

**Attracting Tomorrow**



# **TDK-Micronas**

Most Preferred Partner for Sensing and Control

**TDK-Micronas GmbH**  
Sensor Systems Business Company  
Sensor+Test Digital 2021

# TDK Corporation

## At a glance

TDK Corporation is a leading electronics company. Our focus is on information and communication technology, automotive, industrial and consumer electronics markets. TDK's comprehensive portfolio features passive components such as ceramic, aluminum electrolytic and film capacitors, magnetics, high-frequency, and piezo & protection devices. Our product spectrum also includes sensors and sensor systems such

as temperature and pressure, magnetic and MEMS sensors. In addition, TDK provides power supplies and energy devices, magnetic heads, and more. The portfolio is marketed under the product brands TDK, EPCOS, InvenSense, Micronas, Tronics and TDK-Lambda. The company has a network of design and manufacturing locations and sales offices in Asia, Europe, North and South America.

Key info (fiscal year 2020, ending March 31)		Major milestones	
Business	<ul style="list-style-type: none"> <li>● <b>Passive components</b></li> <li>● <b>Sensor application products</b></li> <li>● <b>Magnetic application products</b></li> <li>● <b>Energy application products</b></li> <li>● <b>Others</b></li> </ul>	<b>1935</b>	TDK ( <i>Tokyo Denki Kagaku Kogyo</i> = <i>Tokyo Electric &amp; Chemical Industries</i> ) established in Japan to manufacture and commercialize ferrites
		<b>1986</b>	SAE Magnetics acquired
		<b>2005</b>	Amperex Technology Limited (ATL) acquired
		<b>2005</b>	Lambda Power Group acquired
Headquarters	<b>Tokyo, Japan</b>	<b>2007</b>	Recording Media business sold
Sales	<b>JPY 1,363 billion</b>	<b>2008</b>	EPCOS AG acquired
Sites	<b>More than 200 factories, R&amp;D &amp; sales offices in more than 30 countries</b>	<b>2016</b>	Micronas Semiconductor Holding AG acquired
		<b>2017</b>	TDK-Qualcomm HF joint venture RF360 started; cooperation with Qualcomm enhanced InvenSense, Inc. acquired
Employees	<b>107,000</b>	<b>2018</b>	Chirp Microsystems, Inc. acquired

# TDK-Micronas at a Glance

TDK-Micronas is the center of competence for magnetic field sensors and CMOS integration of TDK magnetic sensors business group. We have shipped over 5 billion Hall sensors to the automotive and industrial market over 25 years of operational excellence and in-house manufacturing expertise.

TDK-Micronas, most preferred partner for sensing and control.

Key info	
<b>Business</b>	<ul style="list-style-type: none"> <li>● Hall Switches</li> <li>● Hall Linear Sensors</li> <li>● Hall Direct Angle Sensors</li> <li>● TMR Current Sensors</li> <li>● Embedded Motor Controllers</li> <li>● ASICs (ICsense)</li> </ul>
<b>Headquarters</b>	Freiburg im Breisgau, Germany
<b>Sites</b>	In Germany and Belgium
<b>Employees</b>	1,000

**INTERMETALL**



Evolution	
<b>1952</b>	Herbert Mataré, who provided the first functional European transistor, founded Intermetall in Dusseldorf, the world's first company which offered diodes and transistors
<b>1962</b>	Foundation of Freiburg campus
<b>1993</b>	First semiconductor company manufacturing Hall-effect sensors in CMOS technology
<b>1997</b>	Acquisition by Micronas
<b>1998</b>	First programmable CMOS Hall-effect sensor
<b>2009</b>	Focus on Automotive and Industrial electronics
<b>2016</b>	Acquisition by TDK
<b>2017</b>	ICsense NV acquired
<b>2019</b>	More than 5 billion Hall sensors sold



Herbert Mataré (1950)



Premises at Freiburg industrial area 1962

# TDK Corporation

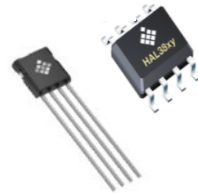
## Sensor Product Portfolio



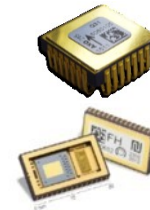
**TMR Angle  
Sensors, Sensor  
Modules &  
MEMS Microphones**



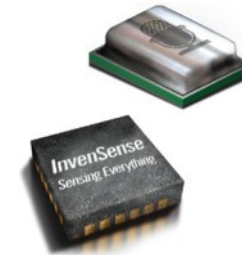
**Temperature  
& Pressure  
Sensors**



**Hall Sensors  
& Embedded  
Controllers**



**MEMS Inertial  
Sensors &  
Gyroscope**



**MEMS Gyro/Accel  
Microphones  
Pressure Sensors**



**Ultrasonic Sensors  
ToF / Fingerprint**

**SSBC Vision: "Be a World No. 1 Sensor Solution Provider."**

# TDK-Micronas Locations

**Leuven, Belgium**  
ICsense



- Research & Development

## TDK-Micronas HQ

**Freiburg, Germany**  
TDK-Micronas



- Production
- Research & Development
- Marketing & Sales
- Administrations

## MSBG HQ

**Saku / Nagano, Japan**  
Asama Techno Factory (ATF)



## TDK HQ

**Tokyo, Japan**



**Haar (Munich), Germany**  
TDK-Micronas New Technologies GmbH



- Research & Development

**Tokyo, Japan**  
TDK-Micronas K.K.

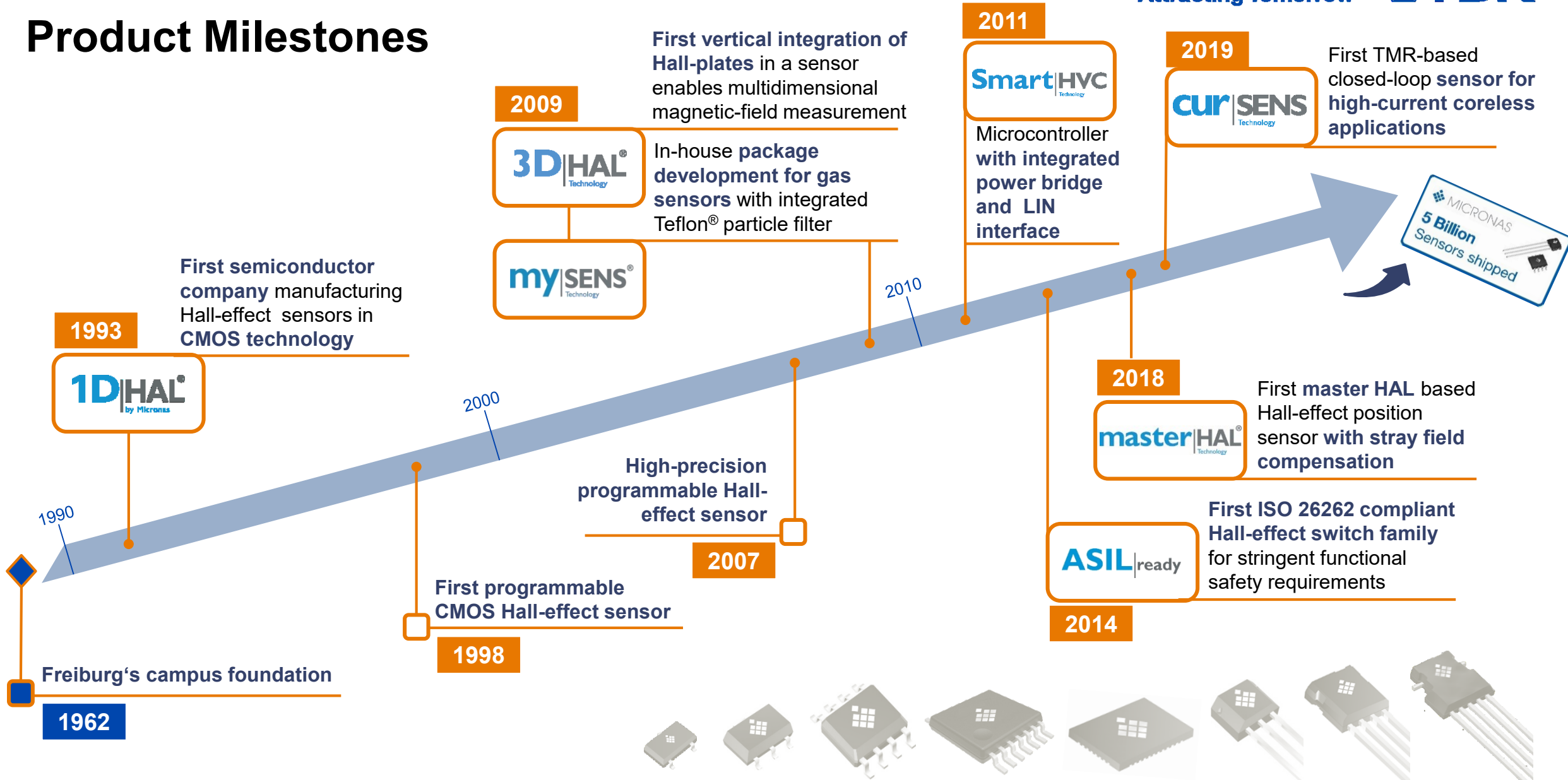


- Marketing & Sales

**Sales Offices in**  
Europe  
China

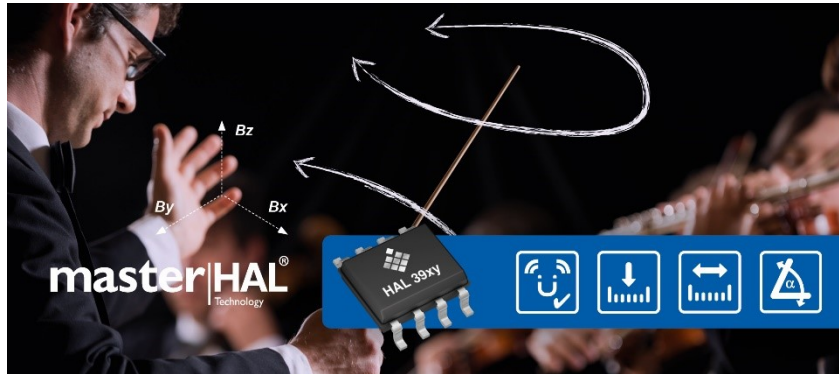
**Representative Offices in**  
China  
Korea  
USA

# TDK-Micronas Product Milestones



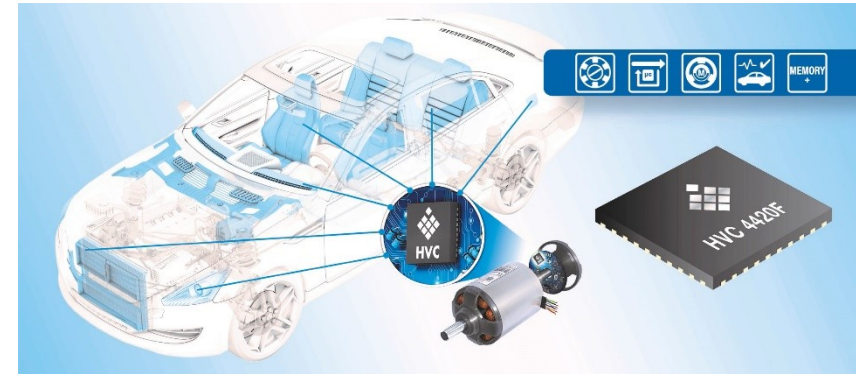


## Magnetic Field Sensors



- Major automotive trends for CO<sub>2</sub> reduction and car electrification are asking for tighter controls, thus increasing the demand for magnetic-field sensors.
- TDK-Micronas has the broadest portfolio for automotive and industrial applications covering switches, linear, direct angle and current sensors.

## Embedded Motor Controllers



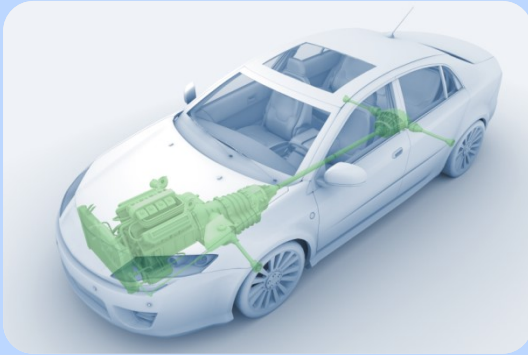
- Up to 100 electric motors per vehicle.
- Fully integrated controllers for BLDC, stepper and BDC motors.
- All-inclusive single-chip control solution provides higher system efficiency to reduce motor size and weight.

# Applications

## Magnetic Field Sensors & Embedded Motor Controllers

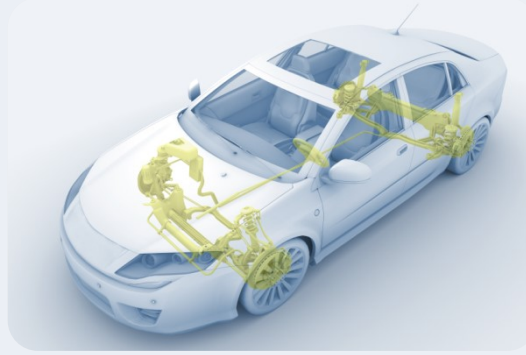
### Automotive

#### Powertrain



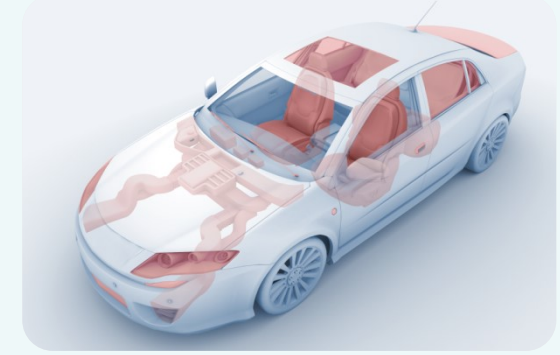
- Active Pedal
- Powertrain Valves
- Battery Management
- Gear Position
- Water/Oil Pumps
- Shift Lever Position
- Turbo Charger
- Liquid Level

#### Chassis & Safety



- Steering Torque
- Steering Angle
- Steering Motor Position
- Chassis Position Sensor
- Braking Pedal

#### Body & Comfort



- Window Lift / Sun Roof
- AGM – Grille Shutter
- LED Fans
- Door Lock
- Buckle Switch
- Adaptive Headlights
- HVAC Blower & Flap Control
- Seat Position / Climate



# Applications

## Magnetic Field Sensors & Embedded Motor Controllers

### Industrial



#### Building, Home & Office Automation

- HVAC
- Rolling Shutters / Blind



#### Home Appliance & White Goods

- Washing Machine / Dishwasher
- Coffee Maker / Water Flow



#### Mobility & Robotics

- E-Bike
- Robots



#### Factory & Process Automation

- Production Equipment
- Solar Energy



#### Garden & Power Tools

- Mower
- Cordless Drill



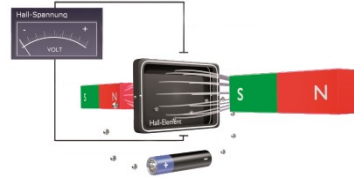
#### Agricultural & Heavy Machinery

- Harvester
- Excavator

# Magnetic Field Sensors Technology

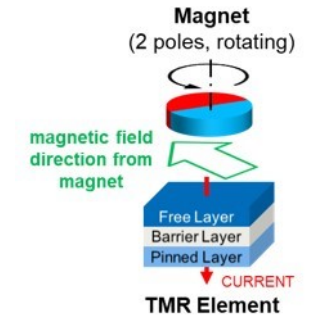
## Hall Effect Principle

- Hall plate voltage is proportional to the intensity of the perpendicular magnetic field
- Field direction can be obtained by combining several Hall plates



## TMR Principle

- Free Layer magnetization direction follows external magnetic field
- The resistance of TMR element is proportional to the relative angle between Free and Pin Layer



## Hall Benefits

- Hall plate can be integrated directly into CMOS process
- Monolithic integration of signal processing ASICs and Hall plates is possible
- Cost effective implementation to perfectly fit a wide range of applications

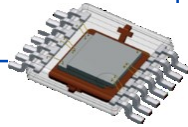
## TMR Benefits

- Much larger signal / noise ratio in comparison with other magnetic sensing technologies (HALL / AMR / GMR)
- Offers best accuracy and/or lowest consumption capability
- TDK technology is very robust with stable performance over temperature and lifetime

# Magnetic Field Sensors Trends

## Redundancy

Two silicon dies are integrated into a single package to respond efficiently to redundancy requirements for most critical applications (pedal, throttle, steering).



## Performance

Higher sensor performance helps to reduce system costs thanks to cheaper magnet use and relaxed system tolerance.

## Digital Interfaces

Requirements for higher diagnosis information and higher bandwidth are inducing a transition trend from analog output towards digital output.

## Robustness

Lifetime robustness, EMC/ESD immunity and immunity against disturbing magnetic stray-fields caused by the increased car electrification (HEV/EV).

## Integration

Capacitors are integrated into the sensor package in order to fulfill stringent EMC/ESD requirements and to reduce overall system costs



## Safety

New product developments and documentation meet the requirements of ISO 26262, the de-facto standard for automotive functional safety.

**ASIL**ready

# Magnetic Field Sensors Products

TDK-Micronas offers the broadest portfolio of magnetic-field sensors for automotive and industrial applications

## Hall Switches

- Position detection
- Replacement of micro switches



Roller shutter



Buckle switch

## 1D Hall Sensors

- Magnetic field amplitude measurement
- Replacement of conventional potentiometer



Steering torque



Pedal position

## 3D Hall Sensors

- Magnetic-field direction measurement
- Precise linear measurement up to 40 mm and angle up to 360°



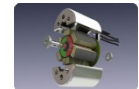
Throttle/EGR valves



Clutch pedal

## TMR Sensors

- Direct measurement of magnetic-field angle
- Highest accuracy and fastest response time



Motor position

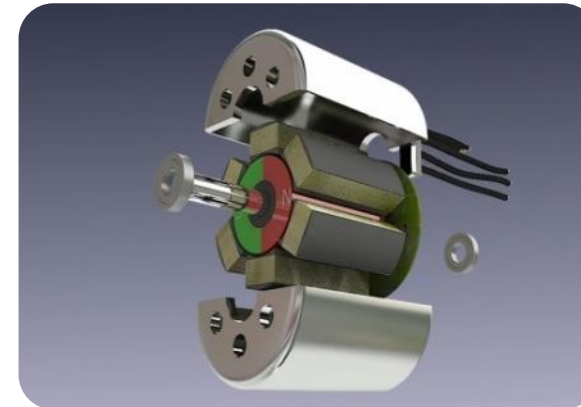


Current sensing

**TDK-Micronas is focusing on fully integrated embedded motor-control solutions, providing high efficiency and flexibility for driving electric motors**

## Technology

- High integration level in HV CMOS technology
  - ▮ 32-bit ARM®-CORTEX®-M3 CPU core
  - ▮ Digital peripheral
  - ▮ Memory
  - ▮ MOSFET HV drive
  - ▮ Analog converters, 12 V voltage regulators
  - ▮ LIN bus transceiver
- Automotive certified firmware package
- Small form factor QFN package
- Automotive range  $T_J = -40\text{ }^{\circ}\text{C}$  to  $150\text{ }^{\circ}\text{C}$

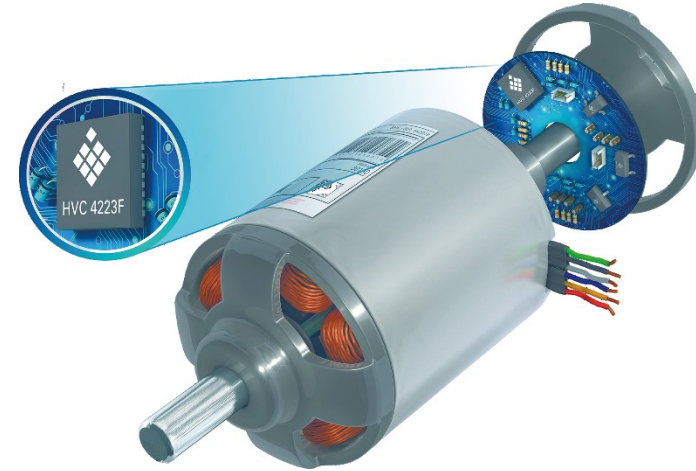




# Embedded Motor-Controllers Trends

## Transition to BLDC

Brushless DC-motors (BLDC) enable weight, space and noise reduction for smart actuator solutions. With higher volume, delta cost compared to Brush DC-motor (BDC) is reduced and largely compensated with other benefits.



## Performance

Smaller motors must reach higher torque and longer lifetime requirements. Better performing and adaptable driving schemes are required.

## Miniaturization

Electronic drives must adapt to smaller form factor motors with minimized footprint and optimized number of external components.

## Cost reduction through software re-use

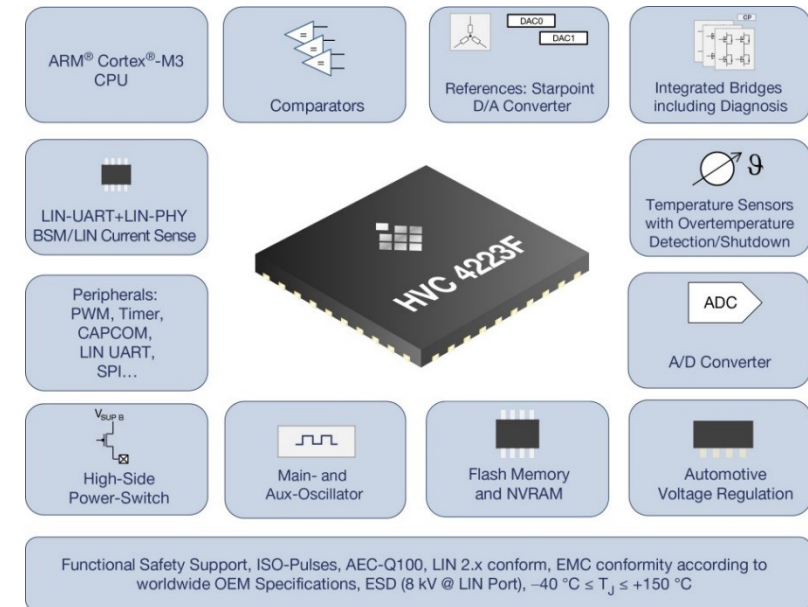
Software development costs are increasing and customers want to use already validated IP with high re-use for several motor platforms.

# Embedded Motor-Controllers Products

Fully integrated single-chip motor-control solution with optimized system efficiency to reduce motor size and weight and improved re-usability and flexibility

## Products

- Flexibility for direct stepper / brushless DC-motor control (sensored / sensorless)
- High-performance to enable sophisticated control schemes
- Minimized number of external components
- Supporting automotive OEM diagnosis routines
- Short development time
  - Easy-to-use development tools and app notes
  - Complete working demos
  - Professional automotive certified firmware package
  - Easy configuration and re-use between different applications



# ICsense – Reduce Cost and Space with ASICs

(Application Specific ICs)

ICsense is an independent design house able to provide complete product solutions based on MNS production know-how



ICsense, a wholly-owned subsidiary of TDK-Micronas, is Europe's premier IC design company. ICsense's core business is ASIC development and supply, and custom IC design services. ICsense has the largest fab-independent European design group with worldclass expertise in analog, digital, mixed-signal and high-voltage IC design. The company develops and supplies customer-exclusive ASIC solutions for the automotive, medical, industrial and consumer market compliant with ISO 9001, ISO 13485, and IEC 61508 - ISO 26262.

Why integrate your existing electronic circuits into a single ASIC ?

- Reduce BOM (Bill-of-Material) costs
- Reduce size and weight
- Reduce power consumption
- Increase reliability and performance
- Reduce test and assembly costs
- Protect your IP



## Main Expertise Areas



Sensor / MEMS



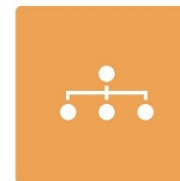
High-Voltage



Power / Battery



Low-Power



Communication

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