Durability Check of Output Shaft Part

P1 Type of IB Series uses angular bearing to allow high maximum load moment.
Make sure that your load moment do not exceed the allowable value through the following calculation.

1. Check Maximum Load Moment

$$Mmax = \frac{Frmax \cdot (Lc + Lr) + Famax \cdot La}{10^3} \quad \cdots (1)$$

Make sure that: $Mmax \leqq Mc$

Table 4 Symbol in Formula (1)

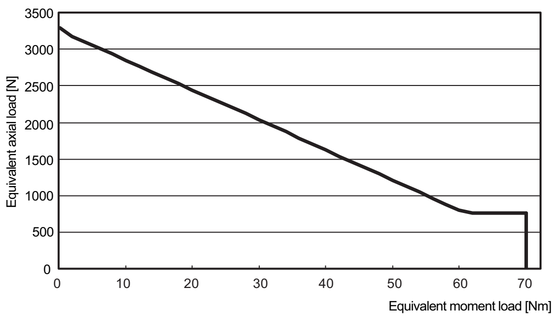
Frmax	Maximum radial load during the operation pattern	N [kgf]	Refer to Fig. 6.
Famax	Maximum axial load during the operation pattern	N [kgf]	
Lr, Lc, La	Load application location	mm	

Table 5 Allowable Moment for P1 Type

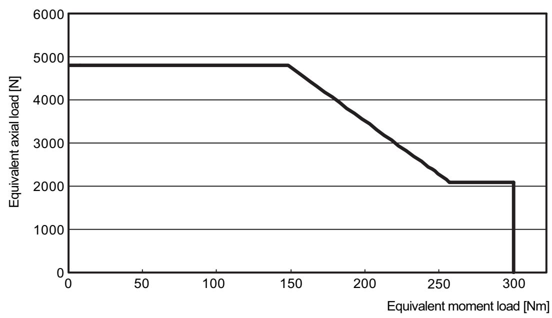
Frame size	Allowable moment Mc	
	Nm	kgfm
P110	70	7.13
P120	300	30.6
P130	620	63.2

Table 6 Dimensions

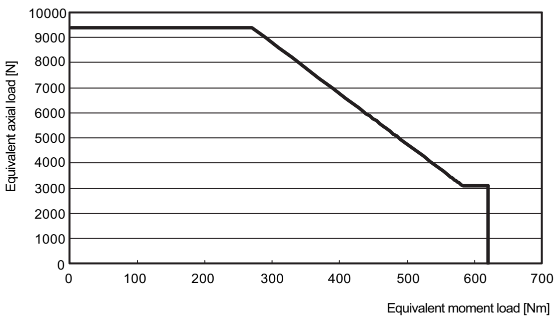
Frame size	Dimension [mm]				
	LB	LC	S	L	Z
P110	52.76	42.38	2	28	19.62
P120	82.56	64.53	2	42	25.97
P130	109.02	86.26	4	82	63.24



P110 Allowable Load Diagram for Moment and Axial Load



P120 Allowable Load Diagram for Moment and Axial Load



P130 Allowable Load Diagram for Moment and Axial Load

- Consult us when the radial load is exerted on the location exceeding the range of "L + S."
- Consult us when the value exceeds the range of allowable load. Units may sometimes be used without problem for some cases, depending on the direction of axial load and the leverage point of the load.

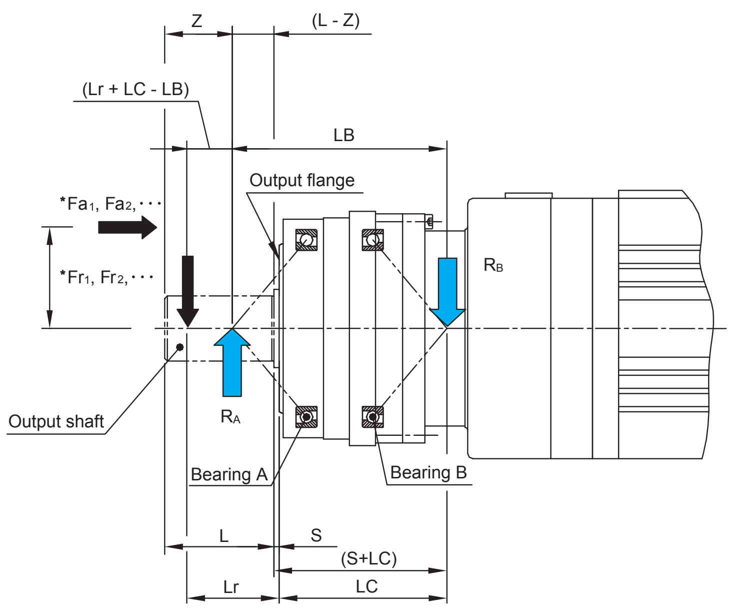


Fig. 5 External Load Effect diagram

*: *Refer to Fig. 6.
Fig. 6 shows the load of each period in the specific operation pattern.

2. Check Equivalent Load Bearing Lifetime

Check lifetime by converting to equivalent load when radial or axial load varies.

Equivalent radial load: Fre

$$Fre = \sqrt[3]{\frac{n_1 \cdot t_1 \cdot (|Fr_1|)^3 + n_2 \cdot t_2 \cdot (|Fr_2|)^3 + \cdots n_n \cdot t_n \cdot (|Fr_n|)^3}{n_1 \cdot t_1 + n_2 \cdot t_2 + \cdots + n_n \cdot t_n}} \cdots (2)$$

Equivalent axial load: Fae

$$Fae = \sqrt[3]{\frac{n_1 \cdot t_1 \cdot (|Fa_1|)^3 + n_2 \cdot t_2 \cdot (|Fa_2|)^3 + \cdots n_n \cdot t_n \cdot (|Fa_n|)^3}{n_1 \cdot t_1 + n_2 \cdot t_2 + \cdots + n_n \cdot t_n}} \cdots (3)$$

Equivalent autput speed: Neo

$$Neo = \frac{n_1 \cdot t_1 + n_2 \cdot t_2 + \cdots + n_n \cdot t_n}{t_1 + t_2 + \cdots t_n} \cdots (4)$$

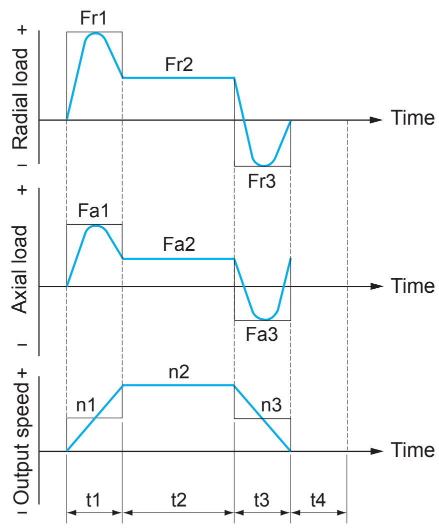


Fig. 6 Example of Load Fluctuation

Table 7 Axial Load Direction and Dynamic Equivalent Load Formula

Axial Load Direction	Load Condition	Bearing Category	Axial Load	Dynamic Equivalent Load
→ (Applied to motor side)	$\frac{R_B}{2Y_2} + Fae \geqq \frac{R_A}{2Y_2}$	Bearing A	$F_{aA} = \frac{R_B}{2Y_2} + Fae$	$P_A = X \cdot R_A + Y \cdot F_{aA}$ Note: When $P_A < R_A$, use $P_A = R_A$.
		Bearing B	–	$P_B = R_B$
	$\frac{R_B}{2Y_2} + Fae < \frac{R_A}{2Y_2}$	Bearing A	–	$P_A = R_A$
		Bearing B	$F_{aB} = \frac{R_A}{2Y_2} - Fae$	$P_B = X \cdot R_B + Y \cdot F_{aB}$ Note: When $P_B < R_B$, use $P_B = R_B$.
← (Applied to output side)	$\frac{R_B}{2Y_2} \leqq \frac{R_A}{2Y_2} + Fae$	Bearing A	–	$P_A = R_A$
		Bearing B	$F_{aB} = \frac{R_A}{2Y_2} + Fae$	$P_B = X \cdot R_B + Y \cdot F_{aB}$ Note: When $P_B < R_A$, use $P_B = R_A$.
	$\frac{R_B}{2Y_2} > \frac{R_A}{2Y_2} + Fae$	Bearing A	$F_{aA} = \frac{R_B}{2Y_2} - Fae$	$P_A = X \cdot R_A + Y \cdot F_{aA}$ Note: When $P_A < R_A$, use $P_A = R_A$.
		Bearing B	–	$P_B = R_B$

Durability Check of Output Shaft Part

Table 8 Main Bearing Specification

Frame size	Dynamic rated load C	Load Factor				e
		X		Y		
	N (kgf)	$F_{aA}/R_A \geqq e$ $F_{aB}/R_B \geqq e$	$F_{aA}/R_A > e$ $F_{aB}/R_B > e$	$F_{aA}/R_A \geqq e$ $F_{aB}/R_B \geqq e$	$F_{aA}/R_A > e$ $F_{aB}/R_B > e$	
P110	3050 (310)	1	0.35	0	0.57	1.14
P120	8950 (910)					
P130	13600 (1390)					

Table 9 Symbols in Table 7 & 8

P	Dynamic equivalent load (Either the larger one of dynamic equivalent load P_A or P_B, each influencing bearing A and B)	N (kgf)	Refer to Table 7 in page 81.
R_A, R_B	Support reaction applied to each bearing A and B calculated from equivalent external load Fre and Fae	N (kgf)	–
X	Radial load factor	–	Refer to Table 8 below.
Y	Axial load factor		
Y_2	Axial load factor $Y_2 = 0.57$ when Fa* / R* > e		
Fa_A, Fa_B	Axial load exerted on each of bearing A and B	N (kgf)	–

Lifetime L_{10h}

$$L_{10h} = \frac{10^6}{60 \cdot Neo} \left(\frac{C}{Cf \cdot Fs \cdot P} \right)^3 \quad \cdots (5)$$

Table 10 Coupling Factor Cf

Coupling Method	Cf
Chain	1.00
Gears	1.25
V-Belt	1.50

Table 11 Shock Factor Fs

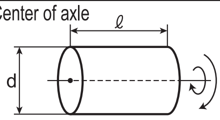
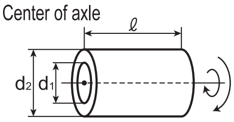
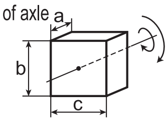
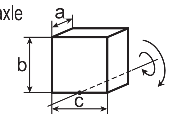
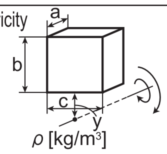
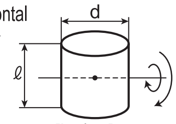
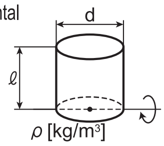
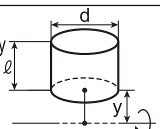
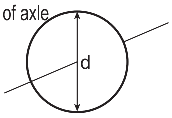
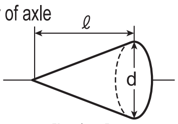
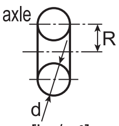
Degree of shock	Fs
Practically no shock	1.0
Light shock	1.0-1.2
Severe shock	1.4-1.6

Table 12 Symbols in Formula (5)

Neo	Equivalent output speed	r/min	Refer to formula (4).
P	Dynamic equivalent load	N (kgf)	Refer to Table 4.
C	Dynamic rated load	N (kgf)	Refer to Table 5.
Cf	Connected load	–	Refer to Table 7.
Fs	Shock factor	–	Refer to Table 8.

Formula for Calculation of Moment of Inertia and GD^2

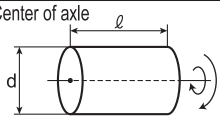
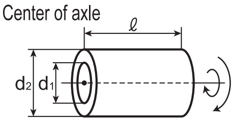
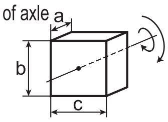
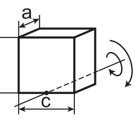
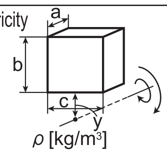
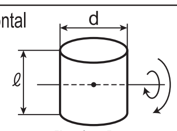
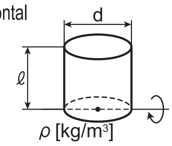
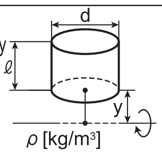
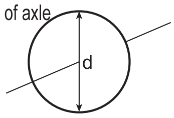
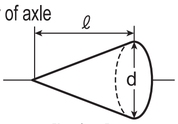
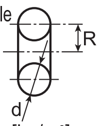
●Formula to Calculate Moment of Inertia and GD^2

Location of rotation	Shape	Mass M [kg]	Moment of Inertia J [kgm^2]	GD^2 GD^2 [kgf·m^2]
Center of axle  ρ [kg/m^3]	Cylinder	$\frac{1}{4}\cdot\pi\cdot d^2\cdot\ell\cdot\rho$	$\frac{1}{32}\cdot\pi\cdot d^4\cdot\ell\cdot\rho$	$\frac{1}{8}\cdot\pi\cdot d^4\cdot\ell\cdot\rho$
Center of axle  ρ [kg/m^3]	Cylinder hollow	$\frac{1}{4}\cdot\pi\cdot(d_1^2-d_2^2)\cdot\ell\cdot\rho$	$\frac{1}{32}\cdot\pi\cdot(d_1^4-d_2^4)\cdot\ell\cdot\rho$	$\frac{1}{8}\cdot\pi\cdot(d_1^4-d_2^4)\cdot\ell\cdot\rho$
Center of axle  ρ [kg/m^3]	Rectangular solid	$a\cdot b\cdot c\cdot\rho$	$\frac{a\cdot b\cdot c}{12}\cdot(b^2+c^2)\cdot\rho$	$\frac{a\cdot b\cdot c}{3}\cdot(b^2+c^2)\cdot\rho$
Edge axle  ρ [kg/m^3]	Rectangular solid	$a\cdot b\cdot c\cdot\rho$	$\frac{a\cdot b\cdot c}{12}\cdot(4b^2+c^2)\cdot\rho$	$\frac{a\cdot b\cdot c}{3}\cdot(4b^2+c^2)\cdot\rho$
Eccentricity  ρ [kg/m^3]	Rectangular solid	$a\cdot b\cdot c\cdot\rho$	$\frac{a\cdot b\cdot c}{12}\cdot(4b^2+c^2+$ $12b\cdot y+12y^2)\cdot\rho$	$\frac{a\cdot b\cdot c}{3}\cdot(4b^2+c^2+$ $12b\cdot y+12y^2)\cdot\rho$
Horizontal center axis  ρ [kg/m^3]	Cylinder	$\frac{1}{4}\cdot\pi\cdot d^2\cdot\ell\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{192}\cdot(4\ell+3d^2)\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{48}\cdot(4\ell+3d^2)\cdot\rho$
Horizontal edge axis  ρ [kg/m^3]	Cylinder	$\frac{1}{4}\cdot\pi\cdot d^2\cdot\ell\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{192}\cdot(16\ell+3d^2)\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{48}\cdot(16\ell+3d^2)\cdot\rho$
Horizontal Eccentricity  ρ [kg/m^3]	Cylinder	$\frac{1}{4}\cdot\pi\cdot d^2\cdot\ell\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{192}\cdot(16\ell^2+3d^2+$ $48y\cdot\ell+48y^2)\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{48}\cdot(16\ell^2+3d^2+$ $48y\cdot\ell+48y^2)\cdot\rho$
Center of axle  ρ [kg/m^3]	Sphere	$\frac{1}{6}\cdot\pi\cdot d^2\cdot\rho$	$\frac{1}{60}\cdot\pi\cdot d^5\cdot\rho$	$\frac{1}{15}\cdot\pi\cdot d^5\cdot\rho$
Center of axle  ρ [kg/m^3]	Cone	$\frac{1}{12}\cdot\pi\cdot d^2\cdot\ell\cdot\rho$	$\frac{1}{160}\cdot\pi\cdot d^4\cdot\ell\cdot\rho$	$\frac{1}{40}\cdot\pi\cdot d^4\cdot\ell\cdot\rho$
Center of axle  ρ [kg/m^3]	Torus	$\frac{1}{2}\cdot\pi^2\cdot R\cdot d^2\cdot\rho$	$\frac{\pi^2\cdot R\cdot d^2}{8}\cdot(4R^2+\frac{3d^2}{4})\cdot\rho$	$\frac{\pi^2\cdot R\cdot d^2}{2}\cdot(4R^2+\frac{3d^2}{4})\cdot\rho$

Dimension: d, ℓ, a, b, c, y, R [m]
Density: ρ [kg/m^3]

Formula for Calculation of Moment of Inertia, Load Torque, and Acceleration Torque

●Formula to Calculate Moment of Inertia and GD^2

Location of rotation	Shape	Mass M [kg]	Moment of Inertia J [kgm²]	GD² GD² [kgf•m²]
Center of axle  ρ [kg/m³]	Cylinder	$\frac{1}{4}\cdot\pi\cdot d^2\cdot\ell\cdot\rho$	$\frac{1}{32}\cdot\pi\cdot d^4\cdot\ell\cdot\rho$	$\frac{1}{8}\cdot\pi\cdot d^4\cdot\ell\cdot\rho$
Center of axle  ρ [kg/m³]	Cylinder hollow	$\frac{1}{4}\cdot\pi\cdot(d_1^2-d_2^2)\cdot\ell\cdot\rho$	$\frac{1}{32}\cdot\pi\cdot(d_1^4-d_2^4)\cdot\ell\cdot\rho$	$\frac{1}{8}\cdot\pi\cdot(d_1^4-d_2^4)\cdot\ell\cdot\rho$
Center of axle  ρ [kg/m³]	Rectangular solid	$a\cdot b\cdot c\cdot\rho$	$\frac{a\cdot b\cdot c}{12}\cdot(b^2+c^2)\cdot\rho$	$\frac{a\cdot b\cdot c}{3}\cdot(b^2+c^2)\cdot\rho$
Edge axle  ρ [kg/m³]	Rectangular solid	$a\cdot b\cdot c\cdot\rho$	$\frac{a\cdot b\cdot c}{12}\cdot(4b^2+c^2)\cdot\rho$	$\frac{a\cdot b\cdot c}{3}\cdot(4b^2+c^2)\cdot\rho$
Eccentricity  ρ [kg/m³]	Rectangular solid	$a\cdot b\cdot c\cdot\rho$	$\frac{a\cdot b\cdot c}{12}\cdot(4b^2+c^2+12b\cdot y+12y^2)\cdot\rho$	$\frac{a\cdot b\cdot c}{3}\cdot(4b^2+c^2+12b\cdot y+12y^2)\cdot\rho$
Horizontal center axis  ρ [kg/m³]	Cylinder	$\frac{1}{4}\cdot\pi\cdot d^2\cdot\ell\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{192}\cdot(4\ell+3d^2)\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{48}\cdot(4\ell+3d^2)\cdot\rho$
Horizontal edge axis  ρ [kg/m³]	Cylinder	$\frac{1}{4}\cdot\pi\cdot d^2\cdot\ell\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{192}\cdot(16\ell+3d^2)\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{48}\cdot(16\ell+3d^2)\cdot\rho$
Horizontal Eccentricity  ρ [kg/m³]	Cylinder	$\frac{1}{4}\cdot\pi\cdot d^2\cdot\ell\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{192}\cdot(16\ell^2+3d^2+48y\cdot\ell+48y^2)\cdot\rho$	$\frac{\pi\cdot d^2\cdot\ell}{48}\cdot(16\ell^2+3d^2+48y\cdot\ell+48y^2)\cdot\rho$
Center of axle  ρ [kg/m³]	Sphere	$\frac{1}{6}\cdot\pi\cdot d^2\cdot\rho$	$\frac{1}{60}\cdot\pi\cdot d^5\cdot\rho$	$\frac{1}{15}\cdot\pi\cdot d^5\cdot\rho$
Center of axle  ρ [kg/m³]	Cone	$\frac{1}{12}\cdot\pi\cdot d^2\cdot\ell\cdot\rho$	$\frac{1}{160}\cdot\pi\cdot d^4\cdot\ell\cdot\rho$	$\frac{1}{40}\cdot\pi\cdot d^4\cdot\ell\cdot\rho$
Center of axle  ρ [kg/m³]	Torus	$\frac{1}{2}\cdot\pi^2\cdot R\cdot d^2\cdot\rho$	$\frac{\pi^2\cdot R\cdot d^2}{8}\cdot(4R^2+\frac{3d^2}{4})\cdot\rho$	$\frac{\pi^2\cdot R\cdot d^2}{2}\cdot(4R^2+\frac{3d^2}{4})\cdot\rho$

Dimension: d, ℓ, a, b, c, y, R [m]
Density: ρ [kg/m³]

Moment of Inertia (at Motor Shaft)

Table 13

Unit: $\times 10^{-4} kg \cdot m^2$

Frame size	Input shaft hollow [mm]	Motor flange code	Reduction ratio 3.7		5		9		11		15	
			Solid shaft	Flange shaft	Solid shaft	Flange shaft	Solid shaft	Flange shaft	Solid shaft	Flange shaft	Solid shaft	Flange shaft
P110	6	7J	0.142	0.141	0.116	0.116	0.098	0.097	0.140	0.140	0.137	0.137
	8	2C, 2D, 2E, 2F, 2G	0.142	0.140	0.116	0.115	0.098	0.097	0.140	0.140	0.137	0.137
	9	2H	0.212	0.211	0.183	0.186	0.168	0.168	0.211	0.211	0.208	0.208
	10	2J	0.211	0.210	0.186	0.185	0.167	0.167				
	11	2K, 2L, 8A	0.210	0.208	0.184	0.184	0.166	0.165	0.209	0.209	0.206	0.206
	14	2P, 2R, 8B, 2T, 2V	0.202	0.201	0.177	0.176	0.158	0.158	0.202	0.202	0.199	0.199
	16	7P, 8E, 7A, 7R	0.422	0.421	0.394	0.396	0.378	0.378				
P120	8	2C, 2D, 2E, 2F, 2G										
	9	2H										
	10	2J					0.506	0.485	0.513	0.512	0.491	0.490
	11	2K, 2L, 8A										
	14	2P, 2R, 8B, 2T, 2V, 0V	0.849	0.831	0.653	0.640	0.504	0.483	0.505	0.503	0.483	0.482
	16	7A, 7P, 8E, 7R, 0U	0.985	0.975	0.789	0.783	0.647	0.645	0.618	0.617	0.596	0.595
	19	7S, 1G, 7X, 7B, 7V	0.962	0.951	0.766	0.760	0.624	0.622	0.599	0.597	0.577	0.576
	22	1S, 0Y, 0W	1.679	1.668	1.483	1.477	1.341	1.339	1.338	1.337	1.316	1.315
	24	7Y, 7Z, 1L	1.657	1.646	1.460	1.455	1.318	1.317	1.315	1.314	1.293	1.293
P130	9	2H										
	10	2J										
	11	2K, 2L, 8A										
	14	2P, 2R, 8B, 2T, 2V, 0V										
	16	7A, 7P, 8E, 7R, 0U										
	19	7S, 1G, 7X, 7B, 7V					1.820	1.797	1.920	1.905	1.822	1.814
	22	1S, 0Y, 0W	3.750	3.611	2.866	2.792	2.211	2.188	2.285	2.269	2.186	2.178
	24	1L, 7Y, 7Z	3.707	3.568	2.823	2.749	2.168	2.145	2.250	2.234	2.152	2.143
	28	1T, 1W, 1X, 0E, 0K	3.827	3.688	2.943	2.869	2.288	2.265				
	35	1Z, 0M, 0X	6.901	6.763	6.018	5.943	5.363	5.159				

Frame size	Input shaft hollow [mm]	Motor flange code	Reduction ratio 21		33		45		81	
			Solid shaft	Flange shaft	Solid shaft	Flange shaft	Solid shaft	Flange shaft	Solid shaft	Flange shaft
P110	6	7J	0.107	0.107	0.092	0.092	0.092	0.092	0.092	0.092
	8	2C, 2D, 2E, 2F, 2G	0.107	0.107	0.092	0.092	0.092	0.092	0.092	0.092
	9	2H	0.178	0.178	0.160	0.160	0.160	0.160		
	10	2J								
	11	2K, 2L, 8A	0.176	0.176	0.157	0.157				
	14	2P, 2R, 8B, 2T, 2V	0.169	0.169						
	16	7P, 8E, 7A, 7R								
P120	8	2C, 2D, 2E, 2F, 2G							0.352	0.352
	9	2H	0.440	0.440			0.410	0.410	0.408	0.408
	10	2J	0.441	0.440						
	11	2K, 2L, 8A					0.407	0.407	0.406	0.406
	14	2P, 2R, 8B, 2T, 2V, 0V	0.432	0.432	0.403	0.403	0.401	0.401		
	16	7A, 7P, 8E, 7R, 0U	0.546	0.546						
	19	7S, 1G, 7X, 7B, 7V	0.527	0.526						
	22	1S, 0Y, 0W								
	24	7Y, 7Z, 1L	1.243	1.243						
P130	9	2H							1.265	1.265
	10	2J			1.284	1.282	1.273	1.272		
	11	2K, 2L, 8A							1.265	1.264
	14	2P, 2R, 8B, 2T, 2V, 0V			1.282	1.280	1.271	1.270	1.263	1.262
	16	7A, 7P, 8E, 7R, 0U	1.555	1.551	1.404	1.402	1.393	1.392		
	19	7S, 1G, 7X, 7B, 7V	1.533	1.529	1.381	1.380	1.370	1.370		
	22	1S, 0Y, 0W	1.897	1.893						
	24	1L, 7Y, 7Z	1.862	1.858	1.711	1.709	1.700	1.699		
	28	1T, 1W, 1X, 0E, 0K								
	35	1Z, 0M, 0X								

GD^2 (at Motor Shaft)

Table 14

Unit: $\times 10^{-4} kg \cdot m^2$

Frame size	Input shaft hollow [mm]	Motor flange code	Reduction ratio 3.7 Solid shaft	3.7 Flange shaft	5 Solid shaft	5 Flange shaft	9 Solid shaft	9 Flange shaft	11 Solid shaft	11 Flange shaft	15 Solid shaft	15 Flange shaft
P110	6	7J	0.568	0.562	0.464	0.464	0.392	0.388	0.560	0.560	0.548	0.548
	8	2C, 2D, 2E, 2F, 2G	0.567	0.561	0.464	0.460	0.392	0.388	0.560	0.559	0.548	0.548
	9	2H	0.850	0.844	0.732	0.744	0.672	0.672	0.844	0.844	0.832	0.832
	10	2J	0.845	0.840	0.744	0.740	0.668	0.668				
	11	2K, 2L, 8A	0.839	0.834	0.736	0.736	0.664	0.660	0.835	0.834	0.824	0.824
	14	2P, 2R, 8B, 2T, 2V	0.809	0.803	0.708	0.704	0.632	0.632	0.807	0.807	0.796	0.796
	16	7P, 8E, 7A, 7R	1.689	1.684	1.576	1.584	1.512	1.512				
P120	8	2C, 2D, 2E, 2F, 2G										
	9	2H										
	10	2J					2.024	1.940	2.051	2.046	1.964	1.960
	11	2K, 2L, 8A										
	14	2P, 2R, 8B, 2T, 2V, 0V	3.397	3.325	2.612	2.560	2.016	1.932	2.018	2.013	1.932	1.928
	16	7A, 7P, 8E, 7R, 0U	3.942	3.899	3.156	3.132	2.588	2.580	2.472	2.467	2.384	2.380
	19	7S, 1G, 7X, 7B, 7V	3.848	3.805	3.064	3.040	2.496	2.488	2.395	2.390	2.308	2.304
	22	1S, 0Y, 0W	6.717	6.674	5.932	5.908	5.364	5.356	5.351	5.346	5.264	5.260
	24	7Y, 7Z, 1L	6.627	6.584	5.840	5.820	5.272	5.268	5.261	5.256	5.172	5.172
P130	9	2H										
	10	2J										
	11	2K, 2L, 8A,										
	14	2P, 2R, 8B, 2T, 2V, 0V										
	16	7A, 7P, 8E, 7R, 0U										
	19	7S, 1G, 7X, 7B, 7V					7.280	7.188	7.681	7.619	7.288	7.256
	22	1S, 0Y, 0W	14.999	14.445	11.464	11.168	8.844	8.752	9.138	9.077	8.744	8.712
	24	1L, 7Y, 7Z	14.827	14.273	11.292	10.996	8.672	8.580	8.999	8.937	8.608	8.572
	28	1T, 1W, 1X, 0E, 0K	15.306	14.752	11.772	11.476	9.152	9.060				
	35	1Z, 0M, 0X	27.605	27.051	24.072	23.772	21.452	20.636				

Frame size	Input shaft hollow [mm]	Motor flange code	Reduction ratio 21 Solid shaft	21 Flange shaft	33 Solid shaft	33 Flange shaft	45 Solid shaft	45 Flange shaft	81 Solid shaft	81 Flange shaft
P110	6	7J	0.428	0.428	0.368	0.368	0.368	0.368	0.368	0.368
	8	2C, 2D, 2E, 2F, 2G	0.428	0.428	0.368	0.368	0.368	0.368	0.368	0.368
	9	2H	0.712	0.712	0.640	0.640	0.640	0.640		
	10	2J								
	11	2K, 2L, 8A	0.704	0.704	0.628	0.628				
	14	2P, 2R, 8B, 2T, 2V	0.676	0.676						
	16	7P, 8E, 7A, 7R								
P120	8	2C, 2D, 2E, 2F, 2G							1.408	1.408
	9	2H	1.760	1.760			1.640	1.640	1.632	1.632
	10	2J	1.764	1.760						
	11	2K, 2L, 8A					1.628	1.628	1.624	1.624
	14	2P, 2R, 8B, 2T, 2V, 0V	1.728	1.728	1.612	1.612	1.604	1.604		
	16	7A, 7P, 8E, 7R, 0U	2.184	2.184						
	19	7S, 1G, 7X, 7B, 7V	2.108	2.104						
	22	1S, 0Y, 0W								
	24	7Y, 7Z, 1L	4.972	4.972						
P130	9	2H							5.060	5.060
	10	2J			5.136	5.128	5.092	5.088		
	11	2K, 2L, 8A,							5.060	5.056
	14	2P, 2R, 8B, 2T, 2V, 0V			5.128	5.120	5.084	5.080	5.052	5.048
	16	7A, 7P, 8E, 7R, 0U	6.220	6.204	5.616	5.608	5.572	5.568		
	19	7S, 1G, 7X, 7B, 7V	6.132	6.116	5.524	5.520	5.480	5.480		
	22	1S, 0Y, 0W	7.588	7.572						
	24	1L, 7Y, 7Z	7.448	7.432	6.844	6.836	6.800	6.796		
	28	1T, 1W, 1X, 0E, 0K								
	35	1Z, 0M, 0X								

Mechanical Precision of Output Part of the Reducer

Mechanical precision of solid shaft (with and without key) and flange shaft is indicated below.

Output Shaft: Solid Shaft（with and without key）

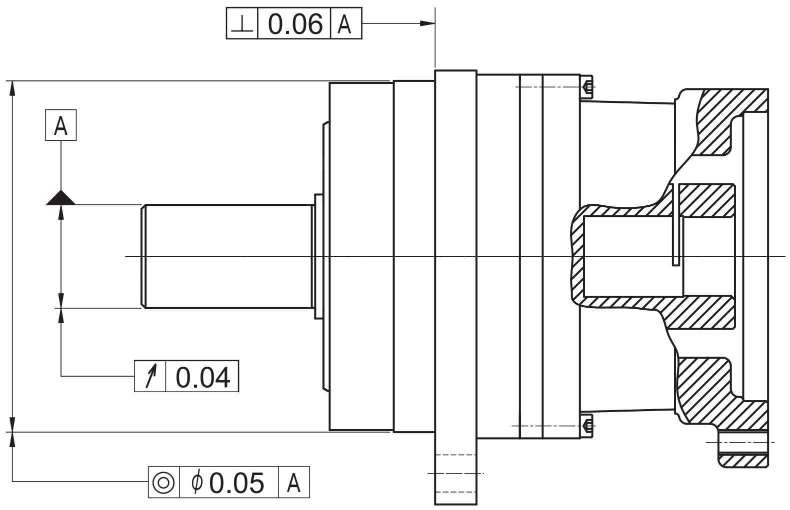


Fig. 7

Output Shaft: Flange Shaft

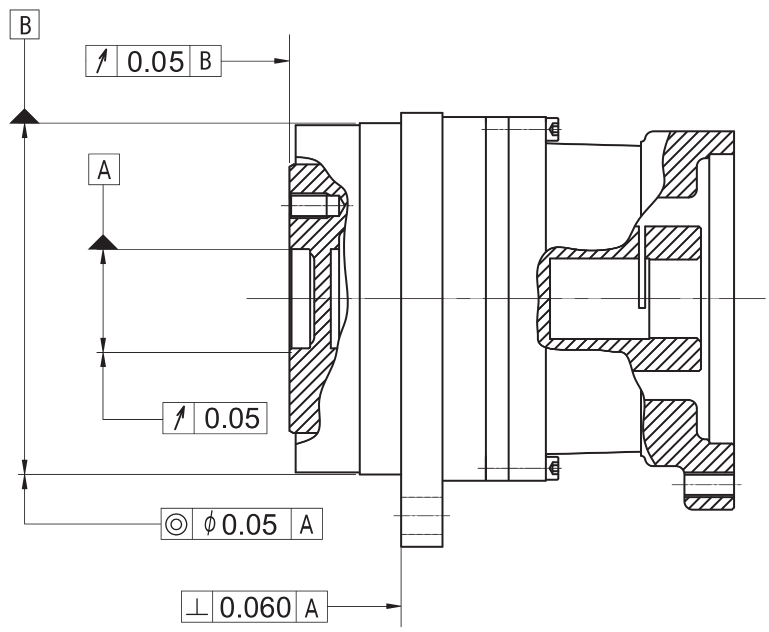


Fig. 8

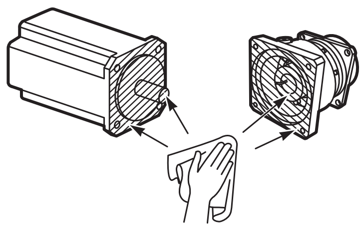
Motor Attachment Procedure

Either straight type, shaft with keyway, or D shaft may be attached to the motor shaft, because special coupling is used for shaft connection part of reducer and motor. Follow the process below from (1) through (7) for assembly. (Remove key while assembly for shaft with keyway.)

(1) Place reducer on an appropriate worktable with output shaft on the bottom side.
(2) Remove fitting of the setting hole (1 place) of the reducer unit (①in figure below).
(3) Match the location by turning by hand to tighten tightening bolt of the coupling into setting hole of the reducer unit (②in figure below).
(4) Insert motor shaft into the center hole of the coupling, press in vertically and fit the pilot part of the reducer unit and motor.
(5) Tighten motor and reducer unit with motor attachment bolt (④in figure below).
(6) Tighten coupling tightening bolt through the setting hole of the side of the reducer unit using a torque wrench bolt (④in figure below). Refer to Table 12 for necessary tightening torque.

Table 15

Coupling hole diameter mm	Tightening bolt	Tightening torque N·m	Allowable transmission torque N·m
ϕ6	M3	1.67	9.18
ϕ8			7.93
ϕ9	M4	3.92	22.0
ϕ10			22.7
ϕ11			24.9
ϕ14			26.4
ϕ16	M5	7.35	49.6
ϕ19			52.9
ϕ22	M6	8.83	61.8
ϕ24			66.2
ϕ28			78.3
ϕ35	M8	21.6	99.2



Make sure that the selected unit can allow maximum emergency torque (peak torque at start and stop) in your operation cycle.

$$\frac{\text{Maximum emergency torque (Peak torque at start or stop)}}{\text{Reduction ratio}} \leqq \text{Allowable transmission torque}$$

(7) Insert fitting (1 place) in the setting hole of the joint cover.

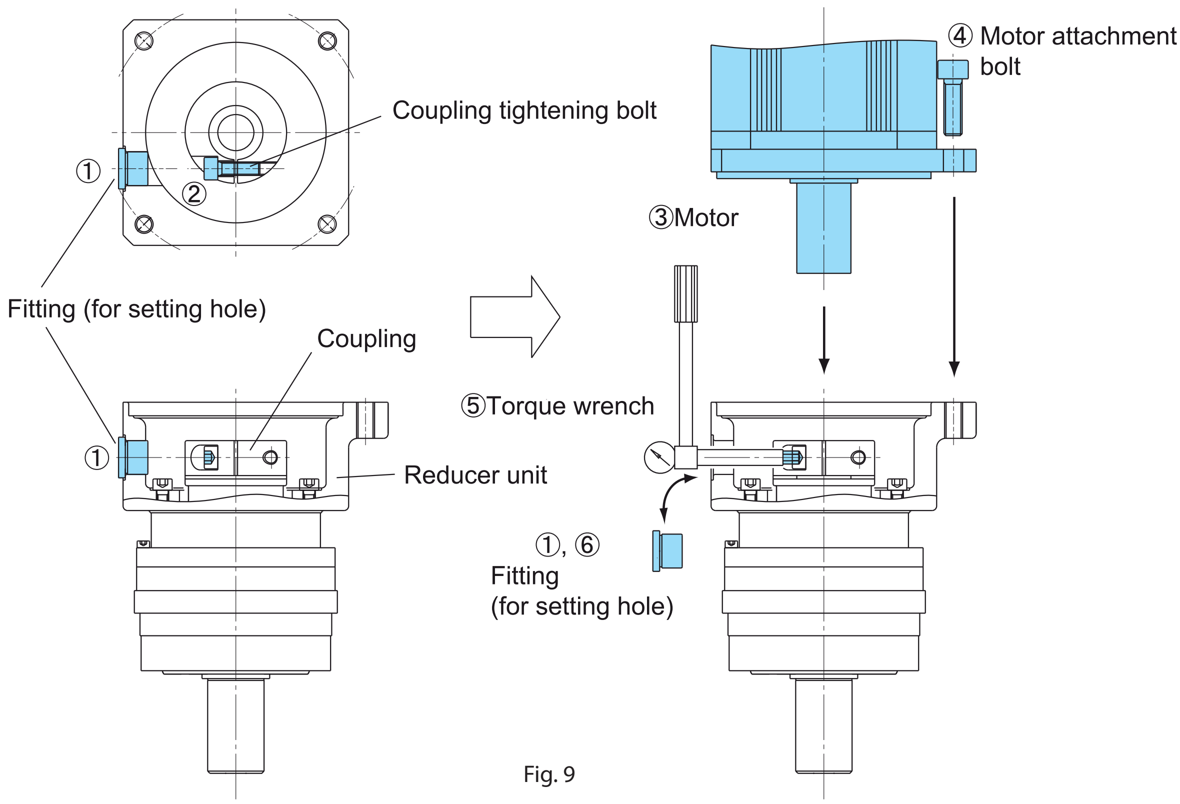
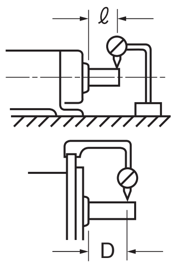
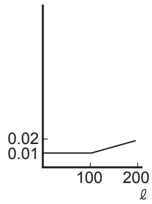
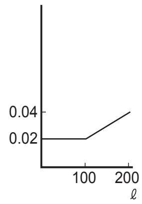
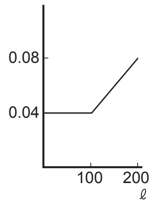
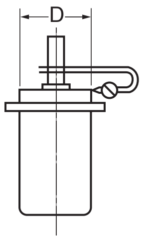
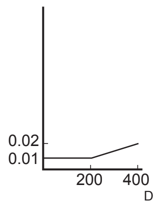
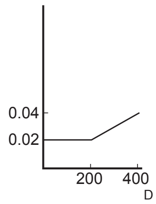
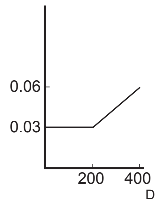
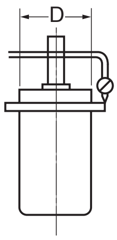
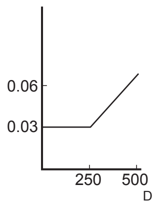
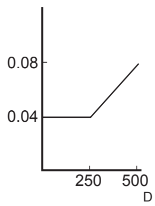
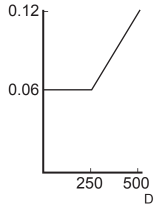


Fig. 9

Table 16

Type	Measuring item	Measuring method	Sketch of measurement	Measuring Instrument	Work accuracy		
					Grade AA	Grade A	Grade B
Foot-mount type and flange type	Run-out of shaft end	Secure the dial gauge on the floor or flange surface. Place the probe of the dial gauge on the circumference close to the shaft end. Turn the shaft once. Difference between the observed maximum and minimum values is the measured value.		Dial gauge	Work accuracy = 0.01 when ℓ≦ 100 As below when ℓ > 100 	Work accuracy = 0.02 when ℓ≦ 100 As below when ℓ > 100 	Work accuracy = 0.04 when ℓ≦ 100 As below when ℓ > 100 
Flange type	Eccentricity of flange engagement O.D.	Secure the dial gauge on the shaft close to the flange surface. Place the probe of the dial gauge on the circumference of flange connection. Turn the shaft once. Half of the difference between the observed maximum and minimum values is the measured value.		Dial gauge	Work accuracy = 0.01 when D ≦ 200 As below when D > 200 	Work accuracy = 0.02 when D ≦ 200 As below when D > 200 	Work accuracy = 0.03 when D ≦ 200 As below when D > 200 
	Perpendicularity with respect to flange surface	Secure the dial gauge on the shaft close to the flange surface. Place the probe of the dial gauge on the flange surface close to flange circumference. Turn the shaft once. The difference between the observed maximum and minimum values is the measured value.		Dial gauge	Work accuracy = 0.03 when D ≦ 250 As below when D > 250 	Work accuracy = 0.04 when D ≦ 250 As below when D > 250 	Work accuracy = 0.06 when D ≦ 250 As below when D > 250 

Warranty

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 designted 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: 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 Products, 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 for the installation site and equipment strictly (Industrial safety and health law, technical standard for electric facilities, extension rules, plant explosion guidelines, building standards law, etc).
- Read the maintenance manual carefully before use. Request a copy from the distributor of the Product or our Sales Department if the maintenance manual is not handy. A copy of maintenance manual should always reach the actual user of the Product.
- Select a sufficient product for the usage condition and application.
- Install protective equipment on the machine side when the machine is used for applications which may cause loss of human life or significant loss in facility, such as use for human transportation or elevators.
- Install an oil pan or other preventive devices in case of oil leakage due to failure or termination of service life when the machine is used for food processing equipment, clean room, or other applications that are sensitive to oil.