QuickField™ applications : DC Electromagnetic plunger

Note 1 : **Bleu** : information will appear on hovering. **Vert** : to an internal link . **Orange** : to an external link.
Note 2 : **F11** turn your browser in presentation mode (Opera browser only).

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Part 1 : DC Magnetic plungers and specs

Part 2 : Designing a plunger

Part 3 : Virtual tests for design and production

(Photo from MSA products catalog)

Magnetic DC plungers and specs

- Different types
- Force/stroke characteristics
- Timing characteristics
- Environment conditions
- A simple design

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(Photo from MSA products catalog)

Magnetic DC plungers and specs

- Different types
- Force/stroke characteristics
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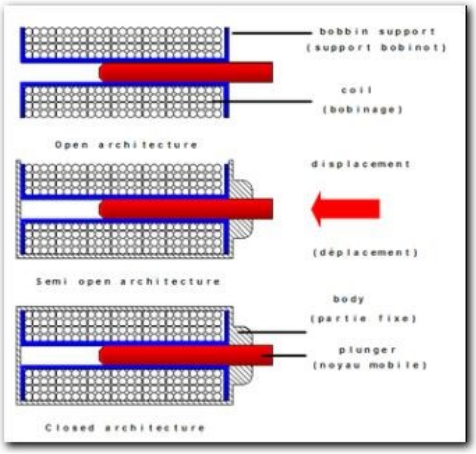
- A simple design

Different types

- C - frame plunger solenoid (semi open architecture)
- D - frame plunger solenoid (closed architecture)
- Tubular plunger solenoid (closed type)

(photos from MSA Products catalog)



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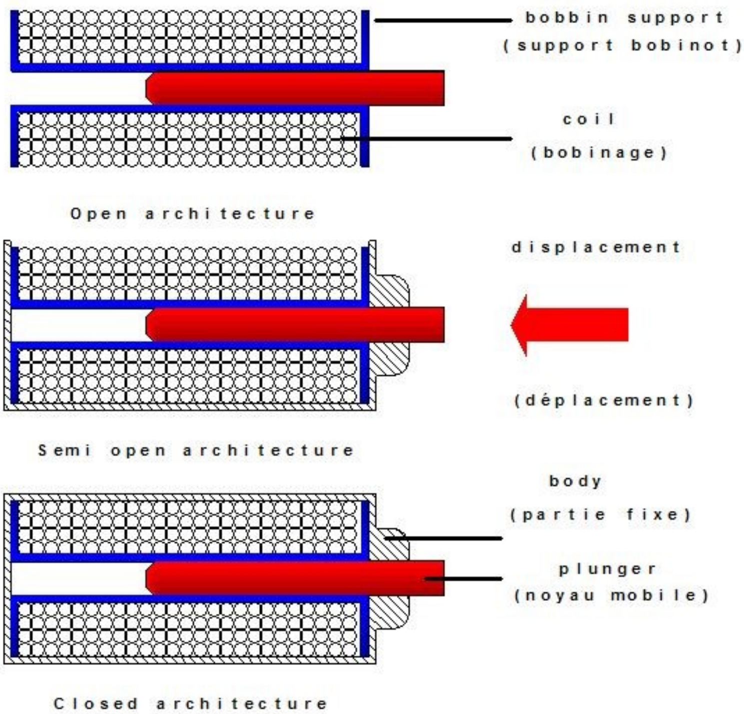
Different types (page 1/2)

- **Open architecture**
- **Semi open architecture**
- **Closed type**



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Different types (page 2/2)

- C - frame plunger solenoid
- D - frame plunger solenoid
- Tubular plunger solenoid

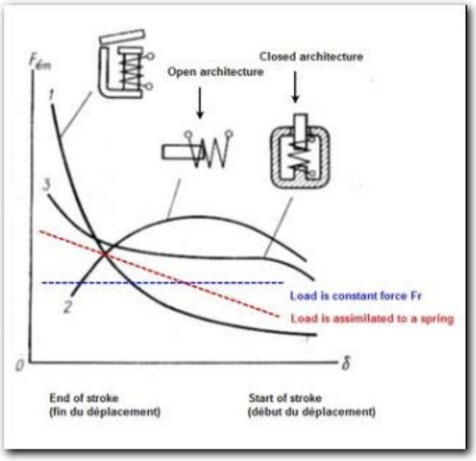
Force/stroke characteristics

The Force/stroke characteristics gives the static force according the displacement of the core. The shortest is the flux path, the strongest is force.

Main points

- **The maximum force is very different for each type**
- **The plunger force must superior to the load force, and the higher is the difference, the faster is the plunger.**
- **The length of the stroke is dependant of the plunger type**

Force vs stroke



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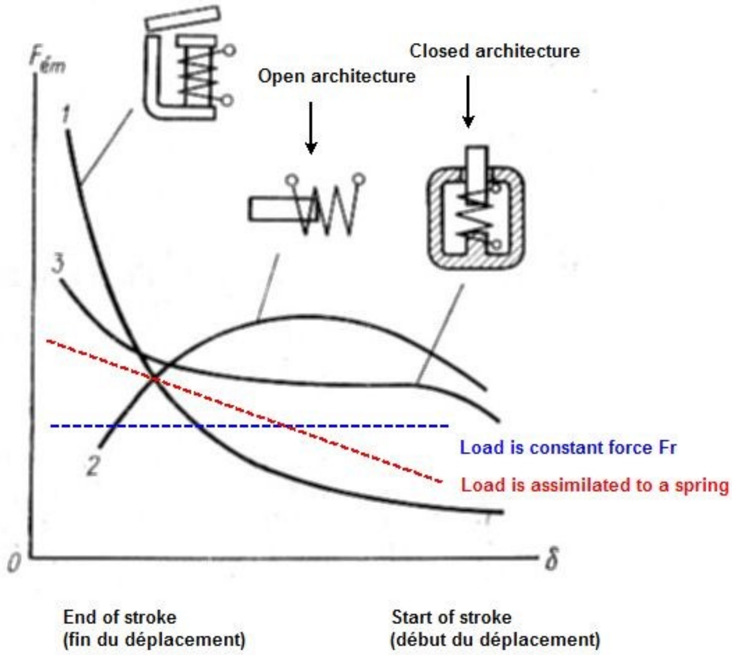
Force/stroke characteristics

- Maximum force
- $F_{plunger} > F_{load}$
- Length of the stroke



Timing characteristics

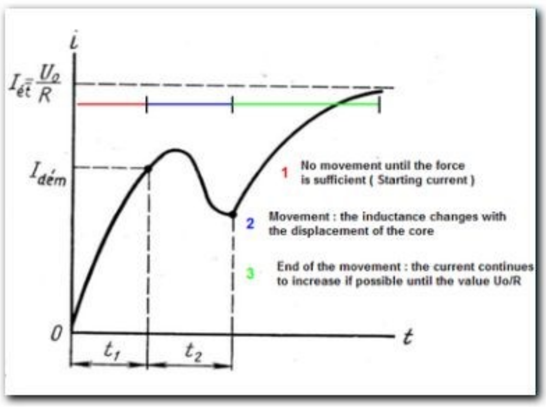
The timing characteristics is important for the applications that require a low response time. The higher is the current to obtain a large force, the longer it will take more time, but the higher the force and the faster is the movement.

Points principaux

- **R and L values of the coil**
- **m × (d²x/d²t) = $F_{plunger}$ − F_{load}**
- **Three steps**

<u>Note</u> : **The use and calculations of these characteristics will be presented in a next webinar.**

Inrush current



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Timing characteristics

- **R and L values of the coil**
- **m × (d²x/d²t) = F_p − F_l**
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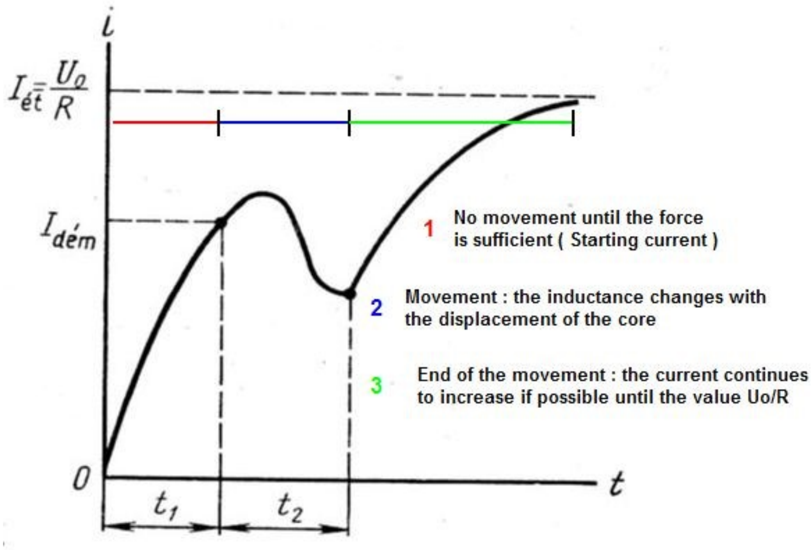

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Environment conditions

The modules of Quickfield allow to check the behaviour of the appliance under different thermal, electrical or mechanical conditions. the available modules are : DC magnetics, AC magnetics, Transient magnetics, DC Conduction + Electrostatics, AC Conduction + Electrostatics, Transient Electric, Static and Transient Heat Transfer and Linear Stress.

Possible conditions to be tested

- **Thermal use of coil**
- **Insulation test**
- **Mounting test**

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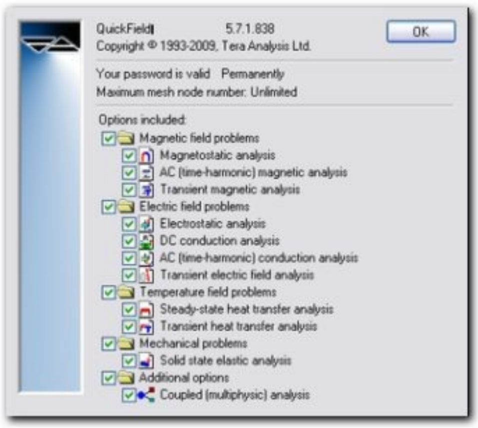
QuickField modules



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Environment conditions

- **Thermal use of coil**
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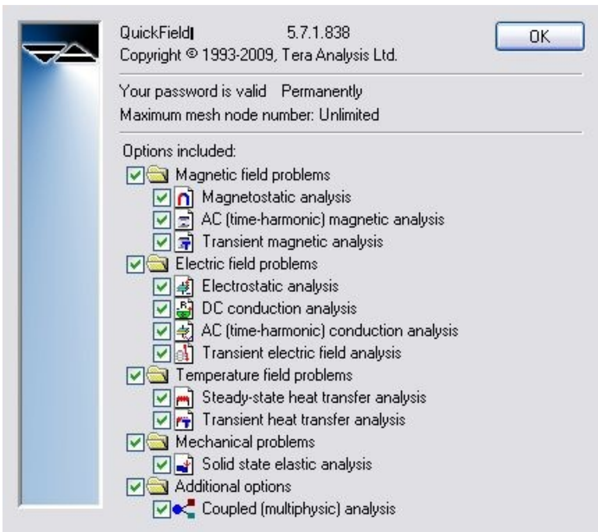

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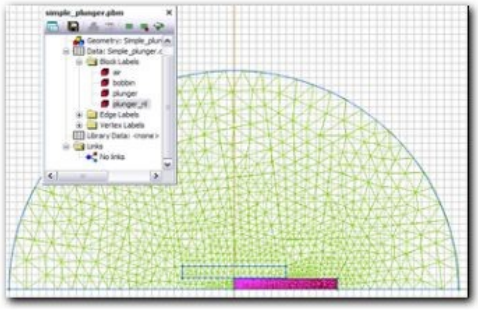
A simple design

Quickfield is pleasant as it's a software that allow you to check simple things very quickkly. Here is an example where you want to ckeck if a linear model can replace a non-linear model (note that as there is no closed magnetical path, the linear choice will always be reasonnable, but the example wants also how to prepare the geometry for use with LabelMover or other modules) Static and Transient Heat Transfer and Linear Stress

Quickfield : as simple as a pocket calculator !!



Main steps

- **The main objects**
- **The bondary conditions**
- **Problem parameters**
- **LabelMover tips**
- **Thermal tips**

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A simple design

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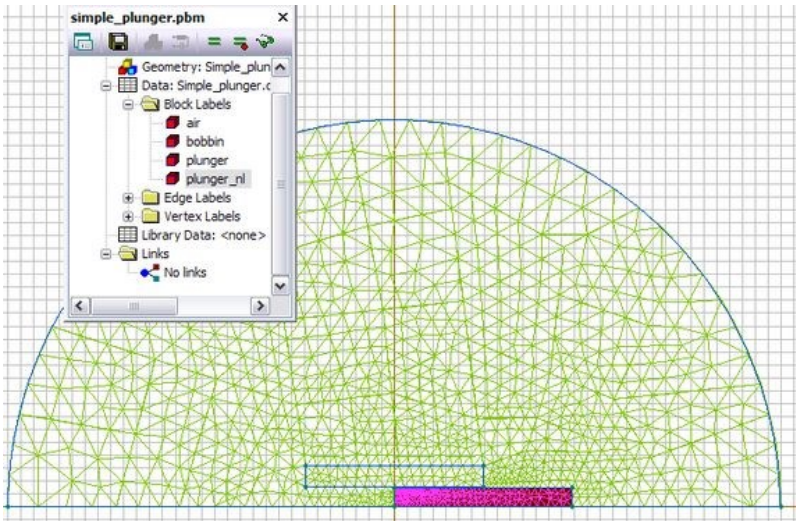

Tubular solenoid from MSA catalog

Designing a plunger

- Datasheet
- Main formulae and calculations
- Designing
- Parameter sweeping with LabelMover
- Improving sweeping with Tcl scripts
- Use of computer algebra systems

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Datasheet

- **Dimensions**
- **Profile**
- **Force**
- **Energy**
- **Temperature ?**
- **Response time ?**

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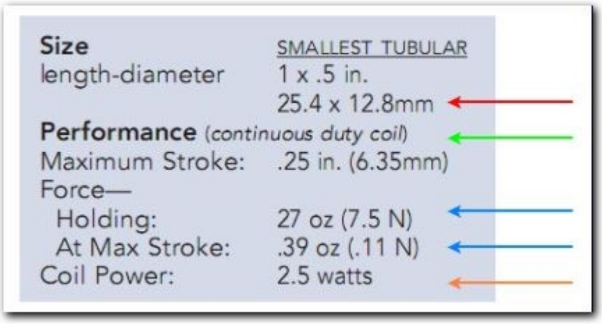

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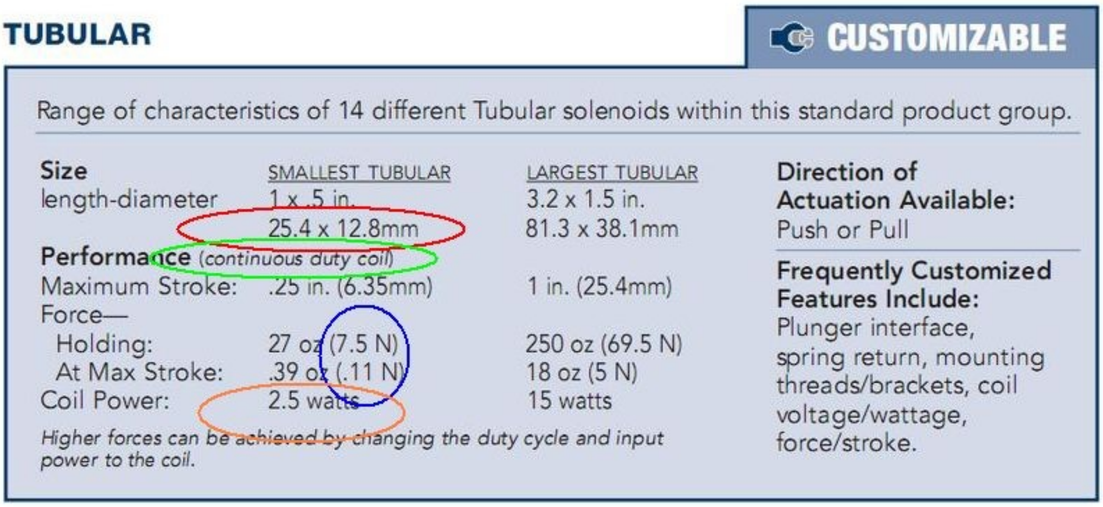

Datasheet • **Dimensions** • **Profile** • **Force** • **Energy** • **Temperature ?** • **Response time ?**

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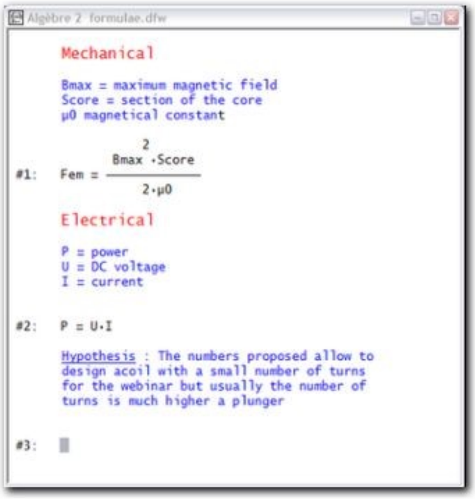
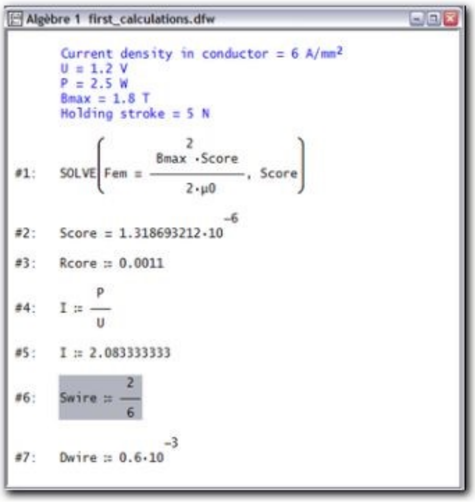
Main formulae

- **Force at the end of the stroke**
- **Electrical power**

Calculations

- **Core section**
- **Wire section**





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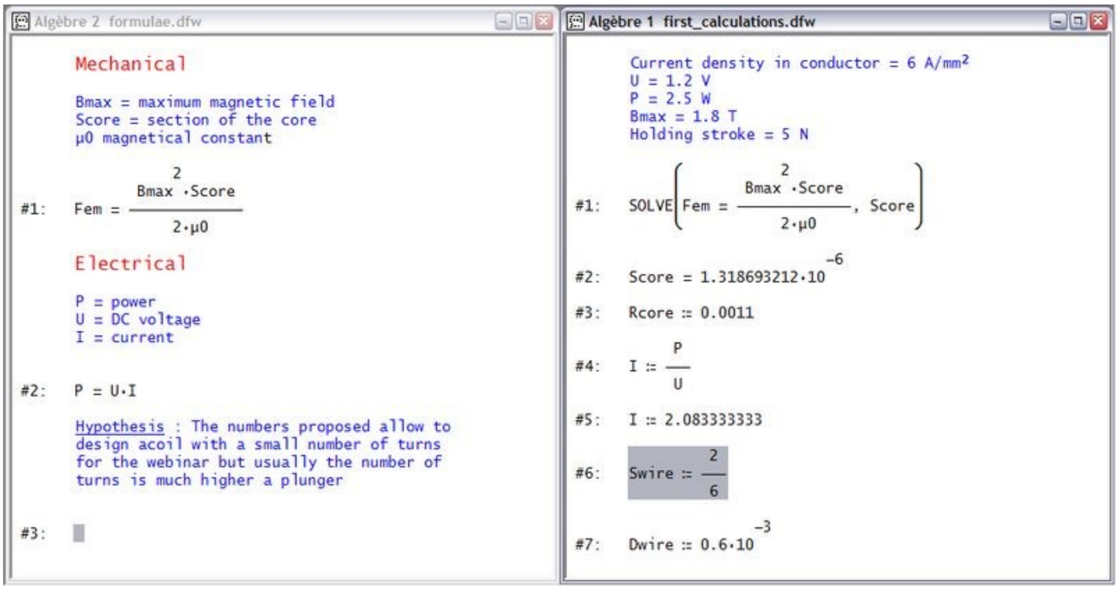


Main formulae • **Maximum force at the end of the stroke** • **Electrical power**

Calculations • **Core section** • **Wire section**

Designing and some tips

- **Thermal coefficient for coils**

Open architecture if h = coil height, D = Dext

K = 25 W/m²×deg if h/D < 1
K = 20 W/m²×deg if h/D = 1
K = 16 W/m²×deg if h/D > 1

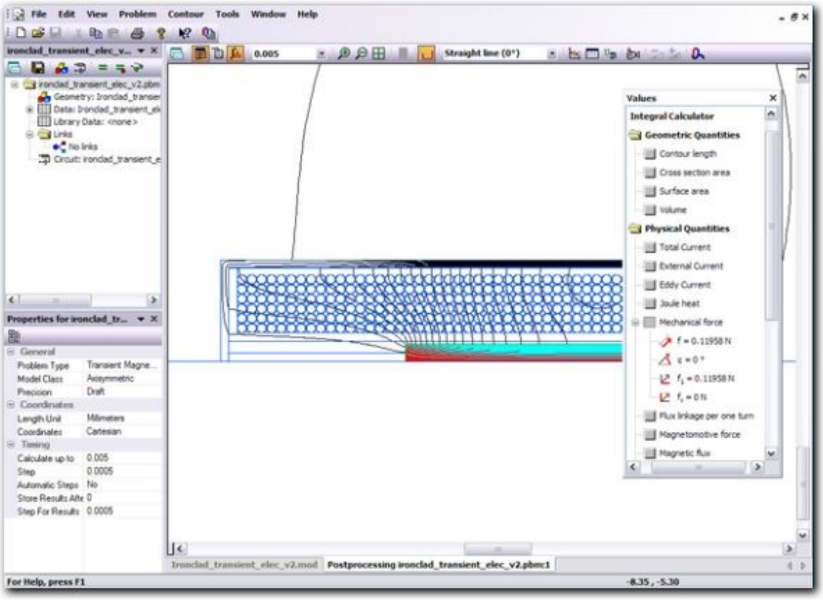
For other surfaces take

K = 5 W/m²×deg (natural convection)
K = 80 W/m²×deg (forced convection)

(For final design these data must be checked)

- **Filling coefficient of windings**

Under a wire diameter of 0.8 mm, this coefficient can be under 0.5 and depends of the type of wire



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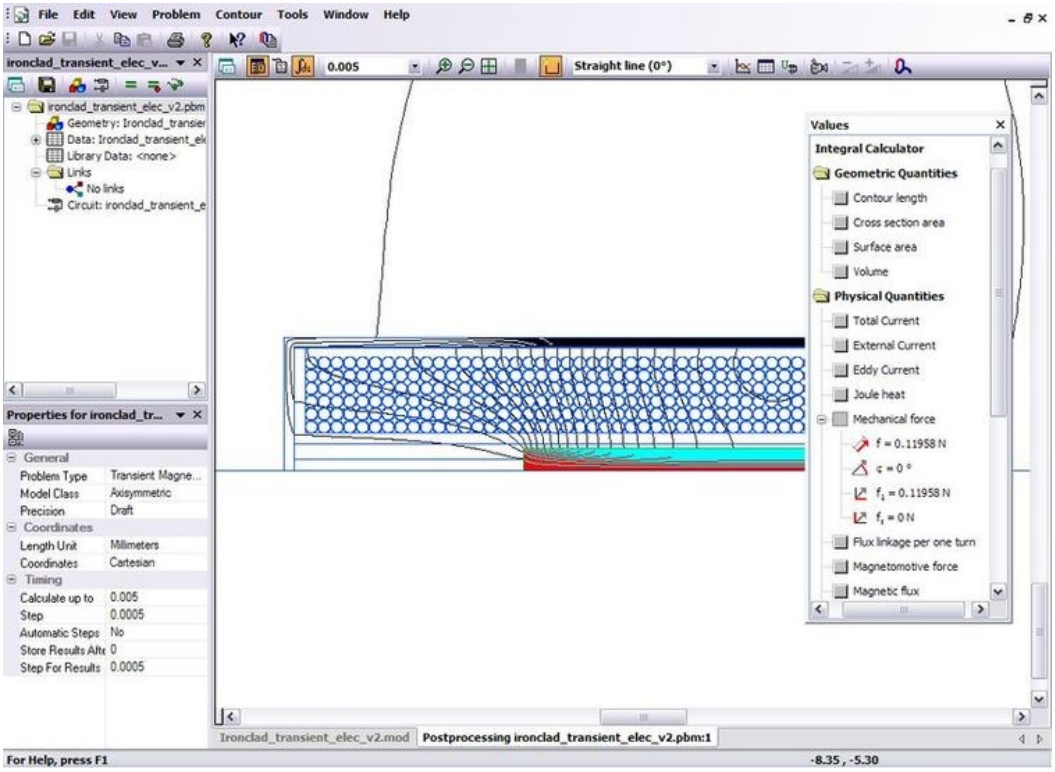

Designing

Example from MSA catalog

Virtual tests for design and production

- General issues
- Thermal model
- Insulation model
- Mounting model
- Tolerance analysis

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Virtual tests for design and production

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General issues

- Think about a global geometry
- Linearize as much as possible
- Transient simulations are longer
- Use circuit (for accuracy and understanding)

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