

## Maxwell 14.0

Maxwell® is the premier electromagnetic field simulation software for engineers tasked with designing and analyzing 3-D and 2-D electromagnetic and electromechanical devices such as motors, actuators, transformers, sensors and coils. Maxwell uses the finite element method to solve static, frequency-domain and time-varying electromagnetic and electric fields. A key benefit of Maxwell is its automated solution process where users are only required to specify geometry, material properties and the desired output. From this point, Maxwell will automatically generate an appropriate, efficient and accurate mesh for solving the problem. This proven automatic adaptive meshing process removes complexity from the analysis process and allows engineers to benefit from a highly-efficient, easy-to-use design flow.

A key feature in Maxwell is the ability to generate high-fidelity, reduced order models from the finite-element solution for use in Simplorer®, ANSYS' multi-domain system simulation software. This capability creates a powerful electromagnetic based design flow that enables users to combine complex circuits with accurate component models from Maxwell to design complete high-performance electromechanical, mechatronic and power electronic systems.

### ANSYS Workbench Integration

Maxwell is now available as a product within ANSYS® Workbench™, the framework upon which the industry's broadest and deepest suite of advanced engineering simulation technology is built. An innovative project schematic view ties together the entire simulation process, guiding the user through complex multiphysics analyses with drag-and-drop simplicity.

### Geometry Sharing

Using Maxwell within ANSYS Workbench provides several advanced capabilities including the ability to share geometry, geometry parameters and material properties between the ANSYS product portfolio and Maxwell.

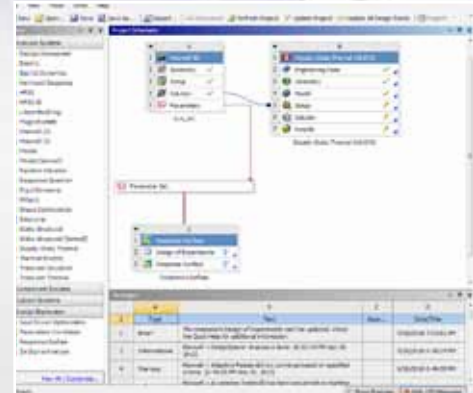
### Multiphysics Coupling

ANSYS Workbench provides new one-way coupling between Maxwell and ANSYS® Mechanical™. Users can consider both volume and surface force density data transfer. Users can solve electromagnetic-thermal interaction problems by solving an electromagnetic problem in Maxwell and mapping the resulting volumetric loss information in ANSYS Mechanical. It is the ideal solution for studying the multiphysics effects of temperature and deformation on electromechanical devices

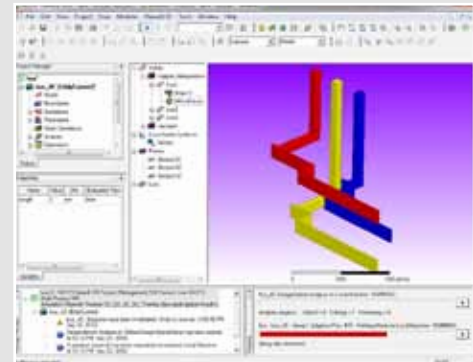
### Design Optimization

ANSYS Workbench enables Maxwell to be included in optimization studies using ANSYS® DesignXplorer™. Inputs and outputs from Maxwell and ANSYS solvers can be combined for system-wide optimization studies.

## Industry Solutions



Maxwell is now available within the ANSYS Workbench



Busbars can be simulated by Maxwell and results linked through ANSYS Workbench to ANSYS Mechanical for thermal and structural analysis

## Product Features

### Low-frequency electromagnetic field simulation and analysis using FEM for 3-D/2-D structures

- Transient - nonlinear analysis with:
  - Motion—rotation, translational, non-cylindrical rotation
  - External circuit coupling
  - Permanent magnet demagnetization analysis
  - Core loss computation
  - Lamination modeling for 3-D
- AC Electromagnetic – Analysis of devices influenced by skin/proximity effects, eddy/displacement currents with automated frequency dependent model generation
- Magnetostatic – Nonlinear analysis with generation
- Electric Field – Transient, electrostatic/ current flow analysis with automated equivalent circuit model generation

### Display of data/visualization of results

- Field visualization and animations (shaded, contour and vector plots)
- Mesh visualization (full, partial)
- Current, induced voltage, flux linkage
- Power loss, stored energy
- Core loss, eddy, excess, hysteresis loss (including the minor loop effects)
- Impedance, inductance, capacitance
- Force, torque
- Custom reports of user-defined solution data

### Performance and integration

- Distributed analysis for parallel computing of parameterized models
- 64-bit operating system support

### Integration

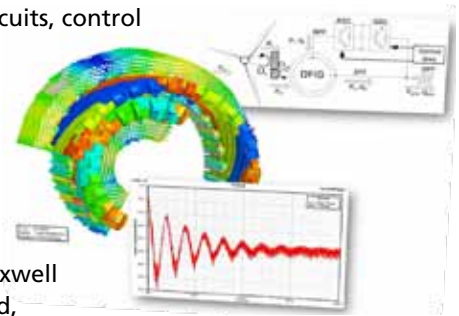
- Simplorer
- ANSYS Mechanical
- ANSYS DesignXplorer
- HFSS™
- RMXprt
- PExprt™

## Comprehensive Electromagnetic Field Simulation

Maxwell includes 3-D/2-D Magnetic Transient, AC electromagnetic, Magnetostatic, Electrostatic, DC Conduction and Electric Transient solvers that accurately solve for force, torque, capacitance, inductance, resistance, and impedance, as well as generate both nonlinear equivalent circuits and state-space models to be employed into the further system and circuit simulation analysis.

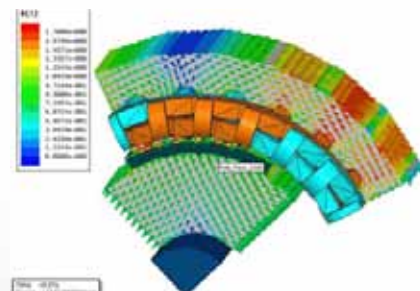
### Transient with Motion

Maxwell's magnetic transient solver with rigid body motion employs state-of-the-art algorithms and a volumetric meshing technique that allows users to efficiently solve computationally intense problems such as electric motors. In addition, the Maxwell magnetic transient solver provides full 3-D coupling with Simplorer. This advanced technology allows users to examine in detail the physical interactions of the electromechanical components in the system design which includes circuits, control loops and analog mixed signal topologies.



### Integrated Electrical Machine Solution

Designers of electrical machines and generators can enhance Maxwell with RMXprt™, a template-based, design tool. Together Maxwell and RMXprt create a truly customized machine design flow. Using classical analytical motor theory and equivalent magnetic circuit methods, RMXprt can calculate machine performance, make initial sizing decisions, and perform hundreds of “what if” analyses in a matter of seconds. RMXprt can then automatically setup the complete Maxwell project (2-D/3-D) including geometry, materials, boundary conditions including the appropriate symmetries and excitations with coupling circuit topology for rigorous electromagnetic transient analysis.



### Automatic Adaptive Meshing

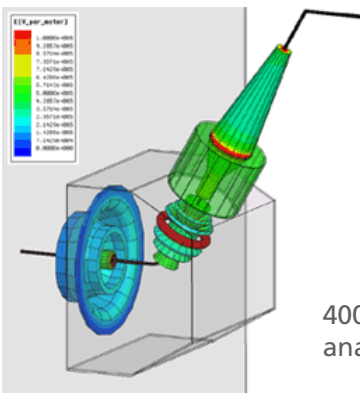
Maxwell includes automatic adaptive meshing techniques. This robust meshing algorithm automatically creates and refines the finite element mesh as the solution converges, streamlining the solution process and making the software very easy-to-use. The meshing process uses a highly robust volumetric meshing (TAU) technique and includes multi-threading capability. The meshing technique results in more efficient and higher-quality meshes that reduce the amount of memory used and speeds the simulation time.

## Dynamic Link – Simplorer

Dynamic links with Simplorer, multi-domain system simulation, allow accurate high-fidelity component models created in Maxwell to be combined with circuits and system architecture to create a powerful, electromagnetic-based design flow.

## High-Performance Computing

Maxwell can leverage today's high-powered computers with multi-processing and distributed analysis options for fast turnaround of your largest designs. The multi-processing option is used for solving models on a single machine with multiple processors or multiple cores which share RAM. The Distributed Solve option allows users to distribute parametric studies across a number of machines to expedite total simulation time. This time-saving capability splits multiple pre-defined parametric design variations (geometry, materials, boundaries and excitations) solves each simulation instance on a separate machine and then reassembles the data. This dramatically accelerates parametric studies and design optimization.



400 KV transformer lead exit analysis performed with Maxwell

## AnsoftLinks for MCAD

AnsoftLinks™ for MCAD facilitates the transfer of 3-D geometry from Mechanical CAD (MCAD) packages into Maxwell using common file formats, such as IGES, STEP, ACIS, Parasolid, ANSYS Mechanical, NASTRAN, Pro/ENGINEER, AutoCAD®, CATIA, and Siemens NX™.

## Magnetization Capabilities

Maxwell provides element-by-element or object-based magnetization capability based on the original non-remnant B(H)-curve. Users are able to account for the magnetization process for both ferromagnetic materials and permanent magnets.

## Demagnetization to 3rd Quadrant

Maxwell's demagnetization analysis features allow the user to study the permanent magnet demagnetization characteristics extended into the third quadrant. External magnetic fields can alter the magnetic properties of hard magnetic materials leading to demagnetization. This affects the performance of the machine.

## Product Features

### Integrated 3-D Modeler Featuring ACIS v19.0 and MFC Technology

- Standard primitives and multi-sweep functions
- Boolean operations: union, subtraction, intersection
- Direct import of SAT and DXF files
- AnsoftLinks™ for import of STEP, IGES and Pro/E files

### Automatic, Adaptive Mesh Technology

- Fault-tolerant meshing algorithms
- Mesh-generation feedback
- GUI performs validation and integrity checks
- Software identifies artifacts within the imported geometry
- Mesh-based model resolution

### Versatile Material Manager and Material Types

- User, group and system libraries
- Linear, nonlinear anisotropic materials
- Material assignment by coordinate type: cartesian, cylindrical or spherical

## Applications

### Electromechanical

- Motors and generators
- Linear or rotational actuators
- Relays
- MEMS
- Magnetic recording heads

### Electromagnetic

- Coils
- Permanent magnets
- Sensors

### Power electronic

- Transformers
- Inverters/Converters
- Bus bars
- Semiconductors as IGBTs and similar devices

### EM behavior

- Insulation studies
- Electrostatic discharge
- Electromagnetic shielding
- EMI/EMC
- Semiconductor
- Biomedical

## The ANSYS Advantage

With the unequalled depth and unparalleled breadth of ANSYS engineering simulation solutions, companies are transforming their leading edge design concepts into innovative products and processes that work. Today, almost all of the top 100 industrial companies on the "FORTUNE Global 500" invest in engineering simulation as a key strategy to win in a globally competitive environment. They choose ANSYS as their simulation partner, deploying the world's most comprehensive multiphysics solutions to solve their complex engineering challenges. The engineered scalability of solutions from ANSYS delivers the flexibility customers need, within an architecture that is adaptable to the processes and design systems of their choice. No wonder the world's most successful companies turn to ANSYS — with a track record of 40 years as the industry leader — for the best in engineering simulation.

**ANSYS**<sup>®</sup>  
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