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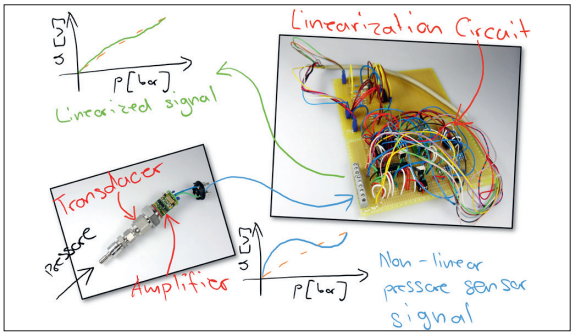
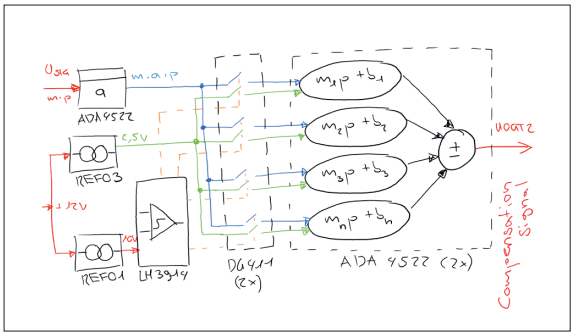
Development of an Analog Pressure Sensor Linearization Concept

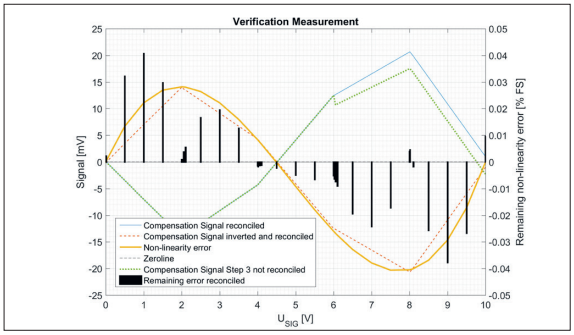
Bachelor Thesis in Mechanical Engineering



Overview of the solution. The blue line in the diagram illustrates the typical third-order non-linearity



Explanatory drawing for introducing the used analog parts to build the in different areas divided linear compensation signals



Verification measurement. The maximum remaining non-linearity error is about 0,04% FS

Introduction: The real sensor (transducer) characteristic curve of a pressure sensor is non-linear due to production errors and physical conditions. The accuracy of a sensor is indicated by the remaining error of a linear approach. The blue line in the figure shows a third-order non-linearity. STS developed a method to compensate the second-order non-linearity error by the analog way over a feedback loop. However, the latest concept of STS is not able to reduce a third-order non-linearity optimally. The main goal of this Bachelor Thesis was to explore the possibility of reducing the third-order non-linearity error better than by the latest concept of STS.

Approach/Technologies: Firstly, a STS approach was tested. Unfortunately, it did not work. Thus, new concepts were developed and tested. Further, many transducers were measured to get some data of the sensors characteristics for possible verification measurements. The knowledge of these measurements was used to develop new concepts. Only one concept was possible to be designed and built. This concept works by approximating the non-linear shape of the transducer signal. This approximated signal (compensation signal) will be subtracted from the raw signal of the transducer. Thus, the non-linearity of the transducer decreases. The other concepts were nice and interesting, but they are not easy or impossible to design to reach the given accuracy goal. The figure illustrates an explanatory drawing of the built analog circuit. The signal of the transducer will be amplified by the state of the art differential amplifier (named USIG). To compensate the non-linear signal, different linear signals are used. According to the raw signal of the transducer, the gain and offset of these linear signals change towards pressure. These functions were calculated in advance.

Result: It can be clearly seen that due to the approximation the remaining error (bar plot, right y-axis) decreases from approx. 0,15% FS to max. 0,04% FS. Some disadvantages such as a lot of parts and a lot of customized resistors for each transducer (to build the linear signals) are unavoidable and must be taken into account if the advantages of an analog concept shall be used in real applications. Finally, it can be said that additional investigations have to show how the gained knowledge of this thesis can be used for the next generation of analog STS sensors.