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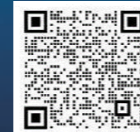
**Europe**

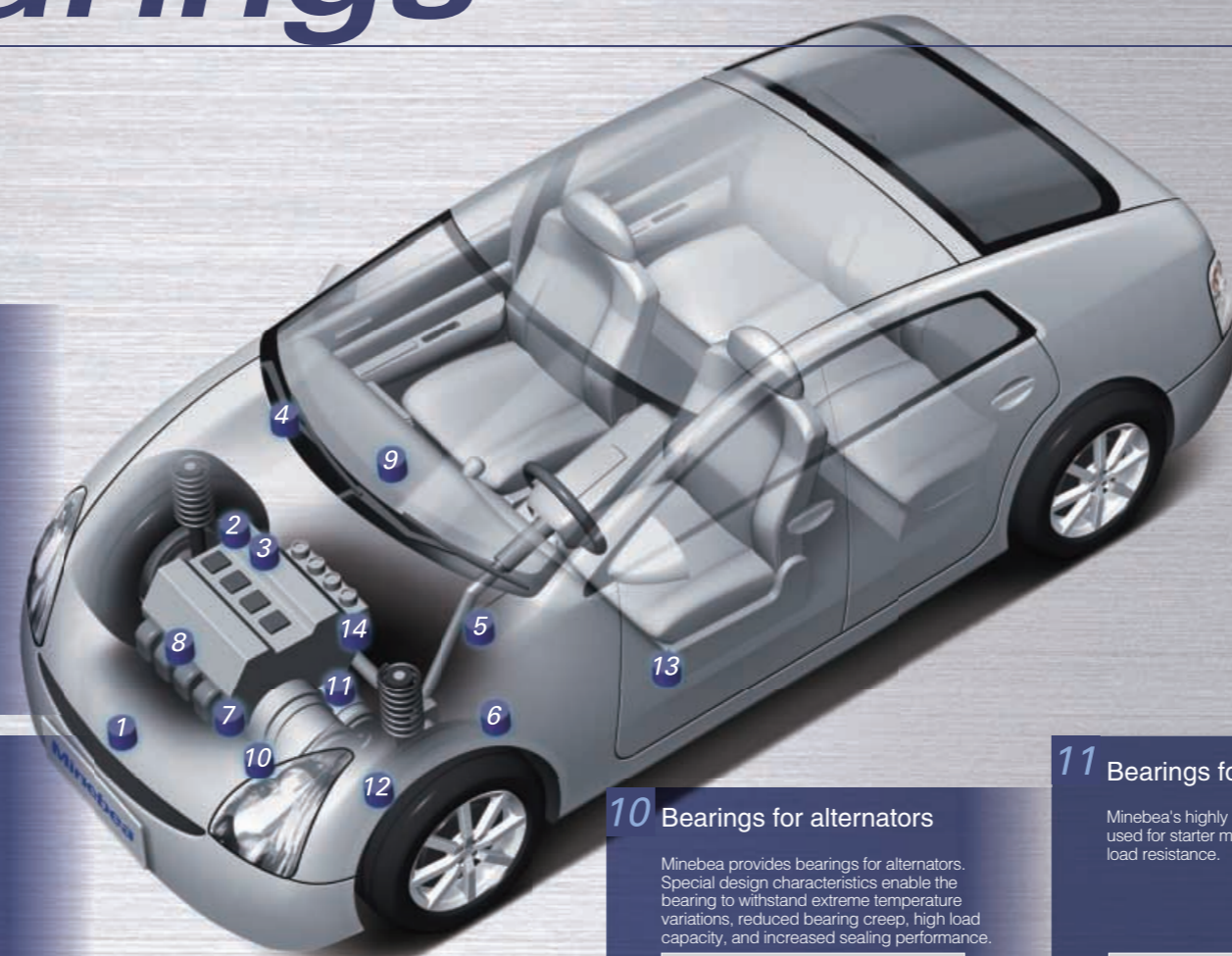
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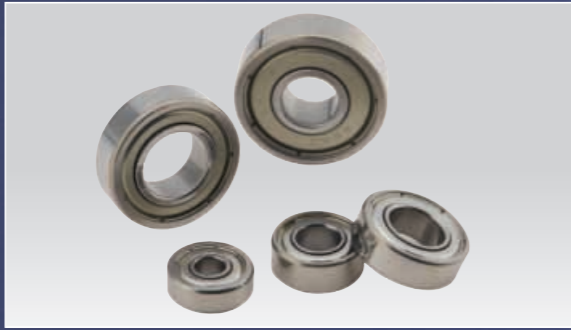
# Automotive Products





## 1 Bearing for engine cooling fan motors

Ball bearings used on fan motors for thermal management of radiators and compressors. These noise sensitive applications require heat resistance and durability against temperature extremes and difficult environments. With a dedicated lubricant and refined manufacturing process, Minebea provides highly reliable ball bearings to customers around the globe.



## 2 Bearings for throttle bodies

Ball bearing requirements for throttle body applications often require additional performance characteristics of the bearing. Utilizing our vertical integration for design and component manufacturing, Minebea has developed a dedicated rubber seal by incorporating a special lip structure, thus reducing air leak across the bearing. Minebea continues to provide highly reliable precision bearings for throttle bodies to control air intake to the engine. Minebea has supplied this market since the inception of fuel injection and retains top market share of bearings for throttle body applications worldwide.



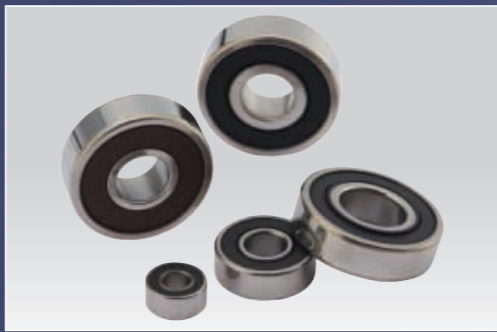
## 3 Bearings for ETC motors

The miniature ball bearings Minebea produces are commonly used for ETC motors that actuate the valve opening and closing within throttle bodies.



## 4 Bearings for wiper motors

The bearings for wiper motors that secure a field of view for drivers require high reliability and thrust load resistance, as well as silence because the motors operate near the passenger compartment. Minebea has the world's top market share in bearings for wiper motors.



## 5 Bearings for EPS motors

Bearings for EPS motors and systems that support vehicle steering are one of the applications whose demand has been rapidly increasing due to the rising rate of their usage. These bearings require not only high reliability but also extreme precision as vibration can adversely affect the steering 'feel' to the driver of the vehicle. Minebea meets customer demand in this application with its advanced processing technology and high volume manufacturing capabilities.



## 6 Bearings for ABS/ESC motors

Extremely reliable bearings are required for ESC motors that control vehicle driving and stopping distance. Minebea is a global leader in the production and supply of concentric ball bearings for motors and eccentric bearings for motors with advanced processing technology.



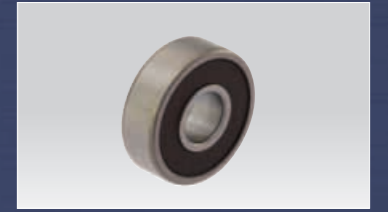
## 7 Bearings for EGR

Minebea's special miniature ball bearings with enhanced high-temperature resistance are commonly found in the mechanical workings of EGR systems for the recirculation of exhaust gas. Due to environmental protection and efficiency mandates, the demand for EGR bearings has been consistently increasing. Minebea is proud with our involvement on these technologies, and is positioned to meet customer demands around the globe.



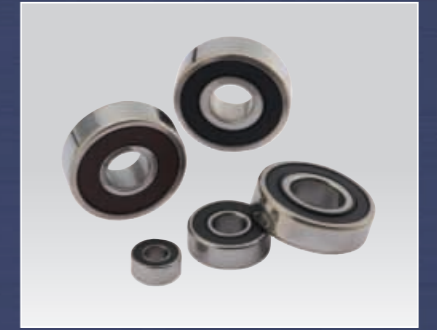
## 8 Bearings for intake manifolds

Minebea's high-precision bearings are used for various valve actuation support to control air intake such as; variable induction systems, swirl control and tumble generation of the intake manifold.



## 9 Bearings for HVAC blower motors

Bearings used in applications which handle air flow of vehicle air conditioning systems require extremely quiet operation in both low-temperature and high-temperature environments because of their proximity to vehicle occupants. Minebea's accumulated advanced processing technology accounts for these stringent requirements and aims at meeting customer demand.



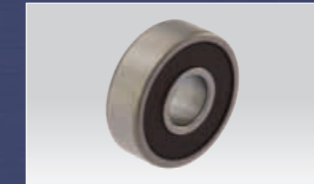
## 10 Bearings for alternators

Minebea provides bearings for alternators. Special design characteristics enable the bearing to withstand extreme temperature variations, reduced bearing creep, high load capacity, and increased sealing performance.



## 11 Bearings for starters

Minebea's highly reliable bearings are used for starter motors that require thrust load resistance.



## 12 Bearings for transmission control

Designed for the specific application parameters associated with transmission control, Minebea ball bearings feature high load capacity and temperature resistance. Since the demand for transmission control bearings has been increasing due to environmental and energy mandates, Minebea has actively, and proudly, been involved in continually supporting applications such as CVT and DCT around the globe.



## 13 Bearings for power seat motors

Minebea's high-precision ball bearings are often used in noise critical motors tasked with seat adjustments such as sliding, reclining, height and lumbar support.



## 14 Bearings for turbochargers

Minebea's specifically engineered bearings for turbochargers assist in substantial friction reduction and enhanced turbo response.



## Topics of Bearings

### Minebea's ball bearings

Minebea is the world's largest manufacturer of miniature and extra small ball bearings. Environmentally friendly manufacturing is located in China, Thailand, Singapore, Japan, and United States. Annual turnout is nearly 3 billion units per year. Because Minebea produces nearly all parts in-house, ranging from inner and outer rings to shields, rubber seals, and retainers; extremely high quality levels are maintained. With advanced precision processing technology and a versatile global infrastructure, Minebea provides bearings to all regions of

the globe, and maintains the world's top market share for in-vehicle miniature and extra small ball bearings. As part of our global effort to maintain conservation of the environment, Minebea manufacturing locations in China, Thailand, and Singapore have vastly reduced discharge of wastewater by reusing it in the manufacturing of additional products. In addition, Minebea-developed purified water-based washing systems have been installed at the manufacturing facilities, thereby eliminating the need to use ozone depleting substances.



Shanghai Plant



### 1 Blower fan for secondary battery cooling

The blower fan for secondary battery cooling realizes low vibration, noise and power consumption with optimization—designed motor parts and dedicated circuit design. The blower fan features a miniature lightweight design, high reliability and extended service life. There are two motor sizes –  $\phi$  50mm and  $\phi$  60mm. (under development)



### 2 DC motor for door mirrors

Minebea's DC motor is used for accurate adjustment of door mirrors to ensure rearward visibility. Minebea utilizes an improved magnetizing method enabling the DC motor low cogging and high reliability, which are critical parameters in meeting customer application requirements.



### 3 LED headlight cooling fan

The LED headlight cooling blower fan minimizes vibration and noise with optimization—designed motor parts and dedicated circuit design. The blower fan assembly is lightweight, and offers a moisture-resistant design with added flexibility as to its installation location. The motor itself has been carefully engineered for high reliability and long service life, and the factory installed connector offers versatility and ease of simple connection.



### 4 Motor for brake negative pressure

The brake vacuum motor fully compensates for the reduction in engine negative pressure in HEV and EV vehicles. Features include a dedicated circuit design, low power consumption, resistance to elevated temperatures, minimized vibration, and a waterproof construction. (under development)



### 5 Brushless motor for inter-vehicular distance sensors

Newly developed brushless motor for encompassing vehicle distance sensing. This noise sensitive scanning motor was design to incorporate reflective optic technology as a means to accurately measure surrounding vehicular distances. The motor is equipped with a integrated circuit and easily driven by DC power supply.



### 6 PM type stepping motor for headlight optical axis adjustment

PM type stepping motor used for headlight optical axis adjustment with HID/LED indicators. Motor capable to move the headlight optical axis as required, either horizontally or vertically (AFS [Adaptive Front-Lighting System]). The use of a liner type PM stepping motor affords noise reduction and added reliability for such an application.



### 9 Charger cooling blower fan for EV/HEV

The charger cooling blower fan for EV/HEV realizes low vibrations and noise with optimization—designed motor parts and dedicated circuit design. The blower fan has a miniature lightweight design, high reliability and long service life. (under development)



### 11 Pump motor for spraying urea

The pump motor is used for decomposing NOX into non-hazardous water and nitrogen by spraying urea into exhaust gas (urea SCR system). The motor has a miniature design and waterproof construction, and is designed to be installed in severe-condition engine compartments.



### 10 Geared PM type stepping motor for HVAC

The geared PM type stepping motor is used for controlling air flow in the air conditioning system. The motor is used extensively for flap actuation which alters the flow of air in the passenger compartment. In addition, the PM stepper motor technology can maintain increased air flow accuracy over what is typically possible with DC motors.



### 12 PM type stepping motor for instrument clusters

The micro stepping PM motor is used for the speedometer and tachometer within the instrument cluster. Owing to direct actuation with no use of gears, the motor offers low noise, high resolution capability and reliability, thus allowing for a more stable display.



### 7 DC motor for door locks

The DC motor for door lock realizes size reduction, high torque and weight reduction. It is designed for miniaturization, low current, low noise, high power, and long service life.



### 8 Motor for cooling fans of in-vehicle cooler

This inner rotor type brushless motor drives the fan of in-vehicle coolers. The motor is equipped with an integrated driver in the end cover, and can be driven with a simple DC power supply. Minebea ball bearings are utilized in the design for increased reliability and noise reduction.



## Topics of Motors

### In Vehicle Brushless Motor

Minebea's in-house design and development locations in Japan, coupled with high volume manufacturing expertise in Thailand, are key elements to fulfill the ever changing technical and commercial needs of our customers. Since Minebea not only designs motors, but also impellers, we are able to provide engineering solutions for the reduction of noise and vibration in accordance with application specifications. Furthermore, Minebea incorporates the use of internally produced high-precision miniature ball bearings for the enhancement of motor performance characteristics. In addition, Minebea is capable to provide additional features such as dedicated circuitry on the

outer rotor design which can utilize external signals to control the velocity and rotational direction. This closed loop velocity control capability can allow for the output of motor rotating speed signals (FG). Should your application require an inner rotor design, Minebea is capable to supply this product factory equipped with motor drivers as an independent series. Whether your application requires Minebea's outer rotor brushless motor, or the inner rotor design, you will have the assurance of utilizing a precision product that is optimally designed and tested for unparalleled performance.



Bang Pa-in Plant, Thailand

### Minebea's In-Vehicle PM Stepping Motors and Microactuators

Minebea produces microactuators that combine gears and PM type stepping motors for in-vehicle air conditioning systems (HVAC). These motors are designed and developed in Hamamatsu, Japan. However, mass production for both products is located in Thailand. Minebea uses internally produced pressed parts, resin molds, magnets and ball bearings for PM type stepping motors and microactuators. To

be sure, since Minebea produces molds for press/resin operations in-house; we are able to tightly control these processes, enabling enhanced production stability and final product quality.



Lop Buri Plant, Thailand



## 1 VR resolver for column EPS

Minebea's variable reluctance (VR) resolver is most suitable for sensing the positions of magnetic poles and speed control for motors for column EPS systems. The VR resolver is a high-precision angle detector developed to reliably endure the application environment all while providing excellent steering feel for the driver.



## 2 VR resolver for rack EPS

Minebea's variable reluctance (VR) resolver is a rotation angle sensor most suitable for sensing the positions of magnetic poles and speed control for motors for rack EPS systems. The high-precision angle detector developed to reliably endure the application environment all while providing excellent steering feel for the driver. In addition, the resolver is versatile as it can also be installed on the front wheel shaft.



## 3 Twin resolvers for torque sensors

The use of resolvers realizes high-precision detection and repeatability. The torque sensor detects steering torque using two brushless resolvers (twin resolvers). Minebea's offering was designed to consistently provide proper environmental resistance and can be installed on the pinion shaft. Moreover, it allows the detection of absolute positions via dedicated control.



## 4 VR resolver for ISG motors

The VR resolver used with ISG motor applications were developed and designed in accordance with Minebea philosophy of reliability. The angle sensor is suitable for sensing magnetic pole positioning and speed control for motors. However, the VR resolver is an angle detector which has the capability to follow the high-speed rotation associated with an ISG motor.



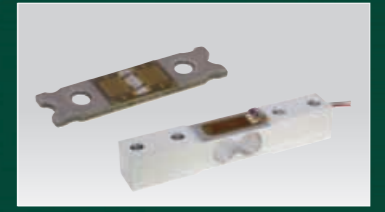
## 5 VR resolver for EV/HEV motors

The VR resolvers developed for EV/HEV motors typically have a larger diameter, but perform the same functions as the smaller units. The VR resolver is the rotation angle sensor most suitable for sensing the positions of magnetic poles and speed control for motors. In general, the product is known for sufficient environmental resistance. In addition, it is quite suitable as a rotation angle sensor for HEV that often require oil resistance.



## 6 Strain gauges for the sensors that detect passengers

The strain gauge-type sensor detects the weight and sitting positions of passengers to control powerful air bag deployment as regulated under the laws in the U.S. The detection method of the strain gauge detects the zero point by aged deterioration allowing for maintenance-free, high-accuracy detection.



## 7 VR resolver for brake systems

VR resolvers are mainly installed in motors for regenerative brakes at present. The positioning and speed control capability can be adopted for used in future brake systems such as brake-by-wire technology.



## 8 Backlights

Minebea's lighting devices are used on a wide range of models as the backlight for LCDs of GPS and instrument clusters. In preparation for increased use in the future, Minebea is developing systems for increased production in Suzhou, China and Lop Buri, Thailand.



## 9 Magnetic clutches for PSD/PTG

Magnetic clutches are used in the actuation control of applications such as: Power Slide Door, Power Lift Gate, and Power Trunk operations (PSD, PLG, PT). The clutches are located on vehicles that offer automatic open/close convenience via motors. As such, Minebea developed this product offering to minimize packaging by utilizing a thin design, and successfully incorporated a friction plate capable of maintaining stable torque for extended periods of time.



# Topics of Sensors

## Minebea's VR resolvers

The VR resolver is a rotation angle sensor that works by variable reactance. It consists of a winding-applied resolver stator and a resolver rotor made entirely of laminated steel plate. As an angle sensor, it has a simple structure, while offering high precision, high resolution and good environmental resistance. Standard models are available in size 15 (stator external diameter  $\phi$  37mm) and 21 (stator external diameter  $\phi$  52mm), and Minebea

has a lineup of multiplication factor angles: 2X to 8X (to 5X for size 15). Minebea develops and designs VR resolvers in Hamamatsu, Japan and mass-produces them in Bang Pa-in, Thailand. Moreover, Minebea separately supplies ICs (R/D converter) that convert resolver signals into digital signals. Minebea develops and markets R/D converters jointly with Analog Devices of the U.S.



Bang Pa-in Plant, Thailand

## Minebea's in-vehicle strain gauge-type load sensor and measurement products

Minebea develops and designs products with strain gauge core technology in Fujisawa, Japan, and mass-produces them in Lop Buri, Thailand. Minebea develops and supplies strain gauges and sensors for measurement, and converters and indicators for load, torque, pressure and displacement for industrial equipment. As their applied products, Minebea has been developing and supplying in-vehicle load sensors since 2002. As industrial measuring devices, Minebea produces

material tension-compression testers equipped with a high-precision load cell (load converter) and control circuit. The testers have a display and operation switches mounted on the front operation panel in a design that puts priority on usability, and the data processing software enables test control, data analysis and calculation from a PC. Minebea provides material tension-compression testers in the pursuit of multifunctional simple operation.



Lop Buri Plant, Thailand.

## Minebea's lighting devices

Minebea's lighting devices are used as backlights for LCD panels that have an LED light source, and as well as for a wide range of applications from smartphones, in-vehicle GPS and center information displays of instrument clusters. In particular, for in-vehicle lighting devices, Minebea ensures high reliability, durability and long service life, and has established a production line with a quality assurance system to deliver customer

satisfaction. With the increase in the rate of vehicles equipped with LCD panels, the demand for backlights is expected to increase greatly in the future, and Minebea's backlights will certainly meet customer demand.



Suzhou Plant, China