



Motion Control Drives
FINE CYCLO[®]
High Precision Gearboxes
DA series

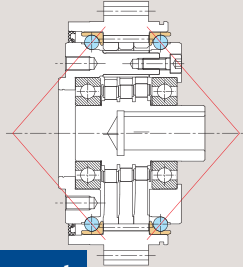
Table of Contents

1. Construction	4
2. Application Examples	4
3. Nomenclature	5
4. Line up	5
5. Speed Ratio and Rotation Direction ...	5
6. Standard Specifications	6
7. Rating	8
8. Engineering Data	12
9. Main Bearings	15
10. Selection	16
11. Notice for Designing.....	18
12. Outline Drawing	21
13. Operating Principle	27
14. Other	
Warranty Standard/Safety Precautions...	28

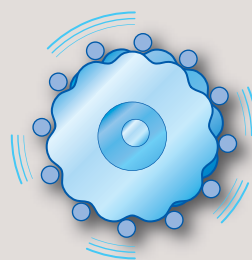
FINE CYCLO® High Precision Gearboxes

DA series

The built-in high-load type angular contact ball bearings, which have a long working point distance, are compact and can receive a large moment load.



High allowable moment



FINE CYCLO® gearboxes were created and developed by Sumitomo. This unique reducer structure without teeth (trochoid tooth profile*) is being used in industrial robots and transfer devices all over the world.

The DA series, developed for non-backlash, has three smooth cycloid discs arranged in a well-balanced manner, and a large number of simultaneous meshing provides a highly rigid and compact structure.

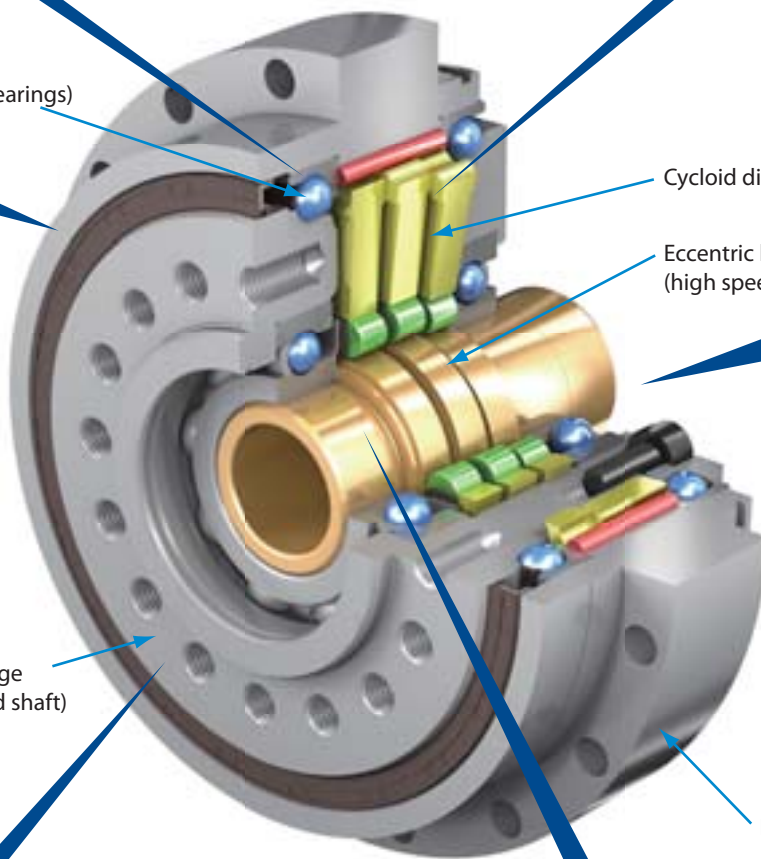
High torque & compact

* Epitrochoid parallel curves

Main bearing
(angular contact ball bearings)

Noise reduction

Noise reduction is realized by adopting a new tooth profile.



Cycloid disc

Eccentric high speed shaft
(high speed shaft)

Single-stage reduction mechanism

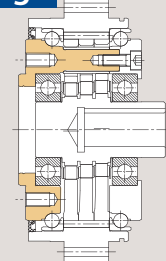
The DA series has a single-stage reduction mechanism, so has a small number of parts and is excellent in cost performance.

Output flange
(slow speed shaft)

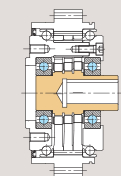
Ring gear housing

Higher flexibility of design

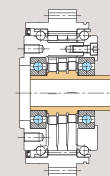
The output flange surface is flat, expanding the design flexibility of the connection surface with the customer's device, and the sealing property is secured.



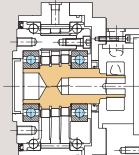
Reduction and customization of assembly steps



With key way



Hollow penetration



Keyless

The eccentric high speed shaft (high speed shaft) to which the servomotor shaft is inputted is supported inside, so motor connection is easy. There are a lot of variations on the input side, so users can customize the FINE CYCLO to suit their needs. Contact our factory for optional parts.

With key way	Standard
Keyless hollow penetration	Option

Expanded Model Lineup

The lineup of the DA series is significantly expanded. The most suitable model can be selected for the user's device.

14 types



27 types


New frame size →

D series (Conventional Product)

Frame size	Reduction ratio		
	59	89	119
D15	●	●	
D25	●	●	●
D30	●	●	●
D35	●	●	●
D45	●	●	●

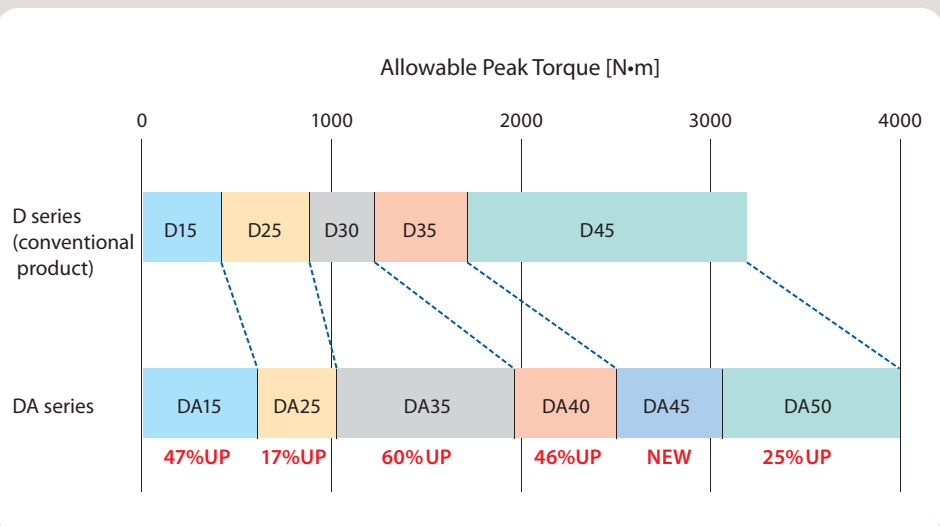
DA series

Frame size	Reduction ratio				
	29	41	59	89	119
DA15		●	●	●	●
DA25	●	●	●	●	●
DA35	●	●	●	●	●
DA40		●	●	●	●
DA45	●	●	●	●	●
DA50		●	●	●	●

 Newly added

Increased Allowable Peak Torque

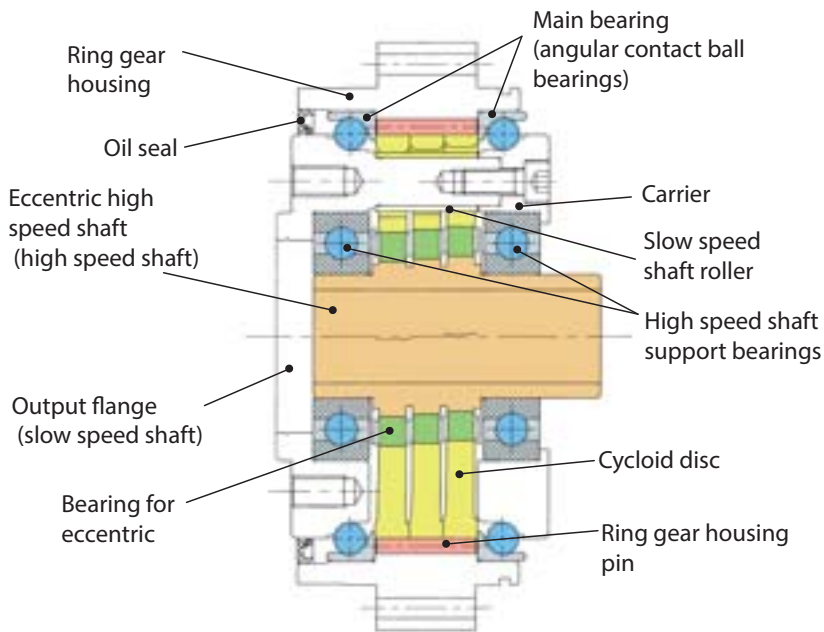
The DA series adopts a new tooth profile, and achieves a significant torque increase by increasing the bearing capacity and the strength of each part.



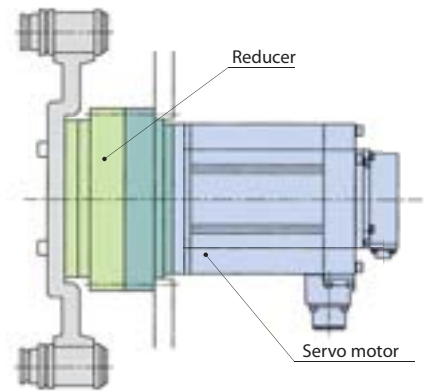
Note: Comparison of frames having the same size. DA45 is a newly added frame size.

1. Construction

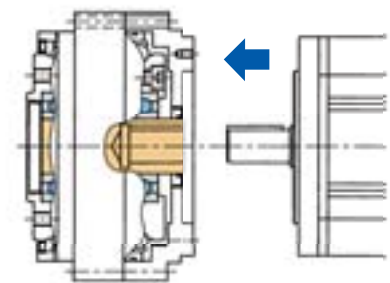
Figure 1



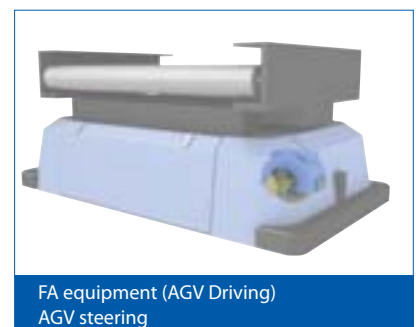
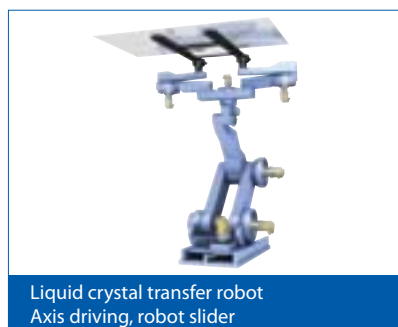
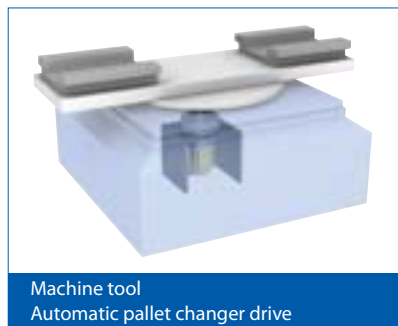
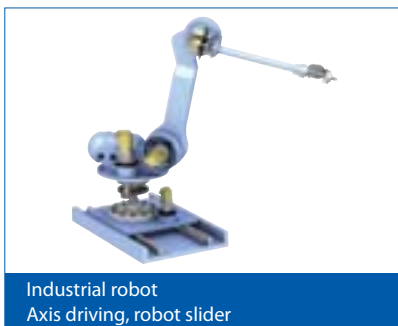
Example for magazine assembly



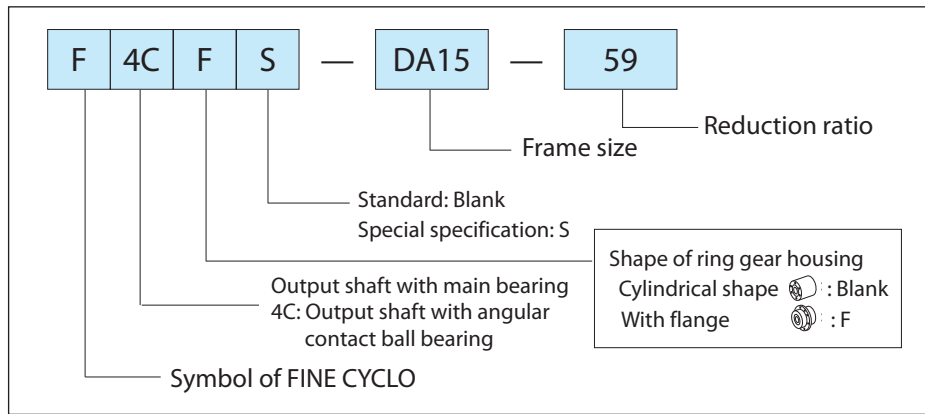
Application Example (with motor flange)



2. Application Examples



3. Nomenclature



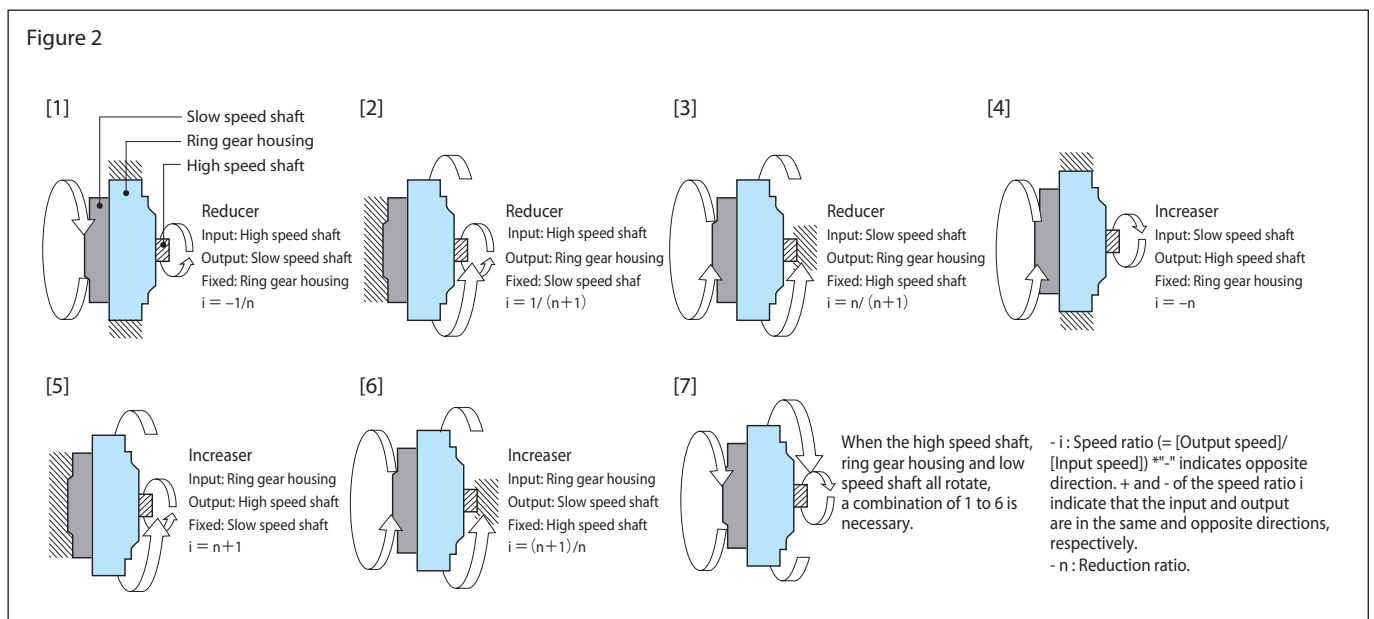
4. Line up

● : Production possible range

Frame size	Reduction ratio				
	29	41	59	89	119
DA15	/	●	●	●	●
DA25	●	●	●	●	●
DA35	●	●	●	●	●
DA40	/	●	●	●	●
DA45	●	●	●	●	●
DA50	/	●	●	●	●

5. Speed Ratio and Rotation Direction

The rotation direction and speed ratio are as illustrated in Figure 2 depending on the fixed, input, and output locations.



6. Standard Specifications

Lubrication	<p>Grease lubrication No grease is filled before shipment from the factory. Be sure to prepare the recommended grease and fill the reducer with it before use. For details, see 11-4 "Lubrication".</p>	
Ambient conditions	Ambient temperature	<p>-10 to + 40°C (Start failure may occur depending on the speed and torque of the motor in use, so consult us if the reducer will be used at about -10 to 0°C.)</p>
	Ambient humidity	85% or less. No condensation.
	Altitude	1000m or lower
	Atmosphere	Free from corrosive gas, volatile gas or steam. Dust-free and well-ventilated area.
	Mounting location	<p>Indoor (Free from dust, water, other liquids) - Mounting in conditions other than the above requires adherence to special specifications. Please consult with us. - Mount in a location that enables easy operation, such as inspection and maintenance. - Mount on a sufficiently rigid member.</p>
Mounting direction	The grease quantity varies according to the mounting direction.	
Painting	Paintless	

7. Rating

Table 1. Rating table (output rotation base)

Output speed (r/min)		5			10			15			20			25		
Frame size	Reduction ratio	Rated output torque (N · m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (N · m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (N · m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (N · m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (N · m)	Input speed (r/min)	Allowable input power (kW)
DA15	41	338	205	0.22	338	410	0.44	336	615	0.66	308	820	0.81	288	1025	0.94
	59	338	295	0.22	338	590	0.44	301	885	0.59	276	1180	0.72	258	1475	0.84
	89	338	445	0.22	300	890	0.39	266	1335	0.52	244	1780	0.64	228	2225	0.75
	119	340	595	0.22	277	1190	0.36	245	1785	0.48	225	2380	0.59	210	2975	0.69
DA25	29	625	145	0.41	625	290	0.82	625	435	1.23	573	580	1.50	536	725	1.75
	41	567	205	0.37	567	410	0.74	563	615	1.11	517	820	1.35	483	1025	1.58
	59	567	295	0.37	567	590	0.74	505	885	0.99	463	1180	1.21	433	1475	1.42
	89	567	445	0.37	504	890	0.66	446	1335	0.88	410	1780	1.07	383	2225	1.25
	119	571	595	0.37	465	1190	0.61	412	1785	0.81	378	2380	0.99	353	2975	1.16
DA35	29	846	145	0.55	846	290	1.11	846	435	1.66	776	580	2.03	726	725	2.38
	41	1081	205	0.71	1081	410	1.41	1073	615	2.11	984	820	2.58	920	1025	3.01
	59	1081	295	0.71	1081	590	1.41	962	885	1.89	882	1180	2.31	825	1475	2.70
	89	1081	445	0.71	960	890	1.26	850	1335	1.67	780	1780	2.04	730	2225	2.39
	119	1087	595	0.71	885	1190	1.16	784	1785	1.54	719	2380	1.88	673	2975	2.20
DA40	41	1379	205	0.90	1379	410	1.80	1369	615	2.69	1255	820	3.29	1174	1025	3.84
	59	1379	295	0.90	1379	590	1.80	1227	885	2.41	1126	1180	2.95	1053	1475	3.44
	89	1379	445	0.90	1225	890	1.60	1085	1335	2.13	995	1780	2.60	930	2225	3.04
	119	1387	595	0.91	1129	1190	1.48	1000	1785	1.96	917	2380	2.40			
DA45	29	1674	145	1.10	1674	290	2.19	1674	435	3.29	1535	580	4.02	1436	725	4.70
	41	1689	205	1.11	1689	410	2.21	1676	615	3.29	1538	820	4.03	1438	1025	4.71
	59	1689	295	1.11	1689	590	2.21	1503	885	2.95	1379	1180	3.61	1289	1475	4.22
	89	1689	445	1.11	1500	890	1.96	1328	1335	2.61	1219	1780	3.19	1140	2225	3.73
	119	1699	595	1.11	1383	1190	1.81	1225	1785	2.41	1124	2380	2.94			
DA50	41	2206	205	1.44	2206	410	2.89	2190	615	4.30	2009	820	5.26	1879	1025	6.15
	59	2206	295	1.44	2206	590	2.89	1963	885	3.85	1801	1180	4.71	1684	1475	5.51
	89	2206	445	1.44	1960	890	2.57	1735	1335	3.41	1592	1780	4.17	1489	2225	4.87
	119	2219	595	1.45	1807	1190	2.37	1600	1785	3.14	1468	2380	3.84			

Table 2. Allowable peak torque and allowable maximum momentary torque at acceleration and deceleration

Frame size	Reduction ratio	Allowable peak torque at acceleration and deceleration (N · m)	Allowable maximum momentary torque (N · m)
DA15	41-119	613	1225
DA25	29-119	1029	2058
DA35	29	1393	2786
	41-119	1960	3920
DA40	41-119	2500	5000
DA45	29	2756	5513
	41-119	3062	6125
DA50	41-119	4000	8000

30			40			50			60			Allowable maximum input speed (r/min)	Allowable average input speed (r/min)		Equivalent on input shaft Moment of inertia ($\times 10^4 \text{kg} \cdot \text{m}^2$)	Mass (kg)
Rated output torque (N·m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (N·m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (N·m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (N·m)	Input speed (r/min)	Allowable input power (kW)		50% ED	100% ED		
273	1230	1.07	250	1640	1.31	234	2050	1.53	221	2460	1.74	6150	5600	2800	0.45	4.7
244	1770	0.96	224	2360	1.17	210	2950	1.37	198	3540	1.56					
216	2670	0.85	198	3560	1.04	185	4450	1.21	175	5340	1.38					
199	3570	0.78	183	4760	0.96											
508	870	1.99	466	1160	2.44	435	1450	2.85	412	1740	3.24	5050	3700	1850	1.72	7.6
458	1230	1.80	420	1640	2.20	393	2050	2.57	372	2460	2.92					
410	1770	1.61	376	2360	1.97	352	2950	2.30	333	3540	2.62					
363	2670	1.42	333	3560	1.74											
335	3570	1.31														
687	870	2.70	630	1160	3.30	590	1450	3.86	558	1740	4.38	4550	2960	1480	4.61	11.8
871	1230	3.42	799	1640	4.19	748	2050	4.89	708	2460	5.56					
781	1770	3.07	717	2360	3.75	670	2950	4.39								
691	2670	2.71														
1112	1230	4.36	1020	1640	5.34	954	2050	6.24	903	2460	7.09	3950	2900	1450	6.54	13.9
997	1770	3.91	914	2360	4.79											
881	2670	3.46														
1359	870	5.34	1247	1160	6.53	1166	1450	7.63	1104	1740	8.67	3550	2240	1120	10.23	17.8
1361	1230	5.35	1249	1640	6.54	1168	2050	7.64	1106	2460	8.68					
1221	1770	4.79	1120	2360	5.86											
1779	1230	6.98	1631	1640	8.54	1526	2050	9.99				3150	2400	1200	17.01	22.3
1595	1770	6.26	1463	2360	7.66											

: 50%ED Use range : 100%ED Use range

Note: 1. Rated output torque

The rated torque indicates the allowable output torque at the output flange.

The rated torque for an input speed of 600 r/min or less with a reduction ratio of 41 to 119 is the same as the rated torque at 600 r/min. The rated torque for an input speed of 435 r/min or less (output speed of 15 r/min or less) with a reduction ratio of 29 is the same as the rated torque at 435 r/min (output speed of 15 r/min).

The input capacity is the required input capacity for 100% rated output torque. This value takes into account the efficiency when using the FINE CYCLO as a reducer.

2. Maximum allowable input speed and allowable average input speed (Table 1).

Although use is possible within the range of the maximum allowable input speed, the allowable average input speed is limited by the operation cycle (% ED).

See P17 Formula 10 for % ED.

3. Allowable peak torque at acceleration and deceleration (Table 2)

Allowable peak torque tolerance applied to the output flange during normal start and stop.

4. Allowable maximum momentary torque (Table 2)

Allowable maximum momentary torque applied instantaneously to the output shaft due to emergency stop, external heavy shock, etc.

This indicates the value in the case of 10^3 times of application during the entire lifetime.

5. Moment of inertia (Table 1)

Indicates the value of the moment of inertia on input shaft (high speed shaft) of each model. When converting these values to inertia ($\text{kgf} \cdot \text{m} \cdot \text{sec}^2$), divide by g (9.8 m/sec^2).

6. Use the following formula to complement the rated torque for speeds not shown in the table.

$$T_N T_{15} \left(\frac{15}{N} \right)^{0.3} \quad \begin{array}{l} T_N: \text{Rated torque for output speed } N \\ T_{15}: \text{Rated torque for output speed } 15 \text{ r/min} \end{array}$$

Table 3. Rating table (input rotation base)

Input speed (r/min)		4000			3000			2500			2000			1750		
Frame size	Reduction ratio	Rated output torque (N·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (N·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (N·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (N·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (N·m)	Output speed (r/min)	Allowable input power (kW)
DA15	41	191	97.6	2.44	209	73.2	2.00	220	61.0	1.76	236	48.8	1.50	245	42.7	1.37
	59	191	67.8	1.70	209	50.8	1.39	220	42.4	1.22	236	33.9	1.05	245	29.7	0.95
	89	191	44.9	1.13	209	33.7	0.92	220	28.1	0.81	236	22.5	0.69	245	19.7	0.63
	119	192	33.6	0.85	210	25.2	0.69	221	21.0	0.61	237	16.8	0.52	246	14.7	0.47
DA25	29				350	103.4	4.74	370	86.2	4.17	395	69.0	3.57	412	60.3	3.25
	41	321	97.6	4.10	350	73.2	3.35	370	61.0	2.95	395	48.8	2.52	412	42.7	2.30
	59	321	67.8	2.85	350	50.8	2.33	370	42.4	2.05	395	33.9	1.75	412	29.7	1.60
	89	321	44.9	1.89	350	33.7	1.54	370	28.1	1.36	395	22.5	1.16	412	19.7	1.06
	119	323	33.6	1.42	353	25.2	1.16	372	21.0	1.02	398	16.8	0.88	414	14.7	0.80
DA35	29							501	86.2	5.65	535	69.0	4.83	557	60.3	4.40
	41				667	73.2	6.39	704	61.0	5.62	753	48.8	4.81	784	42.7	4.38
	59				667	50.8	4.44	704	42.4	3.91	753	33.9	3.34	784	29.7	3.04
	89				667	33.7	2.94	704	28.1	2.59	753	22.5	2.22	784	19.7	2.02
	119				671	25.2	2.21	709	21.0	1.95	758	16.8	1.67	789	14.7	1.52
DA40	41							899	61.0	7.17	961	48.8	6.13	1000	42.7	5.59
	59							899	42.4	4.98	961	33.9	4.26	1000	29.7	3.88
	89							899	28.1	3.30	961	22.5	2.83	1000	19.7	2.57
	119							904	21.0	2.49	966	16.8	2.13	1006	14.7	1.94
DA45	29										1059	69.0	9.56	1102	60.3	8.71
	41							1101	61.0	8.78	1177	48.8	7.51	1225	42.7	6.84
	59							1101	42.4	6.10	1177	33.9	5.22	1225	29.7	4.76
	89							1101	28.1	4.05	1177	22.5	3.46	1225	19.7	3.15
	119							1107	21.0	3.04	1184	16.8	2.60	1232	14.7	2.37
DA50	41										1537	48.8	9.81	1600	42.7	8.94
	59										1537	33.9	6.82	1600	29.7	6.21
	89										1537	22.5	4.52	1600	19.7	4.12
	119										1546	16.8	3.40	1610	14.7	3.10

Table 4. Allowable peak torque and allowable maximum momentary torque at acceleration and deceleration

Frame size	Reduction ratio	Allowable peak torque at acceleration and deceleration (N·m)	Allowable maximum momentary torque (N·m)
DA15	41-119	613	1225
DA25	29-119	1029	2058
DA35	29	1393	2786
	41-119	1960	3920
DA40	41-119	2500	5000
DA45	29	2756	5513
	41-119	3062	6125
DA50	41-119	4000	8000

1500			1000			750			600			Allowable maximum input speed (r/min)	Allowable average input speed (r/min)		Equivalent on input shaft Moment of inertia (x10 ⁴ kg·m ²)	Mass (kg)
Rated output torque (N·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (N·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (N·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (N·m)	Output speed (r/min)	Allowable input power (kW)		50% ED	100% ED		
257	36.6	1.23	290	24.4	0.93	316	18.3	0.76	338	14.6	0.65	6150	5600	2800	0.45	4.7
257	25.4	0.85	290	16.9	0.64	316	12.7	0.53	338	10.2	0.45					
257	16.9	0.57	290	11.2	0.43	316	8.4	0.35	338	6.7	0.30					
258	12.6	0.43	292	8.4	0.32	318	6.3	0.26	340	5.0	0.22					
431	51.7	2.92	487	34.5	2.20	531	25.9	1.80	567	20.7	1.54	5050	3700	1850	1.72	7.6
431	36.6	2.06	487	24.4	1.55	531	18.3	1.27	567	14.6	1.09					
431	25.4	1.43	487	16.9	1.08	531	12.7	0.88	567	10.2	0.76					
431	16.9	0.95	487	11.2	0.72	531	8.4	0.59	567	6.7	0.50					
434	12.6	0.72	490	8.4	0.54	534	6.3	0.44	571	5.0	0.38	4550	2960	1480	4.61	11.8
584	51.7	3.95	659	34.5	2.97	718	25.9	2.43	768	20.7	2.08					
821	36.6	3.93	927	24.4	2.96	1011	18.3	2.42	1081	14.6	2.07					
821	25.4	2.73	927	16.9	2.06	1011	12.7	1.68	1081	10.2	1.44					
821	16.9	1.81	927	11.2	1.36	1011	8.4	1.12	1081	6.7	0.95	3950	2900	1450	4.45	13.9
826	12.6	1.36	933	8.4	1.03	1017	6.3	0.84	1087	5.0	0.72					
1047	36.6	5.02	1183	24.4	3.78	1289	18.3	3.09	1379	14.6	2.64					
1047	25.4	3.49	1183	16.9	2.62	1289	12.7	2.15	1379	10.2	1.84					
1047	16.9	2.31	1183	11.2	1.74	1289	8.4	1.42	1379	6.7	1.22	3550	2240	1120	6.42	17.8
1054	12.6	1.74	1190	8.4	1.31	1297	6.3	1.07	1387	5.0	0.92					
1154	51.7	7.82	1304	34.5	5.88	1421	25.9	4.81	1520	20.7	4.12					
1283	36.6	6.14	1449	24.4	4.62	1579	18.3	3.78	1689	14.6	3.23					
1283	25.4	4.27	1449	16.9	3.21	1579	12.7	2.63	1689	10.2	2.25	3150	2600	1300	9.87	22.3
1283	16.9	2.83	1449	11.2	2.13	1579	8.4	1.74	1689	6.7	1.49					
1291	12.6	2.13	1458	8.4	1.60	1589	6.3	1.31	1699	5.0	1.12					
1676	36.6	8.02	1892	24.4	6.04	2063	18.3	4.94	2206	14.6	4.23					
1676	25.4	5.58	1892	16.9	4.20	2063	12.7	3.43	2206	10.2	2.94	2400	1200	17.01	22.3	
1676	16.9	3.70	1892	11.2	2.78	2063	8.4	2.28	2206	6.7	1.95					
1686	12.6	2.78	1904	8.4	2.09	2075	6.3	1.71	2219	5.0	1.46					

: 50%ED Use range : 100%ED Use range

Note: 1. Rated output torque

The rated torque indicates the allowable output torque at the output flange.

The rated torque for an input speed of 600 r/min or less with a reduction ratio of 41 to 119 is the same as the rated torque at 600 r/min. See P8 Table 1 for the rated torque for an input speed of 435 r/min or less at the reduction ratio 29.

The input capacity is the required input capacity for 100% rated output torque. This value takes into account the efficiency when using the FINE CYCLO as a reducer.

2. Maximum allowable input speed and allowable average input speed (Table 3)

Although use is possible within the range of the maximum allowable input speed, the allowable average input speed is limited by the operation cycle (% ED).

See P17 Formula 10 for % ED.

3. Allowable peak torque at acceleration and deceleration (Table 4)

Allowable peak torque tolerance applied to the output flange during normal start and stop.

4. Allowable maximum momentary torque (Table 4)

Allowable maximum momentary torque applied instantaneously to the output shaft due to emergency stop, external heavy shock, etc.

This indicates the value in the case of 10³ times of application during the entire lifetime.

5. Moment of inertia (Table 3)

Indicates the value of the moment of inertia on input shaft (high speed shaft) of each model. When converting these values to inertia (kgf.m.sec²), divide by g (9.8 m / sec²).

6. Use the following formula to complement the rated torque for speeds not shown in the table.

$$T_N = T_{1750} \left(\frac{1750}{N} \right)^{0.3}$$

T_N : Rated torque for input speed N
 T_{1750} : Rated torque at input speed of 1750 r/min

8. Engineering Data

8-1. Stiffness and Lost Motion

- Hysteresis curve: Relationship between the load unloaded slowly to zero torque after fixing the input shaft (high-speed shaft) and slowly applying torque up to the rating to the output flange, and the torsion angle of the output flange
- Lost motion: Torsion angle under the load of the rating torque $\times \pm 3\%$
- Stiffness: Inclination of the straight line between two points on the hysteresis curve: the points of rated torque $\times 50\%$ and 100%

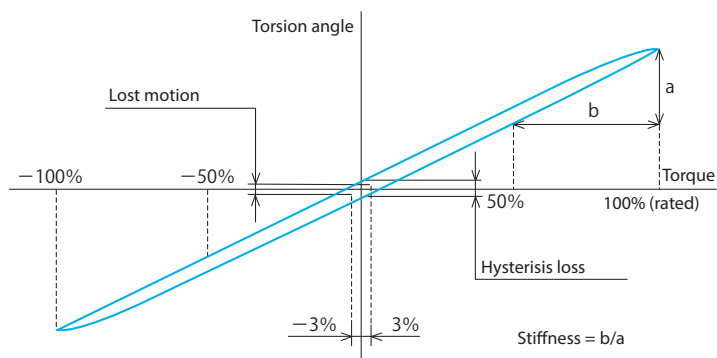


Figure 3. Hysteresis curve

Table 5. Performance values

Frame size	Reduction ratio	Lost motion		Stiffness N · m/arc min
		Measurement torque(±) N · m	Lost motion arc min	
DA15	41	10.1	1.0	49.0
	59	9.03		
	89	7.98		
	119	7.35		
DA25	29	18.8		73.0
	41	16.9		
	59	15.2		
	89	13.4		
DA35	119	12.4		112
	29	25.4		
	41	32.2		
	59	28.9		
DA40	89	25.5		135
	119	23.5		
	41	41.1		
	59	36.8		
DA45	89	32.6	208	
	119	30.0		
	29	50.2		
	41	50.3		
DA50	59	45.1	286	
	89	39.8		
	119	36.8		
	41	65.7		
DA50	59	58.9	344	
	89	52.1		
	119	48.0		
	41	65.7		
DA50	59	58.9	300	
	89	52.1		
	119	48.0		
	41	65.7		
DA50	59	58.9	540	
	89	52.1		
	119	48.0		
	41	65.7		

Note: arc min indicates the angle "minute."
The stiffness indicates the average value (representative value).

8-2. No Load Running Torque

No load running torque means the torque on the high speed shaft side required to rotate the reducer without a load.

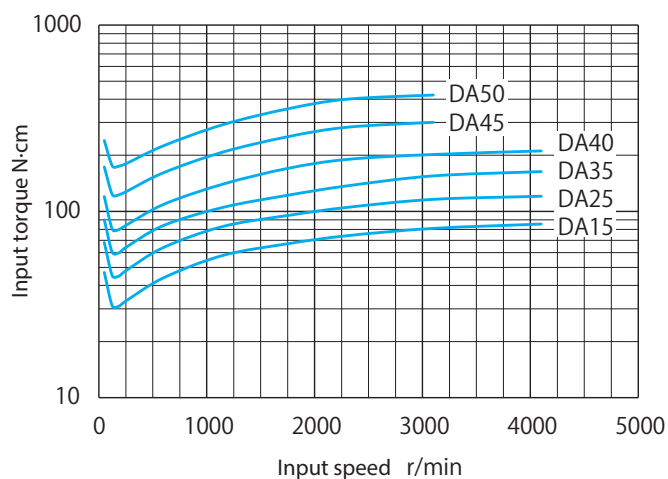


Figure 4

Note: 1. Figure 4 shows the average value after running-in.

2. Measurement conditions

Ring gear housing temperature	Approx. 30°C
Dimensional precision in assembly	See section 11-1.
Lubrication	Sumitomo standard grease

8-3. No Load Friction Torque on Output Shaft

The no load friction torque on output shaft indicates the torque required to start rotation from the output side of reducer without load.

Table 6. No load friction torque values

Frame size	No load friction torque on output shaft N · m
DA15	34
DA25	60
DA35	72
DA40	88
DA45	125
DA50	167

Note: 1. Table 6 shows the average value after running-in.
2. Measurement conditions

Dimensional precision in assembly	See section 11-1.
Lubrication	Sumitomo standard grease

8-4. Efficiency

Figure 5. Efficiency curve

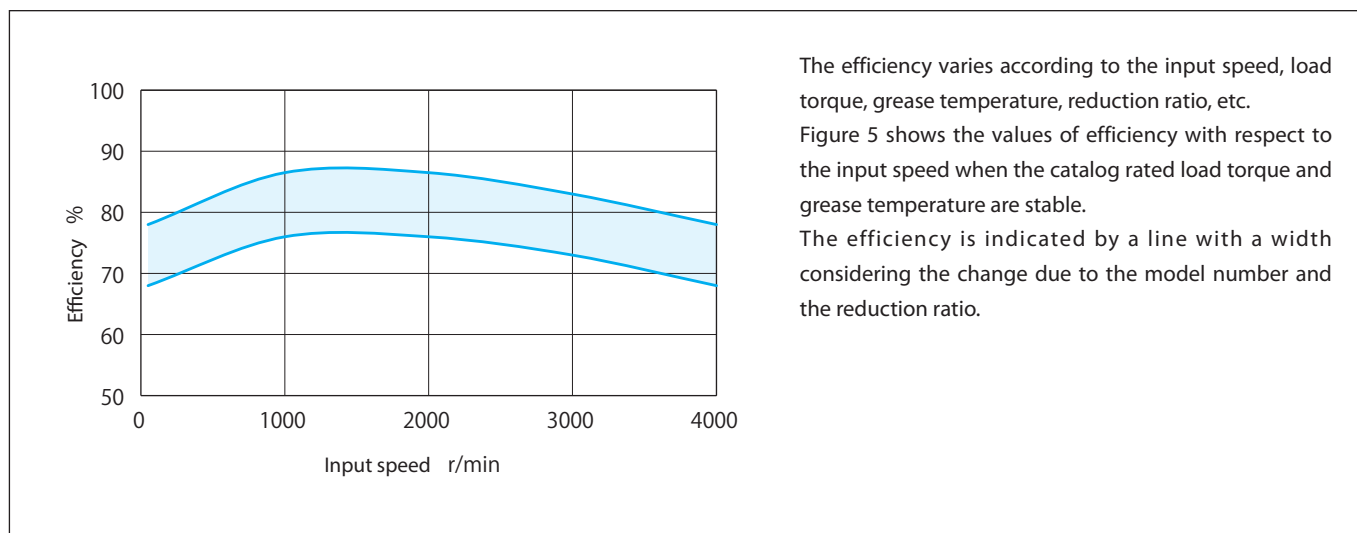
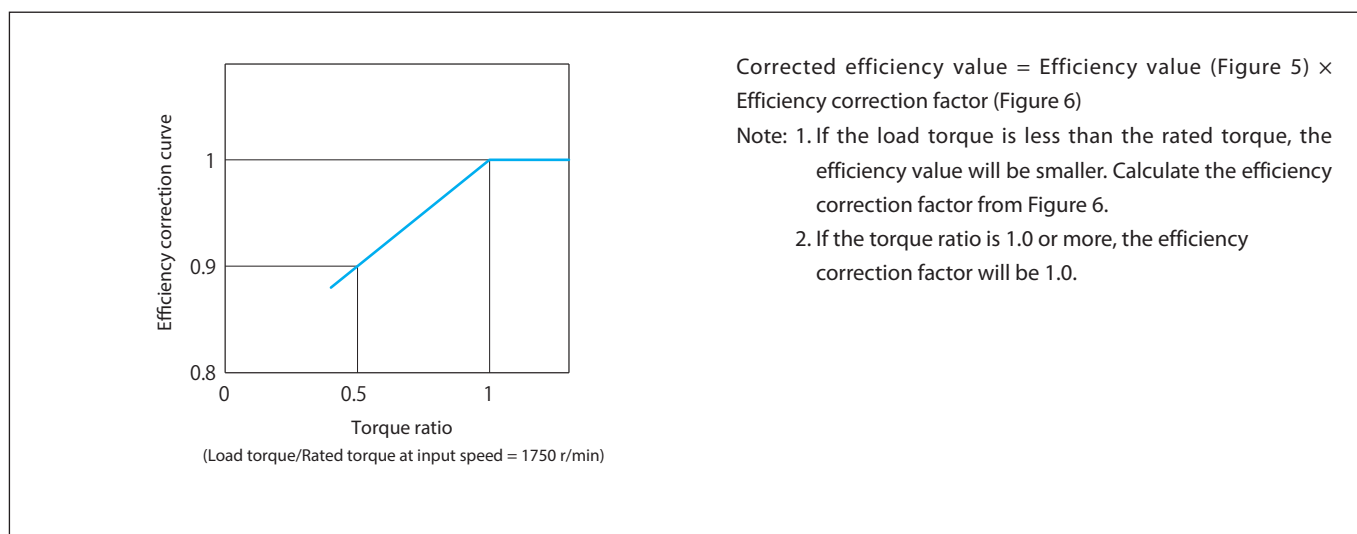


Figure 6. Efficiency correction curve



8-5. High Speed Shaft Radial Load and Axial Load

When mounting a gear or pulley on a high speed shaft, use the reducer within a range where the radial load and axial load do not exceed the allowable values.

Check the radial load and axial load of the high speed shaft according to the following formulas ((1) to (3)).

(1) Radial load P_r

$$P_r = \frac{T \ell}{R} \leq \frac{P_{ro}}{L_f \cdot C_f \cdot F_{s1}} \text{ (N)} \quad \text{(Formula 1)}$$

(2) Axial load P_a

$$P_a \leq \frac{P_{ao}}{C_f \cdot F_{s1}} \text{ (N)} \quad \text{(Formula 2)}$$

(3) When a radial load and axial load coexist

$$\left(\frac{P_r \cdot L_f}{P_{ro}} + \frac{P_a}{P_{ao}} \right) \cdot C_f \cdot F_{s1} \leq 1 \quad \text{(Formula 3)}$$

P_r : Actual radial load (N)

$T \ell$: Actual transmission torque on high speed shaft of reducer (N.m)

R : Pitch circle radius of sprocket, gear, pulley, etc. (m)

P_{ro} : Allowable radial load (N) (Table 7)

P_a : Actual axial load (N)

P_{ao} : Allowable axial load (N) (Table 8)

L_f : Load position factor (Table 9)

C_f : Coupling factor (Table 10)

F_{s1} : Shock factor (Table 11)

Table 7. Allowable radial load P_{ro} (N)

Frame size	Input speed r/min									
	4000	3000	2500	2000	1750	1500	1000	750	600	
DA15	226	245	265	284	294	314	353	392	422	
DA25	334	373	392	422	441	461	530	589	628	
DA35		491	520	559	589	618	706	785	844	
DA40	Reduction ratio 41			436	470	491	517	592	651	702
	Other than reduction ratio 41			573	617	645	679	777	855	921
DA45	Reduction ratio 41			436	470	491	517	592	651	702
	Other than reduction ratio 41			608	657	687	726	824	912	981
DA50				657	687	726	824	912	981	

Use the following formula to complement the allowable radial load for rotation speeds not shown in the table.

$$P_{rN} = P_{r1750} \left(\frac{1750}{N} \right)^{1/3}$$

P_{rN} : Allowable radial load for input speed N

P_{r1750} : Allowable radial load at an input speed of 1750 r/min

Table 8 Allowable axial load P_{ao} (N)

Frame size	Input speed (r/min)									
	4000	3000	2500	2000	1750	1500	1000	750	600	
DA15	245	284	314	343	363	392	471	549	608	
DA25	363	412	451	500	540	579	697	804	883	
DA35		540	589	657	706	755	922	1059	1167	
DA40	Reduction ratio 41			797	886	943	1014	1227	1404	1559
	Other than reduction ratio 41			797	886	943	1014	1227	1404	1559
DA45	Reduction ratio 41			956	1061	1130	1215	1470	1683	1869
	Other than reduction ratio 41			1010	1118	1197	1295	1570	1795	2001
DA50				1118	1197	1295	1570	1795	2001	

Use the following formula to complement the allowable axial load for rotation speeds not shown in the table.

$$P_{aN} = P_{a1750} \left(\frac{1750}{N} \right)^{0.47}$$

P_{aN} : Allowable axial load at input speed N

P_{a1750} : Allowable axial load at an input speed 1750 r/min

Table 9. Load position factor L_f

		Frame size					
		DA15	DA25	DA35	DA40	DA45	DA50
L (mm)	10	0.91	0.87	0.85			
	15	0.99	0.94	0.91	0.91	0.88	
	20	1.25	1.00	0.98	0.97	0.93	0.90
	25	1.56	1.25	1.14	1.09	0.98	0.94
	30	1.88	1.50	1.36	1.30	1.11	0.99
	35	2.19	1.75	1.59	1.52	1.30	1.13
	40		2.00	1.82	1.74	1.48	1.29
	45			2.05	1.96	1.67	1.45
	50				2.17	1.85	1.61
L1	L (mm) when $L_f = 1$	16	20	22	23	27	31
	a	0.072	0.063	0.061	0.055	0.052	0.046

$L \geq L1$ $L_f = L/L1$

$L < L1$ $L_f = 1.0 - a/5 \times (L1-L)$

Table 10. Coupling factor C_f

Load connection factor	C_f
Chain	1
Gear	1.25
Timing belt	1.25
V belt	1.5

Table 11. Shock factor F_{s1}

Load Classification	F_{s1}
Uniform load (No shock)	1
Moderate shock	1-1.2
Heavy shock	1.4-1.6

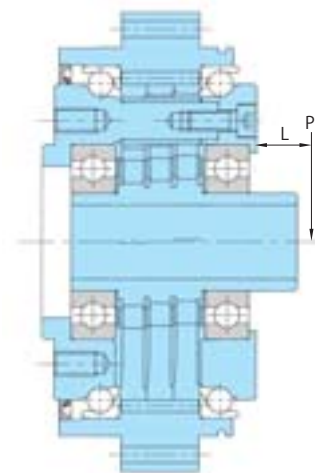


Figure 7. High speed shaft load position

9. Main Bearing

Pr: Actual radial load (N)
Pa: Actual axial load (N)

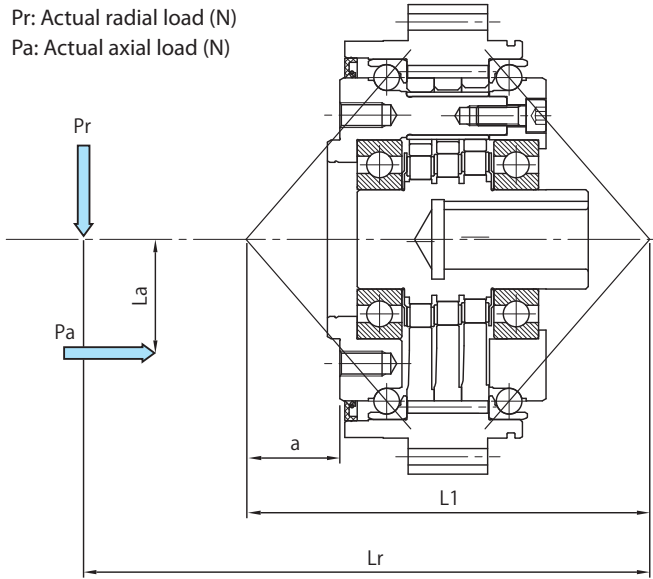


Figure 8. Span between load points

Note) Contact us when $L_r > 4 \times L_1$.

1. Moment stiffness

Indicates the inclination stiffness of the output flange with the external moment.

External moment M

$$M = Pr \cdot L_r + Pa \cdot L_a \dots \dots \dots \text{(Formula 4)}$$

2. Allowable moment and Allowable axial load

Refer to (Formula9), (Formula 6), and Figure 9 for external moment and external axial load.

Equivalent moment Me

$$Me = C_f \cdot F_{s1} \cdot Pr \cdot L_r + C_f \cdot F_{s1} \cdot Pa \cdot L_a \dots \dots \text{(Formula 5)}$$

Equivalent axial load Pae

$$Pae = C_f \cdot F_{s1} \cdot Pa \dots \dots \dots \text{(Formula 6)}$$

Cf : Coupling factor (Table 15)

Fs1 : Shock factor (Table 16)

Table 12. Span between load points (mm)

Frame size	Span between load points	
	L1 (mm)	a (mm)
DA15	119	23.9
DA25	139	30.5
DA35	163	37.8
DA40	171	41.0
DA45	190	49.2
DA50	206	52.4

Table 13. Moment stiffness

Frame size	Moment stiffness (representative value) (N · m/arcmin)
DA15	510
DA25	833
DA35	1127
DA40	1470
DA45	1500
DA50	2450

Table 14. Allowable moment, axial load

Frame size	Allowable moment (N · m)	Allowable axial load (N)
DA15	883	3924
DA25	1660	5220
DA35	Reduction ratio 29	6530
	Reduction ratio 41-119	
DA40	Reduction ratio 41	9000
	Reduction ratio 59-119	
DA45	Reduction ratio 29-41	13000
	Reduction ratio 59-119	
DA50	Reduction ratio 41	15000
	Reduction ratio 59-119	

Table 15. Coupling factor Cf

Load connection factor	Cf
Chain	1
Gear	1.25
Timing belt	1.25
V belt	1.5

Table 16. Shock factor Fs1

Load Classification	Fs1
Uniform load (No shock)	1
Moderate shock	1-1.2
Heavy shock	1.4-1.6

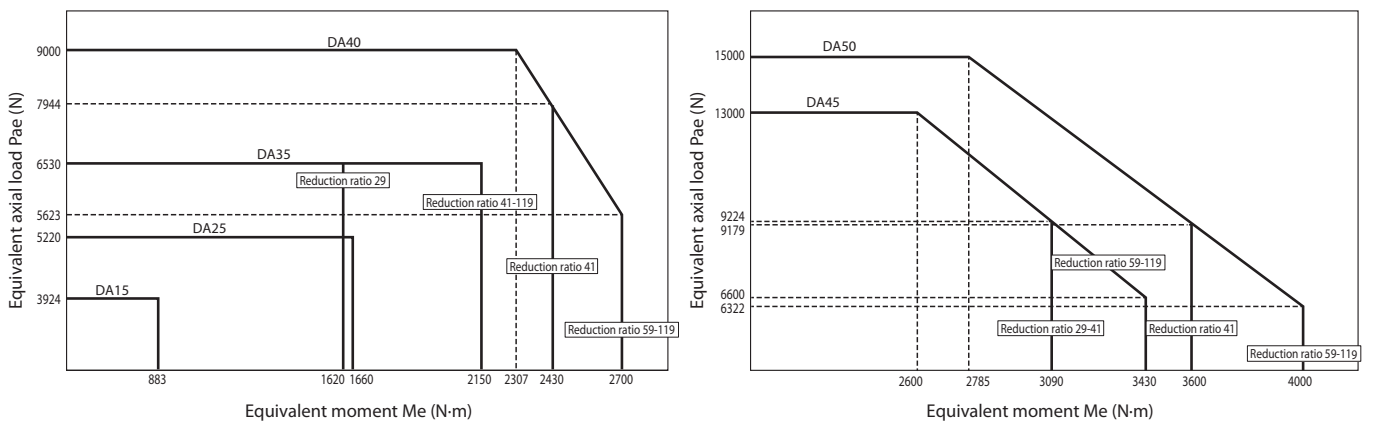
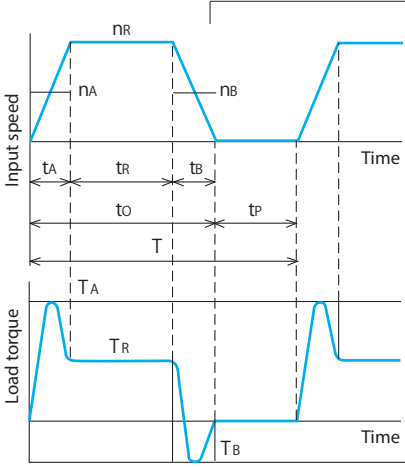


Figure 9. Allowable moment and axial load diagram

10. Selection

10-1. Selection Flow Chart and Calculation Formula

Figure 10 Load pattern

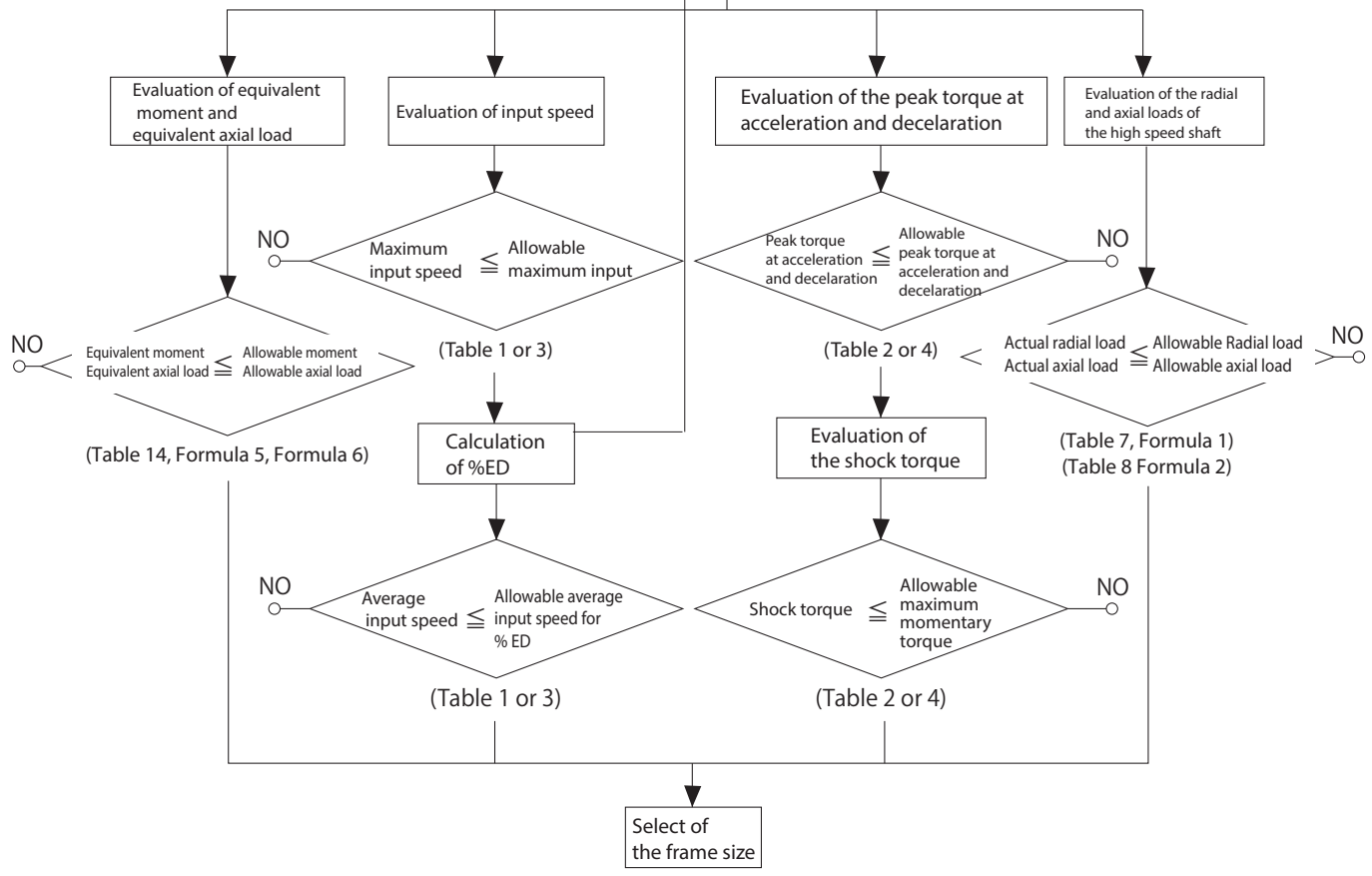
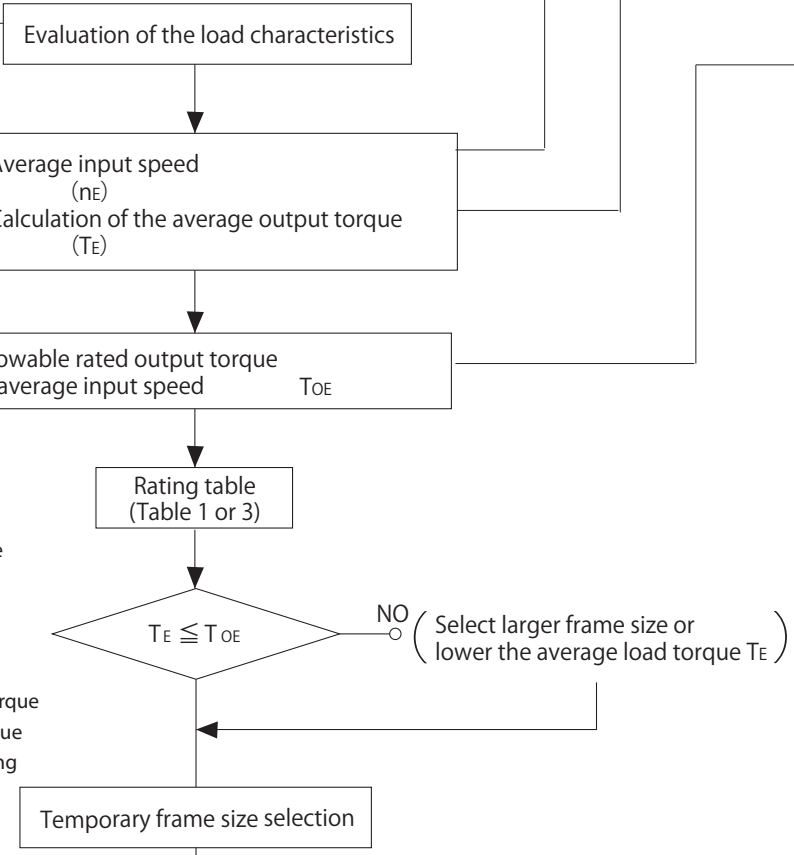


n_A : Average input speed during acceleration
 In the case of Figure 10

$$n_A = \frac{n_R}{2}$$
 n_R : Input speed during normal running
 n_B : Average input speed during deceleration
 In the case of Figure 10

$$n_B = \frac{n_R}{2}$$

t_A : Acceleration time
 t_R : Normal running time
 t_B : Deceleration time
 t_O : Total running time
 t_P : Stand still time
 T : Time cycle
 T_A : Acceleration peak torque
 T_R : Normal running torque
 T_B : Peak torque at braking



Calculation for the load pattern in Figure 10

○ Average input speed $n_E = \frac{t_A \cdot n_A + t_R \cdot n_R + t_B \cdot n_B}{t_o} \dots\dots\dots$ (Formula 7)

○ Average load torque $T_E = \left(\frac{t_A \cdot n_A \cdot T_A^{10/3} + t_R \cdot n_R \cdot T_R^{10/3} + t_B \cdot n_B \cdot T_B^{10/3}}{t_o \cdot n_E} \right)^{0.3} \times F_{s2} \dots\dots$ (Formula 8)

○ Allowable rated torque at average input speed $T_{OE} = \left(\frac{600}{n_E} \right)^{0.3} \times T_o \dots\dots\dots$ (Formula 9)

To: Rated at 600 r/min (Table 3)
 For a reduction ratio of 41 to 119, when $n_E < 600$ r/min, T_{OE} should be rated at 600 r/min (T_o).
 (For a reduction ratio of 29, when $n_E < 435$ r/min, T_{OE} should be rated at output speed 15 r/min (T_o).

○ %ED $\%ED = \frac{t_o}{T} \times 100 \dots\dots\dots$ (Formula 10)

The maximum operation cycle for calculating % ED is 10 minutes. If this is exceeded, calculate as $T = 10$ (minutes).

Table 17 F_{s2} load factor

Load conditions	F_{s2}
Uniform load (No shock)	1
Moderate shock	1-1.2
Heavy shock	1.4-1.6

10-2. Selection Example

Make confirmation assuming F4CF-DA25-119 for the following specifications.

- (Specifications) T_A : Acceleration peak torque 700N·m t_A : Acceleration time 0.3s
 T_R : Normal running torque 300N·m t_R : Normal running time 3.0s
 T_B : Peak torque at braking 500N·m t_B : Deceleration time 0.3s
 Shock torque: 2000N·m 1000 times during the whole lifetime t_P : Stand still time 3.6s
 n_A : Average input speed during acceleration 1250 r/min t_o : Total running time 3.6s
 n_R : Input speed during normal running 2500 r/min T : Time cycle 7.2s
 n_B : Average input speed during deceleration 1250 r/min
 High speed shaft radial load: Timing belt driven, small shock, 196N at a position 25 mm from the shaft end
 Low speed shaft radial load: Gear coupling, small shock, 5800N at a position 60 mm from the flange surface

With almost no shock.

(Calculation) Average input speed $n_E = \frac{0.3 \times 1250 + 3.0 \times 2500 + 0.3 \times 1250}{3.6} = 2292$ (r/min)

Average load torque $T_E = \left(\frac{0.3 \times 1250 \times 700^{10/3} + 3.0 \times 2500 \times 300^{10/3} + 0.3 \times 1250 \times 500^{10/3}}{3.6 \times 2292} \right)^{0.3} \times 1 = 365$ (N·m)

○ Allowable rated torque at average input speed $T_{OE} = \left(\frac{600}{2292} \right)^{0.3} \times 571 = 382$ (N·m) ≥ 365 (N·m) -> F4CF-DA25-119 selected as temporary frame size.

○ %ED calculation $\%ED = \frac{3.6}{7.2} \times 100 = 50\%$

○ Check of maximum input speed 2500 (r/min) < 5050 (r/min) (Table 1 or 3)

○ Check of average input speed 2292 (r/min) at 50% ED < 4200 (r/min) at 50% ED (Table 1 or 3)

○ Check of peak torque at acceleration/deceleration 700 (N·m) < 1029 (N·m) (Table 2 or 4)

○ Check of shock torque 2000 (N·m) < 2058 (N·m) (Table 2 or 4)

○ High speed shaft allowable radial load considering the factors

$Pr_o = 402N = 441 \times (1750/2292)^{1/3}$, $L_f = 1.25$, $C_f = 1.25$, $F_{s1} = 1.2$

$\frac{Pr_o}{L_f \times C_f \times F_{s1}} = \frac{402}{1.25 \times 1.25 \times 1.2} = 214$ (N) > 196 (N) (Table 7, Formula 1)

○ Check of allowable moment

$L_r = 60 + L1 - a = 60 + 139 - 30.5 = 168.5$ (mm)

External moment with factors taken into consideration

$C_f = 1.25$, $F_{s1} = 1.2$, $M = C_f \times F_{s1} \times Pr \times L_r = 1.25 \times 1.2 \times 5800 \times 168.5 \times 10^{-3} = 1466$ (N·m) < 1660 (N·m)

F4CF-DA25-119 is selected based on the above consideration.

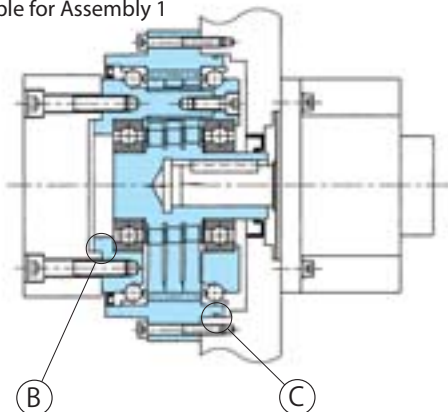
11. Notice for Designing

11-1. Assembly Method and Dimensional precision in assembly

Figure 11 Assembly Method

- The input parts such as motors shall be assembled referring to (C) spigot C in the figure below.
- Use spigot B for the assembly of the output flange, and use spigot A for assembly of the ring gear housing. (B) (A)

Example for Assembly 1



Example for Assembly 2

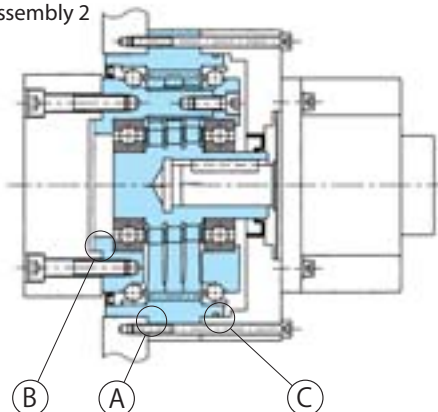


Figure 12. Dimensional precision in assembly

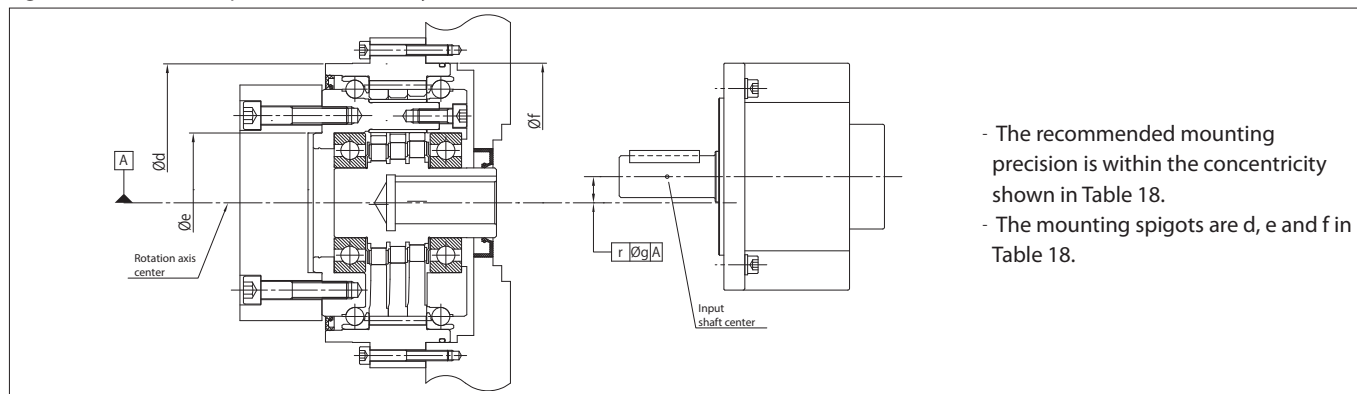


Table 18

Frame size	d	e	f	g
DA15	113H7/h7	47H7/h7	113H7/h7	0.03
DA25	136H7/h7	65H7/h7	136H7/h7	0.03
DA35	160H7/h7	80H7/h7	160H7/h7	0.03
DA40	170H7/h7	75H7/h7	170H7/h7	0.03
DA45	186H7/h7	90H7/h7	186H7/h7	0.03
DA50	202H7/h7	100H7/h7	202H7/h7	0.03

11-2. Bolt Tightening Torque and Allowable Transmission Torque

(1) Allowable transmission torque by bolt

Table 19 shows the number, size and tightening torque of bolts when fastening the output flange and reduction gear of the FINE CYCLO with bolts. At this time, it is possible to transmit the allowable transmission torque shown in Table 19.

Table 19

Frame size	Tightening of the output flange				Tightening of the reducer part			
	Number and size of bolts	Bolt PCD mm	Bolt tightening torque N · m	Allowable transmission torque by bolt N · m	Number and size of bolts	Bolt PCD mm	Bolt tightening torque N · m	Allowable transmission torque by bolt N · m
DA15	12-M8	68	38.3	1478	16-M5	123.5	9.1	1389
DA25	18-M8	85	38.3	2772	16-M6	148	15.7	2356
DA35	16-M10	100	76.5	4594	16-M8	175	38.3	5073
DA40	16-M10	115	76.5	5283	18-M8	184	38.3	6000
DA45	18-M10	124	76.5	6408	16-M10	204	76.5	9371
DA50	18-M12	140	133	10516	16-M10	220	76.5	10106

- Bolt: Use hexagon socket head bolts of strength class 12.9 of JIS B 1176.
- Seat scratch prevention measure: Use conical spring washers (JIS B 1252, class 2) when tightening the reducer part.
- Locking measure: use adhesive (Loctite 262, etc) in addition to conical spring washers as mentioned above.
- Coefficient of friction: 0.15

11-3. Assembly Procedure

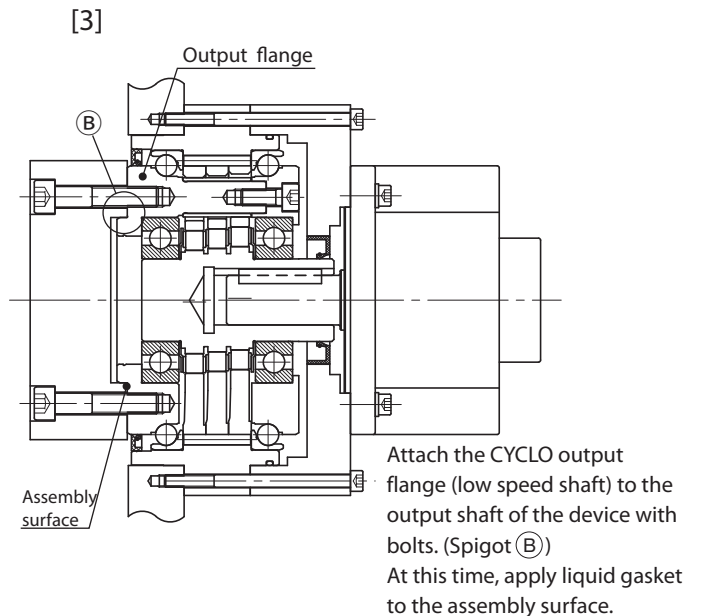
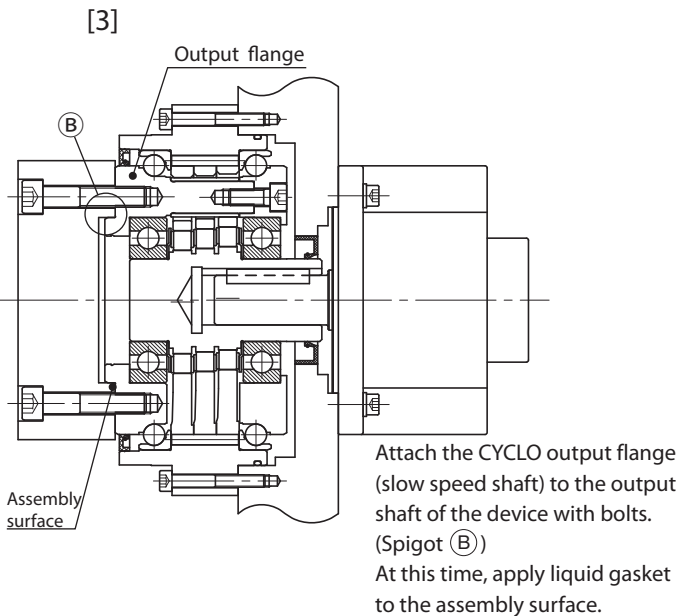
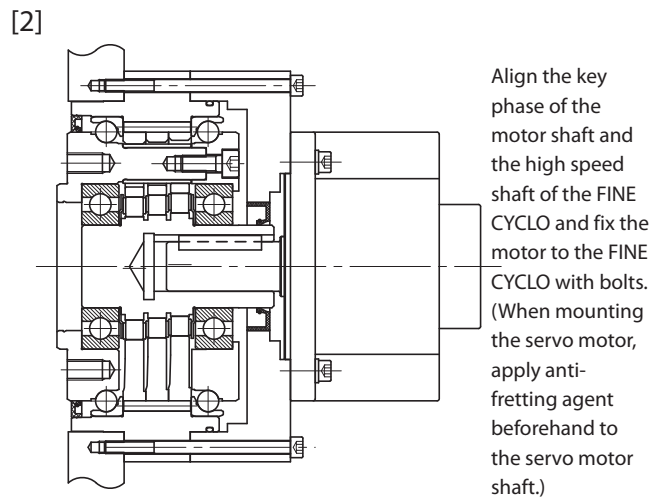
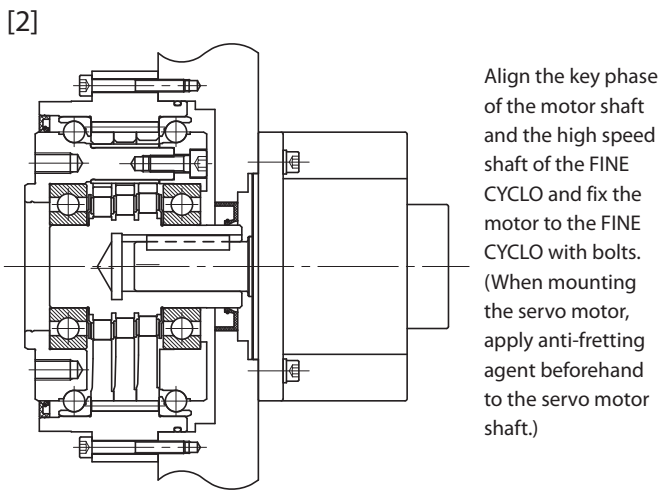
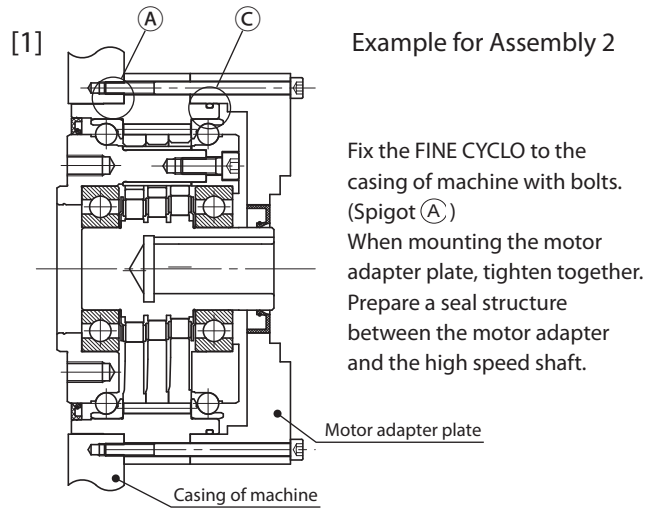
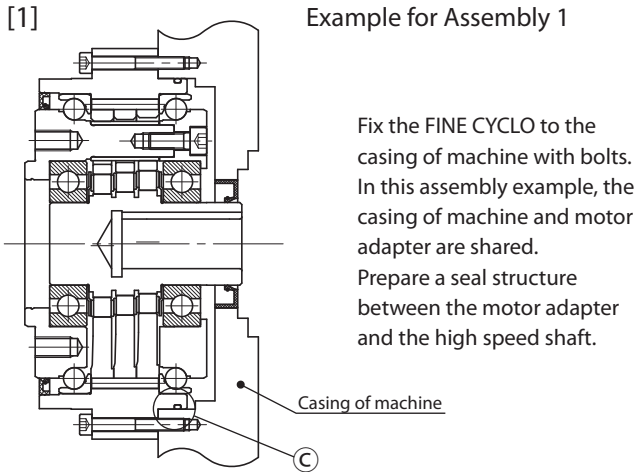


Figure 13. Assembly Procedure

- Notes: 1. The bolts for mounting of the gear reducer shall be fastened by the specified fastening torque (See Table 19).
 2. When mounting the output shaft of the device to the FINE CYCLO output flange (low speed shaft) with bolts, set the length of the bolts to be shorter than the screw depth shown in the output flange of the outline drawing (P21 to 26).

Recommended liquid gasket: ThreeBond Co., Ltd., Liquid gasket ThreeBond 1215

11-4. Lubrication

- For this drive, no grease is filled before shipment, so be sure to prepare the recommended grease (Table 20) and fill the specified filling quantity (Table 21) before operation.

The specified filling quantity is for the drive space. Also fill the device-side space (① and ②) with grease.

Horizontal mounting: Fill about 70% to 80% of the volume of device-side space ①, ② with grease.

Vertical mounting (1): Fill grease for the volume of device-side space ② .

To prevent rise in the internal pressure, secure about 10 to 20% space of the overall volume (drive space + device-side space ① + device-side space ②) in the device-side space ①).

Vertical mounting (2): Fill grease for the volume of device-side space ① .

To prevent rise in the internal pressure, secure about 10 to 20% space of the overall volume (drive space + device-side space ① + device-side space ②) in the device-side space ②). Excessive grease filling causes rise in the internal pressure, which causes grease leak and oil seal detachment.

- The specified filling quantity shown in Table 21 is a guideline so confirm the grease level when filling grease.

- For the grease fill position of the output side, see the A dimensions shown in the table.

- In the initial installation, fill grease from the lower grease fill and discharge hole and surely fill inside the drive with grease.

- Replace grease every 20,000 hours of operation time or every three to five years.

Table 20 DA series recommended grease

Recommended grease	Supplier
Multemp FZ No.00	Kyodo Yushi Co., Ltd.

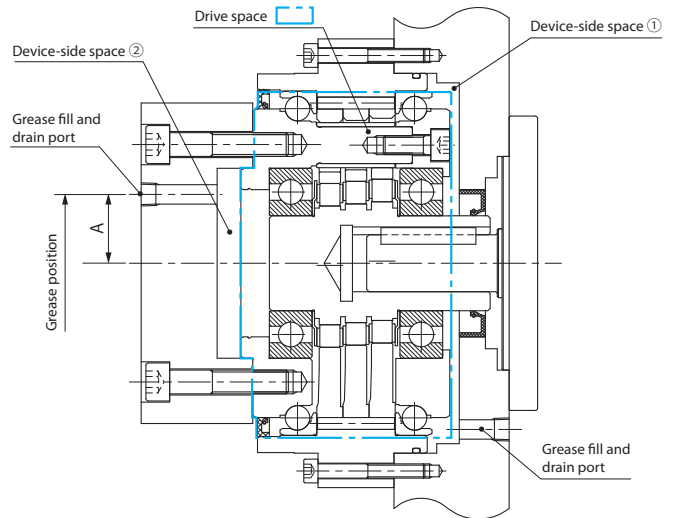
Operating temperature range (ambient temperature: -10 to 40°C)

Table 21 Specified grease filling quantity (drive space)

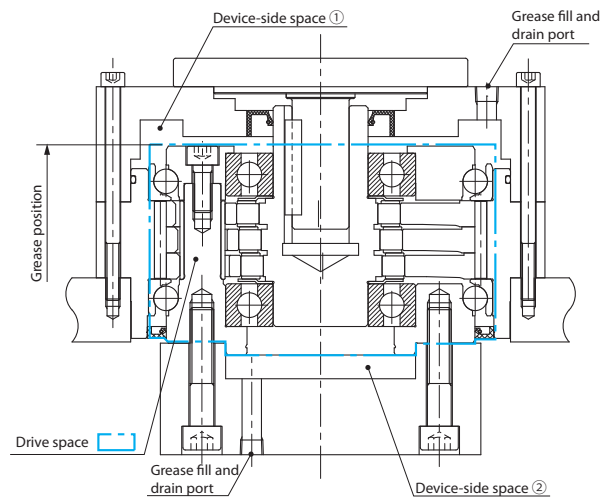
Frame size	Specified grease filling quantity (g)				Grease fill and discharge hole position
	Horizontal mounting		Vertical mounting (1) (2)		
	mL	g	mL	g	A (mm)
DA15	45	39	60	52	20
DA25	105	91	130	113	27
DA35	185	161	225	196	34
DA40	195	170	235	204	36
DA45	205	178	255	222	39
DA50	290	252	350	305	43

Figure 14

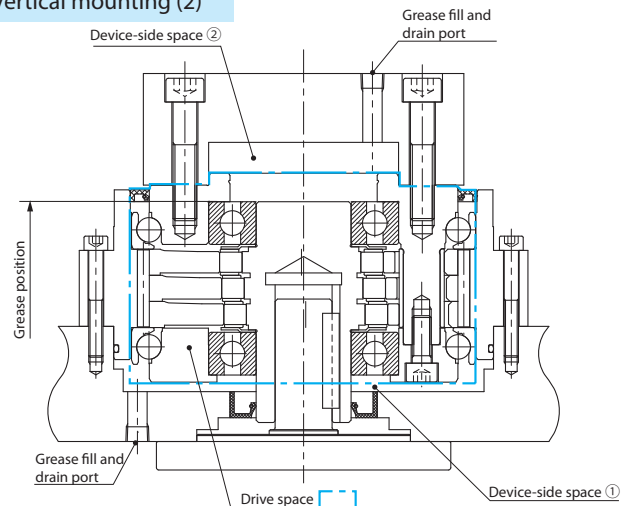
Horizontal mounting



Vertical mounting (1)



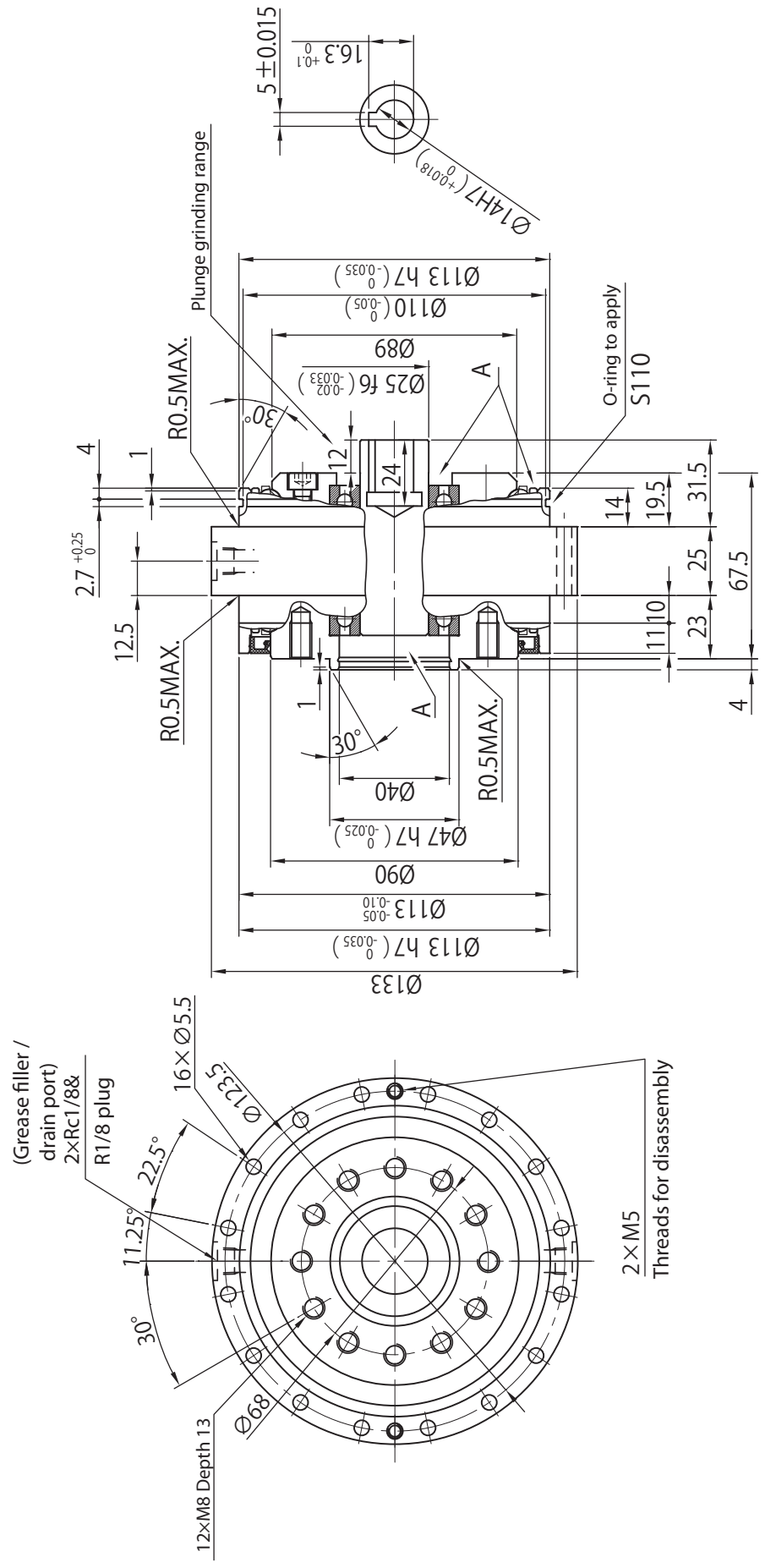
Vertical mounting (2)



12. Outline Drawing

- Part A is not grease sealed.
- Be sure to prepare the sealing structure.
- No paint in the standard specification.

F4CF-DA15 Outline Drawing

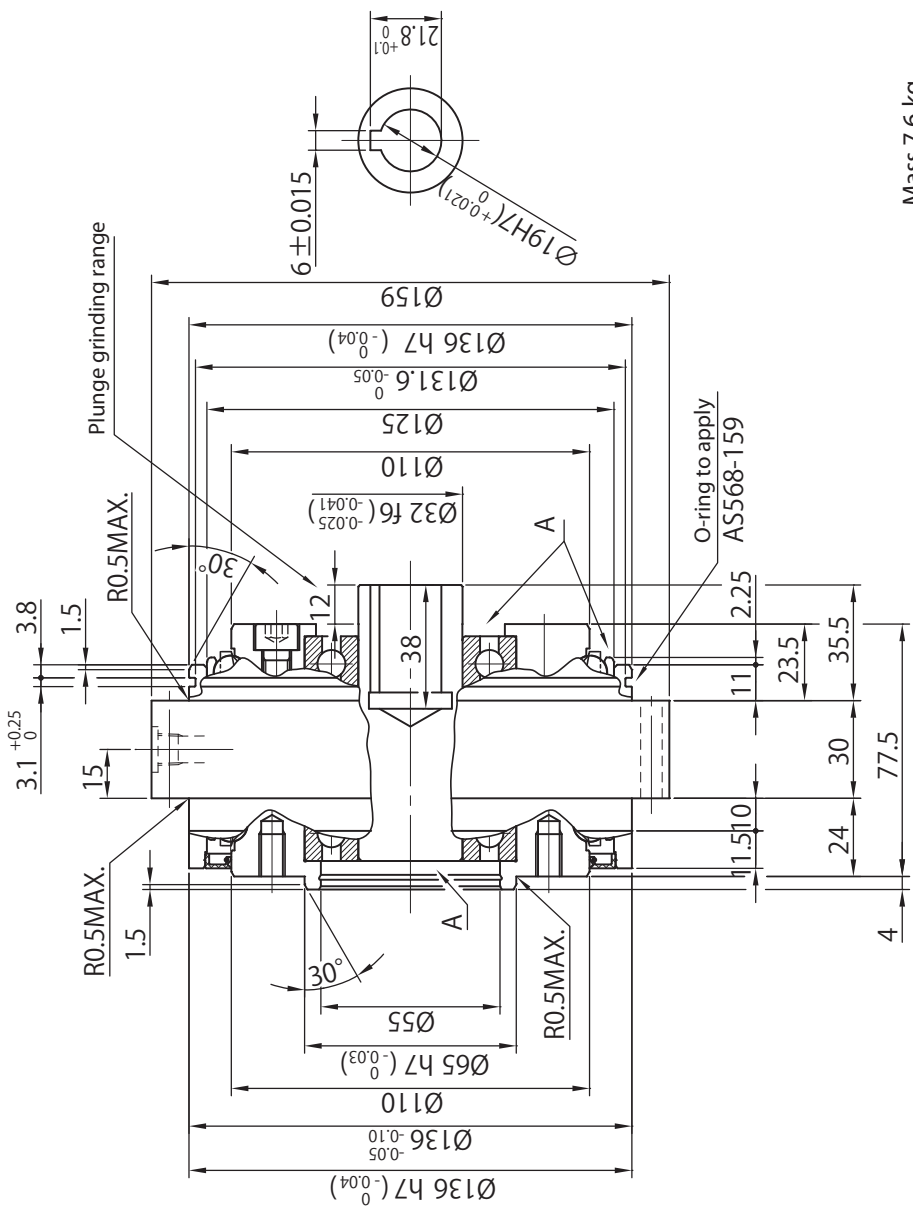
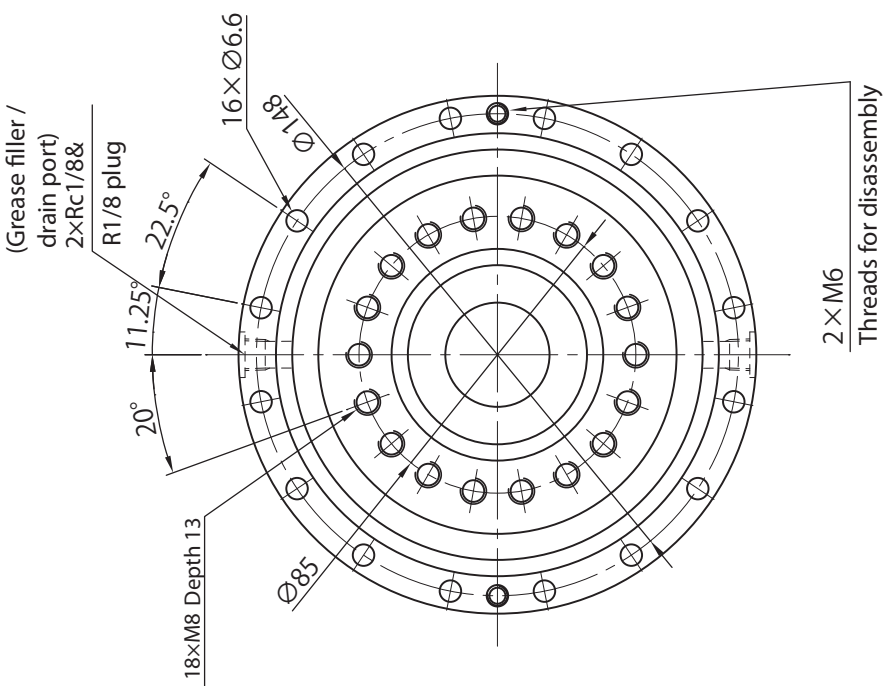


Mass 4.7 kg

* High speed shaft hollow diameter is available up to Ø14 (key 5 × 5).

F4CF-DA25 Outline Drawing

- Part A is not grease sealed.
- Be sure to prepare the sealing structure.
- No paint in the standard specification.

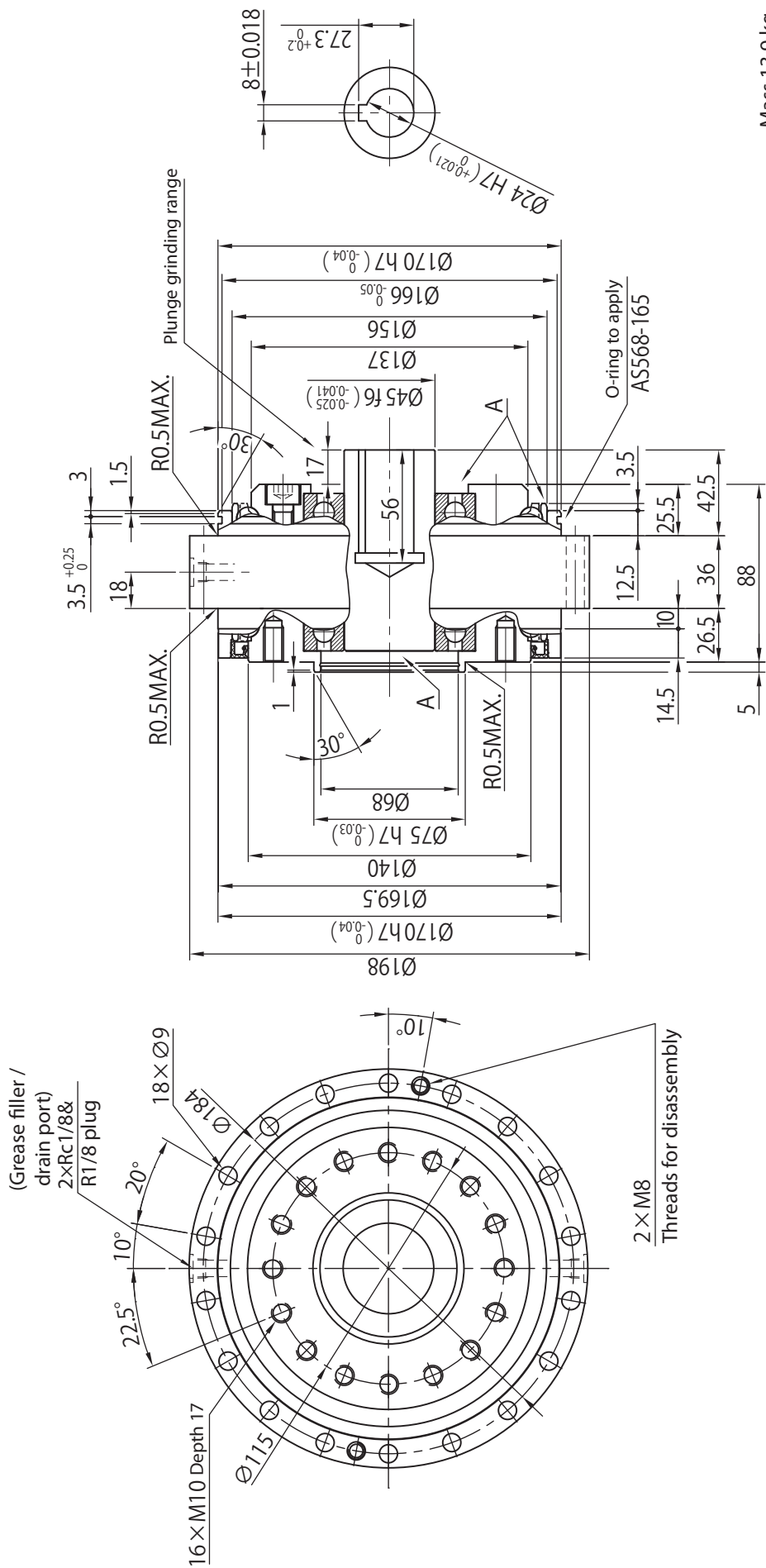


Mass 7.6 kg

* High speed shaft hollow diameter is available up to Ø20 (key 6 x 6).

F4CF-DA40 Outline Drawing

- Part A is not grease sealed.
- Be sure to prepare the sealing structure.
- No paint in the standard specification.

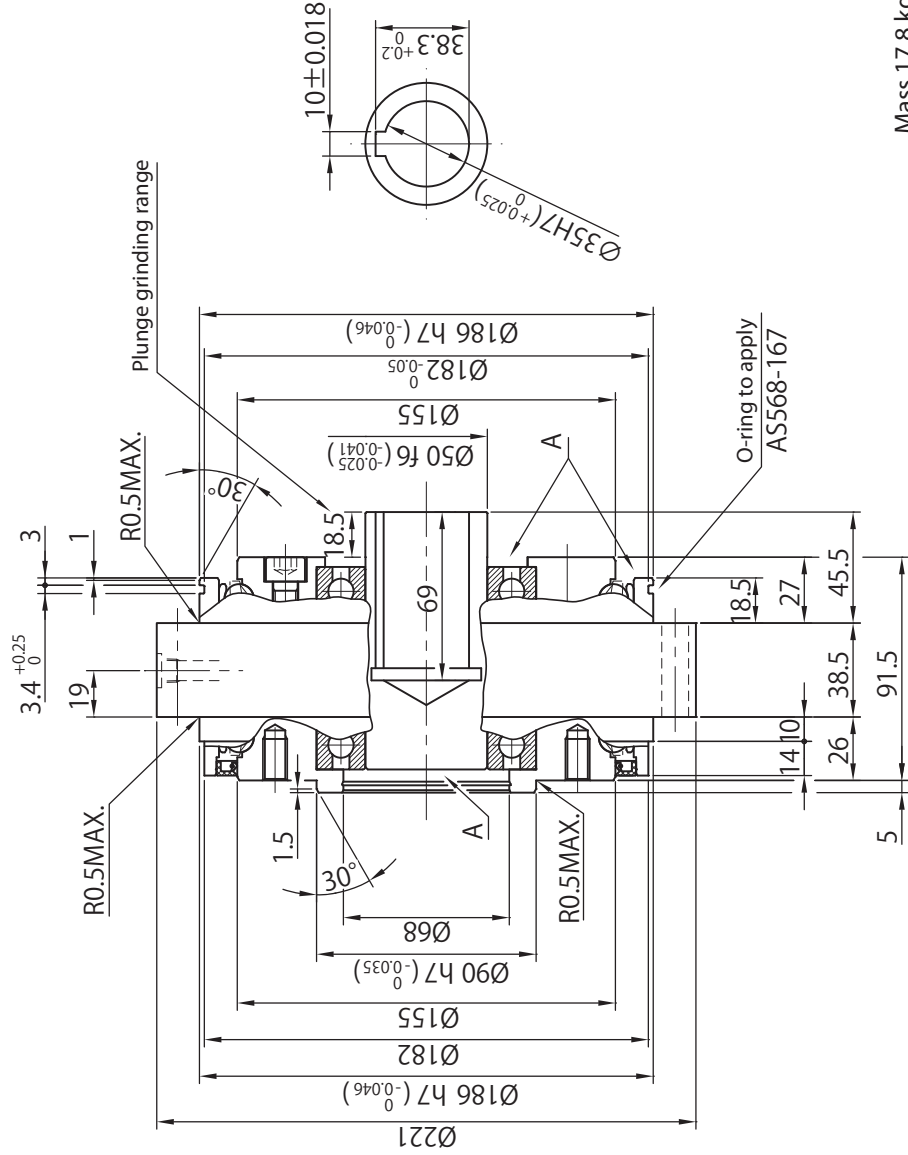
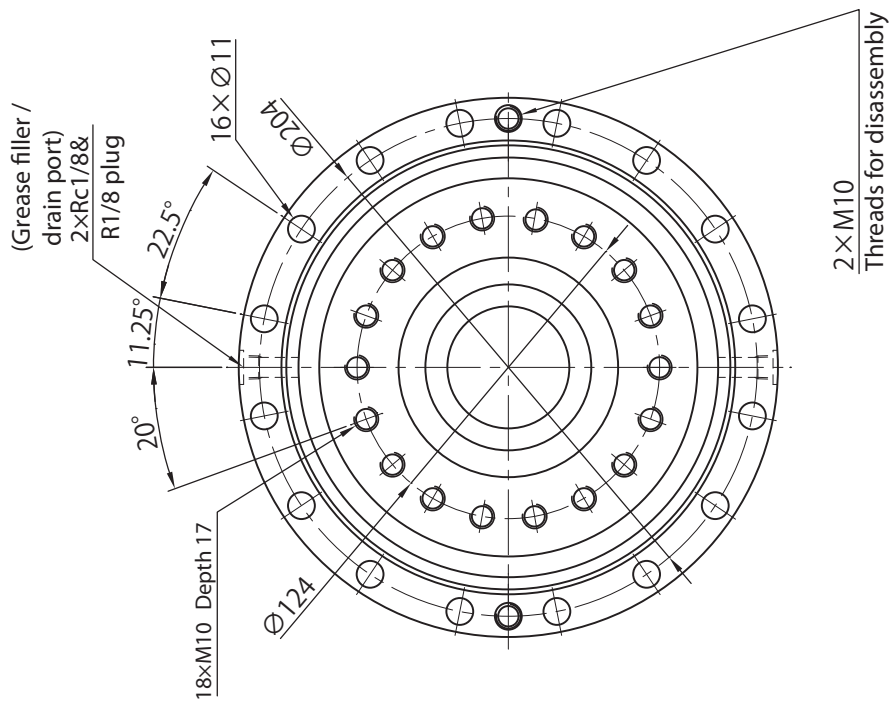


Mass 13.9 kg

* High speed shaft hollow diameter is available up to $\varnothing 32$ (key 10 x 8).

F4CF-DA45 Outline Drawing

- Part A is not grease sealed.
- Be sure to prepare the sealing structure.
- No paint in the standard specification.

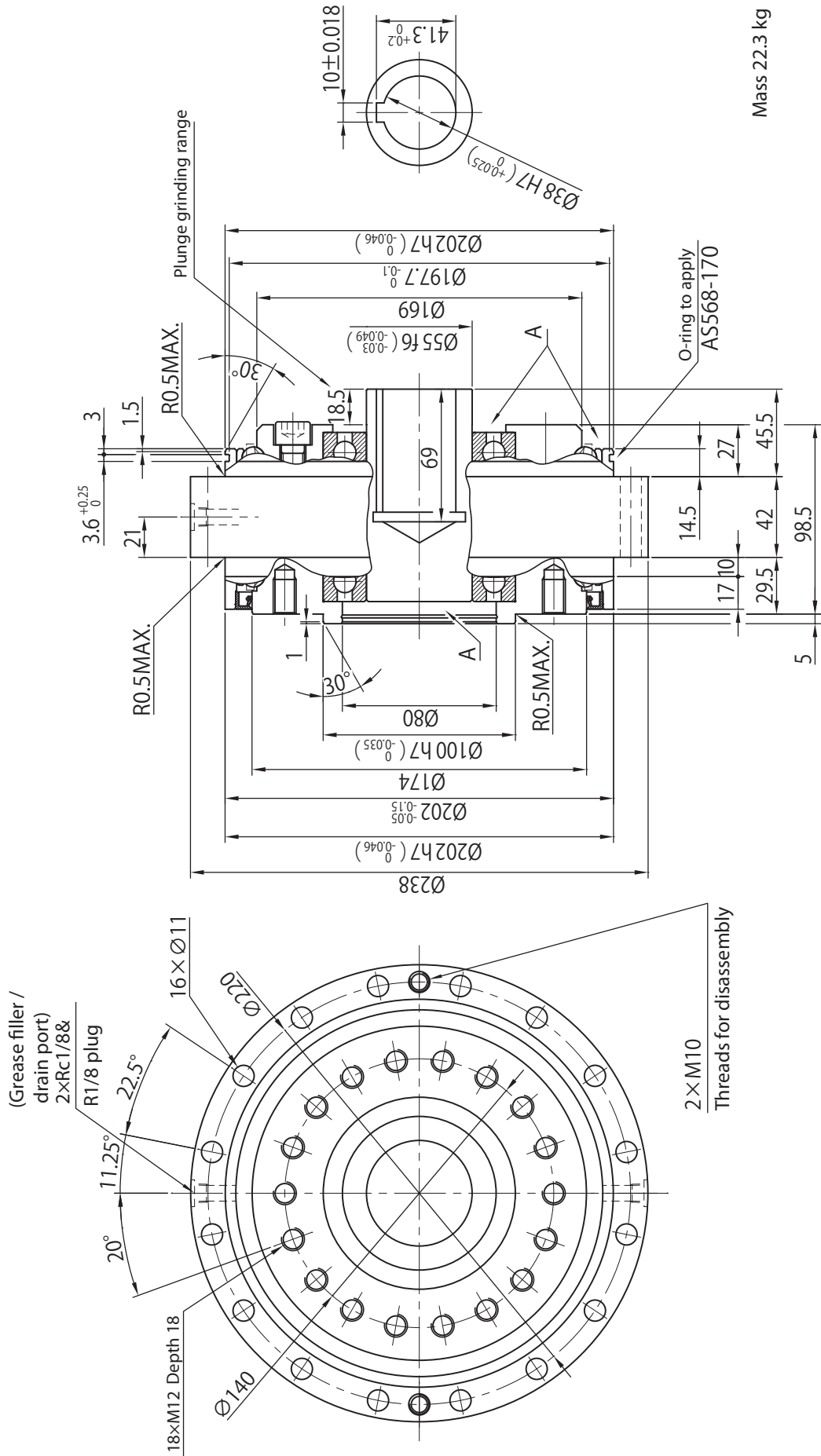


Mass 17.8 kg

* High speed shaft hollow diameter is available up to Ø36 (key 10 x 8).

F4CF-DA50 Outline Drawing

- Part A is not grease sealed.
- Be sure to prepare the sealing structure.
- No paint in the standard specification.



Mass 22.3 kg

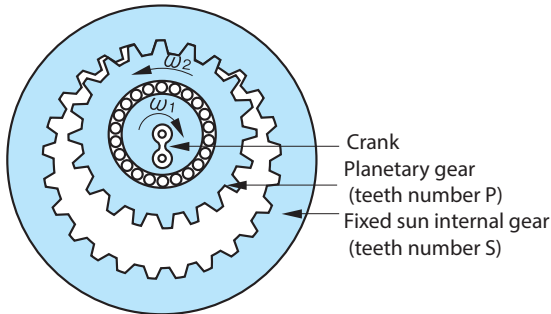
* High speed shaft hollow diameter is available up to $\varnothing 41$ (key 12 x 8).

13. Working Principle

In principle, the FINE CYCLO consists of the following two mechanisms.

- ☆ Internal planetary gear mechanism with one or two teeth difference with trochoid curve tooth profile
- ☆ Constant speed internal gear mechanism with circular tooth

Figure 15 Internal planetary gear mechanism

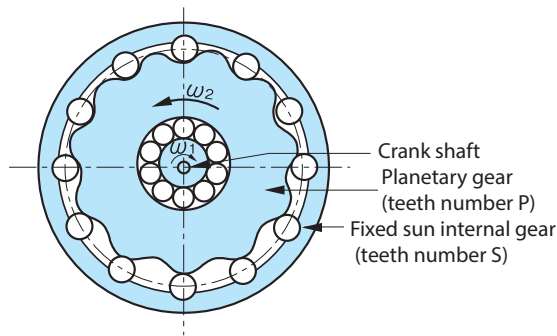


The relationship between the angular velocities ω_1 and ω_2 is expressed by the following formula according to planetary gear theory in the internal planetary gear unit as shown in Figure 15.

$$\omega_2/\omega_1 = 1 - S/P = -(S - P)/P$$

Here, if $S - P = 1$ (tooth number difference 1), $\omega_2 / \omega_1 = -1 / P$, the rotation direction is reverse and the maximum reduction ratio can be obtained. If the common involute teeth are used, it may cause interference on the tooth tips, therefore, this mechanism cannot be used effectively with a single-tooth difference.

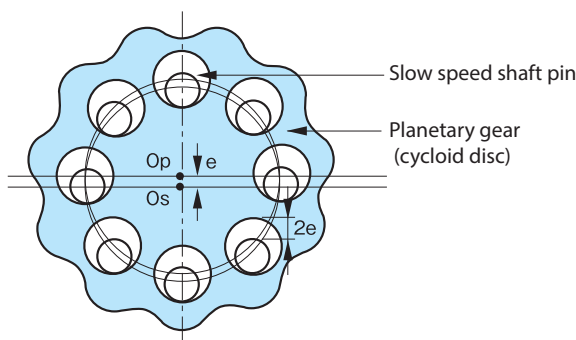
Figure 16. Planetary gear mechanism with one-tooth difference



As shown in Figure 16, in order for the FINE CYCLO to solve this problem,

- (I) circular tooth profile in internal gear
 - (II) epitrochoidal parallel curve in the planetary gear
- are used, and an internal planetary gear with a single-tooth difference, no tooth tip interference and with unparallelled number of teeth in mesh is realized.

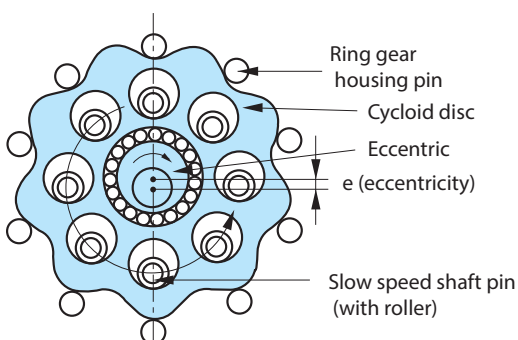
Figure 17 Constant speed gear mechanism



The planetary gear (cycloid disc) revolves at high speed (ω_1) while simultaneously rotating at low speed (ω_2).

The FINE CYCLO uses a constant speed internal gear mechanism with the circular tooth profile shown in Fig. 17 to extract only the decelerated rotation to the slow speed shaft pin. The slow speed shaft pin is arranged concentrically with the crankshaft (high speed axis) center O_s , so it is possible to easily align the high and low speed shafts by implanting this directly into the low speed shaft.

Figure 18. Structural model of the FINE CYCLO



The combination of the above two mechanisms and the installation of rollers in an circular tooth profile as shown in Fig. 18 form the FINE CYCLO.

As the sliding contact is converted back to rolling contact by the rollers, mechanical loss is very small and extremely high gear efficiency is obtained.

14. Other

The specification shown in this document is based on our evaluation method. Evaluate the performance and durability in the condition of installation in the drive considering the field usage conditions, etc. and confirm that there is no problem, by yourself, before using this product.

Be sure not to perform disassembly, inspection, repair, and overhaul in cases of abnormalities of this product by yourself because they have to be performed by our skilled workers with special jigs and tools and expertise.

Note that the specifications and dimensions shown in this document may be changed without notice to customers.

Warranty standard

The scope of warranty of our delivered products is limited only to what we manufactured.

Warranty Period	The warranty period for the Products shall be 18 months after the commencement of delivery or 18 months after the shipment of the Products from the seller's works or 12 months from the Products coming into operation, whichever comes first.
Warranty Condition	In the event that any problem or damage to the Product arises during the "Warranty Period" from defects in the Product whenever the Product is properly installed and combined with the Buyer's equipment or machines, maintained as specified in the maintenance manual, and properly operated under the conditions described in the catalog or as otherwise agree upon in writing between the Seller and the Buyer or its customers; the Seller will provide, at its sole discretion, appropriate repair or replacement of the Product without charge at a designated facility, except as stipulated in the "Warranty Exclusions" as described below. However, if the Product is installed or integrated into the Buyer's equipment or machines, the Seller shall not reimburse the cost of: removal or re-installation of the Product or other incidental costs related thereto, any lost opportunity, any profit loss or other incidental or consequential losses or damages incurred by the Buyer or its customers.
Warranty Exclusions	Notwithstanding the above warranty, the warranty as set forth herein shall not apply to any problem or damage to the Product that is caused by : <ol style="list-style-type: none"> 1. installation, connection, combination or integration of the Product in or to the other equipment or machine that is rendered by any person or entity other than the Seller ; 2. insufficient maintenance or improper operation by the Buyer or its customers, such that the Product is not maintained in accordance with the maintenance manual provided or designated by the Seller ; 3. improper use or operation of the Product by the Buyer or its customers that is not informed to the Seller, including, without limitation, the Buyer's or its customers, operation of the Product not in conformity with the specifications, or use of lubricating oil in the Product that is not recommended by the Seller ; 4. any problem or damage on any equipment or machine to which the Product is installed, connected or combined or on any specifications particular to the Buyer or its customers ; 5. any changes, modifications, improvements or alterations to the Product or those functions that are rendered on the Product by any person or entity other than the Seller ; 6. any parts in the Product that are supplied or designated by the Buyer or its customers ; 7. earthquake, fire, flood, sea-breeze, gas, thunder, acts of God or any other reasons beyond the control of the Seller ; 8. normal wear and tear, or deterioration of the Product's parts, such as bearings, oil-seals ; 9. any other troubles, problems or damage to the Product that are not attributable to the Seller.

Safety Precautions

- Observe the safety rules necessary for the installation location and device in use.
(Ordinance on Industrial Safety and Health, facility's electrical codes, interior wiring code, plant explosion proofing guide, Building Standards Act, etc.)
- Select the product suitable for your operating environment and purpose.
- If you use the product for any devices for which a breakdown of the product is expected to cause a great loss of human life or facility such as systems for human transport, hoisting equipment, etc., install a protection device in the device side for safety.
- When the unit is used in food processing applications, machines for cleanroom and so on, vulnerable to oil contamination, install an oil pan or other such device to cope with oil leakage due to breakdown or failure;

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Specifications, dimensions, and other items are subject to change without prior notice.



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