



8. Automobile

The automobile industry is going through a period of unprecedented change. Computer technology is moving into control and monitoring arrangements for many vehicle systems. Demand continues to increase for improvements in energy consumption, safety and comfort. Accordingly, demand is also rising for high-performance motors for advanced control systems. These sector's products are almost precision machinery components and enable us to maximize our competitive advantages. HCH offers the high reliable bearings for rotary components of automobiles as a business that offers outstanding medium to long-term growth potential and will actively cultivate new demand for these products. Now, it is the exciting and challenging times for all involved in engineering vehicles and vehicle systems.

For the aftermarket for cars and commercial vehicles, HCH has distribution partners all over the world. Our concept is to offer high quality products and premium services to our customers, whether your profession involves maintaining vehicles or supplying products to those who do. As a knowledge engineering company, HCH is much more than a components supplier. Our partners' engineers are well trained directly by HCH to be an expertise to improve overall system reliability, safety and efficiency.



The HCH developed bearing is recommended for use in various automobile parts used under high moments and heavy loads, we can expect further improvement of fatigue life in HCH with improved material and heat treatment.



General requirements for automobile

Maintenance free

For both manufacturers and drivers, it is of utmost importance that all vehicles demand as low maintenance efforts as possible. Because maintenance means standstills and standstills mean loss of income. To meet these needs for reduced maintenance, HCH has been always trying the best to improve its bearings' quality and steel material to sustain long HCH bearings' long service life.



Save power by reducing friction

Reduced energy consumption is of ever increasing importance. The most important for HCH bearings is to reduce the friction inside, by choosing low-friction grease, optimized seals and shields design. With HCH systematic quality control, we offer you with the best application solution for your automobile motor energy saving purpose.



Reduce vibration and noise levels

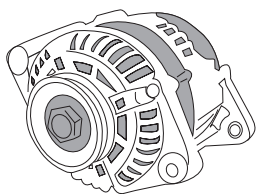
Excessive vibration and noise levels associated with automobile are an increasing concern for optimum performance reasons as well as for compliance with legislation. HCH offers a range of solutions for exceptionally quiet bearing operation, spanning from selection of bearings and lubrication to advanced engineering services, such as dynamic simulation, virtual testing and design concepts.

Environmental friendly

Our products represent a significant contribution to environmentally friendly mobility. As an engineering partner and supplier for almost all automobile manufacturers, we develop and manufacture forward-looking products and system solutions for alternators, engines, transmissions, steering system, metro-electricity and chassis. We use our "advance development and product innovation" process to work on requirements and solutions for the future.

8.1 Alternators & Starter Motors

Alternators



An alternator is a rotating machine supplying power for a vehicle's electric system and charging the battery. The increasing demand for electrical power in cars and the quest for weight reduction is driving the development of high power alternators: more compact alternators, more current producing. This development trend is pushing up alternator speed and operating temperature. Both factors are significant in the selection of a suitable bearing solution.

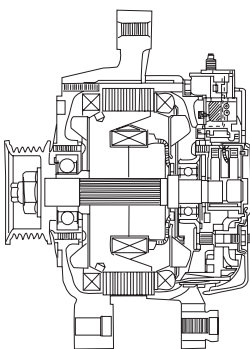
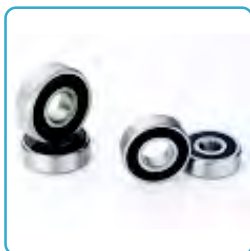
Alternators work in a difficult environment. Engine assembly packaging has often exacerbated this condition by placing alternators in locations where they are more exposed to road-spray or close to the high temperature of the engine's exhaust system. With the requirement for operation in cold-climate starting and hot-climate motorway conditions, alternators must span a very wide operating temperature range, typically from 40 °C to highs approaching 200 °C. High speed alternators run at three to four times engine speed, so the alternator will be subjected to speeds, albeit for limited periods, in excess of 20,000 rev/min.

HCH bearings for alternators

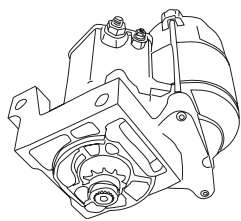
It is important to make various improvements in response to requirements for high-temperature, high-speed performance. Some technical breakthroughs in HCH have been achieved which have contributed to HCH alternator bearing specifications being what they are today. The most noteworthy among them was the development of new grease which eliminated the peculiar problem of early flaking in the outer rings of alternator front bearings. The breakthrough of high-temperature resistance seal material has greatly improved the life of automobile alternator bearings.

High efficiency type alternators as shown in the left picture and water cooled alternators have been developed in order to improve power generation efficiency and lower noise level, and for these rotor support bearings, extremely high heat resistance is required in most cases.

The research and development of new seal structure for alternator bearings to meet the escalating requirements of our customers is ongoing at HCH.



HCH has already developed alternator bearings for high temperature of 180 C and 200 C, based on those for generally required temperature of 150 C, and they are now in mass production.



Starter motors

Most people don't think much about their starter motor until it stops. Car starters and truck starters have to deliver loads of torque for cranking vehicle engines in all conditions. In cold weather, battery drain and oil viscosity take their toll on the starter motor. In hot weather, starter heat soak can lock an iffy starter up. Either way, you're not getting anywhere if your starter motor decides to give up the ghost. Moreover,

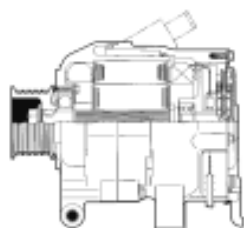
high-torque starter motors and gear-reduction starter motors are available for a high-performance or race engine. We've got you covered there too.

HCH bearings for starters

All of HCH bearings for car and truck starter motors meet rigorous quality standards and are guaranteed to work with your application. Since starter motors face a wide range of temperature and the operating speed are usually high (can reach 10000 rpm), HCH offer synthetic grease that can suffer the temperature range of -40 C to 200 C. with good fatigue resistance characteristics. For the rubber sealed bearings, HCH offer optimized sealing design for your requirement of high running speed and low torque.



Starter generators



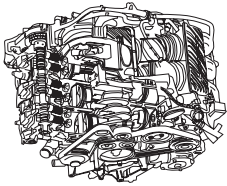
Recently, a starter generator show in the left picture, a new type of alternator with an added function as a starter is already in the market. The purpose of a starter generator are: an easy drive change from a motor to an engine, smooth re-start after a vehicle or an engine stops, and regeneration of brake energy while hybrid vehicles are running. By adding starter function,

higher belt tension is required and higher load is imposed on the bearing at start time, and then a higher capacity bearing is needed. For drastic reduction in fuel consumption in the future, hybrid technology of an electric motor and gasoline engine as exemplified in idle stop is requisite. Starter generators are thought to be increasingly used in the future as essential accessories for hybrid vehicles. As the basic construction of a starter generator is similar to that of an alternator, the required specifications such as maximum rotational speed, heat and environmental resistance, and vibration resistance can be fulfilled by HCH technology accumulated in the alternator bearing development.

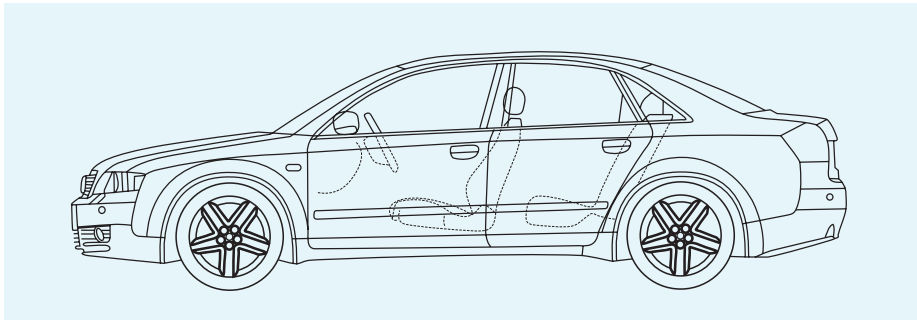


Bearings of the HCH brands are characterized by high performance density, long operating life and maintenance-free bearing solutions in various installation points.

8.2 Engine system



Today's petrol (gasoline) and diesel engines are highly sophisticated and computer regulated devices. The substantial gains seen in recent years in economy and emission levels have been, in the main, due to the very complex and detailed control provided by modern ECU engine management systems. For most of cars, gasoline engines are applied. However, for many heavy vehicles, diesel engines are widely applied.



Cooling system, pumps and fans-- Electric cooling fan motor for engine radiator and air conditioning condenser

Air-conditioning condenser and engine radiator are typically grouped together as a unit at the front of the engine compartment. Automatic air-conditioning systems require efficient and frequent condenser cooling. However, high demands for reduced fuel consumption, longer service life and extended warranty periods impose higher requirements on engine thermal management. Therefore, recent developments further focused on electric water pumps, motorized fans between engine and radiator, as between heater matrix and the vehicle's interior. Usual performance features requested for engine radiator and air-conditioning condenser cooling fan motors are:

- > Compactness
- > Silent running
- > Mechanical and electric components compatibility with frequent and occasional severe contamination
- > Longer service life including systematic running from engine start.
- > Low friction torque for saving electric energy particularly at low operating temperatures.



It goes without saying that social demands for automobiles will continue to rise. HCH would focus on intelligent, modulated, innovative technologies to meet the increasing demands for the future.



HCH bearings for cooling system, pumps and fans of engines

HCH low friction deep groove ball bearings with optimized clearance improve fan running accuracy, power full and silent air flow and contribute to a long service life for the complete motor assembly. HCH has developed a wide variety of innovative solutions. In our work, we continue to aim at combining reduced fuel consumption, emissions and noise with best performance and cost-effectiveness.

Chain / belt shaft load

The tangential loads on sprockets or pulleys when power (load) is transmitted by means of chains or belts can be calculated by formula:

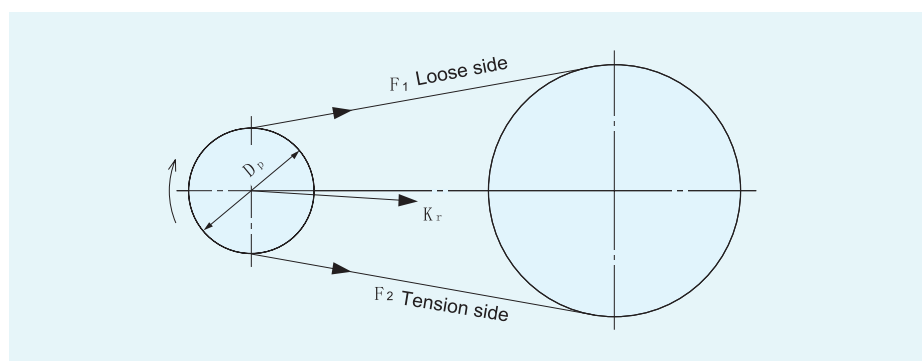
$$K_t = \frac{19.1 \times 10^6 \cdot H}{D_p \cdot n} \text{ N} = \frac{1.95 \times 10^6 \cdot H}{D_p \cdot n} \text{ kgf}$$

where,

K_t : Sprocket/pulley tangential load, N

H : Transmitted force, kW

D_p : Sprocket/pulley pitch diameter, mm



For belt drives, an initial tension is applied to give sufficient constant operating tension on the belt and pulley. Taking this tension into account, the radial loads acting on the pulley are expressed by formula. For chain drives, the same formula can also be used if vibrations and shock loads are taken into consideration.

$$K_r = f_b \cdot K_t$$

where,

K_r : Sprocket or pulley radial load, N

f_b : Chain or belt factor

Chain or belt type	f_b
Chain (single)	1.2~1.5
V-belt	1.5~2.0
Timing belt	1.1~1.3
Flat belt (w / tension pulley)	2.5~3.0
Flat belt	3.0~4.0



Innovation continuously increases the standard of technically based products. Keep updated is critical for automobile transmission manufacturers. We offer our customers perfectly coordinated system solutions. This means that you receive drives and bearing supports from one source and can therefore benefit from entirely new opportunities in performance and design.

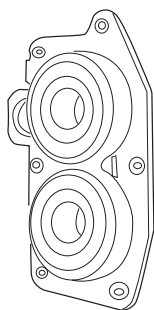
8.3 Driveline

A car's driveline is normally considered to include everything from the clutch through to the driven wheels.

Gearboxes

The gearbox can be considered as a translator working between the engine and the wheels of a vehicle. Or put it another way, it is the gearbox, that enables the engine to answer the driver's request for power in any driving condition, whether the need is for high torque at low speed in hill climbing or for high speed at low torque on the motorway. It is the gearbox, that allows the engine to run in a balanced state and at an appropriate level.

As old as the car industry, there is a strong need for continuous development and innovation in gearbox designs. There are two gearbox designs currently common in car production: one are manual transmission, and the other is automatic transmission. The demands are coming from the market, such as reduction of fuel consumption and noise, improvements in drivability and, last but not least, the "fun-to-drive" factor. HCH contributes to meeting these targets by offering high quality anti-friction bearings.



Bearing carrier

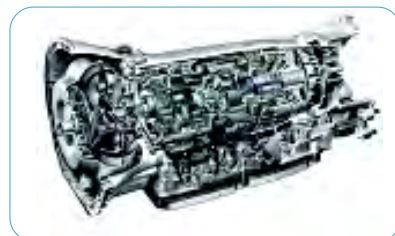
In a car gearbox, the accuracy and stability of the gear wheels' relative position on the main shaft and the layshaft is vital for the correct functioning of the gear mesh. Directly linked to this is the noise and friction behavior of the gearbox. In order to have a stable condition, it is important to have a rigid support of the mainshaft and layshaft. In transmissions with a high power density, this requirement can be enhanced by bearing carrier unit consisting of a sheet metal carrier, and two bearings (typically either deep groove ball bearings) pressed into the carrier. The bearing carrier offers potential for cost saving on the gearbox assembly line. Pre-assembling

the gear shafts in the bearing carrier and then mounting this complete assembly in the casing can be a significantly simplify to the assembly process.

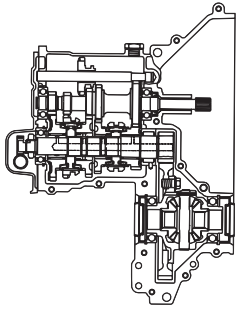
HCH bearings for gearbox

HCH high efficiency tapered roller bearings and ball bearings are used primarily on the pinion and differential shafts in the final drives of rear-wheel drive or all-wheel drive cars. This new improved level of efficiency is possible through the detailed application of HCH's comprehensive theoretical knowledge and specialized manufacturing know-how. HCH high efficiency tapered roller bearings offer reduction of bearing power loss and increased service life by optimized bearing

design which adapts to the external loading conditions. HCH deep groove ball bearings in the gear box usually appear as a pair with located position in the pre-assembled unit bolts onto the gearbox housing. With high quality bearing material and optimized seal construction, we meet our customers' demand with their satisfaction.



Research and development on drive lines to improve fuel consumption is making progress. HCH would focus on attractive product and technology development to meet the increasing demands for the future.



Transmission & Gearbox bearings and HCH solution

Bearings used in transmission or differential gears are usually lubricated by oil containing foreign particles such as swarf, burrs produced when parts are machined, worn powders of gears, and debris from the case. Particularly, the failure mode of bearings under lubricating conditions including hard foreign particles is surface flaking originated at the edges of dents due to roll-over of foreign particles or surface layer peeling caused by abrasive wear. With ordinary bearings, life is shortened to one of several parts to one of several tens of parts of that in clean oil. Therefore this problem is solved

either by the material/heat treatment or the sealing technology improvement as indicated below:

Material/heat treatment technology solution

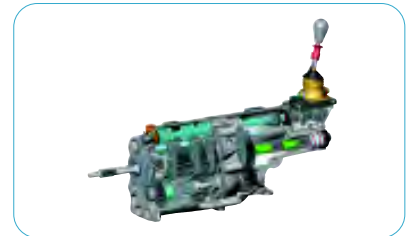
With tapered roller bearings, life is extended by applying HCH's original carburizing steel materials and heat treatment technology. In order to reduce crack propagation and cracking and at the same time for early elimination of dent edges due to foreign particle, a special heat treatment to raise surface hardness and optimize the amount of retained austenite was developed, which extremely extended the bearing service life.

Seal design solution

Regarding sealed ball bearings in transmissions, entry of foreign particles in the oil into bearings is drastically reduced and running torque is also lowered by the HCH optimized seal lip design to minimize the amount of interference change relative to misalignment and axial gear load. The rubber material of the seal is selected considering heat resistance and compatibility with oil. The bearing is filled with grease and sealed to improve initial lubricating performance.

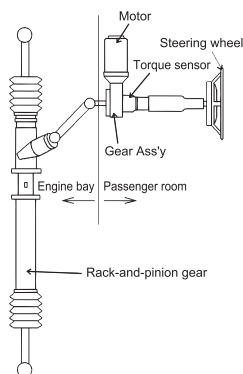
Coping with high load and high moment

Along with making units like transmissions more compact and lightweight, more compact bearings are demanded. On the other hand, engine torque increase and weight reduction of casing bring increase in bearing load and in shaft deflection, resulting a harsh condition for the bearing. As a result, particularly with tapered roller bearings have line contact; life is often shortened due to the edge stress. Based on the results of rigidity analysis of case and shaft systems using the latest computer technology, HCH has developed a special crowning shape in the axial direction that makes contact stress distribution of the area where the rollers contact with the raceway uniformly based on the results of rigidity analysis of case and shaft system, and is now mass producing the bearing with such technology. The life is around 3 times longer compared with an ordinary bearing.



At HCH, we have worked primarily to improve materials and heat treatment methods as well as develop new bearing internal designs that can operate under higher and moment loads and apply these to long-life bearings.

8.4 Steering System

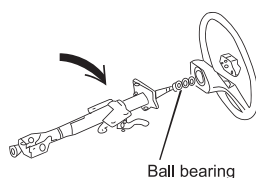


Vehicles have three basic functions: moving, turning and stopping. Turning is the job of the steering system. Steering systems are mechanisms by which turning displacement of the steering wheel is converted to turning of the tires via the steering gear. Various types of rolling bearings are used in the various rotational mechanisms of steering system. The main steering system from the steering wheel to the tires consists of the following components:

- >Steering column
- >Steering gear
- >Hydraulic pump

HCH bearings for steering column

One ball bearing is used on the upper side and the other is on the lower side as column shaft support bearings. This series ball bearings are used due to limited space. Because the radial and axial play of the steering wheel should be minimized, the residual radial clearance of the bearing after mounting should be very small even slightly negative. HCH are able to supply these kinds of bearings with optimized clearance.



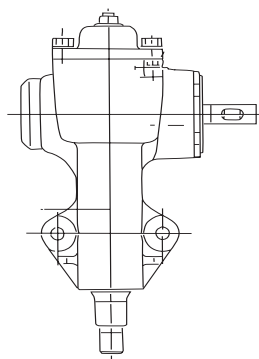
Moreover material with high purity and long service life is heat treated by most advanced machines.

HCH bearings for steering gear

Steering gear bearings are usually for rack-and-pinion type steering. For this application, axial and radial loads are produced by gear reaction. Axial load is supported by the deep groove ball bearing. Since the axial load being placed on the bearing is usually high, and therefore thorough consideration should be given to the allowable axial load of the bearings. In the case of power steering, bearings are also used in the torsion bar, if the clearance after assembly is a source of noise, deep groove ball bearings are used and clearance after assembly is made negative.

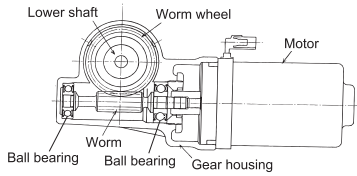
HCH bearings for pumps

Ball bearings are used for pulley support of the engine-driven hydraulic pump (vane pump), which serves as the power source for hydraulic power steering. The configuration is shown in the picture. The side of the bearing facing the pulley is exposed to the air in the engine bay, so the bearing must be sealed. Furthermore, the bearing must have a small running torque in order to minimize energy loss. Therefore, HCH has developed a very light contact type seals for this application. However, if the bearing is mounted near the road surface in the engine bay, HCH contact type seals are used so that muddy water can't get into the bearing if it gets on the bearing from the pulley side.



The performance required of bearings differs somewhat according to the part in which the bearing is used. Excessive axial play must be avoided for parts that affect steering feeling, such as the steering column and steering gear.

Electric power steering



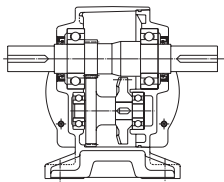
Electric power steering (EPS), which uses an electric motor as its power source, is now being used increasingly in the place of engine-driven hydraulic power steering because it reduces energy loss. Regarding the features of column type EPS shown in the picture, because the motor, reduction gear and other parts com-

posing the power assist mechanism are concentrated on the column, a manual steering system can be converted to a power system merely by changing the column unit. Basically, only the motor and the reduction mechanism are added, and therefore column type EPS is much lighter and more compact than a conventional hydraulic power steering system.



HCH bearings for reduction gear and electric motors

Two deep groove ball bearings are used for worm shaft support. The pre-load is applied from the outer ring side of the motor side bearings. The axial and radial loads produced by reaction of the worm gear are supported by the two bearings. Quiet operation is especially important because it is located in the passenger room, and sufficient consideration must be given to noise regarding these bearings.



Brush-less permanent magnets motors will provide better steering feel due to lower rotor inertia. A brush-less approach will typically provide a longer service life than brush equivalent. The usual performance criteria requested for electric motors are:

- > Silent running
- > Mechanical and electric components compatible with frequent and occasional severe contamination
- > Long service life including resistance to knocks and shocks which may occur during vehicle maintenance
- > Low friction torque, conserving battery power



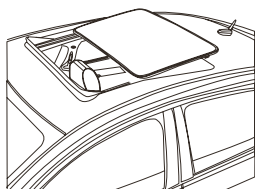
Electro-hydraulic assisted steering, where the hydraulic pump is driven by electric motor, are also becoming more common. In this case steering power is supplied with the required amount of energy for a relatively short duration.

Accordingly, HCH endeavor to develop bearings in electric motors for driving hydraulic gear pump or worm gear reducer with following characteristics:

- > Torque reduction
- > Improved stiffness, under low and high load
- > Low friction for reduced energy consumption
- > Longer service life with HCH high quality bearing material and advanced heat treatment technology

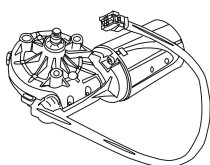
8.5 Metro-electricity

Integrating mechanical systems with electric power lead to more efficient, reliable and safer products. These applications are used everywhere in vehicles such as air conditioning, engine radiator, automatic window lifter, wipers and various sliders. Serving OEM customers of these applications for many years,



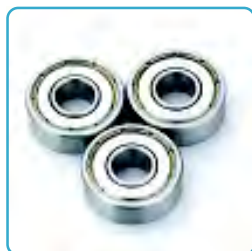
Sliders

When it comes to various sliders, drivers' comfort is paramount. Effortless control of equipment movement and low operating noise levels should be considered. These features increase comfort for drivers and optimize driving conditions.



Wiper motors

One of the most obvious components in this section is wiper motors which are applied with the requirements of silent running and low friction torque for continuously variable speed and permanent rotation.



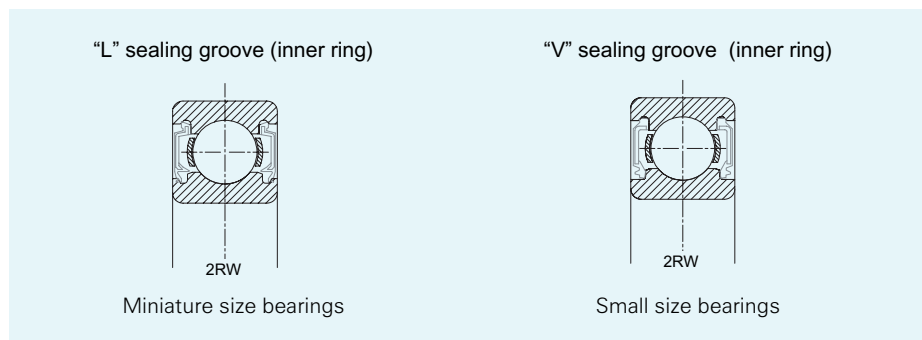
HCH bearings for metro-electricity appliances

HCH low friction deep groove ball bearings with optimized clearance improve motors silent running. What is more, now HCH is improving the seal lip design (2RW) in new ball bearing series production with new sealing standard and improves sealing properties like:

- > Low friction
- > Speed ability
- > Long service life
- > Grease retention
- > Dust exclusion
- > Static and dynamic high pressure water exclusion

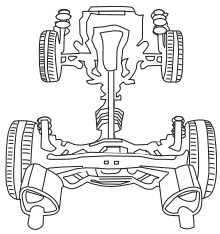


HCH has developed unique application knowledge. We have been able to develop a number of standard and customized solutions. In this work, we continue to focus on our customers by supplying ultra low noise and low vibration, low friction and low torque bearings.



This is a new generation of bearing seals, which offers more possibilities and a wide range of applications. Low-friction HCH ball bearings make shifting easy. In contrast to steel-steel solutions, these rolling bearings offer consistent, low radial internal clearance for the shift drum and wear-free operation.

8.6 Chassis

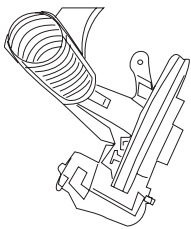


To be cost-effective, these applications need to be compact and require a minimum of maintenance, but there is also an urgent need for these to contribute to increased safety for operators. To meet these demands, HCH offers a wide range of high reliable bearings. For improved cost-effectiveness, the HCH bearings are maintenance-free and facilitate downsizing.

HCH bearings for chassis

Ball bearings with integrated seals that have been lubricated for life are the preferred choice due to their shock resistance and smooth operation. Their low friction and low wear also contribute to fuel savings. HCH offers bearings with the characteristics as following:

- > HCH high quality, ultra clean steel material can improve bearings' liability further than customers' expectation.
- > HCH synthetic grease with multi-temperature function further strengthen the bearing reliability in different working environment.
- > HCH bearings with special designed sealing structure with three sealing lips for better dust preventing function.
- > HCH customized clearance selection system guarantees the bearing's high efficiency and prevent bearings from creep.



Suspension

A vehicle's suspension must:

- > Carry the vehicle mass.
- > Ensure contact between the tyre and the road.
- > Isolate the chassis from the disturbances created by the interface between tyre and road.
- > Guide the wheel in its displacement.



Bearing applications in chassis and attachments are commonly exposed to heavy loads, often in rough working conditions. HCH bearings are designed for tough working environments and also offer minimal environmental impact.

HCH bearings for suspension

Bearings under vehicles' suspension system are usually under very high loads and in very harsh environment especially when the vehicles are on the muddy or dusty road. Working with world famous automotive manufactures, HCH has abundant experience of bearings for suspension. We highly understand the customers' demands on high reliability, low friction, and dust preventing products. HCH's engineering resources and consulting services can help the design engineer improve the overall functionality of suspension.



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