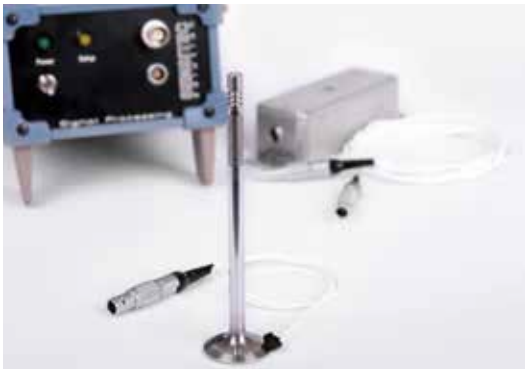
SENSITEC
KÖRBER SOLUTIONS

Magnetic Micro- and Nanotechnology for Robust Sensor Solutions.

Welcome to the Sensor Cosmos.

Curiosity on Mars. Sensitec on board.

Highlights

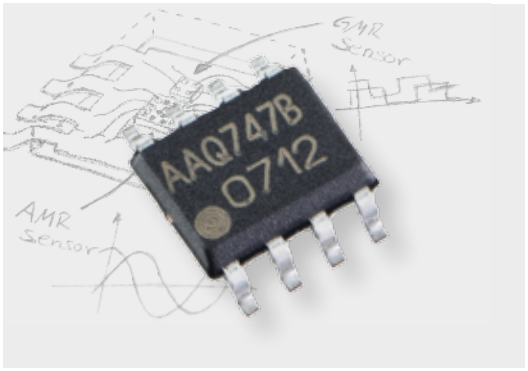


Valve Lift Measurement System

Sensitec Solutions - optimization of powertrain components. The system is designed for test and inspection or research and development tasks, not only for valve lift measurement in fired combustion engines but also for the testing of turbochargers, fuel injectors etc. Due to its compact dimensions the module can be implemented even in the smallest envelopes. For example in the valve train application the sensor module is mounted directly in the valve guide.

TMR for series applications

During the past two years Sensitec has invested significant time and effort in the development of TunnelMagnetoresistive sensor technology. New production processes have been defined, combined with investments in new production machines. Production processes and products based on TMR technology are currently in a transfer phase from pre-industrial research stage to series applications. Soon a comprehensive sensor portfolio will be available for automotive and industrial applications.



AAQ747 for 360° angle measurement

The new AAQ747 is a multi-chip sensor which enables 360° absolute angle measurement with a dipole magnet at the shaft end and which provides at the same time the high accuracy of an AMR sensor. The SO8 package includes an AMR sensor and a GMR sensor which means that the absolute angle measurement can be performed over a range up to 360° via the signal combination of both sensors.

Available online

New! Products marked with this label are available online worldwide at our partner RS Components (http://de.rs-online.com/web). Please use this service especially when ordering smaller quantities.

The Anisotropic MagnetoResistive (AMR) effect was discovered by the British physicist William Thomson (1824 – 1907), later better known as Lord Kelvin. He was Professor for Theoretical Physics at the University of Glasgow from 1856 to 1899 and discovered the AMR-effect in 1857.
It was to take more than 100 years, and the development of thin-film technology, before this effect could be used in industrial applications.

The Company

Since 2015 Sensitec Mainz uses 100 per cent green power, generated by means of hydro power made in Germany.

Sensitec GmbH was founded in 1999 in Lahnau, near to Wetzlar, in Germany with the objective to produce sensors based on the magnetoresistive effect for industrial and automotive series applications. Due to a rapidly expanding market and a continuous product development Sensitec could establish itself quickly and today is a global leader for high-quality and innovative magnetic sensor solutions.

Already in 2000 Sensitec took over the Institute for Micro Structure Technology and Opto Electronics e.V. (IMO) in Wetzlar. This institute already had more than ten years research and development experience in the field of magnetoresistive technology.

In 2003 Sensitec took control of Europe's most efficient and modern factory for AMR-and GMR-technology in Mainz. The range of products for industrial applications could be widened significantly since then. The qualification of various automotive-related products established Sensitec as qualified supplier in the automotive sector. Sensitec achieved a certification according to ISO/TS 16949:2002, which describes the quality management standard for suppliers to the automotive industry. Furthermore Sensitec achieved the environmental management system certification according to ISO 14001 as well as the energy management system according to ISO 50001 for the factory in Mainz.

Since April 2013 Sensitec GmbH is a member of the Körber Group. Sensitec is part of the Business Area Automation and is the core company in the Business Unit Sensor Technology. Körber AG is the holding company of an international technology corporation with more than 11,000 employees worldwide. The corporation combines technology leaders with about 100 production, service and sales companies in the business areas automation, logistic systems, machine tools, pharmaceutical systems, tissue and tobacco.

Our Core Competences

Our core capabilities lie in the design, development, production and marketing of high-quality and innovative magnetic sensor solutions according to the requirements of customers in a wide range of different application fields. Magnetoresistive sensors from Sensitec are used wherever movement is to be controlled or where angle, linear motion, position, electrical current or magnetic field strength are to be detected or measured. Numerous patents and licences for the production and application of MR sensores, backed by a broad spectrum of experience and knowledge in this field, provide the foundation for these capabilities.

Our Values

We are market and technology leader in our market segment. We offer our customers **Performance. Sustained.**

With highly motivated employees, technological competence, many years of industry experience und a high quality and service level we solve the most demanding customer requirements according to our basic values:
Agile. Focused. Inspiring.

SENSITEC
KÖRBER SOLUTIONS

Agile. Focused. Inspiring.

We stand for curiosity and creativity …

… because we want to delight our customers and business partners with new product ideas and solutions and be recognized as an uncomplicated and willing partner.

We keep our eye on the target …

… by working attentively and conscientiously, so that our customers know that they can rely on us.

We excite our customers with our products …

… and sometimes take the path less traveled with the unique technology behind our products to give our customers and partners the best solution.

Performance. Sustained.


Source: NASA/JPL-Caltech


Source: Mainova

MR Sensors »made in Germany«

Sensitive and precise measurement, robust and clever technology

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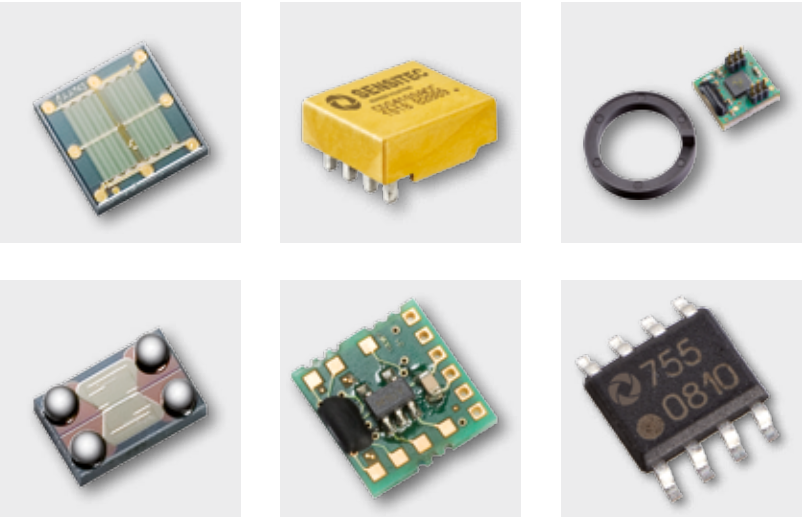
At our location in Mainz we possess Europe's most efficient and modern wafer factory for the production of MR sensor chips. Here we manufacture microchips using thin-film technology to satisfy automotive quality requirements. At our location in Lahnau the chips are integrated into modules and systems to satisfy the requirements of a demanding, world-wide market. Here our administration, sales, development and system production departments are available with specialists to advise our customers regarding the performance and applications of our broad product programme. We apply this specialized know-how to help our customers realize solutions for their special measurement task.

Our product range comprises:

– Measurement scales (magnetized linear scales and pole rings)
– Chip design and chip production
– Integrated signal processing circuits
– Components and system solutions in standard or customized design

Our rigorous quality management system ensures a high level of quality and reliability in series production which is documented by our quality system certification according to ISO/TS 16949.

At the location in Mainz Sensitec was able to implement an environmental management system according to ISO 14001 as well as an energy management system according to ISO 50001.




POLARIS 2100
UltratechStepper

MR Sensor Technology

The MagnetoResistive Effect, »MR-Effect«, has been known for 150 years. However, its use in sensor applications was first made practically possible through the development of thin-film technology some 30 years ago. Since this time, MR sensors have consistently opened up new application fields in magnetic field measurement, be it in an electronic compass, in path- or angle-measuring systems, or in small potential-free current sensors.

The term MR sensor is a collective term for sensors based on a range of different, but related physical principles. All MR effects have in common that the electrical resistance of the sensor changes due to the influence of a magnetic field. By adept arrangement of the structure of the sensor quite different tasks can be solved, to sense for example a magnetic field angle, magnetic field strength or a magnetic field gradient

The **Anisotropic MagnetoResistive (AMR) effect** was discovered by Thomson in 1857 and occurs in ferromagnetic materials, whose specific impedance changes with the direction of the applied magnetic field. The resistance change is in the order of a few percent and this effect can be used even for very weak magnetic fields.

The **Tunnel MagnetoResistive (TMR) effect,** discovered by Julliere in 1975, occurs in layer systems consisting of at least two ferromagnetic layers and a thin isolation layer. The tunnel resistance between both layers depends on the angle of both magnetization directions.

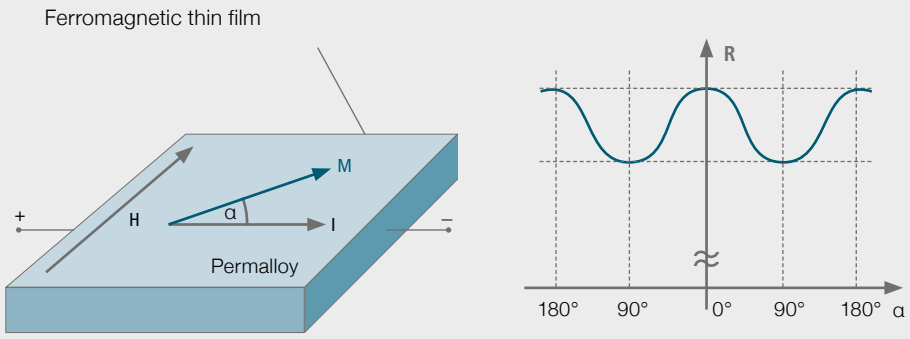
The **Giant MagnetoResistive (GMR) effect** was first discovered in 1988 by Fert and Grünberg, who were awarded with the Nobel Prize for Physics in 2007 for this achievement. This effect occurs in layer systems with at least two ferromagnetic layers and a single non-magnetic, metallic intermediate layer. If the magnetization in these layers is non-parallel, the resistance is larger than if the magnetization is parallel. The difference may reach up to 50 per cent, thus the name “giant”. The change in resistance does not depend on the direction of the current.

The characteristics of GMR sensors can be modified by stacking several layers with different properties and magnetizations. This allows the characteristic curve to be targeted on the specific requirements of a particular measurement application.

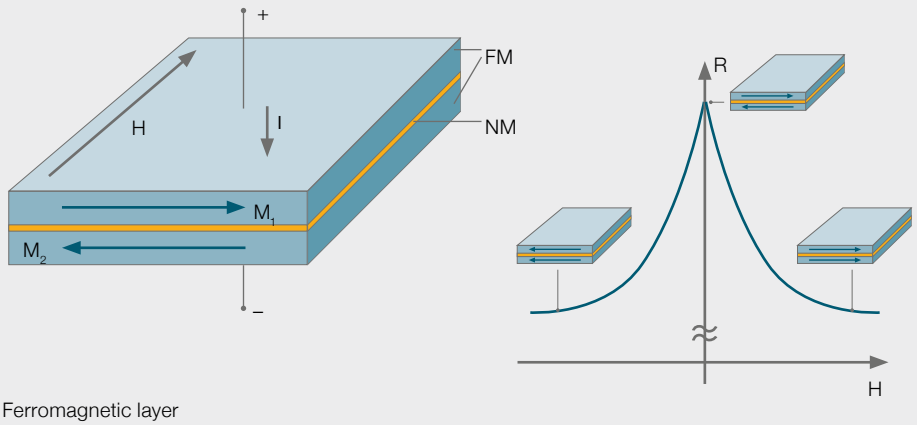
In 1993 von Helmholt et al discovered the **Colossal MagnetoResistive (CMR) effect.** This effect occurs in perowskitic, manganese-based oxides, which change their resistance in the presence of a magnetic field.

Of all the known physical effects, by which a solid changes its properties due to magnetism, MR technology has particularly interesting and convincing advantages. The MR effect enables weak magnetic fields to be detected and delivers a signal with an excellent signal-to-noise relationship.

At Sensitec sensors based on the AMR- and GMR-effects are in series production since several years. The first TMR-sensors are entering series production now. CMR technology is still at the pre-industrial research stage.



Change in resistance (R) of a AMR strip in a magnetic field (H) as a function of the angle (α) between the current (I) and magnetization (M).



FM: Ferromagnetic layer
NM: Nonmagnetic intermediate layer

Simple GMR or TMR 3-layer arrangement. For GMR based sensors the non-magnetic intermediate layer consists of a conductive copper layer and for TMR based sensors this comprises an isolating tunnel barrier. Both magnetizations M_1 and M_2 are turned by the external magnetic field H.

The advantages of magneto-resistive technology

High accuracy
MR sensors feature inherently low hysteresis and high linearity for high measurement accuracy. A variety of different Sensitec technologies, including PerfectWave, FixPitch and PurePitch designs for angle and length measurement, as well as compensation techniques for current sensing, provide even better performance for particularly demanding measurement applications.

High resolution
MR sensors possess a very high resolution, which is particularly important in applications requiring very good control quality, such as encoders for direct drive motors. The low noise associated with MR-sensors combined with the large output signal results in an excellent signal-to-noise ratio.

Dynamic
MR sensors have an extremely high bandwidth and can detect magnetic fields with frequencies in the megahertz range. They are therefore well suited to high speed measuring applications, for example, for measuring the speed of high frequency machine tool spindles. MR sensors also have extremely short response times and can therefore be used for fast switching applications.

High reliability
The solid-state and non-contacting measurement principle means that MR sensors are intrinsically very reliable. This is backed up by wide-ranging and intensive qualification tests, according to the latest industrial and automotive standards, that demonstrate the long-term stability and excellent reliability of Sensitec MR sensors.

Wear-free
The magnetoresistive measurement principle applied in MR sensors is non-contacting, with the result that MR sensors are essentially wear-free. This is the basis for a long operating life without wear or debris, as associated with contacting measurement devices, such as potentio-meters.

High sensitivity
The sensitivity of MR sensors is very high – up to 50 times higher than other solid-state magnetic sensors, such as Hall effect sensors. Sensitec MR sensors can detect the earth's magnetic field for compass applications and are also used succesfully in non-destructive testing and vehicle detection applications, where very weak magnetic fields must be measured accurately.

Robustness
MR sensors are largely unaffected by very high or very low temperatures, oil, dirt or mechanical loads such as shock or vibration. They can also be used in applications subject to radiation and can be applied in a vacuum. Be it 400 million km distant, at -120 °C on the surface of Mars, or 10 km beneath the earth`s surface at +200 °C at the bottom of an oil bore, Sensitec MR sensors operate reliably and long-lived in the most challenging operating environments.

Energy efficient
MR sensors can be specially designed with a high internal resistance, making them well suited to battery powered applications. The low current consumption associated with the compensation measurement principle of the Sensitec current sensors mean that they exhibit a very low power loss and are highly energy efficient.

Galvanic isolation

The non-contacting MR measurement principle provides galvanic separation in applications where electrical isolation is necessary.
The high electrical insulation of Sensitec current sensors is documented by the VDE (German Electrical Engineering Association) product approval.

Easy to integrate

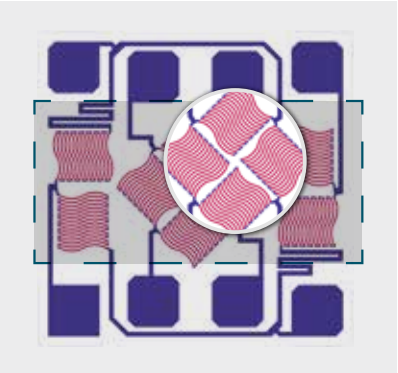
Sensitec MR sensors are inherently compact and their high sensitivity allows them to bridge mechanically dependant distances and tolerances to the magnetic scale. This makes them particularly easy to integrate in new or existing machine designs, where space is at a premium, large mechanical tolerances are unavoidable and assembly effort should be kept as low as possible.

Special Design Features

Sensitec has continuously improved the perfomance of MR sensors by means of different modifications to the chip layout. These patented design concepts, described below in more detail, enable smaller sensor dimensions, higher signal quality, improved robustness with respect to disturbing fields as well as improved control quality.

FreePitch

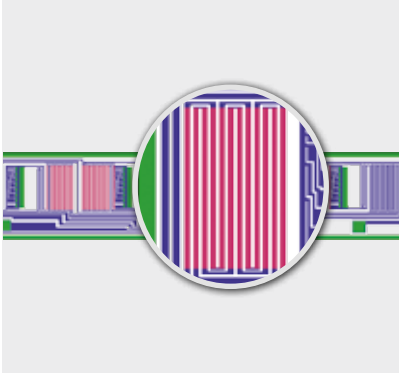
FreePitch sensors are optimized so as to be independent of the pole length (pitch) of the measurement scale. Those sensors are therefore particularly compact and come close to an idealized point-sensor. They are the ideal choice when the solution to a measurement task must be cost-effective. In order to keep the sensor chip small the resistances of the Wheatstone bridges are interlaced. To generate the sine/co-sine 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.



Chip layout of a sensor with FreePitch design.

FixPitch

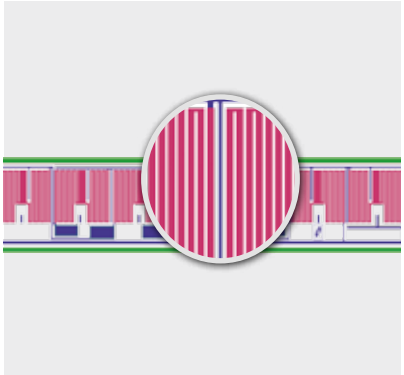
FixPitch sensors are adapted to the pole length (pitch) of the measurement scale, i. e. the MR strips are geometrically matched to a particular pole length. The sine and cosine signals are generated by distributing the resistances of the Wheatstone bridges along the length of a single pole. This geometric arrangement also serves to suppress higher harmonics and to reduce the sensitivity of the sensor to interference fields. In so doing the linearity of the sensor is optimized.



Chip layout of a sensor with FixPitch design.

PurePitch

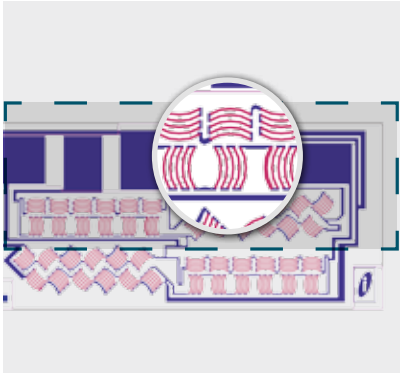
The PurePitch design is an extension of the FixPitch principle in that the resistances are distributed over several poles. This has an averaging effect on errors in the measurement scale without any signal delay. Because the sensor averages over north and south-poles this principle also serves to suppress the influence of homogenous interference fields. These improvements are reflected in a higher performance in control systems where these sensors are implemented.



Chip layout of a sensor with PurePitch design.

PerfectWave

The PerfectWave design improves the signal quality of the FreePitch sensors still further. The 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.



Chip layout of a sensor with PerfectWave design.

SelfBias

SelfBias is a design feature that allows the optimal setting of the operating point for MR sensors in applications where an external bias field is necessary. Special wafer processing techniques allow the integration of a hard magnetic layer directly within the sensor ship itself, so avoiding the need for separate, external magnets to provide the bias field. This saves space, as well as assembly effort for the user.

EcoSensing

Magnetoresistive sensors feature a high bandwidth, almost no power-up delays and can be manufactured with a high resistivity. This makes them particularly well suited to energy-efficient applications and systems, that is, EcoSensing.
MR sensors can be used with their full performance yet still with high energy efficiency in battery-powered applications, for example in EX-environments. Due to their special design TMR sensors are an ideal platform for energy efficient applications. Their high internal resistance is combined with a highly dynamic performance and high output signal strength. This enables long battery operating life as well as energy efficient circuit designs.

SmartFit

The sensor modules featuring SmartFit technology offer additional functions in the signal processing electronics. On the one hand it is possible to parameterize via the signal line. This allows a built-in sensor module to be re-parameterized (e.g. for changing the measurement resolution) without needing additional wiring. Alternatively, the operating status can be indicated remotely, to inform the user about the correct function or about operating disturbances. This helps support the user during assembly and adjustment and allows quick and easy status monitoring during operation. SmartFit technology therefore offers comfort functions to make the sensor system safer, better and easier to use. Both functions are offered individually or in combination in SmartFit sensor modules.

ZeroInertia

ZeroInertia is a dynamic property that can be achieved using sensor systems with this feature. The measurement system exploits already available mechanical components, such as a motor shaft, as the measurement scale and does not need any additional components that would add moment of inertia to the moving object. This can help optimize the efficiency and performance of highly dynamic systems.
With ZeroInertia systems a tooth structure, for example, can be machined directly into the motor shaft and there is no need for an additional measurement scale, such as a pole ring.

We research for the future

The participation of Sensitec in national and international research projects has a long tradition and can be traced back to Sensitec's origin as a private research institute. Our research activities have continued ever since without interruption. Especially due to the co-operation with experts from research institutes, universities and industrial partners the potential of the relatively new MR sensor technology could rapidly develop and could enter numerous application fields. During the examination of the application-specific demands new product ideas, new products and findings were generated. But also the challenges and limits of this new technology became evident. Finally these project co-operations had a considerable contribution to the competence development of all experts involved. The projects desribed below shall give a small idea about the variety of the discussed topics.

A fast and precise counting of blood ingredients, e. g. thrombocytes, is essential for example for the therapy of cancer patients. Leading German companies, research institutes and hospitals are co-operating in the BMBF project **„MRCyte“** to develop a measurement procedure which counts magnetically marked blood cells at the point-of-care by means of GMR sensors.

In association with research institutes and industrial partners in Sweden, Slovenia and Germany Sensitec develops currents sensors for a compact, intelligent and reliable drive technology of electrical commercial vehicles in a project called **„COSIVU“**.

Training and qualification of academic and technical junior employees has a high priority for Sensitec. The European Commission offers the Marie Sklodowska Curie-Programme to support up-and-coming qualified European employees. This offers young doctorands and postdocs a comprehensive qualification and further training via E-learning and local support by the participating European universities and industrial companies. In the project **„WALL“** the project partners and doctorands are currently facing the task „Controlling domain wall dynamics for functional devices“.

In the BMBFproject **„KaLiPso“** Sensitec and their project partners are working on the development of a new measurement system for linear guide systems. KaLiPso stands for „cableless linear guide systems with integrated position measurement“.

To make position sensor technology sustainable we are developing together with universities, research institutes and industrial partners a new generation of magnetic measurement scales which are smaller, more precise and which offer even higher resolution. In the BMBF project **„AQUILA“** TMR sensors are combined with new measurement scales with Energy Harvesting and wireless data transmission.

Without the public support the current and already finished projects would not have been possible. Sensitec would like to take this opportunity to thank the Federal Ministry for Education and Reseach (BMBF), the European Commission and the States of Rhineland-Palatinate and Hesse for their confidence in our competence and technology. Furthermore we thank all our project partners for their competent support.

Awards and Recognition

Our will to offer our customers „Performance. Sustained.“ has been rewarded nationally and internationally with numerous awards for product innovation.

2008 Nomination for Hermes Award
Sensitec was one of the five companies selected from more than 50 entrants to be nominated for the prestigious international technology prize at the Hanover Exhibition. The subject of the nomination was the GLM gear tooth sensor, based on the Giant Magnetoresistive (GMR) effect.

2010 Frost & Sullivan Global New Product Innovation Award for AFF family of magnetic field sensors. Typically used for 3D compass applications in mobile devices, the main criteria for the award were the high accuracy and low power consumption compared to previous compass sensors.

2012 Demography-Fit Certification
As a participant in the Demography-Fit Project in Hesse, Sensitec was awarded a certificate for the measures executed to avoid the effects of demographic change on the workforce. Sensitec was praised particularly for employee development as well as knowledge management.

2013 SUCCESS Innovation Prize in Rhineland-Palatinate
Sensitec was awarded the prize for the development of sensors based on the Tunnel Magnetoresistive (TMR) effect for new sensor applications. The award was presented not only for the technical innovation, but also for the generation of numerous highly-qualified jobs at Sensitec.

2013 Innovation Prize of Rhineland-Palatinate
for the development of a new family of AMR sensors for industrial automation applications. The prize was awarded for the work leading to the AMR FixPitch product family, which offer improved accuracy and sensitivity compared to previous AMR sensors.

2014 Nomination for Hermes Award
For the second time Sensitec was selected by the jury for the short-list of five companies for this international award. Sensitec was nominated for the high bandwidth CMS3000 current sensors based on the AMR effect.

2014 Dürr Supplier Award
Sensitec won the award in the category „Innovation and Technology“ for a customized sensor for balancing machines manufactured by SchenckRotec, a member of the Dürr AG corporation. Sensitec won due to the innovative properties of the sensors as well as for the flexible response to new customer requirements.

What do you want to measure?

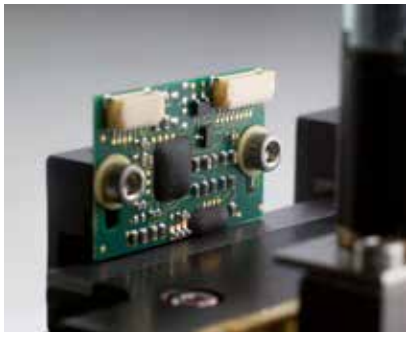
We have the right solution!

Angle Measurement

– incremental or absolute angle measurement
– resolution in the range of seconds of arc
– depending on the application:
  – either with a magnetic measurement scale at the shaft end or shaft circumference
  – or with ferro-magnetic toothed structures at the shaft circumference

Length and Position Measurement

– incremental or absolute path measurement and position sensing
– resolution in sub-µm-range
– depending on the application:
  – either with a magnetic measurement scale
  – or with ferro-magnetic toothed structures

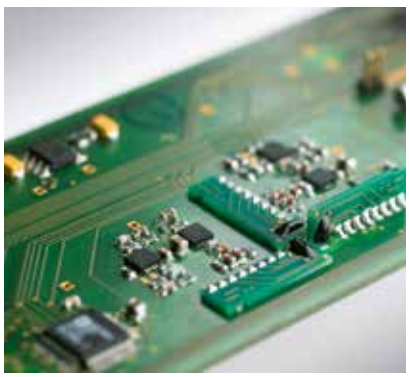


Current Measurement

– highly dynamic, precise current sensors
– without flow concentrators
– very small and compact design
– minimal power consumption
– high insulation strength

Magnetic Field Measurement

– for precise measurement of weak magnetic fields (50 A/m / 62.5 µT)
– possible applications:
  – electrical compass
  – non-contacting switches
  – reference sensors

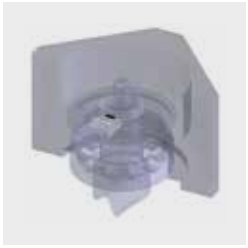


Product Range

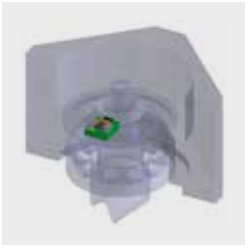
	Component	Module	Kit	System
Angle Measurement	AA700 AL700 GLM700 TA900 TL900 MWX	EBx7800 EBx7900	GLAM700 EBK7000	–
Length and Position Measurement	AA700 AL700 GLM700 TA900 TL900 MLX	EBx7800 EBx7900	GLAM700 EBK7000	–
Current Measurement	CFS1000		CFK1000 CMK2000 CMK3000 CDK4000	CMS2000 CMS3000 CDS4000
Magnetic Field Measurement	AFF700 AFF800 GF700	–	–	–

From component to system: We are a one-stop-shop for everything from a component to a complete system.

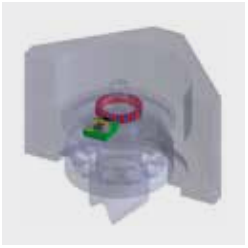
Component



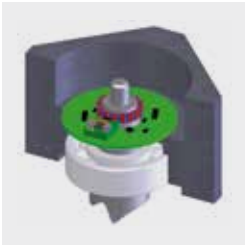
Module



Kit

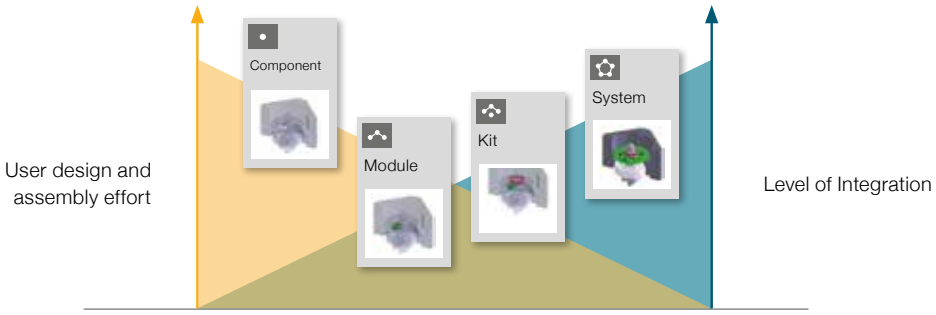


System



Product Programme

Products from Sensitec stand for precise measurement with robust sensor technology. Our magnetoresistive sensor chips and the corresponding microsystems are the basis for the measurement and control of magnetic, electrical and mechanical parameters. At the heart of each sensor is a chip, comprising single nanometre-thin layers or stacks of layers that change their electrical resistance under the influence of an external magnetic field. From chip design and production, to the design of customized measurement scales and the development of integrated signal processing electronics for specific applications, Sensitec is a reliable and competent system partner. We create product innovations as well as microsystem solutions with enduring customer benefits, all from a single source.



You can determine for yourself the level of integration of our products to allow easy implementation in your system.

Component

This term describes single components that are intended for integration into a module or a system. Because the integration must be carried out by the customer, there is an additional design and assembly effort necessary. However, the user has the possibility to configure the complete system as he wishes.

Kit

This term describes a construction set of individual, unassembled components and modules that are intended for easy customer-side assembly and integration into a machine or device.

Module

A module from Sensitec comprises several components. The module itself is not yet functional and requires other components – such as a measurement scale – to form a kit or a system.

System

A system is a fully functional combination of Sensitec components or modules in a single package. The advantage of the complete system is a minimization of design and assembly effort and therefore a fast “time-to-market”.

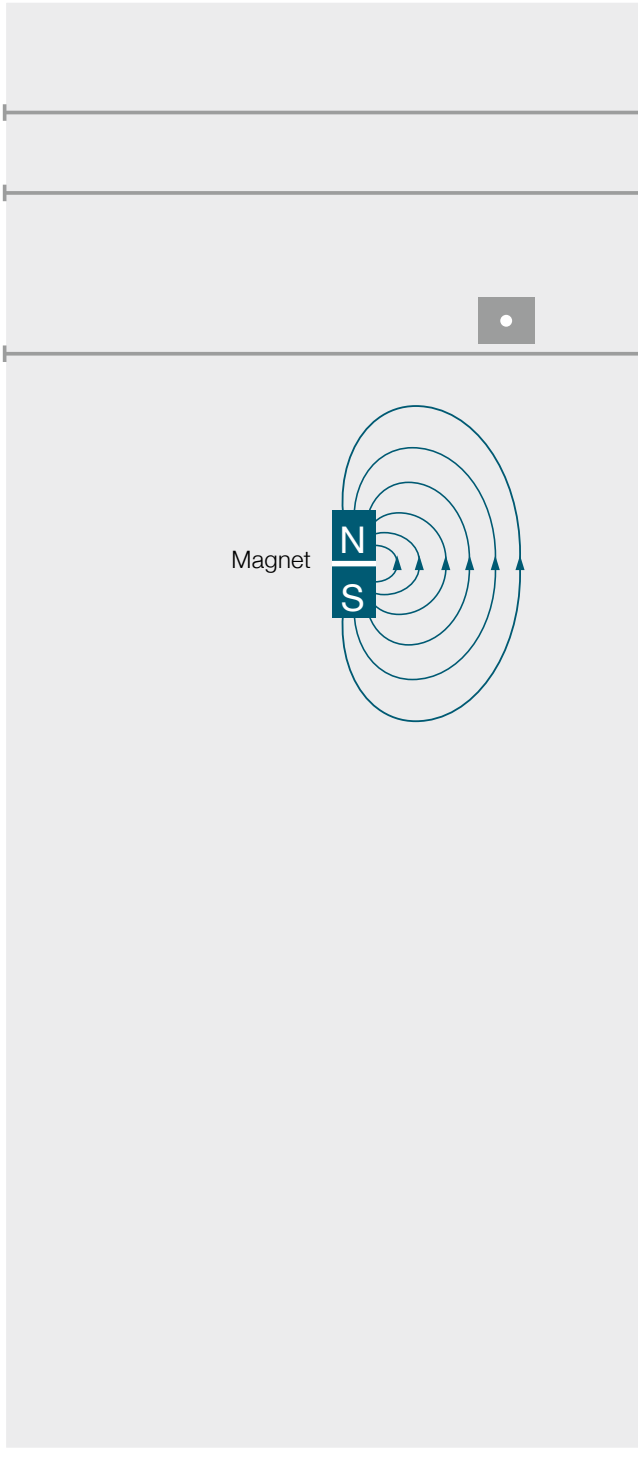
MR Sensor Signal Processing

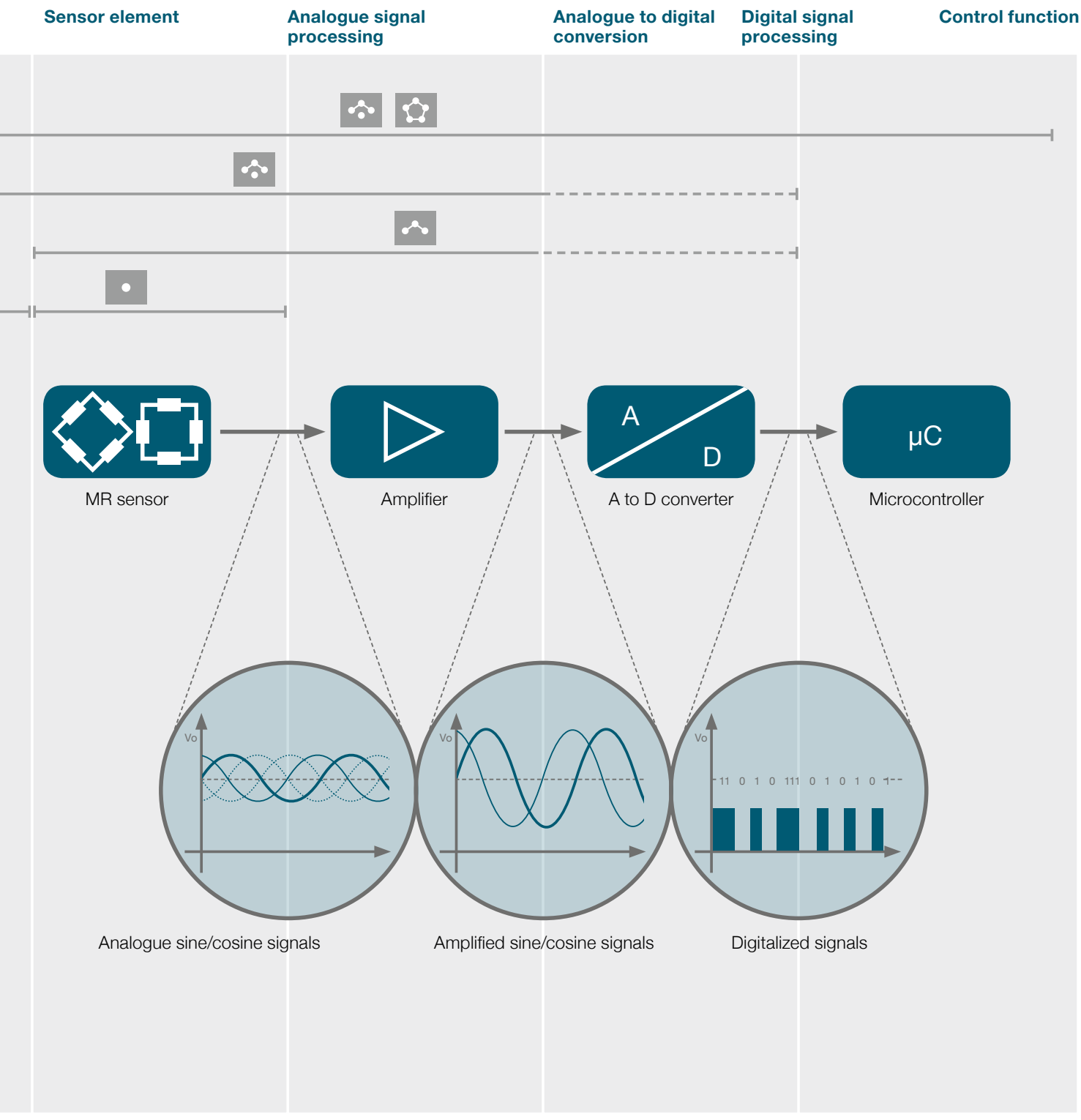
In most applications the “passive” MR sensor requires further signal processing in order to transmit and transform the analogue output signals of the sensor bridges to suit the customer’s application.

This schematic diagram shows a typical signal processing procedure running through different active components which are used to condition the sensor signals and to forward them to the connected interfaces with the appropriate signal level and form.

The diagram shows an exemplary signal chain in an application using a dipole magnet and a FreePitch sensor. Movement of the magnet generates differential sine and cosine output signals from the sensor, which are then typically amplified. By means of an appropriate choice of amplifier, sensor parameters, e. g. offset, can be adjusted. After this the signal can be transferred to an analogue-/digital converter. Quite often this converter is already implemented in an interpolation ASIC or integrated in a microcontroller. The processing of the digital output signals takes place in a microcontroller with a customized adjustment or in the control unit provided by the customer.

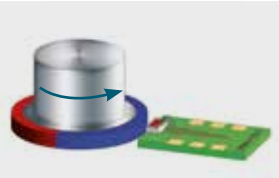
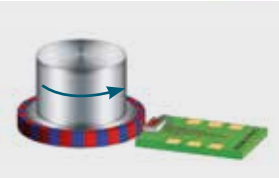
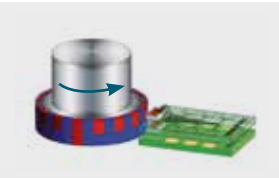
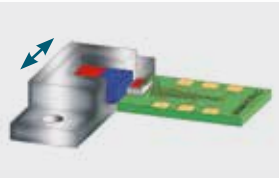
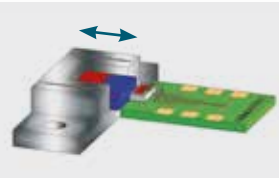
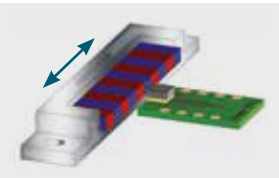
Measurand

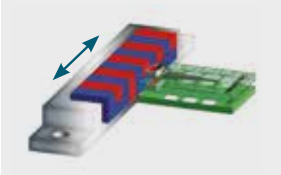
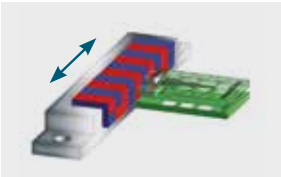
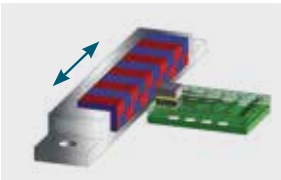
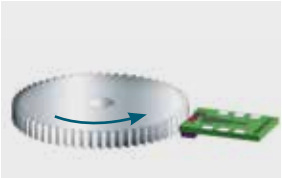
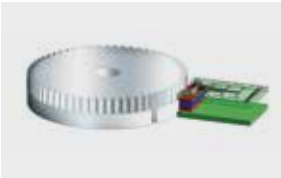
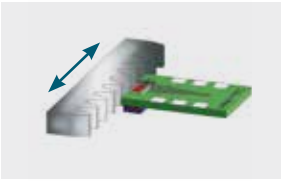
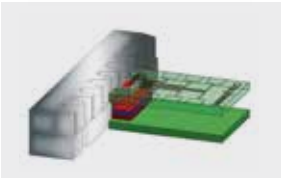


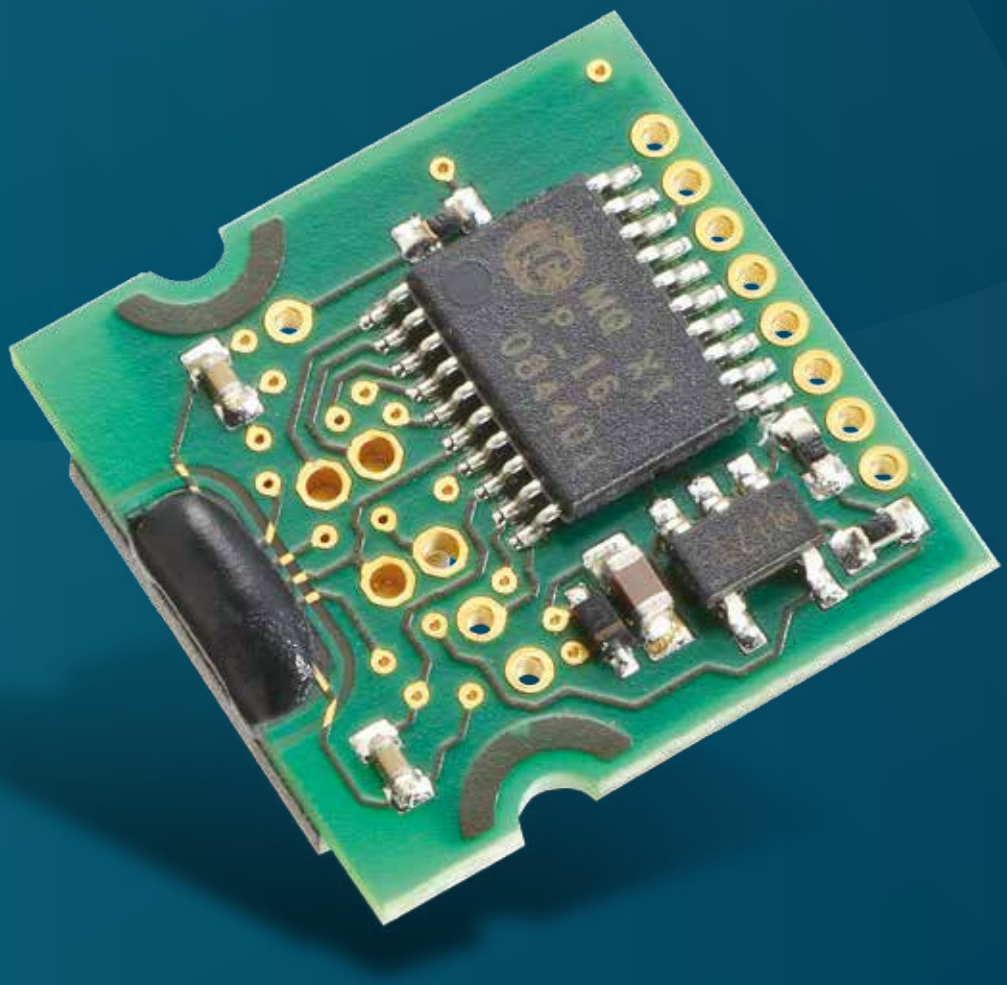

Sensor element
Analogue signal processing
Analogue to digital conversion
Digital signal processing
Control function
A
D
µC
MR sensor
Amplifier
A to D converter
Microcontroller
Vo
Vo
Vo
11 0 1 0 111 0 1 0 1 0 1
Analogue sine/cosine signals
Amplified sine/cosine signals
Digitalized signals

Measuring Configurations

The examples shown here represent a selection of typical measuring arrangements. The choice of the appropriate configuration for a given measuring task depends on the requirements and boundary conditions. Please ask us for advice.

		Configuration	Application Example
1		Rotating magnet; sensor mounted on a substrate on the axis of rotation	Absolute angle measurement up to 360° at the shaft end (axial)
2		Rotating magnet; sensor mounted on a substrate perpendicularly to the axis of rotation	Absolute angle measurement up to 180° at the shaft circumference
3		Magnetic pole ring with fixed pitch; sensor mounted on substrate radially to the pole ring; sensor surface in the plane of the pole ring	Incremental angle measurement at the shaft circumference
4		Sensors mounted perpendicularly to the magnetic tracks on the scale	Incremental angle measurement with reference point
5		Magnet moves linearly; sensor mounted at the edge of a substrate	Absolute length measurement along a magnet
6		Magnet moves linearly; sensor mounted at the edge of a substrate	Magnetic switch
7		Magnet moves linearly; sensor mounted at the edge of a substrate	Magnetic switch
8		Linear magnetic scale with fixed pole length (pitch); sensor mounted perpendicularly to the magnetic track on the scale	Incremental length measurement

		Configuration	Application Example
9		Sensors mounted perpencicularly to the magnetic tracks on the scale	Incremental linear measurement with reference point
10		Multi track linear magnetic scale with fixed pole length (pitch); sensors mounted perpendicularly to the magnetic track on the scale	Absolute length measurement with code track
11		Linear measurement scale with nonius track. Both sensors are mounted perpendicularly to the magnetic tracks	Absolute length measurement using nonius principle
12		Ferro-magnetic toothed wheel with fixed pitch; sensor with bias magnet mounted radially to the toothed wheel	Incremental angle measurement at the shaft circumference
13		Ferromagnetic toothed wheel with fixed tooth structure and ferro-magnetic reference track, sensor with bias magnet mounted per-pendicularly to the tooth structure	Incremental angle measurement with reference
14		Ferro-magnetic toothed rack with fixed pitch; sensor with bias magnet mounted perpendicularly to the rack	Incremental length measurement
15		Ferromagnetic toothed rack with fixed tooth pitch and ferromag-netic reference track, sensor with bias magnet mounted perpen-dicularly to the tooth structure	Incremental length measurement with reference
16		Sensor in the plane of the magnetic field	Magnetic field measurement, compass
17		Sensor mounted across two conductors (U-shaped configuration)	Current measurement



To set the standard you have to be able to measure it. Set the standard.

Sensitec sensors for measuring angles permit continuously precise and dynamic measurement over a broad range of temperatures, even at low field strengths. Sensitec sensors are not susceptible to dirt or interference.

Angle Measurement

Angle measurement is one of the main application areas for MR sensors. The non-contacting, wear-free measuring principle, combined with high accuracy and highly dynamic performance make MR sensors the ideal choice for machine designers. MR sensors offer different methods for the measurement of angles. Each of them is optimized to fulfill the requirements of the individual application.

There are two basic measurement concepts for angle measurement: measurement at the shaft end or measurement at the shaft circumference. For measurement at the shaft end a dipole magnet is typically used to measure the angle. For measurement at the shaft circumference there are two possibilities: Either an active pole ring or a toothed wheel can be used. The active pole ring is made of, for example, elastomer bound hard ferrite and is magnetized with alternating north-south poles. If a toothed wheel is to be used as a passive measurement scale, it has to be manufactured from a magnetically soft metal. When measuring the angle of rotation at the shaft end using a dipole magnet the AA700 series can be used because these sensors feature FreePitch technology and are not fixed to a particular pole length (pitch). If a multi-pole ring is used for measurement at the shaft circumference then a pole matched sensor is appropriate. It is recommended to use sensors featuring FixPitch technology from the AL700 series, such as the AL798 for 1 mm poles (2 mm pole pair length). When using a toothed wheel the sensors from the GLM series are best suited. Here the magnets for the working magnetic field are already integrated in the sensor module. The GLM sensor modules are used not only for measurements using gear wheels, but even using tooth-like structures (e.g. a metal disk with holes) the sensors provide precise sine and cosine signals, which are well suited for further signal processing.

MR sensor at shaft end with dipole magnet

In some applications a reference sensor is needed for homing purposes. This reference can be realized by a second sensor, such as the GF705 or the GF708 magnetic field sensor. A reference position on a second track on the active pole ring is detected by these sensors and used for the generation of a Z-impulse. When using a passive measurement scale a single tooth or a single groove on an additional ring can be used to generate the reference.

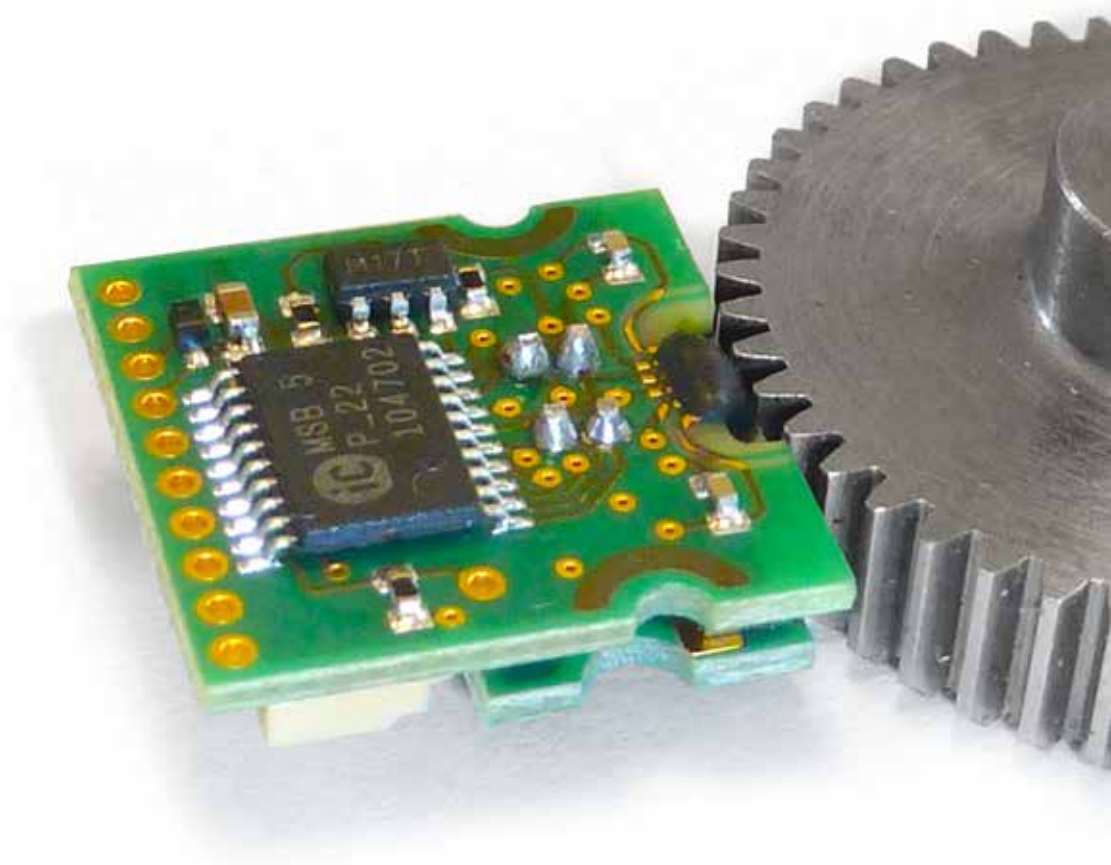
The latest TA and TL sensor families are based on the especially energy efficient TMR effect. The power consumption of these new sensor families, which will be introduced into the market in 2016, is 10 times lower compared to AMR or GMR sensors with a similar resolution.

Therefore TA and TL families are very well suited for applications which are operated using batteries or powered by energy harvesting. These innovative sensors feature a better temperature stability than AMR or GMR sensors. This means that a temperature calibration is no longer necessary in many applications.

MR sensors for angle measurement comprise magnetoresistive strips arranged to form two Wheatstone bridges, which provide differential sine and cosine signals. This configuration reduces temperature drift and increases the signal output of the sensor. In Sensitec's sensor modules the signal is conditioned with additional electronics to convert the delivered signal so that the user can process it easily in his application.

This can typically require a 1 V peak-to-peak signal or a digital signal (AB signals). Also digital serial protocols, such as SSI or BiSS are possible. Offset and phase differences between the sine and cosine signals can also be compensated. The resolution that can be achieved depends on the MR sensor used and the signal conditioning electronics applied. Accuracies in the range of just a few minutes of arc can be readily achieved. With special designs resolutions in the range of seconds of arc can be achieved.

A major advantage of MR sensors for angle measurement is the non-contacting principle and therefore wear-free operation. The gap between the target and sensor can be as much as several millimetres in specific applications. Dust and oil between the MR sensor and the measurement scale do not have any impact on the measurement result. The very high repeatability makes them especially suitable for precision positioning tasks. The highly dynamic performance of MR sensors allows applications with extremely high speeds and accelerations to be realized. The wide range of permissible ambient temperatures allows MR sensors to be used under extreme operating conditions e.g. in measurement probes for oil drilling (at 200 °C and 1000 bar) or in space applications. MR sensors can also be used to construct rotary encoders that can withstand radiation or that can be used in a vacuum. In most applications of this type the conditioning electronics is the limiting factor, rather than the sensor itself.

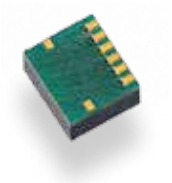


AA700 Family

AMR FreePitch Sensors for Angle Measurement

Component

Online at
www.rs-components.de



The patented chip layout of the new Sensitec AA700 family reflects the concentrated expertise of more than a decade. These new chips are ideally suited for applications where highly precise angle and position measurements must be executed in a flexible and cost-effective manner under difficult operating conditions.

The AA700 sensor components feature FreePitch technology and are independent of a fixed pole length. The sensors are available as bare die for small form factor chip-on-board assembly or as a SO8-housed component for SMD assembly. The AA700 family includes sensors for angle measurement at both shaft end and shaft circumference.

Features

- Based on the anisotropic magnetoresistive (AMR) effect
- Contains two independent Wheatstone bridges
- Sine and cosine output signal
- Ambient temperature range from -40 °C to +150 °C
- Available for SMD assembly
- Automotive qualified (only SO8 and chip)

Advantages

- Large permissible air gap between sensor and measurement scale
- Excellent accuracy, even for weak magnetic field strengths
- High permissible frequency allows measurement of very high speed applications (permissible angular frequency of magnetic field > 1 MHz)
- Tolerant to shaft eccentricity
- Largely insensitive to interference fields
- Minimal offset voltage
- Negligible hysteresis

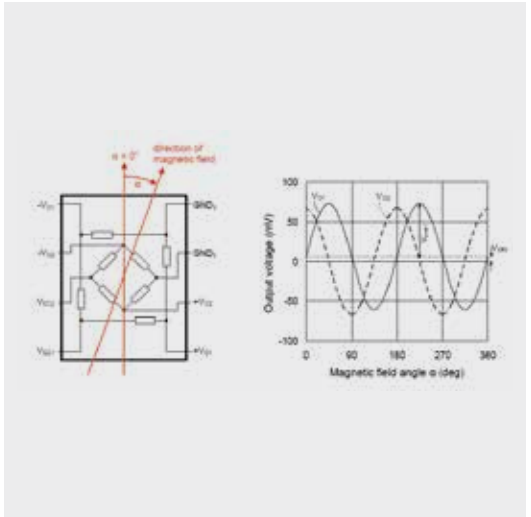
Applications

- Incremental or absolute encoders
- Motor-Feedback-Systems
- Fast rotational speed measurement
- Angle detection (180° absolute at shaft end for AA74x)
- Angle detection (360° absolute at shaft end for AAQ747)
- Wheel speed sensing
- Crankshaft speed sensing

Product Features

Sensor type	Measuring configuration	FreePitch	PerfectWave	Feature
AA745 [1] AA746		√	√	Optimized for measurement at shaft circumference [1] Qualified for automotive applications (only chip)
AA747 [1] AAQ747		√	√	Optimized for measurement at shaft end Tolerant with respect to eccentricity errors [1] Qualified for automotive applications (only chip and SO8)

Torque measurement for active steering with AA745 sensor



Technical Data

Symbol	Parameter	AA745	AA746	AA747	AAQ747[2]	Unit
Δα	Accuracy [1]	±0.05				°
V_{CC}	Supply voltage	5				V
V_{off}	Offset voltage per V_{CC}	±2	±0.5	±2	±2	mV/V
V_{peak}	Signal amplitude per V_{CC}	13.4	13.0			mV/V
R_B	Bridge resistance	3.2	1.2	3.2		kΩ
H_{ext}	Nominal field strength	> 25	> 5	> 25		kA/m

[1] These values refer to operation 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.

[2] The sensor is equipped with additional quadrant outputs. These can be used to determine the absolute position over 360°.

Product Codes

Product code	Dimensions [mm]	Package	Ambient temperature range T_{amb}
AA745AKA	7.6 x 3.5 x 1.4	SIL6	-40 °C to +125 °C
AA745AMA	3.0 x 2.6 x 1.5	LGA6S	-40 °C to +125 °C
AA746	1.7 x 1.6	Bare die	-40 °C to +125 °C
AA746AMA	6.0 x 2.6 x 1.5	LGA6L	-40 °C to +125 °C
AA747AHA	4.9 x 6.0 x 1.8	SO8	-40 °C to +150 °C
AAQ747AHA	4.9 x 6.0 x 1.8	SO8	-40 °C to to +150 °C

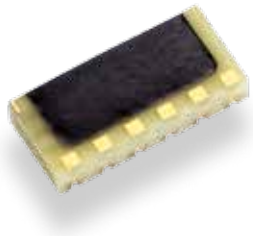
The sensors of the AA700 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form. For the evaluation of your application an evaluation kit is available – please contact our sales team for more information.

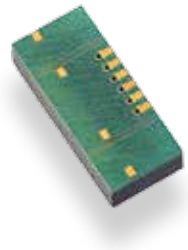
AL700 Family

AMR FixPitch Sensors for Angle Measurement

Component

Online at
www.rs-components.de





The AL700 sensor components are based on the proven FixPitch technology. These sensor components are specially designed for use with active measurement scales, that is, with pole rings. The components are so designed, that they can be assembled at the edge of a substrate to allow easy mounting radially to the pole ring. This family includes sensors incorporating PurePitch technology, such that the sensor averages over several poles. This feature combined with the PerfectWave design, which suppresses higher harmonics in the output signal, provides both excellent angular measurement accuracy and a high signal quality. These sensors are available as a SIL6-housed and LGA6-housed component for SMD assembly.

Features

– Based on the anisotropic magnetoresistive (AMR) effect
– Contains two independent Wheatstone bridges
– Sine and cosine output signal
– Ambient temperature range from -40 °C to +125 °C
– Available for SMD-assembly in SIL6 and LGA6 housing

Advantages

– Large permissible air gap between sensor and measurement scale
– Excellent accuracy by means of PurePitch and PerfectWave technologies
– High permissible frequency allows measurement of very high speed applications (permissible angular frequency of magnetic field > 1 MHz)
– Largely insensitive to homogeneous interference fields due to PerfectWave technology
– No stabilizing magnetic field necessary
– Minimal offset voltage
– Negligible hysteresis

Applications

– Incremental or absolute encoders
– Motor-Feedback-Systems
– Fast rotational speed measurement (e.g. for high frequency spindles)

Product Features

Sensor type	Measuring configuration	FixPitch	PurePitch	PerfectWave	Averaging (Number of poles)
AL780		5 mm		√	1
AL797		2.5 mm	√	√	2
AL794[1)]		2.5 mm	√	√	2
AL796		2 mm	√	√	2
AL798		1 mm	√	√	2
AL795		0.5 mm	√	√	8

[1)] High-impedance

Technical Data

Symbol	Parameter	AL780	AL797	AL794[1)]	AL796	AL798	AL795	Unit
Δα	Accuracy	< 1 % of pitch						
P	Pitch	5	2.5	2.5	2	1	0.5	mm
d	Air gap	~2.5	~1.3	~1.3	~1	~0.5	~0.3	mm
V_{CC}	Supply voltage	5						V
V_{off}	Offset voltage per V_{CC}	±1	±1	±2	±2	±2	±0.5	mV/V
V_{peak}	Signal amplitude per V_{CC}	11.0	11.0	11.0	11.0	11.5	11.0	mV/V
R_B	Bridge resistance	3.2	5.4	62	3.4	3.6	4.6	kΩ
R_S	Sensor resistance	1.6	2.7	31	1.7	1.8	2.3	kΩ
T_{amb}	Ambient temperature range	-40 to +125						°C

[1)] High-impedance
The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

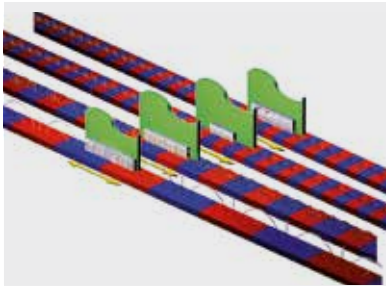
Product Codes

Product code	Package	Dimensions
AL7xxAKA	SIL6	7.6 x 3.5 x 1.4 mm
AL7xxAMA	LGA6L	6 x 2.6 x 1.5 mm
AL798AMA	LGA6S	3 x 2.6 x 1.5 mm

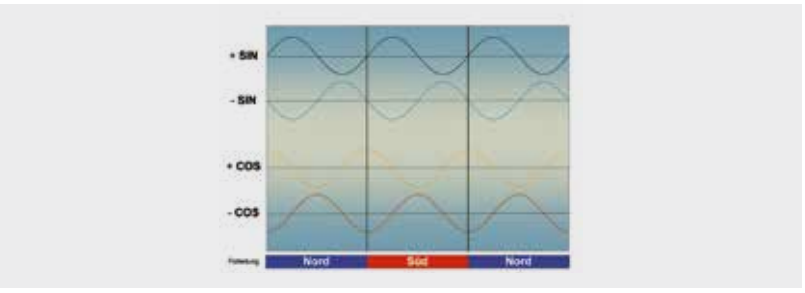
The sensors of the AL700 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form. For the evaluation of your application an evaluation kit is available - our sales engineers will be pleased to give advice to you.

High frequency spindle

Configurations



Schematic diagram of output signals



NEW in 2016!

TA900 Family

TMR FreePitch Sensors for Angle Measurement

The new TA900 family combines the long experience of Sensitec in the field of angle sensor technology with the energy efficiency and temperature stability provided by the new TMR effect. Patented chip layouts enable precise, flexible and cost-efficient angle measurement under difficult operating conditions.

Due to the low power consumption TA900 sensors are especially well suited for applications which are operated by means of battery or powered by energy harvesting. Furthermore, the new sensors are also convenient for EX-protection applications.

A further difference between the established AMR angle sensors and TMR sensors is the capability for 360 ° absolute angle measurement at the shaft end by means of a single sensor element.

TA900 sensors can be applied independently of fixed pole pitches and can be used for angle measurement at the shaft circumference as well as at the shaft end.

Features

– Based on the Tunnel Magnetoresistive (TMR) effect
– Contains two independent Wheatstone bridges
– Sine and cosine output signal
– Ambient temperature range from -40 °C to +150 °C
– Available for SMD-assembly
– Qualification for automotive applications from 2016

Advantages

– Single-turn absolute measurement over 360 ° (mechanical) possible
– Extremely low power consumption, therefore ideally suited for applications with power supply via battery or energy harvesting
– High temperature stability
– Large air gap between sensor and measurement scale
– High precision, even for low field strengths
– High permissible limit frequency allows high-speed applications (permissible rotational frequency of the magnetic field in excess of 1 MHz)
– High tolerance with respect to eccentricity in the mechanical assembly
– Insensitive to homogeneous disturbing fields
– Minimal offset voltage
– Negligible hysteresis

Applications

– Incremental and absolute angle encoders
– Motor-Feedback-Systems
– Fast rotational speed measurement, e. g. in high frequency spindles
– Wheel speed sensors
– Angle measurement for windscreen wipers or throttle valves in cars

Product Features

Sensor type	Measuring configuration	FreePitch	PerfectWave	Feature
TA901 [1)]		√	√	[1)] Qualified for automotive applications from 2016/2017

Technical Data

Symbol	Parameter		TA901	Unit
Δα	Accuracy	30-80 mT	0.4	°
		20-120 mT	0.6	
V_{CC}	Supply voltage		5	V
V_{off}	Offset voltage per V_{CC}		±3	mV/V
V_{peak}	Signal amplitude per V_{CC}		250	mV/V
R_B	Bridge resistance		6	kΩ
H_{ext}	Nominal field strength		30-80	kA/m

The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Product Codes

Product code	Package	Dimensions	Ambient temperature range T_{amb}
TA901AIA-LE	TSSOP8	6.4 x 3.05 mm	-40 … +150 °C

The sensors of the TA900 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form. For the evaluation of your application a sample is available - our sales engineers will be pleased to give advice to you.

NEW in 2016!

TL900 Family

TMR FixPitch Sensors for Angle Measurement

The new TL900 family combines the long experience of Sensitec in the field of angle sensor technology with the energy efficiency and temperature stability provided by the new TMR effect. The TL900 sensor family has been developed for applications using active measurement scales, such as pole rings. The sensors are designed to be mounted at the edge of a printed circuit board or similar substrate and are ideal for off-axis, radial measurement configurations.

This feature, combined with PerfectWave technology, which suppresses higher harmonics in the output signal, provides both excellent angular measurement accuracy and a high signal quality. These sensors will first be available in a LGA-package for SMD assembly. TL900 sensors will also be available as bare die on request. Due to the low power consumption TL900 sensors are especially well suited for applications which are operated by means of battery or powered by energy harvesting. Furthermore, the new sensors are also convenient for EX-protection applications.

Features

– Based on the Tunnel Magnetoresistive (TMR) effect
– Contains two independent Wheatstone bridges
– Sine and cosine output signal
– Ambient temperature range from -40 °C to +125 °C
– Available for SMD-assembly

Advantages

– Extremely low power consumption, therefore ideally suited for applications with power supply via battery or energy harvesting
– High temperature stability
– Large air gap between sensor and measurement scale
– High precision, even for low field strengths
– High permissible limit frequency allows high-speed applications (permissible rotational frequency of the magnetic field in excess of 1 MHz)
– No stabilizing bias field necessary
– Insensitive to homogeneous disturbing fields
– Minimal offset voltage
– Negligible hysteresis

Applications

– Incremental and absolute angle encoders
– Motor-Feedback-Systems
– Fast rotational speed measurement, e. g. in high frequency spindles
– Wheel speed sensors

Product Features

Sensor type	Measuring configuration	FixPitch	Pole pitch [mm]	PurePitch	PerfectWave	Averaging (number of pole pairs)
TL915		5 mm	2.5		√	1
TL914		3 mm	1.5		√	1
TL913		2 mm	1	√	√	2
TL912		1 mm	0.5	√	√	2
TL911		0.5 mm	0.25	√	√	2

Technical Data

Symbol	Parameter		TL915	TL914	TL913	TL912	TL911	Unit
Δα	Accuracy		< 1 % of pole pitch					
P	Pitch		5	3	2	1	0.5	mm
l_p	Pole pitch		2.5	1.5	1	0.5	0.25	mm
d	Air gap		~2	~1.2	~0.8	~0.4	~0.2	mm
V_{CC}	Supply voltage		5					V
V_{off}	Offset voltage per V_{CC}		±15					mV/V
V_{peak}	Signal amplitude per V_{CC}		150					mV/V
R_B	Bridge resistance	normal low power [1]	12 1200					kΩ
R_S	Sensor resistance	normal low power [1]	6 600					kΩ
T_{amb}	Ambient temperature range		-40 to +125					°C

[1] High-impedance version
The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Product Codes

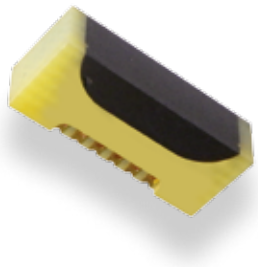
Product code	Package	Dimensions
TL91xAMA-AE	LGA6L	6 x 2.6 x 1.5 mm

The sensors of the TL900 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form. For the evaluation of your application a sample is available - our sales engineers will be pleased to give advice to you.

GLM700 Family

GMR Tooth Sensor Modules for Angle Measurement

Module



The sensors of the GLM700 family are designed for measurement with passive measurement scales, such as toothed racks or toothed wheels. These sensors combine the GL700 series tooth sensors with an integrated biasing magnet in a compact SMD housing, so reducing the design and assembly effort for the user. The GLM700 family of sensor modules can be used to sense the changes in magnetic flux density created by toothed ferromagnetic machine elements, such as gear wheels, in a magnetic field. Based on the GMR effect, these sensors are classified as FixPitch sensors and are matched to a particular tooth pitch. A wide range of tooth pitches between 0.94 mm and 3 mm is covered. A big advantage of these sensors is the universal applicability to a wide variety of tooth-like structures.
In addition to classical tooth profiles, such as involute tooth profiles, also pressed tooth structures with a low tooth depth or even holes in a ferromagnetic material can be used as a passive measurement scale. The modules supply a sine/cosine signal of high quality with high resolution.

There are evaluation-boards (GLAM7xx) available for all tooth pitches with a parallel mounted GLM module, for the development and testing of your sensor module application. The board provides amplified sine and cosine sensor signals. The amplification factor is set at 37, so that the output signals can be processed easily.

Features

– Sensor module for sensing toothed structures
– Based on the giant magnetoresistive (GMR) effect
– Differential sine and cosine output signals
– Ambient temperature range from -40 °C to +125 °C
– Designed for SMD-assembly

Advantages

– Integrated magnet for optimized performance and ease of use
– High dynamic range for high-speed applications
– Parallel or perpendicular mounting on the substrate

Applications

– Incremental angle measurement
– Motor-Feedback-Systems
– Sensor bearings
– Integrated encoder in direct drives

Product Codes

Product code*	Product photo	Sin/Cos differential	Sin/Cos amplified	Dimensions	Ambient temperature range T_{amb}
GLM7xxASB		√		13 x 5.5 x 3.5 mm	-40 to +125 °C
GLAM7xx			√	24 x 21 x 5.1 mm	-25 to +85 °C

The sensors of the GLM700 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form. Gearwheels or other toothed structures, respectively, are available from many suppliers. It is important to use a ferromagnetic material, as only these materials affect the working magnetic field. In special cases, e.g. the rods of pneumatic cylinders, the toothed structures have to be sealed to achieve a smooth surface. There are different technologies to realise a smooth surface in spite of the magnetically soft toothed structure under the surface. Please contact us for more information.

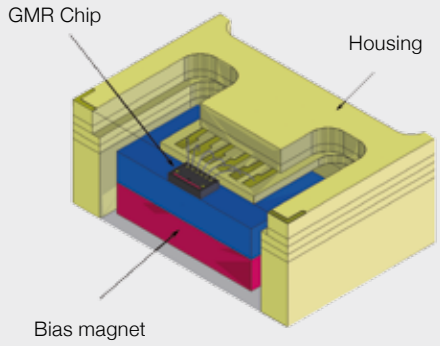
* Please refer to table „Technical Data"

Technical Data

Symbol	Parameter	GLM711	GLM712	GLM713	GLM714	GLM715	Unit
P	Tooth pitch	1.0	2.0	3.0	0.94 (Module 0.3)	1.57 (Module 0.5)	mm
d	Air gap	~200	~400	~600	~190	~310	µm
V_{CC}	Supply voltage	5					V
R_B	Bridge resistance	5.5	5.7	5.7	5.6	5.8	kΩ
R_S	Sensor resistance	2.75	2.85		2.8	2.9	kΩ
f	Frequency range [1]	<1					MHz

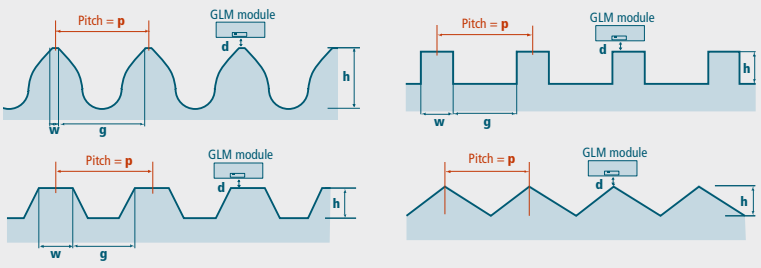
[1] without significant loss of signal amplitude
The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Construction of the module



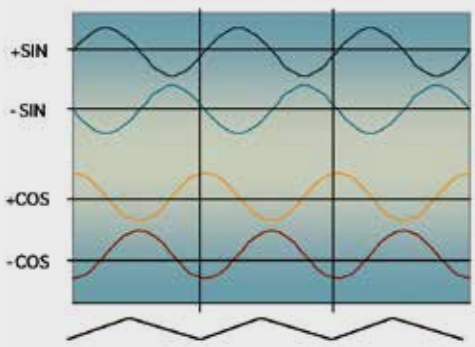
Configurations

GLM sensor modules can be operated with different tooth structures, such as:



Toothed wheels are available on request.

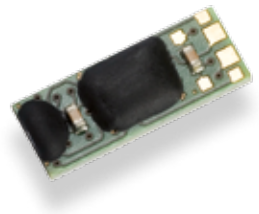
Schematic diagram of output signals



EBX Family

Sensor Module with Incremental Output

Module



Sensitec's EBI sensor modules for incremental measurement comprise MR sensors, mounted on a circuit board together with signal processing electronics. There are standard modules for active and also passive measurement scales. The EBR sensor modules feature an additional sensor, which generates a reference signal in combination with the appropriate measurement scale.

The sensor modules of the 7900 series are designed for measuring at active, magnetized pole rings and measurement scales, whereas the modules of the 7800 series have an integrated magnet to allow the use of passive measurement scales. There are different modules with various electrical interfaces. Serial SSI or BiSS signals can be generated, as well as differential digital AB signals with an additional reference signal (Z signal).

Some of the modules have a very compact configuration and can even be integrated in the smallest available space. The wide range of sensor modules, characterised by their robustness and the low design and assembly effort required by the user, allows a quick market launch for new products. Most sensor modules are calibrated, with respect to sensor characteristics such as offset and so provide better accuracy with low flank jitter.

Features

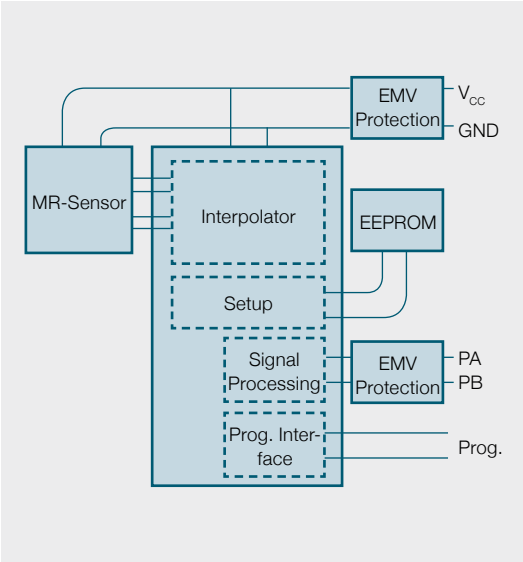
– AB signals (TTL or HTL)
– Z-signal available for some modules
– Wide ambient temperature range

Advantages

– Easy assembly
– Robust, compact design

Applications

– Incremental measurement systems
– Motor-Feedback-Systems



The diagram shows a typical circuit for a sensor module for incremental measurement. The sensor signals are conditioned by the electronics and typically offered to the user as digital signals. These digital square-wave signals are also used for directional recognition and are therefore provided as phase-shifted signals (PA and PB). In addition, a number of modules feature differential signals (NA and NB) as well as indiviudal (PZ) or differential (NZ) reference signals. The electronic circuit is programmable or can be parameterized via an external circuit, so that the resolution can be freely chosen and for most sensor modules the sensor offset and phase error can be compensated.

In addition to the standard sensor modules there is a broad range of customized solutions with specific functions and configurations. Custom-tailored to suit the particular needs and operating conditions of the individual user, these sensor modules can offer many advantages once the necessary development process is completed.

The “x” in the product code in the following tables denotes different versions that are available. Please refer to the data sheet of the particular module, which you can find on our website or obtain from our sales department.

Selection Guide

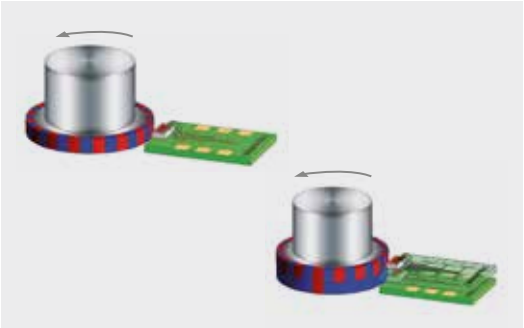
Sensor module	Operating voltage V_{cc}	Pitch (p)	Output	Reference	Measuring steps/pitch (z) [1) 2)]	Information
EBI7901	5 V	1 mm > 2 mm	PA, PB	–	4 - 80	FreePitch (> 2 mm)
EBI7903	5 V	1 mm	PA, PB, PZ	–	8 - 8192	Z-Signal/Pitch
EBI7904	5 V	1 mm	PA, PB	–	8 - 8192	
EBR7911	5 V 10 - 30 V	2 mm	PA, NA, PB, NB, PZ, NZ	√	4 - 400	SmartFit
EBR7912	3.3 - 5 V	2 mm	PA, NA, PB, NB, PZ, NZ	√	4 - 256	
EBx7811	5 V	0.94 mm 1 mm 1.57 mm 2 mm 3 mm	PA, NA, PB, NB (PZ, NZ)	(√)	4 - 400	Reference optional
	5 V	0.94 mm 1 mm 1.57 mm 2 mm 3 mm	PA, NA, PB, NB, (PZ, NZ)	(√)	1 V_{ss}	Reference optional

[1)] Selectable
[2)] Calculation of resolution
p - pitch in mm
n - number of poles/teeth per revolution
z - number of measurement steps per pitch

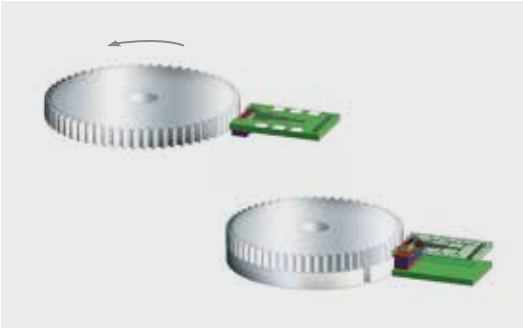
For linear applications:
resolution (mm) = p / z

For rotary (pole ring) applications:
resolution (°) = 360° / (n * z)

Configurations for EBx7900



Configurations for EBx7800



Technical Data

Sensor Modules for Active Measurement Scales

Product code	Resolution up to 80 measuring steps/pitch	
EBI7901CAx-DA FixPitch 1 mm EBI7901ZAx-DA FreePitch > 2 mm	Used sensor	AL798 / AA747
	Length	15.5 mm
	Width	6 mm
	Height	2 mm
	Ambient temperature	-40 °C to +100 °C

EBI7901

Product code	FixPitch 1 mm, resolution up to 8192 measuring steps/pitch	
EBI7903CAx-DA additional Z pulse	Used sensor	AL798
	Length	9.4 mm
	Width	9.8 mm
	Height	3.2 mm
	Ambient temperature	-25 °C to +85 °C

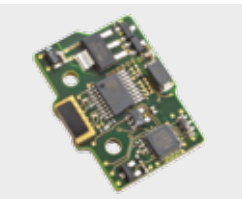
EBI7903

Product code	FixPitch 1 mm, resolution up to 8192 measuring steps/pitch	
EBI7904CAx-DA	Used sensor	AL798
	Length	9.4 mm
	Width	9.8 mm
	Height	3.2 mm
	Ambient temperature	-25 °C to +85 °C

EBI7904

Product code	FixPitch 2 mm, resolution up to 400 measuring steps/pitch	
EBR7911EBx-DA Supply voltage 5 V EBR7911EBx-FA Supply voltage 10-30 V	Used sensor	AL796, GF708
	Length	20.5 mm
	Width	28.6 mm
	Height	5.6 mm
	Ambient temperature	-40 °C to +100 °C

EBR7911



Product code	FixPitch 2 mm, resolution up to 256 measuring steps/pitch	
EBR7912EBx-DA	Used sensor	AL796, GF705
	Length	15 mm
	Width	15 mm
	Height	7.2 mm
	Ambient temperature	-40 °C to +105 °C

EBR7912

Technical Data

Sensor Modules for Passive Measurement Scales

Product code	FixPitch diverse, up to 400 measuring steps/pitch	
EBI7811xBx-DA EBR7811xBx-DA with reference	Used sensor	GL700
	Length	15 mm
	Width	15 mm
	Height	5.2 mm (EBI) / 7 mm (EBR)
	Ambient temperature	-40 °C to +100 °C

EBI7811

Product code	FixPitch diverse, sine / cosine signal 1 V_{ss}	
EBI7811xDB-DA EBR7811xDB-DA with reference	Used sensor	GL700
	Length	15 mm
	Width	15 mm
	Height	5.2 mm (EBI) / 7 mm (EBR)
	Ambient temperature	-40 °C to +100 °C

EBR7811

Pole Rings

● Component

Da: outer diameter
Di: inner diameter
H: width

MWx-I:
Pole ring with incremental magnetization

MWx-R:
Pole ring with incremental magnetization and reference track

Pole rings are active measurement scales. They can be manufactured from different materials. The basic magnetic material is often hard ferrite, bound for example in an elastomer or polyamide matrix. The pole rings are typically magnetized with alternating north-south poles around the circumference. Multi-track pole rings are typically used if an additional reference track is required and other magnetic encodings are also realizable. The pole length is given approximately by the relationship circumference/number of poles. The width of magnetization for a single track pole ring is typically the width of the pole ring. The tracks for multi-track rings are applied so that the signal quality of the total system is optimal.

Sensitec offers standard pole rings in three versions: elastomer bound pole rings are already mounted on a metallic ring – the sintered hard ferrite rings and polymer bound variants can be mounted on a hub by the customer. We would be pleased to offer advice on the right choice of pole ring.

Technical Data

Standard pole rings (elastomer bound)[1]	Product code	Pole pitch [mm]	Sensor	Air gap [µm][2]	Number of poles
Da/Di/H 31.87/20/10	MWx0200FAA-UA	0.5 mm	AL795 / TL912	140	200
	MWx0100FAB-UA	1 mm	AL798 / TL913	300	100
	MWx0050FAC-UA	2 mm	AL796	620	50
	MWx0040FAD-UA	2.5 mm	AL797 / AL794 / TL915	780	40
	MWx0020FAE-UA	5 mm	AL780	1570	20
Da/Di/H 40.78/30/10	MWx0256FAA-UA	0.5 mm	AL795 / TL912	140	256
	MWx0128FAB-UA	1 mm	AL798 / TL913	300	128
	MWx0064FAC-UA	2 mm	AL796	620	64
Da/Di/H 57.3/45/10	MWx0360FAA-UA	0.5 mm	AL795 / TL912	160	360
	MWx0180FAB-UA	1 mm	AL798 / TL913	320	180
	MWx0090FAC-UA	2 mm	AL796	630	90
	MWx0072FAD-UA	2.5 mm	AL797 / TL915	790	72
	MWx0036FAE-UA	5 mm	AL780	1590	36
Da/Di/H 122/90/10	MWx0768FAA-UA	0.5 mm	AL795 / TL912	270	768
	MWx0384FAB-UA	1 mm	AL798 / TL913	430	384
	MWx0192FAC-UA	2 mm	AL796	750	192
Standard pole rings (Hard ferrite 8/22)[3]	**Product code**	**Pole pitch [mm]**	**Sensor**	**Air gap [µm][2]**	**Number of poles**
Da/Di/H 38/30/6.5	MWx0240HAA-UA	0.5 mm	AL795 / TL912	260	240
	MWx0120HAB-UA	1 mm	AL798 / TL913	420	120
	MWx0060HAC-UA	2 mm	AL796	730	60
	MWx0048HAD-UA	2.5 mm	AL797 / AL794 / TL915	890	48
	MWx0024HAE-UA	5 mm	AL780	1690	24
Da/Di/H 41.2/25.05/10	MWx0260HAA-UA	0.5 mm	AL795 / TL912	250	260
	MWx0128HAB-UA	1 mm	AL798 / TL913	90	128
	MWx0064HAC-UA	2 mm	AL796	410	64
Da/Di/H 72/54/7	MWx0226HAB-UA	1 mm	AL798 / TL913	290	226
	MWx0112HAC-UA	2 mm	AL796	290	112

[1] Ambient temperature range: -40 to +160 °C (ring on steel carrier).

[2] Ideal air gap for highest precision. By means of simulation tools Sensitec will be pleased to work out an optimized combination of sensor, pole ring and air gap for your application. Please contact our sales engineer.

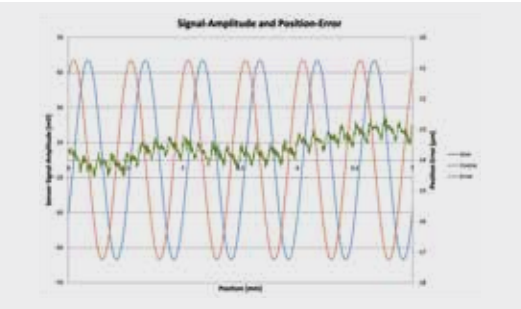
[3] Ambient temperature range: -20 to +200 °C (ring without carrier).

Magnetisation

System

As a manufacturer of magnetic sensors and a supplier of complete sensor solutions special know-how around magnetization belongs to our core competences. In addition to our highly precise magnetization facilities for pole rings and linear measurement scales we apply simulation tools to ensure the optimized design of measurement scales. This enables us to evaluate parameters like magnetic material, air gap and and alignment tolerances and to select the ideal measurement scale for your application. The chip characteristics of our MR sensors are reflected in this calculation to achieve a maximum performance for the complete system. Our magnetization systems are equipped with highly precise reference systems which provide highest accuracy during the magnetization process as well as during the subsequent measurement. The magnetization systems are designed for series application and cost effective production. Furthermore this concept allows a highly flexible utilization for samples and small volumes as well. This is a special advantage because the production takes place on series production systems and the cost for sample production can be reduced to a minimum even in early development stages.

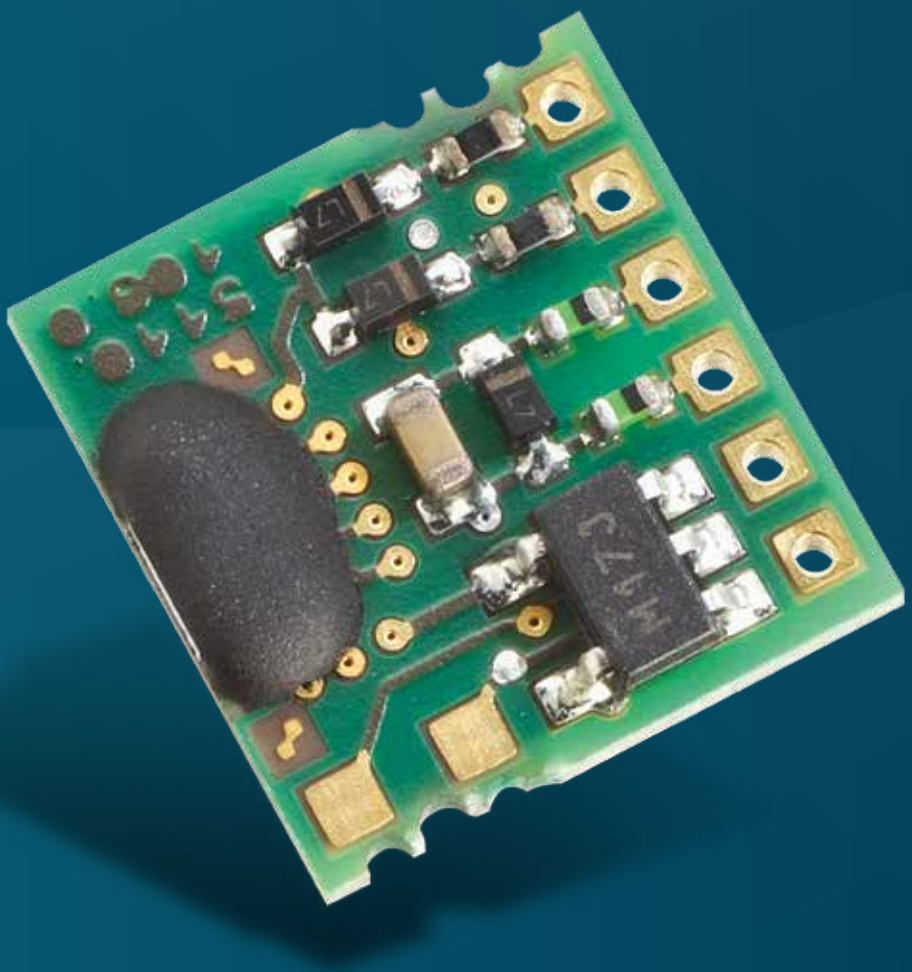
The magnetization is carried out using a pulsed procedure. This means that each magnetic pole is implemented with a very high field strength into the magnetic material. This allows, for example, the magnetization of polymer-bound NeFeB material among others. During magnetization of pole rings the resulting „joint“ between start and end of the magnetization is eliminated by an intelligent process. Pole rings and linear scales can be magnetized with up to three tracks. In adddtion to incremental tracks it is also possible to magnetize reference tracks with one or more poles and of course code tracks with different north and south pole patterns.



Standard pole rings (polymer bound hard ferrite 8/22) [4]	Product code	Pole pitch [mm]	Sensor	Air gap [µm] [2]	Number of poles
Da/Di/H 20.44/15.5/3.5	MWR0032KAC-KH	2 mm	AL796	600	32
Da/Di/H 29/25/5.5	MWx0180KAA-UA	0.5 mm	AL795 / TL912	50	180
	MWx0090KAB-UA	1 mm	AL798 / TL913	140	90
	MWx0046KAC-UA	2 mm	AL796	780	46
	MWx0036KAD-UA	2.5 mm	AL797 / AL794 / TL915	620	36
	MWx0018KAE-UA	5 mm	AL780	1400	18
Da/Di/H 31.7/25/5.5	MWx0200KAA-UA	0.5 mm	AL795 / TL912	220	200
	MWx0100KAB-UA	1 mm	AL798 / TL913	380	100
	MWx0050KAC-UA	2 mm	AL796	700	50
	MWx0040KAD-UA	2.5 mm	AL797 / AL794 / TL915	860	40
	MWx0020KAE-UA	5 mm	AL780	1660	20

Da: outer diameter
Di: inner diameter
H: width

[4] Ambient temperature range: -40 to +105 °C (ring without carrier).



To set the benchmark, you have to be able to measure it. Be the benchmark.

Sensitec sensors for measuring length and position offer extremely sensitive measurement with robust and long-lasting technology. Sensitec sensors measure incremental or absolute length reliably and precisely to an accuracy measured in µm.

Length and Position Measurement

MR sensors are ideally suited to applications in length and position measurement. High repeatability, combined with extreme robustness, make MR-sensors the right solution for demanding position measurement tasks in difficult operating environments.

MR sensors are ideally suited to length and position measurement applications. The high repeatability combined with extreme robustness make MR sensors the right solution for demanding length and position measurement applications even under the harshest ambient conditions.

MR sensors offer different methods for the measurement of linear motion. Each sensor is optimized to fulfill the requirements of the individual application. Both passive as well as active measurement scales can be used. Ferromagnetic toothed structures can be used as a passive measurement scale, whereas magnetic materials with magnetized poles can be used as active measurement scales. An active measurement scale can be made from, for example, elastomer-bound hard ferrite with alternating magnetized north-south poles and in the simplest case with two poles as a pure dipole magnet.
A passive scale is made from a magnetically soft material with a periodic, tooth-like structure such as a toothed rack or holes in a metal belt.

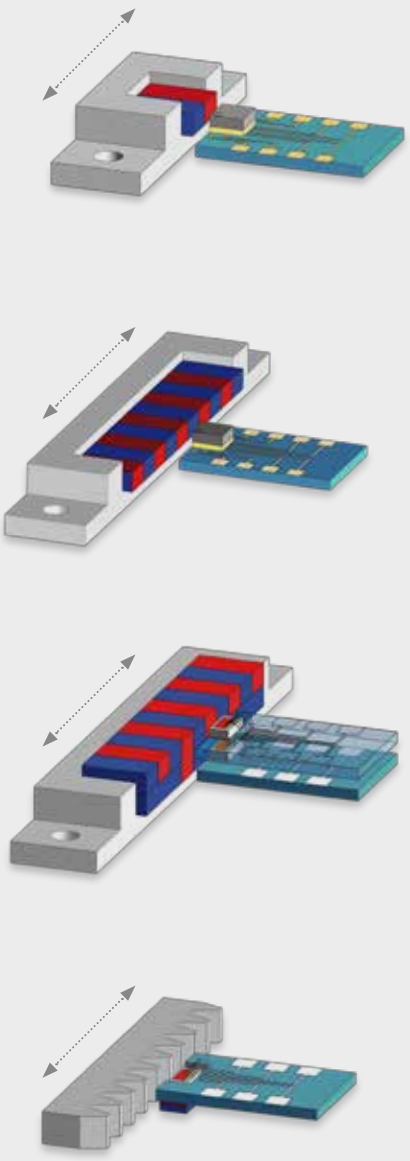
When measuring the distance along the length of a dipole magnet the AA700 family AMR-sensors can be used, because these sensors feature FixPitch technology and are not tied to a particular pole length (pitch). If a linear scale with multiple poles is used then the pole-matched sensors, featuring FixPitch technology, such as the AL798 for 1 mm poles (2 mm pole pair length) are appropriate.

When using passive toothed structures the sensors from the GLM700 family are best suited. These sensors, based on the GMR principle, are integrated in a housing together with a bias magnet, which provides the auxiliary field for the passive measurement scale. This makes it easy to use toothed structures on existing machine elements. A big advantage of these sensors is the reduced effort necessary to combine the sensor and the auxiliary magnet, because the magnet is already integrated in the sensor module. In some applications a reference sensor is needed for homing purposes. This reference can be realized by a second sensor, such as the GF705 or the GF708 magnetic field sensors. They detect an additional magnetic reference track on the scale. In case of a passive measurement scale a second GLM sensor, as already used for the incremental track, can be implemented. The reference signal can easily be generated by an additional tooth or groove.

The latest TA and TL sensor families are based on the especially energy efficient TMR effect. The power consumption of these new sensor families, which will be introduced into the market in 2016, is 10 times lower compared to AMR or GMR sensors with a similar resolution. Therefore TA and TL families are very well suited for applications which are operated using batteries or powered by energy harvesting. The innovative sensors feature a better temperature stability than AMR or GMR sensors. This means that a temperature calibration is no longer necessary in many applications.

MR sensors for length and position measurement comprise magnetoresistive strips arranged to form two Wheatstone bridges, which provide differential sine / cosine output signals. This configuration reduces temperature drift and increases the output signal from the sensor.

In Sensitec's sensor modules the signal is conditioned with additional electronics to convert the delivered signal such that the user can process it easily in his application. Typical output signals from the modules are 1 V peak-to-peak or digital quadrature (A,B) signals. Also digital serial protocols, such as SSI or BiSS, are available. Offset and phase differences between the sine and cosine signals can also be compensated. The resolution that can be achieved depends on the MR sensor used and the signal conditioning electronics applied. Absolute positioning accuracies in the range of just a few µm can be readily achieved. With special designs resolutions in the range of nanometres can be achieved. A major advantage of MR sensors for length and position measurement is the non-contacting principle and therefore wear-free operation. The gap between the target and sensor can be as much as several millimetres in specific applications. Dust and oil between the MR sensor and the measurement scale do not have any impact on the measurement result. The very high repeatability makes them especially suitable for precision positioning tasks. The highly dynamic performance of MR sensors allows applications with extremely high speeds and accelerations to be realized. The wide range of permissible ambient temperatures allows MR sensors to be used under extreme operating conditions e.g. in measurement probes for oil drilling (at 200 °C and 1000 bar) or in space applications. MR sensors can also be used to construct linear encoders that can withstand radiation or that can be used in a vacuum. In most applications of this type the conditioning electronics is the limiting factor, rather than the sensor itself.



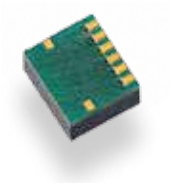
Typical measurement configurations

AA700 Family

AMR FreePitch Sensor for Length and Position Measurement

Component

Online at www.rs-components.de



The patented chip layout of the new Sensitec AA700 family reflects the concentrated expertise of more than a decade. These new chips are ideally suited for applications where highly precise length and position measurements must be executed in a flexible and cost-effective manner under difficult operating conditions.

The AA700 sensor components feature FreePitch technology and are independent of a fixed pole length. The sensors are available as bare die for small form factor chip-on-board assembly or as a SO8-housed component for SMD assembly.

Features

– Based on the anisotropic magnetoresistive (AMR) effect
– Contains two independent Wheatstone bridges
– Sine and cosine output signal
– Ambient temperature range from -40 °C to +150 °C
– Available for SMD assembly
– Automotive qualified (only SO8 and chip)

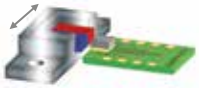
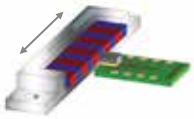
Advantages

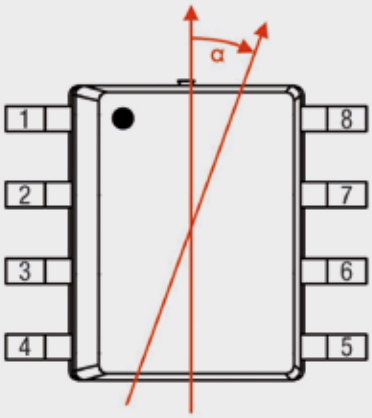
– Large permissible air gap between sensor and measurement scale
– Excellent accuracy, even for weak magnetic field strengths
– High permissible frequency allows measurement of very high speed applications (permissible angular frequency of magnetic field > 1 MHz)
– Largely insensitive to interference fields
– Minimal offset voltage
– Negligible hysteresis

Applications

– Incremental or absolute linear encoders
– Motor-Feedback-Systems
– Speed measurement

Product Features

Sensor type	Measuring configuration	FreePitch	PerfectWave	Feature
AA745 [1] AA746		√	√	For PCB-edge mounting, to optimize the proximity to the scale [1] Qualified for automotive applications (only chip)
AA745 [1]		√	√	[1] Qualified for automotive applications (only chip and SO8)



α= 0°
direction of magnetic field

Technical Data

Symbol	Parameter	AA745	AA746	Unit
ΔI	Accuracy [1]	1 to 5 % of pitch		
V_{CC}	Supply voltage	5		V
V_{off}	Offset voltage per V_{CC}	±2	±0.5	mV/V
V_{peak}	Signal amplitude per V_{CC}	13.4	13.0	mV/V
R_B	Bridge resistance	3.2	1.2	kΩ
H_{ext}	Nominal field strength	> 25	> 5	kA/m

[1] These values refer to operation 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.

Product Codes

Product code	Dimensions [mm]	Package	Ambient temperature range T_{amb}
AA745AKA	7.6 x 3.5 x 1.4	SIL6	-40 °C to +125 °C
AA745AMA	3.0 x 2.6 x 1.5	LGA6S	-40 °C to +125 °C
AA746	1.7 x 1.6	Bare die	-40 °C to +125 °C
AA746AMA	6.0 x 2.6 x 1.5	LGA6L	-40 °C to +125 °C

The sensors of the AA700 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form. For the evaluation of your application an evaluation kit is available. Please contact our sales team for more information.

AL700 Family

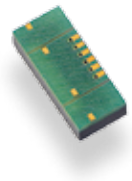
AMR FixPitch Sensors for Length and Position Measurement

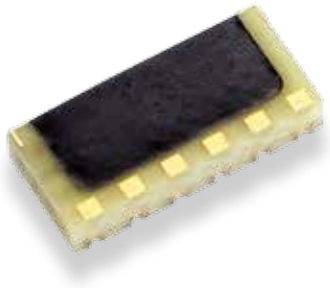
Component

Online at
www.rs-components.de

The AL700 sensor components are based on the proven FixPitch technology. These sensor components are specially designed for use with active measurement scales. The components are so designed, that they can be assembled at the edge of a substrate to allow easy mounting. This family includes sensors incorporating PurePitch technology, such that the sensor averages over several poles.

This feature combined with the PerfectWave design, which suppresses higher harmonics in the output signal, provides both excellent linear measurement accuracy and a high signal quality. These sensors are available as a LGA hosuing or as SIL6-housed component for SMD assembly.





Features

– Based on the anisotropic magnetoresistive (AMR) effect
– Contains two independent Wheatstone bridges
– Sine and cosine output signal
– Ambient temperature range from -40 °C to +125 °C
– Available for SMD-assembly in SIL6 housing and LGA6 housing

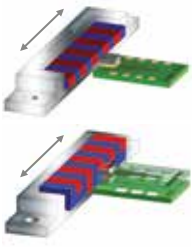
Advantages

– Large permissible air gap between sensor and measurement scale
– Excellent accuracy by means of PurePitch and PerfectWave technologies
– High permissible frequency allows measurement of very high speed applications (permissible angular velocity of magnetic field > 1 MHz)
– Largely insensitive to homogeneous interference fields
– No stabilizing magnetic field necessary
– Minimal offset voltage
– Negligible hysteresis

Applications

– Incremental or absolute encoders
– Micro manipulator
– Microscope table

Product Features

Sensor type	Measuring configuration	FixPitch	PurePitch	PerfectWave	Averaging (Number of poles)
AL780		5 mm		√	1
AL797		2.5 mm	√	√	2
AL794[1)]		2.5 mm	√	√	2
AL796		2 mm	√	√	2
AL798		1 mm	√	√	2
AL795		0.5 mm	√	√	8

[1)] High-impedance

Technical Data

Symbol	Parameter	AL780	AL797	AL794[1)]	AL796	AL798	AL795	Unit
ΔI	Accuracy	< 1 % of pitch						
P	Pitch	5	2.5	2.5	2	1	0.5	mm
d	Air gap	~2.5	~1.3	~1.3	~1	~0.5	~0.3	mm
V_{CC}	Supply voltage	5						V
V_{off}	Offset voltage per V_{CC}	±1	±1	±2	±2	±2	±0.5	mV/V
V_{peak}	Signal amplitude per V_{CC}	11.0	11.0	11.0	11.0	11.5	11.0	mV/V
R_B	Bridge resistance	3.2	5.4	62	3.4	3.6	4.6	kΩ
R_S	Sensor resistance	1.6	2.7	31	1.7	1.8	2.3	kΩ
T_{amb}	Ambient temperature range	-40 to +125						°C

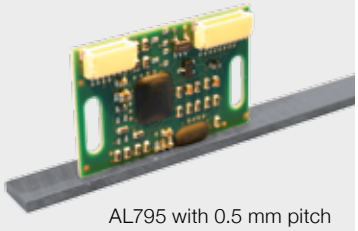
[1)] High-impedance
The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Product Codes

Product code	Package	Dimensions
AL7xxAKA	SIL6	7.6 x 3.5 x 1.4 mm
AL7xxAMA	LGA6L	6 x 2.6 x 1.5 mm
AL798AMA	LGA6S	3 x 2.6 x 1.5 mm

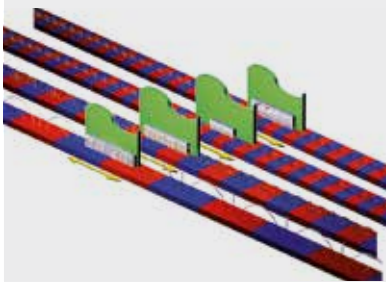
The sensors of the AL700 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form. For the evaluation of your application an evaluation kit is available – our sales engineers will be pleased to offer advice.

AL795

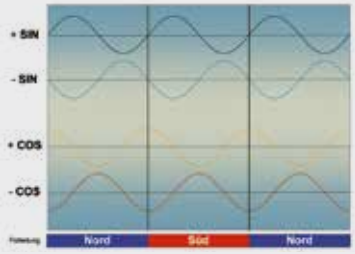


AL795 with 0.5 mm pitch
as a linear incremental encoder

Configurations



Schematic diagram of output signals



NEW in 2016!

TA900 Family

TMR FreePitch Sensors for Length and Position Measurement

The new TA900 family combines the long experience of Sensitec in the field of length and position sensor technology with the energy efficiency and temperature stability provided by the new TMR effect. Patented chip layouts enable precise, flexible and cost-efficient length and positionmeasurement under difficult operating conditions.

Due to the low power consumption TA900 sensors are especially well suited for applications which are operated by means of battery or powered by energy harvesting. Furthermore, the new sensors are also convenient for EX-protection applications.

TA900 sensors can be applied independently of fixed pole pitches and can be used for the absolute measurement of short movements using a dipole magnet.

Features

– Based on the Tunnel Magnetoresistive (TMR) effect
– Contains two independent Wheatstone bridges
– Sine and cosine output signal
– Ambient temperature range from -40 °C to +150 °C
– Available for SMD-assembly
– Qualification for automotive applications from 2016

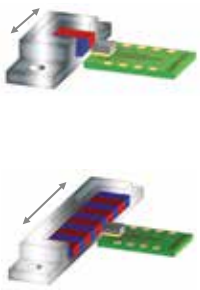
Advantages

– Extremely low power consumption, therefore ideally suited for applications with power supply via battery or energy harvesting
– High temperature stability
– Large air gap between sensor and measurement scale
– High precision, even for low field strengths
– High permissible limit frequency allows high-speed applications (permissible rotational frequency of the magnetic field in excess of 1 MHz)
– High tolerance with respect to eccentricity in the mechanical assembly
– Insensitive to homogeneous disturbing fields
– Minimal offset voltage
– Negligible hysteresis

Applications

– Incremental and absolute linear encoders
– Motor-Feedback-Systems
– Fast linear speed measurement, e. g. for linear motors

Product Features

Sensor type	Measuring configuration	FreePitch	PerfectWave	Feature
TA901 [1]		√	√	[1] Qualified for automotive applications from 2016/2017

Technical Data

Symbol	Parameter		TA901	Unit
ΔI	Accuracy	20-130 mT	1 to 5 % of pitch	
V_{CC}	Supply voltage		5	V
V_{off}	Offset voltage per V_{CC}		±3	mV/V
V_{peak}	Signal amplitude per V_{CC}		250	mV/V
R_B	Bridge resistance		6	kΩ
H_{ext}	Nominal field strength		30-80	kA/m

The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Product Codes

Product code	Package	Dimensions	Ambient temperature range T_{amb}
TA901AIA-LE	TSSOP8	6.4 x 3.05 mm	-40 … +150 °C

The sensors of the TA900 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form. For the evaluation of your application a sample is available - our sales engineers will be pleased to give advice to you.

NEW in 2016!

TL900 Family

TMR FixPitch Sensors for Length and Position Measurement

The new TL900 family combines the long experience of Sensitec in the field of length and position sensor technology with the energy efficiency and temperature stability provided by the new TMR effect. The TL900 sensor family has been developed for applications using active measurement scales, such as linear scales. The sensors are designed to be mounted at the edge of a printed circuit board or similar substrate and are ideal for off-axis, radial measurement configurations.

This feature, combined with PerfectWave technology, which suppresses higher harmonics in the output signal, provides both excellent linear measurement accuracy and a high signal quality. These sensors will first be available in a LGA-package for SMD assembly. TL900 sensors will also be available as bare die on request.

Due to the low power consumption TL900 sensors are especially well suited for applications which are operated by means of battery or powered by energy harvesting. Furthermore, the new sensors are also convenient for EX-protection applications.

Features

– Based on the Tunnel Magnetoresistive (TMR) effect
– Contains two independent Wheatstone bridges
– Sine and cosine output signal
– Ambient temperature range from -40 °C to +125 °C
– Available for SMD-assembly

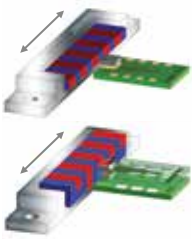
Advantages

– Extremely low power consumption, therefore ideally suited for applications with power supply via battery or energy harvesting
– High temperature stability
– Large air gap between sensor and measurement scale
– High precision, even for low field strengths
– High permissible limit frequency allows high-speed applications (permissible rotational frequency of the magnetic field in excess of 1 MHz)
– No stabilizing bias field necessary
– Insensitive to homogeneous disturbing fields
– Minimal offset voltage
– Negligible hysteresis

Applications

– Incremental and absolute linear encoders
– Motor-Feedback-Systems
– Micro-manipulators
– Microscope tables

Product Features

Sensor type	Measuring configuration	FixPitch	Pole pitch [mm]	PurePitch	PerfectWave	Averaging (Anzahl Polpaare)
TL915		5 mm	2.5		√	1
TL914		3 mm	1.5		√	1
TL913		2 mm	1	√	√	2
TL912		1 mm	0.5	√	√	2
TL911		0.5 mm	0.25	√	√	2

Technical Data

Symbol	Parameter		TL915	TL914	TL913	TL912	TL911	Unit
ΔI	Accuracy		< 1 % of pitch					
P	Pitch		5	3	2	1	0.5	mm
l_p	Pole pitch		2.5	1.5	1	0.5	0.25	mm
d	Air gap		~2	~1.2	~0.8	~0.4	~0.2	mm
V_{CC}	Supply voltage		5					V
V_{off}	Offset voltage per V_{CC}		±15					mV/V
V_{peak}	Signal amplitude per V_{CC}		150					mV/V
R_B	Bridge resistance	normal low power [1]	12 1200					kΩ
R_S	Sensor resistance	normal low power [1]	6 600					kΩ
T_{amb}	Ambient temperature range		-40 … +125					°C

[1] High-impedance version
The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Product Codes

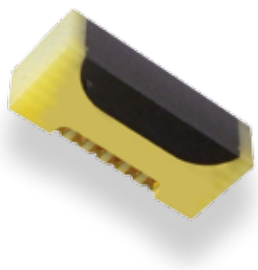
Product code	Package	Dimensions
TL91xAMA-AE	LGA6L	6 x 2.6 x 1.5 mm

The sensors of the TL900 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form. For the evaluation of your application a sample is available - our sales engineers will be pleased to give advice to you.

GLM700 Family

GMR Tooth Sensor Modules for Length and Position Measurement

Module



The sensors of the GLM700 family are designed for measurement with passive measurement scales, such as toothed racks or toothed wheels. These sensors combine the GL700 series tooth sensors with an integrated bias magnet in a compact SMD housing, so reducing the design and assembly effort for the user. The GLM700 family of sensor modules can be used to sense the changes in magnetic flux density created by toothed ferromagnetic machine elements, such as gear wheels, in a magnetic field. Based on the GMR effect, these sensors are classified as **Fix**Pitch sensors and are matched to a particular tooth pitch. A wide range of tooth pitches between 0.94 mm and 3 mm is covered. A big advantage of these sensors is the universal applicability to a wide variety of tooth-like structures. In addition to classical tooth profiles, such as involute tooth profiles, also pressed tooth structures with a low tooth depth or even holes in a ferromagnetic material can be used as a passive measurement scale. The modules supply a sine/cosine signal of high quality with high resolution.

Evaluation-boards (GLAM7xx) are available for all tooth pitches with a parallel mounted GLM module, for the development and testing of your sensor module application. The board provides amplified sine and cosine sensor signals. The amplification factor is set at 37, so that the output signals can be processed easily.

Features

– Sensor module for sensing toothed structures
– Based on the giant magnetoresistive (GMR) effect
– Differential sine and cosine output signals
– Ambient temperature range from -40 °C to +125 °C
– Designed for SMD-assembly

Advantages

– Integrated magnet for optimized performance and ease of use
– High dynamic range for high-speed applications
– Parallel or perpendicular mounting on the substrate

Applications

– Incremental length measurement
– Motor-Feedback-Systems
– Linear guides with integrated sensors

Product Codes

Product code*	Product photo	Sin/Cos diffenential	Sin/Cos amplified	Dimensions	Ambient temperature range T_{amb}
GLM7xxASB		√		13 x 5.5 x 3.5 mm	-40 to +125 °C
GLAM7xx Evaluation-board			√	24 x 21 x 5.1 mm	-25 to +85 °C

The sensors of the GLM700 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form. Gearwheels or other toothed structures, respectively, are available from many suppliers. It is important to use a ferromagnetic material, as only these materials affect the working magnetic field. In special cases, e.g. the rods of pneumatic cylinders, the toothed structures have to be sealed to achieve a smooth surface. There are different technologies to realise a smooth surface in spite of the magnetically soft toothed structure under the surface. Please contact us for more information.

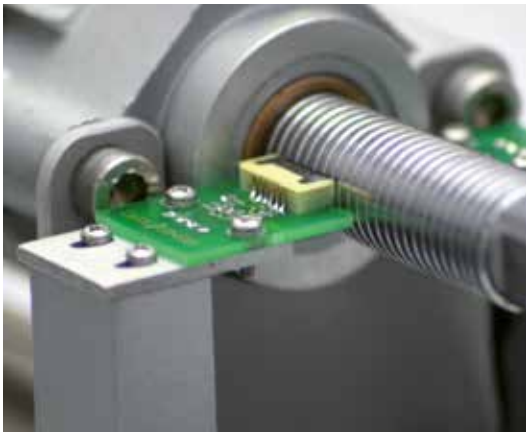
* Please refer to table „Technical Data"

Technical Data

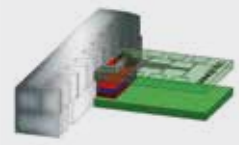
Symbol	Parameter	GLM711	GLM712	GLM713	GLM714	GLM715	Unit
P	Tooth pitch	1.0	2.0	3.0	0.94 (Module 0.3)	1.57 (Module 0.5)	mm
d	Air gap	~200	~400	~600	~190	~310	µm
V_{CC}	Supply voltage	5					V
R_B	Bridge resistance	5.5	5.7	5.7	5.6	5.8	kΩ
R_S	Sensor resistance	2.75	2.85		2.8	2.9	kΩ
f	Frequency range [1]	<1					MHz

[1] without significant loss of signal amplitude
The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

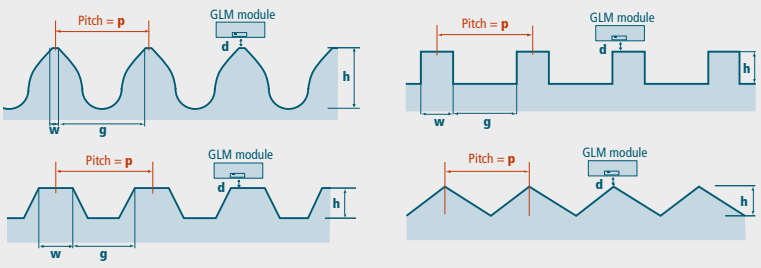
Sensor module detecting a piston rod



Configurations

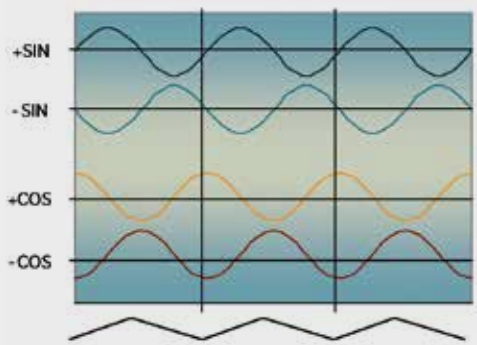


GLM sensor modules can be used with the following tooth profiles, among others:



Toothed racks are available on request.

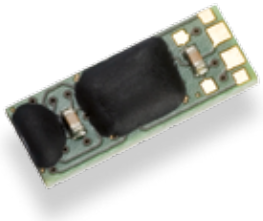
Schematic diagram of output signals



EBX Family

Sensor Module with Incremental Output

Module



Sensitec's sensor modules for incremental measurement comprise MR sensors, mounted on a circuit board together with signal processing electronics. There are standard modules for active and also passive measurement scales. The EBR sensor modules feature an additional sensor, which generates a reference signal in combination with the appropriate measurement scale.

The sensor modules of the 7900 series are designed for measuring at active, magnetized measurement scales, whereas the modules of the 7800 series have an integrated magnet to allow the use of passive measurement scales. There are different modules with various electrical interfaces. Serial SSI or BiSS signals can be generated, as well as differential digital AB signals with an additional reference signal (Z signals). Some of the modules have a very compact configuration and can even be integrated in the smallest available space. The wide range of sensor modules, characterised by their robustness and the low design and assembly effort required by the user, allows a quick market launch for new products. Most sensor modules are calibrated, with respect to sensor characteristics such as offset and so provide better accuracy with low flank jitter.

Features

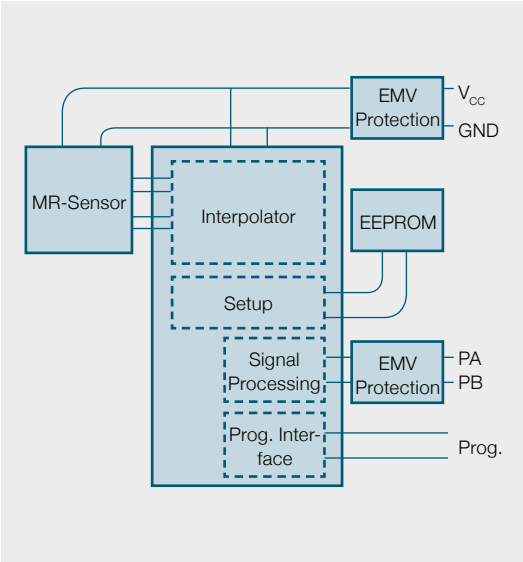
– AB signals (TTL or HTL)
– Z-signal available for some modules
– Wide ambient temperature range

Advantages

– Easy assembly
– Robust, compact design

Applications

– Positioning of linear guides
– Electronic measurement of flow rate



The diagram shows a typical circuit for a sensor module for incremental measurement. The sensor signals are conditioned by the electronics and typically offered to the user as digital signals. These digital square-wave signals are also used for directional recognition and are therefore provided as phase-shifted signals (PA and PB). In addition, a number of modules feature differential signals (NA and NB) as well as indiviudal (PZ) or differential (NZ) reference signals. The electronic circuit is programmable or can be parameterized via an external circuit, so that the resolution can be freely chosen and for most sensor modules the sensor offset and phase error can be compensated.

In addition to the standard sensor modules there is a broad range of customized solutions with specific functions and configurations. Custom-tailored to suit the particular needs and operating conditions of the individual user these sensor modules can offer many advantages once the necessary development process is completed.

The “x” in the product code in the following tables denotes different versions that are available. Please refer to the data sheet of the particular module, which you can find on our website or obtain from our sales department.

Selection Guide

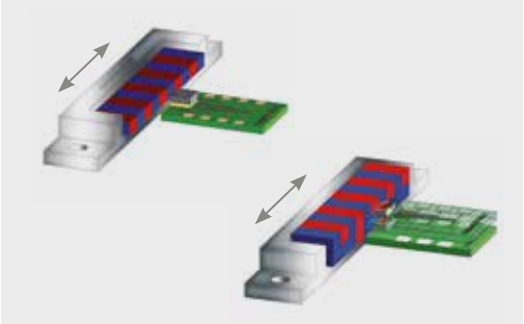
Sensor module	Operating voltage V_{cc}	Pitch (p)	Output	Reference	Measuring steps/pitch (z) [1) 2)]	Information
EBI7901	5 V	1 mm > 2 mm	PA, PB	–	4 - 80	FreePitch (> 2 mm)
EBI7903	5 V	1 mm	PA, PB, PZ	–	8 - 8192	Z-Signal/Pitch
EBI7904	5 V	1 mm	PA, PB	–	8 - 8192	
EBR7911	5 V 10 - 30 V	2 mm	PA, NA, PB, NB, PZ, NZ	√	4 - 400	SmartFit
EBR7912	3.3 - 5 V	2 mm	PA, NA, PB, NB, PZ, NZ	√	4 - 256	
EBx7811	5 V	0.94 mm 1 mm 1.57 mm 2 mm 3 mm	PA, NA, PB, NB (PZ, NZ)	(√)	4 - 400	Reference optional
	5 V	0.94 mm 1 mm 1.57 mm 2 mm 3 mm	PA, NA, PB, NB, (PZ, NZ)	(√)	1 V_{ss}	Reference optional

[1)] Selectable
[2)] Calculation of resolution
p - pitch in mm
n - number of poles/teeth per revolution
z - number of measurement steps per pitch

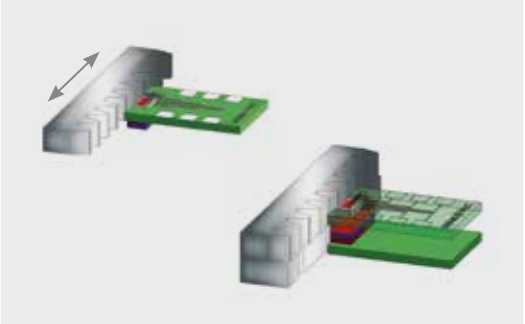
For linear applications:
resolution (mm) = p / z

For rotary applications:
resolution (°) = 360° / (n * z)

Configurations for EBx7900



Configurations for EBx7800



Technical Data

Sensor Modules for Active Measurement Scales

Product code	Resolution up to 80 measuring steps/pitch	
EBI7901CAx-DA FixPitch 1 mm EBI7901ZAx-DA FreePitch > 2 mm	Used sensor	AL798 / AA747
	Length	15.5 mm
	Width	6 mm
	Height	2 mm
	Ambient temperature	-40 °C to +100 °C

EBI7901

Product code	FixPitch 1 mm, resolution up to 8192 measuring steps/pitch	
EBI7903CAx-DA additional Z-pulse	Used sensor	AL798
	Length	9.4 mm
	Width	9.8 mm
	Height	3.2 mm
	Ambient temperature	-25 °C to +85 °C

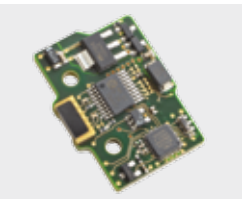
EBI7903

Product code	FixPitch 1 mm, resolution up to 8192 measuring steps/pitch	
EBI7904CAx-DA	Used sensor	AL798
	Length	9.4 mm
	Width	9.8 mm
	Height	3.2 mm
	Ambient temperature	-25 °C to +85 °C

EBI7904

Product code	FixPitch 2 mm, resolution up to 400 measuring steps/pitch	
EBR7911EBx-DA Supply voltage 5 V EBR7911EBx-FA Supply voltage 10-30 V	Used sensor	AL796, GF708
	Length	20.5 mm
	Width	28.6 mm
	Height	5.6 mm
	Ambient temperature	-40 °C to +100 °C

EBR7911



Product code	FixPitch 2 mm, resolution up to 256 measuring steps/pitch	
EBR7912EBx-DA	Used sensor	AL796, GF705
	Length	15 mm
	Width	15 mm
	Height	7.2 mm
	Ambient temperature	-40 °C to +105 °C

EBR7912

Technical Data

Sensor Modules for Passive Measurement Scales

Product code	FixPitch diverse, up to 400 measuring steps/pitch	
EBI7811xBx-DA EBR7811xBx-DA with reference	Used sensor	GL700
	Length	15 mm
	Width	15 mm
	Height	5.2 mm (EBI) / 7mm (EBR)
	Ambient temperature	-40 °C to +100 °C

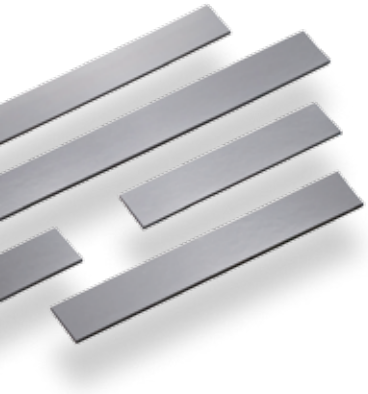
EBI7811

Product code	FixPitch diverse, sine / cosine signal 1 V_{ss}	
EBI7811xDB-DA EBR7811xDB-DA with reference	Used sensor	GL700
	Length	15 mm
	Width	15 mm
	Height	5.2 mm (EBI) / 7mm (EBR)
	Ambient temperature	-40 °C to +100 °C

EBR7811

Linear Measuring Scales

● Component



Two different material variants are used for active linear measurement scales. High remanence and high precision are characteristic features of linear measurement scales made of hard ferrite material whereas Tromaflex® measurement scales mounted on a stainless steel strip allow a flexible handling and are suitable for larger lengths.
On the scales different pole pitches with alternating north and south poles as well as reference tracks can be magnetized. For a magnetization with only an incremental track the width of magnetization equals the width of the measurement scale. The length of the measurement scale of Tromaflex® scales can be chosen freely. Due to their individual material characteristics hard ferrite measurement scales are more suitable for short lengths - please contact us if you have special requirements.

Product code

MLx YYYYUAz UA **Tromaflex®**
MLx YYYYHAz UA **Hard ferrite**

- Product specific temperature range, standard packaging
- Pole pitch (see table right)
- Number of poles
- I - Linear scale incremental magnetization
- R - Linear measurement scale incremental magnetization with reference track

z	Pitch
A	0.5 mm
B	1.0 mm
C	2.0 mm
D	2.5 mm
E	5.0 mm

Example: MLI0050UAC-UA
Incremental, 2 mm pole pitch, 100 mm scale length

Technical Data – Tromaflex® Measurement Scales

Parameter	Value	Unit
Lengths (from stock) [1]	10 / 20 / 50 / 100 / 200 (± 1 mm)	mm
Width	10	mm
Height	1.3	mm
Pitch	0.5 / 1.0 / 2.0 / 2.5 / 5.0	mm
Accuracy of pole length	1	%
Ambient temperature range	-20 to +70	°C

Tromaflex® – Registered trademark of Max Baermann GmbH
[1] Further scale lengths on request

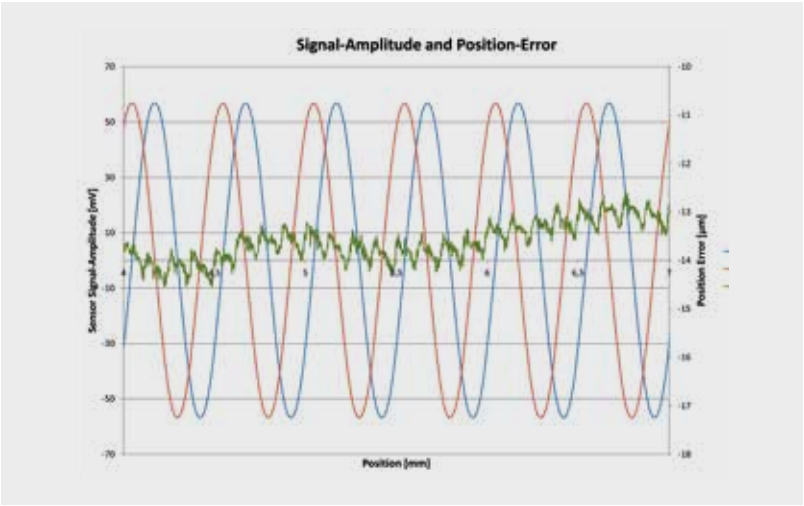
Technical Data – Hard Ferrite Measurement Scales

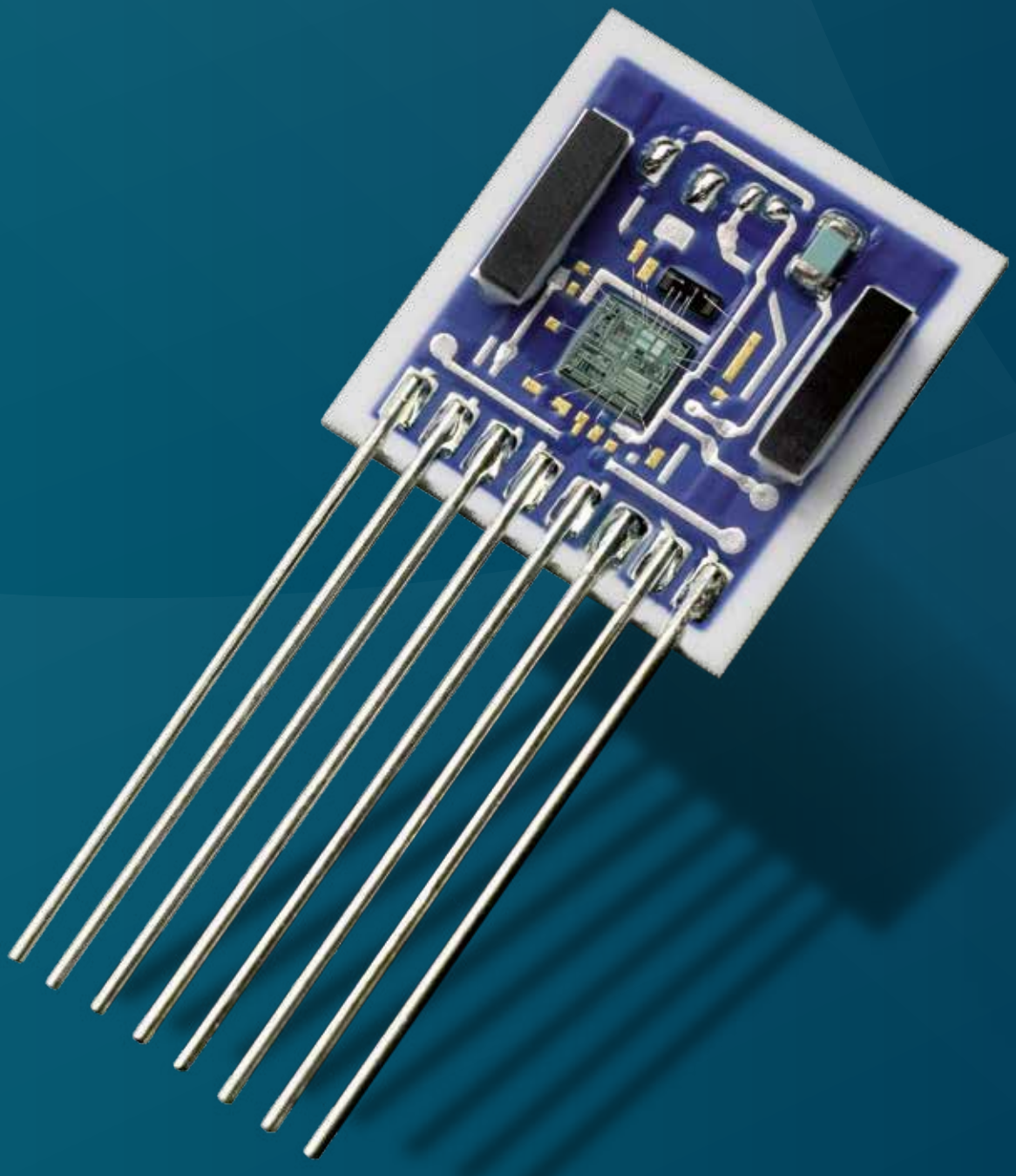
Parameter	Value	Unit
Lengths (from stock) [1]	14 / 24 / 35	mm
Width	4	mm
Height	2	mm
Pitch	0.5 / 1.0 / 2.0 / 2.5 / 5.0	mm
Accuracy of pole length	1	%
Ambient temperature range	-20 to +200	°C

[1] Further scale lengths on request

Magnetisation

As a manufacturer of magnetic sensors and a supplier of complete sensor solutions special know-how around magnetization belongs to our core competences as well. In addition to our highly precise magnetization facilities for pole rings and linear measurement scales we apply simulation tools to ensure the optimized design of measurement scales. This enables us to evaluate parameters like magnetic material, air gap and and alignment tolerances and to select the ideal measurement scale for your application. The chip characteristics of our MR sensors are reflected in this calculation to achieve a maximum performance for the complete system. Our magnetization systems are equipped with highly precise reference systems which provide highest accuracy during the magnetization process as well as during the subsequent measurement. The magnetization systems are designed for series application and cost effective production. Furthermore this concept allows a highly flexible utilization for samples and small volumes as well. This is a special advantage because the production takes place on series production systems and the cost for sample production can be reduced to a minimum even in early development stages. The magnetization is carried out using a pulsed procedure. This means that each magnetic pole is implemented with a very high field strength into the magnetic material. This allows, for example, the magnetization of polymer-bound NeFeB material among others. During magnetization of pole rings the resulting „joint“ between start and end of the magnetization is eliminated by an intelligent process. Pole rings and linear scales can be magnetized with up to three tracks. In adddtion to incremental tracks it is also possible to magnetize reference tracks with one or more poles and of course code tracks with different north and south pole patterns.





To be able to make a difference you have to be able to measure it. Make the difference.

Sensitec sensors for measuring power measure electrical current highly dynamically and accurately. Sensitec sensors are extremely compact, offer excellent linearity and measurement accuracy with much-reduced power consumption.

Current Measurement

Sensitec current sensors, based on innovative MR technology, are small, light and compact products with very high reliability, even in difficult operating environments. They enable a highly dynamic and loss-free measurement of DC and AC currents in the range from a few milliampère to serveral hundred ampère. Sensitec current sensors can be used to measure peak currents up to three times the nominal current rating.

The high bandwidth of up to 2 MHz and particularly fast response make Sensitec currents sensors ideal for highly dynamic current measurement applications. The sensitivity of MR sensors is up to 50 times higher than traditional measurement principles, such as Hall effect. This renders unnecessary components such as ferrite- or heavy iron cores that are typically used to concentrate and guide the magnetic field. Sensitec current sensors are therefore very light and exhibit negligible hysteresis.

The operating principle of Sensitec current sensors is based on a differential magnetic field measurement with compensation. The primary current is fed through a U-shaped busbar, creating a field gradient between the two sides of the busbar. The MR sensor, mounted above the busbar, measures this field gradient. This is compensated by a secondary compensation circuit mounted close to the sensor. The magnitude of the current in the compensation circuit is a measure of the current in the primary circuit and is used as the output signal. The close proximity of the compensation circuit to the sensor means that the required compensation current is very low. The result is an extremely small and light sensor that is immune to homogeneous interference fields and exhibits very low power loss.

Sensitec offers a selection of four current sensor families for PCB mounting. The main difference between these product families are size, supply voltage and bandwidth.

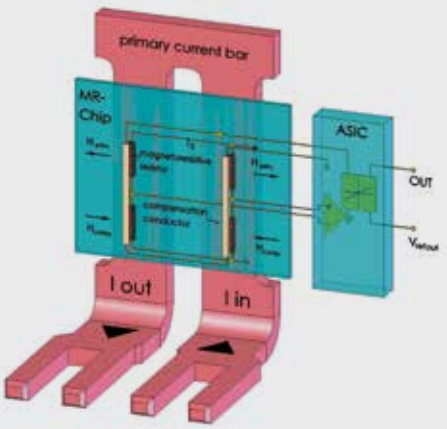
The **CFS1000** current sensor is a programmable sensor with SMD housing and external current conductor. By variation of the geometry of this external current primary current bar the system can be adapted to different current ranges. In so doing the same sensor can be used for different applications.

The **CMS2000** is integrated in a THT housing with a bipolar 15 V supply voltage. Due to the particularly high output voltages it is ideally suited for low-noise measurement tasks.

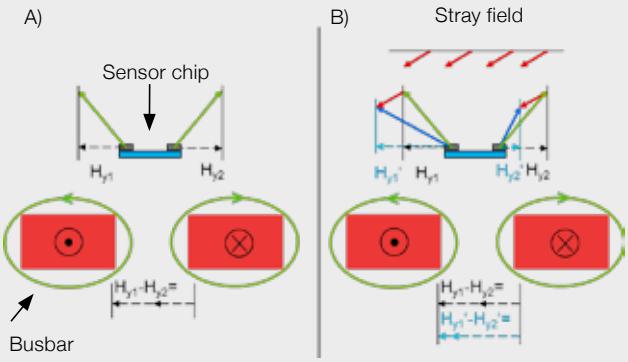
With the **CMS3000** Sensitec presents a further development of the CMS2000 sensor. With a best-in-class bandwidth of 2 MHz and a response time between 25 and 90 ns it enables current measurement in applications in which it was until now not possible to measure highly dynamic currents in a precise, compact and cost-effective way,

Consisting of nine different sensor types the **CDS4000** current sensor family covers nominal currents in the range of 6 A to 150 A and provides a single 5 V power supply. Furthermore this sensor family features an adjustable overcurrent detection as well as a reference voltage input and output.

Schematic structure of a current sensor

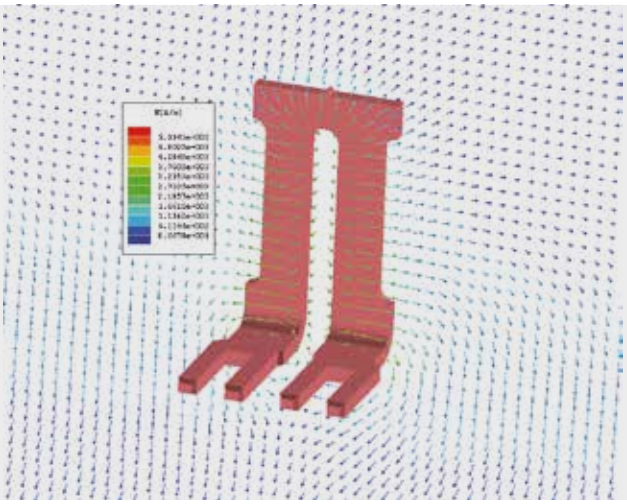


Cross-section through a sensor configuration



Principle of differential field measurement without (Fig. A) and with external stray field (Fig. B). H represents the field components.

Busbar with magnetic field vectors



CFS1000

Programmable SMD housed AMR Current Sensor

System

The programmable CFS1000 current sensor is designed for highly dynamic electronic measurement of DC, AC or pulsed currents with integrated galvanic isolation. It is based on the anisotropic magnetoresistive effect (AMR) and enables excellent dynamic response without hysteresis as present in designs using iron-cores. The sensor device consists of an AMR sensor chip, two bias magnets and a signal conditioning ASIC that are all packaged in a standard SMD SO16 package. By variation of the geometry of an external current conductor, the system can be adapted to different current ranges and applications. The primary current to be measured is fed below the sensor on a PCB or through a busbar. Using a U-shaped conductor allows the generation of a differential magnetic field that reduces the influence of external magnetic stray fields. The sensor system works in closed loop operation, providing high linearity and a low temperature dependency. CFS1000 current sensors are intended for high-volume applications.

Features

– Based on the anisotropic magnetoresistive (AMR) effect
– Measurement range is defined by the geometry of the external primary current bar
– High immunity against magnetic stray fields
– Galvanic isolation between primary and measurement circuit
– Optional end-of-line calibration of sensitivity and offset in final application
– Measurement range up to three times nominal current

Advantages

– Excellent accuracy
– High bandwidth current measurement: DC, AC (up to 500 kHz)
– Standard SO16w package (SMD assembly)
– Fast overcurrent detection with tuneable threshold
– Negligible hysteresis
– Temperature range -40 °C to +125 °C

Applications

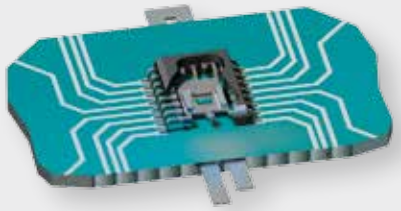
– Electrical speed drives (industry, e-mobility)
– Frequency converters
– Photovoltaics (power inverters, micro inverters)
– Battery management
– Power supplies (welding technology)
– Laser diode drivers
– Switching power supplies

Technical Data

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage	4.75	5.00	5.25	V
I_{PN}	Primary nominal current (RMS)[1]	10	-	1000	A
I_{outN}	Output current at I_{PN}	-	2	-	mA
f_{co}	Upper cut-off frequency (-3 dB)	-	500	-	kHz
ε_{Σ}	Overall accuracy (T = 25 °C; calibrated) [2]	-	-	±1	%
$T_{\varepsilon\Sigma}$	Overall accuracy (T = -40 to +125 °C; calibrated)	-	-	±2	%
$\varepsilon_{\Sigma'}$	Overall accuracy (T = 25 °C; not calibrated)	-	±4	-	%
$T_{\varepsilon\Sigma'}$	Overall accuracy (T = -40 to +125 °C; not calibrated)	-	±5	-	%
T_{amb}	Ambient temperature	-40	-	+125	°C

[1] As measuring range threefold absolute nominal current is gurauranteed, restricted to 1 s in a 60s interval.
[2] Overall accuracy error includes offset, linearity and sensitivity error ($\varepsilon_{\Sigma} = \varepsilon_{G} + \varepsilon_{off} + \varepsilon_{lin}$).

CFS1000



CFS1000 current sensor consisting of AMR sensor chip, signal processing circuit and two bias magnets.

The data given in the table are characteristic target values. Datasheets with complete technical specifications can be found at www.sensitec.com.

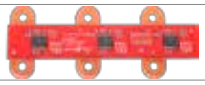
Product Codes Calibration Module

Product code	Number of connectors	Illustration
CFP1000AAA	1x	
CFP1000ABA	4x	

Product Code Sensor

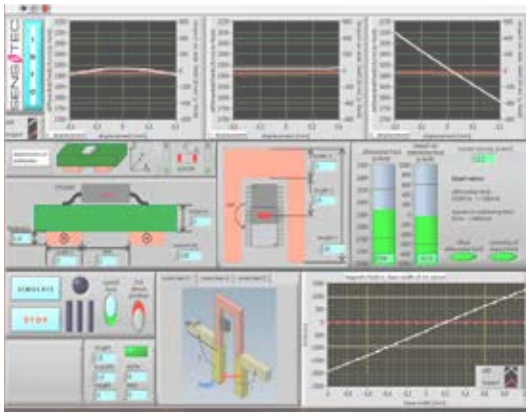
Product code	Package	Packaging	Illustration
CFS1000AAA	SOIC16w	Tape & Reel	

Product Codes Evaluation Boards

Product code	I_{PN} (A)	I_{PR} (A)	Illustration
CFK1015AAA	15	45	
CFK1025AAA	25	75	
CFK1050AAA	50	150	
CFK1100ABA	100	300	
CFK1250ABA	250	750	
CFK1400ABA	400	1200	
CFK1200ACA	3 x 200	3 x 600	

I_{PN} : Nominal primary current (RMS)
I_{PR} : Measurement range (for 1 s in a 60 s interval; RM = 300 Ω)

Analytical simulation



Analytical simulation of CFS1000 sensor for standard current bar designs

CMS2000 Family

AMR Current Sensors with high Signal-to-Noise-Ratio

System

Online at
www.rs-components.de

The CMS2000 current sensor family is designed for highly dynamic electronic measurement of DC, AC, pulsed and mixed currents with integrated galvanic isolation. The magnetoresistive technology enables an excellent dynamic response without the hysteresis that is present in iron core based designs. The CMS2000 product family offers PCB-mountable THT current sensors from 5 A up to 100 A nominal current for industrial applications. Due to the large range of the signal output voltage (up to ± 7.5 V) and the resultant large signal-to-noise ratio they are ideally suited for measurement tasks in the field of power electronics.

Features

– 5 sensor types in the range of 5 A to 100 A nominal current
– Measuring range up to 3 times nominal current
– Galvanic isolation between primary and measurement circuit
– Bipolar ±15 V power supply
– Based on the anisotropic magnetoresistive (AMR) effect

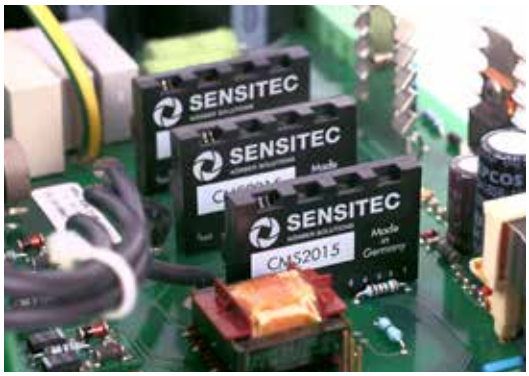
Advantages

– High signal-to-noise ratio
– Excellent accuracy
– Low temperature drift
– Small and compact size
– Highly dynamic response
– Low primary inductance
– Negligible hysteresis

Applications

– Solar power converters
– Measurement technology
– Frequency converters
– Variable speed drives
– Converters for DC motor drives
– Uninterruptible power supplies
– Switched mode power supplies
– Power supplies for welding applications

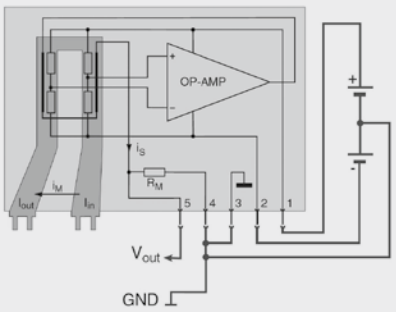
Servo driver with CMS2015 current sensors



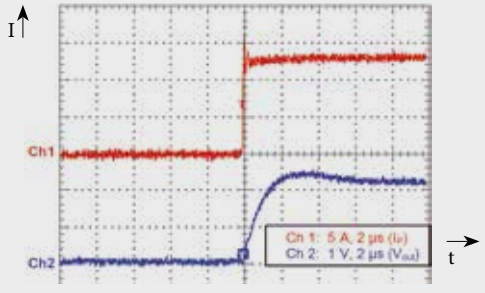
CMK2000 demoboard

The CMK2000 demoboard offers the opportunity to learn the features and benefits of the CMS2000 current sensors in a quick and simple manner.

Design and wiring of CMS2000



Typical current transition response (CMS2015)



Technical Data

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage	± 12	-	± 15	V
V_{outN}	Nominal output current (RMS, at SP3 and SP10)	-	-	± 2.5	V
V_{outN}	Nominal output current (RMS, at SP7)	-	-	± 1.25	V
I_{CN}	Nominal current consumption	-	-	45	mA
εΣ	Overall accuracy for SP3 [1]	-	± 0.8	-	% of I_{PN}
ε_Σ	Overall accuracy for SP10 [1]	-	± 0.5	-	% of I_{PN}
f_{co}	Upper cut-off frequency (-1 dB)	-	100	200	kHz
T_{amb}	Ambient temperature range	-25	-	+85	°C
T_B	Busbar temperature	-25	-	+85	°C
Housing size		35.0 x 7.3 x 23.0 mm (L x B x H)			

[1] $\varepsilon_\Sigma = \varepsilon_G + \varepsilon_{lin}$ with V_{CC} = ± 15 V and T_{amb} = 25 °C.

The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Product Codes

Product code Sensor	Product code Demoboard	I_{PN} (A)	I_{PR} (A)	εΣ (% of I_{PN})	Package
CMS2005-SP3	CMK2005-SP3	5	15	±0.8	
CMS2005-SP10	-	5	15	±0.5	
CMS2015-SP3	CMK2015-SP3	15	45	±0.8	
CMS2015-SP10	-	15	45	±0.5	
CMS2025-SP3	CMK2025-SP3	25	75	±0.8	
CMS2025-SP10	-	25	75	±0.5	
CMS2050-SP3	CMK2050-SP3	50	150	±0.8	
CMS2050-SP7	-	50	220	±0.8	
CMS2050-SP10	-	50	150	±0.5	
CMS2100-SP3	CMK2100-SP3	100	300	±0.8	
CMS2100-SP10	-	100	300	±0.5	

I_{PN} Nominal primary current (RMS).
I_{PR} Measurement range for 1 s in a 60 s interval (@SP7 only 20 ms in a 2 s interval).

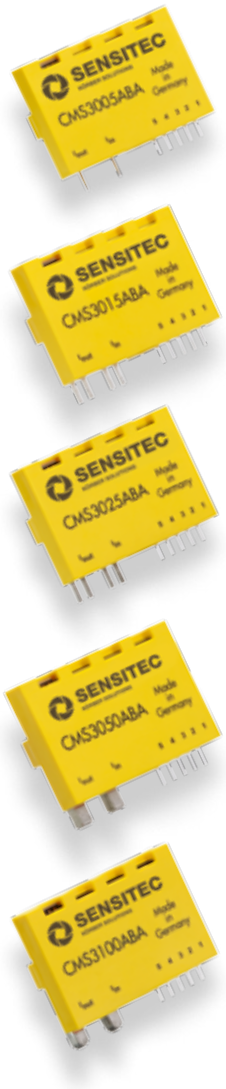
Nominated for the Hermes Award 2014 at the Hannover Fair!

CMS3000 Family

AMR Current Sensors with 2 MHz Bandwidth

System

Online at
www.rs-components.de



The CMS3000 current sensors present a further development of the successful CMS2000 current sensor family. With a best-in-class bandwidth of 2 MHz and a temperature range of -40 °C and +105 °C, new application fields are opened up, in which it was until now not possible to measure highly dynamic currents in a precise, compact and cost-effective way. The new CMS3000 family is based on the magnetoresistive effect. The current sensors are small, light and compact and they provide very high accuracy and reliability, even under difficult environmental operating conditions. They enable a simple, loss-free measurement and evaluation of DC and AC currents with a high signal-to-noise ratio. Apart from the safe galvanic isolation between measurement signal and measurement circuit the applied MR technology offers the advantage of an excellent dynamic response and the absence of hysteresis as typically associated with other types of current sensor, based on iron cores.

Features

– 5 PCB-mountable sensor types in the range of 5 A to 100 A nominal
– Measuring range up to 3 times nominal current
– Galvanic isolation between primary and measurement circuit
– Bipolar ±15 V power supply
– Based on the anisotropic magnetoresistive (AMR) effect

Advantages

– Very high bandwidth of 2 MHz
– Highly dynamic step response
– Large temperature range -40 °C to +105 °C
– Excellent accuracy
– Negligible hysteresis
– Compact size
– High signal-to-noise-ratio

Applications

– Electrical motor control
– DC/DC converter
– Laser diode driver
– Audio amplifier
– Condition monitoring
– Switched mode power supplies
– Sensorless BLDC motors
– Resonant circuit inverter

Servodriver with CMS3050 current sensors

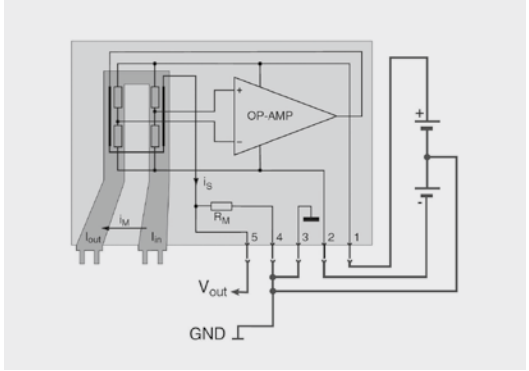
Technical Data

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage	± 11.4	± 15	± 15.7	V
f_{co}	Bandwidth (-3 dB)	–	2	–	MHz
t_{resp}	Response time	–	40	–	ns
V_{outN}	Nominal output voltage (RMS)	–	± 2.5	–	V
ε_{Σ}	Overall accuracy [1]	–	± 1.0	± 1.6	% of I_{PN}
I_{CN}	Nominal current consumption	–	50	60	mA
T_{amb}	Ambient temperature	– 40	–	+ 105	°C
T_B	Busbar temperature	– 40	–	+ 125	°C

[1] Overall accurracy error includes offset, linearity and sensitivity error ($\varepsilon_{\Sigma} = \varepsilon_G + \varepsilon_{off} + \varepsilon_{lin}$) at V_{CC} = ±15 V and Tamb = 25 °C.

The data given in the table are characteristic target values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Design and wiring of CMS3000

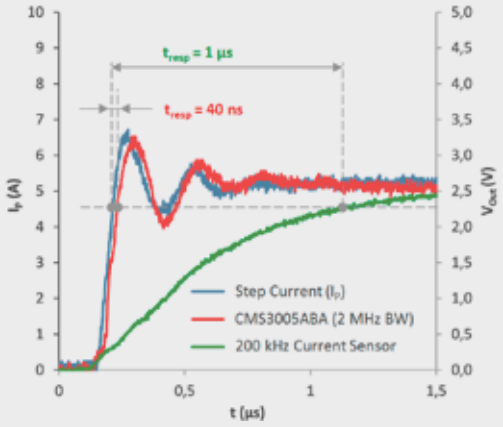


Product Codes

Product code sensor	Product code Demoboard	I_{PN} (A)	I_{PR} (A)	Package size (mm)	Package
CMS3005ABA	CMK3005ABA	5	15	35.0 × 7.3 × 23.0 (L × B × H)	
CMS3015ABA	CMK3015ABA	15	45		
CMS3025ABA	CMK3025ABA	25	75		
CMS3050ABA	CMK3050ABA	50	150		
CMS3100ABA	CMK3100ABA	10	300		

I_{PN}: Nominal primary current (RMS), I_{PR}: MMeasurement range (for 1 s in a 60 s interval)

Response time



High bandwidth leads to a substantial reduction of response time (CMS3005ABA compared to a 200 kHz current sensor).

CMK3000 demoboard

The CMK3000 demoboard offers the opportunity to learn the features and benefits of the CMS3000 current sensors in a quick and simple manner.

CDS4000 Family

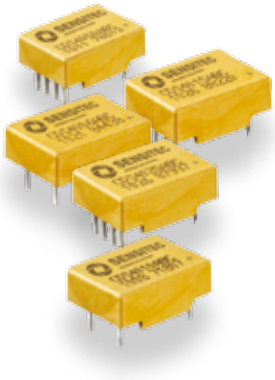
Compact AMR Current Sensors with Overcurrent Detection

System

Online at
www.rs-components.de

The CDS4000 current sensor family is designed for highly dynamic electronic measurement of DC, AC, pulsed and mixed currents with integrated galvanic isolation. The magnetoresistive technology enables an excellent dynamic response without the hysteresis that is present in iron core based designs.

The system accuracy can be improved further by using either the internal or an external reference voltage. This further reduces temperature drift and several sensors can share the same reference voltage. The adjustable overcurrent detection enables a fast response in overload situations to prevent damage to power units. The CDS4000 product family offers PCB-mountable THT current sensors from 6 A up to 150 A nominal current for various industrial applications.



Features

– 9 sensor types in the range of 6 A to 150 A nominal
– Measuring range up to 3 times nominal current
– Galvanic isolation between primary and measurement circuit
– Single 5 V power supply
– Adjustable overcurrent detection
– Based on the anisotropic magnetoresistive (AMR) effect

Advantages

– Excellent accuracy
– Low temperature drift
– Highly dynamic response
– External reference possible
– Low primary inductance
– Negligible hysteresis
– Bus voltage up to 1000 V due to increased insulation strength

Applications

– Solar power converters
– AC variable speed drives
– for DC motor drives
– Uninterruptible power supplies
– Switched mode power supplies
– Power supplies for welding applications
– Laser diode drivers
– Resonant circuit power converter

Servodriver with CDS4006 current sensors

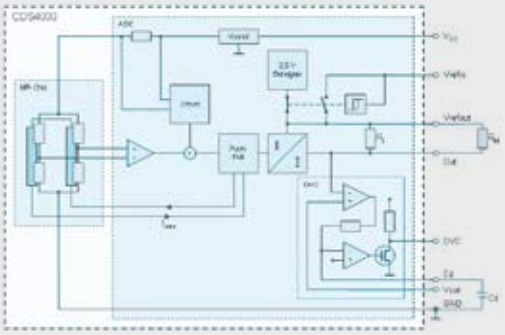
Technical Data

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage	4.75	5	5.25	V
I_{outN}	Nominal output current (RMS)	-	2	-	mA
I_{CN}	Nominal current consumption	-	50	60	mA
ε_{Σ}	Overall accuracy [1]	-	0.8	1.3	% of I_{PN}
f_{co}	Upper cut-off frequency (-1 dB)	200	400	-	kHz
T_{amb}	Ambient temperature range	-40	-	+105	°C
T_B	Busbar temperature	-40	-	+105	°C

Sensor-Typ 6, 10, 25, 50A	Housing Size	21.0 x 15.5 x 8.2 mm (L x B x H)
Sensor-Typ 50, 100, 125, 150A	Housing Size	25.0 x 22.0 x 9.7 mm (L x B x H)

[1] ($\varepsilon_{\Sigma} = \varepsilon_G + \varepsilon_{off} + \varepsilon_{lin}$) with V_{CC} = 5 V and T_{amb} = 25 °C.
The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Design and wiring of CDS4006

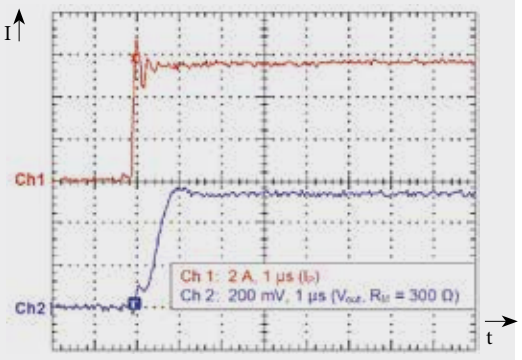


Product Codes

Product code sensor	Product code Demoboard	I_{PN} (A)	I_{PR} (A)	Package
CDS4006ABC-KA	CDK4006ABC-KA	6	18	
CDS4010ABC-KA	CDK4010ABC-KA	10	30	
CDS4015ABC-KA	CDK4015ABC-KA	15	45	
CDS4025ABC-KA	CDK4025ABC-KA	25	75	
CDS4050ABC-KA	CDK4050ABC-KA	50	150	
CDS4050ACC-KA	CDK4050ACC-KA	50	150	
CDS4100ACC-KA	CDK4100ACC-KA	100	300	
CDS4125ACC-KA	CDK4125ACC-KA	125	375	
CDS4150ACC-KA	CDK4150ACC-KA	150	450	

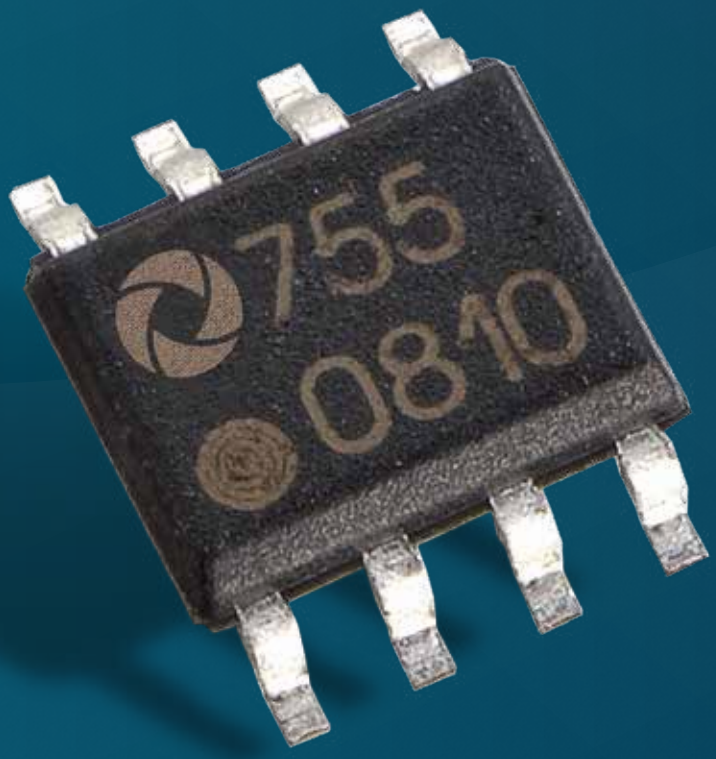
I_{PN}: Nominal primary current (RMS), I_{PR}: Measurement range (For 1 s in a 60 s interval; RM = 300 Ω).

Typical current transition response (CDS4006)



CDK4000 demoboard

The CDK4000 demoboard offers the opportunity to learn the features and benefits of the CDS4000 current sensors in a quick and simple manner.


755
0810

To exercise attraction you have to be able to measure it. Be the main attraction.

Sensitec sensors for measuring magnetic fields are capable of measuring even extremely weak magnetic fields with great accuracy. Sensitec sensors achieve very high resolutions and reproducibilities.

Magnetic Field Measurement

AMR magnetic field sensors from Sensitec are particularly suited to the measurement of low field strengths due to the very high achievable sensitivity, which is considerably higher than other solid-state magnetic sensors, such as Hall effect sensors, with superior zero-point stability and temperature stability.

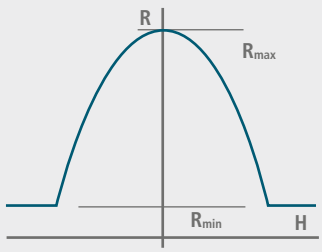
To be able to measure weak magnetic fields, for example the earth's magnetic field with its magnitude of 40 A/m (50 µT), a sensor with high field sensitivity and excellent zero point stability is a pre-requisite. The high sensitivity that can be achieved with AMR sensors with modern designs and using the latest manufacturing technologies make them suitable for numerous applications in industrial and automotive products. These include electronic compasses, magnetometers, vehicle detection or the detection of weakly magnetic objects.

The anisotropic magnetoresistive effect (AMR) occurs in most ferromagnetic materials, such as iron, nickel and cobalt and various alloys. These materials show a dependence of resistivity on the orientation of current flow relative to an internal magnetization vector (anisotropy). The relative change in resistivity between parallel and perpendicular orientation of the current flow and magnetization lies between 2 and 3 % for NiFe alloys that are typically used in AMR sensors. For sensor applications mostly long, thin strips of AMR material are used in order to achieve a high sheet resistance and an easy axis of magnetization along these strips due to shape anisotropy. A simple AMR strip shows the field-resistance characteristic shown in Fig. 1. This characteristic curve shows a quadratic behaviour with very low sensitivity for small fields. The characteristic is not sensitive to the sign of the magnetic field perpendicular to the easy axis, only to the field's magnitude.

In order to linearize this characteristic curve and so make the AMR structure better suited to sensor applications there are a number of design approaches. The Barber-pole structure is one of the most commonly used designs. Thin strips of highly conductive material are deposited on top of the AMR structures at an angle of 45° with respect to the easy axis. The current path is effectively turned by 45° as well, leading to a biasing of the sensor to the operating point with highest sensitivity and linearity. The different possible combinations of orientation between internal magetization vector, Barber-poles and external magnetic field lead to the signal characteristics presented in Fig. 2 for small field strengths. To achieve a large, differential and largely temperature independent output signal, four AMR structures are joined together in a Wheatstone bridge arrangement (Fig. 3).

The bridge offset resulting from manufacturing tolerances leads to a temperature dependent zero point error in magnetic field measurement. For low field magnetic measurements an offset cancellation method needs to be employed. Therefore the flipping principle is applied. By sending current pulses through an integrated metal conductor (Fig. 4) the magnetization of the sensor stripes

1



Unbiased AMR characteristic

Conversion Table for Magnetic Variables

	Flux variable B		Field variable H	
	Tesla [T]	Gauss [G] (obsolete)	A/m	Oersted [Oe] (obsolete)
Tesla	1	1.0×10^{4}	7.96×10^{5}	1.0×10^{4}
Gauss	1.0×10^{-4}	1	79.6	1
A/m	1.26×10^{-6}	1.26×10^{-2}	1	1.26×10^{-2}
Oersted	1.0×10^{-4}	1	79.6	1

The conversion table allows a comparison of magnetic field variables and flux variables.

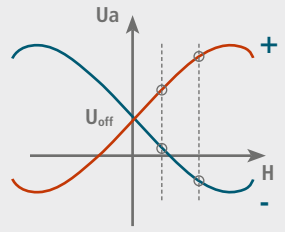
valid for $\mu_r = 1$ (vacuum, air by approximation)

$B = \mu_0 \mu_r H$
with μ_0 = permeability of free space = $1{,}257 \times 10^{-6}$ Vs/Am
and μ_r = relative permeability (dimensionless number)

can be turned by 180° degrees along the easy axis. This leads to a mirroring of the characteristic curve around the bridge offset (Fig. 2 and 3). The resulting output characteristic in both flip states is shown in Fig. 5. By measuring the sensor output in both flip states for a given field the offset of the sensor can be cancelled. By using continuous pulses in alternating polarity this can be done by simple demodulation (analogue or digital).

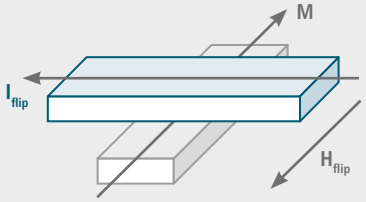
Until recently the required flip currents were too high for many mobile applications. The special design of the Sensitec AFF700 family sensors dramatically reduces the required flip current compared with other, existing solutions. This feature opens up new applications and markets for AMR magnetic field sensors. The AFF700 design is also responsible for reducing magnetic noise and the cross field sensitivity of the sensors, which plays an important role in the design and application of 2D/3D sensor assemblies, as typically found in electronic compasses and magnetometers.

5



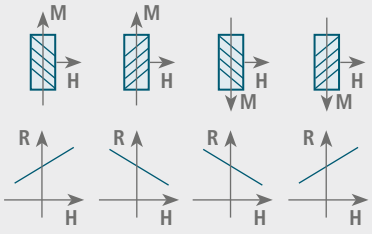
Transfer curve of a flipped sensor. Red and blue indicate the two flip directions. The offset voltage can be determined from the intersection of the curves.

4



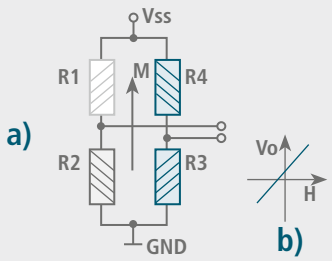
Flip coil (top) with perpendicular orientation to MR Barber pole structure (bottom)

2



Linear range of transfer curves in dependence of the orientation between Barber poles and magnetization

3



a) Equivalent circuit of a Wheatstone bridge consisting of Barber pole structures b) offset of the transfer curve

GMR Technology

GMR magnetic field sensors from Sensitec in multilayer- or spin valve technology are particularly suited to the high resolution magnetic field measurement as well as reference- and switching applications in an industrial environment.

The GMR effect

The giant magnetoresistive effect (GMR) occurs in special stacks comprising thin layers of magnetic and non-magnetic materials. Compared to the AMR effect, which occurs in the bulk AMR material, the GMR effect occurs only at the interlayer boundaries of the layer stacks. The resistance is dependent on the orientation of the magnetization of the different magnetic layers towards each other. The relative change in resistivity between parallel and perpendicular orientation lies between 10 % and 40 % depending on the specific sensor layout and technology. Sensitec GMR sensors use two different types of layer structures – Multilayer and Spin valve.

Multilayer

Magnetic coupling of adjacent magnetic layers, leading to an antiparallel orientation when no external field is applied, can be achieved by using well-defined spacing between these layers (Fig. 1). By using long, thin strips of multilayer structures an easy axis and well-defined sensitivity axis can be created (Fig. 1). An applied magnetic field in plane can overcome the magnetic coupling and turn the magnetization of the magnetic layers to a parallel orientation. The resulting characteristic curve is shown in Fig. 2. It is only dependent on the magnitude of applied field, not on its sign with respect to the sensitivity axis. Due to this fact multilayer sensors are well suited for switching applications as well as for the detection of end positions. Their sensitivity for small fields is very low.

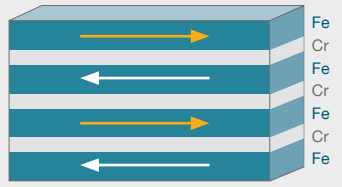
Spin valve

Spin valve structures can be seen as a logical development of the multilayer structure. In a layer stack comprising two magnetic layers that are coupled in antiparallel orientation, the magnetization in one layer is “pinned” by an additional magnetic layer (Fig. 3). Using thin long strips of spin valve stacks and pinning perpendicular to the stripes’ long axis, the magnetization of the free layer is oriented at 90° to the pinned layer when no field is applied, due to shape anisotropy (Fig. 4). For an applied field in the pinning direction the characteristic curve shown in Fig. 5 is obtained.

Bridge circuits using multilayer and spin valve sensor elements

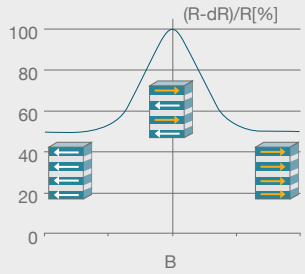
Four sensor elements are typically combined in a bridge assembly, where usually two resistors are shielded by an additional soft magnetic layer and only the change of the unshielded resistors is measured as the bridge output. Fig. 6 shows a schematic of a half shielded spin valve sensor bridge. The characteristic curves shown in Fig. 7 and Fig.8 are obtained for half shielded bridges comprising multilayer and spinvalve sensor elements respectively.

1



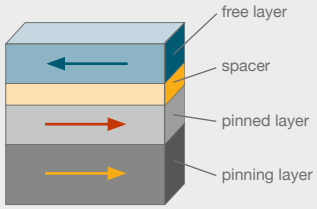
Multilayer structure with antiparallel coupling of the magnetic layers

2



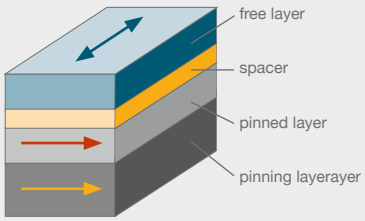
Resistance curve of a multilayer structure in an external magnetic field

3



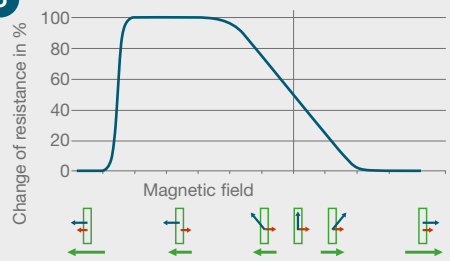
Layer structure of a spin-valve element

4



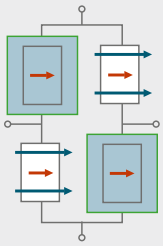
Spin-valve element with shape anisotropy

5



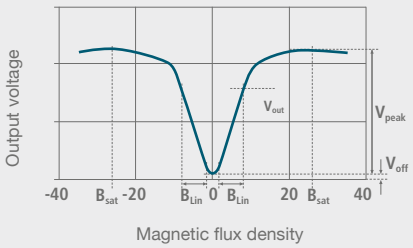
Resistance curve of a spin-valve structure with shape anisotropy (pinning direction: red, free layer: blue and external magnetic field: green)

6



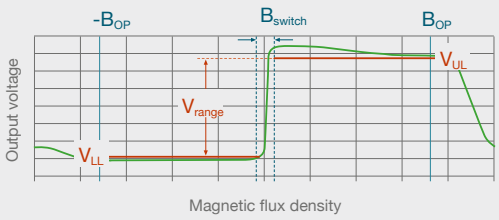
Bridge arrangement for a spin-valve with two shielded resistor elements (pinning direction: red, sensitive axis: blue, shield: green)

7



Typical output voltage of a multilayer bridge circuit with two shielded resistor elements

8



Typical output voltage of a spin valve circuit with two shielded resistor elements

AFF700

AMR Magnetic Field Sensor

Component

The AFF700 sensor family, based on the AMR effect, is designed for low noise magnetic field measurements. The sensors consist of Wheatstone bridge including an integrated flip coil for offset correction. This measurement principle also reduces the temperature coefficient of the offset by a factor of 100.

This sensor family is ideally suited for the detection of weak magnetic fields in the range of several nT to mT including the earth magnetic field.

Features

– Based on the anisotropic magnetoresistive effect
– Wheatstone Bridge configuration
– Integrated flip coil
– Temperature range from -40 °C to +125 °C

Advantages

– Extreme sensitivity
– Wide range of magnetic field strength
– Low power consumption
– Low flip coil resistance
– Very good signal to noise ratio

Applications

– Electronic Compass
– Navigation Systems
– Battery powered applications
– Magnetometry
– Vehicle detection and traffic management

Technical Data of AFF755

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage	-	5	9	V
I_F	Required Flip current	±150	-	-	mA
S	Sensitivity	13	15	17	$\frac{mV/V}{kA/m}$
R_B	Bridge resistance	2.2	2.5	2.8	kΩ
R_F	Flip coil resistance	1.0	1.5	2.0	Ω
H_{ext}	Operating magnetic field range	-400	-	400	A/m
H_{max}	Maximum disturbing field	-	±400	-	A/m

Technical Data of AFF756

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage	-	5	9	V
I_F	Required Flip current	±400	-	-	mA
S	Sensitivity	8	10	12	$\frac{mV/V}{kA/m}$
R_B	Bridge resistance	0.7	1.0	1.3	kΩ
R_F	Flip coil resistance	1.0	1.5	2.0	Ω
H_{ext}	Operating magnetic field range	-800	-	800	A/m
H_{max}	Maximum disturbing field	-	±800	-	A/m

The data given in the tables are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Pinning for SO8 Package

Pin	Symbol	Parameter
1	$+I_F$	Flip coil
2	$-V_{out}$	Negative output voltage
3	I_{test}	Test connector
4	GND	Ground
5	$+V_{out}$	Positive output voltage
6	V_{CC}	Supply voltage
7	I_{test}	Test connector
8	$-I_F$	Flip coil

Pin 1 is marked by a point on housing.

Pinning für LGA-Package

Pin	Symbol	Parameter
1	$+I_F$	Flip coil
2	$-V_{out}$	Negative output voltage
3	I_{test}	Test connector
4	GND	Ground
5	$+V_{out}$	Positive output voltage
6	V_{CC}	Supply voltage
7	I_{test}	Test connector
8	$-I_F$	Flip coil

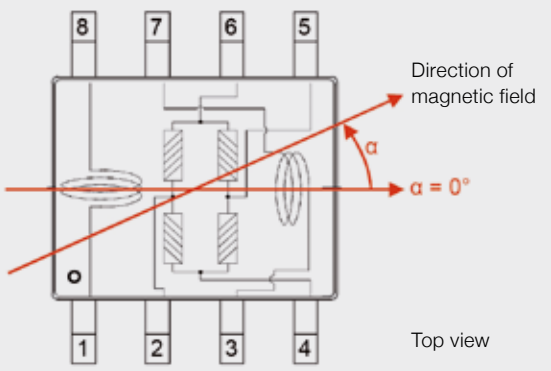
Pin 1 is marked by a point on housing.

Product Codes

Product code	Package
AFF755BHA	SO8
AFF756AHA	SO8
AFF756AMA	LGA8

The sensors of the AFF700 family are also available as individual chips (as wafer, diced on foil or in a waffle pack). Please contact your Sensitec sales engineer for more information on this delivery form.

SO8 Package connections



GF705

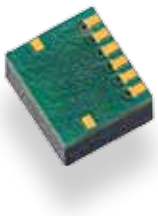
GMR Magnetic Field Sensor

Component

The GF705 is a magnetic field sensor based on the multilayer giant magnetoresistive (GMR) effect. The Sensor contains a Wheatstone bridge with on-chip flux concentrators to improve the sensitivity. The Sensor is ideal for measuring magnetic fields in a linear range from 1.8 mT up to 8 mT.

A typical application is endpoint detection through a cylinder of stainless steel: A moving magnet inside a thick-walled cylinder is detected by a GF705 sensor from the outside.

The GF705 is available as bond version (bare die), as a flip-chip package for SMD assembly and also in a LGA SMD housing.



Features

– Based on the giant magnetoresistive (GMR) effect
– Flip-chip assembly (CSP) also available
– Temperature range from -40 °C to +125 °C

Advantages

– Large air gap
– Excellent absolute accuracy
– Large range of magnetic field strength
– Very small size
– Switching with adjustable switching thresholds

Applications

– Endpoint detection through cylinder wall
– Detection of moving magnet inside a cylinder from outside
– Reference monitoring
– Magnetic switches

Technical Data

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage		-	5	9	V
B_{LIN}	Linear magnetic flux density range (abs)		1.8	-	8	mT
B_{sat}	Saturation magnetic flux density [1]		-	±25	-	mT
S	Sensitivity (in linear range)	B = (1.8…8) mT	8	10	12	$\frac{mV/V}{m/T}$
R_B	Bridge resistance		4	5	7	kΩ
ε_{LIN}	Linearity error	B = (1.8…8) mT	-	1.5	3	% of V_{out}
ε_{Hys}	Hysteresis error		-	1	2.5	% of V_{out}

[1] At B_{sa}t the sensor delivers the maximum output voltage. By exceeding the value of B_{sat} the output signal is no longer unique..
The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Product Codes

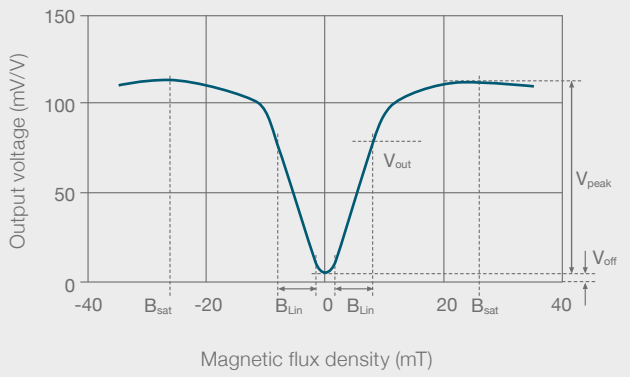
Product code	Package	Dimensions
GF705AMA	LGA6S	3 x 2.6 x 1.5 mm
GF705APA	Flip-chip	1.4 x 0.9 mm
GF705ACA	Bare die	1.46 x 0.96 mm

Pinning

Pin	Symbol	Parameter
1	V_{CC}	Supply voltage
2	$+V_{out}$	Positive output voltage
3	GND	Ground
4	$-V_{out}$	Negative output voltage

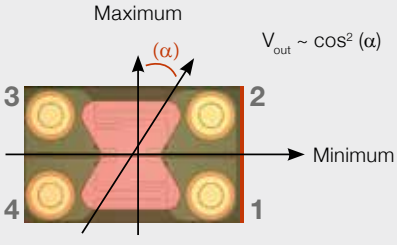
Note: Pin 1 is not marked on the pad / bump side. Since the chip is symmetrical, its orientation is only defined by its long and short side.

Output voltage of the GF705



Typical output voltage of the GF705 depending on the magnetic flux density.

View on pad/bump side



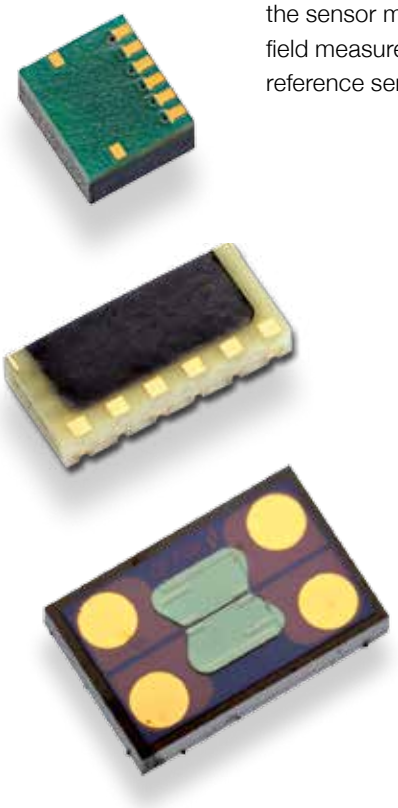
GF708

GMR Magnetic Field Sensor

Component

The GF708 is a magnetic field sensor using spin valve technology based on the GMR effect. The sensor contains a Wheatstone bridge with on-chip flux concentrators to improve the sensitivity.

The high sensitivity and linear operating range of the sensor makes it ideal for precise magnetic field measurements, as well as for switching and reference sensor applications.



Features

– Based on the GMR effect
– Available either as flip-chip (CSP) or in SIL6/LGA package
– Ambient temperature range from -40 °C to +125 °C

Advantages

– Large air gap
– Excellent switching accuracy
– Very small size
– Highly sensitive in linear operating range
– Sensitive to the magnetic field polarity

Applications

– Magnetic switches
– Reference sensors

Technical Data

Symbol	Parameter	Min.	Typ.	Max.	Unit
General					
V_{CC}	Supply voltage	-	5	9	V
R_B	Bridge resistance	13	16	19	kΩ
Switching applications					
B_{op}	Magnetic operation range	-18	-	18	mT
B_{switch}	Magnetic switching range	-1.0	-	1.0	mT
V_{range}	Electrical output range	30	56	70	mV/V
Magnetic field applications					
S	Sensitivity	80	130	160	mV/V/mT
V_{lin}	Linear range of output voltage	30	40	50	mV/V

The data given in the table are characteristic values. Data sheets with complete technical specifications can be found at www.sensitec.com.

Product Codes

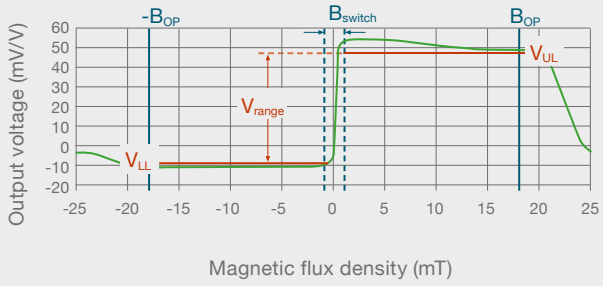
Product code	Package	Dimensions
GF708AKA	SIL6	7.6 x 3.5 x 1.4 mm
GF708AMA	LGA6S	3.0 x 2.6 x 1.5 mm
GF708APA	Flip chip	1.4 x 0.9 mm
GF708ACA	Bare die	1.46 x 0.96 mm

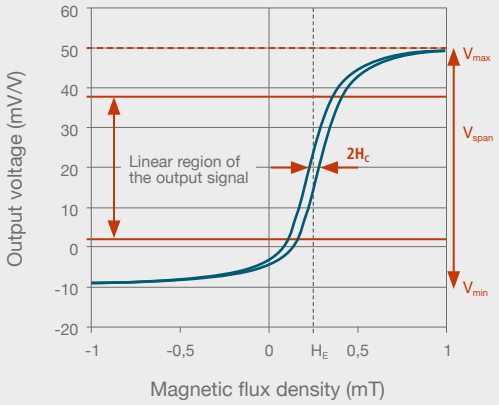
Pinning

Pin	Symbol	Parameter
1	V_{CC}	Supply voltage
2	$-V_{out}$	Negative output voltage
3	GND	Ground
4	$+V_{out}$	Positive output voltage

Note: The orientation of the bare die is shown by the product label and the Sensitec logo

Output voltage of the GF708 sensor



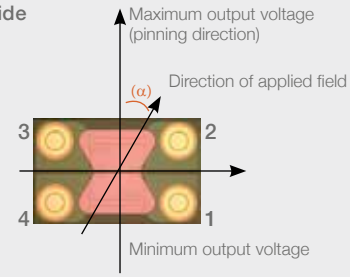


Typical output voltage of the GF708 depending on the magnetic flux density

View on pad/bump/marked side

View on pad/bump side

$V_{out} \sim \cos(a)$

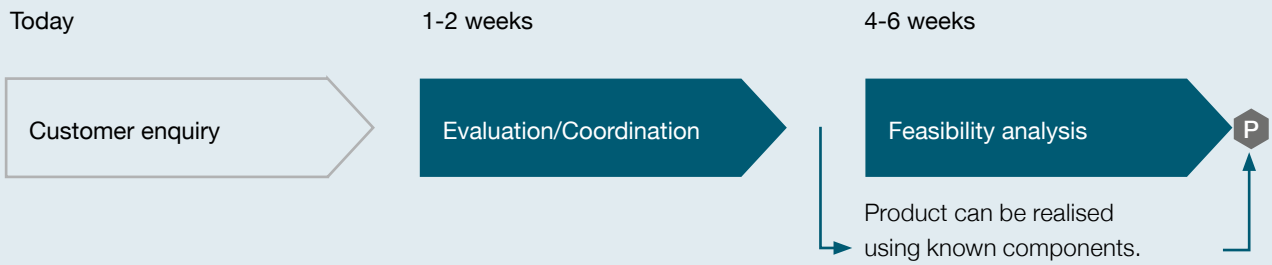


View on marked side (flip-chip only)

Your Path to a System Solution

Some customer requirements cannot be fulfilled using standard components, modules or kits. In this case our competent team of system developers is ready to develop a customized system solution.

Preliminary development

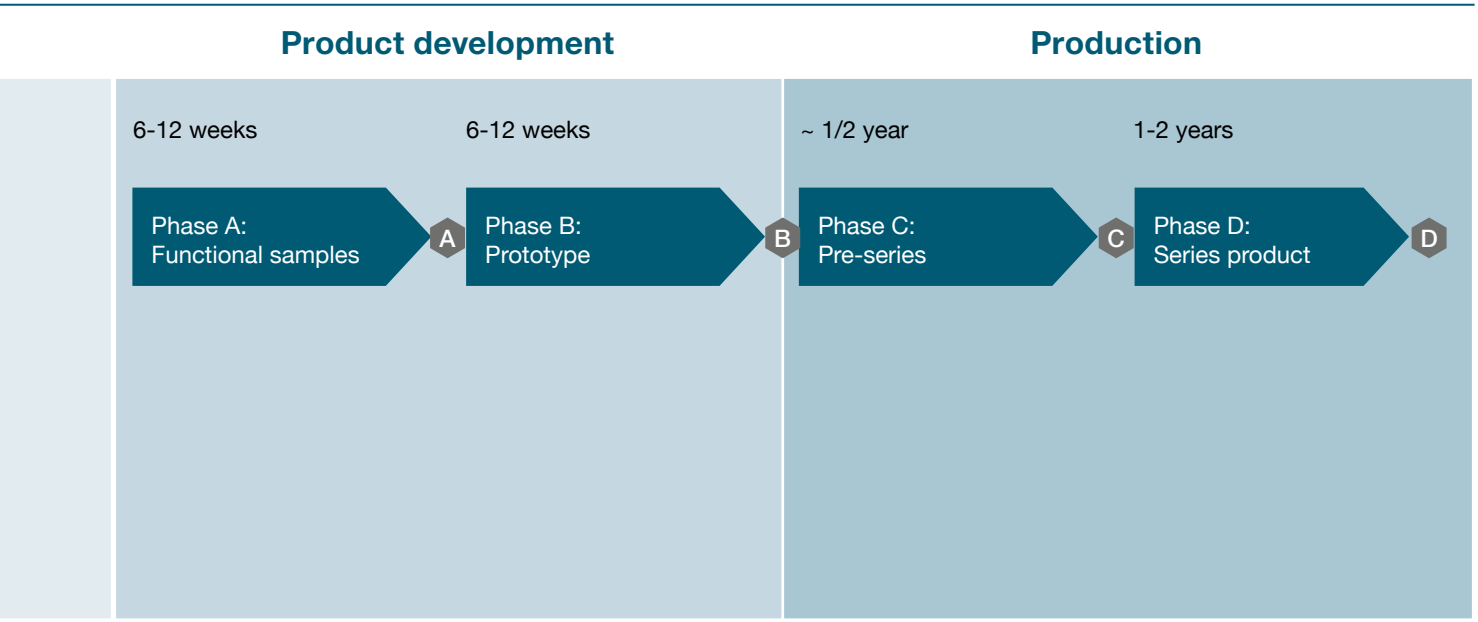


Evaluation/Coordination
Agreement regarding specifications. Collation of further technical and commercial parameters.

Feasibility analysis
Before starting with comprehensive product development a feasibility study including tests and simulation is carried out. This serves to minimize the technical and commercial risk.

Please use the technical questionnaires, which you can find on our website at www.sensitec.com, to provide us with the required specifications for your system.

The diagram below shows the ideal path to a customized system solution. The individual phases and durations are adapted to suit a specific system project.



Product and production development

Product and production development are divided into several phases:

Phase A:
Production of functional samples, possibly with a limited range of functions. Evaluation of the technical feasibility.

Phase B:
Realisation of prototypes with a performance close to that of the series product. Dimensions, design and functions are as defined by the specification. After phase B the actual product development stage is near completion.

Phase C:
Implementation of the production processes on machines for series production.

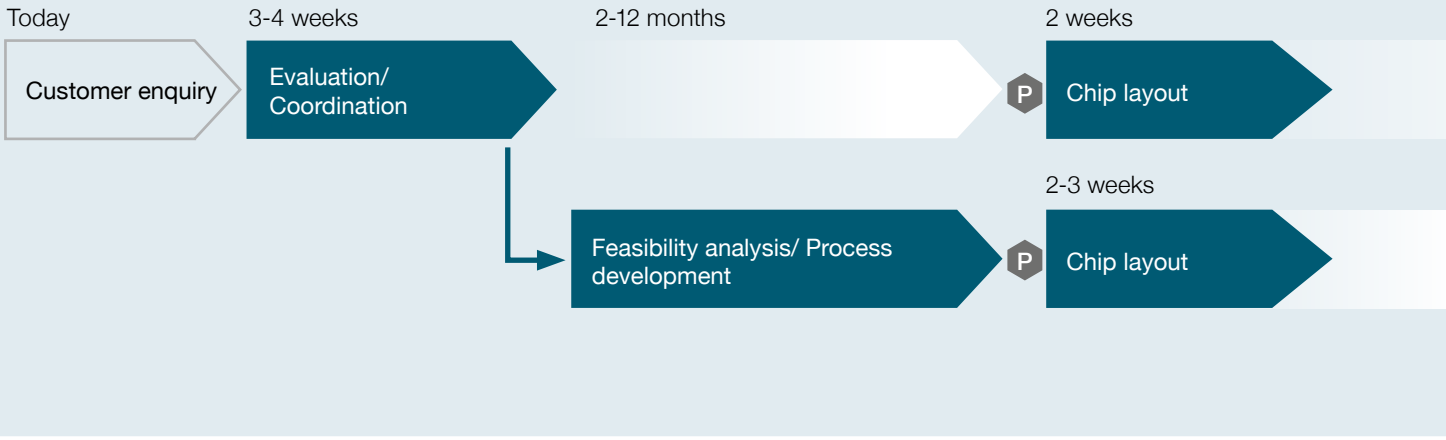
Phase D:
Verification of the product and the production process after a defined period of series production and/or production quantity.
If necessary a plan for further product optimization is created.

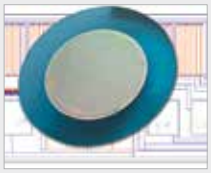
= Design reviews / releases

Your path to a customized chip

In our experience the demands of customer applications are very so widely, that the desired functionality cannot always be realised by a standard chip from our programme. In this case we can support the customer by developing a chip specially designed for his application and performance requirements.

Preliminary development





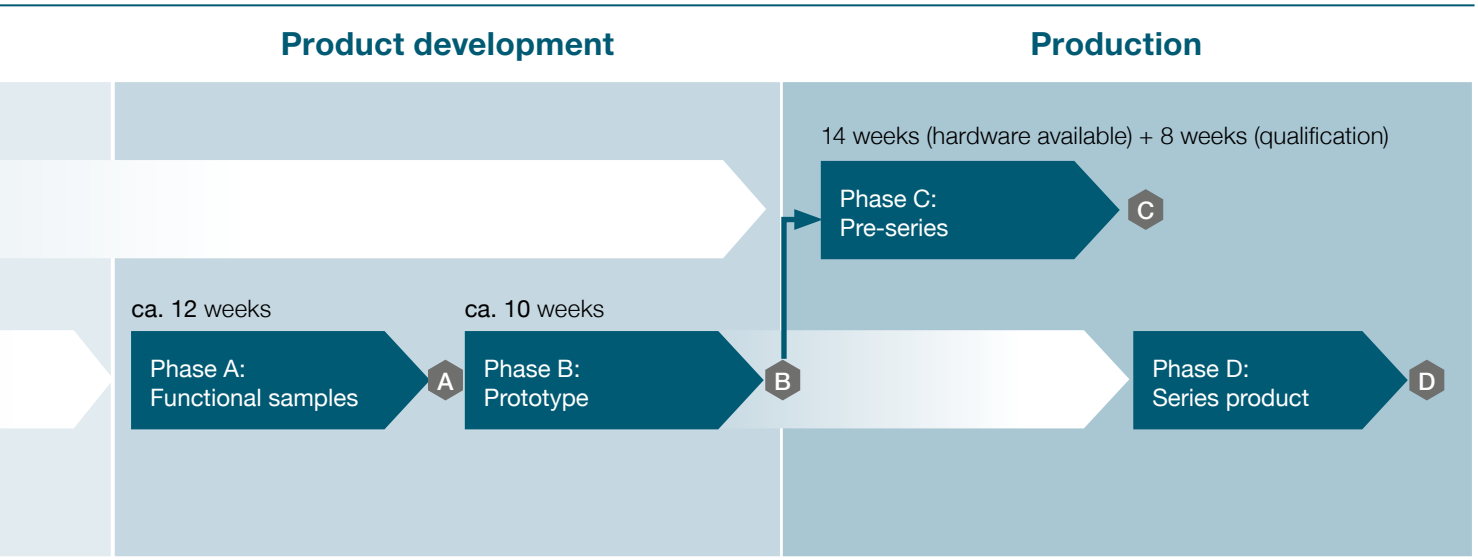
Agreement regarding specifications. Collation of further technical and commercial parameters.

If the customer specifications can be realised by using currently available process blocks and technology platforms, a shortened product development can be initiated directly.

If this is not possible a feasibility study is undertaken to check the realisation by means of simulations and preliminary tests as well as to develop new production processes if necessary.

Thanks to our many years of experience in MR sensor chip layout and design the function of new chip designs can be predicted very accurately by means of specially developed simulation software. Therefore new chip designs can often be adapted to customer specifications without requiring the production of special chip hardware.

In recent years a high level of standardisation has enabled us to minimize the development costs for such a customer-specific chip.



Product and production development

Product and production development are divided into several phases:

Phase A:
Production of functional samples, possibly with a limited range of functions. During phase A several design and process variants can easily be realised and evaluated by means of so-called MPW (Multi-Project-Wafers).

Phase B:
Realisation of prototypes with a performance close to that of the series product. Chip dimensions, design and function are as defined by the specification. After phase B the actual product development stage is near completion.

Phase C:
Production of pre-series
The final design is established on machines for series production and qualified according to the customer's requirements.

Phase D:
Verification of the product and the production after a defined period of series production of chips.
If necessary a plan for further product optimization is created.

= Design reviews / releases

Optimization of Powertrain Components

Sensitec offers contactless measurement systems for fast, high precision length and angle measurement based on the Giant Magnetoresistive (GMR) principle. These complete measurement solutions provide high resolution, high bandwidth and extremely compact dimensions for demanding measurement tasks on engine and powertrain test stands.

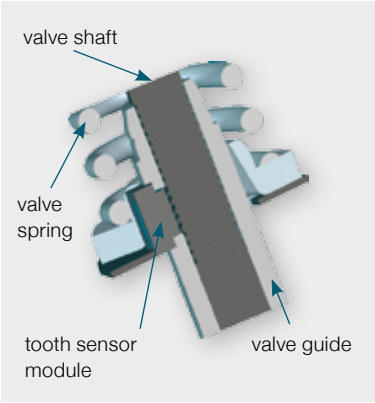


Fig. 1: Modified GLM tooth sensor module: the valve possesses a tooth structure which can be measured by the tooth sensor module.

The drive to lower emissions and the resulting optimization of powertrain components is leading to new measurement tasks for test engineers. To exactly understand the behaviour of these components measurement systems have to be more accurate, more dynamic and operate under more demanding environmental conditions. Measurement solutions based on magnetoresistive sensors open up completely new possibilities.

Miniaturized design

The extremely small dimensions of MR sensors from Sensitec allow the user to measure where he wants to.

Accurate, high resolution

High accuracy and high resolution measurement is guaranteed by the contactless and wear-free operating principle.

Dynamic

MR sensor solutions enable the motion of fast moving components to be tracked.

Robust

MR sensor solutions are largely unaffected by very high or very low temperatures, oil, dirt or mechanical loads such as shock or vibration.

A typical application is valve lift measurement in fired combustion engines. Until now dynamic valve measurement was performed using Laser-Doppler-Vibrometers on electrically driven cylinder heads. GMR sensor solutions from Sensitec allow a direct valve measurement in a fired engine. This enables tests to be carried out under real operating conditions with a significant improvement in the accuracy and dependability of the test results.

The measurement solution from Sensitec includes a GMR sensor, an amplifier and a processing unit which can be controlled by a PC via a USB connection (Fig. 2). The system is especially well suited for test and inspection or research and development tasks, not only for valve lift measurement in fired combustion engines but also for the testing of turbochargers, fuel injectors etc. The sensor head GLM711AVA is intended for the use with ferromagnetic targets with a tooth pitch of 1 mm. A magnet providing the necessary magnetic field and the sensor element are combined in a very compact housing. In combination with the ferromagnetic tooth structure the sensor delivers two 90 degree phase shifted analogue signals (sine and cosine). To allow larger data transmission distances between the sensor and the processing unit an amplifier EPV7702AAA is available. A robust metal housing protects the electronics. The processing unit EPP7703AAA

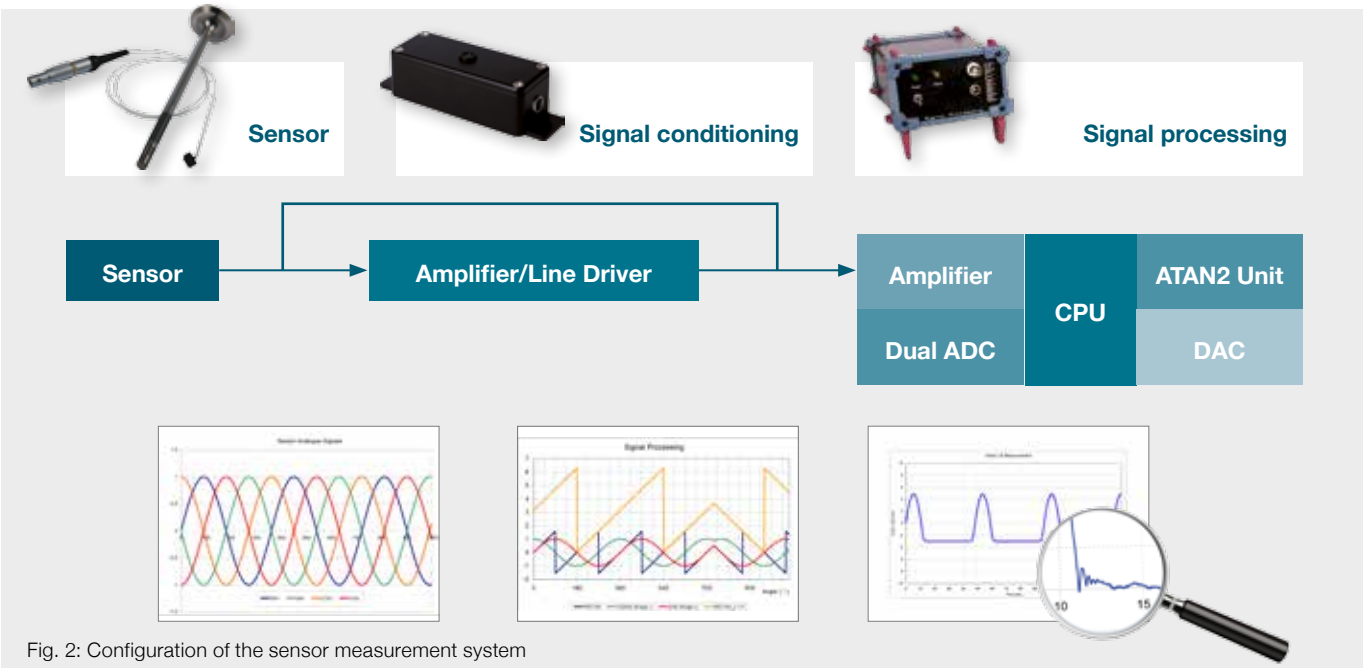


Fig. 2: Configuration of the sensor measurement system

adapts the sensor signals and generates an analogue ratiometric output signal which is proportional to the position of the target. The refresh rate of the signal is up to 100 kHz. The measuring mode is indicated by an LED. The output signal of the processing box can be recorded with a PC based measurement card or an oscilloscope. It is possible to connect different sensors with sine and cosine output to the amplifier or the signal processing unit. The application software running under MS-Windows enables the configuration of the measurement system and the automatic adjustment at the point of measurement.

Applications

– Valve lift
– Valve rotation
– Crankshaft rotation
– Camshaft rotation
– Turbocharger speed
– Injector travel
– etc.

Advantages

– Ratiometric analogue output
– Suitable for long cable lengths (optional amplifier)
– Differential signal processing
– Adjustable pre-amplification
– Scalable resolution (cf. table with technical data on last page)
– Control via PC user interface (MS-Windows)
– Signal processing with 100 kHz
– High bandwidth

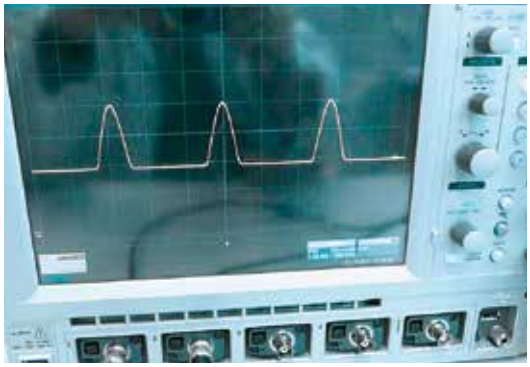


Fig. 3: Typical output signals

Fig. 4: Inlet valves with tooth structure on valve stem

Applications

When development of MR sensor products for industrial and automotive applications began, it was impossible to predict the vast range of diverse applications. Sensitec's MR sensors are in use everywhere, where movement is being controlled and steered, where paths, angles, positions, electric or magnetic fields are measured and detected.

Whether it is in a more than 200 °C hot, almost 10 km deep bore hole for geological research, or on the surface of Mars, -120 °C cold and 400 million km away, or in the steering mechanism of a car or in the objective lens of a professional film camera. Even under the most extreme conditions and in rough environments, MR sensors from Sensitec are characterized by their high reliability and precision. Medical technology, automation, measurement and control technologies, automotive industry or space technology are just some examples of the application areas in which our distinctive know-how and capabilities in MR sensor technology are used to develop progressive solutions.

We provide application engineering support to aid customers in the understanding and specification of our products in system applications. Our support ranges from discussion of possible applications of our sensor products in your system, to answering detailed questions on product performance, to illustrating how to design mechanical and electrical interfaces around our products.

Drive Systems

Typical applications
– Integrated rotary encoder for torque motor
– Linear encoder for direct drive motor
– Shaft-end encoder for compact motor
– Integrated rotary encoder for servo motor

Application example:
Ball bearing with integrated encoder
An incremental encoder is to be integrated within the housing of a ball bearing. The encoder shall provide a resolution of at least 1.25°.

Solution from Sensitec
A GL712 GMR sensor is used to scan a gear wheel with 72 teeth. A comparator is connected directly to the Wheatstone bridge for signal conditioning.

Why use MR sensor technology?
– Simple assembly and adjustment
– No further calibration necessary after final assembly
– A and B signals with 90° phase shift are generated by a single sensor element

Automation

Typical applications
– Linear encoder for direct drive motor
– Limit switch for pneumatic cylinder
– Integrated encoder for ball bearing

Application example:
Door actuator for a passenger lift
Frequency converter, line filter, encoder and asynchronous motor are to be integrated within a single housing for the door of a passenger lift. Improved control characteristics are to be made available by the use of a motor encoder, despite shaft running tolerances of ± 2 mm.

Solution from Sensitec
A sensor of the AA700 family with FreePitch design and a customized reference sensor for the second track are used to scan a dipole magnet.


Source: Fotolia

Why use MR sensor technology?
– Assembly tolerances of several mm are permissible
– No mechanical wear in the measurement system
– Highly dynamic measurement due to the MR technology
– Resistant to oil, humidity and extreme temperature changes

Machine Tools

Typical applications
– Speed measurement system for high-speed spindle
– Integrated encoder for linear bearing

Application example:
Speed measurement for a high-speed spindle
An incremental sine-signal encoder shall measure the speed of a high speed spindle for tool and die machining. An index signal shall be generated per revolution. The output signal shall be RS422 compatible.

Solution from Sensitec
Scanning of a pole ring with a sensor of the AL700 family with FixPitch design and a custom-made reference sensor for the index signal.

Why use MR sensor technology?
– Simple assembly and adjustment
– No mechanical wear in the measurement system
– High repeatability
– Resistant against humidity, dust and oil
– Highly integrated module with integrated signal conditioning electronics

Geological Testing

Typical applications
– Angular sensor for measurement of bore holes

Application example:
Measurement of bit wear in deep drilling
Measurement of bit wear for deep drilling in the earth`s core.

Solution from Sensitec:
Scanning of a pole ring with an FreePitch sensor of the AA700 family and amplification of the electrical signals directly at the sensor. The further signal conditioning takes place externally. The linear movement is converted into a rotational movement, so that the wear measurement takes place within one pole length (pitch).


Source: Fotolia

Why use MR sensor technology?
– Simple adjustment
– No mechanical wear in the measurement system
– Absolute measurement over the full stroke length

Camera Technology

Typical applications
– Integrated angle measurement system for objective
– Rotary encoder for camera swivelling head

Application example:
Recording of aperture, focus and zoom settings of an objective
Information regarding aperture, focus and zoom settings must be stored on the film for subsequent processing, e.g. for digital intermediate or CGI. To store this information a special encoder is needed within the objective.

Solution from Sensitec
A sensor of the AL700 family with FixPitch design with 1 mm pitch and an angle sensor of the AA700 family with FreePitch design for scanning the code track are used. A flexible polymer-bonded ferrite scale is used as the measurement scale.


Source: ARRI

Why use MR sensor technology?
– Simple assembly and adjustment
– No further calibration necessary after final assembly
– A and B signals with 90° phase shift are generated by a single sensor element
– Incremental and code track sensor are mounted on a single board
– Measuring distance is only dependent on the length of the scale

Non-destructive Testing (NDT)

Typical applications
– Magnetic leakage flux testing of ferromagnetic steel pipes for the gas and oil industries

Application example:
Magnetic field sensors for material control
NDT can be used for early identification of hidden defects in materials, components or designs both before and during operation, e.g. in gas or oil pipelines, aircraft take-off, car or train manufacture, or bridge construction.

Solution from Sensitec
GF magnetic field sensors are used for example in the magnetic leakage flux testing of ferromagnetic steel pipes for the gas and oil industries. The sensors can not only identify surface defects, but also anomalies within the steel walls of the pipe. The high sensitivity of the sensors allows defects with very small geometries to be identified. The small dimensions of the sensor allow them to be used in locations that were previously inaccessible.


Source: iStock

Why use MR sensor technology?
– High sensitivity
– High dynamics
– Excellent accuracy
– Small size
– Low power consumption

Aerospace

Typical application
– Integrated encoder for micro-motor in Mars Lander „Curiosity“

Application example:
Incremental encoder in the motors of the mars rovers
The position of motors for the wheels and robotic arm must be measured. Since 2012 – when „Curiosity“ landed on Mars after the flight time of nine months – the search for living microbes is still going on.

Solution from Sensitec
Series production processes are used to manufacture a customer-specific sensor element. Special electronics have been designed in order to avoid damage due to cosmic radiation and the tough environmental conditions on Mars.


Source: NASA/JPL-Caltech

Why use MR sensor technology?
– Resistant to dust, oil and humidity
– Resistant to strong temperature changes
– Insensitive to cosmic or nuclear radiation
– Very low current consumption
– Running on Mars since 2012

Power Electronics

Typical applications
– Current sensor for inverter module
– Current sensor for servo controller

Application example:
Current measurement for dynamic control of servo motors
A fast and highly accurate current measurement is required for the highly dynamic control of servo motors.

Solution from Sensitec
The CDS4000 current sensor is mounted on the controller board. The internal signal conditioning of the sensor system means that no external circuits are necessary. The sensor is provided with a current output.

Why use MR sensor technology?
– Unipolar power supply (+5 V)
– Frequency range from DC up to 200 kHz
– Short-term overcurrent of 3 times nominal current
– Reference voltage input
– Adjustable overcurrent limit

Laser Technology

Typical applications
– Driver for laser diodes

Application example:
Current measurement for recording of output pulses
The detection of highly dynamic output signals of a driver unit for laser diodes necessitates the use of rapid current sensors with a bandwidth of at least 500 kHz. The current sensors must be very small with a reliable integrated galvanic isolation.

Solution from Sensitec
CMS3050 current sensor


Source: iStock

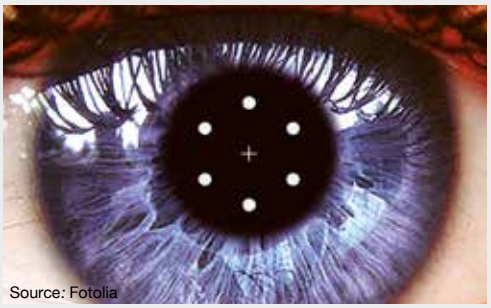
Why use MR sensor technology?
– Excellent measurement accuracy
– Highly dynamic response
– Precise detection of current pulse
– Reliable galvanic isolation
– Robust current output signal

Medical Technology

Typical applications
– Linear encoder for optical biometry
– Diagnostic device for cancer detection
– Linear encoder for micro-manipulator of a microscope

Application example:
Linear encoder for ophtalmological device
The measuring device is used to make measurements between the lens and cornea of the eye when treating cataracts.

Solution from Sensitec
A PurePitch sensor of the AL700 family with pitch length 0.5 mm is used to scan the incremental track of a hard ferrite measurement scale.
A digital hall sensor is used for the reference signal. An interpolation circuit provides a resolution of 248 pulses, representing a linear resolution of better than 2 µm.


Source: Fotolia

Why use MR sensor technology?
– Simple adjustment
– No further calibration necessary after final assembly
– No mechanical wear in the measurement system
– Quasi-absolute position signal by means of the index track
– Service signals on a second connector for easier assembly

Measurement Technology

Typical applications
– Linear encoder for workshop slide gauge
– Linear encoder for electro-mechanical calliper
– Measurement system for portable hardness tester

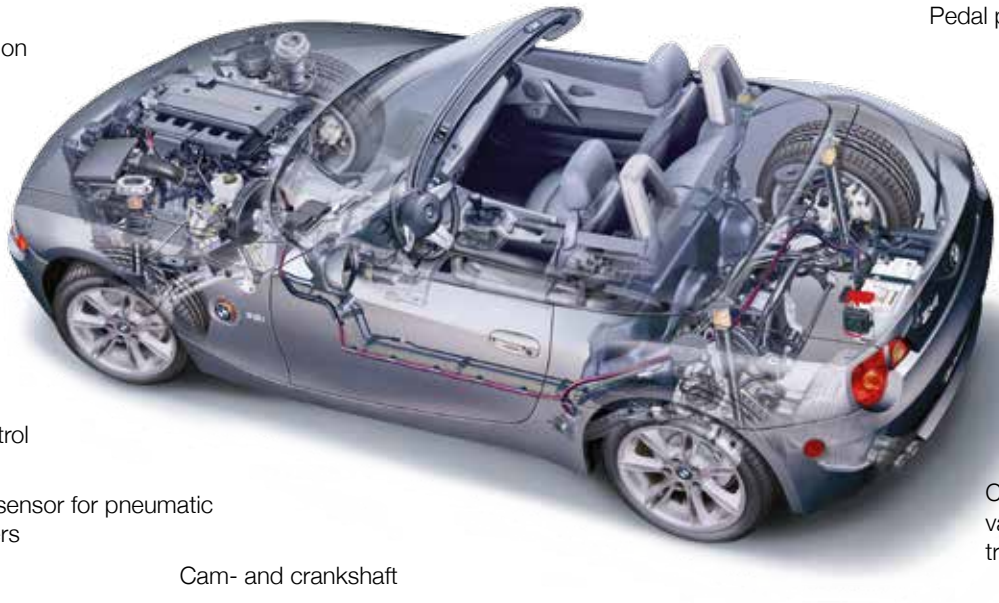
Application example:
Stroke measurement in a workshop calliper gauge
Stroke measurement in a workshop calliper gauge that should be non-contacting and resistant to humidity.

Solution from Sensitec
Custom-made field sensor adapted to the magnetic pole length (pitch).

Why use MR sensor technology?
– Simple adjustment
– No mechanical wear in the measurement system


Source: TESA

– High repeatability
– Resistant against humidity, dust and oil



Automotive

Typical applications
– Motor commutation in power steering
– Valve stroke measurement for motor test stand

Application example:
Motor commutation in power steering
The servo motor that is used to power assist the steering needs electrical input via a sensor measuring motor angle and speed.


Source: Fotolia

Solution from Sensitec
Scanning of a dipole magnet at the shaft end using an AA700 angle sensor

Why use MR sensor technology?
– Contactless, wear-free operating principle for angular and linear measurement
– Withstands extreme operating conditions
– Large air gap
– High bandwidth for measurements in time slots of less than 100 ms
– Very reliable
– Small dimensions
– High precision
– Flexible integration
– Automotive qualification

Automotive

Typical applications
– Steering angle sensor for power steering
– Wheelspeed sensor for ABS-system

Application example:
Wheelspeed sensors
Wheelspeed sensor for detection of the current speed of the wheels or the path or angle passed per unit of time. Precise functionality is a necessity because the operation of other systems in a car, such as anti lock brake system (ABS) or traction control (ASR) depend on the information provided by the wheelspeed sensor.

Solution from Sensitec
AF720 Magnetic field sensor (customized sensor)

Why use MR sensor technology?
– Contactless, wear-free operating principle for angular and linear measurement


Source: Fotolia

– Withstands extreme operating conditions
– Large air gap
– High bandwidth for measurements in time slots of less than 100 ms
– Very reliable
– Small dimensions
– High precision
– Flexible integration
– Automotive qualification

Automotive

Typical applications
– Steering angle sensor for power steering
– Torque sensor for active steering
– Position sensor for pedal travel measurement
– Current sensor for hybrid power plant
– Valve position measurement for motor test stand

Application example:
Torque measurement for active steering system
Measurement of torque for an active steering system in a car.

Solution from Sensitec
Scanning of a pole ring with an angle sensor of the AA700 family. The pole ring and angle sensor are connected with each other via a torsion shaft. Signal conditioning is executed by a customer-specific ASIC directly at the sensor.


Source: Fotolia

Why use MR sensor technology?
– Simple assembly and adjustment
– No further calibration necessary after final assembly
– No mechanical wear in the measurement system
– Resistant to dust and oil

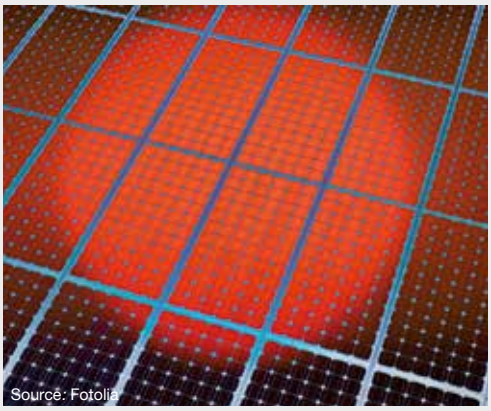
Photovoltaics

Typical applications
– Current sensor for inverter module

Application example:
Current measurement in an inverter for solar energy applications
Inverters for solar energy applications require a high efficiency in order to ensure a conversion of the generated direct voltage into supply voltage with low loss.

Solution from Sensitec:
CFS1000 current sensor

Why use MR sensor technology?
– Excellent accuracy
– Small footprint (SMT mountable)
– Cost-efficient


Source: Fotolia

Wind Energy

Typical applications
– Current sensor for inverter module

Application example:
Adjustment of rotor blades in wind turbine
Each rotor blade of a wind turbine is adjusted by an inverter module according to the direction of wind. Current sensors measure the output current within the closed loop of the inverter module.

Solution from Sensitec
CDS4100 current sensor

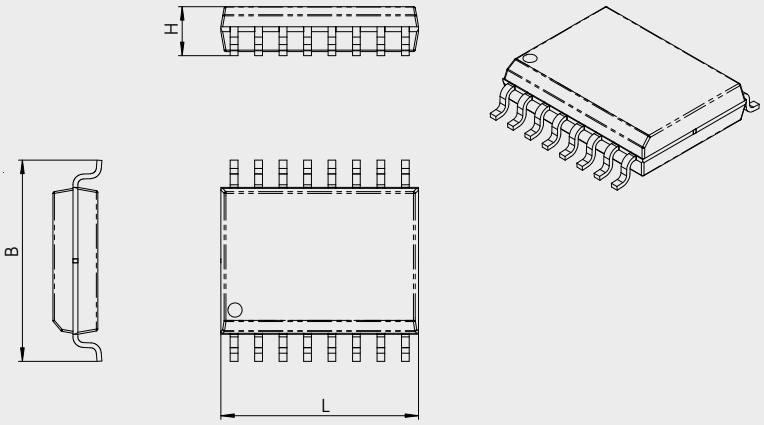
Why use MR sensor technology?
– Higher control quality due to the dynamic response and the good accuracy
– Low temperature drift allows a constant control quality over the complete operating temperature range


Source: Mainova

– Robust current output signal
– Reference voltage input
– Adjustable overcurrent detection

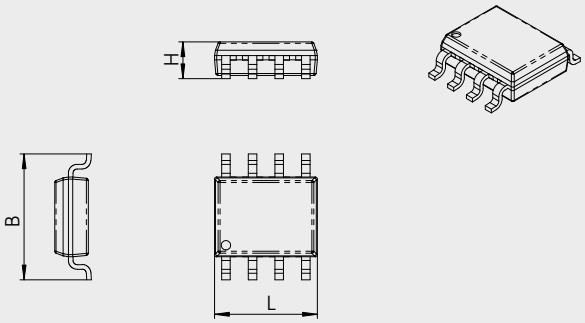
SOIC16w Packaging according to JEDEC MS-013

Length (L): 10.3 mm
Width (B): 10.3 mm
Height (H): 2.65 mm



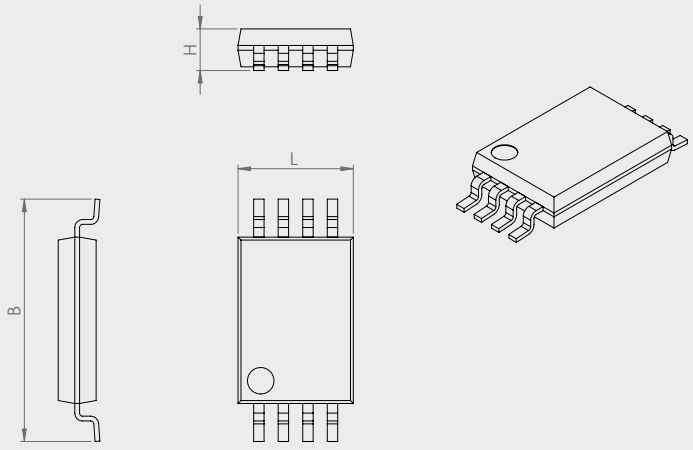
SO8 Packaging according to JEDEC MS-012

Length (L): 4.9 mm
Width (B): 6.0 mm
Height (H): 1.75 mm



TSSOP8 Packaging according to JEDEC MO-153

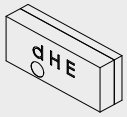
Length (L): 3.05 mm
Width (B): 6.40 mm
Height (H): 1.10 mm

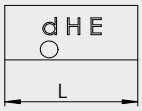


LGA6L Packaging

Length (L): 6.0 mm
Width (B): 2.6 mm
Height (H): 1.5 mm

Marker
d = Sensor type
H = Production week
E = Production year

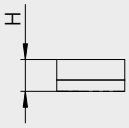


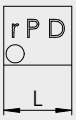


LGA6S Packaging

Length (L): 3.0 mm
Width (B): 2.6 mm
Height (H): 1.5 mm

Marker
r = Sensor type
P = Production week
D = Production year

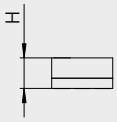


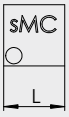


LGA8 Packaging

Length (L): 3.0 mm
Width (B): 3.0 mm
Height (H): 1.4 mm

Marker
d = Sensor type
H = Production week
E = Production year

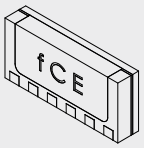


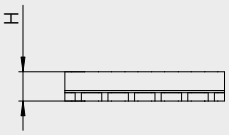


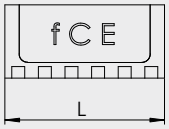
SIL6 Packaging

Length (L): 7.6 mm
Width (B): 3.5 mm
Height (H): 1.4 mm

Marker
f = Sensor type
C = Production week
E = Production year



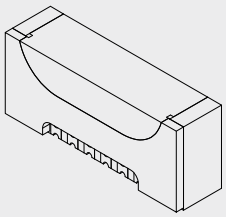


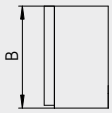


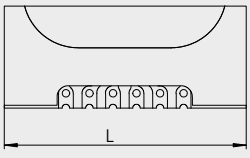
GLM Packaging

Length (L): 13.0 mm
Width (B): 5.5 mm
Height (H): 3.45 mm

Marker
J - Year (e. g. 3 = 2013)
12345 - sequential numbering
DKC - Sensor type



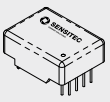




CDS4000 Packaging

Length (L): 21.0 mm
Width (B): 15.5 mm
Height (H): 8.2 mm
Height incl. pins: 12.2 mm

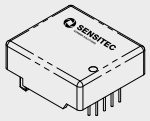
CDS4000 current ranges: 6 A - 50 A

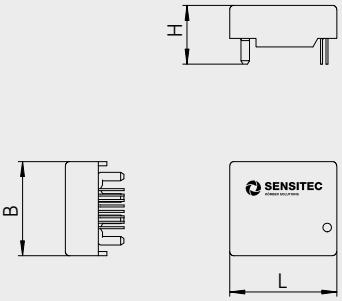


CDS4000 Packaging

Length (L): 25.0 mm
Width (B): 22.0 mm
Height (H): 9.7 mm
Height incl. pins: 13.7 mm

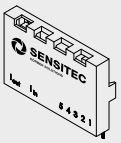
CDS4000 current ranges: 50 A - 150 A

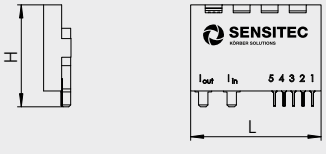




CMS2000/CMS3000 Packaging

Length (L): 34.9 mm
Width (B): 7.3 mm
Height (H): 23.0 mm
Height incl. pins: 27.0 mm





Term	Explanation
Anisotropy	Exhibiting properties with different values when measured in different directions. With AMR sensors anisotropy is used to describe the difference in electrical resistance when the direction of the magnetization changes.
Chip layout	The geometrical design of the MR structures and interface connections of the chip.
Component	This term describes single components that are intended for integration into a module or a system. Because the integration must be carried out by the customer, there is an additional design and assembly effort necessary. However, the user has the possibility to configure the complete system as he wishes.
Delivery forms	Different packages are available in addition to bare die as delivery form.
EcoSensing	MR-sensors have a high bandwidth, virtually no delay and can be manufactured with a high internal resistance. This makes them particularly well suited to energy efficient applications and systems.
Ferromagnetic	A ferromagnetic material, such as iron, becomes magnetized in an external magnetic field and remains magnetized for a period after the material is no longer in the field.
FixPitch	FixPitch sensors are adapted to the pole length (pitch) of the measurement scale. The linearity of the sensor is optimized and the influence of interference fields is minimized.
FreePitch	FreePitch sensors are optimized so as to be independent of the pole length (pitch) of the measurement scale. FreePitch sensors are therefore particularly compact and come close to an idealized point-sensor.
Kit	This term describes a construction set of individual, unassembled components and modules that are intended for easy customer-side assembly and integration into a machine or device.

Term	Explanation
Magnetic field	A magnetic field is a force field with specific field strengths and directions in each point of the field. The magnetic field is caused by movement of electrical charges and needs no medium.
Magnetoresistive	A magnetoresistive material changes the value of its electrical resistance when an external magnetic field is applied to it.
Module	A module from Sensitec comprises several components.The module itself is not yet functional and requires other components - such as a measurement scale – to form a kit or a system.
MPW (Multi Project Wafer)	Realisation of several design variants on a single wafer. This allows the evaluation of a number of different chip designs and/or process alternatives with limited effort – only one set of masks and one wafer run are necessary.
Nominal current	The nominal current is the maximum continuous current the sensor is designed for. Several sensor parameters, such as accuracy, are expressed as a percentage of the nominal current.
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 linearity of the sensor is assured, even for weak magnetic field measurement.
Pitch	Distance between two adjacent north and south poles on a magnetic scale.
Process blocks	Sensitec MR-sensor chips are manufactured by means of thin-film processes, building a chip layer-by-layer on a substrate (typically a silicon wafer). Each layer provides a special function for the sensor chip. For each layer there are diffferent process blocks available, that allow many different customer requirements with respect to function, post-processing etc. to be realised.

Term	Explanation
PurePitch	In PurePitch sensors the FixPitch principle is extended over several poles in order to increase accuracy still further. This arrangement reduces the influence of errors in the measurement scale and improves the immunity to interference fields.
SelfBias	MR-Sensors featuring SelfBias technology do not need any separate magnets to generate a bias field. The sensor can achieve an ideal operating point without the need for an external bias field.
SmartFit	Sensor modules with SmartFit technology offer additional features in the signal conditioning and processing electronics. The circuit can be parameterized via the signal cables and the operating mode can be continuously monitored. SmartFit therefore offers more user comfort in the application and makes the sensor system more secure and simple to operate.
System	A system is a fully functional combination of Sensitec components or modules in a single package. The advantage of the complete system is a minimization of design and assembly effort and, therefore a fast “time-to-market”.
Technology platform	Our automotive-qualified technology platform comprises a number of so-called process blocks. These can be combined like building blocks to generate the production process for a sensor chip. By using the identical manufacturing processes to those applied for our mass produced automotive-qualified sensor chips, we can offer the same closely meshed quality control and continuously optimised, reliable and stable production conditions for low volume customised sensor chips. Standardised procedures as well as special design rules enable a short lead time for the production of new sensor chips.
Thin film technology	In this technology thin material layers, typically under 1 µm, are deposited on a substrate.
Tunnel resistance	Electrical resistance of a very thin barrier that becomes conductive under the influence of a magnetic field.
Waffle pack	Standardised product carrier for chips in die form (chips without package).
ZeroInertia	ZeroInertia represents a dynamic characteristic. Existing machine components are used as measurement scale which often means that no additional inertia is added to the moving object in the form of pole rings or linear measurement scales. This feature is particularly beneficial in highly dynamic applications.

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