

## HEADSTAGE CONNECTIONS

Ground and Reference placement is important in all headstage configurations. They determine the operation of the headstage and can, if incorrectly wired, produce undesired results. This guide illustrates several examples of single and multiple headstage configurations for both single-ended and differential operation. High channel count recordings (implemented either with PZ or multiple Medusa preamplifiers) typically require the use of multiple headstages.

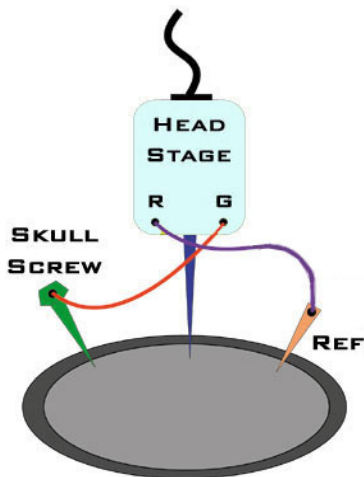
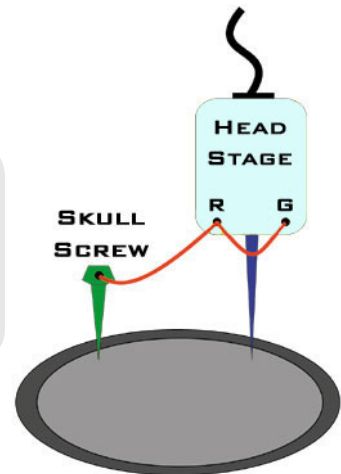
In this guide, single headstage configurations are described first followed by multiple headstage configurations. A common error example is provided for the final illustration.

**Important!:** When using multiple headstages, ground pins on all headstages should be connected together to form a single common ground. This ensures that all headstage ground pins are at the same potential and eliminates additive noise from varying potentials across the subject's brain.

### Single Headstage Configurations

#### Configuration 1: Single headstage with a Shared Ground and Reference

When using a single headstage with a shared ground and reference, the ground and reference pins of the headstage should be tied together. A ground is used and attached to a skull screw. All recordings will reference this connection. This configuration is referred to as "Single-Ended".



#### Configuration 2: Single headstage with a Separate Ground and Reference

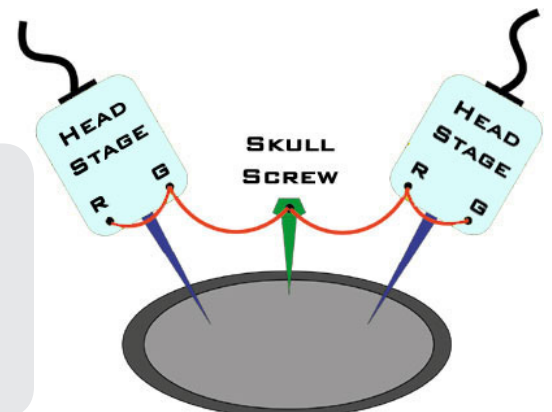
When using a single headstage with a separate ground and reference, it is important that the headstage itself is not single-ended, that is, its ground and reference pins are NOT tied together. This will allow the headstage to reference each channel to ground as well as an additional chosen site on the subject. This configuration is referred to as "Differential".

### Multiple Headstage Configurations

**Note:** All headstages must use the same Ground wire. But not all headstages need to use the same Reference wire.

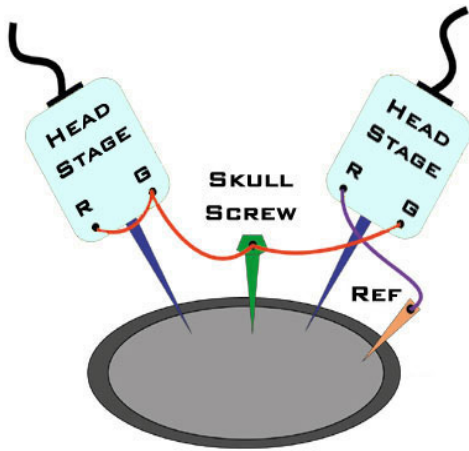
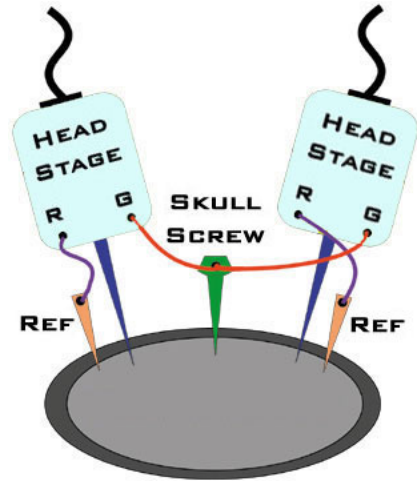
#### Configuration 3: Multiple headstages with a Shared Ground and Reference

When using multiple headstages with a shared ground or reference, the ground and reference pins of each headstage should be tied together. A ground is used and attached to a skull screw. This ground is used by all headstages and ensures the headstages are referencing the same potential. This is a multiple single-ended configuration.



**Configuration 4:** Multiple headstages with a Single Ground and Multiple References

This configuration uses multiple differential headstages each with their own separate references. Notice that all the headstages' ground pin are tied together. This is a multiple differential configuration.



**Configuration 5:** Multiple headstages with a Shared Ground and different Ground/Reference configurations

When using multiple electrodes with a shared ground and separate reference, all headstages' grounds are connected to the skull screw. A reference wire is present and connected to the desired headstage. This ensures all headstages have the same ground potential and provides a reference for the desired headstage. This configuration uses a mixture of single-ended and differential headstages.

Alternatively, to use a single reference for all headstages you may tie all headstage reference pins to the site labeled "Ref".

**A Common Error**

**Common Error:** Multiple headstages with Multiple Grounds and Multiple References

When utilizing multiple headstages a common error is to connect separate grounds for each headstage. This allows additional noise to corrupt signals increasing the number of artifacts present. To avoid this, ensure that all headstage ground pins are wired as a single ground.

