ASIC development for 3D ultrasound computer tomography

Introduction

3D Ultrasound Computer Tomography is a novel method for early detection of breast cancer developed at IPE. The 3D USCT device contains about 2000 ultrasound transceivers placed in a half spherical reservoir filled with water. The transducers are grouped in groups with 18 devices, each group is driven and readout with two USCT9C ASICs that are developed in our group.

Figure 1: 3D ultrasound device

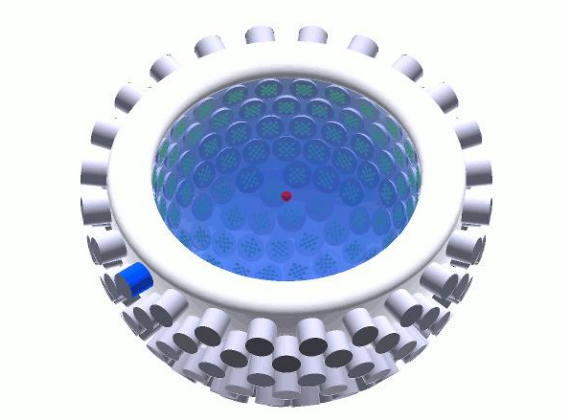

Figure 2: Half spherical reservoir with ultrasound transceivers

Figure 3: Back side of the reservoir, the transceivers are placed in cylindrical cases ("heads")

USCT ASIC

Every ASIC contains nine high voltage analogue drivers and three low noise receivers. The high voltage driver generates output signals with amplitude of 120V. The bandwidth of the amplifier is about 5MHz. The receiver is implemented as a three-stage amplifier; every stage is a voltage amplifier with feedback that uses a single ended inverting amplifier as the active element. The feedback can be configured in

the way to provide wide band (0.1 – 5MHz) and narrow band amplification. Frequencies and amplification can be varied. Input referred noise less than 10µV was simulated.

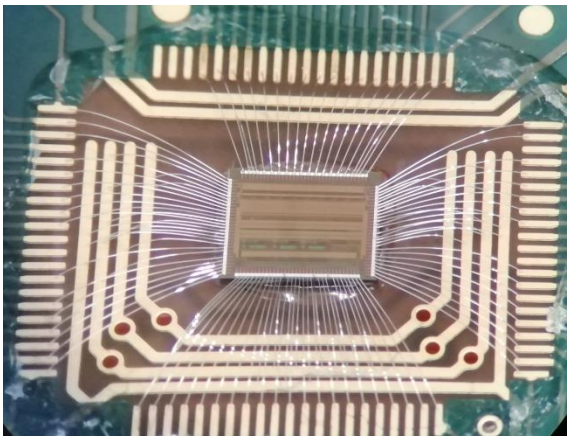

Figure 4: USCT ASIC

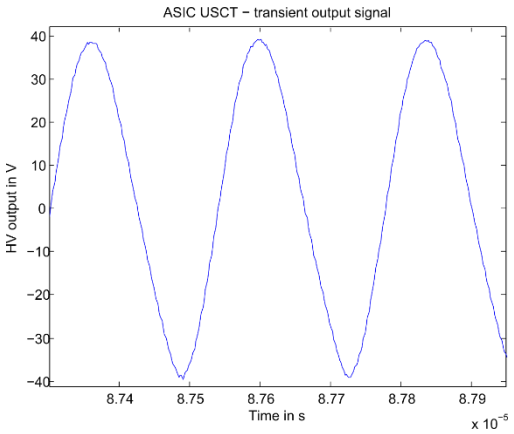

Figure 5: Waveform of the driving signal

One 3D USCT device has been already build. First tests are promising, images of excellent quality can be obtained.

Theme of the thesis

On drawback of the present readout scheme is high complexity. More than six hundred analogues signals are transmitted from ASICs to the ADC cards. If ASIC contained ADCs, the back-end electronics would be purely digital, much simpler and the number of signal lines could be reduced by multiplexing. Another drawback is the use of customized transducers that are wire bonded to the ASICs. New CMUT technology would allow direct implementation of the transducers on the ASICs.

The result would be much simpler and cheaper device, which could be afforded even by small doctor's offices.

For the development of USCT ASIC we need support, and we offer master and bachelor theses and internships. You would learn to design and to test ASICs by working on development of a new medical imaging device that is much simpler than MRT and do not relay on x-ray radiation as CT.

We plan a development of USCT ASIC. In this thesis, the existing USCT ASIC would be revised, and the new ASIC would be implemented in a 180nm HV-CMOS technology. Some circuits (for instance the high voltage amplifier) would be ported from the old technology with small schematics changes. Some circuits would re-designed (low voltage amplifier, digital interface, multiplexer, clock generator) and

some would be based on existing building blocks in 180nm process (e.g. the ADC). The ASICs would be designed to be compatible with CMUT technologies.

Required skills:

Basic knowledge of ASIC design (e.g. obtained within courses DAS, DDS or PSCOC) is beneficial.

Duration: 6 months

Language: English or German

Location: Building 242 (IPE), Campus North

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