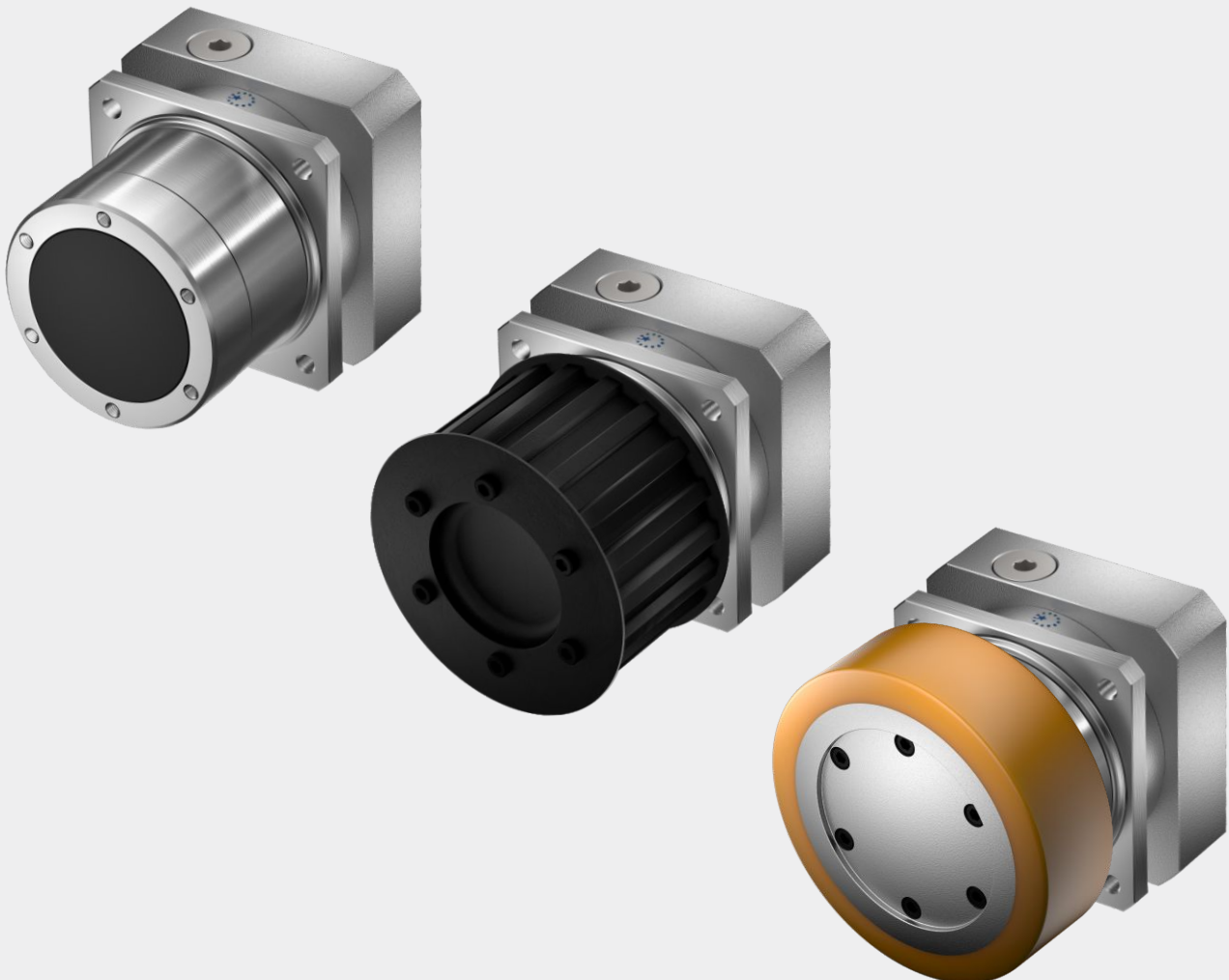# APEX DYNAMICS, INC.

NEW GENERATION PLANETARY GEARBOX
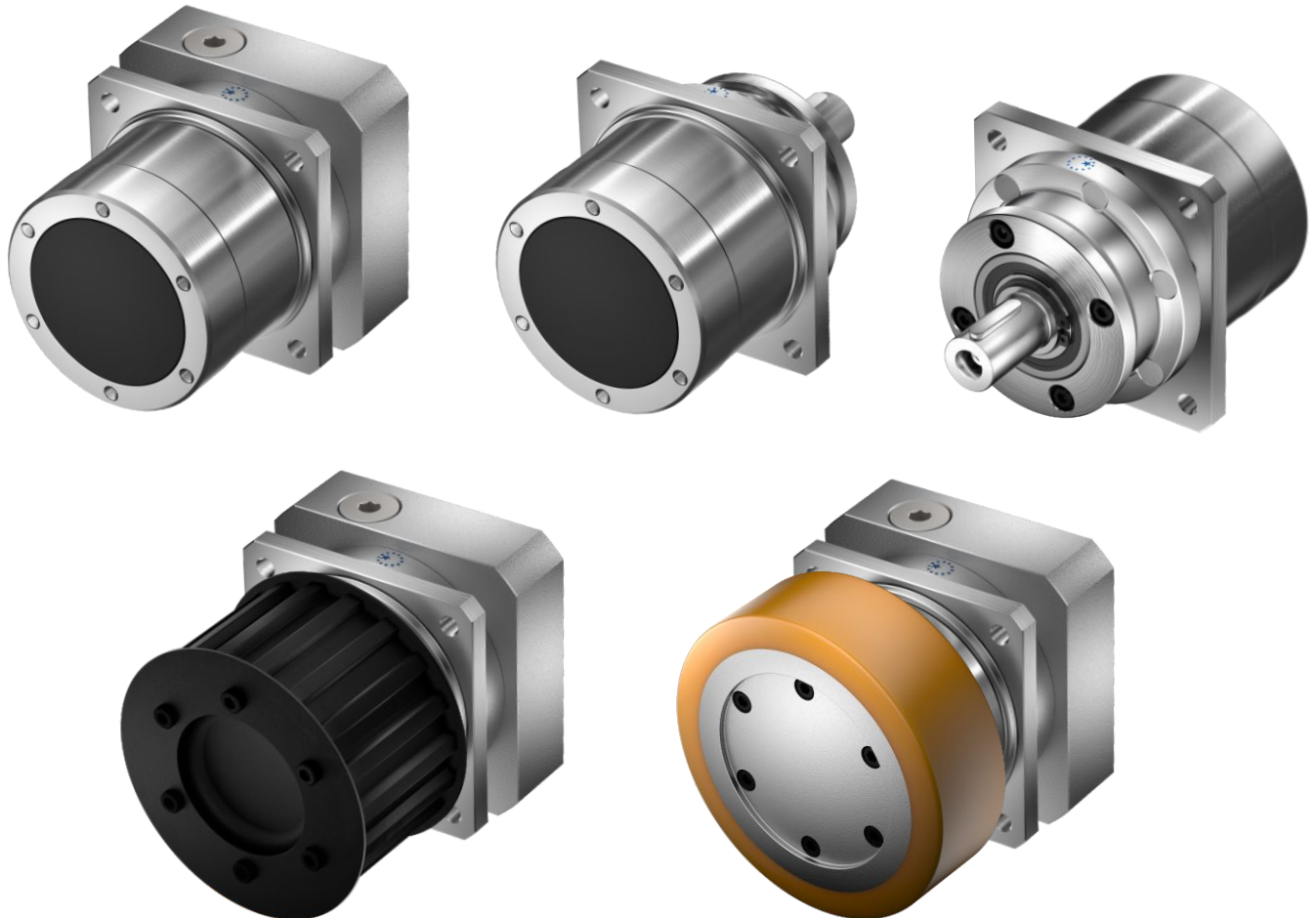
GL / GLS - SERIES

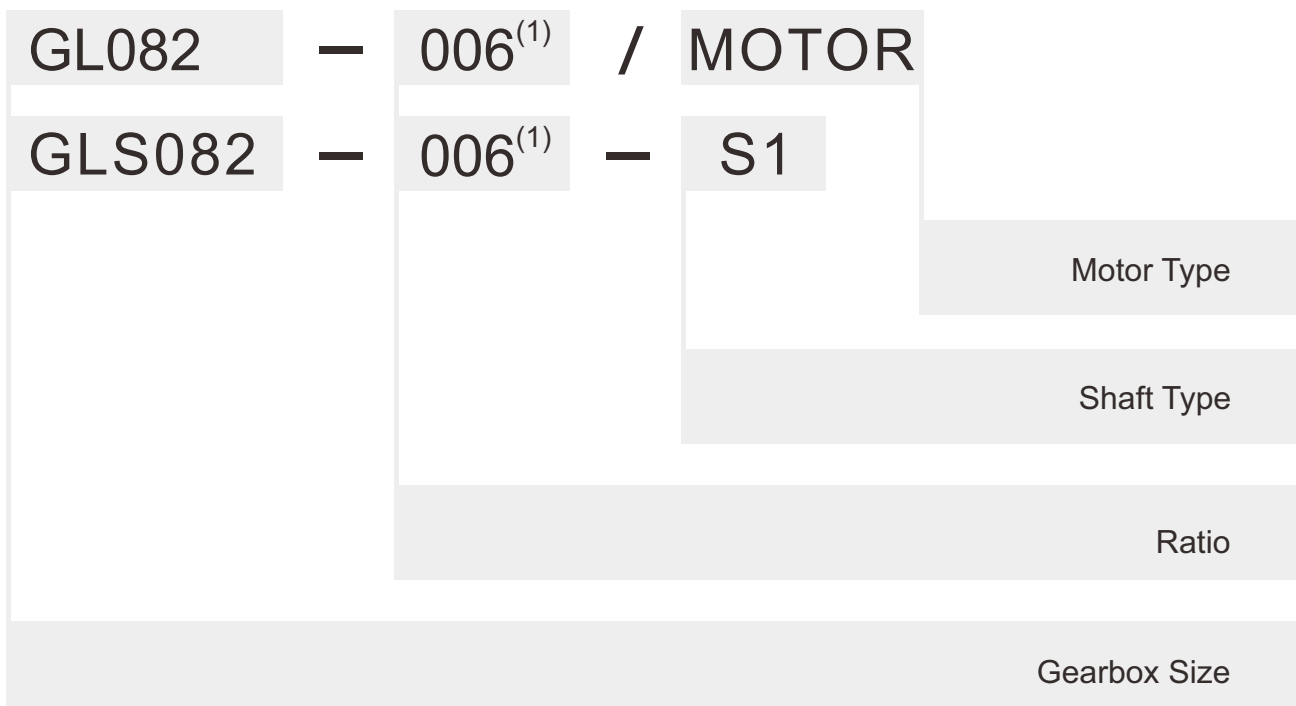## Gearbox Series - GL

▶ # Features:

High radial load

Rotating housing

High efficiency

Low noise

Reduced backlash

Optimized Inertia moment

Limited temperature rise

Long service life

Optimized output torque

Ordering Code - GL / GLS Gearbox

GL082 — 006$^{(1)}$ / MOTOR

GLS082 — 006$^{(1)}$ — S1

Motor Type

Shaft Type

Ratio

Gearbox Size

GLS is the GL version with option input "SHAFT" instead of input "HUB"

Gearbox Size
GL   082 / 100 / 132
GLS   082 / 100 / 132

Ratio$^{(2)}$

GL   2 / 3 / 4 / 6 / 9
          10 / 15 / 20 / 24 / 30 / 36 / 40 / 45 / 60 / 90

GLS   3 / 4 / 6 / 9
          10 / 15 / 20 / 24 / 30 / 36 / 40 / 45 / 60 / 90

Shaft Type : S1 = Smooth Input Shaft
              S2 = Input Shaft with Key

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 - GL Gearbox

Model No.		Stage	Ratio[1]	GL082	GL100	GL132
Nominal Output Torque T_{2N}	Nm	1	2	60	102	280
			3	90	155	355
			4	83	168	308
			6	54	115	252
			9	21	50	145
		2	10	60	102	280
			15	90	155	355
			20	83	168	308
			24	54	115	252
			30	54	115	252
			36	21	50	145
			40	53	96	229
			45	21	50	145
			60	54	115	252
			90	21	50	145
Emergency Stop Torque T_{2NOT}	Nm	1,2	2~90	3 times T_{2N}		
Max. Acceleration Torque T_{2B}	Nm	1,2	2~90	1.5 times T_{2N}		
No Load Running Torque[2]	Nm	1	2~9	0.45	0.7	1.4
		2	10~90	0.2	0.3	0.6
Backlash[3]	arcmin	1	2~9	$\leqq 3$	$\leqq 3$	$\leqq 3$
		2	10~90	$\leqq 5$	$\leqq 5$	$\leqq 5$
Torsional Rigidity	Nm/arcmin	1,2	2~90	8	22	60
Nominal Input Speed n_{1N}	rpm	1	2~9	5,000	3,600	3,600
		2	10~90	5,000	4,600	4,600
Max. Input Speed n_{1B}	rpm	1	2~9	7,000	6,000	6,000
		2	10~90	7,000	7,000	7,000
Max. Radial Load F_{2r}[4]	N	1,2	2~90	2,860	3,400	7,200
Max. Axial Load F_{2a}[4]	N	1,2	2~90	1,430	1,700	3,600
Max. Tilting Moment M_{2k}[4]	Nm	1,2	2~90	117	155	452
Operating Temp	°C	1,2	2~90	-10°C~ 90°C		
Degree of Gearbox Protection		1,2	2~90	IP65		
Lubrication		1,2	2~90	Synthetic lubrication grease		
Mounting Position		1,2	2~90	All directions		
Running Noise[2]	dB(A)	1	2~9	$\leqq 58$	$\leqq 59$	$\leqq 64$
		2	10~90	$\leqq 58$	$\leqq 59$	$\leqq 60$
Efficiency η	%	1	2~9	$\geqq 97\%$		
		2	10~90	$\geqq 94\%$		

(1) Ratio ($i = N_{in} / N_{out}$).
(2) The dB values are measured by gearbox with ratio 9 (1-stage) or ratio 90(2-stage),
    No loading at 3,000 RPMor at the respective Nominal Input Speed by bigger model size.
    By lower ratio and/or higher RPM, the noise level could be 3 to 5 dB(A) higher
(3) Backlash is measured at 2% of Nominal Output Torque T_{2N} .
(4) Applied to the output flange center at 100 rpm. The calculation formula please refer to Fig 1.
(5) Continuous operation is not recommended.

Inertia - GL Gearbox

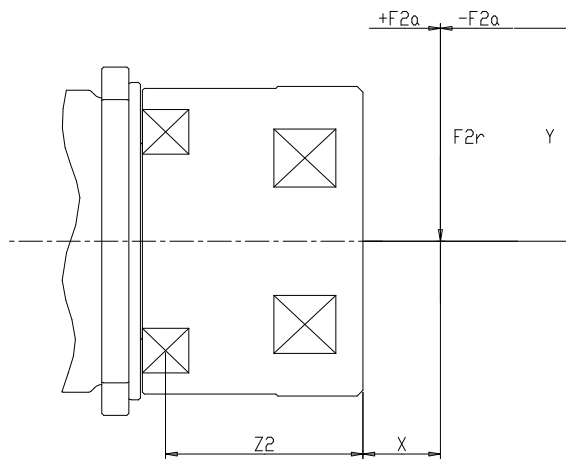| Model No.		GL082		GL100		GL132	
$\varnothing^{(A)}$		1-stage.	2-stage.	1-stage.	2-stage.	1-stage.	2-stage.
8	kg.cm²	–	0.1	–	–	–	–
11		0.21	0.16	–	0.17	–	–
14		0.24	0.2	0.54	0.21	–	0.42
19		0.64	–	0.79	0.6	2.51	0.66
24		–	–	4.06	–	4.78	3.94
28		–	–	–	–	6.15	–
32		–	–	–	–	8.03	–
35		–	–	–	–	14.72	–
38		–	–	–	–	17.38	–
42		–	–	–	–	–	–
48		–	–	–	–	–	–

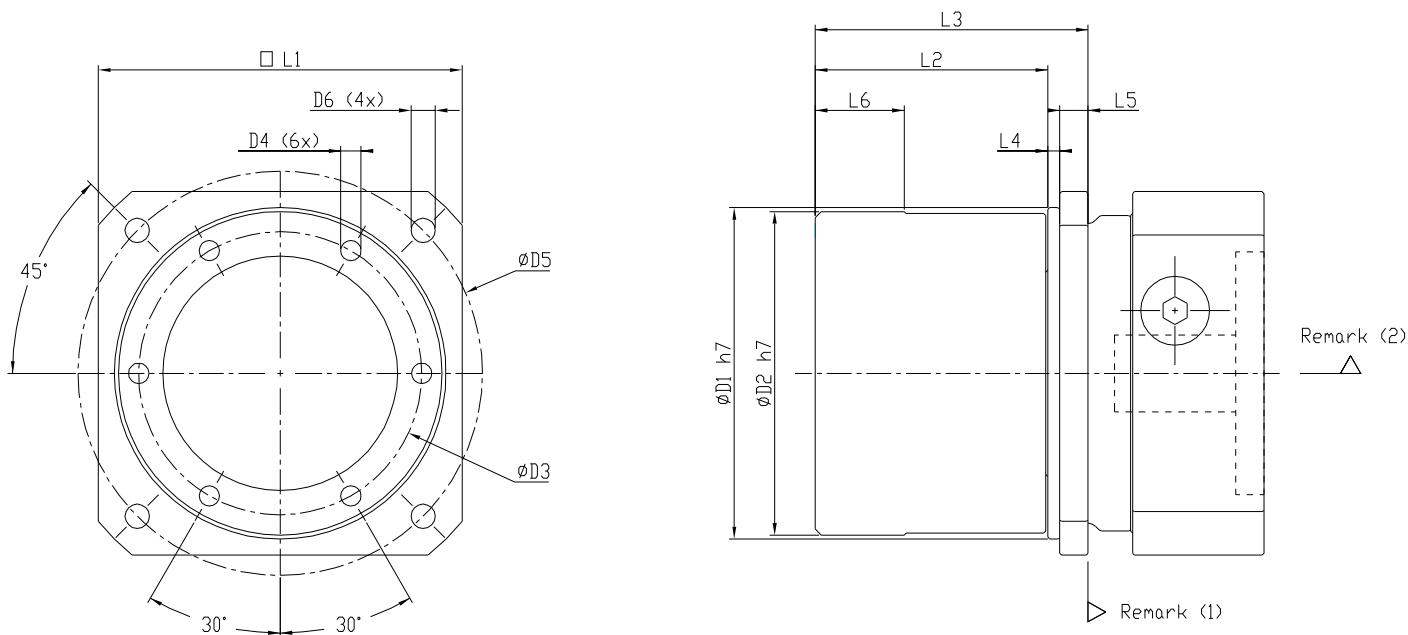(A) Ø = Input shaft diameter.

Fig.1

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

M_{2K} : 【Nm】
F_{2a}, F_{2r} : 【N】
$X, Y, Z2$: 【mm】

GL	082	100	132
Z2【mm】	51	57	78.5

Note : Applied to the output flange center at 100 rpm.

Dimension - GL Gearbox

Dimension	GL082	GL100	GL132
D1 h7	82	100	132
D2 h7	80	96	128
D3	70	84	114
D4 x Pitch x Deep	M5x0.8Px8	M6x1Px10	M8x1.25Px12.5
D5	100	122	166
D6	M6x1P	M8x1.25P	M10x1.5P
L1	90	108	140
L2	57.5	62.5	85.5
L3	67.5	75.5	101.5
L4	3	3.5	4
L5	7	9.5	12
L6	22	24	34

(1) Dimensions are related to motor interface. Please contact APEX for details.
(2) As alternative to input "HUB", input "SHAFT" is also available, please find in page 06.

Dimension - GLS (Input Shaft as Option)

Shaft Option S1

Shaft Option S2
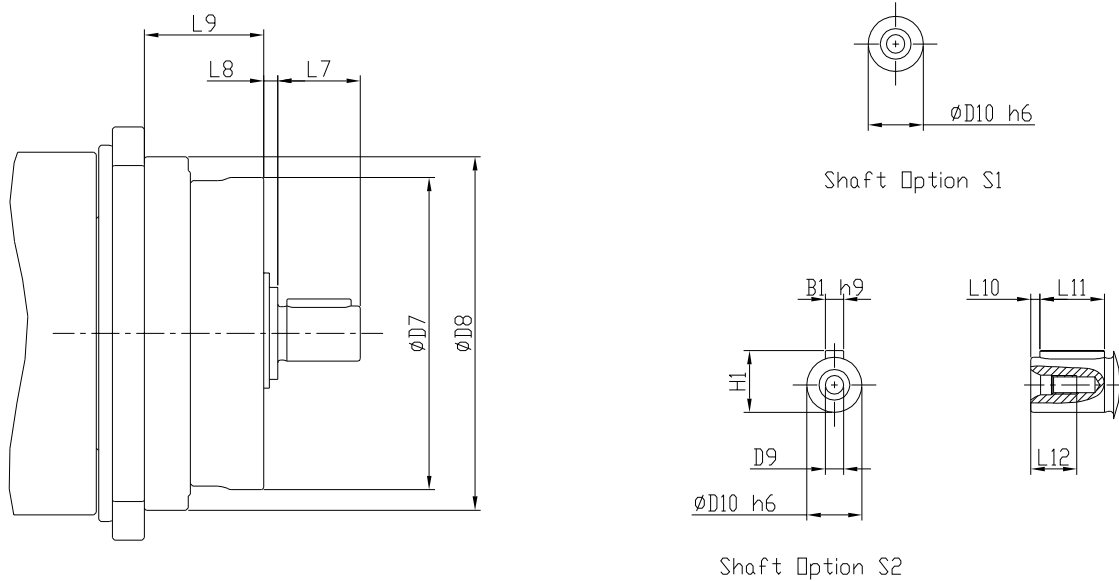
Dimension	Stage	GLS082	GLS100	GLS132
D7	1	68	84	93
	2	60	68	84
D8	1,2	77	100	136
D9	1	M4x0.7P	M8x1.25P	M10x1.5P
	2	M3x0.5P	M4x0.7P	M8x1.25P
D10 h6	1	12	22	28
	2	10	12	22
L7	1	18	36	42
	2	15	18	36
L8	1	3	3	4
	2	3	3	3
L9	1	26	38	45.5
	2	44.5	54	67.5
L10	1	2	3	5
	2	2	2	3
L11	1	14	28	32
	2	10	14	28
L12	1	10	19	22
	2	9	10	19
B1 h9	1	4	6	8
	2	3	4	6
H1	1	13.5	24.5	31
	2	11.2	13.5	24.5

Performance - GLS (Input Shaft as Option)

Model No.		Stage	Ratio[1]	GLS082	GLS100	GLS132
Max. Radial Load F_{1rB}[2]	N	1	3~9	460	600	800
		2	10~90	275	460	600
Max. Axial Load F_{1aB}[2]	N	1	3~9	230	300	400
		2	10~90	137	230	300
Moment of Inertia	kg.cm^2	1	3~9	0.19	0.62	1.78
		2	10~90	0.06	0.19	0.62

(1) Ratio ($i = N_{in} / N_{out}$).
(2) Applied to the input shaft center at 1000 rpm.

Selection of the optimum gearbox

Flowchart

Selection Start

S5
Cyclic Operation

S1
Continuous Operation

YES ← ED<60%
t_{work}<20mins
(Eq.1) → **NO**

Calculate Ratio i **(Eq.2)** | Calculate Ratio i **(Eq.2)**

Calculate the Mean Output Torque T_{2m} **(Eq.3)** | Calculate the Mean Output Torque T_{2m} **(Eq.3)**

Calculate the Max. Acceleration Torque T_{2max} **(Eq.4)**

Select a Larger Gearbox ← **NO** — T_{2max}<T_{2B} T_{2m}<T_{2N}

T_{2m}<T_{2N} — **NO** → Select a Larger Gearbox

YES

Calculate the Mean Output Speed n_{2m} and the Nominal Output Speed n_{2N} of Gearbox **(Eq.5)** **YES**

Select a Smaller Ratio i in Larger Motor If Needed ← **NO** — n_{2m}<n_{2N}

YES

Calculate the Mean Radial F_{2rm} and Axial Loads F_{2am} on Output Shaft of Gearbox **(Eq.6)**

Calculate the Permitted Radial F_{2rB} and Axial Loads F_{2aB} on Output Shaft of Gearbox

F_{2rm}<F_{2rB} F_{2am}<F_{2aB} — **NO** → Select a Larger Gearbox

YES

Select the Required Backlash and Shaft Option

Order your APEX Gearbox

Recommended (for S5 Cycle Operation)

The general design is given for
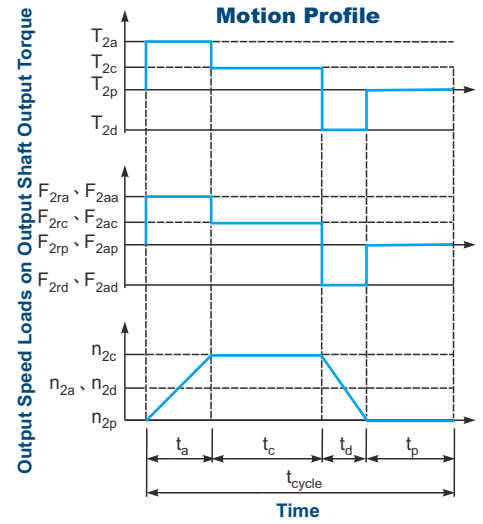
$$\frac{J_L}{i^2} \leq 4 \times J_m$$

The optimal design is given for

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

J_L Load Inertia
J_m Motor Inertia

Motion Profile

Output Speed Loads on Output Shaft Output Torque

Time

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

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

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

n_m Output Speed of the Motor

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

3. $T_{2m} = \sqrt[3]{\dfrac{n_{2a} \times t_a \times T_{2a}^{\;3} + n_{2c} \times t_c \times T_{2c}^{\;3} + n_{2d} \times t_d \times T_{2d}^{\;3}}{n_{2a} \times t_a + n_{2c} \times t_c + n_{2d} \times t_d}}$ **(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. $n_{2a} = n_{2d} = \dfrac{1}{2} \times n_{2c}$

$n_{2m} = \dfrac{n_{2a} \times t_a + n_{2c} \times t_c + n_{2d} \times t_d}{t_a + t_c + t_d}$
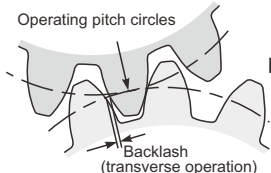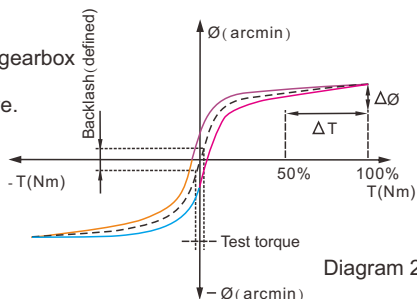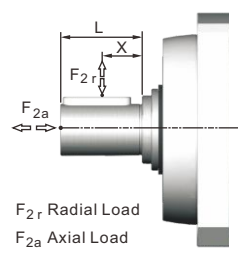
$n_{2N} = \dfrac{n_{1N}}{i}$ **(Eq.5)**

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

$F_{2am} = \sqrt[3]{\dfrac{n_{2a} \times t_a \times F_{2aa}^{\;3} + n_{2c} \times t_c \times F_{2ac}^{\;3} + n_{2d} \times t_d \times F_{2ad}^{\;3}}{n_{2a} \times t_a + n_{2c} \times t_c + n_{2d} \times t_d}}$ **(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'. Operating pitch circles. Diagram 1. Backlash (transverse operation)
Torsional Rigidity	Nm/arcmin	Torsional Rigidity is the quotient ($\triangle T$ / $\triangle \emptyset$) 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. Backlash(defined). $\emptyset$(arcmin). $\Delta\emptyset$. ΔT. - T(Nm). 50%. 100%. T(Nm). Test torque. Diagram 2. $-\emptyset$(arcmin)
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. L. X. F_{2r}. F_{2a}. F_{2r} Radial Load. F_{2a} Axial Load
Efficiency η	%	The transmission efficiency of the gears inside a gearbox (without friction).
Operating Temperature	º 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.cm²	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.