

Simulation setup instructions

Download and install **COMSOL Multiphysics 5.6** software on your personal computer from [www. download.aalto.fi](http://www.download.aalto.fi) and Open the file **trans_design_sim.mph**. Follow the steps to run the simulations.

1. Input parameters

To define the input parameters: In the **model builder** window locate **Global Definitions – Parameters 1**.

Note: Input your geometry i.e. (AA, B, C ...etc.) and other parameters are obtained from analytical calculation (N_p , N_s ...etc.)

2. Build geometry

To build the transformer geometry after updating the input parameters:

In the **model builder** window locate **-Component** (double click) - locate **-Geometry** (single click), From the **Settings window** locate **Build All** (click to build)

3. Build mesh

In the **model builder** window locate **-Mesh** (single click), From the **Settings window** locate **Build All** (click to build)

Simulating different transformer operating conditions

1. Open Circuit Test:

- i. Define the primary coil input: In the **model builder** window locate **-magnetic fields** (double click) to open, locate **- coil 1** (single click), From the **setting window** locate **Coil excitation** list, choose **Circuit (current)**.
- ii. Define the Secondary coil input: In the **model builder** window locate **-coil 2**(single click), From the **setting window** locate **Coil excitation** list, choose **Current** input $I_{coil} = 0$.
- iii. Define the primary coil input: The **model builder** window locates **Electrical circuit** (double click) to open, locate **-Voltage source V1**, From the **setting window** locate **voltage V_{src}** and use the rated supply voltage V_{ac} . (i.e. $\sqrt{2} * V_{ac}$)
- iv. In the **model builder** window locate **Electrical circuit**, locate **- External I vs U1**, From the **setting window** locate **Electric potential** list, choose **Coil voltage (mf/coil1)**.
- v. In the **model builder** window locate on **Study-1** (single click), next go to **setting window** and click on **=Compute**.
- vi. Results: In the **model builder** window locate **Results** (double click) - **derived values** (double click) - **Global Evaluation 1**, From the **setting window** click on **= Evaluate**.

2. Short Circuit Test:

- i. Define the primary coil input: The **model builder** window locates **Electric circuit - Voltage source V1**, From the **setting window** locate **voltage V_{src}** and use 10% of the rated supply voltage V_{ac} . (i.e. $0.1 \cdot \sqrt{2} \cdot V_{ac}$)
- ii. Define the Secondary coil input: In the **model builder** window locate **coil 2**, From the **setting window** locate **Coil excitation** list, choose **Voltage** input $V_{coil} = 0$
- iii. In the **model builder** window locate on **Study-2** (single click), next go to **setting window** and click on **=Compute**.
- iv. Results: In the **model builder** window locate **Results - derived values - Global Evaluation 2**, From the **setting window** click on **= Evaluate**.

3. Load simulation:

- i. Define the primary coil input: The **model builder** window locates **Electric circuit- Voltage source V1**, From the **setting window** locate **voltage V_{src}** and use 100% of rated supply voltage V_{ac} . (i.e. $V_{ac} = \sqrt{2} \cdot 24V$)
- ii. Define the Secondary coil input: In the **model builder** window locate **coil 2**, From the **setting window** locate **Coil excitation** list, choose **Circuit (current)**.
- iii. In the **model builder** window locate **Electrical circuit - External I vs U2**, right click on it and select **Enable**, From the **setting window** locate **Electric potential** list, choose **Coil voltage (mf/coil2)**.
- iv. In the **model builder** window locate **Electrical circuit - Resistor R2**. Right click to enable **Resistor R2**, give your load resistance as input in the parameter table (step1)
- v. In the **model builder** window locate on **Study-3– load_sim** (single click), next go to **setting window** and click on **=Compute**.
- vi. Results: In the **model builder** window locate **Results - derived values - Global Evaluation 3**, From the **setting window** click on **= Evaluate**.