

SLOTLESS MOTOR



Company Profile

Entering into the hybrid stepper motor business in 2007, PrimoPal has grown to where it is now one of China's top manufacturers of stepper motors, brushless motors, servo motors, and an integrated provider of related motion control products and solutions. PrimoPal has become the reliable partner for many industries, from factory automation components to the smart home appliance, from the intelligent management system of large industrial equipment to the control actuator in automotive and telecommunication devices.

Highly recognized for high performance and quality products, now PrimoPal offers four major series of products: stepper motors, brushless DC motors, servo motors and linear motors. Production capacity exceeds more than 2 million motors per year. PrimoPal also has several joint venture companies who specialize in the production of PMDC motors, motion controllers and precision gearboxes. We sell nearly 3 million different motors and companion products to customers worldwide every year.

Our manufacturing bases are equipped with advanced quality testing devices, precise honing machines, auto winding machines, CNC machining centers, and other advanced manufacturing equipment. It makes us have the ability of continuously providing products with superior quality. Besides, we have an engineering team with many years of experience in motor design and application engineering.

We have no doubt that our endeavors enable us to maintain strong presence in the competitive market. To demonstrate our commitment to all our customers, PrimoPal has adopted "Bringing out the Best in Motion" as our official slogan, which means our ultimate goal is to become one of the world's top-level companies in the industry of precision motor and motion control system.

16+

Years Manufacturer

15000m²

Industrial Park

23+

Automatic Production Lines



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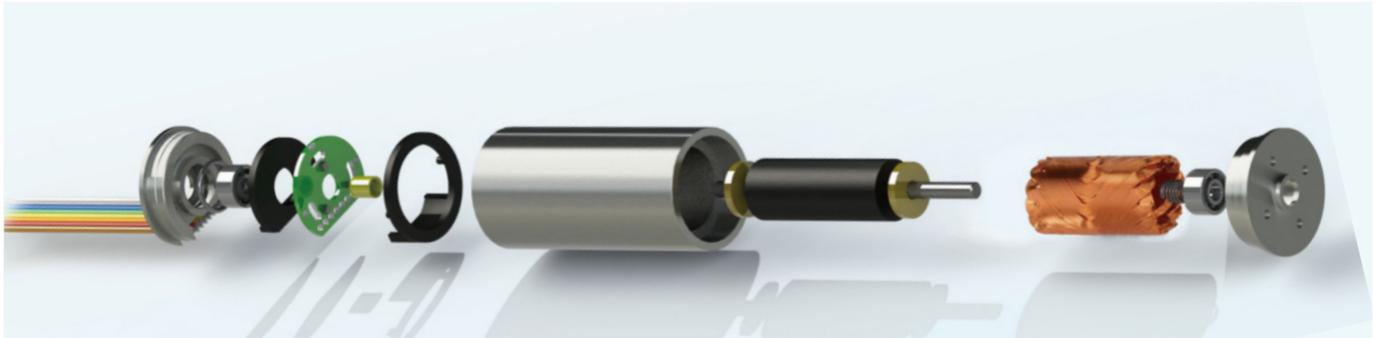
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Slotless Motor Introduction

Slotless Motor is a specialized DC motor featuring a rotor structure without an iron core. With its unique design principles and exceptional performance characteristics, it holds a significant position in high-precision, high-dynamic-response, and miniaturized applications.



As a high-end product in the micro-motor category, the slotless motor achieves outstanding performance including:

high efficiency (70%-90%)

rapid response (<1ms)

low noise (<2% speed fluctuation)

by eliminating iron core eddy current losses and mechanical inertia. This makes it an ideal choice for cutting-edge fields such as aerospace, medical devices, precision instruments, and humanoid robots.



Basic principles and structural composition

Slotless motors, also known as ironless rotor motors, are a type of DC motor based on electromagnetic induction principles. Their key innovation lies in the slotless, cup-shaped winding structure of the rotor.

Compared to traditional DC motors, the most distinctive feature of slotless motors is their absence of an iron core in the rotor. This design fundamentally eliminates eddy current losses and hysteresis losses, significantly improving motor efficiency.

Depending on the commutation method, slotless motors can be classified into two main categories:

Brushed slotless Motors: Utilize mechanical carbon brushes for commutation.

Brushless slotless Motors: Achieve contactless control via electronic commutation.

1.1 Brushed Slotless Motor Structure

The brushed slotless motor primarily consists of an outer housing cup, rotor coil, stator magnets, brushes, commutator, and bearings. Its working principle is as follows: When current flows through the rotor coil, it generates a magnetic field that interacts with the stator's permanent magnets, producing electromagnetic torque to drive rotor rotation. The rotor coil of a brushed slotless motor is cup-shaped and directly wound with enameled wire, eliminating the need for an iron core. As a result, the rotor is lightweight with low rotational inertia, enabling rapid response. The brushes and commutator ensure the correct current direction during rotation to maintain consistent electromagnetic torque.

1.2 Brushless Slotless Motor Structure

The brushless slotless motor employs electronic commutation and mainly comprises stator coils, rotor permanent magnets, position sensors (e.g., Hall elements), drive circuits, and bearings. Its working principle involves the stator coils generating a rotating magnetic field when energized, which interacts with the rotor's permanent magnets to produce torque and drive rotation. Position sensors detect the rotor's real-time position, and the drive circuit switches the stator coil's current direction based on sensor signals, achieving contactless commutation. The stator of a brushless slotless motor typically adopts an ironless design, further reducing size and weight.

1.3 Core Components of Slotless Motors

The performance of slotless motors depends on the following key components:

1. Rotor Winding: Features a cup-shaped structure, usually wound with copper-clad aluminum wire or self-bonding enameled wire. Based on winding methods, it can be categorized as straight-wound, skew-wound, diamond-wound, or hexagonal-wound. Among these, hexagonal winding improves slot fill factor via preformed coils, making it more suitable for high-precision and mass production.

2. Permanent Magnets: Slotless motors use diverse permanent magnet structures, including ring magnets and tile-shaped magnets, with radial or parallel magnetization. Research shows that parallel-magnetized ring magnets offer the highest average air-gap flux density and a near-sinusoidal flux waveform under the same volume, outperforming other topologies.

3. Winding Process: The winding technique is one of the technical barriers in slotless motors. Early models relied on manual winding, with a yield rate of only 75%–85%. With automated winding technology, the yield has surpassed 98%. Current winding methods include linear winding, skewed coils (e.g., Faulhaber's patented technology), and concentric winding (e.g., Maxon's technology).



Switzerland's Maxon



Germany's Faulhaber



China's PrimoPal

4. Control Circuit: The precision and stability of slotless motors heavily depend on drive circuit design. H-bridge drives with PWM modulation are commonly used, adjusting duty cycles for speed control and switching bridge arm states for direction control. PWM carrier frequencies typically range from 5–50 kHz to balance noise and efficiency.

Technical Advantages and Performance Characteristics of Slotless Motors

Slotless motors have gained widespread application in numerous high-tech fields primarily due to their unique technical advantages and exceptional performance characteristics. The core advantage of slotless motors lies in their ironless design, which fundamentally eliminates the eddy current losses and mechanical inertia issues inherent in traditional iron-core motors, granting them significant superiority in efficiency, response speed, and control precision.

2.1 Efficiency Advantages

Slotless motors exhibit far higher efficiency than traditional iron-core motors. Their efficiency typically ranges between 70% and 90%, with some high-end models exceeding 95%, whereas conventional iron-core DC motors usually achieve only 50%–70% efficiency. This efficiency advantage stems from the following factors:

1. Elimination of Eddy Current Losses: The ironless design of slotless motors completely avoids the eddy current losses generated in the iron cores of traditional motors under alternating magnetic fields.

2. Reduced Mechanical Energy Losses: Due to the rotor's lightweight and low moment of inertia, mechanical energy losses during startup and braking are significantly minimized.

3. Optimized Magnetic Field Distribution: The slotless structure of slotless motors reduces cogging torque and hysteresis losses, enhancing energy conversion efficiency.

2.2 Response Speed Advantages

Slotless motors feature an extremely small mechanical time constant, achieving response speeds in the millisecond or even microsecond range—far surpassing traditional motors. For example, the response speed of PrimoPal slotless motors can reach <math><1\text{ms}</math>, while conventional brushed motors typically respond in around 50ms. This rapid response capability makes them excel in applications requiring frequent starts, stops, and directional changes.

Key reasons for this fast response include:

1. Low Rotor Inertia: The lightweight and compact rotor design reduces the moment of inertia to 1/3–1/2 that of traditional motors.

2. Minimized Mechanical Friction: The ironless design decreases friction between the rotor and stator, improving dynamic performance.

3. Linear Characteristics: The electrical and mechanical properties of slotless motors are nearly linear, facilitating precise control and swift response.

2.3 Control Precision Advantages

Slotless motors offer ideal control characteristics, enabling high-precision position and speed regulation. Their control accuracy can reach $\pm 2\%$, significantly outperforming the $\pm 5\%$ of traditional motors. This precision makes them indispensable in applications demanding meticulous operation.

Factors contributing to high control precision:

1. Low Torque Ripple: Slotless motors exhibit minimal torque ripple, ensuring smooth operation and precise control.
2. Linear Electrical Behavior: The nearly linear relationship between voltage and speed simplifies control algorithm design.
3. Superior Thermal Performance: Better heat dissipation than traditional motors allows stable long-term operation.

2.4 Size and Weight Advantages

Slotless motors are substantially smaller and lighter than traditional motors of equivalent power. Compared to iron-core motors with the same power output, their weight and volume are reduced by $1/3-1/2$. This compact and lightweight design provides unique advantages in space-constrained precision devices.

Classification and Technological Evolution of Slotless Motors

Slotless motors can be categorized into various types based on technical characteristics and application scenarios. From the perspective of commutation methods, they are primarily divided into brushed slotless motors and brushless slotless motors. In terms of winding structures, they can be classified as straight-wound, skew-wound, diamond-wound, or hexagonal-wound, among others.

3.1 Brushed vs. Brushless Slotless Motors

Brushed and brushless slotless motors exhibit significant differences in structure and performance:

Feature	Brushed Slotless Motor	Brushless Slotless Motor
Commutation Method	Mechanical carbon brush commutation	Electronic commutation (Hall sensors or encoders)
Response Speed	Slower (~50ms)	Extremely fast (<1ms)
Lifespan	Shorter (brush wear)	Longer (no mechanical contact wear)
Noise Level	Higher (brush friction)	Lower (no mechanical contact)
Cost	Lower	Higher

Brushed slotless motors feature simple structures and low costs but suffer from brush wear, resulting in shorter lifespans. In contrast, brushless slotless motors, despite their complex designs and higher costs, offer extended lifespans, reduced noise, and faster response speeds, making them better suited for high-end applications.

3.2 Winding Structure Classification

The winding structure significantly impacts the performance of slotless motors. Key types include:

1. Straight-Wound:

- * Complex process requiring multiple winding passes.
- * Suitable for low-turn-count, long-winding structures.
- * High slot fill factor but inconsistent winding quality.

2. Skew-Wound (Honeycomb Winding):

- * Features a honeycomb-like pattern with central taps.
- * Compact end dimensions but lower slot fill factor due to overlapping enameled wires during skewed winding.

3. Diamond-Wound:

- * Pre-formed self-bonding enameled coils are arranged on specialized molds to create the armature cup.
- * High slot fill factor and production efficiency, ideal for mass production.

4. Hexagonal-Wound:

- * Combines advantages of straight and skewed windings.
- * Achieves high slot fill factor while maintaining excellent electrical performance.

Winding Factor: A critical parameter for slotless motor performance, comprising:

- * Pitch Factor: Maximized at 1 for full-pitch, non-skewed windings.
- * Distribution Factor: Depends solely on phase belt type (unaffected by coil rows/turns per row).
- * 120° phase belt: 0.827
- * 60° phase belt: 0.955

Applications of Slotless Motors



Artificial Heart



Drug Delivery Equipment



Surgical Robot



Stapler



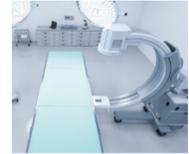
Dental Equipment



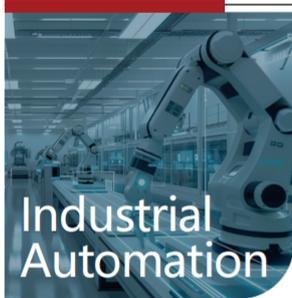
Respirator



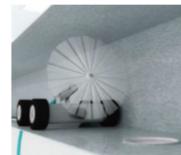
Electric Tool



Orthopedic Surgical Equipment



Pipette



Pipeline Robot



Competition Robots



Dispenser



Precision Measuring Instruments



Electric Tool



Electric Claw



Control System



Driving System



UAV



Dexterous Hand

Motor Parameters Explanation

1. Rated Voltage(V)-Used as a reference for optimal performance and thermal design.

The standard voltage at which the motor is designed to operate continuously under rated conditions.

2.No-load Speed(rpm)-Indicates the theoretical maximum speed of the motor.

$$n_0 = K_e \cdot V$$

The rotational speed of the motor shaft when operating at rated voltage with no external load.

3.No-load Current(mA)- Represents internal losses such as bearing friction and iron/core losses.

The current drawn by the motor when running at rated voltage without any mechanical load.

4.Stall Current(mA)- Important for selecting power supplies and drivers with adequate current capacity.

$$I_{stall} = \frac{V}{R}$$

The maximum current the motor draws when the shaft is completely stopped (zero speed).

5.Terminal Resistance(Ω)- Affects current draw and power loss () under load.

The resistance measured across the motor windings (or terminals).

6.Stall Torque(mN.m)- Indicates the highest mechanical force the motor can provide.

$$T_{stall} = K_t \cdot I_{stall}$$

7.Maximum Efficiency(%)- A key metric to compare motor designs; often occurs below rated load.

$$\eta = \frac{P_{out}}{P_{in}} \times 100\%$$

The peak ratio of mechanical output power to electrical input power during operation.

8.Maximum Power(W)- Critical for determining the motor's performance range and thermal limits.

$$P = \frac{T_{(N \cdot m)} \cdot rpm}{9.55}$$

The highest mechanical power the motor can deliver, usually occurring at around half the stall torque.

9.Rated Torque(mN.m)- Defined by the motor's long-term thermal limits and system load.

The torque the motor can output continuously without overheating or mechanical stress.

10.Rated Current(mA)-Used to size power supply, driver, and thermal dissipation design.

The continuous current required to produce the rated torque at the rated speed.

11.Rated Speed(rpm)-Represents real-world working speed under load.

The rotational speed of the motor under rated voltage and rated torque.

12.Torque Constant(mN.m/A)-Fundamental design parameter of the motor; affects control and force output.

$$K_t = \frac{T}{I}$$

The amount of torque the motor generates per ampere of current.

13.Back EMF Constant(rpm/V)-Indicates how much voltage is generated per rpm; inversely related to torque constant.

$$K_e = \frac{n}{V} \quad K_t = \frac{9.55}{K_e}$$

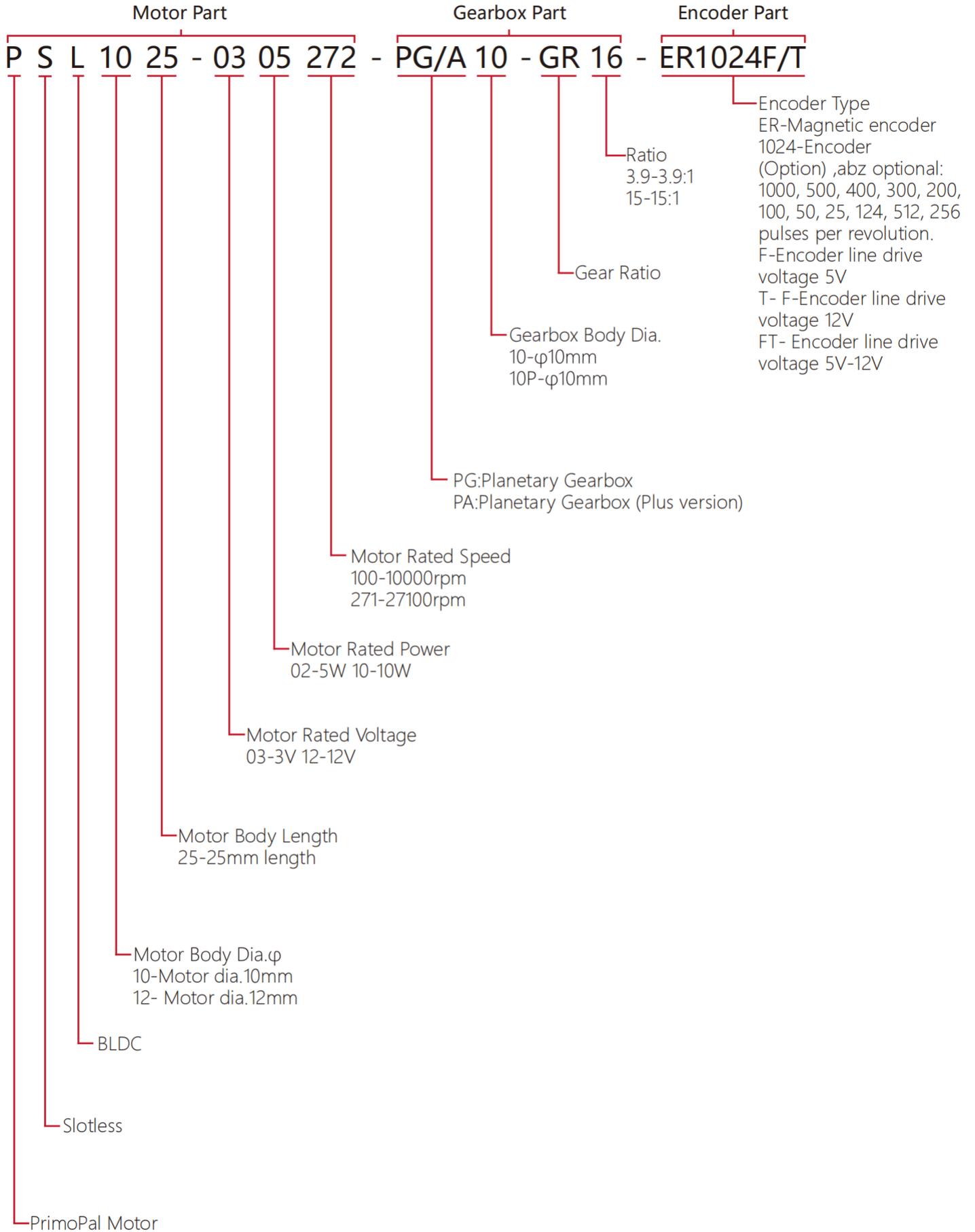
The motor's output speed per unit of motor voltage when rotating as a motor.

14.Speed/Torque Slope(rpm/mN.m)-Helps predict the motor's behavior under varying loads.

$$S = \frac{n_0}{T_{stall}}$$

The rate at which speed decreases as torque increases, typically linear for small DC motors.

Part Number Naming Rule



Brushless DC Slotless Motor

Fuselage Diameter: $\phi 10\text{mm}-\phi 42\text{mm}$

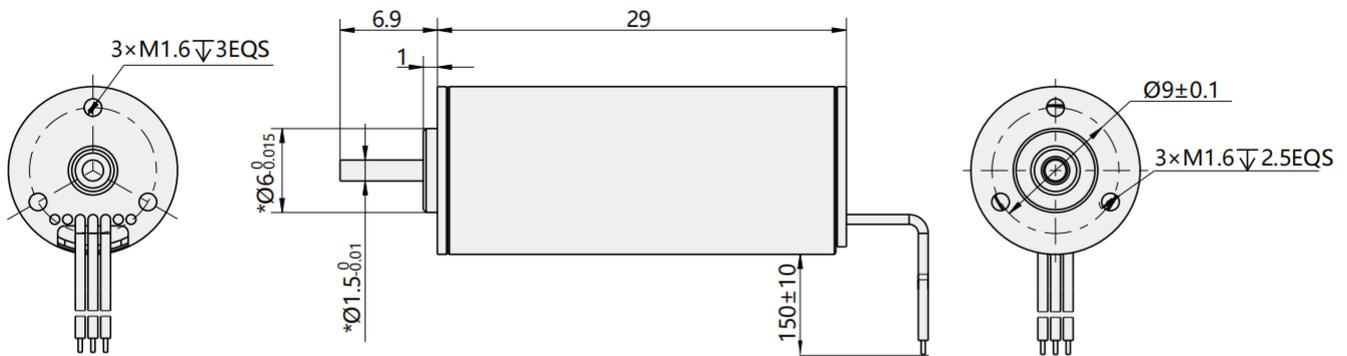
Maximum Power: 5.93-160W

Rated Torque: 1.50-120.0mN.m



PSL1025 ϕ 10mm Series Brushless DC Slotless Motor

Key Data: 5.93-7.60 W, 1.5-2.0 mNm, 22,000-25,000 rpm



ELECTRICAL SPECIFICATION

	Unit	PSL1025-0305272	PSL1025-0606282	PSL1025-0907309	PSL1025-1205287
Rated Voltage	V	3.0	6.0	9.0	12.0
No-load Speed	rpm	27,720	28,210	30,920	28,710
No-load Current	A	0.17	0.01	0.08	0.08
Stall Current	A	8.2	4.2	3.52	2.34
Terminal Resistance	Ω	0.36	1.40	2.55	5.12
Stall Torque	mN·m	8.174	8.346	9.384	8.802
Maximum Efficiency	%	73.3	73.5	73.0	68.4
Maximum Power	W	5.93	6.16	7.60	6.62
Rated Torque	mN·m	1.5	1.5	1.5	2.0
Rated Current	A	1.48	0.76	0.55	0.51
Rated Speed	rpm	22,633	23,137	25,976	22,186
Torque Constant	mN·m /A	1.013	1.9902	2.7207	3.8724
Back EMF Constant	V/Krpm	1.5	0.26	0.35	0.55
Speed/Torque Slope	rpm/mNm	3,391	3,380	3,295	3,262

MECHANICAL SPECIFICATION

Bearing		Ball Bearing
Max. speed	rpm	40,000
Axial play	mm	0...0.29
Radial play		Preloaded
Max. axial load (dynamic)	N	1.5
Max. force for press fits (static)	N	60
Max. radial load (5mm from flange)	N	10
Ambient temperature	$^{\circ}\text{C}$	-40...+100
Max. winding temperature	$^{\circ}\text{C}$	155

THERMAL RESISTANCE

Housing – Ambient	$^{\circ}\text{C} / \text{W}$	9.0
Winding – Housing	$^{\circ}\text{C} / \text{W}$	1.75

THERMAL TIME CONSTANT

Motor	s	588
Winding	s	1.10
Number of pole pairs		1
Number of phases		3
Weight	g	73

GEARBOX

♦ Planetary: PG10 (Page 22)

CONFIGURATION

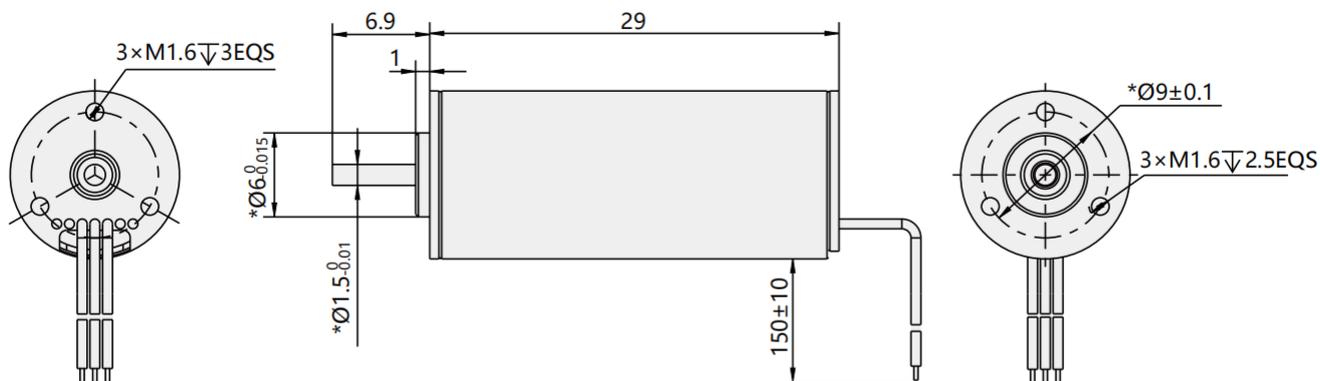
- ♦ Hall Signal Output
- ♦ Incremental Differential Encoder (up to 5000CPR, Optional)
- ♦ Absolute Encoder (up to 12-bit, Optional)

WIRE DEFINITION

PIN 1	Phase U	PIN 7	MOSI
PIN 2	Phase U	PIN 8	CS
PIN 3	Phase V	PIN 9	MISO
PIN 4	Phase V	PIN 10	GND
PIN 5	Phase W	PIN 11	SCLK
PIN 6	Phase W	PIN 12	Vcc 3V-3.6V

PSL1229 ϕ 12mm Series Brushless DC Slotless Motor

Key Data: 5.0 W, 4.0 mNm, 12,000 rpm



ELECTRICAL SPECIFICATION

	Unit	PSL1229-0605120
Rated Voltage	V	6.0
No-load Speed	rpm	15,000
No-load Current	A	0.16
Stall Current	A	6.00
Terminal Resistance	Ω	2.00
Stall Torque	mN·m	19.76
Maximum Efficiency	%	70.00
Maximum Power	W	5.0
Rated Torque	mN·m	4.0
Rated Current	A	1.21
Rated Speed	rpm	12,000
Torque Constant	mN·m / A	3.29
Back EMF Constant	V/Krpm	0.34
Speed/Torque Slope	rpm/mNm	759

MECHANICAL SPECIFICATION

Bearing		Ball Bearing
Max. speed	rpm	20,000
Axial play	mm	0...0.045
Radial play		Preloaded
Max. axial load (dynamic)	N	1
Max. force for press fits (static)	N	10
Max. radial load (5mm from flange)	N	4
Ambient temperature	$^{\circ}\text{C}$	-40...+100
Max. winding temperature	$^{\circ}\text{C}$	155

THERMAL RESISTANCE

Housing – Ambient	$^{\circ}\text{C} / \text{W}$	23
Winding – Housing	$^{\circ}\text{C} / \text{W}$	1.77

THERMAL TIME CONSTANT

Motor	s	352
Winding	s	0.44
Number of pole pairs		1
Number of phases		3
Weight	g	30

GEARBOX

♦ Planetary: PG12 (Page 24), PA12 (Page 35)

CONFIGURATION

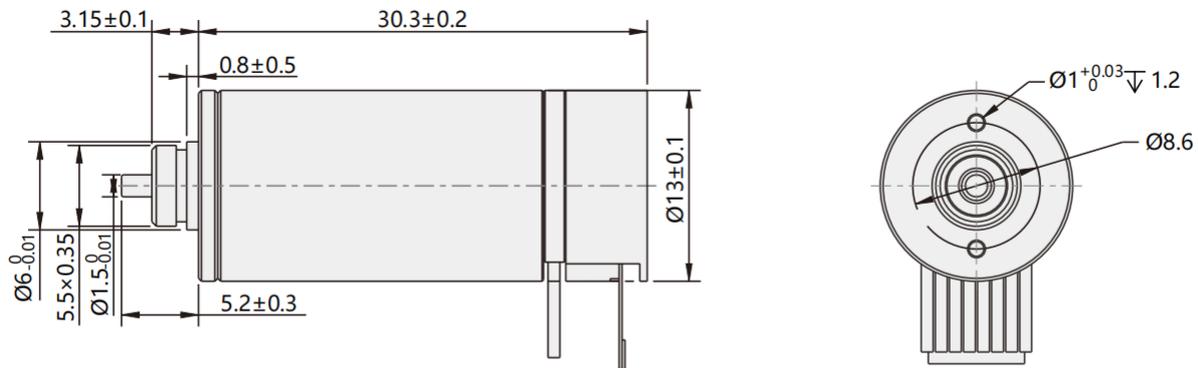
- ♦ Hall Signal Output
- ♦ Incremental Differential Encoder (up to 5000CPR, Optional)
- ♦ Absolute Encoder (up to 12-bit, Optional)

WIRE DEFINITION

PIN 1	Phase U	PIN 7	MOSI
PIN 2	Phase U	PIN 8	CS
PIN 3	Phase V	PIN 9	MISO
PIN 4	Phase V	PIN 10	GND
PIN 5	Phase W	PIN 11	SCLK
PIN 6	Phase W	PIN 12	Vcc 3V-3.6V

PSL1330 ϕ 13mm Series Brushless DC Slotless Motor

Key Data: 2.98-4.42 W, 2.0 mNm, 13,000-17,000 rpm



ELECTRICAL SPECIFICATION

	Unit	PSL1330-0302202	PSL1330-0603202	PSL1330-0903228	PSL1330-1204242
Rated Voltage	V	3.0	6.0	9.0	12.0
No-load Speed	rpm	20,202	20,202	22,870	24,242
No-load Current	A	0.25	0.13	0.10	0.01
Stall Current	A	4.44	2.23	1.88	1.65
Terminal Resistance	Ω	0.67	2.59	4.78	7.28
Stall Torque	mN·m	5.63	5.88	6.31	6.96
Maximum Efficiency	%	58.6	58.6	58.6	58.6
Maximum Power	W	2.98	3.11	3.78	4.42
Rated Torque	mN·m	2.0	2.0	2.0	2.0
Rated Current	A	1.50	0.75	0.56	0.45
Rated Speed	rpm	13,030	13,329	15,624	17,274
Torque Constant	mN·m /A	1.340	2.681	3.551	4.468
Back EMF Constant	V/Krpm	0.23	0.46	0.56	0.50
Speed/Torque Slope	rpm/mNm	3,586	3,436	3,623	3,484

MECHANICAL SPECIFICATION

Bearing		Ball Bearing
Max. speed	rpm	20,000
Axial play	mm	0...0.045
Radial play		Preloaded
Max. axial load (dynamic)	N	1
Max. force for press fits (static)	N	10
Max. radial load (5mm from flange)	N	4
Ambient temperature	$^{\circ}\text{C}$	-40...+100
Max. winding temperature	$^{\circ}\text{C}$	155

THERMAL RESISTANCE

Housing – Ambient	$^{\circ}\text{C} / \text{W}$	23
Winding – Housing	$^{\circ}\text{C} / \text{W}$	1.77

THERMAL TIME CONSTANT

Motor	s	352
Winding	s	0.44
Number of pole pairs		1
Number of phases		3
Weight	g	33

GEARBOX

♦ Planetary: PG13 (Page 25)

CONFIGURATION

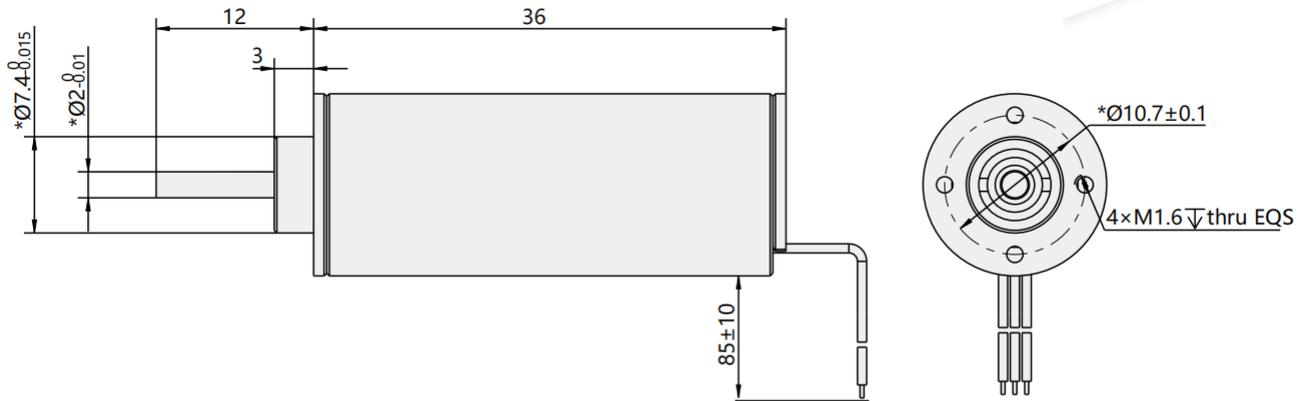
- ♦ Hall Signal Output
- ♦ Incremental Differential Encoder (up to 5000CPR, Optional)
- ♦ Absolute Encoder (up to 12-bit, Optional)

WIRE DEFINITION

PIN 1	/A	PIN 5	B
PIN 2	/B	PIN 6	Z
PIN 3	/Z	PIN 7	Vcc 3V-3.6V
PIN 4	A	PIN 8	GND

PSL1436 ϕ 14mm Series Brushless DC Slotless Motor

Key Data: 5.0 W, 4.0 mNm, 12,000 rpm



ELECTRICAL SPECIFICATION

	Unit	PSL1436-0605120
Rated Voltage	V	6.0
No-load Speed	rpm	15,000
No-load Current	A	0.16
Stall Current	A	7.00
Terminal Resistance	Ω	0.58
Stall Torque	mN·m	22.07
Maximum Efficiency	%	68.00
Maximum Power	W	5.0
Rated Torque	mN·m	4.0
Rated Current	A	1.25
Rated Speed	rpm	12,000
Torque Constant	mN·m /A	3.20
Back EMF Constant	V/Krpm	0.34
Speed/Torque Slope	rpm/mNm	681

MECHANICAL SPECIFICATION

Bearing		Ball Bearing
Max. speed	rpm	20,000
Axial play	mm	0...0.045
Radial play		Preloaded
Max. axial load (dynamic)	N	1
Max. force for press fits (static)	N	10
Max. radial load (5mm from flange)	N	4
Ambient temperature	$^{\circ}\text{C}$	-40...+100
Max. winding temperature	$^{\circ}\text{C}$	80

THERMAL RESISTANCE

Housing – Ambient	$^{\circ}\text{C} / \text{W}$	23
Winding – Housing	$^{\circ}\text{C} / \text{W}$	1.88

THERMAL TIME CONSTANT

Motor	s	355
Winding	s	0.49
Number of pole pairs		1
Number of phases		3
Weight	g	35

GEARBOX

✦ Planetary: PG14 (Page 26), PA14 (Page 36)

CONFIGURATION

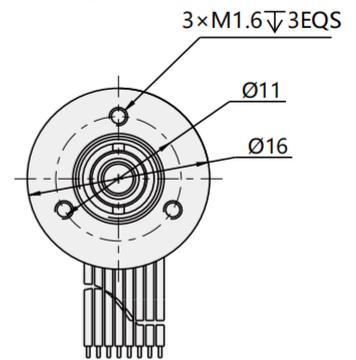
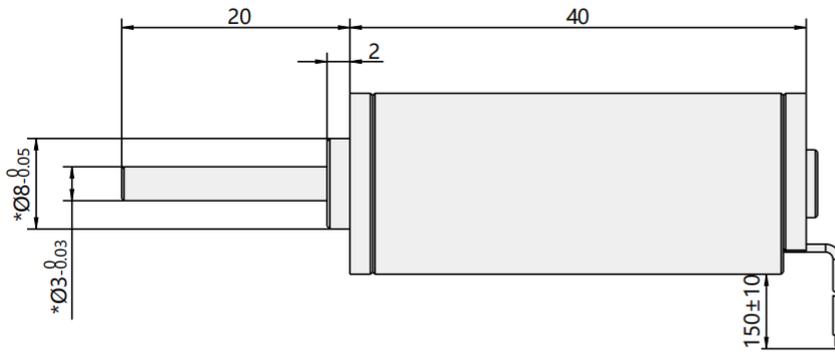
- ✦ Hall Signal Output
- ✦ Incremental Differential Encoder (up to 5000CPR, Optional)
- ✦ Absolute Encoder (up to 12-bit, Optional)

WIRE DEFINITION

PIN 1	/A	PIN 5	B
PIN 2	/B	PIN 6	Z
PIN 3	/Z	PIN 7	Vcc 3V-3.6V
PIN 4	A	PIN 8	GND

PSL1640 ϕ 16mm Series Brushless DC Slotless Motor

Key Data: 33.47-39.49 W, 7.4-7.5 mNm, 44,000-51,000 rpm



ELECTRICAL SPECIFICATION

	Unit	PBLS1640-1833440	PBLS1640-2439513	PBLS1640-3639500	PBLS1640-4839500
Rated Voltage	V	18.0	24.0	36.0	48.0
No-load Speed	rpm	50,000	58,000	56,000	56,000
No-load Current	A	0.31	0.22	0.15	0.12
Stall Current	A	7.62	6.48	4.38	3.12
Terminal Resistance	Ω	0.63	1.31	1.85	3.15
Stall Torque	mN·m	22.2	22.2	22.5	22.2
Maximum Efficiency	%	85.00	84.00	82.40	84.92
Maximum Power	W	33.47	39.49	39.29	38.91
Rated Torque	mN·m	7.4	7.4	7.5	7.4
Rated Current	A	2.54	2.16	1.46	1.04
Rated Speed	rpm	44,000	51,300	50,000	50,000
Torque Constant	mN·m /A	2.91	3.43	5.14	7.12
Back EMF Constant	V/Krpm	0.32	0.38	0.63	0.88
Speed/Torque Slope	rpm/mNm	2,252	2,613	2,489	2,522

MECHANICAL SPECIFICATION

Bearing	Deep Groove Ball Bearing	
Max. speed	rpm	60,000
Axial play	mm	0...0.014
Radial play	Preloaded	
Max. axial load (dynamic)	N	1
Max. force for press fits (static)	N	18
Max. radial load (5mm from flange)	N	6
Ambient temperature	$^{\circ}$ C	-40...+100
Max. winding temperature	$^{\circ}$ C	80

THERMAL RESISTANCE

Housing – Ambient	$^{\circ}$ C / W	31
Winding – Housing	$^{\circ}$ C / W	2.68

THERMAL TIME CONSTANT

Motor	s	388
Winding	s	0.75
Number of pole pairs		1
Number of phases		3
Weight	g	47

GEARBOX

♦ Planetary: PG16 (Page 27), PA16 (Page 37)

CONFIGURATION

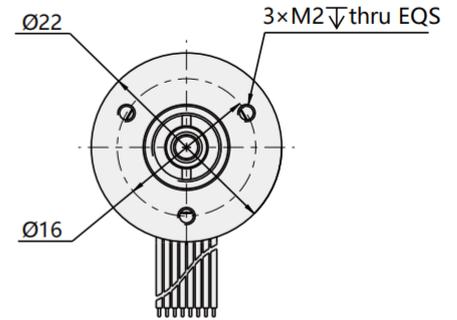
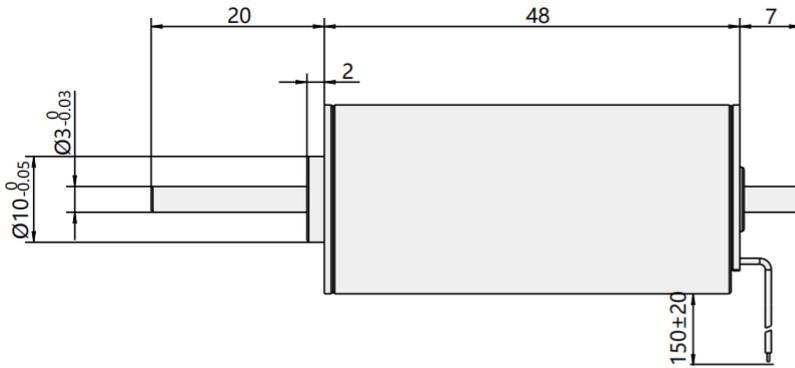
- ♦ Hall Signal Output
- ♦ Incremental Differential Encoder (up to 5000CPR, Optional)
- ♦ Absolute Encoder (up to 12-bit, Optional)

WIRE DEFINITION

PIN 1	Winding 1	PIN 5	GND
PIN 2	Winding 2	PIN 6	Hall A
PIN 3	Winding 3	PIN 7	Hall B
PIN 4	hall 3-24VDC	PIN 8	Hall C

PSL2248 ϕ 22mm Series Brushless DC Slotless Motor

Key Data: 83.0-100.0 W, 20 mNm, 40,000-49,000 rpm



ELECTRICAL SPECIFICATION

	Unit	PSL2248-1883400	PSL2248-2410490	PSL2248-3610474	PSL2248-4810496
Rated Voltage	V	18.0	24.0	36.0	48.0
No-load Speed	rpm	50,000	55,000	53,000	54,000
No-load Current	A	0.30	0.40	0.32	0.14
Stall Current	A	19.20	16.50	10.20	7.50
Terminal Resistance	Ω	0.52	0.60	1.14	2.0
Stall Torque	mN·m	60.0	60.0	60.0	60.0
Maximum Efficiency	%	87.0	89.0	89.0	91.0
Maximum Power	W	83.0	100.0	100.0	100.0
Rated Torque	mN·m	20.0	20.0	20.0	20.0
Rated Current	A	6.40	5.50	3.40	2.50
Rated Speed	rpm	40,000	49,000	47,400	49,600
Torque Constant	mN·m /A	3.13	3.64	5.88	8.00
Back EMF Constant	V/Krpm	0.33	0.38	0.62	0.84
Speed/Torque Slope	rpm/mNm	833	917	883	900

MECHANICAL SPECIFICATION

Bearing		Ball Bearing
Max. speed	rpm	60,000
Axial play	mm	0...0.014
Radial play		Preloaded
Max. axial load (dynamic)	N	3.67
Max. force for press fits (static)	N	53
Max. radial load (5mm from flange)	N	20
Ambient temperature	$^{\circ}\text{C}$	-40...+100
Max. winding temperature	$^{\circ}\text{C}$	80

THERMAL RESISTANCE

Housing – Ambient	$^{\circ}\text{C} / \text{W}$	16
Winding – Housing	$^{\circ}\text{C} / \text{W}$	1.82

THERMAL TIME CONSTANT

Motor	s	840
Winding	s	2.73
Number of pole pairs		1
Number of phases		3
Weight	g	110

GEARBOX

✦ Planetary: PG22 (Page 29), PA22 (Page 39)

CONFIGURATION

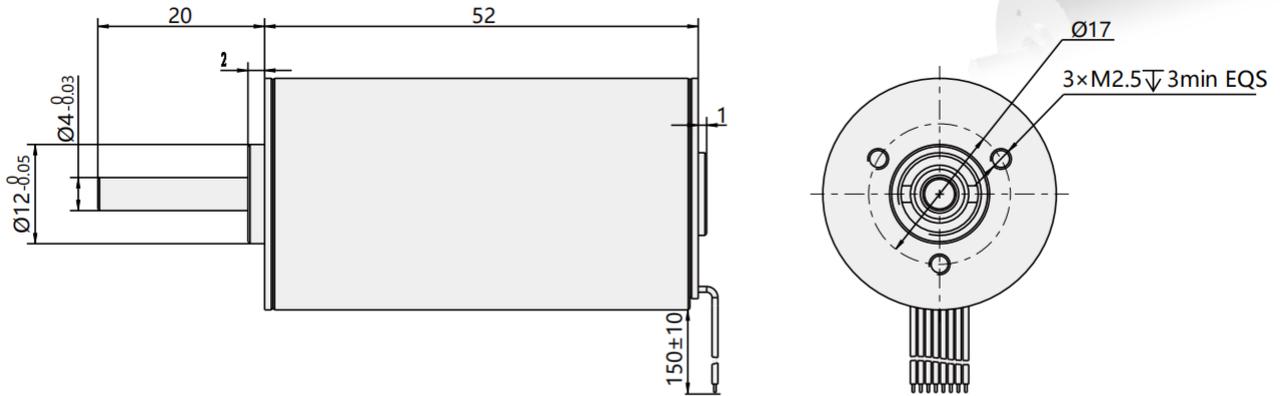
- ✦ Hall Signal Output
- ✦ Incremental Differential Encoder (up to 5000CPR, Optional)
- ✦ Absolute Encoder (up to 12-bit, Optional)

WIRE DEFINITION

PIN 1	/A	PIN 5	B
PIN 2	/B	PIN 6	Z
PIN 3	/Z	PIN 7	Vcc 3V-3.6V
PIN 4	A	PIN 8	GND

PSL2852 ϕ 28mm Series Brushless DC Slotless Motor

Key Data: 30.0-35.0 W, 32.0-34.0 mNm, 6,000-8,000 rpm



ELECTRICAL SPECIFICATION		PSL2852-120369	PSL2852-240384	PSL2852-360383	PSL2852-480383
Rated Voltage	Unit: V	12.0	24.0	36.0	48.0
No-load Speed	rpm	9,270	9,680	9,500	9,400
No-load Current	A	0.20	0.11	0.08	0.06
Stall Current	A	8.31	4.44	3.00	2.28
Terminal Resistance	Ω	1.04	3.40	8.60	13.20
Stall Torque	mN·m	96.0	96.0	96.0	102.0
Maximum Efficiency	%	80.0	84.0	83.0	85.0
Maximum Power	W	30.0	34.0	35.0	35.0
Rated Torque	mN·m	32.0	32.0	32.0	34.0
Rated Current	A	2.77	1.48	1.00	0.76
Rated Speed	rpm	6,970	8,430	8,370	8,340
Torque Constant	mN·m /A	11.55	21.62	32.00	44.74
Back EMF Constant	V/Krpm	1.21	2.26	3.35	4.68
Speed/Torque Slope	rpm/mNm	97	101	99	92

MECHANICAL SPECIFICATION	
Bearing	Ball Bearing
Max. speed	rpm: 10,000
Axial play	mm: 0...0.16
Radial play	Preloaded
Max. axial load (dynamic)	N: 4
Max. force for press fits (static)	N: 96
Max. radial load (5mm from flange)	N: 23
Ambient temperature	$^{\circ}\text{C}$: -40...+100
Max. winding temperature	$^{\circ}\text{C}$: 52.5

THERMAL RESISTANCE	
Housing – Ambient	$^{\circ}\text{C} / \text{W}$: 11.4
Winding – Housing	$^{\circ}\text{C} / \text{W}$: 1.99

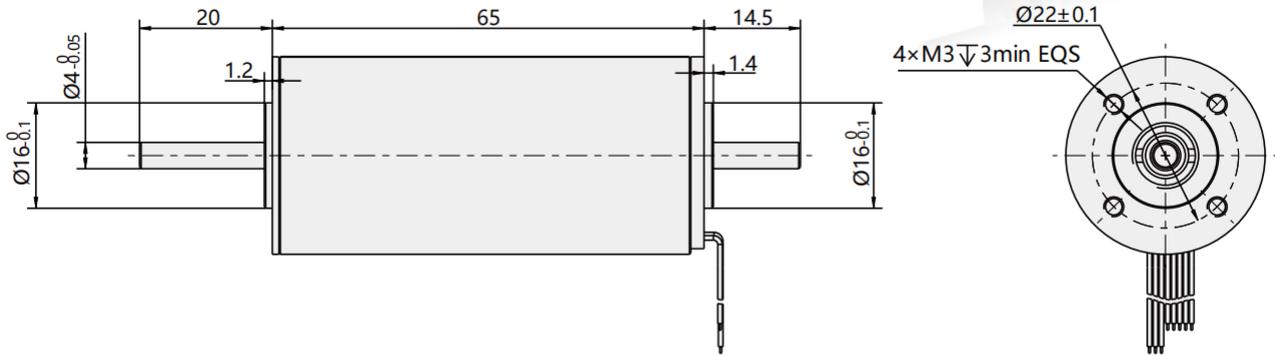
THERMAL TIME CONSTANT	
Motor	s: 838
Winding	s: 1.88
Number of pole pairs	1
Number of phases	3
Weight	g: 170

- GEARBOX**
- ♦ Planetary: PG28 (Page 31)
- CONFIGURATION**
- ♦ Hall Signal Output
 - ♦ Incremental Differential Encoder (up to 5000CPR, Optional)
 - ♦ Absolute Encoder (up to 12-bit, Optional)

WIRE DEFINITION			
PIN 1	/A	PIN 5	B
PIN 2	/B	PIN 6	Z
PIN 3	/Z	PIN 7	Vcc 3V-3.6V
PIN 4	A	PIN 8	GND

PSL3065 ϕ 30mm Series Brushless DC Slotless Motor

Key Data: 65.0 W, 90.0 mNm, 6,900 rpm



ELECTRICAL SPECIFICATION

	Unit	PSL3065-246569
Rated Voltage	V	24.0
No-load Speed	rpm	9,200
No-load Current	A	0.30
Stall Current	A	48.0
Terminal Resistance	Ω	1.00
Stall Torque	mN·m	1,122.08
Maximum Efficiency	%	86.0
Maximum Power	W	65.0
Rated Torque	mN·m	90.0
Rated Current	mA	3.85
Rated Speed	rpm	6,900
Torque Constant	mN·m /A	23.38
Back EMF Constant	V/Krpm	2.45
Speed/Torque Slope	rpm/mNm	8

MECHANICAL SPECIFICATION

		Ball Bearing
Bearing		Ball Bearing
Max. speed	rpm	10,000
Axial play	mm	0...0.4
Radial play		Preloaded
Max. axial load (dynamic)	N	5
Max. force for press fits (static)	N	100
Max. radial load (5mm from flange)	N	26
Ambient temperature	$^{\circ}$ C	-40...+100
Max. winding temperature	$^{\circ}$ C	53

THERMAL RESISTANCE

Housing – Ambient	$^{\circ}$ C / W	10.9
Winding – Housing	$^{\circ}$ C / W	1.96

THERMAL TIME CONSTANT

Motor	s	845
Winding	s	7.3
Number of pole pairs		1
Number of phases		3
Weight	g	176

GEARBOX

♦ Planetary: N/A

CONFIGURATION

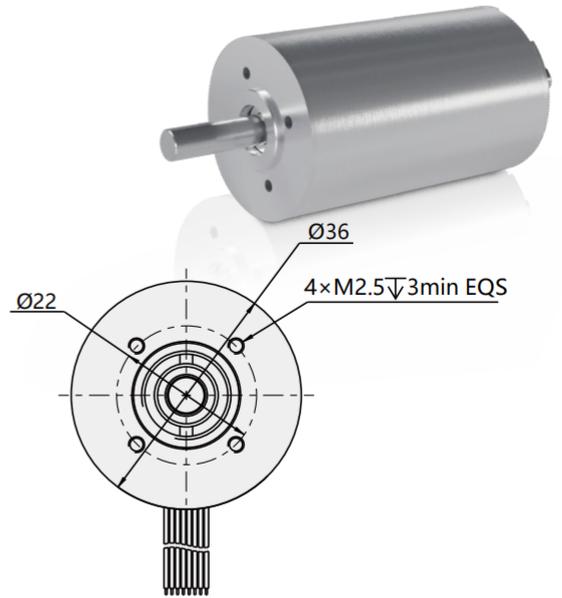
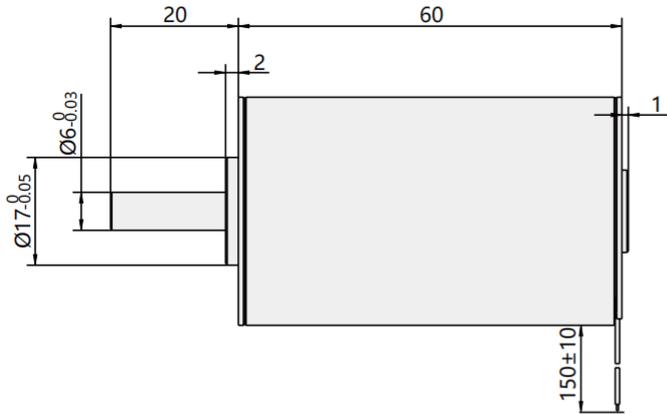
- ♦ Hall Signal Output
- ♦ Incremental Differential Encoder (up to 5000CPR, Optional)
- ♦ Absolute Encoder (up to 12-bit, Optional)

WIRE DEFINITION

PIN 1	/A	PIN 5	B
PIN 2	/B	PIN 6	Z
PIN 3	/Z	PIN 7	Vcc 3V-3.6V
PIN 4	A	PIN 8	GND

PSL3660 ϕ 36mm Series Brushless DC Slotless Motor

Key Data: 68.0-85.0 W, 70.0 mNm, 7,000-11,000 rpm



ELECTRICAL SPECIFICATION

	Unit	PSL3660-186873	PSL3660-246993	PSL3660-3674100	PSL3660-4885117
Rated Voltage	V	18.0	24.0	36.0	48.0
No-load Speed	rpm	10,000	11,000	11,500	13,000
No-load Current	A	0.37	0.37	0.22	0.20
Stall Current	A	12.9	12.3	8.1	6.9
Terminal Resistance	Ω	1.20	1.36	2.90	4.20
Stall Torque	mN·m	210.0	210.0	210.0	210.0
Maximum Efficiency	%	76.0	76.0	79.5	80.0
Maximum Power	W	68.0	69.0	74.0	85.0
Rated Torque	mN·m	70.0	70.0	70.0	70.0
Rated Current	A	4.3	4.1	2.7	2.3
Rated Speed	rpm	7,340	9,345	10,000	11,700
Torque Constant	mN·m /A	14.08	17.07	25.93	30.43
Back EMF Constant	V/Krpm	1.70	1.79	2.71	3.19
Speed/Torque Slope	rpm/mNm	47	52	54	62

MECHANICAL SPECIFICATION

Bearing		Ball Bearing
Max. speed	rpm	14,000
Axial play	mm	0..0.15
Radial play		Preloaded
Max. axial load (dynamic)	N	6
Max. force for press fits (static)	N	100
Max. radial load (5mm from flange)	N	28
Ambient temperature	$^{\circ}$ C	-40...+100
Max. winding temperature	$^{\circ}$ C	53

THERMAL RESISTANCE

Housing – Ambient	$^{\circ}$ C / W	10.0
Winding – Housing	$^{\circ}$ C / W	0.83

THERMAL TIME CONSTANT

Motor	s	1,100
Winding	s	7.2
Number of pole pairs		1
Number of phases		3
Weight	g	270

GEARBOX

♦ Planetary: N/A

CONFIGURATION

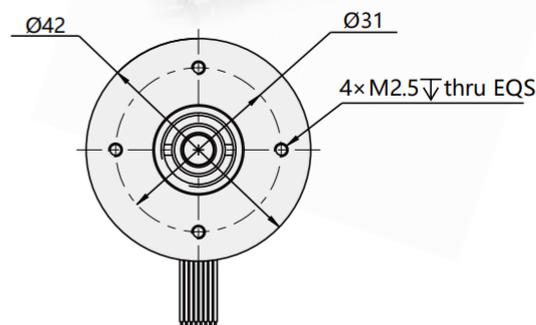
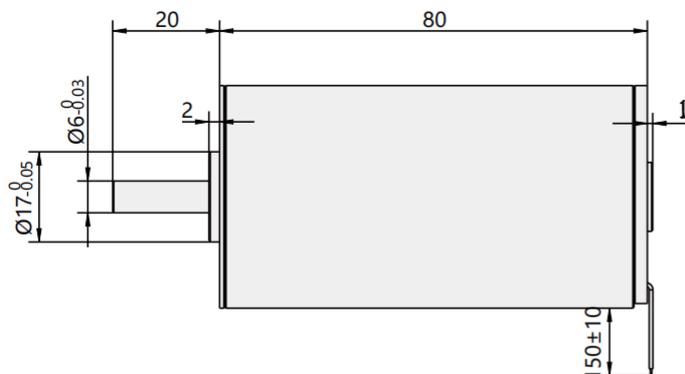
- ♦ Hall Signal Output
- ♦ Incremental Differential Encoder (up to 5000CPR, Optional)
- ♦ Absolute Encoder (up to 12-bit, Optional)

WIRE DEFINITION

PIN 1	/A	PIN 5	B
PIN 2	/B	PIN 6	Z
PIN 3	/Z	PIN 7	Vcc 3V-3.6V
PIN 4	A	PIN 8	GND

PSL4280 ϕ 42mm Series Brushless DC Slotless Motor

Key Data: 66.0-160.0 W, 90.0-120.0 mNm, 6,000-12,000 rpm



ELECTRICAL SPECIFICATION

	Unit	PSL4280-186666	PSL4280-248083	PSL4280-3680116	PSL4280-4816122
Rated Voltage	V	18.0	24.0	36.0	48.0
No-load Speed	rpm	9,000	11,000	13,000	13,800
No-load Current	A	0.60	0.69	0.60	0.58
Stall Current	A	16.2	13.2	12.0	12.38
Terminal Resistance	Ω	0.80	0.90	1.20	1.90
Stall Torque	mN·m	270.0	270.0	270.0	270.0
Maximum Efficiency	%	75.0	80.0	80.0	80.0
Maximum Power	W	66.0	80.0	100.0	160.0
Rated Torque	mN·m	90.0	90.0	90.0	120.0
Rated Current	A	4.89	4.17	3.47	4.17
Rated Speed	rpm	6,678	8,346	11,619	12,200
Torque Constant	mN·m / A	16.67	20.45	22.50	28.80
Back EMF Constant	V/Krpm	1.75	2.14	2.36	3.05
Speed/Torque Slope	rpm/mNm	33	40	48	51

MECHANICAL SPECIFICATION

Bearing		Ball Bearing
Max. speed	rpm	14,000
Axial play	mm	0...0.14
Radial play		Preloaded
Max. axial load (dynamic)	N	7
Max. force for press fits (static)	N	120
Max. radial load (5mm from flange)	N	30
Ambient temperature	$^{\circ}\text{C}$	-40...+100
Max. winding temperature	$^{\circ}\text{C}$	53

THERMAL RESISTANCE

Housing – Ambient	$^{\circ}\text{C} / \text{W}$	12.3
Winding – Housing	$^{\circ}\text{C} / \text{W}$	0.78

THERMAL TIME CONSTANT

Motor	s	1,200
Winding	s	7.89
Number of pole pairs		1
Number of phases		3
Weight	g	500

GEARBOX

♦ Planetary: PG42 (Page 34)

CONFIGURATION

- ♦ Hall Signal Output
- ♦ Incremental Differential Encoder (up to 5000CPR, Optional)
- ♦ Absolute Encoder (up to 12-bit, Optional)

WIRE DEFINITION

PIN 1	/A	PIN 5	B
PIN 2	/B	PIN 6	Z
PIN 3	/Z	PIN 7	Vcc 3V-3.6V
PIN 4	A	PIN 8	GND

Standard Version Micro Planetary Gearbox

Fuselage Diameter: $\phi 4\text{mm}-\phi 42\text{mm}$

Maximum Efficiency: 52-90%

Max.continuous input speed: 5,000-40,000rpm

Plus Version Micro Planetary Gearbox

Fuselage Diameter: $\phi 12\text{mm}-\phi 32\text{mm}$

Maximum Efficiency: 55-75%

Max.continuous input speed: 6,000-16,000rpm



PG06 ϕ 6mm Series Micro Planetary Gearbox

Key Data: 0.04-0.63 W, 52-88%, 40,000 rpm

Standard Version



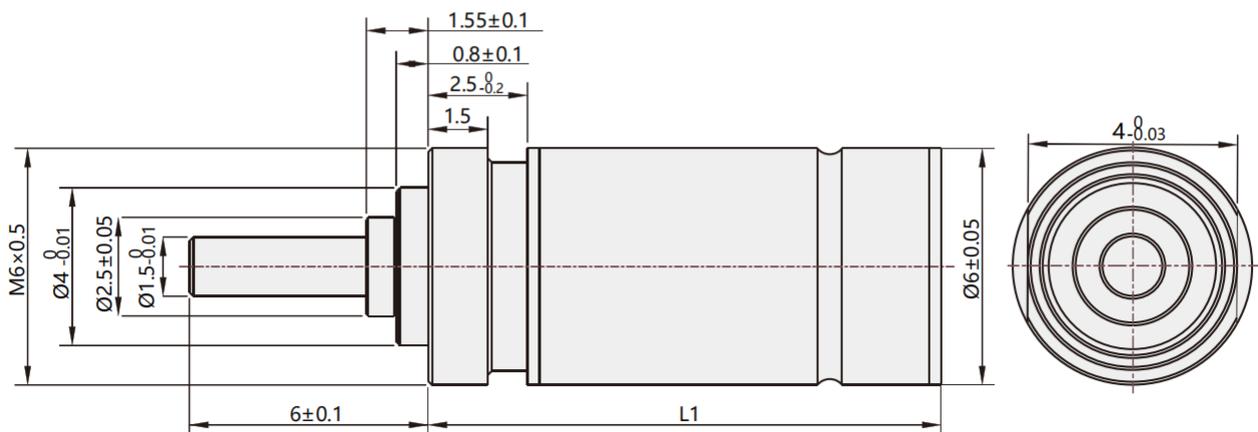
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

	Unit	1	2	3	4	5
Number of stages		1	2	3	4	5
Reduction	N:1	3.9	15	59	231	902
Max.transmittable continuous power	W	0.63	0.39	0.20	0.15	0.04
Max.transmittable intermittent power	W	0.79	0.49	0.25	0.18	0.05
Max.continuous torque	Nm	0.002	0.005	0.010	0.030	0.030
Max.intermittent torque	Nm	0.005	0.010	0.020	0.060	0.060
Max.continuous input speed	rpm	40,000	40,000	40,000	40,000	40,000
Max.intermittent input speed	rpm	40,000	40,000	40,000	40,000	40,000
Max. efficiency	%	88	77	68	60	52
Average backlash at no load	°	1.8	2.0	2.2	2.5	2.8
Max.axial load (dynamic)	N	5	5	5	5	5
Max.radial load (5 mm from flange)	N	5	6	7	8	8
Gearbox length L1	mm	8.1	10.5	12.9	15.3	17.7
Weight	g	1.7	2.1	2.5	2.9	3.3

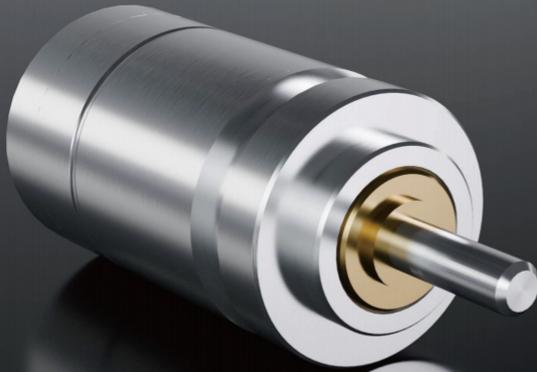
OUTLINE DRAWING



PG08 ϕ 8mm Series Micro Planetary Gearbox

Key Data: 0.04-0.84 W, 59-90%, 12,000 rpm

Standard Version



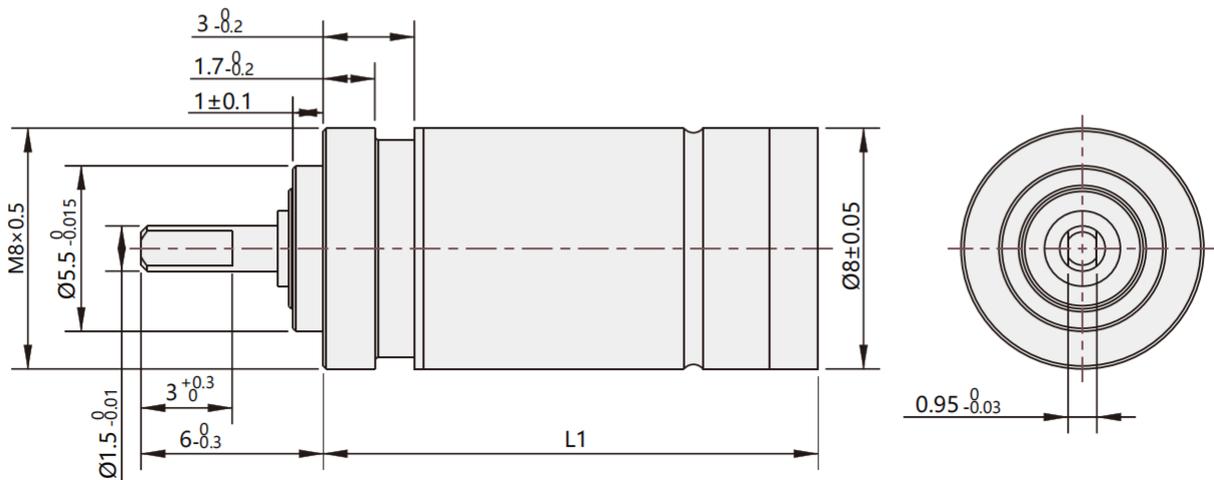
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +80°C

GEARBOX SPECIFICATION

	Unit	1	2	3	4	5
Number of stages		1	2	3	4	5
Reduction	N:1	3.9	15	59	231	902
Max.transmittable continuous power	W	0.84	0.52	0.39	0.13	0.04
Max.transmittable intermittent power	W	1.05	0.65	0.49	0.16	0.05
Max.continuous torque	Nm	0.01	0.02	0.06	0.08	0.10
Max.intermittent torque	Nm	0.015	0.030	0.090	0.120	0.150
Max.continuous input speed	rpm	12,000	12,000	12,000	12,000	12,000
Max.intermittent input speed	rpm	20,000	20,000	20,000	20,000	20,000
Max. efficiency	%	90	81	73	65	59
Average backlash at no load	°	1.8	2.0	2.2	2.5	2.8
Max.axial load (dynamic)	N	5	5	5	5	5
Max.radial load (5 mm from flange)	N	5	6	7	8	8
Gearbox length L1	mm	10.2	13.3	16.3	19.3	22.3
Weight	g	2.6	3.2	3.8	4.4	5.0

OUTLINE DRAWING



PG10 ϕ 10mm Series Micro Planetary Gearbox

Key Data: 0.1-1.6 W, 55-90%, 12,000 rpm

Standard Version



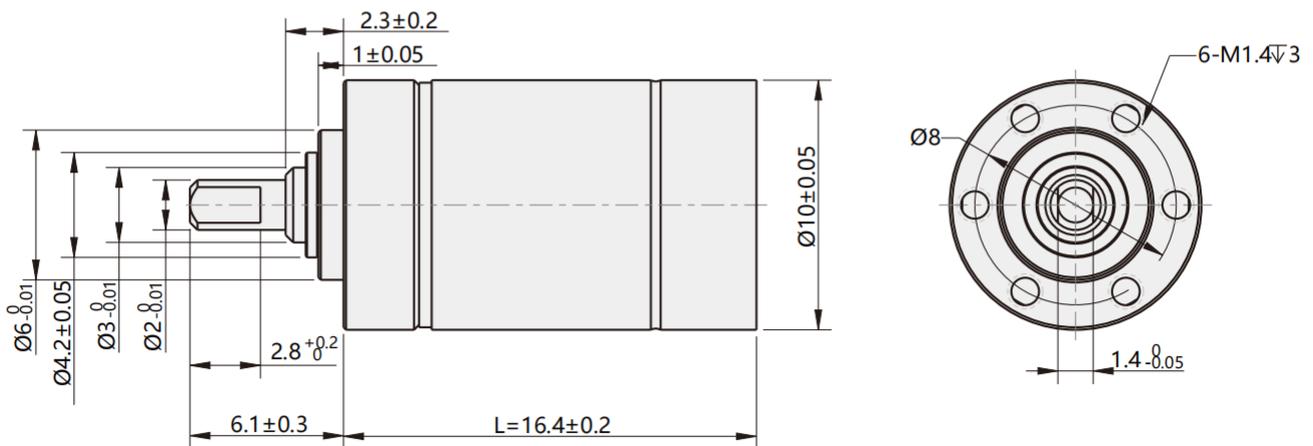
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +80°C

GEARBOX SPECIFICATION

	Unit	1	2	3	4	5
Number of stages		1	2	3	4	5
Reduction	N:1	4	16	64	256	1024
Max.transmittable continuous power	W	1.6	1.2	1.0	0.4	0.1
Max.transmittable intermittent power	W	2.0	1.5	1.3	0.5	0.2
Max.continuous torque	Nm	0.05	0.10	0.15	0.20	0.25
Max.intermittent torque	Nm	0.10	0.15	0.20	0.25	0.30
Max.continuous input speed	rpm	12,000	12,000	12,000	12,000	12,000
Max.intermittent input speed	rpm	15,000	15,000	15,000	15,000	15,000
Max. efficiency	%	90	81	73	65	55
Average backlash at no load	°	1.5	1.8	2.0	2.2	2.5
Max.axial load (dynamic)	N	5	5	5	5	5
Max.radial load (5 mm from flange)	N	5	10	15	20	25
Gearbox length L1	mm	11.0	14.2	17.3	20.5	23.5
Weight	g	6.7	7.2	7.7	8.2	8.7

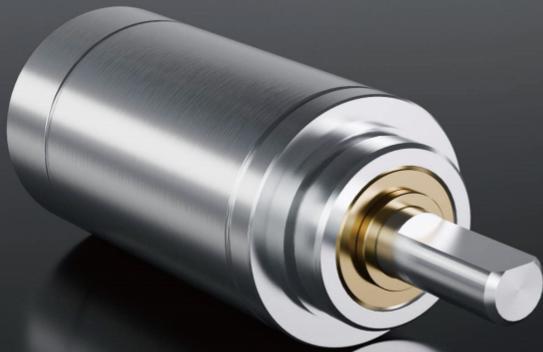
OUTLINE DRAWING



PG11 ϕ 11mm Series Micro Planetary Gearbox

Key Data: 0.4-1.6 W, 65-90%, 12,000 rpm

Standard Version



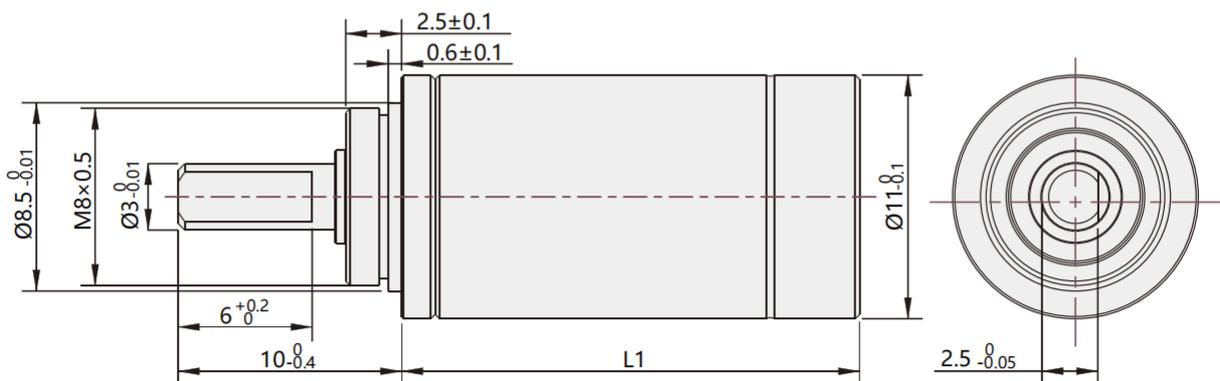
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3	4
Reduction	N:1	3.5/4.3	12/15/18	43/53/66/81	150/186/230 285/352
Max.transmittable continuous power	W	1.6	1.2	1.0	0.4
Max.transmittable intermittent power	W	2.0	1.5	1.3	0.5
Max.continuous torque	Nm	0.10	0.10	0.12	0.15
Max.intermittent torque	Nm	0.15	0.15	0.18	0.20
Max.continuous input speed	rpm	12,000	12,000	12,000	12,000
Max.intermittent input speed	rpm	15,000	15,000	15,000	15,000
Max. efficiency	%	90	81	73	65
Average backlash at no load	°	1.5	1.8	2.0	2.2
Max.axial load (dynamic)	N	5	5	5	5
Max.radial load (5 mm from flange)	N	5	10	15	20
Gearbox length L1	mm	11.0	14.2	17.3	20.5
Weight	g	6.7	7.2	7.7	8.2

OUTLINE DRAWING



PG12 ϕ 12mm Series Micro Planetary Gearbox

Key Data: 0.25-2.0 W, 65-90%, 16,000 rpm

Standard Version



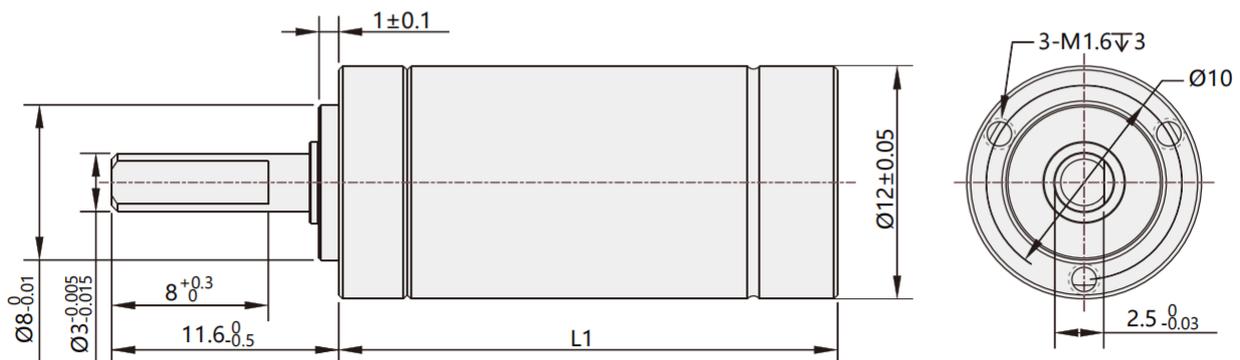
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3	4
Reduction	N:1	3.7/4.2/5	13.4/17.6/18.3 21/25	49/56/65 67/74/77 88/105	180/207/237/246 272/282/311/323 336/370/385/411 458/525
Max.transmittable continuous power	W	2.0	1.0	0.5	0.25
Max.transmittable intermittent power	W	2.5	1.25	0.65	0.30
Max.continuous torque	Nm	0.08	0.11	0.14	0.17
Max.intermittent torque	Nm	0.10	0.14	0.18	0.21
Max.continuous input speed	rpm	16,000	16,000	16,000	16,000
Max.intermittent input speed	rpm	20,000	20,000	20,000	20,000
Max. efficiency	%	90	80	75	65
Average backlash at no load	°	1.2	1.5	1.8	2.1
Max.axial load (dynamic)	N	20	20	20	20
Max.radial load (5 mm from flange)	N	30	35	50	50
Gearbox length L1	mm	15.6	21.0	25.5	30.1
Weight	g	11	14	18	22

OUTLINE DRAWING



PG13 ϕ 13mm Series Micro Planetary Gearbox

Key Data: 2-22 W, 65-85%, 30,000 rpm

Standard Version



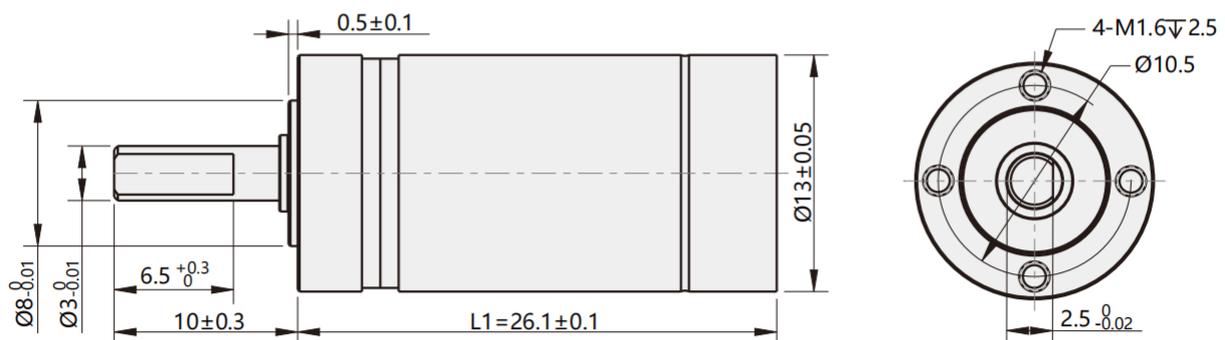
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

	Unit	1	2	3	4
Number of stages		1	2	3	4
Reduction	N:1	5	25	125	625
Max.transmittable continuous power	W	22	11	6	2
Max.transmittable intermittent power	W	27	13	7	3
Max.continuous torque	Nm	0.10	0.20	0.25	0.30
Max.intermittent torque	Nm	0.15	0.25	0.30	0.35
Max.continuous input speed	rpm	30,000	30,000	30,000	30,000
Max.intermittent input speed	rpm	40,000	40,000	40,000	40,000
Max. efficiency	%	85	80	70	65
Average backlash at no load	°	1.2	1.4	1.6	1.8
Max.axial load (dynamic)	N	20	20	20	20
Max.radial load (5 mm from flange)	N	10	15	25	30
Gearbox length L1	mm	16.6	21.3	26.1	31.0
Weight	g	14	19	21	25

OUTLINE DRAWING



PG14 ϕ 14mm Series Micro Planetary Gearbox

Key Data: 0.4-4.0 W, 65-90%, 14,000-16,000 rpm

Standard Version



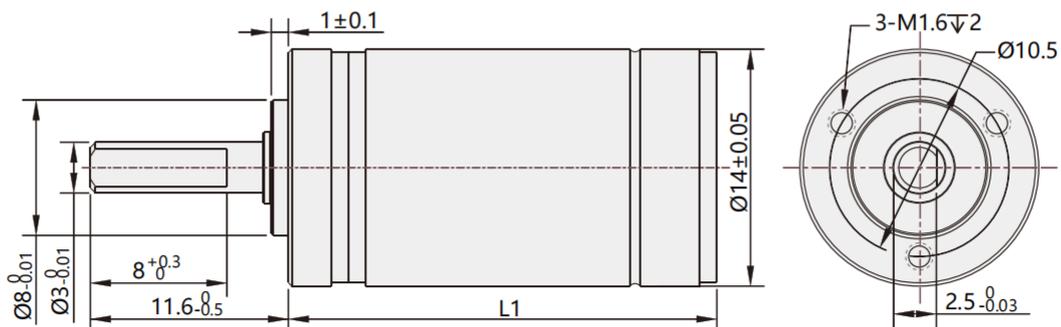
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3	4
Reduction	N:1	3.9/5.3/6.6	16/21/26 28/35	62/83/103 111/138/150 172/186/231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	4.0	2.0	1.0	0.4
Max.transmittable intermittent power	W	5.0	2.5	1.3	0.5
Max.continuous torque	Nm	0.16	0.20	0.25	0.30
Max.intermittent torque	Nm	0.20	0.25	0.31	0.38
Max.continuous input speed	rpm	14,000	16,000	16,000	16,000
Max.intermittent input speed	rpm	17,500	20,000	20,000	20,000
Max. efficiency	%	90	80	75	65
Average backlash at no load	°	1.1	1.3	1.5	1.7
Max.axial load (dynamic)	N	20	20	20	20
Max.radial load (5 mm from flange)	N	30	45	60	60
Gearbox length L1	mm	15.7	20.8	25.1	29.3
Weight	g	14	19	21	23

OUTLINE DRAWING



PG16 ϕ 16mm Series Micro Planetary Gearbox

Key Data: 0.6-6.5 W, 65-90%, 12,000-16,000 rpm

Standard Version



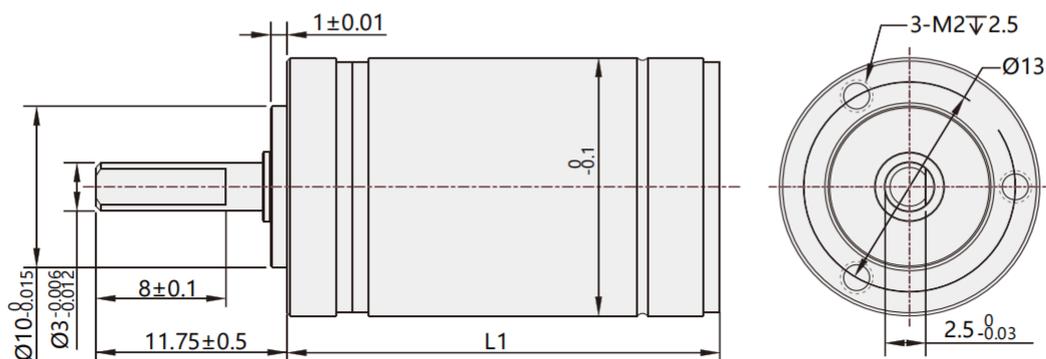
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	2	3
Reduction	N:1	3.9/5.3/6.6	16/21/26 28/35/44	62/83/103/111 138/150/172/186 231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	6.5	3.2	1.6	0.6
Max.transmittable intermittent power	W	8.0	4.0	2.0	0.75
Max.continuous torque	Nm	0.20	0.25	0.35	0.45
Max.intermittent torque	Nm	0.25	0.35	0.45	0.55
Max.continuous input speed	rpm	12,000	14,000	16,000	16,000
Max.intermittent input speed	rpm	15,000	17,500	20,000	20,000
Max. efficiency	%	90	80	75	65
Average backlash at no load	°	1.0	1.2	1.3	1.4
Max.axial load (dynamic)	N	20	20	20	20
Max.radial load (5 mm from flange)	N	30	45	70	70
Gearbox length L1	mm	16.1	22.0	26.6	31.1
Weight	g	20	25	27	31

OUTLINE DRAWING



PG19 ϕ 19mm Series Micro Planetary Gearbox

Key Data: 0.9-13.0 W, 65-90%, 10,000-14,000 rpm

Standard Version



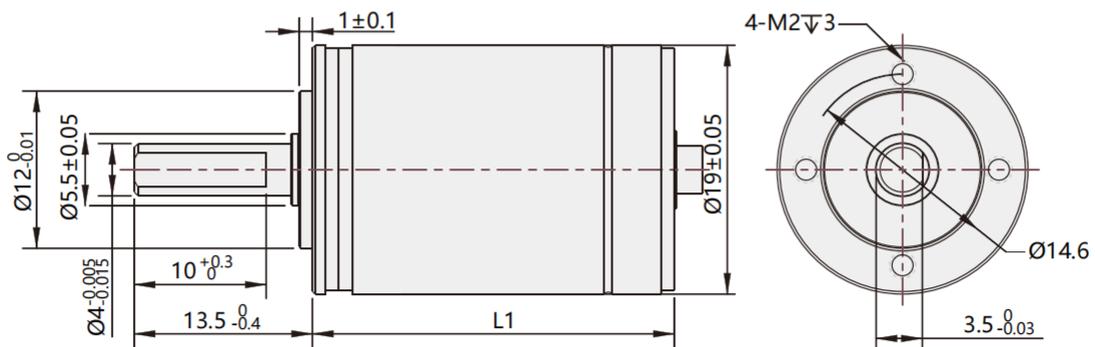
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3	4
Reduction	N:1	3.9/5.3/6.6	16/21/26 28/35	62/83/103/111 138/150/172/186 231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	13.0	6.5	3.2	0.9
Max.transmittable intermittent power	W	16.2	8.1	4.1	1.1
Max.continuous torque	Nm	0.35	0.45	0.65	0.80
Max.intermittent torque	Nm	0.45	0.55	0.80	1.00
Max.continuous input speed	rpm	10,000	12,000	14,000	14,000
Max.intermittent input speed	rpm	12,500	15,000	17,500	17,500
Max. efficiency	%	90	80	75	65
Average backlash at no load	°	0.9	1.2	1.3	1.4
Max.axial load (dynamic)	N	40	40	40	40
Max.radial load (5 mm from flange)	N	50	80	90	90
Gearbox length L1	mm	16.8	22.3	27.4	36.4
Weight	g	30	40	43	55

OUTLINE DRAWING



PG22 ϕ 22mm Series Micro Planetary Gearbox

Standard Version

Key Data: 1.6-24.0 W, 66-90%, 8,000-12,000 rpm

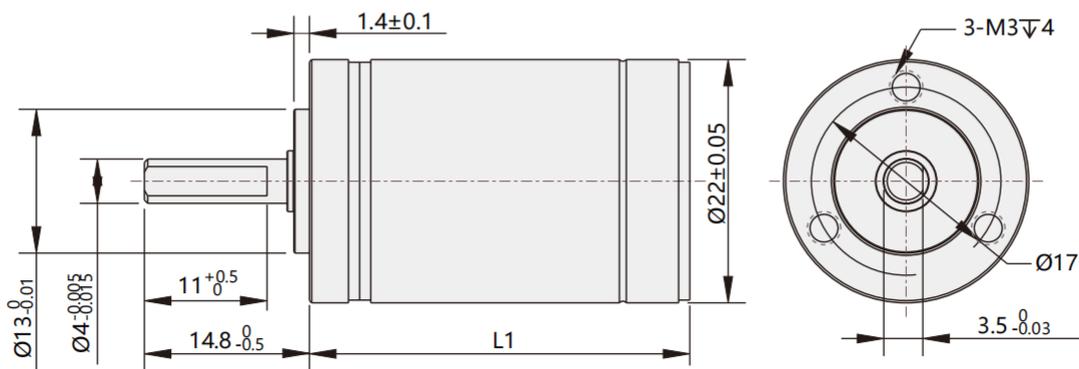


CONFIGURATION	
Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3	4
Reduction	N:1	3.9/5.3/6.6	16/21/26 28/35/44	62/83/103/111 138/150/172/186 231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	24.0	12.0	6.0	1.6
Max.transmittable intermittent power	W	30.0	15.0	7.5	2.0
Max.continuous torque	Nm	0.50	0.70	1.20	1.50
Max.intermittent torque	Nm	0.60	0.90	1.50	1.90
Max.continuous input speed	rpm	8,000	10,000	12,000	12,000
Max.intermittent input speed	rpm	10,000	12,500	15,000	15,000
Max. efficiency	%	90	81	74	66
Average backlash at no load	°	0.9	1.1	1.2	1.4
Max.axial load (dynamic)	N	40	40	40	40
Max.radial load (5 mm from flange)	N	65	100	120	120
Gearbox length L1	mm	21.0	27.5	34.1	43.7
Weight	g	45	58	67	89

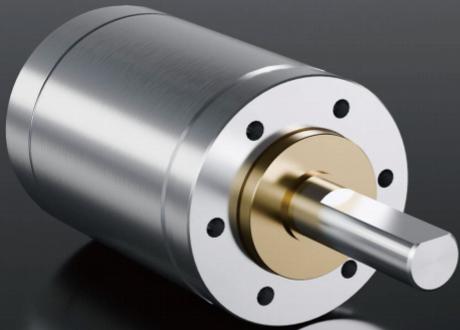
OUTLINE DRAWING



PG26 ϕ 26mm Series Micro Planetary Gearbox

Key Data: 12.0-48.0 W, 75-90%, 7,000-10,000 rpm

Standard Version



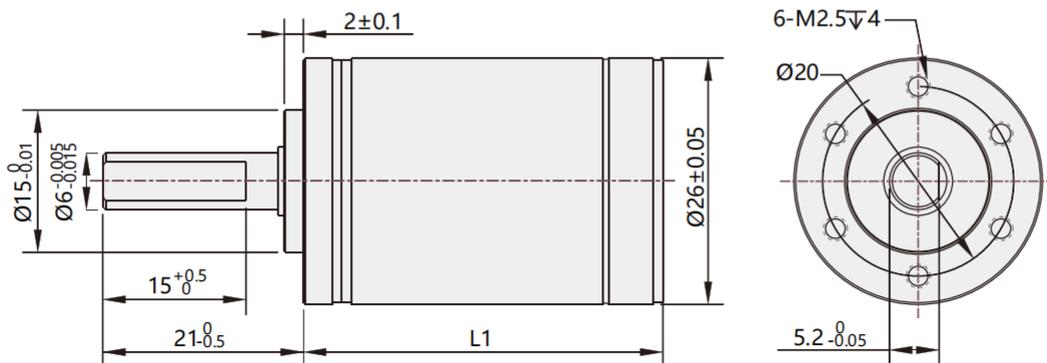
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3
Reduction	N:1	3.9/5.3/6.6	16/21/26 28/35	62/83/103 111/138/150 172/186/231
Max.transmittable continuous power	W	48.0	24.0	12.0
Max.transmittable intermittent power	W	60.0	30.0	15.0
Max.continuous torque	Nm	0.75	2.25	4.50
Max.intermittent torque	Nm	1.10	3.20	6.20
Max.continuous input speed	rpm	7,000	8,000	10,000
Max.intermittent input speed	rpm	8,750	10,000	12,500
Max. efficiency	%	90	78	75
Average backlash at no load	°	0.75	0.95	1.1
Max.axial load (dynamic)	N	80	80	80
Max.radial load (5 mm from flange)	N	95	145	150
Gearbox length L1	mm	23.0	30.3	37.6
Weight	g	75	95	105

OUTLINE DRAWING



PG28 ϕ 26mm Series Micro Planetary Gearbox

Key Data: 8.0-100.0 W, 65-90%, 6,000-7,000 rpm

Standard Version



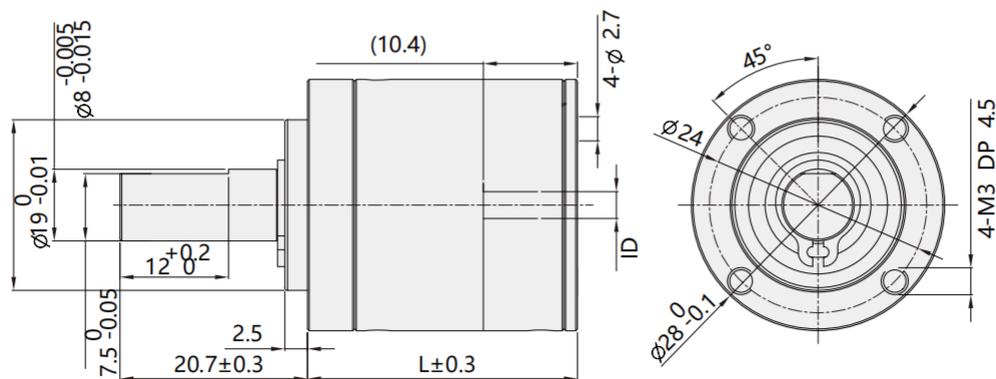
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3	4
Reduction	N:1	3.9/5.3/6.6	16/21/26/28 35	62/83/103 111/138/150 172/186/231	243/326/406 439/546/590 679/734/794
Max.transmittable continuous power	W	100.0	50.0	25.0	8.0
Max.transmittable intermittent power	W	125	62.0	31.0	10.0
Max.continuous torque	Nm	1.25	2.90	5.00	5.00
Max.intermittent torque	Nm	1.60	3.60	6.30	6.30
Max.continuous input speed	rpm	6,000	7,000	7,000	7,000
Max.intermittent input speed	rpm	7,500	8,750	8,750	8,750
Max. efficiency	%	90	81	72	65
Average backlash at no load	°	0.5	0.6	0.7	0.75
Max.axial load (dynamic)	N	100	100	100	100
Max.radial load (5 mm from flange)	N	170	160	160	150
Gearbox length L1	mm	24.2	36.9	43.5	50.2
Weight	g	103	150	174	198

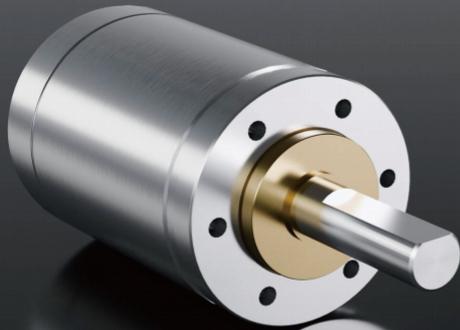
OUTLINE DRAWING



PG32 ϕ 32mm Series Micro Planetary Gearbox

Standard Version

Key Data: 25.0-100.0 W, 75-90%, 6,000-8,000 rpm



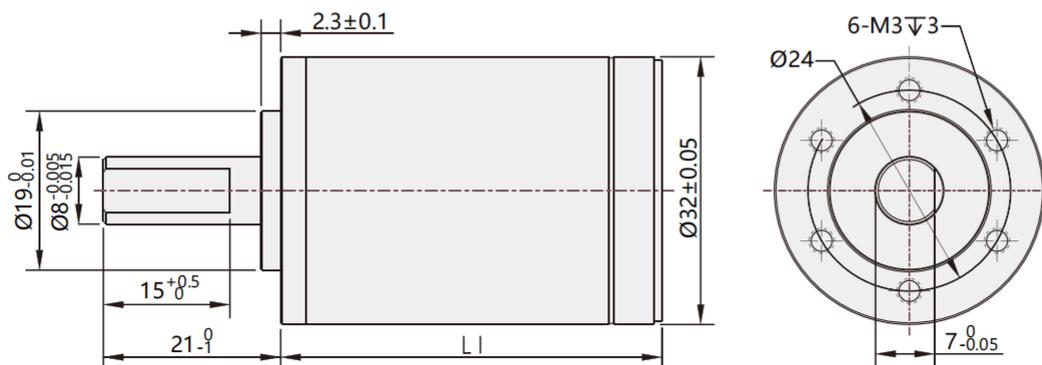
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3
Reduction	N:1	3.9/5.3/6.6	16/21/26 28/35	62/83/103 111/138/150 172/186/231
Max.transmittable continuous power	W	100.0	50.0	25.0
Max.transmittable intermittent power	W	125.0	62.0	31.0
Max.continuous torque	Nm	1.25	2.90	5.00
Max.intermittent torque	Nm	1.60	3.60	6.25
Max.continuous input speed	rpm	6,000	7,000	8,000
Max.intermittent input speed	rpm	7,500	8,750	10,000
Max. efficiency	%	90	78	75
Average backlash at no load	°	0.6	0.7	0.9
Max.axial load (dynamic)	N	110	110	110
Max.radial load (5 mm from flange)	N	160	180	180
Gearbox length L1	mm	26.8	36.1	45.2
Weight	g	140	185	230

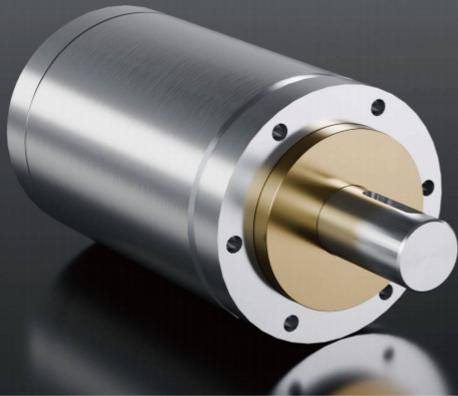
OUTLINE DRAWING



PG37 ϕ 37mm Series Micro Planetary Gearbox

Standard Version

Key Data: 20.0-185.0 W, 70-90%, 5,000-8,000 rpm

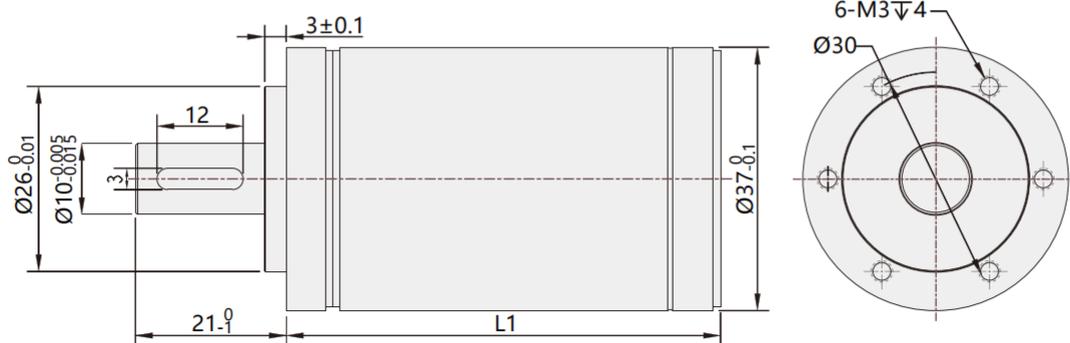


CONFIGURATION	
Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3	4
Reduction	N:1	3.9/5.3/6.6	16/21/26 28/35	62/83/103/111 138/150/172 186/231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	185.0	90.0	45.0	20.0
Max.transmittable intermittent power	W	230.0	115.0	60.0	30.0
Max.continuous torque	Nm	5.00	8.00	12.00	15.00
Max.intermittent torque	Nm	10.00	15.00	20.00	25.00
Max.continuous input speed	rpm	5,000	6,000	7,000	8,000
Max.intermittent input speed	rpm	6,250	7,500	8,750	9,500
Max. efficiency	%	90	80	75	70
Average backlash at no load	°	0.5	0.6	0.7	0.8
Max.axial load (dynamic)	N	240	240	240	240
Max.radial load (5 mm from flange)	N	200	250	250	250
Gearbox length L1	mm	35.4	48.3	60.5	73.0
Weight	g	260	340	410	480

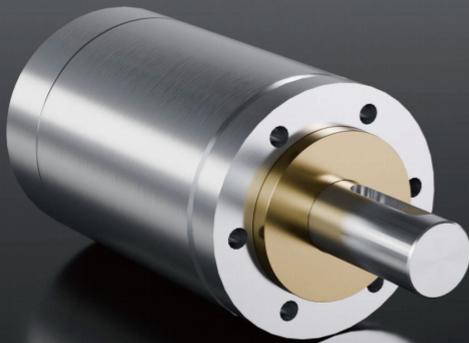
OUTLINE DRAWING



PG42 ϕ 42mm Series Micro Planetary Gearbox

Key Data: 20.0-580.0 W, 64-90%, 8,000 rpm

Standard Version



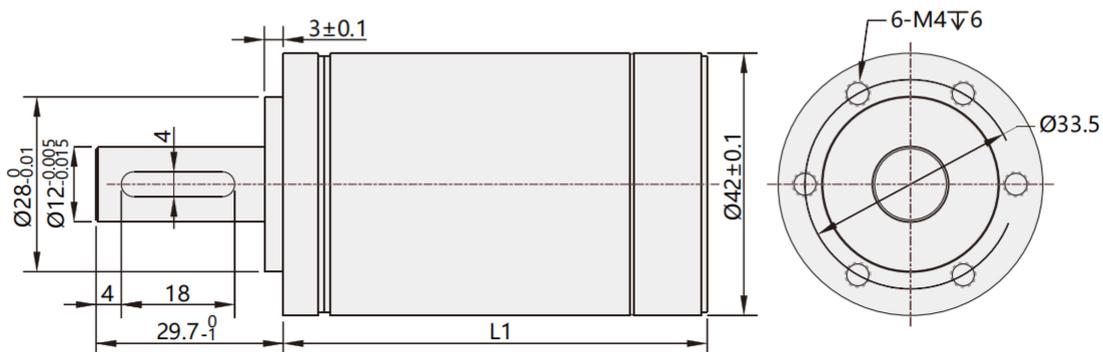
CONFIGURATION

Version	Standard Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3	4
Reduction	N:1	3.9/5.3/6.6	16/21/26 28/35	62/83/103/111 138/150/172 186/231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	580.0	240.0	100.0	20.0
Max.transmittable intermittent power	W	725.0	300.0	125.0	25.0
Max.continuous torque	Nm	8.00	12.00	15.00	20.00
Max.intermittent torque	Nm	15.00	20.00	25.00	30.00
Max.continuous input speed	rpm	8,000	8,000	8,000	8,000
Max.intermittent input speed	rpm	10,000	10,000	10,000	10,000
Max. efficiency	%	90	81	72	64
Average backlash at no load	°	0.6	0.8	1.0	1.0
Max.axial load (dynamic)	N	150	150	150	150
Max.radial load (5 mm from flange)	N	120	240	360	360
Gearbox length L1	mm	40.0	53.8	67.3	80.9
Weight	g	460	500	620	720

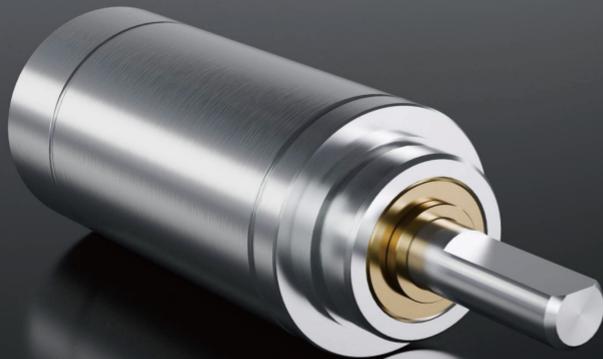
OUTLINE DRAWING



PA12 ϕ 12mm Series Micro Planetary Gearbox

Key Data: 0.6-2.2 W, 55-75%, 16,000 rpm

Plus Version



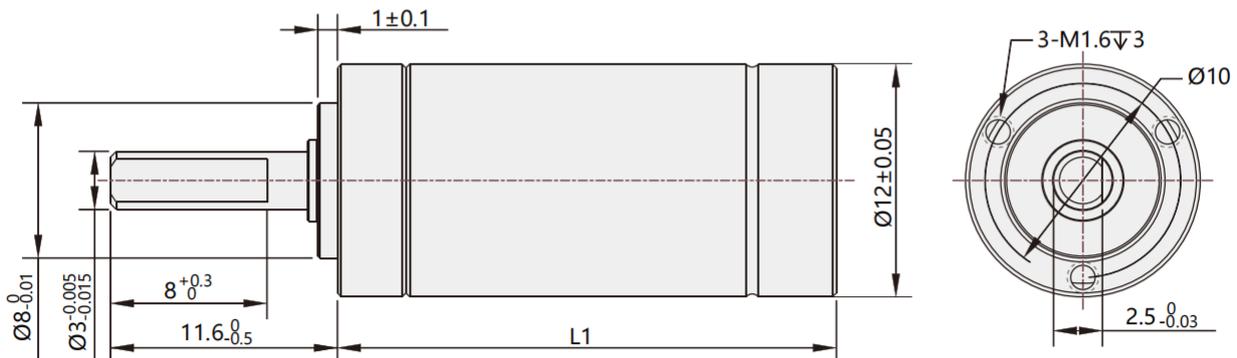
CONFIGURATION

Version	Plus Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3
Reduction	N:1	13.4/17.6/18.3 21/25	49/56/65 67/74/77 88/105	180/207/237/246 272/282/311/323 336/370/385/411 458/525
Max.transmittable continuous power	W	2.2	1.1	0.6
Max.transmittable intermittent power	W	2.8	1.4	0.8
Max.continuous torque	Nm	0.25	0.3	0.35
Max.intermittent torque	Nm	0.30	0.38	0.41
Max.continuous input speed	rpm	16,000	16,000	16,000
Max.intermittent input speed	rpm	20,000	20,000	20,000
Max. efficiency	%	75	65	55
Average backlash at no load	°	1.5	1.8	2.1
Max.axial load (dynamic)	N	20	20	20
Max.radial load (5 mm from flange)	N	45	60	60
Gearbox length L1	mm	23.2	28.0	32.5
Weight	g	16	19	21

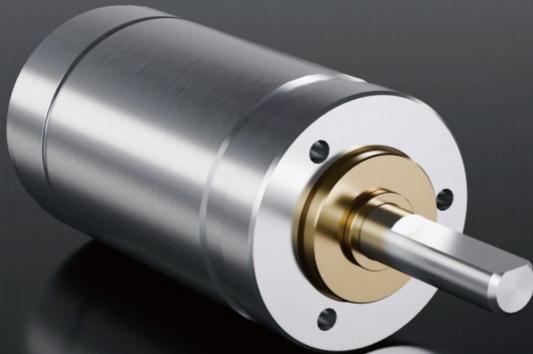
OUTLINE DRAWING



PA14 ϕ 14mm Series Micro Planetary Gearbox

Plus Version

Key Data: 0.7-4.0 W, 55-75%, 14,000-16,000 rpm



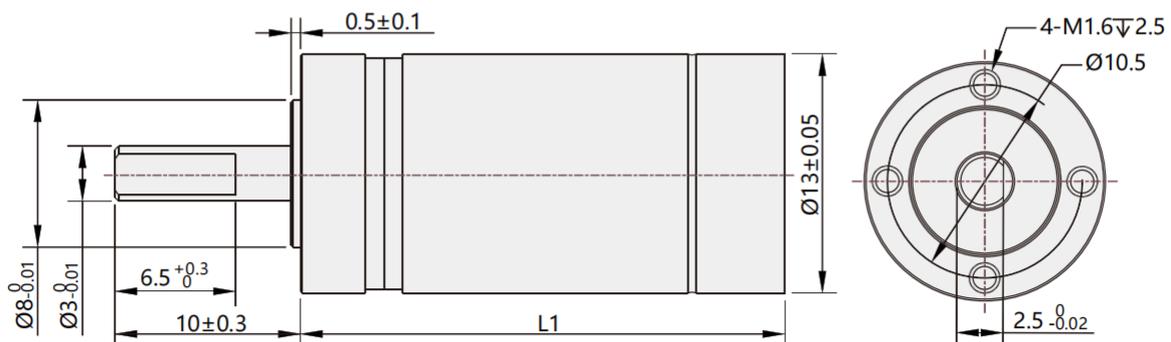
CONFIGURATION

Version	Plus Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3
Reduction	N:1	16/21/26 28/35	62/83/103/111 138/150/172/186 231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	4.0	2.0	0.7
Max.transmittable intermittent power	W	5.0	2.5	1.0
Max.continuous torque	Nm	0.30	0.40	0.50
Max.intermittent torque	Nm	0.40	0.50	0.60
Max.continuous input speed	rpm	14,000	16,000	16,000
Max.intermittent input speed	rpm	17,500	20,000	20,000
Max. efficiency	%	75	65	55
Average backlash at no load	°	1.3	1.5	1.7
Max.axial load (dynamic)	N	20	20	20
Max.radial load (5 mm from flange)	N	45	70	70
Gearbox length L1	mm	24.4	29.3	34.1
Weight	g	21	25	27

OUTLINE DRAWING



PA16 ϕ 16mm Series Micro Planetary Gearbox

Plus Version

Key Data: 1.5-8.0 W, 55-75%, 12,000-16,000 rpm



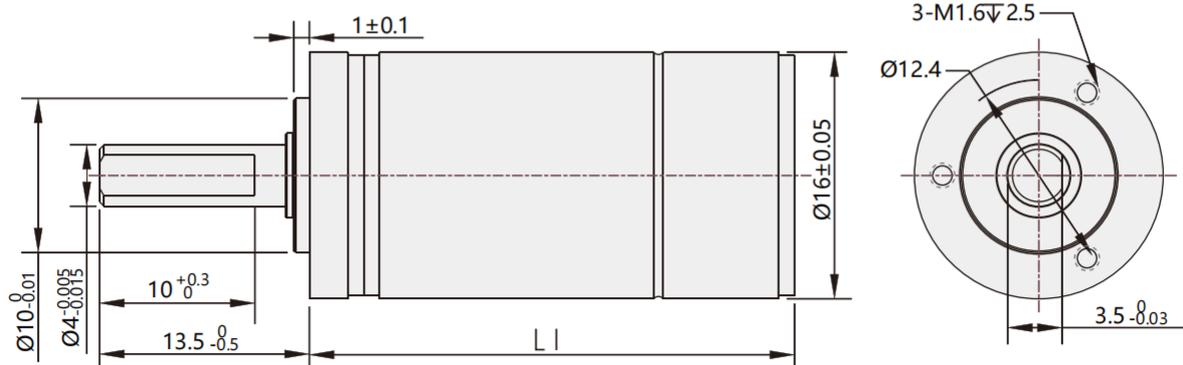
CONFIGURATION

Version	Plus Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3
Reduction	N:1	16/21/26 28/35/44	62/83/103/111 138/150/172/186 231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	8.0	4.0	1.5
Max.transmittable intermittent power	W	10.0	4.40	1.5
Max.continuous torque	Nm	0.55	0.80	0.90
Max.intermittent torque	Nm	0.70	1.00	1.10
Max.continuous input speed	rpm	12,000	14,000	16,000
Max.intermittent input speed	rpm	15,000	17,500	20,000
Max. efficiency	%	75	65	55
Average backlash at no load	°	1.2	1.3	1.4
Max.axial load (dynamic)	N	30	30	30
Max.radial load (5 mm from flange)	N	80	90	90
Gearbox length L1	mm	26.0	31.2	36.4
Weight	g	31	35	39

OUTLINE DRAWING



PA19 ϕ 19mm Series Micro Planetary Gearbox

Key Data: 2.0-15.0 W, 55-75%, 10,000-14,000 rpm

Plus Version



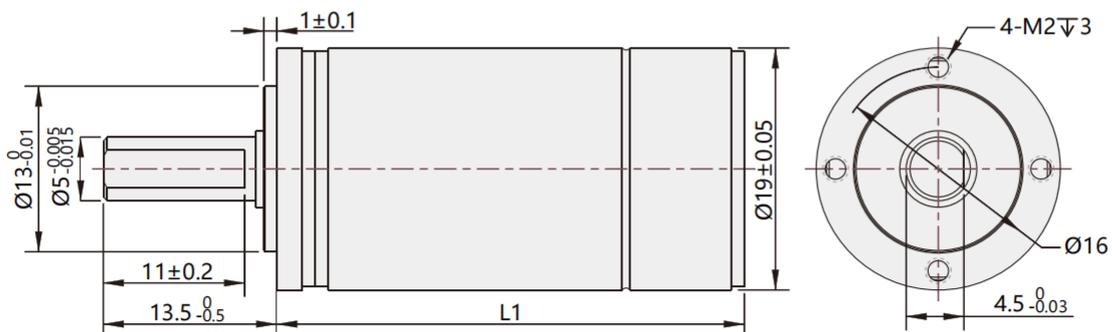
CONFIGURATION

Version	Plus Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3
Reduction	N:1	16/21/26 28/35	62/83/103/111 138/150/172/186 231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	15.0	7.0	2.0
Max.transmittable intermittent power	W	19.0	9.0	3.0
Max.continuous torque	Nm	0.90	1.60	2.00
Max.intermittent torque	Nm	1.15	2.00	2.50
Max.continuous input speed	rpm	10,000	12,000	14,000
Max.intermittent input speed	rpm	12,500	15,000	17,500
Max. efficiency	%	75	65	55
Average backlash at no load	°	1.2	1.3	1.4
Max.axial load (dynamic)	N	40	40	40
Max.radial load (5 mm from flange)	N	100	120	120
Gearbox length L1	mm	30.8	36.4	42.0
Weight	g	51	61	63

OUTLINE DRAWING



PA22 ϕ 22mm Series Micro Planetary Gearbox

Key Data: 2.0-15.0 W, 55-75%, 10,000-14,000 rpm

Plus Version



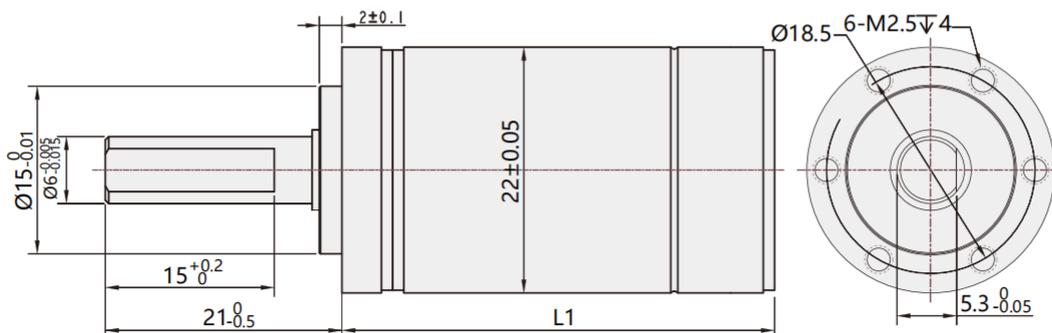
CONFIGURATION

Version	Plus Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3
Reduction	N:1	16/21/26 28/35/44	62/83/103/111 138/150/172/186 231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	15.0	7.0	2.0
Max.transmittable intermittent power	W	19.0	9.0	3.0
Max.continuous torque	Nm	0.90	1.60	2.00
Max.intermittent torque	Nm	1.15	2.00	2.50
Max.continuous input speed	rpm	10,000	12,000	14,000
Max.intermittent input speed	rpm	12,500	15,000	17,500
Max. efficiency	%	75	65	55
Average backlash at no load	°	1.2	1.3	1.4
Max.axial load (dynamic)	N	40	40	40
Max.radial load (5 mm from flange)	N	100	120	120
Gearbox length L1	mm	31.8	38.4	45.0
Weight	g	51	61	63

OUTLINE DRAWING



PA26 ϕ 26mm Series Micro Planetary Gearbox

Plus Version

Key Data: 15.0-60.0 W, 55-75%, 7,000-10,000 rpm



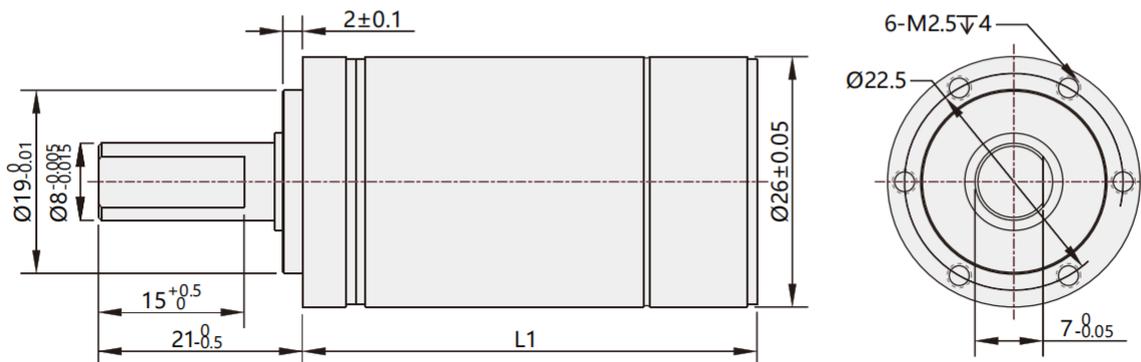
CONFIGURATION

Version	Plus Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3
Reduction	N:1	16/21/26 28/35/44	62/83/103 111/138/150 172/186/231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	60.0	30.0	15.0
Max.transmittable intermittent power	W	75.0	40.0	20.0
Max.continuous torque	Nm	3.00	5.00	6.30
Max.intermittent torque	Nm	4.00	7.00	8.00
Max.continuous input speed	rpm	7,000	8,000	10,000
Max.intermittent input speed	rpm	8,750	10,000	12,500
Max. efficiency	%	75	65	55
Average backlash at no load	°	0.95	1.1	1.3
Max.axial load (dynamic)	N	110	110	110
Max.radial load (5 mm from flange)	N	180	180	180
Gearbox length L1	mm	39.5	46.8	54.0
Weight	g	122	144	153

OUTLINE DRAWING



PA32 ϕ 32mm Series Micro Planetary Gearbox

Key Data: 18.0-110.0 W, 55-76%, 6,000-8,000 rpm

Plus Version



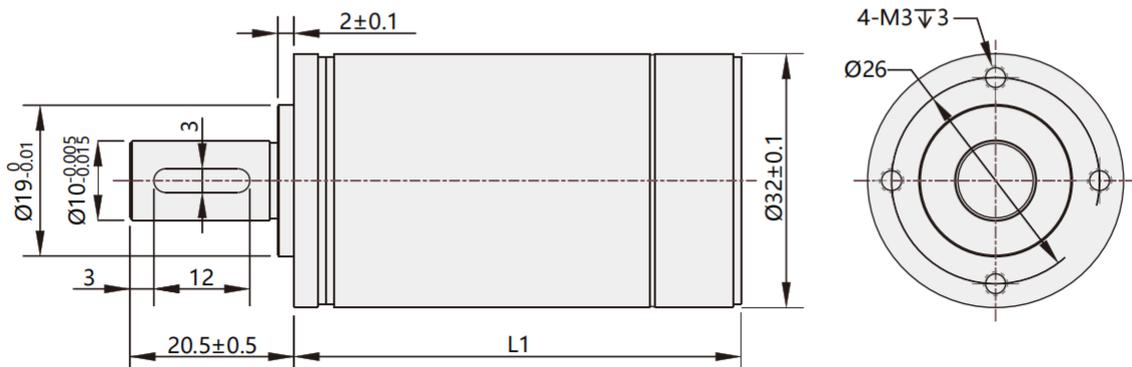
CONFIGURATION

Version	Plus Version
Flange	Standard flange/ configurable flange
Output shaft	Stainless Steel/ configurable shaft
Bearing at output	Ball bearing
Ambient temperature	-40°C ~ +100°C

GEARBOX SPECIFICATION

Number of stages	Unit	1	2	3
Reduction	N:1	16/21/26 28/35	62/83/103/111 138/150/172 186/231	243/326/406/439 546/590/679/734 794/913/987/1135 1227/1526
Max.transmittable continuous power	W	110.0	55.0	18.0
Max.transmittable intermittent power	W	140.0	70.0	25.0
Max.continuous torque	Nm	4.00	8.00	9.00
Max.intermittent torque	Nm	6.00	10.00	12.00
Max.continuous input speed	rpm	6,000	7,000	8,000
Max.intermittent input speed	rpm	7,500	8,750	10,000
Max. efficiency	%	76	65	55
Average backlash at no load	°	0.7	0.9	1.1
Max.axial load (dynamic)	N	110	110	110
Max.radial load (5 mm from flange)	N	200	250	250
Gearbox length L1	mm	44.1	55.9	67.6
Weight	g	200	220	250

OUTLINE DRAWING





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