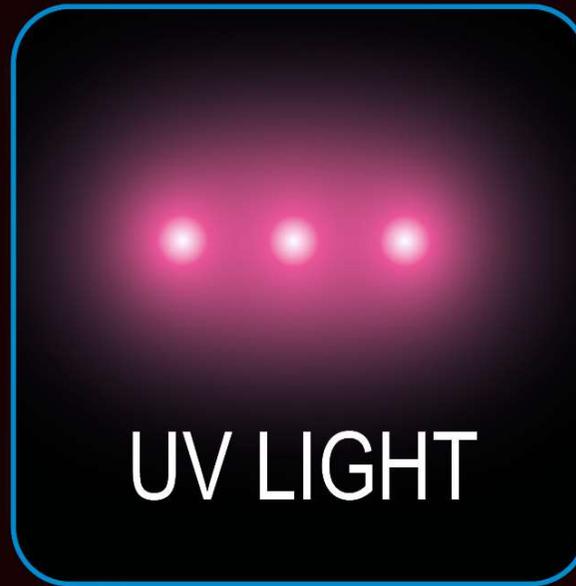
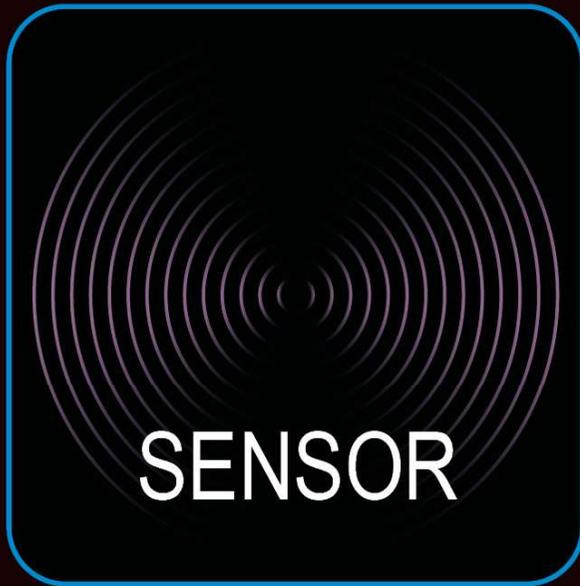


RUTRONIK TECHTALK MEETS



08.06. - 10.06.2021 | **ONLINE**

TDK Micronas Stray-field robust 3D HAL® position sensor family

Frederik Berstecher
Product Marketing Manager | Product Line 3D Position Sensors



Rutronik TechTalk

Education Inspiration Exchange

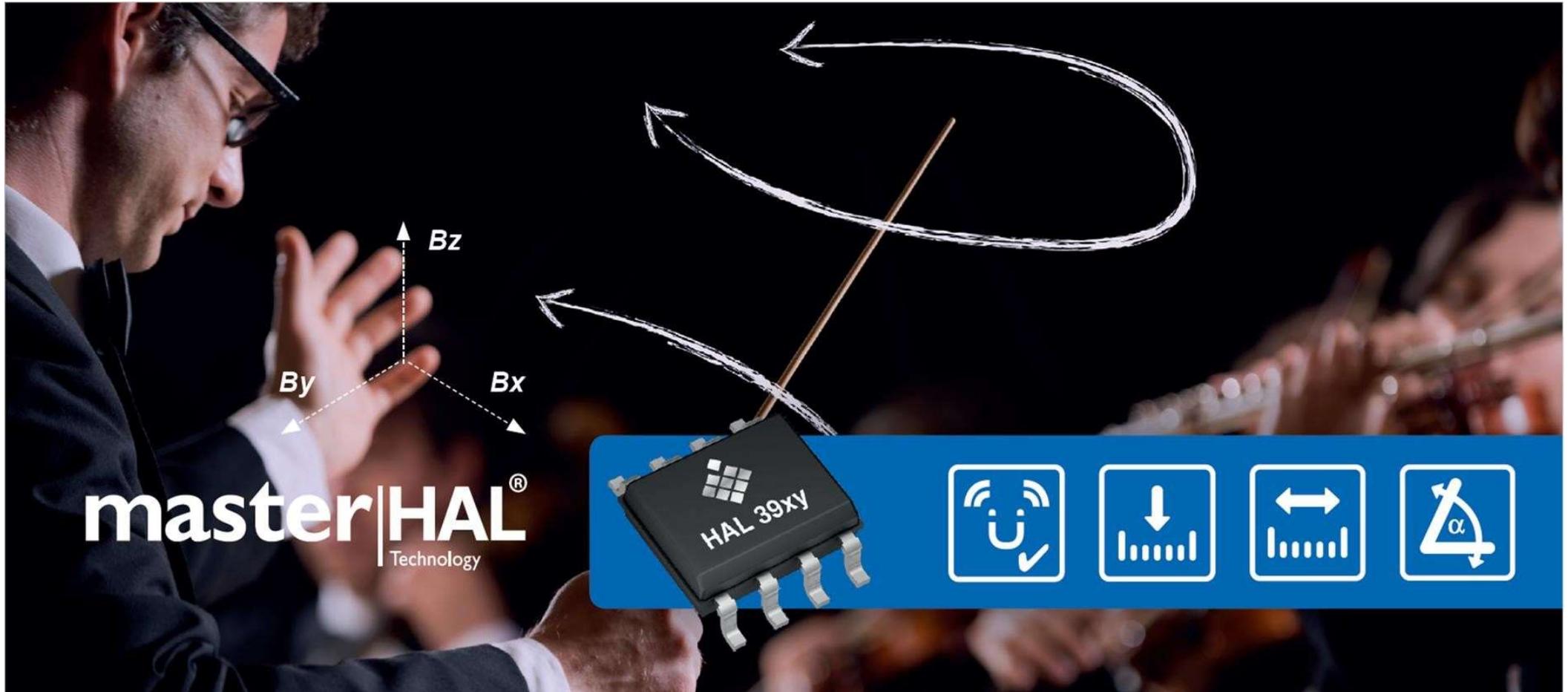


TDK-Micronas GmbH

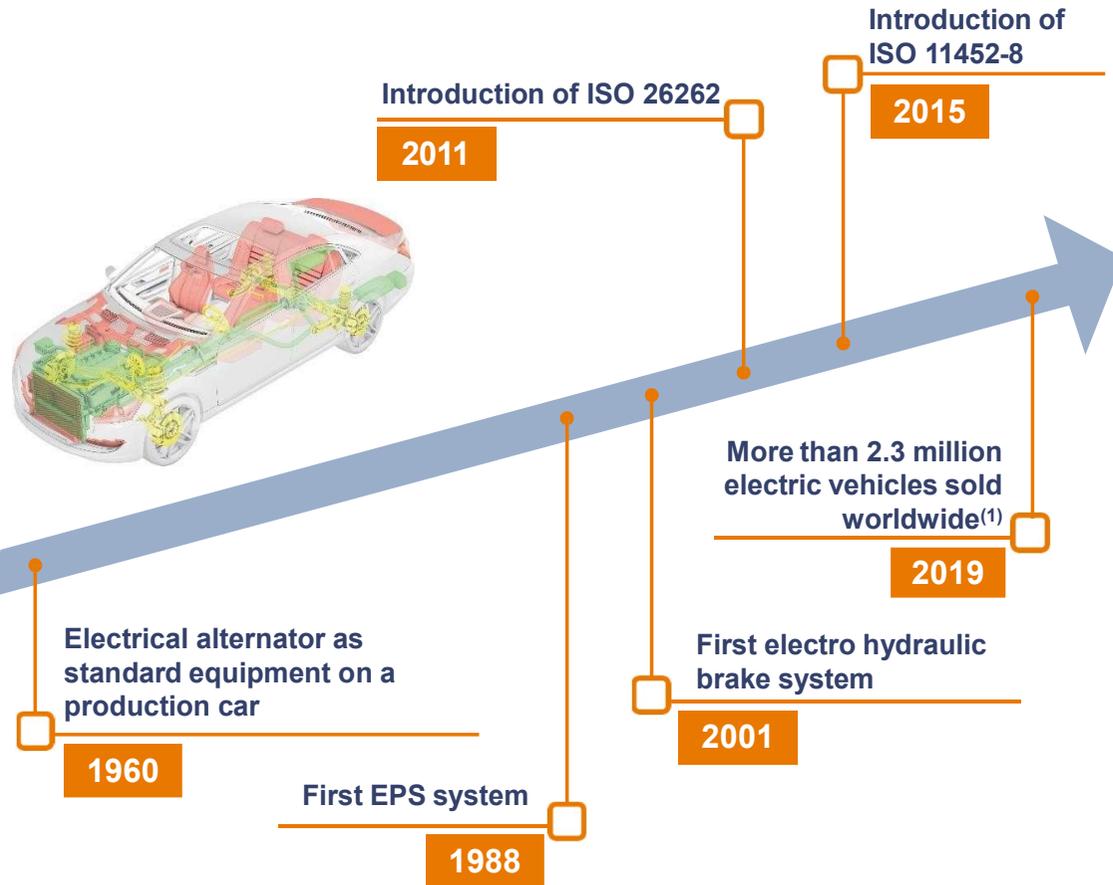
Stray-field robust 3D HAL[®] position sensor family

Frederik Berstecher – Marketing 3D Position Sensors

3D HAL[®] Technology based Stray-field Robust Position Sensor Family – HAL 39xy



Position Measurement more Important than Ever



Modern vehicles require optimized sensor and actuator solutions

- Increased safety in braking, suspension and steering modules
- Enhanced comfort and reliability by replacing mechanical and hydraulic systems with electric systems and contactless sensors
- Increased energy efficiency and reduced CO₂ emissions
- Improved cost efficiency

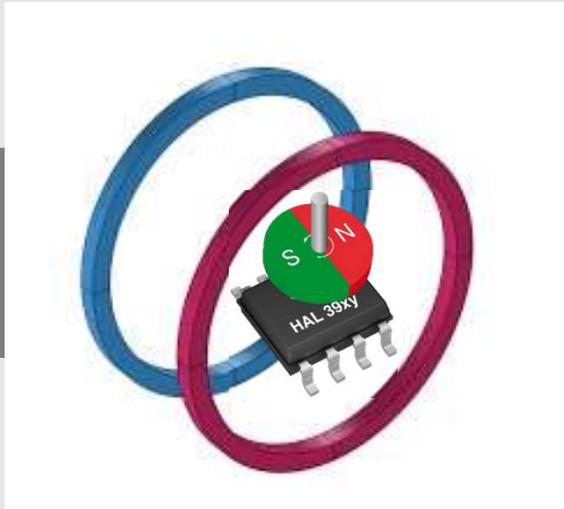


Source: ⁽¹⁾ Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (2020)

The Challenge of Stray Field Immunity

Two kinds of stray fields can be present

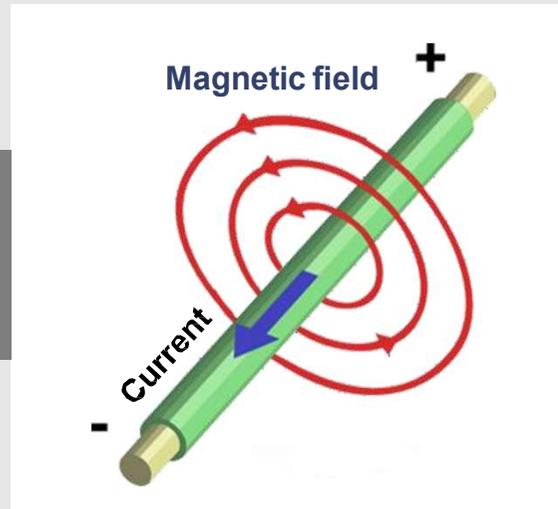
Homogenous stray field



(ISO 11452-8 up to 4000 A/m, Error < 0.12°)

or

Gradient field



Increased angular error up to 5°

Active compensation is required in the presence of stray fields

3D HAL[®] Technology based Stray-field Robust Position Sensor Family – HAL 39xy

Targeting Main Market Requirements

Stray field robustness

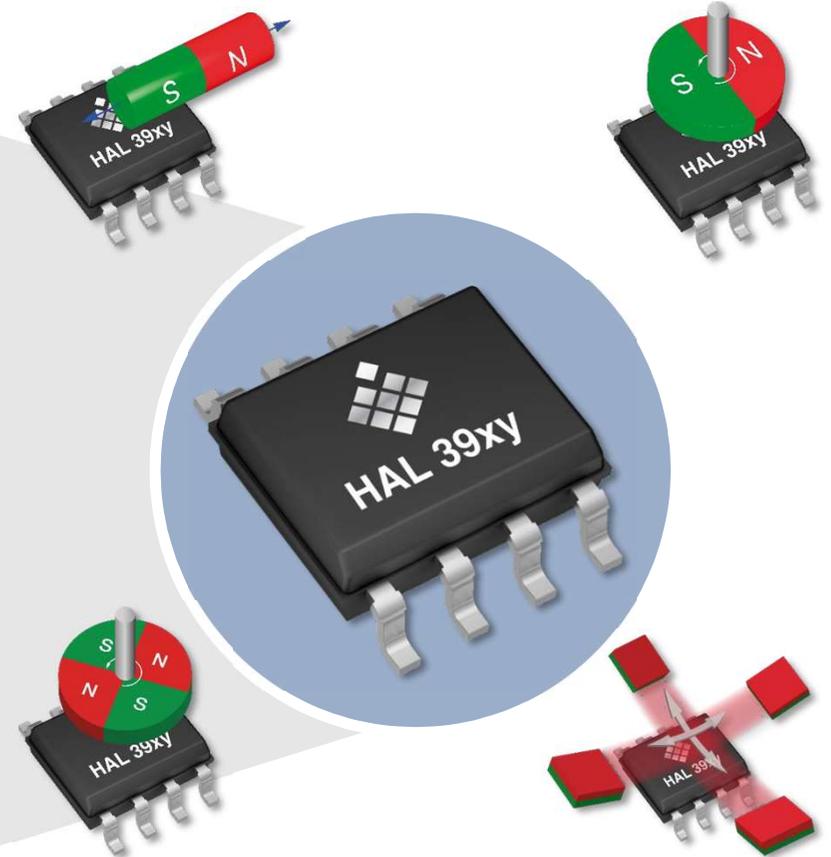
Functional safety

3D capability

Digital interfaces

Low power mode

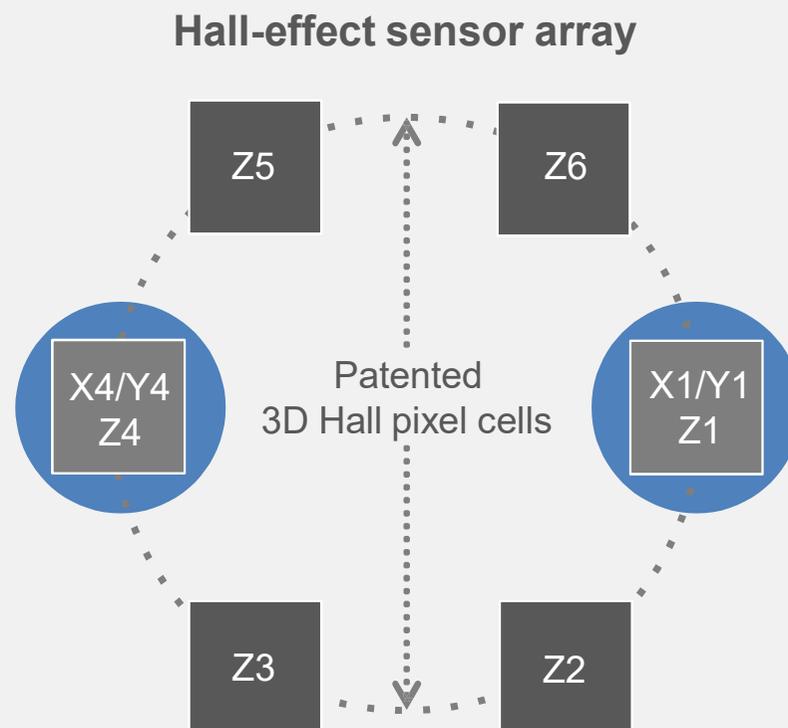
- Innovative sensor array
- Efficient on-chip diagnostics
- 3D HAL[®] Technology
- Flexible architecture
- Direct battery supply



Unique sensor array concept of HAL 39xy with stray field compensation

Linear position

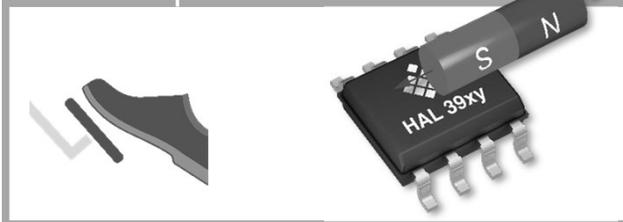
- Extended range up to 30 mm
- E.g. EGR valve, Turbo charger, brake pedal



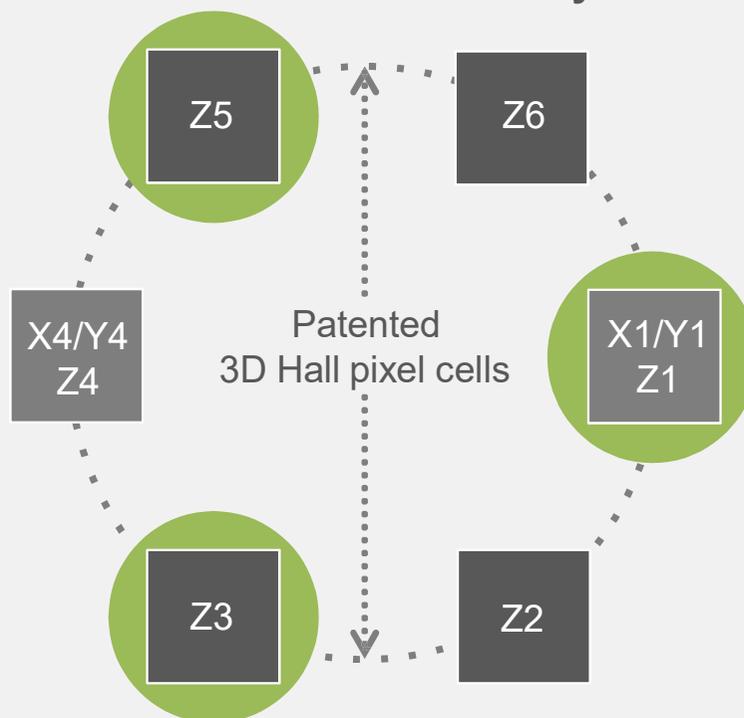
Unique sensor array concept of HAL 39xy with stray field compensation

Linear position

- Extended range up to 30 mm
- E.g. EGR valve, Turbo charger, brake pedal



Hall-effect sensor array



Rotary position up to 360°

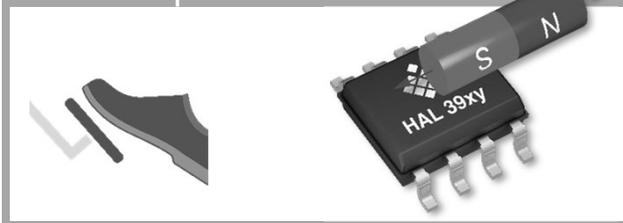
- E.g. Air management valves
- E.g. Transmission actuators
- E.g. Steering angle



Unique sensor array concept of HAL 39xy with stray field compensation

Linear position

- Extended range up to 30 mm
- E.g. EGR valve, Turbo charger, brake pedal

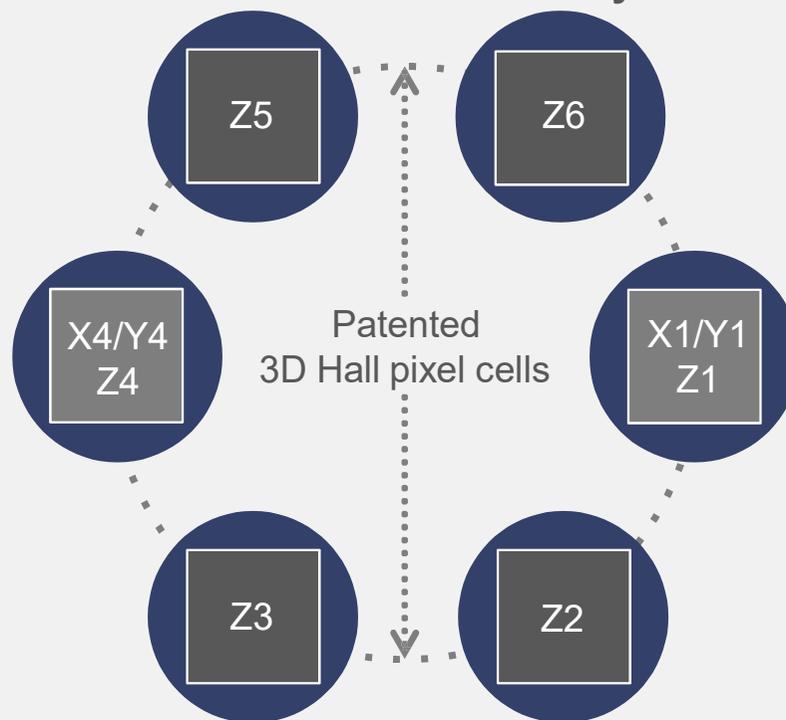


Rotary position up to 180°

- Compensation of gradient fields generated by power lines
- E.g. accelerator pedal

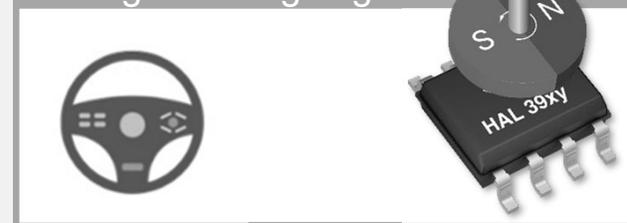


Hall-effect sensor array



Rotary position up to 360°

- E.g. Air management valves
- E.g. Transmission actuators
- E.g. Steering angle



Unique sensor array concept of HAL 39xy with stray field compensation

Linear position

- Extended range up to 30 mm
- E.g. EGR valve, Turbo charger, brake pedal

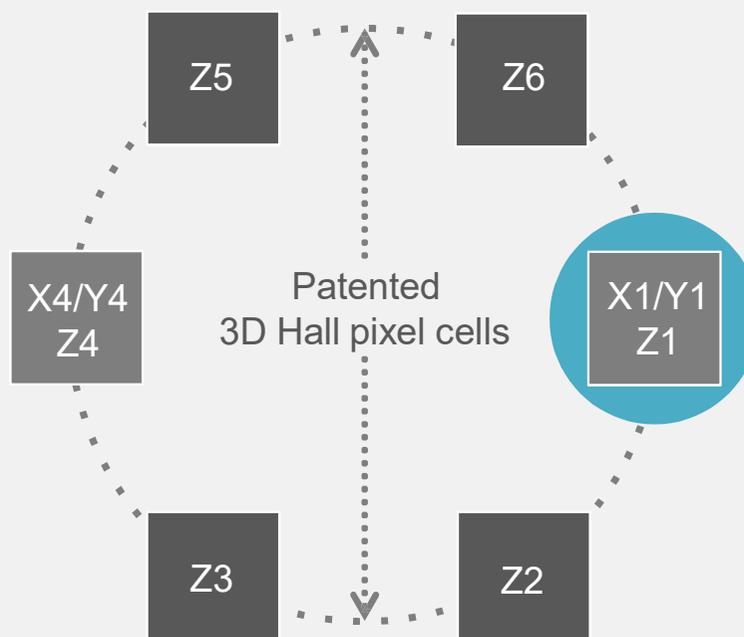


Rotary position up to 180°

- Compensation of gradient fields generated by power lines
- E.g. accelerator pedal

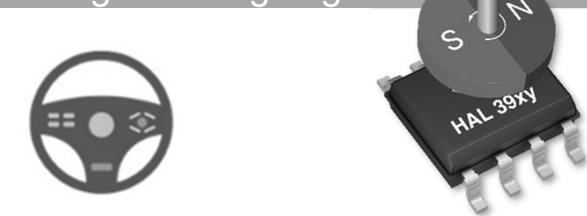


Hall-effect sensor array



Rotary position up to 360°

- E.g. Air management valves
- E.g. Transmission actuators
- E.g. Steering angle



Real 3D magnetic field measurement (B_x , B_y , B_z)

- No stray field compensation
- E.g. gear shifter



Unique sensor array concept of HAL 39xy with stray field compensation

Linear position

- Extended range up to 30 mm
- E.g. EGR valve, Turbo charger, brake pedal

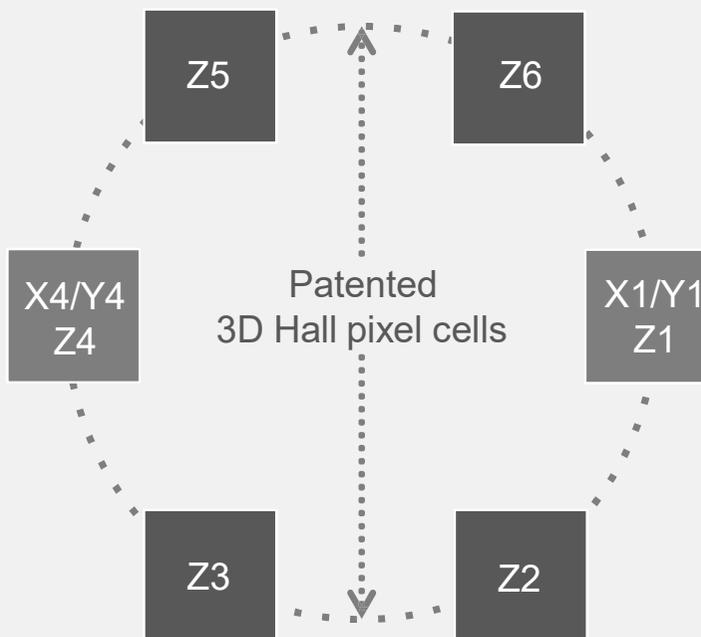


Rotary position up to 180°

- Compensation of gradient fields generated by power lines
- E.g. accelerator pedal



Hall-effect sensor array



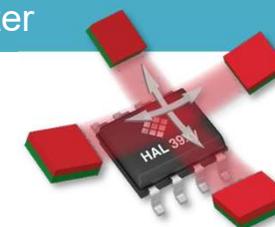
Rotary position up to 360°

- E.g. Air management valves
- E.g. Transmission actuators
- E.g. Steering angle



Real 3D magnetic field measurement (B_x , B_y , B_z)

- No stray field compensation
- E.g. gear shifter

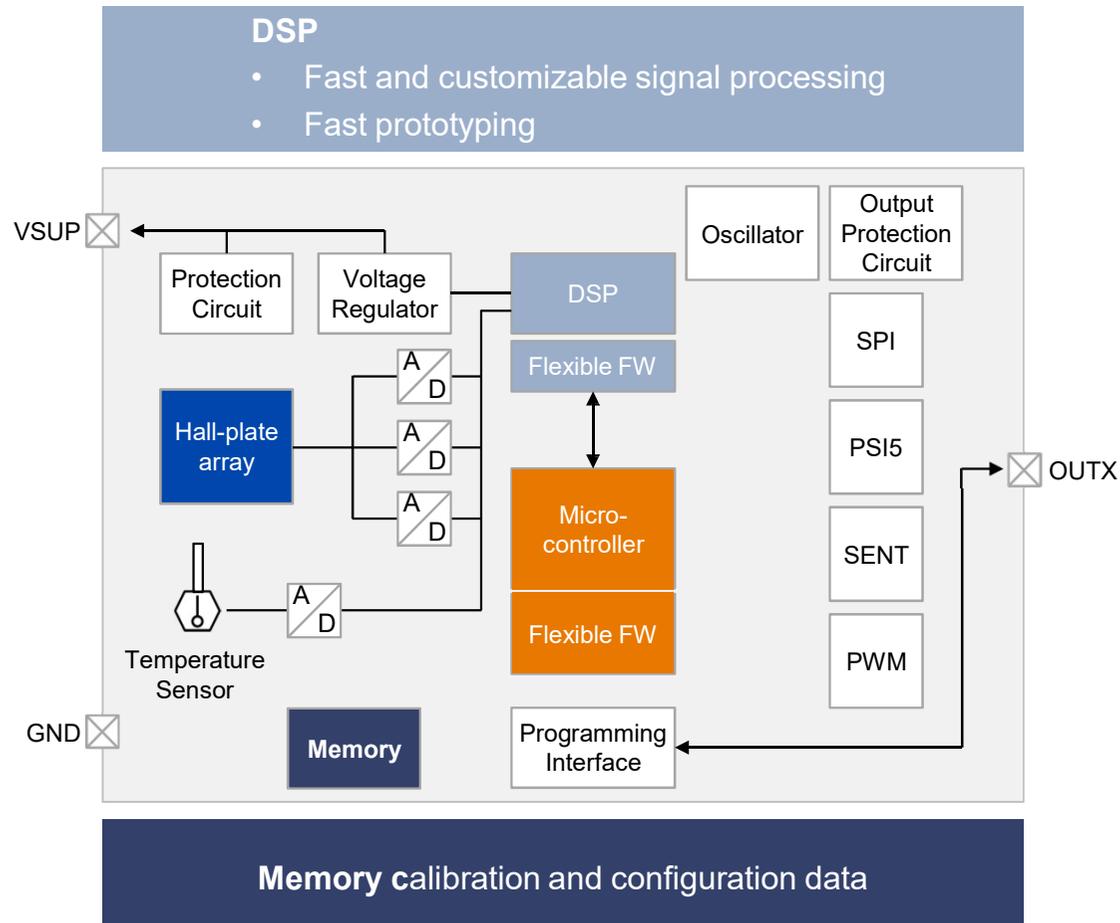


Customer configurable for different measurement tasks

Flexible Architecture of HAL 39xy Family

Hall-plate array

- Efficient stray field compensation
- Flexibility for custom measurement tasks
- Enables 2D and 3D measurements



Microcontroller with programmable firmware

- Flexible output formats
- Overall scheduling
- Interface configuration
- Quick reaction to changes in interface standards (e.g. SENT/PSI5)
- Fast prototyping
- Supervision tasks for enhanced functional safety

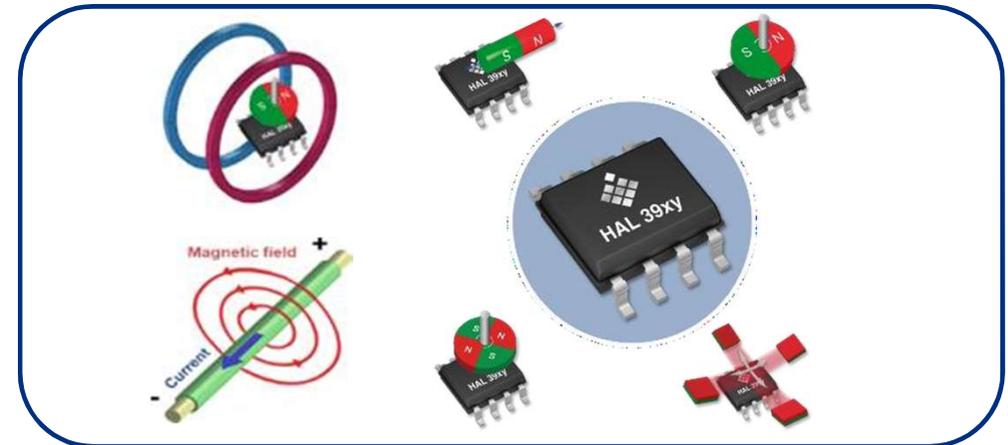
HAL 39xy – One Pager

Applications

- Stray-Field Robust Position Detection up to 360°
- Stray-Field Robust Linear Position Detection
- Real 3D Position Detection

Features

- Stray-Field robust position detection
 - Homogenous: ISO 11452-8:2015 with 4 kA/m DC
 - Gradient fields generated by high currents
 - Error due to Stray-Field $\leq 0.12^\circ$
- Bandwidth up to 8 kHz
- Various output formats
 - SPI (HAL 3900), SENT/PWM (HAL 3930)
 - SPC (HAL3970), PSI5 rev. 2.x (HAL 3980)
- Angular error: $\pm 0.5^\circ$ (plus life time drift: $\pm 0.45^\circ$)
- Setpoint linearization (17 variable & 33 fixed)
- Wide supply voltage range: 3.0 V ... 16 V
- ISO 26262 development: ASIL-B ready
- Customized sleep mode possible
- SOIC-8 package



USPs

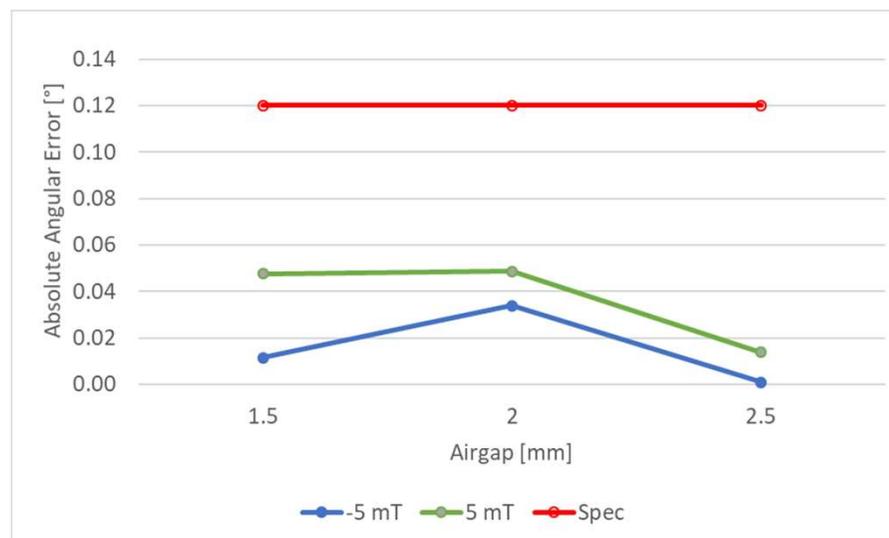
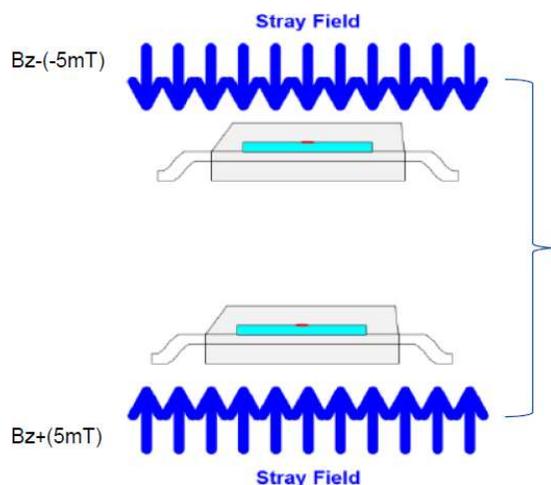
- One device for various stray-field robust measurements
- High temperature grade ($T_A \geq 150^\circ\text{C}$)
- Battery capable device (Load dump robust)
- Customized sleep mode (wake-up by angle/field strength)
- Programmable via output pin with min. VSUP
- Highly flexible architecture to enable customized variants

HAL 39xy Stray-field Robustness vs. Competition (Datasheet Comparison)

- Error according to ISO 11452-8:2015, at 25°C, with stray-field of 4 kA/m from X,Y and Z direction

Condition	HAL 39x0	Competitor A
Configuration 1:	Max. 0.12° with 10 mT wanted signal	Not supported
Configuration 2:	Max. 0.1° @ 10 mT wanted signal	Max. 0.6° @ 20 mT wanted signal Max. 0.3° @ 42 mT wanted signal

Worst case condition Z-direction:



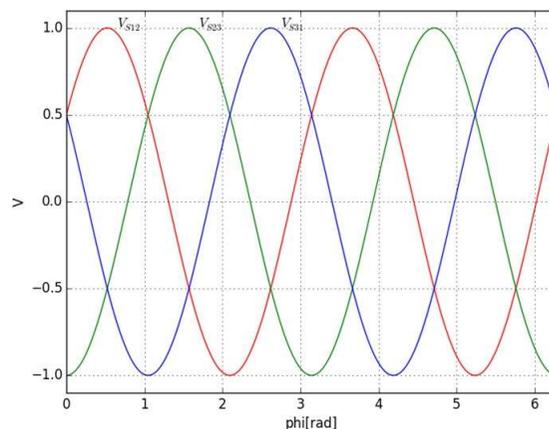
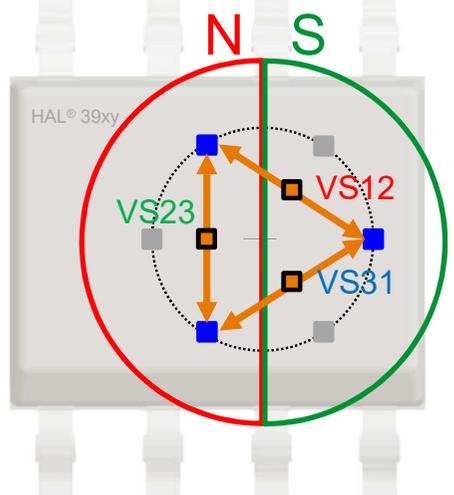
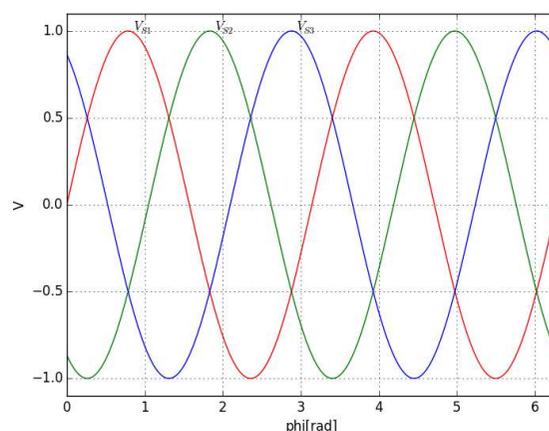
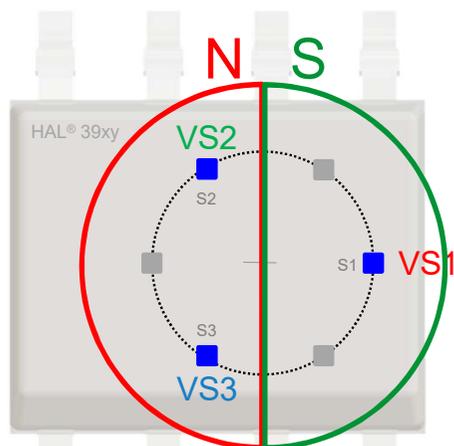
3Z-Plate setup: 90° range, 2-pole magnet (ferrite)



How does the stray-field compensation work?

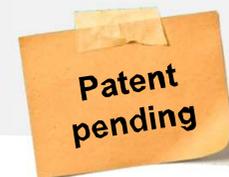


Attracting Tomorrow

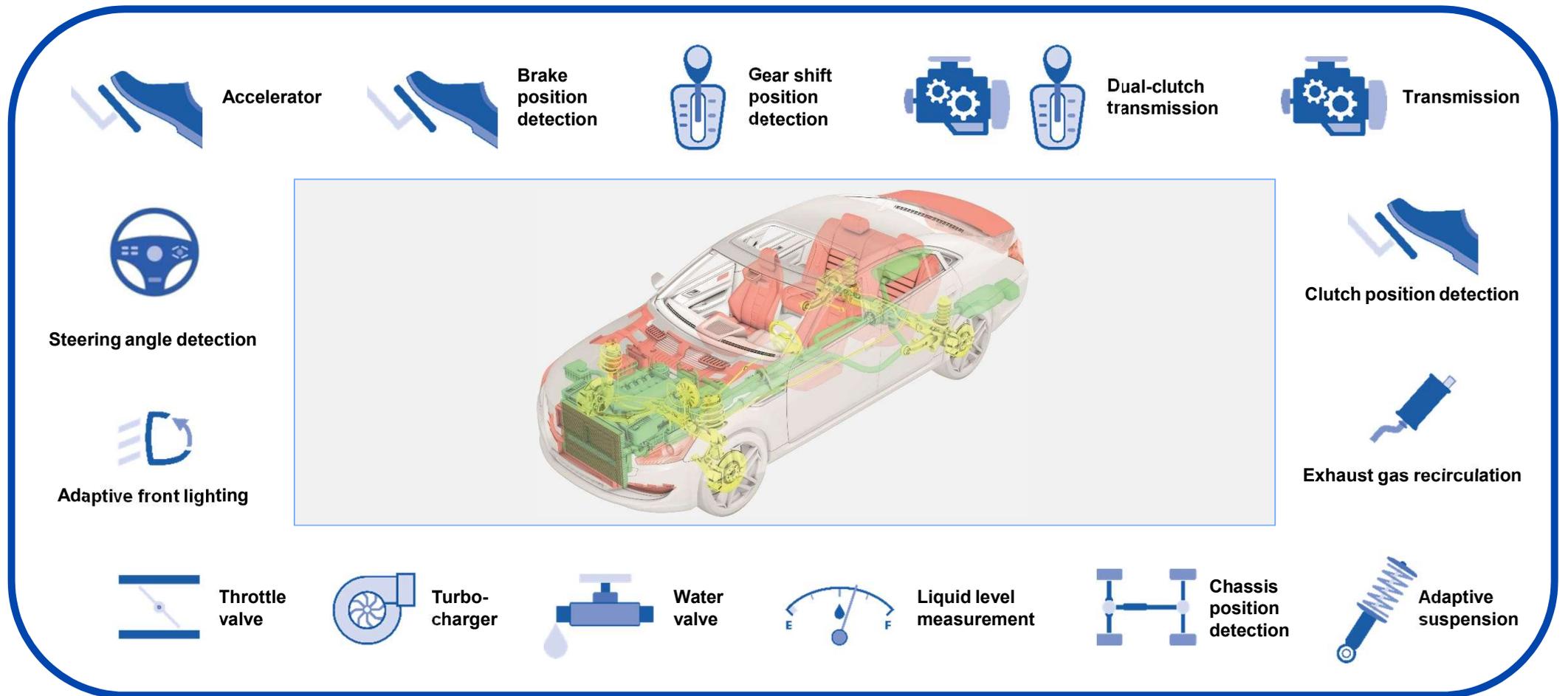


Differential Measurement – 3 x Z plates

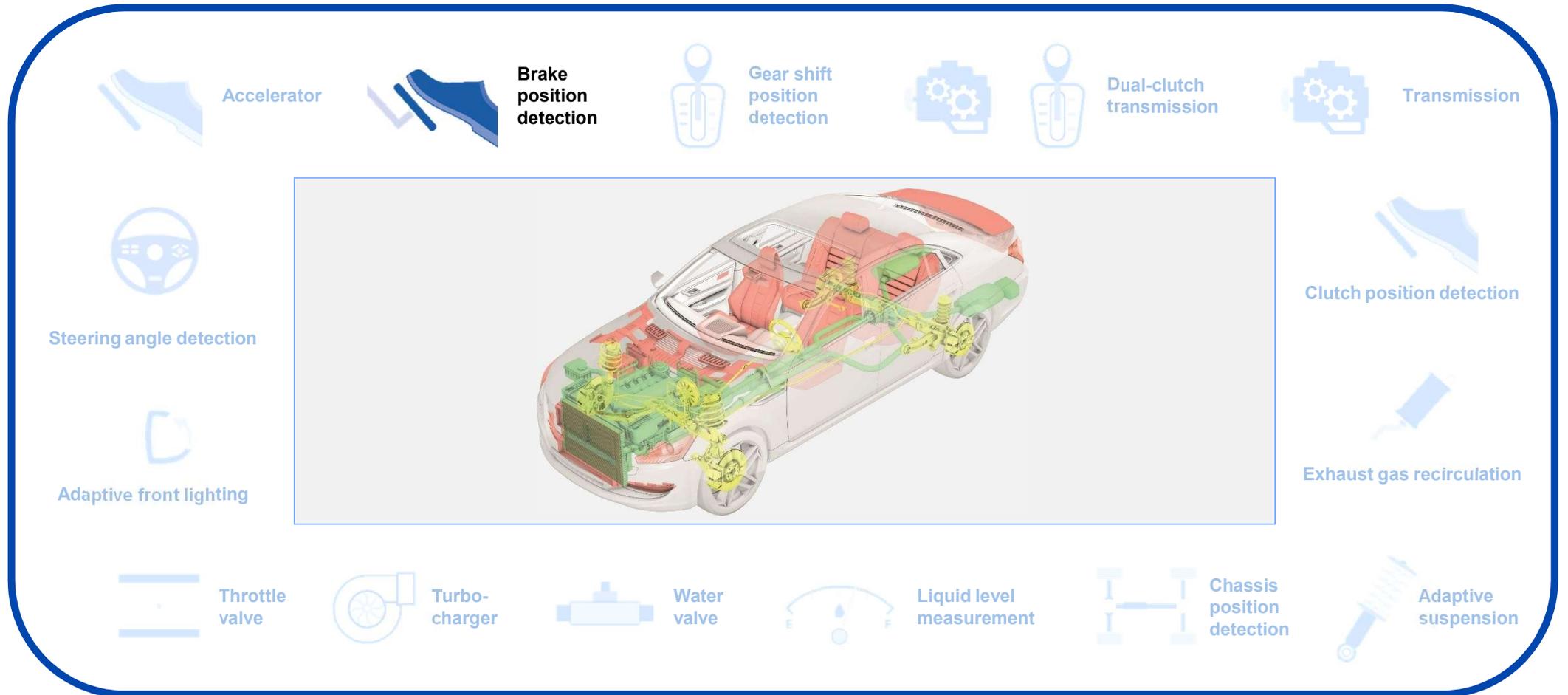
- For 3 Z-plates the angle can be calculated with the following formula at any plate permutation
- For stray field compensation one possibility would be calculating the disturbing field by **averaging the raw sensor signals and subtracting it from each raw signal** before angle calculation
- Calculation of
 - $VS12 = VS1 - VS2$
 - $VS23 = VS2 - VS3$
 - $VS31 = VS3 - VS1$
- to get three new offset free signals
- Angle calculation by using:
 - $\theta = ATAN \left(\frac{\sqrt{3} * VS12}{VS23 - VS31} \right)$



Automotive Application Examples



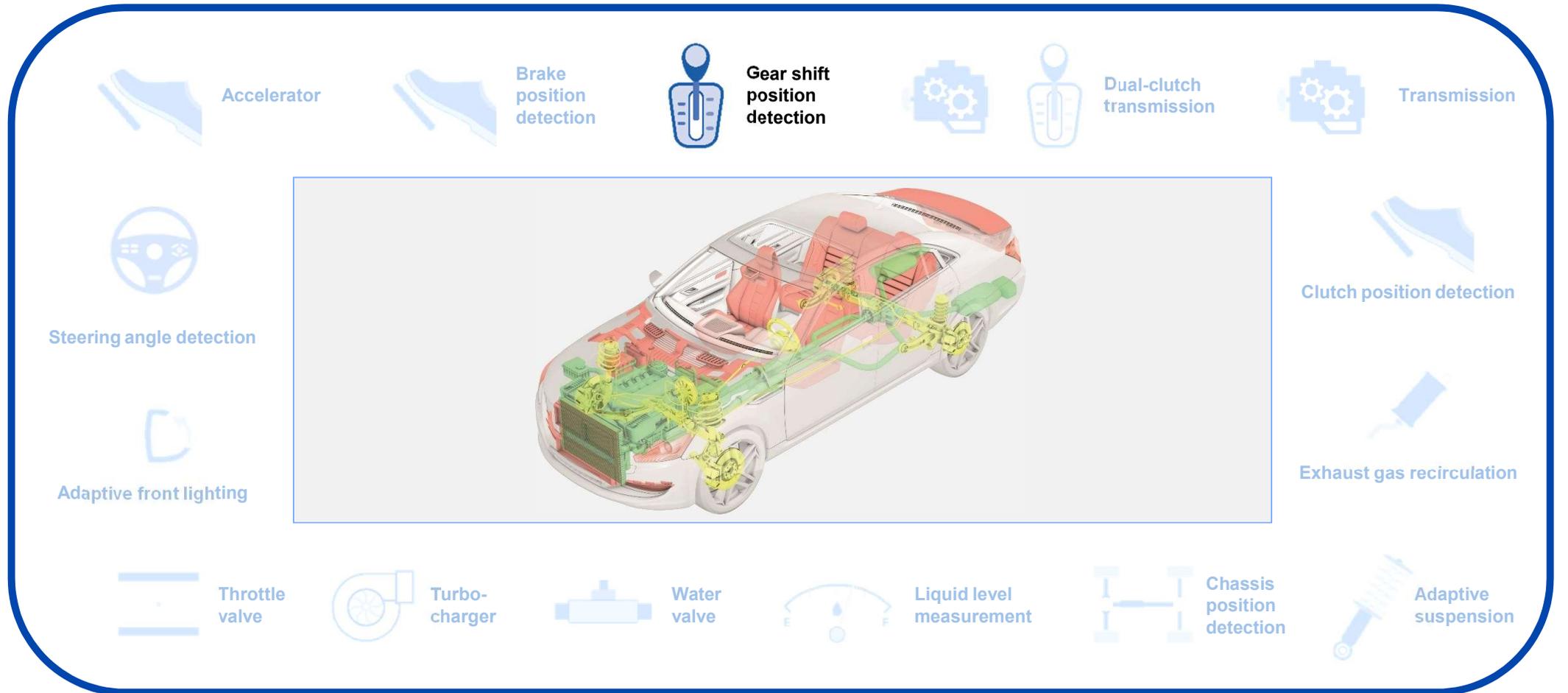
Automotive Application Examples



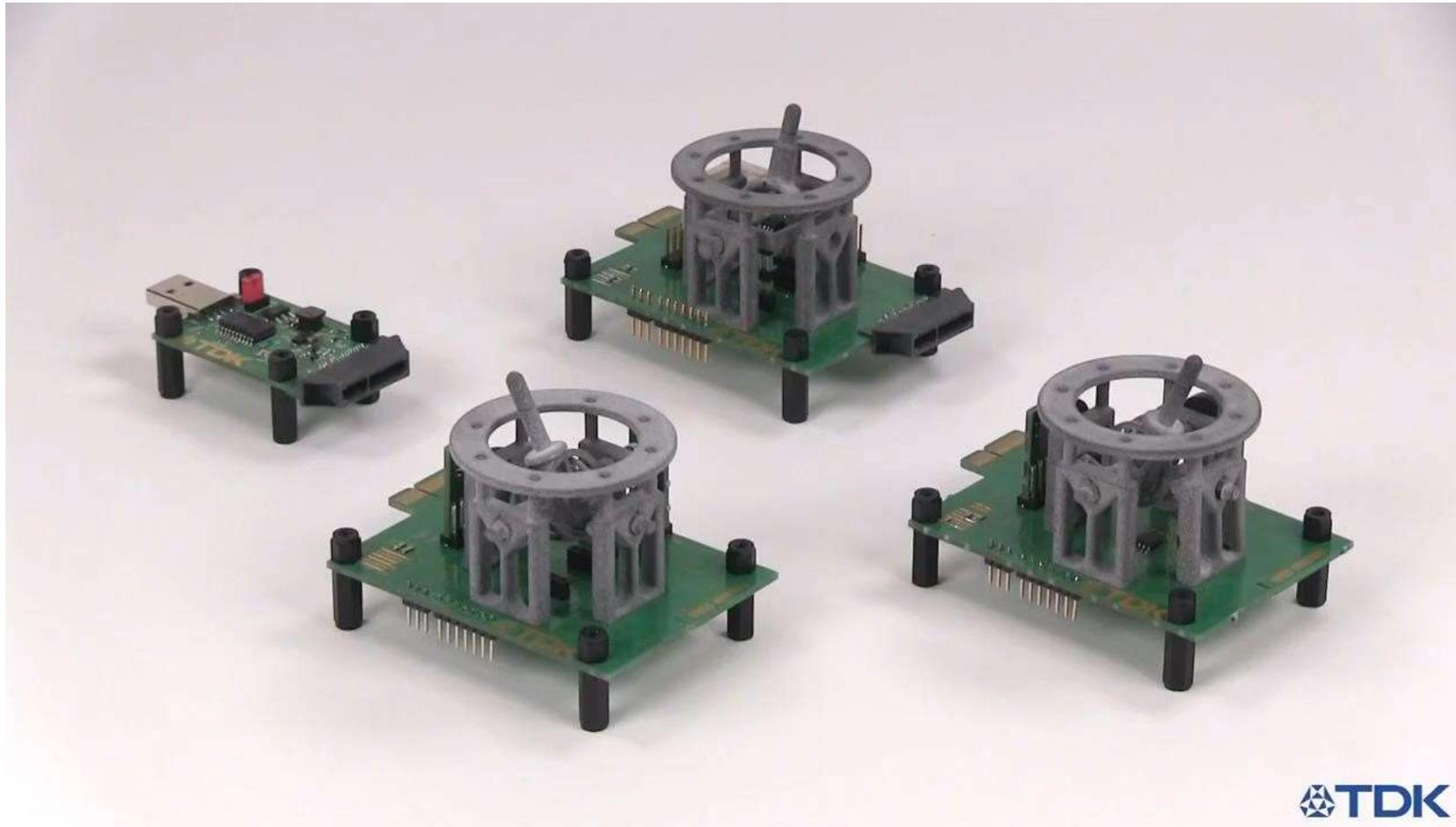
Automotive Application Examples: Brake Stroke Position Detection



Automotive Application Examples



Automotive Application Example: Joystick & Gear Shift Position



Customization of HAL 39xy

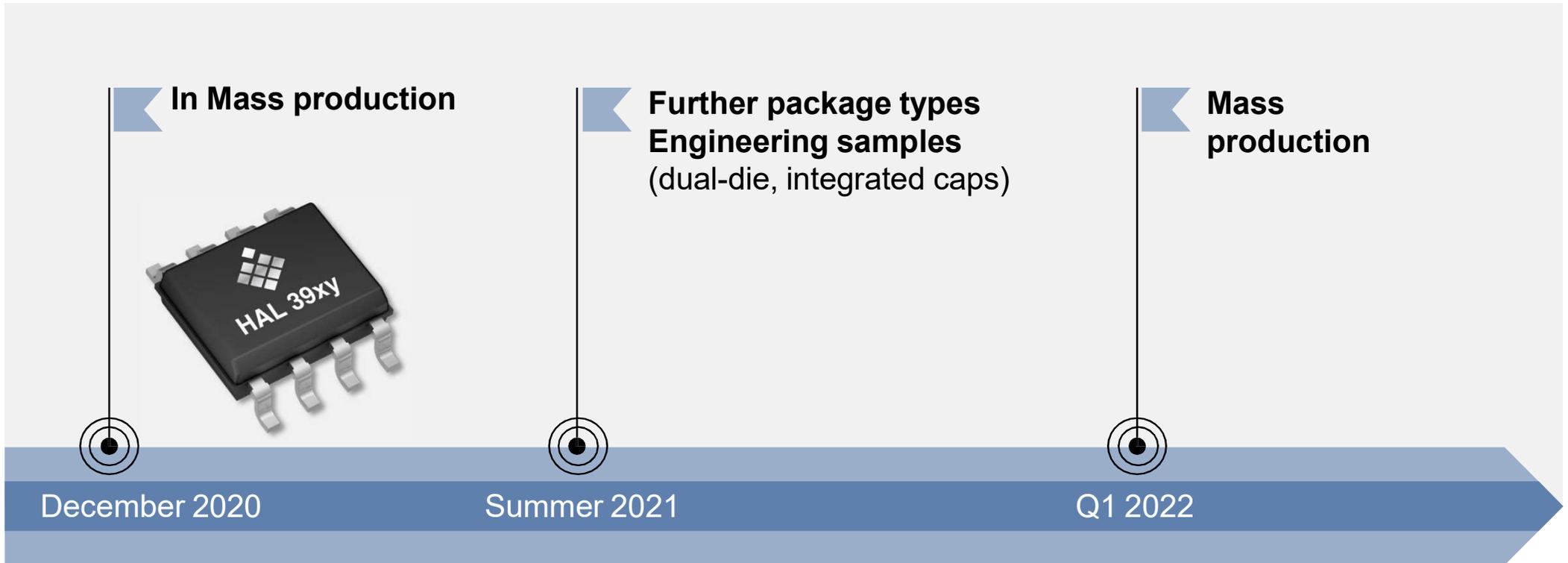
- HAL 39xy offers higher flexibility for today's automotive and industrial market needs
- Please get in touch with  Sales Team if you are looking for new enhanced solutions, like:

Flexible interfaces
e.g. switch output

Customized signal processing
e.g. sum of Z Hall-plates for current measurement; processing of external signals (like temperature sensor information)

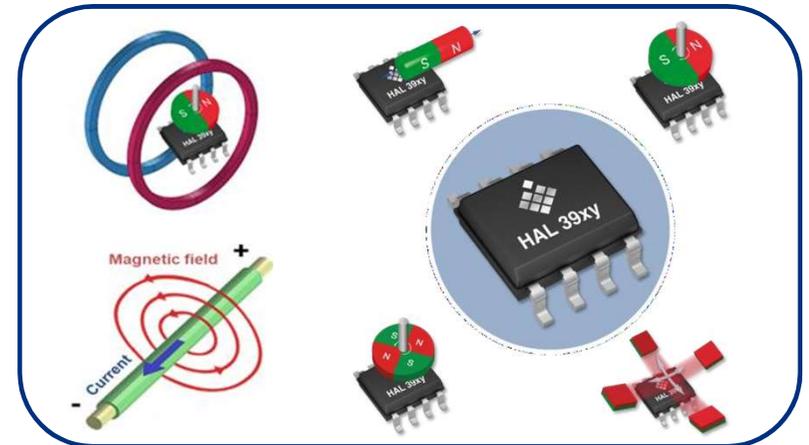
Special safety mechanisms for Functional Safety requirements

Outlook for HAL/R/C[®] 39xy 3D Hall-effect sensors



HAL 39xy at a glance **ASIL**ready

- **Best in class regarding**
- **Unique stray-field concept**
 - for linear & rotary setup's up to 360°
- **Stray-field robustness @ 4 kA/M**
 - HAL 39xy $\leq 0.12^\circ$ (full-filling VW norm)
 - Competition $\leq 0.6^\circ$
- **Flexible measurement setup/front-end**
 - One hardware for four different measurement setup's
 - Competition needs three different setup's
 - Real 3D capability (direct measurement)
- **Customized sleep modes (wake-up by angle/field change)**
- **Highly flexible architecture to enable customized variants**



TechTalk

Education Inspiration Exchange



Thank you for your attention!

Questions?