

HarmonicDrive®

# Large, Hollow-Shaft FBS-2UH Series Speed Reducer

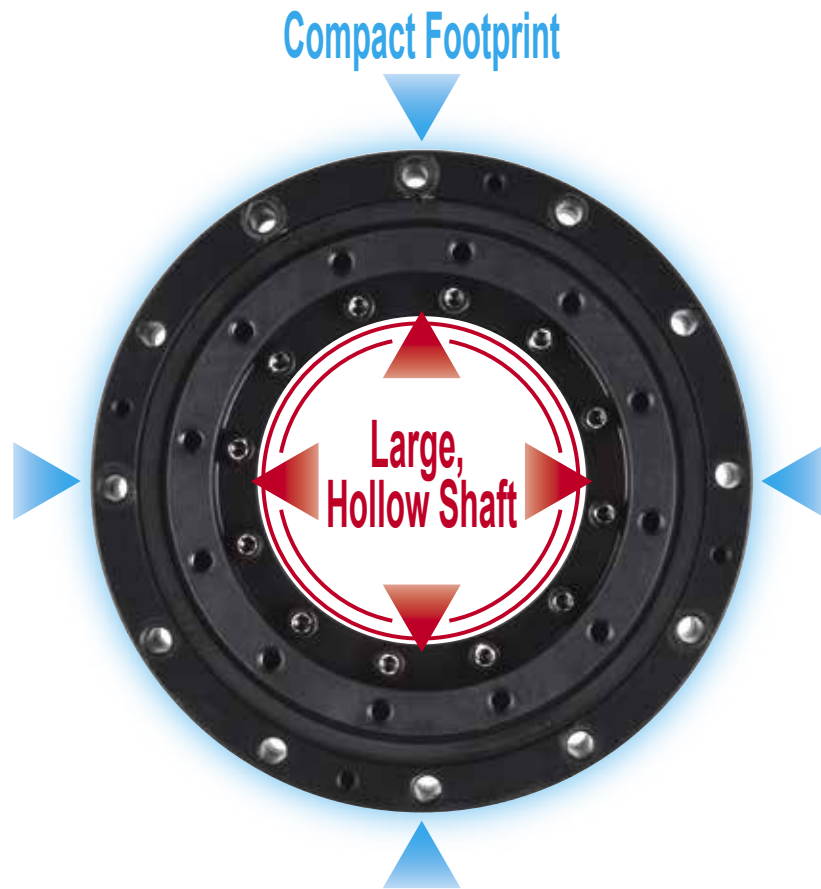


## Compact Design

This new Harmonic Drive® gear features a large, hollow shaft with a compact outer diameter. An extra large hollow shaft is ideal for robots and machines requiring complex cabling to pass through the axis of rotation. The new gear design features Harmonic Drive's "S" tooth profile for optimal tooth engagement resulting in high torque, high-torsional stiffness, long life and smooth rotation. The new FBS Series is available in two sizes (25, 32) and three ratios (30:1, 50:1, 100:1).

## Features

- Extra large hollow-shaft diameter is our largest yet for a standard product
- Compact dimensions for use in robotics
- Outer diameter and hollow bore optimized for design flexibility and performance



Ratio of the Hollow-Shaft Diameter to the Outer Diameter

Size	Hollow-Shaft Diameter	Outer Diameter	Ratio
25	41 mm	93 mm	44%
32	55.1 mm	113 mm	49%

## Ordering Code

**FBS - 25 - 30 - 2UH - SP**

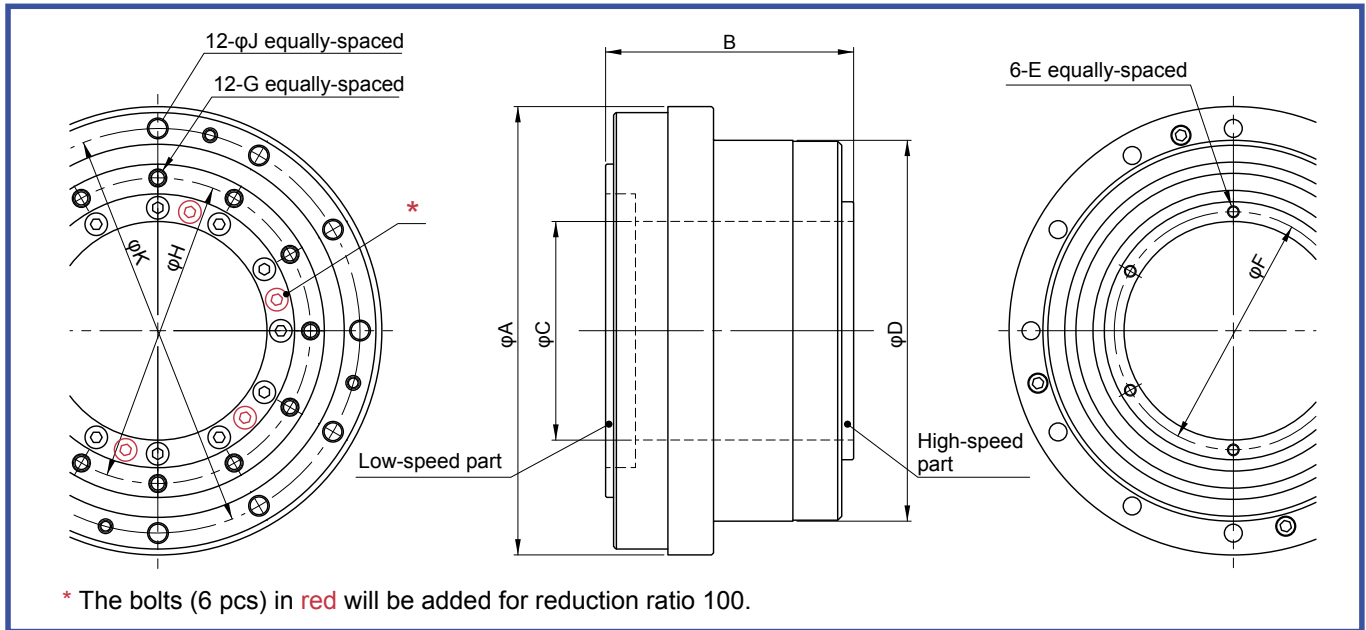
Diagram showing the breakdown of the ordering code: FBS, 25, 30, 2UH, and SP, each with a dotted line pointing down to its corresponding column in the table below.

Model	Size	Reduction Ratio			Type	Special Specifications
FBS Series	25	30	50	100	Unit type	Blank = Standard Product SP = Special Specifications Code
	32	30	50	100		

# Rating Table

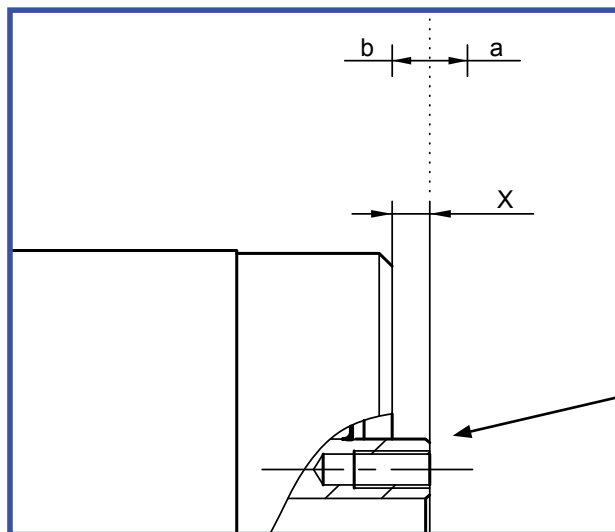
Size	Reduction Ratio	Rated torque at input speed 2000 rpm		Limit for repeated peak torque		Limit for average torque		Limit for momentary peak torque		Allowable maximum input speed rpm	Limit for average input speed rpm	Moment of inertia ( $1/8GD^2$ ) kgcm <sup>2</sup>
		Nm	kgfm	Nm	kgfm	Nm	kgfm	Nm	kgfm			
25	30	15	1.5	25	2.5	24	2.4	50	5.1	3600	2500	1.0
	50	22	2.2	47	4.8	35	3.6	93	9.5			
	100	37	3.8	70	7.1	59	6.0	100	10.2			
32	30	30	3.1	48	4.9	48	4.9	96	9.8		2300	3.3
	50	43	4.4	92	9.4	67	6.8	151	15.4			
	100	56	5.7	106	10.8	89	9.1	151	15.4			

# Outline Dimensions



(Unit: mm)

Size	Symbol	φA	B	φC	φD	E	φF	G	φH	φJ	φK	Weight (kg)
25		93	53.1	41	78	M3	45.5	M3	61.4	3.5	84	1.3
32		113	62.5	55.1	96	M3	60	M4	77	4.5	102	2.2



## Input Shaft (Wave generator axial clearance)

(Unit: mm)

Size	Dimension X	Axial Clearance	
		a	b
25	3	0.1 to 0.7	0.0 to 0.6
32	3	0.2 to 0.8	0.1 to 0.7

Input shaft moves back and forth during normal use. See Application on page 11.

## Positional Accuracy

Reduction Ratio		Size	25	32
30	x 10 <sup>-4</sup> rad		8.7	8.7
	arc-min		3	3
50	x 10 <sup>-4</sup> rad		5.8	5.8
	arc-min		2	2
100	x 10 <sup>-4</sup> rad		5.8	5.8
	arc-min		2	2

## Hysteresis Loss

Reduction Ratio		Size	25	32
30	x 10 <sup>-4</sup> rad		8.7	8.7
	arc-min		3	3
50	x 10 <sup>-4</sup> rad		5.8	5.8
	arc-min		2	2
100	x 10 <sup>-4</sup> rad		2.9	2.9
	arc-min		1	1

## Torsional Stiffness

Symbol		Size	25	32
T1	Nm		7.4	16
	kgfm		0.75	1.6
T2	Nm		26	55
	kgfm		2.7	5.6
Reduction Ratio 30	K1	x 10 <sup>4</sup> Nm/rad	1.3	2.1
		kgfm/arc-min	0.40	0.64
	K2	x 10 <sup>4</sup> Nm/rad	1.3	2.4
		kgfm/arc-min	0.40	0.71
	K3	x 10 <sup>4</sup> Nm/rad	1.6	2.9
		kgfm/arc-min	0.48	0.87
	θ1	x 10 <sup>-4</sup> rad	5.4	7.4
		arc min	1.9	2.5
	θ2	x 10 <sup>-4</sup> rad	19	24
		arc-min	6.6	8.2
Reduction Ratio 50	K1	x 10 <sup>4</sup> Nm/rad	1.9	3.5
		kgfm/arc-min	0.56	1.0
	K2	x 10 <sup>4</sup> Nm/rad	2.0	3.7
		kgfm/arc-min	0.60	1.1
	K3	x 10 <sup>4</sup> Nm/rad	2.3	4.3
		kgfm/arc-min	0.69	1.3
	θ1	x 10 <sup>-4</sup> rad	3.9	4.5
		arc-min	1.4	1.6
	θ2	x 10 <sup>-4</sup> rad	13	15
		arc-min	4.5	5.2
Reduction Ratio 100	K1	x 10 <sup>4</sup> Nm/rad	3.2	6.5
		kgfm/arc-min	0.94	1.9
	K2	x 10 <sup>4</sup> Nm/rad	3.2	6.5
		kgfm/arc-min	0.94	1.9
	K3	x 10 <sup>4</sup> Nm/rad	3.2	6.6
		kgfm/arc-min	0.94	2.0
	θ1	x 10 <sup>-4</sup> rad	2.0	2.2
		arc-min	0.7	0.8
	θ2	x 10 <sup>-4</sup> rad	7.8	8.3
		arc-min	2.7	2.9

\* This table shows the reference values. The minimum value is approximately 70% of the displayed value.

## Starting Torque

(Unit:Ncm)

Reduction Ratio \ Size	25	32
30	25	54
50	15	31
100	11	20

## Back-Driving Torque

(Unit: Nm)

Reduction Ratio \ Size	25	32
30	11	23
50	9	18
100	13	22

## Ratcheting Torque

(Unit: Nm)

Reduction Ratio \ Size	25	32
30	170	270
50	200	410
100	270	510

## Static Torque Limit

The static torque limit is defined as the maximum allowable torque that can be applied to the output in a back drive mode with the input Wave Generator locked.

(Unit: Nm)

Reduction Ratio \ Size	25	32
30	370	730
50		
100		

\* For details of terms, refer to the technical material in the Harmonic Drive® reducer catalog.

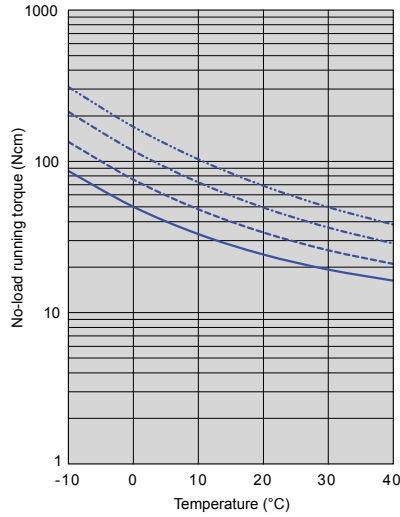
# No-Load Running Torque

No-load running torque is the torque which is required to rotate the input side (high-speed side), when there is no load on the output side (low-speed side).

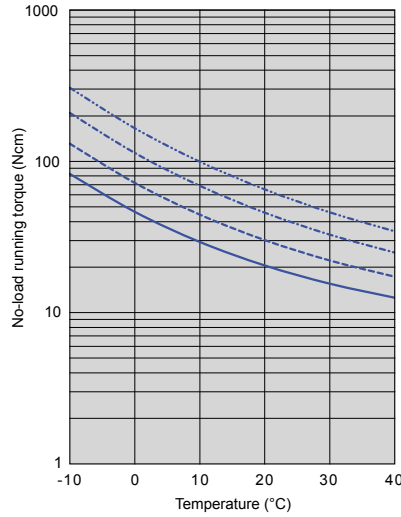
## Measuring Condition

Lubrication	Speed Reducer	Main Bearing
	Harmonic Grease® SK-1A	Harmonic Grease® 4B No.2
Torque value is measured after 2 hours at 2000 rpm input		

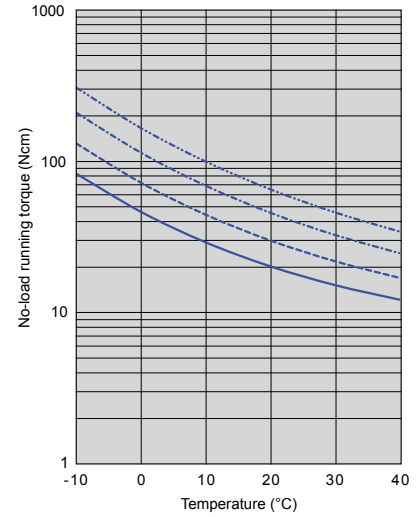
Size: 25  
Ratio: 30



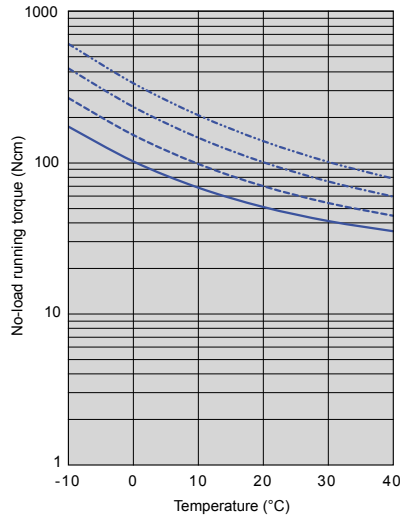
Size: 25  
Ratio: 50



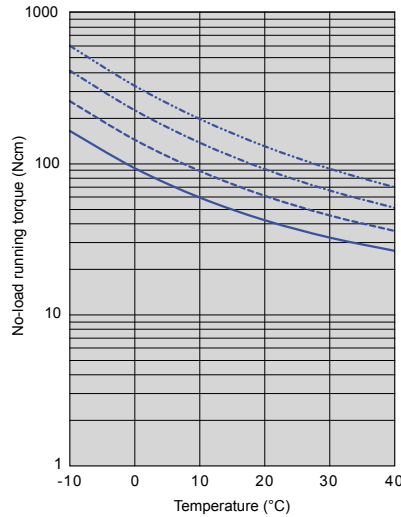
Size: 25  
Ratio: 100



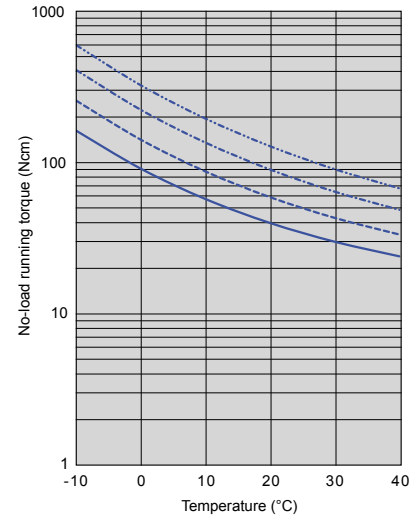
Size: 32  
Ratio: 30



Size: 32  
Ratio: 50



Size: 32  
Ratio: 100



Input speed    — 500rpm    - - - 1000rpm    ····· 2000rpm    - ····· 3500rpm

\* The graphs show the average values.

# Efficiency

The efficiency is lowered depending on the load torque. Obtain efficiency compensation coefficient  $K_e$  from the graph, and check the value through the following formula.

\*1 The efficiency compensation coefficient is the average value when the grease temperature is approximately 30°C.

\*2 When load torque is larger than rated torque, efficiency compensation coefficient  $K_e = 1$ .

Efficiency compensation coefficient:  $K_e$

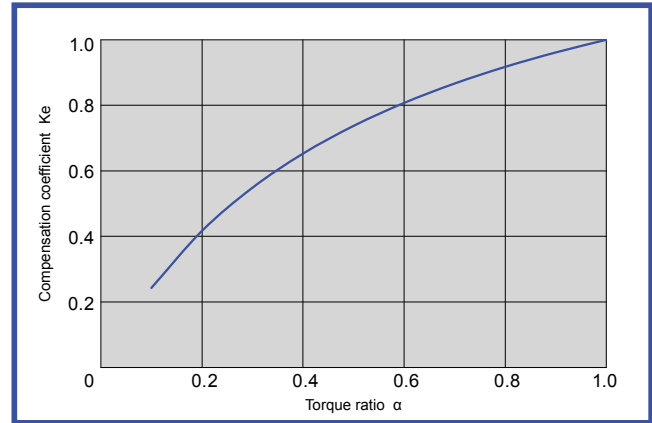
Efficiency at rated torque:  $\eta_R$

Efficiency depending on the load torque:  $\eta$

$$\eta = K_e \times \eta_R$$

$$\text{Torque Ratio } \alpha = \frac{\text{Load torque}}{\text{Rated torque}}$$

## Efficiency Compensation Coefficient

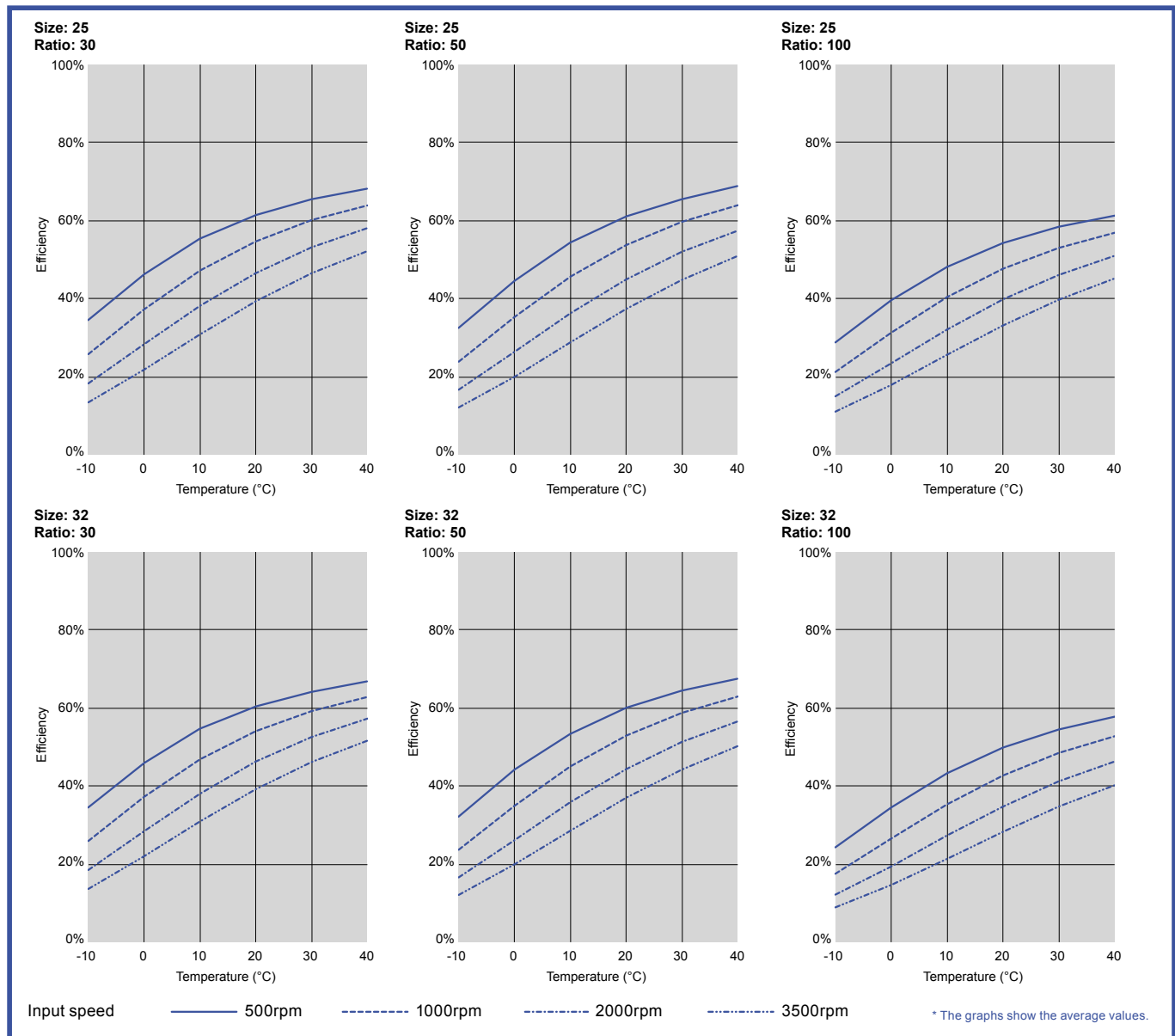


## Measuring Condition

Lubrication	Speed Reducer	Main Bearing
	Harmonic Grease® SK-1A	Harmonic Grease® 4B No.2

Torque value is measured after 2 hours at 2000 rpm input

## Efficiency at Rated Torque

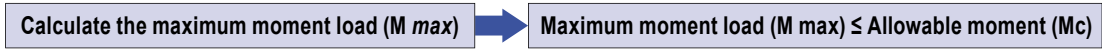


# Specifications of the Main Bearing

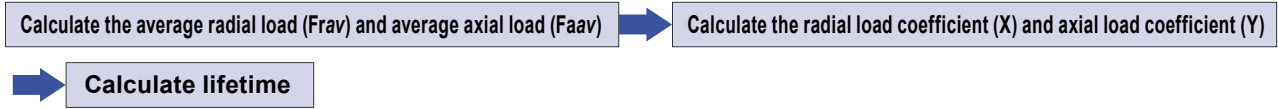
A precision cross roller bearing is built in to directly support the external load (output flange). For maximum performance, check the maximum moment load, life of the cross-roller bearing, and static safety coefficient.

## ■ Procedure for Checking

### (1) Check the maximum moment load ( $M_{max}$ )



### (2) Check the life



### (3) Check the static safety coefficient

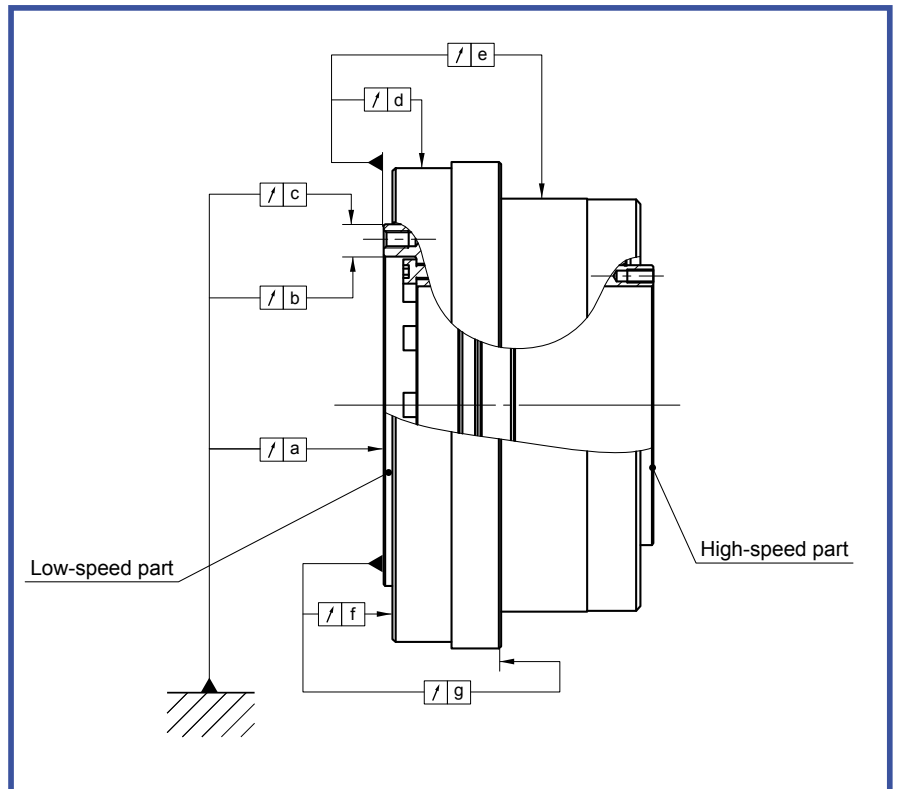


## Main Bearing Specifications

Size	Pitch Circle	Offset	Basic rated load				Allowable moment load $M_c$		Moment stiffness $K_m$	
	$d_p$	R	Basic dynamic rated load C		Basic static rated load $C_0$		Nm	kgfm	$\times 10^4$ Nm/rad	kgfm/arc min
	m	m	$\times 10^2$ N	kgf	$\times 10^2$ N	kgf				
25	0.070	0.011	73	744	110	1122	93	9.5	21	6.2
32	0.086	0.0121	109	1111	179	1825	129	13.2	31	9.2

# Mechanical Accuracy

Symbol \ Size	25	32
a	0.015	0.015
b	0.010	0.010
c	0.010	0.010
d	0.010	0.013
e	0.070	0.073
f	0.010	0.010
g	0.018	0.024

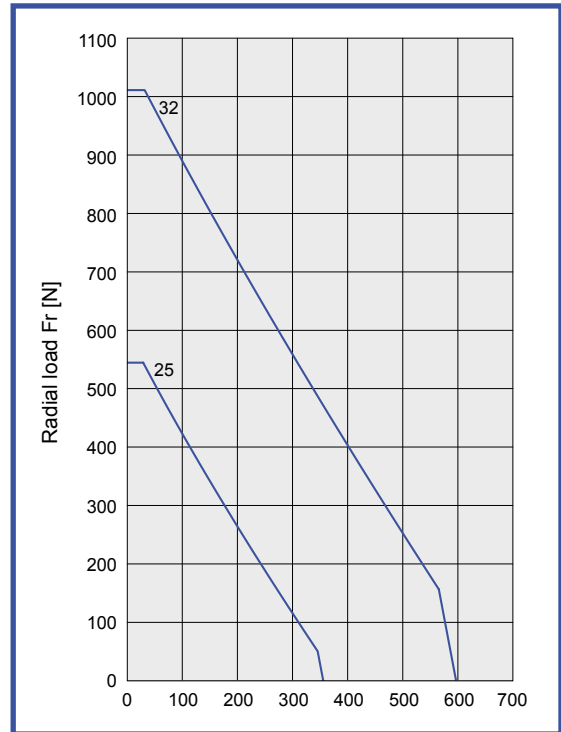
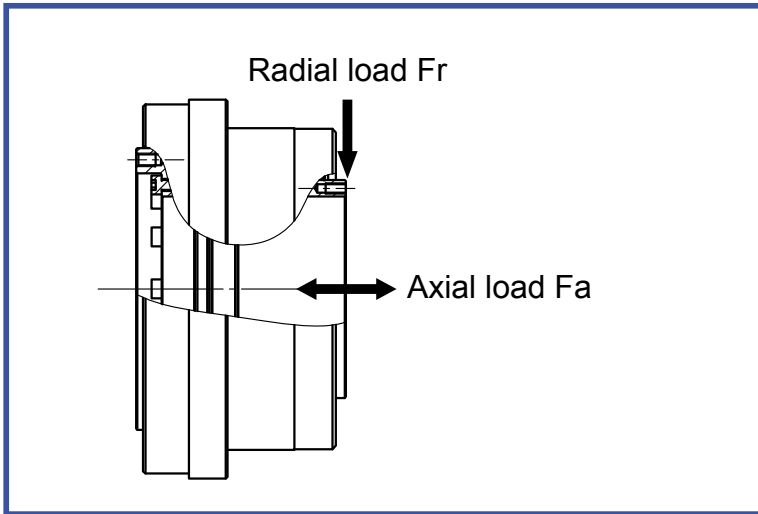




## Allowable Load for the Input Shaft

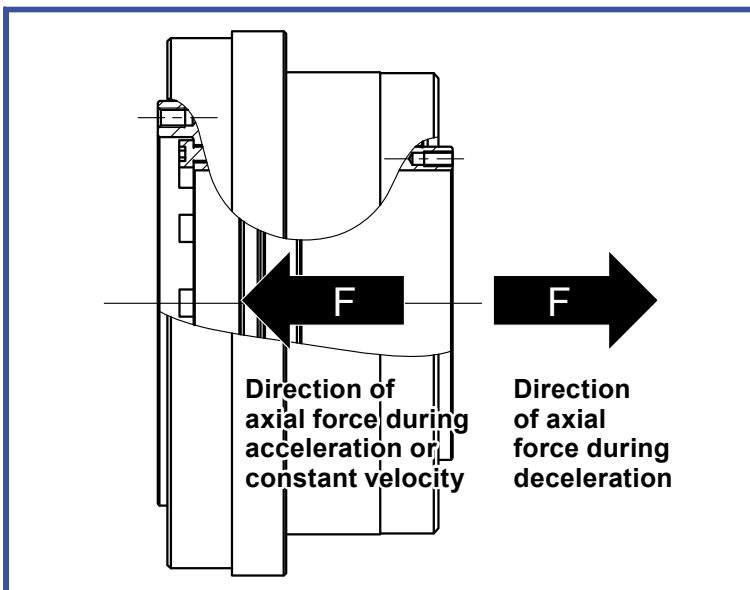
Two bearings support the input shaft. The following graph shows the maximum allowable radial load and axial load for each size.

Note that the values on the graph are the examples when the average input speed is 2000 rpm and basic rating life  $L_{10}$  is 5,000 hours.



## Axial Force of the Input Shaft

The input shaft moves back and forth during use. The amount of axial movement is defined on page 3. If the input shaft axial movement is constrained, a force will be transferred to the customer's structure.



Reduction Ratio	Formula
30	$F = 5.2 \times \frac{T}{D} \times 0.07 \times \tan 32^\circ$
50 or more	$F = 5.2 \times \frac{T}{D} \times 0.07 \times \tan 30^\circ$

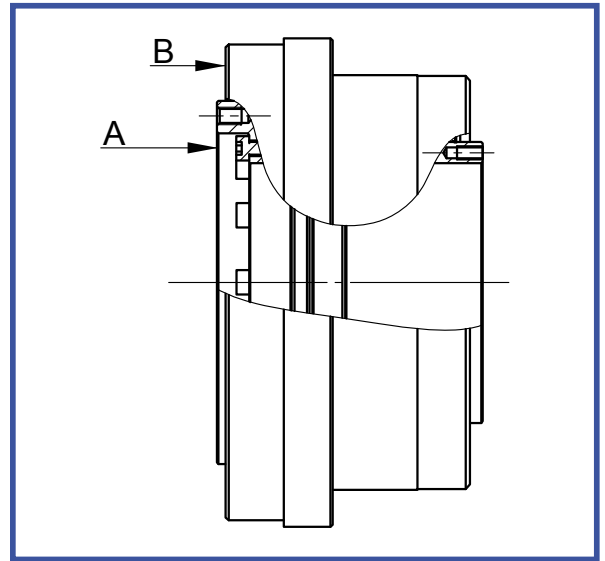
F = Axial force (N)  
 T = Output torque (Nm)  
 D = (Size) x 0.00254 (m)

# Installation and Transmission Torque

## Installation Accuracy

For peak performance of the gear, it is essential that the following tolerances be observed when assembly is complete. Pay careful attention to the following points and maintain the recommended assembly tolerances.

- Contamination due to foreign matter
- Burrs, raised surfaces and location around the tap area of the mounting holes
- Insufficient chamfering on the mounting pilot joint
- Insufficient radii on the mounting pilot joint



### Installation and Torque Transmission Capacity on side A

Item		Size	25	32
Number of bolts			12	12
Bolt size			M3	M4
Mounting P.C.D	mm		61.4	77
Bolt tightening torque	Nm		2.0	4.5
	kgfm		0.2	0.46
Bolt transmission torque	Nm		154	324
	kgfm		15.7	33.1

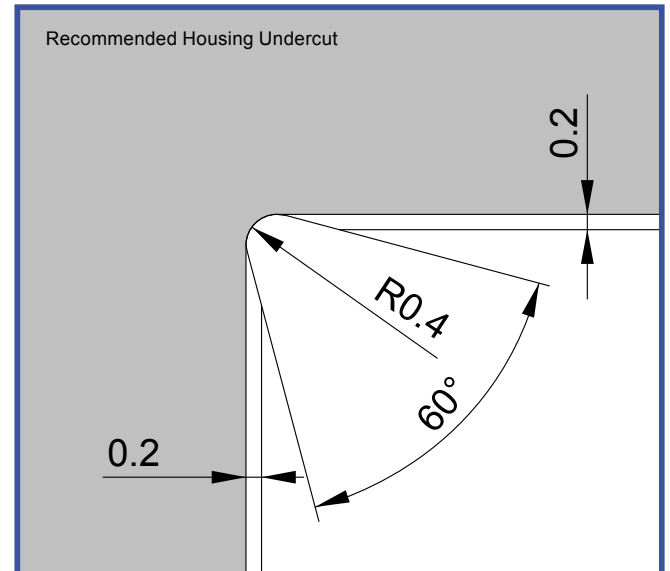
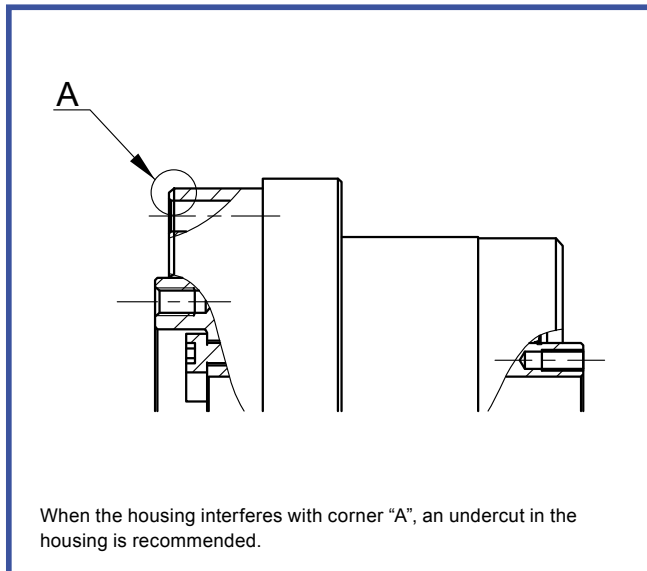
1. The material of the thread must withstand the clamp torque.
2. Recommended bolt: JIS B 1176 socket head cap screw / Strength range : JIS B 1051 over 12.9
3. Torque coefficient: K=0.2
4. Clamp coefficient: A=1.4
5. Tightening friction coefficient  $\mu=0.15$

### Installation and Torque Transmission Capacity on side B

Item		Size	25	32
Number of bolts			12	12
Bolt size			M3	M4
Mounting P.C.D	mm		84	102
Bolt tightening torque	Nm		2.0	4.5
	kgfm		0.2	0.46
Bolt transmission torque	Nm		210	431
	kgfm		21	44

1. The material of the thread must withstand the clamp torque.
2. Recommended bolt: JIS B 1176 socket head cap screw / Strength range : JIS B 1051 over 12.9
3. Torque coefficient: K=0.2
4. Clamp coefficient: A=1.4
5. Tightening friction coefficient  $\mu=0.15$

## Recessing of the Mounting Pilot



## Lubrication

Grease lubrication is standard for the FBS-2UH. There is no need to add or apply grease upon installation since the products are shipped with the grease applied.

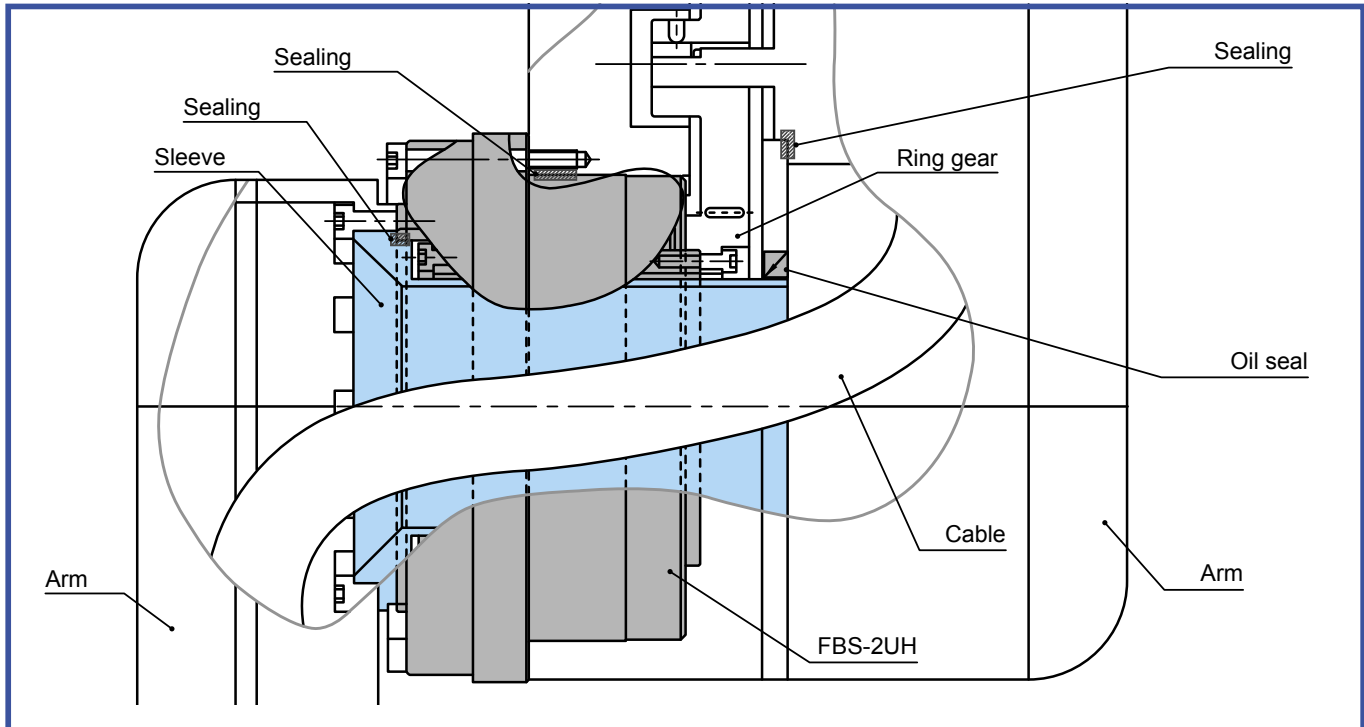
Lubrication part	Speed Reducer	Main Bearing
Grease	Harmonic Grease® SK-1A	Harmonic Grease® 4B No.2
Manufacturer	Harmonic Drive Systems Inc.	
Base oil	Purified mineral oil	Synthetic hydrocarbon oil
Thickener	Lithium soap base	Urea
Base Viscosity cSt (25°C)	265 to 295	290 to 320
Drop point	197°C	247°C
Appearance	Yellow	Light yellow

For details on lubrication, please see the "Engineering Data" in the Reducer Catalog.

## Application

FBS-2UH is not equipped with a rotary shaft seal on the input shaft. The customer must add features to prevent grease leakage.

The following figure shows an example of the seals required to prevent grease leakage. In the example the FBS is driven by a servomotor through two spur gears.



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