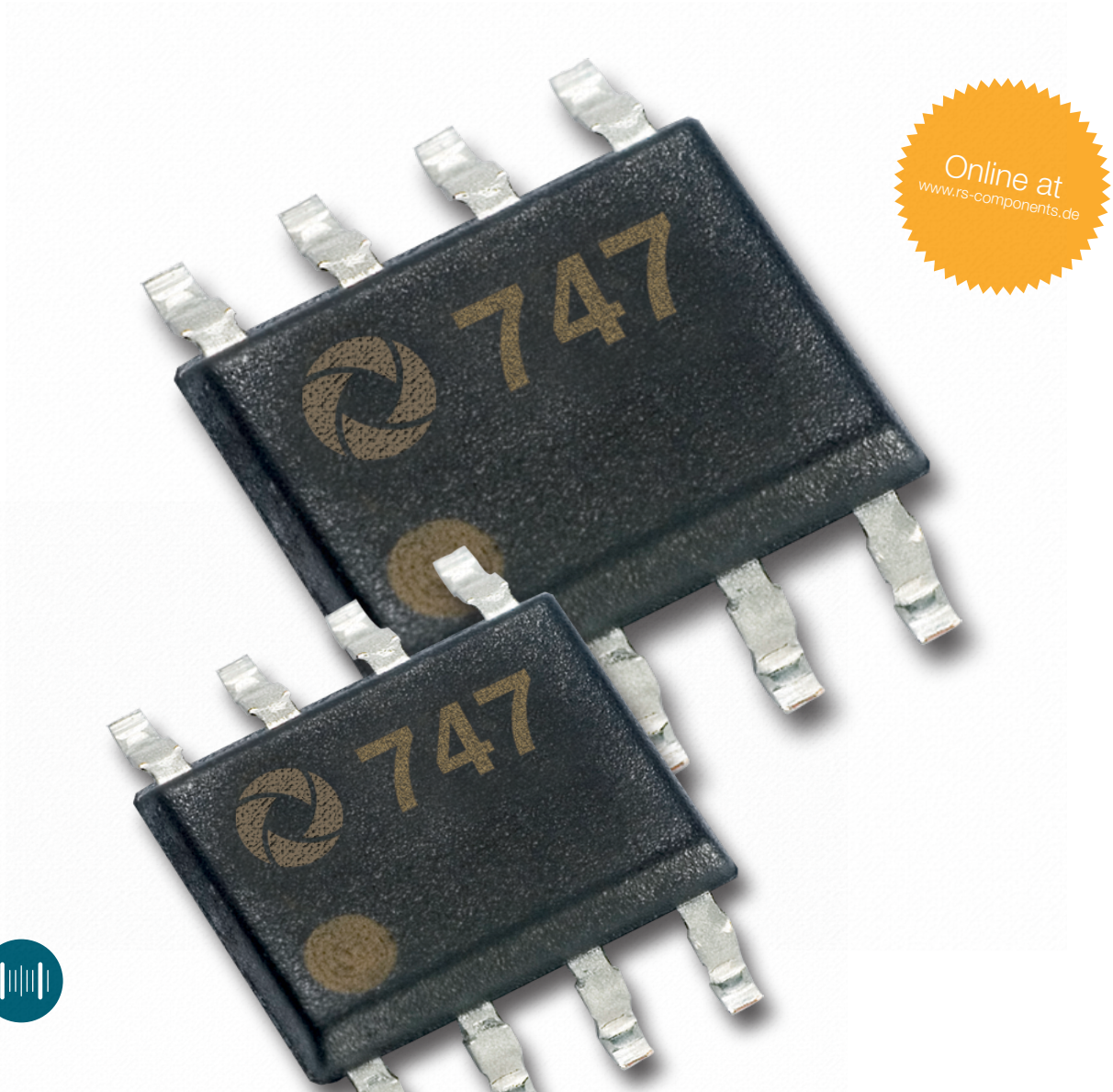
SENSITEC
KÖRBER SOLUTIONS

# AA700
# MagnetoResistive Sensors

## For Angular and Linear Position Sensing Applications.



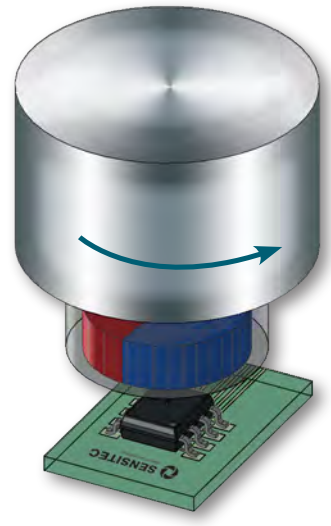

Online at
www.rs-components.de

360°

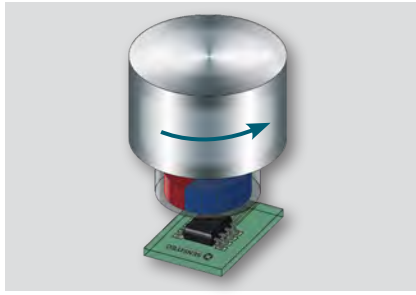
# AA700 Sensors for Angular and Linear Measurement

## The AA700 sensor chips are the first choice for applications where highly precise angular or linear measurements must be executed in a flexible and cost-effective manner under difficult operating conditions … the bridge for your application.

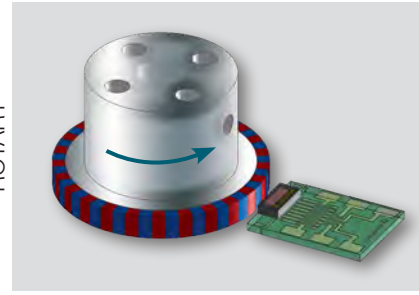
They are based on Anisotropic MagnetoResistive (AMR) sensor technology, which uses magnetic fields to conduct measurement information between the sensor and the physical value, i.e. angle or linear position. The contactless operating principle allows the isolation of all rotating components, making the entire sensing system robust with respect to environmental influences and mechanical wear. AMR sensors feature magnetoresistive elements arranged in a Wheatstone bridge. They evaluate the direction of the magnetic field and not the strength of the field. As a result, AMR sensors are very tolerant with respect to variations in field strength caused by ageing of the magnet, its temperature sensitivity or mechanical fluctuations.



**1.1**
Measuring configuration for absolute shaft-end angular measurement up to 180°.

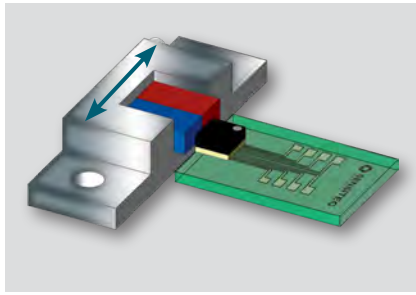


ROTARY

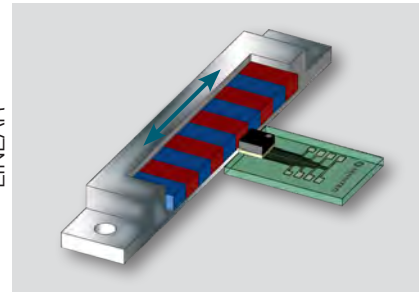


**1.2**
Measuring configuration for incremental angular measurement at the shaft circumference.

**1.3**
Measuring configuration for absolute linear measurement with a dipole magnet.



LINEAR



**1.4**
Measuring configuration for incremental linear measurement with a magnetic scale.

ABSOLUTE INCREMENTAL

# Measuring Configurations

## For Angular and Linear Position Sensing.

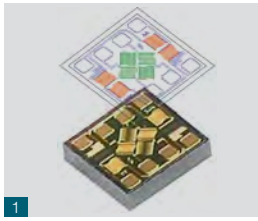
**Features**

- Contactless absolute angle measurement up to 180°
- Excellent accuracy
- High sensitivity
- Extremely robust
- Wide operating temperature range (-40 to +150 °C)
- Small and compact design (available as bare die or in S08 and LGA packages)
- Qualified for automotive applications conditions

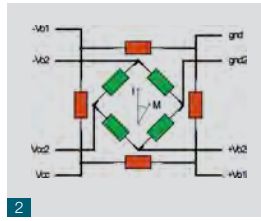
**Benefits**

- Non-contact measurement for maintenance-free, wearless operation
- Large permissible air gap between sensor and magnetic target, thus reducing the user effort in design, assembly and manufacturing
- Highly precise angular and linear measurement with high resolution for an exact performance with very high positioning accuracy
- High bandwidth to enable the monitoring of highly dynamic processes
- Reliable and safe use in difficult operating conditions

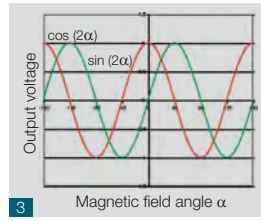
# Operating Principle of the AMR Sensor



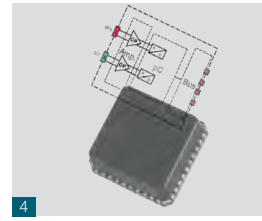

AMR sensor



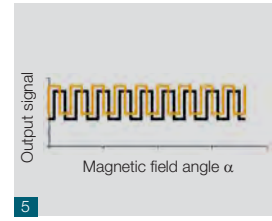

Wheatstone bridges (Sine and Cosine)




Output signal for AMR sensor chip




Microcontroller



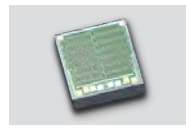

Output signal from microcontroller

In this example, featuring an end-of-shaft application (as shown in measuring configuration 1.1), a diametrically magnetized magnet rotates above the sensor chip (1). In the plane of the Wheatstone bridge (2) this rotating magnetic field delivers two sinusoidal output signals with double the frequency of the angle $\alpha$ between sensor and magnetic field direction. One signal represents the sin(2$\alpha$) function, while the other signal represents the cos(2$\alpha$) function (3). This signal form enables the absolute measurement of angles up to 180 ° and also enables self-diagnosis in safety-critical applications, by means of the equation $\sin^2\alpha + \cos^2\alpha = 1$. An instrumentation amplifier circuit, implemented either as a complete integrated circuit, or constructed via combinations of discrete components and integrated circuits, such as operational amplifiers, is frequently used to amplify the raw sensor signals. These signals can then be digitalized by an interpolation ASIC, ASSP or microcontroller (4) to provide a digital output signal (5).

## The AA700 family sensors are available in three basic designs to cover a multitude of angular and linear measurement applications.

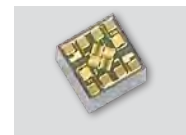
**AA745**

The AA745 sensor chip features a pad arrangement along the long chip edge, by which the MR structures can be located close to the magnetic target. This design is particularly advantageous for measurement tasks at the circumference of a magnetic pole-ring or along a magnetic scale.



**AA746**

The AA746 sensor chip features a design which allows to operate from a field strength of 5 mT. This allows a larger distance between the sensor and the measuring scale to be realized. This design can be used for shaft end or off axis applications.



**AA747**

The AA747 sensor chip features a symmetrical design, where the Wheatstone bridges are arranged around the centre of the chip. This design is specially suited to shaft-end measurement tasks, where the sensor can be mounted on the axis of rotation of the shaft.

# Special Design Features and Technical Data

## FreePitch

FreePitch sensors are optimized so as to be independent of the pole length (pitch) of the measurement scale. Those sensors are therefore particularly compact and come close to an idealized point-sensor. They are the ideal choice when the solution to a measurement task must be cost-effective. In order to keep the sensor chip small the resistances of the Wheatstone bridges are interlaced. To generate the sine/cosine signals the two bridges are oriented at an angle of 45° to one another. FreePitch sensors can be used with pole rings or linear magnetic scales with almost any pole length, as well as with dipole magnets.

## PerfectWave

Sensors with PerfectWave design provide the best signal quality, highest accuracy and optimal sensor linearity by filtering out higher harmonics in the signal. The MagnetoResistive (MR) strips used as resistances have a curved shape, which serves to filter out higher harmonics when the magnetic field direction is converted into an electrical signal. This filter function is achieved by means of the special geometry and arrangement of the MR strips and has no signal delay. The PerfectWave design is particularly effective for small magnetic fields and results in improved linearity, higher accuracy and better signal quality.

### Product Codes AA700

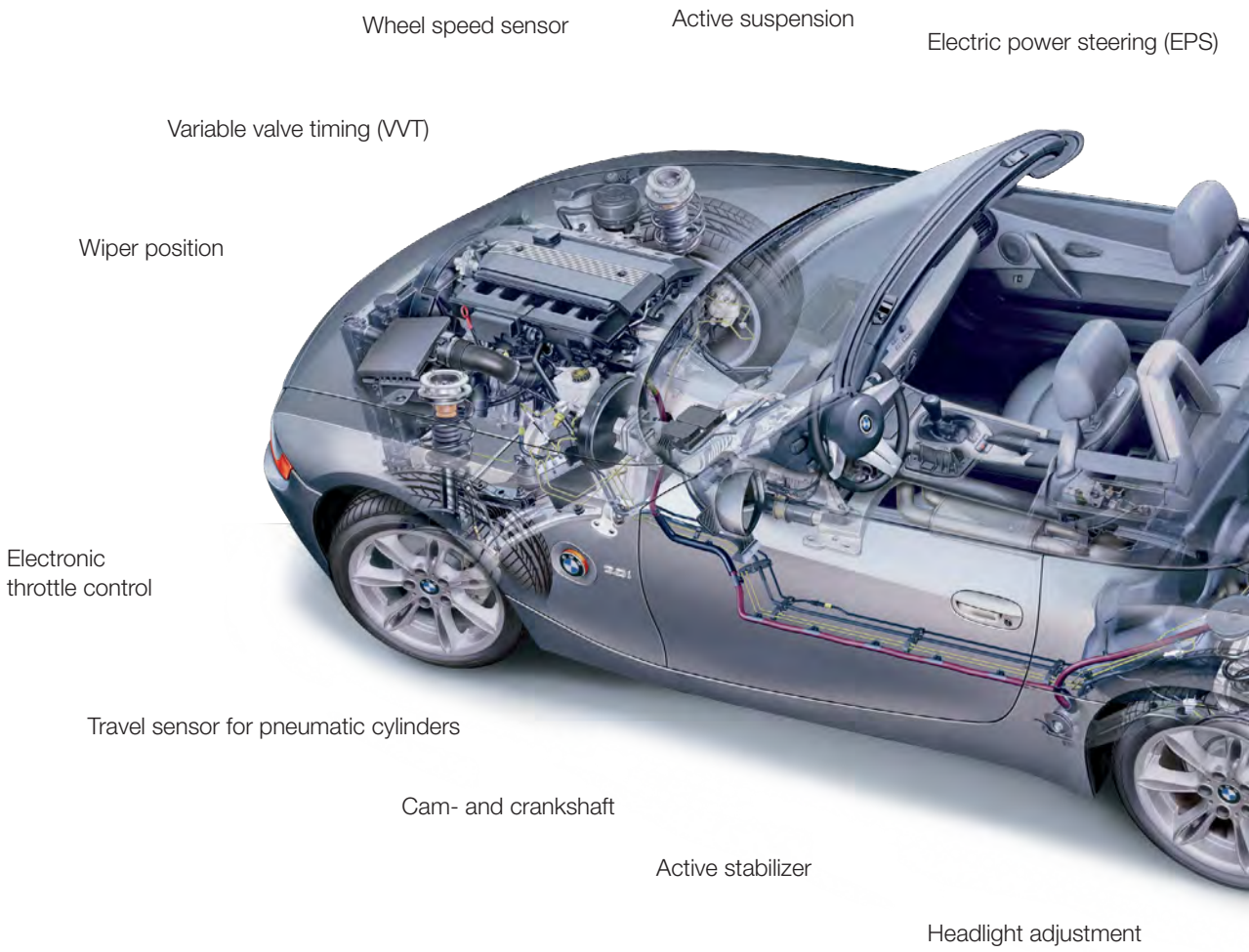
| Product | Dimensions [mm] | Package | Delivery form |
|---|---|---|---|
| AA745ABA [1] | 1.25 x 0.60 | Bare die (wafer, undiced) | Wafer box |
| AA745ACA [1] | 1.25 x 0.60 | Bare die (wafer, diced) | Wafer box |
| AA745AMA | 3.0 x 3.0 x 1.5 | LGA6S | Tape on reel |
| AA747ACA | | Bare die (wafer, diced) | Wafer box |
| AA747AHA [1] | 4.9 x 6.0 | SO8 | Tape on reel |
| AA746ACA | | Bare die (wafer, diced) | Wafer box |
| AA746AMA | 6.0 x 3.0 x 1.5 | LGA6L | Tape on reel |

### Technical Data

| Symbol | Parameter | AA745 | AA746 | AA747 | Unit |
|---|---|---|---|---|---|
| $\Delta\alpha$ | Accuracy [2] | | ±0.1 | | ° |
| $V_{CC}$ | Supply voltage | | +5 | | V |
| $V_{off}$ | Offset voltage per $V_{CC}$ | ±2 | ±0.5 | ±2 | mV/V |
| $V_{peak}$ | Signal amplitude per $V_{CC}$ | 13.0 | 13.0 | 13.0 | mV/V |
| $R_B$ | Bridge resistance | 1.6 | 0.6 | 3.2 | kΩ |
| $H_{ext}$ | Nominal field strength | > 25 | > 5 | > 25 | kA/m |

[1] Automotive qualified AEC-Q100.

[2] These values refer to opera tion in saturation at room temperature. The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.



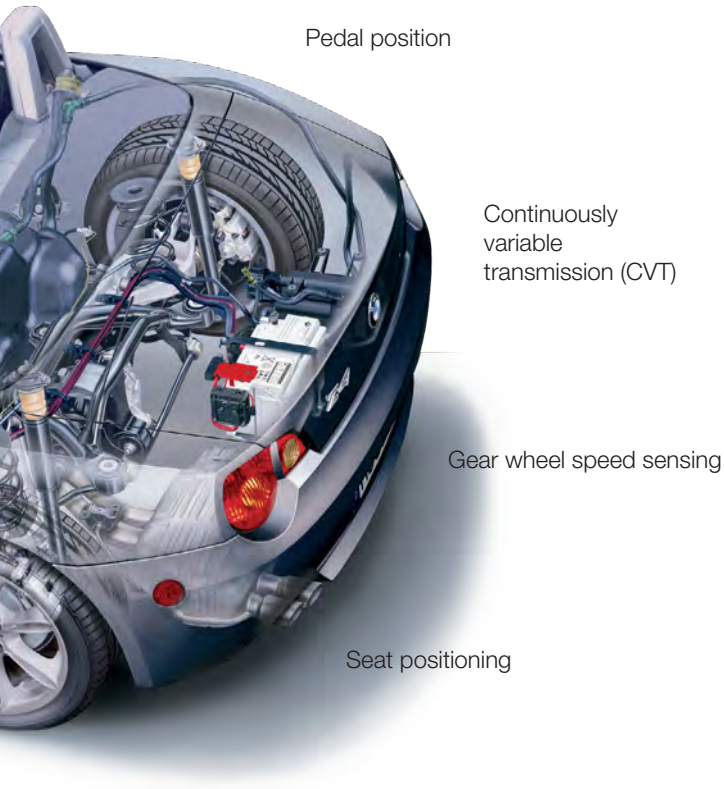

# MagnetoResistive Sensors for Automotive Applications

## Reliable Measurement Data for Safer Vehicles.

The number of sensors providing accurate measurement data is increasing steadily in the field of automotive electronics, as the industry moves closer to incorporating advanced x-by-wire and control systems that rely on accurate measurement.

MagnetoResistive (MR) sensor technology is ideally suited to demanding applications in automotive measurement systems. The contactless, wear-free principle of operation, high precision, high bandwidth and long term stability, combine to deliver highly accurate and robust sensors.

Compared to other technologies, MR sensors from Sensitec offer many technical benefits: they provide car manufacturers a more reliable and accurate solution for automotive angle measurement, improving system stability and overall vehicle safety.




**Advantages:**

- Contactless, wear-free operating principle for angular and linear measurement
- Large air gap
- Large permissible air gap tolerances
- Withstands extreme operating conditions
- Full redundancy possible
- Failsafe design
- Flexible integration
- High bandwidth for measurements in time slots of less than 100 ms

**References:**

- BMW
- Bosch
- Bourns
- Continental
- First Sensor
- Porsche
- Valeo
- VW
- ZF

**Applications:**

- Industrial automation
- Machine tools
- Robotics
- Motion control
- Automotive
- Aerospace
- Camera technology
- Medical technology
- Geological testing
- Testing & measurement

## Power Train

Green motor management helps making cars more efficient. This applies to the conventional combustion engine, where MR sensors can serve as angular sensors for Variable Valve Timing (VVT), camshaft rotation measurement or electronic throttle control as well as linear sensors for pneumatic or hydraulic cylinders.

Hybrid power trains and electric motors also help to conserve natural resources. The commutation of electric motors requires precise angular measurement in time intervals in the millisecond time regime. Here, the high signal-to-noise-ratios of MR sensors allow precise control, avoiding the difficulties associated with semiconductor-based magnetic sensors.

At the same time new transmission technologies make the vehicle more comfortable. Continuously Variable Transmissions (CVT) move steplessly through effective gear ratios. Regardless, whether the application is in a CVT, for crankshaft or camshaft speed measurement, modern transmissions depend on the accurate and reliable wheel or shaft speed information provided by MR sensors.

## Chassis and Body

Automotive chassis applications require highly reliable sensor elements. MagnetoResistive (MR) sensors cover a wide range of high precision contactless angular and linear measurement tasks in chassis applications. Antilock Brake Systems (ABS), Electric Power Steering (EPS), and Electro Hydraulic Brake systems (EHB) are just some of the typical applications, where precision and reliability must never be a trade-off.

For this reason Sensitec's sensor designs and manufacturing processes are dedicated from the very beginning to realising the tightest specification limits, with respect to functional performance under the most demanding operating conditions. The key to success is the avoidance of laser trimming of the analogue device and with it all undesired parametric drift effects.

Sensitec operates the most advanced wafer fabrication for high precision MagnetoResistive sensor chips in Europe and is one of the few MR manufacturer world-wide offering sensors featuring AMR (Anisotropic MagnetoResistive), GMR (Giant MagnetoResistive) as well as TMR (Tunnel Magneto Resistive) technologies.

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