

External Materials in AC/DC

Quick Start Guide

Overview

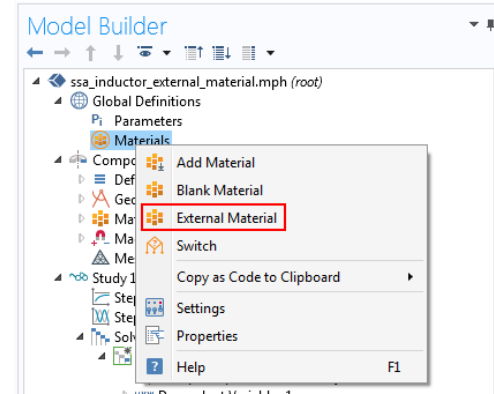
- A new way to specify user-defined material models included in COMSOL Multiphysics version 5.2.
- You can now access external material functions, written in C code, which have been compiled into a shared library.
- By writing a gateway function in C code, you can also use material functions written in another programming language.
- This makes it possible to program your own material models and distribute such models as add-ons.
- Available with the
 - AC/DC Module (2D magnetics available without the AC/DC Module)
 - Structural Mechanics Module
 - MEMS modules
- Examples include a model file, a source code file, and a shared library compiled and linked for 64-bit Windows
- Running the models on Linux™ and OS X requires additional compilation and linking

External Materials

- The external material model is implemented as a C-function with a certain calling convention, compiled and linked to create dynamically linked libraries that can be called from a material node in the Model Builder at runtime.
- For details, see the section *Working with External Materials* in the *COMSOL Multiphysics Reference Manual*.

Add External Material

- Under Global Definitions, right click Materials and add External Material
- In the Settings window, browse to the path of the library file compiled for your OS (e.g. .dll for Windows)



Set Up The Material

- Choose the appropriate **Interface type**:
 - General H(B) Relation** for Magnetic Fields, Magnetic and Electric Fields, and Rotating Machinery, Magnetic.
 - General B(H) Relation** for Magnetic Fields, No Currents and Magnetic Field Formulation.
- Specify the **Number of states** that the external library requires (for the example library, zero)
- In the **Model states** table, enter the initialization vector for the states (for the example library, an empty vector: { })
- In the table in **Material Contents** section, specify the **Material models parameters** required by the external library (for the example library, no parameters are needed, so specify the empty vector: { })

The screenshot shows the 'Settings' window for an 'External Material' model. The 'Interface type' is set to 'General H(B) relation'. The 'Number of states' is set to 0. The 'State name' is 'S'. The 'Required input quantities' table shows 'Magnetic flux density' with unit 'T' and components 'input.B, is1,2,3'. The 'Output quantities' table shows 'Magnetic field' with unit 'A/m' and components 'output.H, is1,2,3'. The 'Model states' table shows 'Magnetic field' with unit 'A/m' and components 'state.H, is1,2,3', and 'User-defined state vector' with unit '1' and components 'state.S, is1,0'. The 'Material Contents' table shows 'Material model parameters' with unit 'par' and components '1'.

Quantity	Unit	Components	Type
Magnetic flux density	T	input.B, is1,2,3	Vector density

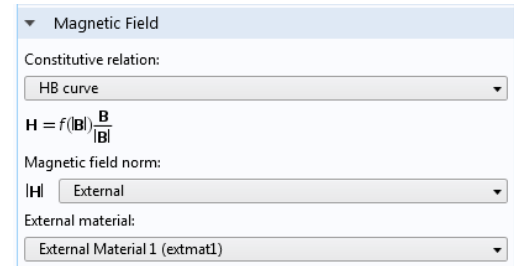
Quantity	Unit	Components	Type
Magnetic field	A/m	output.H, is1,2,3	Covariant vector

Quantity	Unit	Init	Components	Type
Magnetic field	A/m	(0,0,0)	state.H, is1,2,3	Covariant
User-defined state vector	1	()	state.S, is1,0	User-defi

Property	Name	Value	Unit	Property group
<input checked="" type="checkbox"/>	Material model parameters	par	()	General H(B) relation

Use The Material

- Go to the domain feature of the physics (Ampère's Law, Magnetic Flux Conservation...)
- In the **Magnetic Field** section, select **HB curve** as the **Constitutive relation**
- Select **External** as the **Magnetic field norm** specification
- Select the External material previously added



Security Settings

- Use of external libraries is disabled by default for security reasons
- In the Preferences window, under Security, check the Allow external processes and libraries check box
- If external libraries are not allowed, an error occurs while solving

