3-lead Muscle / Electromyography Sensor for Microcontroller Applications

**MyoWare™ Muscle Sensor (AT-04-001)**   **DATASHEET**

FEATURES
- *NEW* - Wearable Design
- *NEW* - Single Supply
  - +2.9V to +5.7V
  - Polarity reversal protection
- *NEW* - Two Output Modes
  - EMG Envelope
  - Raw EMG
- *NEW* - Expandable via Shields
- *NEW* - LED Indicators
- Specially Designed For Microcontrollers
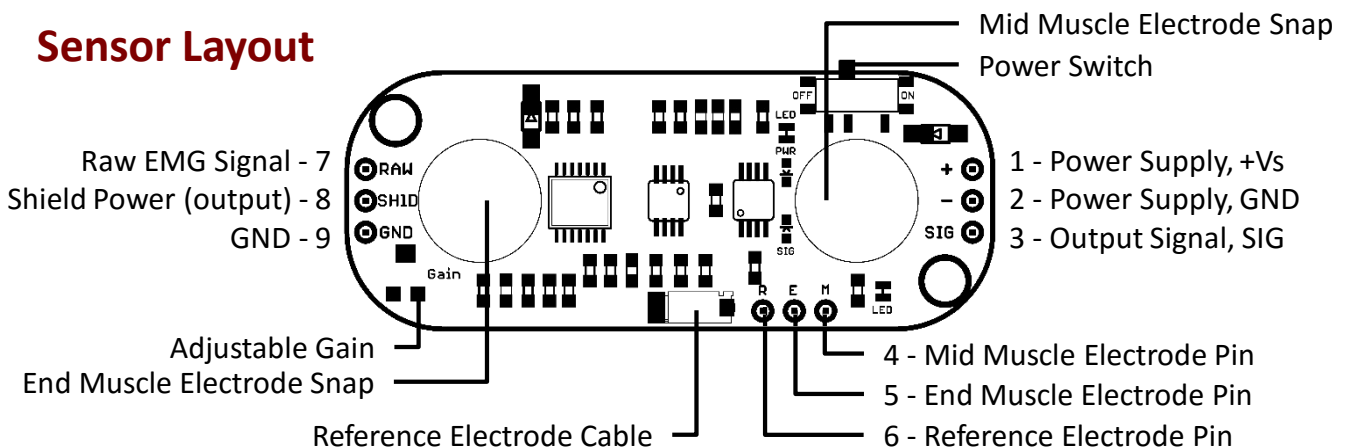- Adjustable Gain

APPLICATIONS
- Video games
- Robotics
- Medical Devices
- Wearable/Mobile Electronics
- Prosthetics/Orthotics
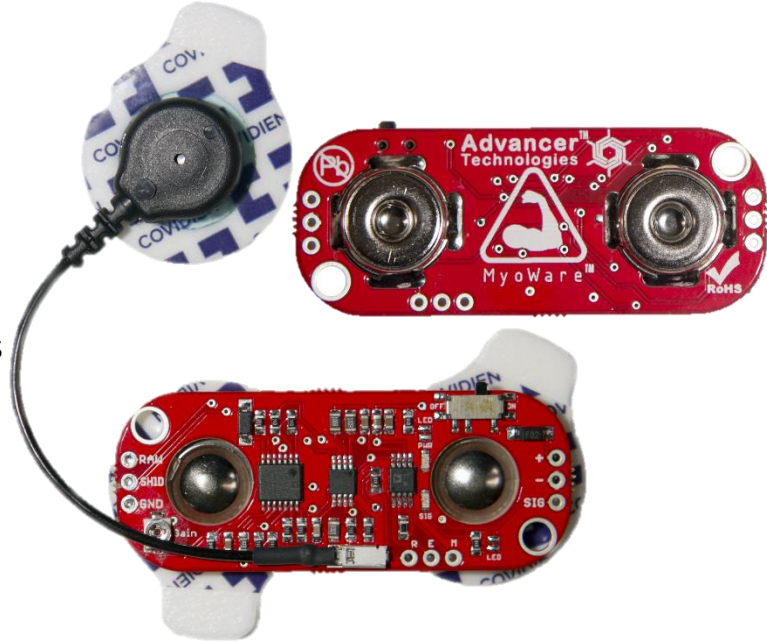
What is electromyography?

Measuring muscle activation via electric potential, referred to as electromyography (EMG), has traditionally been used for medical research and diagnosis of neuromuscular disorders. However, with the advent of ever shrinking yet more powerful microcontrollers and integrated circuits, EMG circuits and sensors have found their way into prosthetics, robotics and other control systems.

Sensor Layout

Mid Muscle Electrode Snap
Power Switch

Raw EMG Signal - 7
Shield Power (output) - 8
GND - 9

1 - Power Supply, +Vs
2 - Power Supply, GND
3 - Output Signal, SIG

Adjustable Gain
End Muscle Electrode Snap

Reference Electrode Cable

4 - Mid Muscle Electrode Pin
5 - End Muscle Electrode Pin
6 - Reference Electrode Pin

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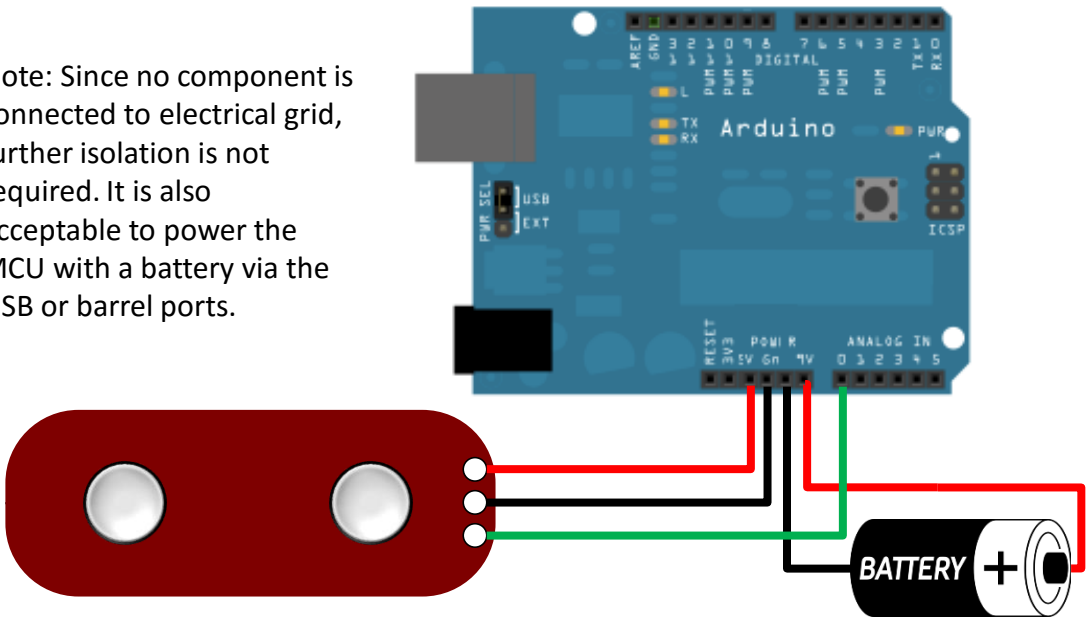
Setup Configurations *(Arduino is shown but MyoWare is compatible with most development boards)*

a) Battery powered with isolation via no direct external connections

RECOMMENDED

Note: Since no component is connected to electrical grid, further isolation is not required. It is also acceptable to power the MCU with a battery via the USB or barrel ports.

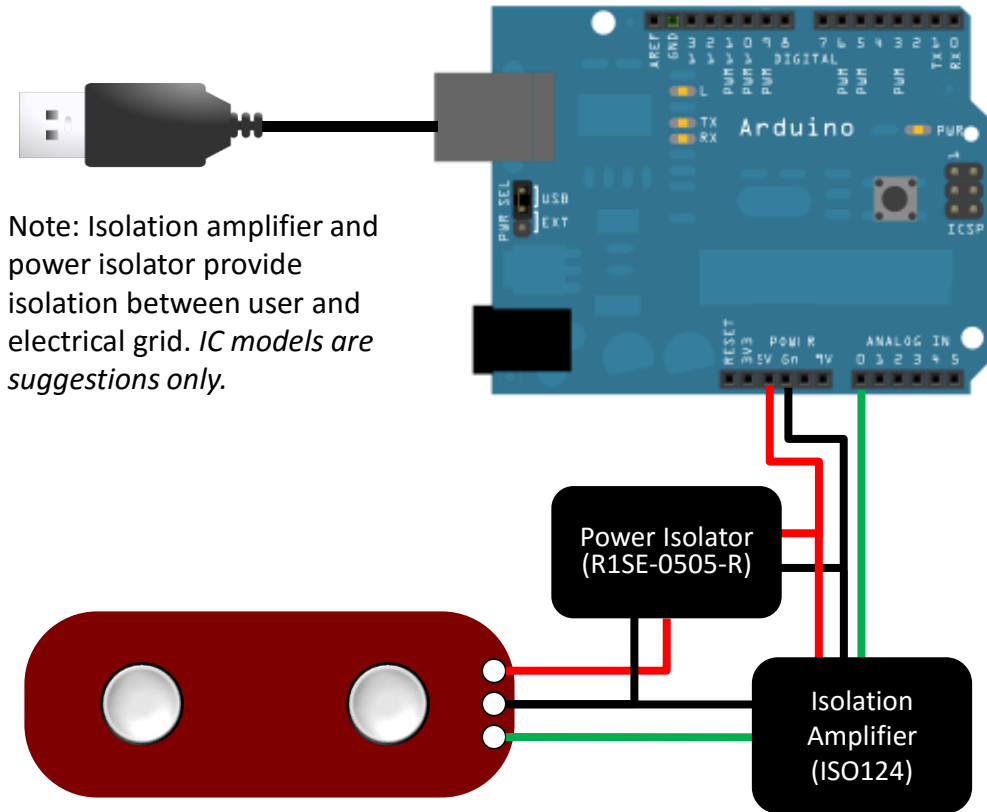### b) Battery powered sensor, Grid powered MCU with output isolation

Note: Isolation amplifier and battery provide isolation between user and electrical grid. *IC models are suggestions only.*
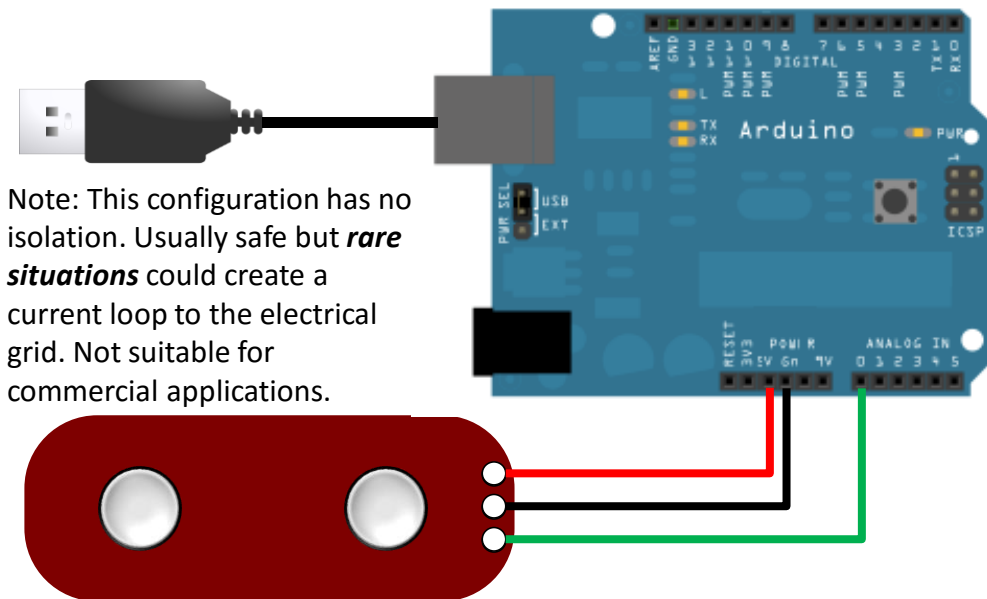
Isolation Amplifier (ISO124)
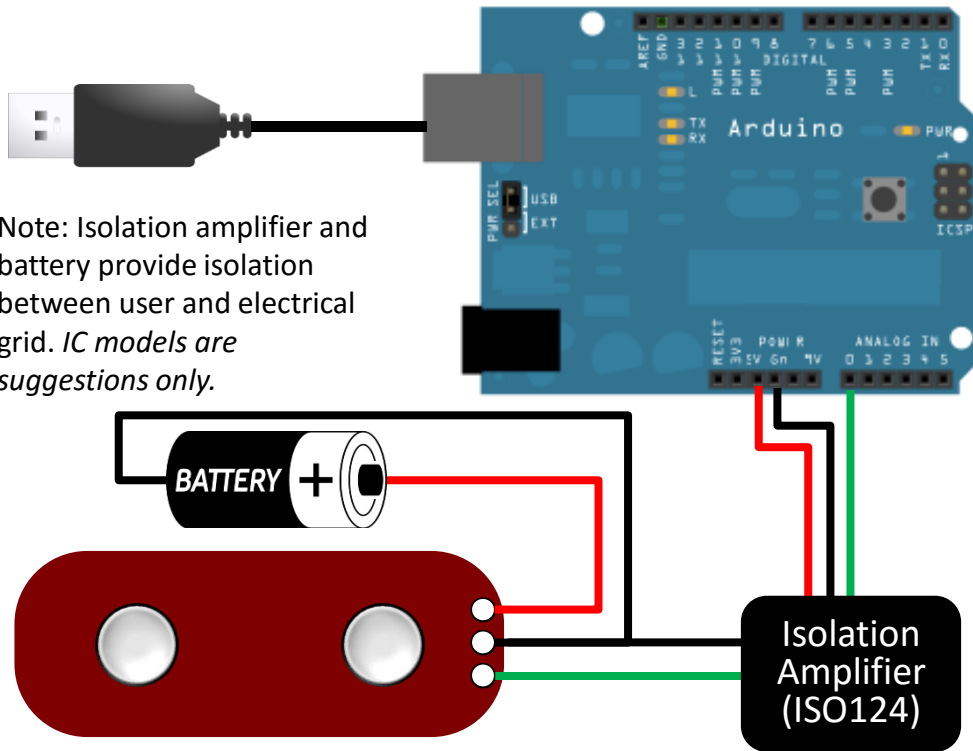
(Note: Arduino and batteries not included. Arduino setup is only an example; sensor will work with numerous other devices.)
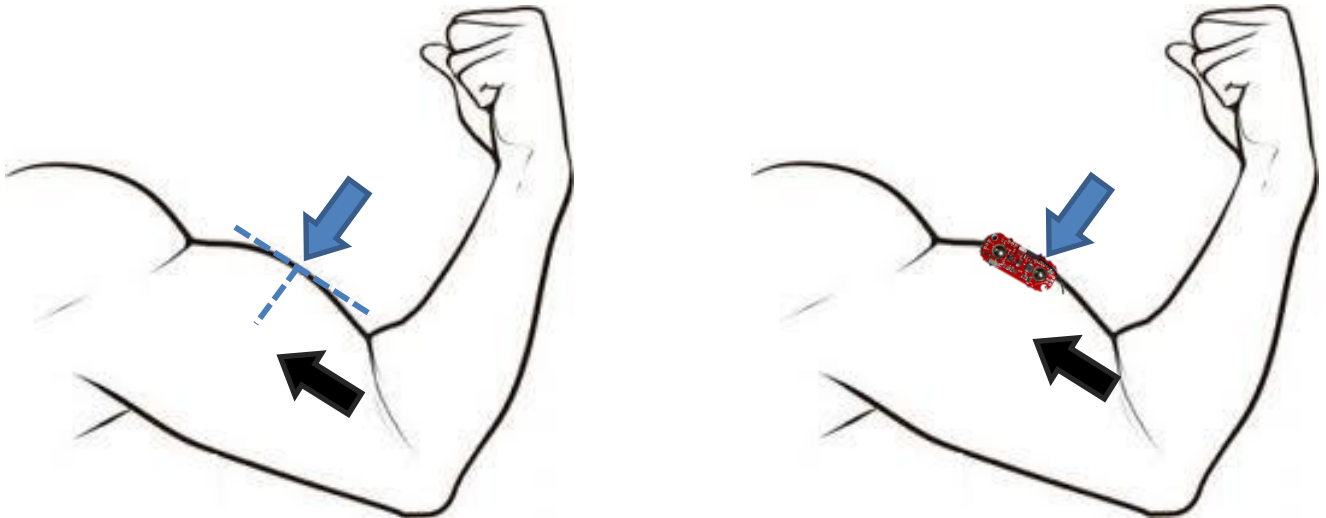
Setup Configurations (cont'd)

c) Grid powered with power and output isolation

Note: Isolation amplifier and power isolator provide isolation between user and electrical grid. *IC models are suggestions only.*

Power Isolator
(R1SE-0505-R)

Isolation
Amplifier
(ISO124)

d) Grid powered. *Warning: No isolation.*

Note: This configuration has no isolation. Usually safe but *rare situations* could create a current loop to the electrical grid. Not suitable for commercial applications.
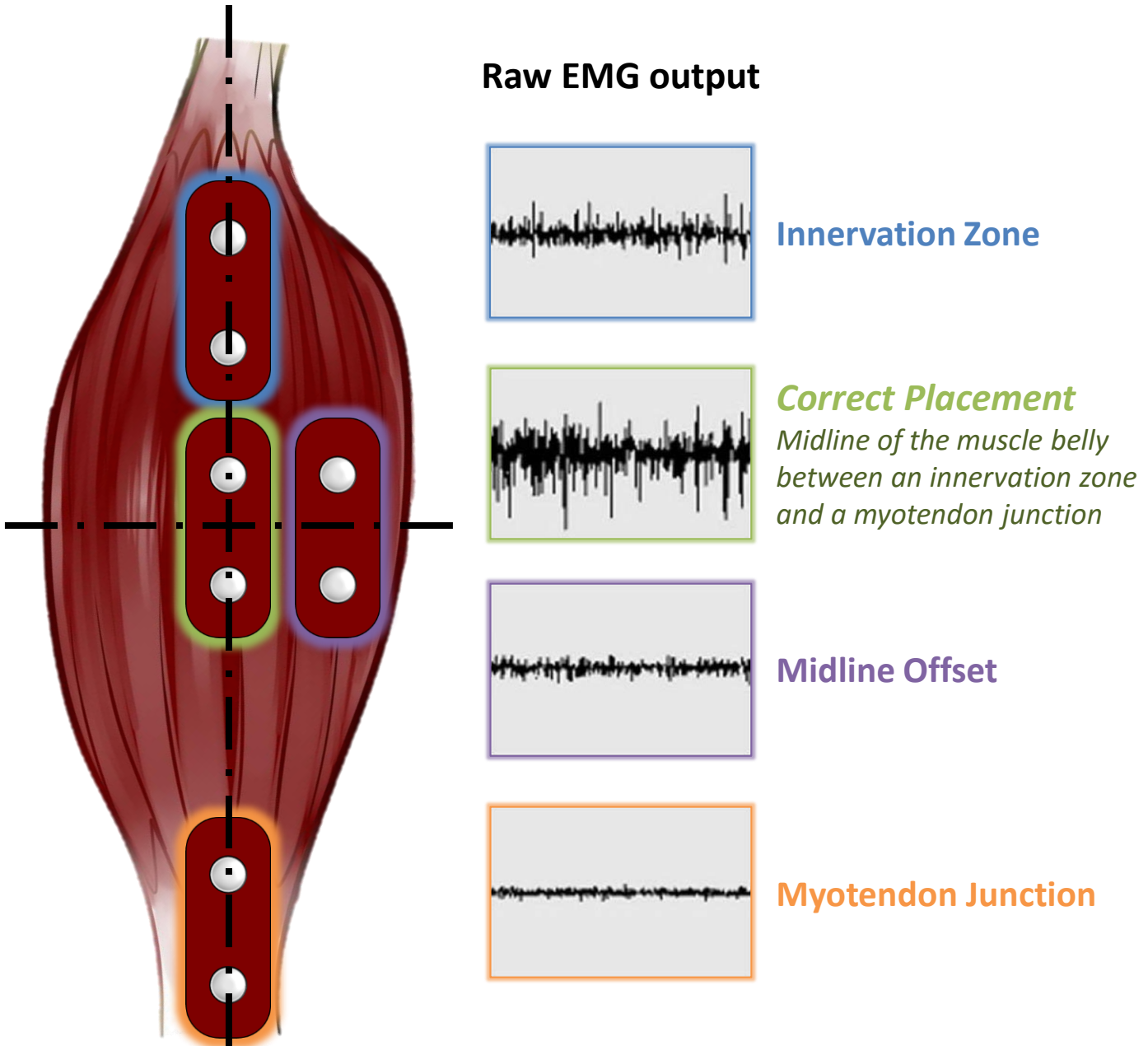
Setup Instructions

Note: Not To Scale

Example Sensor Location for Bicep

1) Thoroughly clean the intended area with soap to remove dirt and oil
2) Snap electrodes to the sensor's snap connectors
   (Note: While you can snap the sensor to the electrodes after they've been placed on the muscle, we do not recommend doing so due to the possibility of excessive force being applied and bruising the skin.)
3) Place the sensor on the desired muscle
   a. After determining which muscle group you want to target (e.g. bicep, forearm, calf), clean the skin thoroughly
   b. Place the sensor so one of the connected electrodes is in the middle of the muscle body. The other electrode should line up in the direction of the muscle length
   c. Peel off the backs of the electrodes to expose the adhesive and apply them to the skin
   d. Place the reference electrode on a bony or nonadjacent muscular part of your body near the targeted muscle
4) Connect to a development board (e.g. Arduino, RaspberryPi), microcontroller, or ADC
   a. See configurations previously shown

Why is electrode placement important?

Raw EMG output

Innervation Zone

Correct Placement
Midline of the muscle belly
between an innervation zone
and a myotendon junction

Midline Offset

Myotendon Junction

Position and orientation of the muscle sensor electrodes has a vast effect on the strength of the signal. The electrodes should be place in the middle of the muscle body and should be aligned with the orientation of the muscle fibers. Placing the sensor in other locations will reduce the strength and quality of the sensor's signal due to a reduction of the number of motor units measured and interference attributed to crosstalk.

RAW EMG vs EMG Envelope

Our Muscle Sensors are designed to be used directly with a microcontroller. Therefore, our sensors primary output is not a RAW EMG signal but rather an amplified, rectified, and integrated signal (AKA the EMG's envelope) that will work well with a microcontroller's analog-to-digital converter (ADC). This difference is illustrated below using a representative EMG signal. *Note: Actual sensor output not shown.*

RAW EMG Signal

Rectified EMG Signal

Rectified & Integrated EMG Signal

Reconfigure for Raw EMG Output

This new version has the ability to output an amplified raw EMG signal.
To output the raw EMG signal, simply connect the raw EMG signal pin to your measuring device instead of the SIG pin.

Note: This output is centered about an offset voltage of +Vs/2, see above. It is important to ensure +Vs is the max voltage of the MCU's analog to digital converter. This will assure that you completely see both positive and negative portions of the waveform.
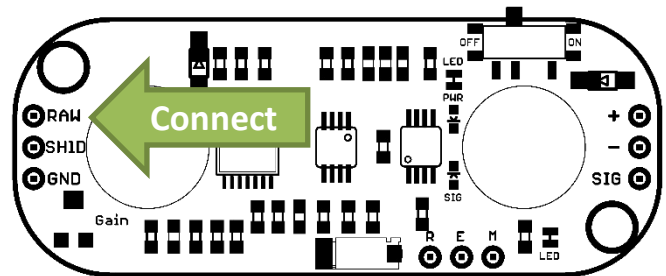
Connecting external electrode cables

This new version has embedded electrode snaps right on the sensor board itself, replacing the need for a cable. However, if the on board snaps do not fit a user's specific application, an external cable can be connected to the board through three through hole pads shown above.
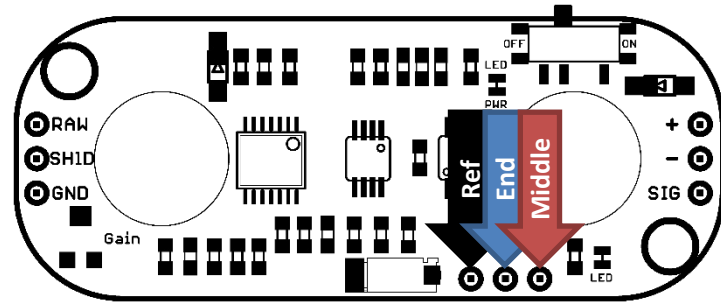
Middle
Connect this pad to the cable leading to an electrode placed in the middle of the muscle body.
End
Connect this to the cable leading to an electrode placed adjacent to the middle electrode towards the end of the muscle body.
Ref
Connect this to the reference electrode. The reference electrode should be placed on an separate section of the body, such as the bony portion of the elbow or a nonadjacent muscle
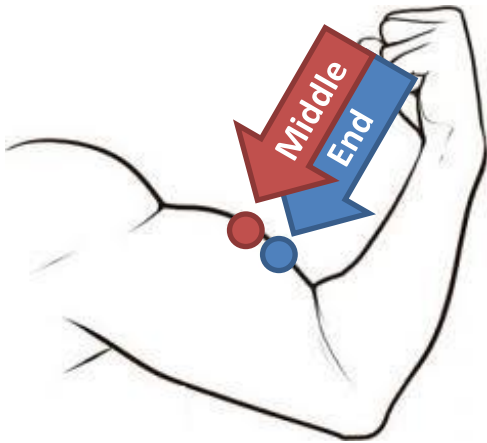
Adjusting the gain

We recommend for users to get their sensor setup working reliably prior to adjusting the gain. The default gain setting should be appropriate for most applications.

To adjust the gain, locate the gain potentiometer in the lower left corner of the sensor (marked as "GAIN"). Using a Phillips screwdriver, turn the potentiometer counterclockwise to increase the output gain; turn the potentiometer clockwise to reduce the gain.

Note: In order to reduce the required voltage for the sensor, the redesign switch out a JFET amplifier for a CMOS amplifier. However CMOS amplifiers tend to have slower recovery times when saturated. Therefore, we advise users to adjust the gain such that the output signal will not saturate the amplifier.

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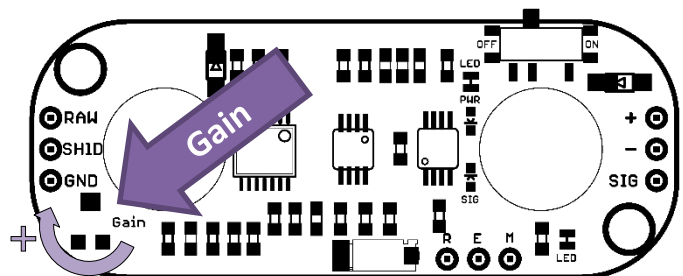
Electrical Specifications

Parameter	Min	TYP	Max
Supply Voltage	+2.9V	+3.3V or +5V	+5.7V
Adjustable Gain Potentiometer	0.01 Ω	50 kΩ	100 kΩ

Output Signal Voltage
    EMG Envelope
    Raw EMG (centered about +Vs/2)
	0V
	0V
		--
		--
			+Vs
			+Vs

Input Impedance	--	110 GΩ	--
Supply Current	--	9 mA	14 mA
Common Mode Rejection Ratio (CMRR)	--	110	--
Input Bias	--	1 pA	--

Dimensions