AND9210/D

Pressure/Proximity Smart Passive Sensor Reference Design[1]

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APPLICATION NOTE

Principle of Operation

The self-tuning Chameleon™ technology in ON Semiconductor's Smart Passive Sensors powered by a Magnus®−S integrated circuit (IC) enables the development of low-cost passive sensors targeting a wide variety of applications.[2] This reference design note presents a Smart Passive Sensor for pressure or proximity sensing using a Magnus−S IC and a conventional compact dipole antenna augmented with a simple floating sheet of metal. The sensor exploits the basic electromagnetic effect where a sheet of metal brought in proximity to an inductive loop lowers the inductance of the loop due to eddy currents generated on the sheet of metal. The closer the sheet gets to the loop, the lower the inductance.

Conventional dipole design for RFID tags uses a small inductive loop to tune out the input capacitance of the RFID IC. By placing a metal sheet near this inductive tuning loop, the inductance depends on the distance between the loop and the sheet. The Chameleon engine in Magnus−S detects the change in inductance and adjusts its input capacitance to maintain peak power to the die. The change in capacitance can be read from the die as a sensor code using the standard EPC™ READ command. The sensor code reflects the relative position of the sheet to the antenna inductor.

A proximity sensor mounts the tag onto one surface and a metal patch onto another surface that moves relative to the tag. As the patch moves closer to the tag, the inductance of the tuning loop decreases. The Chameleon Engine compensates for the lower inductance with higher capacitance which is then readable as a sensor code with higher value. The sensor reports closer proximity with higher sensor codes.

The proximity sensor can be converted into a pressure sensor by using a pressure-sensitive spring between the sheet and the inductor. A simple spring is a small block of closed cell foam, which changes its thickness with pressure. Higher pressure compresses the foam and brings the metal sheet closer to the inductor, lowering its inductance. Just as for the proximity sensor, the Chameleon engine compensates for the lower inductance with higher capacitance leading to a larger sensor code. The sensor reports higher pressure as higher sensor codes.

Sensor Design

The proximity/pressure Smart Passive Sensor uses a conventional compact dipole with an inductive tuning loop fabricated on 127 μm thick PET, polyimide, or other suitable plastic material. The metallization pattern is shown in Figure 1, where the typical line width and space are 1.27 mm.

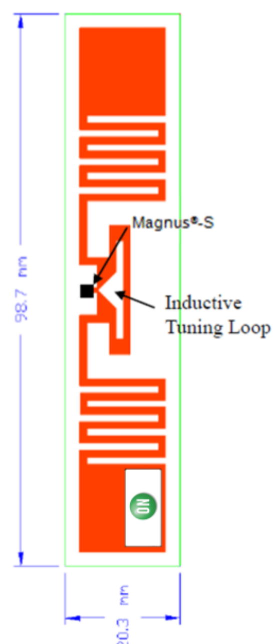

Figure 1. Metallization Pattern for a Proximity/Pressure Sensor

[1]The principles of operation and potential applications described here are for illustrative purposes only, and ON Semiconductor makes no representations regarding the accuracy or effectiveness thereof. The characteristics and capabilities of the Magnus®−S device and the Chameleon™ Engine described herein are subject to change at any time without notice by ON Semiconductor.

[2]Chameleon™ Sensors Application Note AND9209/D.

As shown in Figure 2, the sensor incorporates a metal patch about the size of the inductive tuning loop placed directly over the tuning loop. The gap between the patch and the antenna can range from about 0.5 mm to 3 mm.

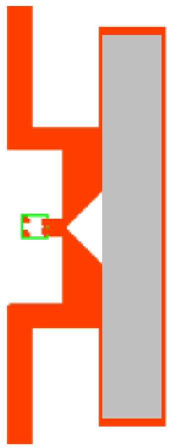

Figure 2. Inductive Loop with Metal Patch

The area enclosed by the inductive tuning loop must be tuned for the application so that the sensor code stays within its total tuning range of 0–31. The sensor code rises as the gap between the tuning loop and the metal patch decreases, so the design target would put the codes near 25 for the smallest gap and near 5 for the largest gap, leaving margin for manufacturing and environmental variations to avoid pegging the sensor at either sensor code end point (0 or 31).

Operation as Pressure Sensor

For operation as a pressure sensor, the metal patch is mounted over the tuning inductor using closed-cell neoprene foam rubber 1.59 mm (1/16 inch) thick. The sensor codes over the North America RFID band are averaged to produce a single average sensor code at each pressure. Averaging increases resolution.[2]

The performance of the sensor in a pressure chamber is shown in Figure 3. Note that the resolution of the pressure chamber is 0.5 PSI. The sensor achieves very linear response to pressure with low hysteresis. A simple linear calibration can be applied to convert the average sensor code reading directly to PSI.

Additional Applications

Pressure sensors can use low-cost closed-cell foams to implement very low-cost sensors; however, foams can take a set over time or wear out. Higher precision pressure sensors using steel springs are also possible.

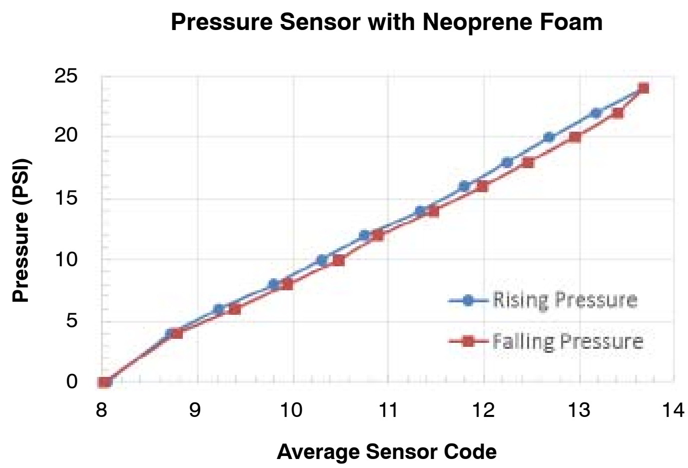

Figure 3. Pressure Sensor Performance in a Pressure Chamber Including Hysteresis

The design concept can also be considered as a metal detector, where the presence or absence of metal can be measured. The presence of metal in fluid flow in plastic pipe can be measured with potential applications in food processing.

Proximity applications also include on/off applications, such as open/closed sensors for doors or windows. As a security seal, the metal can be stripped off when a container is opened enabling the sensor to detect tampering. Conventional RFID tags can only perform this function through the destruction of the tag; leading to the possibility of false positives should the tag be missing. With Magnus–S enabled Smart Passive Sensor tags, the tag reports whether or not tampering has occurred, greatly reducing the chance of a false positive.

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