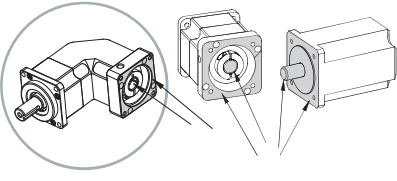
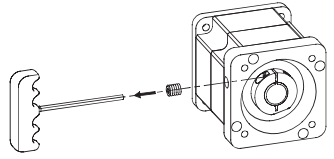
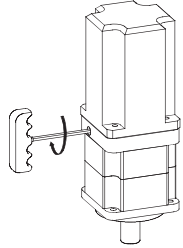
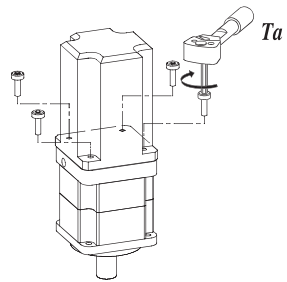
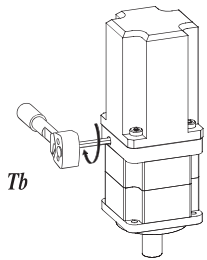
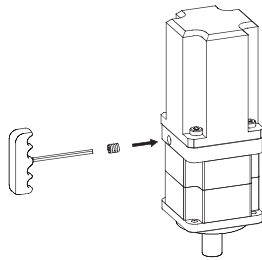


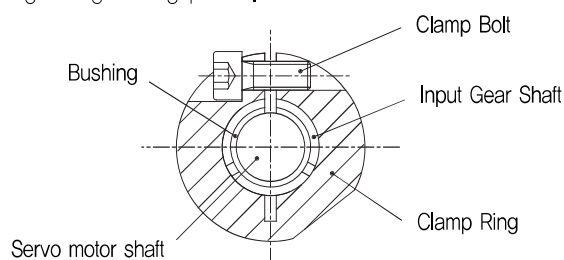
How to mount the servo motor

■ Servo motor mounting To mount with the servo motor, keep the following sequence

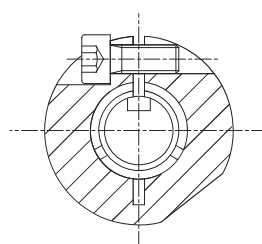
 <p>1 Clean the mounting phase after checking the motor and gearhead sizes. (Check the shaft diameter, use appropriate bush if necessary)</p>	 <p>2 Loosen the screw plug from the adapter flange and adjust the position so that the clamp bolt can be seen. (For proper servo motor shaft fixation method, see 'Appendix 1,')</p>	 <p>3 When mounting onto the motor, closely adhere the adapter flange of the reducer and the motor mounting side and slightly tighten the clamping bolt so that the clamp ring not idle.</p>
 <p>4 Tighten diagonally to the specified tightening torque with a torque wrench, (For tightening torque, see 'Appendix 2,')</p>	 <p>5 Tighten the clamp bolt to the specified tightening torque with a torque wrench, (For tightening torque, see 'Appendix 2,')</p>	 <p>6 Tighten again the screw plug</p>

■ Appendix 1 Proper servo motor shaft fixation method

If the servo motor shaft does not have a circular but key way, remove the key and make sure that the key way of the servo motor shaft and the clamp bolt of the gearhead input shaft can be perpendicular as shown in Fig. B₂ at mounting. Also, arrange each slot position of the Clamp Ring, the Gear Shaft, and the Bushing in a line to get higher tightening power.



(Figure A) Annular shaft



(Figure B) Key way

■ Appendix 2 Wrench Bolt tightening torque

Wrench Bolt Size	Motor mounting(8.8T) Ta		Clamp ring(12.9T)Tb	
	N · m	kgf · cm	N · m	kgf · cm
M3	1,28	13	2,15	22
M4	2,9	30	4,95	50
M5	5,75	59	9,7	99
M6	9,9	101	16,5	168
M8	24	245	40	408
M10	48	489	81	826
M12	83	846	140	1,428
M14	132	1,346	220	2,243
M16	200	2,039	340	3,467

■ Appendix 3 Conversion Table (Torque)

Units to be Converted	1 N · m	1 N · cm	1 kgf · m	1 kgf · cm	1 lbf · ft	1 lbf · in
1 N · m	1	10 ²	0,10197	10,197	0,7376	8,8509
1 N · cm	10 ⁻²	1	1,0197×10 ⁻³	0,10197	7,376×10 ⁻³	8,8509×10 ⁻²
1 kgf · m	9,8066	980,665	1	10 ²	7,233	86,79
1 kgf · cm	9,8066×10 ⁻²	9,8066	10 ⁻²	1	7,233×10 ⁻²	0,8680
1 lbf · ft	1,356	1,356×10 ²	0,1383	13,83	1	12
1 lbf · in	0,113	11,3	1,152×10 ⁻²	1,152	8,333×10 ⁻²	1

■ Appendix 4 Angular Unit Indication method

Angular Unit	Value	Symbol	약어
degree	1/360 circle	°	Deg
arcminute	1/60 degree	′ (prime)	arcmin, amin, MOA
arcsecond	1/60 arcminute	″ (double prime)	arcsec
miliarcsecond	1/1,000 arcsecond		mas

■ Appendix 5 Equipment Protection Grade (IP)

IP(Ingress Protection) is IEC529 standards specify the class of dustproof and waterproof in terms of the equipment protection structure.

The class indications of dustproof and waterproof are as follows.



1 The classification of dustproof (1st digit)

IP Indication	Level of Protection
IP0□	None
IP1□	Protected from the access of a hand
IP2□	Protected from the access of a finger
IP3□	Protected against the tool's edge
IP4□	Protected against the wire
IP5□	Protected against the dust
IP6□	Perfect dust-proof structure

② The classification of waterproof (2nd digit)

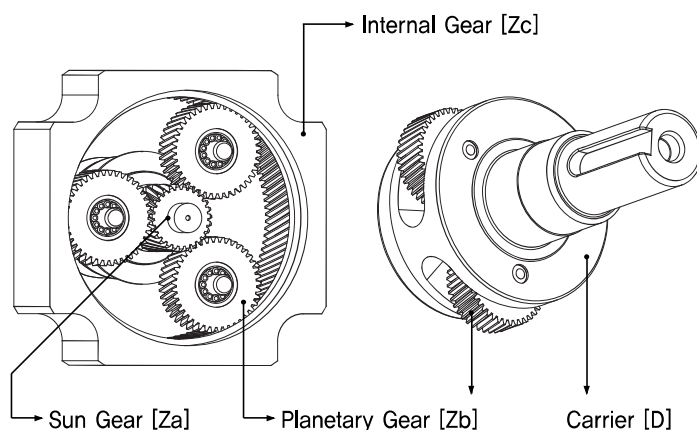
IP Indication	Level of Protection
IP 00	None
IP 01	Protected from the water-drop dropping vertically
IP 02	Protected from the water-drop dropping within a range of 15° from the vertical direction
IP 03	Protected from the water spraying within a range of 60° from the vertical direction
IP 04	Protected from the water splattering from all directions
IP 05	Protected from the water pouring from all directions
IP 06	Protected from the water pouring strongly like a sea wave
IP 07	Possible to use while immersed in the water under certain conditions
IP 08	Possible to use under the water



TECHNICAL MATERIAL

- ▶Classification of planetary gear appliance structure/use
- ▶Reliability assessment terms [I ~ V]
- ▶Gearhead selection examples

■ Planetary gear structure



The major components of Planetary gear heads are

- ① Sun Gear
- ② Planetary Gear
- ③ Internal Gear

and composes of **carriers** as a basic unit.

It is gear equipment with such advantageous features that it cannot only obtain a large reduction ratio but also high efficiency and precise control of power transfer while it is in a compact style.

Type	Fixed component	Input	Output	* Calculation formula of reduction ratio	Reduction ratio range	** Planetary Gear
Planetary Gear	Internal Gear	Sun Gear	Carrier	$\frac{1}{\frac{Z_c}{Z_a} + 1}$	1/3 ~ 1/12	Performance of simultaneous rotation and revolution
Star	Carrier	Sun Gear	Internal Gear	$-\frac{1}{\frac{Z_c}{Z_a}}$	1/2 ~ 1/11	Performance of revolution only
Solar	Sun Gear	Internal Gear	Carrier	$\frac{1}{\frac{Z_a}{Z_c} + 1}$	1/1.2 ~ 1/1.7	Performance of simultaneous rotation and revolution

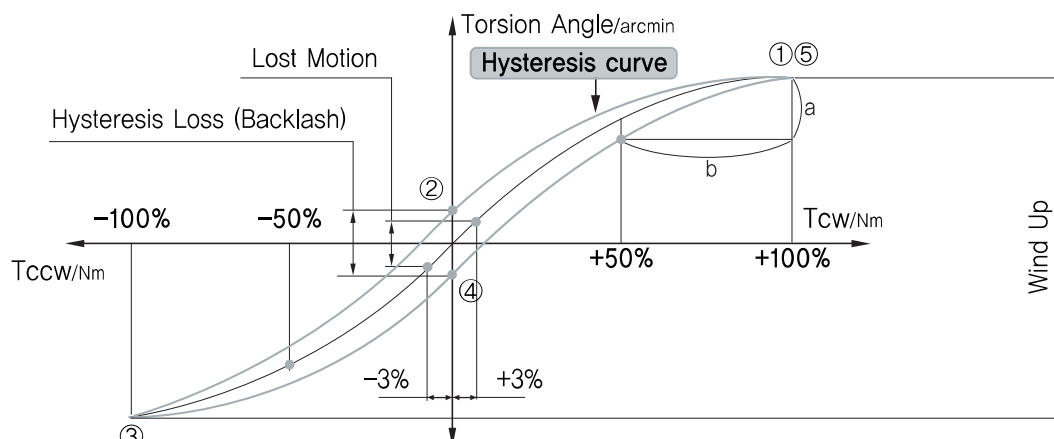
* Z in a calculation formula indicates the number of teeth in each component gear, and the sign (-) means the output direction opposite to that of input.

** It means an operation condition of planetary gears only.

■ Classification of general uses of a planetary reducer (by Backlash grade)

Division	Backlash (arcmin)	Applications	Control method
High precision class	3' or less	<ul style="list-style-type: none"> robot peripheral equipment (Positioner, Slider etc.) inspection equipment, precision FA machinery, medical equipment, Index equipment packing machinery, textile machinery, machine tool 	Position control
Precision class	5' or less	<ul style="list-style-type: none"> precision Conveyor (transfer, division, loading) logistics conveyance system (AGV, automated warehouse) injection machinery extracting equipment 	Speed control
General class (standard class)	10'~30'	<ul style="list-style-type: none"> Conveyor, Bending Machine, Pallet Stacker printing machinery, food processing machinery, film winding machine various kinds of testing instruments 	Torque control

■ Hysteresis curve Torque – torsion angle diagram



■ Backlash Hysteresis Loss (arcmin)

In general, whenever measuring backlash, which indicates the level of a reducer, the value measured by giving 3% of rated output torque of the reducer toward both directions(±3%) should be read. That is, if the input shaft of the reducer is fixed and torque is given to the output part, torsion responding to torque is incurred in the output part. In other words, In general, the torsional angle cannot return to a complete zero, leaving some value with it if a torque is fully applied until it reaches a rated value and then released to a zero, as shown in the line drawing. This is called Hysteresis Loss.

① Normal rotation(rated output torque Tcw) ► ② Zero ► ③ Inverse rotation(rated output torque Tccw) ► ④ Zero ► ⑤ If torque values are gradually changed in the same sequence as normal rotation(rated output torque Tcw), the curve is drawn as shown in the figure [Hysteresis Curve].

As shown in the figure, ②④ value for the zero torque part of the hysteresis curve is called Hysteresis Loss, and for the SPG's planetary reducer(SPI□/SPL□ series), the amount of Hysteresis Loss is measured, and it is set as product backlash specification.

■ Lost Motion Rotational accuracy (arcmin)

Lost Motion indicates angle of torsion in the middle of hysteresis up/down curve width within ±3% of rated output torque for backlash measurement. In general cases, Lost Motion including elastic deformation of power transmission system except Hysteresis Loss is indicated in a higher value.

■ Torsional Rigidity (Nm/arcmin)

Difference in angle of torsion, which is measured while the input shaft is fixed and each 50% and 100% of load torque are given to the output shaft, is expressed in a proportional slope, and torsional rigidity in Fig. [Hysteresis Curve] can be indicated in the following equation.

$$T_r = \frac{b}{a}$$

T_r : Torsional rigidity

a : Difference in angle of torsion when each 50% and 100% of rated output torque are given to the output shaft

b : 50% of rated output torque

■ Wind Up (arcmin)

It indicates a method of finding unidirectional total torsional value (average value) when a load is applied to reducer in no load condition.

$$\theta = d + \frac{T - T_L}{T_r}$$

θ : total torsional value (arcmin)

d : permissible output torque (Nm) × 0.5 unidirectional torsional value in the torque section

T : load torque (Nm)

T_L : permissible output torque (Nm) × 0.5 (= $T_r \times 0.5$)

T_r : torsional torque stiffness (Nm / arcmin)

■ Angle transfer degree (arcmin)

angle transfer degree (or transfer error) indicates the difference between the theoretical output rotation angle and the actual output rotation angle (θ_{out}) when an arbitrary rotation angle (θ_{in}) is instructed to enter.

$$\theta_{er} = \frac{\theta_{in}}{R} - \theta_{out}$$

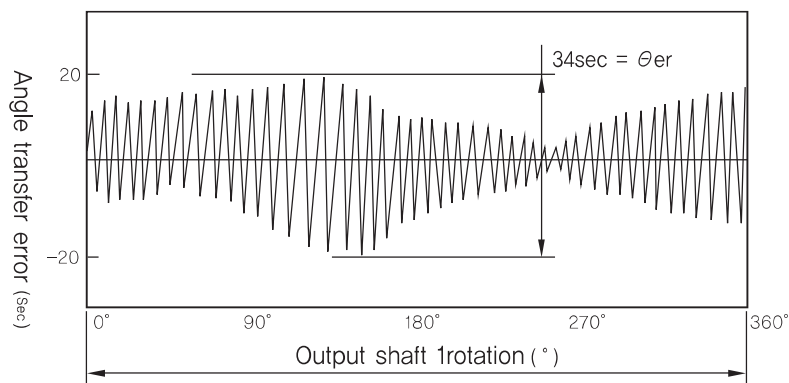
θ_{er} : angle transfer degree (or transfer error)

θ_{in} : input rotation angle

θ_{out} : actual output rotation angle

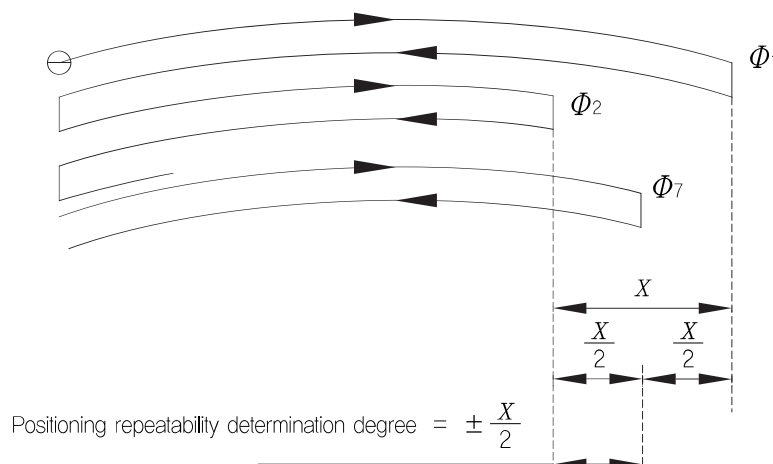
R : planetary gearbox's reduction gear ratio

Example of actual measurement



■ Positioning repeatability determination degree (arcmin)

A positioning repeatability determination degree (or determination error) finds the maximum difference by measuring the stop position of output shaft after it repeats the position determination seven times in the same direction at an arbitrary position. The measurement is shown in an angle and indicated in a way the \pm sign is assigned to the half value of the maximum difference.



■ The Life of Gearheads (hr)

In case of actual operation by assembling a reducer to the equipment, the service life hours shall be obtained through the following calculation formula as each load condition differs from case to case.

$$L_h = *20,000 \times \frac{N_o}{N_m} \times \left(\frac{T_o}{T_m} \right)^3$$

L_h : The life of gearheads (hr)

N_m : Mean value output speed (rpm)^①

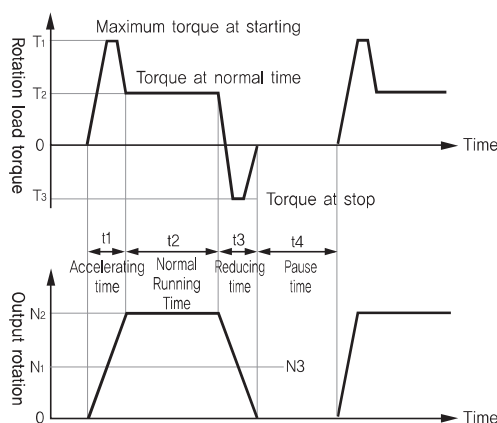
N_o : Rated output speed (rpm)

T_m : Mean value load torque (kg · m)^②

T_o : Rated output torque (kg · m)

* In case of continuous operation (S1) : 10,000hrs

Load Cycle line graph



① N_m : Mean value output speed (rpm)

$$N_m = \frac{t_1 | N_1 | + \dots + t_n | N_n |}{t_1 + \dots + t_n}$$

② T_m : Mean value load torque (kg · m)

$$T_m = \sqrt[3]{\frac{t_1 | N_1 | T_1 |^3 + \dots + t_n | N_n | T_n |^3}{t_1 | N_1 | + \dots + t_n | N_n |}}$$

(In case of Ball Bearing)

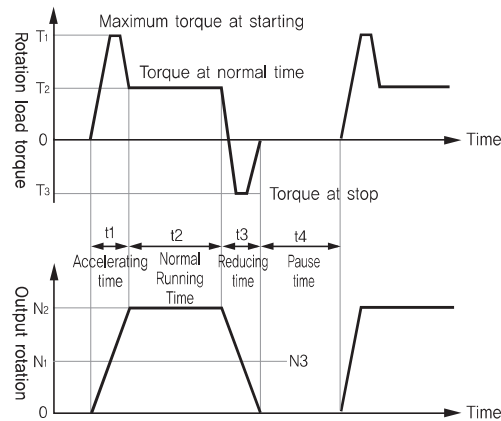
$$T_m = \sqrt[10/3]{\frac{t_1 | N_1 | T_1 |^{10/3} + \dots + t_n | N_n | T_n |^{10/3}}{t_1 | N_1 | + \dots + t_n | N_n |}}$$

(In case of Roller Bearing)

■ Cycle load factor (ED)

In case of actually running a reducer after assembling it to the equipment, please refer to the reducer selection method (24 page) and the following calculation formula at time of selecting a reducer based on the load pattern, as each load condition differs from case to case.

Load Cycle line graph



① ED : Cycle load factor (Duty Cycle)

$$ED (\%) = \frac{(t_1 + t_2 + t_3)}{(t_1 + t_2 + t_3 + t_4)} \times 100$$

$$\text{Operation hours } (T_{\text{work}}) = t_1 + t_2 + t_3 \text{ [sec]}$$

② Zh : Number of Cycle / hr

$$Zh = \frac{3,600 \text{ [s]}}{(t_1 + t_2 + t_3 + t_4)}$$

③ i : Reduction of Gear ratio

$$i = \frac{\text{Maximum input speed (rpm)}}{\text{Maximum output speed (rpm)}}$$

④ Operating Condition

- intermittent operation(S4/S5) : $ED \leq 60\%$ and $T_{\text{work}} \leq 20\text{min}$
- continuous operation : $ED > 60\%$ or $T_{\text{work}} > 20\text{min}$

■ Output shaft maximum load moment (N-mm)

The following calculation formula shows the method seeking the maximum load moment load (M_{max}). Make sure that $M_{max} \leq M_c$.

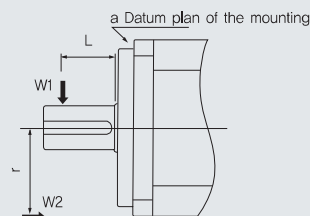
$$M_{max} = W_{1max} \times L + W_{2max} \times r$$

W_1 : Radial Load (N, kgf)

W_2 : Thrust Load (N, kgf)

L, r : length (mm)

M_c : load moment (N-mm, kgf-mm)



■ Overhang Load (O.H.L) calculation

Overhang Load (O.H.L) is referred to as the suspension load applying to a shaft. It would be the best if a planetary reducer is directly connected with a concerned machine, but if it is linked through a chain, belt or gear, the O.H.L applying to the output shaft of a planetary reducer shall be less than an permissible O.H.L of the planetary reducer to be used.

$$O.H.L (N) = \frac{T_e \times K \times L}{R}$$

T_e : correction load torque applying to an output shaft of a planetary reducer (Nm)

[Correction load torque= load torque applying to a planetary reducer(T_i)×Service Factor (S_f)]

R : radius of a pitch circle in a component such as sprocket, pulley, and gear (m)

K : co-efficient followed by a connection method (refer to table 1)

L : co-efficient followed by the position of a load applied (refer to table 2)

(table 1)

Connection method	K
Chain, Timing Belt	1.00
Gear	1.25
V-Belt	1.5
Flat-Belt	2.5

(table 2)

Load position	L
Shaft source	0.75
Shaft middle	1
Shaft end	1.5

(table 3) Service Factor by the load condition

Load condition	Service Factor (S_f)		
	Operation of less than 3 hrs/day	operation of 3~10hr/day	operation of more than 10 hrs /day
Uniform load (In case of unidirectional and continuous operation)	1 (1)	1 (1.25)	1.25 (1.50)
Light impact load (In case of frequent reverse operation)	1 (1.25)	1.25 (1.50)	1.50 (1.75)
Severe impact load (In case of instantaneous reversing and instantaneous stop)	1.25 (1.50)	1.50 (1.75)	1.75 (2.00)

(Note) in the case of more than 10 times of running and stopping in an hour, the co-efficient in () shall be used.

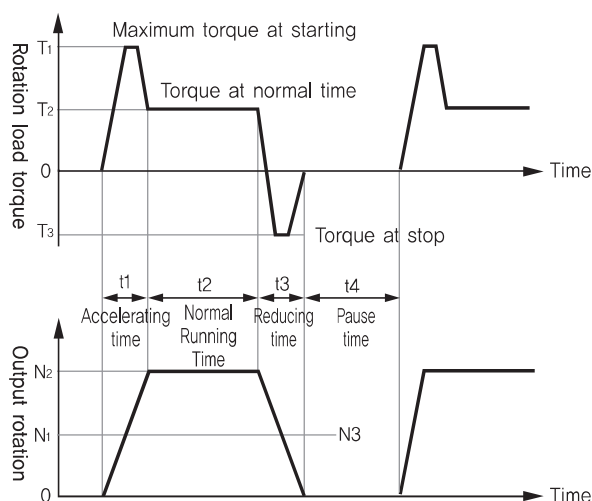
In general, there is almost no condition of continuously uniformed load in servo system. A load torque changes according to the fluctuation in an input rpm, but when it starts or stops, not only a relatively large torque is applied to, but also unexpected shock torque is placed on.

Therefore, first check the load torque pattern below considering the service condition like this, and then select an appropriate reducer model, according to Model selection order.

In addition, if any of the specifications concerning a model exceeds the rated torque values, it would be better if you could examine a model higher a stage than a target model, or consider a lower load torque.

■ Conditions of servo system load to be used (example)

Load Cycle line graph



(table1) Condition of servo motor operation patterns (example)

T_1	Maximum torque at starting time	Nm	100
T_2	Torque at normal time	Nm	30
T_3	Maximum torque at stopping time	Nm	80
N_1	Mean output rpm at accelerating time	rpm	300
N_2	Output rpm at normal operation time	rpm	600
N_3	Mean output rpm at reduction time	rpm	300
t_1	Acceleration hours	sec	0.2
t_2	Normal operation hours	sec	5
t_3	Reduction hours	sec	0.2
t_4	Stopping hours	sec	3

■ reducer model selection (reference: 33 page 「reducer selection method 2」)

First, as the service condition in an example, check on the condition of servo motor operation patterns set out in the 35 page (table1), and then select a model following the order described below.

1 Duty cycle ED / calculation of operation conditions

$$ED (\%) = \frac{(t_1 + t_2 + t_3)}{(t_1 + t_2 + t_3 + t_4)} \times 100 = \frac{(0.2 + 5 + 0.2)}{(0.2 + 5 + 0.2 + 3)} \times 100 = 64.3\% (>60\%)$$

$$\text{Running hours (T}_{\text{work}}) = t_1 + t_2 + t_3 [\text{min}] = (0.2 + 5 + 0.2)/60 [\text{min}] = 0.09 [\text{min}] (<20[\text{min}])$$

∴ Continuous operation S1

2 Calculation of mean output torque (T_m)

$$T_m = \sqrt[3]{\frac{t_1 N_1 T_1^3 + \dots + t_n N_n T_n^3}{t_1 N_1 + \dots + t_n N_n}}$$

$$= \sqrt[3]{\frac{0.2 \times 300 \times 100^3 + 5 \times 600 \times 30^3 + 0.2 \times 300 \times 80^3}{0.2 \times 300 + 5 \times 600 + 0.2 \times 300}}$$

$$\therefore T_m = 38.03 [\text{N} \cdot \text{m}]$$

3 Calculation of maximum acceleration torque [T_{max}]

$$T_{\text{max}} = T_1 \times f_s$$

Z_h [Number of cycles / hr]

$$Z_h = \frac{3,600 [\text{s}]}{(t_1 + t_2 + t_3 + t_4)} = \frac{3,600}{8.4} = 428.6 [\text{cycle}] \text{ Therefore, } f_s = 1 \text{ (refer to table 1 on page 33)}$$

$$\therefore T_{\text{max}} = 100 \times 1 = 100 [\text{N} \cdot \text{m}]$$

4 Determination of maximum output speed & reduction ratio

In case the maximum output speed (N_{max}) of a reducer is set to 600rpm,

$$\text{Reducer ratio(i)} = \frac{\text{Servo motor's maximum output speed (N}_2 \text{ [rpm])}}{\text{Reducer's maximum output speed (N}_{\text{max}} \text{ [rpm])}} = \frac{3,000}{600} = 5 \quad \therefore \text{Reducer ratio(i)} = 1 : 5$$

5 Reducer selection

Compare T_{2N} and T_{2B} Data on the Catalog 「Specifications」for the reduction ratio determined, and then the result values of T_m and T_{max} obtained from the calculation of 2, 3 above, when compared with SPI060S005 (refer to Catalog page 23)

① mean torque [T_m < T_{2N}] : 38.03 [N·m] < 42 [N·m] ② acceleration torque [T_{max} < T_{2B}] : 100 [N·m] < 126 [N·m]

∴ It is judged to be rational that SPI060S005 shall be selected.

6 Verification

The order of the calculations introduced above can be changed depending on a condition, but mean torque [T_m] and maximum acceleration torque [T_{max}] shall be checked without fail to set the equipment and secure the safety of the system. In addition, T_m and T_{max} in the calculation above is nothing but a selection method following the operation pattern of servo motor when the values are needed to set application equipment, so a separate calculation through a structural analysis of equipment setting is required for the selection of more accurate reducer.

Cautions at use and warranty

■ Caution

Be careful of product handling.

- Be careful not to give an impact to the product with a hammer and not to cause damage from a drop at handling.

In case of directly connecting the product to the load side, pay attention to assembling.

- Be careful of direct connection such as concentricity, parallel level, tension, etc. whenever connecting the product to the load side such as a belt, a chain, etc.
- Be careful of handling the edge of the product and the key way of the output shaft. It may cause an injury.
- Do not put a hand or other foreign substance in a rotating shaft while the product drives. It may cause an injury.

Do not give an impact to the product.

- Be careful not to give an excessive impact whenever assembling a pulley, a coupling, a key, etc. to the product.

Do not exceed permissible torque at use.

- Do not give more than the instantaneous permissible maximum torque. It may cause troubles by bolts loosened on the tightening part, shaking, damage, etc.

Do not disassemble the product.

- Do neither disassemble nor reassemble the product. Otherwise the original performance may not be guaranteed.

If any abnormal condition is sensed, stop the system.

- If abnormal sound, vibration, abnormal heat, etc. occur, immediately stop the system. Otherwise it may adversely influence the system.

■ Warranty

A WARRANTY PERIOD AND A WARRANTY LIMIT OF THE PRODUCT IS AS FOLLOWS.

1 Warranty Period

Either 2,000hour working time or 12 months after the delivery for the product, which reaches earlier, should be applied on condition of use with operation, assembling, and lubrication specified by SPG.

2 Warranty Limit

For a fault by a defect in SPG manufacturing during the above warranty period, repair or exchange of the product should be conducted under SPG responsibilities. However, the following cases are excluded from the Warranty Limit.

① Unsuitable handling or use by customers

② Remodeling or repair not by SPG without permission

③ A fault resulting from other reasons except the product

④ Such fault as attributable to natural disaster etc.,
which is not SPG responsibility

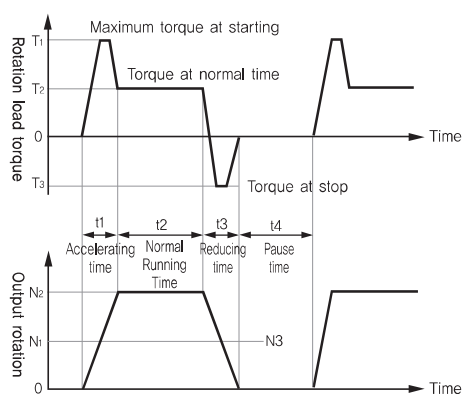
Warranty herein means warranty for the product.

Other losses (chance loss by loss of the machine & assembly man-hour, assembly & disassembly, and mounting costs) arising out of a failure of the product are beyond the range of SPG burdens.

Request Information

Customer	Company :	Zip/Postal Codes :	Name :	Job Title :
	TEL :	FAX :	E-mail :	
Address			Country :	
Operating Conditions				
Machine Name				
Application				
Spec. of the Gearheads	SPI□ / SPL□ –	Reduction Ratio i =	Backlash : arcmin	

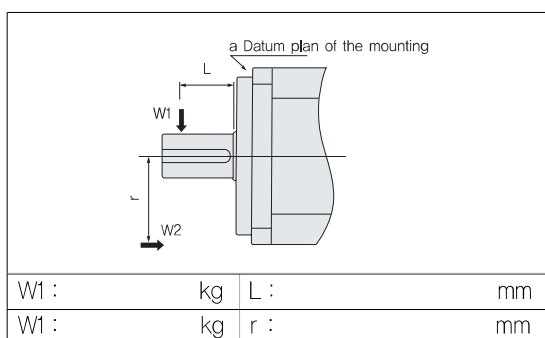
1. The Conditions of Load




	starting (Max.)	Normal	Stop(Max.)	Pause time
N · m	T1	T2	T3	—
rpm	N1	N2	N3	—
sec	t1	t2	t3	t4

Running Time	Cycle/day	Day/year	year
--------------	-----------	----------	------

2. The Load Conditions of Output Shaft



3. The Mounting Direction

☐ Horizontality 
☐ Verticality 

The Outline figure of Mounting

4. The Specifications of Input Side

☐ Servo motor ☐ other ()

Capacity	W
Nominal Torque	N · m
Input Speed	rpm
Output Shaft Dimensions	$\varnothing =$, l mm

5. Others

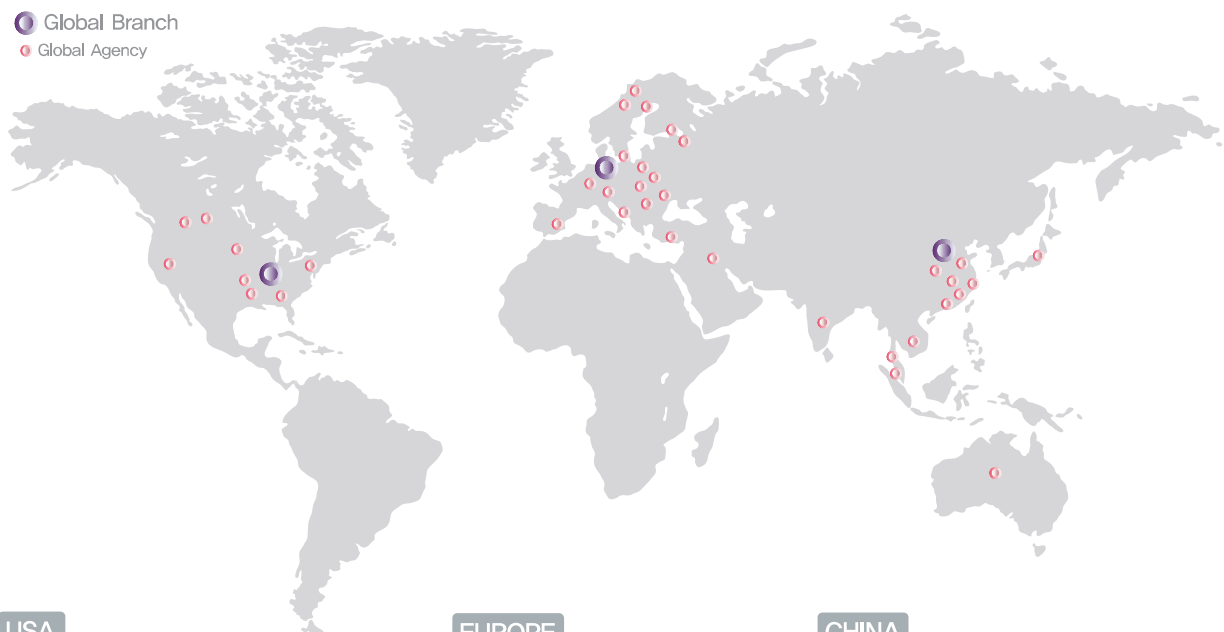
Sales Network

Domestic



Worldwide

 Global Branch
 Global Agency



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