Q: Does the capacitance calculated by Femtet for a parallel plate capacitor coincide with the theoretical value?

A: If the air domain surrounding the capacitor is not taken into account, the calculated value will coincide with the theoretical value. However, if the air domain is considered, it will not coincide.

Please refer to the next few slides.

Additional Information

- The theoretical value of the capacitance of a parallel plate capacitor can be expressed in the equation below.
  $C = \varepsilon_0 * \varepsilon_r * S / d$,

  where:
  - ε_0: Dielectric constant of vacuum,
  - ε_r: Relative permittivity,
  - S: Area of the electrode,
  - d: Distance between the electrodes.

- Apply as follows:
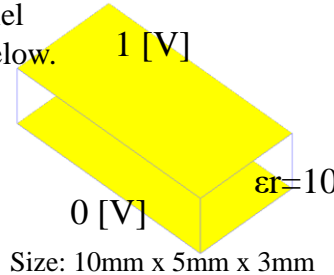 - Boundary conditions: 1 [V] and 0 [V],
  - Relative permittivity, ε_r: 10,
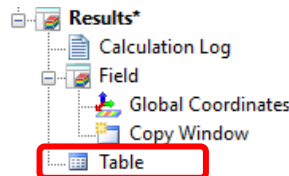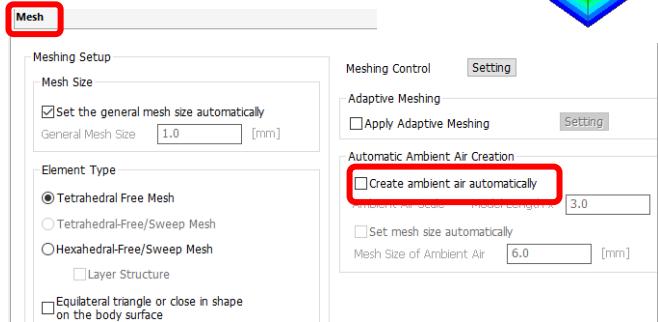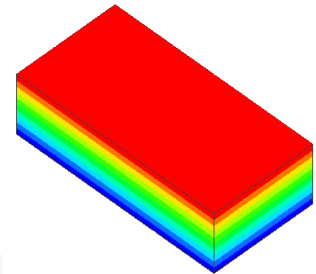 - Size of capacitor: 10 mm x 5 mm x 3 mm.
- Deselect [Create ambient air automatically].
- Femtet's solver calculates to give C of 1.476 [pF].
- Theoretical value is calculated as follows.
  - $C = 8.854e\text{-}12 * 10 * 0.010 * 0.005 / 0.003$
  - $= 1.476$ [pF]

  This value coincides with the result from Femtet.
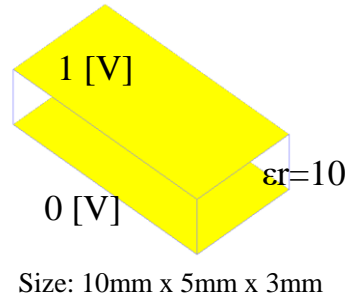
Electric Potential Contour

1 [V]

0 [V]

$\varepsilon_r = 10$

Size: 10mm x 5mm x 3mm

Mesh

Meshing Setup

Mesh Size

☑ Set the general mesh size automatically

General Mesh Size 1.0 [mm]

Element Type

◉ Tetrahedral Free Mesh
○ Tetrahedral-Free/Sweep Mesh
○ Hexahedral-Free/Sweep Mesh
☐ Layer Structure

☐ Equilateral triangle or close in shape on the body surface

Meshing Control Setting

Adaptive Meshing

☐ Apply Adaptive Meshing Setting

Automatic Ambient Air Creation

☐ Create ambient air automatically

Ambient Air Scale Model Length X 3.0

☐ Set mesh size automatically

Mesh Size of Ambient Air 6.0 [mm]

Results*
- Calculation Log
- Field
  - Global Coordinates
  - Copy Window
- Table

Table

Voltage [V]	Capacitance [F]	Electrostatic Force [N]	FEM Info

|	Value
Electrode 1	V0
Electrode 2	V1
C1-2	1.476e-12

Additional Information

Murata Software

Note: An air domain surrounding the capacitor is taken into account.

- If [Create ambient air automatically] is selected, the analysis with an air domain surrounding the parallel plate capacitor taken into account is performed.

- The result from Femtet is C of 1.664 [pF], which is larger than the theoretical value of 1.476 [pF]. This difference arises because Femtet's solver calculates the capacitance with the edge effect of the electrode taken into account and the capacitance contributed by the air domain is further added.
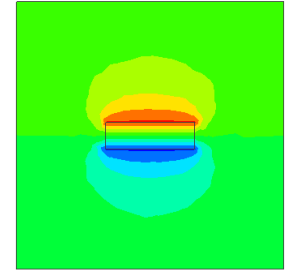
1 [V]

0 [V]

$\varepsilon r = 10$

Size: 10mm x 5mm x 3mm

Electric Potential Contour

Mesh

Meshing Setup

Mesh Size

☑ Set the general mesh size automatically

General Mesh Size   1.0   [mm]

Element Type

◉ Tetrahedral Free Mesh

○ Tetrahedral-Free/Sweep Mesh

○ Hexahedral-Free/Sweep Mesh

   ☐ Layer Structure

Meshing Control   Setting

Adaptive Meshing

☐ Apply Adaptive Meshing   Setting

Automatic Ambient Air Creation

☑ Create ambient air automatically

Ambient Air Scale   Model Length x   3.0

☐ Set mesh size automatically

Mesh Size of Ambient Air   6.0   [mm]

Table

📄 **Results***
- 📄 Calculation Log
- 📄 Field
  - 📄 Global Coordinates
  - 📄 Copy Window
- 📄 Table

Voltage [V] | Capacitance [F] | Electrostatic Force [N] | FEM Info

	Value
Electrode 1	V0
Electrode 2	V1
C1-2	1.664e-12

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