the kit, please download [Arduino IDE v1.8.19 \(legacy IDE\)](#). Using this you'll be able to upload the arduino sketches on your development board and visualise the data on your laptop.

### Legacy IDE (1.8.X)



### Arduino IDE 1.8.19

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board.

Refer to the [Arduino IDE 1.x documentation](#) for installation instructions.

SOURCE CODE

Active development of the Arduino software is [hosted by GitHub](#). See the instructions for [building the code](#). Latest release source code archives are available [here](#). The archives are PGP-signed so they can be verified using [this](#) gpg key.

**DOWNLOAD OPTIONS**

**Windows** Win 7 and newer  
**Windows** ZIP file  
**Windows app** Win 8.1 or 10 

**Linux** 32 bits  
**Linux** 64 bits  
**Linux** ARM 32 bits  
**Linux** ARM 64 bits

**Mac OS X** 10.10 or newer

[Release Notes](#)  
[Checksums \(sha512\)](#)

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**CHAPTER  
SIX**

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## **ASSEMBLING THE KIT**

You can get Muscle BioAmp BisCute from our [online stores](#) (shipping worldwide) and for assembling the BisCute you can either take a look at [this interactive BOM](#) or the step by step guide given below.

**Note:** Follow the highlighted yellow shapes to assemble your Muscle BioAmp BisCute!

Still can't figure out the assembly? You can watch the video below to assemble your Biscute.

<https://youtu.be/2dzW6pVT1L8>

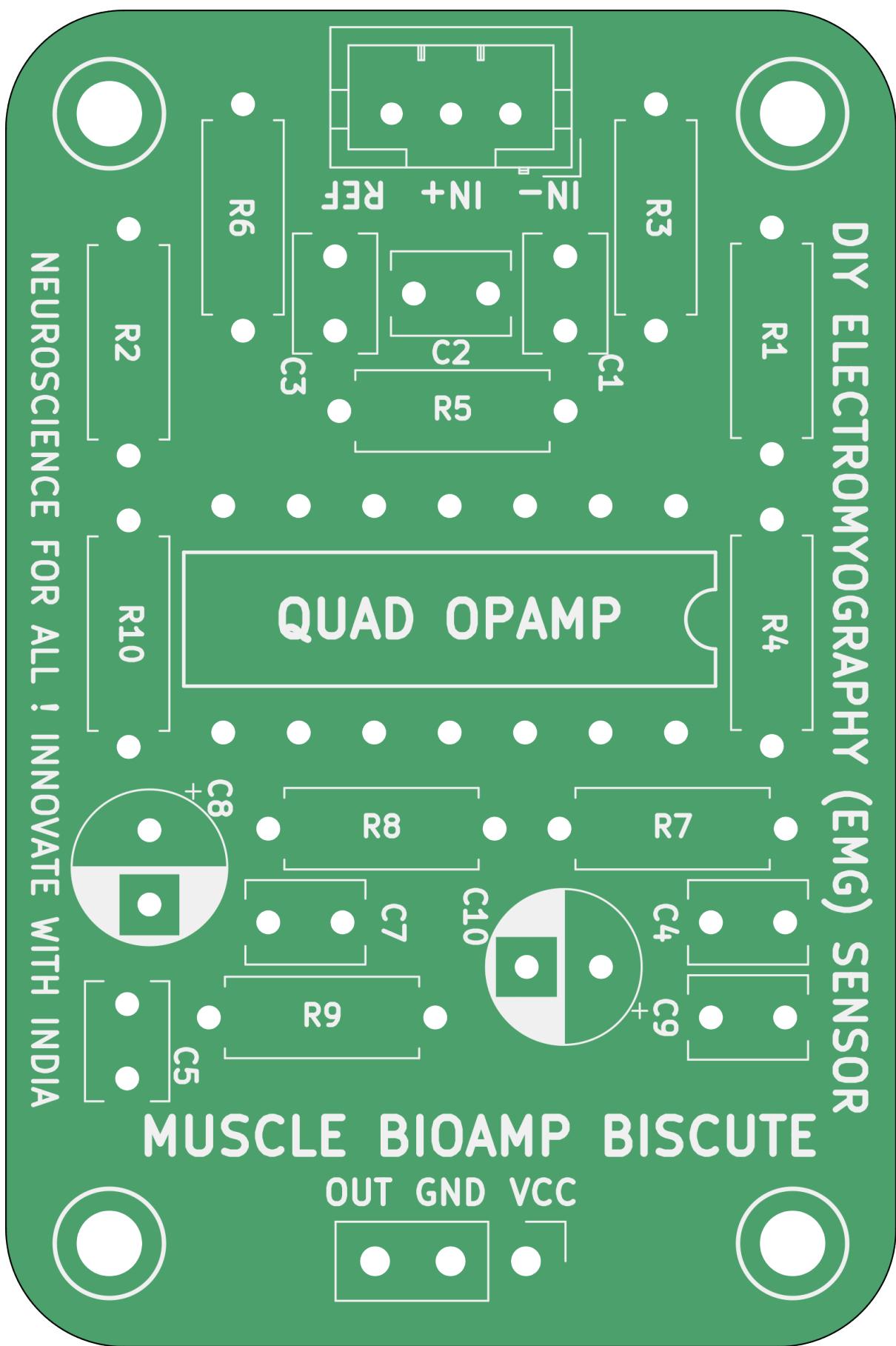


Fig. 1: Step 1 - Bare Board



Fig. 2: Step 2 - 100K Resistors

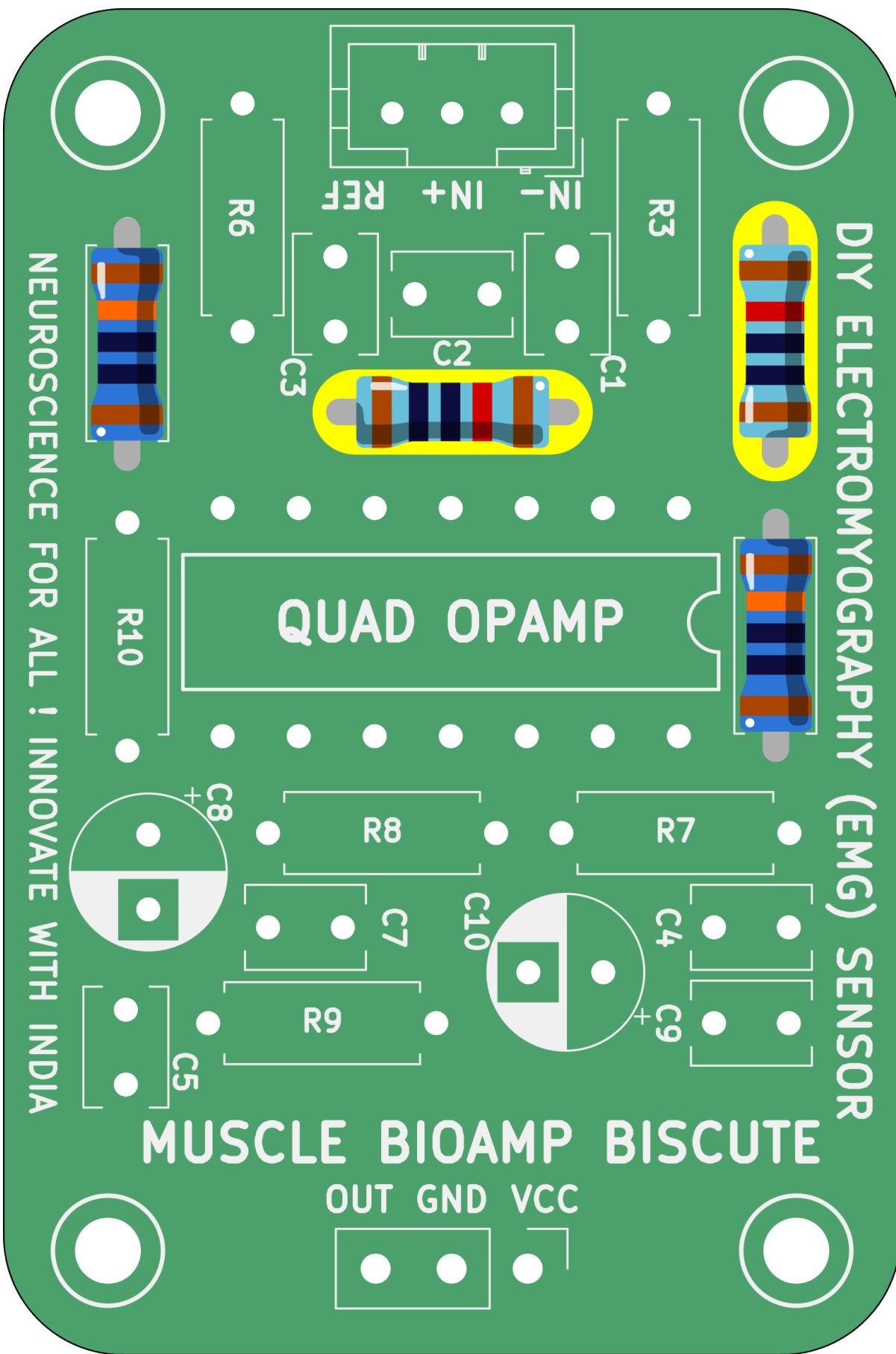


Fig. 3: Step 3 - 10K Resistors



Fig. 4: Step 4 - 1M Resistors

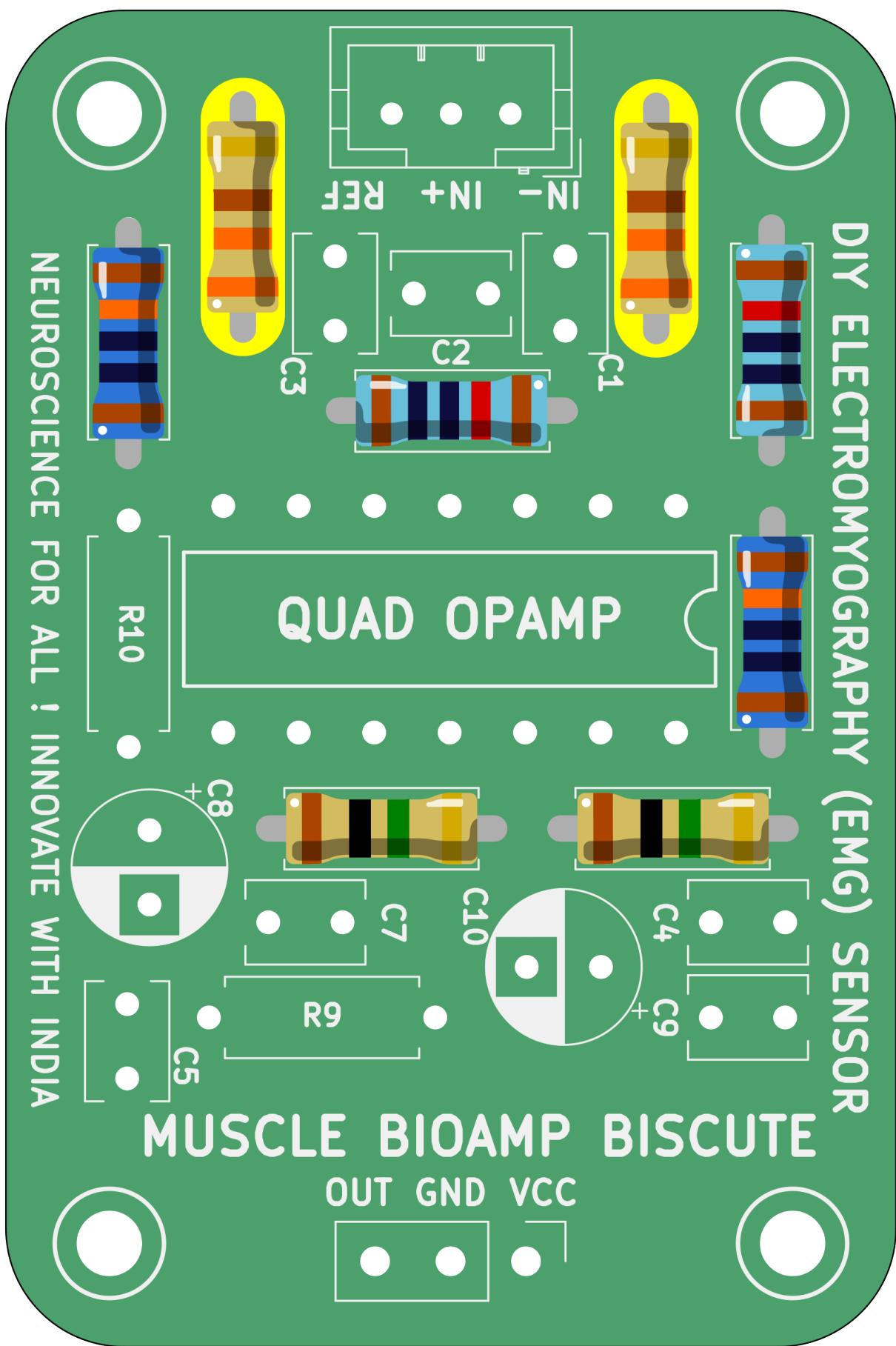


Fig. 5: Step 5 - 330R Resistors

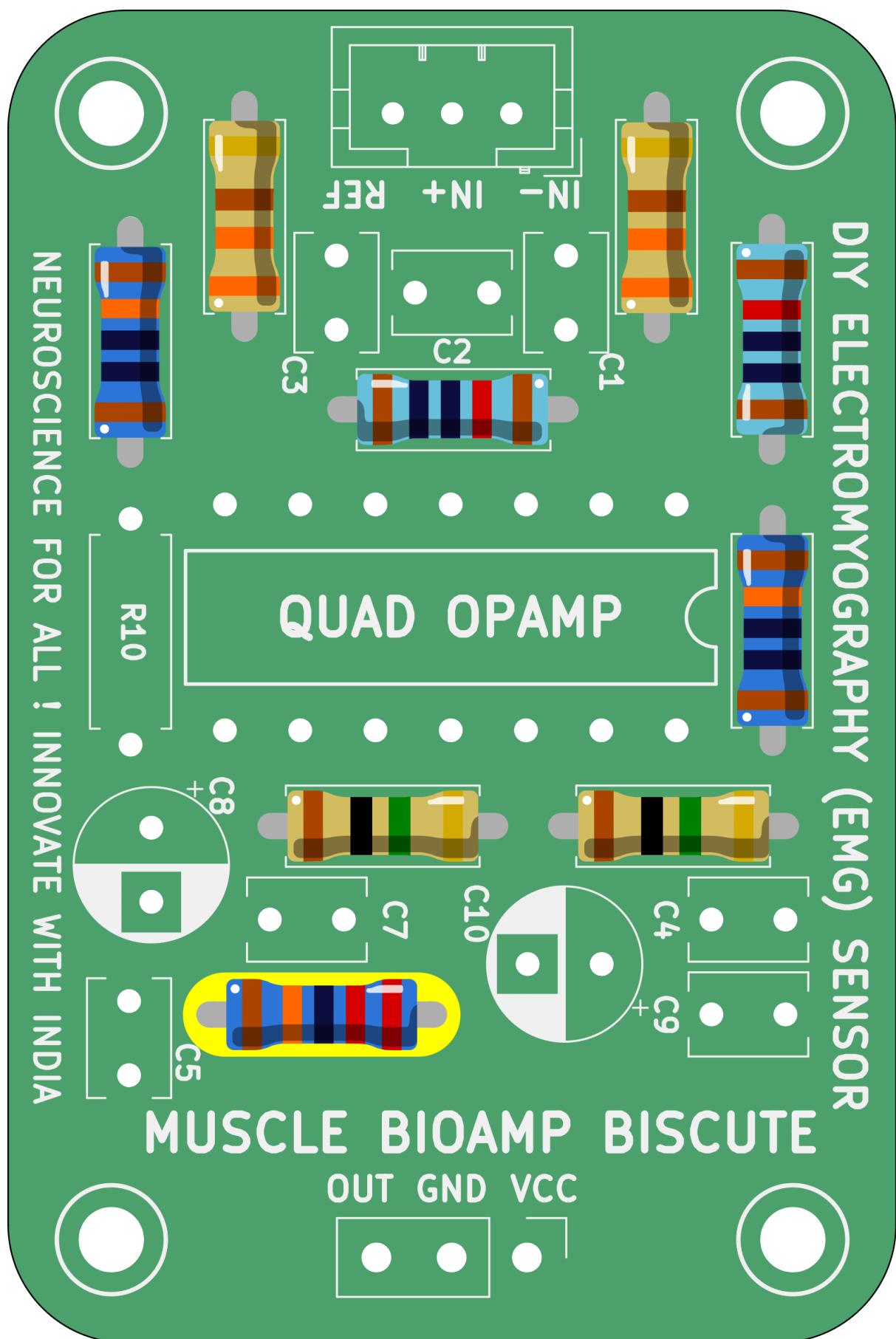


Fig. 6: Step 6 - 220K Resistor

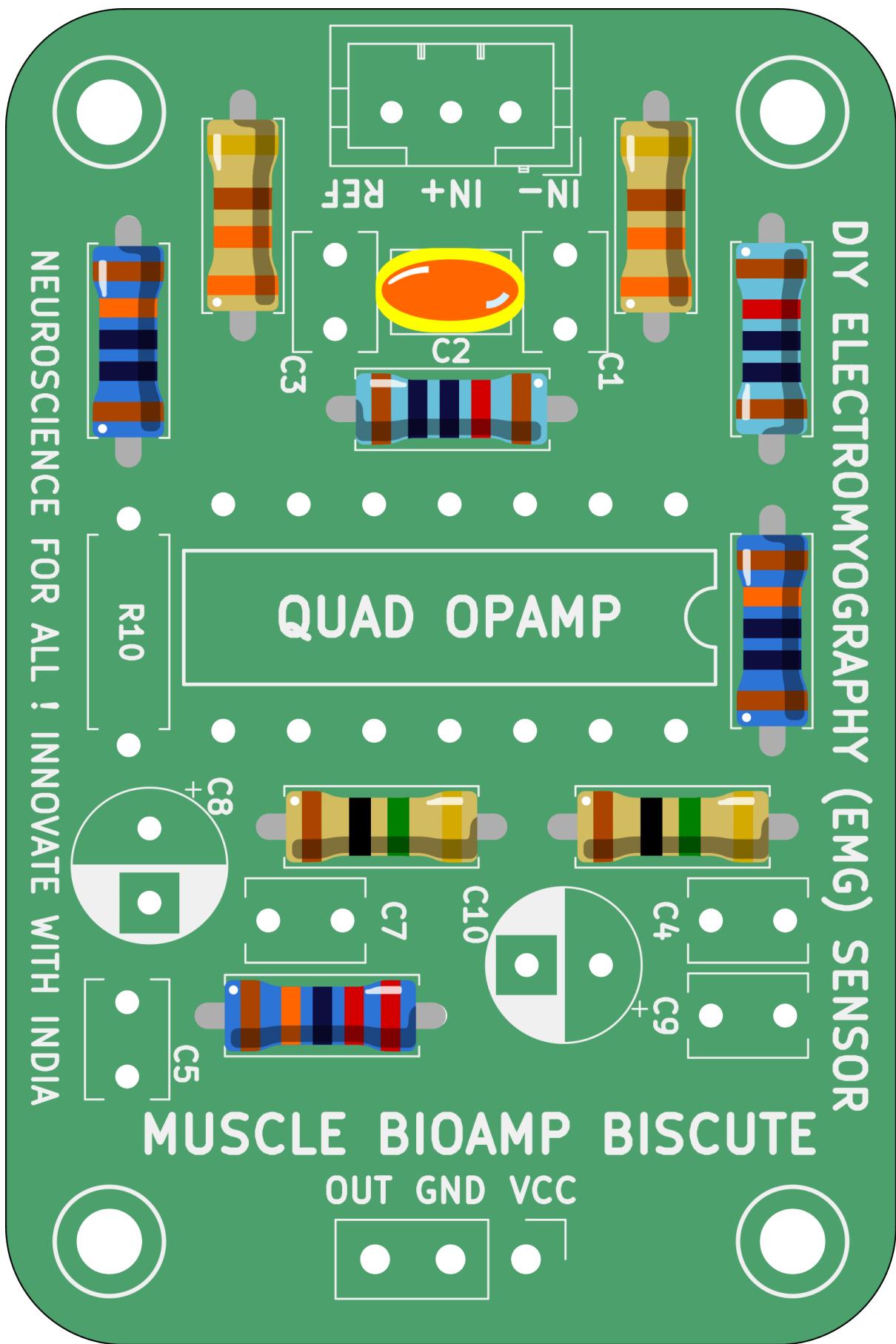


Fig. 7: Step 7 - 4.7nF Capacitor

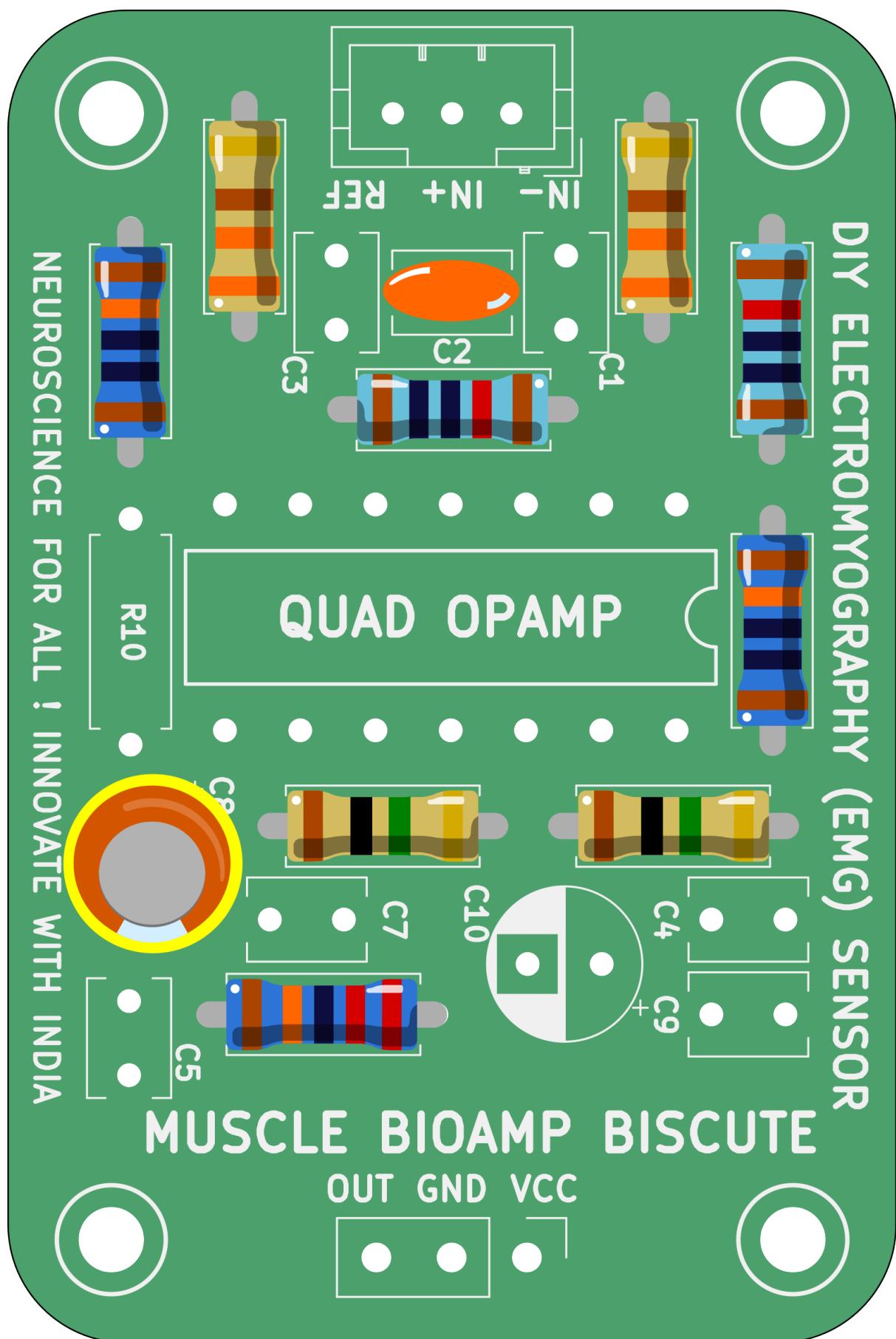


Fig. 8: Step 8 - 2.2uF Capacitor



Fig. 9: Step 9 - 470uF Capacitor

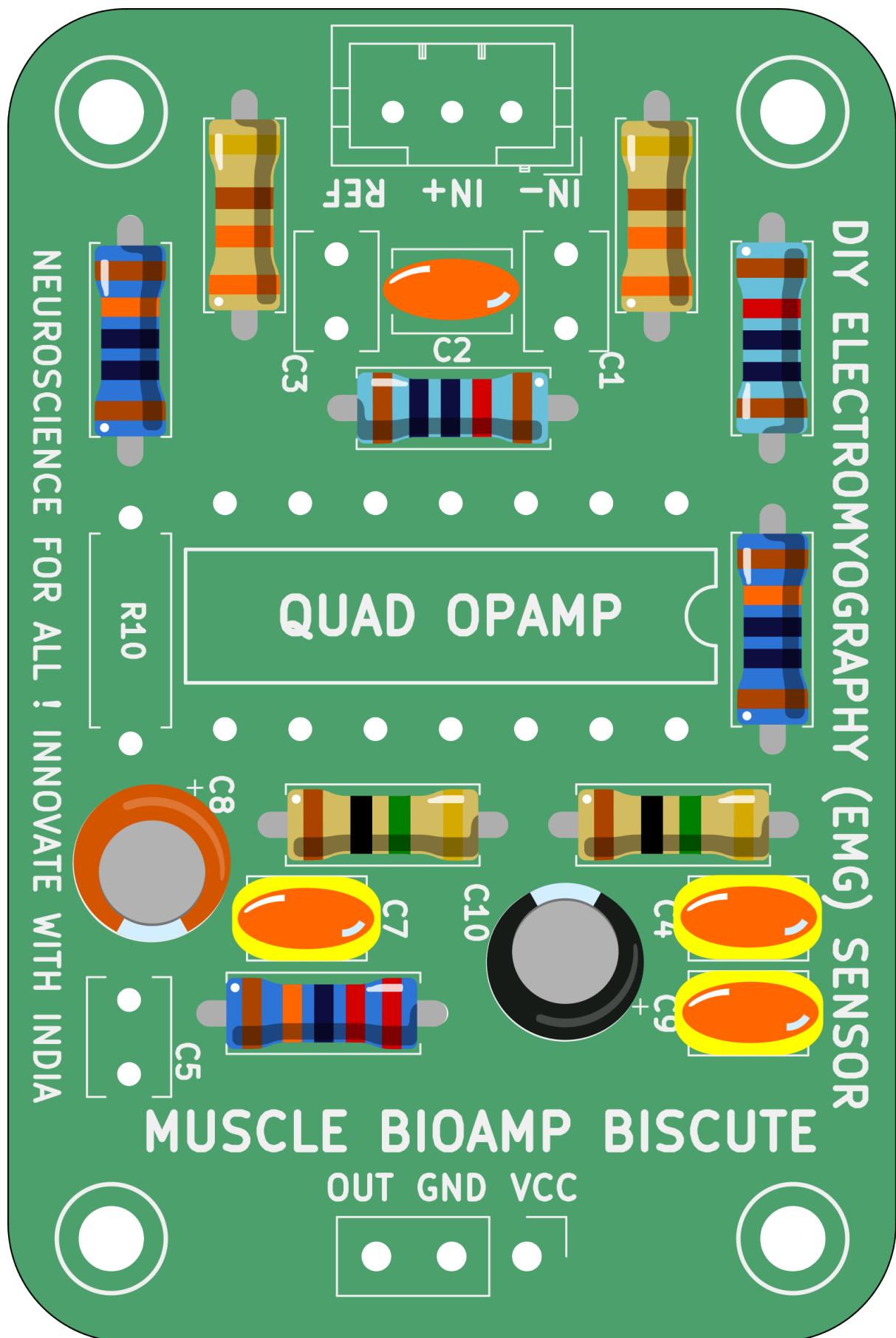


Fig. 10: Step 10 - 100nF Capacitors

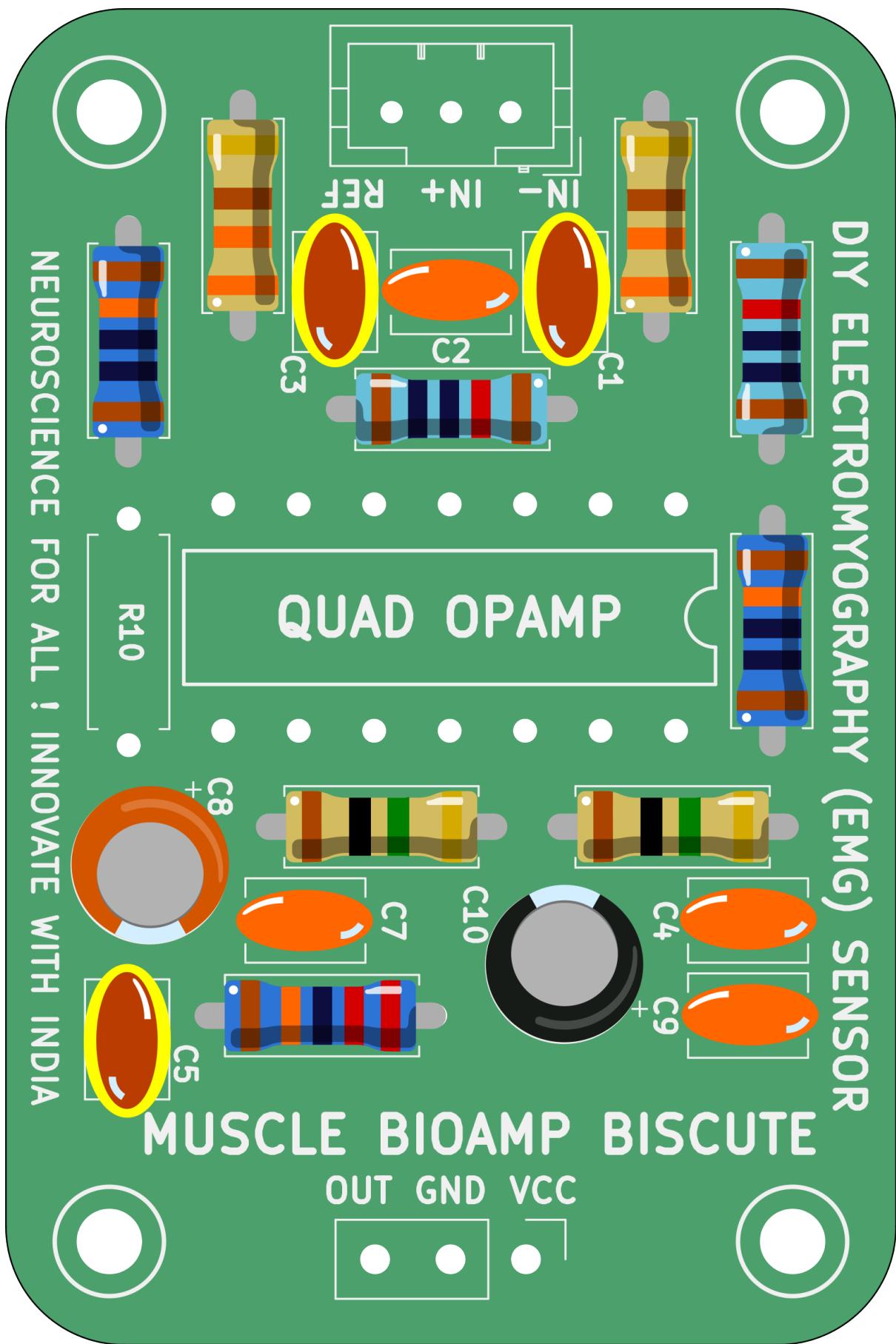


Fig. 11: Step 11 - 1nF Capacitors



Fig. 12: Step 12 - 1K Resistor

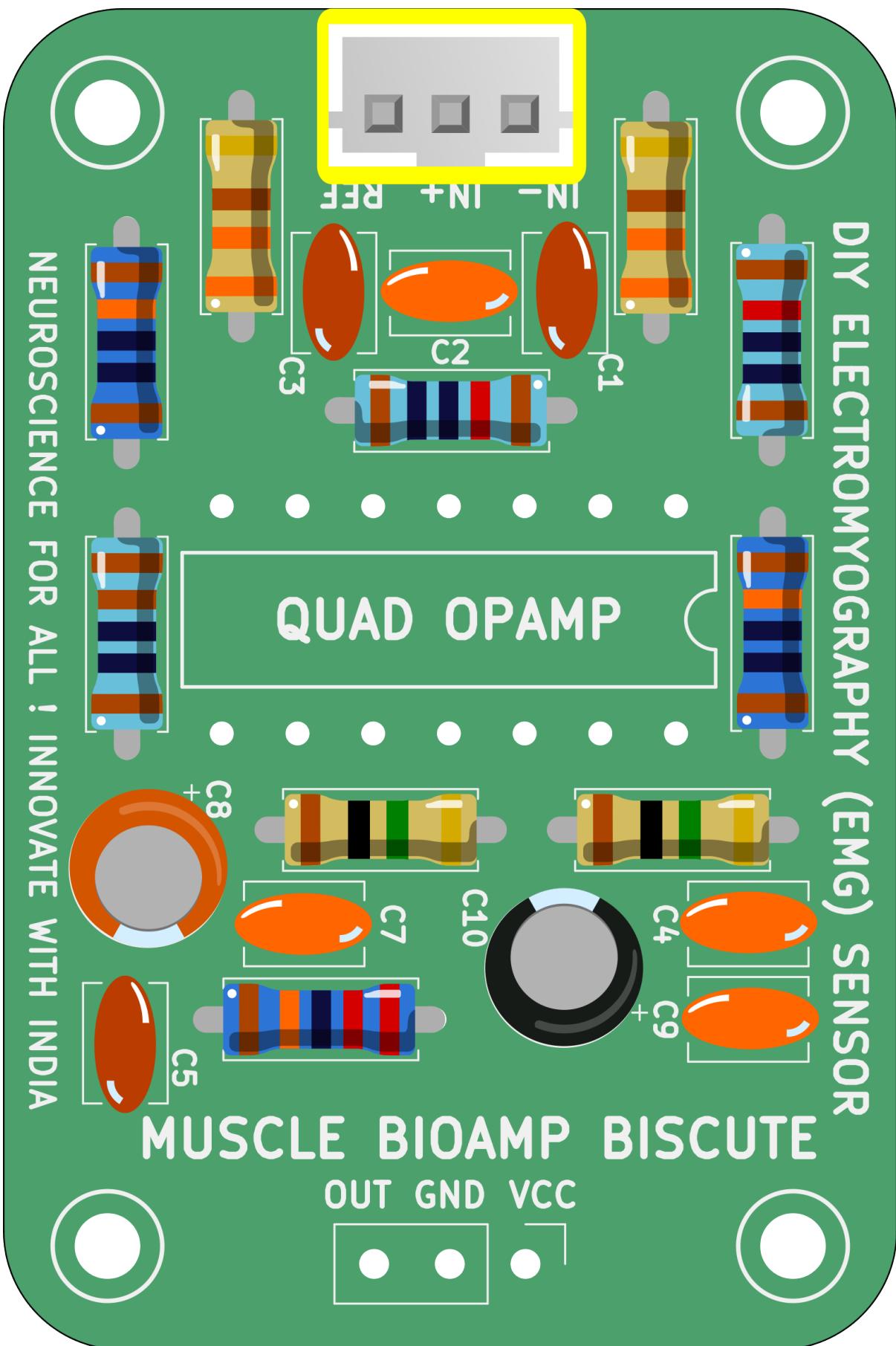


Fig. 13: Step 13 - BioAmp Connector



Fig. 14: Step 14 - Header Pins

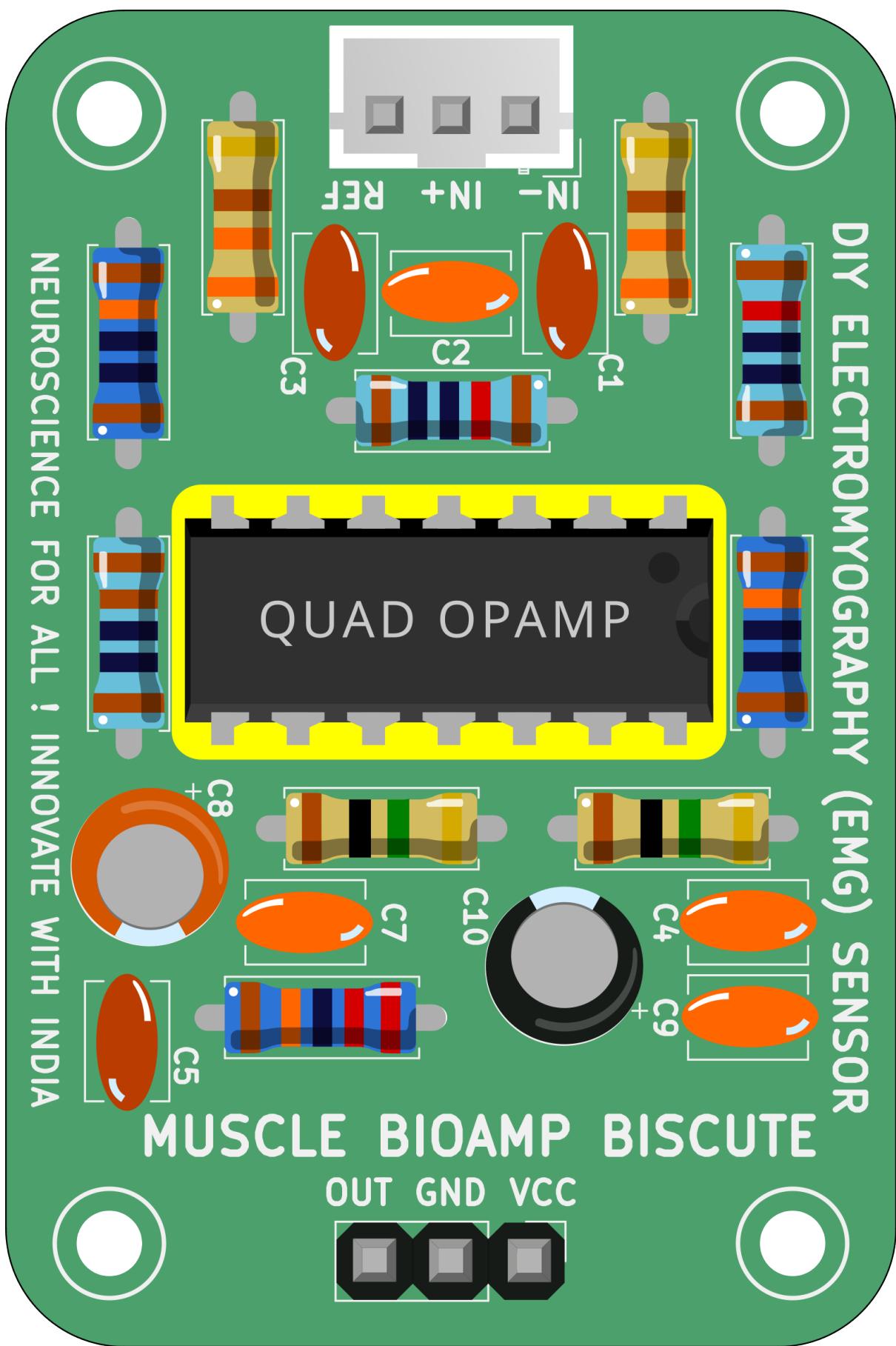
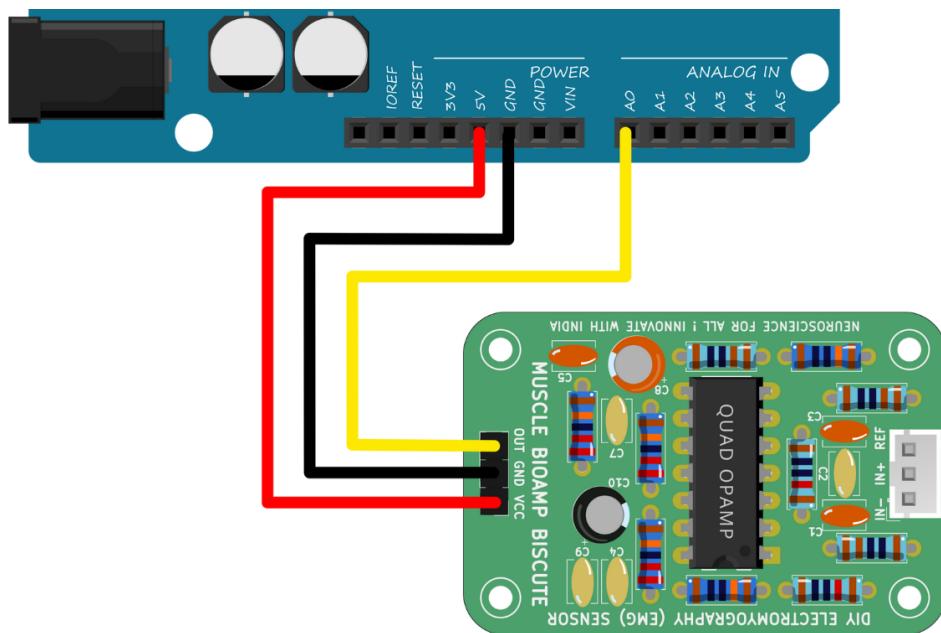


Fig. 15: Step 15 - IC

## USING THE KIT

### 7.1 Step 1: Connect Arduino UNO R3

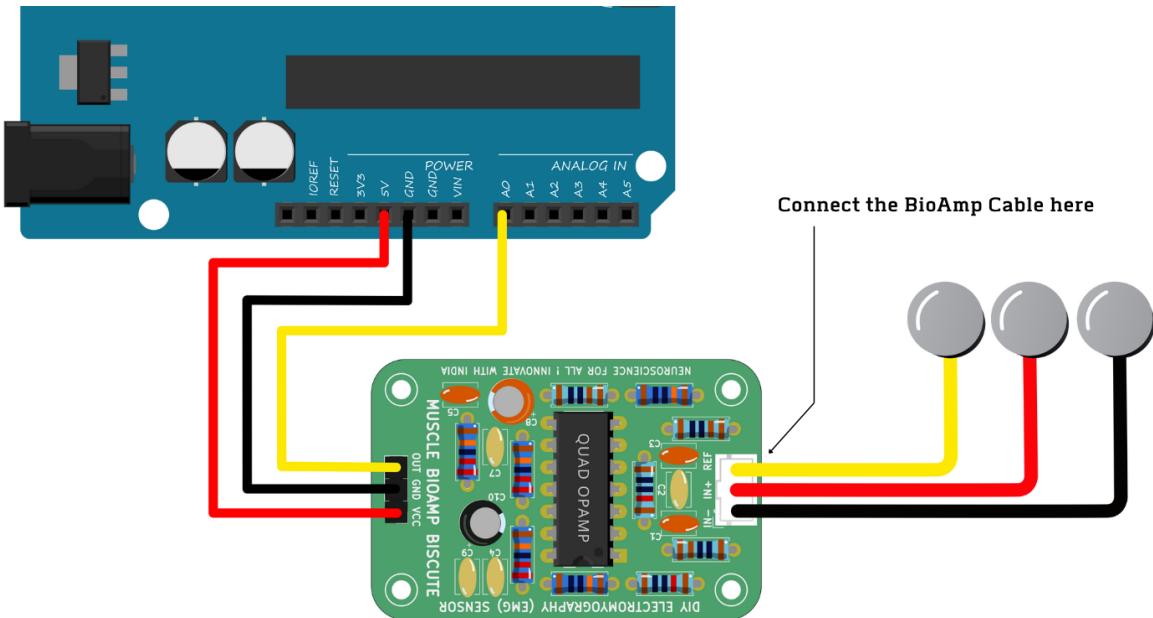


Connect VCC to either 5V or 3.3V, GND to GND, and OUT to Analog pin A0 of your Arduino UNO via jumper cables provided by us. If you are connecting OUT to any other analog pin, then you will have to change the INPUT PIN in the arduino sketch accordingly.

**Note:** For demonstration purposes we are showing connections of the sensor with Arduino UNO R3 but you can use any other development board or a standalone ADC of your choice.

**Warning:** Take precautions while connecting to power, if power pins (GND & VCC) are to be swapped, your sensor will be fried and it'll become unusable (DIE).

## 7.2 Step 3: Connecting electrode cable



Connect the BioAmp cable to Muscle BioAmp Biscuite by inserting the cable end in the JST PH connector as shown above.

## 7.3 Step 4: Skin Preparation

Apply Nuprep Skin Preparation Gel on the skin surface where electrodes would be placed to remove dead skin cells and clean the skin from dirt. After rubbing the skin surface thoroughly, clean it with an alcohol wipe or a wet wipe.

For more information, please check out detailed step by step skin-preparation.

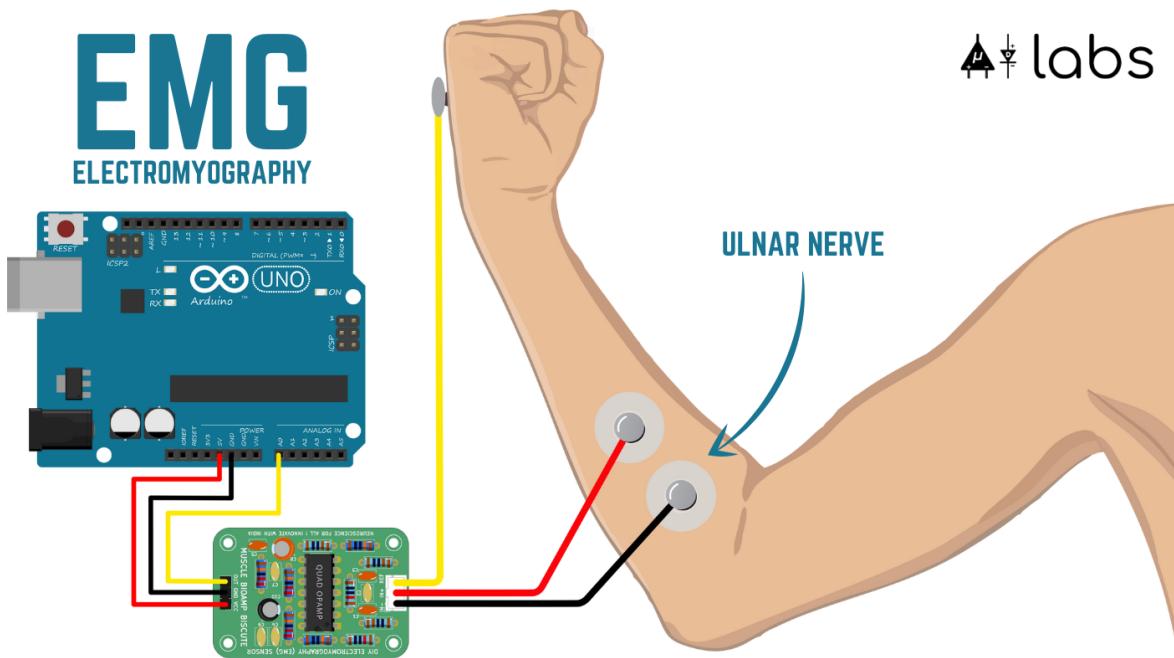
## 7.4 Step 5: Measuring EMG (ElectroMyoGraphy)

### 7.4.1 Electrodes placement

We have 2 options to measure the EMG signals, either using the gel electrodes or using dry electrode based Muscle BioAmp Band. You can try both of them one by one.

- **Using gel electrodes:**

1. Connect the BioAmp cable to gel electrodes,
2. Peel the plastic backing from electrodes
3. Place the IN+ and IN- cables on the arm near the ulnar nerve & REF (reference) at the back of your hand as shown in the connection diagram.



- **Using Muscle BioAmp Band:**

1. Connect the BioAmp cable to Muscle BioAmp Band in a way such that IN+ and IN- are placed on the arm near the ulnar nerve & REF (reference) on the far side of the band.
2. Now put a small drop of electrode gel between the skin and metallic part of BioAmp cable to get the best results.

**Tutorial on how to use the band:**

<https://youtu.be/xYZdw0aes0>

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**Note:** In this demonstration we are recording EMG signals from the ulnar nerve, but you can record EMG from other areas as well (biceps, triceps, legs, jaw etc) as per your project requirements. Just make sure to place the IN+, IN- electrodes on the targeted muscle and REF on a bony part.

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### 7.4.2 Uploading the code

Connect your Arduino UNO to your laptop using the USB cable (Type A to Type B). Copy paste any one of the arduino sketches given below in Arduino IDE v1.8.19 that you downloaded earlier:

EMG Filter: [https://github.com/upsidedownlabs/Muscle-BioAmp-Arduino-Firmware/blob/main/2\\_EMGFilter/2\\_EMGFilter.ino](https://github.com/upsidedownlabs/Muscle-BioAmp-Arduino-Firmware/blob/main/2_EMGFilter/2_EMGFilter.ino)

EMG Envelope: [https://github.com/upsidedownlabs/Muscle-BioAmp-Arduino-Firmware/blob/main/3\\_EMGEvelope/3\\_EMGEvelope.ino](https://github.com/upsidedownlabs/Muscle-BioAmp-Arduino-Firmware/blob/main/3_EMGEvelope/3_EMGEvelope.ino)

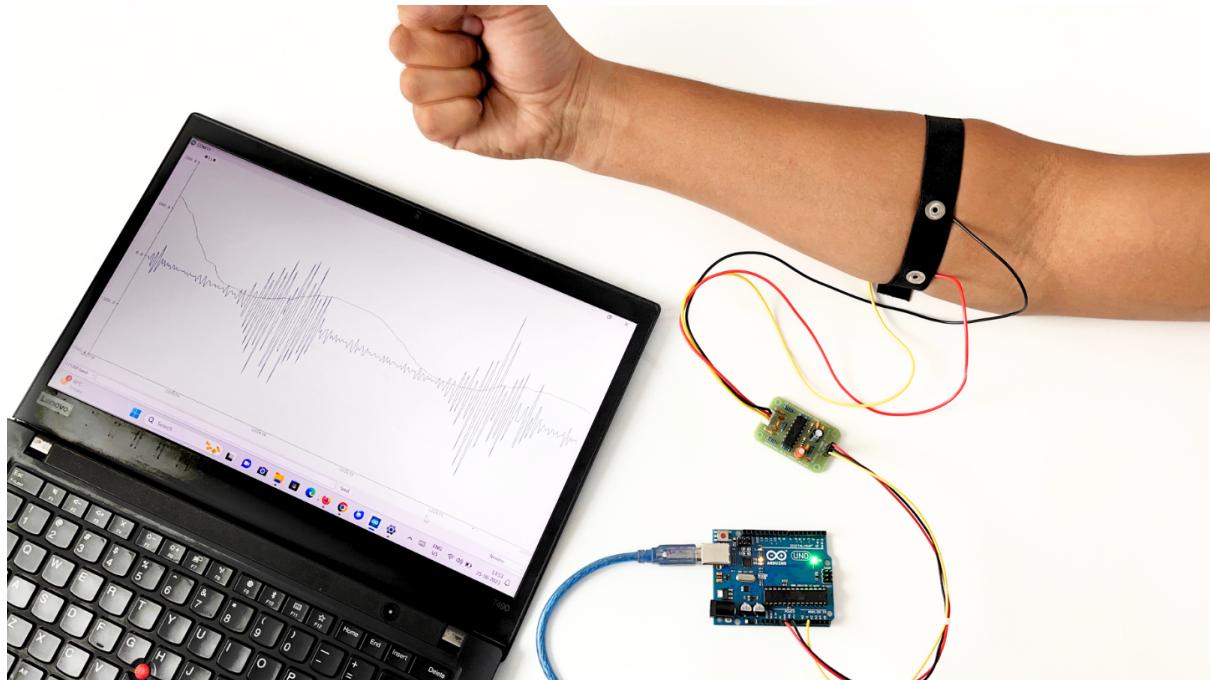
Go to **tools** from the menu bar, select **board** option then select **Arduino UNO**. In the same menu, select the **COM** port on which your Arduino Uno is connected. To find out the right **COM** port, disconnect your board and reopen the menu. The entry that disappears should be the right **COM** port. Now upload the code, & open the serial plotter from the **tools** menu to visualize the EMG signals.

After opening the serial plotter make sure to select the baud rate to 115200.

**Warning:** Make sure your laptop is not connected to a charger and sit 5m away from any AC appliances for best signal acquisition.

### 7.4.3 Visualizing the EMG signals

Now flex your arm to visualize the muscle signals in real time on your laptop.



**Video tutorial:**

<https://youtu.be/ujFsAE0E0nk>