CEDRAT TECHNOLOGIES CONTACTLESS MAGNETIC SENSORS FOR POSITION MEASUREMENT IN THE CENTIMETER RANGE

ADVANTAGES

- Detection range: up to 4cm (Fig. 1)
- Contactless : no wear
- Compact
- Low cost
- Low power consumption
- Insensitive to dust or particle contamination
- Compatible with out-of-sight or integrated magnetic targets

Fig. 1. Magnetic sensors with up to 4cm range

APPLICATIONS

- Localisation
- Process control
- Presence detection
- Thickness measurement (Fig. 2)
- Detection of movement and deformations, measurement of speed

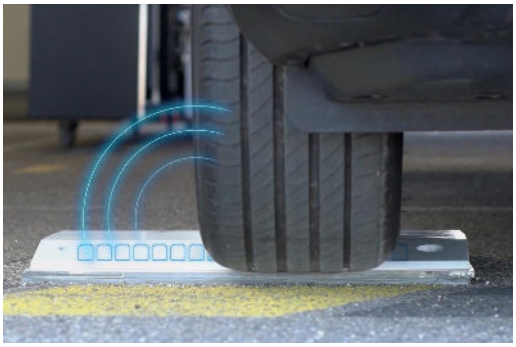


Fig. 2. Michelin QuickScan device: magnetic sensing tire rubber thickness for tire wear assessment

MAGNETIC POSITION SENSING SOLUTIONS

Depending on different parameters such as available power, sensor accuracy or dimensions, different sensor structures can be proposed by Cedrat Technologies, with detection ranges up to 40mm (Fig. 1). Hereafter 3 different structures are described:

- HMP: Hall sensor and Magnet Position sensor
- PCI: Pot shape Coil Inductive sensor
- PCT: Planar shape Coil Transformer

HMP: HALL SENSOR AND MAGNET POSITION SENSOR

The most common set-up (Fig. 3) uses a magnetic sensor coupled to a permanent magnet which is placed on the target. The measuring principle is that the field emitted by the permanent magnet decreases when the distance from the magnet increases. The magnetic sensor measures the intensity of the field, which enables to determine the distance between the sensor and the magnet. The magnetic field sensor is usually chosen among low cost Hall-effect sensors.

Using a permanent magnet as the magnetic field source instead of an active source is particularly well suited for applications with limited electrical power availability, since no power is required to generate the excitation field. Additionally, there is no need for any power wire connection.

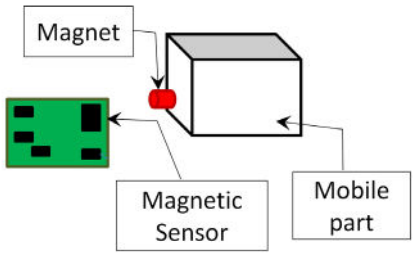


Fig. 3. HMP Magnet on target

www.cedrat-technologies.com | actuator@cedrat-tec.com

Copyright © CEDRAT TECHNOLOGIES | 04/2022

www.cedrat-technologies.com | actuator@cedrat-tec.com

Cedrat Technologies has developed an alternative structure (Fig. 4) where the magnet is integrated close to the sensor and the measured magnetic field is modified by a target made of magnetic material on the moving part. The advantage is that since magnetic material targets are often already present on the mobile parts, its modification is not required. The concept has been patented and the application example of this concept (QickScan tire wear sensor - Fig.2) is described in the last section of the document.

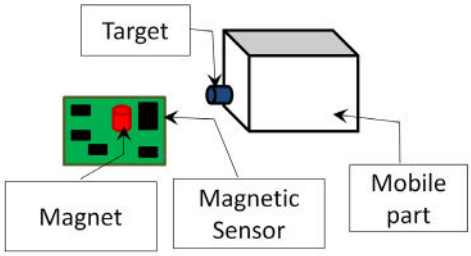


Fig. 4. HMP Magnet on Sensor

PCI: POT SHAPE COIL INDUCTIVE SENSOR

The PCI is another classical inductive sensor type (Fig. 5) which also doesn't require any wire connection on the mobile part. The mobile part includes a magnetic target, which may be a simple plate of magnetic material. The variable magnetic coupling between the coil and the target induces a variation of coil inductance, which is then measured by the signal conditioner.

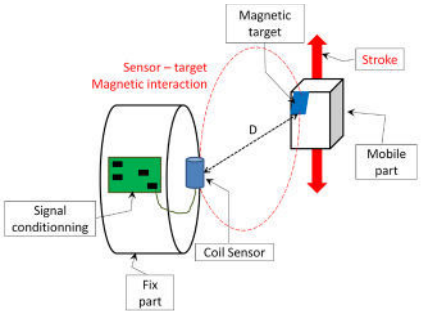


Fig. 5. Inductive sensor graph

PCT: PLANAR SHAPE COIL TRANSFORMER

The Planar Coil Transformer solution (Fig. 6) is also contactless and wireless. The coupling between excitation and detection is modified by magnetic interactions with the target made of magnetic material. This sensor works similarly to a LVDT (linear variable differential transformer) and the detected position is directly linked to the magnitude of the alternative output voltage. The planar coil is integrated directly on the PCB of the conditioner, which makes the assembly very easy.

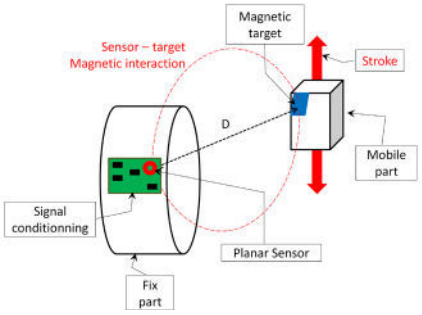


Fig. 6. Magnet sensor graph

Copyright © CEDRAT TECHNOLOGIES | 04/2022

www.cedrat-technologies.com | actuator@cedrat-tec.com

SELECTION GUIDE

Detection range is adjusted by choosing the magnet type (ferrite or rare earth magnets) and the size of emitters and receivers. Design services are proposed by Cedrat Technologies to fit the sensor definition to the application constraints.

Similarly, technological brick of electronics have been developed for each sensor technological solution. Adaptation according to the application is available on request.

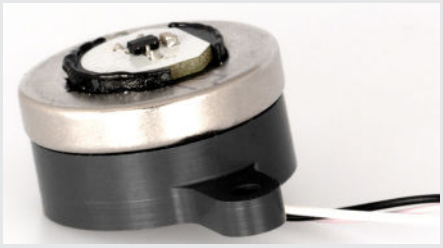
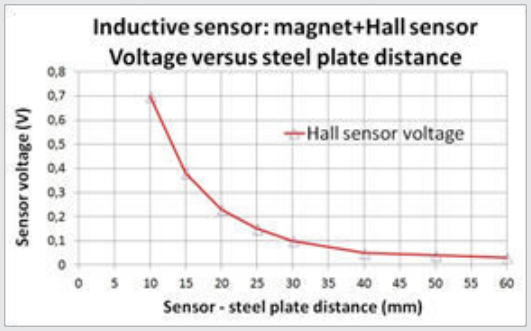
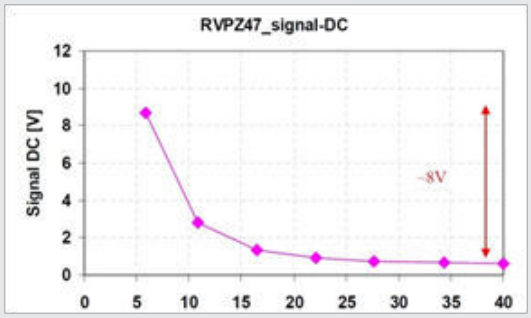
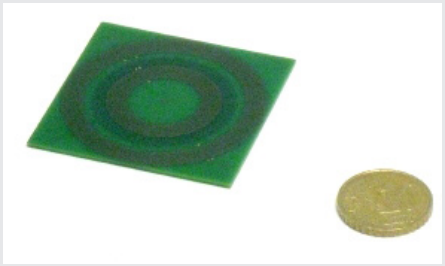
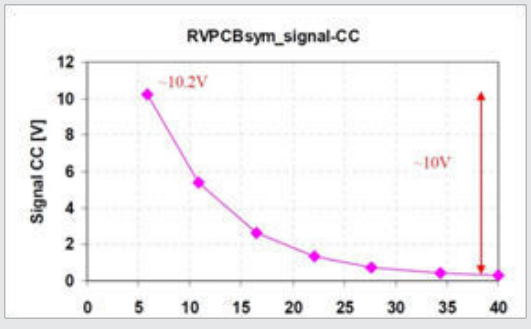
SENSOR NAME & ADVANTAGES	TYPE	CHARACTERISTICS
HMP (Hall Magnet Position sensor) • Low cost • High sensitivity up to 30mm • Very high bandwidth	Hall sensor 	Magnetic field voltage Hall sensor 
PCI (Pot Coil Inductive sensor) • Very low supply power • Shielded • Only two wires • High sensitivity up to 25mm	Inductance measurement 	Excitation coil with shielding ferrite 
PCT (Planar Coil Transformer sensor) • Low cost • Flat, low weight • Easy integration • High sensitivity up to 40mm	PCT sensing element 	Excitation coil integrated within PCB 

Fig. 7. Sensor principles comparison table

Copyright © CEDRAT TECHNOLOGIES | 04/2022

www.cedrat-technologies.com | actuator@cedrat-tec.com

POSITION SENSOR	HMP HALL MAGNET POSITION SENSOR	PCI POT COIL INDUCTIVE SENSOR	PCT PLANAR COIL TRANSFORMER SENSOR
Application	Non contact position sensor		
Target material	Magnetic material		
Description	Magnet + Hall sensor	Sensor + electronics	Sensor + electronics
Target size	Diam. 20-160mm	Diam. 20-160mm	Diam. 20-160mm
Measurement Distance Range	5 – 40mm	5 – 25mm	5 – 40mm
Temperature Range	[-40°C ; +85°C]	[-40°C ; +80°C]	[-40°C ; +80°C]
Sensor size : Diameter	27mm	42mm	Square 44mm sides
Sensor size : Height	16mm	15mm	2mm
Sensor weight	20g	100g	6g
Number of wires	3	2	4
Resolution	+/- 1/400	@5mm : 0.01µm @15mm : 0.06µm @30mm : 1.0µm	@5mm : 0.01µm @15mm : 0.03µm @30mm : 0.11µm
Bandwidth	30kHz	2.5kHz	1kHz
Supply voltage	3V	+/- 9.4Vrms	+/- 5.4Vrms
Current	6mA	15mArms	100mArms
Power Dissipation	18mW	0.3mW	380mW

Fig. 8. Sensor typical caracteristics

APPLICATION EXAMPLE: QUICKSCAN TIRE WEAR SENSOR

In the frame of the long-term partnership between Cedrat Technologies and Michelin, a series of medium range sensors based on the previously described concepts have been developed (Fig. 7, 8). Since the structure of tires integrates magnetic steels to improve the tire rigidity (steel cords), Cedrat Technologies proposed to derive tire rubber wear (tickness reduction) from the measurement of the distance between this magnetic structure and the sensor.

Fig. 9. Tire wear control

As illustrated on Fig. 2 and 10, the sensor measures the distance to the steel cords which depends on the thickness of rubber in-between. This allows to obtain the carving depth of the tire and thus its wear.

The principle has been patented for a series of inductive sensor which are relevant for this application. Today, QuickScan is being deployed in Michelin's offers.

Cedrat Technologies offers to apply these patented sensors for new applications, do not hesitate to contact our team of experts for further information.

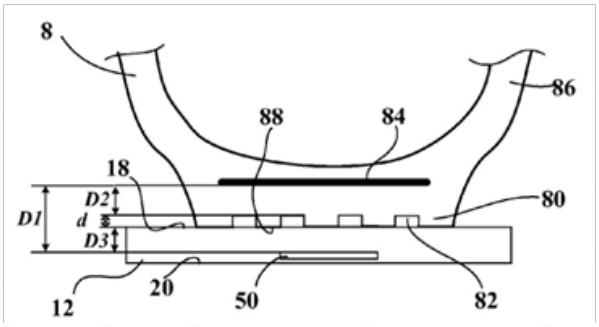


Fig. 10. Principle of tire wear measurement. The tire (referenced 8) includes the tire carving (80) and the steel cords (84). In a plate scanner on the roadway (12) is integrated a set of magnetic sensors (50)

KEYWORDS

Contactless, magnetic, sensor, QuickScan, position, speed, detection, inductive, hall, coil, electromagnetic, proximity sensor, positioning, magnet.

Copyright © CEDRAT TECHNOLOGIES | 04/2022