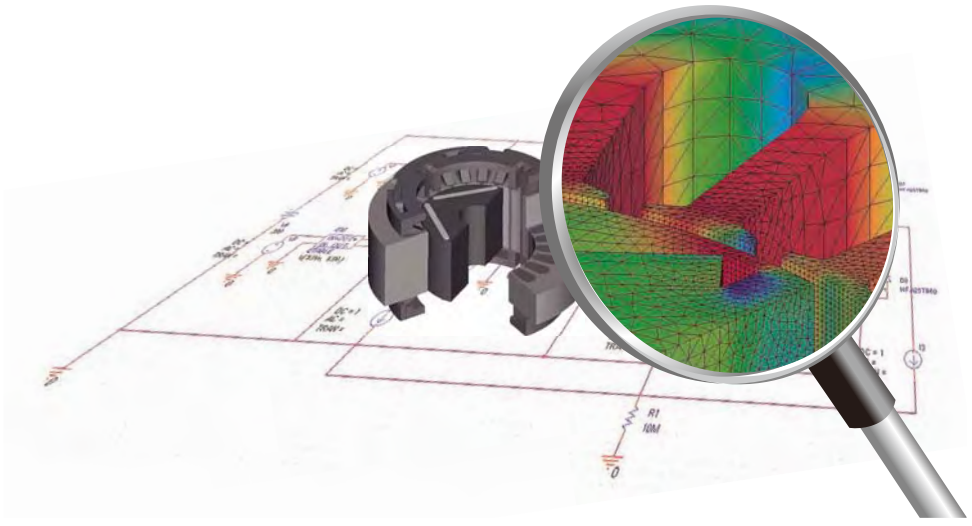
Simulation Technology for Electromechanical Design

JMAG®

JMAG News Letter

Winter,2010



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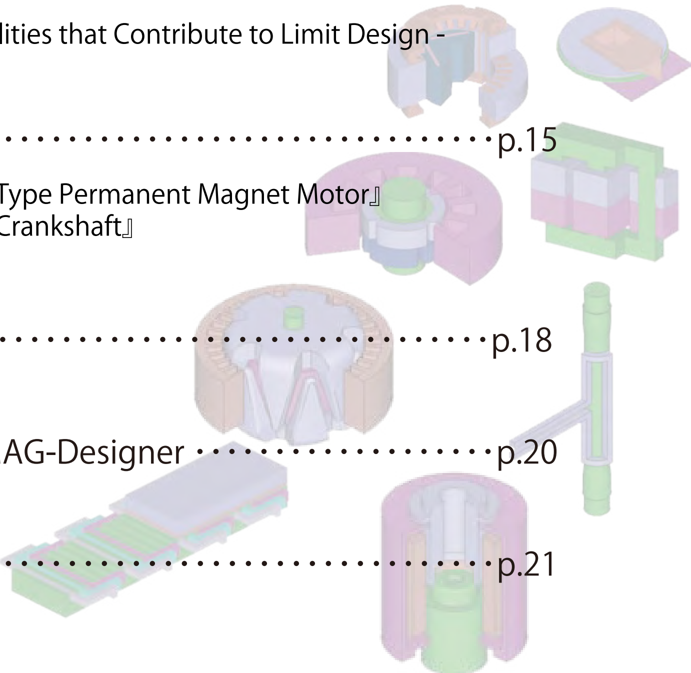
CONTENTS



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JMAG News Letter Winter Edition

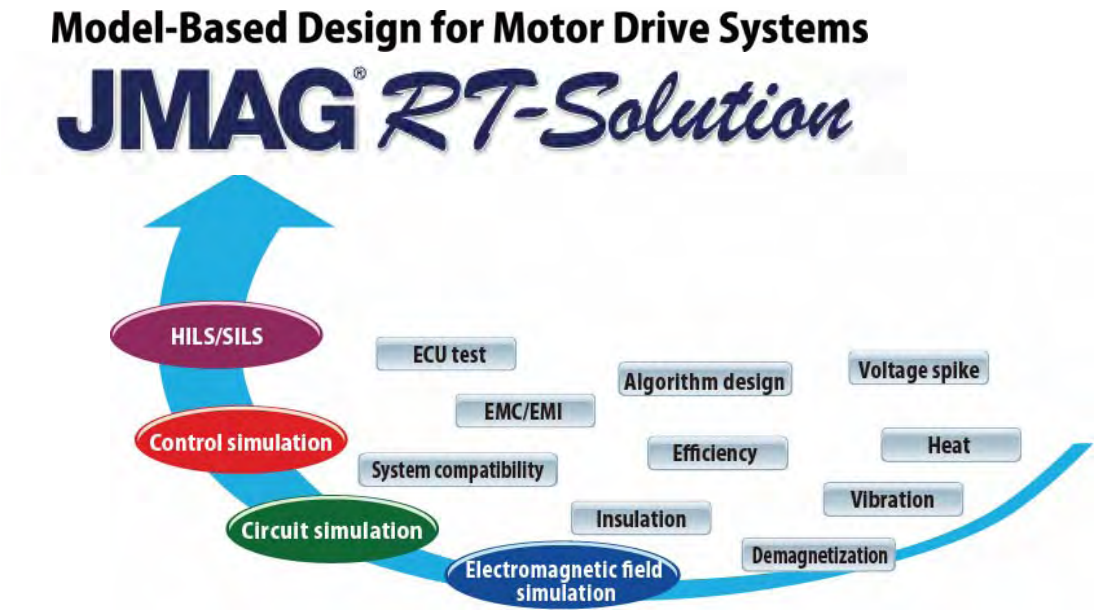
In today's market the requirements for machines that use motors are getting stricter as the amount of time allotted for development of automotive and electronic devices decreases. Model based development can be used to evaluate designs in the early stages of development by creating a virtual model equivalent to a prototype for the product development of motor drive systems. Model based development is quickly becoming a standard in the industry today.

Model based development can be used without consciously modifying the system design and motor design process by implementing JMAG-RT into motor drive simulations. This allows problems in a design to be discovered and resolved in the early stages of development before a prototype even exists. In addition to the development process being more efficient, the total cost of development can be lowered by reducing the number of prototypes that is required.

The Winter Edition of the JMAG News Letter introduces model based development using JMAG-RT. This edition also introduces a version of the free motor design tool, JMAG-Express, that generates JMAG-RT models, allowing users with no analysis experience to obtain motor characteristics instantly and link to circuit/control simulators. We hope you find the information in this edition of the JMAG News Letter Valuable.

<Featuring> Model Based Development Using JMAG-RT

- Sanden Corporation Interview Using JMAG-RT
- Analysis Examples Using JMAG-RT
- [Free Software Distribution] Introducing the Motor Design Tool JMAG-Express Supporting JMAG-RT



What is JMAG-RT?

- JMAG-RT is a function of JMAG that makes motor drive simulations a feasible.
- A behavior model can be generated from a model created using the finite element method to perform analyses in control simulators.
- The torque characteristics that require a magnetic field analysis and the losses of each circuit component that require a control simulation can be obtained simultaneously.
- JMAG-RT can be linked to a real time simulator for ECU design and evaluation.

* For more information about JMAG-RT, see:
http://www.jmag-international.com/solutions/motordrivesystem.html.
* For more information about the free distribution of JMAG-Express supporting JMAG-RT, see:
http://www.jmag-international.com/express/index.html.

Implementing JMAG

SANDEN CORPORATION

JMAG-RT Models Change Energy Management Development by Connecting Companies

JMAG-RT Model: A behavior model (motor model) generated from an FEA model that is used for control simulations.

The Sanden Corporation which designs, develops, and sells inverters for automobiles is planning motor based development using JMAG-RT models for control simulations by creating behavior models based on a proposal from one of their motor design manufacturers. Mr. Hirono and Mr. Tsukamoto, in charge of the design and development of inverters from the Electronic Development R&D Division, Mr. Sekine, in charge of evaluating motors from the Power Electronics Device Group, as well as a representative from the motor manufacture who proposed JMAG-RT to the Sanden Corporation, discuss the benefits of using JMAG-RT.

Daisuke Hirono
Electronic Development Group2
R&D Division
Sanden Corporation

Kazutaka Sekine
Power Electronics Device Group
R&D Division
Sanden Corporation

Takeo Tsukamoto
Electronic Development Group2
R&D Division
Sanden Corporation

Focusing on Enhancing Performance for Compressors in Hybrid Vehicles

What kind of product development is the Sanden Corporation focusing on?

Mr. Hirono Our job focuses mainly on cooling and heating. The field of heating and cooling can be roughly broken into distribution systems for vending machines and refrigeration display cases for supermarkets and convenience stores, living and environment systems for EcoCute and wireless communication modems, as well as the field we are responsible for, automotive systems. We specialize in the design and development of compressors for air conditioners and HVAC units. Presently, we are particularly focused on enhancing the performance of electric compressors for environmentally friendly hybrid vehicles. Mr. Tsukamoto and I are in charge of the motor control design of electric compressors and Mr. Sekine manages the performance of motors.

Recently, the development speed to meet the requirements from our customers is increasing. We are now often required to deliver products within two or three months whereas, conventionally, we had a lead time of half a year. The time allowed for development continues to get shorter. Unfortunately, this means we have to constantly pressure the manufacturers that make the motors we purchase for speed in addition to miniaturization and cost reduction.

What is energy management?

Representative of the Motor Manufacturer My company develops motors as well as the peripheral devices of motors, such as gears and control devices. In the past, our customers required solutions to resolve energy conservation issues, or more specifically, problems related to efficiency. However, today, especially from automotive manufacturers, energy management is becoming a key word. Energy management refers to managing the energy of the entire drive system so that no energy is wasted. The design trends now require a design that not only simply aims for a peak torque, but also reduces the loss in the various drive regions. This means we can't just focus on the region that will be used the most often, but rather, we have to improve efficiency and reduce losses with a balanced design.

Utilizing Electromagnetic Field Analysis

Why do control designers perform electromagnetic field analyses of motors?

Mr. Hirono The Sanden Corporation cannot simply tell the motor manufacture what we need. Therefore, we have an analysis specialist who investigates whether a motor fits the compressor characteristics that we desire. We implemented JMAG two years ago when Mr. Sekine commented that, "We can't understand the high efficiency of a motor without understanding its magnetic field." In that moment we realized that understanding motors, even as control designers, is indispensable.

Mr. Sekine At first, we had no idea how to start using magnetic field analyses. However, we were able to start performing our own magnetic field analyses a month after implementing JMAG by participating in workshops and seminars. Now, we can easily refer to the contour plots and voltage waveforms we obtain from 2D analyses.

We will analyze whether the motor that the motor manufacture has designed for us satisfies our requirements and we will request specific modifications to the motor manufacturers we use to reduce the number of prototypes that need to be built.

Mr. Hirono We ask that the motor manufactures try to achieve the highest accuracy when performing simulations. If the values we have calculated differ from the actual motor control, not only do we have to re-measure the control side, we have to rebuild the control. There are obviously many different elements other than control, such as heat, vibrations, mechanical strength, and noise, but from a control designers perspective, we expect the motor model technology to be highly accurate.

What is required to achieve the accuracy that the Sanden Corporation expects?

Representative of the Motor Manufacturer We design motors by providing our customers with a standard model while referring to products we have built in the past. Knowing the difference between the dimensions of prototypes and the designs is important to increase the design accuracy. For example, cases where the actual air gap is 0.58 when the air gap that is designed is 0.6. Understanding the correction factor of the actual motor and simulation is vital.

Mr. Hirono In the past we have had to have the motor rebuilt when the required characteristics are not satisfied, but today, the characteristics that we have requested are usually fulfilled the first time we receive the motor.

Why did you decide to implement JMAG?

Representative of the Motor Manufacturer It has been 4 years since we implemented JMAG, but we have been using CAE for 10 years. We decided to implement JMAG because our simulations did not provide the results we needed when matching the simulated and experimented results, including the control. We recently started using JMAG-RT. Examining the motors independently is pointless for an analysis. We cannot provide the appropriate motor quickly without predicting how our customers will be using the motor and we work with them in the development and analysis. Using JMAG-RT between my company and the Sanden Corporation is being considered now to reduce the time required for developing motors. We only have to create one or two prototypes because the motor is shaped using simulations allowing us to meet the Sanden Corporations requirements quickly while also reducing the materials and labor that are required.

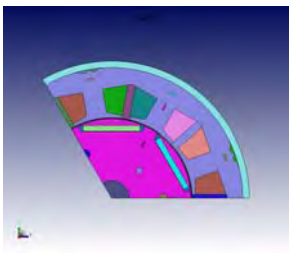
<Compressors from the Sanden Corporation>

Hybrid Compressor

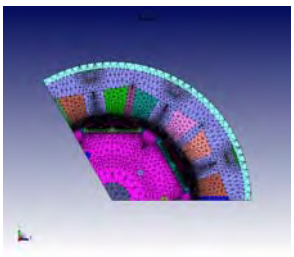
Enhanced HFC134a compressor

Natural refrigerant compressor

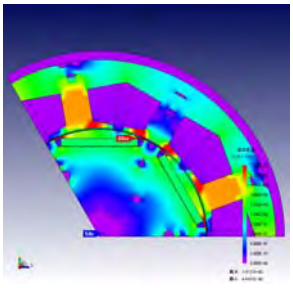
<JMAG Analysis Results 1>



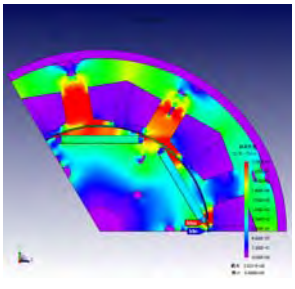
Model



Mesh model



Magnetic flux density distribution (no-load)



Magnetic flux density distribution（overloaded）

Benefits of Using JMAG-RT Between Corporations

Why did you decide to start using JMAG-RT?

Mr. Hirono We originally used the ideal motor model in the control simulation tools, but we discovered the analysis results did not match the experimented results. One of our customers told us we could generate a motor model, JMAG-RT model, in JMAG to use with a control simulation. We then requested a JMAG-RT model be created for us to examine when the representative from the motor manufacture proposed that we use a JMAG-RT model. We are still considering the possibilities for JMAG-RT, but we know we would like to use JMAG-RT to analyze motors for the electric compressors of vehicles.

What are the benefits of using JMAG-RT?

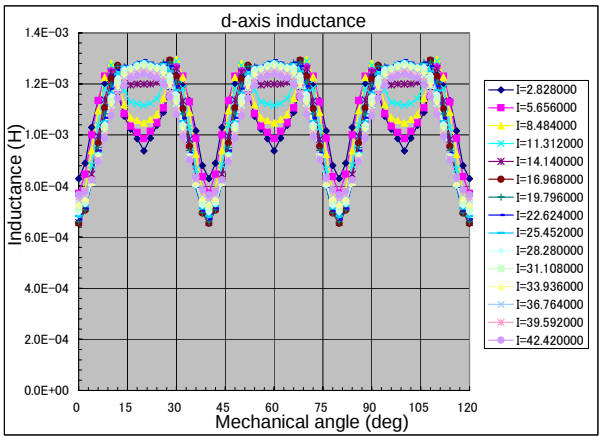
Representative from the Motor Manufacture I think the greatest benefit is being able to define the motor specifications while sharing that information with the customers. We are building motors based on the specifications required by our customers. Therefore, understanding whether or not we have "fulfilled the customer's requirements" and whether or not "the specifications that are requested by our customers can be achieved physically" are very important. If the customer has specific specifications or needs, we can use JMAG-RT as a tool to communicate with our customers. Defining the specifications while sharing the analysis results and information is vital. The greatest benefit of JMAG-RT is probably the ability to define specifications and increase the speed of development.

How are the JMAG-RT models provided to the Sanden Corporation?

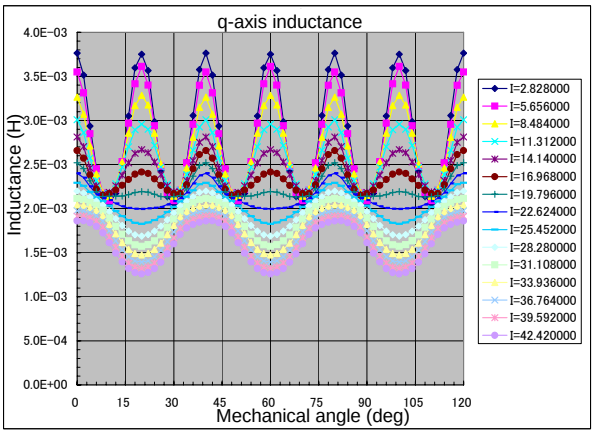
Representative from the Motor Manufacturer We compare the back EMF and torque constant of the motor and previous motors we have made as examples when creating a JMAG-RT model. After we confirm that the results are accurate, we provide the information to our customers. This time we confirmed the LdLq, back EMF, and torque constant before providing the JMAG-RT model to Mr. Hirono.

Mr. Hirono The size of the data for the RT model is small enough that it is sent to me by e-mail.

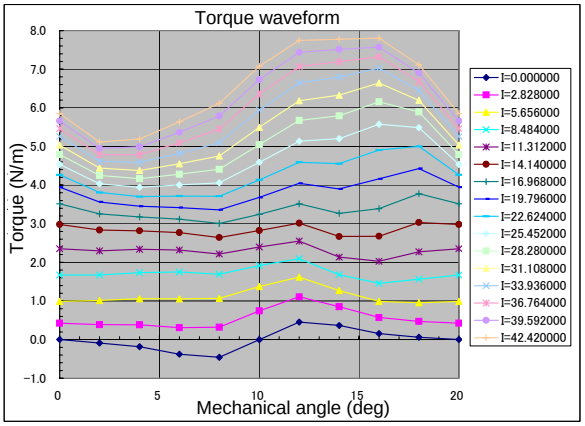
<JMAG Analysis Results 2>



d-axis inductance



q-axis inductance



Torque waveform

Expectations for Model Based Development

What do you expect from JMAG-RT in the future?

Representative from the Motor Manufacturer

Currently it is a trial and error process where customers provide feedback, such as “these results were good, but we would like a little more here." If our customers can test the exact specifications by operating the motor in the product that is being developed, such as the Sanden Corporation and other customers who are using JMAG-RT, they can be more specific about their needs. For instance, “there is no problem with the motor in the steady state, but there is a problem when overloaded or light loaded.” This increases the speed of development because we quickly receive the exact specifications and feedback from our customers. Because JMAG-RT has these various benefits, it is a convenient tool to support the needs of our customers quickly. Moreover, we can confirm whether or not there is any irregular movement in addition to whether or not the back EMF is accurate for the motor because the JMAG-RT behavior model is so accurate. I would like to use JMAG-RT to determine whether a motor is right based on the specifications we receive from our customers the first time around.

Mr. Hirono For the Sanden Corporation, we plan on using JMAG-RT to confirm the parameters of a motor first. We currently receive the LdLq data from the representative of the motor manufacturer, but it is difficult to apply the information and explanation we receive because the results vary with the materials and current that are used. Therefore, first we would like to evaluate the parameters of the motor. In the future, we would like to evaluate the motor parameters, and then perform a coupled analysis of the compressor, motor, inverter, and inverter control. However, the challenge is determining how much of an analysis can be utilized under time and cost constraints. In the past, the control designer needed to understand the motor characteristics to some degree to use the motor effectively in the design, but JMAG-RT allows the control designer to use a motor in simulations without understanding the motor characteristics. I have also come to realize that JMAG-RT also accurately simulates the effects of high harmonics. We can continue the development of the control by determining that a motor is not right even without a prototype. We can cut costs by reducing the number of prototypes as well as, of course, reducing the time and labor required to examine those prototypes. These benefits are huge for us.

Electric compressor

SANDEN
Delivering Excellence

Sanden Corporation	
Established	July 30, 1943
Capital	¥11,037 million
Number of employees	8,750 (consolidated)
Annual sales (consolidated)	¥216,690 million (2009)
President	Kazuyuki Suzuki

Business Outline

The Sanden Corporation manufactures air conditioners for automobiles, vending machines, EcoCute, etc. Since the Sanden Corporation was established in 1943, they have continually provided an impressive line-up of products, systems, and services to customers expanding their business worldwide based on technological development and manufacturing to realize their corporate slogan, "Delivering Excellence." The Sanden Corporation's automotive air conditioning compressors are utilized by domestic as well as European automotive manufacturers.

http://www.sanden.co.jp/

JMAG Application Catalog

Positioning Control Analysis of a Permanent Magnet Linear Motor Using the Control Simulator and the JMAG-RT System

The Application Notes guide users inexperienced in analysis software, or experienced users that want to explore new fields using simulations, through a smooth analysis process.

Here is an introduction for three of our newest examples, “Positioning Control Analysis of Permanent Magnet Linear Motor Using the Control Simulator and the JMAG-RT System”," Torque Characteristics Analysis of a Self Starting Type Permanent Magnet Motor" and "High-Frequency Induction Heating Analysis of a Crankshaft“.

Linear motors have been widely used for carrier devices and machine tools due to their capability of high-speed performance, high acceleration and deceleration, and accurate positioning.

To estimate the response time and the thrust force variation during the positioning control, it is important to take into account the characteristics of both a control circuit and a linear motor in the analysis.

This note presents the use of the JMAG-RT system and the circuit/control simulator to obtain the response time and the thrust force variation of a permanent magnet linear motor.

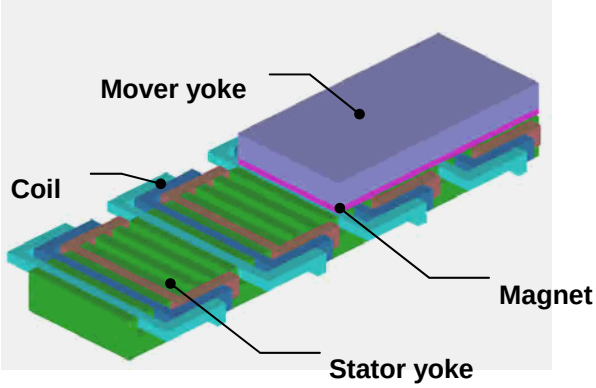


Figure1 Application

Response Time/Thrust Force Variation

Figure 2 shows the position of moving part versus time. Figure 3 shows the thrust force versus time.

In Figure 2, the time needed for the moving part to reach the reference value can be viewed.

Since the RT motor model is created by taking into account the model geometry, thrust force variation by the position of the moving part and slots can be obtained.

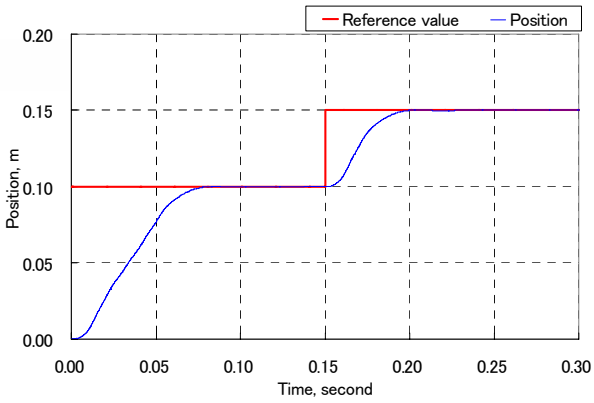


Figure 2 Position of Moving Part

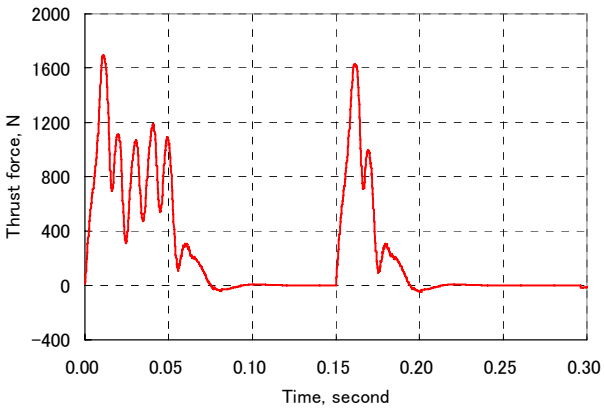
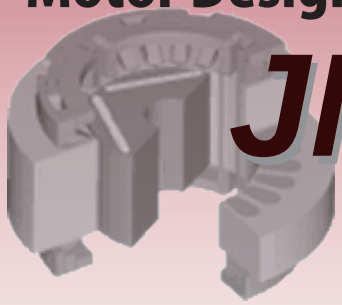


Figure 3 Thrust Force

An additional analysis example is introduced on p. 15.

Motor Designing Tool

Try it now

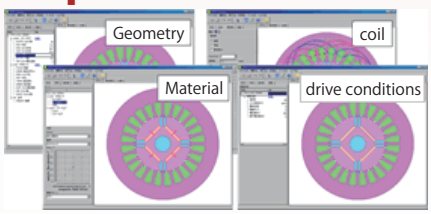


JMAG-Express

for Rotating Machines

- Obtain fundamental characteristics for brushless motors (IPM/SPM) and induction machines instantly.
- It is very quick and easy to satisfy the needs of busy design engineers.
- Requires no analysis experience

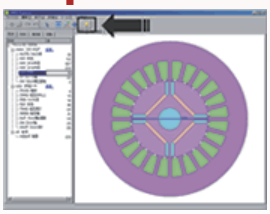
Step1



Enter the Specifications

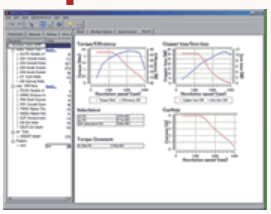
Output: Torque, Efficiency, Copper loss, Iron loss, Inductance, Torque Constant

Step2



Click

Step3

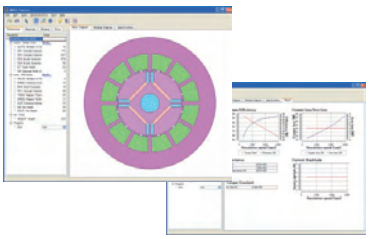


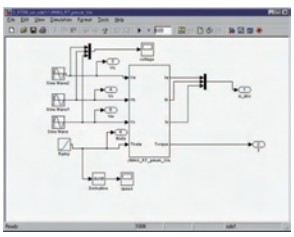
Output the Fundamental Characteristics

New functions implemented based on user feedback

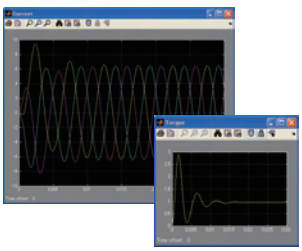
NEW	Generating JMAG-RT Models (Linking to Circuit/ Control Simulators)	Dec. 2009
	JMAG-Express Version Supporting Induction Machines	Nov. 2009

A JMAG-RT model accounting for the characteristics of brushless motors (IPM/SPM) can now be generated.





MATLAB (R) /Simulink (R)



JMAG-RT models can be used in MATLAB(R)/Simulink(R) and PSIM.

- Templates are frequently updated on our website exclusively for JMAG-Express users.
- Your own templates can even be created using JMAG-Designer.

The module can be downloaded from here

www.jmag-international.com/express/

jmag-express@sci.jsol.co.jp

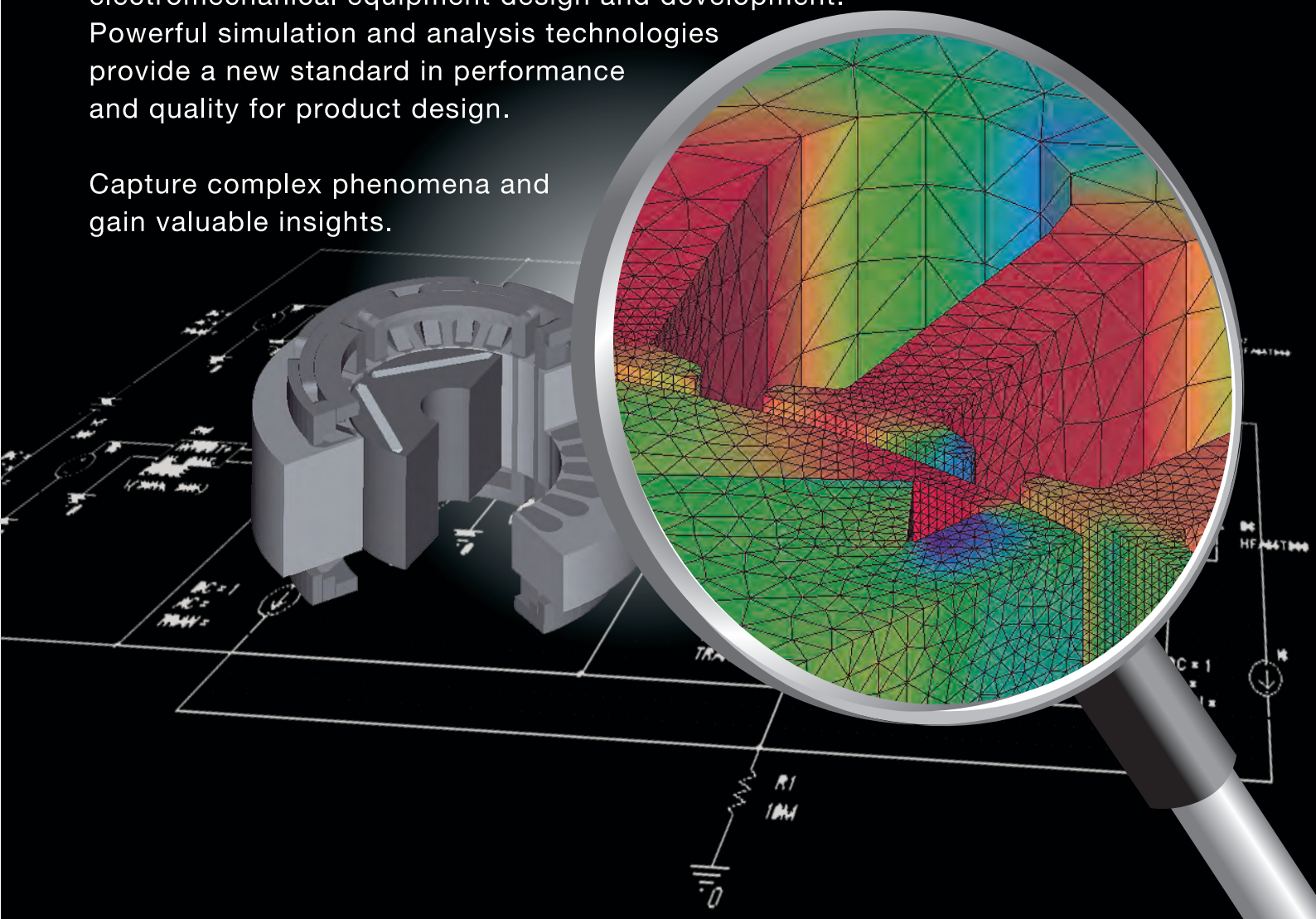
JMAG®

Simulation Technology for Electromechanical Design

It is now simple to be precise

JMAG is a comprehensive software suite for electromechanical equipment design and development. Powerful simulation and analysis technologies provide a new standard in performance and quality for product design.

Capture complex phenomena and gain valuable insights.



Typical applications

-Motors
-Generators
-Transformers
-Reactors
-Solenoids
-Actuators

Analysis functions

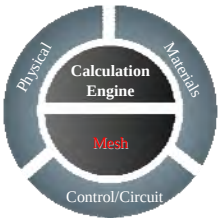
-Magnetics
-Electrostatics
-Thermal
-Structural
-Multi-physics

Interfaces

-Major CAD systems
-Drive/control simulators
-Optimizers
-Other CAE tools

More information and free trial available...

jmag-international.com



Technical Report Vol.2

A Powerful Simulation Engine
- What Does the JMAG Mesh Generation Engine have to Offer? -

These technical reports introduce the scope of JMAG's technological development. This edition introduces the value and future of one of the two major foundations of the simulation engine, the mesh generation engine.

●Optimized Mesh for Analysis of Electromechanical Machines

The JMAG mesh generation engine is for specialized analyses of electromechanical machines. The mesh is optimized based on the needs of our users.

There is a wide range of phenomena acting on electromechanical devices from magnetic saturation and the skin effect to electromagnetic induction and motion. The areas that interest each user differ with the various phenomenon requiring a unique mesh for each type of analysis. This means that our users need the ability to generate a wide range of mesh.

A highly accurate mesh can be generated based on the analysis experience of the user with the universal mesh generation engines that are on the market today, provided there is enough time. However, the need to be able to generate a high quality mesh “simply” is huge. CAE is a tool used to "support" in manufacturing, and is not beneficial unless it can be used in the design and development process.

The JMAG mesh generation engine specializes in the analysis of electromechanical machines, requiring no analysis experience and very little time. A mesh that accurately simulates a wide range of electromagnetic phenomena can be generated simply. A comparison of eddy current losses obtained by generating mesh at different resolutions is indicated in Fig. 1. The resolution of the mesh affects the results that are obtained.

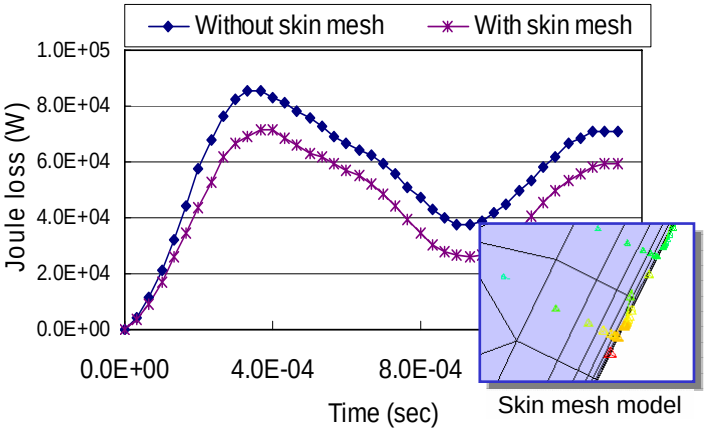


Fig. 1 Comparison of eddy current loss with different resolutions of mesh [1]

●Accuracy and Simplicity is Vital

The mesh generation engine in JMAG that specializes in analyzing electromagnetic machines focuses on a highly accurate mesh that is simple to generate. Two areas of development that allows JMAG to enhance the accuracy of the mesh while making it simpler to generate are outlined below.

(1) Improving accuracy by reducing mesh noise

A high quality of mesh is necessary because a highly accurate cogging torque analysis is required to further reduce the cogging torque of motors, which is only approximately 0.1% of the output torque, in addition to reducing vibration and noise. In this case, the mesh noise affects the analysis causing inaccurate results.

The JMAG mesh generation engine reduces the mesh noise using noise canceling technology. The noise canceling technology allows for the cogging torque to be examined highly accurately without any analysis experience. A comparison of the cogging torque with and without noise canceling technology is indicated in Fig. 2. The periodicity and symmetry of the cogging torque waveform becomes deformed when the mesh noise is not reduced causing inaccurate analysis results while the accuracy can be maintained when the mesh noise is reduced.

(2) Automatically generating high quality mesh efficiently

Generating mesh is merely a part of creating a model for an analysis. However, generating an appropriate mesh necessary to improve the accuracy of an analysis requires the user understands the electromagnetic phenomena occurring within machines and has the pertinent analysis experience. The user has to be capable of automatically generating a high quality mesh efficiently to obtain accurate results.

The JMAG mesh generation engine is enhancing the automatic mesh generation function that can generate a high quality mesh using adaptive mesh. Adaptive mesh generates the optimal mesh for a highly accurate analysis of electromagnetic phenomena while linking to the JMAG solver in the program.

Technical Report Vol.2

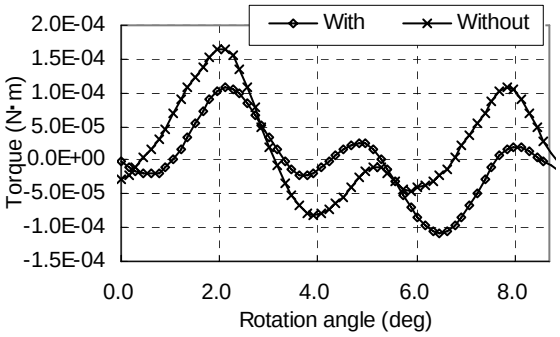


Fig. 2. Comparison of cogging torque with and without noise canceling technology [2]

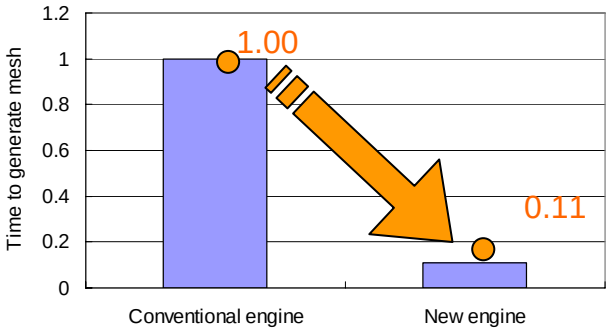


Fig. 3. Variations of time required to generate mesh with the different mesh engines [1].

A high quality mesh can be automatically generated efficiently without the user being aware of its existence. The Keihin Corporation presented a hands on example of the automatic mesh generation function for developing actuators at the JMAG Users Conference 2005.

● Robustness and Speed is Vital

Of coarse, specialized analysis of electromechanical machines is not the only vital aspect of development. The robustness to geometry and data as well as the speed the mesh can be generated is also indispensable. An analysis cannot be performed if the mesh cannot be generated accurately, yet performing an analysis that requires a vast amount of time to generate mesh is also pointless.

The JMAG mesh generation engine is faster than ever before. The variations of the time required to generate mesh with the different mesh engines is indicated in Fig. 3. The time required to generate mesh in the new mesh generation engine has been reduced to 1/9 of the time required for the conventional mesh generation engine, although the time required depends on the analysis target and number of elements.

●Specialized Mesh Team

The JSOL corporation strives to continually enhance the JMAG mesh generation engine to satisfy the needs of our users. The mesh team is responsible for the vast research and development that has been implemented into JMAG.

The JMAG mesh team provides technology to generate the right mesh for analyzing electromechanical machines based on years of analysis experience. The technology is obviously implemented into JMAG, but the mesh team also actively communicates with our users by providing papers of their research, such as [2]-[5], while continually receiving feedback directly from our users.

● Cutting-Edge JMAG Mesh Generation Solver for Electromagnetic Field Analysis

The JMAG mesh generation engine will continue to evolve, enhancing the accuracy and speed as well as supporting larger scale models. There are still many avenues of innovation that can be taken to provide our users with the most accurate mesh that can be generated simply.

JMAG will continue to push the boundaries of electromagnetic field analyses aiming for "simplicity" as part of the modeling process while providing "high quality" mesh vital to achieving the highest level of analysis accuracy.
The next edition introduces material modeling for simulations.

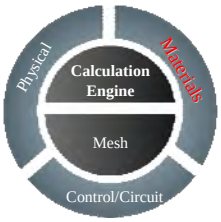
[1]: JMAG Users Conference 2008 Poster Session

[2]: K. Tani, H. Hashimoto, T. Yamada, “High Accuracy Torque Calculation for a Rotating Machine Using Adaptive Meshing," IEEJ-D, Vol.123、No.7 pp.790-797、2003

[3]: K. Tani, T. Yamada, Y. Kawase, "Dynamic Analysis of Linear Actuator Taking into Account Eddy Current Using Finite Element Method and 3-D Mesh Coupling Method," IEEJ SA-98-10、RM-98-74、1998

[4]: K. Tani, T. Yamada, Y. Kawase, "3D Mesh Generation Procedures And Error Estimation Procedures to Magnetic Field Analysis of Magnetic Heads by Finite Element Method," IEICE technical report MR98-52、pp.29-35、1999

[5]: K. Tani, T. Yamada, Y. Kawase, "Dynamic Response Analysis of Linear Actuator Using Finite Element Method and 3-D Mesh Coupling,“ IEEJ SA-99-16、RM-99-70、1999



Technical Report Vol.2

Elaborate Modeling Technology

- Material Modeling and Powerful Analysis Capabilities that Contribute to Limit Design -

The innovations that have been implemented into the technological development of JMAG are introduced in these Technical Reports . This edition, the 4th edition, focuses on the "material modeling" technology.

●Modeling Complex Nonlinear Materials at a Micro Level

$$\nabla \times \frac{1}{\mu_0} \nabla \times A = J - \sigma \frac{\partial A}{\partial t} - \nabla \times M$$

The equation indicated above is the same basic magnetic field analysis equation that can be found in text books. Despite the simplicity, this equation indicates a elaborate distribution for materials because electric conductivity, σ, and magnetization, M, have nonlinear characteristics. These characteristics complicate physical phenomena while drastically affecting the performance of an electrical device. The material modeling used to simulate complicated material properties has a crucial role in simulation technology.

Modeling microscopic nonlinear material properties was achieved through years of cumulative experience. The magnetizing properties of nonlinear materials can be calculated using the Newton-Raphson method by specifying a point sequence for the BH curve. An optimal model for an iron loss analysis is also available using the Steinmetz empirical formula. However, materials have to be modeled very accurately for a limit design that aims to miniaturize a device while increasing efficiency.

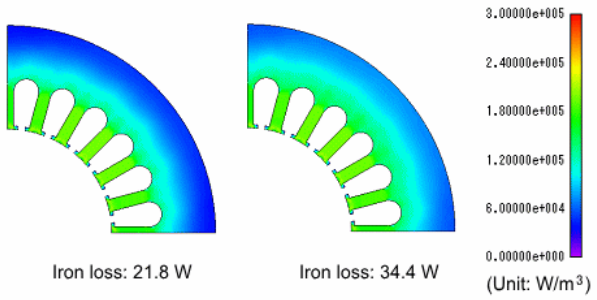
●Accurate Modeling and Powerful Analysis Capabilities required for Limited Design

Motors used for various applications such as cars, require miniaturization while also demanding a reduction in cogging torque and losses. A simulation must obtain highly accurate results to correctly evaluate the miniscule differences in cogging torque. The noise canceling technology implemented in the mesh generation engine that was introduced in the pervious Technical Report can provide a highly accurate numerical analysis.

However, the analysis results and actual measurements will not match even with a highly accurate numerical analysis because the accuracy of the material properties that are modeled, such as anisotropic magnetic materials, affect a simulation more as the accuracy of an analysis increases. This means the materials need to be modeled more accurately for a limit design.

Material modeling requires a specific number of elements to simulate phenomena accurately, but there is another aspect to these "evaluation" tools. Performance characteristics can be obtained through measurements and experimentation, but effects of those characteristics, such as the effects of stress by shrink fitting on magnetic properties, cannot be obtained easily. However, simulation technology has come to be known as an essential tool for analyzing small but vital differences in material properties, providing engineers with the ability to distinguish these slight differences.

Evaluation capabilities by material modeling is crucial to finding solutions to problems. For example, a magnetization analysis can be performed when the properties of the magnet are inaccurate and the back EMF waveform is off. This type of material modeling is extremely accurate and indispensable when trying to solve analytical problems.



Iron loss density distribution (left: without stress; right: with stress)

Fig. 1. Iron loss analysis accounting for shrink fitting

The effects of deterioration caused by stress cannot be visualized with measurements or experimentation.

Technical Report Vol.2

● Integrated Modeling Tools for Analyses

It is difficult to cover the extensive range of material modeling in just a few words. However, the logic behind modeling materials can be viewed as:

Material modeling = material properties + composite materials + external environment

The accuracy of the materials that are modeled cannot simply be thought of as improving the quality of the material properties, but rather modeling the material considering a wide range of variables from modeling composites, such as laminated steel sheets, to the effects of heat and stress. JMAG implements a variety of tools to cover the vast range of variables necessary to model materials accurately.

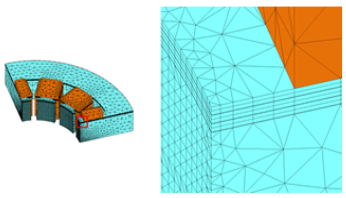
(1) Material Database with Expertise

JMAG implements a database of material properties that includes magnetic and loss characteristics provided by the material manufacturers.

JMAG's material database has reliable data that is guaranteed by, and created with the mastery of the manufacturers. An irreversible demagnetization analysis can be performed using data for a magnet provided by Hitachi Metals, or the magnetic characteristics of the stress dependency of a material provided by Nippon Steel can be used. Each user can also model irreversible demagnetization or magnetic characteristics of the stress dependency in JMAG based on this know-how.

(2) Modeling Specific to Composite Materials

It is essential to model members of materials that have laminated steel sheets or are anisotropic accurately while selecting the appropriate method for modeling. For instance, mesh is not usually generated to model each steel sheet. Generally, the laminated steel sheets are modeled using a block and the analysis load is reduced by specifying the lamination factor. However, a mesh needs to be generated to model the lamination on the surface of a motor if the magnetic flux in the axial direction is strong, such as slim line motors. Tools to increase the accuracy of modeling by selecting the appropriate method based on the purpose of an analysis is said to be one of JMAG's strengths.



(3) Accounting for External Environmental Effects using a Coupled Analysis

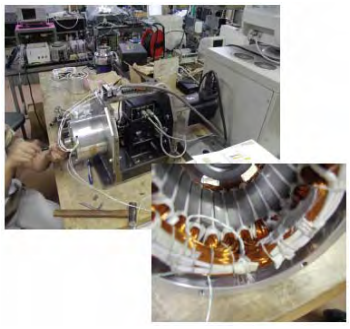
The material properties vary with stress and temperature. The temperature and stress dependency not only need to be determined to visualize these effects, but the temperature distribution and stress distribution also need to be obtained accurately. JMAG implements a coupled analysis function that can accurately evaluate the impact of the temperature and stress dependency. More information about the coupled analysis technology will be introduced in the next edition of the JMAG Newsletter.

●"Powerful Modeling" Achieved Through Experience

The modeling tools generally used for analyses in JMAG have been introduced, but the larger question of how the various options are actually used has not been addressed.

The modeling technology in JMAG has been built on a foundation that is supported by experience that spans 30 years. The modeling tools are utilized capturing this expertise of the functions to increase the accuracy when modeling materials, or combining actual measurements into an analysis.

The JMAG analysis engineers have designed a process proven through actual measurements for developing valid and new methods for modeling.



● The God of Design Resides in Detail

The essential aspects of design, such as limit based design, are hidden in the small but vital "differences" of the members of materials. JMAG offers modeling tools and powerful analysis functions that cast light on these minuscule differences.

JMAG will continue to strive to meet the challenges of modeling complicated materials.

Physical modeling such as coupled analyses will be introduced in the next edition of the JMAG Newsletter.

JMAG Application Catalog

Torque Characteristics Analysis of a Self Starting Type Permanent Magnet Motor

A self starting induction motor that has a rotor and cage operates as an induction motor when starting and as a synchronous motor when the motor reaches synchronous speed with the poles of the permanent magnets. Self starting type permanent magnet motors, often used in industrially or in household appliances, do not require a starting device while providing high-efficiency.

Analyzing the current induced in the rotor bars is important because the induced current essentially determines the performance when the motor operates as an induction motor. For this reason, it is important to evaluate the current that is induced in the self starting type permanent magnet motor.

This example presents the use of a magnetic field analysis to obtain the current density distribution and the slip versus torque curve of a self starting type permanent magnet motor.

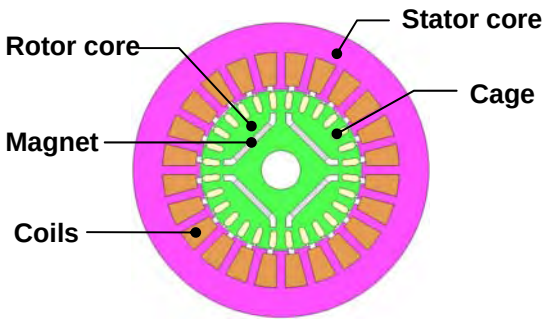


Figure1 Application

Current Density Distribution

The current density distribution at a 0.8 slip is indicated in Figure 2.

If the slip is large, the motor operates as an induction motor. The induced current largely affects the torque characteristics because the torque is produced by the rotating magnetic field produced in the coils and the current induced in the rotor and cage.

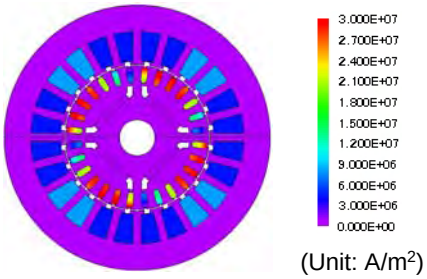


Figure 2 Current density distribution

Flux Lines

The flux lines at a 0 slip is indicated in Figure 3.

If the slip is 0, the motor operates as a synchronous motor. The torque is produced by the attractive force of the permanent magnetic and the reactance magnetic flux because the self starting type permanent magnet motor operates as an IPM motor.

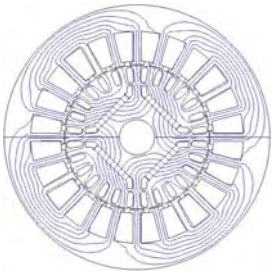


Figure 3 Flux lines

Slip vs. Torque Curve

The slip versus torque curve is indicated in Figure 4.

The torque of the self starting type permanent magnet motor gets smaller as the slip gets larger, reaching a maximum torque at a 0.4 slip.

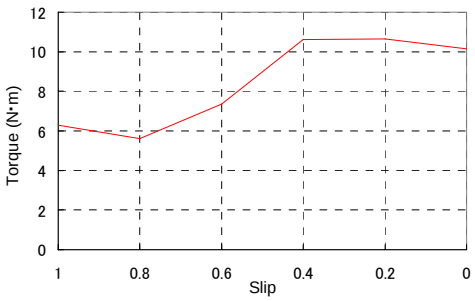


Figure 4 Slip versus torque curve

JMAG Application Catalog

High-Frequency Induction Heating Analysis of a Crankshaft

For the machine parts such as crankshaft, improving abrasion resistance and fatigue resistance is very important. So, high-frequency induction heating, one of the surface hardening methods, is widely used in terms of the strength improvement and cost saving.

In JMAG, high-frequency induction heating analysis is possible. The eddy current loss in the heated part can be obtained using magnetic field analysis, and the obtained loss distribution is used as the heat source for the thermal analysis.

This note shows the temperature distribution and temperature variation of the crankshaft from the use of coupled magnetic field analysis and thermal analysis.

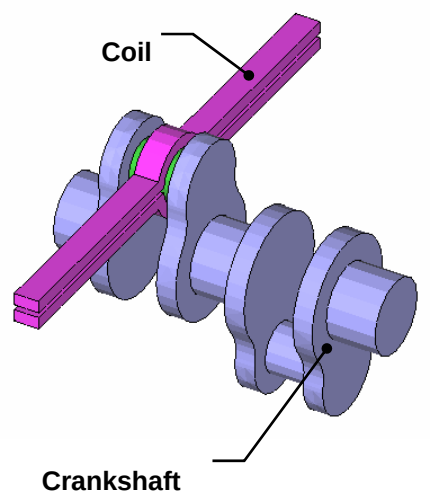
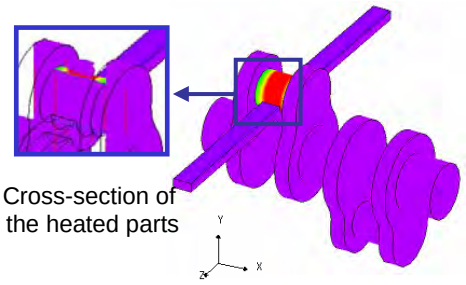


Figure1 Application

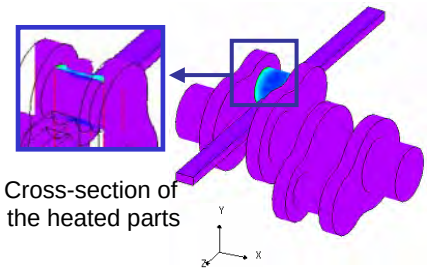
Eddy Current Loss Density Distribution

Figure 2 shows the eddy current loss density distribution in the heated part and the coil.

The magnetic field generated by the coil produces eddy currents on the heated part. In induction heating, those eddy currents will be the heat source. When the temperature exceeds the Curie point, the magnetic properties change, resulting in the decrease of the eddy current loss. When the high frequency is used, eddy currents are induced on the surface of the heated part due to the skin effect.



Between 0.0 and 0.2 seconds



Between 1.8 and 2.0 seconds

Figure 2 Eddy Current Loss Density

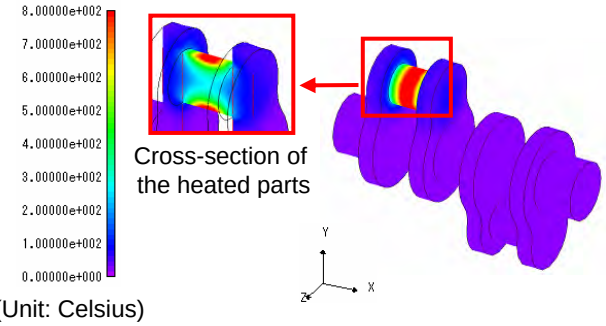
JMAG Application Catalog

High-Frequency Induction Heating Analysis of a Crankshaft

Temperature Distribution, Temperature Variation

Figure 3 shows the temperature distribution of the crankshaft. Figure 4 shows the temperature variation of the heated part.

Magnetic flux is concentrated directly below the heating coil, so more eddy currents are induced, raising the temperature. As shown in the graph, the temperature of the surface of the heated part rises sharply due to the induction heating. The temperature around the area rises moderately due to the heat transfer.



(Unit: Celsius)

Figure 3 Temperature Distribution at 2.0 sec Seconds

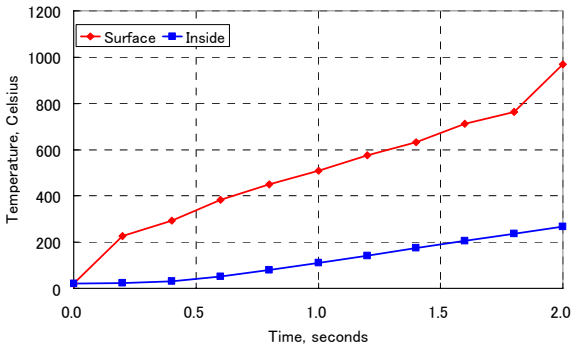


Figure 4 Temperature Variation at the Heated Part

The Application Catalog includes over 100 analysis examples on the JMAG website. Don't hesitate to take a look through the Application Catalog.

JMAG Users Conference 2009　Japan

[What is the JMAG Users Conference?]

The JMAG Users Conference is a conference held once each year in various locations around the world aiming to share technological information with JMAG users. The JMAG Users Conference is a place for an active technological exchange of information from presentations introducing the newest technology worldwide to examples presented by JMAG users and poster sessions created by the JMAG engineers.

[Overview]

The JMAG Users Conference 2009 came to a close successfully with more than 280 participants. We would like to thank all of the users and presenters, as well as the exhibitors for their participation in the JMAG Users Conference. The JMAG Users Conference 20009 was focused around examples presented by JMAG users, seminars introducing the newest solutions, poster sessions held by the JMAG engineers, and exhibitions by various exhibitors. Various presenters introduced user examples and the newest solutions in the general session, special session, transformer session, and induction heating session that composed the conference program.

Many whom attended the conference expressed their interest in the special session held on the first day of the conference, "Discovery and Expansion of IPM Motors - Innovation of Mature Devices -." We are proud that the theme of the JMAG Users Conference 2009, "Discovery," was meaningful to all those whom attended. We thank everyone for their support and participation and we look forward to your continued support in the future.

[General Session]

● JMAG Users Conference Thursday, December 10

•Development Planning of JMAG
Dr. Takashi Yamada, JSOL Corp.

• Interior PM Synchronous Machines: Historical Perspectives, Current Status, and Future Directions
Prof. Thomas M. Jahns, University of Wisconsin

• Product Development and Market Expansion for IPM Motors
Mr. Toshiaki Idemitsu, Manager, Engineering Department, Yaskawa Motor Corporation

• Development and Challenges of Motors for Toyota's Hybrid Vehicles
Prof. Akihide Takahara, Group Manager, Hybrid Vehicle Advanced Technology Engineering Div., Toyota Motor Corporation

• Loss Analysis and Shape Optimization of Interior Permanent Magnet Motors
Prof. Katsumi Yamazaki, Professor, Dept. of Electrical, Electronics, and Computer Engineering, Chiba Institute of Technology

• AcuSolve: 3D Thermal Flow Analysis of JMAG Results
Farzin Shakib, President, ACUSIM Software, Inc.

• Virtual Motor Capable of Connecting to an Inverter that Supports Nonlinear Response (JMAG-RT Compatible)
Mr. Yoshihiko Ozaki, Development Division, DSP Technology, Co., Ltd.

• A Study of Generating Factor of the Electromagnetic Excitation Forces and Development of Low-noise Motors
Dr. Yoshio Yoshikuwa, Head Researcher, Advanced Technology R&D Center, Mechatronics Department, Mitsubishi Electric Corporation

● JMAG Users Conference Friday, December 11

• The Newest Developments of Rare-earth Magnets
Dr. Dai Higuchi, Executive Researcher, Magnet Material Research Center 2nd Development Dep., ShinEtsu Chemical Co., Ltd.

• Examination of a Torque Estimation Method by Using JMAG-RT
Mr. Hajime Hida, Chief Researcher, ECO Technology Research Center Power Systems Research Department, SANYO Electric Co., Ltd.

JMAG Users Conference 2009 Japan

•Expectations from Control Technology to Magnet Field Analysis
Dr. Shinji Doki, Associate Professor, Department of Electrical Engineering ad Computer Science, Graduate School of Engineering, Nagoya University

•Development of Motor for Small Car HEV and Introduction of Co-simulation of Motor Inverter using JMAG-RT
Mr. Masahiro Aoyama, Automobile Powertrain Design Dept. I, Suzuki Motor Corporation

• Utilizing a Magnetic Field Analysis for a Hybrid Stepping Motor
Mr. Masaru Kobori, General Manager, Oriental Motor Co., Ltd.

• Simulation of Small Wind Power Generation System Using PMSG
Dr. Katsumi Kesamaru, Associate Professor, Graduate School of Information Science and Electrical Engineering, Kyushu University

• Analysis of Nonlinear Characteristics in High Temperature Superconductor Rotating Machine
Dr. Taketsune Nakamura, Associate Professor, Department of Electrical Engineering, Graduate School of Engineering, Kyoto University

• Engineer's Education Using Electromagnetics CAE at Mitsubishi Electric
Mr. Hidenobu Itagaki, Chief Engineer, Human Resources Development Center, Mitsubishi Electric Corporation

• Report of Harumi-1 Project
Mr. Katsuyuki Narita, Mr. Tetsuya Hattori, JSOL Corporation

[Transformer Session]

• Development and Performance Evaluation of a Contactless Induction Power Supply (IPS) System for Electric-driven Vehicles
Dr. Yushi Kamiya, Professor, Faculty of Science and Engineering, Waseda University

• Consideration of the Joule Loss in Windings for Power Reactor
Mr. Tsutomu Hamada, Design Group, Automotive Components Department, Electronic Components Business Sector, Tamura Corporation

• Parametrizing the Coil Construction and Coupling Coefficients of Inverter Transformers in JMAG
Mr. Masahiro Kitagawa, Electronic Circuit Development Department Development Division Electronic Device & Component Transformer Session Seminar

• Designing Transformers and Estimating Problems and Countermeasures

[Induction Heating Session]

• Examples Utilizing JMAG
Mr. Shunsuke Funaji, Power Electronics Design Dept. Machinery Factory Machinery & System Hq., Mitsui Engineering & Shipbuilding Co., Ltd.

• Crankshaft Optimization of Induction Heat Treatment Using Computer Aided Engineering
Ms. Akiko Inami, Advanced Manufacturing Technology Dept., Fuji Heavy Industries Ltd.

• Examination of an Induction Heating Simulation Using B-H Curve
Mr. Takashi Horino, Chief, CAE Development Section, Development Department, Technical Headquarters, Neturen Co., Ltd.

Conference Proceedings CD-ROM Available

A CD-ROM of the JMAG Users Conference 2009 Conference Proceedings will be released in March, 2010.
For more information about the JMAG Users Conference 2009 Conference Proceedings CD-ROM, see:
https://www.jmag-international.com/form/contact/web_form.html

A detailed JMAG-Users Conference 2009 program is available at:
http://www.jmag-international.com/event/conference2009/index.html

For Anyone Considering Implementing JMAG-Designer

A 30-day free trial is available for customers considering implementing JMAG-Designer.
Don't hesitate to take advantage of this opportunity to see how easy JMAG-Designer is to use as well as try the various services that are offered.

30-Day Free Trial

A free 30-day trial license is offered to those who would like to try JMAG-Designer. All of the various services that are offered for JMAG can be used during this evaluation period. This opportunity allows you to try the sophisticated pre-processor and the high-speed analysis solver.

The Services Provided During the Trial Period

1 The JMAG Application Catalog

This comprehensive application catalog contains a wide range of example analyses that introduces the vast number of applications and analysis functions that JMAG-Designer has to offer.

2 The Self Learning System (SLS) Practice Mode

The Self Learning System provides an optimum learning environment that guides users through the various procedures for a variety of applications from creating analysis models to specifying the necessary parameters.

3 Tutorials for Each Function

These PDF tutorials are an invaluable resource packed with information about the functions and adaptive mesh options that can be used in JMAG-Designer. Sample data is also provided with each tutorial.

For more information about how to take advantage of this free trial, refer to the following URL:

http://www.jmag-international.com/evaluation/

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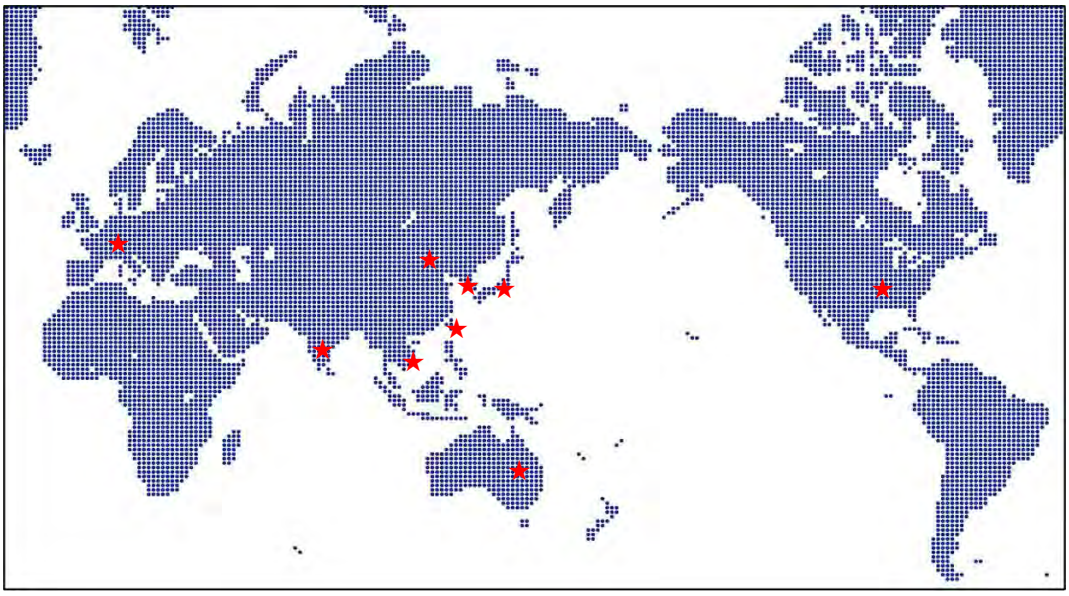

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