COMSOL MULTIPHYSICS

Annex A. Report of Electromagnetic Model

Date	Sep 28, 2017 9:38:21 PM

Contents

1 Model 1 (mod1)

1.1 Definitions

1.1.1 Selections

Explicit 1

Selection type
Explicit

Selection
No boundaries

1.1.2 Coordinate Systems

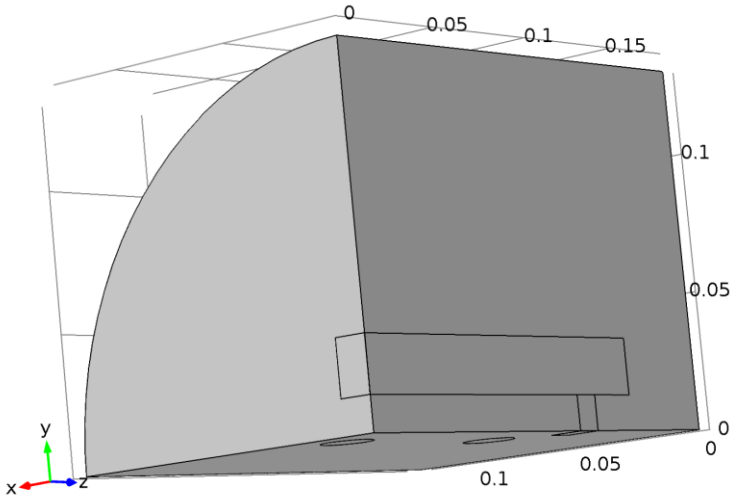
Boundary System 1

Coordinate system type	Boundary system
Identifier	sys1

Settings

Name	Value
Coordinate names	{t1, t2, n}
Create first tangent direction from	Global Cartesian

1.2 Geometry 1



Geometry 1

Units

Length unit	m

Angular unit	deg

Geometry statistics

Property	Value
Space dimension	3
Number of domains	5
Number of boundaries	31
Number of edges	61
Number of vertices	38

1.2.1 Block 1 (blk1)

Position

Name	Value
Position	{0, 0.0125, 0}

Axis

Name	Value
Axis type	Cartesian

Size and shape

Name	Value
Size	{0.0125, 0.02, 0.14}

1.2.2 kulka (blk2)

Position

Name	Value
Position	{0, 0, 0.11}

Size and shape

Name	Value
Size	{0.0125, 0.0125, 0.01}

1.2.3 varztas (cyl1)

Position

Name	Value
Position	{0.0275, 0, 0.01875}

Axis

Name	Value
Axis type	y - axis

Name	Value
Radius	0.009
Height	0.1

1.2.4 vrztas2 (cyl2)

Position

Name	Value
Position	{0.0275, 0, 0.09375}

Axis

Name	Value
Axis type	y - axis
Radius	0.009
Height	0.1

1.2.5 Cylinder 3 (cyl3)

Position

Name	Value
Position	{0, 0, 0}

Axis

Name	Value
Radius	0.13
Height	0.18

1.2.6 Block 3 (blk3)

Position

Name	Value
Position	{-0.13, -0.13, 0}

Size and shape

Name	Value
Size	{0.13, 0.26, 0.2}

1.2.7 Block 4 (blk4)

Position

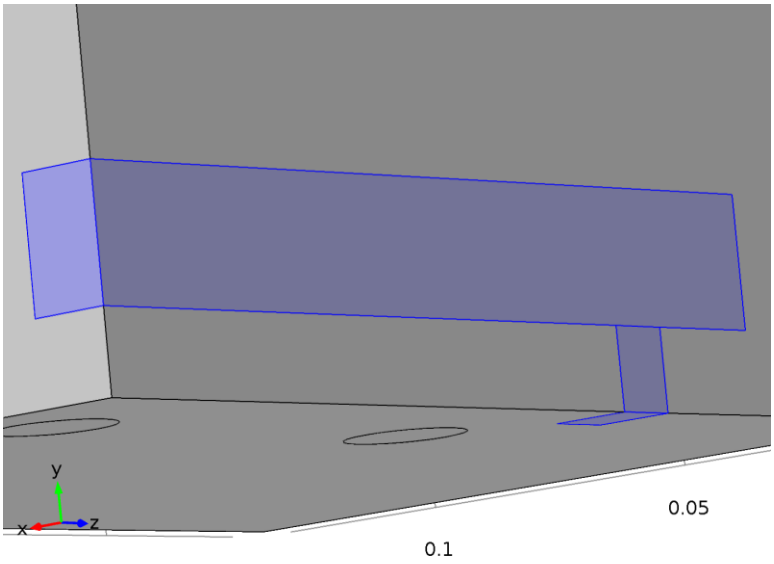
Name	Value
Position	{0, -0.13, 0}

Size and shape

Name	Value
Size	{0.13, 0.13, 0.2}

1.3 Materials

1.3.1 Copper



Copper

Selection

Geometric entity level	Domain
Selection	Domains 2–3

Material parameters

Name	Value	Unit
Relative permeability	1	1
Electrical conductivity	5.998e7[S/m]	S/m
Relative permittivity	1	1

Basic Settings

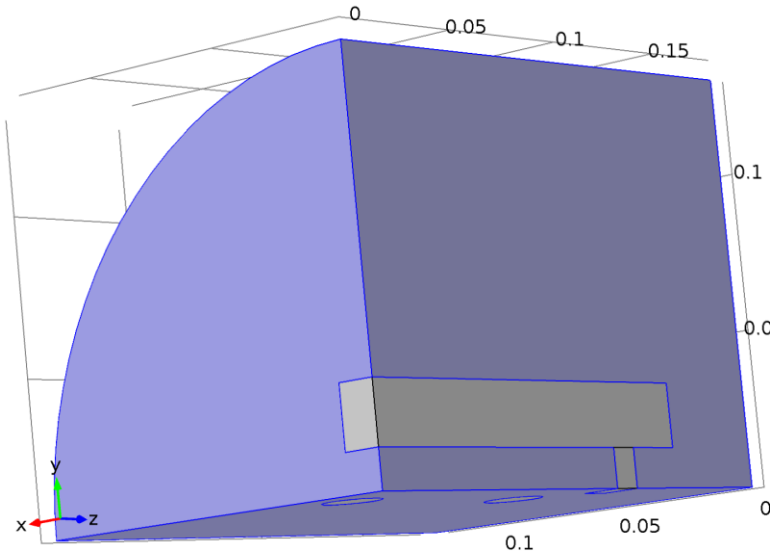
Description	Value
Relative permeability	{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}
Electrical conductivity	{{5.998e7[S/m], 0, 0}, {0, 5.998e7[S/m], 0}, {0, 0, 5.998e7[S/m]}}
Heat capacity at constant pressure	385[J/(kg*K)]
Relative permittivity	{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}
Surface emissivity	0.49
Density	8700[kg/m^3]

Description	Value
Thermal conductivity	{{400[W/(m*K)], 0, 0}, {0, 400[W/(m*K)], 0}, {0, 0, 400[W/(m*K)]}}

Linearized resistivity Settings

Description	Value
Reference resistivity	1.72e-8[ohm*m]
Resistivity temperature coefficient	3.9e-3[1/K]
Reference temperature	273.15[K]

1.3.2 Air



Air

Selection

Geometric entity level	Domain
Selection	Domain 1

Material parameters

Name	Value	Unit
Electrical conductivity	0.000000000000008[S/m]	S/m
Relative permittivity	1	1
Relative permeability	1	1

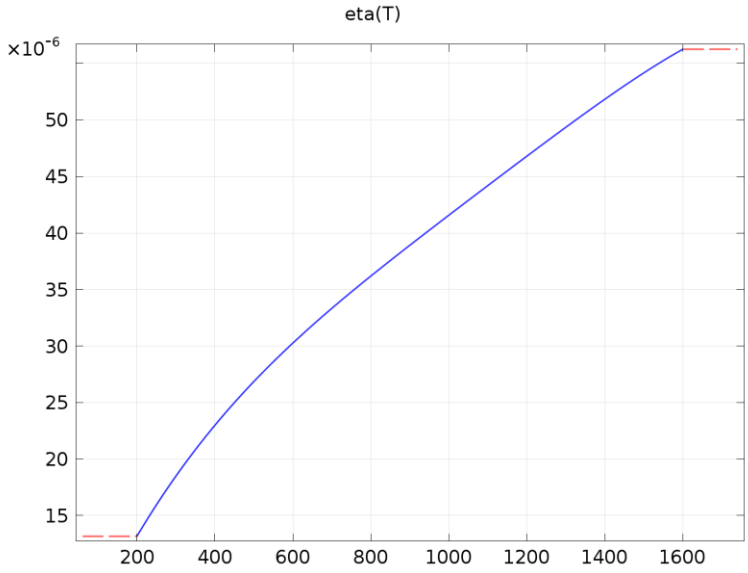
Basic Settings

Description	Value
Dynamic viscosity	eta(T[1/K])[Pa*s]
Ratio of specific heats	1.4

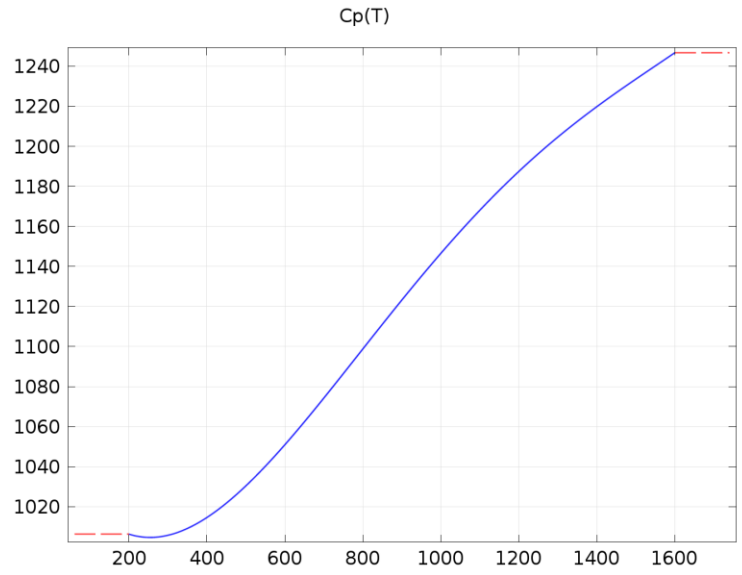
Description	Value
Electrical conductivity	{{0.000000000000008[S/m], 0, 0}, {0, 0.000000000000008[S/m], 0}, {0, 0, 0.000000000000008[S/m]}}
Heat capacity at constant pressure	Cp(T[1/K])[J/(kg*K)]
Density	rho(pA[1/Pa], T[1/K])[kg/m^3]
Thermal conductivity	{{k(T[1/K])[W/(m*K)], 0, 0}, {0, k(T[1/K])[W/(m*K)], 0}, {0, 0, k(T[1/K])[W/(m*K)]}}
Speed of sound	cs(T[1/K])[m/s]
Relative permittivity	{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}
Relative permeability	{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}

Functions

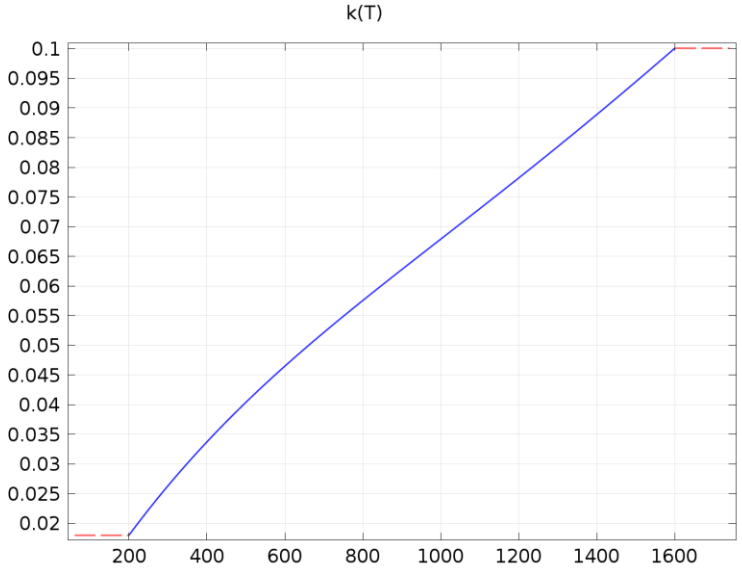
Function name	Type
eta	Piecewise
Cp	Piecewise
rho	Analytic
k	Piecewise
cs	Analytic



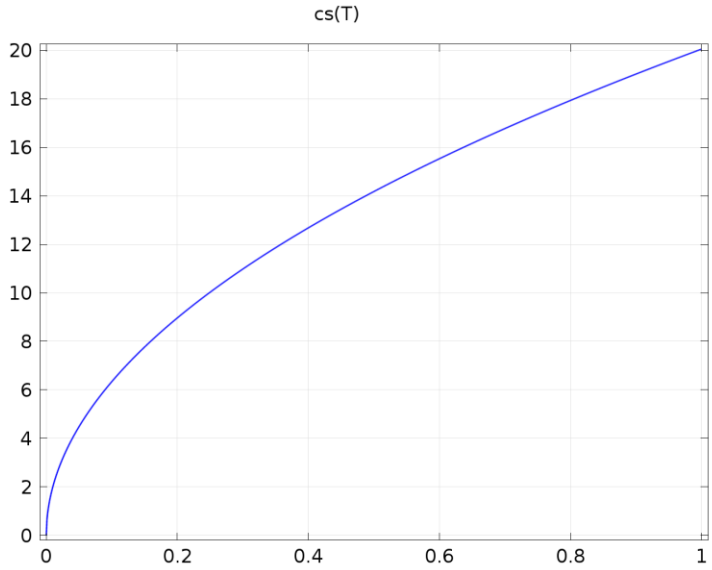
eta


Cp(T)
1240
1220
1200
1180
1160
1140
1120
1100
1080
1060
1040
1020
200
400
600
800
1000
1200
1400
1600

Cp


k(T)
0.1
0.095
0.09
0.085
0.08
0.075
0.07
0.065
0.06
0.055
0.05
0.045
0.04
0.035
0.03
0.025
0.02
200
400
600
800
1000
1200
1400
1600

k

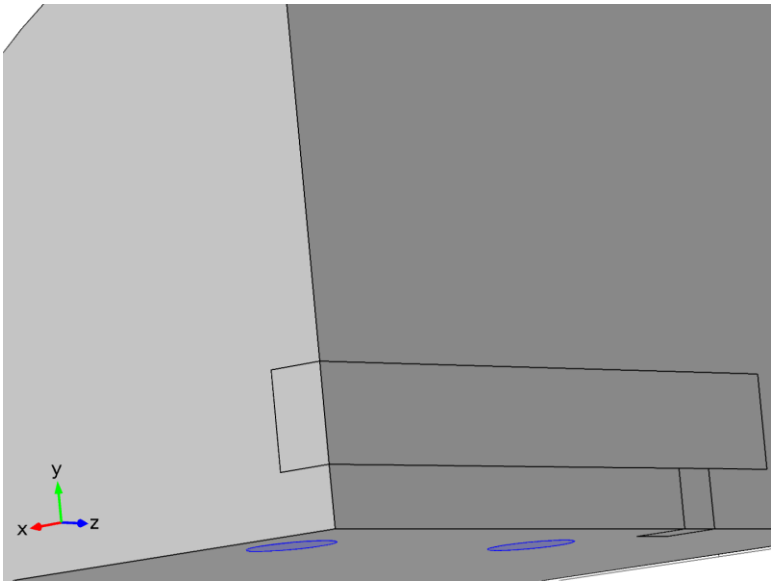


cs

Electrolyte conductivity Settings

Description	Value
Electrolyte conductivity	{{0, 0, 0}, {0, 0, 0}, {0, 0, 0}}

1.3.3 UNS S30615 (UNS S30615) [solid]



UNS S30615 (UNS S30615) [solid]

Selection

Geometric entity level	Domain
Selection	Domains 4–5

Material parameters

Name	Value	Unit

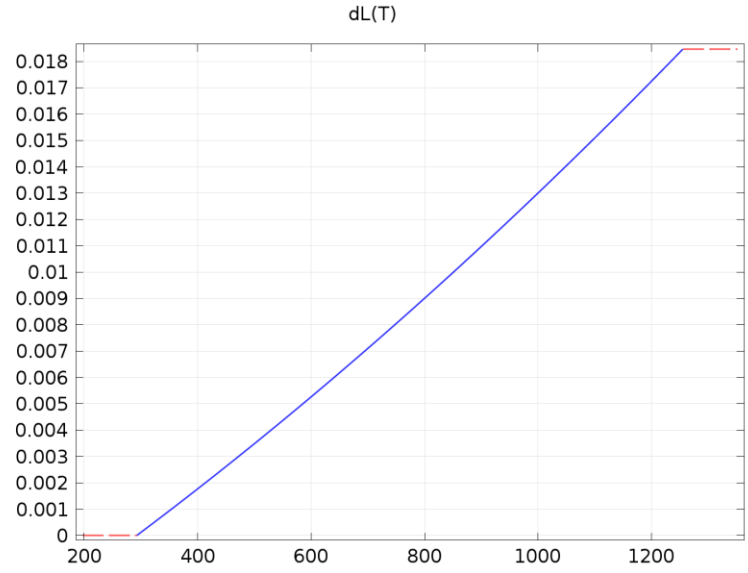
Name	Value	Unit
Electrical conductivity	10000000	S/m
Relative permeability	1	1
Relative permittivity	1	1

Basic Settings

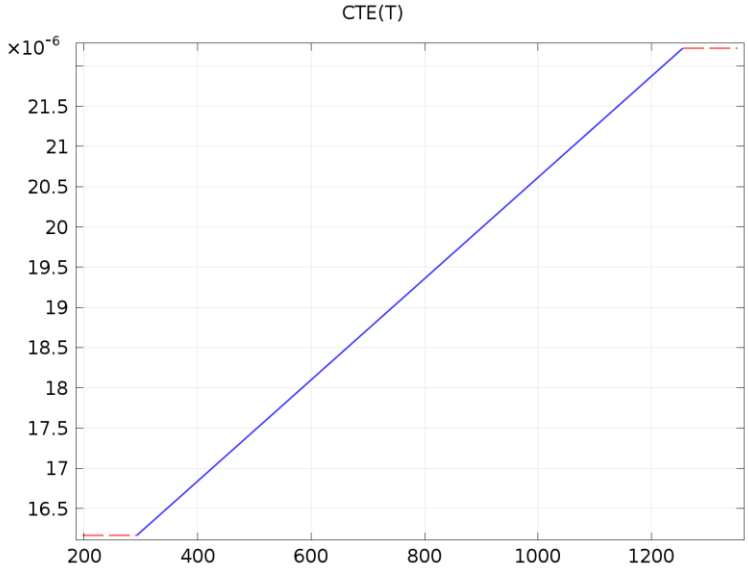
Description	Value
dL	(dL(T[1/K]) - dL(Tempref[1/K]))/(1 + dL(Tempref[1/K]))
CTE	CTE(T[1/K])[1/K]
Thermal conductivity	{{k(T[1/K])[W/(m*K)], 0, 0}, {0, k(T[1/K])[W/(m*K)], 0}, {0, 0, k(T[1/K])[W/(m*K)]}}
Syt	Syt(T[1/K])[Pa]
Coefficient of thermal expansion	{{(alpha(T[1/K])[1/K] + (Tempref - 293[K])*if(abs(T - Tempref)>1e-3, (alpha(T[1/K])[1/K] - alpha(Tempref[1/K])[1/K])/(T - Tempref), d(alpha(T[1/K]), T)[1/K]))/(1 + alpha(Tempref[1/K])[1/K]*(Tempref - 293[K])), 0, 0}, {0, (alpha(T[1/K])[1/K] + (Tempref - 293[K])*if(abs(T - Tempref)>1e-3, (alpha(T[1/K])[1/K] - alpha(Tempref[1/K])[1/K])/(T - Tempref), d(alpha(T[1/K]), T)[1/K]))/(1 + alpha(Tempref[1/K])[1/K]*(Tempref - 293[K])), 0}, {0, 0, (alpha(T[1/K])[1/K] + (Tempref - 293[K])*if(abs(T - Tempref)>1e-3, (alpha(T[1/K])[1/K] - alpha(Tempref[1/K])[1/K])/(T - Tempref), d(alpha(T[1/K]), T)[1/K]))/(1 + alpha(Tempref[1/K])[1/K]*(Tempref - 293[K]))}}
Density	7850
Electrical conductivity	{{10000000, 0, 0}, {0, 10000000, 0}, {0, 0, 10000000}}
Relative permeability	{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}
Relative permittivity	{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}

Functions

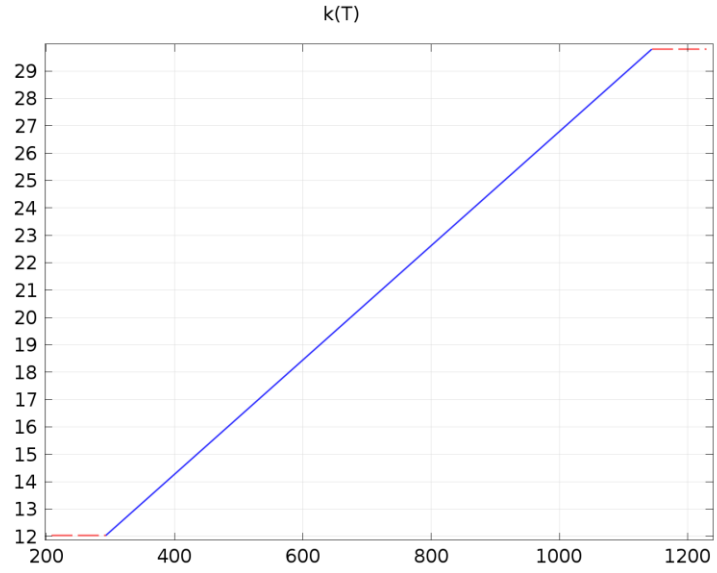
Function name	Type
dL	Piecewise
CTE	Piecewise
k	Piecewise
Syt	Piecewise
alpha	Piecewise
rho	Piecewise


dL(T)
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
200
400
600
800
1000
1200

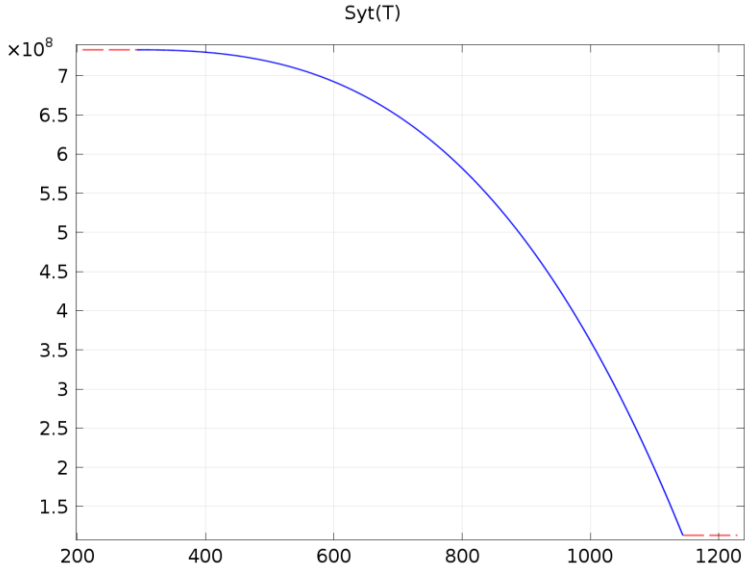
dL


CTE(T)
×10^-6
21.5
21
20.5
20
19.5
19
18.5
18
17.5
17
16.5
200
400
600
800
1000
1200

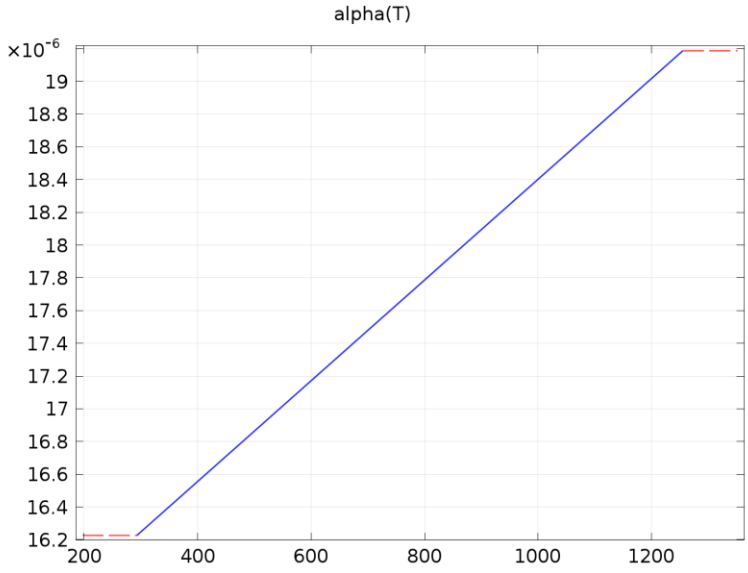
CTE


k(T)
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
200
400
600
800
1000
1200

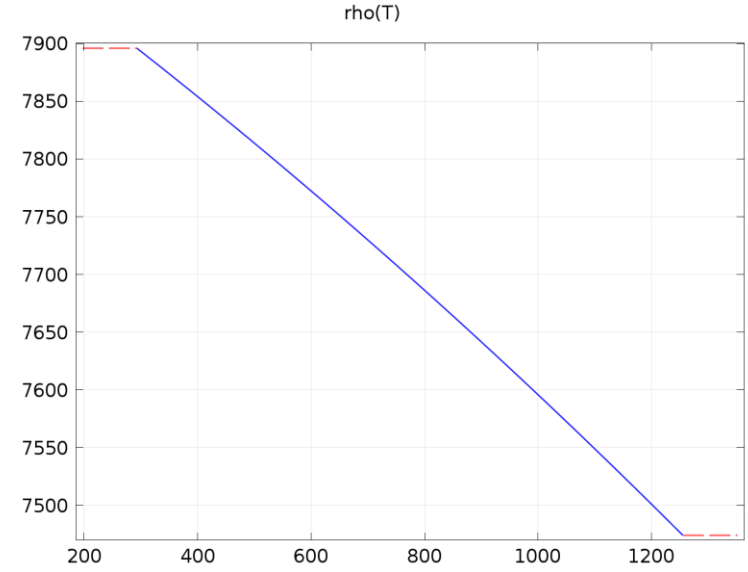
k


Syt(T)
×10^8
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
200
400
600
800
1000
1200

Syt



alpha



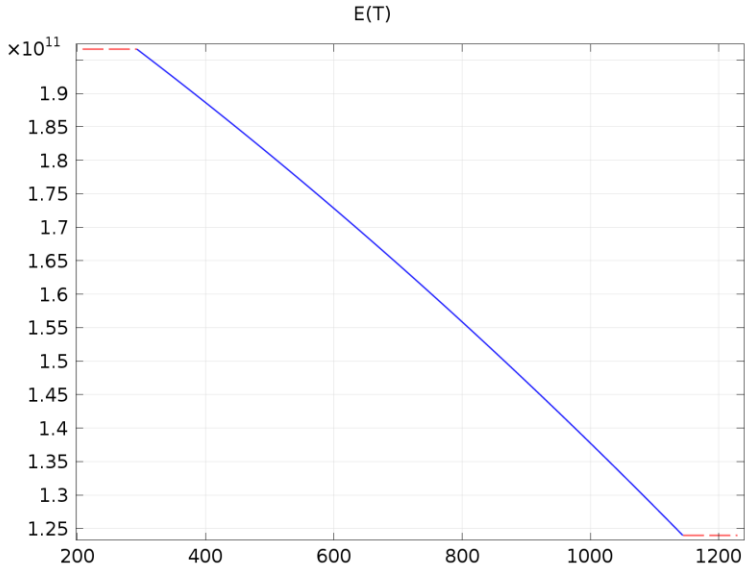
rho

Young's modulus and Poisson's ratio Settings

Description	Value
Young's modulus	205000000000
Poisson's ratio	0.3

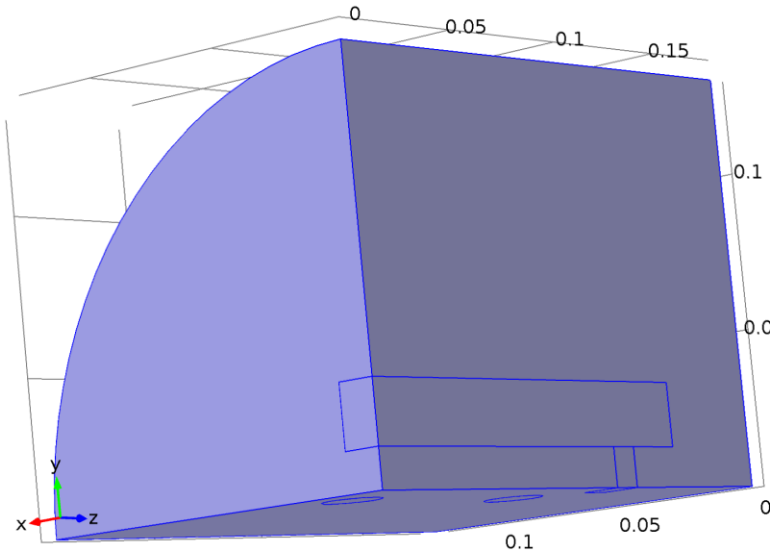
Functions

Function name	Type
E	Piecewise



E

1.4 Magnetic and Electric Fields (mef)



Magnetic and Electric Fields

Selection

Geometric entity level	Domain
Selection	Domains 1–5

Equations

$$\nabla \cdot \mathbf{J} = 0$$
$$\nabla \times \mathbf{H} = \mathbf{J}$$
$$\mathbf{J} = \sigma \mathbf{E} + j\omega \mathbf{D} + \mathbf{J}_e$$
$$\mathbf{E} = -\nabla V - j\omega \mathbf{A}$$
$$\mathbf{B} = \nabla \times \mathbf{A}$$

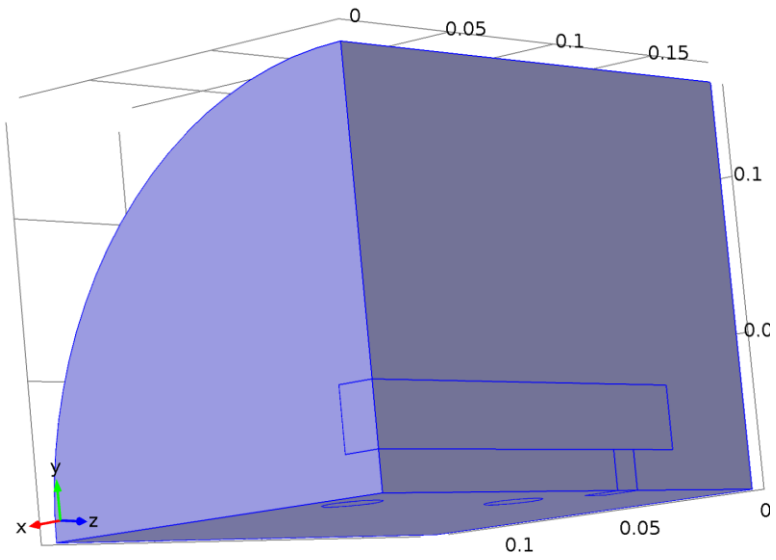
Settings

Description	Value
Magnetic vector potential	Quadratic
Electric potential	Quadratic
Value type when using splitting of complex variables	{Complex, Complex}
Equation form	Study controlled
Solve for	Full field
Activate input sweep	0
Reference impedance	50[ohm]
Show equation assuming	std1/freq

Used products

COMSOL Multiphysics
AC/DC Module

1.4.1 Ampère's Law and Current Conservation 1



Ampère's Law and Current Conservation 1

Selection

Geometric entity level	Domain
Selection	Domains 1–5

Equations

$$(j\omega\sigma - \omega^2\epsilon_0\epsilon_r)\mathbf{A} + \nabla \times (\mu_0^{-1}\mu_r^{-1}\mathbf{B}) - \sigma\mathbf{v} \times \mathbf{B} = \mathbf{J}_e$$

$$\mathbf{B} = \nabla \times \mathbf{A}$$

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

$$\mathbf{D} = \epsilon_0\epsilon_r\mathbf{E}$$

Settings

Settings

Description	Value
Electrical conductivity	From material
Electrical conductivity	{{0, 0, 0}, {0, 0, 0}, {0, 0, 0}}
Constitutive relation	Relative permittivity
Relative permittivity	From material
Relative permittivity	{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}
Constitutive relation	Relative permeability
Relative permeability	From material
Relative permeability	{{1, 0, 0}, {0, 1, 0}, {0, 0, 1}}
Temperature	User defined
Temperature	273.15[K]

Properties from material

Property	Material	Property group
Electrical conductivity	Copper	Basic
Relative permittivity	Copper	Basic
Relative permeability	Copper	Basic
Electrical conductivity	Air	Basic
Relative permittivity	Air	Basic
Relative permeability	Air	Basic
Electrical conductivity	UNS S30615 (UNS S30615) [solid]	Basic
Relative permittivity	UNS S30615 (UNS S30615) [solid]	Basic
Relative permeability	UNS S30615 (UNS S30615) [solid]	Basic

Variables

Name	Expression	Unit	Description	Selection
mef.unTex	-0.5*mef.dnx*(real(up(mef.Dx))*real(up(mef.Ex))+real(up(mef.Dy))*real(up(mef.Ey))+real(up(mef.Dz))*real(up(mef.Ez)))+real(up(mef.Dx))*(real(up(mef.Ex))*mef.dnx+real(up(mef.Ey))*mef.dny+real(up(mef.Ez))*mef.dnz)	Pa	Maxwell upward electric surface stress tensor, x component	Boundaries 6, 8, 11, 13–16, 18–19
mef.unTey	-	Pa	Maxwell upward	Boundaries 6,

Name	Expression	Unit	Description	Selection
	0.5*mef.dny*(real(up(mef.Dx))*real(up(mef.Ex))+real(up(mef.Dy))*real(up(mef.Ey))+real(up(mef.Dz))*real(up(mef.Ez)))+real(up(mef.Dy))*(real(up(mef.Ex))*mef.dnx+real(up(mef.Ey))*mef.dny+real(up(mef.Ez))*mef.dnz)		electric surface stress tensor, y component	8, 11, 13–16, 18–19
mef.unTez	-0.5*mef.dnz*(real(up(mef.Dx))*real(up(mef.Ex))+real(up(mef.Dy))*real(up(mef.Ey))+real(up(mef.Dz))*real(up(mef.Ez)))+real(up(mef.Dz))*(real(up(mef.Ex))*mef.dnx+real(up(mef.Ey))*mef.dny+real(up(mef.Ez))*mef.dnz)	Pa	Maxwell upward electric surface stress tensor, z component	Boundaries 6, 8, 11, 13–16, 18–19
mef.unTex	-0.5*mef.dnx*(real(up(mef.Dx))*real(up(mef.Ex))+real(up(mef.Dy))*real(up(mef.Ey))+real(up(mef.Dz))*real(up(mef.Ez)))+real(up(mef.Dx))*(real(up(mef.Ex))*mef.dnx+real(up(mef.Ey))*mef.dny+real(up(mef.Ez))*mef.dnz)	Pa	Maxwell upward electric surface stress tensor, x component	Boundaries 20–21, 23–24, 26–31
mef.unTey	-0.5*mef.dny*(real(up(mef.Dx))*real(up(mef.Ex))+real(up(mef.Dy))*real(up(mef.Ey))+real(up(mef.Dz))*real(up(mef.Ez)))+real(up(mef.Dy))*(real(up(mef.Ex))*mef.dnx+real(up(mef.Ey))*mef.dny+real(up(mef.Ez))*mef.dnz)	Pa	Maxwell upward electric surface stress tensor, y component	Boundaries 20–21, 23–24, 26–31
mef.unTez	-0.5*mef.dnz*(real(up(mef.Dx))*real(up(mef.Ex))+real(up(mef.Dy))*real(up(mef.Ey))+real(up(mef.Dz))*real(up(mef.Ez)))+real(up(mef.Dz))*(real(up(mef.Ex))*mef.dnx+real(up(mef.Ey))*mef.dny+real(up(mef.Ez))*m	Pa	Maxwell upward electric surface stress tensor, z component	Boundaries 20–21, 23–24, 26–31

Name	Expression	Unit	Description	Selection
	ef.dnz)			
mef.dnTex	-0.5*mef.unx*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dx))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, x component	Boundaries 6, 8, 11, 13–16, 18–19
mef.dnTey	-0.5*mef.uny*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dy))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, y component	Boundaries 6, 8, 11, 13–16, 18–19
mef.dnTez	-0.5*mef.unz*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dz))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, z component	Boundaries 6, 8, 11, 13–16, 18–19
mef.dnTex	-0.5*mef.unx*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dx))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, x component	Boundaries 20–21, 23–24, 26–31
mef.dnTey	-0.5*mef.uny*(real(down(	Pa	Maxwell downward electric surface	Boundaries 20–21, 23–

Name	Expression	Unit	Description	Selection
	mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dy))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)		stress tensor, y component	24, 26–31
mef.dnTez	-0.5*mef.unz*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dz))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, z component	Boundaries 20–21, 23–24, 26–31
mef.dnTex	-0.5*mef.unx*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dx))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, x component	Boundaries 4–5, 10, 12
mef.dnTey	-0.5*mef.uny*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dy))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, y component	Boundaries 4–5, 10, 12
mef.dnTez	-0.5*mef.unz*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(m	Pa	Maxwell downward electric surface stress tensor, z component	Boundaries 4–5, 10, 12

Name	Expression	Unit	Description	Selection
	ef.Ez)))+real(down(mef.Dz))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)			
mef.dnTex	-0.5*mef.unx*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dx))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, x component	Boundaries 1–3, 7, 9, 17
mef.dnTey	-0.5*mef.uny*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dy))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, y component	Boundaries 1–3, 7, 9, 17
mef.dnTez	-0.5*mef.unz*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dz))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, z component	Boundaries 1–3, 7, 9, 17
mef.dnTex	-0.5*mef.unx*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dx))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.	Pa	Maxwell downward electric surface stress tensor, x component	Boundaries 22, 25

Name	Expression	Unit	Description	Selection
	Ez))*mef.unz)			
mef.dnTey	-0.5*mef.uny*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dy))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, y component	Boundaries 22, 25
mef.dnTez	-0.5*mef.unz*(real(down(mef.Dx))*real(down(mef.Ex))+real(down(mef.Dy))*real(down(mef.Ey))+real(down(mef.Dz))*real(down(mef.Ez)))+real(down(mef.Dz))*(real(down(mef.Ex))*mef.unx+real(down(mef.Ey))*mef.uny+real(down(mef.Ez))*mef.unz)	Pa	Maxwell downward electric surface stress tensor, z component	Boundaries 22, 25
mef.unTmx	-0.5*mef.dnx*(real(up(mef.Bx))*real(up(mef.Hx))+real(up(mef.By))*real(up(mef.Hy))+real(up(mef.Bz))*real(up(mef.Hz)))+real(up(mef.Bx))*(real(up(mef.Hx))*mef.dnx+real(up(mef.Hy))*mef.dny+real(up(mef.Hz))*mef.dnz)	Pa	Maxwell upward magnetic surface stress tensor, x component	Boundaries 6, 8, 11, 13–16, 18–19
mef.unTmy	-0.5*mef.dny*(real(up(mef.Bx))*real(up(mef.Hx))+real(up(mef.By))*real(up(mef.Hy))+real(up(mef.Bz))*real(up(mef.Hz)))+real(up(mef.By))*(real(up(mef.Hx))*mef.dnx+real(up(mef.Hy))*mef.dny+real(up(mef.Hz))*mef.dnz)	Pa	Maxwell upward magnetic surface stress tensor, y component	Boundaries 6, 8, 11, 13–16, 18–19
mef.unTmz	-0.5*mef.dnz*(real(up(mef.Bx))*real(up(mef.Hx))+real(up(mef.By))*real(up(mef.	Pa	Maxwell upward magnetic surface stress tensor, z component	Boundaries 6, 8, 11, 13–16, 18–19

Name	Expression	Unit	Description	Selection
	Hy))+real(up(mef.Bz))*real(up(mef.Hz)))+real(up(mef.Bz))*(real(up(mef.Hx))*mef.dnx+real(up(mef.Hy))*mef.dny+real(up(mef.Hz))*mef.dnz)			
mef.unTmx	-0.5*mef.dnx*(real(up(mef.Bx))*real(up(mef.Hx))+real(up(mef.By))*real(up(mef.Hy))+real(up(mef.Bz))*real(up(mef.Hz)))+real(up(mef.Bx))*(real(up(mef.Hx))*mef.dnx+real(up(mef.Hy))*mef.dny+real(up(mef.Hz))*mef.dnz)	Pa	Maxwell upward magnetic surface stress tensor, x component	Boundaries 20–21, 23–24, 26–31
mef.unTmy	-0.5*mef.dny*(real(up(mef.Bx))*real(up(mef.Hx))+real(up(mef.By))*real(up(mef.Hy))+real(up(mef.Bz))*real(up(mef.Hz)))+real(up(mef.By))*(real(up(mef.Hx))*mef.dnx+real(up(mef.Hy))*mef.dny+real(up(mef.Hz))*mef.dnz)	Pa	Maxwell upward magnetic surface stress tensor, y component	Boundaries 20–21, 23–24, 26–31
mef.unTmz	-0.5*mef.dnz*(real(up(mef.Bx))*real(up(mef.Hx))+real(up(mef.By))*real(up(mef.Hy))+real(up(mef.Bz))*real(up(mef.Hz)))+real(up(mef.Bz))*(real(up(mef.Hx))*mef.dnx+real(up(mef.Hy))*mef.dny+real(up(mef.Hz))*mef.dnz)	Pa	Maxwell upward magnetic surface stress tensor, z component	Boundaries 20–21, 23–24, 26–31
mef.dnTmx	-0.5*mef.unx*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.Bx))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, x component	Boundaries 6, 8, 11, 13–16, 18–19

Name	Expression	Unit	Description	Selection
mef.dnTmy	-0.5*mef.uny*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.By))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, y component	Boundaries 6, 8, 11, 13–16, 18–19
mef.dnTmz	-0.5*mef.unz*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.Bz))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, z component	Boundaries 6, 8, 11, 13–16, 18–19
mef.dnTmx	-0.5*mef.unx*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.Bx))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, x component	Boundaries 20–21, 23–24, 26–31
mef.dnTmy	-0.5*mef.uny*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.By))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, y component	Boundaries 20–21, 23–24, 26–31
mef.dnTmz	-0.5*mef.unz*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*re	Pa	Maxwell downward magnetic surface stress tensor, z	Boundaries 20–21, 23–24, 26–31

Name	Expression	Unit	Description	Selection
	al(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.Bz))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)		component	
mef.dnTmx	-0.5*mef.unx*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.Bx))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, x component	Boundaries 4–5, 10, 12
mef.dnTmy	-0.5*mef.uny*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.By))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, y component	Boundaries 4–5, 10, 12
mef.dnTmz	-0.5*mef.unz*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.Bz))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, z component	Boundaries 4–5, 10, 12
mef.dnTmx	-0.5*mef.unx*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.Bx))*(real(down(mef.Hx))*m	Pa	Maxwell downward magnetic surface stress tensor, x component	Boundaries 1–3, 7, 9, 17

Name	Expression	Unit	Description	Selection
	ef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)			
mef.dnTmy	-0.5*mef.uny*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.By))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, y component	Boundaries 1–3, 7, 9, 17
mef.dnTmz	-0.5*mef.unz*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.Bz))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, z component	Boundaries 1–3, 7, 9, 17
mef.dnTmx	-0.5*mef.unx*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.Bx))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, x component	Boundaries 22, 25
mef.dnTmy	-0.5*mef.uny*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.By))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, y component	Boundaries 22, 25

Name	Expression	Unit	Description	Selection
mef.dnTmz	-0.5*mef.unz*(real(down(mef.Bx))*real(down(mef.Hx))+real(down(mef.By))*real(down(mef.Hy))+real(down(mef.Bz))*real(down(mef.Hz)))+real(down(mef.Bz))*(real(down(mef.Hx))*mef.unx+real(down(mef.Hy))*mef.uny+real(down(mef.Hz))*mef.unz)	Pa	Maxwell downward magnetic surface stress tensor, z component	Boundaries 22, 25
mef.sigmaxx	model.input.sigma11	S/m	Electrical conductivity, xx component	Domains 2–3
mef.sigmayx	model.input.sigma21	S/m	Electrical conductivity, yx component	Domains 2–3
mef.sigmazx	model.input.sigma31	S/m	Electrical conductivity, zx component	Domains 2–3
mef.sigmaxy	model.input.sigma12	S/m	Electrical conductivity, xy component	Domains 2–3
mef.sigmayy	model.input.sigma22	S/m	Electrical conductivity, yy component	Domains 2–3
mef.sigmazy	model.input.sigma32	S/m	Electrical conductivity, zy component	Domains 2–3
mef.sigmaxz	model.input.sigma13	S/m	Electrical conductivity, xz component	Domains 2–3
mef.sigmayz	model.input.sigma23	S/m	Electrical conductivity, yz component	Domains 2–3
mef.sigmazz	model.input.sigma33	S/m	Electrical conductivity, zz component	Domains 2–3
mef.sigmaxx	model.input.sigma11	S/m	Electrical conductivity, xx component	Domain 1
mef.sigmayx	model.input.sigma21	S/m	Electrical conductivity, yx component	Domain 1

Name	Expression	Unit	Description	Selection
mef.sigmazx	model.input.sigma31	S/m	Electrical conductivity, zx component	Domain 1
mef.sigmaxy	model.input.sigma12	S/m	Electrical conductivity, xy component	Domain 1
mef.sigmayy	model.input.sigma22	S/m	Electrical conductivity, yy component	Domain 1
mef.sigmazy	model.input.sigma32	S/m	Electrical conductivity, zy component	Domain 1
mef.sigmaxz	model.input.sigma13	S/m	Electrical conductivity, xz component	Domain 1
mef.sigmayz	model.input.sigma23	S/m	Electrical conductivity, yz component	Domain 1
mef.sigmazz	model.input.sigma33	S/m	Electrical conductivity, zz component	Domain 1
mef.sigmaxx	model.input.sigma11	S/m	Electrical conductivity, xx component	Domains 4–5
mef.sigmayx	model.input.sigma21	S/m	Electrical conductivity, yx component	Domains 4–5
mef.sigmazx	model.input.sigma31	S/m	Electrical conductivity, zx component	Domains 4–5
mef.sigmaxy	model.input.sigma12	S/m	Electrical conductivity, xy component	Domains 4–5
mef.sigmayy	model.input.sigma22	S/m	Electrical conductivity, yy component	Domains 4–5
mef.sigmazy	model.input.sigma32	S/m	Electrical conductivity, zy component	Domains 4–5
mef.sigmaxz	model.input.sigma13	S/m	Electrical conductivity, xz component	Domains 4–5
mef.sigmayz	model.input.sigma23	S/m	Electrical	Domains 4–5

Name	Expression	Unit	Description	Selection
			conductivity, yz component	
mef.sigmazz	model.input.sigma33	S/m	Electrical conductivity, zz component	Domains 4–5
mef.epsilonrxx	model.input.epsilonr11	1	Relative permittivity, xx component	Domains 2–3
mef.epsilonryx	model.input.epsilonr21	1	Relative permittivity, yx component	Domains 2–3
mef.epsilonrzx	model.input.epsilonr31	1	Relative permittivity, zx component	Domains 2–3
mef.epsilonrxy	model.input.epsilonr12	1	Relative permittivity, xy component	Domains 2–3
mef.epsilonryy	model.input.epsilonr22	1	Relative permittivity, yy component	Domains 2–3
mef.epsilonrzy	model.input.epsilonr32	1	Relative permittivity, zy component	Domains 2–3
mef.epsilonrxz	model.input.epsilonr13	1	Relative permittivity, xz component	Domains 2–3
mef.epsilonryz	model.input.epsilonr23	1	Relative permittivity, yz component	Domains 2–3
mef.epsilonrzz	model.input.epsilonr33	1	Relative permittivity, zz component	Domains 2–3
mef.epsilonrxx	model.input.epsilonr11	1	Relative permittivity, xx component	Domain 1
mef.epsilonryx	model.input.epsilonr21	1	Relative permittivity, yx component	Domain 1
mef.epsilonrzx	model.input.epsilonr31	1	Relative permittivity, zx component	Domain 1
mef.epsilonrxy	model.input.epsilonr12	1	Relative permittivity, xy component	Domain 1
mef.epsilonryy	model.input.epsilonr22	1	Relative permittivity, yy component	Domain 1
mef.epsilonrzy	model.input.epsilonr32	1	Relative permittivity, zy component	Domain 1
mef.epsilonrxz	model.input.epsilonr13	1	Relative permittivity, xz component	Domain 1
mef.epsilonryz	model.input.epsilonr23	1	Relative permittivity, yz component	Domain 1
mef.epsilonrzz	model.input.epsilonr33	1	Relative permittivity,	Domain 1

Name	Expression	Unit	Description	Selection
			zz component	
mef.epsilonrxx	model.input.epsilonr11	1	Relative permittivity, xx component	Domains 4–5
mef.epsilonryx	model.input.epsilonr21	1	Relative permittivity, yx component	Domains 4–5
mef.epsilonrzx	model.input.epsilonr31	1	Relative permittivity, zx component	Domains 4–5
mef.epsilonrxy	model.input.epsilonr12	1	Relative permittivity, xy component	Domains 4–5
mef.epsilonryy	model.input.epsilonr22	1	Relative permittivity, yy component	Domains 4–5
mef.epsilonrzy	model.input.epsilonr32	1	Relative permittivity, zy component	Domains 4–5
mef.epsilonrxz	model.input.epsilonr13	1	Relative permittivity, xz component	Domains 4–5
mef.epsilonryz	model.input.epsilonr23	1	Relative permittivity, yz component	Domains 4–5
mef.epsilonrzz	model.input.epsilonr33	1	Relative permittivity, zz component	Domains 4–5
mef.murxx	model.input.mur11	1	Relative permeability, xx component	Domains 2–3
mef.muryx	model.input.mur21	1	Relative permeability, yx component	Domains 2–3
mef.murzx	model.input.mur31	1	Relative permeability, zx component	Domains 2–3
mef.murxy	model.input.mur12	1	Relative permeability, xy component	Domains 2–3
mef.muryy	model.input.mur22	1	Relative permeability, yy component	Domains 2–3
mef.murzy	model.input.mur32	1	Relative permeability, zy component	Domains 2–3
mef.murxz	model.input.mur13	1	Relative permeability, xz component	Domains 2–3
mef.muryz	model.input.mur23	1	Relative permeability, yz	Domains 2–3

Name	Expression	Unit	Description	Selection
			component	
mef.murzz	model.input.mur33	1	Relative permeability, zz component	Domains 2–3
mef.murxx	model.input.mur11	1	Relative permeability, xx component	Domain 1
mef.muryx	model.input.mur21	1	Relative permeability, yx component	Domain 1
mef.murzx	model.input.mur31	1	Relative permeability, zx component	Domain 1
mef.murxy	model.input.mur12	1	Relative permeability, xy component	Domain 1
mef.muryy	model.input.mur22	1	Relative permeability, yy component	Domain 1
mef.murzy	model.input.mur32	1	Relative permeability, zy component	Domain 1
mef.murxz	model.input.mur13	1	Relative permeability, xz component	Domain 1
mef.muryz	model.input.mur23	1	Relative permeability, yz component	Domain 1
mef.murzz	model.input.mur33	1	Relative permeability, zz component	Domain 1
mef.murxx	model.input.mur11	1	Relative permeability, xx component	Domains 4–5
mef.muryx	model.input.mur21	1	Relative permeability, yx component	Domains 4–5
mef.murzx	model.input.mur31	1	Relative permeability, zx component	Domains 4–5
mef.murxy	model.input.mur12	1	Relative permeability, xy component	Domains 4–5

Name	Expression	Unit	Description	Selection
mef.muryy	model.input.mur22	1	Relative permeability, yy component	Domains 4–5
mef.murzy	model.input.mur32	1	Relative permeability, zy component	Domains 4–5
mef.murxz	model.input.mur13	1	Relative permeability, xz component	Domains 4–5
mef.muryz	model.input.mur23	1	Relative permeability, yz component	Domains 4–5
mef.murzz	model.input.mur33	1	Relative permeability, zz component	Domains 4–5
mef.Dx	epsilon0_const*mef.Ex+mef.Px	C/m^2	Electric displacement field, x component	Domains 2–3
mef.Dy	epsilon0_const*mef.Ey+mef.Py	C/m^2	Electric displacement field, y component	Domains 2–3
mef.Dz	epsilon0_const*mef.Ez+mef.Pz	C/m^2	Electric displacement field, z component	Domains 2–3
mef.Dx	epsilon0_const*mef.Ex+mef.Px	C/m^2	Electric displacement field, x component	Domain 1
mef.Dy	epsilon0_const*mef.Ey+mef.Py	C/m^2	Electric displacement field, y component	Domain 1
mef.Dz	epsilon0_const*mef.Ez+mef.Pz	C/m^2	Electric displacement field, z component	Domain 1
mef.Dx	epsilon0_const*mef.Ex+mef.Px	C/m^2	Electric displacement field, x component	Domains 4–5
mef.Dy	epsilon0_const*mef.Ey+mef.Py	C/m^2	Electric displacement field, y component	Domains 4–5
mef.Dz	epsilon0_const*mef.Ez+mef.Pz	C/m^2	Electric displacement field, z component	Domains 4–5
mef.Px	epsilon0_const*(mef.chixx*mef.Ex+mef.chixy*mef.Ey+mef.chixz*mef.Ez)	C/m^2	Polarization, x component	Domains 2–3
mef.Py	epsilon0_const*(mef.chiyx*mef.Ex+mef.chiyy*mef.Ey+mef.chiyz*mef.Ez)	C/m^2	Polarization, y component	Domains 2–3
mef.Pz	epsilon0_const*(mef.chizx*mef.Ex+mef.chizy*mef.Ey+mef.chizz*mef.Ez)	C/m^2	Polarization, z component	Domains 2–3

Name	Expression	Unit	Description	Selection
mef.Px	epsilon0_const*(mef.chixx*mef.Ex+mef.chixy*mef.Ey+mef.chixz*mef.Ez)	C/m^2	Polarization, x component	Domain 1
mef.Py	epsilon0_const*(mef.chiyx*mef.Ex+mef.chiyy*mef.Ey+mef.chiyz*mef.Ez)	C/m^2	Polarization, y component	Domain 1
mef.Pz	epsilon0_const*(mef.chizx*mef.Ex+mef.chizy*mef.Ey+mef.chizz*mef.Ez)	C/m^2	Polarization, z component	Domain 1
mef.Px	epsilon0_const*(mef.chixx*mef.Ex+mef.chixy*mef.Ey+mef.chixz*mef.Ez)	C/m^2	Polarization, x component	Domains 4–5
mef.Py	epsilon0_const*(mef.chiyx*mef.Ex+mef.chiyy*mef.Ey+mef.chiyz*mef.Ez)	C/m^2	Polarization, y component	Domains 4–5
mef.Pz	epsilon0_const*(mef.chizx*mef.Ex+mef.chizy*mef.Ey+mef.chizz*mef.Ez)	C/m^2	Polarization, z component	Domains 4–5
mef.chixx	-1+mef.epsilonrxx	1	Electric susceptibility, xx component	Domains 2–3
mef.chiyx	mef.epsilonryx	1	Electric susceptibility, yx component	Domains 2–3
mef.chizx	mef.epsilonrzx	1	Electric susceptibility, zx component	Domains 2–3
mef.chixy	mef.epsilonrxy	1	Electric susceptibility, xy component	Domains 2–3
mef.chiyy	-1+mef.epsilonryy	1	Electric susceptibility, yy component	Domains 2–3
mef.chizy	mef.epsilonrzy	1	Electric susceptibility, zy component	Domains 2–3
mef.chixz	mef.epsilonrxz	1	Electric susceptibility, xz component	Domains 2–3
mef.chiyz	mef.epsilonryz	1	Electric susceptibility, yz component	Domains 2–3
mef.chizz	-1+mef.epsilonrzz	1	Electric	Domains 2–3

Name	Expression	Unit	Description	Selection
			susceptibility, zz component	
mef.chixx	-1+mef.epsilonrxx	1	Electric susceptibility, xx component	Domain 1
mef.chiyx	mef.epsilonryx	1	Electric susceptibility, yx component	Domain 1
mef.chizx	mef.epsilonrzx	1	Electric susceptibility, zx component	Domain 1
mef.chixy	mef.epsilonrxy	1	Electric susceptibility, xy component	Domain 1
mef.chiyy	-1+mef.epsilonryy	1	Electric susceptibility, yy component	Domain 1
mef.chizy	mef.epsilonrzy	1	Electric susceptibility, zy component	Domain 1
mef.chixz	mef.epsilonrxz	1	Electric susceptibility, xz component	Domain 1
mef.chiyz	mef.epsilonryz	1	Electric susceptibility, yz component	Domain 1
mef.chizz	-1+mef.epsilonrzz	1	Electric susceptibility, zz component	Domain 1
mef.chixx	-1+mef.epsilonrxx	1	Electric susceptibility, xx component	Domains 4–5
mef.chiyx	mef.epsilonryx	1	Electric susceptibility, yx component	Domains 4–5
mef.chizx	mef.epsilonrzx	1	Electric susceptibility, zx component	Domains 4–5
mef.chixy	mef.epsilonrxy	1	Electric susceptibility, xy component	Domains 4–5
mef.chiyy	-1+mef.epsilonryy	1	Electric susceptibility, yy	Domains 4–5

Name	Expression	Unit	Description	Selection
			component	
mef.chizy	mef.epsilonrzy	1	Electric susceptibility, zy component	Domains 4–5
mef.chixz	mef.epsilonrxz	1	Electric susceptibility, xz component	Domains 4–5
mef.chiyz	mef.epsilonryz	1	Electric susceptibility, yz component	Domains 4–5
mef.chizz	-1+mef.epsilonrzz	1	Electric susceptibility, zz component	Domains 4–5
mef.normD	sqrt(realdot(mef.Dx,mef.Dx)+realdot(mef.Dy,mef.Dy)+realdot(mef.Dz,mef.Dz))	C/m^2	Electric displacement field norm	Domains 2–3
mef.normD	sqrt(realdot(mef.Dx,mef.Dx)+realdot(mef.Dy,mef.Dy)+realdot(mef.Dz,mef.Dz))	C/m^2	Electric displacement field norm	Domain 1
mef.normD	sqrt(realdot(mef.Dx,mef.Dx)+realdot(mef.Dy,mef.Dy)+realdot(mef.Dz,mef.Dz))	C/m^2	Electric displacement field norm	Domains 4–5
mef.normP	sqrt(realdot(mef.Px,mef.Px)+realdot(mef.Py,mef.Py)+realdot(mef.Pz,mef.Pz))	C/m^2	Polarization norm	Domains 2–3
mef.normP	sqrt(realdot(mef.Px,mef.Px)+realdot(mef.Py,mef.Py)+realdot(mef.Pz,mef.Pz))	C/m^2	Polarization norm	Domain 1
mef.normP	sqrt(realdot(mef.Px,mef.Px)+realdot(mef.Py,mef.Py)+realdot(mef.Pz,mef.Pz))	C/m^2	Polarization norm	Domains 4–5
mef.Hx	(mef.murinvxx*mef.Bx+mef.murinvxy*mef.By+mef.murinvxz*mef.Bz)/mu0_const	A/m	Magnetic field, x component	Domains 2–3
mef.Hy	(mef.murinvyx*mef.Bx+mef.murinvyy*mef.By+mef.murinvyz*mef.Bz)/mu0_const	A/m	Magnetic field, y component	Domains 2–3
mef.Hz	(mef.murinvzx*mef.Bx+mef.murinvzy*mef.By+mef.murinvzz*mef.Bz)/mu0_const	A/m	Magnetic field, z component	Domains 2–3

Name	Expression	Unit	Description	Selection
mef.Hx	(mef.murinvxx*mef.Bx+mef.murinvxy*mef.By+mef.murinvxz*mef.Bz)/mu0_const	A/m	Magnetic field, x component	Domain 1
mef.Hy	(mef.murinvyx*mef.Bx+mef.murinvyy*mef.By+mef.murinvyz*mef.Bz)/mu0_const	A/m	Magnetic field, y component	Domain 1
mef.Hz	(mef.murinvzx*mef.Bx+mef.murinvzy*mef.By+mef.murinvzz*mef.Bz)/mu0_const	A/m	Magnetic field, z component	Domain 1
mef.Hx	(mef.murinvxx*mef.Bx+mef.murinvxy*mef.By+mef.murinvxz*mef.Bz)/mu0_const	A/m	Magnetic field, x component	Domains 4–5
mef.Hy	(mef.murinvyx*mef.Bx+mef.murinvyy*mef.By+mef.murinvyz*mef.Bz)/mu0_const	A/m	Magnetic field, y component	Domains 4–5
mef.Hz	(mef.murinvzx*mef.Bx+mef.murinvzy*mef.By+mef.murinvzz*mef.Bz)/mu0_const	A/m	Magnetic field, z component	Domains 4–5
mef.normH	sqrt(realdot(mef.Hx,mef.Hx)+realdot(mef.Hy,mef.Hy)+realdot(mef.Hz,mef.Hz))	A/m	Magnetic field norm	Domains 2–3
mef.normH	sqrt(realdot(mef.Hx,mef.Hx)+realdot(mef.Hy,mef.Hy)+realdot(mef.Hz,mef.Hz))	A/m	Magnetic field norm	Domain 1
mef.normH	sqrt(realdot(mef.Hx,mef.Hx)+realdot(mef.Hy,mef.Hy)+realdot(mef.Hz,mef.Hz))	A/m	Magnetic field norm	Domains 4–5
mef.Mx	mef.Bx/mu0_const-mef.Hx	A/m	Magnetization, x component	Domains 2–3
mef.My	mef.By/mu0_const-mef.Hy	A/m	Magnetization, y component	Domains 2–3
mef.Mz	mef.Bz/mu0_const-mef.Hz	A/m	Magnetization, z component	Domains 2–3
mef.Mx	mef.Bx/mu0_const-mef.Hx	A/m	Magnetization, x component	Domain 1
mef.My	mef.By/mu0_const-mef.Hy	A/m	Magnetization, y component	Domain 1

Name	Expression	Unit	Description	Selection
mef.Mz	mef.Bz/mu0_const-mef.Hz	A/m	Magnetization, z component	Domain 1
mef.Mx	mef.Bx/mu0_const-mef.Hx	A/m	Magnetization, x component	Domains 4–5
mef.My	mef.By/mu0_const-mef.Hy	A/m	Magnetization, y component	Domains 4–5
mef.Mz	mef.Bz/mu0_const-mef.Hz	A/m	Magnetization, z component	Domains 4–5
mef.normM	sqrt(realdot(mef.Mx,mef.Mx)+realdot(mef.My,mef.My)+realdot(mef.Mz,mef.Mz))	A/m	Magnetization norm	Domains 2–3
mef.normM	sqrt(realdot(mef.Mx,mef.Mx)+realdot(mef.My,mef.My)+realdot(mef.Mz,mef.Mz))	A/m	Magnetization norm	Domain 1
mef.normM	sqrt(realdot(mef.Mx,mef.Mx)+realdot(mef.My,mef.My)+realdot(mef.Mz,mef.Mz))	A/m	Magnetization norm	Domains 4–5
mef.murinvxx	(mef.muryy*mef.murzz-mef.muryz*mef.murzy)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, xx component	Domains 2–3
mef.murinvyx	(mef.muryz*mef.murzx-mef.muryx*mef.murzz)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*m	1	Inverse of relative permeability, yx component	Domains 2–3

Name	Expression	Unit	Description	Selection
	ef.murzx)			
mef.murinvzx	(mef.muryx*mef.murzy-mef.muryy*mef.murzx)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, zx component	Domains 2–3
mef.murinvxy	(mef.murxz*mef.murzy-mef.murxy*mef.murzz)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, xy component	Domains 2–3
mef.murinvyy	(mef.murxx*mef.murzz-mef.murxz*mef.murzx)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, yy component	Domains 2–3
mef.murinvzy	(mef.murxy*mef.murzx-mef.murxx*mef.murzy)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*m	1	Inverse of relative permeability, zy component	Domains 2–3

Name	Expression	Unit	Description	Selection
	ef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)			
mef.murinvxz	(mef.murxy*mef.muryz-mef.murxz*mef.muryy)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, xz component	Domains 2–3
mef.murinvyz	(mef.murxz*mef.muryx-mef.murxx*mef.muryz)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, yz component	Domains 2–3
mef.murinvzz	(mef.murxx*mef.muryy-mef.murxy*mef.muryx)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, zz component	Domains 2–3
mef.murinvxx	(mef.muryy*mef.murzz-mef.muryz*mef.murzy)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.	1	Inverse of relative permeability, xx component	Domain 1

Name	Expression	Unit	Description	Selection
	muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)			
mef.murinvyx	(mef.muryz*mef.murzx-mef.muryx*mef.murzz)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, yx component	Domain 1
mef.murinvzx	(mef.muryx*mef.murzy-mef.muryy*mef.murzx)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, zx component	Domain 1
mef.murinvxy	(mef.murxz*mef.murzy-mef.murxy*mef.murzz)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, xy component	Domain 1

Name	Expression	Unit	Description	Selection
mef.murinvyy	(mef.murxx*mef.murzz-mef.murxz*mef.murzx)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, yy component	Domain 1
mef.murinvzy	(mef.murxy*mef.murzx-mef.murxx*mef.murzy)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, zy component	Domain 1
mef.murinvxz	(mef.murxy*mef.muryz-mef.murxz*mef.muryy)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, xz component	Domain 1
mef.murinvyz	(mef.murxz*mef.muryx-mef.murxx*mef.muryz)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-	1	Inverse of relative permeability, yz component	Domain 1

Name	Expression	Unit	Description	Selection
	mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)			
mef.murinvzz	(mef.murxx*mef.muryy-mef.murxy*mef.muryx)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, zz component	Domain 1
mef.murinvxx	(mef.muryy*mef.murzz-mef.muryz*mef.murzy)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, xx component	Domains 4–5
mef.murinvyx	(mef.muryz*mef.murzx-mef.muryx*mef.murzz)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, yx component	Domains 4–5
mef.murinvzx	(mef.muryx*mef.murzy-mef.muryy*mef.murzx)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.m	1	Inverse of relative permeability, zx component	Domains 4–5

Name	Expression	Unit	Description	Selection
	urxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)			
mef.murinvxy	(mef.murxz*mef.murzy-mef.murxy*mef.murzz)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, xy component	Domains 4–5
mef.murinvyy	(mef.murxx*mef.murzz-mef.murxz*mef.murzx)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, yy component	Domains 4–5
mef.murinvzy	(mef.murxy*mef.murzx-mef.murxx*mef.murzy)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, zy component	Domains 4–5

Name	Expression	Unit	Description	Selection
mef.murinvxz	(mef.murxy*mef.muryz-mef.murxz*mef.muryy)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, xz component	Domains 4–5
mef.murinvyz	(mef.murxz*mef.muryx-mef.murxx*mef.muryz)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, yz component	Domains 4–5
mef.murinvzz	(mef.murxx*mef.muryy-mef.murxy*mef.muryx)/(mef.murxx*mef.muryy*mef.murzz+mef.murxy*mef.muryz*mef.murzx+mef.murxz*mef.muryx*mef.murzy-mef.murxx*mef.muryz*mef.murzy-mef.murxy*mef.muryx*mef.murzz-mef.murxz*mef.muryy*mef.murzx)	1	Inverse of relative permeability, zz component	Domains 4–5
mef.Brx	0	T	Remanent flux density, x component	Domains 2–3
mef.Bry	0	T	Remanent flux density, y component	Domains 2–3
mef.Brz	0	T	Remanent flux density, z	Domains 2–3

Name	Expression	Unit	Description	Selection
			component	
mef.Brx	0	T	Remanent flux density, x component	Domain 1
mef.Bry	0	T	Remanent flux density, y component	Domain 1
mef.Brz	0	T	Remanent flux density, z component	Domain 1
mef.Brx	0	T	Remanent flux density, x component	Domains 4–5
mef.Bry	0	T	Remanent flux density, y component	Domains 4–5
mef.Brz	0	T	Remanent flux density, z component	Domains 4–5
mef.Bx	curlA2x	T	Magnetic flux density, x component	Domains 2–3
mef.By	curlA2y	T	Magnetic flux density, y component	Domains 2–3
mef.Bz	curlA2z	T	Magnetic flux density, z component	Domains 2–3
mef.Bx	curlA2x	T	Magnetic flux density, x component	Domain 1
mef.By	curlA2y	T	Magnetic flux density, y component	Domain 1
mef.Bz	curlA2z	T	Magnetic flux density, z component	Domain 1
mef.Bx	curlA2x	T	Magnetic flux density, x component	Domains 4–5
mef.By	curlA2y	T	Magnetic flux density, y component	Domains 4–5

Name	Expression	Unit	Description	Selection
mef.Bz	curlA2z	T	Magnetic flux density, z component	Domains 4–5
mef.normB	sqrt(realdot(mef.Bx,mef.Bx)+realdot(mef.By,mef.By)+realdot(mef.Bz,mef.Bz))	T	Magnetic flux density norm	Domains 2–3
mef.normB	sqrt(realdot(mef.Bx,mef.Bx)+realdot(mef.By,mef.By)+realdot(mef.Bz,mef.Bz))	T	Magnetic flux density norm	Domain 1
mef.normB	sqrt(realdot(mef.Bx,mef.Bx)+realdot(mef.By,mef.By)+realdot(mef.Bz,mef.Bz))	T	Magnetic flux density norm	Domains 4–5
mef.Ex	-V2x-A2xt	V/m	Electric field, x component	Domains 2–3
mef.Ey	-V2y-A2yt	V/m	Electric field, y component	Domains 2–3
mef.Ez	-V2z-A2zt	V/m	Electric field, z component	Domains 2–3
mef.Ex	-V2x-A2xt	V/m	Electric field, x component	Domain 1
mef.Ey	-V2y-A2yt	V/m	Electric field, y component	Domain 1
mef.Ez	-V2z-A2zt	V/m	Electric field, z component	Domain 1
mef.Ex	-V2x-A2xt	V/m	Electric field, x component	Domains 4–5
mef.Ey	-V2y-A2yt	V/m	Electric field, y component	Domains 4–5
mef.Ez	-V2z-A2zt	V/m	Electric field, z component	Domains 4–5
mef.tEx	-V2Tx-d(mef.tAx,t)	V/m	Tangential electric field, x component	Boundaries 4–6, 8, 10–16, 18–19
mef.tEy	-V2Ty-d(mef.tAy,t)	V/m	Tangential electric field, y component	Boundaries 4–6, 8, 10–16, 18–19
mef.tEz	-V2Tz-d(mef.tAz,t)	V/m	Tangential electric field, z component	Boundaries 4–6, 8, 10–16, 18–19
mef.tEx	-V2Tx-d(mef.tAx,t)	V/m	Tangential electric field, x component	Boundaries 1–3, 7, 9, 17, 20–21, 23–

Name	Expression	Unit	Description	Selection
				24, 26–31
mef.tEy	-V2Ty-d(mef.tAy,t)	V/m	Tangential electric field, y component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.tEz	-V2Tz-d(mef.tAz,t)	V/m	Tangential electric field, z component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.tEx	-V2Tx-d(mef.tAx,t)	V/m	Tangential electric field, x component	Boundaries 22, 25
mef.tEy	-V2Ty-d(mef.tAy,t)	V/m	Tangential electric field, y component	Boundaries 22, 25
mef.tEz	-V2Tz-d(mef.tAz,t)	V/m	Tangential electric field, z component	Boundaries 22, 25
mef.normE	sqrt(realdot(mef.Ex,mef.Ex)+realdot(mef.Ey,mef.Ey)+realdot(mef.Ez,mef.Ez))	V/m	Electric field norm	Domains 2–3
mef.normE	sqrt(realdot(mef.Ex,mef.Ex)+realdot(mef.Ey,mef.Ey)+realdot(mef.Ez,mef.Ez))	V/m	Electric field norm	Domain 1
mef.normE	sqrt(realdot(mef.Ex,mef.Ex)+realdot(mef.Ey,mef.Ey)+realdot(mef.Ez,mef.Ez))	V/m	Electric field norm	Domains 4–5
mef.Jx	mef.Jix+mef.Jex	A/m^2	Current density, x component	Domains 2–3
mef.Jy	mef.Jiy+mef.Jey	A/m^2	Current density, y component	Domains 2–3
mef.Jz	mef.Jiz+mef.Jez	A/m^2	Current density, z component	Domains 2–3
mef.Jx	mef.Jix+mef.Jex	A/m^2	Current density, x component	Domain 1
mef.Jy	mef.Jiy+mef.Jey	A/m^2	Current density, y component	Domain 1
mef.Jz	mef.Jiz+mef.Jez	A/m^2	Current density, z component	Domain 1
mef.Jx	mef.Jix+mef.Jex	A/m^2	Current density, x component	Domains 4–5
mef.Jy	mef.Jiy+mef.Jey	A/m^2	Current density, y component	Domains 4–5
mef.Jz	mef.Jiz+mef.Jez	A/m^2	Current density, z	Domains 4–5

Name	Expression	Unit	Description	Selection
			component	
mef.Jix	mef.sigmaxx*mef.Ex+mef.sigmaxy*mef.Ey+mef.sigmaxz*mef.Ez	A/m^2	Induced current density, x component	Domains 2–3
mef.Jiy	mef.sigmayx*mef.Ex+mef.sigmayy*mef.Ey+mef.sigmayz*mef.Ez	A/m^2	Induced current density, y component	Domains 2–3
mef.Jiz	mef.sigmazx*mef.Ex+mef.sigmazy*mef.Ey+mef.sigmazz*mef.Ez	A/m^2	Induced current density, z component	Domains 2–3
mef.Jix	mef.sigmaxx*mef.Ex+mef.sigmaxy*mef.Ey+mef.sigmaxz*mef.Ez	A/m^2	Induced current density, x component	Domain 1
mef.Jiy	mef.sigmayx*mef.Ex+mef.sigmayy*mef.Ey+mef.sigmayz*mef.Ez	A/m^2	Induced current density, y component	Domain 1
mef.Jiz	mef.sigmazx*mef.Ex+mef.sigmazy*mef.Ey+mef.sigmazz*mef.Ez	A/m^2	Induced current density, z component	Domain 1
mef.Jix	mef.sigmaxx*mef.Ex+mef.sigmaxy*mef.Ey+mef.sigmaxz*mef.Ez	A/m^2	Induced current density, x component	Domains 4–5
mef.Jiy	mef.sigmayx*mef.Ex+mef.sigmayy*mef.Ey+mef.sigmayz*mef.Ez	A/m^2	Induced current density, y component	Domains 4–5
mef.Jiz	mef.sigmazx*mef.Ex+mef.sigmazy*mef.Ey+mef.sigmazz*mef.Ez	A/m^2	Induced current density, z component	Domains 4–5
mef.Jdx	d(mef.Dx,t)	A/m^2	Displacement current density, x component	Domains 2–3
mef.Jdy	d(mef.Dy,t)	A/m^2	Displacement current density, y component	Domains 2–3
mef.Jdz	d(mef.Dz,t)	A/m^2	Displacement current density, z component	Domains 2–3
mef.Jdx	d(mef.Dx,t)	A/m^2	Displacement current density, x component	Domain 1
mef.Jdy	d(mef.Dy,t)	A/m^2	Displacement current density, y component	Domain 1

Name	Expression	Unit	Description	Selection
mef.Jdz	d(mef.Dz,t)	A/m^2	Displacement current density, z component	Domain 1
mef.Jdx	d(mef.Dx,t)	A/m^2	Displacement current density, x component	Domains 4–5
mef.Jdy	d(mef.Dy,t)	A/m^2	Displacement current density, y component	Domains 4–5
mef.Jdz	d(mef.Dz,t)	A/m^2	Displacement current density, z component	Domains 4–5
mef.Jsx	0	A/m	Surface current density, x component	Boundaries 4–6, 8, 10–16, 18–19
mef.Jsy	0	A/m	Surface current density, y component	Boundaries 4–6, 8, 10–16, 18–19
mef.Jsz	0	A/m	Surface current density, z component	Boundaries 4–6, 8, 10–16, 18–19
mef.Jsx	0	A/m	Surface current density, x component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.Jsy	0	A/m	Surface current density, y component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.Jsz	0	A/m	Surface current density, z component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.Jsx	0	A/m	Surface current density, x component	Boundaries 22, 25
mef.Jsy	0	A/m	Surface current density, y component	Boundaries 22, 25
mef.Jsz	0	A/m	Surface current density, z component	Boundaries 22, 25
mef.normJs	sqrt(realdot(mef.Jsx,mef.J	A/m	Surface current	Boundaries

Name	Expression	Unit	Description	Selection
	sx)+realdot(mef.Jsy,mef.Jsy)+realdot(mef.Jsz,mef.Jsz))		density norm	4–6, 8, 10–16, 18–19
mef.normJs	sqrt(realdot(mef.Jsx,mef.Jsx)+realdot(mef.Jsy,mef.Jsy)+realdot(mef.Jsz,mef.Jsz))	A/m	Surface current density norm	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.normJs	sqrt(realdot(mef.Jsx,mef.Jsx)+realdot(mef.Jsy,mef.Jsy)+realdot(mef.Jsz,mef.Jsz))	A/m	Surface current density norm	Boundaries 22, 25
mef.Jex	0	A/m^2	External current density, x component	Domains 2–3
mef.Jey	0	A/m^2	External current density, y component	Domains 2–3
mef.Jez	0	A/m^2	External current density, z component	Domains 2–3
mef.Jex	0	A/m^2	External current density, x component	Domain 1
mef.Jey	0	A/m^2	External current density, y component	Domain 1
mef.Jez	0	A/m^2	External current density, z component	Domain 1
mef.Jex	0	A/m^2	External current density, x component	Domains 4–5
mef.Jey	0	A/m^2	External current density, y component	Domains 4–5
mef.Jez	0	A/m^2	External current density, z component	Domains 4–5
mef.normJ	sqrt(realdot(mef.Jx,mef.Jx)+realdot(mef.Jy,mef.Jy)+realdot(mef.Jz,mef.Jz))	A/m^2	Current density norm	Domains 2–3
mef.normJ	sqrt(realdot(mef.Jx,mef.Jx)+realdot(mef.Jy,mef.Jy)+re	A/m^2	Current density norm	Domain 1

Name	Expression	Unit	Description	Selection
	aldot(mef.Jz,mef.Jz))			
mef.normJ	sqrt(realdot(mef.Jx,mef.Jx)+realdot(mef.Jy,mef.Jy)+realdot(mef.Jz,mef.Jz))	A/m^2	Current density norm	Domains 4–5
mef.W	mef.We+mef.Wm	J/m^3	Energy density	Domains 2–3
mef.W	mef.We+mef.Wm	J/m^3	Energy density	Domain 1
mef.W	mef.We+mef.Wm	J/m^3	Energy density	Domains 4–5
mef.alc1.T	model.input.T	K	Temperature	Domains 2–3
mef.alc1.T	model.input.T	K	Temperature	Domain 1
mef.alc1.T	model.input.T	K	Temperature	Domains 4–5
mef.Qh	mef.Qrh	W/m^3	Electromagnetic heating	Domains 2–3
mef.Qh	mef.Qrh	W/m^3	Electromagnetic heating	Domain 1
mef.Qh	mef.Qrh	W/m^3	Electromagnetic heating	Domains 4–5
mef.Qsh	0	W/m^2	Surface electromagnetic heating	Boundaries 4–6, 8, 10–16, 18–19
mef.Qsh	0	W/m^2	Surface electromagnetic heating	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.Qsh	0	W/m^2	Surface electromagnetic heating	Boundaries 22, 25
mef.tAdepx	tA2x	Wb/m	Tangential magnetic vector potential, x component	Boundaries 4–6, 8, 10–16, 18–19
mef.tAdepy	tA2y	Wb/m	Tangential magnetic vector potential, y component	Boundaries 4–6, 8, 10–16, 18–19
mef.tAdepz	tA2z	Wb/m	Tangential magnetic vector potential, z component	Boundaries 4–6, 8, 10–16, 18–19
mef.tAdepx	tA2x	Wb/m	Tangential magnetic vector potential, x component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.tAdepy	tA2y	Wb/m	Tangential magnetic vector potential, y	Boundaries 1–3, 7, 9, 17,

Name	Expression	Unit	Description	Selection
			component	20–21, 23–24, 26–31
mef.tAdepz	tA2z	Wb/m	Tangential magnetic vector potential, z component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.tAdepx	tA2x	Wb/m	Tangential magnetic vector potential, x component	Boundaries 22, 25
mef.tAdepy	tA2y	Wb/m	Tangential magnetic vector potential, y component	Boundaries 22, 25
mef.tAdepz	tA2z	Wb/m	Tangential magnetic vector potential, z component	Boundaries 22, 25
mef.tAx	mef.tAdepx	Wb/m	Tangential magnetic vector potential, x component	Boundaries 4–6, 8, 10–16, 18–19
mef.tAy	mef.tAdepy	Wb/m	Tangential magnetic vector potential, y component	Boundaries 4–6, 8, 10–16, 18–19
mef.tAz	mef.tAdepz	Wb/m	Tangential magnetic vector potential, z component	Boundaries 4–6, 8, 10–16, 18–19
mef.tAx	mef.tAdepx	Wb/m	Tangential magnetic vector potential, x component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.tAy	mef.tAdepy	Wb/m	Tangential magnetic vector potential, y component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.tAz	mef.tAdepz	Wb/m	Tangential magnetic vector potential, z component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.tAx	mef.tAdepx	Wb/m	Tangential magnetic vector potential, x component	Boundaries 22, 25
mef.tAy	mef.tAdepy	Wb/m	Tangential magnetic vector potential, y component	Boundaries 22, 25
mef.tAz	mef.tAdepz	Wb/m	Tangential magnetic	Boundaries

Name	Expression	Unit	Description	Selection
			vector potential, z component	22, 25
mef.mfenx	dnx	1	Normal vector, x component	Boundaries 4–5, 10, 12
mef.mfeny	dny	1	Normal vector, y component	Boundaries 4–5, 10, 12
mef.mfenz	dnz	1	Normal vector, z component	Boundaries 4–5, 10, 12
mef.mfenx	dnx	1	Normal vector, x component	Boundaries 1–3, 7, 9, 17
mef.mfeny	dny	1	Normal vector, y component	Boundaries 1–3, 7, 9, 17
mef.mfenz	dnz	1	Normal vector, z component	Boundaries 1–3, 7, 9, 17
mef.mfenx	dnx	1	Normal vector, x component	Boundaries 22, 25
mef.mfeny	dny	1	Normal vector, y component	Boundaries 22, 25
mef.mfenz	dnz	1	Normal vector, z component	Boundaries 22, 25
mef.unTx	0	Pa	Maxwell upward surface stress tensor, x component	Boundaries 4–5, 10, 12
mef.unTy	0	Pa	Maxwell upward surface stress tensor, y component	Boundaries 4–5, 10, 12
mef.unTz	0	Pa	Maxwell upward surface stress tensor, z component	Boundaries 4–5, 10, 12
mef.unTx	0	Pa	Maxwell upward surface stress tensor, x component	Boundaries 1–3, 7, 9, 17
mef.unTy	0	Pa	Maxwell upward surface stress tensor, y component	Boundaries 1–3, 7, 9, 17
mef.unTz	0	Pa	Maxwell upward surface stress tensor, z component	Boundaries 1–3, 7, 9, 17
mef.unTx	0	Pa	Maxwell upward surface stress tensor, x component	Boundaries 22, 25

Name	Expression	Unit	Description	Selection
mef.unTy	0	Pa	Maxwell upward surface stress tensor, y component	Boundaries 22, 25
mef.unTz	0	Pa	Maxwell upward surface stress tensor, z component	Boundaries 22, 25
mef.unTx	mef.unTmx+mef.unTex	Pa	Maxwell upward surface stress tensor, x component	Boundaries 6, 8, 11, 13–16, 18–19
mef.unTy	mef.unTmy+mef.unTey	Pa	Maxwell upward surface stress tensor, y component	Boundaries 6, 8, 11, 13–16, 18–19
mef.unTz	mef.unTmz+mef.unTez	Pa	Maxwell upward surface stress tensor, z component	Boundaries 6, 8, 11, 13–16, 18–19
mef.unTx	mef.unTmx+mef.unTex	Pa	Maxwell upward surface stress tensor, x component	Boundaries 20–21, 23–24, 26–31
mef.unTy	mef.unTmy+mef.unTey	Pa	Maxwell upward surface stress tensor, y component	Boundaries 20–21, 23–24, 26–31
mef.unTz	mef.unTmz+mef.unTez	Pa	Maxwell upward surface stress tensor, z component	Boundaries 20–21, 23–24, 26–31
mef.dnTx	mef.dnTmx+mef.dnTex	Pa	Maxwell downward surface stress tensor, x component	Boundaries 4–5, 10, 12
mef.dnTy	mef.dnTmy+mef.dnTey	Pa	Maxwell downward surface stress tensor, y component	Boundaries 4–5, 10, 12
mef.dnTz	mef.dnTmz+mef.dnTez	Pa	Maxwell downward surface stress tensor, z component	Boundaries 4–5, 10, 12
mef.dnTx	mef.dnTmx+mef.dnTex	Pa	Maxwell downward surface stress tensor, x component	Boundaries 1–3, 7, 9, 17
mef.dnTy	mef.dnTmy+mef.dnTey	Pa	Maxwell downward surface stress tensor, y component	Boundaries 1–3, 7, 9, 17
mef.dnTz	mef.dnTmz+mef.dnTez	Pa	Maxwell downward surface stress tensor, z component	Boundaries 1–3, 7, 9, 17
mef.dnTx	mef.dnTmx+mef.dnTex	Pa	Maxwell downward	Boundaries

Name	Expression	Unit	Description	Selection
			surface stress tensor, x component	22, 25
mef.dnTy	mef.dnTmy+mef.dnTey	Pa	Maxwell downward surface stress tensor, y component	Boundaries 22, 25
mef.dnTz	mef.dnTmz+mef.dnTez	Pa	Maxwell downward surface stress tensor, z component	Boundaries 22, 25
mef.dnTx	mef.dnTmx+mef.dnTex	Pa	Maxwell downward surface stress tensor, x component	Boundaries 6, 8, 11, 13–16, 18–19
mef.dnTy	mef.dnTmy+mef.dnTey	Pa	Maxwell downward surface stress tensor, y component	Boundaries 6, 8, 11, 13–16, 18–19
mef.dnTz	mef.dnTmz+mef.dnTez	Pa	Maxwell downward surface stress tensor, z component	Boundaries 6, 8, 11, 13–16, 18–19
mef.dnTx	mef.dnTmx+mef.dnTex	Pa	Maxwell downward surface stress tensor, x component	Boundaries 20–21, 23–24, 26–31
mef.dnTy	mef.dnTmy+mef.dnTey	Pa	Maxwell downward surface stress tensor, y component	Boundaries 20–21, 23–24, 26–31
mef.dnTz	mef.dnTmz+mef.dnTez	Pa	Maxwell downward surface stress tensor, z component	Boundaries 20–21, 23–24, 26–31
mef.unx	unx		Normal vector up direction, x component	Boundaries 4–6, 8, 10–16, 18–19
mef.uny	uny		Normal vector up direction, y component	Boundaries 4–6, 8, 10–16, 18–19
mef.unz	unz		Normal vector up direction, z component	Boundaries 4–6, 8, 10–16, 18–19
mef.unx	unx		Normal vector up direction, x component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.uny	uny		Normal vector up direction, y component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31

Name	Expression	Unit	Description	Selection
mef.unz	unz		Normal vector up direction, z component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.unx	unx		Normal vector up direction, x component	Boundaries 22, 25
mef.uny	uny		Normal vector up direction, y component	Boundaries 22, 25
mef.unz	unz		Normal vector up direction, z component	Boundaries 22, 25
mef.dnx	dnx		Normal vector down direction, x component	Boundaries 4–6, 8, 10–16, 18–19
mef.dny	dny		Normal vector down direction, y component	Boundaries 4–6, 8, 10–16, 18–19
mef.dnz	dnz		Normal vector down direction, z component	Boundaries 4–6, 8, 10–16, 18–19
mef.dnx	dnx		Normal vector down direction, x component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.dny	dny		Normal vector down direction, y component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.dnz	dnz		Normal vector down direction, z component	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.dnx	dnx		Normal vector down direction, x component	Boundaries 22, 25
mef.dny	dny		Normal vector down direction, y component	Boundaries 22, 25
mef.dnz	dnz		Normal vector down direction, z component	Boundaries 22, 25

Name	Expression	Unit	Description	Selection
mef.dWe	mef.We	J/m^3	Integrand for total electric energy	Domains 2–3
mef.dWe	mef.We	J/m^3	Integrand for total electric energy	Domain 1
mef.dWe	mef.We	J/m^3	Integrand for total electric energy	Domains 4–5
mef.We	0.5*epsilon0_const*((mef.epsilonrxx*mef.Ex+mef.epsilonrxy*mef.Ey+mef.epsilonrxz*mef.Ez)*mef.Ex+(mef.epsilonryx*mef.Ex+mef.epsilonryy*mef.Ey+mef.epsilonryz*mef.Ez)*mef.Ey+(mef.epsilonrzx*mef.Ex+mef.epsilonrzy*mef.Ey+mef.epsilonrzz*mef.Ez)*mef.Ez)	J/m^3	Electric energy density	Domains 2–3
mef.We	0.5*epsilon0_const*((mef.epsilonrxx*mef.Ex+mef.epsilonrxy*mef.Ey+mef.epsilonrxz*mef.Ez)*mef.Ex+(mef.epsilonryx*mef.Ex+mef.epsilonryy*mef.Ey+mef.epsilonryz*mef.Ez)*mef.Ey+(mef.epsilonrzx*mef.Ex+mef.epsilonrzy*mef.Ey+mef.epsilonrzz*mef.Ez)*mef.Ez)	J/m^3	Electric energy density	Domain 1
mef.We	0.5*epsilon0_const*((mef.epsilonrxx*mef.Ex+mef.epsilonrxy*mef.Ey+mef.epsilonrxz*mef.Ez)*mef.Ex+(mef.epsilonryx*mef.Ex+mef.epsilonryy*mef.Ey+mef.epsilonryz*mef.Ez)*mef.Ey+(mef.epsilonrzx*mef.Ex+mef.epsilonrzy*mef.Ey+mef.epsilonrzz*mef.Ez)*mef.Ez)	J/m^3	Electric energy density	Domains 4–5
mef.dWm	mef.Wm	J/m^3	Integrand for total magnetic energy	Domains 2–3
mef.dWm	mef.Wm	J/m^3	Integrand for total magnetic energy	Domain 1
mef.dWm	mef.Wm	J/m^3	Integrand for total magnetic energy	Domains 4–5

Name	Expression	Unit	Description	Selection
mef.Wm	0.5*mu0_const*((mef.murxx*mef.Hx+mef.murxy*mef.Hy+mef.murxz*mef.Hz)*mef.Hx+(mef.muryx*mef.Hx+mef.muryy*mef.Hy+mef.muryz*mef.Hz)*mef.Hy+(mef.murzx*mef.Hx+mef.murzy*mef.Hy+mef.murzz*mef.Hz)*mef.Hz)	J/m^3	Magnetic energy density	Domains 2–3
mef.Wm	0.5*mu0_const*((mef.murxx*mef.Hx+mef.murxy*mef.Hy+mef.murxz*mef.Hz)*mef.Hx+(mef.muryx*mef.Hx+mef.muryy*mef.Hy+mef.muryz*mef.Hz)*mef.Hy+(mef.murzx*mef.Hx+mef.murzy*mef.Hy+mef.murzz*mef.Hz)*mef.Hz)	J/m^3	Magnetic energy density	Domain 1
mef.Wm	0.5*mu0_const*((mef.murxx*mef.Hx+mef.murxy*mef.Hy+mef.murxz*mef.Hz)*mef.Hx+(mef.muryx*mef.Hx+mef.muryy*mef.Hy+mef.muryz*mef.Hz)*mef.Hy+(mef.murzx*mef.Hx+mef.murzy*mef.Hy+mef.murzz*mef.Hz)*mef.Hz)	J/m^3	Magnetic energy density	Domains 4–5
mef.Qrh	mef.Jx*mef.Ex+mef.Jy*mef.Ey+mef.Jz*mef.Ez	W/m^3	Resistive losses	Domains 2–3
mef.Qrh	mef.Jx*mef.Ex+mef.Jy*mef.Ey+mef.Jz*mef.Ez	W/m^3	Resistive losses	Domain 1
mef.Qrh	mef.Jx*mef.Ex+mef.Jy*mef.Ey+mef.Jz*mef.Ez	W/m^3	Resistive losses	Domains 4–5
mef.FLtzx	mef.Bz*mef.Jy-mef.By*mef.Jz	N/m^3	Lorentz force contribution, x component	Domains 2–3
mef.FLtzy	-mef.Bz*mef.Jx+mef.Bx*mef.Jz	N/m^3	Lorentz force contribution, y component	Domains 2–3
mef.FLtzz	mef.By*mef.Jx-mef.Bx*mef.Jy	N/m^3	Lorentz force contribution, z component	Domains 2–3
mef.FLtzx	mef.Bz*mef.Jy-mef.By*mef.Jz	N/m^3	Lorentz force contribution, x component	Domain 1

Name	Expression	Unit	Description	Selection
mef.FLtzy	-mef.Bz*mef.Jx+mef.Bx*mef.Jz	N/m^3	Lorentz force contribution, y component	Domain 1
mef.FLtzz	mef.By*mef.Jx-mef.Bx*mef.Jy	N/m^3	Lorentz force contribution, z component	Domain 1
mef.FLtzx	mef.Bz*mef.Jy-mef.By*mef.Jz	N/m^3	Lorentz force contribution, x component	Domains 4–5
mef.FLtzy	-mef.Bz*mef.Jx+mef.Bx*mef.Jz	N/m^3	Lorentz force contribution, y component	Domains 4–5
mef.FLtzz	mef.By*mef.Jx-mef.Bx*mef.Jy	N/m^3	Lorentz force contribution, z component	Domains 4–5
mef.Pox	mef.Hz*mef.Ey-mef.Hy*mef.Ez	W/m^2	Power flow, x component	Domains 2–3
mef.Poy	-mef.Hz*mef.Ex+mef.Hx*mef.Ez	W/m^2	Power flow, y component	Domains 2–3
mef.Poz	mef.Hy*mef.Ex-mef.Hx*mef.Ey	W/m^2	Power flow, z component	Domains 2–3
mef.Pox	mef.Hz*mef.Ey-mef.Hy*mef.Ez	W/m^2	Power flow, x component	Domain 1
mef.Poy	-mef.Hz*mef.Ex+mef.Hx*mef.Ez	W/m^2	Power flow, y component	Domain 1
mef.Poz	mef.Hy*mef.Ex-mef.Hx*mef.Ey	W/m^2	Power flow, z component	Domain 1
mef.Pox	mef.Hz*mef.Ey-mef.Hy*mef.Ez	W/m^2	Power flow, x component	Domains 4–5
mef.Poy	-mef.Hz*mef.Ex+mef.Hx*mef.Ez	W/m^2	Power flow, y component	Domains 4–5
mef.Poz	mef.Hy*mef.Ex-mef.Hx*mef.Ey	W/m^2	Power flow, z component	Domains 4–5
mef.nPo	(mef.Hz*mef.Ey-mef.Hy*mef.Ez)*mef.nx+(-mef.Hz*mef.Ex+mef.Hx*mef.Ez)*mef.ny+(mef.Hy*mef.Ex-mef.Hx*mef.Ey)*mef.nz	W/m^2	Power outflow	Boundaries 4–6, 8, 10–16, 18–19

Name	Expression	Unit	Description	Selection
mef.nPo	(mef.Hz*mef.Ey-mef.Hy*mef.Ez)*mef.nx+(-mef.Hz*mef.Ex+mef.Hx*mef.Ez)*mef.ny+(mef.Hy*mef.Ex-mef.Hx*mef.Ey)*mef.nz	W/m^2	Power outflow	Boundaries 1–3, 7, 9, 17, 20–21, 23–24, 26–31
mef.nPo	(mef.Hz*mef.Ey-mef.Hy*mef.Ez)*mef.nx+(-mef.Hz*mef.Ex+mef.Hx*mef.Ez)*mef.ny+(mef.Hy*mef.Ex-mef.Hx*mef.Ey)*mef.nz	W/m^2	Power outflow	Boundaries 22, 25
mef.alc1.minput_temperature	model.input.minput_temperature	K	Temperature	Domains 1–5
mef.alc1.minput_pressure	1[atm]	Pa	Absolute pressure	Domains 1–5
mef.alc1.minput_strainreferencetemperature	model.input.minput_strainreferencetemperature	K	Strain reference temperature	Domains 1–5

Shape functions

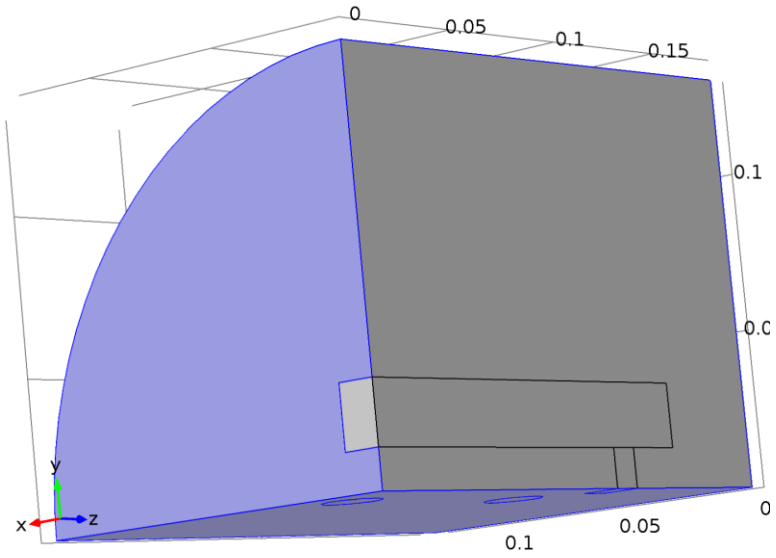
Name	Shape function	Unit	Description	Shape frame	Selection
A2x	Curl (Quadratic)	Wb/m	Magnetic vector potential, x component	Material	Domains 2–3
A2y	Curl (Quadratic)	Wb/m	Magnetic vector potential, y component	Material	Domains 2–3
A2z	Curl (Quadratic)	Wb/m	Magnetic vector potential, z component	Material	Domains 2–3
A2x	Curl (Quadratic)	Wb/m	Magnetic vector potential, x component	Material	Domain 1
A2y	Curl (Quadratic)	Wb/m	Magnetic vector potential, y component	Material	Domain 1
A2z	Curl (Quadratic)	Wb/m	Magnetic vector potential, z component	Material	Domain 1
A2x	Curl (Quadratic)	Wb/m	Magnetic vector potential, x component	Material	Domains 4–5

Name	Shape function	Unit	Description	Shape frame	Selection
A2y	Curl (Quadratic)	Wb/m	Magnetic vector potential, y component	Material	Domains 4–5
A2z	Curl (Quadratic)	Wb/m	Magnetic vector potential, z component	Material	Domains 4–5
V2	Lagrange (Quadratic)	V	Electric potential	Material	Domains 2–3
V2	Lagrange (Quadratic)	V	Electric potential	Material	Domain 1
V2	Lagrange (Quadratic)	V	Electric potential	Material	Domains 4–5

Weak expressions

Weak expression	Integration frame	Selection
mef.d*(mef.Jx*test(V2x)+mef.Jy*test(V2y)+mef.Jz*test(V2z))	Material	Domains 2–3
mef.d*(mef.Jx*test(V2x)+mef.Jy*test(V2y)+mef.Jz*test(V2z))	Material	Domain 1
mef.d*(mef.Jx*test(V2x)+mef.Jy*test(V2y)+mef.Jz*test(V2z))	Material	Domains 4–5
mef.d*(-mef.Hx*test(curlA2x)-mef.Hy*test(curlA2y)-mef.Hz*test(curlA2z)+mef.Jx*test(A2x)+mef.Jy*test(A2y)+mef.Jz*test(A2z))	Material	Domains 2–3
mef.d*(-mef.Hx*test(curlA2x)-mef.Hy*test(curlA2y)-mef.Hz*test(curlA2z)+mef.Jx*test(A2x)+mef.Jy*test(A2y)+mef.Jz*test(A2z))	Material	Domain 1
mef.d*(-mef.Hx*test(curlA2x)-mef.Hy*test(curlA2y)-mef.Hz*test(curlA2z)+mef.Jx*test(A2x)+mef.Jy*test(A2y)+mef.Jz*test(A2z))	Material	Domains 4–5

1.4.2 Magnetic Insulation 1



Magnetic Insulation 1

Selection

Geometric entity level	Boundary
Selection	Boundaries 2–3, 5, 9, 17, 22, 25

Equations

$$\mathbf{n} \times \mathbf{A} = 0$$

Settings

Settings

Description	Value
Apply reaction terms on	All physics (symmetric)
Use weak constraints	0

Variables

Name	Expression	Unit	Description	Selection
mef.Jsx	(up(mef.Hz)-down(mef.Hz))*mef.dny+(-up(mef.Hy)+down(mef.Hy))*mef.dnz	A/m	Surface current density, x component	Boundaries 2–3, 5, 9, 17, 22, 25
mef.Jsy	(-up(mef.Hz)+down(mef.Hz))*mef.dnx+(up(mef.Hx)-down(mef.Hx))*mef.dnz	A/m	Surface current density, y component	Boundaries 2–3, 5, 9, 17, 22, 25
mef.Jsz	(up(mef.Hy)-down(mef.Hy))*mef.dnx+(-up(mef.Hx)+down(mef.Hx))*mef.dny	A/m	Surface current density, z	Boundaries 2–3, 5, 9, 17, 22, 25

Name	Expression	Unit	Description	Selection
			component	
mef.mi1.A0x	0	Wb/m	Magnetic vector potential, x component	Boundaries 2–3, 5, 9, 17, 22, 25
mef.mi1.A0y	0	Wb/m	Magnetic vector potential, y component	Boundaries 2–3, 5, 9, 17, 22, 25
mef.mi1.A0z	0	Wb/m	Magnetic vector potential, z component	Boundaries 2–3, 5, 9, 17, 22, 25

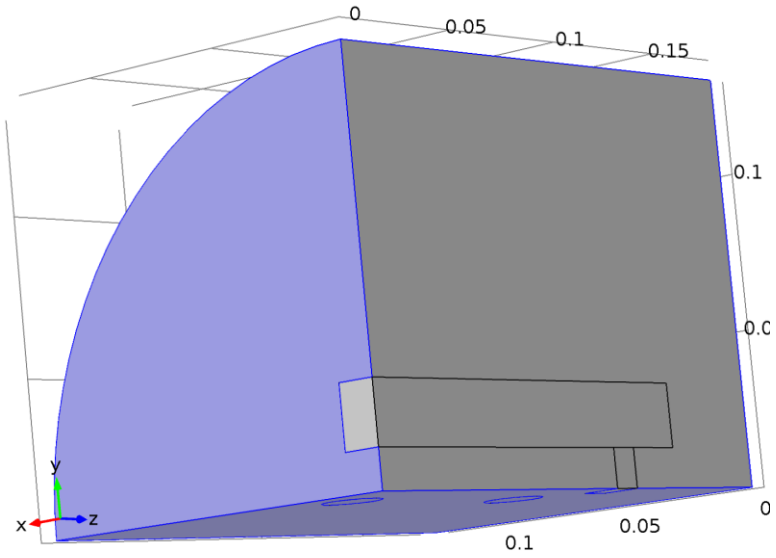
Shape functions

Name	Shape function	Unit	Description	Shape frame	Selection
mef.psi	Lagrange (Quadratic)	A/m	Divergence condition variable	Material	Boundaries 2–3, 5, 9, 17, 22, 25

Constraints

Constraint	Constraint force	Shape function	Selection
mef.mi1.A0x-mef.tAdepx	test(mef.mi1.A0x-mef.tAdepx)	Curl (Quadratic)	Boundaries 2–3, 5, 9, 17, 22, 25
mef.mi1.A0y-mef.tAdepy	test(mef.mi1.A0y-mef.tAdepy)	Curl (Quadratic)	Boundaries 2–3, 5, 9, 17, 22, 25
mef.mi1.A0z-mef.tAdepz	test(mef.mi1.A0z-mef.tAdepz)	Curl (Quadratic)	Boundaries 2–3, 5, 9, 17, 22, 25

Electric Insulation 1



Electric Insulation 1

Selection

Geometric entity level	Boundary
Selection	Boundaries 2–3, 9, 17, 22, 25

Equations

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

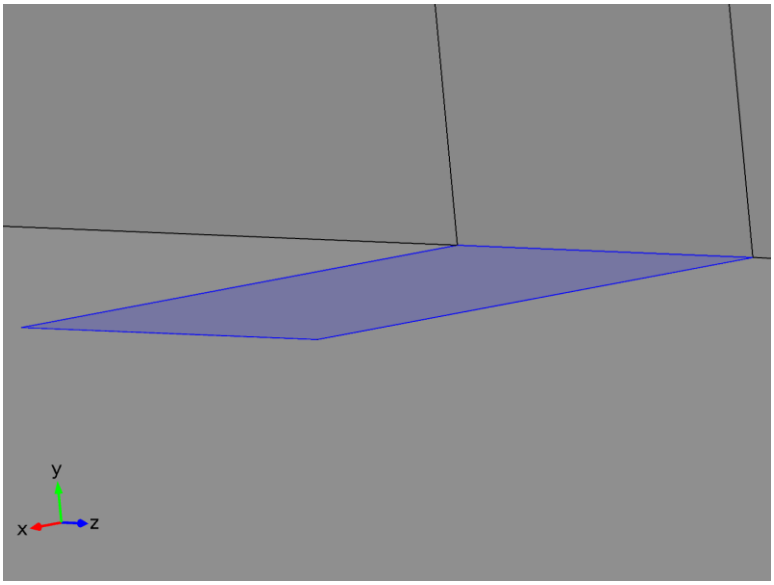
Variables

Name	Expression	Unit	Description	Selection
mef.nJ	0	A/m^2	Normal current density	Boundaries 2–3, 9, 17, 22, 25

Shape functions

Name	Shape function	Unit	Description	Shape frame	Selection
V2	Lagrange (Quadratic)	V	Electric potential	Material	No boundaries

Ground 1



Ground 1

Selection

Geometric entity level	Boundary
Selection	Boundary 5

Equations

$V = 0$

Settings

Settings

Description	Value
Electric potential	0
Apply reaction terms on	All physics (symmetric)
Use weak constraints	0

Variables

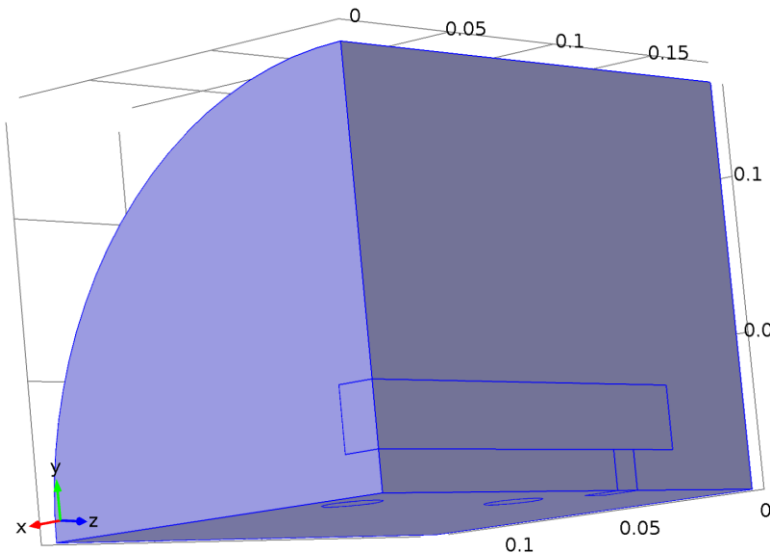
Name	Expression	Unit	Description	Selection
mef.nJ	mef.unx*(down(mef.Jx)-up(mef.Jx))+mef.uny*(down(mef.Jy)-up(mef.Jy))+mef.unz*(down(mef.Jz)-up(mef.Jz))	A/m^2	Normal current density	Boundary 5
mef.V0	0	V	Electric potential	Boundary 5

Constraints

Constraint	Constraint force	Shape function	Selection

Constraint	Constraint force	Shape function	Selection
mef.V0-V2	test(mef.V0-V2)	Lagrange (Quadratic)	Boundary 5

1.4.3 Initial Values 1



Initial Values 1

Selection

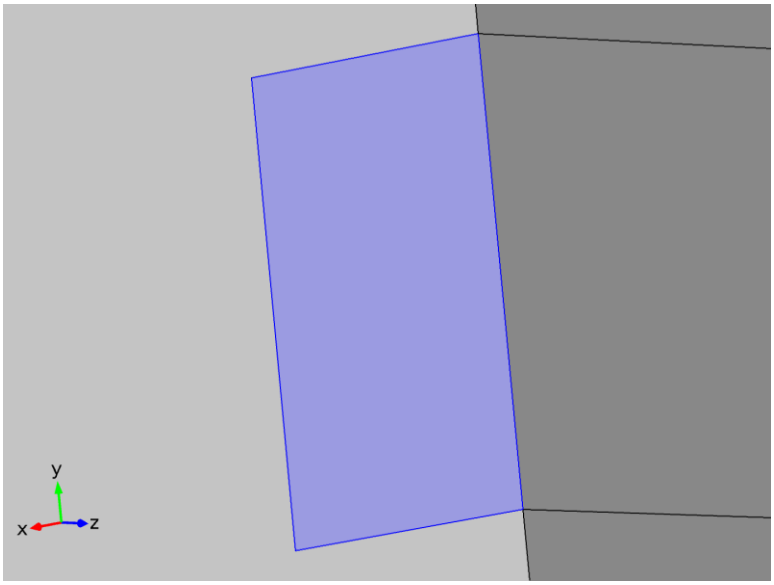
Geometric entity level	Domain
Selection	Domains 1–5

Settings

Settings

Description	Value
Magnetic vector potential	{0, 0, 0}
Electric potential	0

1.4.4 Magnetic Insulation 2



Magnetic Insulation 2

Selection

Geometric entity level	Boundary
Selection	Boundary 12

Equations

$$\mathbf{n} \times \mathbf{A} = 0$$

Settings

Settings

Description	Value
Apply reaction terms on	All physics (symmetric)
Use weak constraints	0

Variables

Name	Expression	Unit	Description	Selection
mef.Jsx	(up(mef.Hz)-down(mef.Hz))*mef.dny+(-up(mef.Hy)+down(mef.Hy))*mef.dnz	A/m	Surface current density, x component	Boundary 12
mef.Jsy	(-up(mef.Hz)+down(mef.Hz))*mef.dnx+(up(mef.Hx)-down(mef.Hx))*mef.dnz	A/m	Surface current density, y component	Boundary 12
mef.Jsz	(up(mef.Hy)-down(mef.Hy))*mef.dnx+(-up(mef.Hx)+down(mef.Hx))*mef.dny	A/m	Surface current density, z	Boundary 12

Name	Expression	Unit	Description	Selection
			component	
mef.mi2.A0x	0	Wb/m	Magnetic vector potential, x component	Boundary 12
mef.mi2.A0y	0	Wb/m	Magnetic vector potential, y component	Boundary 12
mef.mi2.A0z	0	Wb/m	Magnetic vector potential, z component	Boundary 12

Shape functions

Name	Shape function	Unit	Description	Shape frame	Selection
mef.psi	Lagrange (Quadratic)	A/m	Divergence condition variable	Material	Boundary 12

Constraints

Constraint	Constraint force	Shape function	Selection
mef.mi2.A0x-mef.tAdepx	test(mef.mi2.A0x-mef.tAdepx)	Curl (Quadratic)	Boundary 12
mef.mi2.A0y-mef.tAdepy	test(mef.mi2.A0y-mef.tAdepy)	Curl (Quadratic)	Boundary 12
mef.mi2.A0z-mef.tAdepz	test(mef.mi2.A0z-mef.tAdepz)	Curl (Quadratic)	Boundary 12

Electric Insulation 1

Selection

Geometric entity level	Boundary
Selection	No boundaries

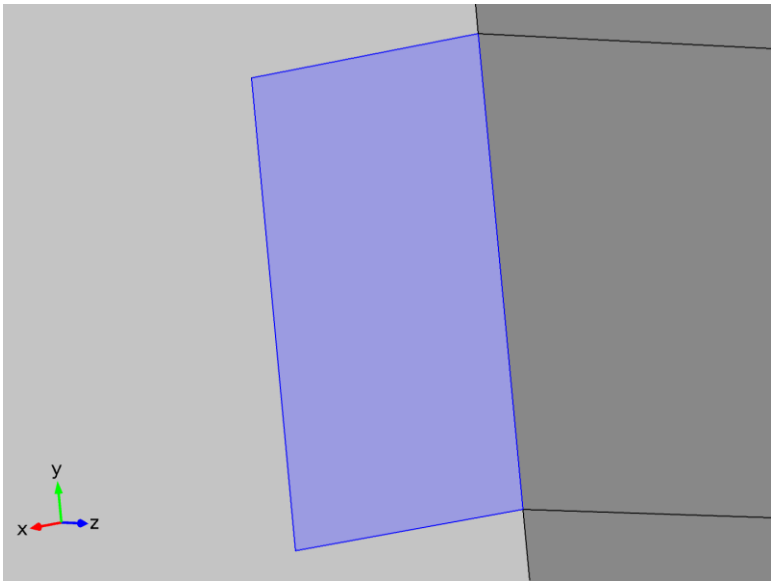
Equations

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

Shape functions

Name	Shape function	Unit	Description	Shape frame	Selection
V2	Lagrange (Quadratic)	V	Electric potential	Material	No boundaries

Normal Current Density 1



Normal Current Density 1

Selection

Geometric entity level	Boundary
Selection	Boundary 12

Equations

$$-\mathbf{n} \cdot \mathbf{J} = J_n$$

Settings

Settings

Description	Value
Type	Inward current density
Normal current density	411696000*3

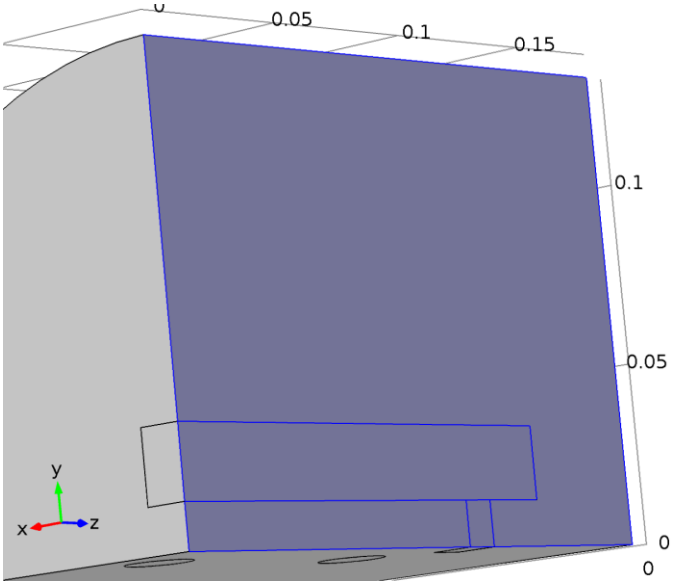
Variables

Name	Expression	Unit	Description	Selection
mef.nJ	mef.mi2.ncd1.nJ	A/m^2	Normal current density	Boundary 12
mef.mi2.ncd1.nJ	1235088000	A/m^2	Normal current density	Boundary 12

Weak expressions

Weak expression	Integration frame	Selection
mef.d*mef.mi2.ncd1.nJ*test(V2)	Material	Boundary 12

1.4.5 Perfect Magnetic Conductor 1



Perfect Magnetic Conductor 1

Selection

Geometric entity level	Boundary
Selection	Boundaries 1, 4, 7, 10

Equations

$$\mathbf{n} \times \mathbf{H} = \underline{0}$$
$$\mathbf{n} \cdot \mathbf{J} = \underline{0}$$

Shape functions

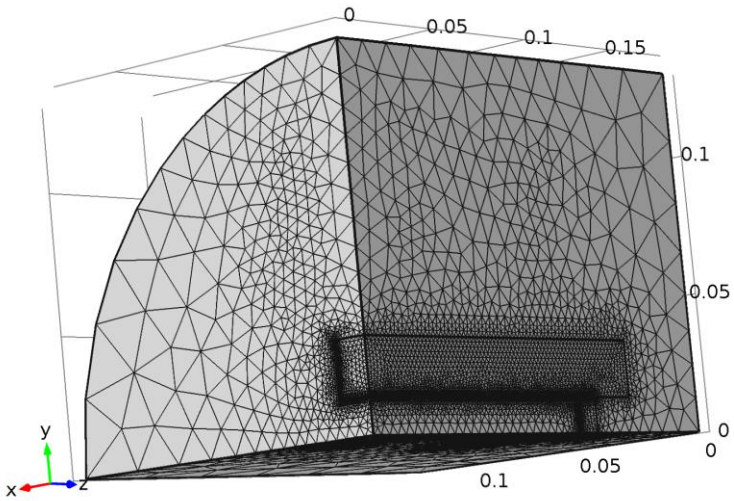
Name	Shape function	Unit	Description	Shape frame	Selection
A2x	Curl (Quadratic)	Wb/m	Magnetic vector potential, x component	Material	No boundaries
A2y	Curl (Quadratic)	Wb/m	Magnetic vector potential, y component	Material	No boundaries
A2z	Curl (Quadratic)	Wb/m	Magnetic vector potential, z component	Material	No boundaries

1.5 Mesh 1

Mesh statistics

Property	Value
Minimum element quality	0.1198
Average element quality	0.7507

Property	Value
Tetrahedral elements	1323477
Triangular elements	68242
Edge elements	1938
Vertex elements	38



Mesh 1

1.5.1 Size (size)

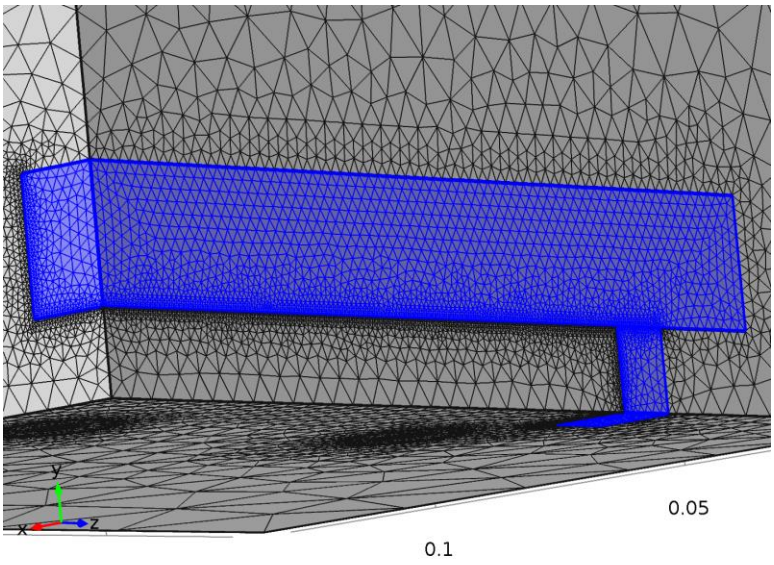
Settings

Name	Value
Maximum element size	0.099
Minimum element size	7.2E-4
Resolution of curvature	0.4
Resolution of narrow regions	0.7
Maximum element growth rate	1.3
Predefined size	Finer
Custom element size	Custom

1.5.2 Size 2 (size2)

Selection

Geometric entity level	Domain
Selection	Domains 2–3



Size 2

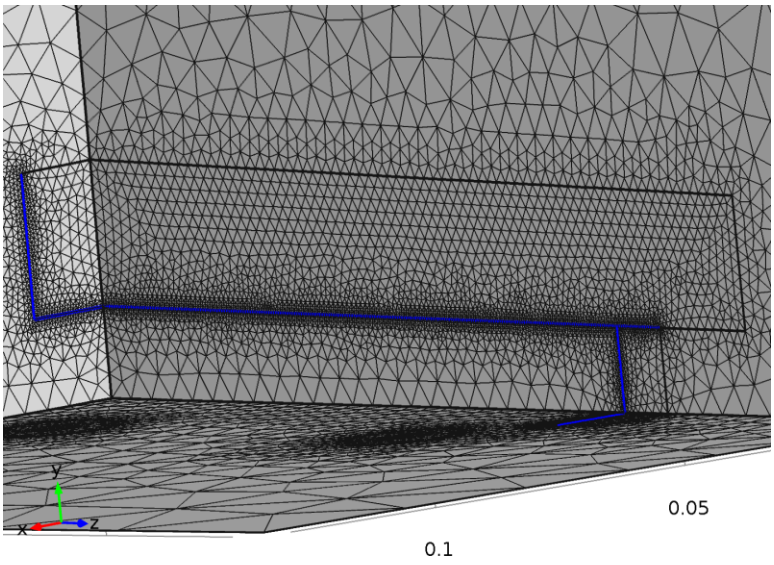
Settings

Name	Value
Maximum element size	0.0020
Minimum element size	0.000324
Resolution of curvature	0.6
Resolution of curvature	Off
Resolution of narrow regions	0.5
Resolution of narrow regions	Off
Maximum element growth rate	1.3
Custom element size	Custom

1.5.3 Size 1 (size1)

Selection

Geometric entity level	Boundary
Selection	Boundaries 6, 11, 13, 19



Size 1

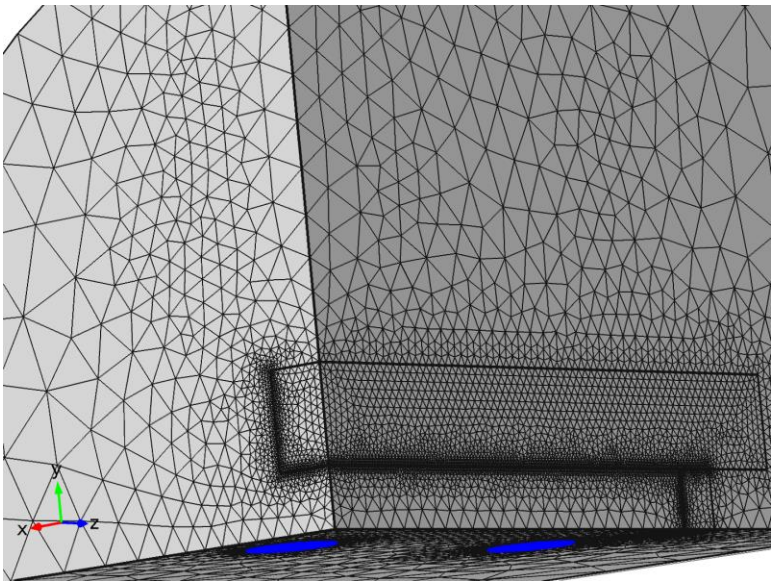
Settings

Name	Value
Maximum element size	0.00049
Minimum element size	0.0000324
Resolution of curvature	0.6
Resolution of curvature	Off
Resolution of narrow regions	0.5
Resolution of narrow regions	Off
Maximum element growth rate	1.3
Custom element size	Custom

1.5.4 Size 3 (size3)

Selection

Geometric entity level	Domain
Selection	Domains 4–5



Size 3

Settings

Name	Value
Maximum element size	0.0018
Minimum element size	0.000324
Resolution of curvature	0.6
Resolution of curvature	Off
Resolution of narrow regions	0.5
Resolution of narrow regions	Off
Maximum element growth rate	1.3
Custom element size	Custom

1.5.5 Free Tetrahedral 1 (ftet1)

Selection

Geometric entity level	Remaining

2 Study 1

2.1 Frequency Domain

Study settings

Property	Value
Include geometric nonlinearity	Off

Frequencies: 20 400 500 600 1000 5000

Mesh selection

Geometry	Mesh
Geometry 1 (geom1)	mesh1

Physics selection

Physics	Discretization
Magnetic and Electric Fields (mef)	physics

2.2 Solver Configurations

2.2.1 Solver 1

Compile Equations: Frequency Domain (st1)

Study and step

Name	Value
Use study	Study 1
Use study step	Frequency Domain

Dependent Variables 1 (v1)

General

Name	Value
Defined by study step	Frequency Domain

Initial values of variables solved for

Name	Value
Solution	Zero

Values of variables not solved for

Name	Value
Solution	Zero

Magnetic vector potential (mod1.A2) (mod1_A2)

General

Name	Value
Field components	{mod1.A2x, mod1.A2y, mod1.A2z}

Electric potential (mod1.V2) (mod1_V2)

General

Name	Value
Field components	mod1.V2

Stationary Solver 1 (s1)

General

Name	Value
Defined by study step	Frequency Domain

Log

```
Stationary Solver 1 in Solver 1 started at 28-Sep-2017 19:15:51.
Parametric solver
Linear solver
Number of degrees of freedom solved for: 10192568.

Parameter freq = 20.
Nonsymmetric matrix found.
Scales for dependent variables:
Magnetic vector potential (mod1.A2): 2
Electric potential (mod1.V2): 1
Iter     Damping    Stepsize #Res #Jac #Sol LinIt   LinErr   LinRes
   1   1.0000000        0.98    1    1    1     4  0.00027 6.6e-007

Parameter freq = 400.
Iter     Damping    Stepsize #Res #Jac #Sol LinIt   LinErr   LinRes
   1   1.0000000         0.9    2    2    2     9  0.00056 1.4e-006

Parameter freq = 500.
Iter     Damping    Stepsize #Res #Jac #Sol LinIt   LinErr   LinRes
   1   1.0000000         0.9    3    3    3    14  0.00034 8.4e-007

Parameter freq = 600.
Iter     Damping    Stepsize #Res #Jac #Sol LinIt   LinErr   LinRes
   1   1.0000000        0.89    4    4    4    19  0.00031 7.9e-007

Parameter freq = 1000.
Iter     Damping    Stepsize #Res #Jac #Sol LinIt   LinErr   LinRes
   1   1.0000000        0.88    5    5    5    25 9.2e-005 2.3e-007

Parameter freq = 5000.
Iter     Damping    Stepsize #Res #Jac #Sol LinIt   LinErr   LinRes
   1   1.0000000        0.82    6    6    6    32  0.00052 1.3e-006
Stationary Solver 1 in Solver 1: Solution time: 8163 s (2 hours, 16 minutes, 3 secon
ds)
                                 Physical memory: 28.7 GB
                                 Virtual memory: 30.47 GB
```

Parametric 1 (p1)

General

Name	Value
Defined by study step	Frequency Domain
Parameter value list	20 400 500 600 1000 5000

Fully Coupled 1 (fc1)

General

Name	Value
Linear solver	Iterative 1

Iterative 1 (i1)

General

Name	Value

Name	Value
Solver	FGMRES

Multigrid 1 (mg1)

Coarse Solver (cs)

Krylov Preconditioner 1 (kp1)

General

Name	Value
Solver	BiCGStab
Preconditioning	Right

3 Results

3.1 Data Sets

3.1.1 Solution 1

Selection

Geometric entity level	Domain
Selection	Geometry geom1

Solution

Name	Value
Solution	Solver 1
Model	Save Point Geometry 1

3.2 Derived Values

3.2.1 Point Evaluation 1

Selection

Geometric entity level	Point
Selection	No points

Data

Name	Value
Data set	Solution 1

Expression

Name	Value
Expression	V2
Unit	V
Description	Electric potential

3.2.2 Volume Integration 1

Selection

Geometric entity level	Domain
Selection	Domain 3

Data

Name	Value
Data set	Solution 1

Expression

Name	Value
Expression	mef.FLtzy
Unit	N
Description	Lorentz force contribution, y component

3.3 Tables

3.3.1 Table 1

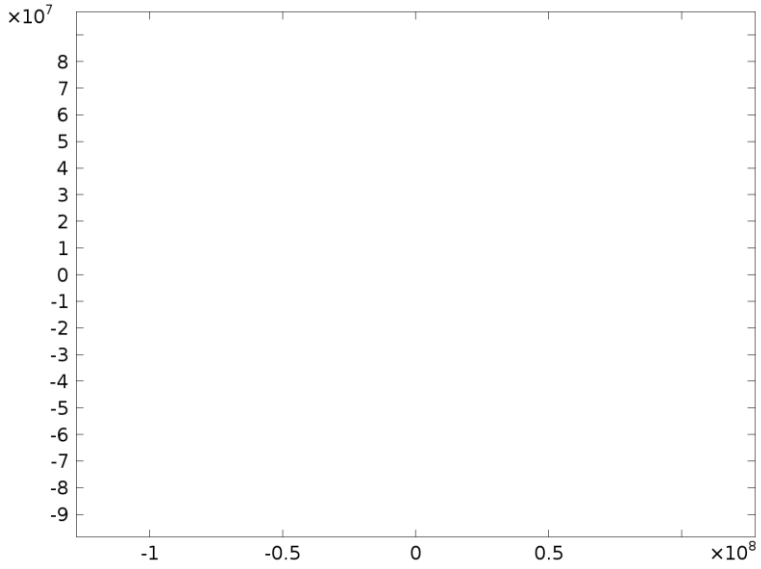
Volume Integration 1 (mef.FLtzy)

Table 1

freq	Lorentz force contribution, y component (N)
20	1.11165e5
400	1.1622e5
500	1.15929e5
600	1.15537e5
1000	1.13846e5
5000	1.09395e5

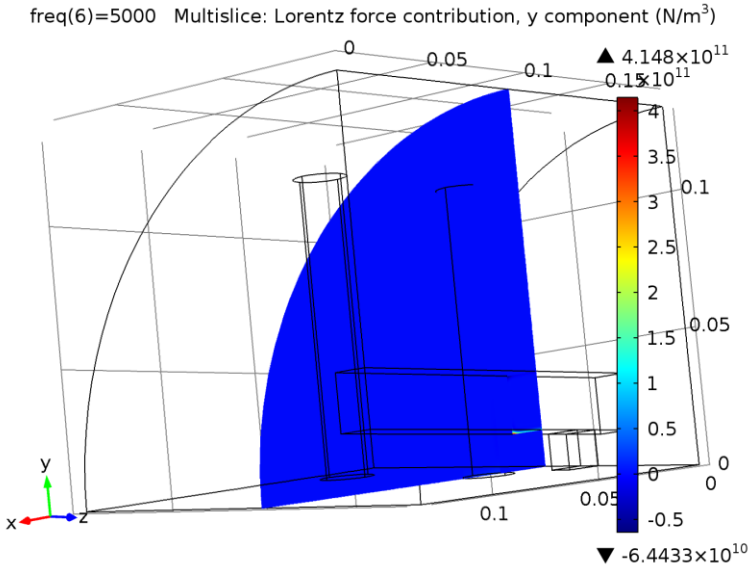
3.4 Plot Groups

3.4.1 2D Plot Group 2



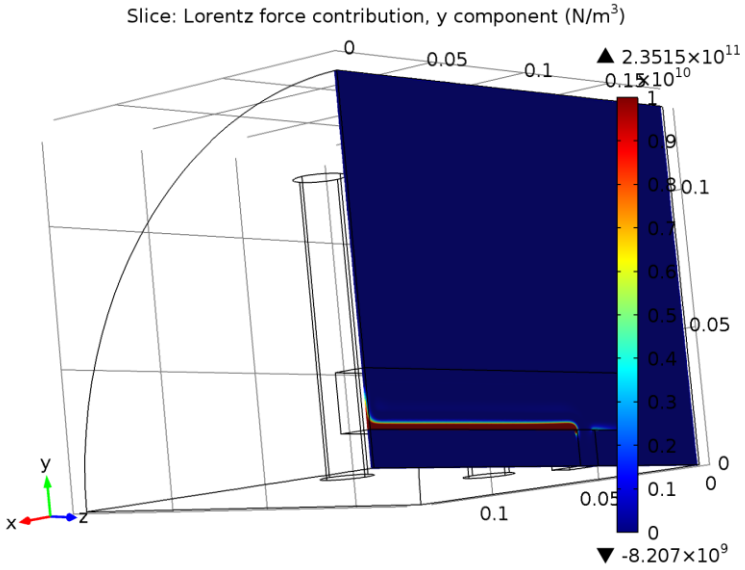
Streamline: Magnetic flux density

3.4.2 Electric Potential (ec)



freq(6)=5000 Multislice: Lorentz force contribution, y component (N/m³)

3.4.3 3D Plot Group 5



Slice: Lorentz force contribution, y component (N/m³)