DUAL-PURPOSE EEG/EKG INSTRUMENTATION AMPLIFIER

Schematic by Adam Overton

last updated 01/2005

DISCLAIMER

WARNING: By using this schematic you, the user, must assume all responsibility for any accident, injury or mortality that may ensue. This circuit is neither "tried-and-true" nor certified to work and is NOT covered by any warranty or claims of safety. Rule #1 for using any sort of electronics, especially those that may come in contact with the body is to NEVER EVER use an AC power source - Only Use DC Power!! And, never connect any portion of this circuit's inputs or outputs to any devices that are AC-powered. In any case: USE AT YOUR OWN RISK

This circuit was designed with the gracious and masterful assistance of David Rosenboom at the California Institute of the Arts between Sept 2003 and March 2004. We used schematics from the HAL EEG ("Computers On the Brain" by Steve Ciarcia, in the June 1998 issue of BYTE magazine) combined with schematics from David Rosenboom's Biofeedback and the Arts (available thru Frog Peak Press, p.123). Additional help came from Ron Kuivila who showed us how to properly modulate the signal in order to get it past the computer's sound card input (which likes to discard all frequencies below 20 Hz). I subsequently have used it successfully in several performance pieces where SuperCollider software is used to demodulate and analyze the heart and/or brainwave signals. This schematic only demonstrates how one a 1-channel device can be built, but it can be expanded to two channels very simply by sharing a TL084 (IC[2]). In my own box, I have four channels of interchangeable EEG or EKG.

For more information on this circuit, how to use it, and how it's been used, please visit:
http://calarts.edu/~aoverton/Resources/EEG_EKG/schematics.php

Required IC's for 1 channel of EEG/EKG:

SIGNAL ACQUISITION & AMPLIFICATION
- 2 x TL084 (IC[1] & IC[2])

MODULATION STAGE
- 1 x Quad Bilateral Switch -- CD4066BC (IC[4])
- 1 x MM74C14 Hex Schmitt Trigger (IC[5])

Required IC's for 2 channels of EEG/EKG:

SIGNAL ACQUISITION & AMPLIFICATION
- 3 x TL084 (IC[1], IC[2] & IC[3])
  -- IC[3] is shared by both channels on the latter high-pass & low-pass filtering stages

MODULATION STAGE
- 1 x Quad Bilateral Switch -- CD4066BC (IC[4])
- 1 x MM74C14 Schmitt Trigger (IC[5])
  -- IC[4] and IC[5] can be shared by both channels during the modulation stage

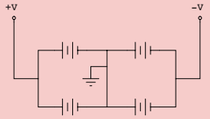
** For typical perfboard use, make sure all the chips are Dual-In-Line (PDIP)
-- this is usually indicated by adding 'N' to the end of the chip #, for instance CD4066BCN

POWERING THE DEVICE

I believe the entire device requires +/- 12V to 15V to work.
We used 4 x 9V batteries: 2 sets of 2.
To get a +V, -V and GND/V_{ss} from 4 batteries:

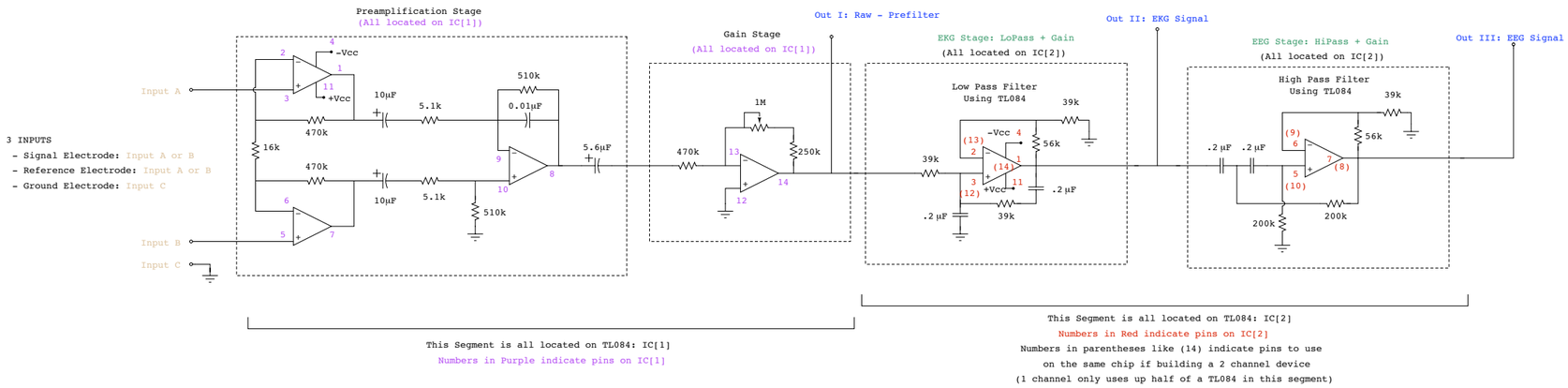
- Connect the +V of one to -V of the other
  -- this gives you your GND/V_{ss}
- Then use the remaining unused poles as your +V and -V
- Finally, combine the +V's, -V's and GND's of the 2 battery pairs

See the diagram below



In this circuit, I labeled the power sources on the chips according the manufacturer's data sheets, however in use I have assumed the following:

* V_{cc} is treated the same as V_{DD}
* GND is treated the same as V_{ss}



MODULATION CIRCUIT

If modulation is desired, feed any of the signals from above into the following modulation circuit. It uses a Schmitt Trigger pulsing at a frequency of around 10 kHz to chop the incoming AC biosignal via an analog switch (CD4066BC). As a result the low frequency input signal slowly modulates the steady Schmitt generated square wave. I then use a very simple envelope follower (implemented in SuperCollider software) to get the original signal back to normal. This modulation circuit is needed if you're trying to get the biosignals into the computer via the sound card; I contacted most every sound-card manufacturer and all of them reported that their devices are programmed to automatically filter out all frequencies below 20 Hz, which is where most of the biosignal activity exists.