

## Project2.2

Report date	Aug 31, 2025, 4:20:57 AM
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# 1 Global Definitions

Date	Aug 14, 2025, 12:37:53 AM
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## GLOBAL SETTINGS

Name	Project2.2.mph
Path	C:\Users\91880\Desktop\placement prep\self project\project2.2.mph
Version	COMSOL Multiphysics 6.3 (Build: 420)

## USED PRODUCTS

COMSOL Multiphysics
AC/DC Module

## COMPUTER INFORMATION

CPU	Intel64 Family 6 Model 140 Stepping 2, 2 cores, 7.65 GB RAM
Operating system	Windows 11

## 1.1 PARAMETERS

### PARAMETERS 1

Name	Expression	Value	Description
T0	300[K]	300 K	
Ta	300[K]	300 K	
P_on	5[W]	5 W	
freq	50e3[Hz]	50000 Hz	
duty	0.5	0.5	
V_on	100[V]	100 V	
V_dc	$V_{on} \cdot \text{duty}$	50 V	
V_peak	$V_{on}$	100 V	
chip_L	2[m]	2 m	
chip_W	2[m]	2 m	
chip_th	0.25[m]	0.25 m	
V_die	$\text{chip\_L} \cdot \text{chip\_W} \cdot \text{chip\_th}$	1 m <sup>3</sup>	
sigma0	$P_{on} \cdot (\text{chip\_th}^2) / (V_{die} \cdot V_{dc}^2)$	1.25E-4 S/m	
hc	50[W/m <sup>2</sup> *K]	50 kg·K/s <sup>3</sup>	

## 1.2 SHARED PROPERTIES

### 1.2.1 Default Model Inputs

Tag	cminpt
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## 2 Component 1

## SETTINGS

Description	Value
Unit system	Same as global system (SI)

## 2.1 DEFINITIONS

### 2.1.1 Coordinate Systems

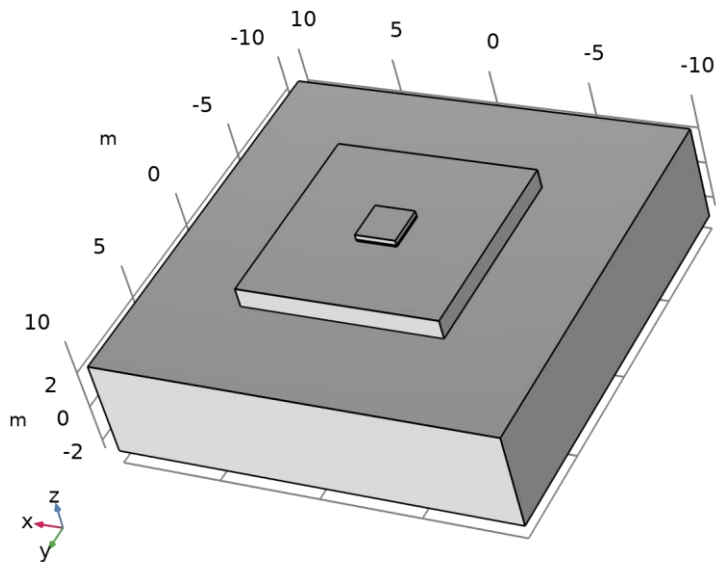
### Boundary System 1

Coordinate system type	Boundary system
Tag	sys1

## COORDINATE NAMES

First	Second	Third
t1	t2	n

## 2.2 GEOMETRY 1



# Geometry 1

## UNITS

Length unit	m
Angular unit	deg

## GEOMETRY STATISTICS

Description	Value
-------------	-------

Description	Value
Space dimension	3
Number of domains	4
Number of boundaries	23
Number of edges	44
Number of vertices	28

### 2.2.1 heat sink (blk1)

#### SIZE AND SHAPE

Description	Value
Width	20
Depth	20
Height	5

#### POSITION

Description	Value
Base	Center
Position	{0, 0, 0}

#### AXIS

Description	Value
Axis type	z - axis

### 2.2.2 substrate (blk2)

#### SIZE AND SHAPE

Description	Value
Width	10
Depth	10
Height	1

#### POSITION

Description	Value
Base	Center
Position	{0, 0, 3}

#### AXIS

Description	Value
Axis type	z - axis

### 2.2.3 TIM (blk3)

#### SIZE AND SHAPE

Description	Value
Width	2
Depth	2
Height	0.1

#### POSITION

Description	Value
Base	Center
Position	{0, 0, 3.55}

#### AXIS

Description	Value
Axis type	z - axis

### 2.2.4 SiC (blk4)

#### SIZE AND SHAPE

Description	Value
Width	2
Depth	2
Height	0.25

#### POSITION

Description	Value
Base	Center
Position	{0, 0, 3.725}

#### AXIS

Description	Value
Axis type	z - axis

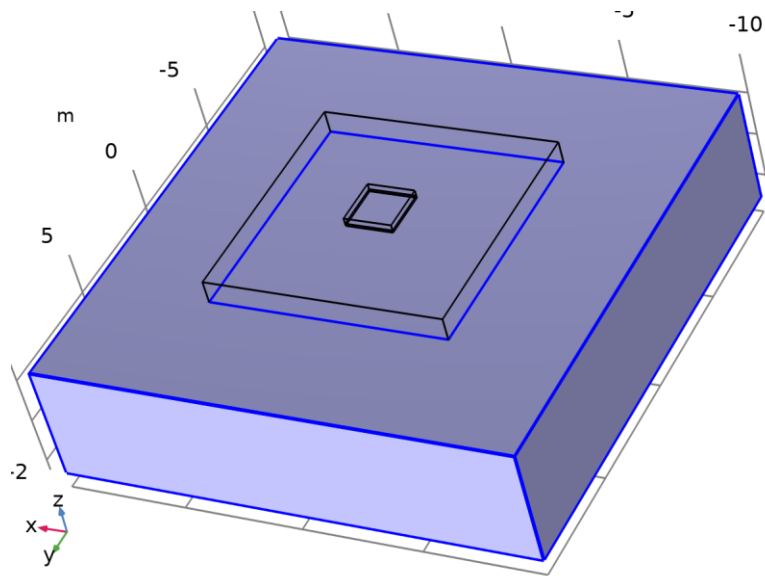
### 2.2.5 Form Union (fin)

#### INFORMATION

Description	Value
Build message	Formed union of 4 solid objects. Union has 4 domains, 23 boundaries, 44 edges, and 28 vertices.

## 2.3 MATERIALS

### 2.3.1 Al - Aluminum



*Al - Aluminum*

#### SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: Domain 1

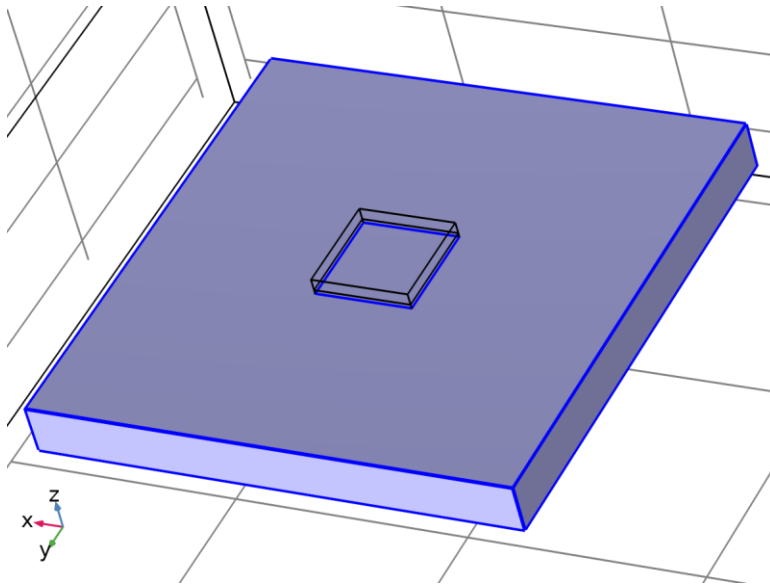
#### MATERIAL PARAMETERS

Name	Value	Unit	Property group
Electric conductivity	3.55E7	S/m	Basic
Heat capacity at constant pressure	904	J/(kg·K)	Basic
Density	2700	kg/m <sup>3</sup>	Basic
Thermal conductivity	237	W/(m·K)	Basic
Relative permittivity	1	1	Basic

#### BASIC

Description	Value	Unit
Electric conductivity	3.55E7	S/m
Heat capacity at constant pressure	904	J/(kg·K)
Density	2700	kg/m <sup>3</sup>
Thermal conductivity	237	W/(m·K)
Relative permittivity	1	1

### 2.3.2 Aluminum Nitride



*Aluminum Nitride*

#### SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: Domain 2

#### MATERIAL PARAMETERS

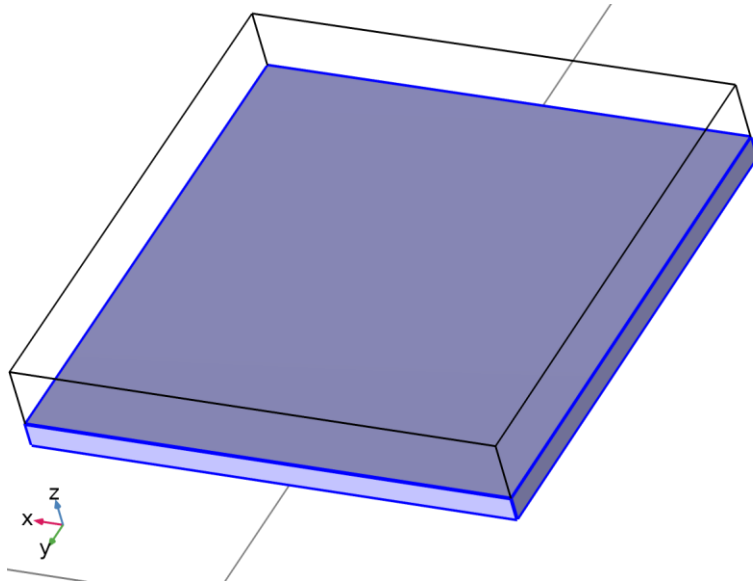
Name	Value	Unit	Property group
Relative permittivity	9	1	Basic
Density	3300	kg/m <sup>3</sup>	Basic
Thermal conductivity	170	W/(m·K)	Basic
Heat capacity at constant pressure	740	J/(kg·K)	Basic
Electric conductivity	170	S/m	Basic

#### BASIC

Description	Value	Unit
Relative permittivity	9	1
Density	3300	kg/m <sup>3</sup>
Thermal conductivity	170	W/(m·K)
Heat capacity at constant pressure	740	J/(kg·K)
Electric conductivity	170	S/m



### 2.3.3 Material 3



Material 3

#### SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: Domain 3

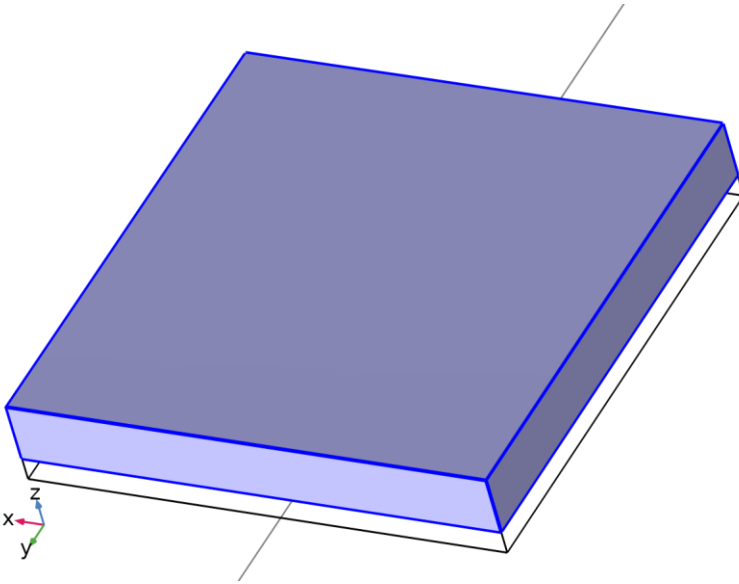
#### MATERIAL PARAMETERS

Name	Value	Unit	Property group
Thermal conductivity	5	W/(m·K)	Basic
Density	3000	kg/m <sup>3</sup>	Basic
Heat capacity at constant pressure	230	J/(kg·K)	Basic
Electric conductivity	1E-12	S/m	Basic
Relative permittivity	4	1	Basic

#### BASIC

Description	Value	Unit
Thermal conductivity	5	W/(m·K)
Density	3000	kg/m <sup>3</sup>
Heat capacity at constant pressure	230	J/(kg·K)
Electric conductivity	1E-12	S/m
Relative permittivity	4	1

### 2.3.4 Silicon Carbide



*Silicon Carbide*

#### SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: Domain 4

#### MATERIAL PARAMETERS

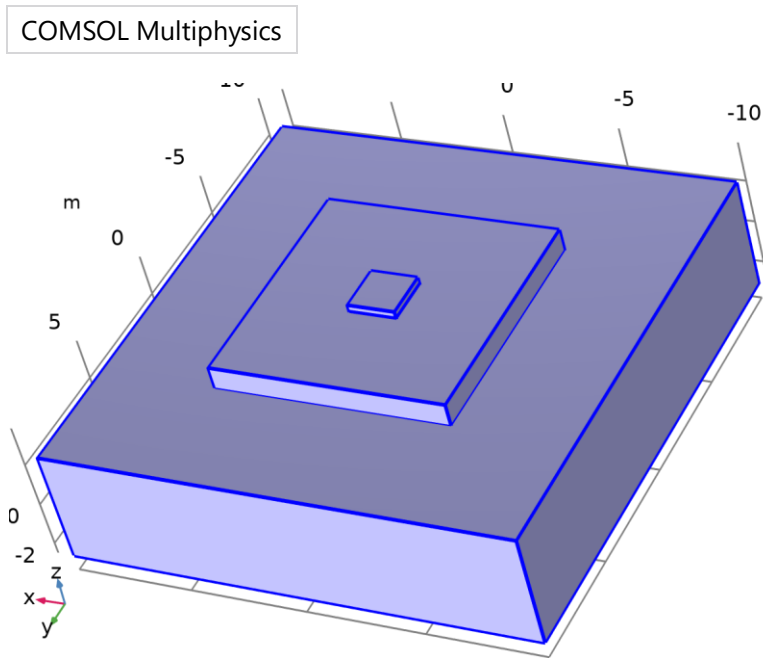
Name	Value	Unit	Property group
Electric conductivity	1.25E-4	S/m	Basic
Heat capacity at constant pressure	690	J/(kg·K)	Basic
Relative permittivity	10	1	Basic
Density	3200	kg/m <sup>3</sup>	Basic
Thermal conductivity	$120 \cdot (300/T)^{0.75}$	W/(m·K)	Basic

#### BASIC

Description	Value	Unit
Electric conductivity	1.25E-4	S/m
Heat capacity at constant pressure	690	J/(kg·K)
Relative permittivity	10	1
Density	3200	kg/m <sup>3</sup>
Thermal conductivity	$120 \cdot (300/T)^{0.75}$	W/(m·K)

## 2.4 HEAT TRANSFER IN SOLIDS

#### USED PRODUCTS



*Heat Transfer in Solids*

SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: All domains

EQUATIONS

$$\rho C_p \frac{\partial T}{\partial t} + \rho C_p \mathbf{u} \cdot \nabla T + \nabla \cdot \mathbf{q} = Q + Q_{\text{ted}}$$

$$\mathbf{q} = -k \nabla T$$

### 2.4.1 Interface Settings

Discretization

SETTINGS

Description	Value
Temperature	Quadratic Lagrange

SETTINGS

Description	Value
Equation form	Study controlled

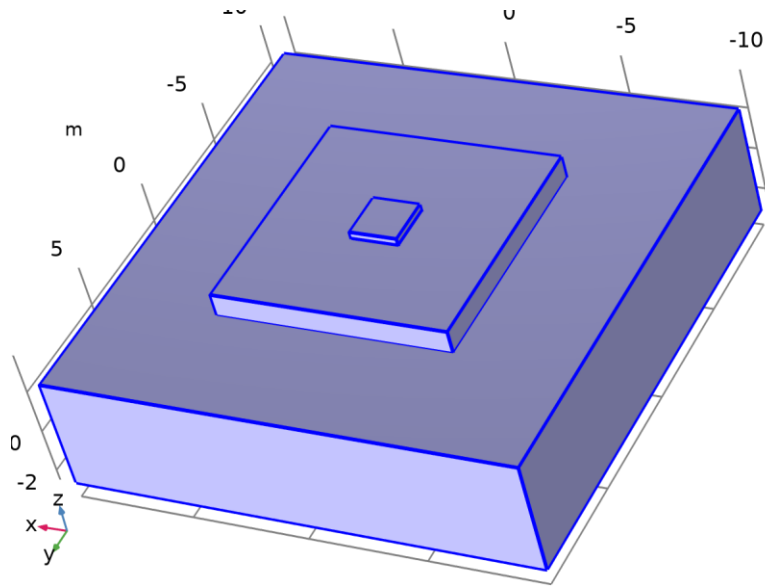
Physical Model

SETTINGS

Description	Value	Unit
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Description	Value	Unit
Reference temperature	User defined	
Reference temperature	T0	K

## 2.4.2 Solid 1



*Solid 1*

### SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: All domains

### EQUATIONS

$$\rho c_p \frac{\partial T}{\partial t} + \rho c_p \mathbf{u} \cdot \nabla T + \nabla \cdot \mathbf{q} = Q + Q_{\text{ted}}$$

$$\mathbf{q} = -k \nabla T$$

### Heat Conduction, Solid

#### SETTINGS

Description	Value
Thermal conductivity	From material

### Thermodynamics, Solid

#### SETTINGS

Description	Value
Density	From material
Heat capacity at constant pressure	From material

## Coordinate System Selection

### SETTINGS

Description	Value
Coordinate system	Global coordinate system

## Model Input

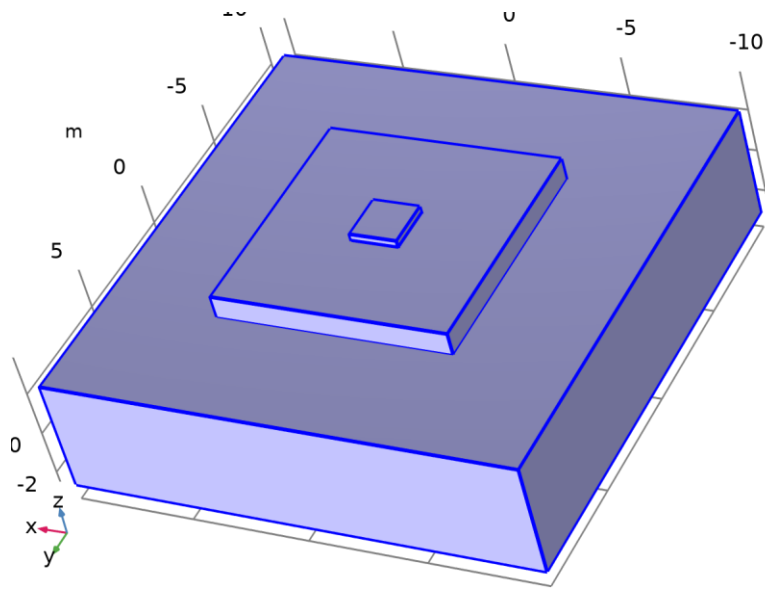
### SETTINGS

Description	Value
Volume reference temperature	Common model input

### PROPERTIES FROM MATERIAL

Property	Material	Property group
Thermal conductivity	Al - Aluminum	Basic
Density	Al - Aluminum	Basic
Heat capacity at constant pressure	Al - Aluminum	Basic
Thermal conductivity	Aluminum Nitride	Basic
Density	Aluminum Nitride	Basic
Heat capacity at constant pressure	Aluminum Nitride	Basic
Thermal conductivity	Material 3	Basic
Density	Material 3	Basic
Heat capacity at constant pressure	Material 3	Basic
Thermal conductivity	Silicon Carbide	Basic
Density	Silicon Carbide	Basic
Heat capacity at constant pressure	Silicon Carbide	Basic

### 2.4.3 Initial Values 1



*Initial Values 1*

#### SELECTION

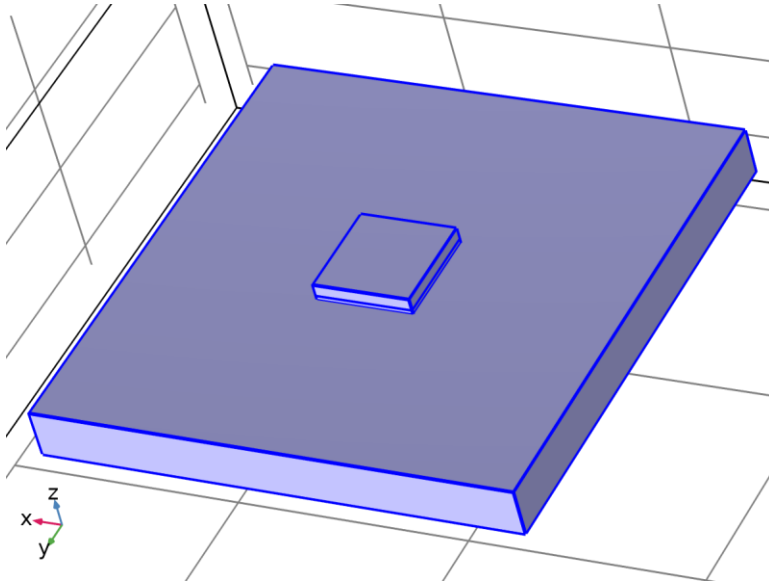
Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: All domains

#### Initial Values

##### SETTINGS

Description	Value	Unit
Temperature	User defined	
Temperature	Ta	K

#### 2.4.4 Thermal Insulation 1



*Thermal Insulation 1*

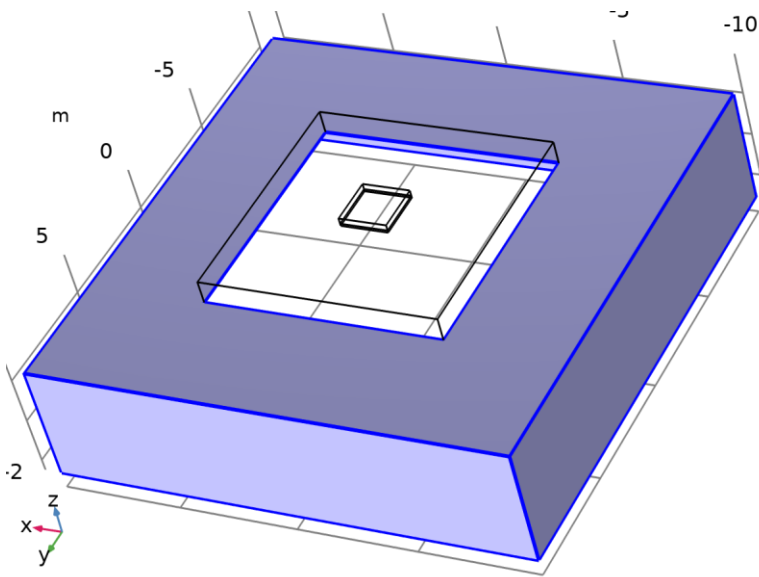
##### SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 2: All boundaries

##### EQUATIONS

$$-\mathbf{n} \cdot \mathbf{q} = 0$$

#### 2.4.5 Heat Flux 1



*Heat Flux 1*

## SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 2: Boundaries 1–2, 4–5, 23

## EQUATIONS

$$-\mathbf{n} \cdot \mathbf{q} = q_0$$

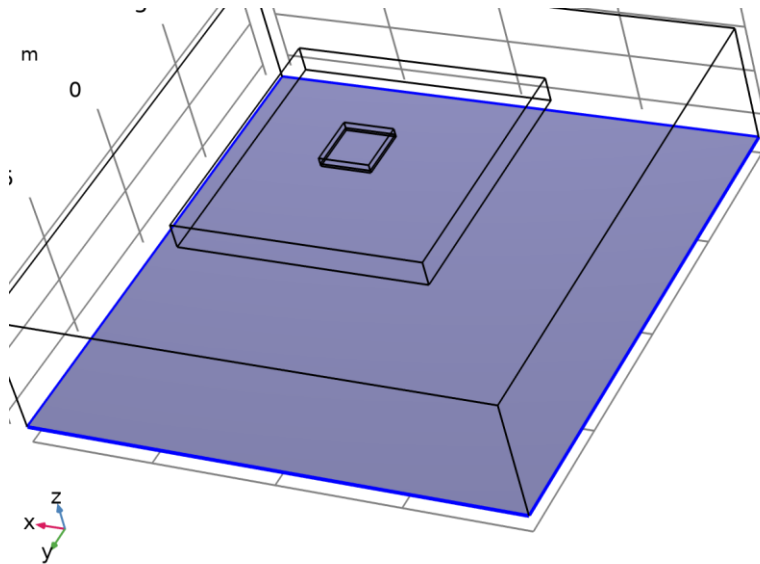
$$q_0 = h(T_{\text{ext}} - T)$$

## Heat Flux

### SETTINGS

Description	Value	Unit
Flux type	Convective heat flux	
Heat transfer coefficient	User defined	
Heat transfer coefficient	hc	W/(m <sup>2</sup> ·K)
External temperature	User defined	
External temperature	Ta	K

## 2.4.6 Temperature 1



### Temperature 1

## SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 2: Boundary 3

## EQUATIONS

$$T = T_0$$



## Temperature

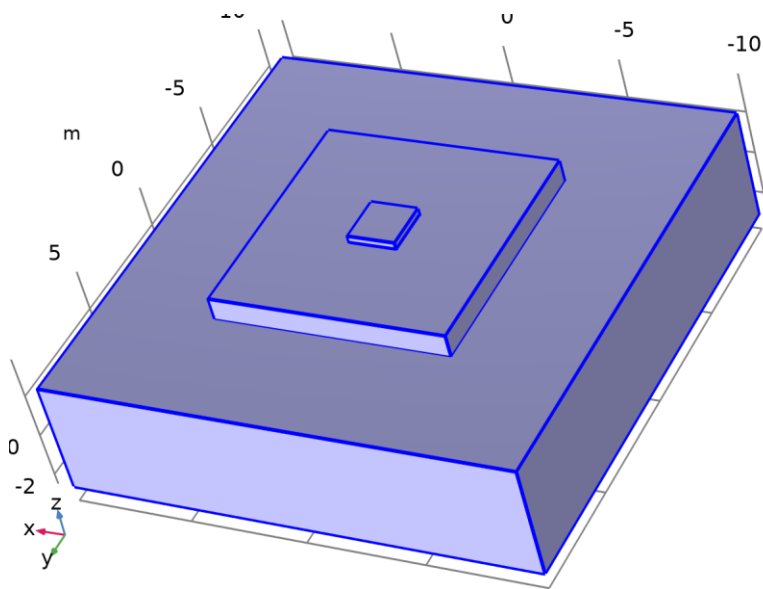
### SETTINGS

Description	Value	Unit
Temperature	User defined	
Temperature	Ta	K

## 2.5 ELECTRIC CURRENTS

### USED PRODUCTS

COMSOL Multiphysics
AC/DC Module



### Electric Currents

### SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: All domains

### EQUATIONS

$$\nabla \cdot \mathbf{J} = Q_{j,v}$$

$$\mathbf{J} = \sigma \mathbf{E} + \frac{\partial \mathbf{D}}{\partial t} + \mathbf{J}_e$$

$$\mathbf{E} = -\nabla V$$

2.5.1 Interface Settings

Discretization

SETTINGS

Description	Value
Electric potential	Quadratic

SETTINGS

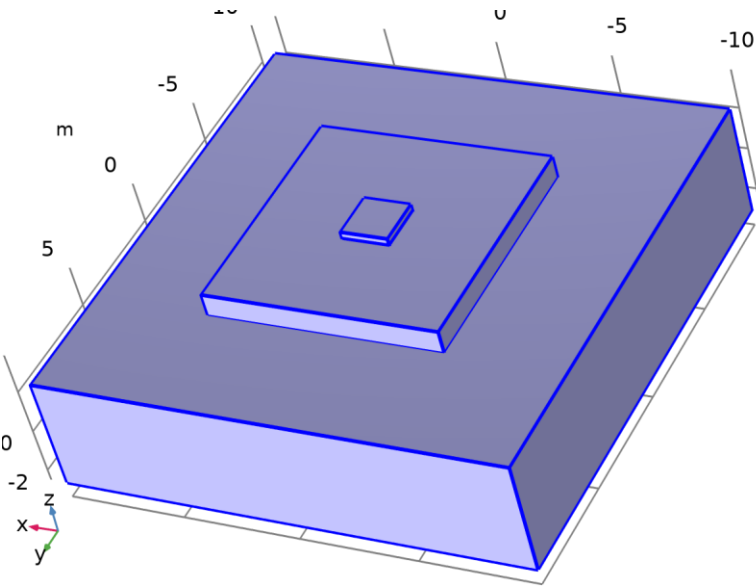
Description	Value
Equation form	Study controlled

Manual Terminal Sweep Settings

SETTINGS

Description	Value	Unit
Use manual terminal sweep	Off	
Reference impedance	50	Ω

2.5.2 Current Conservation 1



Current Conservation 1

SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: All domains

EQUATIONS

$\nabla \cdot \mathbf{J} = Q_{j,v}$

$$\mathbf{J} = \sigma \mathbf{E} + \frac{\partial \mathbf{D}}{\partial t} + \mathbf{J}_e$$

$$\mathbf{E} = -\nabla V$$

### Constitutive Relation Jc-E

#### SETTINGS

Description	Value
Conduction model	Electric conductivity
Electric conductivity	From material

### Constitutive Relation D-E

#### SETTINGS

Description	Value
Dielectric model	Relative permittivity
Relative permittivity	From material

### Coordinate System Selection

#### SETTINGS

Description	Value
Coordinate system	Global coordinate system

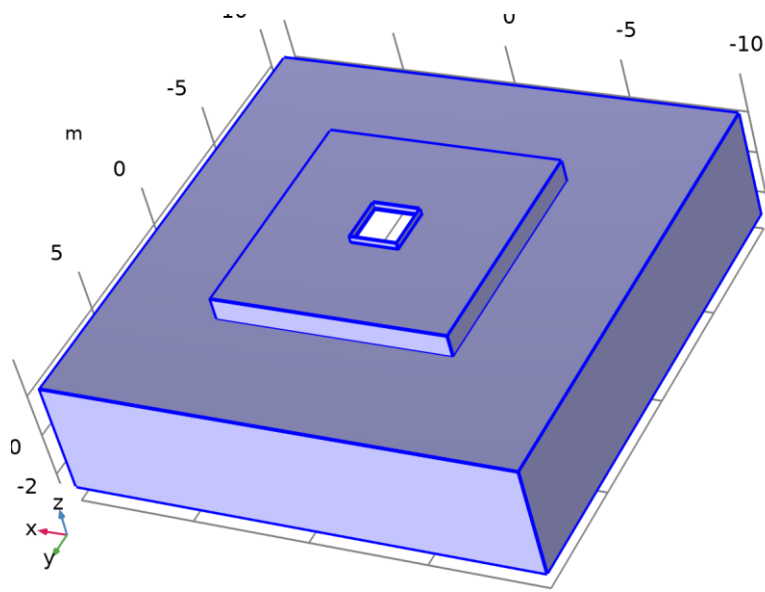
#### USED PRODUCTS

COMSOL Multiphysics

#### PROPERTIES FROM MATERIAL

Property	Material	Property group
Electric conductivity	Al - Aluminum	Basic
Relative permittivity	Al - Aluminum	Basic
Electric conductivity	Aluminum Nitride	Basic
Relative permittivity	Aluminum Nitride	Basic
Electric conductivity	Material 3	Basic
Relative permittivity	Material 3	Basic
Electric conductivity	Silicon Carbide	Basic
Relative permittivity	Silicon Carbide	Basic

### 2.5.3 Electric Insulation 1



*Electric Insulation 1*

#### SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 2: All boundaries

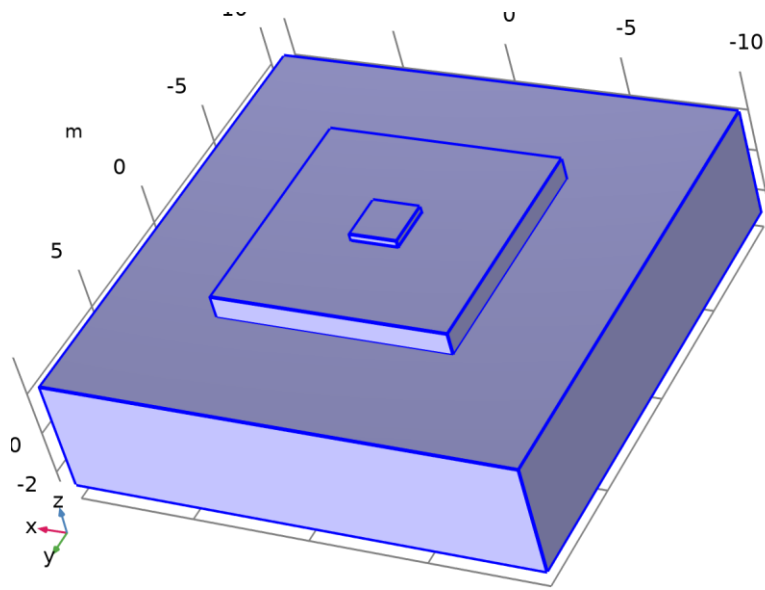
#### EQUATIONS

$$\mathbf{n} \cdot \mathbf{J} = 0$$

#### USED PRODUCTS

COMSOL Multiphysics

## 2.5.4 Initial Values 1



*Initial Values 1*

### SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: All domains

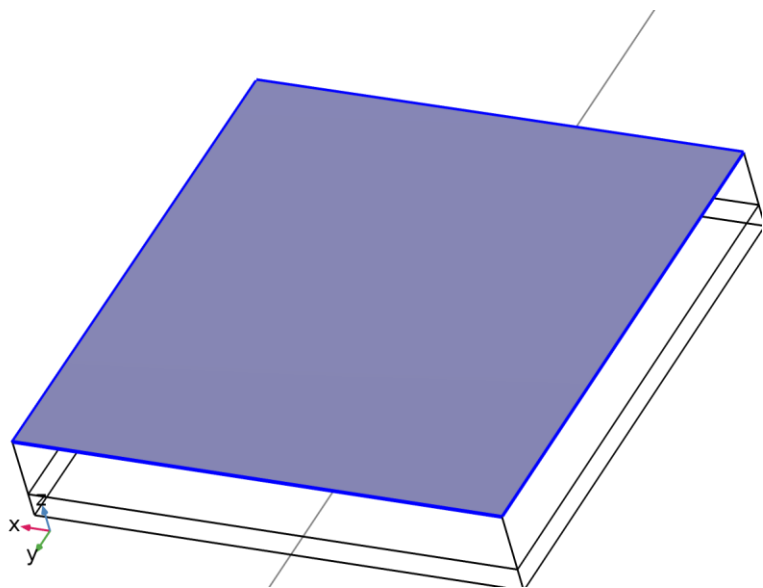
### SETTINGS

Description	Value	Unit
Electric potential	0	V

### USED PRODUCTS

COMSOL Multiphysics
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2.5.5 Terminal 1



Terminal 1

SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 2: Boundary 17

EQUATIONS

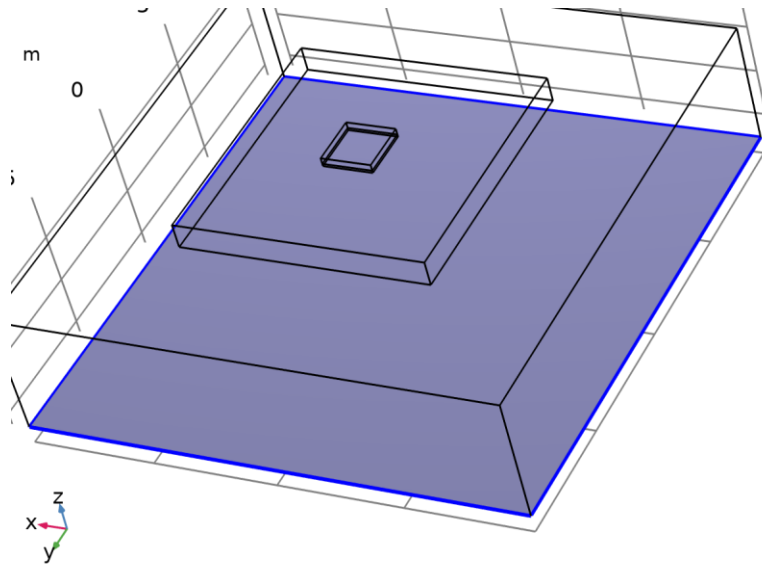
$V = V_0$   
.....

Terminal

SETTINGS

Description	Value	Unit
Terminal name	1	
Terminal type	Voltage	
Voltage	V_dc	V

## 2.5.6 Ground 1



Ground 1

### SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 2: Boundary 3

### EQUATIONS

$$V = 0$$

### USED PRODUCTS

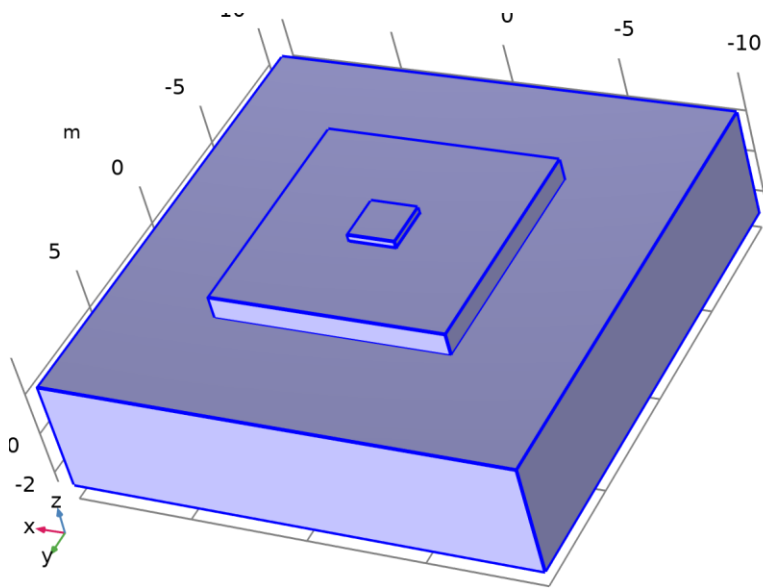
COMSOL Multiphysics

## 2.6 MULTIPHYSICS

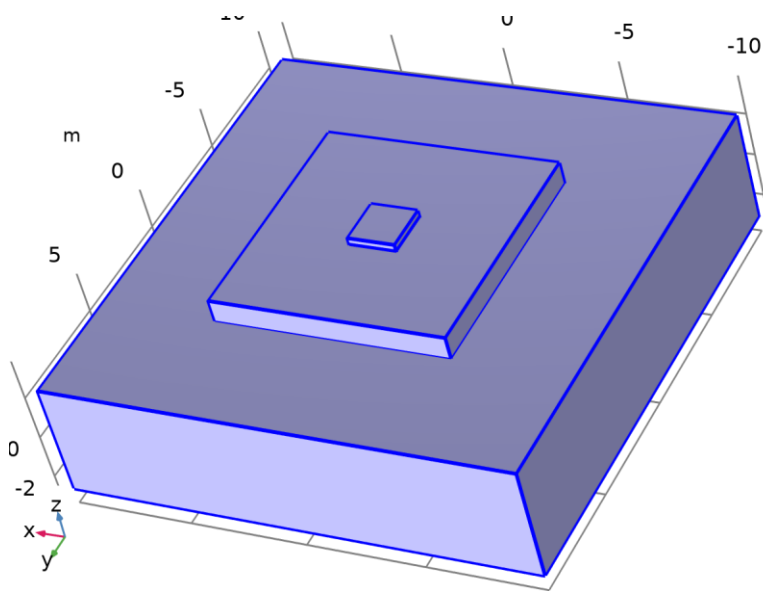
### 2.6.1 Electromagnetic Heating 1

#### USED PRODUCTS

COMSOL Multiphysics



### Electromagnetic Heating 1



### Boundary selection

#### SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 3: All domains

#### EQUATIONS

$$\rho c_p \frac{\partial T}{\partial t} + \rho c_p \mathbf{u} \cdot \nabla T = \nabla \cdot (k \nabla T) + Q_e$$



## Coupled Interfaces

### SETTINGS

Description	Value
Electromagnetic	Electric Currents (ec)
Heat transfer	Heat Transfer in Solids (ht)

### Variables

Name	Expression	Unit	Description	Selection	Details
ht.ndflux_u	$\text{if}(\text{ht.isSolving}, 0, \text{if}(\text{ht.TuIsDown}, 0, -0.5 * \text{emh1.Qb}) + \text{if}(\text{ht.TdIsUp}, -0.5 * \text{emh1.Qb}, 0))$	W/m <sup>2</sup>	Internal normal conductive heat flux, upside	Boundaries 8, 13, 16	+ operation
ht.ndflux_d	$\text{if}(\text{ht.isSolving}, 0, \text{if}(\text{ht.TdIsUp}, 0, -0.5 * \text{emh1.Qb}) + \text{if}(\text{ht.TuIsDown}, -0.5 * \text{emh1.Qb}, 0))$	W/m <sup>2</sup>	Internal normal conductive heat flux, downside	Boundaries 8, 13, 16	+ operation
ht.Q	emh1.Q	W/m <sup>3</sup>	Heat source	Domains 1–4	+ operation
ht.Qtot	emh1.Q	W/m <sup>3</sup>	Total heat source	Domains 1–4	+ operation
ht.Qbtot	emh1.Qb	W/m <sup>2</sup>	Total boundary heat source	Boundaries 1–23	+ operation
ht.ntflux_contrib	emh1.Qb	W/m <sup>2</sup>	Boundary sources and fluxes contribution	Boundaries 8, 13, 16	+ operation
emh1.Q	ec.Qh	W/m <sup>3</sup>	Heat source	Domains 1–4	
emh1.T	T	K	Temperature	Domains 1–4	
emh1.Qb	ec.Qsh	W/m <sup>2</sup>	Boundary heat source	Global	
emh1.varInt	1		Intermediate variable	Boundaries 1–23	Meta
emh1.Tvar	$0.5 * (\text{ht.Tu} + \text{ht.Td})$	K	Temperature	Boundaries 1–23	
emh1.ntfluxInt	$\text{emh1.intExtBnd}(\text{ht.ntflux} * \text{ht.varIntSpa}) + \text{emh1.intIntBnd}(\text{ht.ncflux\_u} * \text{up}(\text{ht.varIntSpa}) + \text{ht.ncflux\_d} * \text{down}(\text{ht.varIntSpa}))$	W	Total net heat rate	Global	
emh1.ntfluxInt_const	$\text{emh1.intExtBnd}(\text{ht.ntflux} * \text{ht.varIntSpa}) + \text{emh1.intIntBnd}(\text{ht.ncflux\_u} * \text{up}(\text{ht.varIntSpa}) + \text{ht.ncflux\_d} * \text{down}(\text{ht.varIntSpa}))$	W	Total net heat rate, constant	Global	

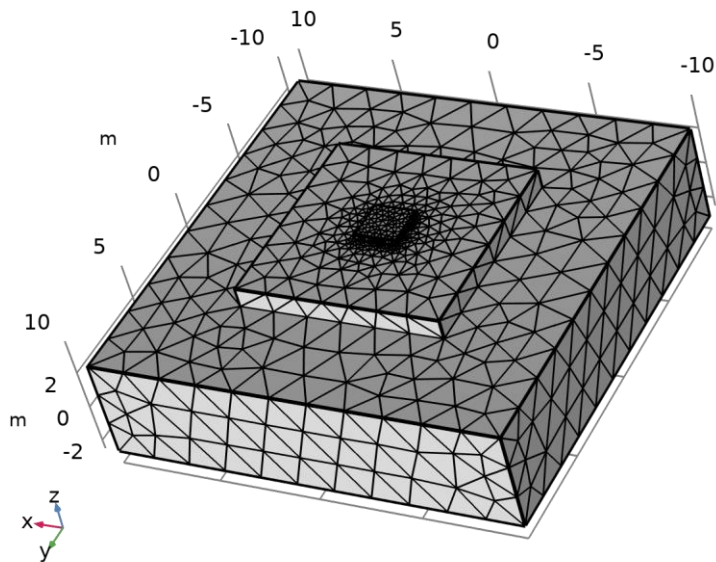
Name	Expression	Unit	Description	Selection	Details
	$1.\text{intIntBnd}(\text{ht.ncflux\_u} * \text{up}(\text{ht.varIntSpa}) + \text{ht.ncflux\_d} * \text{down}(\text{ht.varIntSpa}))$		material properties		
emh1.ntefluxInt	$\text{emh1.intExtBnd}(\text{ht.nteflux} * \text{ht.varIntSpa}) + \text{emh1.intIntBnd}(\text{ht.nthflux\_u} * \text{up}(\text{ht.varIntSpa}) + \text{ht.nthflux\_d} * \text{down}(\text{ht.varIntSpa}))$	W	Total net energy rate	Global	
emh1.ntefluxInt_cst	$\text{emh1.intExtBnd}(\text{ht.nteflux\_cst} * \text{ht.varIntSpa}) + \text{emh1.intIntBnd}(\text{ht.nthflux\_cst\_u} * \text{up}(\text{ht.varIntSpa}) + \text{ht.nthflux\_cst\_d} * \text{down}(\text{ht.varIntSpa}))$	W	Total net energy rate, constant material properties	Global	
emh1.ntfluxInt_u	$\text{emh1.intIntBnd}(\text{ht.ntflux\_u} * \text{up}(\text{ht.varIntSpa}))$	W	Total net heat rate, upside	Global	
emh1.ntfluxInt_cst_u	$\text{emh1.intIntBnd}(\text{ht.ntflux\_u} * \text{up}(\text{ht.varIntSpa}))$	W	Total net heat rate, constant material properties, upside	Global	
emh1.ntefluxInt_u	$\text{emh1.intIntBnd}(\text{ht.nteflux\_u} * \text{up}(\text{ht.varIntSpa}))$	W	Total net energy rate, upside	Global	
emh1.ntefluxInt_cst_u	$\text{emh1.intIntBnd}(\text{ht.nteflux\_cst\_u} * \text{up}(\text{ht.varIntSpa}))$	W	Total net energy rate, constant material properties, upside	Global	
emh1.ntfluxInt_d	$\text{emh1.intIntBnd}(\text{ht.ntflux\_d} * \text{down}(\text{ht.varIntSpa}))$	W	Total net heat rate, downside	Global	
emh1.ntfluxInt_cst_d	$\text{emh1.intIntBnd}(\text{ht.ntflux\_d} * \text{down}(\text{ht.varIntSpa}))$	W	Total net heat rate, constant material properties, downside	Global	
emh1.ntefluxInt_d	$\text{emh1.intIntBnd}(\text{ht.nteflux\_d} * \text{down}(\text{ht.varIntSpa}))$	W	Total net energy rate, downside	Global	
emh1.ntefluxInt_cst_d	$\text{emh1.intIntBnd}(\text{ht.nteflux\_cst\_d} * \text{down}(\text{ht.varIntSpa}))$	W	Total net energy rate, constant material	Global	

Name	Expression	Unit	Description	Selection	Details
			properties, downside		
emh1.Tave	nojac(emh1.intBnd(ht.varIntSpa*ht.rho*ht.Cp*T*max(abs(ht.ux*ht.nxmesh+ht.uy*ht.nymesh+ht.uz*ht.nzmesh),eps)))/nojac(emh1.intBnd(ht.varIntSpa*ht.rho*ht.Cp*max(abs(ht.ux*ht.nxmesh+ht.uy*ht.nymesh+ht.uz*ht.nzmesh),eps)))	K	Weighted average temperature	Global	
emh1.T_cmi	model.input.T_cmi	K	Temperature	Global	Meta

### Weak Expressions

Weak expression	Integration order	Integration frame	Selection
emh1.Q*test(T)*ht.d	4	Spatial	Domains 1–4
emh1.Qb*test(emh1.Tvar)	4	Spatial	Boundaries 1–23

## 2.7 MESH 1



Mesh 1

### 2.7.1 Size (size)

#### SETTINGS

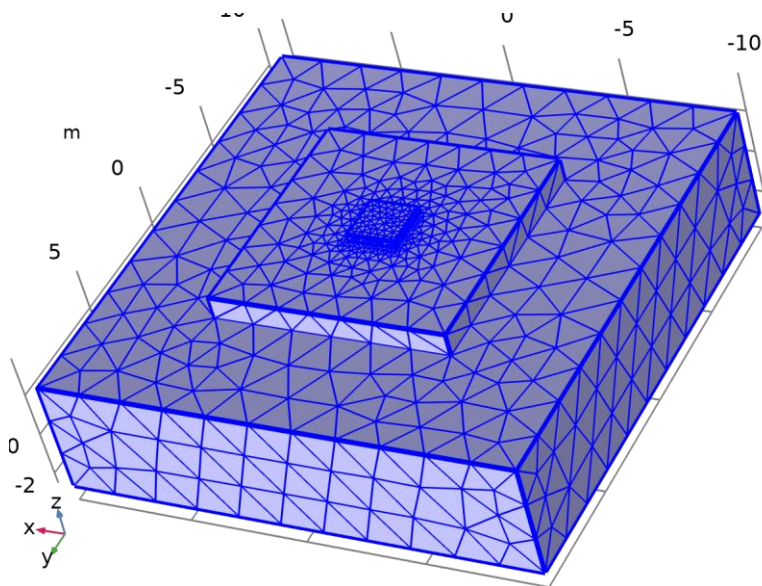
Description	Value
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Description	Value
Maximum element size	2
Minimum element size	0.1474
Curvature factor	0.6
Resolution of narrow regions	0.5
Maximum element growth rate	1.5
Custom element size	Custom

## 2.7.2 Size 1 (size1)

### SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 2: Boundaries 1–23



Size 1

### SETTINGS

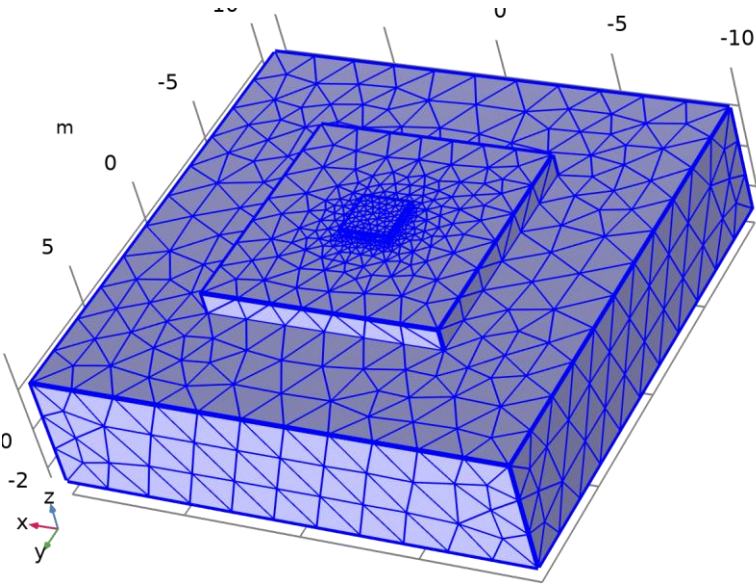
Description	Value
Maximum element size	1.838
Minimum element size	0.05514
Curvature factor	0.6
Curvature factor	Off
Resolution of narrow regions	0.5
Resolution of narrow regions	Off
Maximum element growth rate	1.5
Maximum element growth rate	Off

Description	Value
Custom element size	Custom

### 2.7.3 Free Tetrahedral 1 (ftet1)

#### SELECTION

Geometric entity level	Domain
Selection	Remaining



Free Tetrahedral 1

#### SETTINGS

Description	Value
Avoid inverted curved elements	On

#### INFORMATION

Description	Value
Last build time	< 1 second
Built with	COMSOL 6.3.0.420 (win64), Aug 14, 2025, 12:06:30 PM

### 3 Study 1

#### COMPUTATION INFORMATION

Computation time	3 min 16 s
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#### 3.1 TIME DEPENDENT

Times	Unit
range(0,1,3600)	s

#### STUDY SETTINGS

Description	Value
Include geometric nonlinearity	Off

#### STUDY SETTINGS

Description	Value
Output times	{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584,

Description	Value
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#### PHYSICS AND VARIABLES SELECTION

Key	Solve for
Heat Transfer in Solids (ht)	On
Electric Currents (ec)	On

#### PHYSICS AND VARIABLES SELECTION

Feature	Solve for
Electromagnetic Heating 1 (emh1)	On

#### STORE IN OUTPUT

Interface	Output	Selection
Heat Transfer in Solids (ht)	Physics controlled	
Electric Currents (ec)	Physics controlled	
Electromagnetic Heating 1 (emh1)		

#### MESH SELECTION

Component	Mesh
Component 1	Mesh 1

## 3.2 SOLVER CONFIGURATIONS

### 3.2.1 Solution 1

Compile Equations: Time Dependent (st1)

#### STUDY AND STEP

Description	Value
Use study	<a href="#">Study 1</a>
Use study step	Time Dependent

## Dependent Variables 1 (v1)

### GENERAL

Description	Value
Defined by study step	<a href="#">Step 1: Time Dependent</a>

### INITIAL VALUE CALCULATION CONSTANTS

Constant name	Initial-value source
t	{range(0, 1, 3600)}[s]
timestep	3.6[s]

## Temperature (comp1.T) (comp1\_T)

### GENERAL

Description	Value
Field components	comp1.T
Internal variables	{comp1.ht.dt2Inv_T, comp1.uflux.T, comp1.dflux.T}

## Electric Potential (comp1.V) (comp1\_V)

### GENERAL

Description	Value
Field components	comp1.V

## Time-Dependent Solver 1 (t1)

### GENERAL

Description	Value
Defined by study step	<a href="#">Step 1: Time Dependent</a>
Output times	{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210,

Description	Value
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#### ABSOLUTE TOLERANCE

Field	Method	Tolerance method	Tolerance factor	Derivative tolerance method	Time derivative factor	Tolerance	Tolerance for time derivatives
Temperature (comp1.T)	Use global	Factor	0.1	Automatic	1	0.001	0.001
Electric Potential (comp1.V)	Use global	Factor	0.1	Automatic	1	0.001	0.001

#### TIME STEPPING

Description	Value
Maximum BDF order	2

Description	Value
Error estimation	Exclude algebraic

#### Segregated 1 (se1)

##### GENERAL

Description	Value
Stabilization and acceleration	Anderson acceleration
Dimension of iteration space	5
Mixing parameter	0.9

#### Electric Currents (ss1)

##### GENERAL

Description	Value
Variables	Electric Potential (comp1.V)
Linear solver	<a href="#">Iterative 1</a>

##### METHOD AND TERMINATION

Description	Value
Damping factor	0.8

#### Temperature (ss2)

##### GENERAL

Description	Value
Variables	Temperature (comp1.T)
Linear solver	<a href="#">Direct, heat transfer variables (ht)</a>

##### METHOD AND TERMINATION

Description	Value
Damping factor	0.8
Jacobian update	Once per time step

#### Lower Limit 1 (ll1)

##### LOWER LIMIT

Description	Value
Lower limits (field variables)	comp1.T 0

#### Iterative 1 (i1)

##### GENERAL

Description	Value
Solver	Conjugate gradients

#### Multigrid 1 (mg1)

##### GENERAL

Description	Value
Solver	Algebraic multigrid

#### Direct, heat transfer variables (ht) (d1)

##### GENERAL

Description	Value
Solver	PARDISO
Pivoting perturbation	1E-13

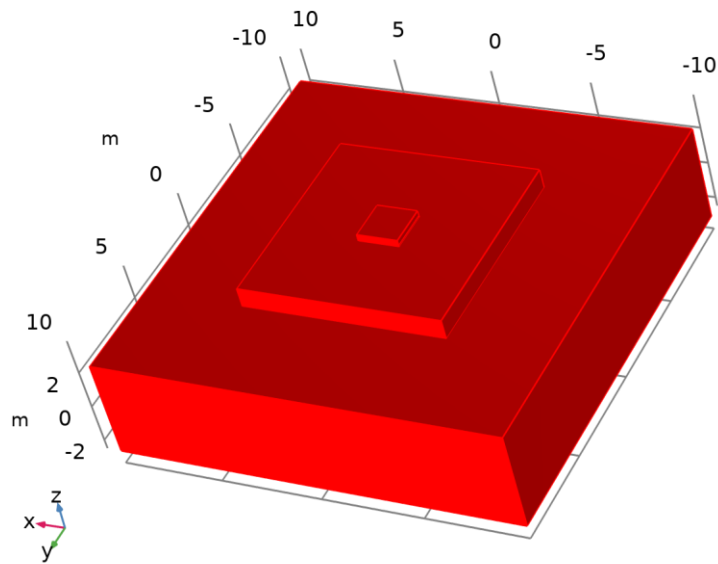
## 4 Results

### 4.1 DATASETS

#### 4.1.1 Study 1/Solution 1

##### SOLUTION

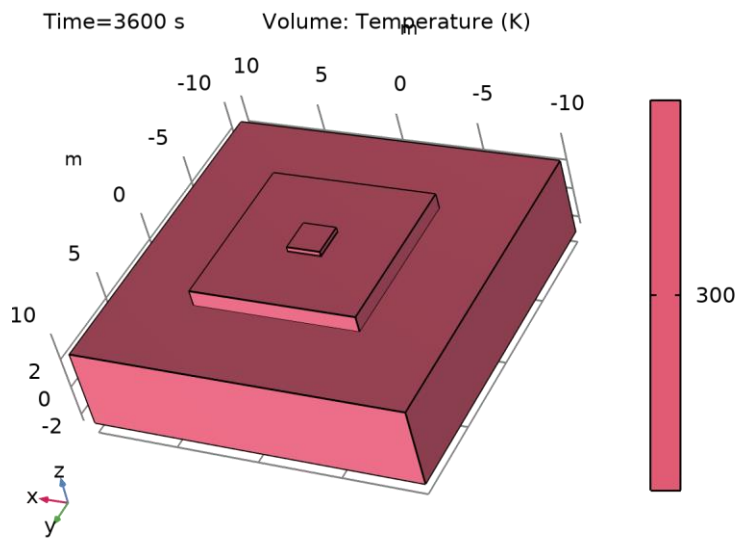
Description	Value
Solution	<a href="#">Solution 1 (sol1)</a>
Component	Component 1 (comp1)



*Dataset: Study 1/Solution 1*

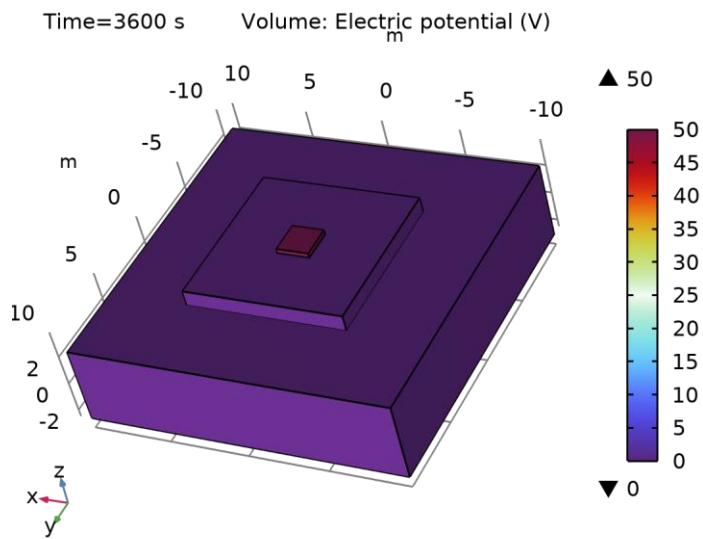
## 4.2 PLOT GROUPS

### 4.2.1 Temperature (ht)



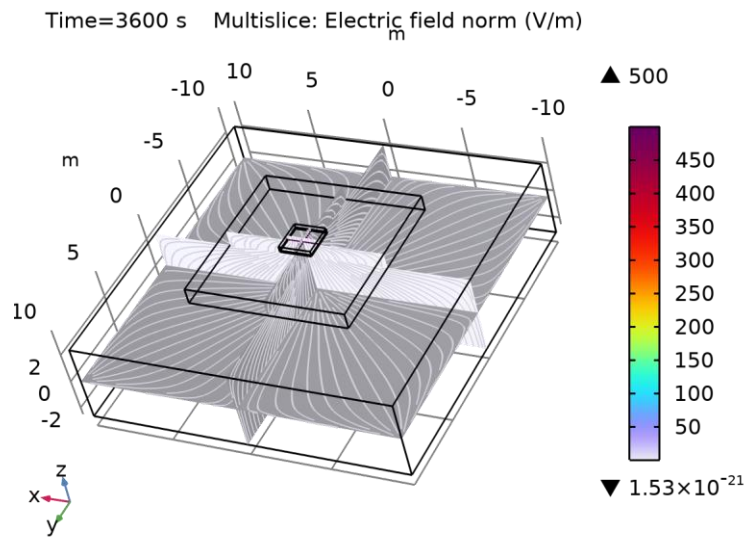
*Volume: Temperature (K)*

### 4.2.2 Electric Potential (ec)



*Volume: Electric potential (V)*

### 4.2.3 Electric Field (ec)



*Multislice: Electric field norm (V/m)*