

HarmonicPlanetary® HPN Value Series

Size

11, 14, 20, 32, 40

5

Sizes

Peak Torque

9Nm ~ 752Nm

Reduction Ratio

Single stage: 3:1 to 10:1, Two stage: 13:1 to 31:1

Backlash

Single stage: < 5 arc-min, Two stage: < 7 arc-min

High Efficiency

Up to 97%

Output Bearing

A radial ball bearing is integrated with the output flange to provide high moment stiffness, high load capacity and precise positioning accuracy.

Easy mounting to a wide variety of servomotors

Quick Connect™ coupling



CONTENTS

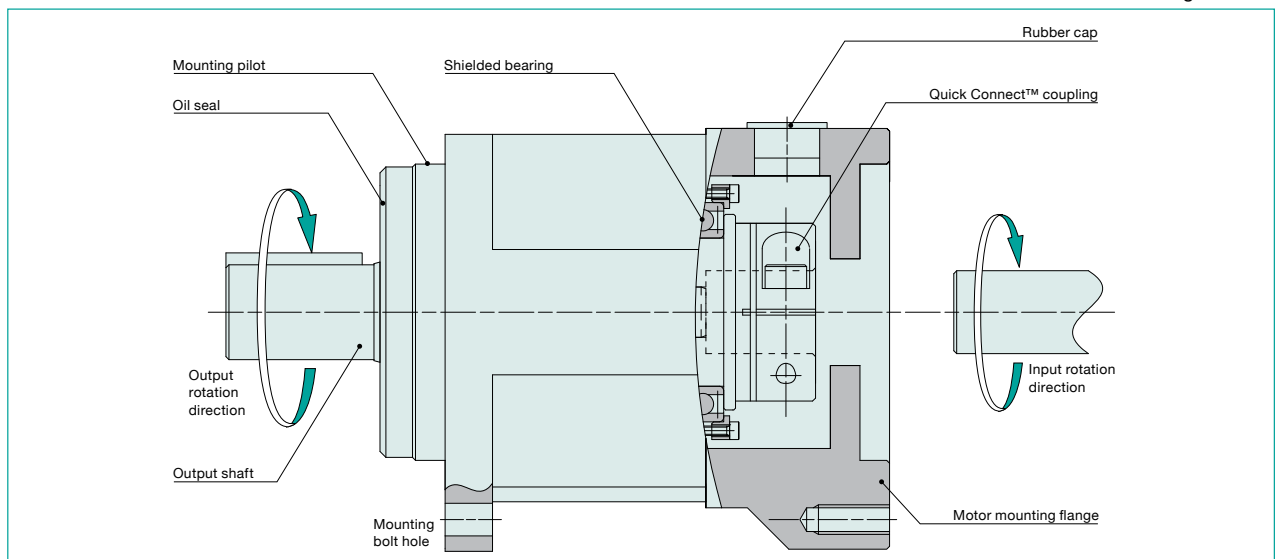
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HPN - 14 A - 05 - J6 - Motor Code

Model Name	Size	Design Revision	Reduction Ratio	Output Configuration	Input Configuration
HarmonicPlanetary® HPN High Torque	11	A	4, 5, 7, 10, 16, 20, 30	J6: Shaft output with key and center tapped hole J8: Shaft output with 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, 7, 10, 13, 21, 31		
	20				
	32				
	40				

Gearhead Construction

Figure 054-1



Rating Table

Please contact our sales office if you have any questions about our specifications or comparison with another company's products.

Table 055-1

Size	Number of Stages	Ratio	Rated Torque *1	Limit for Repeated Peak Torque *2	Limit for Momentary Peak Torque *3	Max. Average Rated Input Speed*4	Max. Input Speed (grease) *5	Allowable Radial Load *6	Allowable Axial Load *7				
			Nm	Nm	Nm	rpm	rpm	N	N				
11	1	4	14	14	40	3,000	10,000	240	280				
		5	14	16	40			260	320				
		7	11	11	40			280	360				
		10	9	9	40			320	420				
	2	16	18	24	40			360	460				
		20	22	24	40			400	560				
		30	25	26	40			480	640				
14	1	3	22	25	89	3,000	6,000	380	340				
		4	28	50	110			420	380				
		5	29	50	107			450	410				
		7	30	37	100			510	480				
		10	18	18	79			570	580				
		13	30	43	106			630	630				
	2	21	30	50	99			740	780				
		31	30	38	101			840	900				
		20	1	3	51			74	226	3,000	6,000	830	900
4	80			130	256	920	1,100						
5	80			149	256	1,000	1,200						
7	80			113	256	1,100	1,400						
10	54			54	216	1,230	1,600						
2	13		80	130	256	1,350	1,850						
	21		80	147	256	1,600	2,100						
	31		80	113	256	1,800	2,200						
	32		1	3	153	254	625	3,000	6,000			1,800	2,000
				4	198	376	625					1,900	2,300
5		200		376	625	2,000	2,500						
7		200		376	625	2,300	2,900						
10		185		185	625	2,600	3,200						
2		13	200	376	625	2,900	3,600						
		21	200	376	625	3,400	3,800						
		31	200	376	625	3,900	3,800						
		40	1	3	440	752	1,137			3,000	6,000	2,800	2,700
4	460			752	1,265	3,100	3,000						
5	480			752	1,265	3,400	3,300						
7	510			752	829	3,800	3,800						
10	480			509	829	4,200	4,200						
2	13		530	752	823	4,500	4,500						
	21		620	752	1,029	5,000	5,000						
	31		700	752	1,097	5,500	5,400						

*1: Rated torque is based on L₅₀ life of 20,000 hours at rated input speed.

*2: The limit for torque during start and stop cycles.

*3: The limit for torque during emergency stops or from external shock loads. Always operate below this value. Calculate the number of permissible events to ensure it meets required operating conditions.

*4: 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.

*5: Maximum instantaneous input speed.

*6: The load at which the output bearing will have 20,000 hour life at the rated input speed. (Axial load = 0 and radial load point is in the center of the output shaft.)

*7: The load at which the output bearing life will be 20,000 hours at the rated input speed. (Radial load = 0 and axial load point is in the center of the output shaft.)

Performance

Table 055-2

Size	Number of Stages	Reduction Ratio	Backlash	Noise*1	Torsional Stiffness	
			arc min	dB	kgfm/arc-min	X100N·m/rad
11	1	4	< 5	< 56*2	0.060	20
		5				
		7				
		10				
	2	16	< 7			
		20				
		30				
14	1	3*2	< 5	< 58*2	0.27	93
		4				
		5				
		7				
		10				
	2	13	< 7			
		21				
		31				
20	1	3*2	< 5	< 60*2	0.77	260
		4				
		5				
		7				
		10				
	2	13	< 7			
		21				
		31				

*1: The above noise values are reference values.

*2: Contact us for noise values for sizes with a reduction ratio of 3.

Table 055-3

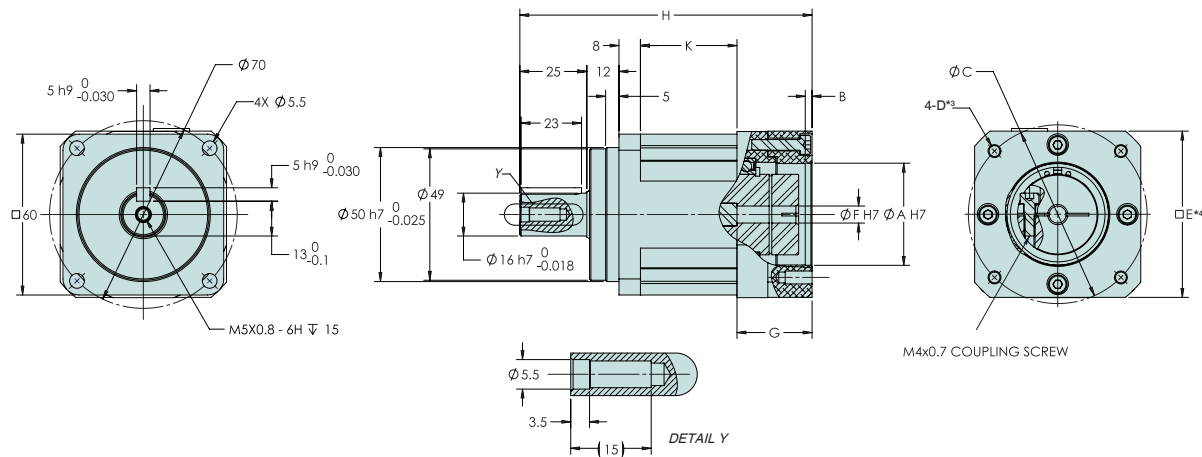
Size	Number of Stages	Reduction Ratio	Backlash	Noise*1	Torsional Stiffness	
			arc min	dB	kgfm/arc-min	X100N·m/rad
32	1	3 ^{*2}	< 5	< 63 ^{*2}	2.8	940
		4				
		5				
		7				
	2	10	< 7			
		13				
		21				
		31				
40	1	3 ^{*2}	< 5	< 65 ^{*2}	4.2	1430
		4				
		5				
		7				
	2	10	< 7			
		13				
		21				
		31				

(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. Output shaft configuration shown is J6 (with a key and center tapped hole). J8 configuration has no key.

HPN-14A Outline Dimensions

Figure 057-1

(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. Output shaft configuration shown is J6 (with a key and center tapped hole). J8 configuration has no key.

Dimension Table

(Unit: mm) Table 057-1

	Flange	Coupling	A (H7)		B	C		F (H7)		G		H ¹	K	Mass(kg) ^{*2}
			Min.	Max. ^{*1}		Min.	Max. ^{*1}	Min.	Max.	Min.	Max.			
Single Stage	Type I	1	30	39	5	35	49	4.8	8	17	25	107	36	0.95
Two Stage												132	61	1.3
Single Stage	Type II	2	50	59	5	56	74	4.8	14	24	31	112	36	1.2
Two Stage												137	61	1.6

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.

^{*4} E dimension is dependent on motor selection.

Moment of Inertia

(10⁻⁴ kgm²) Table 057-2

HPN 14A	Ratio	3	4	5	7	10	13	21	31
	Coupling								
	1	0.24	0.21	0.2	0.19	0.19	0.2	0.2	-
	2	0.124	0.096	0.083	0.072	0.066	0.049	0.043	0.041

Figure 058-1
(Unit: mm)



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.
- *4 E dimension is dependent on motor selection.

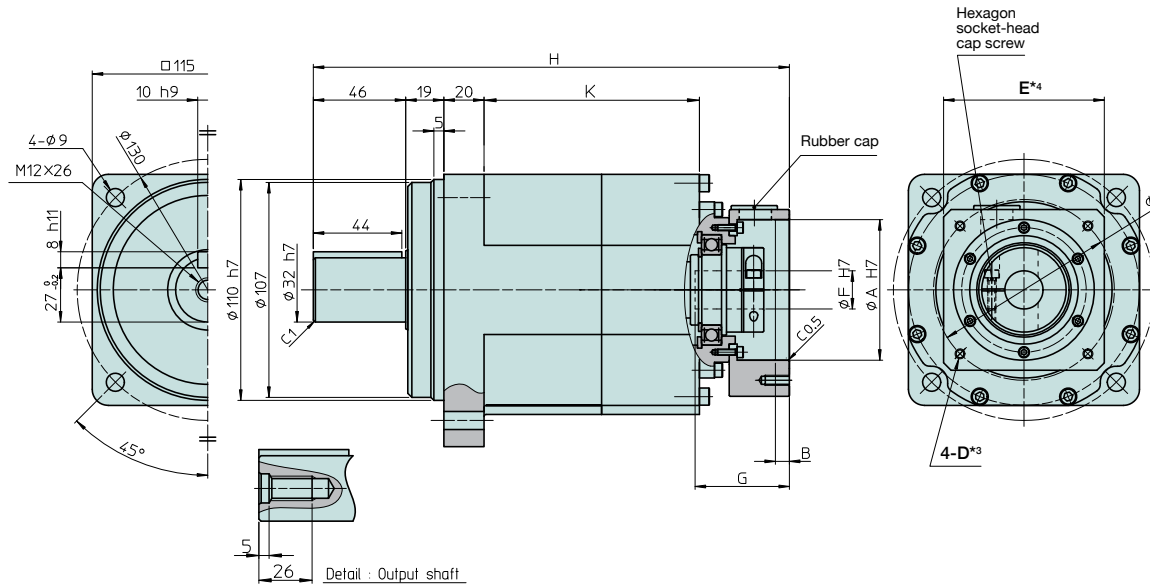
(10⁻⁴ kgm²) Table 058-2

HPN 20A	Ratio	3	4	5	7	10	13	21	31
	Coupling								
	1	1.2	1	1	0.9	0.87	0.9	0.88	0.87

HPN-32A Outline Dimensions

Figure 059-1

(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. Output shaft configuration shown is J6 (with a key and center tapped hole). J8 configuration has no key.

Dimension Table

(Unit: mm) Table 059-1

	Flange	Coupling	A (H7)		B	C		F (H7)		G ^{*1}		H ^{*1}	K	Mass(kg) ^{*2}
			Min.	Max. ^{*1}		Min.	Max. ^{*1}	Min.	Max.	Min.	Max.			
Single Stage	Type I	1	50	85	7	77	110	15.5	25	20	46	195	58.5	6.6
	Type II	2	70	125	7	77	155	15.5	28	47	69	212.5	58.5	7.7
	Type II	3	70	215	6.5	77	260	21.5	41	47	85	233.5	58.5	9.3
Two Stage	Type IV	4	50	85	7	58	110	8	25	21	42	232	107.2	7.9
	Type V	4	50	125	7	58	155	8	25	44	65	255	107.2	9.1

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.

*4 E dimension is dependent on motor selection.

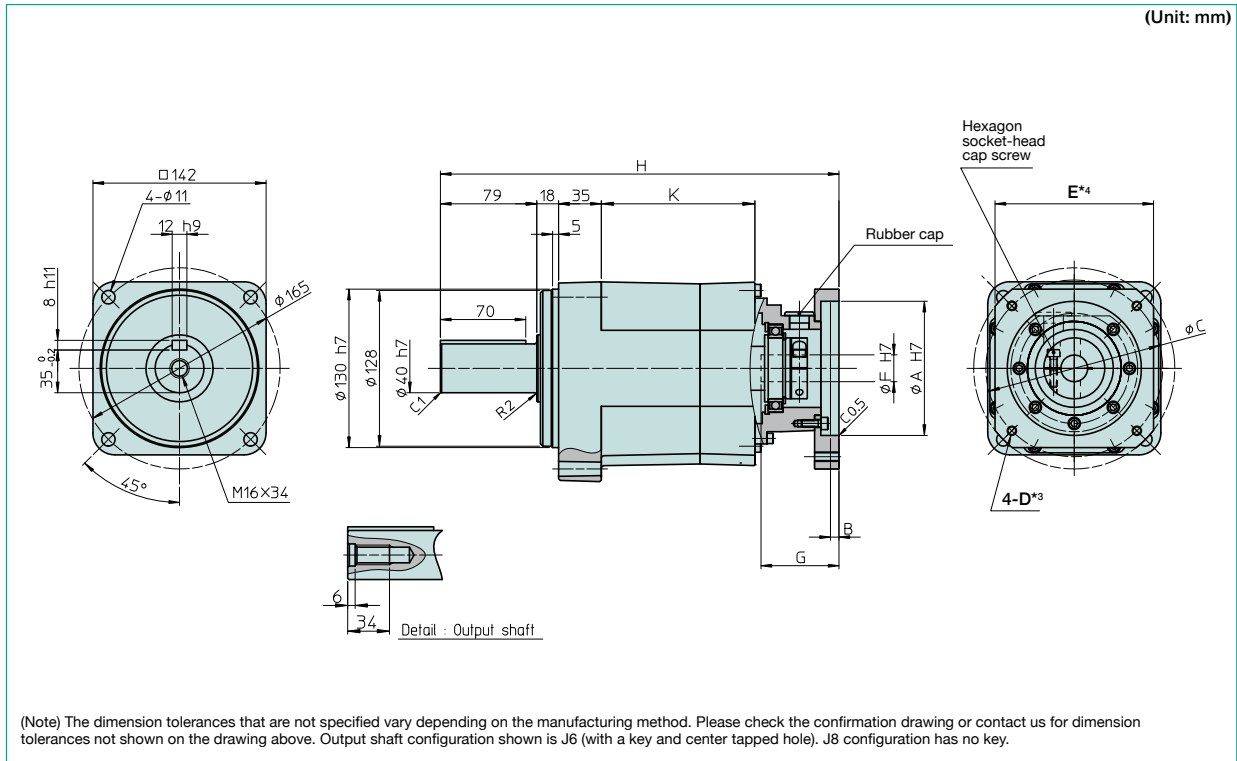
Moment of Inertia

(10⁻⁴ kgm²) Table 059-2

	Coupling	Ratio							
		3	4	5	7	10	13	21	31
HPN 32A	1	2.3	1.7	1.5	1.3	1.2	-	-	-
	2	5	3.8	3.3	2.9	2.7	-	-	-
	3	7.5	6.2	5.7	5.3	5.3	-	-	-
	4	-	-	-	-	-	1.3	1.1	1

HPN-40A Outline Dimensions

Figure 060-1
(Unit: mm)



Dimension Table

(Unit: mm) Table 060-1

	Flange	Coupling	A (H7)		B	C		F (H7)		G ¹		H ¹	K	Mass(kg) ²
			Min.	Max. ¹		Min.	Max. ¹	Min.	Max.	Min.	Max.			
Single Stage	Type I	1	70	215	6.5	78	260	15.5	41	34.5	72	295.5	81	17
	Type II	2	70	175	6.5	78	225	15.5	42	39	105	328.5	81	16
	Type III	3	70	125	7	78	155	15.5	24	47	77	282.5	81	13
Two Stage	Type IV	4	70	125	7	78	155	15.5	28	47	69	309.5	126	17
	Type V	5	70	215	6.5	77	260	21.5	41	47	85	348	126	18

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.

⁴ E dimension is dependent on motor selection.

Moment of Inertia

(10⁻⁴ kgm²) Table 060-2

	Coupling	Ratio							
		3	4	5	7	10	13	21	31
HPN 40A	1	14	9.1	7.3	6.2	5.4	-	-	-
	2	15	11	8.8	7.3	6.5	-	-	-
	3	10.2	6.9	5.4	4.1	3.4	-	-	-
	4	-	-	-	-	-	4.5	3.5	3.4
	5	-	-	-	-	-	7	6	5.8

Product Sizing & Selection

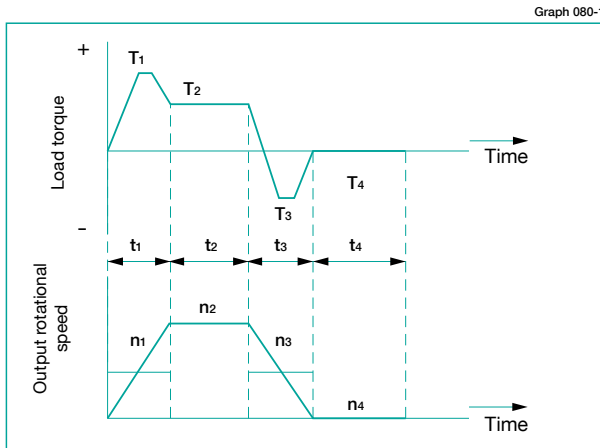
To fully utilize the excellent performance of the HPN HarmonicPlanetary® gearheads, check your operating conditions and, using the flowchart, select the appropriate size gear for your application.

In general, a servo system rarely operates at a continuous load and speed. The input speed, load torque change and a comparatively large torque is applied during start and stop. Unexpected impact torques may also be applied.

Check your operating conditions against the following load torque pattern and select a suitable size based on the flowchart shown on the right. Also check the life and static safety coefficient of the cross roller bearing and input side main bearing (input shaft type only).

Checking the load torque pattern

Review the load torque pattern. Check the specifications shown in the figure below.



Obtain the value of each load torque pattern.

Load torque	T ₁ to T _n (Nm)
Time	t ₁ to t _n (sec)
Output rotational speed	n ₁ to n _n (rpm)

<Normal operation pattern>

Starting	T ₁ , t ₁ , n ₁
Steady operation	T ₂ , t ₂ , n ₂
Stopping (slowing)	T ₃ , t ₃ , n ₃
Idle	T ₄ , t ₄ , n ₄

<Maximum rotational speed>

Max. output rotational speed	n _{o max} ≥ n ₁ to n _n
Max. input rotational speed	n _{i max} n ₁ × R to n _n × R
(Restricted by motors)	R: Reduction ratio

<Impact torque>

When impact torque is applied	T _s
-------------------------------	----------------

<Required life>

$$L_{50} = L \text{ (hours)}$$

Flowchart for selecting a size

Please use the flowchart shown below for selecting a size. Operating conditions must not exceed the performance ratings.

Calculate the average load torque applied on the output side from the load torque pattern: T_{av} (Nm).

$$T_{av} = \sqrt[10/3]{\frac{n_1 \cdot t_1 \cdot T_1^{10/3} + n_2 \cdot t_2 \cdot T_2^{10/3} + \dots + n_n \cdot t_n \cdot T_n^{10/3}}{n_1 \cdot t_1 + n_2 \cdot t_2 + \dots + n_n \cdot t_n}}$$

Calculate the average output speed based on the load torque pattern: n_{o av} (rpm)

$$n_{o av} = \frac{n_1 \cdot t_1 + n_2 \cdot t_2 + \dots + n_n \cdot t_n}{t_1 + t_2 + \dots + t_n}$$

Make a preliminary model selection with the following condition: T_{av} ≤ Average load torque (Refer to rating table).

NG

OK

Determine the reduction ratio (R) based on the maximum output rotational speed (n_{o max}) and maximum input rotational speed (n_{i max}).

$$\frac{n_{i max}}{n_{o max}} \geq R$$

(A limit is placed on n_{i max} by motors.)

Calculate the maximum input speed (n_{i max}) from the maximum output speed (n_{o max}) and the reduction ratio (R).

$$n_{i max} = n_{o max} \cdot R$$

OK

Calculate the average input speed (n_{i av}) from the average output speed (n_{o av}) and the reduction ratio (R): n_{i av} = n_{o av} · R ≤ Max. average input speed (n_r).

NG

OK

Check whether the maximum input speed is equal to or less than the values in the rating table. n_{i max} ≤ maximum input speed (rpm)

NG

OK

Check whether T₁ and T₃ are within peak torques (Nm) on start and stop in the rating table.

NG

OK

Check whether T_s is equal to or less than the momentary max. torque (Nm) value from the ratings.

NG

OK

Calculate the lifetime and check whether it meets the specification requirement.

T_r: Output torque

n_r: Max. average input speed

$$L_{10} = 20,000 \cdot \left(\frac{T_r}{T_{av}} \right)^{10/3} \cdot \left(\frac{n_r}{n_{i av}} \right) \text{ (Hour)}$$

NG

OK

The model number is confirmed.

Refer to the Caution note below.

Review the operation conditions, size and reduction ratio.

Caution

If the expected operation will result in conditions where;

- Actual average load torque (T_{av}) > Permissible maximum value of average load torque or
- Actual average input rotational speed (n_{i av}) > Permissible average input rotational speed (n_r), then please check its effect on the speed reducer temperature rise or other factors. Consider selecting the next larger speed reducer, reduce the operating loads or take other means to ensure safe use of the gear. Exercise caution especially when the duty cycle is close to continuous operation.

Example of model number Selection

Value of each load torque pattern.

Load torque	T_n (Nm)	<Maximum rotational speed>	
Time	t_n (sec)	Max. output rotational speed	$n_o \max = 120$ rpm
Output rotational speed	n_n (rpm)	Max. input rotational speed	$n_i \max = 5,000$ rpm (Restricted by motors)
<Normal operation pattern>			
Starting	$T_1 = 70$ Nm, $t_1 = 0.3$ sec, $n_1 = 60$ rpm	<Impact torque>	
Steady operation	$T_2 = 18$ Nm, $t_2 = 3$ sec, $n_2 = 120$ rpm	When impact torque is applied	$T_s = 180$ Nm
Stopping (slowing)	$T_3 = 35$ Nm, $t_3 = 0.4$ sec, $n_3 = 60$ rpm	<Required life>	
Idle	$T_4 = 0$ Nm, $t_4 = 5$ sec, $n_4 = 0$ rpm	$L_{50} = 30,000$ (hours)	

Calculate the average load torque applied to the output side based on the load torque pattern: T_{av} (Nm).

$$T_{av} = \sqrt[10/3]{\frac{|60\text{rpm}| \cdot 0.3\text{sec} \cdot |70\text{Nm}|^{10/3} + |120\text{rpm}| \cdot 3\text{sec} \cdot |18\text{Nm}|^{10/3} + |60\text{rpm}| \cdot 0.4\text{sec} \cdot |35\text{Nm}|^{10/3}}{|60\text{rpm}| \cdot 0.3\text{sec} + |120\text{rpm}| \cdot 3\text{sec} + |60\text{rpm}| \cdot 0.4\text{sec}}}$$

Calculate the average output speed based on the load torque pattern: $n_o \text{ av}$ (rpm)

$$n_o \text{ av} = \frac{|60\text{rpm}| \cdot 0.3\text{sec} + |120\text{rpm}| \cdot 3\text{sec} + |60\text{rpm}| \cdot 0.4\text{sec} + |0\text{rpm}| \cdot 5\text{sec}}{0.3\text{sec} + 3\text{sec} + 0.4\text{sec} + 5\text{sec}}$$

Make a preliminary model selection with the following conditions. $T_{av} = 30.2$ Nm ≤ 80 Nm. (HPN-20A-31 is tentatively selected based on the average load torque (see the rating table) of size 20 and reduction ratio of 31.)

OK

Determine a reduction ratio (R) from the maximum output speed ($n_o \max$) and maximum input speed ($n_i \max$).

$$\frac{5,000 \text{ rpm}}{120 \text{ rpm}} = 41.7 \geq 31$$

Calculate the maximum input speed ($n_i \max$) from the maximum output speed ($n_o \max$) and reduction ratio (R): $n_i \max = 120 \text{ rpm} \cdot 31 = 3,720$ rpm

OK

Calculate the average input speed ($n_i \text{ av}$) from the average output speed ($n_o \text{ av}$) and reduction ratio (R):
 $n_i \text{ av} = 46.2 \text{ rpm} \cdot 31 = 1,432$ rpm $\leq$ Max average input speed of size 20 3,000 rpm

OK

Check whether the maximum input speed is equal to or less than the values specified in the rating table.
 $n_i \max = 3,720$ rpm ≤ 600 rpm (maximum input speed of size 20)

OK

Check whether T_1 and T_3 are within peak torques (Nm) on start and stop in the rating table.
 $T_1 = 70$ Nm ≤ 113 Nm (Limit for repeated peak torque, size 20)
 $T_3 = 35$ Nm ≤ 113 Nm (Limit for repeated peak torque, size 20)

OK

Check whether T_s is equal to or less than limit for momentary torque (Nm) in the rating table.
 $T_s = 180$ Nm ≤ 256 Nm (momentary max. torque of size 20)

OK

Calculate life and check whether the calculated life meets the requirement.

$$L_{50} = 20,000 \cdot \left(\frac{80\text{Nm}}{30.2\text{Nm}} \right)^{10/3} \cdot \left(\frac{3,000\text{rpm}}{1,432\text{rpm}} \right) = 25,809,937 \text{ (hours)} \geq 30,000 \text{ (hours)}$$

The selection of model number HPN-20A-31 is confirmed from the above calculations.

Refer to the Caution note at the bottom of page 61.

Review the operation conditions, size and reduction ratio.

HarmonicPlanetary[®] HPN Value Series

HPN Precision Planetary Gearheads are Quiet, Lightweight and Compact with Low Cost and Quick Delivery.

HPN Planetary gearheads feature a robust design utilizing helical gears for quiet performance and long life. These gearheads are available with short lead times and are designed to couple to any servomotor with our Quick Connect™ coupling. HPN gearheads are suitable for use in a wide range of applications for precision motion control and positioning. HPN Harmonic Planetary[®] gears are available in 5 sizes: 11, 14, 20, 32, and 40, with reduction ratios ranging from 3:1 to 31:1.

- ◆ **Backlash: One Stage <5 arc-min**
Two Stage <7 arc-min
- ◆ **Low gear ratios, 3:1 to 31:1**
- ◆ **High efficiency**
- ◆ **Helical gearing**
- ◆ **Quiet design: Noise <58dB (Size 14)**



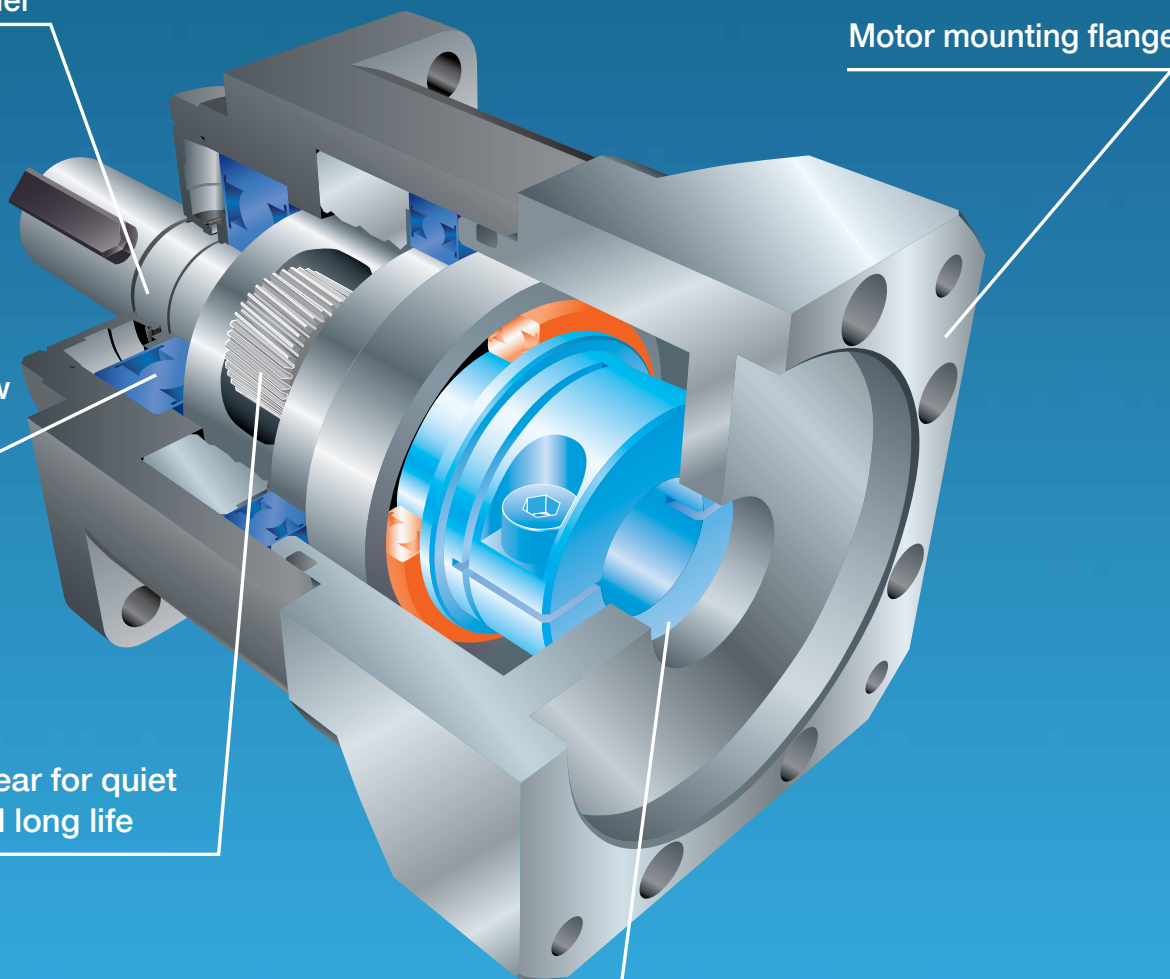
Integrated output
shaft and carrier

Motor mounting flange

Deep groove,
output bearings allow
high shaft loads

Ground helical gear for quiet
performance and long life

Quick Connect™ coupling for
easy mounting of any servomotor



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