

FE based performance estimation of PMBLDC motor based drives

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FE based performance estimation of PMBLDC motor based drives

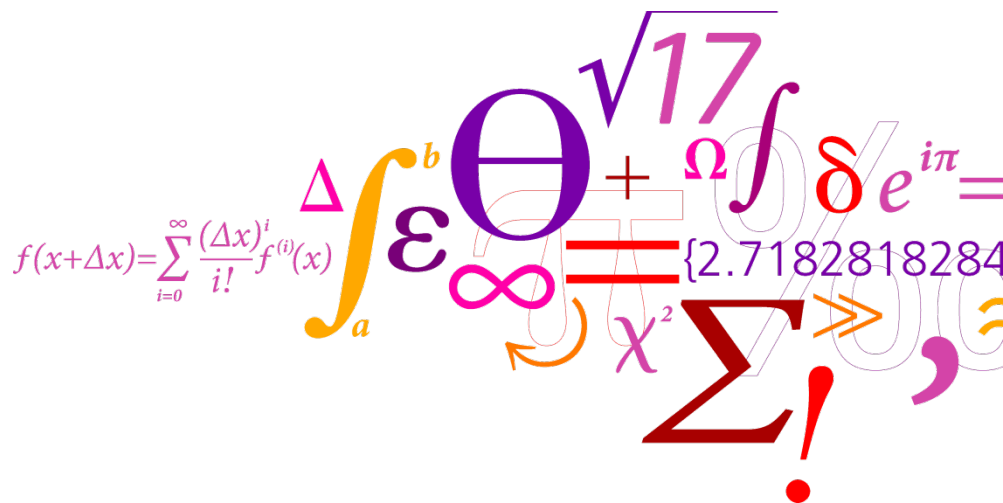
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Presented by
Muhammed Fasil
Ph.D. Student

DTU Electrical Engineering
Department of Electrical Engineering



Background

Permanent magnet drive topology

Simulation method

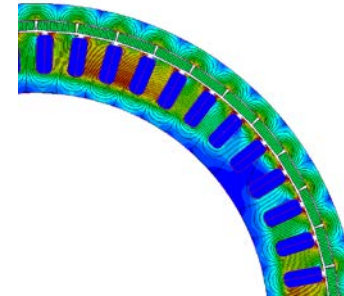
Simulation time

Controller

Radial flux motor



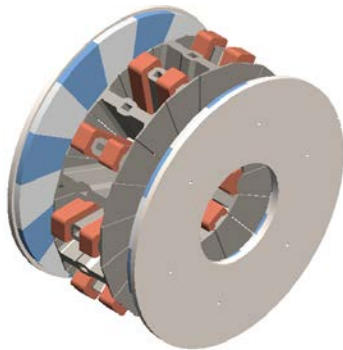
Circuit simulation software 2D-Finite element software



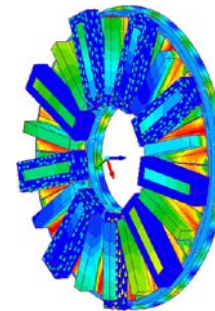
Hours

Controller

Axial flux motor



Circuit simulation software 3D-Finite element software

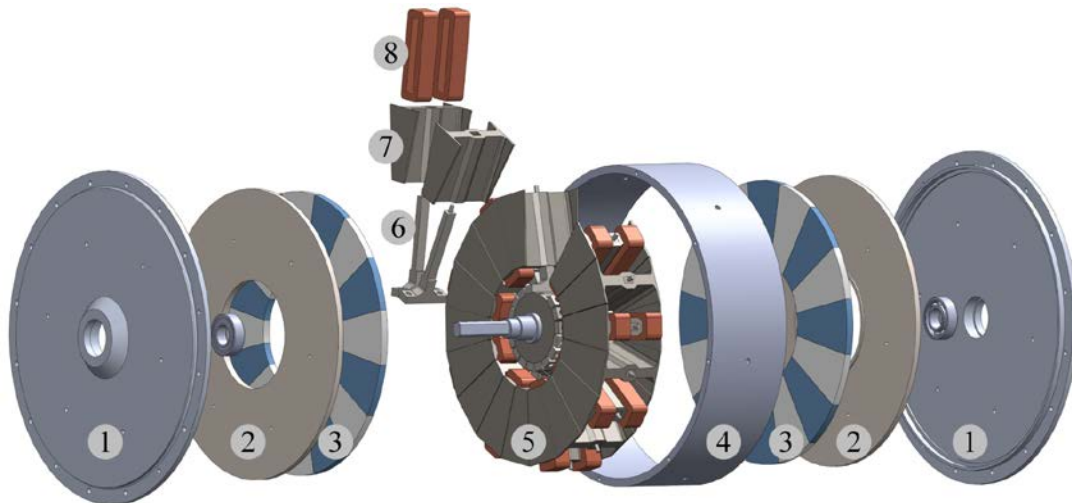


Days

Outline

- Axial flux permanent magnet brushless DC (PMBLDC) motor for an electric two-wheeler
- Proposed approach for the performance simulation of PMBLDC motor drives
- Electromagnetic finite element (FE) model of PMBLDC motor
- System modelling of PMBLDC motor drives in circuit simulation software
- Results of ISO 13064 drive cycle simulation of electric two-wheeler
- Conclusion

Axial flux motor for electric two-wheeler

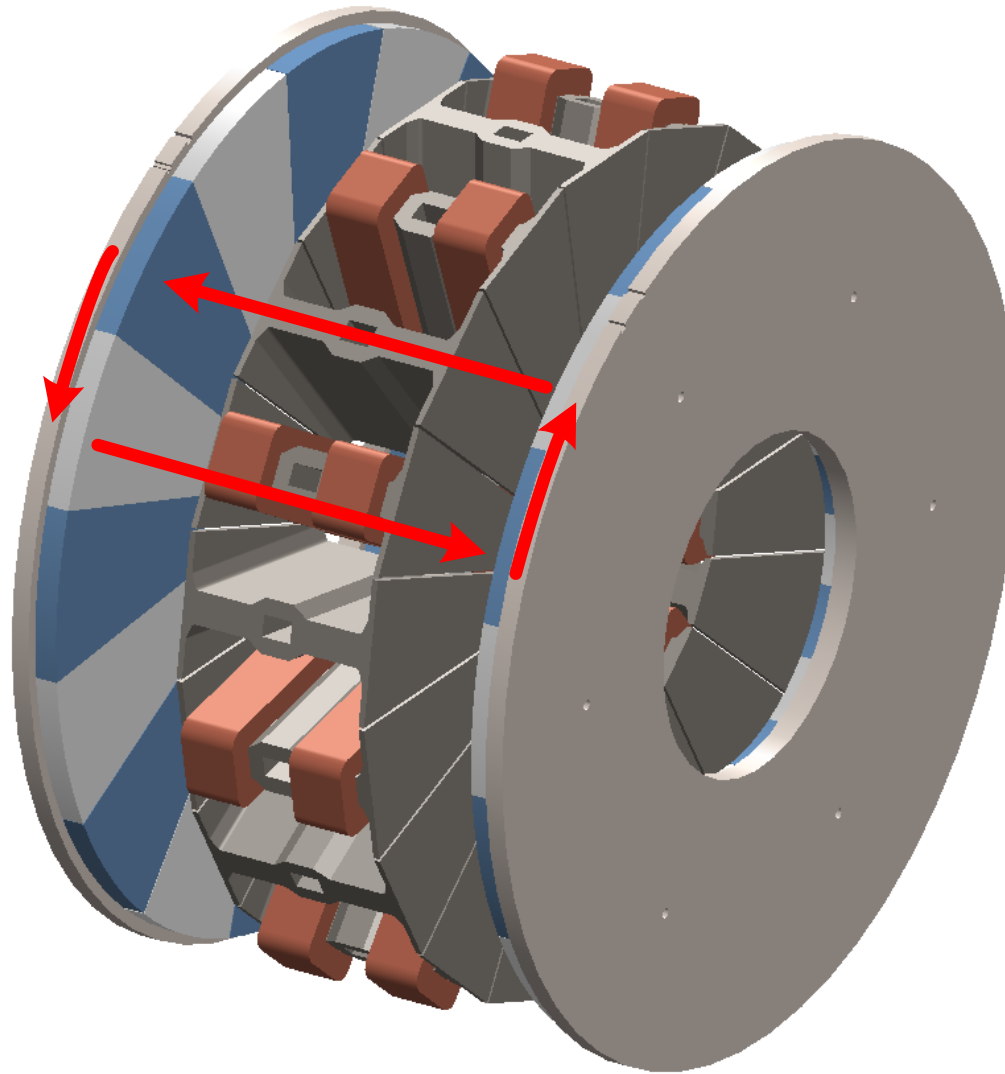


1. end cover, 2. rotor yoke, 3. magnet, 4. casing, 5. stator, 6. tooth holder, 7. stator tooth, and 8. coils

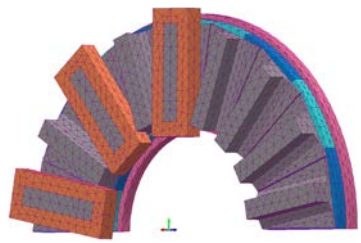
The specification and geometrical dimensions of ferrite magnet sat PMBLDC motor

Parameter	Value
The rated voltage	48 V
The rated power output	700 W
The rated torque	20 N m
Outer diameter of the motor	275 mm
Diameter ratio	0.45
Axial length of the motor	65.5 mm
Number of poles	16
Number of slots	18
Gross slot fill factor	0.5
Thickness of magnet poles	7.5 mm
Length of air gap	0.4 mm
Number of turns per coil	30
Diameter of a coil turn	2.68 mm

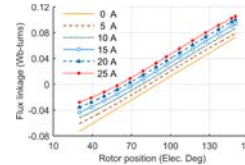
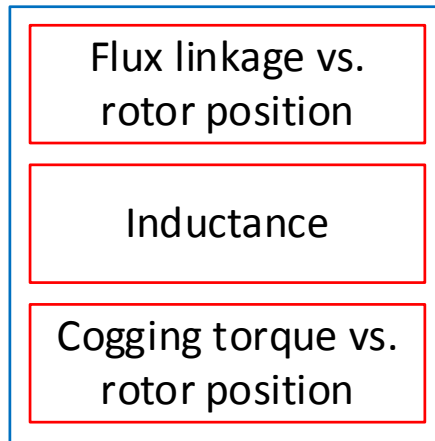
3D Flux path in axial flux machine



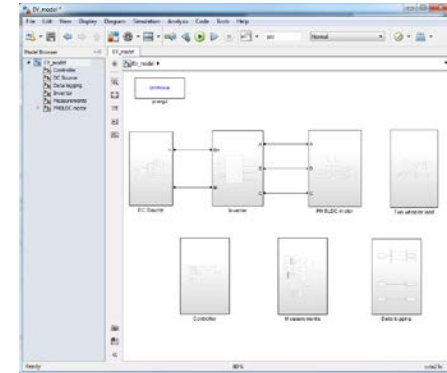
Proposed approach for the performance simulation of PMBLDC motor drives



3D static FE model

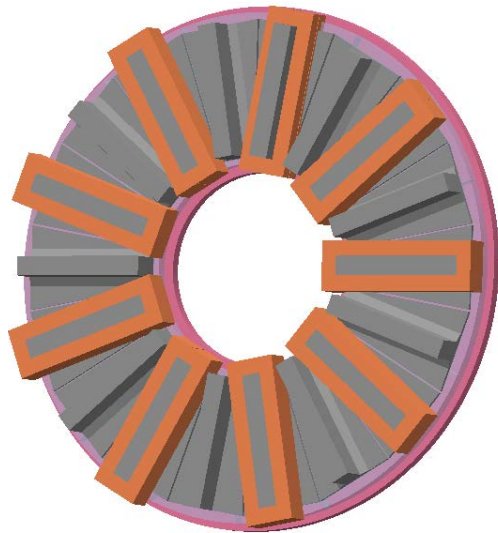


3D data table



Circuit simulation softwares

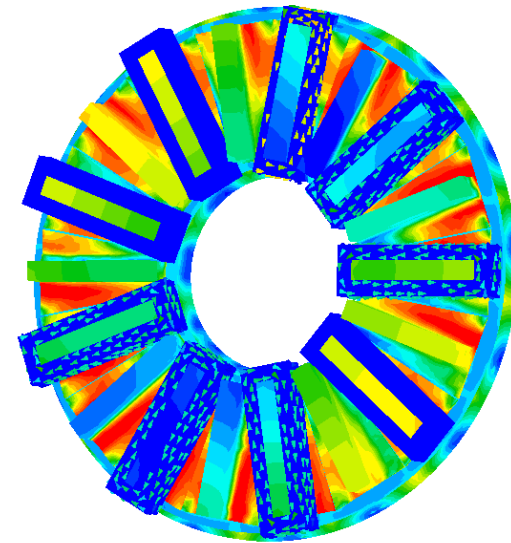
Results from FE software



FE model utilizing
geometrical
symmetry

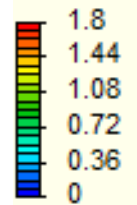


Meshed FE model

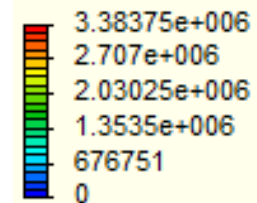


Static field
solutions

Shaded Plot
 $|B|$ smoothed
16

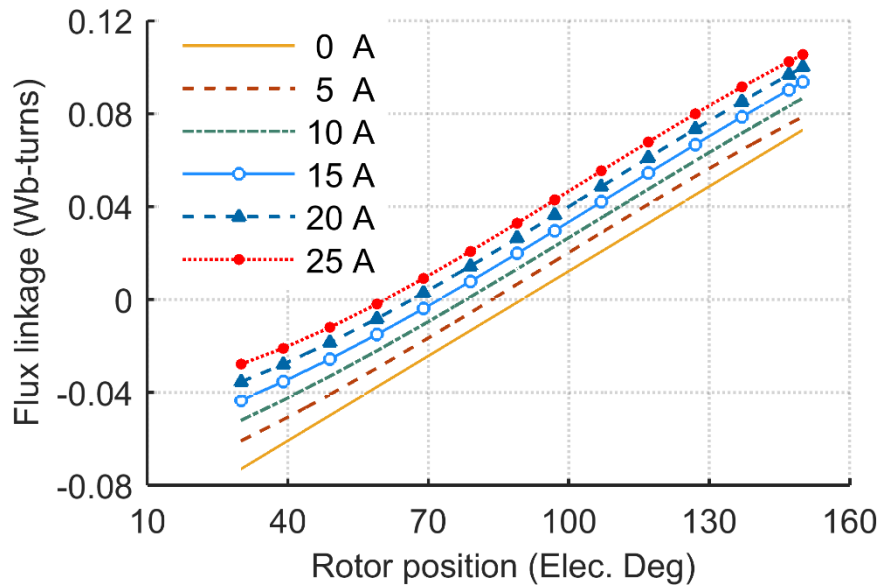


Arrow Plot
 J
16

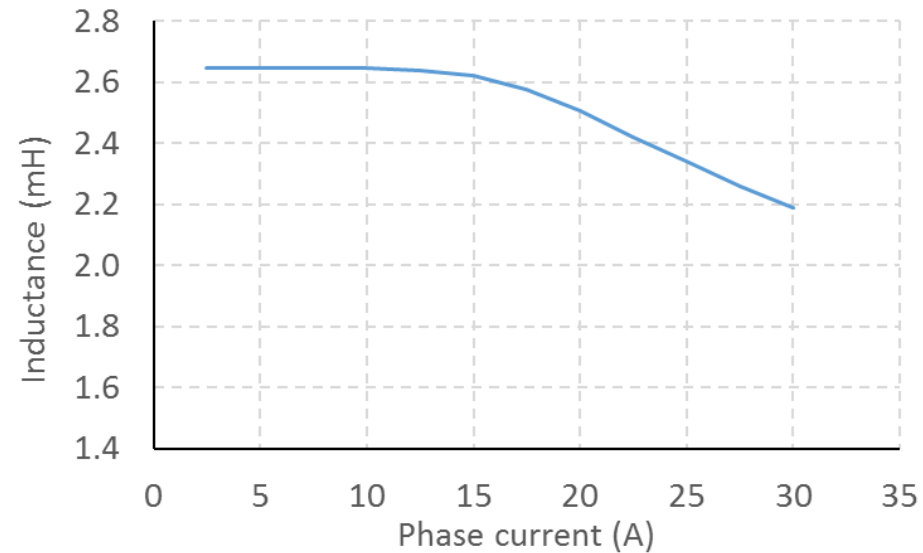


Results from FE software

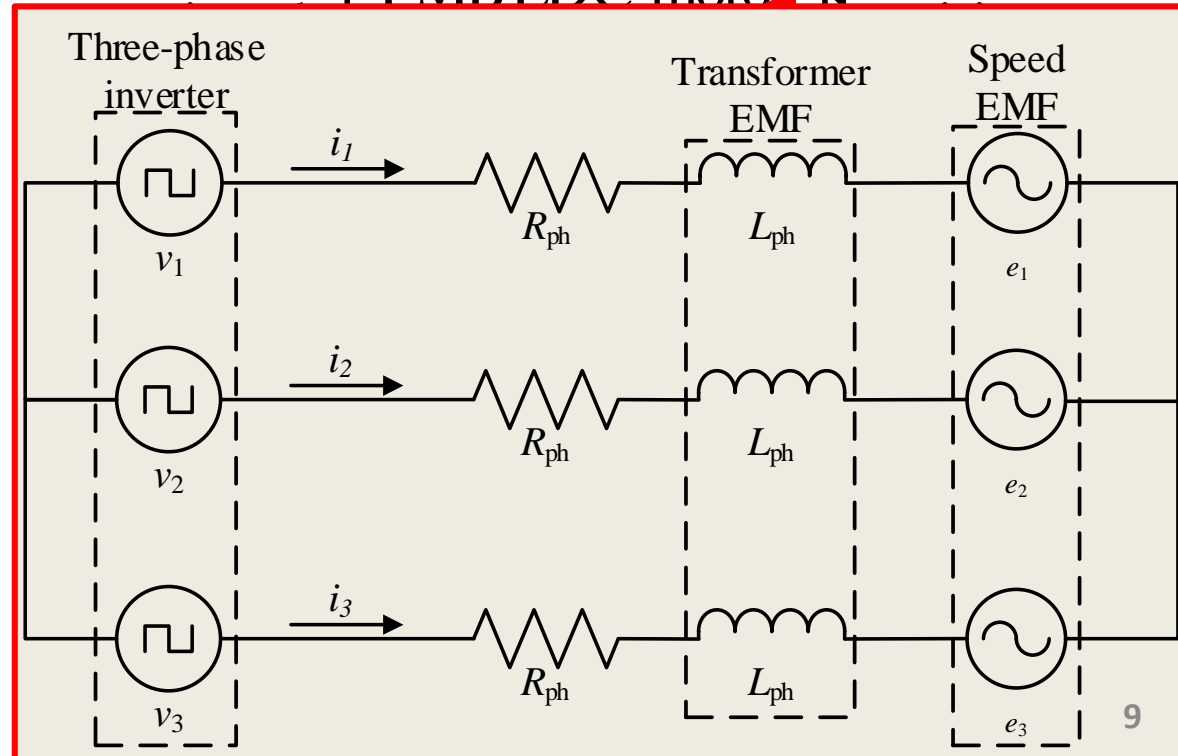
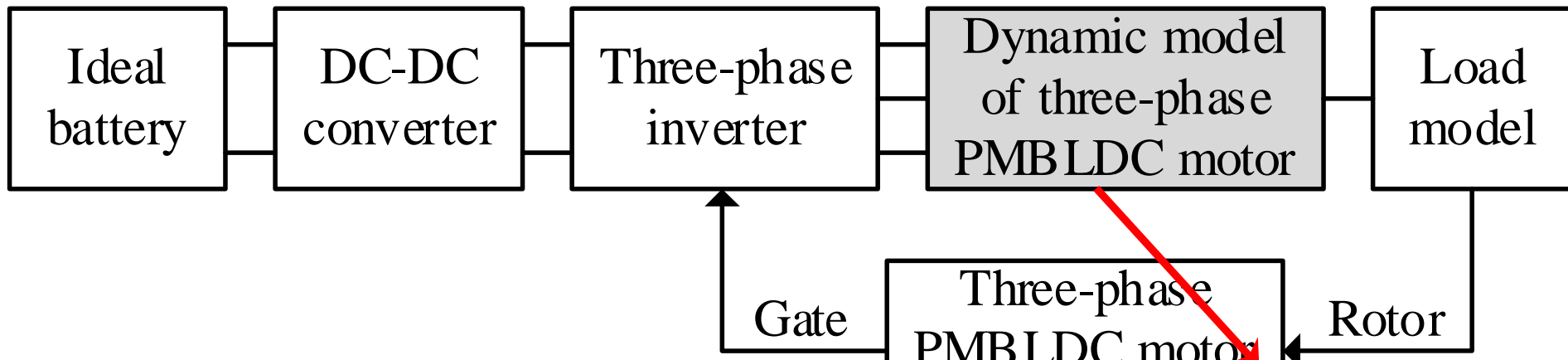
Flux linkage vs. rotor position for different phase current



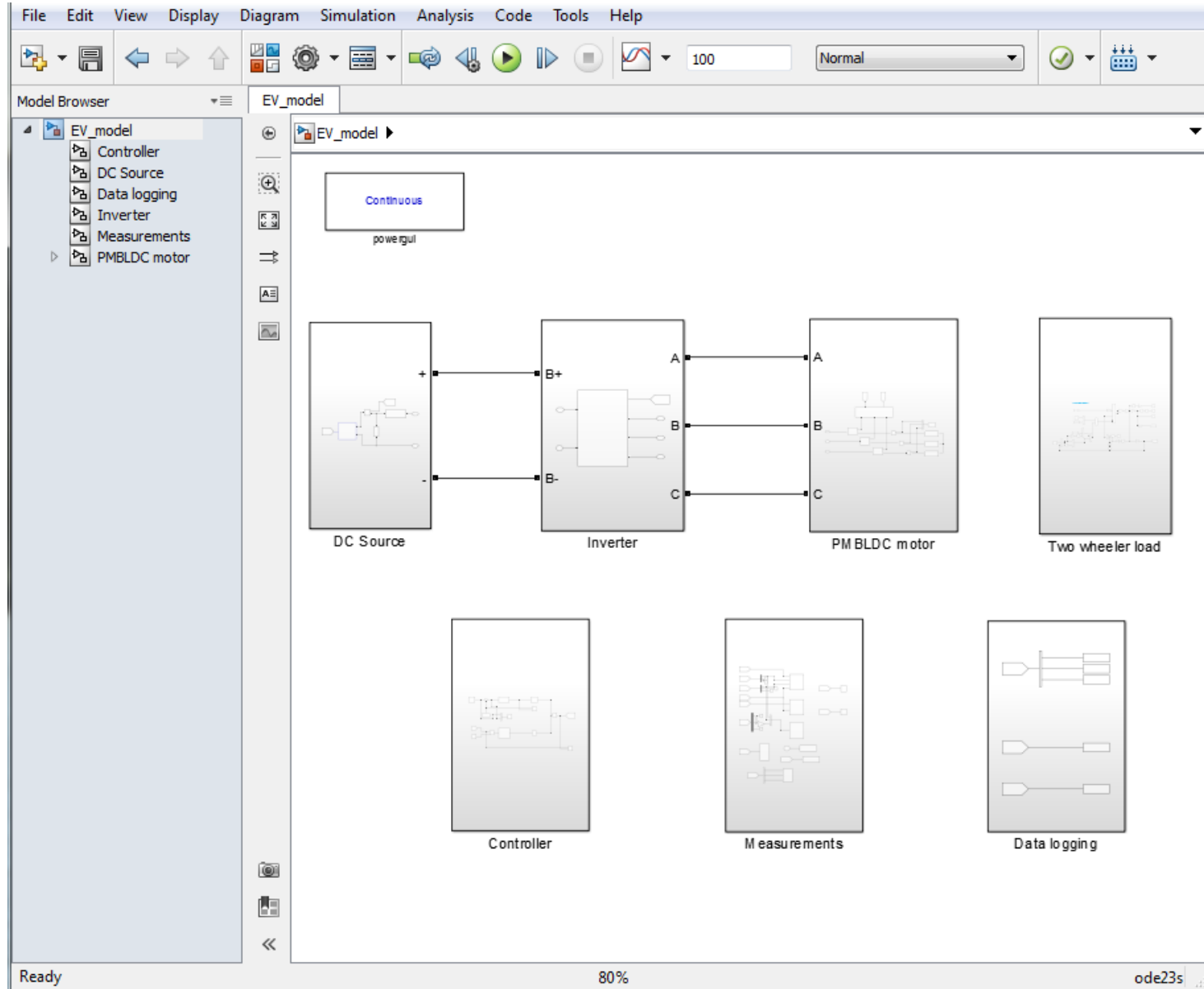
Phase inductance for different phase current



Mathematical model of PMBLDC motor drive in circuit simulation software

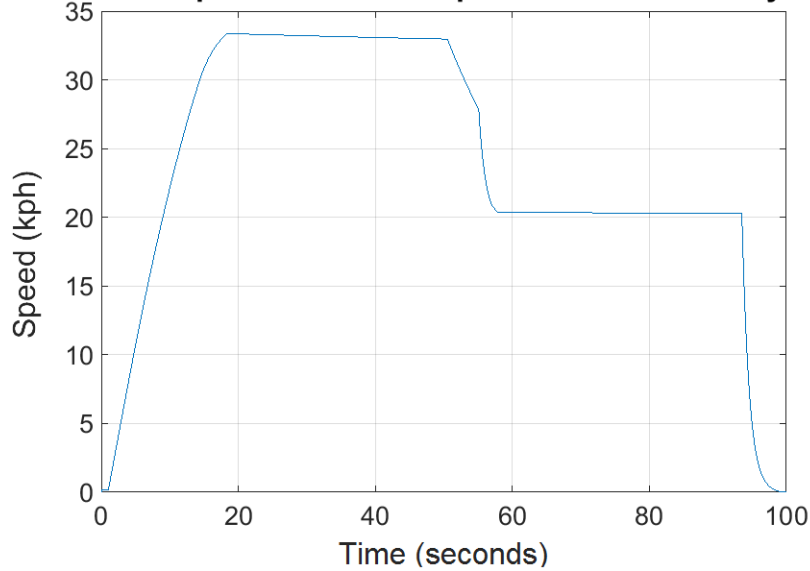


System model of electric two-wheeler in circuit simulation software

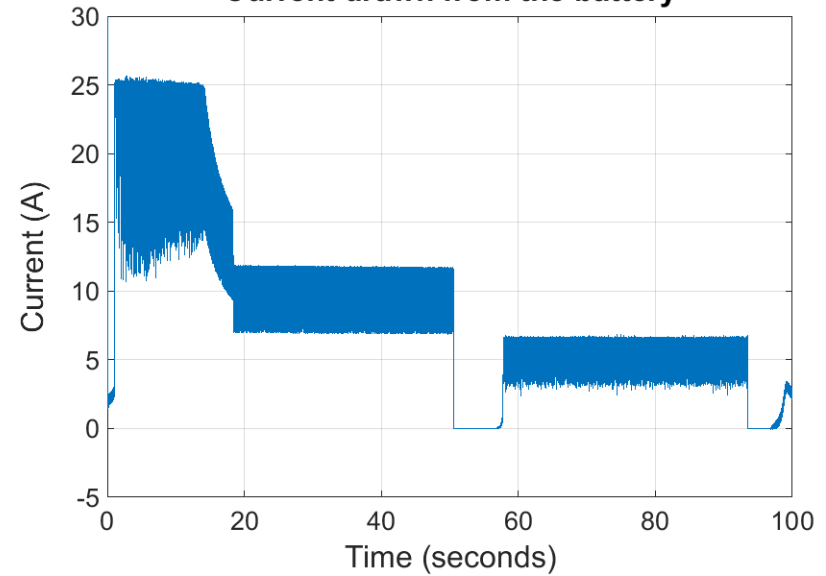


Results of ISO 13064 drive cycle simulation

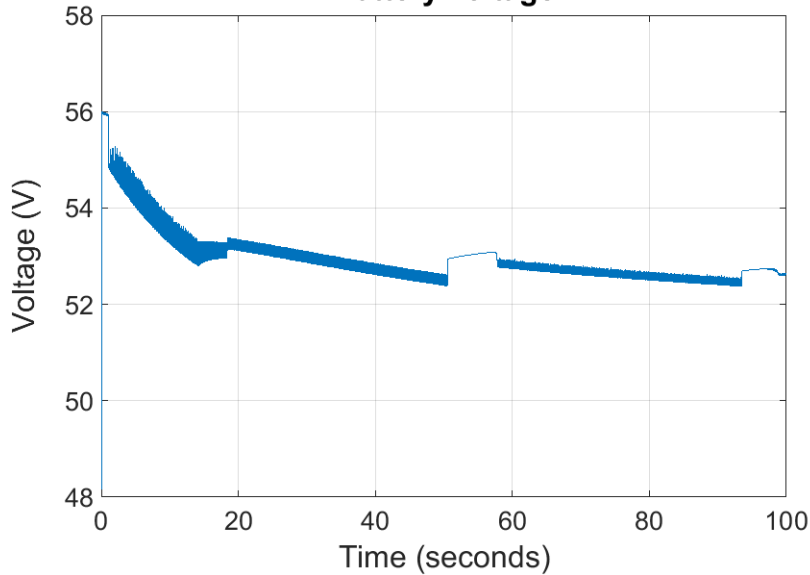
Vehicle speed variation as per ISO 13064 drive cycle



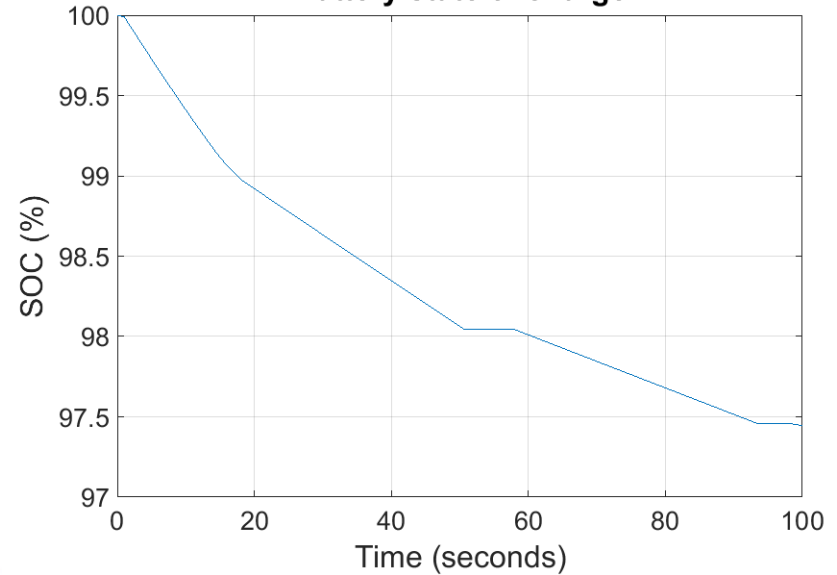
Current drawn from the battery



Battery voltage



Battery state of charge



Conclusion

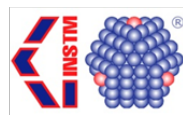
- An accurate dynamic model of PMBLDC motor is developed based on the results from the electromagnetic finite element simulation
- Dynamic model helps to carry out accurate system studies of 3D machine topologies
- The proposed model is used to simulate the system performance of an electric two-wheeler when driven as per ISO 13064 drive cycle
- Experimental validation of the model will be done in coming months

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Consortium



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