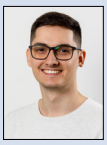

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Subject Area	Sensorics
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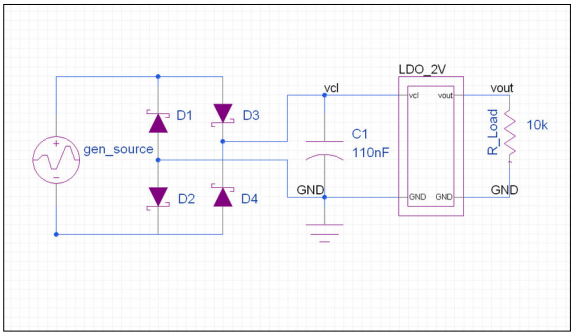
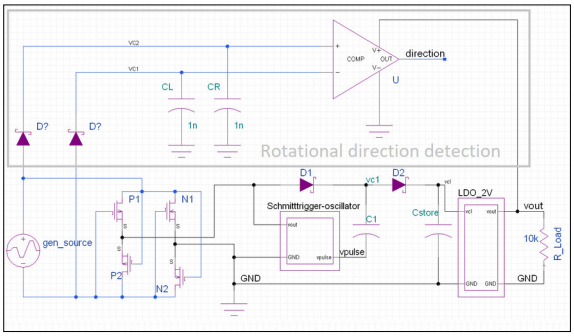
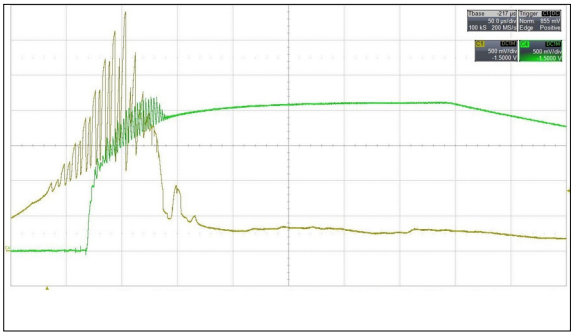
Energy harvesting with a micro generator



Schematic used in earlier versions of the generator
Own presentment



Our proposed schematic
Own presentment



Output voltage (green) versus input voltage (yellow)
Own presentment

Initial Situation: The project partner has developed a micro-generator generating an energetic voltage impulse based on energy harvesting principles. The energy of this voltage pulse is used to wake up the electronics, detect the direction of the impulse, read the last position from a non-volatile memory, determine the current position and write it into the memory. The current micro-generator shall be optimized. This, in consequence, will lead to considerably less energy.

Approach: The main task of this thesis is to generate a constant voltage of 2V that lasts as long as possible. This process is divided in three main steps; first, the voltage generated by the micro-generator needs to get rectified, the produced energy will then have to be stored in a capacitor and as a last step a constant voltage output has to be generated by a voltage regulator. As for the rectifier, two versions were analyzed: a full bridge rectifier with Schottky diodes and a rectifier with MOSFETs.

Since the generated voltage might be less than 2V, it needs to be stepped up first. This is done by a charge pump. Several different charge pumps and step-up converters were analyzed and tested with different types of clocks.

Result: The result of comparing the two rectifiers shows that the MOSFET rectifier itself is roughly 13% more efficient than the diode rectifier because there is no diode voltage drop. However, in the final system design, the MOSFET rectifier does not show any significant advantages.

Of all the charge pumps and oscillator that were tested, the Dickson charge pump using an a-stable multivibrator built with a Schmitt-trigger as a clock was the most efficient one. Nonetheless, the results with a charge pump were worse than just using a capacitor and an LDO after the rectifier. By using the rectifier-capacitor-LDO variant, a constant voltage of 2V was achieved for 600us. With the charge pump after the rectifier, a constant voltage of 2V was achieved for roughly 300us. This leads to the result that the idea of stepping up the voltage with a charge pump does not lead to the intended result. The power consumption of the oscillator is too high.
The detection of rotational direction however did work as intended, using only two diodes, two capacitors and a comparator.

The final conclusion is that the generator needs to output a peak voltage much higher than 2V.