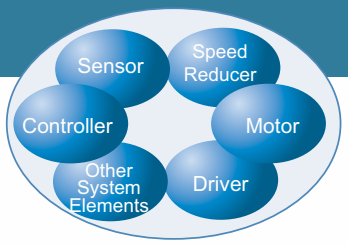


HarmonicGearhead®

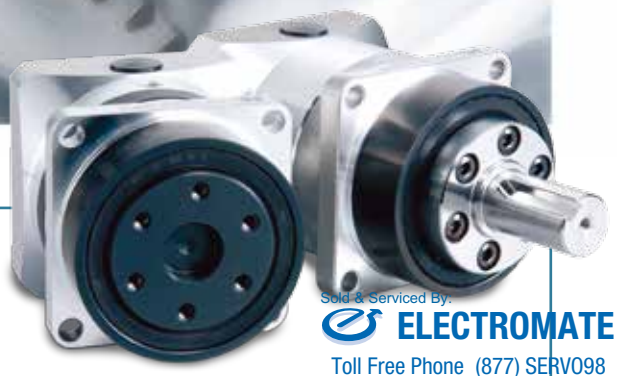
High-Performance Gearheads for Servo Motors

HarmonicPlanetary® HPG series with Helical Gearing

HarmonicPlanetary® HPG series adds new models with helical gearing for improved noise reduction and higher torque capacity.

New models feature low-reduction ratios including 3, 4, 5, 6, 7, 8, 9 and 10:1

HarmonicPlanetary® HPG gearheads add models with helical gearing and low reduction ratios to its current lineup. The new models, HPG-R, add low-speed ratios from 3:1 through 10:1 including all integer ratios in between. HPG-R employs helical gearing for improved noise reduction and higher torque capacity. Ideal for a variety of machinery and equipment designs, these new models complete the already successful HPG line-up.



Features

- **New ratios provide the design engineer with more options to optimize machine design**
- **Helical gearing for noise reduction and higher torque capacity**
- **Permanent Precision, backlash compensating ring gear maintains low backlash for the life of the gear**

Model and Code

HPG - 20 R - 05 BL3 - Z F0 - Motor Code

Model name	Size	Design revision	Reduction ratio	Backlash	Input-side bearing	Output configuration	Input configuration & Options
HPG Standard type Harmonic Planetary®	11	R	4,5,6,7,8,9,10	BL3: Backlash less than 3 arc-min BL1: Backlash less than 1 arc-min (size 14-32 only)	Z: Input side bearing with double non-contact shields D: Input side contact sealed bearing	F0: Flange output J20: Shaft output without key J60: Shaft output with key and center tapped hole	This code represents the motor mounting configuration. Please contact us for a unique part number based on the motor you are using.
	14		3,4,5,6,7,8,9,10			F0: Flange output J2: Straight shaft (without key) J6: Straight shaft (with key and center tap hole)	
	20						
	32						

Rating Table

Table 2-1

Size	Ratio	Rated output torque L10 *1	Rated output torque L50 *1	Average load torque *2	Limit for repeated peak torque *3	Limit for momentary peak torque *4	Maximum average input speed *5	Maximum input speed *6	Moment of inertia *7 (Input-side converted value)	
									Shaft output	Flange output
		Nm	Nm	Nm	Nm	Nm	rpm	rpm	$x10^{-4}kgm^2$	$x10^{-4}kgm^2$
11	4	2.8	4.0	6.3	10	20	3000	10000	0.011	0.0084
	5	2.9	5.0	6.5	10				0.0069	0.0053
	6	2.9	5.0	6.5	10				0.0047	0.0036
	7	3.1	5.0	7.0	9.0				0.0035	0.0027
	8	3.1	5.0	7.0	7.0				0.0026	0.0020
	9	3.1	5.0	6.0	6.0				0.0021	0.0016
	10	3.4	5.0	5.0	5.0				0.0017	0.0013
14	3	4.0	7.0	9.0	20	37	3000	5000	0.089	0.072
	4	7.0	11	16	30	56		6000	0.047	0.037
	5	7.2	11	16	30				0.030	0.023
	6	7.3	11	16	30				0.028	0.024
	7	7.8	12	18	26				0.021	0.018
	8	7.8	12	18	20				0.016	0.014
	9	7.9	12	17	17				0.013	0.011
	10	8.5	13	15	15				0.010	0.0087
20	3	11	17	25	90	124	3000	4000	0.64	0.53
	4	23	36	51	133	217		6000	0.36	0.30
	5	23	38	53	133				0.23	0.19
	6	23	37	53	126				0.15	0.13
	7	25	40	56	108				0.11	0.093
	8	25	40	56	84				0.085	0.070
	9	25	40	57	73				0.067	0.055
	10	27	44	61	65				0.055	0.046
32	3	50	60	110	290	507	3000	3600	3.5	2.8
	4	77	120	170	400	650		6000	1.7	1.3
	5	80	120	180	400				1.1	0.79
	6	80	130	180	390				0.73	0.55
	7	85	138	190	330				0.55	0.41
	8	85	138	190	260				0.43	0.33
	9	86	139	190	220				0.34	0.26
	10	92	149	200	200				0.28	0.22

*1: Rated torque is based on life of 20,000 hours at max average input speed.
*2: Limit for average load torque calculated based on a load torque pattern (refer to gearhead catalog).
*3 The limit for torque during start and stop cycles.
*4: The limit for torque during emergency stops or from external shock loads. Always operate below this value.
*5: Maximum average input speed is limited by heat generation in the speed reducer assuming a continuous operating speed or the average input speed of a motion profile. The actual limit for average input speed depends on the operating environment.
*6: Maximum instantaneous input speed.

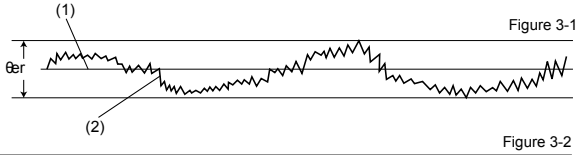
Performance Table

Table 3-1

Size	Ratio	Transmission Accuracy *1	Repeatability *2	Starting torque *3	Back driving torque *4	No load running torque *5
		arc min	arc sec	Ncm	Nm	Ncm
11	4	5	±20	4.7	0.19	6.8
	5			4.1	0.21	5.4
	6			3.6	0.22	4.5
	7			3.3	0.23	3.9
	8			3.0	0.24	3.4
	9			2.8	0.25	3.0
	10			2.6	0.26	2.7
14		4	±15	13	0.38	22
	4			11	0.45	17
	5			10	0.51	13
	6			9.5	0.57	11
	7			9.0	0.63	9.4
	8			8.5	0.68	8.3
	9			8.1	0.73	7.3
	10			7.8	0.78	6.6
20	3	4	±10	31	0.93	50
	4			25	1.0	38
	5			22	1.1	30
	6			20	1.2	25
	7			18	1.3	21
	8			17	1.4	19
	9			17	1.5	17
	10			16	1.6	15
32	3	4	±10	56	1.7	135
	4			52	2.1	101
	5			49	2.5	81
	6			47	2.8	68
	7			45	3.2	58
	8			44	3.5	51
	9			43	3.9	45
	10			42	4.2	41

*1. Transmission accuracy values represent the difference between the theoretical angle and the actual angle of output for any given input. The values shown are maximum values.

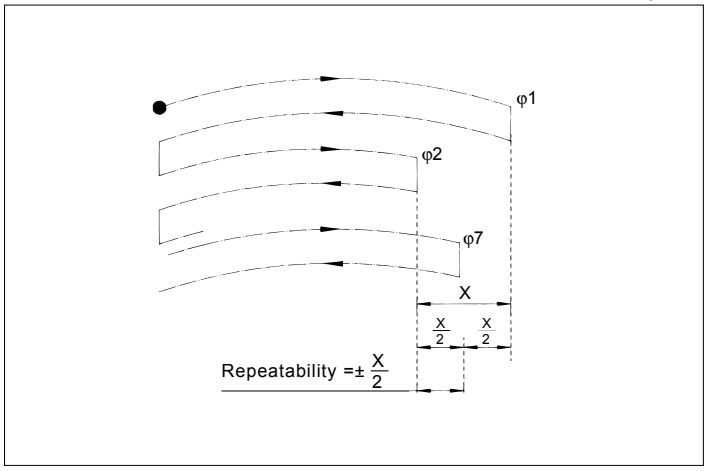
Figure 3-1



θer : Transmission accuracy
θ1 : Input angle
θ2 : Actual output angle
R : Gear reduction ratio

$$\theta er = \theta_2 - \frac{\theta_1}{R}$$

Figure 3-2



*2. The repeatability is measured by moving to a given theoretical position seven times, each time approaching from the same direction. The actual position of the output shaft is measured each time and repeatability is calculated as the 1/2 of the maximum difference of the seven data points. Measured values are indicated in angles (arc-sec) prefixed with "±". The values in the table are maximum values.

*3. Starting torque is the torque value applied to the input side at which the output first starts to rotate. The values in the table are maximum values. and are based on Z option shielded input bearing unloaded at 25° C at 3,000 rpm.

*4: Backdriving torque is the torque value applied to the output side at which the input first starts to rotate. The values in the table are maximum values, and are based on Z option shielded input bearing unloaded at 25° C at 3,000 rpm.

Note: Never rely on these values as a margin in a system that must hold an external load. A brake must be used where back driving is not permissible.

*5: No-load running torque is the torque required at the input to operate the gearhead at a given speed under a no-load condition. The values in the table are average values. and are based on Z option shielded input bearing unloaded at 25° C at 3,000 rpm.

■ Backlash and Torsional Stiffness

■ Gearhead - Standard Backlash (BL3) (≤ 3 arc-min)

Table 4-1

Size	Ratio	Backlash	Torsion angle on one side at T_R x 0.15	Torsional stiffness
			D	A/B
		arc min	arc min	Nm/arc min
11	4	3	2.5	0.64
	5			
	6			
	7			
	8			
	9			
	10			
14	3	3	2.2	1.37
	4			
	5			
	6			
	7			
	8			
	9			
	10			
20	3	3	1.5	5.39
	4			
	5			
	6			
	7			
	8			
	9			
	10			
32	3	3	1.3	21.56
	4			
	5			
	6			
	7			
	8			
	9			
	10			

■ Gearhead - Reduced Backlash (BL1) (≤ 1 arc-min)

Table 4-2

Size	Ratio	Backlash	Torsion angle on one side at T_R x 0.15	Torsional stiffness
			D	A/B
		arc min	arc min	Nm/arc min
11	4	N/A	N/A	N/A
	5			
	6			
	7			
	8			
	9			
	10			
14	3	1	1.1	1.37
	4			
	5			
	6			
	7			
	8			
	9			
	10			
20	3	1	0.6	5.39
	4			
	5			
	6			
	7			
	8			
	9			
	10			
32	3	1	0.5	21.56
	4			
	5			
	6			
	7			
	8			
	9			
	10			

■ Torsional Stiffness Curve

With the input of the gear locked in place, a torque applied to the output flange will torsionally deflect in proportion to the applied torque. We generate a torsional stiffness curve by slowly applying torque to the output in the following sequence:
(1) Clockwise torque to T_R, (2) Return to Zero, (3) Counter-Clockwise torque to $-T_R$, (4) Return to Zero and (5) again Clockwise torque to T_R.
A loop of (1) > (2) > (3) > (4) > (5) will be drawn as in Fig. 4-1.
The torsional stiffness in the region from "0.15 x T_R" to "T_R" is is calculated using the average value of this slope. The torsional stiffness in the region from "zero torque" to "0.15 x T_R" is lower. This is caused by the small amount of backlash plus engagement of the mating parts and loading of the planet gears under the initial torque applied.

■ Calculation of Total Torsion Angle

The method to calculate the total torsion angle (average value) on one side when the speed reducer applies a load in a no-load state.

Formula 4-1

• Calculation formula

$$\theta = D + \frac{T - T_L}{\frac{A}{B}}$$

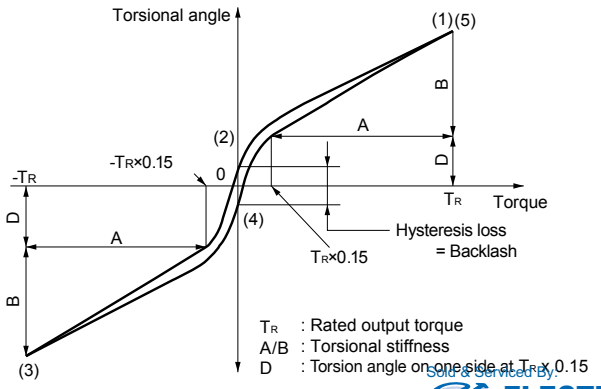
θ	Total torsion angle	———
D	Torsion angle on one side **at output torque x 0.15 torque**	Figure 4-1, Table 4-1 See Table 4-2.
T	Load torque	———
T_L	Output torque x 0.15 torque (= T_R x 0.15)	See Figure 4-1.
A/B	Torsional stiffness	See Figure 4-1 and Tables 4-1 and 4-2.

■ Backlash (Hysteresis Loss)

The vertical distance between points (2) & (4) in Fig. 4-1 is called a hysteresis loss. The hysteresis loss between "Clockwise load torque T_R" and "Counter Clockwise load torque - T_R" is defined as the backlash of the HPG-R series. Backlash of the HPG-R series is less than 3 arc-min (1 arc-min is also available).

Figure 4-1

Torque - Torsional Angle Diagram

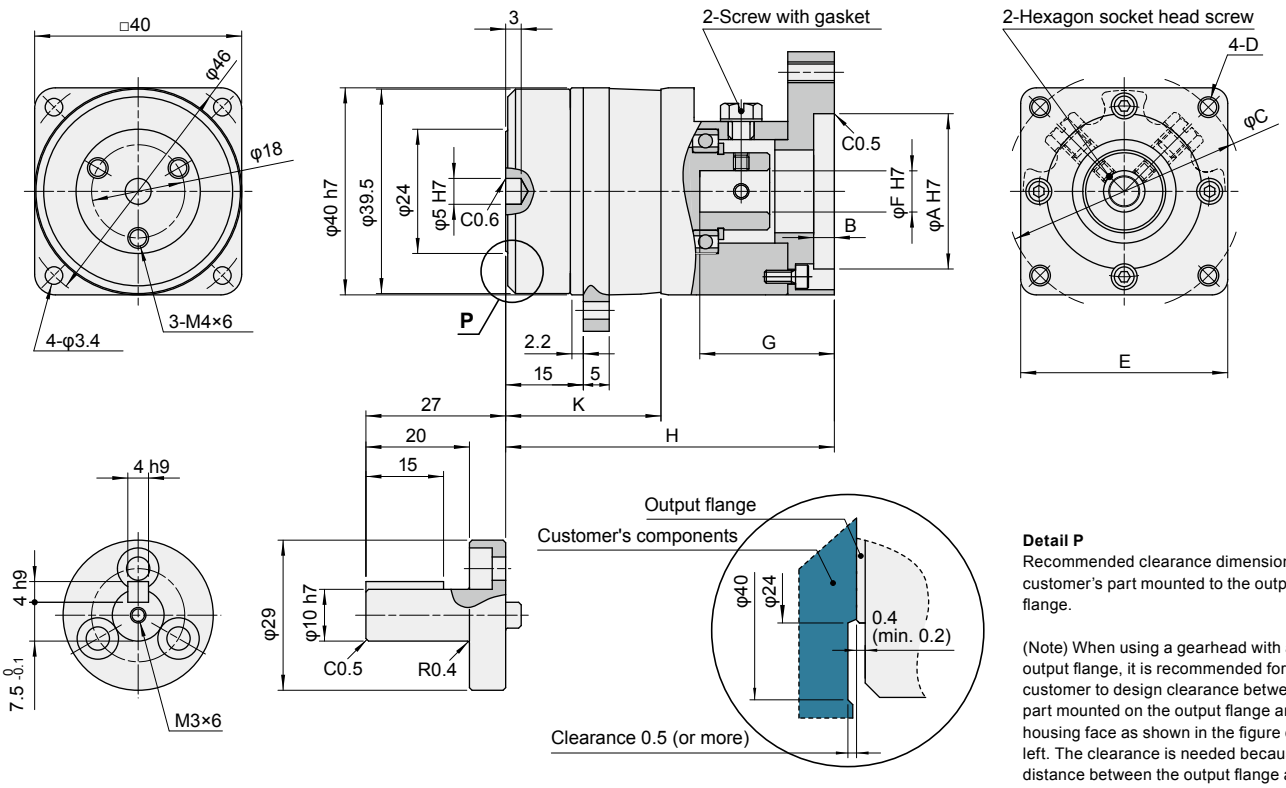


T_R : Rated output torque
A/B : Torsional stiffness
D : Torsion angle on one side at T_R x 0.15

■ Outline Dimensions - Size 11

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed dimensions.

Figure 5-1
Unit: mm



Detail P
Recommended clearance dimension for customer's part mounted to the output flange.

(Note) When using a gearhead with an output flange, it is recommended for the customer to design clearance between the part mounted on the output flange and the housing face as shown in the figure on the left. The clearance is needed because the distance between the output flange and the oil seal (non-rotating) is small (min. 0.2mm)

(Note) The dimension tolerances that are not specified vary depending on the manufacturing method. Please check the confirmation drawing or contact us for dimension tolerances not shown on the drawing above.

■ Dimension Table

Table 5-1
Unit: mm

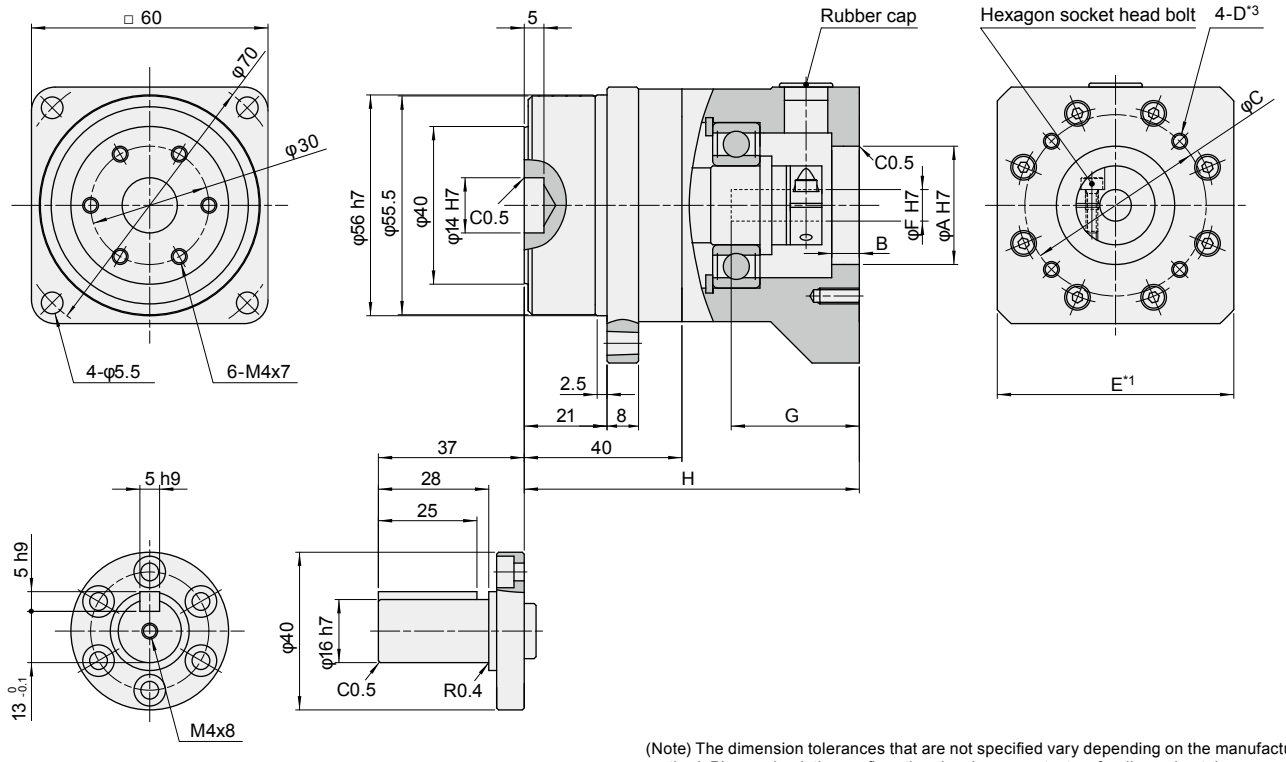
Flange	Coupling	A (H7)		B*1	C		F (H7)		G*1		H*1	Mass (kg) *2	
		Min	Max	Max	Min	Max	Min	Max	Min	Max	Typical	Shaft	Flange
1	1	20	55	4	25	75	5	8	18.5	29	54.5	0.34	0.30

Refer to the confirmation drawing for detailed dimensions. Dimensions of typical products are shown. Please contact us for other mounting options if the configurations shown above are not suitable for your particular motor.
*1 May vary depending on motor interface dimensions.
*2 The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
*3 Tapped hole for motor mounting screw.

■ Outline Dimensions - Size 14

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed dimensions.

Figure 6-1
Unit: mm



(Note) The dimension tolerances that are not specified vary depending on the manufacturing method. Please check the confirmation drawing or contact us for dimension tolerances not shown on the drawing above.

■ Dimension Table

Table 6-1
Unit: mm

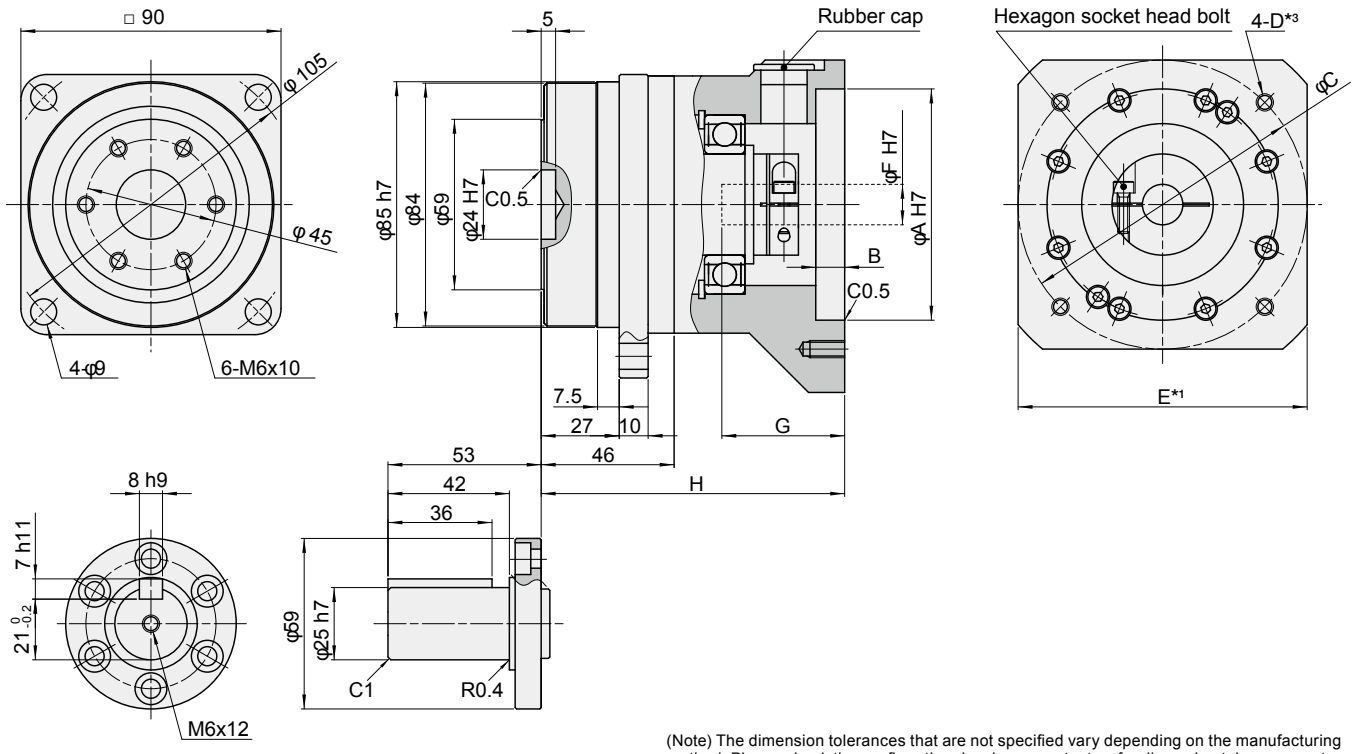
Flange	Coupling	A (H7)		B	C		F (H7)		G		H*1	Mass (kg) *2	
		Min	Max	Max	Min	Max	Min	Max	Min	Max	Typical	Shaft	Flange
1	1	30	55	7	35	75	5.8	8	20.5*1	32.5	85	1.07	0.95

Refer to the confirmation drawing for detailed dimensions. Dimensions of typical products are shown. Please contact us for other mounting options if the configurations shown above are not suitable for your particular motor.
*1 May vary depending on motor interface dimensions.
*2 The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
*3 Tapped hole for motor mounting screw.

■ Outline Dimensions - Size 20

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed dimensions.

Figure 7-1
Unit: mm



(Note) The dimension tolerances that are not specified vary depending on the manufacturing method. Please check the confirmation drawing or contact us for dimension tolerances not shown on the drawing above.

■ Dimension Table

Table 7-1
Unit: mm

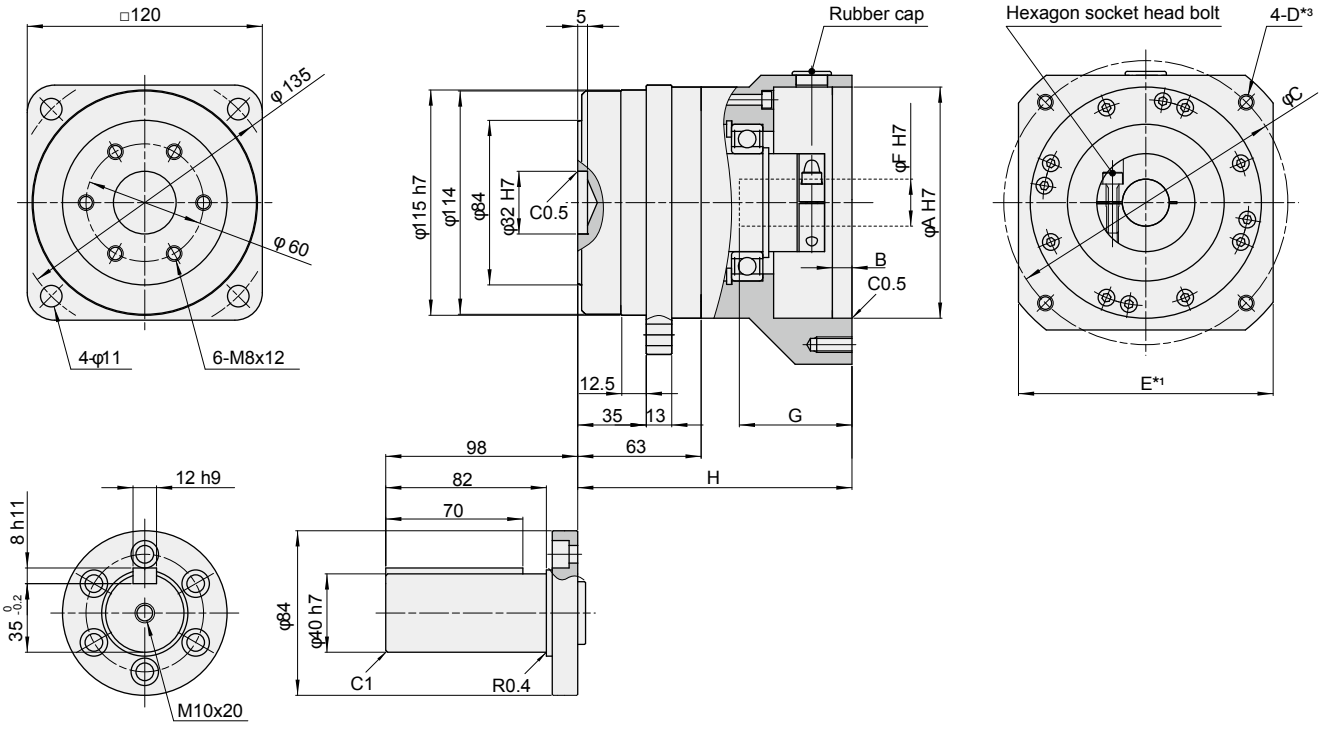
Flange	Coupling	A (H7)		B	C		F (H7)		G		H*1	Mass (kg) *2	
		Min	Max	Max	Min	Max	Min	Max	Min	Max	Typical	Shaft	Flange
1	1	50	68	8	55	84	8.8	19.6	22*1	39	98	3	2.6
2	1	80	95	10	85	125	8.8	19.6	29*1	46	105	3.2	2.8
4	2	38	75*1	10	45	100*1	8.8	19.6	24	46*1	105	3.2	2.8

Refer to the confirmation drawing for detailed dimensions. Dimensions of typical products are shown. Please contact us for other mounting options if the configurations shown above are not suitable for your particular motor.
*1 May vary depending on motor interface dimensions.
*2 The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
*3 Tapped hole for motor mounting screw.

■ Outline Dimensions - Size 32

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed dimensions.

Figure 8-1
Unit: mm



(Note) The dimension tolerances that are not specified vary depending on the manufacturing method. Please check the confirmation drawing or contact us for dimension tolerances not shown on the drawing above.

■ Dimension Table

Table 8-1
Unit: mm

Flange	Coupling	A (H7)		B	C		F (H7)		G		H*1	Mass (kg) *2	
		Min	Max	Max	Min	Max	Min	Max	Min	Max	Typical	Shaft	Flange
1	1	70	81	7	80	112	15.8	26	29*1	56.5	139	8	6.6
4	1	55	95*1	10	60	135*1	15.8	26	40	67.5*1	150	8.1	6.7
5	1	55	175*1	10	65	225*1	15.8	26	49	76.5*1	159	9.7	8.3

Refer to the confirmation drawing for detailed dimensions. Dimensions of typical products are shown. Please contact us for other mounting options if the configurations shown above are not suitable for your particular motor.
*1 May vary depending on motor interface dimensions.
*2 The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
*3 Tapped hole for motor mounting screw.

■ Notices on Handling Products

■ Sizing and Selection

To fully utilize the excellent performance of the HPG HarmonicPlanetary® gearheads, check your operating conditions and, using the flowchart found in our gearhead catalog to select the appropriate size gear for your application.

■ Output Bearing Specifications and Checking Procedure

A precision cross roller bearing supports the external load (output flange).
Check the maximum load, moment load, life of the bearing and static safety coefficient to maximize performance.
For details, refer to our Harmonic Gearhead® catalog series catalog, “Output Bearing Specifications and Checking Procedure”.

■ Handling Instructions

For optimal performance, please follow the safety guide, handling instructions and assembly instructions found in our Harmonic Gearhead® catalog.
Note: The Multemp AC-P (grease) is used as a lubrication for this specification.

■ Name of Lubrication

Multemp AC-P
Manufacturer: KYODO YUSHI CO., LTD.

Table 9-1

Base oil	Composite hydrocarbon oil and diester	Consistency	280
Puffing agent	Lithium soap	Drop point	200 °C
Additives	Extreme-pressure additive and others	Appearance	Black viscose
Standard	NLGI 2		

■ Efficiency

In general, the efficiency of a speed reducer depends on the reduction ratio, input rotational speed, load torque, temperature and lubrication condition.
The efficiency for each frame size and ratio series under the following measurement conditions is plotted in the graphs on the following pages. The values in the graph are average values.

■ Measuring Condition

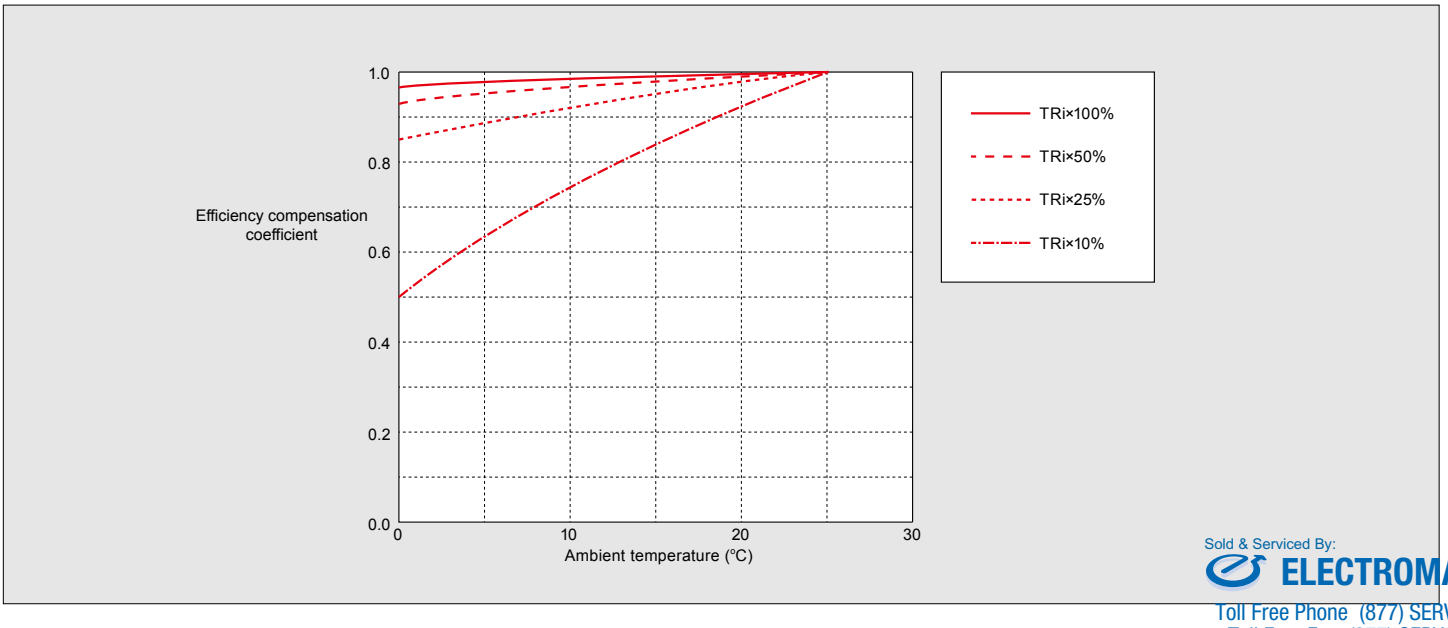
Table 9-2

Input speed	3000 rpm
Ambient temperature	25 °C
Lubricant	Multemp AC-P

■ Efficiency Compensated for Low Temperature

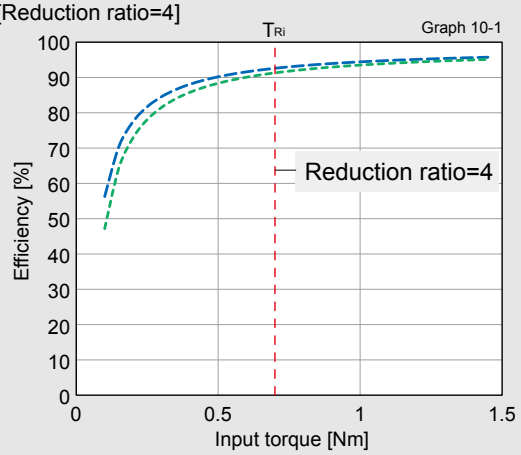
Calculate the efficiency at an ambient temperature of 25°C or less by multiplying the efficiency at 25°C by the low-temperature efficiency compensation value.
Obtain values corresponding to an ambient temperature and to an input torque (TRi*) from the following graphs when calculating the low-temperature efficiency compensation value.

Graph 9-1

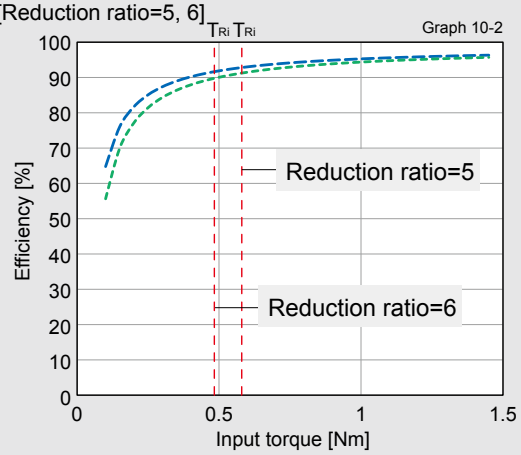


Size 11

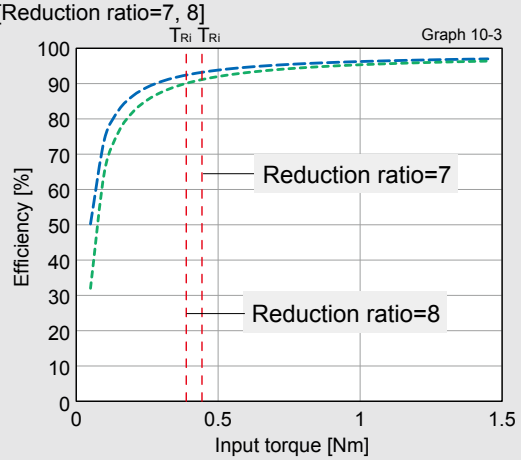
[Reduction ratio=4]



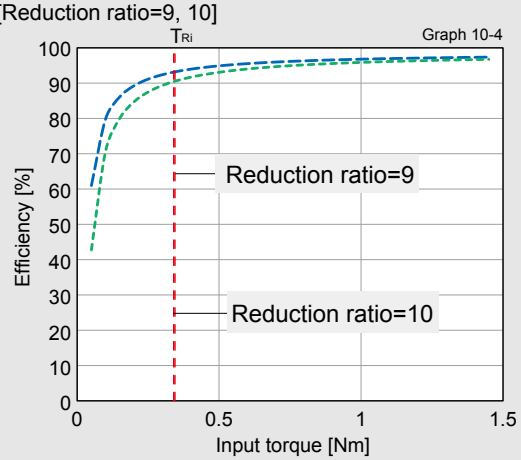
[Reduction ratio=5, 6]



[Reduction ratio=7, 8]



[Reduction ratio=9, 10]



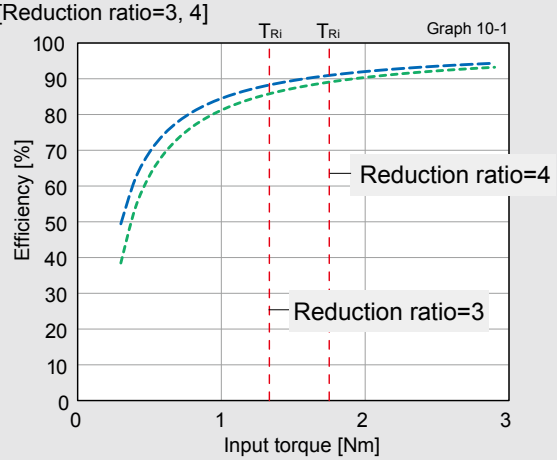
TRi Input torque corresponding to output torque

Gearhead with Z bearing (double shielded)

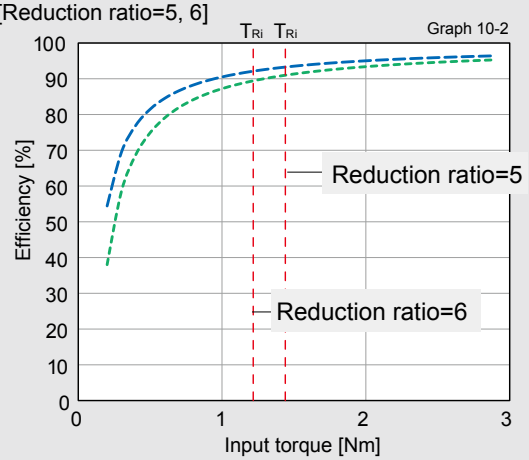
Gearhead with D bearing (double sealed)

Size 14

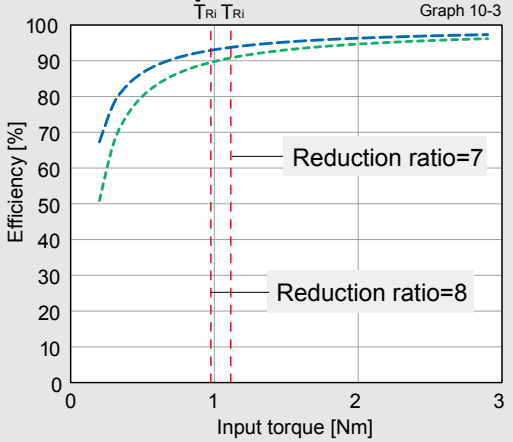
[Reduction ratio=3, 4]



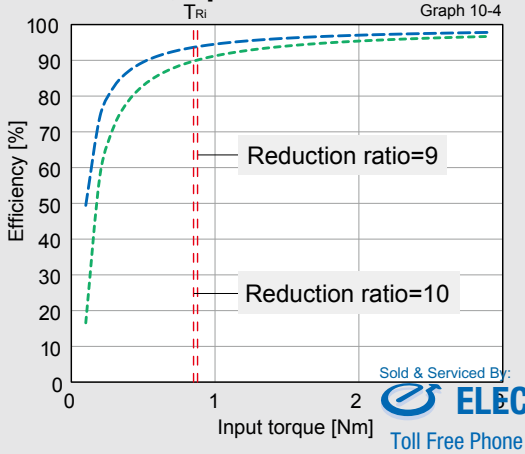
[Reduction ratio=5, 6]



[Reduction ratio=7, 8]



[Reduction ratio=9, 10]



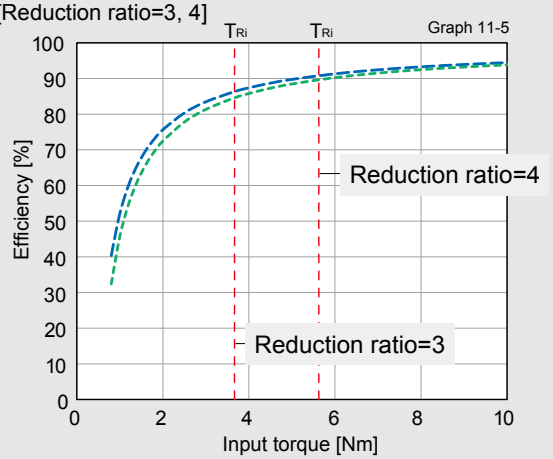
TRi Input torque corresponding to output torque

Gearhead with Z bearing (double shielded)

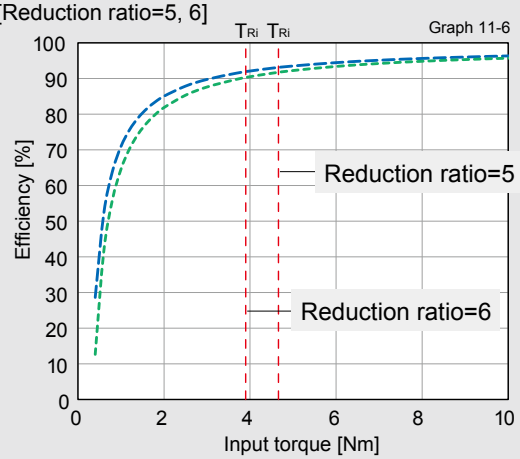
Gearhead with D bearing (double sealed)

Size 20

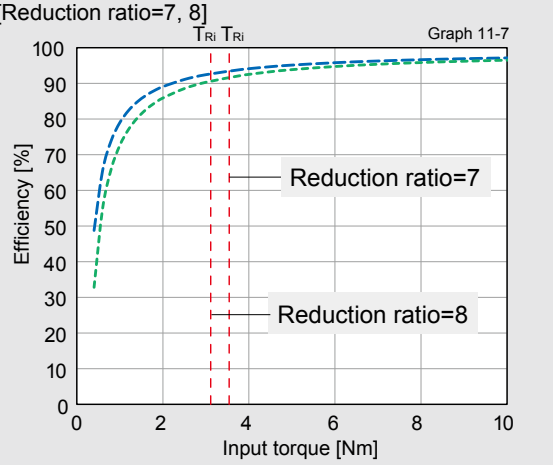
[Reduction ratio=3, 4]



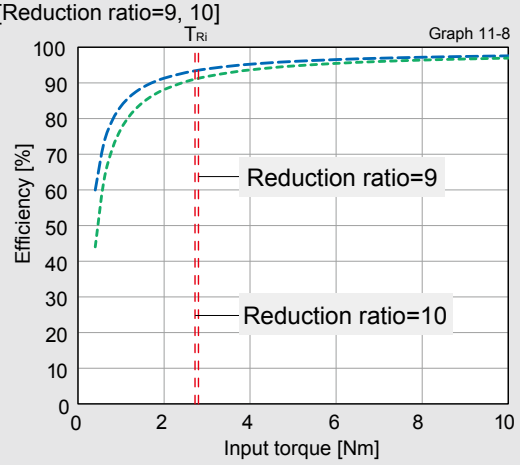
[Reduction ratio=5, 6]



[Reduction ratio=7, 8]



[Reduction ratio=9, 10]



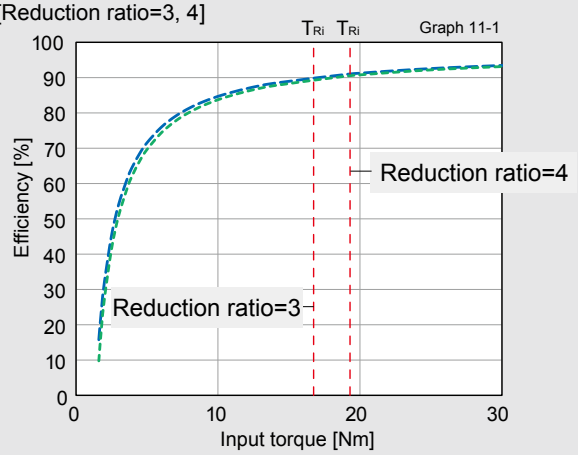
T_{Ri} Input torque corresponding to output torque

Gearhead with Z bearing (double shielded)

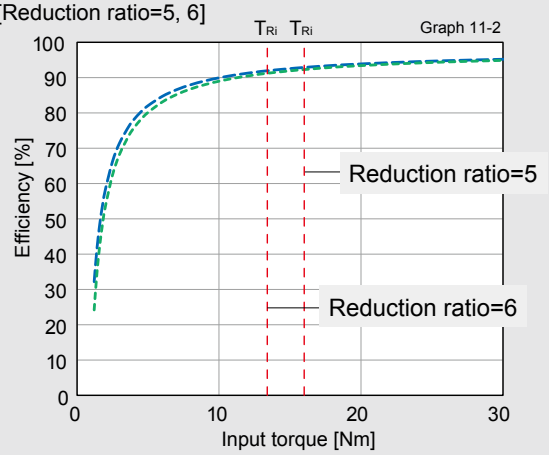
Gearhead with D bearing (double sealed)

Size 32

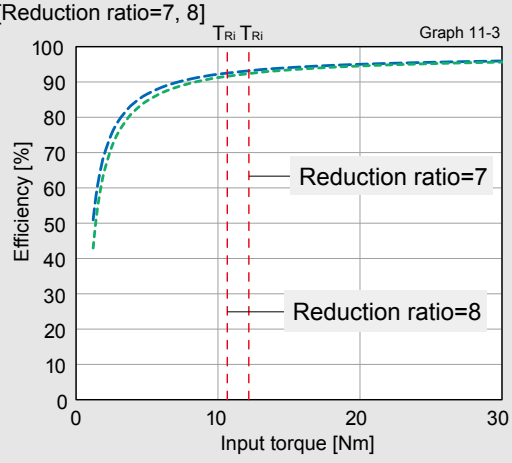
[Reduction ratio=3, 4]



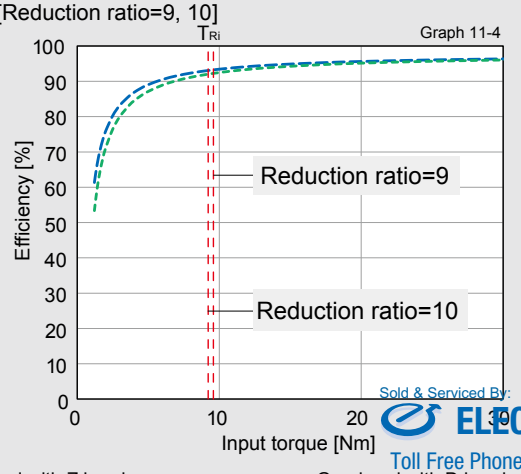
[Reduction ratio=5, 6]



[Reduction ratio=7, 8]



[Reduction ratio=9, 10]



T_{Ri} Input torque corresponding to output torque

Gearhead with Z bearing (double shielded)

Gearhead with D bearing (double sealed)

■ Motor Capacity / Model Matching Table

The matching table is a guide for the combinations with the standard motors.
For information on the combination with a specific motor, please contact us at 800.921.3332.

Table 12-1

Motor capacity	Motor rating rotation speed	Reduction ratio							
W	rpm	3	4	5	6	7	8	9	10
50	3000		11	11	11	11	11	11	11
100	3000		11	11	11	11	14	14	14
150	3000		11	11	11	14	14	14	14
200	3000	14	14	14	14	14	14	20	20
400	3000	14	14	14	14	20	20	20	20
600	3000	20	20	20	20	20	20	20	20
750	3000	20	20	20	20	20	20	20	32
1000	3000	20	20	20	20	20	20	32	32
1500	3000	32	32	32	32	32	32	32	32
2000	3000	32	32	32	32	32	32	32	32
2500	3000	32	32	32	32	32	32	32	
3000	3000	32	32	32	32	32	32		
4000	3000	32	32	32	32	32			
5000	3000	32	32	32					

The numeric values in the table above shows the sizes of speed reducers. The mounting flange dimensions for the respective sizes of speed reducer are shown below:

11 : □40mm	14 : □60mm
20 : □90mm	32 : □120mm