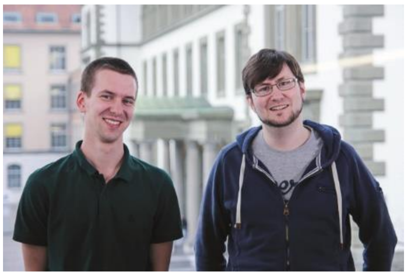
Zurich University
of Applied Sciences

School of Engineering
InES Institute of Embedded Systems

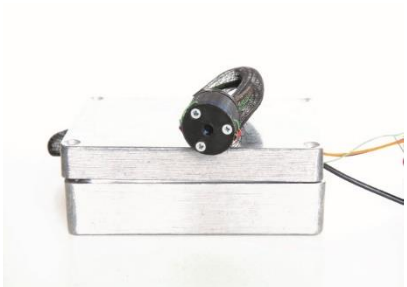
Optical Oxygen Sensor based on FPGA

Measuring the oxygen concentration in liquid and gaseous substances is of great importance in various areas, such as food production, chemistry, medicine or environmental monitoring. This requires reliable, precise and cost-effective oxygen sensors. An optical sensor is particularly well suited to measure oxygen both in gas and dissolved in a medium. The starting point of this thesis was a previous bachelor thesis, in which an optical oxygen sensor based on a PtTFPP luminophore was developed, whose signal processing was realized on an FPGA. In this work the concept for the oxygen sensor was further developed focusing on cost reduction and miniaturization. This resulted in new requirements for the electronic and digital filters and amplifiers, but also for the VHDL code. The amplifiers and filters were redesigned and the VHDL code adapted. The new design allows a massive miniaturization and cost reduction by completely eliminating the expensive optical filters and choosing a new approach to excite the luminophore. Instead of exciting the luminophore from the front as before, we placed the LEDs by 120° around the luminophore, partially exploiting total reflection in the glass support of the luminophore. Instead of measuring the phase shift via the sinusoidal excitation of the luminophore, we followed the approach of exciting the luminophore with pulsed light and measuring the intensity-decay curve of luminescence. The signal of the photodiode was folded with a sine, which in turn leads to a phase shift. The phase detection is carried out using the lock-in method. The maximum measurable phase shift of the final product between air and nitrogen is 3°. Although the oxygen-dependent phase shift of the luminophore is expected to be temperature dependence, it was not possible to distinguish clearly between temperatures due to the limited sensitivity of the sensor. The oxygen sensor developed in this thesis is significantly smaller and less expensive at costs of the sensitivity. The sensor measures 2.5 cm in diameter and 1.5 cm height. Compared to last year's bachelor thesis the costs could be reduced considerably, since no optical filters were used. The precision of the sensor would improve significantly with a better designed amplifier part, as the high noise would be reduced and the averaging of the measured values could be reduced or even omitted.

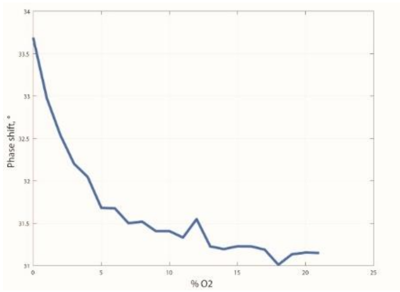


Diplomierende
Levin Angst
Marcel Hermann Wegmann

Dozierende
Matthias Rosenthal
Francesca Venturini



Oxygen sensor on amplifier box



Phase shift with respect to oxygen concentration