Pressure Sensing

Introduction

The measurement of pressure, stress, strain or force is critical in many industrial applications in avoiding catastrophic events. For example, the pressure inside a boiler needs to be monitored and action taken if the measured pressure exceeds the rated maximum pressure for the boiler. Pressure sensors have applications in medical instrumentation, altitude and barometric measurements, consumer devices and wearables and are also used in flow measurement, level or depth sensing and leak testing.

There are various measurements of pressure, for example

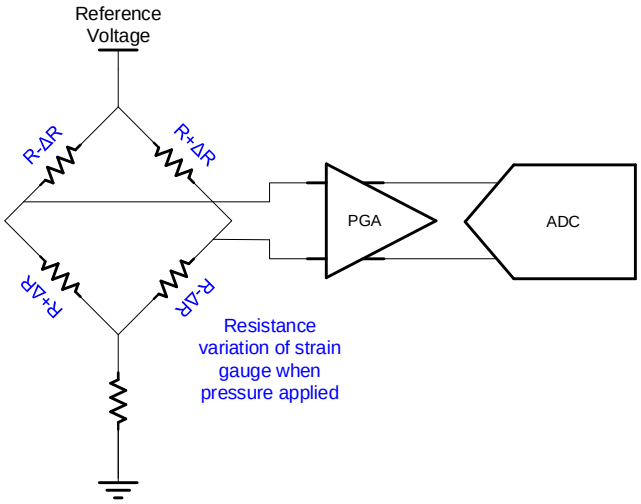
- absolute pressure, the pressure relative to a perfect vacuum, for example atmospheric pressure
- differential pressure, the difference in pressure between two points, for example in flow measurement
- gauge pressure, the pressure relative to ambient pressure around the sensor, for example tyre pressure

These measurement types are distinguished by the reference pressure, so some sensors are capable of recording all types.

Pressure sensors

Pressure sensors are often called pressure transmitters or transducers, where the signal from a pressure sensor is converted to an electrical representation and ultimately digitised as input to a feedback control system. There are many types of pressure sensors available, depending on the type of pressure being measured. For example, differential pressure measurement to calculate flow may use a pitot tube. Capacitive and piezo resistive pressure sensors are common in measuring gauge pressure. These are usually based on a strain gauge consisting of a diaphragm with bonded piezo resistors whose resistance changes when the gauge is stretched or compressed. These variable resistances are arranged in a form that can be represented electrically as a Wheatstone Bridge, and driven by voltage or current references. When one or more gauges is subject to stress, its resistance changes and a voltage, ratiometric with the applied reference voltage, appears at the output of the Wheatstone Bridge which can be conditioned and digitised.

Critical specifications of pressure sensors include sensitivity, linearity and response time. However, given the often harsh environmental operating conditions, hysteresis, reproducibility and long term stability are also vital.



Pressure sensor signal chains solutions

Pressure sensor signal chains involve various elements. A stable voltage or current reference is required as excitation signal for the bridge. Often multiple pressure sensor inputs are catered for with an input multiplexer. The sensitivity of the pressure sensor is usually relatively low, in the order of millivolts per volt of applied reference voltage, producing a signal in the order of tens millivolts for reference voltages of a few volts. A precision programmable gain stage is required to amplify this to the level of the ADC input range. This gain stage may also incorporate filtering to reduce noise. A high-resolution low latency ADC with fast settling is ideal in order to facilitate multiplexed measurements from different sensors. Linearization of the sensor may also be required, often involving the use of look-up tables.

Adesto Pressure Sensing Solutions

Adesto's pressure sensing reference signal chain can be readily integrated into an SoC. Constituent elements of that signal chain are readily available in our silicon proven mixed-signal IP repository. A PGA such as the S3PGAC40LP, together with the low-power 14bit SAR ADC, S3ADS1M14BT40ULP completes the signal chain. A 16:1 input mux, can also be incorporated into the signal path to accommodate complimentary temperature sensing. All other elements of the signal path, such as the signal conditioning and digital filtering can be readily integrated with the converters on a single SmartEdge™ ASIC. No more need for discrete components to build that pressure sensor.