

BEYOND >

# User manual

including technical datasheets for  
Beyond Motors models: AXM2, AXM3 & AXM4

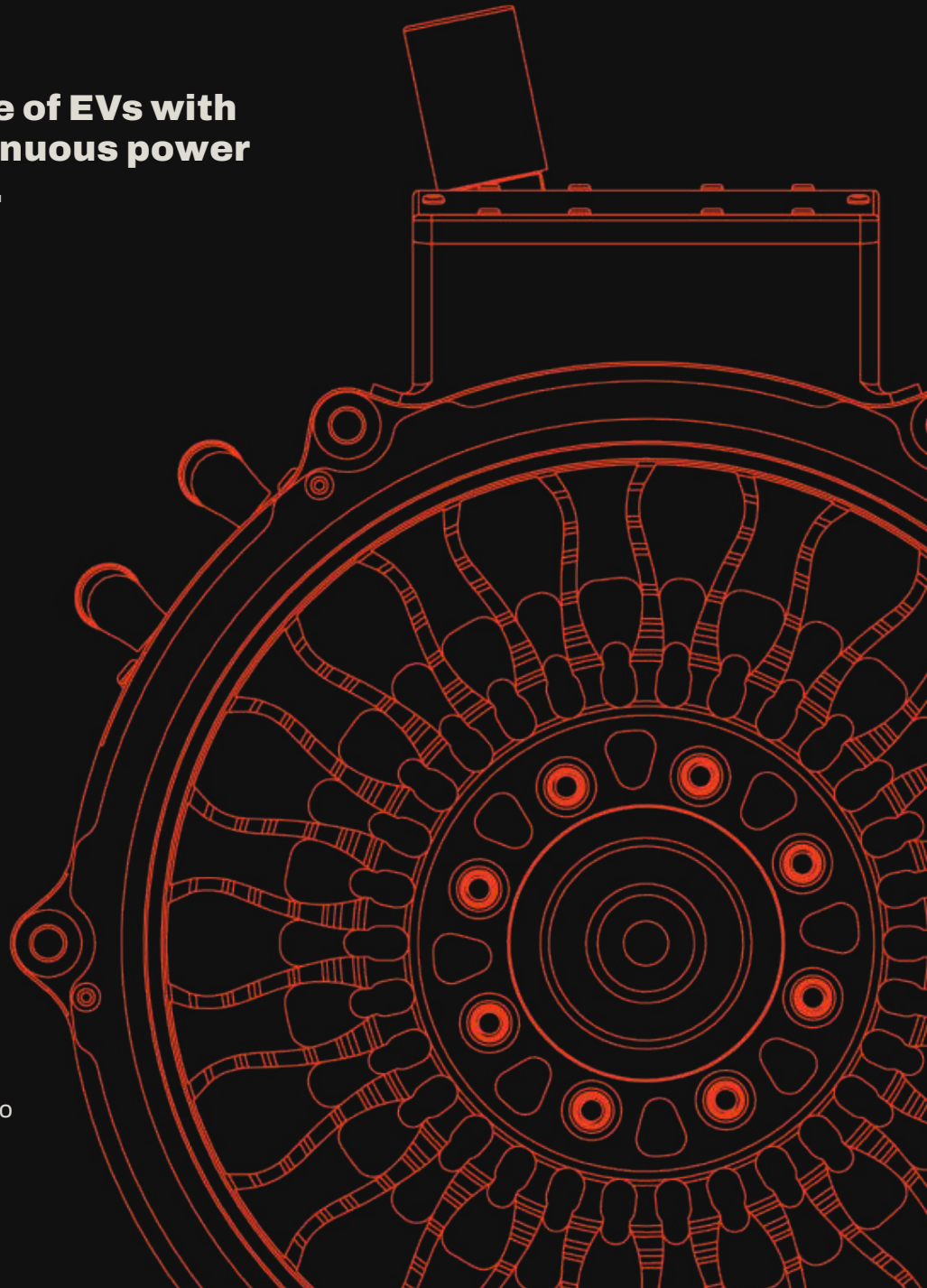
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**Powering the future of EVs with  
unmatchable continuous power  
and torque density.**

Produced by: Beyond Motors

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ENERGISING  
THE FUTURE

# DEVELOPING AXIAL FLUX TECHNOLOGY

Beyond is at the bleeding edge of technology. Located in the heart of Europe, but globally well-connected, we endeavour not to compete in the field of axial flux motors, instead favouring co-operation with innovators that are in need of the most reliable electric drivetrain solutions.

With a product of unmatched power density, quiet and lightweight, we are looking at industries and strategically approaching where we accelerate progress the most.

## WHAT SETS US APART FROM THE REST?

Our goal is simple, but not easy. To provide the most reliable, cost-effective and superb electrical motors for any industry.

**Beyond Motors have:**

**1**  
**SUPERIOR  
STRENGTH AND  
DURABILITY**

**2**  
**UNMATCHABLE  
CONTINUOUS  
POWER DENSITY**

**3**  
**THE MOST  
EFFICIENT WATER  
COOLING SYSTEM**

**4**  
**STACKABLE &  
CUSTOMIZABLE  
DESIGN**

**5**  
**UP TO 1.2  
MW POWER  
OUTPUT**



# INTRODUCTION

This comprehensive guide has been meticulously crafted to provide the user with the necessary information and procedures for safely and effectively handling, installing, operating, and maintaining the equipment.

Adhering to all safety warnings and instructions outlined within this manual is of the utmost importance to prevent any potential injury to personnel. It is crucial that this manual be retained for future reference during all phases of installation, operation, and maintenance.

***Disclaimer of important terms:***

*Generating: Conversion of mechanical energy into electrical energy.*

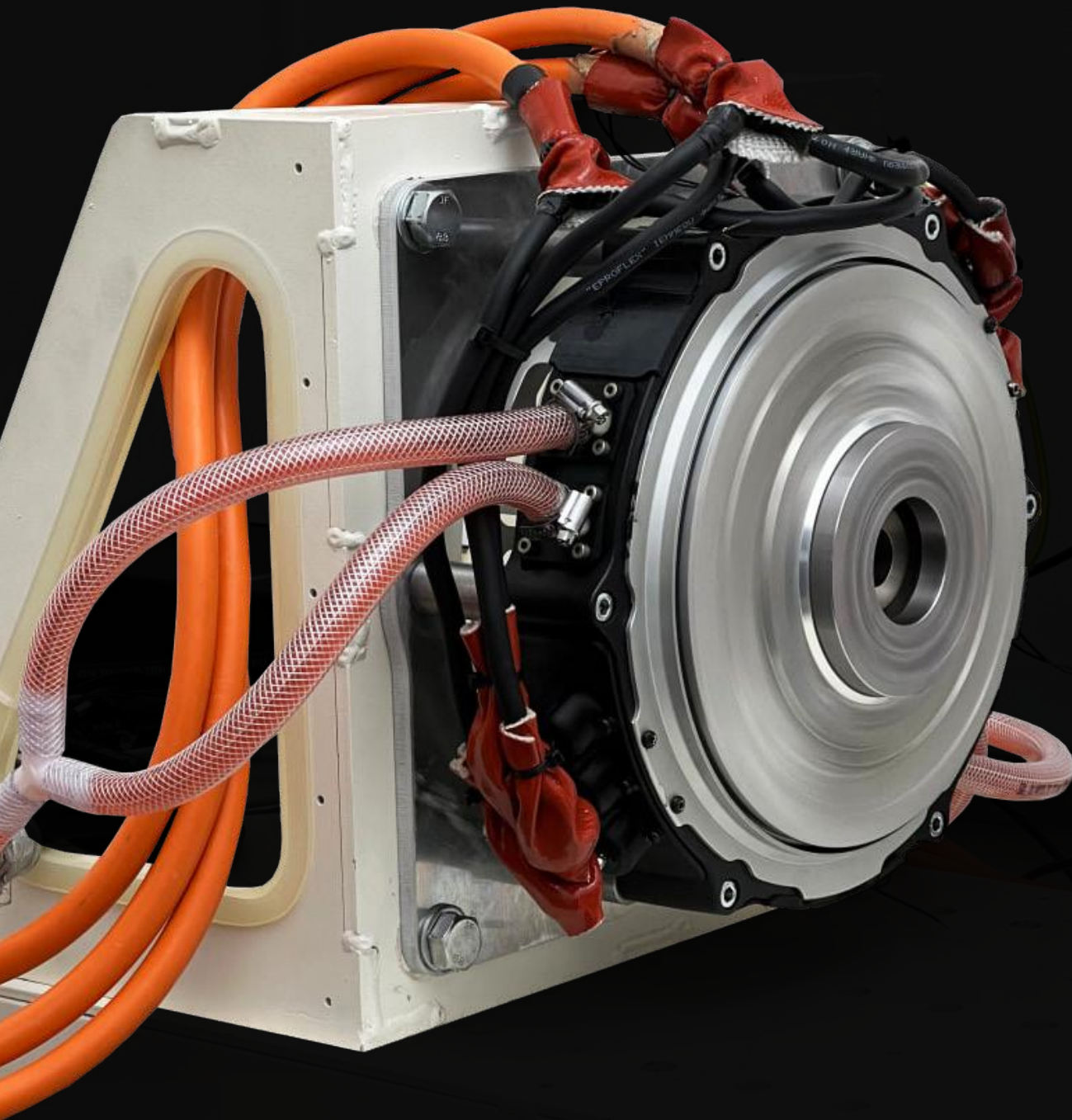
*Inverter: The power supply device that converts DC to AC. The inverter uses rotor position information provided from the resolver to accurately determine the rotor pole position with reference to the stator poles.*

*Motoring: Conversion of electrical energy into mechanical energy*

*Rotor: The rotating portion of the motor*

*Stator: The static, wound portion of the motor*

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# GENERAL INFORMATION

## INGRESS PROTECTION

Our motors have ingress protection IP55.

They are not totally protected from dust so it is recommended to keep the dust away from motor bay area. In case of water ingress, motor should be cleaned with pressured air and/or additionally put into the oven to get rid of the moist at 95-100°C.

## GENERATOR MODE

All our motors work as generators as well. Efficiency and power is the same as in driving mode, the only difference is the settings in the controller.

## POWER RANGE

We are able to provide motors with powers up to 1.2MW of power.

Maximum power one of our motors can provide is 1.2MW of peak power and 690 KW of continuous power. This is our biggest AXM4 Triple motor (3 motors AXM4 stacked together in series). Our smallest currently available motor is AXM2 which has continuous power up to 75 KW at 6000 RPMs.

With lower current or voltage input and/or lower motor speed it can be suitable for applications with lower power requirements like small cars and motorcycles.

## CUSTOMIZABLE OPTIONS

Customizable option - contact us for customized shafts, customized windings, bearings or temperature sensors. We stand ready to customize and tailor solutions to reasonable needs of our customers.

In case of a high order quantity, we are able to develop and produce a whole new motor from scratch according to customers' requirements.

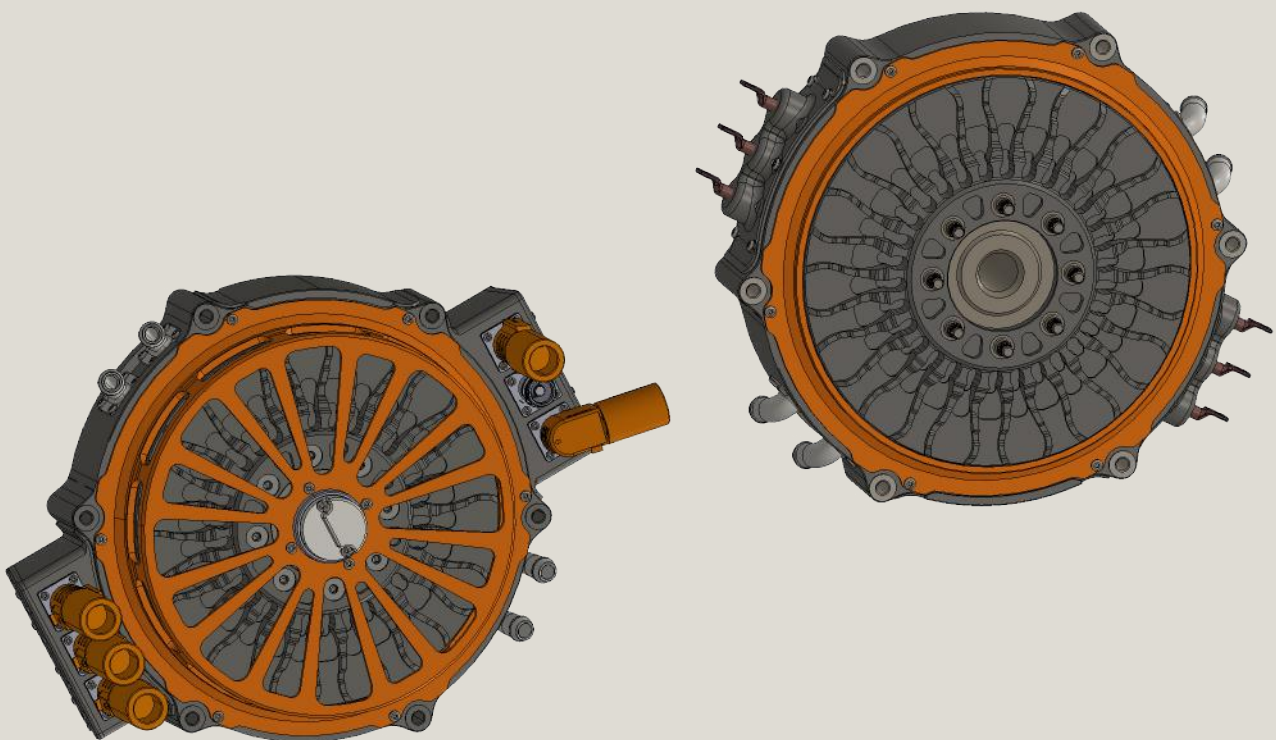
## DOUBLE WINDINGS (2 X UVW) – REDUNDANCY OPTION

All of our motors can be provided with a redundancy option – 2 separated winding halves.

This option is recommended in 2 cases:

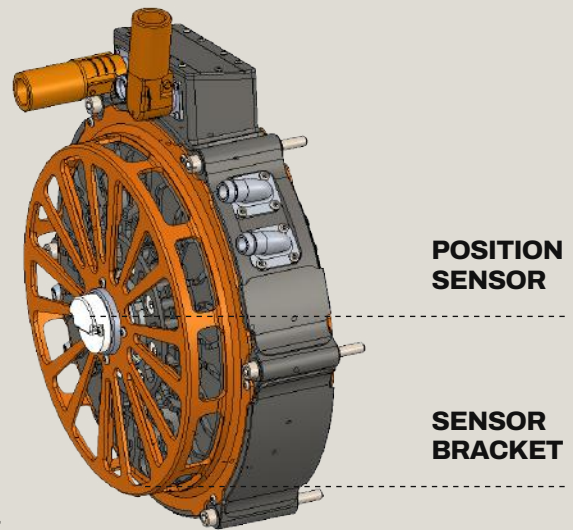
- if one controller cannot provide enough electrical current to enable full power of the motor. In that case, one motor is powered with 2 controllers at the same time.
- if a customer desires an additional safety factor. In case of motor's windings failure, or in case of controller failure, only half of the motor will break and stop working, and the other half will still be able to drive the motor (with half of the power).

In case you choose 2 x UVW motor option, 2 controllers need to drive the motor, each one providing half of the needed current for the motor. In this case you need tandem resolver or encoder signal splitter.



# POSITION SENSOR

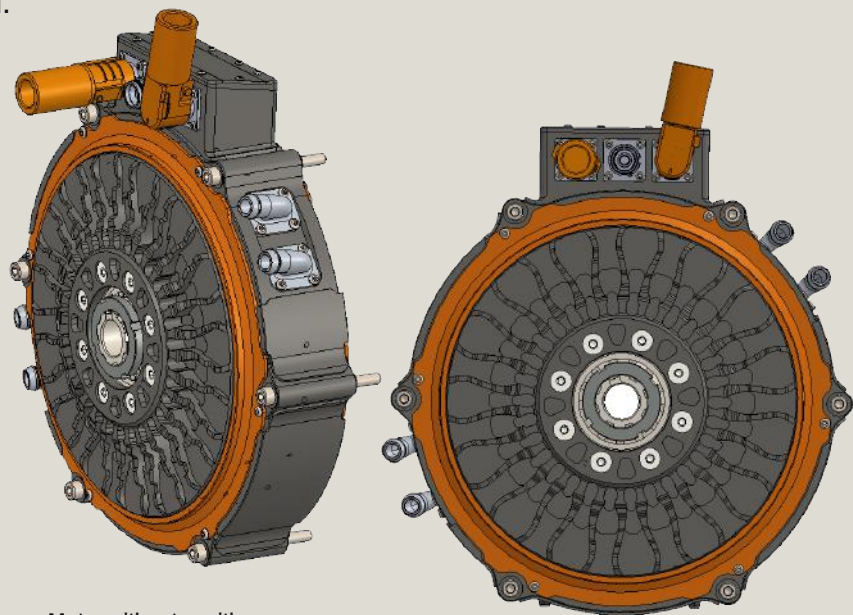
We work with Drivetraininnovation company to provide their controllers for our motors. For their controllers, the most suitable position sensor is encoder which can be chosen in our configurator, together with a suitable bracket. We can also provide different position sensors, depending on the customer requirements. Contact us to know more about that.



In case you choose 2 x UVW motor option, 2 controllers need to drive the motor. In this case you also need tandem resolver or encoder signal splitter. In case of double motor you need to have 2 controllers - each controlling one of the motors. You need either tandem resolver or sensor signal splitter. In case of triple motor you need to have 3 controllers - each controlling one of the motors. You need either triple resolver or sensor signal splitter.

Motor can also be supplied without position sensor. In this case, you have to couple the motor with the suitable controller that offers sensorless motor control.

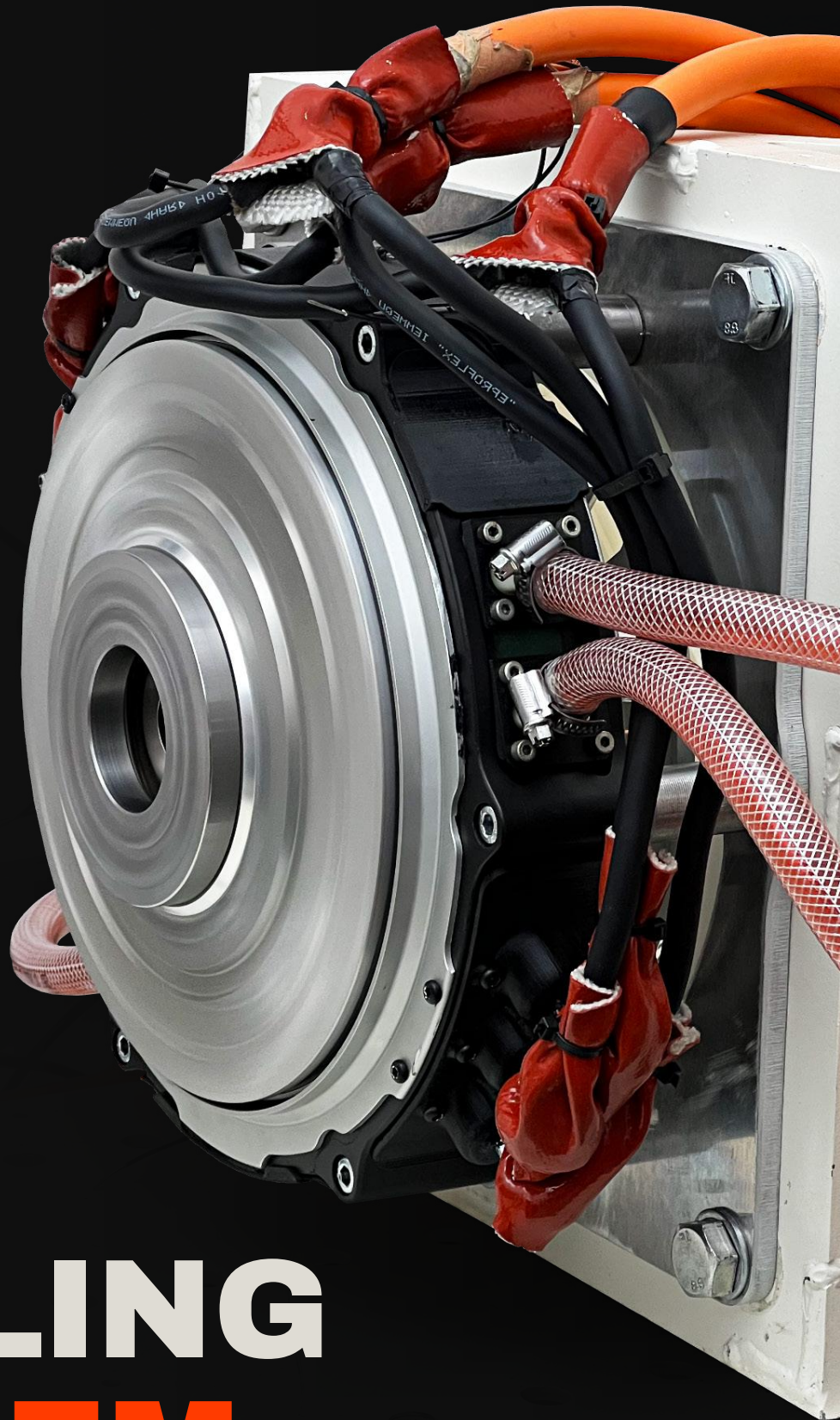
In case of »no sensor« option, the motor has through hole.



Motor without position sensor



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# COOLING SYSTEM

## TEMPERATURE SENSOR

Each motor is provided with an integrated temperature sensor, which is placed directly on the hottest spot of the windings.

Recommended continuous motor temperature is 90°C, maximum continuous temperature is 95°C. Peak short term temperature can go up to 115-120°C.

Minimum starting temperature is -40°C.

In case the temperature is lower than -40, you can heat up the motor by current feeding it without spinning.

## COOLING CONDITIONS

Specifications in the datasheets are provided for ambient temperature of 20°C, inlet coolant temperature 45°C and recommended coolant flows described in the table below.

**! It is necessary to use water + glycol. Pure water or salt water is not allowed !**

Motor size	Minimum Coolant flow and pressure drop	Recommended Coolant flow and pressure drop	Other coolant flows and pressure drops	Maximum continuous pressure drop through the motor	Maximum pressure drop through the motor
AXM2	22 L/min at 0,4bar	30 L/min at 0,7bar	40 L/min at 1 bar	1,2bar	1,5 bar
AXM3	15 L/min at 0,5bar	20 L/min at 1 bar	23 L/min at 1.3 bar	1,3bar	1,8 bar
AXM4	15L/min at 0,6bar	19 L/min at 1 bar	22L/min at 1,4 bar	1,4bar	2 bar

Customer needs to provide adequate coolant flows and coolant inlet temperature.

**Recommended inlet coolant temperature is 45°C or lower.**

Maximum continuous inlet coolant temperature is 60°C.

Maximum short term inlet coolant temperature is 70°C.

Motor's bay area needs to be provided with fresh air and exhaust of hot air. Rotor is designed in a way that creates air flow around it. Forced air flow is not necessary but recommended.

If this is not possible, please contact us to discuss a possible customized solution.

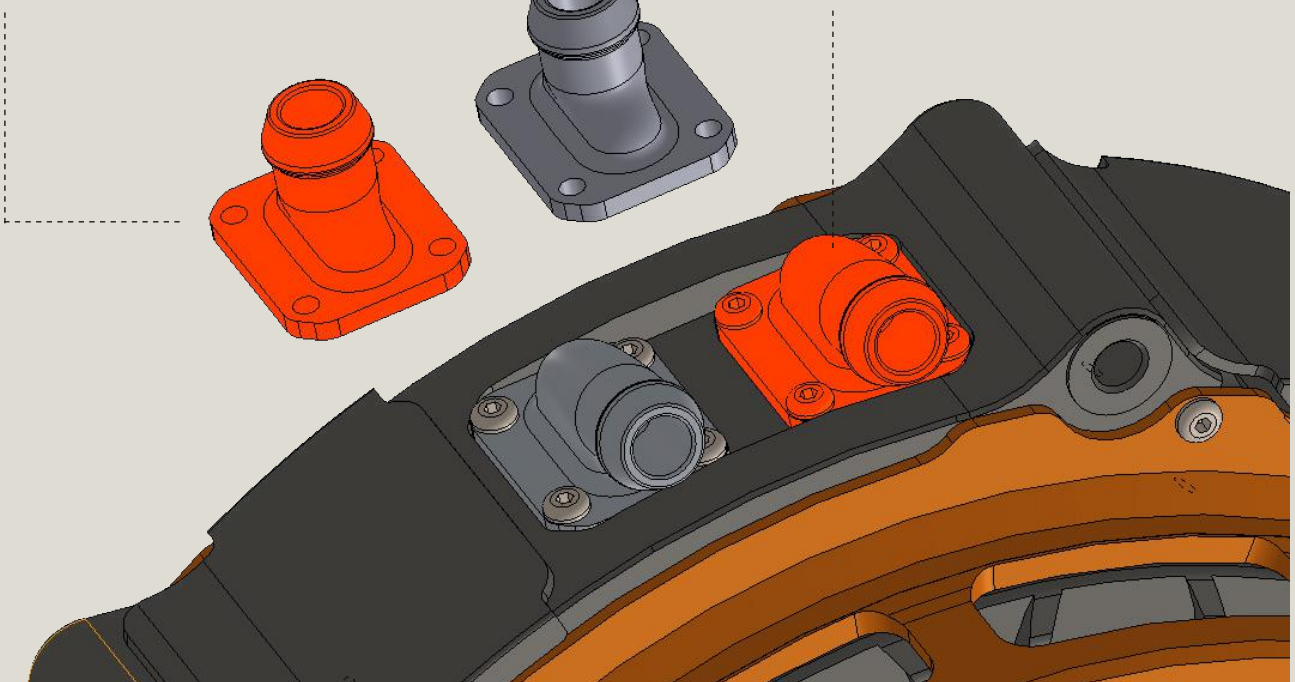
# COOLING PIPES

Customers can choose between straight or angled cooling pipes that come installed on the motor and are free of charge.



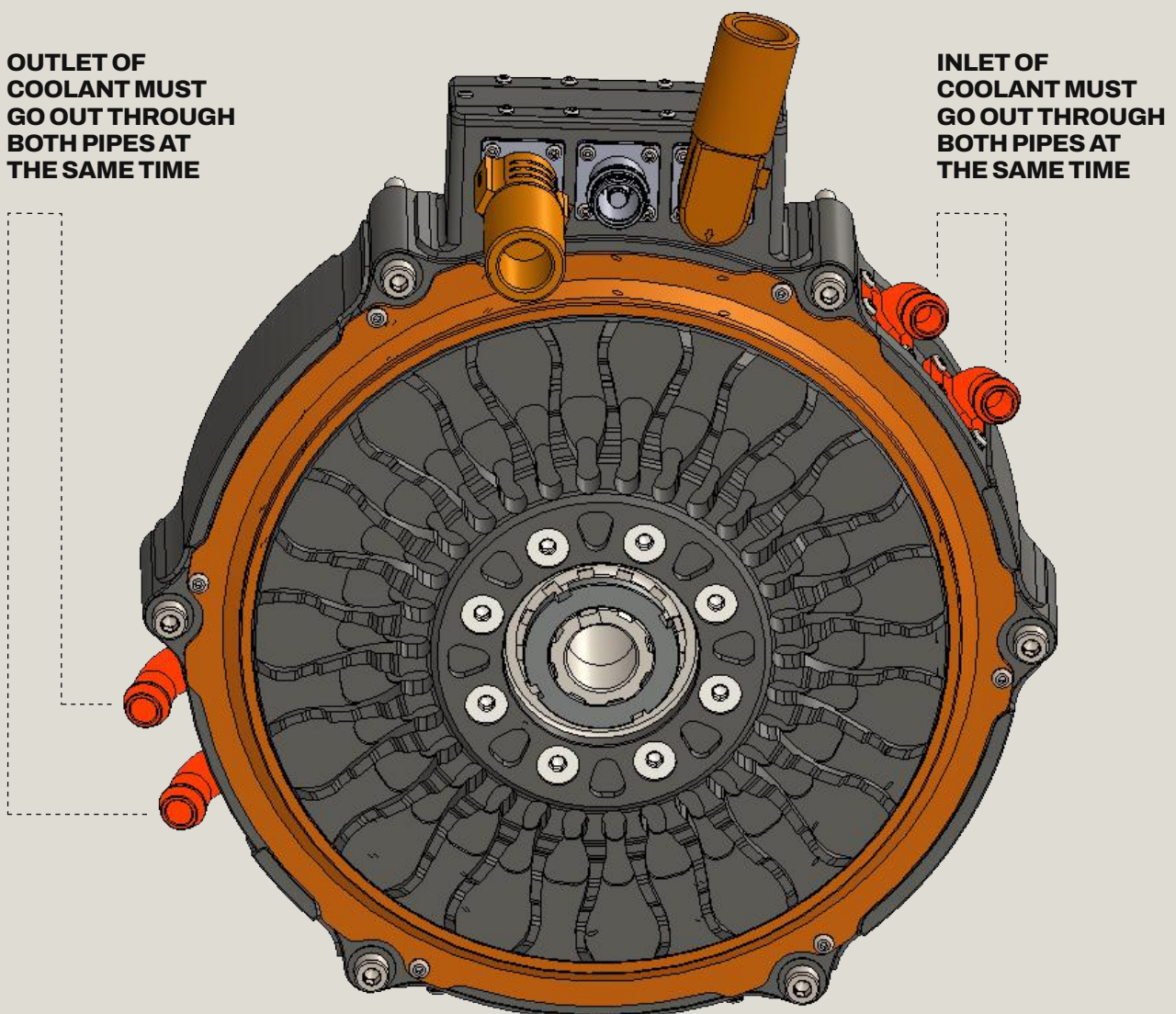
**STRAIGHT INLET/OUTLET  
COOLING PIPES**

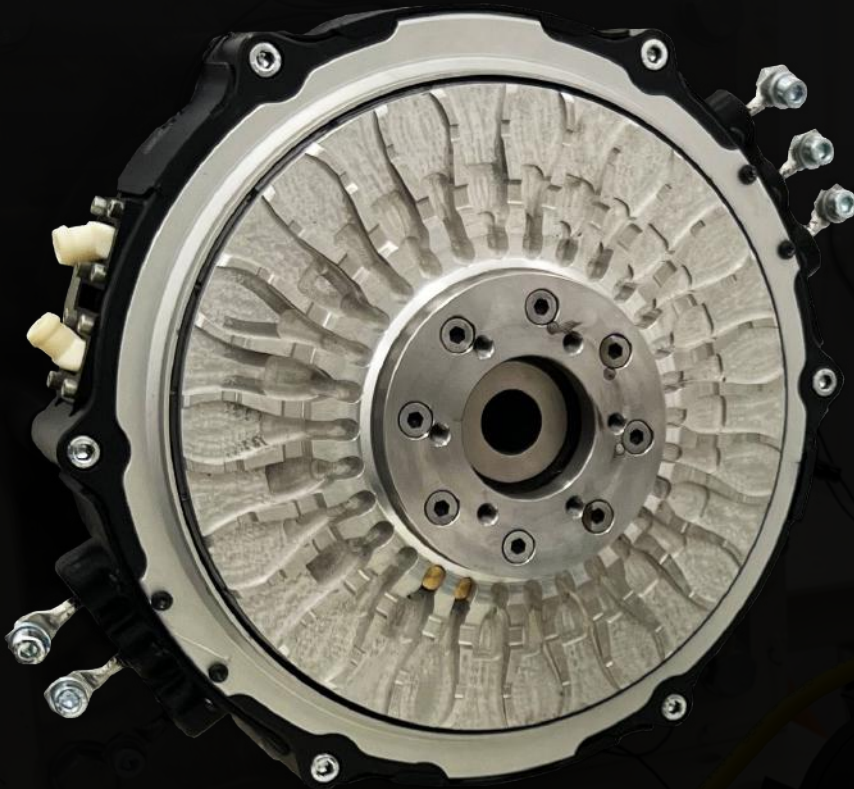
**ANGLED (75°)  
COOLING PIPES**



Coolant outlet is on one side of the motor, and coolant inlet is on the other side of the motor (it doesn't matter which side is inlet and which one is outlet). When attaching coolant hoses to our cooling pipes, two parallel hoses need to be attached to cooling pipes on each side (one coolant hose to one of the pipe).

Equal coolant flow and pressure needs to be provided through both of the pipes. Recommended way is to have 1 common coolant hose that divides into 2 parallel smaller hoses of equal length. Each of the parallel hoses is then attached to each of the cooling pipes.





# SINGLE STATOR & ROTOR MOUNTING

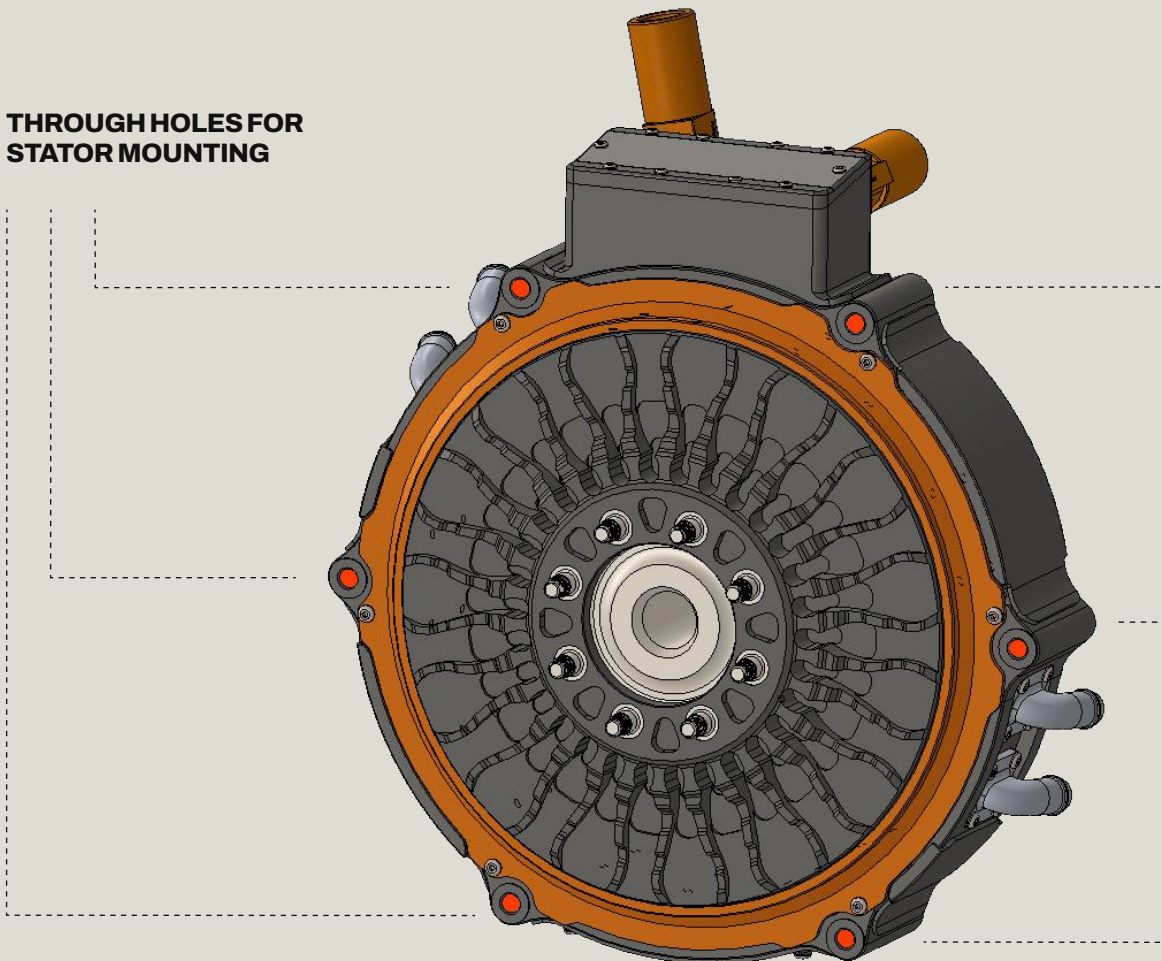
# STATOR

Stator needs to be mounted with bolts mounted through the six holes on the circumference of the stator.

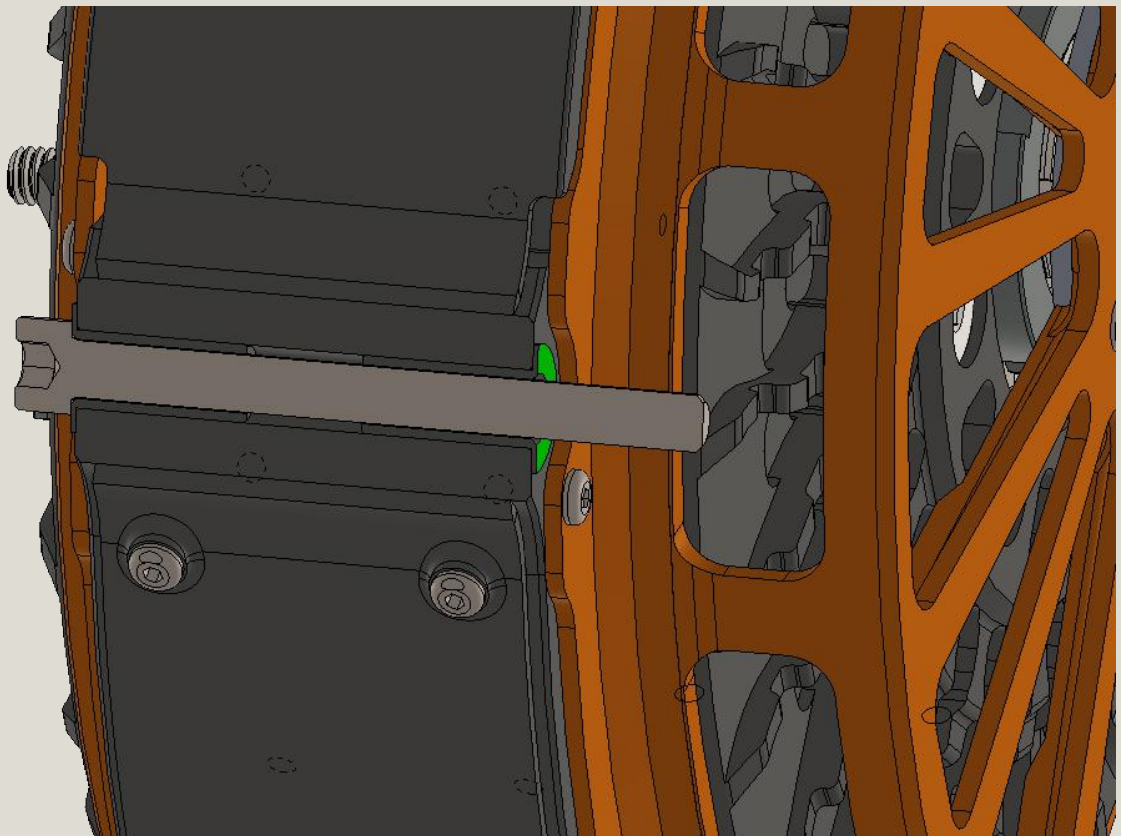
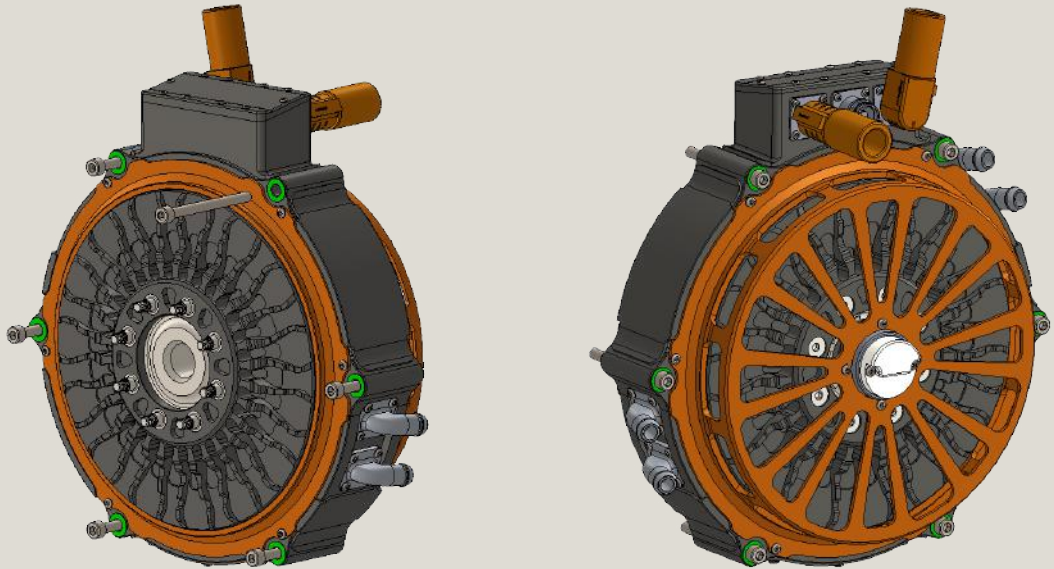
Bolt size:

- For AXM2 motor: bolt diameter M8, length 80mm or more (at least 14mm of thread in bracket to which motor is attached)
- For AXM2 motor: bolt diameter M8, length 85mm or more (at least 19mm of thread in bracket to which motor is attached)
- For AXM4 motor: bolt diameter M10, length 90mm or more (at least 24mm of thread in bracket to which motor is attached)

**THROUGH HOLES FOR  
STATOR MOUNTING**



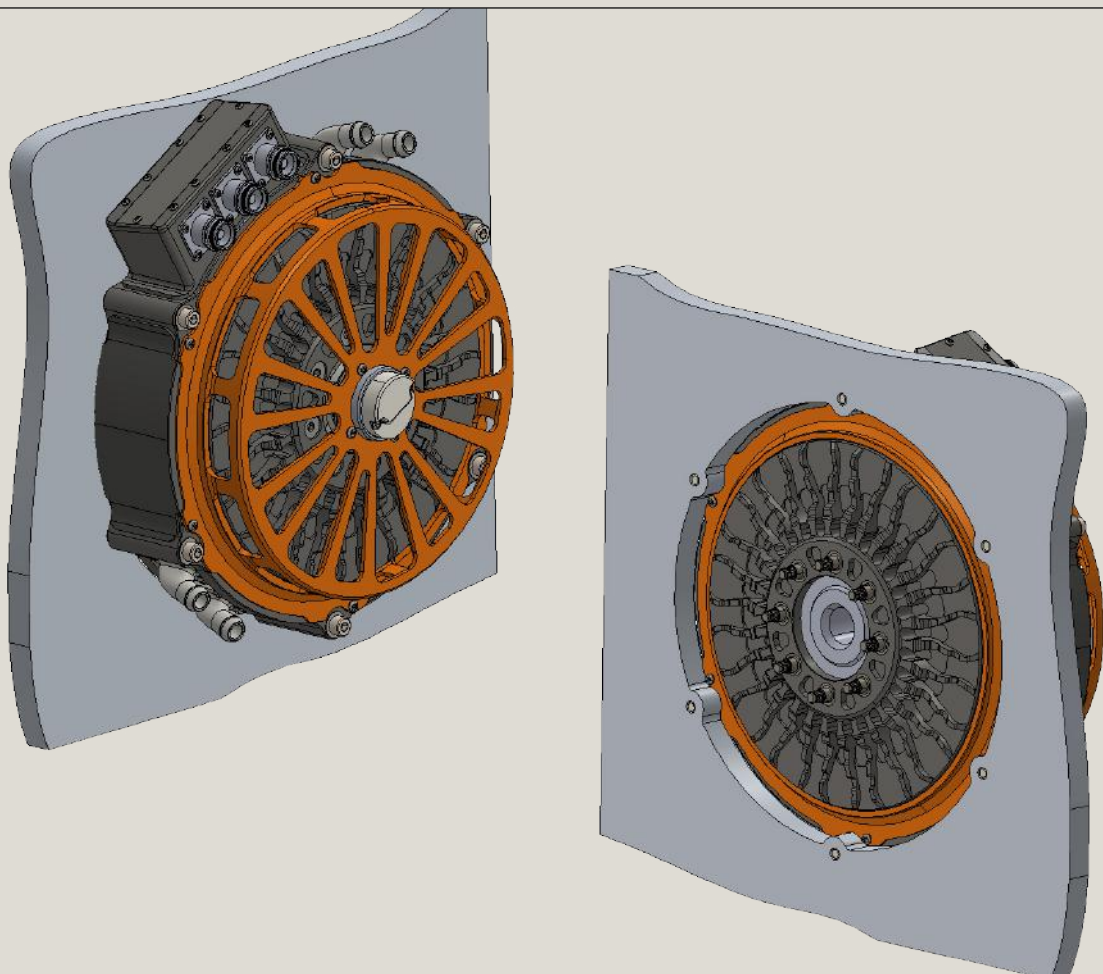
Green surfaces in the pictures below represent mounting/bearing surface. Motors can be mounted from any of the two sides.





One SINGLE motor mounting example – motor is installed to the chassis / plate or structure that has 6 threads in circular position, on every 60°.

Mounting structure can also possess stud bolts in which case the motor is then placed on the stud bolts and tightened with nuts (preferably self-locking nuts).



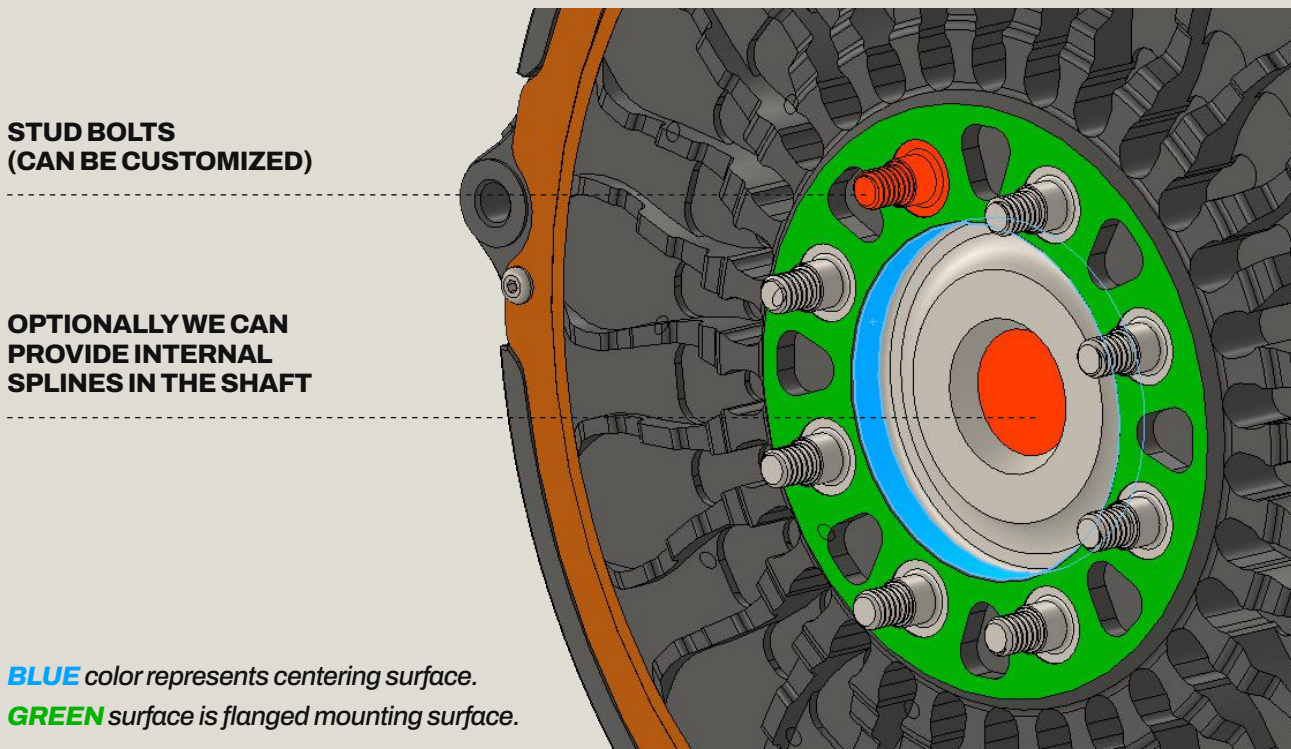
## ROTOR

Via rotor, the motor gives out mechanical power output.

Preferably, torque/power is translated from the motor via stud bolts. The coupling or flanged shaft attached to the rotor needs to be centered according to blue colored rotor surface (preferably with light clearance fit).

Flanged shaft or coupling needs to be attached with self locking nuts, screwed down on stud bolts. Optionally, we can provide customized stud bolts (different diameter, thread or length).

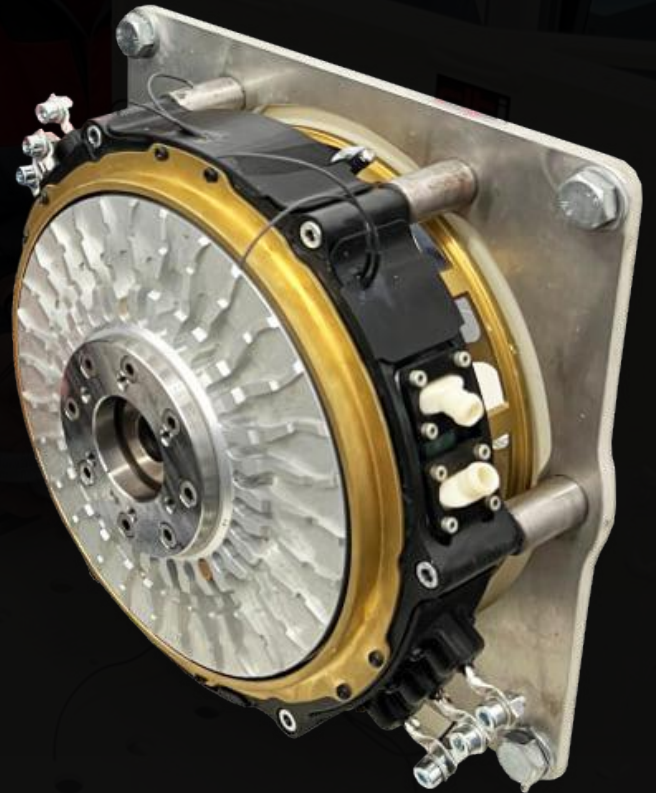
Additionally, we can provide internal splines in the motor shaft.



Power output via rotor is the same in case of Single, Double or Triple motor.

It is very important the rotor's centering surface is concentric with the attached coupling. Maximum allowed misalignment is 0,15mm for AXM2, 0,22mm for AXM3 and 0,3mm for AXM4.

Misalignment clutch or rubber coupling is recommended.



# **STACKING** OPTIONS & STACKED MOTORS MOUNTING

## GENERAL NOTICE

All our motor sizes can be stacked together in series.

### DOUBLE

Two motors connected together in series. In that case, motors provide double the torque and double the power compared to Single motor version.

In case of Double motors, each of the two stacked motors need to be driven with separate controller. So all in all, 2 controllers are needed to propel one DOUBLE motor configuration.

Each of the controllers need to have position sensor signal, so recommended option is either encoder signal splitter or tandem resolver.

### TRIPLE

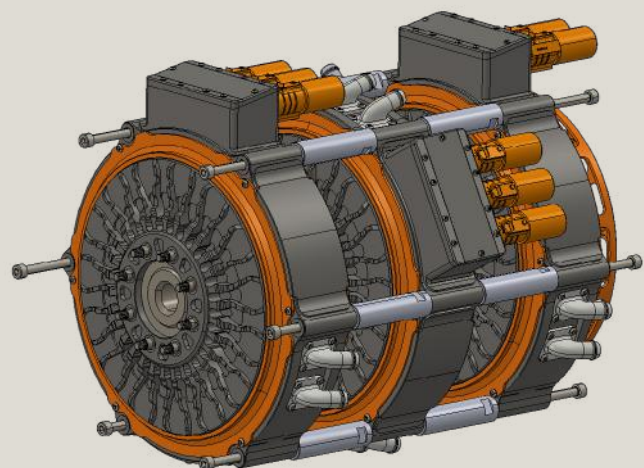
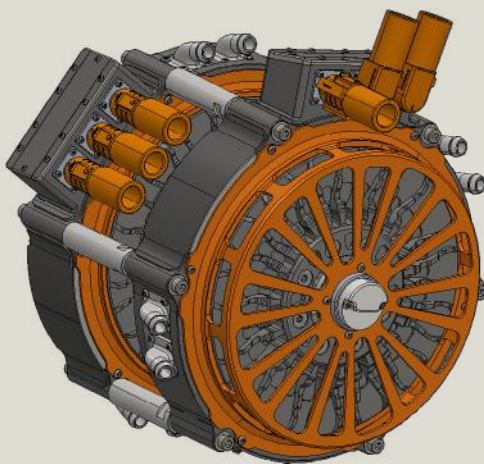
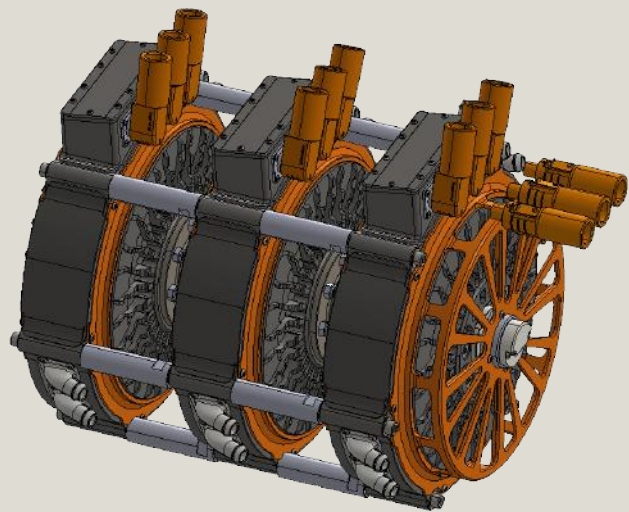
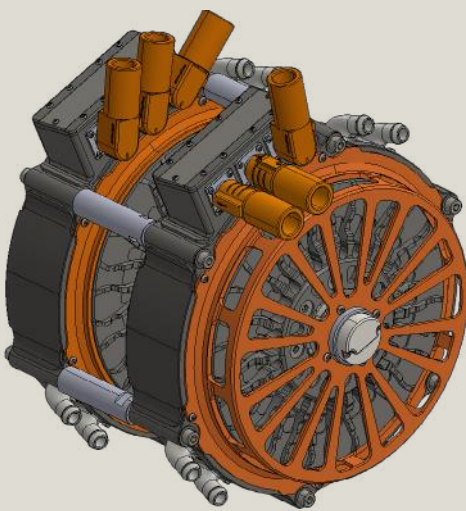
Three motors connected together in series. In that case, motors provide triple the torque and triple the power compared to Single motor version.

In case of Triple motors, each of the three stacked motors need to be driven with separate controller. So all in all, 3 controllers are needed to propel one TRIPLE motor configuration.

Each of the controllers need to have position sensor signal, so recommended option is either encoder signal splitter or triple resolver.

In case of stacking, we offer 2 different alignments between motors that are stacked together.

One version is Aligned – all stacked motors are aligned together (phase connectors in the same position).



The second version is Angled at 60 degrees, meaning the second motor is positioned at 60 degree angle compared to the first one.

## DOUBLE MOTOR MOUNTING

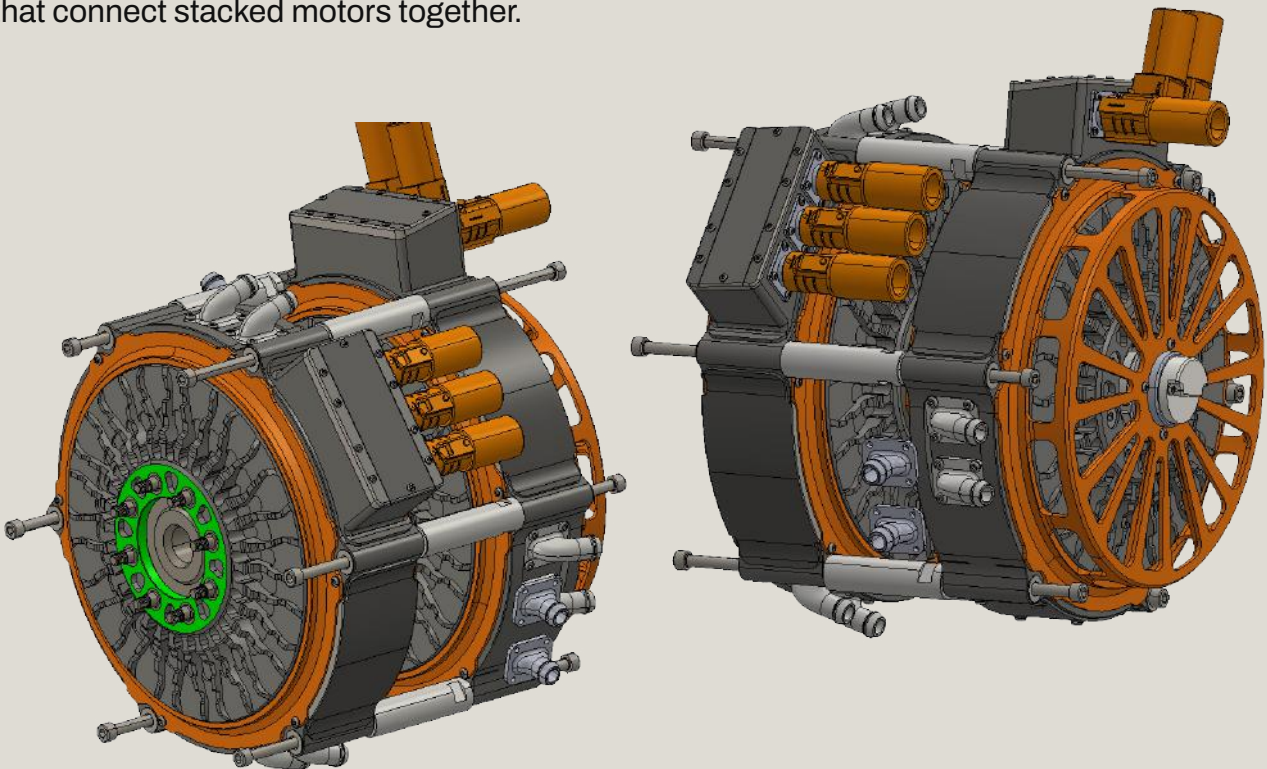
Motor mounting bracket must be placed between heads of the bolts and stator.  
Motor needs to be attached with all 12 bolts (6 from each side).

Motor comes already assembled, so the mounting bolts need to be unscrewed and tightened back again when motor is placed to the mounting brackets.

Mounting brackets need to have through holes for tightening the bolts

Bolts diameter: M8 for AXM2 and AXM3, and M10 for AXM4.

Additionally, the motor can be placed on and fixed via aluminium bars that connect stacked motors together.



One example of DOUBLE motor mounting (the same example can be used for TRIPLE motor).

We recommend mounting plate of 10mm thickness. In case bigger thickness of brackets is used, original bolts have to be replaced by longer ones.

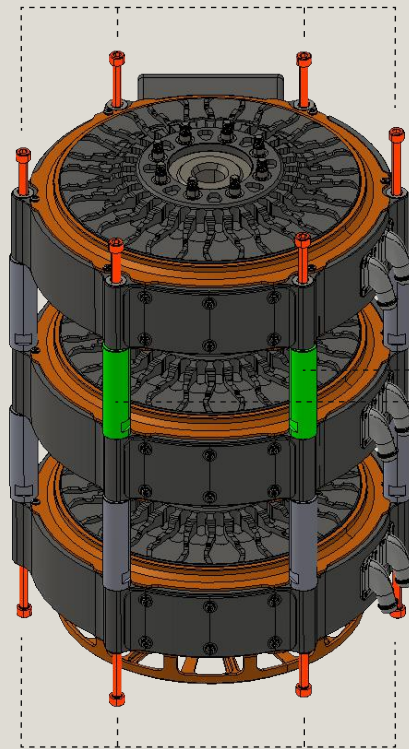
# TRIPLE MOTOR MOUNTING

The same as with Double motor, mounting bracket sits between heads of the bolts and stator.

Motor needs to be attached with all 12 bolts (6 from each side). Motor comes already assembled, so the mounting bolts need to be unscrewed and tightened back again when motor is placed to the mounting brackets.

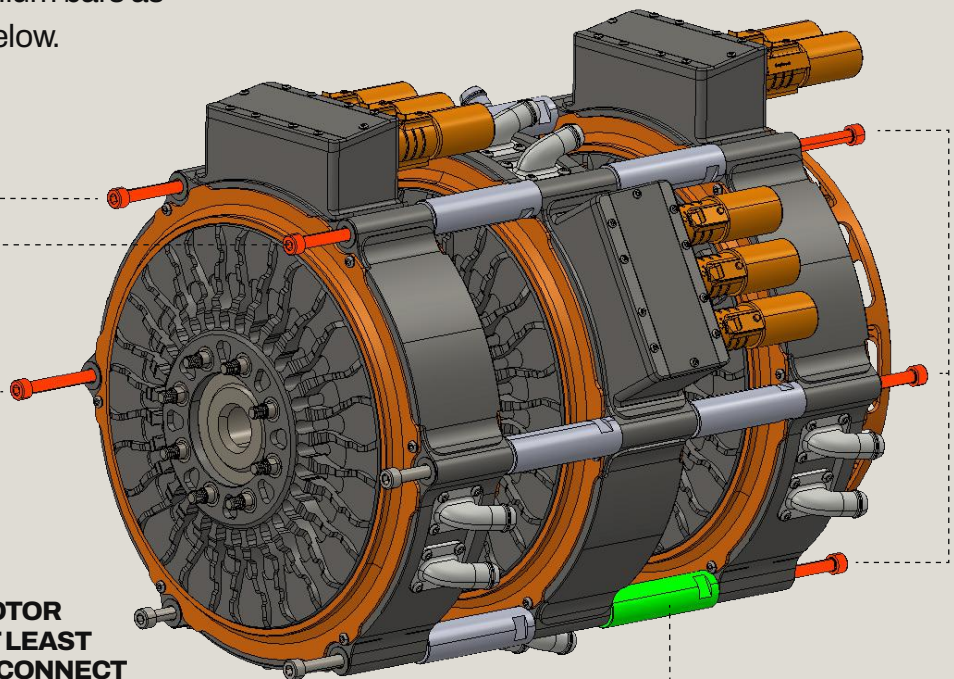
Additionally, in case of TRIPLE motor, the stacked motor also needs to be fixed via at least 2 aluminium bars as marked in the pictures below.

**MOTOR HAS TO BE MOUNTED ON A BRACKET THAT SITS BETWEEN STATOR AND BOLTS HEAD**



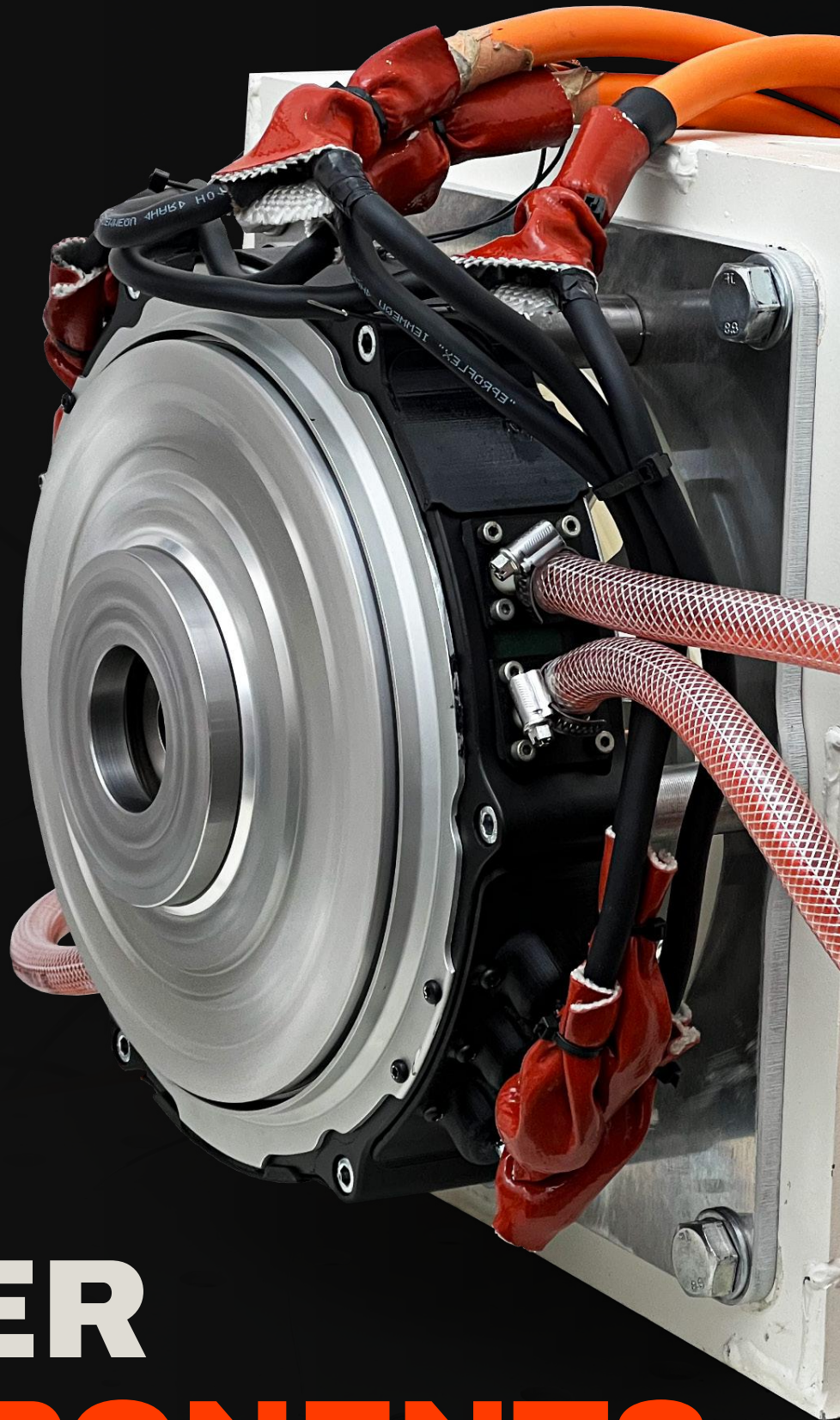
**ADDITIONALLY, TRIPLE MOTOR NEEDS TO BE FIXED VIA AT LEAST 2 ALUMINIUM BRAS BETWEEN STACKED MOTORS**

**MOUNTING BRACKET FOR THE MOTOR NEEDS TO SIT BETWEEN STATOR AND BOLTS HEADS**



**ADDITIONALLY, TRIPLE MOTOR NEEDS TO BE FIXED ON AT LEAST 2 ALUMINIUM BARS THAT CONNECT STACKED MOTORS TOGETHER**

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# OTHER COMPONENTS



## BEARINGS

Standard motor option is One-row deep-groove bearings with metal sealings on both sides.

Stator is also prepared for Double-row deep-groove bearings.

Motor size	One-row deep-groove bearings (Standard option)	Double-row deep-groove bearings (additional option)
<b>AXM2</b>	<b>6206</b>	<b>3206</b>
<b>AXM3</b>	<b>6208</b>	<b>3208</b>
<b>AXM4</b>	<b>6210</b>	<b>3210</b>

Additionally, we can provide other bearings as a part of our customizable solution.

## WINDING TYPES (VOLTAGE TYPES)

All our motor sizes are available in three winding types (Low voltage, Medium voltage, and High voltage).

We always recommend to customers to go on as high voltage as possible because higher voltages require lower electric current for the same power output.

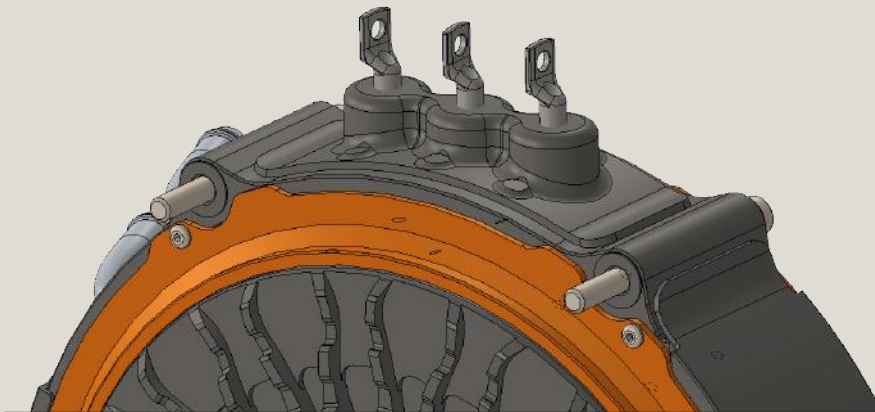
Consequently higher voltage means higher efficiency of the whole system.

## PHASE CONNECTORS

All our motors have 2 phase connector options:

### CABLE LUGS

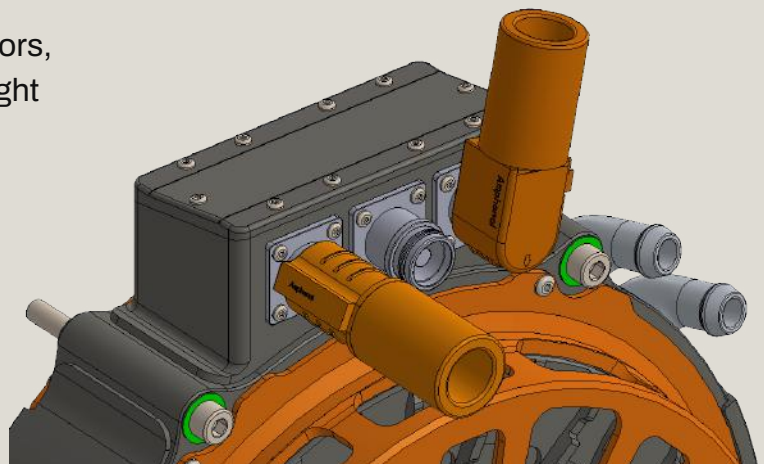
Standard option for UVW connectors are cable lugs.



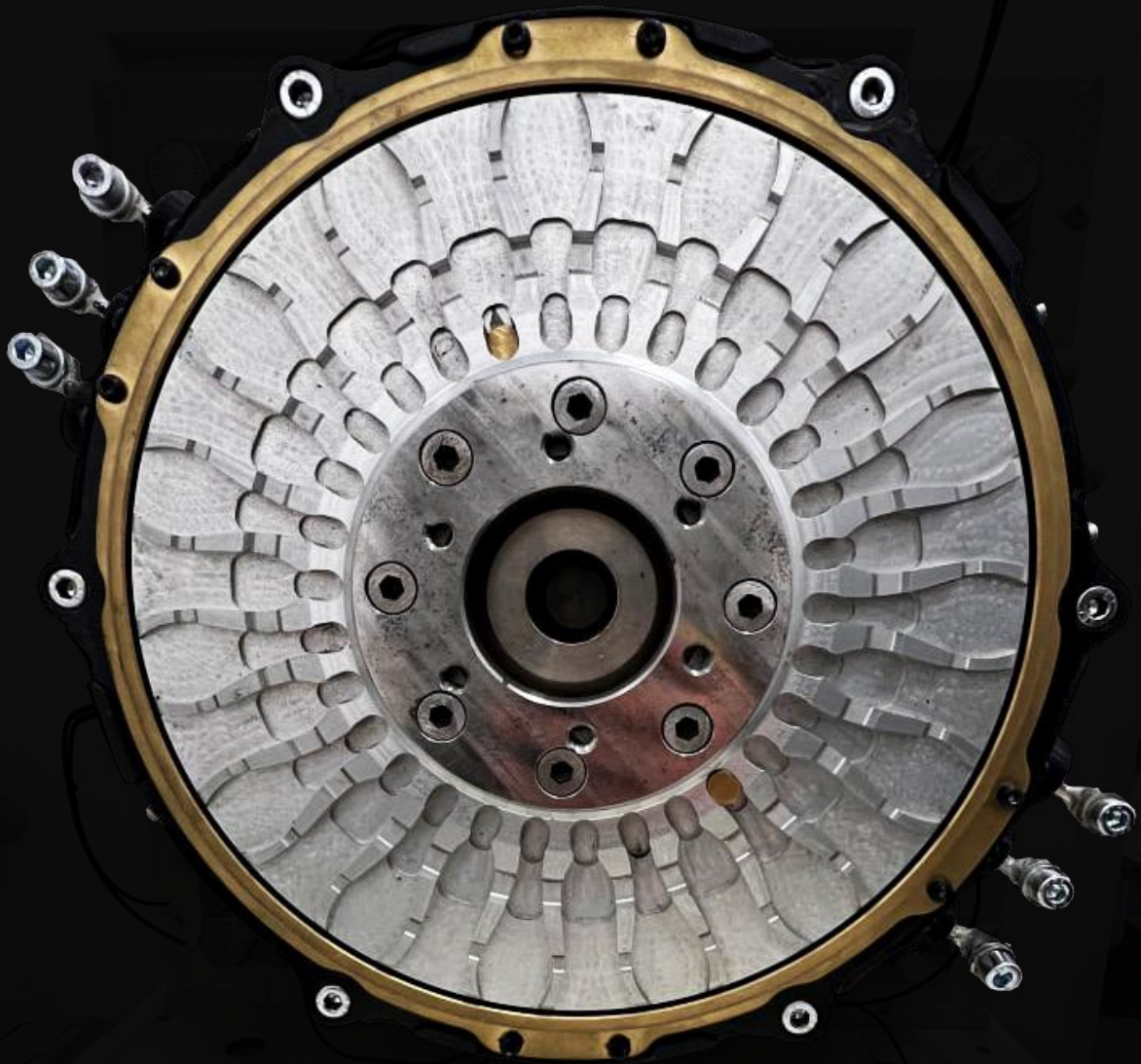
### IP67 CONNECTORS

Customers can choose additional option of Amphenol automotive connectors that provide high electrical insulation and ingress protection (IP67).

In case of chosen Amphenol connectors, customers can choose between straight or bent (90°) version.



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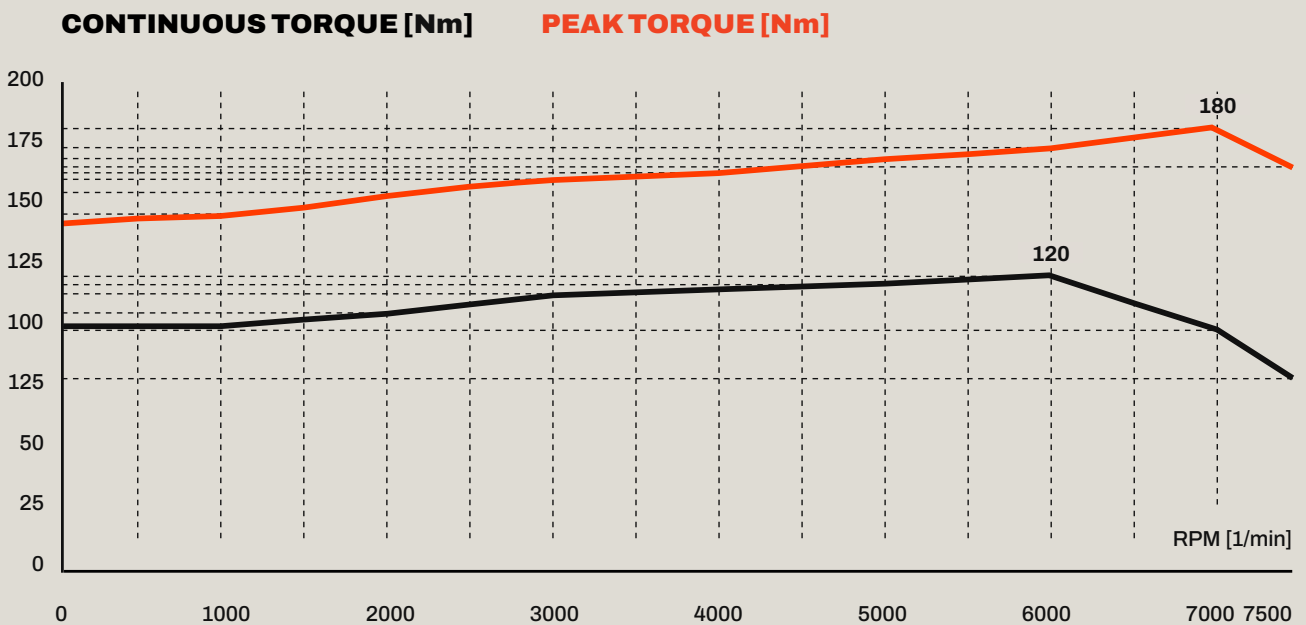
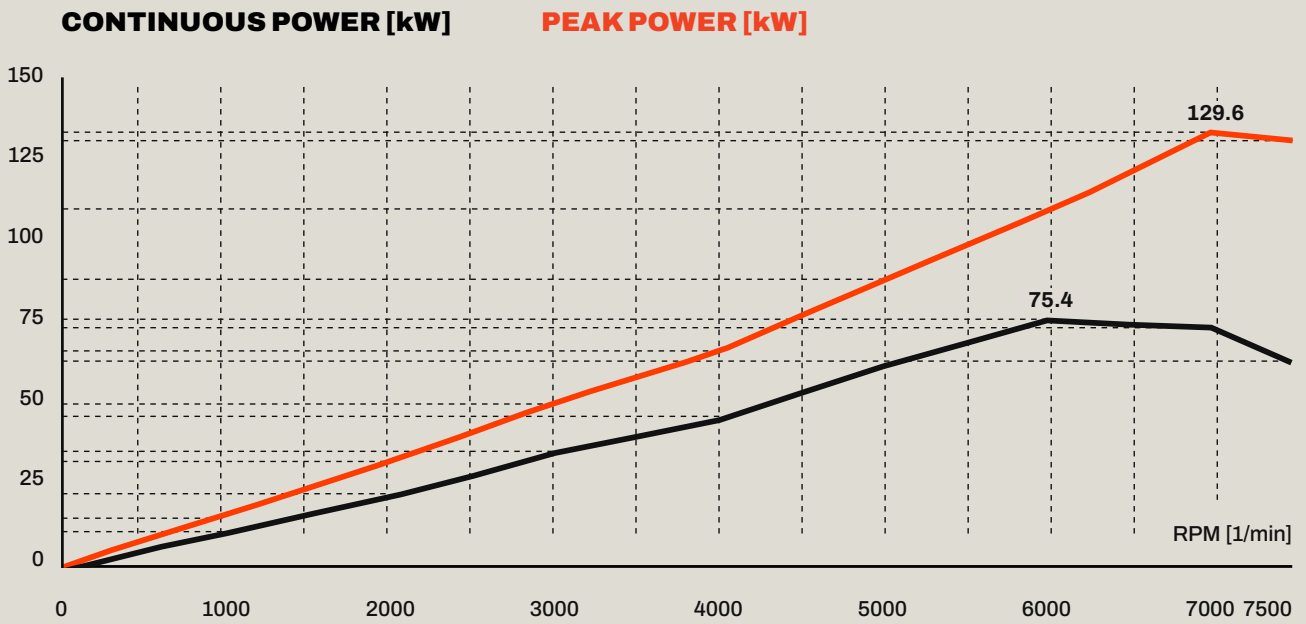


# TECHNICAL DATA & INFORMATION

# AXM2 - OVERVIEW

Motor	AXM2		
	HIGH Voltage (850Vdc)	MEDIUM Voltage (550Vdc)	LOW Voltage (300Vdc)
Winding type			
Peak power	130 kW		
Continuous power	75 kW		
Peak torque	180 Nm		
Continuous torque	120 Nm		
Maximum motor speed	7500 RPM		
Continuous motor speed	6000 RPM		
Peak current	190 Arms	380 Arms	725 Arms
Continuous current	130 Arms	260 Arms	500 Arms
Weight	14,5kg		
Rotor inertia	0,0228 kgm <sup>2</sup>		
Kv at no load	8.8	17.6	33.6
Kv at continuous torque	7	14	26.7
Kv at peak torque	6.2	12.3	23.5
Torque constant	0,95 Nm/Arms	0,48Nm/Arms	0,25Nm/Arms
Motor type	3-phase AC PM	3-phase AC PM	3-phase AC PM

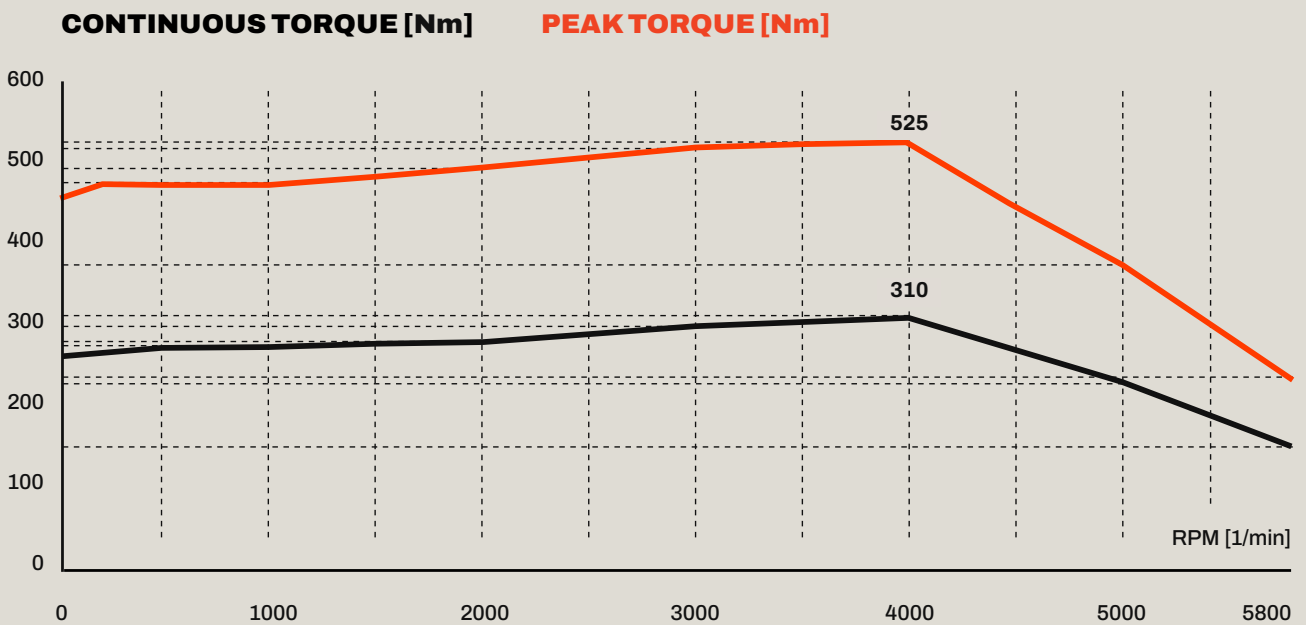
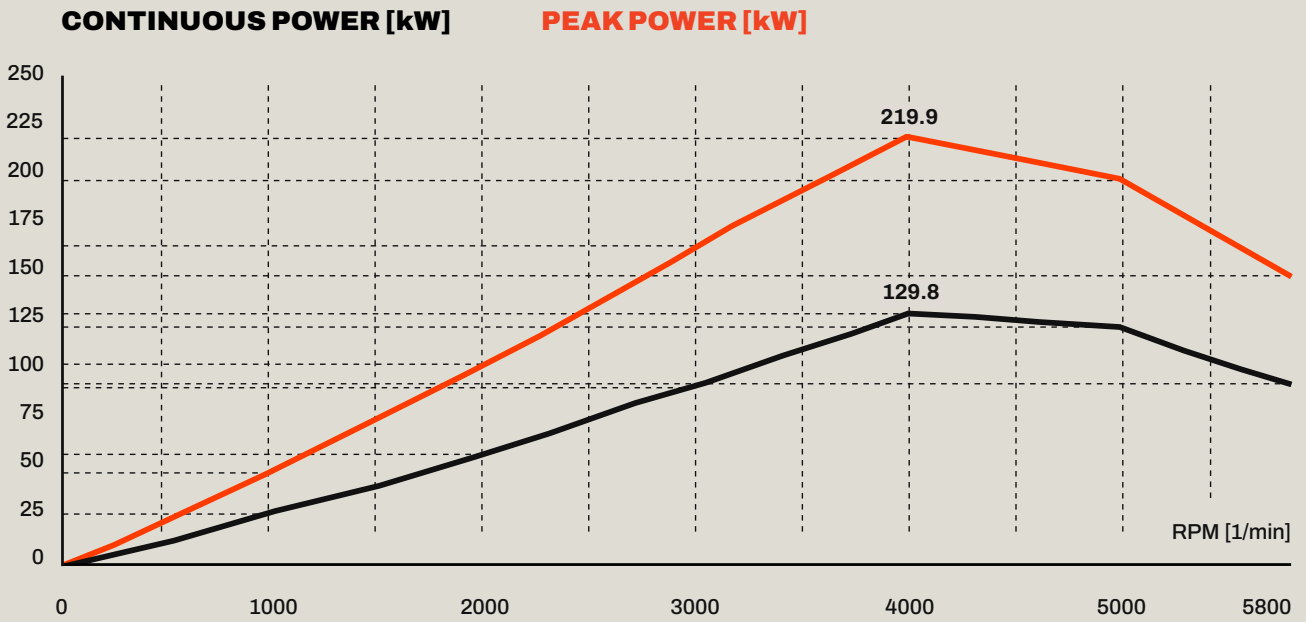
# AXM2 - CHARTS



# AXM3 - OVERVIEW

Motor	AXM3			
Winding type	EXTRA HIGH Voltage (850Vdc)	HIGH Voltage (800Vdc)	MEDIUM Voltage (550Vdc)	LOW Voltage (400Vdc)
Peak power	135 kW (at 2500RPMs)	220 kW		
Continuous power	80 kW (at 2500 RPMs)	130 kW		
Peak torque	525 Nm			
Continuous torque	310 Nm			
Maximum motor speed	3200 RPM	5800 RPM		
Continuous motor speed	2500 RPM	4000 RPM		
Peak current	200 Arms	400 Arms	580 Arms	790 Arms
Continuous current	115 Arms	235 Arms	340 Arms	460 Arms
Weight	27 kg			
Rotor inertia	0,0845kgm <sup>2</sup>			
Kv at no load	4.1	8.3	12	16.3
Kv at continuous torque	3.2	6.5	9.5	12.9
Kv at peak torque	2.85	5.8	8.4	11.45
Torque constant	2,5 Nm/Arms	1,22 Nm/Arms	0,84 Nm/Arms	0,62 Nm/Arms
Motor type	3-phase AC PM	3-phase AC PM	3-phase AC PM	3-phase AC PM

# AXM3 - CHARTS



# AXM4 - OVERVIEW

Motor	AXM4		
Winding type	HIGH Voltage (850Vdc)	MEDIUM Voltage (750Vdc)	LOW Voltage (550Vdc)
Peak power	300 kW (at 3000 RPMs)	430 kW	
Continuous power	230 kW	230 kW	
Peak torque	950 Nm		
Continuous torque	600 Nm		
Maximum motor speed	4500 RPM		
Continuous motor speed	3600 RPM		
Peak current	440 Arms	630 Arms	850 Arms
Continuous current	280 Arms	400 Arms	525 Arms
Weight	48 kg		
Rotor inertia	0,308kgm <sup>2</sup>		
Kv at no load	5.6	8	10.5
Kv at continuous torque	4.35	6.15	8.25
Kv at peak torque	3.85	5.55	7.3
Torque constant	2,07 Nm/Arms	1,45 Nm/Arms	1,1 Nm/Arms
Motor type	3-phase AC PM	3-phase AC PM	3-phase AC PM



# AXM4 - CHARTS

