Simulation of an eddy current based inductive position sensor

First Jun Gao* [(1)], Second David E. Watson [(1)], and Marc P. Y. Desmulliez [(1)]
MicroSystems Engineering Centre (MISEC), School of Engineering & Physical Sciences,
Heriot-Watt University, Edinburgh, UK

Eddy current based inductive position sensor provides feedback information about speed, direction or distance of pieces in movement. This sensor is usually composed of a sensor head and a metal scale. The configuration adopted for this study is made of a planar differential transformer, which is composed of an emitter coil and two receiver coil pairs.

Since the magnetic field generated by the emitter coil is not uniform, there is always an offset in the output signal, which can limit the sensitivity of the sensor. In order to eliminate the offset and increase sensitivity, a new three-layer structure is proposed in this paper, as shown in Figure 1. The two coils in each receiver pair are placed symmetrically at different sides of the emitter coil. The magnetic flux passing through the two coils in the same receiver pair is always the same but with different directions. By electrically connecting the two coils together, the induced voltage in the receiver pair is neutralized, which eliminates the offset.

The properties of the proposed structure were studied numerically using the software package Ansoft Maxwell. The results show that the mutual inductance between emitter coil and the receiver coil is 9 pH when there was no metal scale. Two 0.2 mm thick copper plates were added to the simulation with 0.5 mm distance from the coil group. The mutual inductance and induced voltage change as the position of the coil above the scale changes, the induced voltage is shown in figure 2.

In conclusion, the simulation study verified that the proposed structure had nearly zero offset and good sensitivity to metal scale as predicted. Also the structure has shown potential in other areas such as non-destructive testing, metal and magnetic particles detection and proximity sensing.

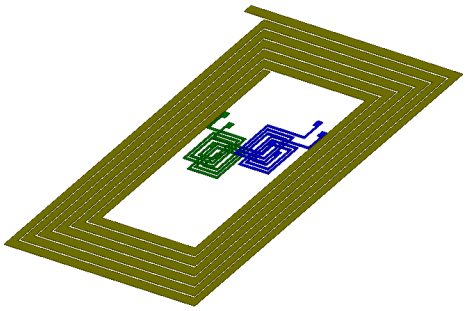

Figure 1 3D structre of the proposed structure

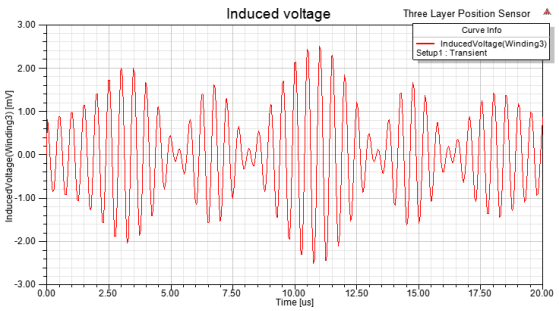

Figure 2 Induced voltage in receiver