Agilent EEsof EDA

Detailed Presentation on Momentum - Part 3 of 3

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Agenda for Half-day Momentum Seminar

30 minutes	**Brief overview of Getting Started with Momentum** ● *Creating/importing artwork in ADS Layout* ● *Momentum versus Momentum RF* ● *Creating substrate stack-ups and mapping layout layers as metallization layers* ● *Placing and defining ports* ● *Defining mesh parameters*
30 minutes	**Overview of Viewing and Using Momentum Results** ● *Momentum Datasets* ● *Momentum Visualization: currents, fields, s-parameters, gamma, ZO* ● *ADS Data Display: s-, y-, and z-parameters, reactance (L/C), Q, etc.*
60 minutes	**Advanced Topics [Part 1]** ● *Momentum Co-simulation (EM/circuit co-simulation) using Layout Components* ● *Momentum Co-optimization (EM/circuit co-optimization) using Layout Components* ● *Thick conductor simulations* {**LAB**} ● *Spiral Inductor simulations* {**LAB**}
15 minutes	**Break**
105 minutes	**Advanced Topics [Part 2]** ● *Advanced Model Composer (AMC)* ● *Advanced Model Composer (AMC)* {**LAB**}
15 minutes	**Final Q&A Session**
4 hours 15 minutes	

Momentum Datasets

Variables Available in the Standard Dataset

- **freq** — Independent frequency variable
- **GAMMA*n*** — Modal propagation constant of port *n* (calculated for single, differential, and coplanar ports only)
- **PORTZ*n*** — Impedance of Port *n*
- **S** — S-matrix, normalized to PORTZ*n*
- **S(i,j)** — S-parameters for each port pairing, normalized to PORTZ*n*
- **S_50** — S-matrix, normalized to 50 ohms
- **S_50(i,j)** — S-parameters for each port pairing, normalized to 50 ohms
- **S_Z0** — S-matrix, normalized to Z0
- **S_Z0(i,j)** — S-parameters for each port pairing, normalized to Z0 of each port
- **Z0n** — Characteristic impedance of Port n (calculated for single, differential, and coplanar ports only, others are 50 ohms)

(Note that these are included in the datasets for Momentum simulations but not for MomentumRF)

Momentum Datasets

Variables Available in the AFS Dataset

- All standard dataset variables, plus...

• S_CONV	Boolean results for AFS convergence (success=1, fail=0) of the entire S-matrix at a given frequency
• S_CONV(i,j)	Boolean results for AFS convergence (success=1, fail=0) of S(i,j) at a given frequency
• S_ERROR	Estimated error of the entire S-matrix at a given frequency (< -60 dB for converged frequency points)
• S_ERROR(i,j)	Estimated error of S(i,j) at a given frequency (< -60 dB for converged frequency points)

Adaptive Frequency Sampling

Adaptive Frequency Sampling (AFS)

-Automatic selection of key frequencies
-Interpolates all S-parameter data using a rational fitting model

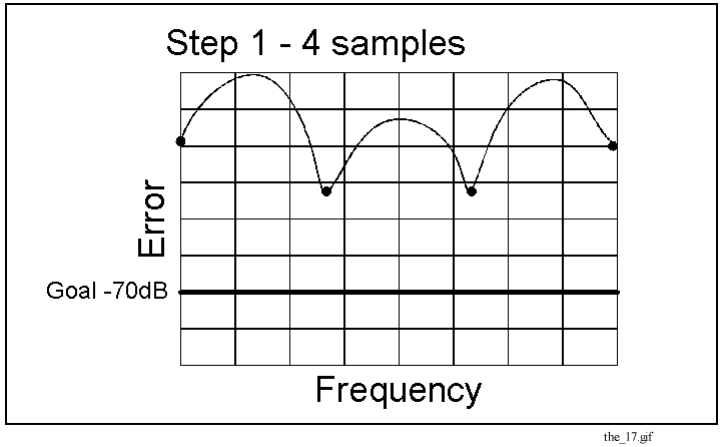
$$S(f) = \frac{A + B*f + C*f^2 + \ldots}{K + L*f + M*f^2 + \ldots}$$

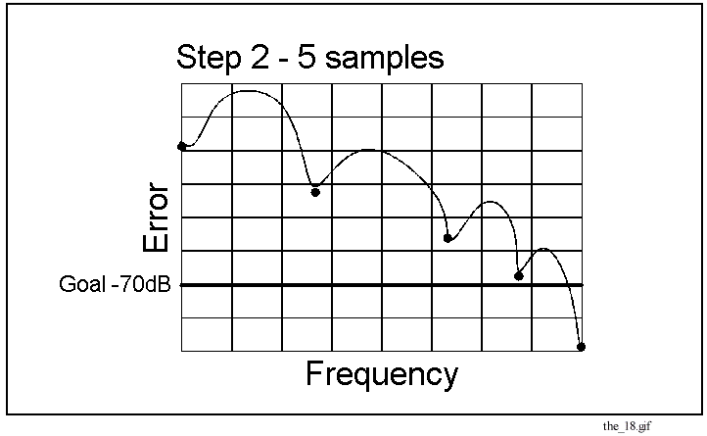
the_16.gif

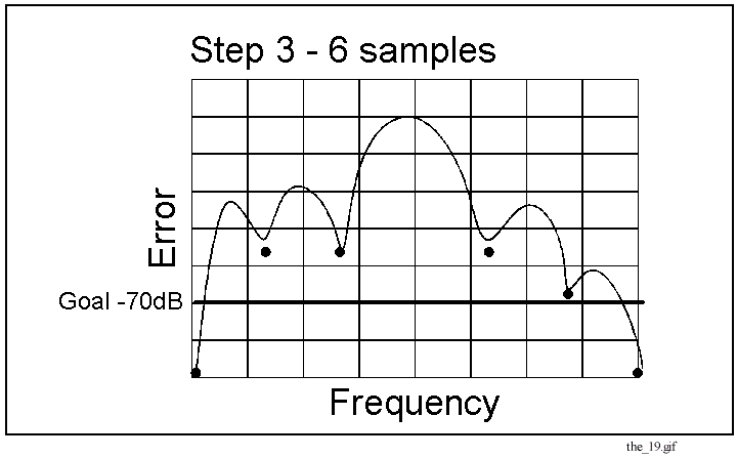
Simple Answer to Convergence

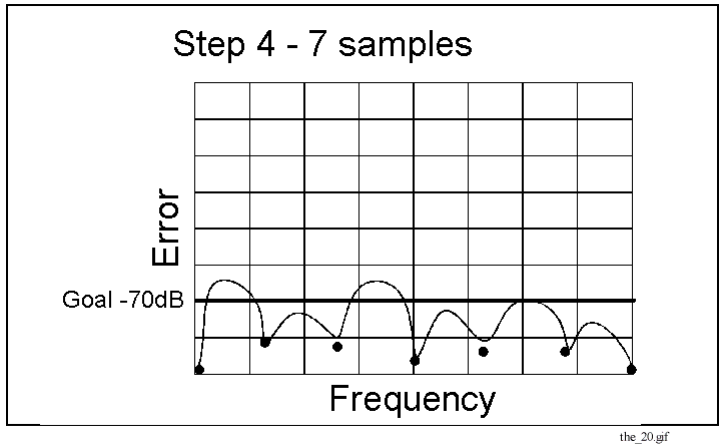
AFS has converged unless it tells you that it hasn't converged (e.g., when the max number of points that you specified was too low)

AFS Convergence Illustration

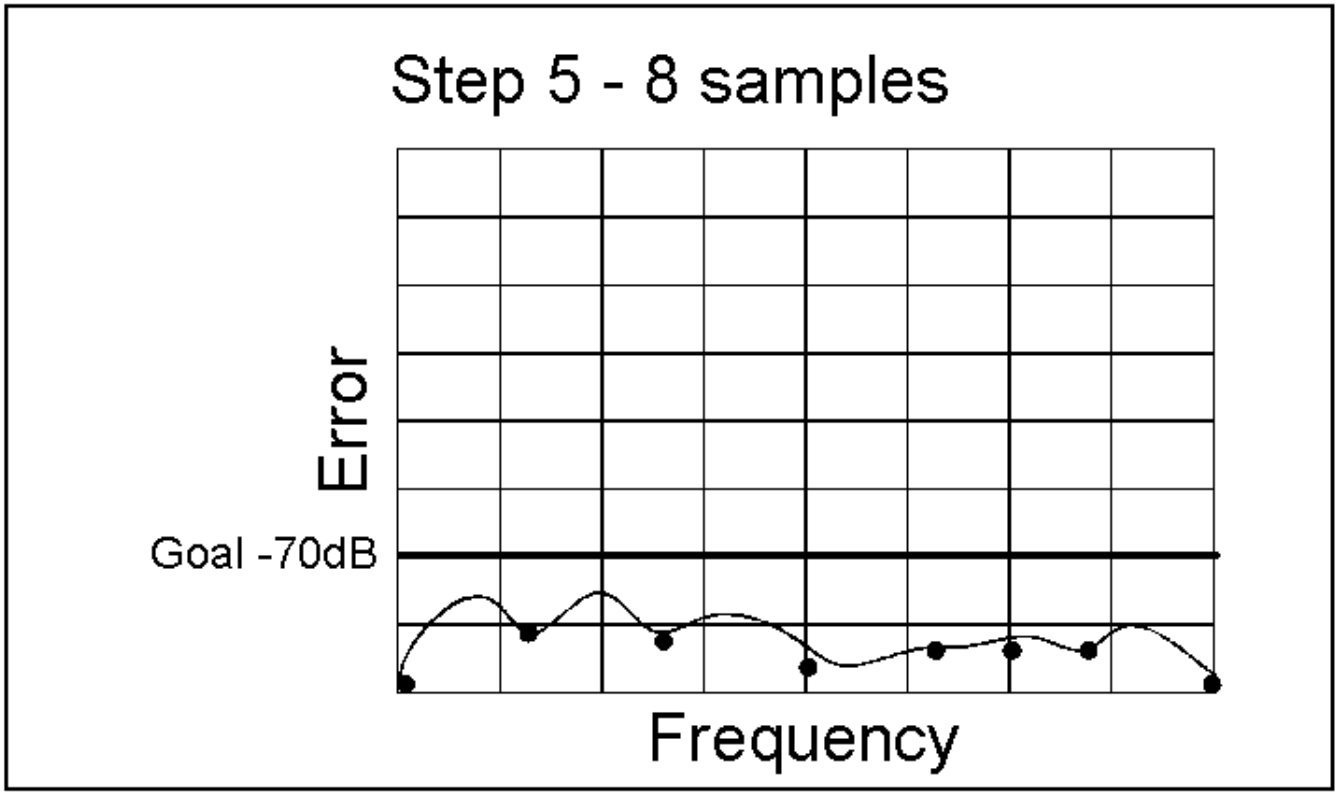








AFS Convergence



the_21.gif

Momentum Datasets

Variables Available in the Far-field Dataset

- **THETA** — Swept parameter of planar cut
- **PHI** — Swept parameter of conical cut
- **Etheta & Ephi** — Absolute E field strength (V) of theta and phi far-field components
- **Htheta & Hphi** — Absolute H field strength (A) of theta and phi far-field components
- **Elhp & Erhp** — Normalized E field strength of LHCP and RHCP far-field components
- **ARcp** — Axial ratio, derived from LHCP and RHCP far-field components
- **Eco & Ecross** — Normalized E field strength of co and cross polarized far-field comp
- **ARlp** — Linear polarization axial ratio, derived from co and cross polarized far-field components
- **Gain, Directivity Efficiency, Effective Area** — Gain, Directivity, Efficiency (in %), and Effective area (in m^2)
- **Power** — Radiation intensity (in watts/steradian)

Momentum Visualization

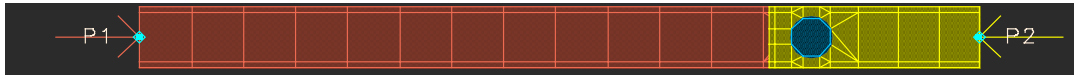
Momentum Visualization Enables You to View and Analyze...

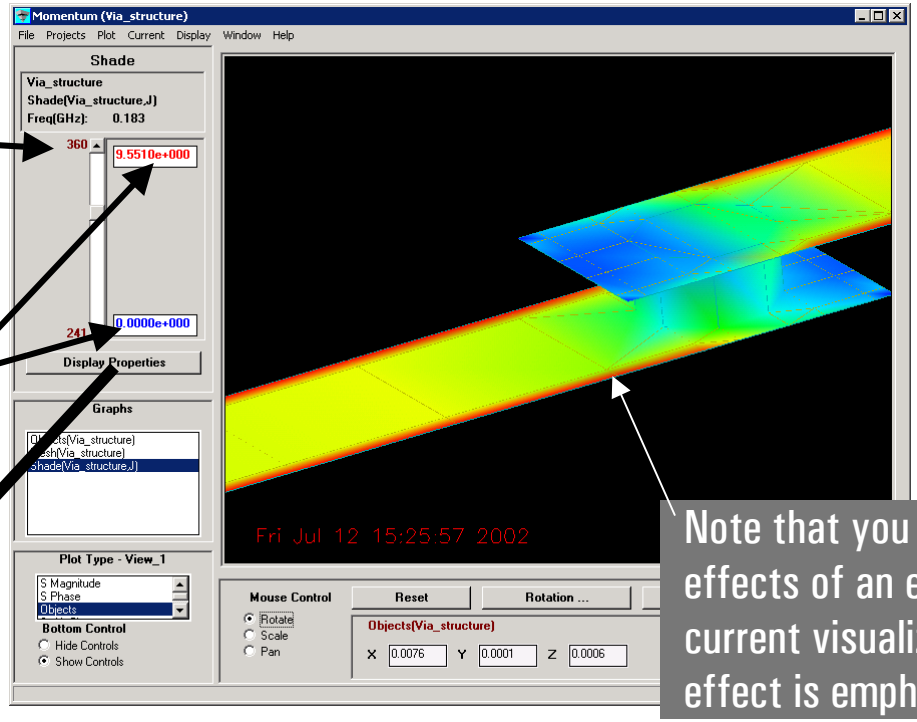
- **Currents** (surface currents)
- **S-parameters** (mag, re, im, phase, and dB of S(i,j))
- **Transmission line data** (propagation constant, characteristic impedance)
- **Far-fields** (radiation patterns & axial ratio in 3D and 2D)
- **Antenna parameters** (gain, directivity, pointing angle, etc.)

Momentum Visualization: *Surface Currents*

When you scroll from 0-360, you are actually varying the phase which illustrates the e^jwt time dependency of the surface currents

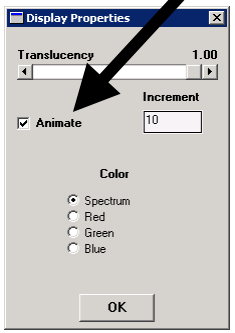
The lower and upper values input into these fields represents the lowest and highest values of the surface current density (A/m) which will be viewed





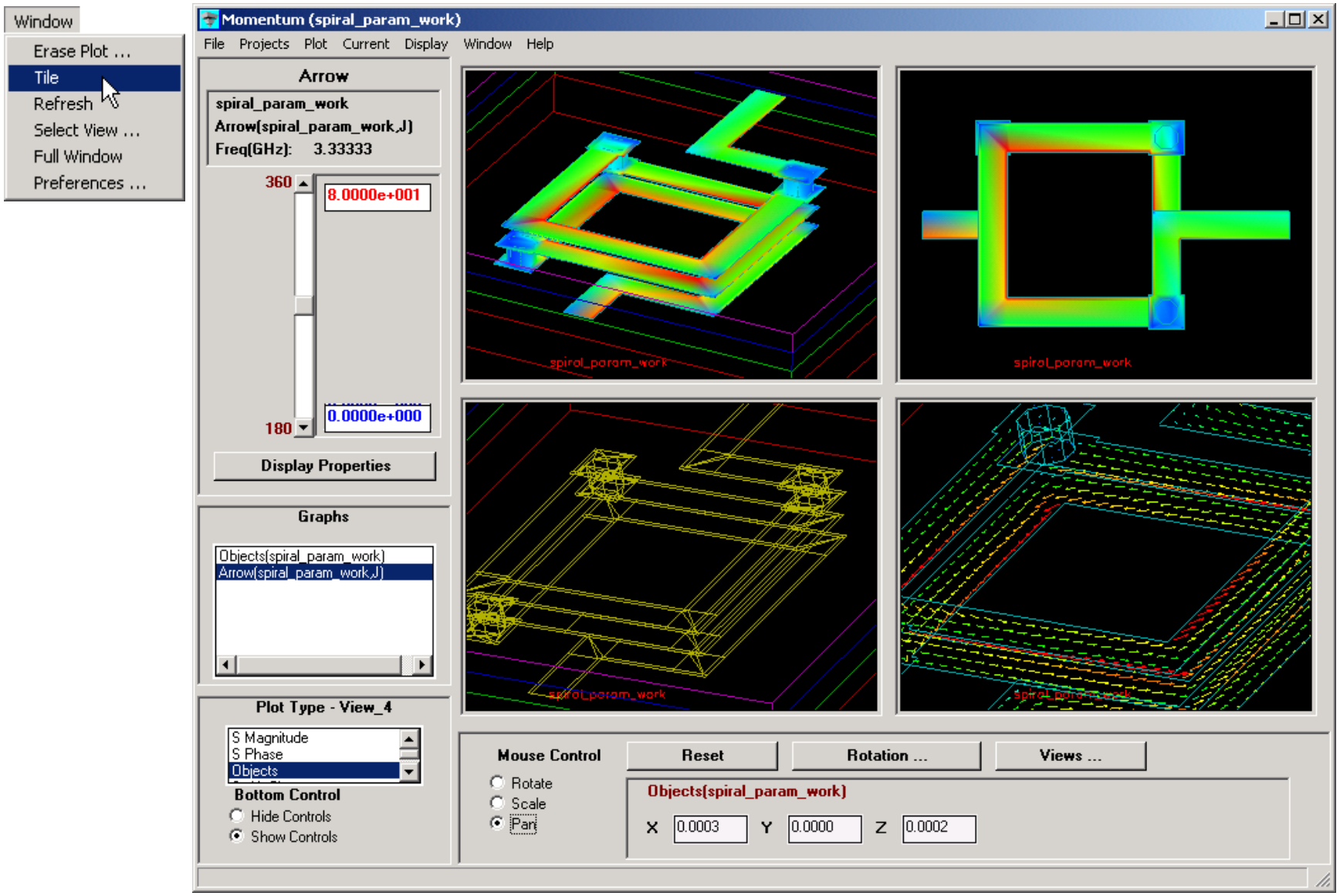
Note that you can also see the effects of an edge mesh in the current visualization (the skin effect is emphasized)

You also have the option to look at the animated currents when click on the Display Properties button



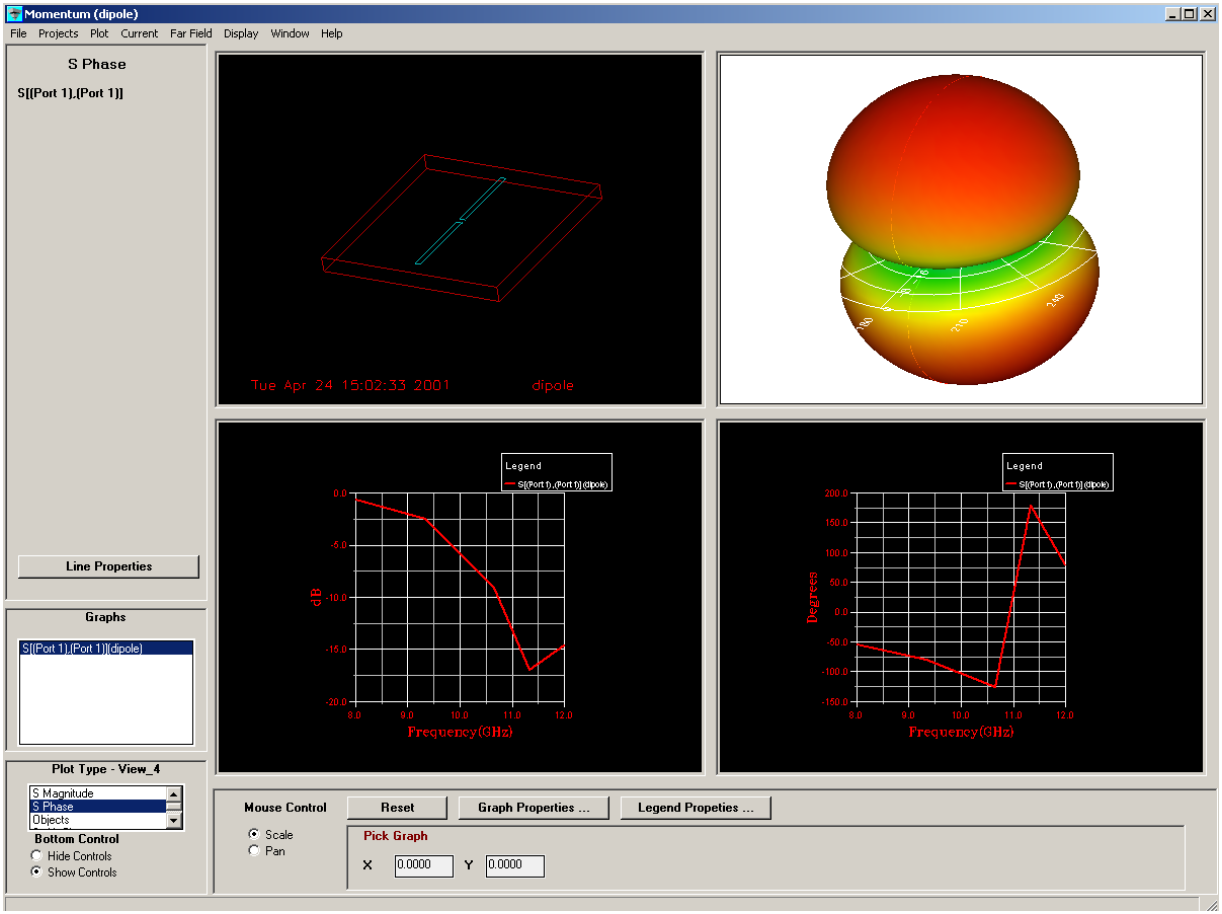
Note: when you are viewing the results for a slot metallization layer, the MAGNETIC currents are plotted instead of the ELECTRIC currents. You will also be viewing the mesh in the slots instead of a mesh on the conductors when viewing the mesh for a slot layer.

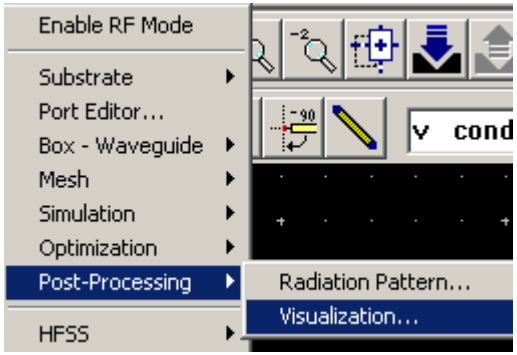
Momentum Visualization: *Surface Currents*



Momentum Visualization:

Far-field Radiation Patterns and S-parameters





Radiation Patterns are only available with Momentum results, not MomentumRF

ADS Data Display: *S-parameters, L, and Q of an Inductor*

Powerful post processing data display allows you to take advantage of countless built-in functions and provides the flexibility to wrote your own (through both measurement equations in a schematic or equations in a data display page).

L_and_C_and_Q_from_Sparameters [page 1]:0

File Edit View Insert Marker Page Options Help

inductor_new_artwork_momRF

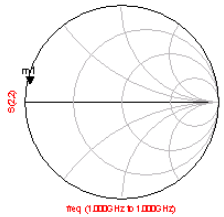
Reactance, L, C and Q calculated from S-parameters at a single frequency (based on marker location)

These equations will determine the Reactance, the Inductance, and the Capacitance at the frequency that the marker is on

Eqn m1_reactance=imag(zin(m1,100))

Eqn m1_L=if (m1_reactance[::] >0.0) then (m1_reactance[::]/(2*pi*indep(m1_reactance[::]))) else 0

Eqn m1_C=if (m1_reactance[::] < 0.0) then 1/(-2*pi*indep(m1_reactance[::])*m1_reactance[::]) else 0



m1
freq=1.000GHz
S(2,2)=0.965 / 169.417
impedance = 0.899 + j4.629

freq	m1	m1_reactance
1.000GHz	0.965 / 169.417	9.259

freq	m1	m1_L
1.000GHz	0.965 / 169.417	1.474E-9

freq	m1	m1_C
1.000GHz	0.965 / 169.417	0.000

Eqn m1_Q=imag(zin(m1,100))/real(zin(m1,100))

freq	m1	m1_Q
1.000GHz	0.965 / 169.417	5.148

Reactance, L, C and Q calculated from S-parameters for all simulated frequencies

This equation will determine Inductance when the reactance is >0 (inductive) and will output 0 when reactance is <0 (capacitive)

Eqn ind=if (reactance[::] >0.0) then (reactance[::]/(2*pi*indep(reactance[::]))) else 0

ind
1.474E-9

This equation will determine Capacitance when the reactance is <0 (capacitive) and will output 0 when reactance is >0 (inductive)

Eqn cap=if (reactance[::] < 0.0) then 1/(-2*pi*indep(reactance[::])*reactance[::]) el

cap
0.000

This equation will determine the Reactance from the S-parameters

Eqn reactance=imag(zin(S(2,2)[::],100))

Alternate approaches:
Reactance, L, C and Q calculated from Y- & Z-parameters for all simulated frequencies

Eqn Y=stoy(S22,100)

Eqn L=imag(1/Y)/(2*pi*freq)

Eqn Q=-1*(imag(Y)/real(Y))

Eqn Z=stoz(S22,100)

Eqn L1=if (imag(Z) >0.0) then (imag(Z)/(2*pi*freq)) else 0

Eqn Q1=imag(Z)/real(Z)

freq	L	Q	Q1	L1
1.000GHz	1.474E-9	5.148	5.148	1.474E-9

To use this Data Display, just select the desired S-parameter Dataset in the Default Dataset field (the drop-down menu just below the file menu and the toolbar)

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