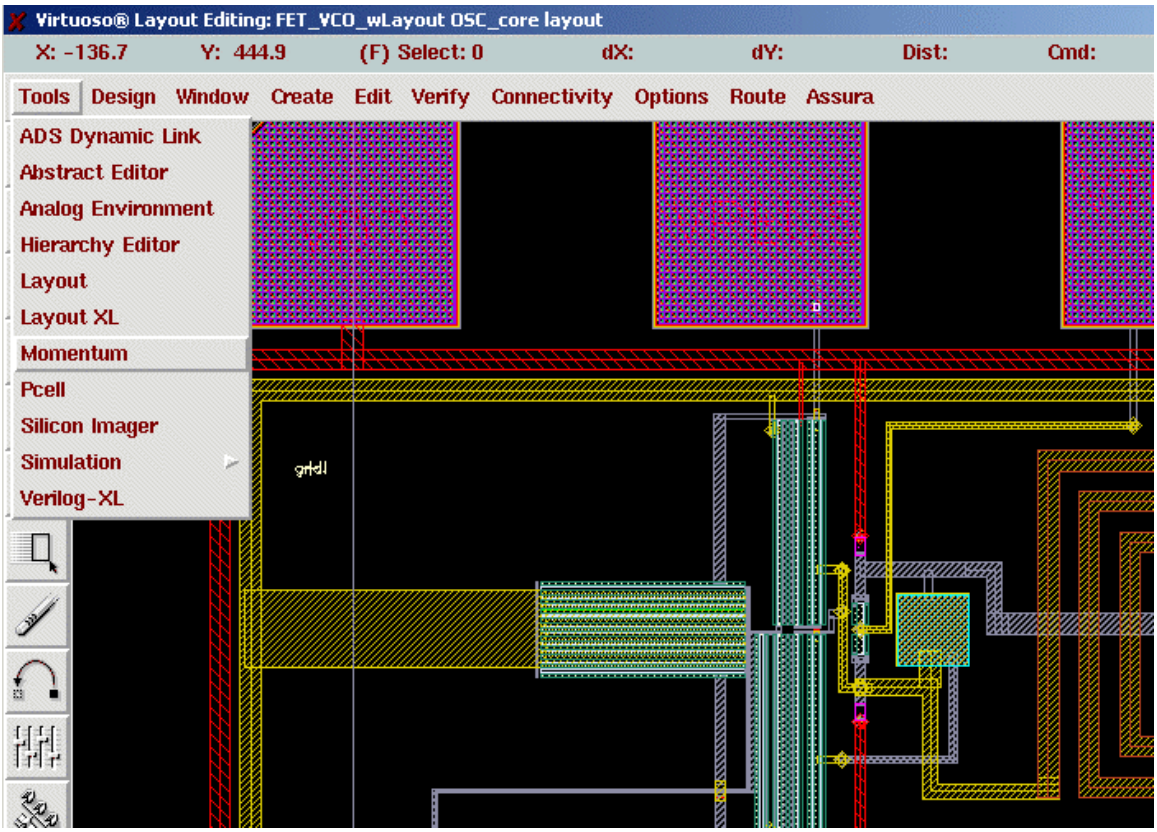
Agilent Technologies

# RF Design Environment 2003C - RFDE Momentum

Momentum integration into the Cadence Virtuoso (layout) environment allows Cadence users to perform EM modeling on select Virtuoso cell(s) as well as physical verification of critical passive nets. Its full integration into the Cadence Virtuoso environment allows designers to extract Momentum cell(s) (i.e. "Make Momentum Cell") and back annotate EM results to Cadence Composer (schematic) with a few simple clicks of the mouse.




RFDE Momentum Integration in Cadence

Momentum EM modeling and verification presents a synergistic tool to existing RC extraction tools. EM modeling and analysis brings a much higher level of confidence to RFIC design by delivering more accurate simulation results for critical nets and components. On the other hand, full chip verification is still requires leading edge RC extraction tools, such as Cadence Assura.

## Momentum Key Benefits

Momentum enables you to:

- Model physically accurate passive components such as spirals, MIM's, TFR's...
- Identify parasitic coupling between components and interconnects
- Aid in Signal Integrity design and verification
- Visualize current flow

## Momentum Key Features

Key features of Momentum include:

- An electromagnetic simulator based on the Method of Moments
- Dual mode modeling engines:
  - Full wave EM solver accounts for full dispersion and radiation
  - Quasi-static EM solver for faster modeling of larger circuits from DC to a half wavelength
- Finite-thickness metal modeling
- Adaptive frequency sampling for fast, accurate, simulation results
- Comprehensive data display tools for viewing results
- Equation and expression capability for performing calculations on simulated data
- Seamless integration in the Cadence Virtuoso custom design platform

## When to Use Momentum EM Simulator

Momentum EM simulation is especially valuable in the following design situations:

**When parasitic coupling is present**. Even when circuit models are physically far apart, unexpected coupling can take place. Examples include metal traces that seem sufficiently separated, but are actually inductively couple to each other because of a resonance condition, and surface waves that are bound to substrate interface and are excited when the right substrate parameters and frequencies are present. Momentum predicts both the parasitic coupling and radiation.

**When an accurate circuit model does not exist or the range limits are exceeded**. All circuit simulator models are developed with a number of range limited control parameters, (such as width, length, height, or dielectric constant). Some models break down gradually, while others generate significant errors as

soon as the range limits are exceeded. Momentum allows designers to model component effects beyond these built-in range limits. For example, if a designer needs an inductor value either smaller or larger than what is provided with a Design Kit, Momentum is the solution. Momentum can be used to generate very accurate electrical models of user-defined passive components.

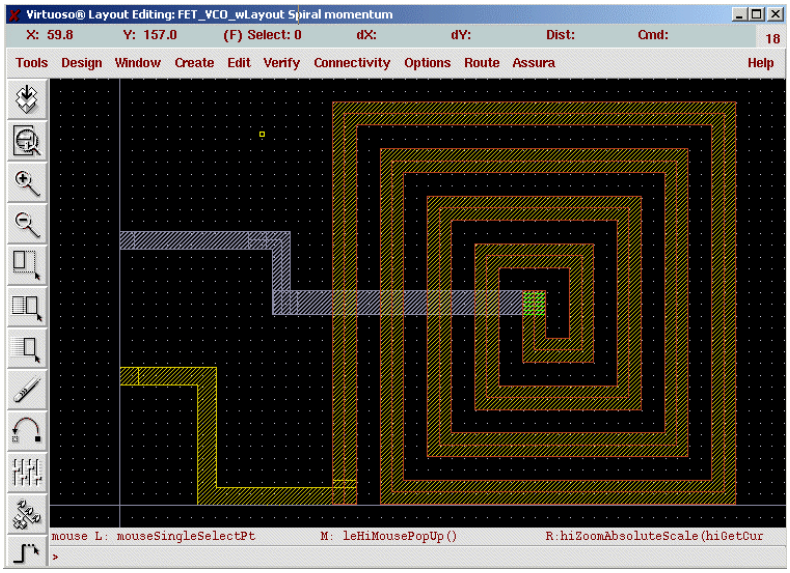
## Momentum Design Process

The following steps describe a typical process for creating and simulating a design with RFDE Momentum:

**Define the substrate characteristics**. A substrate is the media upon which the circuit resides. A complete substrate definition is required in order to simulate a design. The substrate definition includes the number of layers in the substrate and the composition of each layer (physical properties). This is also where you position the layers of your physical design within the substrate, and specify the metal characteristics of these layers. After Momentum substrate file is complete, it is linked to the Technology File of the given process.

**Make Momentum Cell**. You start with the physical dimensions of a planar design, such as a spiral inductor or metal traces on an IC stack. There are three ways to generate a Momentum design (Momentum Cell):

- Convert a schematic into a physical layout
- Draw the design directly in Layout
- Extract a portion of an existing layout as a Momentum cell
- Import a layout from an external source

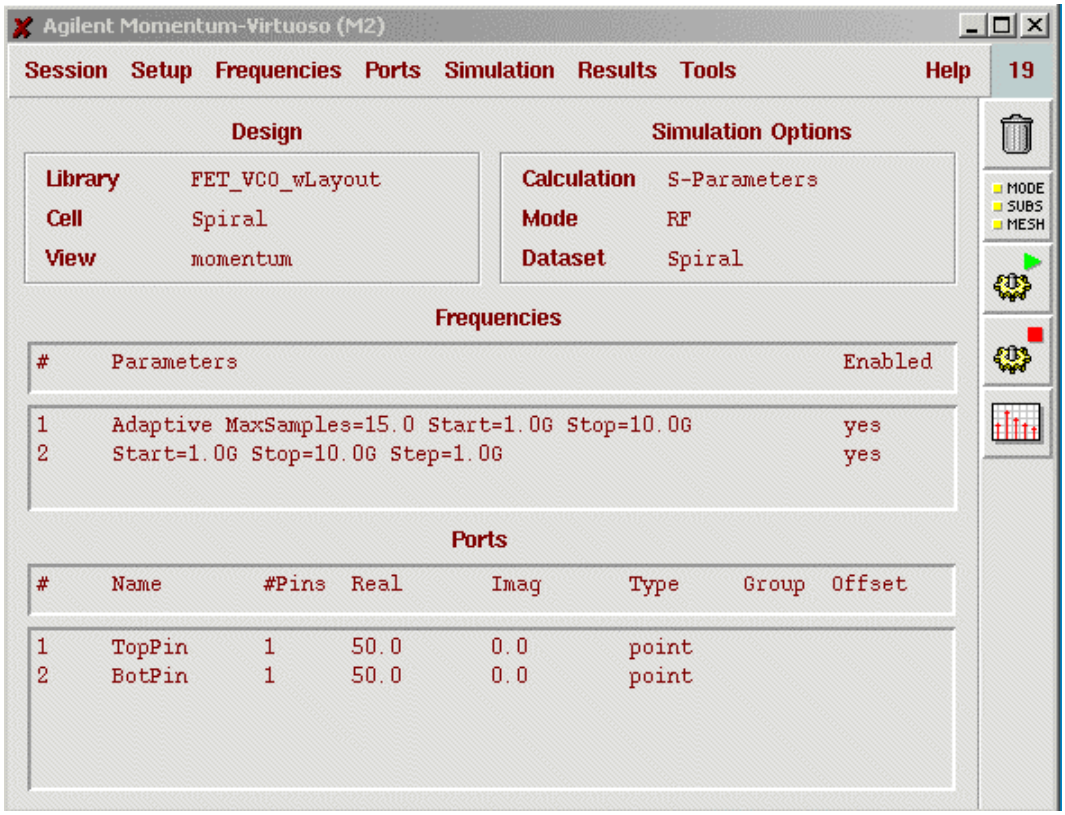



RFDE Momentum Cell

**Choose Momentum or Momentum RF mode**. Momentum can operate in two simulation modes: Microwave or RF. You can select the mode based on your design goals. Use Momentum (microwave) mode for designs requiring full-wave electromagnetic simulations that include microwave radiation effects. Use Momentum RF mode for designs that are geometrically complex, electrically small, and do not radiate. You might also choose Momentum RF mode for quick simulations on new microwave models that can ignore radiation effects, and to conserve computer resources.

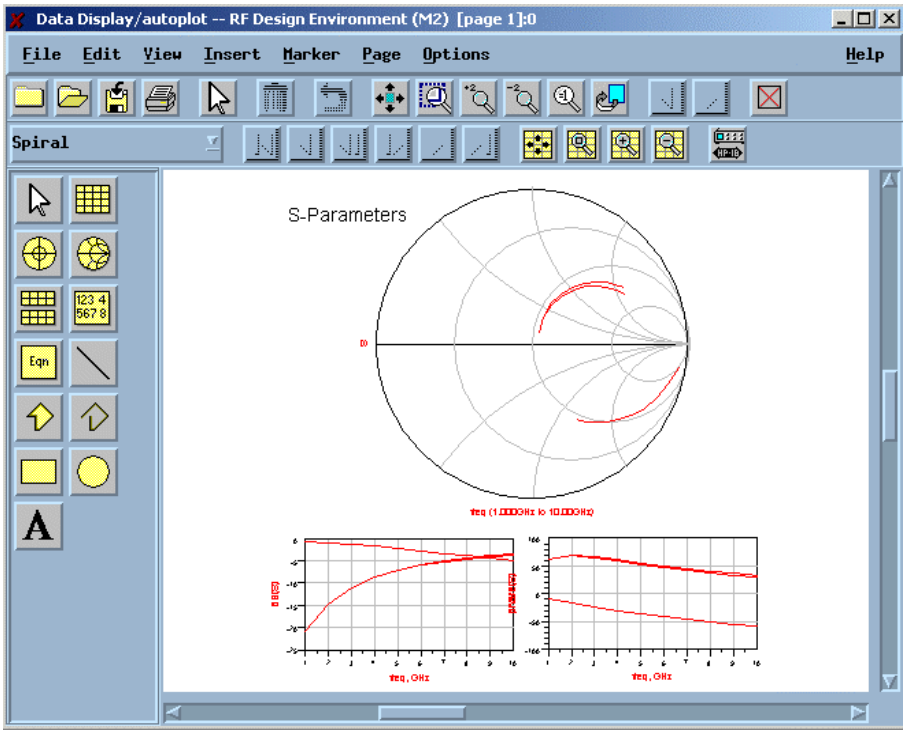
**Assign port properties**. Ports enable you to inject energy into a circuit, which is necessary in order to analyze the behavior of your circuit. You apply ports to a circuit when you create the circuit, and then assign port properties in Momentum. There are several different types of ports that you can use in your circuit, depending on your application.

**Simulate the circuit**. You set up a simulation by specifying the parameters of a frequency plan, such as the frequency range of the simulation and the sweep type. When the setup is complete, you run the simulation. The simulation process uses the Green's functions computed for the substrate, plus the mesh pattern, and the currents in the design are calculated. S-parameters are then computed based on the currents. If the Adaptive Frequency Sample sweep type is chosen, a fast, accurate simulation is generated, based on a rational fit model.

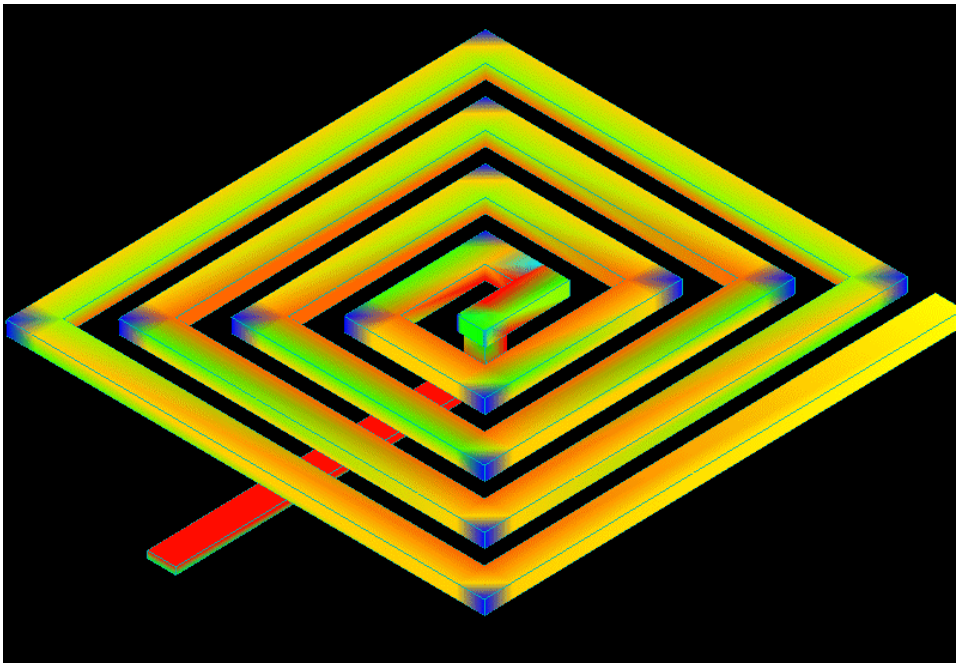



RFDE Momentum Simulation Setup

**View the results**. The data from a Momentum simulation is saved as S-parameters or as EM fields. Use the Data Display or Visualization to view S-parameters and field data.

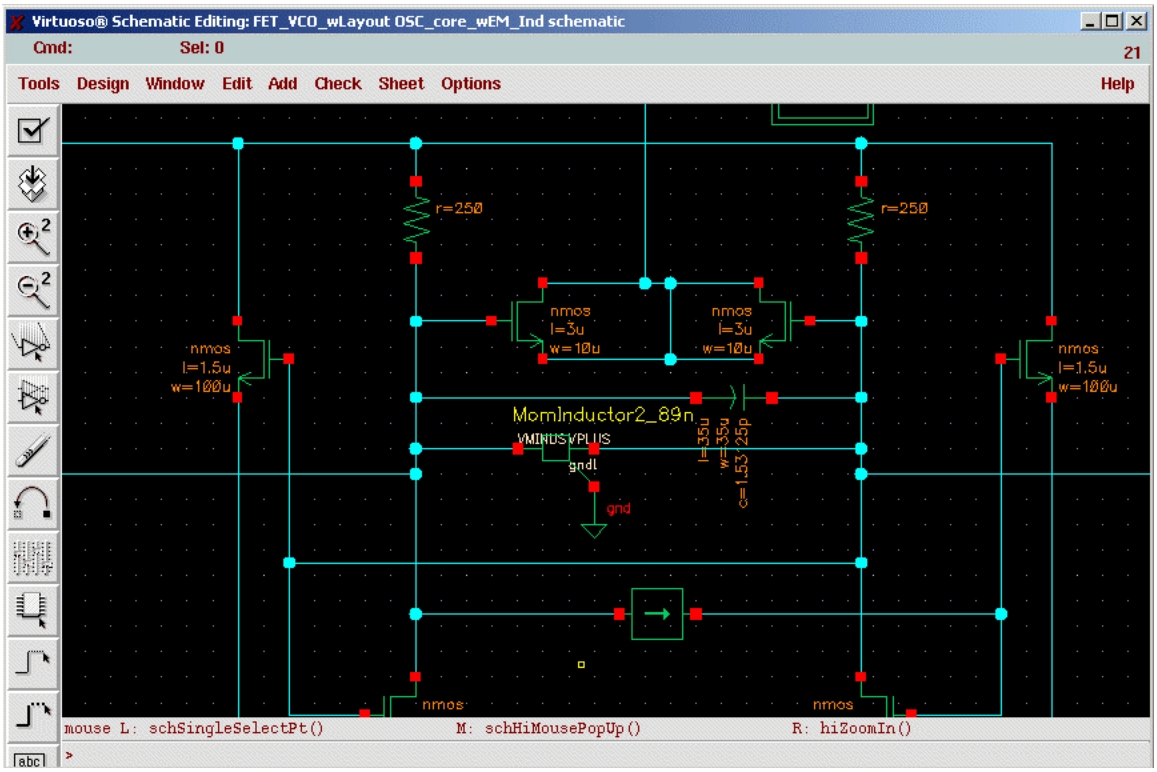



RFDE Momentum Data Display



RFDE Momentum Visualization

**Back-annotate results to the schematic**. The Momentum simulation EM results may also get back-annotated to the schematic (i.e. Cadence Composer) for circuit simulation with other passive/active circuit elements.




RFDE Momentum Back-Annotated Schematic