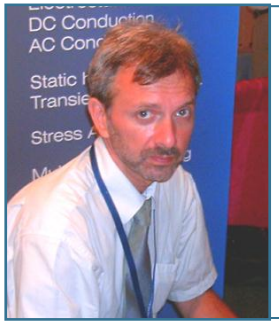
Transformers modeling in QuickField



Vladimir Podnos

Director of marketing and support

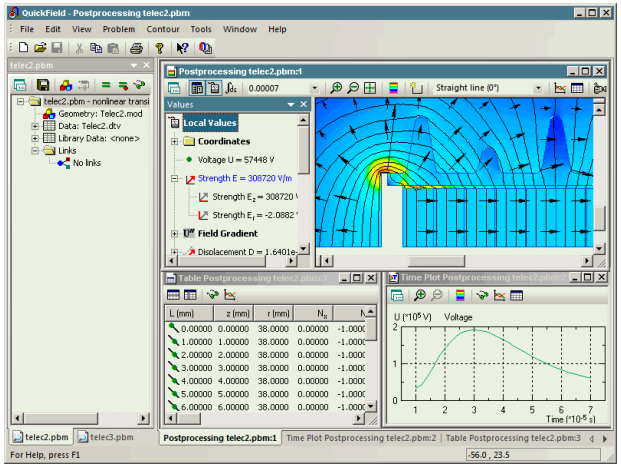
Overview of QuickField capabilities

Alexander Liubimtsev

Support engineer

Live presentation of QuickField transformer simulations

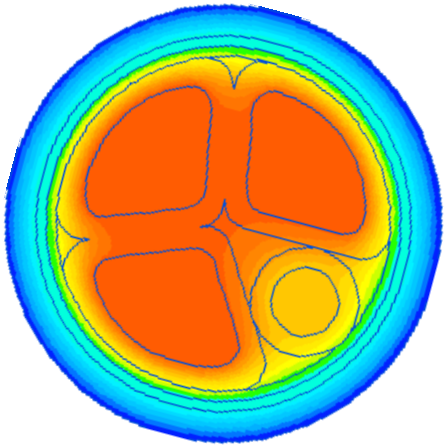
QuickField Analysis Options



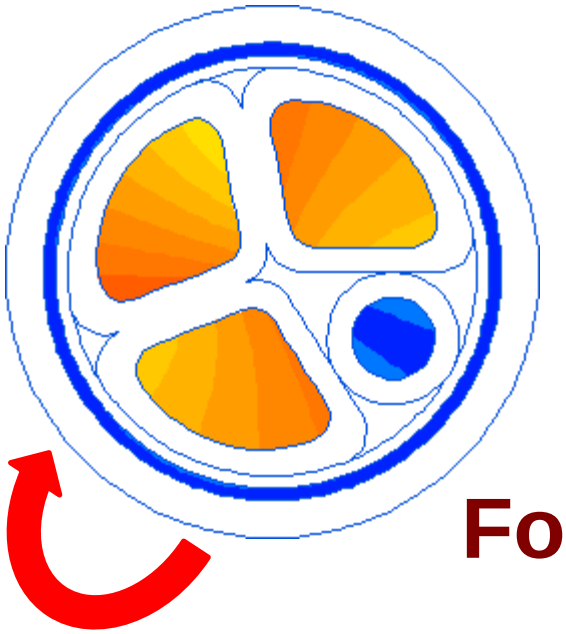
- Magnetic Suite
  - AC Magnetics
  - Transient + DC Magnetics
  - DC Magnetics
- Electric Suite
  - AC conduction + Electrostatics & DC conduction
  - Transient Electric + Electrostatics & DC conduction
  - Electrostatics & DC conduction
- Thermostructural
  - Stress Analysis
  - Transient Heat transfer
  - Steady State Heat transfer

MultiPhysics

Temperature Field

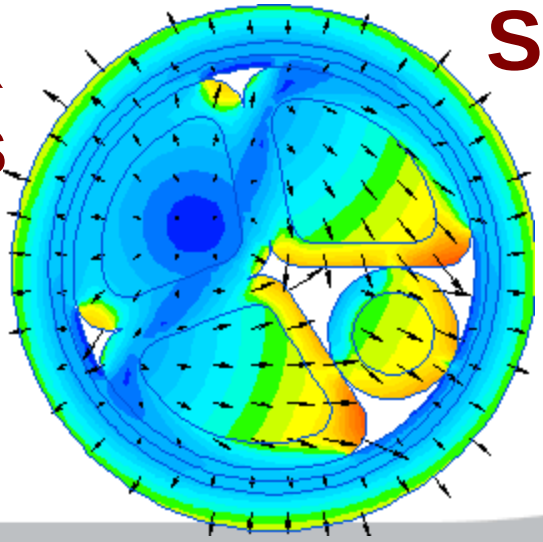


Electromagnetic fields



Thermal Stresses

Forces

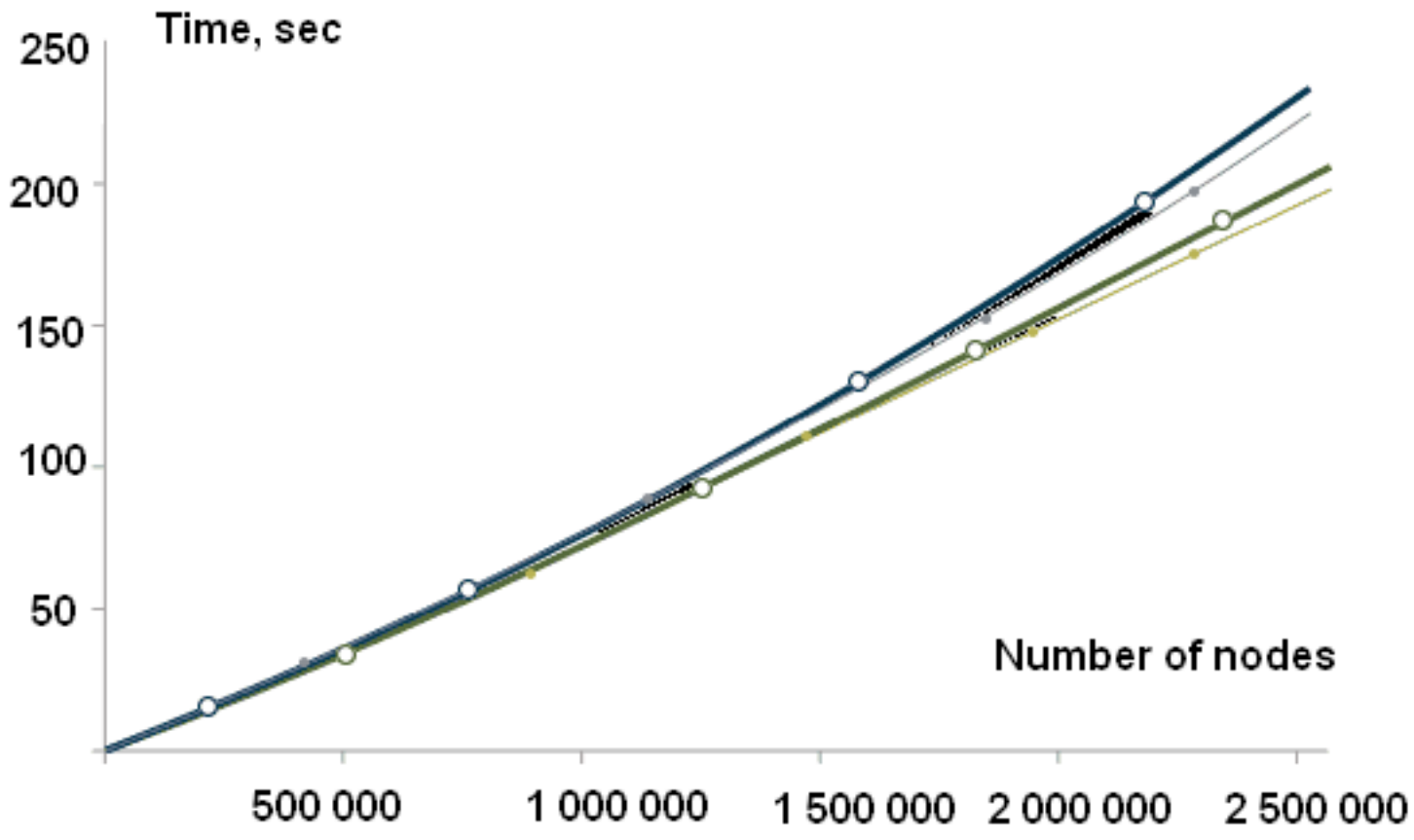


Magnetic state import

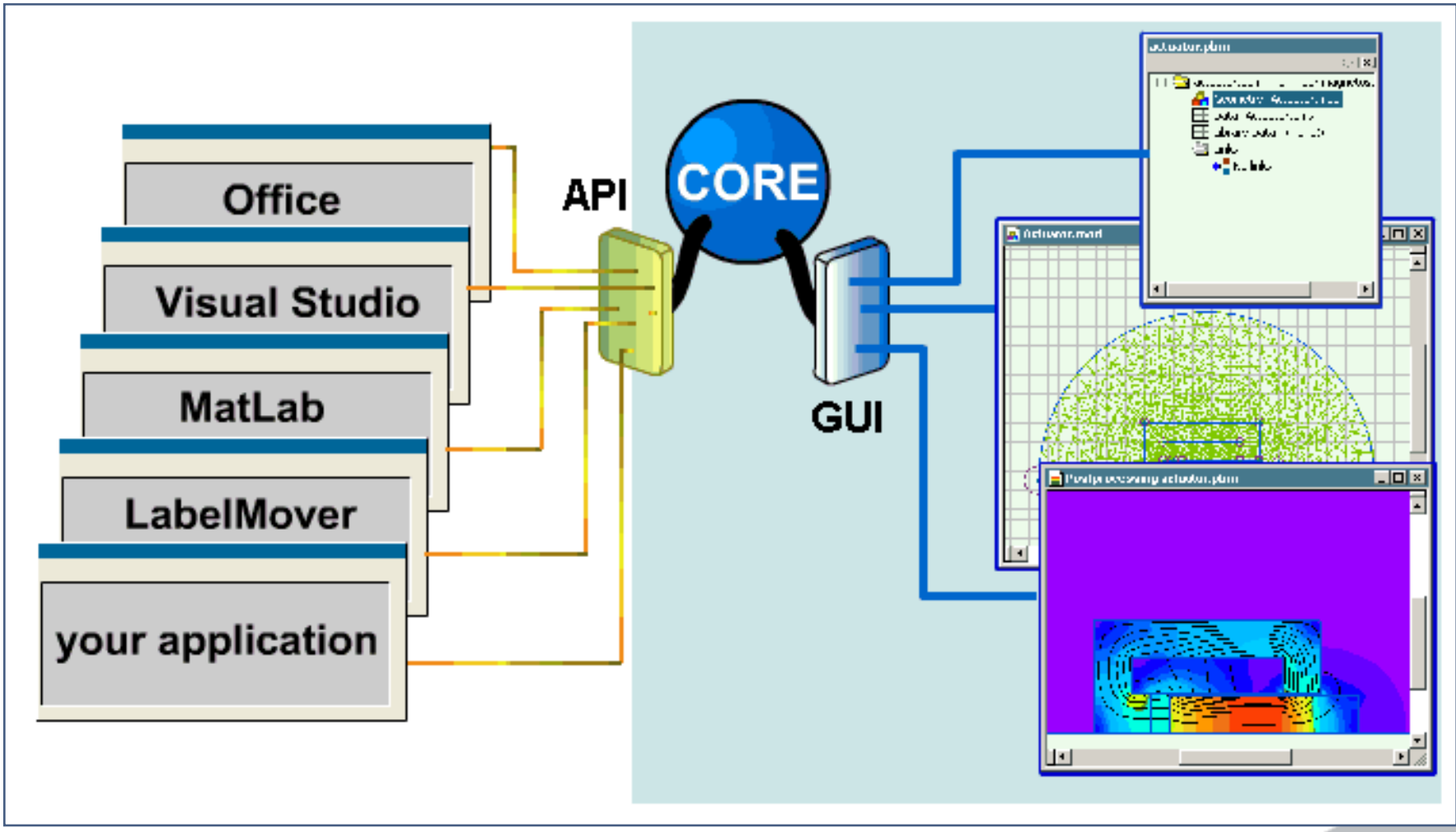
Stresses & Deformations

QuickField solvers

Solution time for various sizes of finite element mesh



Open object interface



ActiveField API object model

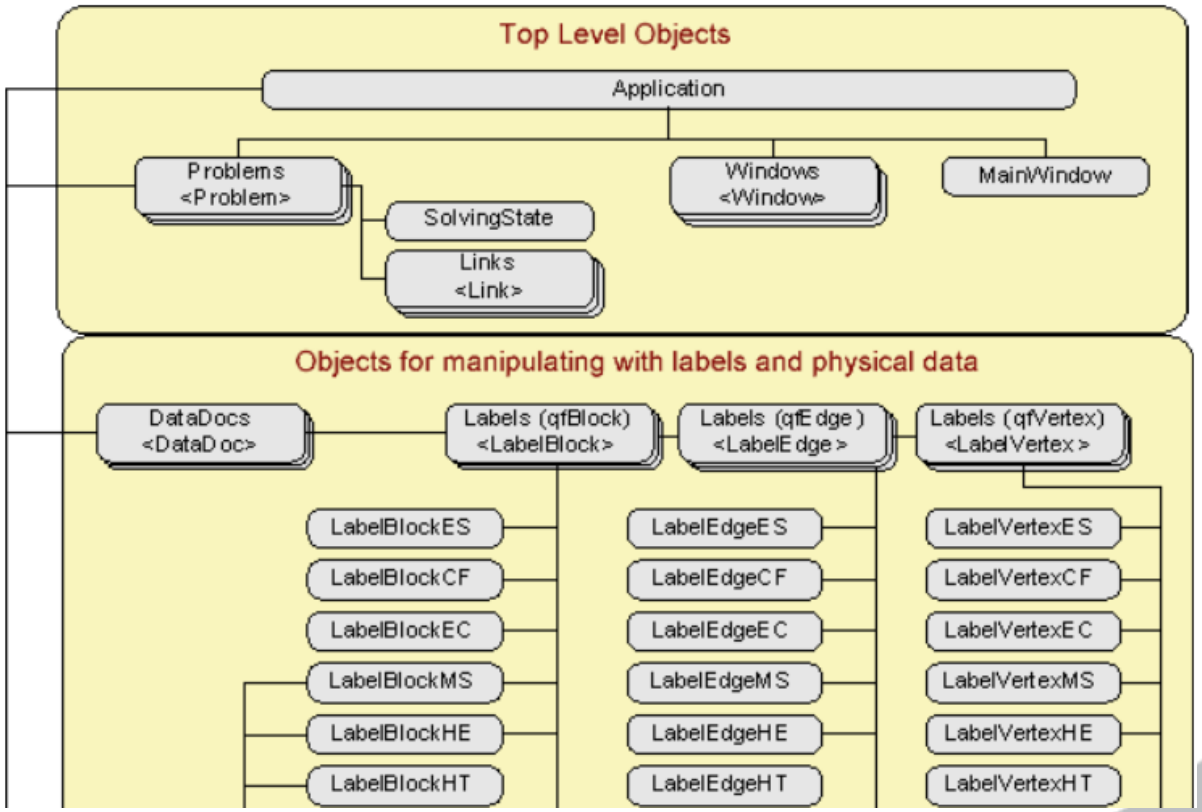
ActiveField™ help | Main QuickField Site | Free Downloads | Contacts

Objects

Properties

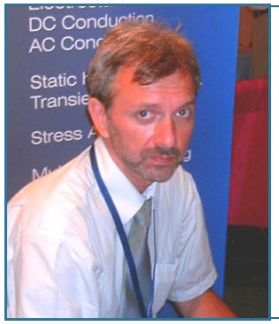
Methods

QuickField Object Model



QuickField Difference

Transformers modeling in QuickField



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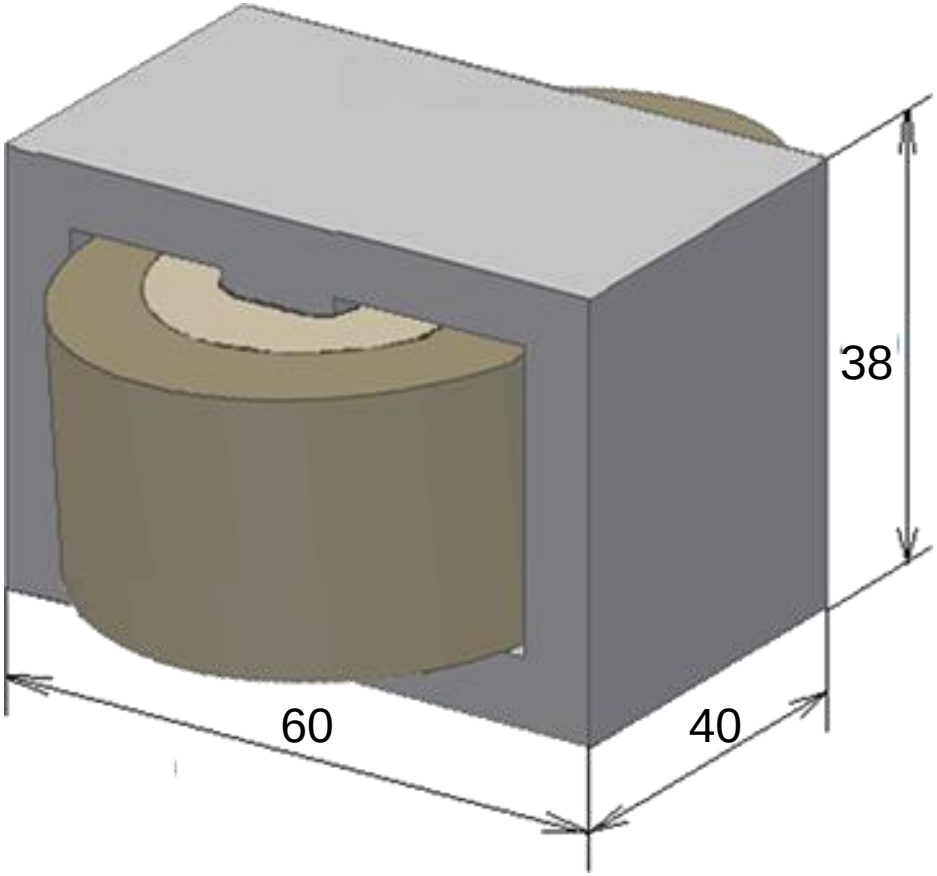
Transformers modeling in QuickField

1. Single phase transformer.
   No load test. Short circuit test.
2. Flyback (pulse) transformer.
3. Three phase transformer. Nonsymmetrical load.
4. Transformer heating. Winding and core losses.
5. Mechanical stress in transformer windings.
6. Transformer tank 3-phase bushing insulator.

Single phase transformer



Dimensions are given in mm

Given:

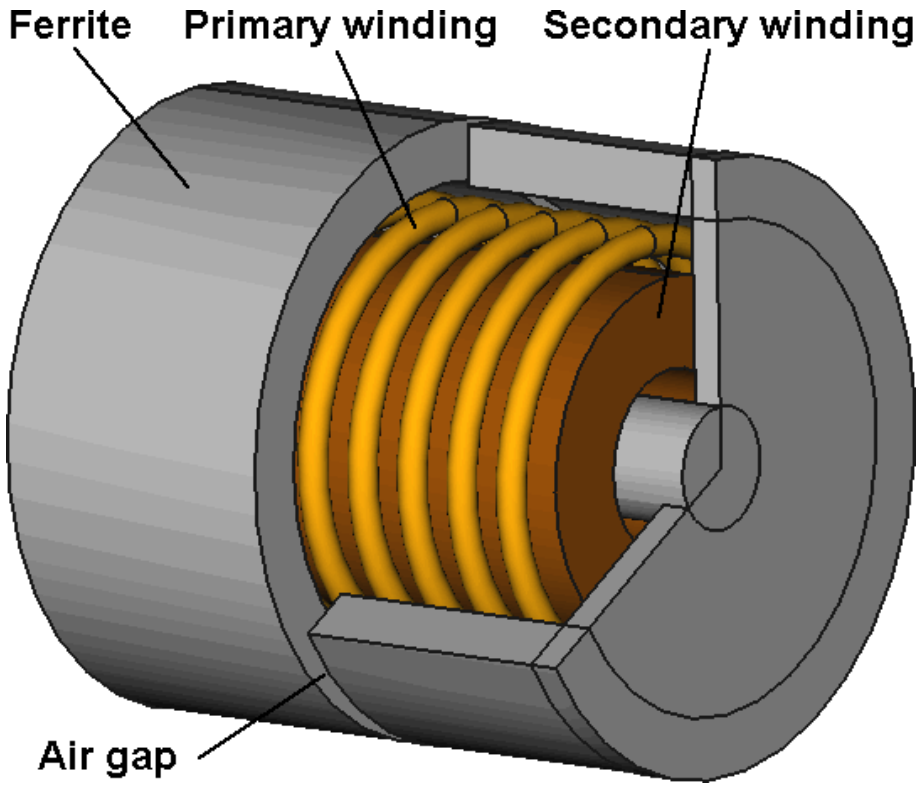
Voltage (RMS) U_1 = 36 V,
Frequency f = 50 Hz,
Core permeability μ = 1000,
Windings (copper) conductivity σ = 56e6 Sm/m.

Windings turns:
N_1 = 640, N_2 = 168.

Calculate:

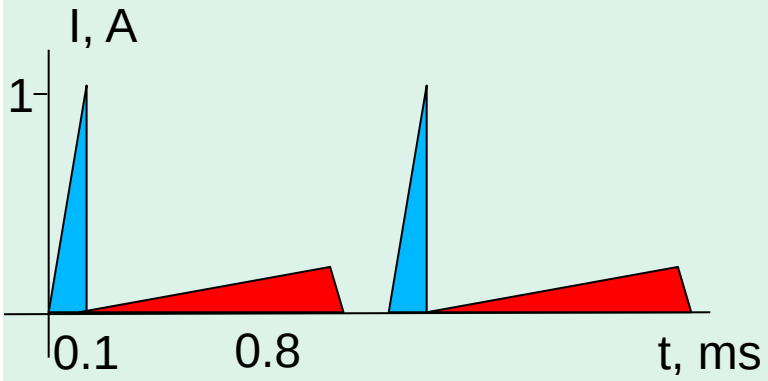
No-load current I_0
Secondary voltage U_2
Magnetic flux density B_0
Short circuit current I_{SC}

Flyback (pulse) transformer



Given :

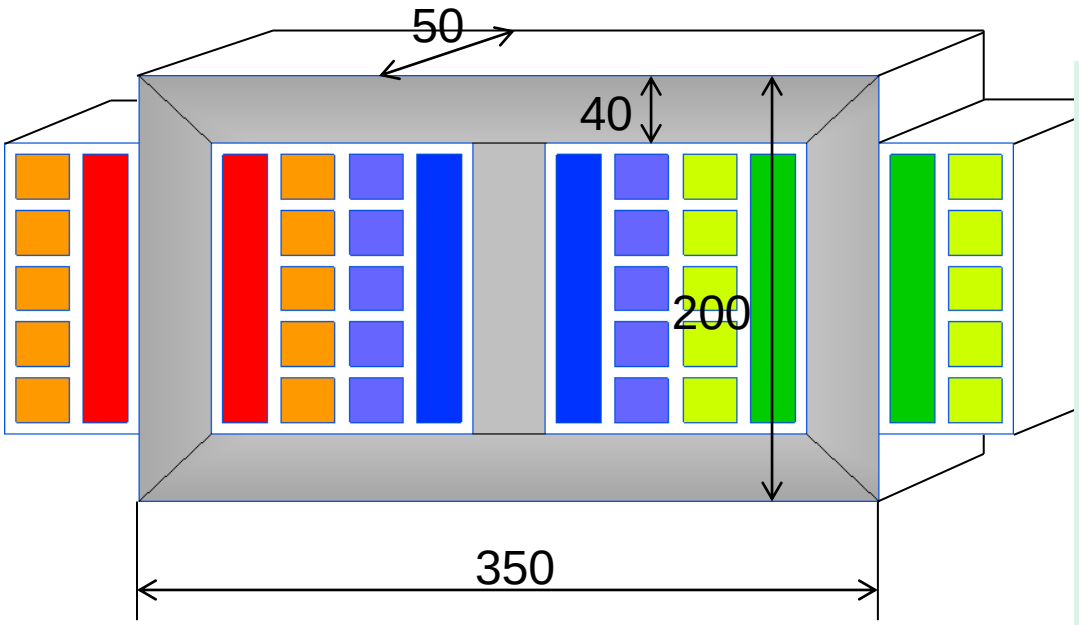
Winding turns
$N_1 = 13$, $N_2 = 200$
Currents of windings are given



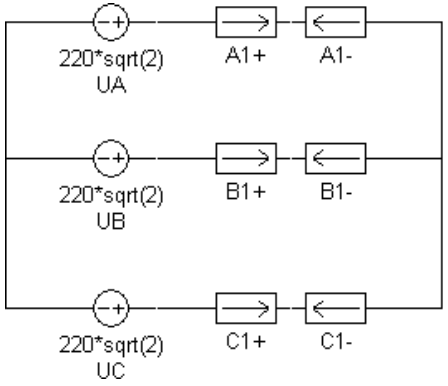
Calculate:
Magnetic flux density outside the transformer.

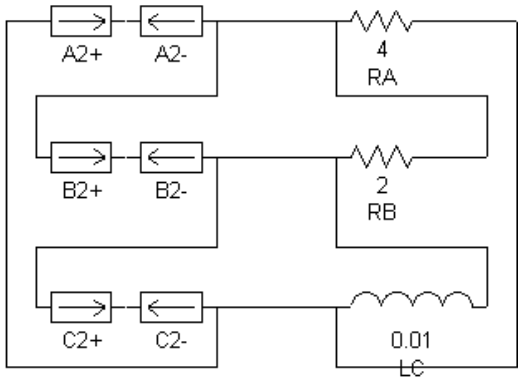
http://www.quickfield.com/advanced/flyback_transformer_emc.htm

Three phase transformer



Dimensions are given in mm



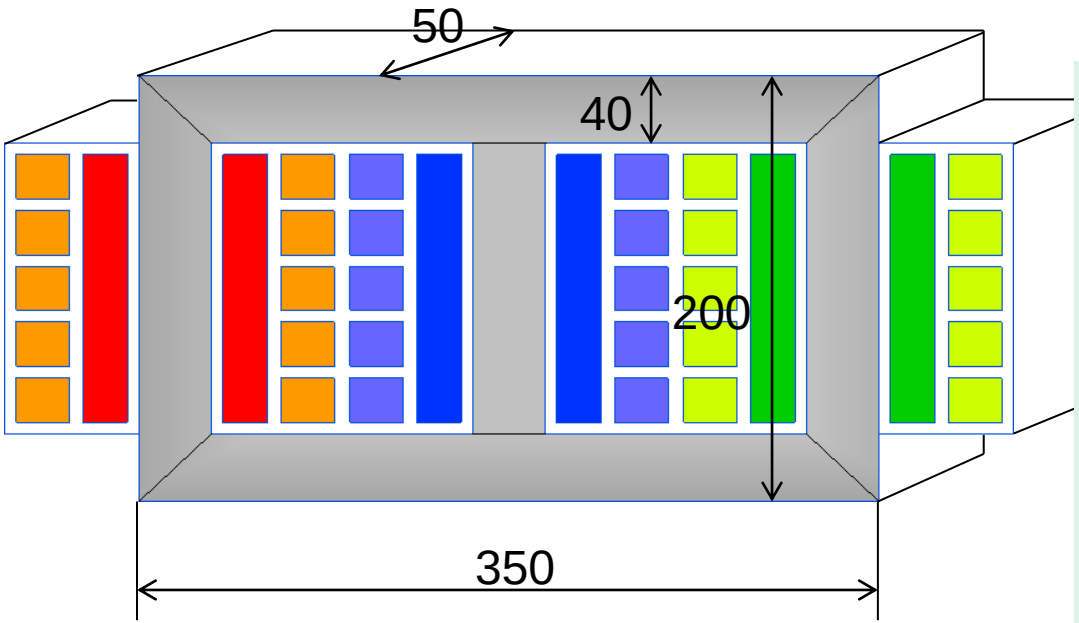


Given:

Phase voltage U = 220 V,
Frequency f = 50 Hz,
Load:
R(A) = 4 Ω,
R(B) = 2 Ω,
L(C) = 0.01 H (3.1 Ω).
Windings turns (Y/Δ):
N_1 = 2560, N_{LV} = 150

Calculate:
Phase currents $\boldsymbol{I}$.

Transformer heating



Dimensions are given in mm

Given:

Thermal conductivity:
copper λ = 380 W/K*m,
steel λ = 40 W/K*m,
Insulation λ = 0.5 W/K*m,
Convection coefficient
α=12 W/K*m^2
Radiation coefficient β=0.9
Temperature T_0 = 20° C

Winding (electric) losses density

$p_{electric} = j^2 / g$ [W/m^3]

j – current density, g – electrical conductivity.

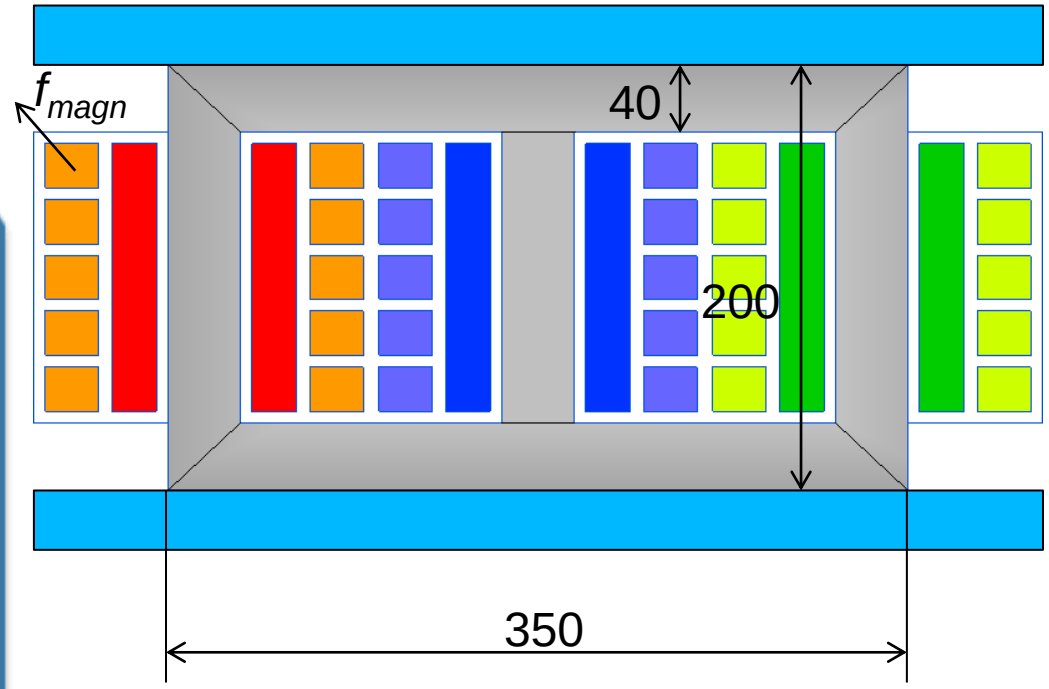
Core (magnetic) losses density

$p_m = C_m * (f/50)^{\alpha} * (B/1.5)^{\beta} * \rho$ [W/m^3],

$\alpha = 1$, $\beta = 2$, $C_m = 1.5$ [W/kg], $\rho = 7650$ [kg/m^3]

Calculate:
Windings temperature

Mechanical stress



Dimensions are given in mm

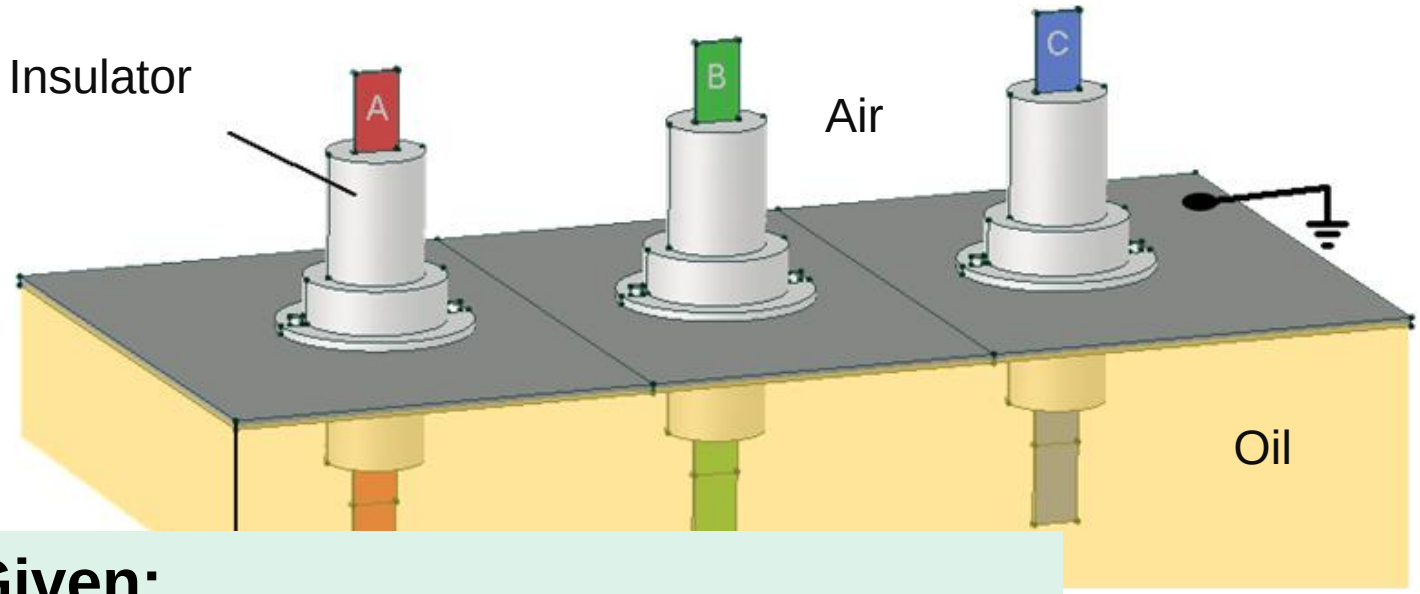
Given:

Young modulus of steel
E = 20 GPa, v = 0.33.
Young modulus of copper
E = 17 GPa, v = 0.33.
Young modulus of insulation
E = 3 GPa, v = 0.45.

AC Magnetics → Magnetic force import f_{magn} → Stress analysis

Calculate:
Windings deformation and mechanical stress in the core.

Transformer tank 3-phase bushing insulator



Given:

$$U_A = 10000\sqrt{2}/\sqrt{3}\times\cos\left(0^0\right) = 8165\ \text{V}$$

$$U_B = 10000\sqrt{2}/\sqrt{3}\times\cos\left(120^0\right) = -4082.5\ \text{V}$$

$$U_C = 10000\sqrt{2}/\sqrt{3}\times\cos\left(240^0\right) = -4082.5\ \text{V}$$

Calculate:
Electric field strength distribution

http://www.quickfield.com/advanced/bushing_insulator.htm