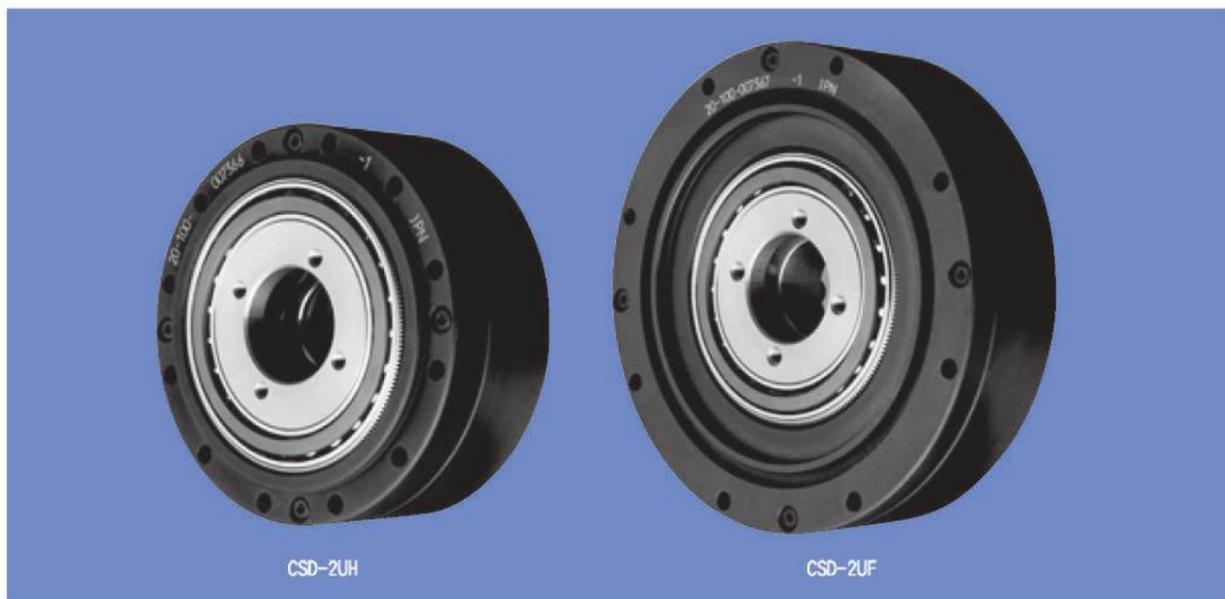


## Features



### CSD Gear Units

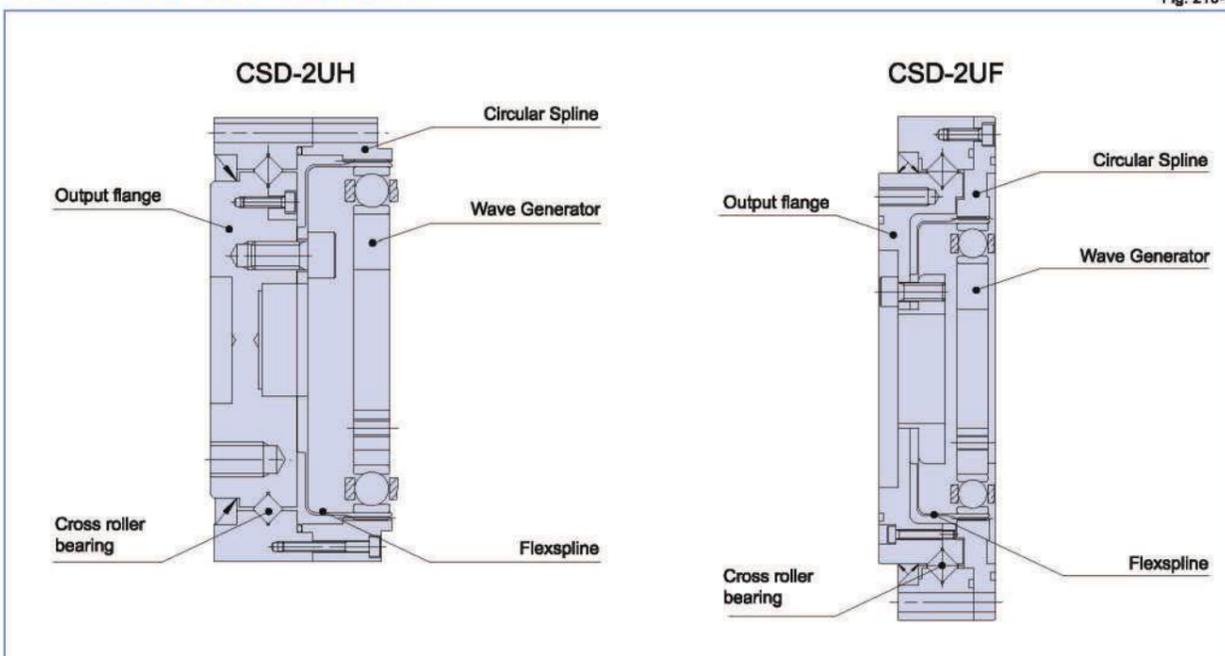
Available in two form factors, the CSD series gear units offer zero backlash while remaining lightweight and compact. These units are ideal for humanoid robots, aerospace, semiconductor equipment and many other critical applications. Ratios available are from 50:1 to 160:1.

### Features

- Zero backlash
- Compact design
- Hollow shaft (2UF only)
- High-load capacity
- Lightweight

### Structure of CSD Gear Unit

Fig. 210-1



## Ordering Code

**CSD - 20 - 100 - 2UH - SP**

Series	Size	Ratio*	Model	Special specification
CSD	14	50	100	2UH= Unit type (Size 14 to 50) 2UF= Hollow shaft (Size 14 to 40) Blank= Standard product SP = Special specification code
	17	50	100	
	20	50	100	
	25	50	100	
	32	50	100	
	40	50	100	
	50	50	100	

\* The reduction ratio value is based on the following configuration: Input: wave generator, fixed: circular spline, output: flexspline

## Technical Data

### Rating table

#### ■ CSD-2UH

Table 211-2

Size	Ratio	Rated Torque at 2000rpm		Limit for Repeated Peak Torque		Limit for Average Torque		Limit for Momentary Peak Torque		Maximum Input Speed (rpm) Grease lubricant	Limit for Average Input Speed (rpm) Grease lubricant	Moment of Inertia	
		Nm	kgfm	Nm	kgfm	Nm	kgfm	Nm	kgfm			I (x10 <sup>4</sup> kgm <sup>2</sup> )	J (x10 <sup>4</sup> kgms <sup>2</sup> )
14	50	3.7	0.38	12	1.2	4.8	0.49	24	2.4	8500	3500	0.021	0.021
	100	5.4	0.55	19	1.9	7.7	0.79	35	3.6				
17	50	11	1.1	23	2.3	18	1.9	48	4.9	7300	3500	0.054	0.055
	100	16	1.6	37	3.8	27	2.8	71	7.2				
20	50	17	1.7	39	4.0	24	2.4	69	7.0	6500	3500	0.090	0.092
	100	28	2.9	57	5.8	34	3.5	95	9.7				
	160	28	2.9	64	6.5	34	3.5	95	9.7				
25	50	27	2.8	69	7.0	38	3.9	127	13	5600	3500	0.282	0.288
	100	47	4.8	110	11	75	7.6	184	19				
	160	47	4.8	123	13	75	7.6	204	21				
32	50	53	5.4	151	15	75	7.6	268	27	4800	3500	1.09	1.11
	100	96	10	233	24	151	15	420	43				
	160	96	10	261	27	151	15	445	45				
40	50	96	10	281	29	137	14	480	49	4000	3000	2.85	2.91
	100	185	19	398	41	260	27	700	71				
	160	206	21	453	46	316	32	765	78				
50	50	172	18	200	51	247	25	1000	102	3500	2500	8.61	8.78
	100	329	34	686	70	466	48	1440	147				
	160	370	38	823	84	590	60	1715	175				

(Note) Moment of inertia:  $I = \frac{1}{4} GD^2$

#### ■ CSD-2UF

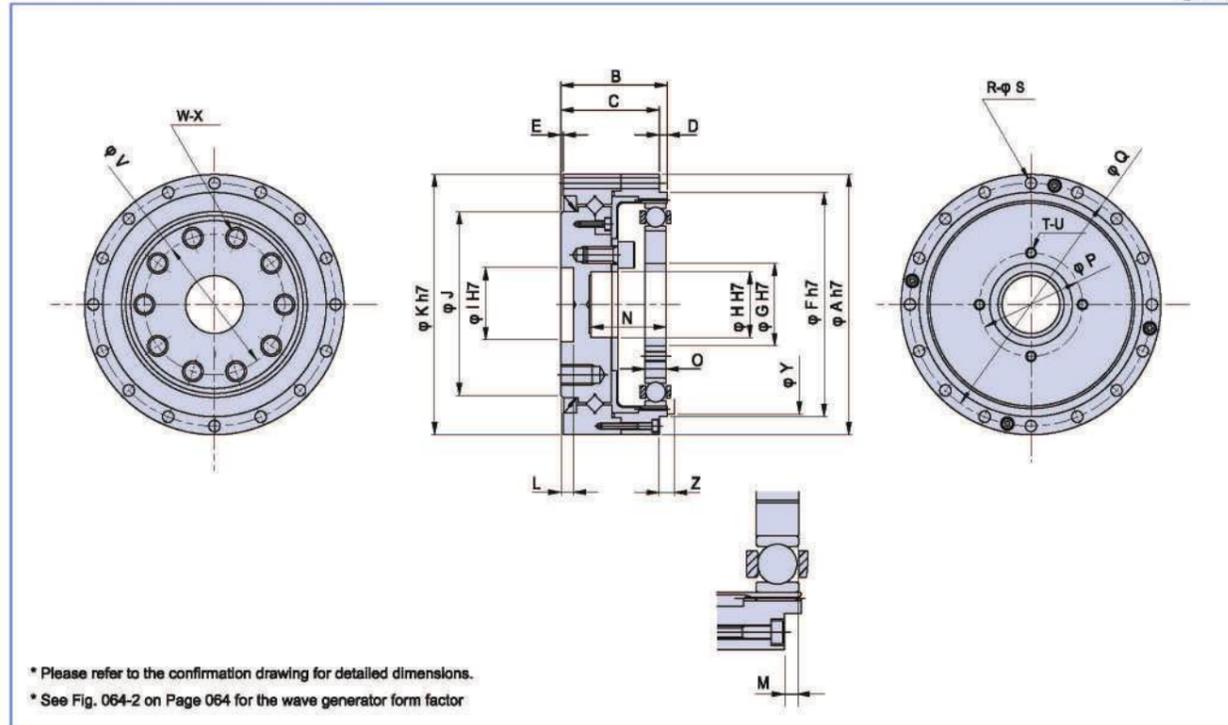
Table 211-3

Size	Ratio	Rated Torque at 2000rpm		Limit for Repeated Peak Torque		Limit for Average Torque		Limit for Momentary Peak Torque		Maximum Input Speed (rpm) Grease lubricant	Limit for Average Input Speed (rpm) Grease lubricant	Moment of Inertia	
		Nm	kgfm	Nm	kgfm	Nm	kgfm	Nm	kgfm			I (x10 <sup>4</sup> kgm <sup>2</sup> )	J (x10 <sup>4</sup> kgms <sup>2</sup> )
14	50	3.7	0.38	12	1.2	4.8	0.49	24	2.4	8500	3500	0.021	0.021
	100	5.4	0.55	19	1.9	7.7	0.79	35	3.6				
17	50	11	1.1	23	2.3	18	1.9	48	4.9	7300	3500	0.054	0.055
	100	16	1.6	37	3.8	27	2.8	71	7.2				
20	50	17	1.7	39	4.0	24	2.4	69	7.0	6500	3500	0.090	0.092
	100	28	2.9	57	5.8	34	3.5	95	9.7				
	160	28	2.9	64	6.5	34	3.5	95	9.7				
25	50	27	2.8	69	7.0	38	3.9	127	13	5600	3500	0.282	0.288
	100	47	4.8	110	11	75	7.6	184	19				
	160	47	4.8	123	13	75	7.6	204	21				
32	50	53	5.4	151	15	75	7.6	268	27	4800	3500	1.09	1.11
	100	96	10	233	24	151	15	420	43				
	160	96	10	261	27	151	15	445	45				
40	50	96	10	281	29	137	14	480	49	4000	3000	2.85	2.91
	100	185	19	398	41	260	27	700	71				
	160	206	21	453	46	316	32	765	78				

(Note) Moment of inertia:  $I = \frac{1}{4} GD^2$

Outline dimensions CSD-2UH

Fig. 212-1



Dimensions CSD-2UH

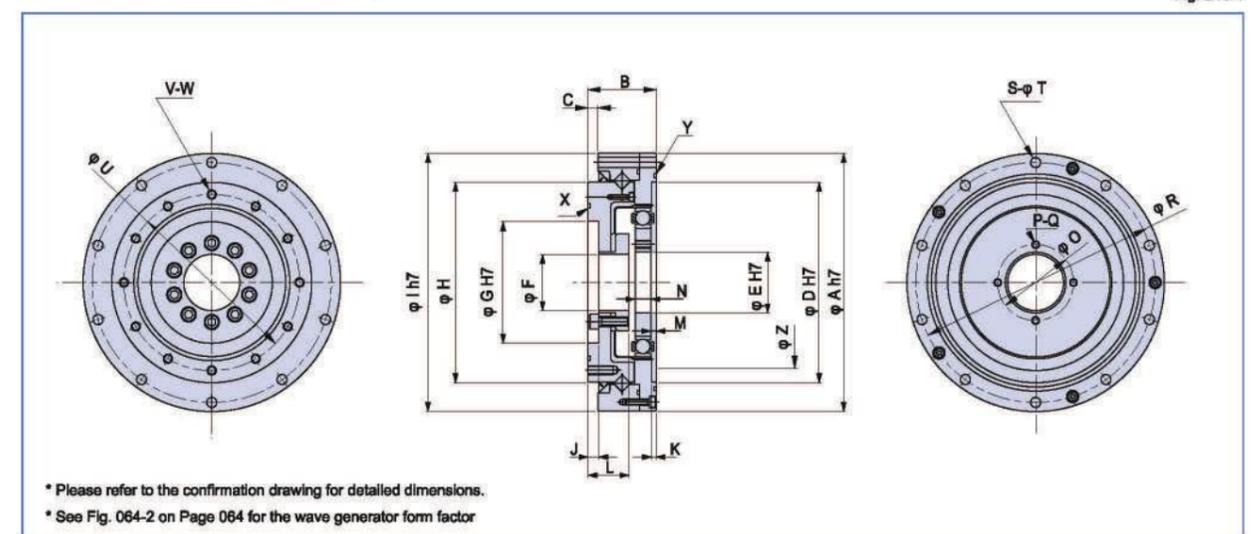
Table 212-1  
Unit : mm

Symbol	Size	14	17	20	25	32	40	50
φA h7		55	62	70	85	112	126	157
B		25	26.5	29.7	37.1	43	51.7	62.5
C		23	24.5	27.7	34.1	40	47.7	58.5
D		2	2	2	3	3	4	4
E		0.5	0.5	0.5	0.5	1	1	1
φF h7		42.5	49.5	58	73	96	108.5	136
φG H7		11	15	20	24	32	40	50
φH H7		11	11	16	20	30	32	44
φI H7		12	14	18	24	32	36	48
φJ		31	38	45	58	78	90	112
φK h7		55	62	70	85	112	126	157
L		5	5	5	5.5	5.5	6	7
M		1.7 <sup>+0.2</sup>	1.7 <sup>+0.2</sup>	1.7 <sup>+0.2</sup>	2.6 <sup>+0.2</sup>	2.5 <sup>+0.2</sup>	3.4 <sup>+0.2</sup>	3.2 <sup>+0.2</sup>
N		14.8	16.3	18.8	23.7	30.6	36.5	44.3
O		4 <sub>-0.1</sub>	5 <sub>-0.1</sub>	5.2 <sub>-0.1</sub>	6.3 <sub>-0.1</sub>	8.6 <sub>-0.1</sub>	10.3 <sub>-0.1</sub>	12.7 <sub>-0.1</sub>
φP(PCD)		17	21	26	30	40	50	60
φQ(PCD)		49	56	64	79	104	117.5	147
R		6	10	12	18	18	18	22
φS		3.4	3.4	3.4	3.4	4.5	5.5	6.6
T		4	4	4	4	4	4	4
U		M3	M3	M3	M3	M4	M5	M6
φV(PCD)		25	27	34	42	57	72	88
W		10	8	8	8	10	10	10
X		M3×7	M5×8	M6×9	M8×12	M8×12	M10×15	M12×18
φY		38	45	53	66	86	106	133
Z		3	3	3.5	4.5	5	6.5	7.5
Mass (kg)		0.35	0.46	0.65	1.2	2.4	3.6	6.9

● Due to different manufacturing methods (casting, machining) of components, tolerances also vary. For dimensions without specified tolerances, please consult our company or authorized agents for the tolerance range

Outline dimensions CSD-2UF

Fig. 213-1



Dimensions CSD-2UF

Table 213-1  
Unit : mm

Symbol	Size	14	17	20	25	32	40
φA h7		70	80	90	110	142	170
B		22	22.7	26.8	31.5	37	45
C		0.5	0.5	2.3	2.1	2.8	6.5
φD H7		48	56	64	80	106	132
φE H7		11	15	20	24	32	40
φF		9	9	18	22	29	37
φG H7		30	34	40	52	70	80
φH		49	59	69	84	110	132
φI h7		70	80	90	110	142	170
J		4.9	5.4	4.8	5.5	6	7
K		2.5	2.5	2.5	3	3	3
L		12.9	13.4	16.8	19.5	22	27
M		2.8 <sup>+0.2</sup>	2.8 <sup>+0.2</sup>	2.8 <sup>+0.2</sup>	3.4 <sup>+0.2</sup>	3.5 <sup>+0.2</sup>	3.6 <sup>+0.2</sup>
N		4 <sub>-0.1</sub>	5 <sub>-0.1</sub>	5.2 <sub>-0.1</sub>	6.3 <sub>-0.1</sub>	8.6 <sub>-0.1</sub>	10.3 <sub>-0.1</sub>
φO(PCD)		17	21	26	30	40	50
P		4	4	4	4	4	4
Q		M3	M3	M3	M3	M4	M5
φR(PCD)		64	74	84	102	132	158
S		6	8	8	10	10	10
φT		3.4	3.4	3.4	4.5	5.5	6.6
φU(PCD)		42	50	60	73	96	116
V		8	10	8	8	8	12
W		M3×5	M3×6	M4×8	M5×8	M6×10	M6×10
X		34.5×0.80	38.0×1.50	S48	S60	S80	S100
Y		49.0×1.50	59.4×1.20	S70	S85	S115	S140
φZ		38	45	53	66	86	106
Mass (kg)		0.50	0.66	0.94	1.7	3.3	5.7

● 由于零部件的制造方法（铸造、机械加工）不同，公差也存在差异。关于没有注明公差的尺寸，如需了解公差范围，请咨询本公司或授权代理商。

Positional accuracy

See "Engineering data" for a description of terms.

Table 214-1

Size	14	17	20	25	32	40	50
Positional Accuracy	×10 <sup>-4</sup> rad	4.4	4.4	2.9	2.9	2.9	2.9
	arc min	1.5	1.5	1.0	1.0	1.0	1.0

Hysteresis loss

See "Engineering data" for a description of terms.

Table 214-2

Ratio	Unit	Size	14	17	20	25	32	40	50
50	×10 <sup>-4</sup> rad		7.3	4.4	4.4	4.4	4.4	4.4	4.4
	arc min		2.5	1.5	1.5	1.5	1.5	1.5	1.5
100 or more	×10 <sup>-4</sup> rad		5.8	2.9	2.9	2.9	2.9	2.9	2.9
	arc min		2.0	1.0	1.0	1.0	1.0	1.0	1.0

**Torsional stiffness**

See "Engineering data" for a description of terms.

Table 214-3

Item	Unit	Size	14	17	20	25	32	40	50	
T <sub>1</sub>	Nm		2.0	3.9	7.0	14	29	54	108	
	kgfm		0.2	0.4	0.7	1.4	3.0	5.5	11	
T <sub>2</sub>	Nm		6.9	12	25	48	108	196	382	
	kgfm		0.7	1.2	2.5	4.9	11	20	39	
Reduction ratio 50	K <sub>1</sub>	×10 <sup>4</sup> Nm/rad	0.29	0.67	1.1	2.0	4.7	8.8	17	
		kgfm/arc min	0.085	0.2	0.32	0.6	1.4	2.6	5.0	
	K <sub>2</sub>	×10 <sup>4</sup> Nm/rad	0.37	0.88	1.3	2.7	6.1	11	21	
		kgfm/arc min	0.11	0.26	0.4	0.8	1.8	3.4	6.3	
	K <sub>3</sub>	×10 <sup>4</sup> Nm/rad	0.47	1.2	2.0	3.7	8.4	15	30	
		kgfm/arc min	0.14	0.34	0.6	1.1	2.5	4.5	9.0	
	θ <sub>1</sub>	×10 <sup>-4</sup> rad	6.9	5.8	6.4	7.0	6.2	6.1	6.4	
		arc min	2.4	2.0	2.2	2.4	2.1	2.1	2.2	
	θ <sub>2</sub>	×10 <sup>-4</sup> rad	19	14	19	18	18	18	18	
		arc min	6.4	4.6	6.6	6.1	6.1	5.9	6.2	
	Reduction ratio 100 or more	K <sub>1</sub>	×10 <sup>4</sup> Nm/rad	0.4	0.84	1.3	2.7	6.1	11	21
			kgfm/arc min	0.12	0.25	0.4	0.8	1.8	3.2	6.3
K <sub>2</sub>		×10 <sup>4</sup> Nm/rad	0.44	0.94	1.7	3.7	7.8	14	29	
		kgfm/arc min	0.13	0.28	0.5	1.1	2.3	4.2	8.5	
K <sub>3</sub>		×10 <sup>4</sup> Nm/rad	0.61	1.3	2.5	4.7	11	20	37	
		kgfm/arc min	0.18	0.39	0.75	1.4	3.3	5.8	11	
θ <sub>1</sub>		×10 <sup>-4</sup> rad	5.0	4.6	5.4	5.2	4.8	4.9	5.1	
		arc min	1.7	1.6	1.8	1.8	1.7	1.7	1.7	
θ <sub>2</sub>		×10 <sup>-4</sup> rad	16	13	15	13	14	14	13	
		arc min	5.4	4.3	5.0	4.5	4.8	4.8	4.6	

\* The values in this table are reference values. The minimum value is approximately 80% of the displayed value.

**Starting torque**

See "Engineering data" for a description of terms. The values in the table below vary depending on the use conditions, use them as reference values.

**CSD-2UH**

Table 214-4 Unit: Ncm

Ratio	Size	14	17	20	25	32	40	50
50		4.4	6.7	8.9	16	32	55	102
100		2.8	3.8	5.1	9.1	20	32	60
160		—	—	3.9	7.2	15	26	47

**CSD-2UF**

Table 214-5 Unit: Ncm

Ratio	Size	14	17	20	25	32	40
50		5.3	7.5	9.7	17	34	58
100		3.2	4.2	5.5	9.6	21	33
160		—	—	4.1	7.4	16	27

**Backdriving torque**

See "Engineering data" for a description of terms. The values in the table below vary depending on the use conditions, use them as reference values.

**CSD-2UH**

Table 215-1 Unit: Nm

Ratio	Size	14	17	20	25	32	40	50
50		2.9	4.3	5.2	9.5	19	33	61
100		3.5	4.6	6.0	11	23	38	71
160		—	—	7.4	13	30	48	89

**CSD-2UF**

Table 215-2 Unit: Nm

Ratio	Size	14	17	20	25	32	40
50		3.3	4.7	5.6	10	20	34
100		3.9	5.0	6.4	11	24	39
160		—	—	7.8	14	31	49

**Ratcheting torque**

See "Engineering data" for a description of terms.

Table 215-3 Unit: Nm

Ratio	Size	14	17	20	25	32	40	50
50		88	150	220	450	980	1800	3700
100		84	160	260	500	1000	2100	4100
160		—	—	220	450	980	1800	3600

**Buckling torque**

See "Engineering data" for a description of terms.

Table 215-4 Unit: Nm

Size	14	17	20	25	32	40	50
Total reduction ratio	190	330	560	1000	2200	4300	8000

**Checking output bearing**

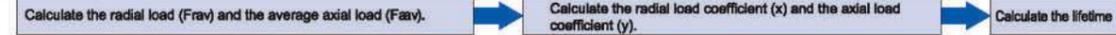
A precision cross roller bearing is built in the gear unit to directly support the external load (output flange). Check the maximum moment load, life of the bearing and static safety coefficient to fully bring out the performance of the unit type. See Page 030 to 034 of "Engineering data" for each calculation formula.

■ Checking procedure

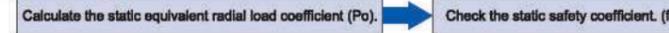
(1) Checking the maximum moment load (Mmax)



(2) Checking the life



(3) Checking the static safety coefficient



■ Output bearing specifications

The specifications of the cross roller bearing are shown in Table 220-1 and -2.

■ CSD-2UH

Table 220-1

Size	Pitch circle dia. of a roller dp m	Offset R m	Basic rated load				Allowable moment load Mc		Moment stiffness Km		Allowable axial load Fa	Allowable radial load Fr
			Basic dynamic rated load C ×10 <sup>2</sup> N	kgf	Basic static rated load Co ×10 <sup>2</sup> N	kgf	Nm	kgfm	×10 <sup>4</sup> Nm / rad	kgfm / arc-min	×10 <sup>2</sup> N	×10 <sup>2</sup> N
14	0.035	0.0095	47	480	60.7	620	41	4.2	4.38	1.3	10.1	6.74
17	0.0425	0.0099	52.9	540	75.5	770	64	6.5	7.75	2.3	11.3	7.58
20	0.050	0.0102	57.8	590	90	920	91	9.3	12.8	3.8	12.4	8.28
25	0.062	0.0130	96.0	980	151	1540	156	16	24.2	7.2	20.5	13.8
32	0.080	0.0144	150	1530	250	2550	313	32	53.9	16	32.1	2.15
40	0.096	0.0151	213	2170	365	3720	450	46	91	27	45.6	3.05
50	0.119	0.0192	348	3550	602	6140	759	77	171	51	74.4	4.99

■ CSD-2UF

Table 220-2

Size	Pitch circle dia. of a roller dp m	Offset R m	Basic rated load				Allowable moment load Mc		Moment stiffness Km		Allowable axial load Fa	Allowable radial load Fr
			Basic dynamic rated load C ×10 <sup>2</sup> N	kgf	Basic static rated load Co ×10 <sup>2</sup> N	kgf	Nm	kgfm	×10 <sup>4</sup> Nm / rad	kgfm / arc-min	×10 <sup>2</sup> N	×10 <sup>2</sup> N
14	0.050	0.0118	57.8	590	90	920	91	9.3	12.8	3.8	12.4	8.28
17	0.060	0.0123	104	1060	163	1670	124	12.6	15.4	4.6	22.2	14.9
20	0.070	0.0128	146	1490	220	2250	187	19.1	25.2	7.5	31.2	20.9
25	0.085	0.0134	218	2230	358	3660	258	26.3	39.2	11.6	46.6	31.2
32	0.111	0.0168	382	3900	654	6680	580	59.1	100	29.6	81.7	54.7
40	0.133	0.0215	433	4410	816	8330	849	86.6	179	53.2	92.6	62.0

(Note)

- \* The basic dynamic rated load means a certain static radial load so that the basic dynamic rated life of the roller bearing is one million rotations.
- \* The basic static rated load means a static load that gives a certain level of contact stress (4 kN/mm<sup>2</sup>) in the center of the contact area between the rolling element receiving the maximum load and the orbit.
- \* The value of the moment stiffness is the average value.
- \* Allowable moment load is the maximum moment load that may be applied to the output shaft. Please adhere to these values for optimum performance. The value of the moment stiffness is the reference value. The lower-limit value is approximate 80% of the displayed value.
- Allowable axial or radial load is the value that satisfies the reducer life when either a genuine radial load or an axial load is applied to the main shaft. (When radial load is L+R=0mm, and axial load is La=0mm)

**Recommended tolerances for assembly**

Recommended tolerances for assembly

Input: Wave generator  
Output: Circular spline  
Fixed: Flexspline

■ CSD-2UH

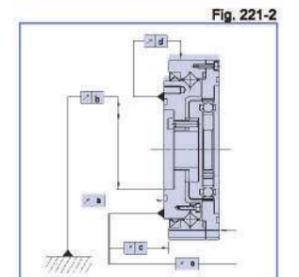
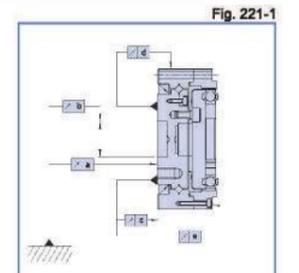
Table 221-1 Unit: mm

Symbol	Size	14	17	20	25	32	40	50
a		0.010	0.010	0.010	0.015	0.015	0.015	0.018
b		0.010	0.012	0.012	0.013	0.013	0.015	0.015
c		0.007	0.007	0.007	0.007	0.007	0.007	0.007
d		0.010	0.010	0.010	0.010	0.010	0.015	0.015
e		0.025	0.025	0.025	0.035	0.037	0.037	0.040

■ CSD-2UF

Table 221-2 Unit: mm

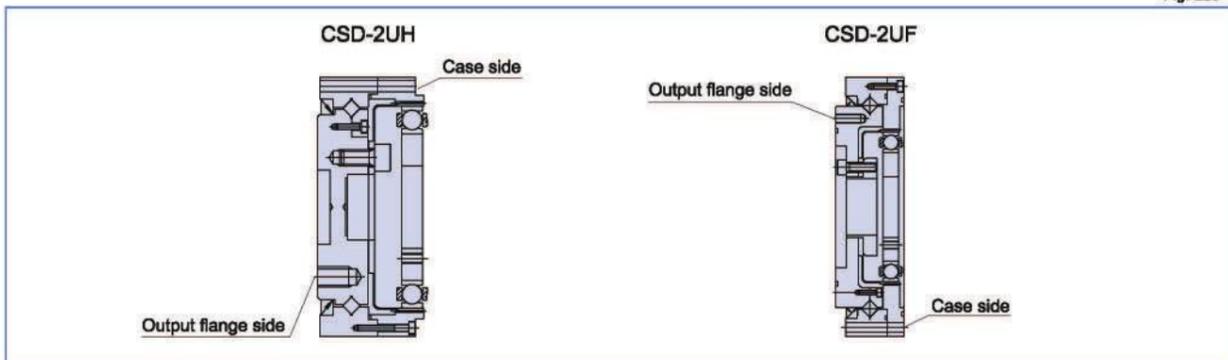
Symbol	Size	14	17	20	25	32	40
a		0.010	0.010	0.010	0.015	0.015	0.015
b		0.010	0.010	0.010	0.010	0.013	0.013
c		0.010	0.010	0.010	0.010	0.013	0.013
d		0.010	0.010	0.010	0.010	0.013	0.013
e		0.031	0.031	0.031	0.041	0.047	0.047



## Design Guide

### Installation and transmission torque

Fig. 223-1



#### Installation on output flange side and resulting transmission torque

##### CSD-2UH

Table 223-1

Item	Size	14	17	20	25	32	40	50
Number of bolts		10	8	8	8	10	10	10
Bolt size		M3	M5	M6	M8	M8	M10	M12
Pitch circle	mm	25	27	34	42	57	72	88
Bolt tightening torque	Nm	2.4	10.8	18.4	44	44	74	128
Torque transmission capacity (bolt only)	Nm	50	122	217	486	824	1665	2933

##### CSD-2UF

Table 223-2

Item	Size	14	17	20	25	32	40
Number of bolts		8	10	8	8	8	12
Bolt size		M3	M3	M4	M5	M6	M6
Pitch circle	mm	42	50	60	73	96	116
Bolt tightening torque	Nm	2.4	2.4	5.4	10.8	18.4	18.4
Torque transmission capacity (bolt only)	Nm	70	104	167	329	765	1109

#### Bolt connection to housing and resulting transmission torque

##### CSD-2UH

Table 223-3

Item	Size	14	17	20	25	32	40	50
Number of bolts		6	10	12	18	18	18	22
Bolt size		M3	M3	M3	M3	M4	M5	M6
Pitch circle	mm	49	56	64	79	104	117.5	147
Bolt tightening torque	Nm	2.4	2.4	2.4	2.4	5.4	10.8	18.4
Torque transmission capacity (bolt only)	Nm	43	82	112	207	461	833	1804

##### CSD-2UF

Table 223-4

Item	Size	14	17	20	25	32	40
Number of bolts		6	8	8	10	10	10
Bolt size		M3	M3	M3	M4	M5	M6
Pitch circle	mm	64	74	84	102	132	158
Bolt tightening torque	Nm	2.4	2.4	2.4	5.4	10.8	18.4
Torque transmission capacity (bolt only)	Nm	80	123	140	359	743	1259

(Table 223-1 to 223-4/Notes)

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

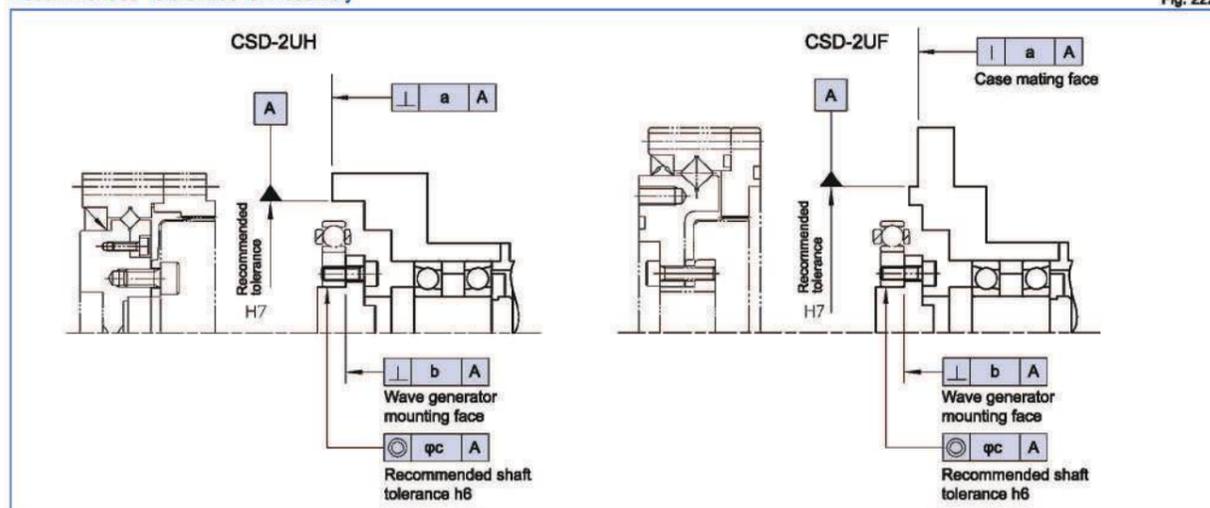
### Recommended tolerances for assembly

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 to avoid grease leakage.

- Warp and deformation on the mounting surface
- Blocking of foreign matter
- Problems caused by burrs, raised surfaces and location around the tap area of the mounting holes
- Insufficient chamfering on the housing mount
- Insufficient radii on the housing mount

#### Recommended Tolerances for Assembly

Fig. 222-1



#### Tolerances for Assembly CSD-2UH

Table 222-1 Unit: mm

Symbol	Size	14	17	20	25	32	40	50
a		0.011	0.015	0.017	0.024	0.026	0.026	0.028
b		0.008	0.010	0.012	0.012	0.012	0.012	0.015
φc		0.016	0.018	0.019	0.022	0.022	0.024	0.030

#### Tolerances for Assembly CSD-2UF

Table 222-2 Unit: mm

Symbol	Size	14	17	20	25	32	40
a		0.011	0.015	0.017	0.024	0.026	0.026
b		0.008	0.010	0.012	0.012	0.012	0.012
φc		0.016	0.018	0.019	0.022	0.022	0.024

### Lubrication

Grease lubrication is standard for the CSD-2UH and CSD-2UF. There is no need to add or apply grease upon installation since the products are shipped with the grease applied. See table below for recommended housing dimensions. These dimensions must be maintained to prevent damage to the gear and to maintain a proper grease cavity.

#### Recommended housing dimensions

Table 224-1 Unit: mm

Symbol	Size	14	17	20	25	32	40	50
a*		1	1	1.5	1.5	2	2.5	3.5
a**		3	3	4.5	4.5	6	7.5	10.5
φb <sup>±0.5</sup>		16	26	30	37	37	45	45

\* For the wave generator facing downward

\*\* For the wave generator facing upward

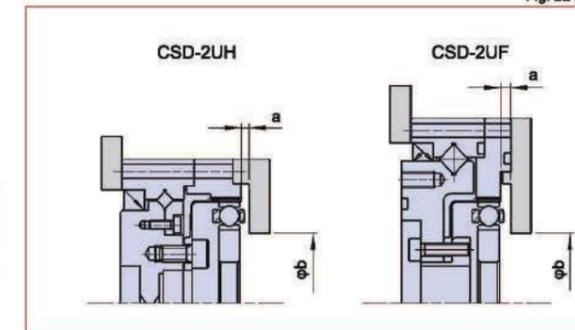
### Sealing

The following sealing mechanism is required to prevent grease leakage and maintain the high durability of the gear.

- Rotating Parts** ..... Oil seal (with a spring). Surface should be smooth (no scratches)
- Mating flange** ..... O-ring and seal adhesive. Take care regarding distortion on the plane and how the O-ring is engaged.
- Screw hole area**..... Screws should have a thread lock (Loctite 242 is recommended) or seal adhesive.

(Note) If you use Harmonic Grease® 4BNo.2 lubrication, strict sealing is required.

Fig. 224-1



Sealing area and the recommended sealing method for the unit type Table 224-3

	Area requiring sealing	Recommended sealing method
Output side	Pass-through hole in the center of the output flange and the output flange mating face	Use O-ring (supplied with the product)
	Mounting screw area	Screw lock agent with sealing effect (Loctite 242 is recommended)
Input side	Flange mating face	Use O-ring (supplied with the product)
	Motor output shaft	Please select a motor which has an oil seal on the output shaft.

## Features



### SHD series

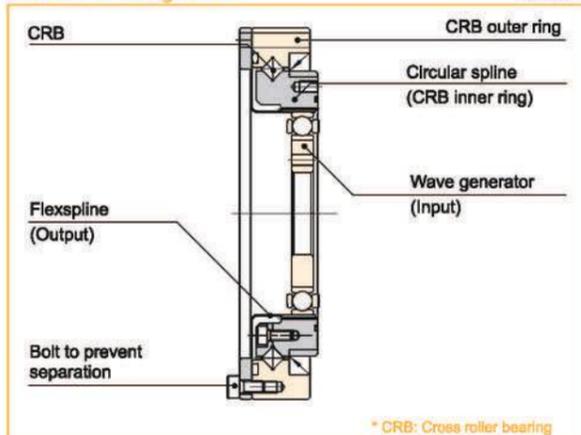
Axially compact, these gear units feature a large hollow input shaft and a robust cross roller bearing so loads can be mounted directly to the unit without the need for additional support bearings

#### Features of SHD series

- Zero Backlash
- Ultra-flat design - 15% thinner than the SHF Series
- Large Hollow Input Shaft
- Accuracy <1 arc-min (most sizes)
- Rigid cross roller output bearing
- Lightweight - 30% lower weight than Standard SHF Series

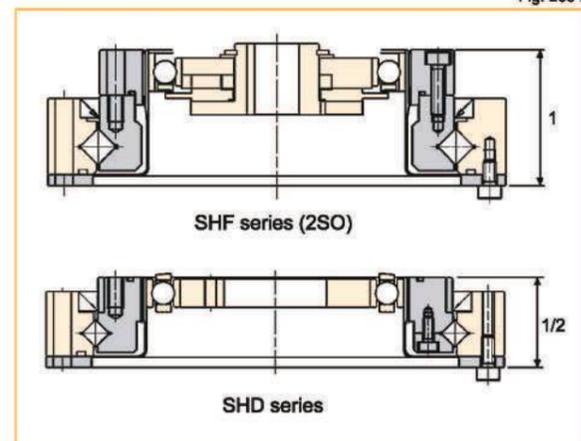
Structure of SHD gear unit

Fig. 268-1



Shaft thickness

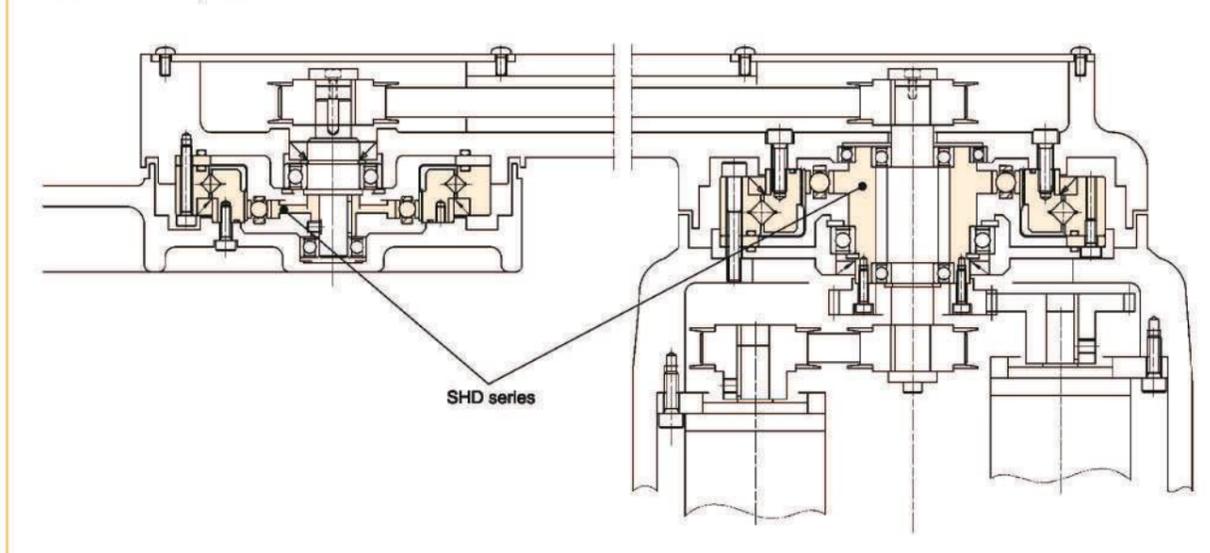
Fig. 268-2



Application example, SHD series

Fig. 269-1

SCARA robot  
SHD is ideal when space is limited.



## Ordering Code

SHD - 20 - 100 - 2SH - SP

Table 269-1

Series	Size	Ratio*1				Model	Special specification
SHD	14	50	100	—		2SH = Simplicity Unit 2UH = Gear Unit	LW = Lightweight SP= Special specification code Blank=Standard product
	17	50	100	—			
	20	50	100	160	160		
	25	50	100	160	160		
	32	50	100	160	160		
	40	50	100	160	160		

\*1 The reduction ratio value is based on the following configuration:  
Input: wave generator, fixed: circular spline, output: flexspline

## Technical Data

Rating table

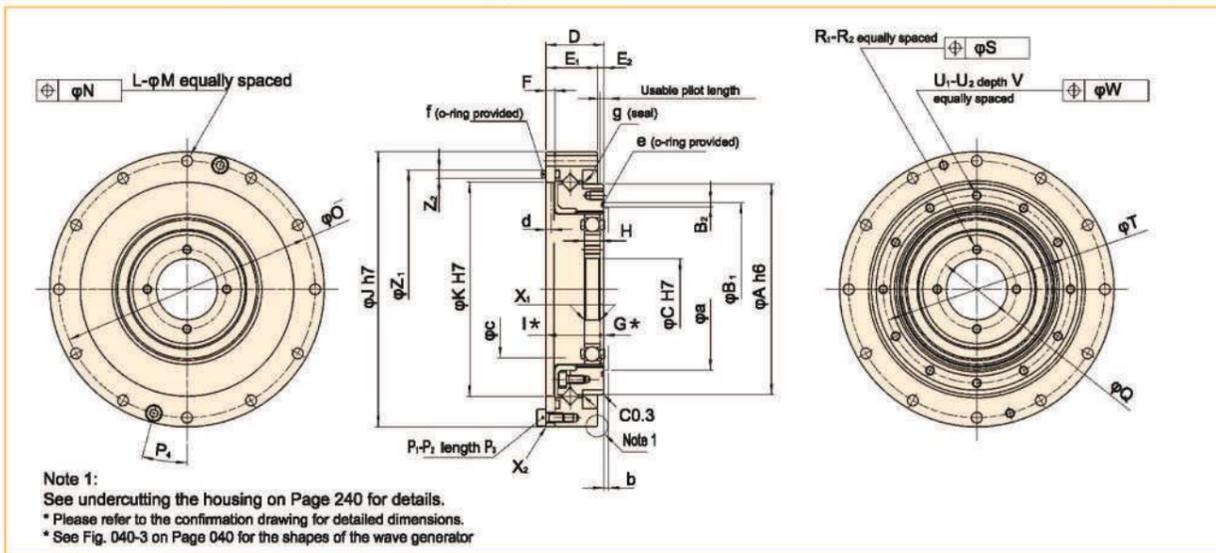
Table 270-1

Size	Ratio	Rated Torque at 2000rpm		Limit for Repeated Peak Torque		Limit for Average Torque		Limit for Momentary Peak Torque		Maximum Input Speed (rpm)	Limit for Average Input Speed (rpm)	Moment of Inertia	
		Nm	kgfm	Nm	kgfm	Nm	kgfm	Nm	kgfm			$I$ ×10 <sup>-4</sup> kgm <sup>2</sup>	$J$ ×10 <sup>-4</sup> kgm <sup>2</sup>
14	50	3.7	0.38	12	1.2	4.8	0.49	23	2.3	8500	3500	0.021	0.021
	100	5.4	0.55	19	1.9	7.7	0.79	35	3.6				
17	50	11	1.1	23	2.3	18	1.9	48	4.9	7300	3500	0.054	0.055
	100	16	1.6	37	3.8	27	2.8	71	7.2				
	160	28	2.9	64	6.5	34	3.5	95	10				
20	50	17	1.7	39	4.0	24	2.4	69	7.0	6500	3500	0.090	0.092
	100	28	2.9	57	5.8	34	3.5	95	10				
	160	28	2.9	64	6.5	34	3.5	95	10				
25	50	27	2.8	69	7.0	38	3.9	127	13	5600	3500	0.282	0.288
	100	47	4.8	110	11	75	7.6	184	19				
	160	47	4.8	123	13	75	7.6	204	21				
32	50	53	5.4	151	15	75	7.6	268	27	4800	3500	1.09	1.11
	100	96	10	233	24	151	15	420	43				
	160	96	10	261	27	151	15	445	45				
40	50	96	10	281	29	137	14	480	49	4000	3000	2.85	2.91
	100	185	19	398	41	260	27	700	71				
	160	206	21	453	46	316	32	765	78				

(Note) 1. Moment of Inertia:  $I = \frac{1}{4} GD^2$   
2. See Rating Table Definitions on Page 12 for details of the terms.

Outline Dimensions SHD-2SH

Fig. 270-1



Dimensions SHD-2SH

Table 271-1 Unit : mm

Symbol	Size	14	17	20	25	32	40
φA h6		49 <sup>0</sup> <sub>-0.016</sub>	59 <sup>0</sup> <sub>-0.019</sub>	69 <sup>0</sup> <sub>-0.019</sub>	84 <sup>0</sup> <sub>-0.022</sub>	110 <sup>0</sup> <sub>-0.022</sub>	132 <sup>0</sup> <sub>-0.029</sub>
φB <sub>1</sub>		39.1 <sup>±0.1</sup>	48.3 <sup>±0.1</sup>	56.8 <sup>±0.1</sup>	70.5 <sup>±0.1</sup>	92 <sup>±0.1</sup>	112.4 <sup>±0.1</sup>
B <sub>2</sub>		0.8 <sup>±0.05</sup>	1.1 <sup>±0.05</sup>	1.4 <sup>±0.05</sup>	1.7 <sup>±0.05</sup>	2 <sup>±0.05</sup>	2.2 <sup>±0.05</sup>
φC H7		11 <sup>±0.018</sup>	15 <sup>±0.018</sup>	20 <sup>±0.021</sup>	24 <sup>±0.021</sup>	32 <sup>±0.025</sup>	40 <sup>±0.028</sup>
D		17.5 <sup>±0.1</sup>	18.5 <sup>±0.1</sup>	19 <sup>±0.1</sup>	22 <sup>±0.1</sup>	27.9 <sup>±0.1</sup>	33 <sup>±0.1</sup>
E <sub>1</sub>		16.5	17	17	20	23.6	28
E <sub>2</sub>		2	2	2	2	4.3	5
F		2.4	3	3	3.3	3.8	4
G*		1.8	1.6	1.2	0.4	0.6	0.8
H		4 <sup>±0.1</sup>	5 <sup>±0.1</sup>	5.2 <sup>±0.1</sup>	6.35 <sup>±0.1</sup>	8.6 <sup>±0.1</sup>	10.3 <sup>±0.1</sup>
I*		15.7 <sup>±0.2</sup>	16.9 <sup>±0.2</sup>	17.8 <sup>±0.2</sup>	21.6 <sup>±0.2</sup>	27.3 <sup>±0.2</sup>	32.2 <sup>±0.2</sup>
φJ h7		70 <sup>±0.030</sup>	80 <sup>±0.035</sup>	110 <sup>±0.035</sup>	142 <sup>±0.040</sup>	170 <sup>±0.045</sup>	170 <sup>±0.045</sup>
φK H7		50 <sup>±0.025</sup>	61 <sup>±0.025</sup>	71 <sup>±0.030</sup>	88 <sup>±0.035</sup>	114 <sup>±0.040</sup>	140 <sup>±0.040</sup>
L		8	12	12	12	12	12
φM		3.5	3.5	3.5	4.5	5.5	6.6
φN		0.25	0.25	0.25	0.25	0.25	0.3
φO		64	74	84	102	132	158
P <sub>1</sub>		2	2	2	4	4	4
P <sub>2</sub>		M3	M3	M3	M3	M4	M4
P <sub>3</sub>		6	6	6	8	10	10
P <sub>4</sub>		22.5°	15°	15°	15°	15°	15°
φQ		17	21	26	30	40	50
R <sub>1</sub>		4	4	4	4	4	4
R <sub>2</sub>		M3	M3	M3	M3	M4	M5
φS		0.25	0.25	0.25	0.25	0.25	0.25
φT		43	52	61.4	76	99	120
U <sub>1</sub>		8	12	12	12	12	12
U <sub>2</sub>		M3	M3	M3	M4	M5	M6
V		4.5	4.5	4.5	6	8	9
φW		0.25	0.25	0.25	0.25	0.25	0.3
X <sub>1</sub>		C0.4	C0.4	C0.5	C0.5	C0.5	C0.5
X <sub>2</sub>		C0.4	C0.4	C0.5	C0.5	C0.5	C0.5
Z <sub>1</sub>		57 <sup>±0.1</sup>	68.1 <sup>±0.1</sup>	78 <sup>±0.1</sup>	94.8 <sup>±0.1</sup>	123 <sup>±0.1</sup>	148 <sup>±0.1</sup>
Z <sub>2</sub>		2 <sup>±0.05</sup>	2 <sup>±0.05</sup>	2.7 <sup>±0.05</sup>	2.4 <sup>±0.05</sup>	2.7 <sup>±0.05</sup>	2.7 <sup>±0.05</sup>
φa		36.5	45	53	66	86	106
b		1	1	1.5	1.5	2	2.5
φc		31	38	45	56	73	90
d		1.4	1.8	1.7	1.8	1.8	1.8
e		d37.1d0.6	d45.4d0.8	d53.28d0.99	d66.5d1.3	d87.5d1.5	d107.5d1.6
f		d54.38d1.19	d64.0d1.5	d72.0d2.0	d88.62d1.78	d117.0d2.0	d142d2.0
g		D49585	D59685	D69785	D84945	D1101226	D1321467
h		1.5	1.5	1.5	3.3	3.3	4
Mass (kg)		0.33	0.42	0.52	0.91	1.87	3.09

● The following dimensions can be modified to accommodate:  
 Wave Generator: C  
 Flexspline: O and P  
 Circular Spline: X<sub>1</sub> and X<sub>2</sub>

● \*The G and I sizes indicated by an asterisk are the mounting positions in the shaft direction and allowance of the three parts (wave generator, flexspline, circular spline). Strictly observe these sizes as they affect the performance and strength.

● As the flexspline is subject to elastic deformation, the inner wall should be φa, b, c or more and it should not exceed φd to prevent possible contact with the housing.

Positional Accuracy

See "Engineering data" for a description of terms.

Table 273-1 Unit: X10<sup>-4</sup>rad (arc-min)

Size	14	17	20	25	32	40	
Positional Accuracy	×10 <sup>-4</sup> rad	4.4	4.4	2.9	2.9	2.9	2.9
	arc min	1.5	1.5	1.0	1.0	1.0	1.0

Hysteresis loss

See "Engineering data" for a description of terms.

Table 273-2

Ratio	Size	14	17	20	25	32	40
50	×10 <sup>-4</sup> rad	7.3	5.8	5.8	5.8	5.8	5.8
	arc min	2.5	2.0	2.0	2.0	2.0	2.0
100 or more	×10 <sup>-4</sup> rad	5.8	2.9	2.9	2.9	2.9	2.9
	arc min	2.0	1.0	1.0	1.0	1.0	1.0

Torsional Stiffness

See "Engineering data" for a description of terms.

Table 273-3

Symbol	Size	14	17	20	25	32	40	
T <sub>1</sub>	Nm	2.0	3.9	7.0	14	29	54	
	kgfm	0.2	0.4	0.7	1.4	3.0	5.5	
T <sub>2</sub>	Nm	6.9	12	25	48	108	196	
	kgfm	0.7	1.2	2.5	4.9	11	20	
Ratio 50	K <sub>1</sub>	×10 <sup>4</sup> Nm/rad	0.29	0.67	1.1	2.0	4.7	8.8
		kgfm/arc min	0.085	0.2	0.32	0.6	1.4	2.6
	K <sub>2</sub>	×10 <sup>4</sup> Nm/rad	0.37	0.88	1.3	2.7	6.1	11
		kgfm/arc min	0.11	0.26	0.4	0.8	1.8	3.4
	K <sub>3</sub>	×10 <sup>4</sup> Nm/rad	0.47	1.2	2.0	3.7	8.4	15
		kgfm/arc min	0.14	0.34	0.6	1.1	2.5	4.5
θ <sub>1</sub>	×10 <sup>-4</sup> rad	6.9	5.8	6.4	7.0	6.2	6.1	
	arc min	2.4	2.0	2.2	2.3	2.1	2.1	
θ <sub>2</sub>	×10 <sup>-4</sup> rad	19	14	19	18	18	18	
	arc min	6.4	4.6	6.3	6.1	6.1	5.9	
Ratio 100 or more	K <sub>1</sub>	×10 <sup>4</sup> Nm/rad	0.4	0.84	1.3	2.7	6.1	11
		kgfm/arc min	0.12	0.25	0.4	0.8	1.8	3.2
	K <sub>2</sub>	×10 <sup>4</sup> Nm/rad	0.44	0.94	1.7	3.7	7.8	14
		kgfm/arc min	0.13	0.28	0.5	1.1	2.3	4.2
	K <sub>3</sub>	×10 <sup>4</sup> Nm/rad	0.61	1.3	2.5	4.7	11	20
		kgfm/arc min	0.18	0.39	0.75	1.4	3.3	5.8
θ <sub>1</sub>	×10 <sup>-4</sup> rad	5.0	4.6	5.4	5.2	4.8	4.9	
	arc min	1.7	1.6	1.8	1.8	1.7	1.7	
θ <sub>2</sub>	×10 <sup>-4</sup> rad	16	13	15	13	14	14	
	arc min	5.4	4.3	5.0	4.5	4.8	4.8	

\* The values in this table are reference values. The minimum value is approximately 80% of the displayed value.

Simplicity unit (2SH) Starting torque

See "Engineering data" for a description of terms. The values are reference values.

Table 274-1 Unit: Ncm

Ratio	Size	14	17	20	25	32	40
50		6.2	19	25	39	60	95
100		4.8	17	22	34	50	78
160		—	—	22	33	47	74

Simplicity unit (2SH) Backdriving torque

See "Engineering data" for a description of terms. The values are reference values.

Table 274-3 Unit: Ncm

Ratio	Size	14	17	20	25	32	40
50		3.7	11	15	24	36	57
100		5.8	21	27	41	60	94
160		—	—	42	64	91	143

Ratcheting torque

See "Engineering data" for a description of terms.

Table 274-5 Unit: Nm

Ratio	Size	14	17	20	25	32	40
50		88	150	220	450	980	1800
100		84	160	260	500	1000	2100
160		—	—	220	450	980	1800

Buckling torque

See "Engineering data" for a description of terms.

Table 274-6 Unit: Nm

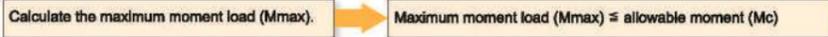
Size	14	17	20	25	32	40
Total reduction ratio	130	260	470	850	1800	3600

**Checking output bearing**

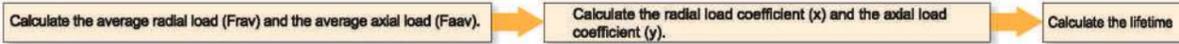
A precision cross roller bearing is built in the unit type to directly support the external load (output flange).  
 Check the maximum moment load, life of the cross roller bearing and static safety coefficient to fully bring out the performance of the unit type.  
 See page 030 to 034 of "Engineering data" for each calculation formula.

■ **Checking procedure**

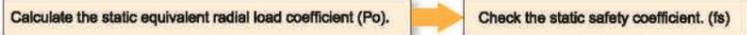
(1) **Checking the maximum moment load (M max)**



(2) **Checking the life**



(3) **Checking the static safety coefficient**



■ **Output bearing specifications**

The specifications of the cross roller are shown in Table 280-1.

**Specifications**

Table 280-1

Size	Pitch circle dia. of a roller		Basic rated load				Allowable moment load Mc		Moment stiffness Km	
	dp	R	Basic dynamic rated load C		Basic static rated load Co		Nm	kgfm	×10 <sup>4</sup>	
			×10 <sup>3</sup> N	kgf	×10 <sup>3</sup> N	kgf			Nm/rad	kgf m/arc min
14	0.0503	0.0111	29	296	43	438	37	3.8	7.08	2.1
17	0.061	0.0115	52	530	81	826	62	6.3	12.7	3.8
20	0.070	0.011	73	744	110	1122	93	9.5	21	6.2
25	0.086	0.0121	109	1111	179	1825	129	13.2	31	9.2
32	0.112	0.0173	191	1948	327	3334	290	29.6	82.1	24.4
40	0.133	0.0195	216	2203	408	4160	424	43.2	145	43.0

(Note) \* The basic dynamic rated load means a certain static radial load so that the basic dynamic rated life of the roller bearing is one million rotations.  
 \* The basic static rated load means a static load that gives a certain level of contact stress (4 kN/mm<sup>2</sup>) in the center of the contact area between the rolling element receiving the maximum load and the orbit.  
 \* The value of the moment stiffness is the average value.

\* As the life of the cross roller bearing of the unit of the reduction ratio corresponding to the table below (Table 280-2) is shorter than that (L<sub>10</sub>) of the gear during operation under the allowable moment load, consideration should be made in designing the load condition and the lifetime.

(Note) The life of the gear indicates the life (L<sub>10</sub>=7000 hours) of the wave generator bearing when it operates at 2000rpm input rotational speed and the rated torque (see "Life of the wave generator" on Page 012).

**Design Guide**

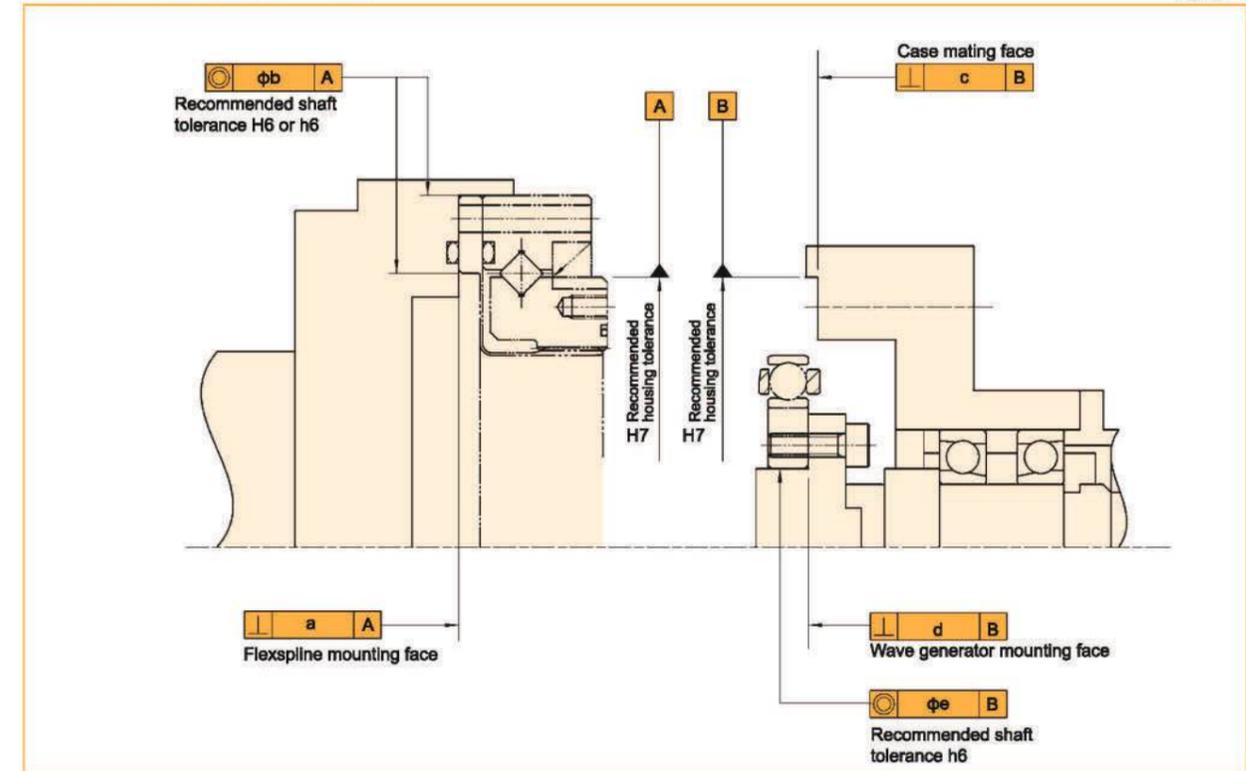
**Installation accuracy**

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 to avoid grease leakage.

- Warp and deformation on the mounting surface
- Blocking of foreign matter
- Problems caused by burrs, raised surfaces and location around the tap area of the mounting holes
- Insufficient chamfering on the housing mount
- Insufficient radii on the housing mount

**Recommended tolerances for assembly**

Fig. 281-1



**Recommended tolerances for assembly**

Table 281-1  
Unit: mm

Symbol	Size	14	17	20	25	32	40
a		0.016	0.021	0.027	0.035	0.042	0.048
φb		0.015	0.018	0.019	0.022	0.022	0.024
c		0.011	0.012	0.013	0.014	0.016	0.016
d		0.008	0.010	0.012	0.012	0.012	0.012
φe		0.016	0.018	0.019	0.022	0.022	0.024

**Installation and transmission torque**

**Installation and transmission torque on (A) side**

Table 282-2

Item	Size	14	17	20	25	32	40
Number of bolts		8	12	12	12	12	12
Bolt size		M3	M3	M3	M4	M5	M6
Pitch Circle Diameter	mm	64	74	84	102	132	158
Clamp torque	Nm	2.0	2.0	2.0	4.5	9.0	15.3
Transmission torque	Nm	108	186	210	431	892	1509

- (Notes) 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. Tightening coefficient: A=1.4  
 5. Tightening friction coefficient  $\mu=0.15$

**Installation and transmission torque on (B) side**

Table 282-3

Item	Size	14	17	20	25	32	40
Number of bolts		8	12	12	12	12	12
Bolt size		M3	M3	M3	M4	M5	M6
Pitch Circle Diameter	mm	43	52	61.4	76	99	120
Effective depth of screw part	mm	4.5	4.5	4.5	6	8	9
Clamp torque	Nm	2.0	2.0	2.0	4.5	9.0	15.3
Transmission torque	Nm	72	130	154	321	668	1148

- (Notes) 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. Tightening coefficient: A=1.4  
 5. Tightening friction coefficient  $\mu=0.15$

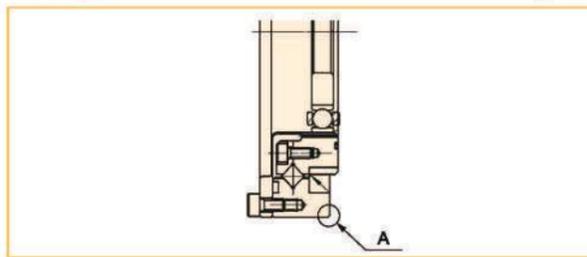
\* Since the flange material on the case side is AL (aluminum), be sure to tighten the bolt to the specified torque as described above. If the tightening torque exceeds the above value, the correct transmission torque may not be secured or the bolt may be loosened. Use washers instead of putting the aluminum directly on the bolt-bearing surface when tightening with the bolt from the A side.

**Recessing of the mounting pilot**

When the housing interferes with corner "A" shown below, an undercut in the housing is recommended.

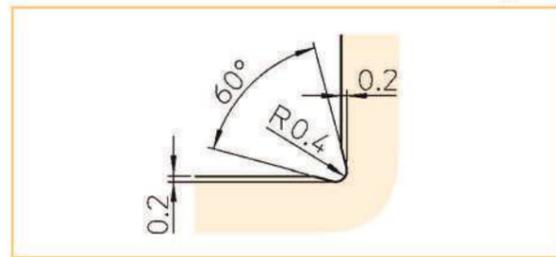
**Mounting pilot**

Fig. 283-1



**Recommended housing undercut**

Fig. 283-2

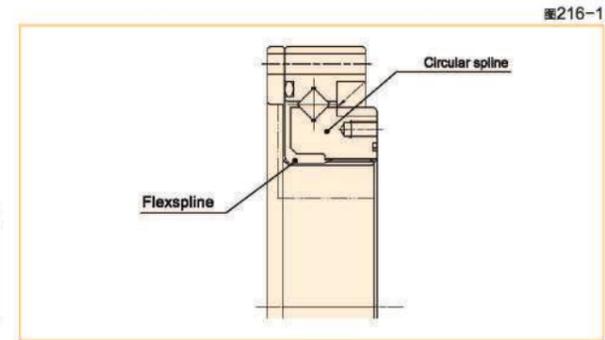


**Output part and fixed part**

The output part of SHD series varies from the fixed position. In addition, the reduction ratio and direction of rotation also change, and the relationship is shown in the following figure

表216-1

Fixed part	Output part	Rotary direction and ratio
Flexspline	Circular spline	② on page 9
Circular spline	Flexspline	① on page 9



**Lubrication**

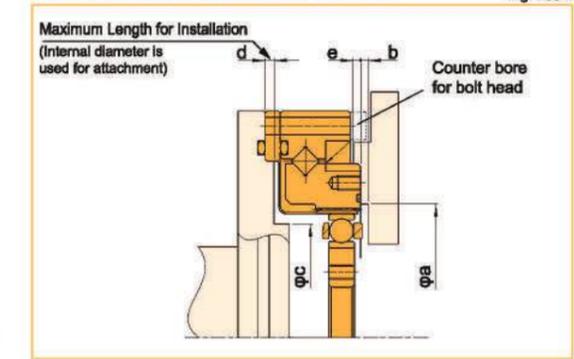
Standard lubrication for SHD series is grease lubrication. See "Engineering data" on Page 016 for details of the lubricant .

**Recommended minimum housing clearance**

These dimensions must be maintained to prevent damage to the gear and to maintain a proper grease cavity.

**Recommended minimum housing clearance**

Fig. 283-4



**Minimum housing clearance**

Table 283-5 Unit: mm

Symbol	Size	14	17	20	25	32	40
$\phi a$		36.5	45	53	66	86	106
b		1(3)	1(3)	1.5(4.5)	1.5(4.5)	2(6)	2.5(7.5)
$\phi c$		31	38	45	56	73	90
d		1.4	1.8	1.7	1.8	1.8	1.8
e		1.5	1.5	1.5	1.5	3.3	4

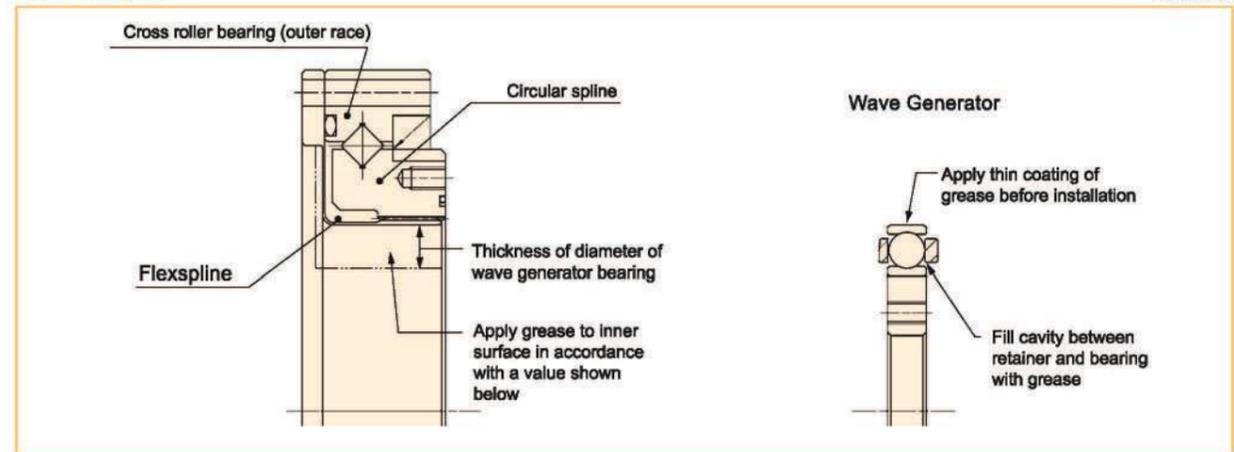
(Note) The value in parenthesis is the value when the wave generator is facing upward.

**Application guide**

As the SHD series is shipped with the outer race of the cross roller bearing and the flexspline temporarily bolted together, grease is applied to the gear teeth, the periphery of the flexspline and the tooth groove of the circular spline. Refer to the following application guide for grease application instructions.

**Application guide**

Table 284-1



**Application quantity**

Table 284-1 Unit: g

Size	14	17	20	25	32	40
Application qty	5	9	13	24	51	99