# Power transformer

*3D Application Note Summary* ***(Qualified with Delaunay mesher and User memory mode)***

This application note presents the modeling of a power transformer with Flux 3D.

### Keywords

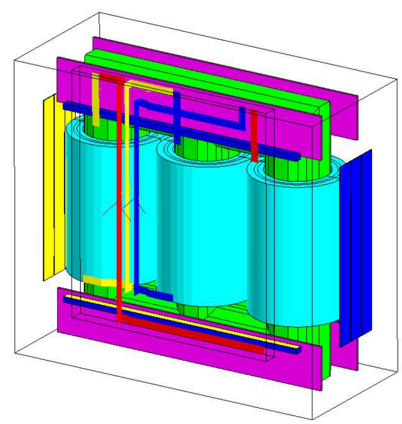
| Applications | Flux main functions | Post-processed quantities |
|---|---|---|
| • Steady State AC Magnetic | • Import Flux object, Aided mesh<br>• Thin region, Region of Surface Impedance type (3D)<br>• Magnetic cut (3D)<br>• Non meshed coil (3D)<br>• Circuit coupling | • Magnetic quantities, Circuit quantities<br>• Iron losses (Bertotti), Joule losses<br>• Inductance computation, Reactance computation |

**Studied device**

The studied device, represented in figure opposite, is a power transformer.

It includes the following elements:

- the magnetic core (green) which has 3 legs
- 1 high voltage and 1 low voltage windings (turquoise) around each leg
- yoke and wall shunts (cyan) are made of magnetic laminated material
- frames (magenta) are magnetic massive iron
- the tank (black, invisible) contains the transformer
- the distribution bars (red, blue and yellow) are the exits of secondary currents and are made of copper material



### In practice

**Open example** = Open Flux + Run the pyFlux command file

- Recommended memory configuration (standard): 4000 MiB Num + 50 MiB Char + 300 MiB GUI
- Computation time: 5 min < t < 2 h [64 bit - 16 GB RAM - 2.2 GHz]

# Example 1: No load test

The goal is to compute the iron losses (losses in the magnetic core).

This modeling is carried out with the Steady State AC Magnetic application.

To perform a no load test, a voltage is imposed in the primary windings, and a zero current is imposed in the secondary windings (corresponding to a no load functioning without receiver).

In these circumstances, the flux leakage is negligible, therefore, only the core, the windings and the surrounding air are represented (simplified geometry).

- Display isovalues of the magnetic flux density on volume regions
- Compute magnetizing currents
- Compute magnetizing reactance
- Compute the zero-sequence voltage
- Compute iron losses (Bertotti) in the core

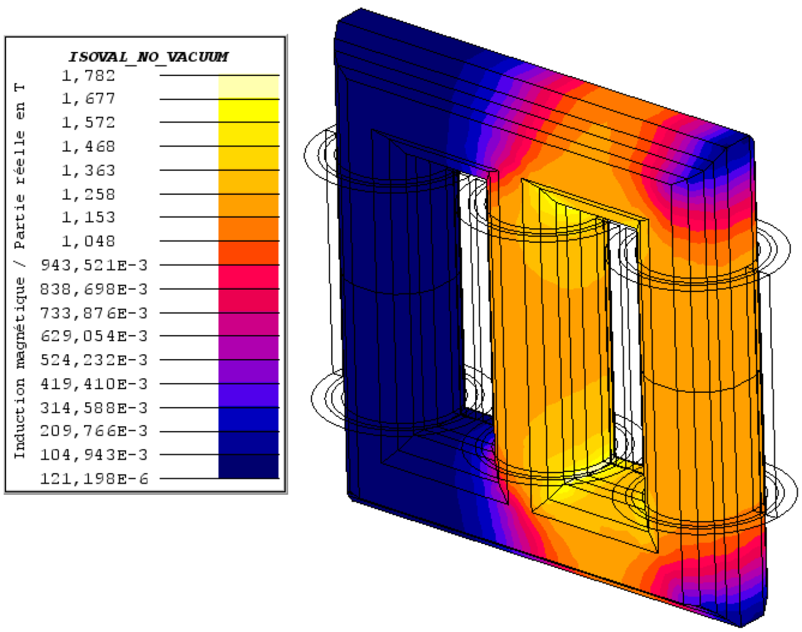



*Figure 1: Isovalues of the magnetic flux density in the core*

# Example 2: Short circuit test

The goal is to compute the losses by Joule effect (losses in the windings) and losses due to flux leakage.

This modeling is carried out with the Steady State AC Magnetic application.

To perform a short circuit test, the secondary circuit is closed (secondary voltage negligible), and the primary circuit is supplied with a reduced voltage.

In these conditions, the flux leakage is important, which is why this test requires a complete model of the transformer (detailed geometry).

- Display isovalues of the magnetic flux density on volume regions
- Compute leakage reactance
- Compute short circuit voltage

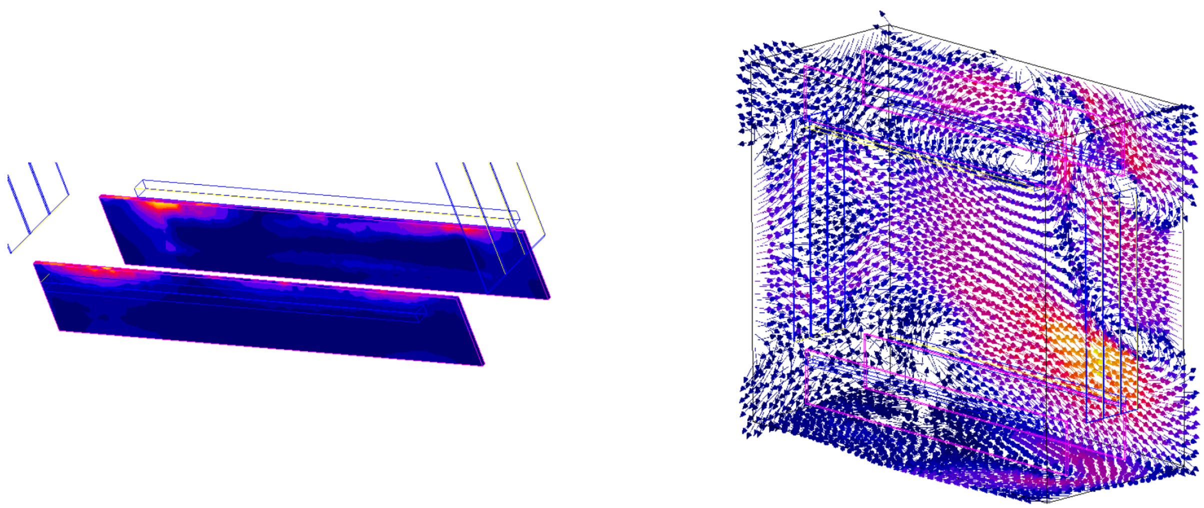


*Figure 2: Eddy currents in conducting parts*

# Example 3: Normal operating conditions

The goal is to analyze the behavior of the transformer with load.

This modeling is carried out with the Steady State AC Magnetic application.

To carry out this case in normal operating conditions, the secondary circuit consists of a resistive load, and the primary circuit is supplied with voltage.

Under these conditions, no assumption is made. This test uses a complete model of the transformer (detailed geometry) to take into account all phenomena.

- Display isovalues of the magnetic flux density on volume regions
- Compute the losses and the efficiency of the transformer to a certain operating point

This case is not described in the tutorial.

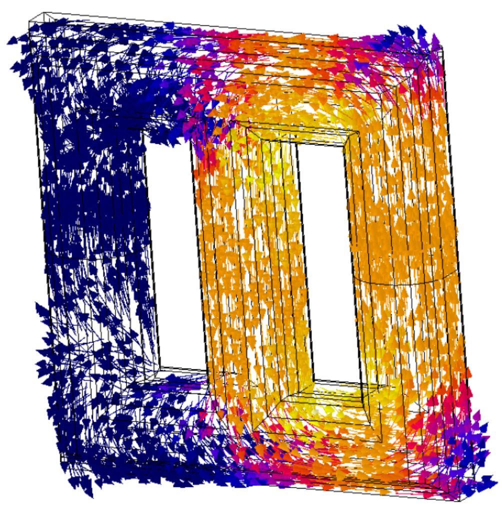


*Figure 3: Arrows of magnetic flux density in the core*