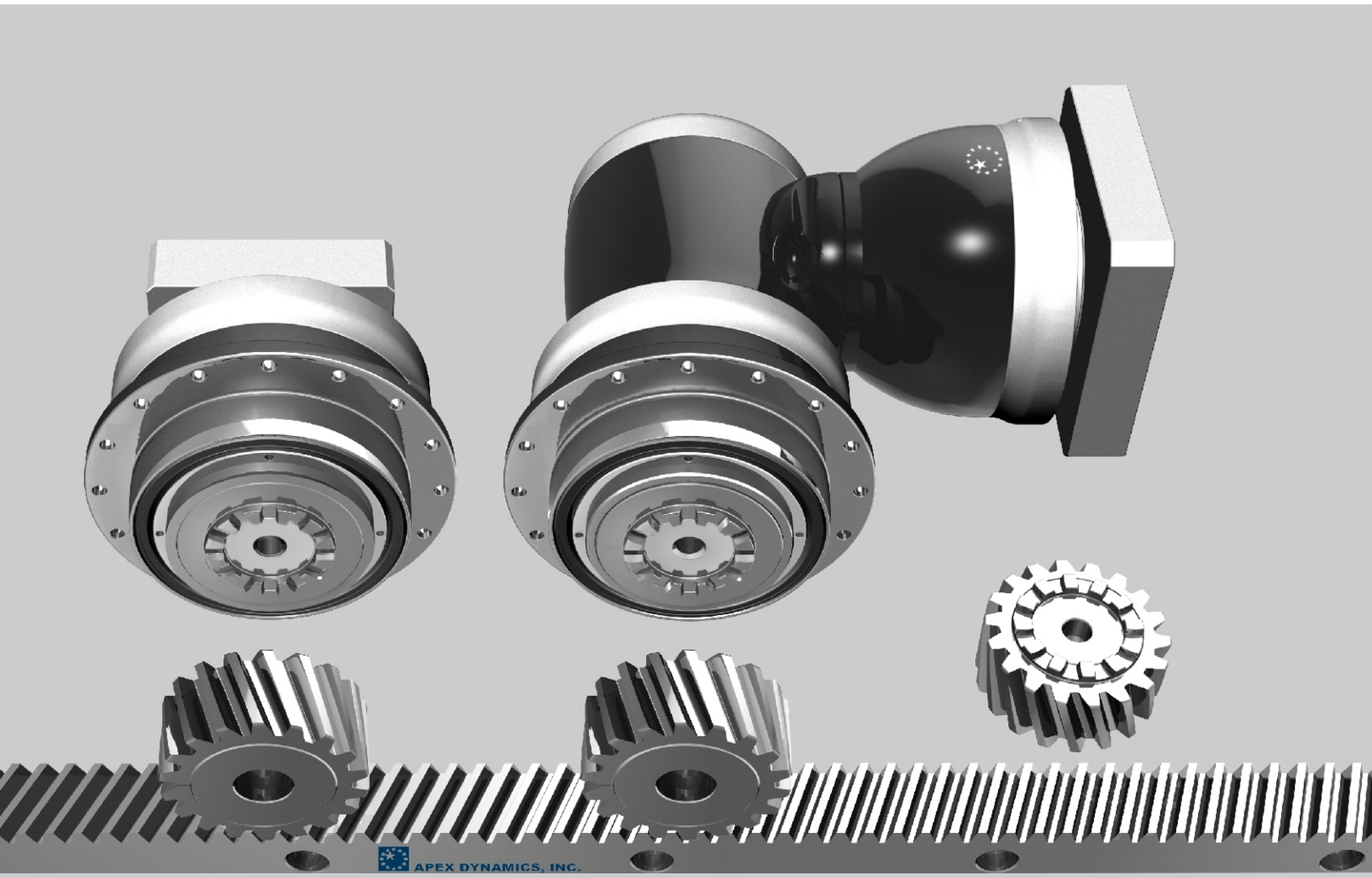
APEX DYNAMICS, INC.

High Torque
High Precision
Planetary Gearbox
AP / APK - SERIES



Gearbox Series - AP / APK

Features:

High Torque
High efficiency
Curvic Interface
Optimized for Rack & Pinion
Optimized output torque & Inertia moment
Long-Term persistence of reduced backlash
Low noise
Limited temperature rise
Long service life
Flexible mounting diameters

AP

APK

Ordering Code - AP / APK Gearbox

AP110	–	005.5[1]	/	MOTOR
APK110	–	005.5[1]	/	MOTOR
				3. Motor Type
				2. Ratio
				1. Gearbox Size

Gearbox Size

AP	110 / 140 / 200 / 255 / 285 / 355 / 450
APK	110 / 140 / 200 / 255 / 285 / 355 / 450

Ratio[2]

AP		5.5
AP	(2 Stg.)	22/27.5/38.5/55
AP	(3 Stg.)	88/110/154/220
APK	(2 Stg.)	5.5 / 11 / 22 / 27.5 / 38.5 / 55
APK	(3 Stg.)	88 / 110 / 137.5 / 154 / 220 / 385
APK	(4 Stg.)	440 / 550 / 770 / 1,078 / 1,540 / 2,695 / 3,850 / 5,500

Motor Type : Manufacturer and Model

(1) Ratio ($i= N_{in} / N_{out}$) .
(2) Please refer to the specifications for the ratios provided in each series.

Performance - AP Gearbox

Model No.		Stage	Ratio(1)	AP110	AP140	AP 200	AP 255	AP 285	AP 355	AP 450
Nominal Output Torque T_{2N}	Nm	1	5.5	370	645	1,430	2,175	4,060	-	-
		2	22	375	650	1,445	2,200	4,100	6,995	13,810
			27.5	375	655	1,445	2,200	4,105	7,000	13,825
			38.5	375	655	1,450	2,200	4,110	7,010	13,845
			55	315	655	1,450	2,205	4,110	7,020	13,855
		3	88	380	655	1,450	2,205	4,115	7,025	13,865
			110	380	655	1,450	2,205	4,115	7,025	13,870
			154	380	655	1,450	2,205	4,120	7,030	13,875
			220	380	655	1,450	2,205	4,120	7,030	13,875
Emergency Stop Torque T_{2NOT}	Nm	1,2,3	5.5~220	3 times T_{2N}						
Max. Acceleration Torque T_{2B}	Nm	1,2,3	5.5~220	1.5 times T_{2N}						
No Load Running Torque(3)	Nm	1	5.5	2.5	7.1	14	22	28	-	-
		2	22~55	1.1	3.7	8	12	18	17	26
		3	88~220	0.7	1.6	4	4.5	6.5	6	12
Backlash(2)	arcmin	1,2,3	5.5~220	≦ 1						
Torsional Rigidity	Nm/arcmin	1,2,3	5.5~220	95	205	650	1,200	1,800	2,850	5,700
Nominal Input Speed n_{1N}	rpm	1	5.5	3,600	3,000	2,700	2,400	2,100	-	-
		2	22~55	4,600	4,000	3,700	3,400	3,100	2,500	2,000
		3	88~220	5,000	4,600	4,000	3,700	3,400	3,100	2,500
Max. Input Speed n_{1B}	rpm	1	5.5	6,000	5,000	4,500	4,000	3,500	-	-
		2	22~55	7,000	6,000	5,500	5,000	4,500	4,000	3,500
		3	88~220	7,000	7,000	6,000	5,500	5,000	4,500	4,000
Max. Axial Load F_{2a}(4)	N	1,2,3	5.5~220	4,070	8,530	17,000	26,900	39,200	101,500	143,700
Max. Bending Moment M_{2k}(4)	Nm	1,2,3	5.5~220	480	1,310	3,530	5,920	9,230	29,100	63,300
Service Life(5)	hr	1,2,3	5.5~220	20,000						
Operating Temp	° C	1,2,3	5.5~220	-10° C~ 90° C						
Degree of Gearbox Protection		1,2,3	5.5~220	IP65						
Lubrication		1,2,3	5.5~220	Synthetic lubrication grease						
Mounting Position		1,2,3	5.5~220	All directions						
Running Noise(3)	dB(A)	1	5.5	≦ 64	≦ 66	≦ 66	≦ 68	≦ 68	-	-
		2	22~55	≦ 62	≦ 64	≦ 66	≦ 67	≦ 67	≦ 68	≦ 70
		3	88~220	≦ 62	≦ 64	≦ 66	≦ 66	≦ 67	≦ 67	≦ 68
Efficiency η	%	1	5.5	≧ 97%						
		2	22~55	≧ 94%						
		3	88~220	≧ 92%						

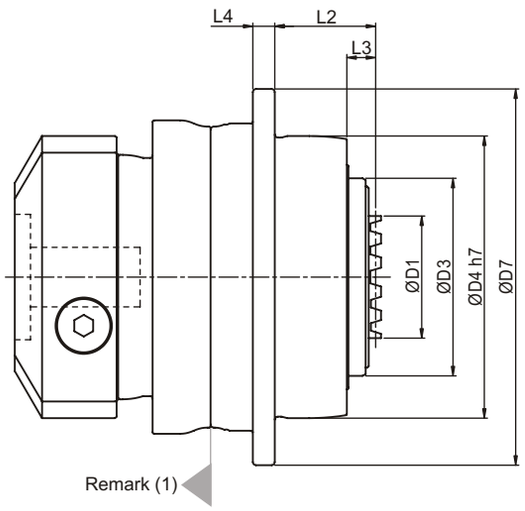
(1) Ratio ($i = N_{in} / N_{out}$).
(2) Backlash is measured at 2% of Nominal Output Torque T_{2N}.
(3) These values are measured by gearbox with ratio = 5.5 (1-stage) or 55 (2-stage) or 220 (3-stage) at 3,000 rpm without load,
By ratio smaller than 10, the noise value would be 3-5dB higher.
(4) Applied to the output curvic flange center at 100 rpm.
(5) Continuous operation is not recommended.

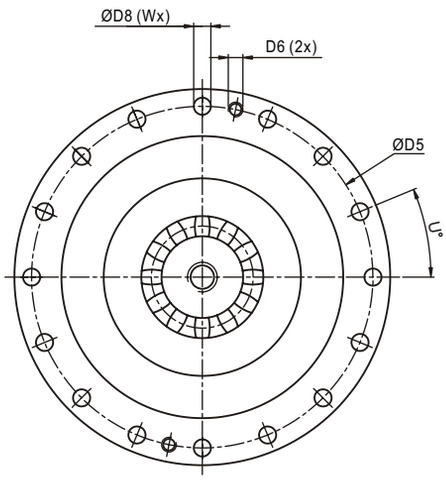
Inertia - AP Gearbox

Model No.		AP110			AP140			AP 200			AP 255			AP 285			AP 355		AP 450	
Ø(A)	stage	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	2	3	2	3
14	kg.cm²	-	-	0.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19		1.68	0.68	0.63	-	-	0.68	-	-	-	-	-	-	-	-	-	-	-	-	-
24		4.89	4.52	-	6.83	5.04	4.52	-	-	5.04	-	-	-	-	-	-	-	-	-	-
28		6.18	-	-	6.69	6.33	-	-	-	6.33	-	-	7.18	-	-	-	-	-	-	-
32		8.58	-	-	9.6	8.73	-	-	10.1	8.73	-	-	10.1	-	-	-	-	-	-	-
35		13.89	-	-	15.05	14.04	-	15.79	15.54	14.04	-	17.75	15.54	-	-	17.75	-	-	-	
38		18.91	-	-	20.82	19.05	-	21.3	21.32	19.05	-	23.26	21.32	-	27.05	23.26	-	23.26	-	27.05
42		-	-	-	22.71	-	-	23.43	23.2	-	24.84	25.4	-	-	28.95	25.4	28.79	25.4	-	28.95
48		-	-	-	55.58	-	-	59.06	56.07	-	60.55	61.02	-	64.93	64.66	61.02	92.76	61.02	106.06	64.66
55		-	-	-	-	-	-	-	-	-	88.2	-	-	92.99	-	-	105.41	-	118.67	-
60		-	-	-	-	-	-	-	-	-	-	-	-	115.8	-	-	-	-	127.37	-

(A) Ø = Input shaft diameter.

Dimension AP Gearbox





Dimension	AP110	AP140	AP 200	AP 255	AP 285	AP 355	AP 450
D1	46	60	80	90	120	120	132
D3	80	100	160	180	200	250	315
D4 h7	110	140	200	255	285	355	450
D5	135	168	233	280	310	385	490
D6	-	-	-	M12	M12	M16	M16
D7	147	180	249.5	302	332	415	530
D8	5.5	6.6	9	13.5	13.5	17.5	22
L2	31.5	40.5	52.5	68.5	77.5	82.5	87.5
L3	9.5	10	11	16	19	22.5	22.5
L4	8	10	12	18	20	45	60
U in Degree	22.5	15	15	11.25	11.25	15	15
W	16	24	24	32	32	24	24

(1) Dimensions are related to motor interface. Please contact APEX for details
(2) Flange Shaft Interface(accessories),please refer to page 14

Performance - APK Gearbox

Model No.		Stage	Ratio(1)	APK 110	APK 140	APK 200	APK 255	APK 285	APK 355	APK 450
Nominal Output Torque T_{2N}	Nm	2	22	375	655	1,445	2,200	4,110	7,010	-
			27.5	375	655	1,445	2,200	4,110	7,015	-
			38.5	375	655	1,450	2,200	4,110	7,020	-
			55	375	655	1,450	2,205	4,115	7,025	-
		3	88	380	655	1,450	2,205	4,115	7,025	13,870
			110	380	655	1,450	2,205	4,115	7,025	13,870
			137.5	380	655	1,450	2,205	4,120	7,030	13,875
			154	380	655	1,450	2,205	4,120	7,030	13,875
			220	380	655	1,450	2,205	4,120	7,030	13,200
			385	380	655	1,450	2,205	4,120	7,030	13,880
		4	440	380	655	1,450	2,205	4,120	7,030	13,880
			550	380	655	1,450	2,210	4,120	7,030	13,880
			770	380	655	1,450	2,210	4,120	7,030	13,880
			1,078	380	655	1,450	2,210	4,120	7,035	13,880
			1,540	380	655	1,450	2,210	4,120	7,035	13,885
			2,695	380	655	1,450	2,210	4,120	7,035	13,885
			3,850	380	655	1,450	2,210	4,120	7,035	13,885
			5,500	315	655	1,450	2,210	4,120	7,035	14,010
Emergency Stop Torque T_{2NOT}	Nm	2,3,4	22~5,500	2 times T_{2N}						
Max. Acceleration Torque T_{2B}	Nm	2,3,4	22~5,500	1.5 times T_{2N}						
No Load Running Torque(3)	Nm	2	22~55	2	3.1	6	13	16	20	-
		3	88~385	1.4	2.4	4.6	7	8.5	10.5	13
		4	440~5,500	0.2	0.3	0.6	0.9	1.2	1.8	2.5
Backlash(2)	arcmin	2,3,4	22~5,500	≦ 1.2						
Torsional Rigidity	Nm/arcmin	2	22~55	56	112	389	642	1,275	2,500	-
		3	88~385	56	112	389	642	1,275	2,500	5,100
		4	440~5,500	45	85	310	535	1,050	1,700	2,700
Nominal Input Speed n_{1N}	rpm	2	22~55	2,800	2,700	2,200	2,100	2,000	1,600	-
		3	88~385	3,000	2,800	2,700	2,200	2,100	2,100	2,000
		4	440~5,500	5,500	4,600	4,600	4,000	3,700	3,700	3,400
Max. Input Speed n_{1B}	rpm	2	22~55	6,000	4,500	4,500	4,000	3,000	2,500	-
		3	88~385	6,000	6,000	4,500	4,500	4,000	4,000	3,000
		4	440~5,500	7,000	7,000	7,000	6,000	5,500	5,500	5,000
Max. Axial Load F_{2a}(4)	N	2,3,4	22~5,500	4,070	8,530	17,000	26,900	39,200	101,500	143,700
Max. Bending Moment M_{2k}(4)	Nm	2,3,4	22~5,500	480	1,310	3,530	5,920	9,230	29,100	63,300
Service Life(5)	hr	2,3,4	22~5,500	20,000						
Operating Temp	° C	2,3,4	22~5,500	-10° C~ 90° C						
Degree of Gearbox Protection		2,3,4	22~5,500	IP65						
Lubrication		2,3,4	22~5,500	Synthetic lubrication grease						
Mounting Position		2,3,4	22~5,500	All directions						
Running Noise(3)	dB(A)	2,3,4	22~5,500	≦ 68	≦ 68	≦ 70	≦ 70	≦ 72	≦ 74	≦ 76
Efficiency η	%	2	22~5,500	≧ 94%						
		3	88~385	≧ 92%						
		4	440~5,500	≧ 90%						

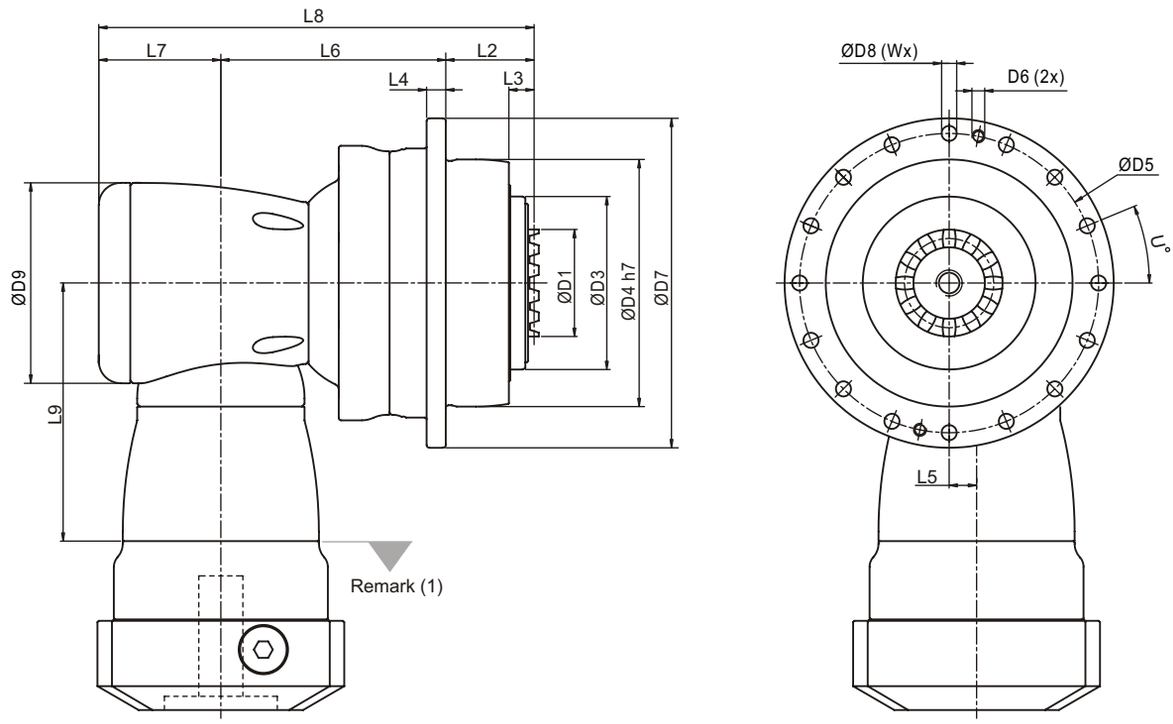
(1) Ratio ($i = N_{in} / N_{out}$) .
(2) Backlash is measured at 2% of Nominal Output Torque T_{2N}.
(3) These values are measured by gearbox with ratio = 5.5 (1-stage) or 55 (2-stage) or 220 (3-stage) at 3,000 rpm without load,
By ratio smaller than 10, the noise value would be 3-5dB higher.
(4) Applied to the output curvic flange center at 100 rpm.
(5) Continuous operation is not recommended.

Inertia - APK Gearbox

Model No.		APK 110			APK 140			APK 200			APK 255			APK 285			APK 355			APK 450	
Ø(A)	stage	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	3	4
8	kg.cm²	-	-	0.17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11		-	-	0.17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14		-	0.47	-	-	-	0.53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19		1.64	0.63	-	-	1.64	0.68	-	-	1.83	-	-	-	-	-	-	-	-	-	-	-
24		4.74	-	-	5.05	4.74	4.52	-	5.05	5.04	-	-	5.63	-	-	-	-	-	-	-	-
28		-	-	-	6.55	5.96	-	-	6.55	-	-	6.98	7.18	-	-	-	-	-	-	-	-
32		-	-	-	9.47	-	-	10.18	9.47	-	-	10.18	10.1	-	-	-	-	-	-	-	-
35		-	-	-	14.91	-	-	15.21	14.91	-	15.21	15.21	15.54	-	15.21	15.54	-	-	15.54	-	17.75
38		-	-	-	20.69	-	-	20.7	20.69	-	20.7	20.7	21.32	21.69	20.7	21.32	-	20.7	21.32	21.69	23.26
42		-	-	-	-	-	-	22.83	-	-	22.83	-	-	23.59	22.83	23.2	25.28	22.83	23.2	23.59	25.4
48		-	-	-	-	-	-	58.45	-	-	58.45	-	-	59.3	58.45	56.07	61.61	58.45	56.07	59.3	61.02
55		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	89.67	-	-	-	-

(A) Ø = Input shaft diameter.

Dimension APK (2 Stage) Gearbox (Ratio i=22~55)

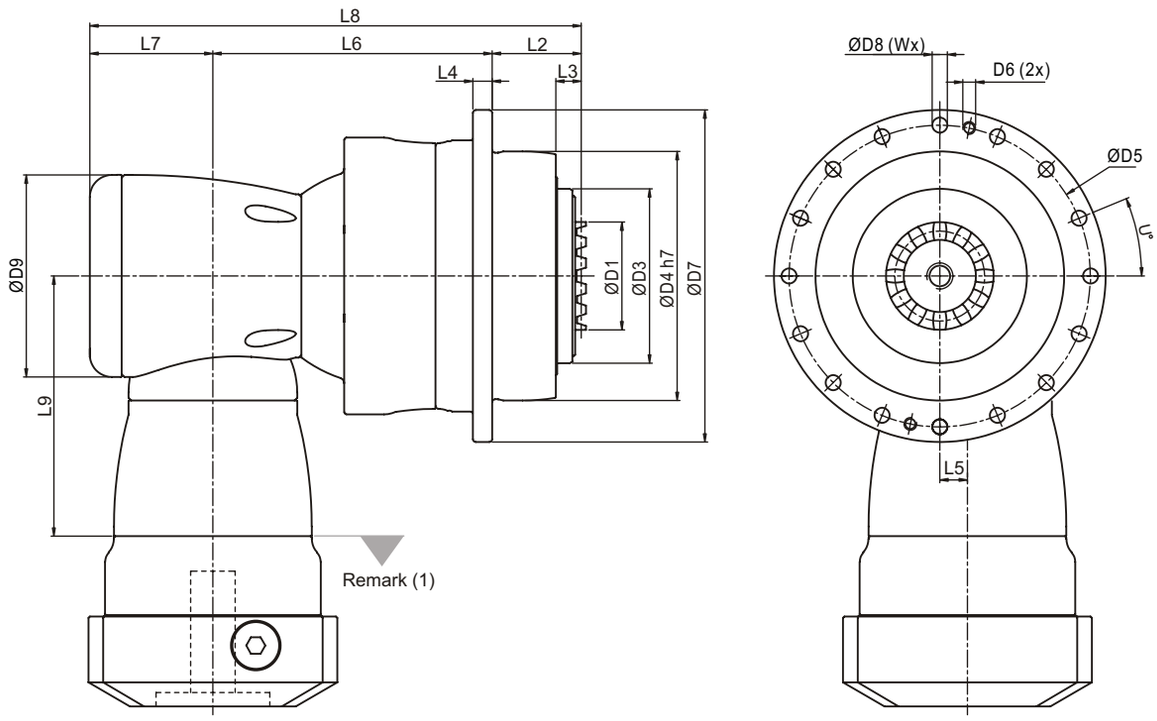


Dimension	APK 110	APK 140	APK 200	APK 255	APK 285	APK 355
D1	46	60	80	90	120	120
D3	80	100	160	180	200	250
D4 h7	110	140	200	255	285	355
D5	135	168	233	280	310	385
D6	-	-	-	M12	M12	M16
D7	147	180	249.5	302	332	415
D8	5.5	6.6	9	13.5	13.5	17.5
D9	116	163	210	210	255	300
L2	31.5	40.5	52.5	68.5	77.5	82.5
L3	9.5	10	11	16	19	22.5
L4	8	10	12	18	20	45
L5	17	25	31	31	36	43
L6	114	147.5	175	191.5	249.5	290
L7	68.3	89	115	115	131	165
L8	213.8	277	342.5	375	458	537.5
L9	129	173.5	228	228	265.5	294.5
U in Degree	22.5	15	15	11.25	11.25	15
W	16	24	24	32	32	24

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

(2) Flange Shaft Interface(accessories),please refer to page 14

Dimension - APK (3 Stage) Gearbox (Ratio i=88~385)

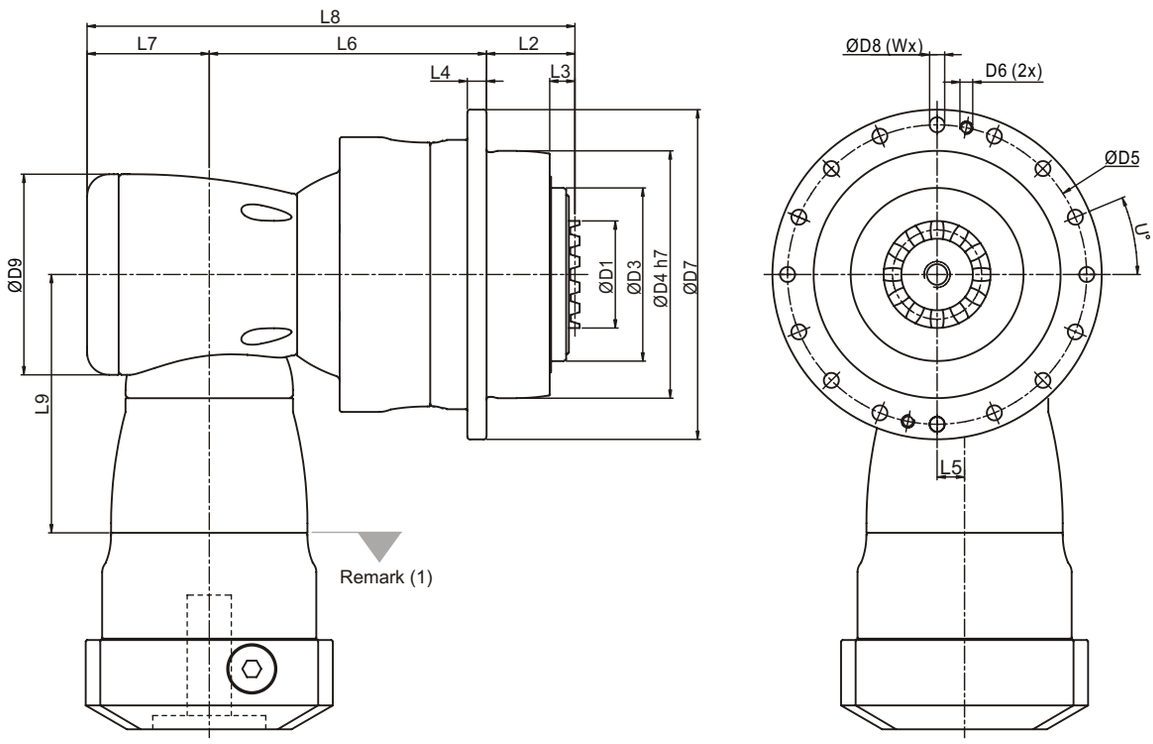


Dimension	APK 110	APK140	APK 200	APK 255	APK 285	APK 355	APK 450
D1	46	60	80	90	120	120	132
D3	80	100	160	180	200	250	315
D4 h7	110	140	200	255	285	355	450
D5	135	168	233	280	310	385	490
D6	-	-	-	M12	M12	M16	M16
D7	147	180	249.5	302	332	415	530
D8	5.5	6.6	9	13.5	13.5	17.5	22
D9	94	116	163	210	210	210	255
L2	31.5	40.5	52.5	68.5	77.5	82.5	87.5
L3	9.5	10	11	16	19	22.5	22.5
L4	8	10	12	18	20	45	60
L5	13	17	25	31	31	31	36
L6	132	164	216.5	254.5	300	332	447.5
L7	53	68.3	89	115	115	115	131
L8	216.5	272.8	358	438	492.5	529.5	666
L9	114.5	129	173.5	228	228	228	265.5
U in Degree	22.5	15	15	11.25	11.25	15	15
W	16	24	24	32	32	24	24

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

(2) Flange Shaft Interface(accessories),please refer to page 14

Dimension - APK (4 Stage) Gearbox (Ratio i=440~5,500)



Dimension	APK 110	APK140	APK 200	APK 255	APK 285	APK 355	APK 450
D1	46	60	80	90	120	120	132
D3	80	100	160	180	200	250	315
D4 h7	110	140	200	255	285	355	450
D5	135	168	233	280	310	385	490
D6	-	-	-	M12	M12	M16	M16
D7	147	180	249.5	302	332	415	530
D8	5.5	6.6	9	13.5	13.5	17.5	22
D9	94	116	163	210	210	210	255
L2	31.5	40.5	52.5	68.5	77.5	82.5	87.5
L3	9.5	10	11	16	19	22.5	22.5
L4	8	10	12	18	20	45	60
L5	13	17	25	31	31	31	36
L6	132	164	216.5	254.5	300	332	447.5
L7	53	68.3	89	115	115	115	131
L8	216.5	272.8	358	438	492.5	529.5	666
L9	114.5	129	173.5	228	228	228	265.5
U in Degree	22.5	15	15	11.25	11.25	15	15
W	16	24	24	32	32	24	24

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

(2) Flange Shaft Interface(accessories),please refer to page 14

Performance - APK (2 Stage) Gearbox (Ratio i=5.5~11)

Model No.		Stage	Ratio[1]	APK 110	APK 140	APK 200	APK 255	APK 285
Nominal Output Torque T_{2N}	Nm	2	5.5	370	645	1,435	2,180	4,080
			11	375	650	1,440	2,195	4,100
Emergency Stop Torque T_{2NOT}	Nm	2	5.5~11	2 times T_{2N}				
Max. Acceleration Torque T_{2B}	Nm	2	5.5~11	1.5 times T_{2N}				
No Load Running Torque[3]	Nm	2	5.5~11	5.8	12	25	48	95
Backlash[2]	arcmin	2	5.5~11	≦ 1.3				
Torsional Rigidity	Nm/arcmin	2	5.5~11	56	112	389	642	1,275
Nominal Input Speed n_{1N}	rpm	2	5.5~11	3,000	2,300	1,800	1,500	1,100
Max. Input Speed n_{1B}	rpm	2	5.5~11	5,500	4,500	3,500	3,000	2,200
Max. Axial Load F_{2a}[4]	N	2	5.5~11	4,070	8,530	17,000	26,900	39,200
Max. Bending Moment M_{2k}[4]	Nm	2	5.5~11	480	1,310	3,530	5,920	9,230
Service Life[5]	hr	2	5.5~11	20,000				
Operating Temp	° C	2	5.5~11	-10° C~ 90° C				
Degree of Gearbox Protection		2	5.5~11	IP65				
Lubrication		2	5.5~11	Synthetic lubrication grease				
Mounting Position		2	5.5~11	All directions				
Running Noise[3]	dB(A)	2	5.5~11	≦ 68	≦ 70	≦ 70	≦ 72	≦ 74
Efficiency η	%	2	5.5~11	≧ 95%				

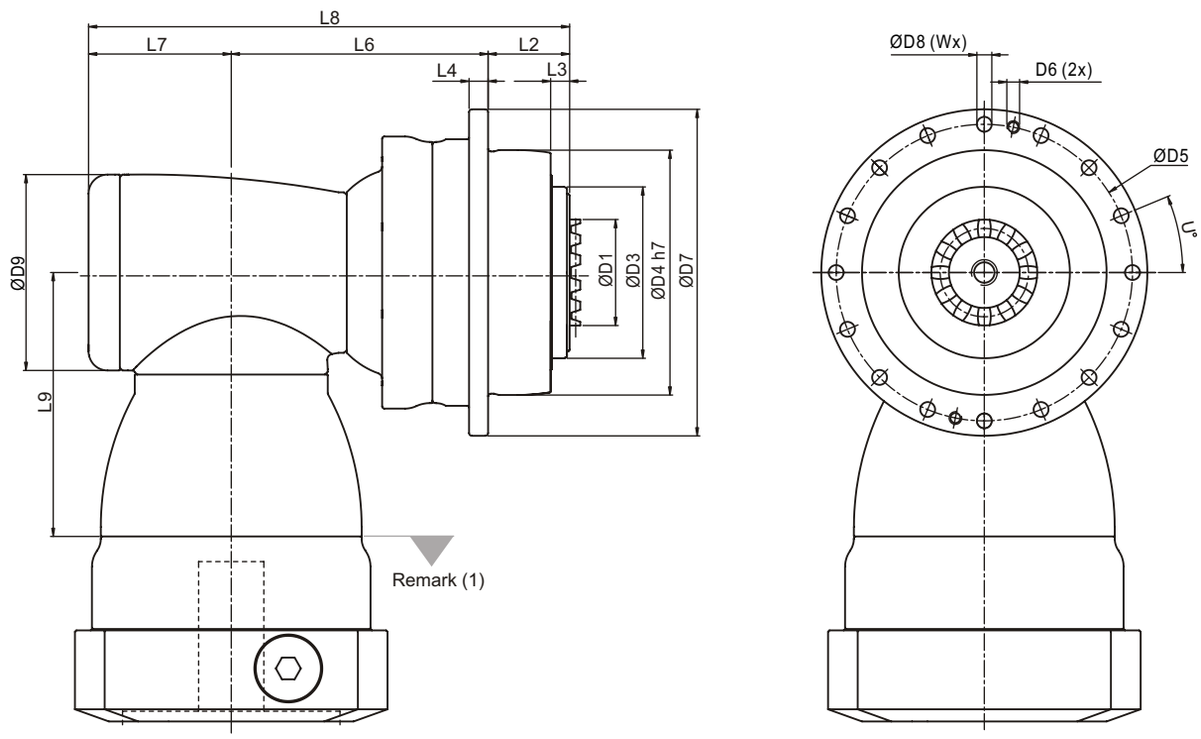
(1) Ratio ($i= N_{in} / N_{out}$) .
(2) Backlash is measured at 2% of Nominal Output Torque T_{2N}.
(3) These values are measured by gearbox with ratio = 5.5 (1-stage) or 55 (2-stage) or 220 (3-stage) at 3,000 rpm without load, By ratio smaller than 10, the noise value would be 3-5dB higher.
(4) Applied to the output curvic flange center at 100 rpm.
(5) Continuous operation is not recommended.

Inertia - APK (2 Stage) Gearbox (Ratio i=5.5~11)

Model No.		APK 110	APK 140	APK 200	APK 255	APK 285
Ø[A]	stage	2	2	2	2	2
19	kg.cm²	1.71	-	-	-	-
24		5.05	6.92	-	-	-
28		6.55	6.98	-	-	-
32		9.47	10.18	-	-	-
35		14.91	15.21	15.21	-	-
38		20.69	20.7	20.7	-	-
42		-	22.83	22.83	23.59	-
48		-	58.45	58.45	59.3	61.61
55		-	-	-	86.95	89.67
60		-	-	-	-	112.49

(A) Ø = Input shaft diameter.

Dimension - APK (2 Stage) Gearbox (Ratio i=5.5~11)

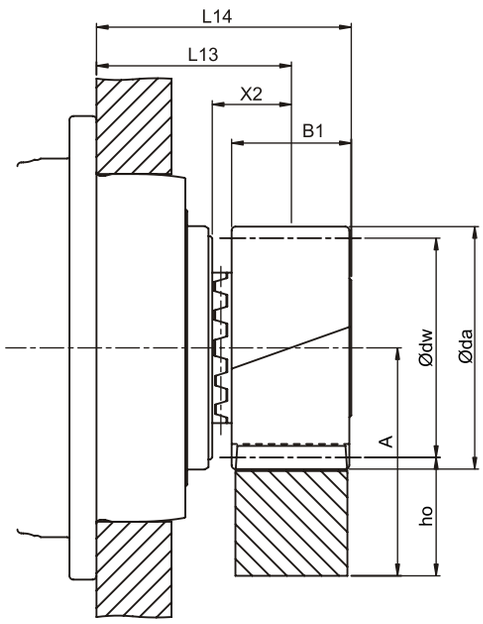


Dimension	APK 110	APK 140	APK 200	APK 255	APK 285
D1	46	60	80	90	120
D3	80	100	160	180	200
D4 h7	110	140	200	255	285
D5	135	168	233	280	310
D6	-	-	-	M12	M12
D7	147	180	249.5	302	332
D8	5.5	6.6	9	13.5	13.5
D9	116	156	156	195	240
L2	31.5	40.5	52.5	68.5	77.5
L3	9.5	10	11	16	19
L4	8	10	12	18	20
L6	124.5	175.5	185	199	265.5
L7	76	97.5	97.5	105.5	141
L8	213.8	277	342.5	375	458
L9	147.5	196.5	196.5	229	260
U in Degree	22.5	15	15	11.25	11.25
W	16	24	24	32	32

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

(2) Flange Shaft Interface(accessories),please refer to page 14

Pinion with Curvic Coupling



Quality DIN4 / Alloy Steel

Tooth Thickness Tolerance e24
Left-Hand Helical
Helical Angle β=19° 31'42" (19.5283°)
Pressure Angle α=20
Case-Hardened and Teeth Ground

$$A = ho + \frac{Ødw}{2}$$

Gearbox Model	Mn	Z(1)	X(2)	da(3)	d(4)	dw(5)	B1	X2	L13	L14	L(6)	Order Code
AP/APK 110	3	20	0.3897	72	63.662	66	31	20.5	49.5	65	200	A03L20
AP/APK 140	4	19	0.4102	91.92	80.639	83.92	41	25.5	63.5	84	253.335	A04L19
AP/APK 200	5	19	0.4002	114.8	100.798	104.8	51	30.5	80.5	106	316.666	A05L19
AP/APK 255	6	19	0.4035	137.8	120.958	125.8	61	35.5	101.5	132	380	A06L19
AP/APK 285	8	19	0.4108	183.85	161.277	167.85	81	45.5	120.5	161	506.667	A08L19
AP/APK 355	8	19	0.4108	183.85	161.277	167.85	81	45.5	125.5	166	506.667	A08L19
AP/APK 450	10	18	0.4257	219.5	190.986	199.5	101	55.5	140.5	191	600	A10L18

(1) Number of teeth (2) Profile modification factor (3) Diameter of addendum circle (4) Pitch circle diameter (5) Working pitch circle diameter
(6) Pitch circle length L = π x d

- Pinion material carburnized, surface hardness reached 60 HRc.
- Teeth surface ground to reduce noise and improve wear resistance.
- Accessories include hexagon socket head cap screws(Strength 12.9，DIN 912)

■ Table 1. The max permitted torque and feed-force of rack and pinion.

Unit / Gearbox Model	Mn	Z(1)	dw(2)	F_{2T}(3)	T_{2B}(4)	M
	【mm】	【 】	【mm】	【N】	【Nm】	【kg】
AP/APK 110	3	20	66	18,535	590	0.92
AP/APK 140	4	19	83.92	31,003	1,250	1.98
AP/APK 200	5	19	104.8	48,612	2,450	3.81
AP/APK 255	6	19	125.8	63,907	3,865	6.61
AP/APK 285	8	19	167.85	131,265	10,585	15.49
AP/APK 355(5)	8	19	167.85	131,761	10,625	15.49
AP/APK 450(5)	10	18	199.5	204,308	19,510	28.13

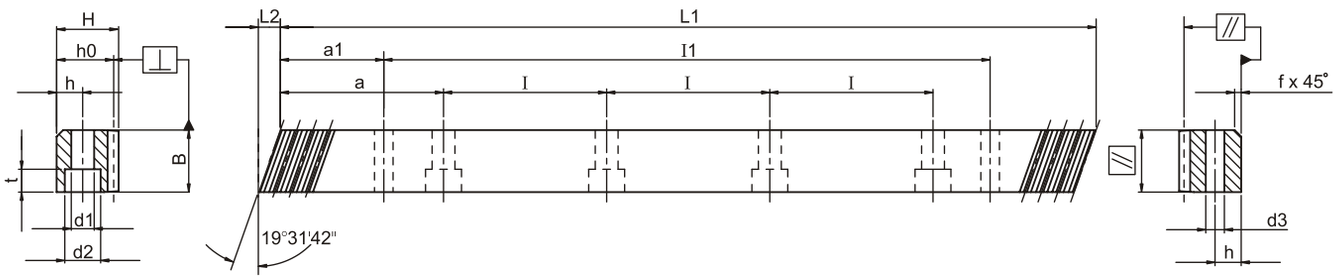
(1)Number of Teeth (2) Work Pitch Circle Diameter(in mm) (3)Maximal Feed-Force (4)Maximal Driving Torque (5)Speed 1.5m/s

- In Table 1, the maximum permissible torque of the pinion on Curvic Flange and the rack is calculated under the basis of a speed 1.5m/s. This condition is under providing good lubrication (using an automatic lubrication system or manually applied grease every day), the tooth root strength factor SF ≧1.4, tooth surface strength coefficient SH ≧1, the safety factor SB≒1, and the required service life of 20,000 hours. By higher speed, the maximal permissible torque reduced. The user needs to increase the safety factor for the application.
  Backlash changes by different center height. Please click on our website http://www.apexdyna.com/

Rack with Helical Teeth / Mn 3

Quality 5 / Alloy Steel

Tooth Thickness Tolerance -15 ~ 0 μm
Right-Hand Helical
Helical Angle β=19° 31'42" (19.5283°)
Pressure Angle α=20
Material Carburized, Induction Hardened
Teeth Ground and all Sides Ground



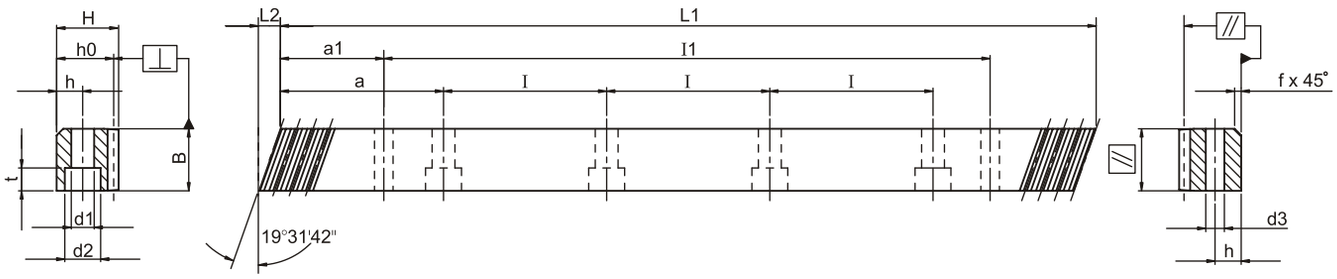
Mn	P_t (1)	L1	L2	Teeth No.	B	H	ho	f	a	l	Holes No.	h	d1	d2	t	a1	l1	d3	Fp (2)	Fp (3)	Order Code
3	10.00002	500	10.3	50	29	29	26	2	62.5	125	4	9	10	15	9	35	430	7.7	0.006	0.023	0305R050M10
3	10.00002	1,000	10.3	100	29	29	26	2	62.5	125	8	9	10	15	9	35	930	7.7	0.006	0.026	0305R100M10
3	10.00002	1,250	10.3	125	29	29	26	2	62.5	125	10	9	10	15	9	35	1,180	7.7	0.006	0.026	0305R125M10
3	10.00002	1,500	10.3	150	29	29	26	2	62.5	125	12	9	10	15	9	35	1,430	7.7	0.006	0.026	0305R150M10
3	10.00002	1,750	10.3	175	29	29	26	2	62.5	125	14	9	10	15	9	35	1,680	7.7	0.006	0.026	0305R175M10
3	10.00002	2,000	10.3	200	29	29	26	2	62.5	125	16	9	10	15	9	35	1,930	7.7	0.007	0.03	0305R200M10

(1) Teeth Pitch Pt = Module x π / cos ß (2) fp = Single Pitch Error (3) Fp = Total Pitch Error

Rack with Helical Teeth / Mn 4-10

Quality 5 / Alloy Steel

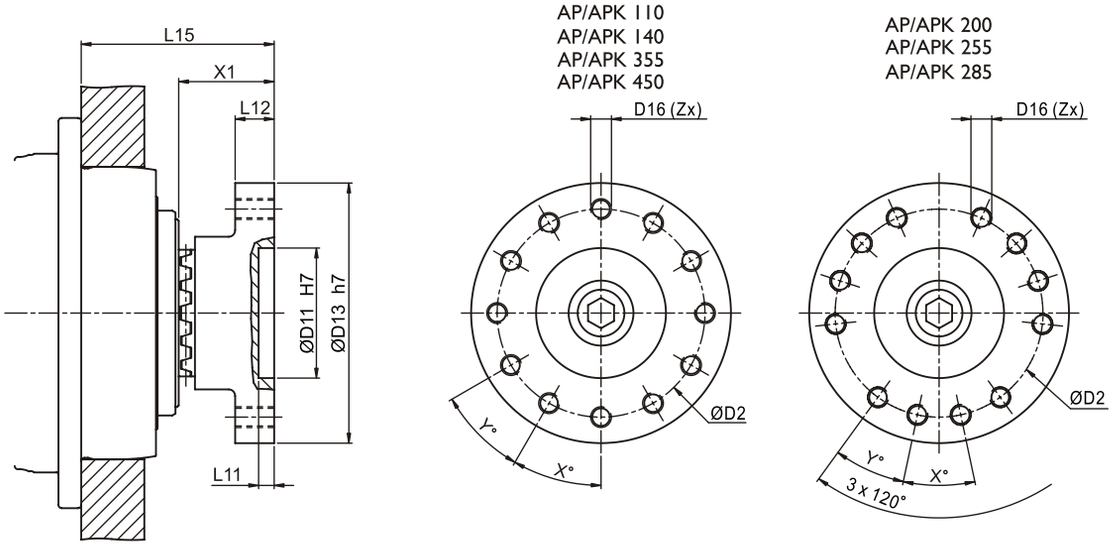
Tooth Thickness Tolerance -15 ~ 0 μm
Right-Hand Helical
Helical Angle β=19° 31'42" (19.5283°)
Pressure Angle α=20
Material Carburized, Induction Hardened
Teeth Ground and all Sides Ground



Mn	P_t (1)	L1	L2	Teeth No.	B	H	ho	f	a	l	Holes No.	h	d1	d2	t	a1	l1	d3	Fp (2)	Fp (3)	Order Code
4	13.33335	506.67	13.8	38	39	39	35	3	62.5	125	4	12	10	15	9	33.3	440.1	7.7	0.007	0.025	0405R050C10
4	13.33335	1,000	13.8	75	39	39	35	3	62.5	125	8	12	10	15	9	33.3	933.4	7.7	0.007	0.028	0405R100C10
4	13.33335	1,000	13.8	75	39	39	35	3	62.5	125	8	12	14	20	13	33.3	933.4	11.7	0.007	0.028	0405R100CS0
4	13.33335	1,253.34	13.8	94	39	39	35	3	62.5	125	10	12	10	15	9	33.3	1186.7	7.7	0.007	0.028	0405R125C10
4	13.33335	1,506.67	13.8	113	39	39	35	3	62.5	125	12	12	10	15	9	33.3	1,440.1	7.7	0.007	0.028	0405R150C10
4	13.33335	1,506.67	13.8	113	39	39	35	3	62.5	125	12	12	14	20	13	33.3	1,440.1	11.7	0.007	0.028	0405R150CS0
4	13.33335	1,760	13.8	132	39	39	35	3	62.5	125	14	12	10	15	9	33.3	1,693.4	7.7	0.007	0.028	0405R175C10
4	13.33335	2,000	13.8	150	39	39	35	3	62.5	125	16	12	10	15	9	33.3	1,933.4	7.7	0.008	0.032	0405R200C10
4	13.33335	2,000	13.8	150	39	39	35	3	62.5	125	16	12	14	20	13	33.3	1,933.4	11.7	0.008	0.032	0405R200CS0
5	16.66669	1,000	17.4	60	49	39	34	3	62.5	125	8	12	14	20	13	37.5	925	11.7	0.007	0.028	0505R100C10
6	20.00003	1,000	20.9	50	59	49	43	3	62.5	125	8	16	18	26	17	37.5	925	15.7	0.007	0.028	0605R100C10
8	26.66671	960	28	36	79	79	71	3	60	120	8	25	22	33	21	120	720	19.7	0.008	0.031	0805R100C10
10	33.33339	1,000	35.1	30	99	99	89	3	62.5	125	8	32	33	48	32	125	750	19.7	0.008	0.031	1005R100C10

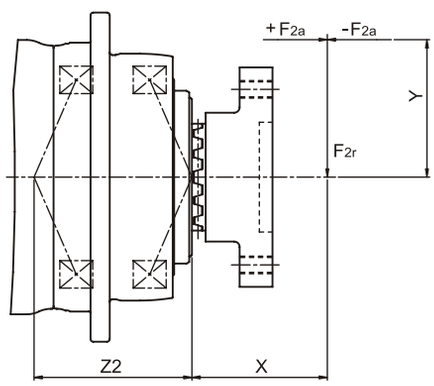
(1) Teeth Pitch Pt = Module x π / cos ß (2) fp = Single Pitch Error (3) Fp = Total Pitch Error

Accessories - Flange Shaft for AP/APK



Gearbox Model	L11	L12	X1	L15	D11 H7	D13 h7	D2	D16	X	Y	Z	Order Code
AP/APK 110	6	15	36	65	50	100	80	M8	30	30	12	FPD046A080
AP/APK 140	6	20	46.5	84.5	50	100	80	M10	30	30	12	FPD060A080
AP/APK 200	8	28	58	108	100	180	140	M16	24	24	12	FPD080A140
AP/APK 255	8	28	65.5	131.5	100	180	140	M16	24	24	12	FPD090A140
AP/APK 285	8	30	90	165	100	200	160	M20	24	24	12	FPD120A160
AP/APK 355	8	36	90	170	120	250	200	M24	22.5	22.5	16	FPD120A200
AP/APK 450	8	45	107.5	192.5	155	315	250	M30	30	30	12	FPD132A250

Note: Dimensions are related to gearbox flange interface



$$M_{2K} = \frac{F_{2a} * Y + F_{2r} * (X+Z2)}{1000}$$

M_{2K} :【Nm】

F_{2a}, F_{2r} :【N】

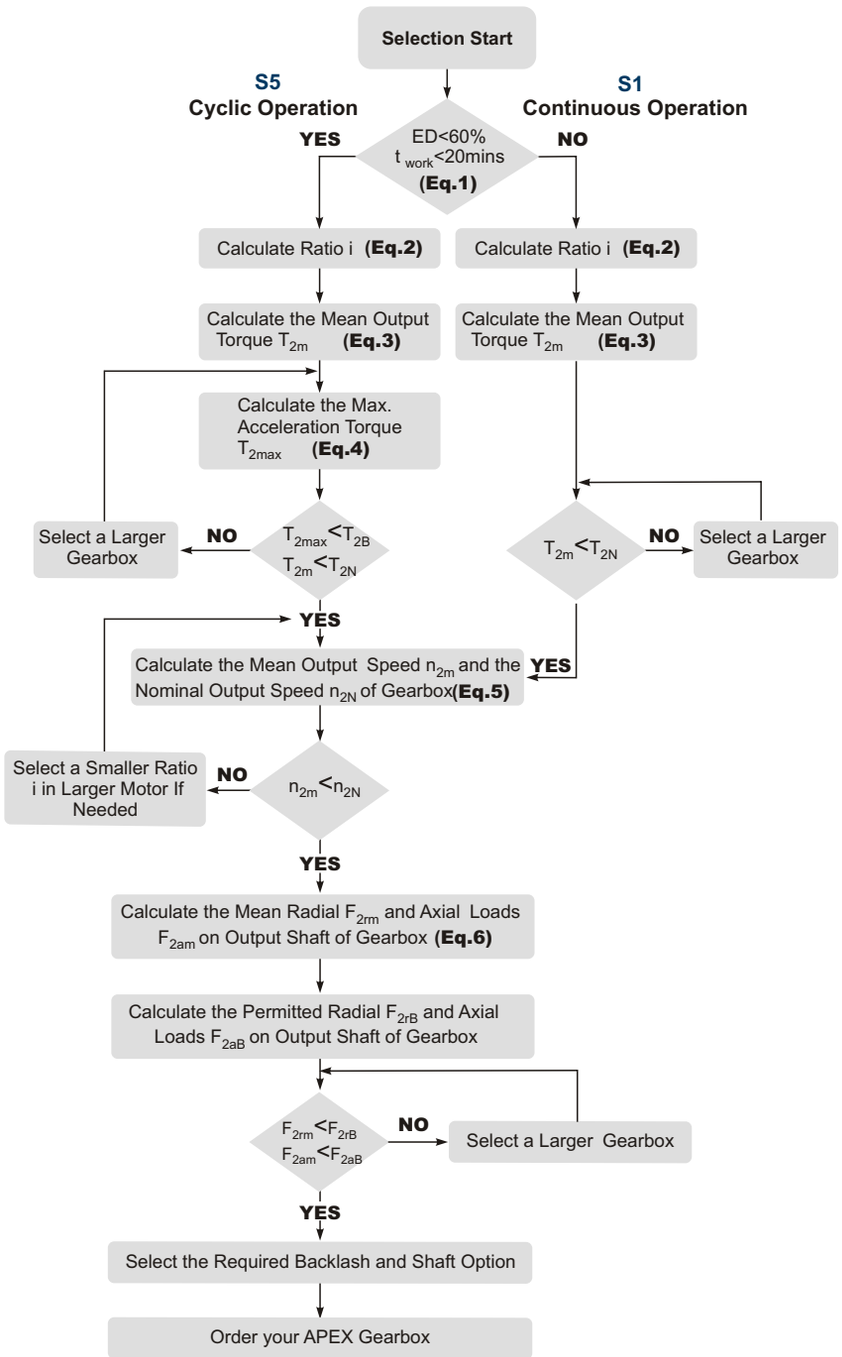
X,Y,Z2 :【mm】

M2K

AP / APK	110	140	200	255	285	355	450
Z2【mm】	106.2	90	122.8	133.2	175.5	220.6	275.3

Note: Applied to the output flange center at 100 rpm

Selection of the optimum gearbox



Recommended (for S5 Cycle Operation)

The general design is given for

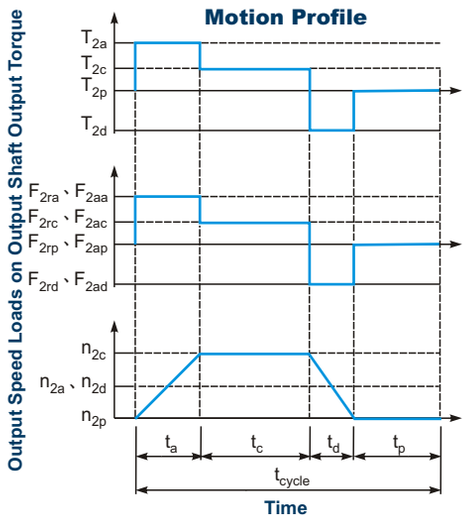
$$\frac{J_L}{i^2} \leq 4 \times J_m$$

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

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

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

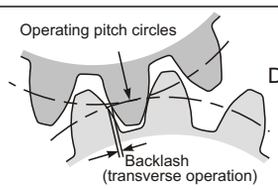
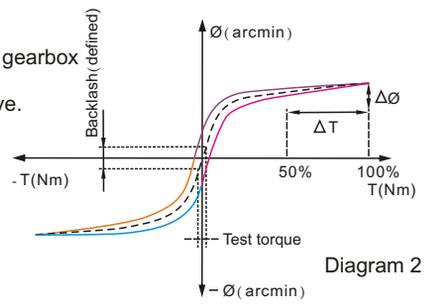
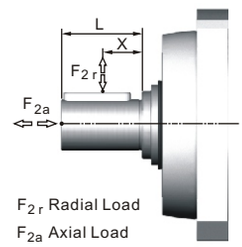
(Eq.5)

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.

Note

Note

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