

# HIGH PRECISION PLANETARY GEARHEADS FOR SERVO MOTORS SPL Series

- ▶ Spur Gear
- ▶ Compact size
- ▶ High Precision, High Durability
- ▶ High Efficiency
- ▶ Easy Mount
- ▶ Protection grade IP65

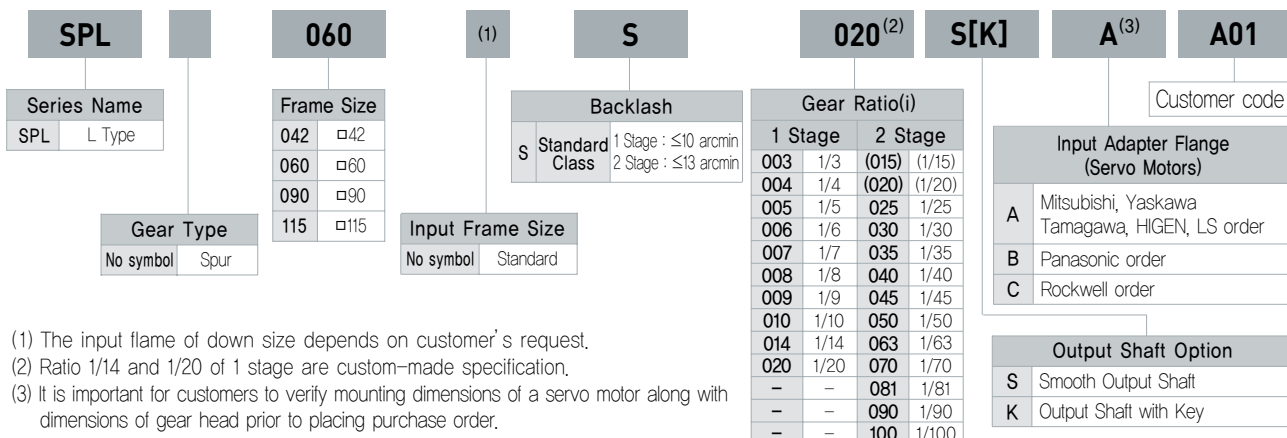
## Specifications

Description	Unit	Stage	Ratio <sup>(1)</sup>	Model No.						
				SPL 042	SPL 060	SPL 060D	SPL 090	SPL 090D	SPL 115	SPL 115D
Nominal Output torque $T_{2N}$ <sup>(2)</sup>	Nm	1	3	7.5	13.5	-	78	-	171	-
			4	10	18	-	102	-	205	-
			5	12.5	22.5	-	112	-	235	-
			6	-	27	-	103	-	-	-
			7	14	31.5	-	100	-	210	-
			8	-	36	-	102	-	-	-
			9	14	34	-	96	-	160	-
			10	10	29	-	80	-	191	-
			14	-	31.5	-	100	-	210	-
			20	-	29	-	80	-	191	-
		2	15	15	-	-	-	-	-	-
			20	14	-	-	-	-	-	-
			25	19	42	42	112	112	235	235
			30	15	46	46	110	112	190	235
			35	19	42	42	112	112	235	235
			40	14	35	35	102	112	205	235
			45	19	42	42	112	112	235	235
			50	19	42	42	112	112	235	235
			63	14	38	38	100	100	210	210
			70	14	38	38	100	100	210	210
81	14	34	34	96	96	160	160			
90	14	34	34	96	96	160	160			
100	10	29	29	80	80	191	191			
Max Acceleration torque $T_{2B}$	Nm	1,2	3~100	3 times of Nominal Output torque						
Nominal Input speed $n_1$	rpm	1,2	3~100	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Max. Input speed $N_1$	rpm	1,2	3~100	6,000	6,000	6,000	5,000	5,000	5,000	5,000
Backlash (Standard class)	arcmin	1	3~20	≤ 13	≤ 13	-	≤ 13	-	≤ 13	-
		2	15~100	≤ 16	≤ 16	≤ 16	≤ 16	≤ 16	≤ 16	≤ 16
Torsional Rigidity	Nm/arcmin	1,2	3~100	2	3	3	12	12	23	23
Max. Radial load $F_r$ max <sup>(2)</sup>	N	1,2	3~100	400	1,100	1,100	2,400	2,400	4,000	4,000
Max. Axial load $F_a$ max <sup>(2)</sup>	N	1,2	3~100	300	600	600	1,800	1,800	2,500	2,500
Service life <sup>(2)</sup>	hr	1,2	3~100	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Noise level <sup>(3)</sup>	dB(A)	1,2	3~100	≤ 61	≤ 63	≤ 63	≤ 65	≤ 65	≤ 68	≤ 68
Weight	kg	1	3~20	0.9	2.0	-	5.7	-	12.9	-
		2	15~100	1.1	2.4	2	7.0	5.9	16.7	14.1
Mass Moment of Inertia <sup>(4)</sup>	kg cm <sup>2</sup>	1	3~20	0.04	0.15	-	0.8	-	2.8	-
		2	15~100	0.03	0.07	0.07	0.5	0.5	1.5	1.5
Operating Temp. <sup>(5)</sup>	°C	1,2	3~100	-10 ~ +90						
Lubrication		1,2	3~100	High temperature & Extreme pressure Lubricant						
Mounting position		1,2	3~100	All directions						
Efficiency $\eta$	%	1	3~20	≥ 95						
		2	15~100	≥ 92						
Degree of protection		1,2	3~100	IP 65						

(1) Ratio =  $N_{in} / N_{out}$  (2) Values were measured at the following conditions : 100 rpm at the output, Load applied to the middle of the output shaft, Load coefficient( $K_a$ ) = 1, Continuous operation( $S_1=10,000$ hrs), (3) Noise level : A measurement 1m away from the gear head, 3000 input rpm and at no load condition, (Background noise 21dB(A)) (4) Moment of inertia : A measurement at the input shaft and representatives from each ratio.( $i=1/5$ ) (5) Operating temperature : Surface temperature of gear case in  $-10^{\circ}\text{C}\sim 40^{\circ}\text{C}$  of ambient temperature.

※ The data in the above table are representative values. Specifications are subject to change without notice to improve product performances.

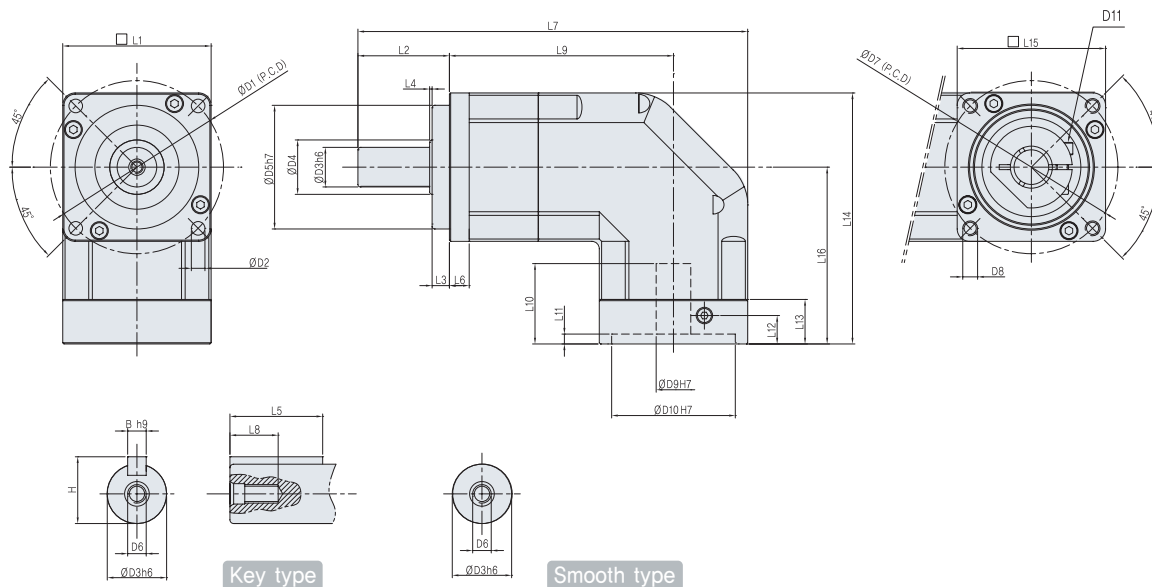
## Coding System



(1) The input flange of down size depends on customer's request.  
 (2) Ratio 1/14 and 1/20 of 1 stage are custom-made specification.  
 (3) It is important for customers to verify mounting dimensions of a servo motor along with dimensions of gear head prior to placing purchase order.

# Planetary Gearheads

■ Dimensions (1 Stage, Ratio(i) = 1/3 ~ 1/20)



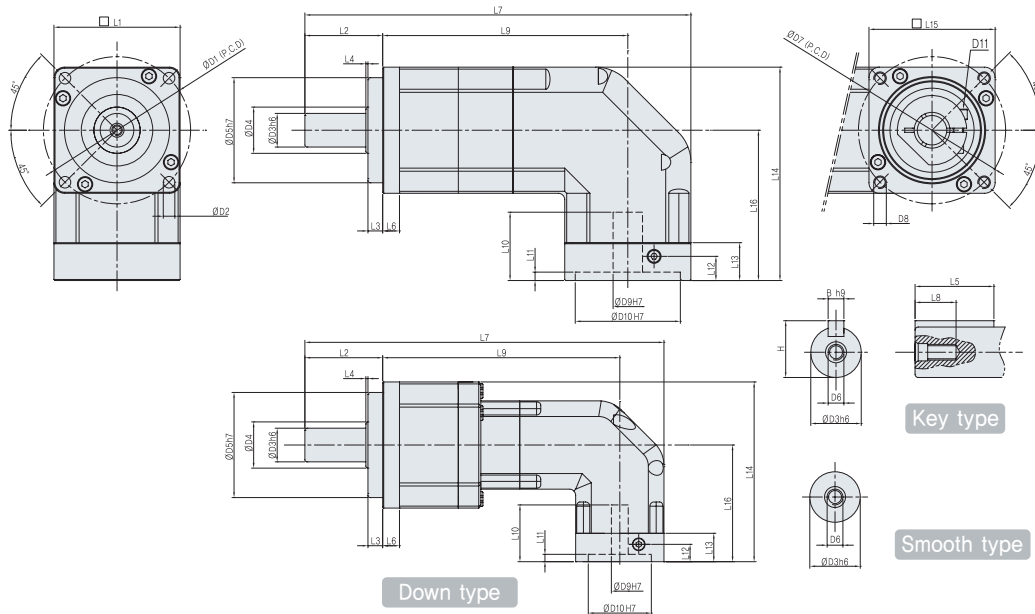
(Unit : mm)

Dimension \ Model	SPL 042	SPL 060	SPL 090	SPL 115
D1	50	70	100	130
D2	3,4	5,5	6,5	9
D3 h6	13	16	22	32
D4	14,5	19,7	24,8	39,8
D5 h7	35	50	80	110
D6	M4xP0,7	M5xP0,8	M8xP1,25	M12xP1,75
D7	A	46	70	145
	B	45	70	-
	C	46	70	-
D8	A	M4 DP 8	M5 DP 12	M6 DP 12
	B	M3 DP 6	M4 DP 12	M5 DP 12
	C	M4 DP 8	M5 DP 12	M6 DP 12
D9 H7	≤ 8	≤ 14	≤ 19	≤ 32
D10 H7	30	50	70	110
D11	M3	M5	M5	M8
L1	42	60	90	115
L2	24,5	37	46	65
L3	4	7	8	12
L4	1	1	1,5	2
L5	16	25	32	45
L6	7	8	10	14
L7	121,6	157,6	216,2	283,8
L8	13	13	19	28
L9	76,1	90,6	125,2	153,8
L10	A, B	27	35,5	73
	C	30,5	40	-
L11	3,5	4	4	7
L12	A, B	8,3	11,5	11,5
	C	11,8	16	16
L13	A, B	13,5	18	18
	C	17	22,5	22,5
L14	A, B	76,5	101,5	133,1
	C	80	106	138,1
L15	42	60	90	130
L16	A, B	55,5	71,5	88,1
	C	59	76	93,1
B h9	5	5	6	10
H	15	18	24,5	35

- Note) 1. Specifications are subject to change without notice to improve product performances.  
 2. The values of D7 through D11 and L10 through L16 on the above table may vary by servo motor.  
 3. CAD files are available to download from website(www.spg.co.kr).

# SPL Series

## ■ Dimensions (2 Stage, Ratio(i) = 1/25 ~ 1/100)

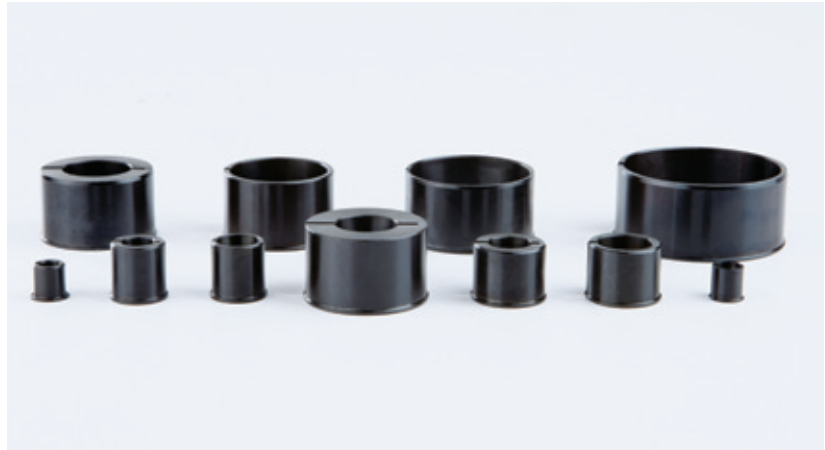
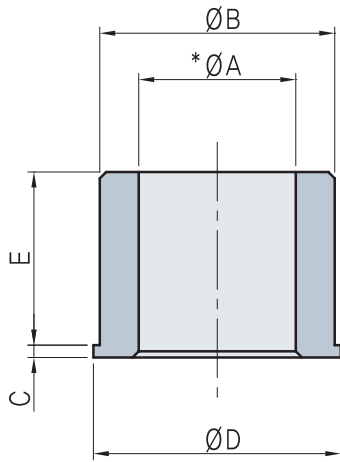


(Unit : mm)

Dimension \ Model	SPL 042	SPL 060	SPL 060D	SPL 090	SPL 090D	SPL 115	SPL 115D
D1	50	70	70	100	100	130	130
D2	3.4	5.5	5.5	6.5	6.5	9	9
D3 h6	13	16	16	22	22	32	32
D4	14.5	19.7	19.7	24.8	24.8	39.8	39.8
D5 h7	35	50	50	80	80	110	110
D6	M4xP0.7	M5xP0.8	M5xP0.8	M8xP1.25	M8xP1.25	M12xP1.75	M12xP1.75
D7	A	46	70	46	90	70	145
	B	45	70	45	90	70	-
	C	46	70	46	90	70	-
D8	A	M4 DP 8	M5 DP 12	M4 DP 8	M6 DP 12	M5 DP 12	M8 DP 20
	B	M3 DP 6	M4 DP 12	M3 DP 6	M5 DP 12	M4 DP 12	-
	C	M4 DP 8	M5 DP 12	M4 DP 8	M6 DP 12	M5 DP 12	-
D9 H7	≤ 8	≤ 14	≤ 8	≤ 19	≤ 14	≤ 32	≤ 19
D10 H7	30	50	30	70	50	110	70
D11	M3	M5	M3	M5	M5	M8	M5
L1	42	60	60	90	90	115	115
L2	24.5	37	37	46	46	65	65
L3	4	7	7	8	8	12	12
L4	1	1	1	1.5	1.5	2	2
L5	16	25	25	32	32	45	45
L6	7	8	8	10	10	14	14
L7	146.6	183.6	170.8	254.2	217.1	333.8	297.9
L8	13	13	13	19	19	28	28
L9	101.1	116.6	112.8	163.2	141.1	203.8	187.9
L10	A, B	27	35.5	27	42.5	35.5	73
	C	30.5	40	30.5	47.5	40	-
	L11	3.5	4	3.5	4	4	7
L12	A, B	8.3	11.5	8.3	11.5	11.5	27.5
	C	11.8	16	11.8	16	16	-
	L13	13.5	18	13.5	18	18	42
L14	A, B	17	22.5	17	23	22.5	-
	C	76.5	101.5	85.5	133.1	116.5	188.8
	L15	80	106	89	138.1	121	-
L16	A, B	42	60	42	90	60	130
	C	55.5	71.5	55.5	88.1	71.5	131.3
	H	59	76	59	93.1	76	-
B h9	5	5	5	6	6	10	10
H	15	18	18	24.5	24.5	35	35

- Note) 1. Specifications are subject to change without notice to improve product performances.  
 2. The values of D7 through D11 and L10 through L16 on the above table may vary by servo motor.  
 3. CAD files are available to download from website(www.spg.co.kr).

## ■ Adapter Bush ( for Motor Shaft )



Dimension \ Model	42	60	90	115	142	180	220
* $\varnothing A$	5, 6, 6.35, 7	6.35, 8, 11, 12	8, 11, 12, 12.7, 14, 16	16, 19, 22, 24, 28	19, 22, 24, 28, 35	35, 42, 44, 45	35, 42, 45
$\varnothing B$	8	14	19	32	38	48	55
C	0.5	1	1	1	1	1	1
$\varnothing D$	9	15	20	33	39	49	56
E	8.5	14	14	19	19	21	27

$\varnothing A$  : Optional dimension depending on type of motor shaft.  
Shall verify prior to order placing.

# Gearhead Selection

## ■ Check points for gearhead selection

### Select Servo Motor

- ① Select motor manufacturer.
- ② Select the model.

### Select Gearhead

- ① Select frame size.
- ② Select gear ratio.
- ③ Select backlash.

### Check Specification of Servo Motor and Gearhead

- ① Check dimension  
(CAD file can be downloaded from [www.spg.co.kr](http://www.spg.co.kr))
- ② Check specification of gear ratio.
  - ▶ External load condition on the output shaft  
(radial load(or O.H.L), thrust load)
  - ▶ Rated torque, stall torque
  - ▶ Rated rpm, max rpm
  - ▶ Inertia moment, Maximum load moment of output shaft
  - ▶ Weight
- ③ Check Specification of Servo Motor.
  - ▶ Rated output
  - ▶ Rated torque
  - ▶ Stall torque
  - ▶ Rated rpm
  - ▶ Max rpm
  - ▶ Rotor inertia...etc.

### Other Check Points

- ① Check output torque on gearhead with the servo motor.
- ② Check if radial and/or thrust load of the assembling device is within the gearhead's tolerance range.
- ③ Check on backlash of the gearhead .
- ④ Check on operating condition (temperature, humidity, cleanness, etc..)

※ A planetary gearhead is designed under an assumption that its working load is run on an ideal and constant load condition. Therefore, select an appropriate product in consideration of a load factor if a working load is in change.

# Gearhead Selection

## ■ Selecting a gearhead <1-a> Simple selection by servo motor capacity and gear ratio (based on Rated input speed 3,000rpm motor)

Ratio Motor Capa.	3	5	10	20	30	40	50	81	100
50W									
100W	SPI□ / SPL□ 042								
200W									
400W	SPI□ / SPL□ 060								
750W									
1,000W									
1,500W	SPI□ / SPL□ 090								
2,000W									
3,000W									
4,000W	SPI□ / SPL□ 115								
5,000W									
6,000W									
7,000W	SPI H / SPL H 142								
8,000W									
11,000W									
12,000W	SPI H / SPL H 180								
15,000W									
22,000W	SPI H / SPL H 220								

## ■ Selecting a gearhead <1-b> Simple selection by servo motor capacity and gear ratio (based on Rated input speed 2,000rpm motor)

Ratio Motor Capa.	3	5	10	20	30	40	50	81	100
50W									
100W	SPI□ / SPL□ 042								
200W									
400W	SPI□ / SPL□ 060								
750W									
1,000W									
1,500W	SPI□ / SPL□ 090								
2,000W									
3,000W									
4,000W	SPI□ / SPL□ 115								
5,000W									
6,000W	SPI H / SPL H 142								
7,000W									
8,000W									
11,000W	SPI H / SPL H 180								
12,000W									
15,000W									
22,000W	SPI H / SPL H 220								

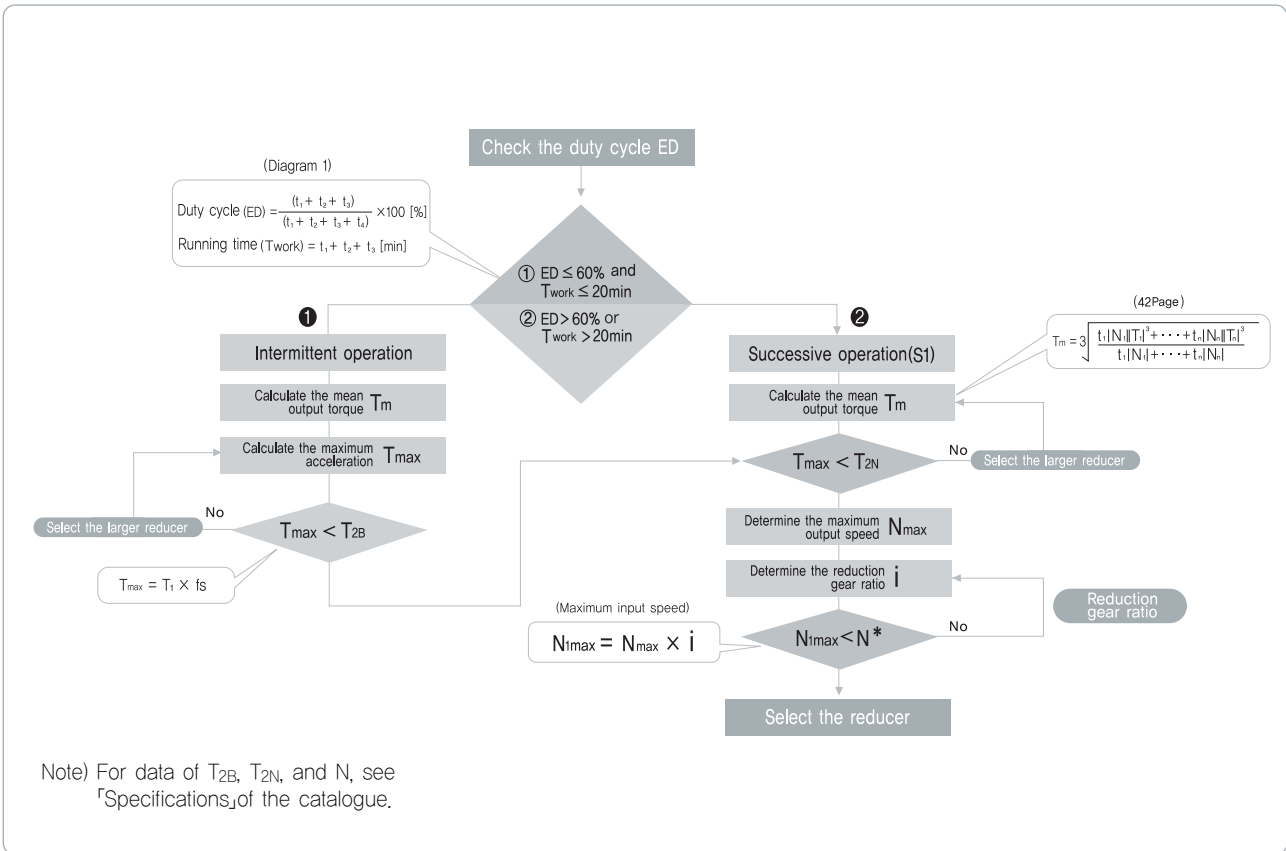
Note) 1. 「Selecting a gearhead <1-a> & <1-b>」 are the reference for simple selection of a gearhead. See 「Selecting a gearhead <2>」 for more accurate selection.

2. Select a gearhead within the range (rated torque X gear ratio X efficiency of servo motor <rated torque of gearhead)

3. Above selection tables refer till 1/50 gear ratio. If in need of the gear ratio above 1/50, contact us for further information and if possible, raise frame size of gearhead by upper one size.

# Gearhead Selection

## How to select a gearhead (2) For selection considering operation conditions

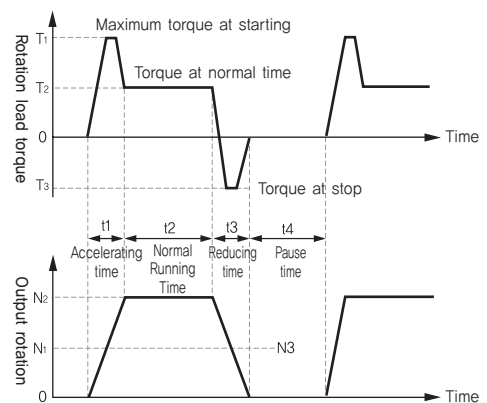


## Table 1 f<sub>s</sub> Table of factors

Number of Cycles/hr	f <sub>s</sub> *
0~1,000	1
1,000~1,500	1.1
1,500~2,000	1.25
2,000~3,000	1.55
3,000~5,000	1.83

Note) f<sub>s</sub> (shock factor) : Shock factor

## Diagram 1 Load Cycle's line graph





# A list of applicable servo motors by gearhead specification

## ■ A list of applicable servo motors by specification

Servo Motor Brand Frame Size of Gearheads	Higens	LS Mecapion	Mitsubishi	Panasonic
SPI(H) 042 SPIFH 042 SPL(H) 042 SPLFH 042	FMA-CKZ5	APM-SAR3A	HC-KFS053(B)	MSMD5AZP1□
	FMA-CK01	APM-SAR5A	HC-KFS13(B)	MSMD5AZS1□
		APM-SA01A	HC-MFS053(B)	MSMD01□P1□
			HC-MFS13(B)	MSMD01□S1□
SPI(H) 060 SPIFH 060 SPL(H) 060 SPLFH 060	FMA-CK02	APM-SB01A	HC-KFS23(B)	MAMA022P1□, S1□
	FMA-CK04	APM-SB02A	HC-KFS43(B)	MAMA042P1□, S1□
	FMA-CN01	APM-SB04A	HC-KFS-46	MSMD02□P1□, S1□
	FMA-CN02		HC-KFS-410	MSMD04□P1□, S1□
	FMA-CN03, 04, 05		HC-MFS23(B)	MQMA01□P1□, S1□
SPI(H) 090 SPIFH 090 SPL(H) 090 SPLFH 090	FMA-CN04A	APM-SC04A	HC-KFS73(B)	MAMA082P1□, S1□
	FMA-CN06	APM-SC06A	HC-MFS73(B)	MSMD08□P1□, S1□
	FMA-CN08	APM-SC08A	HC-UFS-23(B)	MQMA02□P1□, S1□
	FMA-CN10	APM-SC10A	HC-UFS-43(B)	MQMA04□P1□, S1□
	FMA-KN03, 05, 06, 07	APM-SC03, 05, 06, 07D		
SPI(H) 115 SPIFH 115 SPL(H) 115 SPLFH 115	FMA-CN09, 15, 22, 30	APM-SE09A, 15A	HC-LFS-52(B)	MSMA302P1□, S1□
	FMA-KN06A, 11, 16, 22	APM-SE22A, 30A	HC-LFS-102, 152(B)	MSMA402P1□, S1□
	FMA-TN05, 09, 13, 17	APM-SE06D, 11D	HC-SFS-81, 52(B)	MSMA502P1□, S1□
	FMA-LN03, 06, 09, 12	APM-SE16D, 22D	HC-SFS-102, 152(B)	MDMA102P1□, S1□
	FMA-KF08, 10, 15	APM-SE05G, 09G	HC-SFS-53, 103(B)	MDMA152P1□, S1□
	FMA-TF05, 09, 13	APM-SE13G, 17G	HC-SFS-153(B)	MDMA202P1□, S1□
	FMA-LF03, 06, 09	APM-SE03M, 06M	HC-SFS-524(B)	MDMA302P1□, S1□
		APM-SE09M, 12M	HC-SFS-1024(B)	MGMA092P1□, S1□
			HC-SFS-1524(B)	MFMA042P1□, S1□
			HC-RFS-353(B)	MHMA052P1□, S1□
SPIH 142 SPIFH 142 SPLH 142 SPLFH 142 (1 Stage)	FMA-CN30A, 50A	APM-SF30A, 50A	HC-LFS-202, 302(B)	MGMA202P1, S1□
	FMA-KN22A, 35	APM-SF22D, 35D	HC-SFS-121(B)	MGMA302P1, S1□
	FMA-TN20, 30	APM-SF20G, 30G	HC-SFS-201, 202(B)	MFMA152P1, S1□
	FMA-LN12A, 20, 30	APM-SF12M, 20M	HC-SFS-203(B)	MHMA202P1, S1□
	FMA-KF22, 35		HC-SFS-301, 352, 353(B)	MHMA402P1, S1□
	FMA-TF20, 30		HC-SFS-2024(B)	
	FMA-LF12, 20, 30		HC-SFS-3524(B)	
SPIH 180 SPIFH 180 SPLH 180 SPLFH 180 (1E)	FMA-KN55	APM-SF55, 75D	HC-SFS-502(B)	MDMA502P1, S1□
	FMA-TN44, 55	APM-SF44, 60G	HC-SFS-702(B)	MDMA752P1, S1□
	FMA-LN40	APM-SF40M	HC-SFS-5024(B)	MHMA502P1, S1□
	FMA-KF50		HC-SFS-7024(B)	MHMA752P1, S1□
	FMA-TF44			MGMA451P1, S1□
SPIH 220 SPIFH 220 SPLH 220 SPLFH 220 (1E)		APM-SG22, 35, 55, 75, 110D	HC-UFS-202(B)	MFMA252P1, S1□
		APM-SG20, 30, 44, 60G	HC-UFS-352(B)	MFMA452P1, S1□
		APM-SG85, 110, 150G	HC-UFS-502(B)	
		APM-SG12, 20, 60M		

Note) 1. See also "How to select a gearhead 1," (32 Page) by servo motor capacity.

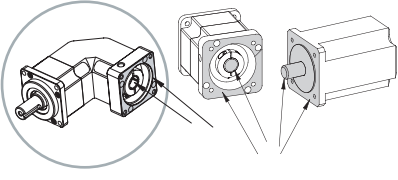
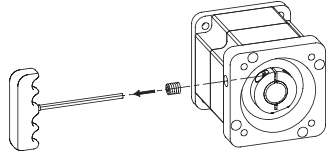
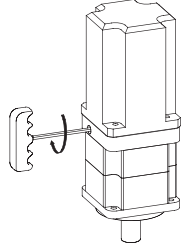
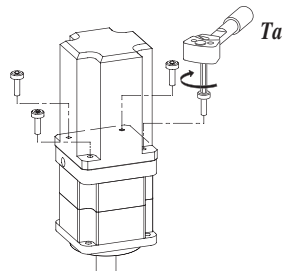
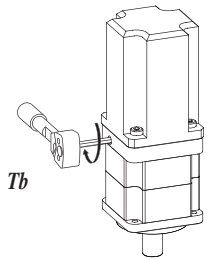
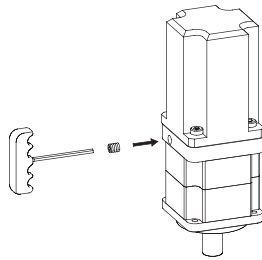
2. Check again specifications and dimensions of the servo motor of the maker after selecting the servo motor.

3. The model names of the above servo motors are arranged by reference to catalogues of each manufacturer, and for more details, contact the manufacturer.

Rockwell	Sanyo	Yaskawa	Fuji
CSMT-A3□□,A5□□,01□□	Q1AA04003D,005D	SGMAH-A3, A5, 01A	GYS500DC1-S8B (B)
SMZ-A3□□,A5□□,01□□	Q1AA04010D	SGMAH-A3, A5, 01B	GYS101DC1-SB (B)
RSMZ-A3□□,A5□□,01□□	Q1EA04003D,005D	SGMAS-A5, 01, C2A	
RSMZ-A8□□	Q1EA04010D	SGMAV-01A, C2A	
	R2AA04003F,05F	SGMJV-A5, 01A	
	R2AA04010F	SJME-01A	
CSMT-02□□,04□□	Q1AA06020D	SGMAH-02A, 02B, 03D, 04A	GYS101DC1-SA (B)
CSMR-01□□	Q2AA06040D	SGMAS-02, 04, 06A	GYS201DC1-SA (B)
CSMZ-02□□,04□□	Q1EA06020D	SGMAV-02, 04, 06A	GYS401DC1-SA (B)
CSMQ-01□□	R2AA06010F	SGMJV-02, 04A	
RSMZ-02□□,04□□	R2AA06020F	SGMPH-01A, 01B	
RSMZ-06□□,08□□,10□□	R2AA06040F	SGMPS-01A	
RSMQ-01□□		SJME-02, 04A	
CSMT-06□□,08□□	Q1AA07075D	SGMAH-07D, 08A	GYC201DC1-SA (B)
CSMR-02□□,04□□	Q2AA07020D	SGMAV-08, 12A	GYC401DC1-SA (B)
CSMZ-07□□	Q2AA07030D	SGMAV-08, 10A	GYS751DC1-SA (B)
CSMQ-02, 04□□	Q2AA07040D	SGMGV-03A, 03D, 05A, 05D	
RSMQ-02, 04□□	Q2AA07050D	SGMJV-08A	
	Q2EA07020D	SGMPS-02, 04A	
	R2AA08020F,40F,75F	SGMSH-10, 15, 20A(D)	
CSMD-07,10,15,20,25,30□□	Q1AA13300D	SGMGH-03, 05, 06, 09, 13A(D)	GYC102DC1-SA (B)
CSMS-30,35,40,45,50□□	Q1AA13400D	SGMGV-09, 13, 20A(D)	GYC152DC1-SA (B)
CSMH-05,10,15□□	Q1AA13500D	SGMPH-08, 15A(D)	GYC202DC1-SA (B)
CSMF-04□□	Q2AA13050H	SGMPS-08, 15A	GYA501BC1-SA (B)
CSMK-03,06,09□□	Q2AA13100H	SGMSH-30, 40, 50A(D)	GYA152BC1-SA (B)
RSMD-08,10,15,20,25,30□□	Q2AA13150H	SGMSS-30, 40, 50, 70A	GYA252BC1-SA (B)
RSMH-05,10,15□□	Q2AA13200H	SGMSV-30, 40, 50A(D)	GYS302DC1-SA (B)
RSMS-30,35,40,45,50□□	Q2CA13200H		GYS402DC1-SA (B)
RSMF-04□□			GYS502DC1-SA (B)
RSMK-03,06,09□□			
RSML-03,06,09□□			
CSMH-20, 30, 40□□	Q2AA18200H	SGMGH-12, 20, 30A(D)	
CSMF-08, 15□□	Q2CA18350H	SGMGV-30A, D	
CSMK-12, 20, 30□□	Q2AA18350H		
RSMD-35, 40□□			
RSMH-20, 30, 40□□			
RSMF-08, 15□□			
RSMK-12, 20, 30□□			
RSML-12, 30□□			
CSMD-45, 50□□	Q1AA18450M	SGMGH-40, 44, 55, 75A	
CSMH-50□□	Q1AA18350H	SGMGH-44, 55, 75D	
CSMK-45, 60□□	Q2AA18450H	SGMGV-44, 55, 75A	
RSMD-45, 50□□	Q2AA18550R	SGMGV-44D	
RSMH-50□□	Q2AA18550H		
RSMK-45, 60□□	Q2AA18450L		
RSML-45, 60□□	Q2CA18450H		
CSMF-25,35,45□□	Q2AA22250H,Q22AA22350H	SGMDH-22, 32, 40A	
RSMF-25,35,45□□	Q2AA22450R	SGMDH-1AA, 1AD, 1EA, 1ED	
	Q2AA22550B	SGMGV-1AA, 1EA	
	Q2AA22700S		
	Q2AA2211KV,Q2AA2215KV		
	Q2CA22550H, Q2CA22700H		

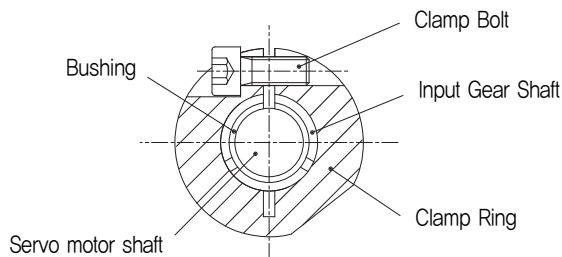
# How to mount the servo motor

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

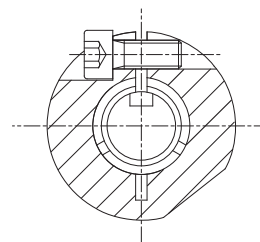
		
<p><b>1</b> Clean the mounting phase after checking the motor and gearhead sizes. (Check the shaft diameter, use appropriate bush if necessary)</p>	<p><b>2</b> Loosen the screw plug from the adapter flange and adjust the position so that the clamp bolt can be seen. (For proper servo motor shaft fixation method, see Appendix 1.)</p>	<p><b>3</b> 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><b>4</b> Tighten diagonally to the specified tightening torque with a torque wrench. (For tightening torque, see Appendix 2.)</p>	<p><b>5</b> Tighten the clamp bolt to the specified tightening torque with a torque wrench. (For tightening torque, see Appendix 2.)</p>	<p><b>6</b> 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. B<sub>1</sub> 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 <sup>2</sup>	0,10197	10,197	0,7376	8,8509
1 N · cm	10 <sup>-2</sup>	1	1,0197×10 <sup>-3</sup>	0,10197	7,376×10 <sup>-3</sup>	8,8509×10 <sup>-2</sup>
1 kgf · m	9,8066	980,665	1	10 <sup>2</sup>	7,233	86,79
1 kgf · cm	9,8066×10 <sup>-2</sup>	9,8066	10 <sup>-2</sup>	1	7,233×10 <sup>-2</sup>	0,8680
1 lbf · ft	1,356	1,356×10 <sup>2</sup>	0,1383	13,83	1	12
1 lbf · in	0,113	11,3	1,152×10 <sup>-2</sup>	1,152	8,333×10 <sup>-2</sup>	1

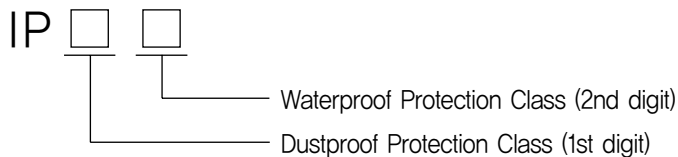
## ■ Appendix 4 Angular Unit Indication method

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□0	None
IP□1	Protected from the water-drop dropping vertically
IP□2	Protected from the water-drop dropping within a range of 15° from the vertical direction
IP□3	Protected from the water spraying within a range of 60° from the vertical direction
IP□4	Protected from the water splattering from all directions
IP□5	Protected from the water pouring from all directions
IP□6	Protected from the water pouring strongly like a sea wave
IP□7	Possible to use while immersed in the water under certain conditions
IP□8	Possible to use under the water