XENSIV™ – sensing the world

Sensor solutions for automotive, industrial, consumer and IoT applications

Edition 2022

www.infineon.com/xensiv

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Infineon XENSIV™ – sensing the world

Infineon XENSIV™ sensors are exceptionally precise thanks to industry-leading technologies. They are the perfect fit for various customer applications in automotive, industrial, consumer and IoT markets.

From a world leader in sensing technology, XENSIV™ sensors simplify lives by enabling “things” to “see”, “hear”, “feel” and , “smell” and therefore intuitively “understand” their environment. Providing exceptional accuracy and best-in-class measurement performance, XENSIV™ sensors add extraordinary value to customer applications. More than 40 years’ experience in sensing solutions and a deep-rooted system understanding result in the broadest portfolio of ready-to-use sensor solutions on the market. Ecosystem partners and our customers partner with us for leading technologies, perfect-fit solutions and continuous innovation.

At Infineon, we are committed to making cars safer, smarter and greener with our innovative and leading sensor portfolio. Today, a new car features numerous safety, body and powertrain applications that rely on sensors. Clearly focused on future trends, our outstanding portfolio of sensor ICs for numerous safety-relevant automotive systems makes cars much safer. In Electric Power Steering (EPS), our magnetic angle sensors and linear Hall sensors are used to measure the steering angle and steering torque. Since all our newly developed parts are based on an ISO 26262-compliant development flow, we do our utmost to support our customers’ designs in achieving the ASIL classification. This means that they can be deployed directly in all safety-relevant applications – making us a leader in supporting ISO 26262-compliant systems.

As part of our comprehensive XENSIV™ sensor family, we now also offer high-performance MEMS microphones qualified according to the state-of-the-art automotive quality standard AEC-Q103-003. These microphones close the industry gap, providing the best possible fit for automotive applications. Automotive XENSIV™ MEMS microphones combine our proven expertise in the automotive industry with our technical leadership in high-end silicon microphones. Our high performance MEMS microphones are also the first choice for consumer applications.

On the automotive front – where safety and high precision are essential – many manufacturers rely on our XENSIV™ products for tire pressure monitoring system (TPMS), seat comfort, side crash detection, pedestrian impact detection and weather applications.

Infineon's RASIC™ 77/79-GHz chips are used in Radar-based driver assistance systems – such for Adaptive Cruise Control or collision avoidance – which recognize objects at a range of up to 250 meters. In fact, our 77/79-GHz SiGe RASIC™ chips lead the MMIC segment. The RASIC™ 77/79-GHz automotive radar support ASIL C, reducing customer R&D efforts.

Our comprehensive family of XENSIV™ sensors includes a wide choice of pressure sensors tailored specifically to the needs of automotive, industrial and consumer sectors. Offering rapid time-to-market, our XENSIV™ portfolio ensures the perfect fit for all performance and integrity needs. Featuring analog and digital interfaces, these sensors give customers a high degree of design flexibility, while also enabling manufacturers to meet evolving market and compliance demands.

The latest XENSIV™ PAS CO2 sensor is an exceptionally small, real CO2 sensor and is ideal for high-volume smart home and building automation applications such as demand-controlled ventilation systems, air purifiers and thermostats. This disruptive sensor technology enables users to accurately measure and adjust indoor air quality, contributing to the overall wellbeing, health and productivity of occupants while also optimizing energy efficiency.

Our XENSIV™ – high-precision coreless current sensors are offered with integrated current rail for low currents as well as external current rail for medium to high currents. The products are intended for use in 48 V as well as high voltage applications such as traction inverters, industrial drives, photovoltaic inverters, or battery disconnect systems. Our sensors provide accurate and stable current measurement up to 120 A or 31 mT respectively.

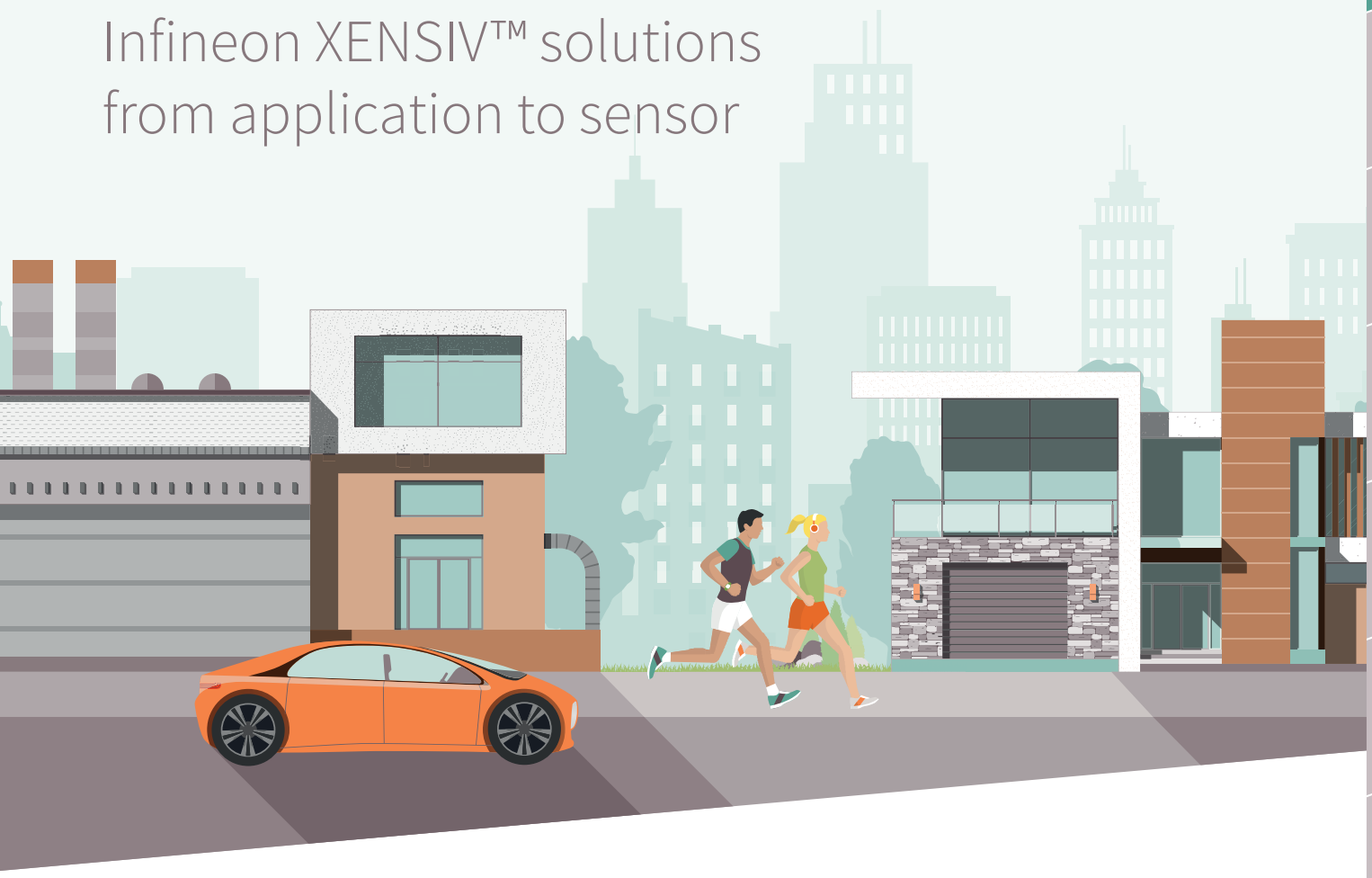
In the Internet of Things, sensors are omnipresent and mark the starting point of each and every IoT system. They collect all kinds of data on their surroundings, providing the entry point for all subsequent functions and features. Building on its well-founded systems expertise, Infineon's broad portfolio in the XENSIV™ family contains ready-to-use solutions to enable a fast time-to-market and reliable functionality for applications in the area of smart home & smart building, smart things, smart factory or smart cars.

Today, we are already inspiring the next generation of smart environments, capable of understanding and responding to human communication.

Infineon's semiconductors are at the very heart of machine-to-machine (M2M), human-machine interface (HMI), mobile and wireless infrastructure technologies. As the technological boundary between humans and machines gradually disappears, these devices need even more advanced intelligence, enriched with voice assistance capabilities and the latest sensor fusion innovations, not to mention robust security technologies to protect personal data.
Infineon's sensors and microphones are already delivering this intelligent functionality and inspiring the next step in mobile connectivity.

Use the qr-code or visit us on www.infineon.com/xensiv to get the whole portfolio overview, our latest downloads and videos.

Infineon XENSIV™ solutions from application to sensor



Find your sensor

Welcome to our new interactive sensor selection tool, designed to connect you with the best fit for your design as quickly and effortlessly as possible. Simply select the overarching industry (automotive or industrial/consumer) and drill down on the applications till you find your target use case. The selection tool will then tell you what Infineon XENSIV™ sensor is the best choice for your design. It couldn't be easier.

Find your sensor on www.infineon.com/fastfinder

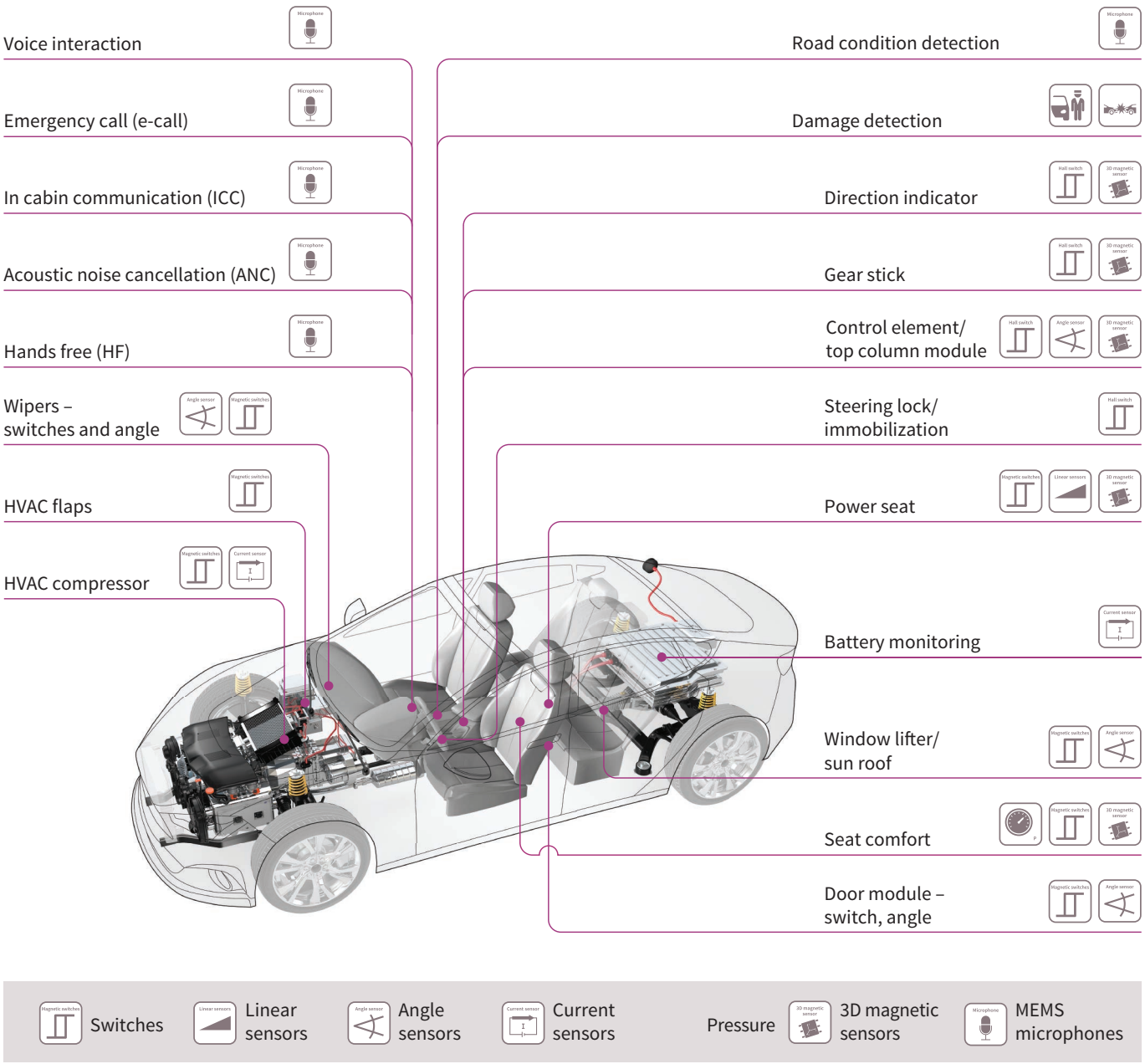
XENSIV™ sensors – part of the Infineon Developer Community

Join the XENSIV™ Developer Community

The Infineon Developer Community offers 24/7 self-service and lightning fast responses to customer demands. Any user, anywhere, anytime – any subject. The community is well-organized due to its multi-channel strategy. Unlike unmoderated forums, the developer community is based on high quality content that is professionally moderated and reviewed.

Check it out and be part of the XENSIV™ sensor community.

XENSIV™ sensors in body applications



The body segment presents the most diverse target market for sensors. Sensors are used for position sensing, motor control, comfort features and HMI applications. Sensor content is expected to grow further as interior and comfort is becoming a key differentiation factor for OEM's. At Infineon, we support body applications with one of the broadest portfolios of sensors and sensing principles in the market at outstanding levels of quality and reliability.

www.infineon.com/body-electronics

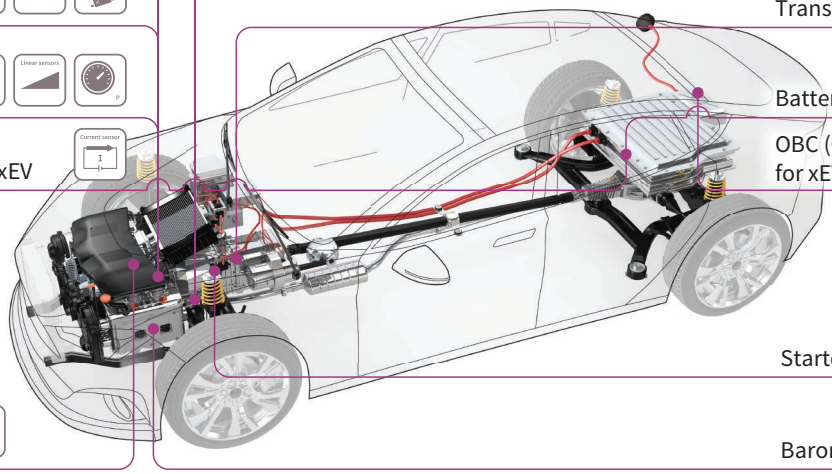
XENSIV™ sensors in powertrain applications

Engine

- Crankshaft
- Camshaft position
- Manifold air pressure
- Secondary air valve
- Turbo charger
- Throttle position
- Variable valve position
- HEV electric motor
- Pedal position
- Exhaust Gas Recirculation (EGR)
- HV battery disconnect for xEV
- DC-DC converter

Transmission

- Clutch position
- Clutch actuator
- Transmission speed
- Transmission actuator
- Transmission gear position
- Oil pump
- Park lock
- Gear stick
- Transfercase
- Battery monitoring for EV
- OBC (On Board Charger) for xEV
- Starter generator
- Barometric air pressure

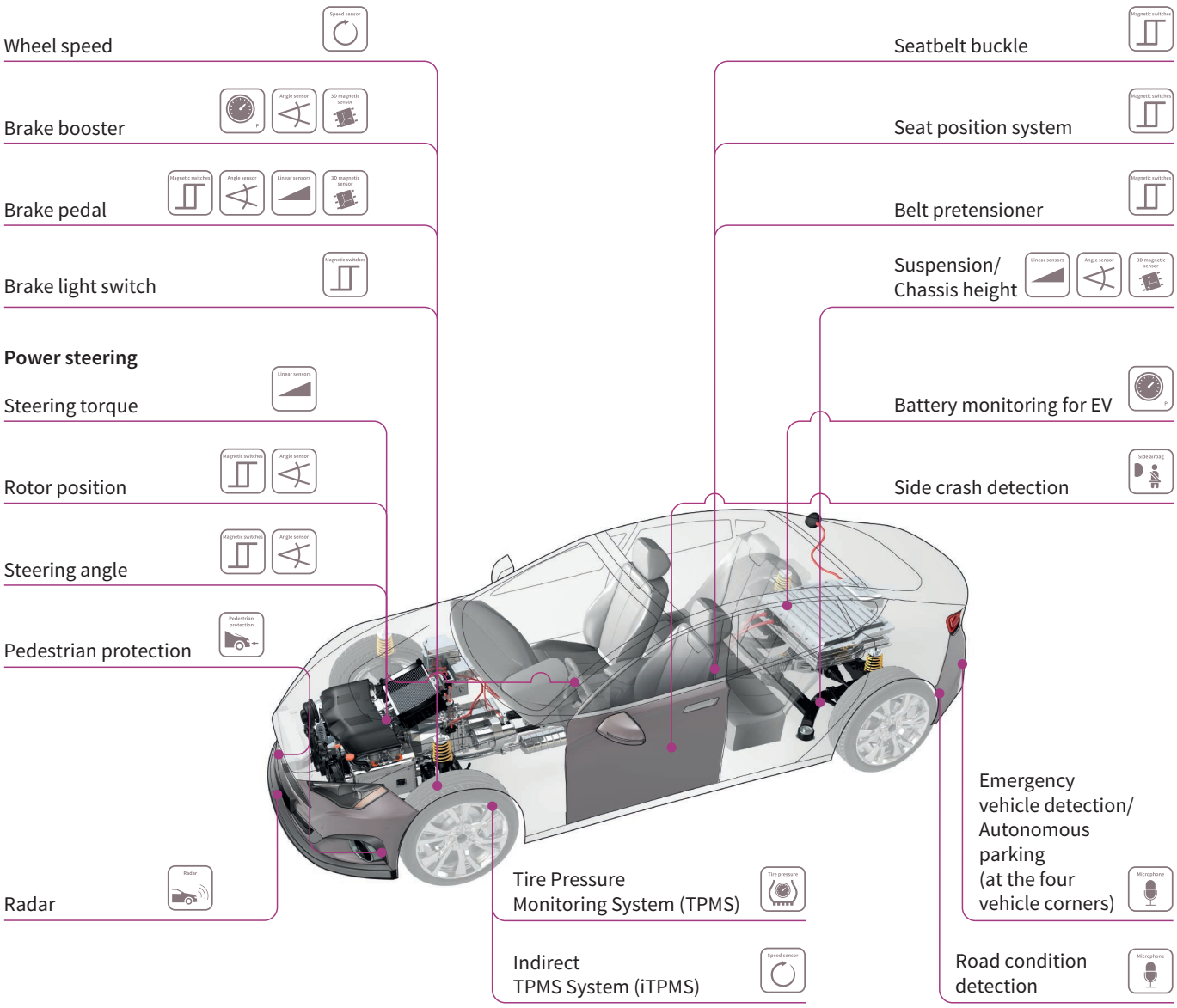


Switches | Linear Hall | Angle sensors | Current sensors | Pressure | Speed sensors | 3D magnetic sensors

Crankshaft, camshaft and transmission speed sensors as well as MAP and BAP pressure sensors are only some of the key elements of multiple modern powertrain applications, such as engine and transmission, which significantly boost drivetrain efficiency. Current sensors provide accurate and stable current measurement for use in 48 V as well as high voltage applications such as traction inverters, industrial drives, photovoltaic inverters, or battery disconnect systems. Our broad portfolio of products fits every customer requirement.

www.infineon.com/powertrain

XENSIV™ sensors in safety applications



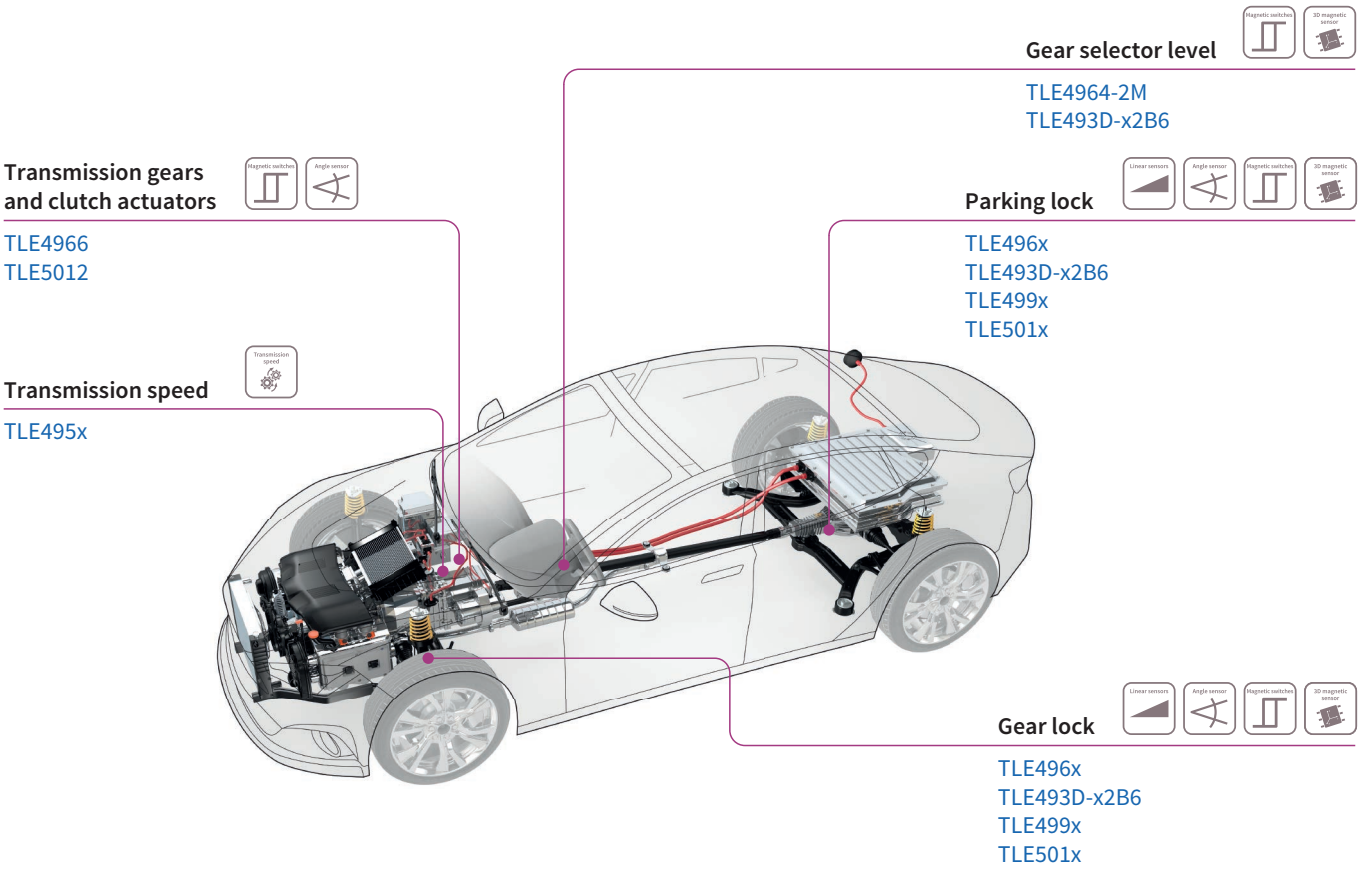
Switches · Linear sensors · Angle sensors · Pedestrian protection · Tire Pressure Monitoring System (TPMS) · 3D magnetic sensors

Radar · Pressure · Speed sensors · Side airbag · MEMS microphones

At Infineon, we focus in particular on sensors for safety applications. These include radars in automatic cruise control systems, wheel speed sensors in ABS and ESP features, pressure sensors and silicon microphones in emergency vehicle detection systems, side airbags and pedestrian protection systems, as well as TPMS sensors. We are the global market leader in most of these areas and our customers value the outstanding levels of quality and reliability that we deliver.

www.infineon.com/chassis-safety-adas

Magnetic sensors in efficient transmission systems



The automotive industry faces the challenge of transitioning towards electro-mobility while also meeting global emissions regulations calling for higher fuel efficiency and lower CO_2 emissions

The transmission transfers engine torque to the wheels as the driver presses on the gas. An efficient system should enable reduced parasitic losses, a long last gear ratio, and aggressive torque converter lock-up schedules (zero slip).

Other essential aspects for modern transmission systems include driving performance and comfort – both of which strongly influence customer purchasing decisions. Automatic transmission architectures (AT, DCT, CVT) have the potential to answer all of these requirements, delivering a smooth driving experience and improved efficiency while at the same time meeting all safety standards with an increased focus on drivability, launch feel, and shift quality over the whole automotive lifecycle.

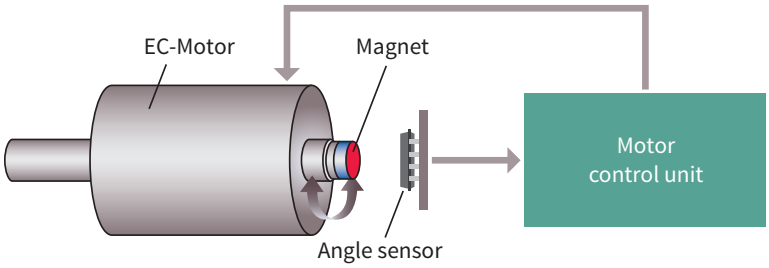
Reliable, accurate sensors are key success factors in many different transmission applications enabling improved system performance and superior control.

Infineon offers a wide range of accurate sensors for all automatic transmissions in hybrid and electric vehicles. These sensors improve transmission system performance as well as safety and driving comfort levels, opening the way for manufacturers to migrate from combustion engines to hybrid and fully electrified powertrains.

www.infineon.com/powertrain

Actuation and motor commutation

Transmission actuators directly influence the controllability, dynamics, size, cost, and efficiency of transmission systems. The performance, efficiency, and controllability of transmission actuators can be significantly improved by integrating rotor position sensors that provide exact position information for motor commutation, especially in conditions with highly dynamic torque (e.g. electric oil pumps).



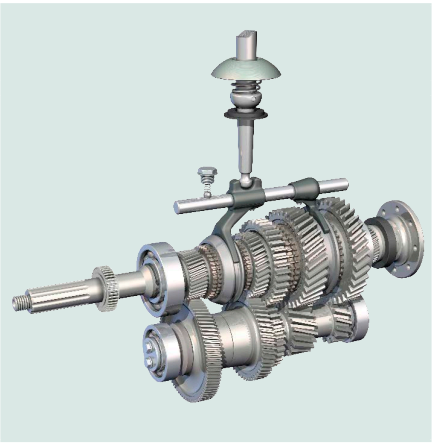
Infineon has wide portfolio of position sensors for motor commutation to address wide range of requirements based on commutation type, accuracy, interface and system cost requirements. We offer all magnetic sensor technologies with in-house production; thus, our customers can choose between Hall sensors, AMR (Anisotropic Magneto Resistive), GMR (Giant Magneto Resistive) or TMR (Tunnel Magneto Resistive) sensors in order to find their best-fit solution for their application.

Magnetic switches

- High temperature stability of the magnetic threshold
- **Highest accuracy and proven quality**
- Easy drop-in replacement
- **Low power consumption** enabling energy-efficient systems

Angle sensors

- Wide portfolio of **analog (sin/cos) and digital angle sensors**
- Support STD digital interface HSM IIF & SPI
- High accuracy MR sensors
- Low power consumption
- **ISO 26262 compliant**
- Grade 0 available



Product	Ordering code	Description
TLE5012B E1000	SP001166960	Digital GMR angle sensor with SPI + incremental encoder interface or Hall switch emulation output
TLE5014SP16 E0001	SP004232096	ISO 26262 compliant (ASIL C-metric), programmable GMR angle sensor with PWM, SENT or SPC, SPI output.
TLE5501 E0001	SP001621824	Tunneling Magneto Resistive (TMR) angle sensor with analog sin/cos output.
TLE5009A16 E2210	SP001296114	Fast Giant-Magneto Resistive (GMR) angle sensor family with analog sin/cos output with built amplifier.
TLE5109A16 E2210	SP000956966	Fast Anisotropic Magneto Resistive (AMR) angle sensor family with analog sin/cos output with built amplifier.
TLE4964-2M	SP000923330	Integrated highly accurate Hall effect switch with superior supply voltage capability, additional product derivatives available.

Gear selector lever

There are different sensing solutions for gear selector devices on the market, depending on the mechanical implementation of the lever movements/positions and the design. Common to all is the ability to detect the discrete position – in other words, the selected operating mode – of the automatic transmission system. Contactless sensing solutions are standard and have a major share in this application field due to their reliability and functional safety gains compared with mechanical switches or potentiometers. Hall switch arrays are often used but pure angular and 3D Hall solutions are common.

TLE496x-xM are integrated Hall-effect sensors, which ensure an easy-to-use and cost-effective solution for position sensing applications. Especially when high temperature stability of the magnetic threshold is required.

Our innovative 3D Hall sensor family TLx493D senses the magnetic field in three dimensions allowing to build a gear stick system using only two 3D Hall sensors instead of an array of Hall switches. The benefit of the 3D Hall technology together with the high accuracy and the small package enables for extremely compact system designs .

Magnetic switches

- **Highest accuracy and proven quality**
- Easy drop-in replacement
- **Low power consumption** enabling energy-efficient systems
- **High supply voltage range** and lead dump capability to ensure cost-effective designs

3D magnetic sensors

- Component reduction due to 3D magnetic measurement principle
- **Best accuracy-package size fit**
- Very low power consumption
- Supporting platform approach due to high flexibility and configurability
- Supporting **ISO 26262 compliant** systems

Product	Ordering code	Description
TLE4964-2M	SP000923330	Integrated highly accurate Hall effect switch with superior supply voltage capability, **additional product derivatives available**.
TLE493D-P2B6 A0	SP005557415	High accuracy low power 3D magnetic Hall sensor with I^2C interface, **additional product derivatives available**.

Parking lock and gear fork

Parking brakes are used in all kinds of transmission types and will continue to be part of battery-powered electric vehicles in future. The position of the parking lock is controlled by a magnetic position sensor that detects the positions “P engaged” and “P not engaged”.

One gear is locked mechanically to avoid that the car moves, while parked. A linear movement is needed, activated by an electrical motor. Therefore, a rotation is transferred to linear movement, which offers many sensing solutions. We know about magnetic angle sensor, magnetic switches and magnetic linear position sensor.

Gear forks are a similar use case they control the engagement and disengagement of different gears in a transmission using a linear movement. Position sensors are used to ensure that a gear fork operates smoothly and safely when switching gears. Different designs with Hall switches as well as linear, angle, or 3D Hall sensors are possible for both applications based on the overall system implementation of the OEM.

Magnetic switches

- **Highest accuracy and proven quality**
- Easy drop-in replacement
- **Low power consumption** enabling energy-efficient systems
- High temperature stability of the magnetic threshold

Angle sensors

- Wide portfolio of **analog (sin/cos) and digital angle sensors**
- Support STD digital interface HSM IIF & SPI
- High accuracy MR sensors
- Low power consumption
- **ISO 26262 compliant**

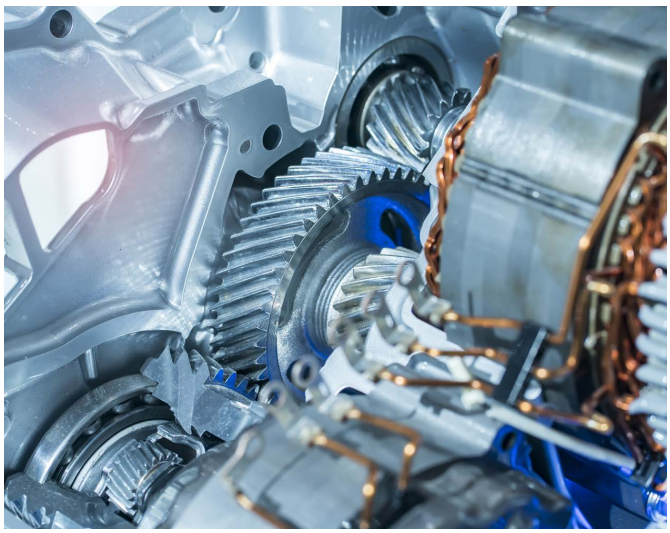
3D magnetic sensors

- Component reduction due to 3D magnetic measurement principle
- Best accuracy-package size fit
- **Very low power consumption**
- Supporting platform approach due to high flexibility and configurability
- **ISO 26262 compliant**

Linear sensors

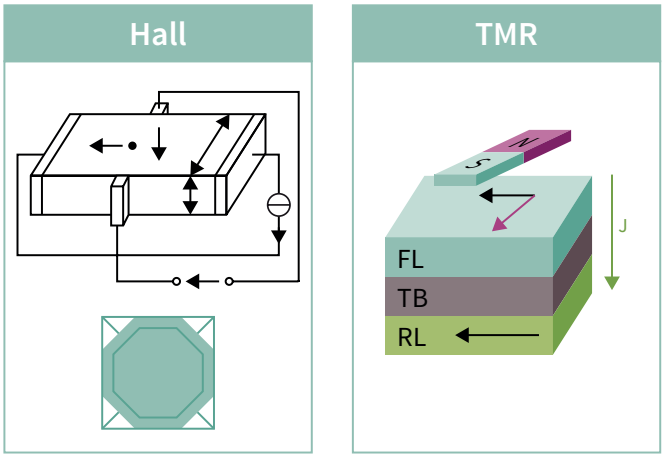
- Enables highly accurate angular and linear position detection as well as current measurements
- High linear and ratiometric push-pull rail-to-rail output signal
- **Low drift of output signal** over temperature and lifetime
- **ISO 26262 ready/ compliant**

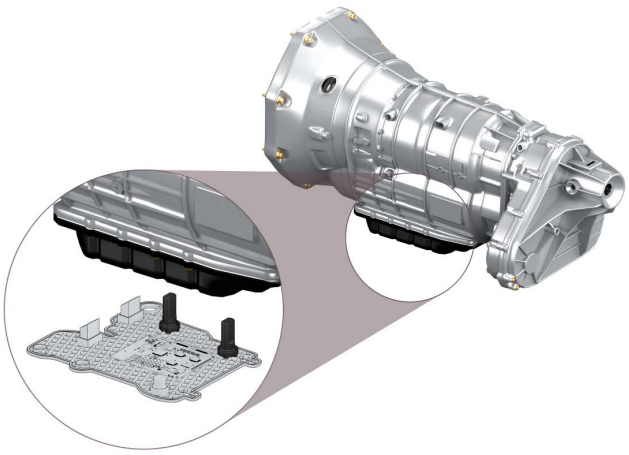
Product	Ordering code	Description
TLE5012	SP001205296	GMR digital angle sensor
TLE5501-E0001	SP001621824	TMR analog sensor
TLE4964-xM	SP000923326	Switch
TLE4961-xM	SP000923322	Latch
TLE4961-1L	SP000848038	Latch
TLE4963-xM	SP000930182	Latch
TLE4968-1M	SP000923334	Latch
TLE4966-xG	SP002983188	Double Hall
TLE4997x	SP000902756	Linear Hall
TLE4998x	SP000476468	Linear Hall
TLE4999x	SP002662500	Linear Hall
TLE493D-P2B6 A0	SP005557415	30 magnetic Hall sensor



Transmission speed sensors

Infineon's transmission speed sensors address all automatic transmission systems (DCT, ECAT, CVT, AMT) as well as hybrid concepts, DHT, and new EVs. Our sensors have been designed to provide excellent performance in the most challenging gears of the transmission systems. Our portfolio of transmission speed sensors is based on two different technologies chosen specifically to deliver the robustness and flexibility required for transmission applications.





Hall-based technology sensors:

- Currently most widely used technology worldwide for speed and position sensing
- Reliable, robust, and easy to use without saturation or flipping, easy to use with back-biased applications

TMR-based technology sensors:

- Combine the high sensitivity and excellent jitter performance of MR technologies
- Combine the robustness and user friendliness of Hall sensors with low-cost ferrite magnets

Two-wire current interface sensors or three-wire voltage interface sensors provide speed information and, depending on the protocol, direction information to the TCU via a PWM protocol.

Product highlights

- **Wide and stable product portfolio** of magnetic speed sensors
- **Two wire current interface** and **three wire voltage interface** available to fit all transmission system in the market including DHT and new 2-gears EV concepts
- **Speed and direction detection** via PWM output protocol available
- ISO ready and **ISO compliant versions** supporting ASIL D on system level
- High magnetic sensitivity & **large operating airgap**
- Fast start-up and **dynamic self calibration principle**
- High vibration suppression capability
- From zero speed up to high frequencies
- **Easy to use for magnetic encoders** and ferromagnetic wheel applications

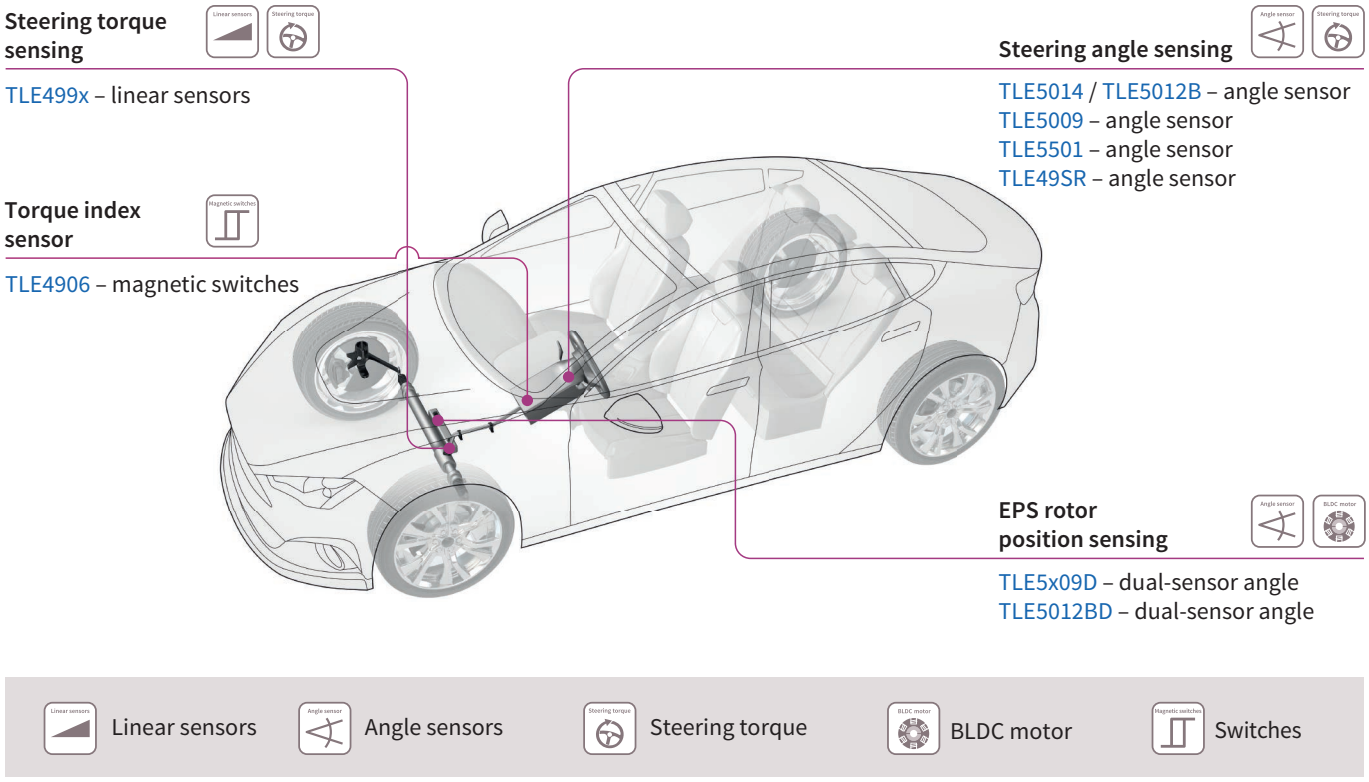
Product	Ordering code	Description
TLE4953C	SP001952920	Two-wire current interface differential speed sensor family with direction detection and active vibration suppression. **Additional product derivatives available.**
TLE4955C	SP001952972	Two-wire current interface differential speed sensor with direction detection and the highest active vibration suppression. **Additional product derivatives available.**
TLE4959C	SP001671650	Three-wire voltage interface differential speed sensor family with and without direction detection and active vibration suppression. **Additional product derivatives available.**

Magnetic position sensors for highest energy efficiency and functional safety in Electric Power Steering (EPS)

Compared to conventional hydraulic power steering solutions, Electric Power Steering (EPS) enables higher energy efficiency, increased steering functionality and reduced space requirements in passenger vehicles.

The functionality of EPS is based on several system-side position sensors, that measure the steering torque input from the driver, the rotor position of the EPS motor, that moves the steering rack and the steering wheel's absolute position.

Typical application for Infineon magnetic position sensors in EPS



Position sensor applications in EPS are safety-related with the highest safety level. The ISO 26262 standard sets high requirements for the diagnostic coverage of random failures and the avoidance of systematic failures in order to reach the highest safety rating on system level resulting in a safety classification of the category ASIL D.

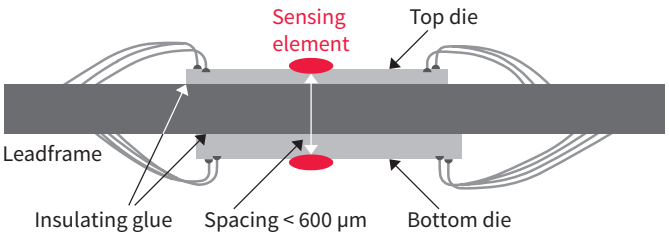
These demanding specifications can typically be achieved by using redundant sensors as well as comparing their signals in a microcontroller.

Infineon offers dual-sensor solutions with two redundant sensors in the place of one for all position sensor applications in EPS. Our dual-sensor package integrates two magnetic position sensors with separate supply pins and separate signal outputs. They are electrically independent thanks to galvanic isolation. This means that the two sensors work independently, thereby increasing system reliability.

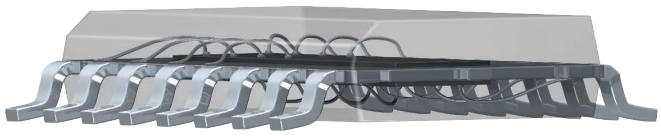
www.infineon.com/eps

Magnetic position sensors for the ultimate in energy efficiency and functional safety in Electric Power Steering (EPS)

Side view of Innovative stack-mounted dual-sensor technology with bonding wires



Transparent 3D-graph of dual-sensor TDSO-16-2 package



Thanks to the use of innovative stack-mounting technology, the devices of the angle sensor family combine two independent sensors within standard and space-saving TDSO packages which are only about 1 mm thick. It has the same width and length as a conventional single-sensor package. Compared to the common approach of side-by-side sensor placement, the advantages of the top-bottom placement include a more homogeneous magnetic field over the sensing elements and a significantly smaller footprint. This saves precious space and cuts down on expense in safety-critical applications.

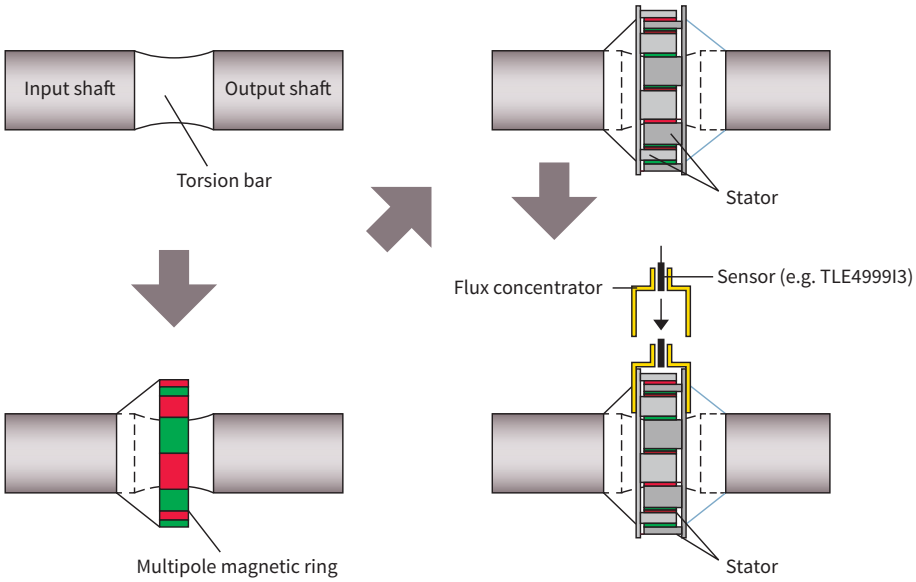
Steering torque sensors

In the field of steering torque sensing, Infineon XENSIV™ TLE499x series offers highly accurate linear Hall sensors for magnetic torque sensing assembly. In order to support a maximum of compatibility with various Electronic Control Unit (ECU) designs, the TLE499x sensors feature PWM, SENT, SPC, PSI5 or ratiometric analog output. They are available in leaded packages, as well as 1 mm thick dual- or single-sensor SMD packages.

TLE4997x	Programmable linear Hall sensor with temperature compensation and ratiometric analog output. Available in a 3-pin leaded package (without integrated capacitors) and an 8-pin dual- or single-sensor SMD package.
TLE4998x	Programmable linear Hall sensor with digital stress and temperature compensation and PWM, SENT or Short-PWM-Code (SPC) output. Available in a 3- or 4-pin leaded package (with or without integrated capacitors) and an 8-pin dual- or single-sensor SMD package.
TLE4999I3	Programmable dual channel linear Hall sensor with PSI5 interface. Developed compliant to ISO 26262 for safety requirements rated up to ASIL D. Available in a 3 pin leaded package.
TLE4999Cx	Programmable dual channel linear Hall sensor with Short-PWM-Code (SPC) interface. Developed compliant to ISO 26262 for safety requirements rated up to ASIL D. Available in an 8-pin dual- or single-sensor SMD package, 4-pin leaded package sensor is already available.

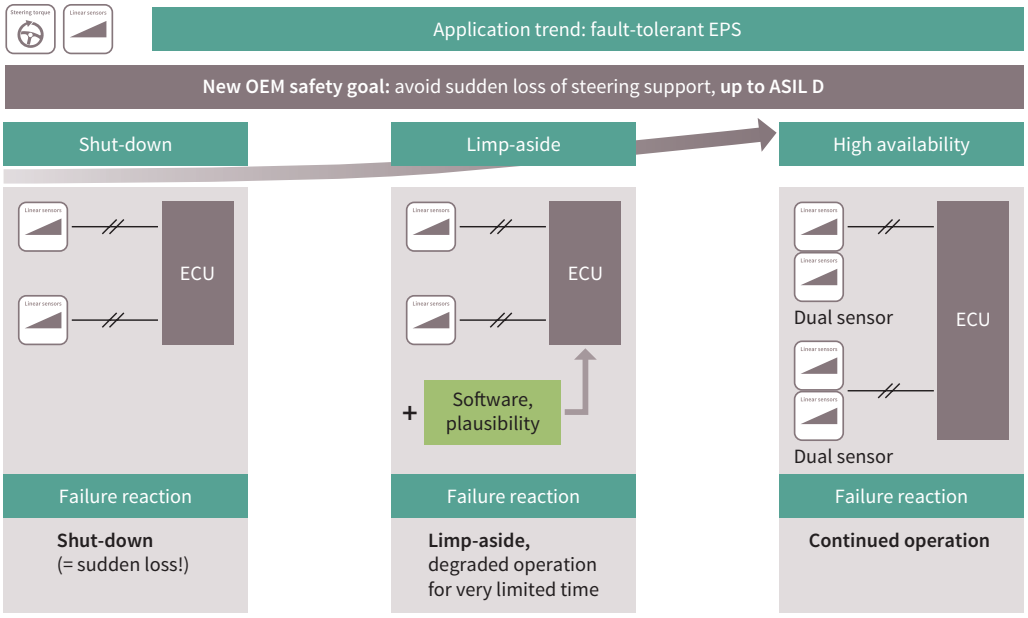
Magnetic position sensors for the ultimate in energy efficiency and functional safety in Electric Power Steering (EPS)

Magnetic torque sensing assembly



Conventional EPS systems, which use two linear Hall sensors for ASIL D compliance, have to shut-down in the event of a loss of one sensor signal. Therefore, the trend in EPS systems is to increase availability by implementing additional sensor signals or plausibility mechanisms.
To support this trend towards high-availability EPS functionality, Infineon recommends the usage of two TLE4998xD dual-sensors or two TLE4999x, each of them with two highly accurate redundant Hall measurement channels (main and sub) integrated on one single chip. In case of one TLE4998xD or TLE4999x signal loss, the remaining dual-sensor (TLE4998xD) or the single die two channels (TLE4999x) in the system provides continued operation of the EPS, avoiding an immediate system shut-down.

Application trend: high availability



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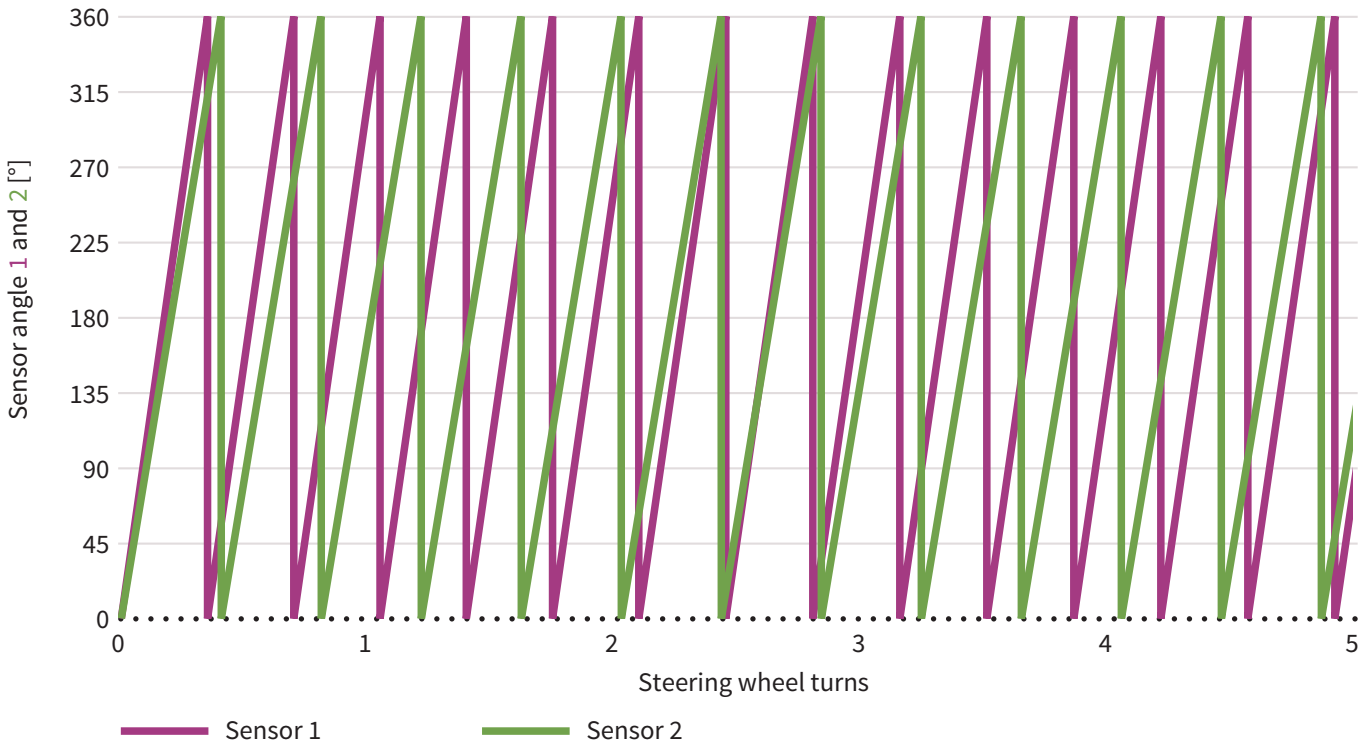
Steering angle sensors

The absolute steering angle position is an input for the Electric Stability Program (ESP) and other driver assistance systems. A typical module design used for steering angle measurement is a design featuring gear wheels with a slightly different number of tooths. The angular positions of the gear wheels are measured by two angle sensors, where the absolute steering wheel position is calculated from those positions via the Vernier principle.

Schematic steering angle sensor module and illustration of the Vernier principle



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Steering angle sensors

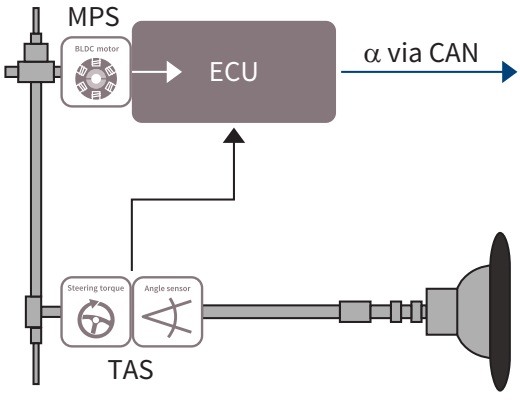
The angle sensors for absolute steering angle measurement are available as a single-sensor SMD package for conventional designs, which achieve the ASIL D rating via a plausibility calculation of the two angle sensor signals as a result of a significant movement of the steering wheel.

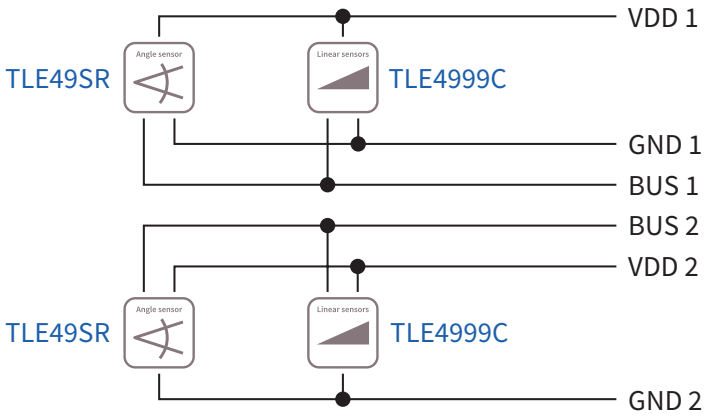
The sensors are also available in dual-sensor packages for module designs, that support an ASIL D-rated steering angle directly at power-on (ASIL D from start).

TLE5009(D)	Fast Giant-Magneto Resistive (GMR) angle sensor with analog sin/cos output. Available in an 8-pin single, 16-pin single- and dual-sensor SMD package.
TLE5109A16(D)	Fast Anisotropic Magneto Resistive (AMR) angle sensor with analog sin/cos output. Available in an 8-pin single, 16-pin single- and dual-sensor SMD package.
TLE5014(D)	ISO 26262-compliant (ASIL C-metric), programmable GMR angle sensor with PWM, SENT or SPC output. Supports Torque-Angle-Sensor (TAS) module bus configuration with TLE4998C. Available in a 16-pin single- and dual-sensor SMD package.
TLE5501	ISO 26262-compliant (ASIL D-metric) Tunneling Magneto Resistive (TMR) angle sensor with analog sin/cos output. Available in an 8-pin single SMD package. Decoupled bridges for redundant external angle calculation and highest diagnostic coverage.
TLE49SR(D)	ISO 26262-compliant (ASIL C-metric) Stray field robust Hall angle sensor with PSI5, PWM, SENT or SPC output. Supports Torque-Angle-Sensor (TAS) module bus configuration with TLE4999C. Available in a 3-pin leaded or 8-pin single- and dual-sensor SMD package. Planned middle of CY2023

Infineon angle sensors support steering angle sensor configurations with an on-board microcontroller, as well as satellite sensor designs, due to a broad variety of supported communication interfaces. In particular, the SPC interface allows the connection of angle sensor(s) and linear Hall sensor(s) on a bus line in combined Torque-Angle-Sensor (TAS) modules. Compared to conventional designs with separate torque sensor and angle sensor modules, this configuration reduces the cost of wiring and saves module space.

Schematic TAS module set-up and SPC bus configuration of the TLE49SR and TLE4999C

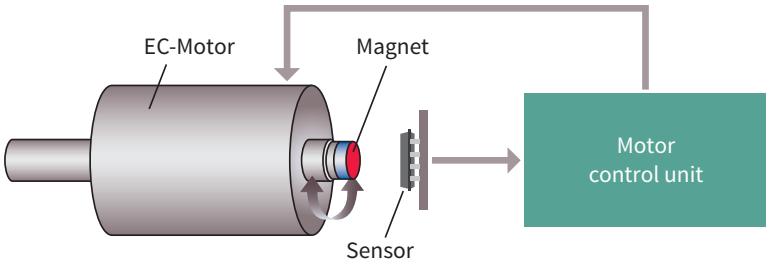




EPS rotor position sensors

The motor, that drives the steering rack in an EPS system is usually a highly efficient brushless DC (BLDC) motor, which relies on a fast and accurate position sensor for commutation. In this application, short latency and high accuracy are essential, as these sensor parameters have a significant impact on torque stability and the energy efficiency of the motor.

Schematic of BLDC motor with a magnetic position sensor for commutation



A correct commutation of the EPS motor has to be ensured, in order to avoid a blocked steering or the erratic steering support. This application is also classified in the category of ASIL D. To achieve this high level of functional safety, Infineon offers angle sensors in the dual-sensor package that allow the integration of two redundant sensors in the place of one.

The TLE5309D, in particular, meets the highest functional safety requirements by using a combination of AMR (Anisotropic-Magneto-Resistance) and GMR (Giant-Magneto-Resistance) technology, which not just offers redundancy, but also integrated diversity in a single product.

Depending on the overall EPS system architecture, the motor position sensor can be directly mounted on the steering ECU, or connected via a cable in a satellite configuration.

The very high level of sensor accuracy required for highest energy efficiency, comparable to the performance of costly resolver solutions, is typically achieved by implementing a continuous calibration algorithm on the steering ECU. By monitoring the sensors output signals and calculating the compensation parameters during operation, this algorithm compensates any drift that occur over temperature and lifetime.

TLE5009A16(D)	Fast dual-GMR angle sensor with analog sin/cos output. Available in a 16-pin dual-sensor SMD package.
TLE5109A16(D)	Fast dual-AMR angle sensor with analog sin/cos output. Available in a 16-pin dual-sensor SMD package.
TLE5309D	Combined AMR and GMR sensor for integrated diversity, featuring fast analog sin/cos output. Available in a 16-pin dual-sensor SMD package.
TLE5012BD	Digital GMR angle sensor with SPI + incremental encoder interface or Hall switch emulation output. Available in a 16-pin dual-sensor SMD package.

New challenges for engine sensors in hybrid powertrains

The prospect of emissions penalties as of 1 January 2021 is prompting many manufacturers to switch to lower-carbon drive systems. Electric cars have become a key talking point on everyone's agenda – especially in California, where a very promising startup recently (February 2020) secured a higher market capitalization than the biggest European car manufacturer.

But there is a wide playing field between conventional combustion engines and all-electric cars, presenting less radical pathways towards achieving the EU fleet-wide average emission target for new cars of 95 g CO_2/km. Scaling from models with a 12 V belt starter generator through integrated 48 V starter generators to high-power 400 V drives, hybrid cars have the potential to drastically reduce noise in urban areas.

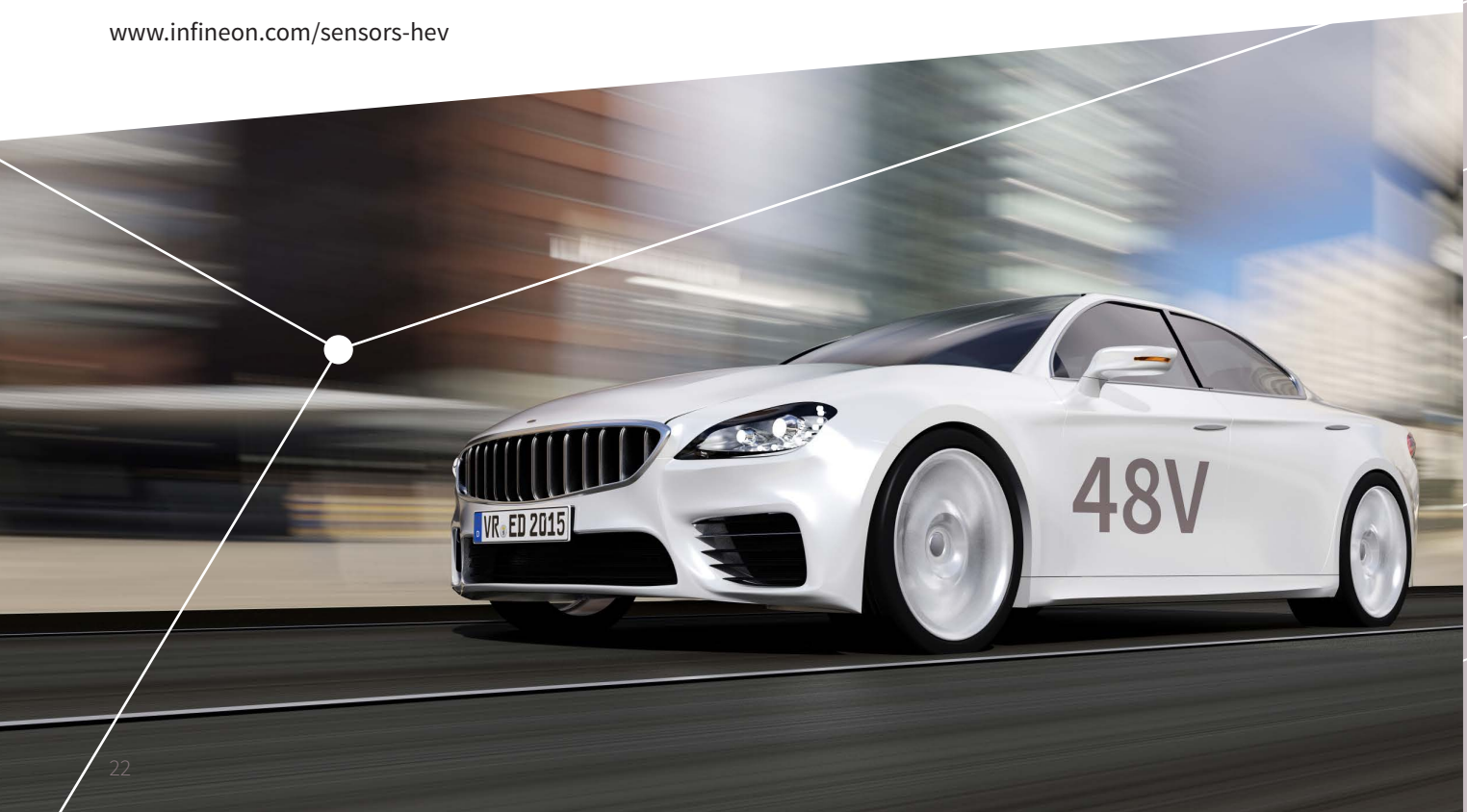
Combustion engines in these hybrid cars face a number of specific challenges when the car is being driven by the electric motor. We will be taking a closer look at them in this article. Time to explore the many additional functions a single crankshaft sensor has to fulfill in a hybrid motor…

Car manufacturers across the globe are expanding their portfolio of drive systems. Even looking beyond the fuel cells and synthetic fuels of tomorrow, there is still a huge number of hybrid options spanning the gap between combustion engines and electric motors.

These options range from stop-start combustion engines, where the motor shuts off for a few seconds at a red light and then cold starts, to plug-in hybrids that can easily drive 50 kilometers in all-electric mode before the combustion engine kicks in as the battery runs low or the vehicle is travelling at high speeds on a highway.

Two different implementations of even the most recent stop-start systems have already been brought to market. In one instance, the combustion engine starts again as if it had not been driven for an hour. The second solution monitors the movement of the engine as it comes to a stop, so when the engine starts up again, the car already knows the position of the crankshaft and the next cylinder to be fired. If we look at the starter generator attachment points on the drive shaft, or the points where the clutch connects different motors to the drive axle, we quickly see that the combustion crankshaft assembly options are virtually limitless.

www.infineon.com/sensors-hev



Drive interplay as experienced by the driver

To maximize acceptance of new electric drive systems, manufacturers must win over former combustion enthusiasts with ease of operation and a predictable, smooth driving experience free of “nasty surprises”.

It’s important that a combustion engine can spring smoothly and almost imperceptibly into action – as already experienced at traffic lights or in traffic jams in start-stop mode. Here, it is essential that the car knows the angle of the crankshaft at all times. If the car stops for three minutes in a traffic jam, the crankshaft sensor is able to ignore a slight temperature drift or, ideally, compensate for it. During a 30-minute drive on rough roads with a crankshaft that is free to move when decoupled from traction wheels, however, the sensor could incorrectly count a slight shake or vibration of a tooth or, in the worst case, interpret these movements as a new, valid signal.

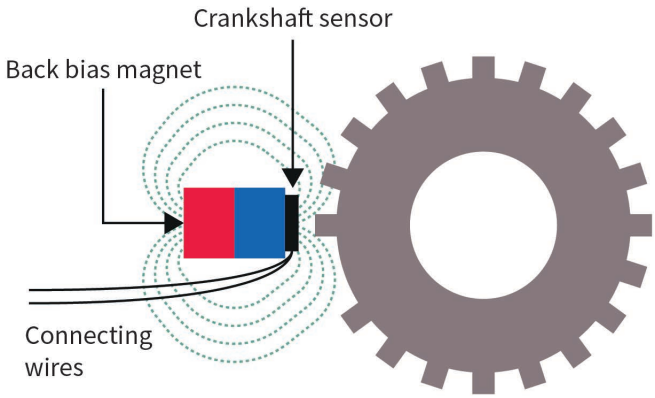
To ensure a combustion engine can glide into action, it is important that the sensor does not incorrectly count any of the teeth moving past it. It is imperative that the sensor:

- Does not miss any teeth
- Does not count any additional teeth
- Does not mistake the rotational direction

These criteria are broken down inside the crankshaft sensor as there is basically a magnet inside the sensor housing and the field lines of this magnet are modulated by the teeth as they spin past.

As such, the sensor’s performance is ultimately determined by fluctuations in magnetic field strengths. And these are dependent on a number of factors including the air gap between the sensor and the trigger wheel and the temperature. To ensure we do not get sidetracked by the various mechanical and electrical details, this paper focuses primarily on the mechanical components that are relevant to the sensor’s performance.

Diagram of a sensor module



The following is a list of functions that help sensors to accurately count teeth.

The conventional stop-start algorithm

The “smallest” solution for reducing fuel consumption involves switching off the engine. It is already widely deployed and available as a conventional stop-start algorithm. This function is able to correctly interpret short stops in congested traffic or at red lights and can compensate for small temperature drifts.

Magnets are subject to very strong temperature drifts, which can change the magnetic field by up to 40 percent over the given temperature range. In the case of crankshafts with well-fitting bearings, the next most significant factor to impact sensor behavior is electrical in source. Number three in the lineup are changes in the air gap between the trigger wheel on the crankshaft and the sensor module on the engine block.

Ideally, the sensor remains fully calibrated and when the combustion engine starts again, it is able to correctly output the position and rotational direction of the crankshaft as soon as the first tooth of the trigger wheel spins past. This functionality can be implemented without any modi-

fications to the architecture of a combustion engine. All it requires is a slightly larger starter battery and starter motor and modifications to the software in the controller.

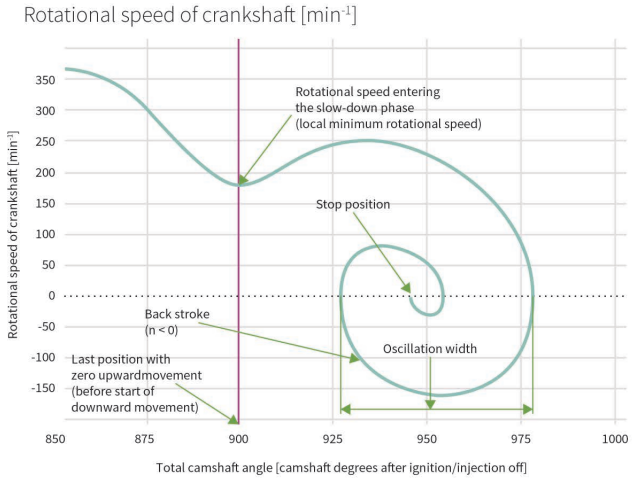


Diagram of the crankshaft coming to rest when ignition is shut off [1]

Figures 2 and 3 show how the disengaged crankshaft comes to a stop when the ignition is turned off as well as the quickest possible start for an Otto engine when compressed air is still in the cylinder (known as a direct start).

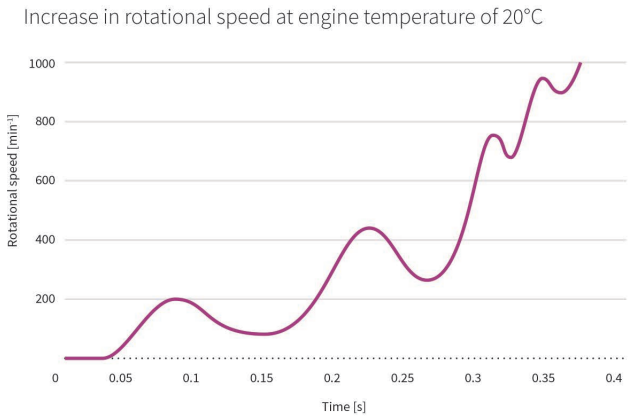


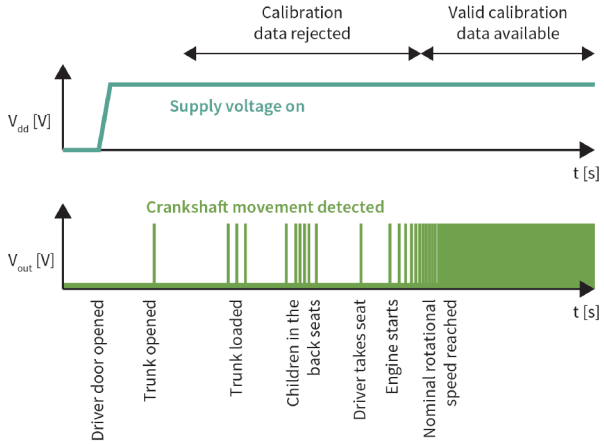
Diagram showing how a crankshaft starts turning again after a direct start [1]

Vibrations while stationary

Modern cars carry out a range of self-diagnostic checks as soon as the driver's door is opened. This reduces the amount of time it takes for a warning lamp to light up. A lot of other things can happen, however, from the moment the car door is opened to the time the car pulls away. The car can be loaded, for example, or children have to be buckled into their seats. As such, it is completely normal for the car to rock slightly while stationary. These slight movements travel through the drive wheels, transmission and clutch and cause the crankshaft trigger wheel to turn. In some unfortunate situations, this can result in the crankshaft sensor picking up a valid magnetic signal.

To overcome this issue, an algorithm has been implemented in the sensor to delete calibration data generated before the engine is switched on.

If we take just a brief look at the wide range of hybrid architectures, it quickly becomes clear that this add-on function will help car manufacturers to identify and ignore any inaccurate calibration data.

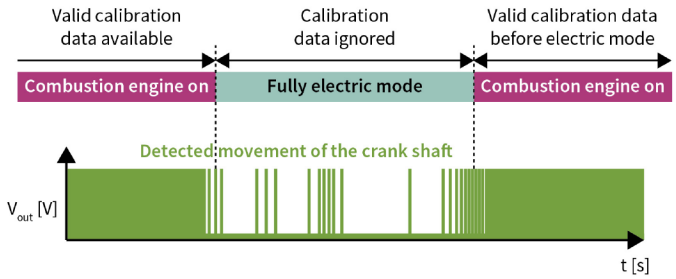


Signal output by the crankshaft sensor when a car is being loaded

As figure 4 shows, we can draw several conclusions from the sensor's output signals over time. Firstly, we can see that the nominal rotational speed was not reached as soon as the sensor was activated. Consequently, the calibration data gathered up to the time where the nominal rotational speed was achieved can be reset without difficulty. Secondly, we see that this procedure can be repeated multiple times if the sensor does not identify a tooth for a certain period of time.

Hybrid algorithm

A new function is required for a "big" plug-in hybrid solution. To correctly identify the position of the crankshaft trigger wheel, an algorithm has been implemented in the sensor that detects slower, sub-nominal crankshaft rotation and, in conjunction with other monitoring functions, prevents incorrect calibrations. New calibration data is only accepted when the system is operating normally.



Signal output by the crankshaft sensor when driving in electric mode

This function enables every crankshaft vibration to be captured with the corresponding signals for forward and backward movement without the crankshaft sensor incorrectly responding to supposed changes to the mechanical setup such as a shift in the air gap or some other mechanical misalignment.

Collectively, the algorithms named here enable the movements of the crankshaft trigger wheel to be accurately observed and tracked. The engine control unit knows at all times which stroke each piston is on and how much time is left until the next ignition (based on the crankshaft angle). If the algorithms are correctly aligned, the system will operate correctly, ensuring that the engine warning light stays off.

Improved crankshaft sensor enables other components to last longer

As the crankshaft sensor always provides reliable information, the sizing of components required to restart the combustion engine can be reduced. The starter generator usually turns the crankshaft for several rotations until the home position of the crankshaft has been detected and a minimum rotational speed in excess of several hundred rotations has been reached. With an advanced crankshaft sensor, the fuel can be injected and ignited in just half a rotation. Starting the engine in this way requires only a fraction of the battery energy needed for a cold start. Manufacturers can thus choose between a longer service life for the starter and battery, or size down and save costs and weight, which – in turn – translates into a slight drop in consumption.

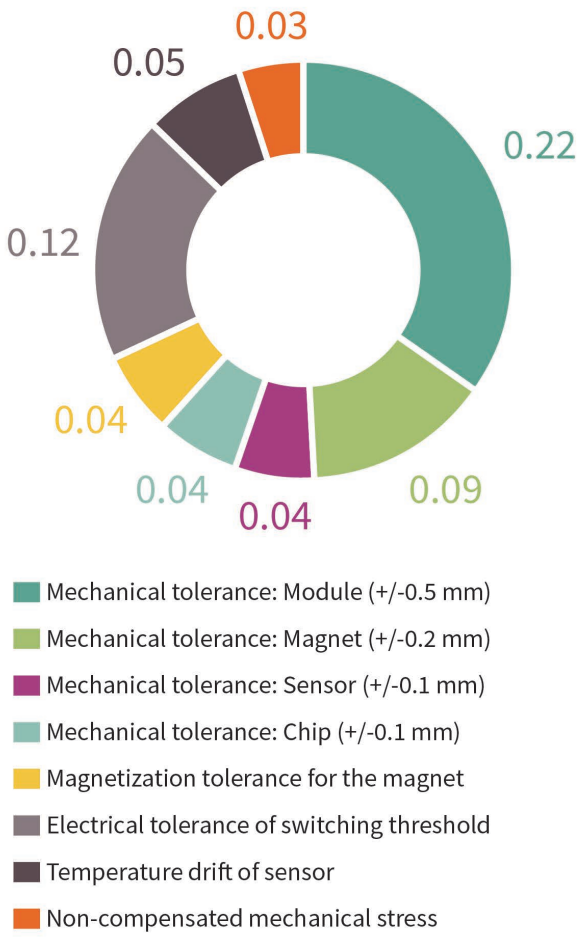
This design also enables a great driving experience as the combustion engine starts easily and smoothly without creating any negative impressions.

More precise switching points with differential camshaft sensor

As part of its XENSIV™ family of sensors, Infineon Technologies has developed active Hall sensors specifically for camshaft and crankshaft applications. These devices can help to optimize the drive experience while extending service life. Installed on the camshaft, the XENSIV™ TLE4929C, for instance, can compensate for production and assembly tolerances on the supplier and manufacturer sides thanks to its programmable switching threshold. This ability means that this position sensor improves angle accuracy on both on the camshaft and the crankshaft.

First of all, it should be noted here that differential Hall sensors, by their very physical nature, only switch when the centerline of the tooth is in front of the sensor. Starting from the centerline of the tooth and moving out, the following tolerances must be taken into account:

- Mechanical tolerances on the tooth itself cause the magnetic center to deviate from the mechanical center
- Mechanical assembly tolerances for the module on the engine block account for the largest deviation
- Mechanical installation tolerances for the magnet and sensor in the module also have to be added
- It goes without saying that the installed magnets are not 100% homogenous; nor are they magnetized at a perfect 90° angle
- Finally, there are also electrical tolerances within certain limits that are attributable to the sensor manufacturer.



Breakdown of position errors by category

Systematic errors are compensated for by the engine control unit and are not included in the above list. They include signal propagation delays, which are already accounted for in the control unit's timer.

All of the components listed above result in a random error, which at best resolves itself but, at worst, can represent a massive fault. To meet the accuracy requirements of today's systems, modern sensors allow switching thresholds to be individually set. The module manufacturer can do this at relatively low cost by individually calibrating the switching point of the module at the end of the production process. It can also be done on the dry engine itself at a slightly higher cost.
The benefit for the car manufacturer here is that the calibration also compensates for their own production tolerances. In contrast, the tier 1 supplier can only compensate for the module itself; the OEM's installation error is not mitigated at all.

A cost-benefit analysis for the required tolerances and resulting calibration cost is advisable.

The actual calibration process is very simple:
At a mid-point in the switching threshold, suitable systems are used to measure the misalignment between the mechanical center of the tooth and the actual electrical edge. After this, the systematic errors are subtracted and the remaining offset is programed and permanently stored in the sensor as the programmable switching threshold.
As shown in figure 6, this method can be used to eliminate nearly all sources of error and improve the overall accuracy from ±0.6° camshaft to ±0.1° camshaft.

Summary

The combustion engine has had its day. From 2020 to 2025, all major car manufacturers worldwide will develop and launch their last hybrid platforms. After this, even the last remaining development engineers working on combustion engines and possibly also transmissions will have to find a new home in the emerging fields of fuel cell, battery and electric drive technologies.
The combustion engines developed today will be around for several decades to come. As such, it is vital that the technology used in these models is reliable, long-lasting, and up to date. Luckily, the challenges that hybrid engines and, in particular, crankshaft and camshaft sensors face in these systems are already known and being successfully addressed by Infineon.

Overview of Infineon XENSIV™ crankshaft sensors

- TLE4929C-XAx – first-generation low-jitter, Hall-based crankshaft sensor.
- TLE4929C-XVA – second generation includes several further crankshaft protocols (by number 14) and a time watchdog to overcome start-up vibrations. In addition, this device is available with nickel plating for the first time.
- TLE4929C-XHA – third generation includes an additional dedicated hybrid watchdog and a new calibration feature to meet increased absolute phase accuracy requirements.

www.infineon.com/sensors-hev

XENSIV™ sensors in smart industry

Proximity detection

Control elements

Gear wheel speed sensor

Rear/tear and vibration detection

Predictive maintenance

Pneumatics

Robot BLDC and position sensing

Robot sensing
Tank level measurement

Tank/fluid level sensing

Electric Commutated (EC) motor

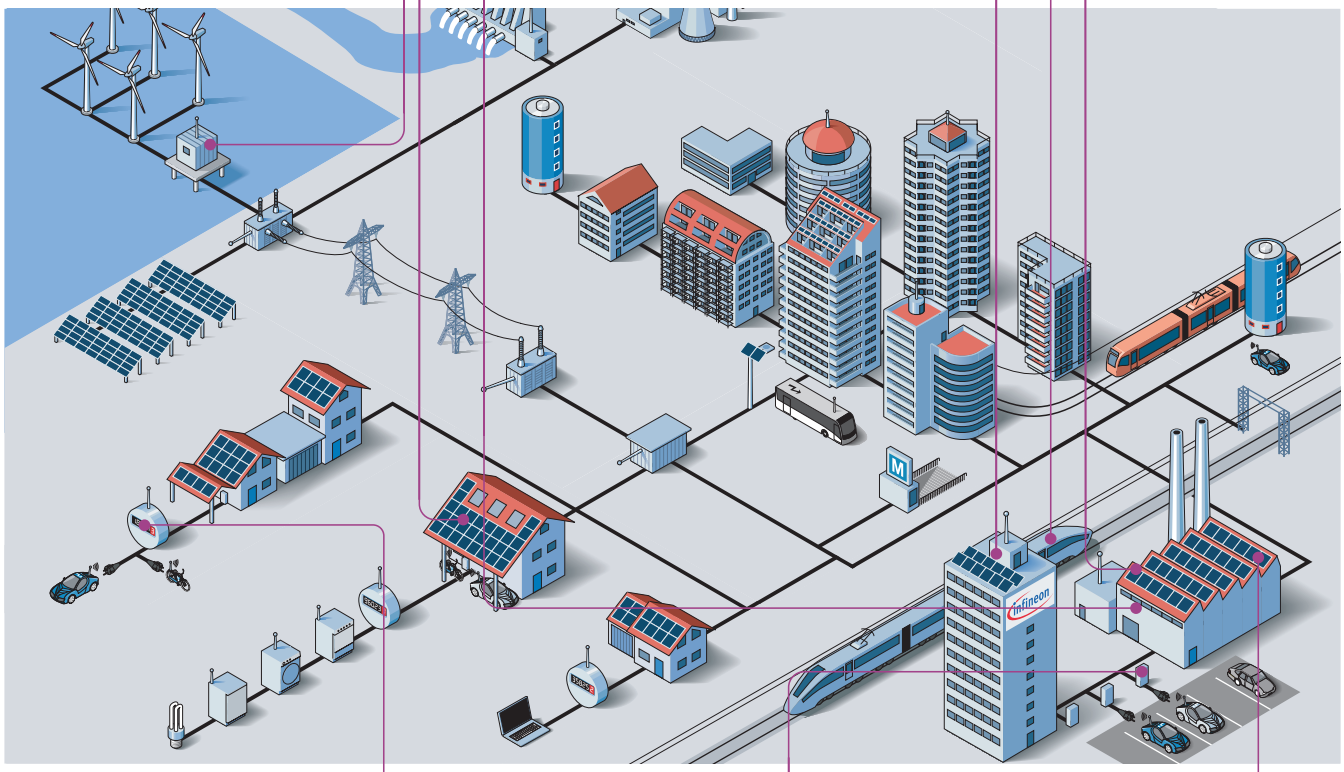
Valve position

Solar panel tracking

Solar inverter current

Barometric pressure sensing

Wind speed sensing



Smart metering

Smart fuses

Charger and battery management

Plug detection in chargers

Absolute and incremental rotary encoder

Switches

Linear sensors

Angle sensors

Current sensors

Speed sensors

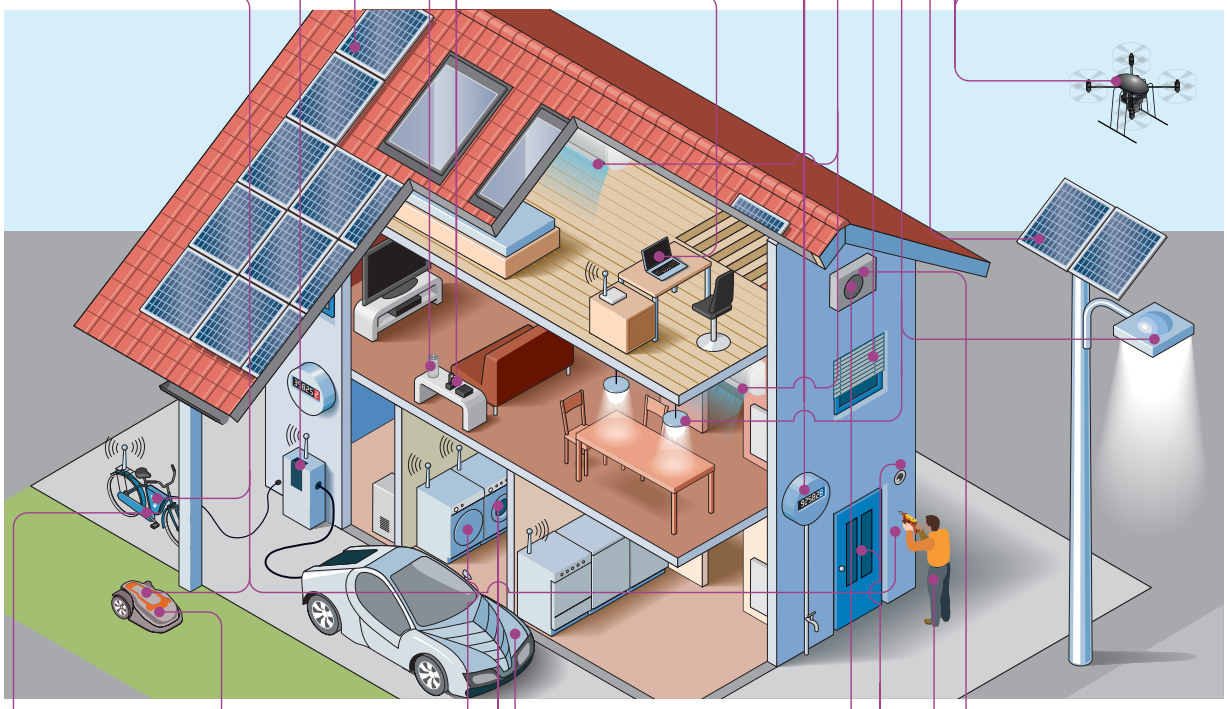
Pressure

Radar

MEMS microphones

3D magnetic sensors

XENSIV™ sensors in smart homes



Flap position/
Control elements

Indoor air quality CO_2 measurement/
Temperature and air flow management/
Predictive maintenance in smart HVAC systems

Proximity sensing for
smart home devices/
Voice user interfaces/
Recording/
Active noise cancellation/
Predictive maintainance

Gas pressure

Smart fuses

Smart
metering

Solar panel tracking/
Solar inverter/
AC and DC current
distribution and monitoring

Position tracking
Index counting

Battery charging
and management

People tracking and
occupancy detection
in IoT/smart home

Electric
commutated
motor

Privacy protection
for laptops with
presence sensing

Window contacts

Intrusion detection

Indoor and outdoor
lighting systems

Battery management
and current monitoring

Robots BLDC
and
joints/arms
position

Drone camera
gimbal

Air flight control

Collision avoidance in
multicopters and robotics

Proximity sensor
to activate appl.

Rear and side
detection
for bicycles

Open/close detection

Collision
avoidance

Imbalance and
state of charge

3D collision
detection
(e.g. Husquarna)

Water level sensing

Presence detection &
zoning with radar/
Voice control with/
MEMS microphones/
Predictive maintenance
for HVAC systems

BSD (Blind Spot Detection)
in the car

Door contacts etc.

Air flow control for ACs
with segmentation

Sensing of vital
functions

Smart locks

Automatic door opening
systems

Intruder alarm/Presence
detection in surveillance

Switches | Linear sensors | Angle sensors | Current sensors | Lighting | Pressure

Radar | MEMS microphones | 3D magnetic sensors | CO_2 sensor

www.infineon.com/smarthome

XENSIV™ sensors in smart building

Smart lighting
Presence detection/
People flow monitoring/
Enabled room segmentation

Circuit breaker
State monitoring

Surveillance cameras
Presence detection for switching camera on & off/
Perimeter monitoring outside of the building

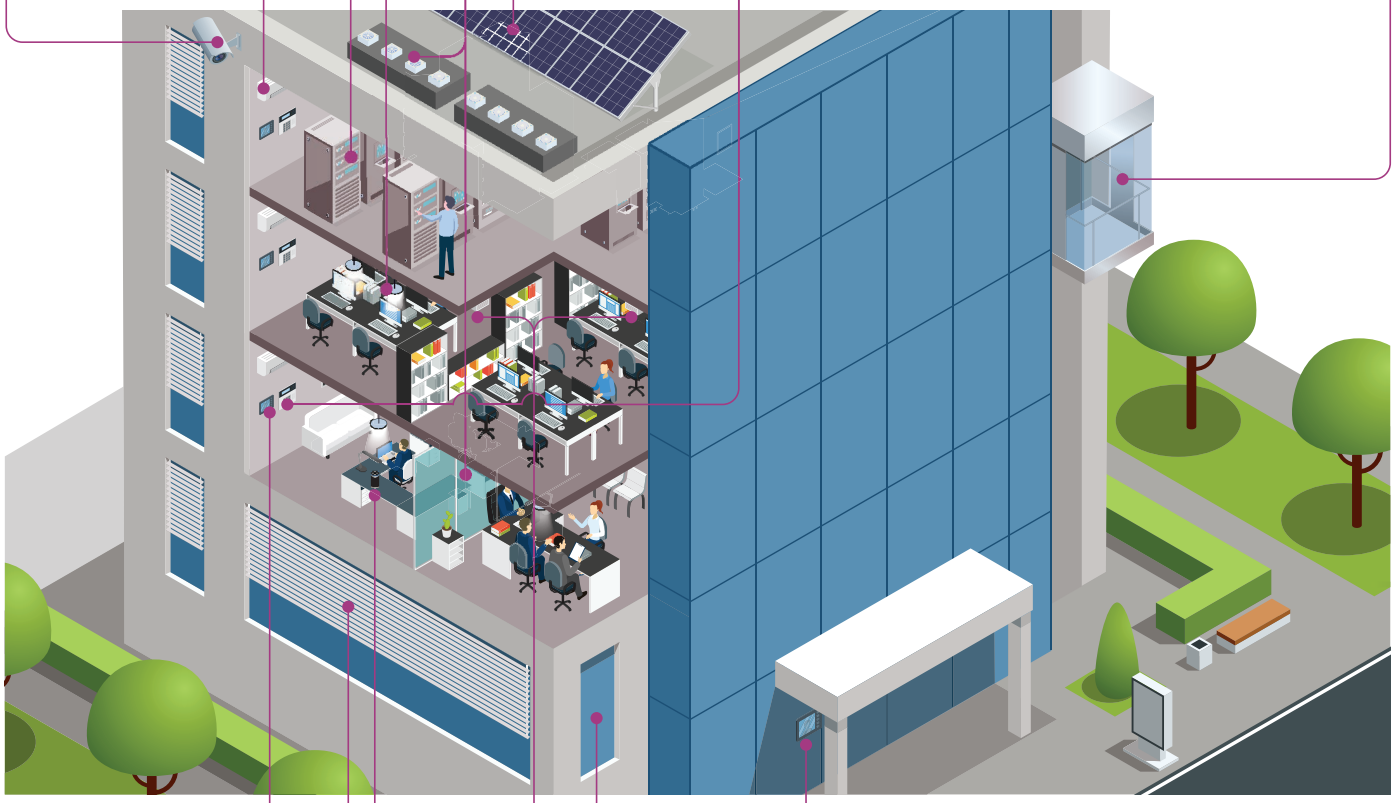
HVAC
Air-flow measurement/
Current sensing at motor and compressor/
Vibration monitoring at compressor/
Noise level monitoring/Indoor air quality monitoring/
Monitoring of motor position/Presence detection

Elevators & escalators
Condition Monitoring & Predictive Maintenance/
Motor position detection/Door position detection/
Device power monitoring/Current sensing at motor and compressors

Smart metering
Anti-tampering protection/
Current measurement/Flow metering

PV Moduls

Smart fuses



Shutters
Position detection

Voice control & VUI
Audio/Presence

Access control
Security systems/Open/close detection

Intrusion detection
Glass break/Presence detection

Room automation
Presence detection/Indoor air quality monitoring/
Noise level monitoring

Switches
Linear sensors
Angle sensors
Current sensors
Lighting
Pressure
Radar
MEMS microphones
3D magnetic sensors
CO_2 sensor
Presence detection

www.infineon.com/smartbuilding

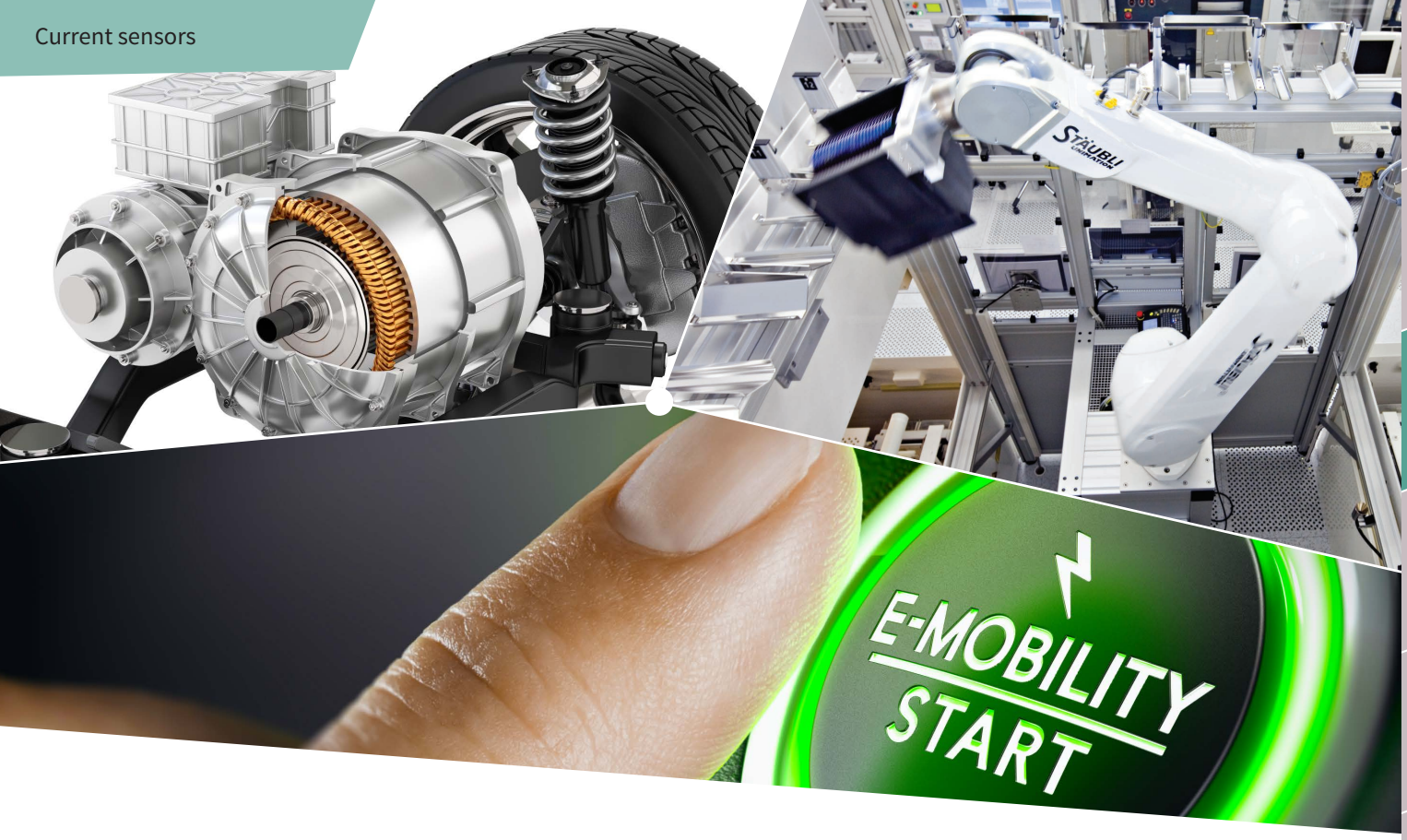
2-wheeler and all-terrain vehicles

Increasingly strict emissions legislation in many countries is also driving demand for efficiency-enabling semiconductor solutions in the small 1- to 2-cylinder combustion engine segment. Looking beyond standard carburetors, customers are increasingly looking for more electrified solutions, ranging from enhanced carburetors to full EFI (Electronic Fuel Injection).

As the market leader in automotive electronics, Infineon is ideally positioned to meet growing needs for fuel-efficient solutions through a wide range of microcontrollers, XENSIV™ sensors, power supplies, transceivers, driver ICs, MOSFETs, IGBTs as well as fully integrated U-chip solutions.
www.infineon.com/cms/en/applications/consumer/light-vehicles/

Commercial, construction and agricultural vehicles (CAV)

As a supplier of semiconductor and system solutions, Infineon constantly develops innovative and efficient solutions. Keeping up with the latest market trends in commercial, construction, and agriculture vehicles (CAV), requires increasingly eco-friendly products and solutions. Especially for CAVs that must operate at the highest possible availability and the lowest possible total cost of ownership (TCO).
Semi- and fully-autonomous technologies make CAVs safer for operators while also being more efficient and precise. Machines that run 24/7 with no downtime. Tractors that independently navigate their surroundings and react based on data they collect. Such machines literally leave fully human-operated systems in the dust. At the same time, electrification is becoming an increasingly attractive option for CAVs. But electrification is not limited to the main drive alone: Hydro-electric or full electric power steering, actuators for lifting, tilting and positioning the fork will reduce the need for energy consuming continuously running hydraulic systems. Joysticks and controls using magnetic sensors will significantly enhance the reliability and longevity of the systems, electrically adjustable and actuated seats, the drivers comfort. All these systems will experience extended lifetime and higher accuracy by using Infineon´s range of Hall switches, 3D magnetic , angular and linear Hall sensors. Manufacturers rely on electric drivetrains to comply with the latest emissions and energy regulations. At the same time, operators use electrification to boost higher process efficiency and yields.
www.infineon.com/cav



XENSIV™ – high-precision coreless current sensors for automotive and industrial

Used to measure both AC and/or DC currents, Infineon's current sensors provide accurate and stable current measurement up to 120 A or 31 mT respectively. Our magnetic current sensors include either an integrated current rail in the package for low currents or measure the magnetic field of an external current rail for medium to high currents. The products are intended for use in 48 V, as well as high voltage and/or wide bandgap applications such as traction inverters, industrial drives, photovoltaic inverters, or EV charging systems.

Infineon's XENSIV™ family of high-precision coreless open-loop current sensors are less bulky, and cost less compared to core-based current sensors. Based on Infineon's precise and stable Hall effect current sensor IC technology, the current sensor analog output signal is highly linear over temperature and lifetime. Due to lacking an iron core or a flux concentrator, the sensor signal shows neither hysteresis nor does it suffer from saturation.

The differential current sensor measurement with two Hall cells ensures high accuracy even in a noisy environment like crosstalk from adjacent current lines or magnetic stray fields. System designers can program the sensitivity of the sensor as well as the threshold levels of the two dedicated overcurrent signals and therefore adapt them to individual requirements without any external components. The contactless current sensor IC also provides a warning signal in case of an over- or under-voltage condition for the supply voltage.

Product Portfolio

Infineon's product portfolio includes wide bandgap current sensors for both industrial and automotive application needs. Our current sensors achieve high accuracy using the Hall effect, which enables current measurements from DC to AC with an internal bandwidth of up to 240 kHz without being disturbed by external magnetic fields.
On the one hand, we have the current sensors with an integrated current rail. The sensors in the TISON package allow the accurate measurement with high frequencies and small impact on the phase shift of the current signal. On the other hand, our current sensors for external current rails are non-invasive Hall effect current sensors and provide safe and reliable solutions for power electronics since there is no additional power dissipation. Our selection of isolated, non-contact current sensors can be used for current detection and monitoring in SiC and GaN applications, including motor control applications.

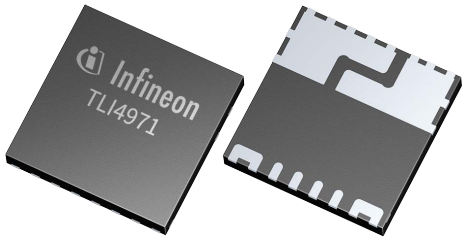
www.infineon.com/current-sensors

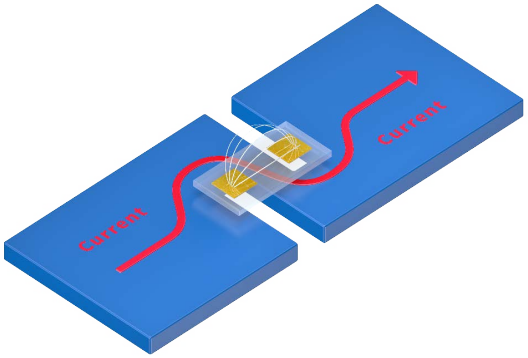
TLI4971

High-precision coreless sensors for industrial applications

Features

- Integrated current rail with typical 220 µΩ insertion resistance enables ultralow power loss
- Small form factor, 8×8 mm SMD, for easy integration and board area saving
- Highly accurate, scalable, DC and AC current sensing
- Bandwidth of 240 kHz enables wide range of applications
- Very low sensitivity error over temperature (< 2.0%)
- Excellent stability of offset over temperature and lifetime
- Galvanic functional isolation up to 1150 V peak V_{IORM}, partial discharge 3500 V_{RMS}, 4 mm clearance and creepage
- Differential sensor principle ensures superior magnetic stray field suppression
- Two independent fast over-current detection (OCD) pins with configurable thresholds enable protection mechanisms for power circuitry (typical 0.7 µs)
- Pre-calibrated sensor





Applications

- Energy storage systems
- Electrical drives (up to 975 V_{pk})
- Photovoltaic inverter
- General purpose & GaN-based inverters
- Chargers
- Power supplies

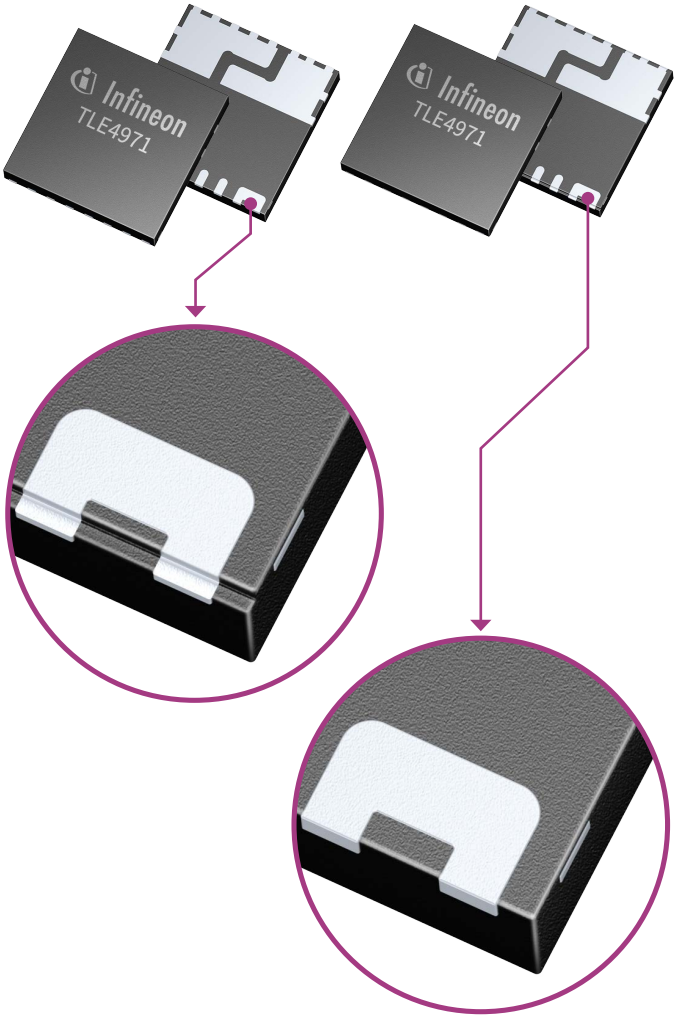
TLE4971

High-precision coreless current sensor for automotive and industrial applications

The Infineon TLE4971 is a high-precision current sensor for bi-directional AC and DC measurements. The device has an analog interface and two fast overcurrent detection outputs that support the power circuitry's protection. Galvanic isolation is provided due to magnetic sensing principle.

Infineon's well-established and robust monolithic Hall technology enables accurate and highly linear measurement of currents with a full scale up to 120 A. Negative effects, like saturation and hysteresis, commonly known from core-based sensor techniques, are not present in the Infineon open loop, coreless sensors principle. The smart current rail design (double U-shape) combined with a differential signal sensing makes the current sensor robust against stray fields. The sensor is shipped as a fully calibrated product without requiring any customer end-of-line calibration. It comes in a small 8×8 mm TISON-8 leadless package, which allows standard SMD assembly. The sensor can be reprogrammed for many parameters enabling the customer to achieve maximal adaption for his application requirements, such as industrial drives, xEV auxiliary drives, PV inverter, DC fast charger and on-board-charger (OBC).

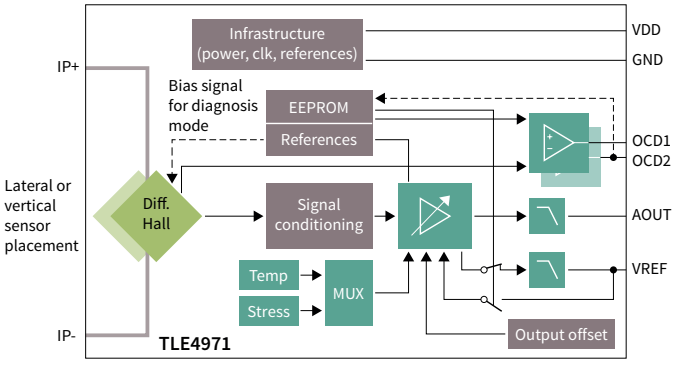
Difference between TISON-8-6 and TISON-8-5



Features and benefits

Key features	Key benefits
› Measurement up to 70 A_{RMS} at 690 V_{RMS}	› Ultra-low power loss due to minimal resistance of current rail
› Typical error at 25°C < 2%	› Reliable current measurement over lifetime (no re-calibration)
› Current rail resistance at 220 µΩ and inductance <1 nH specified typ.	› Functional isolation for high-voltage application
› Analog output signal (with typ. 210 kHz) bandwidth	› Easy and compact package allows high-power density design
› Fast (<0.7 µs) overcurrent detection up to 2 x I_{FSR}	› Pre-programmed variants for 25, 50, 75 and 120 A
› AEC-Q100 Grade 1 qualified (125°C)	› High accuracy, low noise analog output

Block diagram



The integrated primary conductor (current rail) with very low insertion resistance and inductance minimizes the power loss and enables miniaturization of the sensing circuit. The analog output (AOUT) can be configured in single-ended, semi-differential, and fully-differential mode together with the voltage reference pin (VREF)
Two separate overcurrent pins (OCD1/OCD2) provide a fast output signal in case the current exceeds a pre-set threshold.

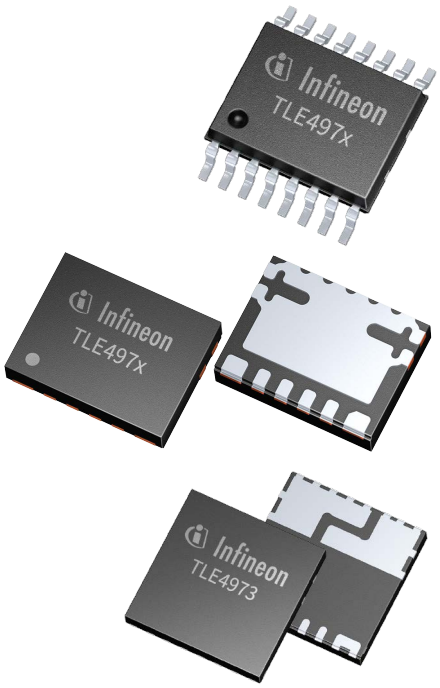
www.infineon.com/current-sensors

TLE4972 / TLE4973

High-precision core-less current sensors for automotive and industrial applications

The Infineon TLE4972 product family of core-less magnetic current sensors specifically addresses requirements for current sensing in automotive applications. The well-established and robust Hall technology enables accurate and highly linear current measurements of the magnetic field induced by the current. With its compact design and diagnosis modes, the TLE4972 is ideal for xEV applications like traction inverters used in hybrid and battery-driven vehicles, as well as for battery main switches.

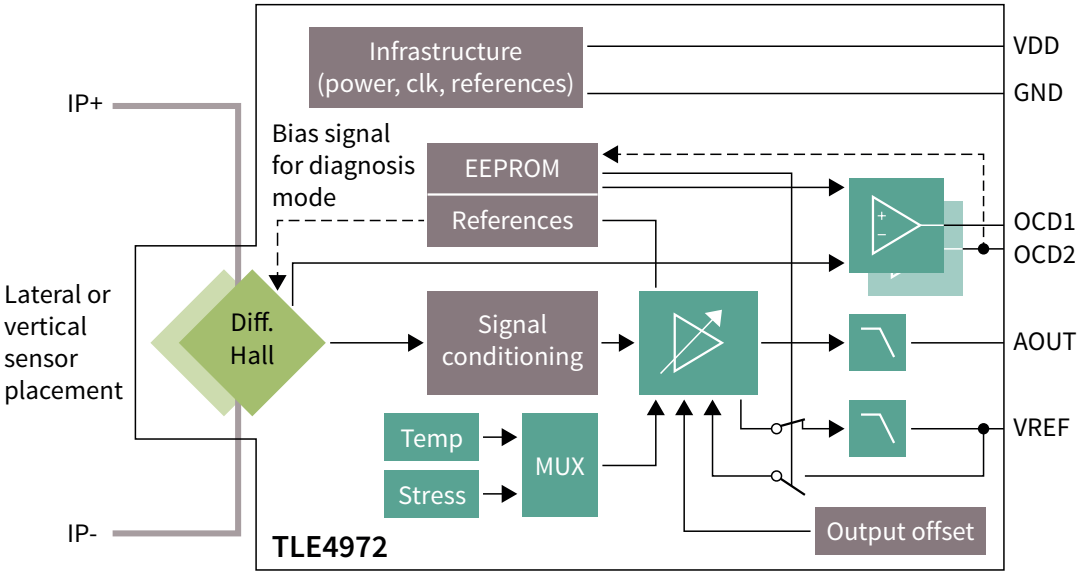
Infineon will expand the sensor portfolio with an new family of 5 V current sensors TLE4973. The new sensors will be available in three different packages to cover a wide range of applications in the automotive and industrial market. Target applications include traction inverter for xEV, auxiliary drives, PV inverter and on-board-charger (OBC).



Features and benefits

Key features	Key benefits
› Hall based coreless magnetic current sensor	› High accuracy up to 2 kA
› AC and DC sensing	› Very low error over temperature and lifetime
› Two dedicated pins for overcurrent detection	› Protection against overcurrent events for fast switching technologies, e.g. SiC
› Scalable sensitivity	› No saturation or hysteresis effects
› ISO 26262 compliant	› Very low power losses through sensing structure
› ASIL B as SEooC	› Ideal for platform designs
› Typical bandwidth of 210 kHz	› Fast reaction time of analog sensor output
	› Simplified functional safety assessment

Block diagram



www.infineon.com/current-sensors

Current sensors – overview

Product	Current range	Bandwidth typ. [kHz]	Sensitivity	Accuracy [%]	Output noise density	Certification	Industrial	ATV	Supply [V]	Current Rail	Package
TLI4971 family →											
TLI4971-A025T5-U-E0001	25 [A]	240	48 [mV/A]	< 2	350 [µA/√Hz]	UL1577/ IEC 62368-1	●	–	3.3	Internal	TISON-8-5
TLI4971-A025T5-E0001	25 [A]	240	48 [mV/A]	< 2	350 [µA/√Hz]	IEC 62368-1	●	–	3.3	Internal	TISON-8-5
TLI4971-A050T5-U-E0001	50 [A]	240	24 [mV/A]	< 2	350 [µA/√Hz]	UL1577/ IEC 62368-1	●	–	3.3	Internal	TISON-8-5
TLI4971-A050T5-E0001	50 [A]	240	24 [mV/A]	< 2	350 [µA/√Hz]	IEC 62368-1	●	–	3.3	Internal	TISON-8-5
TLI4971-A075T5-U-E0001	75 [A]	240	16 [mV/A]	< 2	350 [µA/√Hz]	UL1577/ IEC 62368-1	●	–	3.3	Internal	TISON-8-5
TLI4971-A075T5-E0001	75 [A]	240	16 [mV/A]	< 2	350 [µA/√Hz]	IEC 62368-1	●	–	3.3	Internal	TISON-8-5
TLI4971-A120T5-U-E0001	120 [A]	240	10 [mV/A]	< 2	350 [µA/√Hz]	UL1577/ IEC 62368-1	●	–	3.3	Internal	TISON-8-5
TLI4971-A120T5-E0001	120 [A]	240	10 [mV/A]	< 2	350 [µA/√Hz]	IEC 62368-1	●	–	3.3	Internal	TISON-8-5
TLE4971 family →											
TLE4971-A025N5-U-E0001	25 [A]	210	48 [mV/A]	< 2	260 [µA/√Hz]	UL1577/ IEC 62368-1	●	●	3.3	Internal	TISON-8-5
TLE4971-A025N5-E0001	25 [A]	210	48 [mV/A]	< 2	260 [µA/√Hz]	IEC 62368-1	●	●	3.3	Internal	TISON-8-5
TLE4971-A050N5-U-E0001	50 [A]	210	24 [mV/A]	< 2	260 [µA/√Hz]	UL1577/ IEC 62368-1	●	●	3.3	Internal	TISON-8-5
TLE4971-A050N5-E0001	50 [A]	210	24 [mV/A]	< 2	260 [µA/√Hz]	IEC 62368-1	●	●	3.3	Internal	TISON-8-5
TLE4971-A075N5-U-E0001	75 [A]	210	16 [mV/A]	< 2	260 [µA/√Hz]	UL1577/ IEC 62368-1	●	●	3.3	Internal	TISON-8-5
TLE4971-A075N5-E0001	75 [A]	210	16 [mV/A]	< 2	260 [µA/√Hz]	IEC 62368-1	●	●	3.3	Internal	TISON-8-5
TLE4971-A120N5-U-E0001	120 [A]	210	10 [mV/A]	< 2	260 [µA/√Hz]	UL1577/ IEC 62368-1	●	●	3.3	Internal	TISON-8-5
TLE4971-A120N5-E0001	120 [A]	210	10 [mV/A]	< 2	260 [µA/√Hz]	IEC 62368-1	●	●	3.3	Internal	TISON-8-5
TLE4971-A025T5-U-E0001[1)]	25 [A]	210	48 [mV/A]	< 2	260 [µA/√Hz]	UL1577/ IEC 62368-1	●	●	3.3	Internal	TISON-8-6
TLE4971-A025T5-E0001[1)]	25 [A]	210	48 [mV/A]	< 2	260 [µA/√Hz]	IEC 62368-1	●	●	3.3	Internal	TISON-8-6
TLE4971-A050T5-U-E0001[1)]	50 [A]	210	24 [mV/A]	< 2	260 [µA/√Hz]	UL1577/ IEC 62368-1	●	●	3.3	Internal	TISON-8-6
TLE4971-A050T5-E0001[1)]	50 [A]	210	24 [mV/A]	< 2	260 [µA/√Hz]	IEC 62368-1	●	●	3.3	Internal	TISON-8-6
TLE4971-A075T5-U-E0001[1)]	75 [A]	210	16 [mV/A]	< 2	260 [µA/√Hz]	UL1577/ IEC 62368-1	●	●	3.3	Internal	TISON-8-6
TLE4971-A075T5-E0001[1)]	75 [A]	210	16 [mV/A]	< 2	260 [µA/√Hz]	IEC 62368-1	●	●	3.3	Internal	TISON-8-6
TLE4971-A120T5-U-E0001[1)]	120 [A]	210	10 [mV/A]	< 2	260 [µA/√Hz]	UL1577/ IEC 62368-1	●	●	3.3	Internal	TISON-8-6
TLE4971-A120T5-E0001[1)]	120 [A]	210	10 [mV/A]	< 2	260 [µA/√Hz]	IEC 62368-1	●	●	3.3	Internal	TISON-8-6

1) Coming Q1 2023

Current sensors – overview

Product	Current range	Bandwidth typ. [kHz]	Sensitivity	Accuracy [%]	Output noise density	Certification	Industrial	ATV	Supply [V]	Current Rail	Package
TLE4973 family →											
TLE4973-A025T5-S0001[4]	27.5 [A]	210	65.5 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-A050T5-S0001[4]	55 [A]	210	32.8 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-A075T5-S0001[4]	82.5 [A]	210	21.8 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-A120T5-S0001[4]	132 [A]	210	13.7 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-R025T5-S0001[4]	27.5 [A]	210	65.5 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-R050T5-S0001[4]	55 [A]	210	32.8 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-R075T5-S0001[4]	82.5 [A]	210	21.8 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-R120T5-S0001[4]	132 [A]	210	13.7 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-R025T5-S0010[4]	27.5 [A]	210	65.5 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-R050T5-S0010[4]	55 [A]	210	32.8 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-R075T5-S0010[4]	82.5 [A]	210	21.8 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-R120T5-S0010[4]	132 [A]	210	13.7 [mV/A]	< 2	290 [µA/√Hz]	AEC-Q100	●	●	5.0	Internal	TISON-8-6
TLE4973-AE35D5-S0001[3]	34 [mT]	210	53[1] [mV/mT]	1.0	70 [nT/√Hz]	AEC-Q100	●	●	5.0	external	TDSO-16
TLE4973-RE35D5-S0001[3]	34 [mT]	210	53[1] [mV/mT]	1.0	70 [nT/√Hz]	AEC-Q100	●	●	5.0	external	TDSO-16
TLE4973-RE35D5-S0010[3]	34 [mT]	210	53[1] [mV/mT]	1.0	70 [nT/√Hz]	AEC-Q100	●	●	5.0	external	TDSO-16
TLE4973-AE35S5-S0001[2]	34 [mT]	210	53[1] [mV/mT]	1.0	70 [nT/√Hz]	AEC-Q100	●	●	5.0	external	VSON-6
TLE4973-RE35S5-S0001[2]	34 [mT]	210	53[1] [mV/mT]	1.0	70 [nT/√Hz]	AEC-Q100	●	●	5.0	external	VSON-6
TLE4973-RE35S5-S0010[2]	34 [mT]	210	53[1] [mV/mT]	1.0	70 [nT/√Hz]	AEC-Q100	●	●	5.0	external	VSON-6
TLE4972 family →											
TLE4972-AE35D5	31 [mT]	210	39[1] [mV/mT]	1.0	90 [nT/√Hz]	AEC-Q100	●	●	3.3	external	TDSO-16
TLE4972-AE35S5	31 [mT]	210	39[1] [mV/mT]	1.0	90 [nT/√Hz]	AEC-Q100	●	●	3.3	external	VSON-6

1) Can be reprogrammed by customer
2) Coming Q3 2023
3) Coming Q4 2023
4) Coming Q1 2024

Magnetic sensors

Exceptionally precise magnetic sensors comprising industry-leading switches, linear, angle, 3D and speed sensors

Infineon XENSIV™ sensors are exceptionally precise thanks to an industry-leading magnetic technology portfolio. Our benchmark and innovative magnetic sensor portfolio is the perfect fit for numerous customer applications in automotive, industrial and consumer markets. We offer all magnetic sensor technologies with in-house production, thus our customers can choose between Hall sensors, AMR (Anisotropic Magneto Resistive), GMR (Giant Magneto Resistive) or TMR (Tunnel Magneto Resistive) sensors in order to find their best-fit solution for their application. Infineon's XENSIV™ magnetic sensors combine highest-accuracy with proven quality and safety based on more than 40 years of experience in sensing solutions.

Generally, magnetic sensors measure the strength and/or direction of an applied magnetic field which is generated by e.g. ferromagnetic materials and magnets, inductive coils like in motors, etc. The information on the measured field is processed within the sensor and converted into strength, position, speed, angular and/or direction information. The processed sensor information is transmitted to the application via specific analog or digital interfaces. A wide range of sensors is equipped with additional safety and diagnostic features, and ISO 26262 compliant developed

Our portfolio includes a broad range of ISO 26262 compliant products meeting safety requirements as SEooC (Safety Element out of Context) up to the highest safety level of ASIL D, which are well perceived within the market and used in a wide range of automotive and industrial safety applications.

Magnetic switches

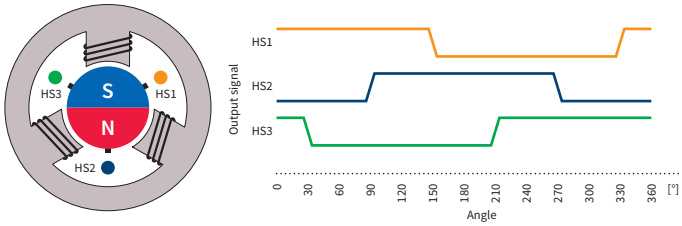
Broadest energy saving portfolio of high precision magnetic switches for automotive, industrial and consumer applications

TLE/TLI/TLV4961, TLE/TLI/TLV4964, TLE/TLI/TLV4968

Energy-efficient magnetic switches family for up to 32 V

The TLE/TLI/TLV496x-xM/L family of magnetic switches saves energy and enables designers to create precise and compact systems. With an operational current consumption of just 1.6 mA, TLE/TLI/TLV496x-xM/L products can cut energy consumption by up to 50 percent, compared with similar competitor products. Thanks to its small magnetic hysteresis, the family paves the way for precise switching points in systems. The integrated temperature profile compensates magnetic drifts and enables stable performance over temperature and lifetime.

TLE/TLI/TLV496x-xM products come in the smallest SOT23 package, thus reducing height by 10 percent compared with predecessor products. The sensors also feature an integrated functionality test for better system control.



Features

- Current consumption of just 1.6 mA
- 3 to 32 V supply voltage range (over voltage up to 42 V)
- 7 kV ESD protection (HBM)
- Overtemperature and overcurrent protection
- Temperature compensation
- Smallest SOT23 package
- Dedicated products for industrial applications (TLI496x) and consumer applications (TLV496x)
- AEC-Q100 qualified

Applications

- Window lifter
- Power closing
- Gear stick
- Seat belt
- BLDC commutation (e.g. wiper, seat belt pretensioner, pump, seating)
- Service robots
- Power tools
- White goods

Product	Type	Operating point B_{OP} [mT]	Release point B_{RP} [mT]	Hysteresis ΔB_{HY} [mT]	Automotive	Industrial	Consumer	Package
TLE4961-1M/L	Latch	2.0	-2.0	4.0	●	●	●	SOT23/SSO-3-2
TLE4961-2M	Latch	5.0	-5.0	10.0	●	●	●	SOT23
TLE4961-3M/L	Latch	7.5	-7.5	15.0	●	●	●	SOT23/SSO-3-2
TLE4961-4M	Latch	10.0	-10.0	20.0	●	●	●	SOT23
TLE4961-5M	Latch	15.0	-15.0	30.0	●	●	●	SOT23
TLE4964-1M	Switch	18.0	12.5	5.5	●	●	●	SOT23
TLE4964-2M	Switch	28.0	22.5	5.5	●	●	●	SOT23
TLE4964-3M	Switch	12.5	9.5	3.0	●	●	●	SOT23
TLE4964-4M	Switch	10.0	8.5	1.5	●	●	●	SOT23
TLE4964-6M	Switch	3.5	2.5	1.0	●	●	●	SOT23
TLE4964-5M	Switch	7.5	5.0	2.5	●	●	●	SOT23
TLE4968-1M/L	Bipolar	1.0	-1.0	2.0	●	●	●	SOT23/SSO-3-2
TLI4961-1M	Latch	2.0	-2.0	4.0	–	●	●	SOT23/SSO-3-2
TLV4961-1M	Latch	2.0	-2.0	4.0	–	–	●	SOT23
TLV4961-3M	Latch	7.5	-7.0	15.0	–	–	●	SOT23
TLV4964-1M	Switch	18.0	12.5	5.5	–	–	●	SOT23
TLV4964-2M	Switch	28.0	22.5	5.5	–	–	●	SOT23

www.infineon.com/magnetic-switches

TLE/TLI4963, TLE/TLI4965

5 V high-precision automotive/industrial Hall-effect sensor

TLE/TLI496x-xM are integrated Hall-effect sensors specially designed for highly accurate applications. The sensors provide an easy-to-use and cost-effective solution for position sensing applications, requiring high temperature stability of the magnetic threshold.

Target applications for TLE/TLI496x-xM are all low-power applications requesting a precision magnetic latch or switch with a broad operating temperature range.

By offering an excellent magnetic behavior Infineon's switches are ideally suited for:

- Index counting application with a pole wheel
- Rotor position detection (BLDC motors)
- Open/close detection

Features

- 3.0 to 5.5 V operating supply voltage
- Low current consumption 1.4 mA
- ESD protection 4 kV HBM
- Active error compensation (chopped)
- High stability of magnetic thresholds
- Low jitter (typ. 0.35 µs)
- Operating temperature range:
  - from -40 to +170°C (TLE496x-xM)
  - from -40 to +125°C (TLI496x-xM)
- Small SMD package SOT23
- TLE: AEC-Q100 qualified
- TLI: JEDEC qualified

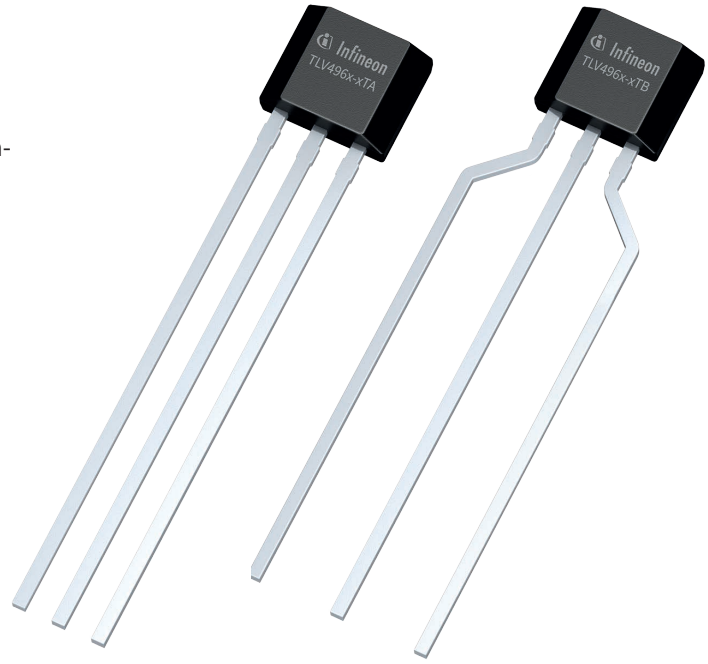
Product	Type	Operating point B_{OP} [mT]	Release point B_{RP} [mT]	Hysteresis ΔB_{HY} [mT]	Automotive	Industrial	Consumer	Package
TLE4963-1M	Latch	2.0	-2.0	4.0	●	●	●	SOT23
TLE4963-2M	Latch	5.0	-5.0	10.0	●	●	●	SOT23
TLE4965-5M	Unipolar switch	7.5	5.0	2.5	●	●	●	SOT23
TLI4963-1M	Latch	2.0	-2.0	4.0	–	●	●	SOT23
TLI4963-2M	Latch	5.0	-5.0	10.0	–	●	●	SOT23
TLI4965-5M	Unipolar switch	7.5	5.0	2.5	–	●	●	SOT23

www.infineon.com/magnetic-switches

TLV496x-xTA / TLV496x-xTB

Precision Hall-effect sensor for consumer applications in leaded package

The TLV496x-xTA/B Hall-effect sensor family comprises a line of magnetic switches for contactless position sensing. The sensors are specially designed to provide an easy-to-use and cost-effective solution for position sensing applications.



Features

- 3.0 to 26 V operating supply voltage
- Low current consumption 1.6 mA
- ESD protection 4 kV HBM
- Operating temperature range from -40 to +125 °C
- Leaded package TO92S

Applications

- BLDC motor commutation for consumer devices (e.g. e-bikes, fans, aircons)
- Position detection e.g. flaps and control buttons

Product	Type	Operating point B_{OP} [mT]	Release point B_{RP} [mT]	Hysteresis ΔB_{HY} [mT]	Consumer	Package
TLV4961-1TA	Latch	2.0	-2.0	4.0	●	TO92S-3-1
TLV4961-1TB	Latch	2.0	-2.0	4.0	●	TO92S-3-2
TLV4961-3TA	Latch	7.5	-7.5	15.0	●	TO92S-3-1
TLV4961-3TB	Latch	7.5	-7.5	15.0	●	TO92S-3-2
TLV4964-4TA	Unipolar switch	10.0	8.5	1.5	●	TO92S-3-1
TLV4964-4TB	Unipolar switch	10.0	8.5	1.5	●	TO92S-3-2
TLV4964-5TA	Unipolar switch	7.5	5.0	2.5	●	TO92S-3-1
TLV4964-5TB	Unipolar switch	7.5	5.0	2.5	●	TO92S-3-2
TLV4968-1TA	Bipolar switch	1.0	-1.0	2.0	●	TO92S-3-1
TLV4968-1TB	Bipolar switch	1.0	-1.0	2.0	●	TO92S-3-2

TLx4966 xG family
Two-in-one double Hall-effect sensor

Our XENSIV™ TLx4966 xG family features two integrated, calibrated sensor elements for detecting direction and counting indexes in one device. This two-in-one feature eliminates the need for a second sensor, which in turn cuts engineering and production costs. Using just one sensor ensures perfect alignment of the sensor elements raising system quality and reliability.

Features

- Two Hall probes
- Excellent matching between the two Hall probes
- Hall plate distance of 1.45 mm
- Outstanding quality
- Information on direction and speed
- TSOP6 package
- AEC-Q100 qualified

Applications

- Window lifter
- Sunroof
- Automatic tailgate
- Automated doors
- Sun blinds

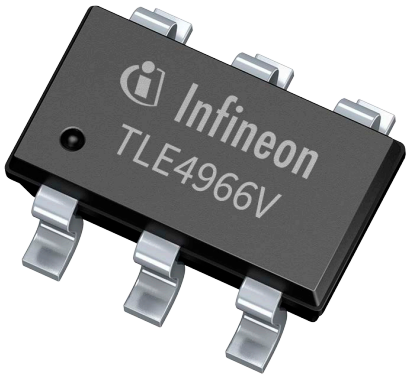
www.infineon.com/magnetic-switches

TLE4966V-1G
Vertical dual-Hall switch

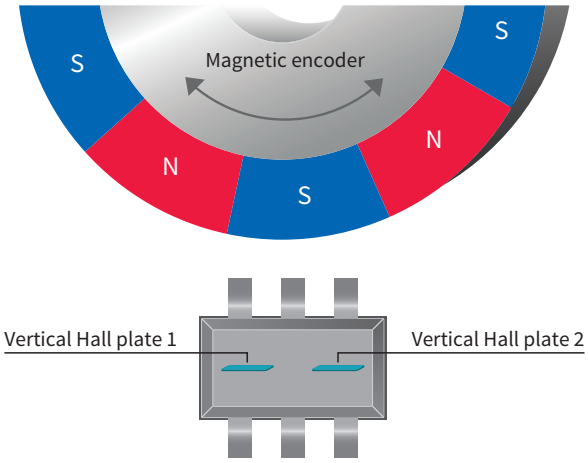
The Infineon vertical double Hall-effect switch TLE4966V-1G is a further development of the TLX4966 xG family. Completely new is the vertical orientation of the Hall plates resulting in in-plane field sensitivity which enables entirely new application layouts. Designed in a new technology, this device offers high voltage capabilities with very small current consumption. The product can be operated from unregulated power supplies, which offers our customers unique freedom of design for their system. This product is AEC-Q100 certified and enables our customers to build systems for the highest automotive quality requirements.

Features

- Saves space
- Easy mounting of sensor and PCB board
- Allows increased mounting flexibility
- Enables new, compact system designs



Sensing direction parallel to target to wheel



Product	Type	Output	Operating point B_{OP} [mT]	Release point B_{RP} [mT]	Hysteresis ΔB_{HY} [mT]	Automotive	Industrial	Consumer	Package
TLE4966G	Double Hall, speed and direction output	Speed and direction	7.5	-7.5	15	●	●	●	TSOP6/ SSO-4-1
TLE4966L	Double Hall, speed and direction output	Speed and direction	7.5	-7.5	15	●	●	●	TSOP6/ SSO-4-1
TLE4966-2G	Double Hall, two independent outputs	Speed and direction	7.5	-7.5	15	●	●	●	TSOP6
TLE4966-3G	Double Hall, speed and direction output	Speed and direction	2.5	-2.5	5	●	●	●	TSOP6
TLE4966V-1G	Vertical double Hall, speed and direction output	Speed and direction	2.5	-2.5	5	●	●	●	TSOP6
TLI4966G	Double Hall, speed and direction output	Speed and direction	7.5	-7.5	15	–	●	●	TSOP6

TLE49x6 / TLI49x6 / TLV49x6 family
High-precision magnetic switches

The TLE49x6, TLI49x6, and the TLV49x6 family comprises high-precision, unipolar Hall-effect switches and latches for different magnetic sensitivities. TLE/TLI/TLV49x6 products have proven successful in many automotive, industrial and consumer applications. The family includes two-wire sensors with a current interface.

Features

- Broad, successful family concept
- Best in class quality
- Chopped Hall system for high sensitivity
- High jitter performance
- SMD and leaded packages
- Open collector or current interface
- Temperature compensation
- Up to 18 V supply
- Dedicated products for industrial (TLI49x6) and consumer applications (TLV49x6)
- AEC-Q100 qualified (TLE products)

Applications

- Power closing
- Gear stick
- Seat belt
- HVAC flap
- BLDC commutation
- 2-wheeler applications

Product	Type	Operating point B_{OP} [mT]	Release point B_{RP} [mT]	Hysteresis ΔB_{HY} [mT]	Automotive	Industrial	Consumer	Package
TLE4906K	Unipolar switch	10.0	8.5	1.5	●	●	●	SC59/SSO-3-2
TLE4906L	Unipolar switch	10.0	8.5	1.5	●	●	●	SC59/SSO-3-2
TLE4906-2K	Unipolar switch	18.0	12.5	5.5	●	●	●	SC59
TLE4906-3K	Unipolar switch	28.0	22.5	5.5	●	●	●	SC59
TLE4946K	Latch	14.0	-14.0	28.0	●	●	●	SC59
TLE4946-1L	Latch	15.0	-15.0	30.0	●	●	●	SSO-3-2
TLE4946-2K	Latch	2.0	-2.0	4.0	●	●	●	SC59/SSO-3-2
TLE4946-2L	Latch	2.0	-2.0	4.0	●	●	●	SC59/SSO-3-2
TLE4976L	Unipolar switch/ Current interface	6.0	4.0	2.0	●	●	●	SSO-3-2
TLE4976-1K	Unipolar switch/ Current interface	9.25	7.25	2.0	●	●	●	SC59
TLE4976-2K	Unipolar switch/ Current interface	4.5	2.7	1.8	●	●	●	SC59
TLV4976-2K	Unipolar switch / Current interface	4.5	2.7	1.8	–	–	●	SC59

3D magnetic sensors

Infineon's 3D magnetic sensor (TLx493D-x2Bx) combines high-accuracy magnetic field measurements with an extremely compact footprint and exceptionally low power consumption (min. 7 nA). This sensor opens up a host of exciting new use cases including innovative human-machine interfaces in the form of industrial joysticks, ergonomic pushbuttons on domestic appliances and highly precise position control in robotics.

The TLE493D-P2B6 is Infineon´s newest magnetic 3D sensor enabled by new and improved accuracy. It is the best product for high performance applications with respect to pricing and package size.

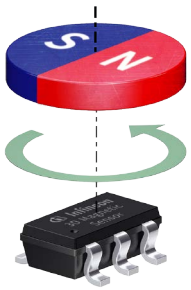
The TLE493D-P2B6 has extremely low current and wake-up function in small package. Also the sensor provides options for configuration to fit best to customer requirements (e.g. data communication, definition of measurements, etc.). The safety manual supports functional safety applications. The configurability of the sensor is used in application platforms to adapt end customer wishes. TLE493D-P2B6 is available in 4 different variants ending with A0, A1, A2 or A3. The underlying feature is the so called Bus mode configuration of this device. It's possible to connect up to 4 sensors to one I^2C bus. The specific addressing is then done via 4 different variants.

www.infineon.com/3d-magnetics

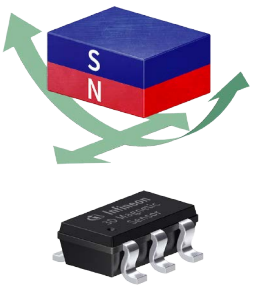
3D magnetic sensors

For consumer and industrial markets

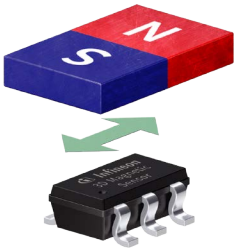
The TLx493D-x2Bx sensor realizes accurate three-dimensional sensing with extremely low power consumption in a small package. Capable of detecting the magnetic field in the x, y, and z-direction, the sensor is ideally suited for the measurement of linear, rotation, or 3-dimensional movements. Thanks to its small package and low power consumption, the TLx493D-x2Bx can be used in new applications, replacing potentiometer and optical solutions. Featuring contactless position sensing and high-temperature stability of the magnetic threshold, the sensor allows systems to get smaller, more accurate, and more robust.



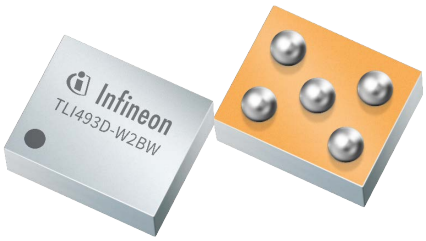
Rotation movement



3D movement



Linear movement



Features

- 3D magnetic sensing
- Integrated temperature sensing
- Low current consumption
  - 7 nA in power-down mode
  - 10 µA in ultralow power mode
- 2.8 to 3.5 V operating supply voltage
- Digital output via a 2-wire standard I2C interface
- Bx, By and Bz linear field measurement up to ±160 mT
- JESD47 qualified
- 12-bit data resolution for each measurement direction
- Various resolution options from 32 µT/LSB to 130 µT
- Operating temperature range from -40 to +125°C

Product	Temperature range	Qualification	Linear magnetic range	Resolution	I_{DD}	Update rate XYZ measurement	Package	Ordering code
TLI493D-A2B6	-40 … 105°C	JESD47	±160 mT ±100 mT	7.7 or 15.4 LSB12/mT	7 nA – 3.4 mA	up to 7.8 kHz	TSOP6	SP001689844
TLI493D-W2BW A0 TLI493D-W2BW A1 TLI493D-W2BW A2 TLI493D-W2BW A3	-40 … 125°C	JESD47	±50, ±100 or ±160 mT	7.7, 15.4 or 30.8 LSB12/mT	7 nA – 3.4 mA	up to 7.8 kHz	WLB-5	SP005409964 SP005409966 SP005409968 SP005409970
TLV493D-A1B6	-40 … 125°C	JESD47	±130 mT (typ)	10.2 LSB12/mT	7 nA – 3.7 mA	up to 3.3 kHz	TSOP6	SP001286056
TLV493D-A2BW	-20 … 85°C	JESD47	±50, ±100 or ±160 mT	7.7, 15.4 or 30.8 LSB12/mT	7 nA – 3.4 mA	up to 7.8 kHz	WLB-5	SP005542151

New features

- Advanced operation modes to provided a high flexiblitity
- Short mode range setting, focusing on the half of the magnetic range, ensuring higher accuracy
- Higher update frequency allows for an application field that requires faster update speed
- Angular mode (for x and y read-out only)

Applications

- Anti tempering protection in smart meters
- Joysticks
- CCTV-control, game consoles
- Control elements e.g. white goods multifunction knobs
- Ergonomic push- and control buttons on domestic appliances and power tools
- Position control in robotics
- Smart lock position detection

www.infineon.com/3d-magnetics

3D magnetic sensors

For automotive applications

Infineon's TLE493D-x2B6 enables all kind of automotive control element applications within the passenger compartment or under the hood with a temperature range of -40 to +125°C, with linear magnetic range requirements up to ±160 mT.

Features

- 3D magnetic sensing
- Integrated temperature sensing
- 2.8 to 3.5 V operating supply voltage
- Low current consumption
  - 0.007 µA in power-down mode
  - 10 µA in ultralow power mode
  - Up to 10 power modes
- Digital output via a 2-wire standard I2C interface
- Bx, By and Bz linear field measurement ±160 mT
- AEC-Q100 qualified
- 12-bit data resolution for each measurement direction
- Various resolution options from 65 µT/LSB to 130 µT
- Operating temperature range from -40 to +125°C

Product	Temperature range	Qualification	Linear magnetic range	Resolution	I_{DD}	Update rate XYZ measurement	Wake-up	Package	Ordering code
TLE493D-A2B6	-40 … 125°C	AEC-Q100	±160 mT ±100 mT	130 µT/LSB 65 µT/LSB [1)]	7 nA – 3.4 mA	up to 7.8 kHz	No	TSOP6	SP001689848
TLE493D-W2B6 A0 TLE493D-W2B6 A1 TLE493D-W2B6 A2 TLE493D-W2B6 A3	-40 … 125°C	AEC-Q100 ISO 26262 ready	±160 mT ±100 mT	130 µT/LSB 65 µT/LSB [1)]	7 nA – 3.4 mA	up to 7.8 kHz	Yes	TSOP6	SP001655334 SP001655340 SP001655344 SP001655348
TLE493D-P2B6 A0 TLE493D-P2B6 A1 TLE493D-P2B6 A2 TLE493D-P2B6 A3	-40 … 125°C	AEC-Q100/ ISO 26262 ready	±160 mT ±100 mT	130 µT/LSB 65 µT/LSB [1)]	7 nA – 3.4 mA	up to 7.8 kHz	Yes	TSOP6	SP005557415 SP005557413 SP005557411 SP005557408

1) Short range mode

The XENSIV™ sensor TLE493D-A2B6 features include a sensor address read-back feature for additional communication verification, a short range mode focusing to half of the magnetic range, ensuring higher accuracy, and an angular mode (for x and y readout only).

With the TLE493D-W2B6/ P2B6 A0-A3, a 3D sensor family with an enhanced dynamic wake-up feature was developed. Four pre-programmed address options (A0-A3) are available, enabling for a fast start-up initialization when used in I2C bus configurations. Our sensors include enhanced test options, and safety documentation is available to enable the usage of this sensor in the context of ASIL B systems.

Compared to the previous products of this family the new TLE493D-P2B6 A0-A3 family offers enhance precision in x-, y-, z- sensing direction, while otherwise featuring the same dynamic wake-up features, programmability, and test options like TLE493D-W2B6 A0-A3.

Applications

- Control elements for infotainment/navigation systems, air-conditions, multifunctional steering wheels, seat controls
- Top column modules e.g. direction indicator, wiper control
- Gear stick position sensing
- Multi-function knobs
- Pedal/valve position sensing

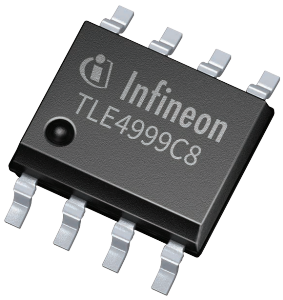
PRO SIL ISO 26262 ready

www.infineon.com/3d-magnetics

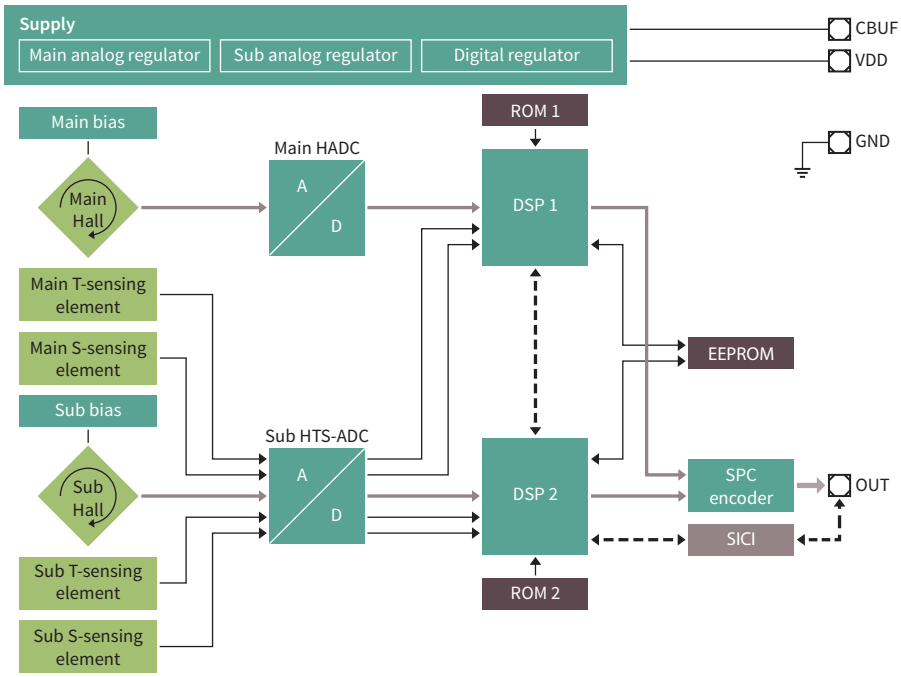
Linear sensors

Programmable dual channel linear Hall sensor with fast SPC interface for high precision applications

Infineon's TLE4999C8 is a programmable dual channel linear Hall sensor designed to meet the requirements of safety critical automotive and industrial applications. It is developed in full compliance with ISO 26262 by means of two sensor elements included within one monolithic silicon design. In order to fulfill the state-of-the-art safety requirements on system level and enable ASIL D system developments the sensor cells are designed in a complementary way. Their signals follow two independent analog paths. Each signal path has its own digital signal processing unit to ensure maximum independency - redundancy, respectively. The sensor offers a multi-point calibration with up to 9 selectable set points for enhanced linearization of the output signal. For an easy and flexible adaptation to non-linearity of magnetic circuit design, the chip provides 5 different calibration characteristics. TLE4999C features a digital Short-PWM-Code (SPC) interface, with a bus-capability for up to 4 sensor ICs on a single data output. The communication interface with min. 0.5 µs unit time guarantees a fast transmission of complete 2 channel data signal in less than 500 µs. The additionally implemented frame holder circuit enables the synchronicity of multiple sensors (e.g. in combination of angle sensors) via a SPC bus. The chip offers a 12, 14 and 16 Bit resolution of the output signal, ensuring highest flexibility and superior noise performance.



Highest accuracy over a wide temperature range and lifetime is achieved by an integrated digital temperature- and stress-compensation. The chip is available in a thin 8-pin SMD single sensor package.



www.infineon.com/linear-sensors

Features

- Fully ISO 262626 compliant, supports ASIL D systems
- < 2 % sensitivity drift, < 100 µT offset drift overtemperature and life time specification
- Integrated digital temperature- and stress-compensation
- Fast digital SPC interface with a unit time down to 0.5 µs
- Multi-point calibration with up to 9 linearization set points

Key benefits

- High diagnostic coverage, ISO 26262-compliancy and dual sensor cell integration enable development of fail operational systems
- Multi-point calibration for better fit into various magnetic circuit designs
- Easy system integration due to programmability of several sensor parameters

Applications

Automotive safety critical applications

- Electric power steering
- Linear movement position sensing
- Pedal position
- Electric throttle control
- Seat rail adjustment
- Headlight adjustment

Industrial applications

- Small home appliances
- Joystick applications

Infineon ISO 26262 dual channel linear Hall product portfolio

Sales name	Interface	Magnetic linear range [mT]	Sensitivity	Sensitivity drift [%]	Gain	Magnetic offset drift [µT][1]	ISO 26262	Ordering code	Package
TLE4997A8D	Analog ratiometric	50, 100, 200	±60 mV/mT default for 100 mT range, with gain 1.5	±3	±4	< ±400	Ready	SP000902760	TDSO-8
TLE4998P8D	Digital interface PWM	50, 100, 200	±48 LSB_{12}/mT default for 100 mT range, with gain 1.5	±2	±4	< ±400	Ready	SP000902776	TDSO-8
TLE4998S8D	Digital interface SENT	50, 100, 200	±48 LSB_{12}/mT default for 100 mT range, with gain 1.5	±2	±4	< ±400	Ready	SP000902784	TDSO-8
TLE4998C8D	Digital interface SPC	50, 100, 200	±48 LSB_{12}/mT default for 100 mT range, with gain 1.5	±2	±4	< ±400	Ready	SP000902768	TDSO-8
TLE4999I3	Digital interface PSI5	12.5, 25	±147.5 LSB_{13}/mT default for 25 mT range, with gain 1.5	±2	±5	< ±100/ < ±200[2]	Compliant	SP001689862	SSO-3
TLE4999C8	Digital interface SPC	25, 50	±36.875 LSB_{12}/mT default for in 50 mT range, with gain 1.0	±2	±5	< ±100/ < ±200[2]	Compliant	SP002662500 (SP005727371)	TDSO-8
TLE4999C4	Digital interface SPC	25, 50	±36.875 LSB_{12}/mT default for in 50 mT range, with gain 1.0	±2	±5	< ±100/ < ±200[2]	Compliant	SP003420076 (SP005727375)	SSO-4

1) Maximum over drift overtemperature and life time
2) Main channel/sub channel

ISO 26262 compliant

ISO 26262 ready

www.infineon.com/linear-sensors

TLE499x family:
programmable analog/digital linear Hall sensor family

Infineon's family of TLE499x linear Hall ICs is tailored to the needs of highly accurate angular and linear position detection and current measurement applications. Each product measures the vertical component of a magnetic field and outputs a signal that is directly proportional to the magnetic field. These programmable linear Hall sensors come with different interface options: TLE4997 features ratiometric analog output, while TLE4998P comes with pulse width modulation (PWM), TLE4998S with single edge nibble transmission (SENT), and TLE4998C with short PWM codes (SPC). These high-precision 12-bit resolution linear Hall sensors feature EEPROM memory for flexible programming across a wide range of parameters.

Thanks to digital signal processing based on a 20-bit DSP architecture plus digital temperature compensation, these sensors deliver outstanding temperature stability compared with similar compensation methods. TLE4998 also includes stress compensation to withstand stress effects from the package, such as moisture, thus ensuring best-inclass accuracy over the device's lifetime.

Features

- Best-in-class accuracy with low drift of output signal temperature range lifetime (including stress compensation in TLE4998)
- Programmable transfer function (gain, offset), clamping, bandwidth, and temperature characteristics
- AEC-Q100 qualified
- Available in various packages including SSO-3-9 with two integrated capacitors to improve ESD and ESC behavior
- Dual-die SMD package
- TLE4997, TLE4998 ISO 26262 ready
- TLE4999 fully ISO 26262 compliant for highest ASIL-levels

Applications

- Detecting linear and angular position
- Detecting pedal and throttle position
- Steering torque measurement
- Headlight leveling
- High-current sensing
- Seat position and occupant detection
- Suspension control
- Detecting gear stick/lever positions
- Detecting liquid levels in fuel tanks
- Current sensing e.g. for battery management

Product	Programm.	Number of pins	Sensitivity (programmable range)	Magnetic offset	Supply voltage (extended range)	Automotive	ISO 26262	Interface	Package
TLE4997	EEPROM	3/Single die SMD 8	±12.5 to ±300 mV/mT	< ±400 µT	5 V ±10% (7 V)	●	–	Analog	SSO-30 TDSO-8
TLE4998P	EEPROM	3/4/Single die SMD 8	±0.2 to ±6%/mT	< ±400 µT	5 V ±10% (16 V)	●	Ready	PWM	SSO-3 SSO-4 SSO-3 (2 capacitors) TDSO- 8
TLE4998S	EEPROM	3/4/Single die SMD 8	±8.2 to ±245 LSB_{12}/mT	< ±400 µT	5 V ±10% (16 V)	●	Ready	SENT	SSO-3 SSO-4 SSO-3 (2 capacitors) TDSO-8
TLE4998C	EEPROM	3/4/Single die SMD 8	±8.2 to ±245 LSB_{12}/mT	< ±400 µT	5 V ±10% (16 V)	●	Ready	SPC	SSO-3 SSO-4 SSO-3 (2 capacitors TDSO-8
TLE4999I3	EEPROM	3	±73.72 to ±147.44[2)] LSB_{13}/mT	< ±300 µT	5.5–7 V ±10% (16 V)	●	Compliant	PSI5	SSO-3
TLE4999C8	EEPROM	Single die SMD 8	±36.85 to ±73.7 LSB_{12}/mT	< ±300 µT	5 V ±10% (16 V)	●	Compliant	SPC	TDSO-8 SSO-4
TLE4999C4	EEPROM	Single die SMD 8	±36.85 to ±73.7 LSB_{12}/mT	< ±300 µT	5 V ±10% (16 V)	●	Compliant	SPC	TDSO-8 SSO-4

1) 147.44 LSB_{13} converts to 294.88 LSB_{12}

ISO 26262 compliant

ISO 26262 ready

www.infineon.com/linear-sensors

Dual linear sensors

Two sensors in one SMD package

The SMD package (TDSO) includes two independent sensors with separate power supplies and separate signal outputs. Due to special mounting technology, Infineon can keep dual-sensor package sizes very small to enable compact PCB layouts and small magnet sizes.

Infineon offers a wide range of Hall sensors in the TDSO package. The combination of two sensors in one package offers sensors redundancy, a feature that is especially interesting for new generation EPS steering systems with increased ISO 26262 requirements and other safety-critical applications. All sensors are automotive qualified.

Most products are also available as a single-sensor solution with only one sensor. The newest member of the TLE499x family, the TLE4999I3, is a fully ISO 26262-compliant linear Hall sensor that includes 2 sensor channels on one chip. The SSO-3 package allows PCB-less application flexibility and the PSI5 interface enables low EMI at high-speed communication with minimum wiring.

Features

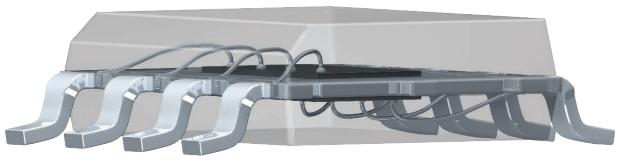
- Two sensors in one package
- Separate power supply and signal output
- AEC-Q100 qualified
- Temperature range from -40 to +125°C
- Outstanding quality
- Single-sensor versions available
- 16-pin and 8-pin versions available
- ISO 26262-ready
- TLE4999I3 ISO 26262-compliant

Automotive applications

- Steering torque systems
- Pedal position
- Any other safety-critical application

Product	Interface	Dual-/ single-sensor available	ISO 26262	Package
TLE4997A8D	Analog	yes/yes	Ready	TDSO-8
TLE4998P8D	PWM	yes/yes	Ready	TDSO-8
TLE4998S8D	SENT	yes/yes	Ready	TDSO-8
TLE4998C8D	SPC	yes/yes	Ready	TDSO-8
TLE4999I3	PSI5	monolithic[1)]	Compliant	SSO-3
TLE4999C8	SPC	monolithic[1)]	Compliant	TDSO-8
TLE4999C4	SPC	monolithic[1)]	Compliant	TDSO-8

1) 2 sensor channels on one chip



ISO 26262 compliant

ISO 26262 ready

Angle sensors

Compact designs in small outline packages – at highest functional safety

Highest variety – low end to high end, standardized and specialized in all four magnetic technologies: Hall, GMR, AMR and TMR

Angle sensors detect the orientation of an applied magnetic field by measuring sine and cosine angle components with monolithically integrated magneto resistive elements.

Infineon offers a large variety of high-precision angle sensors in all common technologies such as AMR (Anisotropic Magnetoresistive), GMR (Giant Magnetoresitive) and also TMR (Tunnel Magnetoresitive). The xMR technologies are complementary. Addressing any kind of rotation applications, Infineon's sensor portfolio consists of products with analogue and digital outputs, as single and dual-chip channel variants and as products for safety-relevant applications. The two-channel analogue TMR angle sensors TLE5501, the digital GMR angle sensor family TLE5014 and the high-precision AMR-based TLE5109 products are among the latest additions to the growing sensor portfolio, which includes all common technologies and is designed for both, industrial and automotive applications.

Infineon's new magnetic sensor products TLE5501, are fast analogue TMR-based angle sensors dedicated to automotive applications. Their fields of use range from steering angle applications, with the highest functional safety requirements, to motors for wipers, pumps and actuators and electric motors in general.

The new TLE5109A16 AMR based products address the need for very precise, fast and yet cost-efficient angle measurement at the highest functional safety levels in automotive and industrial applications. These include position measurement in brushless DC motors for pumps, wipers or brakes, position measurements of valves, flaps or pedals and steering angle measurement.

Infineon's broad portfolio of iGMR sensors are ideal for a wide range of angle applications, such as BLDC motors or steering angle sensors. They are pre-calibrated and ready-to-use. Different levels of signal processing integration from the straight forward TLE5012B to the highly complex and programmable TLE5014 enable designers to optimize system partitioning.

The large portfolio of Infineon Angle sensors is equally suited to meet ready to use industrial and consumer applications like robotics or gimbal and highly safety critical Automotive Applications such as braking or steering.

iGMR, iAMR and iTMR based angle sensors

Diverse redundant sensor with analog and digital interface

Product	Technology	Die configuration	Sin/cos output	Angle output	Second interface	Accuracy	ISO 26262	Package
TLE5009	GMR	Single die	Analog sin/cos	–	–	0.9°	Ready	DSO-8
TLE5009A16(D)	GMR	Dual die	Analog sin/cos	–	–	1.0°	Ready	TDSO-16
TLE5011	GMR	Single die	SSC (SPI)	–	–	1.6°	Ready	DSO-8
TLI5012B	GMR	Single die	SSC (SPI)	SSC (SPI)	PWM/IIF/SPC/HSM	1.9°	QM	DSO-8
TLE5012B(D)	GMR	Single & dual die	SSC (SPI)	SSC (SPI)	PWM/IIF/SPC/HSM	1.0°	Ready	DSO-8/ TDSO-16
TLE5014C16(D)	GMR	Single & dual die	–	SPC	–	1.0°	Compliant	TDSO-16
TLE5014P16(D)	GMR	Single & dual die	–	PWM	–	1.0°	Compliant	TDSO-16
TLE5014S16(D)	GMR	Single & dual die	–	SENT	–	1.0°	Compliant	TDSO-16
TLE5014SP16(D)	GMR	Single & dual die	–	SPI	–	1.0°	QM/Compliant	TDSO-16
TLE5109A16(D)	AMR	Single & dual die	Analog sin/cos	–	–	0.5°	Ready	TDSO-16
TLE5309D	AMR + GMR	Dual die	Analog sin/cos	–	–	AMR 0.5°, GMR 1.0°	Ready	TDSO-16
TLE5501	TMR	Single die	Analog sin/cos	–	–	1.0°	Compliant	DSO-8

SPI = Serial peripheral interface
IIF = Incremental interface
PWM = Pulse width modulation

ISO 26262 compliant

ISO 26262 ready

www.infineon.com/angle-sensors

iTMR based angle sensors

Tunneling Magneto Resisitive (iTMR) technology is offering high sensing sensitivity with a high output voltage, reducing the need for an internal amplifier. Thus, the sensor can be connected directly to the microcontroller without any further amplification. In addition, iTMR technology shows a very low temperature drift, reducing external calibration and compensation efforts. The iTMR technology is also well known for its low current consumption.

TLE5501

With the TLE5501 products, Infineon is currently launching the first angle sensor products based on iTMR technology. TLE5501 is available in two versions.

TLE5501 – product versions with different pin out:

- TLE5501 E0001: pin-compatible to TLE5009 automotive qualified acc. AEC-Q100
- TLE5001 E0002: decoupled bridges for redundant external angle calculation and highest diagnostic coverage, realizing ISO 26262-compliant development ASIL D

Features

- Large output signals of up to 0.37 V/V for direct microcontroller connection
- Discrete bridge with differential sine and cosine output
- Very low supply current: ~2 mA
- Magnetic field range (20–100 mT)
- Typ. angle error ~ 1.0° (overtemperature and lifetime)
- DSO-8 package
- AEC-Q100, grade 0: T_A = -40...+150°C (ambient temperature)
- For TLE5501 E0002:
  - Reaching ASIL D with just one single sensor chip
  - ISO 26262-compliant development ASIL D

Applications

- Steering angle sensor
- BLDC motor commutation (e.g. wipers, pumps and actuators)
- Angular position sensing for e.g. robotics or gimbal
- Electric motors
- Industrial automation
- Safety applications

iGMR based angle sensors

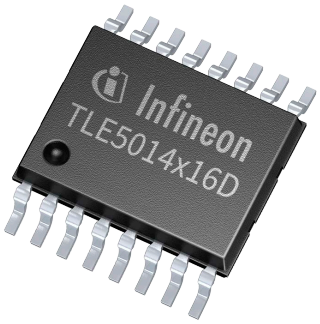
TLE5014(D)

Digital iGMR[2] sensor with an easy-to-use plug-and-play concept for highest functional safety applications

All XENSIV™ TLE5014 angle sensors are available as single and dual die products. The products come pre-configured and pre-calibrated as plug-and-play sensors and are easy to use. Customers can choose between the interfaces SENT, PWM, SPC, and SPI. On top of those protocol options, the sensors can be adapted to any kind of application setup via their programmable E²PROM interfaces. TLE5014 magnetic angle sensors meet ISO 26262 ASIL C for the single die and ISO 26262 ASIL D for the dual die versions. All products are ready for applications with the highest functional safety requirements. The sensors show an extremely small angle error of less than 1° across the entire temperature profile and lifetime. This is particularly helpful in applications with the need for very accurate position sensing such as steering angle sensing or motor commutation. Further application areas range from rotor position measurement, electric power steering (EPS), pedal position to any other kind of position measurement.

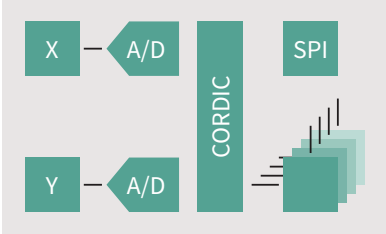
Features

- Easy-to-use, plug-and-play sensors, pre-configured and pre-calibrated
- Offering high flexibility:
  - Available as single and dual die products
  - 12-bit digital interface with protocol options PWM, SENT, SPC and SPI
  - E² PROM and look-up table for customer configuration and calibration
- High angle accuracy: max. 1.0° over temperature and lifetime
- High voltage capability up to 26 V
- Development fully compliant with ISO 26262
  - Developed acc. ASIL D level
  - Dual die sensors reaching ASIL D, single die sensors ASIL C metrics
- Safety manual and safety analysis summary report available on request



Applications

- Steering angle sensing (SAS)
- Motor commutation
- Rotor position measurement
- Pedal position
- Safety applications
- Any other kind of high-accuracy position measurement



1) More information on PRO-SIL™, see page 115
2) Giant Magneto Resistance

ISO 26262 compliant

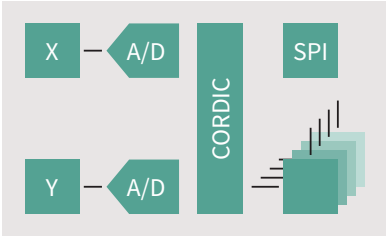
iGMR based angle sensors

TLE5012B, TLE5012B(D)

iGMR sensor with integrated angle calculation and multiple interfaces

Features

- Integrated angle calculation with CORDIC algorithm
- 15-bit representation of calculated angle value
- High update rate up to 43 µs (23 kHz)
- Range of selectable interfaces
- SPI compatible Synchronous Serial Communication (SSC)
- Bi-directional communication up to 8 Mbit/s
- Pulse Width Modulation (PWM)
- Hall Switch Mode (HSM) for motor commutation
- Incremental Interface (IIF)
- Temperature compensation and auto-calibration algorithm
- Diagnostic function for sensor elements and circuitry with PRO-SIL™ support
- Dual die SMD package (redundancy)
- ISO 26262 ready
- Available as single and dual die product



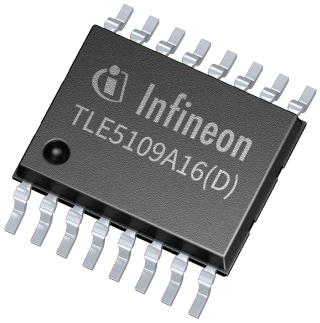
Applications

- Steering angle
- Brushless DC motor commutation (for example Electric Power Steering (EPS))
- Rotary switches
- General angular sensing
- Incremental or absolute magnetic encoders
- Gimbals, drones, robots

iAMR based angle sensors

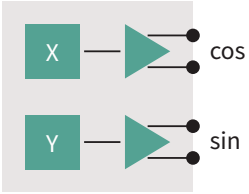
TLE5109A16(D)

Analog iAMR sensor with temperature compensation



Features

- Features a differential or single-ended analog interface for sine and cosine values
- Internal temperature drift compensation for gain and offset
- Also available as a dual-sensor package
- ISO 26262 ready
- Available as single and dual die product



ISO 26262 ready

1) More information on PRO-SIL™, see page 115

www.infineon.com/angle-sensors

Combined iAMR and iGMR based angle sensors

TLE5309D

Dual angle sensor combining iAMR and iGMR technology

The TLE5309D is a diverse redundant angle sensor with analog outputs. It combines a Giant Magneto Resistance (GMR) sensor for full 360° angle range with an Anistropic Magneto Resistance (AMR) sensor for high precision in a flipped configuration in one package. Sine and cosine angle components of a rotating magnetic field are measured by Magneto Resistive (MR) elements. The sensors provide analog sine and cosine output voltages that describe the magnetic angle in a range of 0 to 180° (AMR sensor), and 0 to 360° (GMR sensor), respectively.

The differential MR bridge signals are independent of the magnetic field strength, and the analog output is designed for differential or single ended applications.

The output voltages are designed to use the dynamic range of an A/D-converter using the same supply as the sensor as voltage reference. Both sensor ICs are supplied independently by separate supply and ground pins.

Summary of features

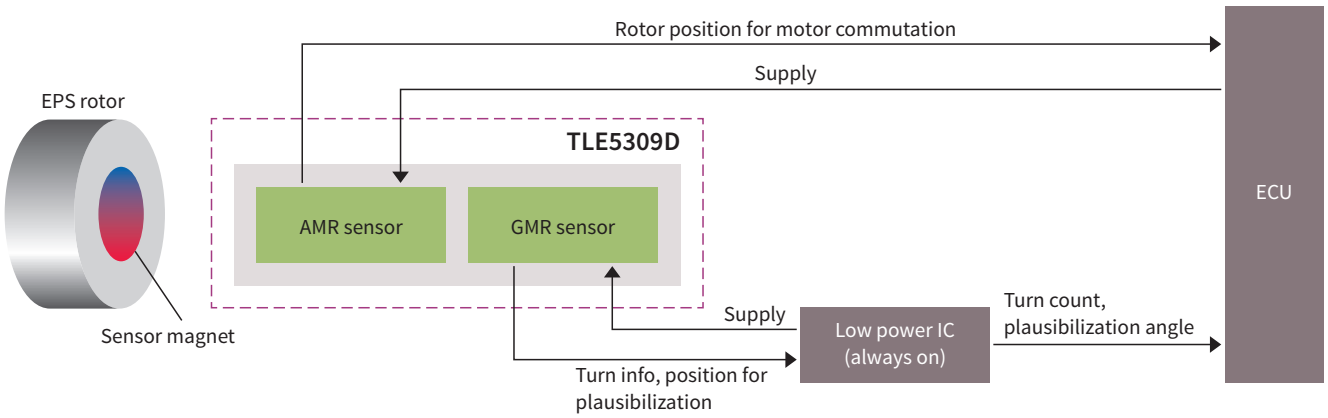
- Separate supply pins for AMR and GMR sensor
- Diverse redundant design with one GMR sensor (top die) and one AMR sensor (bottom die) in one package
- Low current consumption and very fast start up
- 360° contactless angle measurement
- Immune to airgap variations due to MR based sensing principle
- Operating ambient temperature: -40...+125°C/-40...+150°C (TLE5309DHT)

Potential applications

The TLE5309D angle sensor is designed for angular position sensing in safety critical automotive applications. Its high accuracy and 360° measurement range combined with short propagation delay makes it suitable for systems with high speeds and high accuracy demands such as brush-less DC (BLDC) motors for actuators and electric power steering systems (EPS). At the same time its fast start-up time and low overall power consumption enables the device to be employed for low-power turn counting. Extremely low power consumption can be achieved with power cycling, where the advantage of fast power on time reduces the average power consumption.

- BLDC motors for electric power steering (EPS)
- Low-power turn counter

Diagnostic functions in combination with iAMR and iGMR diversity supports ASIL D applications



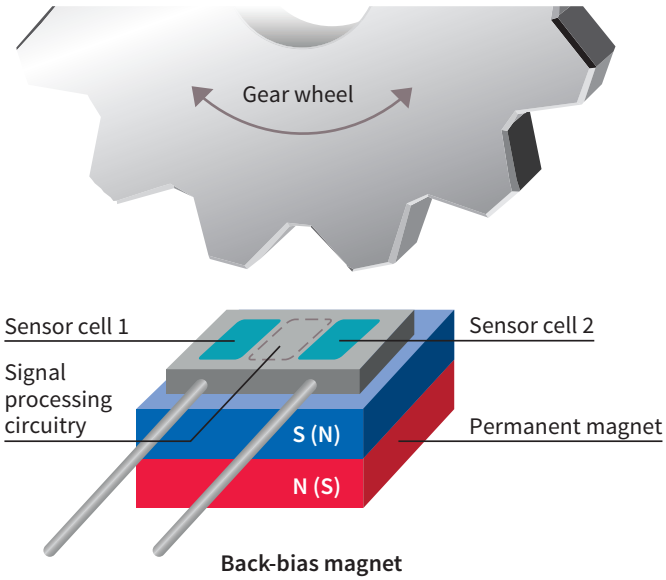
www.infineon.com/angle-sensors

Magnetic speed sensors

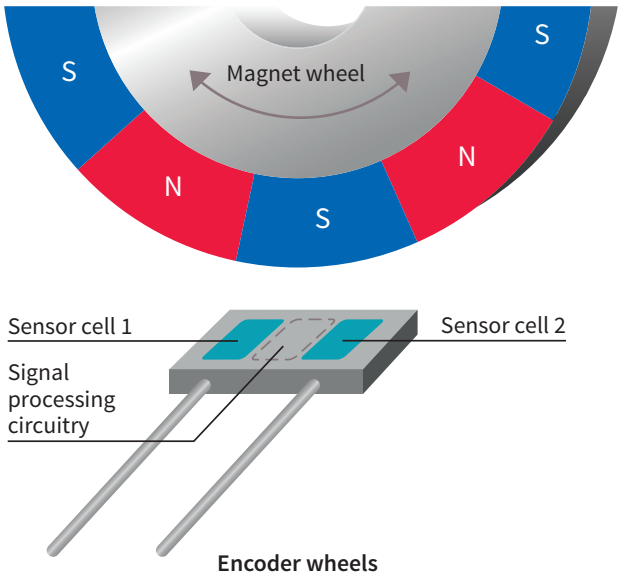
Easy to use, robust and cost-effective sensors for speed measurement

Infineon's Hall- and GMR-based magnetic speed sensors are designed to measure speed in safety and powertrain applications such as speedometers, ABS, camshafts/crankshafts, and automatic transmissions. They are also used in similar applications in the industrial sector. The sensors use a ferromagnetic gear tooth or encoder structure to measure linear or rotational speed and position. Hall sensor measuring rotational speed with a gear tooth and a magnetic encoder wheel. The majority of sensors also feature additional benefits such as integrated capacitorsfor high EMC robustness and the highest levels of ESD protection.

Typical application of a magnetic differential sensor



Back-bias magnet



Encoder wheels

TLE4922

Highly robust, easy-to-use mono-Hall speed sensor with twist-independent mounting

This sensor is specially designed to provide an easy-to-use, robust and cost-effective solution for vehicle or industrial speed sensing applications. The TLE4922 can, therefore, be back-biased using a simple, low-cost bulk magnet, while providing a good air gap performance and switching accuracy. Its hidden adaptive hysteresis and calibration algorithm enable good accuracy over air gap jumps and immunity to vibration and run-out events.

Features

- Large operating air gap capability
- Flexible mounting (also known as Twist-independent mounting)
- Hidden adaptive hysteresis
- Low current consumption
- Reverse magnetic polarity capability
- Advanced protection technology
  - Reverse voltage protection at V_S-pin
  - Short-circuit protection
  - Overtemperature protection
- Wide operating temperature ranges of -40°C ≤ T_j ≤ ±150°C
- High ESD robustness up to ±4 kV HBM
- 3-wire PWM voltage interface

Applications

- Industrial applications
- Two-wheeler and automotive vehicle speed

TLE4927C E6547

Differential Hall effect crankshaft sensor with hidden adaptive hysteresis

Infineon´s TLE4927C detects the motion and position of ferromagnetic and permanent magnet structures by measuring the differential flux density of the magnetic field. A self-calibration mode ensures optimum accuracy in running mode in just a few transitions after start up. The sensor combines a fast power up time with high accuracy and sensitivity for large operating air gaps. Qualified for automotive temperature range and meets the requirements of harsh environmental conditions prevalent in automotive applications. The TLE4927C comes with the SSO package with two integrated capacitors.

Features

- Differential Hall speed sensor to measure speed and position of tooth/pole wheels
- Ease of use single chip solution in SSO-3-92
- Symmetrical switching point in the middle of the tooth/magnetic pole
- South and north pole pre-induction possible
- Digital output signal (voltage interface)
- Fast start-up time
- Reverse voltage protection at Vs-pin
- Short-circuit and over temperature protection of output
- Automotive operating temperature range

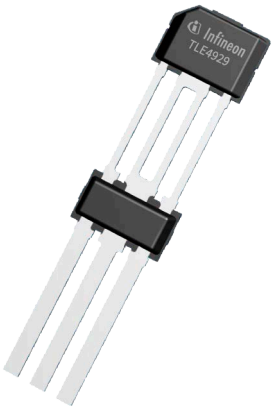
TLE4929

Fully programmable crankshaft sensor with direction detection

The TLE4929 is an active differential Hall sensor ideally suited for crankshaft applications and similar industrial applications, such as a speedometer or any speed sensor with excellent accuracy and low jitter capabilities. It as well addresses new requirements for crankshaft speed sensing from hybrid powertrains. An advanced vibration detection algorithm ensures valid sensor data for any hybrid powertrain traction. This improves efficiency of the engine start and helps to avoid misfiring or ECU error messages caused by wrongly calibrated sensor data. Also, the compatible 3-pin-package allows a one-to-one-replacement of the former generation of crankshaft sensors without direction detection, TLE4924/25/26/27/28, widely backward compatible functionality through flexible EEPROM configuration of parameters, means former TLE492x-family can be mimicked.

Features

- Differential Hall speed sensor to measure speed and position of tooth/pole wheels
- Ease of use single chip solution in SSO-3-52
- Switching point in the middle of the tooth enables backward compatibility
- Robustness over magnetic stray-field due to the differential sensing principle
- Precise miss fire detection through excellent jitter performance
- Dedicated hybrid engine algorithm keeps combustion engine calibrated during an electric drive cycle
- Digital output signal with programmable output-protocol including diagnosis interface
- Direction detection and stop-start-algorithm
- High accuracy and low jitter
- High sensitivity enables large air gap
- End-of-line programmable to adapt engine parameters
- Can be used as a differential camshaft sensor
- Pre-programmed version TLE4929C-XAN available, TLE4929C-X2A available for 2-wheeler applications
- Automotive operating temperature range



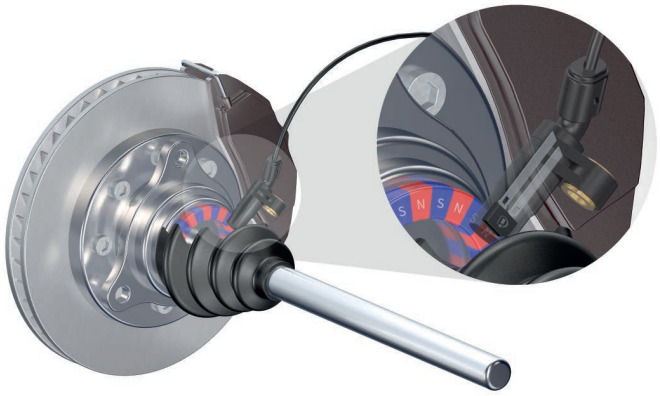
Product	Sensor technology	AEC-Q100 qualified	Direction detection	Automotive	Industrial	Protocol	RoHS
TLE4922	Mono-Hall	●	–	●	●	Single pulse	●
TLE4927	Differential Hall	●	–	●	●	Single pulse	●
TLE4929	Differential Hall	●	●	●	●	PWM, Single pulse	●

Safety first by Infineon wheel speed sensors

Nowadays, wheel speed sensors have to support an ever-growing list of applications. Years ago, ABS systems simply needed to know if a wheel was blocked, and then ESC used the accurate speed of all four wheels for its corrections. Since then, an increasing number of modules in the car take the wheel speed into account for their intelligent functions. The electrical parking brake, for example, needs to know about every inch a car moves when it's supposed to be stationary, and iTPMS uses sophisticated algorithms to determine if a wheel lacks air pressure, and even the central locking locks the doors after a couple of meters and the radio turns up the volume in line with increasing speed. All of the above rely on accurate information from the wheel speed sensor.

Applications

- Wheel speed sensing in automotive applications
- Antilock Braking Systems (ABS)
- Electronic Stability Programs (ESP)
- Automatic transmissions
- iTPMS TLE5041plusC, TLE5045iC and TLE5046iC



TLE4941plusC / TLE4942-1C / TLE4943C

My car, how fast and how far does it drive?

The TLE4941plusC, our best selling sensor, has become an industry standard for wheel speed sensing. TLE4942-1C and TLE4943C are complementing this sensor with additional direction information using PWM or AK protocol, respectively.

As a single chip sensor it magnetically measures the cars wheel speed with its differential Hall technology, making it the ideal all-purpose sensor, equally suitable for pole wheel and steel wheel applications. Theses sensors are immune towards any kind of undesired magnetic stray fields, ferromagnetic particles or other disturbances, because of their differential principle.

Features

- Family of Hall sensors available with and without direction detection
- Excellent stray field robustness

Applications

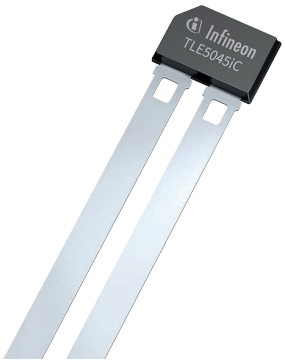
- Pole wheel applications
- Steel/tooth wheel applications by using back bias magnet

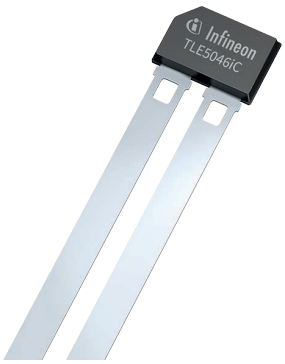
Product	Sensor technology	Pole wheel	Steel wheel	ISO 26262	Direction detection	Protocol	iTPMS
TLE4941plusC	Hall differential	●	●	Compliant	–	Standard	–
TLE4942-1C	Hall differential	●	●	–	●	PWM	–
TLE4943C	Hall differential	●	●	–	●	AK	–

www.infineon.com/speed-sensors

TLE5045iC / TLE5046iC
High end GMR wheel speed sensors

iGMR





The TLE5045/46iC is Infineon's next generation wheel speed sensor family based on GMR technology. The family consists of a designed-to-cost speed-only TLE5045iC, and a high-end TLE5046iC providing not only direction detection but also offering true "zero-speed" capability as well as possibilities of self-diagnostics.

TLE5045iC and TLE5046iC are developed according ISO 26262 to fulfill ASIL B, supporting ASIL D systems. The TLE5046iC with direction detection is available with PWM or AK protocol.

Features

› One family of speed sensors for all wheel speed sensing applications in same package
› Best in class in sensitivity, jitter and duty cycle, independent from magnetic target wheel
› "Zero speed" capability
› ISO 26262 compliant ASIL B development, supporting system ASIL D
› Multiple protocol variants with and without self-diagnosis functionality
› Integrated circuitry for improved EMC and ESD robustness even without external capacitor

Applications

› Pole wheel applications
› Autonomous driving (e.g. park assist)

Product	Sensor technology	Pole wheel	Steel wheel	ISO 26262	Direction detection	Protocol	iTPMS
TLE5045iC	iGMR differential	●	–	Compliant	–	Standard	●
TLE5046iC-PWM	iGMR differential	●	–	Compliant	●	PWM	●
TLE5046iC-AK	iGMR differential	●	–	Compliant	●	AK	●

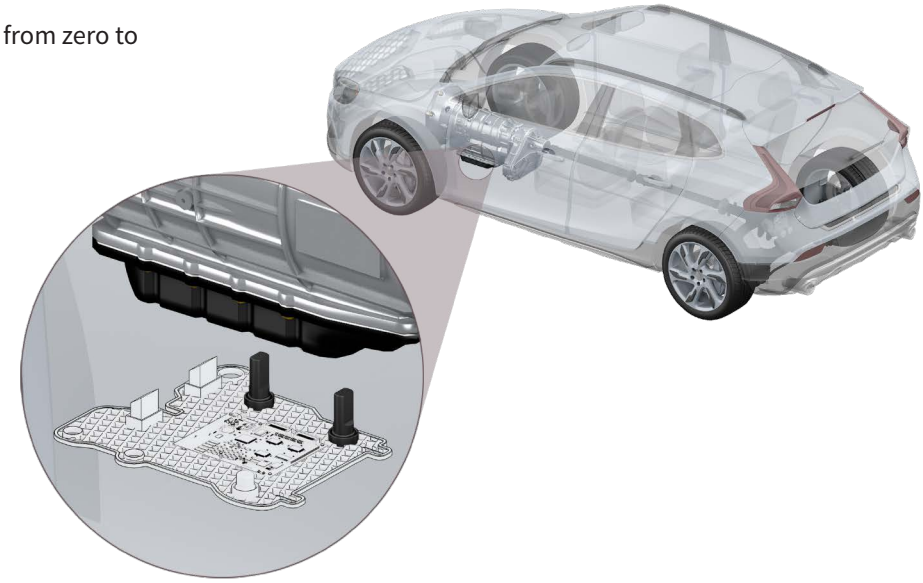
www.infineon.com/speed-sensors

TLE4953C
The two-wire transmission speed sensor

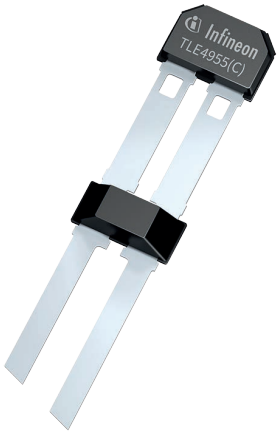
The differential Hall sensor TLE4953C can detect direction and was developed specifically to meet the needs of high-end transmission applications. Its jitter performance and high sensitivity enables designers to create high-accuracy systems with excellent vibration suppression. Adaptive hysteresis and the dynamic self-calibration algorithm ensure outstanding measurement results with both fine and coarse target wheels. As with other Infineon speed sensors, the south and north poles can be pre-inducted. TLE4953 features a current interface and comes in a two-wire package with an integrated 1.8 nF overmolded capacitor for improved EMC.

Features
- Detection of rotation direction
- Highly accurate speed measurements from zero to 12 kHz over large operating air-gaps
- Excellent vibration suppression
- Broad operating temperature range
- AEC-Q100 qualified

Applications
- Automatic transmission systems
- Industrial speed sensing using current sensor interfaces



TLE4955(C)
Leading the way in vibration robustness



TLE4955 is a new family of differential Hall sensors specifically designed to meet the latest requirements in transmission vibration suppression. It provides best-in-class vibration suppression for applications, that require a two-wire current interface. The TLE4955 family provides a similar algorithm plus dynamic self-calibration, jitter and sensitivity levels as our proven TLE4953, thus ensuring accurate speed measurements in the harshest of environments for both fine and coarse target wheels.
Designers can choose different interface protocol versions.

Features
- Detection of rotation direction
- Best-in-class vibration suppression
- Highly accurate speed measurements from zero to 12 kHz over large operating air-gaps
- Broad operating temperature range
  – Four different interface protocols
- AEC-Q100 qualified

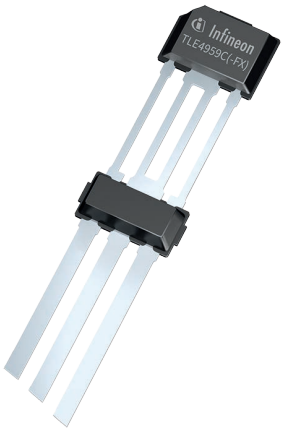
Applications
- Automatic transmission systems
- Industrial speed sensing using current sensor interfaces

www.infineon.com/speed-sensors

TLE4959C, TLE4959C-FX

State-of-the-art three-wire transmission speed sensor with direction detection

With our TLE4959 you now can also address your 3-wire applications with the latest state-of-the art technology of IFX transmission sensors. Differential Hall sensor TLE4959 is your choice when you need a 3-wire-sensor with direction detection and active vibration suppression. Beside it's outstanding airgap and best of class Hall jitter performance, with it's high immunity against strayfields it is the ideal match not only for traditional transmissions but also particularly for hybrid applications.



While TLE4959C is provided with the standard protocol, the FX version gives access to different protocols (e.g. speed only) as it is to be programmed at the customer's premises.

Features

- Active vibration suppression
- Highly accurate speed measurements from 0 Hz to 10 kHz over large operating air-gaps (up to 20k for -FX)
- Common three-wire voltage interface
- Broad operating temperature range
- AEC-Q100 qualified
- FX version customer programmable (protocol, hysteresis level)

Applications

- Automatic (hybrid) transmission systems

TLE4959-5U, TLE4959-5U-FX

State-of-the-art 4-wire transmission speed sensor with direction detection

Infineon released its new transmission speed sensors, the XENSIV™ TLE4959-5U and the TLE4959-5U-FX. These are 4-wire voltage interface differential hall speed sensor for transmission speed applications with vibration suppression and direction detection output. The FX version flexible in terms of protocol, it has customer programmable EEPROM.

State-of-the-art 4-wire transmission speed sensor with direction detection. The TLE4959-5U (FX) is an integrated differential Hall speed sensor ideally suited for transmission applications. Its basic function is to provide rotational speed and direction of rotation information to the transmission control unit. Sophisticated vibration suppression with excellent air-gap performance. TLE4959-5U (FX) includes a sophisticated algorithm which actively suppresses vibration while keeping excellent air-gap performance.

Features

- Voltage interface
- Active vibration suppression
- Direction detection output
- Dynamic self-calibration
- 0 Hz capability
- FX: flexible protocol through customer programmable EEPROM

Target applications

- Automatic transmission applications
- Transmission applications with speed with direction detection

www.infineon.com/speed-sensors

TLE4983 / TLE4984
Mono-Hall based Camshaft speed and position sensors

The TLE4983C, TLE4984C are active Hall sensor ideally suited for camshaft applications in automotive. Its basic function is to map either a tooth or a notch of a gear into a unique electrical output state, while the magnetically bipolar TLE4983C can map also a magnetic encoder wheel. The implemented electrical trimming option for post-fabrication trimming sets the sensor's switching points. This ensures its true power on capability (TPO) even in the case of production spreads such as different magnetic configurations or misalignment. Additionally, a self-calibration algorithm has been implemented to achieve optimum accuracy during normal running operation. The TLE4984C/83C come in a three-pin package SSO-3-9 that has two integrated capacitors for enhanced EMC and micro break performance.

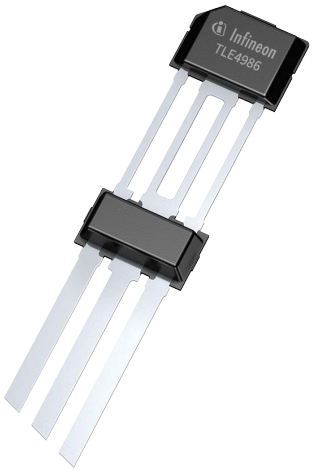
Features

- True Power On functionality (TPO)
- Programmable switching points
- Pre-programmed temperature coefficient for SmCo back-bias magnet
- Single chip solution in SSO-3-9 package
- Twist-Independent Mounting (TIM) for larger fabrication tolerances
- Advanced performance by dynamic self-calibrating principle
- High accuracy and high stability of the magnetic switching points
- High resistance to mechanical stress
- Digital output signal (voltage interface)
- Short-circuit protection
- Enhanced ESD performance
- Automotive qualified

TLE4986

Mono-Hall based Camshaft speed and position sensor

The TLE4986C is an active Hall sensor ideally suited for camshaft applications and similar industrial applications such as speedometer. Its basic function is to map either a tooth or a notch into a unique electrical output state. It has an electrical trimming option for post-fabrication trimming in order to achieve true power on (TPO) capability even in the case of production spreads such as different magnetic configurations or misalignment. Additionally, a self-calibration algorithm has been implemented to achieve optimum accuracy during normal running operation, which by its EEPROM is adaptable in various performance affecting parameter. It comes in a three-pin SSO-3-52 package for the supply voltage and an open drain output.



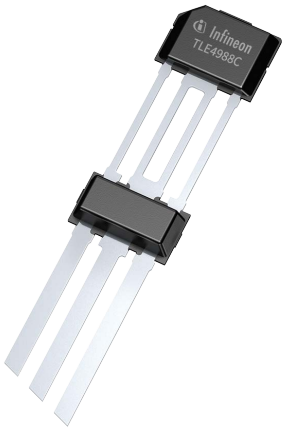
Features

- Hall switching sensor to measure speed or phase of pole/tooth wheels
- Digital output signal (voltage interface)
- Mono-cell chopped Hall system
- TPO True Power On functionality
- TIM Twisted Independent Mounting
- Dynamic self-calibrating algorithm
- IST Individual Switching Threshold
- End-of-line programmable switching points
- EEPROM for various algorithm options
- TC of back-bias magnet pre-programmed
- High resistance to mechanical stress
- Enhanced immunity against ESD and EMC
- Improved µ-cut capability
- Enhanced operating temperature range
- Module package SSO-3-52

TLE4988C

Mono-Hall based Camshaft speed and position sensor with reduced dependence on rare-earth backbias magnets

The Infineon XENSIV™ TLE4988C products feature advanced camshaft sensing performance and improved application adaption. One major benefit of the advanced sensor performance is the reduced dependence from rare-earth backbias magnets for module manufacturers. The TLE4988C has proven right performance with a ferrite backbias magnet for all relevant parameters such as phase jitter, phase accuracy or speed effect across key temperature, air gap and rpm ranges. With automatic in-car TPO calibration a most accurate start up sensing in real application environment is ensured addressing tolerances of ferromagnetic wheels and magnetic encoders, as well as mounting tolerances of the sensor. Infineon´s TLE4988C products are available optimized for the use with three different backbias magnet materials, such as Fe, SmCo and NdFeB. All products come inside the well-established Camshaft sensor package SSO-3-52, allowing low design switch effort in terms of package and performance compatibility with predecessor products.



Features

- Digital output signal (voltage interface)
- True Power On functionality (TPO)
- Auto TPO – automatic in car calibration
- Improved switching level/phase accuracy
- TC range including ferrite
- High speed digital interface for diagnosis / test
- Twisted Independent Mounting (TIM)
- EEPROM for algorithm options and ID
- Increased ESD and EMC immunity, improved µCut feature
- Digital magnet temperature compensation
- Mechanical stress compensation
- Module package SSO-3-52

Product	Sensor technology	Magnet TC	Automotive	Industrial	Protocol	RoHS
TLE4983	Mono-Hall	SmCo	●	●	Single pulse	●
TLE4984	Mono-Hall	SmCo	●	●	Single pulse	●
TLE4986	Mono-Hall	SmCo	●	●	Single pulse	●
TLE4988	Mono-Hall	SmCo, NdFeB, Fe	●	●	Single pulse	●

Magnetic speed sensors – overview

	Icon/ Description	TLE4922	TLE4927	TLE4929	TLE4941plusC	TLE4942	TLE4943	TLE4953	TLE4955	TLE4959	TLE4983/ TLE4984	TLE4986	TLE4988	TLE5041plusC	TLE5045	TLE5046
Automotive	Wheelspeed	●	–	–	●	●	●	–	–	–	–	–	–	●	●	●
	Wheelspeed/ Transmission	–	–	–	●	●	–	–	–	–	–	–	–	–	–	–
	Transmission	●	–	–	●	●	–	●	●	●	–	–	–	–	–	–
	Transmission/ Engine	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Engine	●	●	●	–	–	–	–	–	–	●	●	●	–	–	–
Industrial		●	●	●	●	–	–	–	–	–	–	–	–	–	–	–
Sensor technology		Mono-Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Mono-Hall	Mono-Hall	Mono-Hall	iGMR	iGMR	iGMR
Improved air-gap/jitter performance		–	–	●	–	–	–	–	–	●	–	●	●	●	●	●
Direction information available		–	–	●	–	●	●	●	●	– / ● [3]	–	–	–	–	–	●
True Power On (TPO)		–	–	–	–	–	–	–	–	–	●	●	●	–	–	–
Twist-Independent Mounting (TIM)		●	–	–	–	–	–	–	–	–	●	●	●	–	–	–
Vibration suppression algorithm included		–	–	●	–	–	–	●	●	●	–	–	–	–	–	–
Type of hysteresis [1]		H	H	H/V	H	H	H	V	V	V	H	H	V/H	H	H	H
		A	A	A/F	F	F	A	A	A	A	–	P/A	P/A	F	A	A
Interface [2]	# of pins	4	3	3	2	2	2	2	2	3/4	3	3	3	2	2	2
	Interface	V	V	V	C	C	C	C	C	V	V	V	V	C	C	C
	Protocol	S	S	S/P	S	P	AK	P	P	P	S	S	S	S	S	P/AK
Electrostatic Discharge (ESD)	Human Body Model (HBM)	3 kV	6 kV	6 kV	12 kV	12 kV	12 kV	12 kV	12 kV	6 kV	–	6 kV	6 kV	12 kV	12 kV	12 kV
Package without integrated capacitor		●	–	–	–	–	–	●	●	●	–	–	–	–	●	●
Package with integrated capacitor		–	●	●	●	●	●	●	●	●	●	●	●	●	–	–

1) H = Hidden; V = Visible; F = Fixed; A = Adaptive; P = Programmable
2) AK = AK protocol; C = Current; V = Voltage interface; S = Single pulse; P = PWM protocol
3) Depending on derivative

Pressure sensors

For automotive, industrial and consumer applications - ensure the perfect fit for all performance and integrity needs

Infineon XENSIV™ pressure sensors measure the pressure of air and gases across various industries and applications. In their function as a pressure transducer sensor, they convert physical pressure into an electric signal. Infineon XENSIV™ pressure sensors combine the functions of sensing (via a pressure sensor element) and conversion into an electrical signal (via an absolute pressure transducer and signal processing) in one integrated silicon device.

The sensor element and its integrated circuits (IC) are the heart of pressure sensor technology. Infineon's small pressure sensor IC chips support various applications with best-in-class performance. Infineon is one of the world's largest semiconductor pressure sensor and transducer manufacturers, thanks to a varied portfolio of absolute air pressure sensor ICs. Our comprehensive family of XENSIV™ sensors includes a wide selection of pressure-sensitive sensors tailored specifically to the automotive, consumer and industrial sectors. XENSIV™ sensors are compact, designed to save energy, and offer a rapid time-to-market – a perfect fit for any performance and integrity need.

www.infineon.com/pressure

Cars have to act and perform in the same way whether driving along a coast or through mountains. As a result of different locations, the composition and the quality of the air around changes. It is important that the engine react immediately to these changes. Infineon offers various pressure sensors for barometric measurements with analog and digital interface and various pressure ranges.

Powertrain systems have to fulfill the constantly increasing stringent media requirements. Environmental legislation aims to deliver cleaner air by ensuring a steady global decrease in CO_2 emissions. Thanks to their accurate measurement capability, Infineon MAP and turbo MAP product with analog or digital interface enable engines to meet these requirements.

Typical safety-related automotive pressure sensing applications such as side impact and pedestrian protection call for the highest quality and accuracy standards with full ISO 26262 compliance. Every year thousands of pedestrians are severely injured in traffic due to slow or failing sensing elements. Our Infineon XENSIV™ safety pressure sensor family includes integrated pressure sensors that tick all these boxes with PSI5 peripheral sensor interfaces for safety-critical use cases. Our sensors support new safety systems, increasing the protection of pedestrians and car occupants in the event of a collision.

Our family of digital barometric pressure sensors also gives designers the best choice when it comes to mobile and wearable devices. Highlights include small form factors to facilitate system integration, highest precision and relative accuracy over a wide temperature range, fast read-out speeds via the serial I^2C/SPI interface, and low power consumption to ensure longer battery lifetimes.

Infineon's tire pressure sensors perform all of the functions necessary to implement a state-of-the-art module for a Tire Pressure Monitoring System (TPMS). As part of our XENSIV™ Pressure Sensors portfolio, our SP40 TPMS sensor ICs are easy to integrate and feature a microcontroller, sensors, wireless communication, and convenient peripherals. They only need a few passive components and a battery to complete a full automotive TPMS sensor assembly.

Automotive applications

- Barometric absolute pressure
- Seat comfort systems
- Manifold absolute pressure
- Exhaust gas recirculation
- Secondary air valve
- Fuel vapor/ORVR
- Natural gas vehicle
- Side crash detection
- Pedestrian impact detection
- Battery monitoring for EV
- Brake booster
- 2-wheeler ECU and MAP
- Valve based TPMS modules
  - OEM
  - Aftermarket
  - Retrofit
  - In tire TPMS modules

Industrial applications

- Industrial and process controls
- Gas flow
- Level meter
- Barometric pressure
- Altitude compensation systems
- Weather stations
- Engine management systems
- Medical equipment

Consumer applications

- Smartphones and tablets
- Smart watches and wearables
- Predictive maintenance in HVAC systems
- Smart home
- Home appliances
- Multicopter and other IoT use cases

www.infineon.com/pressure

Barometric (BAP) & Manifold (MAP) sensors

Infineon's pressure sensors offer the highest quality and accuracy for safety-relevant automotive, industrial, or consumer lifestyle applications. Typical safety-related automotive pressure sensing applications such as side-impact and pedestrian protection call for the highest quality and accuracy standards with full ISO 26262 compliance. Our XENSIV™ family includes integrated pressure sensors that tick all these boxes with PSI5 peripheral sensor interfaces for a safety-critical use case.

Discover our highlight product dedicated to **2-wheelers: KP212 enables lower CO_2 emissions**, as well as lower fuel consumption, which makes it the right fit product worldwide to fulfill emission regulation requirements such as CN6 and Bharat 6. Of course, these sensors can also be used in industrial control, consumer applications, as well as medical applications.

KP21x / KP22x – Analog manifold air pressure sensor IC family (MAP + turbo MAP)

Features

- Manifold air pressure measurement – MAP and turbo MAP
- Excellent accuracy of up to 1.0 kPa over a large temperature range
- Ratiometric analog voltage output proportional to the applied pressure
- Output signal fully compensated over pressure and temperature
- Pressure range from 10 to 400 kPa
- Temperature range from -40 to +140°C
- Output clamping (optional)
- Complete product family available with multiple transfer function
- Reverse polarity protection
- Green SMD package

www.infineon.com/bap-map-pressure

KP23x – Analog barometric air pressure (BAP) sensor IC family

Features

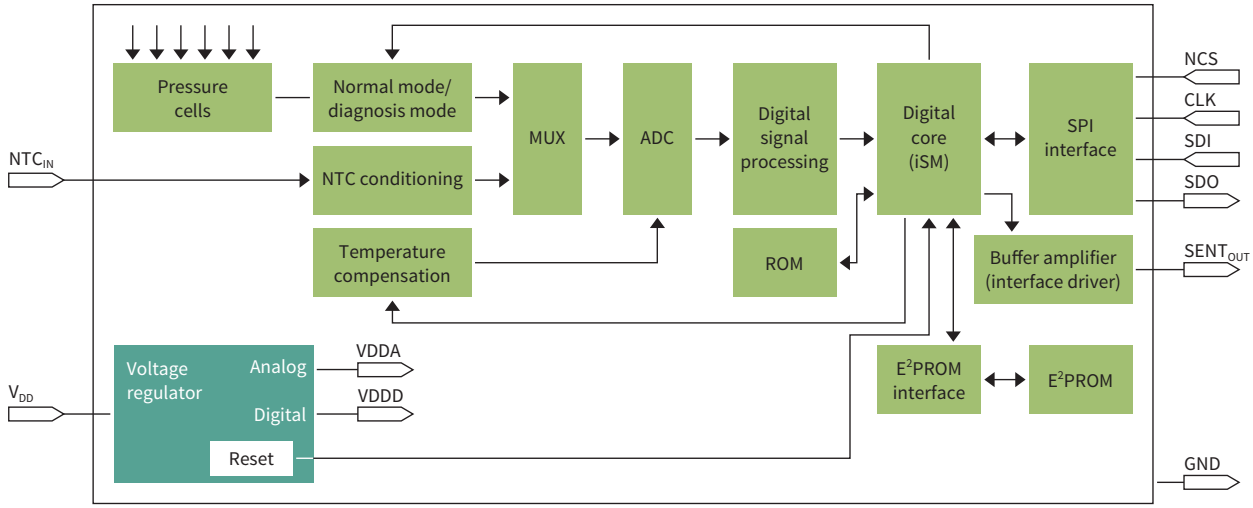
- Absolute air pressure measurement
- Excellent accuracy of 1.0 kPa over a large temperature range
- Ratiometric analog voltage output proportional to the applied pressure
- Output signal fully compensated across pressure and temperature range
- Pressure range from 15 to 165 kPa
- Temperature range from -40 to +125°C
- Serial service interface
- Open Bond Detection (OBD) for supply and GND
- Inverse polarity protection
- Green SMD package

KP25x / KP264 – Digital barometric air pressure (BAP) sensor IC family

Features

- Absolute air pressure measurement
- Excellent accuracy of 1.0 kPa over a large temperature range
- Real 10-bit pressure resolution
- Integrated temperature sensor
- Real 10-bit temperature resolution
- Power-down mode for reduced power consumption
- Self diagnosis features
- Output signal fully compensated across pressure and temperature range
- Pressure range from 10 to 165 kPa
- Temperature range from -40 to +125°C
- Green SMD package
- ISO 26262 ready

Block diagram



ISO 26262 ready

www.infineon.com/bap-map-pressure

KP46x digital barometric air pressure family in new DFN-8 package

Features

- High accuracy pressure sensing (±1.0 kPa)
- Pressure range 40 to 115 kPa
- Operating ambient temperature range -40...+125°C
- Best-in-class low power consumption with dedicated power-down mode for energy saving
- 10-, 12- or 14-bit resolution pressure and temperature values via SPI interface and backwards compatibility to KP253/KP256
- Integrated signal path diagnosis features
- Green, small 4.5×5.1 mm 8-pin DFN package

Product	Operating pressure range [kPa]	P-accuracy -40°C [kPa]	P-accuracy +125°C [kPa]	T-accuracy +25…+125°C [°C]	Supply current I_{VDD} [mA]	Supply current power down I_{VDD_PD} [µA]
KP464 [1]	40… 115	±1.5	±1.5	±3	3.5 (without SPI comm.)	10
KP464E [1]	40… 115	±1.5	±2.0	±3	3.5 (without SPI comm.)	10
KP466 [1]	60… 165	±4	±2.0	±3.5	3.5 (without SPI comm.)	10

1) Available Q2/2023

KP276 – Media robust MAP sensor with digital interface

Features

- Media robustness for current automotive requirements
- Digital single edge nibble transmission (SENT) interface (282 clock ticks)
- Excellent accuracy of ±0.77 percent FSS
- Green SMD package
- Temperature range -40 to +170°C (170°C for 20 min. max., 150°C operating)
- Integrated NTC temperature sensor functionality with fast start up time (typ. 10ms)

Integrated pressure sensor ICs for manifold and barometric air pressure

Product	Max. accuracy [kPa]	Max. operating temperature [°C]	Automotive	Industrial	ISO 26262	Pressure range [kPa]
KP21x	1.0	140	●	●	–	10 ... 150
KP22x	2.5	140	●	●	–	10 ... 400
KP23x	1.0	125	●	●	–	15 ... 115
KP236N6165	1.0	125	●	●	–	60 ... 165
KP253	1.0	125	●	●	Ready	60 ... 165
KP254	1.5	125	●	●	Ready	40 ... 115
KP255	1.4	140	●	●	Ready	10 ... 125
KP256	1.0	125	●	●	Ready	60 ... 165
KP264 [1]	1.5	125	●	●	Ready	40 ... 115
KP276	3.0	170	●	●	Ready	10 ... 400

1) Package with small 4-hole lid

For more information on the product, contact our product support.

ISO 26262 ready

www.infineon.com/bap-map-pressure

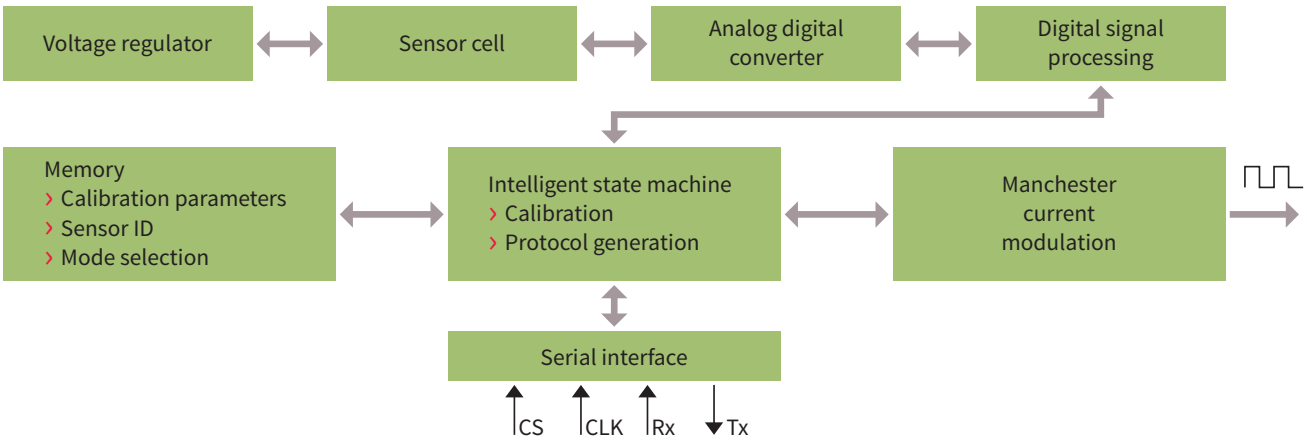
KP200 / KP201 / KP204

PRO SIL 1)

PSI5 PRO-SIL™ ready pressure sensor ICs for side crash detection and pedestrian protection

Features

- Two-wire interface with on-chip current modulator for PSI5 communication
- Fully PSI5 compliant with support for multiple modes
- Synchronous or asynchronous data transmission
- EEPROM for unique ID number, calibration and mode selection
- Serial service interface for EEPROM programming
- On-chip voltage regulator
- Reverse polarity protection
- Fully AK-LV29 and AK-LV38 compliant
- Patented on-chip diagnosis of pressure cells and circuitry
- PRO-SIL™ support in line with IEC 61508 and ISO 26262
- Green SMD package
- KP201 qualified for higher operating temperatures up to 125°C
- KP204 with 4-hole lid supporting insect intrusion protection



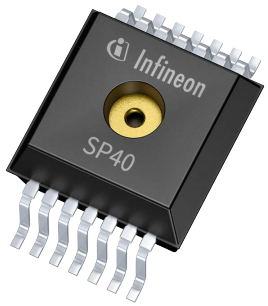
Product family KP20x	Key features of KP201 and KP204	ISO 26262
KP200 / KP201 / KP204	KP201 qualified for higher operating temperatures up to 125°C KP204 with 4-hole lid supporting protection against insect intrusion	Ready

1) More information on PRO-SIL™, see page 115

PRO SIL ISO 26262 ready

SP40+

Tire pressure sensor for Tire Pressure Monitoring Systems (TPMS)



SP40+ provides a very high level of integration and is optimized to perform all of the functions necessary to implement a state-of-the-art sensor module for Tire Pressure Monitoring System (TPMS). With its integrated microcontroller, sensors and convenient peripherals, the SP40+ needs the addition of only a few passive components and a battery to complete a full TPMS module.

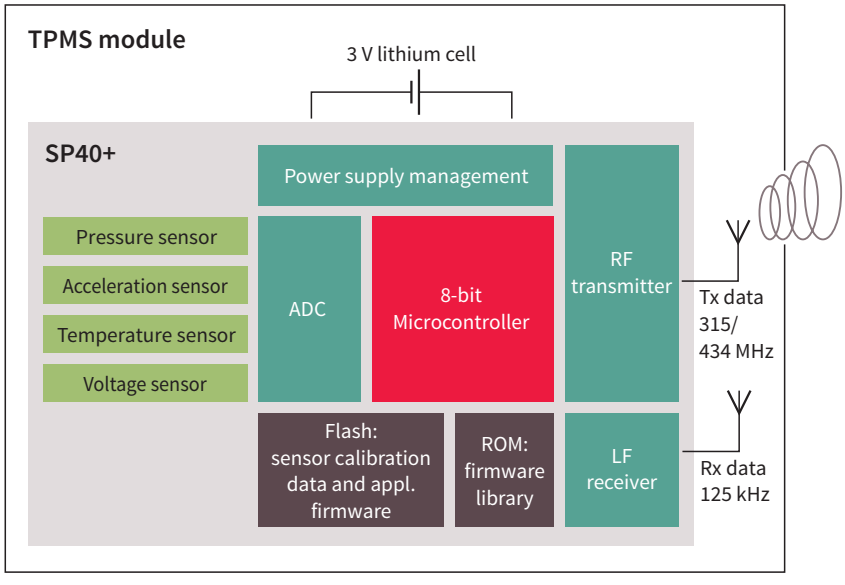
SP40+ measures pressure, radial acceleration, temperature and supply voltage and is certified as a green package compliant with RoHS. SP40+ comes with a pressure-auto-ranging feature, providing best-in-class pressure-accuracy in the range from 100 to 1400 kPa, making it the ideal choice for all car types from passenger vehicle to heavy trucks.

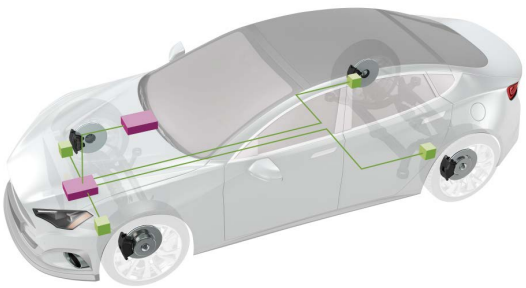
Compared to the previous generation SP37, the SP40+ family offers even lower current consumption and more features like larger flash, better sensor accuracy and higher pressure range.

Features

- Pressure sensor
- Radial acceleration sensor
- Temperature sensor
- Supply voltage sensor
- Embedded 8051 compatible 8-bit microcontroller
- 12 kB on-chip flash memory, plus optional additional 2 kB (for example for LF bootloader)
- 160 Byte retention RAM
- 315 and 434 MHz FSK/GFSK/OOK/ASK RF transmitter
- RF output power of 5 dBm
- 125 kHz ASK high-sensitivity LF receiver
- Advanced power control/wake-up system to minimize battery charge consumption
- Ultra-low power down current of < 540 nA
- Supply voltage range from 1.6 to 3.6 V
- Operating temperature range from -40 to +125°C
- DSOSP-14-82 package
- RoHS compliant, green package

Product	Pressure range [kPa]	On-chip flash memory [kB]	Key features
SP400-11-01	100–900	12	› Highest integration › Very low energy consumption › Robust g- and p- sensor › High LF sensitivity
SP400-11-11	100–900	12 + 2	
SP400-15-11	100–1400	12 + 2	





SP40+ fully supports all necessary requirements for a Tire Pressure Monitoring System (TPMS)

www.infineon.com/tpms-sensors

Digital barometric pressure sensors

For mobile and wearable devices

Infineon's digital barometric pressure sensor family is the best choice for mobile and wearable devices due to its small form factor, high precision, and low power consumption. Pressure sensing is based on capacitive technology, which guarantees ultrahigh precision (±2 cm) and excellent relative accuracy (±0.06 hPa) over a wide temperature range. The sensor's internal signal processor converts the output from the pressure and temperature sensor elements to 24-bit results. Each pressure sensor has been calibrated individually and contains calibration coefficients. The coefficients are used in the application to convert the measurement results to true pressure and temperature values. All sensors have a FIFO that can store the last 32 measurements. Since the host processor can remain in a sleep mode for a longer period between readouts, a FIFO can reduce the system power consumption. Sensor measurements and calibration coefficients are available via the serial I^2C/SPI interface.

DPS310

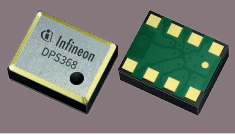
A barometric pressure sensor with very low power consumption is recommended for applications where power consumption is critical and the highest precision in pressure metering is required.

DPS368

DPS368 offers the best-in-class resolution (±2 cm), a very fast read-out speed, and low current consumption. The sensor can be used in harsh environments, as it is robust against water (IPx8 - 50 m underwater for 1 hour), dust and humidity. The small package size saves up to 80 percent of the space and makes the DPS368 ideal for mobile applications and wearable devices.

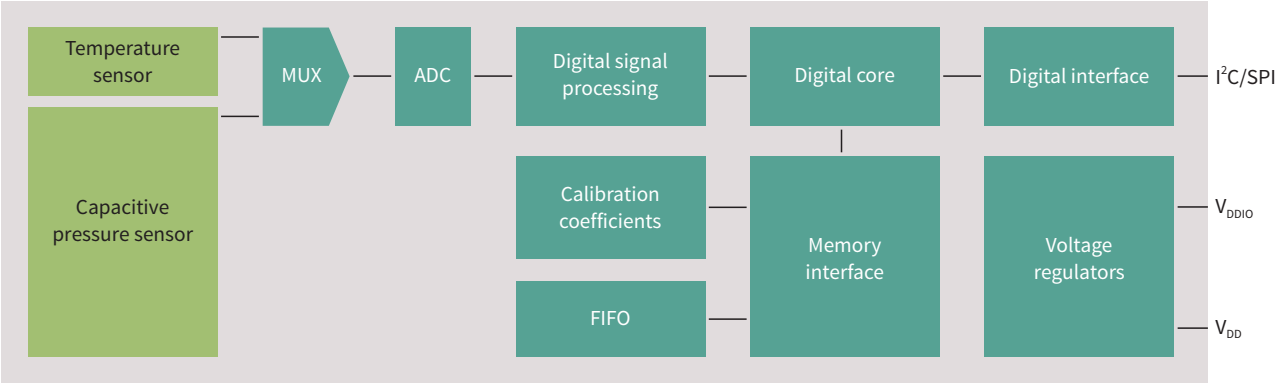
Typical applications

- Drones: altitude detection and height stability
- Health and fitness: accurate elevation gain and step counting (e.g. for smartwatches)
- Outdoor Navigation: GPS start-up time/accuracy improvement; dead reckoning (e.g. in tunnels)
- Indoor navigation: floor detection e.g. in shopping malls and parking garages
- Smart home: micro weather forecasting; room temperature control; intruder detection
- Airflow control: Smart filter replacement alarm (e.g. in home appliances); predictive maintenance
- Health care: fall detection; respiratory devices; smart inhalers

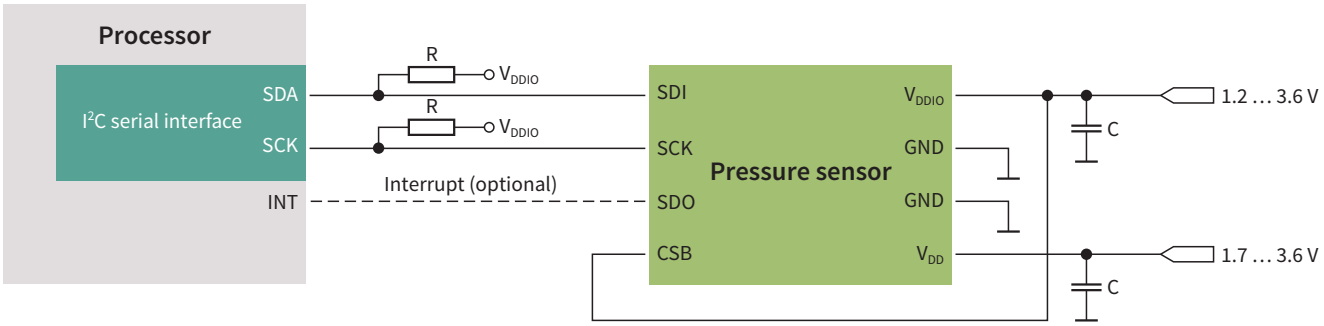
Key product features	DPS310 	DPS368 
Package size	2.0 x 2.5 x 1.0 mm	2.0 x 2.5 x 1.1 mm
Operating pressure range	300 … 1200 hPa	
Operating temperature range	-40 … 85°C	
Pressure level precision	± 0.002 hPa (or ±0.02 m)	
Relative accuracy	± 0.06 hPa (or ±0.5 m)	
Absolute accuracy	± 1 hPa (or ±8 m)	
Temperature accuracy	0.5°C	
Pressure temperature sensitivity	0.5 Pa/K	
Measurement time	3.6 ms (low precision); 27.6 ms (standard mode)	
Average current consumption @ 1 Hz sampling rate	1.7 µA pressure measurement, 1.5 µA temp. measurement, standby 0.5 µA	
Supply voltage	V_{DDIO}: 1.2 – 3.6 V; V_{DD}: 1.7 – 3.6 V	
Operating modes	Command (manual), background (automatic), standby	
Interface	I^2C and SPI, both with optional interrupt	

www.infineon.com/pressure-sensors-iot

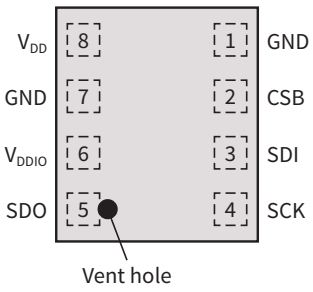
Functional block diagram



Application circuit example (in I²C configuration)



Pin configuration (top view)



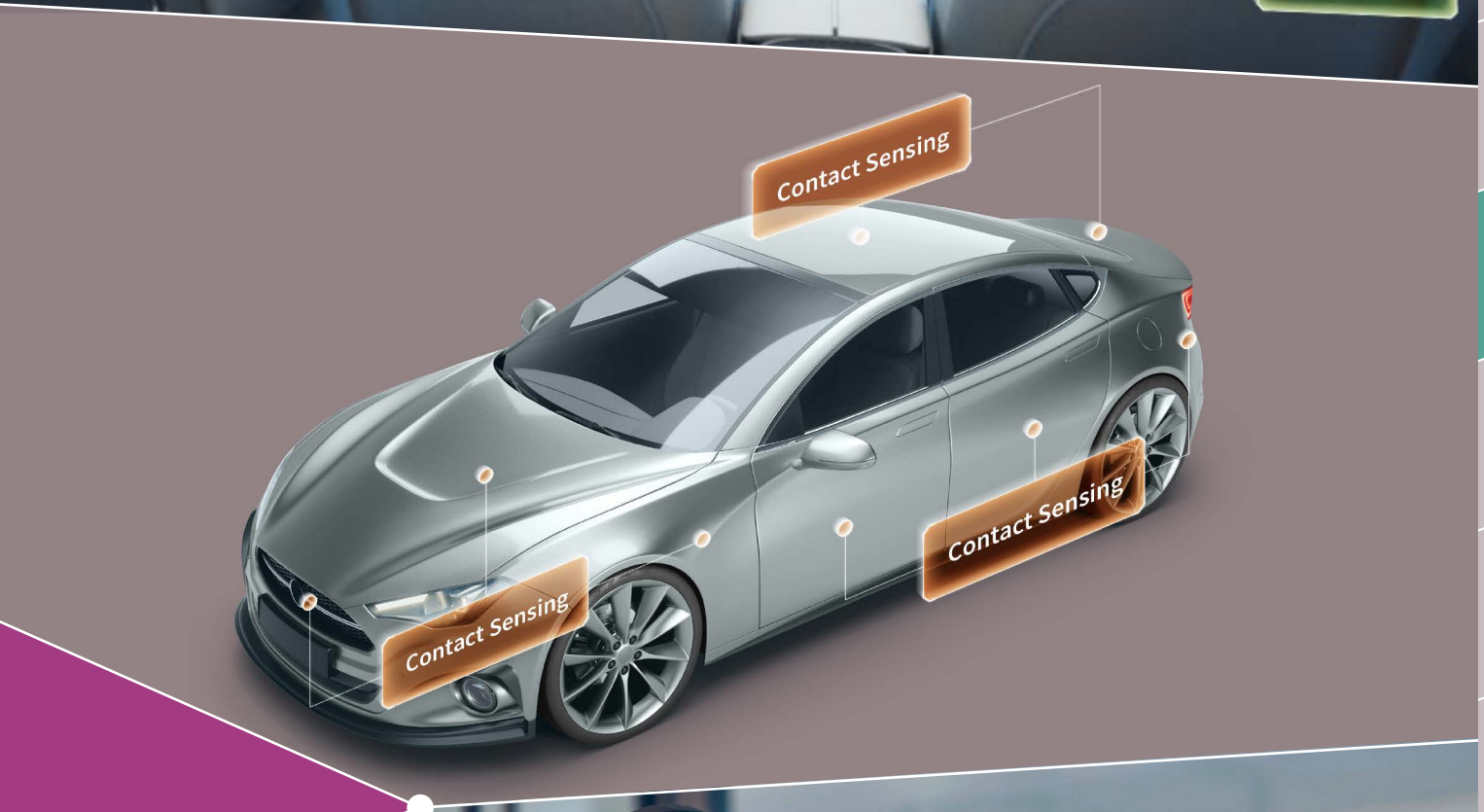
Pin	Name	Function
1	GND	Ground
2	CSB	Chip select
3	SDI	Serial data in/out
4	SCK	Serial clock
5	SDO	Serial data out
6	V_{DDIO}	Digital interface supply
7	GND	Ground
8	V_{DD}	Analog supply

Infineon inside pressure sensor partners

Building upon its best-in-class technology, Infineon offers a full range of barometric pressure sensors as chipsets. Infineon's network of global partners offers customers a comprehensive portfolio of Infineon inside pressure sensors that will propel performance to the next level even for the most demanding applications.

Visit www.infineon.com/pressure-sensor-partners to learn more and purchase our partner solutions.

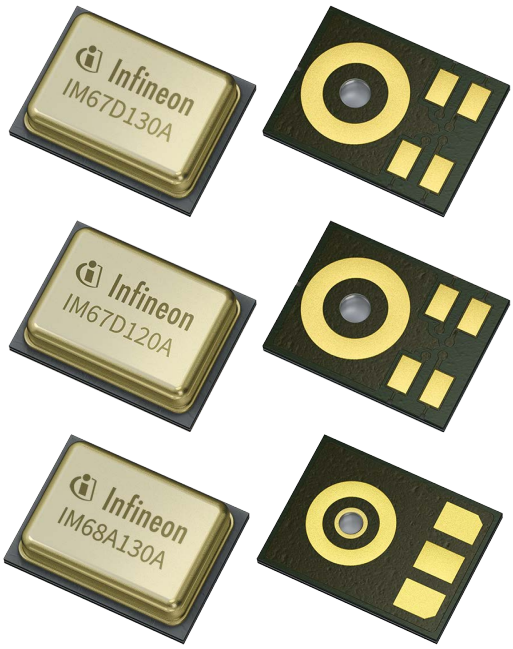

ANC
Speech array
ANC
Speech
Speech
Speech array
Speech array


Contact Sensing
Contact Sensing
Contact Sensing

MEMS microphones for automotive applications

Qualified according to automotive standard, AEC-Q103-003

As part of our comprehensive XENSIV™ sensor family, we also offer high-performance MEMS microphones, qualified according to the state-of-the-art automotive quality standard AEC-Q103-003. These microphones close the gap in the automotive industry, providing the best possible fit for automotive applications.
These automotive XENSIV™ MEMS microphones combine our proven expertise in the automotive industry with our technical leadership in high-end MEMS microphones. They are suited to all applications inside and outside the car, where the best audio performance in harsh automotive environments is required.



Customer benefit

- Automotive qualification according to AEC-Q103, together with long term availability reduces design-in risk and effort
- Increased operating temperature range allows flexible usage in automotive environment up to +105°C
- Best in class audio performance (SNR, AOP, THD) for optimum speech quality and capture of distortion-free audio signals in loud environments such as inside a car
- Narrow sensitivity matching for enhanced performance of beam-forming (noise suppression) arrays
- Flat frequency and stable phase response to < 10 Hz for optimal fit in acoustic noise cancellation use cases (for IM66D130A and IM68A130A, best fit for ANC/RNC automotive applications)

Parametrics	IM66D130A	IM67D120A	IM67D130A	IM68D130A
Acoustic overload point	130 dBSPL	120 dBSPL	130 dBSPL	130 dBSPL
Current consumption	1.300 µA	980 µA	980 µA	105 µA
Interfaces	PDM	PDM	PDM	Analog single-ended output
Sensitivity	-36 dBFS	-26 dBFS	-36 dBFS	-39 dBFS
Signal to noise	66 dB(A)	> 67 dB(A)	> 67 dB(A)	68 dB(A)
Supply voltage	–	1.62 – 3.6 V	1.62 – 3.6 V	–
LFRO	< 10 Hz	28 Hz	28 Hz	< 10 Hz
Ordering code	Coming soon	SP005550431	SP005582032	SP005738297

www.infineon.com/mems-automotive

Typical applications for automotive MEMS microphones in-cabin and outside of the vehicle

Speech: Hands free / e-call / ICC
Enabling distortion free audio capturing for all speech related application thanks to their high SNR and low distortions.

Interior

Speech: Microphone arrays – beamforming voice command
Making possible to operate infotainment systems with voice commands due to their narrow sensitivity matching for enhanced performance of beam-forming arrays .

Interior

Active and road noise cancellation
Enabling a quite environment for comfortable travels, the microphones are a good fit for ANC applications thanks to their flat frequency and stable phase response. IM68A130A and IM66D130A: dedicated product family for ANC with superior performance with analog and digital interface.

Interior

› **Event sound detection / sirens detection / contact detection**
› **Road condition detection**
Contributing to road safety, by detecting sounds like sirens from emergency vehicles or even dangerous road conditions thanks their large dynamic range and acoustic overload point.

Exterior

Voice recognition / external interaction
Allowing external interaction e.g. for controlling certain functions via voice commands due to their good suitability for voice recognition use cases.

Exterior

www.infineon.com/mems-automotive

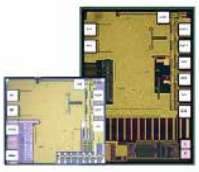
MEMS microphones for consumer applications

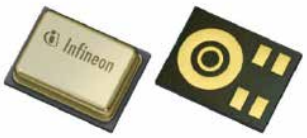
High performance analog and digital MEMS microphones for consumer electronics

Infineon's XENSIV™ MEMS microphones are designed for capturing audio signals with unprecedented precision and quality. The microphones are comprised of Infineon's MEMS microphone chips and ASICs which are not without reason the world's best-selling microphone components.

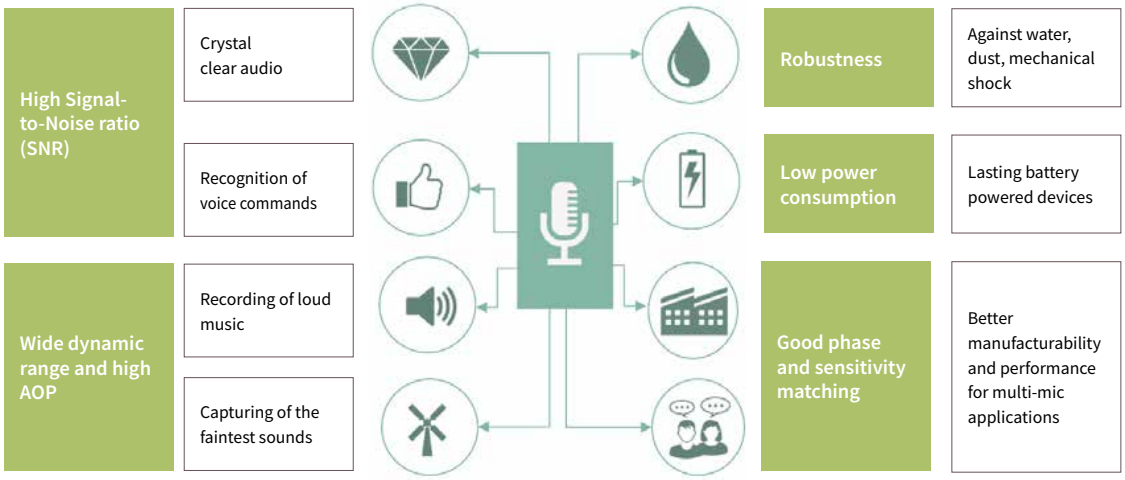
Infineon microphone system

MEMS	ASIC	Package



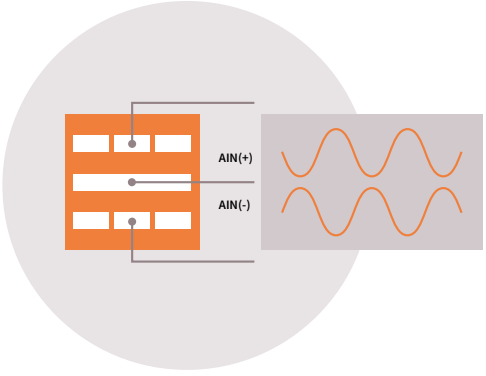


XENSIV™ MEMS microphones feature ultra-low self-noise (high SNR), extremely low distortions (THD) even at high sound pressure levels (SPL), very tight part-to-part phase, and sensitivity matching, a flat frequency response with a low LFRO (low frequency roll-off) and an ultra-low group delay. Combined with selectable power modes and their very small package size, Infineon XENSIV™ MEMS microphones are a perfect match for consumer electronics with excellent audio capturing functionalities and also for selected industrial applications such as predictive maintenance and security.



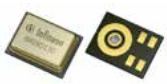
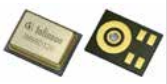
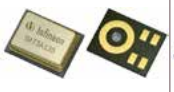
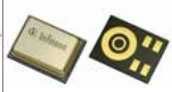
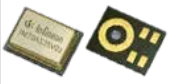
Infineon's Sealed Dual Membrane (SDM) MEMS technology

Infineon's latest Sealed Dual Membrane MEMS technology delivers high ingress protection (IP57) at a microphone level. The sealed MEMS design prevents water or dust from entering between membrane and backplate, preventing mechanical blockage or electric leakage issues commonly observed in MEMS microphones. Microphones built with the sealed dual membrane technology can be used to create IP68 devices, requiring only minimal mesh protection.



www.infineon.com/mems-consumer

Product portfolio

	IM69D130	IM69D120	IM69D127 NEW	IM73A135 NEW	IM72D128 NEW	IM70A135 NEW
						
Environmental robustness			IP57	IP57	IP57	IP57
Sensitivity @ 1 kHz, 94 dBSPL(dBFS)	-36 ±1 dBFS	-26 ±1 dBFS	-34 ±1 dBFS	-38 ±1 dBV	-36 ±1 dBFS	-38 ±1 dBV
Signal-to-noise Ratio (SNR)	69 dB(A) @ 3.072 MHz 64 dB(A) @ 768 kHz	69 dB(A) @ 3.072 MHz 64 dB(A) @ 768 kHz	69 dB (A) @ 3.072 MHz 65 dB(A) @ 768 kHz	73 dB(A) @ 2.75 V 71 dB(A) @ 1.60 V	72 dB(A) @ 3.072 MHz 67 dB(A) @ 768 kHz	70 dB(A) @ 2.75 V 69 dB(A) @ 1.60 V
Acoustic overload point (1/10% THD)	128/130 dBSPL	118/120 dBSPL	123/127 dBSPL	132/135 dBSPL	126/128 dBSPL	130/135 dBSPL
Current consumption	980 µA @ 3.072 MHz 300 µA @ 768 kHz	980 µA @ 3.072 MHz 300 µA @ 768 kHz	980 µA @ 3.072 MHz 300 µA @ 768 kHz	170 µA @ 2.75 V 70 µA @ 1.60 V	980 µA @ 3.072 MHz 280 µA @ 768 kHz	170 µA @ 2.75 V 70 µA @ 1.60 V
Low frequency roll off (LFRO)	28 Hz	28 Hz	40 Hz	20 Hz	20 Hz	37 Hz
Group delay @ 1 kHz	6 µs	6 µs	9 µs	2 µs	7 µs	2 µs
Supply voltage	1.62 to 3.60 V	1.62 to 3.60 V	1.62 to 3.60 V	1.52 to 3.00 V	1.62 to 3.60 V	1.52 to 3.00 V
Interface	Digital PDM	Digital PDM	Digital PDM	Analog differential	Digital PDM	Analog differential
Port location	Bottom port	Bottom port	Bottom port	Bottom port	Bottom port	Bottom port
Package dimensions	4.00 x 3.00 x 1.20 mm³	4.00 x 3.00 x 1.20 mm³	3.60 x 2.50 x 1.00 mm³	4.00 x 3.00 x 1.20 mm³	4.00 x 3.00 x 1.20 mm³	3.50 x 2.65 x 1.00 mm³
Typical applications: TWS earbuds			✓			✓
Typical applications: ANC headphones	✓		✓	✓	✓	✓
Typical applications: Smart speakers	✓	✓		✓	✓	
Typical applications: Conference systems	✓			✓	✓	
Typical applications: Laptops / tablets		✓	✓		✓	
Typical applications: Wearables			✓			✓

Features, applications and use cases

Features

- Ultra-low self-noise/ultra-high SNR
- Selectable power modes
- Sealed Dual Membrane (SDM) technology with ingress protection at microphone level
- Extremely low distortions (THD) even at high sound pressure levels
- High dynamic range and very high acoustic overload points (AOP)
- Very tight part-to-part phase and sensitivity matching
- Flat frequency response with a low LFRO (low frequency roll-off)
- Ultra-low group delay
- Very small package sizes

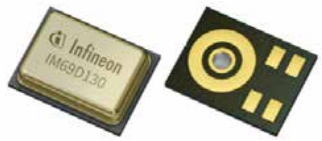
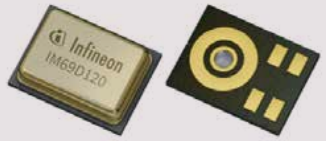
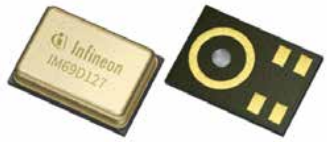
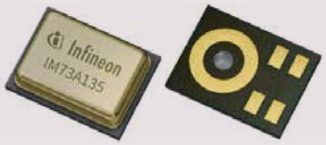
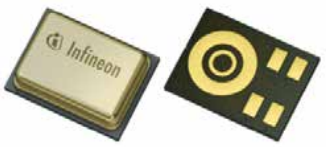
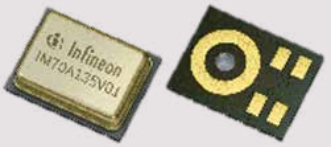
Typical application

- TWS earbuds
- ANC headphones
- Smart speakers
- Conference speakers
- Laptops/tablets
- Wearables
- AR/VR devices

Typical use cases

- Studio quality audio capturing for communication devices
- Low latency wide band audio signal capturing for Active Noise Cancellation (ANC) and transparent hearing functionality
- Battery and size constraint devices
- Multi-microphone (array) based beamforming and source separation for audio zoom features and multi user audio capturing
- High range, far field voice pickup for multi room applications
- Capturing of audio signals in loud environments
- Audio pattern detection for predictive maintenance and security

www.infineon.com/mems-consumer

Product	Description
IM69D130 	IM69D130 is a high-performance digital MEMS microphone making use of Infineon's Dual Backplate MEMS technology to deliver 105 dB dynamic range and high output linearity up to 130 dBSPL. The application benefits are crystal clear audio signals, extended pick-up distance and sensitivity to both soft and loud signals - from whispe-red speech to rock concerts.
IM69D120 	IM69D120 is a high-performance digital MEMS microphone making use of Infineon's Dual Backplate MEMS technology to deliver 95 dB dynamic range and high output linearity up to 120 dBSPL. If IM69D130 is used in a 16 bit audio signal chain, the full SNR performance would not be realized as the noise floor will be limited by the system dynamic range. IM69D120 has been specifically designed to preserve 69 dB(A) SNR in a 16 bit system. This is achie-ved by increasing the microphone sensitivity to -26 dBFS, and reducing the acoustic overload point to 120 dBSPL.
IM69D127 	IM69D127 is a digital high-performance MEMS microphone based on Infineon's new Sealed Dual Membrane MEMS technology which delivers high ingress protection (IP57) at a microphone level. Its small size of only 3.60 x 2.50 x 1.00 mm3 makes it a perfect match for compact audio devices, such as TWS earbuds.
IM73A135 	Infineon's XENSIV™ MEMS analog microphone IM73A135 sets a new performance benchmark in MEMS microphones. A best-in-class signal to noise ratio (SNR) of 73 dB and a high acoustic overload point of 135 dBSPL enable clear audio pick up of the quietest and the loudest sounds. This microphone is based on Infineon's new Sealed Dual Membrane MEMS technology which delivers high ingress protection (IP57) at a microphone level. The IM73A135 allows designers to reach a level of high audio performance that was previously only achievable by ECMs while at the same time reaping the benefits inherent in MEMS technology.
IM72D128 	The IM72D128V01 is an ultra-high-performance digital microphone designed for applications which require a very high SNR (low self-noise) and low distortions (high AOP). This microphone is based on Infineon's new Sealed Dual Membrane MEMS technology which delivers high ingress protection (IP57) at a microphone level. The flat frequency response (20Hz low-frequency roll-off) and tight manufacturing tolerance improve performance of multi-microphone (array) applications. The digital microphone ASIC contains an extremely low-noise preamplifier and a high-performance sigma-delta ADC. Different power modes can be selected in order to suit specific clock frequency and current consumption requirements. Each IM72D128V01 microphone is calibrated with an advanced Infineon calibration algorithm, resulting in very low sensitivity tolerances (± 1dB).
IM70A135 	Infineon's XENSIV™ MEMS analog microphone IM70A135 is a compact high performance microphone with a very high acoustic overload point of 135 dBSPL and a size of only 3.50 x 2.65 x 1.00 mm3. This microphone is based on Infineon's new Sealed Dual Membrane MEMS technology which delivers high ingress protection (IP57) at a microphone level. The small size makes this microphone especially suited for TWS earbud applications.

EVAL AHNB IM69D130V01

Enables the evaluation of Infineon digital XENSIV™ MEMS microphones

The Infineon Audiohub Nano enables the evaluation of Infineon digital PDM XENSIV™ MEMS microphones. The kit includes an Infineon Audiohub Nano and four IM69D130 digital microphones on flex board. Up to two Infineon digital XENSIV™ MEMS microphones can be connected to the evaluation board in mono or stereo output. The evaluation board provides a USB audio interface to stream audio data from the microphone with any audio recording and editing software.

Summary of features

- Audio streaming over USB interface
- 48 kHz sampling rate
- 24-bit audio data (stereo)
- Mode switch for toggling between normal mode and low power mode with 4 pre-defined gain configurations
- LEDs indication for the configured gain level in normal mode and low power mode
- Volume unit meter display with on board LEDs
- Powered through Micro-USB

EVAL AHNB ANALOGV01

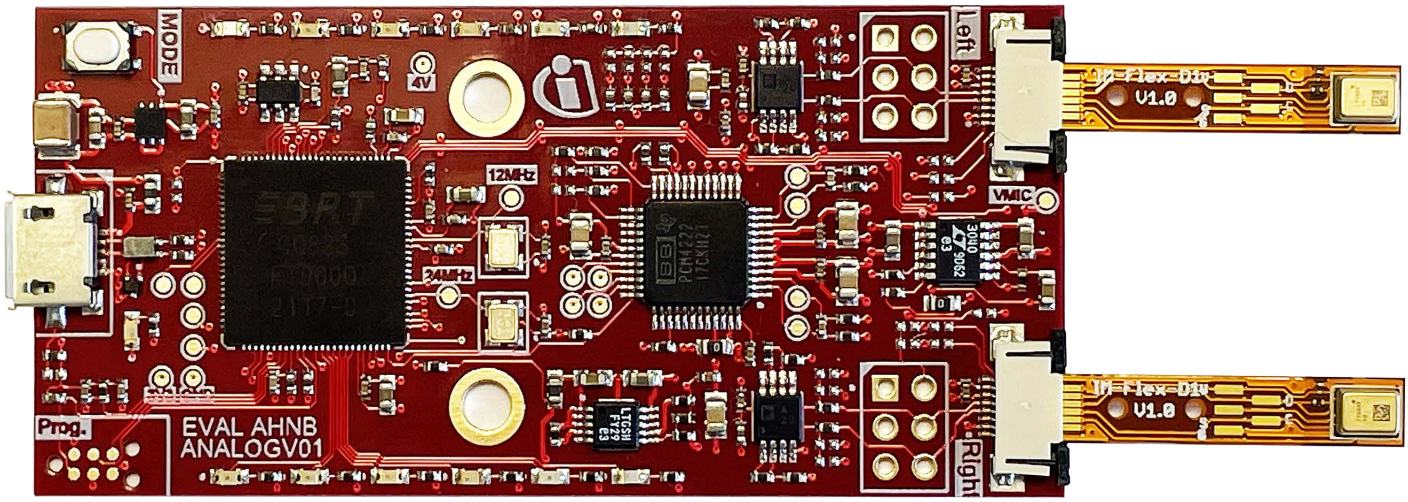
Analog XENSIV™ MEMS microphones evaluation board

The Infineon Audiohub Nano analogs enables the evaluation of Infineon analog XENSIV™ MEMS microphones. The kit includes an Infineon Audiohub Nano and four analog microphones on flex board. Up to two Infineon analog XENSIV™ MEMS microphones can be connected to the evaluation board in mono or stereo output. The evaluation board provides a USB audio interface to stream audio data from the microphone with any audio recording and editing software.

Summary of features

- Audio interface for analog XENSIV™ MEMS microphones
- Audio streaming over USB interface
- 48 kHz sampling rate
- 24-bit audio data (stereo)
- Dynamic range 120 dB
- LED indication for the configured gain level in normal mode and low power mode
- Volume unit meter display with onboard LEDs
- Powered through Micro-USB

Product	SP No.	OPN No.
EVAL AHNB IM69D130V01	SP005285852	EVALAHNBIM69D130V01TOBO1
EVAL AHNB ANALOGV01	SP005568087	EVALAHNBANALOGV01TOBO1



XENSIV™ MEMS microphone partners

Building upon the superior XENSIV™ MEMS microphone performance, Infineon's extensive network of global partners offers customers a comprehensive portfolio of XENSIV™ MEMS microphone-based reference designs, as well as Infineon inside MEMS microphones that will propel audio performance to the next level even for the most demanding applications. Click on the buttons below to learn more about our partner solutions.

Radar sensors

Giving technology the ability to “see”

Radar offers a host of advantages over passive infrared (PIR) technology in motion detection applications. These include greater accuracy and more precise measurement of detected objects, paving the way for new capabilities in speed detection and motion sensing. These advanced capabilities enable all sorts of “things” such as robots, cars, smart home devices and even lights to “see” their surroundings and respond dynamically.

Market leader in radar chips, we offer a wide portfolio of mmWave radar sensors as part of our XENSIV™ family. Designed to support different industrial, consumer and automotive applications, Infineon’s millimeter wave (mmWave) radar portfolio offers both FMCW as well as Doppler radar sensors supporting 24 GHz, 60 GHz and 77/79 GHz. In addition, customers can rely on us for the full range of automotive radar 24GHz, 60GHz and 77/79 GHz front-end MMICs (RASIC™) supporting everything from warning functions (e.g. LCA/BSD) to active safety systems such as Automatic Emergency Braking (AEB) and even to dynamic driving tasks like ACC.

RASIC™ automotive radar 77/79 GHz

Front-end ICs for automotive radars

RXS81xxx – family of transceiver MMICs for 77 GHz automotive radar

Infineon has been delivering automotive 77 GHz radar products for over 10 years. Infineon's family of radar transceiver MEMs (RASIC™) addresses the needs of 77/79 GHz radar for all safety-critical applications from automatic emergency-braking (AEB) to high-resolution radars in automated driving. It supports for precise distance measurement and simultaneous transmitter operation for MIMO.

RXS81xxx is a highly integrated device that performs all functions of a radar front-end in a single device – from FMCW signal conditioning to generation of digital receive data output. On-chip sensors for temperature, output power and multiple monitoring circuits allow for calibration and monitoring. Controlling the MMIC is done via SPI.

Infineon offers a complete suite of 77/79 GHz radar chipsets consisting of

- Radar 77 GHz transceiver MMIC (RASIC™) with RXS81xxx
- Radar MCU family featuring radar signal processing units (2nd generation AURIX™ TC3xx)
- Radar system power supply with numerous safety functions (TLF3068x)

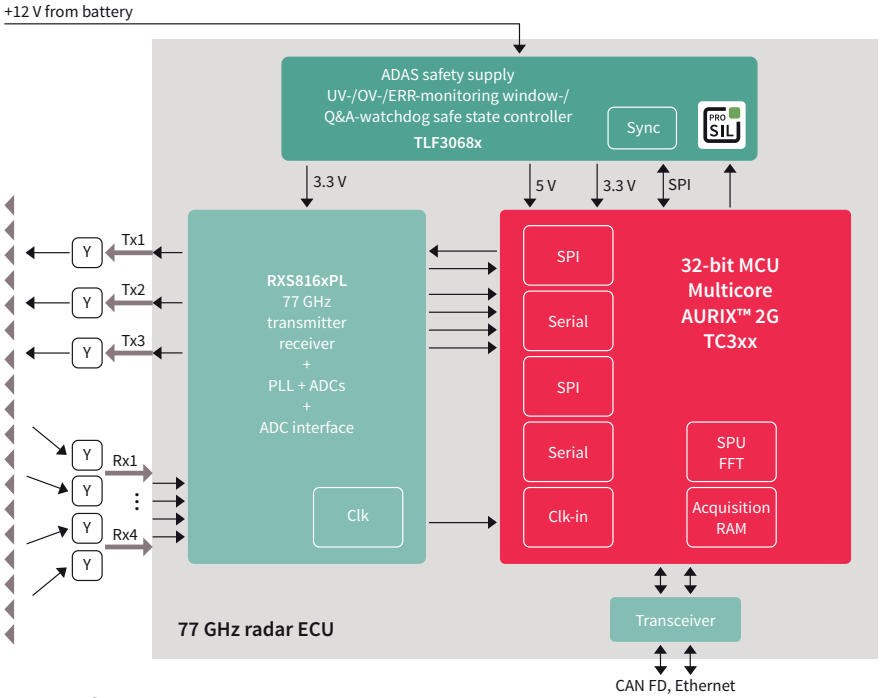
Customer benefits:

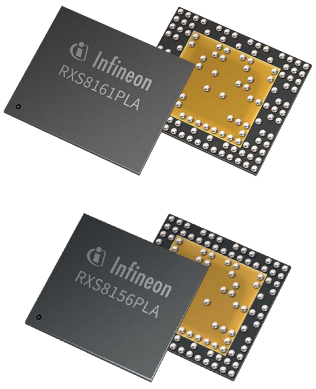
- One 77/79 GHz radar platform supporting all types of automotive radar applications
- Scalability by cascading multiple MMICs and MCUs enabling most advanced sensors
- Flexibility through numerous configuration parameters
- ASIL C support reducing customer R&D efforts

77 GHz – Product overview

Product	Config.	Key benefits	Features
RXS816xPL	3Tx4Rx	RXS8161PLx: Standalone transceiver MMIC RXS8162PLD: Transceiver MMIC for cascaded setup	› Transmit channels (2Tx or 3Tx, up to 1 GHz BW within 76–77 GHz) › Receive channels: 4Rx › Integrated PLL (Phase Locked Loop) › Sequencer enabling the execution of an user-defined ramp configuration › Integrated Analog-to-Digital Converter (ADC) › Integrated calibration functionality › Build-in monitoring functionality › Compliant to ISO 26262; capable for up to ASIL C
RXS8156PLA	2Tx4Rx	RXS8156PLA: Cost-optimized transceiver MMIC	

Please be aware that 77/79 GHz Radar products are not available via Infineon's distribution partners.





ISO 26262 compliant

www.infineon.com/rasic

Automotive radar 60 GHz

XENSIV™ 60GHz radar sensor for automotive enables highly reliable in-cabin monitoring systems

XENSIV™ BGT60ATR24C, an automotive 60 GHz radar sensor, enables ultra-wide bandwidth FMCW operation in a small package. Sensor configuration and data acquisition are enabled with a digital interface and the integrated state machine enables independent data acquisition with power mode optimization for lowest power consumption.

Summary of features

- 60 GHz radar sensor for FMCW operation
- 4 GHz bandwidth
- 2Tx/4Rx channels
- Digital interface for chip configuration and radar data acquisition
- Optimized power modes for low-power operation
- Integrated state machine for independent operation
- AEC-Q100/101 qualified

Benefits

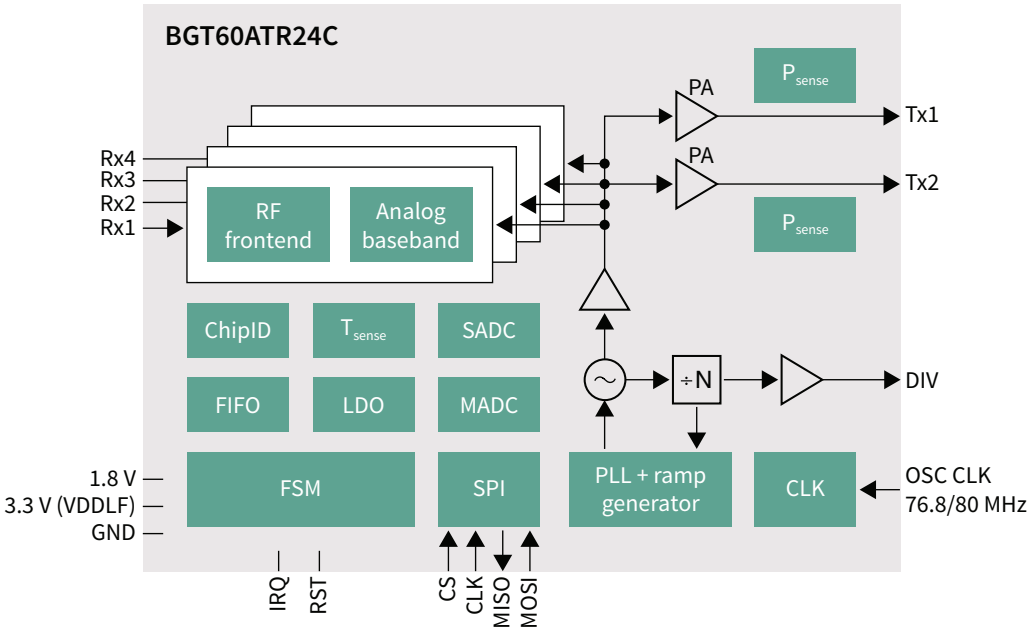
- Low power consumption
- Accurate and robust performance
- Excellent thermal management
- Size and space optimized solution

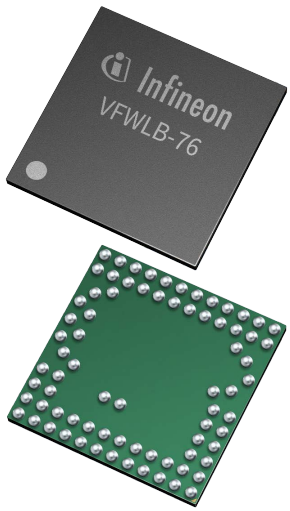
Potential applications

- Radar frontend for gesture sensing
- High resolution FMCW radars
- Short range sensing operations
- Hidden sensing applications behind radome

60 GHz – Product overview

Product	Frequency [GHz]	SP number	Packages
BGT60ATR24C	58 – 62	SP005350514	VFWLB-76-1
SHIELD_60ATR24ES_01	58 – 62	SP005448216	VFWLB-76-1





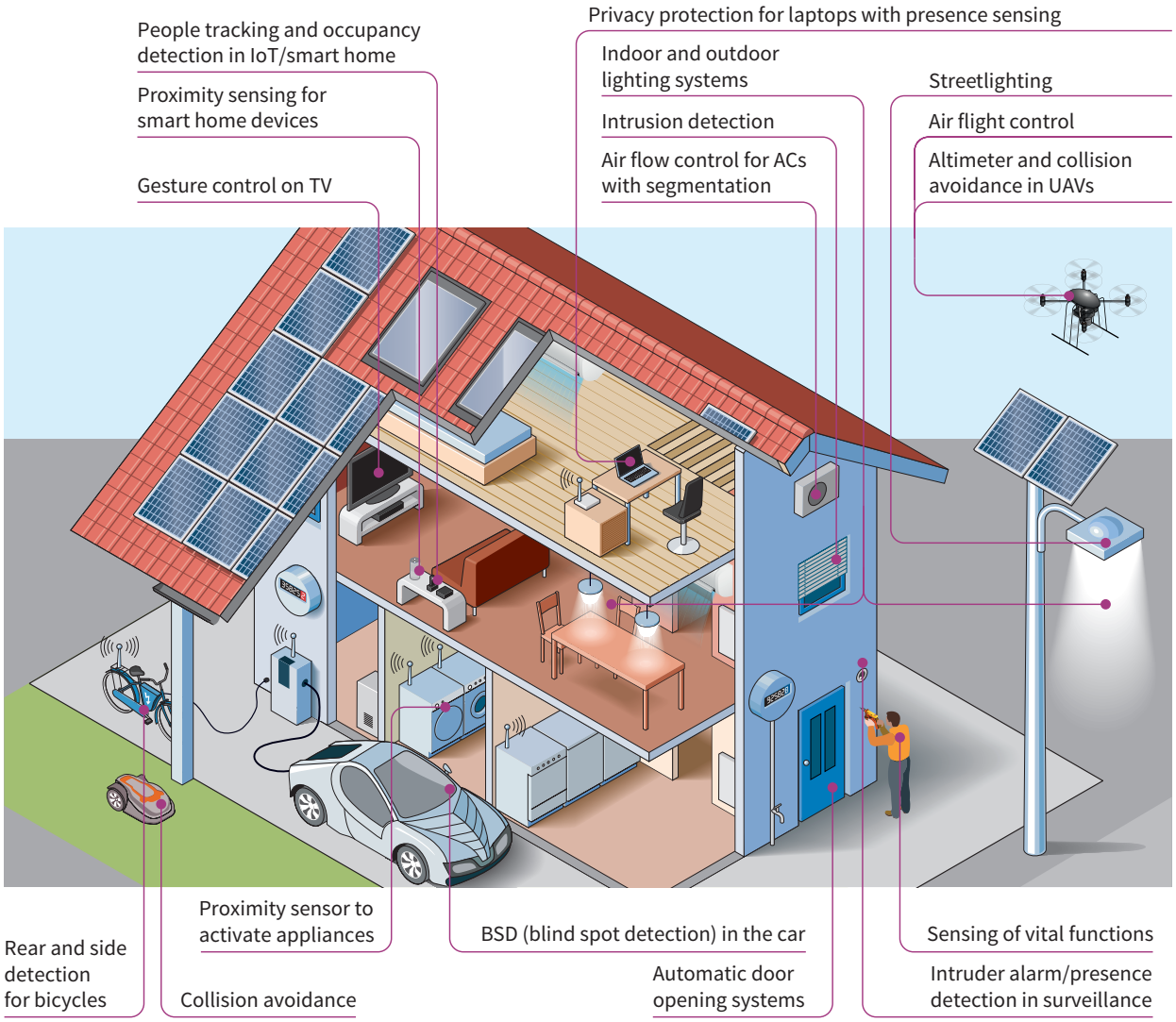
Radar sensors for IoT & consumer devices

As market leader in radar chips, we offer a wide portfolio of mmWave radar sensors as part of our XENSIV™ sensor family – including Doppler radar as well as FMCW radar systems. This portfolio includes the smallest 24 GHz MMIC in the market as well as the most integrated and largest 24 GHz radar transceiver family currently available. Those radar chips are designed to support different industrial, smart home, and consumer applications. In addition, we also offer radar sensors in the 60 GHz range, which are used in consumer products such as Smart TVs or the Google Pixel 4 Smartphone.

Motion detection with radar offers significant advantages over PIR and other motion-sensing technologies

With our 24 and 60 GHz radar sensors, we cover a wide range of applications. Many of them are based on motion detection triggering systems like lighting solutions, automatic doors, camera and security systems, or smart home devices. In contrast to other motion detection technologies like PIR, radar technology offers significant advantages. These include smaller system sizes, greater accuracy, and more precise measurements of detected objects. In addition, radar can also determine the direction of a moving object, speed of an object, distance, and depending on the antenna configuration, even the position of a moving object.

Applications for Infineon's radar sensors



www.infineon.com/radar-for-iot

Key benefits of radar sensing

- Direction, proximity, and speed detection
- Segmentation and tracking functionalities
- Target positioning
- Detection through non-conductive materials
  - Product design flexibility
  - Anonymous sensing
- Maintains operation through harsh environmental conditions such as rain, snow, fog, dust, etc.
- Sensitive enough to capture breathing and heartbeat
  - Radar can feel presence & vital functions
- Radar performance parameters can be adjusted
  - Adaptable to different application requirements

Applications

New application or simple PIR replacement? Radar has it covered.

Radar, used in motion detection applications, increases accuracy when compared to passive infrared (PIR) technology, allowing more precise measurement of object detection, and providing new capabilities such as the detection of speed and the direction of moving objects. Radar is also superior to camera-based systems by allowing detection of the objects while keeping identities anonymous.

Example applications that can benefit from radar technology

Smart Home

Robust, discreet, small

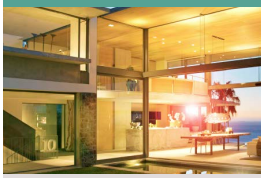
Door opening

Direction of travel to remove false opening

Security

Privacy protection, and increased accuracy

Lighting



Indoor and outdoor. Resistant to harsh weather

Monitors and laptops

Small, hidden, sensitive

Home appliances

Activate displays based on presence around

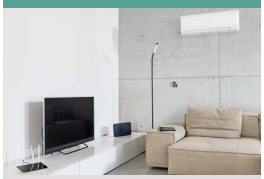
Air conditioners

Track people to move the airflow away from them

Smart speaker

Eliminate keyword based activation

TV



Safe energy & OLED lifetime by turning off

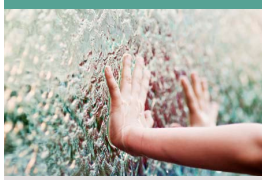
Gaming and VR

Enhance gaming experience

Gesture control

Additional gesture package available

Material detection



Object recognition and classification

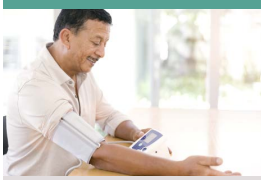
Service robots

Robust, small footprint, accurate

Robotics

Safety, accuracy and efficiency

Vital sensing

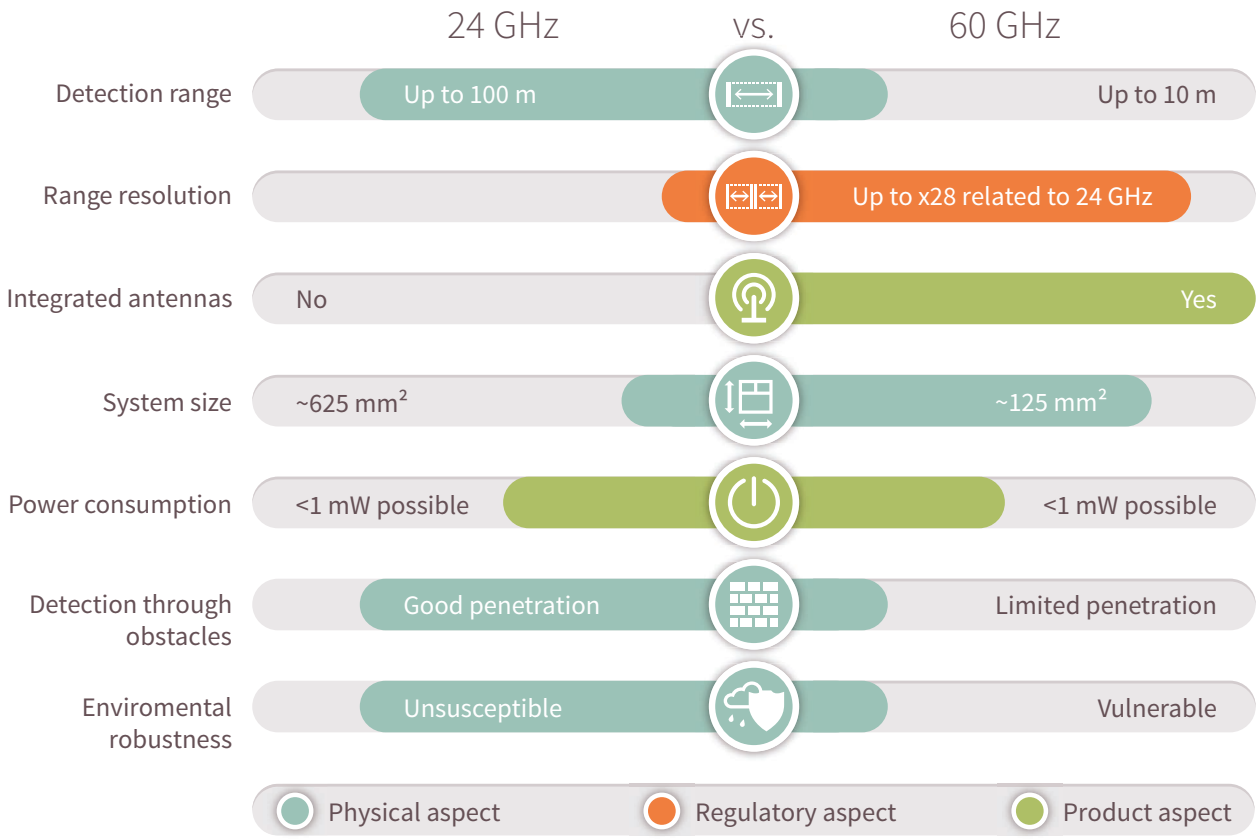


Breathing & heart rate measurement

When to use 24 GHz or 60 GHz radar technology

In the 24 GHz range, the bandwidth for FMCW radar operations covers 250 MHz within the regulated ISM band. In the 60 GHz regime, an unlicensed ultra-wideband of up to 7 GHz can be used for short-range applications. Consequently, 60 GHz FMCW radar systems can offer a better resolution and therefore allow additional use cases such as human tracking and segmentation. Even gesture control, material classification, or the monitoring of various vital functions (respiration, heartbeat, or even blood pressure) is possible with radar technology due to micromotion detection.

Radar sensors for industrial and consumer applications



Partners

Click this link to view our network of partners who provide modules and design support for all 24 GHz industrial applications:

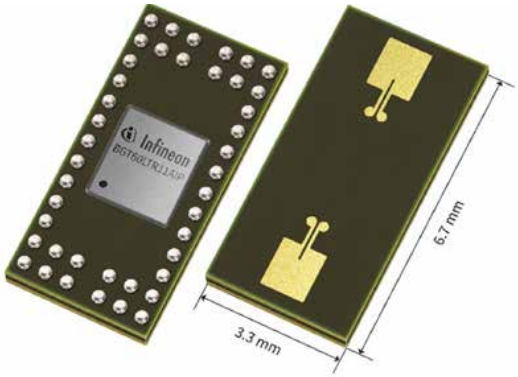
www.infineon.com/radar-for-iot

Have questions?

Visit our Community to inquire, share, and connect:

XENSIV™ 60 GHz radar sensors

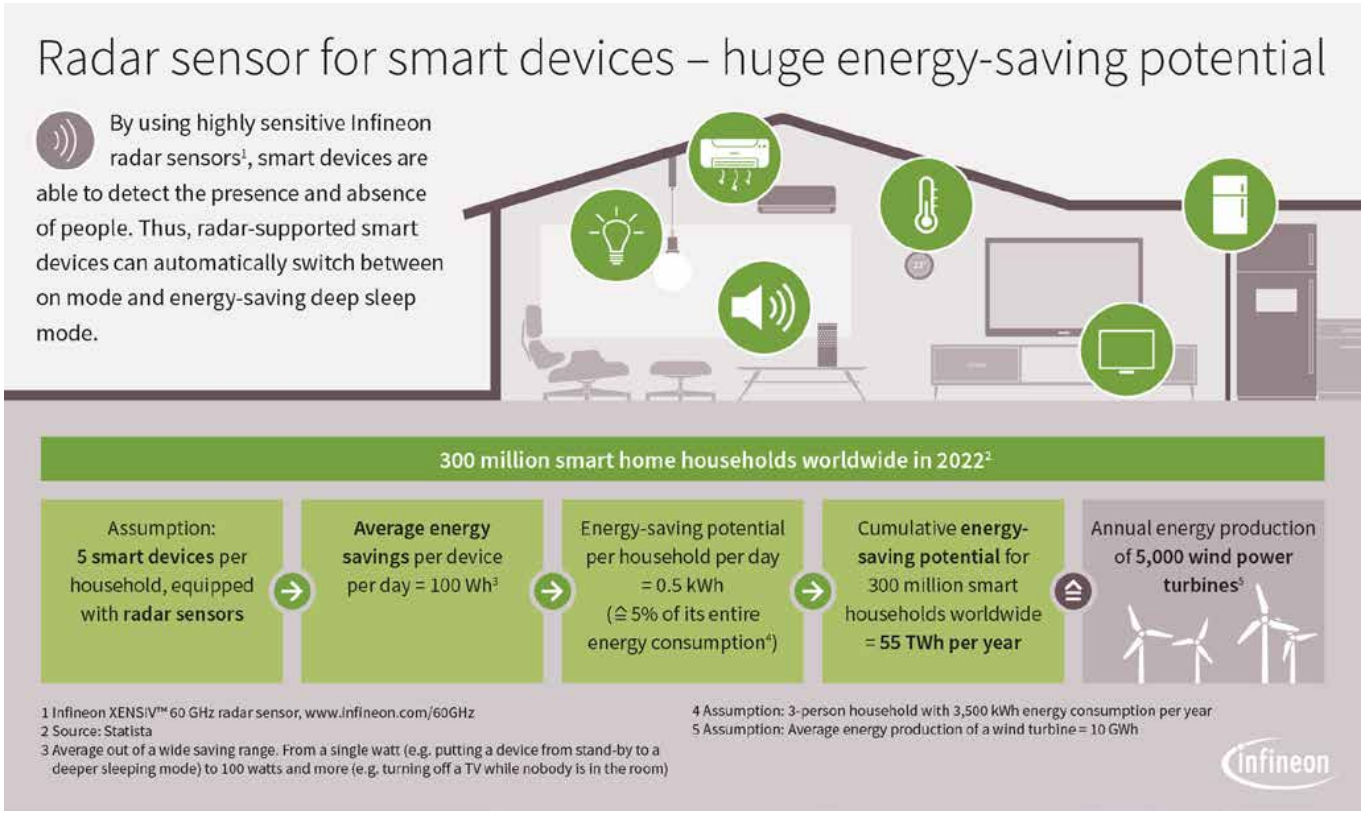
Infineon's innovative XENSIV™ 60 GHz radar chip enables things to see and revolutionizes the human-machine interface.



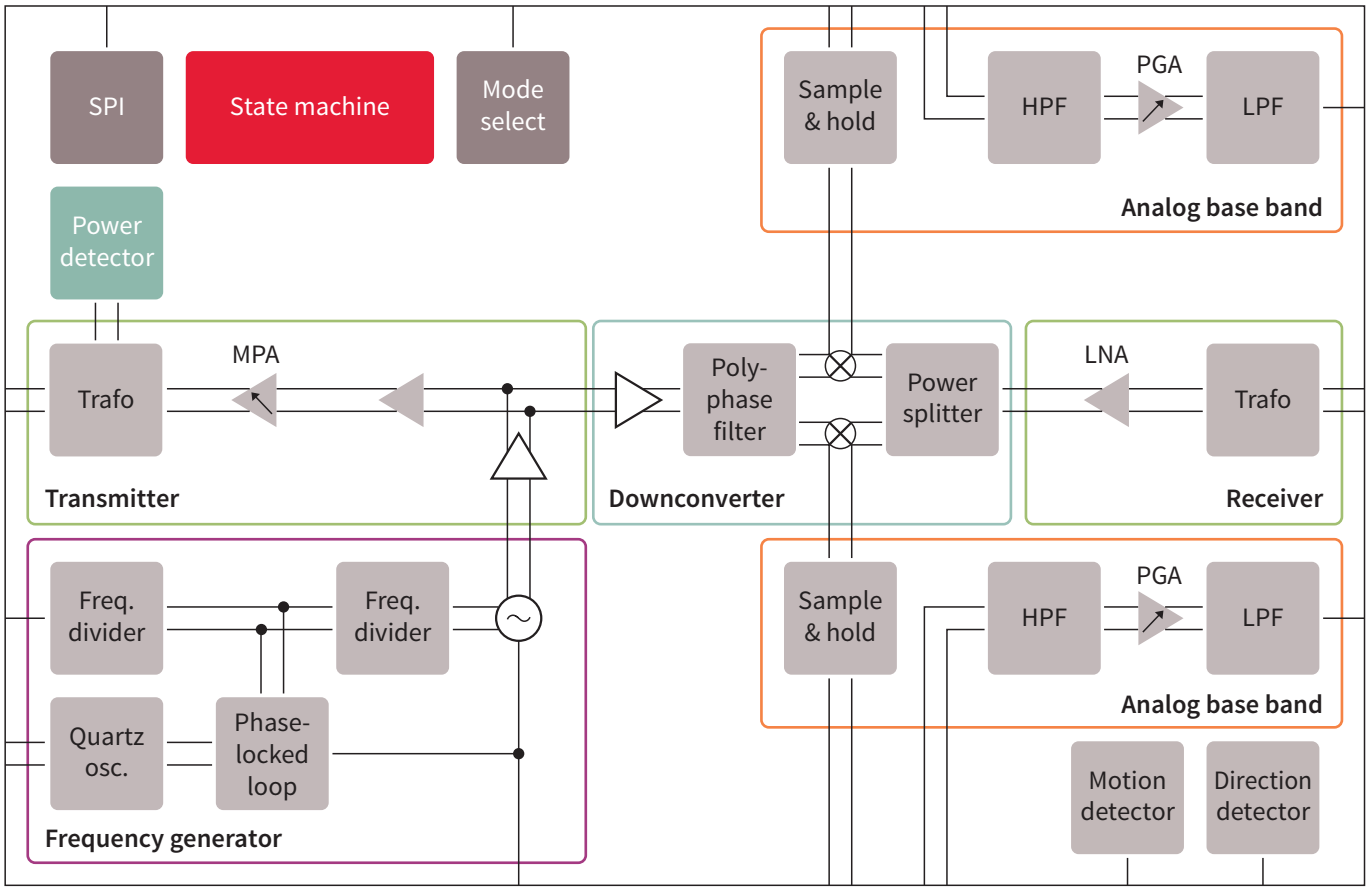
BGT60LTR11AIP for consumer and IoT applications

The BGT60LTR11AIP is a fully integrated microwave motion sensor including Antennas in Package (AIP) as well as built-in detectors for motion and direction of motion. A state machine enables operation of the device without any external microcontroller. In this autonomous mode, it detects a human target up to 7 m with a low power consumption of less than 2 mW. The BGT60LTR11AIP enables radar technology for everyone, since it does not require know-how in RF, antenna design, or radar signal processing. These features make the small-sized radar solution a compelling smart and cost-effective replacement for conventional PIR sensors in low power or battery-powered applications. Also, with its small form factor, Infineon's highly integrated radar sensor solutions bring innovative, intuitive sensing capabilities to many applications.

Radar has been demonstrated to be a powerful sensor for short-range motion detection. Through reliable presence and absence detection, smart devices equipped with radar sensors become more energy efficient and therefore smart and more sustainable. Users can also benefit from vacancy detection in applications such as televisions. For example BGT60LTR11AIP has been implemented in Samsung's Frame TV 2021, which puts the TV from art mode into sleep mode when there is no person nearby for a user-specified time. This function not only saves energy, but also displays lifetime. BGT60LTR11AIP has a high sensitivity and can detect if a person is present and if the device needs to be ready – similar to a screensaver that deactivates the PC monitor after a certain time without mouse or keyboard input and reactivates it as soon as new input is noticed. Through this reliable presence and absence detection, Infineon's 60 GHz radar powers the design of truly smart, energy-saving devices. Find out more at: www.infineon.com/green-energy



Block diagram of the BGT60LTR11AIP



Key features

- 3.3 x 6.7 x 0.56 mm package size
- 1Tx 1Rx Antennas in Package (AIP) with 80° field of view
- Built-in motion detector
- Built-in direction of motion detector
- Multiple modes of operation incl. a completely autonomous mode
- Adjustable performance parameters: detection sensitivity, hold time and frequency of operation
- FR4 material for PCB design is sufficient

Key benefits

- Autonomous mode
  - Up to 7 m detection range
  - Less than 2 mW power consumption
  - Requires minimal external circuitry incl. crystal, LDO and some resistors capacitors

Adding a M0 MCU extends flexibility

- Up to 14 m detection range (SPI mode)
- Less than 2 mW power consumption possible

Target application

- Smart building and smart home
- Home appliances
- Smart home security
- Room air conditioners
- Automated door openers
- Smart entrance counter solution
- Displays such as TVs, monitors, laptops or tablets
- Lighting systems and lighting control

www.infineon.com/60GHz

Product portfolio

Product	SP	OPN	Description	Package
BGT60LTR11AIP	–	BGT60LTR11SAIPXUMA1	XENSIV™ 60GHz first completely autonomous radar sensor for motion sensing	UF2BGA-42
BGT60LTR11SAIP	SP005832449	BGT60LTR11SAIPXUMA1	XENSIV™ 60GHz first completely autonomous radar sensor for motion sensing	
DEMO BGT60LTR11AIP	SP005422969	DEMOBGT60LTR11AIPTOBO1	Demonstration kit (Shield + 60 GHz baseboard)	
SHIELD_BGT60LTR11AIP	SP005422968	SHIELDBGT60LTR11AIPTOBO1	Shield fitting on 60 GHz baseboard	
SHIELD_AUTONOM_BGT60	SP005630363	SHIELDAUTONOMBGT60TOBO1	Shield for autonomous operation of BGT60LTR11AIP; directly fits on Arduino MKR board	
REF BGT60LTR11AIP	SP005636053	REFBGT60LTR11AIPTOBO1	Reference design	
S2GO RADAR BGT60LTR11	SP005594890	S2GORADARBGT60LTR11TOBO1	Shield2Go version	
DEMO BGT60TR13C	SP005728718	DEMOBGT60TR13CTOBO1	–	VF2BGA-40
BGT60TR13C	SP002262606	BGT60TR13CE6327XUMA1	–	

DEMO BGT60LTR11AIP

For evaluation of the completely autonomous 60 GHz radar sensor MMIC for motion sensing

This demo features Infineon's first completely autonomous radar sensor – the BGT60LTR11AIP. The 60 GHz radar MMIC is a fully integrated microwave motion sensor including Antennas in Package (AIP) as well as integrated detectors for motion and direction of motion. A state machine enables operation of the device without any external microcontroller. In this autonomous mode, it detects a human target up to 7 m with a low-power consumption of less than 2 mW. These features make the small-sized radar solution a compelling, smart and cost-effective replacement for conventional PIR sensors in low-power or battery-powered applications.

For evaluation of the BGT60LTR11AIP MMIC, this demo includes the BGT60LTR11AIP shield as well as the Infineon Radar Baseboard MCU7.

The BGT60LTR11AIP shield can be attached to an Arduino MKR board or the included Infineon Radar Baseboard MCU7. Infineon's Toolbox supports this platform with a demonstration software and a Radar GUI to display and analyze acquired data in time and frequency domain. It further enables to change various performance parameters of the BGT60LTR11AIP in order to evaluate this radar sensor.

BGT60TR13C – 60 GHz radar sensor for advance sensing

Enablement of horizontal and vertical angular measurement

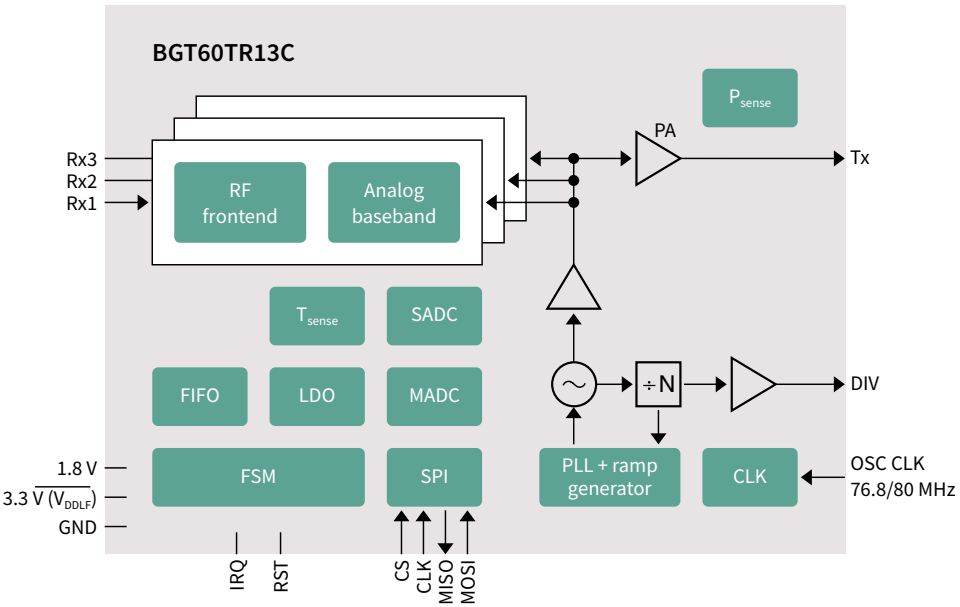
The BGT60TR13C MMIC is a 60 GHz radar sensor with integrated antennas and comes with one transmitting and three receiving antennas. Thanks to the Antennas in Package (AIP) concept, the antenna design complexity at the user end can be eliminated and the PCB designed with standard FR4 materials.

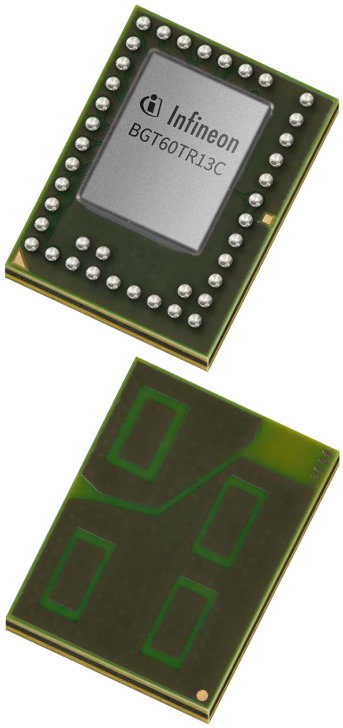
BGT60TR13C offers innovative and intuitive sensing capabilities

With its small form factor and low power consumption, BGT60TR13C MMIC brings innovative, intuitive sensing capabilities to many applications. Based on the developed algorithm the MMIC can serve established as well as new applications and use cases without intruding on privacy. Thanks to its feature-set, the MMIC can measure velocity, angle, horizontal as well as vertical.

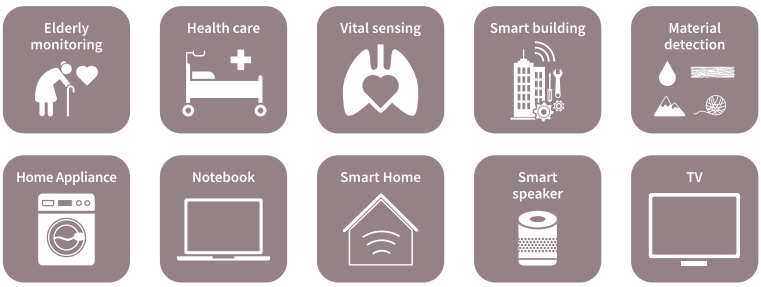
BGT60TR13C has been demonstrated to be a powerful sensor for:

- Presence detection/segmentation/tracking: BGT60TR13C enables human presence detection, tracking, and segmentation while providing extremely high accuracy in detecting micro and macro motions
- Gesture Sensing: BGT60TR13C ensures detection of submillimeter motions
- Vital sensing: BGT60TR13C is able to track vital signs in consumer electronics, healthcare as well as industrial applications





Target applications



www.infineon.com/60GHz

Features and benefits

Key features	Key benefits
› Integrated Finite-State-Machine (FSM)	› Allows semi-autonomous operation › Highly configurable modulation and power modes › MCU only needs to configure sensor and fetch data
› Very fast chirp speed: 400 MHz/µs	› High velocity resolution
› High Signal-To-Noise Ratio (SNR)	› People can be detected up to 15 m › High sensitivity allows submillimeter level motion detection
› Ultra-wide bandwidth >5 GHz	› Allows simultaneous measurement of target range and velocity
› FMCW operation	› High accuracy of range measurements › Reduced interference with other sensors
› Integrated L-shaped antennas + small package size (6.5 x 5.0 x 0.9 mm³)	› L-shape enables horizontal and vertical angular measurements › Thanks to small package size, PCB area can be saved + design-in process simplified
› <5 mW (duty cycling according to released FCC waiver)	› Reduces average power consumption › Optimized power modes for low power consumption

Product portfolio

Product	SP No.	OPN No.
DEMO BGT60TR13C	SP005728718	DEMOBGT60TR13CTOBO1
BGT60TR13C	SP002262606	BGT60TR13CE6327XUMA1

DEMO BGT60TR13C

Getting started with the XENSIV™ 60GHz demo board for advanced sensing

BGT60TR13C offers innovative and intuitive sensing capabilities

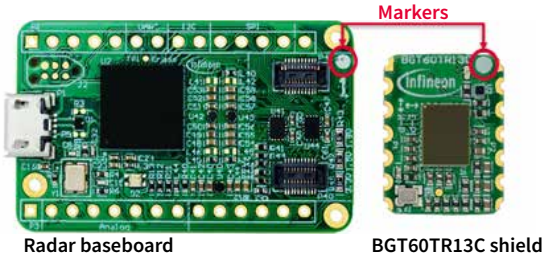
This demo board features Infineon's 60GHz XENSIV™ radar sensor BGT60TR13C and consists of a radar baseboard as well as a BGT60TR13C shield.

The radar baseboard is a 40.64 mm x 25.4 mm printed circuit board (PCB). Its main purpose is to provide a generic sensor interface for BGT60TR13C MMIC. The central microcontroller unit (MCU) can perform radar data processing or forward the sensor data to a USB interface or an Arduino MKR interface.

The BGT60TR13C shield presents a minimized form factor of 17 x 12.7 mm² and comes with an integrated BGT60TR13C Antenna-in-Package (AIP) radar chip of 6.5 x 5.0 x 0.85 mm³. Moreover, the shield contains a digital interface for configuration and transfer of the acquired radar data to a microcontroller board. The shield is optimized for fast prototyping designs and system integrations as well as initial product feature evaluations. In addition, it offers developers the flexibility to choose their own platform depending on their preferred use cases.

Several benefits come along with the BGT60TR13C demoboard:

- Flexible platform selection
- Variable connector options, and option to solder onto other PCBs
- Highly flexible configuration on FMCW modulation
- Power consumption can be optimized according to use case

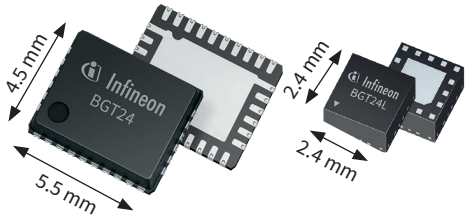


www.infineon.com/demo-bgt60tr13c

24 GHz radar sensors

Infineon BGT24M / BGT24L family of MMIC chips

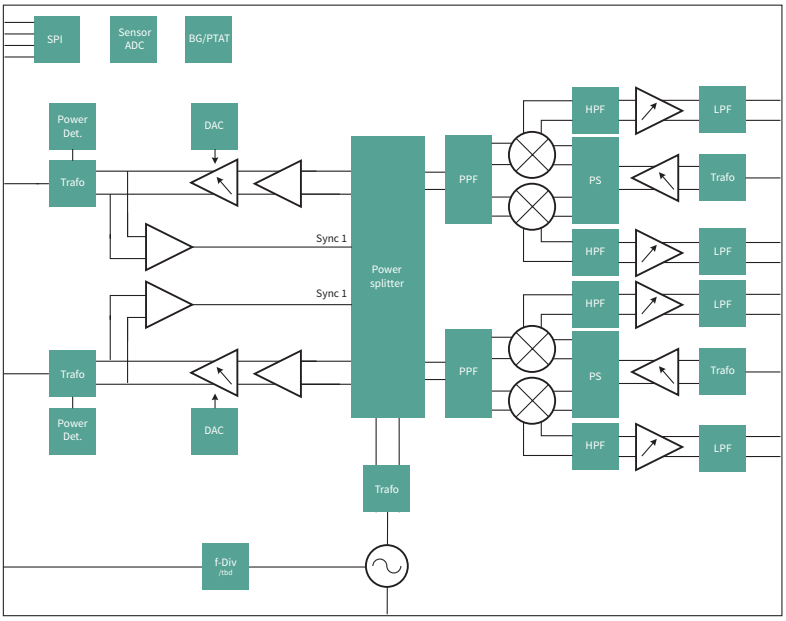
Infineon's range of 24 GHz industrial radar chips provides five configurations of transmit and receiver channels, ensuring that there is a chip to support your specific application. From basic applications such as motion detection in security systems, which only requires one transmit and one receive channel, to more complex applications like 3D positioning, which requires two or more receive channels, our range of radar chips supports all of your requirements.

Features	Infineon MMIC	Benefits
› 24 GHz ISM band operation for motion, speed, direction movement and distance measurements › Five 24 GHz chips available › Highly integrated MMICs		› Long-range distance detection of moving objects up to 50 m › Wide range speed detection up to ±100 km/h › Low BOM costs

Product	Configuration	Features
BGT24MTR11	1Tx + 1Rx	› Measures, not just motion, but also speed, direction, and distance › Small form factor › Resistance to moisture, dirt, and temperature › Increased area coverage › Discrete design › Low power MMICs for energy saving › Privacy protection › Adaptable to different application requirements › Highly integrated chips eliminating costly external components
BGT24MR2	2Rx	
BGT24MTR12	1Tx + 2Rx	
BGT24LTR11	1Tx + 1Rx	
BGT24LTR22	2Tx + 2Rx	

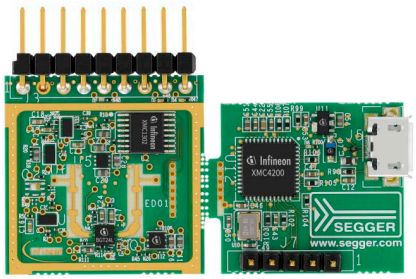
The BGT24LTR22 key features

› 24 GHz transceiver MMIC
› Fully integrated low phase noise VCO
› Integrated analog base band stage with programmable gain and filter settings
› Bi-directional pin for synchronization
› Built in temperature compensation circuit for VCO stabilization, no PLL needed
› Low power consumption
› Fully ESD protected device
› Single ended RF and IF terminals
› Single supply voltage 1.5 V



24 GHz evaluation and demonstration boards

In addition to the BGT24M/L family of MMIC chips, Infineon provides a continuously expanding range of evaluation and demonstration boards to support the testing and development of radar in multiple applications of our customers. All boards are provided with base-level software to support the ease of use and faster time-to-market integration.

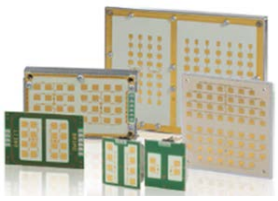
Features	Infineon development kit	Benefits
› Four system boards available › All include 24 GHz radar chip and XMC™ microcontroller › Kit contains user manual, GUI, MATLAB compiler and Gerber files › Software available via Infineon Toolbox	 Demonstrator with SW support	› Capability to detect motion, speed and direction of movement (approaching or retreating) distance and angle of arrival based on hardware › Fast prototyping with available software

Sense2GoL Pulse (BGT24LTR11 + XMC4700)	Distance2Go (BGT24MTR11 + XMC4200)	Distance2GoL (BGT24LTR11 + XMC4700)	Position2Go (BGT24MTR12 + XMC4700)
› Capability to detect motion, speed, and direction of movement (approaching or retreating) › Detection range of 18 m for a human target at a power consumption < 5 mW › High sensitivity of detection in comparison to PIR › Arduino compatible microcontroller board (Arduino standard connectors) › Modulation parameters can be changed to suit the application requirements › Multiple current sensors for current consumption monitoring and optimization › Integrated multiple-element patch antennas	› Capability to detect the distance of multiple targets › Capability to detect motion, speed, and direction of movement (approaching or retreating) › Operates in harsh environments and detects through non-metallic materials › BGT24MTR11 – 24 GHz highly integrated RF MMIC › XMC4200 Arm® Cortex™-M4 –32-bit industrial microcontroller › Debug over Cortex™ 10 pin debug connector › Integrated multiple-element patch antennas	› Capability to detect the distance of the closest human target › Capability to detect motion, speed, and direction of movement (approaching or retreating) › Very low power consumption due to duty cycling options › Operates in harsh environments and detects through non-metallic materials › BGT24LTR11 – 24 GHz highly integrated RF MMIC › XMC4700 Arm® Cortex™-M4 –32-bit industrial microcontroller › Debug over Cortex™ 10 pin debug connector › Microstrip patch antennas with 10 dBi gain and 29°/80° field of view	› Capability to detect and track the position of multiple targets › Capability to detect the distance of multiple targets › Capability to detect motion, speed, and direction of movement (approaching or retreating) › Operates in harsh environments and detects through non-metallic materials › BGT24MTR12 – 24 GHz highly integrated RF MMIC › XMC4700 Arm® Cortex™-M4 –32-bit industrial microcontroller › Debug over Cortex™ 10 pin debug connector › Integrated multiple-element patch antennas
Main applications › Security › Indoor and outdoor lighting › Smart home › Automatic door opener › Intelligent switches › Speed measurement	**Main applications** › Drone: soft landing/obstacle avoidance › Smart toilets › Tank level sensing › Intelligent switches	**Main applications** › Smart home devices › Indoor and outdoor lighting systems › Unmanned Aerial Vehicles (UAV) › Security systems from commercial surveillance to low-power IP cameras › HVAC products like smart air conditioners › Smart sanitary facilities (eg Smart Toilets)	**Main applications** › Drone/robots: obstacle avoidance › Security systems incl. surveillance cameras › People tracking (IoT, smart home) › Vital sensing
Board dimensions › Board 55 mm x 85 mm › Shield: 55 mm x 66 mm	**Board dimensions** › Board 36 mm x 45 mm	**Board dimensions** › Board 55 mm x 85 mm › Shield: 55 mm x 66 mm	**Board dimensions** › Board 50 mm x 45 mm
Kit contents › RF radar shield: SHIELD_BGT24LTR11 › Programmed controller board: RADAR BB XMC4700 › Micro USB cable › SW GUI to operate kit › Doppler FW and SW [1] › Schematic and bill-of-materials of module	**Kit contents** › User's manual › Demonstration board › SW GUI to operate kit › FMCW FW and SW [1] › Doppler FW and SW [1] › Schematic and bill-of-materials of module	**Kit contents** › RF radar shield: SHIELD_BGT24LTR11 › Programmed controller board: RADAR BB XMC4700 › Micro USB cable › SW GUI to operate kit › Doppler FW and SW [1]	**Kit contents** › User's manual › Demonstration board › Corner reflector › SW GUI to operate kit › FMCW FW and SW › Doppler FW and SW › Schematic and bill-of-materials of module

1) Usage of the FMCW and/or Doppler FW and SW requires agreeing to Infineon's user's agreement and licensing terms.

24 GHz partner modules

Partnering with the leading radar solution providers enables Infineon to connect our customers looking for turnkey solutions and design support for a complete range of applications. Utilizing our strong network of partners, the radar portfolio is extended to include a range of easy-to-integrate modules. Each of them contains Infineon's 24 GHz MMIC.

Features	Partner modules using Infineon chips	Benefits
› Complete module, including radar MMIC, antenna options, MCU signal processing options, and SW options (Doppler, FSK and FMCW versions available)	 Module (RF module; RF module + MCU including SW)	› Ease of design › Turnkey solution, no need for test and certification

By integrating Infineon's 24GHz MMIC chip into the partners easy-to-use and simple-to-integrate modules the complexity and time to market for a range of applications such as smart home automation, camera & security systems, air conditioners, UAVs, robotics, and smart lighting, are reduced.

Partners

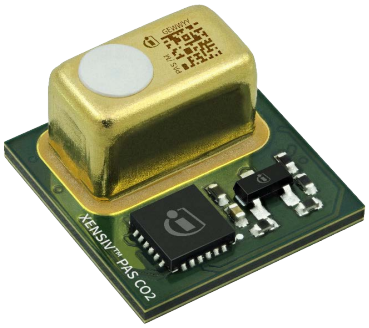
Visit the link below to view our network of partners who provide modules and design support for all 24GHz industrial applications: www.infineon.com/24GHzPartners

Learn radar with Infineon on www.infineon.com/MakeRadar

For the first time, we bring radar to makers and developers. Here you can test, develop, and learn radar and its applications. At www.infineon.com/makeradar, you will see how simple it has become to work with ultrasmall radar sensors. The board and data will flow to your browser for testing, and this is not all, if you want to take the next step just take the available Arduino code examples and start your project.

PAS CO2

High performance in a small size – Introducing a disruptive CO_2 sensor based on photoacoustic spectroscopy (PAS)



Infineon's PAS CO2 breaks the boundaries of CO_2 sensing with its exceptionally small form factor and high accuracy in its class.

Measure what matters with our PAS CO2 sensor

CO_2 measurement contributes to improvements in health, comfort and productivity as well as energy efficiency. Even at moderate levels, CO_2 can have a negative impact on health and productivity, causing drowsiness and headaches. Fortunately, smart indoor air quality sensors can "smell" rising levels of CO_2 and either alert the user or trigger a system response. Awareness of indoor air quality is further increasing as a result of the COVID-19 pandemic, making accurate, affordable monitoring solutions like PAS CO2 more important than ever. Given the correlation between CO_2 and aerosol concentration, CO_2 sensors can contribute to mitigating the transmission of not only COVID-19 but also other airborne illnesses such as the common cold and influenza. Furthermore, CO_2 sensors can facilitate demandcontrolled ventilation, leading to improvements in energy efficiency and significant savings on energy bills.

Accurate, real-time CO_2 measurement thanks to superior MEMS technology

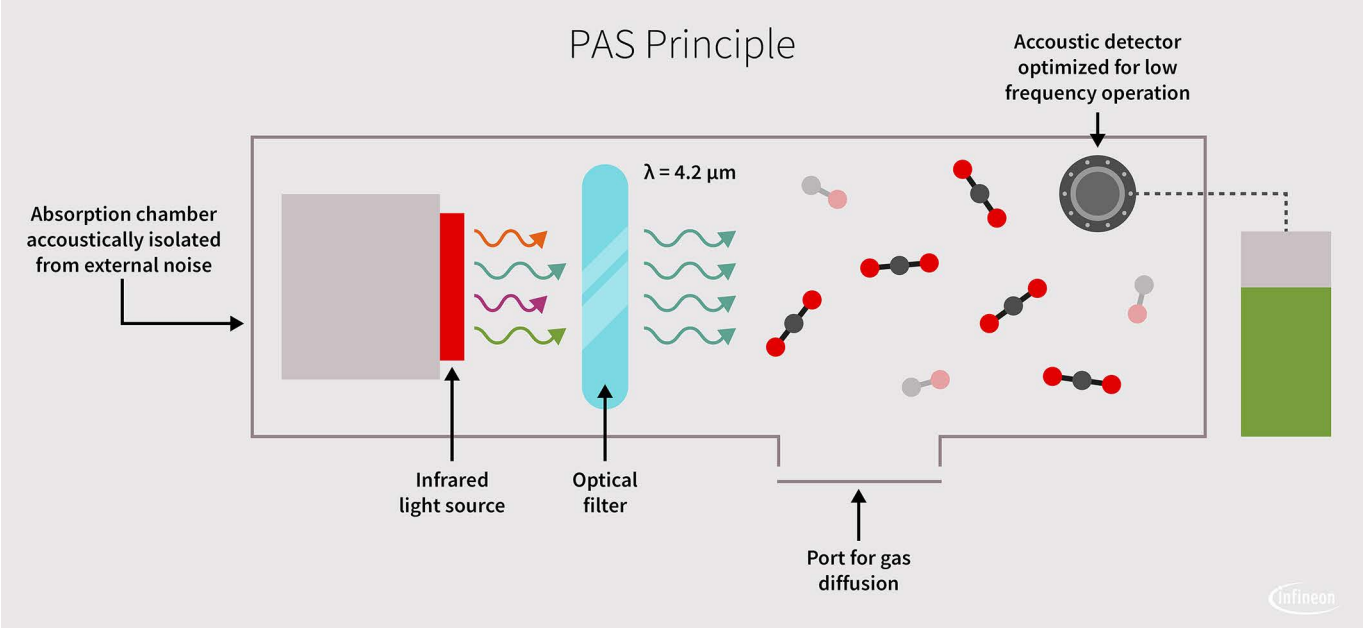
Widespread adoption of real CO_2 sensors has so far been hampered by size, performance and cost constraints. Infineon's PAS CO2 sensor leverages photoacoustic spectroscopy (PAS) technology to provide an exceptionally small, real CO_2 sensor that is both highly accurate and cost-effective. Infineon's leading position in MEMS technology is the foundation for this unique and accurate CO_2 detection approach. Reliable CO_2 measurement enables smart monitoring of indoor air quality, facilitating improvements in health, productivity and overall well-being. These features make the PAS CO2 sensor ideal for demand-controlled ventilation and air conditioning applications (HVAC) as well as for integration into consumer IoT devices such as air purifiers, thermostats, baby monitoring devices, wake-up alarms and smart speakers.

Disruptive environmental sensor technology from Infineon

PAS CO2 integrates on the PCB a photoacoustic transducer, including an acoustic detector, infrared source and optical filter; a microcontroller for signal processing and a MOSFET chip to drive the infrared source. The exceptional sensitivity of the acoustic detector coupled with the integrated PCB design reduce space requirements by more than 75 percent compared to nowadays state-of-the-art NDIR CO_2 sensors.

www.infineon.com/CO2

The PAS (photoacoustic spectroscopy) principle:
The sensor is characterized by a disruptive measurement principle called PAS (photoacoustic spectroscopy). It works as follows: pulses of infrared light pass through an optical filter tuned to the CO_2 absorption wavelength. The CO_2 molecules absorb the filtered light, causing them to shake and generate a pressure wave with each pulse. This is called the photo-acoustic effect. The sound is then detected by an acoustic detector optimized for low frequency operation and converted to a CO_2 concentration reading by the microcontroller.



Features and benefits

Features	Benefits
› Exceptionally small form factor (14 x 13.8 x 7.5 mm^3)	› Space savings in customers' end products
› High accuracy (±30 ppm ±3% of reading)	› High-quality data and compliance with smart building standards
› SMD package delivered in tape and reel	› Cost-effective high-volume assembly and easy system integration
› Advanced compensation and self-calibration algorithms	› Plug & play for fast design-to-market
› Various configuration options (e.g. sampling rate, baseline calibration) and interfaces (UART, I^2C, PWM)	› Customer flexibility thanks to configuration options

XENSIV™ PAS CO2 sensor community

Learn more or ask questions

Applications

› HVAC (Heating, Ventilation and Air Conditioning) systems
› Smart home appliances such as air purifiers, air conditioners and thermostats
› Consumer devices for air quality monitoring such as personal assistants and CO_2 traffic lights
› Smart indoor lighting

www.infineon.com/CO2

Intuitive sensing

Giving things human-like senses for a better contextual awareness

Imagine a world where technology is unobtrusive and seamlessly integrated into our lives. Where intentional/deliberate communication between people and devices is no longer necessary. In this world, there is no need to push buttons or issue commands in order to activate devices, because technology is capable of interpreting implicit intentions and context. This enhances the user experience and makes it more natural – it almost seems like the devices around us intuitively understand what we want them to do. At Infineon, this future is already becoming reality. We develop sensor solutions that enable simple and effortless user interactions with all kinds of smart devices. Bridging the gap between the real and digital worlds, our technology is developed to make life easier, safer, greener and more efficient. Our intuitive sensing solutions are at the very core of this mission. Reflecting our belief that the essential value of sensor technology lies in making our lives more convenient through seamless, natural interactions between people and sensing devices, our aim is to leave you free to focus on what really matters in life.

Choose your type of sense

Thanks to industry-leading technologies Infineon XENSIV™ sensors are exceptionally precise. They are the perfect fit for various customer applications in automotive, industrial and consumer markets.

Pressure sensors

Our digital barometric pressure sensors give designers the best choice when it comes small form factors, highest precision and accuracy over a wide temperature range, fast read-out speeds and low power consumption.

Radar sensors

Radar supports existing applications while providing features that enable completely new use cases. It measures velocity, range and angle, both horizontal and vertical, for precise position mapping and 3D tracking.

MEMS microphones

MEMS microphones overcome existing audio chain limitations and are designed for applications where low self-noise (high SNR), wide dynamic range, low distortions and a high acoustic overload point are required.

PAS CO2 sensor

Leveraging photoacoustic spectroscopy (PAS), Infineon has developed an exceptionally small CO2 sensor that overcomes existing size, cost and performance challenges.

Today, sensors already enable interactions between people and devices

This interaction often depends on the interpretation and merging of information from different sources. Machines cannot yet read our minds and do not always have the information necessary to correctly evaluate a given situation. So, we sometimes have to explicitly tell devices what we want them to do. This can be inconvenient and time-consuming. Inspired by human nature, Infineon intuitive sensing solutions are designed to take the complexity out of our interaction with devices.

Reflecting a holistic approach, we combine different sensors with state-of-the-art software to create a comprehensive picture of the world around us. By fusing several smart sensors into one coherent intelligent system, our intuitive sensing solutions simplify complex technical processes and enable people to effortlessly interact with devices. These smart devices intuitively sense the world around them, determining what is expected and needed from them.

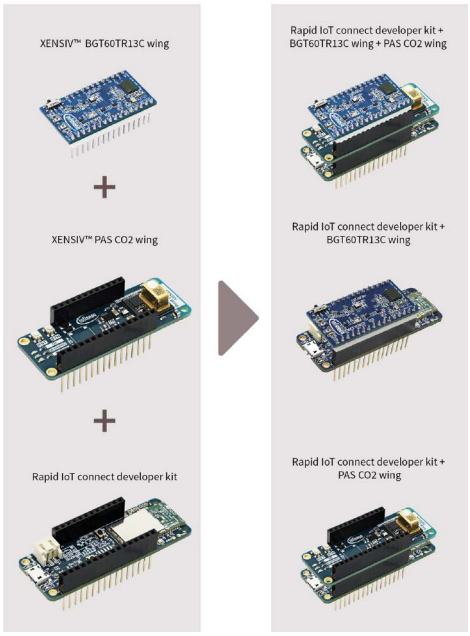
www.infineon.com/intuitivesensing

XENSIV™ connected sensor kit

Rapid IoT prototyping experience enabled by XENSIV™ sensors

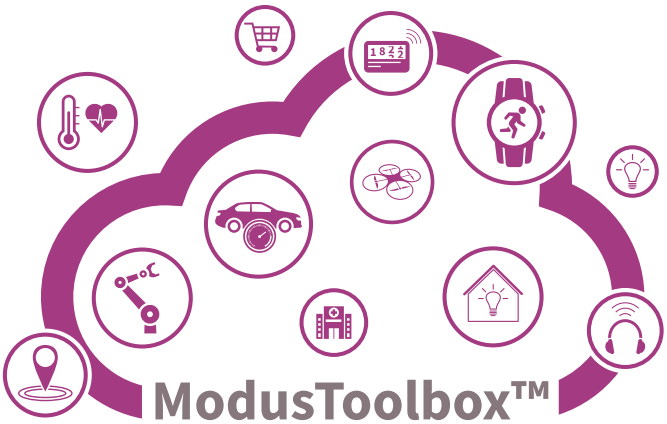
The XENSIV™ connected sensor kit enables rapid development of a custom solution built on Infineon products. The CSK supports customers in testing sensor-driven IoT products and use cases as well as in prototyping. It offers a real-time sensor evaluation with custom configurations and cloud-based sensor data visualization with sensor fusion. The development kit supports use cases based on XENSIV™ 60 GHz radar and PAS CO2 with DPS368 pressure sensor (Sense), PSoC™ 6 microcontroller embedded processing (Compute), connectivity via Infineon AIROC™ CYW43012 Wi-Fi and Bluetooth® Combo (Connect) and hardware security with OPTIGA™ Trust M (Secure). Code examples and sensor libraries are available in the Infineon software ecosystem ModusToolbox™ to help customers create use case-specific application codes for new product offerings.

XENSIV™ connected sensor kit



Features and benefits

Key features	Key benefits
› Small form-factor (22.5×63×30 mm) adafruit feather compatible design	› Ideal for prototyping battery-powered IoT devices due to optimized power consumption. Suited for customer field trials.
› AC and DC sensing	› Rapid development and deployment via code examples in ModusToolbox™ for presence detection, entrance counter, air quality measurements. Enabler for Multi-sensor data fusion.
› Wi-Fi and Bluetooth 5.0-compliant combo radio module	› Secure cloud device onboarding and management with OPTIGA™ Trust M. Secure kit provisioning (unique user ID).
› Power optimized design, deployable with battery	
› Interchangeable sensor wings – 60 GHz Radar, PAS CO2	
› Seamless integration into ModusToolbox™	
› FCC and CE certified	



The Infineon Rapid IoT Connect SOM platform deployed on the XENSIV™ CSK provides hardware, firmware, and cloud artifacts to enable rapid onboarding to the Internet of Things. Bidirectional XENSIV™ sensor to cloud data communication is securely enabled. The XENSIV™ CSK is a pre-implemented Infineon Prototyping Sensor System that makes it possible to provision, monitor and manage Infineon hardware remotely. Sensor2cloud kit set up takes 10 minutes with 12 months free user access to a dedicated cloud demo platform for sensor data collection and interpretation as well as sensor data download.

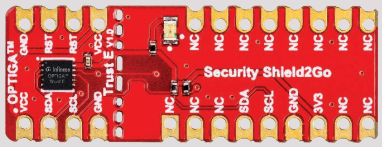
Product	Description	OPN No.
XENSIV™ KIT CSK PASCO2	Rapid prototyping platform for use cases based on Infineon's XENSIV™ PAS CO2 sensor	KITCSKPASCO2TOBO1
XENSIV™ KIT CSK BGT60TR13C	Rapid prototyping platform for use cases based on Infineon's XENSIV™ 60GHz radar sensor	KITCSKBGT60TR13CTOBO1

www.infineon.com/connectedsensorkit

Shields2Go

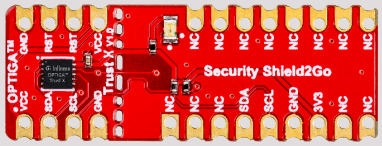
Infineon's Shield2Go boards offer a unique customer and evaluation experience – the boards are equipped with one Infineon IC and come with a ready-to-use Arduino library. Customers can now develop their own system solutions by combining 2GO boards together with Infineon MyIoT adapters. MyIoT adapters are gateways to external hardware solutions like Arduino and Raspberry PI, which are popular IoT hardware platforms. All this enables the fastest evaluation and development of the IoT system.

Security



Product name: OPTIGA™ Trust E Security Shield2Go
Sales name: S2GO_Security_OPTIGA_E
Ordering code: SP001820138

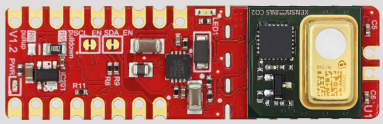
Product information



Product name: OPTIGA™ Trust X Security Shield2Go
Sales name: S2GO SECURITY OPTIGA X
Ordering code: SP002349576

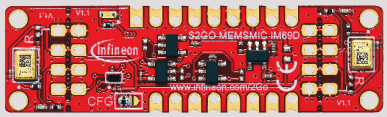
Product information

Sensors



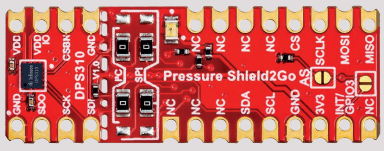
Product name: PASCO2V01 Shield2Go
Sales name: SHIELD PASCO2 SENSOR
Ordering code: SP002851544

Product information



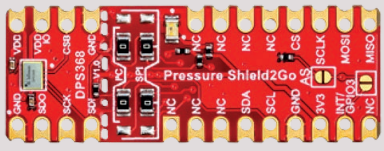
Product name: IM69D130 Microphone Shield2Go
Sales name: S2GO MEMSMIC IM69D
Ordering code: SP002851544

Product information



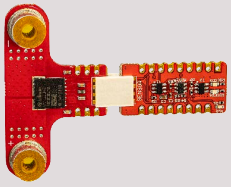
Product name: S2GO Pressure Sensor DPS310
Sales name: S2GO_PRESSURE_DPS310
Ordering code: SP001777630

Product information



Product name: S2GO Pressure Sensor DPS368
Sales name: S2GO PRESSURE DPS368
Ordering code: SP005338022

Product information



Product name: TLI4971 Current Sense Shield2Go
Sales name: S2GO_CUR-SENSE_TLI4971
Ordering code: SP005345472

Product information

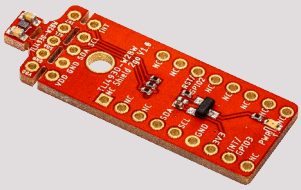
www.infineon.com/sensors2go www.infineon.com/makers

Shields2Go

Sensors

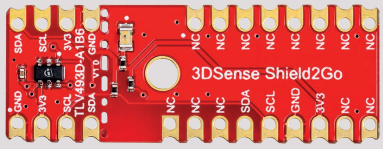
Product name: TLE493DW2B6 3DSense Shield2Go
Sales name: S2GO_3D_TLE493DW2B6-A0
Ordering code: SP004308594

Product information



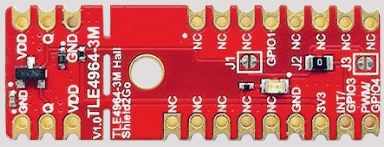
Product name: TLI493D-W2BW 3D Sense Shield2Go in small WLB-5 package (1.13 mm x 0.93 mm x 0.59 mm)
Sales name: S2GO_3D_TLI493DW2BW-A0
Ordering code: SP005410385

Product information



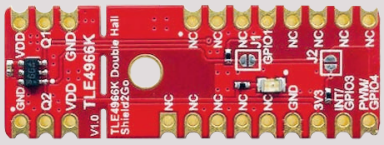
Product name: TLV493D 3D Sense Shield2Go
Sales name: S2GO_3D-SENSE_TLV493D
Ordering code: SP001823678

Product information



Product name: TLE4964-3M Hall Sense Shield2Go
Sales name: S2GO_HALL_TLE4964-3M
Ordering code: SP004308590

Product information

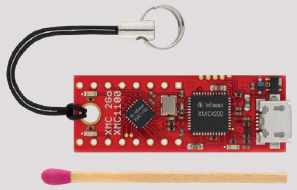


Product name: TLE4966K Double Hall Shield2Go
Sales name: S2GO_2_HALL_TLE4966K
Ordering code: SP004308598

Product information

Shields2Go

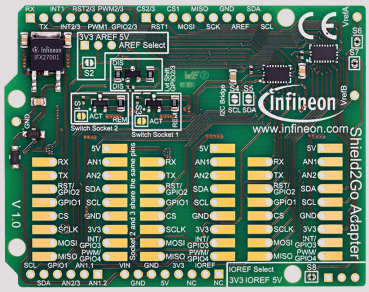
Microcontroller



Product name: XMC 2Go Kit
Sales name: KIT_XMC_2GO_XMC1100_V1
Ordering code: SP001199544

Product information

MyIoT – Adapter



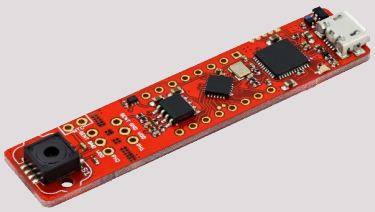
Product name: MyIoT Adapter
Sales name: MYIOTADAPTERTOBO1
Ordering code: SP002434972

Infineon's 2Go boards offer a unique customer and evaluation experience – the boards are equipped with one Infineon IC and come with a ready-to-use Arduino library. Customers can now develop their own system solutions by combining 2Go boards together with Infineon MyIoT adapters.
MyIoT adapters are gateways to external hardware solutions like Arduino and Raspberry PI, which are popular IoT hardware platforms. All this enables the fastest evaluation and development of IoT system.

Product information

Sensor 2GO kits

Infineon's XENSIV™ Sensor 2GO kits are budget-priced evaluation boards that are already equipped with a sensor combined with an Arm® Cortex®-M0 CPU. The Sensor 2GO kits provide a complete set of on-board devices, including an on-board debugger. Build your own application and gadget with the Sensor 2GO kits. Our 2GO kits are ready-to-use plug-and-play boards.



Automotive Pressure Sensor 2GO kit

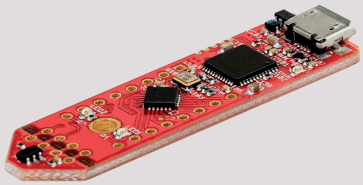
Product name: KP215F1701-PS2GO-KIT/KP229E3518-PS2GO-KIT/ KP236-PS2GO-KIT/KP254-PS2GO-KIT/ KP275-PS2GO-KIT

Ordering code: SP002676652/SP002676656/ SP002676664/SP002676664/ SP002676648

Features

- We offer five different derivatives
  - KP215F1701 MAP: Analog Manifold Air Pressure Sensor
  - KP229E3518 TurboMAP: Analog Turbo Manifold Air Pressure Sensor
  - KP236 BAP: Analog Barometric Air Pressure
  - KP254 dBAP: Digital Barometric Air Pressure (SPI)
  - KP275 dMAP: Digital Manifold Air Pressure Sensor (SENT)
- Pressure and external temperature measurement – ONLY KP275dMAP
- CSV file can be generated for each derivative
- External NTC included KP275-PS2GO-KIT
- Configuration of different transfer functions possible, KP215F1701-PS2GO-KIT and KP229E3518-PS2GO-KIT
- A pressure connector consisting of a fast connector for 6mm tubes, pressure couple, and sealing is included
- GUI software for free download
- Power over USB (micro USB), ESD and reverse current protection
- GUI for free download

Product information



3D Magnetic Sensor 2GO kit

Product name: TLE493D-A2B6 MS2GO/TLE493D-W2B6 MS2GO/ TLV493D-A1B6 MS2GO

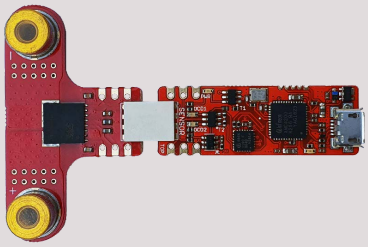
Ordering code: SP001707582/SP001707578/ SP001707574

Features

- We offer three different derivatives
  - TLE493D-A2B6 (three dimensional magnetic sensor)
  - TLE493D-W2B6 (three dimensional magnetic sensor)
  - TLV493D-A1B6 (three dimensional magnetic sensor)
- XMC1100 (Arm® Cortex®-M0 based)
- On-board J-Link Lite Debugger (Realized with XMC4200 Microcontroller)
- Power over USB (Micro USB), ESD and reverse current protection
- GUI for free download

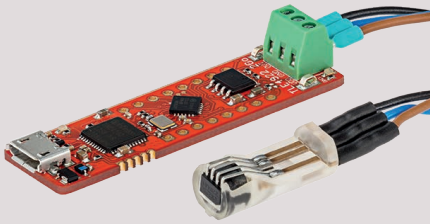
Product information

Sensor 2GO kits



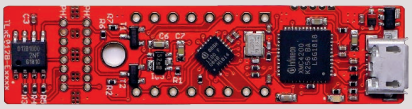
TLI4971 Current Sensor 2GO kit
Product name: TLI4971_MS2GO
Ordering code: SP005345474
Features
- XENSIV™ magnetic current sensor TLI4971-A120T
- Sensor board for high current capability (≤20 A)
- Complete evaluation set including control and debug
- First measurements possible within minutes

Product information



Speed Sensor 2GO kit
Product name: TLE4922 MS2GO
Ordering code: SP003029974
Features
- Budget-priced evaluation board for speed sensing
- Complete speed sensor incl. back-bias magnet, fixing and cable
- TLE4922 (active mono cell Hall sensor)
- XMC1100 (Arm® Cortex®-M0 based)
- On-board J-Link Lite Debugger (realized with XMC4200 microcontroller)
- Power over USB (Micro USB), ESD and reverse current protection
- GUI based tool for real in-application evaluation for free download

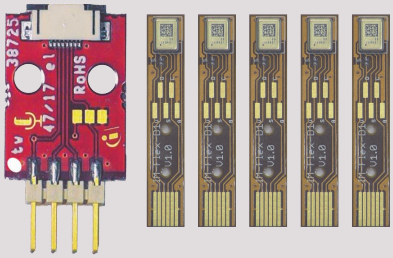
Product information



Angle Sensor 2GO kit
Product name: TLE5012B_E1000_MS2GO/ TLI5012B_E1000_MS2GO/ TLE5012B_E5000_MS2GO/ TLE5012B_E9000_MS2GO
Ordering code: SP002133956/ SP002133960/ SP002133964/ SP002133968
Features
- Budget-priced evaluation board for angle and position sensing
- We offer four derivatives:
  - TLE5012B E1000 version: automotive predefined variant with SSC and IIF communication protocols
  - TLE5012B E5000 version: automotive predefined variant with SSC and PWM communication protocols
  - TLE5012B E9000 version: automotive predefined variant with SSC and SPC communication protocols
  - TLI5012B E1000 version: industrial predefined variant with SSC and IIF communication protocols
- TLE5012B/TLI5012B GMR digital angle sensor
- XMC1100 (Arm® Cortex®-M0 based)
- On-board J-Link Lite Debugger (realized with XMC4200 microcontroller)
- The kit is compatible with the angle rotate knob for fast evaluation
- GUI based tool for real in-application evaluation for free download

Product information

Sensor 2GO kits



Microphone flex evaluation kits

Product name: EVAL_IM69D130_FLEXKIT/
EVAL_IM69D120_FLEXKIT/
EVAL_IM69D127_FLEXKIT/
EVAL_IM73D135_FLEXKIT/
EVAL_IM72D128_FLEXKIT/
EVAL_IM70A135_FLEXKIT/
EVAL_IM67D120_FLEXKIT/
EVAL_IM67D130_FLEXKIT

Ordering code: SP002153022/
SP002153026/
SP005403891/
SP005415695/
SP005429924/
SP005728204/
SP005560671/
SP005537489

The flex evaluation kits allow simple and easy evaluation of XENSIV™ MEMS microphones. One microphone of the respective type is mounted on each flex board. A flex board can be easily connected to an audio testing setup with the included adapter board via a 6-position ZIF connector.
Each kit includes five flex boards and one adapter board.
All digital flex kits can be connected to Infineon's EVAL AHNB IM69D130V01 evaluation board.

Features

- Quick and easy connection to evaluation system
- Small size: 25×4.5 mm
- Pre-soldered MEMS microphone
- Configurable select pin configuration for digital microphones

Product information

XENSIV™ – TLE4966 Hall switches 2GO kit

Product name: TLE4966 MS2GO

Ordering code: SP005406992

The board features our 3D magnetic sensor, TLI493D-W2BW used as reference magnetic probe for correlating magnetic switching points with magnetic field strength. Mechanically, the board is compatible with the Out-of-Shaft mechanical Add on, which must be ordered separately.

Features

- TLE4966V-1G, double vertical Hall latch with direction detection
- TLE4966G, double lateral Hall latch with direction detection
- XMC1100 (Arm® Cortex®-M0 based)
- On-board J-Link Lite Debugger (Realized with XMC4200 Microcontroller)
- Power over USB (Micro USB), ESD and reverse current protection
- GUI for free download

Product information

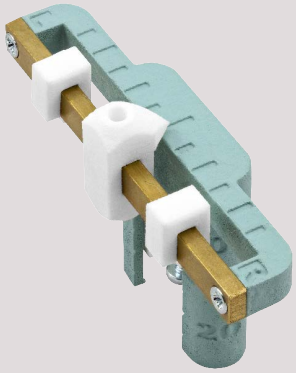
Add ons for Sensor 2GO kits and Shield2Go

Joystick for all 3D Magnetic Sensor 2GO kits and Shield2Go
Product name: JOYSTICK FOR 3D 2 GO KIT
Ordering code: SP001491834
Features
- Easy mounting on all 3D magnetic sensor 2GO kits and Shield2Go
- First magnetic joystick measurements within minutes

Product information

Rotate knob for all 3D Magnetic Sensor 2GO kits, Angle Sensor 2GO kits and 3D Magnetic Sensor Shield2Go
Product name: ROTATE KNOB 3D 2 GO KIT
Ordering code: SP001504602
Features
- Easy mounting on all 3D magnetic and angle sensor 2GO kits as well as 3D magnetic sensor Shield2Go
- Rotate knob with a magnet as used in control elements and push buttons
- Use cases 3D magnetic sensors: rotational and vertical movements of control elements and push buttons
- Use cases angle sensors: simulates rotational movements for angle measurements

Product information



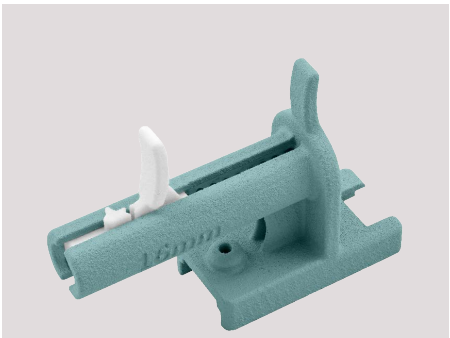
Linear slider for all 3D Magnetic Sensor 2GO kits and Shield2Go
Product name: LINEAR-SLIDER 2GO
Ordering code: SP002043034
Features
- Easy mounting on all 3D magnetic sensor 2GO kits and Shield2Go
- First magnetic linear evaluations within minutes
- Use case: linear movements
- Linear slider with magnet – flexible setup: adaptable air-gaps, two different magnetic strengths/materials and distance limiters

Product information

Out of shaft adapter for all 3D Magnetic Sensor 2GO kits and Shield2Go
Product name: OUT OF SHAFT FOR 3D 2 GO
Ordering code: SP003475178
Features
- Easy mounting on all 3D magnetic sensor 2GO kits and Shield2Go
- Use case: angle measurement in out of shaft configuration with 3D Hall sensor
- Three different out of shaft configurations possible (x-z, y-z and x-y axis)
- Magnetic rotation bar with ring magnet included

Product information

Add ons for Sensor 2GO kits and Shield2Go



Linear control trigger for all 3D Magnetic Sensor 2GO kits and Shield2Go
Product name: POWER_DRILL2GO
Ordering code: SP005350194
Features
- Easy mounting on all 3D magnetic sensor 2GO kits and Shield2Go
- Use case: control trigger for e.g. power drill (linear position measurements with 3D Hall sensor)
- Magnetic slider with magnet included

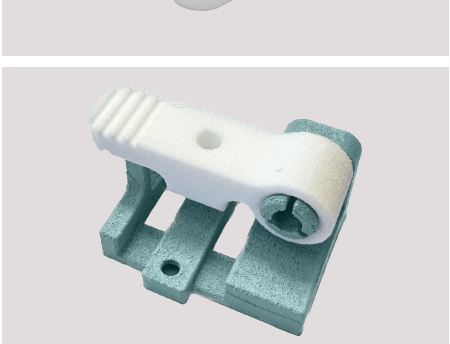
Product information

Human Machine Interface (HMI) direction indicator for all 3D Magnetic Sensor 2GO kits and Shield2Go
Product name: DIR_INDICATOR2GO
Ordering code: SP005350196
Features
- Easy mounting on all 3D magnetic sensor 2GO kits and Shield2Go
- Use case: human-machine interface (3x3 position matrix) for e.g. automotive direction indicator
- Magnetic direction indicator with magnet included in the handle bar

Product information

HMI mini control with 4 directions and 360° rotation for all 3D Magnetic Sensor 2GO kits and Shield2Go
Product name: MINI_CONTROL2GO
Ordering code: SP005350192
Features
- Easy mounting on all 3D magnetic sensor 2GO kits and Shield2Go
- Use case: left/right/forward and backward including 360° rotation at all positions
- Control element includes a magnet

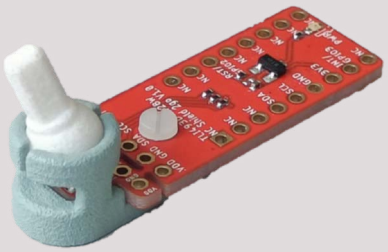
Product information



OpenClose Adapter for Hall switch Shield2Go
Product name: OPENCLOSE2GOHSTOBO1
Features
- Open & Close detection with magnet for positions detection
- Presence and non-presence detection

Product information

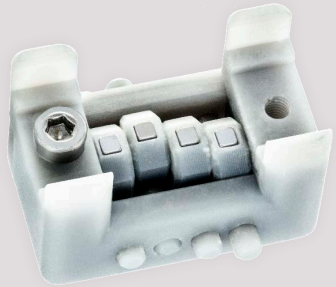
Add ons for Sensor 2GO kits and Shield2Go



Play2Go for 3D Magnetic Sensor
Product name: PLAY2GO
Ordering code: SP005731811
The Infineon PLAY2GO is a very small joystick that can be actuated with your thumb. In terms of size it is a direct replacement to those potentiometer joysticks often used in gaming controllers and similar devices. The joystick itself comes with a pre-mounted magnet and is especially made to be combined with the TLI493D-W2BW 3D magnetic sensor Shield2Go in order to evaluate three dimensional movements of consumer or also industrial joysticks.

Features
- Easy mounting on TLI493D-W2BW Shield2Go
- First magnetic joystick measurements within minutes
- GUI for free download

Product information



Contactless switch array for all 3D magnetic sensor 2GO kits and Shield2Go

Summary of features
- Contactless magnetic based „4-bit DIP Switch“ for configuration using a magnetic 3D sensor for detection
- Four movable tiny magnets are used to configure a four bit value

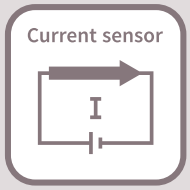
Potential applications
- Industrial
- Consumer

Complementary magnets
- TRU COMPONENTS 505944 Permanent-Magnet Würfel

Self-service

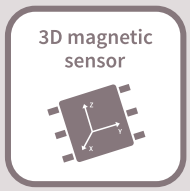
Choose the best fit magnetic sensor solution from broadest portfolio

Our sensor simulation tools allow you to compare products in application conditions. The tools are easy-to-use and will guide you in identifying the most suitable Infineon XENSIV™ - sensor combined with the best-fit magnet.



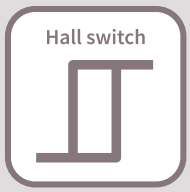
XENSIV™ – Current Sensor Simulation Tool
Define and optimize the current sensing structure for your system. The tool supports design of lateral and vertical insertions for PCB (2 to 10 layer stack) or bus-bar based applications. The simulation will provide insertion resistance, field transfer factor, sensitivity range, measurement range and power dissipation as well as cross-talk in case of a 3-phase system.

Direct link to the Current Sensor Simulation Tool:
https://currentsensorsim.infineon.com/



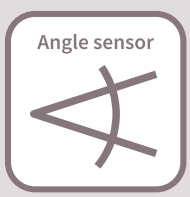
XENSIV™ – 3D Magnetic Sensors Simulation Tool
3D magnetic field sensor for smaller, more accurate and robust designs. The sensor family, with low current consumption and cost-optimized design, specifically addresses the needs of new magnetic sensor applications in consumer, industrial and automotive. They are ideally suited for the measurement of three dimensional movement within a magnetic field, linear slide movement as well as 360° angle rotation.

Direct link to the 3D Magnetic Sensors Simulation Tool:
https://www.infineon.com/3dsim



XENSIV™ – Magnetic Hall Switches Simulation Tool
Discover Infineon's broad energy saving portfolio of Hall switches in smallest package. Simulate your Hall switch applications and see the results in an accurate simulation of the magnetic field and the switching behavior of the Hall switch in the application.

Direct link to the Hall Switches Simulation Tool:
https://www.infineon.com/hallsim



XENSIV™ – Magnetic Angle Sensors Simulation Tool
Highest variety - low end to high end, standardized and specialized in all four magnetic technologies: Hall, GMR, AMR and TMR. This tool calculates the valid distance from the magnet surface to the sensor and the assembly error, given certain parameters: magnetic properties, sensor specification and assembly tolerances.

Direct link to the Angle Sensors Simulation Tool:
https://www.infineon.com/anglesim

All simulation tools can be easily accessed via this link: https://www.infineon.com/xensiv-simulation-tools

ISO 26262 - Functional Safety (FuSa)

Dependable electronics based on Functional Safety

The transformation in the automotive industry is being driven by megatrends such as automated driving and connectivity, all of which increases the need for safe electronic systems. These systems require highly integrated and safe electronic semiconductors. Today's standard for safe automated and safe autonomous systems is the ISO 26262 that is already implemented in the Infineon automotive products and well-established in the company's development processes and all product support activities.

Infineon is actively monitoring the trends in the automotive industry. We provide components and chipsets as well as system knowledge to support all safety-relevant automotive systems. Our broad product portfolio addresses a wide range of functionalities with sensors, computing and actuating chips complemented by power supply chips and communication ICs. For easy integration and minimum effort at the system integrator level, Infineon provides all of the necessary supporting information and documentation, as well as support from our team of experts. The required conformity evidence to ISO 26262 series of standards is available for all Infineon automotive safety products.

Functional safety is an inherent part of the proprietary development processes in Infineon. All products with assigned ASIL-classified safety requirements are subject to appropriate internal audits, assessments, and confirmations. With that, we ensure that these components fulfill the requirements for ISO 26262-compliant and ISO 26262-ready classifications – both are recognizable by our PRO-SIL™ trademark. With regard to ISO 26262-compliance, PRO-SIL™ indicates that assigned product safety requirements are fulfilled and conform to the ISO 26262 series of standards. With regard to ISO 26262-readyness, PRO-SIL™ indicates that the integrator gets the necessary information to integrate a non-ISO 26262 developed part into his safe system according to ISO 26262 clause 8-13.

All ISO 26262-compliant and ISO 26262-ready parts are produced according to Infineon's comprehensive automotive quality processes, resulting in the highest-possible product reliability. With our passion for quality and by taking a holistic functional safety approach, Infineon provides dependable electronics to support today's safety-relevant systems and future fail-operational systems essential for highly automated and autonomous driving.

PRO SIL ISO 26262 ready

PRO SIL ISO 26262 compliant

www.infineon.com/iso26262

Dependability is the key driver for the megatrend towards autonomous driving

The future car is fully connected and always online. It is all-electric and autonomous. To make this a reality, it takes both – technology and trust.

All levels of automated driving, but especially higher levels such as Level 3, 4, 5, require the driver's and passengers' trust for its adoption. Car occupants and other road users need to trust in cars that enable safe and flawless automated driving in any environment, regardless of the roads' type and condition, the weather or the age of the car. They also want to trust in the fact that automated cars are secure.

Especially, higher levels of automated driving systems are the basis for trust only if they feature high availability of safety and cybersecurity. Only then will they be perceived as "dependable" – and thus be fully trusted.

Dependable electronics enable systems that are the foundation for trust

The key to the successful combination of both technology and trust, is dependable electronics.

So what is it that distinguishes Infineon's dependable electronics? Quite simply:

We offer innovative top-quality semiconductors and semiconductor solutions combined with broad system knowledge. As your trusted partner for premium products and services, we understand the dependability system requirements of robustness, reliability, availability, safety, and security as well as the added value of operational excellence.

Infineon is automotive dependability

Infineon's dependable electronics are built on a zero defect automotive quality mindset, which results in the high reliability and robustness of our semiconductors. They also incorporate a holistic Functional Safety approach enabling highly available fail-operational systems that meet the requirements of functional safety in accordance with ISO 26262. Furthermore, our dependable electronics leverage a deeply embedded broad system knowledge. We add extensive cybersecurity expertise that integrates our scalable product portfolio and a vast security system know-how.

All these ingredients of our dependable electronics enable a dependable, robust, safe and secure system that operates in all conditions. Our dependable electronics product portfolio provides sensors, microcontrollers, memory solutions, power electronics, vehicle communications and power supply ICs.

So if you want to rely on a trusted partner offering all relevant ingredients for your dependable systems – automotive quality, Functional Safety, cybersecurity, innovative products, system understanding, operational excellence – then you need Infineon and Infineon automotive dependability.

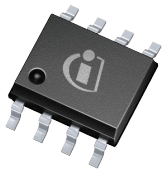
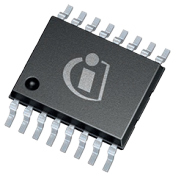
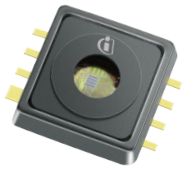
As the number one partner in the automotive industry, we shape the future of mobility making cars clean, safe and smart – through dependable electronics that enable systems that are the foundation for trust.

ProSIL™ products support a safety use case

Customer use case	System integration: Efforts	System integration: Documentation	Safety feature description	Infineon label
Design with safety product to develop its own safety system	Use case specific	Use case specific	Product with diagnostic or safety features	PRO SIL
Hardware integration using products developed with Infineon automotive processes	Medium	Safety app. note	Safety analyses and customer documentation supporting ISO 26262 system integrations	PRO SIL ISO 26262 ready
System designed around Infineon components developed specifically for safety relevant applications	Low	Safety manual	Product developed according to ISO 26262 process with required documentation	PRO SIL ISO 26262 compliant

www.infineon.com/dependable-electronics

Packages

DSO-8/TDSO-8	TDSO-16	DSOF-8-16	DSOF-8-164
			

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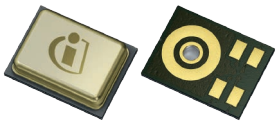
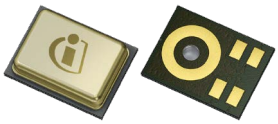
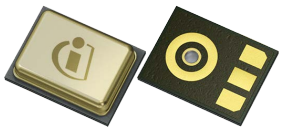
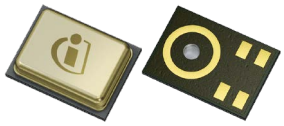
LLGA-5-1/3/4	LLGA-5-2	TLGA-4-2	TLGA-5-1
			

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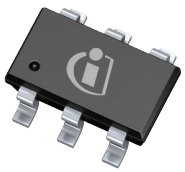
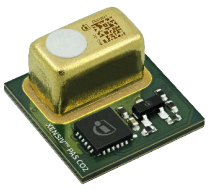
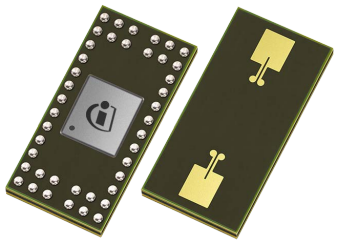
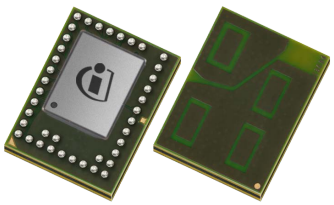
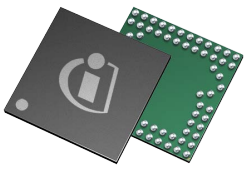
			

UF2BGA-42-1	VF2BGA-40-1	VFWLB-76-1
		

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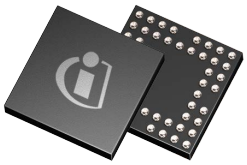
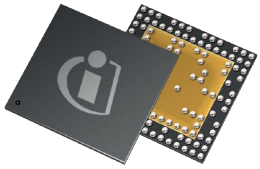
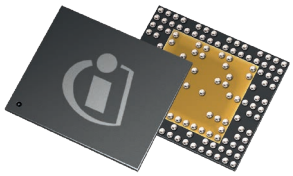
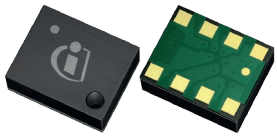
Packages

WFWLB-52 (eWLB)	WFWLB-131 (eWLB)	WFWLB-138 (eWLB)	VLGA-8-1
			

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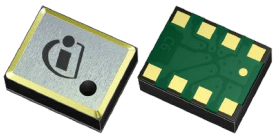	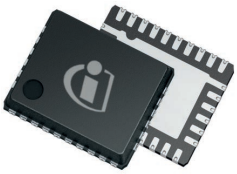	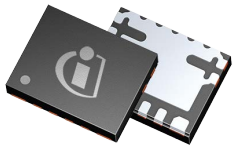	

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		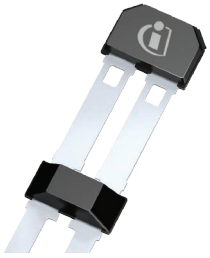	

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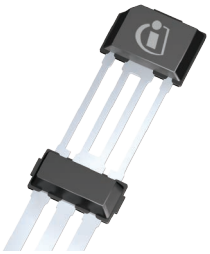	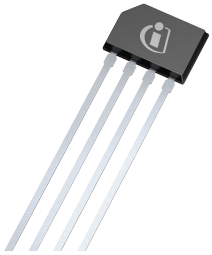	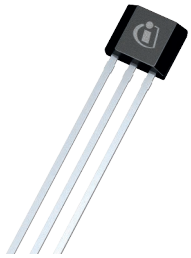	

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