# MINEBEA

## New FDBs for HDD Spindle Motors

## “ROF Type”

*May 20, 2004*

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Our basic development concepts were:

1) High suitability for mass-production,
2) Unparalleled cost-competitiveness, and
3) High performance.

## 2. Characteristics

**By using Minebea's**

**Ball Bearing Manufacturing Technology,**

**Production Lines, and**

**Production Method,**

**which monthly turn out 170 million pieces of ball bearings (or 340 million pieces in terms of number of rings), and by applying**

**Quenching and Grinding Finish to Stainless Steel,**

**the key component of FDB ~ the Bearing portion ~ is produced.**

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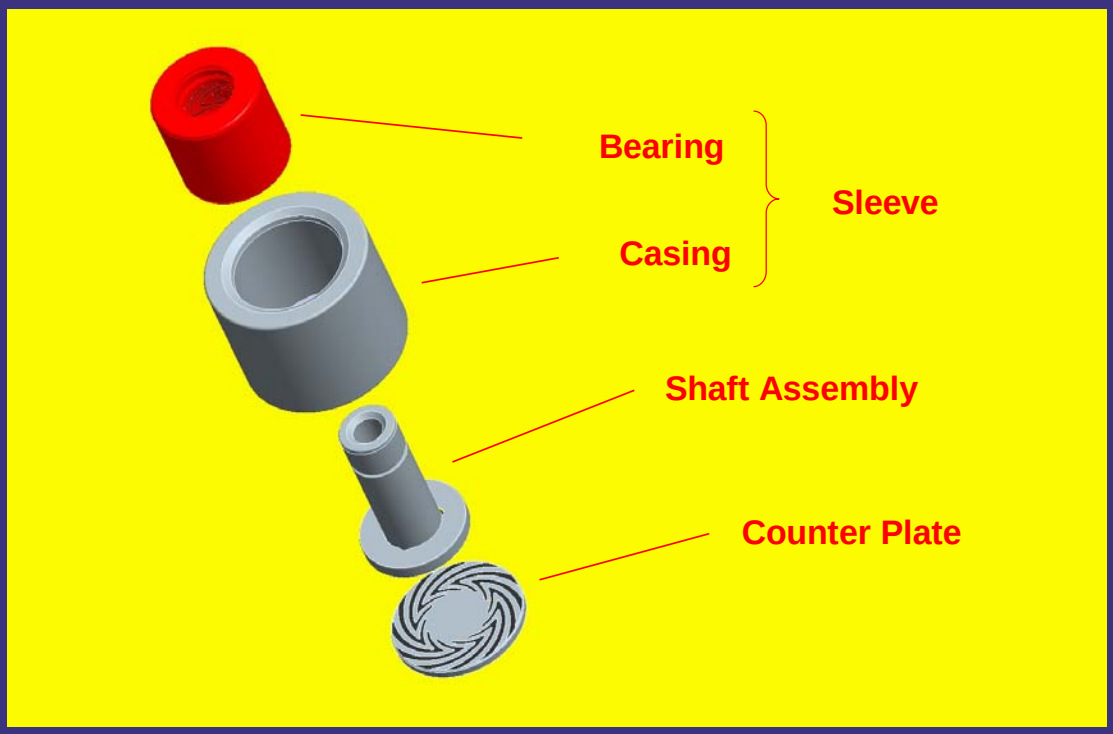
Minebea produces 170 million ball bearings a month, which translates into 340 million rings. We use our unique ball bearing manufacturing technology, production lines and production methods to manufacture the bearing portion that is at the heart of fluid dynamic bearings (FDB). These bearing portions have exactly the same basic dimensions, shape and design as bearings of conventional FDBs.

## 3. Structure of ROF Type FDB Unit

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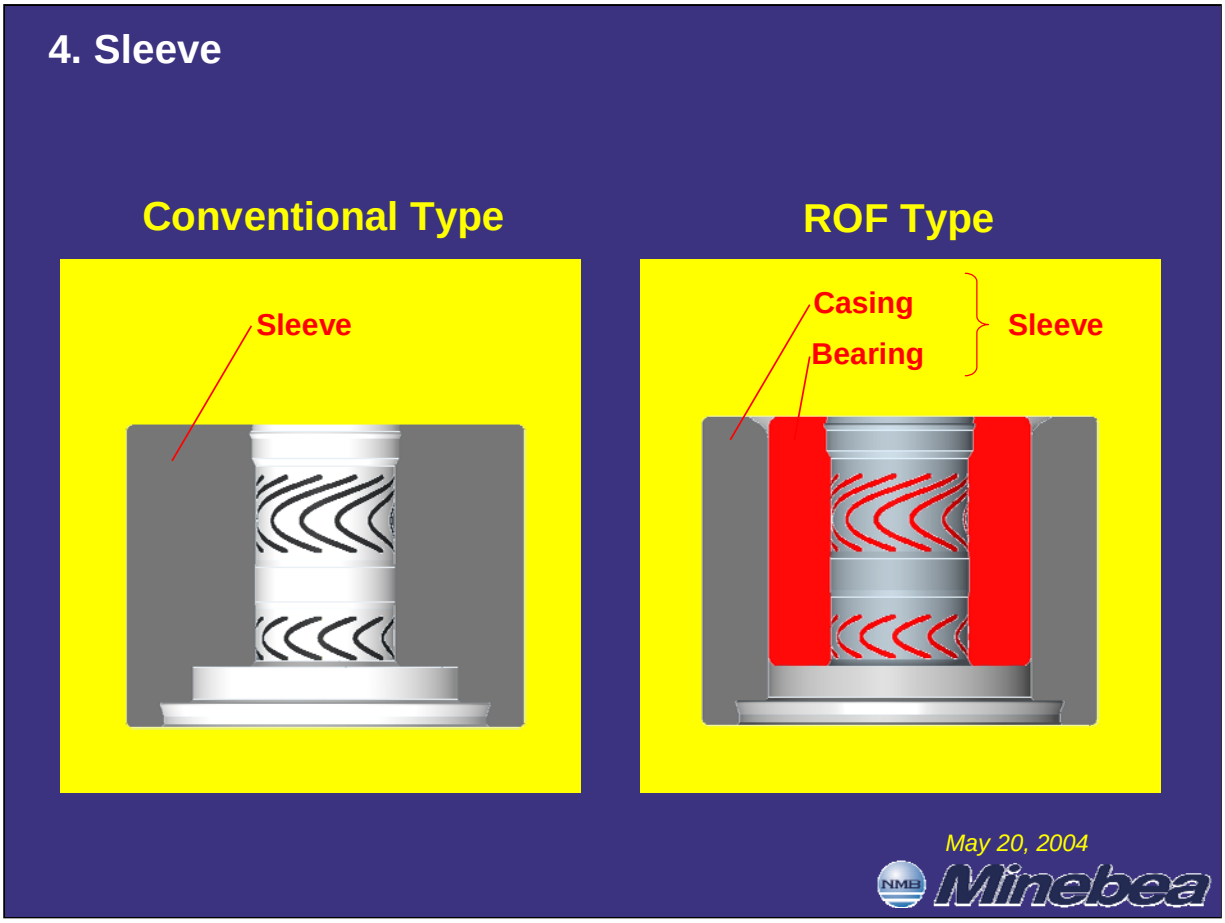
The new ROF type FDB units are comprised of four parts.

In conventional FDB units the bearing portion and casing were an integrated component called a "sleeve." The ROF type divides the sleeve into two parts, the bearing portion and the casing. The bearing portion, which is the most important and most expensive part, is manufactured with exactly the same processes and technologies as conventional ball bearings.

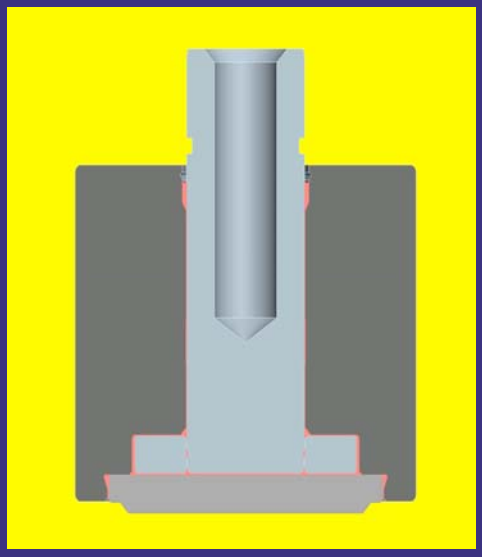
The other parts, the shaft assembly and counter plate, are exactly the same as used in conventional FDB units.



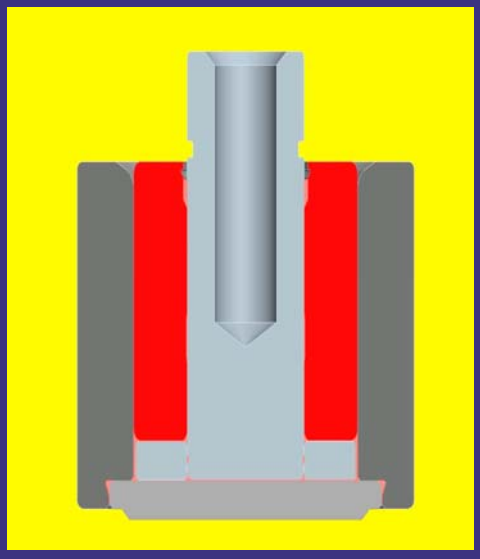

A conventional FDB sleeve is formed with a precision lathe as illustrated in the drawing on the left. In the ROF type, the bearing portion is in ring form and produced on the ball bearing production line.

## 5. Comparison with Conventional FDB

**Conventional Type**



**ROF Type**



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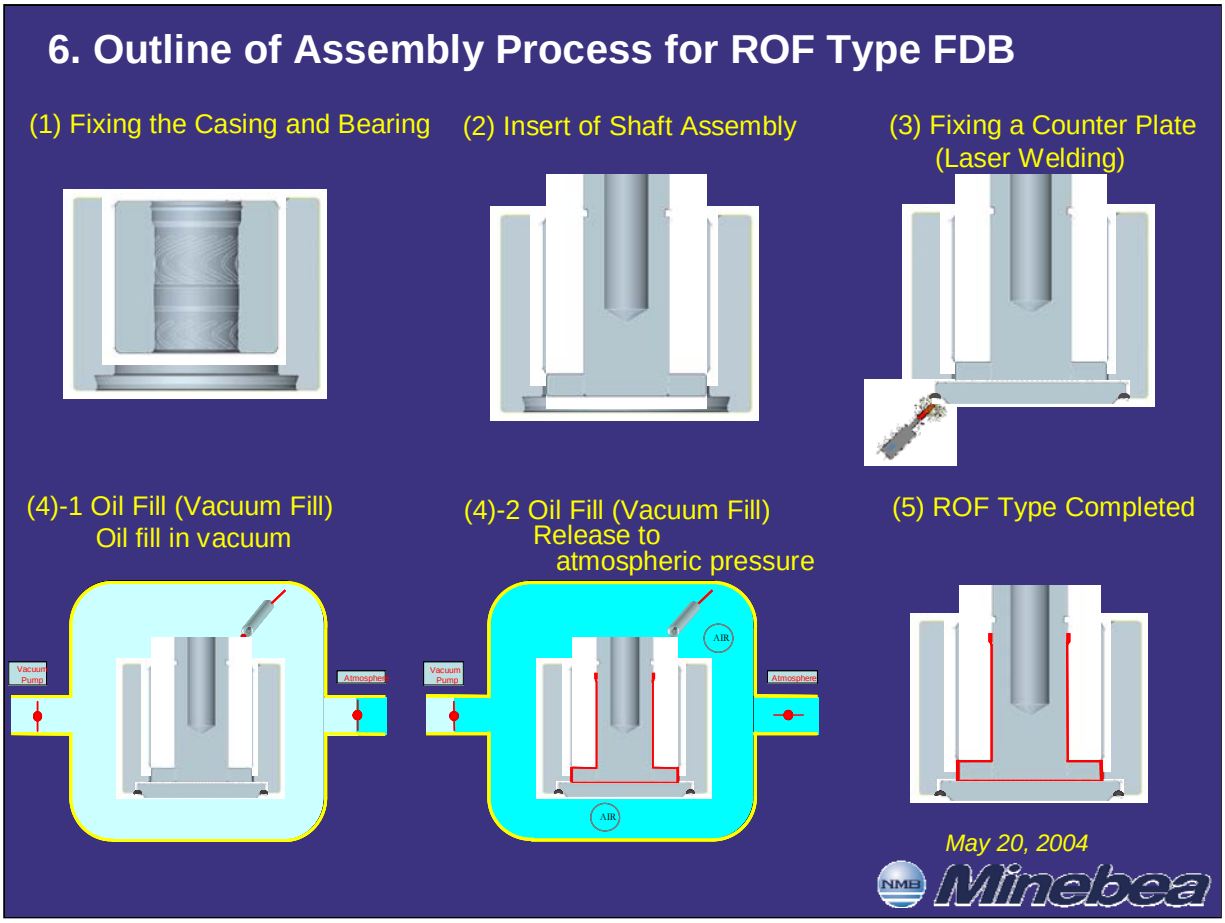
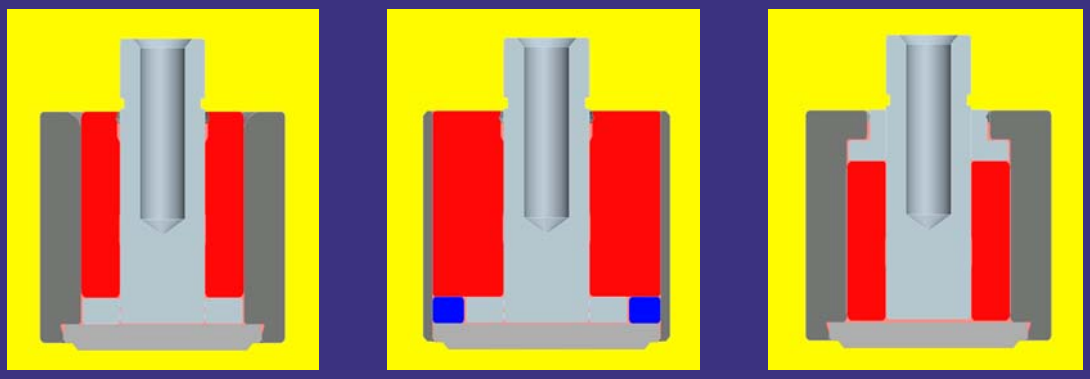
Comparing the overall structure of conventional and ROF type FDB units, you will see that the only difference is the new design concept for the sleeve; everything else is the same.




The assembly process for the ROF type begins by fixing the casing and the bearing. Next we insert the shaft assembly and laser-weld the counter plate in place. The laser welding is exactly the same as used for conventional FDB units. We fill the oil exactly as we would for conventional FDB units. That is, the FDB unit is placed in a chamber and the air is released to create an ultra-vacuum. We use micro-drops developed by Minebea to add the required oil and then return the chamber to atmospheric pressure so that the oil is injected into the bearing, completing the ROF type FDB unit.

## 7. Structural Examples of ROF Type FDB

Example 1 | Example 2 | Example 3



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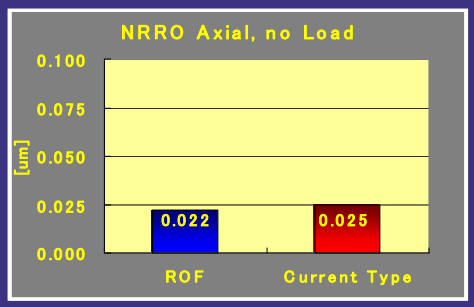
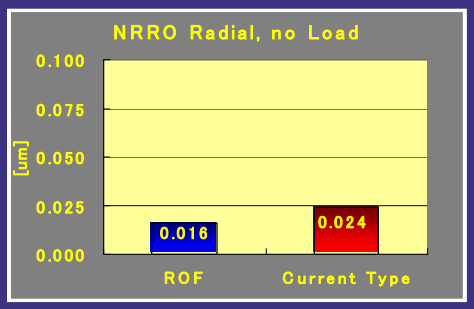
There are several different structures of ROF type possible.
Up to now we have explained Example 1. In Example 2, the blue areas represent spacers.
These spacers can also be processed on the bearing production line.
In Example 3 the thrust is arrayed at the top. Minebea develops a variety of structures for different applications.

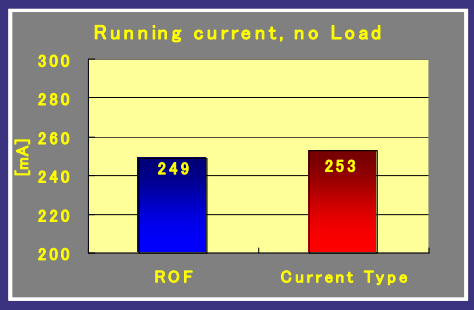
## 8. Performance Comparison between Conventional FDB Motor and ROF Type FDB Motor




NRRO Axial, Hub Disk Seating Surface




NRRO radial, Hub Outer Diameter ($\phi$25)




Motor Run Current (No disk)

**Improved basic property, in comparison with conventional FDB motor of identical dimension**

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In this slide we compare the axial and radial NRRO (non-repeatable run out) for conventional FDB motors and ROF motors of exactly the same dimensions. The ROF type offers superior performance.

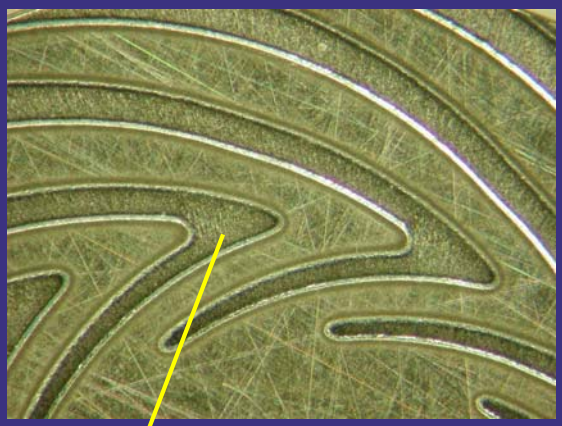
## 9. Comparison of Groove Shape between Conventional FDB and ROF Type FDB

<Photo>

**Conventional FDB**

Groove looks rough

**ROF Type FDB**



Groove looks smooth

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The differences in performance are due to differences in grove shape.

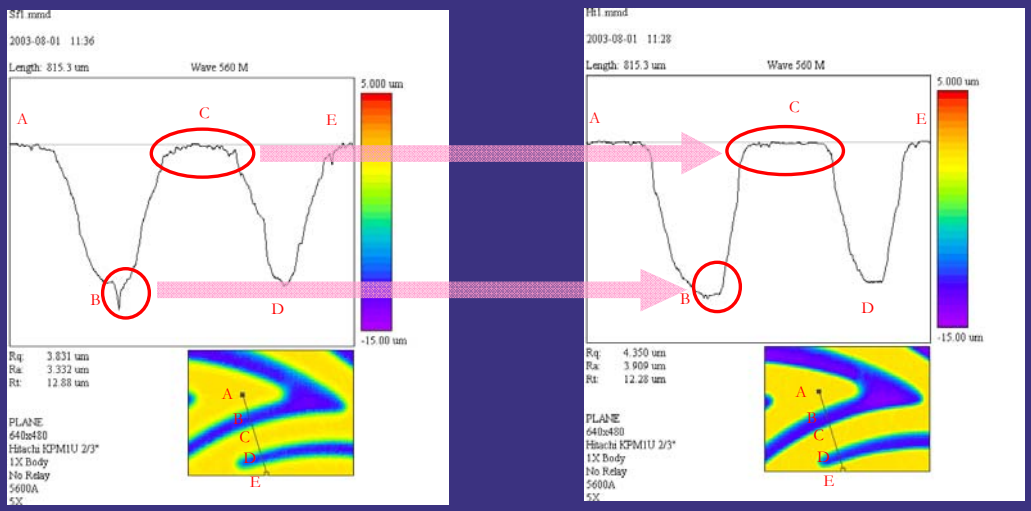
As you can see, after electro chemical machining process the surface of the conventional FDB's groove is very rough.

But the ROF type features stainless steel quenching and grinding, so when it is given electro chemical machining process its groove surface is extremely smooth.

## 9. Comparison of Groove Shape between Conventional FDB and ROF Type FDB

Conventional FDB

ROF Type




**Groove shape is notably improved.**

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The differences when measured with a surface scanner are striking.

A, C and E represent the surface; B and D are the troughs of the grooves. The ROF type has a much sharper groove shape and smoother surface compared to the conventional FDB. It is this difference that results in superior dynamic pressure performance for the ROF type.

## 10. Productivity Comparison

| | As compared with conventional FDB unit |
|---|---|
| Personnel | 1／3 or less |
| Floor Area | 1／4 or less |
| Time Required | 1／4 or less |

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Compared to conventional FDB units, the ROF type units offer substantial labor, space and time savings because they use the same production line as bearings. This allows production costs to be held to under 1/2 those of conventional FDB units, making the ROF type FDB units an extremely cost-competitive product.

# MINEBEA CO., LTD.

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Any statements in the presentation which are not an historical fact are future projections made based on certain assumptions and our management's judgment drawn from currently available information.

Please note that actual performance may vary significantly from any particular projection, due to various factors.

Factors affecting our actual performance include: (i) changes in economic indicators surrounding us or demand trends; (ii) fluctuation of foreign exchange rates or interest rates; and (iii) our ability to continue R&D, manufacturing and marketing in a timely manner in the electronics business sector, where technological innovations are rapid and new products are launched continuously. However, this is not a complete list of the factors affecting actual performance.



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