



# Infineon XENSIV™ – magnetic sensor solutions for power tools

April 2023



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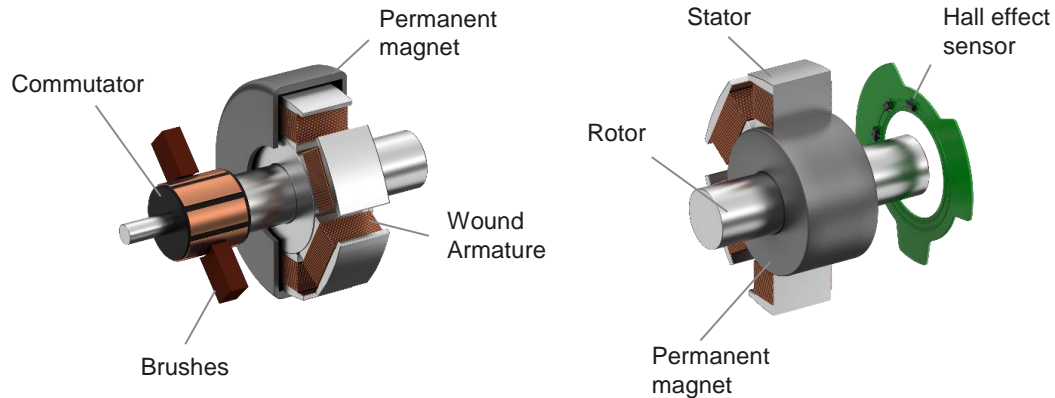
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# Application trend: BLDC motor adoption – brushed DC motors are replaced by BLDC motors

## Trend description



## Customer benefits

- Longer life span and no regular maintenance due to removed brushes and commutators
- Higher efficiency and less heat
- Lower noise and EMI
- Higher torque in smaller form factor
- Less weight and more compact

## Customer challenges

- Durability – low power consumption due to battery driven devices
- Zero/slow speed torque – immediate rotor position detection even during slow speeds or at rest
- Ergonomics – small form factor
- Low-cost and reliable solutions for the consumer market
- Precise determination of the rotor position

## Solution – 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



# Success story

## Cordless power tools – magnetic switches

### Project description

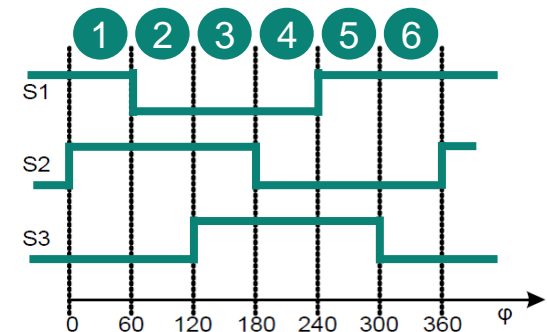
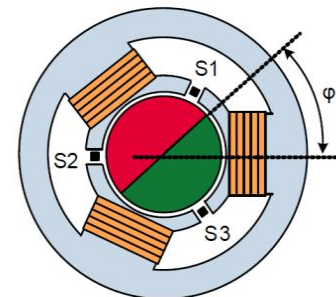
- Application: **Cordless power tools**
- Sub-application: BLDC motor commutation
- Customer: European OEM
- Product(s): [TLI4963-1M](#)
- Related applications: **Vacuum cleaner (robot), lawn mower,...**



### 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. 0.35  $\mu$ s)
- SOT23 package

### Block diagram



# Success story

## Cordless hedge trimmer – magnetic switches

### Project description

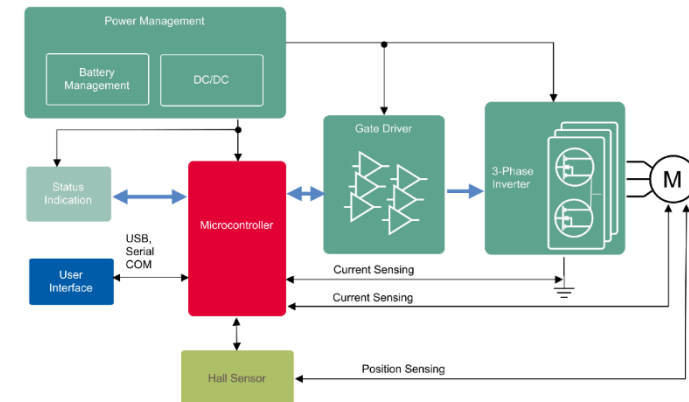
- Application: **Cordless hedge trimmer**
- Sub-application: BLDC motor commutation
- Customer: European OEM
- Product(s): [TLI4946-2K](#)
- Related applications: **Power tools, lawn mower, vacuum cleaner...**



### Success factors

- Operation from unregulated power supply
- Active error compensation
- Reverse battery protection (-18 V)
- Superior temperature stability
- Low jitter (typically 1  $\mu$ s)
- High ESD performance ( $\pm 4$  kV HBM)

### Block diagram



# Success story

## Cordless vacuum cleaner – magnetic switches

### Project description

- Application: **Cordless vacuum cleaner**
- Sub-application: BLDC motor commutation
- Customer: Asian household appliance manufacturer
- Product(s): [TLE4945L](#)
- Related applications: **Vacuum cleaner robot, lawn mower, power tools...**

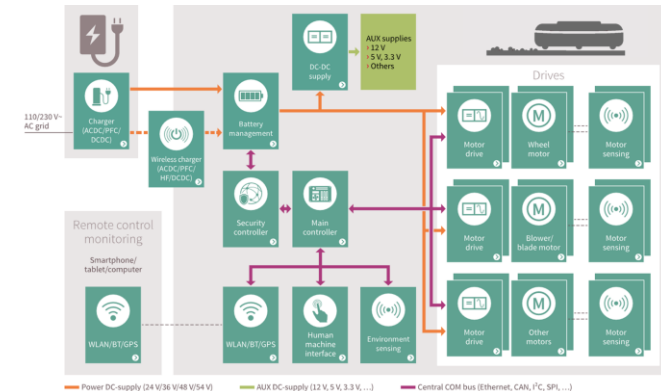


Cordless vacuum cleaner

### Success factors

- 3.8 to 24.0 V operating supply voltage
- Operating temperature range from -40 to 170°C
- Unchopped bipolar switch
- Temperature compensated magnetic performance
- Protection against reversed polarity
- Output protection against electrical disturbances

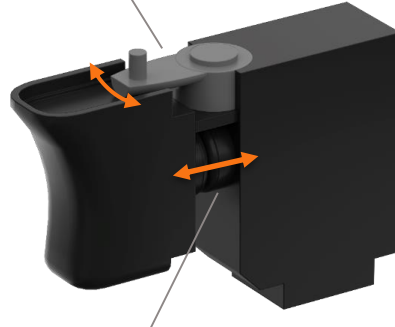
### Block diagram



# Innovation potential: Drill trigger – replace resistive potentiometer based triggers with a magnetic solution

## Innovation description

Left/right selection knob



Linear movement trigger

## Customer challenges

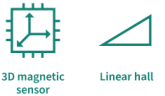
- Functional mechanical trigger design
- Media robustness → dirty environment
- Limited space → small form factor
- Low-cost and reliable solutions for the consumer market
- Low power consumption → battery powered application
- Precise determination of linear trigger and direction indicator position

## Customer benefits

- Prevent fast wear-out over time due to:
  - humidity
  - high temperatures
  - excessive dust
- Extended durability due to contactless sensing principle
- Lower system effort and cost by combining linear movement and direction detection

## Solution – 3D Hall & linear sensors

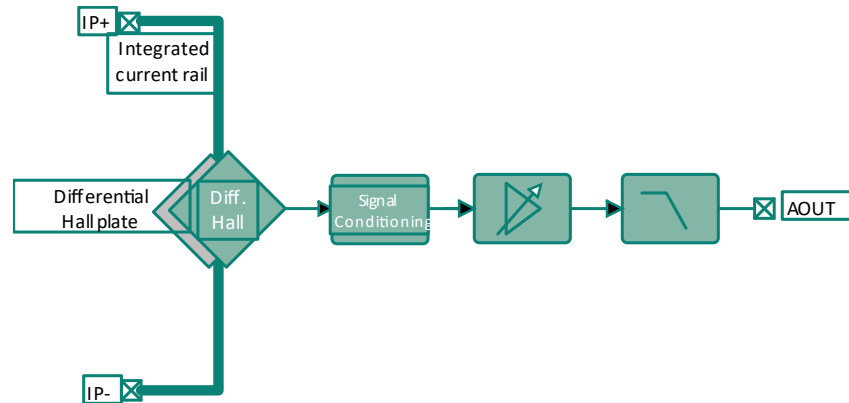
- |   |  |
|---|--|
| <ul style="list-style-type: none"><li>– D Hall family:</li><li>– Highly accurate linear sensing in 3 dimensions</li><li>– I<sup>2</sup>C digital interface</li><li>– Wake-Up functionality</li><li>– Min. power consumption of 7 nA</li></ul> | <ul style="list-style-type: none"><li>– Linear family:</li><li>– Highly accurate linear sensing in 1 dimension</li><li>– Analog &amp; digital (PWM, SENT, SPC) interface</li><li>– Low drift of output signal</li><li>– EEPROM for end-of-line programming</li></ul> |
|---|--|





# Innovation potential: Current measurement – replace shunt resistor and OP-amp with a current sensor

## Innovation description



## Customer challenges

- Full torque at 0 RPM
- Long lifetime expectations
- Smooth operation
- Reliable solutions for the consumer market
- Ergonomics – small form factor and low weight

## Customer benefits

- Smooth operation due to torque control
- Reduced area compared to existing solutions
- Scalable power classes from few hundred Watt up to 10 kW
- End of line programmability without additional components due to integrated EEPROM
- Sensing range can be changed without EEPROM usage
- Fully developed according SIL-standard

## Solution – current sensors

- Low weight: 173 mg
- **High accuracy: +/-1%**
- **Different measurement ranges**
  - with integrated current rail: +/-25 A up to +/-120 A
  - with external current rail: +/-150 A up to +/-2000 A
- **Integrated self-diagnosis** and safety mechanism



# Success story

## Drive – magnetic current sensor

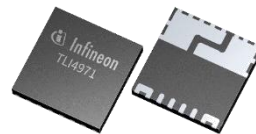
### Project description

- Application: **Motor drive**
- Sub-application: Inverter: In leg current sensing and power control
- Customer: Europe and US
- Product(s): TLI4971: all 4 current ranges with and without UL-certification
- Related applications: **SiC-drive, GaN-drive, general purpose drive**

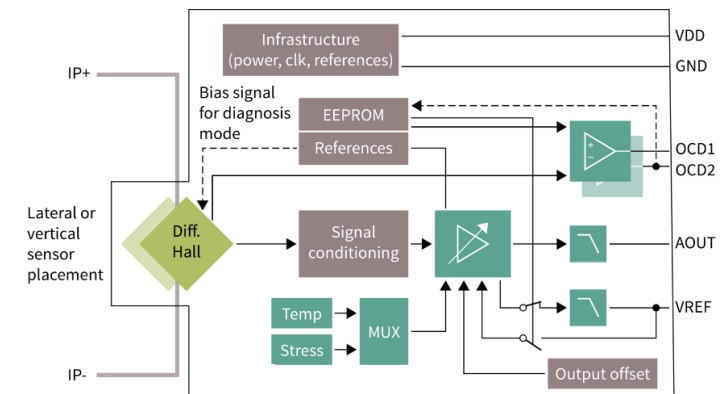


### Success factors

- Low insertion resistance of 220  $\mu\text{Ohm}$
- Good heat transfer to the PCB (outstanding in the market)
- OCD-channel to protect power semiconductors
- Diagnostic Mode: self test during startup
- Sufficient bandwidth (240 kHz)
- Scalability of Power Classes



### Block diagram



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# XENSIV™ – magnetic sensor applications in power tools

### Position sensing

**Drill trigger**

**Direction indication**

TLx493D-x2Bx – 3D sensor  
 TLE499x – linear sensor  
 TLx4964-x – magnetic switch



### BLDC motor commutation

**Rotor position detection**

TLI4961-x – magnetic latch  
 TLE4968-x – high sensitive magnetic latch  
 TLI4963-x – cost-effective magnetic latch  
 TLI5012B – digital angle sensor  
 TLE5x09 – amplified analog angle sensor  
 TLE5501 – analog angle sensor

**iGMR iTMR**

### Current sensing

**Current measurement**

TLI4971 / TLE4971 –  
 for continuous currents  $\leq 120$  A  
 TLE4972 – for continuous currents  
 $> 120$  A

# XENSIV™ – magnetic switch families

## Tailored to your needs



		Key value	
Position detection	<b>TLx4964-xM:</b> Family of <b>32 V</b> high precision automotive/industrial/consumer qualified <b>unipolar Hall switches</b>	▶	<b>Low current consumption</b>
	<b>TLx4965-xM:</b> Family of <b>5 V</b> high precision automotive/industrial qualified <b>unipolar Hall switches</b>	▶	<b>Enables cost-effective PCB based systems</b>
Speed direction	<b>TLx4966-xG:</b> Family of <b>24 V</b> high precision automotive/industrial qualified <b>double Hall latches</b>	▶	<b>Saves cost and PCB space</b>
Motor commutation	<b>TLx4961-xM:</b> Family of <b>32 V</b> high precision automotive/industrial/consumer qualified <b>Hall latches</b>	▶	<b>High stability of magnetic thresholds</b>
	<b>TLx4963-xM:</b> Family of <b>5 V</b> high precision automotive/industrial qualified <b>Hall latches</b>	▶	<b>Enables cost-effective PCB based systems</b>
	<b>TLx4968-xM:</b> High precision automotive/industrial qualified <b>32 V bipolar Hall switch</b>	▶	<b>Small hysteresis → highly sensitive</b>

# TLx496x family

## 3<sup>rd</sup> generation of magnetic switches and latches



### Industry Plus – TLE496x –

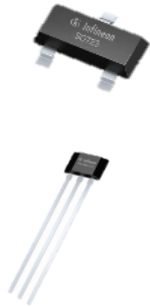
– **Temperature**  
-40 to 170°C

– **Package**  
PG-SOT23  
PG-SSO3

– **Supply voltage**  
3.0 to 5.5 V  
3.0 to 32.0 V

– **Current consumption**  
1.5 to 1.6 mA

For extreme harsh environments



### Industry – TLI496x –

– **Temperature**  
-40 to 125°C

– **Package**  
PG-SOT23  
PG-SSO3

– **Supply voltage**  
3.0 to 5.5 V  
3.0 to 32.0 V

– **Current consumption**  
1.5 to 1.6 mA



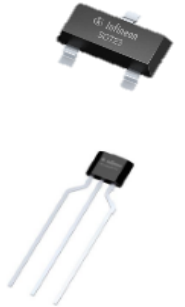
### Consumer – TLV496x –

– **Temperature:**  
-40 to 125°C  
-40 to 85°C

– **Package:**  
PG-SOT23  
PG-TO92S

– **Supply voltage:**  
3.0 to 26.0 V

– **Current consumption**  
1.6 mA



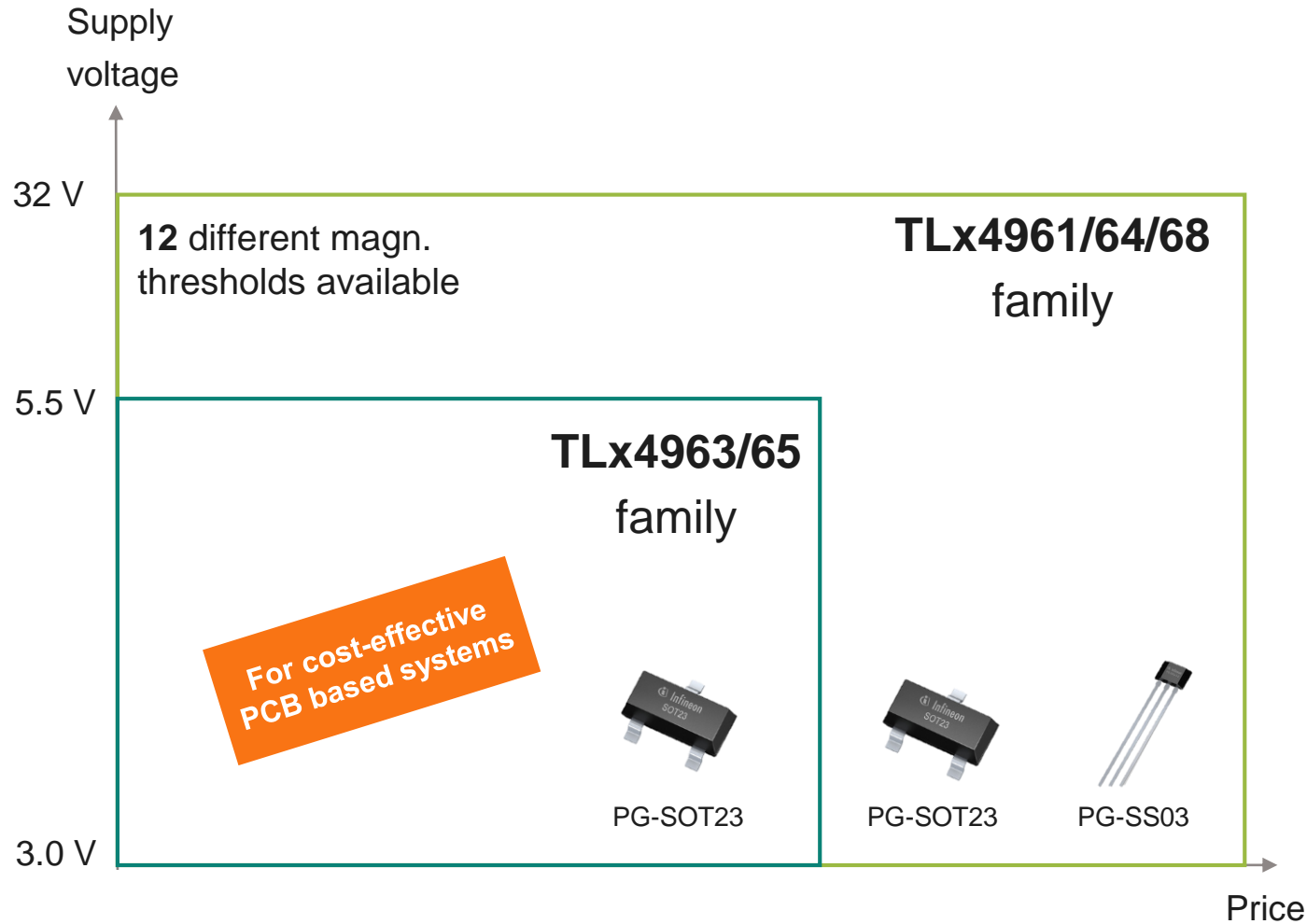
Price

Price

Broad portfolio of available thresholds

# TLx4961/63/68 and TLx4964/65 family

## For motor commutation and position sensing



### Product highlights

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

Product	$B_{op}/B_{rp}$ [mT]	Type	Package
<a href="#">TLI4963-1M</a>	2.0 / -2.0	5 V latch	PG-SOT23
<a href="#">TLI4965-5M</a>	7.5 / 5.0	5 V switch	PG-SOT23
<a href="#">TLE4961-3M/L</a>	7.5 / -7.5	32 V latch	PG-SOT23 PG-SS03
<a href="#">TLE4964-2M</a>	28.0 / 22.5	32 V switch	PG-SOT23
<a href="#">TLE4968-1M/L</a>	1 / -1	32 V latch	PG-SOT23 PG-SS03

# TLE4913 and TLV4961/4/8 – xTA/TB

## Specialized products for special requirements

### TLE4913 – low power version

- Micro power design (average current in standby mode ~4  $\mu$ A)
- 2.4 to 5.5 V supply voltage range
- High sensitivity and high stability of the magnetic switching points
- High resistance to mechanical stress
- Digital output signal
- Switching for both poles of a magnet – **omnipolar**
- Standardized SMD package PG-SC59



### TLV4961/4/8 – xTA/TB – consumer version

- 3.0 to 26.0 V operating supply voltage
- Operation from unregulated power supply
- Output overcurrent & overtemperature protection
- Active error compensation
- High stability of magnetic thresholds
- High ESD performance
- Leaded, halogen-free package **PG-TO92S**
- JESD47 qualified





# TLE499x

## Family of linear sensors

### Product highlights

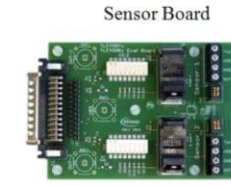
- High **linear** and ratiometric **push-pull rail-to-rail output signal**
- **Low drift** of output signal over temperature and lifetime
- **Selectable** 12/13/14/16bit **output signals**, secured by CRC and rolling counter
- Main and sub channel **programmable** independently in **EEPROM**
- Operating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

PRO  
SIL   
ISO 26262  
compliant

PRO  
SIL   
ISO 26262  
ready



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Linear hall

USB-Cable



Power Supply



Product	Linear range [mT]	Offset drift [ $\mu\text{T}/^\circ\text{C}$ ]	Safety level	Interface	Package
<a href="#">TLE4997x</a>	$\pm 50, \pm 100, \pm 200$	7.7 / 15.4	QM, ISO 26262 ready	Analog	SSO-3-9 TDSO-8
<a href="#">TLE4998x</a>	$\pm 50, \pm 100, \pm 200$	7.7 / 15.4	QM, ISO 26262 ready	PWM, SENT, SPC	SSO-3-10, SSO-4-1 SSO-3-9, TDSO-8
<a href="#">TLE4999x</a>	$\pm 25, \pm 50$	7.7 / 15.4	ISO 26262 compliant	PSI5, (SPC)	SSO-3-9, TDSO-8

# TLx493D-x2Bx

## Family of 3D magnetic sensors

### Product highlights

- Accurate linear **sensing** in **3 dimensions**
- **Magnetic field** range: **±160 mT**
- Four preconfigured address types (A0 to A3)
- **Green** packages
- Broad microcontroller compatibility
- Min. **power consumption: 7 nA**
- **Temperature** range: **-40 to 125°C**
- **I<sup>2</sup>C** digital **interface**
- Best accuracy-package size fit
- High flexibility and configurability to support **platform approach**
- **ISO26262 ready**



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3D magnetic sensor

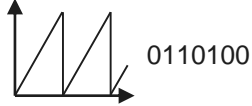
Product	Linear range [mT]	Sensitivity [LSB <sub>12</sub> /mT]	Functional safety	Wake up	Package
<a href="#">TLI493D-A2B6</a>	±100 or 160	7.7 or 15.4	No	No	PG-TSOP6
<a href="#">TLI493D-W2BW</a> (A0-A3)	±50, 100 or 160	7.7, 15.4 or 30.8	No	Yes	WLB-5
<a href="#">TLE493D-P2B6</a> (A0-A3)	±100 or 160	7.7 or 15.4	Yes	Yes	PG-TSOP6

# XENSIV™ – angle sensors: Wide portfolio of sensors with different interfaces tailored to your design needs

## Angle sensor portfolio

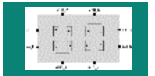


digital angle

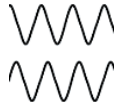


0110100


TLI5012B




amplified analog sin/cos



TLE5x09



analog sin/cos



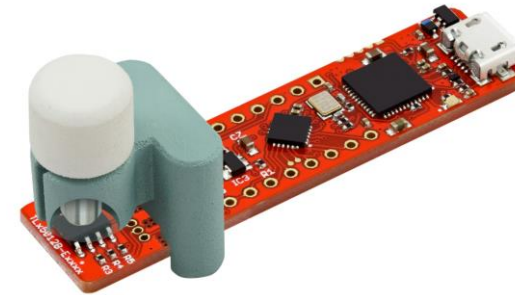
TLE5501



Experience our [evaluation boards](#)



Angle sensor



Product	Technology	Interface	Temperature	Package
<a href="#">TLI5012B</a>	GMR	SPI, IIF	-40 to 125°C	DSO - 8
<a href="#">TLE5501</a>	TMR	analog sin/cos	-40 to 150°C	DSO - 8
<a href="#">TLE5x09</a>	GMR/AMR	analog sin/cos	-40 to 125°C	TDSO - 16

# TLx497x

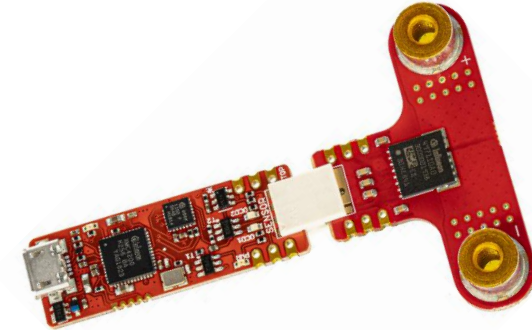
## Family of current sensors

### Product highlights

- Developed according to **SIL standard**
- Intrinsic **stray-field robustness** through differential measurement
- High bandwidth for **fast measurement**
  - TLE497x: 210 kHz
  - TLI4971: 240 kHz
- **High accuracy** over temperature and lifetime
- 3.3 V supply voltage
- **Large measurement ranges**
  - TLE4972: 0 to 31 mT (0 A to >2 kA)
  - TLx4971: +-25 A, +-50 A +-75 A, +-120 A
- Fast overcurrent detection output (OCD)
- **Analog output signal**



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Current sensor

Product	Current rail	Temperature	Functional safety	Package
<a href="#">TLI4971</a>	Integrated	-40 to 105°C	No	TISON-8
<a href="#">TLE4971</a>	Integrated	-40 to 125°C	No	TISON-8
<a href="#">TLE4972</a>	External	-40 to 150°C	Yes	TDSO-16, VSON-6

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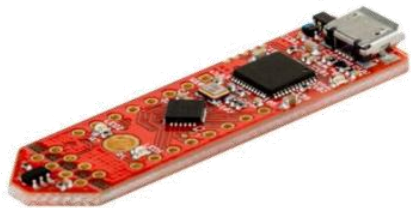
# XENSIV™ evaluation tool environment

## 2GO kit, Shield2GO and add-on



### 2GO kit

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



### Shield2GO

- Comprise one board with one single Infineon IC
- Solderless connectors included
- Arduino based software



### Add-on

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



### GUI & code

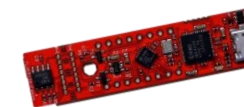
- Graphical user interface (GUI)
- Arduino library / GitHub



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

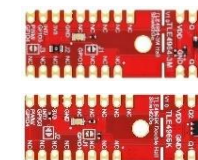
# XENSIV™ 2GO kits portfolio overview

Product group	Sales name	Ordering code
Magnetic switches	TLE4966_MS2GO	SP005406992
Angle	TLE5012B_E1000_MS2GO	SP002133956
	TLE5012B_E5000_MS2GO	SP002133964
	TLE5012B_E9000_MS2GO	SP002133968
	TLI5012B_E1000_MS2GO	SP002133960
3D Hall	TLE493D-P2B6MS2GO	SP005571233
	TLE493D-W2B6_MS2GO	SP001707578
	TLV493D-A1B6_MS2GO	SP001707574
Current	TLI4971_MS2GO	SP005345474



# XENSIV™ Shield2GO portfolio overview

Product group	Sales name	Ordering code
Magnetic switches	S2GO_HALL_TLE4964-3M	SP004308590
	S2GO_2_HALL_TLE4966K	SP004308598
3D Hall	S2GO_3D_TLE493DW2B6-A0	SP004308594
	S2GO_3D_TLI493DW2BW-A0	SP005410385
	S2GO_3D-SENSE_TLV493D	SP001823678
Current	S2GO_CUR-SENSE_TLI4971	SP005345472
MyloT adapter	MYIOTADAPTERTOBO1	SP002434972



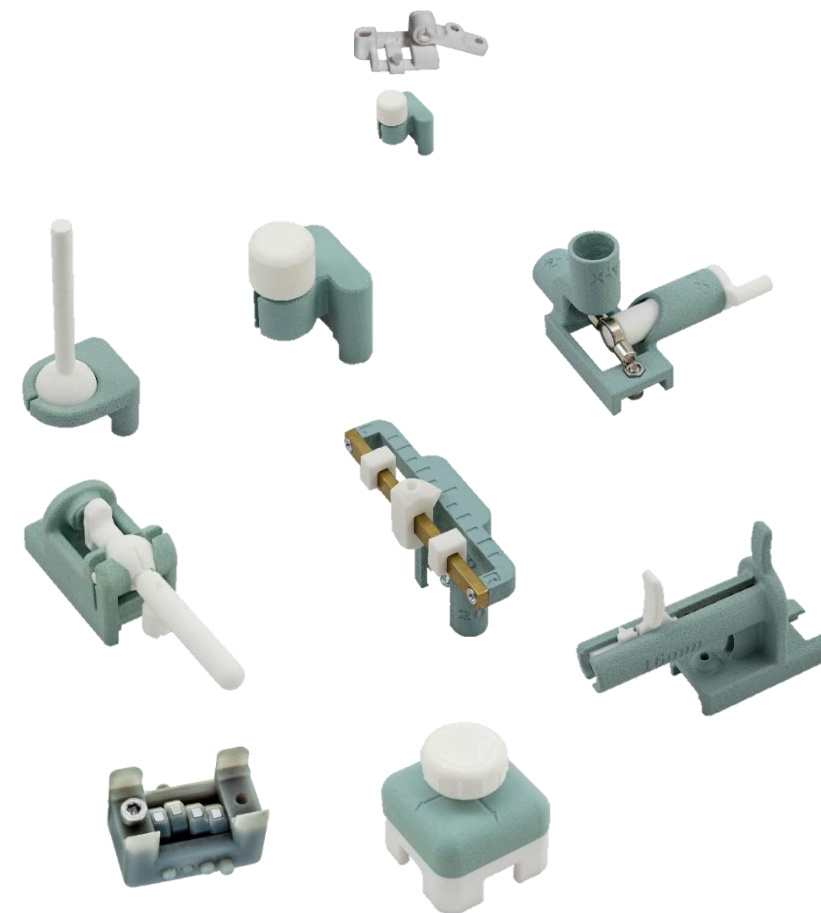


# XENSIV™ add-ons portfolio overview



Check our webpage for adjustable add-on **3D printing files**: <https://www.infineon.com/sensors-2go>

Product group	Sales name	Ordering code
Magnetic switches	OPENCLOSE2GOHS	SP005544849
Angle	ROTATE KNOB ANGLE 2GO	SP002441192
3D Hall	ROTATE KNOB 3D 2 GO KIT	SP001504602
	OUT OF SHAFT FOR 3D 2 GO	SP003475178
	JOYSTICK FOR 3D 2 GO KIT	SP001491834
	LINEAR-SLIDER 2GO	SP002043034
	DIR_INDICATOR2GO	SP005350196
	POWER_DRILL2GO	SP005350194
	MINI_CONTROL2GO	SP005350192
	PLAY2GO FOR 3D 2 GO KIT	SP005731811
	LINEAR SPINDLE MOVEMENT FOR 3D 2 GO	Soon available!
	CONTACTLESS SWITCH ARRAY FOR 3D 2GO	Self-services → <b>Adjustable printing files available for download</b>



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

## Keep it simple and fast



### Infineon Developer Community

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

The screenshot shows the Infineon Developer Center website. A search bar at the top contains the word 'Magnetic'. Below the search bar, there are navigation tabs for 'My Space', 'Tools', and 'Software'. The 'Tools' section is active, displaying a list of tools under the heading 'Tools'. The tools are listed in a grid format with columns for a tool icon, title, description, tags, and an 'Open' or 'Install' button. The tools listed are:

- 3D Magnetic Design Tool**: XENSIV™ Sensor online simulation tool offering accurate three-dimensional sensing of the infineon 3D magnetic Hall sensors products. Tags: Anglemeasurement, linearposition, J... Open
- HallDesk Magnetic Hall Switch Simulation**: XENSIV™ Sensor online simulation tool offering an accurate simulation of the magnetic field and the switching behavior of all infineon Hall switch sensor products. Tags: Magneticfield, HallDesk, HallSwitch Open
- Magnetic Design Tool: Angle Sensors**: XENSIV™ Sensor online simulation tool measuring the valid air-gap (distances from magnet surface to sensor) given a certain magnet size and remanence (diametrical magnetization). Tags: Anglesensors, Magneticdesign Open
- Simulation Model Finder**: Parametric Selection Tool for finding Simulation Model products. Tags: SimulationModel, Spice, PSpice, Ple... Open
- TLx4966 Magnetic Sensor Evaluation App**: Evaluation software for TLx4966 Magnetic Sensor 2Go kits. Connect to evaluation board, observe and log real time sensor data, visualize it using the built in tool or save it to a file. Version: 1.0.4.202109230553 Tags: Embedded Software, Application & A... Install Download
- TLx493D Magnetic Sensor Evaluation App**: Evaluation software for TLx493D 3D Hall Sensor 2Go kits. Connect to sensors and use 2Go kit addons to test them in various scenarios. Version: 6.1.0.202108261231 Tags: TLx493D, 3D, Application, Embedde... Install Download

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

### Arduino / GitHub library

Adjustable and easy-to-use code examples for fast and simple evaluation

The screenshot shows the Infineon GitHub repository page. The repository is named 'Infineon' and is located in Heubiberg, Germany. The page displays several pinned repositories:

- modustoolbox-software**: This README contains links and information on Cypress and third-party middleware for ModusToolbox, as well as BSPs and other resources. 14 stars, 4 forks.
- Code-Examples-for-ModusToolbox-Software**: This README links to all available code examples for ModusToolbox software. 37 stars, 15 forks.
- optiga-trust-m**: OPTIGA™ Trust M Software Framework. 60 stars, 35 forks.
- XMC-for-Arduino**: Integration of Infineon's XMC microcontrollers into the Arduino IDE. 77 stars, 48 forks.
- AURIX\_code\_examples**: This repository contains code example projects for the AURIX™ Development Studio. 162 stars, 138 forks.
- embedded-hw-peripheral-libs-quick-links**: Quick links to Infineon sensors, actuators, and application specific IC's software resources on GitHub. 6 stars, 1 fork.

The page also shows a 'Repositories' section with a search bar and filters for 'Type', 'Language', and 'Sort'. The 'modustoolbox-software' repository is highlighted, showing its README content and statistics. The 'XMC-for-Arduino' repository is also highlighted, showing its README content and statistics.

<https://github.com/Infineon>

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# The power tool market is changing towards cordless solutions – get your share with Infineon's XENSIV™ sensor solutions



- Cordless power tools (CPT) are on the rise due to the **rapid industrialization** in developed and developing countries, and the **do-it-yourself (DIY) trend** for consumers.
- The cordless power tool market shifts to **brushless DC motors** to lower noise, **enable compact designs** and **increase efficiency** and reliability.
- **Easy to use** and **energy efficient sensors** with a small form factor and **precise position information** are the key success factor in modern system designs.
- Infineon 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 and keep a competitive advantage.



<https://www.infineon.com/sensor>

