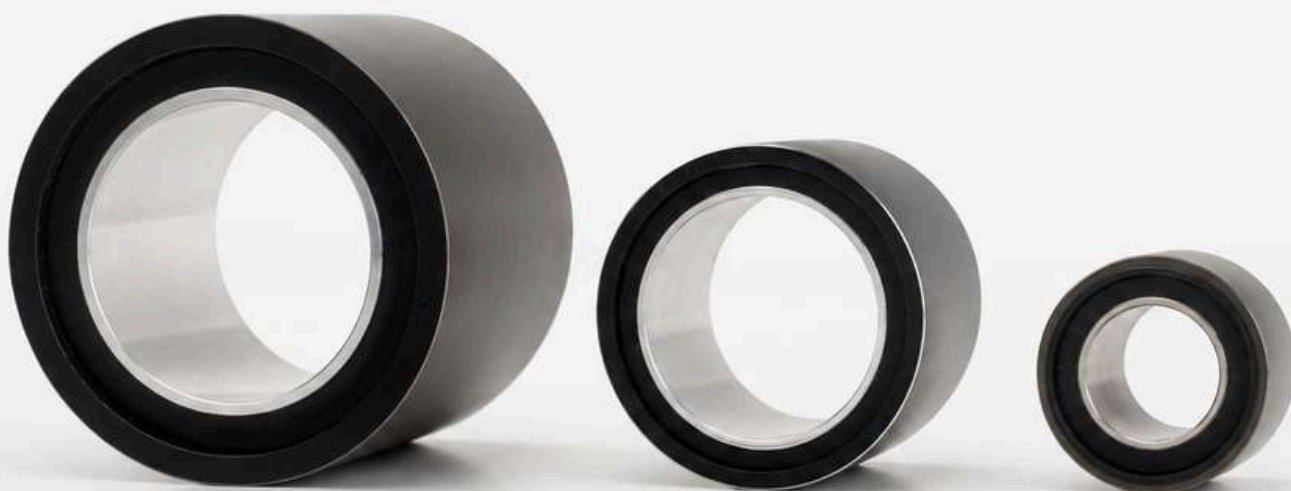


Product Catalog

GearTorq™ Motors

Extreme Torque Density



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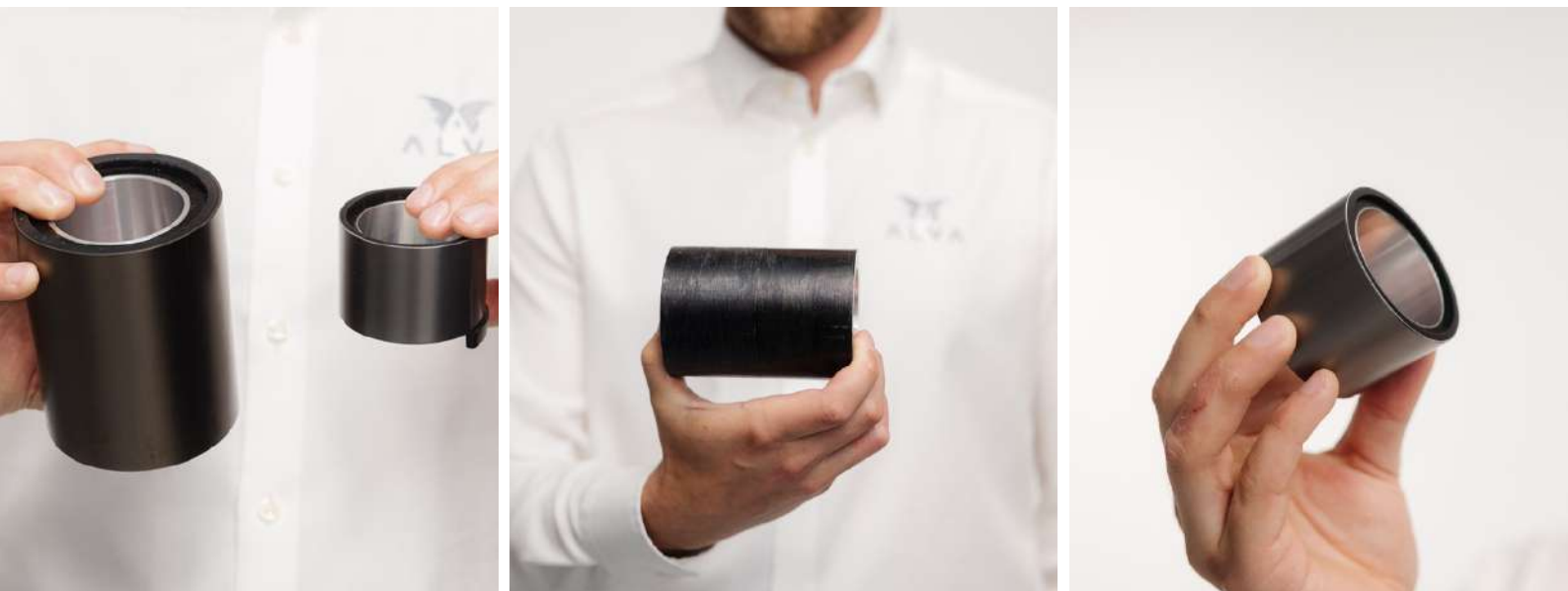


About Us

Purpose & mission

In Alva, we envision a world where everyone enjoys a high standard of living, made possible through universal access to energy and human-centered technology.

Our purpose is to create affordable, energy-efficient motors and generators that improve lives and protect the planet.



Safety & reliability by design

We direct our passion for electric solutions into every product & system that leaves our production facility. With complete control of the entire value chain, we monitor every component all the way from design to finished product, with full traceability along the way. We design our motors with safety & reliability as our leading design criteria. This way, you can focus on what really matters, & rest assured that your Alva system will perform in any & all conditions.

Our Origin

Alva was founded in 2017 in Trondheim, Norway, starting as a passion project in our founder Jørgen Selnes' garage. What began as an idea to rethink electric motor technology has grown into a dedicated company focused on pushing the boundaries of what electric motors can achieve. With a strong foundation of innovation & collaboration, we continue to develop groundbreaking solutions that meet the evolving needs of various industries.

Industries & Applications

Powering the Future

At Alva, we're pioneering electrification with innovative motor technology, driving sustainable transformation within aerospace, defence & robotics. With FiberPrinting™ technology, we engineer the reliability & efficiency to propel industries forward.



Aerospace

With Alva's FiberPrinting™ slotless motors, high torque density actuators for aerospace applications can be realized. Reducing weight, increasing performance and delivering smooth motion and increased dynamic behaviour.

Defence

Alva motors designed for defence & heavy-duty equipment, will offer high torque, lightweight designs, compact integration & low power usage for critical applications in dynamic environments.

Medical robots and devices.

High torque density, compact and efficient motors boost Medical robots and devices by maximizing throughput in tight spaces. Alva's slotless motors ensure precise and cogging free motion, reducing energy and maintenance costs.

Stabilized Platforms

With Alva's FiberPrinting™ slotless motors the Size, Weight & Dynamic performance of Stabilized platforms can be improved through high peak torque, high precision & high gravimetric torque density.

Semiconductor

Alva's high-precision motors with zero cogging, no torque saturation and high torque density allows for highly optimized applications with vibration-free movements. The potted motors are perfect for cleanrooms and the efficient designs lead to maximized throughput and decreased maintenance.

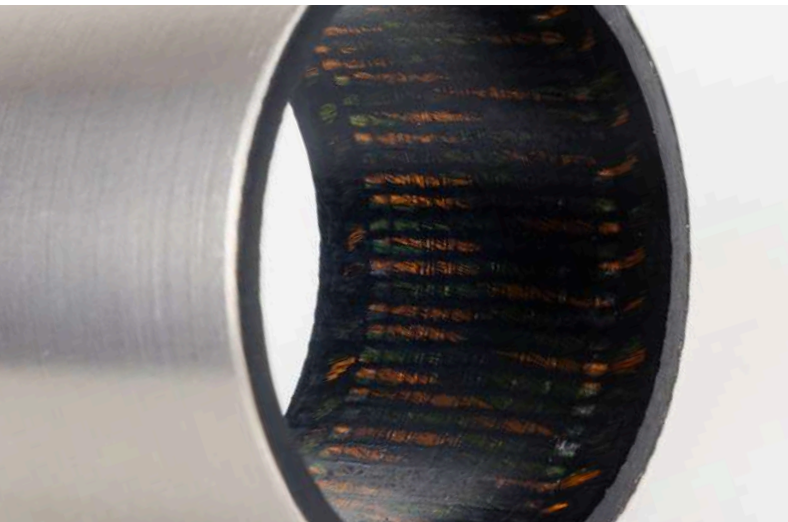
Robotics

Alva Industries' FiberPrinting™ motors offer high torque density & large through-hole, making them ideal for compact & strong actuators with gearboxes integrated in the center of the motor. GearTorq™ motors are cogging free which makes them highly transparent & easy to include in a Sim2Real workflows.

FiberPrinting™

A Patented Technology

Alva's next-gen electric motors are manufactured by our patented FiberPrinting™ technology. This groundbreaking & 6 times patented process enables us to rapidly design & manufacture ironless & slotless windings with high copper fill factor for any electric motor or generator, setting a new standard in precision, torque-density & adaptability.



The FiberPrinting™ Process

Alva's FiberPrinting™ revolutionizes stator windings for rotary, linear, and arc motors. With a 60% copper fill factor, it boosts efficiency, torque, and power. The process enables custom stators for precision & performance applications across industries like marine, medical, and aerospace.

- High Copper Fill: Maximizes power, reduces resistance.
- Non-Skewed Windings: Perfect magnetic alignment.

The Advantage

Alva's next-generation electric motors are powered by FiberPrinting™, our six-time patented technology. This never before seen method allows us to design & produce ironless, slotless windings with unmatched precision & torque density. With a high copper fill factor, custom shapes, & non-skewed windings, FiberPrinting™ pushes the limits of electric motor performance - delivering higher power, efficiency, & reliability for any application.

GearTorq™ Motors

Performance in a Compact form

GearTorq™ is a slotless thin-section frameless motor series for high-performance applications. The GearTorq™ motor series has zero cogging, high torque density, no saturation & large through-hole.



Performance

Alva's proprietary manufacturing technology allows for maximised copper fill factor & non-skewed stator windings, which result in a motor-constant & torque-density rivalling even the best slotted motors.

Light & Compact

The removal of the iron-teeth in the GearTorq™ motors result in a stator & rotor that's astonishingly thin & light. The motors feature a large through-hole that allows for design of incredible compact actuators.

Dynamic

GearTorq™ torque motors are slotless & therefore has virtually zero cogging torque, minor torque ripple & no torque saturation. Making them the perfect choice for highly dynamic applications that also require high-performance.

Custom Sizes

Custom Size For Any Application

Alva offers custom GearTorq™ motor sizes when a standard size doesn't fit your application. Contact us at sales@alvaindustries.com if you are interested or design your own custom motor with our web-based design suite [TorqStudio](#).

Outer Diameter

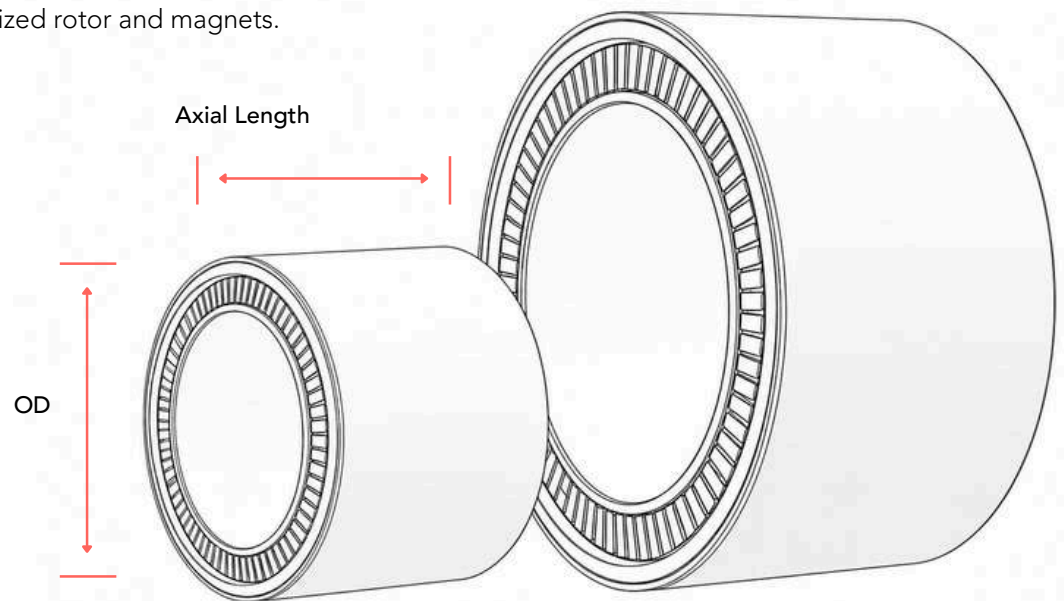
Due to the flexibility of FiberPrinting™, the outer diameter can be adjusted according to your exact needs with no fixed increment limitation. Increasing the diameter results in higher torque then increasing the length.

Axial Length

The axial length can be adjusted to fit your mechanical assembly perfectly with no fixed increment limitation.

Rotor size

The GearTorq™ motors can be customised to meet the exact balance that you require between low weight & high torque. A custom motor can be offered with optimized sized rotor and magnets.



GearTorq™ Motors

One Size For Every Need

The FiberPrinting™ technology allows for production of motors in almost any size. The GearTorq™ initial product portfolio includes motor sizes from 39 mm up to 88 mm, growing from diameter and lenght to keep a cylindrical shape factor.

	Motor	Motor constant [Nm/√W]	Continuous torque [Nm]	Rated voltage [V]	Stator OD [mm]	Axial length [mm]	Rotor ID [mm]	Total mass [g]
GearTorq™	39-35-M	0.074	0.33	72	39	35	23	149
	64-45-M	0.22	1.45	72	64	45	47.7	318.3
	88-110-M	0.87	9.21	72	88	109.8	54.54	2239

Access the latest CAD-files for all motors on our [website](#).

TorqStudio: Design your own motor

TorqStudio allows you to design & analyse your own motor with a fast & easy to use web-based interface. Access it today to explore the possibilities at [TorqStudio](#).

Contact us at sales@alvaindustries.com to access information about timeline, Minimum Order Quantity (MOQ) & Non Recurring Engineering (NRE) costs of custom motors.



GearTorq™ Motors

Configured To Your Needs

Check out the [Product Selector](#) & [TorqStudio](#) to simplify the configuration process.

Winding Options

Number of series turns

1-8 - The stator can be configured with a variant of series connections. Higher number of series turns result in higher torque/voltage constants & lower no-load speed.

Star & Delta winding connection

Y - Star connection. The three phases are connected as a star which result in higher torque/voltage constants & lower no-load speed.

D - Delta connection. The phases are connected in a triangle which result in lower torque/voltage constants & higher no-load speed.

Cable Options

Cable gauge

1-99 - All motor sizes comes with a default gauge. Cable gauge can be customised on demand.

Cable type

A - UL rated cable with PTFE wire insulation.

Sensor Options

Temperature sensor options

A - 10K NTC with a B25/100 value of $3492 \pm 1\% K$

Position sensor option

A - 3-phase hall-effect sensor with open-drain output, built-in 1.2 kΩ pull-up resistor, & 5 VDC input voltage.



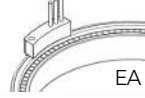
Terminal direction options



A - Axial - Cables exit axially, terminal block in line with outer diameter of stator.



R - Radial - Cables exit radially, terminal block in line with inner diameter of stator.



EA - External Axial - Cables exit axially, terminal block in line with inner diameter of stator.



IR - Internal Radial - Cables exit radially, terminal block in line with outer diameter of stator.

How to Read a Part Number:

GTM-39-35-M-4Y-R-26A-A0-001

GTM	GTM - GearTorq™ Motor
39	Diameter - Stator OD (mm)
35	Axial Length - Stator Length (mm)
M	Motor Variant - M - Max
4Y	Winding Option - Series Turns + Star(Y)/Delta(D)
R	Terminal Direction Options
26A	Cable Gauge & Type - AWG(1-99) 0 Type (A-Z)
A0	Sensor Options - Temp + Position (A-Z) + (A-Z) (0 = None)
001	Unique Identifier

Motor	Variant options	Series turns options	Connection options	Terminal direction options	Standard cable	Temp sensor options	Position sensor options
39-35	M - Max	2, 4, 8	Y - Star D - Delta	IR - Internal Radial	26A	A - 10K NTC	On request
64-45	M - Max	1, 3	Y - Star D - Delta	EA - External Axial	20A	A - 10K NTC	On request
88-110	M - Max	1, 3	Y - Star D - Delta	A - Axial	12A	A - 10K NTC	On request

Variations of all motor configurations, including rotor thickness, winding options, terminal directions, cabling and sensor alternatives can be realized on request.

GearTorq™ 39-35

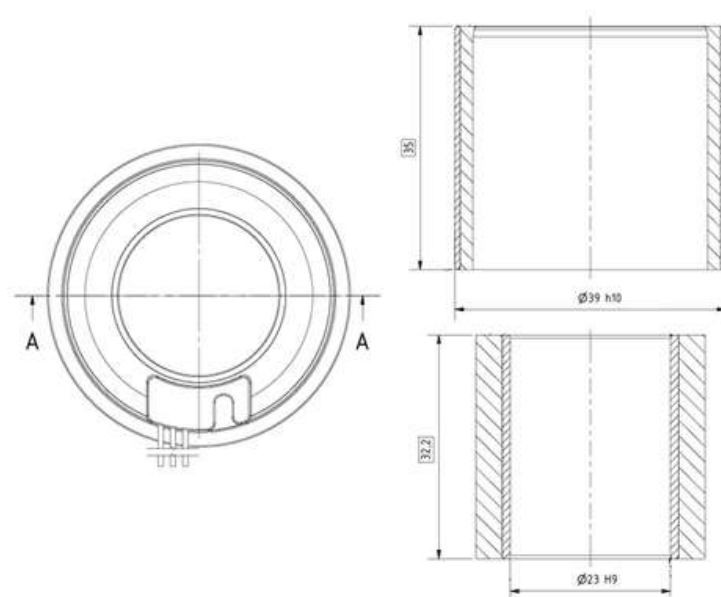
PROPERTY	UNIT	GTM-39-35-M					
Motor type	-	Max					
Winding type	-	2D	2Y	4D	4Y	8D	8Y
PERFORMANCE							
Motor constant ¹	Nm/√W	0.074					
Continuous torque ²	Nm	0.33					
Peak torque, 1 s ³	Nm	2.4					
Peak torque, 3 s ³	Nm	1.7					
Peak torque, 5 s ³	Nm	1.5					
Cogging torque	Nm	0.0					
Max continuous current ²	Arms	14.7	8.5	7.36	4.25	3.68	2.13
Peak current, 1 s ³	Arms	97.6	56.4	48.8	28.2	24.4	14.1
Peak current, 3 s ³	Arms	71.3	41.2	35.7	20.6	17.9	10.3
Peak current, 5 s ³	Arms	60.7	35	30.3	17.5	15.2	8.76
Max speed at max voltage ⁴	RPM	10000	10000	10000	9820	8550	4910
ELECTRICAL							
Torque constant ¹	Nm/Arms	0.0246	0.0427	0.0493	0.0855	0.0987	0.17
Voltage constant ¹	V/kRPM	2.1	3.66	4.2	7.33	8.41	14.6
Line to line resistance ¹	Ohm	0.0733	0.21	0.293	0.879	1.17	3.52
Line to line inductance ¹	μH	1.49	4.48	5.97	17.9	23.9	71.7
Electrical time constant	μs	20.4					
Spatial harmonic torque ripple	%	0.31					

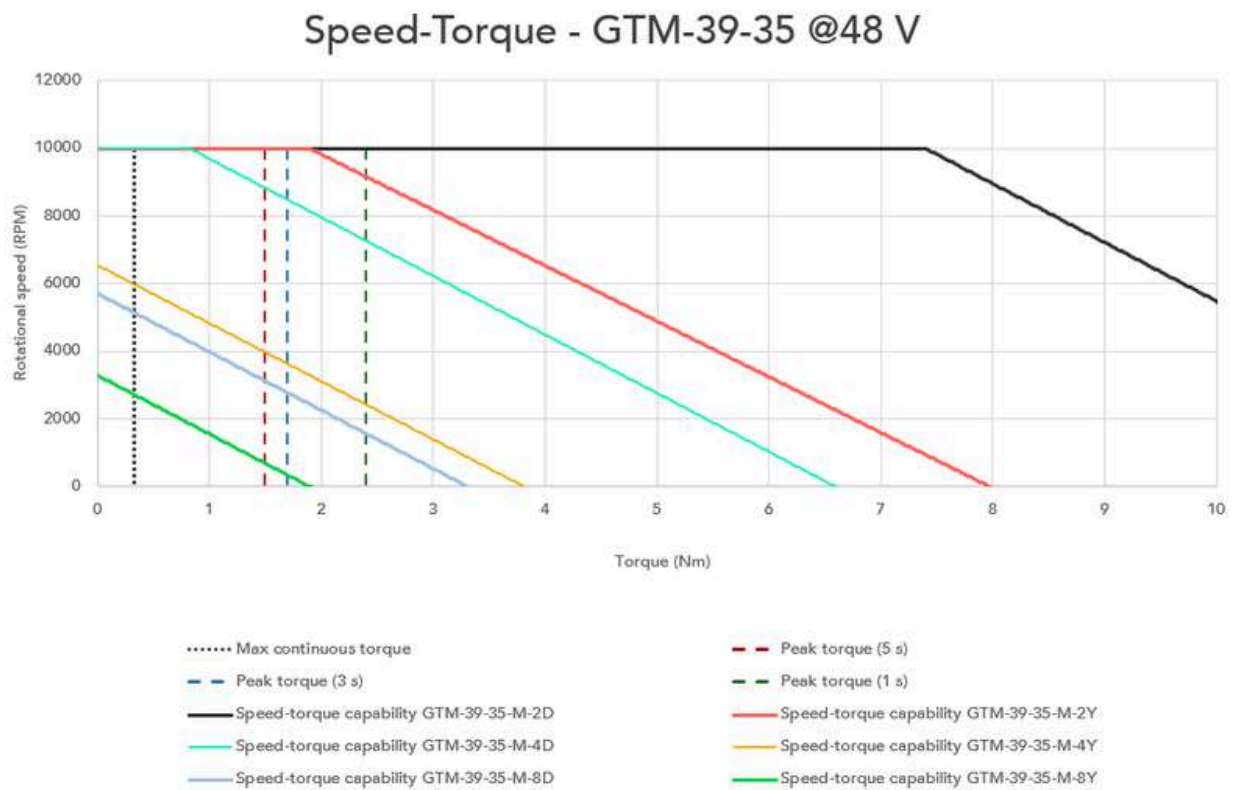
PROPERTY	UNIT	GTM-39-35-M
Rated voltage	V	72
Poles	-	22
Thermal resistance ²	C/W	3.4
Max stator temperature	°C	140
Max rotor temperature	°C	85
Continuous power loss ²	W	35
MECHANICAL		
Stator outer diameter (OD)	mm	39
Stator OD tolerance	mm	h10
Rotor inner diameter (ID)	mm	23
Rotor ID tolerance	mm	H9
Stator axial length	mm	35
Stator axial length tolerance	mm	+/- 0.2
Rotor axial length	mm	32.2
Rotor axial length tolerance	mm	+/- 0.15
Rotational inertia	gcm ²	200
Stator mass ⁵	g	49.6
Rotor mass	g	99.4
Total mass ⁵	g	149
Power cable length	mm	500
Power cable size	-	AWG26
ENVIRONMENTAL		
Minimum ambient temperature	°C	-40
Maximum ambient temperature	°C	80
Ambient conditions	°C	20

¹Windings at 20 °C & w/o AC cables. ²Housing without fins, 5 m/s airflow, 20°C ambient temp (conservative cooling assumptions, contact us for a continuous torque analysis for your application).

³Winding temperature increases from 20 °C to 140 °C. ⁴Lowest of max mechanical speed & max electrical speed at rated voltage. ⁵W/o AC cables.

Disclaimer: The values & specifications provided are for reference only & may be subject to change or contain inaccuracies.



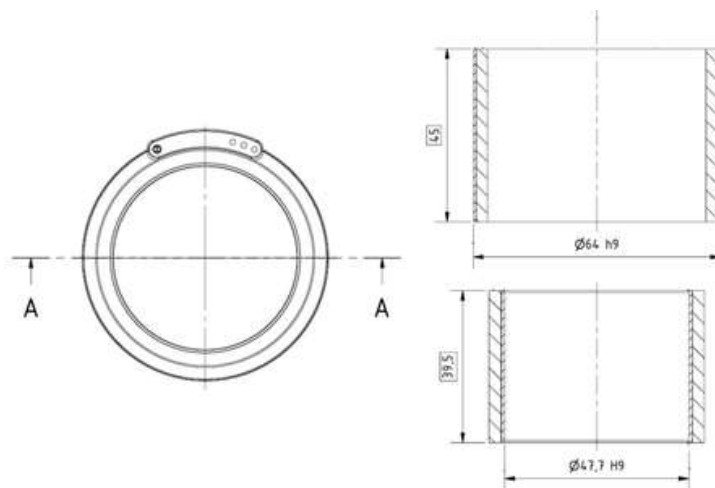


*Speed-Torque curves can be generated for your specific supply voltage, please contact sales@alvaindustries.com if you require this.

GearTorq™ 64-45

PROPERTY	UNIT	GTM-64-45-M			
Motor type	-	Max			
Winding type	-	1D	1Y	3D	3Y
PERFORMANCE					
Motor constant ¹	Nm/√W	0.22			
Continuous torque ²	Nm	1.45			
Peak torque, 1 s ³	Nm	14.4			
Peak torque, 3 s ³	Nm	9.3			
Peak torque, 5 s ³	Nm	7.8			
Cogging torque	Nm	0.0			
Max continuous current ²	Arms	68.5	39.5	22.8	13.2
Peak current, 1 s ³	Arms	634	366	211	122
Peak current, 3 s ³	Arms	412	238	138	79.3
Peak current, 5 s ³	Arms	343	198	115	66
Max speed at max voltage ⁴	RPM	8700	8700	8700	7090
ELECTRICAL					
Torque constant ¹	Nm/Arms	0.0227	0.0393	0.0682	0.118
Voltage constant ¹	V/kRPM	1.93	3.38	5.8	10.1
Line to line resistance ¹	Ohm	0.00676	0.0203	0.0608	0.182
Line to line inductance ¹	μH	0.445	1.34	4	12
Electrical time constant	μs	66			
Spatial harmonic torque ripple	%	0.483			

PROPERTY	UNIT	GTM-64-45-M
Rated voltage	V	72
Poles	-	26
Thermal resistance ²	C/W	1.7
Max stator temperature	°C	140
Max rotor temperature	°C	85
Continuous power loss ²	W	69.9
MECHANICAL		
Stator outer diameter (OD)	mm	64
Stator OD tolerance	mm	h9
Rotor inner diameter (ID)	mm	47.7
Rotor ID tolerance	mm	H9
Stator axial length	mm	45
Stator axial length tolerance	mm	+/- 0.2
Rotor axial length	mm	39.5
Rotor axial length tolerance	mm	+/-0.15
Rotational inertia	gcm ²	1082
Stator mass ⁵	g	159.5
Rotor mass	g	158.8
Total mass ⁵	g	318.3
Power cable length	mm	500
Power cable size	-	AWG20
ENVIRONMENTAL		
Minimum ambient temperature	°C	-40
Maximum ambient temperature	°C	80
Ambient conditions	°C	20



¹Windings at 20 °C & w/o AC cables. ²Housing without fins, 5 m/s airflow, 20°C ambient temp (conservative cooling assumptions, contact us for a continuous torque analysis for your application).

³Winding temperature increases from 20 °C to 140 °C. ⁴Lowest of max mechanical speed & max electrical speed at rated voltage. ⁵W/o AC cables.

Disclaimer: The values & specifications provided are for reference only & may be subject to change or contain inaccuracies.



*Speed-Torque curves can be generated for your specific supply voltage,
please contact sales@alvaindustries.com if you require this.

GearTorq™ 88-110

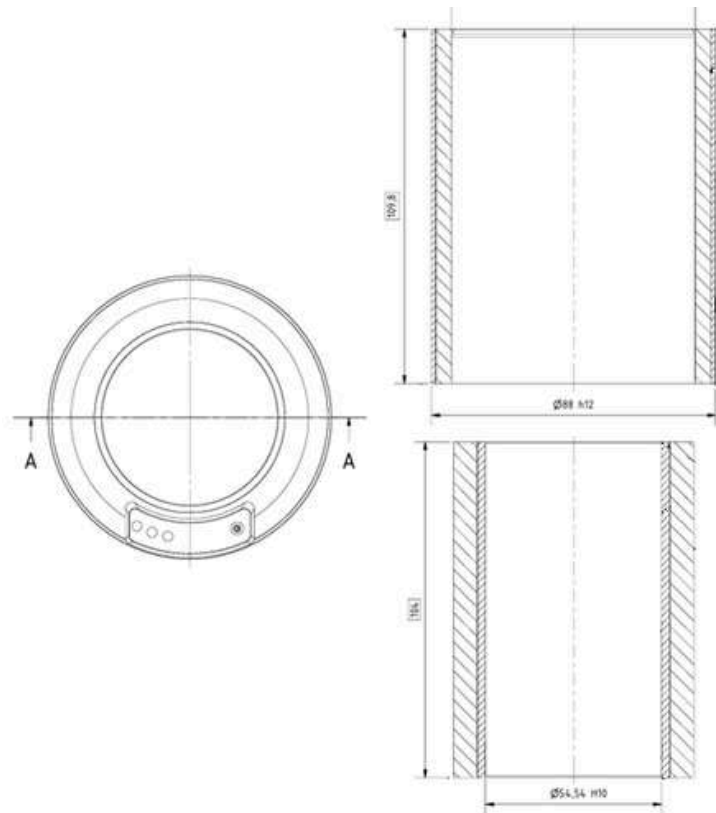
PROPERTY	UNIT	GTM-88-110-M			
Motor type	-	Max			
Winding type	-	1D	1Y	3D	3Y
PERFORMANCE					
Motor constant ¹	Nm/√W	0.87			
Continuous torque ²	Nm	9.21			
Peak torque, 1 s ³	Nm	114.1			
Peak torque, 3 s ³	Nm	72.5			
Peak torque, 5 s ³	Nm	60			
Cogging torque	Nm	0.0			
Max continuous current ²	Arms	130	74.9	43.3	25
Peak current, 1 s ³	Arms	1504	868	502	290
Peak current, 3 s ³	Arms	956	552	319	184
Peak current, 5 s ³	Arms	791	457	264	153
Max speed at max voltage ⁴	RPM	4800	4800	3710	2120
ELECTRICAL					
Torque constant ¹	Nm/Arms	0.0759	0.131	0.227	0.394
Voltage constant ¹	V/kRPM	6.45	11.3	19.3	33.9
Line to line resistance ¹	Ohm	0.00509	0.0153	0.0458	0.137
Line to line inductance ¹	μH	0.933	2.8	8.4	25.2
Electrical time constant	μs	183.3			
Spatial harmonic torque ripple	%	0.61			

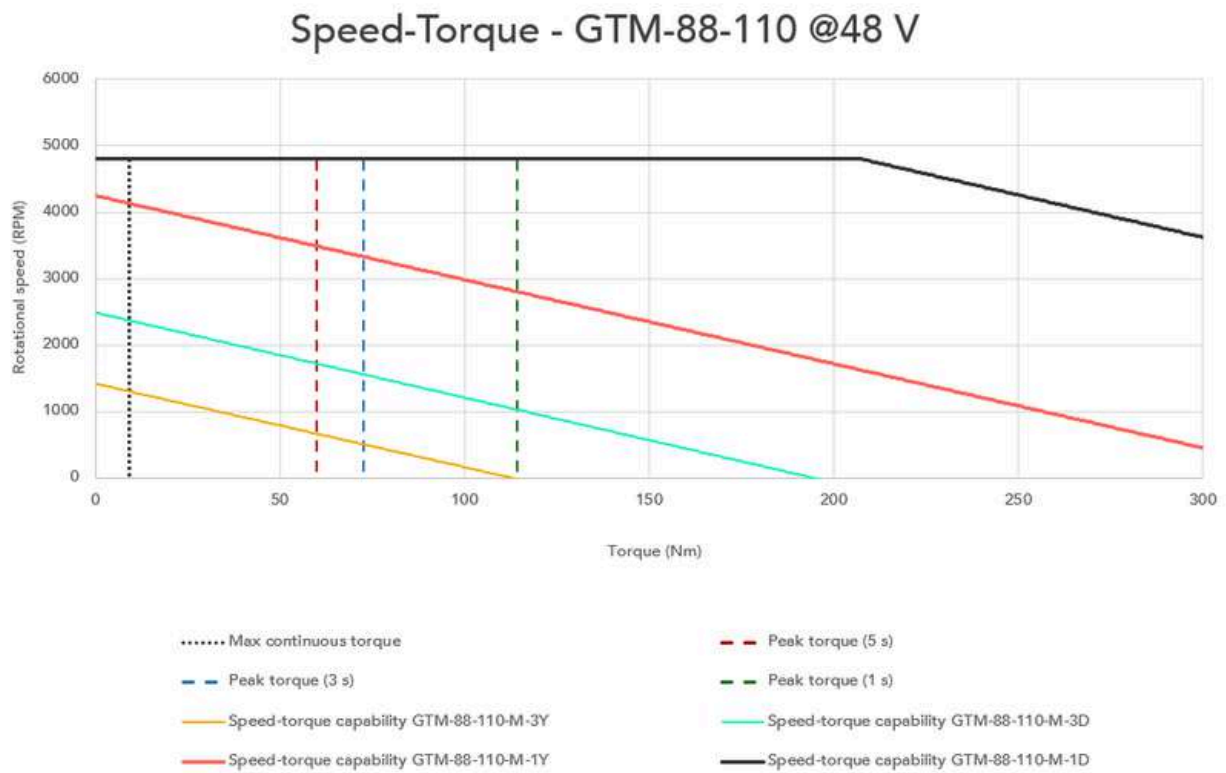
PROPERTY	UNIT	GTM-88-110-M
Rated voltage	V	72
Poles	-	20
Thermal resistance ²	C/W	0.63
Max stator temperature	°C	140
Max rotor temperature	°C	85
Continuous power loss ²	W	189
MECHANICAL		
Stator outer diameter (OD)	mm	88
Stator OD tolerance	mm	h12
Rotor inner diameter (ID)	mm	54.54
Rotor ID tolerance	mm	H10
Stator axial length	mm	109.8
Stator axial length tolerance	mm	+/- 0.2
Rotor axial length	mm	104
Rotor axial length tolerance	mm	+/-0.15
Rotational inertia	gcm ²	14575
Stator mass ⁵	g	924
Rotor mass	g	1315
Total mass ⁵	g	2239
Power cable length	mm	500
Power cable size	-	AWG12
ENVIRONMENTAL		
Minimum ambient temperature	°C	-40
Maximum ambient temperature	°C	80
Ambient conditions	°C	20

¹Windings at 20 °C & w/o AC cables. ²Housing without fins, 5 m/s airflow, 20°C ambient temp (conservative cooling assumptions, contact us for a continuous torque analysis for your application).

³Winding temperature increases from 20 °C to 140 °C. ⁴Lowest of max mechanical speed & max electrical speed at rated voltage. ⁵W/o AC cables.

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*Speed-Torque curves can be generated for your specific supply voltage, please contact sales@alvaindustries.com if you require this.

Ordering Alva Motors

Pricing & Lead-Time

Alva's pricing strategy focuses on delivering customer value while ensuring sustainable profitability. Instead of cost-plus pricing, we collaborate with customers to establish pricing that fosters win-win outcomes. Our goal is to maintain stable pricing, allowing customers to rely on consistent quality. Final pricing will depend on factors like part configuration, motor size, annual volumes, & testing requirements.

Standard products are delivered in 20 weeks for small quantities, with plans to reduce this. Custom solutions may extend lead times to 28 weeks, from specifications to prototype. We work closely with customers to meet timelines, & volume lead times are determined upon request based on customer needs.

Delivery Terms

Alva's standard delivery terms are EXW; however, Alva remains flexible & open to discussing customized delivery arrangements to meet customers' specific needs.

Terms & Conditions

Alva's term & conditions can be found under www.alvaindustries.com/terms-conditions & as an annex of this product guide.

How to place an order

Use the [Product Selector](#) to configure & order your motor or get in touch with Alva's sales team at sales@alvaindustries.com to receive an official quotation according to which an order can be placed, or a sales contract can be signed.

Scope of delivery

Stator
FiberPrinting™ stator with a aluminium sleeve with tight tolerances for easy mechanical integration. The aluminium sleeve is engraved with the PN & SN of the stator.

The stator comes with pre-installed cables with a length of 500mm with flying leads. The standard cable is UL rated with PTFE insulation material.

Rotor
The rotor consists of a magnetic Halbach, for maximum performance with a glass fiber sleeve, for maximum reliability, and a inner aluminium ring with tight tolerances for easy mechanical integration.

The inner aluminium ring is engraved with the PN & SN of the rotor.

GTM-39-35-M-4Y-R-26A-A0-001

Motor Series
GTM - GearTorq™ Motor

Diameter
Stator OD (mm)

Axial Length
Stator Length (mm)

Motor Variant
L - Lite
M - Max

Unique Identifier

Sensor Options
Temperature + Position (A-Z) + (A-Z) (0 = None)

Cable Gauge & Type
AWG(1-99) + Type(A-Z)

Terminal Option
A - Axial Direction
R - Radial Direction

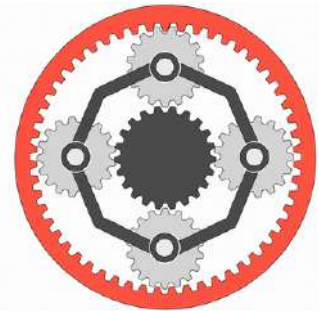
Winding Option
Series Turns + Star(Y)/Delta(D)

Gear Alternatives

The selection of a specific gear-type to combine with the frameless motor is dependent on the system requirements. Gear topologies have different pros and cons and different applications require different things. Here is a quick introduction to some alternatives.

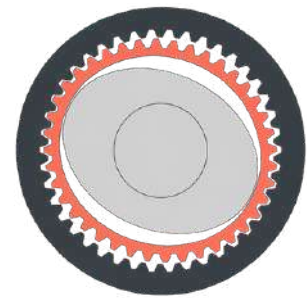
A **planetary** gear is a type of epicyclic gear system composed of an input gear in the centre (sun) with surrounding driven gears (planets) that interact with the output gear. The system can be composed of one, or several, stages depending on the required gear-ratio.

Planetary gears show great torsional stiffness because the load is distributed across multiple planet gears. They can also handle sudden chock loads well, and can be designed for great torque density, and high speed efficiency. They do however suffer from backlash and to reach higher gear-ratios several stages need to be stacked which leads to a longer actuator.

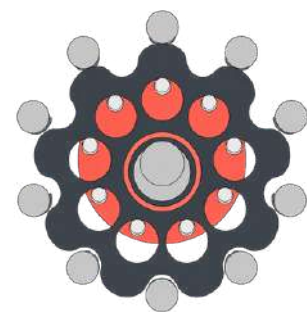


A **strain wave** gear is composed of three parts. An elliptical wave generator, that rotates inside a flexible cup with external teeth, that interacts with the static outside gear ring. This creates a compact stage that can handle high gear ratios while still remaining flat.

Strain wave gears have many gear teeth in contact at all time and can therefore have very limited, close to zero, backlash. Also, they allow for a hollow bore in the centre for routing of cables etc. On the downside they lack stiffness because of the flexible parts and they can be limited in the high speed availability.

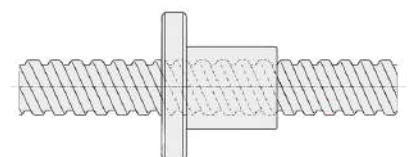


A **cycloidal** gear consists of a rotating input shaft with an excentric pin. This pin moves a system of discs, rollers and pins in a smooth motion where a high number of the gear surfaces are in contact. This results in a very high load-sharing which allows for this type of gear to handle high shock loads. High gear ratio in a single stage and low backlash is also other benefits. The downsides are higher mechanical complexity and considerable vibrations at higher speeds.



A **ball screw** is a good alternative when a rotating motion from the motor needs to be translated into a linear motor from the actuator. The ball screw is a threaded shaft where a ball nut with recirculating ball bearings is moved linearly.

Since the gear relies on rolling elements some advantages include high efficiency and smooth motion. The downsides can be no hollow-bore available and limitations on high speeds when long and thin ball screws are used.



Mechanical Integration

Safety precautions

The frameless motor rotors contain high-energy rare-earth magnets that produce strong magnetic fields. Therefore, anyone with active implants, such as pacemakers, should keep a safe distance from the rotors of these motors.

The rotor's magnetic field creates strong attractive forces to ferromagnetic materials when in close proximity. If the rotor & surrounding ferromagnetic items are not properly restrained, this can result in collisions, potentially damaging the rotor or causing personnel injuries (e.g., pinched fingers). When handling the rotor, precautions should be taken to remove all other magnetic items from an area greater than approximately 3 times the diameter of the rotor. This includes other rotors.

Strong magnetic fields produced by the rotor magnets may affect or damage electronic devices & measuring equipment. Rotors should not be placed near computer disks, computers, monitors, credit cards, etc.



Handling & Storage

Correct handling & storage of motor components is very important. It is recommended that stators & rotors be stored in their original packaging until installation is required. Special care must be taken when handling stator assemblies, as damage to the coil insulation and lead wires can result in electrical shorts and possible electrical shocks.

Precautions should also be taken when handling the rotor assembly, as strong magnetic forces are present. The magnets on the rotor are brittle & prone to cracking, chipping, or even shattering on impact.

Do not pull on the phase cables, while stripping the cables, a proper cable stripping tool that does not pull on the cable must be used.

Mechanical Integration

General considerations

Alva frameless motors are supplied as rotor & stator pairs. From this point forward, the part that the rotor attaches to will be referred to as the rotor carrier, & the part that the stator attaches to will be referred to as the housing. Both the stator & rotor have an aluminium backing ring(sleeve) on the mounting side. Only the exposed surfaces of these rings should be subjected to force during assembly or disassembly. Depending on the motor configuration, it may only be possible to insert the rotor from one side of the stator.



Alva's motors are electromagnetically self-sufficient, i.e., proper operation does not depend on the electromagnetic properties of surrounding parts. For structural purposes, it is recommended that the housing & rotor carrier be made of aluminum. This is particularly beneficial for applications operating within a large temperature range, as the coefficient of thermal expansion (CTE) is matched with the stator/rotor sleeve.

It is good practice to design any electrically conducting surfaces to have a minimum of 0.5mm of clearance to the stator windings in all directions for electrical insulation purposes. The windings should not be in direct contact with any electrically conducting surfaces. If grounding is required, a ground stud can be placed on the housing or stator sleeve. While this may not be at the same voltage potential as the stator stack, it represents a typical grounding scheme used in most motors with two- or three-part housings. A ground stud is typically only necessary when the motor operates without isolation between the mains & the motor drive.

The housing & surrounding parts must be designed with sufficient clearance around the terminal block & phase cables to ensure no stress is applied to the terminal block. Please refer to the STEP files for specific motor measurements & tolerances for the terminal block.

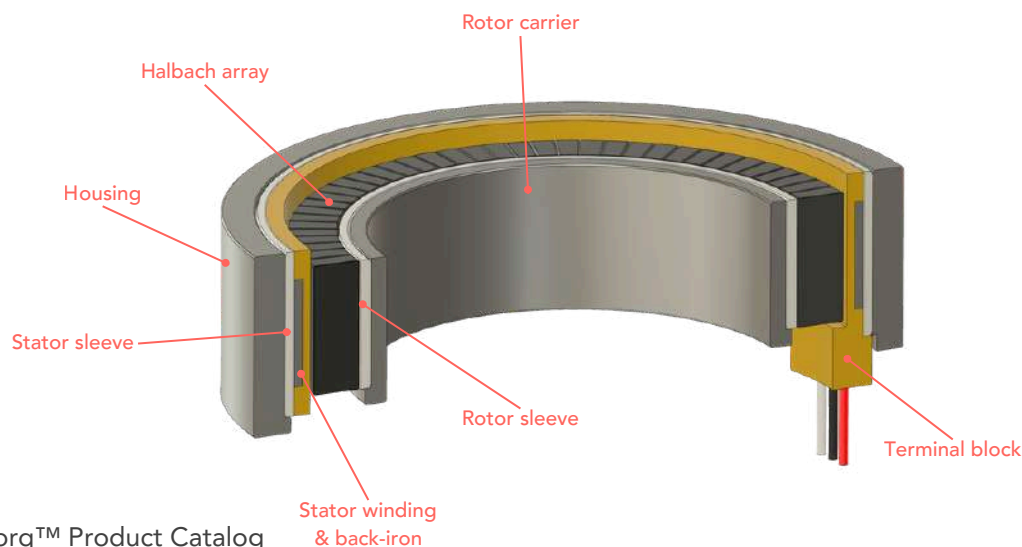
The following section is also available as easy to follow Youtube videos:

[How to Integrate Frameless Motors: SlimTorq™ Motor Assembly Guide](#)

[Axial Clamping Explained: Frameless SlimTorq™ Motor Assembly](#)

[Thin Bond Line Adhesion: Frameless Motor Integration Tutorial](#)

[Thick Bond Line Adhesion: Frameless Motor Integration Tutorial](#)



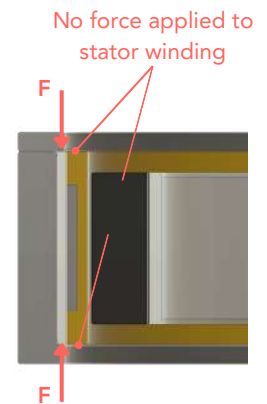
Mechanical Integration

Retention

A well designed integration method is required to assure a strong retention of the rotor & stator to allow for robust torque transfer. The outlined options will all achieve a strong retention if they are applied correctly.

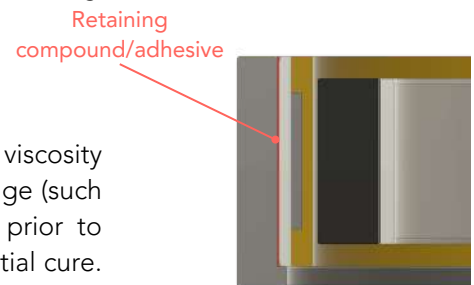
Axial clamping

The simplest method of retention is axial clamping. This allows for easy assembly & disassembly of the stator & rotor. It's recommended to use one or several clamping components to evenly distribute the clamping force on the aluminium sleeves. Clamping force should only be applied to the stator/rotor aluminium sleeve. Absolutely no force should be applied on the stator winding or the rotor magnets. The amount of clamping force as well as the housing shoulder & clamping parts should be designed so that the stresses in the stator/rotor sleeve are appropriate. It's recommended to add a thermal paste on the mounting surfaces to maximise the thermal performance of the motor.



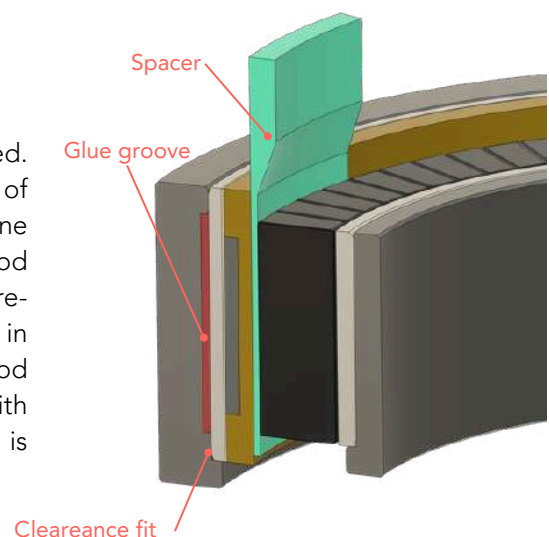
Bonding: Small gap

The most space efficient option is to bond the parts using a low viscosity adhesive or retaining compound with sufficient temperature range (such as Loctite 638). The mating surfaces should be clean & dry prior to assembly & the parts need to be held in position during the initial cure. It should be noted that disassembly is not possible with this retention method.



Bonding: Large gap

A large gap bonding method can also be used if desired. Stator to rotor alignment can either be achieved by use of spacers (spacers are not included) in the airgap OR combine a clearance fit with a glue groove. Note that the spacer method requires the rotor (alternatively a dummy rotor) to be pre-mounted on the rotor carrier while the stator is glued in place & vice versa. A general structural adhesive with good gap filling capabilities should be used. In applications with high power demands a thermally conductive adhesive is required (such as the MG chemicals 8329 TFS).



Interference fit

The use of an interference fit to circumvent the need for clamping & adhesives is possible but requires careful consideration not to overstress & damage the stator or rotor. Therefore it is not recommended over the use of axial clamping or bonding. Alva should be consulted before an interference fit is implemented.

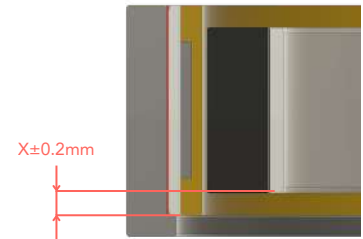
Mechanical Integration

Alignment

A good alignment between the rotor & stator is important to ensure safe operation & high performance of the motor.

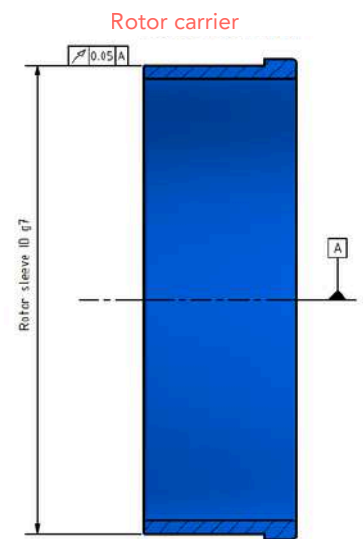
Axial alignment

Axial placement of the stator & rotor should be ensured by the use of a hard-stop shoulder on the rotor carrier & the stator housing. The shoulders should control the axial alignment to center the rotor within the stator with a $\pm 0.2\text{mm}$ tolerance.



Rotor radial alignment

It's recommend to retain the rotor with axial clamping, small bond line, clearance fit with a glue groove or full interference fit. For all the methods except for the full interference fit, it's recommended to dimension the diameter of the rotor carrier (where the rotor ID sits) equal to the rotor sleeve ID with a g7 tolerance, or tighter. It's important that the rotor carrier has maximum runout of 0.05mm relative to the rotation axis if one these methods are used. Please contact Alva if you are considering a full interference fit.

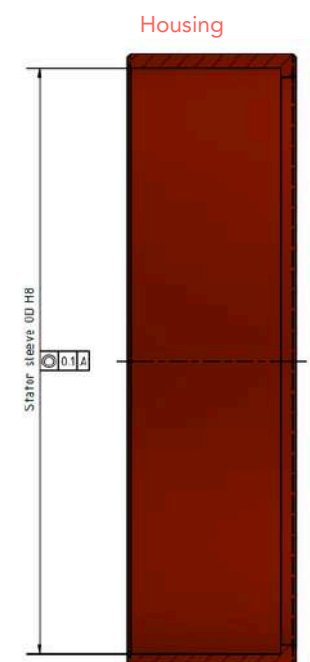


Stator radial alignment

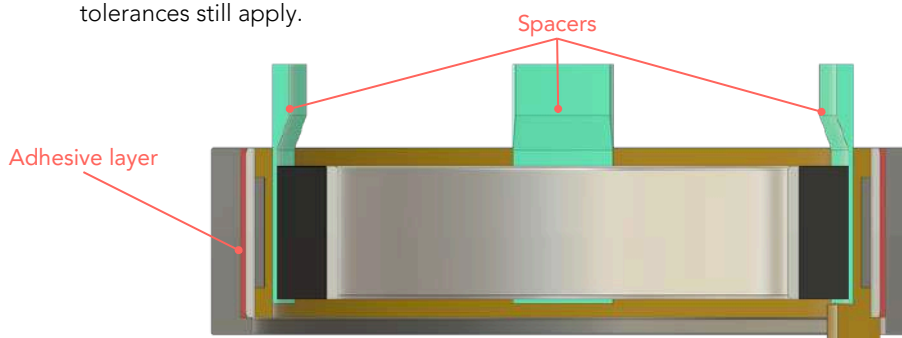
Stator alignment options:

1. Alignment with the stator housing
2. In-situ alignment with spacers

Alignment through the housing is achieved by a clearance fit between the stator sleeve and the housing. In this case the housing mating surface ID should be dimensioned equal to the Stator sleeve OD with a H8 tolerance or tighter. The housing mating surface should be concentric to the rotor carrier rotation axis to within 0.1mm in the final assembly.



In situ alignment is achieved by first assembling the rotor, then bonding the stator into the housing while using spacers between the stator & rotor to ensure the correct airgap. In this case there should be a minimal stator sleeve to housing gap of 0.1mm (minimal, not nominal). This method of assembly, though more process demanding, reduces the need for high precision on the housing ID & general assembly tolerances. Note that the requirement for rotor carrier tolerances still apply.



Integration Considerations - Frameless motor + Gears

In addition to restraining the stator and rotor part of the frameless motor (see previous section), a few other considerations should be made to mechanically integrate the motor with gears to achieve sufficient performance and durability.

Air gap integrity – The frameless motor is inherently designed with a small air gap (a couple of tenths of a millimetre). Keeping the rotor concentric in the stator, at all scenarios of loads executed on the gear-set, is crucial. This affects bearing selection and the individual parts design, depending on the loads the system will manage. Also, tolerance stack-up becomes more complex because of larger number of parts to account for.

Heat management – Since the gear-set will most likely be placed centrally, inside the rotor, most heat that is generated in the gear-set due to friction and other losses will affect the motor temperature. Keeping track and balancing the loss and performance requirements with the allowed temperature that the motor can work with is key, keeping in mind that the rotor and magnets cannot withstand same peak temperatures as the stator.

Balancing inertia – In a geared system, the reflected inertia amplification is n^2 , where n is the gear ratio. Finding the right balance between rotor-to-load matching (preferably close to 1:1) and making sure the joint is back driveable at the same time, can be tricky. It depends on the dynamic movement specification of the system, and the level of back drivability that is required.

Vibrations – Introducing gears inherently leads to more vibrations in the system. Making sure all parts is designed correctly, and balanced, is key to reduce vibrations.

Hollow bore – By adding a gear-set in the centre, the bore is effectively limited. Depending on the choice of gear-technology, different levels of hollow designs can be achieved. Strain wave gears is generally easiest to make and still maintain a hollow bore, and planetary gears is also possible.

Lubrication shielding – If the gear type requires lubrication it needs to be shielded from the motor section

Sensor feedback – If high precision is required it can be wise to design for dual sensor feedback (one for each side of the gear) to account for backlash and other non-regularities.

Choosing a Motor Drive

Commutation Type

GearTorq™ motors have an almost perfect sinusoidal back-EMF & it is therefore recommended to use sinusoidal, or even better, FOC commutation. Trapezoidal commutation can be utilised, however, with a penalty in terms of precision & performance.

Switching Frequency

Slotless motors have a relatively low inductance, & therefore a low electrical time constant. It's therefore important to use a high enough switching frequency to maximise the precision & performance of the motors in your application. The general recommendation is to use a switching frequency of at least 20kHz. The required switching frequency can be reduced by adding output filter on the motor drive to increase the system inductance. Please contact us at sales@alvaindustries.com if you are uncertain if your application require a output filter.

Current Rating

Most motor drives has two current ratings: continuous- & peak-current. It's important to understand both ratings & assure to pick the motor drive with correct current ratings for your application.

Continuous current

The required continuous current rating can be calculated with the equation below. It's important to consider that the continuous current rating of motor drives is dependant on ambient temperature, cooling conditions & switching frequency. So ensure to review these aspects of the motor drive & if your are uncertain you should contact your motor drive supplier for support.

$$\text{ContinuousCurrent}(A_{rms}) = \frac{\text{ContinuousTorque}(Nm)}{K_T(Nm \div A_{rms})}$$

Electrical Frequency

It's important to select a motor drive that has high enough electrical frequency for your application. It's easy to calculate the required electrical frequency for your application, see the equation below:

$$\text{ElectricalFrequency}(Hz) = \frac{\text{MaxSpeed}(RPM) \times \text{No. Poles}}{2 \times 60(s \div min)}$$

Sensored vs Sensorless control

The GearTorq™ motors can be controlled both by a sensed & sensorless motor drive. If you have a precision applications where you need to control the motors either in position- or torque-mode it's highly recommended to use a sensed motor drive with an high-end encoder. In performance applications, where low-speed performance & precision isn't of importance, sensorless control is a good option.

Voltage Level

Your power source & motor drive should have a high enough voltage rating to reach the required no-load max speed of your application. Use the equation below to calculate the required voltage level for your application.

$$VDC(V) = K_E(V \div kRPM) \times 1000 \times \text{Speed}(RPM)$$

Peak Current

The required peak current rating can be calculated with the equation below. Keep in mind that the equation is only valid for a ideal motor drive which means you should add a buffer of 15% to account for current ripple caused by switching.

$$\text{PeakCurrent}(A_{rms}) = \frac{\text{PeakTorque}(Nm)}{K_T(Nm \div A_{rms})}$$

Definitions & Glossary

Motor constant, K_m

The motor constant for the three-phase GearTorq™ motors is given by the torque constant, & line to line resistance, see the equation below:

$$K_m (Nm \div \sqrt{W}) = \frac{K_T (Nm \div A_{rms})}{\sqrt{Line2LineResistance (Ohm) \times \frac{3}{2}}}$$

Note that the line to line resistance is converted to the three-phase equivalent of the resistance by multiplying it with the factor of 3/2.

Voltage constant, K_e

The voltage constant is based on peak value of the line-to-line voltage & the rotational speed.

$$K_E (V \div kRPM) = \frac{Line2LineVoltage (V)}{1000 \times RotationalSpeed (RPM)}$$

Torque constant, K_t

The torque constant is based on the torque output & RMS I_q current.

$$K_T (Nm \div A_{rms}) = \frac{Torque (Nm)}{I_q (A_{rms})}$$

Max continuous torque

The highest torque the motor can output continuously without overheating. The stated values assume that the motor is mounted in a small housing placed in an airflow with an airspeed of 5 m/s and an ambient temperature of 20°C.

Keep in mind that higher continuous torque can be expected if the motor is mounted in thermally conducting housing with larger cooling surface and increased airflow. The motors are not limited by saturation so the continuous torque is mostly dependant of the cooling ability of the overall assembly.

Peak torque

The peak torque assumes the motor starts from a rest with a motor temperature equivalent to the ambient temperature of 20°C.

Line to line resistance

The resistance measured at the motor terminals. Also called terminal resistance. The phase resistance can be calculated with the equations below.

Delta connections:

Phase resistance = Line-to-line resistance x 1.5

Star connections:

Phase resistance = Line-to-line resistance x 0.5

Electrical Time Constant

The electrical time constant (denoted as τ) of an electric motor or circuit is a measure of how quickly the current in the motor or circuit responds to changes in voltage. It indicates how fast the current can rise to its steady-state value after a voltage is applied.

In a motor, it's calculated as the ratio of the motor's inductance (L) to its resistance (R):

$$\tau = \frac{L}{R}$$

The time constant impacts how quickly a motor can accelerate or decelerate and how it will behave under dynamic load conditions.

Continuous power loss

The continuous power loss is the loss that is generated as heat at the rated continuous torque. The value is based on the assumption that the speed is equal to 0 RPM, i.e. speed dependant losses are not considered.

FAQs

Contact us today

For any additional inquiries not addressed on this page, please feel free to contact us at sales@alvaindustries.com. Our team will respond quickly to assist you.

How do I mechanically integrate the motor?

There are three general concepts for mechanical integration of the frameless motors.

1. Clamping
2. Adhesion
3. Interference fit

All three has their inherent advantages & considerations, please read more under [Mechanical Integration](#).

Do you offer custom motors?

Due the inherent simplicity & flexibility our manufacturing technology FiberPrinting™ we can offer fully custom solutions for your application. Please contact us at sales@alvaindustries.com to learn more.

Does the motors come with a temperature sensor?

Most of the GearTorq™ motors can be ordered with a temperature sensor as an optional feature. Please see the [Ordering Alva Motors](#) section to see how you configure your product with a temperature sensor. The default temp sensor (A) is a 10K NTC with a B25/100 value of $3492 \pm 1\% \text{ K}$ (TDK B57541G1103+000).

What is the airgap between rotor and stator?

The airgap dimension is dependant on the motor size, you can find the mechanical dimensions of the motor components in the CAD file.

What's required to drive the motors?

The GearTorq™ motors are of the three-phase BLDC type & can be driven with most off-the-shelf controllers. The motors can be driven in trapezoidal, FOC, sinusoidal mode & with or without sensor feedback. Special considerations need to be taken regarding the switching frequency due to low inductance of the motors. Please read more under [Choosing a Motor Drive](#).

How do I select the correct motor for my application?

The easiest way to select the correct motor for your application is to use our [Product Selector](#). Insert your requirements in the Product Selector and it will find precisely the right motor for you. It will also allow you to fully configure the motor and order it. We are happy to help if you desire personal assistance to select the right motor, just contact us on sales@alvaindustries.com.

What's the typical delivery time for a standard motor?

Depending on the version of the motor, the lead time may vary. As a general rule of thumb, for units that are standard configurations, the lead time for small volumes (1-5 units) is around 20 weeks. For bigger volumes or small customizations the lead time may change, please reach out to us at sales@alvaindustries.com or call us.

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Can I change the specifications of the motors?

Each motor has multiple winding configurations to align with your required max-speed. The motors can be configured in Star(Y) and Delta(D), and in different number of series-turns.

The motors can be equipped with temperature sensors and different wire gauges.

To understand how to configure your product please see [Configured To Your Needs](#) section & to simplify the process check out our [Product Selector](#).

Please contact us at sales@alvaindustries.com if there isn't a configuration that meets your needs. Our FiberPrinting™ technology allows us to quickly develop custom motors according to your requirements.

What are the tolerances for the mounting?

You can find the mechanical tolerances of the motor components in the mechanical section of each product page. For more information how to mechanically integrate the motors into your application please see [Mechanical Integration](#) section. The STEP files of the motors are available on the website.

Are these motors more expensive than other slotless motors?

No. Alva's manufacturing methods, lead by the FiberPrinting™ technology, are comparable in cost & price with motors with similar characteristics (thin, light, cogging free slotless frameless motors).

Are slotless motors more expensive than slotted motors?

Alva's FiberPrinting™ manufacturing technology for slottless stators & proprietary manufacturing method of Halbach array rotors, allow for production cost that can be quite competitive to even manufacturing methods of slotted motors, enabling also competitive pricing. On the other hand, slotless motors from other manufacturers tend to be more expensive than slotted motors due to the larger magnets & legacy manufacturing methods.

Are these motors available for high voltage?

All the GearTorq™ motors are rated with a maximum voltage level of 72V. Higher voltage ratings will be available in the future. Please contact sales@alvaindustries.com if your application require a higher voltage rating.

FAQs

Contact us today

For any additional inquiries not addressed on this page, please feel free to contact us at sales@alvaindustries.com. Our team will respond quickly to assist you.

Do I need to have active cooling on the motors to achieve the specifications of Torque/speed?

The continuous torque and speed values in the product guide are based on the assumption that motors are mounted in a small housing and with some airflow passing over the housing. To understand how the motor will perform in your application please insert your requirements and select the correct cooling conditions in our [Product Selector](#). Or contact us at sales@alvaindustries.com & we can support you with a detailed thermal & performance study.

Can I use the motors with magnetic encoders?

Yes, the GearTorq™ motors can be combined with magnetic encoders. It's important to review the requirements of the magnetic encoder in terms of maximum external magnetic field. The table below shows minimum required distance measured from the stator edge to the magnetic encoder.

39-35-M	3 mm
64-45-M	3 mm
88-110-M	7.5 mm

Are there possibilities for Custom Mounting solutions?

Our expertise not only lies on the design and manufacture of motors but also in their integration into diverse types of housings and mechatronics designs. Given that the possibilities to mount a frameless motor may vary, we give standard recommendations on how customers can do that on their own: [Mechanical Integration](#). However, we are also capable of modifying the mounting possibilities of the motors, according to the applications needs. Reach out to: sales@alvaindustries.com or call us.

Can I combine these motors with a gearbox?

With a large inner-diameter and low-speed dependant losses, the GearTorq™ motors are highly suitable to be combined with gearboxes for torque demanding applications. They can be combined with all the typical type of gearboxes for precision applications such as planetary-, worm-, strain wave-, bevel- and cycloidal-gearbox.

What is the life time of frameless motors?

The GearTorq™ motors are brushless motors, they are therefore inherently not exposed to any mechanical wear assuming a well designed mechanical assembly. The Litz Wire of the stator windings are isolated with of a P180 enamel according to IEC 60172, with a rated lifetime of 20,000 hrs at a continuous temperature of 180 °C.

As long as the motors doesn't exceed their maximum rated temperature of 140°C, the motors will have next to unlimited life-time.



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