

**Most Preferred Partner
for Sensing and Control**



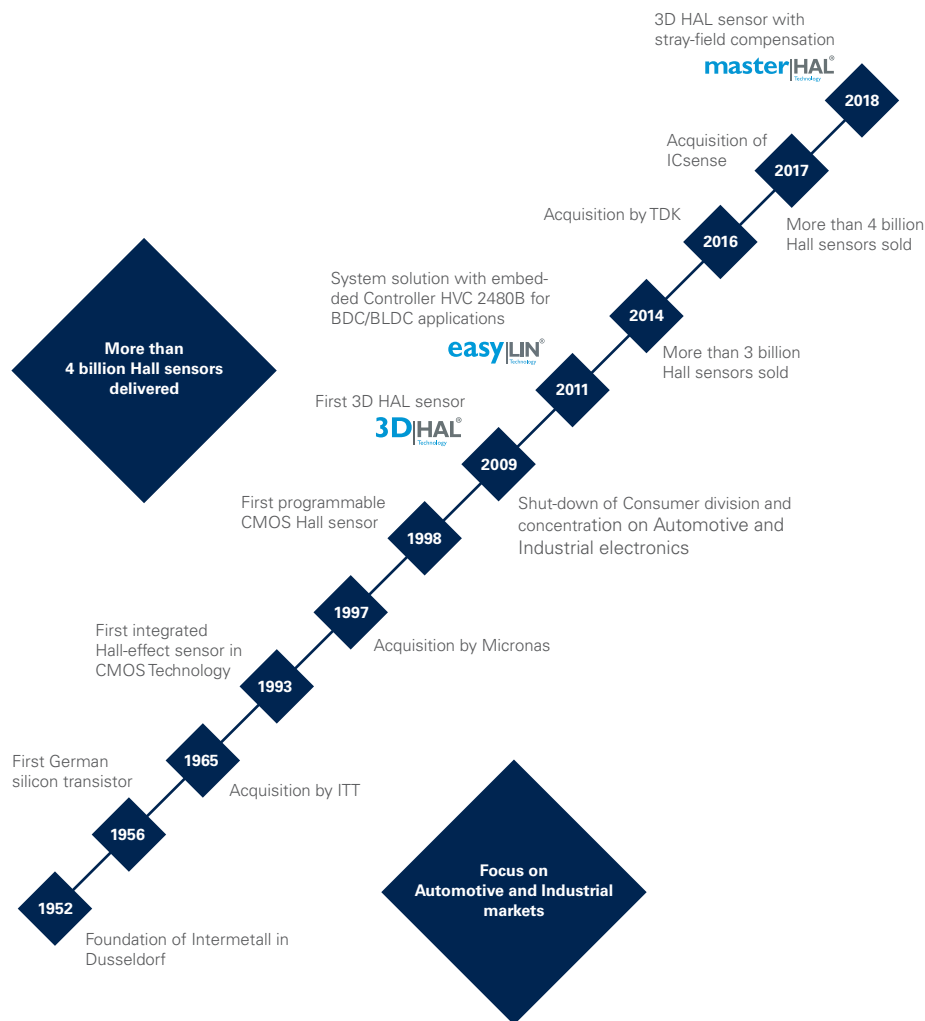
Explore Intelligent Technologies

Sensors and Embedded Motor Controllers
for Automotive and Industrial 2019



TDK-Micronas Milestones

Once pioneering CMOS-based Hall-effect sensors, TDK-Micronas offers its customers today the world's broadest range of Hall-effect sensors. TDK-Micronas' expertise combines perfectly with its CMOS and mixed-signal design resources to create accurate, intelligent sensors for a broad range of Automotive and Industrial applications. Starting the track record in 1966 with the first tuner diode, TDK-Micronas today offers a very large product portfolio for innovative sensor-based system solutions.



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ISO 14001 Certificate



SISTA Certificate



AEO Certificate



ISO 9001 Certificate



ISO 16949 Certificate



EMAS Certificate

Overview of Product Lines



Single-Axis Hall Sensor Product Line

HAL 8 Product Family

- $T_J = -40$ to $170\text{ }^{\circ}\text{C}$
- TO92UT or TO92UP package
- Programmable (EEPROM)
- Proven-in-use quality
- Temperature stability

HAL 830

- Analog output

HAC 830

- Integrated Caps
- High accuracy
- Analog output

HAC 835

- Analog and PWM output

HAL 18 Product Family

- $T_J = -40$ to $170\text{ }^{\circ}\text{C}$
- TO92 package
- Ratiometric analog output
- Value optimized version (10 bit)

HAL 1880

- Programmable (EEPROM)

HAL 1881/82/83

- Pre-configured sensitivity (EEPROM)

HAL 28 Product Family

- $T_J = -40$ to $170\text{ }^{\circ}\text{C}$
- TO92UT package
- High-precision sensors
- Digital signal processing
- Direct 12V battery supply

HAL 283x

- SENT interface (SAE J2716 rev. 3)
- Up to 16-bit resolution

HAL 2850

- Programmable PWM output
- 12-bit resolution

HAL 24 Product Family

- $T_J = -40$ to $170\text{ }^{\circ}\text{C}$
- TO92, SOIC8, or TSSOP14 package
- Programmable (EEPROM)
- On-board diagnostic features
- Versatility and high precision

HAL 2420

- 2-point calibration
- Analog output

HAL 2425

- 2-point calibration
- 16 setpoints linearization
- Analog output

HAR 2425

- Dual-die version
- Analog output

HAL 2455

- 16 setpoints linearization
- PWM output

HAR 2455

- Dual-Die version
- PWM output

3D Position Hall Sensor Product Line

HAL 37 Product Family

- $T_J = -40$ to $170\text{ }^{\circ}\text{C}$
- SOIC8, TO92UP, or TO92UF package
- Superior accuracy
- Programmable characteristics in a non-volatile memory
- Diagnostic functions
- Measurement of angular and linear position

HAL 371x

- 12-bit analog or PWM modulo output

HAL 372x

- 12-bit analog output

HAL 373x

- PWM and SENT output

HAR 371x

- 12-bit analog or PWM modulo output
- Dual-die variant

HAR 372x

- 12-bit analog output
- Dual-die variant

HAR 373x

- PWM and SENT output
- Dual-die variant

HAC 371x

- 12-bit analog or PWM/SENT modulo output
- Integrated capacitors
- ISO 26262 ready

HAC 372x

- 12-bit analog output
- Integrated capacitors
- ISO 26262 ready

HAC 373x

- PWM and SENT output
- Integrated capacitors
- ISO 26262 ready

HAR 379x

- PWM and SENT output
- Dual-die variant
- ISO 26262 ready

HAL 39 Product Family

- $T_A = -40$ to $160\text{ }^{\circ}\text{C}$
- SOIC8 package
- SEooC according to ISO 26262
- Stray field compensation for homogeneous and gradient magnetic fields
- 3D position detection (linear movement, angle and position)
- Direct 12 V battery supply
- Programmable characteristics in a non-volatile memory

HAL 3900

- SPI interface
- Position and B_x , B_y , B_z

HAL 3930

- PWM/SENT/Switch interface
- Up to two angles

HAL 3980

- PSi5 Rev. 2.x interface
- Angle and angle velocity

Hall Switch Product Line

HAL 1002 Switch

- Open-drain output (3-wire)
- Chopper stabilized
- Highly precise customer-programmable switching points
- $T_J = -40\text{ }^{\circ}\text{C}$ to $170\text{ }^{\circ}\text{C}$
- TO92UT package

HAL 15 Switch Family

- Open-drain output (3-wire) or current output (2-wire)
- Chopper stabilized
- Different highly precise switching points
- $T_J = -40$ to $170\text{ }^{\circ}\text{C}$
- SOT23 and TO92UA package

Embedded Motor Controllers

HVC 42 Product Family

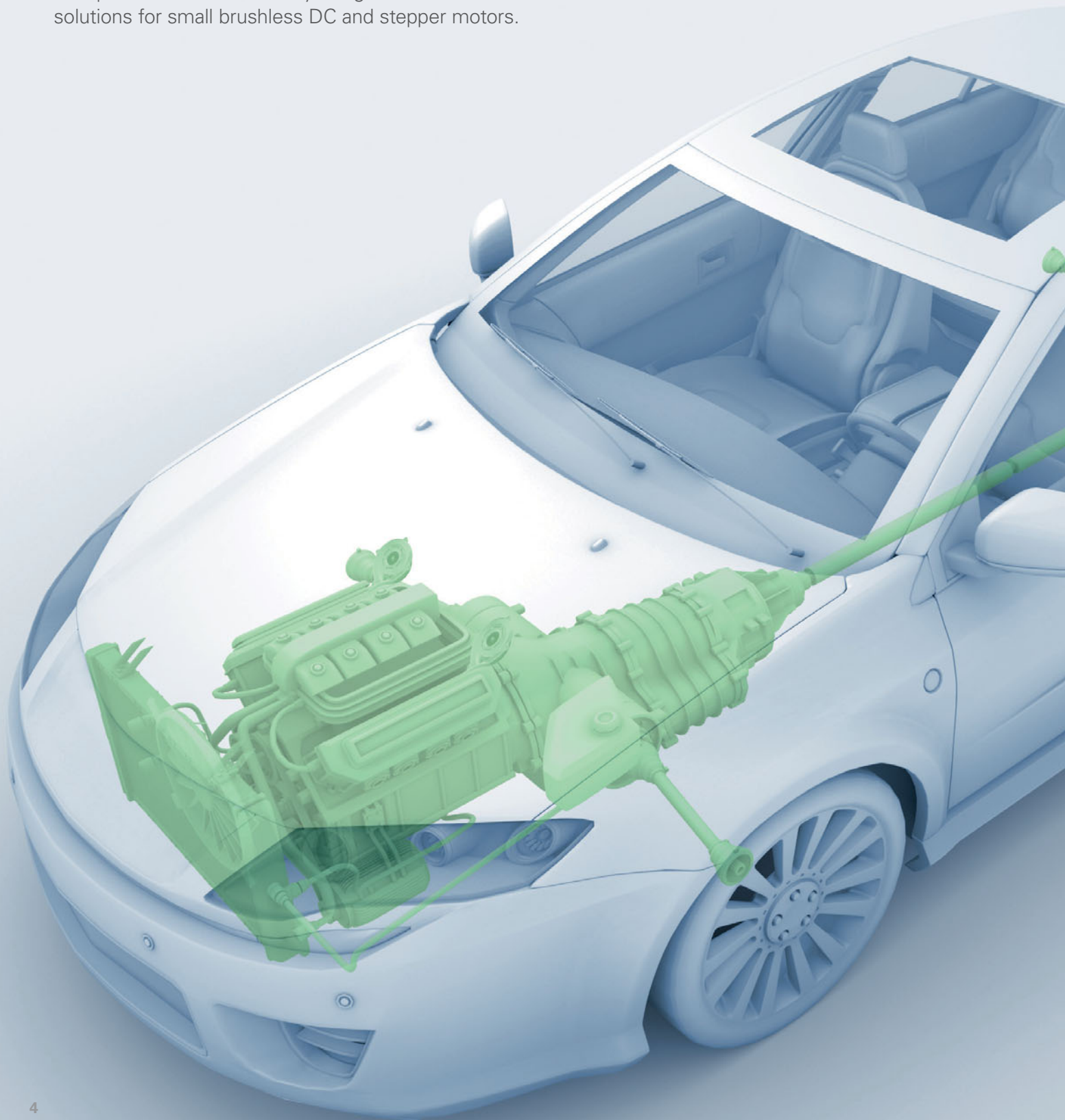
- $T_J = -40$ to $150\text{ }^{\circ}\text{C}$
- QFN40 package, 6x6 mm
- All-in-one flexible integration of entire embedded Motor Control IPs
- Communication via e.g. UART, SPI, LIN2.x

HVC 4223F

- Dual Mode Supply Voltage: 5.4 V to 18 V, 40 V load dump fulfillment of Automotive OEM requirement specifications
- Internal Half-Bridges with charge pump up to $3 \times 600\text{ mA}$ steady current, 1000 mA amplify current

Automotive Applications

Automotive is the key focus application area for TDK-Micronas, that maintains full control of production from wafer fab, assembly and final testing to provide highest flexibility to meet automotive supply and quality requirements. TDK-Micronas offers the world's largest Hall sensor portfolio covering all automotive applications in Powertrain, Chassis and Safety, and Body and Comfort. TDK-Micronas also provides innovative fully integrated embedded motor controller solutions for small brushless DC and stepper motors.



Powertrain

An increased demand for high energy efficiency and CO₂ reduction asks for optimized sensor and actuator solutions. TDK-Micronas aims to provide solutions for all powertrain applications from battery management to exhaust valves through shift lever and pedal position sensors. TDK-Micronas develops high accuracy sensors designed to withstand harsh under-the-hood environments: insensitive to vibrations, temperature drift and dirt.

Examples for automotive applications using Micronas products

Active Pedal – Clutch

Modern systems like cruise-control, electrical parking brake, start-stop functions, start lock and torque adjustment require a displacement sensor on the clutch master cylinder. The displacement sensor measures up to 40 mm movement. Two-dimensional Hall-effect sensors are a robust and cost-effective solution for this task.

Sensor Type: 3D
Micronas Products inside:

- HAL 37xy
- HAR 37xy
- HAL 3930

Active Pedal – Acceleration

Electronic throttle control replaces the mechanical link between acceleration pedal and throttle valve (drive-by-wire). Linear Hall sensors with analog output are used to detect pedal courses with small angle (<20°). They ensure reliability and high accuracy, especially to detect the accelerator idle position. Two sensors are always used for redundancy.

Sensor Type: Linear
Micronas Products inside:

- HAL 830
- HAL 2420
- HAR 24xy
- HAL 3930

Powertrain Valves – Throttle

The throttle valve directly regulates the amount of air entering the engine (gasoline internal combustion engine) or is used to generate the intake manifold vacuum (diesel engine). Linear or D Hall sensors with analog output are used to detect throttle position. Sensors with integrated capacitor bring EMC robustness and system cost advantages.

Sensor Type: 3D, Linear
Micronas Products inside:

- HAC 830
- HAL 2425
- HAL 37xy
- HAR 37xy

Powertrain Valves – EGR

EGR works by recirculating a portion of the engine's exhaust gas back into the engine cylinders leading to reduced fuel consumption of the vehicle and less CO₂ emissions. Sensors based on the 3D HAL technology provide an optimal solution for the measurement of the actual valve position being robust against air gap and temperature variations. Depending on requirements linear sensors can also be used. Some modules are leadframe based and sensors with integrated capacitor bring EMC robustness and system cost advantages.

Sensor Type: 3D, Linear
Micronas Products inside:

- HAC 830
- HAC 37xy

Powertrain Valves – Thermal Valves

Sensors based on the 3D HAL technology provide an optimal solution for the measurement of the actual valve position being robust against air gap and temperature variations. HVC all-in-one integrated solutions offer a very small footprint while matching the power requirement for a BLDC drive in a single chip without the need for external MOSFET. By this supporting the transition to an intelligent valve actuator.

Sensor Type: 3D
Controller Type: HVC

Micronas Products inside:

- HAC 37xy
- HAL 3930
- HVC 4223F

Battery Management

Battery located under the engine hood. A high-precision current sensor is required for battery management system structuring SOC (State of Charge) and SOH (State of Health) estimation. A current sensor features low output voltage drifts over temperature and multiple programmable magnetic field range.

Sensor Type: Current Sensor, Linear
Micronas Products inside:

- HAL 2425
- HAR 24xy

Gear Position

Commonly located on the automatic transmission, the gear position sensor communicates the gear shift's position to the vehicle's electrical system. A combination of several linear Hall sensors (up to 6) is deployed in each transmission. Analog or PWM output is required. Depending on the distance to be measured, linearization setpoints may be required.

Sensor Type: 3D, Linear
Micronas Products inside:

- HAL 1880
- HAL 24xy
- HAL 37xy
- HAL 3900 & HAL 3930

Water/Oil Pumps

Hall switches are used for any type of pumps like for water and oil to detect the position of the impeller. To reduce the overall current consumption, the HAL 1502 3-wire version with only 1.6 mA is preferred. HVC products are also very well suited to provide efficient BLDC drives for types of pumps. Flexible solutions can be implemented in the area of Oil-, Water- and Fuel-pumps.

Sensor Type: Switch
Controller Type: HVC
Micronas Products inside:

- HAL 15xy 2-wire
- HVC 4223F

Liquid Level

Hall sensors are used to detect liquid levels, for instance brake liquid level. Linearization setpoints are required.

Sensor Type: Linear, 3D
Micronas Products inside:

- HAL 2425
- HAL 37xy
- HAL 3930

Shift Lever Position

The gear shift application setup can be realized either as extremely price-attractive solution by using several Hall switches placed at each gear position or by a highly integrated solution using only one 3D sensor which is capable of measuring extended distances.

Sensor Type: Switch, 3D
Micronas Products inside:

- HAL 15xy 3-wire
- HAL 37xy
- HAL 3900 & HAL 3930

Turbo Charger

Linear Hall sensors with analog output are used to detect the position of a valve which blocks or increases the air flow through the turbine. They ensure reliability and high accuracy together with small offset and sensitivity drift over lifetime and temperature. Some modules are leadframe based and sensors with integrated capacitor bring EMC robustness and system cost advantages.

Sensor Type: Linear, 3D
Micronas Products inside:

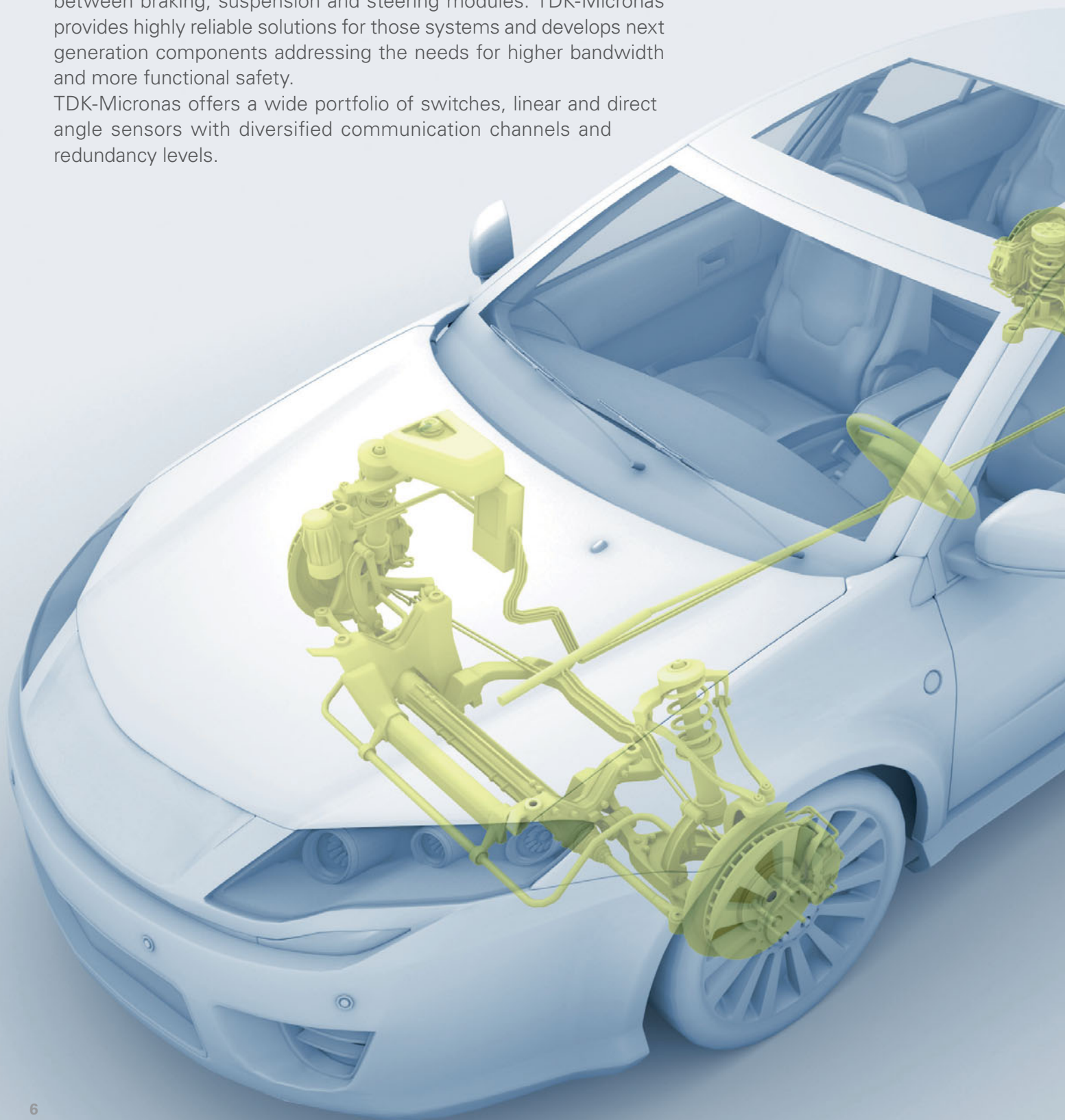
- HAC 830
- HAL 2425
- HAC 37xy

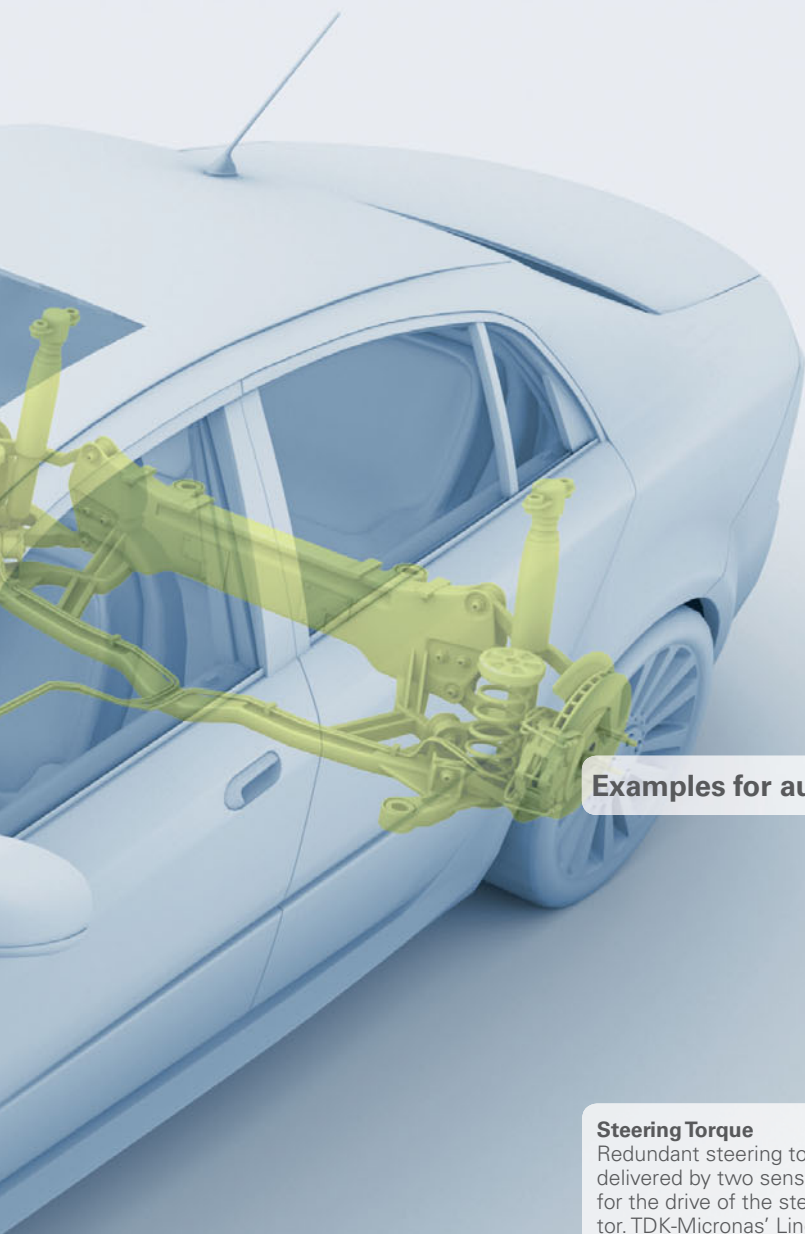
Automotive Applications

Chassis & Safety

Both comfort and safety requirements are driving the trends towards higher safety integration and safe exchange of sensor information between braking, suspension and steering modules. TDK-Micronas provides highly reliable solutions for those systems and develops next generation components addressing the needs for higher bandwidth and more functional safety.

TDK-Micronas offers a wide portfolio of switches, linear and direct angle sensors with diversified communication channels and redundancy levels.





Examples for automotive applications using Micronas products

Steering Torque

Redundant steering torque information delivered by two sensors is essential for the drive of the steering assist motor. TDK-Micronas' Linear Hall sensors are used for magnetic field amplitude measurement offering low-noise and low-offset drift capabilities. Analog output and digital output (PWM or SENT) are available. Redundant sensors bring cost advantage.

Sensor Type: Linear
Micronas Products inside:

- HAL 835
- HAL 283x
- HAR 24xy

Steering Angle

3D Hall-effect sensors measuring angles up to 360° are a cost-efficient solution for a contactless steering position measurement. The devices support state-of-the-art interfaces like PWM and SENT.

Sensor Type: 3D
Micronas Products inside:

- HAL 3930

Steering Motor – BLDC Motor

As part of the power steering system, Hall switches are used for BLDC motor commutation. To reduce the overall current consumption, the HAL 1502 3-wire version with only 1.6 mA is preferred.

Sensor Type: Switch
Micronas Products inside:

- HAL 15xy 3-wire

Chassis Position Sensor

The chassis position sensors (CPS) are located near the vehicle's front and rear axes. They determine the vehicle's current position and adjust the range of the main headlights accordingly. CPS requires angular sensors with full 360° measurement range, which is usually split into four segments of 90° or three of 120°. The interface is usually analog, PWM, or recently also PSI5.

Sensor Type: 3D
Micronas Products inside:

- HAL 3715, HAC 3715, HAL 3930, HAL 3980

Braking Pedal

A 2-wire unipolar Hall switch or a 3D Hall sensor can be used to determine when the pedal has passed a certain position whereas the 3D sensor measures the complete angle/movement of the pedal, providing higher safety.

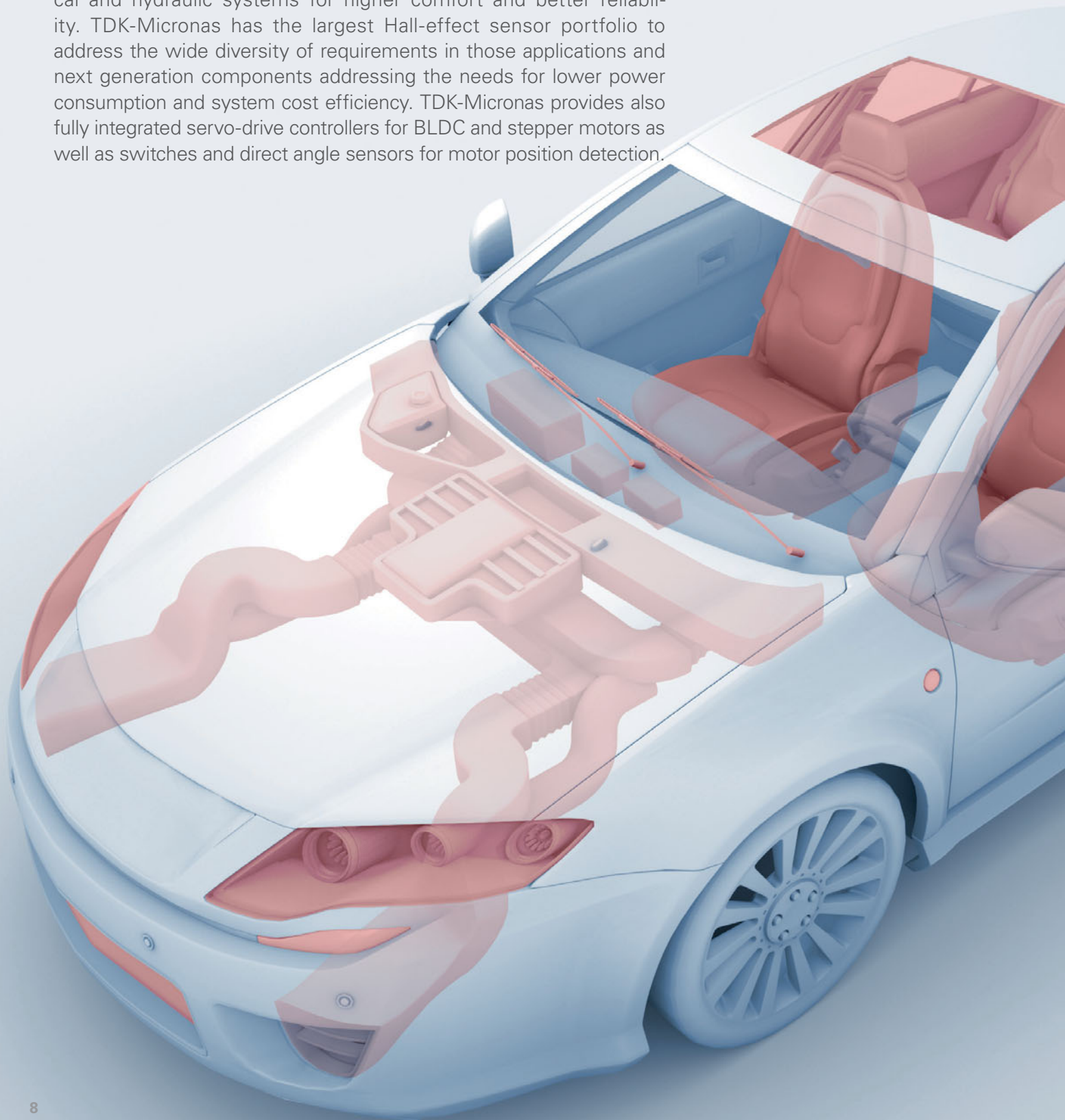
Sensor Type: Switch, 3D
Micronas Products inside:

- HAL 15xy 2-wire
- HAL 3930
- HAL 3980

Automotive Applications

Body & Comfort

Important electrification trend in the vehicle body compartment. Contactless sensors and electric motors are replacing mechanical and hydraulic systems for higher comfort and better reliability. TDK-Micronas has the largest Hall-effect sensor portfolio to address the wide diversity of requirements in those applications and next generation components addressing the needs for lower power consumption and system cost efficiency. TDK-Micronas provides also fully integrated servo-drive controllers for BLDC and stepper motors as well as switches and direct angle sensors for motor position detection.



Examples for automotive applications using Micronas products

Sun Roof / Window Lifter

Hall switches are used to determine the position of the window pane by measuring the motion direction, as well as counting the revolutions of the window lifter motor.

Sensor Type: Switch

Micronas Products inside:

- HAL 15xy 3-wire

Door Lock

Hall switches are used to detect whether the car doors are locked or not. By skipping the third wire, the 2-wire sensor type is preferred for this kind of application in order to save costs.

Sensor Type: Switch

Micronas Products inside:

- HAL 15xy 2-wire

Door Handle

The small footprint and the optimized amount of external components does fit perfectly into this application limited extremely in space. Due to achieved automotive OEMs Emission and Imission radio regulations, even the use in this harsh environment is a perfect fit for HVC family.

Controller Type: HVC

Micronas Products inside:

- HVC 4223F

Buckle Switch

Due to the greater distance from the sensor to the control unit, a 2-wire Hall switch is often the preferred sensor type for buckle applications. Depending on the application set-up a unipolar or latching type can be used.

Sensor Type: Switch

Micronas Products inside:

- HAL 15xy 2-wire

Adaptive Headlights and LED Fan

Within the adaptive headlights module, the "zero-position" of the swivel module is generally given by a Hall-effect switch. Modern cars make use of intelligent lighting technologies. The HVC family provides a best fit due to flexibility and optimized size constraints due to reduced amount of external components. This ensures best fit for mechanical adaptation (levelling, bending, automatic high-beam) as well as cooling (LED fan), simultaneously used to take care of defog the headlight, utilizing the small footprint and the reduced power requirements.

Sensor Type: Switch, 3D

Controller Type: HVC

Micronas Products inside:

- HAL 1002
- HAL 15xy 3-wire
- HAL 37xy, HAL 3930, HAL 3980
- HVC 4223F

HVAC – Blower and Flap Control

Micronas HVC solutions are offering ideal small and highly integrated one-chip-all-inclusive solutions allowing motor control with different driving schemes with low motor current ripple, supporting LIN auto-addressing, and stall detection. This is to prevent noise in a sound sensitive area. HVC family is best fitting into this requirement, as sophisticated software algorithms can be engineered onto the integrated μ C-IP to have the best fit between application, actuator, motor and electronics.

Sensor Type: Switch

Controller Type: HVC

Micronas Products inside:

- HAL 15xy 2-wire
- HVC 4223F

AGM – Grille Shutter

To increase CO₂ reduction and fuel savings by improved cw-value, the Automated Grille-Shutter (AGM) needs to adapt to driving conditions (speed, temperature, etc.). The flexible HVC products are perfectly tailored to provide the required functionality in the limited construction space within harsh environmental conditions.

Controller Type: HVC

Micronas Products inside:

- HVC 4223F

Seat – Position

The seat position detection is one part of the airbag control system. The task of the Hall switch is to determine the zone along the seat track, where the seat is actually positioned. 2-wire switches are the preferred solution.

Sensor Type: Switch

Micronas Products inside:

- HAL 15xy 2-wire

Seat – Climate Control

HVC all-in-one integrated solutions are matching the power requirements for BLDC motor drive in a single-chip solution without the need for external MOSFETs and allow a distributed system of motor controllers within the seat by LIN network interconnection.

Controller Type: HVC

Micronas Products inside:

- HVC 4223F

Industrial Applications

TDK-Micronas' sensor and embedded controller solutions are also sought after in non-automotive applications. They are widely used in all types of white goods, such as washing machines, tumble dryers, induction cookers, as well as heating and cooling systems. Further areas of applications can be found in the industrial arena, for example to control robots or to automate assembly equipment. Hall-effect sensors can be found in almost any machine that needs to measure position, linear or rotational movement or even current. By means of the Hall-effect other parameters can also be measured indirectly like rpm, leveling, pressure, force or even torque.



Building, Home and Office Automation

TDK-Micronas provides solutions for building, home and office automation from HVAC (Heating, Ventilation, and Air Conditioning), rolling shutters, vending machines to printers and metering applications.



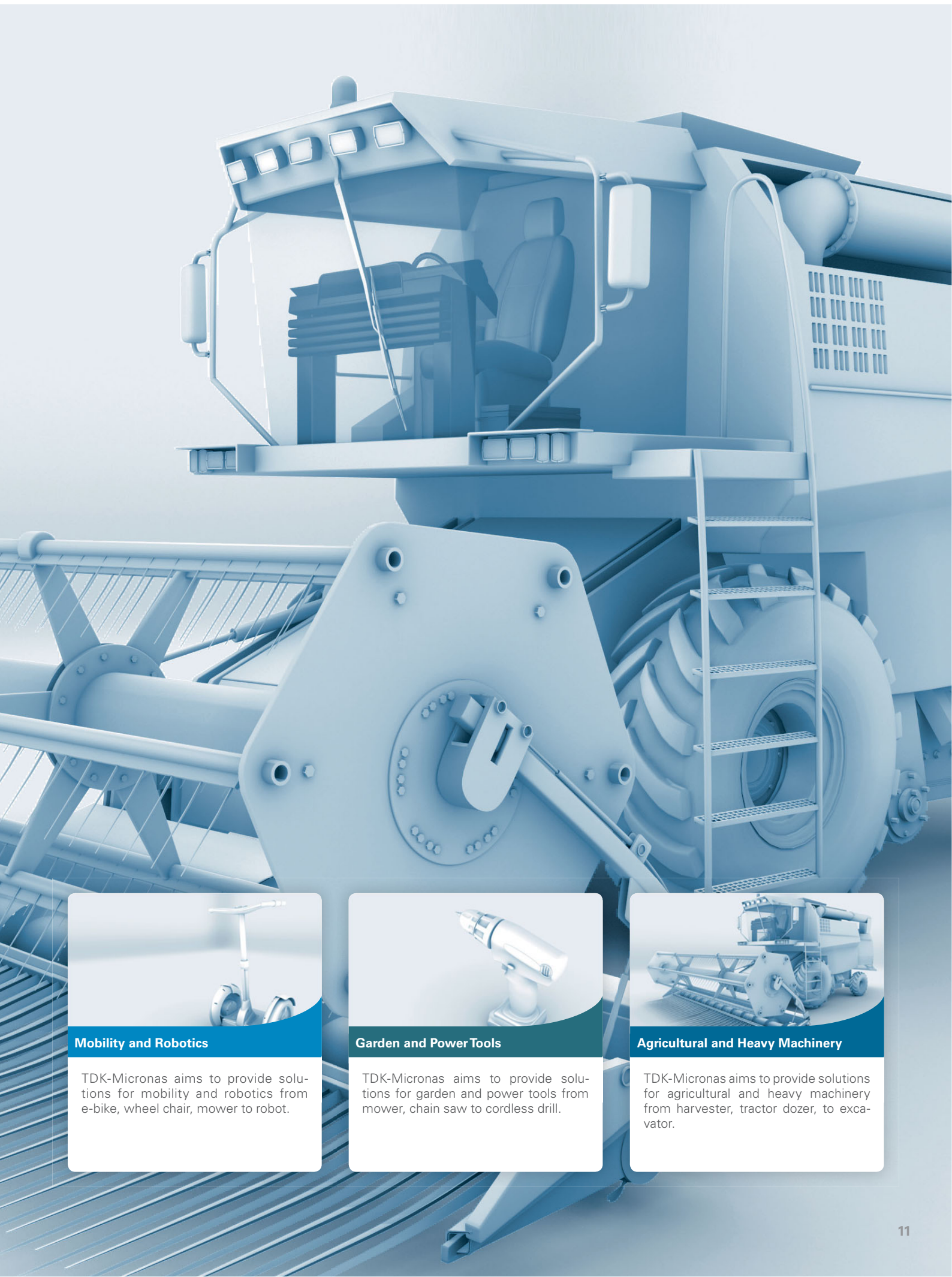
Factory and Process Automation

TDK-Micronas provides solutions for Factory and process automation applications from solar energy, man-machine interface to process control.



Home Appliance and White Goods

TDK-Micronas provides solutions for home appliances and white goods from washing machine, dishwasher, cook top to coffee machine.



Mobility and Robotics

TDK-Micronas aims to provide solutions for mobility and robotics from e-bike, wheel chair, mower to robot.



Garden and Power Tools

TDK-Micronas aims to provide solutions for garden and power tools from mower, chain saw to cordless drill.



Agricultural and Heavy Machinery

TDK-Micronas aims to provide solutions for agricultural and heavy machinery from harvester, tractor dozer, to excavator.

Reduce Cost and Space with ASICs (Application-Specific ICs)

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 world-class 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 ISO9001, ISO13485, and IEC61508-ISO26262.

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



Sensor / MEMS



High-Voltage



Power / Battery



Low-Power



Communication

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Introduction to Hall-Effect Technology



Owing to their various advantages like contactless sensing and high reliability, Hall-effect sensors are indispensable components in the Automotive and Industrial sector. Silicon is used almost exclusively as a basic material for the technical implementation of magnetic field sensors, as the Hall-effect is most pronounced in semiconductors. For these achievements we rely on an US American physicist, named Edwin Herbert Hall (1855–1938) after whom this physical effect is named. He found out that the electrons of the current flow in an electrical conductor are diverted from their normal direct path by an outer magnetic field applied perpendicular to their motion. Due to the so-called Lorentz force, a potential difference is created proportional to the field strength of the magnetic field and to the current strength. Based on this effect, Hall sensors can detect various parameters.

RPM Measurement

When applying a magnet to a propeller or tooth wheel, the Hall-effect sensor (typically a Hall switch) detects the change of the magnetic field (ON/OFF state) and counts these changes.

Rotary Position

Typically, linear and direct-angle Hall sensors are used in applications where a rotary position has to be continuously measured. Both sensor types output a signal which is proportional to the angular positions. Linear Hall sensors are often used for smaller angular ranges whereas a direct-angle sensor is well suited for angles up to 360°.

Linear Movement

Linear movements can be measured by detecting the position of a moving permanent magnet followed by calculating the covered distance. For distance measurements up to 40 mm, both linear Hall sensors and direct-angle sensors can be applied.

Leveling

The measurement of a liquid level is carried out via detection of either a rotary position (when a float gauge module is used) or a linear movement.

Force/Pressure Measurement

The Hall-effect sensor detects the displacement of a spring or a membrane when applying force or pressure to it. The displacement is nothing but a linear movement.

Torque Measurement

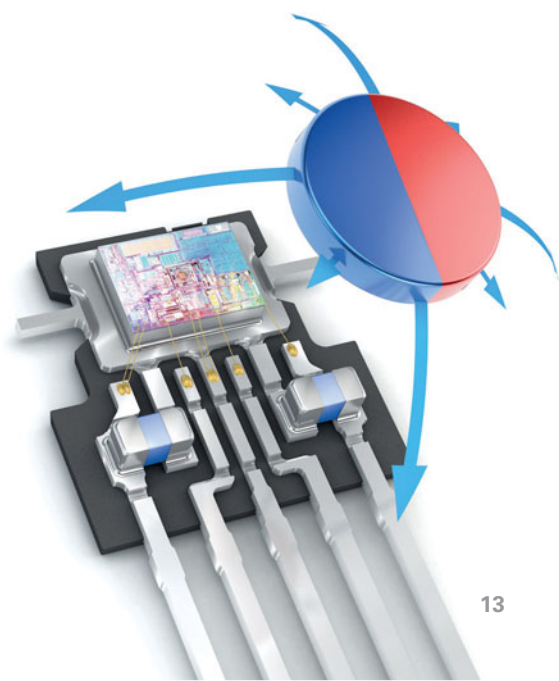
Torque measurement represents a sub-form of force measurement. When a force or torque is applied, the displacement of one object or two objects adjacent to each other can be measured by a linear Hall sensor.

Current Sensing

When an electrical current flows through a conductor, it is surrounded by a magnetic field. Therefore, all linear Hall sensors can also be used for indirect current measurements. The output signal of the sensor is proportional to detected magnetic field strength which in turn is proportional to the current strength.

Stray-Field Compensation

Motors and power lines can carry high currents generating magnetic fields that interfere with magnetic-field sensors. Today, a modern Hall-effect sensor must offer robust stray-field immunity conforming to the latest ISO 11452-8 standard and related OEM requirements.



Selection Guide



Guide Hall Switches

Guide Single-Axis Sensors

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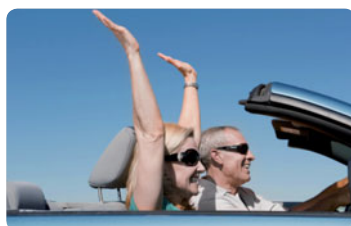
Guide Multi-Axis Sensors

Functions

- Position Detection
- Linear Movement
- Current Measurement

Generic Applications

- RPM Measurement
- Rotary Position
- Leveling
- Force/Pressure Measurement
- Torque Measurement



POSITION



DISTANCE



ANGLE



CURRENT



PRESSURE



TORQUE



EMBEDDED
CONTROLLER



STEPPER



BLDC



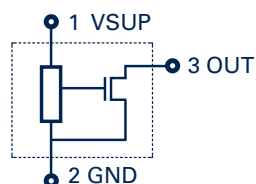
STRAY-FIELD COMPENSATION

Selection Guide



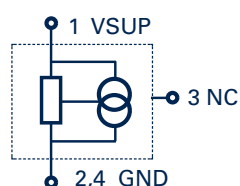
Additional Information

Unipolar:	Output turns low with magnetic south pole and turns high when the magnetic field is removed. Sensor does not respond to magnetic north pole of magnet.
Latching:	Output turns low with the magnetic south pole and turns high with the magnetic north pole of the magnet. The output does not change if the magnetic field is removed.
Bipolar:	Output turns low with magnetic south pole and turns high with the magnetic north pole. The output state is not defined if the magnetic field is removed.
Unipolar Inverted	Output turns high with magnetic south pole and turns low if the magnetic field is removed.



3-Wire Switch:

The voltage is monitored and the switch operates as indicated according to the type of switch.



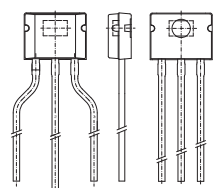
2-Wire Switch:

The current is monitored and the switch operates as indicated by the type of switch. Current level is as specified within the data sheet.

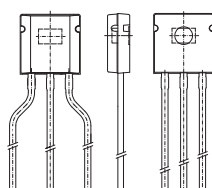
Hardware/Software Information

Programming Information	HAL USB-Kit	HAL APB V5.1	TDK-MSP V1.0	CGS Production Programmer
	HAL 188y HAL 24xy HAR 24xy HAL 37xy HAC 37xy HAR 37xy	HAL 8xy HAC 830 HAL 1002	HAL 1002 HAL 188y HAL 24xy HAR 24xy HAL 28xy HAL 83x HAC 830 HAL 37xy HAC 37xy HAR 37xy HAL 39xy	HAL 188y HAL 24xy HAR 24xy HAL 37xy HAC 37xy HAR 37xy

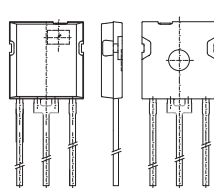
Package Information



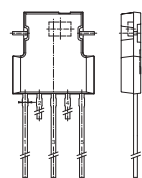
TO92UA



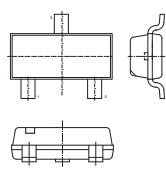
TO92UT



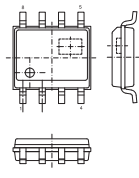
TO92UP 3-pin



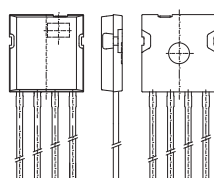
TO92UF



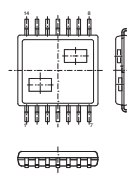
SOT23



SOIC8



TO92UP 4-pin



TSSOP14

Hall Switches

Variant		Magnetic Characteristics Typical @ 25 °C		Type				Typical temperature coefficient				Configuration		Package			Current Consumption					Supply Voltage			Application Range			
		B _{ON} – [mT]	B _{OFF} – [mT]																									
				Unipolar	Unipolar Inverted	Bipolar	Latching	0 ppm/K	–300 ppm/K	–1000 ppm/K	–1200 ppm/K	2-Wire	3-Wire	SOT23	TO92UA ^{1,2)}	TO-92UT	I _{SUP} = 1.6 mA	I _{SUP} = 7 mA	I _{SUP} low1 = 2...5 mA	I _{SUP} low2 = 5...7 mA	I _{SUP} high = 12...17 mA	V _{SUP} = 2.7...24V	V _{SUP} = 3...24V	V _{SUP} = 4.5V... 8.5V	Position Detection	RPM Measurement	Brushless DC Motor	
HAL 10xy ³⁾	HAL 1002	Programmable		●	●		●	Programmable ⁵⁾					●			●	●							●				
HAL 15xy ^{3,4)}	HAL 1501	0.4	–0.4			●		●					●	●	●		●					●				●	●	●
	HAL 1502	2.5	–2.5				●			●			●	●	●		●					●				●	●	●
	HAL 1503	5.5	3.7	●						●			●	●	●		●					●				●	●	●
	HAL 1504	7.6	–7.6				●				●		●	●	●		●					●				●	●	●
	HAL 1505	13.5	–13.5				●				●		●	●	●		●					●				●	●	●
	HAL 1506	18.9	17.3	●						●			●	●	●		●					●				●	●	
	HAL 1507	28.2	23.9	●					●				●	●	●		●					●				●	●	
	HAL 1508 ⁶⁾	–5.5	–3.7	●						●				●	●	●		●				●				●	●	●
	HAL 1509	3.7	5.5		●					●				●	●	●		●								●	●	●
	HAL 1510	12	7	●							●			●	●	●		●				●				●	●	●
	HAL 1561	4	–4				●	●					●		●	●				●	●		●			●	●	●
	HAL 1562	12	–12				●	●					●		●	●				●	●		●			●	●	●
	HAL 1563	7.6	9.4		●			●					●		●	●				●	●		●			●	●	●
	HAL 1564	4.1	6		●					●			●		●	●			●		●		●			●	●	●
	HAL 1565	6	4.1	●						●			●		●	●			●		●		●			●	●	●
	HAL 1566	9.4	7.6	●				●					●		●	●				●	●		●			●	●	●

¹⁾ straight or spread leads

²⁾ standard 15.7 ± 0.2 mm or long lead length 21 ± 0.2 mm

³⁾ T_J = –40 °C to 170 °C

⁴⁾ ISO 26262 compliant

⁵⁾ from 0 to –2000 ppm/K

⁶⁾ north pole sensitive

Hall Sensor Ordering Codes

HAL	1502	PA	T	C	P	Q	SP
Hall Sensor	Sensor Type	Package UA/JQ = TO92UA UT = TO92UT UP = TO92UP UF = TO92UF SU = SOT23 DJ = SOIC8 GP = TSSOP14	Temperature Range C: T _J = 0 °C to 85 °C I: T _J = –20 °C to 125 °C E: T _J = –40 °C to 100 °C K: T _J = –40 °C to 140 °C A: T _J = –40 °C to 170 °C	Configuration 1 = TO92 – Inline, Spread (Ammopack only) 2 = TO92 – Inline, Not Spread 4 = TO92UF – Carrier Tape 4 = SOT23 – Carrier Tape 4 = SOIC8 – Carrier Tape	Packaging B = Bulk A = Ammopack R = Reel (SOT23 and SOIC8)	Quantity 1 = 2000 per box 2 = 2000 per box 4 = 4800 per box 5 = 15000 per box 8 = 7000 per box	Special Procedure

Single-Axis Hall Sensors



Variant			Magnetic Range		Type							Configuration					Electrical Characteristics		Config.		Package						Application Range						
		Programmable	B _{min} [mT]	B _{max} [mT]	Setpoints	Analog	PWM	PSI5/SPI	SENT	Integrated Capacitors	Redundancy Function	Stray-Field Compensation	Overvoltage Detection	Undervoltage Detection	Open VSUP Detection	Open GND Detection	Overcurrent Detection	V _{SUP} [V]	I _{out} (max) - [mA]	2-Wire	3-Wire	TO92UA	TO92UT	TO92UP	TO92UF	SOIC8	TSSOP14	Linear Movement	Current Measurement	Rotary Position	Leveling	Force/Pressure	Torque Measurement
HAL 8xy	HAL 830	●	±30	±100	2	●							●	●	●	●	●	4.5 to 5.5	1.2		●		●					●	●	●	●	●	
	HAC 830	●	±30	±100	2	●				●			●	●	●	●	●	4.5 to 5.5	1.2		●			●				●	●	●	●	●	
	HAL 835	●	±15	±150	2	●	■				●		●	●	●	●	●	4.5 to 5.5	1.2		●		●					●	●	●	●	●	●
	HAL 855	●	±30	±150	32		■							●	●	●	●	4.5 to 14	20		●		●					●	●	●	●	●	
	HAL 856	●	±30	±150	32		■							●	●	●	●	4.5 to 14	◆	●			●					●	●	●	●	●	
HAL 188y	HAL 1880	●	±20	±160	0	●							●	●			●	4.5 to 5.5	1		●	●						●	●	●	●		
	HAL 1881		-50	+50	0	●							●	●			●	4.5 to 5.5	1		●	●						●	●	●	●		
	HAL 1882		-80	+80	0	●							●	●			●	4.5 to 5.5	1		●	●						●	●	●	●		
	HAL 1883		-100	+100	0	●							●	●			●	4.5 to 5.5	1		●	●						●	●	●	●		
HAL 24xy	HAL 2420	●	±25	±200	2	●							●	●	●	●	●	4.5 to 5.5	1.2		●		●			●		●	●	●	●	●	●
	HAL 2425	●	±25	±200	16	●							●	●	●	●	●	4.5 to 5.5	1.2		●		●			●		●	●	●	●	●	●
	HAR 2425	●	±25	±200	16	●					●		●	●	●	●	●	4.5 to 5.5	1.2		●					●		●	●	●	●	●	●
	HAL 2455	●	±25	±200	16		■						●	●	●	●	●	4.5 to 5.5	1.2		●		●			●		●	●	●	●	●	●
	HAR 2455	●	±25	±200	16		■				●		●	●	●	●	●	4.5 to 5.5	1.2		●					●		●	●	●	●	●	●
HAL 28xy	HAL 2830	●	±20	±160	2				●				●	●	●	●	●	4.5 to 17	20		●		●					●	●	●	●	●	●
	HAL 2831	●	±20	±160	2				●				●	●	●	●	●	4.5 to 17	20		●		●					●	●	●	●	●	●
	HAL 2832	●	±20	±160	2				●				●	●	●	●	●	4.5 to 17	20		●		●					●	●	●	●	●	●
	HAL 2833	●	±20	±160	2				●				●	●	●	●	●	4.5 to 17	20		●		●					●	●	●	●	●	●
	HAL 2850	●	±20	±160	2		■						●	●	●	●	●	4.5 to 17	20		●		●					●	●	●	●	●	●

■ Programmable PWM frequency ◆ Programmable: see data sheet

Multi-Axis Hall Sensors

HAL 37xy	HAL 3711	•	±20	±100	33		■		•				•	•	•	•	•	4.5 to 5.5	1.2	•			•		•			•	•		
	HAL 3715	•	±20	±100	33	•							•	•	•	•	•	4.5 to 5.5	1.2	•			•		•			•	•		
	HAL 3725	•	±20	±100	33	•							•	•	•	•	•	4.5 to 5.5	1.2	•			•		•			•	•		
	HAL 3726	•	±20	±100	33	•							•	•	•	•	•	4.5 to 5.5	1.2	•			•		•		•	•	•		
	HAL 3727	•	±20	±100	33	•							•	•	•	•	•	4.5 to 5.5	1.2	•			•		•		•	•	•		
	HAL 3735	•	±20	±100	33		■		•				•	•	•	•	•	4.5 to 5.5	1.2	•			•		•			•	•		
	HAL 3736	•	±20	±100	33		■		•				•	•	•	•	•	4.5 to 5.5	1.2	•			•		•		•	•	•		
	HAL 3737	•	±20	±100	33		■		•				•	•	•	•	•	4.5 to 5.5	1.2	•			•		•		•	•	•		
HAR 37xy	HAR 3711	•	±20	±100	33		■		•		•		•	•	•	•	•	4.5 to 5.5	1.2	•				•				•	•		
	HAR 3715	•	±20	±100	33	•					•		•	•	•	•	•	4.5 to 5.5	1.2	•				•				•	•		
	HAR 3725	•	±20	±100	33	•					•		•	•	•	•	•	4.5 to 5.5	1.2	•				•				•	•		
	HAR 3726	•	±20	±100	33	•					•		•	•	•	•	•	4.5 to 5.5	1.2	•				•			•	•	•		
	HAR 3727	•	±20	±100	33	•					•		•	•	•	•	•	4.5 to 5.5	1.2	•				•			•	•	•		
	HAR 3735	•	±20	±100	33		■		•		•		•	•	•	•	•	4.5 to 5.5	1.2	•				•				•	•		
	HAR 3736	•	±20	±100	33		■		•		•		•	•	•	•	•	4.5 to 5.5	1.2	•				•			•	•	•		
	HAR 3737	•	±20	±100	33		■		•		•		•	•	•	•	•	4.5 to 5.5	1.2	•				•			•	•	•		
	HAR 3795	•	±20	±100	33		■		•		•		•	•	•	•	•	4.5 to 5.5	1.2	•				•				•	•		
	HAR 3796	•	±20	±100	33		■		•		•		•	•	•	•	•	4.5 to 5.5	1.2	•				•			•	•	•		
HAC 37xy	HAC 3711	•	±20	±100	33		■		•	•			•	•	•	•	•	4.5 to 5.5	1.2	•				•				•	•		
	HAC 3715	•	±20	±100	33	•				•			•	•	•	•	•	4.5 to 5.5	1.2	•				•				•	•		
	HAC 3725	•	±20	±100	33	•				•			•	•	•	•	•	4.5 to 5.5	1.2	•				•				•	•		
	HAC 3726	•	±20	±100	33	•				•			•	•	•	•	•	4.5 to 5.5	1.2	•				•			•	•	•		
	HAC 3727	•	±20	±100	33	•				•			•	•	•	•	•	4.5 to 5.5	1.2	•				•			•	•	•		
	HAC 3735	•	±20	±100	33		■		•	•			•	•	•	•	•	4.5 to 5.5	1.2	•				•				•	•		
	HAC 3736	•	±20	±100	33		■		•	•			•	•	•	•	•	4.5 to 5.5	1.2	•				•			•	•	•		
HAL 39xy	HAL 3900	•	±10	±130	33			•				•	•	•	•	•	•	3.0 to 5.5	-	•					•		•	•	•		
	HAL 3930	•	±10	±130	33		■		•				•	•	•	•	•	3.0 to 16	20	•					•		•	•	•		
	HAL 3980	•	±10	±130	33			•					•	•	•	•	•	3.0 to 11	-	•					•		•	•	•		

■ Programmable PWM frequency

HAL[®] 1002



In-System Programmable Hall Switch



Functions

The HAL 1002 is the optimal system solution for applications, such as:

- Position detection
- Current measurement

Application Examples

- Endposition detection
- Liquid-level detection
- Electronic fuse
- Bending lights

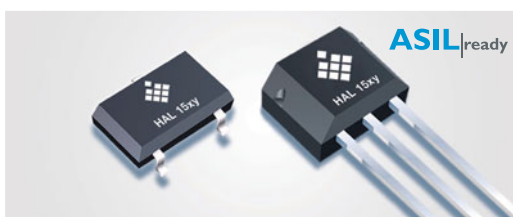
Features

- Operates from –40 °C up to 170 °C junction temperature
- High-precision Hall switch with programmable switching points and switching behavior
- Switching points programmable from –30 mT up to 150 mT in steps of 0.5% of the magnetic field range
- Multiple programmable magnetic characteristics in a non-volatile memory (EEPROM) with redundancy and lock function
- Temperature characteristics are programmable for matching all common magnetic materials
- Programming through modulation of the supply voltage
- Operates from 4.5 V up to 5.5 V supply voltage in specification and functions up to 8.5 V
- Operates with static magnetic fields and dynamic magnetic fields up to 2 kHz
- Magnetic characteristics are extremely robust against mechanical stress effects
- Overvoltage and reverse-voltage protection at all pins
- Short-circuit protected push-pull output
- High ESD performance: 8 kV
- EMC optimized design
- Package: TO92UT-2

HAL[®] 15xy



First ISO 26262 Compliant Low-Power Hall Switch Family



Application Examples

The HAL 15xy sensor family is the optimal system solution for applications, such as:

- Endposition detection
- Brushless DC motor commutation
- Revolutions per minute (RPM) or other rotary measurements

Features

- 3-wire version with a short-circuit protected open-drain output
- 2-wire version with current output
- Very low current consumption of typ. 1.6 mA
- Wide supply voltage operation from 2.7 V to 24 V
- Overvoltage protection capability up to 40 V
- Available in the smallest SOT23 and TO92UA package
- Highest ESD performance up to ±8 kV
- Reverse-voltage protection at supply pin
- Sampling and output refresh time of 2 μs
- Operating with static and dynamic magnetic fields up to 12 kHz at lowest output jitter of max. 0.72 μs (RMS). Customized versions are possible up to 93 kHz.
- AEC-Q 100 qualification
- ISO 26262 compliant with additional functional safety features like power-on self-test
- Wide junction temperature range from –40 °C to 170 °C, especially designed for operation in harsh environments
- Magnetic characteristics are robust against mechanical stress
- Broad variety of temperature-compensated constant switching points
- Package: SOT23 or TO92UA

HAL[®] 188y



Linear Hall-Effect Sensor Family – Programmable or with Fixed Sensitivity



Application Examples

HAL 188y is the optimal system solution for applications such as:

- Linear movement
- Distance measurements
- Current measurements
- Gear position sensor

Note: HAL 1880 can replace HAL 1820.
HAL 188y can replace HAL 182y.

Features

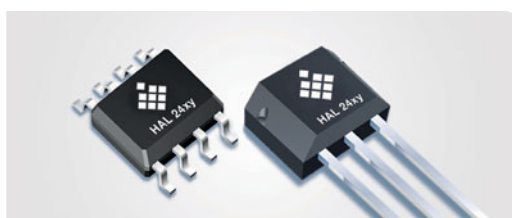
- Operates from –40 °C up to 170 °C junction temperature
- Linear Hall-effect sensor with ratiometric analog output
- Various programmable magnetic characteristics with non-volatile memory
- Digital signal processing
- Continuous measurement ranges from ± 20 mT to ± 160 mT
- Temperature characteristics programmable for matching all common magnetic materials
- Programming via supply voltage
- Lock function and built-in redundancy for EEPROM memory
- Operates from 4.5 V up to 5.5 V supply voltage
- Operates with static magnetic fields and dynamic magnetic fields up to 5 kHz
- Overvoltage and reverse-voltage protection on VSUP pin
- Magnetic characteristics extremely robust against mechanical stress
- Short-circuit protected output
- Package: TO92UA

Type	Sensitivity [mV/mT]
HAL 1880	programmable
HAL 1881	50
HAL 1882	31.25
HAL 1883	25

HAL[®] 24xy



Precise and Robust Programmable Linear Hall-Effect Sensor Family



Applications

The HAL 24xy is the optimal system solution for applications such as:

- Angular measurement: throttle position, pedal position, steering torque, and EGR applications

Family Overview

HAL 2420 Analog output, 2-point calibration
 HAL 2425 Analog output, 2-point calibration, 16 setpoints linearization
 HAL 2455 PWM output (up to 2 kHz), 16 setpoints linearization

Features

- High-precision linear Hall-effect sensor with ratiometric 12-bit analog output
- 16 setpoints for various output signal characteristics (HAL 2425), HAL 2455)
- High immunity against ESD (8 kV)
- Multiple customer-programmable magnetic characteristics in EEPROM with redundancy and lock function
- Programmable temperature compensation for sensitivity and offset
- Magnetic field measurements in the range up to 200 mT
- Low output voltage drifts over temp.
- Open-circuit (ground and supply line break detection), overvoltage and under-voltage detection
- Programmable output clamping function
- Digital readout of temperature and magnetic field information in calibration mode
- Operates from 4.5 V up to 5.5 V supply voltage in specification
- Operates with static magnetic fields and dynamic magnetic fields up to 2 kHz
- Overvoltage and reverse-voltage protection at all pins
- Short-circuit protected push-pull output
- Package: SOIC8 or TO92UT

HAR 24xy



Precise and Robust Programmable Linear Hall-Effect Sensor Family – with Redundancy Functionality



Applications

The HAR 24xy is the optimal system solution for applications such as:

- Angular measurement: throttle position, pedal position, steering torque, and EGR applications
- Distance and linear movement measurements in safety critical applications

Family Overview

HAR 2425 Analog output, 2-point calibration, 16 setpoints linearization

HAR 2455 PWM output (up to 2 kHz), 16 setpoints linearization

Features

- High-precision linear Hall-effect sensor with ratiometric 12-bit analog output (HAR 2425) or PWM output (HAR 2455)
- Dual-die Hall-effect sensors for true redundancy
- 16 setpoints for various output signal characteristics
- High immunity against HBM ESD (8 kV)
- Multiple customer-programmable magnetic characteristics in EEPROM with redundancy and lock function
- Programmable temperature compensation for sensitivity and offset
- Magnetic field measurements in the range up to 200 mT
- Low output voltage drifts over temp.
- Open-circuit (ground and supply line break detection), overvoltage and under-voltage detection
- Programmable output clamping function
- Digital readout of temperature and magnetic field information in calibration mode
- Operates from 4.5 V up to 5.5 V supply voltage in specification
- Operates with static magnetic fields and dynamic magnetic fields up to 2 kHz
- Overvoltage and reverse-voltage protection at all pins
- Short-circuit protected push-pull output
- Package: TSSOP14

HAL[®] 28xy



Linear Hall-Effect Sensor Family with Digital Interfaces



Functions

Due to the sensors' versatile programming characteristics and low drifts, the HAL 28xy family is the optimal system solution for functions, such as:

- Linear movement
- Current measurement

Generic Applications

- Steering torque
- Turbo charger

Features

- Operating junction temperature range: –40 °C up to 170 °C
- High-precision linear Hall-effect sensor
- Spinning-current offset compensation
- Built-in temperature sensor
- Built-in RISC processor
- Digital signal processing
- Up to 16 bit resolution
- Customer-programmable temperature compensation of Hall sensitivity (2nd order) and Hall offset (1st order)
- Different interface options: SENT or PWM output up to 2 kHz (HAL 2850)
- Magnetic characteristics extremely robust against mechanical stress
- Non-volatile EEPROM with redundancy and lock function
- Package: TO92UT

Variant	Resolution	Pulse Pause	Output
HAL 2830	12 bit	No	SENT SAE-J2716 release 2010-01
HAL 2831	16 bit	No	SENT SAE-J2716 release 2010-01
HAL 2832	12 bit	Yes	SENT SAE-J2716 release 2010-01
HAL 2833	16 bit	Yes	SENT SAE-J2716 release 2010-01
HAL 2850	12 bit	–	PWM

HAL[®] 83x



Programmable Linear Hall-Effect Sensor Family



Applications

The HAL 83x is the optimal system solution for applications such as:

- Linear movement
- Angle detection
- Accelerator pedal
- Throttle position
- Steering torque
- Exhaust gas recirculation
- Turbo charger

Note: HAL 830 can replace HAL 805, HAL 815 or HAL 817
HAL 835 can replace HAL 810 or HAL 825

Features

- High-precision linear Hall-effect sensor with 12-bit analog output
- Programmable temperature compensation for sensitivity
- Open-circuit (ground and supply line break) detection with 5 k Ω pull-up and pull-down resistor, overvoltage and undervoltage detection
- Programmable clamping function
- Programming and operation of multiple sensors at the same supply line
- High immunity against ESD
- Operates from 4.5 V up to 5.5 V supply voltage in specification and functions up to 8.5 V
- Overvoltage and reverse-voltage protection at all pins, short-circuit protected push-pull output
- Magnetic field measurement range from ± 15 mT up to ± 150 mT (HAL 835)
- Flexible analog / PWM output (HAL 835)
- Programmable low-pass filter at 80 Hz (less noise) or 2 kHz (faster response) (HAL 835)
- Offset drift over temperature less than $\pm 0.2\%$ of V_{SUP} ($\pm 0.1\%$ for HAL 835)
- Package: TO92UT

HAL 830	Analog output, 30 mT to 100 mT range
HAL 835	Analog and PWM output, 15 mT to 150 mT range additional features

HAC 830



Robust Multi-Purpose Linear Hall-Effect Sensor with Integrated Capacitors



Functions

The HAC 830 is the optimal system solution for applications such as:

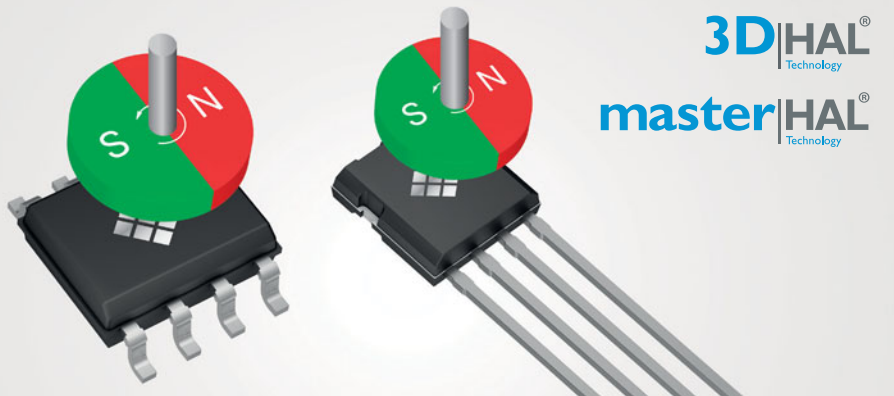
- Linear movement
- Angle detection
- Accelerator pedal
- Throttle position
- Steering torque
- Exhaust gas recirculation
- Turbo charger

Features

- High-precision linear Hall-effect sensor with 12-bit analog output
- Integrated capacitors for improved electromagnetic compatibility (EMC) and PCB-less applications
- Programmable temperature compensation for sensitivity
- Open-circuit (ground and supply line break) detection with 5 k Ω pull-up and pull-down resistor, overvoltage and undervoltage detection
- Programmable clamping function
- Programming and operation of multiple sensors at the same supply line
- High immunity against HBM ESD
- Operates from 4.5 V up to 5.5 V supply voltage in specification and functions up to 8.5 V
- Overvoltage and reverse-voltage protection at all pins, short-circuit protected push-pull output
- Magnetic field measurement range from ± 30 mT up to ± 100 mT
- Package: TO92UP

3D HAL® Technology from TDK-Micronas

Stray-Field Robust Position Detection



In the area of position detection in Automotive or Industrial applications, the requirements to sensors are steadily increasing. Their accuracy and reliability in harsh environments has to grow steadily. For applications measuring small distances (up to 6 mm) or small angle ranges (up to 60°), established linear (1D) Hall-effect sensors could show excellent and reliable performance.

For larger ranges, a new technology is needed. To this end, TDK-Micronas has developed the Hall sensor family HAL 37. With this family, angle measurements, formerly only to be done with on-chip flux concentrators or complex dual-package AMR (Anisotropic Magneto Resistance) sensors, can now be implemented in a CMOS process. Contrary to the AMR technology, measurements of angles up to 360°, as well as linear distances can both be realized.

As a next step, stray-fields are a big challenge for magnetic-field sensors. The motors and power lines in hybrid electric vehicles (HEVs) and battery electric vehicles (BEVs) carry high currents and can generate magnetic fields that interfere with magnetic-field sensors. Today, a modern Hall-effect sensor must offer robust stray-field immunity conforming to the latest ISO 11452-8 standard and related OEM requirements.

These new requirements are addressed by the HAL 39 family. Its unique stray-field concept is based on an array of vertical and horizontal Hall plates using the patented 3D HAL pixel cell. The highly flexible sensor array enables design engineers to select the best stray-field compensation for any given measurement task.

The HAL 39xy family offers four different measurement modes:

- Linear position detection with stray-field compensation
- Rotary 360° angle detection with stray-field compensation
- Rotary 180° angle detection with stray-field compensation, including gradient fields
- Real 3D magnetic field measurement (B_x , B_y , B_z)

Overall, the various family members support different output formats like ratiometric analog, PWM, SENT, SPI, and PSI5. The devices can be easily adapted to the different applications by providing easy programmability. Key parameters like offset, gain, zero angle, output offset and gain, setpoints for linearization and clamping levels can be stored in the built-in memory.

Today, the product family consists of the second-generation HAL 37xy and the third-generation HAL 39xy.

HAL[®] 37xy



Programmable Hall-Effect Sensor Family for Rotational or Linear Position Detection based on 3D HAL[®] Technology



Functions

HAL 37xy provides an optimal system solution for functions such as:

- Rotary movement detection
- Linear movement detection

Applications Examples

- EGR valve position
- Clutch pedal position
- Gear selector
- Cylinder and valve position sensing
- Non-contact potentiometer

Features

- Measurement extremely robust against temperature and stress influence
- Operating with magnetic field amplitudes down to ± 20 mT with an angular accuracy of $\pm 0.5\%$ FS (digital output, X-Y Hall plates)
- 12 bit ratiometric linear analog output for HAL 372x
- HAL 371x with modulo $90^\circ/120^\circ$ for chassis systems
- 0.2 kHz to 2 kHz PWM (up to 12 bit) or 12 bit SENT output for HAL 3711/HAL 373x
- Programmable arbitrary output characteristic with up to 33 setpoints
- Operates from $V_{SUP} = 4.5$ V up to 5.5 V
- Operates from $T_J = -40$ °C up to 170 °C
- Programming via the sensor's output pin
- Programmable characteristics in EEPROM with redundancy and lock function
- 2nd-order temperature-dependent offset of programmable for X/Y- or Z-channel
- On-board diagnostics
- Short-circuit protected push-pull output
- Over-/reverse-voltage protection at V_{SUP}
- Under- and overvoltage detection at V_{SUP}
- Wire-break detection with pull-up and pull-down resistor
- Package: SOIC8 or TO92UP

HAC 37xy



Programmable Hall-Effect Sensor Family based on 3D HAL[®] Technology – with Integrated Capacitors



Functions

HAC 37 provides an optimal system solution for functions such as:

- Rotary movement detection
- Linear movement detection

Applications Examples

- EGR valve position
- Turbocharger Actuator Position
- Position detection in Transmission Systems
- Cylinder and valve position sensing
- Non-contact potentiometer

Features

- Measurement extremely robust against temperature and stress influence
- Integrated capacitors for improved electromagnetic compatibility (EMC) and PCB-less applications
- Operating with magnetic field amplitudes down to ± 20 mT with an angular accuracy of $\pm 0.5\%$ FS (digital output, X-Y Hall plates)
- 12 bit ratiometric linear analog output for HAC 372x
- HAC 371x with modulo $90^\circ/120^\circ$ for chassis systems
- 0.2 kHz to 2 kHz PWM (up to 12 bit) or 12 bit SENT output for HAC 3711/HAC 373x
- SENT SAE J2716 rev. 2016 protocol:
 - H.1 Format: Transmission of position and temperature or magnetic field amplitude on fast and slow channel
 - H.2 Format: Three data nibbles
 - H.4 Format: Secure channel format
- Programmable arbitrary output characteristic with up to 33 setpoints
- Operates from $V_{SUP} = 4.5$ V up to 5.5 V
- Operates from $T_J = -40$ °C up to 170 °C
- Programming via the sensor's output pin
- Programmable characteristics in EEPROM with redundancy and lock function
- 2nd-order temperature-dependent offset of programmable for X/Y- or Z-channel
- On-board diagnostics
- Wire-break detection with pull-up and pull-down resistor
- Package: TO92UF

HAR 37xy



Programmable Hall-Effect Sensor Family based on
3D HAL® Technology – with Redundancy Functionality



Functions

HAR 37xy provides an optimal system solution for functions such as:

- Rotary movement detection
- Linear movement detection

Applications Examples

- EGR valve position
- Clutch pedal position
- Gear selector
- Cylinder and valve position sensing
- Non-contact potentiometer

Features

- Measurement extremely robust against temperature and stress influence
- Operating with magnetic field amplitudes down to ± 20 mT with an angular accuracy of $\pm 0.5\%$ FS (digital output, X-Y Hall plates)
- 12 bit ratiometric linear analog output for HAR 372x
- HAR 371x with modulo $90^\circ/120^\circ$ for chassis systems
- 0.2 kHz to 2 kHz PWM (up to 12 bit) or 12 bit SENT output for HAR 3711 / HAR 373x
- HAR 379x: SENT SAE J2716 rev. 2016 protocol:
 - H.1: Two 12 bit fast channels (position & temperature or magnetic amplitude)
 - H.2: 12 bit fast channel
 - H.4: 12 bit secure single sensor
- Programmable arbitrary output characteristic with up to 33 setpoints
- Operates from $V_{SUP} = 4.5$ V up to 5.5 V
- Operates from $T_J = -40$ °C up to 170 °C
- Programming via the sensor's output pin
- Programmable characteristics in EEPROM with redundancy and lock function
- 2nd-order temperature-dependent offset of programmable for X/Y- or Z-channel
- On-board diagnostics
- Package: SOIC8

HAL® 39xy



Programmable Hall-Effect Sensor Family for 3D Position
Detection – with Stray-Field Compensation



Functions

HAL 39xy provides an optimal system solution for functions such as:

- Rotary movement detection
- Linear movement detection
- 3D position detection (two angles or B_x , B_y , B_z raw values)

Applications Examples

- Chassis position
- Turbo-charger actuators
- Valve position detection (e.g. EGR)
- Shift position
- Steering angle
- Clutch position
- Transmission position detection

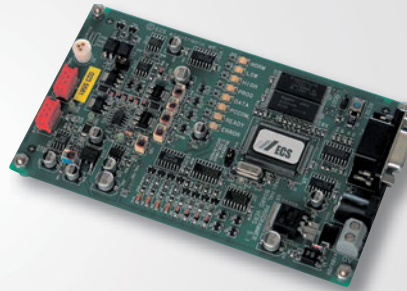
Features

- Accurate angular measurement up to 360° and linear position detection
- 3D position detection supporting transmission of two angles out of B_x , B_y , B_z as well as temperature compensated raw values
- Compensation of magnetic stray fields (homogenous and gradient fields)
- ASIL B ready (SEooC acc. ISO 26262)
- Wide supply voltage range: 3.0 V to 16 V
- Configurable output slew rates
- SPI interface: Slave, up to 10 MHz (HAL 3900)
- 0.1 kHz to 2 kHz PWM, up to 13 bit (HAL 3930)
- SENT according to SAE J 2716 rev. 4 (HAL 3930)
- Support of three different SENT frames (HAL 3930)
 - H.1: Two 12 bit fast channels (position & temperature or magnetic amplitude)
 - H.2: 12 bit fast channel
 - H.4: 12 bit secure single sensor
- PSI5 interface according to rev. 2.x (HAL 3980)
- $T_A = -40$ °C ... 160 °C
- Programming via the sensor's output pin
- Package: SOIC8

Tool Chain for Hall-Effect Sensors



USB-Programming-Kit V1.01



HAL APB V5.1



MSP V1.0

TDK-Micronas provides three dedicated programming tools supporting all programmable sensors. These three programmers are used as a general-purpose programming interface for the entire programmable Hall-effect sensor portfolio from TDK-Micronas.

The HAL USB-Programming-Kit V1.01 is intended for lab/engineering purposes only. This programming kit can be used for the products HAL 188y, HAL 24xy, HAR 24xy, HAL 37xy, HAC 37xy, and HAR 37xy.

The HAL APB V5.1 (Application Programmer Board) is also intended for lab/engineering purposes only. This programmer board can be used for the products HAL 8xy, HAC 830, and HAL 1002.

The new **Magnetic Sensor Programmer V1.0 (MSP)** for short) can be used for the products HAL 1002, HAL 188y, HAL 24xy, HAR 24xy, HAL 28xy, HAL 83x, HAC 830, HAL 37xy, HAC 37xy, HAR 37xy, and HAL 39xy.

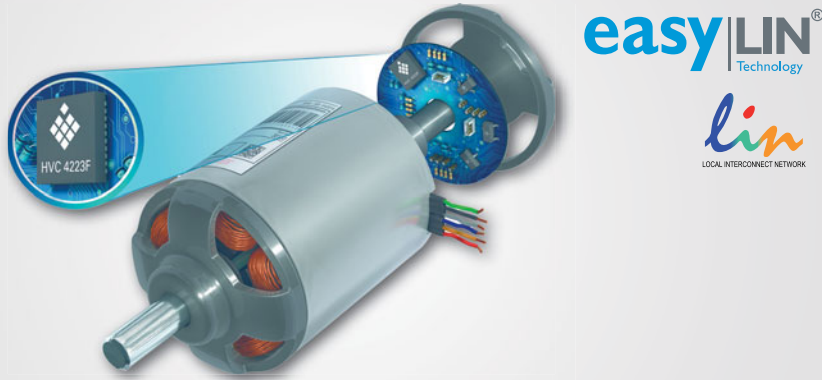
TDK-Micronas provides application software supporting a command interface for the communication with a PC. This allows the implementation of specific PC software for engineering purposes or development.

With the CGS Production Programmer, the sensor families HAL 18xy, HAL 24xy, and HAL 37xy can be programmed reliably and efficiently with the tools developed by CGS. In mixing mode, several sensors can be programmed in parallel. Therefore, test time and costs are significantly reduced.

For each of the programmable Hall sensor families, a specific engineering PC software exists. This software provides a graphical user interface based on LabVIEW™ on a PC.

CGS
Production Programmer

Introduction to Embedded Motor Controllers



The Micronas embedded motor controller family combines an industry standard ARM® Cortex®-M3 microcontroller core and a wide range of additional functions which, up to now, could only be realized via a combination of several external semiconductor parts.

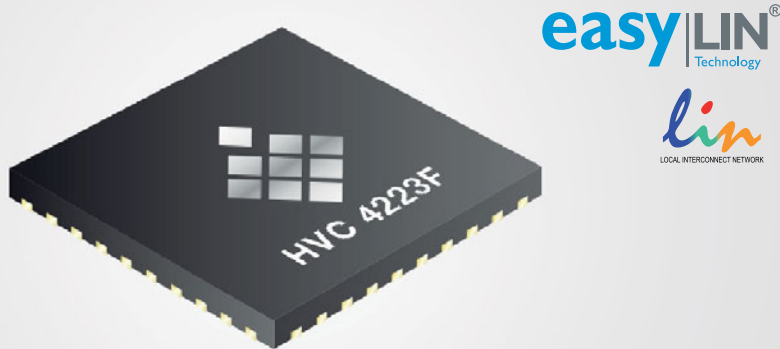
The family is designed as an embedded controller for smart actuators. It features advanced integration for compact and cost-effective system designs for use in automotive applications and beyond (industrial, consumer, instrumentation, etc.).

Replacement of conventional mechanical drive by “on-demand” electric drive and a general adoption of a more efficient solution to control electrical motors are the main reasons for a growing demand for cost-effective system solutions for electrical motor control and drive. Long lifetime reliability, reduction of weight as well as overall dimension, and flexibility to easily adapt to several types of motors and applications are additional key issues which have to be addressed especially for automotive applications. Thanks to their better efficiency, lower acoustic- and electrical noise, brushless DC (BLDC) are gaining a significant share of the electrical motors by replacing conventional motors.

TDK-Micronas’ embedded motor controller integrates almost all surrounding circuits needed for driving electrical motors. In addition to the UART interface, the built-in networking capabilities enable the deployment of LIN bus control compliant to LIN-2.x for a wider range of applications like e.g. cross-linked smart actuator. Reducing the number of external components to a minimum, the product’s flexible peripherals allow direct controlling of brushless, brush-type DC- and stepper electrical motors, either by means of six fully integrated half-bridges or by controlling three external MOSFET half-bridges. Thanks to this flexibility in driving the electrical motor, the HVC controllers provide an effective system solution for both small and medium sized electrical motors, enabling a common product platform by a family concept. This gives our customers a decisive competitive edge because they are much faster at the implementation stage and need fewer resources in the development process of their various applications.

HVC 4223F

Embedded Motor Controller for Smart Actuators



The new HVC 4223F embedded motor controller family from TDK-Micronas enables cost-effective realization of powerful and compact DC motor (BLDC or stepper) control. Powered by a high-performance 32-bit ARM[®] μ C core (ARM[®] Cortex[®]-M3) and integrating high-performance analog functions, the HVC 4223F economically addresses growing challenges in the automotive market and beyond (industrial, consumer, instrumentation, etc.). The flexible peripherals of the product provide all means to directly control brush-type, stepper (bipolar or three phase), or brushless direct current (BLDC) motors via integrated high-performance half-bridges without the need for external components.

Beside timers/counters, interrupt controller, multichannel A/D converter, SPI, and enhanced PWMs with diagnosis functions, this device contains an advanced LIN UART interface with a LIN 2.x transceiver with provisions for voltage regulators for direct connection to a 5.4 V to 18 V automotive power supply. The support of various power management modes makes it possible to adjust current consumption according to system needs. The HVC 4223F further features a flash program memory with a size of 32 kbytes, providing high flexibility in code development, production ramp-up, and in-system code update.

Various integrated digital and analog circuit units such as comparators with virtual star point reference, current scaling or an embedded programmable gain amplifier allow users to further minimize the number of external components. The computation capacity supports complex motor control algorithms such as Space Vector Modulation (SVM) for Permanent Magnet Synchronous Motors (PMSM) in addition to six-step commutation with sensor feedback or sensorless control as well as various stepping configurations. The setup makes the adaption to new motor types fast and easy.

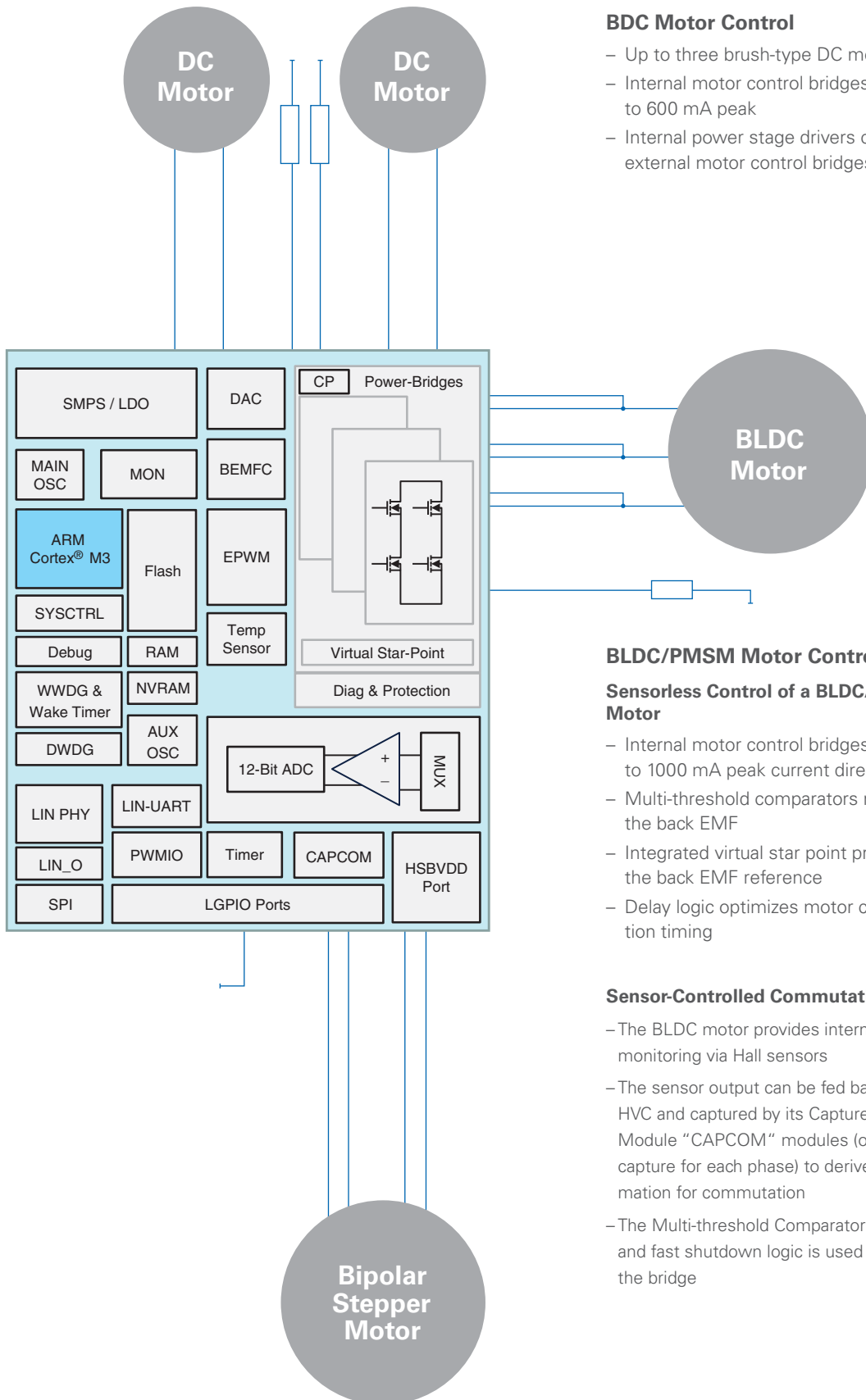
Features

- Six integrated half-bridges up to 6 x 500 mA or 1000 mA (depending on configuration)
- Temperature range up to $T_A = 125^\circ\text{C}$ (Automotive Grade-1)
- Supply voltage: 5.4 V ... 18 V, Load dump up to 40 V
- High-performance 32-bit ARM[®] Cortex[®]-M3, running at up to 20 MHz
- Memory:
 - 2 kbyte RAM
 - 32 kbyte Flash
 - On-chip NVRAM with wear leveling
- Logic modules dedicated for controlling BLDC or BDC motors
- Comparators with integrated virtual star point and reference currents
- Digital and window watchdog timers with different, independent clocks
- 12-bit multi-channel ADC
- Programmable gain amplifier
- 16-bit free-running counter with three capture/compare-modules
- Two 16-bit timers
- Enhanced PWMs (EPWMs), providing edge/center-aligned signals with non-overlapping capability
- SPI and enhanced LIN 2.x UART
- LIN 2.x transceiver
- Integrated temperature sensor
- Active EMI suppression hardware
- Several diagnosis and protection functions such as:
 - Integrated H-bridge diagnostic features
 - Internal protection for non-overlapping bridge activation
 - Clock/temperature/supply supervision
 - Overvoltage/Overcurrent protection
- Power saving modes
- Package: QFN40 - 6x6

Functions

The HVC 4223F is the enhanced system solution to drive stepper, BLDC or up to two BDC motors for various applications in the automotive environment, like grille shutter, HVAC flaps, LED headlight & fan and much more, as well as in the industrial environment, enabling smart mechatronical actuators.

Motor Control Applications



BDC Motor Control

- Up to three brush-type DC motors
- Internal motor control bridges drive up to 600 mA peak
- Internal power stage drivers control external motor control bridges

BLDC/PMSM Motor Control

Sensorless Control of a BLDC/PMSM Motor

- Internal motor control bridges drive up to 1000 mA peak current directly
- Multi-threshold comparators measure the back EMF
- Integrated virtual star point provides the back EMF reference
- Delay logic optimizes motor commutation timing

Sensor-Controlled Commutation

- The BLDC motor provides internal position monitoring via Hall sensors
- The sensor output can be fed back to the HVC and captured by its Capture/Compare Module “CAPCOM” modules (one input capture for each phase) to derive the information for commutation
- The Multi-threshold Comparator “MTC” and fast shutdown logic is used to protect the bridge

Toolchain for Embedded Motor Controllers



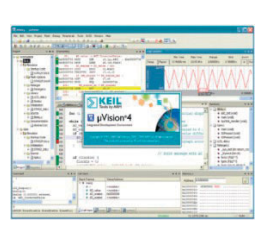
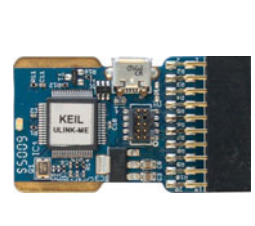
Development Tools and Software

- Automotive-certified firmware package ASPICE/ASIL for BLDC and stepper motor applications including EasyGUI
- Micronas APN package with API for motor commutation
- JTAG Emulator (JEM) with single-wire debug interface
- Application and evaluation boards
- Integrated development environment with debugger and compilers from several 3rd-party vendors

Boards, Software and Compiler

- For demonstrations and evaluation use
- For dedicated applications, e.g. BLDC/Stepper/BDC/PMS

Development Tools and Compiler

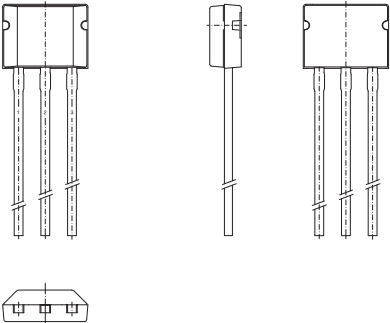
	SDB-I First steps with HVC 4223F to evaluate the small yet "all-onboard" solution.		Application board Flexible due to onboard programming socket
	KEIL MDK for ARM[®] Cortex[®]-M3 Complete software development environment Ask for free version.		ULINK-ME Debug adapter via JTAG or SWD

Application Support

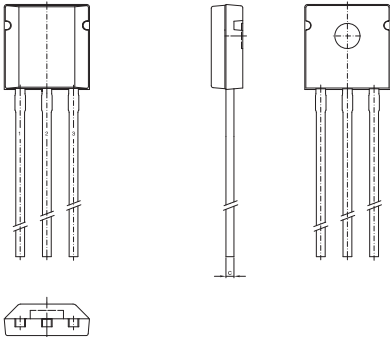
<pre>// Configure L0PIO 0 as push-pull outp L0PIO->C0a = (BIT_0); L0PIO->OD = BIT_0; // Initialize SYSTICK with 1ms if (SysTick_Config(20000)) // 200 error_handler(); while(1) { ... if ((loop % 50) == 0) { if (MyLinStatus.L_networkData) L0PIO->ODput(MIT); // synchronize LIN frame out // with data from the appli // clear update flag L0PIO->clr_key_state(); // read keys and write the L0PIO->key_state(rd_key); if (L0PIO->tm_MSP()) // { // If yes, read value // and write it to L0PIO } } }</pre> 	Firmware Package Professional, Automotive ASPICE and Functional-Safety supporting firmware package available for buy-out. Various target platforms available by easy adaptation. Running standard- and sophisticated motor-control routines for BLDC and stepper motors.		J-Link In-circuit programmer via JTAG or SWD
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Package Information

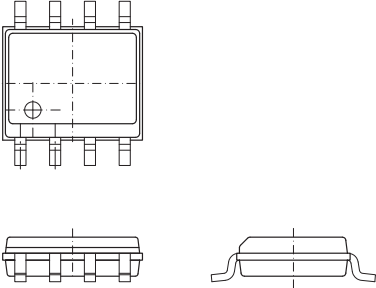
TO92UA



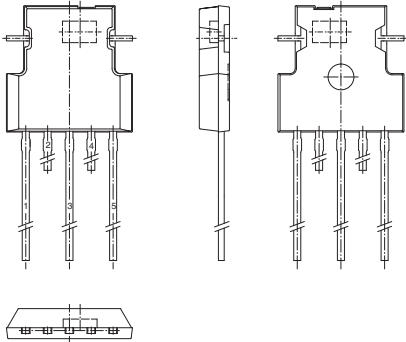
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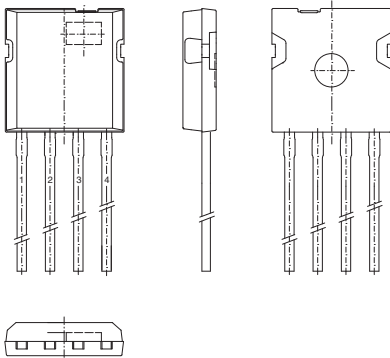
SOIC8



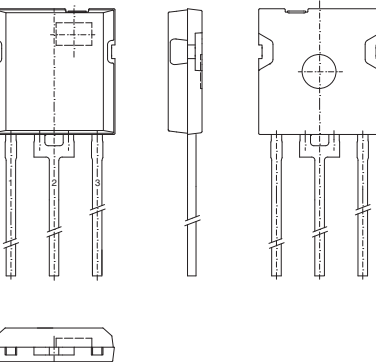
TO92UF



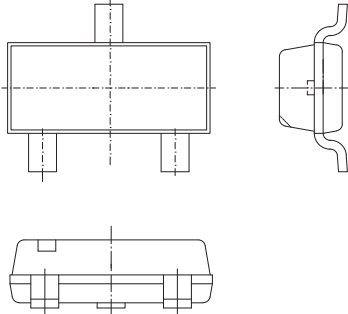
TO92UP 4-pin



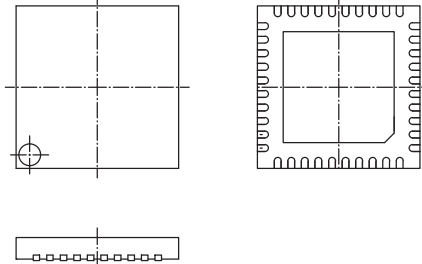
TO92UP 3-pin



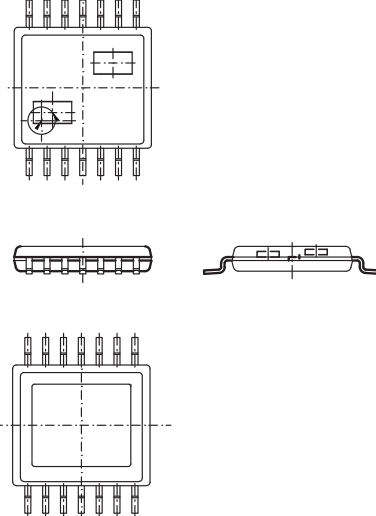
SOT23



QFN40 - 6x6



TSSOP14



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- HAL
- masterHAL
- varioHAL
- 1D HAL
- 2D HAL
- 3D HAL
- easyLIN
- zero ppm

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TDK Corporation is a leading electronics company based in Tokyo, Japan. It was established in 1935 to commercialize ferrite, a key material in electronic and magnetic products. TDK's comprehensive portfolio features passive components such as ceramic, aluminum electrolytic and film capacitors, as well as magnetics, high-frequency, and piezo and protection devices. The 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. These products are marketed under the product brands TDK, EPCOS, InvenSense, Micronas, Tronics and TDK-Lambda. TDK focuses on demanding markets in the areas of information and communication technology and automotive, industrial and consumer electronics. The company has a network of design and manufacturing locations and sales offices in Asia, Europe, and in North and South America. In fiscal 2018, TDK posted total sales of USD 12 billion and employed about 103,000 people worldwide.

About TDK-Micronas

TDK-Micronas is the most preferred partner for sensing and control. TDK-Micronas serves all major automotive electronics customers worldwide, many of them in long-term partnerships for lasting success. Operational headquarters are based in Freiburg im Breisgau (Germany). Currently, TDK-Micronas employs around 900 persons. For more information about TDK-Micronas and its products, please visit www.micronas.com.

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