

**Koyo**

Wind Turbine Generator Products

# Wind Turbine Generators

**JTEKT**

JTEKT CORPORATION

CAT. NO.B1002E

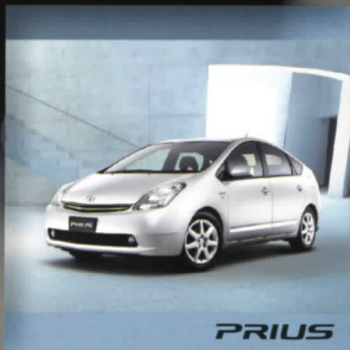
# Trust

## Synergy of cutting-edge bearing technologies and machine tool technologies...JTEKT

Established in 1935, "Koyo" has continued to evolve as a leading international bearing brand for over 70 years. Many kinds of bearings are manufactured that contribute to society such as the launch of the world's first ceramic bearings into market. The bearing business—based on an elemental technology that supports rotational motion—is often described as "the Industry's Heart" and the machine tool business, which is also called "the Mother of Machines". Combining these two businesses, a new company was established in 2006, JTEKT. Manufacturing bearings and large-scale machining tools (i.e., for gearbox machining) enables us to respond to a wide variety of market needs. Besides machine tools and bearing technologies, we also have the technologies to produce automotive steering and drive line parts for transmitting torque. We also contribute to the environment as a world-leading parts manufacturer.

## Contributing to the realisation of an environment-friendly society through not only eco-cars but also wind turbine generators

The "Prius", a hybrid vehicle manufactured by Toyota, has attracted much attention worldwide as an ultra-fuel-efficient eco-car, where JTEKT bearings and steering components are implemented. We have also begun providing the bearings for the "main shaft" of the wind turbine generators introduced in Europe even before the Kyoto Protocol was enacted in 1997. The wind turbine generator(wind turbine) market has been growing rapidly, backed by the rising public interest in bringing a halt to global warming. The generating output of wind turbines has also improved significantly, increasing from the 200kW class to a 2MW class, and now even to multi-MW classes. In 2007, wind turbines utilising JTEKT bearings for the main shaft contributed to reducing CO<sub>2</sub> by 7.6 million tons. In addition to bearings, we also supply numerous large-scale machining centres for manufacturing gearboxes. Based on the three aspects of "safety," "environment" and "comfort," JTEKT is committed to environment-friendly manufacturing that society can trust.



# Technology

## Wind turbine generator operating environment

The wind energy moving wind turbine blades is changed into rotational energy at the rotor. That energy is then transferred through the main shaft and gearbox, and finally transformed into electricity by the generator. This is the main flow of the power train in a wind turbine generator. The load on the wind turbine generator (Fig. 1) varies widely from light to heavy according to the wind speed and direction, which changes every 0.1sec, and this affects rotational speed as well (Fig. 2). Additionally, the operating temperatures can range from -30 to 100°C. Even under such severe conditions, the designed service life for bearings is over 20 years, a strict requirement in order to ensure high reliability.

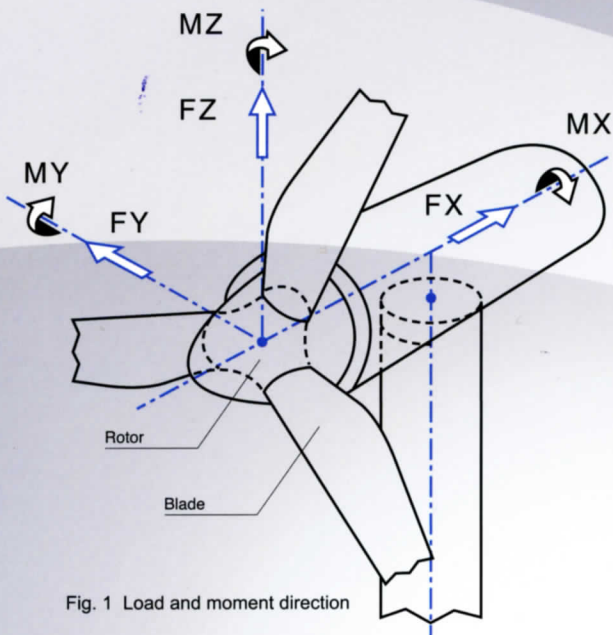


Fig. 1 Load and moment direction

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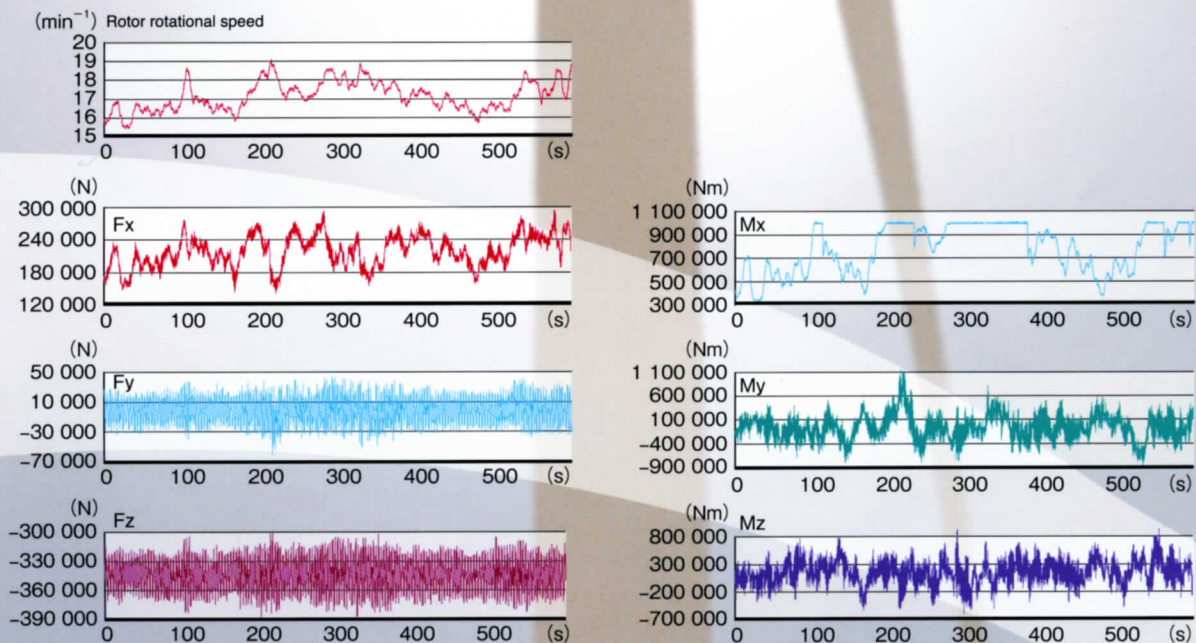


Fig. 2 Example of load conditions used for bearing selection: 600sec (rotor rotational speed, load, moment)

## Hybrid ceramic bearings for generators

Bearings used in generators are subject to electric pitting—a phenomenon where the surface melts locally because sparks are generated as the electricity passes through the ultra-thin oil layer and into the bearing while it is rotating—and this is one of the factors that can lead to damage and reduce bearing service life. As a measure to prevent this, a ceramic ball with excellent insulation performance is used for as rolling elements, creating a hybrid ceramic bearing with good efficiency. Furthermore, compared to common bearings, the hybrid ceramic bearing does not reach high temperatures when rotating (Fig. 3), which improve the life of the lubrication and the duration of preventive maintenance.

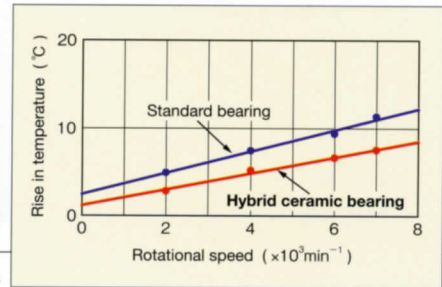


Fig. 3 Temperature rising characteristics of hybrid ceramic bearings

## Main shaft bearings

After the wind load is transferred through the rotor, this important component transmits the rotational torque to the gearbox. Spherical roller bearings (Fig. 4) are mainly utilised for the main shaft bearings because of their superior aligning characteristics and load durability. At JTEKT, compact and highly reliable bearings are selected taking into account thorough analyses of complicated rotor rotational speeds, appropriate loads, the shaft, housing rigidity and lubrication. An example of the main shaft configuration is shown in Fig. 5, and Fig. 6 shows an FEM analysis example for the main shaft housing.

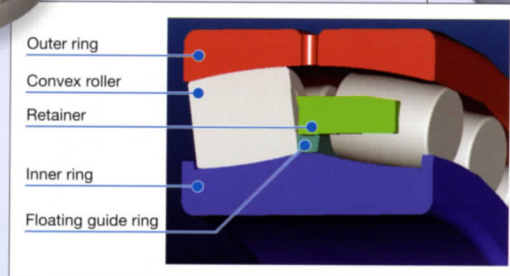
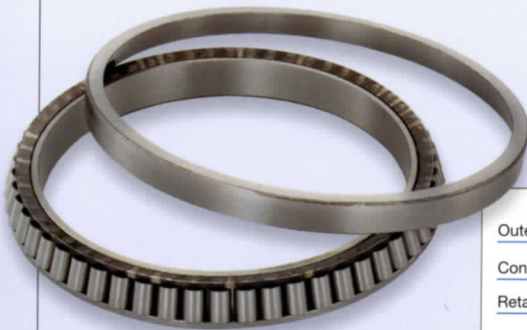


Fig. 4 Main shaft bearings (spherical roller bearings)

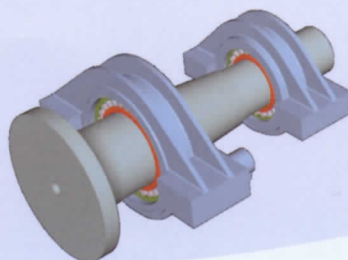


Fig. 5 Example of the main shaft configuration

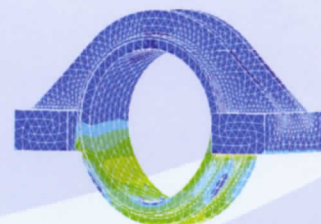


Fig. 6 Example of a FEM analysis for the main shaft housing

## Gearbox bearings

The gearbox is the component that increases the rotational speed transmitted via the main shaft up to the point where power can be generated. It consists of planet gears, a ring gear, a low-speed shaft, an intermediate shaft, and a high-speed shaft. Figure 7 shows a typical configuration for a one-stage-planetary gear and two-stage-parallel shafts (intermediate and high-speed shafts). In many cases, double-row cylindrical roller bearings are used for the planet gear section, but recently the utilisation of an integral-type bearing (Fig. 8) is on the increase.

It is also important to investigate the proper bearings for the gearbox using an analysis program similar to that for the main shaft. An example of analysis results for the planet gear section is shown in Fig. 9. If the rigidity of the planet gear is low, the ring gear deforms, and this may have an influence on the inner components and shorten the service life of the bearings.



## Reduction gear (Nabtesco Corporation)



## KE bearings for yaw-driven reduction gears

The bearings utilised in reduction gears can be subjected to contamination of metallic particles resulting from exposure to abrasive microscopic particulates, and this can influence the bearing service life. Koyo KE tapered roller bearings have the best results when subjected to such severe conditions. KE bearings have an extremely hard raceway surface, and the volume of the retained austenite has been optimised, resulting in bearings that have dramatically improved performance in contaminated lubricants. The service life characteristics for these bearings are shown in Fig. 10.

## Main shaft oil seal

### Full-rubber Seal (MS type)

- Full-rubber material simplifies installation
- Can be manufactured with a cut-type in one location

### Pressure-resistant seal (MHSA type)

- Reduction of lip deformation due to pressure
- Excellent sealing performance under high-pressure conditions

MHSA type

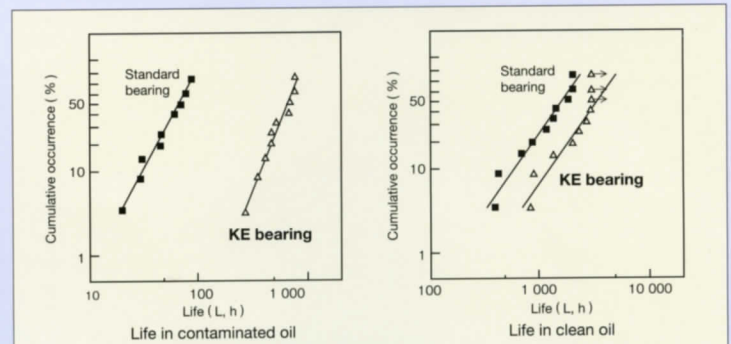


Fig. 10 KE bearing life characteristics

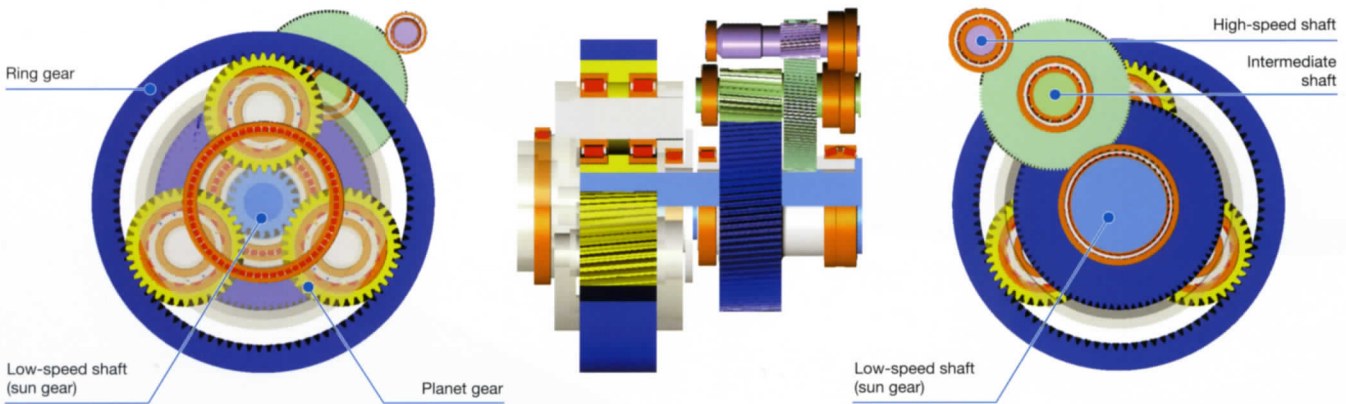
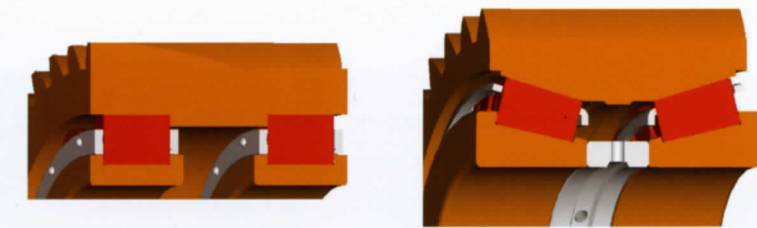


Fig. 7 Example of a gearbox configuration



Example of a double-row-cylindrical roller bearing (integral type) adoption

Example of a double-row-tapered roller bearing (integral type) adoption

Fig. 8 Example of a bearing arrangement for a planet gear section on a low-speed shaft

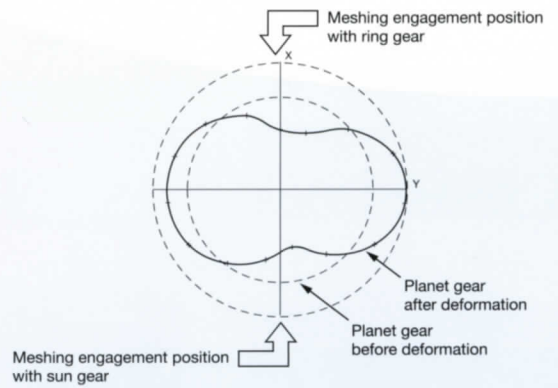


Fig. 9 Planet gear rigidity study results

## JTEKT Products Utilised in Wind Turbine Generator Production and Control

### Machine tools

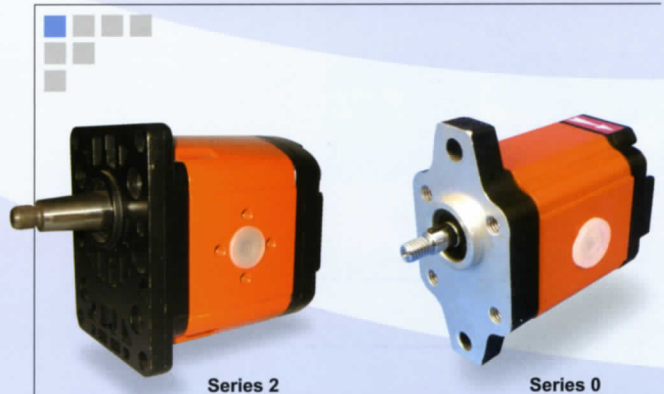


FH1250SX

This large-scale horizontal machining centre is suited for the machining of large components, and offers maximum performance in class (palette sizes over 1,000mm square), size, speed and power.

Maximum size: Work piece area diameter 2400mm x 1800mm  
 Maximum speed: Rapid feeding 42m/min  
 Maximum power: High-torque spindle ensures excellent cutting performance

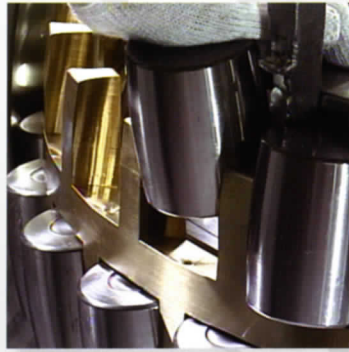
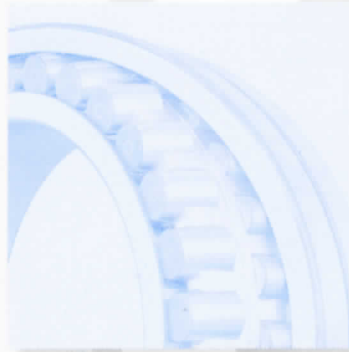
### Pitch brake hydraulic pumps



Series 2

Series 0

Utilised as the power pack for pitch brakes. Power packs reduce the rotor speed using a disc in a way similar to that of the disc brakes used in automobiles. For safety, the brake is equipped with an independent hydraulic system.



# Quality

**Offering Japanese quality with prestigious development and manufacturing techniques**

In recent years, the output capacity of wind turbine generators has continued to increase. However, growth in terms of the size of wind turbines has reached its limits. The current demand is for smaller and lighter wind turbines with equivalent or better power-generating capability, higher reliability, and maintenance-free systems. With this background, the performance requirements demanded from bearings have become increasingly diverse. Other important issues include consideration for characteristics such as energy efficiency, safety, high product quality that is compliant with global standards, and more competitive pricing. Utilising its development expertise, JTEKT is introducing cutting-edge technologies to resolve such issues. To support this, basic technologies applied in various fields, such as tribology, nano technology, materials development, precision machining and heat treatment processes, are included as well. We have established a worldwide network to further deepen the use of these basic technologies and expand our technology development capabilities even further. High evaluations are received not only from our customers, but also from other markets.

In terms of manufacturing, we integrate mass production technologies acquired through automobile bearing production and large-scale product production technologies acquired through bearing production for the steel-making industry and tunnel boring machines to create manufacturing lines never before imagined. Product management systems such as "KAIZEN" and "MIERUKA" are also implemented to ensure world-class Japanese quality.

# GLOBAL NETWORK

Global Network for Manufacturing and Sales

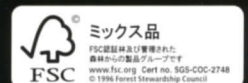


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Value & Technology



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