Four types of Position Sensors

Radial Reluctance Sensors

Calnetix radial reluctance sensors consist of two pairs of diametrically opposite sensor heads aligned with the measurement axes, laminated sensor target mounted on the rotor and associated electronics. Each sensor head is composed of a laminated horse-shoe-shaped core and an electrical coil wound around it. Radial displacements of the rotor cause change in the gaps between the sensor target and the cores of the sensor heads. This leads to changes in the gap reluctances and, subsequently, coil inductances, the latter being converted by the sensor electronics into voltages representing measured displacements.

Axial Reluctance Sensors

Calnetix axial "Button-Head" sensors have a similar operating principle as the radial reluctance sensors, but use rotor axial faces perpendicular to the rotational axis as targets. The sensor is named 'Button-Head' because the shape of the sensor head resembles a button. In contrast to radial reluctance sensor targets, an axial target would be highly impractical to laminate, which negatively affects the sensor bandwidth. Fortunately, this is not an issue because the required bandwidth is lower for the axial bearings than for the radials.

Constant-Flux Axial Edge Sensors

This is a unique proprietary patented Calnetix design of an axial position sensor, which does not require an axial rotor face for a target, but instead measures axial displacements of the edges of a laminated target, similar to the one used in the radial sensors. Both the radial reluctance sensor and the constant-flux edge sensor can use the same target. One of the main advantages of this sensor is its ability to measure axial displacements tangential to the sensor in a "slide-by" mode. This arrangement greatly simplifies the machine assembly.

In contrast to the conventional "reluctance" sensors, the constant-flux edge sensor does not rely on measurements of a gap reluctance or associated coil inductance. Instead, it uses two coils, the first generates an excitation magnetic flux, whereas the second picks up a portion of this flux varying with the axial position of the rotor. The magnitude of the excitation flux is maintained constant, regardless of the radial rotor position, temperature, external magnetic field, etc., hence "Constant-Flux" is in the name. The second coil is made very thin using flexible PCB technology and placed directly into the air gap. The voltage induced in the second coil is then used as a measure of the axial rotor displacements. The constant-flux edge sensor, however, uses a soft-magnetic (laminated electrical steel) target similar to the reluctance sensors. On the other hand, it also benefits from eddy-currents induced in non-magnetic conductive media adjacent to the faces of the soft magnetic target, similar to the conventional eddy-current position sensors.

In contrast to the previously known designs of the edge sensors, which were truly “reluctance sensors,” Calnetix’s design approach results in a high signal-to-noise ratio as well as low sensitivities to radial target displacements, temperature, external magnetic fields and other factors.

CBR Eddy Current Sensors

To further improve the design of a constant-flux edge sensor, Calnetix has recently developed a unique design of an eddy-current sensor named “Combination Composite-Backiron Resonance-Drive” Eddy-Current Sensor (CBR Eddy-Current Sensor).

In contrast to the constant-flux edge sensor, the CBR eddy-current sensor does not use a laminated target on the rotor, which greatly simplifies the manufacturing process. Its eight fully identical sensor heads allow measurements of both radial and axial displacements of a rotor, with the axial displacements being measured in a “slide-by” mode. In contrast to the commercial eddy-current sensors, the CBR sensor uses twisted-pairs of lead wires instead of coaxial cables, which makes passing through machine and MBC interfaces much easier.