Sumitomo Drive Technologies

Always on the Move

Motion Control Drives

FINE CYCLO®

F4C-D series

Catalogue 991138/EN-03/2012

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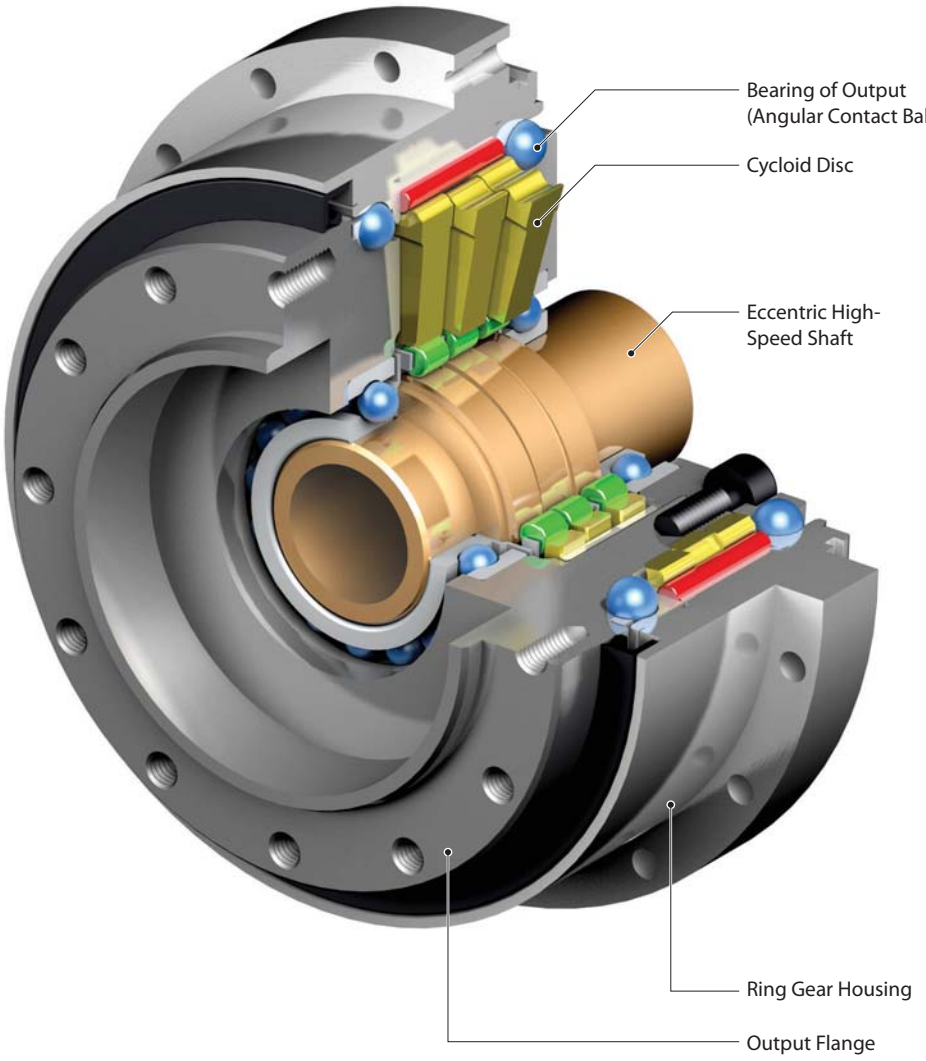
ISO9001 PTC NAGOYA PLANT
ISO14001 PTC NAGOYA PLANT

Motion Control Drives
FINE CYCLO®

F4C-D series

NEW



Excellent Cost Performance

Simple construction with less number of parts than single stage reducer mechanism

High Torque, High Allowable Moment Compact Design

Allowable peak torque: Maximum 24% increase
Allowable moment: Maximum 45% increase
(Compared to traditional models)

Reduces Man-Hour for Assembly

Flat output flange simplifies sealing process High-speed shaft supported by the reducer simplifies coupling with motor.

New Model Enables Simpler Designing Improved Interface for Coupling Machines

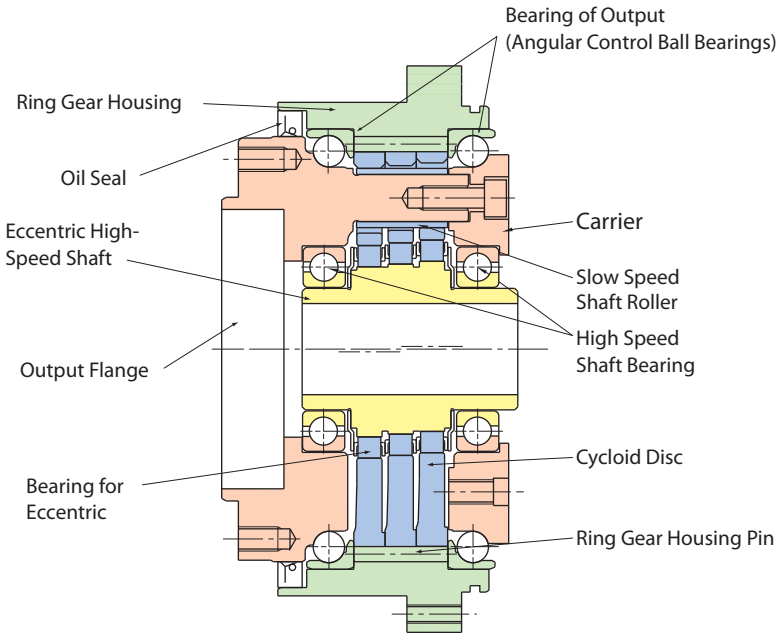
Customer can choose the location of the attachment bolt on the output flange.This was done by the unified construction of the output flange and slow speed shaft pin.

Large Hollow Diameter for the High-Speed Shaft

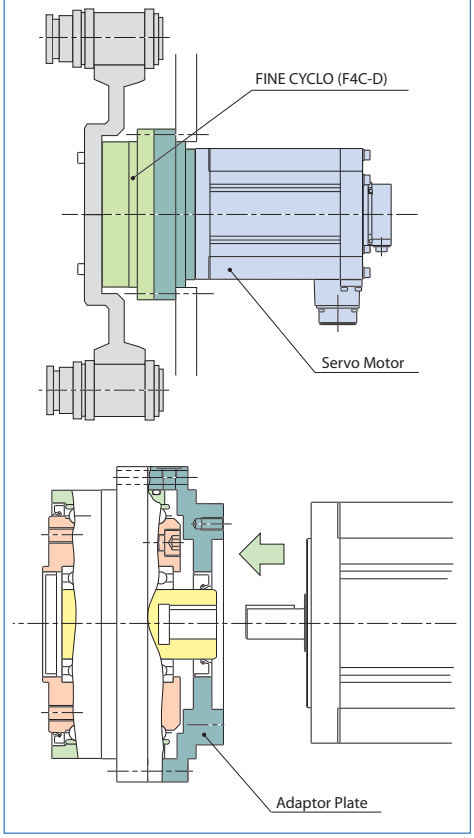
Reduced Length for Gearmotor Type
Maximum 33% increase compared to the traditional high-speed hollow shaft.

1. Construction

Fig. D-1

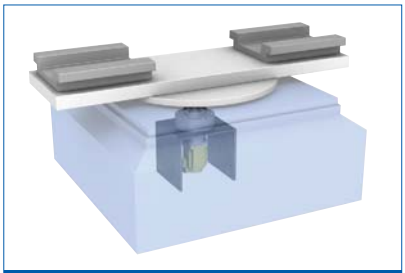


Main Example of Use

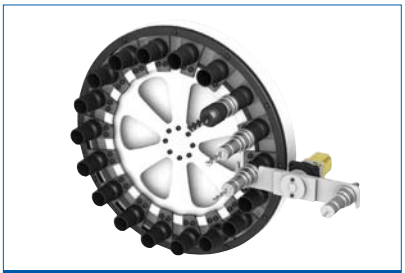


2. Application Examples

Industrial Robot
Axis Driving, Robot Slider



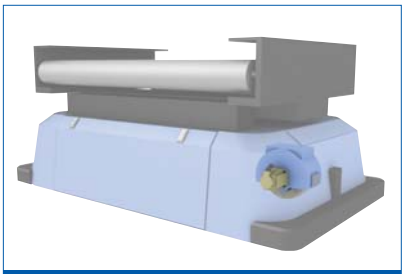
Machine Tool
Automatic Pallet Changer Drive



Machine Tool Magazine Drive

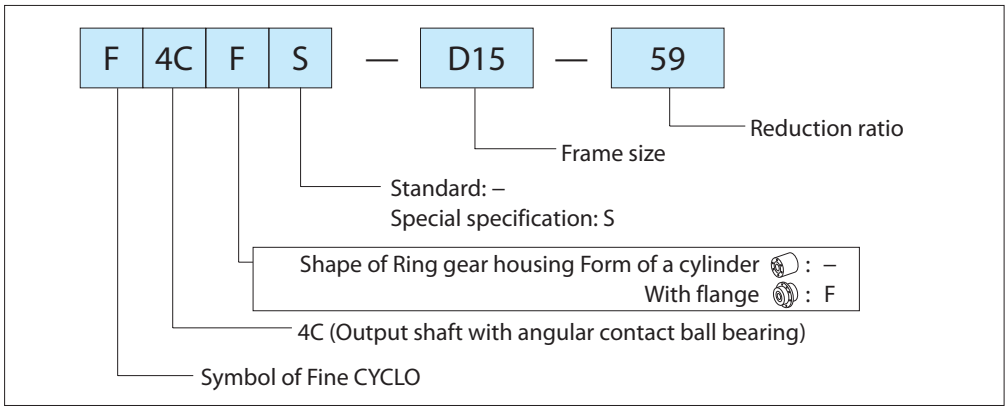
Machine Tool
Automatic Pallet Pool Drive

Liquid Crystal Transfer Robot
Axis Driving, Robot Slider



FA Equipment (AGV Driving)

3. Nomenclature



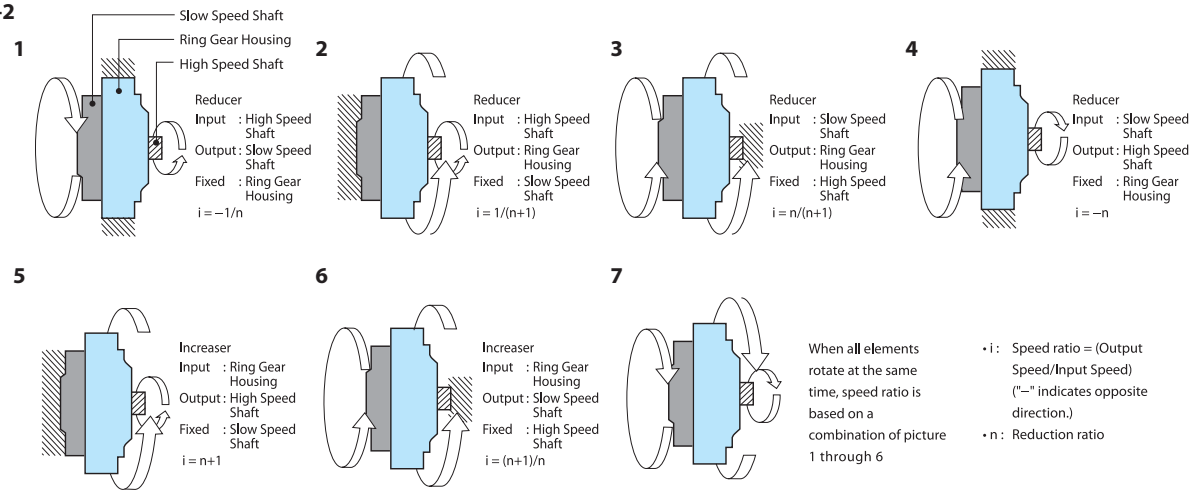
4. Products

Mark: Model Lineup

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

5. Speed Ratio & Rotation Direction

Fig. D-2



6. Operating Principles

The reducer portion of the FINE CYCLO® is fundamentaly different in principle and mechanism from the involute gearing mechanism of competitive gearmotors. The unique speed reducer portion is an ingenious combination of the following two mechanisms:

☆ A combination of a planet gear and a fixed internal sun gear. In the FINE CYCLO®, the planet gear has cycloidal-shaped teeth and the sun gear has circular pin teeth.
The number of teeth in the planet gear is one or two less than the sun gear.

☆ A constant speed internal gearing mechanism.

Fig. D-3 Principle of internal Planetary Gearing

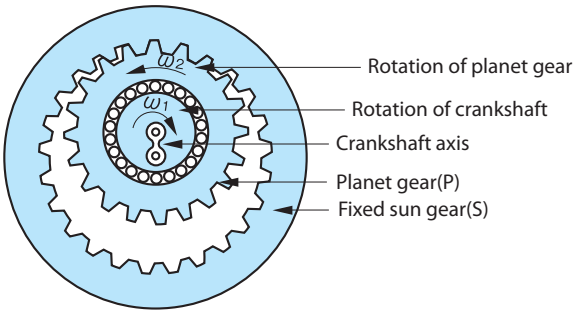


Fig. D-4 Epitrochoid Planet Gear-Circular(PIN) Tooth Sun Gear Combination

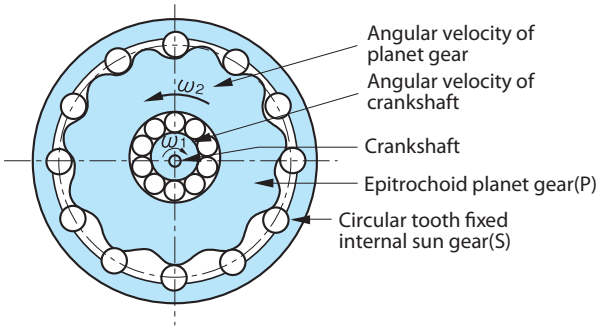


Fig. D-5 Constant Speed Internal Gearing

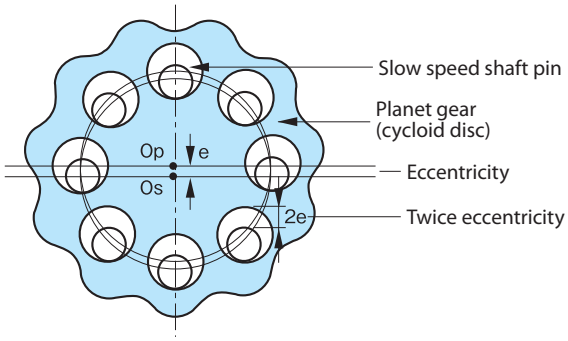
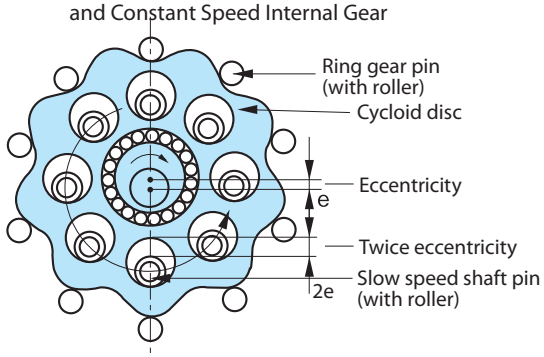


Fig. D-6 Combination of Planet-Sun Gears and Constant Speed Internal Gear



See Fig. D-3

In equation 1, below, P identifies the number of the planet gear teeth, S that of the sun gear, ω2 the angular velocity of the planet gear around its own axis. The velocity ratio of ω2 to ω1 is shown as follows:

$$\frac{\omega 2}{\omega 1} = 1 - \frac{S}{P} = -\frac{S-P}{P} \quad \cdots\text{Equation 1}$$

With S greater by one or two than P in this equation, the highest velocity ratio is obtainable.

That is, if S−P=1 is applied to Equation 1, the velocity ratio may be calculated from the following equation:

$$\frac{\omega 2}{\omega 1} = \frac{1}{P} \quad \cdots\text{Equation 2}$$

Or if S−P=2 is applied to Equation 1, the velocity ratio may be calculated from the following equation:

$$\frac{\omega 2}{\omega 1} = \frac{2}{P} \quad \cdots\text{Equation 3}$$

As the crankshaft rotates at the angular velocity ω1 around the axis of the sun gear, the planet gear rotates at the angular velocity:

$$-\frac{1\omega 1}{P} \quad \text{or} \quad -\frac{2\omega 1}{P}$$

When P indicates the number of the teeth of the planet gear and the symbol indicates that the rotation of the planet gear is in a reverse direction to that of the crankshaft.

In the FINE CYCLO®, illustrated in Fig. D-4, circular teeth(pins) are adapted for the sun gear and epitrochoid curved teeth for the planet gear, thereby avoiding tooth top interference. The rotation of the planet gear around its own axis is taken out through a constant speed internal gearing mechanism as shown in Fig. D-5.

In this mechanism shown in Fig. D-6, the pins of the slow speed shaft are evenly spaced on a circle that is concentric to the axis of the sun gear. The pins transmit the rotation of the planet gear by rolling internally on the circumference of the bores of each planet gear or cycloid disc. The diameter of the bores minus the diameter of the slow speed shaft pins is equal to twice the eccentricity value of the crank shaft (eccentric). This mechanism smoothly transmits only the rotation of the planet gear around its own axis to the slow speed shaft.

7. Rating

Table D-1 Rating Table (Output rotation base)

Output speed n_2 (r/min)		5			10			15			20			25		
Frame size	Reduction ratio	Rated output torque (Upper/N·m) (Lower/kgf·m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Input speed (r/min)	Allowable input power (kW)
D15	59	226 23.0	295	0.15	226 23.0	590	0.30	201 20.5	885	0.39	184 18.8	1180	0.48	172 17.6	1475	0.56
	89	226 23.0	445	0.15	201 20.5	890	0.26	178 18.1	1335	0.35	163 16.6	1780	0.43	153 15.6	2225	0.50
D25	59	487 49.7	295	0.32	487 49.7	590	0.64	434 44.2	885	0.85	398 40.6	1180	1.04	372 38.0	1475	1.22
	89	487 49.7	445	0.32	433 44.1	890	0.57	383 39.0	1335	0.75	351 35.8	1780	0.92	329 33.5	2225	1.08
	119	487 49.7	595	0.32	396 40.4	1190	0.52	351 35.8	1785	0.69	322 32.8	2380	0.84	301 30.7	2975	0.99
D30	59	635 64.8	295	0.42	635 64.8	590	0.84	566 57.7	885	1.11	519 52.9	1180	1.36	486 49.5	1475	1.59
	89	635 64.8	445	0.42	565 57.6	890	0.74	500 51.0	1335	0.98	459 46.8	1780	1.20	429 43.7	2225	1.40
	119	635 64.8	595	0.42	517 52.7	1190	0.68	458 46.7	1785	0.90	420 42.8	2380	1.10	393 40.1	2975	1.29
D35	59	899 92	295	0.59	899 91.7	590	1.18	800 81.6	885	1.57	734 74.8	1180	1.92	686 70.0	1475	2.25
	89	899 92	445	0.59	798 81.4	890	1.05	707 72.1	1335	1.39	649 66.1	1780	1.70	607 61.8	2225	1.98
	119	899 91.7	595	0.59	732 74.6	1190	0.96	648 66.1	1785	1.27	594 60.6	2380	1.56	556 56.7	2975	1.82
D45	59	1756 179	295	1.15	1756 179	590	2.31	1565 160	885	3.07	1436 146	1180	3.76	1343 137	1475	4.39
	89	1756 179	445	1.15	1562 159	890	2.04	1383 141	1335	2.72	1269 129	1780	3.32	1180 121	2225	3.88
	119	1756 179	595	1.15	1431 146	1190	1.87	1267 129	1785	2.49	1162 118	2380	3.04			

Table D-2 Maximum acceleration or deceleration torque

Frame size	Maximum acceleration T_{2A} or deceleration torque T_{2B}		Peak torque for emergency stop T_{2max}	
	(N•m)	(kgf•m)	(N•m)	(kgf•m)
D15	417	42.5	834	85
D25	883	90	1766	180
D30	1226	125	2453	250
D35	1717	175	3581	365
D45	3188	325	6377	650

30			40			50			60			Allowable maximum input speed (r/min)	Allowable maximum output speed(r/min)		Equivalent On input shaft Upper/Moment of inertia ($\times10^{-4}$kg·m^2) Lower/GD^2 ($\times10^{-4}$kgf·m^2)	Mass (kg)
Rated output torque (Upper/N·m) (Lower/kgf·m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Input speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Input speed (r/min)	Allowable input power (kW)		50% ED	100% ED		
163 16.6	1770	0.64	150 15.3	2360	0.78	140 14.3	2950	0.92	133 13.5	3540	1.04	6150	5600	2800	0.38 1.52	5.2
145 14.7	2670	0.57	133 13.5	3560	0.69	124 12.6	4450	0.81	117 12.0	5340	0.92				0.37 1.50	
353 35.9	1770	1.38	323 33.0	2360	1.69	302 30.8	2950	1.98	286 29.2	3540	2.25	5050	4200	2100	1.55 6.19	8.1
311 31.7	2670	1.22	285 29.1	3560	1.49										1.54 6.15	
285 29.1	3570	1.12													1.53 6.12	
460 46.9	1770	1.81	422 43.0	2360	2.21	394 40.2	2950	2.58	373 38.1	3540	2.93	4550	3800	1900	3.99 15.96	11
406 41.4	2670	1.59	373 38.0	3560	1.95										3.96 15.85	
372 37.9	3570	1.46													3.95 15.81	
650 66.2	1770	2.55	596 60.8	2360	3.12	557 56.8	2950	3.65				3950	3300	1650	4.93 19.71	15
574 58.5	2670	2.25													4.89 19.55	
															4.87 19.50	
1271 130	1770	4.99	1166 119	2360	6.11							3150	2600	1300	12.51 50.03	24
															12.41 49.65	
															12.38 49.52	

: 50%ED range : 100%ED range

Notes:

1. Rated output torque
   Rated output torque implies allowable mean load torque at each output speed. Rated output torque for below 600r/min input is the same as 600r/min.
   Allowable input power is the value converted from rated output torque, when it is 100%. This value takes efficiency of FINE CYCLO® in consideration.
2. Allowable maximum input speed and allowable mean input speed
   Reducer may be used within maximum input speed indicated in the Table, however, allowable mean input speed is limited by operation (%ED).
3. Allowable acceleration or deceleration peak torque
   Allowable peak torque at normal start and stop.
4. Allowable momentary maximum torque
   Allowable momentary maximum torque at emergency stop or heavy shock, when loading 1000 times in overall lifetime.
5. Moment of inertia, GD^2
   Value at input shaft. Divide them by g (Moment of inertia: 9.8m/sec^2) or 4g (GD^2: 4 x 9.8m/sec^2) to convert from them to inertia.
6. Calculate the rated torque using the following formula when the speed is not shown in the table above.

$$T_{2N} = T_{2N,15} \left(\frac{15}{n_2} \right)^{0.3}$$

T_{2N}: Rated torque at output speed n_2
$T_{2N,15}$: Rated torque at output speed n_2 is 15 r/min

Table D-3 Rating Table (Input rotation base)

Input speed n_1 (r/min)		4000			3000			2500			2000			1750		
Frame size	Reduction ratio	Rated output torque (Upper/N·m) (Lower/kgf·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Output speed (r/min)	Allowable input power (kW)
D15	59	128 13.0	67.8	1.13	139 14.2	50.8	0.93	147 15.0	42.4	0.82	157 16.1	a33.9	0.70	164 16.7	29.7	0.64
	89	128 13.0	44.9	0.75	139 14.2	33.7	0.61	147 15.0	28.1	0.54	157 16.1	22.5	0.46	164 16.7	19.7	0.42
D25	59	275 28.1	67.8	2.44	300 30.6	50.8	2.00	317 32.4	42.4	1.76	339 34.6	33.9	1.50	353 36.0	29.7	1.37
	89	275 28.1	44.9	1.62	300 30.6	33.7	1.32	317 32.4	28.1	1.16	339 34.6	22.5	1.00	353 36.0	19.7	0.91
	119	275 28.1	33.6	1.21	300 30.6	25.2	0.99	317 32.4	21.0	0.87	339 34.6	16.8	0.75	353 36.0	14.7	0.68
D30	59				392 40.0	50.8	2.61	414 42.3	42.4	2.30	443 45.2	33.9	1.96	461 47.0	29.7	1.79
	89				392 40.0	33.7	1.73	414 42.3	28.1	1.52	443 45.2	22.5	1.30	461 47.0	19.7	1.19
	119				392 40.0	25.2	1.29	414 42.3	21.0	1.14	443 45.2	16.8	0.97	461 47.0	14.7	0.89
D35	59				554 56.6	50.8	3.69	586 59.8	42.4	3.25	626 63.9	33.9	2.78	652 66.5	29.7	2.53
	89				554 56.6	33.7	2.44	589 59.8	28.1	2.15	626 63.9	22.5	1.84	652 66.5	19.7	1.68
	119							589 59.8	21.0	1.61	626 63.9	16.8	1.38	652 66.5	14.7	1.25
D45	59							1145 117	42.4	6.35	1224 125	33.9	5.43	1274 130	29.7	4.94
	89							1145 117	28.1	4.21	1224 125	22.5	3.60	1274 130	19.7	3.28
	119							1145 117	21.0	3.15	1224 125	16.8	2.69	1274 130	14.7	2.45

Table D-2 Maximum acceleration or deceleration torque

Frame size	Maximum acceleration T_{2A} or deceleration torque T_{2B}		Peak torque for emergency stop T_{2max}	
	(N•m)	(kgf•m)	(N•m)	(kgf•m)
D15	417	42.5	834	85
D25	883	90	1766	180
D30	1226	125	2453	250
D35	1717	175	3581	365
D45	3188	325	6377	650

1500			1000			750			600			Allowable maximum input speed (r/min)	Allowable maximum input speed(r/min)		Equivalent On input shaft Upper/Moment of inertia ($\times 10^{-4}$kg·m^2) Lower/GD^2 ($\times 10^{-4}$kgf·m^2)	Mass (kg)
Rated output torque (Upper/N·m) (Lower/kgf·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Output speed (r/min)	Allowable input power (kW)	Rated output torque (Upper/N·m) (Lower/kgf·m)	Output speed (r/min)	Allowable input power (kW)		50% ED	100% ED		
171 17.5	25.4	0.57	194 19.8	16.9	0.43	211 21.5	12.7	0.35	226 23.0	10.2	0.30	6150	5600	2800	0.38 1.52	5.2
171 17.5	16.9	0.38	194 19.8	11.2	0.28	211 21.5	8.43	0.23	226 23.0	6.74	0.20				0.37 1.50	
370 37.7	25.4	1.23	418 42.6	16.9	0.93	455 46.5	12.7	0.76	487 49.7	10.2	0.65	5050	4200	2100	1.55 6.19	8.1
370 37.7	16.9	0.81	418 42.6	11.2	0.61	455 46.5	8.43	0.50	487 49.7	6.74	0.43				1.54 6.15	
370 37.7	12.6	0.61	418 42.6	8.4	0.46	455 46.5	6.30	0.38	487 49.7	5.04	0.32				1.53 6.12	
483 49.3	25.4	1.61	545 55.6	16.9	1.21	594 60.6	12.7	0.99	635 64.8	10.2	0.85	4550	3800	1900	3.99 15.96	11
483 49.3	16.9	1.06	545 55.6	11.2	0.80	594 60.6	8.43	0.66	635 64.8	6.74	0.56				3.96 15.85	
483 49.3	12.6	0.80	545 55.6	8.4	0.60	594 60.6	6.30	0.49	635 64.8	5.04	0.42				3.95 15.81	
683 69.7	25.4	2.27	771 78.7	16.9	1.71	840 85.8	12.7	1.40	899 91.7	10.2	1.20	3950	3300	1650	4.93 19.71	15
683 69.7	16.9	1.50	771 78.8	11.2	1.13	840 85.8	8.43	0.93	899 91.7	6.74	0.79				4.89 19.55	
683 69.7	12.6	1.13	771 78.6	8.40	0.85	840 85.8	6.30	0.69	899 91.7	5.04	0.59				4.87 19.50	
1334 136	25.4	4.44	1507 154	16.9	3.34	1643 168	12.7	2.73	1756 179	10.2	2.34	3150	2600	1300	12.51 50.03	24
1334 136	16.9	2.94	1507 154	11.2	2.22	1643 168	8.43	1.81	1756 179	6.74	1.55				12.41 49.65	
1334 136	12.6	2.20	1507 154	8.40	1.66	1643 168	6.30	1.35	1756 179	5.04	1.16				12.38 49.52	

: 50%ED range : 100%ED range

Notes:

1. Rated output torque
   Rated output torque implies allowable mean load torque at each output speed. Rated output torque for below 600r/min input is the same as 600r/min.
   Allowable input power is the value converted from rated output torque, when it is 100%. This value takes efficiency of FINE CYCLO® in consideration.
2. Allowable maximum input speed and allowable mean input speed
   Reducer may be used within maximum input speed indicated in the Table, however, allowable mean input speed is limited by operation (%ED).
3. Allowable acceleration or deceleration peak torque
   Allowable peak torque at normal start and stop.
4. Allowable momentary maximum torque
   Allowable momentary maximum torque at emergency stop or heavy shock, when loading 1000 times in overall lifetime.
5. Moment of inertia, GD^2
   Value at input shaft. Divide them by g (Moment of inertia: 9.8m/sec^2) or 4g (GD^2: 4 x 9.8m/sec^2) to convert from them to inertia.
6. Calculate the rated torque using the following formula when the speed is not shown in the table above.

$$T_{2N} = T_{2N,1750} \left(\frac{1750}{n_1} \right)^{0.3}$$

T_{2N} : Rated torque at input speed n_1
$T_{2N,1750}$: Rated torque at input speed n_1 is 1750 r/min

8. Engineering Data

8-1. Stiffness and lost motion

•Hysteresis curve : Relationship between load and displacement of output flange (rotational angle) when load is removed slowly from allowable torque to zero torque, with fixed input shaft.

•Lost Motion : Torsional deflected angle at ±3% of allowable output torque.

•Stiffness : Slope of the straight line connecting two points, when allowable torque is 50% and 100% on the hysteresis curve.

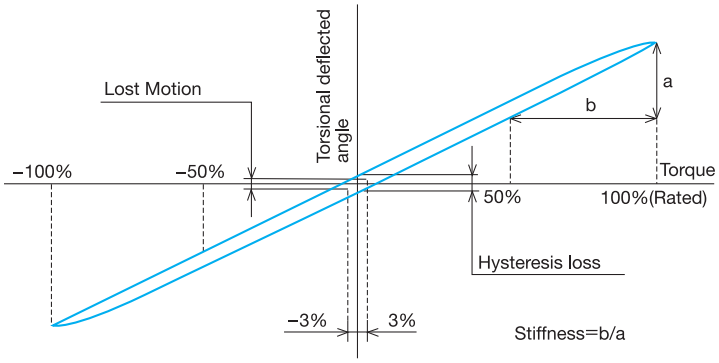


Fig. D-7 Hysteresis curve

8-2. No Load Running Torque

No load running torque indicates torque on input shaft for rotating reducer under no-load condition.
Shown values are applicable only on standard design as shown on Fig. D1

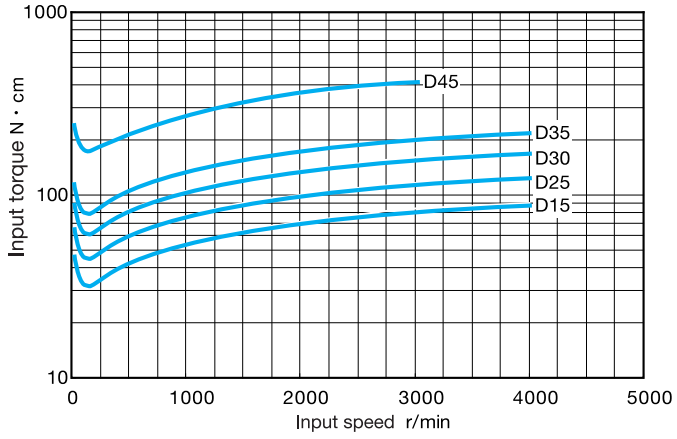


Fig. D-8

Notes) 1. Fig. D-8 shows average data after reducers have been run.
2. Measurement Conditions

Ring gear housing temperature	Approx. 30°C
Accuracy in assembled dimensions	Refer to 11.1
Lubrication	Standard grease

Table D-4 Engineering data

Frame size	i	Rated output torque at output speed 15 r/min	Lost Motion		Stiffness
			Measured torque (±) N·m	Lost Motion arc min	N·m/arc min
D15	59	201	6.03	1.0	49.0
	89	178	5.34		
D25	59	434	13.0		112
	89	383	11.5		
	119	351	10.5		
D30	59	566	17.0		173
	89	500	15.0		
	119	458	13.7		
D35	59	800	24.0		220
	89	707	21.2		
	119	648	19.4		
D45	59	1565	47.0		450
	89	1383	41.5		
	119	1267	38.0		

Note) Arc min means "minute" of the angle.Stiffness is the average value (typical data).

(Example calculation of torsional deflected angle)

Calculation of torsion angle when torque is applied in one direction using D35-59 as example.

1) When load torque is 15N·m

(When load torque is in the range of lost motion)

$$\theta = \frac{15}{24} \times \frac{1}{2} = 0.3125 \text{ arcmin}$$

2) When load torque is 600N·m

$$\theta = \frac{1}{2} + \frac{600-24}{220} = 3.12 \text{ arcmin}$$

8-3. Breakaway torque on output shaft (BTO)

Indicates torque necessary to start rotation from output side of reducer from stop without load.

Table D-5 Value of breakaway torque from output side (starting torque)

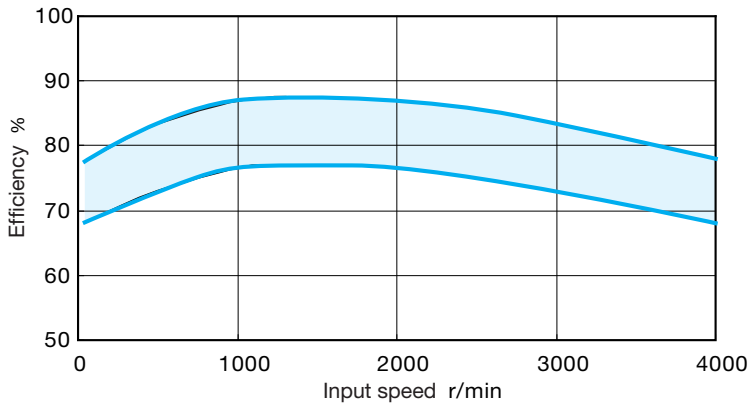
Frame size	N • m
D15	70
D25	100
D30	120
D35	140
D45	245

Notes: 1. Table D-5 shows max. torque from output side BTO.
2. Measurement Conditions

Accuracy in assembled dimensions	Refer Item 11-1
Lubrication	Standard grease

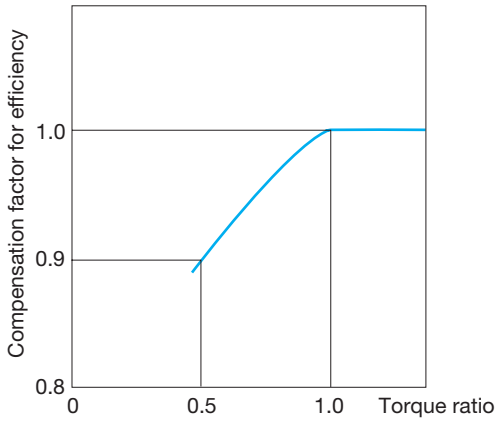
8-4. Efficiency

Fig. D-9 Efficiency Curve



Efficiency varies by input speed, load torque, grease temperature, reduction ratio, etc.
Fig. D-9 indicates efficiency vs. input speed at allowable output torque with stable grease temperature.
Efficiency curve is indicated with flexible coverage for variations in models and reduction ratio.

Fig. D-10 Compensation Curve of Efficiency



(Load torque/Rated output torque at 1750 r/min)

Compensation efficiency =
Efficiency (Fig.D-9) x Compensation factor for efficiency (Fig.D-10)

Note) 1. Efficiency varies when load torque differs with allowable torque. Check the compensation factor in the left diagram.
2. When torque ratio is over 1.0, compensation factor for efficiency is 1.0.

8-5. ALLOWABLE RADIAL LOAD & AXIAL LOAD OF HIGH SPEED SHAFT

When a gear or sheave is mounted on the high speed shaft, radial load and axial load should be equal to or less than allowable value.
Check radial & axial load by following the next formula (① ~ ③).

① Radial load Pr

$$Pr = \frac{T\ell}{R} \leqq \frac{Pro}{Lf \cdot Cf \cdot F_{S1}} \quad [N, kgf] \qquad \text{(Formula D-1)}$$

② Axial load Pa

$$Pa \leqq \frac{Pao}{Cf \cdot F_{S1}} \quad [N, kgf] \qquad \text{(FormulaD-2)}$$

③ When radial and axial load co-exist

$$\left(\frac{Pr \cdot Lf}{Pro} + \frac{Pa}{Pao} \right) \cdot Cf \cdot F_{S1} \leqq 1 \qquad \text{(FormulaD-3)}$$

Pr : Actual radial load [N, kgf]
$T\ell$: Equivalent torque on input shaf [N·m, kgf·m]
R : Pitch circle radius of sprocket, gear, or sheave [m]
Pro : Allowable radial load [N, kgf] (Table D-6)
Pa : Actual axial load [N, kgf]
Pao : Allowable axial load [N, kgf] (Table D-7)
Lf : Load location factor (Table D-8)
Cf : Coupling factor (Table D-9)
F_{S1} : Shock factor (Table D-10)

Table D-6 Actual radial load Pro (Up: N/Down: kgf)

Frame size	Input speed r/min								
	4000	3000	2500	2000	1750	1500	1000	750	600
D15	226 23	245 25	265 27	284 29	294 30	314 32	353 36	392 40	422 43
D25	334 34	373 38	392 40	422 43	441 45	461 47	530 54	589 60	628 64
D30		432 44	461 47	500 51	520 53	549 56	628 64	687 70	746 76
D35		491 50	520 53	559 57	589 60	618 63	706 72	785 80	844 86
D45			608 62	657 67	687 70	726 74	824 84	912 93	981 100

Table D-7 Actual axial load Pao (Up: N/Down: kgf)

Frame size	Input speed r/min								
	4000	3000	2500	2000	1750	1500	1000	750	600
D15	245 25	284 29	314 32	343 35	363 37	392 40	471 48	549 56	608 62
D25	363 37	412 42	451 46	500 51	540 55	579 59	697 71	804 82	883 90
D30		520 53	569 58	638 65	677 69	726 74	883 90	1001 102	1118 114
D35		540 55	589 60	657 67	706 72	755 77	922 94	1059 108	1167 119
D45			1010 103	1118 114	1197 122	1295 132	1570 160	1795 183	2001 204

Calculate the actual radial load using the following formula when the speed is not shown in the table above.

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

P_{rN} : Actual radial load when input speed N
P_{r1750} : Actual radial load when input speed 1750r/min

Calculate the actual axial load using the following formula when the speed is not shown in the table above.

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

P_{aN} : Actual axial load when output speed N
P_{a1750} : Actual axial load when output speed 1750r/min

Table D-8 Load Location Factor Lf

L (mm)	Frame size				
	D15	D25	D30	D35	D45
10	0.91	0.87			
15	0.99	0.94	0.92	0.91	
20	1.25	1.00	0.98	0.97	0.90
25	1.56	1.25	1.14	1.09	0.94
30	1.88	1.50	1.36	1.30	0.99
35	2.19	1.75	1.59	1.52	1.13
40		2.00	1.82	1.74	1.29
45			2.05	1.96	1.45
50				2.17	1.61
60					1.94
Lf=When 1 of L(mm)	16	20	22	23	31
a	0.072	0.063	0.061	0.055	0.046

$L \geqq L1$ Lf=L/L1 L1:Lf = When 1 of L
L<L1 Lf=1.0−a/5× (L1−L)

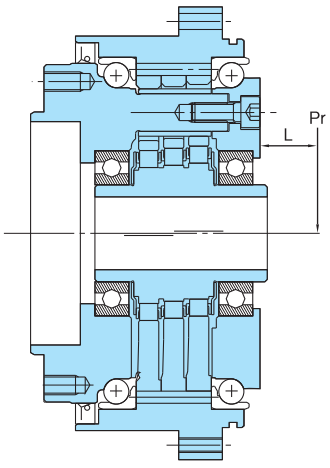


Fig. D-11 Load location on input shaft

Table D-9 Coupling Factor Cf

Coupling method	Cf
Chain	1
Machine gear or pinion	1.25
Timing belt	1.25
V-Belt	1.5

Table D-10 Shock Factor F_{S1}

Degree of shock	F_{S1}
Practically no shock	1
Light shock	1~1.2
Severe shock	1.4~1.6

9. Main Bearings

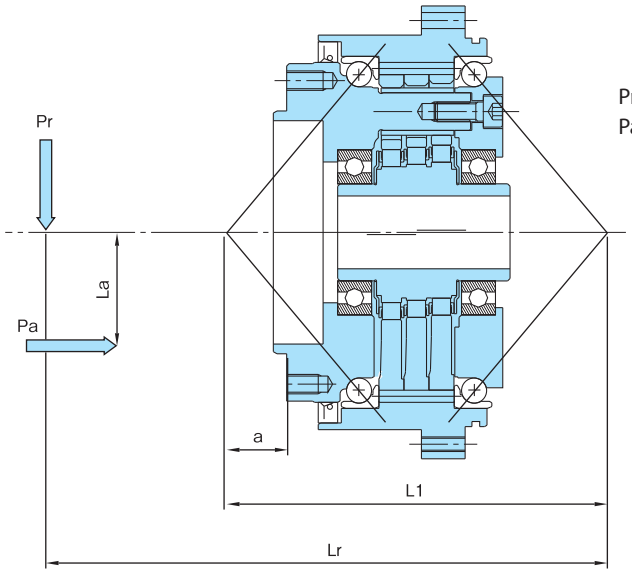


Fig. D-12 Span between each loading point
Note) Consult us if: Lr>4×L1

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

Table D-11Span of Loading Points (mm)

Frame size	Span of Loading Points	
	L1(mm)	a(mm)
D15	119	23.6
D25	139	23.4
D30	157	24.5
D35	170	40.5
D45	206	52.4

Table D-12 Moment Stiffness*

Frame size	Moment Stiffness (N·m/arcmin)
D15	510
D25	833
D30	1127
D35	1470
D45	2450

* Average values
* Durchschnittswerte

Moment Stiffness = Kippsteifigkeit

1. Moment Stiffness
Indicates stiffness on inclination of output shaft with external moment.

External moment (M)
$M=Pr \cdot Lr + Pa \cdot La$ ..... (Formula D-4)

2. Allowable Moment & Allowable Axial Load
Check external moment and external axial load with Formula D-5, Formula D-6, and Fig.D-13.

Equivalent moment (Me)
$Me=Cf \cdot F_{S1} \cdot Pr \cdot Lr + Cf \cdot F_{S1} \cdot Pa \cdot La$ ..... (Formula D-5)

Equivalent axial load (Pae)
$Pae=Cf \cdot F_{S1} \cdot Pa$ ..... (Formula D-6)
Cf : Coupling factor [Table D-14]
F_{S1}: Shock factor [Table D-15]

Table D-13 Allowable Moment & Allowable Axial Load

Frame size	Allowable Moment (N·m)	Allowable Axial Load (N)
D15	883	3924
D25	1177	3924
D30	1668	5199
D35	1962	7848
D45	2943	10791

Allowable Moment = zul. dyn. Kippmoment
Allowable Axial Load = zul. Axialkraft F_{2A}

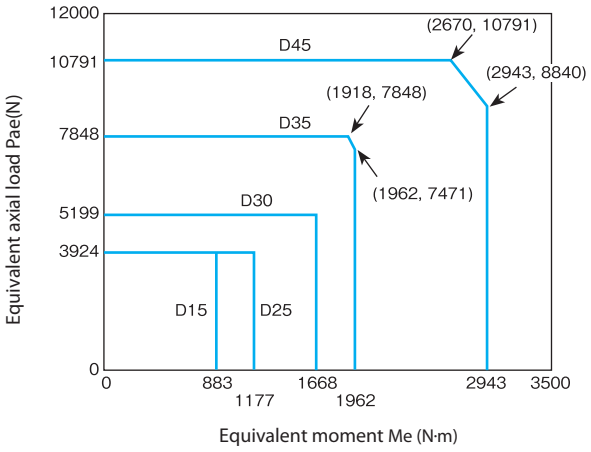


Fig. D-13 Diagram of Allowable Moment & Axial Load

Table D-14 Coupling Factor Cf

Load connection factor	Cf
General purpose chain	1
Machine gear or pinion	1.25
Timing belt	1.25
V-Belt	1.5

Table D-15 Shock factor F_{S1}

Load Classification	F_{S1}
Uniform load (no shock)	1
Moderate shocks	1~1.2
Heavy shocks	1.4~1.6

10. Selection

10-1. Flow Cart and Formula of Selection

FIG. D-14 Load cycle

n_A : Average input speed during acceleration under condition defined in Fig. D-14

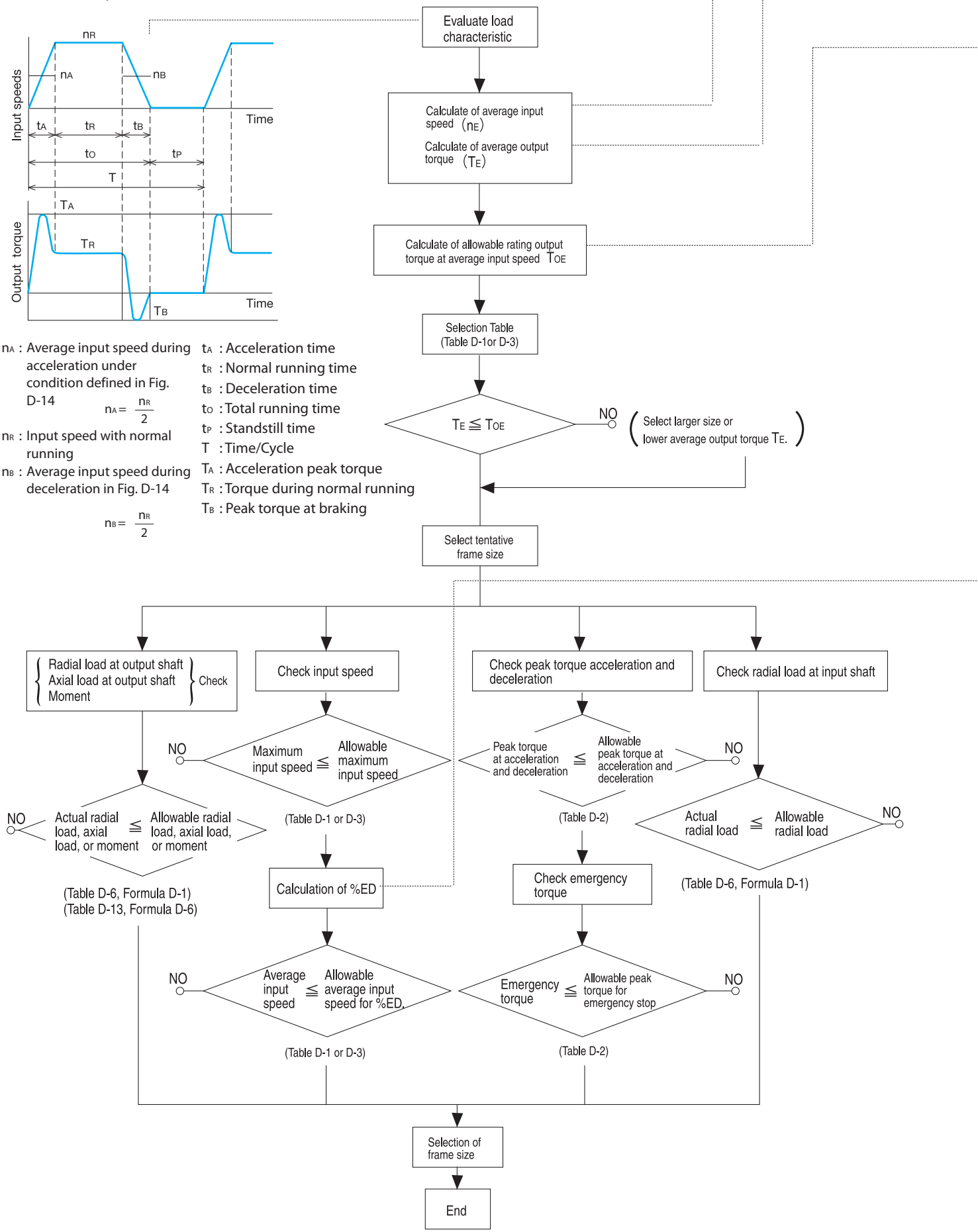
$$n_A = \frac{n_R}{2}$$

n_R : Input speed with normal running

n_B : Average input speed during deceleration in Fig. D-14

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

t_A : Acceleration time
t_R : Normal running time
t_B : Deceleration time
t_O : Total running time
t_P : Standstill time
T : Time/Cycle
T_A : Acceleration peak torque
T_R : Torque during normal running
T_B : Peak torque at braking



Calculation in Load Condition of Fig. D-14

○ Average input speed $n_E = \left(\frac{t_A n_A + t_R n_R + t_B n_B}{t_O} \right)$ ·····(Formula D-8)

○ Average output torque $T_E = \left(\frac{t_A n_A T_A^{10/3} + t_R n_R T_R^{10/3} + t_B n_B T_B^{10/3}}{t_O} \right)^{0.3} \times F_{S2}$ ·····(Formula D-9)

○ Allowable rating output torque at average input speed $T_{OE} = \left(\frac{600}{n_E} \right)^{0.3} \times To$ ·····(Formula D-10)

To: Rated output torque at input speed 600r/min (Table D-3)
When n_E<600, T_{OE} equals to T_O at input speed 600r/min.

○ %ED $ED = \frac{t_O}{T} \times 100$ ·····(Formula D-10)

Maximum of single cycle time is 10 minutes when calculating %ED. When single cycle time is over 10 minutes, calculate %ED as T=10 (minutes).

Table D-16 F_{S2} Load factor

Loading condition	F_{S2}
Uniform load	1
Moderate shock	1~1.2
Heavy shock	1.4~1.6

10-2. Example of Selection

Evaluate F4CF-D25-119 for following specification.

(Specification)
T_A : Acceleration peak torque 600N·m
T_R : Normal running torque 250N·m
T_B : Peak torque at breaking 400N·m
Emergency torque : 1700N·m
(1000 times during overall life time)
n_A : Average input speed during acceleration 1250r/min
n_R : Input speed with normal running 2500r/min
n_B : Average input speed during deceleration 1250r/min

t_A : Acceleration time 0.3sec
t_R : Normal running time 3.0sec
t_B : Deceleration time 0.3sec
t_P : Total running time 3.6sec
t_O : Standstill time 3.6sec
T : Single cycle time 7.2sec
Radial load at input shaft : Operated by timing belt with moderate shock 196N at point 25mm from end of shaft
Radial load at output shaft : Connection with gear, moderate shock 4116N at 60mm point from side of flange

It considered that reducer is used to operate wrist of robot with moderate shock.

(Calculate) Average input speed $n_E = \frac{0.3\times1250 + 3.0\times2500 + 0.3\times1250}{3.6} = 2292(r/min)$

Average output torque $T_E = \left(\frac{0.3\times1250\times600^{10/3} + 3.0\times2500\times250^{10/3} + 0.3\times1250\times400^{10/3}}{3.6 \times 2292} \right)^{0.3} \times 1 = 306(N\cdot m)$

○ Allowable output torque at average input speed $T_{OE} = \left(\frac{600}{2292} \right)^{0.3} \times 487 = 326(N\cdot m) \geqq 306(N\cdot m)$ ➡ F4CF—D25—119

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

○ Evaluate of maximum input speed 2500(r/min) < 5050(r/min) (Table D-1or D-3)
○ Evaluate of average input speed 2292(r/min) at50%ED < 4200(r/min) at50%ED (Table D-1or D-3)
○ Evaluate of peak torque at acceleration and deceleration 600(N·m) < 883(N·m) (Table D-2)
○ Evaluate of emergency torque 1700(N·m) < 1766(N·m)(with dowel pins) (Table D-2)
○ Allowable radial load at input shaft with coefficient in consideration
Pro = 402N = 441×(1750/2292)$^{1/3}$, Lf = 1.25, Cf = 1.25, F_{S1} = 1.2

$\frac{Pro}{Lf\times Cf\times F_{S1}} = \frac{420}{1.25\times1.25\times1.2} = 214(N) > 196(N)$ (Table D-6, Fomula D-1)

○ Evaluate of allowable moment
Lr = 55 + L1−a = 55 + 139−23.4 = 175.6
External Moment Calculated with the Coefficient
Cf = 1.25, F_{S1} = 1.2, M = Cf × F_{S1} × Pr × Lr = 1.25 × 1.2 × 4116 × 175.6 x 10 E-3 = 1084(N·m) < 1177(N·m)

F4CF-D25-119 is selected by evaluation above.

11. Notice for Designing

11-1. Precision in Assembly Dimensions

Fig. D-15 Method of Assembly

- Pilot for mounting input parts(motor etc.) are as Ⓒ in following figure.
- Use Ⓑ for output shaft assembly and Ⓐ for casing assembly as pilot for mounting.

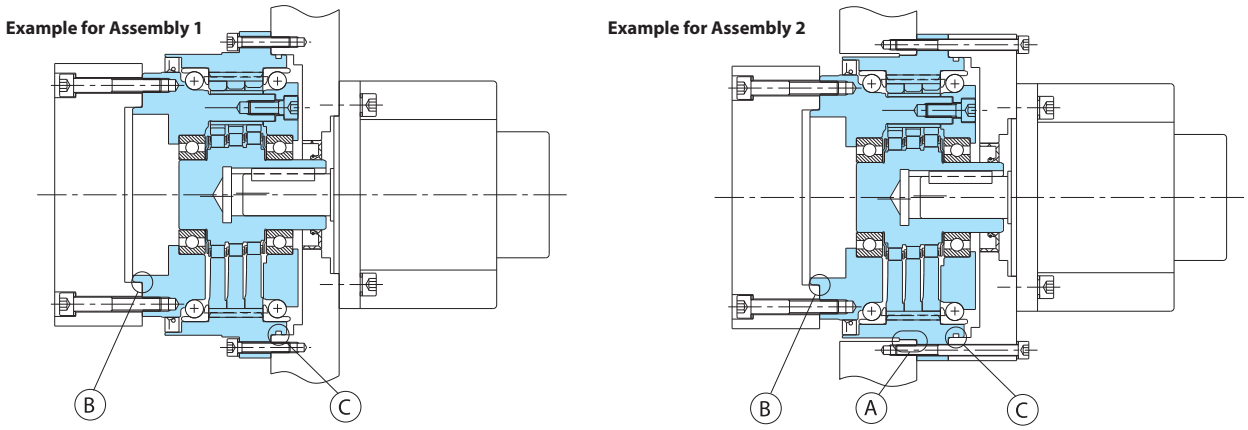
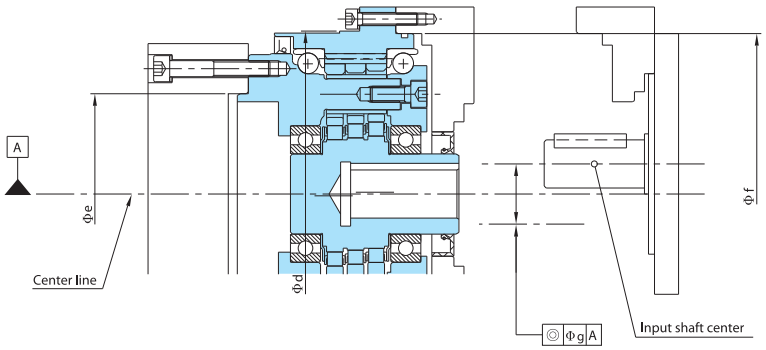


Fig. D-16 Precision in assembly dimensions



- Recommended precision of concentricity for attachment parts should be the same as or less than Table D-17.
- Attachment pilots are "d," "e," and "f" in Table D-17.

TAble D-17

Frame size	d	e	f	g
D15	124H7/h7	47H7/h7	123H7/h7	0.03
D25	145H7/h7	80H7/h7	145H7/h7	0.03
D30	163H7/h7	100H7/h7	160H7/h7	0.03
D35	174H7/h7	75H7/h7	174H7/h7	0.03
D45	220H7/h7	100H7/h7	220H7/h7	0.03

11-2. Tightening Torque and Allowable Transmitted Torque for Bolts

(1) Allowable transmitted torque for bolts
Quantity, size, and tightening torque of bolt for the output flange and ring gear housing are shown in Table D-18. Allowable peak torque for emergency stop that can be transmitted is shown in Table D-19.

Table D-18

Frame size	Output Flange Bolts			Ring gear housing bolts		
	Number of bolts-size	Tightening torque		Number of bolts-size	Tightening torque	
		N·m	kgf·cm		N·m	kgf·cm
D15	12—M8	38.3	390	12—M6	15.7	160
D25	12—M8	38.3	390	16—M6	15.7	160
D30	16—M8	38.3	390	16—M6	15.7	160
D35	12—M10	76.5	780	16—M8	38.3	390
D45	16—M12	133	1360	16—M10	76.5	780

- Bolt: Use metric hexagon socket head cap screw based on JIS B1176, strength grade 12.9"
- Countermeasure for bolts loosening: Use adhesives (Loctite262, etc.) or spring washer (based on JIS B1252, class 2).
- Use conical spring washer (Based on JIS B1252, class 2) on flange side when coupling the reducer to prevent damaging the bolt bearing surface.

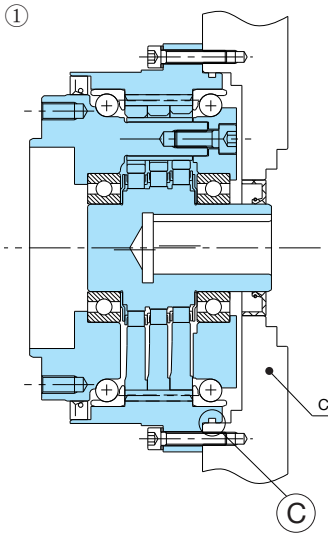
Table D-19

Frame size	Allowable transmitted torque by bolts	
	N·m	kgf·m
D15	1478	151
D25	2065	211
D30	2786	284
D35	3962	404
D45	9347	954

- Friction Coefficient: 0.15

11-3. Assembly Procedure

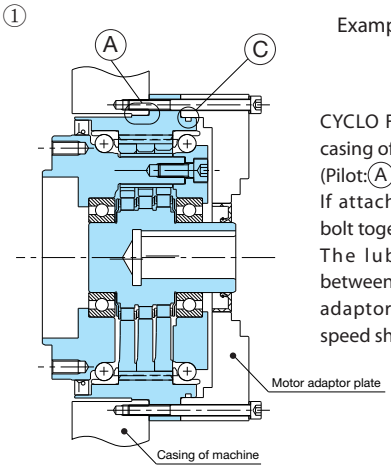
①



Example for Assembly 1

CYCLO F-Series is attached to the casing of machine with bolts.
Motor adaptor is a part of the casing in this example.
Please consider and select the construction.
The lubricant must be sealed between the motor
adaptor plate and eccentric high speed shaft.

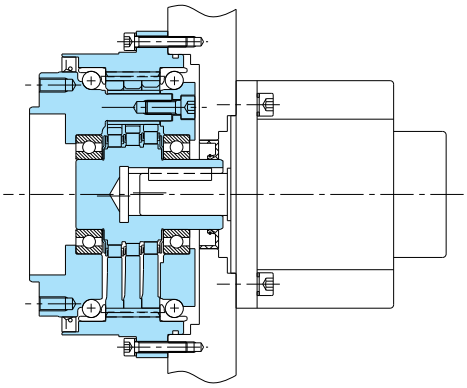
①



Example for Assembly 2

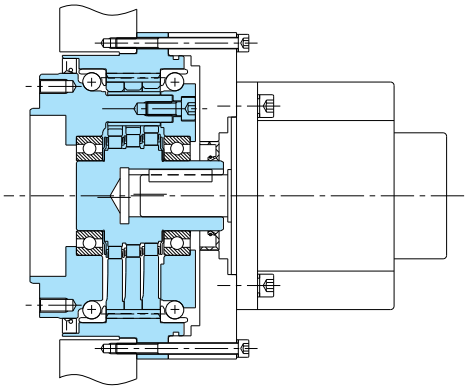
CYCLO F-Series is attached to the casing of machine with bolts.
(Pilot: Ⓐ)
If attaching motor adapter plate, bolt together with reducer part.
The lubricant must be sealed between the motor
adaptor plate and eccentric high speed shaft.

②



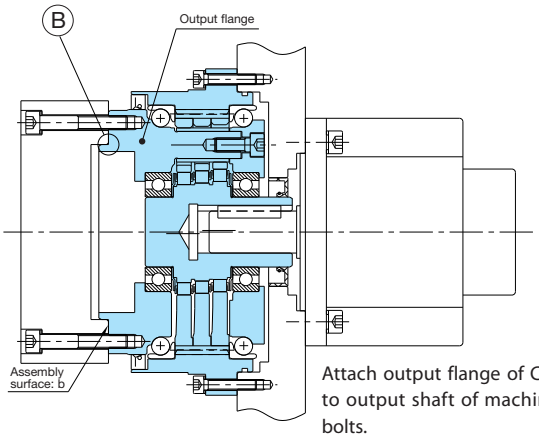
Match the phase of motor shaft and input shaft of reducer. Attach motor to reducer parts with bolts.
(Apply prevention agent for fretting to motor shaft before assembly.)

②



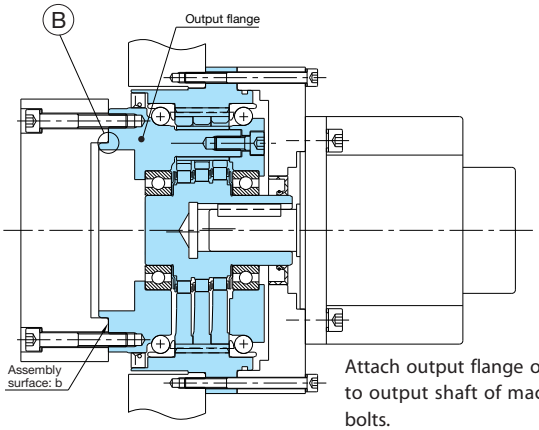
Match the phase of motor shaft and input shaft of reducer. Attach motor to reducer parts with bolts.
(Apply prevention agent for fretting to motor shaft before assembly.)

③



Attach output flange of CYCLO to output shaft of machine by bolts.
(Pilot: Ⓑ)
Apply liquid gasket to the assembly side "b" at this point.

③



Attach output flange of CYCLO to output shaft of machine by bolts.
(Pilot: Ⓑ)
Apply liquid gasket to the assembly side "b" at this point.

Notes1) Make sure to apply specified tightening torque(refer to Table D-18) to bolts when attaching reducer.
Notes2) Choose bolts shorter then the depth of tap indicated in output side flange in Outline Drawing (P19-P20), when attaching output shaft to output side flange (slow speed shaft)of CYCLO DRIVE.

Recommended liquid gasket: Liquid gasket Three Bond 1215 of Three Bond Co., Ltd.

11-4. Lubrication

- F4CF-D-Series are shipped with grease drained at the time of shipment. Customer must prepare and fill appropriate amount of (Table D-20) recommended grease (Table D-21). **Only valid for units without motor (input) adapter.**
- Use quantity indicated in Table D-21 as a guide, check the actual grease level when filling grease.
- Match the position of filler and drain port at output side with one of eccentric planetary shaft bearing. (See ""A"" in Fig.D-17 and Table D-20)"
- When supplying with grease for the first time, fill from lower drain port to ensure grease circulation.
- Change grease every 20,000 hours or every 3~5 years.

Table D-20 Recommended Grease for F4CF-D Series

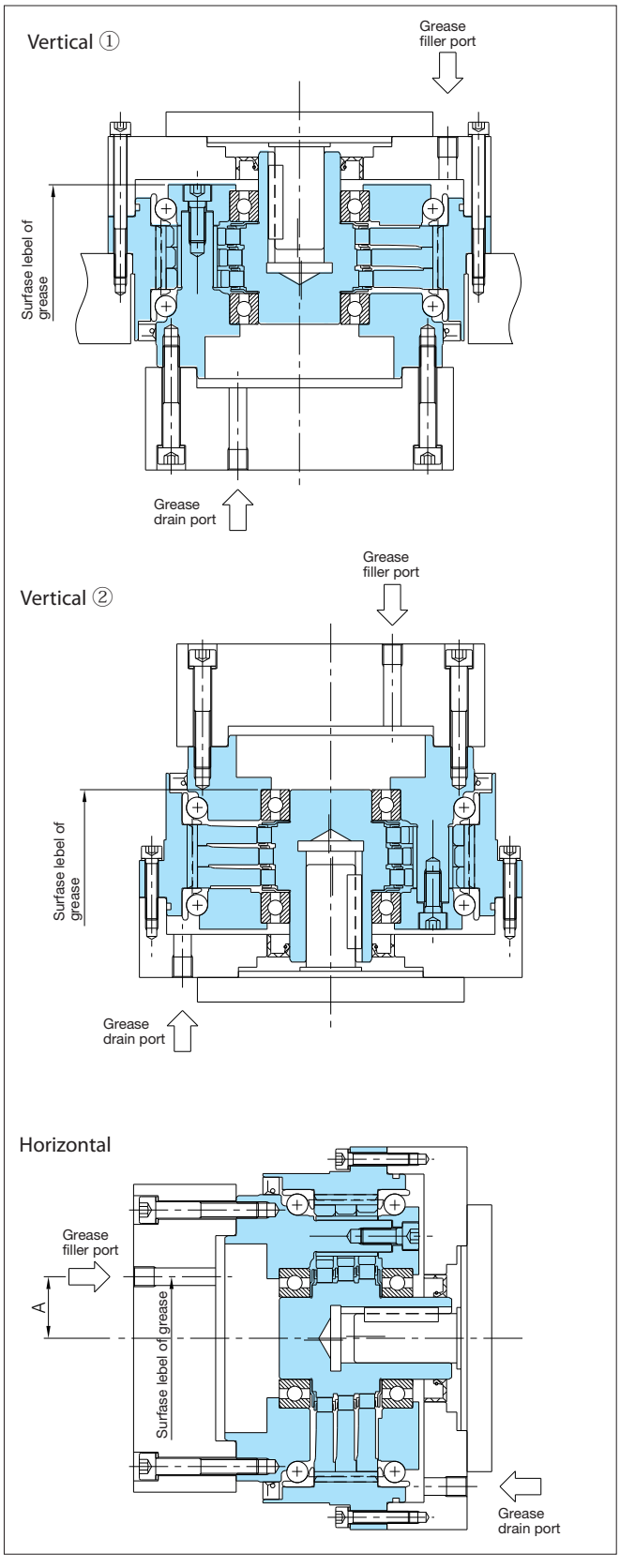
Name of recommended	Supplier
Multemp FZ No.00	Kyodo Yushi Co., Ltd.

Ambient Temperature: −10~40°C

Table D-21

Frame size	Grease(g)			Position of grease filler port A(mm)
	Vertical ①	Vertical ②	Horizontal	
D15	55	40	50	20
D25	100	45	95	26
D30	220	85	200	29
D35	190	150	160	34
D45	320	260	270	39

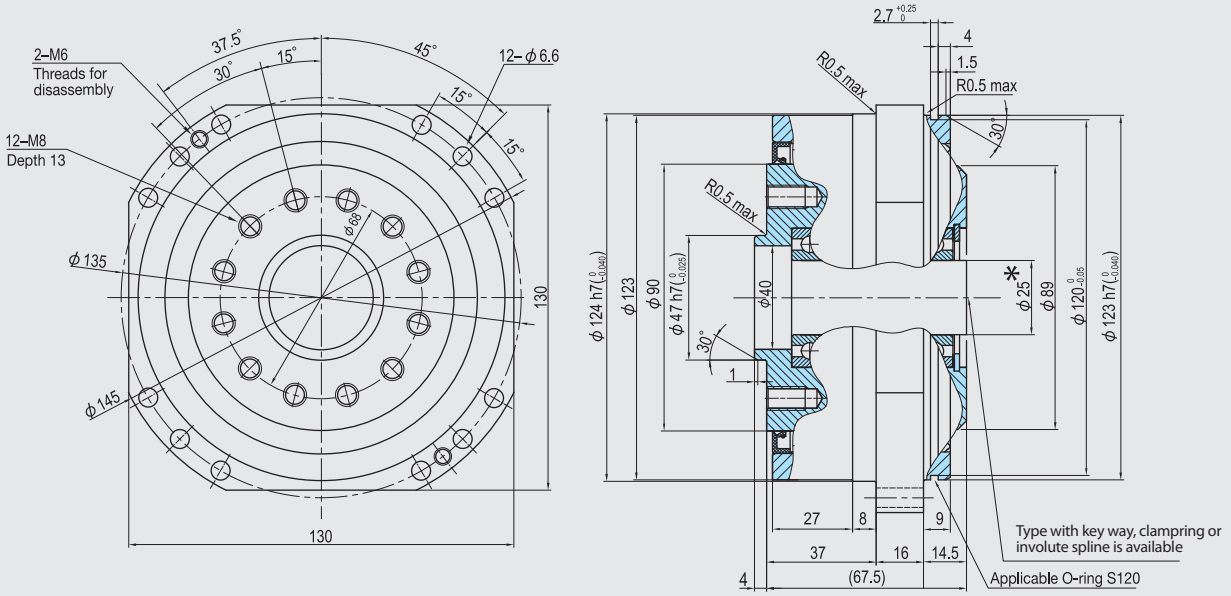
Fig. D-17



12. Outline Drawing

12-1. Outline Drawing without Input Section

F4CF-D15



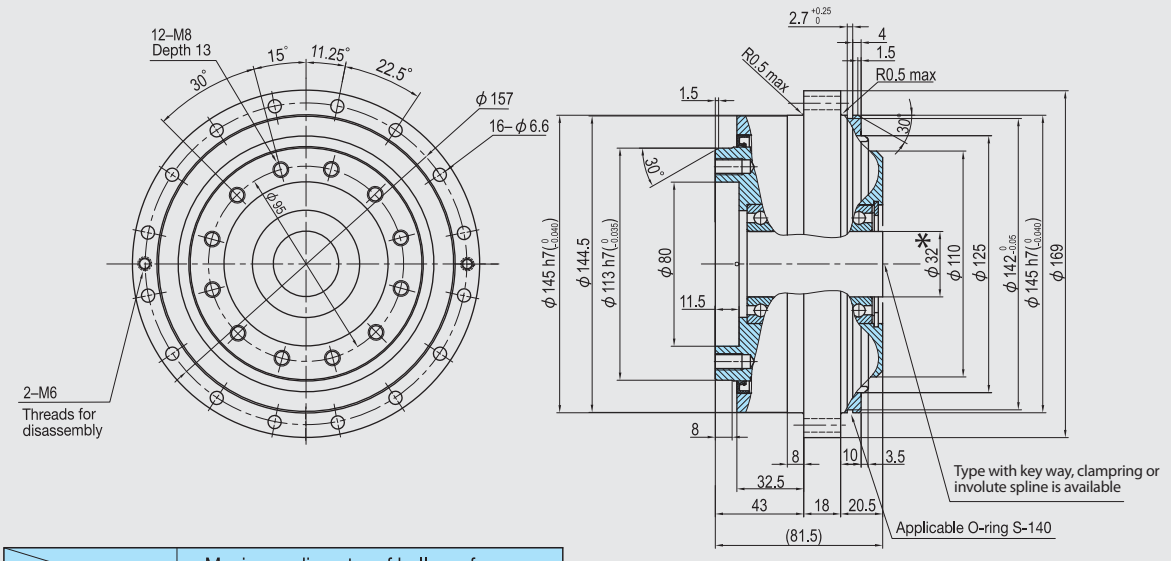
	Maximum diameter of hollow of high-speed shaft
Key method	Ø14 (Key 5x5)
Spline method	Ø17 (DIN 5480 involute spline)

Note: Consult us for the specification of high-speed shaft.

Mass 5.2kg

✻Inner diameter of bearing

F4CF-D25



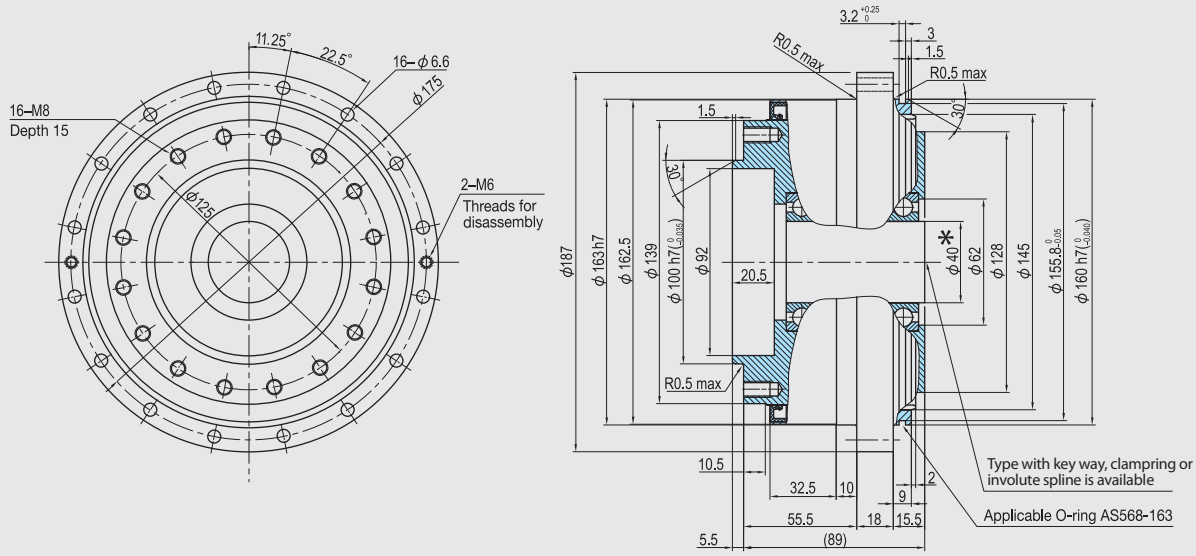
	Maximum diameter of hollow of high-speed shaft
Key method	Ø 20 (Key 6x6)
Spline method	Ø 24 (DIN 5480 involute spline)

Note: Consult us for the specification of high-speed shaft.

Mass 8.1kg

✻Inner diameter of bearing

F4CF-D30



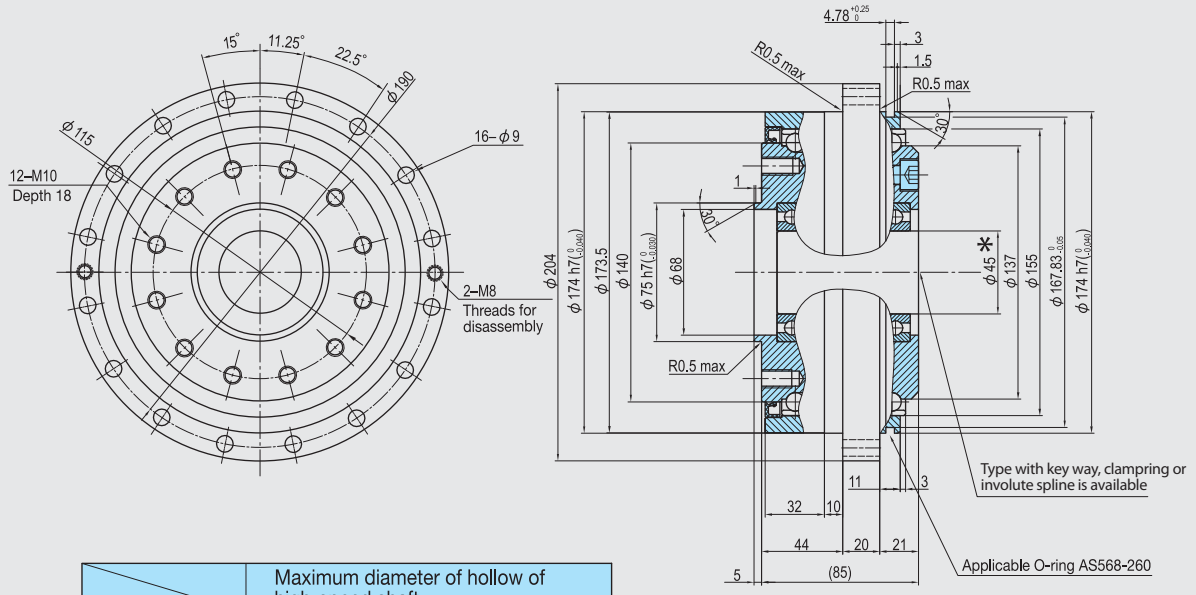
	Maximum diameter of hollow of high-speed shaft
Key method	Ø 27 (Key 8x7)
Spline method	Ø 30 (DIN 5480 involute spline)

Note: Consult us for the specification of high-speed shaft.

Mass 11kg

✻Inner diameter of bearing

F4CF-D35



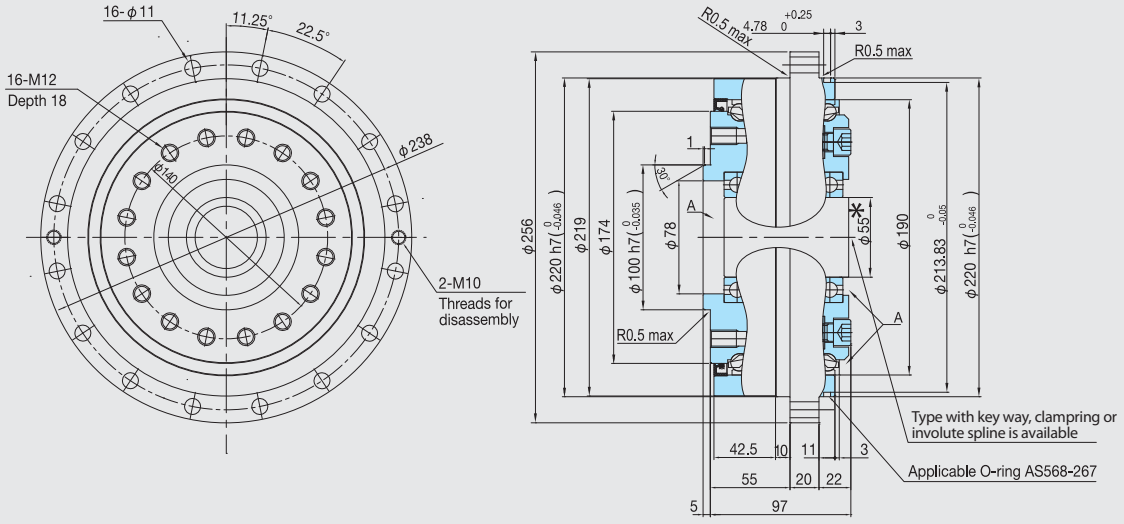
	Maximum diameter of hollow of high-speed shaft
Key method	Ø 32(Key 10x8)
Spline method	Ø 35(DIN 5480 involute spline)

Note: Consult us for the specification of high-speed shaft.

Mass 15kg

✻Inner diameter of bearing

F4CF-D45



	Maximum diameter of hollow of high-speed shaft
Key method	Ø 41(Key 12x8)
Spline method	Ø 45(DIN 5480 involute spline)

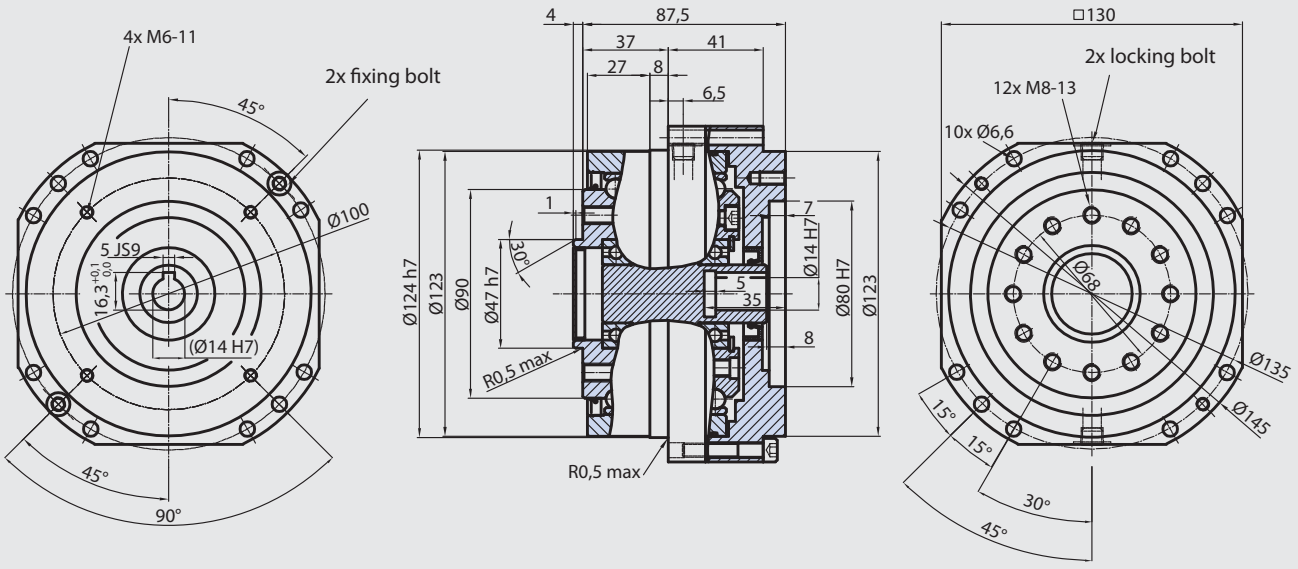
Note: Consult us for the specification of high-speed shaft.

Mass 24kg

*Inner diameter of bearing

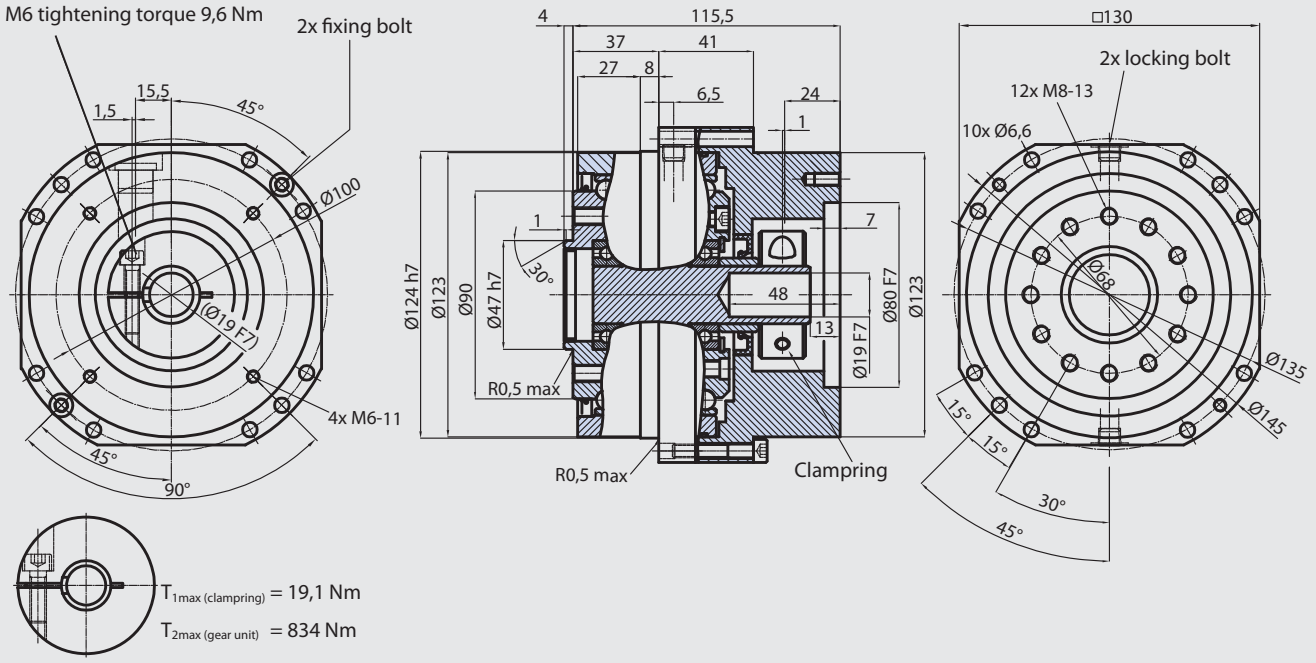
12-2. Outline Drawing with Integrated Motorflanges

F4CF-D15 (with keyway)



Mass 7,3 kg

F4CF-D15 (with clampring)



$T_{1max\ (clampring)}$ = 19,1 Nm

$T_{2max\ (gear\ unit)}$ = 834 Nm

Take care of the mounting position of the clampring!

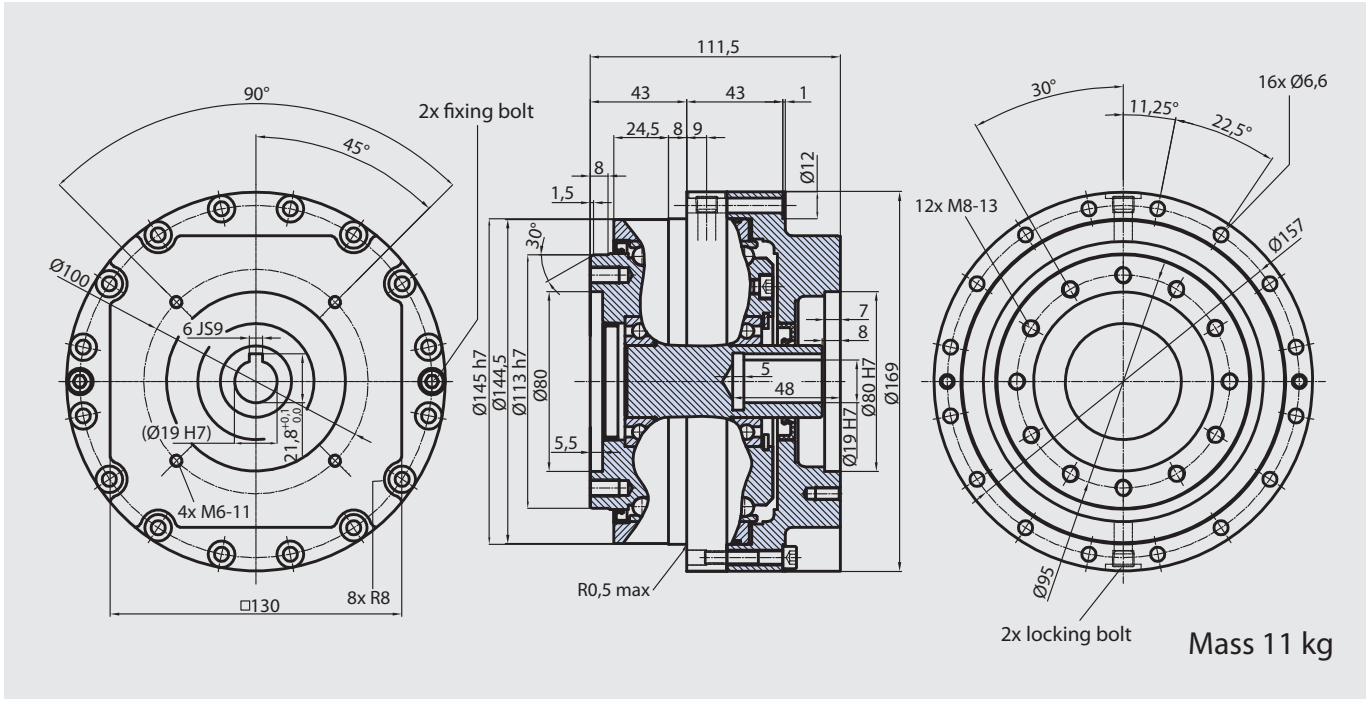
The input hollow shaft and the motor shaft must be free of grease.

Mass 8,8 kg

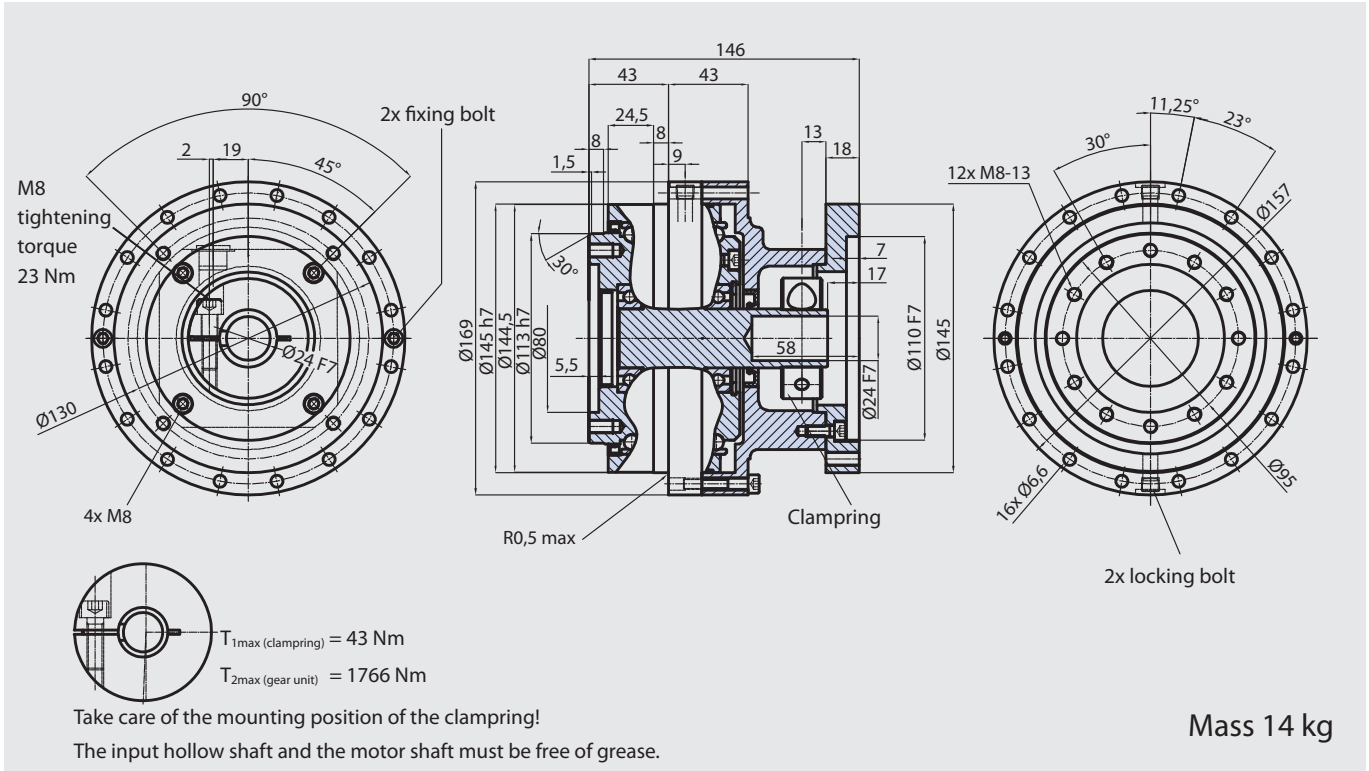
	Maximum diameter of hollow input shaft
Keyway design	Ø14 with keyway according to DIN 6885 page 1
Clampring design	Ø19 with clampring

Note: For other motor dimensions consult Sumitomo(SHI)Cyclo Drive Germany GmbH

F4CF-D25 (with keyway)



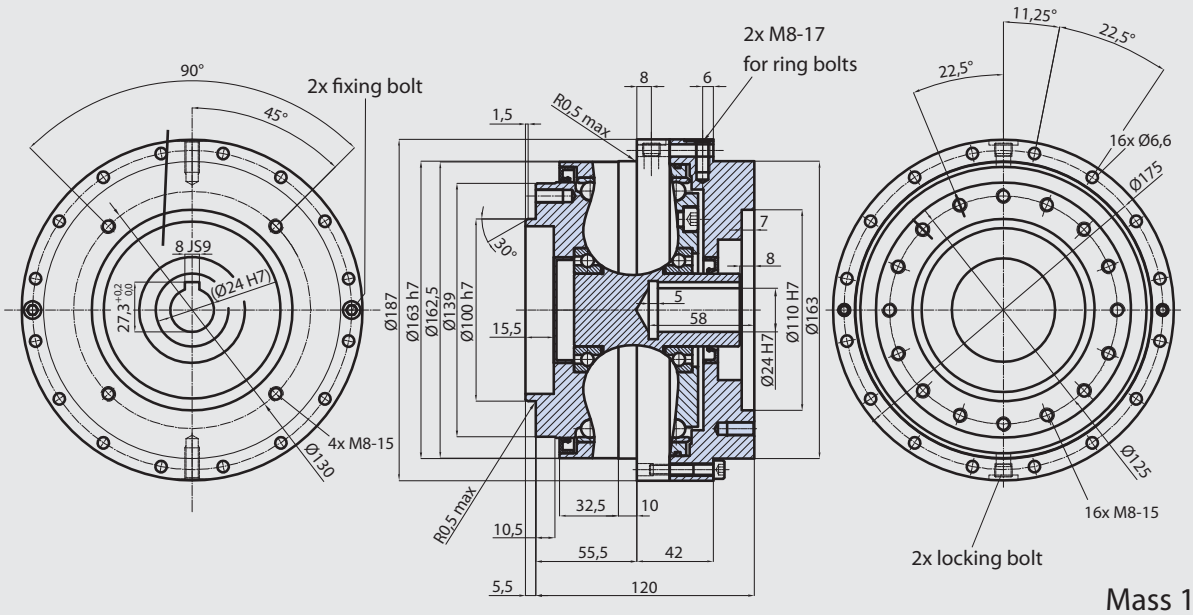
F4CF-D25 (with clampring)



	Maximum diameter of hollow input shaft
Keyway design	Ø19 with keyway according to DIN 6885 page 1
Clampring design	Ø24 with clampring

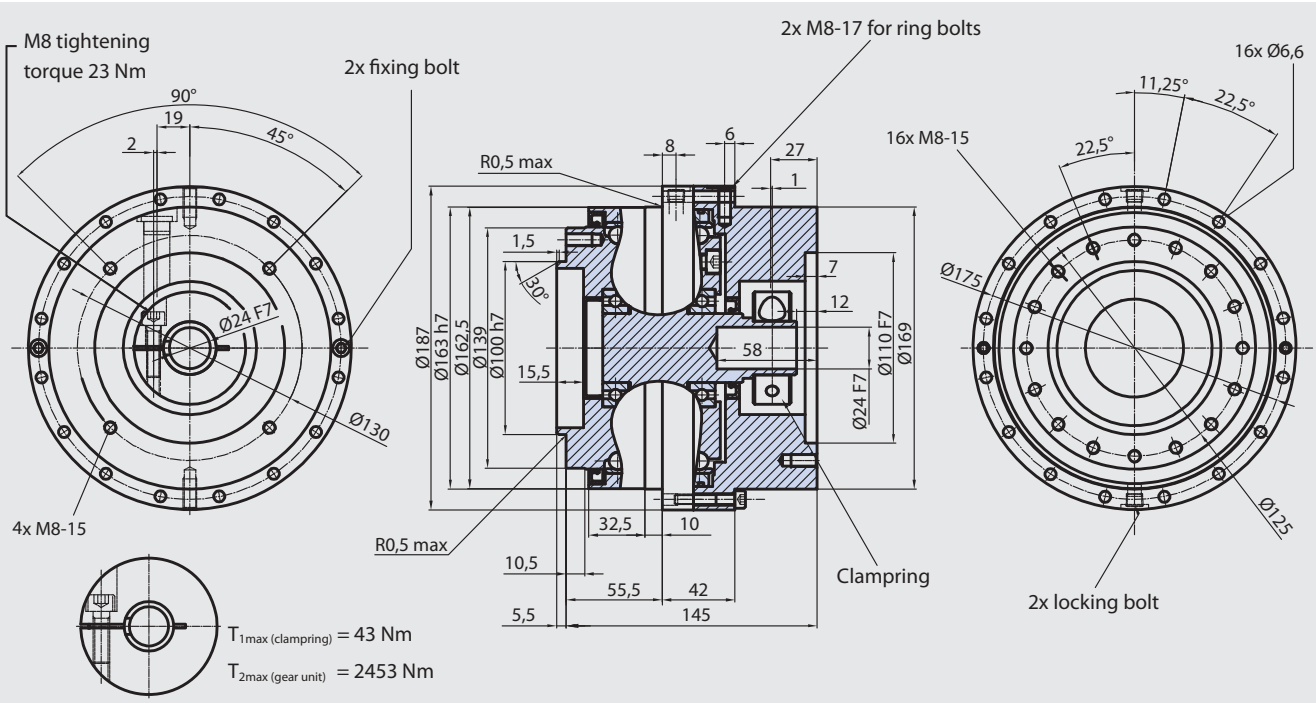
Note: For other motor dimensions consult Sumitomo(SHI)Cyclo Drive Germany GmbH

F4CF-D30 (with keyway)



Mass 15 kg

F4CF-D30 (with clampring)



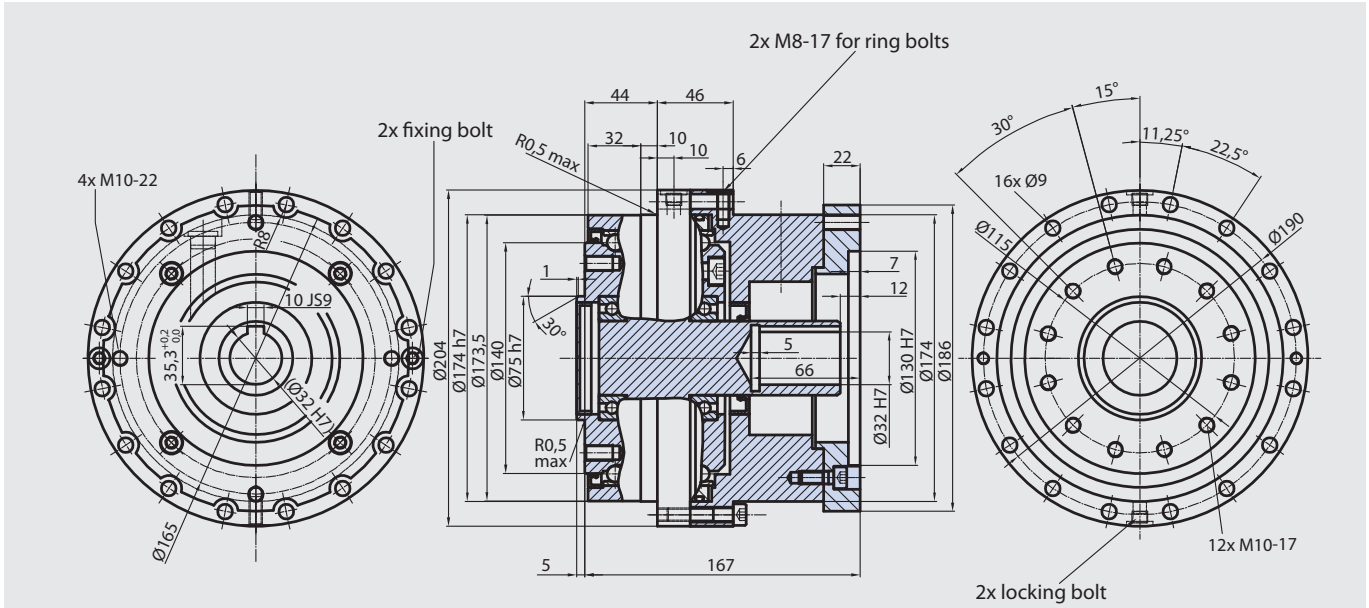
Take care of the mounting position of the clampring!
The input hollow shaft and the motor shaft must be free of grease.

Mass 18 kg

	Maximum diameter of hollow input shaft
Keyway design	Ø27 with keyway according to DIN 6885 page 1
Clampring design	Ø24 with clampring

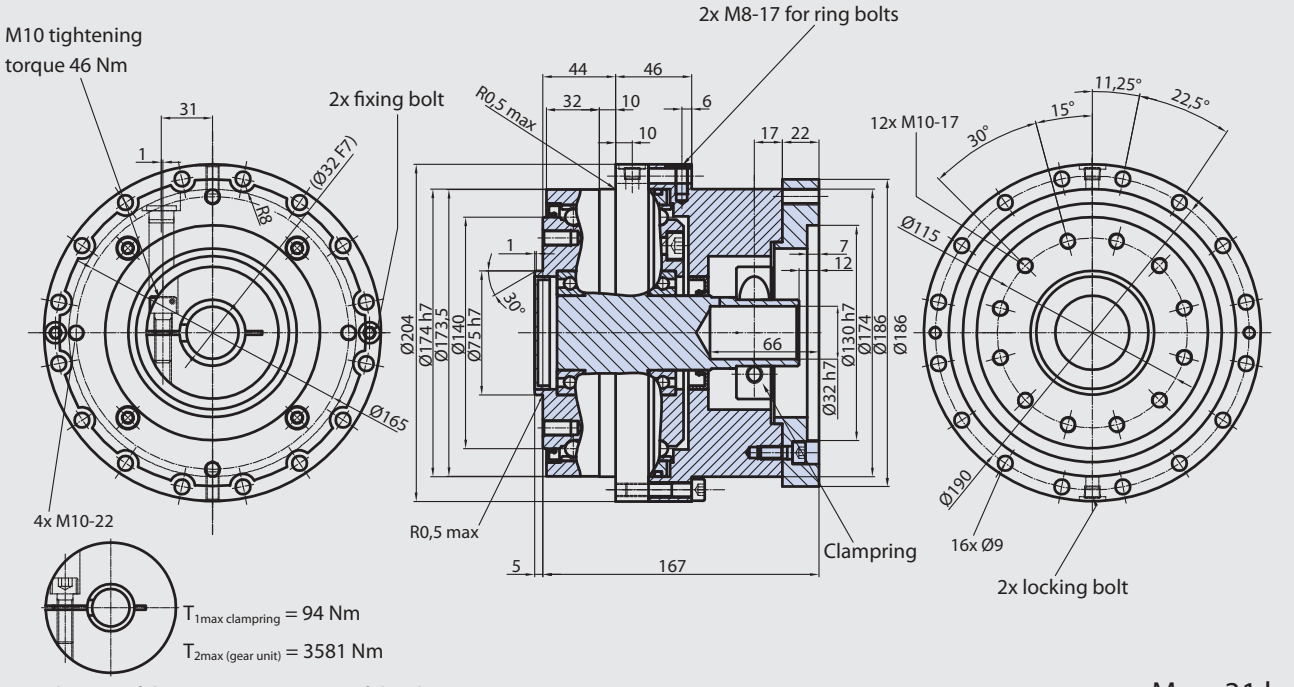
Note: For other motor dimensions consult Sumitomo(SHI)Cyclo Drive Germany GmbH

F4CF-D35 (with keyway)



Mass 31 kg

F4CF-D35 (with clampring)



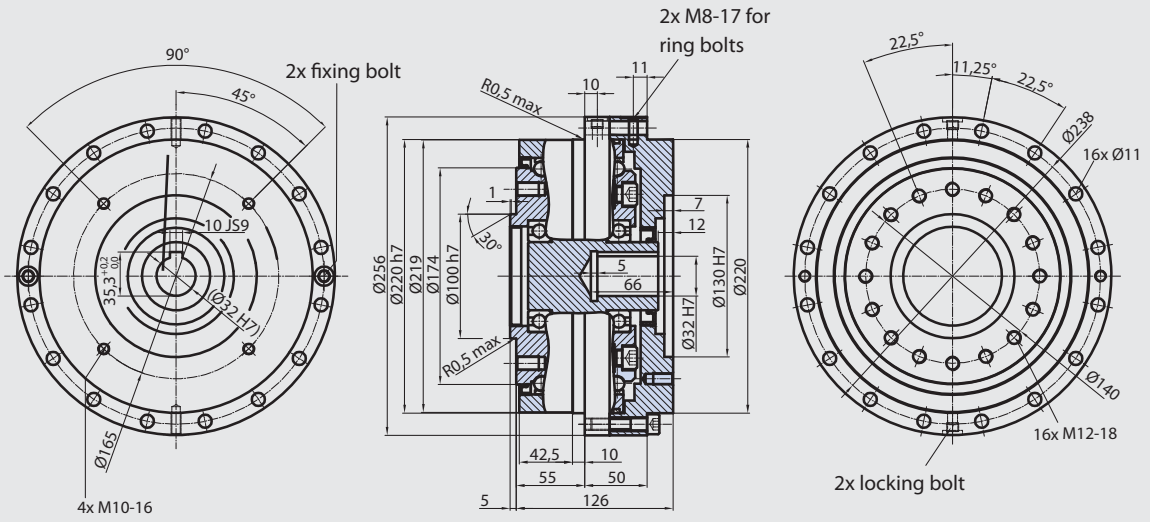
Take care of the mounting position of the clampring!
The input hollow shaft and the motor shaft must be free of grease.

Mass 31 kg

	Maximum diameter of hollow input shaft
Keyway design	Ø32 with keyway according to DIN 6885 page 1
Clampring design	Ø32 with clampring

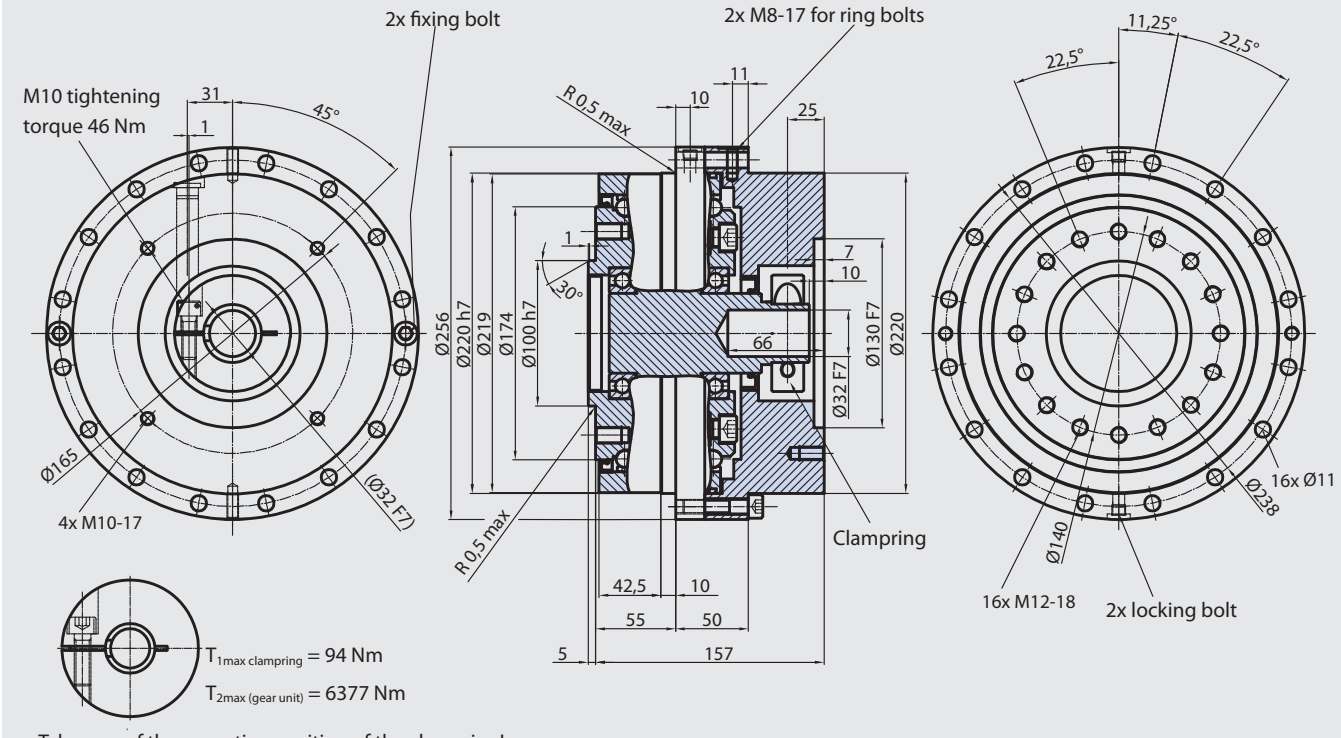
Note: For other motor dimensions consult Sumitomo(SHI)Cyclo Drive Germany GmbH

F4CF-D45 (with keyway)



Mass 30 kg

F4CF-D45 (with clampring)



Take care of the mounting position of the clampring!
The input hollow shaft and the motor shaft must be free of grease.

Mass 41 kg

	Maximum diameter of hollow input shaft
Keyway design	Ø41 with keyway according to DIN 6885 page 1
Clampring design	Ø38 with clampring

Note: For other motor dimensions consult Sumitomo(SHI)Cyclo Drive Germany GmbH

MEMO

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