Agilent Technologies

Advanced Design System 2002

Model Composer

February 2002

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Contents

Chapter 1: Model Composer

The Model Composer enables you to create multidimensional, parameterized, passive planar components. The unique, patented modeling method is EM based, thus providing EM accuracy and generality at traditional circuit simulation speed.

The Model Composer enables you to create many standard interconnect components such as opens, stubs, bends, and tees on custom substrates. The models are fully compatible within Advanced Design System and include both a schematic and layout representation, as well as the electrical model. Components are created in libraries, which are logical groupings or sets of components.

You can use the models as you would other Advanced Design System microstrip components. They are compatible with all simulators, including optimization and tuning.

The component definition and generation process is simple. The Model Composer wizard leads you through each step, and you can save your work at any time, exit the tool, then return to complete your work later.

Refer to these topics:

- “Requirements” on page 1-2 lists what is required in order to use the Model Composer.
- “Creating Models” on page 1-2 describes how to create or edit a library of components.
- “Using Models” on page 1-14 describes how to access and use your models.
- “Troubleshooting a Library” on page 1-19 offers some suggestions if you have problems with your components or libraries.
- “About the Model Composer” on page 1-21 gives some background information on the Model Composer.
- “Model Composer Components” on page 1-27 is a reference of the types of microstrip components that can be modeled using the Model Composer.

Requirements

Model Composer can be used with Advanced Design System 1.5 or later. Be sure your system meets the general requirements described in the Advanced Design System Install Guide. Install Advanced Design System, then install Model Composer. The Model Composer can be downloaded from the Agilent EEsof website. Complete instructions for installing Model Composer can also be found on the website. There is no license required to run Model Composer.

Once your setup is complete, continue to “Creating Models” on page 1-2.

Creating Models

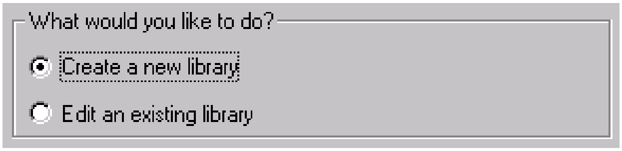
The Model Composer wizard makes it very easy to create a library of passive components. To define a collection of models, select the Tools menu on the Schematic window and choose *Model Composer > Create/Modify Library*. Follow the instructions that are displayed for each step of the process.

Tip In the course of defining a library, you can save your work at any time and close the tool. Your partially defined library will be available next time you start the Model Composer wizard.

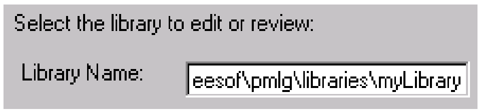
If the Model Composer menu selections do not appear under the Tools menu on the Schematic window, make sure you have installed the software correctly. For more information refer to the section “Requirements” on page 1-2.

Creating or Editing a Library

You can create a new library of components or edit an existing library.



- If you are creating a new library, type the library name. All libraries are created under `$HOME/hpeesof/pmlg/libraries`, but they can be moved later.



- If you are editing a library, type the library name. If you have moved the library from `$HOME/hpeesof/pmlg/libraries` to another location, click **Browse** to specify the path.

Click *Next* to continue to the next step.

Specifying a Substrate

A *substrate*, which is the layers of material that surround a component, affects the characteristics of the model. All models in a library must be calculated using the same substrate. Select a substrate or, if one is not suitable, create one by clicking **Create/Modify Substrate**.

If you want to edit a substrate, first select the substrate using the **Browse** button, then click **Create/Modify Substrate**.

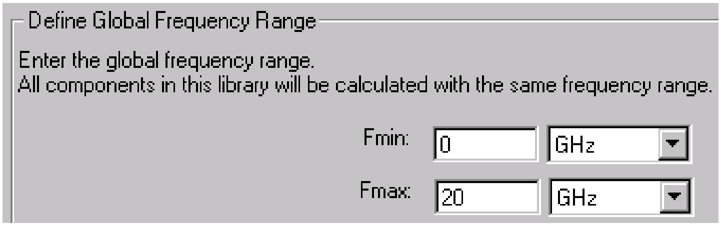
When working with substrates, consider the following:

- There are a variety of predefined substrates that are included with Momentum. They can be found under <installation_directory>*/momentum/lib*. They can be used as is or as the basis for creating a new substrate.
- A substrate can have multiple metallization layers. Strip layers can be used, Slot layers cannot. When defining the component parameters, make sure to specify a valid Layer parameter for each component.
- If you are editing a library and change the substrate, all models in the library must be recalculated.

If you are not familiar with substrates or how to define one, refer to the *Momentum* manual.

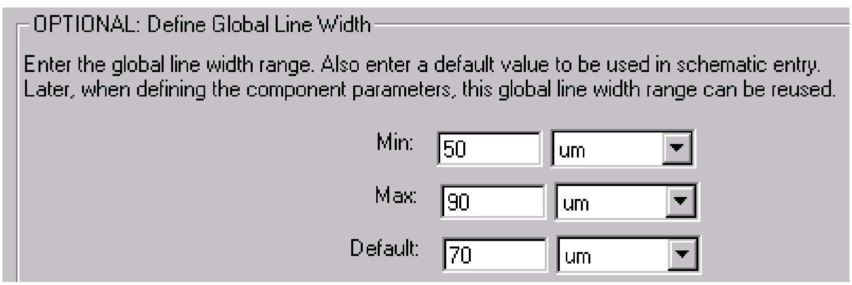
Setting the Frequency Range and Global Variables

The models in a library are calculated over a defined frequency range. Specify a minimum and maximum to set the frequency range for these components.



Setting a global line width is optional, but it offers a convenient way to specify a consistent line width for multiple components in a library:

- *Min* and *Max* enable you to specify a range of valid widths. Later, you can easily set component parameters to this variable. This is described in “Defining Component Parameters” on page 1-8.
- The Width parameter of a component will automatically be set to the *Default* value you enter here. You can see this when you edit a component that has been added to a schematic. You can change the width to any value within the *Min* and *Max* range.

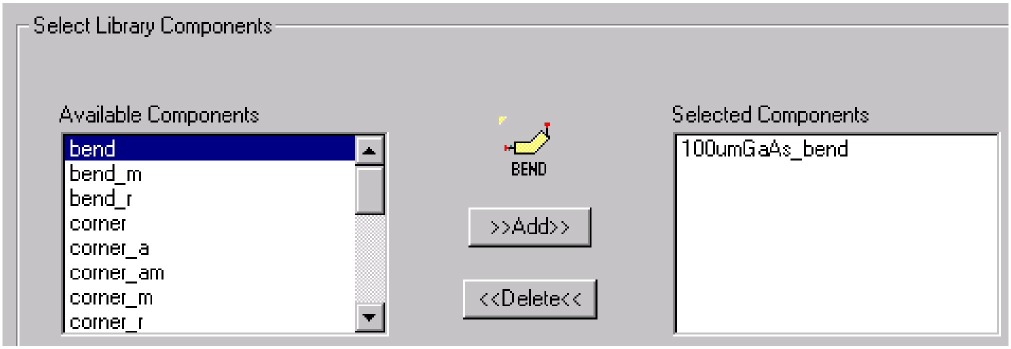


Note Make sure that the specified ranges are physically meaningful, that is, make sure that no higher order modes are excited for structures with *Max* width, at *Fmax* frequency, on the specified substrate.

Be aware that the wider the frequency range and line width, the more simulations will be required to calculate a component, and the longer the component generation process will become.

Selecting Components

Select the components that you want to add to the library. Choose a component from the list of *Available Components* and click **Add**. To delete a component from the library, highlight it in the *Selected Component* list and click **Delete**.



As you select components, note that:

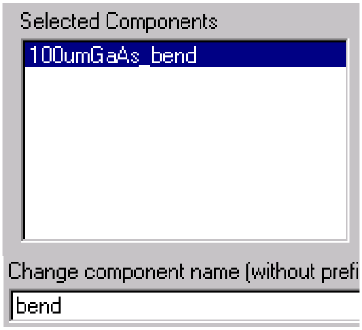
- To aid in choosing components, a description of the selected component appears at the bottom of the list.

- A prefix is applied to the name of a selected component. The default prefix describes the substrate that was selected earlier in the setup. You can change the prefix as desired. A unique prefix is required, and all components in the library will be updated with the same prefix.

- You can select the same component more than once. This enables you to define the same type of component but with different parameters.

Customizing Component Names and Descriptions

You can edit the names of the components in the library as desired. This name will appear as the Instance Name when the component is placed on a schematic



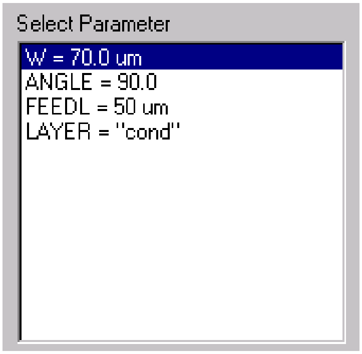
You can also edit the component description. This appears at the bottom of the Schematic window when the component is selected.

Defining Component Parameters

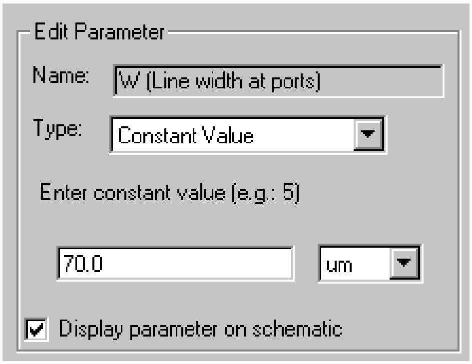
Before the components can be generated, the parameters for each component must be set. These parameters define the limits and ranges of a component, which is taken into account during the model generation process. All parameters have a default value, but you should review all parameters and change them as needed.

- Select a component from the *Select Component* list.

- Select a parameter from the *Select Parameter* list.

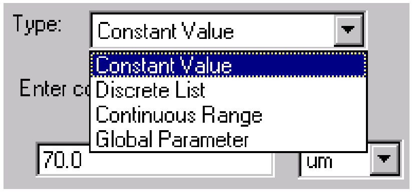


- Use the fields on the right side of the panel to edit the parameter.



If you change a parameter:

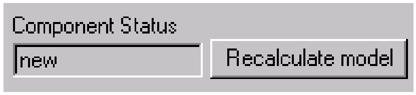
- You can change the parameter type to Constant Value, Discrete List, Continuous Range, or Global Parameter.



  - *Constant Value* is a single value and you will not be able to edit this value later on, such as after you add the component to a schematic.
  - *Discrete List* is a set of discrete values. When you use the component on a schematic, you can edit the parameter to any value in this list.
  - *Continuous Range* enables you to change the parameter to any value within the range after the component is added to a schematic.

    A maximum of 2 parameters in a component can be modeled in a continuous way.
  - *Global Parameter* sets the parameter to the continuous global line width range that you defined earlier. When you add the component to a schematic, the parameter will be set to the default value you specified for the global line width. You can change the parameter to any value in the global line width range.
- All components modeled with the Model Composer have a feedline attached to each port. As the modeling process is based on EM simulations, the components must have a non-zero length. Typically, the height of the substrate, or the width of line, can be used as feedline length (FEEDL).
- Make sure that the Layer parameter is set correctly.

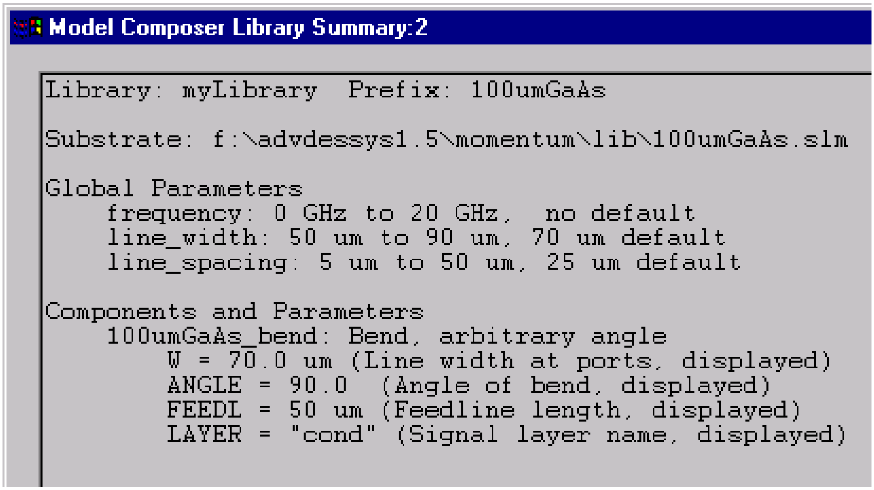
You should verify the Component Status of a component:



- *New* means the component has not been calculated yet or the parameter definition has changed so that a recalculation is required. You will see this status when a new component is added to the library, when the substrate is modified, or if component parameter settings are changed. If you want to force a component to be recalculated, click **Recalculate model**.
- *Done* means that component modeling has been successfully calculated. You would see this if you edit or review an existing library.
- *Error* means that an attempt was made to calculate the component, but it was unsuccessful. The error is probably due to combinations of parameters and substrate settings that are physically impossible. For suggestions on how to correct this, refer to "Troubleshooting a Library" on page 1-19.
- *Computing* means that the component modeling is in currently in process, the modeling process was stopped and is partially complete, or the component was skipped. Any earlier calculated data will be (re-)used if the simulation continues or restarts.

Starting the Generation Process

Click **View Summary** to ensure that your settings are correct. To help ensure that models are generated successfully, it is worthwhile to take the time to check all parameter values and ranges thoroughly.



To start generating the components, click **Save** to save your work, then click **Start Library Generation**. The Model Composer Library Summary window will display. It explains that the library generation process will start as a separate process running in the background, and it tells you where the completed library will be stored. Click **OK** to start the modeling process now.

At this time, you can exit Advanced Design System, or continue with other tasks, depending on the available computer memory and processor power.

A Momentum status window will pop-up after some time. This window can be minimized, and it will disappear when the library generation is done.

A library can take some time to complete, so use the Status Control to view progress. Refer to "Viewing and Controlling the Model Generation Process" on page 1-13.

The components are generated based on the substrate, frequency range, and component parameter settings. Depending on the parameter definitions for a component, an appropriate number of Momentum simulations is run for each component, and the behavior of the component is saved in the form of S-parameters.

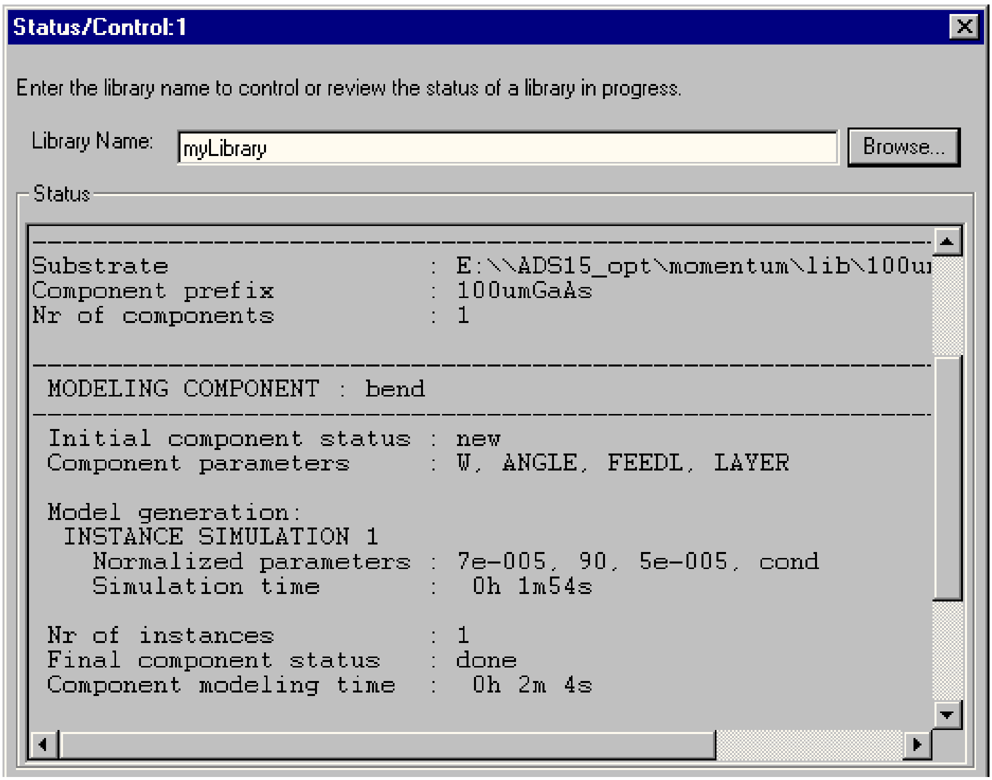
If the library is taking a very long time to generate or you are getting errors, make sure that:

- The frequency range, substrate definition, and component parameters make physical sense.
- Try reducing the frequency range and the number of continuously-varying parameters of a component. Continuously varying parameters can be replaced by discrete parameter lists or constant parameter values.
- For more suggestions, refer to "Troubleshooting a Library" on page 1-19

Viewing and Controlling the Model Generation Process

To check on the progress, from the Tools menu choose *Model Composer > Status/Control*. This can be done from any Advanced Design System session that is running on the same computer and started by the same user. Type in the *Library Name* or click **Browse** to locate the library of interest. This dialog box:

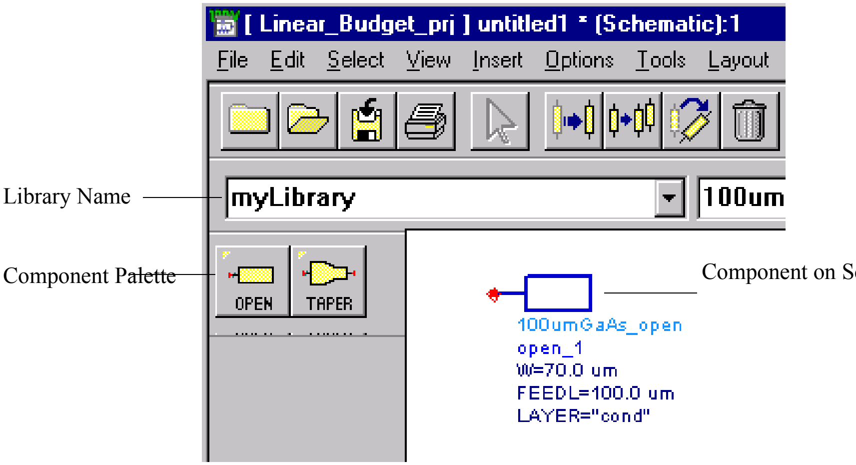
- Lists the status of the components in the library
- Displays any error messages or warnings
- Enables you to stop the process for a component or the entire library



Once the models are generated, continue to "Using Models" on page 1-14.

Using Models

Components created with the Model Composer can be added to a schematic like any other Advanced Design System component. You can also edit parameters.



To use components created with the Model Composer, refer to these topics:

- "Preparing to Use Models" on page 1-15 describes the steps you need to take before you can use a library. *You must complete this section in order to use a library.*
- "Locating Models" on page 1-17 describes how to select a library and access components.
- "Editing Component Values" on page 1-18 describes how to edit the parameters of a component.
- "Moving and Copying Libraries" on page 1-19 describes how to copy or move a library to another location.

Preparing to Use Models

The library generated by the Model Composer is actually a standard ADS Design Kit. Before you can use a library, you must first install the design kit. For detailed information on installing and enabling design kits, refer to the ADS *"Design Kit Installation and Setup"* documentation.

To install and enable your design kit:

1. From the ADS *Main* window, choose **DesignKit > Install Design Kits**. The *Install ADS Design Kit* dialog box appears.

2. Enter the following information in the *Path* field of the *Install ADS Design Kit* dialog box:

   $HOME/hpeesof/pmlg/libraries/<*library_name*>

   where <*library_name*> is the name defined in "Creating or Editing a Library" on page 1-3.

   After the path is entered, the other three fields (i.e. *Name*, *Boot File* and *Version*) are automatically filled in.

3. Use the *Select Installation Level* drop-down menu to select an appropriate level for your design kit.

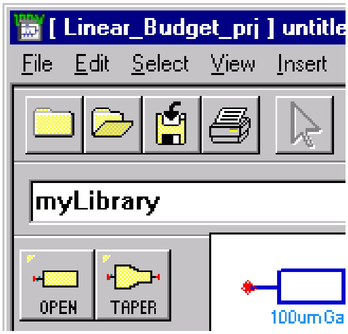
4. After selecting a level, click **OK** in the *Install ADS Design Kit* dialog to install and enable the design kit. An *Information Message* dialog stating that the design kit was successfully enabled appears.

5. Click **OK** to clear the *Information Message* dialog. Your design kit is now ready for use.

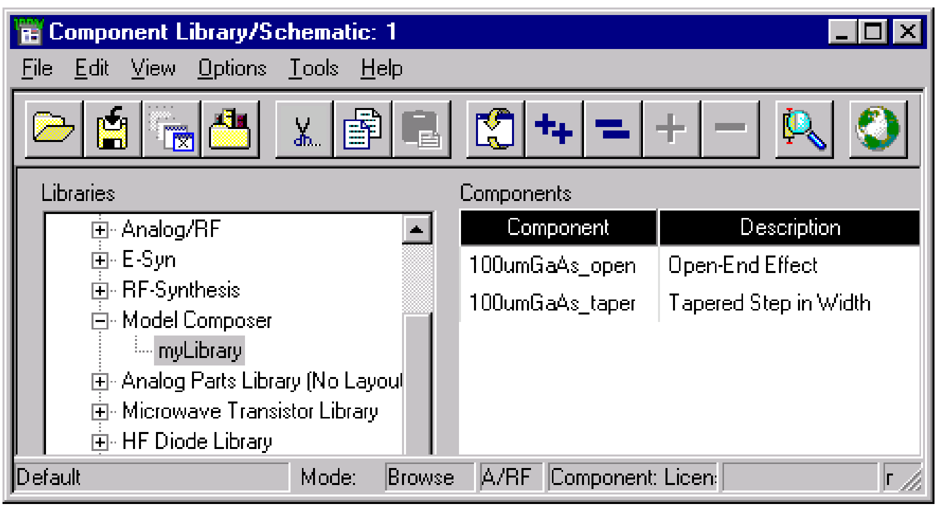
Locating Models

You access and use your models in the same way as any other components in Advanced Design System:

- From the Component Palette. The name of the library appears in the Component Palette list. When you select the library, a palette of the components you created is displayed. You select and place these components in the same way as other Advanced Design System components.



- From the Component Library. In the lists of libraries you will find *Model Composer*, and below this your libraries will appear.



Note If a library does not appear in the Component Palette or Component Library, make sure you have completed the steps in the section "Preparing to Use Models" on page 1-15.

Editing Component Values

You can edit component parameters, based on the following conditions:

- If a component has *constant* parameters, these parameters cannot be changed.
- If a component was created with *discrete* parameters, you can only select values that were specified when the model was generated.
- If a component was created with *continuous* or *global* parameters, you can select any value within the range that was specified when the model was created.

A component can have a combination of constant, discrete, continuous, and global parameters. For more information on how parameters are defined, refer to the section "Defining Component Parameters" on page 1-8.

Notes A library can contain components located on different substrate layers. Make sure the *Layer* parameter is set correctly for any components you use from a library.

A feedline of length FEEDL is attached to each port of the components. Take this length into account while using the components from a library.

Moving and Copying Libraries

All libraries are created under `$HOME/hpeesof/pmlg/libraries`, but they can be moved or copied to a new location. If you do this, be sure to complete the steps in the section "Preparing to Use Models" on page 1-15. Otherwise, you may use the incorrect copy or the library name may not appear in the Component Palette or Component Library list.

Note You may want to zip the library prior to relocating it. To do this, open a term or MS-DOS window and type

`zip -r` <*library_name*> `$HOME/hpeesof/pmlg/libraries/`<*library_name*>

Troubleshooting a Library

This section identifies problems that you may encounter when working with the Model Composer and offers suggestions to fix the problem.

The library does not appear in the Component Palette or Component Library.

- Ensure you have installed the library (ADS Design Kit). Refer to "Preparing to Use Models" on page 1-15.
- Ensure that your design kit and its installation LEVEL are both enabled. For more information on installing and enabling design kits, refer to the ADS *"Design Kit Installation and Setup"* documentation.
- Ensure that there are no conflicts between the new ADS Design Kit software and an older version of the software. For more information refer to Appendix A of the ADS *"Design Kit Installation and Setup"* documentation.

Errors are produced when attempting to generate a library of components.

This can be due to a variety of problems. Usually, this will be caused by unphysical combinations of

- Substrate
- Maximum frequency
- Layout parameters

so that higher order modes are excited, the Momentum simulator produces unphysical results, and the Model Composer modeling process does not converge.

Possible solutions are:

- Limit the frequency range
- Limit parameter ranges (for example, limit width)
- Check units (for example, m instead of um)
- Limit the number of continuously varying parameters. The maximum is two per component, for practical reasons. Consider that the modeler uses about 5 to 10 Momentum simulations for each continuously-varying parameter. This means that one continuous parameter would require 5 to 10 Momentum simulations; two continuous parameters, 25 to 100 simulations; three would require 125 to 1000 simulations; 4 continuous parameters, 625 to 10,000 simulations.
- Use constant values and discrete lists. Quite often, the line width of the metallization is limited, and varies in a discrete way, based on a given technology or application. If so, use discrete parameter lists that correspond with the real world limitations.
- Replace a single component definition (with widely varying ranges) by multiple components of the same kind, each valid in a subset of the original parameter space.
- Perform a worst case analysis of the library specs (check the combination of max frequency, max width, and substrate) to make sure that no higher order modes occur. Momentum can be used to see if the simulation results (S-data) make sense.

A general work-around is in most cases to use discrete lists and limit ranges. The wider the ranges, and the more continuously varying parameters, the more Momentum simulations are needed, and the longer the modeling time will be.

Think carefully about the parameter ranges and ensure that all values are physically possible.

If higher order modes occur, the Momentum simulation will fail, and so, then, will the Model Composer process.

About the Model Composer

The Model Composer provides a method to build multidimensional parameterized analytical models for passive planar components. This method produces analytical models that can be used by all Advanced Design System circuit simulators, and the models are highly accurate. The model generation is based on EM simulation techniques, providing EM accuracy and generality at traditional circuit simulation speed.

The model generation technique is referred to as *Multidimensional Adaptive Parameter Sampling* (MAPS). It selects a minimum number of EM simulations, and builds a global analytical fitting model for the scattering parameters of general planar structures as a function of the geometrical parameters and of the frequency, with a predefined accuracy. Data points are selected efficiently and model complexity is automatically adapted. The algorithm consists of an adaptive modeling loop and an adaptive sample selection loop. Descriptions of each follow. An example is also presented to illustrate the technique.

Adaptive Model Building Algorithm

The scattering parameters *S* are represented by a weighted sum of multidimensional orthonormal polynomials (multinomials) P_m. The multinomials only depend on the multidimensional coordinates $\bar{x}$ in the parameter space *R*, while the weights C_m only depend on the frequency *f*:

$$S(f,\bar{x}) \approx M(f,\bar{x}) = \sum_{m=1}^{M} C_m(f) P_m(\bar{x}) \tag{1}$$

The weights C_m are calculated by fitting equation (1) on a set of *D* data points $\{\bar{x}_d, S(f,\bar{x}_d)\}$ (with $d = 1, ..., D$). The number of multinomials in the sum is adaptively increased until the error function:

$$E(f,\bar{x}) = |M(f,\bar{x}) - S(f,\bar{x})| \tag{2}$$

is lower than a given threshold (which is function of the desired accuracy of the model) in all the data points. For numerical stability and efficiency reasons orthonormal multinomials are used, i.e. the multinomials $P_m(\bar{x})$ satisfy the condition:

$$\sum_{d=1}^{D} P_k(\bar{x}_d) P_l(\bar{x}_d) = \begin{cases} 1 & \text{for } (k = l) \\ 0 & \text{for } (k \neq l) \end{cases} \tag{3}$$

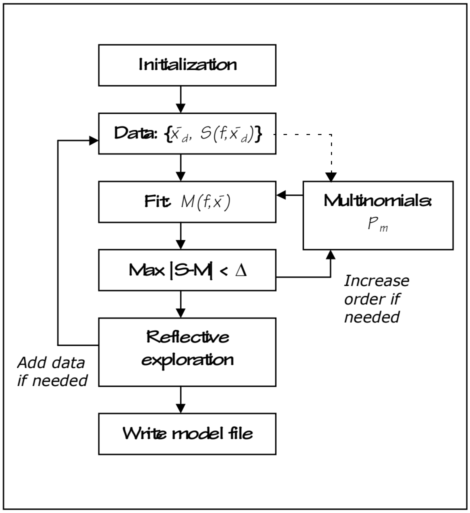
Adaptive Data Selecting Algorithm

The modeling process starts with an initial set of data points. New data points are selected adaptively in such a way that a predefined accuracy Δ for the models is guaranteed. The process of selecting data points and building models in an adaptive way is often called *reflective exploration*. Reflective exploration is useful when the process that provides the data is very costly, which is the case for full-wave electro-magnetic (EM) simulators. Reflective exploration requires *reflective functions* that are used to select a new data point. The reflective function used in the MAPS algorithm is the difference between two different models (different order M in equation (1)). A new data point is selected near the maximum of the reflective function. When the magnitude of the reflective function becomes smaller than Δ over the whole parameter space, no new data point is selected.

If one of the scattering parameters has a local minimum or maximum in the parameter space of interest, it is important to have at least one data point in the close vicinity of this extremum in order to get an accurate approximation. Therefore, if there is no data point close to a local maximum or minimum of $M(f,\bar{x})$, the local extremum is selected as a new data point. For resonant structures, the power loss has local maxima at the resonance frequencies. Again, to get an accurate approximation, a good knowledge of these local maxima is very important.

The scattering parameters of a linear, time-invariant, passive circuit satisfy certain physical conditions. If the model fails these physical conditions, it cannot accurately model the scattering parameters. The physical conditions act as additional reflective functions: if they are not satisfied, a new data point is chosen where the criteria are violated the most.

The complete flowchart of the algorithm is shown.



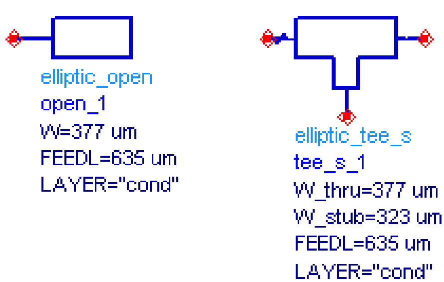
Example

The example presented here consists of two parts:

- The generation of a microstrip open stub and a symmetrical tee model
- Using these microstrip components to build a lowpass filter

Model Generation of Microstrip Components

The Model Composer was used to generate analytical models for an open stub (*open*) and for a symmetrical tee (*tee_s*), both on a 635 µm microstrip substrate, with ε_r = 10.0. Feedlines are connected to all ports (FEEDL=635 µm).



The open stub model (*open*) has one variable geometrical parameter, the width of the stub (*W*). There is only one relevant S-parameter, S_{11}.

The symmetrical tee model (*tee_s)* has two geometrical parameters: the width of the thru line (*W_thru*) and the width of the stub (*W_stub*). There are three relevant S-parameters, S_{11}, S_{12} and S_{13}. The ranges of the continuously varying geometrical parameters are in Table 1-4.

Table 1-4. Parameter ranges for microstrips *open stub* and *tee*

component	variable	min	max
open	*W*	100 µm	1000 µm
	f	1 GHz	20 GHz
tee_s	*W_thru*	100 µm	1000 µm
	W_stub	300 µm	600 µm
	f	1 GHz	20 GHz

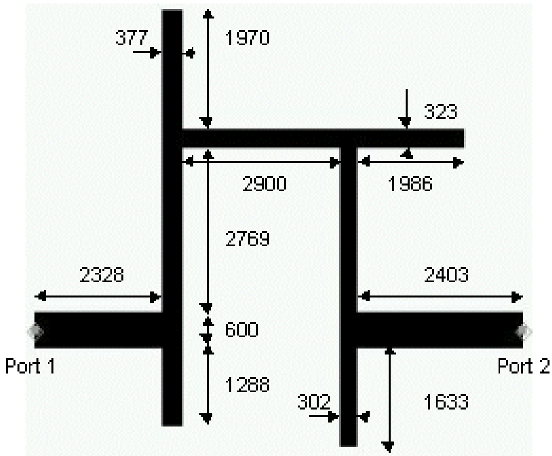
The Model Composer combines all S-parameters of multiple discrete parameter settings in one single global model file. The scattering parameters are generated using the Momentum simulator.

The desired accuracy for the open stub model was set to -55 dB (default accuracy). Building this model required 10 data points (adaptively selected). The accuracy of the model was checked in 71 points randomly chosen along the W-axis. The maximum deviation found between the Model Composer model and Momentum was -60.6 dB.

The desired accuracy for the tee model was set to -55 dB (default accuracy). Here there were 16 data points needed (adaptively selected) during model generation. The accuracy of the tee model was checked in 208 points randomly chosen in the parameter space. The maximum deviation found between the Model Composer model and Momentum was -54.3 dB.

Library Usage to Design a Lowpass filter

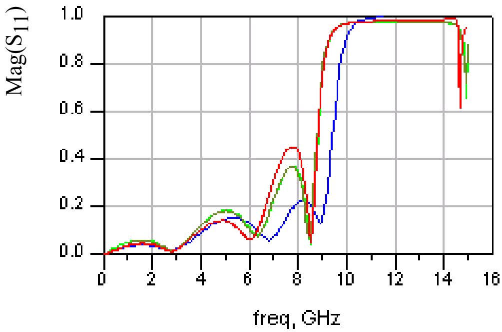
The adaptively generated models were then used to simulate a lowpass elliptic filter on a 635 µm microstrip substrate ($\varepsilon_r = 10.0$). The layout is shown here.

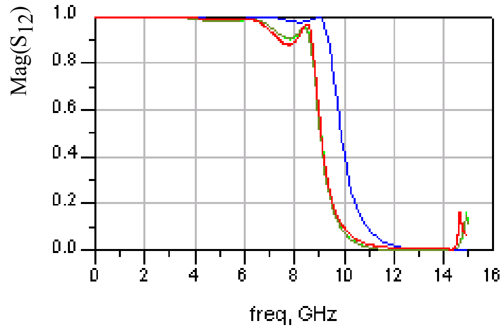


The graphs show the magnitude of S_{11} and S_{12} simulated with Momentum (red), with standard ADS analytical models (blue), and with the new EM-based Model Composer models for the open end (*open*) and the tee (*tee_s*) components (green).

The results using the multiple Model Composer models correspond very well to the global full-wave Momentum results, and yet the simulation using the Model Composer models took only a fraction of the time required for the full-wave Momentum simulation (due to the divide and conquer technique used).

On a 450 MHz PC, the full-wave simulation took 5037 seconds, while the simulation using the Model Composer models was virtually instantaneous. The results obtained with the “classic” analytical models of the circuit simulator differ significantly from the full-wave results because they were used outside their validity range.

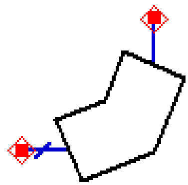

Mag(S11)
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
14
16
freq, GHz


Mag(S12)
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
14
16
freq, GHz

Model Composer Components

bend (Arbitrary Angle Bend)

Symbol



Parameters

W = Line width at ports

ANGLE = Angle of bend, in degrees

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

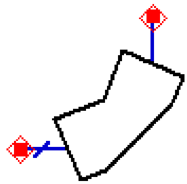
W ≥ 0

-135 ≤ ANGLE ≤ 135

FEEDL > 0

bend_m (Mitered Arbitrary Angle Bend)

Symbol



Parameters

W = Line width at ports

ANGLE = Angle of bend, in degrees

M = Miter fraction

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

$W \geq 0$

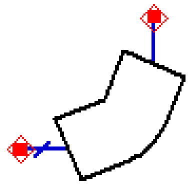
$-135 \leq ANGLE \leq 135$

$0 \leq M \leq 1$

$FEEDL > 0$

bend_r (Rounded Arbitrary Angle Bend)

Symbol



Parameters

W = Line width at ports

ANGLE = Angle of bend, in degrees

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

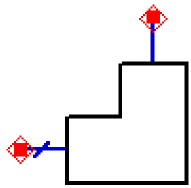
$W \geq 0$

$-135 \leq ANGLE \leq 135$

$FEEDL > 0$

corner (90-degree Corner)

Symbol



Parameters

W = Line width at ports

FEEDL = Feedline length

LAYER = Signal layer name

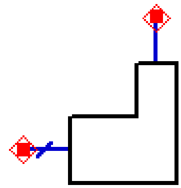
Range of Usage

W ≥ 0

FEEDL > 0

corner_a (90-degree Asymmetric Corner)

Symbol



Parameters

W1 = Line width at port 1

W2 = Line width at port 2

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

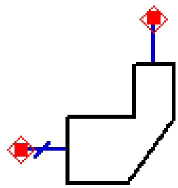
$W1 \geq 0$

$W2 \geq 0$

FEEDL > 0

corner_am (90-degree, Asymmetric, 50%-miter Corner)

Symbol



Parameters

W1 = Line width at port 1

W2 = Line width at port 2

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

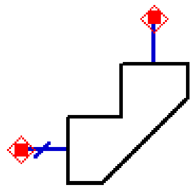
W1 ≥ 0

W2 ≥ 0

FEEDL > 0

corner_m (90-degree Mitered Corner)

Symbol



Parameters

W = Line width at ports

M = Miter fraction

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

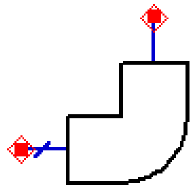
$W \geq 0$

$0 \leq M \leq 1$

$FEEDL > 0$

corner_r (90-degree Rounded Corner)

Symbol



Parameters

W = Line width at ports

FEEDL = Feedline length

LAYER = Signal layer name

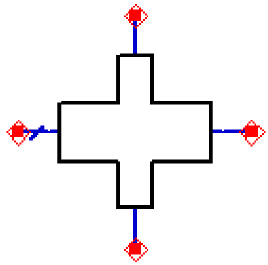
Range of Usage

W ≥ 0

FEEDL > 0

cross (Cross Junction)

Symbol



Parameters

W1 = Line width at port 1

W2 = Line width at port 2

W3 = Line width at port 3

W4 = Line width at port 4

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

$W1 \geq 0$

$W2 \geq 0$

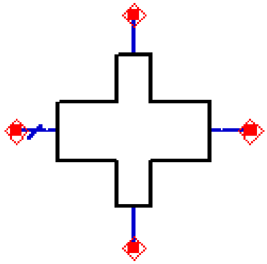
$W3 \geq 0$

$W4 \geq 0$

$FEEDL > 0$

cross_s (Symmetric Cross Junction)

Symbol



Parameters

W_thru = Thru line width

W_cross = Cross line width

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

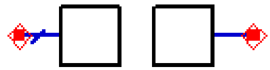
W_thru ≥ 0

W_cross ≥ 0

FEEDL > 0

gap (Symmetric Gap)

Symbol



Parameters

W = Line width

S = Spacing of gap

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

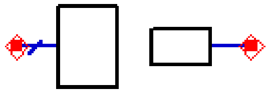
$W \geq 0$

$S \geq 0$

$FEEDL > 0$

gap_a (Asymmetric Gap)

Symbol



Parameters

W1 = Line width at port 1

W2 = Line width at port 2

S = Spacing of gap

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

$W1 \geq 0$

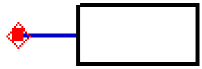
$W2 \geq 0$

$S \geq 0$

$FEEDL > 0$

open (Open-end Effect)

Symbol



Parameters

W = Line width

FEEDL = Feedline length

LAYER = Signal layer name

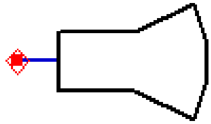
Range of Usage

$W \geq 0$

$FEEDL > 0$

rstub (Radial Stub)

Symbol



Parameters

W = Width of input line

L = Length of stub

ANGLE = Angle of stub, in degrees

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

$W \geq 0$

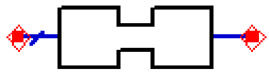
$L \geq 0$

$-270 \leq ANGLE \leq 270$

$FEEDL > 0$

slit (Symmetric Slit)

Symbol



Parameters

W = Line width at ports

W_slit = Line width of slit

L = Length of slit

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

W ≥ 0

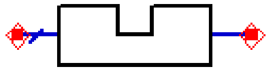
W_slit ≥ 0

L ≥ 0

FEEDL > 0

slit_a (Asymmetric, One-sided Slit)

Symbol



Parameters

W = Line width at ports

W_slit = Line width of slit

L = Length of slit

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

W ≥ 0

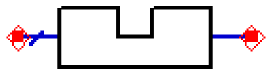
W_slit ≥ 0

L ≥ 0

FEEDL > 0

step (Step in Width)

Symbol



Parameters

W1 = Line width at port 1

W2 = Line width at port 2

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

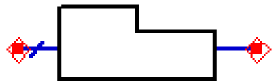
W1 ≥ 0

W2 ≥ 0

FEEDL > 0

step_a (Asymmetric, One-sided Step in Width)

Symbol



Parameters

W1 = Line width at port 1

W2 = Line width at port 2

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

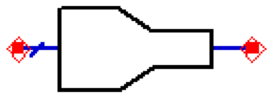
W1 ≥ 0

W2 ≥ 0

FEEDL > 0

taper (Tapered Step in Width)

Symbol



Parameters

W1 = Line width at port 1

W2 = Line width at port 2

L = Length of taper

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

W1 ≥ 0

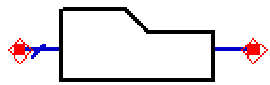
W2 ≥ 0

L ≥ 0

FEEDL > 0

taper_a (Asymmetric, One-sided, Tapered Step in Width)

Symbol



Parameters

W1 = Line width at port 1

W2 = Line width at port 2

L = Length of taper

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

$W1 \geq 0$

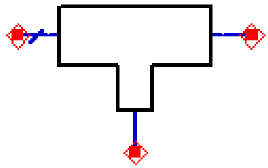
$W2 \geq 0$

$L \geq 0$

$FEEDL > 0$

tee (Tee Junction)

Symbol



Parameters

W1 = Line width at port 1

W2 = Line width at port 2

W3 = Line width at port 3

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

W1 ≥ 0

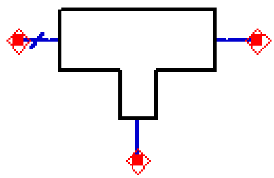
W2 ≥ 0

W3 ≥ 0

FEEDL > 0

tee_s (Symmetric Tee Junction)

Symbol



Parameters

W_thru = Thru line width

W_stub = Stub line width

FEEDL = Feedline length

LAYER = Signal layer name

Range of Usage

W_thru ≥ 0

W_stub ≥ 0

FEEDL > 0

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