NEW HORIZON COLLEGE OF ENGINEERING | IEEE NHCE STUDENT BRANCH | IEEE Industrial Electronics Society, New Horizon College of Engineering | IEEE IES Bangalore Chapter

Webinar

SynRM/IPM Motor Design Using JMAG

4th May 2026

04:00 PM - 05:00 PM

Join with Meeting link

Teams Meeting ID:
311 623 122 915 409

Passcode:
Cg6Lu92R

Mr. Jeevan S
FEA Support Engineer
Powersys Engineering Solutions

Faculty Coordinator	Convenor			
Prof. Satishkumar D	Dr. S Sujitha	Dr. Revathi V	Dr. R J Anandhi	Dr. Manjunatha
	HoD - EEE	Dean - R & D	Dean - Academics	Principal

Organised by
Department of Electrical and Electronics Engineering

Venue: Microsoft Teams (Online)

Date: 4th May 2026

Faculty Coordinator: Prof. Satishkumar D

Targeted Audience: Students and EEE Department Faculty from New Horizon College of Engineering

Description:

Topic: *Design of Interior Permanent Magnet (IPM) Motor Using JMAG*

The Department of Electrical and Electronics Engineering, NHCE organized an insightful webinar on **“Design of SynRM/IPM Motor Using JMAG”** to provide students, researchers, and faculty members with practical exposure to advanced electric motor design and simulation techniques. The session was delivered by **Mr. Jeevan S**, FEA Support Engineer from Powersys Engineering Solutions, who shared detailed knowledge about the application of JMAG software in the development of high-performance electrical machines.

The webinar began with an introduction to the growing importance of electric machines in electric vehicles, industrial automation, renewable energy systems, robotics, aerospace, and defence applications. The speaker explained how modern motor design requires accurate electromagnetic analysis, thermal evaluation, structural validation, and optimization techniques to achieve higher efficiency, reliability, and compactness. JMAG was introduced as a powerful simulation platform capable of handling all these requirements in an integrated environment.

The session first focused on the fundamentals of **Interior Permanent Magnet (IPM) motors** and **Synchronous Reluctance Motors (SynRM)**. The speaker discussed the operating principles, rotor structures, torque production mechanisms, and advantages of IPM motors such as high power density, better efficiency, wide speed range, and excellent torque characteristics. The comparison between conventional induction motors and advanced IPM/SynRM motors was also explained to help participants understand the importance of these machines in modern electric drive systems.

A detailed explanation of the **motor design workflow in JMAG** was presented. The speaker demonstrated how motor specifications are initially defined based on application requirements. Important parameters such as DC bus voltage, rated speed, maximum speed, continuous torque, peak torque, efficiency targets, and cooling conditions were considered during the design process. The importance of selecting suitable stator and rotor dimensions for achieving desired performance was emphasized.

The webinar then moved to the **rotor and magnet design stage**, where different rotor topologies supported in JMAG were discussed. The speaker explained V-shaped magnet arrangements, double-layer permanent magnet structures, spoke-type rotor designs, and multi-pole rotor configurations. The impact of magnet dimensions, rotor barriers, flux paths, and air-gap design on torque generation and flux weakening capability was illustrated using simulation examples. Participants learned how proper rotor design improves motor efficiency, reduces torque ripple, and enhances high-speed operation.

One of the key highlights of the webinar was the discussion on **Finite Element Analysis (FEA)**. The speaker demonstrated how JMAG performs detailed electromagnetic analysis using FEA techniques. The software was used to evaluate magnetic flux distribution, magnetic saturation, torque characteristics, induced back EMF, cogging torque, and demagnetization effects. The participants gained understanding of how accurate electromagnetic simulation helps engineers predict motor behavior before prototype manufacturing, thereby reducing development cost and time.

The session also covered **motor loss analysis and efficiency prediction**. Different types of losses such as copper losses, iron/core losses, eddy current losses, hysteresis losses, and permanent magnet losses were explained in detail. The speaker showed how JMAG accurately estimates these losses under varying operating conditions, enabling engineers to improve overall motor efficiency and thermal performance. The significance of efficiency mapping for electric vehicle traction motors and industrial drives was also discussed.

Another important topic addressed during the webinar was **multi-physics simulation**. The speaker explained that modern motor development not only requires electromagnetic analysis but also thermal and structural validation. JMAG integrates electromagnetic, thermal, vibration, and stress analysis within a single environment. Thermal analysis helps in evaluating temperature rise in windings and magnets, while structural analysis predicts rotor stress and mechanical deformation during high-speed operation. This integrated approach enables complete virtual validation of the motor before physical manufacturing.

The webinar further explored the capability of **running multiple simulation studies simultaneously** in JMAG. The speaker demonstrated how different studies such as torque analysis, efficiency mapping, thermal analysis, induced voltage studies, and speed-torque performance evaluation can be performed using the same geometry model. This feature allows engineers to compare multiple operating conditions efficiently and identify design errors at an early stage. The use of parametric studies and automated simulation workflows for rapid design evaluation was also discussed.

A significant portion of the session focused on the **integration of JMAG with power electronics and control systems**. The speaker explained the concept of model reduction, where detailed 2D and 3D electromagnetic models are converted into 1D system-level models suitable for controller design and drive simulations. These models can be integrated with software platforms such as MATLAB/Simulink and SIMBA for motor-drive co-simulation. This integration helps engineers develop advanced control algorithms, optimize inverter performance, and analyze complete electric drive systems.

The speaker also introduced the **optimization features available in JMAG**. Advanced optimization techniques were demonstrated for torque maximization, loss minimization, thermal optimization, and weight reduction. JMAG supports automated optimization using multiple design variables and objective functions, enabling engineers to achieve the best motor performance efficiently. The use of high-performance computing environments and job schedulers such as LSF, PBS, and TORQ for large-scale simulations was briefly discussed.

The webinar included several practical demonstrations and simulation case studies, which helped participants understand the real-time implementation of motor design concepts. The interactive nature of the session encouraged participants to ask questions related to motor modeling, mesh generation, magnet selection, torque ripple reduction, cooling techniques, and controller integration. The speaker provided detailed answers and shared valuable industry-oriented insights regarding electric motor development and simulation practices.

Overall, the webinar provided comprehensive knowledge on the design, simulation, analysis, and optimization of IPM and SynRM motors using JMAG software. The session successfully bridged the gap between theoretical concepts and industrial applications, helping participants understand modern electric machine development methodologies. The webinar was highly beneficial for students, faculty members, researchers, and industry professionals interested in electric vehicle technology, advanced motor drives, and electromagnetic simulation.

Outline

- Introduction to EM design tool
- Design verification using analytical tool : JMAG express classic
  - Case study 1
- Design verification using analytical tool : JMAG express
  - Case study 1 – Case study 3
- Design verification through detailed 2D FEA analysis : JMAG designer
  - Case study 1 – Case study 8
- High fidelity component definition and validation using 3D modelling: JMAG designer
  - Case study 9 - Case study 10
- System model verification and control design : JMAG RT
  - Case study 11
- JMAG users in India and Globally

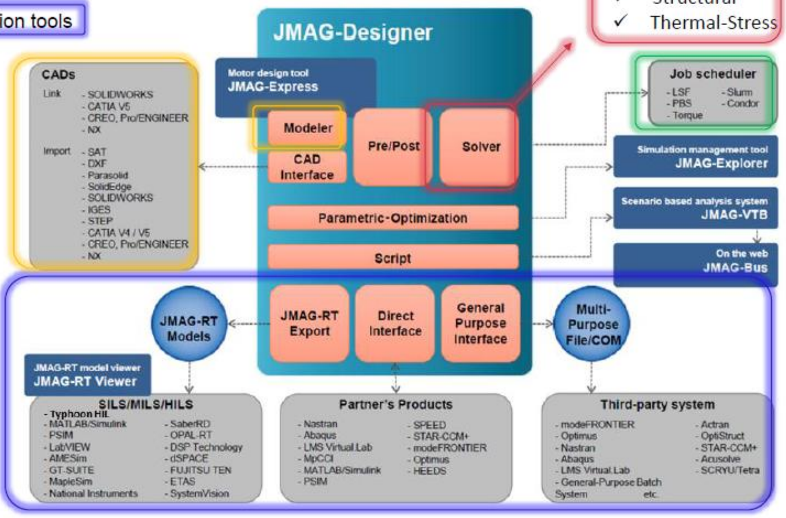
POWERSYS

JMAG Structure & Application Overview

1. Data connection between software and physics
2. Efficient HPC implementation and optimization
3. Common CAD for FEA
4. Integration of different simulation tools

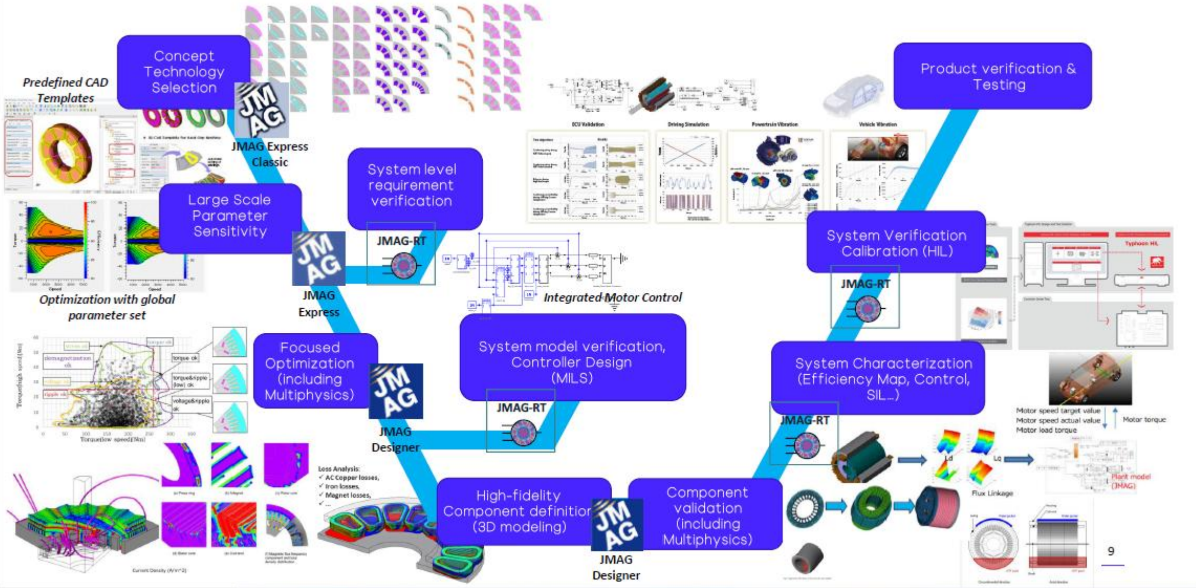
Solvers in JMAG

- ✓ Magnetics
- ✓ Electrostatics
- ✓ Thermal
- ✓ Structural
- ✓ Thermal-Stress



POWERSYS

Motor Design Workflow using JMAG (V Cycle)



Case Study-II

Creating IPM Motor Efficiency Maps

Problem Statement

Creating an efficiency map requires an enormous number of computations and it takes time to organize the results. Although it is possible to estimate efficiency by calculating the torque, voltage, and current from motor voltage equations and torque equations, but it is difficult to estimate iron loss this way. Also, considering the effects from nonlinear magnetization characteristics of the motor, it is difficult to calculate efficiency accurately.

It is useful to create an efficiency map for motor design and control design since the efficiency varies with the rotation speed and load.

Analysis Objective

In JMAG-Designer, an efficiency map can be easily created taking into account the influence from iron loss and nonlinear magnetization characteristics. In this study, an efficiency map of an IPM motor is created and the loss ratios at each operating point are evaluated.

From Fig. 1, the output torque and input torque efficiencies can be seen. It can be seen that in the high rotation speed half of the map that the efficiency is higher in the output torque area than in the input torque area. Iron loss, magnetic flux, and power factor maps are shown from Fig. 2 to Fig. 10.

Response table is used to specify the range of current, phase and speed for the different operating region.

JMAG-Designer: Create Response Table

Method of Calculation: Speed Priority | Torque: Torque | Pole: 8 | Phases: 3

Speed Priority | Reduced Order Model | Accuracy Priority

Motor Type: PMSM (3 or 6 Phase) | Job Count: 17

	Parameter	Type		Range
1	Current, A	Table	Edit...	12.5, 100, 200, 300
2	Phase, deg	Table	Edit...	0, 30, 60, 90
3	Speed, r/min	Table	Edit...	2000, 6000, 10000

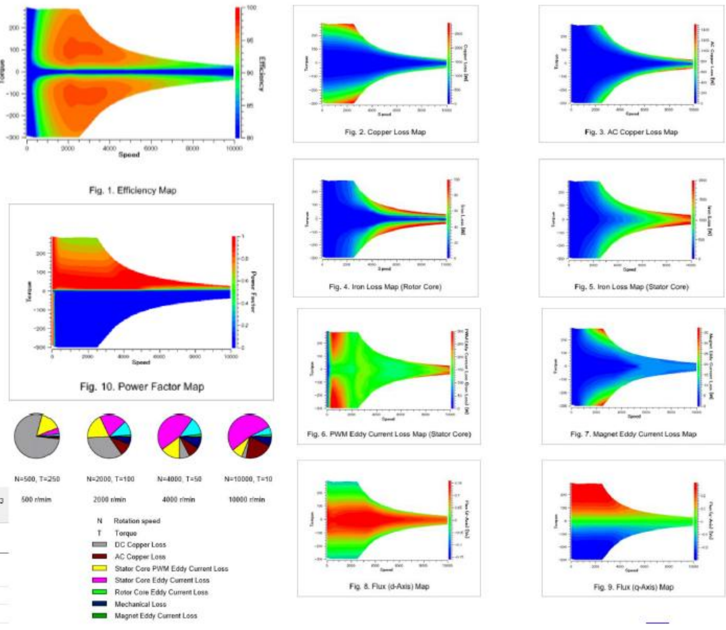


Fig. 1. Efficiency Map

Fig. 2. Copper Loss Map

Fig. 3. AC Copper Loss Map

Fig. 4. Iron Loss Map (Rotor Core)

Fig. 5. Iron Loss Map (Stator Core)

Fig. 6. PWM Eddy Current Loss Map (Stator Core)

Fig. 7. Magnet Eddy Current Loss Map

Fig. 8. Flux (d-Axis) Map

Fig. 9. Flux (q-Axis) Map

Fig. 10. Power Factor Map

Fig. 11. Loss Ratios at Each Operating Point

8/5/2026

Head of the Department
Department of Electrical and Electronics Engineering
New Horizon College of Engineering
Ring Road, Kadubisanahalli, Bellandur Post
Bangalore - 560103, Karnataka, India