Printed circuit board design with QuickField

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Introduction

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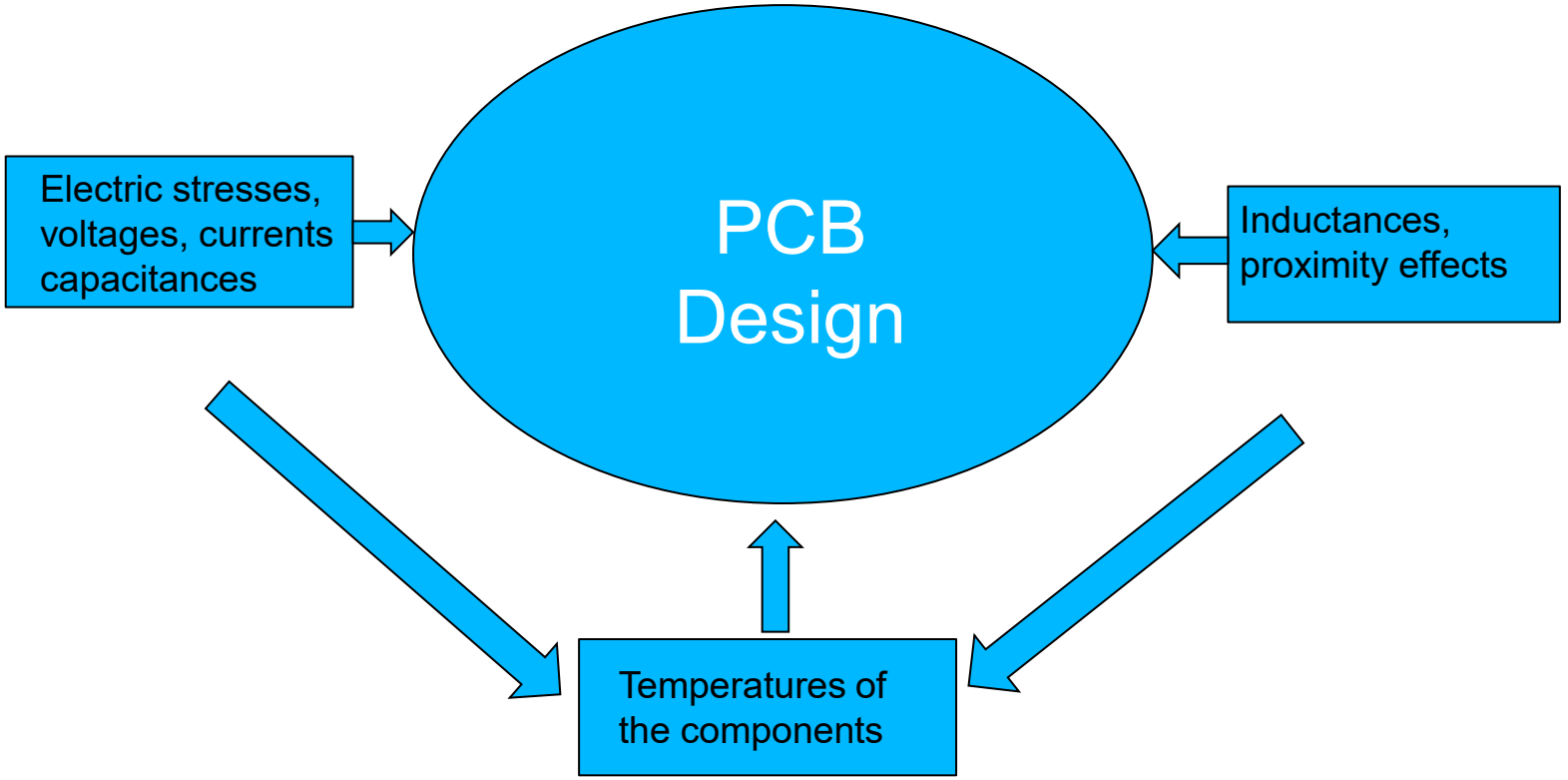
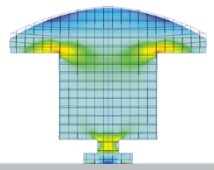
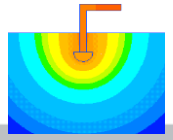
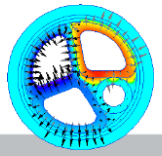
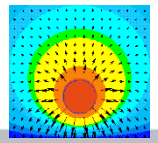
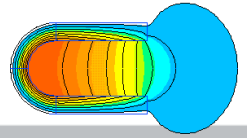
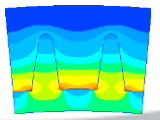
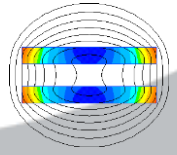
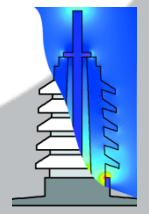
Live demonstration

PCB Design challenges



QuickField Analysis Options

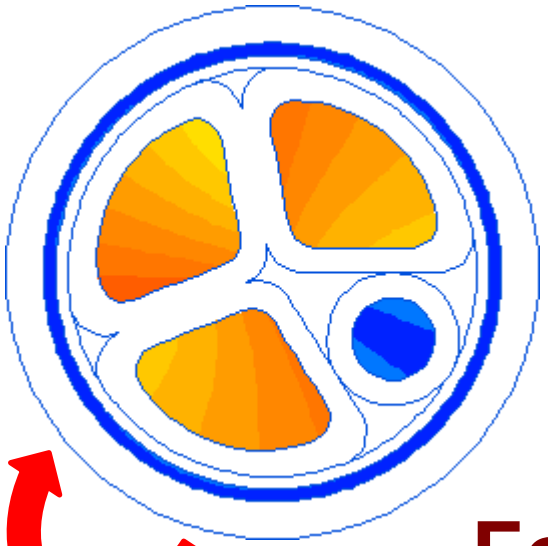
Magnetic analysis suite	
Magnetic Problems	Magnetostatics
	AC Magnetics
	Transient Magnetic
Electric analysis suite	
Electric Problems	Electrostatics (2D,3D) and DC Conduction (2D,3D)
	AC Conduction
	Transient Electric field
Thermostructural analysis suite	
Thermal and mechanical problems	Steady-State Heat transfer (2D,3D)
	Transient Heat transfer
	Stress analysis

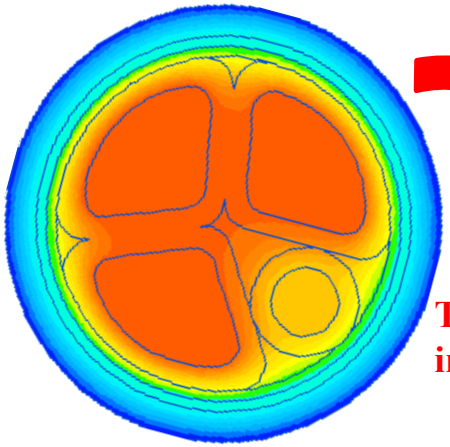
MultiPhysics (2D)

Temperature field

Electromagnetic fields



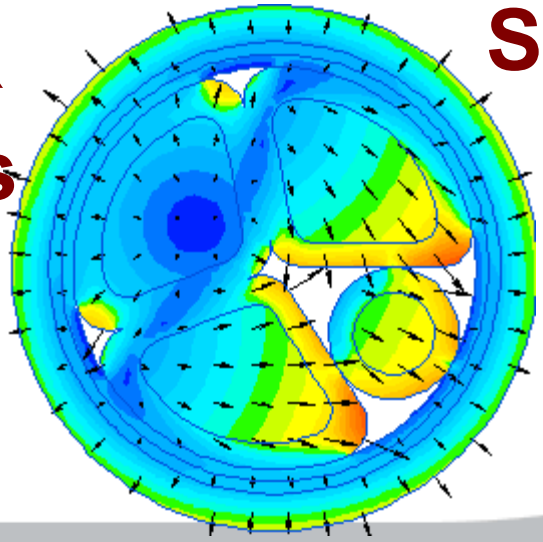
Losses



Temperature field import

Thermal Stresses

Forces



Magnetic state import

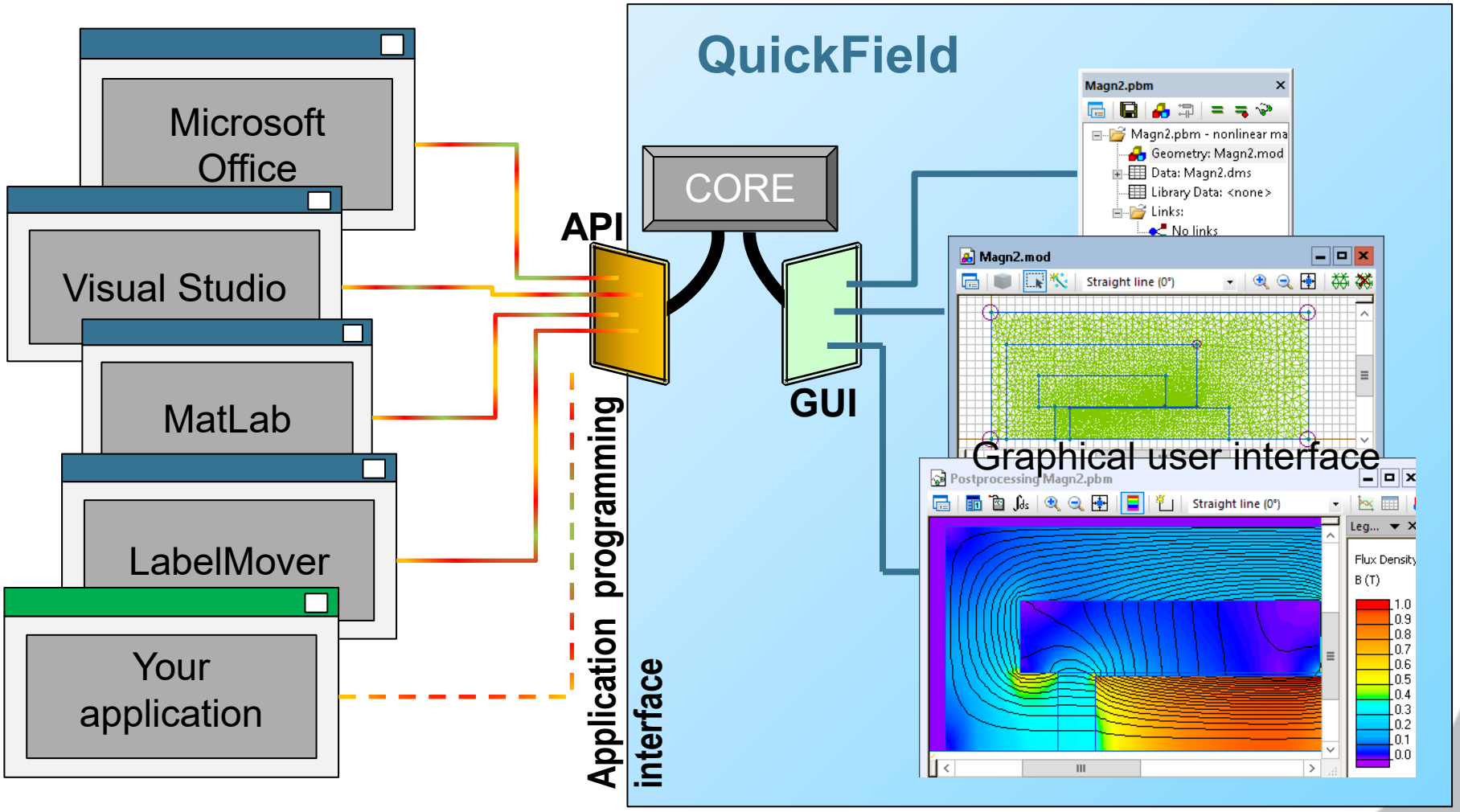
Stresses & Deformations

MultiPhysics (2D)

Source problem ---> *Transferred data* ---> **Destination problem**

Source: \ **Destination**:	DC magnetics	AC magnetics	Transient magnetics	Static heat transfer	Transient heat transfer	Stress Analysis
DC magnetics	Magnetic permeability	Magnetic permeability	Initial magnetic field			Force
AC magnetics				Joule heat	Joule heat	Force
Transient magnetics			Initial magnetic field	Joule heat	Joule heat	Force
Electrostatics						Force
DC conduction				Joule heat	Joule heat	
AC conduction				Joule heat	Joule heat	Force
Transient electric						
Static heat transfer		Temperature			Initial temperatures	Temperature
Transient heat transfer		Temperature			Initial temperatures	Temperature
Stress Analysis						

Open object interface



QuickField Difference

Printed circuit board design with QuickField

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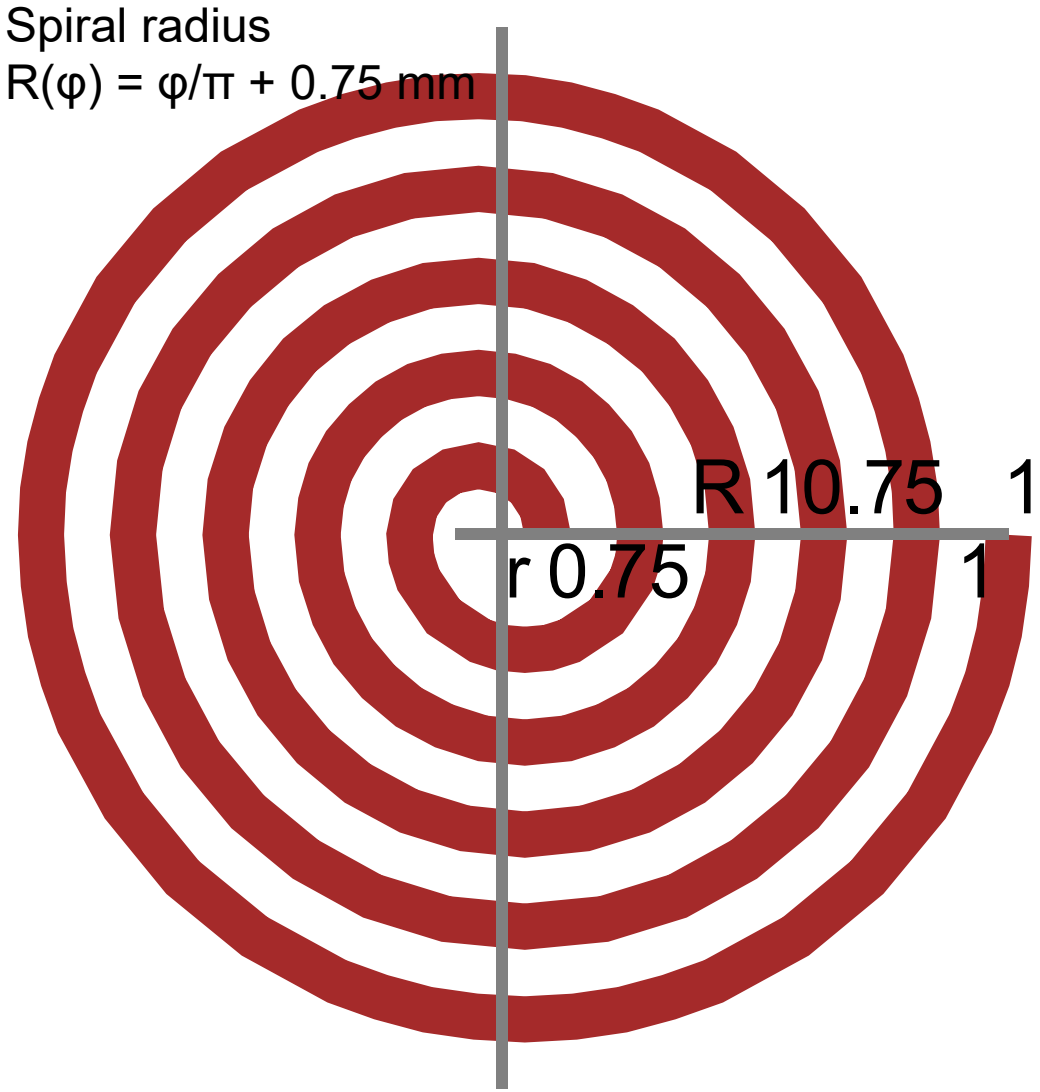
1. PCB flat spiral coil inductance
2. PCB hatched ground plane electrical resistance
3. PCB board heating 2D
4. Microphone PCB thermal analysis 3D
5. PCB via capacitance
6. DIP socket pin-to-pin capacitance

PCB flat spiral coil inductance



Problem specification:

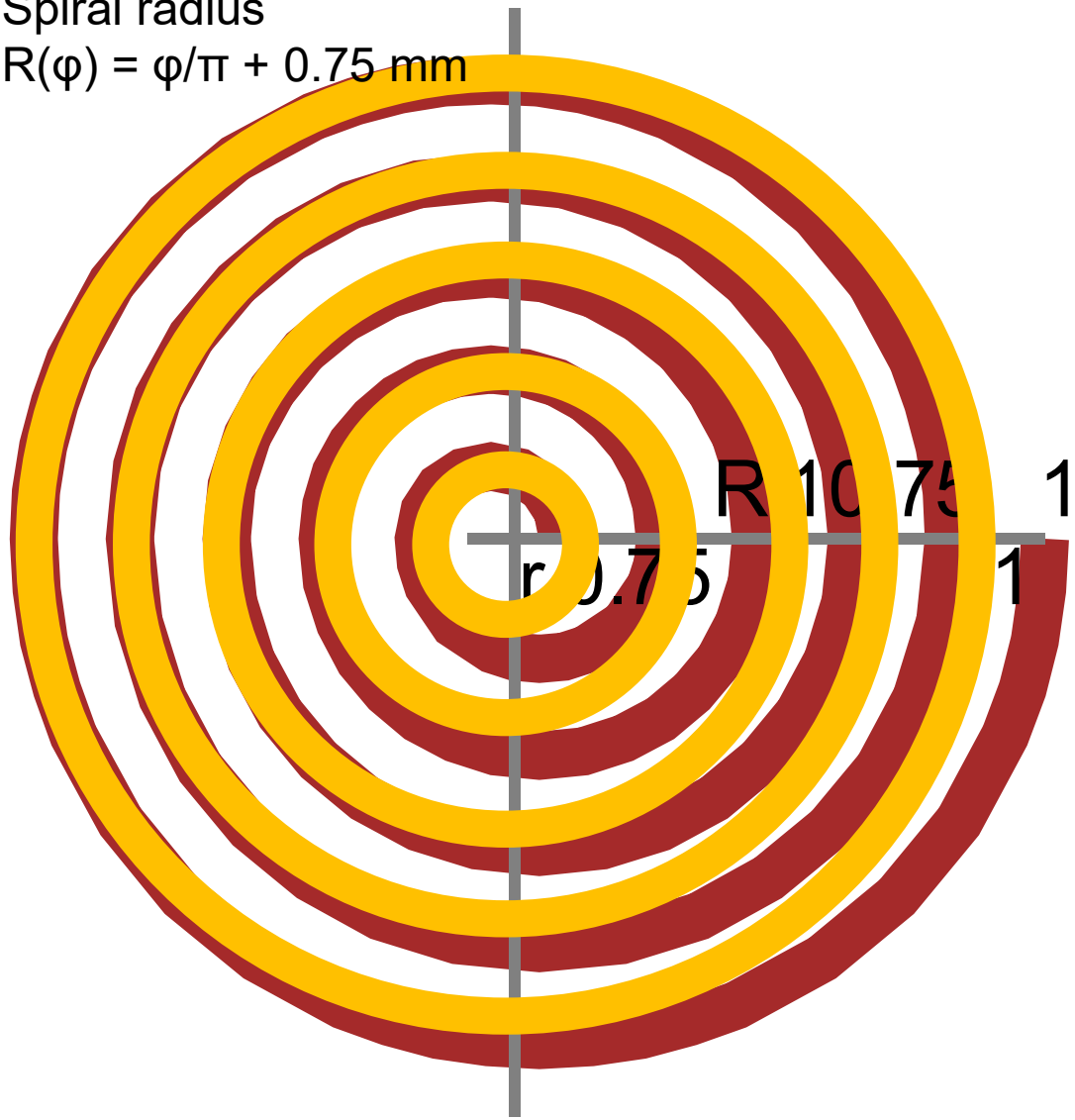
Copper spiral coil
on FR-4 board
Foil thickness 0.035 mm

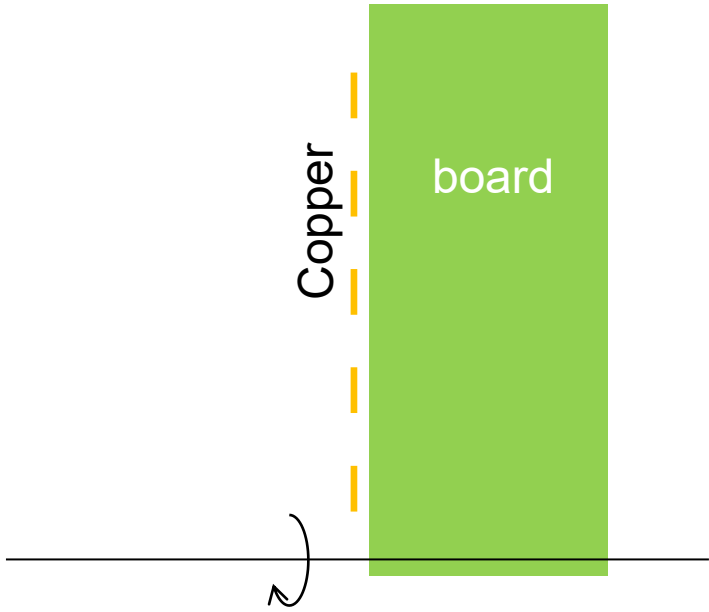
Task:

Determine the inductance of the spiral coil.

PCB flat spiral coil inductance

Spiral radius
$R(\varphi) = \varphi/\pi + 0.75$ mm

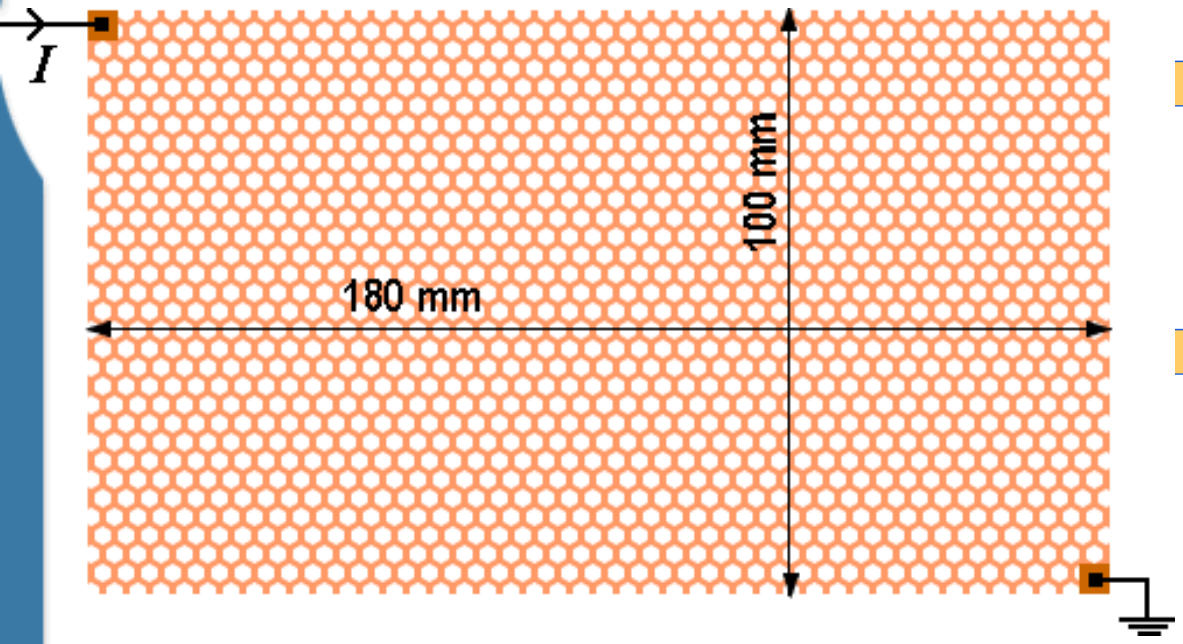


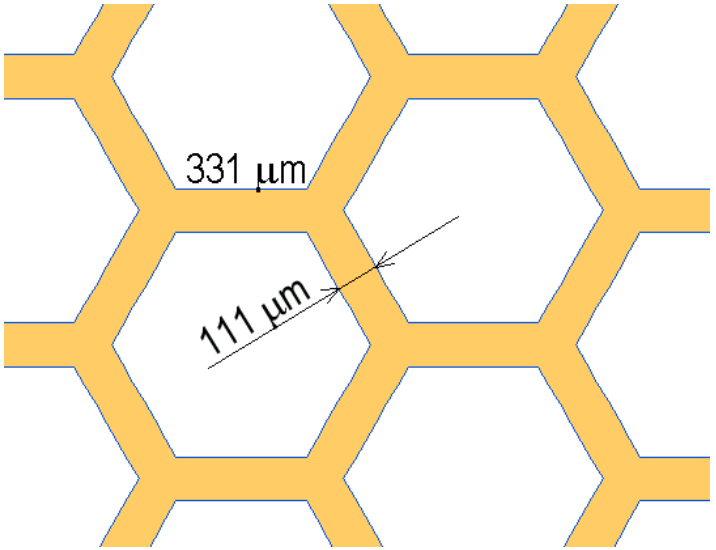


Equivalent coil construction.

turn #	Radius, mm *Spiral*	*Concentric*
	0.75	
1	2.75	1.75
2	4.75	3.75
3	6.75	5.75
4	8.75	7.75
5	10.75	9.75

PCB hatched ground plane electrical resistance





Problem specification:

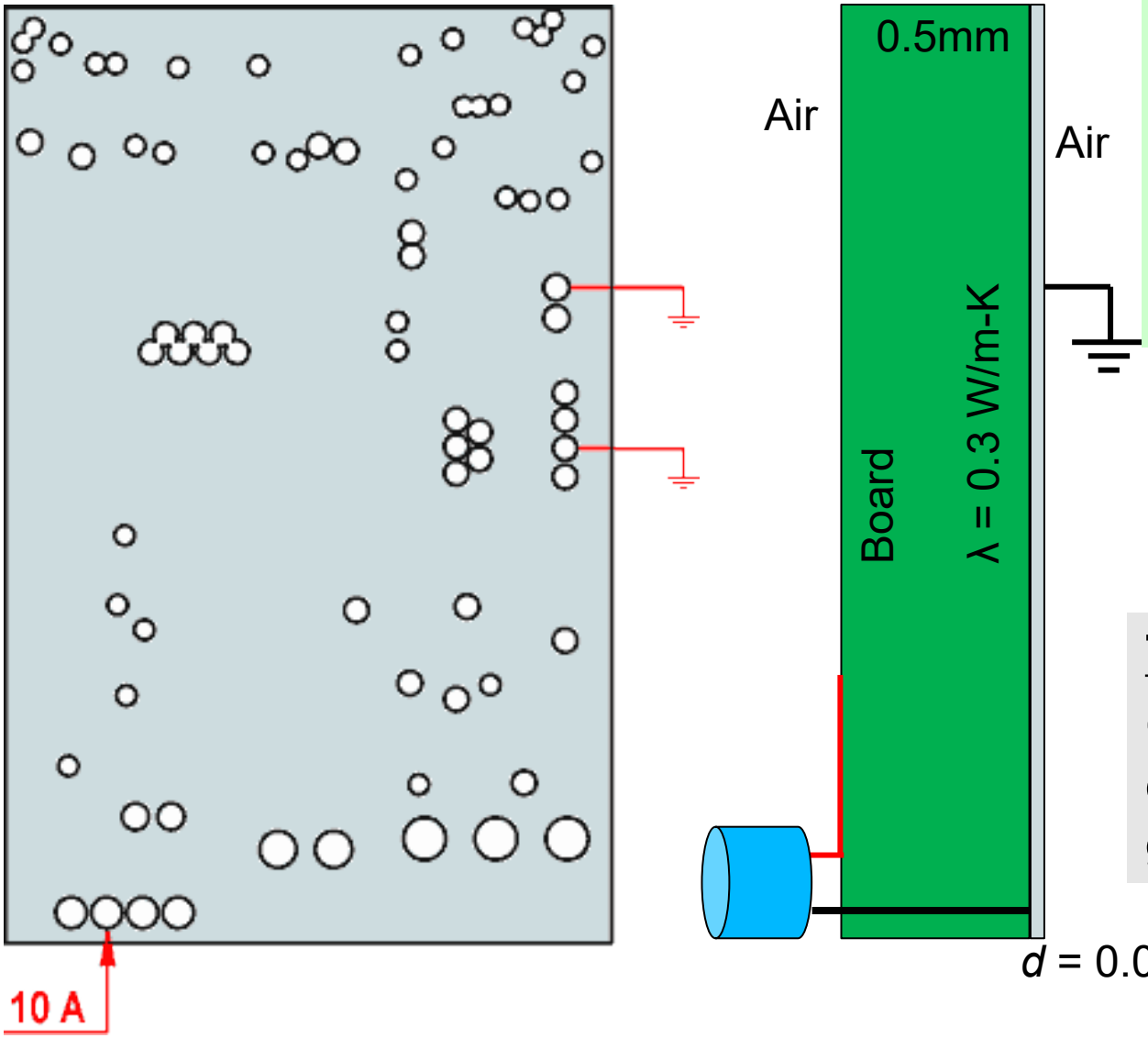
Electric conductivity
of copper 56 MS/m
Plane thickness 0.035 mm

Task:

Calculate the equivalent electric resistivity

https://quickfield.com/advanced/pcb_hatched_ground_plane.htm

PCB ground plane heating 2D



Problem specification:

Copper thermal conductivity
λ = 380 W/m-K.
Ambient air temperature
T_0 = 20 °C

Joule heat:
DC Conduction > Heat-transfer

Task:

Calculate temperature distribution in a ground plane.

https://quickfield.com/advanced/pcb-heating.htm

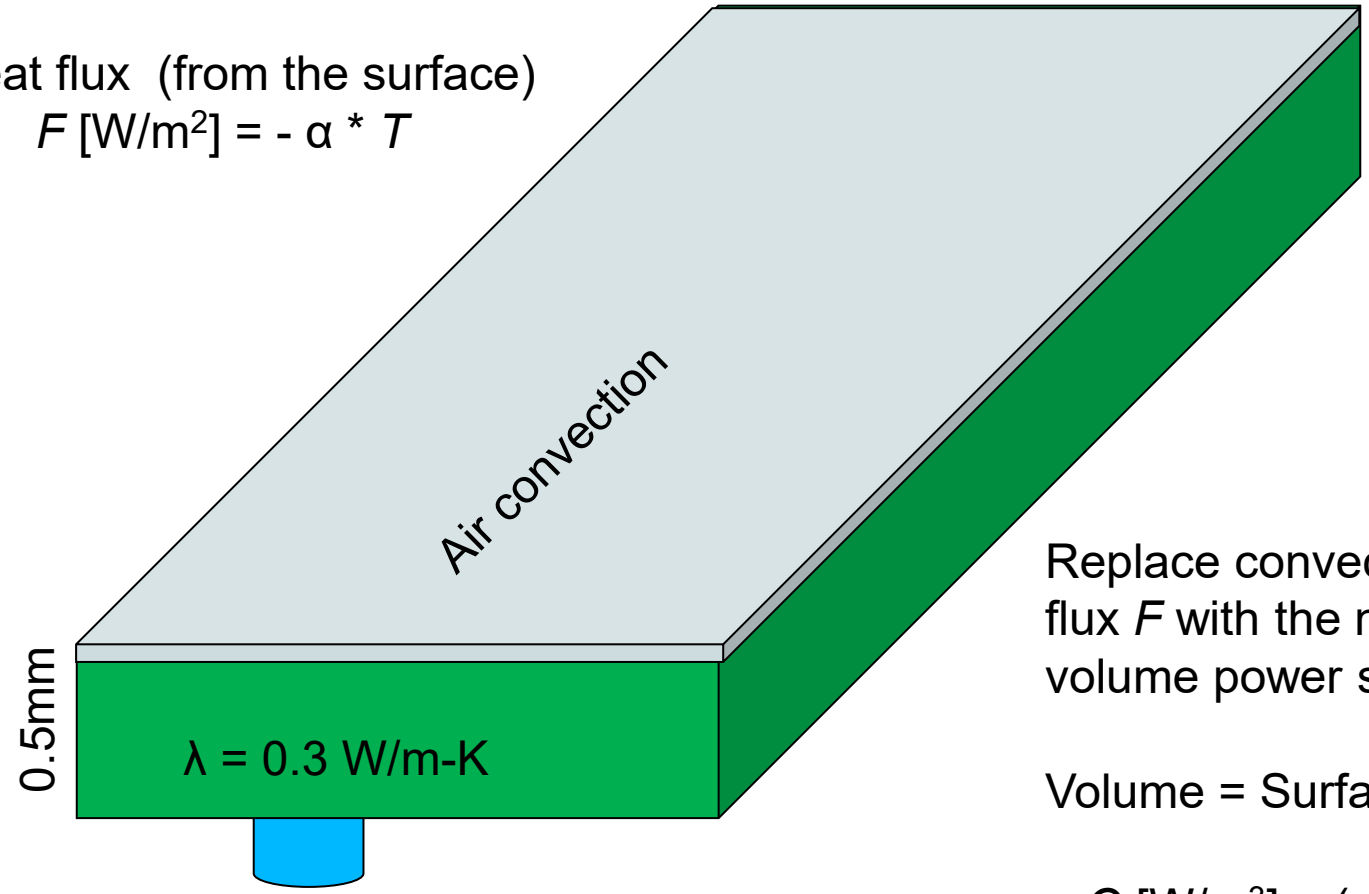
PCB ground plane heating 2D

Natural air convection

$\alpha = 10\ W/K\text{-}m^2$

Heat flux (from the surface)

$F\ [W/m^2] = -\alpha * T$

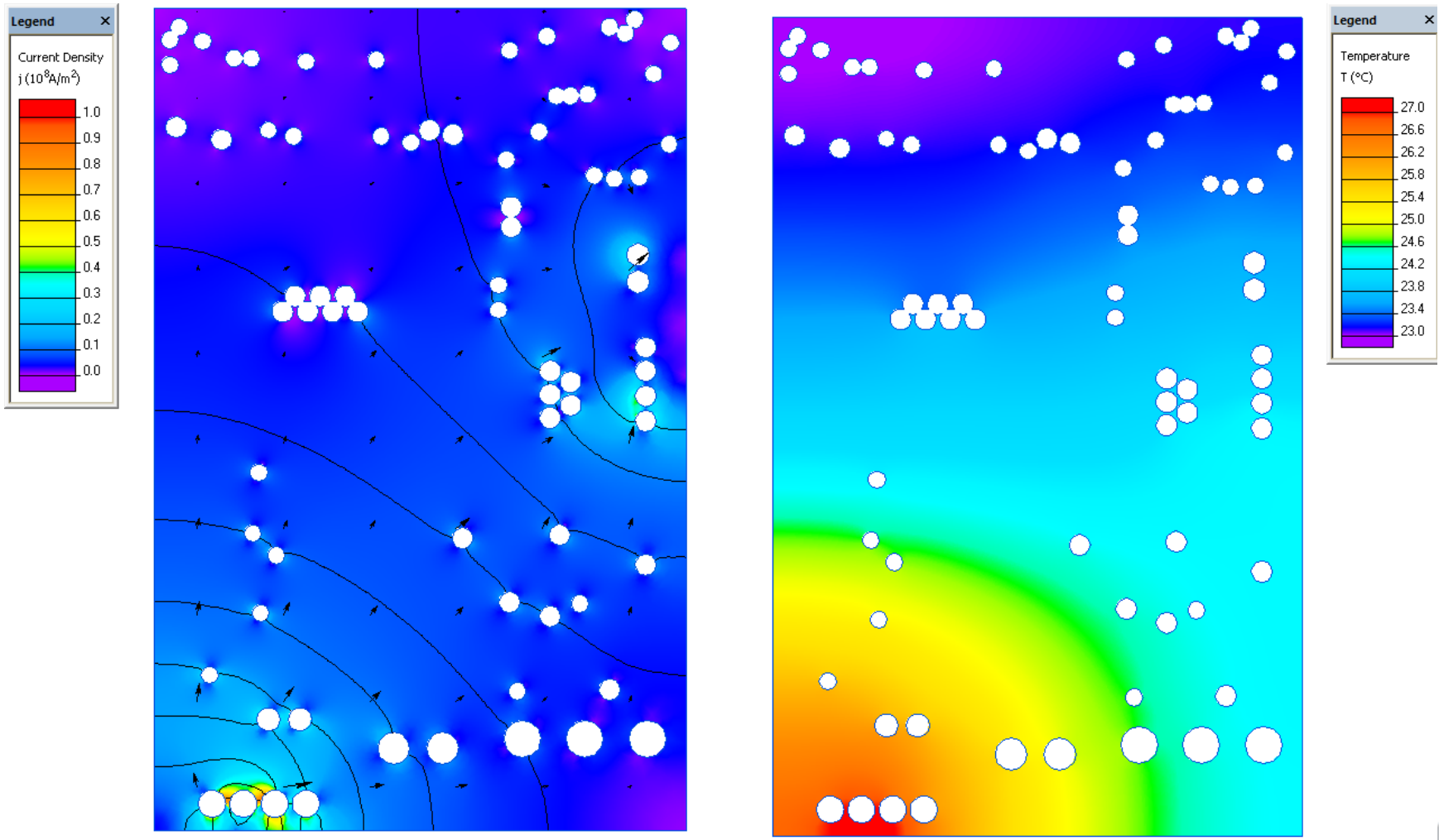


Replace convection heat flux *F* with the negative volume power source *Q*:

Volume = Surface area * d

$Q\ [W/m^3] = (-\ \alpha *\ T\ ) / d$

PCB board heating 2D

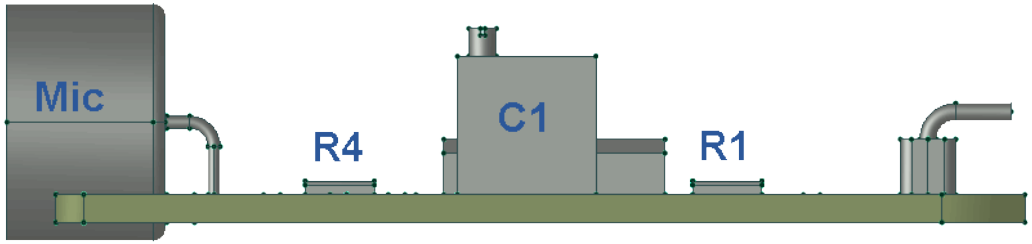


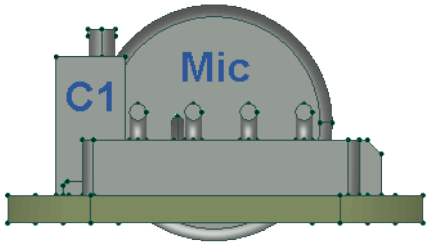
Current density plot

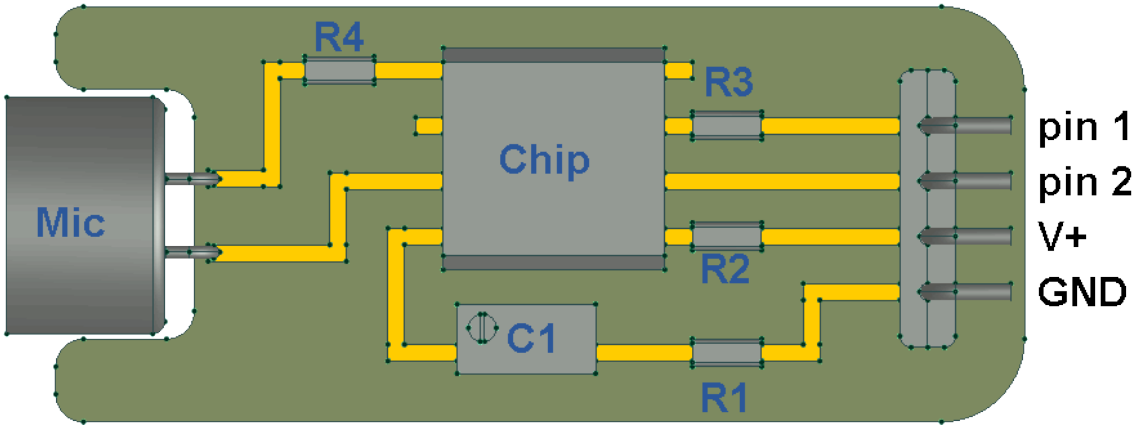
Temperature plot

https://quickfield.com/advanced/pcb-heating.htm

Microphone PCB thermal analysis 3D







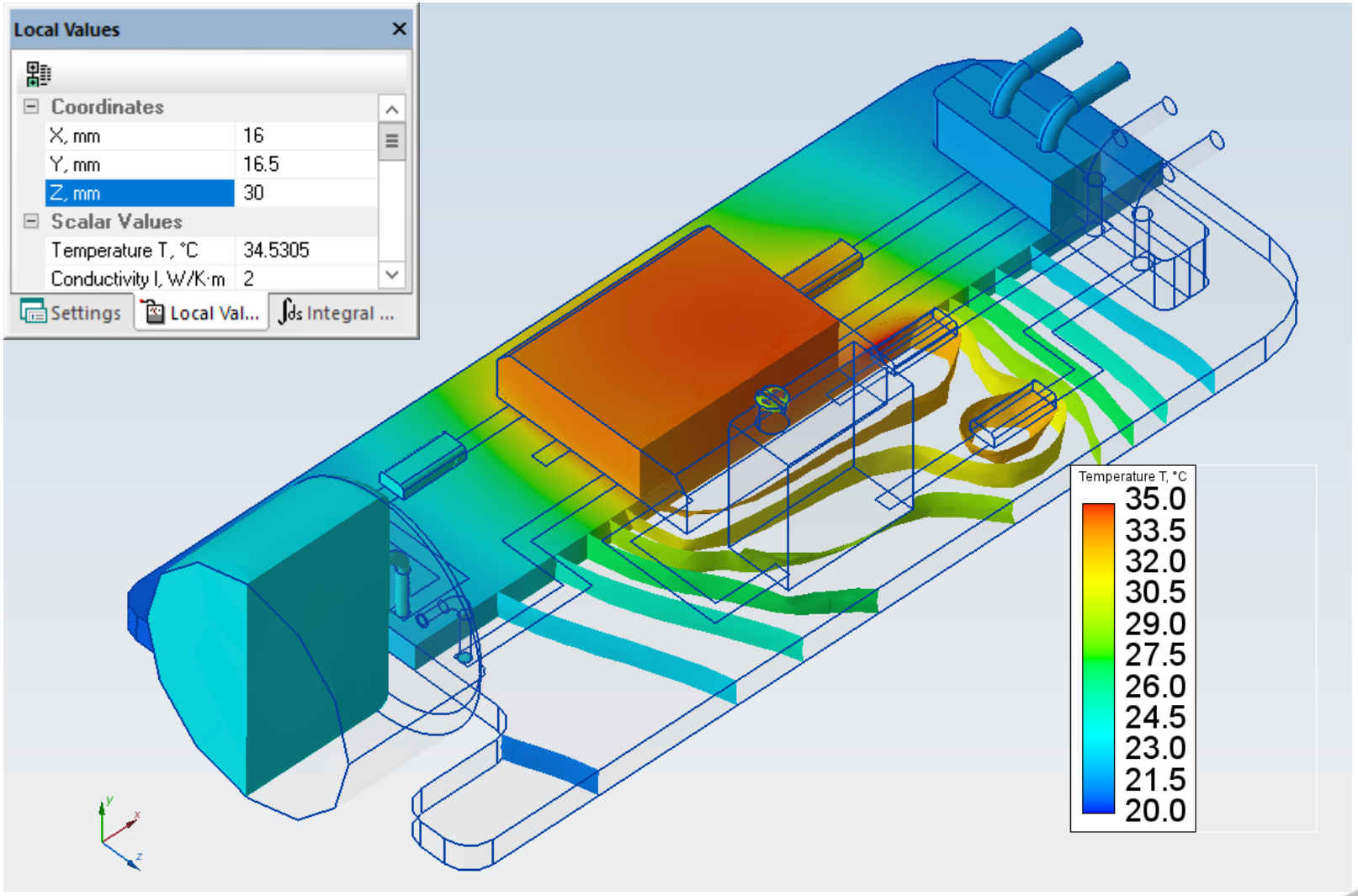
Task:

Calculate the temperature distribution in a printed circuit board

Problem specification:

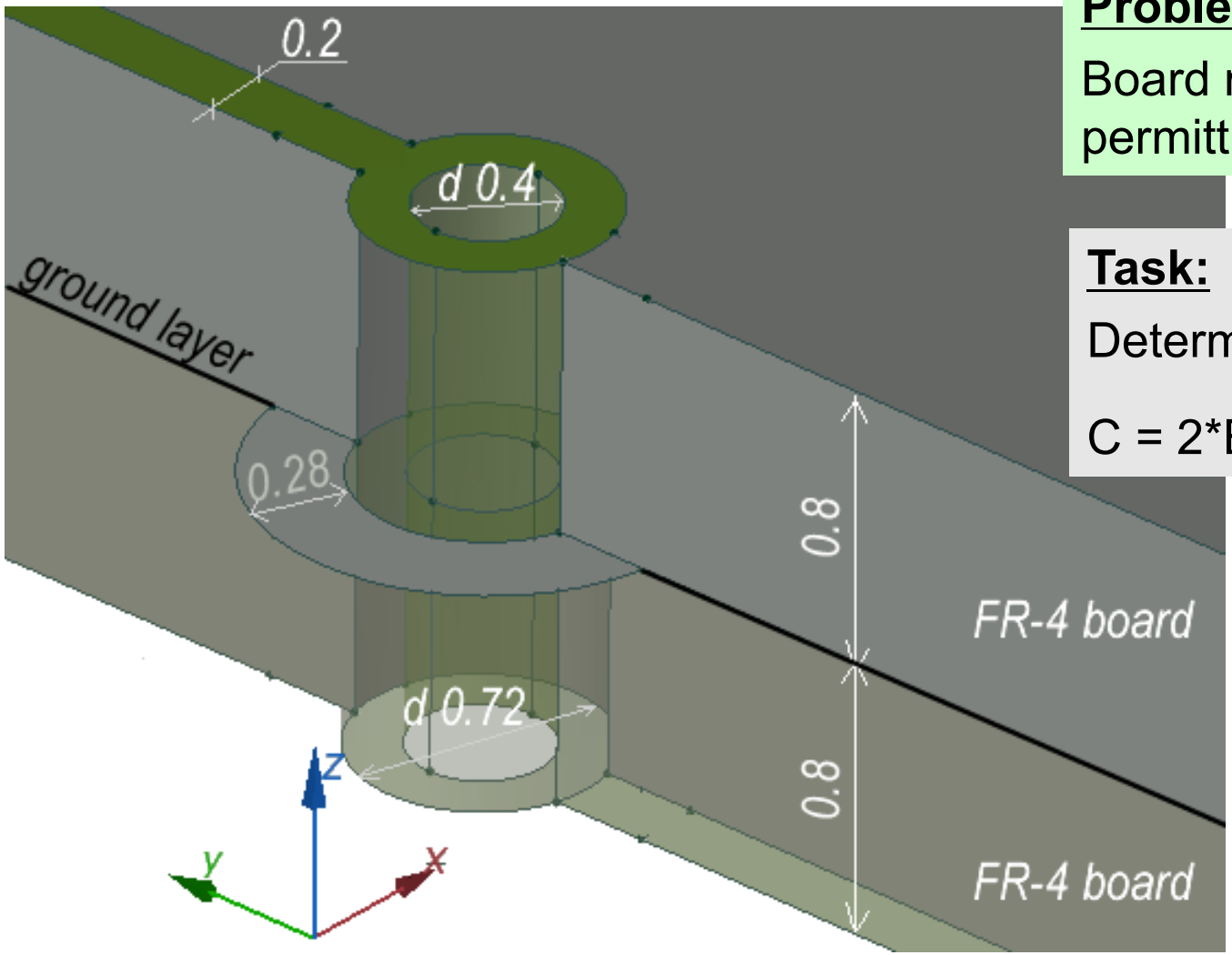
Ambient air temperature
T_0 = 20 ˚C
Board thermal conductivity
λ = 0.3 W/m-K
Power consumption:
Chip – 0.1 W
Mic - 0.01 W
C1 - 0.01 W
Current: 0.1 A
R1=R2=R3=R4 = 1 Ohm

Microphone PCB thermal analysis 3D



https://quickfield.com/advanced/pcb_microphone.htm

PCB via capacitance



Problem specification:

Board relative electric permittivity 4.7

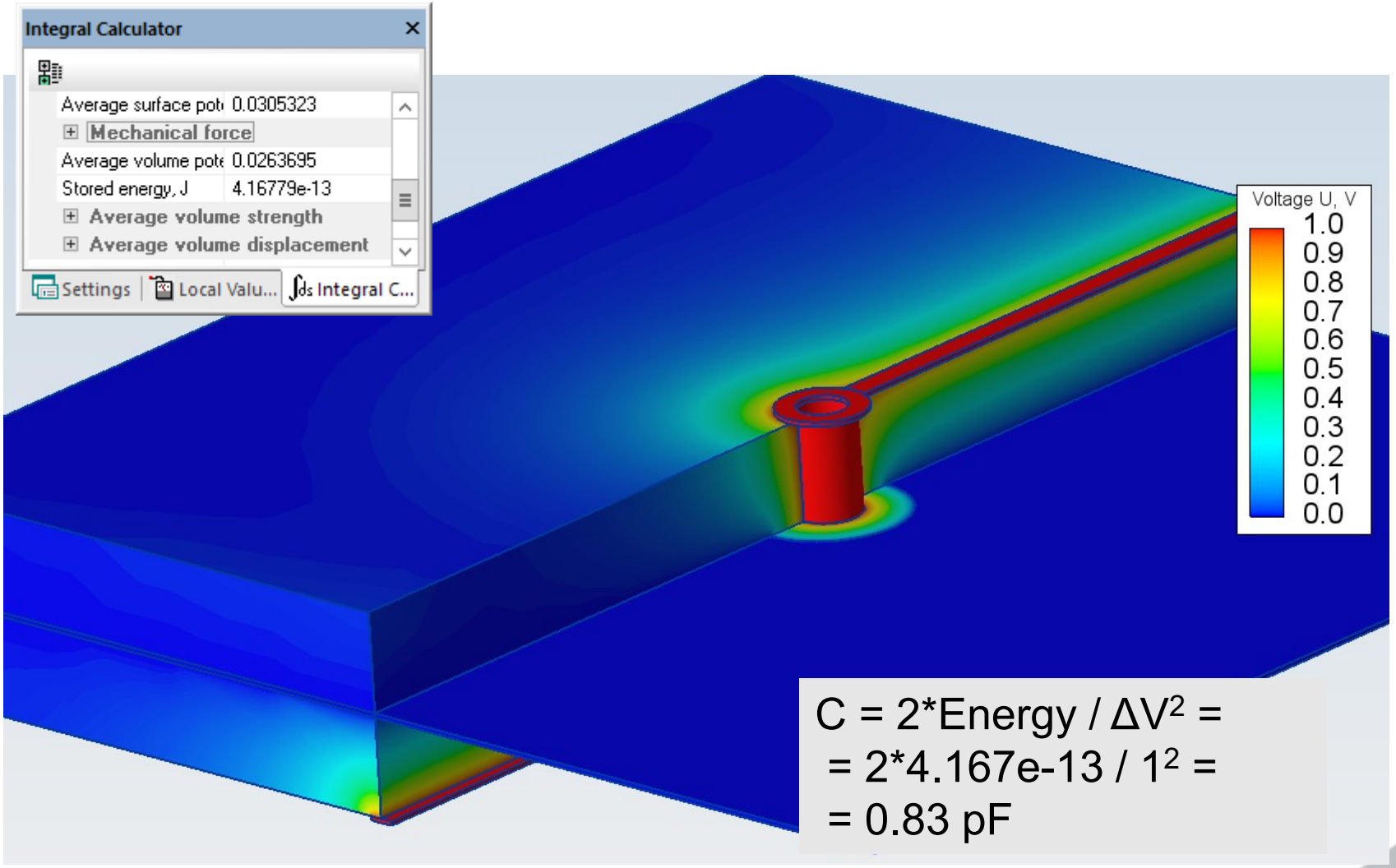
Task:

Determine capacitance

$C = 2*\text{Energy} / \Delta V^2$

https://quickfield.com/advanced/pcb_via_capacitance.htm

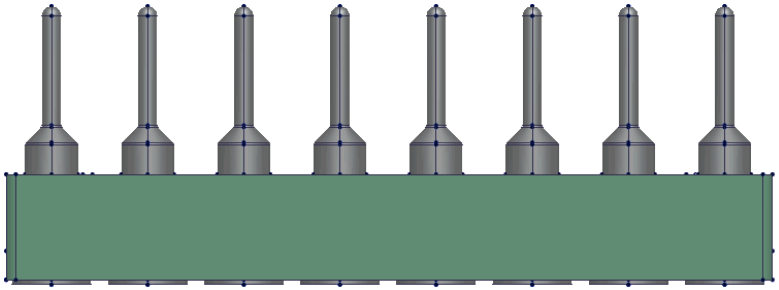
PCB via capacitance

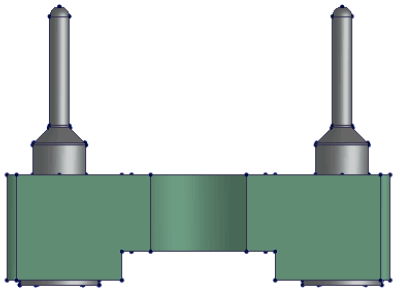


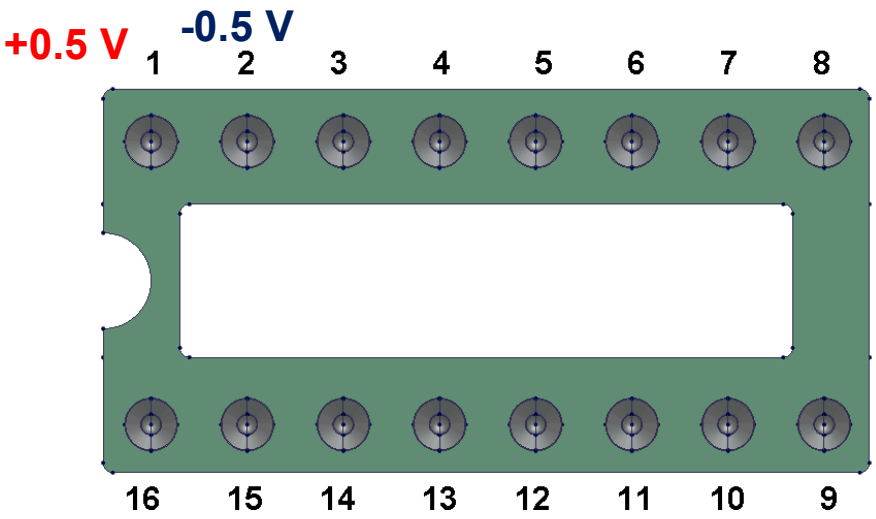
$C = 2*Energy / \Delta V^2 =$
$= 2*4.167e\text{-}13 / 1^2 =$
$= 0.83$ pF

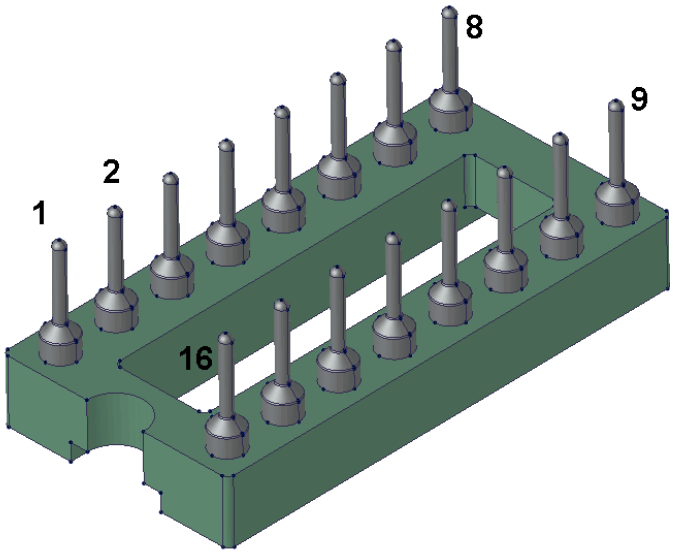
https://quickfield.com/advanced/pcb_via_capacitance.htm

DIP socket pin-to-pin capacitance









Problem specification:

Dielectric relative electric permittivity 3.

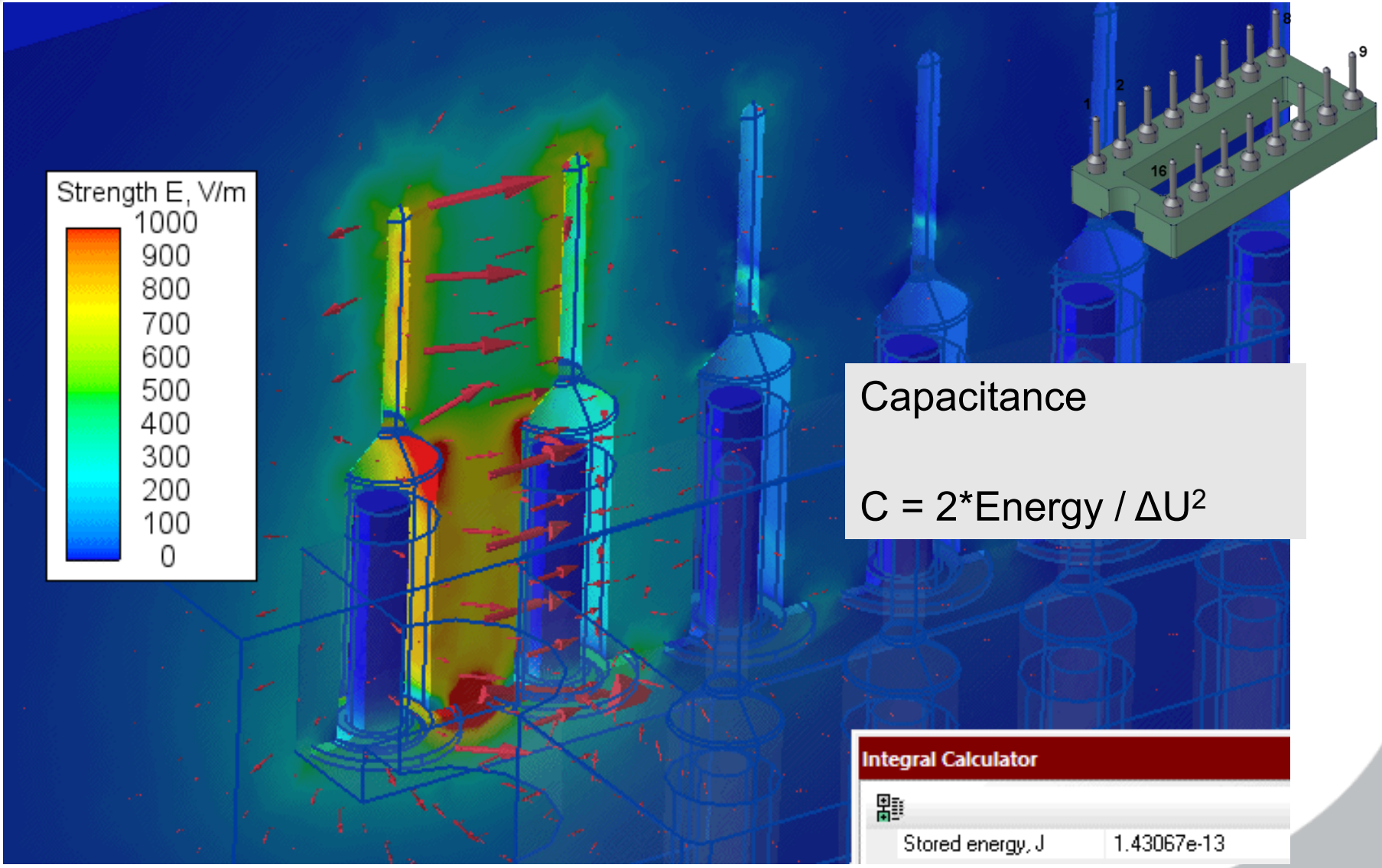
Task:

Determine pin to pin capacitance

$C = 2*\text{Energy} / \Delta V^2$

https://quickfield.com/advanced/dip_socket_capacitance.htm

DIP socket pin-to-pin capacitance



https://quickfield.com/advanced/dip_socket_capacitance.htm