APEX DYNAMICS, INC.

HIGH PERFORMANCE HYPOID GEARBOX K-SERIES KH / KF



Planetary Gearbox Series

Features:

Innovative Hypoid Helical Bevel Gear
Optimized Inertia Moment
High Positioning Accuracy
High Efficiency
Low Noise
Long Service Life
Flexible Mounting
Multiple Output Types
Same Rotating Direction on Output as the Servo-Motor

The output shaft of APEX K-series rotates in the same direction as the servo-motor that simplifies the machine control and setting.



KH **KF-S1 / S2** **KF-S3** **KF-S4**

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ORDERING CODE

KF	–	010[1]	–	S1 [2]	/	MOTOR
KH	–	010[1]			/	MOTOR

Motor Type :
Manufacturer and Model

Ratio[1]:
1-stage: 3, 4, 5, 7,10
2-stage: 12, 16, 20, 25, 28, 35, 40, 50, 70, 100

Spiral Bevel
Ratio[1]:
1-stage: 1, 2

Gear Size:
KF : KF060, KF075, KF100, KF140, KF180, KF210, KF240
KF(Spiral Bevel) : KF060, KF075, KF100, KF140, KF180, KF210, KF240
KH : KH064, KH090, KH110, KH140, KH200, KH255, KH285

Ordering Example : KF100 - 010 - S1 / SIEMENS 1FT6 041 - 4AF71

(1) Ratio ($i= N_{in} / N_{out}$) .
(2) S1 = Smooth Output Shaft.
S2 = Output Shaft with Key.
S3 = DIN 5480 Output Shaft.
S4 = Hollow Output Shaft.

KH Gearbox Performance

Model No.		Stages	Ratio(1)	KH 064	KH 090	KH 110	KH 140	KH 200	KH 255	KH 285
Nominal Output Torque T_{2N}	Nm	1	3	25	50	110	210	420	820	1,600
			4	25	60	110	210	420	820	1,600
			5	25	60	110	210	420	820	1,600
			7	23	50	100	200	390	750	1,400
			10	18	40	85	170	360	600	1,100
		2	12	25	60	110	210	420	820	1,600
			16	25	60	110	210	420	820	1,600
			20	25	60	110	210	420	820	1,600
			25	25	60	110	210	420	820	1,600
			28	25	60	110	210	420	820	1,600
			35	25	60	110	210	420	820	1,600
			40	25	60	110	210	420	820	1,600
			50	25	60	110	210	420	820	1,600
			70	23	50	100	200	390	750	1,400
			100	18	40	85	170	360	600	1,100
Emergency Stop Torque T_{2NOT}	Nm	1,2	3~100	2 times T_{2N}						
Max. Acceleration Torque T_{2B}	Nm	1,2	3~100	1,5 times T_{2N}						
No Load Running Torque(4)	Nm	1	3~10	0.9	1.6	3.2	4.2	9.6	16.5	26.4
		2	12~100	0.1	0.1	0.2	0.4	1.1	1.9	3
Backlash(2)	arcmin	1	3~10	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3
		2	12~100	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3
Torsional Rigidity	Nm/arcmin	1,2	3~100	1.1	4.5	10	23	54	90	170
Nominal Input Speed n_{1N}	rpm	1	3~10	3,000	2,800	2,700	2,000	2,000	2,000	1,500
		2	12~100	5,500	4,600	4,600	4,000	3,700	3,400	3,100
Max. Input Speed n_{1B}	rpm	1	3~10	6,000	6,000	4,500	4,500	4,000	3,000	2,500
		2	12~100	7,000	7,000	7,000	6,000	5,500	5,000	4,500
Max. Radial Load F_{2rB}(3)	N	1,2	3~100	2,400	4,500	5,100	13,000	28,700	36,200	58,300
Max. Axial Load F_{2aB}(3)	N	1,2	3~100	1,200	2,250	2,550	6,500	14,350	18,100	29,150
Service Life(5)	hr	1,2	3~100	20,000						
Operating Temp	° C	1,2	3~100	0° C~ +90° C						
Degree of Gearbox Protection		1,2	3~100	IP65						
Lubrication		1,2	3~100	Synthetic lubrication grease						
Mounting Position		1,2	3~100	All directions						
Running Noise(4)	dB(A)	1,2	3~100	≦ 64	≦ 66	≦ 66	≦ 68	≦ 68	≦ 70	≦ 72
Efficiency η	%	1	3~10	≧ 96%						
		2	12~100	≧ 94%						

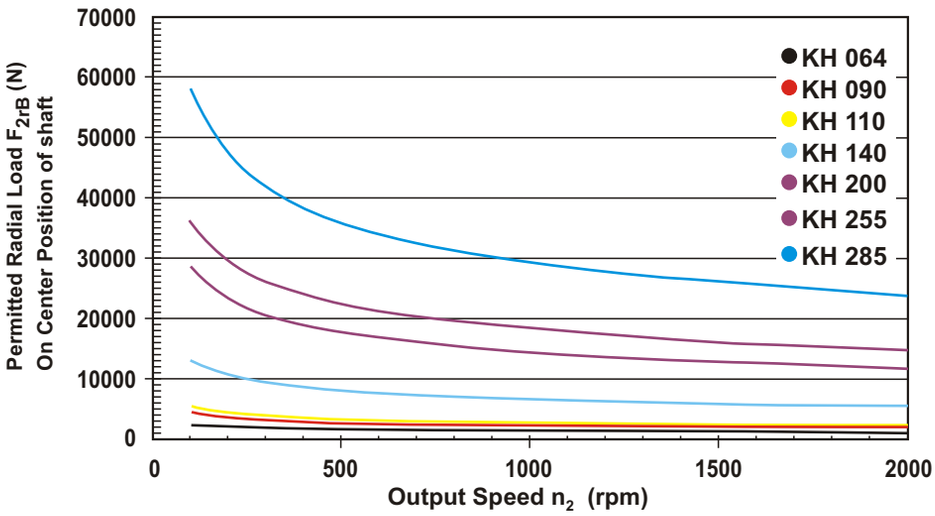
(1) Ratio (i= N_{in} / N_{out}) .
(2) Backlash is measured at 2% of Nominal Output Torque T_{2N}.
(3) Applied to the output shaft center at 100 rpm.
(4) These values are measured by gearbox with ratio = 10 (1-stage) and 100 (2-stage) without loading at 3,000 rpm, or at the Nominal Input Speed n_{1N}.
(5) For continuous operation, the service life time is less than 10,000 hrs.

KH Gearbox Inertia

Model No.		KH 064		KH 090		KH 110		KH 140		KH 200		KH 255		KH 285	
Ø[A] (C3)		1-stage	2-stage	1-stage	2-stage	1-stage	2-stage	1-stage	2-stage	1-stage	2-stage	1-stage	2-stage	1-stage	2-stage
8	kg.cm²	0.1	0.1	-	-	-	-	-	-	-	-	-	-	-	-
11		0.17	0.16	0.18	0.17	-	-	-	-	-	-	-	-	-	-
14		0.21	0.2	0.5	0.21	-	0.53	-	-	-	-	-	-	-	-
19		0.62	-	0.65	0.63	1.69	0.68	-	1.83	-	-	-	-	-	-
24		-	-	4.49	-	4.89	4.52	5.05	5.04	-	5.63	-	-	-	-
28		-	-	-	-	6.14	-	6.55	6.33	-	7.18	-	-	-	-
32		-	-	-	-	8.54	-	9.47	8.73	10.18	10.1	-	12.63	-	-
35		-	-	-	-	13.86	-	14.91	14.04	15.21	15.54	15.68	17.75	23.46	20.8
38		-	-	-	-	18.87	-	20.69	19.05	20.7	21.32	21.69	23.26	23.46	27.05
42		-	-	-	-	-	-	22.58	-	22.83	23.2	23.59	25.4	25.28	28.95
48		-	-	-	-	-	-	55.45	-	58.45	56.07	59.3	61.02	61.61	64.66
55		-	-	-	-	-	-	-	-	-	-	86.95	-	89.67	-
60		-	-	-	-	-	-	-	-	-	-	-	-	112.49	-

(A) Ø = Input shaft diameter.

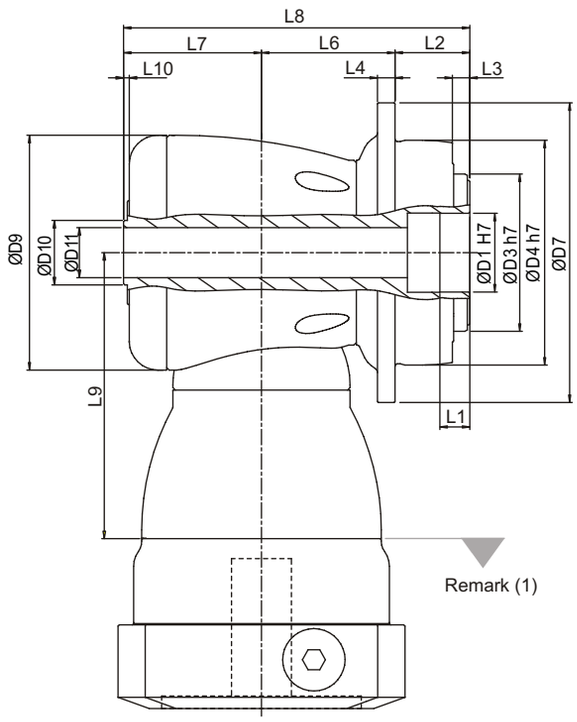
Permitted Radial And Axial Loads

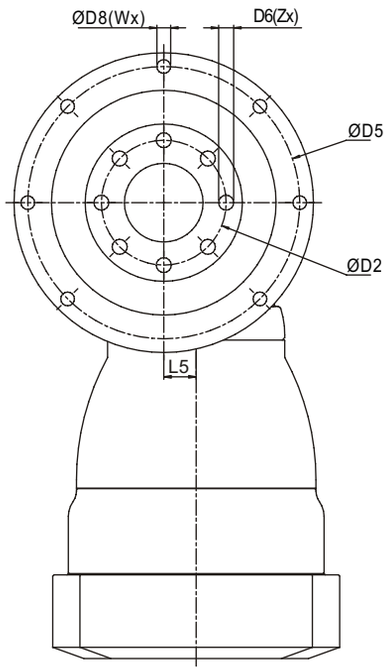


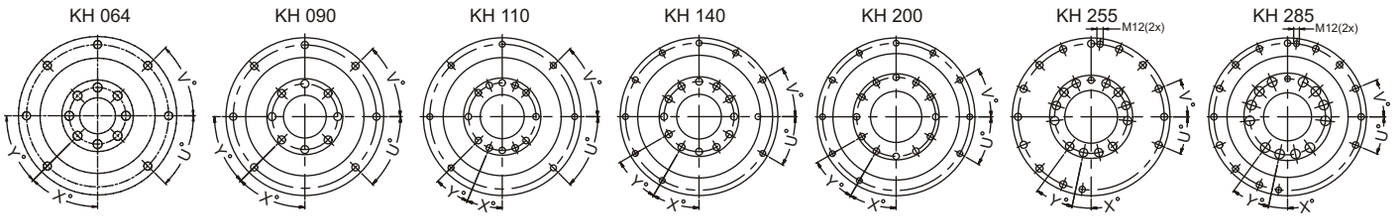
Permitted radial load F_{2r} on center of output flange on various output speeds.
Values are provided for 20,000 hours(A) life.

(A) For Continuous Operation(S1), the service life reduced to 50%.

KH Series Dimension







Dimension	KH 064	KH 090	KH 110	KH 140	KH 200	KH 255	KH 285
	1~2-stage	1~2-stage	1~2-stage	1~2-stage	1~2-stage	1~2-stage	1~2-stage
D1 H7	20	31.5	40	50	80	100	100
D2	31.5	50	63	80	125	140	160
D3 h7	40	63	80	100	160	180	200
D4 h7	64	90	110	140	200	255	285
D5	79	109	135	168	233	280	310
D6	M5x0.8Px8	M6x1Px10	M6x1Px12	M8x1.25Px15	M10x1.5Px20	M16x2Px25	M20x2.5Px31
D7	88	120	147	180	249.5	302	332
D8	4.5	5.5	5.5	6.6	9	13.5	13.5
D9	73	94	116	163	210	255	300
D10	18.5	25.8	36.8	55.2	69.2	82.2	92.2
D11	10	20	28	40	55	62	70
L1	8	12	12	12	16	20	20
L2	19.5	30	29	38	50	66	75
L3	4	7	7	7.5	8.5	13.5	16.5
L4	5	7	8	10	12	18	20
L5	10	13	17	25	31	36	43
L6	43	53.5	67	81	117	132	160.5
L7	46	55.3	71.3	91.8	118	134	168
L8	108.5	138.8	167.3	210.8	285	332	403.5
L9	94	114.5	129	173.5	228	265.5	294.5
L10	1.5	2.3	3	2.8	3	3	3
X in Degree	45°	45°	22.5°	30°	30°	12°	12°
Y in Degree	45°	45°	22.5°	30°	30°	24°	24°
Z	8	8	12	12	12	12	12
U in Degree	45°	45°	45°	30°	30°	22.5°	22.5°
V in Degree	45°	45°	45°	30°	30°	22.5°	22.5°
W	7	7	7	10	10	13	13

(1) Dimensions are related to motor interface. Please contact APEX for details.

KF Gearbox Performance

Model No.		Stages	Ratio(1)	KF 060	KF 075	KF 100	KF 140	KF 180	KF 210	KF 240
Nominal Output Torque T_{2N}	Nm	1	3	25	50	110	210	420	820	1,600
			4	25	60	110	210	420	820	1,600
			5	25	60	110	210	420	820	1,600
			7	23	50	100	200	390	750	1,400
			10	18	40	85	170	360	600	1,100
		2	12	25	60	110	210	420	820	1,600
			16	25	60	110	210	420	820	1,600
			20	25	60	110	210	420	820	1,600
			25	25	60	110	210	420	820	1,600
			28	25	60	110	210	420	820	1,600
			35	25	60	110	210	420	820	1,600
			40	25	60	110	210	420	820	1,600
			50	25	60	110	210	420	820	1,600
			70	23	50	100	200	390	750	1,400
			100	18	40	85	170	360	600	1,100
Emergency Stop Torque T_{2NOT}	Nm	1,2	3~100	2 times T_{2N}						
Max. Acceleration Torque T_{2B}	Nm	1,2	3~100	1,5 times T_{2N}						
No Load Running Torque(4)	Nm	1	3~10	0.8	1.3	2.6	3.5	8	11	17.6
		2	12~100	0.1	0.1	0.2	0.3	0.9	1.2	1.9
Backlash(2)	arcmin	1	3~10	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3
		2	12~100	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3
Torsional Rigidity	Nm/arcmin	1,2	3~100	0.8	3.5	9	20.5	44	80	168
Nominal Input Speed n_{1N}	rpm	1	3~10	3,000	2,800	2,700	2,000	2,000	2,000	1,500
		2	12~100	5,500	4,500	4,200	3,900	3,400	2,800	2,200
Max. Input Speed n_{1B}	rpm	1	3~10	6,000	6,000	4,500	4,500	4,000	3,000	2,500
		2	12~100	7,000	7,000	7,000	6,000	5,500	5,000	4,500
Max. Radial Load F_{2rB}(3)	N	1,2	3~100	5,700	8,200	12,200	20,100	30,700	40,900	51,900
Max. Axial Load F_{2aB}(3)	N	1,2	3~100	2,850	4,100	6,100	10,050	15,350	20,450	20,950
Service Life(5)	hr	1,2	3~100	20,000						
Operating Temp	° C	1,2	3~100	0° C~ +90° C						
Degree of Gearbox Protection		1,2	3~100	IP65						
Lubrication		1,2	3~100	Synthetic lubrication grease						
Mounting Position		1,2	3~100	All directions						
Running Noise(4)	dB(A)	1,2	3~100	≦ 64	≦ 66	≦ 66	≦ 68	≦ 68	≦ 70	≦ 72
Efficiency η	%	1	3~10	≧ 96%						
		2	12~100	≧ 94%						

(1) Ratio (i= N_{in} / N_{out}) .

(2) Backlash is measured at 2% of Nominal Output Torque T_{2N}.

(3) Applied to the output shaft center at 100 rpm.

(4) These values are measured by gearbox with ratio = 10 (1-stage) and 100 (2-stage) without loading at 3,000 rpm, or at the Nominal Input Speed n_{1N}.

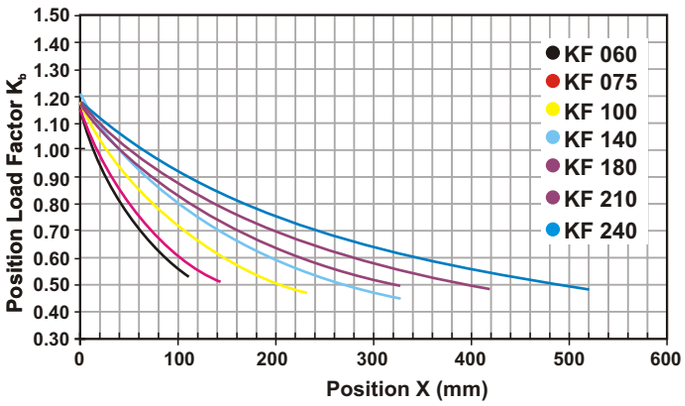
(5) For continuous operation, the service life time is less than 10,000 hrs.

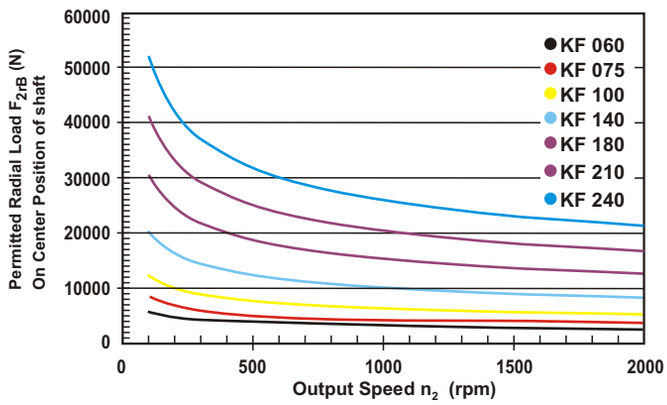
KF Gearbox Inertia

Model No.		KF 060		KF 075		KF 100		KF 140		KF 180		KF 210		KF 240	
Ø[A] (C3)		1-stage	2-stage	1-stage	2-stage	1-stage	2-stage	1-stage	2-stage	1-stage	2-stage	1-stage	2-stage	1-stage	2-stage
8		0.1	0.1	-		-	-	-	-	-	-	-	-	-	-
11		0.17	0.16	0.18	0.17	-	-	-	-	-	-	-	-	-	-
14		0.21	0.2	0.5	0.21	-	0.53	-	-	-	-	-	-	-	-
19		0.62	-	0.65	0.63	1.69	0.68	-	1.83	-	-	-	-	-	-
24		-	-	4.49	-	4.89	4.52	5.05	5.04	-	5.63	-	-	-	-
28		-	-	-	-	6.14	-	6.55	6.33	-	7.18	-	-	-	-
32	kg.cm²	-	-	-	-	8.54	-	9.47	8.73	10.18	10.1	-	12.63	-	-
35		-	-	-	-	13.86	-	14.91	14.04	15.21	15.54	15.68	17.75	23.46	20.8
38		-	-	-	-	18.87	-	20.69	19.05	20.7	21.32	21.69	23.26	23.46	27.05
42		-	-	-	-	-	-	22.58	-	22.83	23.2	23.59	25.4	25.28	28.95
48		-	-	-	-	-	-	55.45	-	58.45	56.07	59.3	61.02	61.61	64.66
55		-	-	-	-	-	-	-	-	-	-	86.95	-	89.67	-
60		-	-	-	-	-	-	-	-	-	-	-	-	112.49	-

(A) Ø = Input shaft diameter.

Permitted Radial And Axial Loads[A]



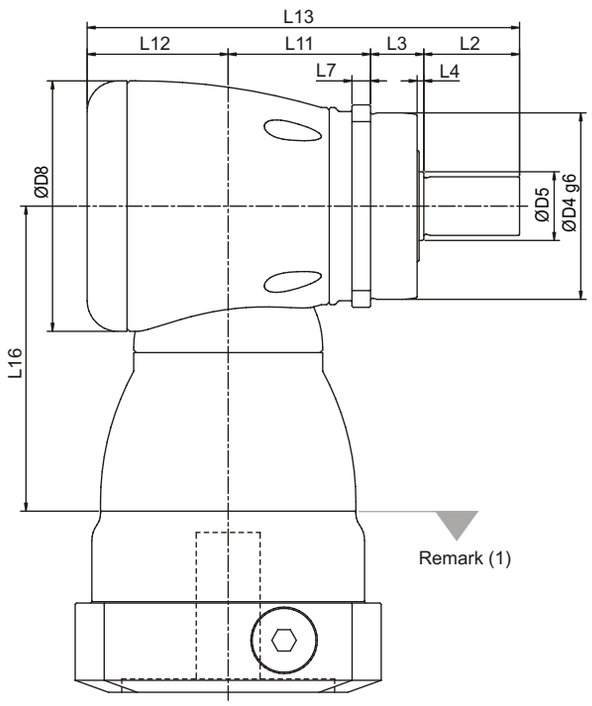


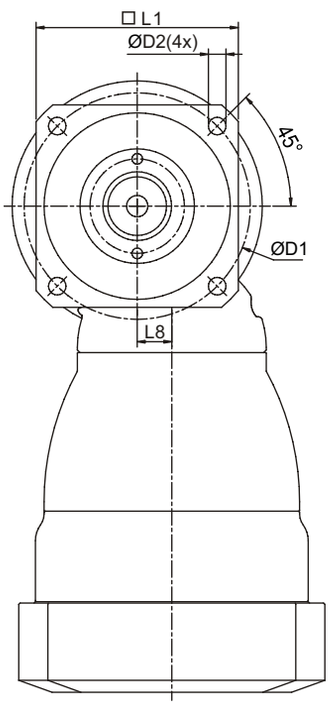
If radial force F_{2r} is not exerted on the center of the output shaft X<1/2 L or X>1/2 L, the permitted radial and axial loads can be calculated by the position load factor K_b on the above diagram.

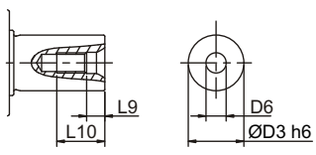
Permitted radial load F_{2r} on center of output shaft.
X=1/2 L for various output speeds.
Values are provided for 20,000 hours[B] life.

(A) Permitted loading values on the output shaft. Please refer to P. 16 glossary.
(B) For Continuous Operation(S1), the service life reduced to 50%.

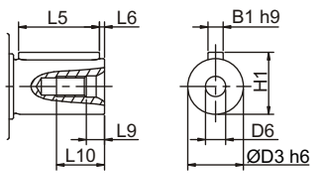
KF-S1 / S2 / S3 Series Dimension



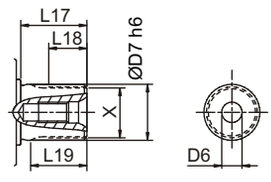




Shaft Option S1



Shaft Option S2

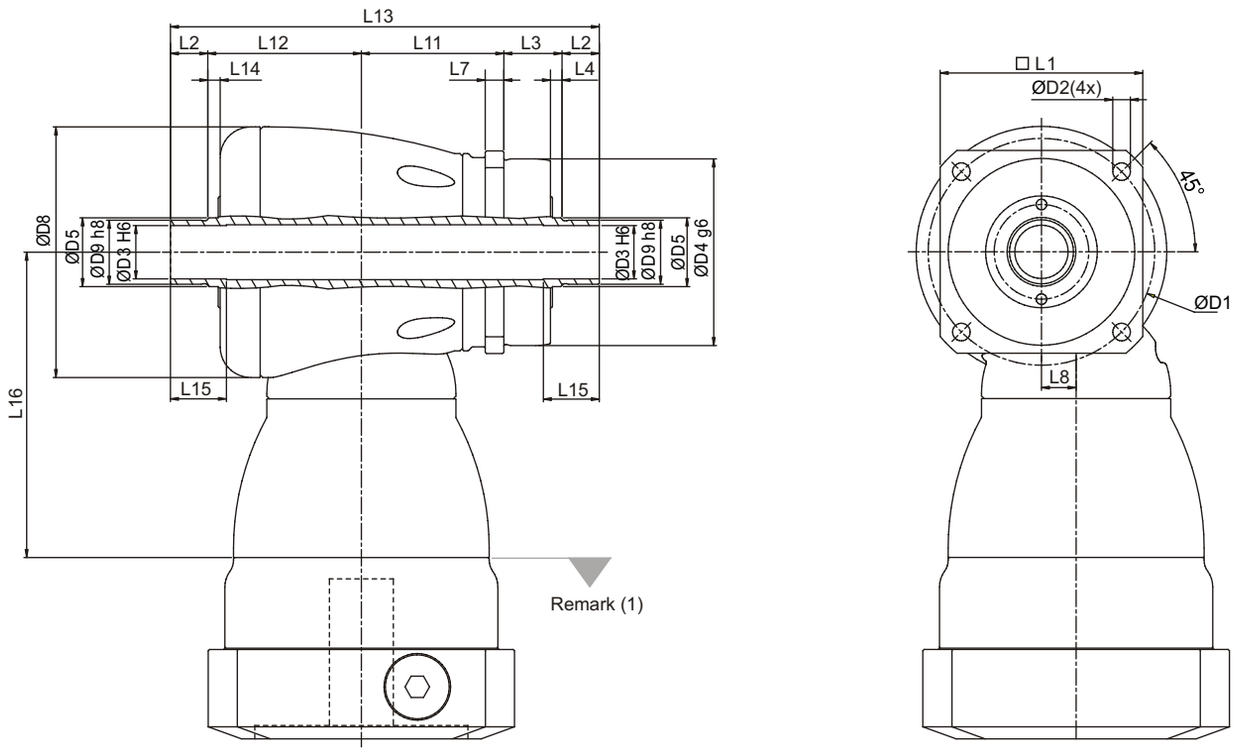


Shaft Option S3

Dimension	KF 060	KF 075	KF 100	KF 140	KF 180	KF 210	KF 240
	1~2-stage	1~2-stage	1~2-stage	1~2-stage	1~2-stage	1~2-stage	1~2-stage
D1	68	85	120	165	215	250	290
D2	5.5	6.6	9	11	13.5	17	17
D3 h6	16	22	32	40	55	75	85
D4 g6	60	70	90	130	160	180	200
D5	18.5	25.8	36.8	55.2	69.2	82.2	92.2
D6	M5X0.8P	M8X1.25P	M12X1.75P	M16X2P	M20X2.5P	M20X2.5P	M20X2.5P
D7 h6	16	22	32	40	55	75	85
D8	73	94	116	163	210	255	300
L1	62	76	101	141	182	215	245
L2	28	36	58	82	82	105	130
L3	20	20	30	30	30	38	40
L4	2	2.5	3	3	3	3	3
L5	25	32	50	63	70	90	125
L6	2	2	4	5	6	7	3
L7	6	7	10	12	15	17	20
L8	10	13	17	25	31	36	43
L9	4.8	7.2	10	12	15	15	15
L10	12.5	19	28	36	42	42	42
L11	43	53.5	67	90	119	141	176
L12	44.5	53	68.3	89	115	131	165
L13	135.5	162.5	223.3	291	346	415	511
L16	94	114.5	129	173.5	228	265.5	294.5
L17	26	26	26	40	41.5	52	60
L18	15	15	15	20	21.5	28	36
L19	21	22.5	23	33.5	33.5	45	53
B1 h9	5	6	10	12	16	20	22
H1	18	24.5	35	43	59	79.5	90
X DIN 5480	W16x0.8x30x18x6m	W22x1.25x30x16x6m	W32x1.25x30x24x6m	W40x2x30x18x6m	W55x2x30x26x6m	W70x2x30x34x6m	W80x2x30x38x6m

(1) Dimensions are related to motor interface. Please contact APEX for details.

KF-S4 Series Dimension



Dimension	KF 060	KF 075	KF 100	KF 140	KF 180
	1~2-stage	1~2-stage	1~2-stage	1~2-stage	1~2-stage
D1	68	85	120	165	215
D2	5.5	6.6	9	11	13.5
D3 H6	15	20	30	40	55
D4 g6	60	70	90	130	160
D5	18.5	25.8	36.8	55.2	69.2
D8	73	94	116	163	210
D9 h8	18	24	36	50	68
L1	62	76	101	141	182
L2	12	14	18	22	23
L3	22	21.8	32	33	34
L4	4	4.3	5	6	7
L7	6	7	10	12	15
L8	10	13	17	25	31
L11	43	53.5	67	90	119
L12	48.5	57.7	73.3	95	122
L13	137.5	161	208.3	262	321
L14	4	4.7	5	6	7
L15	19	21	25	30	30
L16	94	114.5	129	173.5	228

(1) Dimensions are related to motor interface. Please contact APEX for details.

KF Gearbox Performance (Spiral Bevel)

Model No.		Stages	Ratio[1]	KF 060	KF 075	KF 100	KF 140	KF 180	KF 210	KF 240
Nominal Output Torque T_{2N}	Nm	1	1	25	45	78	150	360	585	1,300
			2	24	42	68	150	330	544	1,220
Emergency Stop Torque T_{2NOT}	Nm	1	1~2	2 times T_{2N}						
Max. Acceleration Torque T_{2B}	Nm	1	1~2	1,5 times T_{2N}						
No Load Running Torque[4]	Nm	1	1~2	0.3	0.3	1.5	1.7	5.5	9	20
Backlash[2]	arcmin	1	1~2	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3	≦ 3
Torsional Rigidity	Nm/arcmin	1	1~2	0.8	3.5	9	20.5	44	80	168
Nominal Input Speed n_{1N}	rpm	1	1~2	6,500	4,500	3,500	2,000	1,500	1,200	1,000
Max. Input Speed n_{1B}	rpm	1	1~2	7,500	6,500	5,500	4,500	3,500	3,000	2,200
Max. Radial Load F_{2rB}[3]	N	1	1~2	5,400	7,700	11,100	18,100	29,100	36,400	46,900
Max. Axial Load F_{2aB}[3]	N	1	1~2	2,700	3,850	5,550	9,050	14,550	18,200	23,450
Service Life[5]	hr	1	1~2	20,000						
Operating Temp	° C	1	1~2	0° C~ +90° C						
Degree of Gearbox Protection		1	1~2	IP65						
Lubrication		1	1~2	Synthetic lubrication grease						
Mounting Position		1	1~2	All directions						
Running Noise[4]	dB(A)	1	1~2	≦ 68	≦ 70	≦ 74	≦ 76	≦ 77	≦ 78	≦ 80
Efficiency η	%	1	1~2	≧ 97%						

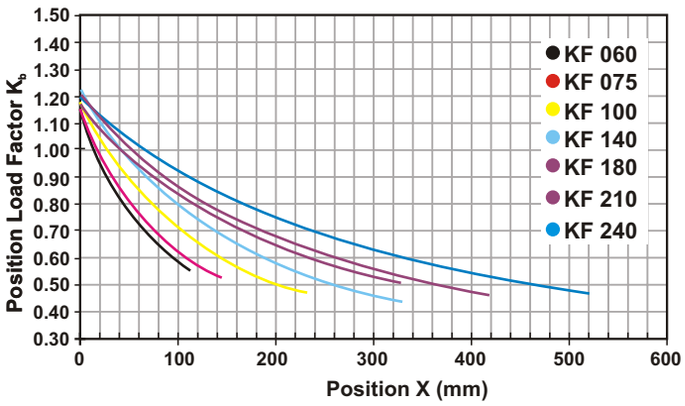
(1) Ratio ($i = N_{in} / N_{out}$).
(2) Backlash is measured at 2% of Nominal Output Torque T_{2N}.
(3) Applied to the output shaft center at 100 rpm.
(4) These values are measured by gearbox with ratio = 2 (1-stage) without loading at 3,000 rpm, or at the Nominal Input Speed n_{1N}.
(5) For continuous operation, the service life time is less than 10,000 hrs.

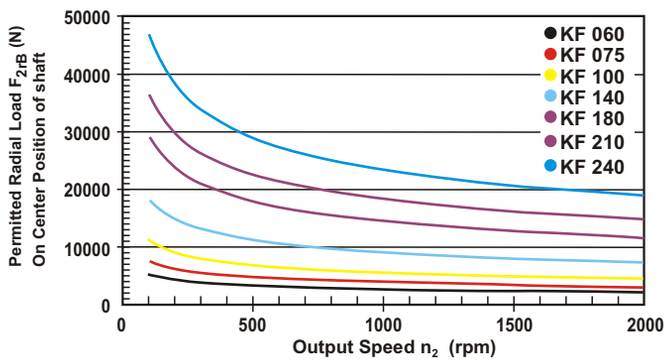
KF Gearbox Inertia (Spiral Bevel)

Model No.		KF 060	KF 075	KF 100	KF 140	KF 180	KF 210	KF 240
Ø(A) (C3)		1-stage	1-stage	1-stage	1-stage	1-stage	1-stage	1-stage
8		0.1	-	-	-	-	-	-
11		0.17	0.18	-	-	-	-	-
14		0.21	0.5	-	-	-	-	-
19		0.62	0.65	1.69	-	-	-	-
24		-	4.49	4.89	5.05	-	-	-
28		-	-	6.14	6.55	-	-	-
32	kg. cm²	-	-	8.54	9.47	10.18	-	-
35		-	-	13.86	14.91	15.21	15.68	23.46
38		-	-	18.87	20.69	20.7	21.69	23.46
42		-	-	-	22.58	22.83	23.59	25.28
48		-	-	-	55.45	58.45	59.3	61.61
55		-	-	-	-	-	86.95	89.67
60		-	-	-	-	-	-	112.49

(A) Ø = Input shaft diameter.

Permitted Radial And Axial Loads(A)



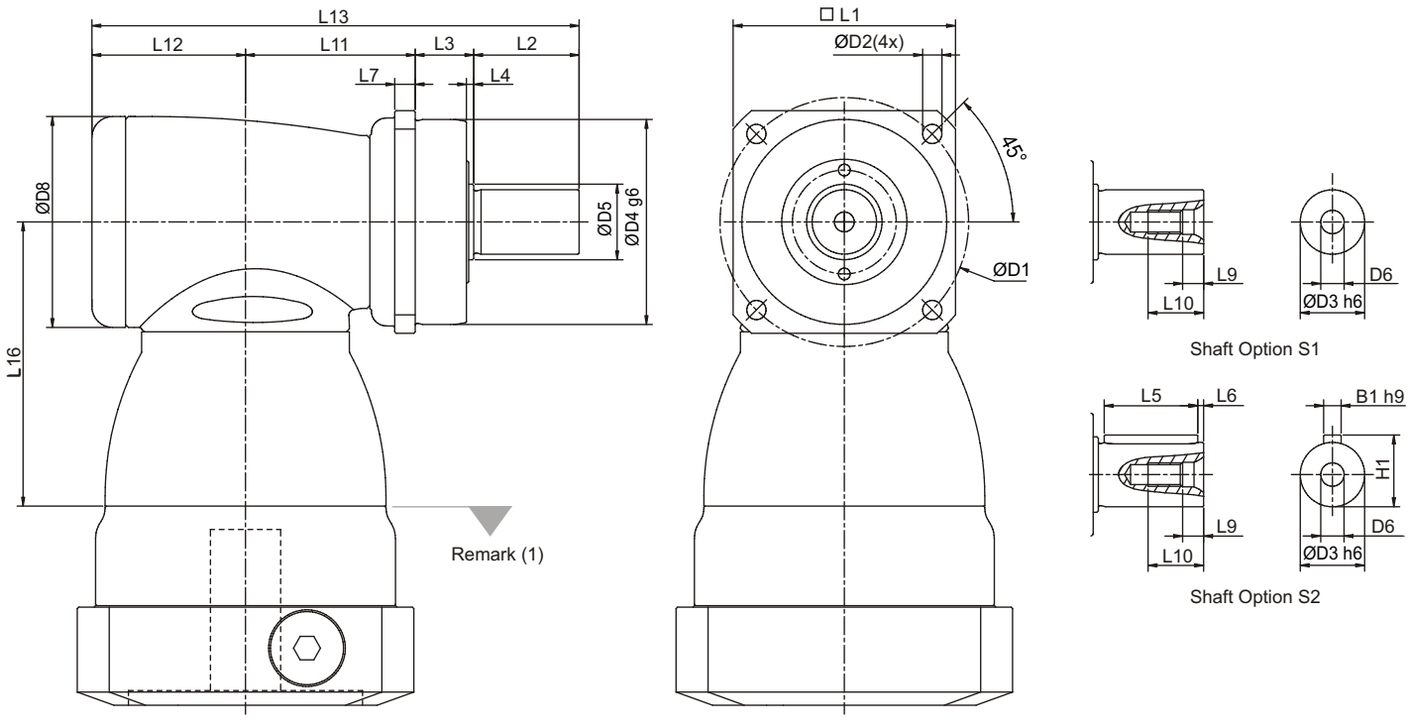


If radial force F_{2r} is not exerted on the center of the output shaft X<1/2 L or X>1/2 L, the permitted radial and axial loads can be calculated by the position load factor K_b on the above diagram.

Permitted radial load F_{2r} on center of output shaft.
X=1/2 L for various output speeds.
Values are provided for 20,000 hours(B) life.

(A) Permitted loading values on the output shaft. Please refer to P. 16 glossary.
(B) For Continuous Operation(S1), the service life reduced to 50%.

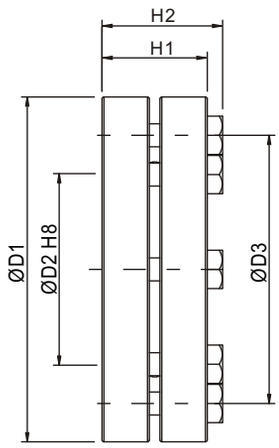
KF Dimension (Spiral Bevel)



Dimension	KF 060	KF 075	KF 100	KF 140	KF 180	KF 210	KF 240
	1-stage	1-stage	1-stage	1-stage	1-stage	1-stage	1-stage
D1	68	85	120	165	215	250	290
D2	5.5	6.6	9	11	13.5	17	17
D3 h6	16	22	32	40	55	75	85
D4 g6	60	70	90	130	160	180	200
D5	18.5	25.8	36.8	55.2	69.2	82.2	92.2
D6	M5X0.8P	M8X1.25P	M12X1.75P	M16X2P	M20X2.5P	M20X2.5P	M20X2.5P
D8	64	72	92	116	156	195	240
L1	62	76	101	141	182	215	245
L2	28	36	58	82	82	105	130
L3	20	20	30	30	30	38	40
L4	2	2.5	3	3	3	3	3
L5	25	32	50	63	70	90	125
L6	2	2	4	5	6	7	3
L7	6	7	10	12	15	17	20
L9	4.8	7.2	10	12	15	15	15
L10	12.5	19	28	36	42	42	42
L11	50	58	67.5	88	127	131.5	169
L12	46.5	52.5	61.5	76	97.5	105.5	141
L13	144.5	166.5	217	276	336.5	380	480
L16	81.5	97	113.5	147.5	196.5	229	260
B1 h9	5	6	10	12	16	20	22
H1	18	24.5	35	43	59	79.5	90

(1) Dimensions are related to motor interface. Please contact APEX for details.

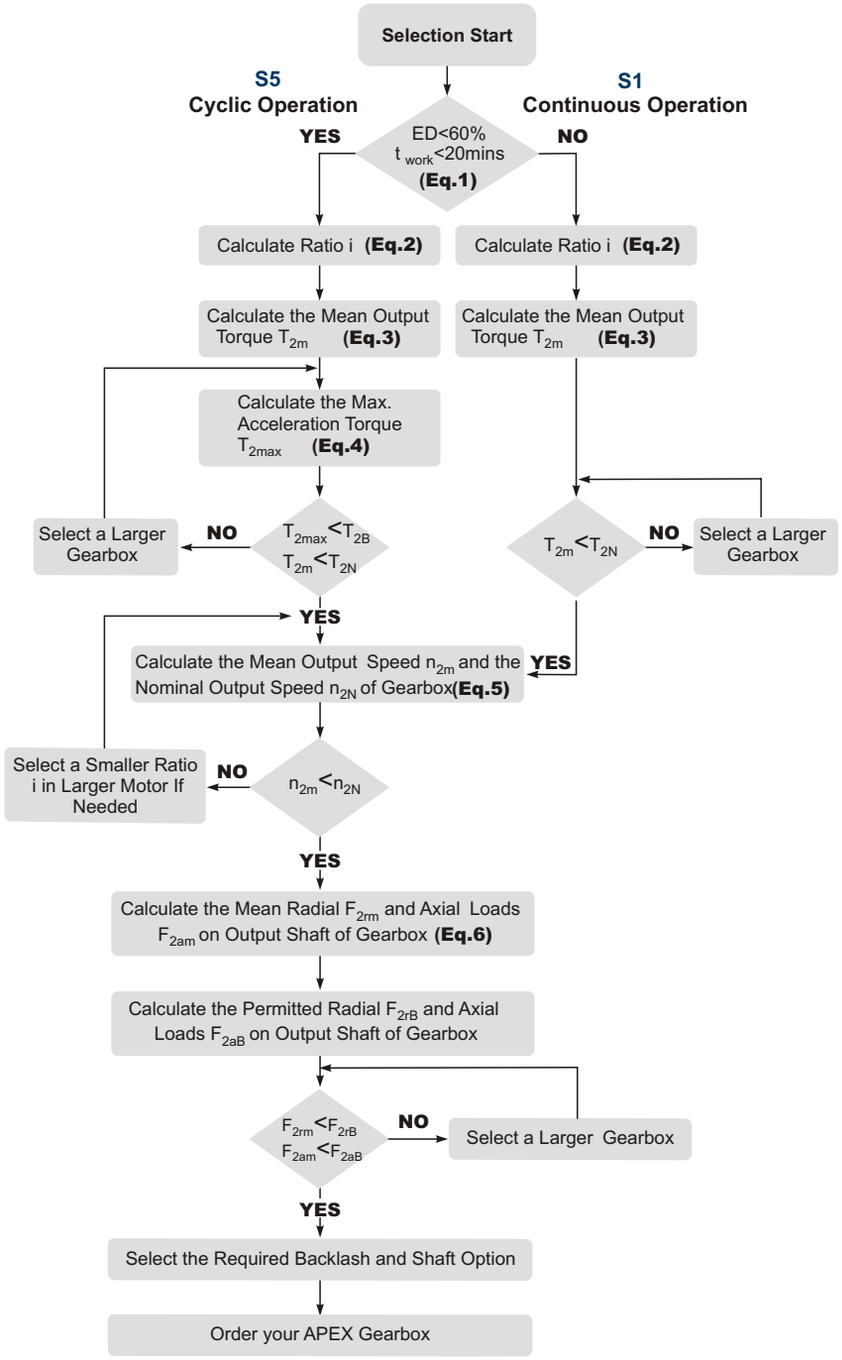
SHRINK DISC POWER LOCK



SHRINK DISC POWER LOCK

Model No.	Dimension	D1	D2	D3	H1	H2	J (kg.cm^2)
KF 060	SSD-d18xdw15	44	18	30	15	18.5	0.36
KF 075	SSD-d24xdw20	50	24	36	19.5	23	0.76
KF 100	SSD-d36xdw30	72	36	52	23.5	27.5	3.93
KF 140	SSD-d50xdw40	90	50	70	27.5	31.5	11.11
KF 180	SSD-d68xdw55	115	68	86	30.5	34.5	28.84

Selection of the optimum gearbox



Recommended (for S5 Cycle Operation)

The general design is given for

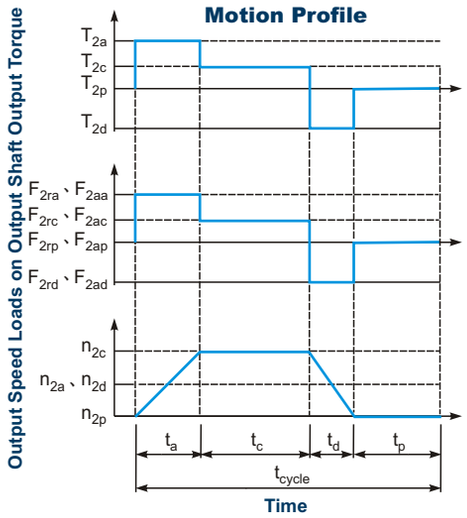
$$\frac{J_L}{i^2} \leq 4 \times J_m$$

The optimal design is given for

$$\frac{J_L}{i^2} \cong J_m$$

J_L Load Inertia

J_m Motor Inertia



1. $ED = \frac{t_a + t_c + t_d}{t_{cycle}} \times 100\%$, $t_{work} = t_a + t_c + t_d$

Index : a. Acceleration, c. Constant,
d. Deceleration, p. Pause **(Eq.1)**

2. $i \cong \frac{n_m}{n_{work}}$

n_m Output Speed of the Motor

n_{work} Working Speed **(Eq.2)**

3. $$T_{2m} = \sqrt[3]{\frac{n_{2a} \times t_a \times T_{2a}^{\ 3} + n_{2c} \times t_c \times T_{2c}^{\ 3} + n_{2d} \times t_d \times T_{2d}^{\ 3}}{n_{2a} \times t_a + n_{2c} \times t_c + n_{2d} \times t_d}}$$

(Eq.3)

4. $T_{2max} = T_{mB} \times i \times K_s \times \eta$

where K_s is

K_s	No. of Cycles / hr
1.0	0 ~ 1,000
1.1	1,000 ~ 1,500
1.3	1,500 ~ 2,000
1.6	2.000 ~ 3,000
1.8	3.000 ~ 5,000

T_{mB} Max. Output Torque of the Motor

η Efficency of the Gearbox **(Eq.4)**

5. $n_{2a} = n_{2d} = \frac{1}{2} \times n_{2c}$

$$n_{2m} = \frac{n_{2a} \times t_a + n_{2c} \times t_c + n_{2d} \times t_d}{t_a + t_c + t_d}$$

$$n_{2N} = \frac{n_{1N}}{i}$$

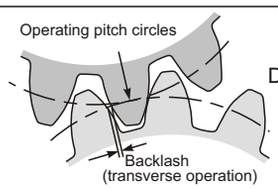
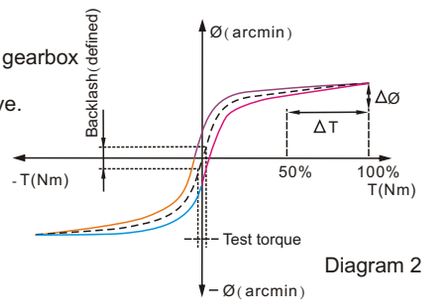
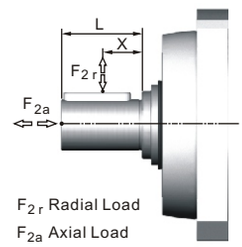
(Eq.5)

6. $$F_{2rm} = \sqrt[3]{\frac{n_{2a} \times t_a \times F_{2ra}^{\ 3} + n_{2c} \times t_c \times F_{2rc}^{\ 3} + n_{2d} \times t_d \times F_{2rd}^{\ 3}}{n_{2a} \times t_a + n_{2c} \times t_c + n_{2d} \times t_d}}$$

$$F_{2am} = \sqrt[3]{\frac{n_{2a} \times t_a \times F_{2aa}^{\ 3} + n_{2c} \times t_c \times F_{2ac}^{\ 3} + n_{2d} \times t_d \times F_{2ad}^{\ 3}}{n_{2a} \times t_a + n_{2c} \times t_c + n_{2d} \times t_d}}$$

(Eq.6)

Glossary

Emergency Stop Torque T_{2NOT}	Nm	The Emergency Stop Torque is the maximum permitted torque at the output of gearbox. This may happen only occasionally and may not exceed 1,000 times during the whole service life.
Max. Acceleration Torque T_{2B}	Nm	Under the Cyclic Operation (S5), the Max. Acceleration Torque is the maximum torque which can be transmitted only briefly to the output of gearbox up to 1,000 cycles/hr.
No Load Running Torque	Nm	The No Load Running Torque is the min. torque to overcome the internal friction of a gearbox without loading*.
Nominal Input Speed n_{1N}	rpm	The Nominal Input Speed is the permitted input speed of gearbox by the Continuous Operation (S1) while the housing temperature does not exceed 90°C. This value is measured at environment temperature 25°C.
Max. Input Speed n_{1B}	rpm	The Max. Input Speed is the max. permitted input speed of gearbox by the Cyclic operation (S5). This value is measured at environment temperature 25°C and serves as the absolute limit of the gearbox.
Backlash	arcmin	The Backlash is the maximum angular measurement between two teeth of gears when the transverse operation occurs (refer to Diagram 1). The arcmin is the measurement unit for the backlash. One arcmin equals 1/ 60 degree, symbolized as 1'.  Diagram 1
Torsional Rigidity	Nm/arcmin	Torsional Rigidity is the quotient (△T / △Ø) between the applied torque and resulting torsion angle. This value indicates how much torque is needed on the gearbox to rotate the output shaft for 1 arcmin. The Torsional Rigidity can be determined by Hysteresis Curve. Hysteresis Curve When the input shaft is locked, increase torque at the output slowly up to T_{2B} in both directions and then release the torque gradually. According to the measured torque and torsion angle, a closed curve will be acquired as in the Diagram 2.  Diagram 2
Radial Load And Axial Load	N	The permitted radial and axial loads on output shaft of the gearbox depend on the design of the gearbox supporting bearings. For more information, please refer to APEX website. 
Efficiency η	%	The transmission efficiency of the gears inside a gearbox (without friction).
Operating Temperature	° C	The Operating Temperature indicates the temperature of gearbox housing.
Degree of Protection		IP code stands for International Protection standard. The IP65 as example: the first IP number stands for protection degree against dust; the second IP number stands for protection against liquid.
Lubrication		APEX uses synthetic lubrication grease. Alternate greases are available, please contact APEX.
Running Noise	dB(A)	The Running Noise is measured depends on gearbox size, the ratio and the speed*. Higher speed usually induces higher noise level, while higher ratio induces lower noise level.
Moment of Inertia J_1	$kg.cm^2$	The Moment of Inertia J1 is a measurement of the effort applied to an object to maintain its momentary condition at rest or rotating.
Breakaway Torque	Nm	The Breakaway Torque is the minimum torque to start the rotation from the input side of gearbox. A smaller size or a higher ratio gearbox requests less Breakaway Torque.
Back Driving Torque	Nm	The Back Driving Torque is the minimum torque to start the rotation from the output side of gearbox. A larger size or a higher ratio gearbox requires greater Back Driving Torque.

* This value is measured at environment temperature 25°C and the input speed 3,000 rpm. If the Nominal Input Speed n_{1N} of gearbox is lower than 3,000 rpm, this value is measured by that specific Nominal Input Speed.