

Inertialsensorik für Tirepressure Monitoring Anwendungen

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Sense&Control



Agenda

1

Infineon overview

2

Tire pressure Monitoring system (TPMS) roadmap

3

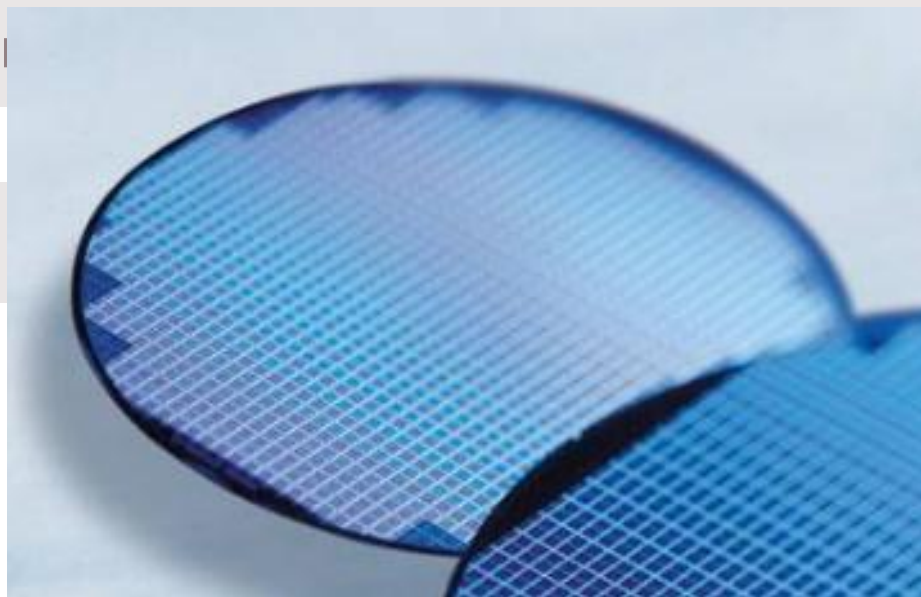
TPMS concepts

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3 TPMS concepts



Über Infineon

Portfolio

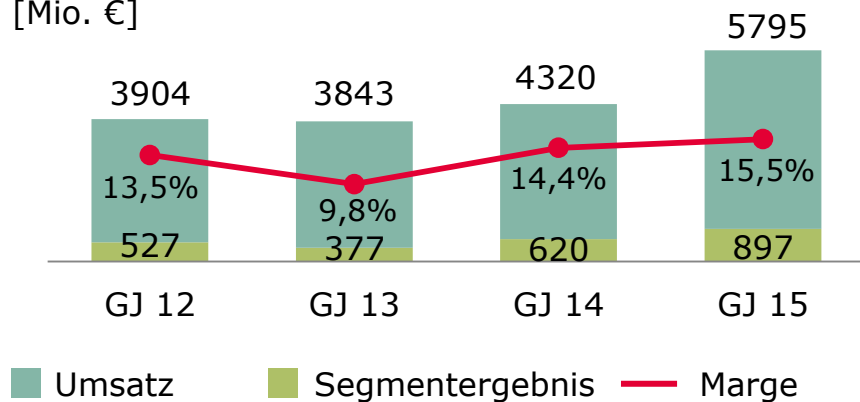
Vier Segmente:

- > Automotive
- > Industrial Power Control
- > Power Management & Multimarket
- > Chip Card & Security

Starkes Technologieportfolio mit mehr als 25.000 Patenten und Patentanmeldungen (Stand: Sept. 2015)

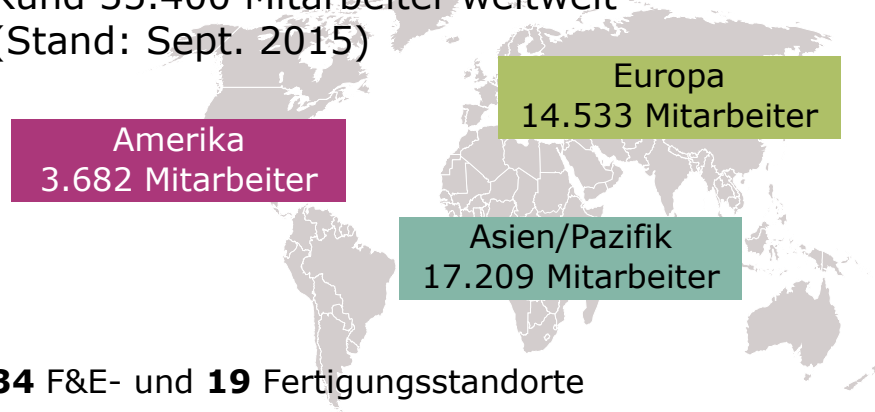
Finanzen

[Mio. €]



Mitarbeiter

Rund 35.400 Mitarbeiter weltweit (Stand: Sept. 2015)



34 F&E- und **19** Fertigungsstandorte

Marktposition*



Automotive Segment – umweltfreundliche, sichere und smarte Mobilität



Umweltfreundlich

- > Umweltfreundliche Verbrennungsmotoren
- > Effizientes Energie-Management
- > Elektroantrieb



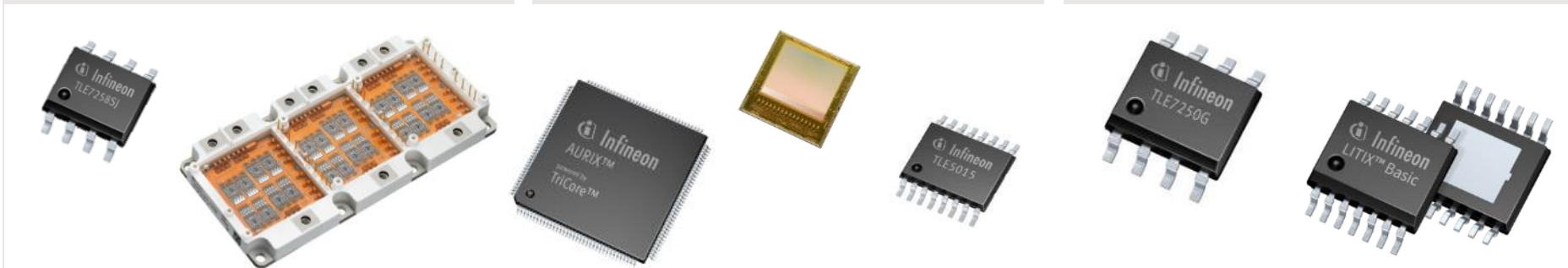
Sicher

- > Fußgänger- und Insassenschutz
- > Kollisionsvermeidung
- > Fahrerassistenz-Systeme

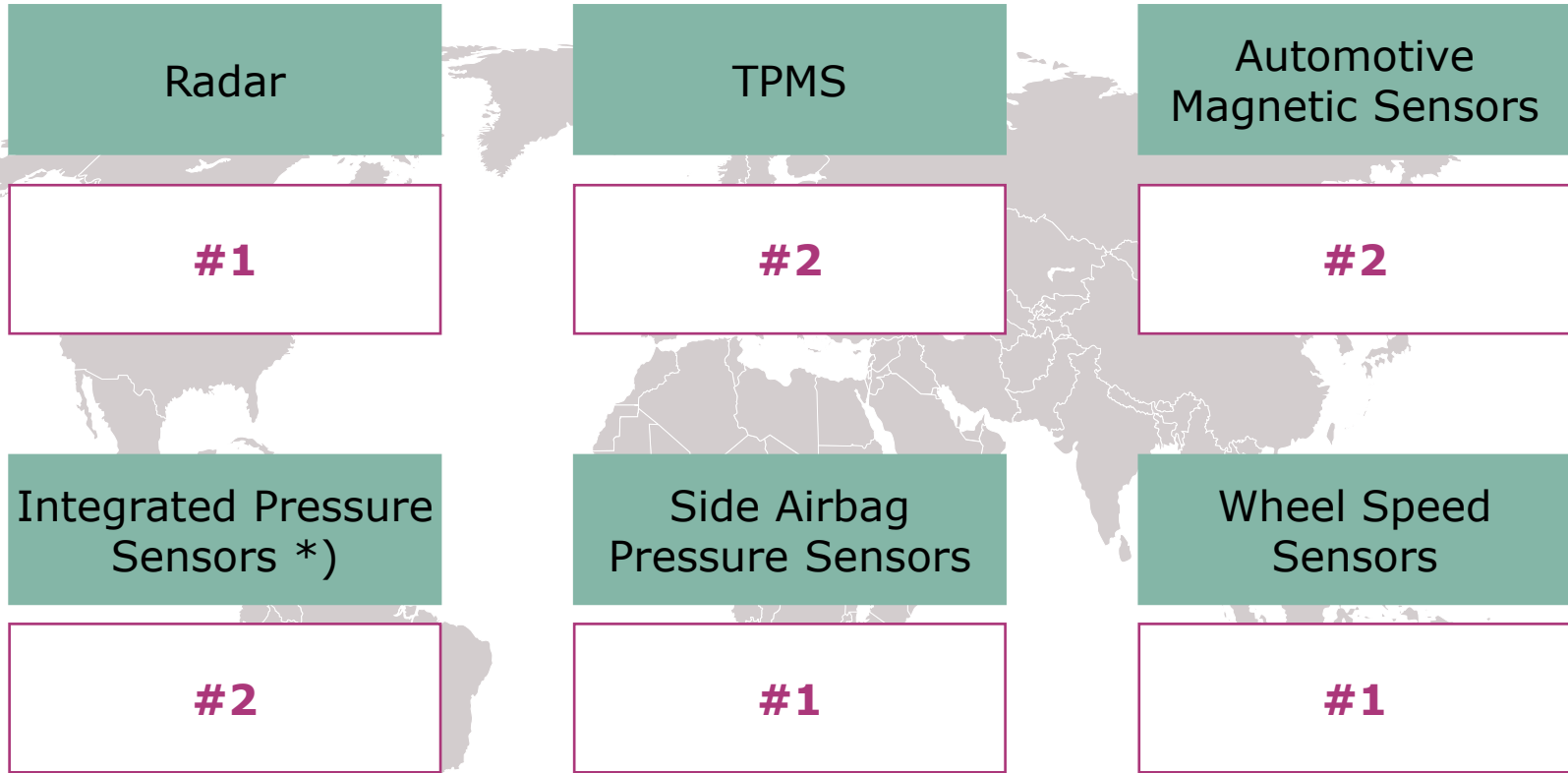


Smart

- > Fahrkomfort
- > Sichere Konnektivität sowie Integrität und Schutz persönlicher Daten



Sense & Control holds leading positions in various sensor market segments



Sources:

IHS ADAS Sensor Market Shares – 2014

IHS Magnetic Sensor Market Tracker Automotive H2 2015

Strategy Analytics

Infineon's estimation

*) includes barometric & manifold absolute pressure sensors/side airbag pressure sensors

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Wide adoption of premium features, ADAS and CO2 reduction drive automotive growth



Vehicle production



- › ~3% growth per annum
- › highest growth in emerging markets
- › Western Europe recovering, the US on high level

Drivers for semiconductor content per car

CO₂ reduction



- › driven by legislation
- › improvements of ICE* (e.g. electric steering, electric pumps and motors)
- › adoption of EV/HEV

Advanced Safety



- › current: crash avoidance
- › next: assisted Driving
- › future: autonomous driving

Comfort, Premium



- › premium cars are early adopters of high-end comfort and safety features
- › trickling down to mid-range

* ICE: Internal combustion engine

Sources: IHS Inc., Strategy Analytics, Infineon

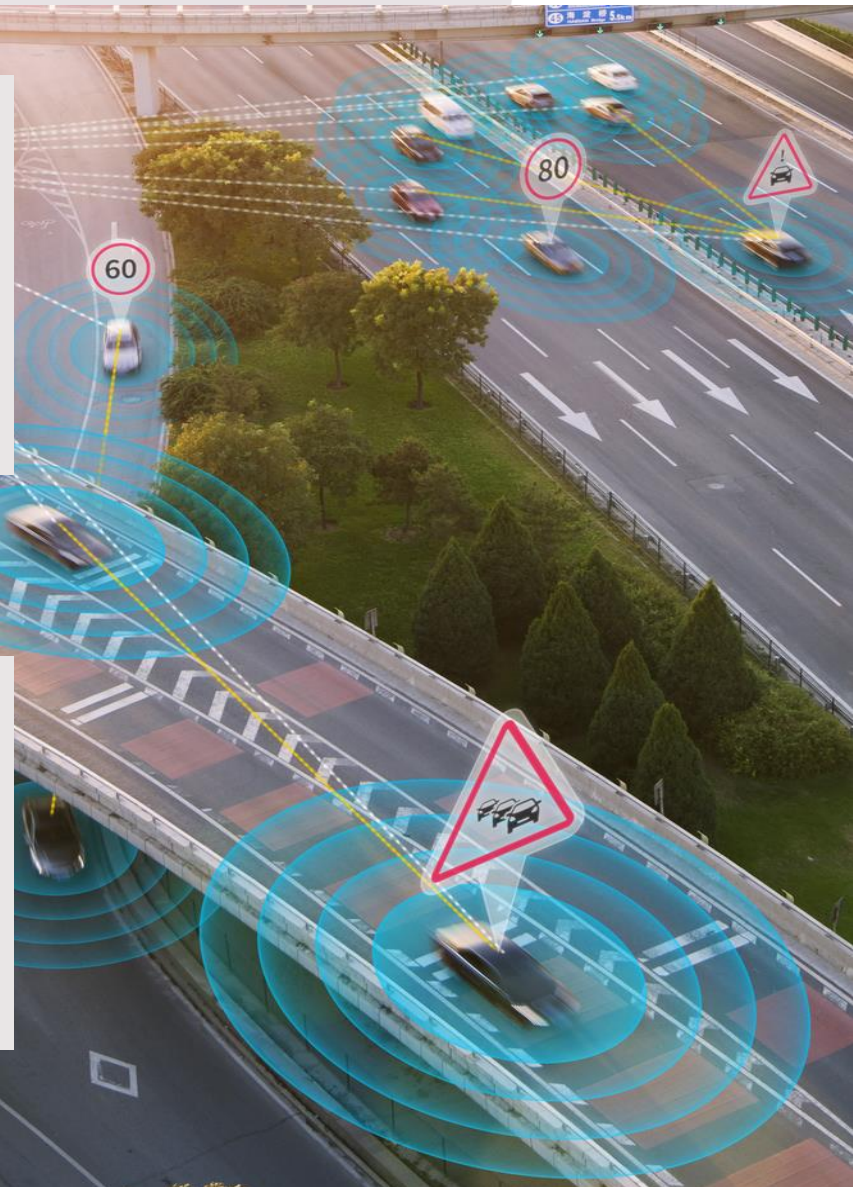
Autonomous driving influences automotive industry and brings new requirements

Opportunities

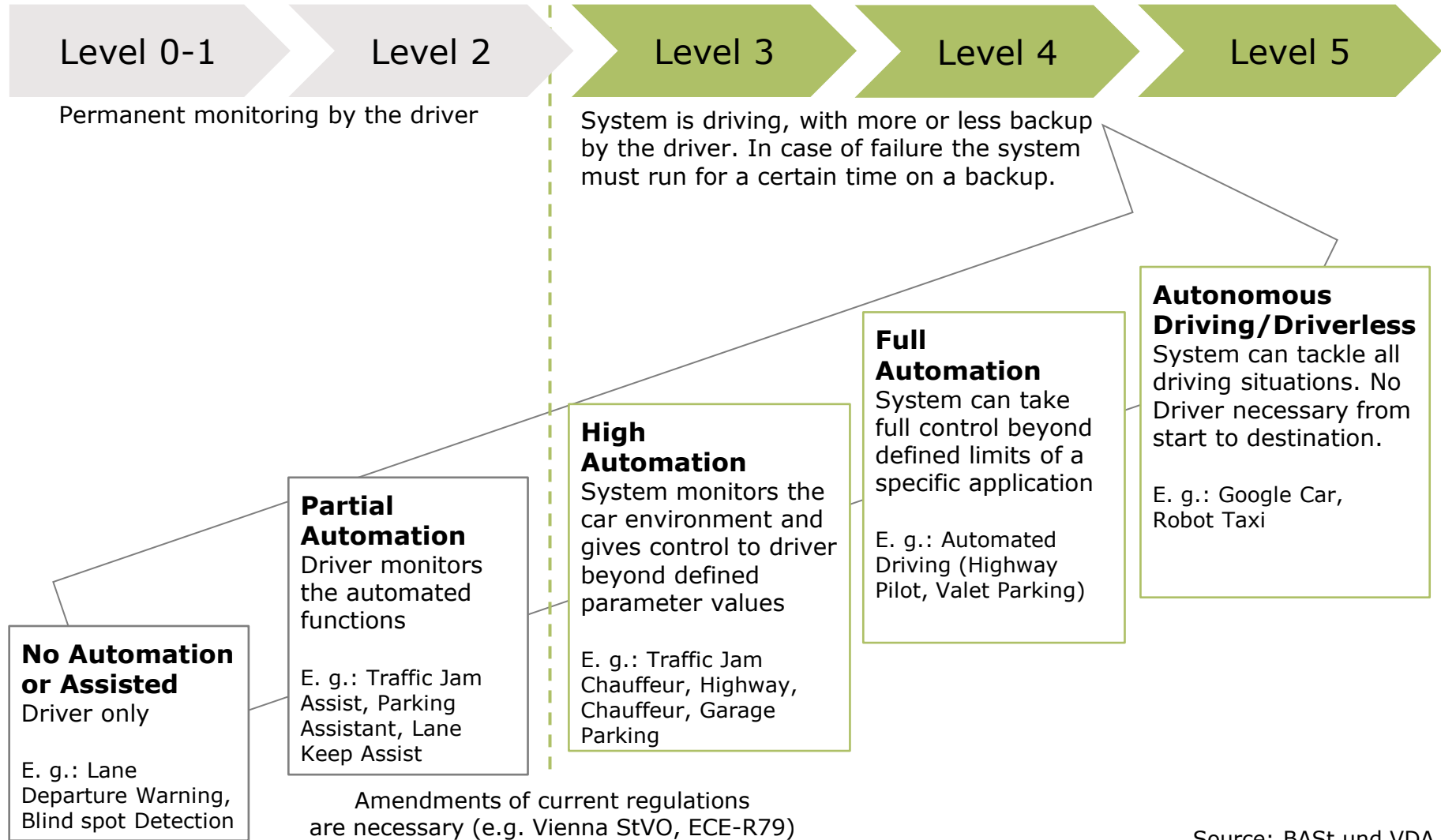
- › Tire is the only interface to the road
- › Intelligent tires provide additional information (e.g. road surface detection, tire information etc.) to driver assistance system

Challenges

- › Any tire failures have a major impact on vehicle safety
- › Autonomous driving requires advanced safety level

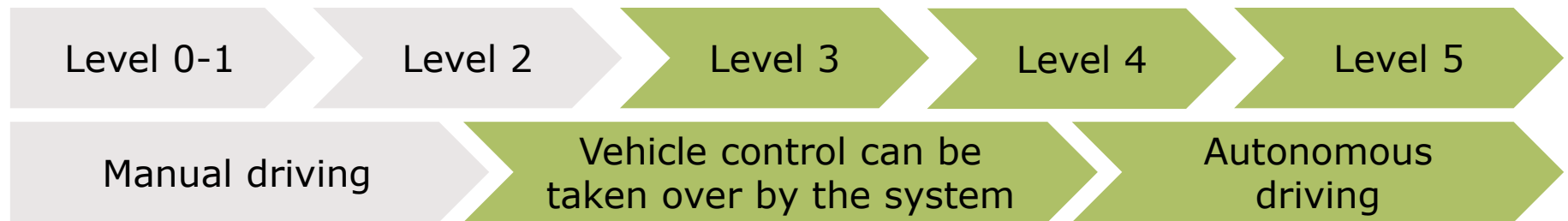


The 5 levels of increased automation (SAE/VDA definition)



Source: BAST und VDA

Increased sensor and system requirements for increased automation



Standard TPMS

- › Pressure measurement
- › Temperature measurement

In-tire TPMS

- › Tires size, season, mileage
- › Load detection

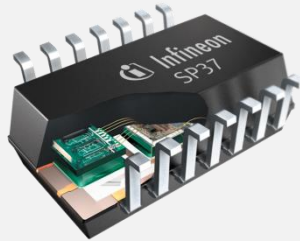
Intelligent TPMS

- › Road surface detection
- › Friction detection
- › Tread depth detection

Infineon stands for TPMS innovation and quality for more than 10 years



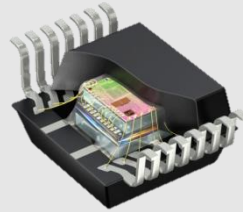
TPMS Roadmap



SP37

- > World's leader in quality and reliability
- > Best in class pressure measurement performance

Production



SP40

- > Lowest power consumption
- > Highest pressure accuracy
- > In tire capable
- > Encryption acc. AES128

Ramp up

SPxx

- > New integrated MEMS
- > New intelligent features

Concept

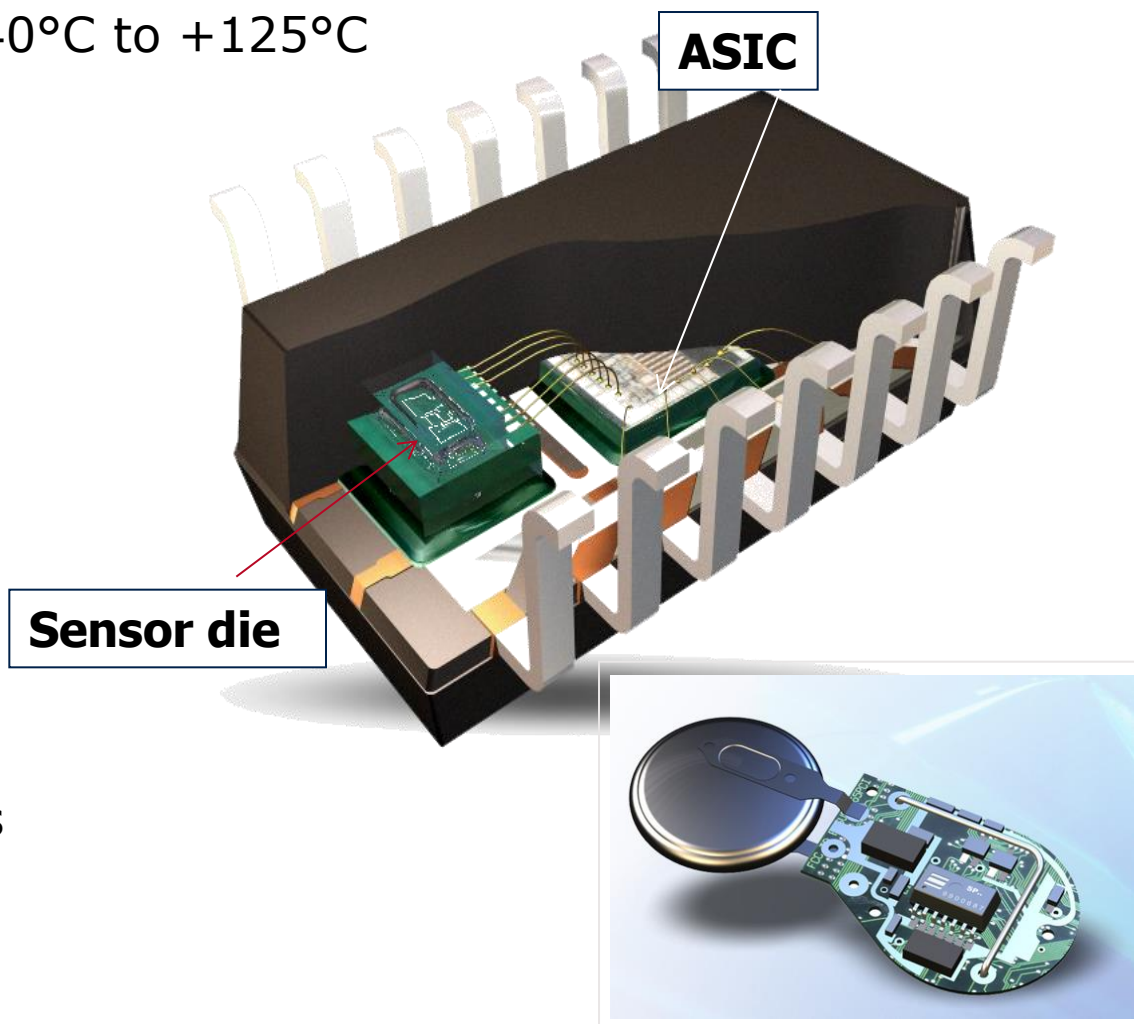
SP40: a highly integrated component for TPMS

- › Absolute pressure sensor 100 to 500/750/900kPa
- › Glass-Silicon-Glass MEMS providing outstanding media compatibility
- › Z-axis accelerometer 355g
- › Temperature sensor
- › RF ISM-Band transmitter
- › State of the art LF-receiver
- › Power management circuitry and low current consumption supporting small battery size
- › Microcontroller with 14k flash memory
- › Comprehensive firmware library
 - Facilitating application code development
 - APS algorithm supporting tire localization ¹⁾

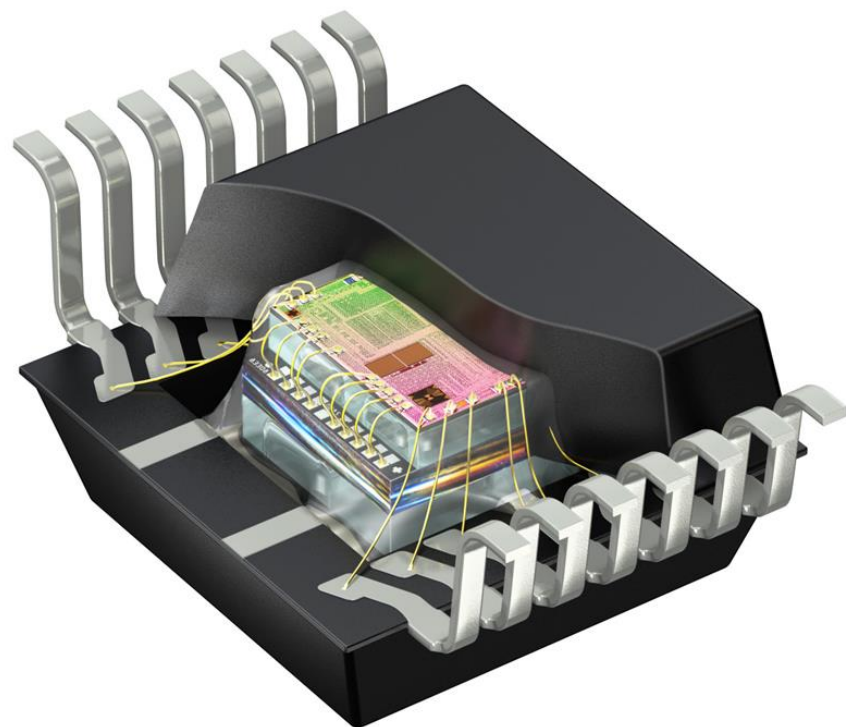
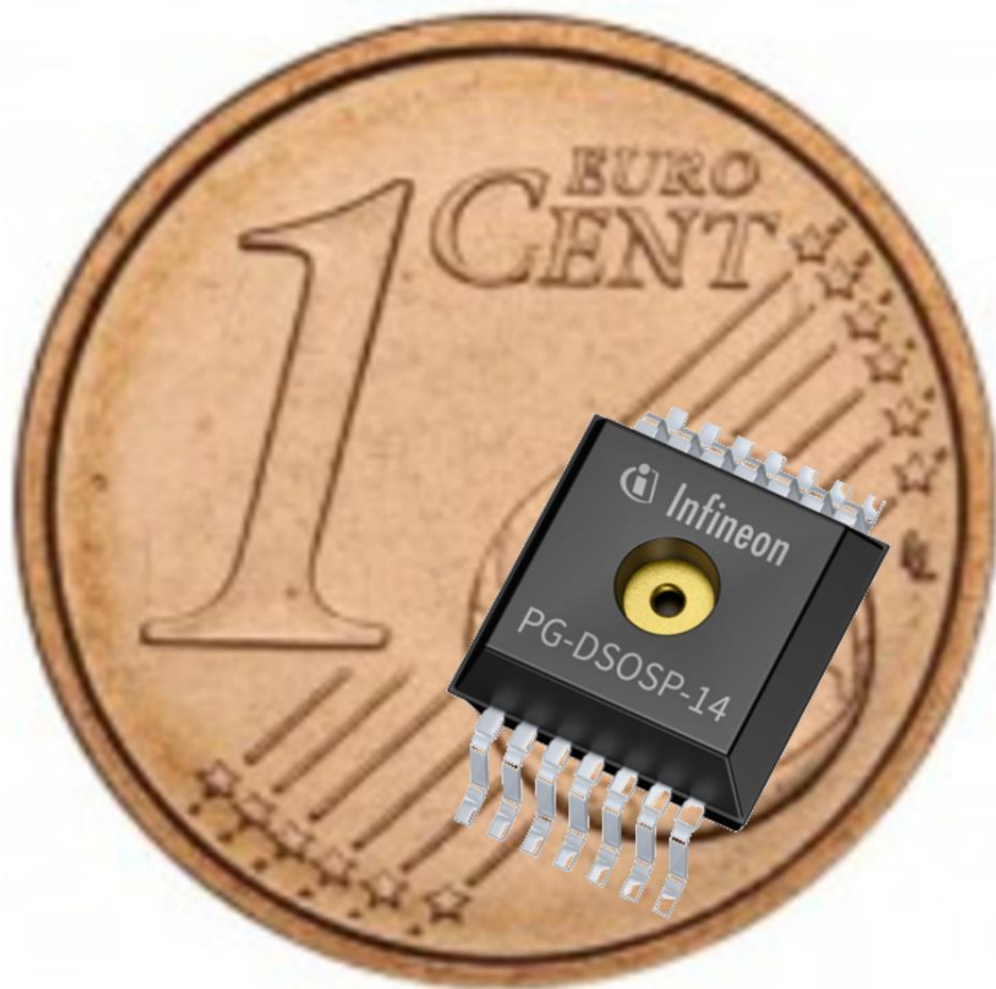
¹⁾ by correlation of APS data with wheel-speed sensor data

TPMS Features SP37

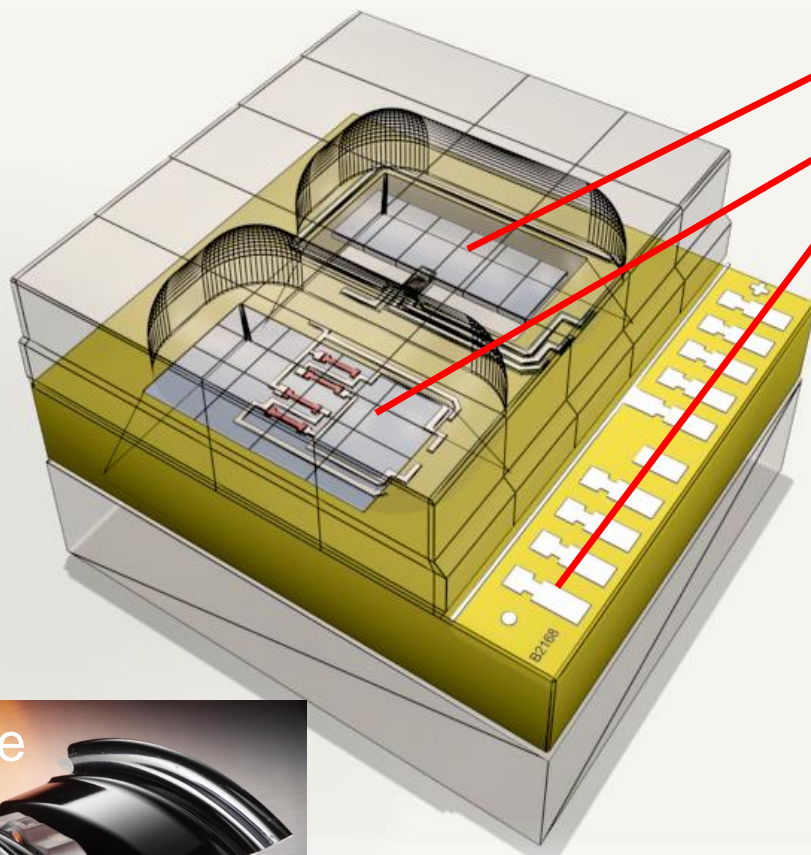
- > Lifetime 10 Years – Battery requirement
- > Operating temperature: -40°C to +125°C
- > Measurement of
 - Temperature
 - Pressure
 - Acceleration/Motion
 - Battery Voltage
- > RF Transmission
- > LF communication
- > Ultra-low standby currents



SP40 package and construction



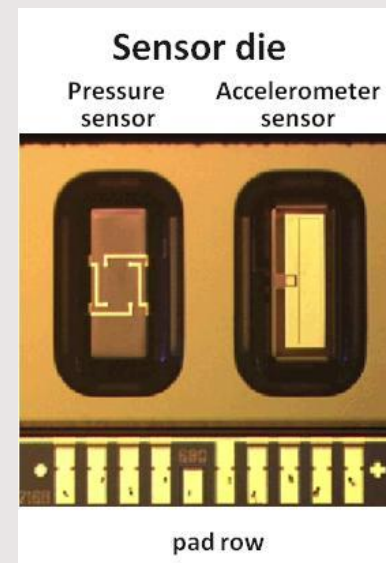
MEMS-Sensor



- Accelerometer (g-cell)**
- Pressure sensor (p-cell)**
- Bond pads for wire bonding**



Module



Sensor die

Pressure sensor

Accelerometer sensor

pad row

On tire mounting enables new features beyond classical TPMS

› **Load detection**

- Precise load detection
- Reduced total cost of ownership

› **Road surface detection**

- Active and real time tracking of road surface. ABS/ESP is only reactive
- Increased vehicle safety

› **Tread depth detection**

- Real time tracking of tires quality
- Reduced cost for end user



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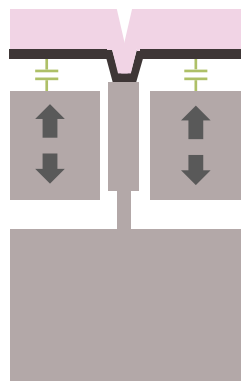
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TPMS concepts

Readout

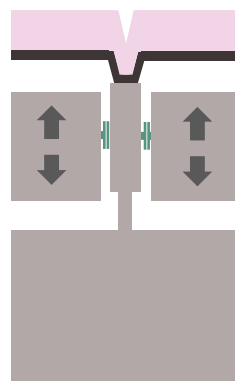
Lid readout



- medium gap distance
- lid subject to mechanical influence (buckling ...)
- linear capacitance dependence

› example: initial parallel plate design

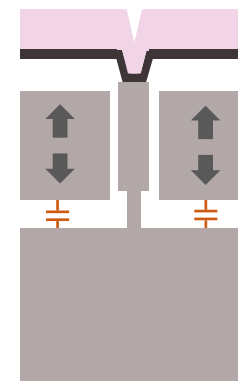
Side readout



- low gap distance
- little mechanical influence on stator expected
- capacitance is maximal for neutral position \Rightarrow quadratic dependence on acceleration (low sensitivity)

› example: comb structure design

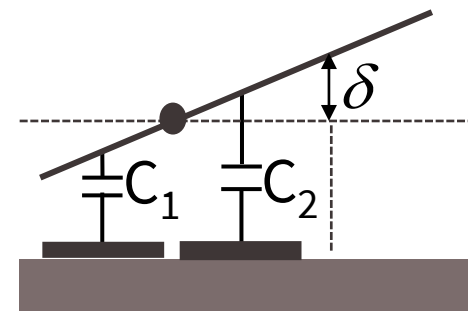
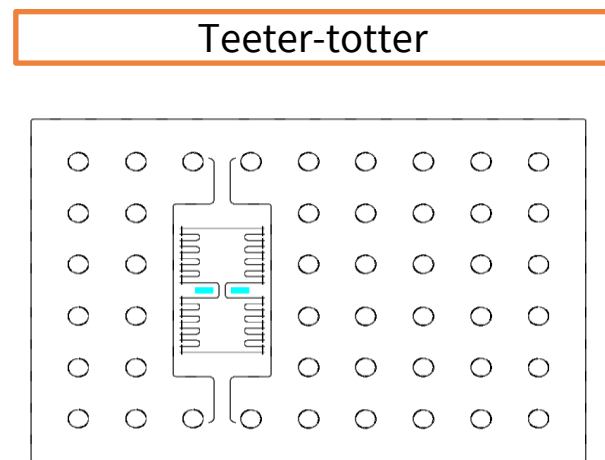
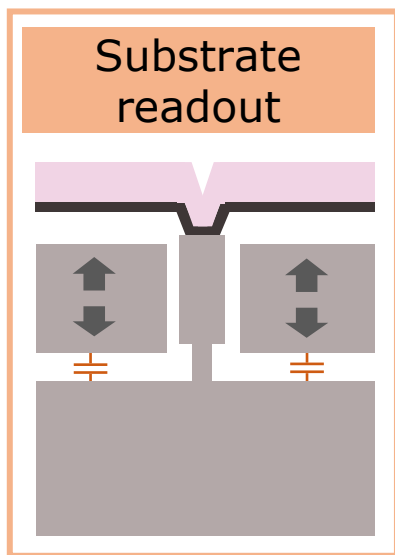
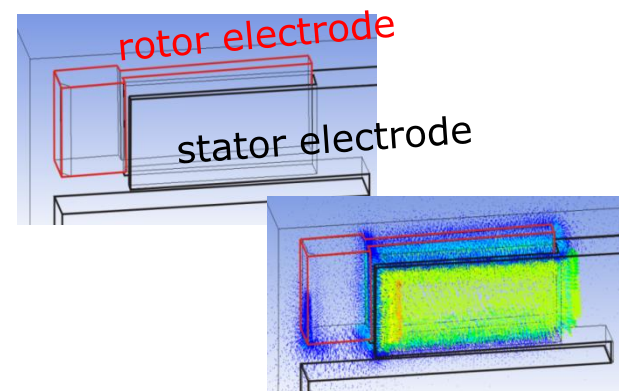
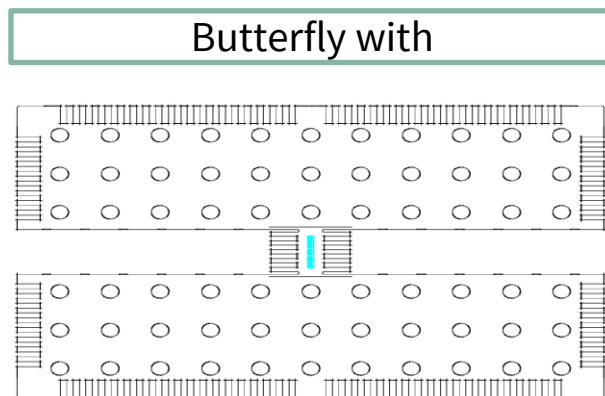
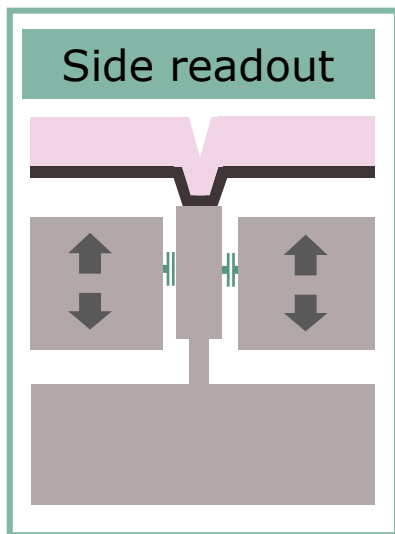
Substrate readout



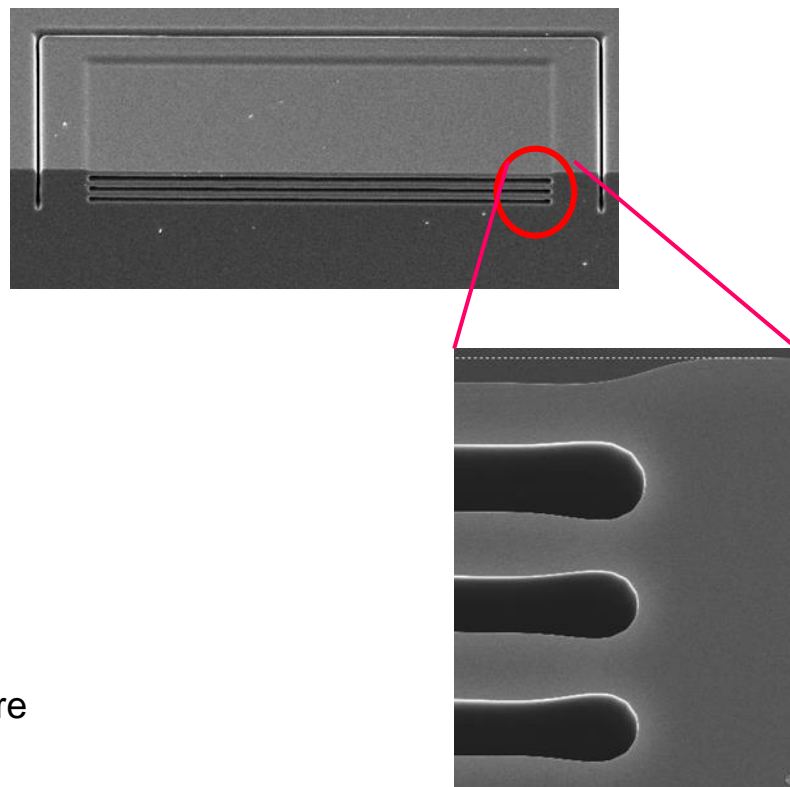
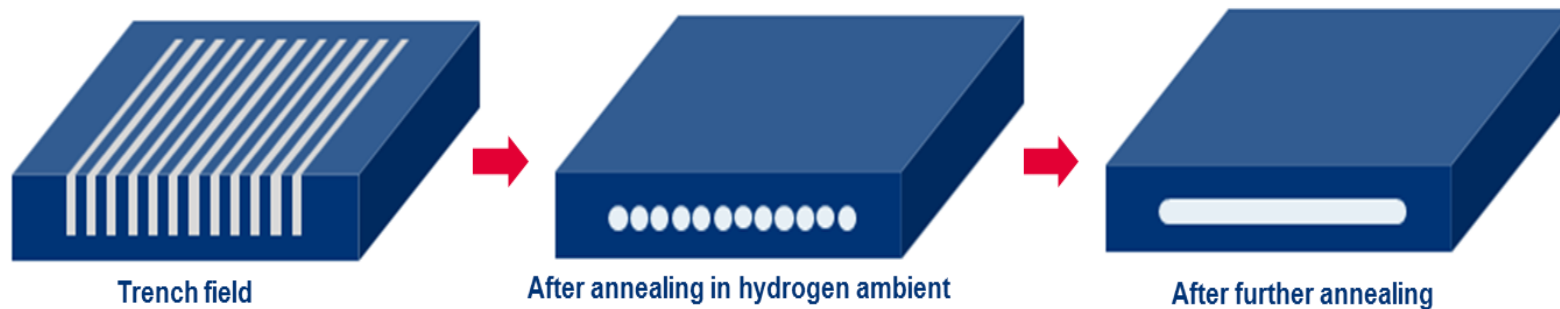
- massive stator electrode \Rightarrow little mechanical influence
- linear capacitance dependence
- high gap distance
- implant concept possibly trickier

› example: teeter-totter design

Sensing concepts



Venezia process



SEM picture of a cross section of Venezia structure

Design concept cross section

Fully planarized integration concept

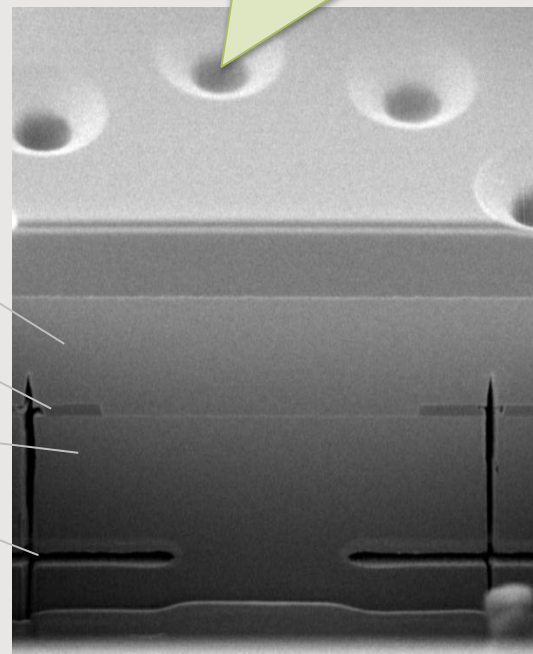


Out of plane movement

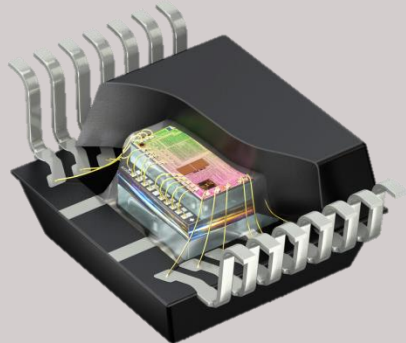
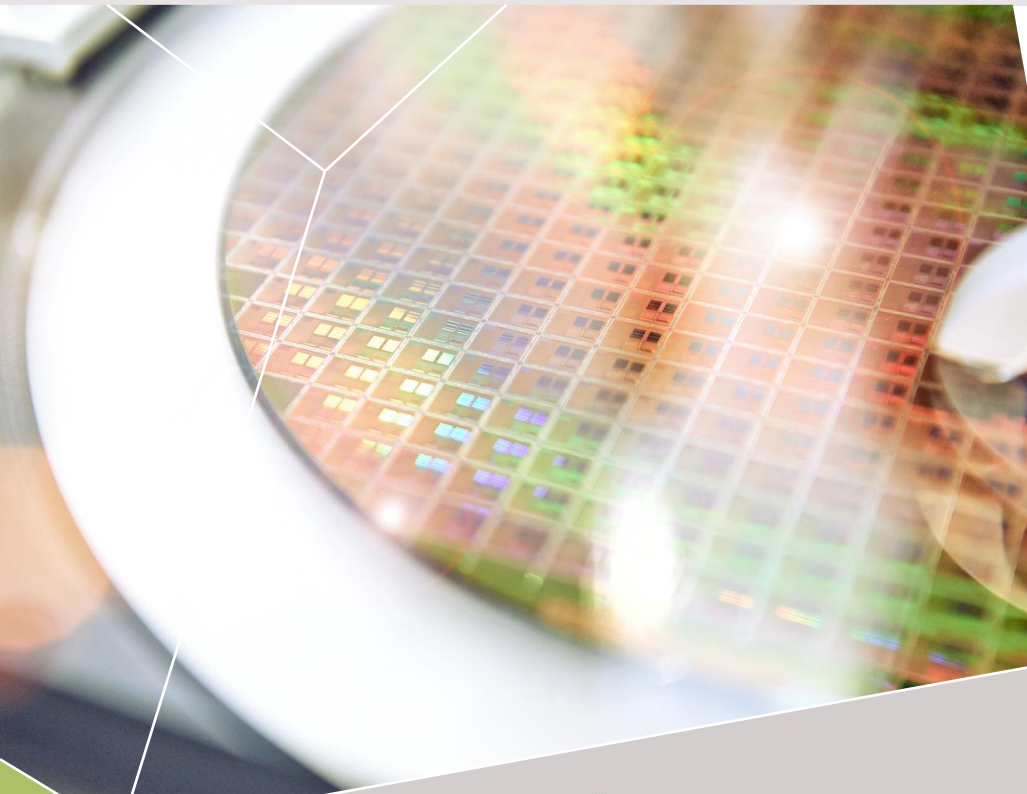


Oxide
 Sacrificial layer based cavity
 SON
 Venezia based cavity

Holes for strip of sacrificial layer



Infineon Automotive – Your trusted partner for TPMS



Our aspiration

- › Preferred partner for our customers
- › Smooth production and delivery
- › We focus on stability and the 100 percent fulfillment of our commitments

Our path

- › Integrated approach along the entire value chain
- › Broad innovative product portfolio, leading edge technologies and system expertise
- › Proactive Quality Management for products and processes

Our standards

- › International Standards, e.g. TS16949, ISO 9001, IEC 17025
- › Functional safety (ISO26262)
- › Specific customer requirements



Part of your life. Part of tomorrow.

