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APEX DYNAMICS, INC.

PLANETARY GEARBOX
NEW GENERATION P-SERIES

PEII / PGII / PAII / PSII / PD / PL
PEIIR / PGIIR / PAIIR / PSIIR / PDR / PLR



New Generation P Series

Features:

Economic
High efficiency
Low noise
Reduced backlash
Optimized Inertia moment
Limited temperature rise
Long service life
Flexible mounting diameters
Minimized size and weight

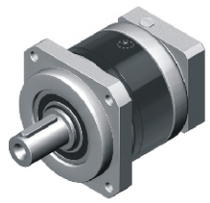
The perfect servo planetary gearbox !
The brand new APEX PII / PIIR series.
The PII / PIIR series is an economic high precision planetary gearbox with excellent performance and quality. Our innovative PII / PIIR series design features minimal size, light weight and high efficiency.


PEII


PEIIR


PGII

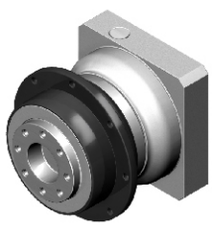

PGIIR


PAII


PAIIR


PSII


PSIIR


PD


PDR


PL


PLR

ORDERING CODE

PEII 090	–	010[1]	–	( )[2]	/	MOTOR
PEIIR 090	–	010[1]	–	( )[2]	/	MOTOR

Motor Type :
Manufacturer and Model

Ratio[1]:
1-stage: 3, 4, 5, 7 ,9[3] ,10
2-stage: 12[5],15, 16, 20, 25, 30, 35, 40, 50, 70, 81[3], 100
3-stage[4]: 120, 160, 200, 280, 350, 500, 700, 1000

Gearbox Size:
PEII : PEII 050, PEII 070, PEII 090, PEII 120, PEII 155
PGII : PGII 040, PGII 060, PGII 080, PGII 120, PGII 160
PAII : PAII 042, PAII 060, PAII 090, PAII 115, PAII 142
PSII : PSII A, PSII B, PSII C, PSII D, PSII E
PD : PD 053, PD 064, PD 090, PD 110
PL : PL 070, PL 090, PL 120,

Ordering Example : PEII 090 - 010 / SIEMENS 1FT6 041 - 4AF71
PAII 090 - 010 - S1 / SIEMENS 1FT6 041 - 4AF71

Gearbox Size:
PEIIR : PEIIR 050, PEIIR 070, PEIIR 090, PEIIR 120, PEIIR 155
PGIIR : PGIIR 040, PGIIR 060, PGIIR 080, PGIIR 120, PGIIR 160
PAIIR : PAIIR 042, PAIIR 060, PAIIR 090, PAIIR 115, PAIIR 142
PSIIR : PSIIR A, PSIIR B, PSIIR C, PSIIR D, PSIIR E
PDR : PDR 053, PDR 064, PDR 090, PDR 110
PLR : PLR 070, PLR 090, PLR 120

Ordering Example : PEIIR 090 - 010 / SIEMENS 1FT6 041 - 4AF71
PAIIR 090 - 010 - S1 / SIEMENS 1FT6 041 - 4AF71

(1) Ratio (i= N_{in} / N_{out}) .
(2) S1 = Smooth Output Shaft. S1 shaft is only provided for PAII / PAIIR series.
S2 = Output Shaft with Key. This is the standard shaft for PII / PIIR gearbox.
(3) Only provided for PSII / PSIIR and PAII / PAIIR series.
(4) Only provided for PGII and PGIIR series.
(5) Only provided for PL and PLR series.

PL / PLR Gearbox Performance

Model No.		Stages	Ratio(1)	Type	PL 070	PL 090	PL 120
					PLR 070	PLR 090	PLR 120
Nominal Output Torque T_{2N}	Nm	1	3	All	30	67	107
			4		39	86	137
			5		40	89	140
			7		37	80	128
			10		27	59	93
		2	12		31	69	109
			15		31	70	110
			16		39	86	137
			20		39	88	141
			25		40	89	140
			30		32	72	111
			35		36	80	130
			40		41	92	143
			50		42	90	143
			70		37	81	131
			100		27	59	93
Emergency Stop Torque T_{2NOT}	Nm	1,2	3~10	All	3 times T_{2N}		
Max. Acceleration Torque T_{2B}	Nm	1,2	3~10	All	T_{2B} = 60% of T_{2NOT}		
No Load Running Torque(4)	Nm	1	3~10	PL	0.10	0.40	0.80
				PLR	0.15	0.45	0.85
		2	12~100	PL	0.10	0.30	0.40
				PLR	0.15	0.35	0.45
Backlash(2)	arcmin	1	3~10	PL	≦ 7	≦ 6	≦ 6
				PLR	≦ 11	≦ 10	≦ 10
		2	12~100	PL	≦ 9	≦ 8	≦ 8
				PLR	≦ 13	≦ 12	≦ 12
Torsional Rigidity	Nm/arcmin	1,2	3~100	All	2.2	8	12
Nominal Input Speed n_{1N}	rpm	1,2	3~100	All	4,000	3,600	3,600
Max. Input Speed n_{1B}	rpm	1,2	3~100	All	6,000	6,000	4,800
Max. Radial Load F_{2rB}(3)	N	1,2	3~100	All	2,600	3,100	6,550
Max. Axial Load F_{2aB}(3)	N	1,2	3~100	All	1,300	1,550	3,275
Service Life(5)	hr	1,2	3~100	All	20,000		
Operating Temp	° C	1,2	3~100	All	0° C~ +90° C		
Degree of Gearbox Protection		1,2	3~100	All	IP65		
Lubrication		1,2	3~100	All	Synthetic lubrication grease		
Mounting Position		1,2	3~100	All	All directions		
Running Noise(4)	dB(A)	1,2	3~100	PL	≦ 62	≦ 64	≦ 66
				PLR	≦ 72	≦ 74	≦ 75
Efficiency η	%	1	3~10	PL	≧ 97%		
				PLR	≧ 93%		
		2	12~100	PL	≧ 94%		
				PLR	≧ 90%		

(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) or ratio = 100 (2-stage) at 3,000 rpm without load.
(5) For continuous operation, the service life time is less than 10,000 hrs.

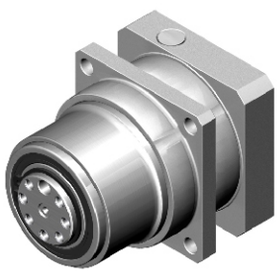
PL Gearbox Inertia

Model No.		PL 070		PL 090		PL 120	
Ø(A) (C3)		1-stage	2-stage	1-stage	2-stage	1-stage	2-stage
8	kg.cm²	0.12	0.10	-	-	-	-
11		0.19	0.16	-	-	-	-
14		0.22	0.20	0.36	0.24	-	-
19		1.53	1.51	1.70	1.58	2.20	1.73
24		-	-	2.24	2.12	2.74	2.27
28		-	-	2.68	2.55	3.17	2.70
32		-	-	-	-	7.77	7.30
35		-	-	-	-	10.80	10.30
38		-	-	-	-	14.00	13.50
42		-	-	-	-	-	-

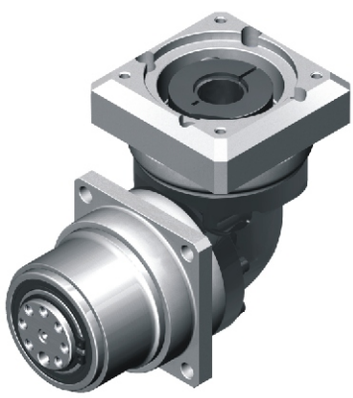
PLR Gearbox Inertia

Model No.		PLR 070		PLR 090		PLR 120	
Ø(A) (C3)		1-stage	2-stage	1-stage	2-stage	1-stage	2-stage
8	kg.cm²	0.36	0.36	-	-	-	-
11		0.39	0.39	-	-	-	-
14		0.43	0.43	1.87	1.87	-	-
19		1.24	1.24	2.67	2.67	6.80	6.80
24		-	-	2.97	2.97	7.10	7.10
28		-	-	3.47	3.47	7.59	7.59
32		-	-	-	-	10.56	10.56
35		-	-	-	-	11.97	11.97
38		-	-	-	-	13.95	13.95
42		-	-	-	-	-	-

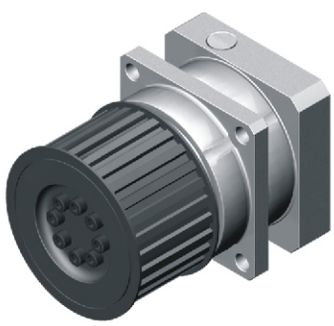
(A) Ø = Input shaft diameter.



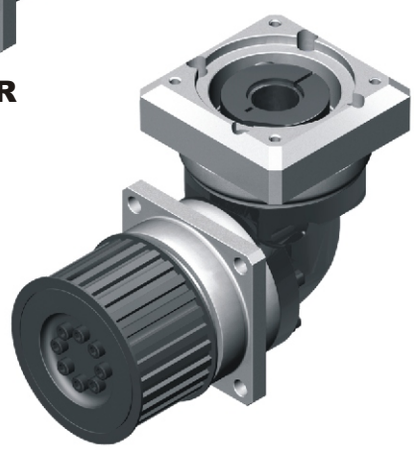
PL



PLR

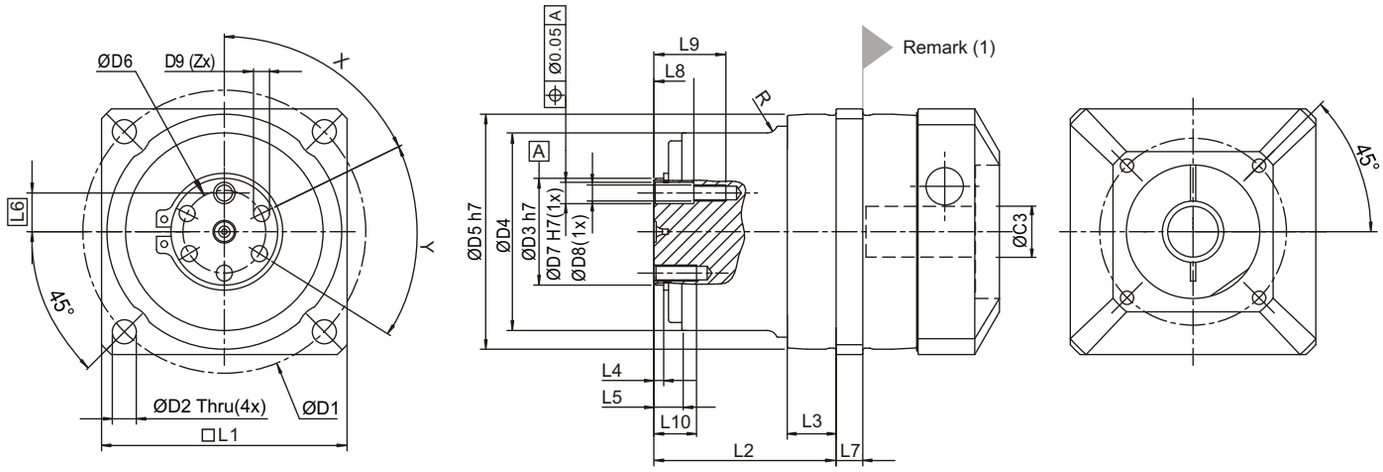


PL+Pulley



PLR+Pulley

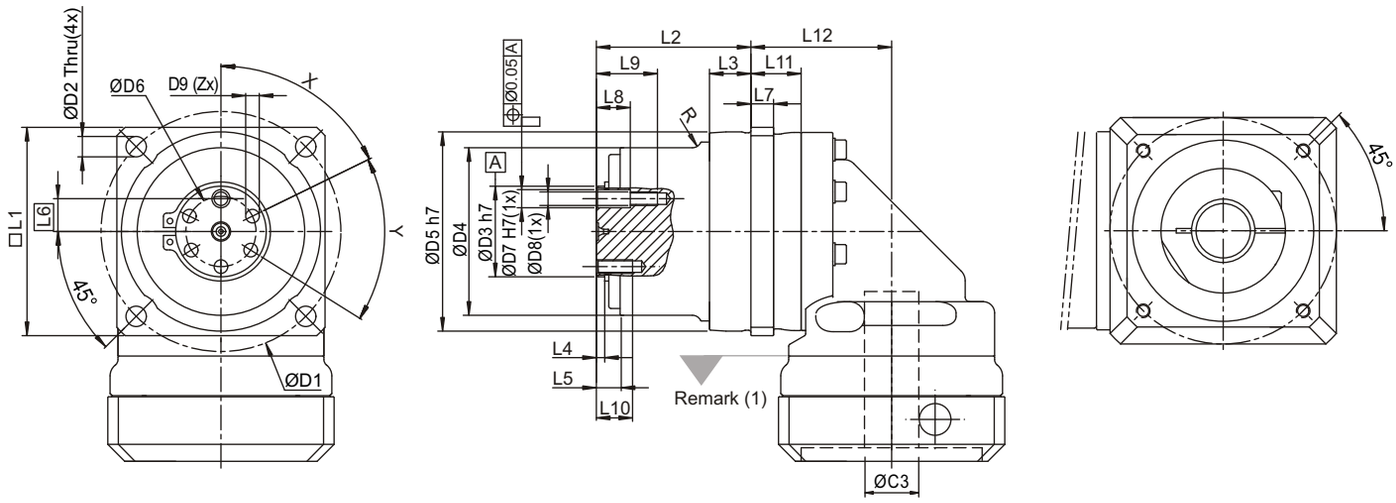
PL Series Dimension



Dimension	PL 070		PL 090		PL 120	
	1-stage	2-stage	1-stage	2-stage	1-stage	2-stage
D1	82		106		144	
D2	6.6		9		13	
D3 h7	25		40		50	
D4	58		74		100	
D5 h7	68		88		118	
D6	18		31		37	
D7 H7	6		8		8	
D8	M5X0.8P		M6X1P		M6X1P	
D9	M5X0.8P		M6X1P		M8X1.25P	
R	-		4		2	
L1	70		92		122	
L2	60.2		68.3		82.2	
L3	12.7		18.3		15.7	
L4	3.8		3.7		4.5	
L5	10		10.5		12.5	
L6	8.8		14.5		18.5	
L7	8		10		12	
L8	10		15		16	
L9	18.5		27		28	
L10	12		16		16	
X in Degree	64°		45°		45°	
Y in Degree	58°		45°		45°	
Z	5		7		7	

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

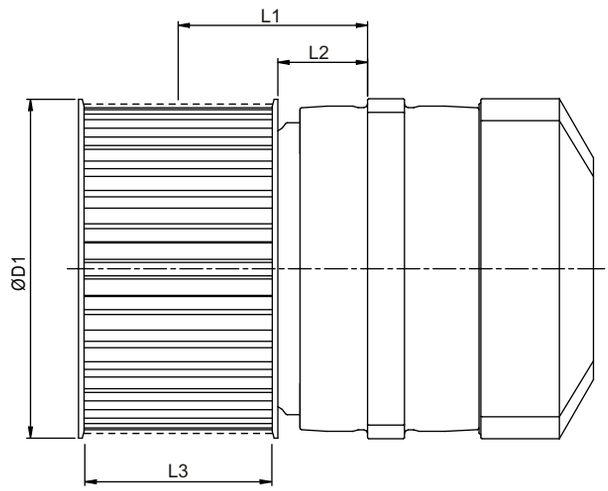
PLR Series Dimension



Dimension	PLR 070		PLR 090		PLR 120	
	1-stage	2-stage	1-stage	2-stage	1-stage	2-stage
D1	82		106		144	
D2	6.6		9		13	
D3 h7	25		40		50	
D4	58		74		100	
D5 h7	68		88		118	
D6	18		31		37	
D7 H7	6		8		8	
D8	M5X0.8P		M6X1P		M6X1P	
D9	M5X0.8P		M6X1P		M8X1.25P	
R	-		4		2	
L1	70		92		122	
L2	60.2		68.3		82.2	
L3	12.7		18.3		15.7	
L4	3.8		3.7		4.5	
L5	10		10.5		12.5	
L6	8.8		14.5		18.5	
L7	8		10		12	
L8	10		15		16	
L9	18.5		27		28	
L10	12		16		16	
L11	16.8	36.8	22.2	48.9	34.8	71.1
L12	46.3	66.3	62.2	88.9	85.8	122.1
X in Degree	64°		45°		45°	
Y in Degree	58°		45°		45°	
Z	5		7		7	

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

PL+PULLEY Dimension



Reducer	Belt Pulley	D1	L1	L2	L3	Pitch P	No.of Teeth Z	Circumference Z*P	Interia J	Mass m
						mm		mm/rotation	$kgcm^2$	kg
PL 070 PLR 070	AT05-W50-T43	71	41.8	14.8	51	5	43	215	4.68	0.57
	HTD 5M-W50-T44	72.9	41.8	14.8	51	5	44	220	5.58	0.65
	5GT-W50-T44	72.9	41.8	14.8	51	5	44	220	5.58	0.65
PL 090 PLR 090	AT10-W50-T28	91.7	51.3	24.3	51	10	28	280	14.07	1.00
	HTD 8M-W50-T36	98.4	51.3	24.3	51	8	36	288	17.78	1.18
	8YU-W50-T36	98.4	51.3	24.3	51	8	36	288	17.78	1.18
PL 120 PLR 120	AT20-W75-T19	124.6	57.7	17.7	76	20	19	380	69.55	2.71
	HTD 14M-W75-T28	137	57.7	17.7	76	14	28	392	87.83	3.20

PULLEY ORDERING CODE

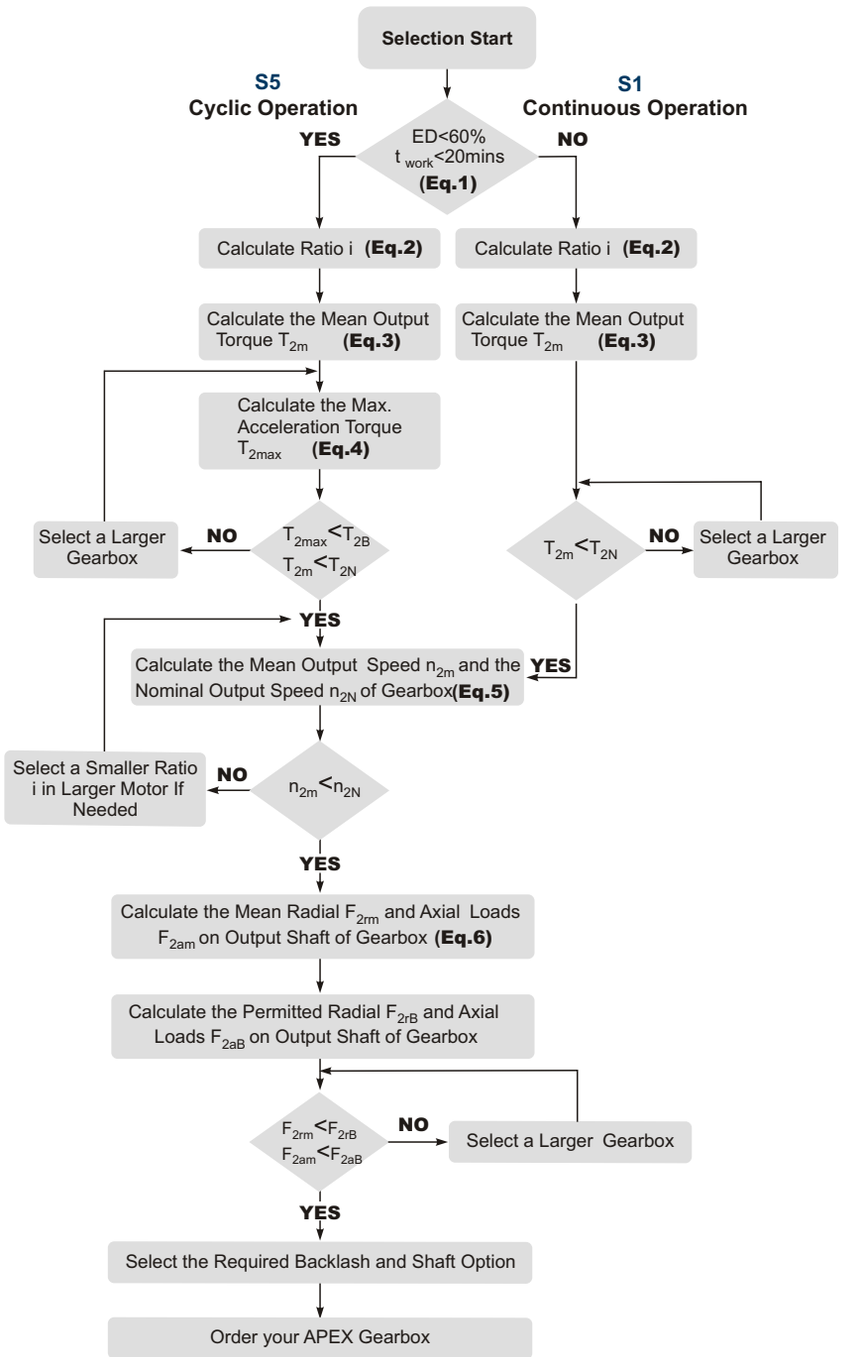
PUL070(1) – AT05(2) – B(3)

Pulley size corresponds to gearbox size:
PUL 070: PL 070, PLR 070
PUL 090: PL 090, PLR 090
PUL 120: PL 120, PLR 120

Ordering Example : PUL 070 - AT05 - B
PUL 090 - 8YU - N

(1) Pulley size.
(2) Pulley specification.
(3) Pulley appearance. B = Manganese phosphate blackening (Standard)
N = Nickel plating

Selection of the optimum gearbox



Recommended (for S5 Cycle Operation)

The general design is given for

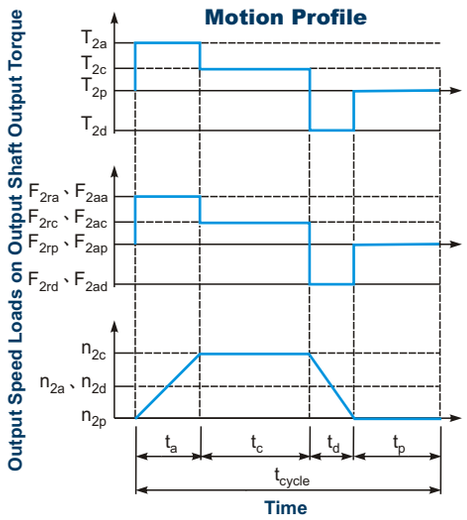
$$\frac{J_L}{i^2} \leq 4 \times J_m$$

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

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

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

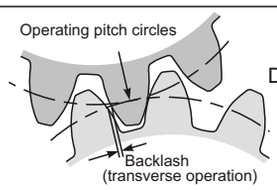
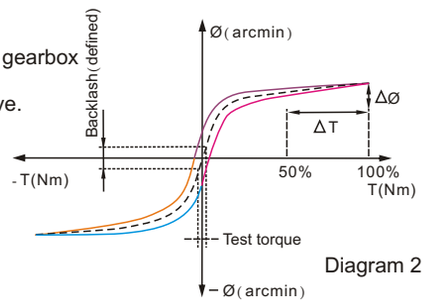
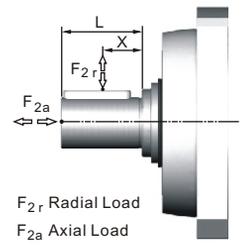
(Eq.5)

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)

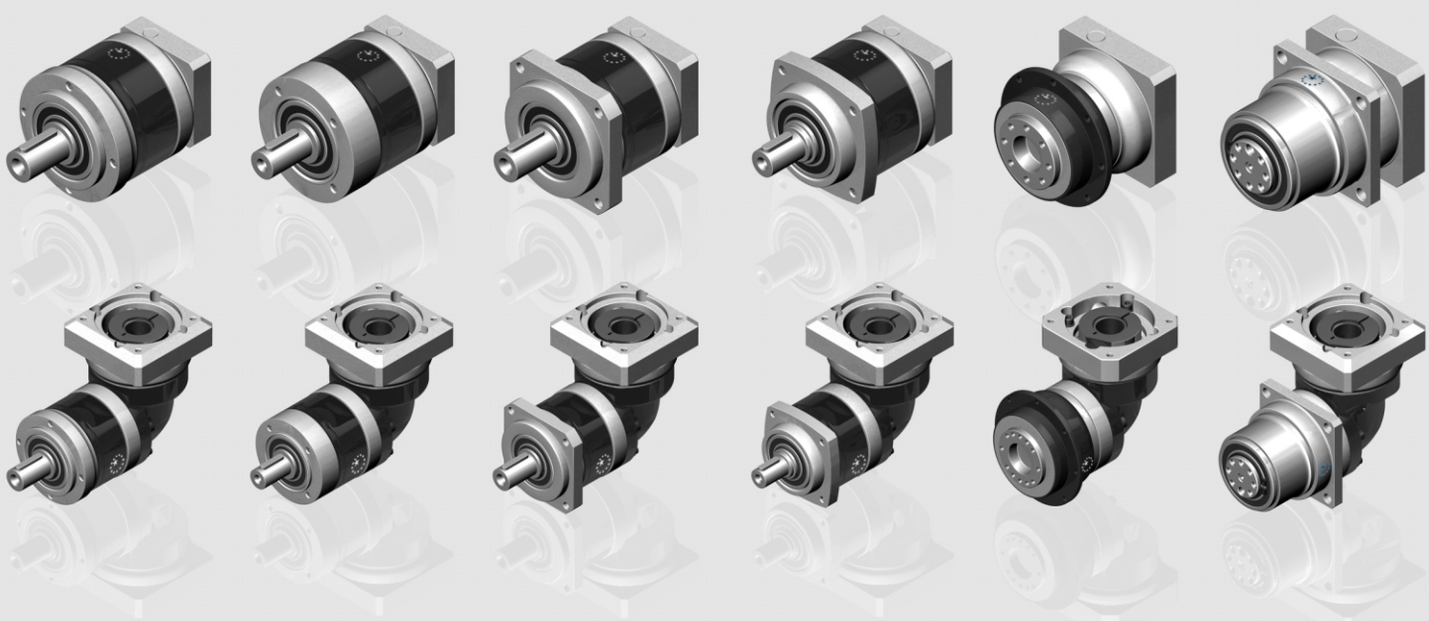
Glossary

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. 
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 over 3,000 rpm, this value is measured by that specific Nominal Input Speed.

Note

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APEX-2015-08-PII/PIIR SERIES-1.0E-1.0V

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