



XENSIV™ - magnetic sensor solutions for efficient transmission systems

2022



Agenda

1 Applications trends and sensor use-cases

2 Infineon sensor solutions

Magnetic position sensors

Speed sensors

3 Tools and kits

4 Summary

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1 Applications trends and sensor use-cases

2 Infineon sensor solutions

Magnetic position sensors

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4 Summary

Efficient transmission systems are key to enable clean, safe and smart cars



Megatrends

Zero CO₂ becomes real



- › Energy-efficient forms of mobility
- › EVs will become the new normal

A driver becomes a passenger



- › Increasing safety requirements

A car becomes a smarter car



- › Differentiation via user experience
- › Modular architectures

Transmission trends

- › Efficient transmission systems
- › New transmission architectures for EVs

- › Transmission system development according to functional safety requirements

- › Driving comfort and smooth driving experience

Sensor challenges

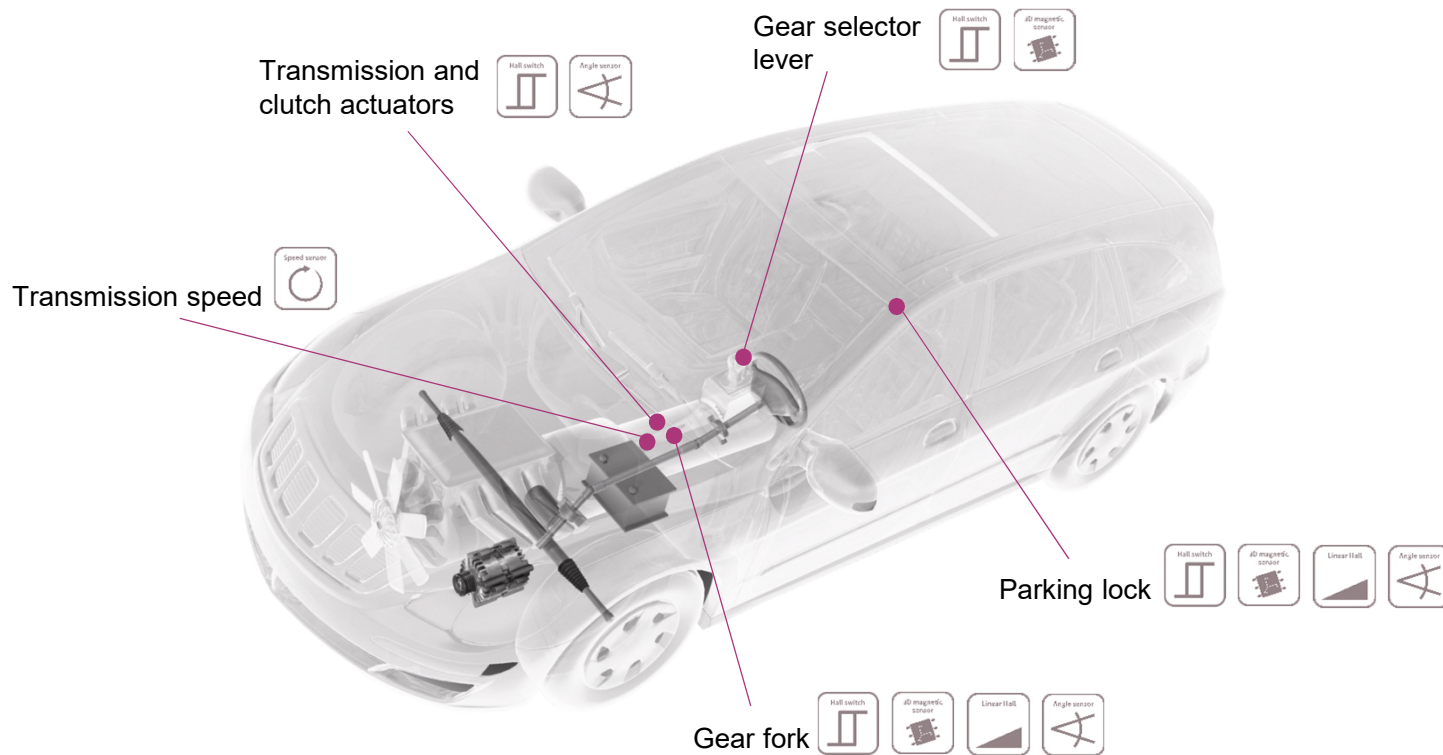
Functional safety

Exact and reliable sensor information

Broad portfolio to support different implementations

High quality and lifetime expectations

XENSIV™ - magnetic sensor applications in transmission systems



Gear selector lever

Position sensors to enable compact and safe designs



Challenges

- › Trend to more compact system designs enables higher in-cabin design flexibility
- › Ease of use for new mechanical concepts
- › Redundant system design to meet all safety critical requirements

Solutions



Magnetic switches

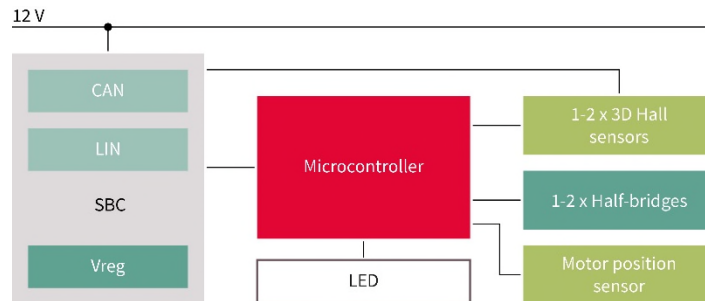


- › **Highest accuracy and proven quality**
- › Easy drop-in replacement
- › **Low power consumption** enabling energy-efficient systems
- › **High supply voltage range** and load dump capability to ensure cost-effective designs

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



Success story

Gear stick– magnetic switches



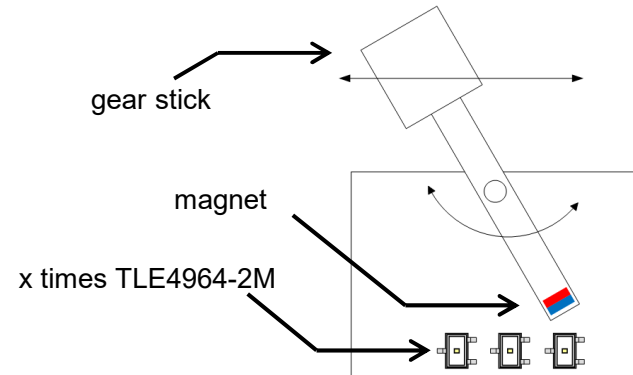
Project description

- › Application : **Gear selector lever**
- › Sub-Application: Position sensing
- › Customer: Major EU tier 1, Chinese tier 1
- › Product (s): **TLE4964-2M**
- › Related applications: Gear knob, steering wheel lever

Success factors

- › Proven, safe and precise concept
- › Implicit redundancy (up to 18 sensors/ system)
- › Excellent price-performance fit
- › IFX quality and logistic reliability
- › IFX customer first mentality
- › Simplified design in due to excellent simulation tool

Block diagram



Success story

Gear stick– 3D magnetic sensor



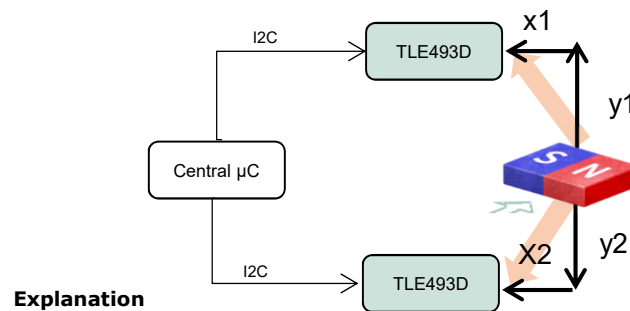
Project description

- › Application : **Gear selector lever**
- › Sub-Application: Position sensing
- › Customer: Major EU tier 1
- › Product (s): **TLE493D-W2B6**
- › Related applications: Control elements, gear stick in CAV

Success factors

- › Overall system cost reduction, several Hall switches replaced by one 3D sensors
- › Excellent price performance ratio to enable space and cost optimized solutions
- › ISO26262 ready
- › Strong customer support via magnetic field simulations and magnet selection and position guidance

Block diagram

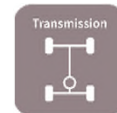


Explanation

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

Transmission actuators (clutch and gear actuator)

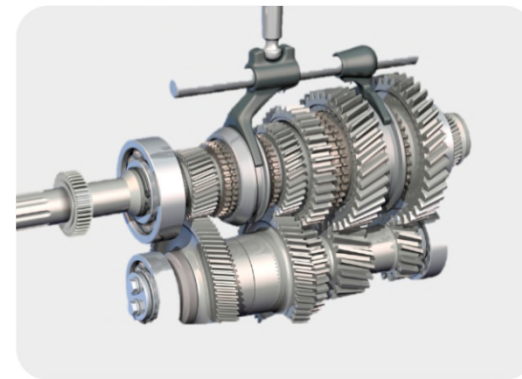
Rotor position sensors to enable efficient, smooth and low noise actuation



Challenges

- › High dynamics and torque density
- › Low noise and power consumption
- › Harsh ambient conditions
- › Modular design and reduced weight

Solutions



Magnetic switches

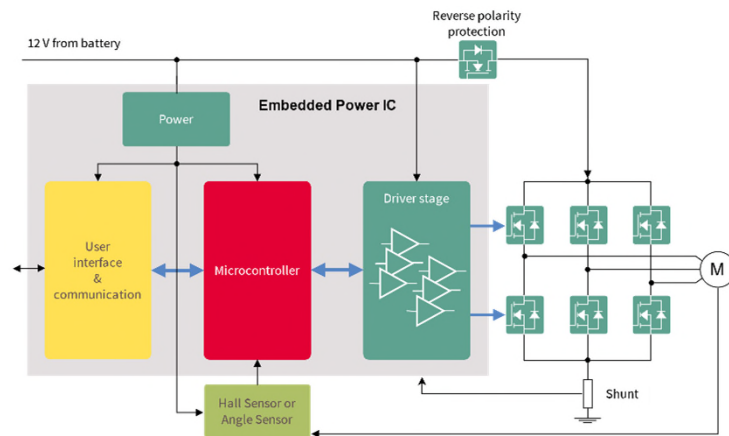


- › High temperature stability of the magnetic threshold
- › **Highest accuracy and proven quality**
- › Easy drop-in replacement
- › **Low power consumption** enabling energy-efficient systems

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



Success story

Clutch actuator – angle sensor



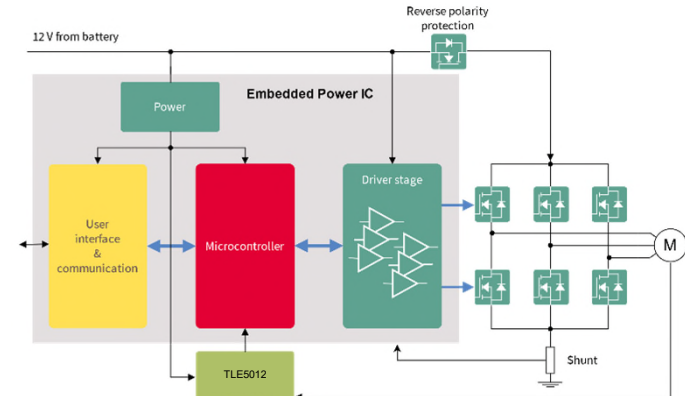
Project description

- › Application : **Transmission actuator**
- › Sub-Application: Modular clutch actuator
- › Customer: Major German tier 1
- › Product (s): **TLE5012 (digital angle sensor)**
- › Related applications: Gear actuator

Success factors

- › Digital angle sensor with standard interfaces e.g. IIF & SPI
- › Accurate absolute position detection
- › Ease of sensor integration
- › Digital interface with absolute angle info for MCU reduces overhead for angle estimation and the need for a high precision ADC
- › IIF position info & SPI for diagnostics

Block diagram

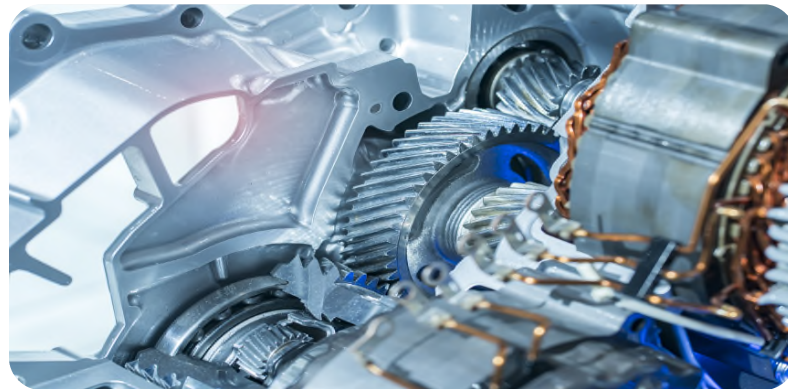


Parking lock and gear fork

Position sensors to enable reliable and accurate design

Challenges

- › Accurate position sensing of parking state (engaged / not engaged)
- › Functional safety (ISO 26262) requirements
- › Grade 0 application
- › Highly precise sensor information to ensure safe and smooth operation during gear shifting



Magnetic switches



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- › High temperature stability of the magnetic threshold

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3D magnetic sensor



- › 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 ready**

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**

Success story

Electric parking brake – magnetic switches



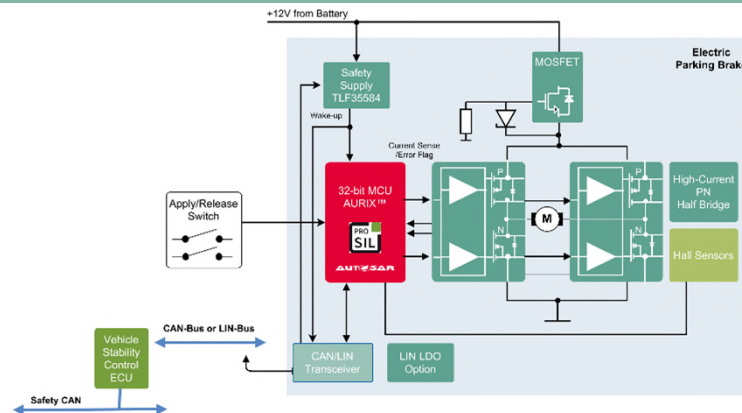
Project description

- › Application : **Electric parking brake**
- › Sub-Application: Park, no park detection
- › Customer: German OEM
- › Product (s): **TLE4968-1M**
- › Related applications: Gear fork

Success factors

- › 3.0 V to 32 V operating supply voltage
- › Overvoltage capability up to 42 V without external resistor
- › Output overcurrent & overtemperature protection
- › Active error compensation
- › High ESD performance
- › Very high quality standards

Block diagram



Transmission speed sensors

Robust and reliable sensors to overcome challenges in harsh environments

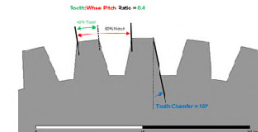
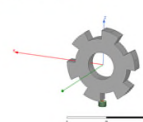
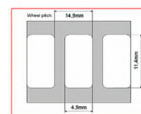
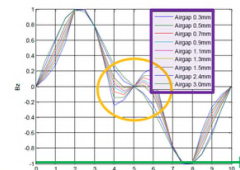
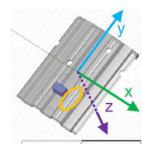
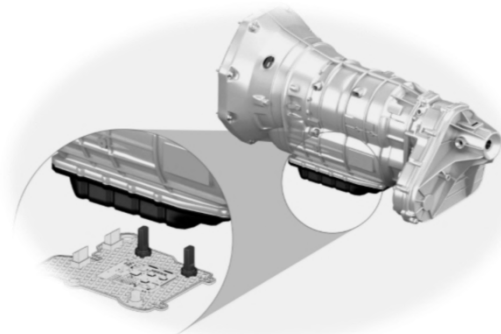
Challenges

- › Large airgap tolerances
- › Rotational and airgap vibration
- › Sudden airgap jumps
- › Large spectrum of target wheels and long pitch pole wheels
- › Stray fields

Solutions

2-wire current interface output sensor

- › High sensitivity
- › Active vibration suppression algorithm, adaptive hysteresis and 0Hz capability
- › Dynamic self calibration principle
- › Visible hysteresis concept to provide accurate switching at every wheel geometry
- › Differential principle to cancel out stray fields



Helix Angle = 0°



Helix Angle = 20°



Success story

Transmission speed sensors

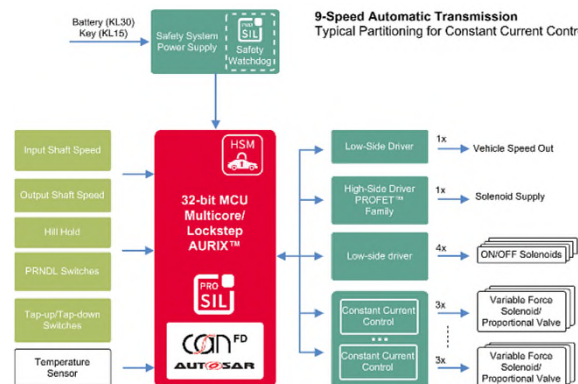
Project description

- › Application : **Transmission** (DCT, CVT, ECAT, DHT)
- › Sub-Application: -
- › Customer: Most major Tier 1's, in Europe, China, APAC, Japan and America
- › Product (s): **TLE495x**
- › Related applications: Speed sensing

Success factors

- › More than 20 years of experience in the transmission speed sensor business
- › Our broad portfolio and deep understanding of the customer's needs allows us to offer solutions for all types of requirements, interfaces and protocols
- › Meeting the highest quality and reliability requirements (<0,2 dpm)
- › Competitive pricing

Block diagram



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Magnetic position sensors

Speed sensors

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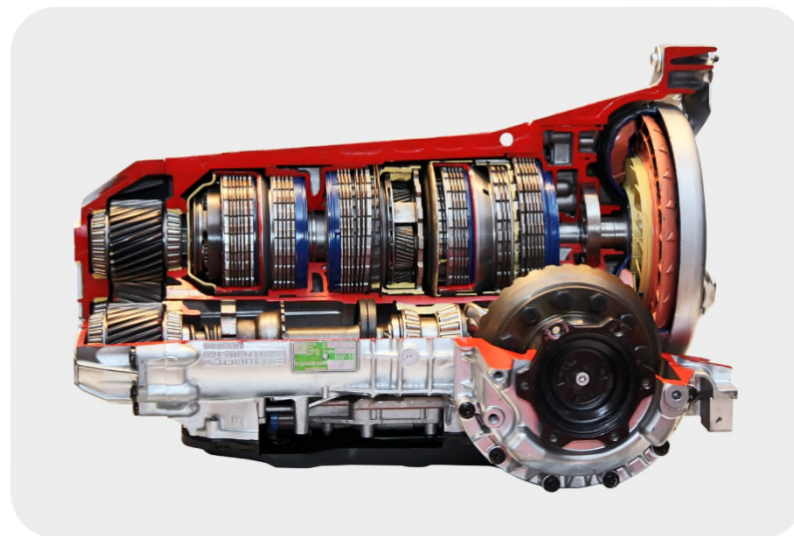
XENSIV™ - sensor solutions for transmission system

Check our application

[fast finder](#)



[XENSIV™ speed
sensors](#)



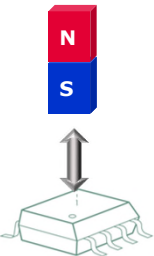
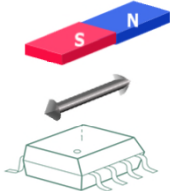
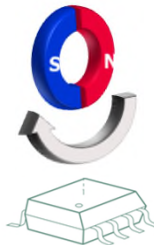
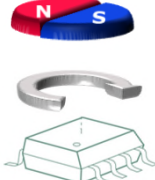

[XENSIV™ magnetic
switches](#)

[XENSIV™ 3D
magnetic sensor](#)

[XENSIV™ linear
sensors](#)

[XENSIV™ angle
sensors](#)

Magnetic position sensor – use cases

Proximity	Linear position	Rotational speed and direction	Angular position	3D movement
				
Detecting the absence and the presence of a magnetic field	Detecting and measuring the position of linear movements	Measuring the rotational speed and direction of a magnetic field via index counting	Detecting and measuring the position angular movements	Detecting and measuring the position 3-dimensional movements
XENSIV™ switch	XENSIV™ switch	XENSIV™ switch	XENSIV™ angle sensors	XENSIV™ 3D sensors
XENSIV™ 3D sensors	XENSIV™ 3D sensors	XENSIV™ 3D sensors	XENSIV™ 3D sensors	
XENSIV™ linear ICs	XENSIV™ linear ICs	XENSIV™ linear ICs		
		XENSIV™ speed sensors		

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XENSIV™ - magnetic switch families

Position detection and motor commutation tailored to your needs



Key value

Position detection

TLE4964-xM

Family of **32 V** high precision automotive qualified **unipolar** Hall **switches**



Operation from
unregulated power supply

TLE4965-xM

Family of **5 V** high precision automotive qualified **unipolar** Hall **switches**



Enables cost-effective
PCB based systems

TLE4966-xG

Family of **24 V** high precision automotive qualified **dual** Hall **latches**



Rotational speed and
direction detection

Motor commutation

TLE4961-xM

Family of **32 V** high precision automotive qualified Hall **latches**



Operation from
unregulated power supply

TLE4963-xM

Family of **5 V** high precision automotive qualified Hall **latches**



Enables cost-effective
PCB based systems

TLE4968-xM

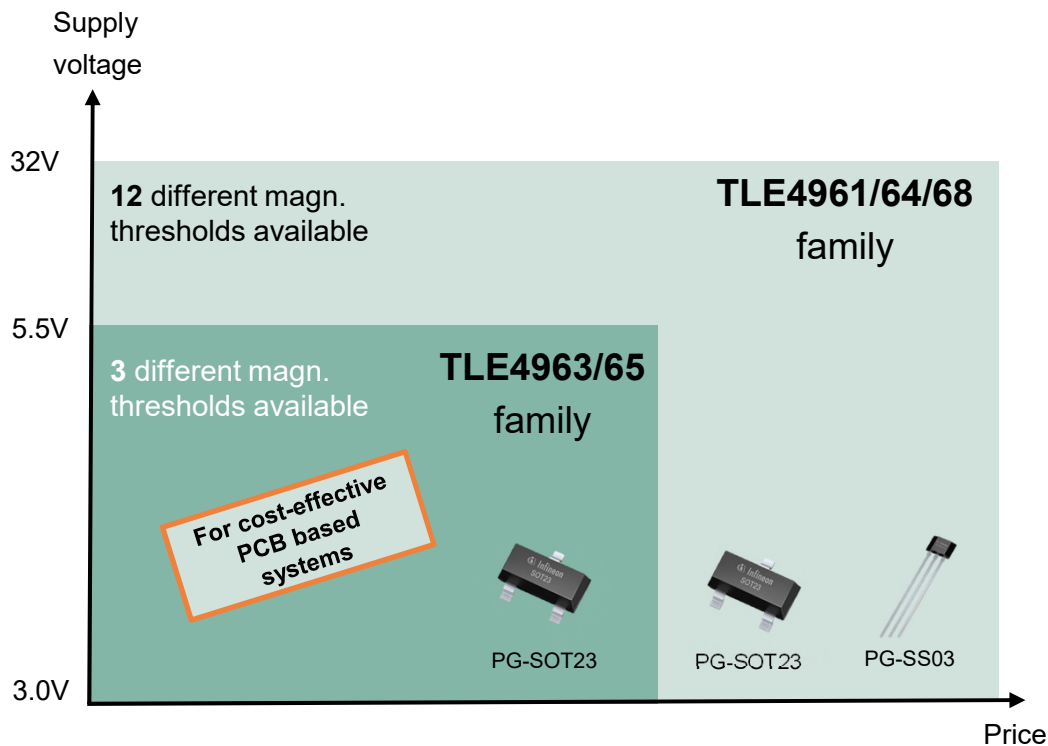
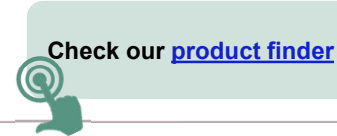
High precision automotive qualified **32 V** **bipolar** Hall **switch**



Small hysteresis → highly
sensitive

TLE4961/63/68 and TLE4964/65 family

For motor commutation and position sensing



Product highlights

- > 3.0 V to 5.5/32 V operating supply voltage
- > Low current consumption of ~1.5mA
- > Low jitter (typ. 0.35 μ s)
- > High stability of magnetic thresholds
- > Active error compensation
- > High ESD performance
- > Operating temperature range from -40 to +170°C

Product	Bop [mT]	Brp [mT]	Type	Package
TLE4963-1M	2.0	-2.0	5 V latch	PG-SOT23
TLE4965-5M	7.5	5.0	5 V switch	PG-SOT23
TLE4961-3M/L	7.5	-7.5	32 V latch	PG-SOT23/ PG-SSO3
TLE4964-2M	28.0	22.5	32 V switch	PG-SOT23
TLE4968-1M/L	1	-1	32 V latch	PG-SOT23/ PG-SSO3

TLE4966

Family of double Hall switches



Product highlights

- › **Speed-speed** or **direction-speed detection** due to two integrated Hall sensor elements
- › **Excellent sensitivity** and **stability** of the magnetic **switching points**
- › **Operation** even from an **unregulated power supply**
- › **Reverse battery protection** (-18V)
- › Mounting flexibility - **horizontal** (H) and **vertical** (V) **sensing** possibility
- › **Different** operating supply **voltage ranges** available
 - › 2.7V to 24V
 - › 3.5V to 32V
- › **Overvoltage capability** up to 42V without external resistor
- › Automotive **temperature range** -40° to 170°C



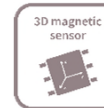
Experience our
[evaluation boards](#)



Product	Bop [mT]	Brp [mT]	Detection	Sensing	Package
TLE4966L	7.5	-7.5	speed-direction	H	PG-SSO3
TLE4966G	7.5	-7.5	speed-direction	H	PG-TSOP6
TLE4966-2G	7.5	-7.5	speed-speed	H	PG-TSOP6
TLE4966-3G	2.5	-2.5	speed-direction	H	PG-TSOP6
TLE4966V-1G	2.5	-2.5	speed-direction	V	PG-TSOP6

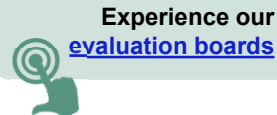
TLE493D-x2B6

Family of 3D magnetic sensors



Product highlights

- › Accurate linear **sensing** in **3 dimensions**
- › **Magnetic field** range: **$\pm 160\text{mT}$**
- › Four preconfigured address types (A0 to A3)
- › **Green** packages
- › Broad microcontroller compatibility
- › Min. **power consumption**: **7 nA**
- › **Temperature** range: **-40°C to 125°C**
- › **I²C** digital **interface**
- › Best accuracy-package size fit
- › High flexibility and configurability to support **platform approach**
- › ISO 26262 ready



Product	Magnetic linear range [mT]	Sensitivity [LSB ₁₂ /mT]	Functional safety	Wake up	Package
TLE493D-A2B6	± 100 or ± 160	7.7 or 15.4	No	No	PG-TSOP6
TLE493D-W2B6 (A0-A3)	± 100 or ± 160	7.7 or 15.4	Yes	Yes	PG-TSOP6
TLE493D-P2B6 (A0-A3)	± 100 or ± 160	7.7 or 15.4	Yes	Yes	PG-TSOP6

TLE499x

Family of linear sensors

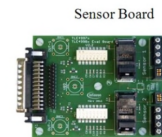


Product highlights

- › High **linear** and ratiometric **push-pull rail-to-rail output signal**
- › **Low drift** of output signal over temperature and lifetime
- › **Selectable** 12/13/14/16bit **output signals**, secured by CRC and rolling counter
- › Main and sub channel **programmable** independently in **EEPROM**
- › Operating temperature range: **-40°C to 125°C/150°C**
- › **ISO 26262 compliant** or ready
- › Several interface options available: **PWM, SENT, SPC, PSI5, analog**
- › **Dual die** options available



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[evaluation boards](#)



USB-Cable



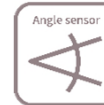
Power Supply



Product	Magnetic linear range [mT]	Magnetic offset drift [$\mu\text{T}/^\circ\text{C}$]	Safety	Interface	Package
TLE4997x	± 50 , ± 100 , ± 200	7.7 or 15.4	QM, ISO 26262 ready	Analog	SSO-3-9 TDSO-8
TLE4998x	± 50 , ± 100 , ± 200	7.7 or 15.4	QM, ISO 26262 ready	PWM, SENT, SPC	SSO-3-10, SSO-4-1 SSO-3-9, TDSO-8
TLE4999x	± 25 , ± 50	7.7 or 15.4	ISO 26262 compliant	PSI5, (SPC)	SSO-3-9, (TDSO-8)

XENSIV™ - angle sensors

Wide portfolio of sensors with different interfaces tailored to your design needs



Angle sensor portfolio



digital angle



TLE5012B(D)
TLE5014
TLE5014 (D)



amplified
analog sin/cos



TLE5x09
TLE5x09A16(D)



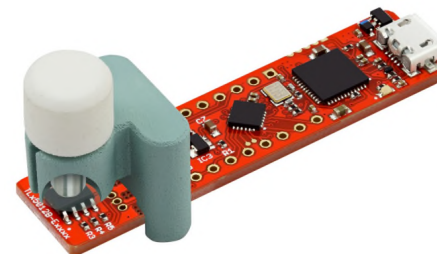
analog sin/cos



TLE5501



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Product	Technology	Interface	Temperature [°C]	Package
TLE5012	GMR	SPI,IIF, SPI HSM SPI PWM SPI SPC	-40 to 150	DSO - 8
TLE5014	GMR	SPC,SPI, PWM	-40 to 125	TDSO - 16
TLE5501	TMR	analog sin/cos	-40 to 150	DSO - 8
TLE5x09	GMR/AMR	analog sin/cos	-40 to 125 grade 0 coming soon	TDSO - 16

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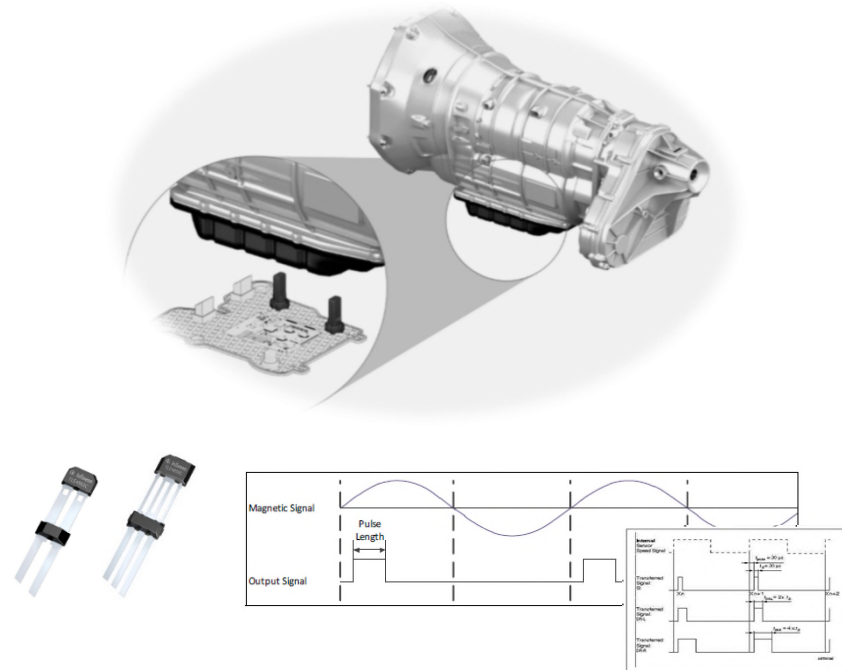
XENSIV™ - transmission speed sensors

Accurate speed sensors to improve transmission efficiency



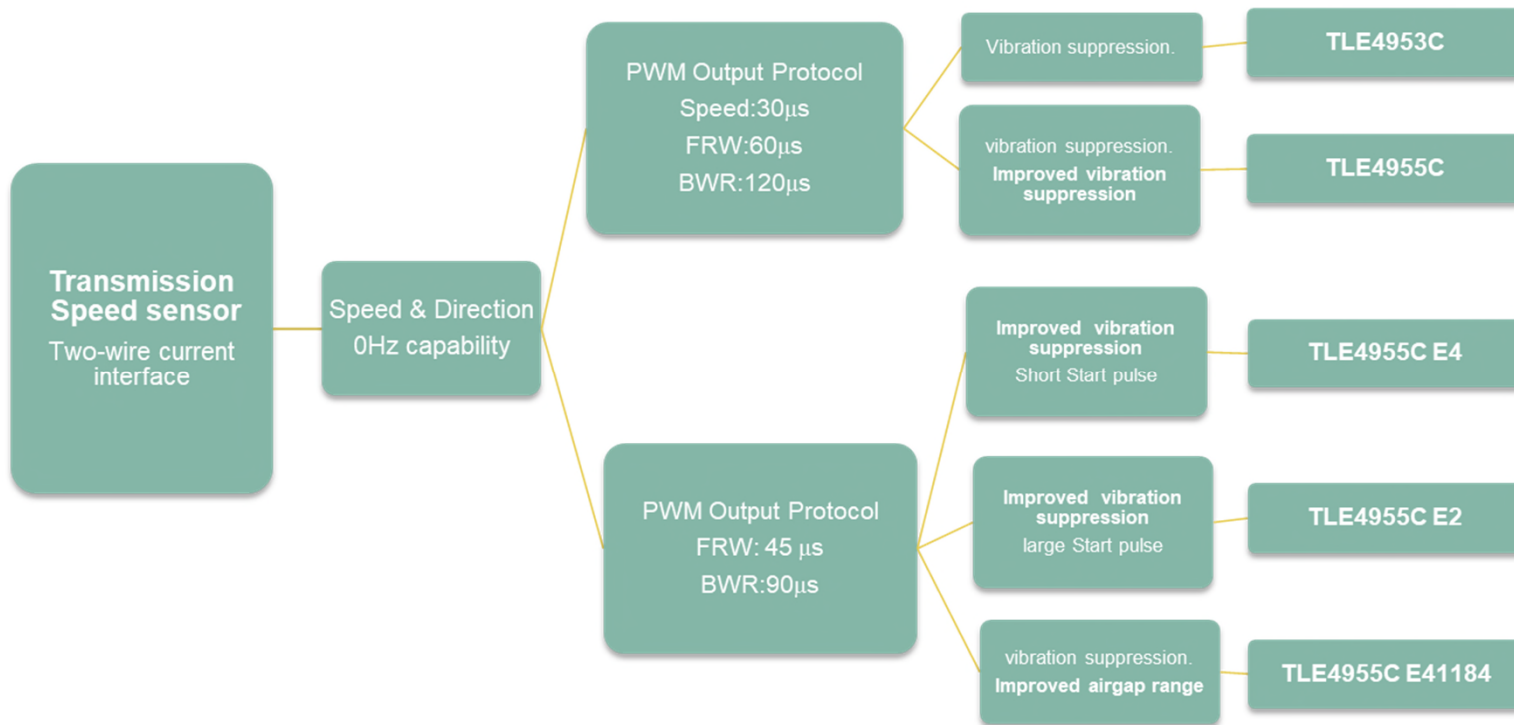
Product highlights

- › **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



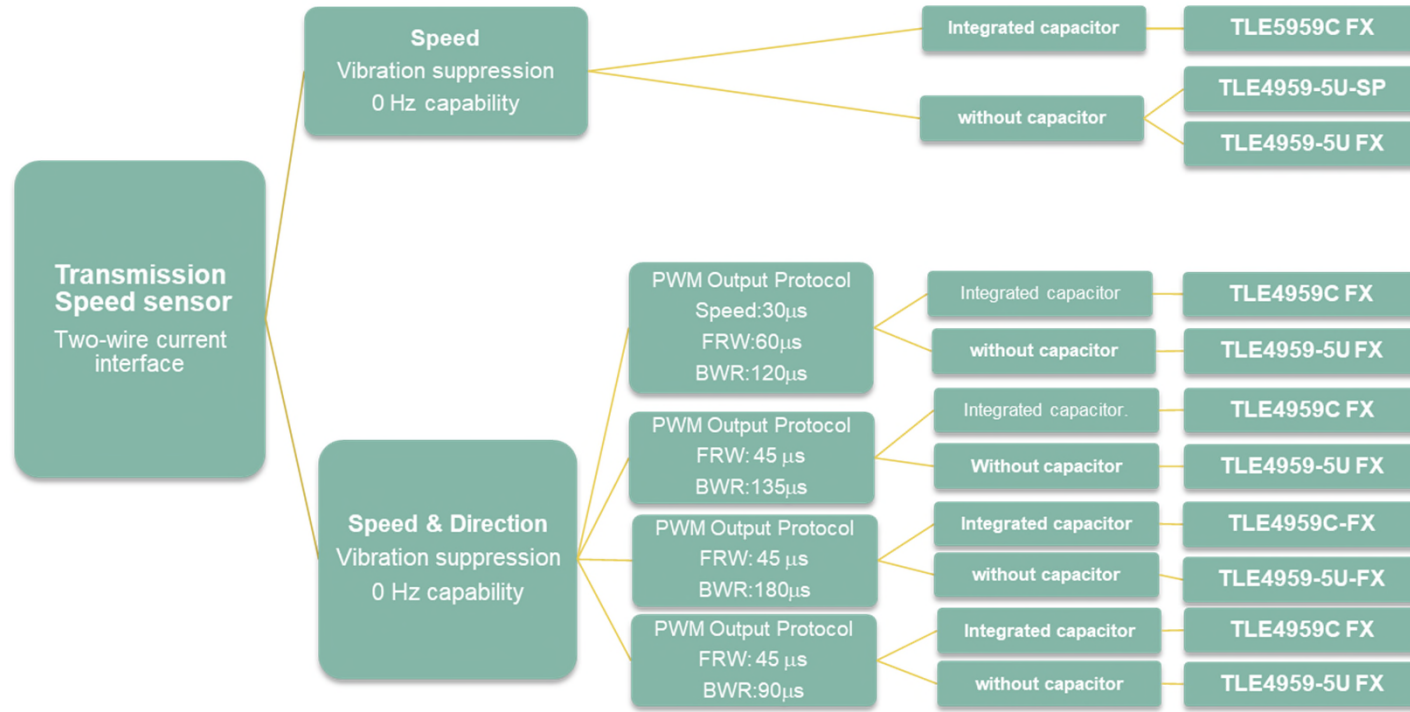
Speed sensor product selection guide

2-wire current interface



Speed sensor product selection guide

3-wire voltage interfaces



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XENSIV™ evaluation tool environment

2GO kit, Shield2GO and add-on



Check our [webpage](#) for all **XENSIV™ kit** material (e.g.: 3D printing files, user guides, details, ...)

2GO kit	Shield2GO	Add-on
<ul style="list-style-type: none">> One Infineon sensor IC combined with an ARM® Cortex™-M0 CPU> USB connection for fast evaluation> On-board debugging	<ul style="list-style-type: none">> Comprise one board with one single Infineon IC> Solderless connectors included> Arduino based software	<ul style="list-style-type: none">> Several 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



2GO kits portfolio overview

#	Product group	Sales name	Order code	
1	Magnetic switch	TLE4966_MS2GO	SP005406992	
2	Angle	TLE5012B_E1000_MS2GO	SP002133956	
3		TLE5012B_E5000_MS2GO	SP002133964	
4		TLE5012B_E9000_MS2GO	SP002133968	
5		TLI5012B_E1000_MS2GO	SP002133960	
6	3D magnetic	TLE493D-P2B6MS2GO	SP005571233	
7		TLE493D-W2B6_MS2GO	SP001707578	
8		TLV493D-A1B6_MS2GO	SP001707574	
9	Speed	TLE4922_MS2GO	SP003029974	



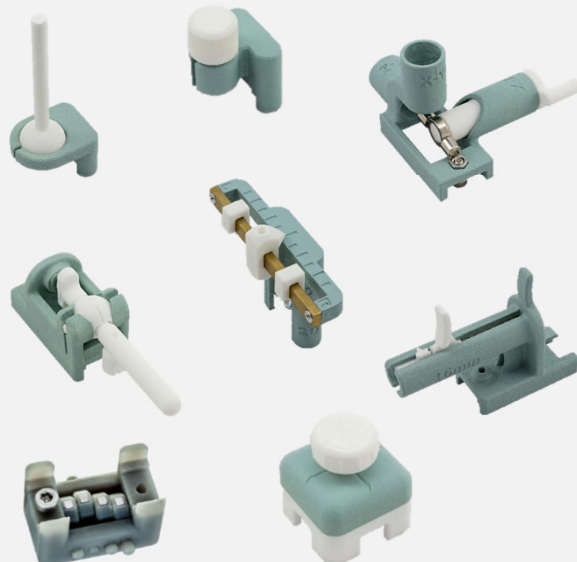
Shield2GO portfolio overview

#	Product group	Sales name	Order code	
1	Magnetic switch	S2GO_HALL_TLE4964-3M	SP004308590	
2		S2GO_2_HALL_TLE4966K	SP004308598	
3	3D magnetic	S2GO_3D_TLE493DW2B6-A0	SP004308594	
4		S2GO_3D_TLI493DW2BW-A0	SP005410385	
5		S2GO_3D-SENSE_TLV493D	SP001823678	

Add-on portfolio overview



Check our [webpage](#) for adjustable add-on 3D printing files

#	Product group	Sales name	Order code	
1	Magnetic switch	OPENCLOSE2GOHS	SP005544849	
2	Angle	ROTATE KNOB ANGLE 2GO	SP002441192	
3	3D magnetic	ROTATE KNOB 3D 2 GO KIT	SP001504602	
4		OUT OF SHAFT FOR 3D 2 GO	SP003475178	
5		JOYSTICK FOR 3D 2 GO KIT	SP001491834	
6		LINEAR-SLIDER 2GO	SP002043034	
7		DIR_INDICATOR2GO	SP005350196	
8		POWER_DRILL2GO	SP005350194	
9		MINI_CONTROL2GO	SP005350192	
10		PLAY2GO FOR 3D 2 GO KIT	Will come soon!	
11		LINEAR SPINDLE MOVEMENT FOR 3D 2 GO	Will come soon!	
12		CONTACTLESS SWITCH ARRAY FOR 3D 2GO	Self-services → Adjustable printing files available for download	

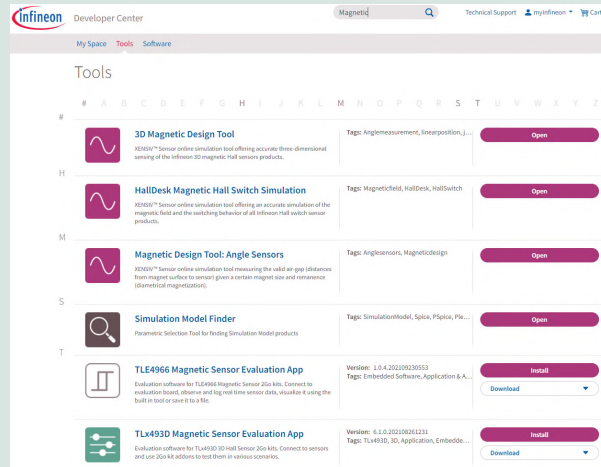
GUI and code examples for XENSIV™ 2GO kits and Shield2GOs

Keep it simple and fast



Infineon developer center

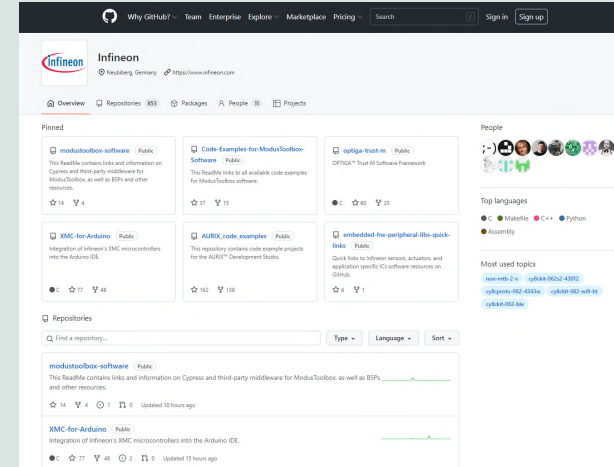
- › Easy-to-use GUI for fast and simple evaluation without programming



<https://www.infineon.com/infineon-developer-center>

Arduino / GitHub library

- › Easy-to-use and adjustable code examples for fast and simple evaluation



<https://github.com/Infineon>

Agenda

1 Applications trends and sensor use-cases

2 Infineon sensor solutions

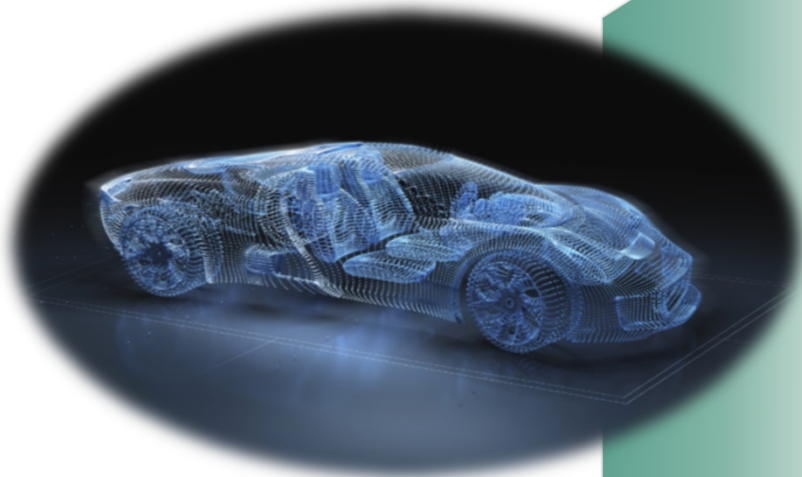
Magnetic position sensors

Speed sensors

3 Tools and kits

4 **Summary**

Transmission systems are changing - get your share with Infineon's XENSIV™ sensor solutions



- › Modern transmission systems need to meet evolving **efficiency, safety and driving comfort** requirements
- › **Intelligent actuation systems and precise position and speed sensing** are key enablers in meeting these requirements
- › **Ease of use** and fulfilling **customers expectations** are one of the main success factors in system designs
- › Infineon's is due to its **broad portfolio** complemented by an **excellent system understanding** and its **best-in-class quality** (< 0.5 dpm) the perfect partner to gain a competitive advantage



Further information on our website

<https://www.infineon.com/magnetic-sensors>

- › Application notes
- › Presentations
- › Articles
- › Boards
- › eLearnings
- › Evaluation kits
- › Online simulation tools & product finders
- › Podcasts
- › Reference designs
- › White papers



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