Component Description Format User Guide

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Contents

1

What is CDF?

Overview

The Component Description Format (CDF) describes the parameters and the attributes of parameters of individual components and libraries of components. The CDF lets you create and describe your own components.

This topic describes how you can use the Component Description Format to create and describe your own components.

This topic assumes that you are a computer-aided design librarian or a circuit designer and that you are familiar with designing and developing electronic components with Virtuoso® design and simulation software.

A CDF description assigns parameters and parameter attributes to libraries and cells for many purposes:

- Assigning parameter names and values
- Allocating units and default values
- Checking that values lie within specified ranges
- Dynamically changing how parameters are displayed depending on predefined conditions
- Executing a SKILL callback function whenever certain information is changed

  Note: Callbacks are called only from the Add Instance and Edit Object Properties forms. As a consequence, many problems are associated with callbacks and their use is discouraged.

The CDF gives you:

- a single location for storing all component information so that applications can share and reuse parts of the component description.
- independence from applications and cellviews.
- a graphical user interface (the Edit CDF form) for entering and editing component information.
- strict checking so that tools do not need to check component data before using it.
- basic units and scale factors that are common in electrical design.
- a modular format, so that you can edit and update parts of a description.
- a command to copy the CDF description of one component into another component.

Licensing Requirements

For information on licensing in the Virtuoso Studio design environment, see *Virtuoso Software Licensing and Configuration Guide*.

A Typical Application

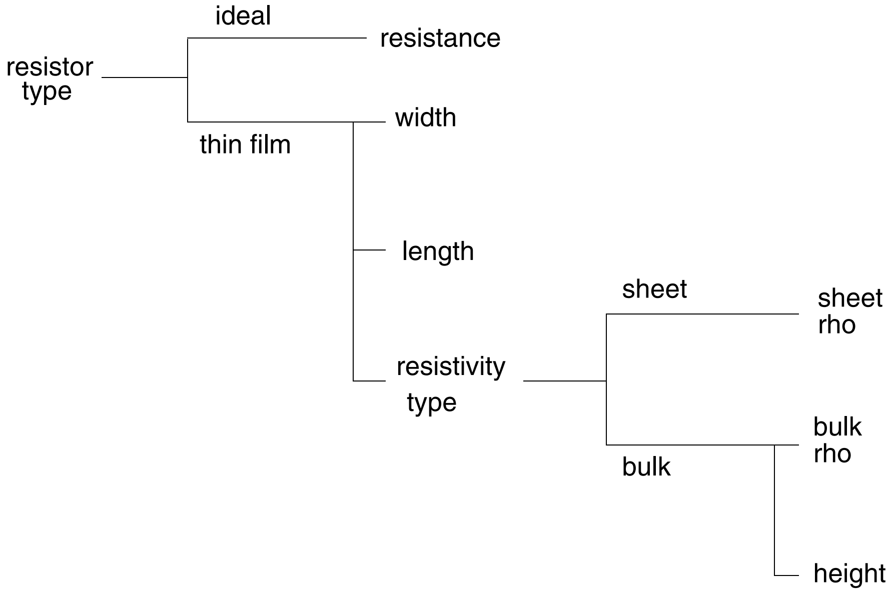
The CDF encompasses all levels of components, including discrete and full-custom components, and all cellviews of components. For example, the resistor cell *res* can take on two forms: an ideal resistor or a thin film resistor. If you want an ideal resistor, you specify the value of resistance desired. If you want a thin-film resistor, which models discontinuities as well as skin and substrate effects, you specify the length and width of the resistor and the resistivity of the material in which the resistor body is built.

You can choose how to specify the thin film resistivity by

- Specifying the resistivity as a sheet resistance (ohms per square)
- Specifying the bulk resistivity of the material

  In this case, you need to also specify the height of the resistor body.

To determine what parameters the resistor needs, follow the decision tree in the following figure:



This pattern of resistor parameters illustrates how you can construct a CDF description for this resistor that lets you automatically switch between different choices.

To create a complete CDF for this resistor, you create eight parameters.

The first parameter is the radio button field, *resistorType*. It is always displayed and editable and has only two values, *ideal* and *thin_film*.

The second parameter, *resistance*, uses a *cdfgData* variable expression to test the value of *resistorType*.

The cdfgData variable is used within the callback code to either read or write the CDF data for the current parameter. It uses the value field to get the current value of any parameter in the CDF description.

In the example below, the cdfgData variable is used to read the value of *resistance* parameter:

```
?use "cdfgData->resistorType->value == \"ideal\""
```

Implying that the *resistance* parameter should be used only if the resistor type is set to ideal. (== is an equality test, not an assignment.)

You can also use cdfgData to set the value of a parameter. For example,

```
?use "cdfgData->paramName->value = paramValue"
```

cdfgData callback is also triggered by the Edit Object Properties Form to get the current value of a parameter.

The third, fourth, and fifth parameters behave in the opposite manner from *resistance*. Through another cdfgData expression for each parameter, *width*, *length*, and *resistType* become active if *resistorType* = *thin_film,* and they become unavailable if *resistorType* = *ideal*. The *width* and *length* parameters have floating-point numerical values. The *resistType* parameter is a string with only two values, *sheet* and *bulk*.

The last three parameters, *srho*, *brho*, and *height*, have floating-point numerical values. *srho* becomes active when *resistType* = *sheet*, while *brho* and *height* become active when *resistType* = *bulk*.

Additionally, you can use CDF to display prompts that spell out the complete name of each variable (*bulk rho* instead of *brho*), and you can also set the CDF of this resistor to accept expressions (such as those in the Analog Expression Language (AEL) for the values of these parameters.

When a designer accesses this resistor through the *Add Instance, Create Instance,* or *Edit Properties* command, the form prompts the designer for the necessary values. The form changes based on the values entered.

The CDF description of the resistance parameters for this resistor is stored in the following SKILL code.

```
libId = ddGetObj("base")
cellId = ddGetObj("base" "res")

cdfDataId = cdfCreateBaseCellCDF(cellId)

cdfParamId = cdfCreateParam(cdfDataId
?name           "resistorType"
?type           "radio"
?prompt         "Type:"
?defValue       "ideal"
?choices        list("ideal" "thin film")
?callback       "myResistorTypeCB()")

cdfParamId = cdfCreateParam(cdfDataId
?name           "resistance"
?type           "float"
?prompt         "Resistance:"
?defValue       100.0
?use "cdfgData->resistorType->value == \"ideal\""
?callback       "myResCB()")

cdfParamId = cdfCreateParam(cdfDataId
?name           "width"
?type           "float"
?prompt         "Width:"
?defValue       20e-6
?use "cdfgData->resistorType->value == \"thin film\""
?callback       "myWidthCB()")

cdfParamId = cdfCreateParam(cdfDataId
?name           "length"
?type           "float"
?prompt         "Length:"
?defValue       100e-6
?use "cdfgData->resistorType->value == \"thin film\""
?callback       "myLengthCB()")

cdfParamId = cdfCreateParam(cdfDataId
?name           "resistType"
?type           "radio"
?prompt         "Resistivity Type:"
?defValue       "sheet"
?choices        list("sheet" "bulk")
?use            "cdfgData->resistorType->value ==\"thin film\""
?callback       "myResTypeCB()")

cdfParamId = cdfCreateParam(cdfDataId
?name           "srho"
?type           "float"
?prompt         "Sheet Rho:"
?defValue       25.0
?use            "cdfgData->resistorType->value == \"thin
film\"   && cdfgData->resistType->value == \"sheet\""
?callback       "mySheetRhoCB()")
```

```
cdfParamId = cdfCreateParam(cdfDataId
?name           "brho"
?type           "float"
?prompt         "Bulk Rho:"
?defValue       25e-10
?use            "cdfgData->resistorType->value == \"thin
film\"   && cdfgData->resistType->value == \"bulk\""
?callback       "myBulkRhoCB()")
```

```
cdfParamId = cdfCreateParam(cdfDataId
?name           "height"
?type           "float"
?prompt         "Height:"
?defValue       25e-10
?use            "cdfgData->resistorType->value == \"thin
film\"   && cdfgData->resistType->value == \"bulk\""
?callback       "myHeightCB()")
```

Levels of CDF Data

You can attach a CDF description to either a component or a library of components. When you attach a description to a library, all components in the library inherit the description. When you attach a description to a component, you only attach the description to the *cell.*

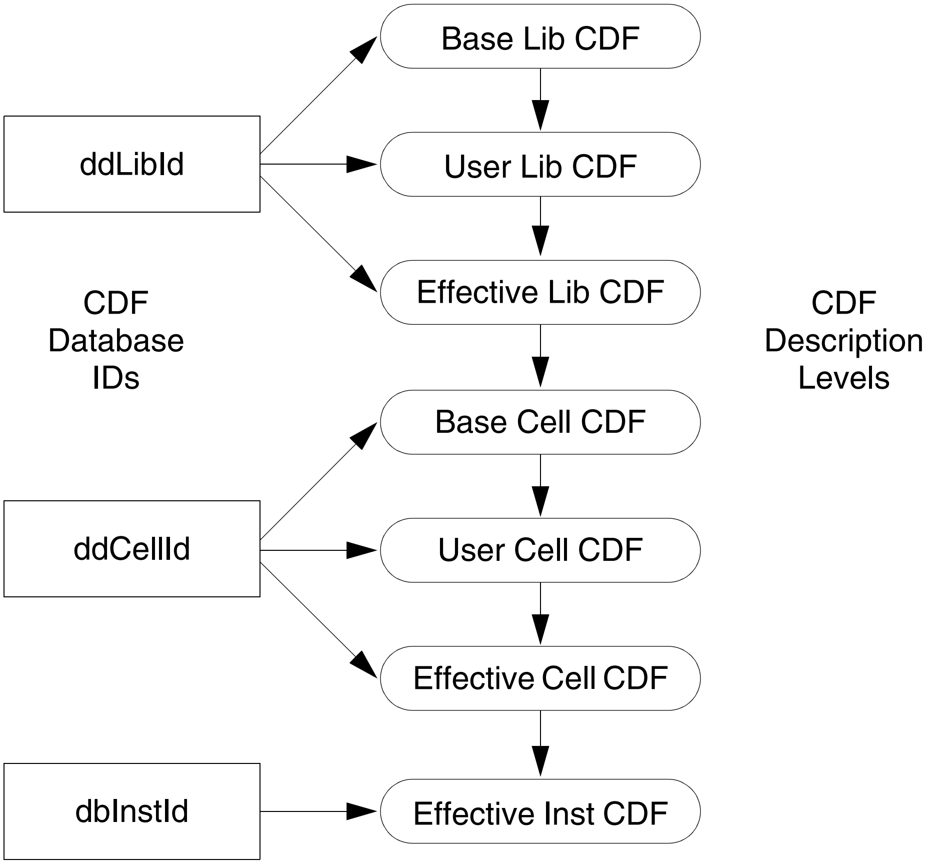
Librarians usually create and maintain the CDF descriptions for components. Library users see the effects of the descriptions as they use components from the library. However, you might want to override parts of the default description. For example, you might want to specify your own default values for CDF parameters. So that you can override the description, Cadence defines the following description levels:

- The *base-level* CDF is the description that is permanently attached to a cell or library. When the system reads in a cell or library, any base-level CDF attached to it is also read. The creator of a base-level CDF must have write permission on the object to which the description is being attached.
- The *user-level* CDF is a user-specific overlay description on top of the base-level CDF for a cell or a library (although the base-level does not have to exist). The system never saves a user-level CDF, so you must save it to a file and reload this level on startup. You do not need write permission to attach user-level CDF information to an object.
- The *effective-level* CDF is an overlay of a user-level CDF description on top of a corresponding base-level CDF description.

Note: Because user-level CDF is specific to a user and not a library or cell, simulation results can be different for different users. The use of user-level CDF is therefore discouraged.

“Overlay” means “effectively replaces.” A user cell value of 10,000 ohms for the resistor parameter *r* takes the place of any base- or library-level value for *r*. Each level of CDF is optional. You can create cell-level CDFs without having library-level CDFs, and you can create user-level CDFs without having base-level CDFs.

Both libraries and cells can have base- and user-level CDF descriptions. The effective-library CDF is the overlay of the user-library CDF on top of the base-library CDF. The effective cell-level CDF is the overlay of the user cell CDF on top of the base cell CDF, overlaid on top of the effective library-level CDF. Finally, the effective instance CDF is the effective cell-level CDF with instance-specific information added to the CDF description. The following figure shows the relationship between CDF levels and the Cadence database.



CDF Worksheet

Before you start to build a component, you need to decide how you intend to use it, in which applications, and with what requirements. Before you create the cell and CDF, you need to determine the following:

1. What applications will you use?
   - ❑ Design Entry
   - ❑ Simulation
   - ❑ Layout
   - ❑ Design Checking
   - ❑ Place and Route
2. What views are required by the applications you will use?
   - ❑ Design Entry — symbol
   - ❑ Layout — layout, flat, or Pcell
   - ❑ Simulation — ams, spectre etc.
   - ❑ Design Checking — auLvs, lvs
3. What parameters are required by the applications?
   - ❑ Layout — Pcell parameters, view names
   - ❑ Simulation — model parameters
4. What restrictions do the applications impose on the parameters?
   - ❑ Simulation — parameter representation
   - ❑ Layout — Pcell parameters representation, correspondence between the Pcell and CDF default values
   - ❑ Are parameter values discrete values or any value in a range?
5. What dependencies do the parameters have on each other?
6. How do you want the user interface (the Add Instance and Edit Property forms) to appear?
   - ❑ Are there parameters that you want to hide from the user?
   - ❑ Are there parameters that you want the user to see but not be able to edit?
   - ❑ What parameters should appear at the top of the forms?

This user guide illustrates each task with examples based on two components. In the first example, you examine the CDF of the functional block description of a complex pole. This component uses a macro model and is set up for simulation using the Virtuoso Spectre simulator. This example illustrates parameter passing in hierarchical designs.

In the second example, you create the CDF for a BICMOS NFET from the CDF information for another component. The NFET is specified as a parameterized cell (Pcell) that can be simulated with Analog LVS. This example illustrates some of the consequences of specifying particular values for a component CDF description.

For example, the answers to the set of questions for the BICMOS NFET cell would be as follows:

1. What applications will you use?
   - ❑ Design Entry — Yes
   - ❑ Simulation — Yes
   - ❑ Layout — Yes
   - ❑ Design Checking — Yes
   - ❑ Place and Route — No
2. What views are required by the applications?
   - ❑ Schematics — symbol with G, S, and D pins for the gate, source, and drain. You do not need a bulk node connection in this case.
   - ❑ Simulation — *spectre* interfaces to the Spectre simulator.
   - ❑ Layout — Pcell for the usual case, but also a large power transistor for I/O in a flat layout. Both layouts have G, S, and D connections.
   - ❑ Design Checking — *auLvs*
3. What parameters are required by the applications?
   - ❑ Schematics — none
   - ❑ Virtuoso XL Layout Editor (Virtuoso XL) — width, length, bend, contact information, and *maskLayoutViewName* (because there are two different layouts)
   - ❑ Spectre — model parameters, including w and l and a bulk node
   - ❑ LVS — w and l
4. What restrictions do the applications impose on the parameters?
   - ❑ Simulation — simulator parameters must be strings.

- ❑ Layout — Pcell parameters need to be floating-point numbers and the defaults between the CDF and the Pcell must match.
- ❑ The length parameter has a minimum and a maximum. The width parameter has a minimum and a maximum. The length and width must be on grid. There are no other specific discrete values.

5. Do the parameters have dependencies on each other?

- ❑ The number of gates is a function of width. If the width exceeds 120, the layout changes to have two gates (a bend with connections).
- ❑ If a designer selects the alternate large layout, the width and length are updated to reflect the value.
- ❑ Length and width of each two parameters: one a string for simulation and one a floating-point number for the Pcell. You should not have to enter both and they should be synchronized.
- ❑ The model parameters are dependent on the physical parameters. For example, you might calculate a value for the drain diffusion area and a value for the source diffusion area based on the physical parameters.

6. How do you want the user interface to appear? Are there parameters that you want to be hidden from designers? Are there parameters that you want the designers to see but not edit? What parameters should appear at the top of the list?

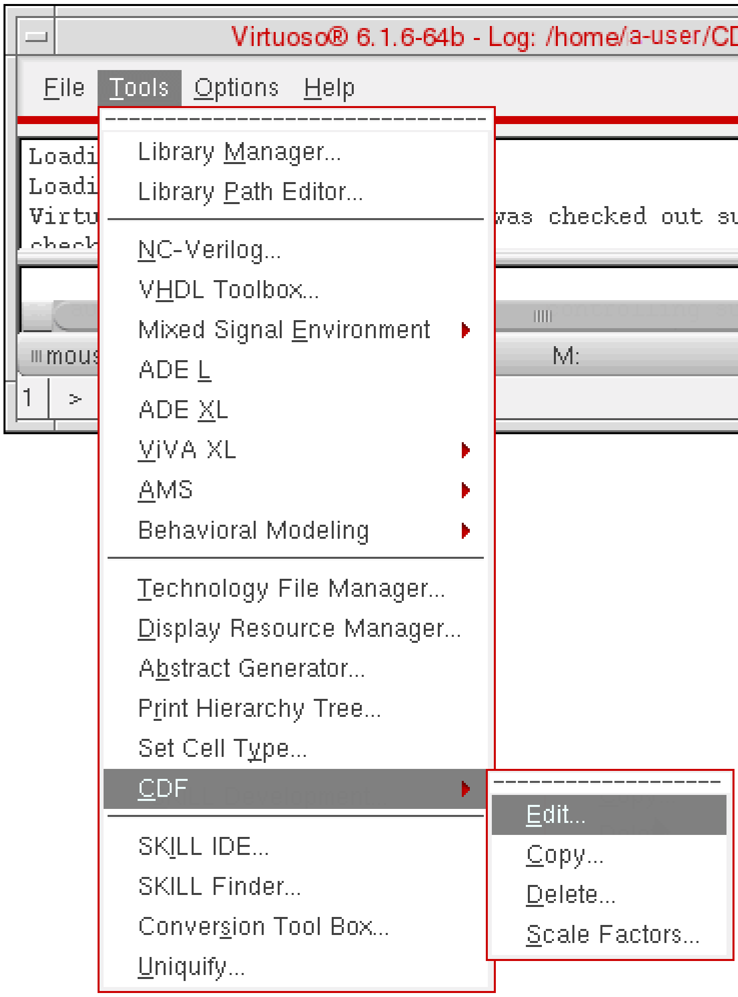
- ❑ If a designer selects the alternate large size layout, the width and length cannot be edited because there is only one large size device.
- ❑ The bends parameter is not visible to a designer because it is not under the designer’s control.
- ❑ The Pcell length and width are not visible to a designer. You want the designer to specify the width and length only once so that the forms show only the string version.
- ❑ Because drain and source diffusion areas are calculated, they should not be editable.
- ❑ Show width and length and the layout choice at the top of the forms because those are the parameters that designers must frequently edit.

2

CDF Commands

CIW CDF Commands

This section describes commands for managing Component Description Format (CDF) information. These CDF commands are on the *Tools* menu of the Command Interpreter Window (CIW). The following menu is just one of many different *Tools* menus you might see, depending on which Cadence® software you own. However, all CIW *Tools* menus have the same CDF commands.



```
Loadi
Loadi
Virtu                    was checked out successfully. Total
check
```

Edit lets you modify CDF information for a cell or library.

Copy lets you copy CDF information from one cell or library to another.

Delete lets you remove CDF information from a cell or library.

Scale Factors lets you set scaling factors for displaying CDF parameters.

Edit

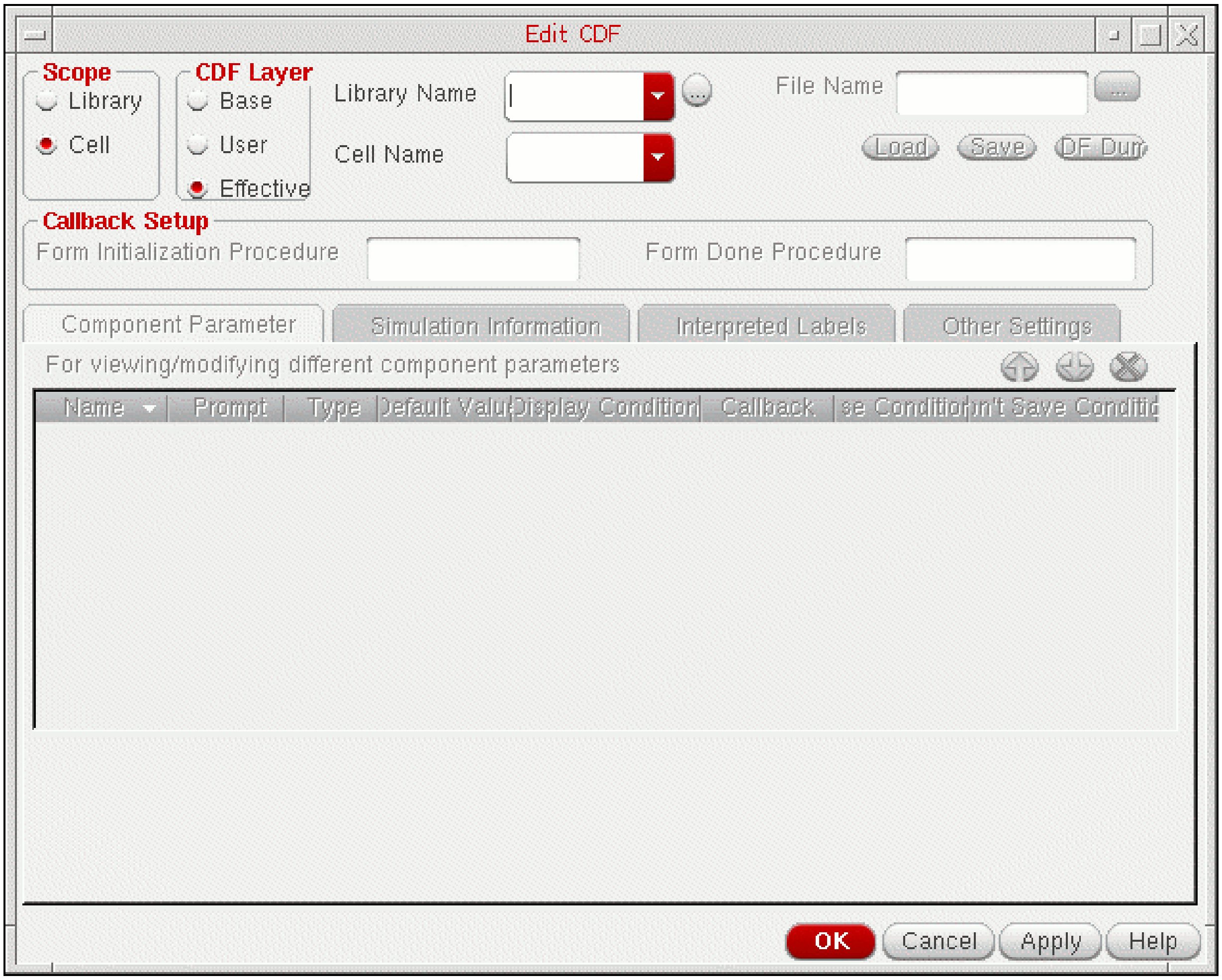
Tools ⇛ **CDF** ⇛ **Edit ...**

Creates or edits CDF data for a library or cell. With this command, you can

- Add component parameters
- Delete component parameters
- Modify attributes of component parameters
- Rearrange the display order of component parameters
- Modify simulation information for all available simulators
- Modify interpreted label information for schematic annotation
- Modify special CDF properties that define CDF-generated forms, such as the Add Instance form

You can select CDF data for a cell or library on the Edit CDF form. Once you make a CDF selection, this form modifies itself and expands to include any existing CDF information.

Edit CDF Form (Initial)



- **Scope** lets you choose a CDF scope of *Library* or *Cell*.
  - **Library** lets you edit CDF data for a library.
  - **Cell** lets you edit CDF data for a cell. (The default value.)
- **CDF Layer** lets you choose a CDF level of *Base*, *User*, or *Effective*.
  - **Base** mode writes information to the library or cell when you click *Apply*, so you must have write privileges to the library and cell.
  - **User** mode writes data to the user-level CDF when you click *Apply*. The editor does not store data permanently in the library or cell, so you must save it to a file and reload this level on startup if you want to reuse the data. You do not need write privileges to the library or cell to attach user-level CDF information.

> **Note:** Because user-level CDF is specific to a user and not a library or cell, simulation results can be different for different users. The use of user-level CDF is therefore discouraged.

- ❑ **Effective** mode, in contrast to *user* mode, writes information to the user-level CDF only when the new information differs from base-level CDF information. The editor does not store data permanently in the library or cell, so you do not need write privileges.

For further information, see "Levels of CDF Data" on page 14.

- **Library Name** is the name of the library whose CDF data you want to edit.

  Select the library name using the *Library Name* cyclic field, or click the browse button to use the Library Browser form to select the library.

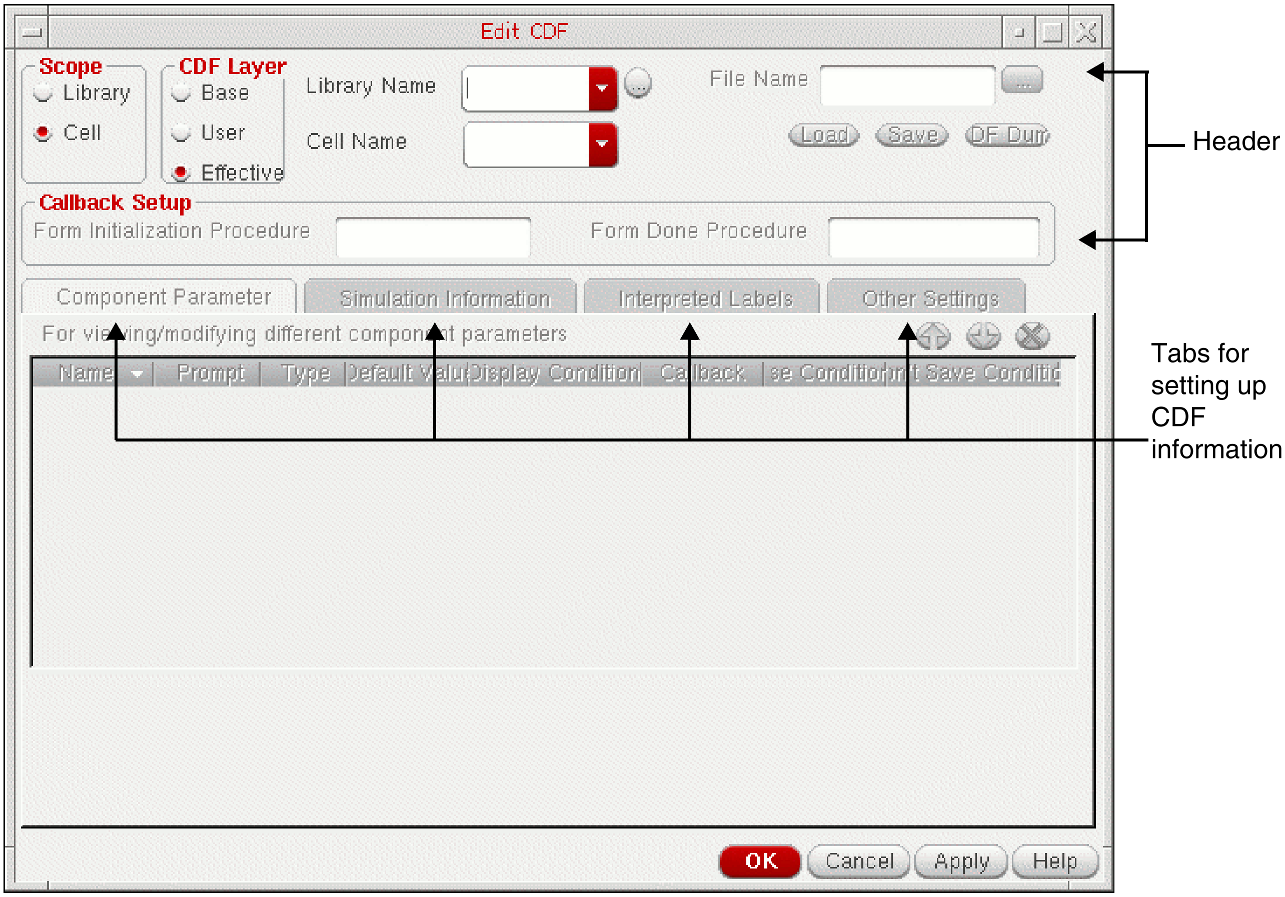
- **Cell Name** is the name of the cell whose CDF data you want to edit.

Note: If you press *Enter* or click *OK*, the values you have entered take effect, but the Edit CDF form also closes. Move the cursor or press the *Tab* key when you finish an entry in a field and want to move to another field. Click *Apply* if you want the information you entered to take effect and you want the form to stay open.

Edit CDF Form

You can use the Edit CDF form to create, view, or edit a CDF description. The Edit CDF form gives you access to all portions of cell and library CDF descriptions. It consists of a header for identifying the library or cell CDF description, specifying procedures for preprocessing and postprocessing CDF data, and four tabs for details about component parameters, simulation information, interpreted labels, and other settings.

Edit CDF Form



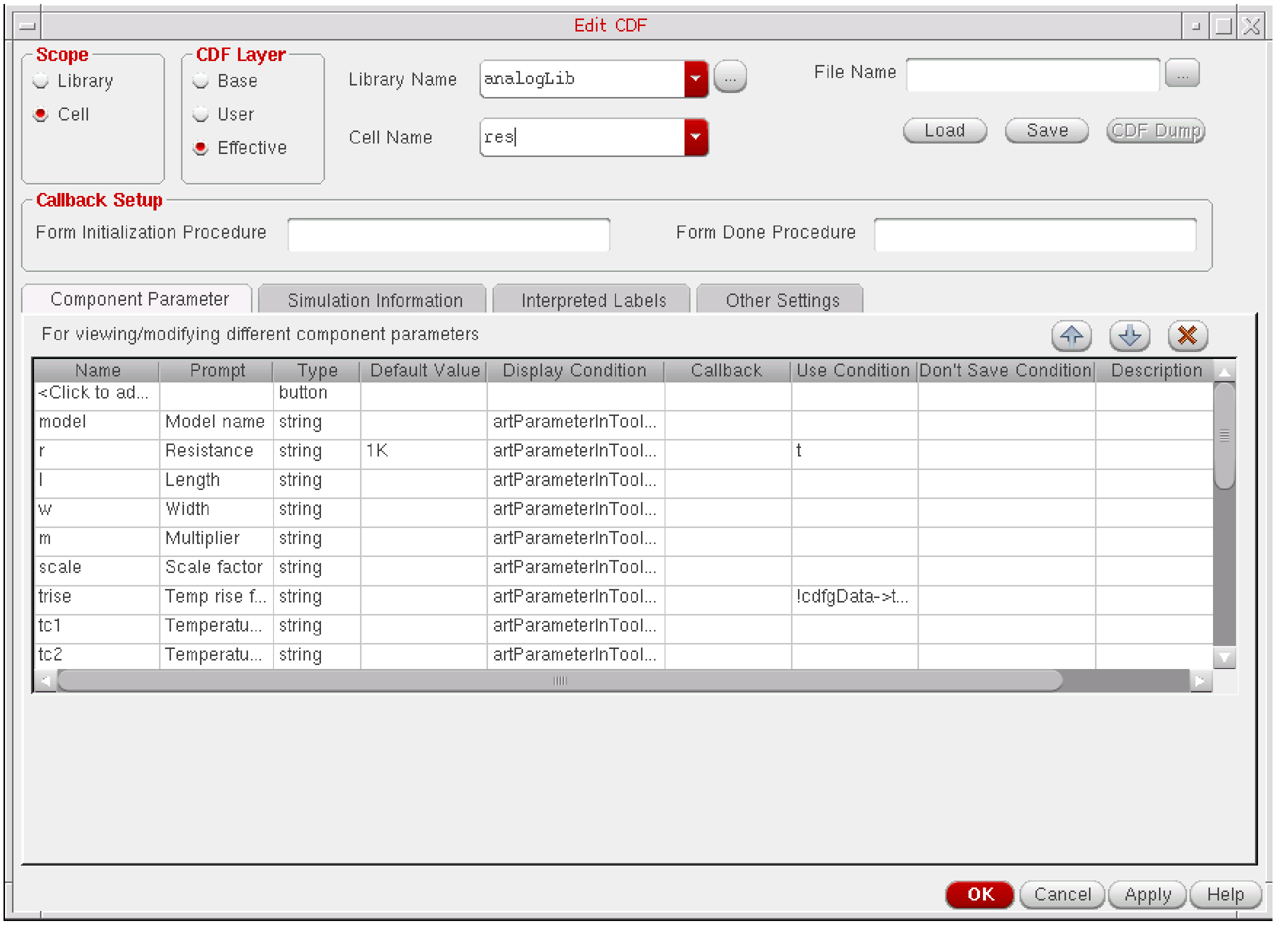
Scope
○ Library
● Cell

CDF Layer
○ Base
○ User
● Effective

The following sections in this chapter describe the fields and buttons in the header. Subsequent chapters describe each of the four tabs.

Edit CDF Form (Redisplayed)

After you enter a CDF cell or library name, the Edit CDF form displays component parameter information in the Component Parameter tab as shown in the following figure. Click the other tabs to examine their contents.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: analogLib

Cell Name: res

File Name:

Callback Setup

Form Initialization Procedure:

Form Done Procedure:

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition	Description
<Click to ad...		button						
model	Model name	string		artParameterInTool...				
r	Resistance	string	1K	artParameterInTool...		t		
l	Length	string		artParameterInTool...				
w	Width	string		artParameterInTool...				
m	Multiplier	string		artParameterInTool...				
scale	Scale factor	string		artParameterInTool...				
trise	Temp rise f...	string		artParameterInTool...		!cdfgData->t...		
tc1	Temperatu...	string		artParameterInTool...				
tc2	Temperatu...	string		artParameterInTool...				

File Name is the name of a file that you can create where you can store all the current editor field values. You can store the CDF description of a cell, including *User* or *Effective* levels, for future use by the Edit CDF form. You can type in the name of the file.

Load loads the CDF information in the file in the *File Name* field. The Edit CDF form redisplays to show the new information. The editor does not save CDF data to the cell or library until you click *OK* or *Apply*.

Save saves the contents of the Edit CDF form to the file in the *File Name* field.

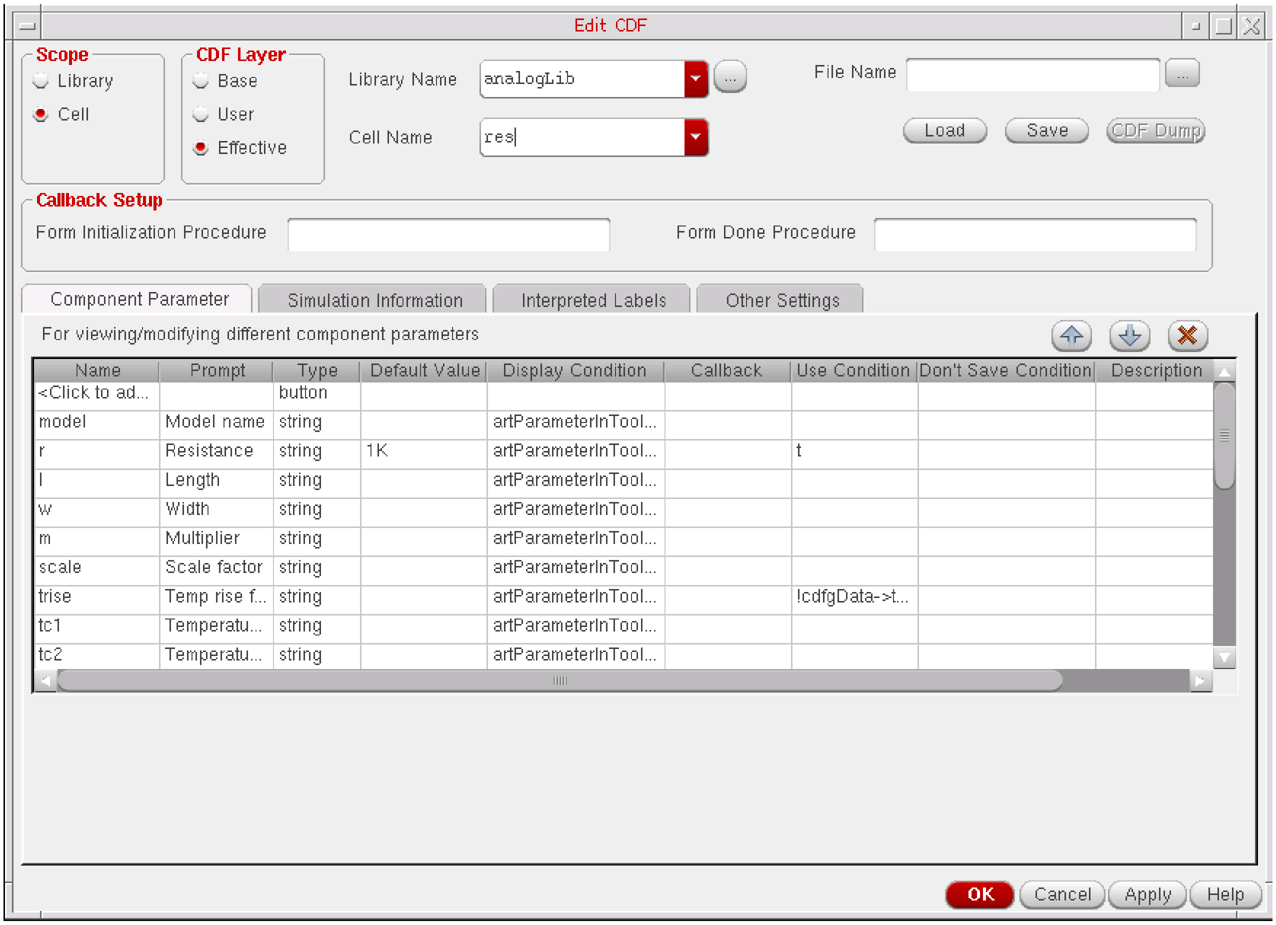
CDF Dump saves the CDF information in SKILL format to the file in the *File Name* field. You can use the SKILL file to load the CDF information later with the `load("`*`filename`*`")` command in the Command Interpreter Window (CIW), or customize it to modify the CDF information.

formInitProc lets you specify an optional procedure (a Cadence® SKILL language routine that you provide) that executes automatically when the component is placed on an instantiation form. For more information, see Initialization Procedure on page 125.

doneProc lets you specify an optional procedure (a SKILL routine that you provide) that executes after you change any parameter on the instantiation form. For more information, see Postprocessing Procedure on page 126.

Component Parameter tab

You use the Component Parameter tab of the Edit CDF form to view and edit component parameters. You can also add, delete, insert, and rearrange parameters and edit their attributes. You can also add a tooltip for a parameter under the Description column.



Edit CDF

Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: analogLib

Cell Name: res

File Name:

Callback Setup

Form Initialization Procedure:

Form Done Procedure:

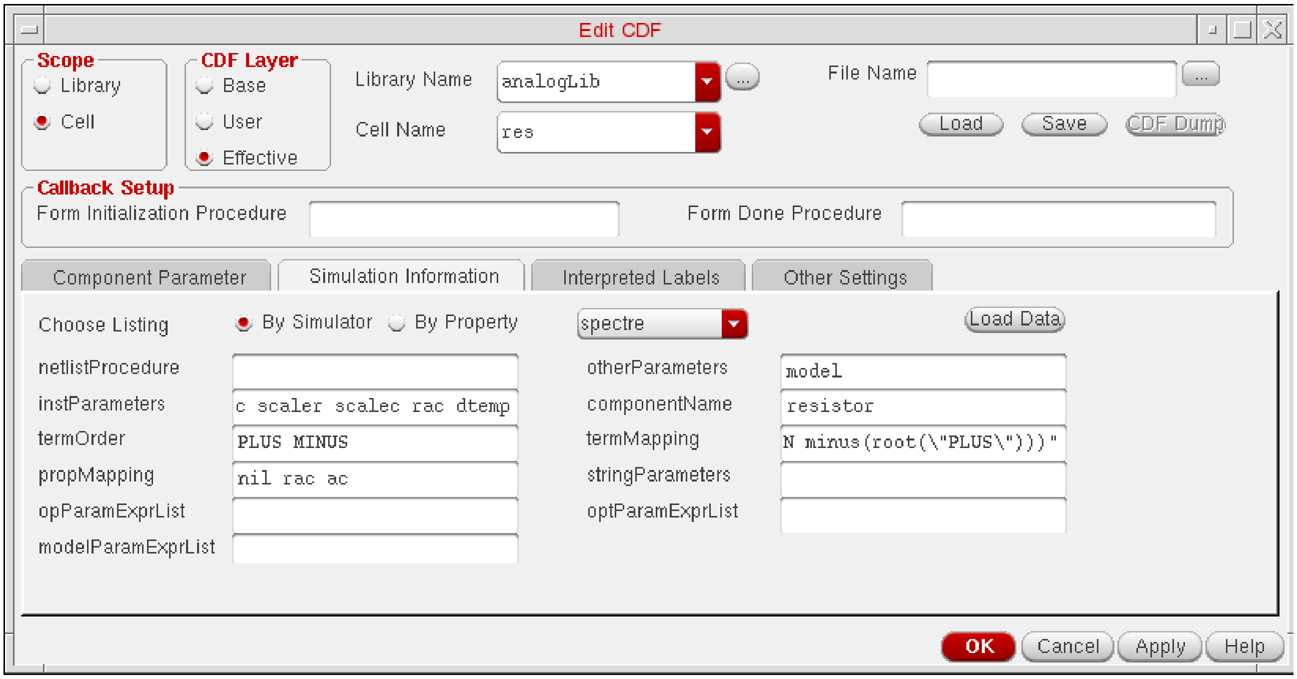
For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition	Description
<Click to ad...		button						
model	Model name	string		artParameterInTool...				
r	Resistance	string	1K	artParameterInTool...		t		
l	Length	string		artParameterInTool...				
w	Width	string		artParameterInTool...				
m	Multiplier	string		artParameterInTool...				
scale	Scale factor	string		artParameterInTool...				
trise	Temp rise f...	string		artParameterInTool...		!cdfgData->t...		
tc1	Temperatu...	string		artParameterInTool...				
tc2	Temperatu...	string		artParameterInTool...				

For information about the Component Parameter tab, see Chapter 3, “Defining Parameters.”

Simulation Information tab

The Simulation Information tab of the form lets you edit simulation information for simulators registered in the software.



Edit CDF

Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: analogLib

Cell Name: res

File Name:

Callback Setup

Form Initialization Procedure:

Form Done Procedure:

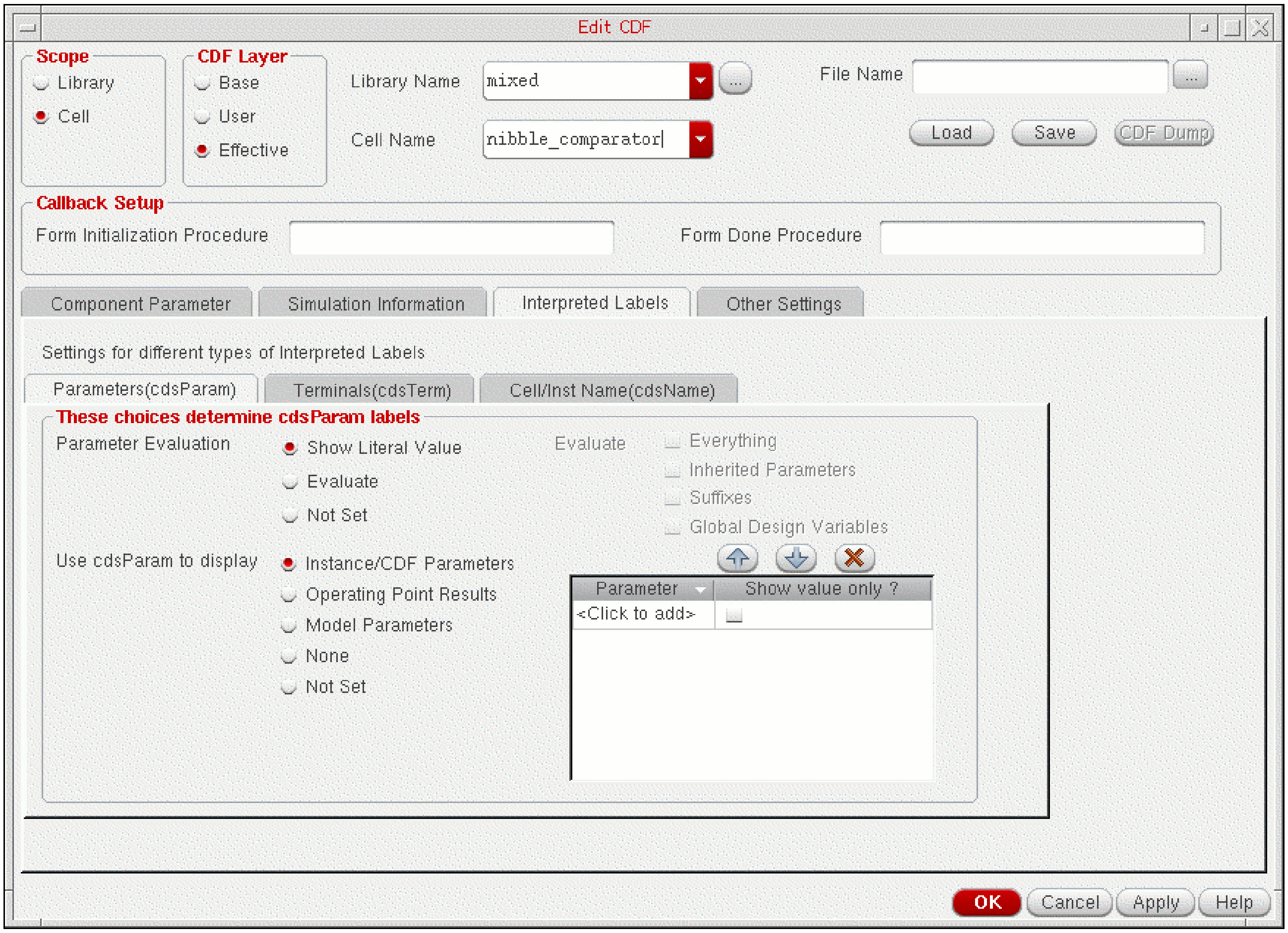
Choose Listing: ● By Simulator ○ By Property — spectre

netlistProcedure		otherParameters	model
instParameters	c scaler scalec rac dtemp	componentName	resistor
termOrder	PLUS MINUS	termMapping	N minus(root(\"PLUS\")))"
propMapping	nil rac ac	stringParameters	
opParamExprList		optParamExprList	
modelParamExprList			

For information about modifying the options for simulation information using the Simulation Information tab, see Chapter 4, “Modifying Simulation Information.”

Interpreted Labels Information tab

The Interpreted Labels Information tab of the Edit CDF form lets you edit interpreted label information in the CDF description. Chapter 5, “Specifying Label Information,” describes the options for interpreted labels.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: mixed

Cell Name: nibble_comparator

File Name:

Callback Setup

Form Initialization Procedure:

Form Done Procedure:

Settings for different types of Interpreted Labels

These choices determine cdsParam labels

Parameter Evaluation: ● Show Literal Value ○ Evaluate ○ Not Set

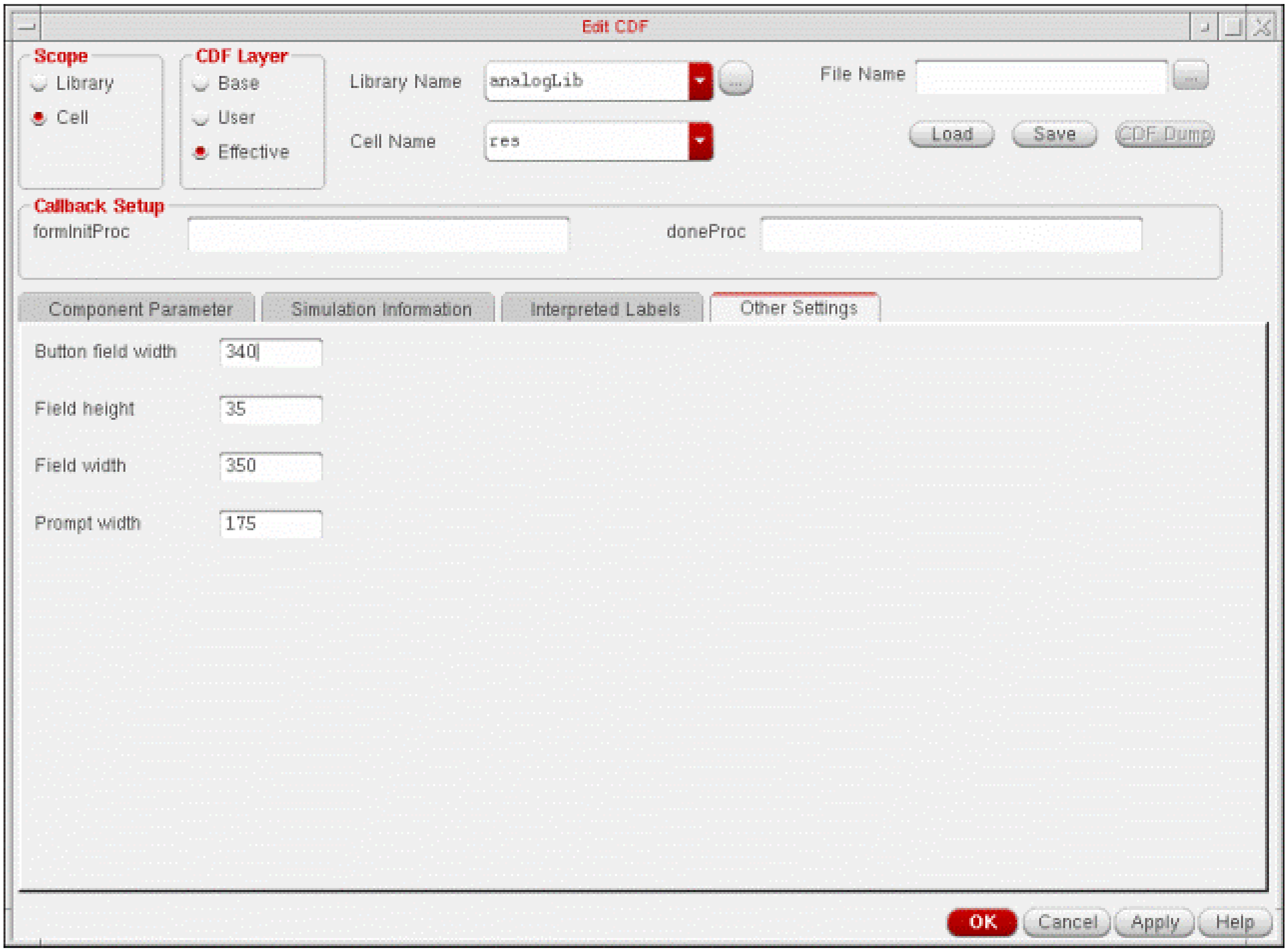
Evaluate: □ Everything □ Inherited Parameters □ Suffixes □ Global Design Variables

Use cdsParam to display: ● Instance/CDF Parameters ○ Operating Point Results ○ Model Parameters ○ None ○ Not Set

Parameter	Show value only ?
<Click to add>	□

Other Settings

The Other Settings tab of the Edit CDF form lets you edit CDF property fields that are not in any of the previous categories. Chapter 6, “Other CDF Information,” describes the options for other information.



Edit CDF

Scope
○ Library
● Cell

CDF Layer
○ Base
○ User
● Effective

Library Name: analogLib
Cell Name: res
File Name:

Callback Setup
formInitProc:
doneProc:

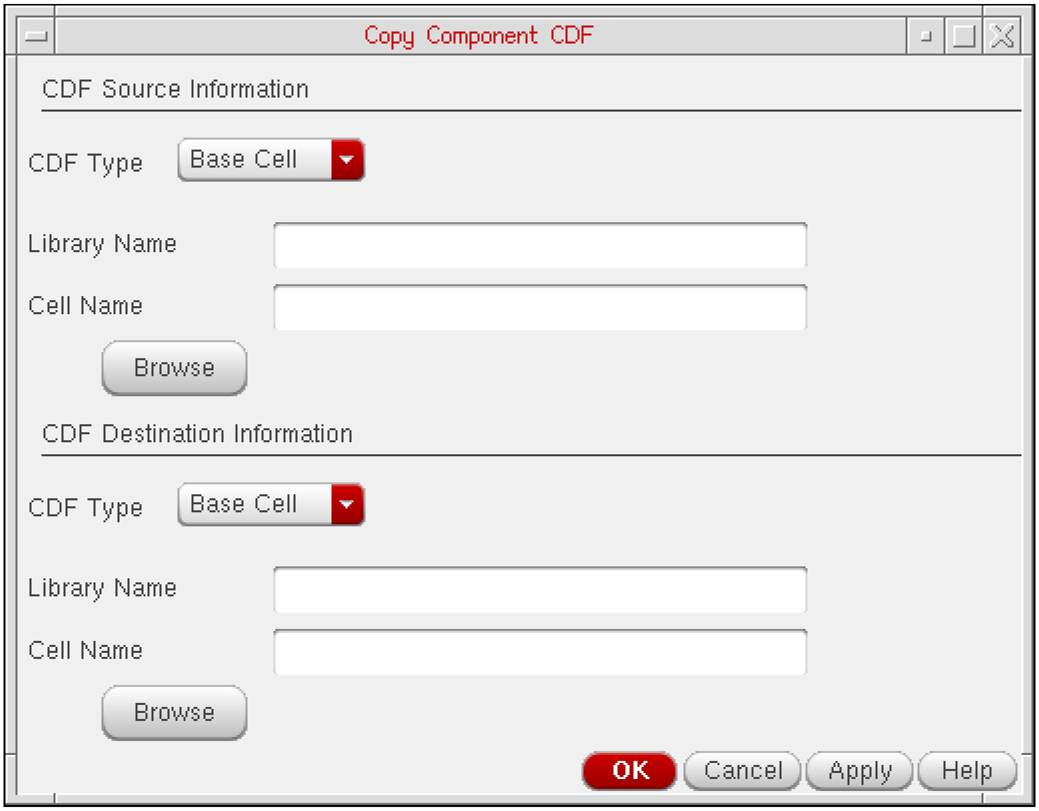
Other Settings
Button field width: 340
Field height: 35
Field width: 350
Prompt width: 175

Copy

Tools ⇛ **CDF** ⇛ **Copy ...**

Copies CDF data from one library or cell to a new library or cell.

Copy Component CDF Form



Copy Component CDF

CDF Source Information

CDF Type: Base Cell

Library Name:

Cell Name:

CDF Destination Information

CDF Type: Base Cell

Library Name:

Cell Name:

CDF Source Information

CDF Type is the type of CDF to copy. You can specify either a base-level or a user-level CDF description as the source CDF type. You cannot specify the effective-level CDF description as the source or the destination.

Library Name is the name of the library whose CDF data you want to copy.

Cell Name is the name of the cell whose CDF data you want to copy.

Browse displays the Library Browser.

CDF Destination Information

CDF Type is the type of destination CDF. You can specify either a base-level or a user-level CDF description as the destination CDF type. You cannot use effective-level CDF as a destination CDF type.

Library Name is the name of a library or a library that contains a cell into which you want to copy a CDF description.

Cell Name is the name of the cell into which you want to copy a CDF description.

Browse displays the Library Browser.

Caution

You cannot copy cell CDF data back to the same cell, and you cannot copy a level of CDF data if it has not been created yet. In both cases, the system issues an error message.

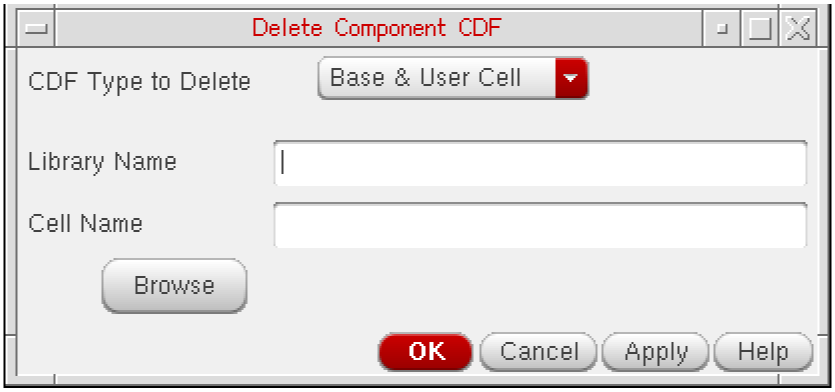
If you copy a cell (component) or library to another cell or library, the CDF data might not be copied. The transfer of CDF data occurs only if the target cell or library never existed and is created in the copy operation. If, however, the target cell or library already exists, or you copy only a cellview (a view of the component), the CDF data of the target cell (or library) remains unchanged. Use the *Copy CDF* command to avoid this problem.

Delete

Tools ⇛ **CDF** ⇛ **Delete ...**

Removes CDF data from a library or cell.

Delete Component CDF Form



CDF Type to Delete: Base & User Cell

Library Name:

Cell Name:

CDF Type to Delete lets you choose the type of CDF to delete.

Library Name is the name of either a library whose CDF description you want to delete or a library that contains a cell whose CDF description you want to delete.

Cell Name is the name of the cell whose CDF description you want to delete.

Browse displays the Library Browser.

Scale Factors

Tools ⇛ **CDF** ⇛ **Scale Factors ...**

Displays the Units Scaling Factors form, which you can use to set scaling factors for displaying CDF parameters. These abbreviations are used on the form:

f	femto (one quadrillionth)
p	pico (one trillionth)
n	nano (one billionth)
u	micro (one millionth)
m	milli (one thousandth)
c	centi (one hundredth)
k	kilo (one thousand)
M	mega (one million)
G	giga (one billion)

Rounding with Scaling Factors

When a scaling factor is set to a value other than the input value, the output string is rounded based on the following standards:

- If the input value is an integer, no rounding will occur.

```
Input: 1497Output: 1.497K
```

- If the number of decimal digits of the output value is greater than12, the output value will be rounded to maintain no more than12 decimal digits.

```
Input: 1234.12345678901234    Output: 1.234123456789K
Input: 123456.7890123456      Output: 123.456789012346K
Input: 123.4567890123456      Output: 123.456789012346
```

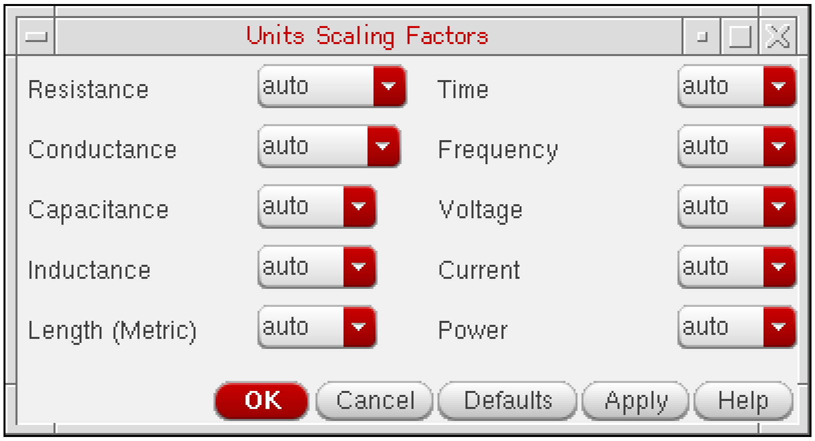
- If the number of decimal digits of the input value is12 or less, the number of decimal digits in the output will be maintained unless it exceeds12.

```
Input: 1497.5                 Output: 1.4975K
Input: 1497.56789             Output: 1.49756789K
Input: 123.12345678987        Output: 1.231234567899K
```

- Trailing decimal zeros will be truncated to the number of decimal zeros in the input.

```
Input: 120000.0                  Output: 120.0K
Input: 11000000.00               Output: 11.00M
Input: 11000000.0                Output: 11.0M
Input: 11                        Output: 11000000.0u
```

Units Scaling Factors Form



Resistance	auto	Time	auto
Conductance	auto	Frequency	auto
Capacitance	auto	Voltage	auto
Inductance	auto	Current	auto
Length (Metric)	auto	Power	auto

The following two entries are common to every field on the Units Scaling Factors form:

auto automatically scales to the most efficient representation

none uses value as entered, without modifying it

Resistance has a cyclic field for choosing how to show resistance.

t_unitName	**t_scaleFactor**	**Description**
`resistance`	*Ohms*	ohms
	kOhms	one thousand ohms
	MOhms	one million ohms

Conductance has a cyclic field for choosing how to show conductance.

t_unitName	**t_scaleFactor**	**Description**

conductance	*uMhos*	microsiemens
	mMhos	millisiemens
	Mhos	siemens

Capacitance has a cyclic field for choosing how to show capacitance.

t_unitName	**t_scaleFactor**	**Description**
capacitance	*fF*	femtofarad
	pF	picofarad
	nF	nanofarad
	uF	microfarad
	mF	millifarad
	F	farad

Inductance has a cyclic field for choosing how to show inductance.

t_unitName	**t_scaleFactor**	**Description**
inductance	*pH*	picohenry
	nH	nanohenry
	uH	microhenry
	mH	millihenry
	H	henry

Length (Metric) has a cyclic field for choosing how to show length.

t_unitName	**t_scaleFactor**	**Description**
lengthMetric	*uM*	micrometer
	mM	millimeter
	cM	centimeter
	M	meter

Time has a cyclic field for choosing how to show time.

t_unitName	**t_scaleFactor**	**Description**
`time`	*pS*	picosecond
	nS	nanosecond
	uS	microsecond
	mS	millisecond
	S	second

Frequency has a cyclic field for choosing how to show frequency.

t_unitName	**t_scaleFactor**	**Description**
`frequency`	*Hz*	hertz
	kHz	kilohertz
	MHz	megahertz
	GHz	gigahertz

Voltage has a cyclic field for choosing how to show voltage.

t_unitName	**t_scaleFactor**	**Description**
`voltage`	*uV*	microvolts
	mV	millivolts
	V	volts
	kV	kilovolts

Current has a cyclic field for choosing how to show current.

t_unitName	**t_scaleFactor**	**Description**

`current`	*pA*	picoamperes
	nA	nanoamperes
	uA	microamperes
	mA	milliamperes
	A	amperes

Power has a cyclic field for choosing how to show power.

t_unitName	**t_scaleFactor**	**Description**
`power`	*uW*	microwatts
	mW	milliwatts
	W	watts

SKILL Function

You can use the following Cadence SKILL language commands to set scale factors.

```
cdfGetUnitScaleFactor( t_unitName) => t_scaleFactor
cdfSetUnitScaleFactor( t_unitName t_scaleFactor) => t / nil
```

For example, to set lengthMetric to m (millimeters), use the following command:

```
cdfSetUnitScaleFactor("lengthMetric" "m")
```

You can use abbreviations listed earlier instead of specifying the complete scale factor. For example, to change the scale factor for resistance to *MOhms*, enter:

```
cdfSetUnitScaleFactor("resistance" "M")
```

To display the current scale factor for *power*, enter:

```
cdfGetUnitScaleFactor("power")
```

The system returns the present value, such as *auto.*

You can also set the *t_scaleFactor* to *auto* or *none* using the `cdfGetUnitScaleFactor` SKILL command. In SKILL expressions only, you can use the following ISO1000 standard units in scale factors.

Symbol	Name	Factor
Y	yotta	10^{24}
Z	zetta	10^{21}
E	exa	10^{18}
P	peta	10^{15}
T	tera	10^{12}
h	hecto	10^{2}
da	deca	10
d	deci	10^{-1}
centi	c	10^{-2}
a	atto	10^{-18}
z	zepto	10^{-21}
y	yocto	10^{-24}

To display the Units Scaling Factors form and edit the scale factors, use the SKILL function `cdfEditScaleFactors`.

SKILL CDF Functions

You can use SKILL functions to create, view, or modify CDF information. *CDF Functions* in *Virtuoso ADE SKILL Reference* describes the SKILL functions you can use to do the same data entry operations you perform with the Edit CDF form.

To create, view, or modify CDF information by using SKILL functions, follow these steps:

1. Write or "dump" any existing CDF (base) into files by using the `cdfDump` function.

   ```
   cdfDump(
   "libName"
   filename
   ?cellName "cellName"
   ?level {’base | ’user}
   ?edit g_edit
   )
   ```

   Consider the following examples.

   Example 1:

   ```
   cdfDump("analogLib" "edtmp" ?cellName "nfet" ?level ’base ?edit t)
   ```

   Example 2:

   ```
   cdfDump("myLib" "/home/me/nmos.new.cdf" ?cellName "nmos" ?level 'base ?edit
   nil)
   ```

   If you specify the *`libName`* only, *`cdfDump`* writes only the library CDF data to the file specified in *`filename`*. The other arguments are optional. You must always specify a *`libName`* and a *`filename`*.

   The `?cellName` argument dumps the CDF description from that cell.

   With the `?level` argument, you can choose base- or user-level CDF. The default is `base`.

   The `?edit` option lets you automatically load the dump file into a temporary editor window. The default is `nil`.

   You can specify a text editor by adding a line to your `.cdsinit` file. The following example uses the `vi` editor.

   ```
   editor = "xterm -g 80x35+30+30 -e vi"
   ```

2. Modify the CDF file to add any missing parameters or update any existing parameters.

3. In the Command Interpreter Window (CIW), load the updated CDF file by using the `load` SKILL function.

   ```
   load("filename")
   ```

   Example 1:

```
load("edtmp")
```

Example 2:

```
load("nmos.new.cdf")
```

Note: You will be able to reload the CDF description if you have write permissions for a cell. If you want to change the CDF description of a component but do not have the appropriate permissions, you can copy the cell to one of your own libraries. Copying a cell to a new cell also copies its CDF description, which you can then edit. Alternatively, you can change the user-level CDF description.

To create a CDF description for a new cell, you can first dump the CDF description from a similar cell, change the cell or library name, then load the file as described in this section. If the library and cell you specified exist, a new CDF description is created.

If you have the *skillDev* software, you can get a list of all the available CDF functions by typing the following command in the CIW:

```
listFunctions("cdf")
```

Saving User-Level CDF Information

User-level CDF information is not written to your system disk. When you exit the Cadence software, all user-level CDF information that you have not specifically saved is lost. If you want to save your user-level data, you must write it to a file.

If you are using the Edit CDF form in the Cadence Analog Design Environment, you can save any CDF description that you are working on with the *File Name* field and its associated buttons.

In the *File Name* field, enter the name of the file where you want to save the CDF data, and click *Save*.

1. To retrieve this CDF information, open the Edit CDF form again.
2. Select the name of the library, cell, and CDF Layer (User).
3. Type the filename in the *File Name* field, and click *Load*.

Using SKILL

If you are using SKILL, use `cdfDump` to save the user-level CDF data and `load` to restore it.

1. Type the following SKILL command:

```
cdfDump("lib_name" "filename" ?cellName "cell_name"
    ?level 'user ?edit t)
```

An editor window appears, showing the file specified in `filename`.

2. Save the contents of this new file.
3. To restore the user-level CDF data, type

```
load("filename")
```

The `load` command reads the information in the file to determine which library, cell, and level of CDF description to access. It then executes the SKILL functions contained in the file, replacing the saved user-level data in the correct library and cell.

Complex Pole Example

To look at the CDF information for this component, you need the functional library, which is in the following location:

```
<your_install_dir>/etc/cdslib/artist/functional
```

Make sure that your `cds.lib` file includes the definition of this library.

Using the Edit CDF Form

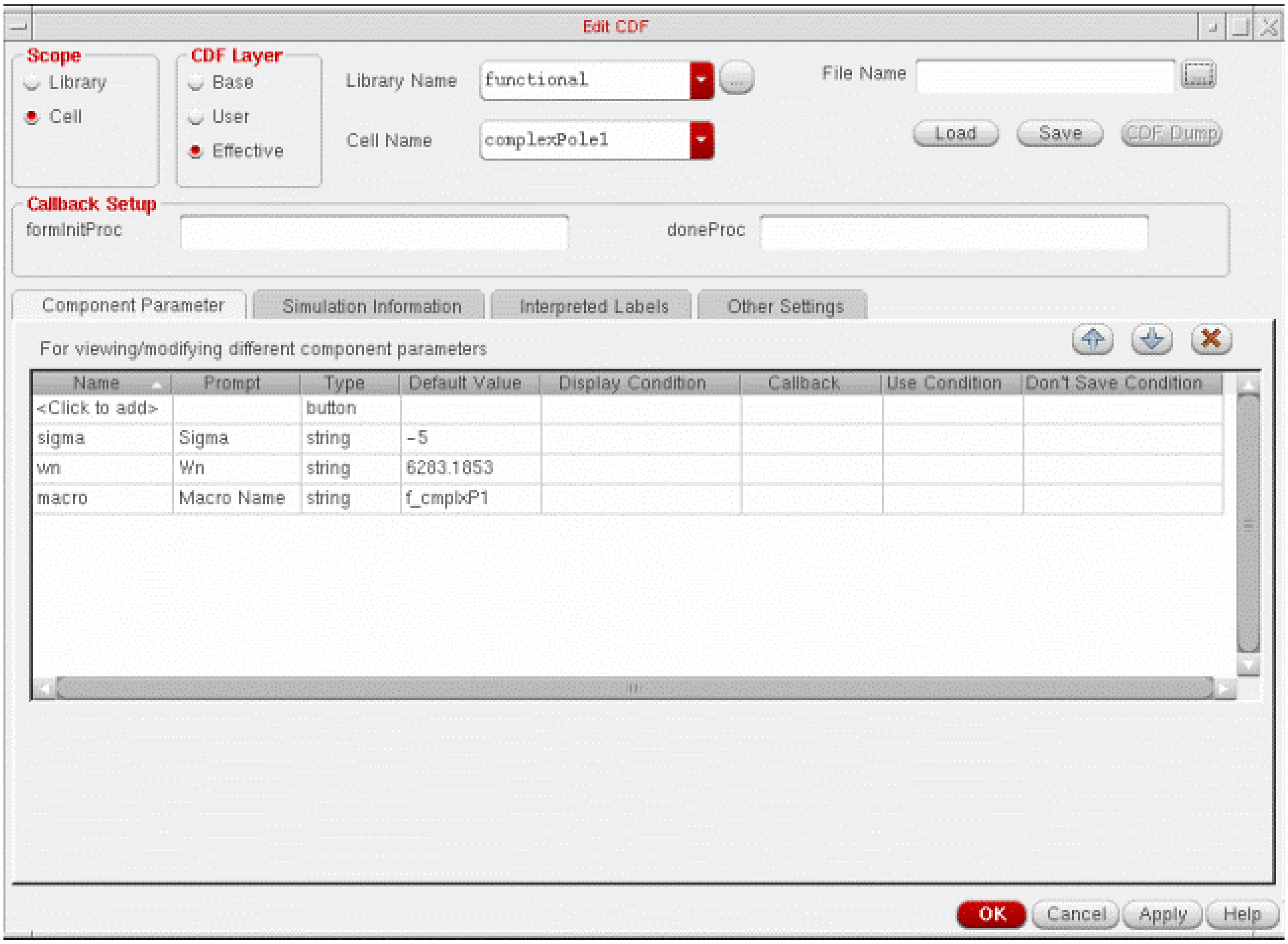
Follow these steps to edit the CDF of the `complexPole1` cell in the functional block library:

1. From the CIW menu banner, choose *Tools – CDF – Edit*.

   The Edit CDF form appears.

2. In the *Scope* group box, select *Cell*.
3. In the *Library Name* cyclic field, select the library *functional*.
4. In the *Cell Name* cyclic field, select the cell *complexPole1*.

   The CDF description for the *complexPole1* component appears in the form.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: functional

Cell Name: complexPole1

File Name:

Callback Setup: formInitProc: doneProc:

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition
<Click to add>		button					
sigma	Sigma	string	-5				
wn	Wn	string	6283.1853				
macro	Macro Name	string	f_cmplxP1				

You should see a header and four tabs, each with information specific to the complex pole cell.

Using the header, you can save the current CDF descriptions to a named file or load another CDF description onto the named cell from a file. This is useful if you want to see the results of changing certain CDF properties. You can store the alternatives in different files and load them as required. You can also save the CDF data from one cell and then load (transfer) it onto another cell.

At the end of Chapter 3, "Defining Parameters," you examine the Component Parameter tab in detail.

NFET Example

In the complex pole example, you examine an existing CDF description. In the NFET example, you create a new cell and a new CDF description.

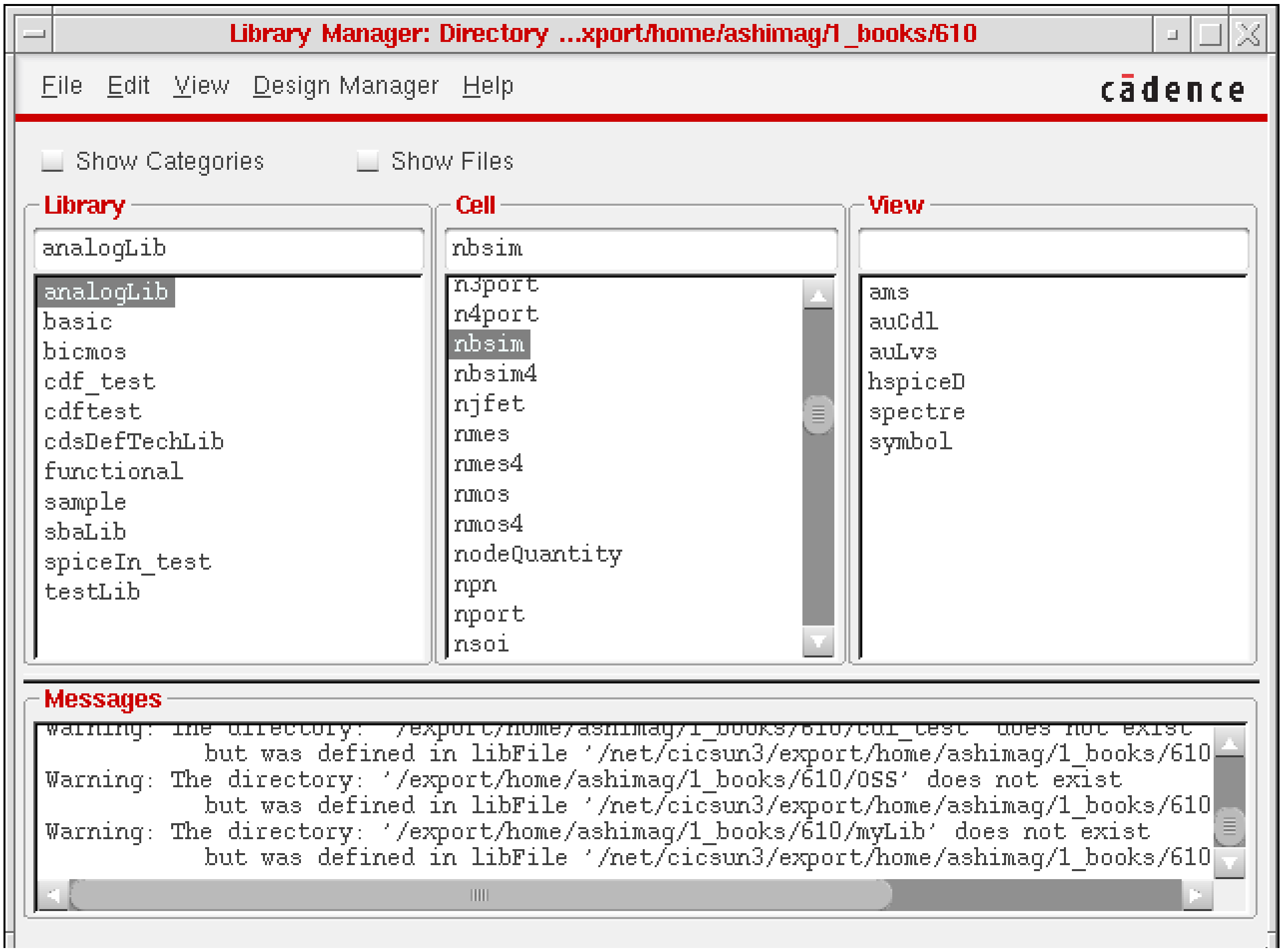
Using the Edit CDF Form

When you copy a cell to another cell, all views and the CDF descriptions are copied if the destination cell did not previously exist. Copy the *nbsim* component from the analog library to create the basis for the new *nfet* component. You can then edit settings for parameters, simulation, labels, and other information in the CDF description of the *nfet* component.

1. Create a library called *bicmos*.

   Make sure that you include this library in your `cds.lib` file.

2. In the CIW, open the Library Manager by choosing *Tools – Library Manager*.
3. Select *analogLib* to display its components (cells).
4. Scroll down the cell list and select *nbsim*.

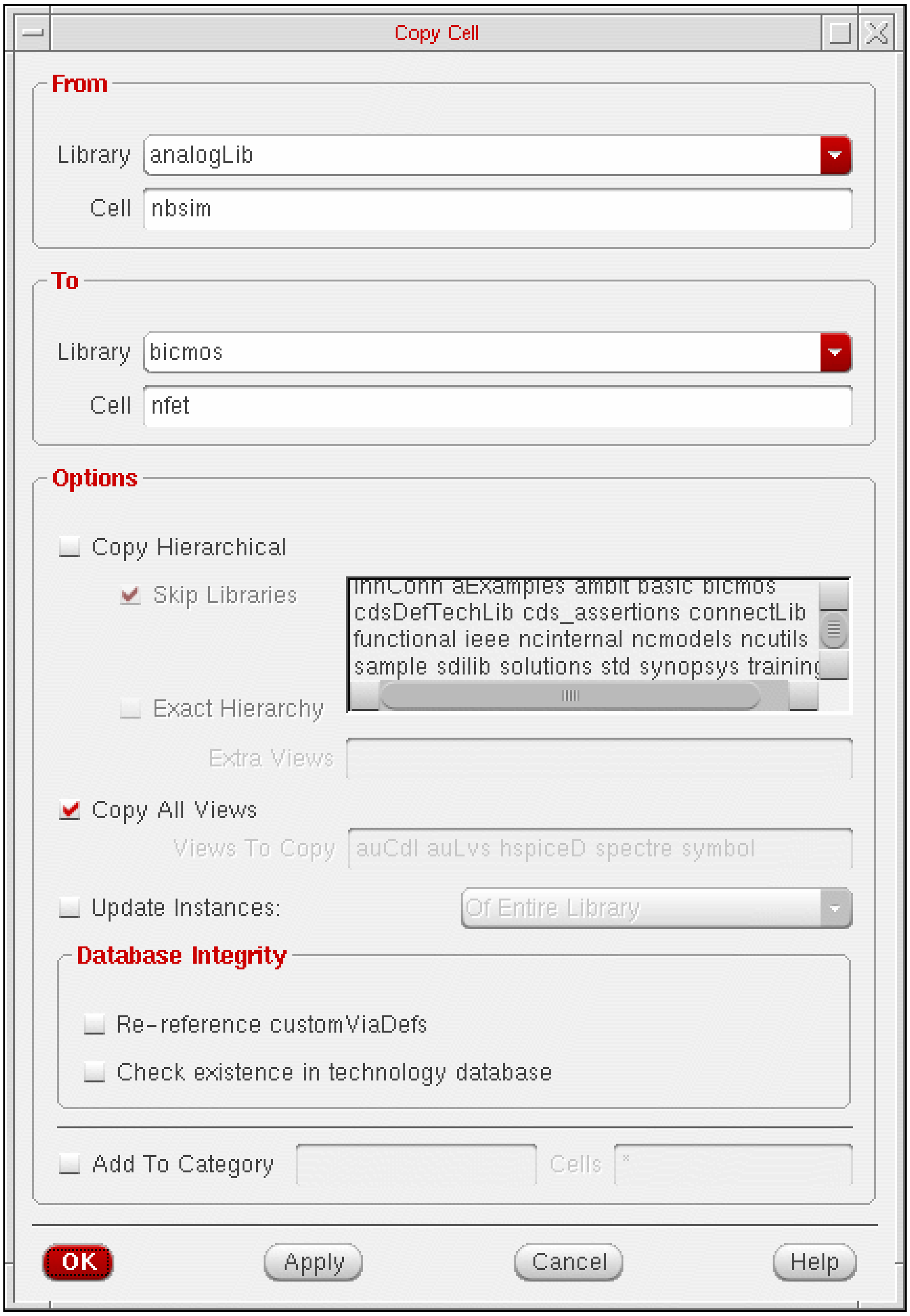


Library: analogLib

Cell: nbsim

```
Warning: The directory: '/export/home/ashimag/1_books/610/cdf_test' does not exist
            but was defined in libFile '/net/cicsun3/export/home/ashimag/1_books/610
Warning: The directory: '/export/home/ashimag/1_books/610/OSS' does not exist
            but was defined in libFile '/net/cicsun3/export/home/ashimag/1_books/610
Warning: The directory: '/export/home/ashimag/1_books/610/myLib' does not exist
            but was defined in libFile '/net/cicsun3/export/home/ashimag/1_books/610
```

5. Choose *Edit – Copy* and select *bicmos* from the *To* library cyclic field and specify the target cell as *nfet*.



Copy Cell

From

Library: analogLib

Cell: nbsim

To

Library: bicmos

Cell: nfet

Options

☐ Copy Hierarchical

☑ Skip Libraries: innConn aExamples ambit basic bicmos cdsDefTechLib cds_assertions connectLib functional ieee ncinternal ncmodels ncutils sample sdilib solutions std synopsys trainin

☐ Exact Hierarchy

Extra Views

☑ Copy All Views

Views To Copy: auCdl auLvs hspiceD spectre symbol

☐ Update Instances: Of Entire Library

Database Integrity

☐ Re-reference customViaDefs

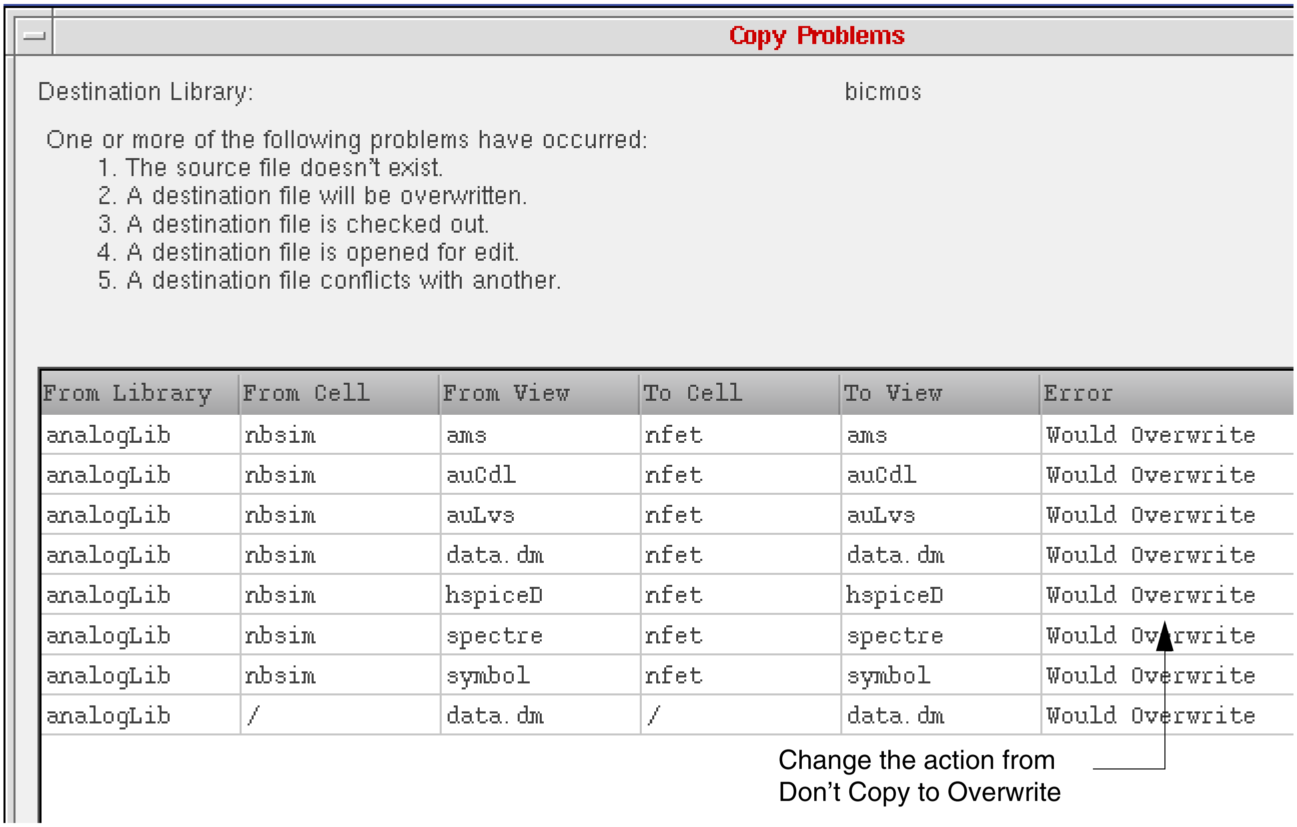
☐ Check existence in technology database

☐ Add To Category

Cells: *

6. Click *OK* to make a copy of *nbsim* in the *bicmos* library under the cell name of *nfet*.

7. In the *Copy Problems* dialog box change the *Don't Copy* action to *Overwrite* from the Action cyclic field for each view type.



Destination Library: bicmos

One or more of the following problems have occurred:
1. The source file doesn't exist.
2. A destination file will be overwritten.
3. A destination file is checked out.
4. A destination file is opened for edit.
5. A destination file conflicts with another.

From Library	From Cell	From View	To Cell	To View	Error
analogLib	nbsim	ams	nfet	ams	Would Overwrite
analogLib	nbsim	auCdl	nfet	auCdl	Would Overwrite
analogLib	nbsim	auLvs	nfet	auLvs	Would Overwrite
analogLib	nbsim	data.dm	nfet	data.dm	Would Overwrite
analogLib	nbsim	hspiceD	nfet	hspiceD	Would Overwrite
analogLib	nbsim	spectre	nfet	spectre	Would Overwrite
analogLib	nbsim	symbol	nfet	symbol	Would Overwrite
analogLib	/	data.dm	/	data.dm	Would Overwrite

Change the action from Don't Copy to Overwrite

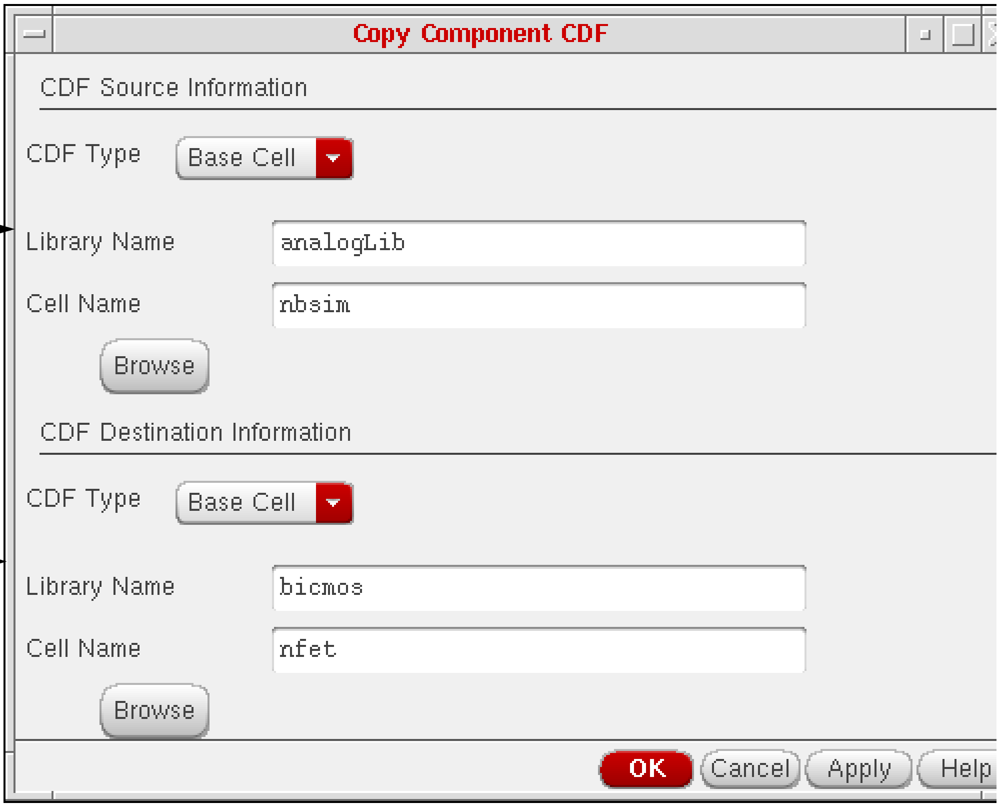
8. Alternatively from the CIW, choose *Tools – CDF – Copy*.

   The Copy Component CDF form opens.

9. Type the *analogLib* library and the *nbsim* cell in the CDF Source Information section.

10. Type the name of your destination library (*bicmos*) and the cell name (*nfet*) in the CDF Destination Information section.

Press the *Tab* key at the end of each entry.



The source cell is entered automatically when browsing

Enter the name and library of the destination cell.

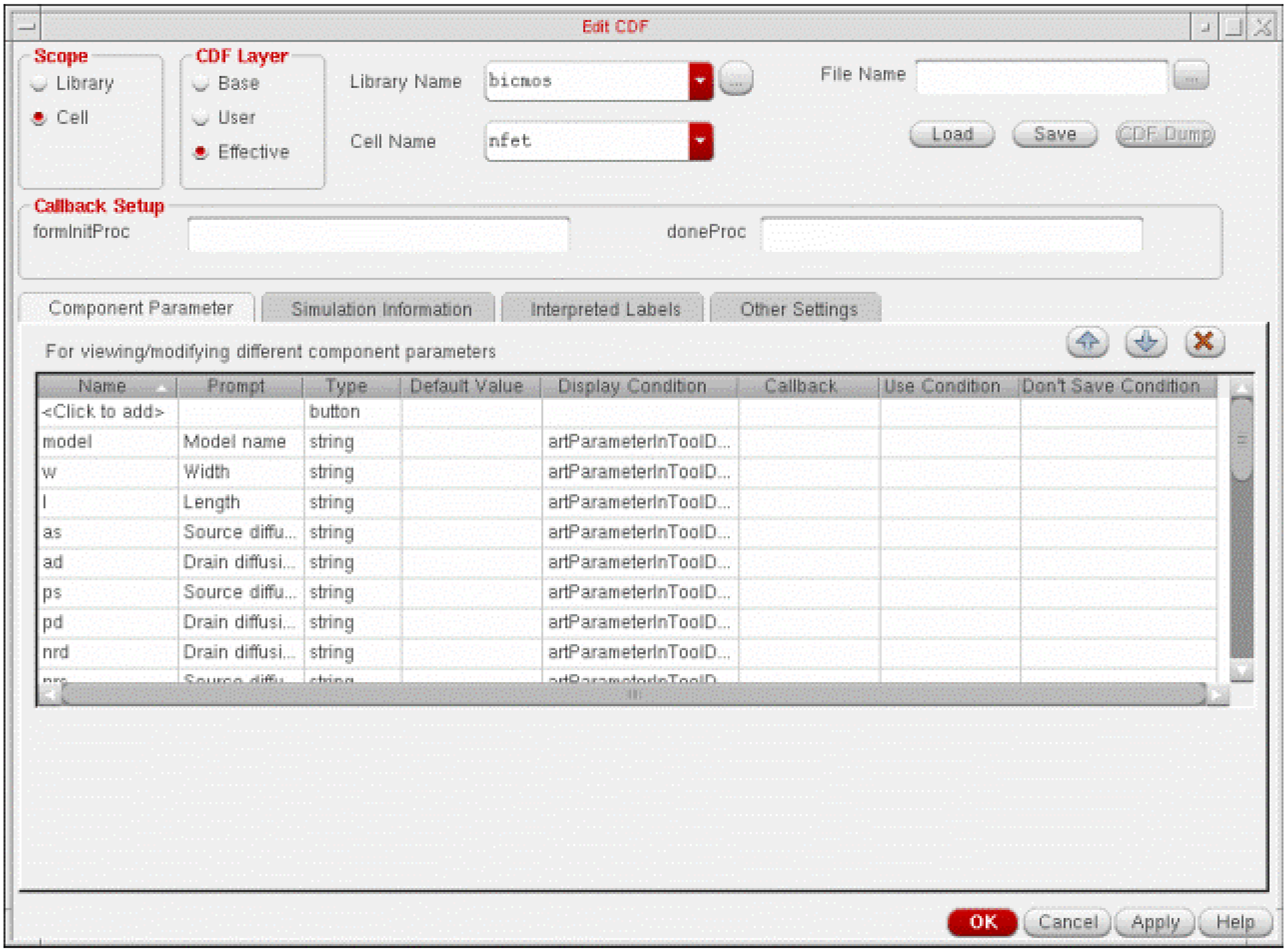
CDF Type: Base Cell
Library Name: analogLib
Cell Name: nbsim

CDF Type: Base Cell
Library Name: bicmos
Cell Name: nfet

11. Click *Apply*.

You can look at the CDF description of *nfet* using the Edit CDF form, as you did in the complex pole example in this chapter.

➤ From the CIW, choose *Tools – CDF – Edit*.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: bicmos

Cell Name: nfet

File Name:

Callback Setup

formInitProc:

doneProc:

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition
<Click to add>		button					
model	Model name	string		artParameterInToolD...			
w	Width	string		artParameterInToolD...			
l	Length	string		artParameterInToolD...			
as	Source diffu...	string		artParameterInToolD...			
ad	Drain diffusi...	string		artParameterInToolD...			
ps	Source diffu...	string		artParameterInToolD...			
pd	Drain diffusi...	string		artParameterInToolD...			
nrd	Drain diffusi...	string		artParameterInToolD...			
nrs	Source diffu...	string		artParameterInToolD...			

In Chapter 3, "Defining Parameters," you will change some of the parameter attributes to make *nfet* a different part from *nbsim*.

Using SKILL

The following SKILL function copies the base-level CDF description of *nbsim* in *analogLib* to *nfet* in *bicmos*.

```
cdfCopyCDF( dest_cell "baseCellData" srcCDF )
```

This is possible only after you have performed these assignments, in order:

```
    source_cell = ddGetObj( "analogLib" "nbsim" )
    srcCDF = cdfGetBaseCellCDF( source_cell )
    dest_cell = ddGetObj( "bicmos" "nfet" )
    if( destCDF = cdfGetBaseCellCDF(dest_cell) then
        cdfDeleteCDF( destCDF )
    )
```

If the *`destCDF`* already has a CDF description of the specified type, a warning message will be displayed in the CIW indicating that the Base/User CDF already exists. In this case, the CDF copy function will not be performed.

Refer to Appendix D, "NBSIM Transistor CDF SKILL Description," for an example of the SKILL CDF description of the *nbsim* cell.

3

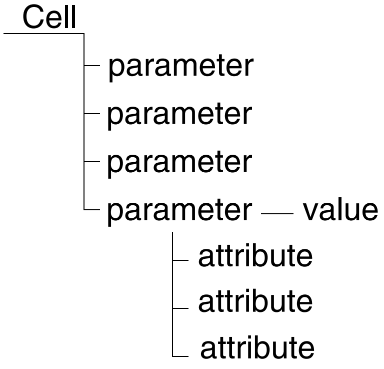
Defining Parameters

Overview

This chapter describes how to create cell parameters and set parameter attributes.

Each cell has a set of one or more parameters that describe the function of the cell. At any one time, a parameter has one value and a set of attributes. Unlike the value, attributes impose features and limitations on the parameters themselves, independent of their values. For example, the Boolean attribute means that a parameter can have only one of two values. A float attribute requires that the value of the parameter be a floating-point number.

Another attribute can determine whether the parameter value is displayed on a form or in the schematic.



The parameters section of a Component Description Format (CDF) describes what parameters the component has, and the attributes of a component's parameters. You can describe the value of a parameter using long expressions based on the Analog Expression Language (AEL). These expressions can include mathematical operations and functions that call the value of other parameters. Attribute values are limited to specific values.

When a cell is instantiated into a design, the parameters of that cell become properties.

The difference between a parameter and a property is the following:

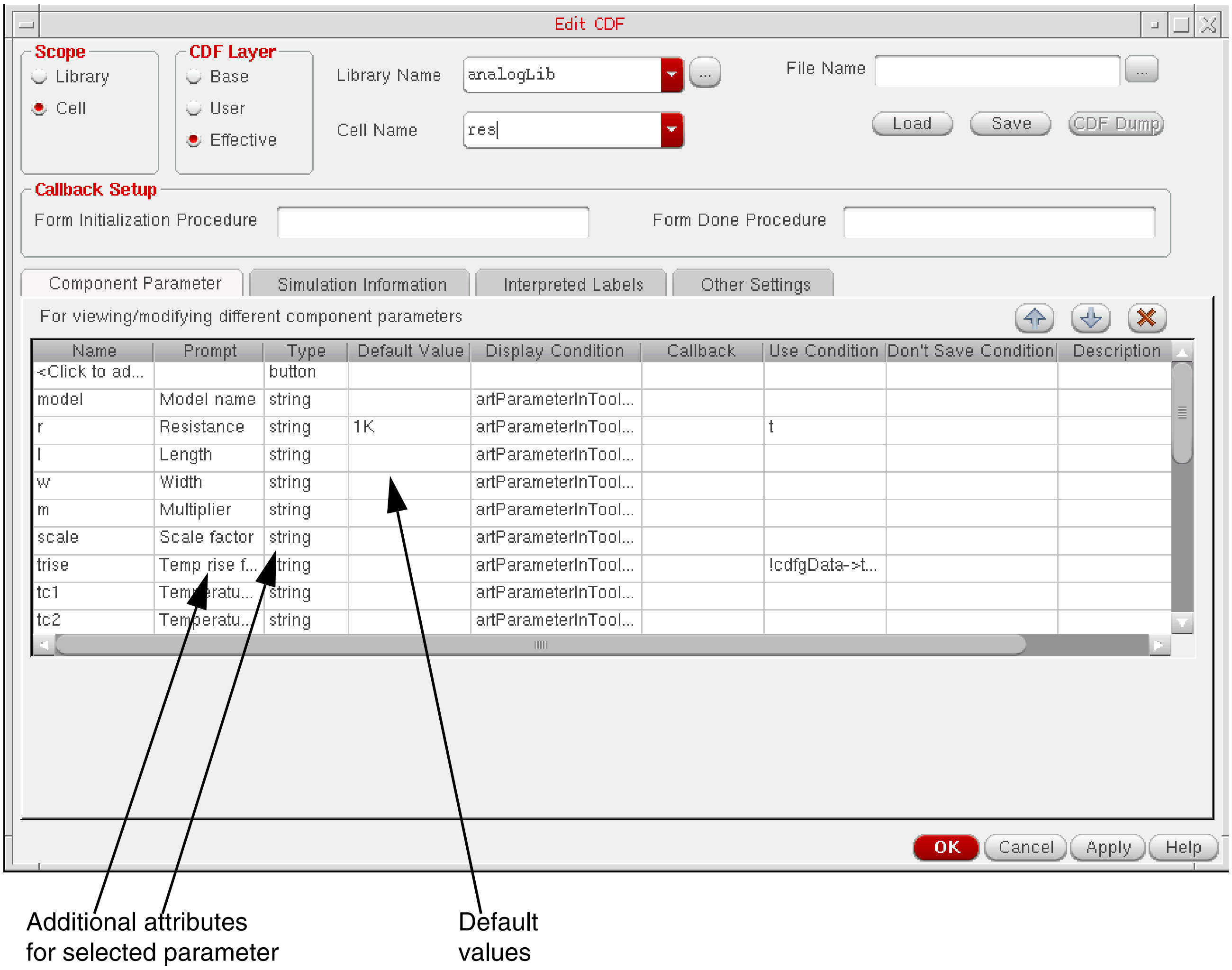
- A parameter is a characteristic of a component that has special meaning to the component. Different instances of the same component do not always use the same parameters and almost never use the same values for their parameters.
- A property is how a component parameter is viewed by the Cadence® database when it deals with each instance.

You can set up a hierarchy of CDF descriptions, one overriding the other, because you might want to override specific attributes of some parameters. For example, if you define the *xyz* parameter on a base-level CDF, you can define the same *xyz* parameter on the corresponding user-level CDF. Because the user-level description overlays the base-level description, the user-level attributes override the base-level attributes. However, certain parameter attributes, such as the parameter name, cannot be overridden.

Note: Because user-level CDF is specific to a user and not a library or cell, simulation results can be different for different users. The use of user-level CDF is therefore discouraged.

Component Parameters

The Component Parameter tab of the Edit CDF form lists all of the parameters defined for the selected CDF description. (Refer to Chapter 2, "CDF Commands," to learn how to select libraries and cells.) Use the scroll bar on the right side of the tab to view more parameters.



Scope
○ Library
● Cell

CDF Layer
○ Base
○ User
● Effective

Library Name analogLib

Cell Name res

File Name

Callback Setup

Form Initialization Procedure

Form Done Procedure

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition	Description
<Click to ad...		button						
model	Model name	string		artParameterInTool...				
r	Resistance	string	1K	artParameterInTool...		t		
l	Length	string		artParameterInTool...				
w	Width	string		artParameterInTool...				
m	Multiplier	string		artParameterInTool...				
scale	Scale factor	string		artParameterInTool...				
trise	Temp rise f...	string		artParameterInTool...		!cdfgData->t...		
tc1	Temperatu...	string		artParameterInTool...				
tc2	Temperatu...	string		artParameterInTool...				

Additional attributes
for selected parameter

Default
values

The parameter information is displayed in the columns described in Columns in the Component Parameter Tab . When you select a parameter, additional attributes can be specified for the parameter in the fields that appear in the bottom part of the Component Parameter tab. These fields are described in Fields in the Component Parameter Tab.

The buttons on the top right of the Component Parameter tab allow you to move the selected parameter relative to other parameters, or delete the selected parameter. Alternatively, you can also change the sequence of existing parameters by using the right mouse button. These buttons (and the alternate method to use the right mouse button) are described in Table 3-1 on page 59.

Columns in the Component Parameter Tab

The following columns are displayed in the table displayed in the Component Parameter tab:

Column	Description
Name	Displays the parameter name. All parameters must have a name defined, and parameter names cannot begin with a number. Sometimes this name is dictated by the application that uses the parameter. To add a new parameter double-click where it says *<click to add>*, type the parameter name, then press *Enter*. You can also insert a new parameter below an existing parameter. To insert a new parameter, right-click and choose *Insert Below*.
Prompt	Displays the prompt for the parameter. It is useful if you become familiar with parameters from their details in other forms that use the prompt rather than the name.
Type	Displays the data type of the parameter. You need to specify data type for every parameter. Valid data types are *string*, *int* (integer), *float* (floating-point number), *radio* (radio button), *cyclic* (cyclic field), *boolean, button*, and *netSet*.

Column	Description
Default Value	Displays the default value specified for the parameter. **Note:** You cannot enter or modify the default values displayed in this column. To specify the default value for a parameter, select the parameter and enter the default value in the *Default Value* field that appears in the bottom part of the Component Parameter tab. ADE netlister supports CDF Parameters with values in binary, hexadecimal, octal, and decimal formats. The syntax to specify the value is as follows: `size'<base> <number>` where: `<>` contains the optional part `size` specifies the number of binary bits the number is comprised of `'` is a separator (single quote). `<base>` specifies the base, which can be one of the following: ❑ `’b` or `’B` – binary. For example, `2'b10` ❑ `’o` or `’O` – octal. For example, `7'O34` ❑ `’h` or `’H` – hexadecimal. For example, `8'hF` ❑ `’d` or `’D` – decimal. For example, `5'd11` **Note:** To evaluate a number in these formats, set the *Parse as CEL* and *Parse as Number* fields to *Yes*.
Display Condition	Determines if this parameter is displayed in forms that display CDF parameters, such as the Edit Object Properties form or the Add Instance form. You must enter *t*, *nil*, or a SKILL expression that evaluates to *t* or *nil* in this field to determine if this parameter is to be displayed. If the field evaluates to non-*nil* (the default), the parameter is displayed. If the field evaluates to *nil*, the parameter is not displayed.

Column	Description
Callback	Specifies a SKILL routine to be executed *whenever the value of the parameter changes*. The value of this optional field must be a string. Your entry can be the entire function to be executed or a call to a function that is defined elsewhere. If you do not enter anything in this field, the system assumes that there is no callback. The CDF parameter callback is primarily a GUI based callback. GUI based callbacks occur when you modify the values in the parameter form fields. A GUI based callback is active when the CDF parameters are displayed in the Add Instance form or the Edit Object Properties form when you use the Create Instance or Edit Properties commands. For more information on callbacks, refer to Chapter 7, "Writing Callbacks."
Use Condition	Determines if the parameter is to be used. Often, you can enter Cadence SKILL language expression that evaluates to *t* or *nil* in this field to determine if this parameter is applicable. When the field evaluates to *nil*, the system never displays the parameter. When it evaluates to non-*nil* (the default), then based on the value of **Display Condition**, the system will display the parameter.
Don't Save Condition	Determines if the parameter value is to be saved on the instance. This attribute is for programming use only. Typically, you should set this field to *nil* and not use it. If the field evaluates to *nil* (the default), the parameter value is saved as a property on the instance. If the field evaluates to non-*nil*, the parameter value is not saved as a property on the instance. *Caution* ***The Don't Save Condition attribute overrides the Store Default setting. If Store Default is yes and Don't Save Condition is yes, not even the default property is saved.***
Description	Allows you to specify a tooltip or description for each parameter. The text specified as description will be displayed on Edit Object Properties, Create Instance form and Property Editor assistants.

The following fields are displayed in the bottom part of the Component Parameter tab when you select a parameter in the Component Parameter tab. The display of these fields depend on the data type of the parameter. For more information, see Attributes and Parameter Types on page 59.

Fields in the Component Parameter Tab

The following columns are displayed in the table displayed in the *Component Parameter* tab:

Field	Description
Default Value	Specifies the default value for the selected parameter. Most parameters must have a default defined. The default value depends on the data type for this parameter. Parameter values can be long mathematical expressions with variables and functions of other parameters. **Note:** A default value is mandatory for parameters of type `int`, `float`, `radio`, `cyclic` and `netset`. If you do not specify a default value for parameters of these types, an error message in the CIW displays the list of parameters for which a default value is not specified, and these parameters are not saved in the CDF if you click *OK* or *Apply* in the Edit CDF form. If you do not want the Edit CDF form to be closed without saving these parameters in the CDF, set the `cdfAllowOKApplyPopups=t` environment variable in your `.cdsenv` file or `.cdsinit` file, or enter `cdfAllowOKApplyPopups=t` in the CIW. If this environment variable is set, a popup message displays the list of parameters for which a default value is not specified, and you cannot close the Edit CDF form until you specify a default value for these parameters.

Field	Description
Store Default	Specifies whether to store the default value of a parameter as a parameter attribute on the instance. All tools based on the Cadence Virtuoso Analog Design software use the CDF description to find default values if there is no property on an instance. If set to *no*, then the default value that you set for a parameter is not preserved. In such a case, if you modify the default value of a parameter, then the change is reflected in all existing instances as well as new instances of a component. When the default value of the CDF parameter changes, all the instances including the ones already instantiated, are updated with the new default value of the CDF parameter. To see the change in an open window you must choose *Window – Redraw* from the Cadence menu. If set to *yes,* then a parameter attribute that stores the default value of the parameter is added on the instance. Later if the default value for the parameter is modified, then those instances that are already instantiated, retain the old default value of the parameter. Only new instantiations have the new default value of the parameter. One disadvantage of setting this attribute to *yes* is that if the default value of a parameter changes, the existing instances that use the default value do not automatically change to the new default value. That is, they retain the old default value. By default, *Store Default* is set to *no*.

Field	Description
Evaluation Mode	Evaluates the specified parameter using pre-defined combinations of *Parse As CEL* and *Parse As Number*. Here, *Parse As CEL* evaluates the parameter using the CDF Expression Language (CEL) or Analog Expression Language (AEL) evaluator, whereas *Parse As Number* evaluates the specified parameter to a floating-point number. The available evaluation modes are: ■ Literal: This mode sets the following values: *Parse As Number*=`no`, *Parse As CEL*=`no` It performs no evaluation on the parameter values. The *Units* field is disabled in this case. If *Units* is already specified, the value is highlighted to indicate an invalid setting. ■ Number: This mode sets the following values: *Parse As Number*=`yes`, *Parse As CEL*=`no` It converts a string parameter to a numeric value. ■ Inset: This mode sets the following values: *Parse As Number*=`no`, *Parse As CEL*=`yes` It evaluates `iPar` and `pPar` (CEL expression). ■ Expression: This mode sets the following values: *Parse As Number*=`yes`, *Parse As CEL*=`yes` It performs complete evaluation with the specified units.
Editable Condition	Determines if this parameter can be edited in forms that display CDF parameters, such as the Edit Object Properties form or the Add Instance form. Often, you can enter a SKILL expression that evaluates to *t* or *nil* in this field to determine if the parameter is editable. If the field evaluates to non-*nil* (the default), the parameter is editable. If the field evaluates to *nil*, the parameter is not editable. (If not editable, the parameter is dimmed so that you can see the value but you cannot edit it.) This field is valid only for *string*, *int*, and *float* data types.

Field	Description
Units	Determines the unit suffix and scale factor to use when displaying the parameter value. Use this attribute only with *string* type parameters where the response to *Parse as Number* is *yes*. (This specification has no effect if you set it for other parameter types.) The units attribute must be one of the following: resistance, capacitance, inductance, conductance, time, frequency, power, powerDB, lengthMetric, lengthEnglish, angle, voltage, current, or temperature.
Choices	The space- or comma- separated list of selections for a *cyclic* or *radio* data type. This attribute does not apply to other types of parameters. How to specify choices depends on two cases: ■ If each choice is a single word, you can separate the choices with spaces. ■ If any choice is a group of words, you must separate each choice with a comma (,). (When using commas, do not leave extra spaces between choices because these spaces become part of the choice value.) A typical entry in the form field might be `choice 1,choice 2,choice 3` Notice that there is no blank between the number 1 and the comma, or between the comma and the *c* in *choice*. **Note:** The *Choices* field is mandatory for parameters of type `radio` and `cyclic`. If you do not specify the choices for parameters of these types, an error message in the CIW displays the list of parameters for which the choices are not specified, and these parameters are not saved in the CDF if you click *OK* or *Apply* in the Edit CDF form. If you do not want the Edit CDF form to be closed without saving these parameters in the CDF, set the `cdfAllowOKApplyPopups=t` environment variable in your `.cdsenv` file or `.cdsinit` file, or enter `cdfAllowOKApplyPopups=t` in the CIW. If this environment variable is set, a popup message displays the list of parameters for which the choices are not specified, and you cannot close the Edit CDF form until you specify the choices for these parameters.

Table 3-1 Buttons in the Component Parameter Tab

Button	Description
⇧	**Move Up** lets you change the sequence of existing parameters. You can move a parameter relative to other parameters in the Component Parameters section of the Edit CDF form. Commands that use CDF data display CDF parameters in the same order as the Component Parameter tab. To avoid unnecessary scrolling, place frequently used parameters at the top. To move a parameter up in the existing sequence of parameters by using the right mouse button, right-click and choose *Move Up*.
⇩	**Move Down** lets you change the sequence of existing parameters. You can move a parameter relative to other parameters in the Component Parameters section of the Edit CDF form. To move a parameter down in the existing sequence of parameters by using the right mouse button, right-click and choose *Move Down*.
✖	**Delete** lets you delete the selected parameter from the CDF. The only way you can undo a deletion is to cancel all of your edits. To delete a parameter by using the right mouse button, right-click and choose *Delete*.

Note: The CDF description does not change until you click *Apply* or *OK* on the Edit CDF form.

Attributes and Parameter Types

Certain attributes are meaningful for some parameter types but not for others. For example, the *editable* attribute is meaningful for *string*, *integer*, and *float* types, but not for *radio*.

The following table shows the attributes that are required (req), optional (opt), and unused for each data type. The *use* attribute is for programming use only (prog). You should set the *dontSave* attribute to the default value *nil* for all parameter types.

Attribute in UI[1]	Attribute in SKILL[2]	String	Integer	Float	Radio	Cyclic	Boolean	Button
Type	paramType	req	req	req	req	req	req	req

Attribute in UI[1]	Attribute in SKILL[2]	String	Integer	Float	Radio	Cyclic	Boolean	Button
Parse as number	parseAsNumber	opt	unused	unused	unused	unused	unused	unused
Units	units	opt	unused	unused	unused	unused	unused	unused
Parse as CEL	parseAsCEL	opt	unused	unused	opt	opt	unused	unused
Store Default	storeDefault	opt	opt	opt	opt	opt	opt	unused
Name	name	req	req	req	req	req	req	req
Prompt	prompt	req	req	req	req	req	req	req
Choices	choices	unused	unused	unused	req	req	unused	unused
Default Value	defValue	req	req	req	req	req	req	unused
Use Condition	use	prog	prog	prog	prog	prog	prog	prog
Display Condition	display	opt	opt	opt	opt	opt	opt	opt
Don’t Save Condition	dontSave	nil	nil	nil	nil	nil	nil	nil
Editable Condition	editable	opt	opt	opt	unused	unused	unused	unused
Callback	callback	opt	opt	opt	opt	opt	opt	opt
Description	description	opt	opt	opt	opt	opt	opt	opt

[1] Attribute name displayed in the Edit CDF form.
[2] Attribute named used in SKILL.

Editing Parameters

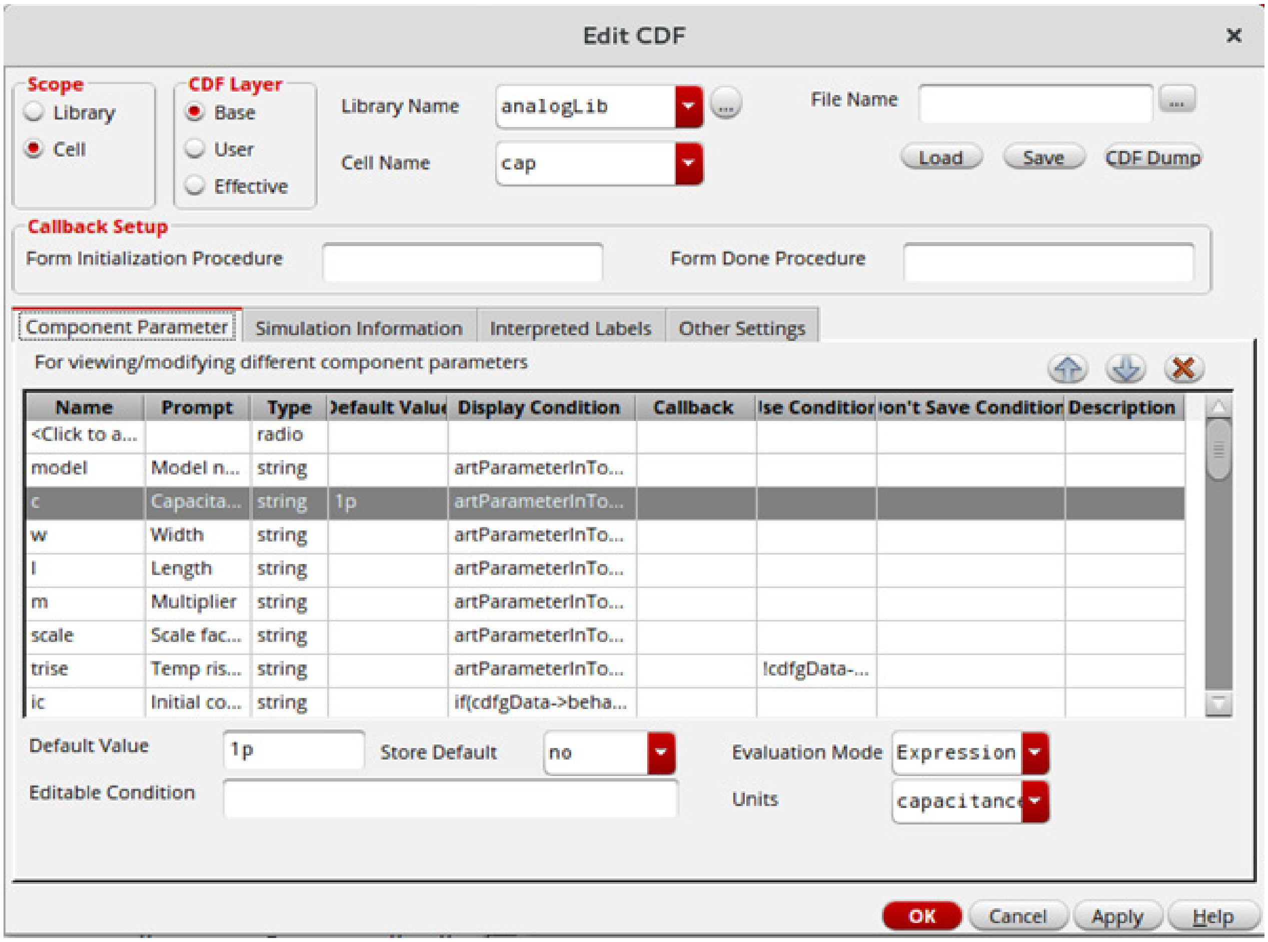
All the parameter attributes descriptions in the previous section apply whether you are using SKILL or the Edit CDF form. The following sections describe how you edit parameters using either method.

Using the Edit CDF Form

You use the Component Parameter tab in the Edit CDF form to edit parameter attributes to test variations in your design. You can also create a new parameter by editing an existing parameter and changing its name. This way, you can use some or all of the parameter attributes from the original parameter.

1. Click the Component Parameter tab in the Edit CDF form.
2. Select the parameter you want to edit.

The attributes for the parameter are displayed in the fields that appear in the Component Parameter tab.



Scope: ○ Library ● Cell

CDF Layer: ● Base ○ User ○ Effective

Library Name: analogLib

Cell Name: cap

File Name:

Callback Setup

Form Initialization Procedure:

Form Done Procedure:

For viewing/modifying different component parameters

Name	Prompt	Type	)efault Valu	Display Condition	Callback	Ise Conditior	on't Save Conditior	Description
<Click to a...		radio						
model	Model n...	string		artParameterInTo...				
c	Capacita...	string	1p	artParameterInTo...				
w	Width	string		artParameterInTo...				
l	Length	string		artParameterInTo...				
m	Multiplier	string		artParameterInTo...				
scale	Scale fac...	string		artParameterInTo...				
trise	Temp ris...	string		artParameterInTo...		!cdfgData-...		
ic	Initial co...	string		if(cdfgData->beha...				

Default Value: 1p

Store Default: no

Evaluation Mode: Expression

Editable Condition:

Units: capacitanc

3. Change the parameter attributes.
4. Click *Apply* to enter the changes.

Using SKILL

You can use SKILL functions to create and modify parameters and their attributes. For details, see *CDF SKILL Summary* in *Virtuoso ADE SKILL Reference*.

The following SKILL functions create the parameters for the sample CDF description represented here by the variable *cdfDataId*.

The first function defines the sample parameter *maskLayoutViewName*:

```
cdfParamId = cdfCreateParam(cdfDataId
?type           "cyclic"
?name           "maskLayoutViewName"
?prompt         "Type of layout"
?choices        ("layout" "layout.pwr")
?defValue       "layout"
?callback       "mosLayout( )")
```

The following functions define the sample parameter *width* with a callback from the parameter *w*:

```
cdfParamId = cdfCreateParam(cdfDataId
?type                "string"
?parseAsNumber "yes"
?units               "lengthMetric"
?parseAsCEL          "yes"
?storeDefault        "no"
?name                "w"
?prompt              "width"
?defValue            7u
?display             "artParameterInToolDisplay('w)"
?editable            "cdfgData->maskLayoutViewName->..."
?callback            "pcMOSw( )")
```

The following SKILL functions define the parameters *bend* and *bendt*:

```
cdfParamId = cdfCreateParam(cdfDataId
?type                boolean
?name                "bend"
?prompt              "PCell add bend?"
?defValue            nil
?display              nil)
```

```
cdfParamId = cdfCreateParam(cdfDataId
?type                float
?name                "bendt"
?prompt              "PCell add bend?"
?defValue            0.0
?display              nil)
```

The following SKILL function defines the sample parameter *diffD*:

```
cdfParamId = cdfCreateParam(cdfDataId
?type                boolean
?name                "diffD"
?prompt              "Drain pin diffusion only?"
?defValue            t
?display              "(cdfgData->bend->value) && ...")
```

Passing Parameters in a Design

In algebraic expressions that define the value of parameters, the *pPar*, *iPar*, *atPar,* and *dotPar* functions inherit the value of a parameter from a particular instance of the component.

- *pPar* means parent parameter, NLP (netlist processor) syntax [*+name*]
- *iPar* stands for instance parameter, NLP syntax [*~name*]
- *atPar* is named after the NLP syntax [*@name*]
- *dotPar* is named after the NLP syntax [*.name*]

The syntax of all four functions is:

```
_Par("parameter")
```

You can use these inherited parameter value functions to pass parameters in a design. If you change the value of one parameter, you also change every other parameter whose value is defined by an expression that includes a *Par* function of the parameter that you changed. Different *Par* functions can be used in the same expression.

You can define variables by expressions that use any combination of *pPar, iPar, atPar,* and *dotPar*. Those functions can reference other variables that are defined by expressions that include one of the *Par* functions. This chain can continue indefinitely. Circular references generate errors.

pPar

pPar("x") lets you reference the value of parameter *x* from the parent instance of the component.

An example of *pPar* used in a parameter definition is

```
rate = pPar("slewRate") + 100.0
```

When Analog Expression Language (AEL) evaluates this expression, it searches the parent instance for the value of `slewRate` and substitutes it into the expression. If it cannot find `slewRate` on the parent instance, AEL searches the parent cell’s effective CDF for a value for `slewRate`.

Top-level schematic instances with parameters defined by expressions using *pPar* follow a special procedure. The netlister first searches the property list of the top-level schematic for a value for the referenced parameter. If it cannot find it, it searches the top-level cell’s effective cell CDF for a default value for the parameter. This value can also be defined with an expression, but that expression can only include the *iPar* and *dotPar* functions.

iPar

iPar("x") lets you reference the value of a parameter on the current instance.

Suppose the parameter *i12* of a component is defined as a function of its input noise current, *n*:

```
i12 = V1/r12 + iPar("n")
```

The AEL evaluates this expression by searching the current instance for the value of *n*, which it substitutes into the expression. If the current instance does not have the parameter *n*, AEL uses the cell’s effective CDF value as a default value for *n*. Changing the value of *n* does not have an effect unless you change the value of *n* on this specific instance.

Caution

Use the iPar function when the value of a parameter depends on the value of another parameter on the current instance but ensure that these parameters are not dependant on each other. For example, if you use the `cap` ***symbol and specify the length as iPar("w") and width as iPar(“l”) you will get a segmentation fault error as this results in infinite recursion.***

More About iPar and pPar

iPar lets you reference a parameter of an instance in the current schematic cellview, while *pPar* lets you reference a parameter passed into the schematic.

For example, consider that the current schematic has two parameters called `param1` and `param2` and an instance `I0` on the schematic with three parameters `p1`, `p2`, and `p3`. In this case, you can use *iPar* and *pPar* as follows:

```
p1 = 23*pPar(param1)
p2 = 17
p3 = iPar(p1)+iPar(p2)+pPar(param2)
```

The above usage results in `p1` being equal to 23 times of the current parameter value of `param1` passed into the schematic. The parameter `p3` is the result of `p1` + `p2` using the current parameter values of the instance `I0`, plus the value of `param2` of the current schematic.

atPar

The use of *atPar* is discouraged. Use *pPar* instead. *atPar* searches the entire design hierarchy, looking at the parent, grandparent, and great-grandparent of the instance, and so on, until it finds the original value.

If *atPar* cannot find the parameter value anywhere in the design hierarchy, it then searches the current instance master, which is typically the simulation primitive for the device in a library. If that fails, *atPar* checks the global block for your simulator (*nlpglobals*).

dotPar

The use of *dotPar* is discouraged. It is not supported in several netlist situations.

When trying to evaluate a parameter on a primitive at the bottom level of a design hierarchy, *dotPar* behaves like *iPar*. If a property on a component or functional block higher up in the design hierarchy uses *dotPar("x")* in its definition, *dotPar* goes down to the bottom of the design hierarchy, searching for *x* on the leaf instance or primitive currently being output to the netlist.

At the top level of a design, *dotPar* searches the top-level cellview rather than the instance.

Inherited Parameters in Callbacks

Do not use callbacks based on parameters whose values are defined by expressions that include inherited parameter functions. Changes to the inherited parameters do not trigger the callbacks. Use callbacks only to establish dependencies between parameters whose values are numeric constants.

For example, in a transistor with the length parameter *L*, *L* is defined by a callback. Normally, changes in the value of the width parameter *W* trigger the *L* callback. The expression for this is

```
cdfgData -> L -> value = cdfgData -> W -> value
```

In this example, *W* is defined by the following expression:

```
W = pPar("test_width")*10u
```

If you change the value of *test_width*, the callback that defines *L* is not triggered, and the value of *L* becomes out of date.

Parameterized Cells

Although parameterized cells (Pcells) provide great design flexibility, they also have unique requirements for their CDF descriptions. These requirements include the following.

- When you define Pcell parameters in CDF, ensure that the type of each CDF parameter is consistent with parameter type specified in the Pcell.
- The default value for CDF parameters that are directly mapped to Pcell stretch parameters must be the same as the minimum value of the Pcell parameter.

  If the CDF default value is larger than the minimum Pcell stretch parameter value, when you place a Pcell with a parameter value less than the CDF default value, the Pcell shrinks to the minimum Pcell stretch value.
- In layout, Pcell*s* do not understand string variables. All variables must be floating-point numbers if you are using stretch parameters.
- In a schematic, the system places Pcell symbols according to string variables because it must understand expressions (using the Analog Expression Language). Variables are most likely to be strings to allow scaling units (nanometers, micrometers, and so on).

The second and third items might appear to conflict, but you can use one of the two methods to simultaneously support the requirements of layout and schematics.

- Create two CDF parameters. One is a string variable for the schematic instantiation of the Pcell symbol. The other is a floating -point number variable for the Pcell layout view. You must maintain both variables.
- Create a callback for the floating point parameter based on the value of the string parameter. The user enters the string value and both values are set.

Complex Pole Example

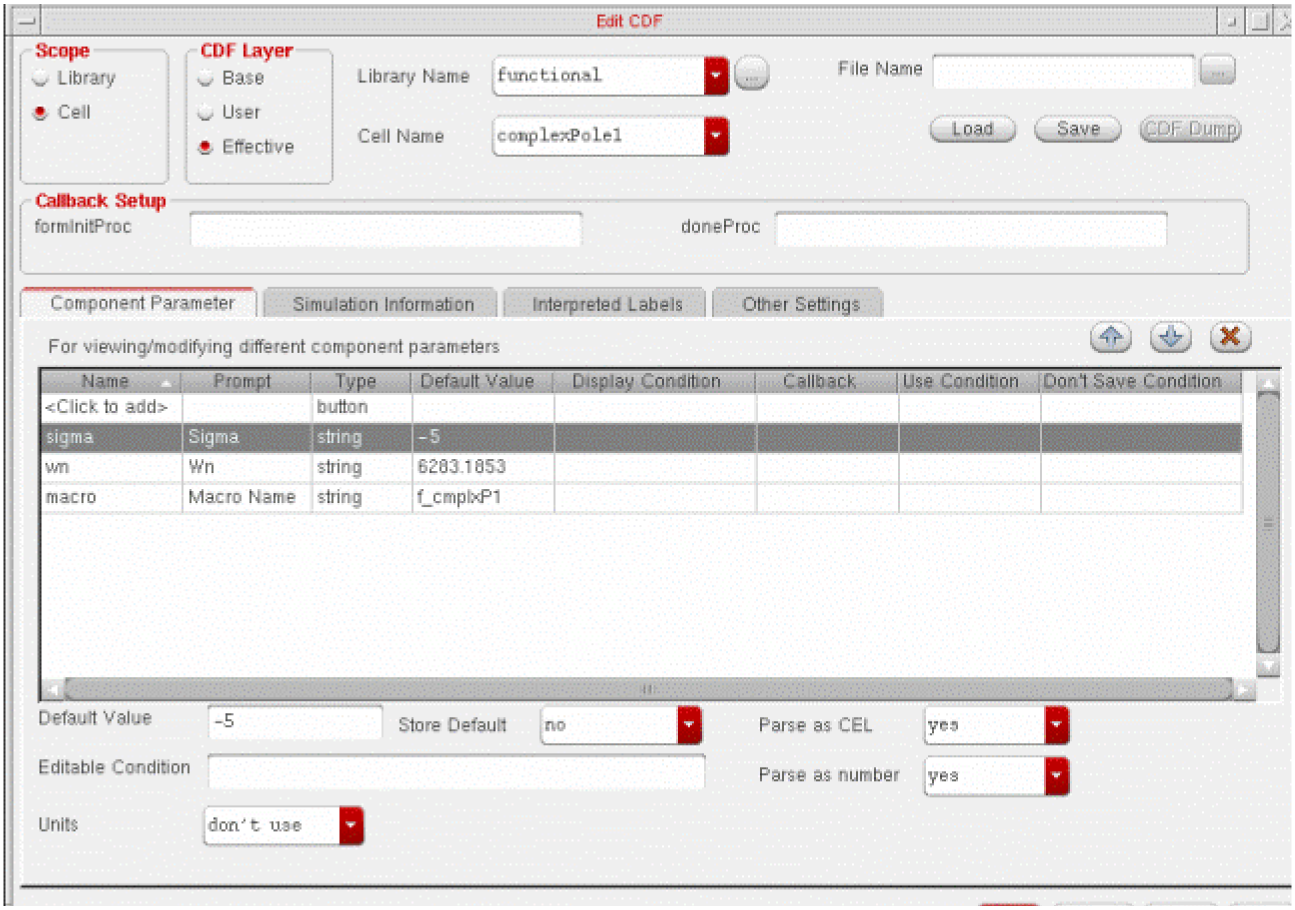
Using the same complex pole example from Chapter 2, “CDF Commands,” you should have the Edit CDF form open and selected the Component Parameter tab on the form.

The Component Parameter tab lists all component parameters. For *complexPole1,* these are *sigma*, *wn*, and *macro*.

Using the Component Parameter Tab

You can examine the different features of the Component Parameter tab using the *complexPole1* as an example.

➤ In the Component Parameter tab, select the *sigma* parameter.



Scope
○ Library
● Cell

CDF Layer
○ Base
○ User
● Effective

Library Name: functional

Cell Name: complexPole1

File Name:

Callback Setup
formInitProc:
doneProc:

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition
<Click to add>		button					
sigma	Sigma	string	-5				
wn	Wn	string	6283.1853				
macro	Macro Name	string	f_cmplxP1				

Default Value: -5
Store Default: no
Parse as CEL: yes
Editable Condition:
Parse as number: yes
Units: don't use

The attributes for the parameter are displayed in the fields that appear in the bottom part of the Component Parameter tab.

The parameter *name* is set to *sigma*. The prompt used in the Edit Object Properties and Add Instance forms is *Sigma*. When you are done, you see the parameter name *Sigma*, but the system keeps track of the parameter by its real name, *sigma*. The parameter has a *Type* equal to *string*. The default value of *sigma* is -5, so every instance of the *complexPole1* in a schematic has this value initially. The *Parse as number* and *Parse as CEL* attributes are set to *yes* (true).

The first two parameters, *sigma* and *wn*, are component specific. The third parameter, *macro*, identifies the file that contains the macro (subcircuit) definition. The default value of *macro* is the *f_cmplxP1* file. Because *macro* is a CDF parameter, you can change its value to point to another file. This lets you create your own macros and reference them from the Edit CDF form. Editing at this level changes all instances of *complexPole1*. To change *complexPole1* in a particular design, use the *Edit Properties* command in the schematic editor.

If you want to make changes to the complex pole CDF description, copy the cell to a new library for which you have write access.

The complex pole example continues at the end of the next chapter, where you examine the options available for CDF simulation information.

NFET Example

This section shows you how to use the Edit CDF form to set up parameters and their attributes for the NFET cell. You should have the Edit CDF form open for the NFET cell created in Chapter 2, "CDF Commands."

The sample NFET component requires a *maskLayoutViewName* parameter and five parameters needed for the Pcell layout. The following table describes the parameters.

Parameter	Description
maskLayoutViewName	Cyclic field that distinguishes between two layout views
width	Floating-point number that defines the width of the gate
length	Floating-point number that defines the length of the gate
bend	Boolean to control conditional inclusion of shapes for bend
bendt	Boolean to help stretch shapes correctly when bend occurs
diffD	Boolean to control conditional inclusion of shapes for diffusion drain contact versus metal drain contact

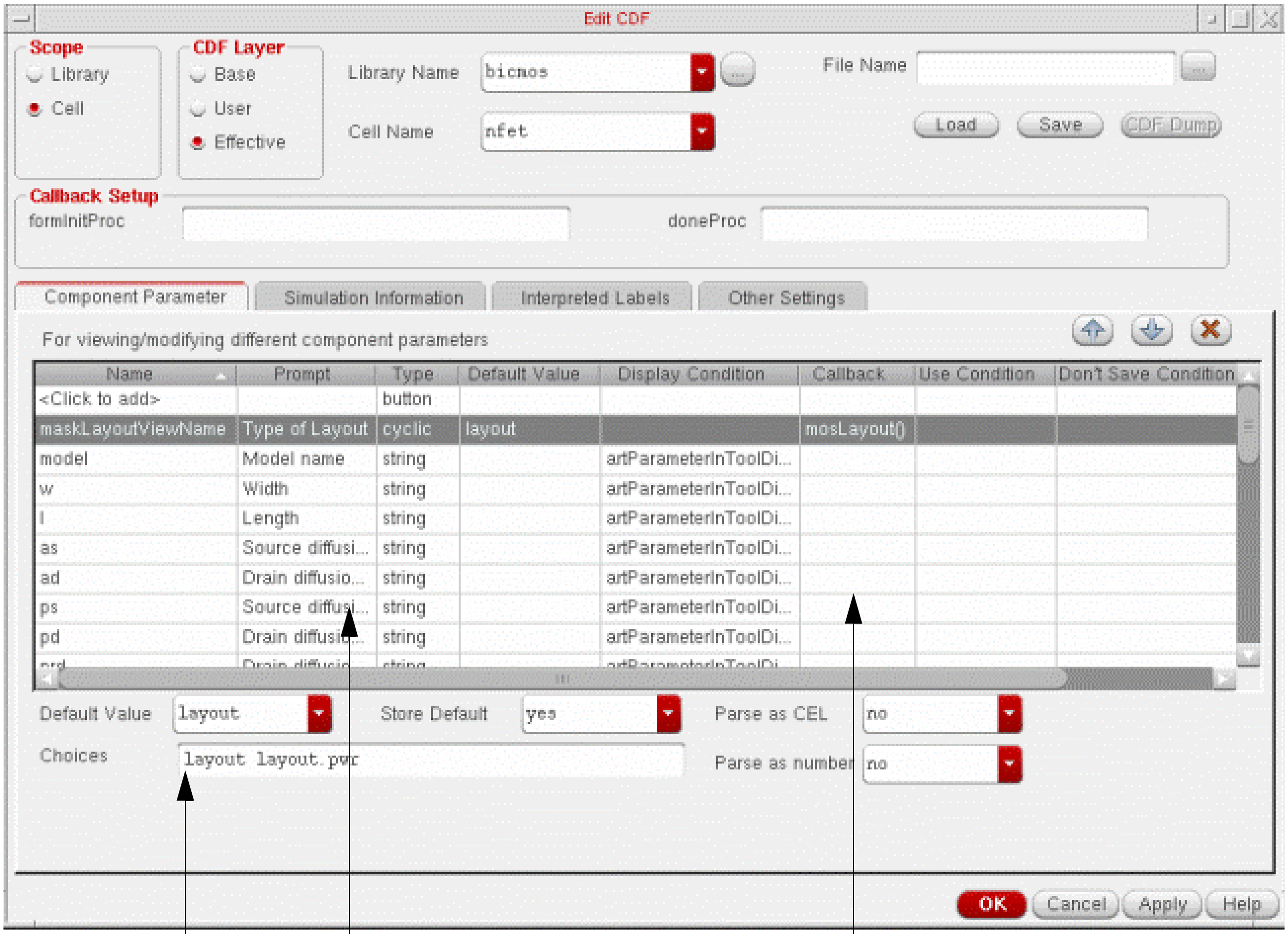
Adding New Parameters

Use the following procedure to add new parameters to the NFET CDF description.

1. Click the Component Parameter tab on the Edit CDF form.
2. In the *Name* column, double-click where it says *<click to add>,* type `maskLayoutViewName`, then press the *Tab* key.

   The *maskLayoutViewName* parameter is displayed in a new row.

   maskLayoutViewName is a cyclic parameter that lets you choose between two layouts. The following figure describes decisions you must make about prompt use, parameter type selection, and callback actions for the *maskLayoutViewName* parameter for the NFET component.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: bicmos

Cell Name: nfet

File Name:

Callback Setup

formInitProc:

doneProc:

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition
<Click to add>		button					
maskLayoutViewName	Type of Layout	cyclic	layout		mosLayout()		
model	Model name	string		artParameterInToolDi...			
w	Width	string		artParameterInToolDi...			
l	Length	string		artParameterInToolDi...			
as	Source diffusi...	string		artParameterInToolDi...			
ad	Drain diffusio...	string		artParameterInToolDi...			
ps	Source diffusi...	string		artParameterInToolDi...			
pd	Drain diffusi...	string		artParameterInToolDi...			
prd	Drain diffusio	string		artParameterInToolDi			

Default Value: layout

Store Default: yes

Parse as CEL: no

Choices: layout layout.pwr

Parse as number: no

This cyclic field limits the user to two choices.

This prompt is more meaningful than the name required by Virtuoso Layout.

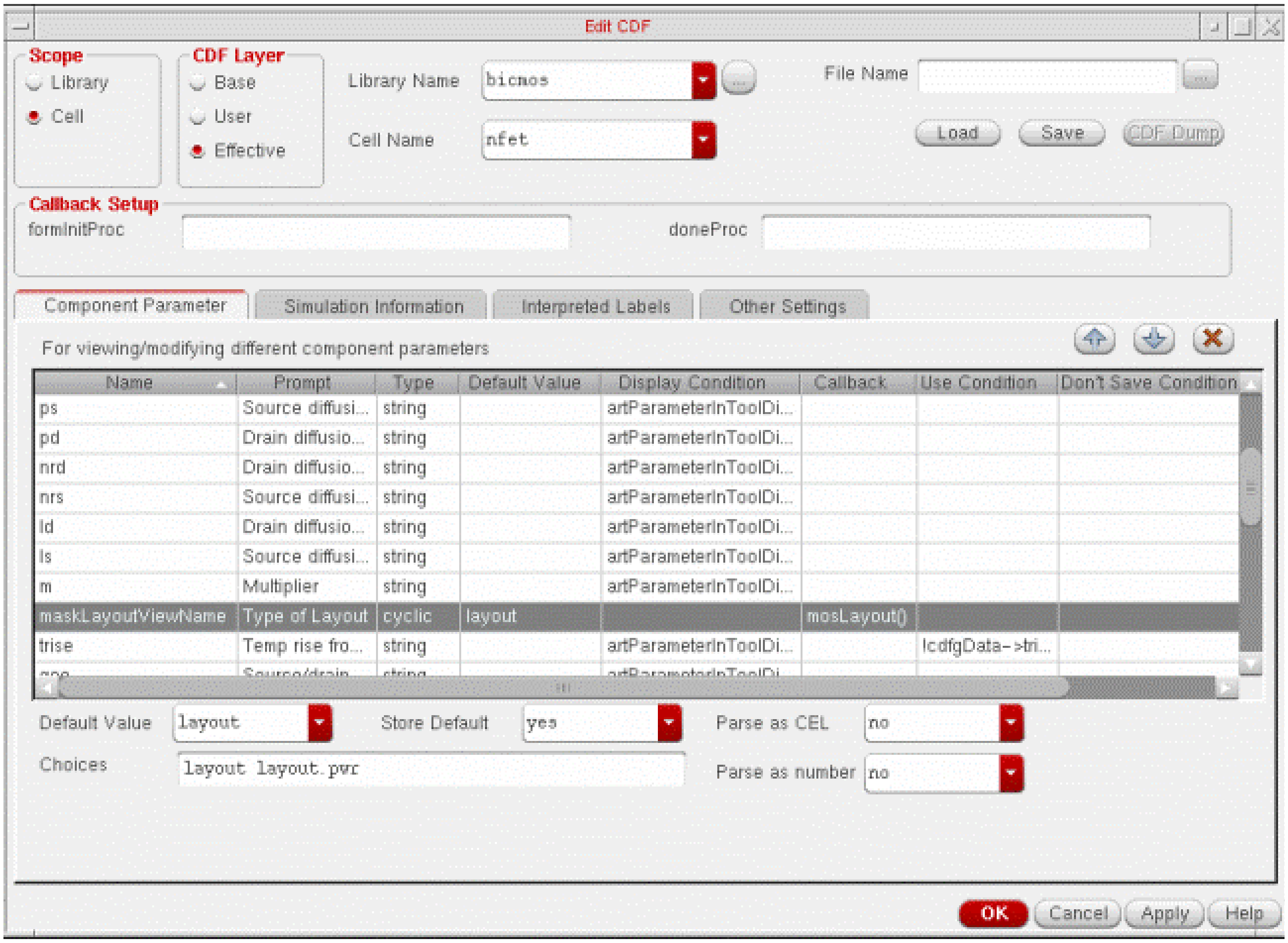
Use this callback to update width and length.

3. In the *Prompt* field, type `Type of Layout`, then press the *Tab* key.
4. In the *Type* cyclic field, select *cyclic*.
5. Double-click the *Callback* field and type `mosLayout()`.
6. In the *Choices* field, type the following:

   `layout layout.pwr`

7. In the *Default Value* cyclic field in the bottom of the form, select *layout*.
8. In the *Store Default*, *Parse as CEL* and *Parse as number* cyclic fields, select *No*.

9. Click the ⇩ button to move the `maskLayoutViewName` parameter after the parameter `m` as shown below:



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: bicmos

Cell Name: nfet

File Name:

Callback Setup: formInitProc doneProc

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition
ps	Source diffusi...	string		artParameterInToolDi...			
pd	Drain diffusio...	string		artParameterInToolDi...			
nrd	Drain diffusio...	string		artParameterInToolDi...			
nrs	Source diffusi...	string		artParameterInToolDi...			
ld	Drain diffusio...	string		artParameterInToolDi...			
ls	Source diffusi...	string		artParameterInToolDi...			
m	Multiplier	string		artParameterInToolDi...			
maskLayoutViewName	Type of Layout	cyclic	layout		mosLayout()		
trise	Temp rise fro...	string		artParameterInToolDi...		lcdfgData->tri...	
geo	Source/drain...	string		artParameterInToolDi...			

Default Value: layout

Store Default: yes

Parse as CEL: no

Choices: layout layout.pwr

Parse as number: no

10. When you are done, click *Apply* so that your entries take effect.

Setting Sample Callbacks

Because you copied the CDF description for the NFET component from the *nbsim* CDF description, there is already a width parameter *w* in the CDF setup for the simulators. You can set up a callback that updates the *width* parameter whenever the *w* parameter is updated. Then designers don't have to enter the width twice.

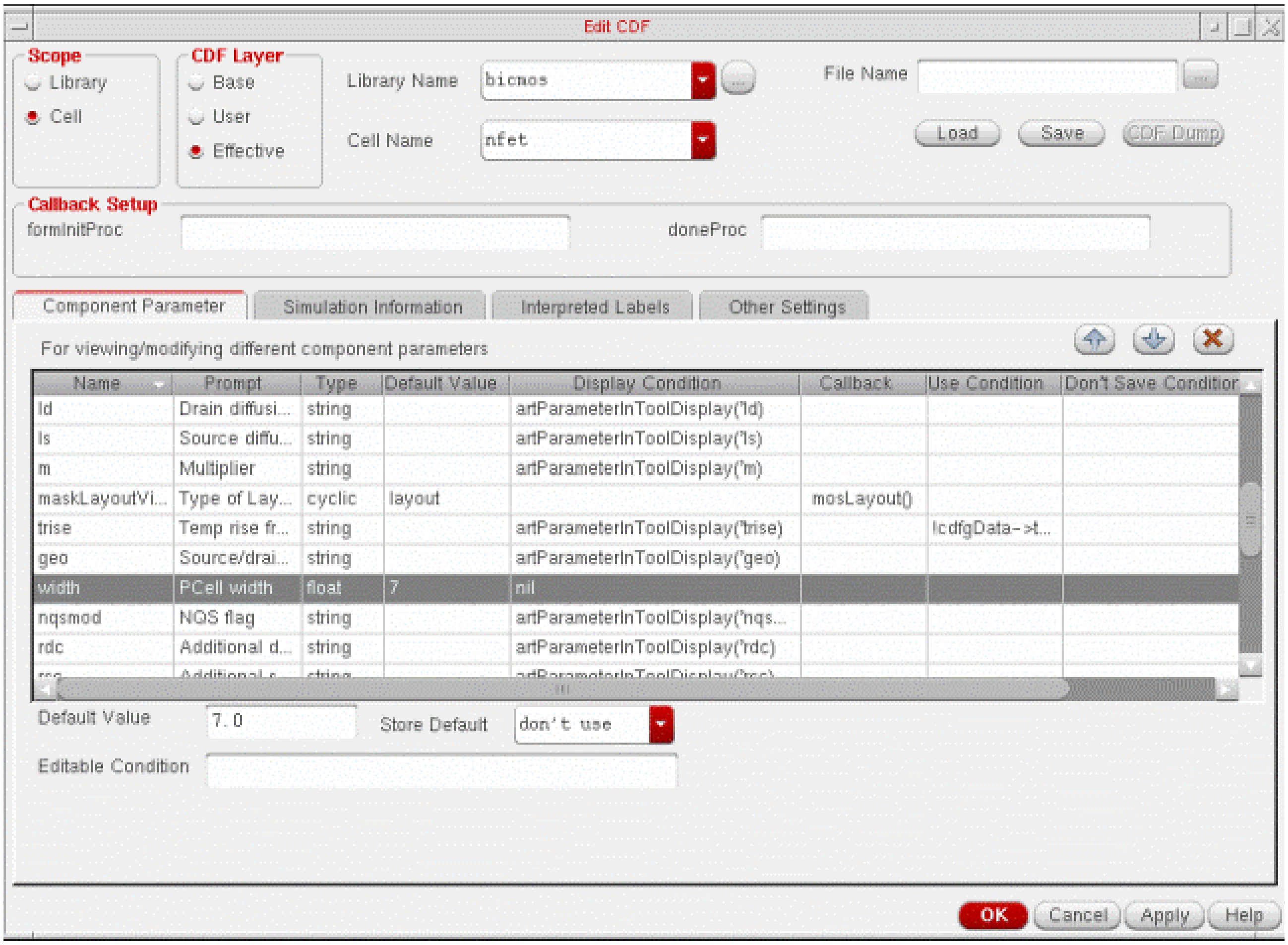
1. In the *Name* column, double-click where it says *<click to add>*, type `width`, then press the *Tab* key.
2. In the *Prompt* field, type `PCell width`, then press the *Tab* key.

3. In the *Type* cyclic field, select *float*.
4. In the *Default Value* field in the bottom of the form, enter a default value, say `7.0`, that matches the default value for the parameter *w*.
5. In the *Store Default* cyclic field, select *don't use*.

   The new width parameter does not need to be displayed in forms that display CDF information because the callback sets the value.
6. Double-click the *Display Condition* field and type `nil`.

   This indicates that the `width` parameter will not be displayed in forms that display CDF parameters.

   Because this parameter is set automatically by another parameter, put it near the end of the parameter list.
7. Click the ⇩ button to move the `width` parameter after the parameter `geo`.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: bicmos

Cell Name: nfet

File Name:

Callback Setup

formInitProc:

doneProc:

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Conditior
ld	Drain diffusi...	string		artParameterInToolDisplay('ld)			
ls	Source diffu...	string		artParameterInToolDisplay('ls)			
m	Multiplier	string		artParameterInToolDisplay('m)			
maskLayoutVi...	Type of Lay...	cyclic	layout		mosLayout()		
trise	Temp rise fr...	string		artParameterInToolDisplay('trise)		lcdfgData->t...	
geo	Source/drai...	string		artParameterInToolDisplay('geo)			
width	PCell width	float	7	nil			
nqsmod	NQS flag	string		artParameterInToolDisplay('nqs...			
rdc	Additional d...	string		artParameterInToolDisplay('rdc)			
rsc	Additional s...	string		artParameterInToolDisplay('rsc)			

Default Value: 7.0

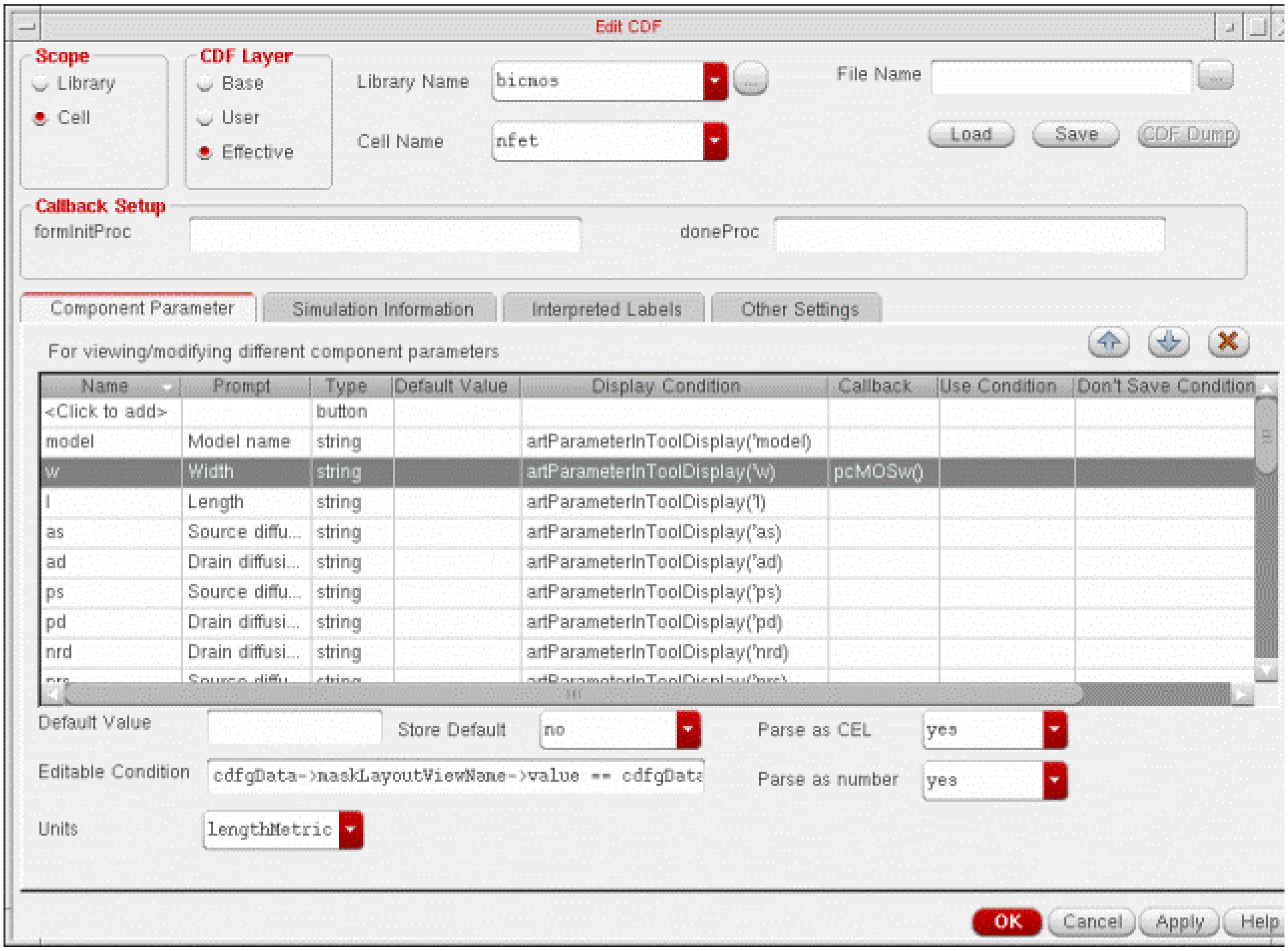
Store Default: don't use

Editable Condition:

8. Click *Apply* to save the new parameter.
9. In the Component Parameter tab, select the *w* parameter.
10. Double-click the *Callback* field and type in the callback name `pcMOSw()`.

    (Refer to Chapter 7, "Writing Callbacks," for a description of callback procedures.)
11. In the *Editable Condition* field, make the parameter not editable by typing

```
cdfgData->maskLayoutViewName->value ==
    cdfgData->maskLayoutViewName->defValue
```



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: bicmos

Cell Name: nfet

File Name:

formInitProc:

doneProc:

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition
<Click to add>		button					
model	Model name	string		artParameterInToolDisplay('model)			
w	Width	string		artParameterInToolDisplay('w)	pcMOSw()		
l	Length	string		artParameterInToolDisplay('l)			
as	Source diffu...	string		artParameterInToolDisplay('as)			
ad	Drain diffusi...	string		artParameterInToolDisplay('ad)			
ps	Source diffu...	string		artParameterInToolDisplay('ps)			
pd	Drain diffusi...	string		artParameterInToolDisplay('pd)			
nrd	Drain diffusi...	string		artParameterInToolDisplay('nrd)			
nrs	Source diffu...	string		artParameterInToolDisplay('nrs)			

Default Value:

Store Default: no

Parse as CEL: yes

Editable Condition: `cdfgData->maskLayoutViewName->value == cdfgDat`

Parse as number: yes

Units: lengthMetric

The expression in the *Editable Condition* field of parameter *w* controls the designer's ability to change this parameter. This expression evaluates to *nil* if the attribute *maskLayoutViewName* is not the same as its default value. In other words, if the designer selects the *layout.pwr* view name, this parameter is not editable.

The expression `artParameterInToolDisplay('w)` in the *Display Condition* field of parameter *w* (copied as part of the *w* parameter from the *analogLib* library) controls the display of parameters when the user uses the *Edit – Properties – Tool Filter* command. The expression evaluates to *t* if this parameter is associated with the tool selected.

You can expand the *Display Condition* attribute expression. For example, to turn off the display of *w* whenever the *maskLayoutViewName* is *layout.pwr* (instead of making it uneditable), you can use the following:

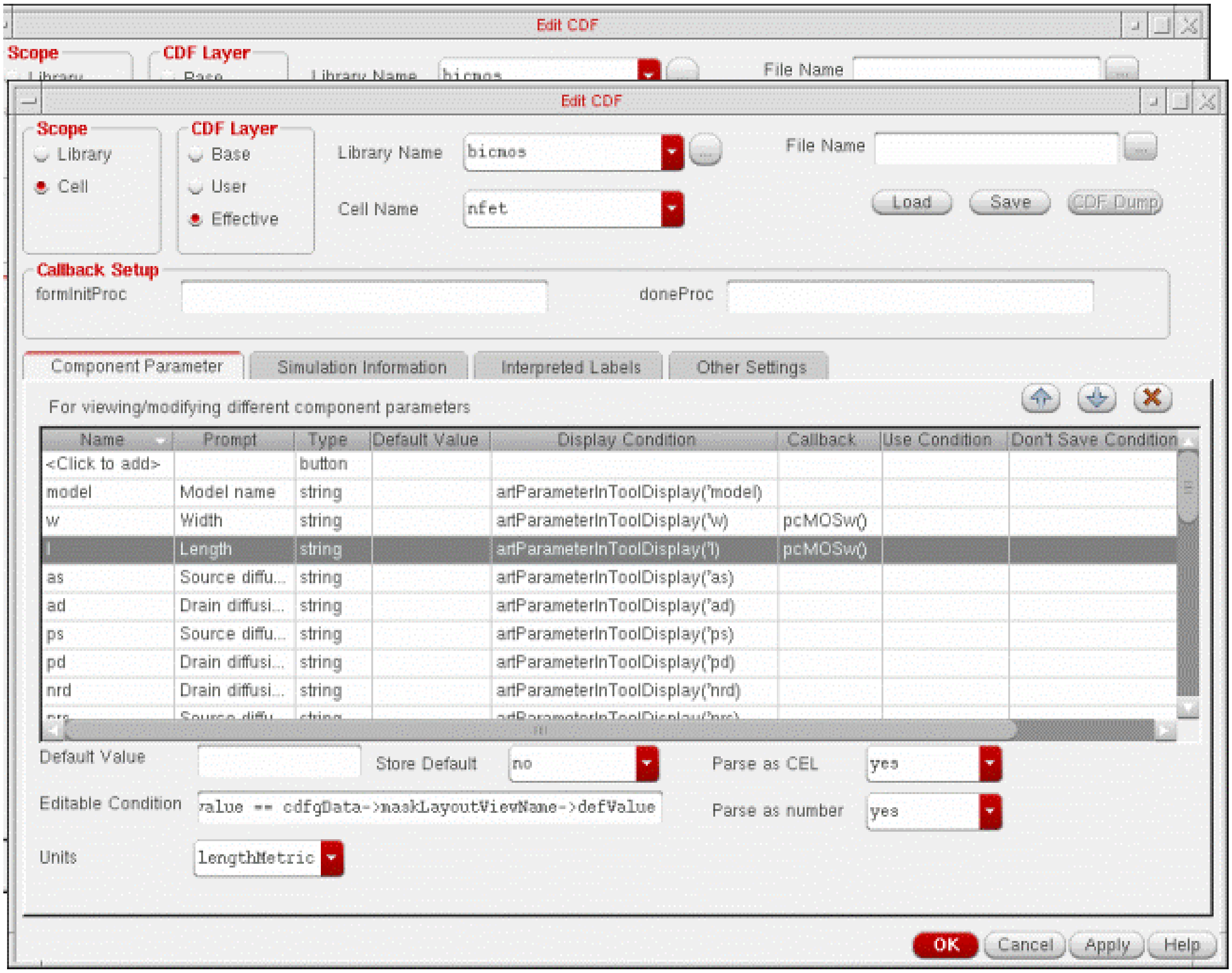
```
artParameterInToolDisplay('w) &&
    (cdfgData->maskLayoutViewName->value ==
    cdfgData->maskLayoutViewName->defValue)
```

The function `artParameterInToolDisplay` takes a parameter name as its argument. It evaluates that parameter in the current CDF description and decides to display it or not, depending on whether the parameter is used by the simulator you are running.

Completing Parameter Definitions

Fill in the required information for the remaining parameters.

1. Repeat the previous procedure for the *l* and *length* parameters that you used for *w* and *width* as shown in the following figures.



Edit CDF

Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: bicmos

Cell Name: nfet

File Name:

Callback Setup

formInitProc:

doneProc:

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition
<Click to add>		button					
model	Model name	string		artParameterInToolDisplay('model)			
w	Width	string		artParameterInToolDisplay('w)	pcMOSw()		
l	Length	string		artParameterInToolDisplay('l)	pcMOSw()		
as	Source diffu...	string		artParameterInToolDisplay('as)			
ad	Drain diffusi...	string		artParameterInToolDisplay('ad)			
ps	Source diffu...	string		artParameterInToolDisplay('ps)			
pd	Drain diffusi...	string		artParameterInToolDisplay('pd)			
nrd	Drain diffusi...	string		artParameterInToolDisplay('nrd)			
nrs	Source diffu...	string		artParameterInToolDisplay('nrs)			

Default Value:

Store Default: no

Parse as CEL: yes

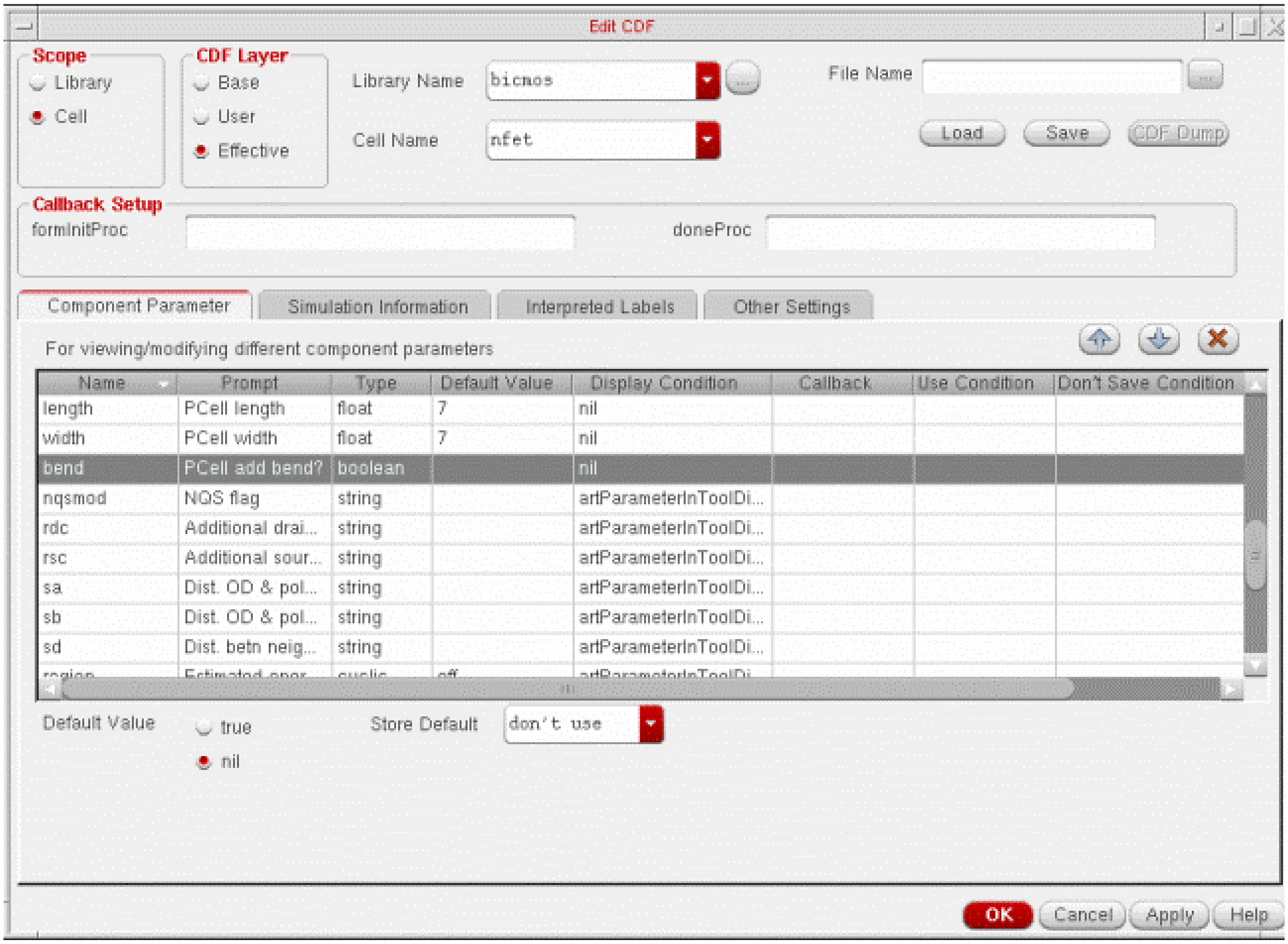
Editable Condition: value == cdfgData->maskLayoutViewName->defValue

Parse as number: yes

Units: lengthMetric

2. Using the Component Parameter tab again, add the parameters *bend* and *bendt* as illustrated in the following figure.

   The Pcell parameters *bend* and *bendt* can also be controlled by the *width* parameter. You can place both parameters at the bottom of the parameter list because they are driven by the callback and, therefore, do not need to be displayed.



Scope
○ Library
● Cell

CDF Layer
○ Base
○ User
● Effective

Library Name: bicmos

Cell Name: nfet

File Name:

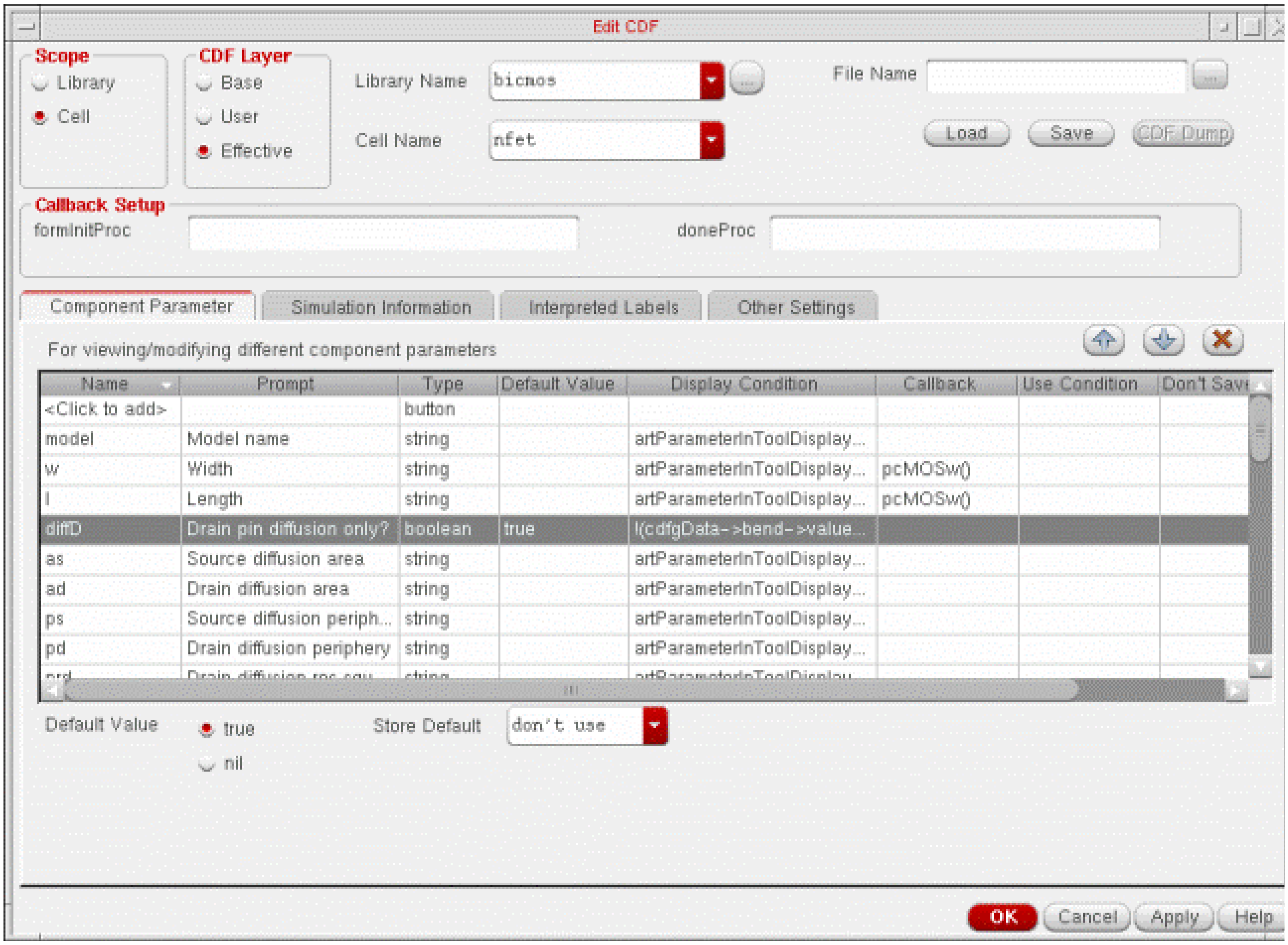
Callback Setup
formInitProc:
doneProc:

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save Condition
length	PCell length	float	7	nil			
width	PCell width	float	7	nil			
bend	PCell add bend?	boolean		nil			
nqsmod	NQS flag	string		artParameterInToolDi...			
rdc	Additional drai...	string		artParameterInToolDi...			
rsc	Additional sour...	string		artParameterInToolDi...			
sa	Dist. OD & pol...	string		artParameterInToolDi...			
sb	Dist. OD & pol...	string		artParameterInToolDi...			
sd	Dist. betn neig...	string		artParameterInToolDi...			
region	Estimated oper...	cyclic	off	artParameterInToolDi...			

Default Value ○ true ● nil

Store Default: don't use



Edit CDF

Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: bicmos

Cell Name: nfet

File Name:

Callback Setup

formInitProc:

doneProc:

For viewing/modifying different component parameters

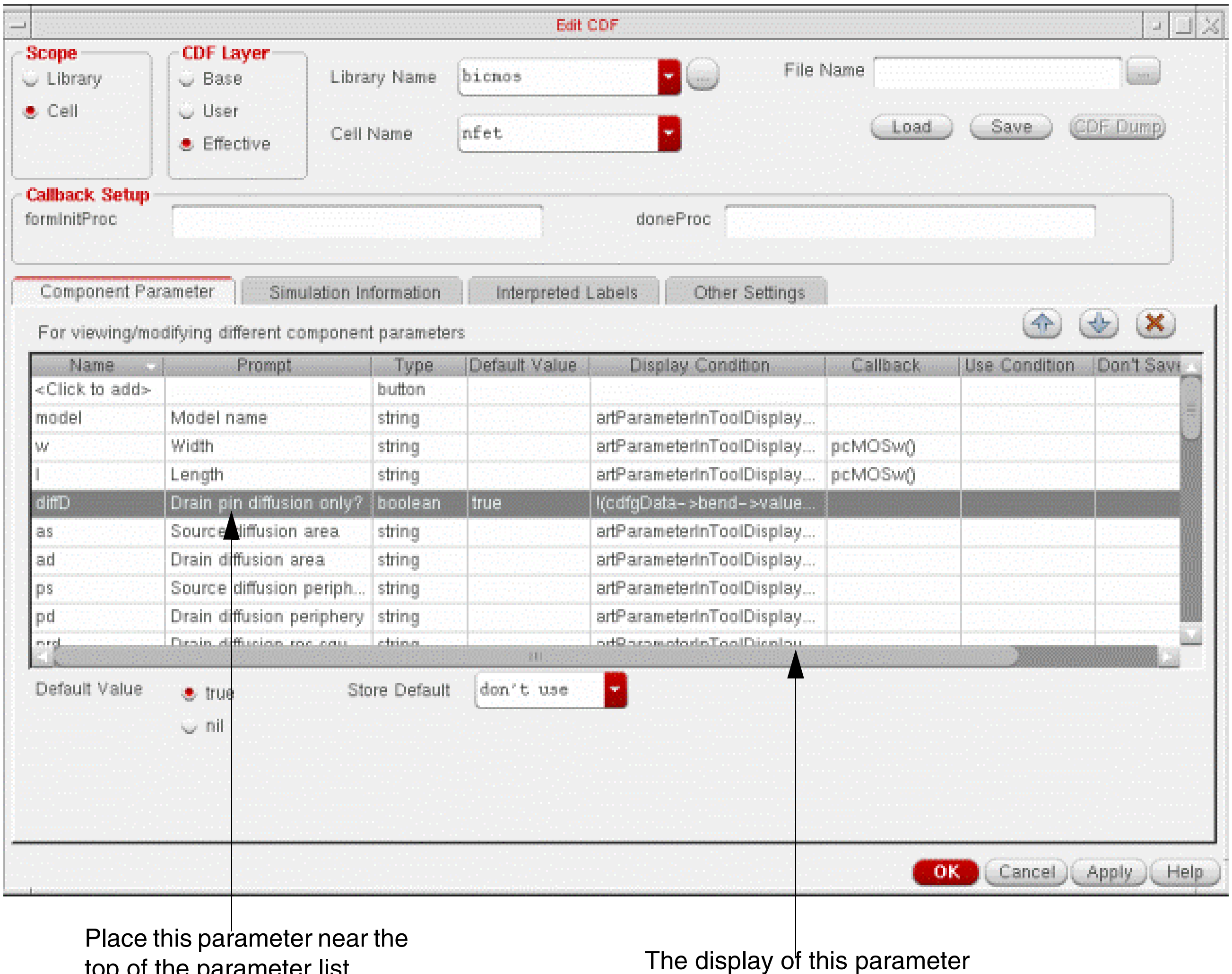
Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save
<Click to add>		button					
model	Model name	string		artParameterInToolDisplay...			
w	Width	string		artParameterInToolDisplay...	pcMOSw()		
l	Length	string		artParameterInToolDisplay...	pcMOSw()		
diffD	Drain pin diffusion only?	boolean	true	!(cdfgData->bend->value...			
as	Source diffusion area	string		artParameterInToolDisplay...			
ad	Drain diffusion area	string		artParameterInToolDisplay...			
ps	Source diffusion periph...	string		artParameterInToolDisplay...			
pd	Drain diffusion periphery	string		artParameterInToolDisplay...			
prd	Drain diffusion res squ	string		artParameterInToolDisplay			

Default Value: ● true ○ nil

Store Default: don't use

3. Add the *diffD* parameter as shown below.

The last Pcell parameter is the boolean, *diffD*, which prompts the designer to specify whether or not to use diffusion to make contact with the drain. The display of this parameter depends on the value of *bend* and the type of layout selected. If you use *layout.pwr*, there is no reason to ask about the drain connection. The same is true if you are using a bend.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: bicmos

Cell Name: nfet

File Name:

Callback Setup

formInitProc:

doneProc:

For viewing/modifying different component parameters

Name	Prompt	Type	Default Value	Display Condition	Callback	Use Condition	Don't Save
<Click to add>		button					
model	Model name	string		artParameterInToolDisplay...			
w	Width	string		artParameterInToolDisplay...	pcMOSw()		
l	Length	string		artParameterInToolDisplay...	pcMOSw()		
diffD	Drain pin diffusion only?	boolean	true	!(cdfgData->bend->value...			
as	Source diffusion area	string		artParameterInToolDisplay...			
ad	Drain diffusion area	string		artParameterInToolDisplay...			
ps	Source diffusion periph...	string		artParameterInToolDisplay...			
pd	Drain diffusion periphery	string		artParameterInToolDisplay...			
prd	Drain diffusion res squ	string		artParameterInToolDisplay...			

Default Value: ● true ○ nil

Store Default: don't use

Place this parameter near the top of the parameter list because the user needs to select a value.

The display of this parameter depends on the value of bend and maskLayoutViewName parameters.

The complete expression in the *Display Condition* field is as follows:

```
!(cdfgData->bend->value) &&
    !(cdfgData->maskLayoutViewName->value=="layout.pwr")
```

You are ready to set the simulation options in the NFET CDF description, which are described in the next chapter.

4

Modifying Simulation Information

Overview

Before you can simulate a component, you must enter information required by each of the simulators you intend to use. The Simulation Information tab in the Edit CDF form lists the simulators associated with a CDF description. Use this tab to enter detailed information for each simulator.

Simulation Information Tab

Unlike the parameter attributes that you enter in the Component Parameter tab, the information you enter into the Simulation Information tab is a set of directions, parameters, and terminal names used by the simulator when it simulates the cell.

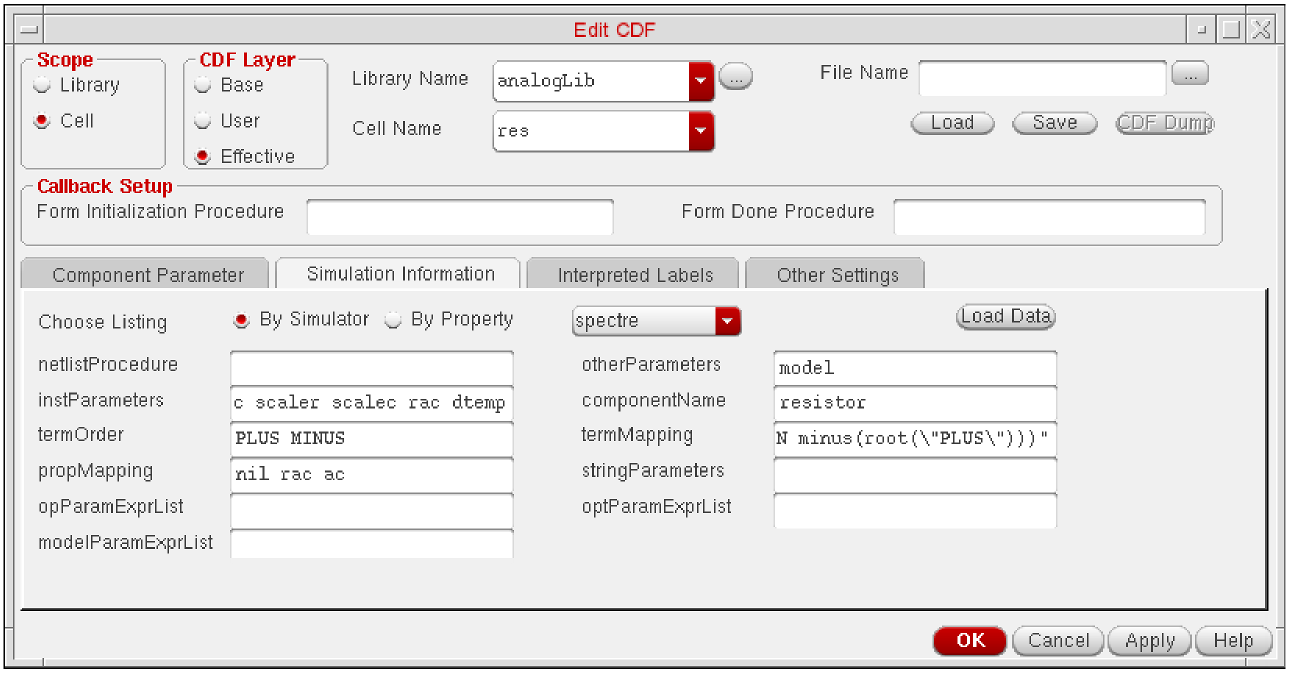
Like other CDF information, you can specify CDF simulation information at the *Base*, *User*, and *Effective* levels. For details on these CDF levels, see "Levels of CDF Data" on page 14.

Caution

Exercise caution when you specify simulation information at the User level. If you specify simulation information at the User level, the simulation information at the Effective level uses only the User level simulation information. It does not use any simulation information specified at the Base level. This behavior is different from other CDF

information, such as component parameters, where the Effective level information is set using Base level information overlaid by User level information.

Each simulator requires a unique set of information. Not every field described in this tab appears for each simulator. Only those fields that are appropriate for the simulator you select are displayed. You can modify each of the fields in this tab.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: analogLib

Cell Name: res

Choose Listing: ● By Simulator ○ By Property spectre

instParameters: c scaler scalec rac dtemp

termOrder: PLUS MINUS

propMapping: nil rac ac

otherParameters: model

componentName: resistor

termMapping: N minus(root(\"PLUS\"))"

Choose Listing

- **By Simulator** is a cyclic field that lets you select the simulator whose attributes you want to modify. When you select a new value, the form redisplays to show attributes for that simulator. After you change the attributes of one simulator, click *Apply* before you change the attributes of another simulator.
- **By Property** is a cyclic field that lets you select the attribute whose values you to modify for various simulators. When you select a new value, the form redisplays to show the value of that attribute for all simulators. After you change the value of the attribute, click *Apply* before you change the value of another attribute.

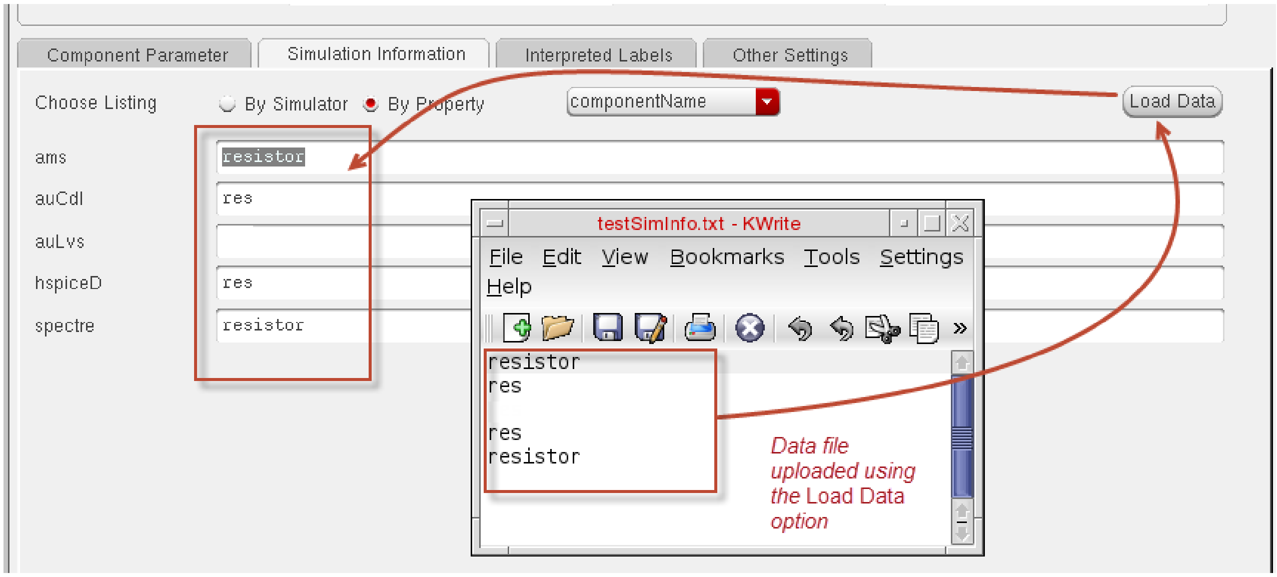
The **Load Data** button lets you load simulation information in the fields from a simple text file. Use this feature to load large strings and values maintained in a file.

To load data from a file:

1. Choose the preferred listing. See Choose Listing.

2. Ensure that the text file contains data in the correct order and sequence. The file must contain the values in the sequence in which the parameters appear in the form. If you want to leave a parameter value blank, add a blank line in the correct sequence.
3. Click **Load Data**. The Choose a File form appears.
4. Select the file from the Choose a File form, and click **Open**.

The data gets loaded in the fields, as illustrated in the following figure. It is possible to edit the values in the fields.



Choose Listing ○ By Simulator ● By Property componentName

ams resistor
auCdl res
auLvs
hspiceD res
spectre resistor

```
resistor
res

res
resistor
```

Data file uploaded using the Load Data option

The following are some key fields whose values you provide through the Simulation Information tab:

netlistProcedure is the name of the netlist procedure to use. Procedures that come with the system are defined in `<`*`your_install_dir`*`>/tools/dfII/etc/context`. You can also define your own procedures.

For the spectre interface, the netlister chooses a default netlist procedure if none is specified.

The netlist procedures for spectre that are supplied by Cadence start with spectre.

Note: The netlist procedure name can be defined as either a symbol (without quotation marks) or a string (with quotation marks). For example, *ansCdlHnlPrintInst* (symbol) or *"ansCdlHnlPrintInst"* (string).

enumParameters are parameters of SPICE and Spectre primitives, where the values of the parameters are enumerations. The parameter names must be names recognized by the targeted simulator.

referenceParameters are parameters that have instance names as their values. The parameter names must be names recognized by the targeted simulator.

stringParameters are parameters that are treated as strings when they are written to the netlist. The parameter names must be names recognized by the targeted simulator.

arrayParameters are parameters that must be written to the netlist as arrays. The parameter names must be names recognized by the targeted simulator.

extraTerminals contains information for writing inherited connection terminals on instances. This information is used when the simulator view of an instance contains more terminals than are present on the symbol view.

otherParameters for spectre are parameters not defined in instParameters. These parameters are processed in a special way by the netlist procedure.

Typical values are *macro*, *model*, and *bn*. (The parameter names you list must reflect the property mapping you specify in the *propMapping* field.) If you use a tool filter, parameters that are not used by the tool are not displayed. Any field you specify in *otherParameters*, however, is displayed regardless of the tool filter (with the *artParameterInToolDisplay* function).

instParameters a list of simulator names of parameters that you want to include with this device in the netlist. (The parameter names you list must reflect the property mapping you specify in the *propMapping* field.)

Some simulators require that a property have a different name or different capitalization from the parameter name in the parameter definition. For LVS (Layout Versus Schematic), this depends on the parameter names used in the LVS rules in your technology file. For example, the capacitor parameter might be *c,* and the LVS rules can refer to the property *C*. You can set the *propMapping* field to map the value of *c* to *C* so that the parameters listed with each instance are *C*.

componentName is the type of component you are creating, such as BJT, JFET, and MOSFET.

For the spectre interface, if the "model" parameter ("Model Name") has a value, that value is used as the name of the model in the netlist. Otherwise, the value of this entry is used as the name of the model. If neither the model parameter nor the *componentName* entry has a value, the name of the cell is used as the name of the model.

When you are using *auLVS* and *auCDL*, component names can be anything. For other simulators, you must use lowercase component names similar to those used in *analogLib*. This is critical for SPICE types of netlists.

termOrder is a list of terminals that define the net order for your component. The nets are considered those nets connecting the terminals in the order given in this list.

You can also use programmable nodes to define the net order. The use of programmable nodes is discouraged in releases 4.4.3 and later. Instead, use inherited connections. You can use the conversion tools to convert your designs. Programmable nodes are not supported by spectre.

To do this, you need to define a bulk node property (usually *bn*). The following entry is an example of *termOrder* input:

```
PLUS MINUS progn(bn)
```

This indicates that the third net, *progn*, is defined by the bulk node property instead of by a connection to a pin. The property *bn* must have a default value when using LVS.

Note: You can set a net name to a global net (such as *gnd!* or *vdd!*), to one of the instance pins (such as PLUS or MINUS), or to a net name, as long as the net, pin, or name exists in the cellview. You can assign a net name to *bn*. (This is called parameterizing the bulk node.) You can also set a net name to any other net. If the netlisting is flat, the net name must be fully qualified, identifying all levels of hierarchy in the design. If the netlisting is hierarchical, the net name does not need be fully qualified if it is a local net name on the same page.

Caution

> ***You must escape invalid characters while specifying termOrder using symbols to make them valid symbols in SKILL. All symbols must be preceded by the backslash (\) as used in the following code:***
>
> ```
> cdfId = cdfCreateBaseCellCDF( cellId )
> .
> .
> .
> cdfId->simInfo->spectre = ’(nil
>     otherParameters (model)
>     instParameters (w l as ad ps pd nrd nrs ld ls m trise region)
>     termOrder ( a\<0\> a\<1\> )
>     termMapping (nil D \:d G \:g S \:s B \:b )
>     )
> ```

deviceTerminals lets you define the terminal names to be listed in the device definition line. If you leave this field blank, the terminals listed use the same names as those in the *termOrder* field. Used by *auLVS* only.

The entries in this field are usually different from those in the *termOrder* field when you have a programmable node (the bulk node). For example, if you used *progn(bn)* in the *termOrder* field for the three-terminal capacitor, you might see the following entry in *deviceTerminals*:

```
PLUS MINUS BULK
```

termMapping is used when the simulator has different names for the component terminals than the cell schematic. It is set up as a disembodied property list. Therefore, the first entry in the list is `nil`. This is followed by a set of name-value pairs, where the first name is the terminal name on the symbol and the second name is its corresponding terminal name used by the simulator for the device.

For example, in the *nbsim* cell in *analogLib*, the terminals names *D*, *G*, and *S* are specified in uppercase. Although uppercase terminal names are appropriate for SPICE, the Spectre simulator expects the terminal names *d*, *g*, and *s* in lowercase. Therefore, in the SKILL version, to map between the two sets of terminal names for the Spectre simulator, you can enter the following code in the *simInfo* field:

```
termMapping(nil D \:d G \:g S \:s B \:b)
```

Note: Make sure all non-alphanumeric characters are preceded by a backslash (\).

This is important when you use backannotation because the simulator saves the results under the terminal name that it recognizes.

propMapping lets you enter your own CDF parameter names in place of the names recognized by the simulator. You can define different name mappings for each simulator. A single parameter can be identified a different way for each simulator.

You specify an entry in the *propMapping* field in the following format:

```
nil simParamName1 CDFparamName1
    simParamName2 CDFparamName2 ...
```

This format represents a disembodied property list, so the first element is always *nil*.

The LVS *propMapping* list is *nil C c*. The CDF parameter name is *c*, but under the LVS rules, it must be *C*. In another simulator, the same CDF parameter value might be referred to as *F*. In this case, the *propMapping* list for this simulator is *nil F c*. A third simulator might refer to this value as *cap*, making its *propMapping* list *nil cap c*.

modelName is used only by the analog-microwave version of CDL.

permuteRule, used only in *auLVS*, lets you indicate the permutability of the pins, that is, whether pins can be swapped or if they must be fixed. For example, the capacitor in the *propMapping* definition shows that the PLUS and MINUS terminals are permutable.

namePrefix lets you enter a prefix for defining the instance in the netlist. This is not used by the spectre interface. Typically, this is the first letter of your component. The netlister takes this prefix (R, for example), and the name of your component (12, for example), and forms the name (R12).

You can also use a function or expression to evaluate the prefix. Ensure that the function or expression returns a string value.

- To use a function to evaluate the prefix, specify the prefix as:

  ```
  FUNCTION myFunction
  ```

  where `myFunction` is the name of the function that returns the prefix value. The function must be defined in your `.cdsinit` or `.cdsenv` file.

- To use an expression to evaluate the prefix, specify the prefix as:

  ```
  FUNCTION myExpression
  ```

  where `myExpression` is any expression that returns a prefix value. For example, specify the following expression to use the value of the `myPrefix` property on an instance as the prefix:

  ```
  FUNCTION cdfGetInstCDF(hnlCurrentInst)->myPrefix->value
  ```

current lets you save the simulation and definition of the current plot set. This is not used by the spectre interface. The only choices for this field are *port* or *nil*. If you do not specify a choice, no currents are saved. You can choose to save or plot the current for the port of a device or through a component. For SPICE-based simulators, you cannot save currents on specific ports. Currents can be saved only on the component (for example, resistors). The Spectre simulator lets you save currents on specific ports. For devices (for example, an *npn* transistor), you probably want to save currents on a port.

Typically, only the positive port current of a component current is written to the simulation PSF file, and the Cadence Analog Design Environment software calculates the negative port by taking the negative of the positive port. To use this feature to extract component currents, you must set the *termMapping* field as follows:

```
termMapping =
    (nil PLUS \:p MINUS "(FUNCTION minus(root(\"PLUS\")))")
```

modelParameters is used only by the microwave simulator HP MNS.

opParamExprList lets you specify DC operating point information.

optParamExprList lets you specify transient operating point information.

modelParamExprList lets you specify model parameters.

Tip

For more information and examples on opParamExprList, optParamExprList, and modelParamExprList, see Accessing Subcircuit Model Parameter and Operating Point Information on page 168.

Simulator Options

The following table lists five simulators and the options that apply to them.

Option	spectre	auLVS	ams	auCdl	hspiceD
netlistProcedure	Yes	Yes	Yes	Yes	Yes
otherParameters	Yes	Yes	Yes	Yes	Yes
instParameters	Yes	Yes	Yes	Yes	Yes
enumParameters	No	No	Yes	No	No
modelArguments	No	No	No	No	No
macroArguments	No	No	No	No	No
componentName	Yes	Yes	Yes	Yes	Yes
termOrder	Yes	Yes	Yes	Yes	Yes
deviceTerminals	No	Yes	No	No	No
termMapping	Yes	No	Yes	No	Yes
propMapping	Yes	Yes	Yes	Yes	Yes
excludeParameters	No	No	Yes	No	No
extraTerminals	No	No	Yes	No	No
isPrimitive	No	No	Yes	No	No
permuteRule	No	Yes	No	No	No
namePrefix	No	Yes	No	Yes	Yes
current	No	No	No	No	No
arrayParameters	No	No	Yes	No	No
stringParameters	Yes	No	Yes	No	No
referenceParameters	No	No	Yes	No	No
opParamExprList	Yes	No	Yes	No	Yes
optParamExprList	Yes	No	Yes	No	Yes
modelParamExprList	Yes	No	No	No	No
dollarParams	No	No	No	Yes	No

Option	spectre	auLVS	ams	auCdl	hspiceD
dollarEqualParams	No	No	No	Yes	No
modelName	No	No	No	Yes	No

Editing Simulator Options

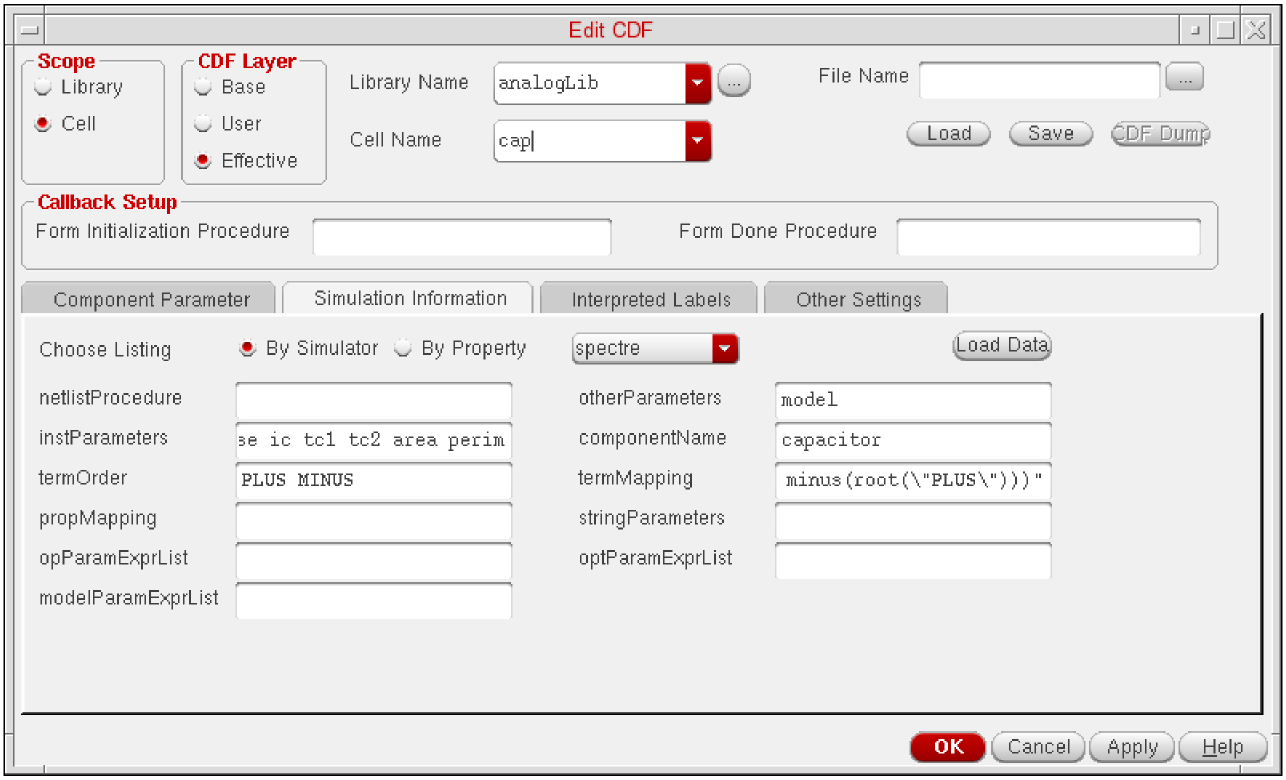
Setting simulator options can be a lengthy process. You should copy CDF simulator information from other components and libraries whenever possible. This section describes editing simulator options with the Edit CDF form and with SKILL functions.

Using the Edit CDF Form

Use the following procedure to set simulator options with the Edit CDF form:

1. Click the Simulation Information tab in the Edit CDF form.
2. Do one of the following:

❑ To specify the settings for a simulator, select the *By Simulator* radio button and choose the simulator in the *Choose Listing* cyclic field. Add or modify the simulator settings as needed.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: analogLib

Cell Name: cap

File Name:

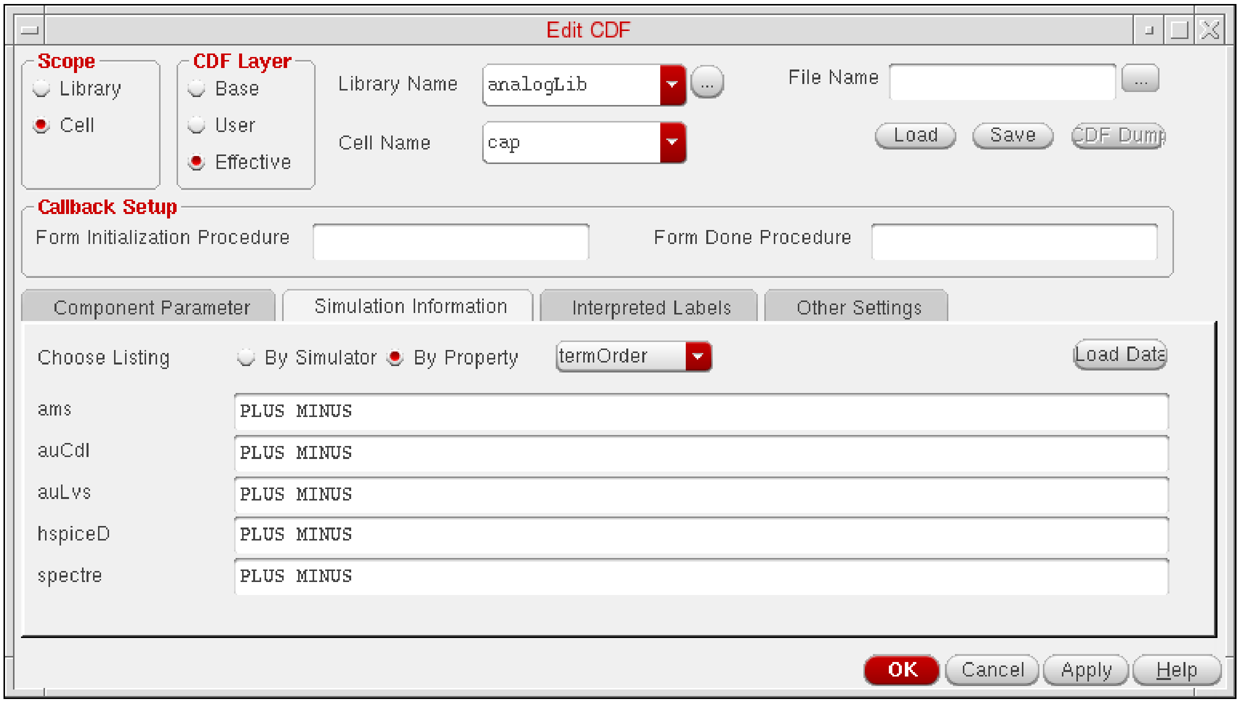
Form Initialization Procedure:

Form Done Procedure:

Choose Listing: ● By Simulator ○ By Property — spectre

netlistProcedure		otherParameters	model
instParameters	se ic tc1 tc2 area perim	componentName	capacitor
termOrder	PLUS MINUS	termMapping	minus(root(\"PLUS\")) "
propMapping		stringParameters	
opParamExprList		optParamExprList	
modelParamExprList			

❑ To specify the settings for a property, select the *By Property* radio button and choose the property in the *Choose Listing* cyclic field. Add or modify the settings for the property for each simulator as needed.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: analogLib

Cell Name: cap

Choose Listing: ○ By Simulator ● By Property termOrder

ams	PLUS MINUS
auCdl	PLUS MINUS
auLvs	PLUS MINUS
hspiceD	PLUS MINUS
spectre	PLUS MINUS

3. Click *Apply.*
4. Click the Component Parameter tab to check that all simulator parameters are defined.

Note: When you edit the simulator information the CDF termOrder may not be automatically updated. Instead, you may get the *Want to Update* dialog box to confirm overwriting the existing CDF termOrder.
You can suppress the Want to Update dialog box by setting the .cdsenv variable `queryCDFtermOrder` to `nil`. This will ensure that the CDF is automatically updated without checking for confirmation. You can undo the automatic update by setting this variable back to its default value, `t`.

Using SKILL

You can use the SKILL variable *cdfId* and the right arrow (->) operator to specify simulator options. Enter the options for each simulator as elements of a disembodied property list.

For details, see *CDF SKILL Summary* in *Virtuoso ADE L SKILL Reference*.

The following SKILL expression sets the options for the Spectre (spectre) simulator:

```
cdfId = cdfCreateBaseCellCDF( cellId )
.
.
.
cdfId->simInfo->spectre = ’(nil
    otherParameters (model)
    instParameters (w l as ad ps pd nrd nrs ld ls m trise region)
    termOrder ( D G S B )
    termMapping (nil D \:d G \:g S \:s B \:b )
    )
```

The following SKILL expression sets the options for the Analog LVS (auLvs) simulator, given a definition for *cellId*:

```
cdfId = cdfCreateBaseCellCDF( cellId )
.
.
.
cdfId->simInfo->auLvs = ’(nil
    netlistProcedure ansLvsCompPrim
    instParameters (m l v)
    componentName n0bsim
    termOrder (D G S progn(bn))
    deviceTerminals (D G S B)
    propMapping (nil L l W w)
    permuteRule "(p D S)"
    namePrefix "Q")
```

The following SKILL expression sets the options for the Spectre simulator:

```
cdfId = cdfCreateBaseCellCDF( cellId )
.
.
.
cdfId->simInfo->spectre = ’(nil
    netlistProcedure ansSpectreDevPrim
    otherParameters (bn model)
    instParameters (w l as ad ps pd nrd nrs ld ls m trise)
    componentName bsim1
    namePrefix "S"
    current port)
```

The following SKILL expression sets the options for the Cadence SPICE (cdsSpice) simulator:

```
cdfId = cdfCreateBaseCellCDF( cellId )
.
.
```

```
.
cdfId->simInfo->cdsSpice = ’(nil
    netlistProcedure ansSpiceDevPrim
    otherParameters (model bn)
    instParameters (m w l ad as pd ps nrd
        nrs ld ls off vds vgs vbs)
    componentName bsim
    termOrder (D G S progn(bn))
    propmapping (nil vds Vds vgs Vgs vbs Vbs)
    namePrefix "S"
    current port)
```

Complex Pole Example

In this portion of the complex pole example, you use the Simulation Information tab to look at the simulation information provided with the *complexPole1* component.

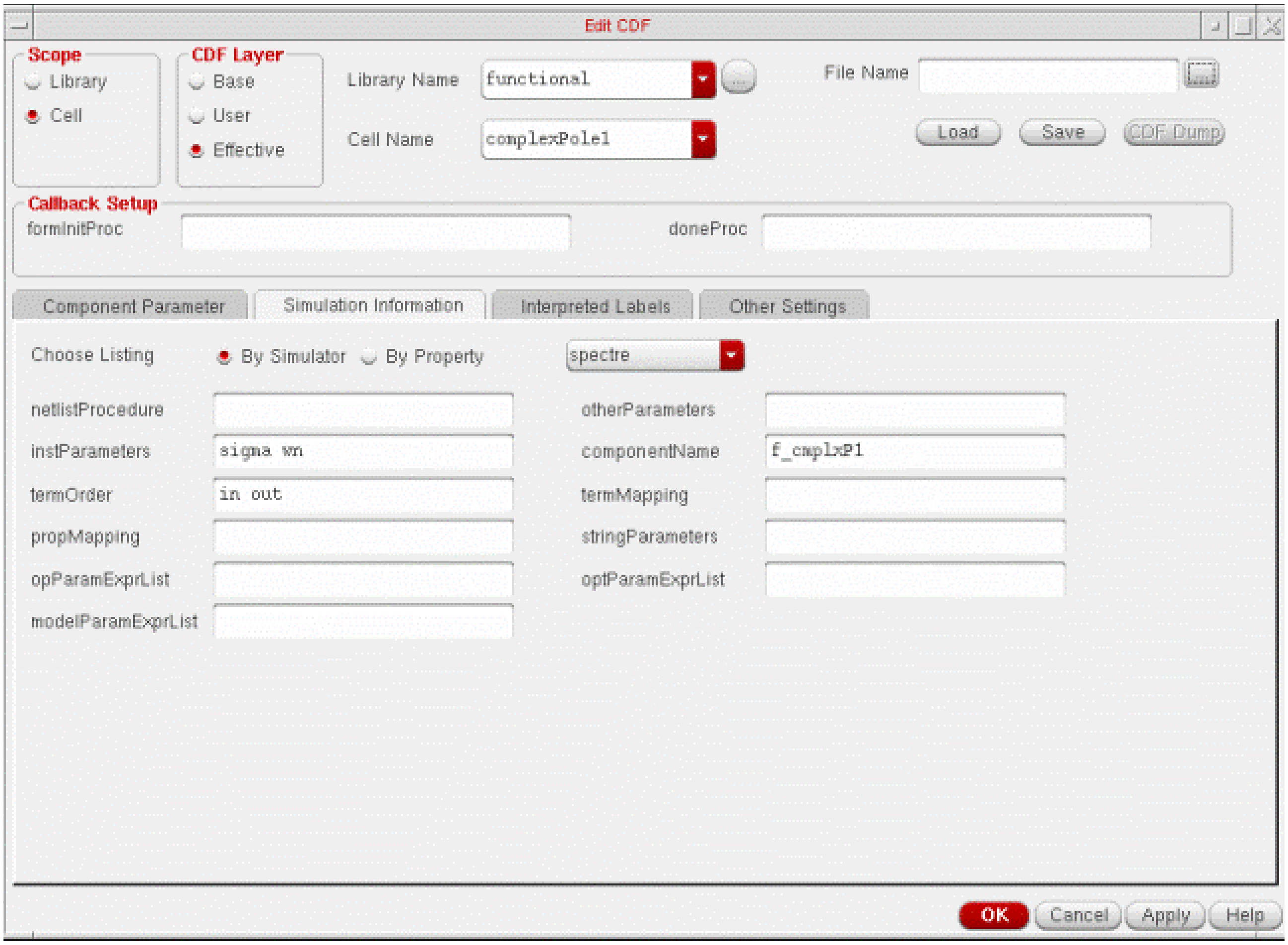
1. Click the Simulation Information tab on the Edit CDF form.

   This tab shows the simulator-specific data.

2. Select the *By Simulator* radio button and choose a simulator in the *Choose Listing* cyclic field. *S*ee the details for each simulator.

3. In the *Choose Listing* cyclic field, select *spectre*.

The form displays all of the fields applicable to *spectre*. However, not all fields are required by different netlist procedures.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: functional

Cell Name: complexPole1

Choose Listing: ● By Simulator ○ By Property spectre

instParameters: sigma wn

termOrder: in out

componentName: f_cmplxP1

For *spectre*, *complexPole1* requires no netlist procedure.

The other important fields are *termOrder* and *instParameters*. The *termOrder* field is an ordered list of the terminals as named on the symbol. The netlister uses this list. The order is important, especially if the component is defined by a subcircuit: the order in *termOrder* maps to the node numbers specified in the first line of the subcircuit.

Because *complexPole1* uses a macro model (subcircuit definition) to define its operation, the CDF parameter model must have a value in the Component Parameters section for spectre. If you are using a schematic to describe the component, the model information is unnecessary.

For the spectre interface, the *instParameters* field determines the names of the parameters of all types of components, primitives, subcircuits, model cards, and Verilog-A modules. The subcircuit definition for f_cmplxP1 is

```
subckt f_cmplxP1 (1 2)
parameters sigma wn
E1 3 0 1 0 1E-6 (??)
R1 (4 5) resistor r=1
L1 (3 4) inductor l=(1/(-2*sigma))
C1 (5 0) capacitor c=(-2*(sigma))/((wn*wn)+(sigma*sigma))
ends
```

This model, and others used by the functional block library, are in the following file:

your_install_dir/tools/dfII/etc/cdslib/artist/spectre/functional.scs

The order of parameters is particularly important in the case of macro models. The first parameter in the list is assigned to the variable *&2* in the subcircuit description, the second to *&3*, and so forth. In this example, *complexPole1* is defined by a macro model and the parameters *sigma* and *wn* on the symbol instance are passed to the model file *f_cmplxP1* as *&2* and *&3*.

The model file (*f_cmplxP1*) for the complex pole is

```
.SUBCKT &1 1 2
E1 3 0 1 0 1E-6
R1 4 5 1
L1 3 4 (1/(-2*(&2)))
C1 5 0 (-2*((&2)))/(((&3)*(&3))+((&2)*(&2)))
.ENDS &1
```

This model, and others used by the functional block library, are in the following directory:

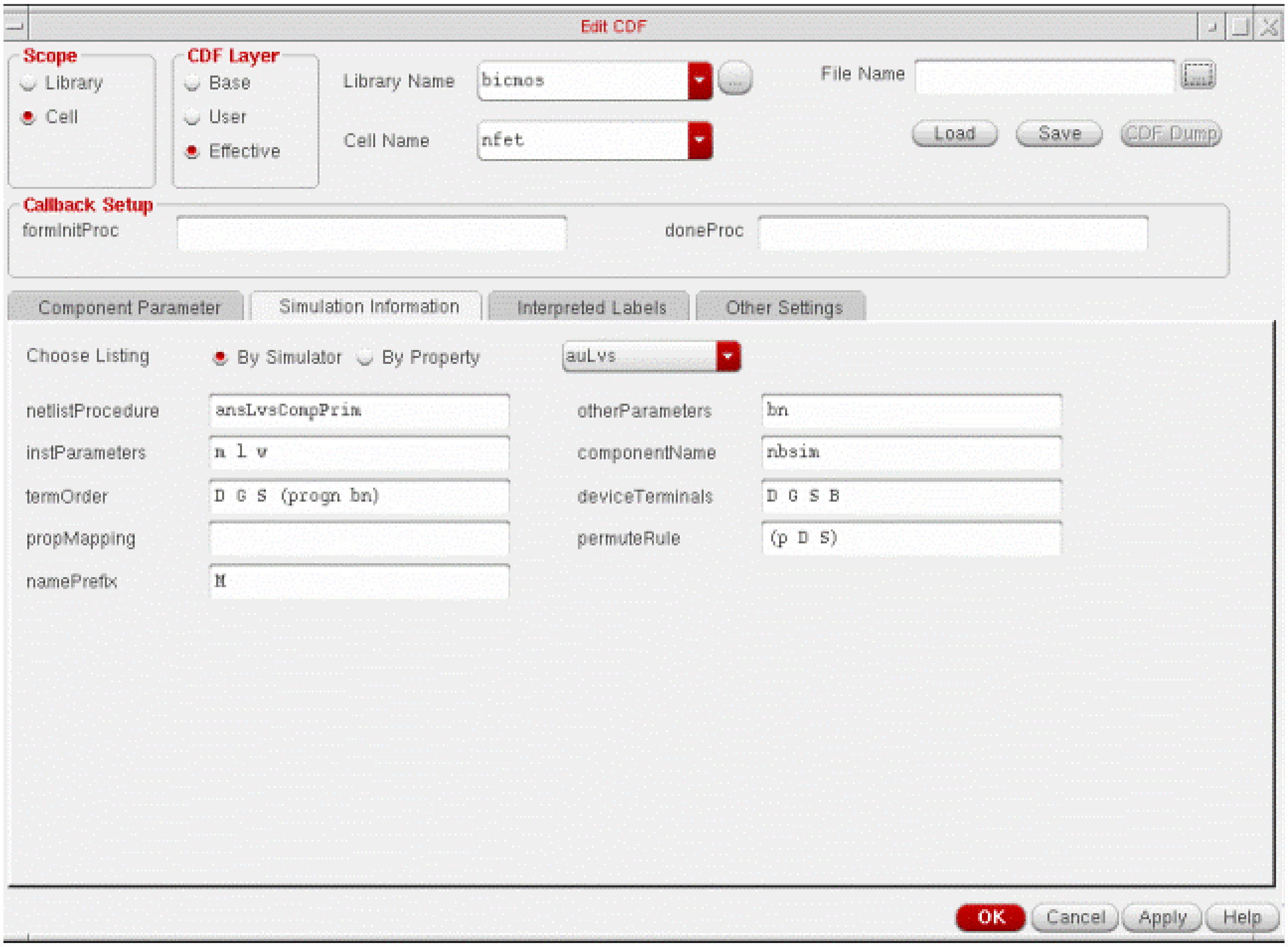
your_install_dir/tools/dfII/etc/cdslib/artist/cdsSpice/functional

NFET Example

Before proceeding with this example, open the Edit CDF form and set it to edit the *nfet* cell in the *bicmos* library. Click the Simulation Information tab.

For this NFET example, the next step in CDF development is to select simulator options for the new component. Because you copied the CDF description for the NFET component from *analogLib*, there are five simulators with their options already defined, including *auLvs* and *spectre*.

For the Analog-Microwave LVS (auLvs) simulator, you need to define three parameters in the parameter section of the CDF description, *m*, *l*, and *w*. For the NFET example, these parameters were copied from the *analogLib nbsim* cell.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: bicmos

Cell Name: nfet

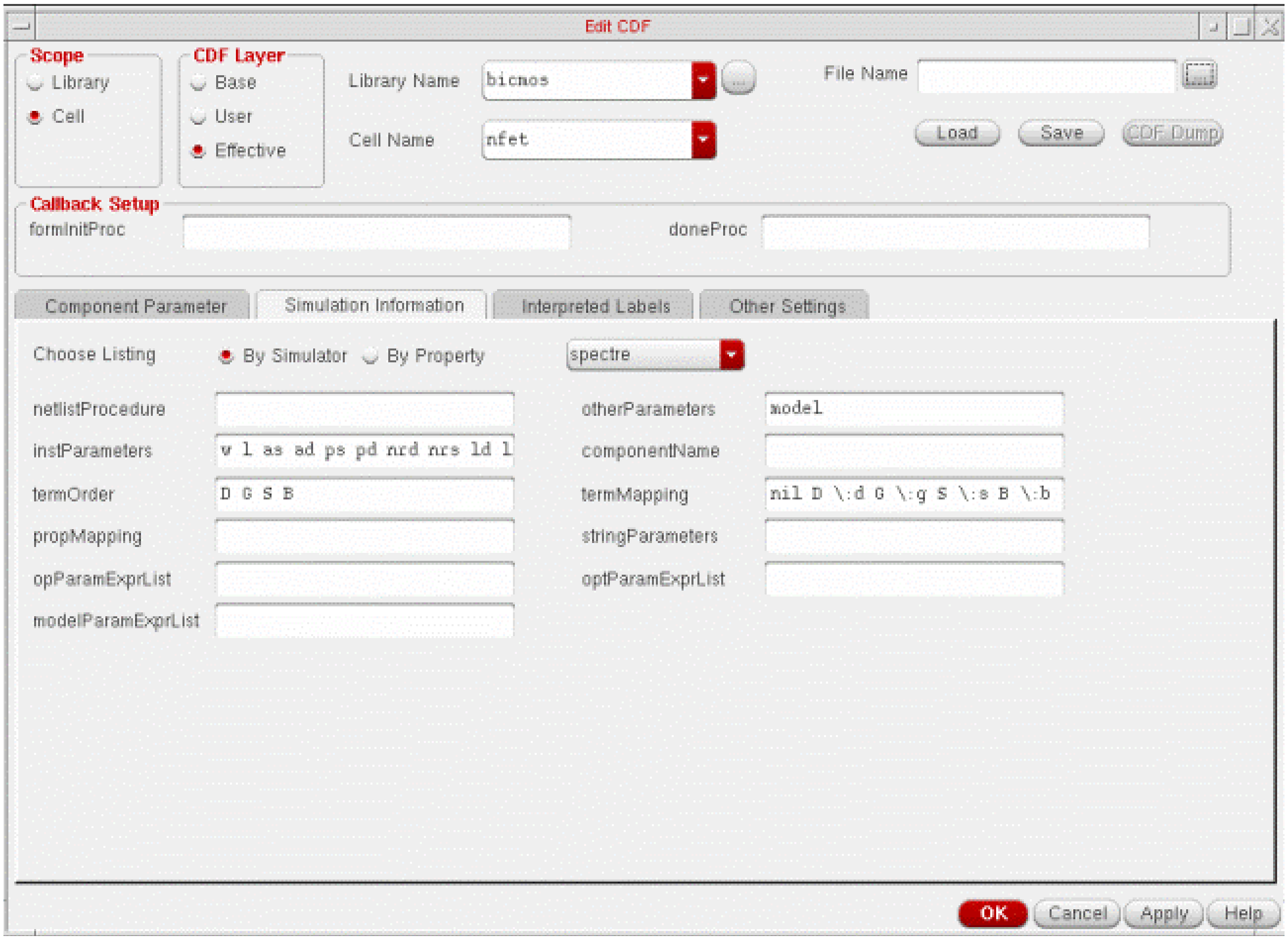
File Name:

Callback Setup
formInitProc:
doneProc:

Choose Listing: ● By Simulator ○ By Property — auLvs

netlistProcedure	ansLvsCompPrim	otherParameters	bn
instParameters	m l w	componentName	nbsim
termOrder	D G S (progn bn)	deviceTerminals	D G S B
propMapping		permuteRule	(p D S)
namePrefix	M		

You also need parameters for the spectre interface but these are already defined in the original CDF that was copied. The Spectre simulator does not require property mapping.



Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: bicmos

Cell Name: nfet

Choose Listing: ● By Simulator ○ By Property spectre

instParameters: w l as ad ps pd nrd nrs ld l

otherParameters: model

termOrder: D G S B

termMapping: nil D \:d G \:g S \:s B \:b

5

Specifying Label Information

Interpreted Labels Information

You can use interpreted labels to display parameter values, evaluated parameter values, net connectivity information, backannotated simulation information, and more.

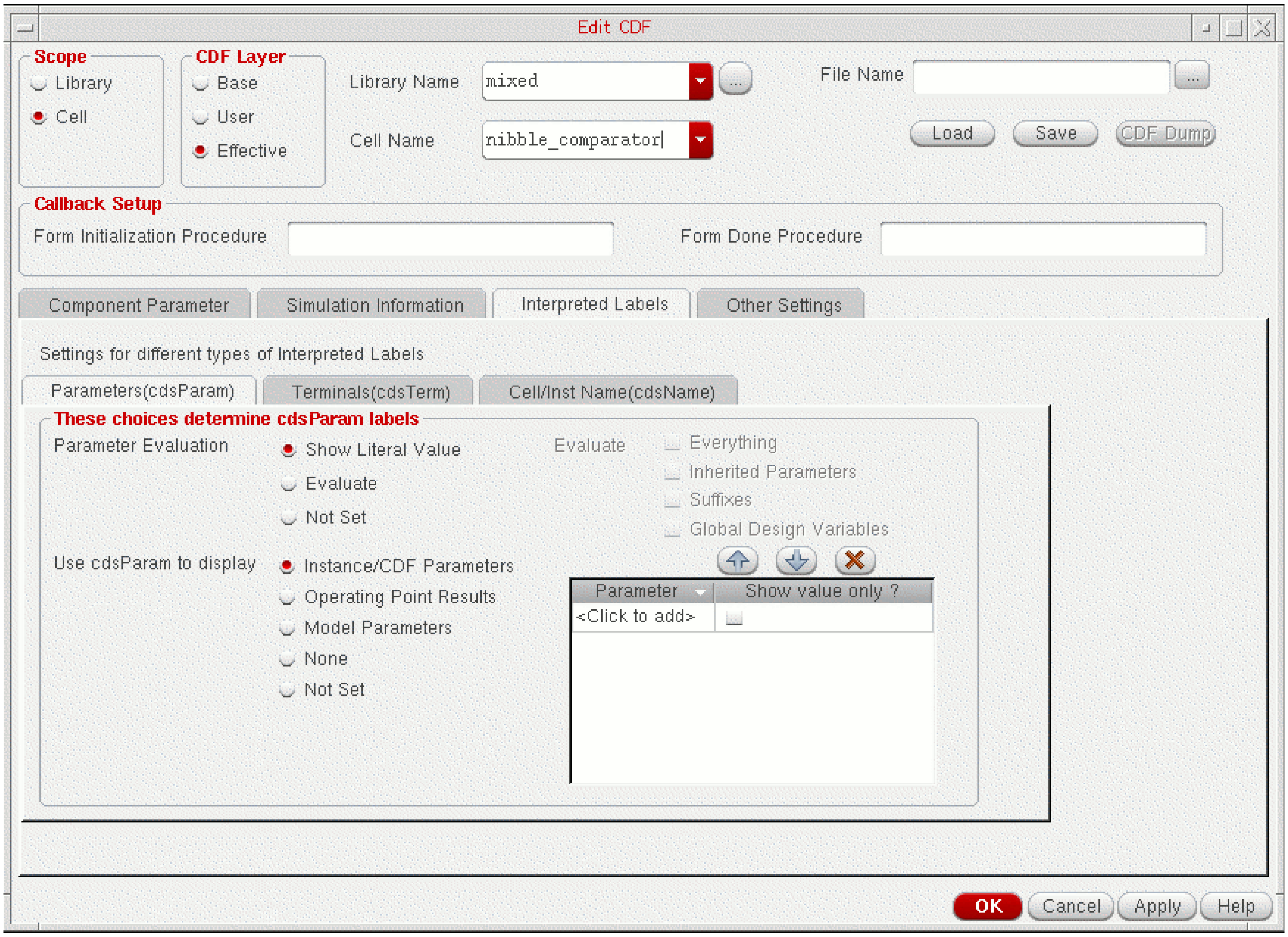
You can set the default label display options in the Interpreted Labels tab of the Edit CDF form. The Interpreted Labels tab has the following three tabs that are described below:

- Parameters(cdsParam)
- Terminals(cdsTerm)
- Cell/Inst Name(cdsName)

Library label information differs from cell label information. So the display that you see in Parameters(cdsParam), Terminals(cdsTerm) and Cell/Inst Name(cdsName) tabs depends on whether you are viewing the CDF for a library or a cell. For more information about the tabs, see the following sections.

Parameters(cdsParam)

The *cdsParam*( ) labels (usually placed on the layer *annotate drawing*) display information about parameter values or backannotated parameter values. You can set the default display options for cdsParam labels in the Parameters(cdsParam) tab.



Scope
○ Library
● Cell

CDF Layer
○ Base
○ User
● Effective

Library Name: mixed

Cell Name: nibble_comparator

File Name:

Callback Setup
Form Initialization Procedure:
Form Done Procedure:

Settings for different types of Interpreted Labels

These choices determine cdsParam labels

Parameter Evaluation
● Show Literal Value
○ Evaluate
○ Not Set

Evaluate
□ Everything
□ Inherited Parameters
□ Suffixes
□ Global Design Variables

Use cdsParam to display
● Instance/CDF Parameters
○ Operating Point Results
○ Model Parameters
○ None
○ Not Set

Parameter	Show value only ?
<Click to add>	□

The fields in the Parameters(cdsParam) tab are described below:

- **Parameter Evaluation** selects a method for displaying parameter values. (These different methods of display are necessary because a parameter value can be a constant, a design variable, an expression using constants or design variables, or a value or expression inherited from the hierarchy.)
    - **Show Literal Value** displays the literal parameter value as entered.
    - **Evaluate** evaluates the parameter value as specified in the *Evaluate* field.

- ❑ **Not Set** enables you to specify a value of not set for any field. This means that the parameter is deleted from or not added to the base-level library CDF. The corresponding value of the parameter is picked from the library level for any field on the *Interpreted Labels* tab.

- **Evaluate** selects the parameter evaluation method if *Parameter Evaluation* is set to *Evaluate*. Select the check box next to one of the following options:

  - ❑ **Everything** performs complete numeric evaluation of the expression and displays the result. For example, if the value is *Rin*10* and *Rin* is 5, it displays *50*. If the value is *pPar(Rin)*100* and the parent instance has a parameter *Rin* set to 10, it displays *1000*.

  - ❑ **Inherited Parameters** evaluates inherited parameters in expressions. For example, if the value is *pPar(Rin)*100* and the parent instance has a parameter *Rin* set to 10, the label displays *10 * 100*.

  - ❑ **Suffixes** converts suffixes in the parameter value to numerical values. For example, 1K becomes 1000.

  - ❑ **Global Design Variables** evaluates global design variables in expressions. For example, if the value is *Rin*100* and *Rin* is 5, the label displays *5 * 100*.

- **Use cdsParam to display** allows you to select the kind of parameters to display for cells.

  - ❑ **Instance/CDF Parameter** displays the instance or CDF parameters listed in the table. For information about selecting the parameters to be displayed, see Specifying cdsParam Parameters to Display on page 106.

  - ❑ **Operating Point Result** displays the DC or transient operating point results from simulation for the parameters listed in the table. For information about selecting the parameters to be displayed, see Specifying cdsParam Parameters to Display on page 106.

  - ❑ **Model Parameters** displays the simulation values for the model parameters listed in the table. For information about selecting the parameters to be displayed, see Specifying cdsParam Parameters to Display on page 106.

  - ❑ **None** displays no parameters

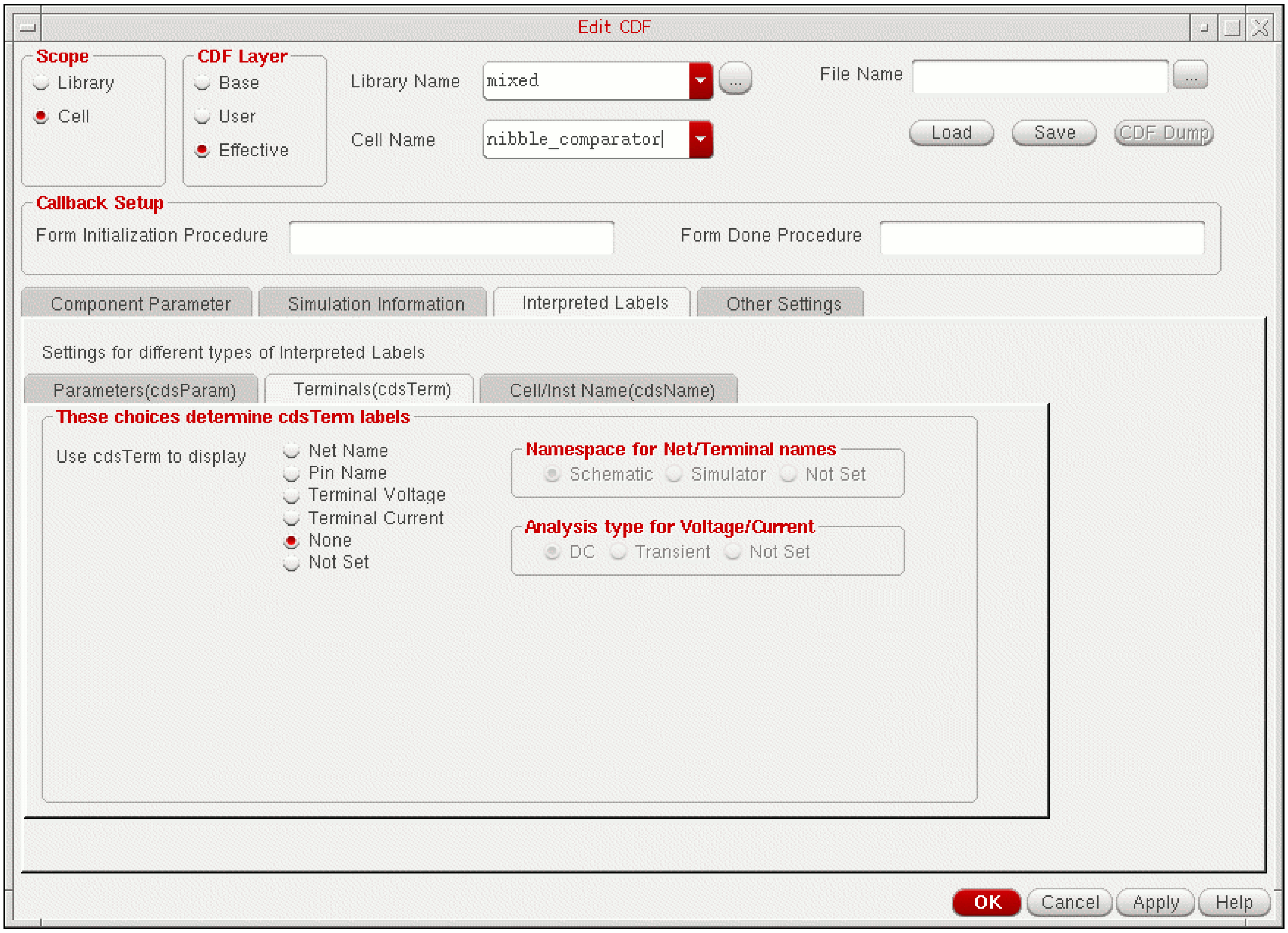
  - ❑ **Not Set** specifies that you made no selection for this field

  Note: The **Use cdsParam to display** fields are not applicable to library-level CDF.

- **Operating Point Results Type** selects the simulation type for the operating point result that you want to annotate. The choices are *DC* or *Transient*. This field is for operating point parameters only.

Terminals(cdsTerm)

The *cdsTerm( )* labels (usually placed on the layer *annotate drawing8*) display information about the pin or about the nets attached to the pin. You can set the default display options for cdsTerm labels in the Terminals(cdsTerm) tab.



Edit CDF

Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: mixed

Cell Name: nibble_comparator

File Name:

Callback Setup

Form Initialization Procedure:

Form Done Procedure:

Settings for different types of Interpreted Labels

These choices determine cdsTerm labels

Use cdsTerm to display: ○ Net Name ○ Pin Name ○ Terminal Voltage ○ Terminal Current ● None ○ Not Set

Namespace for Net/Terminal names: ● Schematic ○ Simulator ○ Not Set

Analysis type for Voltage/Current: ● DC ○ Transient ○ Not Set

The fields in the Terminals(cdsTerm) tab are described below:

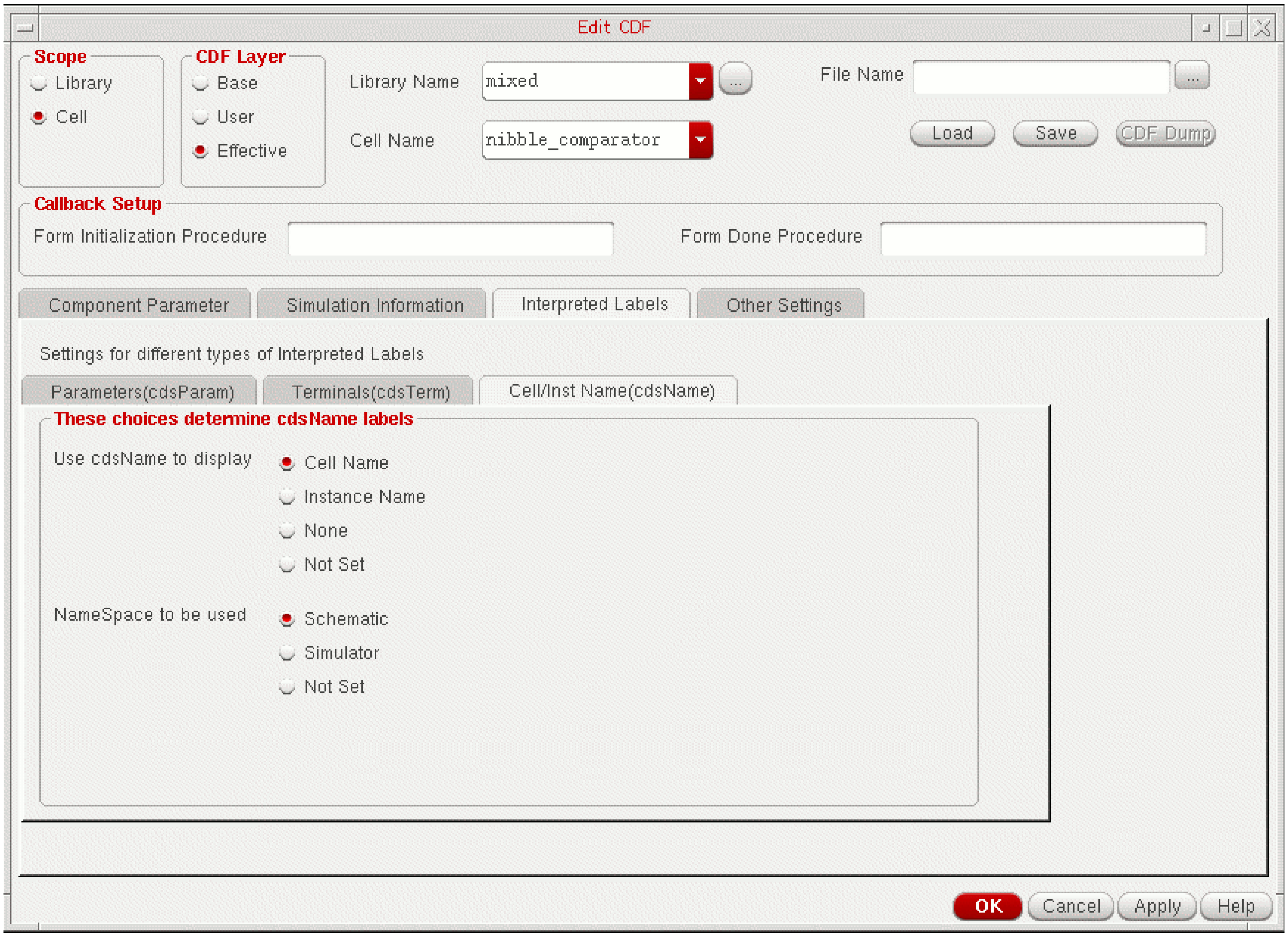
- **Use cdsTerm to display** selects what is displayed next to the component terminals.
  - ❑ **Net Name** displays the terminal net names.
  - ❑ **Pin Name** displays the terminal pin names.
  - ❑ **Terminal Voltage** displays the terminal voltage.
  - ❑ **Terminal Current** displays the terminal current.
  - ❑ **None** does not display cdsTerm labels.

- ❑ **Not Set** specifies that you made no selection for this field.

- **Namespace for Net/Terminal names** selects the type of net name to display if *Use cdsTerm to display* is set to *Net Name* or *Pin Name*. The choices are *Schematic*, *Simulator*, or *Not Set*.
- **Analysis type for Voltage/Current** selects the simulation type for the result that you want to annotate.The choices are *DC*, *Transient*, or *Not Set*. This field is used only when *Use cdsTerm to display* is either *Terminal Voltage* or *Terminal Current*.

Cell/Inst Name(cdsName)

The *cdsName( )* labels (usually placed on the layer *annotate drawing7*) display information about the cell name or the instance name. You can set the default display options for cdsName labels in the Cell/Inst Name(cdsName) tab.



Edit CDF

Scope: ○ Library ● Cell
CDF Layer: ○ Base ○ User ● Effective
Library Name: mixed
Cell Name: nibble_comparator
File Name:
Callback Setup
Form Initialization Procedure:
Form Done Procedure:

Settings for different types of Interpreted Labels

These choices determine cdsName labels

Use cdsName to display: ● Cell Name ○ Instance Name ○ None ○ Not Set
NameSpace to be used: ● Schematic ○ Simulator ○ Not Set

The fields in the Cell/Inst Name(cdsName) tab are described below:

- **Use cdsName to display** selects what is displayed next to the component symbol.
    - **Cell Name** displays the cell name of the component.
    - **Instance Name** displays the instance name of the component.
    - **None** specifies that no information is displayed.
    - **Not Set** specifies that you made no selection for this field.
- **NameSpace to be used** selects the type of instance name. The choices are *Schematic*, *Simulator*, or *Not Set*. This field is used only when the *Use cdsName to display* is *Instance Name*.

Creating Labels Using the Edit CDF Form

You can make selections for label information for both library and cell CDFs. You can use the following procedure to create labels for a library CDF.

1. Click the Interpreted Labels tab of the Edit CDF form.
2. Make edits for library or cell CDF label specifications.
3. Click *Apply* to apply these specifications to the current CDF.

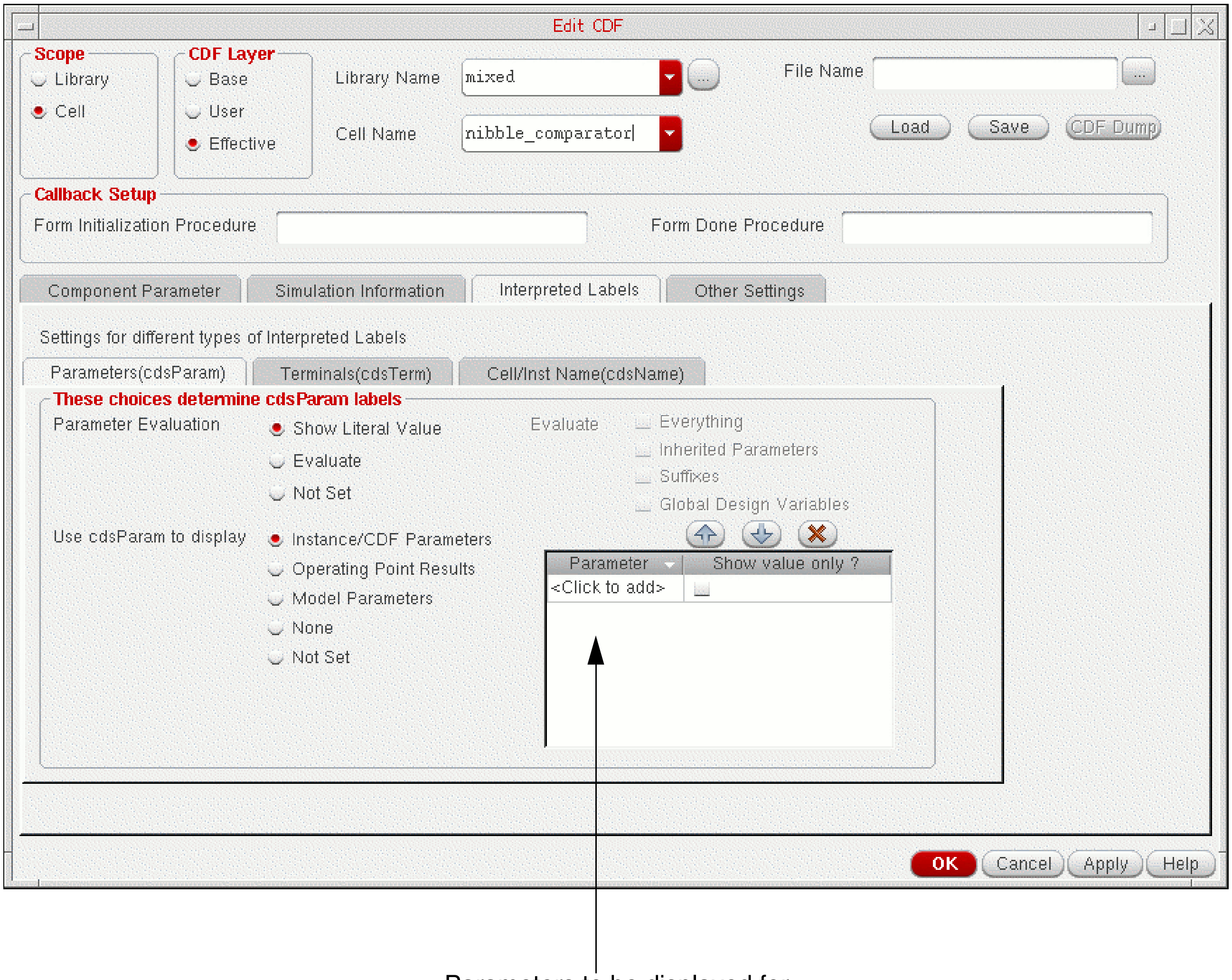
Specifying cdsParam Parameters to Display

The Parameters(cdsParam) tab on the Interpreted Labels tab of the Edit CDF form allows you to specify the parameters to be displayed for cdsParam labels.

To specify the cdsParam parameters to display, do the following:

1. Select the radio button corresponding to the parameters you want to display—*Instance/ CDF Parameter*, *Operating Point Result* or *Model Parameters*.

The table on the right lists the parameters to be displayed. For example, the table in the following figure lists the parameters to be displayed if the *Instance/CDF Parameter* radio button is selected.



Edit CDF

Scope: ○ Library ● Cell

CDF Layer: ○ Base ○ User ● Effective

Library Name: mixed

Cell Name: nibble_comparator

File Name:

Callback Setup

Form Initialization Procedure:

Form Done Procedure:

Settings for different types of Interpreted Labels

These choices determine cdsParam labels

Parameter Evaluation: ● Show Literal Value ○ Evaluate ○ Not Set

Evaluate: □ Everything □ Inherited Parameters □ Suffixes □ Global Design Variables

Use cdsParam to display: ● Instance/CDF Parameters ○ Operating Point Results ○ Model Parameters ○ None ○ Not Set

Parameter	Show value only ?
<Click to add>	□

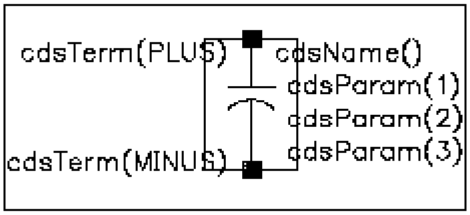
Parameters to be displayed for
cdsParam labels

2. Specify the parameters you want to display:

- To add a parameter, click where it says *<Click to add>* in the *Parameter* column and type the name of the parameter.

  Note: The new parameter is also displayed in the Component Parameter tab.

- The parameters are displayed in the order in which they are listed in the table. The number of parameters that are displayed is also limited to the number of cdsParam labels on the cell. For example, the following figure shows the symbol for a capacitor that has three cdsParam labels. For this cell, only the first three parameters listed in the table are displayed.



To change the order in which the parameters are listed in the table, select a parameter and click the ↑ or ↓ buttons.

- By default, a parameter name and its value are displayed in the format:
  `parameter name : value`

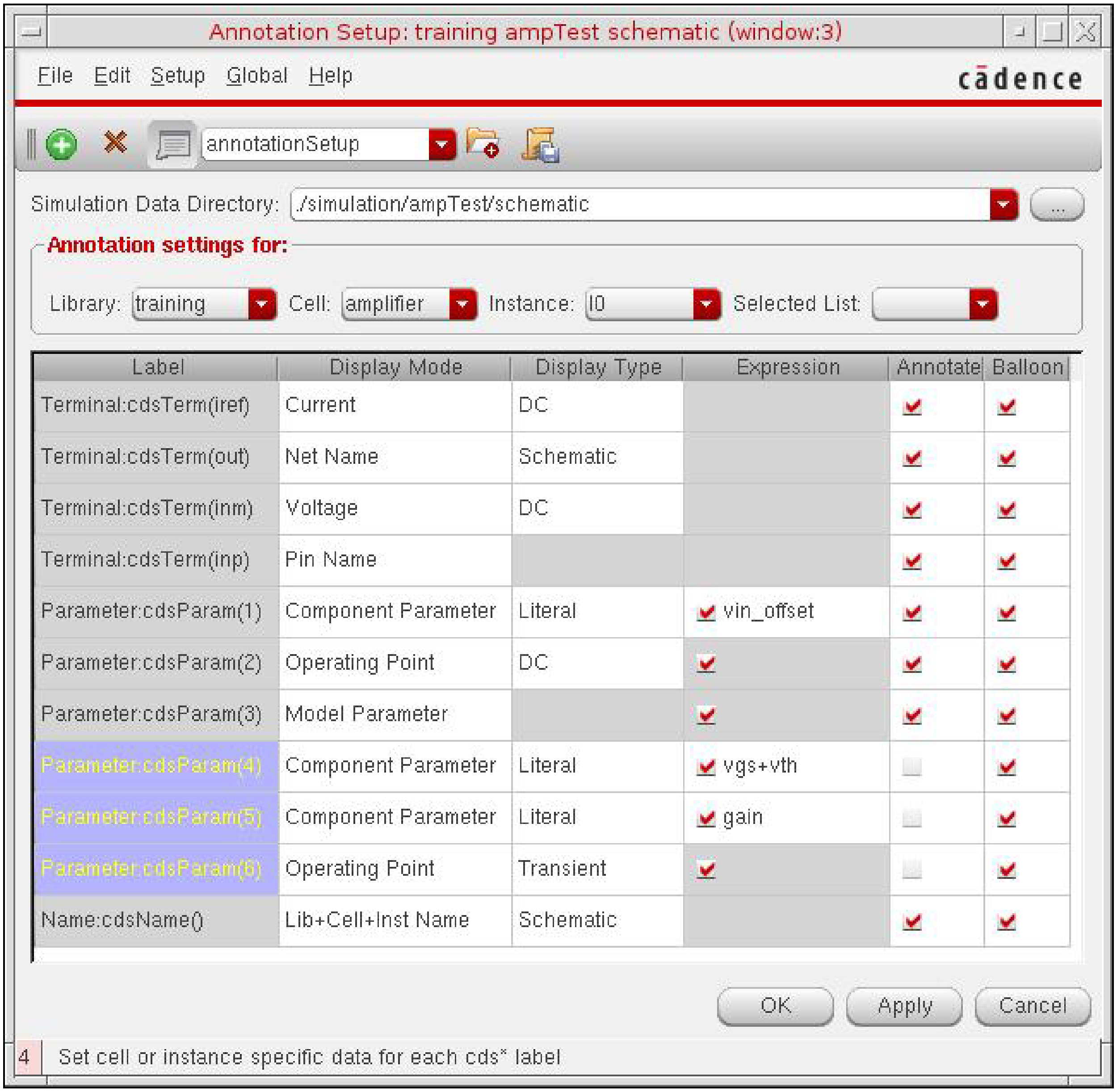
  To display only the value of a parameter, select the check box next to the parameter in the *Show Value Only ?* column.

- To delete a parameter, select the parameter and click the ✕ button.

3. Click *Apply*.

The Annotation Setup Form

You can control the creation of CDF labels by using the *View – Annotations – Setup* command in the Schematic to open the Annotation Setup form.



Annotation Setup: training ampTest schematic (window:3)

annotationSetup

Simulation Data Directory: ./simulation/ampTest/schematic

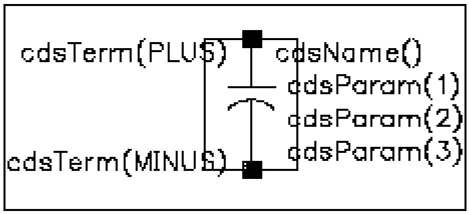
Annotation settings for:

Library: training Cell: amplifier Instance: I0 Selected List:

Label	Display Mode	Display Type	Expression	Annotate	Balloon
Terminal:cdsTerm(iref)	Current	DC		✓	✓
Terminal:cdsTerm(out)	Net Name	Schematic		✓	✓
Terminal:cdsTerm(inm)	Voltage	DC		✓	✓
Terminal:cdsTerm(inp)	Pin Name			✓	✓
Parameter:cdsParam(1)	Component Parameter	Literal	✓ vin_offset	✓	✓
Parameter:cdsParam(2)	Operating Point	DC	✓	✓	✓
Parameter:cdsParam(3)	Model Parameter		✓	✓	✓
Parameter:cdsParam(4)	Component Parameter	Literal	✓ vgs+vth	☐	✓
Parameter:cdsParam(5)	Component Parameter	Literal	✓ gain	☐	✓
Parameter:cdsParam(6)	Operating Point	Transient	✓	☐	✓
Name:cdsName()	Lib+Cell+Inst Name	Schematic		✓	✓

4 Set cell or instance specific data for each cds* label

When you change the display of information in the Annotation Setup form, the display of *ilLabels* (labels generated automatically during automatic symbol generation) and interpreted labels is affected. *ilLabels* are usually defined on symbols and are displayed when you place the symbol in a schematic. For example, the following figure shows the symbol for a capacitor from *analogLib*:



The *cdsTerm( )* labels (usually placed on the layer *annotate drawing8*) display information about the pin or about the nets attached to the pin. These labels must follow the syntax *cdsTerm(pinName)*. In the Annotation Setup form, you can use the Terminal:cdsTerm() label settings to control the *cdsTerm* labels.

The *cdsName( )* labels (usually placed on the layer *annotate drawing7*) display information about the cell name, the instance name, the library name, or a combination of any two. In the Annotation Setup form, you can use the Instance:cdsName() label settings to control the *cdsName* label.

The *cdsParam*( ) labels (usually placed on the layer *annotate drawing*) display information about parameter values or backannotated parameter values. These labels are usually generated during automatic symbol generation, but you can define additional labels. The only requirement for the parameter labels is that they should be sequential, starting with 1 if they are numbers. In the Annotation Setup form, you can use the Parameter:cdsParam() label settings to control the *cdsParam* labels.

Note: You must declare the parameter names in the *Instance/CDF Parameter* field in the Parameters(cdsParam) tab on the Interpreted Labels tab of the Edit CDF form. The cdsParam points to those parameters in an ordered manner. If you change the order of those parameters, the displayed values will be changed.

In the Annotation Setup form, individual rows are displayed for each parameter name label. If you add another parameter label to the selected cell or instance, a row appears on the Annotation Setup form. The added row is colored to distinguish from the other parameter labels of the design.

When the design is open, the default annotation settings for the design are retrieved from the CDF. If you select a library, and select * in the Cell and Instance drop-down lists, and click *Apply*, then the library-level annotation settings are applied to all the instances in the selected library. Similarly, if you select a library and a cell, and select * in the Instance drop-down list, and click *Apply*, then the cell-level annotation settings are applied to all the instances in the selected cell. Select the *Apply * Settings to All* option from the Edit menu to apply the library or cell-level annotation settings to all the instances. If this option is not selected, then the library or cell-level annotation settings are not applied to those instances on which the custom annotation settings are applied.

Any changes (at library, cell or instance level) in the Annotation Setup form does not affect the CDF or instance properties. However, you can save the annotation settings to the user cell level CDF (It is not written to the database or saved when you exit the Cadence software.) To keep this library and cell CDF information, copy it into a library or base CDF description that is permanently saved.

Creating Labels in the Schematic Editor

You can set up label display with the Annotation Setup form and the Edit CDF form as follows:

1. Set up your component and place it in a schematic.
2. Choose *View – Annotations– Setup* to set up the labels you want placed with the component and click *Apply*.
3. On the Edit CDF form, look at the effective-level CDF description for the labeled component.

   The effective-level cell CDF is the combination of the base-level CDF (with all the parameter and simulation information defined) and the user-level CDF that you created with the Annotation Setup form.
4. Type in a filename and click *Save* to save the contents of the form in a file.
5. Change the CDF type to *base*.
6. Enter the same filename and click *Load*.

   The effective-level CDF is copied to a base-level CDF with all the interpreted label information set up as you saw it.
7. Click *OK* to save this new base CDF description.
8. Repeat this procedure to create a library CDF description.

When you place a component in the schematic editor, the Add Instance form shows the parameters associated with this component. No CDF properties (labels) appear unless you assign parameter values other than the default values. If you want to see the value of any parameter displayed in the design window, you can toggle the display setting for that parameter to make it visible.

Creating Labels with SKILL

You can use the following Cadence SKILL language functions with the right arrow operator `(->`) to select label specifications. You enter the specifications as properties of either the library or cell CDF. Not all properties need to be set. Enter only those properties that you want set.

For details, see *CDF SKILL Summary* in *Virtuoso ADE SKILL Reference*.

The following SKILL expressions set label CDF specifications at the library level:

- paramDisplayMode (equivalent to *Use cdsParam to display* setting in the Parameters(cdsParam) tab)

  ```
  libId = ddGetObj("analogLib")
  cdfId = cdfCreateBaseLibCDF(libId)
  cdfId->paramDisplayMode = “parameter”
  ```

- paramEvaluate (equivalent to *Evaluate* setting in the Parameters(cdsParam) tab)

  ```
  cdfId->paramEvaluate = "t nil nil nil nil"
  ```

  For the paramEvaluate option list, the first entry applies to literal, the second to suffixes, the third to globals, the fourth to inheritance, and the fifth to full.

- paramSimType (equivalent to *Operating Point Results Type* setting in the Parameters(cdsParam) tab)

  ```
  cdfId->paramSimType = "DC"
  ```

- termDisplayMode (equivalent to *Use cdsTerm to display* setting in the Terminals(cdsTerm) tab)

  ```
  cdfId->termDisplayMode = "netName"
  ```

- termSimType (equivalent to *Analysis type for Voltage/Current* setting in the Terminals(cdsTerm) tab)

  ```
  cdfId->termSimType = "DC"
  ```

- netNameType (equivalent to *Namespace for Net/Terminal names* setting in the Terminals(cdsTerm) tab)

  ```
  cdfId->netNameType = "schematic"
  ```

- instDisplayMode (equivalent to *Use cdsName to display* setting in the Cell/Inst Name(cdsName) tab)

  ```
  cdfId->instDisplayMode = "instName"
  ```

- `instNameType (equivalent to` *Namespace to be used* setting in the Cell/Inst Name(cdsName) tab)

  ```
  cdfId->instNameType = "schematic"
  ```

The following expressions set label CDF specifications at the cell level:

- paramLabelSet (equivalent to *Instance/CDF Parameters* setting in the Parameters(cdsParam) tab)

  ```
  cell = ddGetObj(libId->name "NFET")
  cdfId = cdfCreateBaseCellCDF(cell)
  cdfId->paramLabelSet = "-model l w"
  ```

- opPointLabelSet equivalent to *Operating Point Results* setting in the Parameters(cdsParam) tab)

  ```
  cdfId->opPointLabelSet = "id vgs vds"
  ```

- modelLabelSet (equivalent to *Model Parameters* setting in the Parameters(cdsParam) tab)

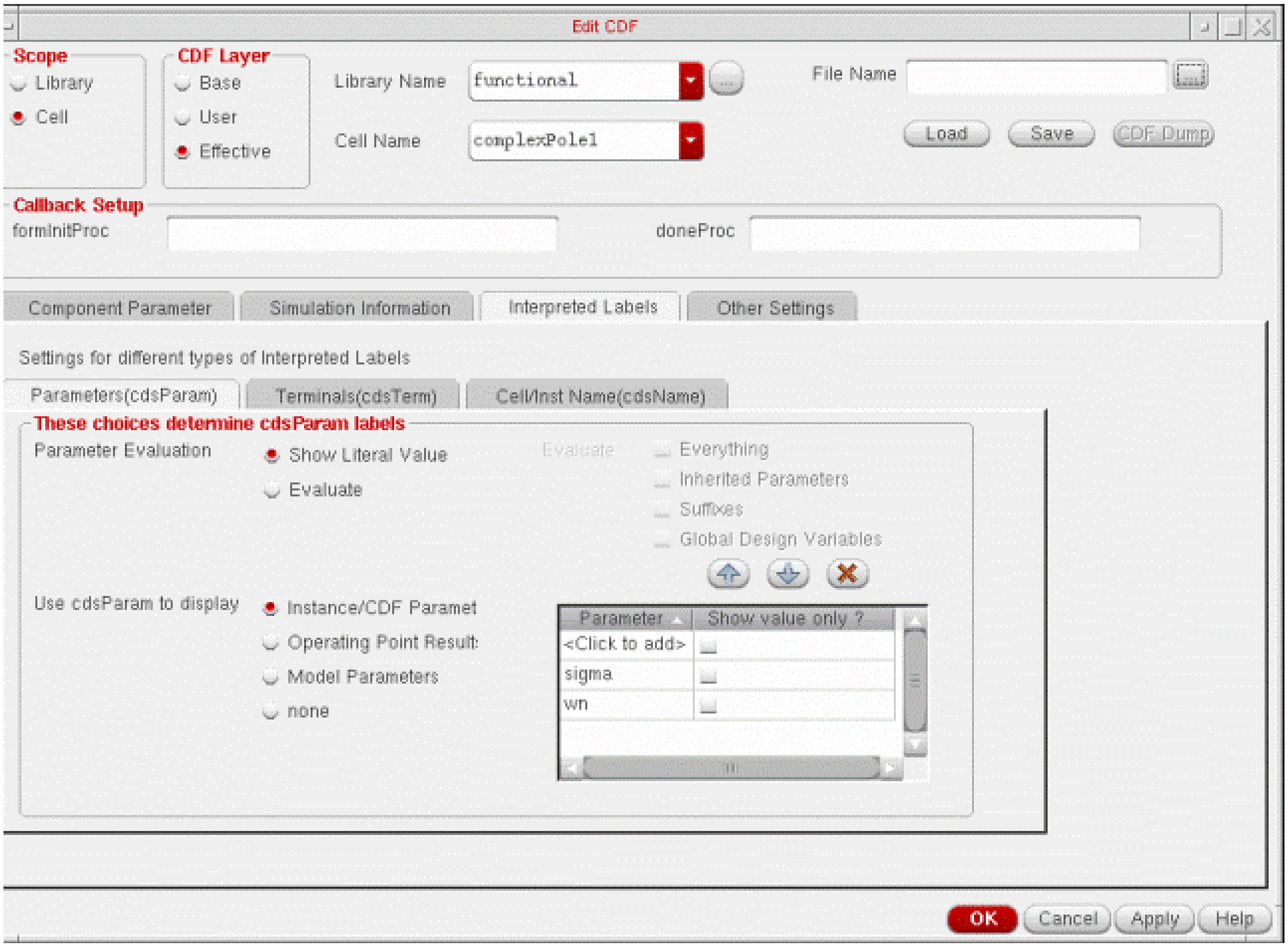
  ```
  cdfId->modelLabelSet = "vfb phi eta"
  ```

  Note: While setting label specifications, extra spacing between values is not permitted.

Complex Pole Example

In previous chapters, you used the Edit CDF form on the *complexPole1* component to look at the Component Parameter and Simulation Information sections of the CDF description. Now you look at the Interpreted Labels information in the complex pole CDF description and see how it affects the display of the component’s symbol.

The following figure shows the Interpreted Labels tab of the Edit CDF form for *complexPole1*.



Scope
○ Library
● Cell

CDF Layer
○ Base
○ User
● Effective

Library Name: functional

Cell Name: complexPole1

File Name:

Callback Setup
formInitProc:
doneProc:

Settings for different types of Interpreted Labels

These choices determine cdsParam labels

Parameter Evaluation
● Show Literal Value
○ Evaluate

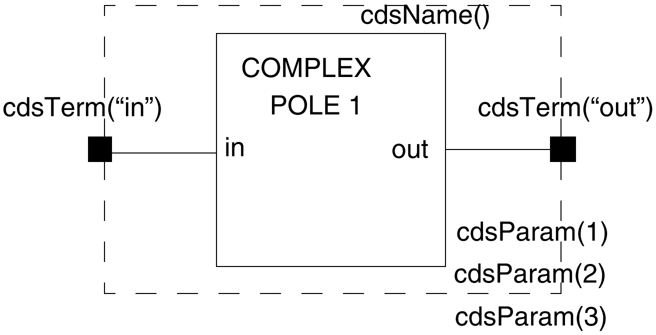
Evaluate
□ Everything
□ Inherited Parameters
□ Suffixes
□ Global Design Variables

Use cdsParam to display
● Instance/CDF Paramet
○ Operating Point Result
○ Model Parameters
○ none

Parameter	Show value only ?
<Click to add>	□
sigma	□
wn	□

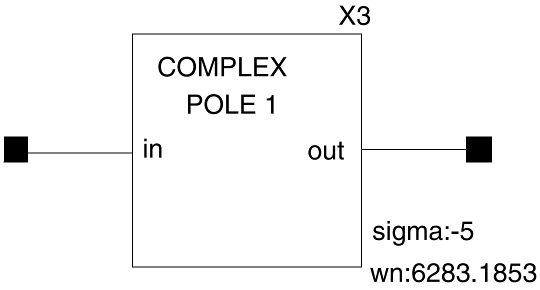
1. Look at the *complexPole1* symbol in the Symbol Editor. (Open the complexPole1 design, specifying the symbol cellview.)

   You see a generic version of the component, with no values displayed.



2. Open an empty schematic editor window by creating a new design.
3. Use the *Add Instance* command to add a *complexPole1* component to the schematic.

   Its symbol looks like this:



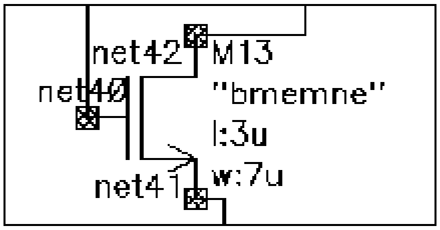
The two default parameter values from the Component Parameters tab and the instance name are set to be displayed (with the *Use cdsParam to display* setting in the Parameters(cdsParam) tab and the *Use cdsName to display* setting in the Cell/Inst Name(cdsName) tab). However, the *Use cdsTerm to display* setting in the Terminals(cdsTerm) tab is set to *Net Name*, and the component is by itself, not connected to any nets. There are no net names to display on the terminals (*in* and *out*).

NFET Example

The NFET symbol in the following figure shows the effect of setting *Use cdsParam to display* setting in the Parameters(cdsParam) tab to *Instance/CDF Parameters* with the *model*, *l* and *w* parameters*.* Three parameters, *model*, *l*, and *w,* are displayed. There is no parameter name displayed with *bmemne* (the model name) because the *Show Value Only* check box next to the *model* parameter is selected in the Parameters(cdsParam) tab.

The default values from the CDF description are displayed for the *l* and *w* parameters, as shown by the format of *parameter name : value* (*l:3u* and *w:7u*). In addition, the *Use cdsTerm to display* setting in the Terminals(cdsTerm) tab is set to *Net Name* and the *Use cdsName to display* setting in the Cell/Inst Name(cdsName) tab is set to *Instance Name*.

Unlike the complex pole example, this transistor is connected to nets in a schematic, so the net and instance names are all displayed.

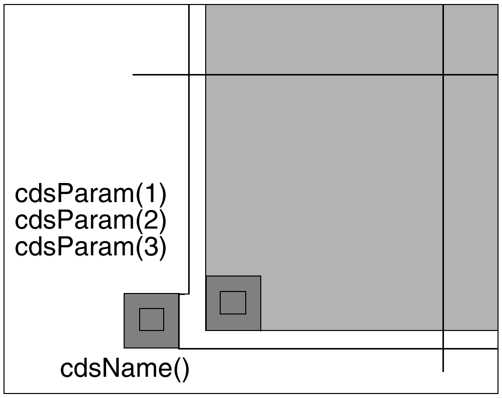


Try changing the fields to different settings and then view the results.

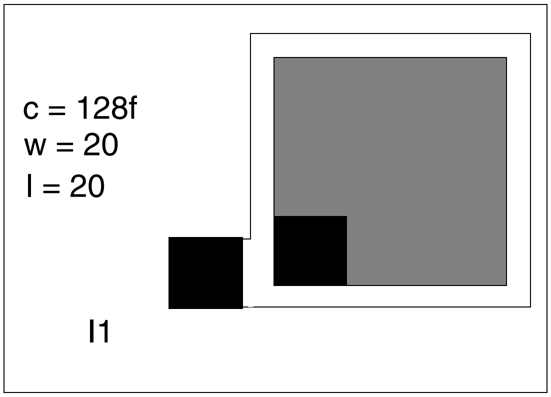
You can use labels in any view. For example, you can set up a layout with labels so that you can

instance and parameter information when you place an instance:

Layout Master



Instance



This can be especially useful when you build the *ivpcell* used in layout extraction. In this way, when you look at the extracted layout, you see the instance found and the parameters measured.

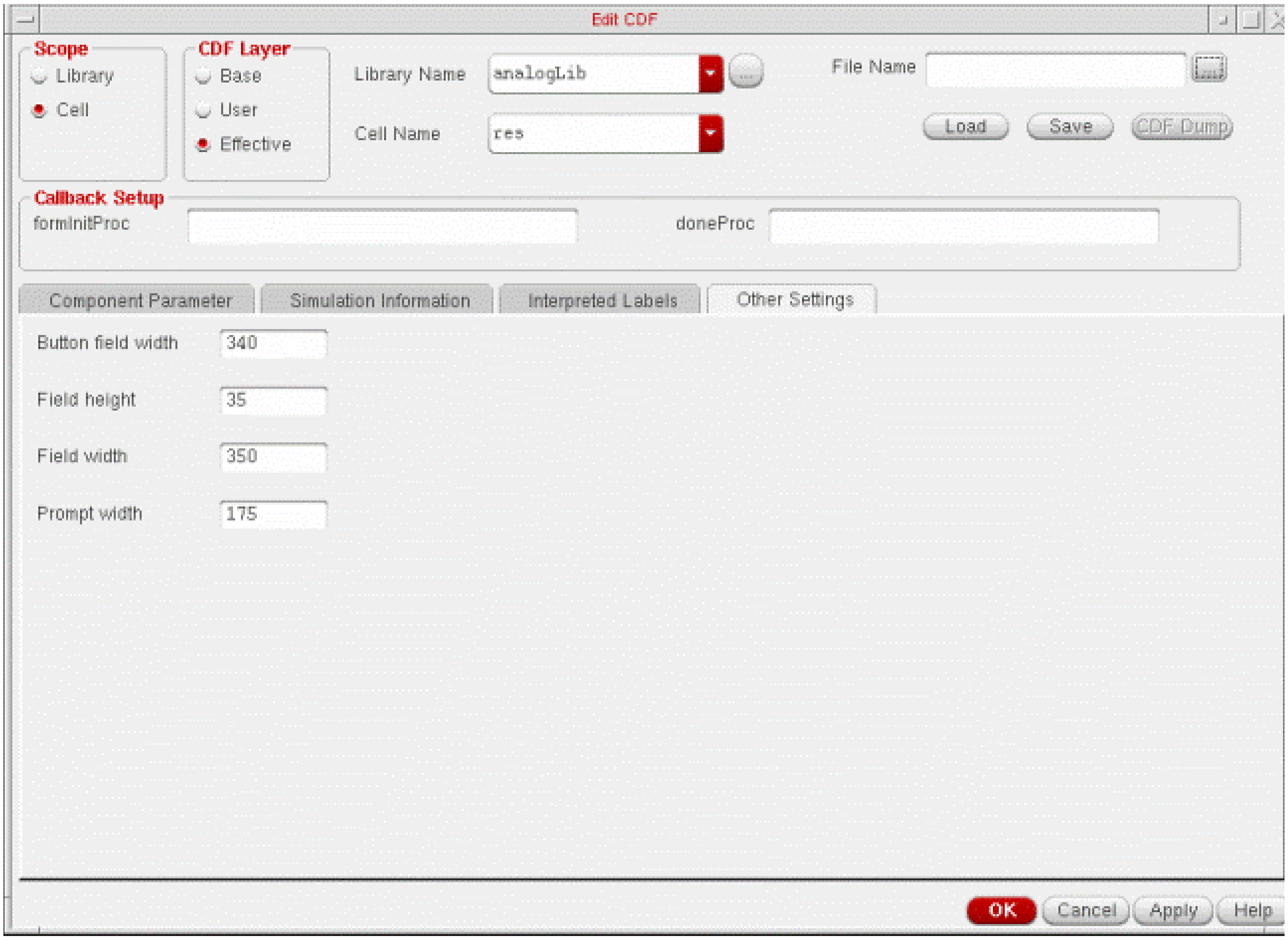
Note: These labels do not pick up hierarchical information, so *cdsName* will only show the current name, not the hierarchical name.

6

Other CDF Information

Other Settings Tab

You use the Other Settings tab of the Edit CDF form to specify the sizes of input fields.



Scope
○ Library
● Cell

CDF Layer
○ Base
○ User
● Effective

Library Name: analogLib
Cell Name: res
File Name:

Callback Setup
formInitProc:
doneProc:

Button field width: 340
Field height: 35
Field width: 350
Prompt width: 175

The following fields let you control the size of parameters on an instantiation form (such as the Add Instance or Edit Object Properties forms). These fields do not affect the display in the Edit CDF form.

Button field width lets you specify the width of a button on the instantiation form. The default width is 340 pixels.

Field height lets you specify the height of a field on the instantiation form. The default height is 35 pixels.

Field width lets you specify the width of a field on the instantiation form. The default width is 350 pixels.

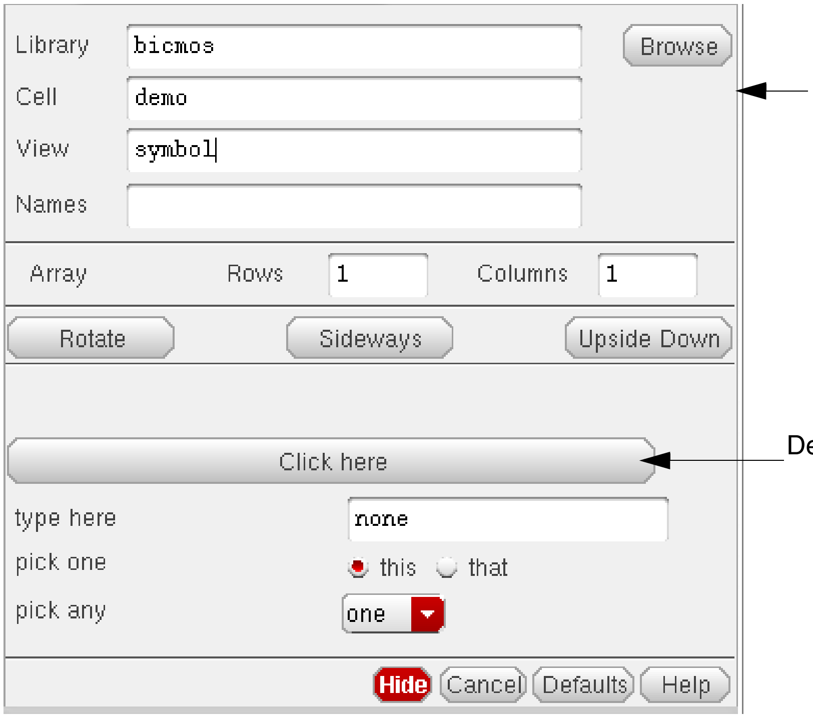
Prompt width lets you specify the width of the prompt on the instantiation form. The default width is 175 pixels.

Setting Up Fields and Prompts

The input fields and prompts for a component are displayed on an instantiation form, such as the Add Instance or Edit Object Properties forms. The following examples show the Add Instance form as it appears when a component is instantiated. The sample CDF description in these examples defines four parameters: a button, a string, a cyclic field, and a radio button field.

Adjusting Button Fields

You can adjust the width of a field with the *Button field width* parameter in the Other Settings tab on the Edit CDF form. The following examples show button fields on two Add Instance forms. The following form shows the button with the default width of 340 pixels.



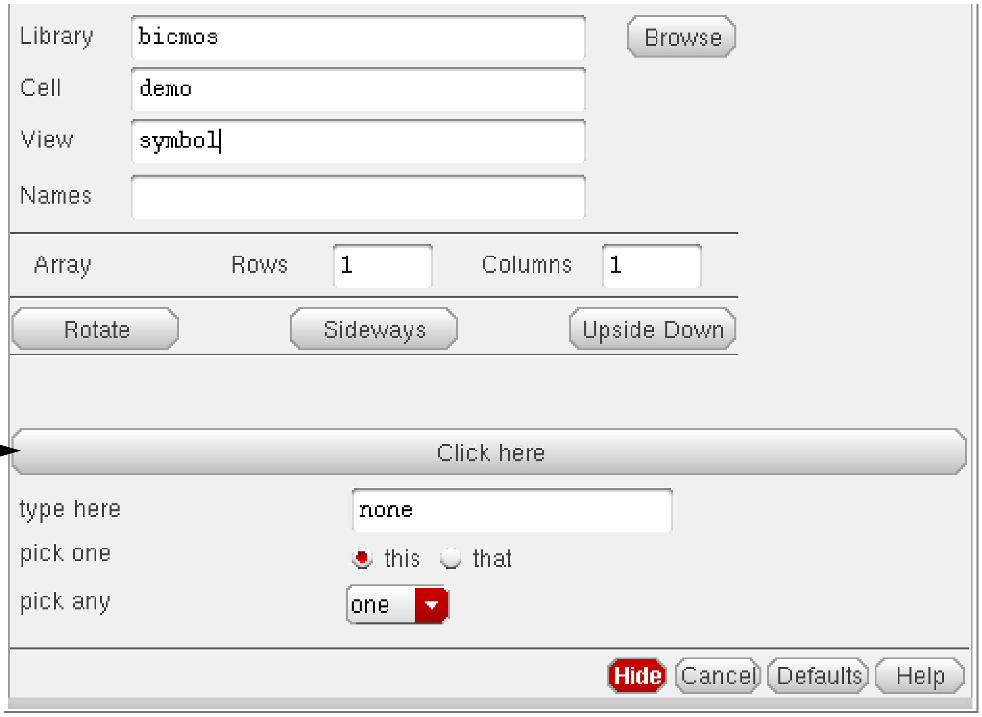
Library bicmos
Cell demo
View symbol
Names
Array Rows 1 Columns 1
type here none
pick one ● this ○ that
pick any one

Form with default button field width (340 pixels)

Default button size

The following form shows the button with a width of 500 pixels.

Form with button field width set to 500 pixels

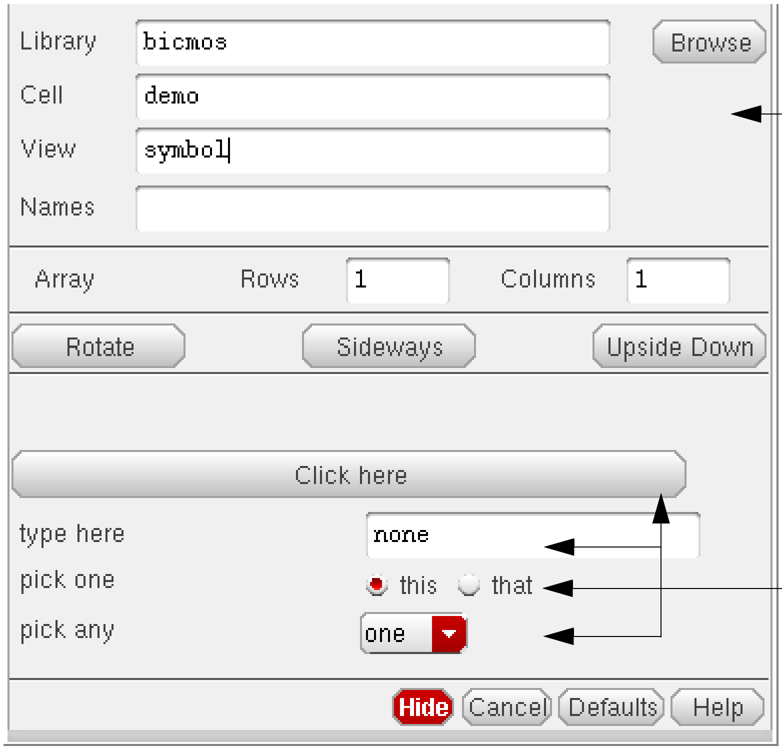


Library: bicmos
Cell: demo
View: symbol
Names:
Array Rows: 1 Columns: 1
type here: none
pick one: ● this ○ that
pick any: one

Wide button

Adjusting Field Heights

You can adjust the height of a field with the *Field height* parameter in the Other Settings tab on the Edit CDF form. The following example shows fields on two Add Instance forms. The following form shows the fields at the default height of 35 pixels.

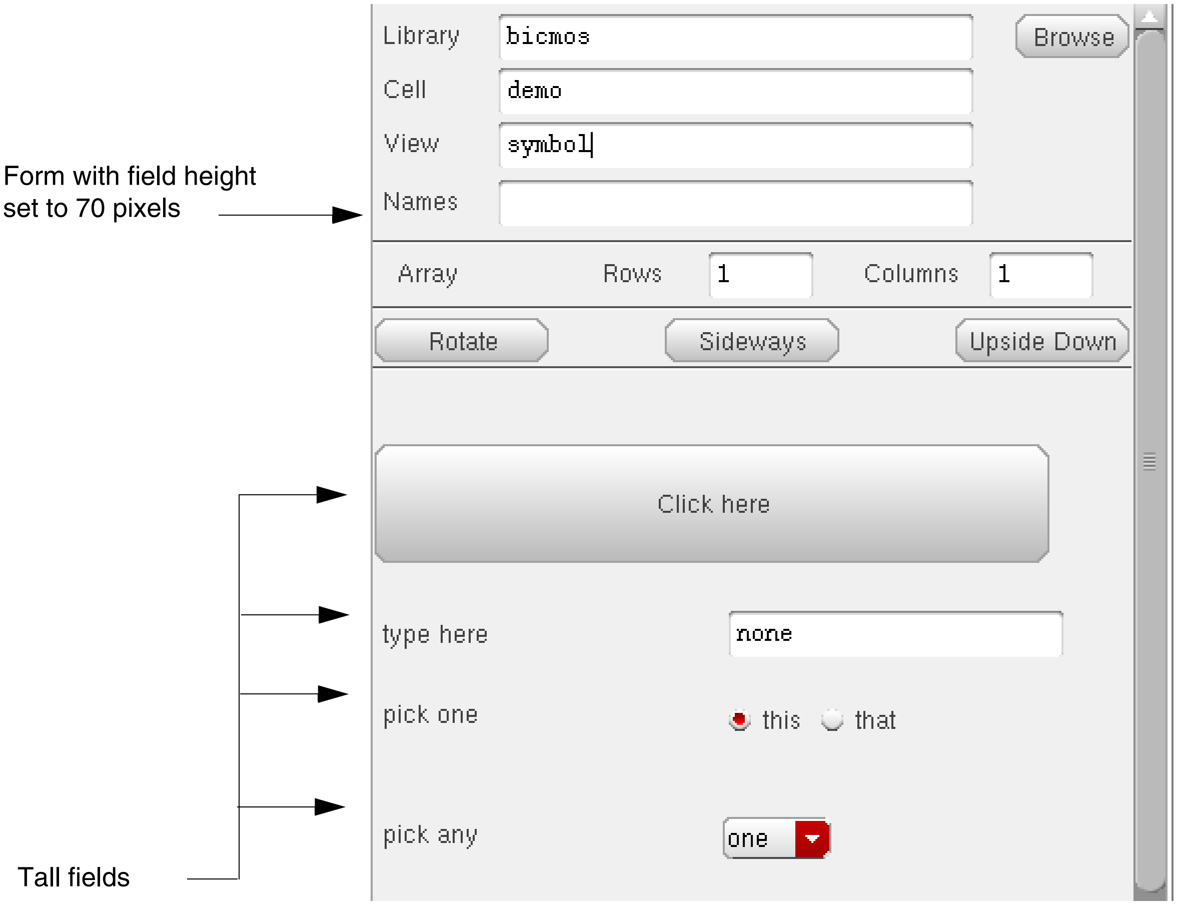


Library	bicmos
Cell	demo
View	symbol
Names	
Array	Rows 1 Columns 1
type here	none
pick one	● this ○ that
pick any	one

Form with default field height (35 pixels)

Default fields

The following form shows the field height at 70 pixels.



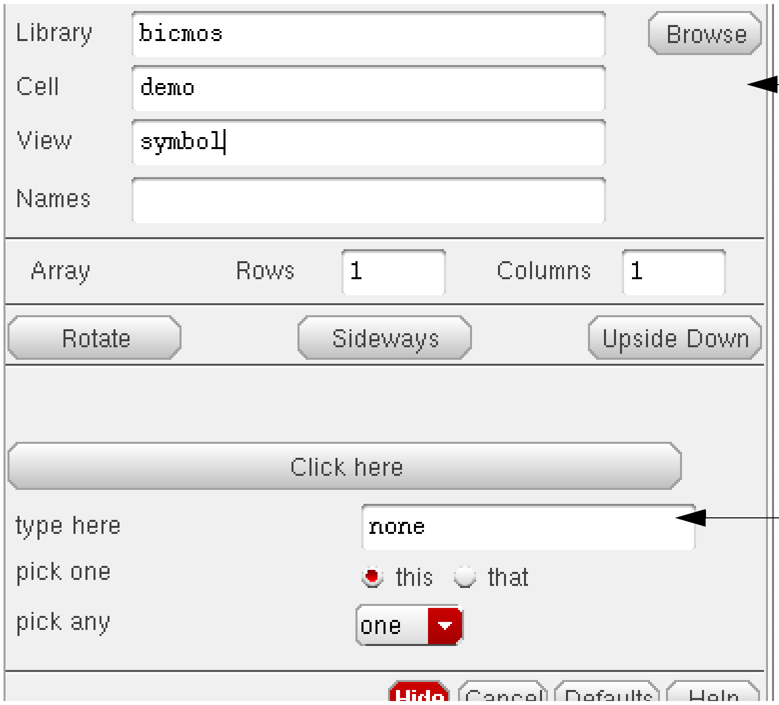
Library: bicmos
Cell: demo
View: symbol
Names:
Array Rows: 1 Columns: 1
type here: none
pick one: ● this ○ that
pick any: one

Form with field height set to 70 pixels

Tall fields

Adjusting Field Widths

You can adjust the width of a field with the *Field width* parameter in the Other Settings tab on the Edit CDF form. This parameter adjusts the width of string input fields only. (You adjust the width of a button field with the *Button field width* parameter in the Other Settings tab on the Edit CDF form.) The following examples show string input fields on two Add Instance forms. The following form shows the field at the default width of 350 pixels.

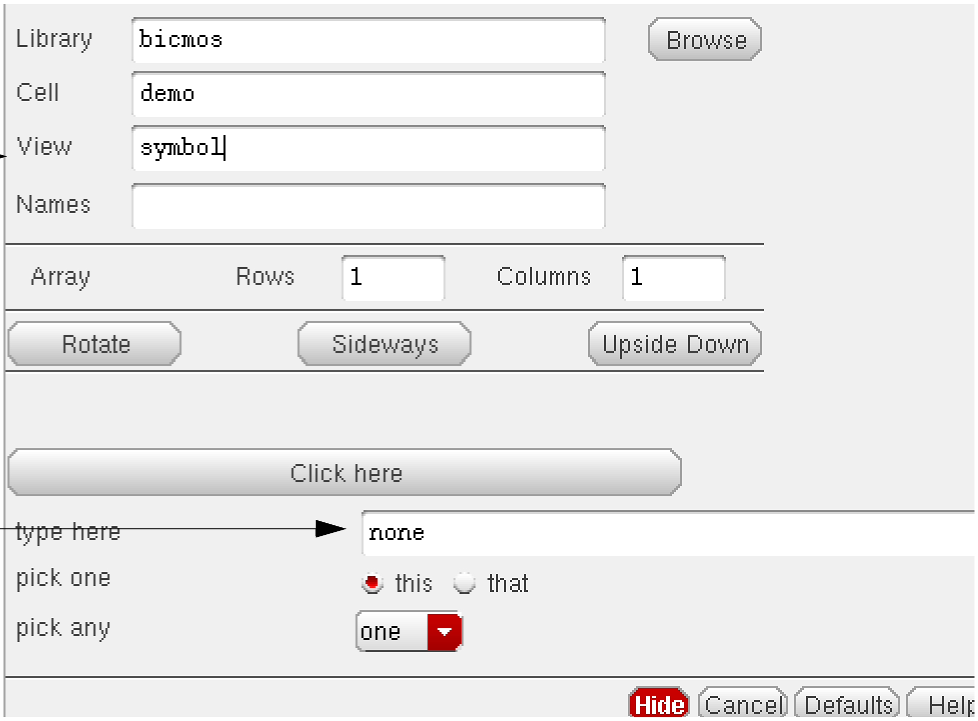


Library: bicmos
Cell: demo
View: symbol
Names:
Array — Rows: 1 — Columns: 1
type here: none
pick one: ● this ○ that
pick any: one

Form with default field width (350 pixels)

Default field

The following form shows a field width of 500 pixels.



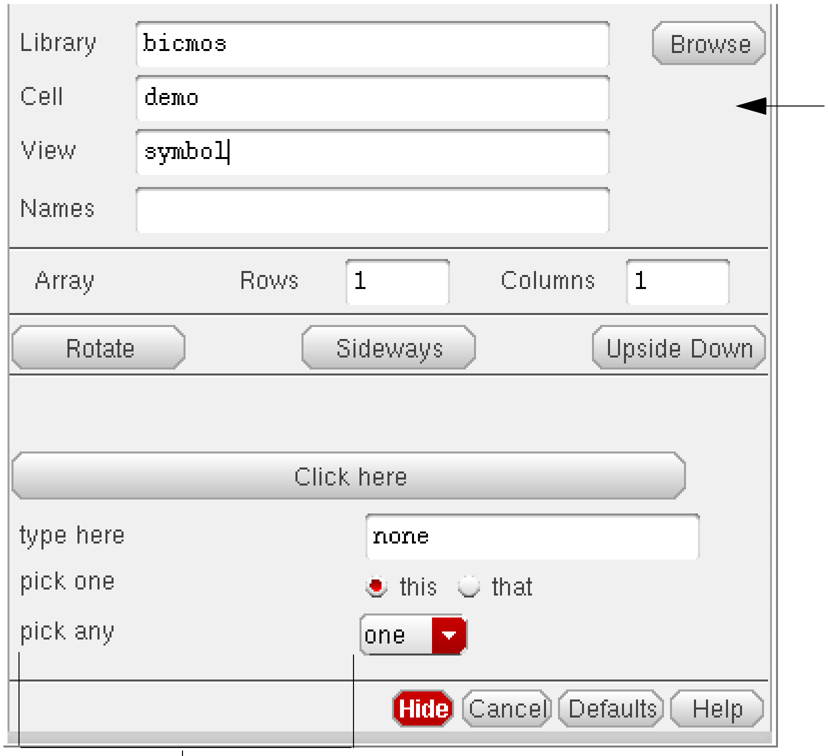
Library: bicmos
Cell: demo
View: symbol
Names:
Array — Rows: 1 — Columns: 1
type here: none
pick one: ● this ○ that
pick any: one

Form with field width set to 500 pixels

Wide field

Adjusting Prompt Widths

You can adjust the width of a prompt with the *Prompt width* parameter in the Other Settings tab on the Edit CDF form. The following example shows prompts on two Add Instance forms. The following form shows the prompts at the default width of 175 pixels.



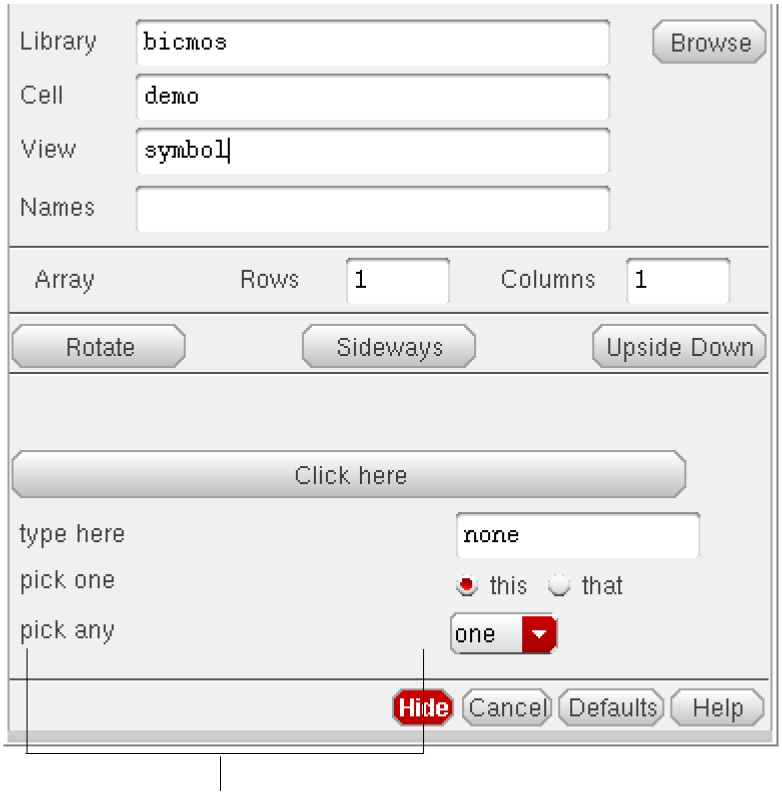
Library: bicmos
Cell: demo
View: symbol
Names:
Array Rows: 1 Columns: 1
type here: none
pick one: ● this ○ that
pick any: one

Form with default prompt width (175 pixels)

Default prompt width

The following form shows the prompt width of 200 pixels.

Form with prompt width set to 200 pixels



Library bicmos
Cell demo
View symbol
Names
Array Rows 1 Columns 1
type here none
pick one ● this ○ that
pick any one

Wider prompt width

Initialization Procedure

The *formInitProc* field in the header of the Edit CDF form lets you enter the name of an optional procedure for preprocessing CDF data. The procedure executes when the contents of the CDF are displayed on a form, such as the Add Instance form or the Edit Object Properties form. The procedure takes a single argument, *cdfDataId*, which is the database object that represents the CDF description for the component being loaded into the form. You enter only the function name (with no parentheses) in the *formInitProc* field.

In the NFET example, you might enter an initialization procedure to reset all NFET parameters to their defaults each time the component is displayed on a form. (This is only an example. It is not practical to reset parameters to their default values every time you return to the Edit Object Properties form.)

Enter the procedure name, *setDefaults*, in the *formInitProc* field. This procedure takes only one argument, *cdfDataId*, which is used to point to the parameters and values of the associated component.

You can create the SKILL procedure with a standard editor. You must load the file in order for the initialization procedure to be called and run. (See "Loading Callbacks" on page 132 for details about loading or attaching a SKILL procedure.)

```
procedure(setDefaults(cdfDataId)
        ;used as formInitProc to set all nfet values to the
        ;default values as form is entered
    cdfDataId->w->value = cdfDataId->w->defValue
    cdfDataId->width->value = cdfDataId->width->defValue
    cdfDataId->l->value = cdfDataId->l->defValue
    cdfDataId->length->value=cdfDataId->length->defValue
)
```

An initialization procedure runs every time the form is updated. The procedure runs when you change a value on the component (a callback), and when you point to a new component.

You can also enter the following SKILL expression to set the *formInitProc* property when you create the cell CDF:

```
cdfId = cdfCreateBaseCellCDF( cellId )
.
.
.
cdfId->formInitProc = "setDefaults"
```

Postprocessing Procedure

The *doneProc* field in the header of the Edit CDF form lets you enter the name of an optional procedure to be executed after you change a parameter on a component instance. You execute the procedure when you click *Apply* on the Edit Object Properties form or when you place an instance of the component using the Add Instance form.

For the NFET example, a *DoneProc* procedure might recalculate the simulation parameters every time the instance changes. Enter the procedure name in the *DoneProc* field. In the following example, the procedure name is *calcSimParams*. This procedure takes a single argument, *cellId*, that identifies the cell of the instance that was modified. Throughout the procedure, *cdfgData*, the global variable for CDF information, accesses the CDF information.

You can create the SKILL procedure with a standard editor. You must load this file in order for the procedure to be called and run. (See "Loading Callbacks" on page 132 for details about loading or attaching a SKILL procedure.)

```
procedure(calcSimParams(cellId)
    cdfgData = cdfGetInstCDF(cellId)
        tmp=cdfParseFloatString(cdfgData->w->value)
        cdfgData->ad->value=sprintf(s "%g" (tmp * 7.0 * 1e-6))
        cdfgData->as->value=sprintf(s "%g" (tmp * 7.0 * 1e-6))
        cdfgData->pd->value=sprintf(s "%g" ((tmp + 7e-6) * 2))
        cdfgData->ps->value=sprintf(s "%g" ((tmp + 7e-6) * 2))
)
```

You can also enter the following SKILL expression to set a postprocessing procedure when you create the cell CDF:

```
cdfId = cdfCreateBaseCellCDF( cellId )
...
cdfId->doneProc = “calcSimParams”
```

7

Writing Callbacks

Overview

A callback procedure is a Cadence® SKILL language expression that is evaluated when a parameter value changes. Using callbacks is a powerful way to control relationships between parameters and the restrictions on the parameter itself.

Note: Cadence advises you to have sufficient knowledge of callback procedures before using them.

Callbacks can be GUI-based or database-based. GUI-based callbacks occur when you modify the values in the parameter form fields. Database-based callbacks occur when the parameter value is modified via a database action. The CDF parameter callback is primarily a GUI-based callback. A GUI-based callback is active when the CDF parameters are displayed in the Add Instance form or the Edit Object Properties form when you use the Create Instance or Edit Properties commands.

Note: The CDF parameter callback is invoked only when you use the Create Instance or the Edit Properties commands. You can specify a callback for each parameter. If you modify the parameter values through other commands then the CDF parameter callback is not invoked.

CDF callbacks are used for a variety of purposes, such as:

- Validating entered values
- Controlling form appearance
- Computing the values of other CDF parameters, such as derived parameters

The first two of these do not present any significant danger - but the third - derived parameters - can cause major trouble, specifically if the derived value is being used (in simulation, physical verification, or a Pcell, for example).

You can enter a callback as a SKILL expression that you type directly in the callback field of the parameter section of the Edit CDF form. You can also enter a callback by using the *?callback* keyword as an argument to the *cdfCreateParam* function:

```
cdfParamId = cdfCreateParam(cdfDataId
?type "string"
?parseAsNumber "yes"
?units "lengthMetric"
?parseAsCEL "yes"
?storeDefault "no"
?name "pName2"
?prompt "width"
?defValue 7u
?display "artParameterInToolDisplay('w)"
?editable "cdfgData->maskLayoutViewName->..."
?callback "cdfgData->pName1->value =
    cdfgData->pName2->value")
```

In this example, the callback on parameter *pName2* sets the value of parameter *pName1* to the new value when the value of *pName2* changes.

A callback can also be a call to a function that you loaded previously.

```
cdfParamId = cdfCreateParam(cdfDataId
?type "string"
?parseAsNumber "yes"
?units "lengthMetric"
?parseAsCEL "yes"
?storeDefault "no"
?name "pName2"
?prompt "width"
?defValue 7u
?display "artParameterInToolDisplay(’w)"
?editable "cdfgData->maskLayoutViewName->..."
?callback "myFunc( )")
```

In the second example, the callback on parameter *pName2* calls the function *myFunc( )* when the value of *pName2* changes.

When using callbacks, always use the global variable *cdfgData* to access information about parameter values and default values.

Note: Because of infrastructure limitations, parameter callback functions do not support changing the choices of CDF parameter fields that appear as radio buttons in the GUI.

To get the default value for a parameter, type the following expression:

```
cdfgData->paramName->defValue
```

To get the current value for a parameter, type the following expression:

```
cdfgData->paramName->value
```

To set the value of a parameter, type either of the following expressions:

```
cdfgData->paramName->value = 10
```

```
cdfgData->paramName->value =
    cdfgData->paramName->defValue
```

Tip

It is recommended to define callbacks in the `.libInit` file to enable loading only the required callbacks when you open a cellview. Defining callbacks in the `.cdsinit` file loads all the callbacks irrespective of their which can impact performance.

Loading Callbacks

Once you define the SKILL callback procedures, you need to load the files. From the Command Interpreter Window in your `.cdsinit` file, type

```
load("path/callbacks.il")
```

You must make sure that the callbacks are loaded before you use the library and that the callback files are archived whenever you archive the library.

As an alternative, you can attach a callback file to a library. You attach callback files to a library by including a `libInit.il` file in that library. `libInit.il` is a text file that contains calls to load other SKILL files or contexts in the library or to initialize autoload properties.

You must always use the file name `libInit.il` or `libInit.ils`. You can have one such file in each library. The following example is the contents of a `libInit.il` file in a microwave library:

```
load( ddGetObj( "microwave" nil nil "libraProcs" )~>path )
load( ddGetObj( "microwave" nil nil "hpmnsProcs" )~>path )
load( ddGetObj( "microwave" nil nil "mharmProcs" )~>path )
load( ddGetObj( "microwave" nil nil "callbacks" )~>path )
```

where `ddGetObj` uses the following syntax:

```
ddGetObj( libName cellName viewName fileName)
```

If you attach the file to the library, the file is automatically loaded whenever the library is opened. This guarantees that the functions are defined. In addition, when you archive your library, the CDF callback functions are automatically archived.

Debugging Callbacks

Introducing Debug CDF

Starting with IC6.1.6, you can use a new plugin, *Debug CDF*, to debug the CDF callback procedures. These are written using simple SKILL expressions for form initialization (`forminit`), form completion (`doneProc`), and any parameter's field value modification (parameter callbacks).

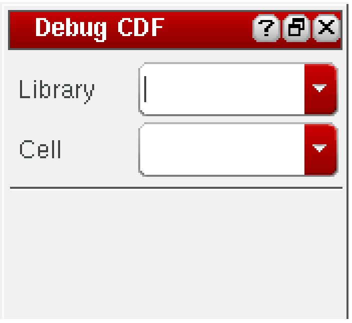
The Debug CDF plugin is not installed by default when you open any CDF-based application window. To install the plugin, select the *Debug CDF* option from the *Windows–Plugins* menu. Once installed, the Debug CDF plugin creates the *Debug CDF* assistant. Using the *Debug CDF* assistant you can set breakpoints on the available CDF callback procedures for debugging.

Installing Debug CDF

To install the *Debug CDF* plugin in an application window:

➡ From the menu bar, choose *Windows–Plugins–Debug CDF*.

The *Debug CDF* assistant is displayed and the SKILL IDE window is launched simultaneously.



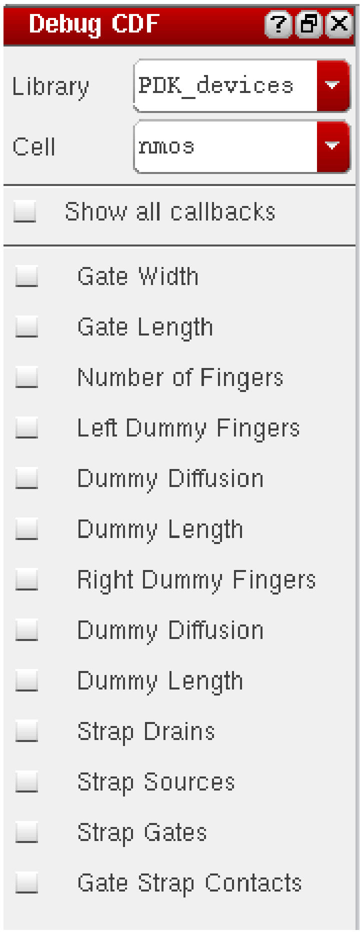
Note: You need working knowledge of SKILL IDE to use the *Debug CDF* assistant. For information about the SKILL IDE window, see *Cadence SKILL IDE User Guide*.

By default, the assistant is docked to the left side of the application window on which it is installed. You can dock/undock the assistant to/from the application window as you would do to any other assistant.

The Debug CDF Assistant User Interface

The *Debug CDF* assistant consists of the *Library* and *Cell* drop-down fields and a list of the CDF parameters.

The *Library* field consists of a list of libraries based on `cds.lib`. The *Cell* field consists of a list of cells based on the selected library. By default, the *Library* and *Cell* fields are blank. When you select a library (`lib`) and a cell (`cell`) from the respective drop-down fields, the Debug CDF plugin displays a list consisting of parameters (and forminit and doneproc) for which callbacks are defined. Each parameter is displayed with a check box next to it, as shown in the figure below:



Library PDK_devices

Cell nmos

□ Show all callbacks

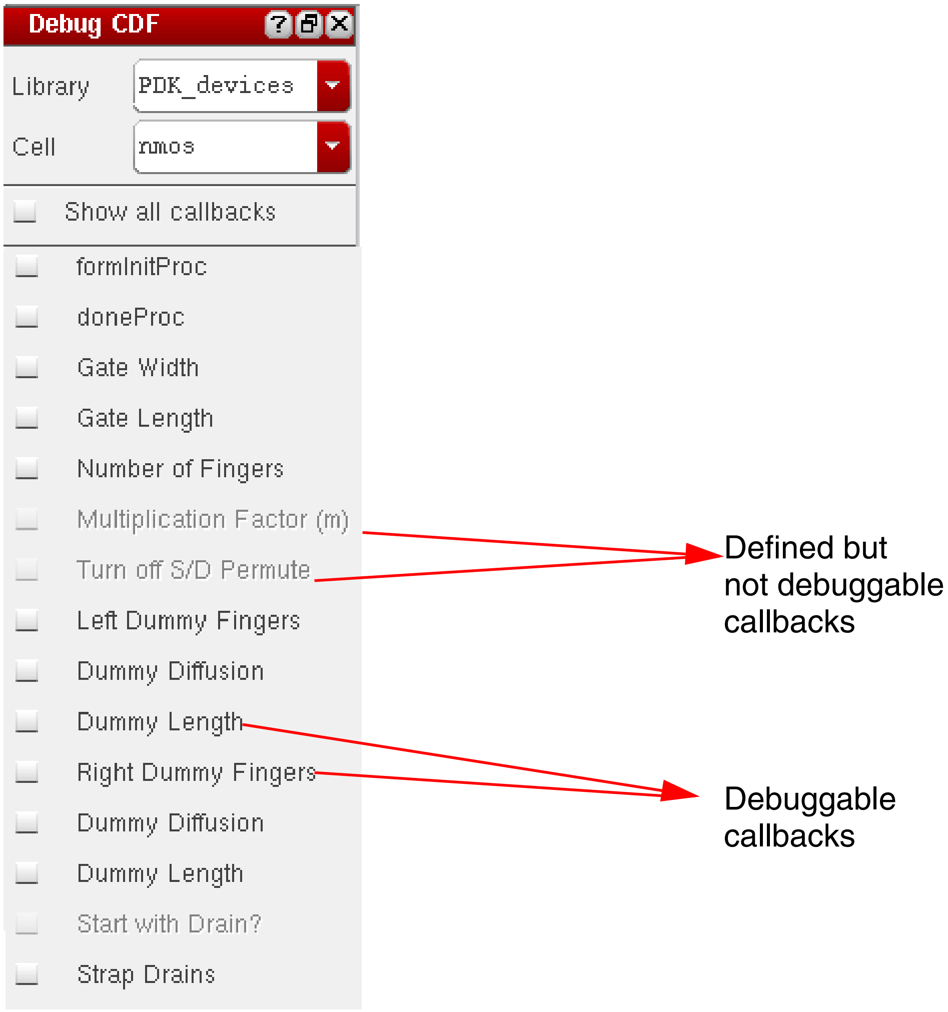
□ Gate Width
□ Gate Length
□ Number of Fingers
□ Left Dummy Fingers
□ Dummy Diffusion
□ Dummy Length
□ Right Dummy Fingers
□ Dummy Diffusion
□ Dummy Length
□ Strap Drains
□ Strap Sources
□ Strap Gates
□ Gate Strap Contacts

If a parameter's callback is a 'simple' function and the function is loaded, the callback is considered debuggable. Callbacks that are not loaded are considered 'not debuggable'.

To view all the callbacks defined for the selected `lib/cell` pair:

➡ On the *Debug CDF* assistant, select the *Show all callbacks* check box.
The *Debug CDF* assistant displays all callbacks defined for the `lib/cell` pair

regardless of whether they are debuggable or not. Callbacks that are debuggable are enabled; otherwise they are disabled.



Library PDK_devices

Cell nmos

□ Show all callbacks

□ formInitProc
□ doneProc
□ Gate Width
□ Gate Length
□ Number of Fingers
□ Multiplication Factor (m)
□ Turn off S/D Permute
□ Left Dummy Fingers
□ Dummy Diffusion
□ Dummy Length
□ Right Dummy Fingers
□ Dummy Diffusion
□ Dummy Length
□ Start with Drain?
□ Strap Drains

Defined but not debuggable callbacks

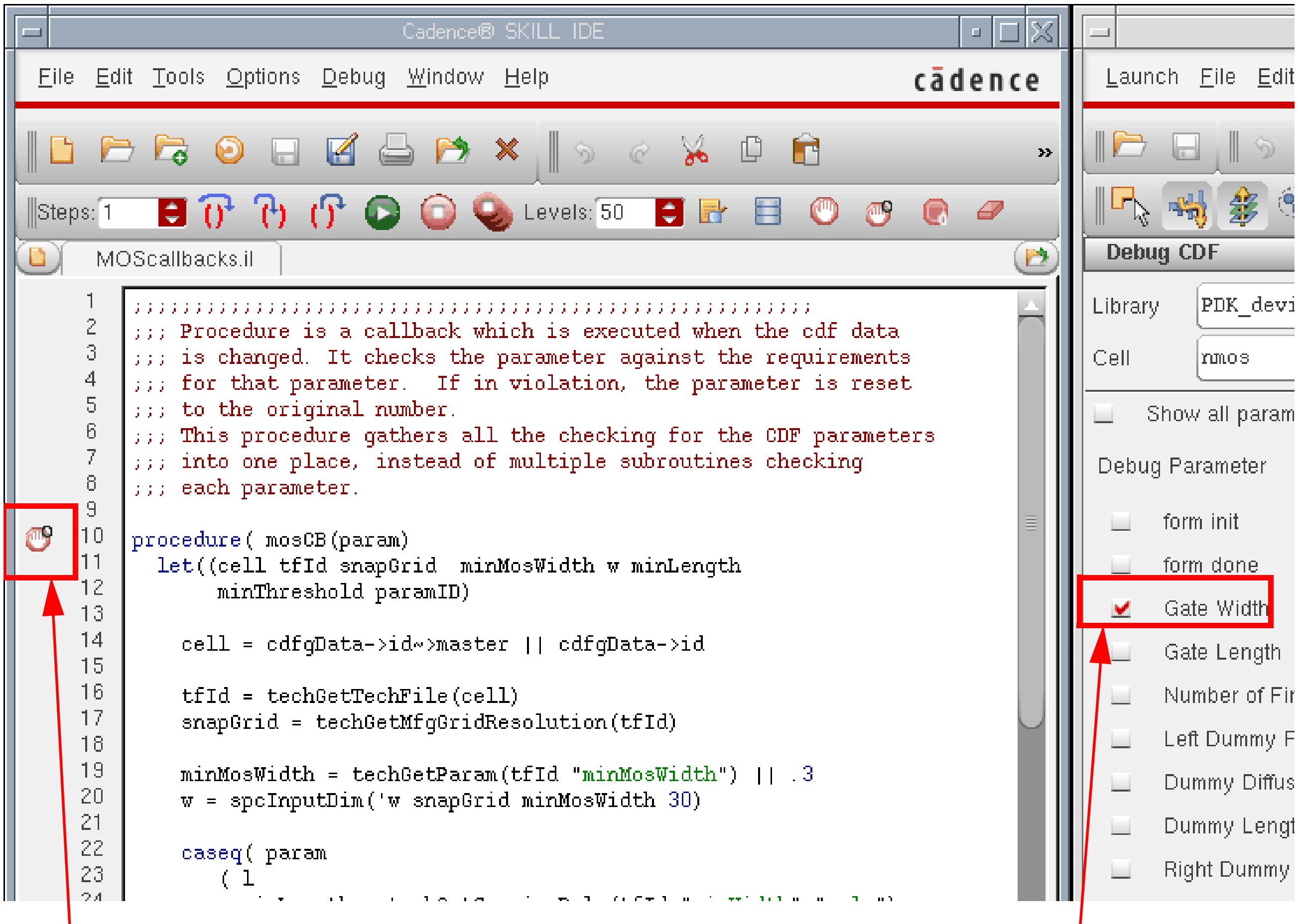
Debuggable callbacks

To debug a callback, Debug CDF plugin requires *support files*, which contain the callback procedures and other SKILL code necessary for a design. Typically, these support files are included in the `libInit.il` file (for the selected library) and are therefore automatically loaded by the Debug CDF plugin. However, if these support files are not included in `libInit.il`, you will need to load these files manually after the SKILL IDE window is launched.

Starting the Debug Process

To start the debug process:

1. On the *Debug CDF* assistant, select the check box next to the parameter for which you want to examine/debug the callback procedure.
   The SKILL IDE window is automatically displayed with the corresponding source file and the breakpoint marker on the left margin of the source file, as shown below.



```
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;; Procedure is a callback which is executed when the cdf data
;;; is changed. It checks the parameter against the requirements
;;; for that parameter.  If in violation, the parameter is reset
;;; to the original number.
;;; This procedure gathers all the checking for the CDF parameters
;;; into one place, instead of multiple subroutines checking
;;; each parameter.

procedure( mosCB(param)
  let((cell tfId snapGrid  minMosWidth w minLength
       minThreshold paramID)

    cell = cdfgData->id~>master || cdfgData->id

    tfId = techGetTechFile(cell)
    snapGrid = techGetMfgGridResolution(tfId)

    minMosWidth = techGetParam(tfId "minMosWidth") || .3
    w = spcInputDim('w snapGrid minMosWidth 30)

    caseq( param
       ( l
```

Library PDK_devi

Cell nmos

□ Show all param

Debug Parameter

□ form init
□ form done
☑ Gate Width
□ Gate Length
□ Number of Fi
□ Left Dummy F
□ Dummy Diffus
□ Dummy Lengt
□ Right Dummy

Selected parameter

SKILL IDE window is displayed with the breakpoint marker

Note: When you unset a selected parameter, its breakpoint is removed.

2. To trigger a parameter callback, modify the value of the selected parameter on the form displayed by using the *Edit Properties* or *Create Instance* commands, or from the Property Editor assistant.

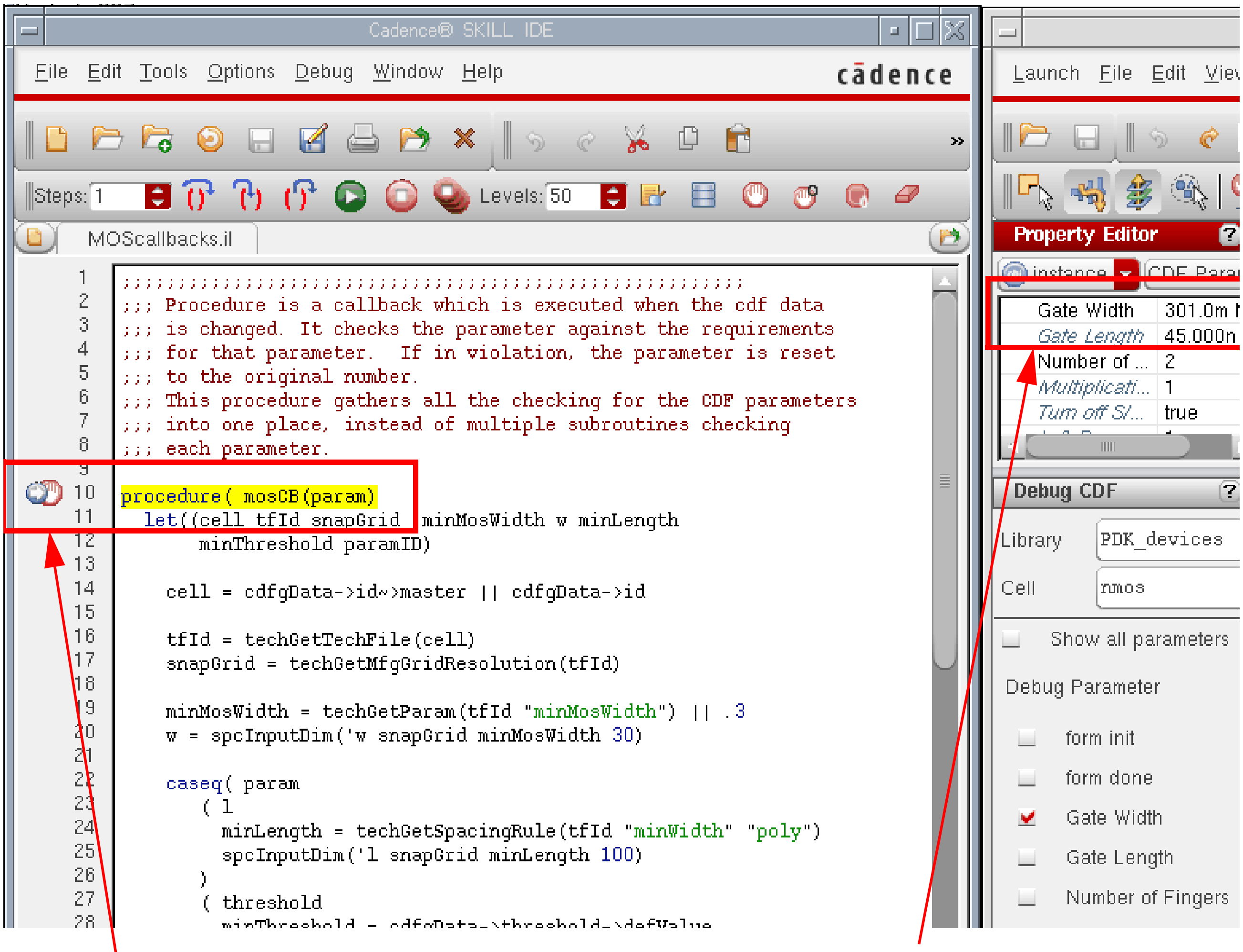
   To trigger the `formInitProc` callback, *update* the form containing the required CDF parameters.

   ❑ The `formInitProc` callback debug process is executed whenever the Edit instance Properties form is seeded with a new instance. So whenever you select the instance in the design, the `formInitProc` is triggered.

   ❑ The `formInitProc` callback debug process is triggered whenever the Create Instance form is seeded with a new combination of the lib/cell `lib/cell` pair that contains CDF data.

   To trigger the `doneProc` callback, click either the *Apply* or *OK* button on the form containing the CDF parameters.

Now, since the breakpoint has been set and the callback procedure is triggered, the execution of the callback will pause at the breakpoint. This would happen at the entry point of the callback procedure.



```
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;; Procedure is a callback which is executed when the cdf data
;;; is changed. It checks the parameter against the requirements
;;; for that parameter.  If in violation, the parameter is reset
;;; to the original number.
;;; This procedure gathers all the checking for the CDF parameters
;;; into one place, instead of multiple subroutines checking
;;; each parameter.

procedure( mosCB(param)
  let((cell tfId snapGrid minMosWidth w minLength
       minThreshold paramID)

    cell = cdfgData->id~>master || cdfgData->id

    tfId = techGetTechFile(cell)
    snapGrid = techGetMfgGridResolution(tfId)

    minMosWidth = techGetParam(tfId "minMosWidth") || .3
    w = spcInputDim('w snapGrid minMosWidth 30)

    caseq( param
       ( l
         minLength = techGetSpacingRule(tfId "minWidth" "poly")
         spcInputDim('l snapGrid minLength 100)
       )
       ( threshold
         minThreshold = cdfgData->threshold->defValue
```

Gate Width	301.0m
Gate Length	45.000n
Number of ...	2
Multiplicati...	1
Turn off S/...	true

Debug CDF

Library: PDK_devices

Cell: nmos

□ Show all parameters

Debug Parameter

□ form init

□ form done

☑ Gate Width

□ Gate Length

□ Number of Fingers

Breakpoint has been

Value of the selected parameter was updated to trigger the callback

3. In the SKILL IDE window, you can use debugging commands, such as *Step*, *Next*, and *Continue*, and set break points to examine/debug the callback procedure. For information about SKILL IDE debugging commands, see *Cadence SKILL IDE User Guide*.

Terminating Debug CDF

To terminate the *Debug CDF* plugin from an application window:

➡ From the menu bar, choose *Windows–Plugins–Debug CDF*.

The *Debug CDF* assistant is removed from the application window. In addition, the *Debug CDF* option is also removed from the assistant list that is displayed when you right-click the menubar or toolbar. Also, all breakpoints that were set by the *Debug CDF* plugin during the debugging process are cleared.

Note: Closing the *Debug CDF* plugin does not close the SKILL IDE window.

Starting Debug CDF in Multiple Windows

In a Virtuoso session, you can start multiple *Debug CDF* plugins in multiple windows. The Debug CDF plugin tracks all breakpoint settings based on the `lib/cell` pair. So, when you set breakpoints for the `lib/cell` pair in the *Debug CDF* assistant in one window, the same settings are reflected in the other window's *Debug CDF* assistant when you select the same `lib/cell` pair.

For example, when you set breakpoints for the `PDK_devices/nmos` pair in the *Debug CDF* assistant installed in VSE in one window, the same breakpoints will be visible when you start the *Debug CDF* assistant in another VLS window and in the assistant you will see the `PDK_devices/nmos` as the `lib/cell` pair.

Note: When you exit the Debug CDF plugin in one application window, only the `lib/cell` breakpoints that are not shared by another window’s Debug CDF plugin are removed.

All the breakpoints set by the Debug CDF plugin are removed when no active Debug CDF plugins exist in any of the windows of a Virtuoso session.

Note: Not all current SKILL breakpoints are removed and only the breakpoints set by the Debug CDF plugin are removed. So, when you add or remove breakpoints directly from SKILL IDE window or from CIW, the corresponding parameters in the *Debug CDF* assistant are not automatically updated.

NFET Example

To understand how to use callbacks, look at the NFET CDF description. The following callback functions are specified for the NFET component:

- *mosLayout*( ) on parameter *maskLayoutViewName*
- *pcMOSw*( ) on parameter *w*
- *pcMOSl*( ) on parameter *l*

mosLayout Callback

In the NFET CDF description, when you select the *layout.pwr* option of the *maskLayoutViewName* parameter, the values of the other parameters are constant. You can use the *mosLayout* callback procedure to set these values automatically whenever the *maskLayoutViewName* is *layout.pwr*. As the following example shows, whenever the value of *maskLayoutViewName* changes, the callback checks the value of *maskLayoutViewName* and, if the value is *layout.pwr*, sets the parameter values:

```
procedure( mosLayout( )
    if((cdfgData->maskLayoutViewName->value ==
        cdfgData->maskLayoutViewName->defValue)
    then      ; It is layout. Use defaults.
        cdfgData->w->value=cdfgData->w->defValue
        cdfgData->width->value=cdfgData->width->defValue
        cdfgData->l->value=cdfgData->l->defValue
        cdfgData->length->value=cdfgData->length->defValue
        cdfgData->bend->value=cdfgData->bend->defValue
        cdfgData->bendt->value=cdfgData->bendt->defValue
        cdfgData->ad->value=cdfgData->ad->defValue
        cdfgData->as->value=cdfgData->as->defValue
        cdfgData->pd->value=cdfgData->pd->defValue
        cdfgData->ps->value=cdfgData->ps->defValue
        cdfgData->diffD->value=cdfgData->diffD->defValue
    else      ; It is layout.pwr. Use known values.
        cdfgData->w->value="880u"
        cdfgData->width->value=880
        cdfgData->l->value="12u"
        cdfgData->length->value=12
        cdfgData->bend->value=cdfgData->bend->defValue
        cdfgData->bendt->value=cdfgData->bendt->defValue
        cdfgData->ad->value="6.16e-09"
        cdfgData->as->value="6.16e-09"
        cdfgData->pd->value="0.001774"
        cdfgData->ps->value="0.001774"
        cdfgData->diffD->value=nil
    )
)
```

pcMOSw Callback

The *pcMOSw* callback is similar to the *pcMOSl* callback*. pcMOSw* checks the input, sets the *width* parameter, determines if there should be a bend, and calculates some of the simulation parameters:

```
procedure( pcMOSw( )
  prog(()
    if( (cdfgData->maskLayoutViewName->value ==
            cdfgData->maskLayoutViewName->defValue)
                 ; Do this only if maskLayoutViewName is
                 ; layout. Otherwise, mosLayout sets it.
    then
        tmp = evalstring(cdfgData->w->value)
        if( (tmp && (typep(tmp)!='flonum))
        then
            error("Width value must be a floating
                 point number. Set to default." )
            cdfgData->w->value = cdfgData->w->defValue
            cdfgData->width->value =
                 cdfgData->width->defValue
            cdfgData->bend->value =
                 cdfgData->bend->defValue
            cdfgData->bendt->value =
                 cdfgData->bendt->defValue
            cdfgData->ad->value = cdfgData->ad->defValue
            cdfgData->as->value = cdfgData->as->defValue
            cdfgData->pd->value = cdfgData->pd->defValue
            cdfgData->ps->value = cdfgData->ps->defValue
            return(nil)
        )
        tmp = ( tmp / 1e-6 )
        if( (tmp < cdfgData->width->defValue)
        then
            error("Width value is less than
                 minimum (7u). Set to default." )
            cdfgData->w->value = cdfgData->w->defValue
            cdfgData->width->value =
                 cdfgData->width->defValue
            cdfgData->bend->value =
                 cdfgData->bend->defValue
            cdfgData->bendt->value =
                 cdfgData->bendt->defValue
            cdfgData->ad->value = cdfgData->ad->defValue
            cdfgData->as->value = cdfgData->as->defValue
            cdfgData->pd->value = cdfgData->pd->defValue
            cdfgData->ps->value = cdfgData->ps->defValue
            return(nil)
        )
        if( (tmp > 240 )
        then
            error("Width value is greater than
                 maximum (240u). Set to default." )
            cdfgData->w->value = cdfgData->w->defValue
            cdfgData->width->value =
                 cdfgData->width->defValue
            cdfgData->bend->value =
                 cdfgData->bend->defValue
            cdfgData->bendt->value =
                 cdfgData->bendt->defValue
            cdfgData->ad->value = cdfgData->ad->defValue
            cdfgData->as->value = cdfgData->as->defValue
            cdfgData->pd->value = cdfgData->pd->defValue
            cdfgData->ps->value = cdfgData->ps->defValue
            return(nil)
        )
        if( (tmp <= 240 )
        then
            cdfgData->maskLayoutViewName->value =
                 cdfgData->maskLayoutViewName->defValue
            grid = round(tmp/0.5)
            newwidth = grid*0.50
            if( (newwidth != tmp)
            then
                 error("Width is set to nearest value
                     on 0.50 micron pitch.")
                 cdfgData->w->value =
                     sprintf(s "%g" (newwidth * 1e-6))
            )
            if( (tmp > 120) ;criteria for setting bend here
            then
                 cdfgData->width->value = tmp/2
                 cdfgData->bend->value = t
                 cdfgData->bendt->value = 1
                 cdfgData->diffD->value = nil
            else
                 cdfgData->width->value = tmp
                 cdfgData->bend->value =
                     cdfgData->bend->defValue
                 cdfgData->bendt->value =
                     cdfgData->bendt->defValue
            )
        )
        cdfgData->ad->value =
            sprintf(s "%g" (tmp * 7.0 * 1e-12))
        cdfgData->as->value =
            sprintf(s "%g" (tmp * 7.0 * 1e-12))
        cdfgData->pd->value =
            sprintf(s "%g" ((tmp + 7.0) * 2e-6))
        cdfgData->ps->value =
            sprintf(s "%g" ((tmp + 7.0) * 2e-6))
    )
  )
)
```

pcMOSl Callback

When the *length* and *width* parameters for the NFET CDF description were created, the *l* and *w* parameters already existed for one of the simulators. Instead of prompting the user twice for the same information, callbacks attached to the *l* and *w* parameters can update the *length* and *width* parameters automatically.

The *pcMOSl* callback runs whenever the value of *l* changes. The callback verifies that the *maskLayoutViewName* parameter value is *layout*. (For the other option, *layout.pwr*, the parameter values are controlled by the *mosLayout* callback, shown in the previous section.) The callback then checks the new value against the minimum value, the maximum value, and the grid. If the value is not valid, the callback resets the lengths to the default value. If the value is valid, the callback sets the *length* parameter value. The following example shows this process:

```
procedure( pcMOSl( )
  prog(()
    if((cdfgData->maskLayoutViewName->value ==
        cdfgData->maskLayoutViewName->defValue)
                ; Do this only if maskLayoutViewName is
                ; layout. Otherwise, mosLayout sets it.
    then
                ; Convert input string to float.
        tmp = evalstring(cdfgData->l->value)
        if( (tmp && (typep(tmp)!=’flonum))
        then
            error("Length value must be a floating point
                 number. Set to default." )
                 ; error will send message to CIW
            cdfgData->l->value = cdfgData->l->defValue
            cdfgData->length->value =
            cdfgData->length->defValue
            return(nil)
        )
        tmp = ( tmp / 1e-6 )    ; Convert to user units.
        if( (tmp < 3.0)
        then
            error("Length is less than minimum (3u).
                 Set it to default." )
            cdfgData->l->value = cdfgData->l->defValue
            cdfgData->length->value =
                 cdfgData->length->defValue
            return(nil)
        )
        if( (tmp > 15.0 )
        then
            error("Length value is greater than
                 maximum (15u). Set it to default." )
            cdfgData->l->value=cdfgData->l->defValue
            cdfgData->length->value =
                 cdfgData->length->defValue
            return(nil)
        )
                 ; The following checks the value against
                 ; the grid and fixes it if necessary.
        grid = round(tmp/0.5)
        newlength = grid*0.50
        if( (newlength != tmp)
        then
            or("Length is set to nearest value
                 on 0.50 micron pitch.")
            cdfgData->l->value = sprintf(s "%g"
                 (newlength * 1e-6))
        )
                 ; Set the Pcell param value.
        cdfgData->length->value = tmp
    )
  )
)
```

8

Verifying CDF Operation

Testing the Component

Once you have completed the design of your component (all views and the Component Description Format are done), test the operation of the component’s CDF description before using the component in your design. The following is a procedure you might use.

Test Procedure

1. Open an empty schematic and place instances of your symbol.
2. As you place the instances, use different parameter values.

   Check the Add Instance form for confirmation that your parameter definitions and callbacks are working. Look for the following indications:

   ❑ Parameters have the units you expected.

   ❑ Parameters have the defaults you expected.

   ❑ The correct parameters are at the top of the list of parameters. You should not have to keep scrolling down the form to edit important parameters.

   ❑ Parameters that are supposed to become noneditable do so when expected.

   ❑ Parameters that are not supposed to be displayed are not displayed as expected.

   ❑ Do your callbacks get called? First check. Do they stacktrace because you forgot to load them?

   ❑ Parameters whose values depend on other parameters update as you expect.

   ❑ Are your callbacks doing the range checking you set up?

   ❑ Can you enter bad parameter values?
3. After you place the instances, use Edit Properties (in the schematic editor) to look at the properties stored on the instances.

   Look for the following:

   ❑ Are you saving the default values?

   ❑ Are nondisplayed parameters being set as you expected? If they are not displayed, it is hard to know that they worked.
4. Draw a minimal schematic and go to the simulator you will be using. Generate a netlist to make sure that your component netlists as you expect.

5. Once you are satisfied with the schematic and simulation results, go to an empty layout and repeat the CDF tests to see the effect on your layout.

Virtuoso XL Layout Editor Procedure

If you are going to use the Virtuoso® XL Layout Editor (Virtuoso XL),

1. Make a simple schematic with some examples of your component randomly wired to each other.
2. Go through the Virtuoso XL design cycle.
3. Check that you have set all the parameters that Virtuoso XL requires.
4. Does Virtuoso XL place the layouts you expect with appropriate connectivity?

LVS Procedure

If you are using Layout Versus Schematic (LVS),

1. Create a simple schematic and layout with few instances.
2. Run extraction and LVS.
3. Make sure the LVS netlist is correct.

   This also gives you a chance to check out the LVS rules in a controlled experiment using just one device.

Making Changes

If you find a problem or change the design, follow these guidelines:

- If problems occur during testing, fix the views or CDF and retest.
- For the parameter type `netSet`, it is mandatory to set the attribute *storeDefault* to *yes*.
- If the problem or change occurs after you have placed multiple instances of the component, consider the following:
    - ❑ You might need to change just the user interface, such as the order of the parameters or which parameters are displayed in the form or label display. When you make a change, it is inherited by all existing instances.
    - ❑ If you change the default value of a parameter with the attribute *storeDefault = no,* it is inherited by all existing instances. (Use the *Window – Redraw* command to see the changes reflected in the current window.)
    - ❑ If you change the default value of a parameter with *storeDefault = yes,* changing the default value does not update the existing instance, because the value was saved as a property on each instance.
    - ❑ If you change a callback that sets the value of one parameter based on an equation involving another parameter, changing the default value does not update the existing instances. You must also trigger the callback again, for each instance.

    In the last two cases, you can update existing instances using the *Cadence Analog Design Environment – Design Variables – Update* command. This command updates the default values and triggers all of the callbacks of all of the instances in the current window. The *Update* command has the following limitations:

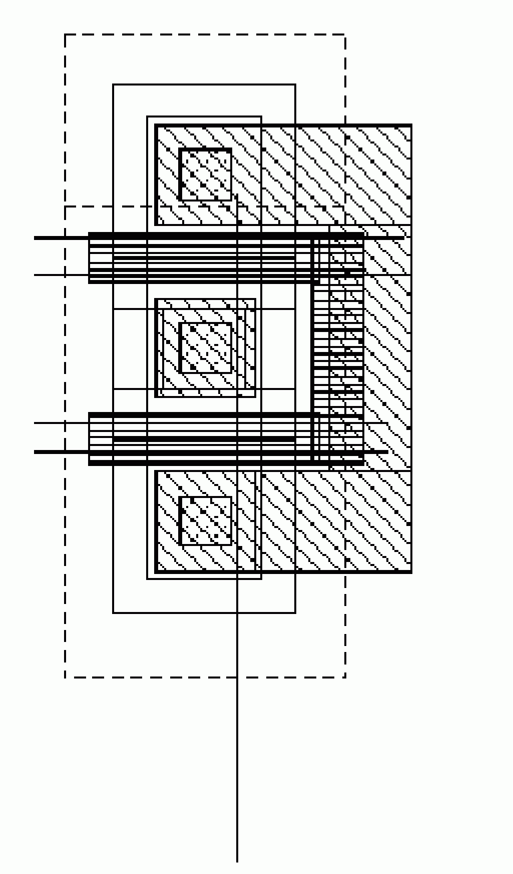
    - ❑ The update works only on the open cell.
    - ❑ The update does not traverse the design hierarchy.
    - ❑ There is no guaranteed order of running the callbacks, so you need to make sure that your callbacks work well together.

Finishing the NFET Example

In the last part of the NFET example you can see visible changes in the cell layout and form displays as a result of changing the CDF data.

Varying the Layout

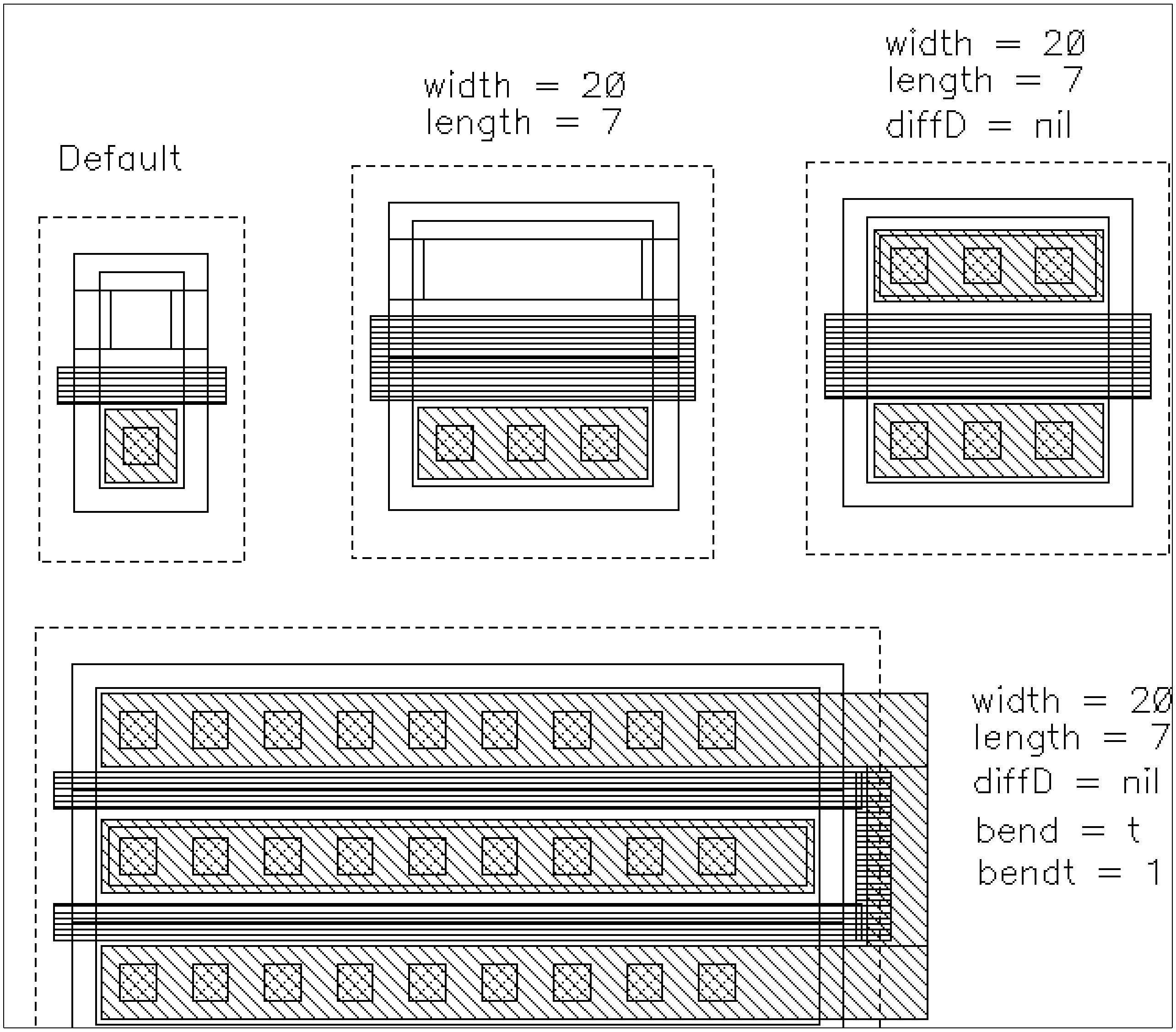
Once you enter all the CDF information for the NFET into the system, you can display the transistor layout. The Pcell layout (stored in view *layout*) might look as shown in the following figure:



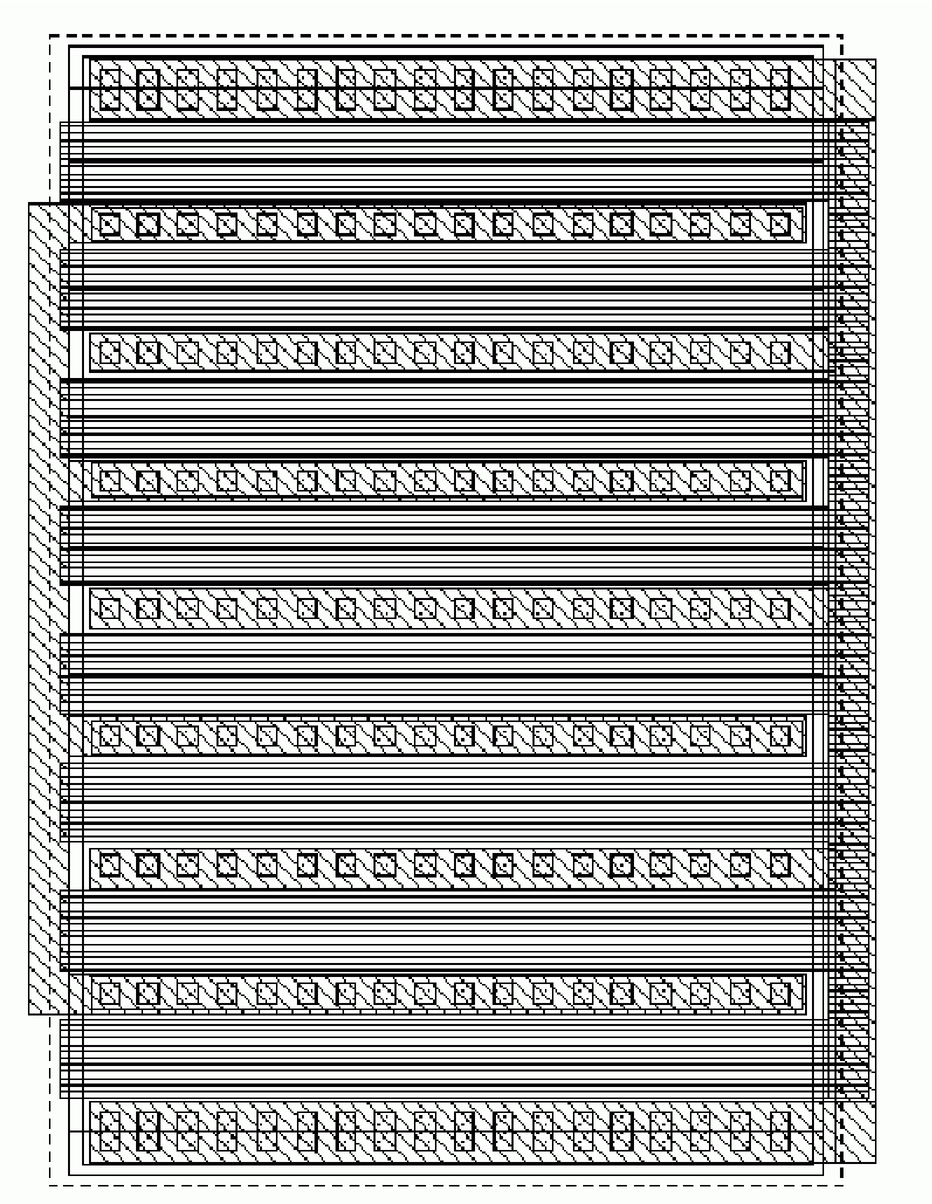
This is a Pcell with the following parameters:

width	float, defining the width of the gates
length	float, defining the length of the gates
bend	Boolean, to control conditional inclusion of shapes for bend
bendt	float, to help in stretching shapes correctly when bend occurs
diffD	Boolean, to control conditional inclusion of shapes for diffusion drain contact versus metal drain contact

The NFET looks like the following with different parameter combinations:

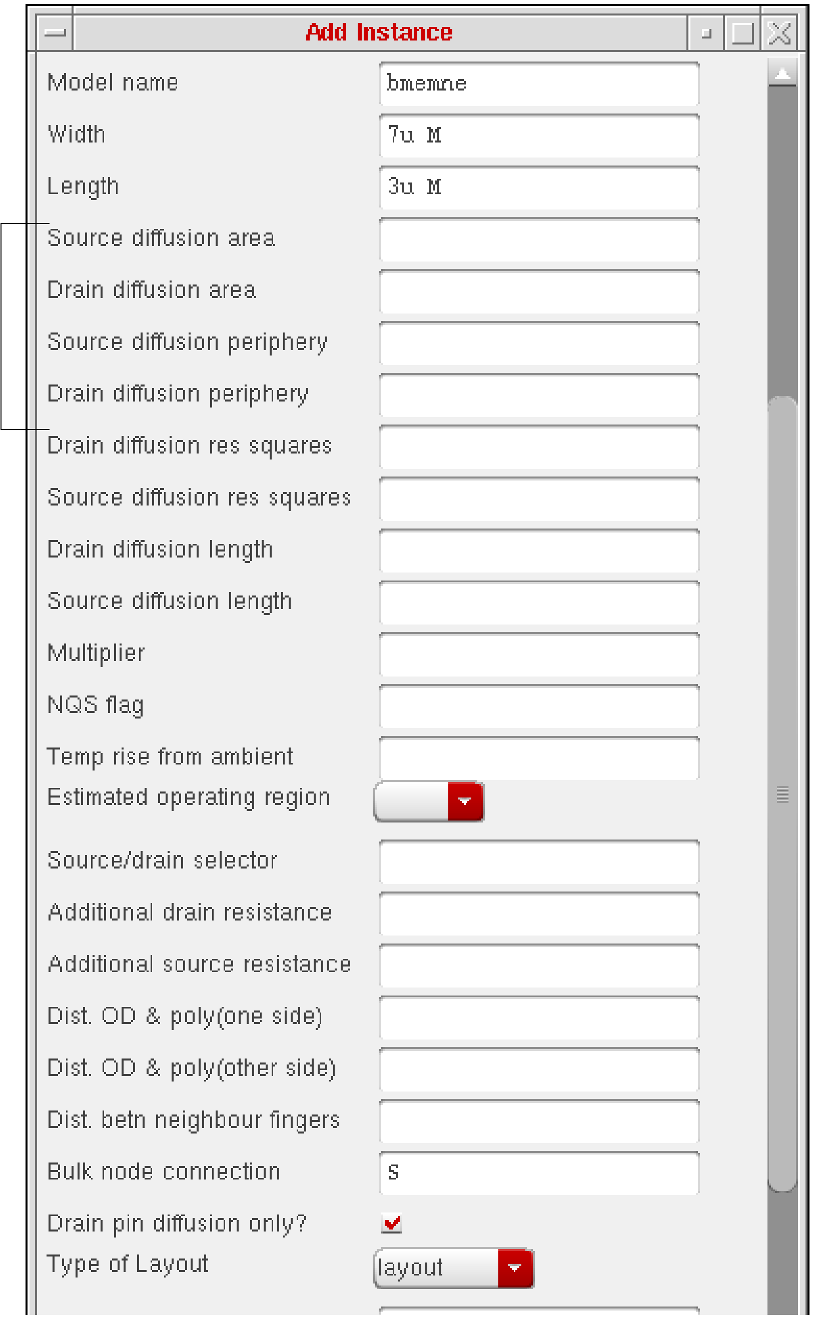


In addition, you need the fixed layout for the power applications. This might be stored under view *layout.pwr*, have a gate width of 880 micrometers and length of 12 micrometers, and look like this:



Changing Parameters

Now try to use the NFET in a design.



Add Instance

Model name	bmemne
Width	7u M
Length	3u M
Source diffusion area	
Drain diffusion area	
Source diffusion periphery	
Drain diffusion periphery	
Drain diffusion res squares	
Source diffusion res squares	
Drain diffusion length	
Source diffusion length	
Multiplier	
NQS flag	
Temp rise from ambient	
Estimated operating region	
Source/drain selector	
Additional drain resistance	
Additional source resistance	
Dist. OD & poly(one side)	
Dist. OD & poly(other side)	
Dist. betn neighbour fingers	
Bulk node connection	S
Drain pin diffusion only?	☑
Type of Layout	layout

No default values

When you first use the Add Instance form, some fields are dimmed.

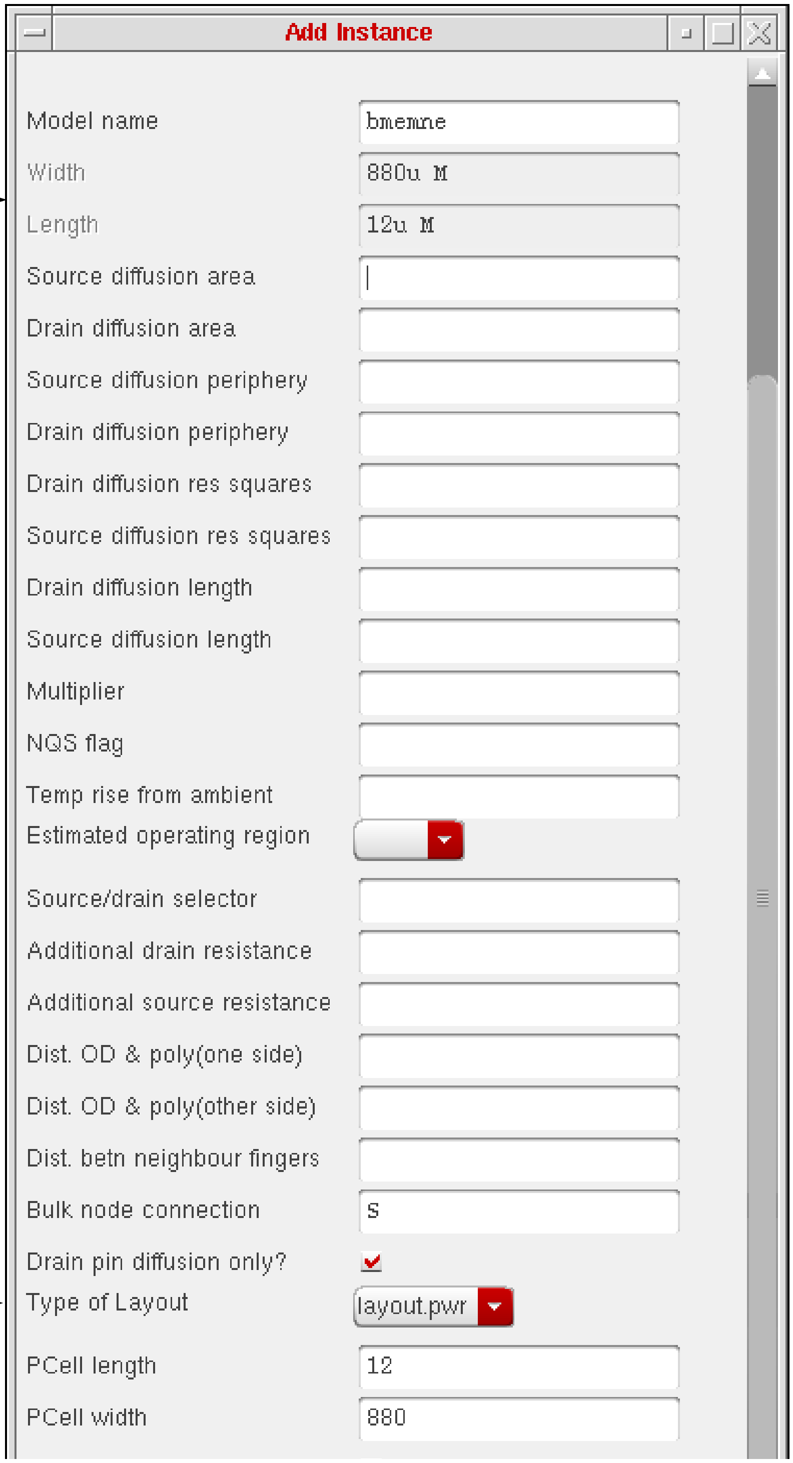
The first time you open the Add Instance form for your component, it shows all default values. Some default values are not defined. At this point, you might want to go back to the Edit CDF form and add the appropriate default values.

Notice, however, that you cannot enter values in the fields with dim names. If you use the CDF description to set a parameter to be displayed, but not editable, the parameter field is not editable on the Add Instance form.

The type of *layout* is *cyclic,* as you specified. The width and length are prompted for only once, as a string with units of length.

As you place instances of the NFET, you never change the value for the bulk node connection. Therefore, you might use the Edit CDF form to move that parameter down in the list of parameters until it is below other parameters that you do change.

1. Change the Type of Layout cyclic button. The Add Instance form updates as follows:



Add Instance

Model name	bmemne
Width	880u M
Length	12u M
Source diffusion area	
Drain diffusion area	
Source diffusion periphery	
Drain diffusion periphery	
Drain diffusion res squares	
Source diffusion res squares	
Drain diffusion length	
Source diffusion length	
Multiplier	
NQS flag	
Temp rise from ambient	
Estimated operating region	
Source/drain selector	
Additional drain resistance	
Additional source resistance	
Dist. OD & poly(one side)	
Dist. OD & poly(other side)	
Dist. betn neighbour fingers	
Bulk node connection	S
Drain pin diffusion only?	☑
Type of Layout	layout.pwr
PCell length	12
PCell width	880

Width and length are set and are not editable

Set to appropriate value

Alternate layout

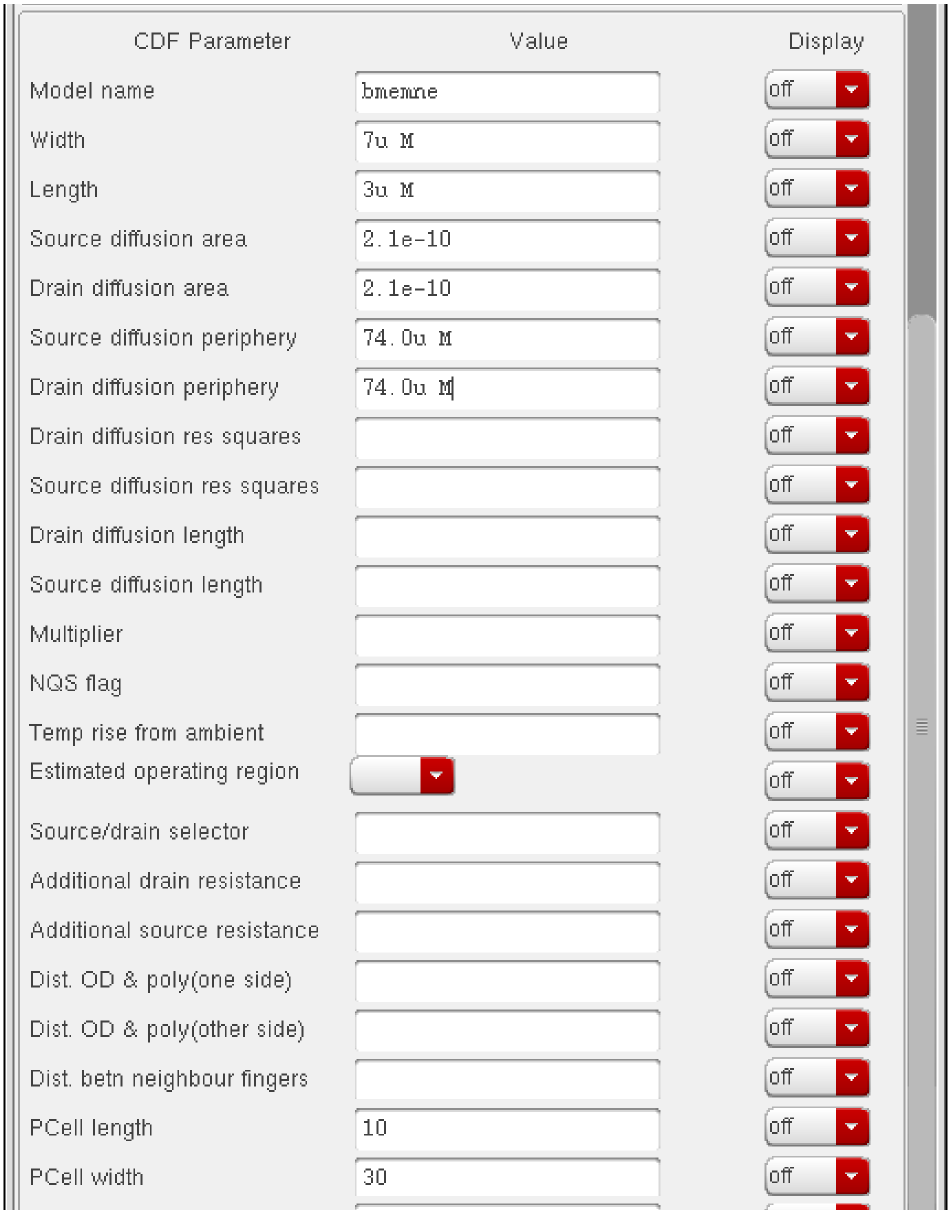
You can see the form modify itself to show the new fields, indicating that the callbacks are working.

At this point you still cannot see if the Pcell parameters are being set properly.

2. Use the *Edit – Properties – Object* command on a few examples to verify the operation of the Pcell parameters in the CDF description.

3. Using the Edit Object Properties form, create an instance with *width* set to `30u`, *length* set to `10u`, the default layout, and a drain diffusion pin.

   The CDF Parameter fields in the Edit Object Properties form should look like this:

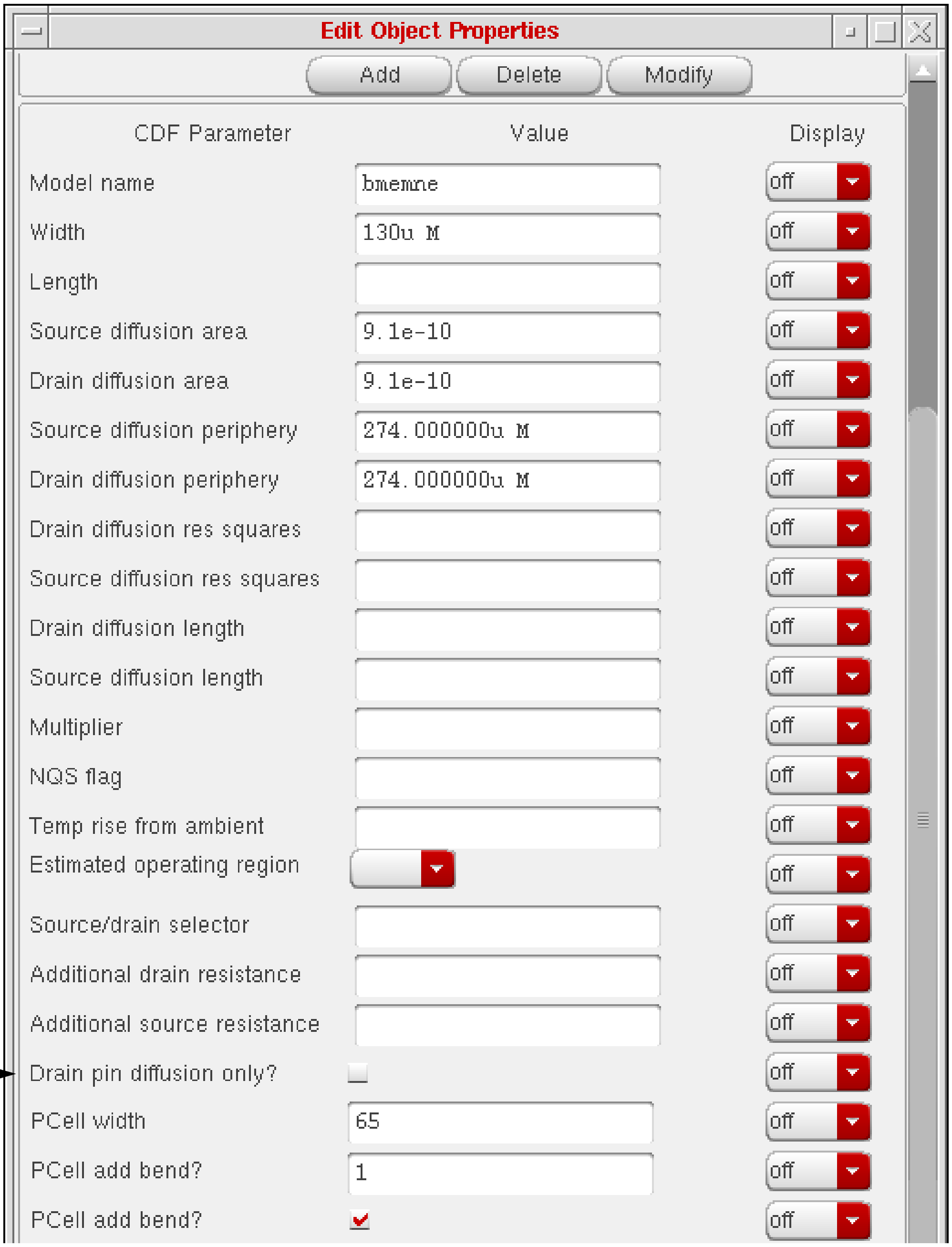


CDF Parameter	Value	Display
Model name	bmemne	off
Width	7u M	off
Length	3u M	off
Source diffusion area	2.1e-10	off
Drain diffusion area	2.1e-10	off
Source diffusion periphery	74.0u M	off
Drain diffusion periphery	74.0u M	off
Drain diffusion res squares		off
Source diffusion res squares		off
Drain diffusion length		off
Source diffusion length		off
Multiplier		off
NQS flag		off
Temp rise from ambient		off
Estimated operating region		off
Source/drain selector		off
Additional drain resistance		off
Additional source resistance		off
Dist. OD & poly(one side)		off
Dist. OD & poly(other side)		off
Dist. betn neighbour fingers		off
PCell length	10	off
PCell width	30	off

These values indicate that the callbacks used to generate Pcell parameter values worked correctly. If you have a different result, check the callbacks in the CDF description.

4. Create an instance of the NFET with *width* set to `130u`, *length* set to `3u` (default), the default layout, and no drain diffusion pin (required).

   The Edit Object Properties form should look like the following:



CDF Parameter	Value	Display
Model name	bmemne	off
Width	130u M	off
Length		off
Source diffusion area	9.1e-10	off
Drain diffusion area	9.1e-10	off
Source diffusion periphery	274.000000u M	off
Drain diffusion periphery	274.000000u M	off
Drain diffusion res squares		off
Source diffusion res squares		off
Drain diffusion length		off
Source diffusion length		off
Multiplier		off
NQS flag		off
Temp rise from ambient		off
Estimated operating region		off
Source/drain selector		off
Additional drain resistance		off
Additional source resistance		off
Drain pin diffusion only?	☐	off
PCell width	65	off
PCell add bend?	1	off
PCell add bend?	☑	off

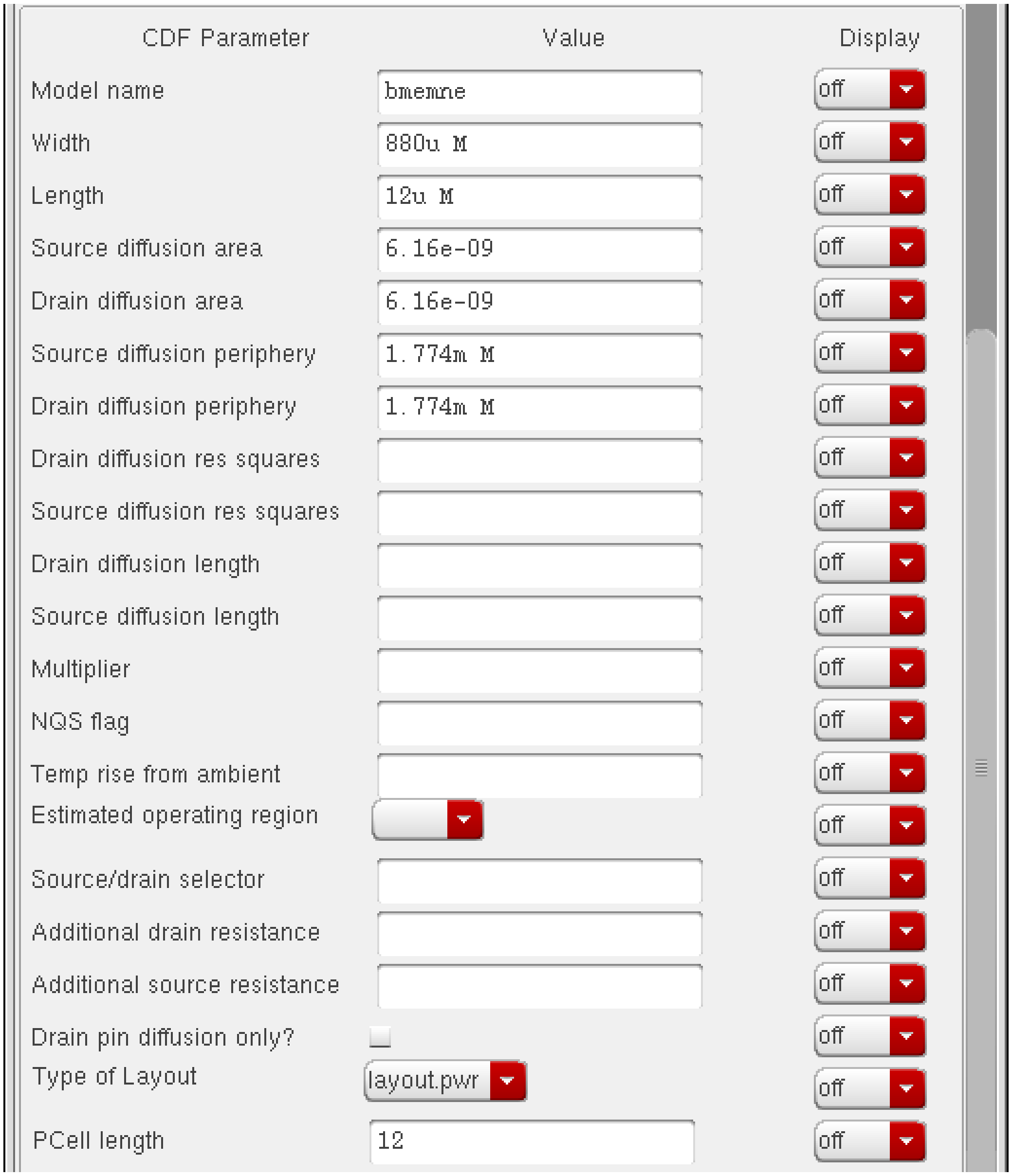
width is > 120,
so bend is turned on

width is > 120,
so no diffD

Both of the length parameters are default values, so no property is saved.

5. Create an instance with *maskLayoutViewName* as `layout.pwr`.

   You see the following:



CDF Parameter	Value	Display
Model name	bmemne	off
Width	880u M	off
Length	12u M	off
Source diffusion area	6.16e-09	off
Drain diffusion area	6.16e-09	off
Source diffusion periphery	1.774m M	off
Drain diffusion periphery	1.774m M	off
Drain diffusion res squares		off
Source diffusion res squares		off
Drain diffusion length		off
Source diffusion length		off
Multiplier		off
NQS flag		off
Temp rise from ambient		off
Estimated operating region		off
Source/drain selector		off
Additional drain resistance		off
Additional source resistance		off
Drain pin diffusion only?	□	off
Type of Layout	layout.pwr	off
PCell length	12	off

All the callbacks are triggered, as expected.

A

Advice and Warnings

This section answers frequently asked questions not already covered, and warns you about common mistakes.

- Library CDF versus Cell CDF

  A cell inherits all definitions from the library CDF. If there are changes in the cell CDF, the changes override the library CDF at the cell level. It is important to be aware of what is in the library CDF of any cell you work on.

- CDF level differences

  Remember that only the base-level CDF is saved to disk. The user-level CDF is used only for one session and cannot be saved. If you have a base and user CDF, the effective CDF is everything from the base CDF updated with anything new from the user CDF. In the Edit CDF form, you can "edit" the effective CDF. In reality, the effective CDF is just there to give you a way to look at the total CDF for a component. There is nothing to edit in an effective CDF, so changing the effective CDF in the Edit CDF form does nothing.

- Update

  The update function under *Cadence Analog Design Environment– Design Variables – Update* in the schematic editor updates only what is in the current window and for only one level of hierarchy.

- Parameter values and callbacks

  If you use *iPar*, *pPar, atPar, dotPar,* or the old notation ({}) to inherit the value of a parameter, as the real value changes, the callbacks associated with that parameter are NOT triggered. So, be aware of that when determining which parameters inherit values. Similarly, if you assign a design variable as a parameter value, the setting of the design variable does not trigger callbacks.

- Units

  The units you can use in the CDF are limited to those offered in the Edit CDF form. There are no user-defined units.

- Range checking

  CDF provides no automatic range checking. You must use callbacks to do that.

- Pcell default values

  There is no system mechanism to ensure that your Pcell defaults and CDF defaults are synchronized, so you must manage this.

- Callback files

  If you define your callbacks in a separate file (not self-contained in the CDF or attached to the library), you must remember to archive that file whenever you archive your library.

- Callback limitation

  You can control parameter values with callbacks, but you cannot affect anything in the simulation information section.

- Boolean properties

  Be careful of using the CDF "Boolean." It is defined as *t* or *nil*. If you add a property to an instance using the *Add* button in the Edit Object Properties form you will see that the system models that kind of Boolean as TRUE or FALSE. There are some applications that depend on that. For example, the property *lvsIgnore* used in DLE and LVS must be TRUE or FALSE. So, if you want to add it to your CDF, instead of making it a CDF Boolean type, make it a cyclic type and set its choices to TRUE and FALSE.

- Triggering callbacks

  Callbacks are triggered whenever a change is made to the parameter value, even if the change is caused by loading a default value. You need to ensure that default values do not violate any relationships that you are trying to enforce.

  Use callbacks to establish dependencies between parameters whose values are numeric constants.

  Avoid using callbacks on parameters whose values are expressions. Such values require update evaluations and can quickly become out of date. If you do choose to use callbacks of this type, you will need to run a hierarchical evaluator that will walk the entire design to trigger all CDF callbacks whenever the value of the parameter is changed. Note, too, that a hierarchical evaluator will not be reliable with pPar() parameters.

- Layout extraction, properties, and callbacks

  When you run layout extraction to find devices in the layout, you can also measure the sizes of the devices. When you save that information, it is stored as a property on the symbol (*auLvs* or an *ivpcell*) that is placed in the extracted layout. For example, when extraction finds an NFET, it places the cell *nfet auLvs* at the location of the recognition shape. That instance has the connectivity that was found and has the properties for the measured values saved, probably the length and width. Setting those measured parameters by extraction does not trigger any callbacks on those parameters. This is especially important to remember if you are doing parasitic resimulation, because you need all parameters necessary for simulation to be set in the extracted layout. You cannot rely on the callbacks; you must redo the calculations in the extraction rules.

- LVS case sensitivity

  Remember the property mapping example for LVS. Even though CDF might use lowercase parameter names, LVS expects capital letters. If you do not enter this mapping properly, the parameters are not netlisted correctly and in LVS this most likely means that size comparisons are not made at all.

- The Virtuoso® layout editor now accesses and uses CDF parameters.

- Property value replacement and callbacks

  Using *Edit – Search – Replace* to find a property and change its value across a set of instances does not trigger callbacks associated with the parameter. The *Cadence Analog Design Environment – Design Variables – Update* command triggers the callbacks associated with each variable, but you cannot control the order in which the callbacks are executed.

  In addition, if you use the default value for a parameter, and set *storeDefault* to *no*, there is no property for *Edit – Search – Replace* to find. However, changing the default value does change it.

- Numerical value format

  Be careful about entering blanks when entering values in a form or defining values or default values. In the CDF, “ 12” does not equal 12; nor does
  “12 ”. “12 u” does not equal “12u”. This can cause errors.

- The *dontSave* parameter attribute

  Do not use the *dontSave* parameter attribute unless you are absolutely sure you need to. It can lead to unexpected results, especially when callbacks are used. The only thing that *dontSave* does for you is save the space used to store the property value on a parameter that you think is not so useful. One example is when you use the parameter *resType* on a resistor to trigger callbacks to set up the rest of the parameters based on the resistor type. Once that is done, you do not think the value of *resType* needs to be saved. The problems occur when you edit the parameters on existing instances and the values do not match.

- Reserved words

  There are words that are reserved and cannot be used as net, component, property, or parameter names. Do not use any of the following:

  - ❑ Command or function names that your simulator uses
  - ❑ A parameter or property name or prompt that is already in use
  - ❑ The names of fields
  - ❑ “others,” “loadSave,” “simInfo,” “othersFG,” “area,” “resistor,” or “multiplier”

  In addition, if you want to make sure a property you define does not go into the netlist, do not use the name of a CDF parameter.

- Initial and final procedures

  Avoid using too many initial and final procedures (*formInitProc* and *doneProc*). Running one or two procedures every time you change a parameter can slow down system performance noticeably.

- Layout name labels

  Labels in layout do not know the hierarchy, so they cannot display hierarchical names, only current names.

- Do not use parameter names that begin with a number.
- Changes in the Edit CDF form do not take effect until you click *Apply* on the Edit CDF form.
- Avoid using the *dontUse* attribute.

B

Troubleshooting CDF Callback

CDF callbacks are used for various tasks, such as calibrating entered values and controlling form appearance. You can also use them to compute the values of other CDF parameters, especially derived parameters. Using CDF callbacks to derive a value of another parameter is also referred to as a push model because at the point of creation or change of the source parameter, the derived parameter is pushed.

Potential Problems

Using CDF callbacks for computing the value of a derived parameter can cause data inconsistency if the callbacks do not get invoked. Using callbacks to derive parameters also prevents parameterization of the source parameter, which can cause problems.

Using callbacks to derive parameters can cause tools that sweep parameters to function inconsistently. Such an inconsistency can lead to issues when you use the source parameter for simulation, and the derived parameter for layout and physical verification.

There are several situations in which a callback does not get invoked. An example of such a situation is when you use the search and replace forms in Schematic Editor or the Layout Editor. In such a case, potentially all derived parameters become outdated.

Note: You can use CDF callbacks to compute a derived value for display purposes without major issues. Cadence recommends that you a label, such as *derived parameter* to indicate that they are estimated values. If the source parameter is an expression, you can make the derived parameter for display purposes show *Not available* or a similar term to indicate that the estimate could not be computed.

Resolution

Use a pull model instead of the push model. This means that each application that requires a derived parameter should compute the value from the source parameter at the time of usage. Typically these need to be done for the following:

- Simulation

  Calculate the derived parameter within a subckt model. The simulator can calculate a derived parameter when the hierarchy is flattened, using parameters passed to each occurrence.

- Pcells

  Calculate the derived parameter value in the Pcell SKILL code. For graphical Pcells, consider rewriting them in SKILL. However, in simple cases, you can get your graphical Pcell to work by using string parameters, and `cdfParseFloatString()` to convert those strings to numbers wherever used.

- Physical Verification

  The derivation of parameters to compare can be done in custom Diva or Assura rules, because these rules allow SKILL code to do the computation. You can also consider making the source parameters the parameters that can be extracted from the layout. This way, the source parameters can be compared directly.

Important

For more information on the CDF callback problem and its alternatives, see the CDF Callback Solution Page.

C

Accessing Subcircuit Simulation Data

Overview

This appendix describes how to access simulation data from primitive subcircuits and schematics when you use the spectre interface. By modifying the Component Description Format (CDF) description of components in a design, you can annotate and plot subcircuit port currents, primitive model parameters, and operating point parameters. You can apply the techniques described here to any simulation primitive, not just subcircuits. These techniques allow you to annotate derived parameters on the schematic.

Text-based subcircuits are frequently used to

- Provide a better model of device behavior
- Allow quick modification of the netlist representing the subcircuit

The first section describes how to modify a CDF description to obtain subcircuit port currents. The second section describes how to obtain the derived model parameters and operating point information. The third section describes how to obtain model parameters and operating point information from schematics below the level of the component in question. The last section reviews one method of editing a CDF description.

Note: Unless otherwise specified, the information in this appendix is for the *spectre* simulator. Other simulators may require a variation on the syntaxes detailed here.

The subcircuit examples use this simplified operational amplifier model. You can find this in the file

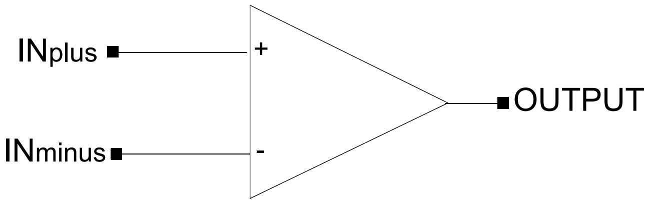
`your_install_dir/tools/dfII/samples/artist/models/spectre/vcvsOpampModels.scs`

```
subckt opamp (plus minus output)
parameters inputCap=500e-15
C1 (plus minus) capacitor c=inputCap
E1 (aout 0 plus minus) vcvs gain=1e6
R3 (aout output) r100m
R4 (plus minus) r10M
ends
```

```
model r100m resistor r=100e-3
model r10M resistor r=10e6
```

The subcircuit is represented at the next higher level in the design hierarchy by a symbol, with pins `INplus`, `INminus`, and `OUTPUT`. The instance `I16` in the cellview `vcvsOpampTest` schematic in the library `aExamples` references the cellview.

If you update the CDF, you must generate a new netlist in order for the enhancements described here to work.



symbol

Accessing Subcircuit Port Currents

You can obtain the port current of subcircuits of a component with simple simInfo on the CDF of that component. For the Spectre® circuit simulator, the use of expressions is not necessary because this simulator handles the calculation of currents.

Note: Only the port currents may be obtained. No access is provided to internal subcircuit currents.

The required simInfo is best illustrated by an example. To provide access to the currents entering through the plus, minus, and output ports of the operational amplifier model for spectre, add the following Cadence® SKILL language lines to the text of the spectre Simulation Information section of the operational amplifier CDF description, using the symbol pin names `INplus`, `INminus`, and `OUTPUT`:

```
termMapping ( nil INplus \:1 INminus \:2 OUTPUT \:3)
```

The *termMapping* property value is a disembodied property list (DPL*)*, which provides information to the data access code on how to obtain data for the relevant terminal. This information is also used by the simulator interface to generate appropriate save statements. The first term of the *termMapping* entry should always be *nil*.

Note: spectre requires the order number of the terminal for subcircuits, not the name. So instead of `":plus"`, `":1"` is required.

The *termMapping* property describes that the schematic terminal `INplus` is mapped to plus, and `INminus` is mapped to minus, and `OUTPUT` is mapped to the simulator name output. The colon character (`:`) is the Spectre simulator's instance-terminal delimiter.

To save currents, use the Save Options form on the simulation window, or use the *Outputs – To Be Saved* command. You can select the individual terminals on the `I16` instance in the `vcvsOpampTest` schematic cellview. During simulation, only the currents you specify are saved.

Accessing Subcircuit Model Parameter and Operating Point Information

By modifying a device CDF description, you can save additional model parameters or operating point information using the following functions:

- **opParamExprList** for specifying DC operating point information
- **optParamExprList** for specifying transient operating point information
- **modelParamExprList** for specifying model parameters

After simulation, you can access this information from the calculator or by using the label display mechanism. This method differs from the one used in the previous example in that you must fully specify the required functions. This is demonstrated in the following example.

In this example, three additional operating point parameters are resistors: *rin* (input resistance), *rout* (output resistance), and *gain*. Add the following lines to the spectre Simulation Information section of the operational amplifier CDF description:

```
opParamExprList  ("rin"  "OP(mappedRoot(\".R4\") \"res\")")
("rout" "OP(mappedRoot(\".R3\") \"res\")")
("gain" "1e6")
```

The *opParamExprList* property is a list of pairs. The first element of each pair is the name of the new property, and the second element is the expression that must be evaluated to compute the new property. *OP* is the operating parameter function, which takes an instance name and an associated parameter as arguments. The second argument *res* is the resistance parameter for that component. The first argument, `mappedRoot(\".R4\")`, is the expression for the name of the instance.

The *mappedRoot()* function takes the string (`\".R4\"`) and prepends the simulator instance name of the current instance. The dot character (`.`) is the spectre subcircuit delimiter. Since the property value is a string, substrings (such as `".R4"`) must be escaped (`\".R4\"`).

The *root()* function prepends the schematic name (rather than simulator name) of the device instance in question. The *root()* function also adds a slash (the schematic delimiter) before its argument.

Note: Use of the *root()* function is recommended over the *mappedRoot()* function in CDF mapping. This is because the *root()* function gives you the flexibility to specify schematic names, which are simulator independent, instead of simulator specific names. Consider the following example.

```
("id" "OP(root(\"M0\") \"id\")")
("id" "OP(root(\"M2<1>\") \"id\")")
```

In this example, M0 is non-iterated and M2 is an iterated instance.

Use the *mappedRoot()* function only when you know the exact simulator name, as shown in the following example (for a spectre simulator):

```
("id"  "OP(mappedRoot(\".M0\") \"id\")")
("id" "OP(mappedRoot(\".M2\\\\\\\\<1\\\\\\\\>\") \"id\")")
```

In this example, M0 is non-iterated and M2 is an iterated instance.

The other two functions provided, *inst()* and *mappedInst()*, do not take arguments and return the schematic and simulator instance names, respectively.

The following table shows the difference between the four functions.

Function Syntax	**Value Returned**
root(string)	strcat(instSchematicName "/" string)
mappedRoot(string)	strcat(instSimulatorName string)
inst()	instSchematicName
mappedInst()	instSimulatorName

The SKILL function *strcat* is the standard SKILL string concatenate function.

Given an instance of the subcircuit with the name `I16` and the simulator instance name of `I16`, the expressions in the example would evaluate as follows:

```
mappedRoot(\".R4\") -> "I16.R4"
root(\"inplus\") -> "I16/inplus"
```

The other functions would act as follows:

```
inst() -> "I16"
mappedInst() -> "I16"
```

Similarly, you can add transient operating point information and model parameters if you replace *opParamExprList* with *optParamExprList* and *modelParamExprList* respectively. Also replace *OP* with *OPT* and *MP* as follows:

```
OP(instance_name parameter)
```

```
OPT(instance_name parameter)
MP(instance_name parameter)
```

Following are examples of *optParamExprList* and *modelParamExprList*:

```
optParamExprList  ("rin" "OPT(mappedRoot('.R4') 'res')")
modelParamExprList   (("afin" "MP(mappedRoot(\".R4\") \"af\")")
                     ("afout" "MP(mappedRoot(\".R3\") \"af\")"))
```

In the same way, you can add parameters to cells that are similar to the ones you find in *analogLib*. The following addition to a resistor CDF description adds a conductance property:

```
opParamExprList  ("cond"  "1.0/OP(inst() \"res\")")
```

You can define your own functions to perform computations. Consider the following example which adds the `xyz` parameter:

```
opParamExprList  ("xyz"  "userFun(inst())")
```

When the `xyz` operating point property is accessed, the function `userFun()` is called with the schematic name of the instance in question. The `userFunc()` should return an integer if the operation is successful. If `userFunc()` does not return an integer, then the parameter is not displayed. Some more examples of user defined functions are as follows.

```
opParamExprList  ("avgcurrent"   "averageCurrent(root('PLUS'))")
    ("pwr"          "instPwr(inst())")

defun( instPwr ( instName )
    (let (i v)
        i = OP(instName "i")
        v = OP(instName "v")
        (when (and i v)  i * v )
)

defun( averageCurrent (instTerm)
    (let (i)
        i = IT( instTerm)
        (when i average(i))
    )

)
```

While using a user a user defined function with `opParamExprList` ensure that the function is defined, otherwise it causes an error. This process can aid debugging.

The expression you use to define a given property can be arbitrary, but if the expression evaluates incorrectly or the current is not saved, the system generates an error. This can be slow down the simulation if there are many instances of the device on a schematic attempting to display this property. For example, you might add the following `avecurrent` property to a resistor to compute the average transient current through the resistor:

```
opParamExprList  ("avecurrent"  "average(IT(root(\"PLUS\")))")
```

If you did not save the current, then the `IT()` function returns `nil`, and the `average()` function complains about a `nil` argument. To prevent this, add logic to the expression as in this example:

```
opParamExprList  ("avecurrent"  "let(((i IT(root(\"PLUS\"))))(and i average(i)))")
```

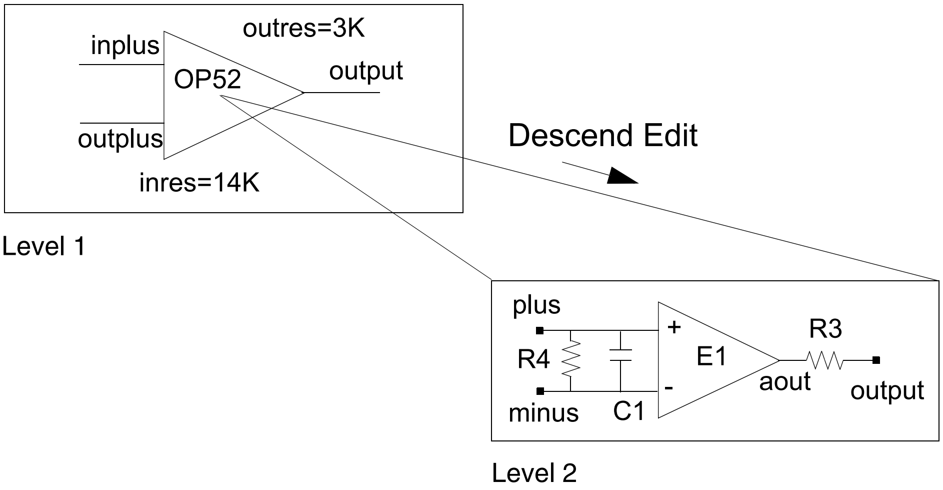
If you did not save the current, this expression prevents the system from flagging errors.

You can use standard SKILL functions like *let* in these expressions. *IT* and *average* are private, internal SKILL functions that are not documented for any other use.

Accessing Schematic Primitive Model and Operating Point Information

You can apply the methods for accessing model and operating point information in subcircuits to access that same information in schematics. By modifying the CDF description of a component, you can access model or operating point information in a schematic one level below the component and display it at the component's level.

For example, the instance `I19` in the cellview `vcvsOpampTest` is a schematic of the same subcircuit. On the next higher level is another schematic, where the sample schematic is represented by a symbol.



By putting a particular statement in the model or operating point expression list of the CDF *simInfo* section of *OP52*, you can define new parameters such as *inres* and *outres*, base them on primitive values one level down, such as *R4* and *R3*, and display their values on *OP52*.

To create the two parameters in the example, include these statements in the simInfo section of *OP52* for each simulator that you are using:

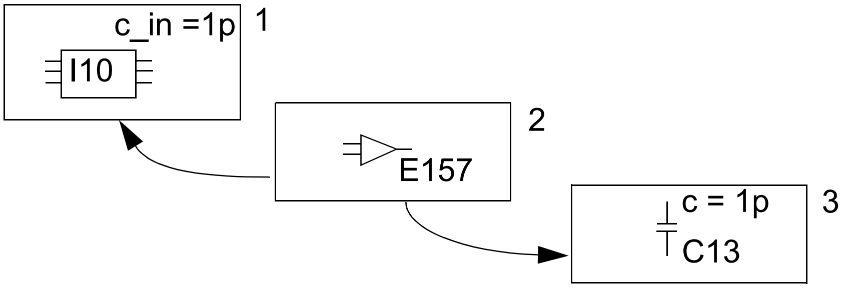
```
opParamExprList  ("inres" "OP(root(\"R4\") \"res\")")
    ("outres" "OP(root(\"R3\") \"res\")")
```

In this example, *inres* and *outres* are parameter names that you define. They derive their values from the *res* parameter on primitives *R4* and *R3*, respectively. For schematics you use the *root* function.

To display the information produced by these CDF description entries, make sure that you have created enough labels for your component and that those labels are set to display model or operating point values. For model data, use *modelParamExprList* and the *MP* function.

Note: CDF data is not view specific, so do not reference parameters in views that are not netlisted because of their position in the view switch list.

To refer to primitive data several design levels below the component where you want the data displayed, you need to include all the instance names from each level.



For this example, use the following statement in the CDF description of `I10` to display the capacitance on `C13` as the input capacitance of `I10`.

```
opParamExprList  ("cin" "OP(root(\"E157/C13\") \"c\"))
```

Editing a CDF Description

Writable Cells

To modify a cell CDF description for which you have write access

1. In the CIW, type

   `cdfDump( "lib" "`*`full_path/filename`*`" ?cellName "cell" ?edit ’t ?level ’base)`

   and wait for a window to appear.

2. Edit the file, making the necessary changes.
3. Load the file in the CIW with

   `load("`*`full_path`*`/`*`filename`*`")`

Sample CDF

The `aExamples` library demonstrates several different methods of parameter display.

The following is a sample CDF for several of the schematics in the `aExamples` library. Spectre examples are given:

- opamp (macro model)

```
cdfId->simInfo->spectre = '( nil
        propMapping       nil
        instParameters    nil
        otherParameters   (model)
        netlistProcedure  nil
        termMapping      ( nil IN\plus ":1" IN\minus ":2" OUTPUT ":3")
        termOrder         ("INplus" "INminus" "OUTPUT")
        componentName     opamp
        opParamExprList   ("rin" "OP(mappedRoot(".R4") "res")") ("rout"
"OP(mappedRoot(".R3") "res")") ("gain" "1e6"))
```

- opamp_sch (1 level display):

```
cdfId->simInfo->spectre = ’( nil
        termOrder         ("INplus" "INminus" "OUTPUT")
        componentName nil
        opParamExprList  ("inres" "OP(root("R2") "res")") ("outres"
"OP(root("R3") "res")"))
```

- opamp_2Level (2 level display):

```
cdfId->simInfo->spectre = ’( nil
        termOrder         ("in_plus" "in_minus" "out_again")
        componentName     "subcircuit"
       opParamExprList  ("cin" "OP(root("I0/C0") "cap")") ("rin" "OP(root("I0/
R2") "res")"))
```

D

NBSIM Transistor CDF SKILL Description

Dumping the CDF description of the *nbsim* cell in the *analogLib* library produces the following:

```
/****************************************************/
LIBRARY = "analogLib"
CELL = "nbsim"
/****************************************************/

let( ( libId cellId cdfId )

    unless( cellId = ddGetObj( LIBRARY CELL )
        error( "Could not get cell %s." CELL )
    )
    when( cdfId = cdfGetBaseCellCDF( cellId )
        cdfDeleteCDF( cdfId )
    )

    cdfId = cdfCreateBaseCellCDF( cellId )

;;; Parameters
cdfCreateParam( cdfId
    ?name "model"
    ?prompt "Model name"
    ?defValue ""
    ?type "string"
    ?display "artParameterInToolDisplay('model)"
    ?parseAsCEL "yes"
)

 cdfCreateParam( cdfId
     ?name "bn"
     ?prompt "Bulk node connection"
     ?defValue "S"
     ?type "string"
     ?display "artParameterInToolDisplay('bn)"
     ?parseAsCEL "yes"
 )

 cdfCreateParam( cdfId
     ?name "m"
     ?prompt "Multiplier"
     ?defValue "1"
     ?type "string"
     ?display "artParameterInToolDisplay('m)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )

 cdfCreateParam( cdfId
     ?name "w"
     ?prompt "Width"
     ?units "lengthMetric"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('w)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
 cdfCreateParam( cdfId
     ?name "l"
     ?prompt "Length"
     ?units "lengthMetric"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('l)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
 cdfCreateParam( cdfId
     ?name "ad"
     ?prompt "Drain diffusion area"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('ad)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
 cdfCreateParam( cdfId
     ?name "as"
     ?prompt "Source diffusion area"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('as)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
 cdfCreateParam( cdfId
     ?name "pd"
     ?prompt "Drain diffusion periphery"
     ?units "lengthMetric"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('pd)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
 cdfCreateParam( cdfId
     ?name "ps"
     ?prompt "Source diffusion periphery"
     ?units "lengthMetric"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('ps)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
 cdfCreateParam( cdfId
     ?name "nrd"
     ?prompt "Drain diffusion res squares"
```

```
        ?defValue ""
        ?type "string"
        ?display "artParameterInToolDisplay('nrd)"
        ?parseAsNumber "yes"
        ?parseAsCEL "yes"
)
cdfCreateParam( cdfId
        ?name "nrs"
        ?prompt "Source diffusion res squares"
        ?defValue ""
        ?type "string"
        ?display "artParameterInToolDisplay('nrs)"
        ?parseAsNumber "yes"
        ?parseAsCEL "yes"
)
cdfCreateParam( cdfId
        ?name "ld"
        ?prompt "Drain diffusion length"
        ?units "lengthMetric"
        ?defValue ""
        ?type "string"
        ?display "artParameterInToolDisplay('ld)"
        ?parseAsNumber "yes"
        ?parseAsCEL "yes"
)
cdfCreateParam( cdfId
        ?name "ls"
        ?prompt "Source diffusion length"
        ?units "lengthMetric"
        ?defValue ""
        ?type "string"
        ?display "artParameterInToolDisplay('ls)"
        ?parseAsNumber "yes"
        ?parseAsCEL "yes"
)
cdfCreateParam( cdfId
        ?name "off"
        ?prompt "Device initially off"
        ?type "boolean"
        ?display "artParameterInToolDisplay('off)"
)
cdfCreateParam( cdfId
        ?name "Vds"
        ?prompt "Drain source initial voltage"
        ?units "voltage"
        ?defValue ""
        ?type "string"
        ?display "artParameterInToolDisplay('Vds)"
        ?parseAsNumber "yes"
        ?parseAsCEL "yes"
)
cdfCreateParam( cdfId
        ?name "Vgs"
        ?prompt "Gate source initial voltage"
        ?units "voltage"
        ?defValue ""
        ?type "string"
        ?display "artParameterInToolDisplay('Vgs)"
```

```
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
 cdfCreateParam( cdfId
     ?name "Vbs"
     ?prompt "Bulk source initial voltage"
     ?units "voltage"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('Vbs)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
 cdfCreateParam( cdfId
     ?name "trise"
     ?prompt "Temp rise from ambient"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('trise)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
 cdfCreateParam( cdfId
     ?name "region"
     ?prompt "Estimated operating region"
     ?defValue "triode"
     ?choices '("off" "triode" "sat" "subth")
     ?type "cyclic"
     ?display "artParameterInToolDisplay('region)"
     ?parseAsCEL "yes"
 )
 cdfCreateParam( cdfId
     ?name "rdc"
     ?prompt "Additional drain resistance"
     ?units "current"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('rdc)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
cdfCreateParam( cdfId
     ?name "rsc"
     ?prompt "Additional source resistance"
     ?units "current"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('rsc)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
cdfCreateParam( cdfId
     ?name "dtemp"
     ?prompt "Temperature difference"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('dtemp)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
cdfCreateParam( cdfId
     ?name "geo"
     ?prompt "Source/drain selector"
     ?defValue ""
     ?type "string"
     ?display "artParameterInToolDisplay('geo)"
     ?parseAsNumber "yes"
     ?parseAsCEL "yes"
 )
;;; Simulator Information
cdfId->simInfo = list( nil )
cdfId->simInfo->auCdl = '( nil
     netlistProcedure        ansCdlCompPrim
     instParameters          (m L W)
     componentName           nbsim
     termOrder               (D G S progn(bn))
     propMapping             (nil L l W w)
     namePrefix              "M"
     modelName               "NM"
)
cdfId->simInfo->auLvs = '( nil
propMapping              nil
netlistProcedure         ansLvsCompPrim
instParameters           (m l w)
componentName            nbsim
termOrder                (D G S progn(bn))
deviceTerminals          "D G S B"
permuteRule              "(p D S)"
namePrefix               "Q"
)
cdfId->simInfo->cdsSpice = '( nil
netlistProcedure         ansSpiceDevPrim
instParameters           (m w l ad as pd ps nrd nrs ld ls off vds vgs vbs)
otherParameters          (model bn)
componentName            bsim
termOrder                (D G S progn(bn))
propMapping              (nil vds Vds vgs Vgs vbs Vbs)
namePrefix               "S"
current                  port
dcSens                   t
acSens                   t
)
cdfId->simInfo->hspiceS = '( nil
netlistProcedure         ansSpiceDevPrim
instParameters           (l w ad as pd ps nrd nrs rdc rsc off Vds Vgs Vbs dtemp
    geo m)
otherParameters          (bn model)
componentName            hnmos
termOrder                (D G S progn(bn))
propMapping              (nil vds Vds vgs Vgs vbs Vbs)
namePrefix               "M"
current                  port
dcSens                   t
acSens                   t
)
```

```
cdfId->simInfo->spectre = '( nil
propMapping              nil
otherParameters           (bn model)
instParameters            (w l as ad ps pd nrd nrs ld ls m trise
    region)
termOrder                 (D G S progn(bn))
termMapping               (nil D d G g S s B b)
)
```

```
cdfId->simInfo->spectreS = '( nil
propMapping              nil
netlistProcedure         ansSpectreSDevPrim
otherParameters           (bn model region)
instParameters            (w l as ad ps pd nrd nrs ld ls m trise)
termOrder                 (D G S progn(bn))
termMapping               (nil D d G g S s B b)
namePrefix               "S"
componentName            bsim1
current                  port
)
```

```
;;; Properties
cdfId->formInitProc             = ""
cdfId->doneProc                 = ""
cdfId->buttonFieldWidth         = 340
cdfId->fieldHeight              = 35
cdfId->fieldWidth               = 350
cdfId->promptWidth              = 175
cdfId->modelLabelSet            = "vfb phi eta"
cdfId->opPointLabelSet          = "id vgs vds"
cdfId->paramLabelSet            = "-model l w"
cdfSaveCDF( cdfId )
```

```
)
```

E

CDF Environment Variables

This appendix describes the public environment variables that control the characteristics of the Component Description Format. You can customize the operation and behavior of CDF features and form by changing the values of particular environment variables. The default value of each variable appears in the syntax descriptions.

See the following function for more information:

- defaultCDFType

defaultCDFType

Specifies the default value of the radio options in the CDF form.

In `.cdsenv`:

```
cdf.editor defaultCDFType cyclic "Effective" nil
```

In `.cdsinit` or the CIW:

```
envSetVal( "cdf.editor" "defaultCDFType" 'cyclic
     "Effective" )
```

Valid Values:

`Base`	Always considers the base values.
`User`	Always considers the user-defined values.
`Effective`	Always considers the effective values.

Default Value: `Effective`

defaultDisplay

Displays the library and cell information in the CDF form based on the specified options.

In `.cdsenv`:

```
cdf.editor defaultDisplay cyclic
     "SelectionThenLast" nil
```

In `.cdsinit` or the CIW:

```
envSetVal( "cdf.editor" "defaultDisplay" 'cyclic
     "SelectionThenLast" )
```

Valid Values:

`Selection`	The current instance.
`Last`	The library or the library and cellview that was previously shown in the edit CDF form. **Note:** The previous value is shown only if you close the previous form by selecting OK or Cancel. If you close the form by pressing Escape, the previous details are not shown. user's selection
`SelectionThenLast`	if there is a current selection that's used, otherwise the previous value is restored.
`None`	Restores the previous behavior.

Default Value: `Effective`

Glossary

A

AEL

Analog Expression Language. A syntax for expressions that allows the rapid evaluation of those expressions. AEL lets you express values as mathematical expressions instead of single, fixed values. Refer to the *Analog Expression Language Reference.*

auCdl

Analog and Microwave CDL. The analog and microwave version of CDL, which originally only ran on digital designs.

auLvs

Analog and Microwave LVS. The analog and microwave version of LVS, which originally only ran on digital designs.

B

base level

The fundamental representation of a cell or library CDF description. Base level and user level are combined to produce the effective level, with user-level values overriding base-level values. Only the base level is permanently stored to the system disk.

C

callback procedure

A procedure triggered by a change in a parameter in a CDF description. Callbacks can be SKILL procedures, expressions, or functions entered directly into the Edit Component Parameter form, or they can be calls to procedures located elsewhere.

CDF

Component Description Format. A system for dynamically changing and storing parameters and displaying information for components and sets of components for different versions (levels) of designs.

CDL

Circuit Description Language. CDL is a subset of SPICE used by Dracula®, with extensions that allow for such things as global signals and empty cells.

CEL

CDF Expression Language. Another name for AEL.

cell

The Cadence software representation of a design element (or component).

CIW

Command Interpreter Window. The primary user interface for launching Cadence software. The Edit CDF form starts from the Tools menu in the CIW. You can enter SKILL commands in the CIW command line.

component

A fundamental unit within a system that encapsulates behavior and/or structure (also known as an *element*). A cell, with cellviews and associated CDF.

cyclic field

A type of form field that displays only one value, but reveals a sliding menu when you select the field.

D

disembodied property list

A software record used to store and retrieve component properties. New properties can be dynamically added or removed. A disembodied property list starts with a SKILL data object, usually *nil*, followed by alternating name and value pairs.

E

effective level

A masked sum of all the CDF values for a cell or library.

F

form field

The empty rectangle on a form where you type in values and names.

H

hpmns

MNS™ microwave design simulator from Hewlett-Packard.

I

interpreted labels

Displayed component values which change with each instance or change as the component parameters change.

instance parameters

Those parameters used in a module description that change with each instantiation of that module. These parameters are defined in the first section of a module, the module interface declarations, and are specified each time a module is called in a netlist instance statement.

L

libra

Libra®. A microwave design simulator from EESof.

LVS

Layout Versus Schematic. A Dracula verification tool that confirms that your layout matches your original schematic.

M

mharm

Microwave Harmonica®. A microwave design simulator from Compact Software.

model

A named instance with a unique group of parameters specifying the behavior of one particular version of a component. You can use models to instantiate components with parametric specifications different than those in the original component definition.

model parameter

Those parameters in a module description that remain the same with each instantiation of the original module, but which are designed to be changed when the module is called by a model. These parameters are defined in the second section of a module, the global module scope declarations, and they are specified each time a module is called in a model instance statement.

N

nil

No value (an absence of value) or a *false* value.

P

parameter

A characteristic of a component.

parameter attributes

A characteristic of a parameter.

parse

The system evaluation of CDF information. Values can be parsed in absolute terms or according to a predefined system.

Pcell

A parameterized cell. You can change a set of cells by changing one parameter.

prompt

The title or words to the left of the form field or button that tell you the name or nature of the parameter or other value that you enter at that place in the form.

property

A piece of information about an instance or object in a design.

R

radio button

An entry on a form that behaves as a push button does. You click the button to turn the function on (the symbol turns black) and off (the symbol turns white).

radio field

A set of interlinked radio buttons in a single form field associated with one parameter. Typically, only one button can be on at any one time.

S

SKILL

A proprietary Cadence programming language based on over 1,200 functions. Each function follows a standard SKILL syntax and acts on a particular data type or data object.

SKILL command

When SKILL functions or expressions are used alone or entered into the CIW command line, they are often called SKILL commands.

SKILL expression

An equation where a data object is set equal to a SKILL function. AEL expressions can be used to express individual values in a SKILL function.

SKILL function

The fundamental element in the SKILL language. An operation to be performed (usually specific to Cadence software), usually followed by the items or data objects that the operation is to be performed on.

SKILL procedure

A short program or “script” or routine made up of multiple SKILL expressions and functions.

SKILL routine

A program made up of multiple SKILL expressions and functions.

T

A non-*nil* or *true* value. Used in Boolean values.

U

user level

A temporary level of cell or library CDF information that overrides base-level information, but is lost at the end of each design session unless you take specific actions to save it.

V

VLE

Virtuoso Layout Editor. Cadence’s integrated circuit layout editor that supports IC cell layout design down to the polygon level.

W

watscad

WATSCAD™. A switched capacitor design simulator from the University of Waterloo.