A Custom EIT System Based On Off-The-Shelf Equipment

Thomas Dowrick[1], Camille Blochet[1], Nicolas Chaulet[1] and David Holder[1]

[1]Department of Medical Physics, University College London, London, United Kingdom, t.dowrick@ucl.ac.uk

Abstract: The construction of an EIT system using a commercially available current source and EEG amplifier is discussed. The Keithley 6221 current source offers functionality equivalent to that of existing bespoke systems, alongside the ease of use of a commercial system. When combined with a BioSemi EEG amplifier, a full EIT system is produced. Analysis of the signal quality of the source and imaging experiments on a saline tank verify the feasibility of the approach.

1 Introduction

The main components of an EIT system are a current source and a voltage measurement unit. Both are typically constructed from discrete components, or manufactured as custom PCBs/ICs [1-3]. Such approaches work well, especially in instances where the system requirements are well defined. However, such systems can be heavily reliant on the end user, who may not be an engineer, being familiar with the intricacies of the underlying electronics. There can also be significant lead times relating to the design and manufacture of such equipment.

Advantages are available if flexible EIT systems can be built using commercially available equipment. To this end, the suitability of the Keithley 6221 current source for EIT imaging is investigated.

2 Hardware & Results

The Keithley 6221 Current Source is most commonly used for the test and evaluation of semiconductors and nanotechnology devices. However, its ability to accurately source small AC currents (2pA – 100mA) up to a frequency of 100kHz, coupled with a very large output impedance ($10^{14}\Omega$), excellent stability, simple interface and the ability to produce composite waveforms make it highly suited for use in an EIT system.

Key requirements of an EIT current source are low noise and stability across variations in load, current magnitude and frequency The noise magnitude and variations across different current amplitudes and frequencies are shown in Figure 1. It can be seen that the noise level has a maximum of ~0.06%, which is comparable to that of existing EIT systems [4]. The noise is largely invariant with the applied current magnitude, and decreases as the frequency is increased. The large output impedance of the current source gives an extremely stable signal across different loads; variations of approximately one part in a million were seen when the load was varied between 100Ω and 100kΩ.

To test the ability of the current source to produce EIT images, the 6221 was used in conjunction with an EEG system [5] for measurement, to image a Perspex rod in a 32 channel, saline filled tank. A simple switching system, based on the ADG714 and controlled via an Arduino was used to control the injection pattern. The entire system was controlled serially though a MATLAB interface. Figure 2 shows the result of the imaging experiment.

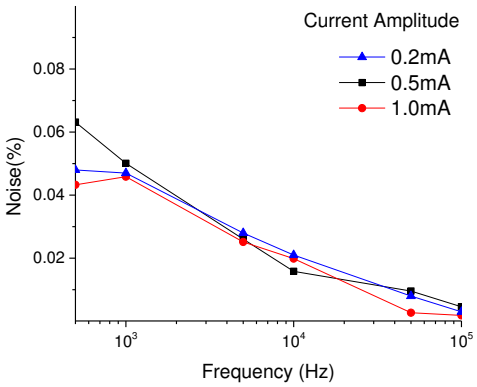

Figure 1: Noise levels, as a percentage of the mean voltage at the frequency of interest, measured across a 1kΩ resistor over 1000 cycles.

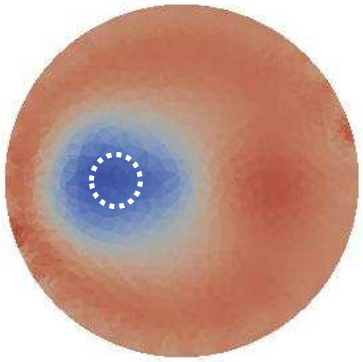

Figure 2: EIT image of a saline tank. The white dashed line indicates the position of the Perspex rod.

3 Conclusions

An EIT system has been presented that uses an off the shelf current source, which offers advantages in terms of flexibility and ease of use when compared to existing systems, while maintaining comparable, or better, functionality. The noise in the system is comparable to existing EIT current sources and the load regulation is excellent. Having established the feasibility of the approach, the system can be used for a broader range of imaging experiments, including more challenging tank imaging, animal studies and human trials.

References

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