XENSIV™ Sensors

IPCEI Microelectronics Workshop

Severin Neuner & Jernej Pogacnik
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Sensing the world - for 40+ years with many milestones

1986
First integrated magnetic speed sensor developed

Around 1980
Discrete magnetics sensors from Siemens Halbleiter

2002
Start of sensor package production in Malaysia

2004
Acquisition of Sensonor in Norway for TPMS product technology

2006
First integrated GMR-based Sensor in mass production

1988
First fully integrated MEMS pressure sensor for airbag

2009
Infineon launches world‘s first 77 GHz automotive radar chip based on SiGe

2014
More than 250M TPMS sensors delivered to customers

2018
100 million 77 GHz radar chips delivered to customers

2018
First fully compliant ASIL D sensors for mass production

2019
Infineon first to launch fully integrated radar transceiver

Sense & Control addresses a wide range of applications in all markets

Vehicle Automation & Chassis

- Front & Corner Radar
- TPMS
- ABS
- EPS
- Side Airbag
- Seat belt buckle
- Chassis height

Vehicle Motion

- Inverter & xEV
- Transmission
- Engine
- Manifold Air pressure
- Barometic Air pressure
- Drives
- Battery Management

Vehicle User Experience

- Top column module
- Seat comfort
- Window lift/sunroof
- Wiper
- Motor Control
- RKE
- Noise cancellation

Industrial & Consumer

- Inverter
- Drives
- Robotics
- Home automation
- Smart meter
- Joysticks
- eBikes, eScooter

Introduction to the sensor product portfolio and Sense & Control org.

Magnetic Speed

- Wheel Speed
- Engine
- Transmission

Magnetic Position

- 3D Magnetic
- Angle Sensor
- Hall switch
- Linear Hall

Magnetic Current

- Current Sensor

Inductive Position

- Inductive Angle

MSS

MEMS

- Side Airbag Pressure
- Barometric Pressure
- Manifold Pressure
- Tire Pressure Monitoring Sensors (TPMS)
- Silicon Microphone
- 3D Mirror (Imager)

MEMS

Radar

- 77GHz Radar
- 24/ 60GHz Radar

Radar

Worldwide SC manufacturing sites frontend, backend and R&D

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TSS

Transmition Speed Sensors

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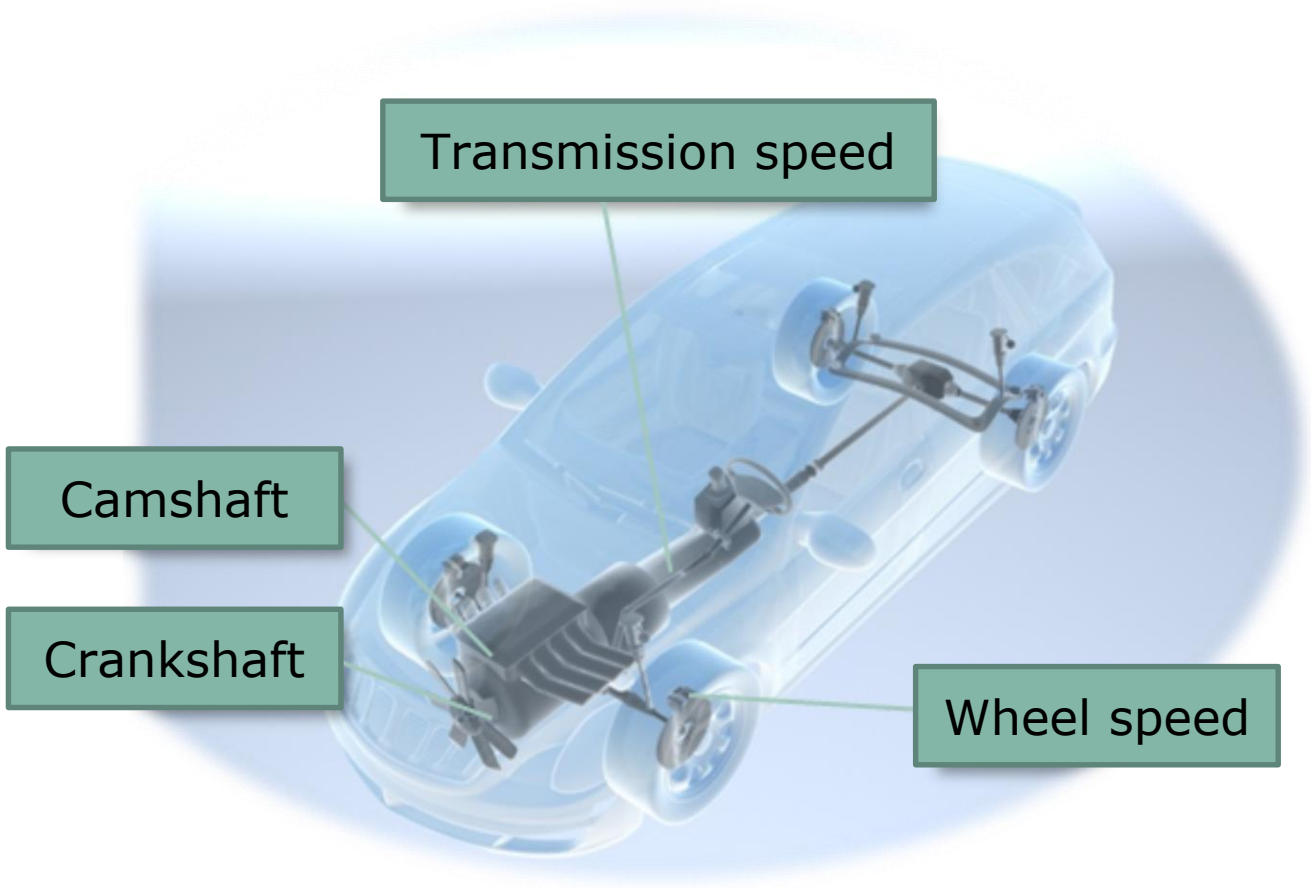
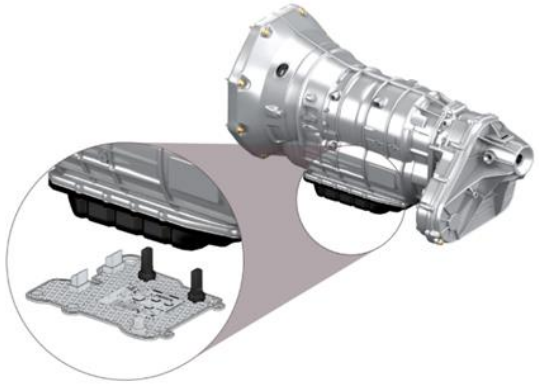
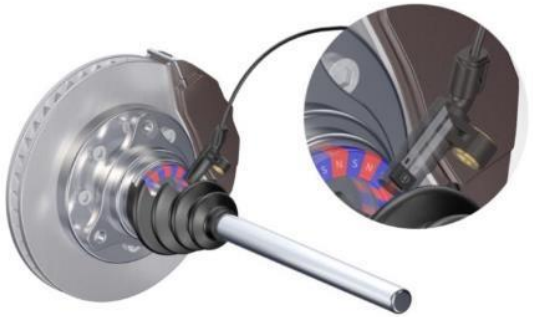
Other Speed Sensors Applications

Speed sensor in automotive applications

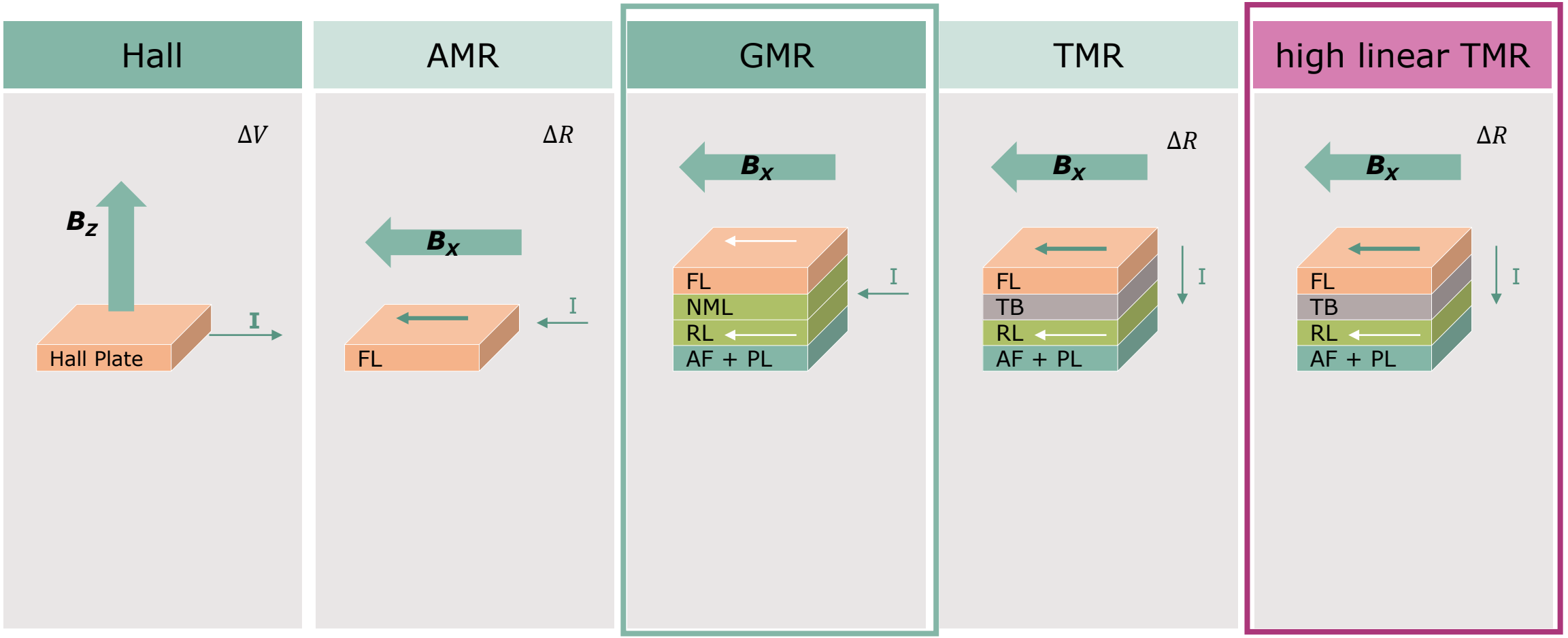






› The automotive industry faces the **challenge of transitioning to electric vehicles while meeting global emission regulations such as EURO 7 which require higher fuel efficiency and lower CO2 emissions.**

Different Sensor Technologies provided by Semiconductor Suppliers



› IFX's xMR speed sensors are focusing on the **integrated GMR** **and the latest developed** **integrated high linearity TMR**

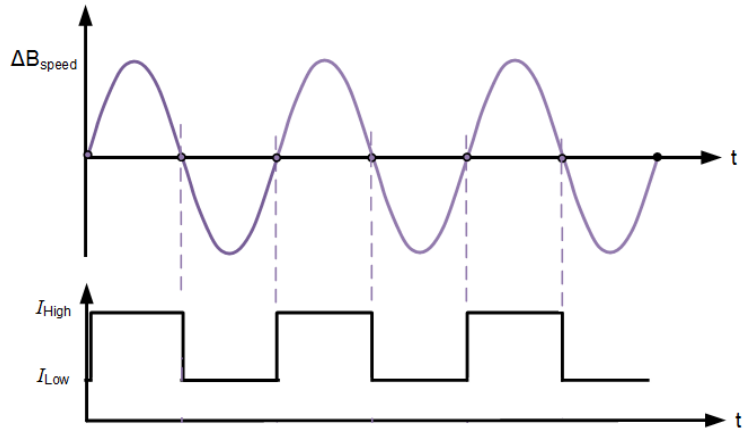
FL: Free Layer NML: Non Magnetic Layer RL: Reference Layer AF: Anti Ferro Magnet TB: Tunnel Barrier PL: Pinned Layer

Measurement principle of magnetic speed sensors

(a) (b)

Typical sensing arrangement for wheel speed measurement
(a) pole wheel with sensor (b) toothed wheel with sensor and back-bias magnet

1. Rotating shaft applies **magnetic field to sensor**
2. **Sensor measures magnetic field** and delivers output signal (i.e. duty cycle or direction)



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Speed sensors in automotive applications

WSS

Wheel Speed Sensors

TSS

Transmition Speed Sensors

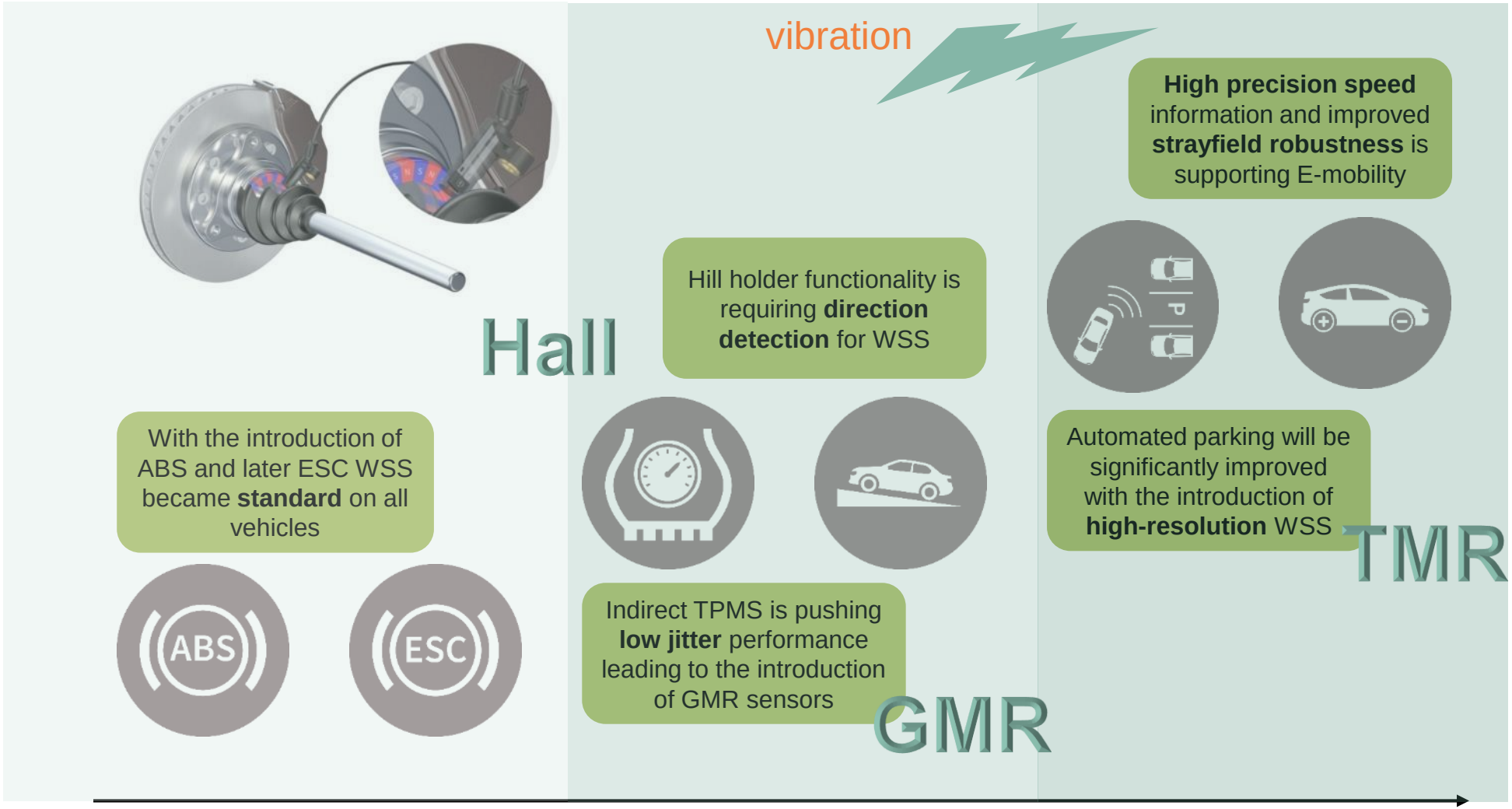
ESS

Engine Speed Sensors

Other

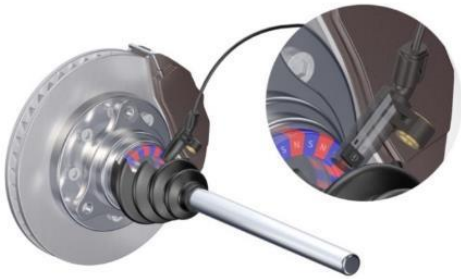
Other Speed Sensors Applications

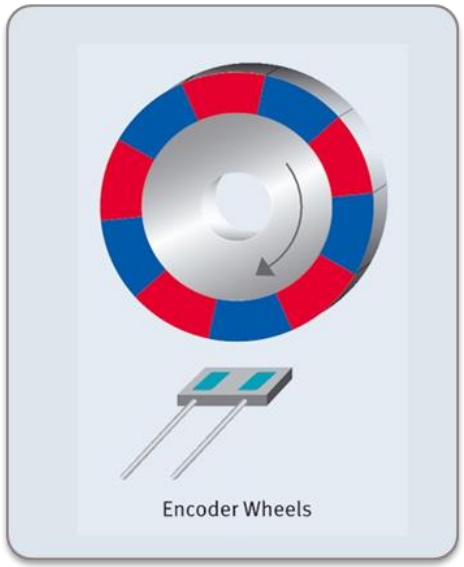
With the introduction of new driver assist functions the **functionality of WSS is constantly increasing**



Wheel speed sensors
Product release

TLE4941plusC	› Standard Hall WSS sensor without direction detection supporting **ABS** and **ESC** functions
TLE4942-1C **TLE4943C**	› Standard WSS with direction detection via PWM or AK protocol supporting in addition to **ABS** and **Hill Holder** and **Park Assist** functions
TLE5045xiC **TLE5046xiC** **TLE504x MTiC**	› WSS with or without direction detection (PWM and AK protocol available) suitable for **ABS**, **Hill Holder**, **Park Assist**. › ASIL B(D) › High accuracy sensor supporting **iTPMS**
TLE55493C	› State of the art WSS with direction detection via AK protocol suitable for **ABS**, **Hill Holder**, **Park Assist** and **iTPMS** › **ASIL C(D)** › High accuracy and high resolution sensor support all side applications incl. **Automated Parking**





2-wire current sensor interface

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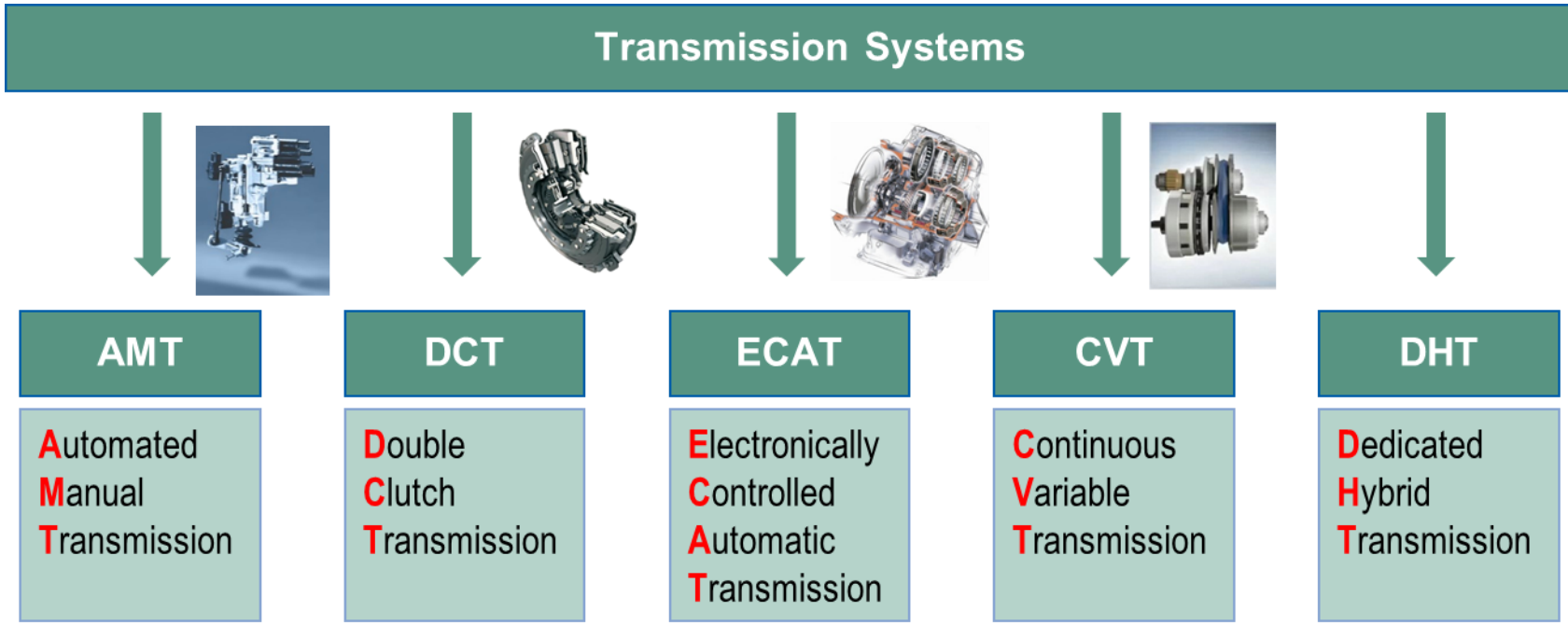
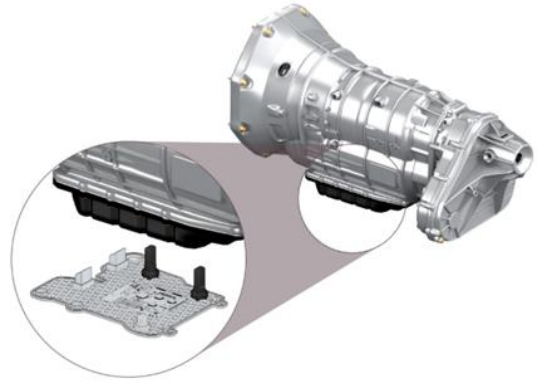
Classification of application types

Main automatic transmission systems in to the market



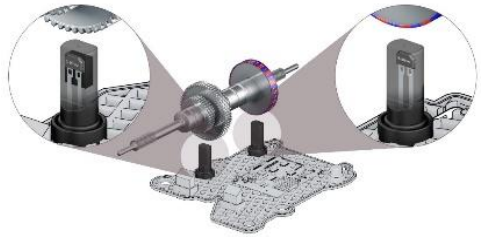


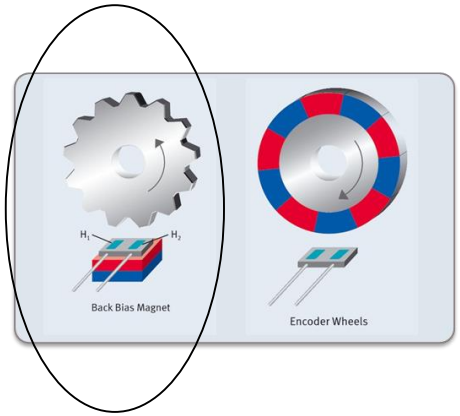
Automatic transmissions need rotational speed sensors to enable slip control of all kind of clutches or pulleys for comfortable gear shifting and economic driving.

IFX transmission speed sensors address every automatic transmissions as DCT, ECAT, CVT, AMT well as hybrid concept, DHT and new **EVs**.

Transmission speed sensors
Product release

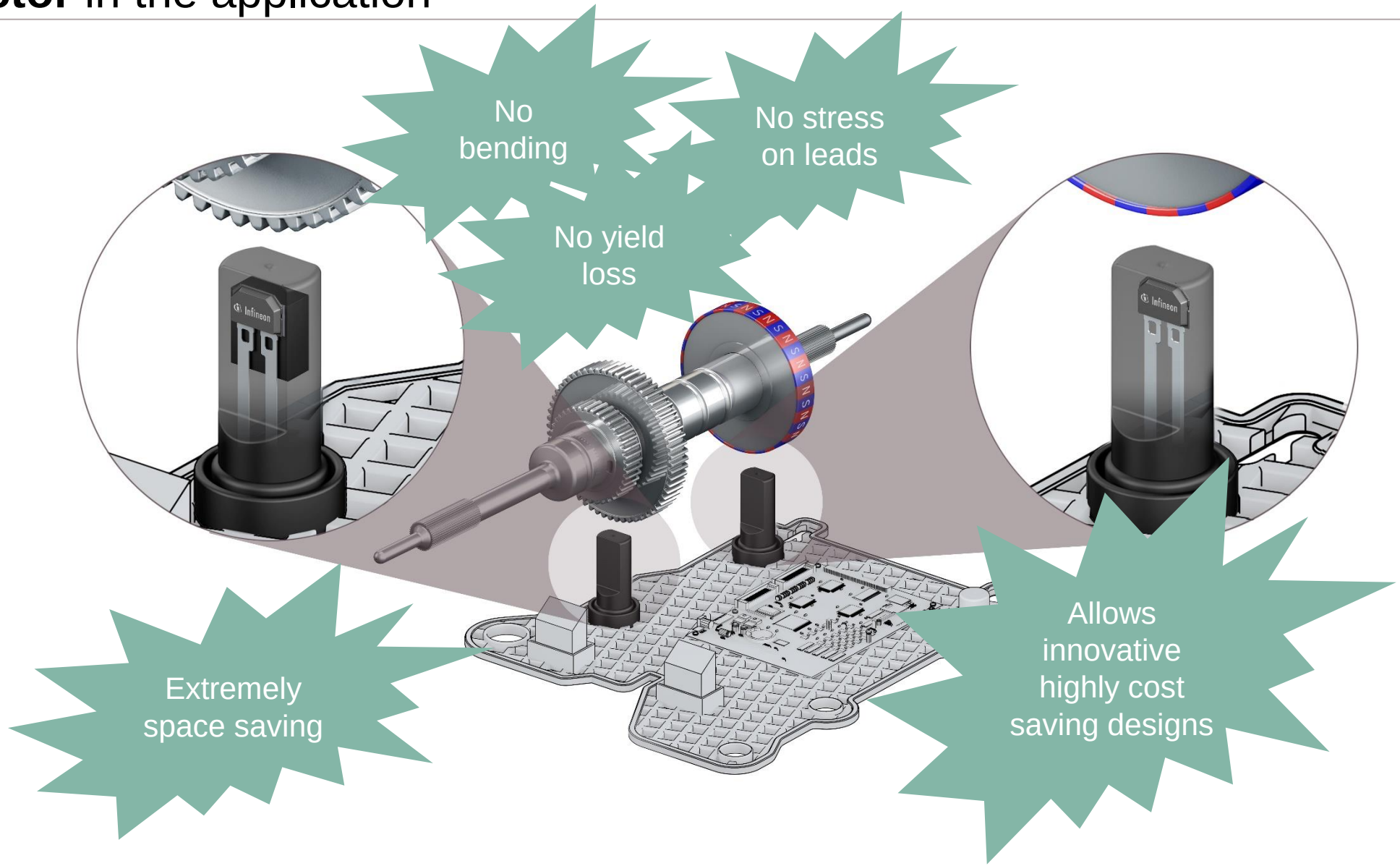
TLE4953C	› Standard Hall TSS sensor with direction detection via PWM protocol. › 2-wire current sensor interface with vibration suppression
TLE4955C Ex	› Standard Hall TSS with direction detection via PWM (**different protocols available**) › 2-wire current sensor with **improved vibration suppression**
TLE5555iC Ex	› **State of the Art** TSS with direction detection via PWM protocol (different protocol and algorithm for application optimization available) › **ASIL B(D) and iBB version available** › Top and side read capability › 2-wire current sensor interface with improved vibration suppression
TLE4959C	› **3-wire voltage interface** TSS with and without direction detection via PWM protocol (different versions available). › **Vibration suppression**
TLE4921-5U	› 3-wire voltage interface TSS without direction





2-wire and 3- wire sensor interface

To sum-up: The hlTMR enables **strong module cost down** with **smaller form factor** in the application



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TLE498x Camshaft sensor generations

TLE4983C

TLE4984C

- High volume sensor family
- Integrated capacitors
- TC pre-programmed for SmCo

TLE4986C
TLE4986C-XAS-M47
TLE4986C-XTS-M47
TLE4986C-XTS-M47D

TLE4931C

- Improved accuracy, flexible algorithms via EEPROM
- Integrated capacitors
- TC pre-programmed for SmCo, EEPROM-ID option
- Customer exclusive (Continental)

TLE4988C
TLE4988C-XTS-M28
TLE4988C-XTN-M28
TLE4988C-XTF-M28
TLE4988CB-XTF-M28

TLE4989C

- Highest accuracy, extended algorithms and features
- Higher integration of passives, premium EMC immunity
- SmCo, NdFeB, Ferrite TC trimming options
- Back bias integrated magnet version (Ferrite)
- Customer exclusive (Continental)

2008 → 2014 → 2019 → SOP

TLE492x Crankshaft sensor generations

TLE4929C
TLE4929C-XAx
TLE4929C-XVA
TLE4929C-XHA
TLE4929C-X2A

- Protocols flexibility covering major Tier 1 requirements
- Watchdogs available to support Stop-Start functions, keeps calibration under startup vibration or during electric driving
  - "XHA" dedicated version for Hybrid vehicles
  - "X2A" Customized version for 2-wheeler

TLE4931C

- Customer exclusive (Continental)

TLE4922

- Speed sensor especially optimized for 2-wheeler applications
- Low cost sensor for VR sensor alternative
  - Crankshaft (&Transmission) speed and position sensing
  - Speedometer applications

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Other Speed Sensors Applications

Speed Sensors are used in **many other applications**. Everywhere where **speed and direction information** is need.

Many other applications!

› Enable **new applications**

› **Coolant pump & Fans**

TLE4959C new derivative!

› **Tachometers**

TLE4922
TLE4988C

› **Hydraulic machines & Harvester**

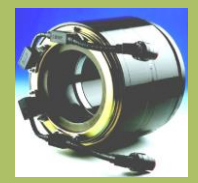
TLE4955C/ E4
TLE4941plusC

› **Trucks**

TLE4959C
TLE5555iC

› **Railway**

TLE4941plusC



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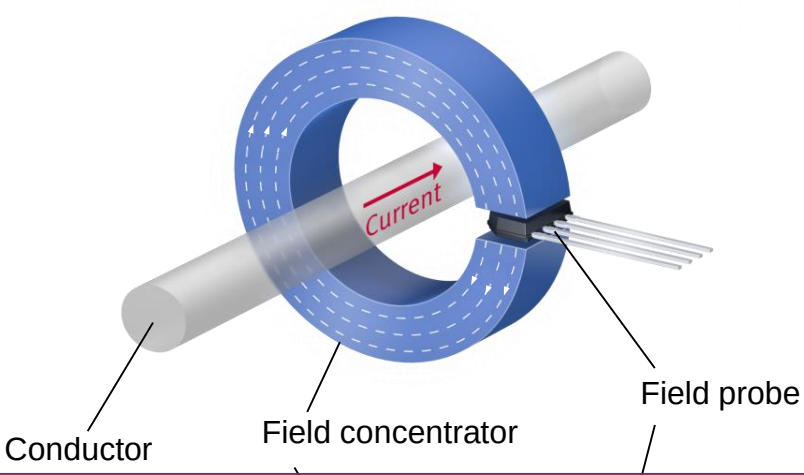
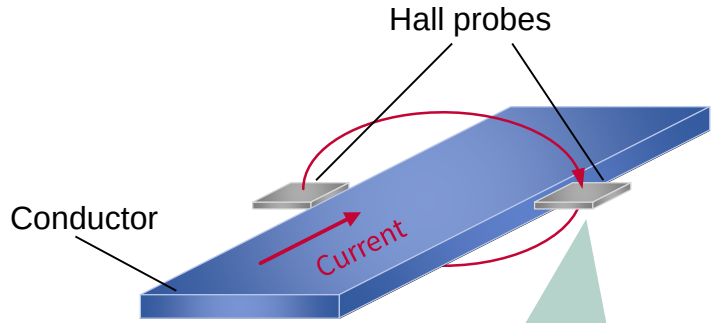
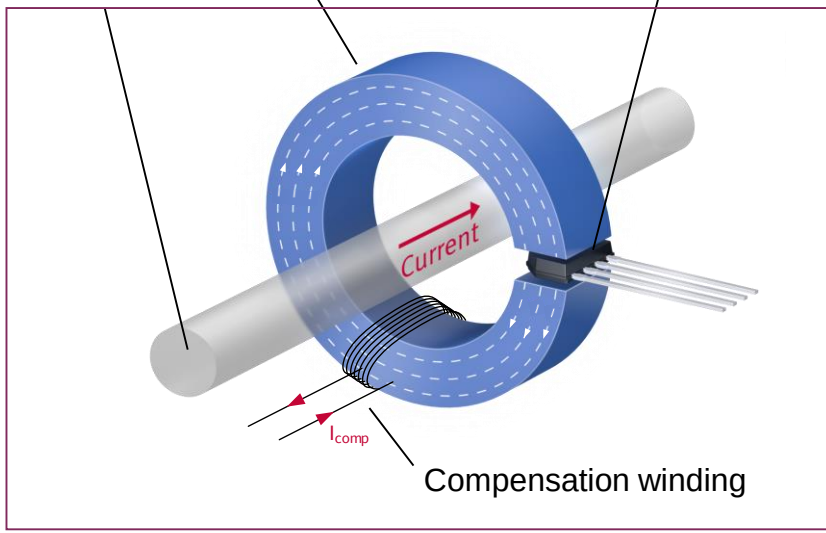
Infineon sensing solutions for the future involve two sensors compared to the single sensor (w/ core)

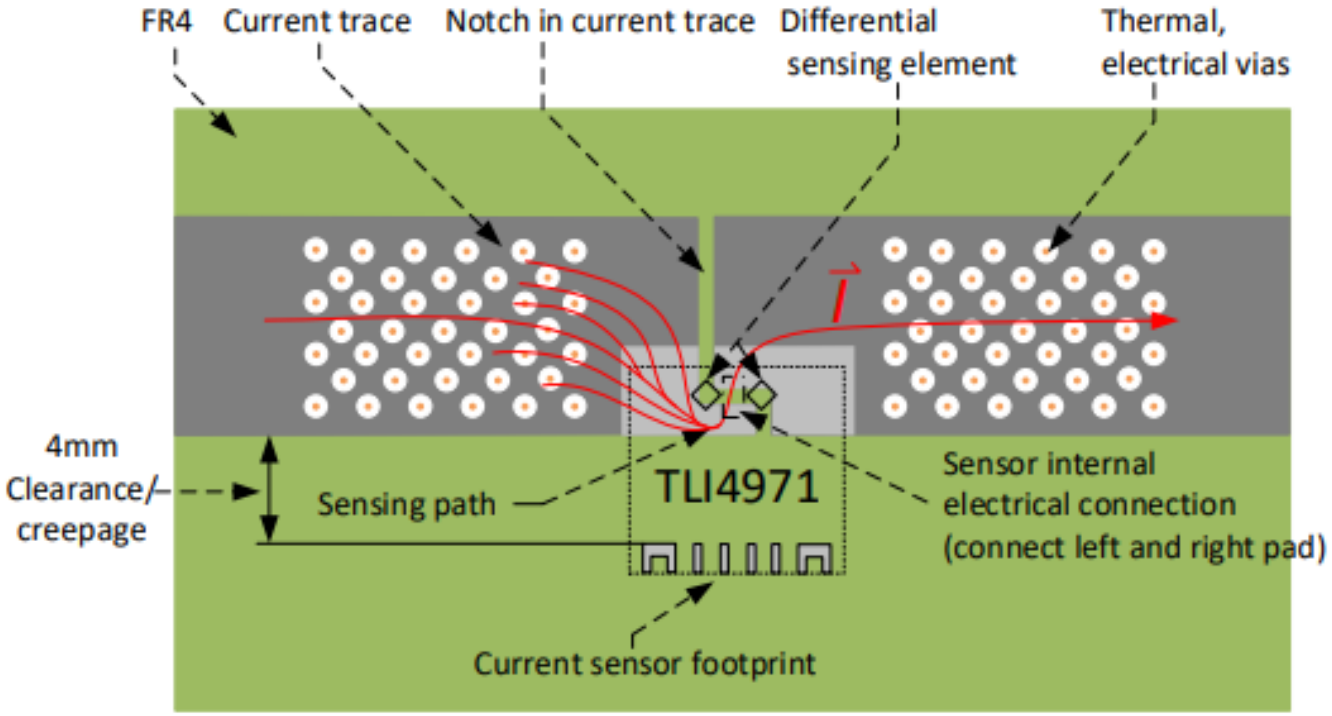
	Core-based	Core-less
Open Loop		
Closed Loop		

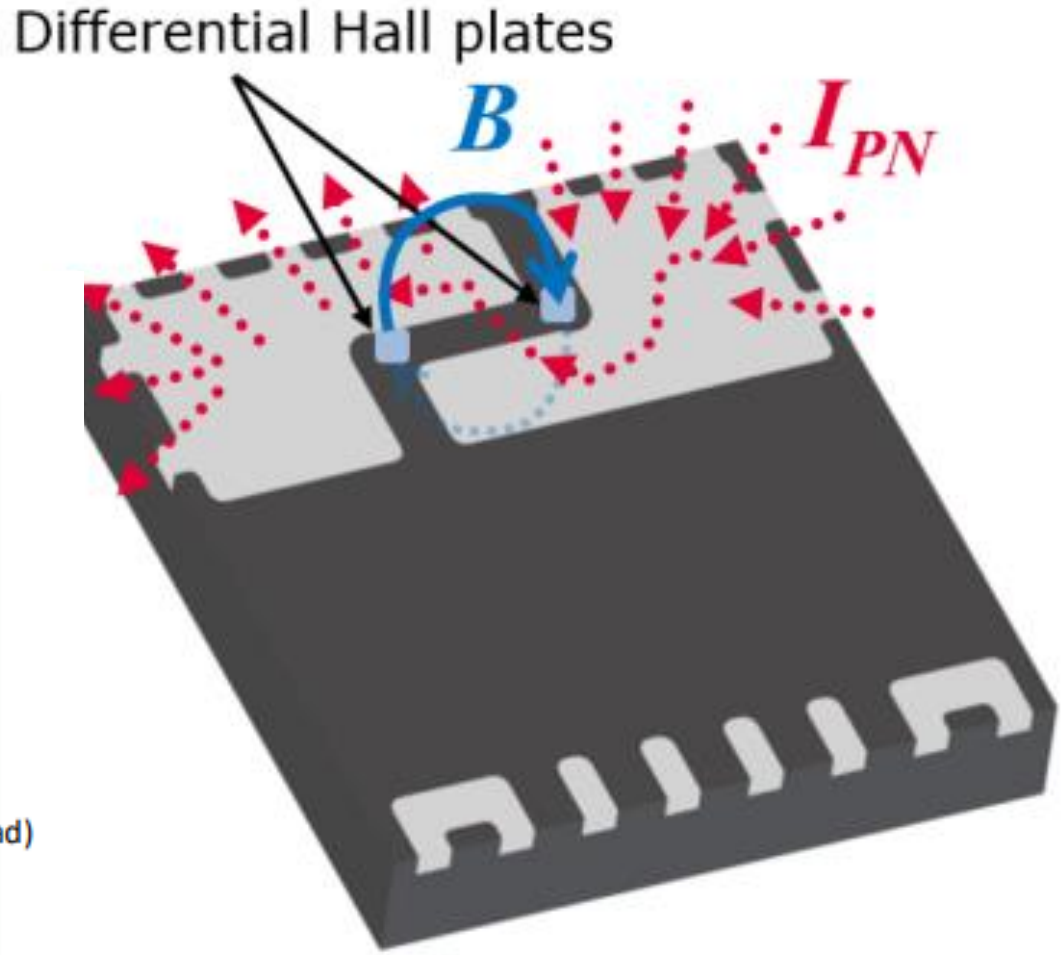
Infineon's choice for next generation current sensor

Advantages

- Stray field suppression through *differential voltage measurement* of 2 Hall probes/cell
- No saturation, no hysteresis, high linearity
- Low dependency on temperature and lifetime
- Sensor comes in small SMD packages

TLx4971 current flow and hall cells positions

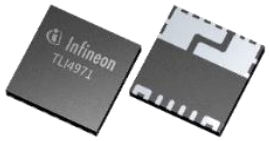




Current Sensor Portfolio and related timeline

TLx4971/2 family designed for drives.
Common features: same ASIC, 3.3V, OCD, FuSa concept
analog output, 240kHz, programmable output mode

TLI4971, industrial, internal rail 120A, 220µΩ
690V RMS, Functional isolation, 10-30kW drives



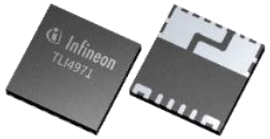
TLE4973 family,
Ind/ automotive,
5V portfolio extension
EEPROM, digital interface
for prog / monitoring
2% total error (incl. lifetime)

Current sensor for
Converter applications

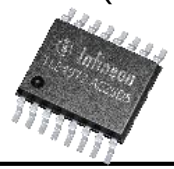
Reinforced Isolation extension
Reinforced isolation in 300mil DSO package

TLE4972, automotive, external rail
2% total error (incl. lifetime)

TLE4971, automotive



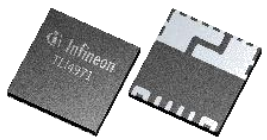
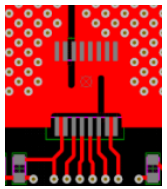
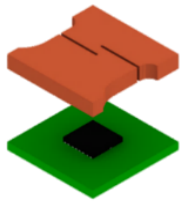
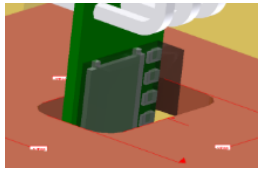
TLE4972, automotive, external rail
TDSO 16, 2% total error (incl. lifetime)



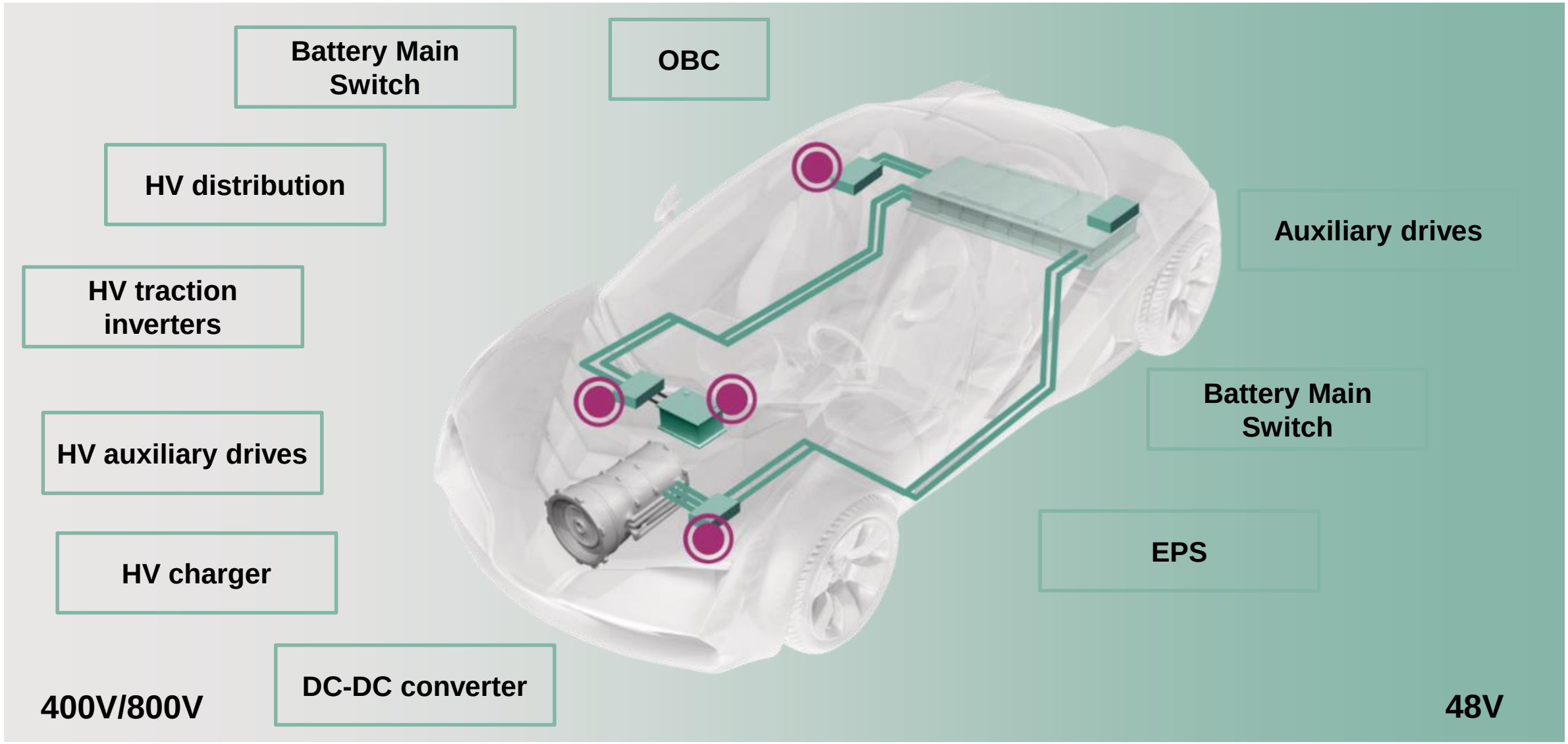
Release in 2023

Current sensor for
Protection applications

Through **different sensor implementations** TLx497x covers a **wide range** for current measurement with **one design**

<120A	~200A	>500A, up to 2kA	>500A, up to 2kA
Measurement range			
iCR	**eCR**		
Lateral	Lateral on PCB	Lateral on Busbar	Vertical
› PCB implementation › Fixed sensing structure › PG-TISON-6	› PCB implementation › Customized sensing structure › PG-TDSO-16	› Bus-bar implementation › Customized sensing structure › PG-VSON-6	› Bus-bar implementation › Customized sensing structure › PG-VSON-6
	 	 	 

Wide market - Typical applications in xEV



Some **Success stories:** *From UPS to Heat Pumps*

UPS (100kW)

- BMS
- **TLE4972**

Succes Factors:

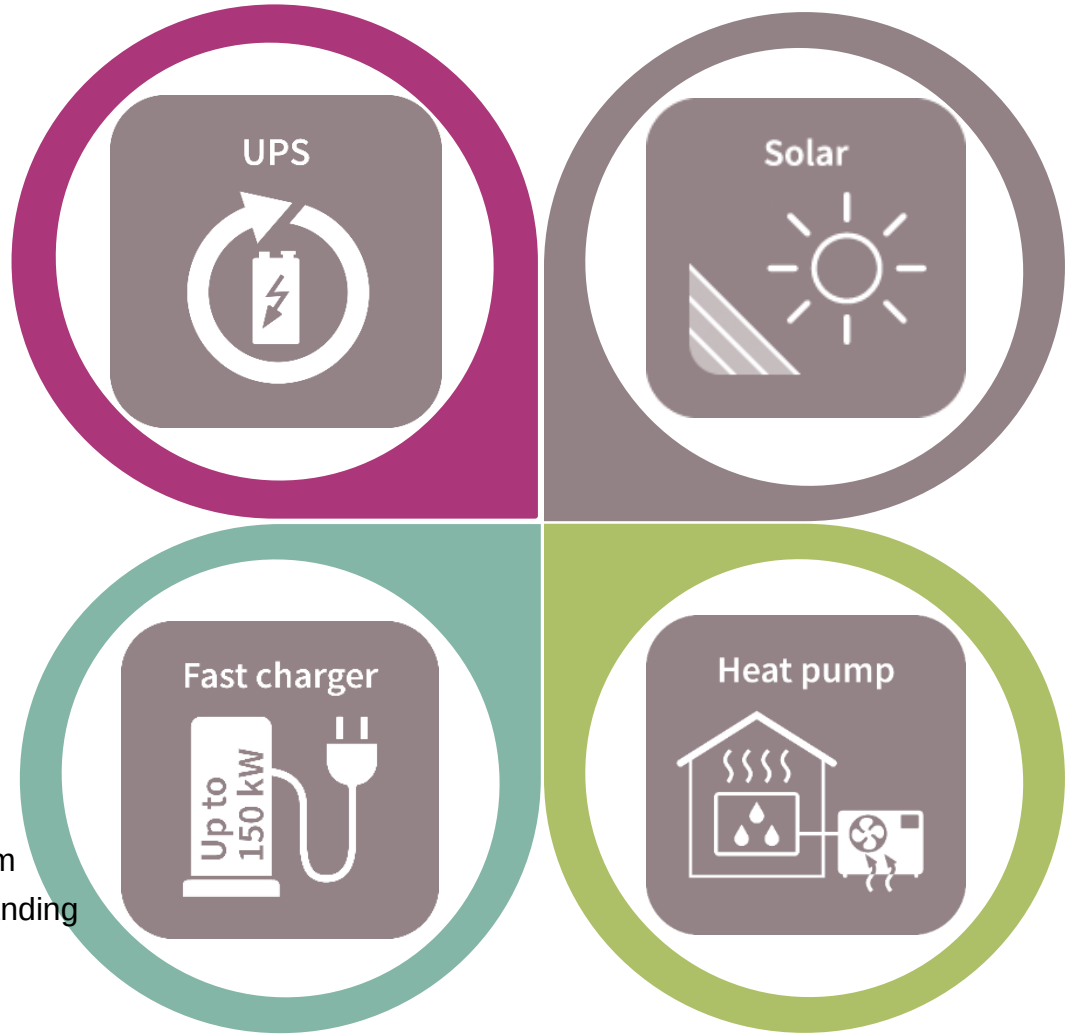
- **Low insertion resistance** due to external busbar
- **OCD-channel** to protect power semiconductors

EV-DC charging

- Current distribution control
- **TLI4971: 120A UL-certified**

Success Factors:

- **Low insertion resistance** of 220µOhm
- **Excellent heat transfer** to pcb (outstanding in the market)
- **OCD-channel** to protect power semiconductors
- **Isolation** of 975V



PV-Inverter

- MPPT & PFC
- **TLE4971: 25A and 50A-version**

Succes Factors:

- **Low insertion resistance** of 220µOhm
- **Excellent heat transfer** to pcb (outstanding in the market)
- **Isolation** of 975V

Heat Pump System

- PFC + Motor drive
- **TLE4971 different variants**

Success factors:

- **Low insertion resistance** of 220µOhm
- **Good heat transfer** to the pcb (outstanding in the market)
- **OCD-channel** to protect power semiconductors
- **Isolation** of 975V
- 210kHz = **needed bandwidth for PFC**

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Basic Product Infos

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Current sensor integration

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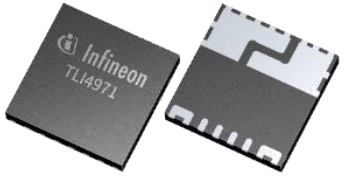
Competences

TLI4971 & TLE4971 Industrial and Automotive Current Sensor



https://www.infineon.com/cms/en/product/sensor/current-sensors/tli4971-a120t5-e0001/

Key features **industrial current sensor**		**Key value**
Multiple Options	The TLI4971 offers **broad flexibility** as many settings can be optimized by customers in the application. Additionally pre-programmed devices are available	**8 different variants** 120 A, 75 A, 50 A and 25 A **(UL and non-UL)**
Application range	A **bandwidth of 240 kHz**, the intrinsic linearity and the very low insertion **resistance of 220 µΩ** allows a wide range applications, also GaN and SiC applications	**Wide range of applications**
Optimized motor control	**Stray field robust** design with differential measurement of magnetic field allows **accurate in-phase measurement** in harsh environments	Optimized **in-phase** measurement **for motor control**
Cost optimization	**Reduced BOM cost** due to two integrated OCD (Over-Current Detection) pins with less than 1 µs reaction time	**Reduced system costs** due to **less external components**
Robust design	With the **8 x 8 mm power package** a galvanic isolated measurement for **high voltage applications** is possible	Outstanding **small package size** meats **high performance**

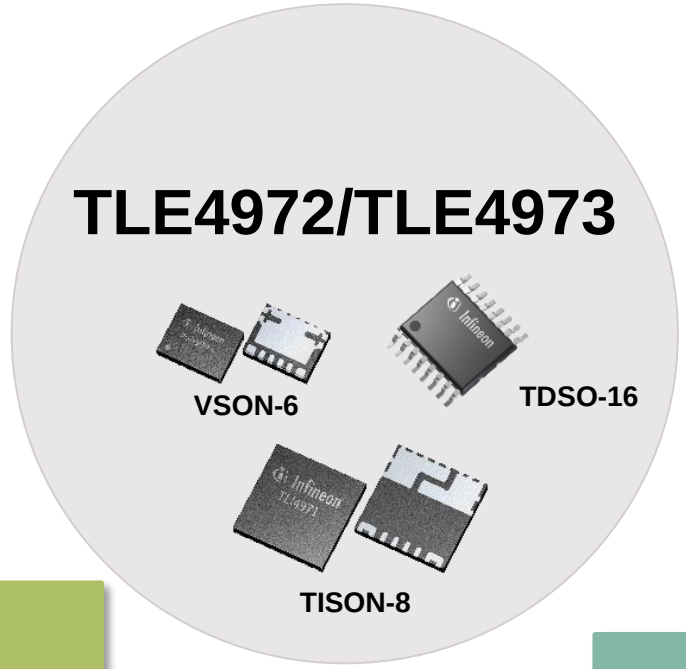
TLE4972/TLE4973 sensor family

Fully scalable: one sensor family for a wide measurement range

- One package with **integrated current rail** (PG-TISON-6) for **up to 132A**
- Two packages with **external current rail for up to 2kA**

High accuracy

- **Highly accurate sensing over temperature and lifetime** thanks to high linearity, stray-field robustness and lack of hysteresis
- Possibility of **in-system, end-of-line calibration**



Space and cost saving

- **No magnetic concentrator or a shield** is required due to the **differential sensing principle**

Overcurrent protection

- **Integrated and programmable** solution for overcurrent protection through a dedicated output (typical **response time 0.7µs**, 64 threshold levels).

Additional functions

- Flexibility through **9 programmable sensitivity ranges and 64 OCD thresholds**
- Easy to address new designs for different power classes

Functional Safety

- **ASIL-B(D) ISO 26262** sensor enables high ASIL rating on system level
- **Diagnosis mode** for AOUT and OCD pins implemented

Reliability

- **Low total error over temperature and lifetime** allow for reliable performance over time

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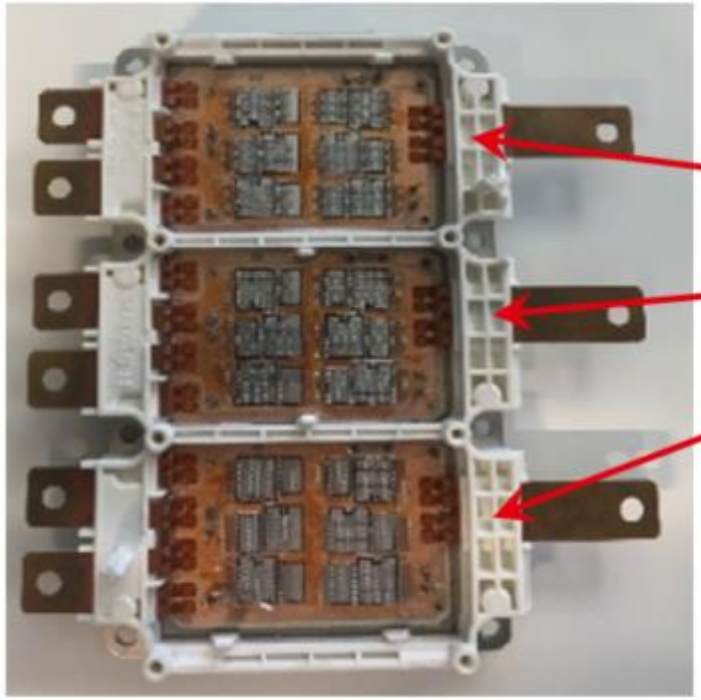
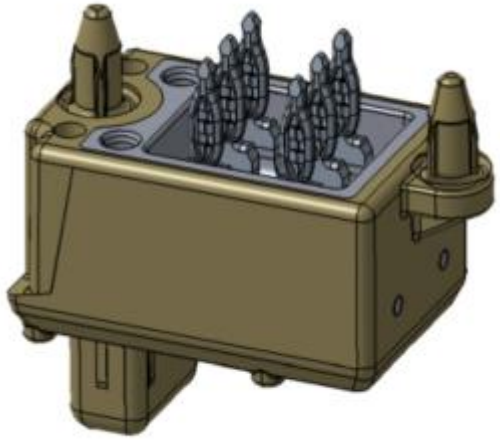
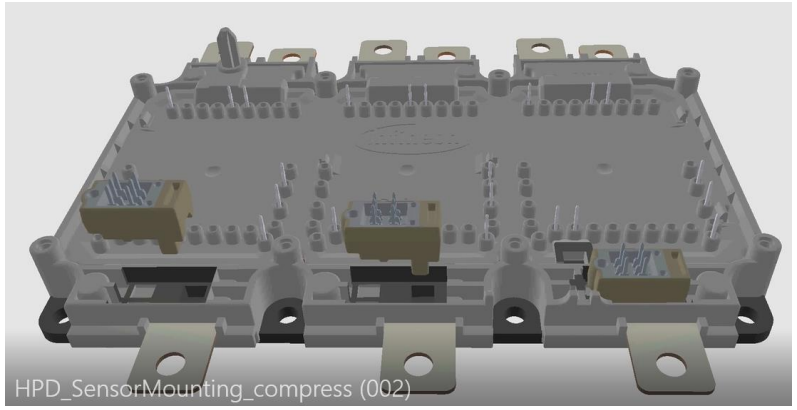
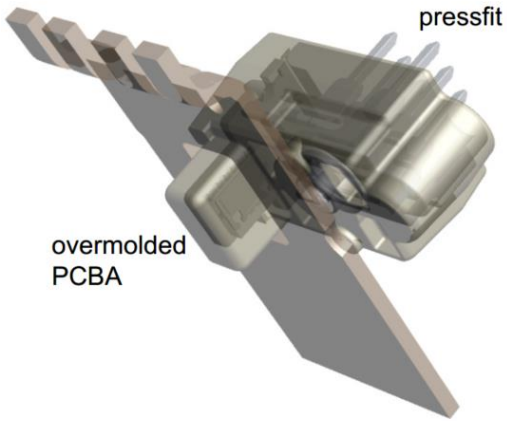
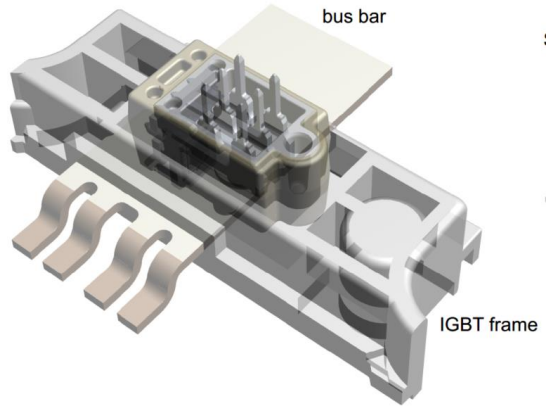
Swoboda module enables **snap-in insertion of current sensor** in HybridPack Gen2











Agenda

Portfolio

Products

Basic Product Infos

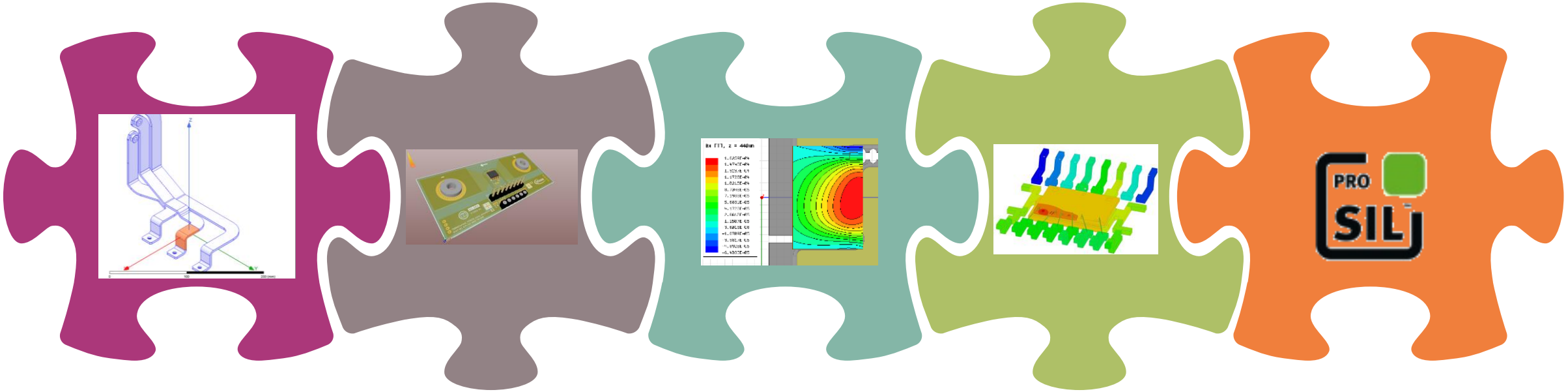
Modules

Current sensor integration

Support

Competences

What we **offer**:



Mechanical Design

- Current **Rails**
- Bus **bars**

Electrical/ Magnetic Design

- **Layout** Design
- **Schematic** Design
- **SPICE** Simulations

FEM Simulations

- Online **FEM Simulation Tool**
- **Dedicated** Support

Thermal Analysis

- **Ansys** Simulation
- **Thermal Measurements**

Functional Safety

- **Customer Safety** Analysis
- **P2S FuSa** Support

Table of contents

Product HIGHLIGHTS and new developments in automotive, industrial & consumer enabling you to grow successfully your distribution business

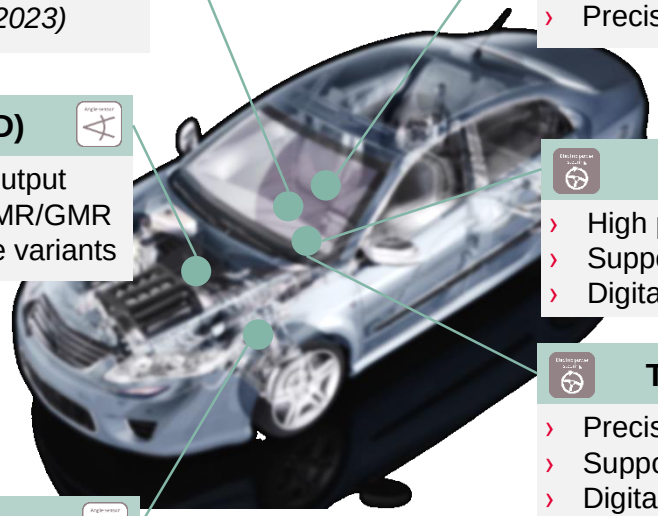
Released & New Automotive Product

TLE493D-P/W3xx

- Enhanced accuracy
- I²C and SPI variants
- Full ISO26262 compliant *(upcoming 2023)*

TLE5501

- Analog sin/cos output
- Dual channel TMR
- Precise (<1° accuracy)



TLE5x09(D)

- Analog sin/cos output
- AMR, GMR & AMR/GMR
- Single & dual die variants

TLE4999

- High precision, low noise
- Supporting ASIL-D
- Digital interfaces

TLE5014(D)

- Precise (<1° accuracy)
- Supporting ASIL-C/D
- Digital interfaces

TLE49SR

- Stray-field robust (>5mT)
- Digital interfaces
- Precise (<1° accuracy) *(upcoming 2023)*

TLE496x-Family

- Broad switch family
- Vertical & planar options
- SMD & leaded packages

Industrial & Consumer Highlights

TLx493D-A/W2BW

- Ultra small WLB-package
- Wide usage range
- Wake-up option

TLI5590

- High precision analog
- Ultra-fine pitch for encoder & smart camera solutions
- Ultra small WLB-package *(upcoming 2022)*

TLx496x-Family

- Broad switch family
- Vertical & planar options
- SMD & leaded packages

TLx5012(D)

- Digital interfaces
- Broad application usage
- Single & dual die variants

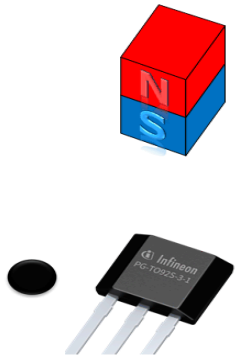
TLE5501

- Analog sin/cos output
- Dual channel TMR
- Precise (<1° accuracy)

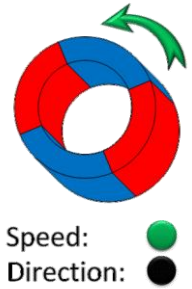
Our complete Position Sensor portfolio well addresses a very broad range of applications beyond the above!

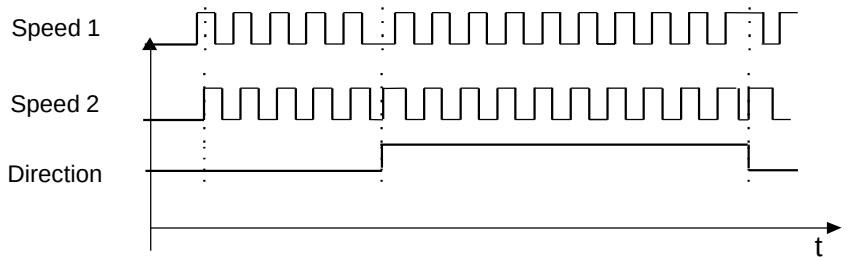
XENSIV™ – magnetic switch use-cases

Position sensing with Hall switches

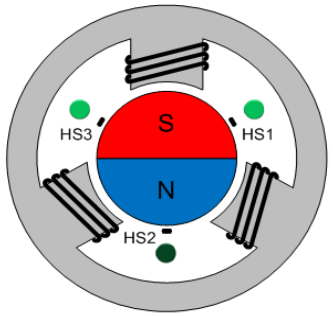


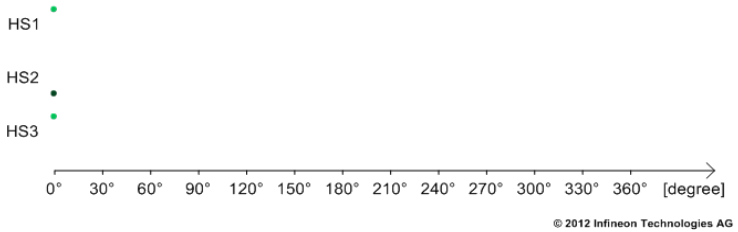
Speed and direction detection with double Hall latches



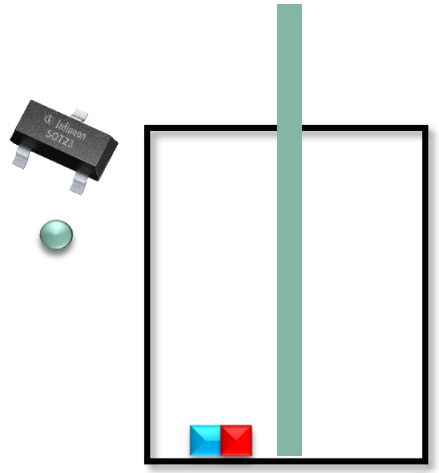


Motor commutation with Hall latches





Level sensing with Hall switches

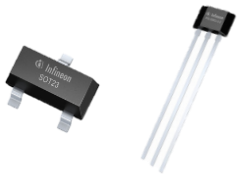


Infineon Hall Switches
TLx496x Family

TLx496x
3rd generation of Hall Switches and Latches

Automotiv
- TLE496x -

- **Temperature:**
  -40° to 170°C
- **Package:**
  PG-SOT23
  PG-SSO3

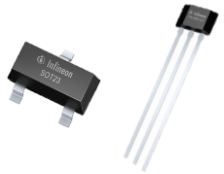


- **Supply voltage:**
  3.0 V to 5.5 V
  3.0 to 32.0 V
- **Current consumption**
  1,5 mA to 1,6 mA

PRICE

Industry
- TLI496x -

- **Temperature:**
  -40° to 125°C
- **Package:**
  PG-SOT23
  PG-SSO3



- **Supply voltage:**
  3.0 V to 5.5 V
  3.0 to 32.0 V
- **Current consumption**
  1,5 mA to 1,6 mA

Consumer
- TLV496x -

- **Temperature:**
  -40° to 125°C
- **Package:**
  PG-TO92S

- **Supply voltage:**
  3.0 to 26.0 V
- **Current consumption**
  1,6 mA

PRICE

Broad portfolio of available thresholds

Success story
Cordless power tools

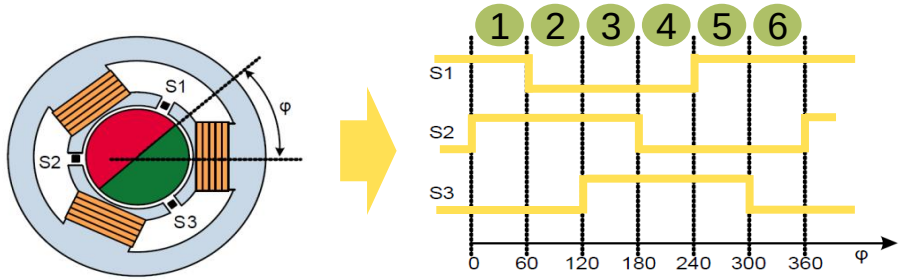
Project description

- Application : **Cordless power tools**
- Sub-application: BLDC motor commutation
- Customer: European OEM
- Product (s): TLI4963-1M
- Related applications: **Vacuum cleaner (robot), lawn mower, …**

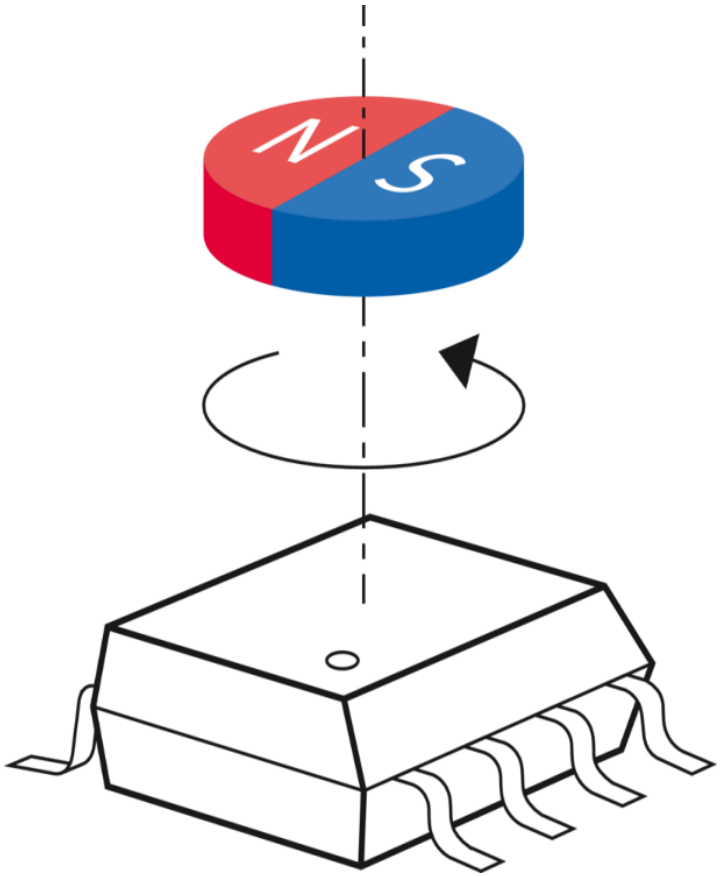
Success factors

- Cost effective latch with excellent performance
- Low current consumption of 1.5 mA
- Active error compensation
- High stability of magnetic thresholds
- Low jitter (typ. 0.35µs)
- SOT23 package

Block diagram



Infineon angle sensors at a glance



An angle sensor by Infineon…

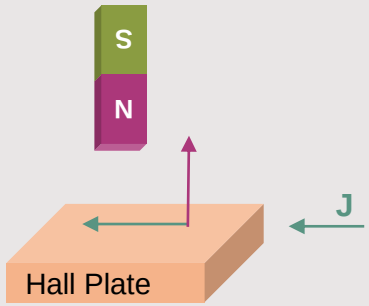
- detects the angle of a rotating magnet
- is ideal for position sensing (e.g. steering angle in a car) or control of brushless DC motors
- is available
  - with analog or various digital interfaces
  - as single and dual channel product
  - in variants for safety relevant applications
- supports automotive and industrial standards
- guarantees reliable operation and long lifetime due to Infineon's highest quality standards

Infineon – first to offer all magnetic sensor technologies (with in-house production)

Hall

ΔU

$(Hall\ voltage)$



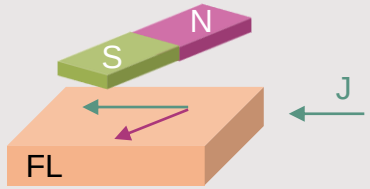
- High field range
- No magnetic hysteresis
- Monolithically integrated in BiCMOS, BCD

High volume production

AMR
(Anisotropic Magnetoresistance)

ΔR

$(Electrical\ resistance)$



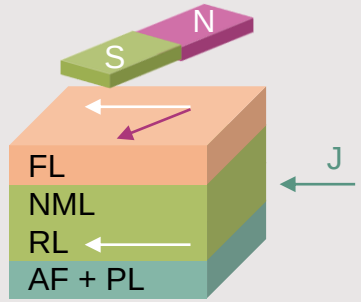
- High sensitivity
- High field range
- Low Jitter
- 180^0 angle range
- Monolithically integrated in CMOS, BCD

Volume production

GMR
(Giant Magnetoresistance)

ΔR

$(Electrical\ resistance)$



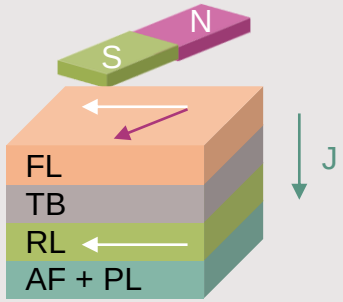
- Very high sensitivity
- For fields up to 100mT
- Low Jitter
- 360^0 angle range
- Monolithically integrated in CMOS, BiCMOS, BCD

High volume production

TMR
(Tunnel Magnetoresistance)

ΔR

$(Electrical\ resistance)$



- Ultra high sensitivity
- For fields up to 100mT
- Low Jitter
- 360^0 angle range
- Low power

Volume production

FL: Free Layer NML: Non Magnetic Layer RL: Reference Layer AF: Anti Ferro Magnet TB: Tunnel Barrier PL: Pinned Layer

Success Story
BLDC EPS-Motor – Angle Sensors

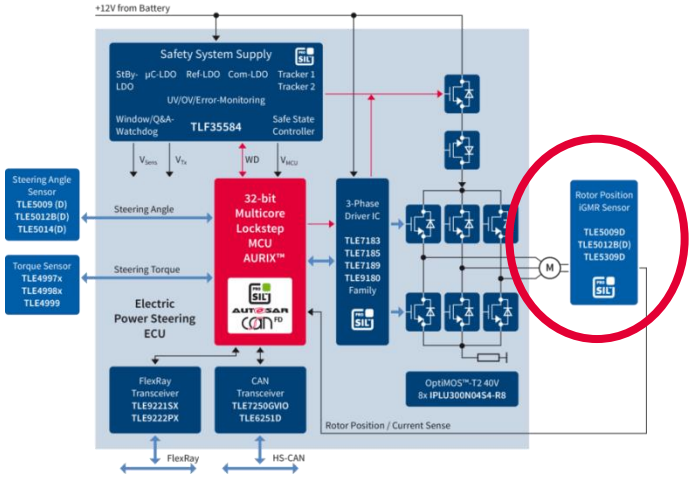
Project Description

- Application : Electronic Power Steering
- Sub-Application: BLDC Motor Commutation
- Customer: Major EU Tier 1 for Steering Systems
- Product (s): TLE5903D Angle Sensor
- Competitor(s): n/a
- Related applications: Any type of Motor Commutation requiring high safety levels e.g. car steering & braking, robotics

Success Factors

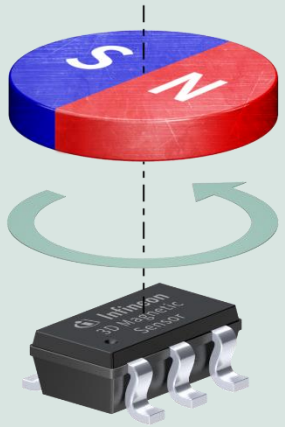
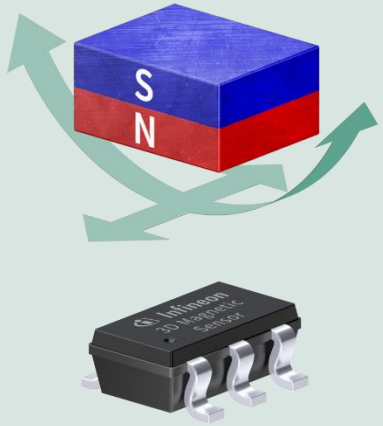
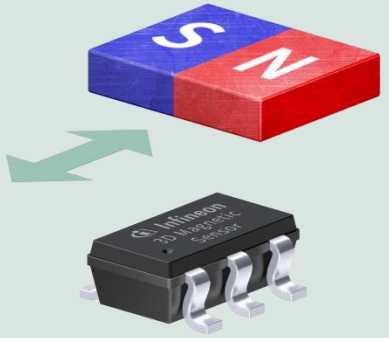
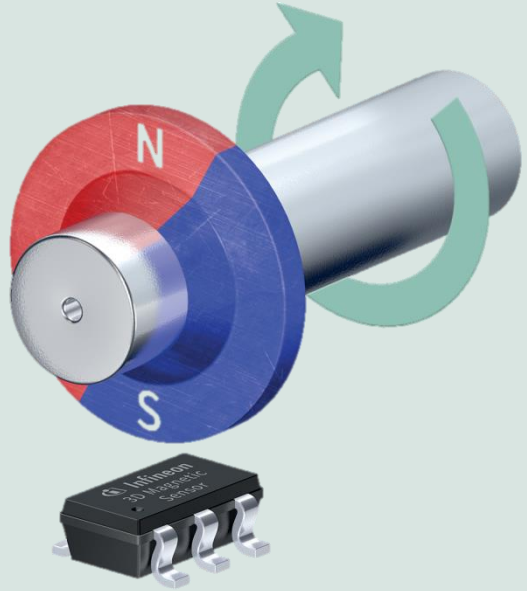
- Redundant Dual Die device with two dies in one package – allowing small size of magnet/sensor system
- Diversity due to use of 1x iAMR + 1x iGMR improving functional safety capability
- Preparing of Safety Documents and support as required by Tier1 for discussion with OEMs
- High accuracy lifetime & temperature
- Highest quality level – based on Infineon Zero-Defect program resulting in <0.1 dpm
- Safety: ISO26262 ready

Product functionality



- TLE5309D used for BLDC Motor Commutation

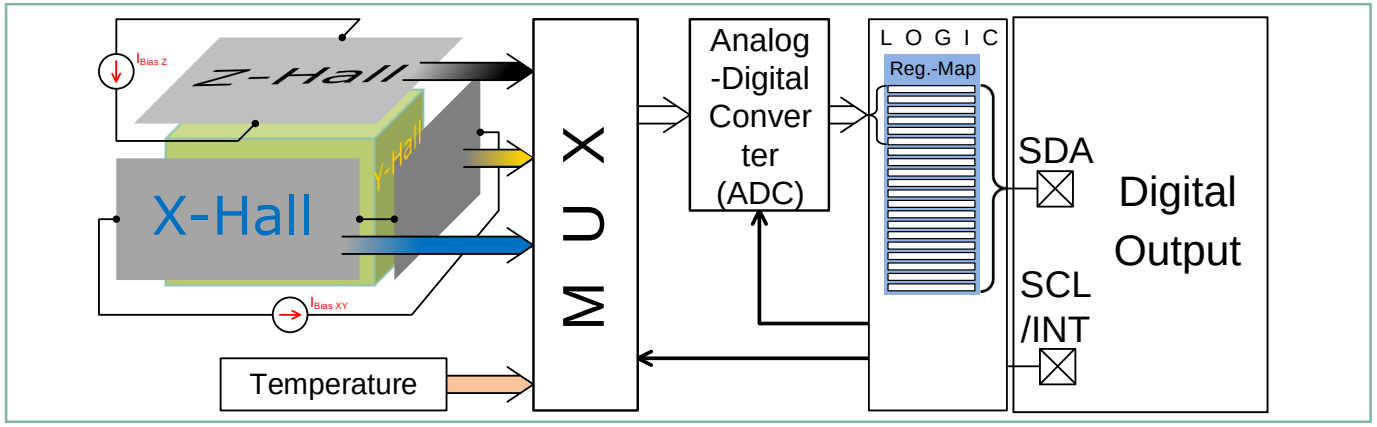
3D Magnetic Hall Sensor - Sensing Overview

Rotation Movement	3D Movement	Linear Movement	Out of Shaft Movement
			

- Based on Hall-technology
- Detects the strength of a magnetic field in all three dimensions, i.e. x-, y- and z-axis
- In addition, able to detect linear movements & the angular position of a rotating magnetic field
- Is available for consumer (TLV493D), industrial (TLI493D) and automotive (TLE493D) applications

3D Magnetic Hall Sensor - Save Money by Component Saving

Infineon 3D Hall-technology



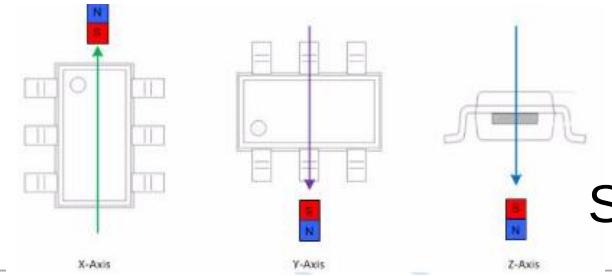
Benefits of 3D Hall-technology

- High Magnetic Accuracy
- Low Offset
- Low X/Y Mismatch
- High Linear Measurement Range

Cost efficient system designs by component reduction

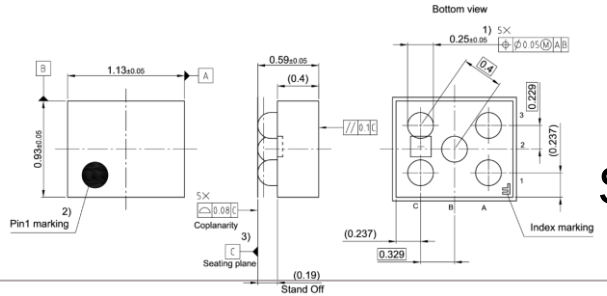
Package 3D Hall-technology

TSOP-6



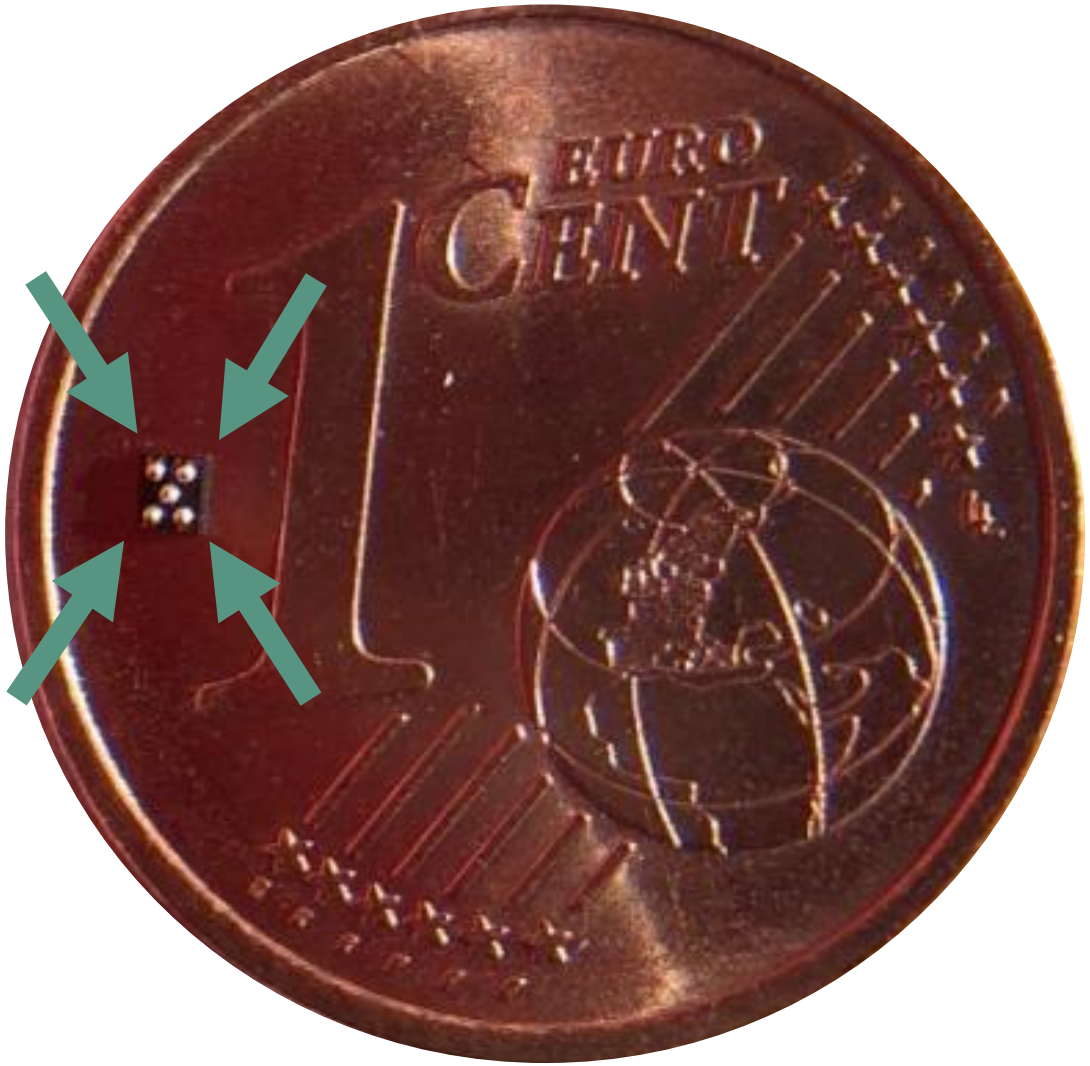
Size: 2.9 x 2.8 x 1.1 mm

WLB-5



Size: 1.13 x 0.93 x 0.59 mm

New wafer level package 3D Hall sensor: **TLI493D-W2BW**



Success Story
Gearstick – 3D Hall Sensor

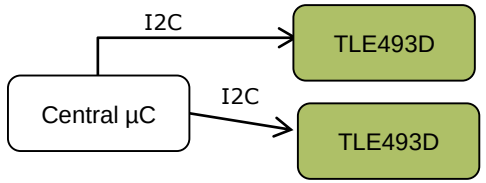
Project Description

- Application : ATV Gearstick
- Sub-Application: Multiple redundant position sensing
- Customer: Major German Tier1
- Product (s): 2x TLE493D-W2B6 (3D magnetic Hall Sensor)
- Competitor(s): Melexis
- Related applications: Drive By Wire, Gearsticks in CAV

Success Factors

- System cost reduction
- 10 or more switch replaced by 1-2 x 3D sensors
- Space saving by smaller PCB
- Redundancy realized by 2 x 3D sensors
- We supported the customer with simulations of the magnetic field and provided guidelines for magnet position and selection. See also online simulation tool: Link
- Safety: ISO26262 ready

Block Diagram



Explanation

Position detection by 3D sensor in 2 and 3 directions
2. sensor for redundancy
2 sensors served by 1 µC

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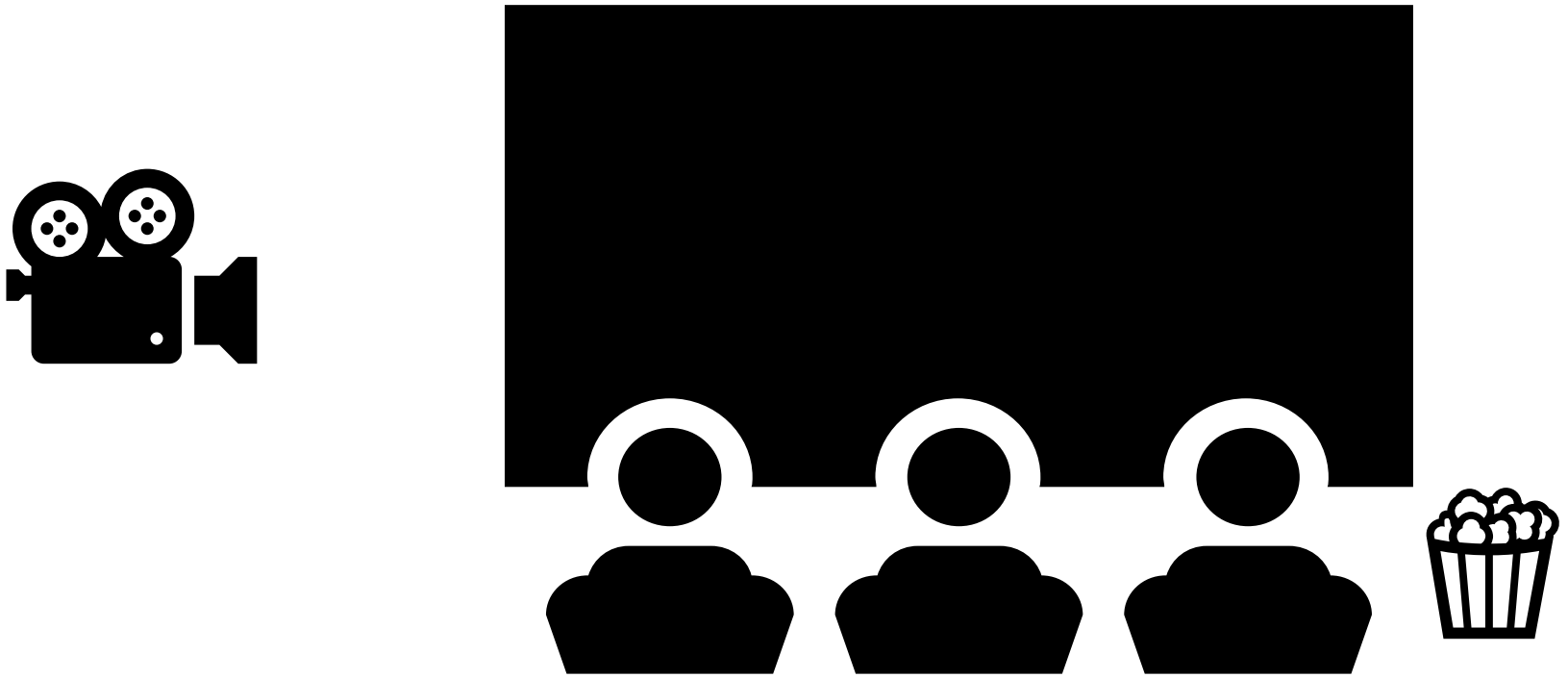
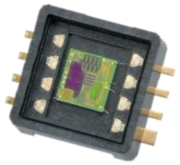
Intuitive Sensing Technology



https://www.infineon.com/cms/en/product/technology/intuitive-sensing/#!?videoId=6eoSCVnznm2tawyGaMfZVq

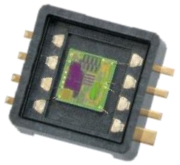
XENSIV™ BAP Products



KP120

2001

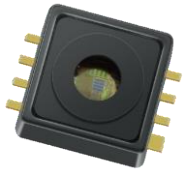
First analog BAP



KP125

2005

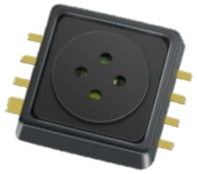
Updated BAP variant



KP23x/KP25x

2011

New analog BAP and first digital one



KP264

2019

Robust BAP with functional safety documentation

KP46x

2023

New digital BAP in small DFN package

Highlights:

- **Increased pressure accuracy** over lifetime
- **Optimized supply voltage range**
- **Reduced power consumption**
- **Extended SPI interface.** 10-bit, 12-bit and 14-bit pressure and temperature readout for each derivate.
- **New** and **small** DFN **package**

Main Markets/Applications:

- ECU (Electronic Control Unit)
- MAF (Mass Air Flow)
- Seat Comfort
- Battery Monitoring

Product Information:

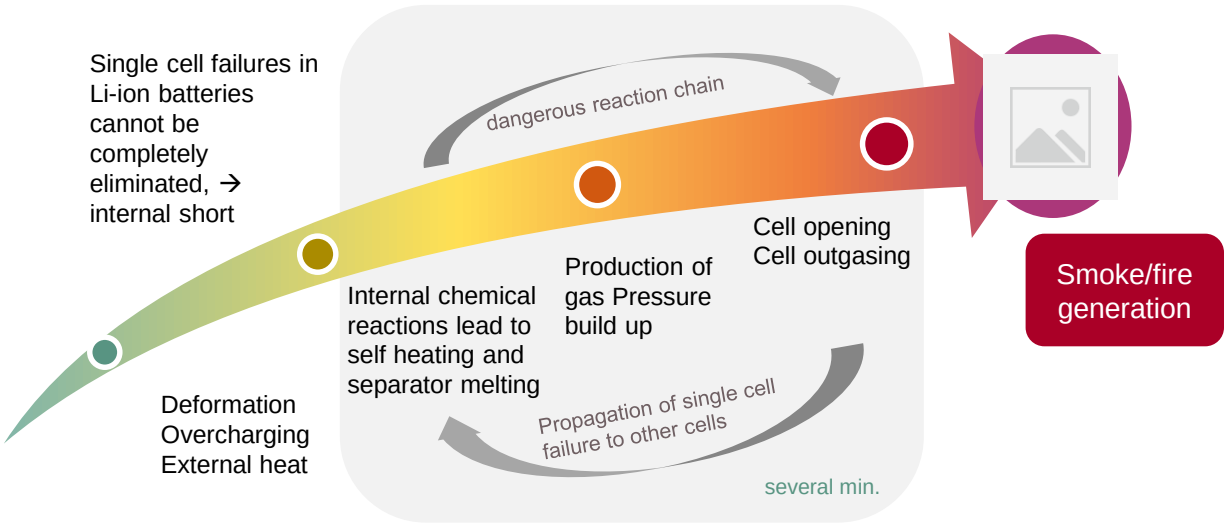
- SMD package (DFN/DSOF, 8 pin)
- Tape & reel

RoHS

Halogen-Free

Thermal Runaway in HV Battery Monitoring Systems is detected as early as possible with Infineon Pressure Sensors

Thermal Runaway must to be detected fast



GTR20 Regulation

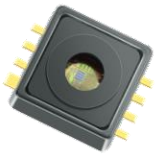
5mn to leave the car after early warning

Detection speed is KEY

Enough time for passengers to escape

Pressure sensing is best method:

Roubustness, cost, detection speed



TODAY

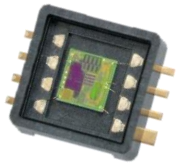
KP236/256

Digital & Analog BAP Sensors

Product characteristics

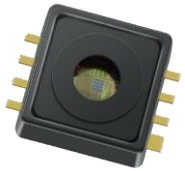
- High Accuracy +/- 1.0kPA
- Wide operating temperature range 40°C to +125°C
- Infineon “Zero Defect” Quality, 100% inhouse technologies, AEC-Q103 qualification

XENSIV™ MAP Products



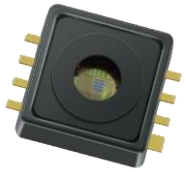
KP11x

2005
First analog MAP



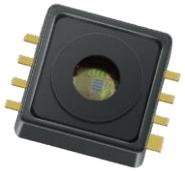
KP21x/KP22x

2009
Improved analog MAP



KP275

2016
First media robust digital MAP



KP276

2019
Improved analog MAP

Highlights:

- Integrated sensor solution (1 chip)
- Updated **SENT** protocol with 282 clock ticks
- **Pressure range** from **10 to 400 kPa**
- High **Accuracy over lifetime** sensing up to **±0.77% FSS** (Full Scale Span)
- **Fast NTC/Pressure Start-up** (typ. 10ms)

Main Markets/Applications:

- ORVR (Onboard Refueling Vapor Recovery)
- MAP (Manifold Absolute Pressure)
- EGR (Exhaust Gas Recirculation)

Product Information:

- SMD package (DSOF, 8 pin)
- Tape & reel

lead-free

RoHS

Halogen-Free

Infineon First automotive qualified XENSIV™ MEMS microphones are available now

AEC-Q qualified microphones serve multiple automotive applications

Speech: HF / e-call beamforming

interior

Active and road noise cancellation

interior

Speech: In Cabin Communication

interior

Emergency vehicle detection

exterior

Road condition/ Damage detection

exterior

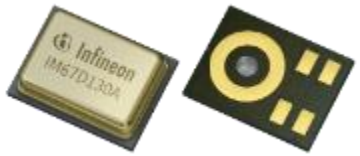
External voice interaction

exterior

Infineon pioneering automotive MEMS microphone market

Many new emerging automotive applications and increasing number of microphones → market needs changing towards stricter quality standards and automotive specific requirements

XENSIV™ IM67D130A and IM67D120A MEMS microphone



First in the market

ATV qualified AEC-Q103

Customer values

Automotive standards **compliance**

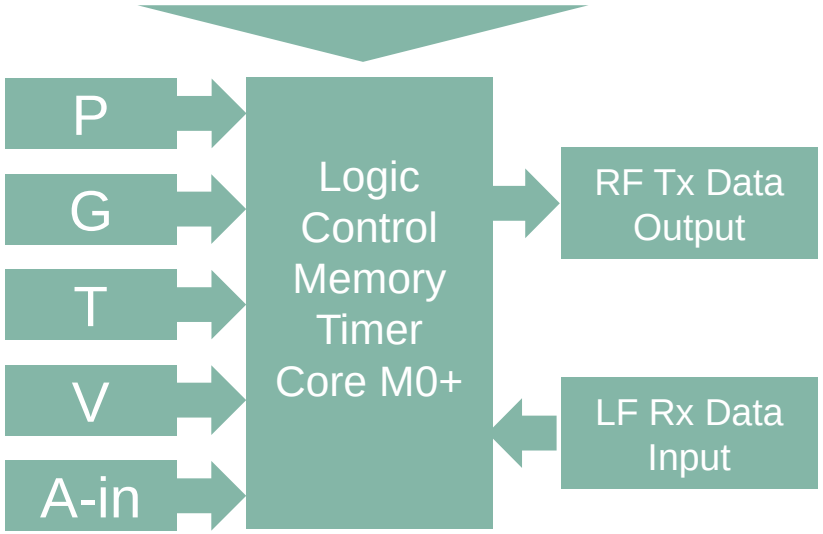
- Reduced risk of qualification fails
- Wide operating temperature
- Long term availability
- **Reduced costs** of re-qualification
- Enables platform development

Best **speech quality** in loud environments

Combining our proven expertise in the automotive industry with our technical leadership in high-end silicon microphones

SP49 Next Generation TPMS Sensor
High-Level Features

Tire Pressure Monitoring Sensor



Description

- 4 Integrated sensors and configurable analog input:
  - Pressure
  - Acceleration
  - Analog input
  - Temperature
  - Battery Voltage
  - Interface for external Bluetooth
- Pressure Range up to 920kPa
- High Resolution Acceleration Range for motion detection and auto-localization
- Advanced Power Control Features to enable a battery life time of 10years with standard battery CR2032
- Tire localization (APS) with SP49 (on request)
- Supply Voltage Range: 1.7 to 3.6V
- Operating Temperature Range: -40 to +125°C
- PG-DSOSP-14 package
- ISO 26262 ASIL A (on request)

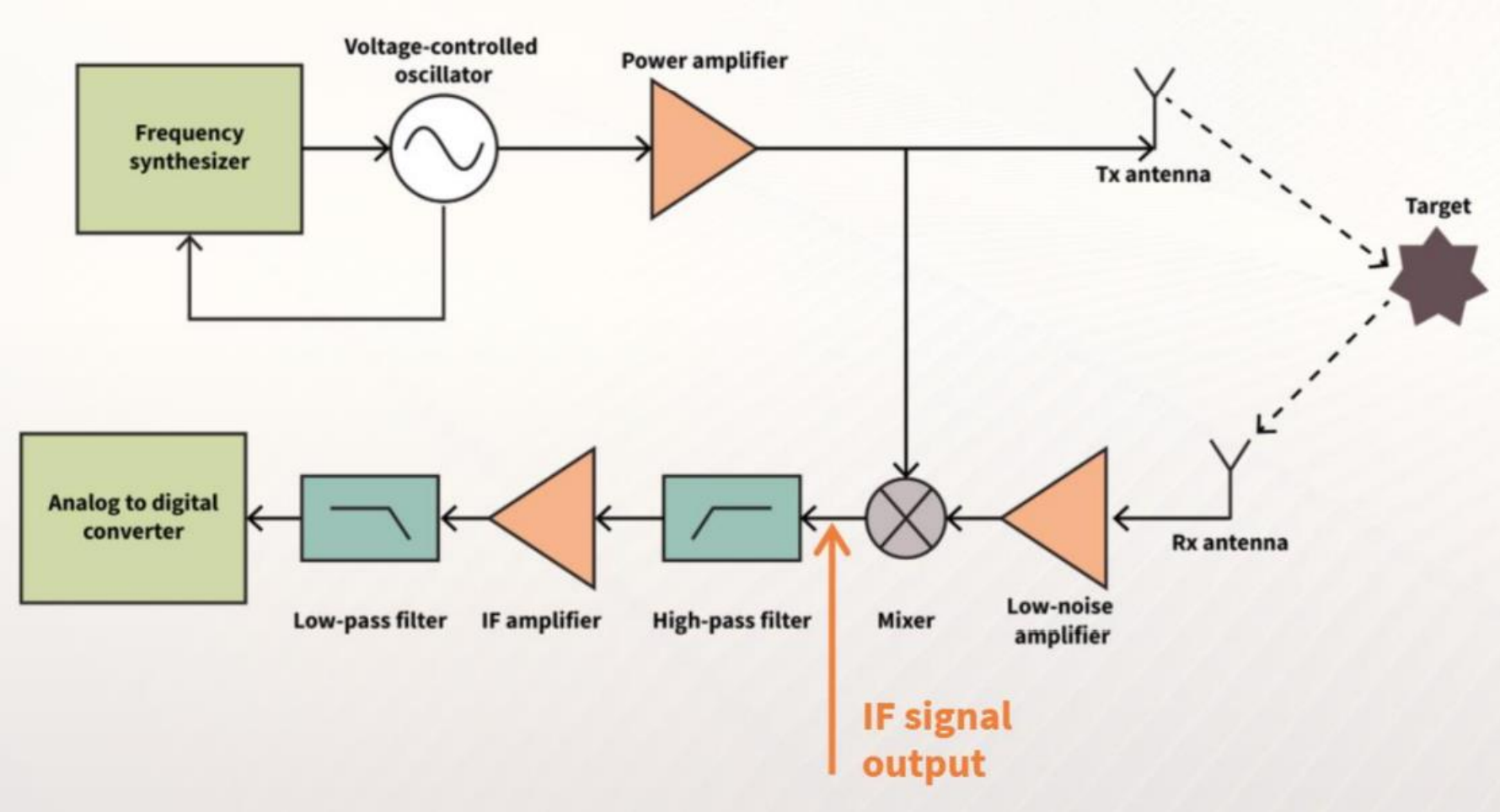
Perfectly suited for

Major market: Standard TPMS
- Evolving requirements
- Continuous productivity increase

Evolving market: Intelligent tire
- Support first features and implementations
- Based on high volume hardware

Table of contents

Radar working principle

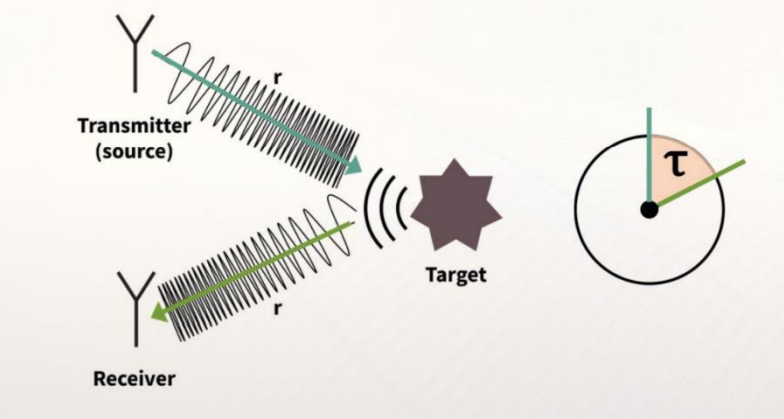


- Modulated Frequency (chirp) is sent via Tx antenna
- Signal gets reflected by Target
- Receiving reflected signal at Rx antenna
- Mixing the Rx signal together with the Tx signal
- ➔ Intermediate Frequency (IF) signal
- Frequency of IF signal is dependent on the distance, different distances give different frequences
- IF signal is digitalized and stored in FIFO
- ➔ Microcontroller reads out the FIFO and calculates FFT

- Micromovements smaller than the wavelength of the emitted signal (e.g. Heartbeat) can be detected as well

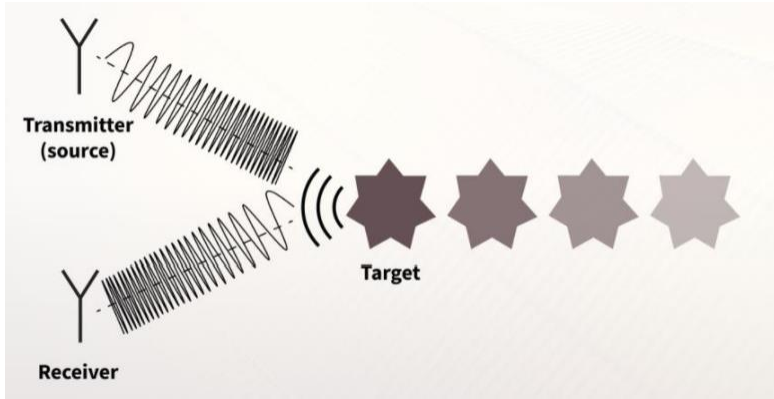
Possible measurements with radar sensors

Range:
How far is the object away?



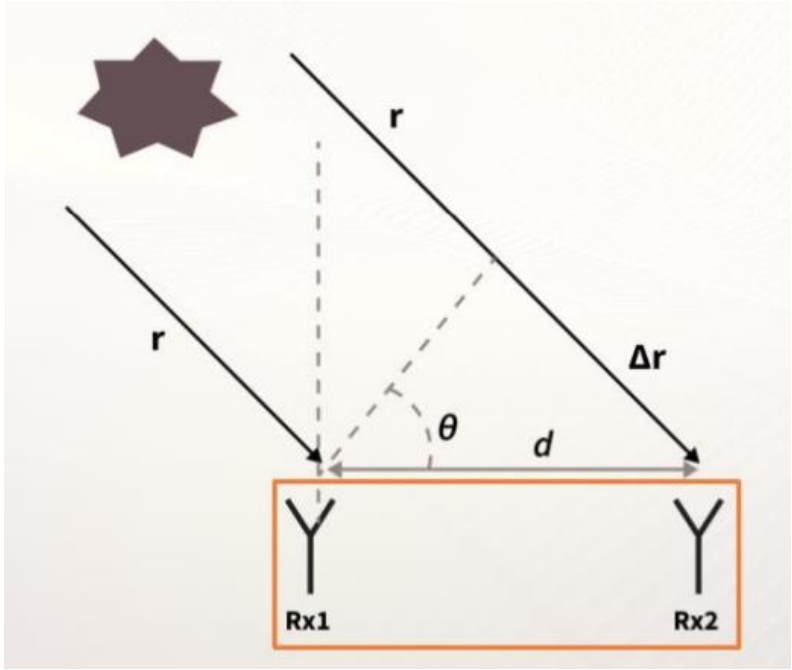
- One Tx signals is sent
- Calculating the frequency (FFT) gives the distance information

Doppler Speed:
How fast is the object moving?



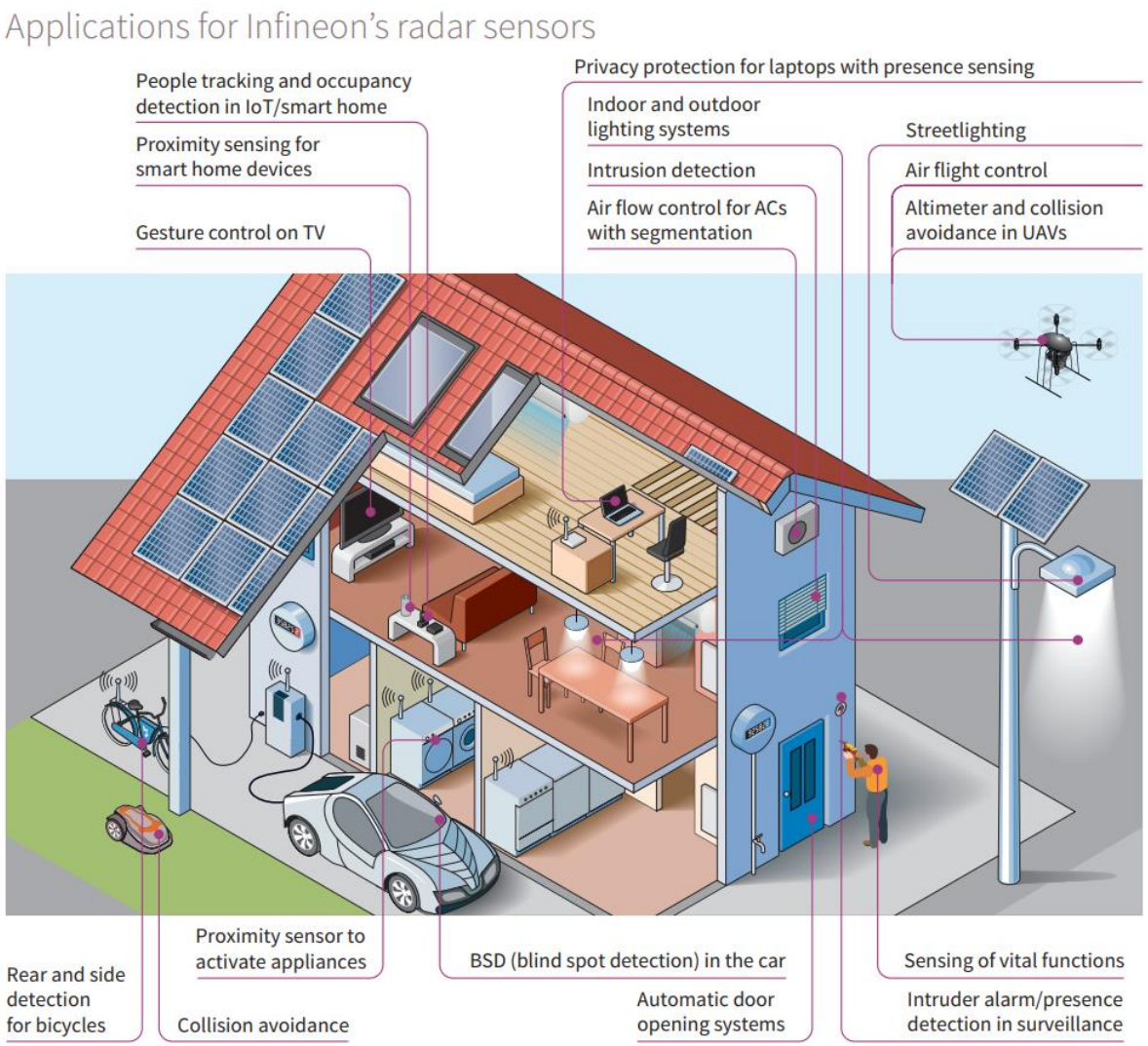
- Multiple consecutive Tx signals are sent
- Calculating the phase shift between the received signals gives the speed information

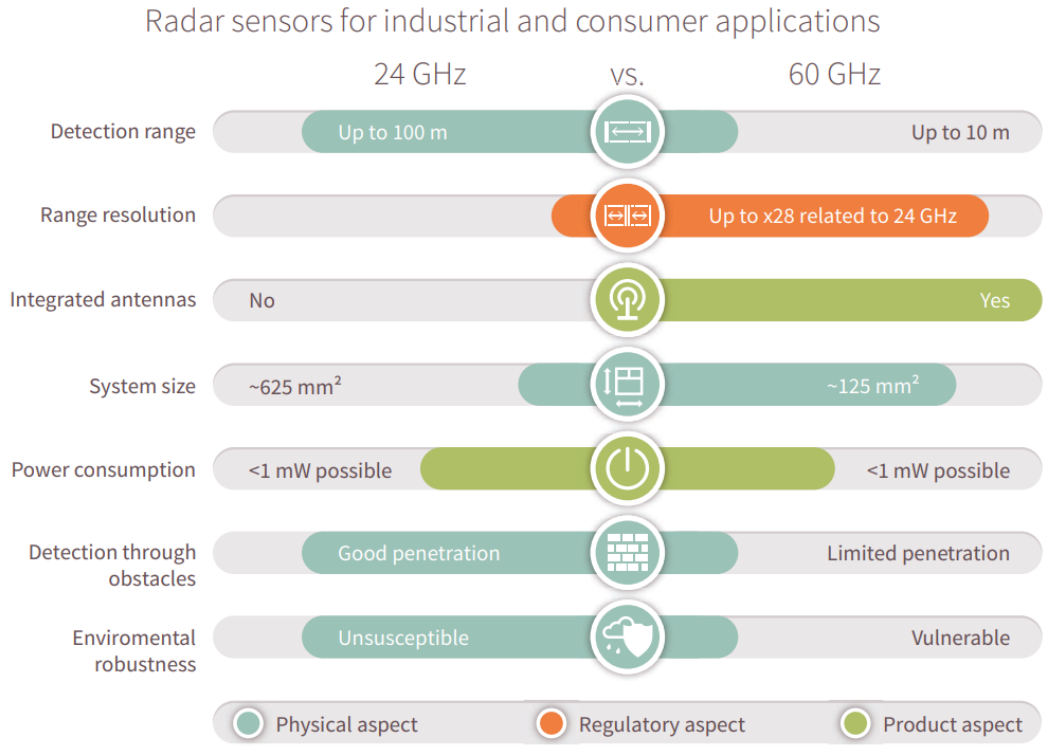
Angle:
In which direction is the object?



- One Tx signal is sent
- Multiple Rx Antennas needed
- Calculating the phase shift between the received signals gives the angle information

Non-automotive radar use cases





Radar product development involves innovations from chip level to module level

Chip level

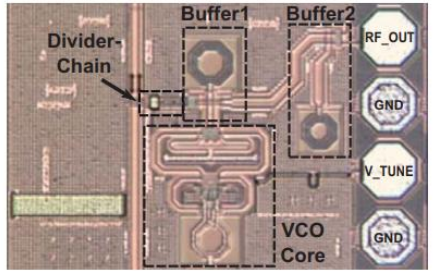
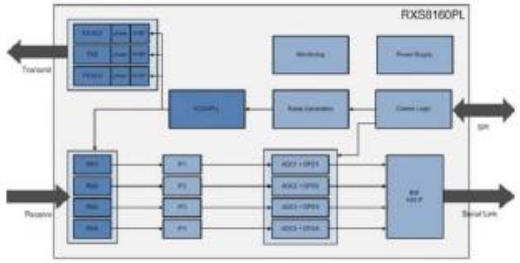


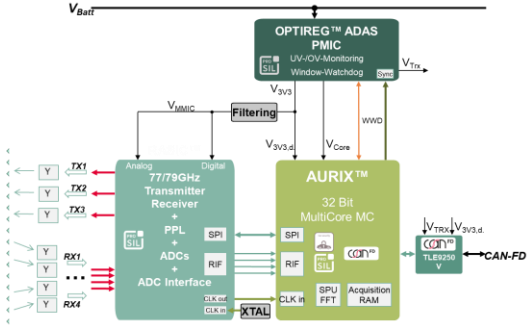
Fig. 3. Chip-Photography of the test chip (630μm x 400μm).

Source: D. Reiter et al., "A Low Phase Noise, Wide Tuning Range 20GHz Magnetic-Coupled Hartley-VCO in a 28nm CMOS Technology," 2019 IEEE Radio and Wireless Symposium (RWS), 2019, pp. 1-3, doi: 10.1109/RWS.2019.8714258.

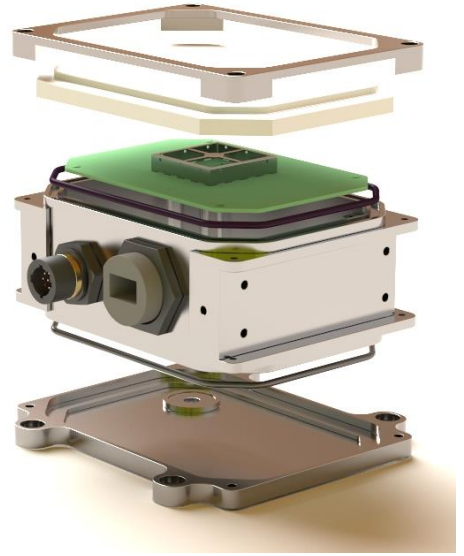
Product level



System level



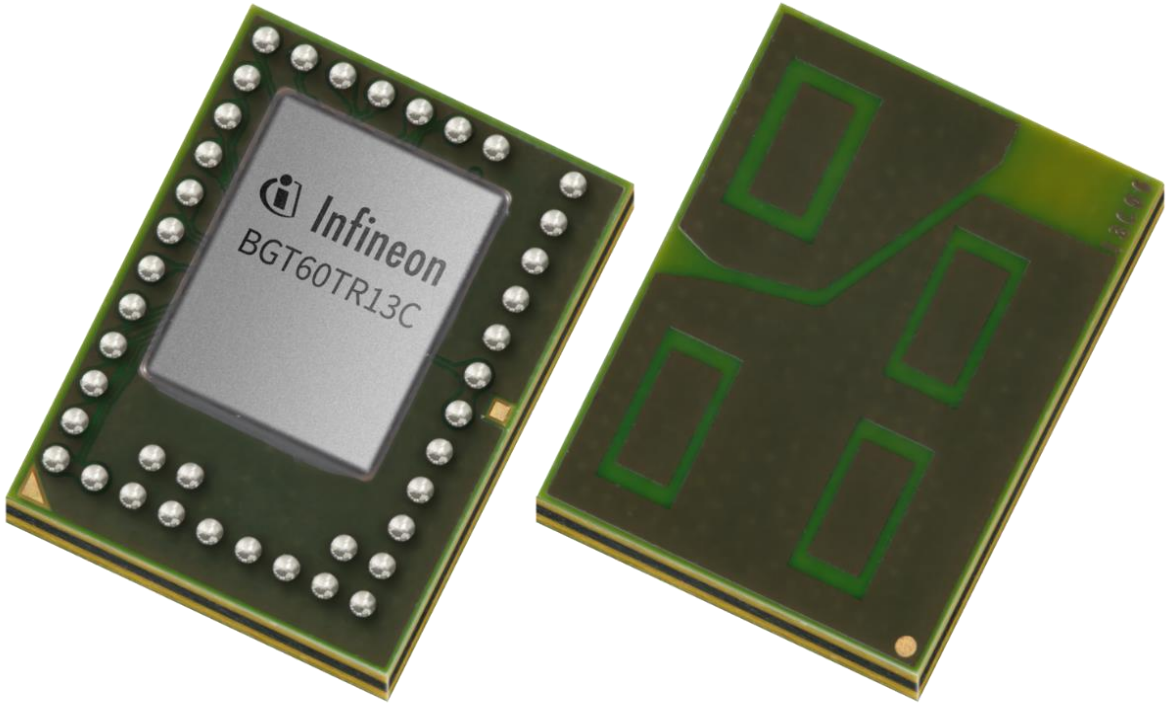
Module level



Connected Sensor Kit

BGT60TR13C

- 60 GHz radar sensor
- 1 Tx and 3 Rx antennas
- Antenna on package ➔ no special PCB manufacturing needed



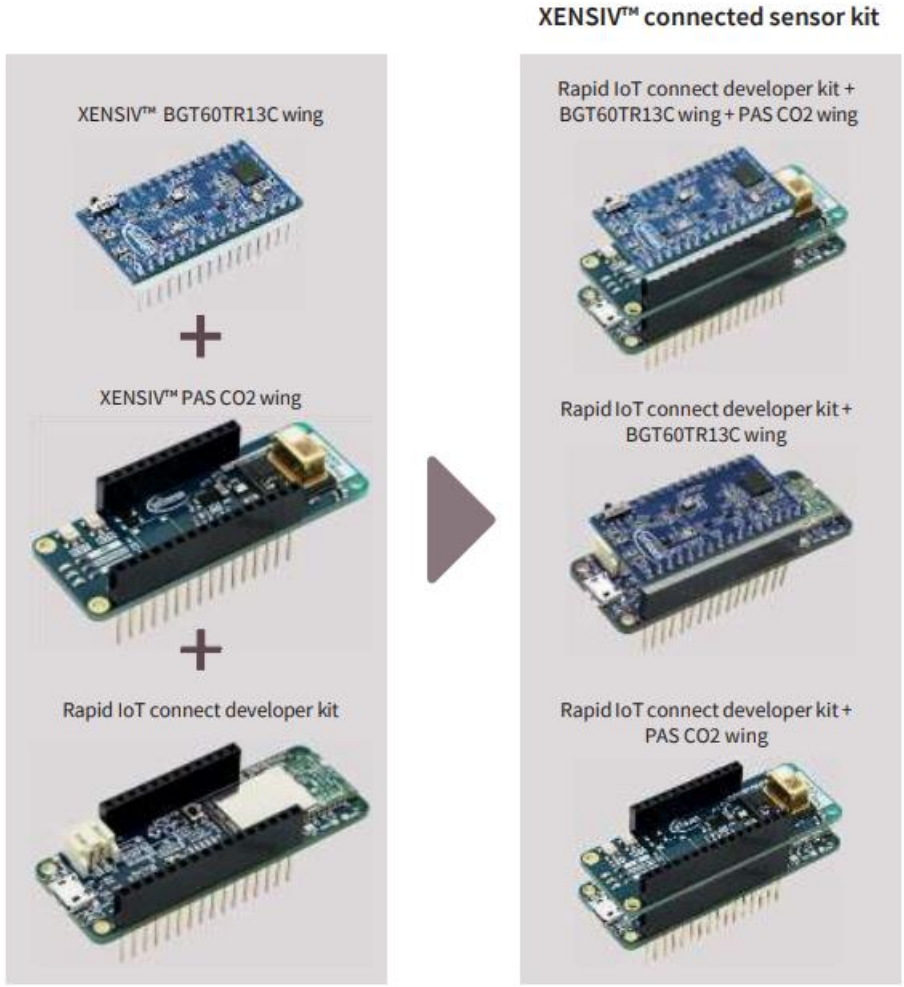


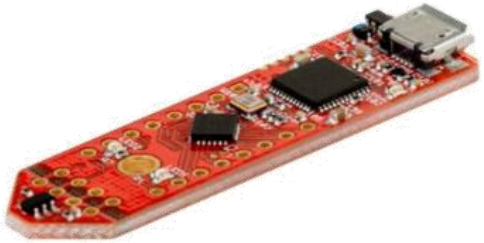
Table of contents

XENSIV™ evaluation tool environment
2GO kits & Shield2GOs & Add ons

Check out for full XENSIV™ kit info like videos, guides, kit details or self-services:
https://infineon.com/sensor2go

2GO kits

- One Infineon sensor IC combined with an ARM® Cortex™-M0 CPU
- USB connection for fast evaluation
- On-board debugging

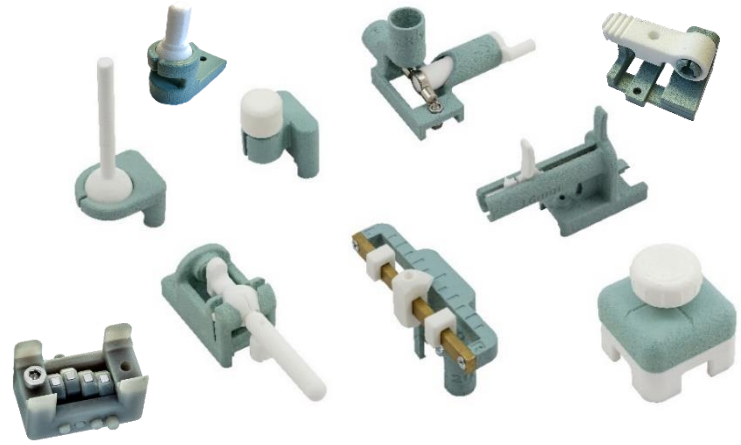


Shield2GOs

- Comprise one board with one single Infineon IC
- Comes with solderless connectors
- The software for the Shield2GO is based on Arduino

Add ons

- Several different Add ons for different use cases available
- Easy-to-use and mountable to our 2GO and Shield2Go kits



GUI & Code

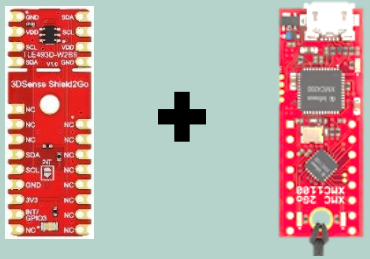
Graphical User Interface (GUI)	Arduino Library / GitHub

XENSIV™ Add ons fit on 2GO kits and Shield2GOs

Add ons

\+

Shield2GO + XMC™ 2GO



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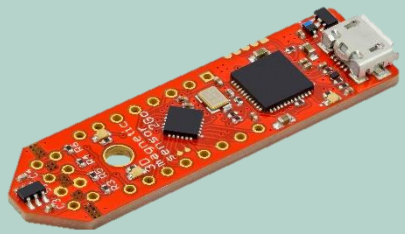
2GO kit



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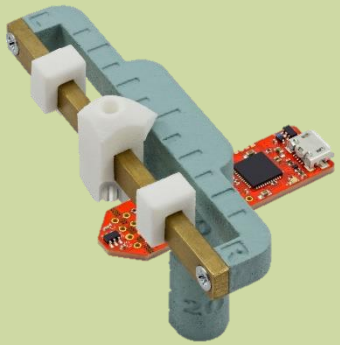
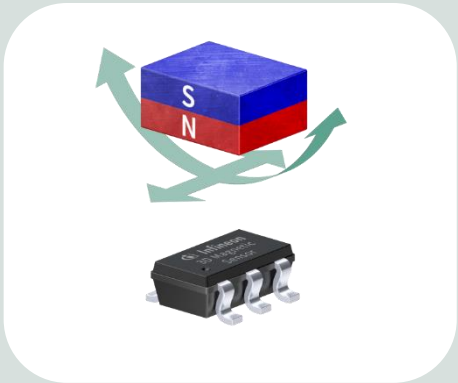
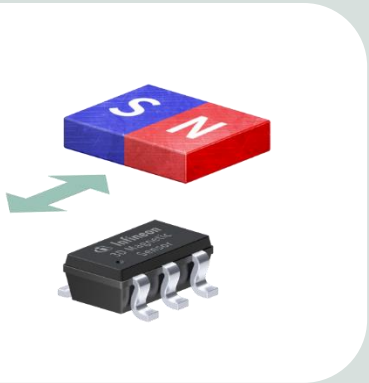
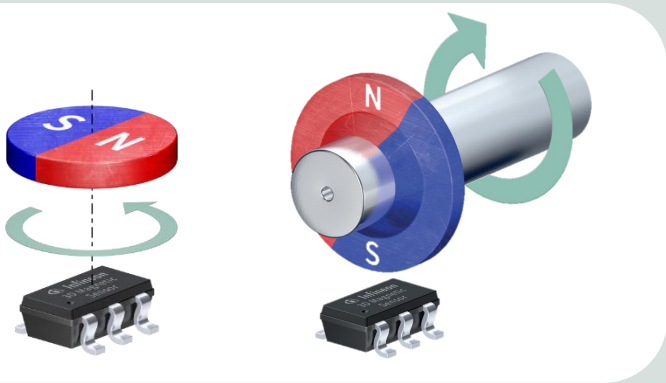
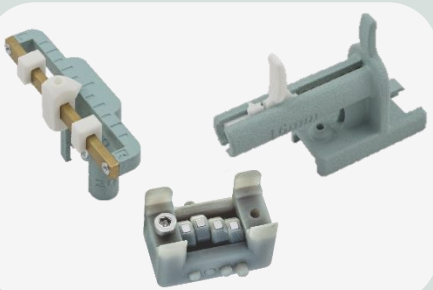
Shield2GO + XMC™ 2GO + Add on

=

2GO kit + Add on



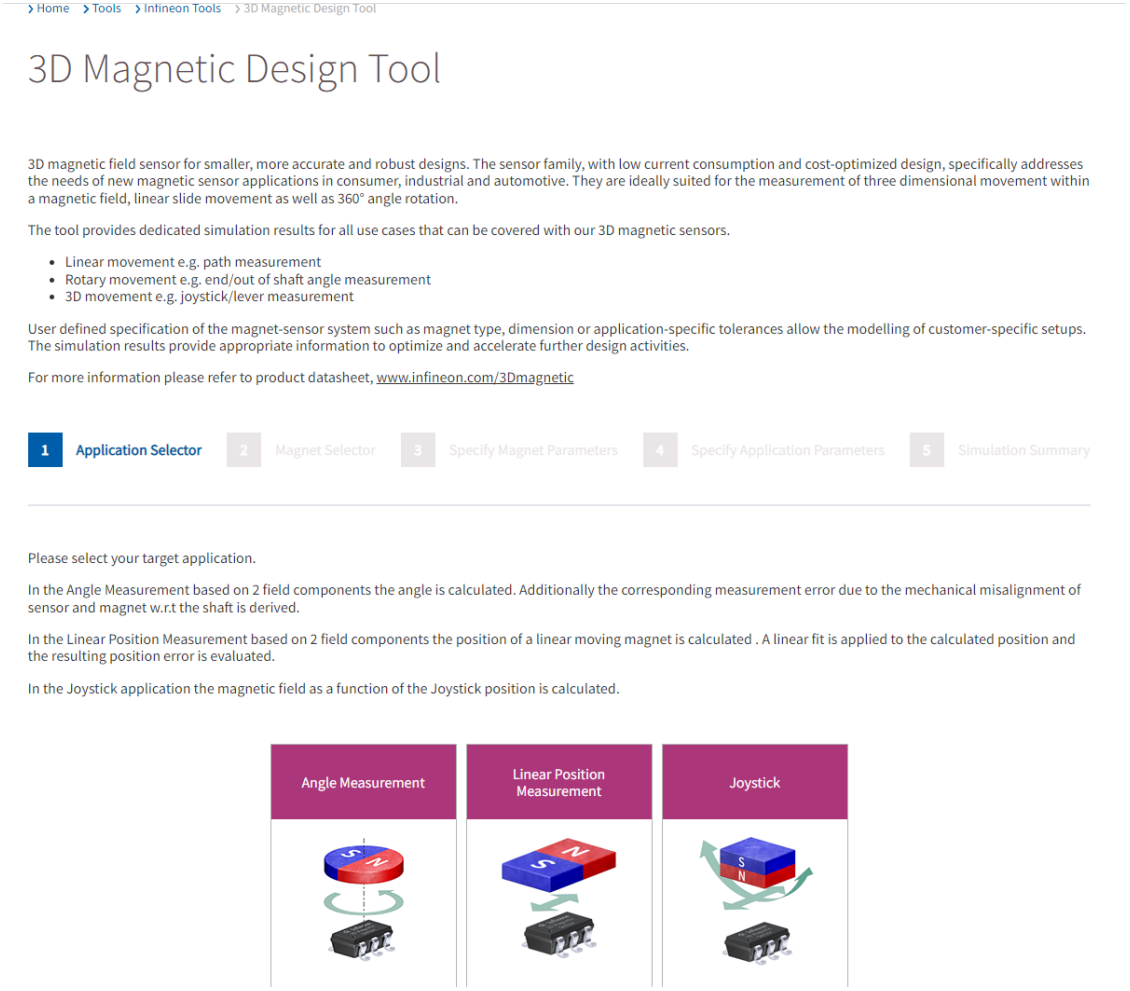
XENSIV™ Add ons and its usecases

	3D Position	Linear Position	Angular Position
Use case			
Sensor type	3D Magnetic Sensor	3D Magnetic Sensor	3D Magnetic Sensor; Angle Sensor; 3D Magnetic Sensor
Add on			

Simulation tools

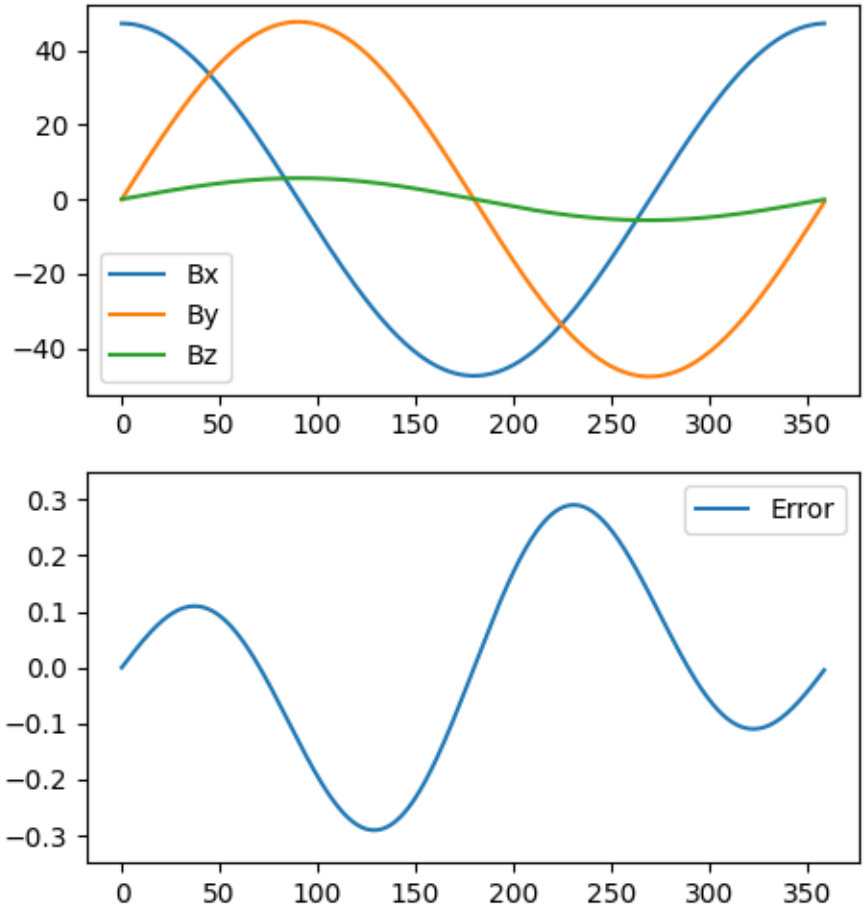
MagPyLib: https://magpylib.readthedocs.io/en/latest/

Infineon online simulation tool: https://design.infineon.com/3dsim/



Simulation tools

MagPyLib: https://magpylib.readthedocs.io/en/latest/



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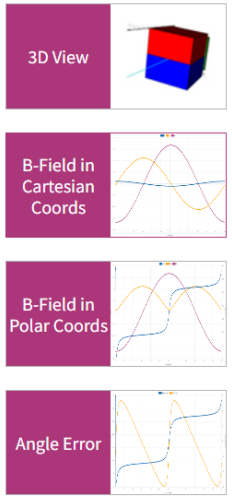

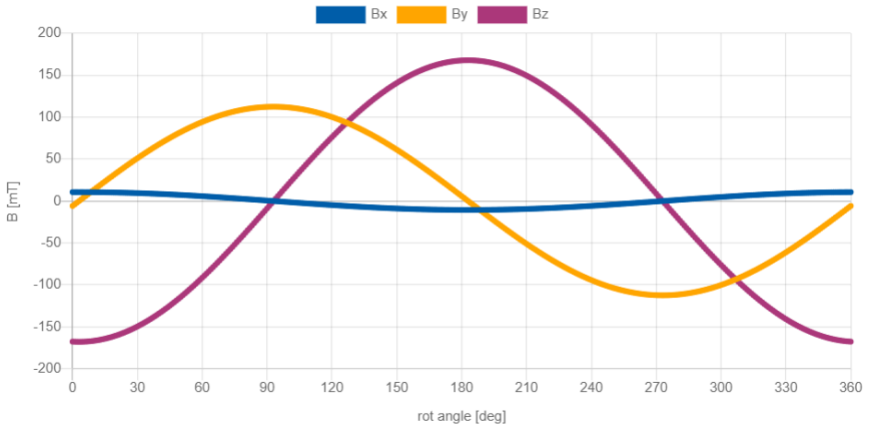

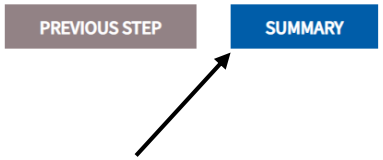

Export to Excel & Other tools

Part of your life. Part of tomorrow.