



**FEUP** FACULDADE DE ENGENHARIA  
UNIVERSIDADE DO PORTO

DEMec - Dep. of Mechanical Engineering  
SAIC- Automation, Instrumentation and Control Section  
Master in Mechanical Engineering

## **Electromechanical Systems**

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Support documents to TP classes

Electric motors in battery electric vehicles

Paulo Abreu

**2026 Edition**

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# Electric Motors in Battery Electric Vehicles

## Applications, Types, and Trends

Paulo Abreu  
March 2026

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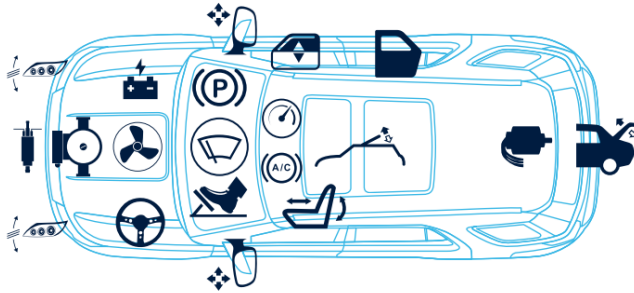
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## Electric motors in cars

**The Multi-Motor Vehicle:** Modern EVs are not just one motor; they contain dozens!



**Examples:**

- Windshield Wipers
- Doors glass, mirrors, doors
- Seat Actuation/Adjustment
- Braking
- Power steering
- Air conditioning
- Water, oil, fuel pumps
- Traction and drive systems

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<https://www.st.com/en/applications/automotive.html>

<https://ev-database.org>

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## Electric Motors in the Modern Vehicle

**The Multi-Motor Ecosystem:** A modern EV can contain over 50 individual motors

**Classification by Function**

- **Auxiliary Systems** (Low Voltage 12V/48V): intermittent or continuous duty (Wipers, seats, pumps)
- **Traction Systems** (High Voltage 400V/800V): high-power propulsion

**Classification by Control**

- **Open-Loop:** Brushed DC, Steppers (Simple, low-cost)
- **Closed-Loop:** BLDC, PMSM, IPMSynRM (High-performance, requires Inverters)

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### Auxiliary Actuators (Intermittent Duty)

#### Brushed DC Motors:

- **Applications:** power windows, trunk latches, side-mirror adjustment
- **Engineering Logic:** high starting torque and very low system cost. Simple PWM control is sufficient

#### Stepper Motors:

- **Applications:** headlight leveling/swiveling, HVAC flap control, HUD positioning
- **Engineering Logic:** provides precise "digital" positioning without the need for an expensive encoder (sensorless positioning)

### High-Duty Auxiliaries & Thermal Management

#### BLDC Motors (Brushless DC):

- **Applications:** electric water pumps, oil pumps, and HVAC blowers
- **Engineering Logic:** used where high reliability and continuous operation are required. Removing brushes eliminates wear and electromagnetic interference (EMI)

**E-Compressors:** high-voltage BLDC motors with integrated inverter driving a compressor used for cabin climate control and battery thermal management. These are critical for maintaining battery health during rapid charging

### Traction Motor Topologies

Traction motors are characterized by high torque density and wide speed ranges

- **Induction Motors (IM):** high reliability, no magnets (Tesla Model S/X front)
- **Wound Rotor Synchronous (WRSM):** no magnets; uses copper coils on the rotor. Allows for "flux weakening" at high speeds (BMW i4, Renault Zoe)
- **IPMSynRM (Internal Permanent Magnet Synchronous Reluctance):** combines magnetic torque and reluctance torque for maximum efficiency (Tesla Model 3/Y)
- **PMSM (Permanent Magnet Synchronous):** the industry standard for high efficiency and compact packaging (Audi e-tron, VW ID series)

### Performance Geometries: Radial vs. Axial Flux

#### Radial Flux (Standard)

- Flux travels perpendicular to the shaft
- The "workhorse" of the industry due to mature manufacturing processes

#### Axial Flux (Performance)

- Flux travels parallel to the shaft ("Pancake" shape)
- **Advantage:** Highest torque density and compact axial length
- **Usage:** Hypercars (Ferrari SF90, Koenigsegg) and in-wheel motor applications

## Industrial Servos vs. EV Traction Motors

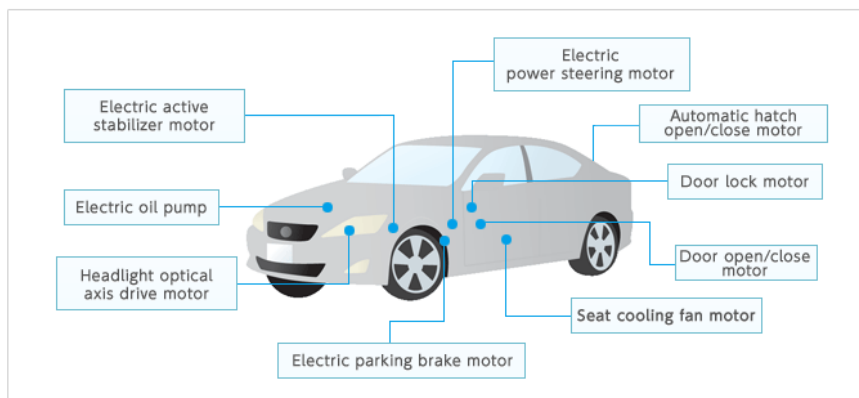
Every traction motor in a modern EV is essentially a giant, high-voltage servomotor

Feature	Industrial Servomotor	EV Traction Motor
Primary KPI	Positioning Precision	Efficiency and Range (km/kWh)
Dynamic Priority	High bandwidth; instant start/stop	High torque density; smooth acceleration
Voltage Range	Typically 230V - 400V AC	High Voltage (400 V- 800V DC Bus)
Feedback Device	Optical/Magnetic Encoder or Resolver	Rugged Resolver (high vibration resistance)
Cooling Strategy	Natural convection or forced air	Liquid cooling (Water/Glycol or Oil-path)
Control Logic	Field-Oriented Control (FOC)	Field-Oriented Control (FOC)

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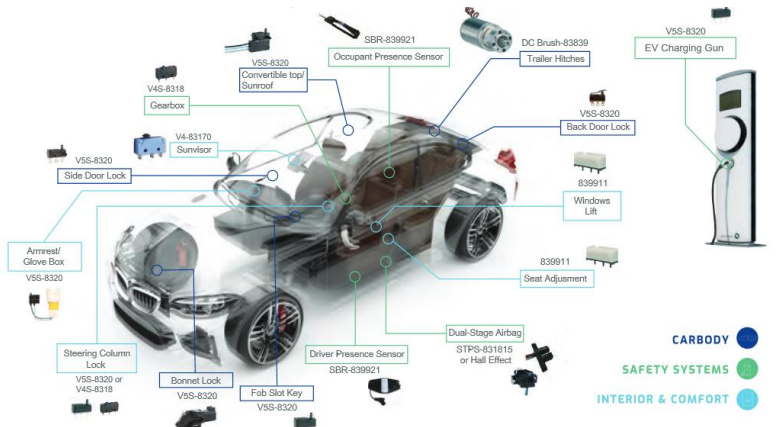
## NIDEC BLDC motors for cars



<https://www.nidec.com/en/technology/capability/brushless/>

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## Crouzet components for electric cars



[https://media.crouzet.com/catalog/\\_brochures/en/CZ\\_market\\_automotive\\_EN.pdf](https://media.crouzet.com/catalog/_brochures/en/CZ_market_automotive_EN.pdf)

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## Key Electric Motor Technologies in BEVs

### Powertrain Configurations

- Single motor, dual motor, triple motor, and four motor

### Core Components of a BEV Powertrain

- Electric Motor types
- Transmission systems (fixed ratio)
- Motor Control Unit (MCU) and Vehicle Control Unit (VCU)
- Battery Management Systems and charging
- Regenerative braking systems



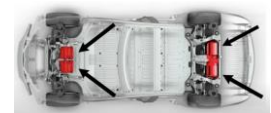
Single motor (ex.: Tesla Model 3 Standard range)



Dual motor configuration (ex.: Tesla Model 3)



Triple motor configuration (ex.: Tesla Model X Plaid)



Four individual motors, Ex.: Rimac Nevara Model

<https://ev-database.org/>  
<https://afdc.energy.gov/>

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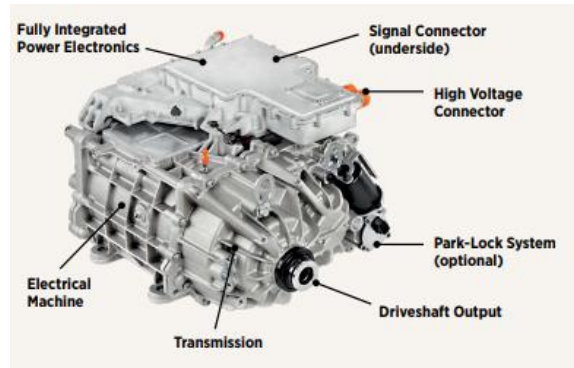
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## Integrated Electric Drive Units (iDM)

**The Concept of Integration:** Combining the motor, transmission, and inverter into a single unit

### Main Components

- Electric Motor: the traction source
- Transmission: reducer system
- Inverter: power electronics handling input voltage
- Cooling System: water or oil-based thermal management
- Hardware Interface: features signal connectors, high voltage connectors, and optional park-lock systems



Example: [BorgWarner Integrated Drive Module \(iDM\)](#)

[video](#)

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## iDM Technical Specifications

**Voltage Range:** 400 V to 800 V

### Peak Performance

- Power: 115 kW to >500 kW
- Torque: 1700 Nm to 5000 Nm

### Flexible Machine Architecture

- Supports Permanent Magnet, AC Induction, and Wound Rotor Synchronous machines

### Inverter Technology

- Utilizes Silicon IGBTs and Silicon Carbide MOSFET

Example: [BorgWarner Integrated Drive Module \(iDM\)](#)

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## Classification of Traction Motors

Great variety of motors

- Induction motors (IM) (asynchronous motors)
  - Tesla Model S, Mercedes EQC, Audi
- Permanent Magnet Synchronous Motors (PMSM)
  - Audi, Polstar
- Internal Permanent Magnet Synchronous Reluctance Motors (IPMSynRM)
  - Tesla Model 3
- Wound Rotor Synchronous Motors (WRSM) (brushed motors)
  - BMW iX4, Renault Zoe

Performance Metric

- Speed range, from 9000 rpm up to 18000 rpm
- Torque: high values, up to 600 Nm
- Battery pack voltage: 300 V DC up to 800 V DC

[see video](#)

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## Comparative Analysis of Traction Motors

Vehicle	Motor Type	Battery	Other data
Tesla Plaid	AWD, 3 motors IPMSynRM 2 in Rear, 1 in Front	100 kWh, 400 V	20k rpm, 750 kW, 1420 Nm <a href="#">ref.</a>
Jaguar I-Pace	AWD, 2 motors PMSM	90 kWh, 400 V	13-14 k rpm, 249 kW /696 Nm <a href="#">ref.</a>
BMW iX3 50 xDrive (6 <sup>th</sup> gen.)	AWD Front: IM, Rear: WRSM	108 kWh, 800 V	4607 rpm /5000 rpm 345 kW, 645 Nm, 6.6 kg/kW <a href="#">ref.</a>
Renault Zoe	Front: WRSM	21 kWh, 400 V	11160 rpm (Model R135) 100 kW, 245 Nm <a href="#">ref</a>
Audi Q6 e-tron quattro	quattro AWD: 2 motors, - Front: IM, Rear: PMSM	100 kWh, 800 V	14k rpm 315 kW, 855Nm <a href="#">ref</a>
Mercedes CLA 350	AWD, Front and Rear: PMSM	100 kWh, 800 V	16-18k rpm 260 kW, 515 Nm <a href="#">ref</a>

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## Tesla Electric Motors Overview

### Two Key Motor Types

- IPMSynRM, Internal Permanent Magnets Synchronous Reluctance Motor
- IM, Induction Motor

Tesla Model 3's IPM-SynRM electric motor explained



Tesla Model-3-electric-motor-explained (Dec. 2020)

Tesla rear motor and drive unit <https://youtu.be/MQV3D8F6gvw>

- Tesla Model S (AWD dual motor), 3.2s (0-100 km/h), 250 km/h
- Tesla Model 3 RWD, 6.1s (0-100 km/h), 225 km/h, 239 kW/420 Nm  
<https://ev-database.org>
- [Tesla Model S Plaid Motor](#) (Munro Live Youtube channel)
- [Tesla Model 3 and Y Modular Motors](#): [Webberauto](#) Youtube channel

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## Tesla Electric Motors Overview

### Tesla Model 3 and Model Y motors

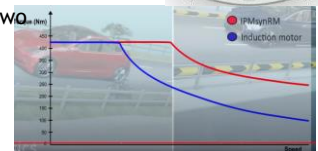
- Rear motor: AC **PMSynRM**, liquid-cooled
- Front motor (AWD vehicles): AC induction motor (**IM**), liquid-cooled
- Transmission type: gearbox with a fixed ratio of 9:1
- Battery - High Voltage: liquid-cooled lithium ion (Li-ion), 345 V DC

### Tesla Model S and Model X motors

- Front and rear motor: AC **PMSynRM**, liquid-cooled
- Transmission type: gearbox with a fixed ratio of 7.56:1 (front) and 9.04:1 (rear)
- Battery - High Voltage: liquid-cooled lithium-ion (Li-ion), 400 V DC

### Tesla Model S Plaid and Model X Plaid motors

- Front and rear motor: AC **PMSynRM**, carbon-fiber-wrapped rotor, liquid-cooled, two motors at the rear and one at front
- Transmission type: gearbox with a fixed ratio of 7.56:1 (front and rear)
- Battery - High Voltage: liquid-cooled lithium-ion (Li-ion), 400 V DC



[Tesla Model 3 Motor Tear Down video](#)

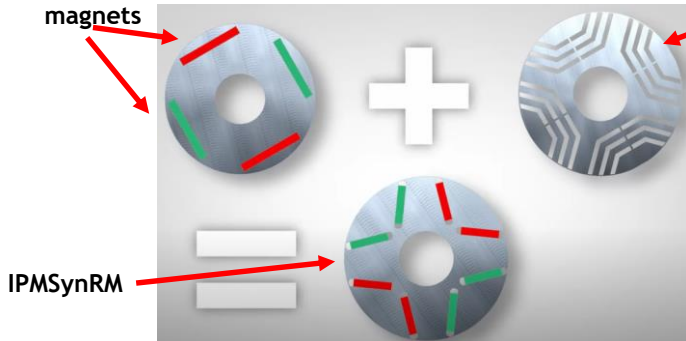
[Tesla Model S Plaid Motor video](#)

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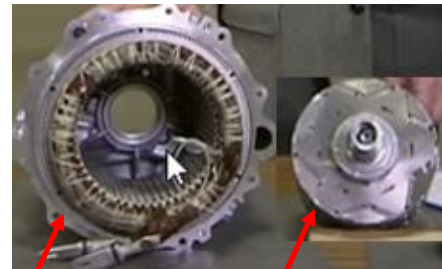
## Tesla electric motors

**IPMSynRM**, Internal Permanent Magnet Synchronous Reluctance Motor

Internal permanent magnets



Reluctance rotor



stator

rotor

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<https://youtu.be/wFZZ5PICQeo?si=pnVvgu9SelU2ZwQG>

## Electric Motors in Mercedes EQ series

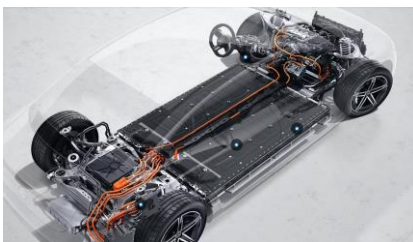
Series EQA, EQC, (2019) use IM (out of production)

Series EQB (Front axis: IM, rear axis: PMSM)

Series EQE, EQS, use PMSM

Series CLA (2026)[ref], use PMSM

Common platform (EVA) supports one or two motors, depending on the version (EQE, EQS, EQS SUV)



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## Electric Motors in Audi Q4 50 e-tron Quattro

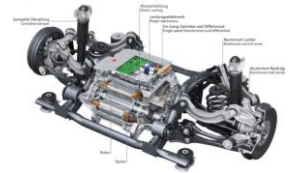
### Permanent Magnet Synchronous motor (PMSM) on the rear axle

- water-cooled, maximum speed of 16000 rpm, one-speed transmission ratio 11.5:1; overall weight 90 kg

### Induction motor (IM) on the front axle

- maximum speed of 14 000 rpm, combined cooling with coolant and oil; one-speed transmission with a ratio of 10.0:1; overall weight 60 kg

Two three-phase AC motors, that combine to produce a maximum output of 220 kW and 460 Nm of torque. The rear motor generates 150 kW and 310 Nm, the front motor 80 kW and 162 Nm



Rear axle



Front axle

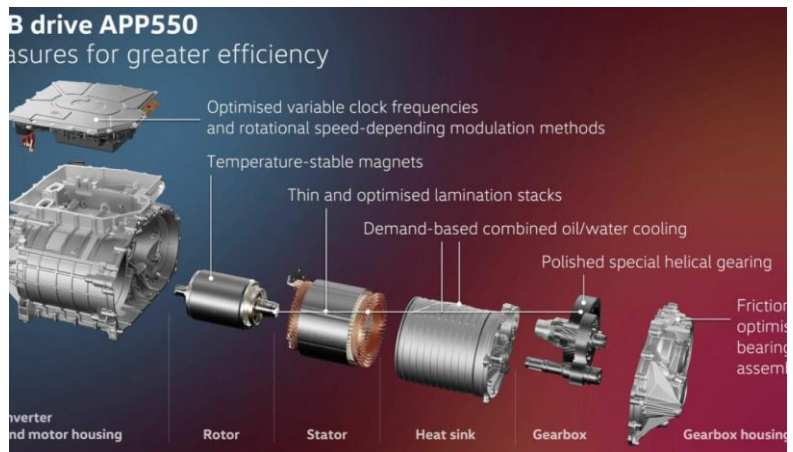
[Reference link](#)

[Audi e-tron s VIDEO](#)

## Electric Motors in Audi Q4 50 e-tron Quattro

Audi has a new electric motor for the Q4 e-tron for 2024

The Q4 e-tron, with rear and all-wheel drive, receives a new permanent magnet synchronous motor (PMSM) on the rear axle, produced by VW, also used in the ID7 (Model APP550)



## Electric Motors in Audi e-tron Models

Multiple Models: A6 e-tron, S6 e-tron, S e-tron GT, RS e-tron GT, Q4 e-tron, Q6 e-tron, SQ6 SUV e-tron

Multiple versions: e-tron, e-tron performance, e-tron quattro

Common building platform PPE (Premium Platform Electric)

Use PMSM and IM in A6 e-tron Models

Example: A6 Avant e-tron versions:

- e-tron (210 kW, 435 Nm, Battery 76 kWh), single motor PMSM, rear
- e-tron performance (270 kW, 565 Nm, Battery 95 kWh), single motor PMSM, rear
- e-tron quattro (315 kW, 275 Nm front, 565 Nm rear, Battery 95 kWh), two motors, PMSM rear, IM front (ref.)

## Electric Motors in Audi e-tron Models

Model	Motor Configuration	Motor Type	Total Power Output [kW]	Total Torque [Nm]
<u>Audi Q4 e-tron 35 (2024)</u>	Single Rear Motor	PMSM [ <u>ref</u> ]	125	310
<u>Audi Q4 e-tron 55 quattro</u>	Dual Motors (Front and Rear)	PMSM rear IM front [ <u>ref</u> ]	250	134/545
<u>Audi Q6 SUV e-tron</u>	Single Rear Motor	PMSM [ <u>ref</u> ]	185	450
<u>Audi Q6 SUV e-tron quattro</u>	Dual Motors (Front and Rear)	IM front , PMSM rear [ <u>ref</u> ]	285	275/580
<b>Audi Q8 S e-tron quattro (2023)</b> * <u>production canceled in January 2025</u>	Triple Motors (Two Rear, One Front)	One IM front, two IM rear, [ <u>ref</u> ]	370	973

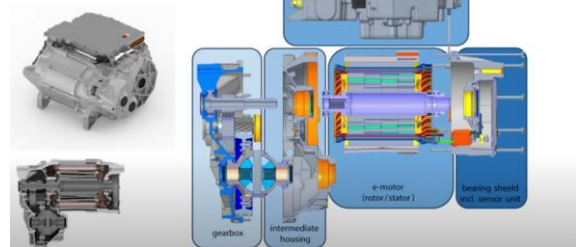
## Electric Motors in VW Models

The (VW) MEB (*Modularer E-Antriebs-Baukasten*) platform is a modular electric vehicle (EV) platform developed by VW Group (VW, Audi, Seat, and Skoda), allowing to power vehicles ranging from small city cars to large SUVs, incorporating distinct number and type of motors. It is used by VW ID3/4/5, Skoda Enyaq, Cupra Born, Audi Q4 etron. It is a 400 V system, while the Audi PPE is 800 V

The ID4 dual motor (AWD) uses

- Rear axle: **PMSM motor**, one-speed gearbox, inverter, 150 kW
- Front axle: **IM** (asynchronous) motor, one-speed gearbox, inverter, 80 kW

MEB Base+ technical highlights  
Overview e-drive



VW MEB base platform

Volkswagen ID.4: Electric Motor Teardown and Analysis video

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## Electric Motors in VW Models

Model	Motor Configuration	Motor Type	Total Power Output [kW]	Total Torque [Nm]
<u>Volkswagen ID.3 Pro 58kWh 204 HP (2023)</u>	Single Rear Motor	PMSM [ref]	150	310
<u>Volkswagen ID.4 Pro 4MOTION 77kWh 286 HP (2023)</u>	Dual Motors (Front and Rear)	Front: IM Rear: PMSM [ref]	210	134/545
<u>Volkswagen ID.5 Pure 52kWh 170 HP (2024)</u>	Single Rear Motor	PMSM [ref]	125	310
<u>Volkswagen ID.7 GTX 4MOTION (2024)</u>	Dual Motors (Front and Rear)	Front: IM Rear: PMSM [ref]	250	679
<u>Volkswagen ID Buzz LWB Pro</u>	Single Rear Motor	PMSM [ref]	210	560
<u>Volkswagen ID. EVERY1 (2027)</u>	Single front Motor		70	310

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## Electric Motors in BMW Models

The 6th Generation of BMW electric motors (Gen6 eDrive), debuting with the "Neue Klasse" platform in 2025/2026, represents a shift from the previous Gen5 units found in the i4 or iX

- Instead of using the same motor type on both axles, BMW now uses two different technologies: WRSM (rear axle) and IM (front axle)
- **800-Volt Architecture:** this is the first BMW generation to move from 400V to 800V, allowing for thinner wiring (less weight) and much faster charging
- **Weight Reduction:** the integrated drive unit (motor + inverter + transmission) is roughly **10% lighter** than Gen5, with some motor variants weighing around **125 kg**
- **Efficiency:** overall drivetrain efficiency is improved by **20%**, contributing to a claimed **30% increase in total driving range** (BMW claim)

[BMW Gen6 Motors: A Deeper Look at the Power Behind the Neue Klasse \(Feb. 2025\)](#)

[Video on BMW electric motors production line](#)

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## Electric Motors in BMW Models

**Wound Rotor Synchronous Motors (WRSM)** (brushed motors)

- Single motor on rear axle (iX3 40 (RWD) (235 kW/500 Nm)
- Dual engine AWD (iX3 50 xDrive) (345 kW/645 Nm)

Current and future developments:

- [The start of a new era. The all-new BMW iX3 \(Sept. 2025\)](#)
- [M eDrive First Look \(Jan 2026\)](#)

[Video on BMW electric motors production line](#)

Brush Module for  
BMW iX / MK60 /  
xDrive40/50 / iX3



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## BMW: brushed electric motor



close-up of the slip-ring assembly that powers the rotor of the motor used in BMW's iX-M60 electric SUV  
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## Electric Motors in BMW Models

Model	Motor Configuration	Motor Type (BMW official)	Total Power Output [kW]	Total Torque [Nm]
BMW G26 i4 eDrive35 (2024-2026)	Single rear motor	1× WRSM (rear)	210	400
BMW G26 i4 xDrive40 ( )	Dual motors (front + rear)	Rear WRSM + Front IM	295	600
BMW i7 eDrive50 (G70) (2023- )	Single rear motor	1× WRSM (rear)	335	650
BMW iX3 40 (Neue Klasse) (2026- )	Single rear motor	1× Gen6 WRSM (rear)	235	500
BMW iX3 50 xDrive (Neue Klasse) (2026- )	Dual motors (front + rear)	Rear Gen6 WRSM + Front IM	345	645

Note: WRSM - Wound Rotor Synchronous Motors are also known as Electric Excited Synchronous Motor (EESM)

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Trend	Direction
Modular motor families	↑ Strategic priority
800-V motor design	↑ Universal
SiC + advanced control	↑ Enabler
Permanent magnets	↓ Decreasing
WRSM ( EESM )	↑ Rapid growth
Induction motors	↑ Return as secondary motors
Axial-flux	↑ Niche / performance

### New Technologies

- In-Rotor Inductive-Excited Synchronous Motors (I2SynM) - no brushes, no slip rings, no rare-earth magnets
- Dual-Rotor Motors: electric motors featuring a U-shaped rotor design that leverages magnetic fields more effectively, reducing production costs and enhancing efficiency
- Hub-Motors, i.e., in-wheel electric motors
- Axial Flux Motors - high torque density, used in hypercars

## In-Rotor Inductive-Excited Synchronous Motors

Introduced in September 2023

In-rotor Inductive-excited Synchronous Motor ( $I^2SM$ ) (Motor from ZF Friedrichshafen AG)

- Synchronous motor, with wound stator and wound rotor, but without brushes or slip rings
- The energy to the rotor is induced, via an inductive exciter inside the rotor shaft
- Rotor cooled by circulating oil

Video ZF's  $I^2SM$  2023  
News sept 23

**Synchronous motor without rare earth magnets! Alternative to Permanent Magnet Synchronous Motor (PMSM), with similar performance**

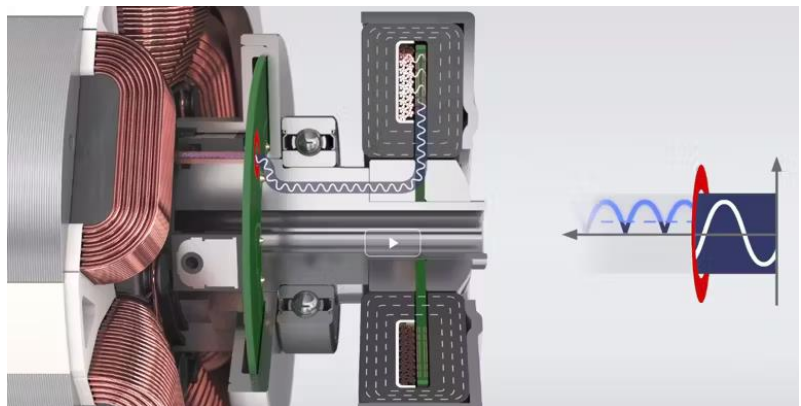
See also **Magnet Free Motor**  
By Mahle, with similar structure



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## In-Rotor Inductive-Excited Synchronous Motors

Close-up of the inductive power transmission system used to energize the rotor in Inductive-excited Synchronous Motor ( $I^2SM$ )



34 <https://www.mahle.com/en/about-mahle/>

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## Dual-Rotor Motors

A **Dual-Rotor electric motor** is a machine that uses two rotors interacting with a single stator. This architectural change is not a new motor “type” in the electromagnetic sense, but a topology that can be combined with PMSM, induction, reluctance, or electrically excited machines

### Main dual-rotor configurations

- (a) **Stator between two rotors** (most common in EVs):
  - One inner rotor; One outer rotor; Stator sandwiched between them
  - Both rotors may be mechanically coupled or fixed to the same output
  - This is the configuration used by [DeepDrive](#)
- (b) **Axial-flux dual-rotor**
  - Stator disc between two rotor discs (used by YASA)
  - Extremely high torque density; used in some axial-flux machines, though mechanically demanding

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## Dual-Rotor Motors

### Advantages

- **Higher Efficiency** - the interaction of both rotors with the stator’s magnetic field results in better energy use and reduced losses
- **Increased Torque Density** - the dual-rotor setup effectively doubles torque production surfaces, leading to improved performance
- Lower magnetic and iron losses: less electrical steel; shorter magnetic flux paths; lower iron losses in driving cycles
- **Optimized Material Use** - the design maximizes magnetic field utilization and minimizes reliance on rare-earth materials
- **Enhanced Performance** - it provides better power delivery, making it suitable for high-performance electric systems, applicable to EV traction and direct-drive concepts

Example [DeepDrive dual-rotor motor](#), that uses dual-rotor PM, radial flux

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## Hub-Motors

Hub motors, integrated directly into the wheels of a vehicle, eliminate the need for traditional drivetrain components like axles, differentials, and transmissions. This design offers several advantages:

- **Improved Efficiency:** reduces energy losses associated with mechanical components, leading to higher overall efficiency
- **Enhanced Handling:** allows precise control of each wheel independently, improving traction, stability, and handling through torque vectoring
- **Space Savings:** frees up space within the vehicle, enabling more flexible and innovative designs
- **Simplified Design:** integrates power electronics and digital control within the motor, simplifying the vehicle's architecture and potentially reducing manufacturing costs

## Hub-Motors Suppliers

- **Protean Electric** (UK / Global): known for their in-wheel motor technology, [Protean Electric offers](#) hub motors that are designed to improve vehicle efficiency and performance. Recently ([September 25](#) ) unveiled a 220 kW / 2500 Nm per-wheel hub motor (Model Pm18) targeting sports cars
- **Elaphe Propulsion Technologies** (Slovenia): specialization in high-performance in-wheel electric propulsion systems, providing solutions for various types of electric vehicles. Motors capable of >1,500 Nm per wheel.
- **DeepDrive Company** (Germany): provides dual-rotor electrical motors configured as hub motors ( see [series 16" RM1250](#) )



DeepDrive 16" RM1250

Renault R5 T3E uses two Protean rear-wheel motors, boasting an output of over 410kW, 800 V battery, [[ref, 3/2025](#)]

## High-power density integrated motor drive

H3X Technologies launch HPDM-180R

- Highly integrated system – Electric motor + inverter + planetary gearbox
- Simultaneous cooling of the power electronics and stator with a single additively manufactured cooling jacket
- 80 kW in a 16 kg package (11 kW/kg)
- Continuous torque of 576 Nm, 3000 RPM shaft speed
- Scalable core technology from 30 kW to 30 MW
- Peak system efficiency of 94.6%
- Suitable for airborne applications, as a propeller-driven aircraft

H3X defines the extreme end of electric motor performance



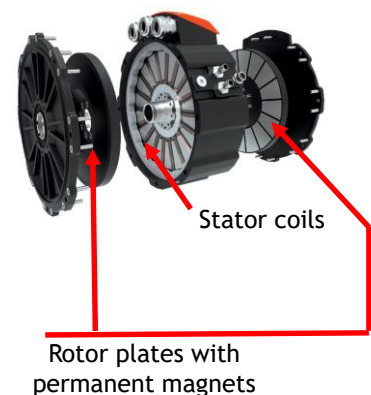
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## Axial Flux Motors for Cars

Design and Operation:

- Structure: axial flux motors are typically flatter and more compact, resembling a disc or frisbee. This design allows them to be smaller and lighter while still providing high power output
- Magnetic Flux Direction: in axial flux motors, the magnetic flux travels parallel to the axis of rotation, unlike radial flux motors where the flux travels perpendicular to the axis
- Operation as a PMSM
- Example of a dual-rotor axial-flux motor!

Article on Axial Flux motors - [The new hope](#)



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## Axial Flux Motors for Cars

### Manufacturers:

- YASA Motors, acquired by Mercedes-Benz in 2021, with motors used in high-performance vehicles, including Mercedes-Benz's AMG, Ferrari SF90, Koenigsegg Regera
- eHelix, has developed the SPX177, an electric motor for hypercar projects. The SPX177 motor weighs only 28 kg and delivers 650 kW of continuous power
- Magnax motors specializes in yokeless axial flux motor technology. Their motors are designed for various applications, including eMobility and aerospace. Magnax's axial flux motors promise up to 8% efficiency, making them highly attractive for electric vehicle manufacturers
- Traxial motors, a subsidiary of Magnax, focuses on high-performance yokeless axial flux motors for ground e-mobility

## Axial Flux Motors for cars

### Manufacturers: YASA

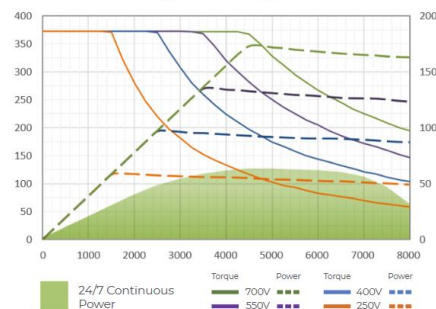
#### Detail on YASA P400 motor

- up to 370 Nm and 160 kW @700 V
- axial length of just 80.4 mm

#### Characteristics:

- PMSM with axial flux
- High torque density,
- Low cogging torque
- High efficiency,
- Integrated into the wheel hubs

Example Electrical Performance with 800V controller  
 @450ARMS P400 R

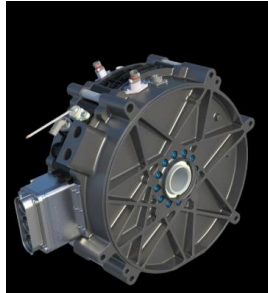


Motor YASA P400R

## Axial Flux Motors for cars

### YASA YM720 Specification

Peak Torque (30s): 700 Nm  
 Peak Power (30s): 350 kW  
 Continuous torque: 350 Nm  
 Continuous power: 180 kW  
 Max speed: 10,000 rpm  
 Mass: 33 kg  
 Size: 345 x 123 mm  
 Cooling medium: dielectric oil  
 Peak power density: 10.6 kW/kg



### New Yasa Motor - Oct 2025 (prototype motor)

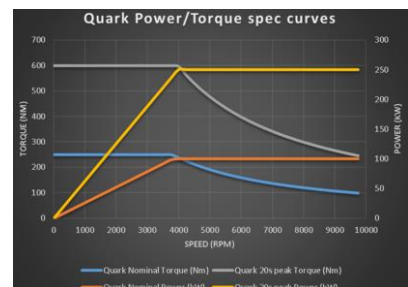
Peak Torque: 700 Nm  
 Peak Power: 750 kW  
 Continuous power 350kW-400kW  
 Mass: 2.7 kg  
 Peak power density: 59 kW/kg !!!



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## Current use of axial flux motors in hypercars

- [Ferrari SF90 Stradale](#) (780 HP) uses 3 [YASA](#) motors - 220 cv (two in the front axle and one in rear), plus 4L V8 motor - 780 cv ( total of 1000 cv)
- [Koenigsegg Regera hybrid hypercar](#) (1500 HP) uses 3 YASA motors - 400 cv (two YASA 750 on the rear axle and a YASA 400 on the front axle), plus twin-turbo V8 motor -1100 cv (total 1500 cv) ([ref](#))
- [Koenigsegg Gemera hybrid hypercar \(1100 HP\)](#) uses three PMSM with axial flux ([Quark](#) motors 250 kW/600 Nm each, plus a 2L V8 motor) ([video](#)) ([video II](#))
- [Mercedes Concept AMG GT XX \( 1360 cv\)](#) fully electric, two High Performance Electric Drive Units (HP.EDUs) - one at the front with one axial flux motor, and one at the rear with two axial flux motors
- The [Quark e-motor](#) was introduced in 2022, developed by Koenigsegg. It uses radial and axial flux (Raxial). It weighs around 28.5 kg and has a volume of 8 liters. The Quark motor produces a peak power of 250 kW and a peak torque of 600 Nm with a maximum RPM of 9000



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## Future of Electric Motors in Cars

### Key Trends:

- Higher power density with compact designs
- Reduced reliance on rare-earth materials
- Integrated motor-inverter-gearbox solutions
- In-wheel motors