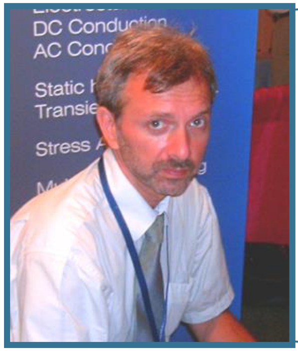
PCB traces impedance calculation with QuickField



Vladimir Podnos,
Director of Marketing and Support,
Tera Analysis Ltd.

Alexander Lyubimtsev
Support Engineer
Tera Analysis Ltd.

QuickField Analysis Options

<table>
<tr><th colspan="2">Magnetic analysis suite</th></tr>
<tr><td rowspan="3">Magnetic Problems</td><td>Magnetostatics</td></tr>
<tr><td>AC Magnetics</td></tr>
<tr><td>Transient Magnetic</td></tr>
<tr><th colspan="2">Electric analysis suite</th></tr>
<tr><td rowspan="3">Electric Problems</td><td>Electrostatics (2D,3D) and DC Conduction</td></tr>
<tr><td>AC Conduction</td></tr>
<tr><td>Transient Electric field</td></tr>
<tr><th colspan="2">Thermostructural analysis suite</th></tr>
<tr><td rowspan="3">Thermal and mechanical problems</td><td>Steady-State Heat transfer</td></tr>
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<tr><td>Stress analysis</td></tr>
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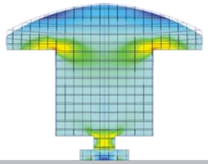
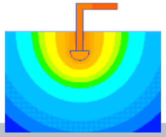
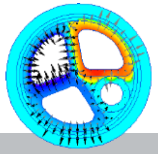
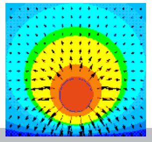
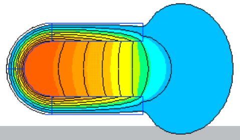
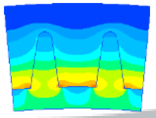
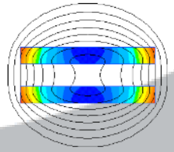
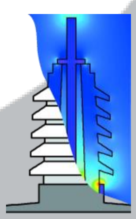
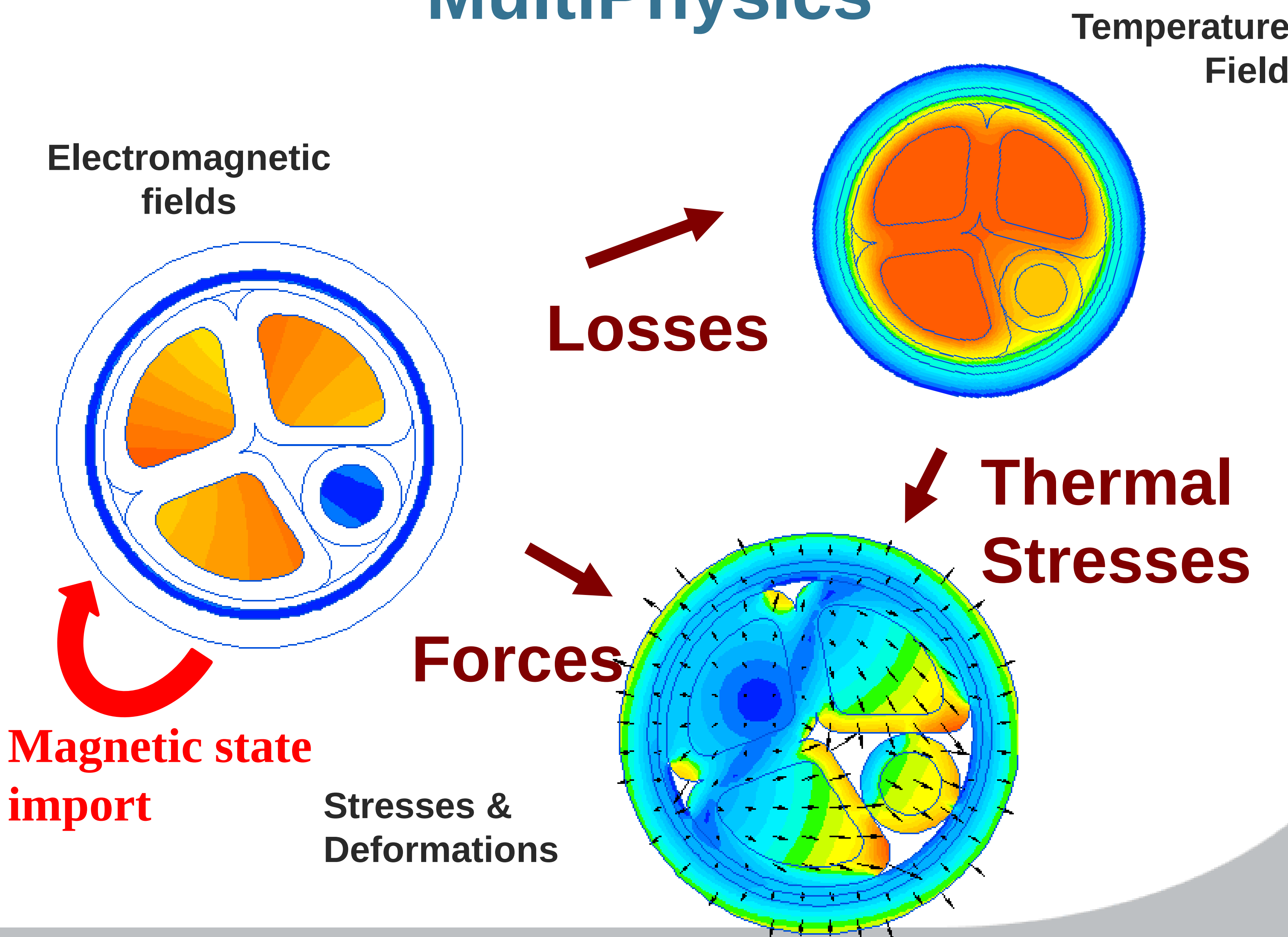
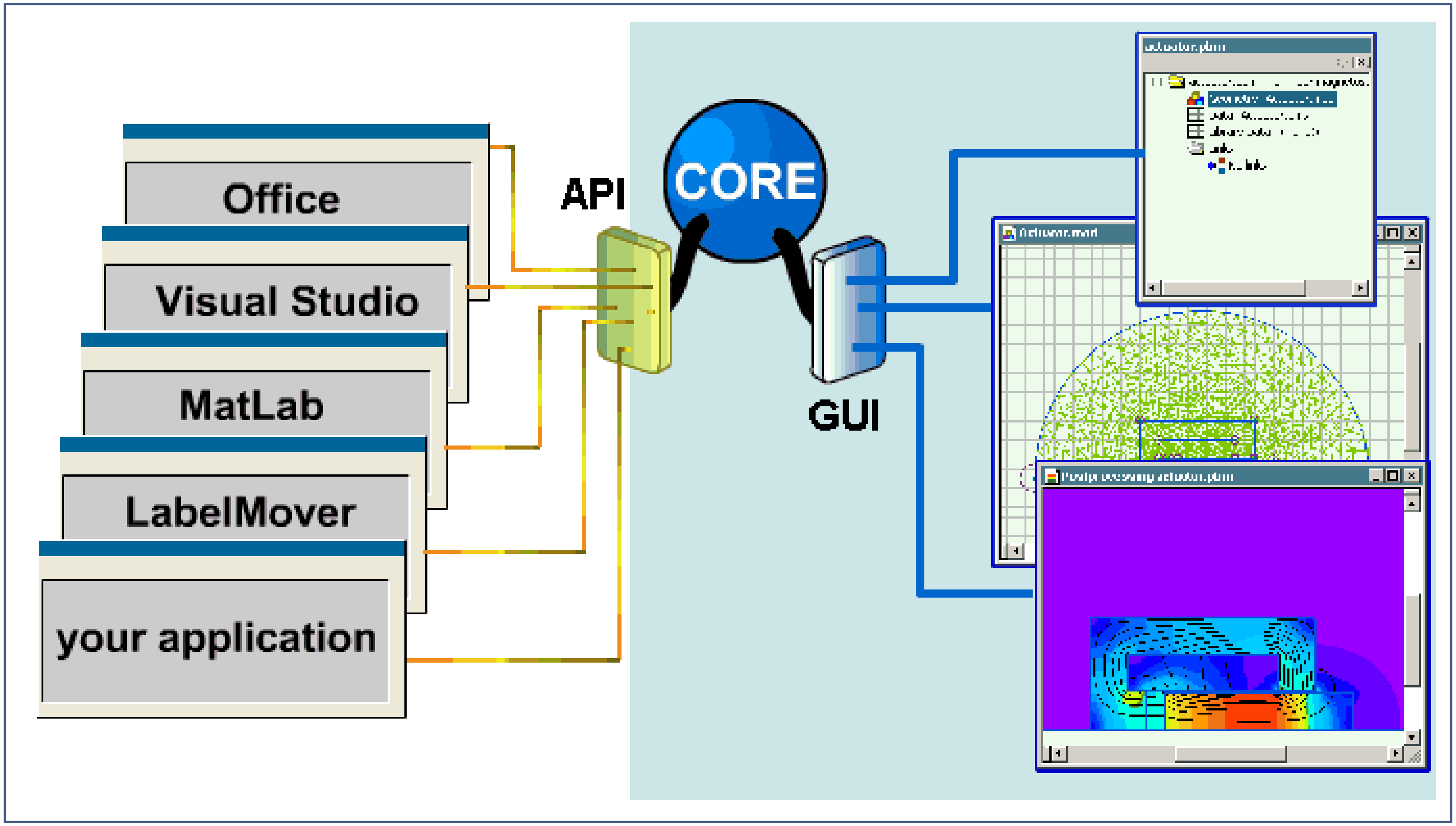









MultiPhysics



Open object interface



QuickField Difference

Field simulation software

www.QuickField.com

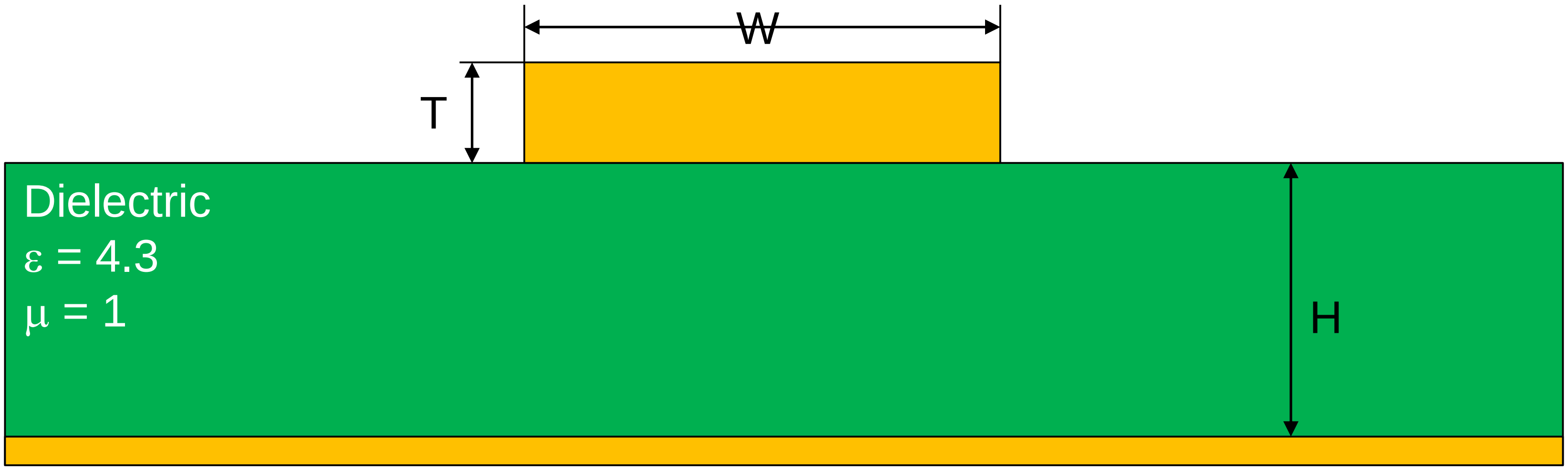
No training required

PCB traces impedance calculation with QuickField

1. Microstrip impedance Z_0
2. Differential impedance Z_{diff}
3. Equivalent circuit

4. Losses
5. Microstrip crossover 3D
6. Capacitance matrix,
   Inductance matrix

1. Microstrip capacitance, inductance



Problem specification:

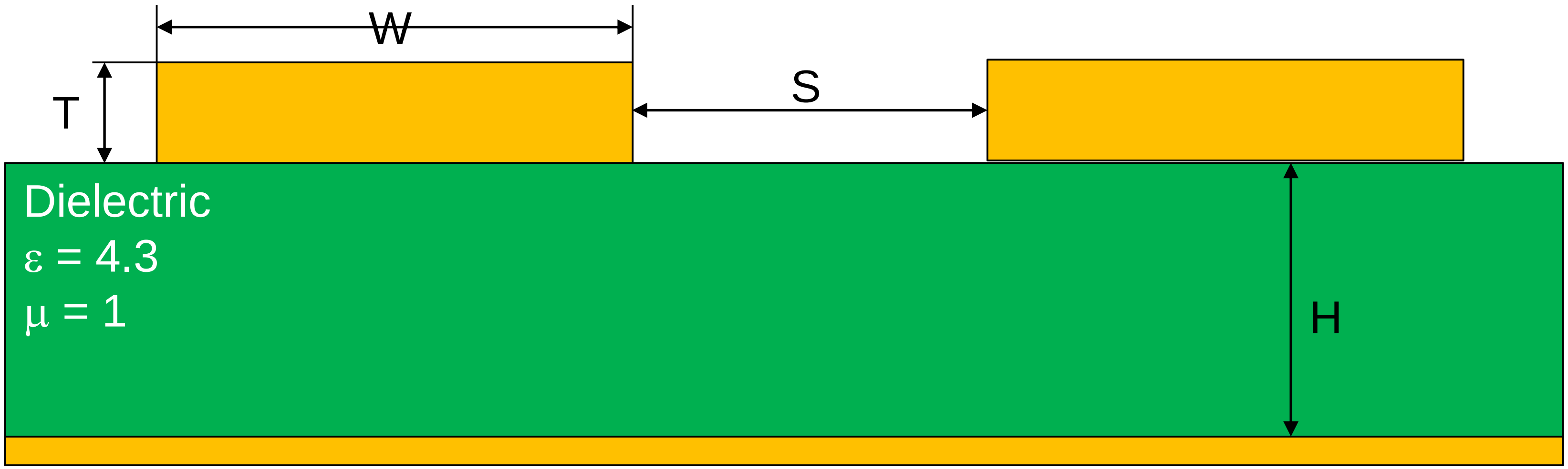
W = 200 um (7,9 mils)
T = 35 um (1,38 mils)
H = 420 um (16,5 mills)
f = 100 MHz

Tasks:

Calculate impedance Z0

$$Z0 = \sqrt{\frac{L0}{C0}}$$

2. Differential impedance



Problem specification:

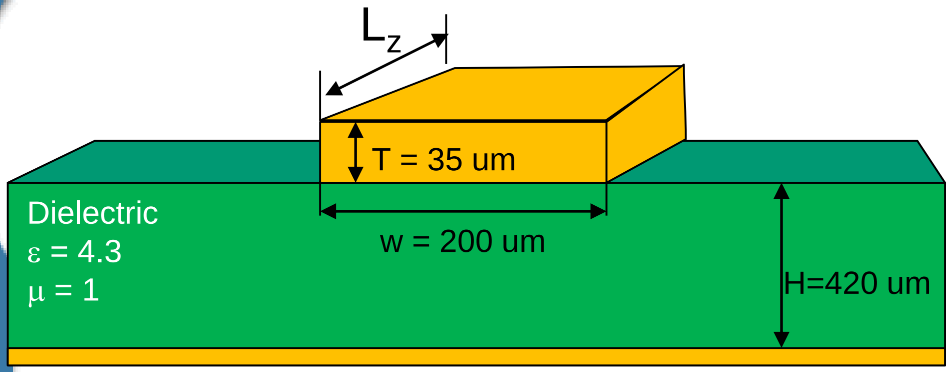
W = 200 um (7,9 mils)
T = 35 um (1,38 mils)
H = 420 um (16,5 mills)
f = 100 MHz
S = 130 um (5,1 mils)

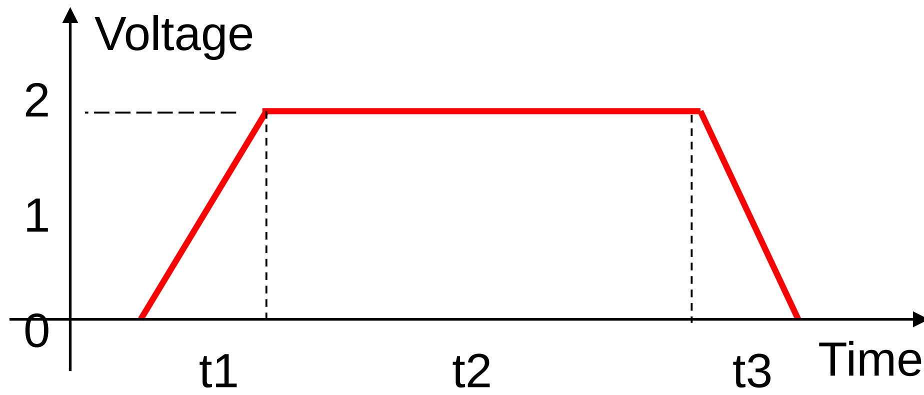
Tasks:

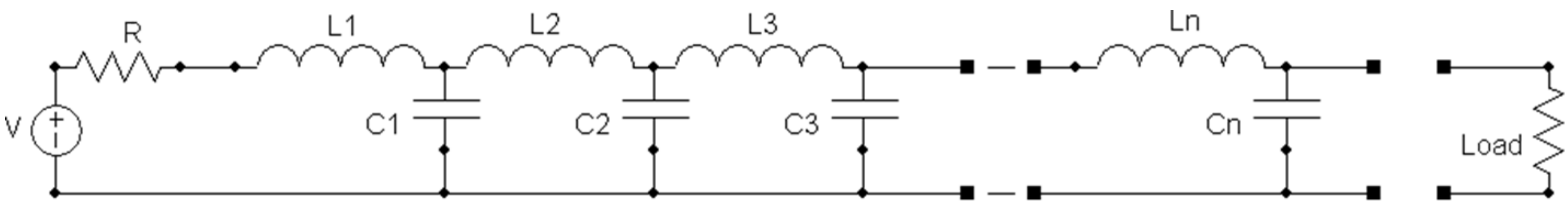
Calculate impedance Z_{diff}

$$Z_{diff} = \sqrt{\frac{L_{diff}}{C_{diff}}}$$

3. Equivalent circuit







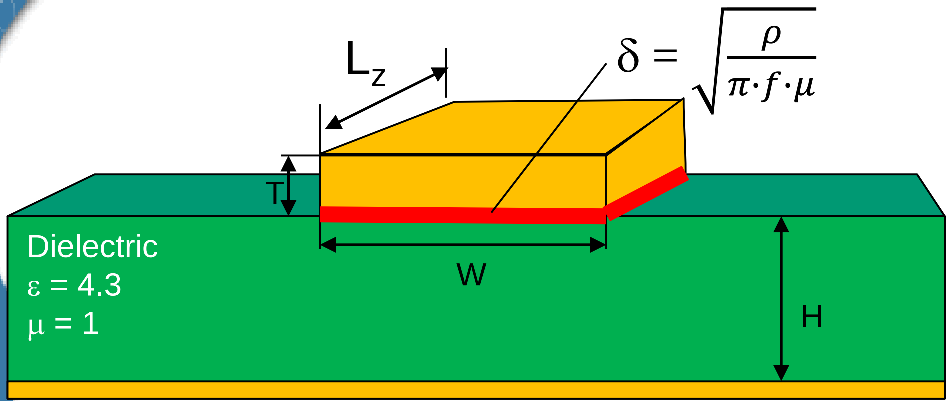
Problem specification:

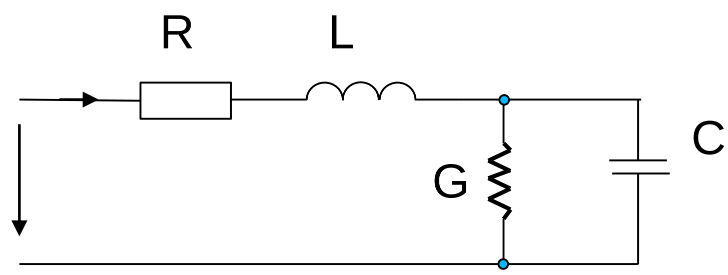
L = 71.2 nH   t1 = 0.25 ns
C = 7.76 pF   t2 = 5 ns
L_z = 5 inches   t3 = 0.25 ns
Segments number *n* = 30

Tasks:

Calculate voltage pulse propagation

4. Losses (R,G)





$$R_{ac} \sim \frac{\rho}{W\delta} = \frac{\sqrt{\rho \cdot \mu \cdot \pi f}}{W} = R_s\sqrt{f}$$

δ – skin depth

R_{ac} – AC resistance

R_s – surface resistance

Dielectric constant $\varepsilon = \varepsilon' - j \cdot \varepsilon''$

Loss tangent $\tan(\delta_d) = \varepsilon'' / \varepsilon'$

Conductivity $\gamma = 2\pi f \cdot \varepsilon' \cdot \tan(\delta_d)$

Problem specification:

L = 71.2 nH f = 100 MHz

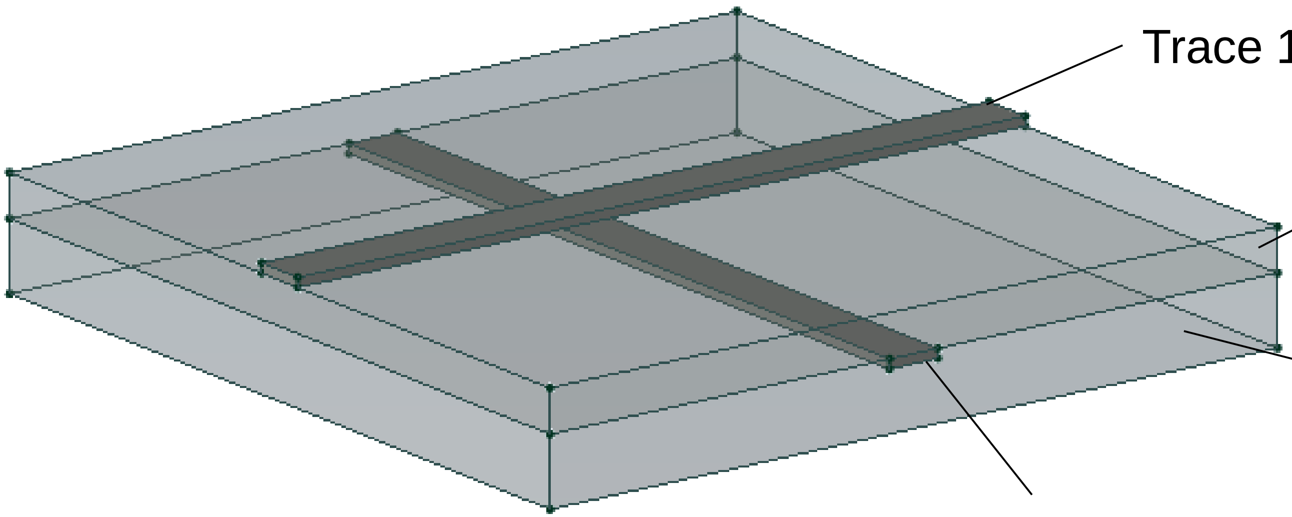
C = 7.76 pF $\tan(\delta_d)$ = 0.018

L_z = 5 inches

Tasks:

Calculate resistance and shunt conductivity

5. Microstrip crossover 3D



Problem specification:

f = 500 MHz

Tasks:

Calculate mutual capacitance

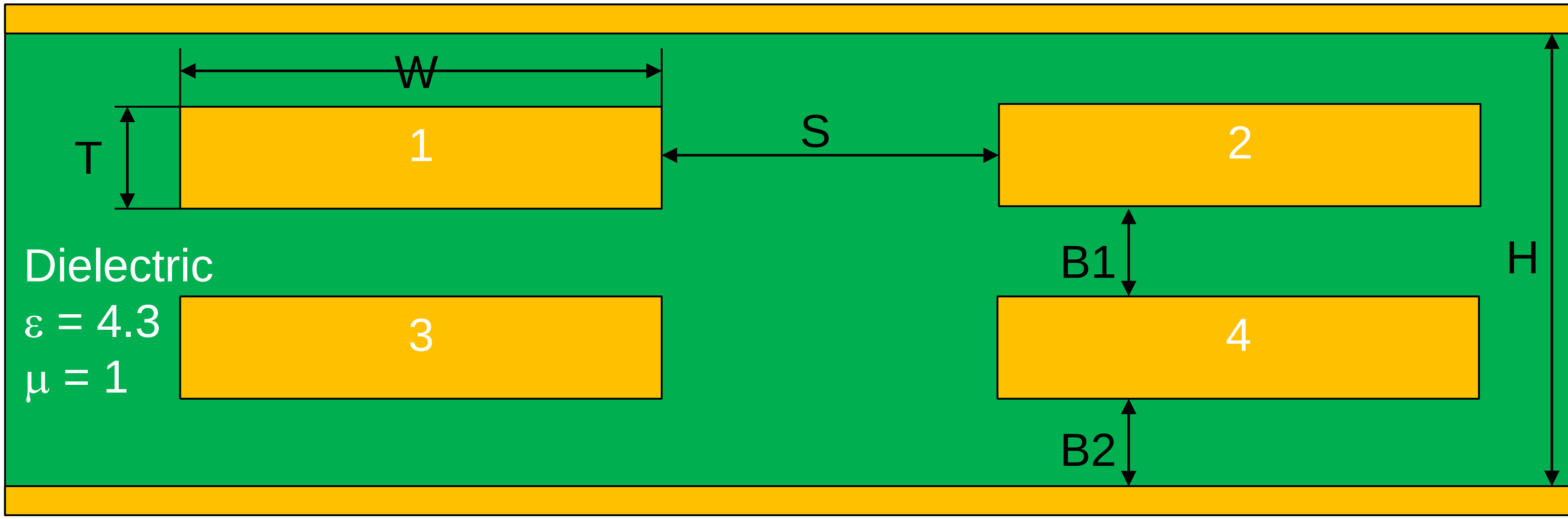
Daniel G. Swanson, Jr. *What's My Impedance?*
IEEE Microwave Magazine, © IEEE
December 2001

$$L = \frac{1}{c^2 \cdot C_0}$$

ε_0

http://quickfield.com/advanced/microstrip_crossover.htm

6. Capacitance matrix, Inductance matrix



Problem specification:

W = 200 um (7,9 mils) S = 130 um
T = 35 um (1,38 mils) B1 = 150 um
H = 420 um (16,5 mills) B2 = 100 um
f = 100 MHz

Tasks:

Calculate capacitance matrix and inductance matrix

	GND	1	2	3	4
1	C0				
2	C0				
3	C0				
4	C0				

http://quickfield.com/glossary/capacitance_matrix.htm