Design of Two Instrumentation Amplifier Circuits

Project 2

ECE 6400 Electronic Instrumentation

Summer II 2008

version 9 July 2008

1. Design of a Micro-Electrode Array Preamplifier

A micro-electrode array is essentially a Petri dish with an array of microelectrodes plated onto the bottom of the dish. Neurons, grown on top of these electrodes, connect to one another to form biological neural networks. These electrodes are used to measure and stimulate the electrical activity of these neural networks to study the effects of pharmacological agents, network formation, learning mechanisms, etc. [1]

Neurons (and electrodes) are bathed in a solution necessary for neuron growth and function. A reference electrode placed in the solution is considered to be the signal ground. Electrodes enable measurement of extracellular voltages with respect to the reference node.

Assume that the electrode voltages are sinusoidal with peak-to-peak voltage $\leq 100\ \mu V$ with frequencies ranging from 30 Hz – 3 kHz. Also assume that electrodes can have a DC offset ranging from -100mV to 100mV. Your electrode preamplifier must provide a voltage gain of 50 V/V while blocking any DC component. Assume that the electrode can be modeled as a voltage source with an output resistance of 100 kΩ (see [2] for a more complete discussion of these values). The design must utilize a Linear Technology LT1167 instrumentation amplifier.

a. Based on the above description, develop a list of quantitative specifications for your preamplifier. What is your recommendation for an acceptable CMRR? You need not worry about the upper frequency of the amplifier pass-band; a later project will add a suitable low-pass filter.
b. Design your preamplifier around the LT1167 instrumentation amplifier (you will need to read the LT1167 datasheet).
c. Use only standard value components. You must use Digi-Key (digikey.com) as the parts provider. Provide a spreadsheet that lists all parts (description and Digi-Key part number), cost per part, and total cost for your design.
d. Use LTspice/SwitcherCAD™ to test your design to insure that all specifications are met.
e. Evaluate the CMRR performance of your preamplifier using LTspice/SwitcherCAD™.
f. Prepare a report that summarizes your design and includes all requested information.

2. Design of a Transducer Bridge

Using a Honeywell RTD (Resistance Temperature Detector) TD4A (Digi-Key part # 480-2016-ND) design a transducer bridge that will translate a -40° C to 160° C liquid temperature into a 0 to 10 V voltage.

a. Use only standard value components. You must use Digi-Key (digikey.com) as the parts provider. Provide a spreadsheet that lists all parts (description and Digi-Key part number), cost per part, and total cost for your design.
b. Use LTspice/SwitcherCAD™ to test your design to insure that all specifications are met.
c. Evaluate the linearity of your design by comparing the actual voltage vs. temperature graph to an ideal voltage vs. temperature graph that would be obtained with an ideal RTD.
d. Prepare a report that summarizes your design and includes all requested information.

Reminders

1. Projects are to be completed on an individual basis.
2. You may NOT use any references other than your text, references cited in the project description, or references cited in the syllabus to complete this project. If you use one of these sources, CITE the source!

References

[1] S. Marom and G. Shahaf, "Development, learning, and memory in large random networks of cortical neurons: lessons beyond anatomy," *Quarterly Review of Biophysics*, vol. 35, pp. 63-87, 2002.
[2] R. A. Blum, J. D. Ross, E. A. Brown, and S. P. DeWeerth, "An integrated system for simultaneous, multichannel neuron stimulation and recording," *IEEE Transactions on Circuits and Systems—I*, vol. 54, pp. 2608-2618, 2007.