shading pvc

Report date	Aug 31, 2025, 4:26:48 AM

Contents

1   Global Definitions

Date	Aug 5, 2025, 12:44:43 PM

GLOBAL SETTINGS

Name	Project3.1.mph
Path	C:\Users\91880\Desktop\placement prep\self project\project3.1.mph
Version	COMSOL Multiphysics 6.3 (Build: 420)

USED PRODUCTS

COMSOL Multiphysics

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
eta	0.18	0.18	efficiency of PV cells
beta	0.0045	0.0045	temperature coefficient
T_ref	298.15[K]	298.15 K	reference temp
q_sum	1000[W/m^2]	1000 W/m²	sunlight irradiance
q_shade	200[W/m^2]	200 W/m²	shaded irradiance
T_amb	298.15[K]	298.15 K	ambient temp
hc	10	10	convective coolong coeff

2 Component 1

Description	Value
Unit system	Same as global system (SI)

2.1 DEFINITIONS

2.1.1 Selections

sunlight

Selection type
Explicit

Selection
Boundaries 4, 8, 12, 16, 20, 24, 29, 33, 37, 41, 45, 49, 54, 58, 62, 66, 70, 74, 79, 83, 87, 91, 95, 99, 104, 108, 112, 116, 120, 124, 129, 133, 137, 141, 145, 149, 154, 158, 162, 166, 170, 174, 179, 183, 187, 191, 195, 199

COLOR

Description	Value
Color	Color 2

shaded

Selection type
Explicit

Selection
Boundaries 204, 208, 212, 216, 220, 224, 229, 233, 237, 241, 245, 249

COLOR

Description	Value
Color	Color 19

2.1.2 Coordinate Systems

Boundary System 1

Coordinate system type	Boundary system
Tag	sys1

COORDINATE NAMES

First	Second	Third

First	Second	Third
t1	t2	n

2.2   GEOMETRY 1
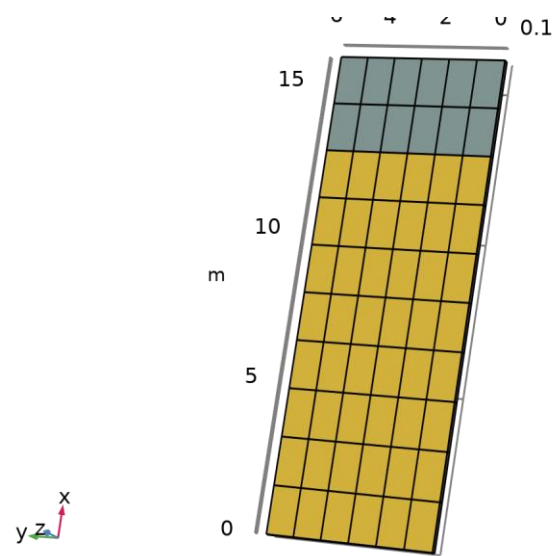
Geometry 1

Length unit	m
Angular unit	deg

GEOMETRY STATISTICS

Description	Value
Space dimension	3
Number of domains	60
Number of boundaries	256
Number of edges	349
Number of vertices	154

2.2.1   Block 1 (blk1)

SIZE AND SHAPE

Description	Value
Width	1.6
Depth	1
Height	0.15

Description	Value
Position	{0, 0, 0}

AXIS

Description	Value
Axis type	z - axis

2.2.2 Array 1 (arr1)

INPUT OBJECTS

Description	Value
Input objects	geom1, Geometry geom1: Object: blk1

SIZE

Description	Value
Size	{10, 6, 1}

DISPLACEMENT

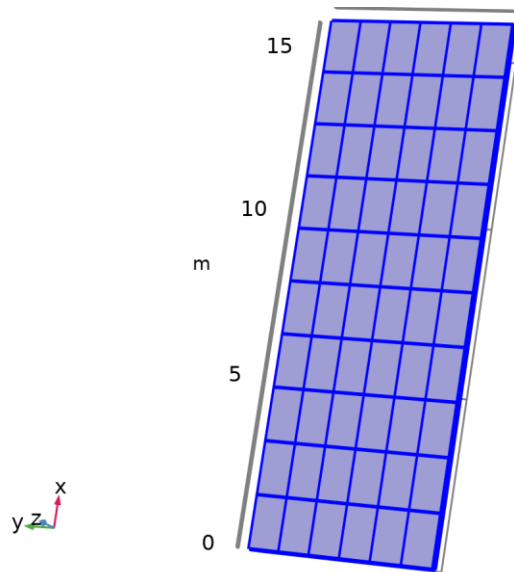| Description	Value
Displacement	{1.6, 1, 0}

2.2.3 Form Union (fin)

INFORMATION

Description	Value
Build message	Formed union of 60 solid objects. Union has 60 domains, 256 boundaries, 349 edges, and 154 vertices.

2.3 MATERIALS

2.3.1 Silicon

Silicon

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

MATERIAL PARAMETERS

Name	Value	Unit	Property group
Heat capacity at constant pressure	700	J/(kg·K)	Basic
Density	2329	kg/m³	Basic
Thermal conductivity	130	W/(m·K)	Basic

BASIC

Description	Value	Unit
Heat capacity at constant pressure	700	J/(kg·K)
Density	2329	kg/m³
Thermal conductivity	130	W/(m·K)

2.4 HEAT TRANSFER IN SOLIDS

USED PRODUCTS

COMSOL Multiphysics
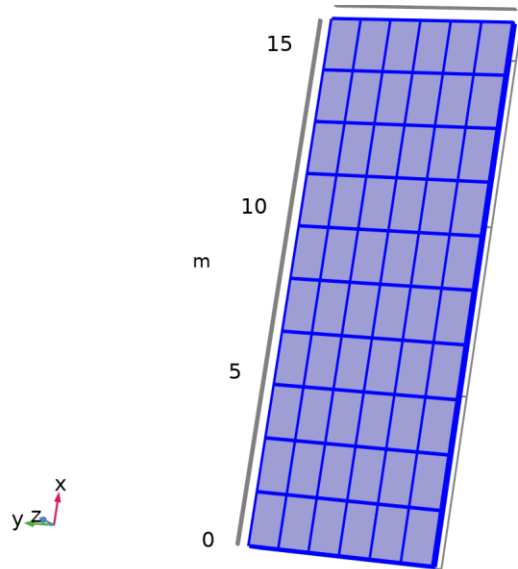
Heat Transfer in Solids

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

EQUATIONS

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

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
Reference temperature	User defined	
Reference temperature	293.15	K

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2.4.2 Solid 1
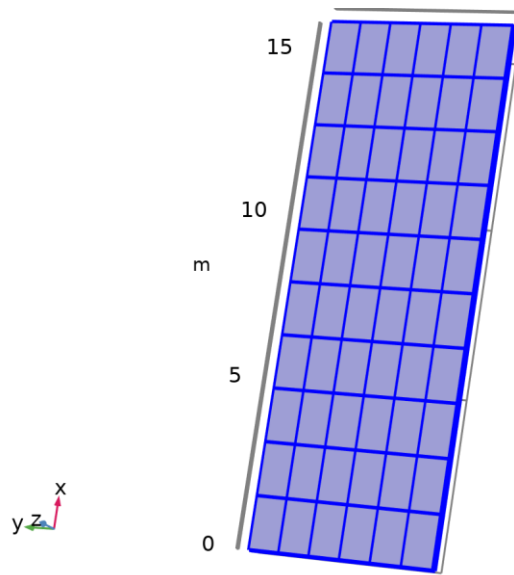
Solid 1

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

Description	Value
Coordinate system	Global coordinate system

Property	Material	Property group
Thermal conductivity	Silicon	Basic
Density	Silicon	Basic
Heat capacity at constant pressure	Silicon	Basic

2.4.3 Initial Values 1
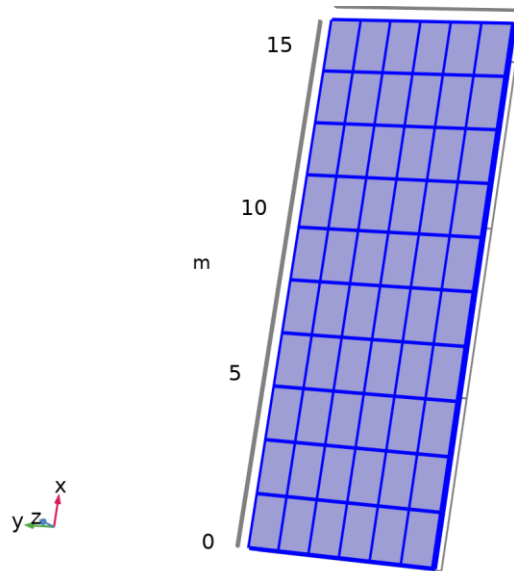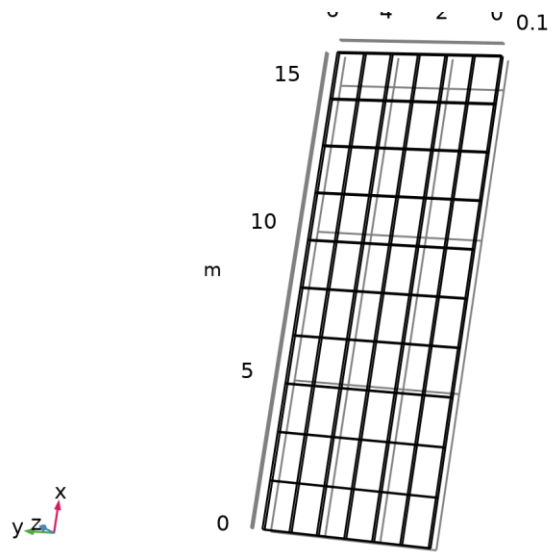

Initial Values 1

SELECTION

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

Initial Values

SETTINGS

Description	Value	Unit
Temperature	User defined	
Temperature	T_amb	K

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2.4.4 Thermal Insulation 1
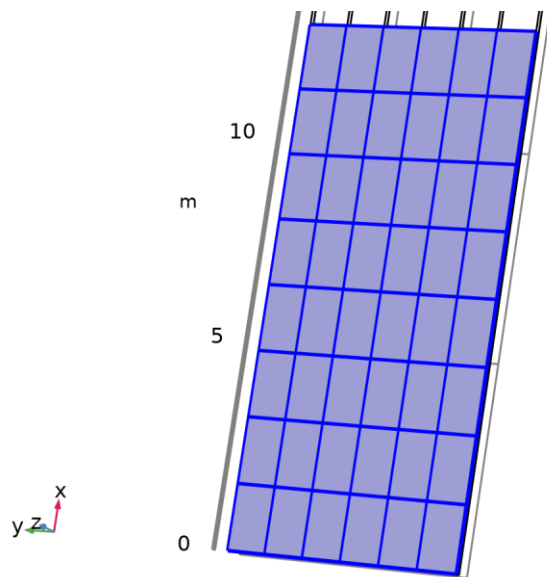

Thermal Insulation 1

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

EQUATIONS

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

2.4.5 solar flux sunlight

solar flux sunlight

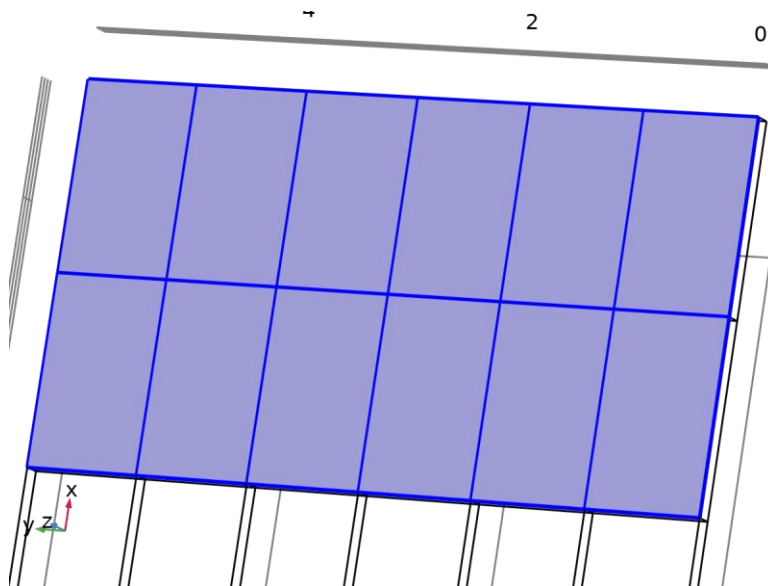| Geometric entity level	Boundary
Name	sunlight
Selection	Named sel1: Geometry geom1: Dimension 2: Boundaries 4, 8, 12, 16, 20, 24, 29, 33, 37, 41, 45, 49, 54, 58, 62, 66, 70, 74, 79, 83, 87, 91, 95, 99, 104, 108, 112, 116, 120, 124, 129, 133, 137, 141, 145, 149, 154, 158, 162, 166, 170, 174, 179, 183, 187, 191, 195, 199

EQUATIONS

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

Heat Flux

SETTINGS

Description	Value	Unit
Flux type	General inward heat flux	
Inward heat flux	q_sum*(1 - eta*(1 - beta*(T - T_ref)))	W/m²

2.4.6 solar flux shaded

solar flux shaded

SELECTION

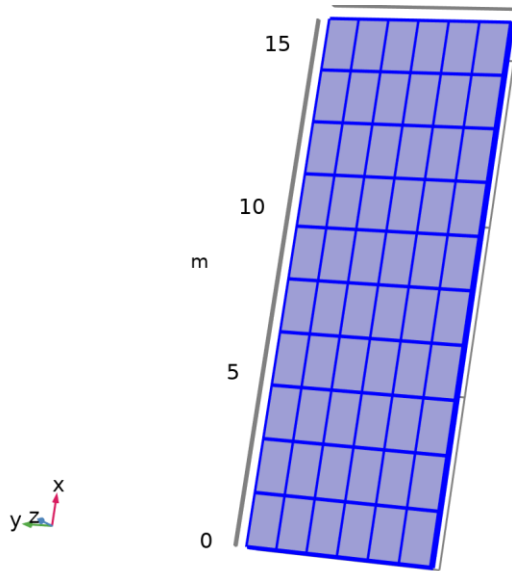| Geometric entity level	Boundary
Name	shaded
Selection	Named sel2: Geometry geom1: Dimension 2: Boundaries 204, 208, 212, 216, 220, 224, 229, 233, 237, 241, 245, 249

EQUATIONS

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

Heat Flux

Description	Value	Unit
Flux type	General inward heat flux	
Inward heat flux	q_shade*(1 - eta*(1 - beta*(T - T_ref)))	W/m²

2.4.7 convective cooling

convective cooling

SELECTION

| Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 2: Boundaries 1–5, 7–9, 11–13, 15–17, 19–21, 23–25, 27–29, 32–33, 36–37, 40–41, 44–45, 48–50, 52–54, 57–58, 61–62, 65–66, 69–70, 73–75, 77–79, 82–83, 86–87, 90–91, 94–95, 98–100, 102–104, 107–108, 111–112, 115–116, 119–120, 123–125, 127–129, 132–133, 136–137, 140–141, 144–145, 148–150, 152–154, 157–158, 161–162, 165–166, 169–170, 173–175, 177–179, 182–183, 186–187, 190–191, 194–195, 198–200, 202–204, 207–208, 211–212, 215–216, 219–220, 223–225, 227–229, 232–233, 236–237, 240–241, 244–245, 248–256

EQUATIONS

$$-\mathbf{n} \cdot \mathbf{q} = q_0$$
$$q_0 = h\left(T_{ext} - T\right)$$

Heat Flux

SETTINGS

Description	Value	Unit
Flux type	Convective heat flux	
Heat transfer coefficient	User defined	
Heat transfer coefficient	hc	W/(m²·K)
External temperature	User defined	
External temperature	T_amb	K

2.5 MESH 1
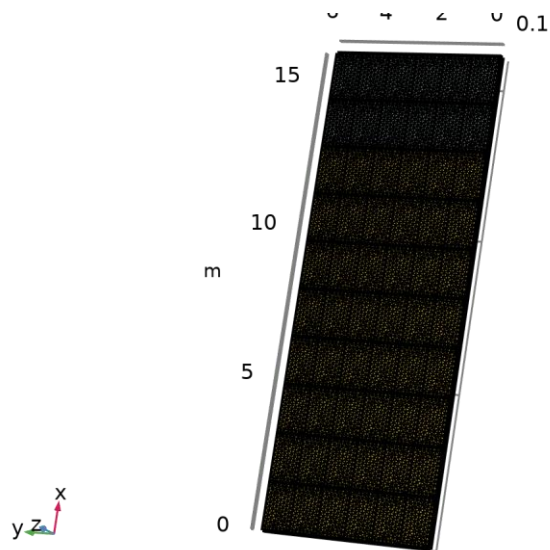
Mesh 1

2.5.1 Size (size)

SETTINGS

Description	Value
Maximum element size	0.4602
Minimum element size	0.024
Curvature factor	0.3
Resolution of narrow regions	0.85
Maximum element growth rate	1.35
Predefined size	Extra fine
Custom element size	Custom

2.5.2 Size 1 (size1)

SELECTION

Geometric entity level	Boundary

Selection	Geometry geom1: Dimension 2: Boundaries 1–256
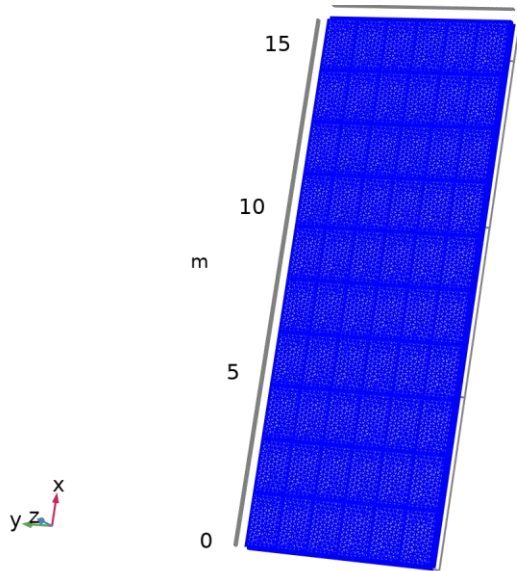
Size 1

SETTINGS

Description	Value
Maximum element size	0.1559
Minimum element size	0.004677
Curvature factor	0.3
Curvature factor	Off
Resolution of narrow regions	0.85
Resolution of narrow regions	Off
Maximum element growth rate	1.35
Maximum element growth rate	Off
Predefined size	Extra fine
Custom element size	Custom

2.5.3 Free Tetrahedral 1 (ftet1)

SELECTION

Geometric entity level	Domain
Selection	Remaining
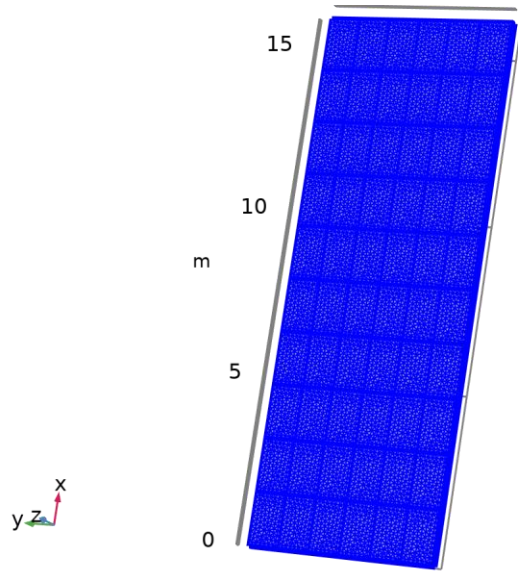
Free Tetrahedral 1

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 5, 2025, 12:13:14 PM

3 Study 1

Computation time	10 s

3.1 TIME DEPENDENT

Times	Unit
range(0,60,3600)	s

STUDY SETTINGS

Description	Value
Include geometric nonlinearity	Off

STUDY SETTINGS

Description	Value
Output times	{0, 60, 120, 180, 240, 300, 360, 420, 480, 540, 600, 660, 720, 780, 840, 900, 960, 1020, 1080, 1140, 1200, 1260, 1320, 1380, 1440, 1500, 1560, 1620, 1680, 1740, 1800, 1860, 1920, 1980, 2040, 2100, 2160, 2220, 2280, 2340, 2400, 2460, 2520, 2580, 2640, 2700, 2760, 2820, 2880, 2940, 3000, 3060, 3120, 3180, 3240, 3300, 3360, 3420, 3480, 3540, 3600}

PHYSICS AND VARIABLES SELECTION

Key	Solve for
Heat Transfer in Solids (ht)	On

STORE IN OUTPUT

Interface	Output	Selection
Heat Transfer in Solids (ht)	Physics controlled	

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	Study 1

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Description	Value
Use study step	Time Dependent

Dependent Variables 1 (v1)

GENERAL

Description	Value
Defined by study step	Step 1: Time Dependent

INITIAL VALUE CALCULATION CONSTANTS

Constant name	Initial-value source
t	{range(0, 60, 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}

Time-Dependent Solver 1 (t1)

GENERAL

Description	Value
Defined by study step	Step 1: Time Dependent
Output times	{0, 60, 120, 180, 240, 300, 360, 420, 480, 540, 600, 660, 720, 780, 840, 900, 960, 1020, 1080, 1140, 1200, 1260, 1320, 1380, 1440, 1500, 1560, 1620, 1680, 1740, 1800, 1860, 1920, 1980, 2040, 2100, 2160, 2220, 2280, 2340, 2400, 2460, 2520, 2580, 2640, 2700, 2760, 2820, 2880, 2940, 3000, 3060, 3120, 3180, 3240, 3300, 3360, 3420, 3480, 3540, 3600}

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

TIME STEPPING

Description	Value
Maximum BDF order	2

Description	Value
Error estimation	Exclude algebraic

Fully Coupled 1 (fc1)

GENERAL

Description	Value
Linear solver	Direct, heat transfer variables (ht)

METHOD AND TERMINATION

Description	Value
Damping factor	0.9
Jacobian update	Once per time step
Stabilization and acceleration	Anderson acceleration
Dimension of iteration space	5
Mixing parameter	0.9
Iteration delay	1

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
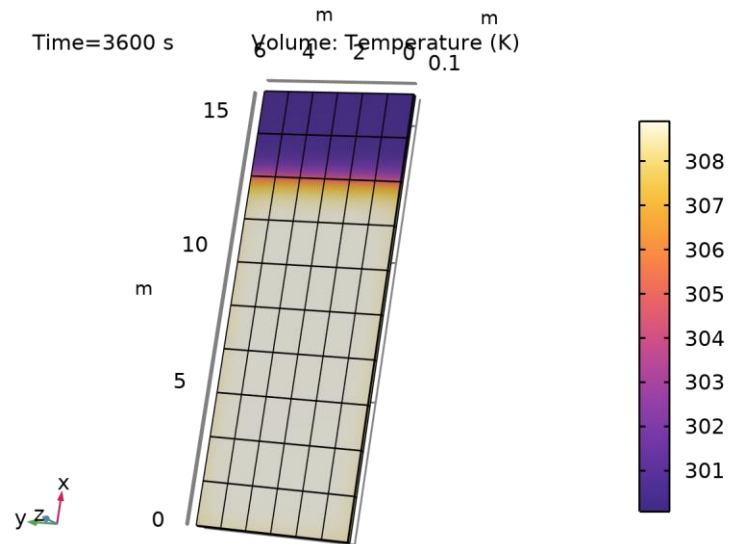
SOLUTION

Description	Value
Solution	Solution 1 (sol1)
Component	Component 1 (comp1)
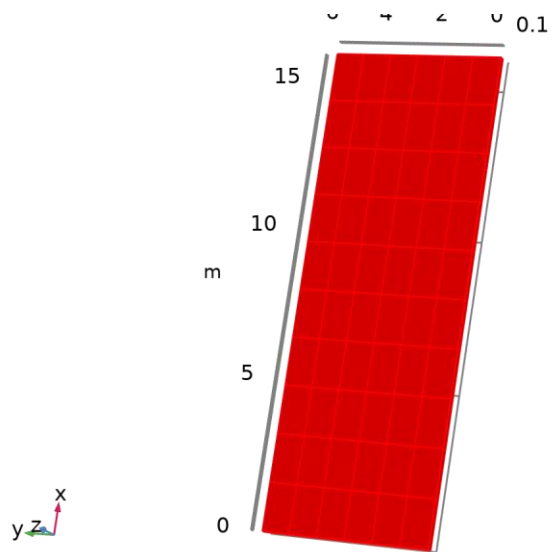
Dataset: Study 1/Solution 1

4.2 PLOT GROUPS

4.2.1 Temperature (ht)

Volume: Temperature (K)