Nanosymposium

116. Techniques in Electrophysiological Recording and Stimulation

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Title: Towards an implantable integrated neural recording system for neonatal mice.

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Abstract: The recording of neural signals from the brain of neonatal mice is of interest for the understanding of the functionality of the brain and its development processes. Treatments for certain forms of neural diseases like epilepsy are investigated with the help of neural recordings from mice [Marguet, Nature Medicine 21, 1436-1444, 2015]. For a systematic investigation of these processes, long term neural recordings of neonatal mice are needed. Neonatal mice have a weight of only 3 - 5 grams; commercially available recording systems are much too heavy and large for this application. To overcome this, an implantable neural recording system is proposed that can be placed inside a neonatal mouse (back, neck and head) and record Low Field Potentials (LFP) and Action Potentials (AP) from the brain. The system is connected via a connector at the back of the mouse to a data acquisition system. The miniaturized system consists of a Neuronexus silicone probe, a custom designed Application Specific Integrated Circuit (ASIC) and a connector (Omnetics). The analog signals are recorded, digitized in close proximity to the brain and transmitted via a digital interface. The components are placed on flexible substrate which provides a better handling for the surgeon. The integrated circuit has a size of only 1.5 x 1.5 mm2. It is wire-bonded onto the substrate, the analog inputs are bonded directly to the electrode to reduce the wiring and minimize the exposure to noise for the sensitive analogue signals. The ASIC is designed in a 130 nm CMOS technology, comprises 16 analog channels, preamplifiers, multiplexer, a post amplifier with switchable gain and a 10 bit SAR ADC. The analog signals are digitized with 20 kSample/s/channel and transmitted via an SPI Interface [Bahr, BIOSTEC, V1 263-269, Italy, 2016]. The ASIC was successfully implemented and used in a neural recording from a mouse (Bahr, BMT, 2016). A version with increased bandwidth (0.1 Hz to 10 kHz) has been designed. A prototype is constructed using wire-bonding, the ASIC is bonded onto the PCB, the electrode is connected via an Omnetics connector. The size of the ASIC is small enough to fit into the long term neural acquisition system. This shows the suitability of the proposed design. The results show that the custom designed ASIC is suitable for the proposed system. The used advanced 130 nm CMOS technology is suitable for mixed signal and analog design implementation for biomedical signal acquisition. The technology is power efficient and it enables the required size reduction for the implantable

system. With these results it could be shown that the proposed neural recording system can be realized for long term acquisition from neonatal mice.

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