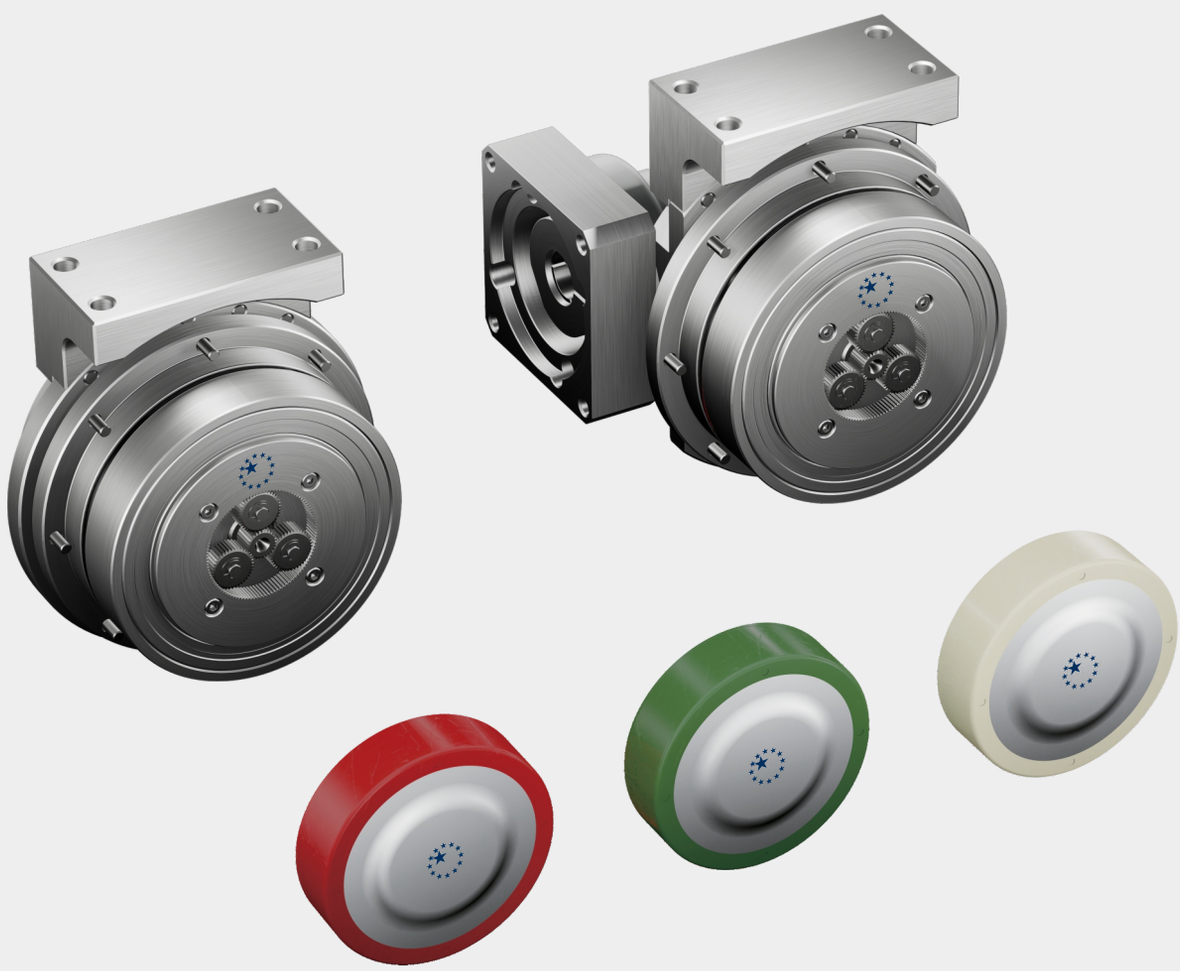
APEX DYNAMICS, INC.

NEW GENERATION PLANETARY GEARBOX

GV / GVR Series for AGV Application



Gearbox Series - GV / GVR

Features:

- Special Design for AGV Application
- Minimized Gearbox Length for High Reduction Ratio
  Optimizing Space Arrangement inside AGV
- Ring-Gear Housing Rotation
- High Torque / High Driving Transmission
- High Efficiency / Optimized Inertia Moment
- High Torsional Rigidity
- High-Strength Bearing and Wheel Hub
  Supporting High Vertical Load Capacity
- Long Service Life

Ordering Code - GV / GVR Gearbox

GV130	—	022.5[1]	—	A[2]					/	MOTOR
GV130	—	022.5[1]	—	B[2]	—	BP[3]			/	MOTOR
GVR165	—	031.5[1]	—	E[2]	—	BP[3]	—	D[4]	/	MOTOR

Motor Type

Application Direction

(optional) Base Plate

Rims Type

Ratio

Gearbox Size

Gearbox Size

GV	098 / 130 / 165
GVR	098 / 130 / 165

Ratio[1]

GV	(2 Stg.)	22.5 / 31.5
GVR	(2 Stg.)	22.5 / 31.5

Rims Type[2] : A / B / E

Base Plate[3]: with Base-Plate

Application Direction[4]: B = 9 o'clock
(For GVR series only) **D = 3 o'clock**

Motor Type
Manufacturer and Model

(1) Ratio (i= N_{in} / N_{out}). Please refer to the specifications for the ratios provided in each series.
(2) Please refer to page 03.
(3) Please refer to page 09.
(4) Please refer to page 07.

Technical Data - Rims

Rims			
Type	A	B	E
Color	Green	Red	Cream
Hardness	64 Sh-D	98 Sh-A	64 Sh-D
Material	TPU	TPU	Hytrel
Temperature Range°C	-30 to +120	-30 to +100	-50 to +150
Properties	Low Noise Wear-Resistant High Loading Capacity Floor Protection	Low Noise Wear-Resistant High Loading Capacity Floor Protection	Low Noise Best Wear-Resistant High Loading Capacity Floor Protection

Size	GV098	GV130	GV165
Diameter [mm]	140	180	220
Weight [Kg]	0.52	1.13	2.1
Inertia J [kg.cm^2]	16.7	60.9	173.4

Ordering Example : EP-GV098-A

Performance - GV / GVR Gearbox

Model No.		Stage	Ratio(1)	Type	GV098 GVR098	GV130 GVR130	GV165 GVR165
Nominal Output Torque T_{2N}	Nm	2	22.5	ALL	76	237	418
			31.5		54	180	396
Emergency Stop Torque T_{2NOT}	Nm	2	22.5~31.5	ALL	3 times T_{2N}		
Max. Acceleration Torque T_{2B}	Nm	2	22.5~31.5	ALL	1.8 times T_{2N}		
No Load Running Torque(2)	Nm	2	22.5~31.5	GV	0.3	0.4	0.8
		2	22.5~31.5	GVR	1.58	2.5	3
Backlash(3)	arcmin	2	22.5~31.5	GV	≦ 8	≦ 8	≦ 8
				GVR	≦ 12	≦ 12	≦ 12
Torsional Rigidity	Nm/arcmin	2	22.5~31.5	ALL	8	12	16
Nominal Input Speed n_{1N}	rpm	2	22.5~31.5	ALL	3,600	3,600	2,500
Max. Input Speed n_{1B}	rpm	2	22.5~31.5	ALL	6,000	4,800	3,600
Max. Vertical Load	kg	2	22.5~31.5	ALL	580	1,000	1,450
Max. Tilting Moment M_{2k}(4)	Nm	2	22.5~31.5	ALL	115	250	470
Operating Temp	° C	2	22.5~31.5	ALL	0° C~ 90° C		
Degree of Gearbox Protection		2	22.5~31.5	ALL	IP54		
Lubrication		2	22.5~31.5	ALL	Lubricant		
Mounting Position		2	22.5~31.5	ALL	All directions		
Running Noise(2)	dB(A)	2	22.5~31.5	GV	≦ 64	≦ 66	≦ 68
				GVR	≦ 74	≦ 75	≦ 77
Efficiency η	%	2	22.5~31.5	GV	≧ 94%		
				GVR	≧ 90%		

(1) Ratio (i = Nin / Nout).
(2) The values are measured by gearbox with ratio 31.5 (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 values could be 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.

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

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

GV / GVR	098	130	165
Z2【mm】	37.5	49.5	63

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

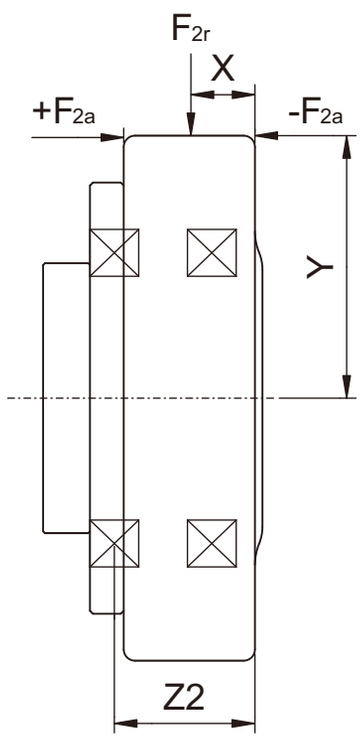


Fig.1

Inertia - GV / GVR Gearbox

Model No.		GV098		GV130		GV165	
Ø(A)(C3)	Ratio	22.5	31.5	22.5	31.5	22.5	31.5
8	kg.cm²	0.14	0.14	0.58	0.58	–	–
11		0.14	0.14	0.58	0.57	–	–
14		0.13	0.13	0.56	0.56	2.60	2.58
19		–	–	0.52	0.52	2.55	2.53
24		–	–	–	–	2.44	2.42
28		–	–	–	–	2.30	2.28

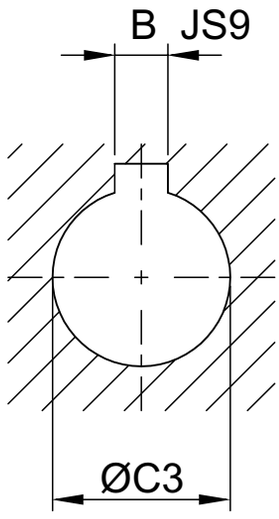
(A) Ø = Input shaft diameter.

Model No.		GVR098	GVR130	GVR165
Ø(A)(C3)	Stage	2-stage	2-stage	2-stage
8	kg.cm²	0.18	0.36	–
11		0.20	0.39	–
14		0.24	0.43	1.87
19		–	1.24	2.67
24		–	–	2.97
28		–	–	3.47

(A) Ø = Input shaft diameter.

Dimension - GV Keyway

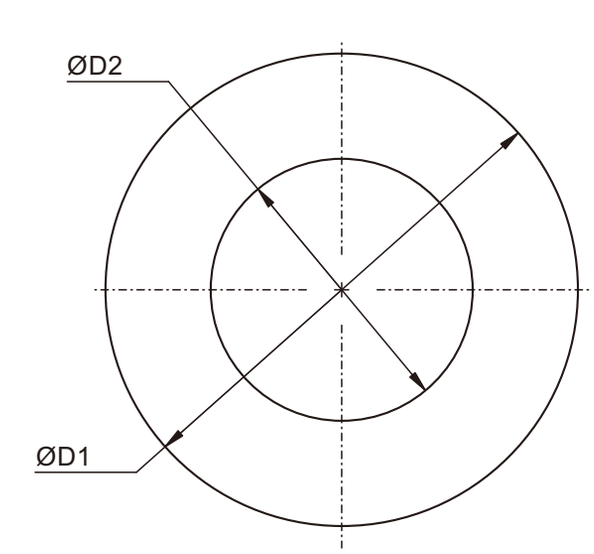
B(1)	Dimension
2	6 ≦ ØC3 ≦ 8
3	8 < ØC3 ≦ 10
4	10 < ØC3 ≦ 12
5	12 < ØC3 ≦ 17
6	17 < ØC3 ≦ 22
8	22 < ØC3 ≦ 30

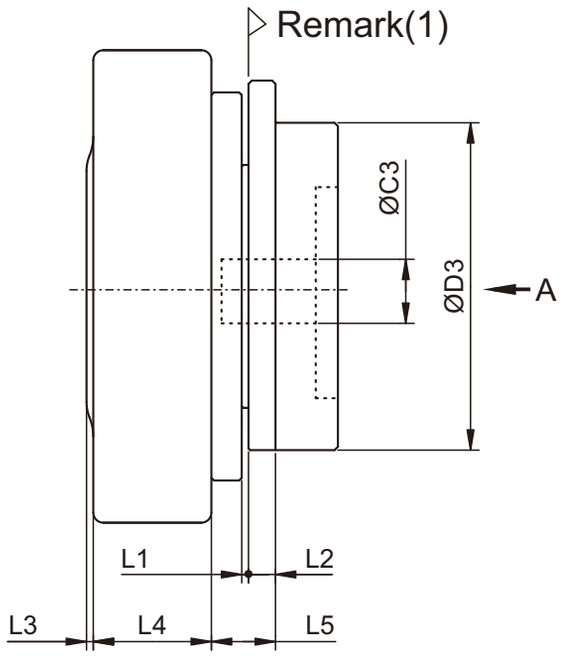


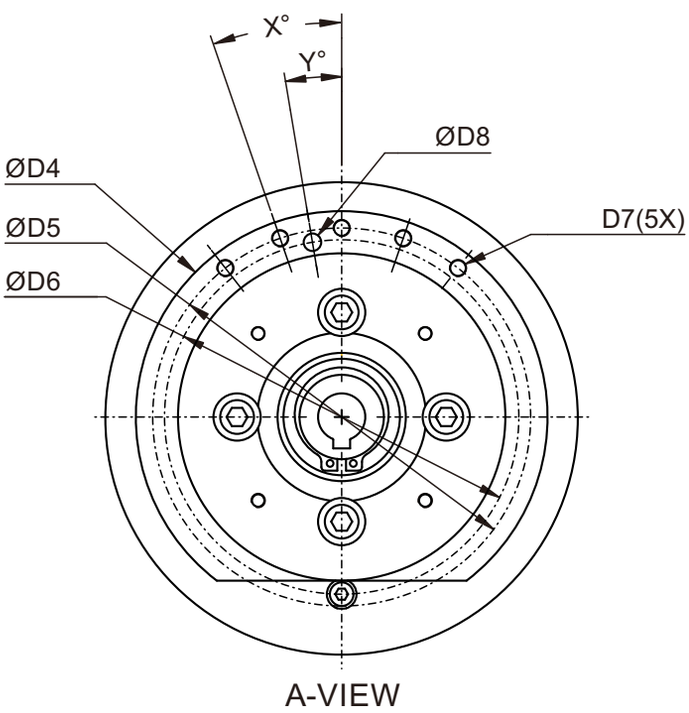
(1) Finish bore with keyway which ≧Ø6, acc. to DIN 6885/1 JS9.
Please apply motor key with suitable strength.

* Please Note, GV can only be combined to a motor with key and keyway.
For motor without key & keyway, please contact APEX Sales.

Dimension - GV Gearbox







A-VIEW

Dimension	GV098	GV130	GV165
D1 h11	140	180	220
D2	75	95	110
D3	97	128	162
D4 g6	122	158	200
D5	112	148	185
D6	105	138.5	176.5
D7	M5x0.8Px8L	M6x1Px12L	M8x1.25Px16L
D8	5.2	6.4	9
L1	2	3	4
L2	8	12	16
L3	2	4.5	5
L4	35	48	60
L5	19	25.5	33
X in Degree	19	18	19
Y in Degree	9.5	9	9.5

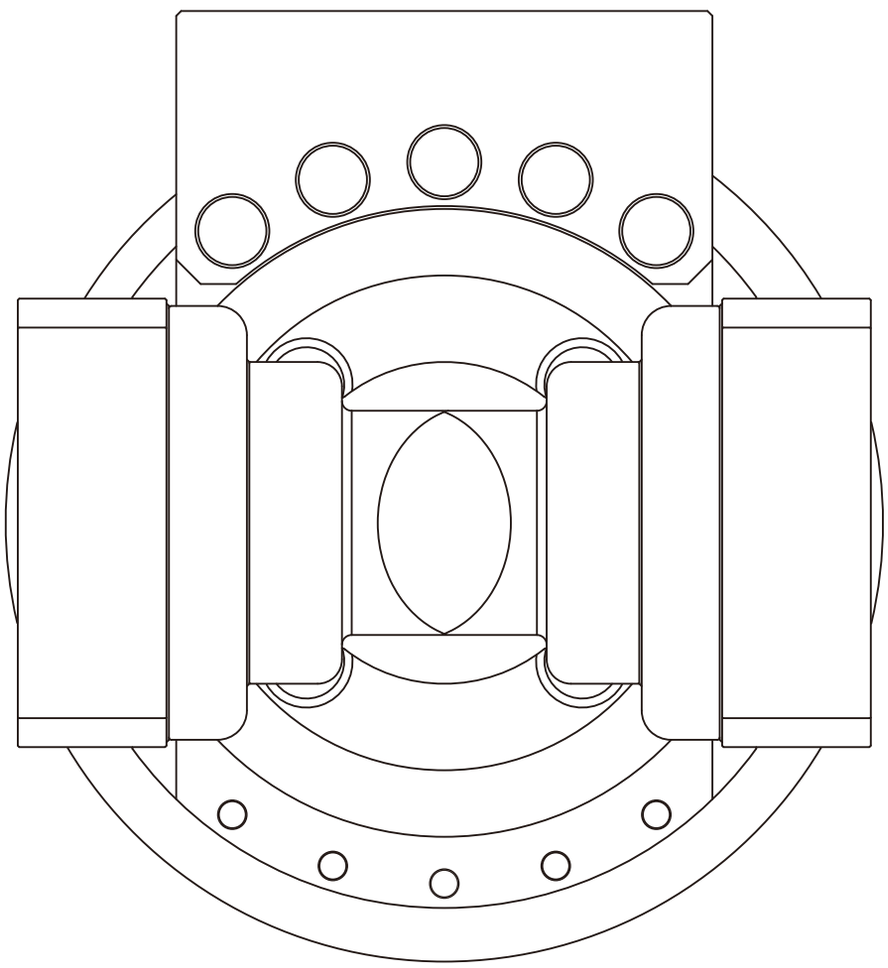
(1) Dimensions are related to motor interface. Please contact APEX for details.

* Finish bore with keyway which ≧Ø6 keyway, according to DIN 6885/1, dimensional tolerance is JS9.
Please refer to page 05 for keyway dimensions corresponding to each bore diameter.

Application Direction - GVR Gearbox

Ordearing Code : GVR165 - 031.5 - A - BP - D / MOTOR

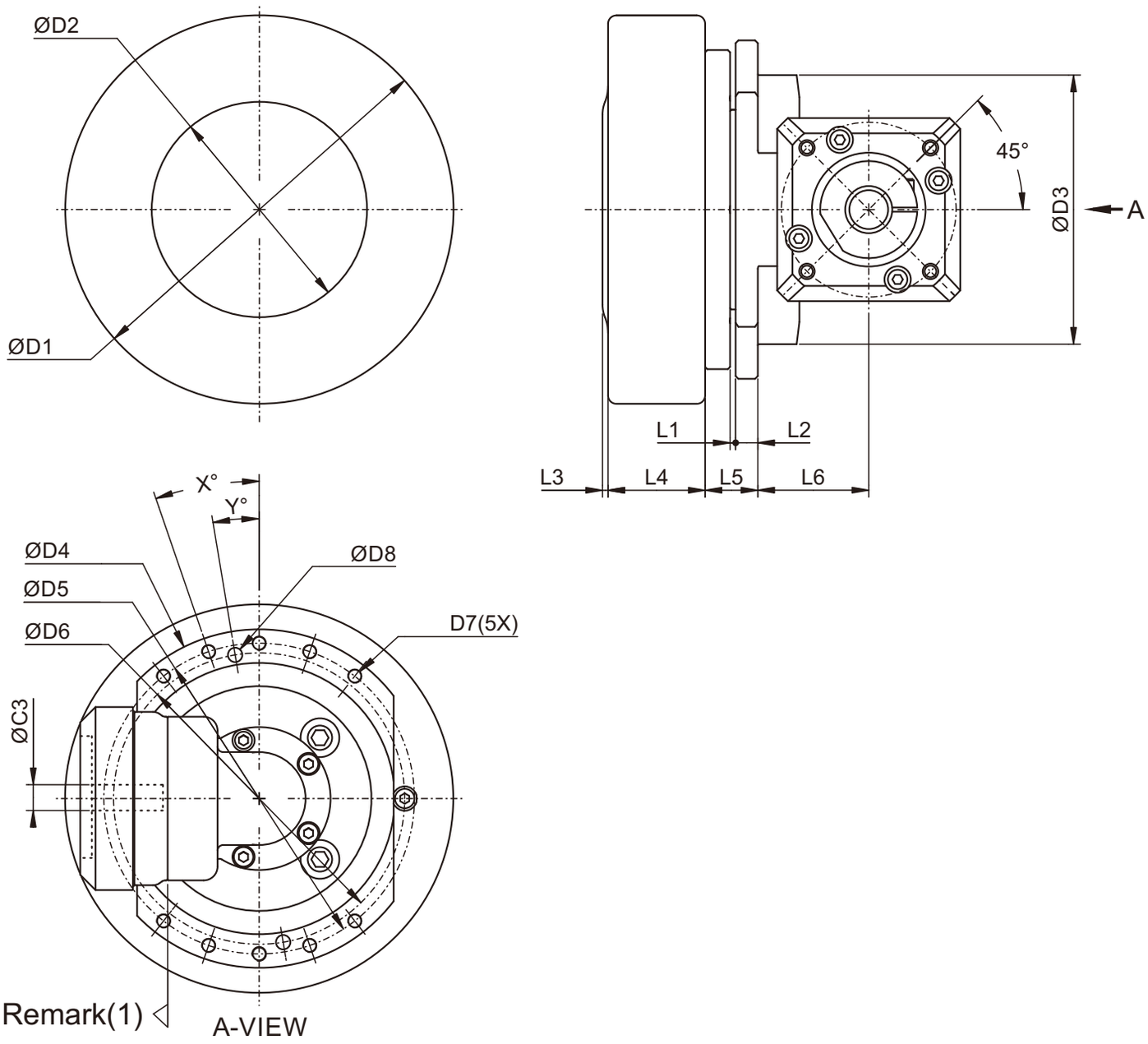
GVR165 - 031.5 - A - BP - B / MOTOR



B
9 o'clock

D
3 o'clock

Dimension - GVR Gearbox



Dimension	GVR098	GVR130	GVR165
D1 h11	140	180	220
D2	75	95	110
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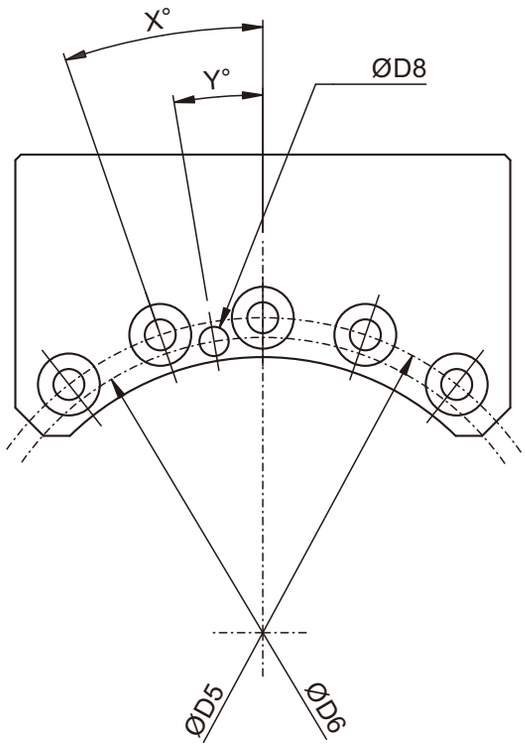
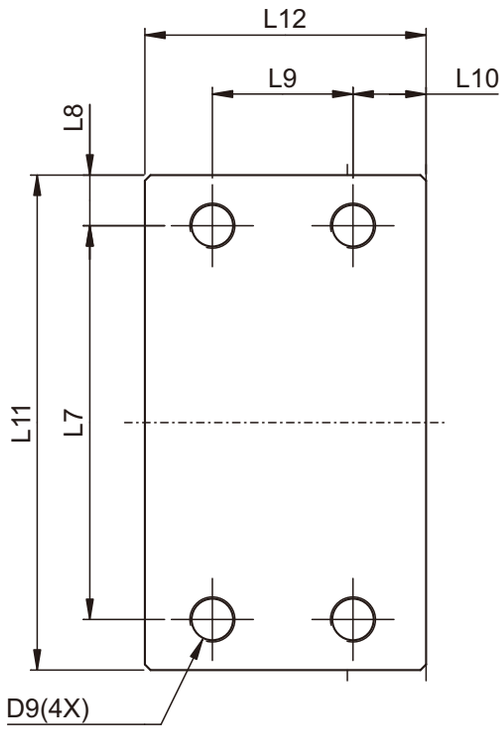
D4 g6	122	158	200
D5	112	148	185
D6	105	138.5	176.5
D7	M5x0.8Px8L	M6x1Px12L	M8x1.25Px16L
D8	5.2	6.4	9
L1	2	3	4
L2	8	12	16
L3	2	4.5	5
L4	35	48	60
L5	19	25.5	33
L6	40	53	64
X in Degree	19	18	19
Y in Degree	9.5	9	9.5

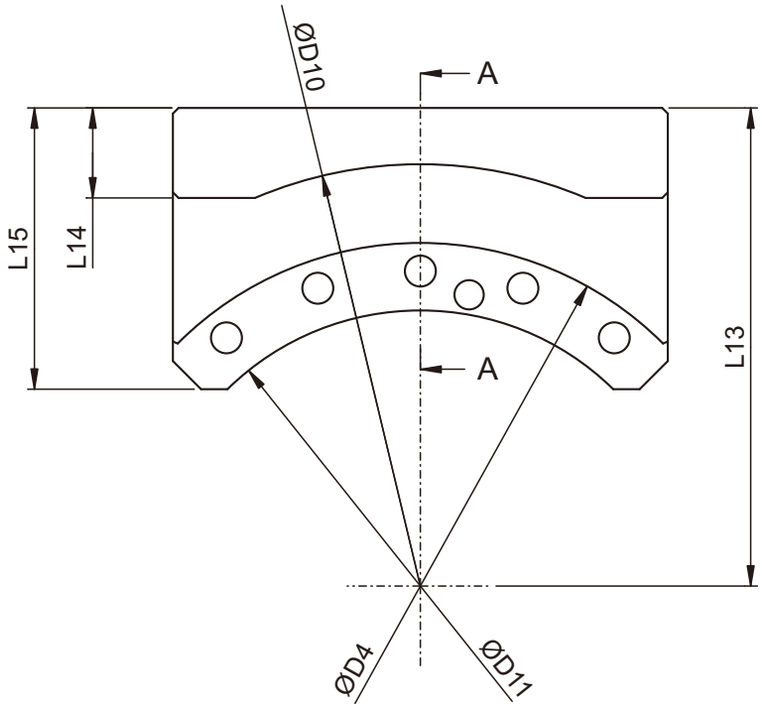
(1) Dimensions are related to motor interface. Please contact APEX for details.

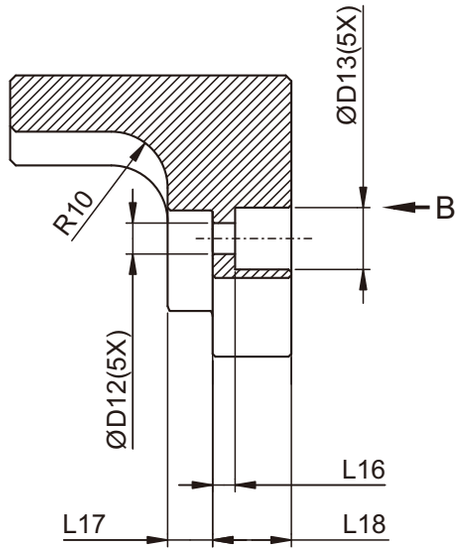
Base-Plate for Mounting - GV / GVR Gearbox



B-VIEW







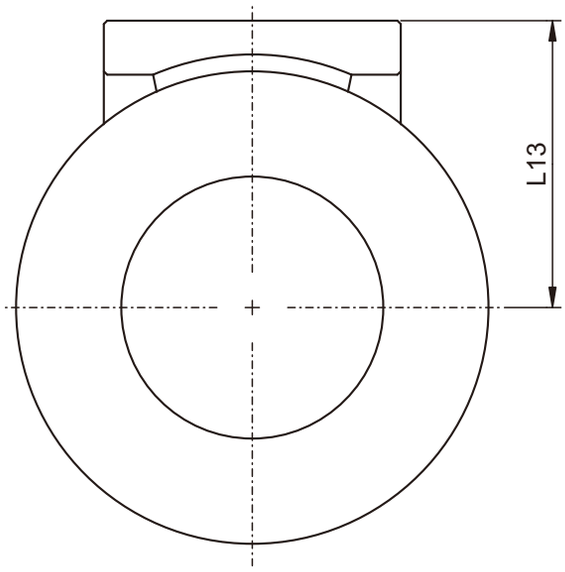
SECTION A-A

Base-Plate for Mounting - GV / GVR Gearbox

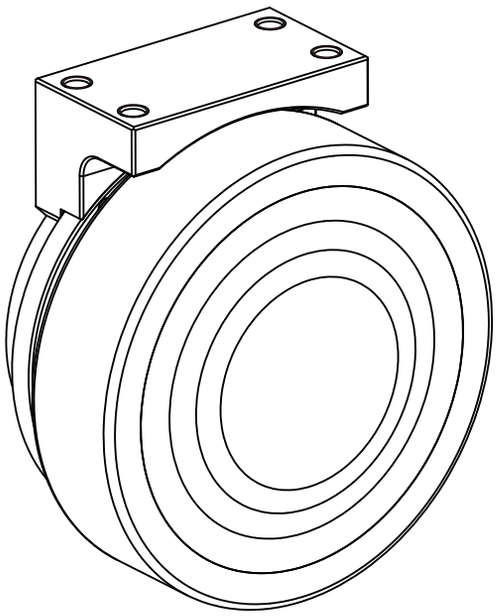
Dimension	GV098 / GVR098	GV130 / GVR130	GV165 / GVR165
D4 H7	122	158	200
D5	112	148	185
D6	105	138.5	176.5
D8	5.2	6.4	9
D9	M8x1.25x15L	M10x1.5Px18L	M12x1.75Px22L
D10	150	190	230
D11	98	130	163
D12	5.5	6.6	9
D13	11	14	17.5
L7	70	90	120
L8	9	10	11
L9	25	34	50
L10	13	13	15
L11	88	110	142
L12	50	60	80
L13	85	105	130
L14	16	20	25
L15	50	56	70
L16	4	4.5	8
L17	8	12	16
L18	14	16.5	22
X in Degree	19	18	19
Y in Degree	9.5	9	9.5

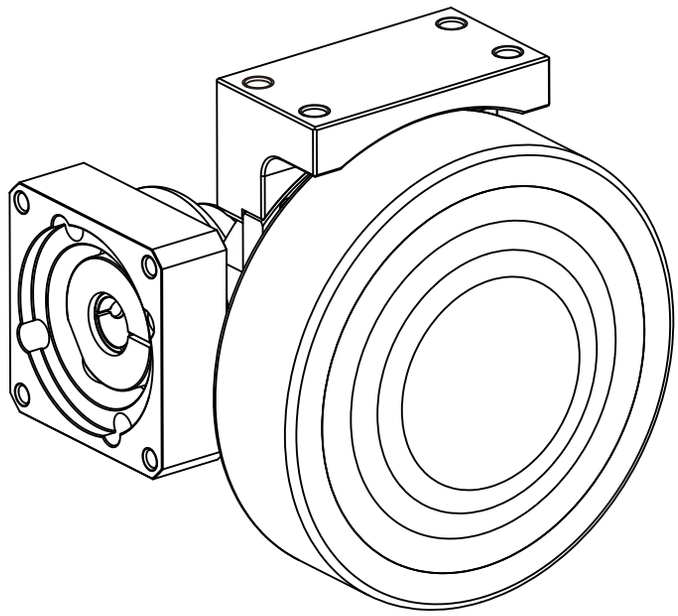
Ordearing Example : BP - GV098

Base-Plate for Mounting - GV / GVR Gearbox

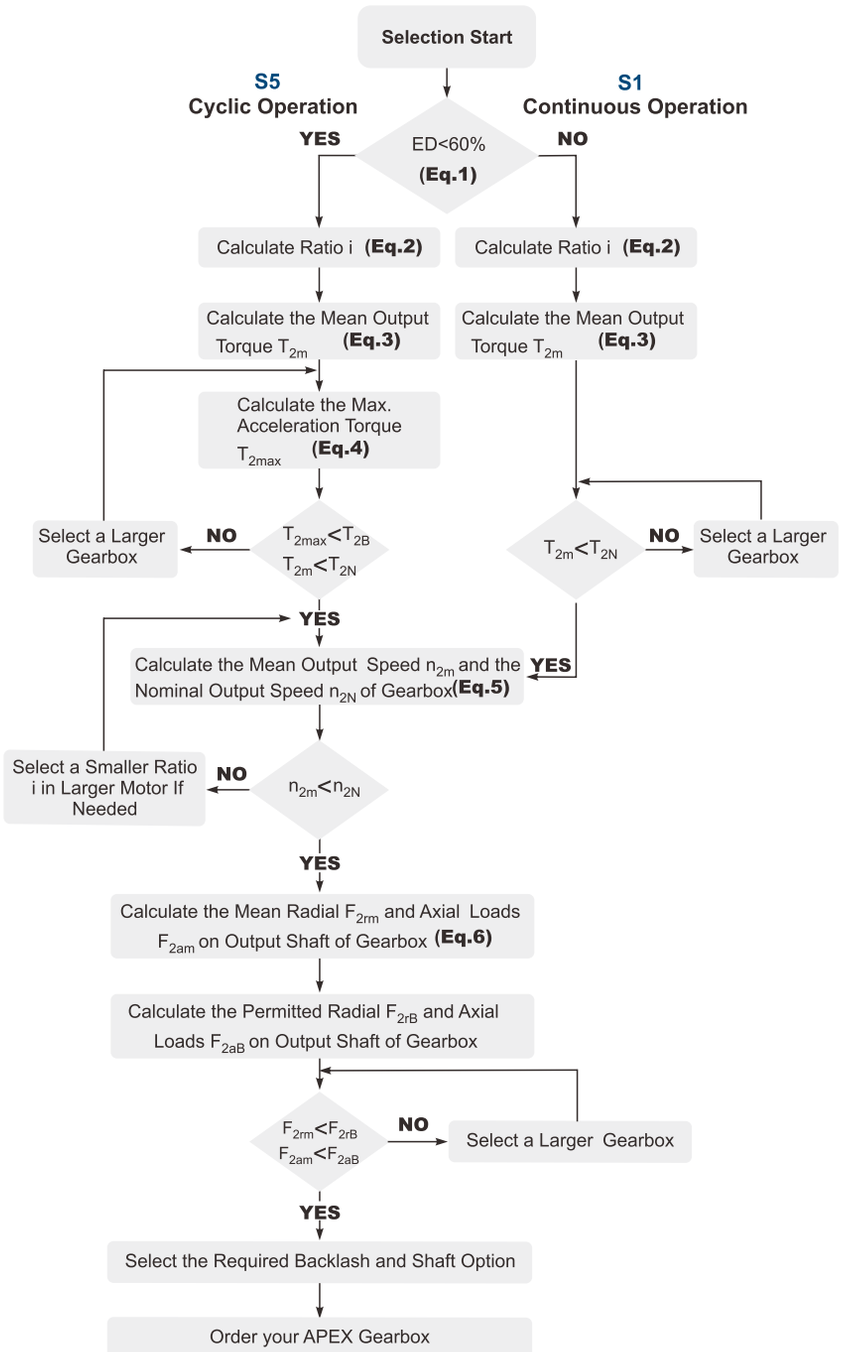


Dimension	GV098 / GVR098	GV130 / GVR130	GV165 / GVR165
L13	85	105	130





Selection of the optimum gearbox



Recommended (for S5 Cycle Operation)

The general design is given for

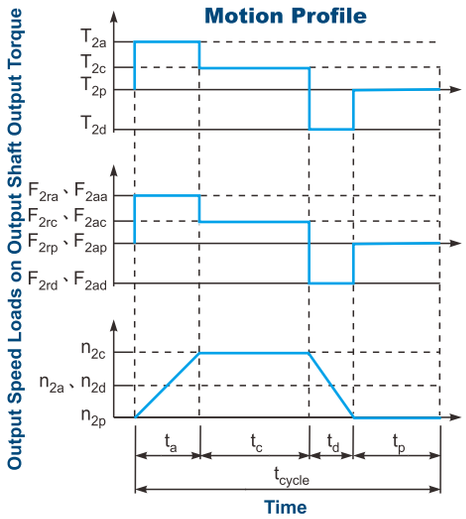
$$\frac{J_L}{i^2} \leq 4 \times J_m$$

The optimal design is given for

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

J_L Load Inertia

J_m Motor Inertia



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

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

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

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

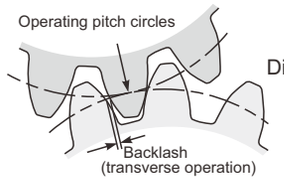
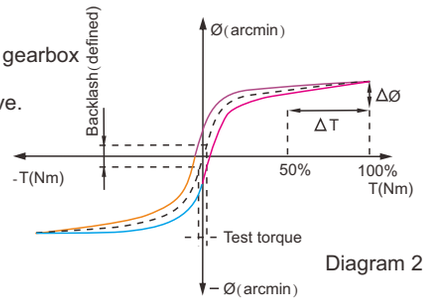
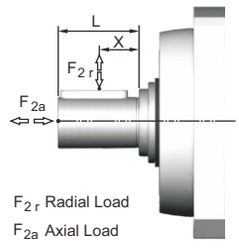
(Eq.5)

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.

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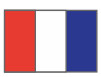

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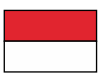

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