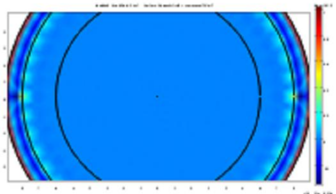
COMSOL Model Report



1. Table of Contents

2. Model Properties

Property	Value
Model name	
Author	
Company	
Department	
Reference	
URL	
Saved date	Nov 4, 2009 9:52:54 PM
Creation date	Oct 27, 2009 8:29:47 PM
COMSOL version	COMSOL 3.5.0.603

File name: C:\Users\Jacob\Documents\Jacob's Documents\School\Research\Comsol\2-D Cylinder-Silver\2D-Cylinder-Silver-30nm_Drude.mph

Application modes and modules used in this model:

- Geom1 (2D)
  - In-Plane TM Waves (RF Module)

3. Global Expressions

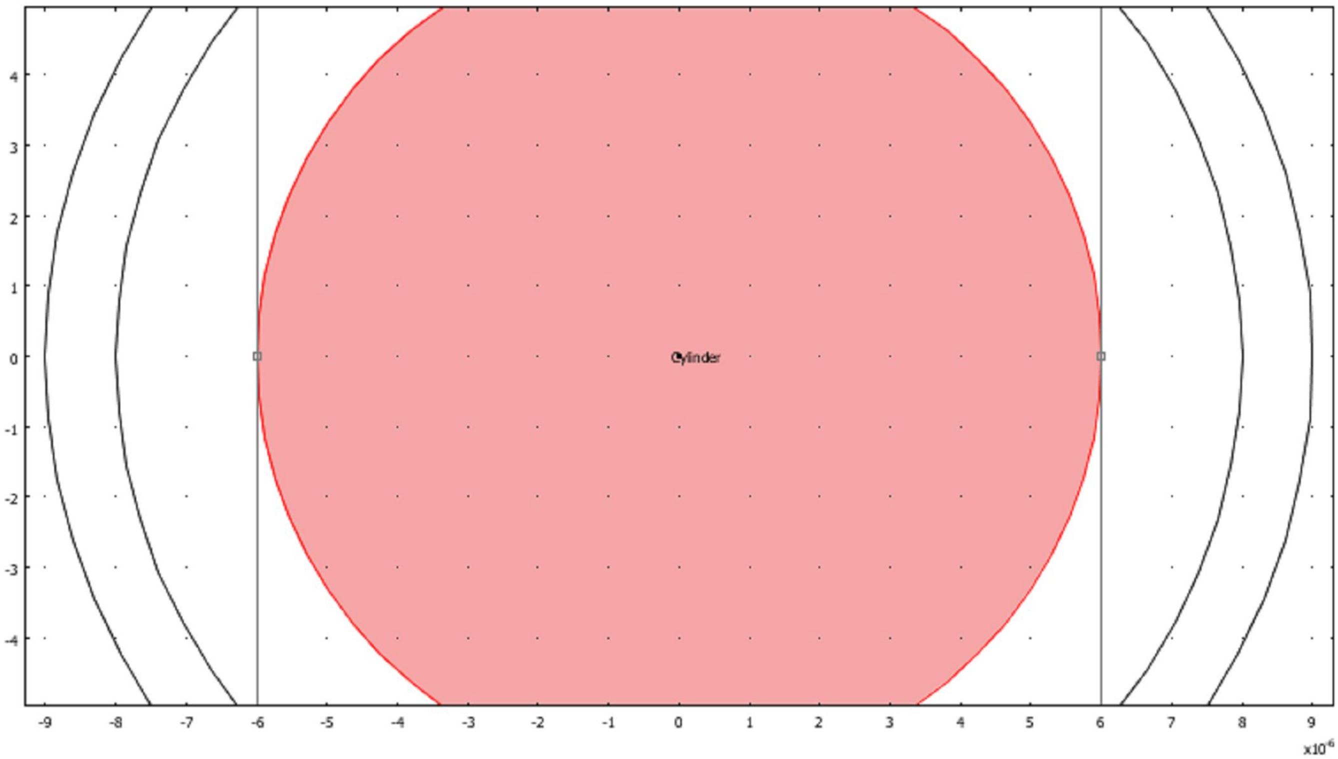
Name	Expression	Unit	Description
w	2*pi*(3e8[m/s])/lambda0_rfweh	1/s	
wt	0.273e14[1/s]	1/s	

wp	1.367e16[1/s]	1/s	
e_drude	5-(wp^2)/(w*(w+j*wt))	1	

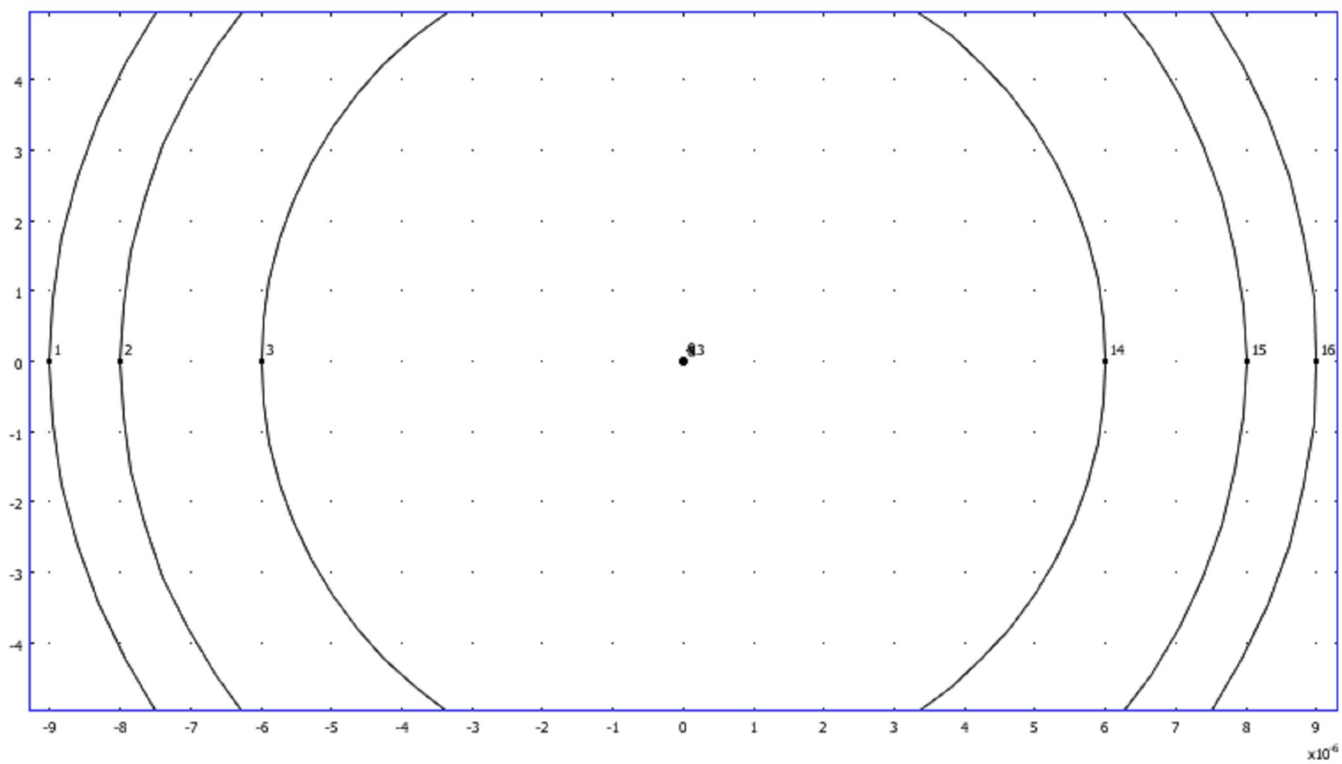
4. Geometry

Number of geometries: 1

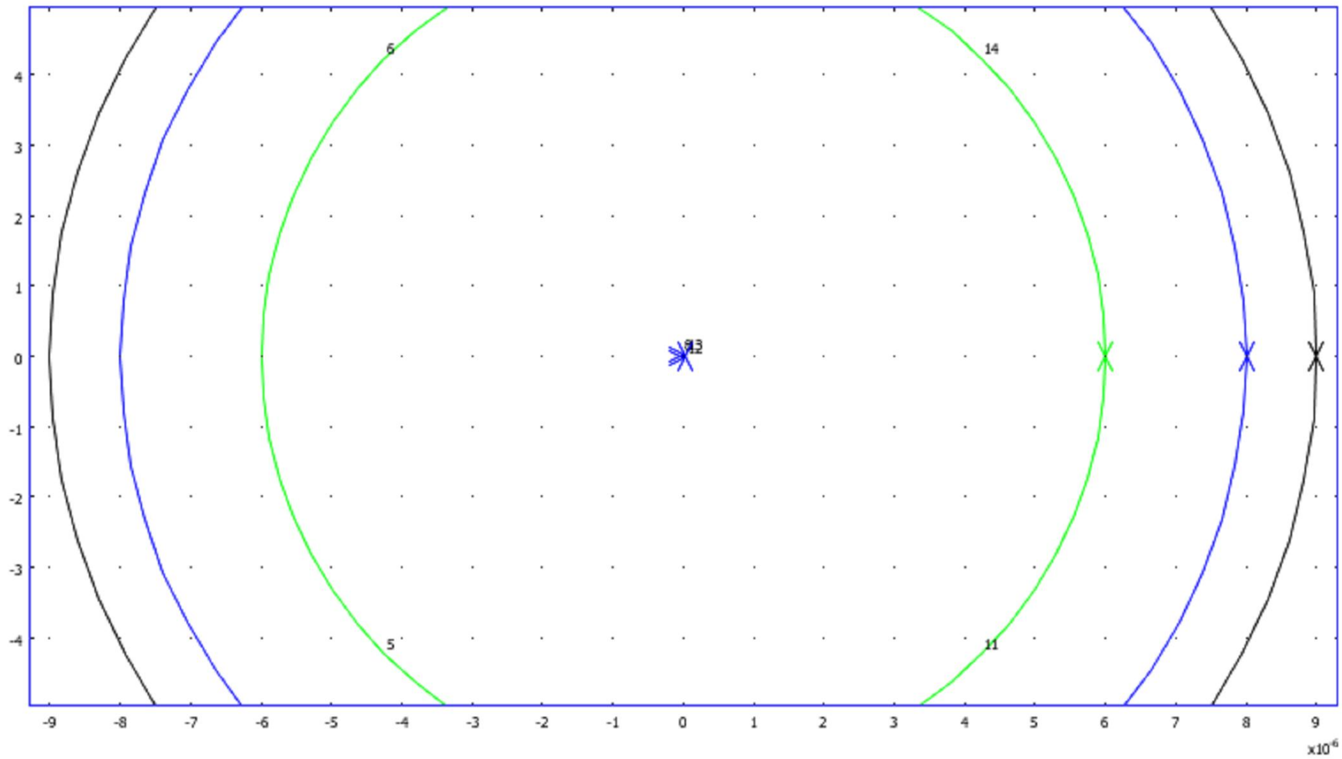
4.1. Geom1



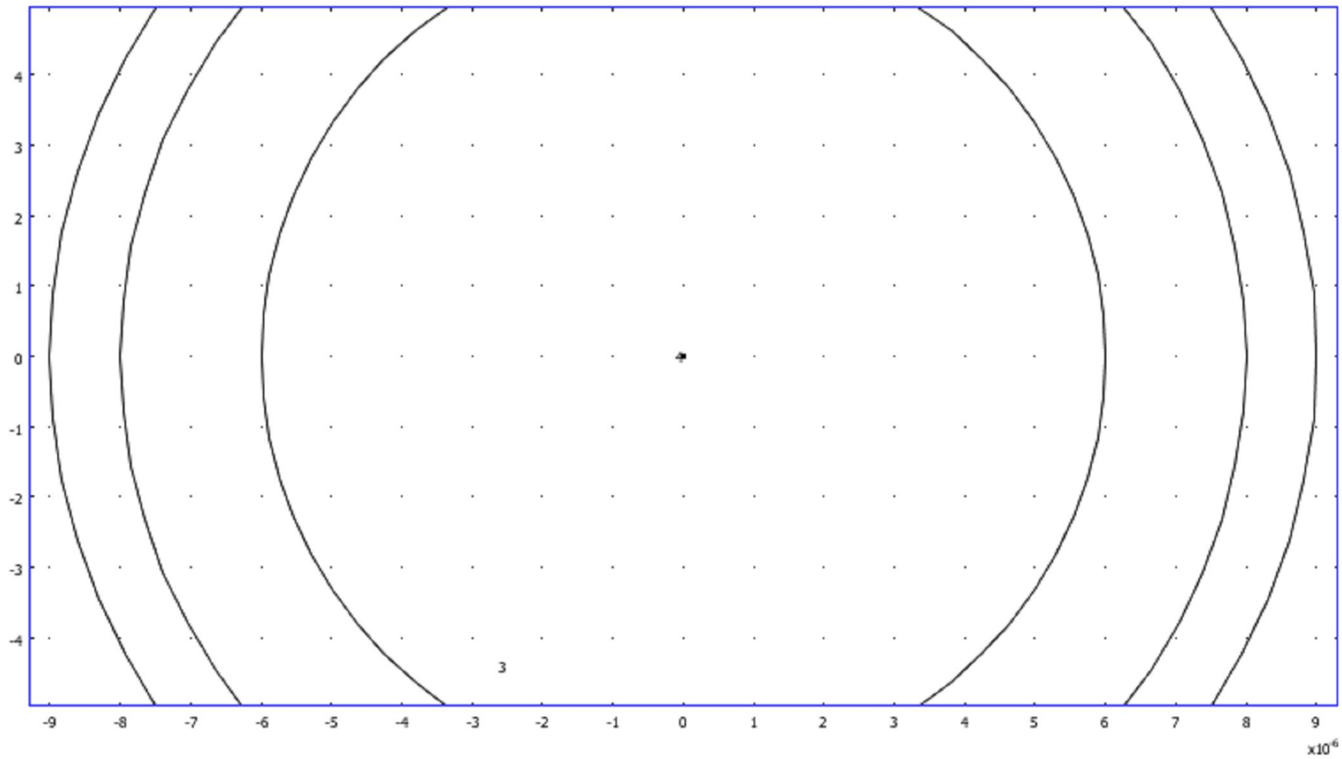
4.1.1. Point mode



4.1.2. Boundary mode



4.1.3. Subdomain mode



5. Geom1

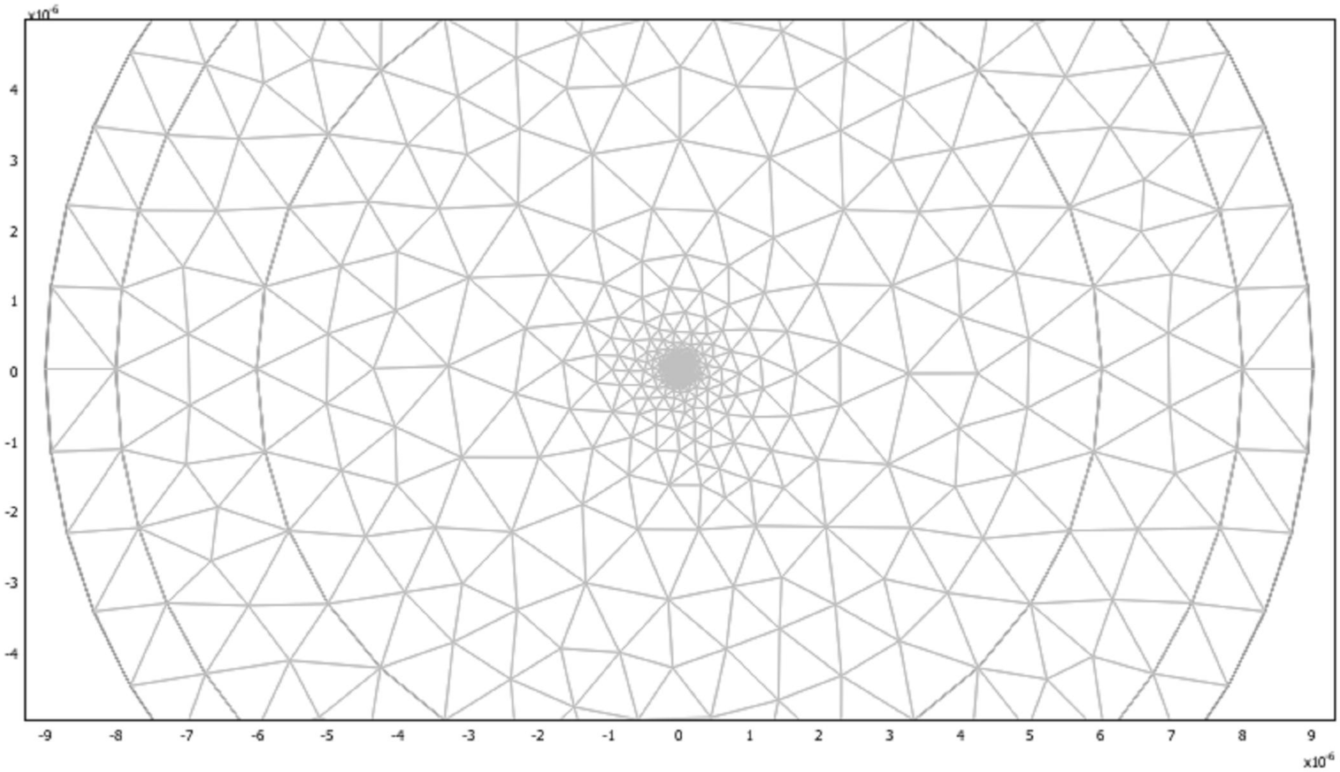
Space dimensions: 2D

Independent variables: x, y, z

5.1. Mesh

5.1.1. Mesh Statistics

Number of degrees of freedom	3581
Number of mesh points	908
Number of elements	1766
Triangular	1766
Quadrilateral	0
Number of boundary elements	148
Number of vertex elements	16
Minimum element quality	0.771
Element area ratio	0



5.2. Application Mode: In-Plane TM Waves (rfweh)

Application mode type: In-Plane TM Waves (RF Module)

Application mode name: rfweh

5.2.1. Scalar Variables

Name	Variable	Value	Unit	Description
epsilon0	epsilon0_rfweh	8.854187817e-12	F/m	Permittivity of vacuum
mu0	mu0_rfweh	4*pi*1e-7	H/m	Permeability of vacuum
lambda0	lambda0_rfweh	340e-9	m	Free space wavelength
H0iz	H0iz_rfweh	exp(-j*k0_rfweh*x)	A/m	Incident magnetic field, z component

5.2.2. Application Mode Properties

Property	Value
Default element type	Lagrange - Quadratic
Analysis type	Harmonic propagation
Field type	TM waves
Specify wave using	Free space wavelength
Specify eigenvalues using	Eigenfrequency

Divergence condition	Off
Frame	Frame (ref)
Weak constraints	Off
Vector element constraint	Off
Constraint type	Ideal

5.2.3. Variables

Dependent variables: Ez, Hz, Ax, Ay, Az, scEz, scHz, psi

Shape functions: shlag(2,'Hz')

Interior boundaries active

5.2.4. Boundary Settings

Boundary		1-2, 9, 16	3-4, 7-8, 10, 12-13, 15	5-6, 11, 14
Type		Scattering boundary condition	Continuity	Continuity
Magnetic field (H0)	A/m	**{0;0;1}**	{0;0;0}	{0;0;0}
Far-Field (farfield)		{}	{}	**{{Far;nxEx_rfweh nxEy_rfweh nxEz_rfweh;nxcurlEx_rfweh nxcurlEy_rfweh nxcurlEz_rfweh;ref}}**

5.2.5. Subdomain Settings

Subdomain		1-2	3-4
Shape functions (shape)		**shlag(2,'Hz')**	**shlag(2,'Hz')**
Integration order (gporder)		**4**	**4**
Constraint order (cporder)		**2**	**2**
matparams		**n**	**n**
Stype		**Cylindrical**	None

6. Solver Settings

Solve using a script: off

Analysis type	Harmonic_propagation
Auto select solver	On
Solver	Parametric
Solution form	Automatic
Symmetric	auto
Adaptive mesh refinement	Off
Optimization/Sensitivity	Off
Plot while solving	Off

6.1. Direct (UMFPACK)

Solver type: Linear system solver

Parameter	Value
Pivot threshold	0.1
Memory allocation factor	0.7

6.2. Stationary

Parameter	Value
Linearity	Automatic
Relative tolerance	1.0E-6
Maximum number of iterations	25
Manual tuning of damping parameters	Off
Highly nonlinear problem	Off
Initial damping factor	1.0
Minimum damping factor	1.0E-4
Restriction for step size update	10.0

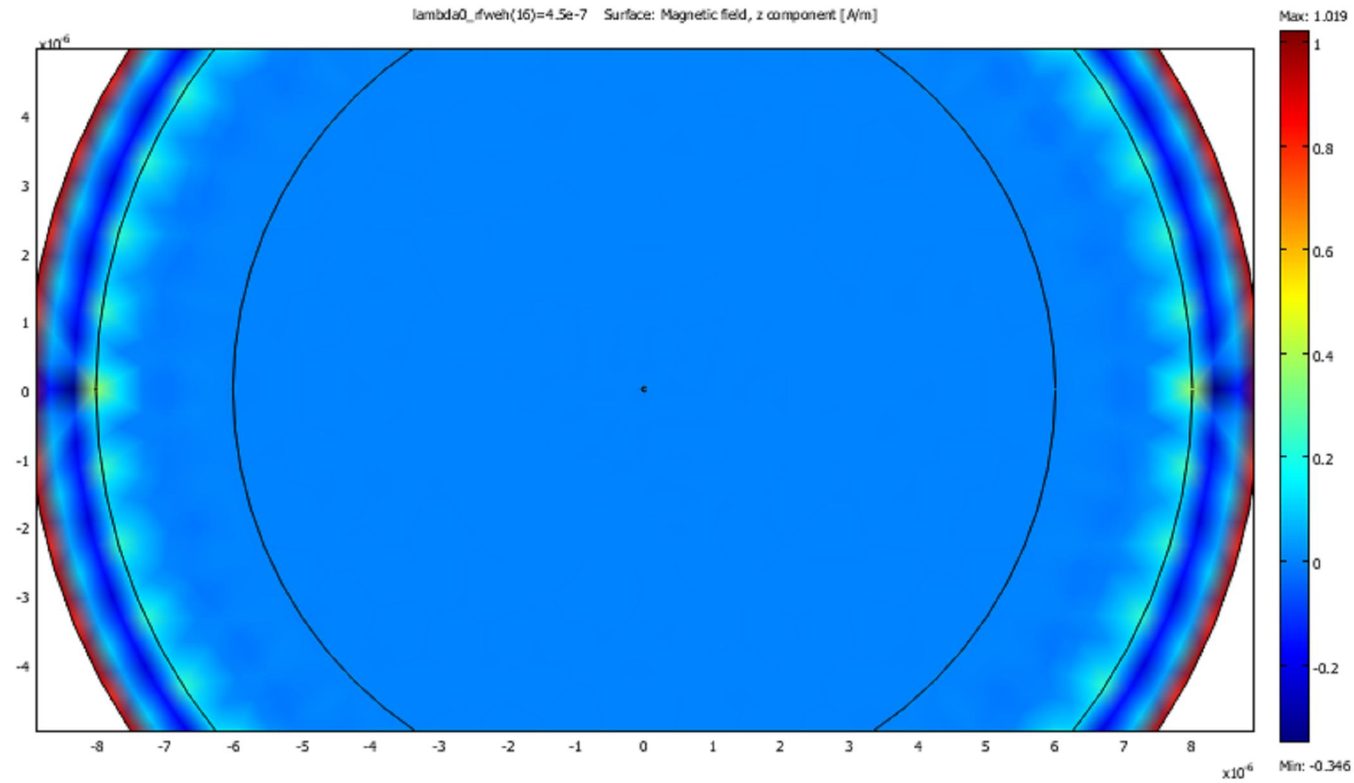
6.3. Parametric

Parameter	Value
Parameter name	lambda0_rfweh
Parameter values	range(300e-9,10e-9,450e-9)
Predictor	Linear
Manual tuning of parameter step size	Off
Initial step size	0.0
Minimum step size	0.0
Maximum step size	0.0

6.4. Advanced

Parameter	Value
Constraint handling method	Elimination
Null-space function	Automatic
Automatic assembly block size	On
Assembly block size	1000
Use Hermitian transpose of constraint matrix and in symmetry detection	Off
Use complex functions with real input	On
Stop if error due to undefined operation	On
Store solution on file	Off
Type of scaling	Automatic
Manual scaling	
Row equilibration	On
Manual control of reassembly	Off
Load constant	On
Constraint constant	On
Mass constant	On
Damping (mass) constant	On
Jacobian constant	On
Constraint Jacobian constant	On

7. Postprocessing



8. Variables

8.1. Boundary

8.1.1. Boundary 1-4, 9-10, 15-16

Name	Description	Unit	Expression
Hiz_rfweh	Incident magnetic field	A/m	0
dVolbnd_rfweh	Area integration contribution	1	detJ_rfweh * sqrt((invJxx_rfweh * nx_rfweh+invJyx_rfweh * ny_rfweh)^2+(invJxy_rfweh * nx_rfweh+invJyy_rfweh * ny_rfweh)^2)
nPoav_rfweh	Power outflow, time average	W/m^2	nx_rfweh * Poxav_rfweh+ny_rfweh * Poyav_rfweh
nxEx_rfweh	Tangential electric field	V/m	0
nxcurlEx_rfweh	Tangential curl of E, x component	V/m^2	-jomega_rfweh * mu_rfweh * ny_rfweh * Hz
nxEy_rfweh	Tangential electric field	V/m	0
nxcurlEy_rfweh	Tangential curl of E, y component	V/m^2	jomega_rfweh * mu_rfweh * nx_rfweh * Hz

nxEz_rfweh	Tangential electric field	V/m	nx_rfweh * Ey_rfweh-ny_rfweh * Ex_rfweh
nxcurlEz_rfweh	Tangential curl of E, z component	V/m^2	0
Z_TE_rfweh	Wave impedance, TE waves	ohm	omega_rfweh * mu_rfweh/betaport_rfweh
Z_TM_rfweh	Wave impedance, TM waves	ohm	betaport_rfweh/(omega_rfweh * epsilon_rfweh)
Z_TEM_rfweh	Wave impedance, TEM waves	ohm	sqrt(mu_rfweh/epsilon_rfweh)
Pin_port_rfweh	Port power level for the inport	W	Pport_rfweh
wport_rfweh	Width of port	m	
hport_rfweh	Height of port	m	
ahx_rfweh	Voltage reference direction, x component	1	
ahy_rfweh	Voltage reference direction, y component	1	

8.1.2. Boundary 5, 7-8, 11-13

Name	Description	Unit	Expression
Hiz_rfweh	Incident magnetic field	A/m	H0iz_rfweh
dVolbnd_rfweh	Area integration contribution	1	1
nPoav_rfweh	Power outflow, time average	W/m^2	nx_rfweh * Poxav_rfweh+ny_rfweh * Poyav_rfweh
nxEx_rfweh	Tangential electric field	V/m	0
nxcurlEx_rfweh	Tangential curl of E, x component	V/m^2	-jomega_rfweh * mu_rfweh * ny_rfweh * Hz
nxEy_rfweh	Tangential electric field	V/m	0
nxcurlEy_rfweh	Tangential curl of E, y component	V/m^2	jomega_rfweh * mu_rfweh * nx_rfweh * Hz
nxEz_rfweh	Tangential electric field	V/m	nx_rfweh * Ey_rfweh-ny_rfweh * Ex_rfweh
nxcurlEz_rfweh	Tangential curl of E, z component	V/m^2	0
Z_TE_rfweh	Wave impedance, TE waves	ohm	omega_rfweh * mu_rfweh/betaport_rfweh
Z_TM_rfweh	Wave impedance, TM waves	ohm	betaport_rfweh/(omega_rfweh * epsilon_rfweh)
Z_TEM_rfweh	Wave impedance, TEM waves	ohm	sqrt(mu_rfweh/epsilon_rfweh)
Pin_port_rfweh	Port power level for the inport	W	Pport_rfweh
wport_rfweh	Width of port	m	
hport_rfweh	Height of port	m	
ahx_rfweh	Voltage reference direction, x component	1	
ahy_rfweh	Voltage reference direction, y component	1	

8.1.3. Boundary 6, 14

Name	Description	Unit	Expression
Hiz_rfweh	Incident magnetic field	A/m	H0iz_rfweh
dVolbnd_rfweh	Area integration contribution	1	1

nPoav_rfweh	Power outflow, time average	W/m^2	nx_rfweh * Poxav_rfweh+ny_rfweh * Poyav_rfweh
nxEx_rfweh	Tangential electric field	V/m	0
nxcurlEx_rfweh	Tangential curl of E, x component	V/m^2	jomega_rfweh * mu_rfweh * ny_rfweh * Hz
nxEy_rfweh	Tangential electric field	V/m	0
nxcurlEy_rfweh	Tangential curl of E, y component	V/m^2	-jomega_rfweh * mu_rfweh * nx_rfweh * Hz
nxEz_rfweh	Tangential electric field	V/m	-nx_rfweh * Ey_rfweh+ny_rfweh * Ex_rfweh
nxcurlEz_rfweh	Tangential curl of E, z component	V/m^2	0
Z_TE_rfweh	Wave impedance, TE waves	ohm	omega_rfweh * mu_rfweh/betaport_rfweh
Z_TM_rfweh	Wave impedance, TM waves	ohm	betaport_rfweh/(omega_rfweh * epsilon_rfweh)
Z_TEM_rfweh	Wave impedance, TEM waves	ohm	sqrt(mu_rfweh/epsilon_rfweh)
Pin_port_rfweh	Port power level for the inport	W	Pport_rfweh
wport_rfweh	Width of port	m	
hport_rfweh	Height of port	m	
ahx_rfweh	Voltage reference direction, x component	1	
ahy_rfweh	Voltage reference direction, y component	1	

8.2. Subdomain

8.2.1. Subdomain 1

Name	Description	Unit	Expression
dr_guess_rfweh	Width in radial direction default guess	m	1e-006
R0_guess_rfweh	Inner radius default guess	m	8e-006
SRcoord_rfweh	PML radial coordinate	m	R0_rfweh+(sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2)-R0_rfweh) * lambdaS_rfweh * (1-i)/dr_rfweh
Sx_rfweh	PML x coordinate	m	SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2)
Sdx_guess_rfweh	Width in x direction default guess	m	9e-006
rCylx_rfweh	PML r cylindrical vector, x component	m	x-srcpntx_rfweh
Sy_rfweh	PML y coordinate	m	SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2)
Sdy_guess_rfweh	Width in y direction default guess	m	9e-006
rCyly_rfweh	PML r cylindrical vector, y component	m	y-srcpnty_rfweh
detJ_rfweh	PML transformation matrix	1	d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x) * d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-

	determinant		srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y)-d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y) * d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x)
Jxx_rfweh	PML transformation matrix, element xx	1	d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x)
invJxx_rfweh	PML inverse transformation matrix, element xx	1	d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y)/detJ_rfweh
Jxy_rfweh	PML transformation matrix, element xy	1	d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y)
invJxy_rfweh	PML inverse transformation matrix, element xy	1	-d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y)/detJ_rfweh
Jyx_rfweh	PML transformation matrix, element yx	1	d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x)
invJyx_rfweh	PML inverse transformation matrix, element yx	1	-d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x)/detJ_rfweh
Jyy_rfweh	PML transformation matrix, element yy	1	d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y)
invJyy_rfweh	PML inverse transformation matrix, element yy	1	d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x)/detJ_rfweh
k_rfweh	Wave number	1/m	k0_rfweh * sqrt(mur_rfweh * (epsilonr_rfweh+sigma_rfweh/(jomega_rfweh * epsilon0_rfweh)))
dVol_rfweh	Volume integration contribution	1	detJ_rfweh
c_rfweh	Phase velocity	m/s	c0_rfweh/sqrt(epsilonr_rfweh * mur_rfweh)
Z_wave_rfweh	Wave impedance	ohm	c_rfweh * mu0_rfweh * mur_rfweh
delta_rfweh	Skin depth	m	1/real(sqrt(j * omega_rfweh * mu0_rfweh * mur_rfweh * (sigma_rfweh+j * omega_rfweh * epsilon0_rfweh * epsilonr_rfweh)))
Hiz_rfweh	Incident magnetic field	A/m	0
curlHx_rfweh	Curl of magnetic field, x component	A/m^2	invJyx_rfweh * Hzx+invJyy_rfweh * Hzy

curlHy_rfweh	Curl of magnetic field, y component	A/m^2	-invJxx_rfweh * Hzx-invJxy_rfweh * Hzy
depHz_rfweh	Magnetic field test variable, z component	A/m	Hz
scHz	Scattered magnetic field, z component	A/m	Hz-Hiz_rfweh
Qmav_rfweh	Magnetic hysteresis losses	W/m^3	real(0.5 * j * omega_rfweh * Bz_rfweh * conj(Hz))
epsilon_rfweh	Permittivity	F/m	epsilon0_rfweh * epsilonr_rfweh
epsilonxx_rfweh	Permittivity, xx component	F/m	epsilon0_rfweh * epsilonrxx_rfweh
epsilonxy_rfweh	Permittivity, xy component	F/m	epsilon0_rfweh * epsilonrxy_rfweh
epsilonyx_rfweh	Permittivity, yx component	F/m	epsilon0_rfweh * epsilonryx_rfweh
epsilonyy_rfweh	Permittivity, yy component	F/m	epsilon0_rfweh * epsilonryy_rfweh
mu_rfweh	Permeability	H/m	mu0_rfweh * mur_rfweh
muzz_rfweh	Permeability, zz component	H/m	mu0_rfweh * murzz_rfweh
Dx_rfweh	Electric displacement, x component	C/m^2	epsilonxx_rfweh * Ex_rfweh+epsilonxy_rfweh * Ey_rfweh
scDx_rfweh	Scattered electric displacement, x component	C/m^2	epsilonxx_rfweh * scEx_rfweh+epsilonxy_rfweh * scEy_rfweh
Jdx_rfweh	Displacement current density, x component	A/m^2	jomega_rfweh * Dx_rfweh
Jix_rfweh	Induced current density, x component	A/m^2	sigmaxx_rfweh * Ex_rfweh+sigmaxy_rfweh * Ey_rfweh
Ex_rfweh	Electric field, x component	V/m	jwEx_rfweh/jomega_rfweh
jwEx_rfweh	Electric field, x component, times jω	m*kg/(s^4*A)	curlHx_rfweh/(n_rfweh^2 * epsilon0_rfweh)
scEx_rfweh	Scattered electric field, x component	V/m	(invJyx_rfweh * d(scHz,x)+invJyy_rfweh * d(scHz,y))/(n_rfweh^2 * epsilon0_rfweh * jomega_rfweh)
Eix_rfweh	Incident electric field, x component	V/m	(invJyx_rfweh * d(Hiz_rfweh,x)+invJyy_rfweh * d(Hiz_rfweh,y))/(n_rfweh^2 * jomega_rfweh * epsilon0_rfweh)
Dy_rfweh	Electric displacement, y component	C/m^2	epsilonyx_rfweh * Ex_rfweh+epsilonyy_rfweh * Ey_rfweh
scDy_rfweh	Scattered electric displacement,	C/m^2	epsilonyx_rfweh * scEx_rfweh+epsilonyy_rfweh * scEy_rfweh

	y component		
Jdy_rfweh	Displacement current density, y component	A/m^2	jomega_rfweh * Dy_rfweh
Jiy_rfweh	Induced current density, y component	A/m^2	sigmayx_rfweh * Ex_rfweh+sigmayy_rfweh * Ey_rfweh
Ey_rfweh	Electric field, y component	V/m	jwEy_rfweh/jomega_rfweh
jwEy_rfweh	Electric field, y component, times jω	m*kg/(s^4*A)	curlHy_rfweh/(n_rfweh^2 * epsilon0_rfweh)
scEy_rfweh	Scattered electric field, y component	V/m	-(invJxx_rfweh * d(scHz,x)+invJxy_rfweh * d(scHz,y))/(n_rfweh^2 * epsilon0_rfweh * jomega_rfweh)
Eiy_rfweh	Incident electric field, y component	V/m	(invJxx_rfweh * d(-Hiz_rfweh,x)+invJxy_rfweh * d(-Hiz_rfweh,y))/(n_rfweh^2 * jomega_rfweh * epsilon0_rfweh)
Bz_rfweh	Magnetic flux density, z component	T	mu_rfweh * Hz
scBz_rfweh	Scattered magnetic flux density, z component	T	mu_rfweh * scHz
normH_rfweh	Magnetic field, norm	A/m	abs(Hz)
normB_rfweh	Magnetic flux density, norm	T	abs(Bz_rfweh)
normscH_rfweh	Scattered magnetic field, norm	A/m	abs(scHz)
normscB_rfweh	Scattered magnetic flux density, norm	T	abs(scBz_rfweh)
normE_rfweh	Electric field, norm	V/m	sqrt(abs(Ex_rfweh)^2+abs(Ey_rfweh)^2)
normD_rfweh	Electric displacement, norm	C/m^2	sqrt(abs(Dx_rfweh)^2+abs(Dy_rfweh)^2)
normscE_rfweh	Scattered electric field, norm	V/m	sqrt(abs(scEx_rfweh)^2+abs(scEy_rfweh)^2)
normscD_rfweh	Scattered electric displacement, norm	C/m^2	sqrt(abs(scDx_rfweh)^2+abs(scDy_rfweh)^2)
normPoav_rfweh	Power flow, time average, norm	W/m^2	sqrt(abs(Poxav_rfweh)^2+abs(Poyav_rfweh)^2)
Wmav_rfweh	Magnetic energy density, time average	J/m^3	0.25 * real(Hz * conj(Bz_rfweh))

Weav_rfweh	Electric energy density, time average	J/m^3	0.25 * real(Ex_rfweh * conj(Dx_rfweh)+Ey_rfweh * conj(Dy_rfweh))
Wav_rfweh	Total energy density, time average	J/m^3	Wmav_rfweh+Weav_rfweh
Qav_rfweh	Resistive heating, time average	W/m^3	0.5 * real(sigmaxx_rfweh * Ex_rfweh * conj(Ex_rfweh)+sigmaxy_rfweh * Ey_rfweh * conj(Ex_rfweh)-j * real(omega_rfweh) * Ex_rfweh * conj(Dx_rfweh)+sigmayx_rfweh * Ex_rfweh * conj(Ey_rfweh)+sigmayy_rfweh * Ey_rfweh * conj(Ey_rfweh)-j * real(omega_rfweh) * Ey_rfweh * conj(Dy_rfweh))
Poxav_rfweh	Power flow, time average, x component	W/m^2	0.5 * real(Ey_rfweh * conj(Hz))
Poyav_rfweh	Power flow, time average, y component	W/m^2	0.5 * real(-Ex_rfweh * conj(Hz))
Farx	Far-field variable, Farx	V/m	Farx(x,y)
Fary	Far-field variable, Fary	V/m	Fary(x,y)
normFar	Far-field variable, normFar	V/m	sqrt(abs(Farx)^2+abs(Fary)^2)
normFardB	Far-field variable (dB), normFar	1	20 * log10(sqrt(abs(Farx)^2+abs(Fary)^2))

8.2.2. Subdomain 2

Name	Description	Unit	Expression
dr_guess_rfweh	Width in radial direction default guess	m	2e-006
R0_guess_rfweh	Inner radius default guess	m	6e-006
SRcoord_rfweh	PML radial coordinate	m	R0_rfweh+(sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2)-R0_rfweh) * lambdaS_rfweh * (1-i)/dr_rfweh
Sx_rfweh	PML x coordinate	m	SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2)
Sdx_guess_rfweh	Width in x direction default guess	m	8e-006
rCylx_rfweh	PML r cylindrical vector, x component	m	x-srcpntx_rfweh
Sy_rfweh	PML y coordinate	m	SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2)

Sdy_guess_rfweh	Width in y direction default guess	m	8e-006
rCyly_rfweh	PML r cylindrical vector, y component	m	y-srcpnty_rfweh
detJ_rfweh	PML transformation matrix determinant	1	d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x) * d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y)-d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y) * d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x)
Jxx_rfweh	PML transformation matrix, element xx	1	d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x)
invJxx_rfweh	PML inverse transformation matrix, element xx	1	d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y)/detJ_rfweh
Jxy_rfweh	PML transformation matrix, element xy	1	d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y)
invJxy_rfweh	PML inverse transformation matrix, element xy	1	-d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y)/detJ_rfweh
Jyx_rfweh	PML transformation matrix, element yx	1	d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x)
invJyx_rfweh	PML inverse transformation matrix, element yx	1	-d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x)/detJ_rfweh
Jyy_rfweh	PML transformation matrix, element yy	1	d(SRcoord_rfweh * (y-srcpnty_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),y)
invJyy_rfweh	PML inverse transformation matrix, element yy	1	d(SRcoord_rfweh * (x-srcpntx_rfweh)/sqrt(abs(x-srcpntx_rfweh)^2+abs(y-srcpnty_rfweh)^2),x)/detJ_rfweh
k_rfweh	Wave number	1/m	k0_rfweh * sqrt(mur_rfweh * (epsilonr_rfweh+sigma_rfweh/(jomega_rfweh * epsilon0_rfweh)))
dVol_rfweh	Volume integration contribution	1	detJ_rfweh
c_rfweh	Phase velocity	m/s	c0_rfweh/sqrt(epsilonr_rfweh * mur_rfweh)

Z_wave_rfweh	Wave impedance	ohm	c_rfweh * mu0_rfweh * mur_rfweh
delta_rfweh	Skin depth	m	1/real(sqrt(j * omega_rfweh * mu0_rfweh * mur_rfweh * (sigma_rfweh+j * omega_rfweh * epsilon0_rfweh * epsilonr_rfweh)))
Hiz_rfweh	Incident magnetic field	A/m	0
curlHx_rfweh	Curl of magnetic field, x component	A/m^2	invJyx_rfweh * Hzx+invJyy_rfweh * Hzy
curlHy_rfweh	Curl of magnetic field, y component	A/m^2	-invJxx_rfweh * Hzx-invJxy_rfweh * Hzy
depHz_rfweh	Magnetic field test variable, z component	A/m	Hz
scHz	Scattered magnetic field, z component	A/m	Hz-Hiz_rfweh
Qmav_rfweh	Magnetic hysteresis losses	W/m^3	real(0.5 * j * omega_rfweh * Bz_rfweh * conj(Hz))
epsilon_rfweh	Permittivity	F/m	epsilon0_rfweh * epsilonr_rfweh
epsilonxx_rfweh	Permittivity, xx component	F/m	epsilon0_rfweh * epsilonrxx_rfweh
epsilonxy_rfweh	Permittivity, xy component	F/m	epsilon0_rfweh * epsilonrxy_rfweh
epsilonyx_rfweh	Permittivity, yx component	F/m	epsilon0_rfweh * epsilonryx_rfweh
epsilonyy_rfweh	Permittivity, yy component	F/m	epsilon0_rfweh * epsilonryy_rfweh
mu_rfweh	Permeability	H/m	mu0_rfweh * mur_rfweh
muzz_rfweh	Permeability, zz component	H/m	mu0_rfweh * murzz_rfweh
Dx_rfweh	Electric displacement, x component	C/m^2	epsilonxx_rfweh * Ex_rfweh+epsilonxy_rfweh * Ey_rfweh
scDx_rfweh	Scattered electric displacement, x component	C/m^2	epsilonxx_rfweh * scEx_rfweh+epsilonxy_rfweh * scEy_rfweh
Jdx_rfweh	Displacement current density, x component	A/m^2	jomega_rfweh * Dx_rfweh
Jix_rfweh	Induced current density, x component	A/m^2	sigmaxx_rfweh * Ex_rfweh+sigmaxy_rfweh * Ey_rfweh
Ex_rfweh	Electric field, x component	V/m	jwEx_rfweh/jomega_rfweh
jwEx_rfweh	Electric field, x component, times jω	m*kg/(s^4*A)	curlHx_rfweh/(n_rfweh^2 * epsilon0_rfweh)

scEx_rfweh	Scattered electric field, x component	V/m	(invJyx_rfweh * d(scHz,x)+invJyy_rfweh * d(scHz,y))/(n_rfweh^2 * epsilon0_rfweh * jomega_rfweh)
Eix_rfweh	Incident electric field, x component	V/m	(invJyx_rfweh * d(Hiz_rfweh,x)+invJyy_rfweh * d(Hiz_rfweh,y))/(n_rfweh^2 * jomega_rfweh * epsilon0_rfweh)
Dy_rfweh	Electric displacement, y component	C/m^2	epsilonyx_rfweh * Ex_rfweh+epsilonyy_rfweh * Ey_rfweh
scDy_rfweh	Scattered electric displacement, y component	C/m^2	epsilonyx_rfweh * scEx_rfweh+epsilonyy_rfweh * scEy_rfweh
Jdy_rfweh	Displacement current density, y component	A/m^2	jomega_rfweh * Dy_rfweh
Jiy_rfweh	Induced current density, y component	A/m^2	sigmayx_rfweh * Ex_rfweh+sigmayy_rfweh * Ey_rfweh
Ey_rfweh	Electric field, y component	V/m	jwEy_rfweh/jomega_rfweh
jwEy_rfweh	Electric field, y component, times jω	m*kg/(s^4*A)	curlHy_rfweh/(n_rfweh^2 * epsilon0_rfweh)
scEy_rfweh	Scattered electric field, y component	V/m	-(invJxx_rfweh * d(scHz,x)+invJxy_rfweh * d(scHz,y))/(n_rfweh^2 * epsilon0_rfweh * jomega_rfweh)
Eiy_rfweh	Incident electric field, y component	V/m	(invJxx_rfweh * d(-Hiz_rfweh,x)+invJxy_rfweh * d(-Hiz_rfweh,y))/(n_rfweh^2 * jomega_rfweh * epsilon0_rfweh)
Bz_rfweh	Magnetic flux density, z component	T	mu_rfweh * Hz
scBz_rfweh	Scattered magnetic flux density, z component	T	mu_rfweh * scHz
normH_rfweh	Magnetic field, norm	A/m	abs(Hz)
normB_rfweh	Magnetic flux density, norm	T	abs(Bz_rfweh)
normscH_rfweh	Scattered magnetic field, norm	A/m	abs(scHz)
normscB_rfweh	Scattered magnetic flux density, norm	T	abs(scBz_rfweh)
normE_rfweh	Electric field, norm	V/m	sqrt(abs(Ex_rfweh)^2+abs(Ey_rfweh)^2)
normD_rfweh	Electric displacement, norm	C/m^2	sqrt(abs(Dx_rfweh)^2+abs(Dy_rfweh)^2)
normscE_rfweh	Scattered electric field,	V/m	sqrt(abs(scEx_rfweh)^2+abs(scEy_rfweh)^2)

	norm		
normscD_rfweh	Scattered electric displacement, norm	C/m^2	sqrt(abs(scDx_rfweh)^2+abs(scDy_rfweh)^2)
normPoav_rfweh	Power flow, time average, norm	W/m^2	sqrt(abs(Poxav_rfweh)^2+abs(Poyav_rfweh)^2)
Wmav_rfweh	Magnetic energy density, time average	J/m^3	0.25 * real(Hz * conj(Bz_rfweh))
Weav_rfweh	Electric energy density, time average	J/m^3	0.25 * real(Ex_rfweh * conj(Dx_rfweh)+Ey_rfweh * conj(Dy_rfweh))
Wav_rfweh	Total energy density, time average	J/m^3	Wmav_rfweh+Weav_rfweh
Qav_rfweh	Resistive heating, time average	W/m^3	0.5 * real(sigmaxx_rfweh * Ex_rfweh * conj(Ex_rfweh)+sigmaxy_rfweh * Ey_rfweh * conj(Ex_rfweh)-j * real(omega_rfweh) * Ex_rfweh * conj(Dx_rfweh)+sigmayx_rfweh * Ex_rfweh * conj(Ey_rfweh)+sigmayy_rfweh * Ey_rfweh * conj(Ey_rfweh)-j * real(omega_rfweh) * Ey_rfweh * conj(Dy_rfweh))
Poxav_rfweh	Power flow, time average, x component	W/m^2	0.5 * real(Ey_rfweh * conj(Hz))
Poyav_rfweh	Power flow, time average, y component	W/m^2	0.5 * real(-Ex_rfweh * conj(Hz))
Farx	Far-field variable, Farx	V/m	Farx(x,y)
Fary	Far-field variable, Fary	V/m	Fary(x,y)
normFar	Far-field variable, normFar	V/m	sqrt(abs(Farx)^2+abs(Fary)^2)
normFardB	Far-field variable (dB), normFar	1	20 * log10(sqrt(abs(Farx)^2+abs(Fary)^2))

8.2.3. Subdomain 3-4

Name	Description	Unit	Expression
dr_guess_rfweh	Width in radial direction default guess	m	0
R0_guess_rfweh	Inner radius default guess	m	0
SRcoord_rfweh	PML radial coordinate	m	
Sx_rfweh	PML x coordinate	m	x

Sdx_guess_rfweh	Width in x direction default guess	m	0
rCylx_rfweh	PML r cylindrical vector, x component	m	
Sy_rfweh	PML y coordinate	m	y
Sdy_guess_rfweh	Width in y direction default guess	m	0
rCyly_rfweh	PML r cylindrical vector, y component	m	
detJ_rfweh	PML transformation matrix determinant	1	1
Jxx_rfweh	PML transformation matrix, element xx	1	1
invJxx_rfweh	PML inverse transformation matrix, element xx	1	1
Jxy_rfweh	PML transformation matrix, element xy	1	0
invJxy_rfweh	PML inverse transformation matrix, element xy	1	0
Jyx_rfweh	PML transformation matrix, element yx	1	0
invJyx_rfweh	PML inverse transformation matrix, element yx	1	0
Jyy_rfweh	PML transformation matrix, element yy	1	1
invJyy_rfweh	PML inverse transformation matrix, element yy	1	1
k_rfweh	Wave number	1/m	k0_rfweh * sqrt(mur_rfweh * (epsilonr_rfweh+sigma_rfweh/(jomega_rfweh * epsilon0_rfweh)))

dVol_rfweh	Volume integration contribution	1	detJ_rfweh
c_rfweh	Phase velocity	m/s	c0_rfweh/sqrt(epsilonr_rfweh * mur_rfweh)
Z_wave_rfweh	Wave impedance	ohm	c_rfweh * mu0_rfweh * mur_rfweh
delta_rfweh	Skin depth	m	1/real(sqrt(j * omega_rfweh * mu0_rfweh * mur_rfweh * (sigma_rfweh+j * omega_rfweh * epsilon0_rfweh * epsilonr_rfweh)))
Hiz_rfweh	Incident magnetic field	A/m	H0iz_rfweh * exp(j * phase)
curlHx_rfweh	Curl of magnetic field, x component	A/m^2	Hzy
curlHy_rfweh	Curl of magnetic field, y component	A/m^2	-Hzx
depHz_rfweh	Magnetic field test variable, z component	A/m	Hz
scHz	Scattered magnetic field, z component	A/m	Hz-Hiz_rfweh
Qmav_rfweh	Magnetic hysteresis losses	W/m^3	real(0.5 * j * omega_rfweh * Bz_rfweh * conj(Hz))
epsilon_rfweh	Permittivity	F/m	epsilon0_rfweh * epsilonr_rfweh
epsilonxx_rfweh	Permittivity, xx component	F/m	epsilon0_rfweh * epsilonrxx_rfweh
epsilonxy_rfweh	Permittivity, xy component	F/m	epsilon0_rfweh * epsilonrxy_rfweh
epsilonyx_rfweh	Permittivity, yx component	F/m	epsilon0_rfweh * epsilonryx_rfweh
epsilonyy_rfweh	Permittivity, yy component	F/m	epsilon0_rfweh * epsilonryy_rfweh
mu_rfweh	Permeability	H/m	mu0_rfweh * mur_rfweh
muzz_rfweh	Permeability, zz component	H/m	mu0_rfweh * murzz_rfweh
Dx_rfweh	Electric displacement, x component	C/m^2	epsilonxx_rfweh * Ex_rfweh+epsilonxy_rfweh * Ey_rfweh
scDx_rfweh	Scattered electric displacement, x component	C/m^2	epsilonxx_rfweh * scEx_rfweh+epsilonxy_rfweh * scEy_rfweh
Jdx_rfweh	Displacement current density, x component	A/m^2	jomega_rfweh * Dx_rfweh
Jix_rfweh	Induced current density, x component	A/m^2	sigmaxx_rfweh * Ex_rfweh+sigmaxy_rfweh * Ey_rfweh
Ex_rfweh	Electric field, x component	V/m	jwEx_rfweh/jomega_rfweh

jwEx_rfweh	Electric field, x component, times jω	m*kg/(s^4*A)	curlHx_rfweh/(n_rfweh^2 * epsilon0_rfweh)
scEx_rfweh	Scattered electric field, x component	V/m	d(scHz,y)/(n_rfweh^2 * epsilon0_rfweh * jomega_rfweh)
Eix_rfweh	Incident electric field, x component	V/m	d(Hiz_rfweh,y)/(n_rfweh^2 * jomega_rfweh * epsilon0_rfweh)
Dy_rfweh	Electric displacement, y component	C/m^2	epsilonyx_rfweh * Ex_rfweh+epsilonyy_rfweh * Ey_rfweh
scDy_rfweh	Scattered electric displacement, y component	C/m^2	epsilonyx_rfweh * scEx_rfweh+epsilonyy_rfweh * scEy_rfweh
Jdy_rfweh	Displacement current density, y component	A/m^2	jomega_rfweh * Dy_rfweh
Jiy_rfweh	Induced current density, y component	A/m^2	sigmayx_rfweh * Ex_rfweh+sigmayy_rfweh * Ey_rfweh
Ey_rfweh	Electric field, y component	V/m	jwEy_rfweh/jomega_rfweh
jwEy_rfweh	Electric field, y component, times jω	m*kg/(s^4*A)	curlHy_rfweh/(n_rfweh^2 * epsilon0_rfweh)
scEy_rfweh	Scattered electric field, y component	V/m	-d(scHz,x)/(n_rfweh^2 * epsilon0_rfweh * jomega_rfweh)
Eiy_rfweh	Incident electric field, y component	V/m	d(-Hiz_rfweh,x)/(n_rfweh^2 * jomega_rfweh * epsilon0_rfweh)
Bz_rfweh	Magnetic flux density, z component	T	mu_rfweh * Hz
scBz_rfweh	Scattered magnetic flux density, z component	T	mu_rfweh * scHz
normH_rfweh	Magnetic field, norm	A/m	abs(Hz)
normB_rfweh	Magnetic flux density, norm	T	abs(Bz_rfweh)
normscH_rfweh	Scattered magnetic field, norm	A/m	abs(scHz)
normscB_rfweh	Scattered magnetic flux density, norm	T	abs(scBz_rfweh)
normE_rfweh	Electric field, norm	V/m	sqrt(abs(Ex_rfweh)^2+abs(Ey_rfweh)^2)
normD_rfweh	Electric displacement,	C/m^2	sqrt(abs(Dx_rfweh)^2+abs(Dy_rfweh)^2)

	norm		
normscE_rfweh	Scattered electric field, norm	V/m	sqrt(abs(scEx_rfweh)^2+abs(scEy_rfweh)^2)
normscD_rfweh	Scattered electric displacement, norm	C/m^2	sqrt(abs(scDx_rfweh)^2+abs(scDy_rfweh)^2)
normPoav_rfweh	Power flow, time average, norm	W/m^2	sqrt(abs(Poxav_rfweh)^2+abs(Poyav_rfweh)^2)
Wmav_rfweh	Magnetic energy density, time average	J/m^3	0.25 * real(Hz * conj(Bz_rfweh))
Weav_rfweh	Electric energy density, time average	J/m^3	0.25 * real(Ex_rfweh * conj(Dx_rfweh)+Ey_rfweh * conj(Dy_rfweh))
Wav_rfweh	Total energy density, time average	J/m^3	Wmav_rfweh+Weav_rfweh
Qav_rfweh	Resistive heating, time average	W/m^3	0.5 * real(sigmaxx_rfweh * Ex_rfweh * conj(Ex_rfweh)+sigmaxy_rfweh * Ey_rfweh * conj(Ex_rfweh)-j * real(omega_rfweh) * Ex_rfweh * conj(Dx_rfweh)+sigmayx_rfweh * Ex_rfweh * conj(Ey_rfweh)+sigmayy_rfweh * Ey_rfweh * conj(Ey_rfweh)-j * real(omega_rfweh) * Ey_rfweh * conj(Dy_rfweh))
Poxav_rfweh	Power flow, time average, x component	W/m^2	0.5 * real(Ey_rfweh * conj(Hz))
Poyav_rfweh	Power flow, time average, y component	W/m^2	0.5 * real(-Ex_rfweh * conj(Hz))
Farx	Far-field variable, Farx	V/m	Farx(x,y)
Fary	Far-field variable, Fary	V/m	Fary(x,y)
normFar	Far-field variable, normFar	V/m	sqrt(abs(Farx)^2+abs(Fary)^2)
normFardB	Far-field variable (dB), normFar	1	20 * log10(sqrt(abs(Farx)^2+abs(Fary)^2))