Electrical Drive Technology for Electric Vehicles

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CU Seminar

17 March 2023

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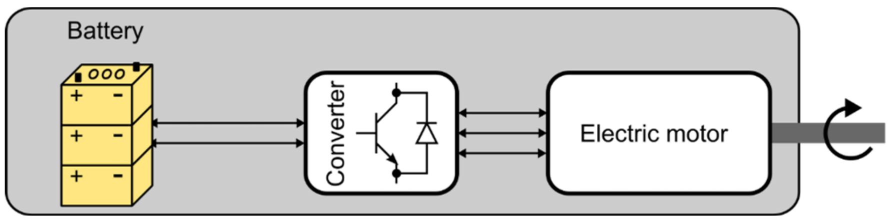
Overview

- Introduction
- Different types of electrical drives for EVs
- Application examples

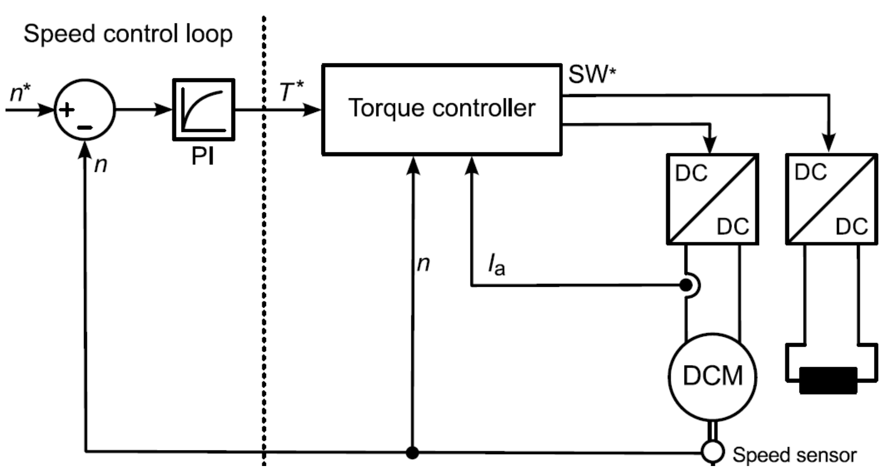
Variable-speed drive system in electric vehicle

- Power source: DC source
  - Battery, fuel cell and solar cell
- Power electronic converter
  - Converting DC to AC and regulating input power for motor
- Electric motor



Control loop of electrical drives in EVs.

- ► In conventional vehicle, speed controller is the driver.
- ► In sophisticated vehicle control, speed controller is partly influenced by the vehicle controller.



Technical requirements of electric vehicle drives

- Variable torque-speed operating range

  High torque at low speed, wide constant power range
- Compactness and low weight
- High efficiency
- Fast torque dynamics
- Regenerative braking
- Low acoustic noise emission
- Reliability and robustness

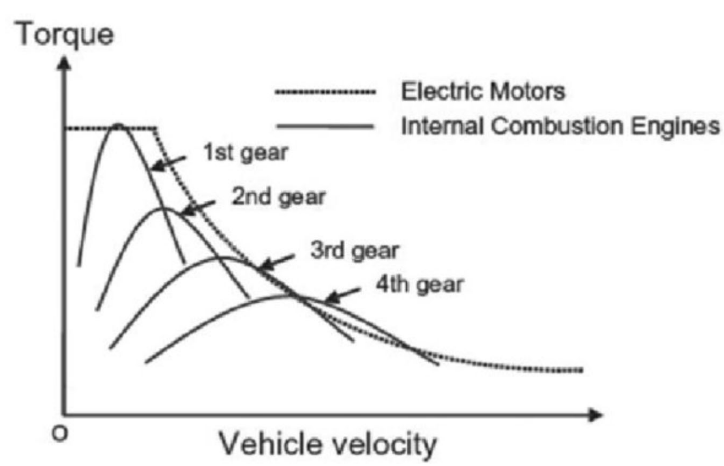
- Technical parameters are

Torque, Speed, Size, Weight, Efficiency, Power, Cooling, Acoustic noise, Operating temp, Life time, Cost

Source: https://electriccarsreport.com/wp-content

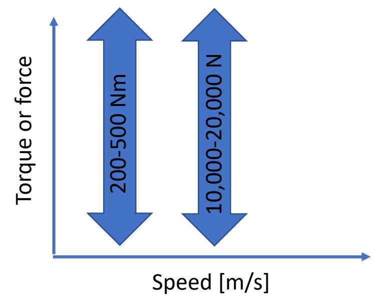
Advantages of electric drive vs ICE in torque-speed curve

- Operation from stand still
- Higher dynamic
- More quiet
- No emission



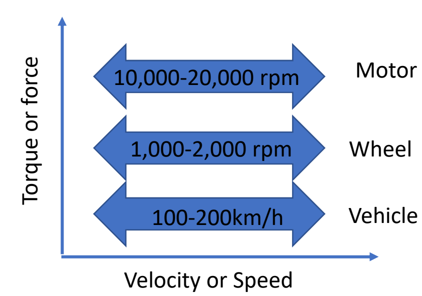
Source: R. Zhang, Novel electronic braking system design for EVS..., DOI: 10.1007/s12239-017-0070-0

Typical design ranges of electric cars



Gear ratio = 5 – 10

r = 0.3-0.4m



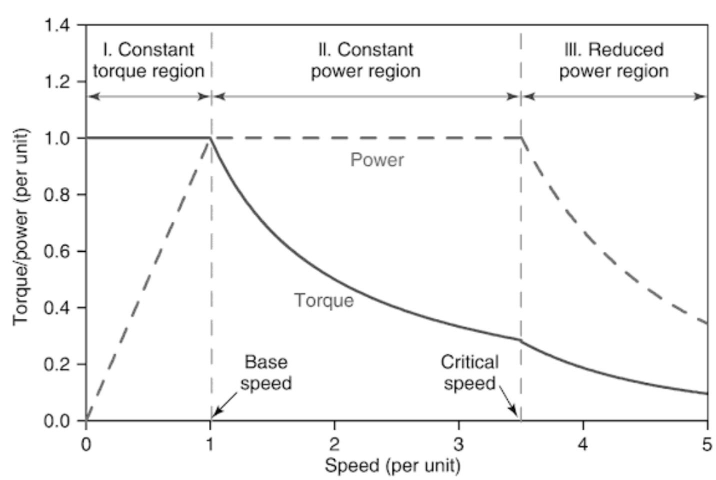
Example

$n_{\text{wheel}} = \frac{V \cdot 60}{r \cdot 2\pi \cdot 3.6}$ [rpm]

V = 100 km/h ; r = 0.3m

$n_{\text{wheel}} = \frac{100 \cdot 60}{0.3 \cdot 2\pi \cdot 3.6}$ = 884.6 [rpm]

Typical torque-speed curve of electrical drives with power curve



Source: David Crolla, Encyclopedia of Automotive Engineering

Efficiency and losses in torque speed diagram

- Copper losses – current, frequency
- Core losses – voltage, frequency

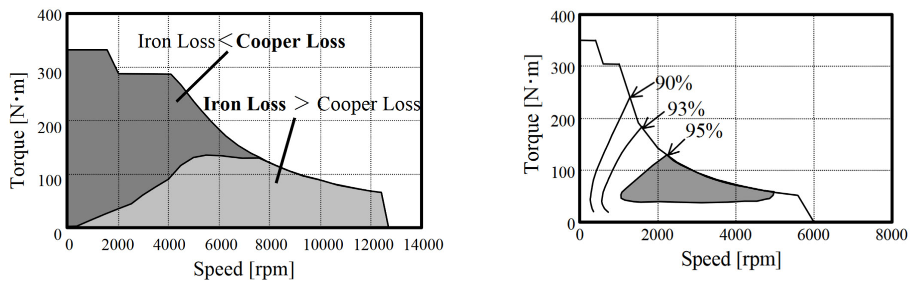
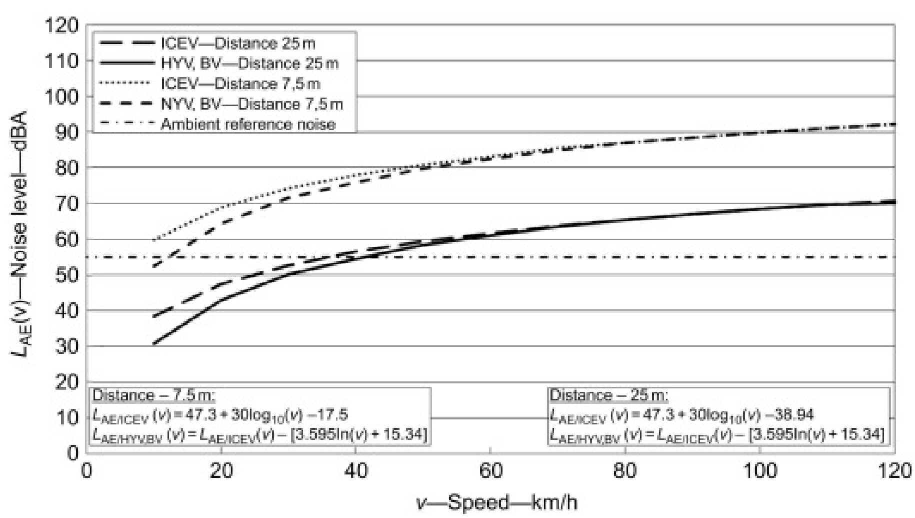


Fig. 18. 2000 Prius motor loss map

Source: M. Kamiya, Development of Traction Drive Motors for the Toyota Hybrid System, International Power Electronics Conference 2005

Acoustic noise of electric drives vs ICE



Source: D. Teodorović, M. Janić, Transportation, Environment, and Society in Transportation Engineering, 2017

Acoustic noise problematics in EVs

- Acoustic noise is mainly emitted from the propulsion system.
- Acoustic comfort for passenger is important.
- Pedestrian safety is also a major concern.
- Acoustic Vehicle Alerting System (AVAS)

"From July 1, 2019, any electric vehicle with four or more wheels that wants to be approved for road use in the European Union is going to have to have an "Acoustic Vehicle Alert System," or AVAS, fitted, making a continuous noise of at least 56 decibels if the car's going 20 km/h (12 mph) or slower."

Source: https://newatlas.com/eu-ev-acoustic-noise-avas/60022/

Different types of electrical drives for EVs

Classification of electrical machines

Conventional power supply

- Standing field
  - DC-Machine (DCM)
    - Wound field
    - Permanent-magnet
    - Universal machine
- Rotating field
  - Synchronous Machines (SM)
    - Wound field/ slip ring
    - Permanent-magnet
  - Induction Machines (IM)
    - Wound rotor
    - Cage type
    - Cage type single phase

Converter-fed

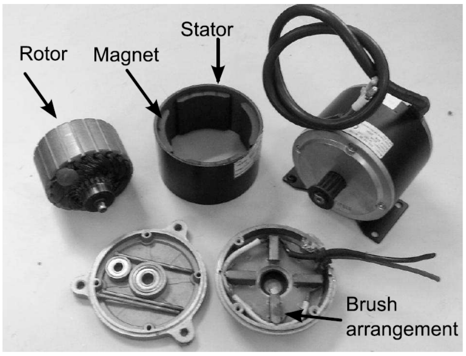
- Servo DC-machine
- Excited rotor
  - Servo permanent magnet
  - Brushless DC
  - Hybrid synchronous
  - Transversal flux
- Unexcited rotor
  - Stepping
  - Synchronous reluctance
  - Switched reluctance
- Servo induction machine
- Doubly fed

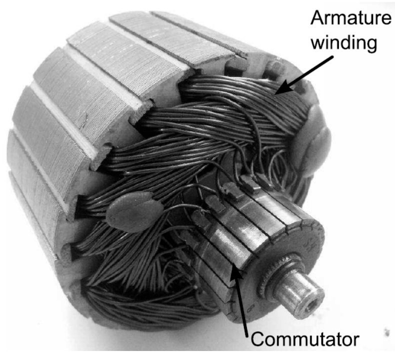
Electric Drive Technology for EVs

Types of electric motor for EVs

- DC-machines
- Permanent magnet synchronous machine
- Brushless DC-machines
- Induction machine
- Switched reluctance machine

DC-machine structure





Merits

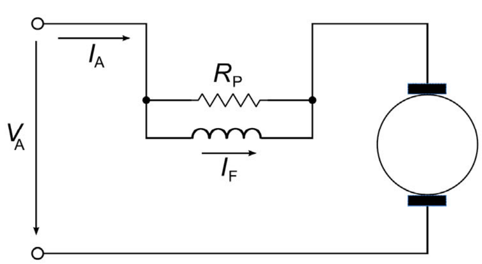
- Simple control, no speed or rotor position sensor required
- Simple converter

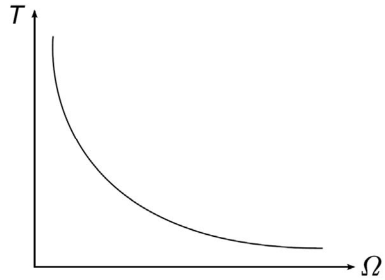
Demerits

- Large size
- Maintenance of brush
- Overloading capability is limited by the current density of brushes. ($10A/mm^2$)

Series DC-machine for traction drive (without converter)

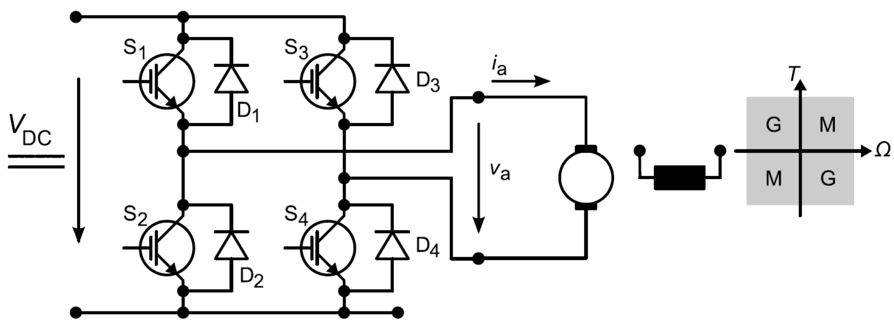
- Directly fed by battery with out power electronics converter
- Self-regulated torque speed curve
- High starting torque with lower starting current
- Speed will be driven to the equilibrium point at high speed (preferred behaviour of EVs.
- Very high no-load speed





Converter of DC-machine for electric cars

- Full bridge DC-DC converter
- Four quadrant operation



Electric Drive Technology for EVs

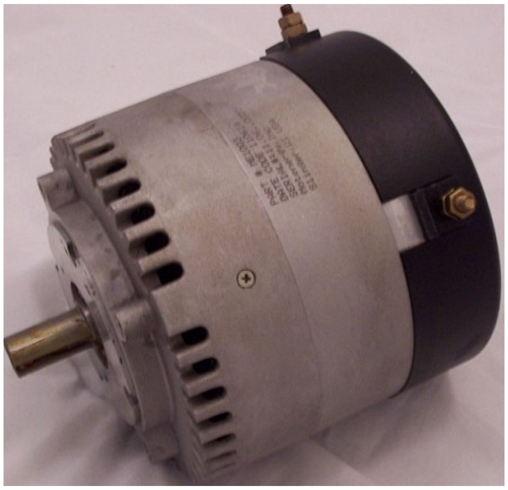
Example of DC-machine for electric cars

- Type: Series wound DC
- Diameter: 9.25”
- Length: 13.60” (face-face)
- Weight: 129 lbs.
- HP: 30 (Continuous @ 144V)
- RPM: 5,800
- Torque: 70 lbs.-ft. @ 450 Amps
- Shaft: Double or Single ende
- Mounting: Industry standard configuration
- Insulation: Class “H”

https://www.electriccarpartscompany.com/ImPulse-9-EV-DC-Motor

Example of DC-machine for electric cars

- Permanent Magnet DC motor with very high efficiency.
- 11.5 KW (15.4 HP) 200A continuous, and 23 KW (30.8 HP) 400A peak (1 min) at 72VDC.
- 9.4 KW (12.7 HP) continuous, and 19.1 KW (25.7 HP) peak at 48VDC.
- 4.7 KW (6.4 HP) continuous, and 9.5 KW (12.8 HP) peak at 24VDC.
- Motorcycles, go-carts
- The M103 Motor weighs 39 Lbs. (17.7 Kg)



https://www.electriccarpartscompany.com/ImPulse-9-EV-DC-Motor

Synchronous speed

- The rotating field speed is determined by the input frequency.
- The more pole pairs, the lower speed.

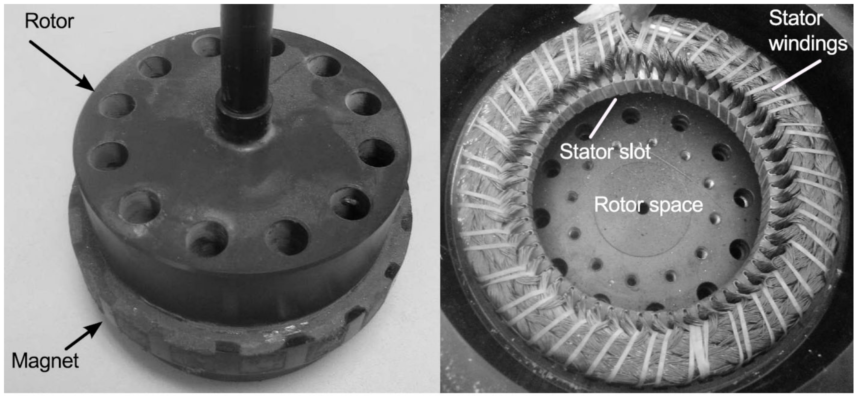
$$n = \frac{f}{pair}$$

$$n = \frac{f}{p/2}$$

Number of poles	Synchronous speed per minute	
	60 Hertz	50 Hertz
2	3.600	3.000
4	1.800	1.500
6	1.200	1.000
8	900	750
10	720	600

Source: https://static.weg.net/medias/downloadcenter/ha0/h5f/WEG-motors-specification-of-electric-motors-50039409-brochure-english-web.pdf

Structure of PMSM



Merits

- Compact
- High efficiency

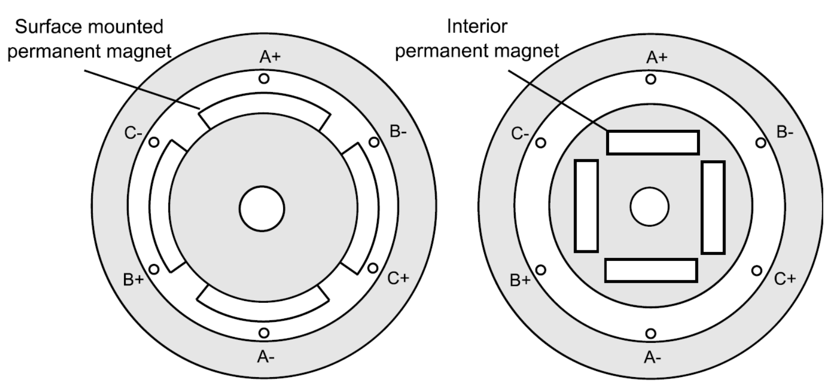
Demerits

- High temperature sensitive
- High losses at high speed
- Danger by short-circuit fault

Classification of PMSM

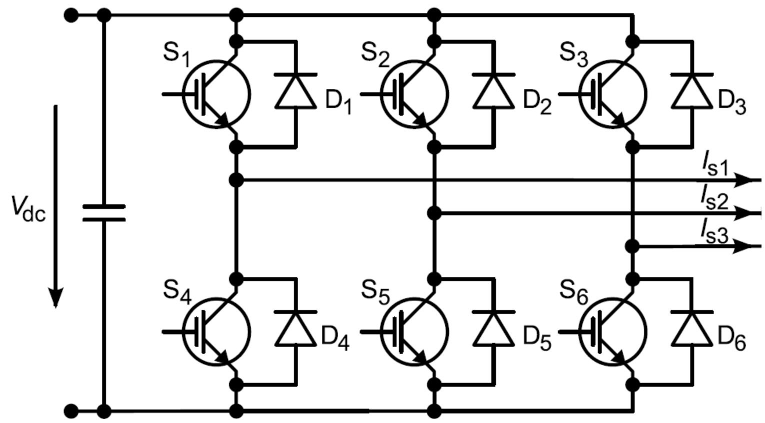
- convenient for manufacturing

- power-to-weight ratio
- high efficiency,
- rugged construction
- low cogging torque
- capability of reluctance torque



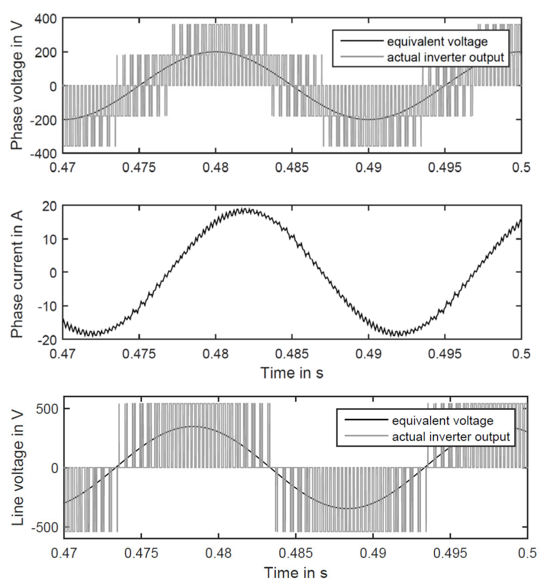
Converter for PMSM

- Vdc = VL-Lpeak
- PWM, constant switching frequency
- Risk of shoot-through
- Industrial compact design
- Need rotor position sensor



Output voltage of the PMSM converter

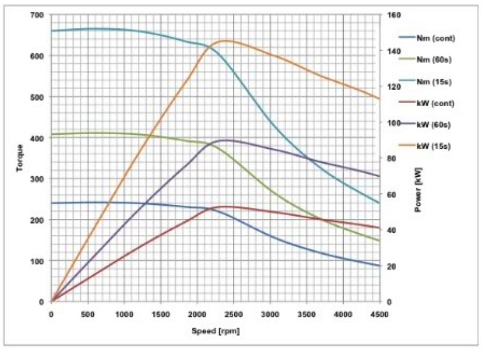
- Pulsed output voltage
- Overridden ripples in currents
- 5 voltage levels in phase voltage
- 3 voltage levels in line voltage

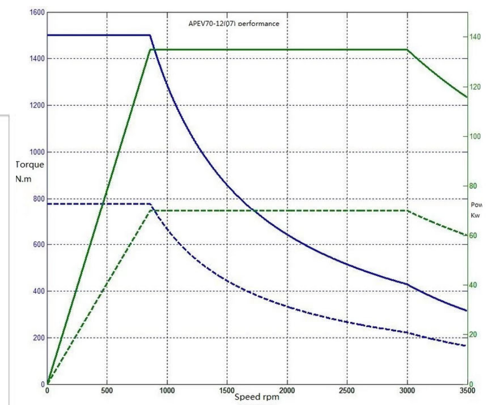


Torque-speed curve data and overload capability

Performance Prediction 4 Turn:

N_t	4		(Number of Turns)
Vs_DC	391	V	
S / P	1		(1 for parallel, 2 for series)
I_nom	300	A	
I_max	380	A	



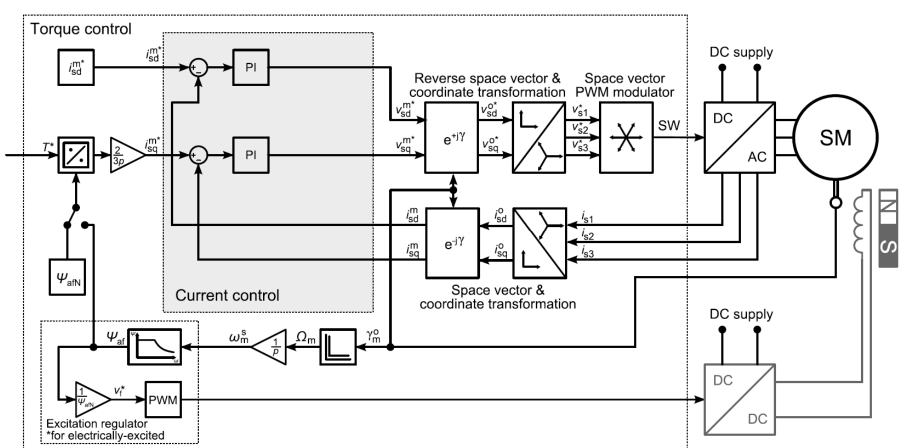


Practical

Ideal

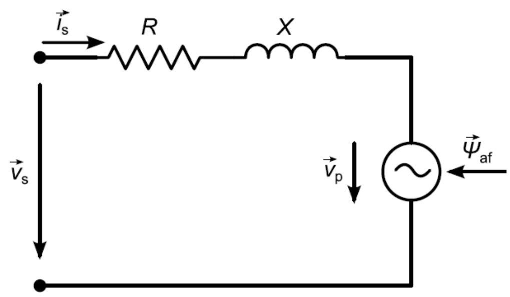
Vector control for PMSM

- Detection of the rotor position and calculate the back-emf
- Using the calculated back-emf as reference point to inject the stator input current

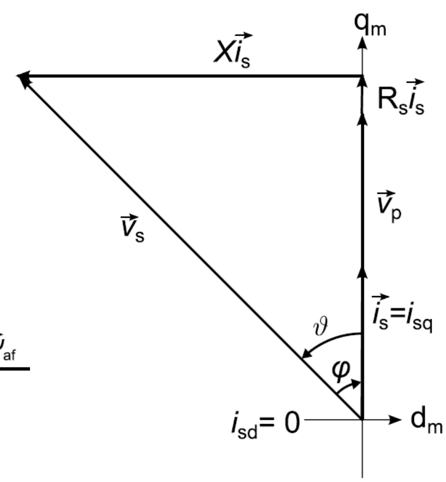


Maximum torque per ampere operation

- By keeping the current to be always in phase with the back-emf. The output torque is generated with the minimum stator current.
- When using vector control, this mode is obtained by adjusting the current in the d-axis to be null.

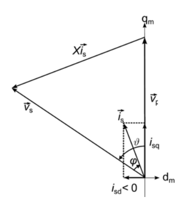


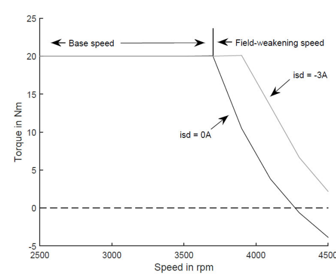
a) full circuit

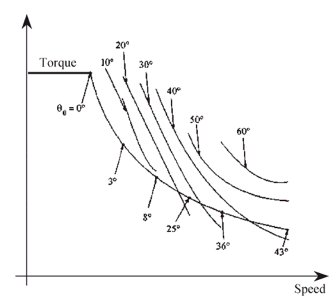


Field weakening operation in PMSM

- For PMSM, normally field weakening operation is not possible, since the excitation cannot be adjusted.
- An indirect field weakening operation is to inject current into the d-axis using vector control.
- This operation is equivalent to advancing the phase of the input voltage to be leading the back-emf.





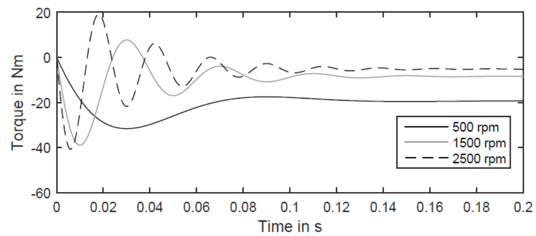


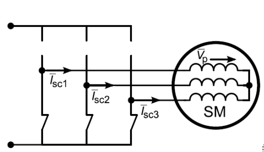
- High losses due to additional current in the d-axis.
- Risk of overvoltage when shutting down the inverter suddenly.

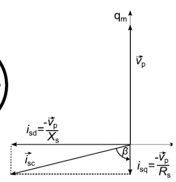
Source: M. Zeraoulia, M. Benbouzid, D. Diallo. Electric motor drive selection issues for HEV propulsion systems: A comparative study. IEEE Transactions on Vehicular Technology, IEEE, 2006, 55 (6), pp.1756-1764.

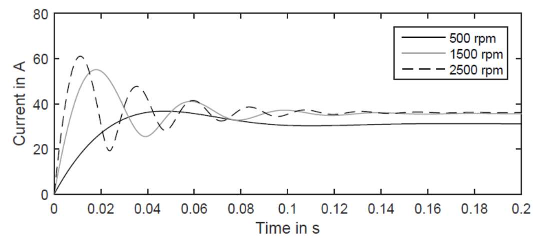
Short-circuit torque in PMSM

- High braking torque, when the windings are short-circuited
- Strong torque pulses leading to mechanical damages in gear-box or mechanical coupling
- Possible danger of flame when the motor keeps running.









Example : 170 kW PMSM for EVs

Technical Data

170kW Permanent Magnet Synchronous Machine	
Nominal voltage	350V
Phase current (@ 460Nm)	1000A pk
Continuous shaft power (dependant on speed)	75kW to 125kW
Continuous shaft power (dependant on speed)	233Nm to 248Nm
Motor assembly mass	75kg
Max operating speed	12,200rpm
Typical coolant temperature	65°C
Number of poles	8
Automotive qualification	Yes
Peak power (60 second)	170kW
Peak torque	
90 seconds	460Nm
60 seconds	510Nm
30 seconds	630Nm
10 seconds	670Nm

Source: http://www.zytekautomotive.co.uk/products/electric-engines/170kw/

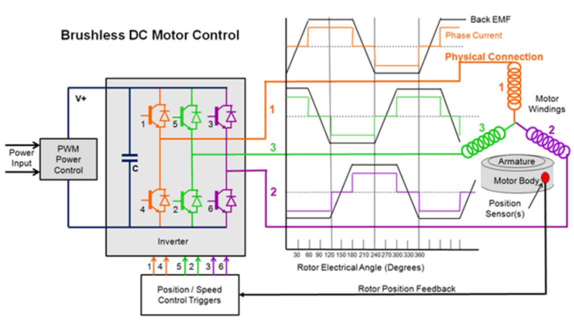
Example : PMSM inverter

Technical Data	
Peak electrical power	250kW @ 450V
Efficiency	97.5%
Phase current	1000A pk
Dimensions	400 x 300 x 111.5mm
Weight	12kg
Volume	13.4l
Power density	18kW/l
Main processor	Infineon TC1798 (32bit/300MHz)
Monitoring processor	Infineon XC2388E (16bit/128MHz)
Signature watchdog	Infineon CIC61508
Safety	ASIL D compliant
Communication	Flexray/CAN
Automotive qualification	Yes
Motor control	Zytek proprietory sinusoidal space vector PWM

Source: http://www.zytekautomotive.co.uk/products/electric-engines/170kw/

BLDC

- Brushless DC motor
  - 3-phase
  - Trapezoidal phase currents
  - Using hall sensors
  - Power from several hundreds to several kWs



Difference between BLDC and PMSM

- Permanent magnet synchronous motor
  - 3-phase
  - Same principle with BLDC
  - Sinusoidal phase currents
  - Less torque ripple
  - Several tens kWs

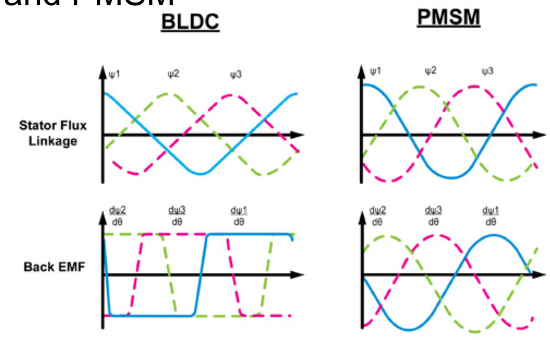
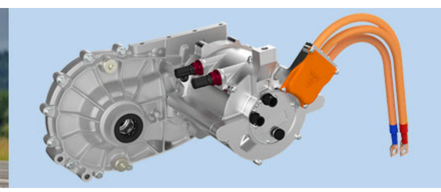
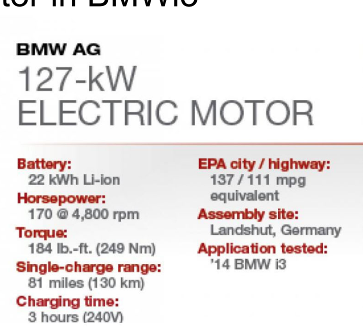


Figure 1. PMSM vs. BLDC BEMF Waveforms

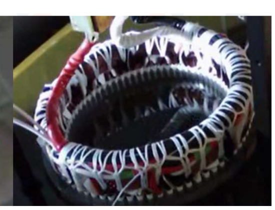


Example of electric motor in BMWi3

- ► 127kW NdFe-B- IPM Motor
- ► Max torque 249 Nm
- ► Single speed automatic transmission



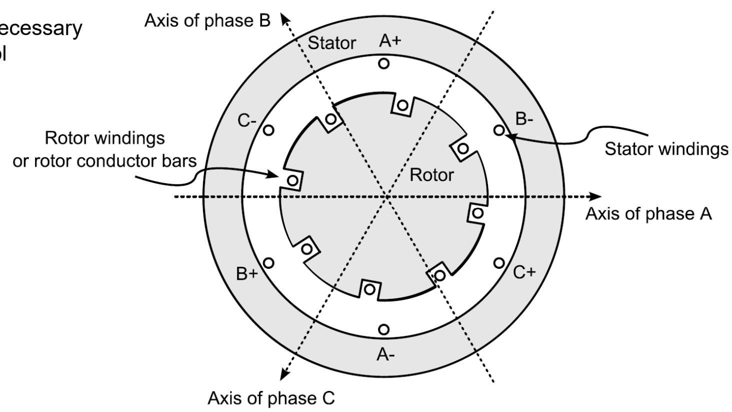
https://www.wardsauto.com/



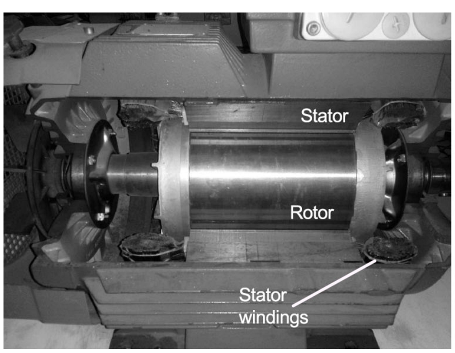
Source: www.motordesign.com

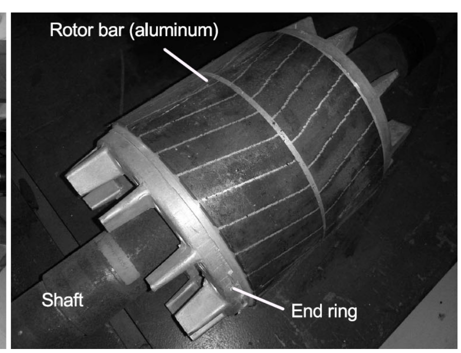
Induction motor

- Squirrel-cage type is more popular now.
- Field oriented control for dynamic torque control
- Speed sensor is necessary for dynamic control



Structure of induction machine





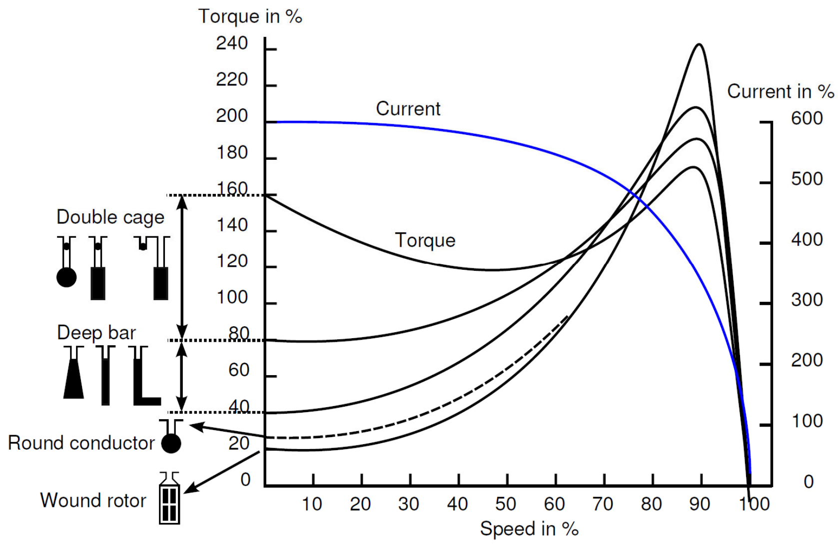
Merits

- Robust
- Dynamic torque control possible
- Compact converter

Demerits

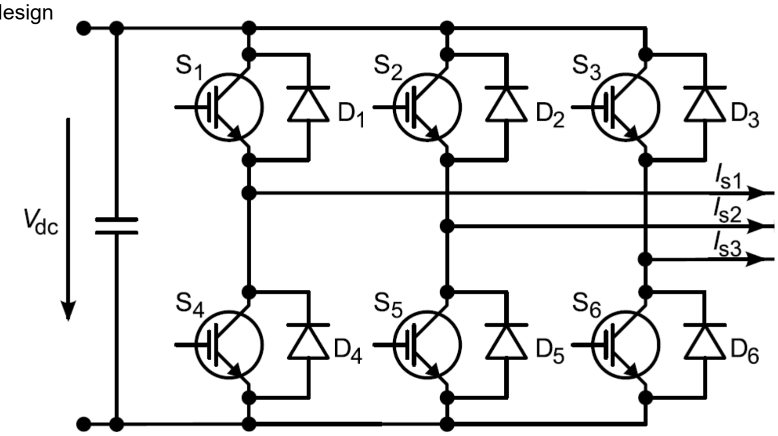
- Large size
- Low efficiency at low speed range
- Large end-turn

Torque speed characteristics by different rotor bar design



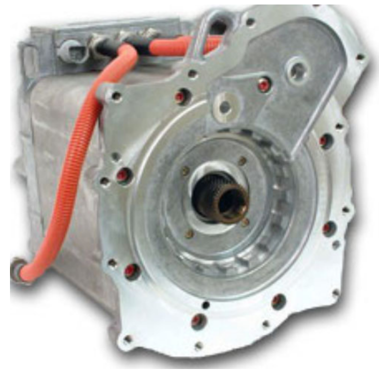
Converter for induction motor

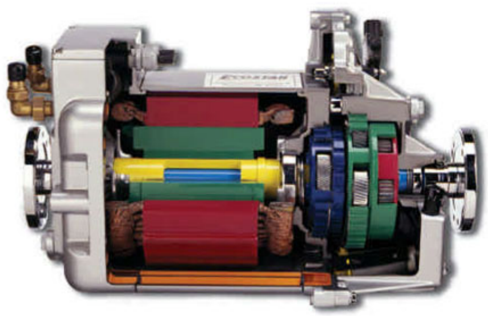
- Vdc = VL-Lpeak
- PWM, constant switching frequency
- Risk of shoot-through
- Industrial compact design



Example of induction motor for electric cars

- 1990 Ford rangers EVs
- 3-phase water-cooled AC induction motor
- 6 pin connector
- Weight: 140lbs.
- 33 KW / 67 Peak -- 42 HP / 90 Peak
- Rear axle, hollow shaft with differential gear

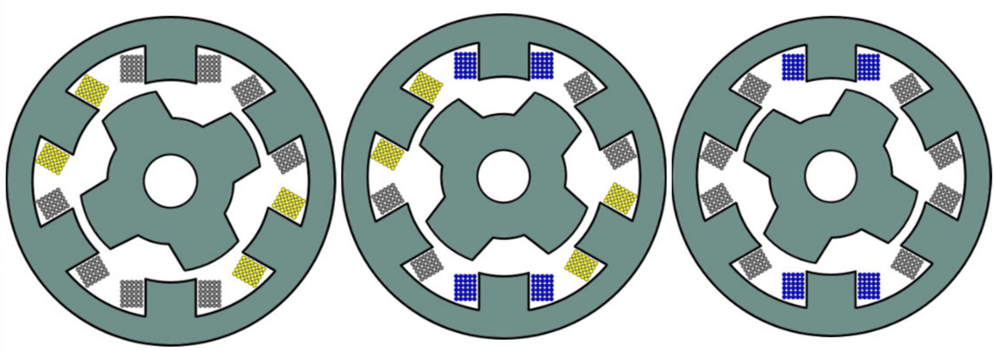




http://www.zuglet.com/ev/fordsiemens/fordsiemens.html

Switched Reluctance Machines

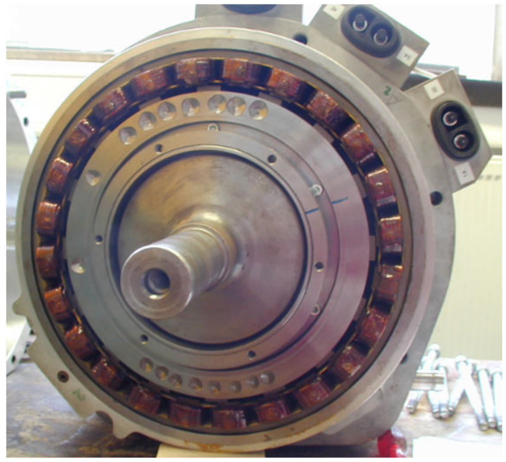
- Principle of SRM



Structure of SRM

- Simple and robust rotor
- Concentrated windings
- No excitation in rotor
- Converter with unipolar current

-



Working principle

- Variable phase inductance
- Inductance slope determines torque sign
- Excitation on one half of the entire period
- Operation with magnetic saturation

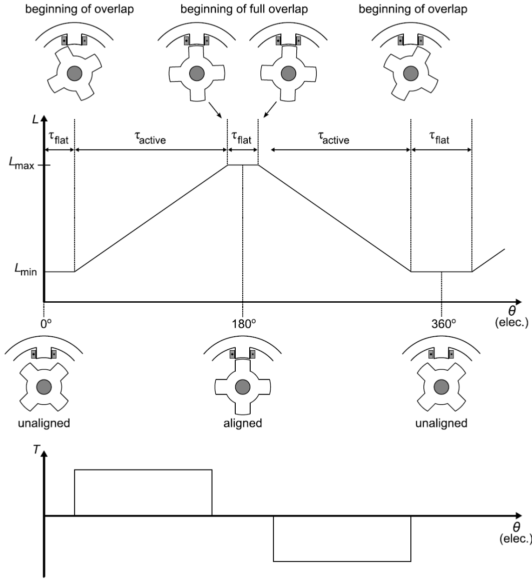


Figure 7.5: Inductance profile of one phase and torque production region

Converter of SRM

- Asymmetrical half bridge converter for one phase
- Phase independency
- Shoot-through free, high reliability
- Limp-home capability

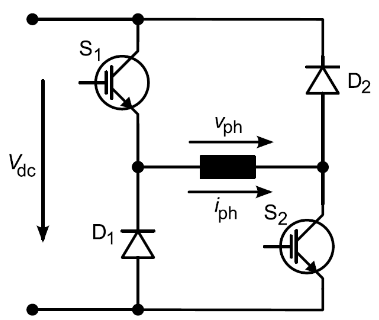
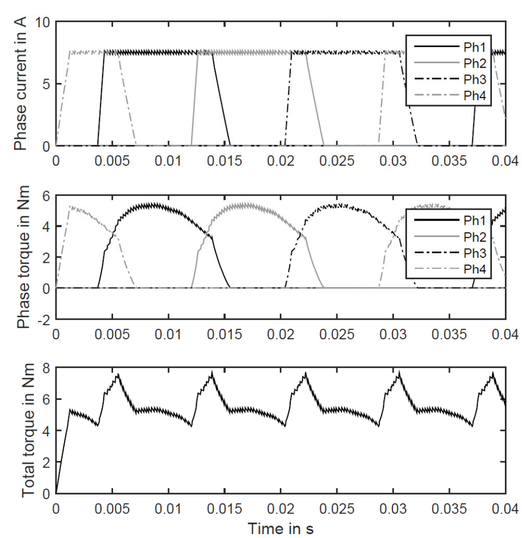


Table of switching states

S1	S2	D1	D2	v_{ph}	Excitation mode
on	on	off	off	$+V_{dc}$	Magnetization (+1)
on	off	off	on	0	} Freewheeling (0)
off	on	on	off	0	
off	off	on	on	$-V_{dc}$	Demagnetization (-1)

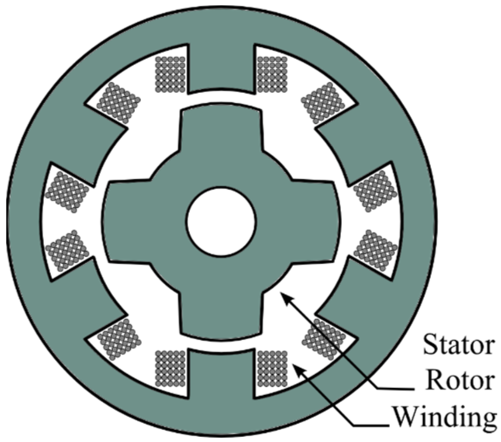
Torque ripples in SRMs

- Inherent torque ripple
- Torque ripple during commutation
- Torque ripple minimization techniques, e.g. current profiling and DITC.



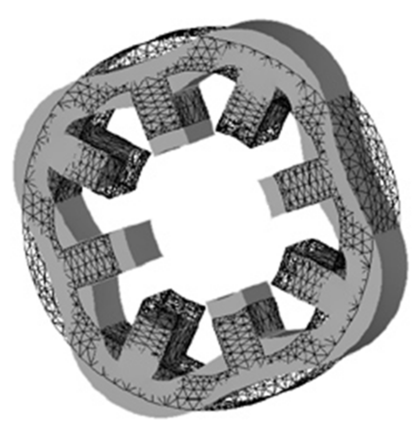
Merits of switched reluctance motor

- Simple and robust rotor
  - No brush
  - Less materials
  - Capability for high centrifugal force
- Concentrated windings
  - Less end-turn – less materials
- No excitation in rotor
- Converter with unipolar current
  - Independent phases – limp-home
  - high reliability
  - No short-circuit currents



Demerits

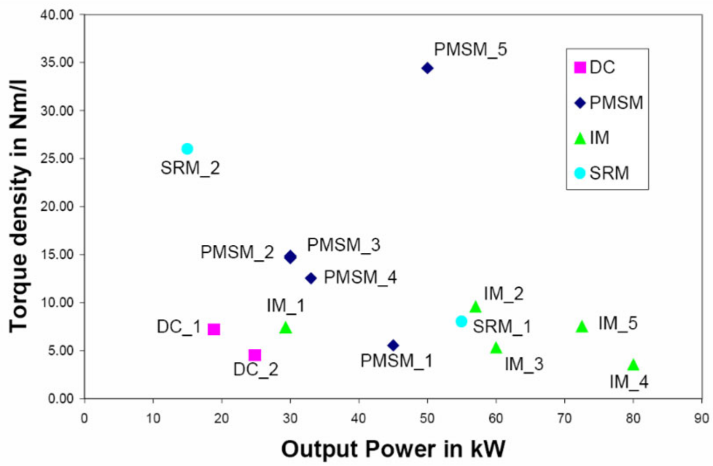
- Double salient structure
  - Torque ripple
  - Noise from vibrations and aerodynamic
  - Salient rotor - friction and windage losses
- Converter is necessary.
- Position information is needed.
  - Cost of position sensor



Source: ISEA, RWTH-Aachen University

Torque density per volume

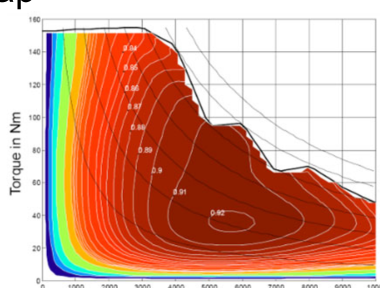
- Motor diameter is a quadratic function of radius.
- Motors in different applications have different designs.



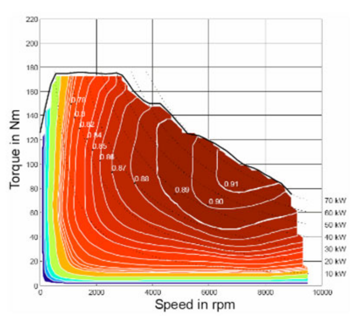
Characteristical efficiency map

- IM has high efficiency at intermediate speed
- SRM has high efficiency at high speed.
- PMSM has higher efficiency in average.

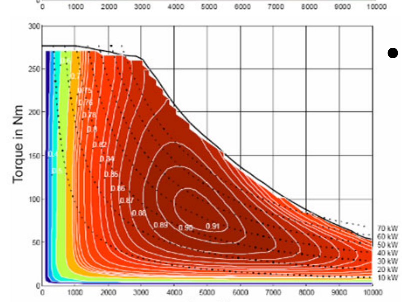
●PMSM



● SRM



●IM



Comparison of different motor types

Aspects	DC	PMSM &BLDC	IM	SRM
Efficiency	+	+++	++	++
High speed operation	O	+	+	+++
Low-maintenance	O	+	++	++
Manufacturing costs	+++	++	+	O
Dynamic	O	+	++	++
Control simplicity	+++	+	+	O
Number of applications	++	+	+++	O

+++very high ++ **high** + **moderate**
O low

Application examples

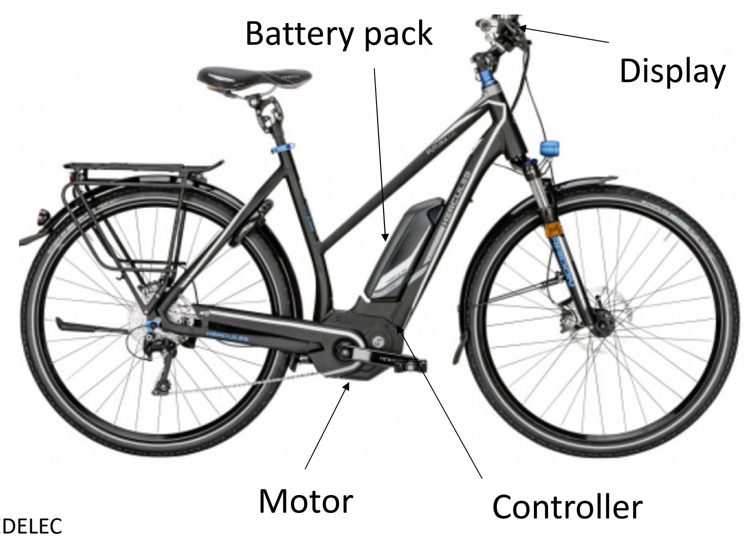
Electrical drives for electric bicycles/small scooter

- Major requirements, compact and light, low cost, robust and reliable
- Power : 250-500W
- Torque : up to 30-50Nm
- Motor speed: several hundreds rpms
- Vehicle speed : up to 25kmh
- Middle motor with integrated gear
- Regenerative braking is optional.
- Direct drive: large diameter
- Planetary gear for smaller size : e.g. 3:1
- Complicated control due to hybrid drive concept
- Air cooling is a must.

Kalkhoff PEDELEC

Stromer ST1 – rear motor

Electric system of PEDELEC



Kalkhoff PEDELEC

Motor configuration in PEDELEC

- General feature
  - Power rating: 250W /500W** for some country
  - Weight: 2.5-5kg
  - Max assisting speed: 25-45 km/h
  - BLDC motor
  - With gear or no gear

- The position of the motor has a significant impact.
  - 1. Motor in the bottom bracket (middle motor)
  - 2. Motor in the hub of the front wheel
  - 3. Motor in the hub of the rear wheel

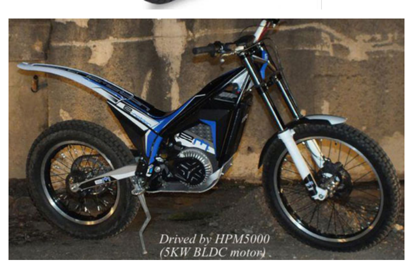
Electrical drives for motorcycles

- Major requirements, compact and light, cheap, robust and reliable

- Power : 1kW-5kW
- Torque : up to several tens Nm
- Motor speed : several thousands rpm
- Vehicle speed : up to 50-70-90 kmh

- Regenerative braking is optional.
- Mechanical coupling: chain, gear
- Direct drive rare.
- Air cooling is default.

Source: https://wangbinbin2019.en



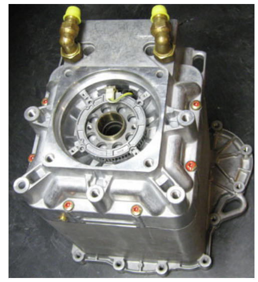
Source: https://www.goldenmotor.com

Electrical drives for passenger cars

- Major requirements, robust and reliable

- Power : tens kW to few hundreds kW
- Torque : several hundreds Nm
- Motor speed : several thousands up to more than ten thousands
- Vehicle speed : up to more than 200 km/h

- Mechanical coupling: gear
- In-wheel drive possible
- Water cooing is dominant due to space limitation.



Source: http://www.zuglet.com/ev/fordsiemens/fordsiemens.html

Source: Protean Electric Unveils Production In-Wheel Electric Drive System

Types of electrical motors in electric car

Vehicle	Motor type	Specifics
BMW i3	Interior PM	Rare-earth
Chevrolet Volt	Interior PM	Ferrite/ Rare-earth
Hyunday Sonata	Surface PM	Rare-earth
Mitsubishi PHEV	Interior PM	Rare-earth
Nissan Leaf	Interior PM	Rare-earth
Porsche Panamera	Surface PM	Rare-earth
Tesla S	Induction motor	Copper cage
Toyota Prius	Interior PM	Rare-earth

EV models	EV motors
Fiat Panda Elettra	Series dc motor
Mazda Bongo	Shunt dc motor
Conceptor G-Van	Separately excited dc motor
Suzuki Senior Tricycle	PM dc motor
Fiat Seicento Elettra	Induction motor
Ford Th!nk City	Induction motor
GM EV1	Induction motor
Honda EV Plus	PM synchronous motor
Nissan Altra	PM synchronous motor
Toyota RAV4	PM synchronous motor
Chloride Lucas	Switched reluctance motor

Source: Marco Villani, High Performance Electrical Motors for Automotive Applications – Status and Future of Motors with Low Cost Permanent Magnets

Source: C. C. Chan, K. T. Chau, Modern Electric Vehicle Technology

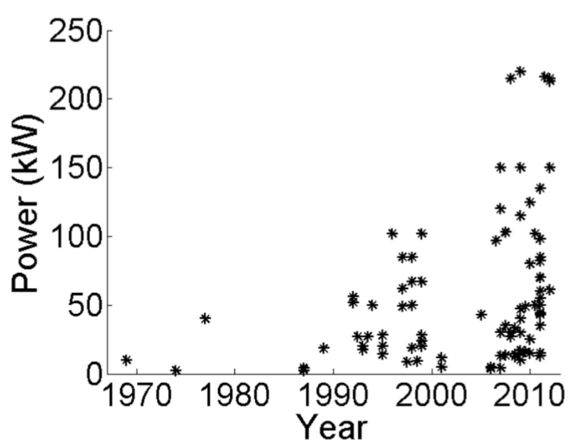
Types of electrical motors in electric car (cont.)

Model	Battery type	Energy storage (kWh)	Nominal range (km)	Market release	Power (kW)	Motor type
Tesla Model S	Li	42	258	2012	215	IM
Tesla Model S	Li	65	370	2012	215	IM
Tesla Model S	Li	85	483	2012	215	IM
Lightning GT	Li	40	240	2012	150	PM
Hyundai BlueOn	Li	16,4	140	2012	61	PM
Honda Fit EV	Li		113	2012		IM
Toyota RAV4 EV	Li	30	160	2012		IM
Saab 9-3 ePower	Li	35,5	200	2011	135	
CODA Sedan	Li	34	193	2011	100	
Ford Focus Electric	Li	23	160	2011	100	IM
Skoda Octavia Green E Line	Li	26,5	140	2011	85	
Volvo C30 DRIVe Electric	Li	24	150	2011	82	
Renault Fluence Z.E.	Li	22	161	2011	70	SB
Renault ZOE	Li	22	160	2011	60	SB
Tata Indica Vista EV	Li	26,5	241	2011	55	PM
Ford Tourneo Connect EV	Li	21	160	2011	50	IM
Kangoo Express Z.E	Li	22	170	2011	44	SB
Fiat Doblò	Li	18	140	2011	43	IM
Peugeot iOn	Li	16	130	2011	35	PM
Renault Twizy	Li	7	100	2011	15	
REVA NXR	Pb	9,6	160	2011	13	IM
BYD F3M	Li	15	100	2010	125	PM
Nissan Leaf	Li	24	175	2010	80	PM
Ford Transit Connect EV	Li	28	129	2010	50	IM
Citroen C zero	Li	16	130	2010	49	PM
Gordon Murray T-27	Li	12	130	2010	25	
Wheego Whip LiFe	Li	30	161	2010	15	IM
Venturi Fétish	Li	54	340	2009	220	
Mini E	Li	35	195	2009	150	IM
BYD e6	Li	60	330	2009	115	PM
Mitsubishi i MiEV	Li	16	160	2009	47	PM
Subaru Stella EV	Li	9,2	80	2009	40	
Smart ED	Li	16,5	135	2009	30	PM
Citroën C1 ev'ie	Li	30	110	2009	30	IM

Source: de Santiago, J., Bernhoff, H., Ekergård, B., Eriksson, S., Ferhatovic, S. et al. (2012) "Electrical Motor Drivelines in Commercial All Electric Vehicles: a Review“, IEEE Transactions on Vehicular Technology
SB = Synchronous brushed

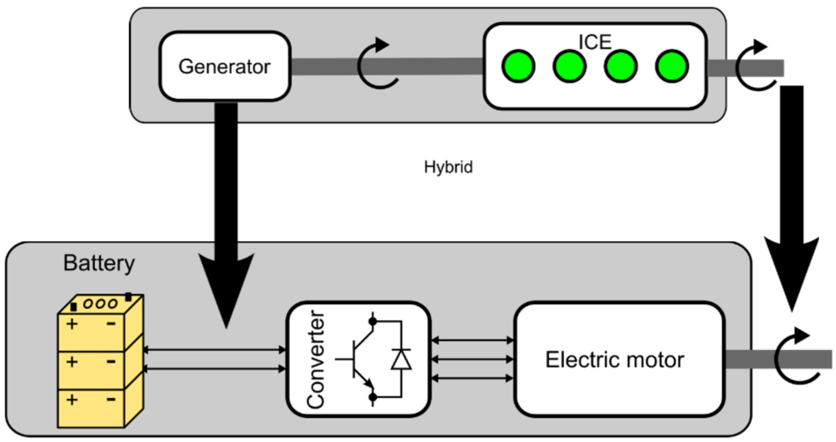
Driving power of EVs

- Driving power by electric motor sufficiently covers all EV power requirements.

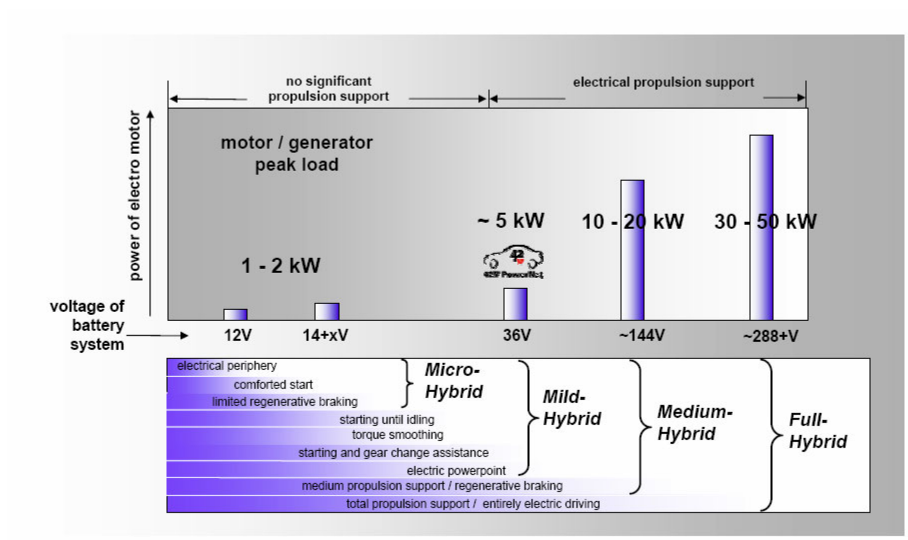


Source: de Santiago, J., Bernhoff, H., Ekergård, B., Eriksson, S., Ferhatovic, S. et al. (2012) "Electrical Motor Drivelines in Commercial All Electric Vehicles: a Review“, IEEE Transactions on Vehicular Technology

Electrical drives in HEV



Level of installed driving power for HEVs



Power and voltage range of electrical drives for EV

- Bicycle and scooter
  - 180 – 500 W, DC bus voltage 24-36 V
- Motorcycle
  - 800 W - 4 kW, DC bus voltage 36-96 V
- Cars
  - Hybrid power 5-30 kW, DC bus voltage 200-600 V
  - EV power 45 - 80 kW, DC bus voltage 200-800 V
- Bus
  - 40 kW - 150 kW or more, DC bus voltage 400-1200 V
- Railways and traction
  - from hundreds kW to few MW, DC bus voltage 500V – few kV

Example of drive system in Audi e-tron

Source: Audi

Technical specification

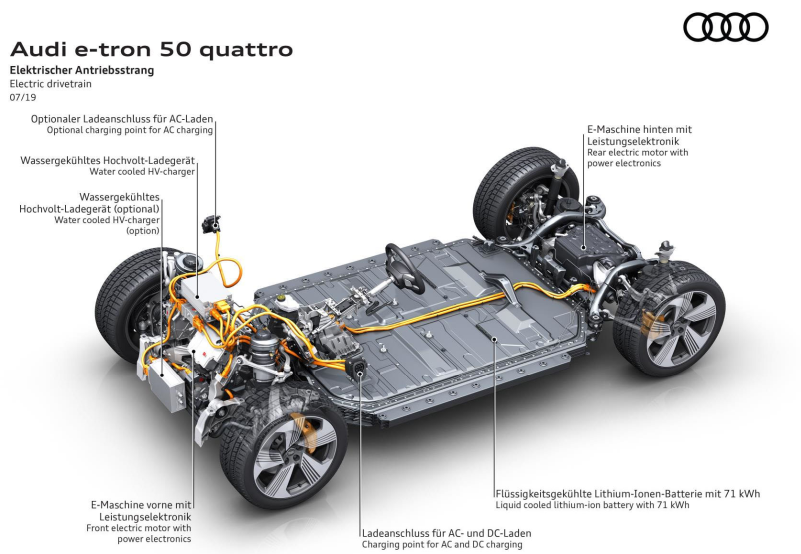
- AWD with two PMSM motor drives
- Single speed transmission
- Boost mode 15-20%

Audi e-tron Technical data

	e-tron 55 quattro
Drive system	2 Electric motors
Max. output (kW (hp))	265 (360) Front electric motor 125 (170) Rear electric motor 140 (190)
Max. output (kW (hp)) in boost mode	300 (408) Front electric motor 135 (184) Rear electric motor 165 (224)
Max. torque (Nm)	561
Max. torque (Nm) in boost mode	664
Gearbox	Single speed gearbox
Drive	quattro
Acceleration 0-100 km/h (s)	6.6
Acceleration 0-100 km/h (s) in boost mode	5.7
Top speed (km/h)	200
High voltage battery energy content	Lithium-ion in 95 kWh
Electric range refers to the electric power consumption in NEDC (WLTP) test cycle in km	385 (411)
Steering	Electromechanical progressive steering with speed-dependent power assistance
Front brake	Disc, brake calipers painted in orange
Rear brake	Disc, brake calipers painted in orange
Luggage volume (L) at front	60
Luggage volume (L) at rear	660
Wheel 9.5J x 21 with 265/45 R21 tyres	•
Collapsible spare tire	•

Source: Audi e-tron brochure

Electrical drive layout



Source: Audi

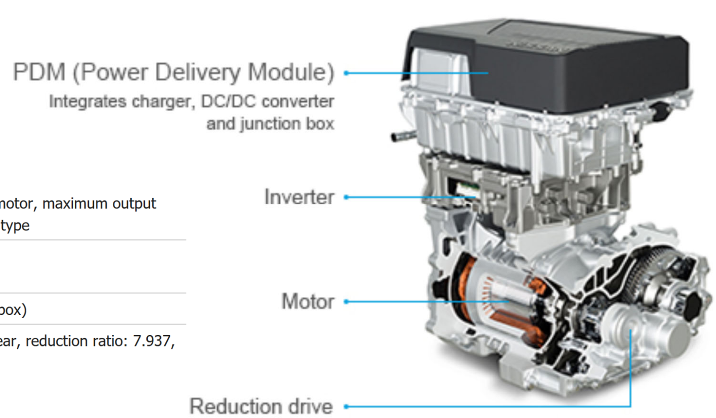
Example of drive system in Nissan Leaf

Source: Nissan

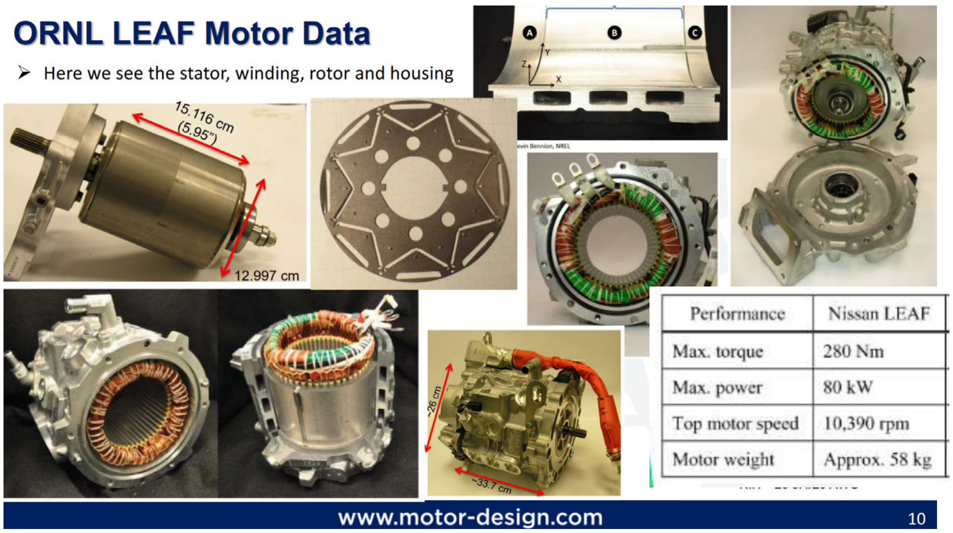
Drive system in Nissan Leaf

- PMSM
- Max torque 280Nm
- Max power 80kW
- Max speed 10,390 rpm
- Integrated drive

Power motor (3-phase AC synchronous motor, maximum output 80kW, maximum torque 280N·m) EM61 type
Inverter (IGBT x 6)
DC-DC converter (doubles as a junction box)
Power transmission system (reduction gear, reduction ratio: 7.937, without gear-shifting) model: RE1F61A



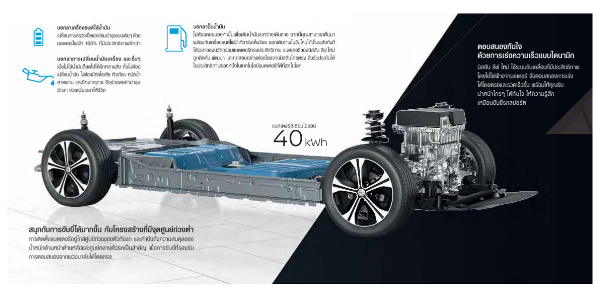
Example of PM synchronous machine in Nissan Leaf



Performance	Nissan LEAF
Max. torque	280 Nm
Max. power	80 kW
Top motor speed	10,390 rpm
Motor weight	Approx. 58 kg

Technical specification

- Front drive
- PMSM drive
- Single speed



- **มอเตอร์ให้กำลังสูงสุด กิโลวัตต์ (พีเอส)**
  110 kW [150 PS]
- **แรงบิดสูงสุด นิวตัน-เมตร (กิโลกรัม-เมตร)**
  320
- **มอเตอร์ไฟฟ้า**
  AC SYNCHRONOUS
- **ระบบเกียร์**
  Single Speed Gear Reduction
- **ความจุแบตเตอรี่**
  40kWh

Source: https://www.nissan.co.th/vehicles/new-vehicles/leaf/specifications.html#grade-B12P-0|specs

Battery warranty of Nissan Leaf

- Assumption: Power consumption = 150Wh/km
- Battery capacity of 40kWh
  - Range per one charge = 40kwh/150Wh/km =266.7km
- Warranty of 160,000km
  - Number of battery cycle (full cycle equivalent) = 16000km/266km=600cycles
- Warranty is plausible, but calendric life time and temperature cycle are also relevant factors.

รับประกันอายุความคงทนและประสิทธิภาพการทำงานคุณภาพระดับสูงของแบตเตอรี่ลิเธียม ไอออนความจุ 40 kWh ในรถยนต์ นิสสัน ลีฟ ใหม่ สามารถใช้งานได้ถึง 8 ปี หรือ 160,000 กิโลเมตร (แล้วแต่ระยะใดถึงก่อน) นอกจากนี้ นิสสัน ลีฟ ใหม่ ยังกล้ารับประกันระบบไฟฟ้าถึง 5 ปี หรือ 100,000 กิโลเมตร (แล้วแต่ระยะใดถึงก่อน)