Murata Software

Femtet Seminar

Electromagnetic Analysis Exercise

S-Parameters of Open Stub

202009

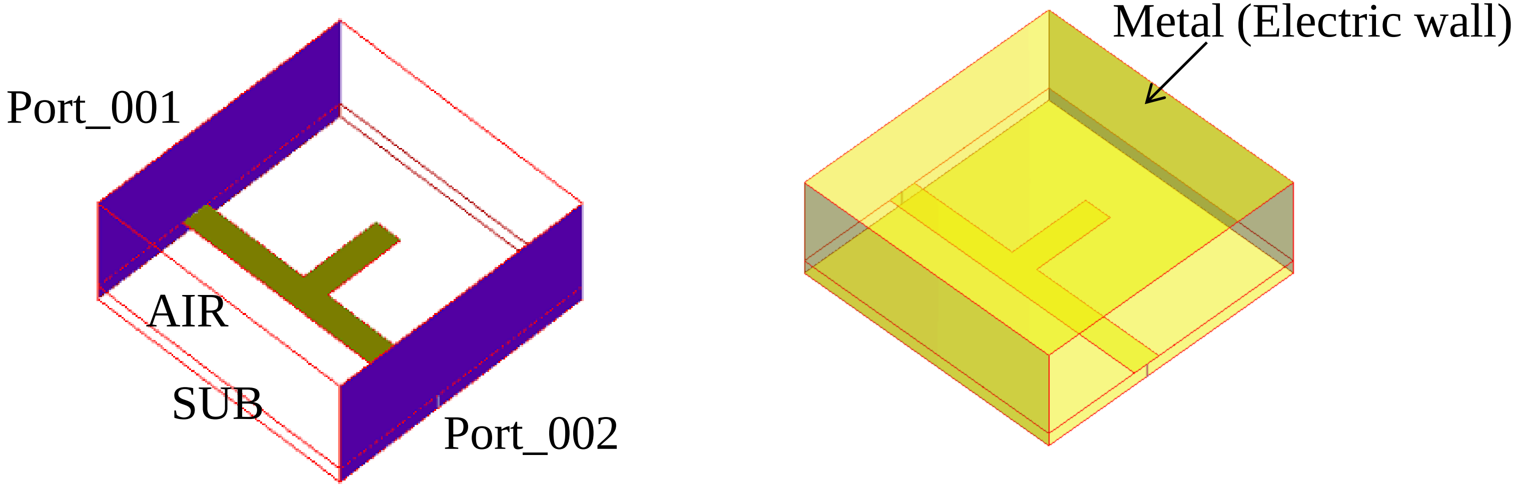
Table of Contents

0. Define an Analysis Model
1. Create a Project ……………... 3D, Model unit: mm
2. Create a Model …..…………... 3D Form
3. Set Analysis Condition….…… Frequency Sweep
4. Set Material Property ………. Permittivity and Conductivity
5. Set Boundary Condition…….. Port Setting
6. Run Solver
7. Results Display……………..…. Electromagnetic Field and S-Parameters

0. Define an Analysis Model

Murata Software

S-Parameters of an open stub surrounded by metal is solved.



(a) Appearance

(b) Shielding by Metal

Fig.1 Open Stub

0. Define an Analysis Model

Murata Software

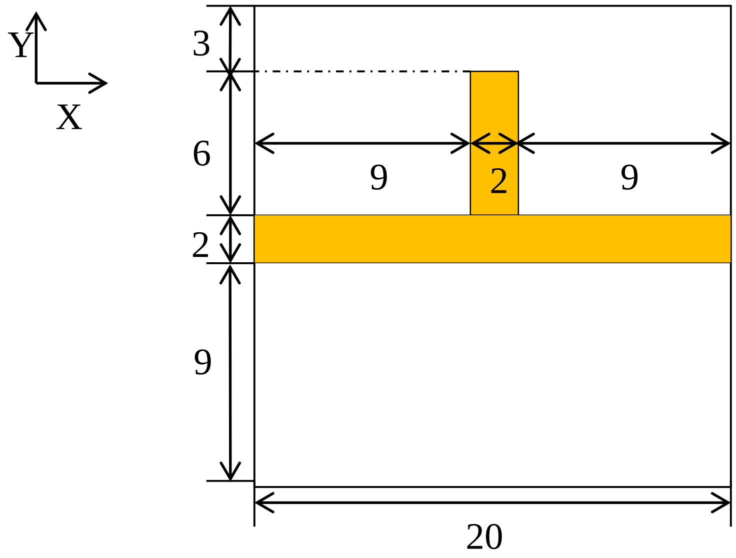


Fig.2 XY Plane of Open Stub

<u>Analysis Frequencies</u>

1GHz ～ 10GHz

<u>SUB (Substrate)</u>

Thickness: 1mm

Material: Glass Epoxy

Relative Permittivity: 4.25

tanδ： 0.01

<u>AIR</u>

Height: 6.4mm

<u>ELECTRODE</u>

Material: Cu

Conductivity: 5.977e7[S/m]

Relative Permeability: 1

1. Create a Project

Preparation

For easy drawing, change the settings to display bodies in wireframe.
Click Femtet button , go to [General Settings] > [GUI Settings] > [Modeling Setting], then deselect [Paint and Shade].

Create a New Project

1. Click Femtet button, select [New Project]
2. In the [Analysis Space Setting] dialog box, check that Model unit is mm and Analysis Space is 3D. Click OK. (Fig. 3)

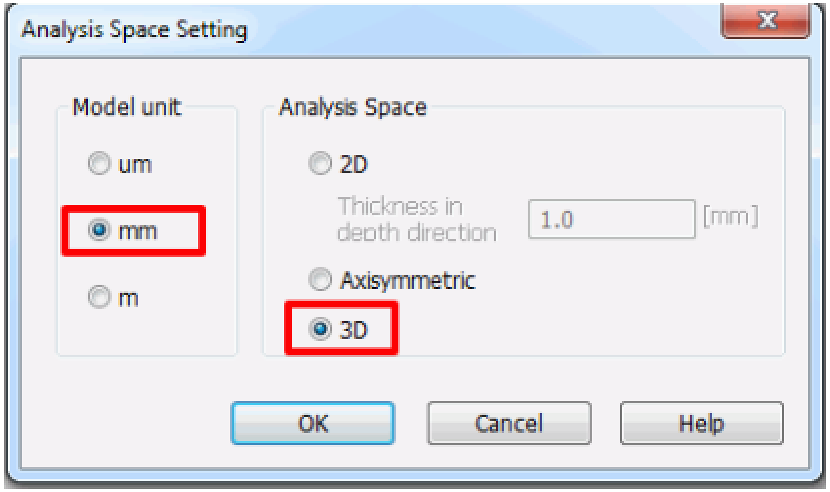


Fig. 3 [Analysis Space Setting] Dialog Box

2. Create a Model

Murata Software

Create a Model on the Modeling Window

Create a Substrate Body

On the [Create a solid body] button

select [Body [Specify Length]].

Startpoint: (0,0,0), Width: 20, Depth: 20, Height: 1

(Fig. 4)

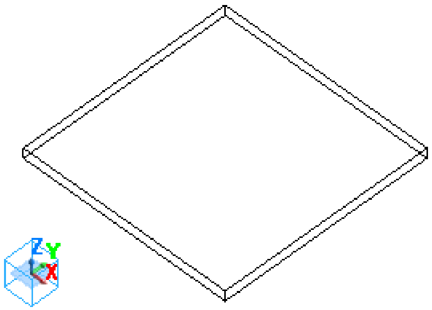


Fig.4 Substrate Body

Create a Air Body

Startpoint: (0,0,0), Width: 20, Depth: 20, Height: 6.4

(Fig. 5)

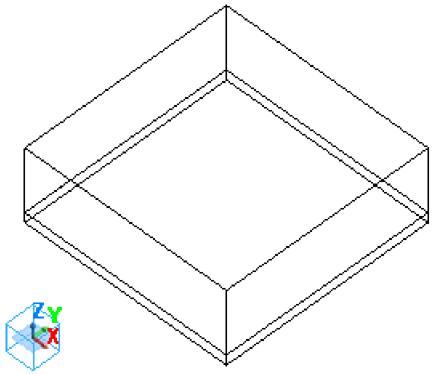


Fig.5 Air Body

Exit

Press [Exit].

2. Create a Model

Murata Software

Create an Electrode Body 1

On the [Create a sheet body] button

select [Rectangle [Specify Length]]

Startpoint: (0,0,1), Width: 20, Height: 2

(Fig. 6)

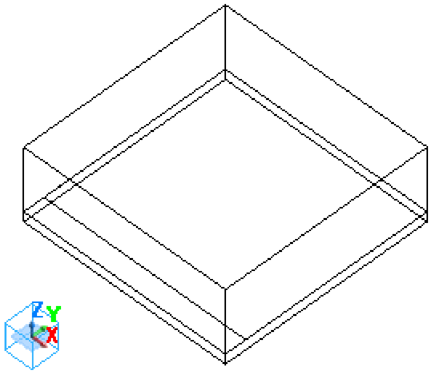


Fig.6 Electrode Body 1

Create an Electrode Body 2

Startpoint: (9,2,1), Width: 2, Height: 6

(Fig. 7)

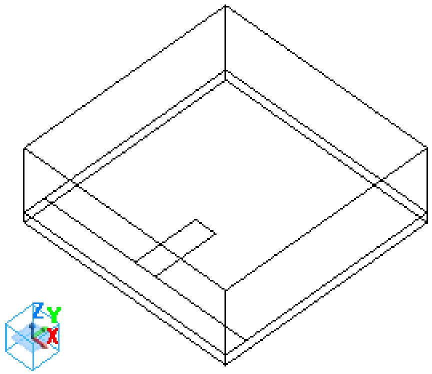


Fig.7 Electrode Body 2

Exit

Press [Exit].

2. Create a Model

Murata Software

Unite Electrode Bodies

Select the electrode bodies 1 and 2 with [Ctrl] key being pressed.
On the right-click menu, select [Boolean] > [Unite]. (Fig. 8)

The two electrode bodies are united. (Fig. 9)

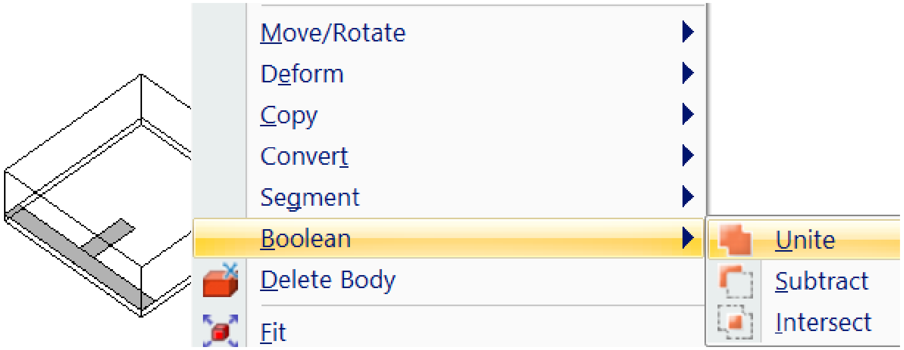


Fig.8 Unite Two Bodies

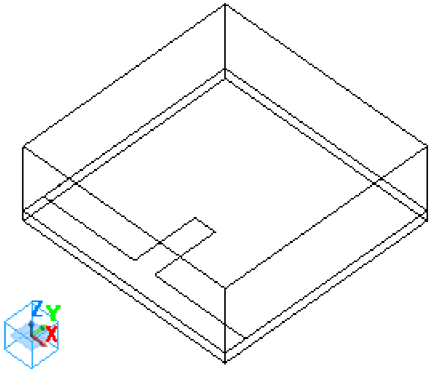


Fig.9 United Body of Electrodes

Exit

Press [Exit].

2. Create a Model

Move Electrode Body

Select electrode body.

On the right-click menu, select [Move/Rotate] > [Move] (Fig. 10)

Set Move vector: (0,9,0) (Fig. 11)

Exit

Press [Exit].

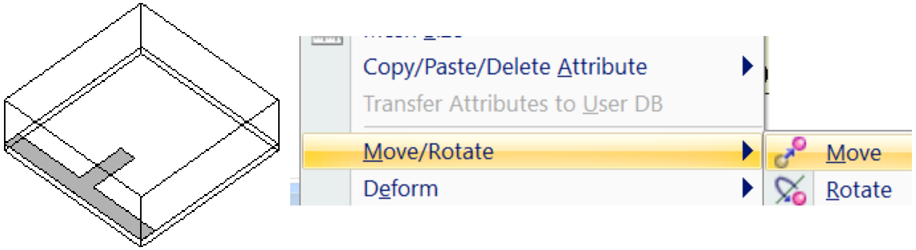


Fig.10 Move Electrode Body

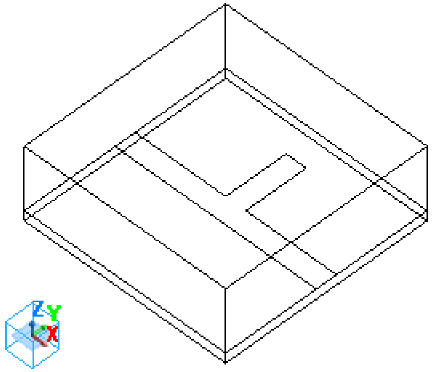


Fig.11 Moved Electrode Body

3. Set Analysis Condition

Select Solver

On the [Analysis Condition] button, open [Analysis Condition Setting] dialog box.
On the [Solver] tab, select [Electromagnetic analysis *Hertz*].

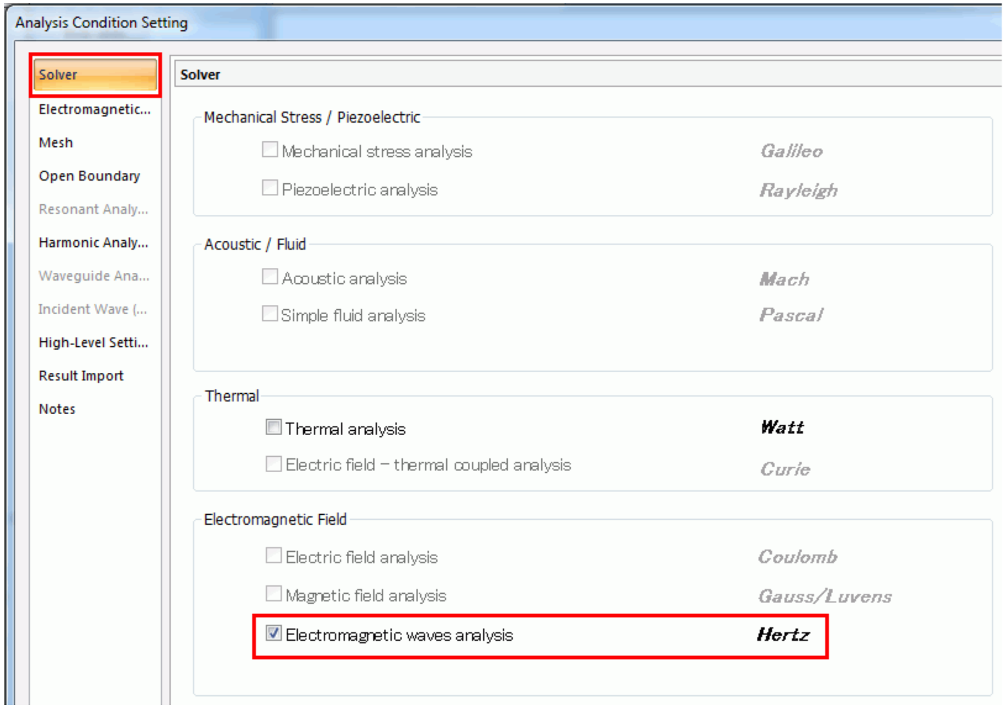


Fig.12 [Solver] Tab

3. Set Analysis Condition

Murata Software

For S-parameters analysis, select Harmonic Analysis on the [Electromagnetic Analysis] tab. (Fig. 13(a))
On the [Harmonic Analysis] tab, select Sweep Type: Liner Step by Division Number, and enter Minimum frequency: 1, Maximum frequency: 10GHz, and Division number: 100. (Fig. 13(b))
Mesh setting is on the following page.

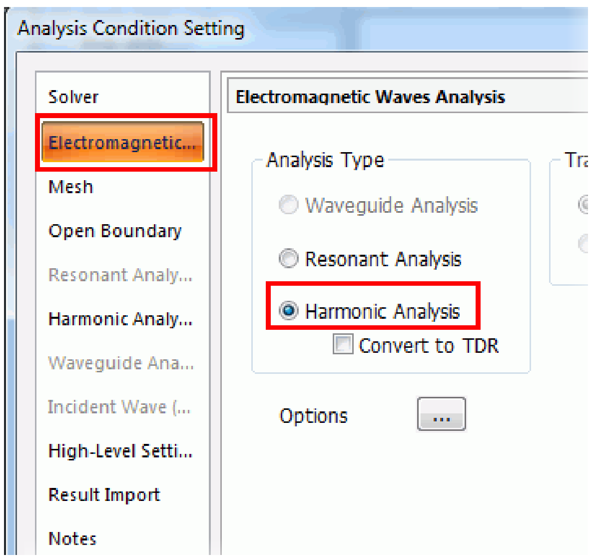


Fig.13(a) [Electromagnetic Analysis] Tab

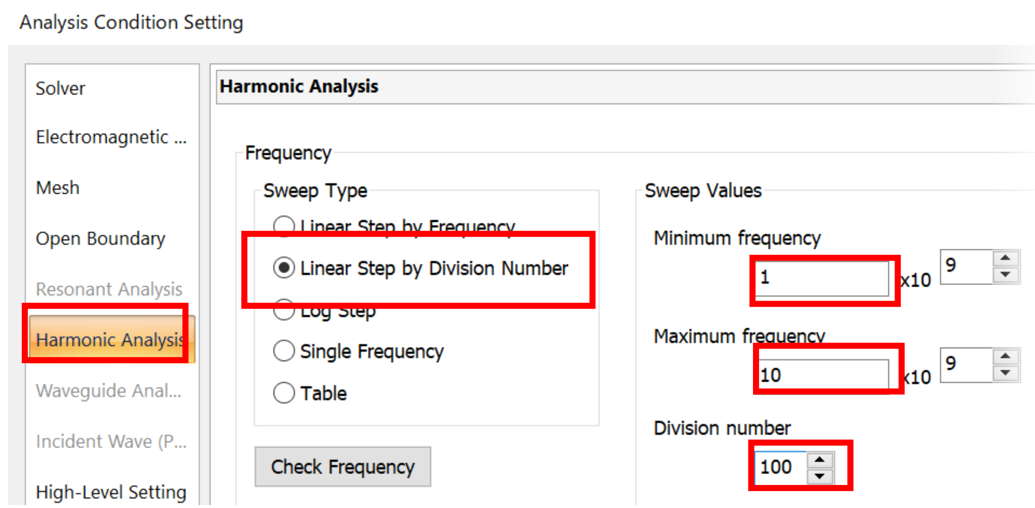


Fig.13(b) [Harmonic Analysis] Tab

3. Set Analysis Condition

Murata Software

General Mesh Size Setting

1/10 of the overall size is automatically set.

Do Not Use Adaptive Mesh

In this exercise, deselect this option to finish calculation in short time.
**Usually, this option is selected.*

Reference Frequency Setting

In this exercise, it is assumed that the resonant frequency is known to be around 5GHz.

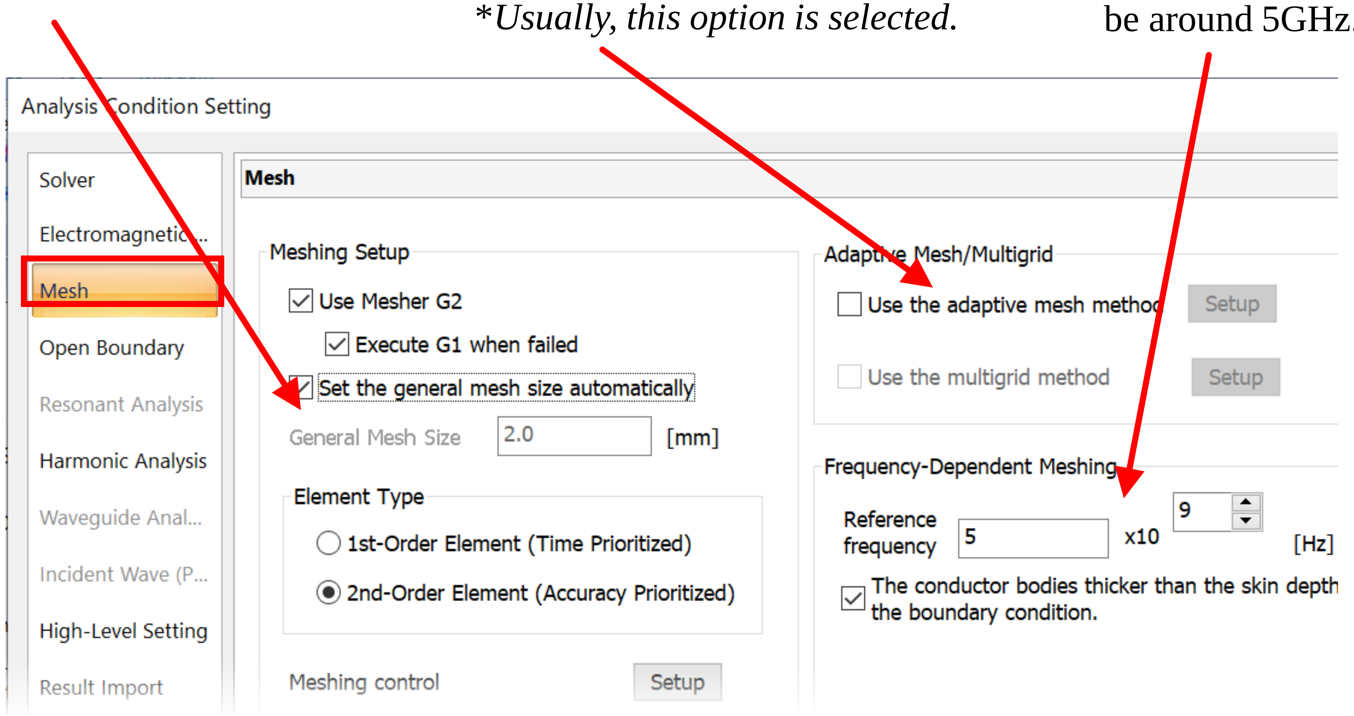


Fig.13(c) [Mesh] Tab of [Analysis Condition Setting]

4. Set Material Property

Right-click the substrate and select [Body Attribute/Material Property] on the appearing menu. (Fig.14)

Type SUB in the [Body Attribute Name].

In the [Material DB], go to [03_Resin], and select [006_Glass_epoxy].
(Fig.15)

Press [Edit Data] to check the material property.

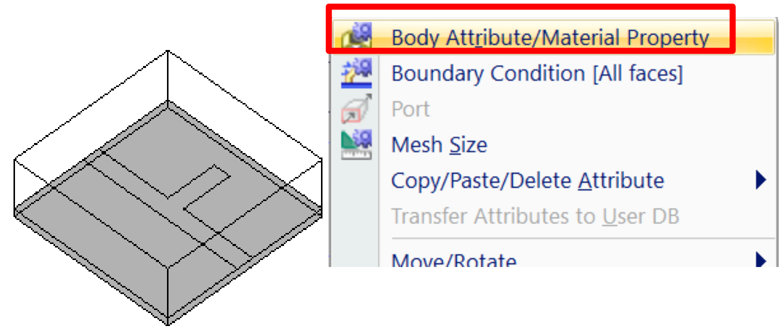


Fig.14 Select Substrate Body

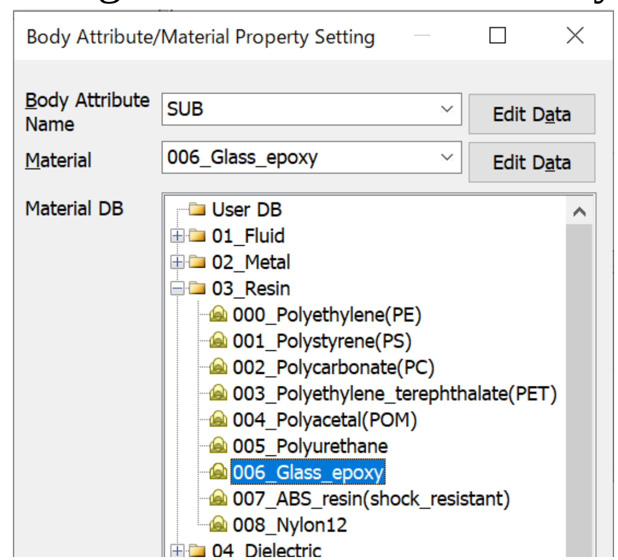


Fig.15 Select Glass Epoxy

4. Set Material Property

Right-click the air domain and select [Body Attribute/Material Property] on the appearing menu. (Fig. 16)

Type AIR in the [Body Attribute Name].

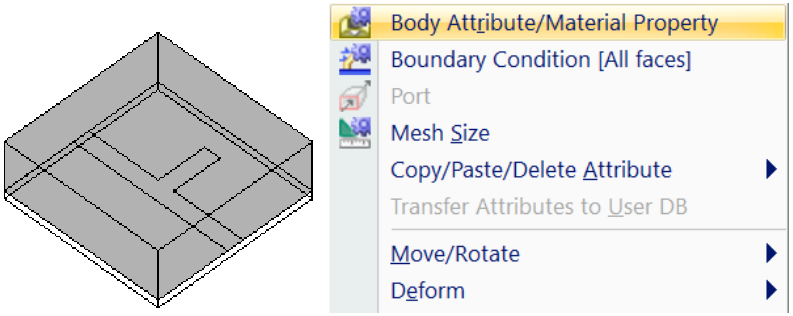


Fig.16 Select Air Domain

In the Material DB, go to [01_Fluid], and select [000_Air]. (Fig.17)

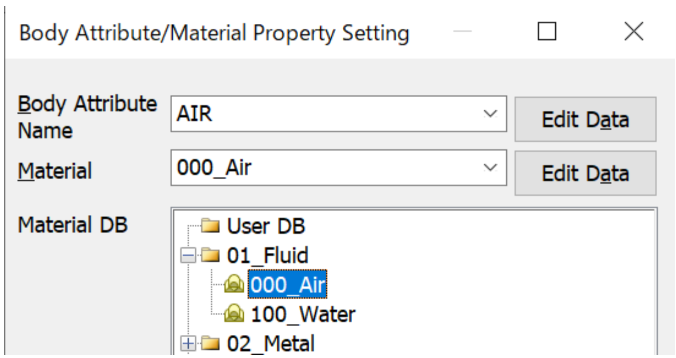


Fig.17 Select Air

4. Set Material Property

Right-click the electrode and select [Body Attribute/Material Property] on the appearing menu. (Fig. 18)

Type ELECTRODE in the [Body Attribute Name].

In the Material DB, go to [02_Metal], and select [008_Cu]. (Fig.19)

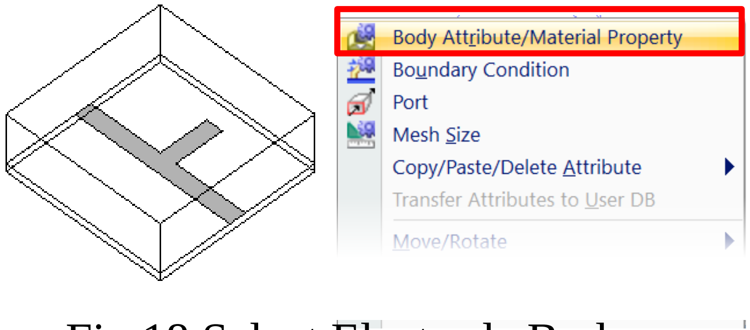


Fig.18 Select Electrode Body

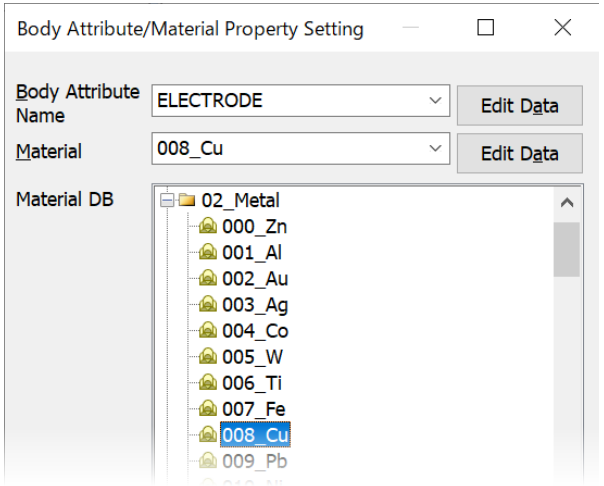


Fig. 19 Select Cu

5. Set Boundary Condition

Murata Software

Port Setting

Select a face for setup.

Port_001 is set up as follows;

Select faces of the substrate and air domain with Ctrl key being pressed.

On the right-click menu, select [Port]. (Fig. 20)

Confirm the port name is [Port_001] and press OK button.

A dialog box for analysis condition setting will show up. (Fig.21)

Select [Specify] for [Reference Impedance].

Press Setup button for [Integral Path] and set as follows on the modeling window;

Integral path: startpoint (20, 10, 1), endpoint (20, 10, 0)) (Fig. 22 on the following page)

Likewise, Port_002 is set up.

Integral path: startpoint (0, 10, 1), endpoint (0, 10, 0) (Fig. 23 on the following page)

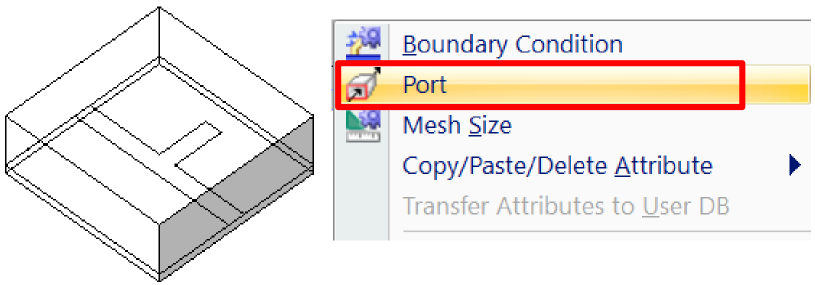


Fig. 20 Select Port_001 for Setup

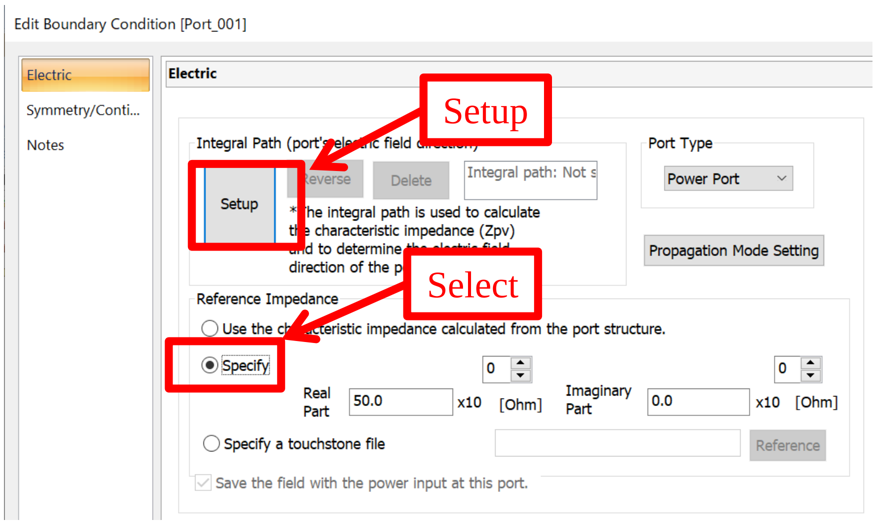


Fig. 21 Dialog Box for Editing Boundary Condition

5. Set Boundary Condition

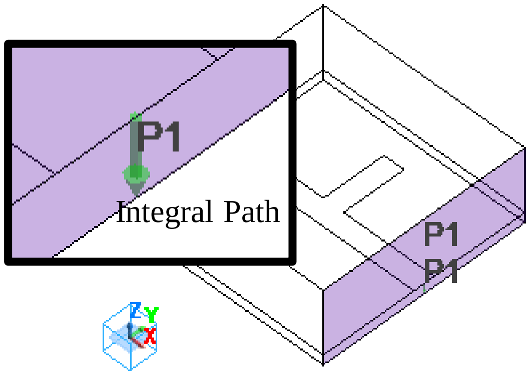


Fig. 22 Integral Path on Port_001

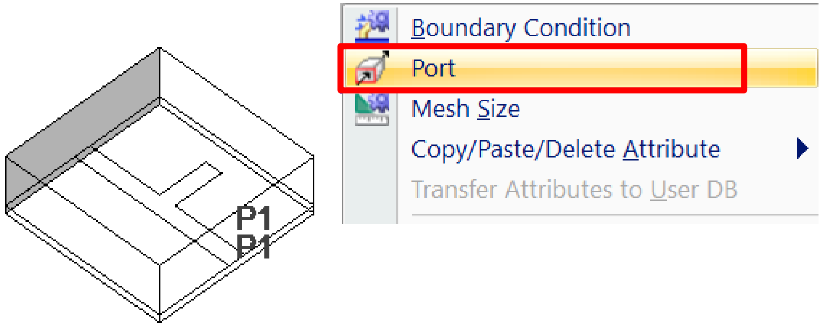


Fig.23 Integral Path on Port_002

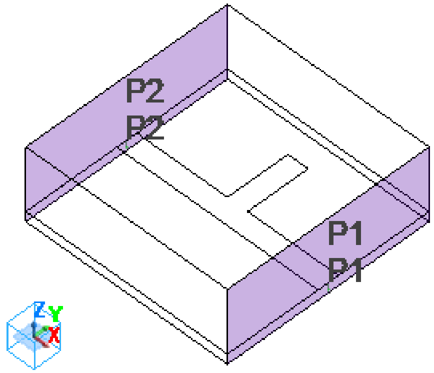


Fig.24 The Model with Two Ports

6. Run Solver

Murata Software

Save Analysis Model

Click Femtet button , select [Save Project As].

Type Exercise, press [Run Mesher/Solver]

When the analysis is finished, [Calculation Finished] dialog box will appear.

Check [Fields] is selected for [Show Results], and press [Show] button to see the results window. (Fig. 25)

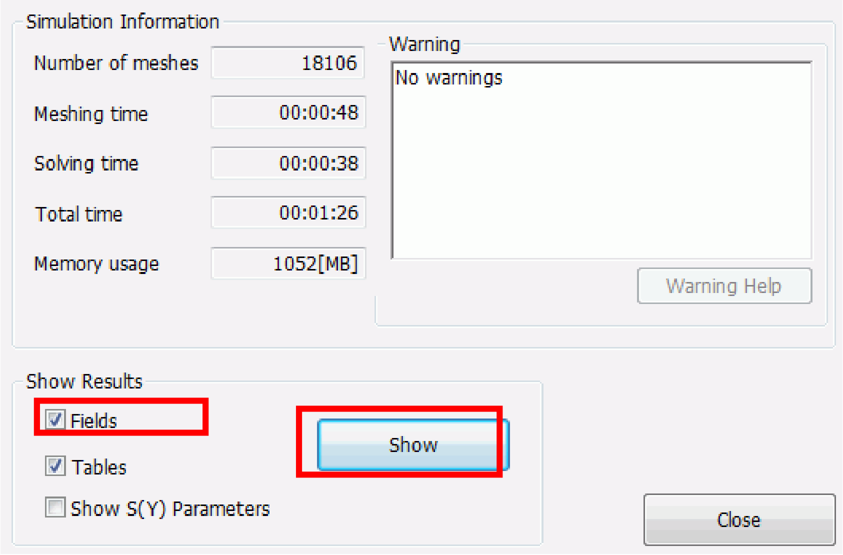


Fig.25 [Calculation Finished] Dialog Box

7. Results Display: Magnetic Field

Murata Software

Select Electromagnetic Analysis as an analysis type.
Set electric field [V/m] for the field type.
Press [Vector diagram] (Fig. 26)
The electric filed displayed here is input from Port-001.

To view the electric field input from Port_002,
press [Field Superposition Setting] button and set as in Table 2.

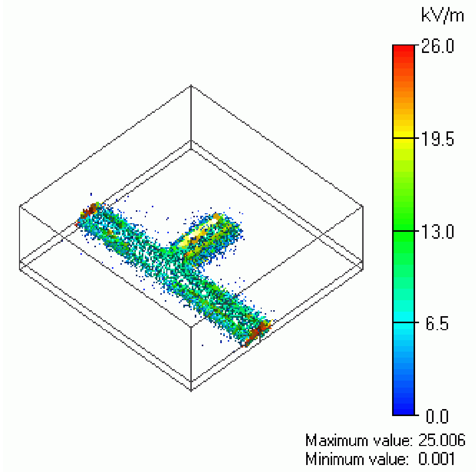


Fig.26 Electric Field Vector Diagram

Port Name	MAG	PHASE[deg]
Port_001:m1	1.0	0.0
Port_002:m1	0.0	0.0

Table 1: Input from Port_001

Port Name	MAG	PHASE[deg]
Port_001:m1	0.0	0.0
Port_002:m1	1.0	0.0

Table 2: Input from Port_002

7. Results Display: S-Parameters

Click [Chart], and select [SYZ matrix].
A dialog box will show up. (Fig. 27)

In [Matrix], select 11 and 21.
Press [XY Graph] button.
S_{11} and S_{21} will be displayed. (Fig. 28)

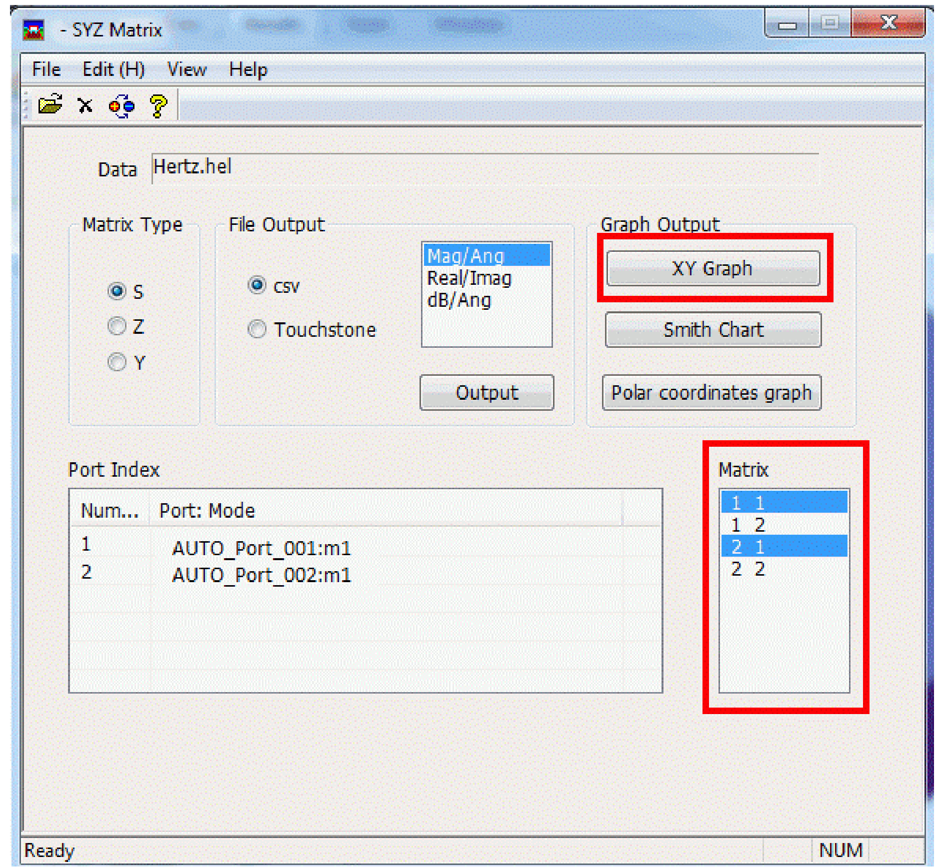


Fig. 27 Dialog Box of SYZ Matrix

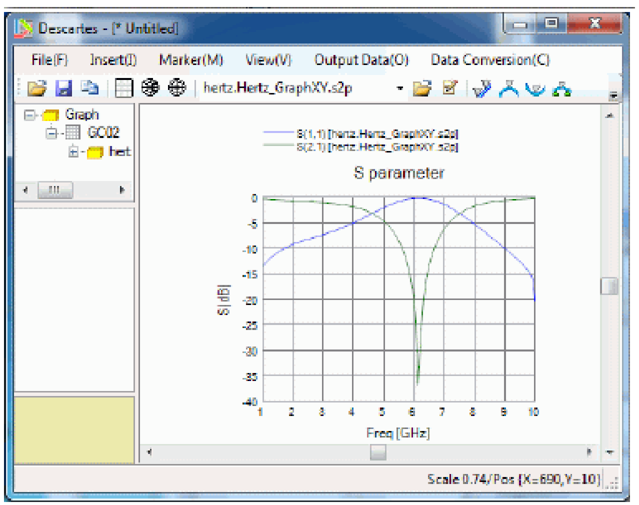


Fig. 28 S-Parameters