HSPICE® Command Reference

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SYNOPSYS®

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Contents

About This Manual

This manual describes the individual HSPICE commands you can use to simulate and analyze your circuit designs.

Inside This Manual

This manual contains the chapters described below. For descriptions of the other manuals in the HSPICE documentation set, see the next section, The HSPICE Documentation Set.

Chapter	Description
Chapter 1, Command Categories	Lists all commands you can use in HSPICE, arranged by task.
Chapter 2, Commands in HSPICE Netlists	Contains an alphabetical listing of all commands you can use in an HSPICE netlist.
Chapter 3, Options in HSPICE Netlists	Describes the simulation options you can set using various forms of the `.OPTION` command.
Chapter 4, Commands in Digital Vector Files	Contains an alphabetical listing of the commands you can use in an digital vector file.

The HSPICE Documentation Set

This manual is a part of the HSPICE documentation set, which includes the following manuals:

Manual	Description
HSPICE Simulation and Analysis User Guide	Describes how to use HSPICE to simulate and analyze your circuit designs. This is the main HSPICE user guide.
HSPICE Signal Integrity Guide	Describes how to use HSPICE to maintain signal integrity in your chip design.
HSPICE Applications Manual	Provides application examples and additional HSPICE user information.
HSPICE Command Reference	Provides reference information for HSPICE commands.
HPSPICE Elements and Device Models Manual	Describes standard models you can use when simulating your circuit designs in HSPICE, including passive devices, diodes, JFET and MESFET devices, and BJT devices.
HPSPICE MOSFET Models Manual	Describes standard MOSFET models you can use when simulating your circuit designs in HSPICE.
HSPICE RF Manual	Describes a special set of analysis and design capabilities added to HSPICE to support RF and high-speed circuit design.
AvanWaves User Guide	Describes the AvanWaves tool, which you can use to display waveforms generated during HSPICE circuit design simulation.

Manual	Description
HSPICE Quick Reference Guide	Provides key reference information for using HSPICE, including syntax and descriptions for commands, options, parameters, elements, and more.
HSPICE Device Models Quick Reference Guide	Provides key reference information for using HSPICE device models, including passive devices, diodes, JFET and MESFET devices, and BJT devices.

Searching Across the HSPICE Documentation Set

Synopsys includes an index with your HSPICE documentation that lets you search the entire HSPICE documentation set for a particular topic or keyword. In a single operation, you can instantly generate a list of hits that are hyperlinked to the occurrences of your search term. For information on how to perform searches across multiple PDF documents, see the HSPICE release notes (available on SolvNet at http://solvnet.synopsys.com) or the Adobe Reader online help.

Note: To use this feature, the HSPICE documentation files, the Index directory, and the index.pdx file must reside in the same directory. (This is the default installation for Synopsys documentation.) Also, Adobe Acrobat must be invoked as a standalone application rather than as a plug-in to your web browser.

Other Related Publications

For additional information about HSPICE, see:

- The HSPICE release notes, available on SolvNet (see Accessing SolvNet on page xix)
- Documentation on the Web, which provides PDF documents and is available through SolvNet at http://solvnet.synopsys.com
- The Synopsys MediaDocs Shop, from which you can order printed copies of Synopsys documents, at http://mediadocs.synopsys.com

You might also want to refer to the documentation for the following related Synopsys products:

- CosmosScope
- Aurora
- Raphael
- VCS

Conventions

The following conventions are used in Synopsys documentation:

Convention	Description
`Courier`	Indicates command syntax.
`Italic`	Indicates a user-defined value, such as *`object_name`*.
`Bold`	Indicates user input—text you type verbatim—in syntax and examples.
`[]`	Denotes optional parameters, such as `write_file [-f filename]`
`...`	Indicates that a parameter can be repeated as many times as necessary: *`pin1 [pin2 ... pinN]`*
|	Indicates a choice among alternatives, such as `low | medium | high`
\	Indicates a continuation of a command line.
/	Indicates levels of directory structure.
Edit > Copy	Indicates a path to a menu command, such as opening the Edit menu and choosing Copy.
Control-c	Indicates a keyboard combination, such as holding down the Control key and pressing c.

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2. If prompted, enter your user name and password. (If you do not have a Synopsys user name and password, follow the instructions to register with SolvNet.)

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- Send an e-mail message to your local support center.
  - E-mail support_center@synopsys.com from within North America.
  - Find other local support center e-mail addresses at http://www.synopsys.com/support/support_ctr.
- Telephone your local support center.
  - Call (800) 245-8005 from within the continental United States.

- Call (650) 584-4200 from Canada.

- Find other local support center telephone numbers at http://www.synopsys.com/support/support_ctr.

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Command Categories

Lists all commands you can use in HSPICE, arranged by task.

Alter Blocks

Use these commands in your HSPICE netlist to run alternative simulations of your netlist by using different data.

.ALIAS .ALTER .DEL LIB
.TEMP

Analysis

Use these commands in your HSPICE netlist to start different types of HSPICE analysis to save the simulation results into a file, and to load the results of a previous simulation into a new simulation.

.AC .LIN .SAMPLE
.DC .NET .SENS
.DCMATCH .NOISE .TEMP

.DISTO	.OP	.TF
.FFT	.PAT	.TRAN
.FOUR	.PZ	

Conditional Block

Use these commands in your HSPICE netlist to setup a conditional block. HSPICE does not execute the commands in the conditional block, unless the specified conditions are true.

.ELSE	.ELSEIF	.ENDIF
.IF		

Digital Vector

Use these commands in your digital vector (VEC) file.

ENABLE	SLOPE	VIH
IDELAY	TDELAY	VIL
IO	TFALL	VNAME
ODELAY	TRISE	VOH
OUT or OUTZ	TRIZ	VOL
PERIOD	TSKIP	VREF
RADIX	TUNIT	VTH

Encryption

Use these commands in your HSPICE netlist to mark the start and end of an encrypted section of a netlist.

.PROTECT	.UNPROTECT

Field Solver

Use these commands in your HSPICE netlist to define a field solver.

.FSOPTIONS .LAYERSTACK .MATERIAL
.SHAPE

Files

Use this command in your HSPICE netlist to call other files that are not part of the netlist.

.VEC

Input/Output Buffer Information Specification (IBIS)

Use these commands in your HSPICE netlist for specifying input/output buffer information.

.EBD .IBIS .ICM
.PKG

Library Management

Use these commands in your HSPICE netlist to manage libraries of circuit designs, and to call other files when simulating your netlist.

.DEL LIB .INCLUDE .PROTECT
.ENDL .LIB .UNPROTECT

Model Definition

Use these commands in your HSPICE netlist to define models.

.MALIAS .MODEL

Node Naming

Use these commands in your HSPICE netlist to name nodes in circuit designs.

.CONNECT .GLOBAL

Output Porting

Use these commands in your HSPICE netlist to specify the output of a simulation to a printer, plotter, or graph. You can also define the parameters to measure, and to report in the simulation output.

.BIASCHK	.MEASURE	.PROBE
.DOUT	.PLOT	.STIM
.GRAPH	.PRINT	.WIDTH

Setup

Use these commands in your HSPICE netlist to setup your netlist for simulation.

.DATA	.IC	.PARAM
.DCVOLT	.LOAD	.SAVE
.ENDDATA	.NODESET	.TITLE
.GLOBAL	.OPTION	

Simulation Runs

Use these commands in your HSPICE netlist to mark the start and end of individual simulation runs, and conditions that apply throughout an individual simulation run.

.END .TEMP .TITLE

Subcircuits

Use these commands in your HSPICE netlist to define subcircuits, and to add instances of subcircuits to your netlist.

.ENDS .INCLUDE .MODEL
.EOM .MACRO .SUBCKT

Verilog-A

Use the following command in your HSPICE netlist to declare the Verilog-A source name and path within the netlist.

.HDL

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Commands in HSPICE Netlists

Contains an alphabetical listing of all commands you can use in an HSPICE netlist.

Here are the commands described in this chapter. For a list of commands grouped according to tasks that use each command, see Chapter 1, Command Categories.

.AC

Syntax

Single/Double Sweep

```
.AC type np fstart fstop

.AC type np fstart fstop <SWEEP var <START=>start
+ <STOP=>stop <STEP=>incr>

.AC type np fstart fstop <SWEEP var type np start stop>

.AC type np fstart fstop
+ <SWEEP var START="param_expr1"
+ STOP="param_expr2" STEP="param_expr3">

.AC type np fstart fstop <SWEEP var start_expr
+ stop_expr step_expr>
```

Sweep Using Parameters

```
.AC type np fstart fstop <SWEEP DATA = datanm>

.AC DATA = datanm

.AC DATA = datanm <SWEEP var <START=>start <STOP=>stop
+ <STEP=>incr>

.AC DATA = datanm <SWEEP var type np start stop>

.AC DATA = datanm <SWEEP var START="param_expr1"
+ STOP="param_expr2" STEP="param_expr3">

.AC DATA = datanm <SWEEP var start_expr stop_expr
+ step_expr>
```

In HSPICE RF, you can run a parameter sweep around a single analysis, but the parameter sweep cannot change `.OPTION` values.

Optimization

```
.AC DATA = datanm OPTIMIZE = opt_par_fun
+ RESULTS = measnames MODEL = optmod
```

HSPICE RF supports optimization for bisection only.

Random/Monte Carlo

```
.AC type np fstart fstop <SWEEP MONTE = val>
+ <firstrun = num1>
```

-or-

```
.AC type np fstart fstop <SWEEP MONTE = list<(>
+ <num1:num2> <num3> <num5:num6> <num7> <)> >
```

Example 1

```
.AC DEC 10 1K 100MEG
```

This example performs a frequency sweep, by 10 points per decade, from 1kHz to 100MHz.

Example 2

```
.AC LIN 100 1 100HZ
```

This example runs a 100-point frequency sweep from 1- to 100-Hz.

Example 3

```
.AC DEC 10 1 10K SWEEP cload LIN 20 1pf 10pf
```

This example performs an AC analysis for each value of `cload`. This results from a linear sweep of `cload` between 1- and 10-pF (20 points), sweeping the frequency by 10 points per decade, from 1- to 10-kHz.

Example 4

```
.AC DEC 10 1 10K SWEEP rx POI 2 5k 15k
```

This example performs an AC analysis for each value of `rx`, `5k` and `15k`, sweeping the frequency by 10 points per decade, from 1- to 10-kHz.

Example 5

```
.AC DEC 10 1 10K SWEEP DATA = datanm
```

This example uses the `.DATA` statement to perform a series of AC analyses, modifying more than one parameter. The `datanm` file contains the parameters.

Example 6

```
.AC DEC 10 1 10K SWEEP MONTE = 30
```

This example illustrates a frequency sweep, and a Monte Carlo analysis (not supported in HSPICE RF) with 30 trials.

Example 7

```
AC DEC 10 1 10K SWEEP MONTE = 10 firstrun=15
```

This example illustrates a frequency sweep and a Monte Carlo analysis from the 15th to the 24th trials.

Example 8

```
.AC DEC 10 1 10K SWEEP MONTE = list(10 20:30 35:40 50)
```

This example illustrates a frequency sweep and a Monte Carlo analysis at 10th trial, and then from the 20th to 30th trial, followed by the 35th to 40th trial, and finally at 50th trial.

Description

You can use the `.AC` statement in several different formats, depending on the application as shown in the examples. You can also use the `.AC` statement to perform data-driven analysis in HSPICE.

If the input file includes an `.AC` statement, HSPICE runs AC analysis for the circuit, over a selected frequency range for each parameter in the second sweep.

For AC analysis, the data file must include at least one independent AC source element statement (for example, `VI INPUT GND AC 1V`). HSPICE checks for this condition, and reports a fatal error if you did not specify such AC sources.

You also cannot use this statement in HSPICE RF.

Argument	Definition
DATA = *datanm*	Data name, referenced in the .AC statement (not supported in HSPICE RF).
incr	Increment value of the voltage, current, element, or model parameter. If you use *type* variation, specify the *np* (number of points) instead of *incr*.

Argument	Definition
fstart	Starting frequency. If you use POI (list of points) type variation, use a list of frequency values, not fstart fstop.
fstop	Final frequency.
MONTE = val	Produces a number (*val*) of randomly-generated values (HSPICE only; not supported in HSPICE RF). HSPICE uses these values to select parameters from a distribution, either *Gaussian*, *Uniform*, or *Random Limit*.
np	Number of points, or points per decade or octave, depending on which keyword precedes it.
start	Starting voltage or current, or any parameter value for an element or model.
stop	Final voltage or current, or any parameter value for an element or a model.
SWEEP	Indicates that the .AC statement specifies a second sweep.
TEMP	Indicates a temperature sweep
type	Can be any of the following keywords: • DEC – decade variation. • OCT – octave variation. • LIN – linear variation. • POI – list of points.
var	Name of an independent voltage or current source, element or model parameter, or the TEMP (temperature sweep) keyword. HSPICE or HSPICE RF supports source value sweep, referring to the source name (SPICE style). If you select a parameter sweep, a .DATA statement, and a temperature sweep, then you must choose a parameter name for the source value. You must also later refer to it in the .AC statement. The parameter name cannot start with V or I.

Argument	Definition
firstrun	The `val` value specifies the number of Monte Carlo iterations to perform. The `firstrun` value specifies the desired number of iterations. HSPICE runs from num1 to num1+val-1.
list	The iterations at which HSPICE performs a Monte Carlo analysis. You can write more than one number after `list`. The colon represents "from ... to ...". Specifying only one number makes HSPICE run at only the specified point.

See Also

.DC
.TRAN

.ALIAS

Syntax

```
.ALIAS <model_name1> <model_name2>
```

Example 1

You delete a library named *poweramp*, that contains a model named *pa1*. Another library contains an equivalent model named *par1*. You can then alias the pa1 model name to the par1 model name:

```
.ALIAS pa1 par1
```

During simulation when HSPICE encounters a model named `pa1` in your netlist, it initially cannot find this model because you used a `.ALTER` statement to delete the library that contained the model. However, the `.ALIAS` statement indicates to use the `par1` model in place of the old `pa1` model and HSPICE *does* find this new model in another library, so simulation continues.

You must specify an old model name and a new model name to use in its place. You cannot use `.ALIAS` without any model names:

```
.ALIAS
```

or with only *one* model name:

```
.ALIAS pa1
```

You also cannot alias a model name to *more than one* model name, because then the simulator would not know which of these new models to use in place of the deleted or renamed model:

```
.ALIAS pa1 par1 par2
```

For the same reason, you cannot alias a model name to a second model name, and then alias the second model name to a third model name:

```
.ALIAS pa1 par1
.ALIAS par1 par2
```

If your netlist does not contain an `.ALTER` command, and if the `.ALIAS` does not report a usage error, then the `.ALIAS` does not affect the simulation results.

Example 2

Your netlist might contain the statement:

```
.ALIAS myfet nfet
```

Without a .ALTER statement, HSPICE does not use nfet to replace myfet during simulation.

If your netlist contains one or more .ALTER commands, the first simulation uses the original myfet model. After the first simulation, if the netlist references myfet from a deleted library, .ALIAS substitutes nfet in place of the missing model.

- If HSPICE finds model definitions for both myfet and nfet, it reports an error and aborts.
- If HSPICE finds a model definition for myfet, but not for nfet, it reports a warning, and simulation continues by using the original myfet model.
- If HSPICE finds a model definition for nfet, but not for myfet, it reports a *replacement successful* message.

Description

You can use .ALTER statements to rename a model to rename a library containing a model, or to delete an entire library of models in HSPICE. If your netlist references the old model name, then after you use one of these types of .ALTER statements, HSPICE no longer finds this model.

Note: HSPICE RF does not support the .ALIAS statement.

For example, if you use .DEL LIB in the .ALTER block to delete a library, the .ALTER command deletes all models in this library. If your netlist references one or more models in the deleted library, then HSPICE no longer finds the models.

To resolve this issue, HSPICE provides a .ALIAS command to let you alias the old model name to another model name that HSPICE can find in the existing model libraries.

See Also

.ALTER
.MALIAS

.ALTER

Syntax

```
.ALTER <title_string>
```

Example

```
.ALTER simulation_run2
```

Description

You can use the .ALTER statement to rerun an HSPICE simulation by using different parameters and data. HSPICE RF does not support the .ALTER statement.

Use parameter (variable) values for .PRINT and .PLOT statements, before you alter them. The .ALTER block cannot include .PRINT, .PLOT, .GRAPH or any other input/output statements. You can include analysis statements (.DC, .AC, .TRAN, .FOUR, .DISTO, .PZ, and so on) in a .ALTER block in an input netlist file.

However, if you change only the analysis type, and you do not change the circuit itself, then simulation runs faster if you specify all analysis types in one block, instead of using separate .ALTER blocks for each analysis type.

The .ALTER sequence or block can contain:

- Element statements (except source elements)
- .ALIAS statements
- .DATA statements
- .DEL LIB statements
- .IC (initial condition) and .NODESET statements
- .INCLUDE statements
- .LIB statements
- .MODEL statements
- .OP statements
- .OPTION statements
- .PARAM statements
- .TEMP statements

- .TF statements
- .TRAN, .DC, and .AC statements

Argument	Definition
title_string	Any string up to 72 characters. HSPICE prints the appropriate title string for each .ALTER run in each section heading of the output listing, and in the graph data (.tr#) files.

Note: The .MALIAS command is not officially supported in .ALTER blocks.

See Also

.OPTION MEASFILE

.BIASCHK

Syntax

As an expression monitor:

```
.BIASCHK 'expression' <limit = lim> <noise = ns>
+ <max = max> <min = min>
+ <simulation = op | dc | tr | all> <monitor = v | i |  w | l >
+ <tstart = time1> <tstop = time2> <autostop>
```

As an element and model monitor:

```
.BIASCHK type <region=cutoff | linear | saturation>
+ terminal1=t1 <terminal2=t2> <limit=lim>
+ <noise=ns> <max=max> <min=min>
+ <simulation=op | dc | tr | all> <monitor=v | i | w | l>
+ <name=name1, name2, ...>
+ <mname=modname_1, modname_2, ...>
+ <tstart=time1> <tstop=time2> <autostop>
+ <except=name_1,name_2, ...>
```

Example 1

This example uses the `.BIASCHK` statement to monitor an expression:

```
.biaschk 'v(1)' min = 'v(2)*2' simulation= op
```

Example 2

This example uses the `.BIASCHK` statement to monitor an element and model type:

```
.biaschk nmos terminal1 = vg terminal2 = vs
   simulation = tr name = m1
```

In this example, `terminal1` and `terminal2` are the terminals between which you want to check.

Description

The `.BIASCHK` statement can monitor the voltage bias, current, device-size, expression and region during analysis, and reports:

- Element name
- Time
- Terminals

- Bias that exceeds the limit
- Number of times the bias exceeds the limit for an element

HSPICE saves the information as both a warning and a BIASCHK summary in the **.lis* file or a file you define in the `.OPTION BIASFILE` command option. You can use this command only for active elements, capacitors, and subcircuits.

If a model name, referenced in an active element statement, contains a period (.), then `.BIASCHK` reports an error. This occurs because it is unclear whether a reference such as `x.123` is a model name or a sub-circuit name (123 model in the x subcircuit).

More than one simulation type or all simulation types can be set in one `.BIASCHK` command, and more than one region can be set in one `.BIASCHK` command.

Instance (element) and model names can contain wildcards, either “?” (stands for one character) or “*” (stands for 0 or more characters).

If you do not set *name* and *mname*, HSPICE checks all elements of this type for bias voltage (you must include type in the biaschk card). However, if `type = subckt`, at least one *name* or *mname* must be specified in the `.BIASCHK` command; otherwise, a warning message is issued and this command ignored.

After a simulation that uses the `.BIASCHK` command runs, HSPICE outputs a results summary including the element name, time, terminals, model name, and the number of times the bias exceeded the limit for a specified element.

Interactions with Other Options

If you set `.OPTION BIAWARN` to `1`, HSPICE immediately outputs a warning message that includes the element name, time, terminals and model name when the limit is exceeded during the analysis you define. If you set the `autostop` keyword, HSPICE automatically stops at that situation.

If you set `.OPTION BIASFILE`, HSPICE outputs the summary into a file you define in the biasfile. Otherwise, HSPICE outputs the summary to a **.lis* file.

Argument	Definition
type	Element type to check. MOS (C, BJT, ...) For a monitor, *type* can be DIODE, BIPOLAR, BJT, JFET, MOS, NMOS, PMOS, C, or SUBCKT. When used with REGION, *type* can be MOS only.
`terminal 1, 2`	Terminals, between which HSPICE checks (that is, checks between *terminal1* and *terminal2*): • For MOS level 57: *nd, ng, ns, ne, np, n6* • For MOS level 58: *nd, ngf, ns, ngb* • For MOS level 59: *nd, ng, ns, ne, np* • For other MOS level: *nd, ng, ns, nb* • For capacitor: *n1, n2* • For diode: *np*, *nn* • For bipolar: *nc*, *nb*, *ne*, *ns* • For JFET: *nd*, *ng*, *ns*, *nb* For `type` = `subckt`, the terminal names are those pins defined by the subcircuit definition of `mname`.
`limit`	Biaschk limit that you define. Reports an error if the bias voltage (between appointed terminals of appointed elements and models) is larger than the limit.

`noise`	Biaschk noise that you define. The default is 0.1v.
	Noise-filter some of the results (the local maximum bias voltage, that is larger than the limit).
	The next local max replaces the local max, if all of the following conditions are satisfied:
	`local_max-local_min<noise>.`
	`next local_max-local_min<noise>.`
	This local max is smaller than the next local max. For a parasitic diode, HSPICE ignores the smaller local max biased voltage, and does not output this voltage.
	To disable this feature, set the noise detection level to 0.

`max`	Maximum value.

Argument	Definition
min	Minimum value.
name	Element name to check. If name and mname are not both set for the element type, the elements of this type are all checked. You can define more than one element name in keyword name with a comma (,) delimiter. If doing bias checking for subcircuits: • When both mname and name are defined while multiple name definitions are allowed, if a name is also an instance of mname, then only those names are checked, others will be ignored. • This command is ignored if no name is an instance of mname. • For name definitions which are not of the type defined in mname will be ignored. • If a mname is not defined, the subcircuit type is determined by the first name definition.
mname	Model name. HSPICE checks elements of the model for bias. If you define mname, then HSPICE checks all devices of this model. You can define more than one model name in keyword mname with the comma (,) delimiter. If mname and name are not both set for the element type, the elements of this type are all checked. If doing bias checking for subcircuits: • Once there is one and only one mname defined, the terminal names for this .command are those pins defined by the subckt definition of mname. • Multiple mname definitions are not allowed. • Wildcarding is not supported for mname. • If only mname is specified in subckt bias check, then all subcircuits will be checked.
region	Values can be cutoff, linear, or saturation. HSPICE monitors when the MOS device, defined in the .BIASCHK command, enters and leaves the specified region (such as cutoff).
simulation	The simulation type you want to monitor. You can specify op, dc, tr (transient), and all (op, dc, and tr). The tr option is the default simulation type.

Argument	Definition
`monitor`	The kind of value you want to monitor. You can specify v (voltage), i (current), w, and l (device size) for the element type. This parameter is not used for an expression-type monitor.
`tstart`	The biaschk start time during transient analysis. The default is 0.
`tstop`	The biaschk end time during transient analysis. The analysis ends on its own by default if you do not set this parameter.
`autostop`	When set, HSPICE supports an autostop for a biaschk card so that it can report error messages and stop the simulation immediately.
`except`	Lets you specify the element or instance that you do not want to bias check.

See Also

.OPTION BIASFILE
.OPTION BIAWARN

.CONNECT

Syntax

```
.CONNECT node1 node2
```

Example

```
     ...
.subckt eye_diagram node1 node2 ...
.connect node1 node2
...
.ends
```

This is now the same as the following:

```
    ...
.subckt eye_diagram node1 node1 ...
...
.ends
...
```

HSPICE reports the following error message:

```
**error**: subcircuit definition duplicates node node1
```

To apply any HSPICE statement to *node2*, apply it to *node1* instead. Then, to change the netlist construction to recognize *node2*, use a .ALTER statement.

Example 2

```
*example for  .connect
vcc 0 cc 5v
r1  0 1  5k
r2  1 cc 5k
.tran 1n 10n
.print i(vcc) v(1)
.alter
.connect cc 1
.end
```

The first .TRAN simulation includes two resistors. Later simulations have only one resistor, because r2 is shorted by connecting cc with 1. v(1) does not print out, but v(cc) prints out instead.

Use multiple .CONNECT statements to connect several nodes together.

Example 3

```
.CONNECT node1 node2
.CONNECT node2 node3
```

This example connects both *node2* and *node3* to *node1*. All connected nodes must be in the same subcircuit or all in the main circuit. The first HSPICE simulation evaluates only *node1*; *node2*, and *node3* are the same node as *node1*. Use `.ALTER` statements to simulate *node2* and *node3*.

If you set `.OPTION NODE`, then HSPICE prints out a node connection table.

Description

The `.CONNECT` statement connects two nodes in your HSPICE netlist so that simulation evaluates two nodes as only one node. Both nodes must be at the same level in the circuit design that you are simulating: you cannot connect nodes that belong to different subcircuits.

If you connect *node2* to *node1*, HSPICE does not recognize *node2* at all. You also cannot use this statement in HSPICE RF.

Argument	Definition
node1	Name of the first of two nodes to connect to each other.
node2	Name of the second of two nodes to connect to each other. The first node replaces this node in the simulation.

See Also

.ALTER
.CONNECT
.OPTION NODE

.DATA

Syntax

Inline statement:

```
.DATA datanm pnam1 <pnam2 pnam3 ... pnamxxx >
+   pval1<pval2  pval3 ... pvalxxx>
+   pval1’ <pval2’ pval3’ ... pvalxxx’>
.ENDDATA
```

External File statement for concatenated data files:

```
.DATA datanm MER
+ FILE = ’filename1’ pname1 = colnum <pname2 = colnum ...>
+ <FILE = ’filename2’ pname1 = colnum
+ <pname2 = colnum ...>> ... <OUT = ’fileout’>
.ENDDATA
```

Column Laminated statement:

```
.DATA datanm LAM
+ FILE = ’filename1’ pname1 = colnum
+ <panme2 = colnum ...>
+ <FILE = ’filename2’ pname1 = colnum
+ <pname2 = colnum ...>> ... <OUT = ’fileout’>
.ENDDATA
```

Example

```
* Inline .DATA statement
   .TRAN    1n   100n      SWEEP DATA = devinf
   .AC DEC    10   1hz   10khz   SWEEP DATA = devinf
   .DC TEMP   -55   125   10   SWEEP DATA = devinf
   .DATA   devinf   width   length   thresh   cap
  +      50u   30u   1.2v   1.2pf
  +       25u    15u   1.0v    0.8pf
  +       5u   2u   0.7v   0.6pf
.ENDDATA
```

HSPICE or HSPICE RF performs the above analyses for each set of parameter values defined in the `.DATA` statement. For example, the program first uses the `width = 50u`, `length = 30u`, `thresh = 1.2v`, and `cap = 1.2pf` parameters to perform `.TRAN`, `.AC`, and `.DC` analyses.

HSPICE or HSPICE RF then repeats the analyses for `width = 25u`, `length = 15u`, `thresh = 1.0v`, and `cap = 0.8pf`, and again for the values on each subsequent line in the `.DATA` block.

Example 2

```
* .DATA as the inner sweep
M1 1 2 3 0 N   W = 50u   L = LN
   VGS 2 0 0.0v
   VBS 3 0 VBS
   VDS 1 0 VDS
   .PARAM VDS = 0 VBS = 0 L = 1.0u
   .DC DATA = vdot
   .DATA vdot
      VBS   VDS   L
       0    0.1   1.5u
        0   0.1   1.0u
        0   0.1   0.8u
       -1    0.1   1.0u
      -2    0.1    1.0u
       -3   0.1   1.0u
        0   1.0    1.0u
        0    5.0   1.0u
.ENDDATA
```

This example performs a DC sweep analysis for each set of VBS, VDS, and L parameters in the `.DATA vdot` block. That is, HSPICE or HSPICE RF runs eight DC analyses, one for each line of parameter values in the `.DATA` block.

Example 3

```
* .DATA as the outer sweep
   .PARAM W1 = 50u W2 = 50u L = 1u CAP = 0
   .TRAN 1n 100n SWEEP DATA = d1
   .DATA d1
      W1     W2    L      CAP
      50u    40u   1.0u   1.2pf
      25u    20u   0.8u   0.9pf
.ENDDATA
```

In this example:

- The default start time for the `.TRAN` analysis is 0.
- The time increment is 1 ns.
- The stop time is 100 ns.

This results in transient analyses at every time value from 0 to 100 ns in steps of 1 ns by using the first set of parameter values in the `.DATA d1` block. Then HSPICE or HSPICE RF reads the next set of parameter values, and performs another 100 transient analyses. It sweeps time from 0 to 100 ns in 1 ns steps. The outer sweep is time, and the inner sweep varies the parameter values. HSPICE or HSPICE RF performs two hundred analyses: 100 time increments, times 2 sets of parameter values.

Example 4

```
* External File .DATA for concatenated data files
.DATA datanm MER
   + FILE = filename1 pname1 = colnum
   + <pname2 = colnum ...>
   + <FILE = filename2 pname1 = colnum
   + <pname2 = colnum ...>>
   + ...
   + <OUT = fileout>
.ENDDATA
```

Example 5

If you concatenate the three files (*file1*, *file2*, and *file3*).

```
file1   file2   file3
a a a   b b b   c c c
a a a   b b b   c c c
a a a
```

The data appears as follows:

```
a a a
a a a
a a a
b b b
b b b
c c c
c c c
```

The number of lines (rows) of data in each file does not need to be the same. The simulator assumes that the associated parameter of each column of the A file is the same as each column of the other files.

The .DATA statement for this example is:

```
* External File .DATA statement
.DATA inputdata MER
   FILE = 'file1' p1 = 1 p2 = 3 p3 = 4
   FILE = 'file2' p1 = 1
   FILE = 'file3'
.ENDDATA
```

This listing concatenates *file1*, *file2*, and *file3* to form the inputdata dataset. The data in *file1* is at the top of the file, followed by the data in *file2*, and *file3*. The inputdata in the .DATA statement references the dataname specified in either the .DC, .AC, or .TRAN analysis statements. The parameter fields specify the column that contains the parameters (you must already have defined the parameter names in .PARAM statements). For

example, the values for the p1 parameter are in column 1 of *file1* and *file2*. The values for the *p2* parameter are in column 3 of *file1*.

For data files with fewer columns than others, HSPICE or HSPICE RF assigns values of zero to the missing parameters.

Example 6

Three files (*D*, *E*, and *F*) contain the following columns of data:

```
File D   File E   File F
d1 d2 d3   e4 e5   f6
d1 d2 d3   e4 e5   f6
d1 d2 d3   e4 e5   f6
```

The laminated data appears as follows:

```
d1 d2 d3   e4 e5   f6
d1 d2 d3   e4 e5   f6
d1 d2 d3   e4 e5   f6
```

The number of columns of data does not need to be the same in the three files.

The number of lines (rows) of data in each file does not need to be the same. HSPICE interprets missing data points as zero. HSPICE RF does not support column-laminated data files.

The `.DATA` statement for this example is:

```
* Column-Laminated .DATA statement
.DATA dataname LAM
   FILE = 'file1' p1 = 1 p2 = 2 p3 = 3
   FILE = 'file2' p4 = 1 p5 = 2
   OUT = 'fileout'
.ENDDATA
```

This listing laminates columns from *file1*, and *file2*, into the *fileout* output file. Columns one, two, and three of *file1*, and columns one and two of *file2*, are designated as the columns to place in the output file. You can specify up to 10 files per `.DATA` statement.

If you run HSPICE on a different machine than the one on which the input data files reside (such as when you work over a network), use full path names instead of aliases. Aliases might have different definitions on different machines.

Description

Data-driven analysis syntax requires a `.DATA` statement, and an analysis statement that contains a `DATA = dataname` keyword.

You can use the .DATA statement to concatenate or column-laminate data sets to optimize measured I-V, C-V, transient or S parameter data.

You can also use the .DATA statement for a first or second sweep variable when you characterize cells, and test worst-case corners. Simulation reads data measured in a lab, such as transistor I-V data, one transistor at a time in an outer analysis loop. Within the outer loop, the analysis reads data for each transistor (IDS curve, GDS curve, and so on), one curve at a time in an inner analysis loop.

The .DATA statement specifies parameters that change values, and the sets of values to assign during each simulation. The required simulations run as an internal loop. This bypasses reading-in the netlist and setting-up the simulation, which saves computing time. In internal loop simulation, you can also plot simulation results against each other, and print them in a single output.

You can enter any number of parameters in a .DATA block. The .AC, .DC, and .TRAN statements can use external and inline data provided in .DATA statements. The number of data values per line does not need to correspond to the number of parameters. For example, you do not need to enter 20 values on each line in the .DATA block, if each simulation pass requires 20 parameters: the program reads 20 values on each pass, no matter how you format the values.

Each .DATA statement can contain up to 50 parameters. If you need more than 50 parameters in a single .DATA statement, place 50 or fewer parameters in the .DATA statement, and use .ALTER statements for the remaining parameters.

HSPICE or HSPICE RF refers to .DATA statements by their datanames so each dataname must be unique. HSPICE or HSPICE RF support three .DATA statement formats:

- Inline data, which is parameter data, listed in a .DATA statement block. The datanm parameter in a .DC, .AC, or .TRAN analysis statement, calls this statement. The number of parameters that HSPICE or HSPICE RF reads, determines the number of columns of data. The physical number of data numbers per line does not need to correspond to the number of parameters. For example, if the simulation needs 20 parameters, you do not need 20 numbers per line.
- Data that is concatenated from external files. Concatenated data files are files with the same number of columns, placed one after another.

- Data that is column-laminated from external files. Column lamination means that the columns of files with the same number of rows, are arranged side-by-side.

To use external files with the .DATA format:

- Use the MER and LAM keywords to tell HSPICE or HSPICE RF to expect external file data, rather than inline data.
- Use the FILE keyword to specify the external filename.
- You can use simple file names, such as out.dat, without the single or double quotes (‘ ’ or “ ”), but use the quotes when file names start with numbers, such as “1234.dat”.
- File names are case sensitive on Unix systems.

For data-driven analysis, specify the start time (time 0) in the analysis statement so analysis correctly calculates the stop time.

The following shows how different types of analysis use .DATA statements.

Operating point:

```
.DC DATA = dataname
```

DC sweep:

```
.DC vin 1 5 .25 SWEEP DATA = dataname
```

AC sweep:

```
.AC dec 10 100 10meg SWEEP DATA = dataname
```

TRAN sweep:

```
.TRAN 1n 10n SWEEP DATA = dataname
```

Argument	Definition
colnum	Column number in the data file for the parameter value. The column does not need to be the same between files.
datanm	Data name, referenced in the .TRAN, .DC, or .AC statement.
filenamei	Data file to read. HSPICE or HSPICE RF concatenates files in the order they appear in the .DATA statement. You can specify up to 10 files.

Argument	Definition
fileouti	Data file name, where simulation writes concatenated data. This file contains the full syntax for an inline .DATA statement, and can replace the .DATA statement that created it in the netlist. You can output the file, and use it to generate one data file from many.
LAM	Column-laminated (parallel merging) data files to use.
MER	Concatenated (series merging) data files to use.
pnami	Parameter names, used for source value, element value, device size, model parameter value, and so on. You must declare these names in a .PARAM statement.
pvali	Parameter value.

See Also

.AC
.DC
.ENDDATA
.PARAM
.TRAN

.DC

Syntax

Sweep or Parameterized Sweep:

```
.DC var1 START = start1 STOP = stop1 STEP = incr1

.DC var1 START = <param_expr1>
+ STOP = <param_expr2> STEP = <param_expr3>

.DC var1 start1 stop1 incr1
+ <SWEEP var2 type np start2 stop2>

.DC var1 start1 stop1 incr1 <var2 start2 stop2 incr2>
```

HSPICE supports the start and stop syntax; HSPICE RF does not.

Data-Driven Sweep:

```
.DC var1 type np start1 stop1 <SWEEP DATA = datanm>

.DC DATA = datanm<SWEEP var2 start2 stop2 incr2>

.DC DATA = datanm
```

HSPICE supports the start and stop syntax; HSPICE RF does not.

Monte Carlo:

```
.DC var1 type np start1 stop1 <SWEEP MONTE = val>

.DC MONTE = val
```

HSPICE supports Monte Carlo analysis; HSPICE RF does not.

Optimization:

```
.DC DATA = datanm OPTIMIZE = opt_par_fun
+   RESULTS = measnames MODEL = optmod

.DC var1 start1 stop1 SWEEP OPTIMIZE = OPTxxx
+   RESULTS = measname MODEL = optmod
```

Example 1

```
.DC VIN 0.25 5.0 0.25
```

This example sweeps the value of the VIN voltage source, from 0.25 volts to 5.0 volts in increments of 0.25 volts.

Example 2

```
.DC VDS 0 10 0.5 VGS 0 5 1
```

This example sweeps the drain-to-source voltage, from 0 to 10 V in 0.5 V increments, at VGS values of 0, 1, 2, 3, 4, and 5 V.

Example 3

```
.DC TEMP -55 125 10
```

This example starts a DC analysis of the circuit, from -55°C to 125°C in 10°C increments.

Example 4

```
.DC TEMP POI 5 0 30 50 100 125
```

This script runs a DC analysis, at five temperatures: 0, 30, 50, 100, and 125°C.

Example 5

```
.DC xval 1k 10k .5k SWEEP TEMP LIN 5 25 125
```

This example runs a DC analysis on the circuit, at each temperature value. The temperatures result from a linear temperature sweep, from 25°C to 125°C (five points), which sweeps a resistor value named *xval*, from 1 k to 10 k in 0.5 k increments.

Example 6

```
.DC DATA = datanm SWEEP par1 DEC 10 1k 100k
```

This example specifies a sweep of the *par1* value, from 1 k to 100 k in increments of 10 points per decade.

Example 7

```
.DC par1 DEC 10 1k 100k SWEEP DATA = datanm
```

This example also requests a DC analysis, at specified parameters in the .DATA datanm statement. It also sweeps the *par1* parameter, from 1k to 100k in increments of 10 points per decade.

Example 8

```
.DC par1 DEC 10 1k 100k SWEEP MONTE = 30
```

This example invokes a DC sweep of the *par1* parameter from 1k to 100k by 10 points per decade by using 30 randomly generated (Monte Carlo) values HSPICE supports Monte Carlo analysis; HSPICE RF does not.

Example 9

```
* Schmitt Trigger Example
*file: bjtschmt.sp   bipolar schmitt trigger
.OPTION post = 2
vcc 6 0 dc 12
vin 1 0 dc 0 pwl(0,0 2.5u,12 5u,0)
cb1 2 4 .1pf
rc1 6 2 1k
rc2 6 5 1k
rb1 2 4 5.6k
rb2 4 0 4.7k
re 3 0 .47k
diode 0 1 dmod
q1 2 1 3 bmod 1 ic = 0,8
q2 5 4 3 bmod 1 ic = .5,0.2
.dc vin 0,12,.1
.model dmod d is = 1e-15 rs = 10
.model bmod npn is = 1e-15 bf = 80 tf = 1n
+ cjc = 2pf cje = 1pf rc = 50 rb = 100 vaf = 200
.plot v(1) v(5)
.graph dc model = schmittplot input = v(1)
+ output = v(5) 4.0 5.0
.model schmittplot plot xscal = 1 yscal = 1
+ xmin = .5u xmax = 1.2u
.end
```

Example 10

```
.DC par1 DEC 10 1k 100k SWEEP MONTE = 10 firstrun = 11
```

This example invokes a DC sweep of the *par1* parameter from 1k to 100k by 10 points per decade and uses 10 randomly generated (Monte Carlo) values from 11th to 20th trials.

Example 11

```
.DC par1 DEC 10 1k 100k SWEEP MONTE = list(10 20:30 35:40 50)
```

This example invokes a DC sweep of the *par1* parameter from 1k to 100k by 10 points per decade and a Monte Carlo analysis at the 10th trial, then from the 20th to the 30th, followed by the 35th to 40th trials, and finally at the 50th trial.

Description

You can use the .DC statement in DC analysis, to:

- Sweep any parameter value (HSPICE and HSPICE RF).
- Sweep any source value (HSPICE and HSPICE RF).
- Sweep temperature range (HSPICE and HSPICE RF).
- Perform a DC Monte Carlo (random sweep) analysis (HSPICE only; not supported in HSPICE RF).
- Perform a data-driven sweep (HSPICE and HSPICE RF).
- Perform a DC circuit optimization for a data-driven sweep (HSPICE and HSPICE RF).
- Perform a DC circuit optimization by using start and stop (HSPICE only; not supported in HSPICE RF).
- Perform a DC model characterization (HSPICE only; not supported in HSPICE RF).

The format for the .DC statement depends on the application that uses it.

Argument	Definition
DATA = *datanm*	*Datanm* is the reference name of a .DATA statement.
incr1 …	Voltage, current, element, or model parameters; or temperature increments.
MODEL	Specifies the optimization reference name. The .MODEL OPT statement uses this name in an optimization analysis
MONTE = *val*	*val* is the number of randomly-generated values, which you can use to select parameters from a distribution. The distribution can be *Gaussian*, *Uniform*, or *Random Limit.*
np	Number of points per decade or per octave or just number of points, based on which keyword precedes it.
OPTIMIZE	Specifies the parameter reference name, used for optimization in the .PARAM statement
RESULTS	Measure name used for optimization in the .MEASURE statement

Argument	Definition
start1 …	Starting voltage, current, element, or model parameters; or temperature values. If you use the POI (list of points) variation type, specify a list of parameter values, instead of *start stop*. HSPICE supports the *start* and *stop* syntax; HSPICE RF does not.
stop1 …	Final voltage, current, any element, model parameter, or temperature values.
SWEEP	Indicates that a second sweep has a different type of variation (DEC, OCT, LIN, POI, or DATA statement; or MONTE = *val*)
TEMP	Indicates a temperature sweep.
type	Can be any of the following keywords: • DEC — decade variation • OCT — octave variation • LIN — linear variation • POI — list of points
var1 …	• Name of an independent voltage or current source, or • Name of any element or model parameter, or • TEMP keyword (indicating a temperature sweep). HSPICE supports a source value sweep, which refers to the source name (SPICE style). However, if you select a parameter sweep, a `.DATA` statement, and a temperature sweep, then you must select a parameter name for the source value. A later .DC statement must refer to this name. The parameter name must not start with V, I, or TEMP. In HSPICE RF, you can run a parameter sweep around a single analysis, but the parameter sweep cannot change any `.OPTION` value.
firstrun	The *val* value specifies the number of Monte Carlo iterations to perform. The *firstrun* value specifies the desired number of iterations. HSPICE runs from num1 to num1+val-1.
list	The iterations at which HSPICE performs a Monte Carlo analysis. You can write more than one number after *list*. The colon represents "from ... to ...". Specifying only one number makes HSPICE run at only the specified point.

See Also

.MODEL
.OPTION DCIC
.PARAM

.DCMATCH

Syntax

```
.DCMATCH OUTVAR <THRESHOLD=T> <FILE=string>
+ <PERTURBATION=P> <INTERVAL=Int>
```

Example 1

```
.DCmatch V(9) V(4,2) I(VCC)
```

HSPICE reports DCmatch variations on the voltage of node 9, the voltage difference between nodes 4 and 2, and on the current through the source VCC.

Example 2

```
.DC XVal Start=1K Stop=9K Step=1K
.DCMATCH V(vcc) interval=3
```

The variable XVal is being sweep in the .DC command. It takes nine values in sequence from 1k to 9k in increments of 1k. Tabular output for the .DCMATCH command is only generated for the set XVal={1k, 4k, 7k, 9k}.

Description

You use this command to calculate the effects of local variations in device characteristics on the DC solution of a circuit.

You can perform only one DCMATCH analysis per simulation. Only the last .DCMATCH statement is used in case more than one in present. The others are discarded with warnings.

.

Argument	Definition
OUTVAR	Valid node voltages, the difference between node pairs or branch currents.
THRESHOLD	Report devices with a relative contribution above Threshold in the summary table. • T=0: reports results for all devices • T<0: suppresses table output; however, individual results are still available through .PROBE or .MEASURE statements. The upper limit for T is 1, but at least 10 devices are reported, or all if there are less than 10. Default value is 0.01.

Argument	Definition
FILE	Valid file name for the output tables. Default is `basename.dm#` where "#" is the usual sequence number for HSPICE output files.
PERTURBATION	Indicates that perturbations of P standard deviation will be used in calculating the finite difference approximations to device derivatives. The valid range for P is 0.01 to 6, with a default value of 2.
INTERVAL	Applies only if a DC sweep is specified. *Int* is a positive integer. A summary is printed at the first sweep point, then for each subsequent increment of *Int*, and then, if not already printed, at the final sweep point. Only single sweeps are supported.

See Also

.DC
.MEASURE (Average, RMS, MIN, MAX, INTEG, and PP)
.MEASURE (Equation Evaluation/ Arithmetic Expression)
.MEASURE (FIND and WHEN)
.PROBE

.DCVOLT

Syntax

```
.DCVOLT V(node1) = val1 V(node2) = val2 ...

.DCVOLT V node1 val1 <node2 val2 ...>
```

Example

```
.DCVOLT 11 5 4 -5 2 2.2
```

Description

Use the `.IC` statement or the `.DCVOLT` statement to set transient initial conditions in HSPICE, but not in HSPICE RF. How it initializes depends on whether the `.TRAN` analysis statement includes the `UIC` parameter.

Note: In HSPICE RF, `.IC` is always set to OFF.

If you specify the `UIC` parameter in the `.TRAN` statement, HSPICE does not calculate the initial DC operating point, but directly enters transient analysis. Transient analysis uses the `.IC` initialization values as part of the solution for timepoint zero (calculating the zero timepoint applies a fixed equivalent voltage source). The `.IC` statement is equivalent to specifying the `IC` parameter on each element statement, but is more convenient. You can still specify the `IC` parameter, but it does not have precedence over values set in the `.IC` statement.

If you do *not* specify the `UIC` parameter in the `.TRAN` statement, HSPICE computes the DC operating point solution, before the transient analysis. The node voltages that you specify in the `.IC` statement are fixed to determine the DC operating point. HSPICE RF does not output node voltage from operating point (`.OP`), if time `(t) < 0`. Transient analysis releases the initialized nodes to calculate the second and later time points.

Argument	Definition
val1 ...	Specifies voltages. The significance of these voltages depends on whether you specify the UIC parameter in the .TRAN statement.
node1 ...	Node numbers or names can include full paths or circuit numbers.

See Also

.IC
.TRAN

.DEL LIB

Syntax

```
.DEL LIB ‘<filepath>filename’ entryname

.DEL LIB libnumber entryname
```

Example 1

This example uses an .ALTER block so it applies to HSPICE but not to HSPICE RF.

```
FILE1: ALTER1 TEST CMOS INVERTER
   .OPTION ACCT LIST
   .TEMP 125
   .PARAM WVAL = 15U VDD = 5
   *
   .OP
   .DC VIN 0 5 0.1
   .PLOT DC V(3) V(2)
   *
   VDD 1 0 VDD
   VIN 2 0
   *
   M1 3 2 1 1 P 6U 15U
   M2 3 2 0 0 N 6U W = WVAL
   *
.LIB 'MOS.LIB' NORMAL
.ALTER
   .DEL LIB 'MOS.LIB' NORMAL      $removes LIB from memory
$PROTECTION
.PROT          $protect statements
      $below .PROT
   .LIB 'MOS.LIB' FAST       $get fast model library
.UNPROT
   .ALTER
   .OPTION NOMOD OPTS      $suppress printing model
      $parameters and print the
      $option summary
   .TEMP -50 0 50      $run with different
      $temperatures
   .PARAM WVAL = 100U VDD = 5.5       $change the parameters
   VDD 1 0 5.5      $using VDD 1 0 5.5 to
      $change the power supply
      $VDD value doesn't
      $work
   VIN 2 0 PWL 0NS 0 2NS 5 4NS 0 5NS 5
         $change the input
      $source
```

```
   .OP VOL      $node voltage table of
         $operating points
   .TRAN 1NS 5NS      $run with transient
      $also
   M2 3 2 0 0 N 6U WVAL      $change channel width
   .MEAS SW2 TRIG V(3) VAL = 2.5 RISE = 1 TARG V(3)
   + VAL = VDD CROSS = 2       $measure output
   *
.END
```

Example 1 calculates a DC transfer function for a CMOS inverter.

1. First, HSPICE simulates the device by using the NORMAL inverter model from the MOS.LIB library.
2. Using the .ALTER block and the .LIB command, HSPICE substitutes a faster CMOS inverter, FAST for NORMAL.
3. HSPICE then resimulates the circuit.
4. Using the second .ALTER block, HSPICE executes DC transfer analysis simulations at three different temperatures, and with an n-channel width of 100 mm, instead of 15 mm.
5. HSPICE also runs a transient analysis in the second .ALTER block. Use the .MEASURE statement to measure the rise time of the inverter.

Example 2

This example uses an .ALTER block so it applies to HSPICE but not to HSPICE RF.

```
FILE2: ALTER2.SP CMOS INVERTER USING SUBCIRCUIT
.OPTION LIST ACCT
.MACRO INV 1 2 3
M1 3 2 1 1 P 6U 15U
M2 3 2 0 0 N 6U 8U
.LIB 'MOS.LIB' NORMAL
.EOM INV
XINV 1 2 3 INV
VDD 1 0 5
VIN 2 0
.DC VIN 0 5 0. 1
.PLOT V(3) V(2)
.ALTER
.DEL LIB 'MOS.LIB' NORMAL
.TF V(3) VIN         $DC small-signal transfer
      $function
*
.MACRO INV 1 2 3         $change data within
```

```
      $subcircuit def
M1 4 2 1 1 P 100U 100U          $change channel
      $length,width,also
         $topology
M2 4 2 0 0 N 6U   8U          $change topology
R4 4 3 100          $add the new element
C3 3 0 10P          $add the new element
.LIB 'MOS.LIB' SLOW          $set slow model library
$.INC 'MOS2.DAT'          $not allowed to be used
      $inside subcircuit, allowed
      $outside subcircuit
.EOM INV
.END
```

In this example, the `.ALTER` block adds a resistor and capacitor network to the circuit. The network connects to the output of the inverter, and HSPICE simulates a DC small-signal transfer function.

Description

Use the `.DEL LIB` statement to remove library data from memory. The next time you run a simulation, the `.DEL LIB` statement removes the `.LIB` call statement with the same library number and entry name, from memory. You can then use a `.LIB` statement to replace the deleted library.

You can use the `.DEL LIB` statement with the `.ALTER` statement. HSPICE RF does not support the `.ALTER` statement.

Argument	Definition
entryname	Entry name, used in the library call statement to delete.
filename	Name of a file to delete from the data file. The file path, plus the file name, can be up to 256 characters long. You can use any file name that is valid for the operating system that you use. Enclose the file path and file name in single or double quote marks.
filepath	Path name of a file, if the operating system supports tree-structured directories.
libnumber	Library number, used in the library call statement to delete.

See Also

.ALTER
.LIB

.DISTO

Syntax

```
.DISTO Rload <inter <skw2 <refpwr <spwf>>>>
```

Example

```
.DISTO RL 2 0.95 1.0E-3 0.75
```

Description

The .DISTO statement computes the distortion characteristics of the circuit in an AC small-signal, sinusoidal, steady-state analysis. You can use the .DISTO statement in HSPICE, but not in HSPICE RF.

The program computes and reports five distortion measures at the specified load resistor. The analysis assumes that the input uses one or two signal frequencies.

- HSPICE uses the first frequency (F1, the nominal analysis frequency) to calculate harmonic distortion. The .AC statement frequency-sweep sets it.
- HSPICE uses the optional second input frequency (F2) to calculate intermodulation distortion. To set it implicitly, specify the skw2 parameter, which is the F2/F1 ratio

HSPICE performs only one distortion analysis per simulation. HSPICE RF does not support the .DISTO statement. If your design contains more than one .DISTO statement, HSPICE runs only the last statement. The .DISTO statement calculates distortions for diodes, BJTs (levels 1, 2, 3, and 4), and MOSFETs (Level49 and Level53, Version 3.22).

You can use the .DISTO command only with the .AC command.

.

Argument	Definition
Rload	The resistor element name of the output load resistor, into which the output power feeds.
refpwr	Reference power level, used to compute the distortion products. If you omit *refpwr*, the default value is 1mW, measured in decibels magnitude (dbM). The value must be *≥1e-10*.

Argument	Definition
skw2	Ratio of the second frequency (F2) to the nominal analysis frequency (F1) in the range *1e-3* < *skw2* < *0.999*. If you omit *skw2*, the default value is 0.9.
spwf	Amplitude of the second frequency (F2). The value must be ≥ *1e-3*. Default = 1.0.
inter	Interval at which HSPICE prints a distortion-measure summary. Specifies a number of frequency points in the AC sweep (see the *np* parameter in the .AC command). • If you omit *inter* or set it to zero, HSPICE does not print a summary. To print or plot the distortion measures, use the .PRINT or .PLOT statement. • If you set inter to 1 or higher, HSPICE prints a summary of the first frequency, and of each subsequent inter-frequency increment. To obtain a summary printout for only the first and last frequencies, set inter equal to the total number of increments needed to reach fstop in the .AC statement. For a summary printout of only the first frequency, set inter to greater than the total number of increments required to reach *fstop*. HSPICE prints an extensive summary from the distortion analysis for each frequency listed. Use the *inter* parameter in the `.DISTO` statement to limit the amount of output generated.

.DISTO Value	Description
DIM2	Intermodulation distortion, first difference. Relative magnitude and phase of the frequency component (F1 - F2).
DIM3	Intermodulation distortion, second difference. The relative magnitude and phase of the frequency component (2 · F1 - F2).
HD2	Second-order harmonic distortion. Relative magnitude and phase of the frequency component 2 · F1 (ignores F2).

.DISTO Value	Description
HD3	Third-order harmonic distortion. Relative magnitude and phase of the frequency component 3 · F1 (ignores F2).
SIM2	Intermodulation distortion, sum. Relative magnitude and phase of the frequency component (F1 + F2).

See Also

.AC

.DOUT

Syntax

```
.DOUT nd VTH ( time state < time state > )

.DOUT nd VLO VHI ( time state < time state > )
```

The first syntax specifies a single threshold voltage, VTH. A voltage level above VTH is high; any level below VTH is low.

The second syntax defines a threshold for both a logic high (VHI) and low (VLO).

Note: If you specify VTH, VLO, and VHI in the same statement, then only VTH is processed, and VLO and VHI are ignored.

Example

```
.PARAM VTH = 3.0
.DOUT node1 VTH(0.0n 0 1.0n 1
+ 2.0n X 3.0n U 4.0n Z 5.0n 0)
```

The .PARAM statement in this example sets the VTH variable value to 3. The .DOUT statement, operating on the node1 node, uses VTH as its threshold voltage.

When *node1* is above 3V, it is a logic 1; otherwise, it is a logic 0.

- At 0ns, the expected state of *node1* is logic-low.
- At 1ns, the expected state is logic-high.
- At 2ns, 3ns, and 4ns, the expected state is “do not care”.
- At 5ns, the expected state is again logic low.

Description

The digital output (.DOUT) statement specifies the expected final state of an output signal.

During simulation, HSPICE or HSPICE RF compares simulation results with the expected output. If the states are different, an error report results.

Argument	Definition
nd	Node name.
time	Absolute timepoint.
state	Expected condition of the *nd* node at the specified *time:* • 0 expect ZERO,LOW. • 1 expect ONE,HIGH. • else Don't care.
VTH	Single voltage threshold.
VLO	Voltage of the logic-low state.
VHI	Voltage of the logic-high state.

For both syntax cases, the *time*, *state* pair describes the expected output. During simulation, the simulated results are compared against the expected output vector. If the states are different, HSPICE RF reports an error message. Legal values for *state* are:

.DOUT State Value	Description
0	expect ZERO
1	expect ONE
X, x	do not care
U, u	do not care
Z, z	expect HIGH IMPEDANCE (don't care). HSPICE RF cannot detect a high impedance state so it treats Z, z as "don't care" state.

See Also

.GRAPH
.MEASURE
.PARAM
.PLOT
.PRINT
.PROBE
.STIM

.EBD

Syntax

```
.EBD ebdname
+ file = 'filename'
+ model = 'modelname'
+ component = 'compname:reference_designator'
+ {component = 'compname:reference_designator'...}
```

Example

```
.ebd ebd
   + file = 'test.ebd'
   + model = '16Meg X 8 SIMM Module'
   + component = 'cmpnt:u21'
.ibis cmpnt
   + file = 'ebd.ibs'
   + component = 'SIMM'
   + hsp_ver = 2003.09 nowarn
```

This example corresponds to the following *.ebd* file:

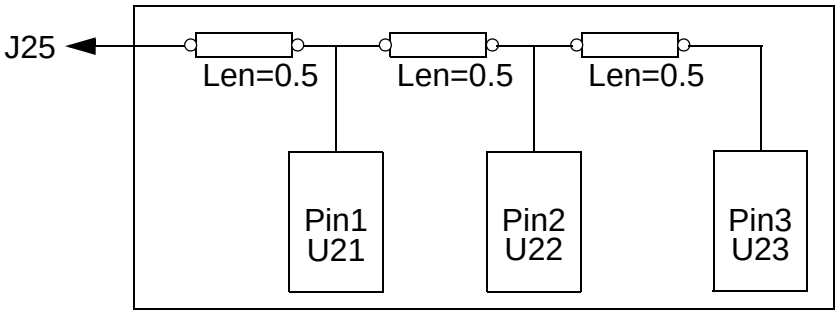
```
   .................
   [Begin Board Description] 16Meg X 8 SIMM Module
   .................
   [Pin List] signal_name
   J25          POWER5
   [Path Description] CAS_2
   Pin J25
   Len = 0.5 L=8.35n C=3.34p R=0.01 /
   Node u21.1
   Len = 0.5 L=8.35n C=3.34p R=0.01 /
   Node u22.2
   Len = 0.5 L=8.35n C=3.34p R=0.01 /
   Node u23.3
```

Description

The `.EBD` command provides the IBIS(V 3.2) EBD feature. HSPICE uses the *.ebd* file when simulating the line connected with the u21 reference_designator. The format of node names is *ebdname_SignalName*. For example, the format of a node name called J25 is `ebd_POWER5` (see Figure 1).

Argument	Definition
compname	Name of a *.ibs* file that describes a component.
reference_designator	Reference designator that maps the component.

Figure 1 Circuit Connection for EBD Example



See Also

.IBIS
.PKG

.ELSE

Syntax

.ELSE

Description

.ELSE precedes one or more commands in a conditional block, after the last .ELSEIF statement, but before the .ENDIF statement. HSPICE executes these commands by default, if the conditions in the preceding .IF statement, and in all of the preceding .ELSEIF statements in the same conditional block, are all false.

For the syntax and a description of how to use the .ELSE statement within the context of a conditional block, see the .IF statement.

See Also

.ELSEIF
.ENDIF
.IF

.ELSEIF

Syntax

```
.ELSEIF
```

Description

HSPICE executes the commands that follow the first `.ELSEIF` statement, only if *condition1* in the preceding `.IF` statement is false, and *condition2* in the first `.ELSEIF` statement is true.

If *condition1* in the `.IF` statement and *condition2* in the first `.ELSEIF` statement are both false, then HSPICE moves on to the next `.ELSEIF` statement, if there is one. If this second `.ELSEIF` condition is true, HSPICE executes the commands that follow the second `.ELSEIF` statement, instead of the commands after the first `.ELSEIF` statement.

HSPICE ignores the commands in all false `.IF` and `.ELSEIF` statements, until it reaches the first `.ELSEIF` condition that is true. If no `.IF` or `.ELSEIF` condition is true, HSPICE continues to the `.ELSE` statement

For the syntax and a description of how to use the `.ELSEIF` statement within the context of a conditional block, see the `.IF` statement.

See Also

.ELSE
.ENDIF
.IF

.END

Syntax

```
.END <comment>
```

Example

```
MOS OUTPUT
   .OPTION NODE NOPAGE
   VDS 3 0
   VGS 2 0
   M1 1 2 0 0 MOD1 L = 4U W = 6U AD = 10P AS = 10P
   .MODEL MOD1 NMOS VTO = -2 NSUB = 1.0E15 TOX = 1000
   + UO = 550
   VIDS 3 1
   .DC   VDS 0 10 0.5    VGS 0 5 1
   .PRINT DC I(M1) V(2)
.END MOS OUTPUT
MOS CAPS
   .OPTION SCALE = 1U SCALM = 1U WL ACCT
   .OP
   .TRAN .1 6
   V1 1 0 PWL 0 -1.5V 6 4.5V
   V2 2 0 1.5VOLTS
   MODN1 2 1 0 0 M 10 3
   .MODEL M NMOS VTO = 1 NSUB = 1E15 TOX = 1000
   + UO = 800 LEVEL = 1 CAPOP = 2
   .PLOT TRAN V(1) (0,5) LX18(M1) LX19(M1) LX20(M1)
   + (0,6E-13)
.END MOS CAPS
```

Description

An `.END` statement must be the last statement in the input netlist file. The period preceding `END` is a required part of the statement.

Any text that follows the `.END` statement is a comment, and has no effect on that simulation.

An input file that contains more than one simulation run must include an `.END` statement for each simulation run. You can concatenate several simulations into a single file.

Argument	Definition
<comment>	Can be any comment. Typically, the comment is the name of the netlist file or of the simulation run, that this command terminates.

.ENDDATA

Syntax

```
.ENDDATA
```

Description

Use the .ENDDATA statement to end a .DATA block in an HSPICE input netlist.

See Also

.DATA

.ENDIF

Syntax

```
.ENDIF
```

Description

The `.ENDIF` statement ends a conditional block of commands that begins with an `.IF` statement.

For the syntax and a description of how to use the `.ENDIF` statement within the context of a conditional block, see the `.IF` statement.

See Also

.ELSE
.ELSEIF
.IF

.ENDL

Syntax

```
.ENDL
```

Description

Use the `.ENDL` statement to end a `.LIB` statement in an HSPICE input netlist.

See Also

.LIB

.ENDS

Syntax

```
.ENDS <SUBNAME>
```

Example 1

```
.ENDS mos_circuit
```

This example terminates a subcircuit named *mos_circuit*.

Example 2

```
.ENDS
```

If you omit the subcircuit name as in this second example, this statement terminates all subcircuit definitions that begin with a .SUBCKT statement.

Description

Use the .ENDS statement to terminate a .SUBCKT statement.

This statement must be the last for any subcircuit definition that starts with a .SUBCKT command.

You can nest subcircuit references (calls) within subcircuits in HSPICE or HSPICE RF. However, in HSPICE RF, you cannot replicate output commands within subcircuit (subckt) definitions.

Argument	Definition
<*SUBNAME*>	Name of the subcircuit description to terminate, that begins with a .SUBCKT command.

See Also

.SUBCKT

.EOM

Syntax

```
.EOM <SUBNAME>
```

Example 1

```
.EOM diode_circuit
```

This example terminates a subcircuit named *diode_circuit*.

Example 2

```
.EOM
```

If you omit the subcircuit name as in this second example, this statement terminates all subcircuit definitions that begin with a `.MACRO` statement.

Description

Use the `.EOM` statement to terminate a `.MACRO` statement.

This statement must be the last for any subcircuit definition that starts with a `.MACRO` command.

You can nest subcircuit references (calls) within subcircuits in HSPICE or HSPICE RF. However, in HSPICE RF, you cannot replicate output commands within subcircuit (`subckt`) definitions.

Argument	Definition
<*SUBNAME*>	Name of the subcircuit description to terminate, that begins with a `.SUBCKT` command.

See Also

.MACRO

.FFT

Syntax

```
.FFT <output_var> <START=value> <STOP=value>
+ <NP=value> <FORMAT=keyword>
+ <WINDOW=keyword> <ALFA=value>
+ <FREQ=value> <FMIN=value> <FMAX=value>
```

Example 1

```
.FFT v(1)
.FFT v(1,2) np=1024 start=0.3m stop=0.5m freq=5.0k
+ window=kaiser alfa=2.5
.FFT I(rload) start=0m to=2.0m fmin=100k fmax=120k
+ format=unorm
.FFT par('v(1) + v(2)') from=0.2u stop=1.2u
+ window=harris
```

Example 2

```
.FFT v(1) np=1024
.FFT v(2) np=1024
```

This example generates an *.ft0* file for the FFT of v(1), and an *.ft1* file for the FFT of v(2).

Description

The `.FFT` statement uses internal time point values to calculate the Discrete Fourier Transform (DFT) value, which HSPICE uses for spectrum analysis. A DFT uses sequences of time values to determine the frequency content of analog signals in circuit simulation.

You can specify only one output variable in an `.FFT` command. The following is an incorrect use of the command, because it contains two variables in one `.FFT` command:

```
.FFT v(1) v(2) np=1024
```

Argument	Definition
output_var	Can be any valid output variable, such as voltage, current, or power.
START	Start of the output variable waveform to analyze. Defaults to the START value in the .TRAN statement, which defaults to 0.

Argument	Definition
FROM	An alias for START in .FFT statements.
STOP	End of the output variable waveform to analyze. Defaults to the TSTOP value in the .TRAN statement.
TO	An alias for STOP, in .FFT statements.
NP	Number of points to use in the FFT analysis. NP must be a power of 2. If NP is not a power of 2, HSPICE automatically adjusts it to the closest higher number that is a power of 2. Default=1024.
FORMAT	Specifies the output format: • NORM= normalized magnitude (default) • UNORM=unnormalized magnitude
WINDOW	Specifies the window type to use: • RECT=simple rectangular truncation window (default). • BART=Bartlett (triangular) window. • HANN=Hanning window. • HAMM=Hamming window. • BLACK=Blackman window. • HARRIS=Blackman-Harris window. • GAUSS=Gaussian window. • KAISER=Kaiser-Bessel window.
ALFA	Parameter to use in GAUSS and KAISER windows to control the highest side-lobe level, bandwidth, and so on. 1.0 <= ALFA <= 20.0 Default=3.0
FREQ	Frequency to analyze. If FREQ is non-zero, the output lists only the harmonics of this frequency, based on FMIN and FMAX. HSPICE also prints the THD for these harmonics. Default=0.0 (Hz).

Argument	Definition
FMIN	Minimum frequency for which HSPICE prints FFT output into the listing file. THD calculations also use this frequency. T = (STOP-START) Default=1.0/T (Hz).
FMAX	Maximum frequency for which HSPICE prints FFT output into the listing file. THD calculations also use this frequency. Default=0.5*NP*FM IN (Hz).

See Also

.TRAN

.FOUR

Syntax

```
.FOUR freq ov1 <ov2 ov3 ...>
```

Example

```
.FOUR 100K V(5)
```

Description

This statement performs a Fourier analysis as part of the transient analysis. You can use the .FOUR statement in or HSPICE RF to HSPICE perform the Fourier analysis over the interval (tstop-fperiod, tstop), where:

- tstop is the final time, specified for the transient analysis.
- fperiod is a fundamental frequency period (freq parameter).

HSPICE or HSPICE RF performs Fourier analysis on 501 points of transient analysis data on the last 1/f time period, where f is the fundamental Fourier frequency. HSPICE or HSPICE RF interpolates transient data to fit on 501 points, running from (tstop-1/f) to tstop.

To calculate the phase, the normalized component, and the Fourier component, HSPICE or HSPICE RF uses 10 frequency bins. The Fourier analysis determines the DC component, and the first nine AC components. For improved accuracy, the .FOUR statement can use non-linear, instead of linear interpolation.

You can only use a .FOUR statement in conjunction with a .TRAN statement.

Argument	Definition
freq	Fundamental frequency
ov1 …	Output variables to analyze.

See Also

.TRAN

.FSOPTIONS

Syntax

```
.FSOPTIONS name <ACCURACY=LOW|MEDIUM|HIGH> +
<GRIDFACTOR=val> <PRINTDATA=YES|NO>
+ <COMPUTEG0=YES|NO> <COMPUTEGD=YES|NO>
+ <COMPUTERO=YES|NO> <COMPUTERS=YES|NO>
```

Description

Use the `.FSOPTIONS` statement to set various options for the field solver. The following rules apply to the Field Solver when specifying options with the `.FSOPTIONS` statement:

- The field solver always computes the L and C matrices.
- If `COMPUTERS=YES`, then the field solver starts, and calculates Lo, Ro, and Rs.
- For each accuracy mode, the field solver uses either the pre-defined number of segments or the number of segments that you specified. It then multiplies this number times the `GRIDFACTOR` to obtain the final number of segments.

Because a wide range of applications are available, the pre-defined accuracy level might not be accurate enough for some applications. If you need a higher accuracy than the value that the `HIGH` option sets, then increase either the `GRIDFACTOR` value or the `N`, `NH`, or `NW` values to increase the mesh density.

Argument	Definition
name	Option name.
ACCURACY	Sets the solver accuracy to one of the following: • LOW • MEDIUM • HIGH
GRIDFACTOR	Multiplication factor (integer) to determine the final number of segments used to define the shape. If you set COMPUTERS=yes, the field solver does not use this parameter to compute Ro and Rs values.
PRINTDATA	The solver prints output matrices.

Argument	Definition
COMPUTEGO	The solver computes the static conductance matrix.
COMPUTEGD	The solver computes the dielectric loss matrix.
COMPUTERO	The solver computes the DC resistance matrix.
COMPUTERS	The solver computes the skin-effect resistance matrix. This parameter uses the filament method solver to compute R_o and R_s.

See Also

.LAYERSTACK
.MATERIAL
.SHAPE

.GLOBAL

Syntax

```
.GLOBAL node1 node2 node3 ...
```

Example

This example shows global definitions for VDD and `input_sig` nodes.

```
.GLOBAL VDD input_sig
```

Description

The `.GLOBAL` statement globally assigns a node name in HSPICE or HSPICE RF. This means that all references to a global node name, used at any level of the hierarchy in the circuit, connect to the same node.

The most common use of a `.GLOBAL` statement is if your netlist file includes subcircuits. This statement assigns a common node name to subcircuit nodes. Another common use of `.GLOBAL` statements is to assign power supply connections of all subcircuits. For example, `.GLOBAL VCC` connects all subcircuits with the internal node name VCC.

Ordinarily, in a subcircuit, the node name consists of the circuit number, concatenated to the node name. When you use a `.GLOBAL` statement, HSPICE or HSPICE RF does not concatenate the node name with the circuit number, and assigns only the global name. You can then exclude the power node name in the subcircuit or macro call.

Argument	Definition
node1 node2	Name of a global nodes, such as supply and clock names; overrides local subcircuit definitions.

.GRAPH

Note: This is an obsolete command. You can gain the same functionality by using the .PROBE command.

Syntax

```
.GRAPH antype <MODEL = mname> <unam1 = > ov1,
+ <unam2 = >ov2 ... <unamn = >ovn (plo,phi)
```

Example

```
.GRAPH DC cgb = lx18(m1) cgd = lx19(m1)
+ cgs = lx20(m1)
.GRAPH DC MODEL = plotbjt
+ model_ib = i2(q1)    meas_ib = par(ib)
+ model_ic = i1(q1)    meas_ic = par(ic)
+ model_beta = par('i1(q1)/i2(q1)')
+ meas_beta = par('par(ic)/par(ib)')(1e-10,1e-1)
.MODEL plotbjt PLOT MONO = 1 YSCAL = 2 XSCAL = 2
+ XMIN = 1e-8 XMAX = 1e-1
```

Description

Use the .GRAPH statement when you need high-resolution plots of HSPICE simulation results. You cannot use .GRAPH statements in the PC version of HSPICE or in any versions of HSPICE RF.

Each .GRAPH statement creates a new *.gr#* file, where # ranges first from 0 to 9, and then from a to z. You can create up to 10000 graph files.

You can include wildcards in .GRAPH statements (HSPICE only).

Argument	Definition
antype	Type of analysis for the specified plots (outputs). Analysis types are: DC, AC, TRAN, NOISE, or DISTO (you cannot run DISTO analysis in HSPICE RF).
mname	Plot model name, referenced in the .GRAPH statement. Use .GRAPH and its plot name to create high-resolution plots directly from HSPICE.
unam1…	You can define output names, which correspond to the ov1 ov2 … output variables (*unam1 unam2 ...*), and use them as labels, instead of output variables for a high resolution graphic output.

Argument	Definition
ov1 …	Output variables to print. Can be voltage, current, or element template variables (HSPICE only; HSPICE RF does not support element template output, or .GRAPH statements), from a different type of analysis. You can also use algebraic expressions as output variables, but you must define them inside the PAR( ) statement.
plo, phi	Lower and upper plot limits. Set the plot limits only at the end of the .GRAPH statement.

See Also

.DOUT
.MEASURE
.PLOT
.PRINT
.PROBE
.STIM

.HDL

Syntax

```
.HDL filename
```

Example 1

```
.hdl "/myhome/Verilog_A_lib/res.va"
```

This example loads the `res.va` Verilog-A model file from the /myhome/Verilog_A_lib directory.

Example 2

```
.hdl "va_models"
```

This example loads the `va_models.va` Verilog-A model file (not va_model file) from the current working directory.

Description

This `.HDL` command specifies the Verilog-A source name and path within the netlist. The Verilog-A file is assumed to have a **.va* extension only when a prefix is provided.

In `.MODEL` statements, you must add the Verilog-A type of model cards. Every Verilog-A module can have one or more associated model cards. The type of model card(s) should be the same as the Verilog-A module name. Verilog-A module names cannot conflict with HSPICE built-in device keywords. If a conflict occurs, HSPICE issues a warning message and the Verilog-A module definition is ignored.

.IBIS

Syntax

```
.IBIS cname keyword_1 = value_1 ...
+ [keyword_M= value_M]
```

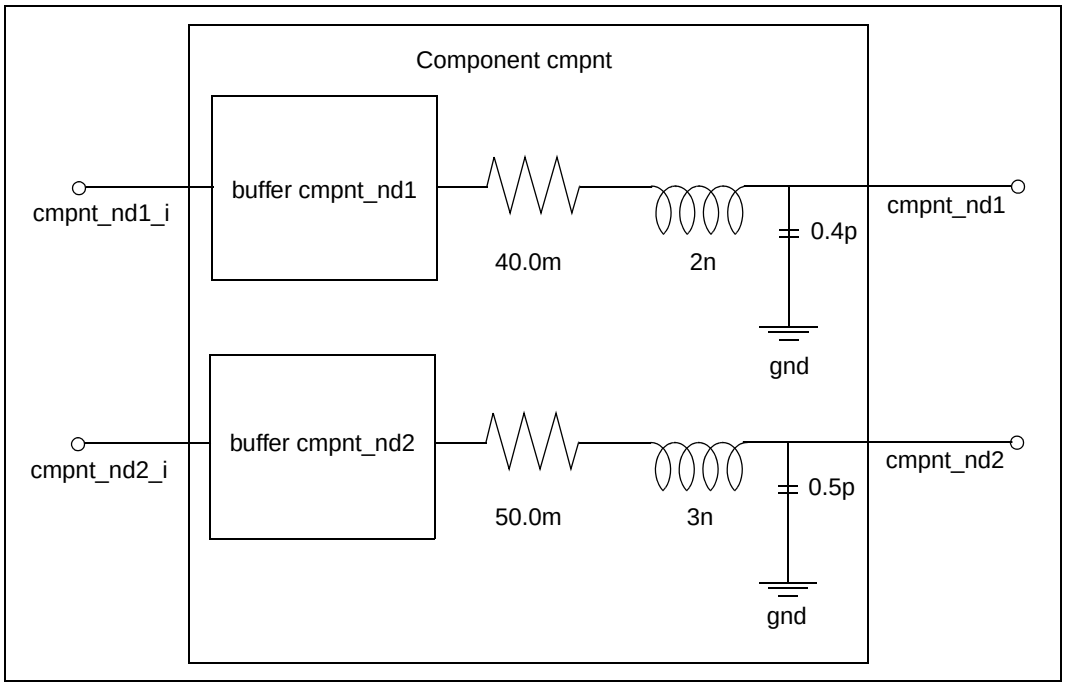
Example

```
.ibis cmpnt
+ file = ’ebd.ibs’
+ component = ’SIMM’
+ hsp_ver = 2002.4 nowarn package = 2
```

This example corresponds to the following *ebd.ibs* file:

```
[Component]   SIMM
[Manufacturer]   TEST
[Package]
R_pkg    200m    NA   NA
L_pkg    7.0nH    NA    NA
C_pkg    1.5pF    NA    NA
|
[Pin]   signal_name   model_name   R_pin   L_pin   C_pin
|
1    ND1    ECL    40.0m   2n   0.4p
2    ND2    NMOS    50.0m   3n   0.5p
.....................
```

Figure 2 Equivalent Circuit for EBD Example



Description

This is the general syntax for the `.IBIS` command when used with a component. The optional keywords are in square brackets.

Argument	Definition
cname	Instance name of this ibis command

Argument	Definition
keyword_i= *value_i*	Assigns the *value_i* value to the *keyword_i* keyword. Required keywords are: • file='*file_name*' identifies the IBIS file. The *file_name* parameter must be lower case and must specify either the absolute path for the file or the path relative to the directory from which you run the simulation. For example: file = '.ibis/at16245.ibs' file = '/home/oneuser/ibis/models/abc.ibs' • component='*component_name*' identifies the component for an `.ibis` command from the IBIS file, specified using the file='...' keyword. The *component_name* keyword is case-sensitive, and it must match one of the components from the IBIS file. For example: component = 'procfast' component = 'Virtex_SSTL_3-I_BG432' component = '10_pdref' $ SPICE-formatted [Pin]

Argument	Definition
keyword_m= *value_m*	Optional keywords: • package = [0|1|2|3] (default is 3) • 0, does not add the rlc package into the component. • 1, adds [Package] (in .ibs file). • 2, adds [Pin] (in .ibs file). • 3, If [Package Model] is defined, set package with package model. If it is not defined, set package with [Pin]. If the package information is not set in [Pin], set package with [Package] as a default. Package Model can be defined in either the IBIS file or the PKG file. • The following optional keywords are the same as for the B Element (I/O buffer). For more information, see “Specifying Common Keywords” in the Modeling Input/Output Buffers Using IBIS chapter of the *HSPICE Signal Integrity Guide*. • typ • interpo • ramp_rwf • ramp_fwf • rwf_tune • fwf_tune • pd_scal • pu_scal • pc_scal • gc_scal • rwf_scal • fwf_scal • nowarn • hsp_ver • c_com_pu • c_com_pd • c_com_pc • c_com_gc

See Also

.EBD
.PKG

.IC

Syntax

```
.IC V(node1) = val1 V(node2) = val2 ...
```

Example

```
.IC V(11) = 5 V(4) = -5 V(2) = 2.2
```

Description

Use the `.IC` statement or the `.DCVOLT` statement to set transient initial conditions in HSPICE, but not in HSPICE RF. How it initializes depends on whether the `.TRAN` analysis statement includes the `UIC` parameter.

Note: In HSPICE RF, `.IC` is always set to `OFF`.

If you specify the UIC parameter in the `.TRAN` statement, HSPICE does not calculate the initial DC operating point, but directly enters transient analysis. Transient analysis uses the `.IC` initialization values as part of the solution for timepoint zero (calculating the zero timepoint applies a fixed equivalent voltage source). The `.IC` statement is equivalent to specifying the `IC` parameter on each element statement, but is more convenient. You can still specify the `IC` parameter, but it does not have precedence over values set in the `.IC` statement.

If you do *not* specify the `UIC` parameter in the `.TRAN` statement, HSPICE computes the DC operating point solution before the transient analysis. The node voltages that you specify in the `.IC` statement are fixed to determine the DC operating point. HSPICE RF does not output node voltage from operating point (`.OP`), if time (t) < 0. Transient analysis releases the initialized nodes to calculate the second and later time points.

Argument	Definition
val1 ...	Specifies voltages. The significance of these voltages depends on whether you specify the UIC parameter in the .TRAN statement.
node1 ...	Node numbers or names can include full paths or circuit numbers.

See Also

.DCVOLT
.TRAN
.OPTION DCIC

.ICM

Syntax

```
.ICM icmname
+ file = 'icmfilename'
+ model = 'icmmodelname'
```

Example 1

```
.ICM icm1
+ file = 'test1.icm'
+ model = 'FourLineModel1'
```

Example 2

The following example shows how to reference a pin of ICM model in HSPICE netlist.

```
icm1_NodeMap1_pin1, icm1_NodeMap2_pin1,
icm1_NodeMap2_pin2, ...
```

Description

The `.ICM` command automatically creates port names that reference the pin name of an ICM model and generate a series of element (W/S/RLGCK) nodes on the pin when one of the following conditions occur:

- If the model is described using [Nodal Path Description] 'icmname'_'nodemapname'_'pinname'
- If the model is described using [Tree Path Description] 'icmname'_'pinmapname'_'pinname'

Argument	Definition
icmname	`.ICM` command card name.
icmfilename	Name of an .icm file that contains an ICM model.
icmmodelname	Working model in an .icm file.
nodemapname	Name of the [ICM node map] keyword in an .icm file.
pinmapname	Name of the [ICM pin map] keyword in an .icm file.
pinname	Name of the first column of entries of the [ICM node map] or [ICM pin map].

.IF

Syntax

```
.IF (condition1)
...
<.ELSEIF (condition2)
... >
<.ELSE
... >
.ENDIF
```

Example

```
.IF (a==b)
.INCLUDE /myhome/subcircuits/diode_circuit1
...
.ELSEIF (a==c)
.INCLUDE /myhome/subcircuits/diode_circuit2
...
.ELSE
.INCLUDE /myhome/subcircuits/diode_circuit3
...
.ENDIF
```

Description

HSPICE executes the commands that follow the first `.ELSEIF` statement, only if *condition1* in the preceding `.IF` statement is false, and *condition2* in the first `.ELSEIF` statement is true.

If *condition1* in the `.IF` statement and *condition2* in the first `.ELSEIF` statement are both false, then HSPICE moves on to the next `.ELSEIF` statement, if there is one. If this second `.ELSEIF` condition is true, HSPICE executes the commands that follow the second `.ELSEIF` statement, instead of the commands after the first `.ELSEIF` statement.

HSPICE ignores the commands in all false `.IF` and `.ELSEIF` statements, until it reaches the first `.ELSEIF` condition that is true. If no `.IF` or `.ELSEIF` condition is true, HSPICE continues to the `.ELSE` statement

`.ELSE` precedes one or more commands in a conditional block, after the last `.ELSEIF` statement, but before the `.ENDIF` statement. HSPICE executes these commands by default, if the conditions in the preceding `.IF` statement, and in all of the preceding `.ELSEIF` statements in the same conditional block, are all false.

The `.ENDIF` statement ends a conditional block of commands that begins with an `.IF` statement.

Argument	Definition
condcition1	Condition that must be true, before HSPICE executes the commands that follow the `.IF` statement.
condition2	Condition that must be true, before HSPICE executes the commands that follow the `.ELSEIF` statement. HSPICE executes the commands that follow *condition2*, only if *condition1* is false and *condition2* is true.

See Also

.ELSE
.ELSEIF
.ENDIF

.INCLUDE

Syntax

```
.INCLUDE '<filepath> filename'
```

Example

```
.INCLUDE /myhome/subcircuits/diode_circuit
```

Description

You can include a netlist as a subcircuit in one or more other netlists. To include another netlist in the current netlist, use the `.INCLUDE` statement.

Argument	Definition
filepath	Path name of a file for computer operating systems that support tree-structured directories. A .INC file can contain nested .INC calls to itself or to another .INC file. If you use a relative path in a nested .INC call, the path starts from the directory of the parent .INC file, not from the work directory. If the path starts from the work directory, HSPICE can also find the .INC file, but prints a warning.
filename	Name of a file to include in the data file. The file path, plus the file name, can be up to 1024 characters long. You can use any valid file name for the computer's operating system. You *must* enclose the file path and name in single or double quotation marks.

.LAYERSTACK

Syntax

```
.LAYERSTACK sname <BACKGROUND=mname>
+ <LAYER=(mname,thickness) ...>
```

Description

A layer stack defines a stack of dielectric or metal layers.

You must associate each transmission line system with *one*, and *only* one, layer stack. However, you can associate a single-layer stack with *many* transmission line systems.

In the layer stack:

- Layers are listed from bottom to top.
- Metal layers (ground planes) are located only at the bottom, only at the top, or both at the top and bottom.
- Layers are stacked in the y-direction, and the bottom of a layer stack is at y=0.
- All conductors must be located above y=0.
- Background material must be dielectric.

The following limiting cases apply to the `.LAYERSTACK` command:

- Free space without ground:
  `.LAYERSTACK mystack`
- Free space with a (bottom) ground plane:
  `.LAYERSTACK halfSpace PEC 0.1mm`

Argument	Definition
sname	Layer stack name.
mname	Material name.
BACKGROUND	Background dielectric material name. By default, the Field Solver assumes AIR for the background.
thickness	Layer thickness.

See Also

.FSOPTIONS
.MATERIAL
.SHAPE

.LIB

Syntax

Use the following syntax for library calls:

```
.LIB ‘<filepath> filename’ entryname
```

Use the following syntax to define library files:

```
.LIB entryname1
. $ ANY VALID SET OF HSPICE STATEMENTS
.ENDL entryname1
.LIB entryname2
.
. $ ANY VALID SET OF HSPICE STATEMENTS
.ENDL entryname2
.LIB entryname3
.
. $ ANY VALID ET OF HSPICE STATEMENTS
.ENDL entryname3
```

Example 1

```
* Library call
.LIB 'MODELS' cmos1
```

Example 2

```
.LIB MOS7
$ Any valid set of HSPICE commands
.
.
.
.ENDL MOS7
```

Example 3

The following are an illegal example and a legal example of nested `.LIB` statements for the *file3* library.

Illegal:

```
.LIB MOS7
...
.LIB 'file3' MOS7 $ This call is illegal in MOS7 library
...
...
.ENDL
```

Legal:

```
.LIB MOS7
...
.LIB 'file1' MOS8
.LIB 'file2' MOS9
.LIB CTT $ file2 is already open for the CTT
   $ entry point
.ENDL
```

Example 4

```
.LIB TT
$TYPICAL P-CHANNEL AND N-CHANNEL CMOS LIBRARY
$ PROCESS: 1.0U CMOS, FAB7
$ following distributions are 3 sigma ABSOLUTE GAUSSIAN
.PARAM TOX = AGAUSS(200,20,3)   $ 200 angstrom +/- 20a
+ XL = AGAUSS(0.1u,0.13u,3)   $ polysilicon CD
+ DELVTON = AGAUSS(0.0,.2V,3)   $ n-ch threshold change
+ DELVTOP = AGAUSS(0.0,.15V,3)
   $ p-ch threshold change
.INC '/usr/meta/lib/cmos1_mod.dat'
   $ model include file
.ENDL TT
.LIB FF
$HIGH GAIN P-CH AND N-CH CMOS LIBRARY 3SIGMA VALUES
.PARAM TOX = 220 XL = -0.03 DELVTON = -.2V
+ DELVTOP = -0.15V
.INC '/usr/meta/lib/cmos1_mod.dat'
   $ model include file
.ENDL FF
```

This example is a `.LIB` call statement of model skew parameters, and features both worst-case and statistical distribution data. The statistical distribution median value is the default for all non-Monte Carlo analysis. The model is in the /usr/meta/lib/cmos1_mod.dat include file.

```
.MODEL NCH NMOS LEVEL = 2 XL = XL TOX = TOX
+ DELVTO = DELVTON .....
.MODEL PCH PMOS LEVEL = 2 XL = XL TOX = TOX
+ DELVTO = DELVTOP .....
```

The `.model` keyword (left side) equates to the skew parameter (right side). A `.model` keyword can be the same as a skew parameter.

Description

To create and read from libraries of commonly-used commands, device models, subcircuit analysis, and statements (library calls) in library files, use the `.LIB` call statement. As HSPICE or HSPICE RF encounters each `.LIB` call name in the main data file, it reads the corresponding entry from the designated library file, until it finds an `.ENDL` statement.

You can also place a `.LIB` call statement in an `.ALTER` block.

To build libraries (library file definition), use the `.LIB` statement in a library file. For each macro in a library, use a library definition statement (`.LIB entryname`) and an `.ENDL` statement.

The `.LIB` statement begins the library macro, and the `.ENDL` statement ends the library macro. The text after a library file entry name must consist of HSPICE or HSPICE RF statements.

Library calls can call other libraries (nested library calls), if they are different files. You can nest library calls to any depth. Use nesting with the `.ALTER` statement to create a sequence of model runs. Each run can consist of similar components by using different model parameters, without duplicating the entire input file.

The simulator uses the `.LIB` statement and the `.INCLUDE` statement to access the models and skew parameters. The library contains parameters that modify `.MODEL` statements.

Argument	Definition
filepath	Path to a file. Used where a computer supports tree-structured directories. When the LIB file (or alias) is in the same directory where you run HSPICE or HSPICE RF, you do not need to specify a directory path; the netlist runs on any machine. Use the "../" syntax in the filepath to designate the parent directory of the current directory.
entryname	Entry name for the section of the library file to include. The first character of an entryname cannot be an integer.
filename	Name of a file to include in the data file. The combination of filepath plus filename can be up to 256 characters long, structured as any filename that is valid for the computer's operating system. Enclose the file path and file name in single or double quotation marks. Use the "../" syntax in the filename to designate the parent directory of the current directory.

See Also

.ALTER

.ENDL
.INCLUDE

.LIN

Syntax

```
.LIN <sparcalc = [1|0] <modelname = ...>>
+ <filename = ...> <format=[selem|citi|touchstone]>
+ <noisecalc = [1|0] <gdcalc = [1|0]>
+ <mixedmode2port = [dd|dc|ds|cd|cc|cs|sd|sc|ss]>
+ <dataformat = [ri|ma|db]>
```

Example

```
.LIN sparcalc=1 modelname=my_custom_model
+ filename=mydesign format=touchstone noisecalc=1
+ gdcalc=1 dataformat=ri
```

This example extracts linear transfer parameters for a general multi-port network, performs a 2-port noise analysis, and performs a group-delay analysis for a model named `my_custom_model`. The output is in the `mydesign` output file, which is in the TOUCHSTONE format. The data format in the TOUCHSTONE file is real-imaginary.

Description

The `.LIN` command extracts noise and linear transfer parameters for a general multi-port network.

When used with P (port) element(s) and `.AC` commands, `.LIN` makes available a broad set of linear port-wise measurements:

- standard and mixed-mode multi-port S (scattering) parameters
- standard and mixed-mode multi-port Y/Z parameters
- standard mode multi-port H parameter
- standard mode two-port noise parameters
- standard and mixed-mode group delays
- standard mode stability factors
- standard mode gain factors
- standard mode matching coefficients

The `.LIN` command computes the S (scattering), Y (admittance), Z (impedance) parameters directly, and H (hybrid) parameters directly based on the location of the port (P) elements in your circuit, and the specified values for their reference impedances.

The `.LIN` command also supports mixed-mode transfer parameters calculation and group delay analysis when used together with mixed-mode P elements.

By default, the `.LIN` command creates a *.sc#* file with the same base name as your netlist. This file contains S parameter, noise parameter, and group delay data as a function of the frequency. You can use this file as model data for the S element.

Argument	Definition
sparcalc	If 1, extract S parameters (default).
modelname	Model name listed in the .MODEL statement in the .sc# model output file.
filename	Output file name (default=netlist name).
format	Output file format: • selem is for S element .sc# format, which you can include in the netlist. • citi is CITIfile format. • touchstone is TOUCHSTONE file format.
noisecalc	If 1, extract noise parameters (perform 2-port noise analysis). Default=0.
gdcalc	If 1, extract group delay (perform group delay analysis). Default=0.

Argument	Definition
mixedmode2port	The mixedmode2port keyword describes the mixed-mode data map of output mixed mode S parameter matrix. The availability and default value for this keyword depends on the first two port (P element) configuration as follows: • case 1: p1=p2=single (standard mode P element) available: ss default: ss • case 2: p1=p2=balanced (mixed mode P element) available: dd, cd, dc, cc default: dd • case 3: p1=balanced p2=single available: ds, cs default: ds • case 4: p1=single p2=balanced available: sd, sc default: sd
dataformat	The dataformat keyword describe the data format output to the .sc#/touchstone/citi file. • dataformat=RI, real-imaginary. This is the default for .sc#/citi file. • dataformat=MA, magnitude-phase. This is the default format for touchstone file. • dataformat=DB, DB(magnitude)-phase. HSPICE uses six digits for both frequency and S Parameters in HSPICE generated data files (.sc#/touchstone/citifile). The number of digits for noise parameters are five in *.sc#* and touchstone files and six digits in citifiles.

.LOAD

Syntax

```
.LOAD <FILE = load_file> <RUN = PREVIOUS | CURRENT>
```

Example 1

```
.TITLE
.SAVE FILE=design.ic
.LOAD FILE=design.ic0
                $load--design.ic0 save--design.ic0
.alter
...            $load--none   save--design.ic1
.alter
...             $load--none   save--design.ic2
.end
```

This example loads a file name *design.ic0*, which you previously saved using a .SAVE command.

Example 2

```
.TITLE
.SAVE FILE=design.ic
.LOAD FILE=design.ic RUN=PREVIOUS
               $load--none   save--design.ic0
.alter
...           $load--design.ic0 save--design.ic1
.alter
...           $load--design.ic1 save--design.ic2
.end
```

Example 3

```
.TITLE
.SAVE FILE=design.ic
.LOAD FILE=design.ic RUN=CURRENT
             $load--design.ic0 save--design.ic0
.alter
...          $load--design.ic1 save--design.ic1
.alter
...          $load--design.ic2 save--design.ic2
.end
```

Description

Use the .LOAD statement to input the contents of a file, that you stored using the .SAVE statement in HSPICE.

Note: HSPICE RF does not support the .SAVE and .LOAD (save and restart) statements.

Files stored with the .SAVE statement contain operating point information for the point in the analysis at which you executed .SAVE.

Do not use the .LOAD command for concatenated netlist files.

Argument	Definition
load_file	Name of the file in which .SAVE saved an operating point for the circuit under simulation.The format of the file name is <*design*>.ic#. Default is <*design*>.ic0, where *design* is the root name of the design.
RUN=	Used only outside of .ALTER statements in a netlist that contains .ALTER statements. The format of file name is <*design*>.ic.
PREVIOUS	Each .ALTER run uses the saved operating point from the previous .ALTER run in the same simulation.
CURRENT	Each .ALTER run uses the saved operating point from the current .ALTER run in the last simulation.

See Also

.ALTER
.SAVE

.MACRO

In HSPICE RF, you cannot replicate output commands within subcircuit (subckt) definitions.

Syntax

```
.MACRO subnam n1 <n2 n3 …> <parnam = val>
.EOM
```

Example 1

```
*FILE SUB2.SP TEST OF SUBCIRCUITS
.OPTION LIST ACCT
   V1 1 0 1
.PARAM P5 = 5 P2 = 10
.SUBCKT SUB1 1 2 P4 = 4
   R1 1 0 P4
   R2 2 0 P5
   X1 1 2 SUB2 P6 = 7
   X2 1 2 SUB2
.ENDS
*
.MACRO SUB2 1 2 P6 = 11
   R1 1 2 P6
   R2 2 0 P2
.EOM
   X1 1 2 SUB1 P4 = 6
   X2 3 4 SUB1 P6 = 15
   X3 3 4 SUB2
*
.MODEL DA D CJA = CAJA CJP = CAJP VRB = -20 IS = 7.62E-18
+   PHI = .5 EXA = .5 EXP = .33
.PARAM CAJA = 2.535E-16 CAJP = 2.53E-16
.END
```

The preceding example defines two subcircuits: SUB1 and SUB2. These are resistor divider networks, whose resistance values are parameters (variables). The X1, X2, and X3 statements call these subcircuits. Because the resistor values are different in each call, these three calls produce different subcircuits.

Example 2

```
.SUBCKT Inv a y Strength = 3
   Mp1 <MosPinList> pMosMod L = 1.2u W = ’Strength * 2u’
   Mn1 <MosPinList> nMosMod L = 1.2u W = ’Strength * 1u’
.ENDS
...
```

```
xInv0 a y0 Inv         $ Default devices: p device = 6u,
         $ n device = 3u
xInv1 a y1 Inv Strength = 5         $ p device = 10u, n
device = 5u
xInv2 a y2 Inv Strength = 1         $ p device =  2u, n
device = 1u
...
```

This example implements an inverter that uses a *Strength* parameter. By default, the inverter can drive three devices. Enter a new value for the *Strength* parameter in the element line to select larger or smaller inverters for the application.

Description

You can create a subcircuit description for a commonly-used circuit, and include one or more references to the subcircuit in your netlist.

To define a subcircuit in your netlist, use the .MACRO statement. Use the .EOM statement to terminate a .MACRO statement.

Argument	Definition
subnam	Specifies a reference name for the subcircuit model call.
n1 …	Node numbers for external reference; cannot be the ground node (zero). Any element nodes that are in the subcircuit, but are not in this list, are strictly local with three exceptions: • Ground node (zero). • Nodes assigned using BULK = node in MOSFET or BJT models. • Nodes assigned using the .GLOBAL statement.
parnam	A parameter name set to a value. Use only in the subcircuit. To override this value, assign it in the subcircuit call, or set a value in a .PARAM statement.
SubDefaultsList	<*SubParam1*>=<*Expression*> [<*SubParam2*>=<*Expression*>...]

See Also

.ENDS
.EOM
.MACRO
.SUBCKT

.MALIAS

Syntax

```
.MALIAS model_name=alias_name1 <alias_name2 ...>
```

- *model_name* is the model name defined in the .model card.
- *alias_name1*... is the alias that an instance (element) of the model references.

Example

```
*file: test malias statement
.OPTION acct tnom=50 list gmin=1e-14 post
.temp 0.0 25
.tran .1 2
vdd 2 0 pwl 0 -1 1 1
d1 2 1 zend dtemp=25
d2 1 0 zen dtemp=25
* malias statements
.malias zendef = zen zend
* model definition
.model zendef d (vj=.8 is=1e-16 ibv=1e-9 bv=6.0 rs=10
+ tt=0.11n n=1.0 eg=1.11 m=.5 cjo=1pf tref=50)
.end
```

- *zendef* is a diode model
- *zen* and *zend* are its aliases.
- The *zendef* model points to both the *zen* and *zend* aliases.

Description

You can use the .MALIAS statement to assign an alias (another name) to a diode, BJT, JFET, or MOSFET model that you defined in a .MODEL statement. You cannot use the .MALIAS statement in HSPICE RF.

.MALIAS differs from .ALIAS in two ways:

- A model can define the alias in an .ALIAS statement, but not the alias in a .MALIAS statement. The .MALIAS statment applies to an element (an instance of the model), not to the model itself.
- The .ALIAS command works only if you include .ALTER in the netlist. You can use .MALIAS without .ALTER.

You can use .MALIAS to alias to a model name that you defined in a .MODEL statement or to alias to a subcircuit name that you defined in a .SUBCKT statement. The syntax for .MALIAS is the same in either usage.

Note: Using .MALIAS in .ALTER blocks is not recommended or supported.

See Also

.ALIAS

.MATERIAL

Note: You cannot use the .MATERIAL statement in HSPICE RF.

Syntax

```
.MATERIAL mname METAL|DIELECTRIC <ER=val>
+ <UR=val> <CONDUCTIVITY=val> <LOSSTANGENT=val>
```

Description

The field solver assigns the following default values for metal:

- CONDUCTIVITY = -1 (perfect conductor)
- ER = 1
- UR = 1

PEC is a pre-defined metal name. You cannot redefine its default values.

The field solver assigns the following default values for dielectrics:

- CONDUCTIVITY = 0 (lossless dielectric)
- LOSSTANGENT = 0 (lossless dielectric)
- ER = 1
- UR = 1

AIR is a pre-defined dielectric name. You cannot redefine its default values.

Because the field solver does not currently support magnetic materials, it ignores UR values.

Argument	Definition
mname	Material name.
METAL|DIELECTRIC	Material type: METAL or DIELECTRIC.
ER	Dielectric constant (relative permittivity).
UR	Relative permeability.
CONDUCTIVITY	Static field conductivity of conductor or lossy dielectric (S/m).
LOSSTANGENT	Alternating field loss tangent of dielectric (tan δ).

See Also

.LAYERSTACK

.MEASURE

Description

Use the .MEASURE statement to modify information and to define the results of successive HSPICE or HSPICE RF simulations. The .MEASURE statement prints user-defined electrical specifications of a circuit. Optimization (HSPICE only) uses .MEASURE statements extensively. The specifications include:

- propagation
- delay
- rise time
- fall time
- peak-to-peak voltage
- minimum and maximum voltage over a specified period
- other user-defined variables

You can also use .MEASURE with either the error function (ERRfun) or GOAL parameter to optimize circuit component values (HSPICE only), and to curve-fit measured data to model parameters.

The .MEASURE statement can use several different formats, depending on the application. You can use it for either DC sweep, AC, or transient analyses.

See Also

.AC
.DC
.DCMATCH
.DOUT
.GRAPH
.OPTION MEASDGT
.OPTION MEASFAIL
.OPTION MEASFILE
.OPTION MEASSORT
.OPTION MEASOUT
.PLOT
.PRINT
.PROBE
.STIM
.TRAN

.MEASURE (Rise, Fall, and Delay Measurements)

Syntax

```
.MEASURE <DC | AC | TRAN> result TRIG … TARG …
+ <GOAL = val> <MINVAL = val> <WEIGHT = val>
```

The input syntax for delay, rise time, and fall time in HSPICE RF is:

```
.MEASURE <TRAN > varname TRIG_SPEC TARG_SPEC
```

In this syntax, `varname` is the user-defined variable name for the measurement (the time difference between TRIG and TARG events). The input syntax of *TRIG_SPEC* and *TARG_SPEC* is:

```
TRIG var VAL = val < TD = td > < CROSS = c | LAST >
+ < RISE = r | LAST > < FALL = f | LAST >
+ <TRIG AT = time>

TARG var VAL = val < TD = td > < CROSS = c | LAST >
+ < RISE =  r | LAST  > < FALL = f | LAST>
+ <TRIG AT = time>
```

Example 1

```
* Example of rise/fall/delay measurement
.MEASURE TRAN tdlay TRIG V(1) VAL = 2.5 TD = 10n
+ RISE = 2 TARG V(2) VAL = 2.5 FALL = 2
```

This example measures the propagation delay between nodes 1 and 2 for a transient analysis. HSPICE measures the delay from the second rising edge of the voltage at node 1 to the second falling edge of node 2. The measurement begins when the second rising voltage at node 1 is 2.5 V, and ends when the second falling voltage at node 2 is 2.5 V. The `TD = 10n` parameter counts the crossings, after 10 ns has elapsed. HSPICE prints results as `tdlay = <value>`.

Example 2

```
.MEASURE TRAN riset TRIG I(Q1) VAL = 0.5m RISE = 3
+ TARG I(Q1) VAL = 4.5m RISE = 3
* Rise/fall/delay measure with TRIG and TARG specs
.MEASURE pwidth TRIG AT = 10n TARG V(IN) VAL = 2.5
+ CROSS = 3
```

In the last example, `TRIG. AT = 10n` starts measuring time at t = 10 ns in the transient analysis. The `TARG` parameters end time measurement when V(IN) = 2.5 V, on the third crossing. `pwidth` is the printed output variable.

If you use the `.TRAN` analysis statement with a `.MEASURE` statement, do not use a non-zero start time in `.TRAN` statement or the `.MEASURE` results might be incorrect.

Example 3

```
.MEAS TRAN TDEL12 TRIG V(signal1) VAL='VDD/2'
+ RISE=10 TARG V(signal2) VAL='VDD/2' RISE=1 TD=TRIG
```

This example shows a target that is delayed until the trigger time before the target counts the edges.

Description

Use the Rise, Fall, and Delay form of the `.MEASURE` statement to measure independent-variable (time, frequency, or any parameter or temperature) differential measurements such as rise time, fall time, slew rate, or any measurement that requires determining independent variable values. This format specifies `TRIG` and `TARG` substatements. These two statements specify the beginning and end of a voltage or current amplitude measurement.

Argument	Definition
MEASURE	Specifies measurements. You can abbreviate to MEAS.
result	Name associated with the measured value in the HSPICE or HSPICE RF output. This example measures the independent variable, beginning at the trigger, and ending at the target: • Transient analysis measures time. • AC analysis measures frequency. • DC analysis measures the DC sweep variable. If simulation reaches the target before the trigger activates, the resulting value is negative. Do not use DC, TRAN, or AC as the *result* name.
TRIG…	Identifies the beginning of trigger specifications.

Argument	Definition
TARG …	Identifies the beginning of target specifications.The input syntax for delay, rise time, and fall time in HSPICE RF is: .MEASURE < TRAN > *varname TRIG_SPEC TARG_SPEC* *varname* is the user-defined variable name for the measurement, the time difference between TRIG and TARG events.
<*DC* | *AC* | *TRAN*>	Specifies the analysis type of the measurement. If you omit this parameter, HSPICE or HSPICE RF uses the last analysis mode that you requested.
GOAL	Specifies the desired measure value in ERR calculation for optimization. To calculate the error, the simulation uses the equation: $ERRfun = (GOAL - result)/GOAL$.
MINVAL	If the absolute value of GOAL is less than MINVAL, the MINVAL replaces the GOAL value in the denominator of the ERRfun expression. Used only in ERR calculation for optimization. Default = 1.0e-12.
WEIGHT	Multiplies the calculated error by the weight value. Used only in ERR calculation for optimization. Default = 1.0.

TRIG/TARG Parameter	Definition
TRIG	Indicates the beginning of the trigger specification.
trig_val	Value of *trig_var*, which increments the counter for crossings, rises, or falls, by one.
trig_var	Specifies the name of the output variable, that determines the logical beginning of a measurement. If HSPICE or HSPICE RF reaches the target before the trigger activates, .MEASURE reports a negative value.
TARG	Indicates the beginning of the target signal specification.

TRIG/TARG Parameter	Definition
targ_val	Specifies the value of the *targ_var*, which increments the counter for crossings, rises, or falls, by one.
targ_var	Name of the output variable, at which HSPICE or HSPICE RF determines the propagation delay with respect to the *trig_var*.
time_delay	Amount of simulation time that must elapse, before HSPICE or HSPICE RF enables the measurement. Simulation counts the number of crossings, rises, or falls, only after the *time_delay* value. Default trigger delay is zero.

.MEASURE (Average, RMS, and Peak Measurements)

Syntax

```
.MEASURE <TRAN > out_var func var
+ FROM = start TO = end
```

Example 1

```
.MEAS TRAN RMSVAL RMS V(OUT) FROM = 0NS TO = 10NS
```

In this example, the .MEASURE statement calculates the RMS voltage of the OUT node, from 0ns to 10ns. It then labels the result RMSVAL.

Example 2

```
.MEAS MAXCUR MAX I(VDD) FROM = 10NS TO = 200NS
```

In this example, the .MEASURE statement finds the maximum current of the VDD voltage supply, between 10ns and 200ns in the simulation. The result is called MAXCUR.

Example 3

```
.MEAS P2P PP PAR('V(OUT)/V(IN)')
+ FROM = 0NS TO = 200NS
```

In this example, the .MEASURE statement uses the ratio of V(OUT) and V(IN) to find the peak-to-peak value in the interval of 0ns to 200ns.

Description

This .MEASURE statement reports the average, RMS, or peak value of the specified output variable.

Argument	Definition
varname	User-defined variable name for the measurement.
func	One of the following keywords: • AVG: Average area under *var*, divided by the period of interest. • MAX: Maximum value of *var* over the specified interval. • MIN: Minimum value of *var* over the specified interval. • PP: Peak-to-peak: reports the maximum value, minus the minimum of *var* over the specified interval. • RMS: Root mean squared: calculates the square root of the area under the var^2 curve, divided by the period of interest. • INTEG: Integral of *var* over the specified period.
out_var var	Name of the output variable, which can be either the node voltage or the branch current of the circuit. You can also use an expression, consisting of the node voltages or the branch current.
start	Starting time of the measurement period.
end	Ending time of the measurement period.

.MEASURE (FIND and WHEN)

Syntax

```
.MEASURE <DC | AC | TRAN> result
+ WHEN out_var = val <TD = val>
+ < RISE = r | LAST > < FALL = f | LAST >
+ < CROSS = c | LAST >
+ <GOAL = val> <MINVAL = val> <WEIGHT = val>

.MEASURE <DC | AC | TRAN> result
+ WHEN out_var1 = out_var2
+ < TD = val > < RISE = r | LAST >
+ < FALL = f | LAST >
+ < CROSS = c| LAST > <GOAL = val>
+ <MINVAL = val> <WEIGHT = val>

.MEASURE <DC | AC | TRAN> result FIND out_var1
+ WHEN out_var2 = val < TD = val >
+ < RISE = r | LAST >
+ < FALL = f | LAST > < CROSS = c| LAST >
+ <GOAL = val> <MINVAL = val> <WEIGHT = val>

.MEASURE <DC | AC | TRAN> result FIND out_var1
+ WHEN out_var2 = out_var3 <TD = val >
+ < RISE = r | LAST > < FALL = f | LAST >
+ <CROSS = c | LAST> <GOAL = val>
+ <MINVAL = val> <WEIGHT = val>

.MEASURE <DC | AC | TRAN> result FIND out_var1
+ AT = val <GOAL = val> <MINVAL = val>
+ <WEIGHT = val>

.MEASURE DC result FIND <DCMATCH_TOTAL |
+ DCMATCH(InstanceName)> AT = val
```

Example

```
* MEASURE statement using FIND/WHEN
.MEAS TRAN TRT FIND PAR('V(3)-V(4)')
+ WHEN V(1)=PAR('V(2)/2') RISE = LAST
.MEAS STIME WHEN V(4) = 2.5 CROSS = 3
```

In this example, the first measurement, TRT, calculates the difference between V(3) and V(4) when V(1) is half the voltage of V(2) at the last rise event.

The second measurement, STIME, finds the time when V(4) is 2.5V at the third rise-fall event. A CROSS event is a rising or falling edge.

Description

The `FIND` and `WHEN` functions of the `.MEASURE` statement specify to measure:

- Any independent variables (time, frequency, parameter).
- Any dependent variables (voltage or current, for example).
- Derivative of a dependent variable, if a specific event occurs.

Argument	Definition
CROSS = c *RISE = r* *FALL = f*	Numbers indicate which CROSS, FALL, or RISE event to measure. For example: .meas tran tdlay trig v(1) val=1.5 td=10n + rise=2 targ v(2) val=1.5 fall=2 In the above example, rise=2 specifies to measure the v(1) voltage, only on the first two rising edges of the waveform. The value of these first two rising edges is 1. However, trig v(1) val=1.5 indicates to trigger when the voltage on the rising edge voltage is 1.5, which never occurs on these first two rising edges. So the v(1) voltage measurement never finds a trigger. • RISE = r, the WHEN condition is met, and measurement occurs after the designated signal has risen r rise times. • FALL = f, measurement occurs when the designated signal has fallen f fall times. A crossing is either a rise or a fall so for CROSS = c, measurement occurs when the designated signal has achieved a total of c crossing times as a result of either rising or falling. For TARG, the LAST keyword specifies the last event.

Argument	Definition
LAST	HSPICE or HSPICE RF measures when the last CROSS, FALL, or RISE event occurs. • CROSS = LAST, measurement occurs the last time the WHEN condition is true for a rising or falling signal. • FALL = LAST, measurement occurs the last time the WHEN condition is true for a falling signal. • RISE = LAST, measurement occurs the last time the WHEN condition is true for a rising signal. LAST is a reserved word; you cannot use it as a parameter name in the above .MEASURE statements.
AT = val	Special case for trigger specification. *val* is: • Time for TRAN analysis. • Frequency for AC analysis. • Parameter for DC analysis. • *SweepValue* from .DC mismatch analysis. The trigger determines where measurement takes place.
<DC | AC | TRAN>	Analysis type for the measurement. If you omit this parameter, HSPICE or HSPICE RF assumes the last analysis type that you requested.
FIND	Selects the FIND function.
GOAL	Desired .MEASURE value. Optimization uses this value in ERR calculation. The following equation calculates the error: $ERRfun = (GOAL - result)/GOAL$. In HSPICE RF output, you cannot apply .MEASURE to waveforms generated from another .MEASURE statement in a parameter sweep.
LAST	Starts measurement at the last CROSS, FALL, or RISE event. • For CROSS = LAST, measurement starts the last time the WHEN condition is true for either a rising or falling signal. • For FALL = LAST, measurement starts the last time the WHEN condition is true for a falling signal. • For RISE = LAST, measurement starts the last time the WHEN condition is true for a rising signal. LAST is a reserved word. Do not use it as a parameter name in these .MEASURE statements.

Argument	Definition
MINVAL	If the absolute value of GOAL is less than MINVAL, then MINVAL replaces the GOAL value in the denominator of the ERRfun expression. Used only in ERR calculation for optimization. Default = 1.0e-12.
out_var(1,2,3)	These variables establish conditions that start a measurement.
result	Name of a measured value in the HSPICE or HSPICE RF output.
TD	Time at which measurement starts.
WEIGHT	Multiplies the calculated error by the weight value. Used only in ERR calculation for optimization. Default = 1.0.
WHEN	Selects the WHEN function.
DCMATCH (*InstanceName*)	.DCMATCH contribution from *InstanceName.*
DCMATCH_TOTAL	.DCMATCH total output variation.

.MEASURE (Equation Evaluation/ Arithmetic Expression)

Syntax

```
.MEASURE <DC | TRAN | AC> result PARAM = 'equation'
+ <GOAL = val> <MINVAL = val>

.MEASURE TRAN varname PARAM = "expression"
```

Example

```
.MEAS TRAN V3MAX MAX V(3) FROM 0NS TO 100NS
.MEAS TRAN V2MIN MIN V(2) FROM 0NS TO 100NS
.MEAS VARG PARAM = '(V2MIN + V3MAX)/2'
```

The first two measurements, V3MAX and V2MIN, set up the variables for the third .MEASURE statement.

- V3MAX is the maximum voltage of V(3) between 0ns and 100ns of the simulation.
- V2MIN is the minimum voltage of V(2) during that same interval.
- VARG is the mathematical average of the V3MAX and V2MIN measurements.

Description

Use the Equation Evaluation form of the .MEASURE statement to evaluate an equation, that is a function of the results of previous .MEASURE statements. The equation must not be a function of node voltages or branch currents.

The *expression* option is an arithmetic expression, that uses results from other prior .MEASURE statements.

Expressions used in arithmetic expression must not be a function of node voltages or branch currents. Expressions used in all other .MEASURE statements can contain either node voltages or branch currents, but must not use results from other .MEASURE statements.

.MEASURE (Average, RMS, MIN, MAX, INTEG, and PP)

Syntax

```
.MEASURE <DC | AC | TRAN> result func out_var
+ <FROM = val> <TO = val> <GOAL = val>
+ <MINVAL = val> <WEIGHT = val>

.MEASURE DC results <MAX>
+ <DCMATCH_TOTAL | DCMATCH(InstanceName)>
```

Example 1

```
.MEAS TRAN avgval AVG V(10) FROM = 10ns TO = 55ns
```

This example calculates the average nodal voltage value for node 10, during the transient sweep, from the time 10 ns to 55 ns. It prints out the result as *avgval*.

Example 2

```
.MEAS TRAN MAXVAL MAX V(1,2) FROM = 15ns  TO = 100ns
```

This example finds the maximum voltage difference between nodes 1 and 2 for the time period from 15 ns to 100 ns.

Example 3

```
.MEAS TRAN MINVAL MIN V(1,2) FROM = 15ns TO = 100ns
.MEAS TRAN P2PVAL PP I(M1)  FROM = 10ns TO = 100ns
```

Description

Average (AVG), RMS, MIN, MAX, and peak-to-peak (PP) measurement modes report statistical functions of the output variable, rather than analysis values.

- AVG calculates the area under an output variable, divided by the periods of interest.
- RMS divides the square root of the area under the output variable square, by the period of interest.
- MIN reports the minimum value of the output function, over the specified interval.
- MAX reports the maximum value of the output function, over the specified interval.
- PP (peak-to-peak) reports the maximum value, minus the minimum value, over the specified interval.

AVG, RMS, and INTEG have no meaning in a DC data sweep so if you use them, HSPICE or HSPICE RF issues a warning message.

Argument	Definition
<DC|AC|TRAN>	Specifies the analysis type for the measurement. If you omit this parameter, HSPICE or HSPICE RF assumes the last analysis mode that you requested.
FROM	Specifies the initial value for the *func* calculation. For transient analysis, this value is in units of time.
TO	Specifies the end of the *func* calculation.
GOAL	Specifies the .MEASURE value. Optimization uses this value for ERR calculation. This equation calculates the error: $ERRfun = (GOAL - result)/GOAL$ In HSPICE RF simulation output, you cannot apply .MEASURE to waveforms generated from another .MEASURE statement in a parameter sweep.
func	Indicates one of the measure statement types: • AVG (average): Calculates the area under the out_var, divided by the periods of interest. • MAX (maximum): Reports the maximum value of the out_var, over the specified interval. • MIN (minimum): Reports the minimum value of the out_var, over the specified interval. • PP (peak-to-peak): Reports the maximum value, minus the minimum value of the out_var, over the specified interval. • RMS (root mean squared): Calculates the square root of the area under the out_var2 curve, divided by the period of interest.
result	Name of the measured value in the output. The value is a function of the variable (*out_var*) and *func*.
out_var	Name of any output variable whose function (*func*) the simulation measures.
WEIGHT	Multiplies the calculated error, by the weight value. Used only in ERR calculation for optimization. Default = 1.0.

Argument	Definition
DCMATCH (*InstanceName*)	.DCMATCH contribution from *InstanceName.*
DCMATCH_TOTAL	.DCMATCH total output variation.

.MEASURE (Integral Function)

Syntax

```
.MEASURE <DC | AC | TRAN> result INTEGRAL out_var
+ <FROM = val> <TO = val> <GOAL = val>
+ <MINVAL = val> <WEIGHT = val>
```

Example

```
.MEAS TRAN charge INTEG I(cload) FROM = 10ns
+ TO = 100ns
```

This example calculates the integral of *I(cload)*, from 10 ns to 100 ns.

Description

The `INTEGRAL` function reports the integral of an output variable, over a specified period.

The `INTEGRAL` function (with func), uses the same syntax as the average (AVG), RMS, MIN, MAX, and peak-to-peak (PP) measurement mode to defined the `INTEGRAL` (`INTEG`).

.MEASURE (Derivative Function)

Syntax

```
.MEASURE <DC | AC | TRAN> result DERIVATIVE out_var
+ AT = val <GOAL = val> <MINVAL = val>
+ <WEIGHT = val>

.MEASURE <DC | AC | TRAN> result DERIVATIVE out_var
+ WHEN var2 = val <RISE = r | LAST>
+ <FALL = f | LAST> <CROSS = c | LAST> <TD = tdval>
+ <GOAL = goalval> <MINVAL = minval>
+ <WEIGHT = weightval>

.MEASURE <DC | AC | TRAN> result DERIVATIVE out_var
+ WHEN var2 = var3 <RISE = r | LAST>
+ <FALL = f | LAST> <CROSS = c | LAST> <TD = tdval>
+ <GOAL = goalval> <MINVAL = minval>
+ <WEIGHT = weightval>
```

Example 1

```
.MEAS TRAN slew rate DERIV V(out) AT = 25ns
```

This example calculates the derivative of V(out), at 25 ns.

Example 2

```
.MEAS TRAN slew DERIV v(1) WHEN v(1) = '0.90*vdd'
```

This example calculates the derivative of v(1) when v(1) is equal to 0.9*vdd.

Example 3

```
.MEAS AC delay DERIV 'VP(output)/360.0' AT = 10khz
```

This example calculates the derivative of VP(output)/360.0 when the frequency is 10 kHz.

Description

The DERIVATIVE function provides the derivative of:

- An output variable, at a specified time or frequency.
- Any sweep variable, depending on the type of analysis.
- A specified output variable when some specific event occurs.

Argument	Definition
AT = val	Value of *out_var*, at which the derivative is found.
CROSS = c *RISE = r* *FALL = f*	The numbers indicate which occurrence of a CROSS, FALL, or RISE event starts a measurement. • For RISE = r when the designated signal has risen r rise times, the WHEN condition is met, and measurement starts. • For FALL = f, measurement starts when the designated signal has fallen f fall times. A crossing is either a rise or a fall so for CROSS = c, measurement starts when the designated signal has achieved a total of c crossing times as a result of either rising or falling.
<DC|AC|TRAN>	Specifies the analysis type to measure. If you omit this parameter, HSPICE or HSPICE RF assumes the last analysis mode that you requested.
DERIVATIVE	Selects the derivative function. You can abbreviate to DERIV.
GOAL	Specifies the desired .MEASURE value. Optimization uses this value for ERR calculation. This equation calculates the error: $ERRfun = (GOAL - result)/GOAL$ In HSPICE RF output, you cannot apply .MEASURE to waveforms generated from another .MEASURE statement in a parameter sweep.
LAST	Measures when the last CROSS, FALL, or RISE event occurs. • CROSS = LAST, measures the last time the WHEN condition is true for a rising or falling signal. • FALL = LAST, measures the last time WHEN is true for a falling signal. • RISE = LAST, measures the last time WHEN is true for a rising signal. LAST is a reserved word; do not use it as a parameter name in the above .MEASURE statements.
MINVAL	If the absolute value of GOAL is less than MINVAL, MINVAL replaces the GOAL value in the denominator of the ERRfun expression. Used only in ERR calculation for optimization. Default = 1.0e-12.

Argument	Definition
out_var	Variable for which HSPICE or HSPICE RF finds the derivative.
result	Name of the measured value in the output.
TD	Identifies the time when measurement starts.
var(2,3)	These variables establish conditions that start a measurement.
WEIGHT	Multiplies the calculated error, between result and GOAL, by the weight value. Used only in ERR calculation for optimization. Default = 1.0.
WHEN	Selects the WHEN function.

.MEASURE (Error Function)

Syntax

```
.MEASURE <DC | AC | TRAN> result
+ ERRfun meas_var calc_var
+ <MINVAL = val> < IGNORE | YMIN = val>
+ <YMAX = val> <WEIGHT = val> <FROM = val>
+ <TO = val>
```

Description

The relative error function reports the relative difference between two output variables. You can use this format in optimization and curve-fitting of measured data. The relative error format specifies the variable to measure and calculate, from the .PARAM variable. To calculate the relative error between the two, HSPICE or HSPICE RF uses the ERR, ERR1, ERR2, or ERR3 functions. With this format, you can specify a group of parameters to vary to match the calculated value and the measured data.

Argument	Definition
<DC|AC|TRAN>	Specifies the analysis type for the measurement. If you omit this parameter, HSPICE or HSPICE RF assumes the last analysis mode that you requested.
result	Name of the measured result in the output.
ERRfun	ERRfun indicates which error function to use: ERR, ERR1, ERR2, or ERR3.
meas_var	Name of any output variable or parameter in the data statement. *M* denotes the *meas_var* in the error equation.
calc_var	Name of the simulated output variable or parameter in the .MEASURE statement to compare with *meas_var*. *C* is the *calc_var* in the error equation.
IGNOR|YMIN	If the absolute value of meas_var is less than the IGNOR value, then the ERRfun calculation does not consider this point. Default = 1.0e-15.

Argument	Definition
FROM	Specifies the beginning of the ERRfun calculation. For transient analysis, the *from* value is in units of time. Defaults to the first value of the sweep variable.
WEIGHT	Multiplies the calculated error, by the weight value. Used only in ERR calculation for optimization. Default = 1.0.
YMAX	If the absolute value of meas_var is greater than the YMAX value, then the ERRfun calculation does not consider this point. Default = 1.0e+15.
TO	End of the ERRfun calculation. Default is last value of the sweep variable.
MINVAL	If the absolute value of meas_var is less than MINVAL, MINVAL replaces the meas_var value in the denominator of the ERRfun expression. Used only in ERR calculation for optimization. Default = 1.0e-12.

.MEASURE (Pushout Bisection)

Syntax

```
.MEASURE TRAN MeasureName MeasureClause
pushout=time <lower/upper>
```

-or-

```
.MEASURE TRAN MeasureName MeasureClause
pushout_per=percentage <lower/upper>
```

Example 1

```
.Param DelayTime = Opt1 ( 0.0n, 0.0n , 5.0n )
.Tran 1n 8n Sweep Optimize=Opt1  Result=setup_prop  + Model=OptMod
.Measure Tran setup_prop Trig v(data)
+ Val = 'v(Vdd) 2' fall = 1 Targ v(D_Output)
+ Val = 'v(Vdd)' rise = 1 pushout=1.5n lower
```

In this example, the parameter to be optimized is `Delaytime` and the evaluation goal is `setup_prop`. The `Pushout=1.5 lower` means that the `setup_prop` of the final solution is not `1.5n` far from the `setup_prop` of the lower bound of the parameter (`0.0n`).

Example 2

```
.Measure Tran setup_prop Trig v(data)
+ Val = 'v(Vdd)/2' fall = 1 Targ v(D_Output)
+ Val = 'v(Vdd)' rise = 1 pushout_per=0.1 lower
```

In this example, the differences between the `setup_prop` of the final solution and that of the lower bound of the parameter (`0.0n`) is not more than 10%.

Description

Pushout is only employed in bisection analysis. In Pushout Bisection, instead of finding the last point just before failure, you specify a maximum allowed pushout time to control the distance from failure.

Argument	Definition
pushout=time	Specifies the time. An appropriate time must be specified to obtain the pushout result (an absolute time).
pushout_per= percentage	Defines a relative error. If you specify a 0.1 relative error, the T_lower or T_upper and T_pushout have more than a 10% difference in value. This occurrence causes the iteration to stop and output the optimized parameter.
lower/upper	Specifies the parameter boundary values for pushout comparison. These arguments are optional. If the parameter is defined as .PARAM <ParamName>=OPTxxx(<Initial>, <min>. <max>), the "lower" means the lower bound "min", and the “upper” means the upper bound "max". Default=lower.

.MODEL

Syntax

```
.MODEL mname type <VERSION = version_number>
+ <pname1 = val1 pname2 = val2 ...>

.MODEL mname OPT <parameter=val ...>
```

The following is the .MODEL syntax for use with .GRAPH:

```
.MODEL mname PLOT (pnam1 = val1 pnam2 = val2….)
```

The following syntax is used for a Monte Carlo analysis:

```
.MODEL mname ModelType (<LEVEL=val>
+ <keyname1=val1><keyname2=val2>
+ <keyname3=val3><LOT</n></distribution>><value>
+ <DEV</n></distribution>><value>...)
+ <VERSION=version_number>
```

Example 1

```
.MODEL MOD1 NPN BF=50 IS=1E-13 VBF=50 AREA=2 PJ=3,
+ N=1.05
```

Example 2

This example shows a .MODEL statement used for a Monte Carlo analysis:

```
.model m1 nmos level=6 bulk=2 vt=0.7 dev/2 0.1
+ tox=520 lot/gauss 0.3 a1=.5 a2=1.5 cdb=10e-16
+ csb=10e-16 tcv=.0024
```

Description

Use the .MODEL command to include an instance (element) of a pre-defined HSPICE model in your input netlist.

For each optimization within a data file, specify a .MODEL statement. HSPICE can then execute more than one optimization per simulation run. The .MODEL optimization statement defines:

- Convergence criteria.
- Number of iterations.
- Derivative methods.

Argument	Definition
mname	Model name reference. Elements must use this name to refer to the model. If model names contain periods (.), the automatic model selector might fail. When used with .GRAPH, this is the plot model name, referenced in .GRAPH statements.
type	Selects a model type. Must be one of the following. AMP operational amplifier model C capacitor model CORE magnetic core model D diode model L inductor model or magnetic core mutual inductor model NJF n-channel JFET model NMOS n-channel MOSFET model NPN npn BJT model OPT optimization model PJF p-channel JFET model PLOT plot model for the .GRAPH statement PMOS p-channel MOSFET model PNP pnp BJT model R resistor model U lossy transmission line model (lumped) W lossy transmission line model SP S parameter

Argument	Definition
CENDIF	Selects different derivative methods. Default=1.0e-9. The following calculates the gradient of the RESULTS functions: ||Transpose(Jacobi(F(X))) * F(X)||, where F(X) is the RESULT function If the resulting gradient is less than CENDIF, HSPICE uses more accurate but more time-consuming derivative methods. By default, HSPICE uses faster but less-accurate derivative methods. To use the more-accurate methods, set CENDIF to a larger value than GRAD. If the gradient of the RESULTS function is less than GRAD, optimization finishes before CENDIF takes effect. • If the value is too large, the optimizer requires more CPU time. • If the value is too small, the optimizer might not find as accurate an answer.
CLOSE	Initial estimate of how close parameter initial value estimates are to the solution. CLOSE multiplies changes in new parameter estimates. If you use a large CLOSE value, the optimizer takes large steps toward the solution. For a small value, the optimizer takes smaller steps toward the solution. You can use a smaller value for close parameter estimates, and a larger value for rough initial guesses. Default=1.0. • If CLOSE is greater than 100, the steepest descent in the Levenburg-Marquardt algorithm dominates. • If CLOSE is less than 1, the Gauss-Newton method dominates. For more details, see L. Spruiell, “Optimization Error Surfaces,” *Meta-Software Journal,* Volume 1, Number 4, December 1994.
CUT	Modifies CLOSE, depending on how successful iterations are, toward the solution. If the last iteration succeeds, descent toward the CLOSE solution decreases by the CUT value. That is, CLOSE = CLOSE / CUT If the last iteration was not a successful descent to the solution, CLOSE increases by CUT squared. That is, CLOSE = CLOSE * CUT * CUT CUT drives CLOSE up or down, depending on the relative success in finding the solution. The CUT value must be > 1. Default = 2.0.
DEV	(Monte Carlo) DEV tolerance, which is independent (each device varies independently).

Argument	Definition
DIFSIZ	Increment change in a parameter value for gradient calculations (Δx = *DIFSIZ* · *max(x,* 0.1*)*). If you specify delta in a .PARAM statement, then Δx = delta. Default = 1e-3.
distribution	(Monte Carlo) The distribution function name, which must be specified as GAUSS, AGAUSS, LIMIT, UNIF, or AUNIF. If you do not set the distribution function, the default distribution function is used. The default distribution function is uniform distribution.
GRAD	Represents possible convergence, if the gradient of the RESULTS function is less than GRAD. Most applications use values of 1e-6 to 1e-5. Too large a value can stop the optimizer before finding the best solution. Too small a value requires more iterations. Default=1.0e-6.
ITROPT	Maximum number of iterations. Typically, you need no more than 20-40 iterations to find a solution. Too many iterations can imply that the RELIN, GRAD, or RELOUT values are too small. Default=20.
LEVEL	Selects an optimizing algorithm. • LEVEL=1 specifies the Modified Levenberg-Marquardt method. You would use this setting with multiple optimization parameters and goals. • LEVEL=2 specifies the BISECTION method in HSPICE RF. You would use this setting with one optimization parameter. • LEVEL=3 specifies the PASSFAIL method. You would use this setting with two optimization parameter. This argument is ignored when METHOD has been specified.
LOT	(Monte Carlo) The LOT tolerance, which requires all devices that refer to the same model use the same adjustments to the model parameter.
LOT/n DEV/n	(Monte Carlo) Specifies which of ten random number generators numbered 0 through 9 are used to calculate parameter value deviations. This correlates deviations between parameters in the same model as well as between models. The generators for DEV and LOT tolerances are distinct: Ten generators exist for both DEV tracking and LOT tracking. N must be an integer 0 to 9.
keyword	(Monte Carlo) Model parameter keyword.
MAX	Sets the upper limit on CLOSE. Use values > 100. Default=6.0e+5.

Argument	Definition
METHOD	Specifies an optimization method. • METHOD = LM specifies the Modified Levenberg-Marquardt method. • METHOD = BISECTION specifies the Bisection method. • METHOD = PASSFAIL specifies the Passfail method. This argument supersedes LEVEL when present.
PARMIN	Allows better control of incremental parameter changes, during error calculations. Default=0.1. This produces more control over the trade-off between simulation time and optimization result accuracy. To calculate parameter increments, HSPICE uses the relationship: Dpar_val = DIFSIZ · MAX(par_val, PARMIN)
PLOT	A .GRAPH statement model.
pname1 ...	Parameter name. Assign a model parameter name (*pname1*) from the parameter names for the appropriate model type. Each model section provides default values. For legibility, enclose the parameter assignment list in parentheses, and use either blanks or commas to separate each assignment. Use a plus sign (+) to start a continuation line. When used with .GRAPH, each .GRAPH statement includes several model parameters. If you do not specify model parameters, HSPICE uses the default values of the model parameters, described in the following table. *Pnamn* is one of the model parameters of a .GRAPH statement, and *valn* is the value of pnamn. Valn can be more than one parameter.
RELIN	Sets the relative input parameter (delta_par_val / MAX(par_val,1e-6)) for convergence. If all optimizing input parameters vary by no more than RELIN between iterations, the solution converges. RELIN is a relative variance test so a value of 0.001 implies that optimizing parameters vary by less than 0.1%, from one iteration to the next. Default=0.001.
RELOUT	Sets the relative tolerance to finish optimization. For RELOUT=0.001, if the relative difference in the RESULTS functions, from one iteration to the next, is less than 0.001, then optimization is finished. Default=0.001.

Argument	Definition
VERSION	HSPICE or HSPICE RF version number. Allows portability of the BSIM (LEVEL=13) and BSIM2 (LEVEL = 39) models, between HSPICE releases. HSPICE release numbers, and the corresponding version numbers, are: HSPICE *release* *Version number* 9007B 9007.02 9007D 9007.04 92A 92.01 92B 92.02 93A 93.01 93A.02 93.02 95.3 95.3 96.1 96.1 The VERSION parameter is valid only for LEVEL 13 and LEVEL 39 models. Use it with HSPICE Release H93A.02 and higher. If you use the parameter with any other model, or with a release before H93A.02, HSPICE issues a warning, but the simulation continues.You can also use VERSION to denote the BSIM3v3 version number only in model LEVELs 49 and 53. For LEVELs 49 and 53, the HSPVER parameter denotes the HSPICE or HSPICE RF release number.

.NET

Syntax

One-Port Network

```
.NET input <RIN = val>

.NET input <val>
```

Two-Port Network

```
.NET output input <ROUT = val> <RIN = val>
```

Example

One-Port Network

```
.NET   VINAC   RIN = 50
.NET   IIN   RIN = 50
```

Two-Port Network

```
.NET V(10,30)   VINAC   ROUT = 75   RIN = 50
.NET I(RX)   VINAC   ROUT = 75   RIN = 50
```

Description

You can use the .NET statement or HSPICE RF to compute parameters for:

- Z impedance matrix.
- Y admittance matrix.
- H hybrid matrix
- S scattering matrix.

You can use the .NET statement only in conjunction with the .AC statement.

HSPICE or HSPICE RF also computes:

- Input impedance.
- Output impedance.
- Admittance.

This analysis is part of AC small-signal analysis. To run network analysis, specify the frequency sweep for the .AC statement.

Argument	Definition
input	Name of the voltage or current source for AC input.
output	Output port. It can be: • An output voltage, V(n1<,n2>). • An output current, I(source), or I(element).
RIN	Input or source resistance. RIN calculates output impedance, output admittance, and scattering parameters. The default RIN value is 1 ohm.
ROUT	Output or load resistance. ROUT calculates input impedance, admittance, and scattering parameters. Default=1 ohm.

See Also

.AC

.NODESET

Syntax

```
.NODESET V(node1) = val1 <V(node2) = val2 ...>
```

or

```
.NODESET node1 val1 <node2 val2>
```

Example

```
.NODESET V(5:SETX) = 3.5V V(X1.X2.VINT) = 1V
.NODESET V(12) = 4.5 V(4) = 2.23
.NODESET 12 4.5 4 2.23 1 1
```

Description

The .NODESET statement initializes all specified nodal voltages for DC operating point analysis. Use the .NODESET statement to correct convergence problems in DC analysis. If you set the node values in the circuit close to the actual DC operating point solution, you enhance convergence of the simulation. The HSPICE or HSPICE RF simulator uses the NODESET voltages only in the first iteration to set an initial guess for DC operating point analysis.

Argument	Definition
node1 ...	Node numbers or names can include full paths or circuit numbers.
val1	Specifies voltages.

See Also

.DC

.NOISE

Syntax

```
.NOISE ovv srcnam inter
```

Example

```
.NOISE V(5) VIN 10
```

Description

Use the .NOISE and .AC statements to control the noise analysis of the circuit.

You can use the .NOISE statement only in conjunction with the .AC statement.

Argument	Definition
ovv	Nodal voltage output variable. Defines the node at which HSPICE or HSPICE RF sums the noise.
srcnam	Name of the independent voltage or current source to use as the noise input reference
inter	Interval at which HSPICE or HSPICE RF prints a noise analysis summary. *inter* specifies how many frequency points to summarize in the AC sweep. If you omit *inter*, or set it to zero, HSPICE or HSPICE RF does not print a summary. If inter is equal to or greater than one, HSPICE or HSPICE RF prints summary for the first frequency, and once for each subsequent increment of the inter frequency. The noise report is sorted according to the contribution of each node to the overall noise level.

See Also

.AC

.OP

Syntax

```
.OP <format> <time> <format> <time>... <interpolation>
```

Example 1

```
.OP .5NS CUR 10NS VOL 17.5NS 20NS 25NS
```

This example calculates:

- Operating point at .05ns.
- Currents at 10 ns for the transient analysis.
- Voltages at 17.5 ns, 20 ns and 25 ns for the transient analysis.

Example 2

```
.OP
```

This example calculates a complete DC operating point solution.

Description

When you include an `.OP` statement in an input file, HSPICE or HSPICE RF calculates the DC operating point of the circuit. You can also use the `.OP` statement to produce an operating point during a transient analysis. You can include only one `.OP` statement in a simulation.

If an analysis requires calculating an operating point, you do not need to specify the `.OP` statement; HSPICE or HSPICE RF calculates an operating point. If you use a `.OP` statement, and if you include the `UIC` parameter in a `.TRAN` analysis statement, then simulation omits the `time = 0` operating point analysis, and issues a warning in the output listing.

Argument	Definition
format	Any of the following keywords. Only the first letter is required. Default = ALL • ALL: Full operating point, including voltage, currents, conductances, and capacitances. This parameter outputs voltage/current for the specified time. • BRIEF: Produces a one-line summary of each element's voltage, current, and power. Current is stated in milliamperes, and power is in milliwatts. • CURRENT: Voltage table with a brief summary of element currents and power. • DEBUG: Usually invoked only if a simulation does not converge. Debug prints the non-convergent nodes, with the new voltage, old voltage, and the tolerance (degree of non-convergence). It also prints the non-convergent elements with their tolerance values. • NONE: Inhibits node and element printouts, but performs additional analysis that you specify. • VOLTAGE: Voltage table only. The preceding keywords are mutually-exclusive; use only one at a time.
time	Place this parameter directly after ALL, VOLTAGE, CURRENT, or DEBUG. It specifies the time at which HSPICE or HSPICE RF prints the report. HSPICE RF returns node voltages only if time (t) is 0.
interpolation	Selects the interpolation method for .OP time points during transient analysis, or no interpolation. Only the first character is required; that is, typing *i* has the same effect as typing *interpolation*. Default is not active. If you specify *interpolation*, all of the time points in the .OP statement (except time=0) use the interpolation method to calculate the OP value during the transient analysis. If you use this keyword, it must be at the end of the .OP statement. HSPICE ignores any word after this keyword.

See Also

.TRAN

.OPTION

Syntax

```
.OPTION opt1 <opt2 opt3 ...>
```

Argument	Definition
opt1 ...	Specifies input control options. Many options are in the form <*opt*> = *x*, where <*opt*> is the option name and *x* is the value assigned to that option. Options are described in detail in Chapter 3, Options in HSPICE Netlists.

Example

```
.OPTION BRIEF $ Sets BRIEF to 1 (turns it on)
* Netlist, models,
...
.OPTION BRIEF = 0 $ Turns BRIEF off
```

This example sets the BRIEF option to 1 to suppress a printout. It then resets BRIEF to 0 later in the input file to resume the printout.

Description

You use the .OPTION command to modify various aspects of a Synopsys HSPICE or HSPICE RF simulation, including:

- output types
- accuracy
- speed
- convergence

You can set any number of options in one .OPTION statement, and you can include any number of .OPTION statements in an input netlist file. Most options default to 0 (OFF) when you do not assign a value by using either .OPTION <*opt*> = <*val*> or the option with no assignment: .OPTION <*opt*>.

To reset options, set them to 0 (.OPTION <*opt*> = 0). To redefine an option, enter a new .OPTION statement; HSPICE or HSPICE RF uses the last definition.

You can use the following types of options with this command. For detailed information on individual options, see Chapter 3, Options in HSPICE Netlists.

- General Control Options
- CPU Options
- Interface Options
- Analysis Options
- Error Options
- Version Option
- Model Analysis Options
- DC Operating Point, DC Sweep, and Pole/Zero Options
- Transient and AC Small Signal Analysis Options
- Transient Control Options
- Input/Output Options
- AC Control Options
- Common Model Interface Options
- Verilog-A Options

For instructions on how to use options that are relevant to a specific simulation type, see the appropriate DC, transient, and AC analysis chapters in the *HSPICE Simulation and Analysis User Guide*.

.PARAM

Syntax

Simple parameter assignment:

```
.PARAM <ParamName>=<RealNumber>
```

Algebraic parameter assignments:

```
.PARAM <ParamName>='<AlgebraicExpression>'
```

```
.PARAM <ParamName1>=<ParamName2>
```

User-defined functions:

```
.PARAM <ParamName>(<pv1>[<pv2>])='<Expression>'
```

Pre-defined analysis functions:

```
.PARAM <FunctionName> = <Value>
```

Optimized parameter assignment:

```
.PARAM parameter=OPTxxx (initial_guess, low_limit,
+ upper_limit)
```

```
.PARAM parameter=OPTxxx (initial_guess, low_limit,
+ upper_limit, delta)
```

```
.PARAM <paramname>=str('string')
```

Example 1

```
* Simple parameter assignment
.PARAM power_cylces=256
```

Example 2

```
* Numerical parameter assignment
.PARAM TermValue = 1g
   rTerm Bit0 0 TermValue
   rTerm Bit1 0 TermValue
...
```

Example 3

```
* Parameter assignment using expressions
.PARAM Pi             = '355/113'
.PARAM Pi2             = '2*Pi'
.PARAM npRatio          = 2.1
```

```
.PARAM nWidth          = 3u
.PARAM pWidth          = 'nWidth * npRatio'
Mp1   ... <pModelName> W = pWidth
Mn1   ... <nModelName> W = nWidth
...
```

Example 4

```
* Algebraic parameter
.param x=cos(2)+sin(2)
```

Example 5

```
* Algebraic expression as an output variable
.PRINT DC v(3) gain=PAR('v(3)/v(2)')
+ PAR('V(4)/V(2)')
```

Example 6

```
* My own user-defined functions
.PARAM <MyFunc( x, y )> = 'Sqrt((x*x)+(y*y))'
.PARAM CentToFar (c)                = '(((c*9)/5)+32)'
.PARAM F(p1,p2)               = 'Log(Cos(p1)*Sin(p2))'
.PARAM SqrdProd (a,b)               = '(a*a)*(b*b)'
```

Example 7

```
* Pre-defined analysis function
.PARAM mcVar = Agauss(1.0,0.1)
```

Example 8

```
.PARAM vtx=OPT1(.7,.3,1.0) uox=OPT1(650,400,900)
```

In this example, `uox` and `vtx` are the variable model parameters, which optimize a model for a selected set of electrical specifications.

The estimated initial value for the `vtx` parameter is 0.7 volts. You can vary this value within the limits of 0.3 and 1.0 volts for the optimization procedure. The optimization parameter reference name (OPT1) references the associated optimization analysis statement (not shown).

Example 9

```
.PARAM fltmod = str('bpfmodel')
s1 n1 n2 n3 n_ref fqmodel=fltmod zo=50 fbase=25e6 fmax=1e9
```

This example shows how you can define and use string parameters.

Description

The `.PARAM` statement defines parameters. Parameters in HSPICE or HSPICE RF are names that have associated numeric values.

A parameter definition in HSPICE or HSPICE RF always uses the last value found in the input netlist (subject to local versus global parameter rules).

Use any of the following methods to define parameters:

- A simple parameter assignment is a constant real number. The parameter keeps this value, unless a later definition changes its value, or an algebraic expression assigns a new value during simulation. HSPICE or HSPICE RF does not warn you if it reassigns a parameter.
- An algebraic parameter (equation) is an algebraic expression of real values, a predefined or user-defined function, or circuit or model values. Enclose a complex expression in single quotes to invoke the algebraic processor, *unless* the expression begins with an alphabetic character and contains no spaces. A simple expression consists of a single parameter name. To use an algebraic expression as an output variable in a `.PRINT`, `.PLOT`, or `.PROBE` statement, use the `PAR` keyword or HSPICE RF (except that you cannot use the `.PLOT` statement in HSPICE RF).
- A user-defined function assignment is similar to an algebraic parameter. HSPICE or HSPICE RF extends the algebraic parameter definition to include function parameters, used in the algebraic that defines the function. You can nest user-defined functions up to three deep.
- A pre-defined analysis function. HSPICE or HSPICE RF provides several specialized analysis types, which require a way to control the analysis:
  - Temperature functions (*fn*)
  - Optimization guess/range

HSPICE also supports the following predefined parameter types, that HSPICE RF does *not* support:

- frequency
- time
- Monte Carlo functions

Argument	Definition
OPTxxx	Optimization parameter reference name. The associated optimization analysis references this name. Must agree with the OPTxxx name in the analysis command associated with an OPTIMIZE keyname.
parameter	Parameter to vary. • Initial value estimate • Lower limit. • Upper limit. If the optimizer does not find the best solution within these constraints, it attempts to find the best solution without constraints.
delta	The final parameter value is the initial guess ± (*n*·delta). If you do not specify *delta*, the final parameter value is between *low_limit* and *upper_limit*. For example, you can use this parameter to optimize transistor drawn widths and lengths, which must be quantized.

.PAT

Syntax

```
.PAT <PatName>=data <RB=val> <R=repeat>

.PAT <patName>=[component 1 ... component n] <RB=val>
+ <R=repeat>
```

Example 1

The following example shows the .PAT command used for a b-string:

```
.PAT a1=b1010 r=1 rb=1
```

Example 2

The following example shows how an existing patname is used to define a new patname:

```
.PAT a1=b1010 r=1 rb=1
.PAT a2=a1
```

Example 3

This example shows a nested structure:

```
.PAT a1=[b1010 r=1 rb=2 b1100]
```

Example 4

This final example shows how a predefined nested structure is used as a component in a new nested structure:

```
.PAT a1=[b1010 r=1 rb=2 b1100] r=1 rb=1
.PAT a2=[a1 b0m0m] r=2 rb=1
```

Description

When the .PAT command is used in an input file, some patnames are predefined and can be used in a pattern source. Patnames can associate a b-string or nested structure (NS), which are two different types of pattern sources. In this case, a b-string is a series of 1, 0, m, and z states. The NS is a combination of a b-string and another NS defined in the .PAT command. The .PAT command can also be used to define a new patname, which can be a b-string or NS.

You should avoid using a predefined patname to define another patname, which creates a circular definition. A circular definition is created when a patname is defined that depends on another patname, which in turn is defined

by the original patname. HSPICE detects circular definitions and issues an error report.

Nested structures must use brackets “[ ]”, but HSPICE does not support using multiple brackets in one statement. If you need to use another nested structure as a component in an NS, define the NS in a new .PAT command.

Argument	Definition
data	String of 1, 0, M, or Z that represents a pattern source. The first letter must be “B,” which represents it as a binary bit stream. This series is called b-string. A 1 represents the high voltage or current value, and a 0 is the low voltage or current value. An m represents the value which is equal to 0.5*(vhi+vlo), and a z represents the high impedance state (only for voltage source).
PatName	Pattern name that has an associated b-string or nested structure.
component	The elements that make up a nested structure. Components can be b-strings or a patnames defined in other .PAT commands.
RB=*val*	Specifies the starting component of a repetition. The repeat data starts from the component or bit indicated by RB. RB must be an integer. If RB is larger than the length of the NS or b-string, an error is issued. If it is less than 1, it is automatically set to 1.
R=*repeat*	Specifies how many times the repeating operation is executed. With no argument, the source repeats from the beginning of the NS or b-string. If R=-1, the repeating operation continues forever. The R must be an integer. If it is less than -1, it automatically set to 0.

.PKG

Syntax

```
.PKG pkgname
+file= 'pkgfilename'
+model= 'pkgmodelname'
```

Example 1

```
.pkg p_test
+ file='processor_clk_ff.ibs'
+ model='FCPGA_FF_PKG'
```

Example 2

The following example shows how pin1 is referenced:

```
p_test_pin1_dia and p_test_pin1
```

The element name becomes:

```
w_p_test_pin1_?? or r_p_test_pin1_?? ...
```

Description

The .PKG command provides the IBIS(V 3.2) Package Model feature. It supports both sections and matrixes.

The .PKG command automatically creates a series of elements (W or rlc). The following nodes are referenced in the netlist:

- Nodes on the die side:

  *'pkgname'_'pinname'*_dia

- Nodes on the pin side:

  'pkgname'_'pinname'

See Example 2 for how pin1 is referenced.

Argument	Definition
pkgname	package card name

Argument	Definition
pkgfilename	name of a .pkg or .ibs file that contains package models.
pkgmodelname	working model in the .pkg file

See Also

.EBD
.IBIS

.PLOT

Note: This is an obsolete command. You can gain the same functionality by using the .PRINT command.

Syntax

```
.PLOT antype ov1 <(plo1,phi1)> <ov2> <(plo2,phi2)> ...>
```

Example 1

```
.PLOT DC V(4) V(5) V(1) PAR(`I1(Q1)/I2(Q1)')
.PLOT TRAN V(17,5) (2,5) I(VIN) V(17) (1,9)
.PLOT AC VM(5) VM(31,24) VDB(5) VP(5) INOISE
```

- In the first line, PAR plots the ratio of the collector current and the base current for the Q1 transistor.
- In the second line, the VDB output variable plots the AC analysis results (in decibels) for node 5.
- In the third line, the AC plot can include NOISE results and other variables that you specify.

Example 2

```
.PLOT AC ZIN YOUT(P) S11(DB) S12(M) Z11(R)
.PLOT DISTO HD2 HD3(R) SIM2
.PLOT TRAN V(5,3) V(4) (0,5) V(7) (0,10)
.PLOT DC V(1) V(2) (0,0) V(3) V(4) (0,5)
```

In the last line above, HSPICE sets the plot limits for V(1) and V(2), but you specify 0 and 5 volts as the plot limits for V(3) and V(4).

Description

The .PLOT statement plots the output values of one or more variables in a selected HSPICE analysis. Each .PLOT statement defines the contents of one plot, which can contain more than one output variable.

If more than one output variable appears on the same plot, HSPICE prints *and* plots the first variable specified. To print out more than one variable, include another .PLOT statement.

You can include wildcards in .PLOT statements (HSPICE only).

Argument	Definition
antype	Type of analysis for the specified plots. Analysis types are: DC, AC, TRAN, NOISE, or DISTO.
ov1 …	Output variables to plot: voltage, current, or element template variables (HSPICE only; HSPICE RF does not support element template output or .PLOT statements), from a DC, AC, TRAN, NOISE, or DISTO analysis. See the next sections for syntax.
plo1, phi1 …	Lower and upper plot limits. The plot for each output variable uses the first set of plot limits, after the output variable name. Set a new plot limit for each output variable, after the first plot limit. For example to plot all output variables that use the same scale, specify one set of plot limits at the end of the .PLOT statement. If you set the plot limits to (0,0) HSPICE automatically sets the plot limits.

See Also

.AC
.DOUT
.GRAPH
.MEASURE
.PRINT
.PROBE
.STIM

.PRINT

Syntax

```
.PRINT antype ov1 <ov2 … >
```

Example 1

```
* CASE 1
.print v(din) i(mxn18)
.dc vdin 0 5.0 0.05
.tran 1ns 60ns
* CASE 2
.dc vdin 0 5.0 0.05
.tran 1ns 60ns
.print v(din) i(mxn18)
* CASE 3
.dc vdin 0 5.0 0.05
.print v(din) i(mxn18)
.tran 1ns 60ns
```

- If you replace the .PRINT statement with:

  ```
  .print TRAN v(din) i(mnx)
  ```

  then all three cases have identical .sw0 and .tr0 files.

- If you replace the .print statement with:

  ```
  .print DC v(din) i(mnx)
  ```

  then the .sw0 and .tr0 files are different.

Example 2

```
.PRINT TRAN V (4) I(VIN) PAR(`V(OUT)/V(IN)')
```

This example prints the results of a transient analysis for the nodal voltage named 4. It also prints the current through the voltage source named VIN. It also prints the ratio of the nodal voltage at the OUT and IN nodes.

Example 3

```
.PRINT AC VM(4,2) VR(7) VP(8,3) II(R1)
```

- Depending on the value of the ACOUT option, VM(4,2) prints the AC magnitude of the voltage difference, or the difference of the voltage magnitudes, between nodes 4 and 2.
- VR(7) prints the real part of the AC voltage, between node 7 and ground.

- Depending on the ACOUT value, VP(8,3) prints the phase of the voltage difference between nodes 8 and 3, or the difference of the phase of voltage at node 8 and voltage at node 3.
- II(R1) prints the imaginary part of the current, through R1.

Example 4

```
.PRINT AC ZIN YOUT(P) S11(DB) S12(M) Z11(R)
```

This example prints:

- The magnitude of the input impedance.
- The phase of the output admittance.
- Several S and Z parameters.

This statement accompanies a network analysis by using the `.AC` and `.NET` analysis statements.

Example 5

```
.PRINT DC V(2) I(VSRC) V(23,17) I1(R1) I1(M1)
```

This example prints the DC analysis results for several different nodal voltages and currents, through:

- The resistor named R1.
- The voltage source named VSRC.
- The drain-to-source current of the MOSFET named M1.

Example 6

```
.PRINT NOISE INOISE
```

This example prints the equivalent input noise.

Example 7

```
.PRINT DISTO HD3 SIM2(DB)
```

This example prints the magnitude of third-order harmonic distortion, and the decibel value of the intermodulation distortion sum, through the load resistor that you specify in the `.DISTO` statement (HSPICE only; not supported in HSPICE RF).

Example 8

```
.PRINT AC INOISE ONOISE VM(OUT) HD3
```

This statement includes NOISE, DISTO, and AC output variables in the same .PRINT statement in HSPICE. HSPICE RF supports NOISE and AC analysis, but not DISTO.

Example 9

```
.PRINT pj1 = par(‘p(rd) +p(rs)‘)
```

This statement prints the value of pj1 with the specified function.

HSPICE or HSPICE RF ignores .PRINT statement references to nonexistent netlist part names, and prints those names in a warning.

Example 10

Derivative function:

```
.PRINT der=deriv('v(NodeX)')
```

Integrate function:

```
.PRINT int = integ('v(NodeX)')
```

The parameter can be a node voltage, or a reasonable expression.

Example 11

```
.print p1 = 3
.print p2 = par("p1*5")
```

You can use p1 and p2 as parameters in netlist. The p1 value is 3; the p2 value is 15.

Description

The .PRINT statement specifies output variables for which HSPICE or HSPICE RF prints values. You can include wildcards in .PRINT statements.

You can also use the iall keyword in a .PRINT statement to print all branch currents of all diode, BJT, JFET, or MOSFET elements in your circuit design.

Argument	Definition
antype	Type of analysis for outputs. Antype is one of the following types: DC, AC, TRAN, NOISE, or DISTO (you cannot run DISTO analysis in HSPICE RF).
ov1 …	Output variables to print. These are voltage, current, or element template (HSPICE only; HSPICE RF does not support element template output) variables, from a DC, AC, TRAN, NOISE, or DISTO analysis (you cannot run DISTO analysis in HSPICE RF).

See Also

.AC
.DC
.OPTION ACOUT
.DISTO
.DOUT
.GRAPH
.MEASURE
.NOISE
.PLOT
.PROBE
.STIM
.TRAN

.PROBE

Syntax

```
.PROBE antype ov1 <ov2 ...>
```

Example 1

```
.PROBE DC V(4) V(5) V(1) beta = PAR(`I1(Q1)/I2(Q1)')
```

Example 2

```
* Derivative function
.PROBE der=deriv('v(NodeX)')
* Integrate function
.PROBE int = integ('v(NodeX)')
```

Description

The .PROBE statement saves output variables into interface and graph data files.The parameter can be a node voltage, or a reasonable expression. You can include wildcards in .PROBE statements.

Argument	Definition
antype	Type of analysis for the specified plots. Analysis types are: DC, AC, TRAN, NOISE, or DISTO (you cannot run DISTO analysis in HSPICE RF).
ov1 …	Output variables to plot: voltage, current, or element template (HSPICE only; HSPICE RF does not support element template output) variables from a DC, DCMATCH, AC, TRAN, NOISE, or DISTO analysis (you cannot run DISTO analysis in HSPICE RF). .PROBE can include more than one output variable.

See Also

.AC
.DC
.DCMATCH
.DISTO
.DOUT
.GRAPH
.MEASURE
.NOISE
.PLOT
.PRINT
.STIM
.TRAN

.PROTECT

Syntax

```
.PROTECT
```

Description

The .PROTECT statement keeps models and cell libraries private. HSPICE RF does not support the .PROTECT statement.

- The .PROTECT statement suppresses printing text from the list file, such as when you use the BRIEF option.
- The .UNPROTECT command restores normal output functions.
- Any elements and models located between a .PROTECT and an .UNPROTECT statement, inhibit the element and model listing from the LIST option.
- The .OPTION NODE nodal cross reference, and the .OP operating point printout, do not list any nodes that are contained within the .PROTECT and .UNPROTECT statements.

See Also

.UNPROTECT

.PZ

Syntax

```
.PZ output input

.PZ ov srcname
```

Example

```
.PZ   V(10)   VIN
.PZ   I(RL)   ISORC
```

- In the first pole/zero analysis, the output is the voltage for node 10, and the input is the `VIN` independent voltage source.
- In the second pole/zero analysis, the output is the branch current for the RL branch, and the input is the `ISORC` independent current source.

Description

The `.PZ` command performs pole/zero analysis (you do not need to specify `.OP`, because the simulator automatically invokes an operating point calculation). See “Pole/Zero Analysis” in the *HSPICE Applications Manual* for complete information about pole/zero analysis.

For a description of pole/zero options, see Chapter 3, Options in HSPICE Netlists.

.

Argument	Definition
input	Input source. Can be the name of any independent voltage or current source.
output	Output variables, which can be: • Any node voltage, V(*n*). • Any branch current, I(*branch_name*).

Argument	Definition
ov	Output variable: • a node voltage V(*n*), or • a branch current I(*element*)
srcnam	Input source: • an independent voltage or • a current source name

See Also

.DC

.SAMPLE

Syntax

```
.SAMPLE FS = freq <TOL = val> <NUMF = val>
+ <MAXFLD = val> <BETA = val>
```

Description

To acquire data from analog signals, use the `.SAMPLE` statement with the `.NOISE` and `.AC` statements to analyze data sampling noise in HSPICE or HSPICE RF. The SAMPLE analysis performs a noise-folding analysis, at the output node.

.

Argument	Definition
FS = freq	Sample frequency in hertz.
TOL	Sampling-error tolerance: the ratio of the noise power (in the highest folding interval) to the noise power (in baseband). Default = 1.0e-3.
NUMF	Maximum number of frequencies that you can specify. The algorithm requires about ten times this number of internally-generated frequencies so keep this value small. Default = 100.
MAXFLD	Maximum number of folding intervals (default = 10.0). The highest frequency (in hertz) that you can specify is: FMAX = MAXFLD · FS
BETA	Optional noise integrator (duty cycle), at the sampling node: • BETA = 0 no integrator • BETA = 1 simple integrator (default) If you clock the integrator (integrates during a fraction of the 1/FS sampling interval), then set BETA to the duty cycle of the integrator.

See Also

.AC
.NOISE

.SAVE

Syntax

```
.SAVE <TYPE = type_keyword> <FILE = save_file>
+ <LEVEL = level_keyword> <TIME = save_time>
```

Example

```
.TEMP -25 0 25
.SAVE TYPE=NODESET FILE=my_design.ic0 LEVEL=ALL
+ TIME=0
```

This example saves the operating point corresponding to `.TEMP -25` to a file named *my_design.ic0*.

Description

The `.SAVE` statement in HSPICE stores the operating point of a circuit in a file that you specify. HSPICE RF does not support the `.SAVE` statement. For quick DC convergence in subsequent simulations, use the `.LOAD` statement to input the contents of this file. HSPICE saves the operating point by default, even if the HSPICE input file does not contain a `.SAVE` statement. To not save the operating point, specify `.SAVE LEVEL = NONE`.

You can save the operating point data as either an `.IC` or a `.NODESET` statement.

A parameter or temperature sweep saves only the first operating point.

.

Argument	Definition
type_keyword	Storage method for saving the operating point. The type can be one of the following. Default is NODESET. • `.NODESET`: Stores the operating point as a .NODESET statement. Later simulations initialize all node voltages to these values, if you use the .LOAD statement. If circuit conditions change incrementally, DC converges within a few iterations. • `.IC`: Stores the operating point as a .IC statement. Later simulations initialize node voltages to these values if the netlist includes the `.LOAD` statements.
save_file	Name of the file that stores DC operating point data. The file name format is <*design*>.ic#. Default is <*design*>.ic0.

Argument	Definition
level_keyword	Circuit level, at which you save the operating point. The level can be one of the following. • ALL (default): Saves all nodes, from the top to the lowest circuit level. This option offers the greatest improvement in simulation time. • TOP: Saves only nodes in the top-level design. Does not save subcircuit nodes. • NONE: Does not save the operating point.
save_time	Time during transient analysis when HSPICE saves the operating point. HSPICE requires a valid transient analysis statement to save a DC operating point. Default = 0.

See Also

.IC
.LOAD
.NODESET

.SENS

Syntax

```
.SENS ov1 <ov2 ...>
```

Example

```
.SENS V(9) V(4,3) V(17) I(VCC)
```

Description

The .SENS command obtains DC small-signal sensitivities of output variables for circuit parameters. You can use this command HSPICE, but not in HSPICE RF.

If the input file includes a .SENS statement, HSPICE determines DC small-signal sensitivities for each specified output variable, relative to every circuit parameter. The sensitivity measurement is the partial derivative of each output variable for a specified circuit element, measured at the operating point, and normalized to the total change in output magnitude. Therefore, the sum of the sensitivities of all elements is 100%. DC small-signal sensitivities are calculated for:

- resistors
- voltage sources
- current sources
- diodes
- BJTs (including Level 4, the VBIC95 model)
- MOSFETs (Level49 and Level53, Version=3.22).

You can perform only one .SENS analysis per simulation. Only the last .SENS statement is used in case more than one in present. The others are discarded with warnings.

The amount of output generated from a .SENS analysis is dependent on the size of the circuit.

.

Argument	Definition
ov1 ov2 ...	Branch currents, or nodal voltage for DC component-sensitivity analysis

See Also

.DC

.SHAPE

Syntax

```
.SHAPE sname Shape_Descriptor
```

Description

Use the .SHAPE statement to define a shape. The Field Solver uses the shape to describe a cross-section of the conductor.

Argument	Definition
sname	Shape name.
Shape_Descriptor	One of the following: • Rectangle • Circle • Strip • Polygon

See Also

.FSOPTIONS
.LAYERSTACK
.MATERIAL

.SHAPE (Defining Rectangles)

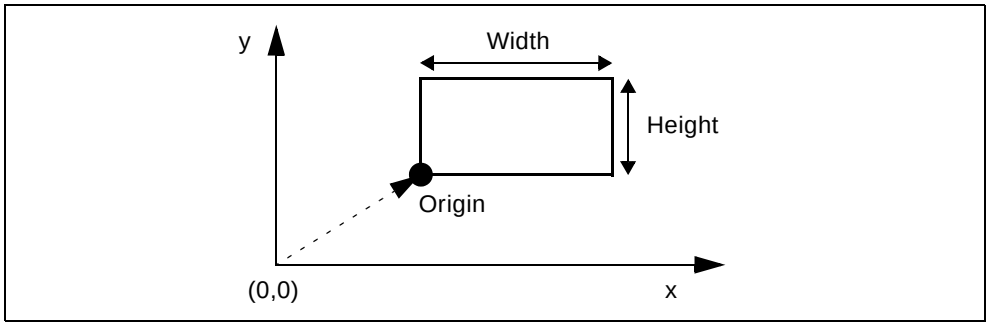
Syntax

```
.SHAPE RECTANGLE WIDTH=val HEIGHT=val <NW=val>
+ <NH=val>
```

Description

Use the RECTANGLE option to define a rectangle. Normally, you do not need to specify the NW and NH values because the field solver automatically sets these values, depending on the *accuracy* mode. You can specify both values, or specify only one of these values and let the solver determine the other.

Figure 3 Coordinates of a Rectangle



Argument	Definition
WIDTH	Width of the rectangle (size in the *x*-direction).
HEIGHT	Height of the rectangle (size in the *y*-direction).
NW	Number of horizontal (x) segments in a rectangle with a specified width.
NH	Number of vertical (y) segments in a rectangle with a specified height.

.SHAPE (Defining Circles)

Syntax

```
.SHAPE CIRCLE RADIUS=val <N=val>
```

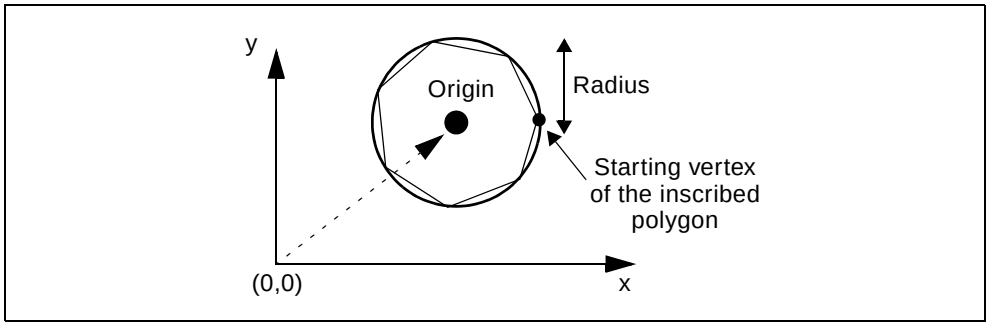
Description

The CIRCLE option to defines a circle in the Field Solver. The Field Solver approximates a circle as an inscribed regular polygon with *N* edges. The more edges, the more accurate the circle approximation is.

Do not use the CIRCLE descriptor to model actual polygons; instead use the POLYGON descriptor.

Normally, you do not need to specify the N value, because the field solver automatically sets this value, depending on the *accuracy* mode. But you can specify this value if you need to

Figure 4 Coordinates of a Circle



Argument	Definition
RADIUS	Radius of the circle.
N	Number of segments to approximate a circle with a specified radius.

.SHAPE (Defining Polygons)

Syntax

```
.SHAPE POLYGON VERTEX=(x1 y1 x2 y2 ...)
+ <N=(n1,n2,...)>
```

Example 1

The following rectangular polygon uses the default number of segments:

```
.SHAPE POLYGON VERTEX=(1 10 1 11 5 11 5 10)
```

Example 2

The following rectangular polygon uses five segments for each edge:

```
.SHAPE POLYGON VERTEX=(1 10 1 11 5 11 5 10)
+ N=5
```

Example 3

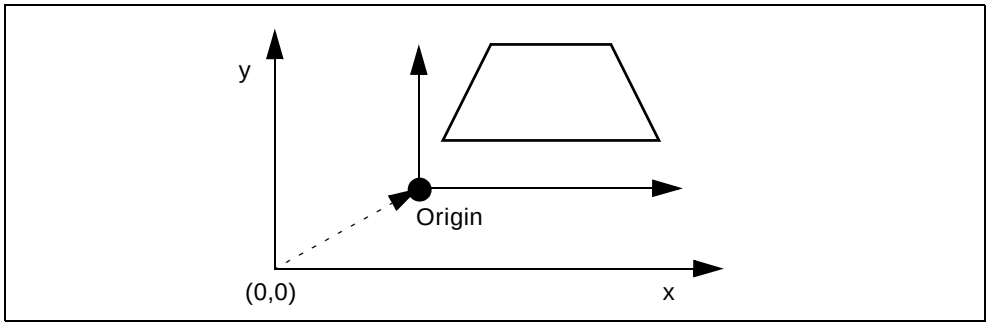
Rectangular polygon by using the different number of segments for each edge:

```
.SHAPE POLYGON VERTEX=(1 10 1 11 5 11 5 10)
+ N=(5 3 5 3)
```

Description

The `.SHAPE POLYGON` command option defines a polygon in a Field Solver. The specified coordinates are within the local coordinate with respect to the origin of a conductor.

Figure 5 Coordinates of a Polygon



Argument	Definition
VERTEX	(*x*, *y*) coordinates of vertices. Listed either in clockwise or counter-clockwise direction.
N	Number of segments that define the polygon with the specified *X* and *Y* coordinates. You can specify a different *N* value for each edge. If you specify only one *N* value, then the Field Solver uses this value for *all* edges. For example, the first value of *N, n1*, corresponds to the number of segments for the edge from (*x1 y1*) to (*x2 y2*).

.SHAPE (Defining Strip Polygons)

Syntax

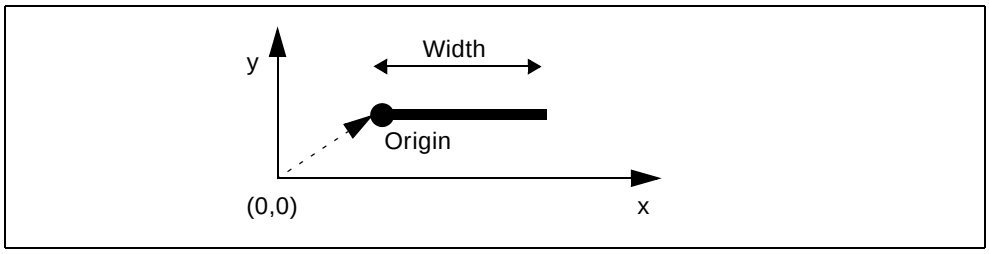
```
.SHAPE STRIP WIDTH=val <N=val>
```

Description

Normally, you do not need to specify the `N` value, because the field solver automatically sets this value, depending on the *accuracy* mode. But you can specify this value if you need to.

The field solver (filament method) does not support this shape.

Figure 6 Coordinates of a Strip Polygon



Argument	Definition
WIDTH	Width of the strip (size in the *x*-direction).
N	Number of segments that define the strip shape with the specified width.

.STIM

Syntax

General

```
.STIM <tran|ac|dc> PWL|DATA|VEC
+ <filename=output_filename> ...
```

PWL Source (Transient Analysis Only)

```
.STIM   [tran] PWL [filename=output_filename]
+   [name1=] ovar1 [node1=n+] [node2=n-]
+   [[name2=]ovar2 [node1=n+] [node2=n-] ...]
+   [from=val] [to=val] [npoints=val]

.STIM   [tran] PWL [filename=output_filename]
+   [name1=] ovar1 [node1=n+] [node2=n-]
+   [[name2=]ovar2 [node1=n+] [node2=n-] ...]
+   indepvar=[(]t1 [t2 ...[)]]
```

Data Card

```
.STIM   [tran | ac | dc] DATA [filename=output_filename]
+   dataname [name1=] ovar1
+   [[name2=]ovar2 ...] [from= val] [to=val]
+   [npoints=val] [indepout=val]

.STIM   [tran | ac | dc] DATA [filename=output_filename]
+   dataname [name1=] ovar1
+   [[name2=]ovar2 ...] indepvar=[(]t1 [t2 ...[)]]
+   [indepout=val]
```

Digital Vector File (Transient Analysis Only)

```
.STIM [tran] VEC [filename=output_filename]
+   vth=val vtl=val [voh=val] [vol=val]
+ [name1=] ovar1 [[name2=] ovar2 ...]
+ [from=val] [to=val] [npoints=val]

.STIM [tran] VEC [filename=output_filename]
+   vth=val vtl=val [voh=val] [vol=val]
+ [name1=] ovar1 [[name2=] ovar2 ...]
+ indepvar=[(]t1 [t2 ...[)]]
```

Description

You can use the `.STIM` statement to reuse the results (output) of one simulation as input stimuli in a new simulation.

The `.STIM` statement specifies:

- Expected stimulus (PWL Source, DATA CARD, or VEC FILE).
- Signals to transform.
- Independent variables.

One `.STIM` statement produces one corresponding output file.

PWL Source (Transient Analysis Only):

Argument	Definition
tran	Transient simulation.
filename	Output file name. If you do not specify a file, HSPICE uses the input filename.
namei	PWL Source Name that you specify. The name must start with V (for a voltage source) or I (for a current source).
ovar1	Output variable that you specify. *ovar* can be: • Node voltage. • Element current. • Parameter string. If you use a parameter string, you must specify *name1*. You cannot use character strings as parameter values in HSPICE RF. For example: v(1), i(r1), v(2,1), par('v(1)+v(2)')
node1	Positive terminal node name.
node2	Negative terminal node name.
from	Specifies the time to start output of simulation results. For transient analysis, uses the time units that you specified.
npoints	Number of output time points.

Argument	Definition
to	Specifies the time to end output of simulation results. For transient analysis, uses the time units that you specified. The *from* value can be greater than the *to* value.
indepvar	Specifies dispersed (independent-variable) time points. You must specify dispersed time points in *increasing* order.

Data Card:

Argument	Definition
tran | ac | dc	Selects the simulation type: transient, AC, or DC.
filename	Output file name. If you do not specify a file, HSPICE uses the input filename.
dataname	Name of the data card to generate.
from	Specifies the time to start output of simulation results. For transient analysis, uses the time units that you specified.
to	Specifies the time to end output of simulation results. For transient analysis, uses the time units that you specified.
namei	Name of a parameter of the data card to generate.
npoints	Number of output independent-variable points.
indepvar	Specifies dispersed independent-variable points.
indepout	Indicates whether to generate the independent variable column. • indepout, indepout = 1, or on, produces the independent variable column. You can specify the independent-variables in any order. • indepout= 0 or off (default) does not create an independent variable column. You can place the indepout field anywhere after the ovar1 field.

Argument	Definition
ovari	Output variable that you specify. *ovar* can be: • Node voltage. • Element current. • Element templates (HSPICE only). • Parameter string. You cannot use character strings as parameter values in HSPICE RF. For example: v(1), i(r1), v(2,1), par('v(1)+v(2)'), LX1(m1), LX2(m1)

Digital Vector File (Transient Analysis Only):

Argument	Definition
namei	Signal name that you specify.
filename	Output file name. If you do not specify a file, HSPICE uses the input filename.
ovari	Output variable that you specify. *ovar* can only be a node voltage.
from	Specifies the time to start output of simulation results. For transient analysis, uses the time units that you specified.
to	Time to the end output of simulation results. For transient analysis, uses the specified time units.The *from* value can be greater than the *to* value.
npoints	Number of output time points.
indepvar	Specifies dispersed independent-variable points. You must specify dispersed time points in *increasing* order.
vth	High voltage threshold.
vtl	Low voltage threshold.
voh	Logic-high voltage for each output signal.
vol	Logic-low voltage for each output signal.

See Also

.DOUT
.GRAPH
.MEASURE
.PLOT
.PRINT
.PROBE

.SUBCKT

In HSPICE RF, you cannot replicate output commands within subcircuit (subckt) definitions.

Syntax

```
.SUBCKT subnam n1 <n2 n3 …> <parnam = val>
.ENDS

.SUBCKT <SubName><PinList>[<SubDefaultsList>]
.ENDS

.SUBCKT subnam n1 <n2 n3 …> <param=str('string')>
.ENDS
```

Example 1

```
*FILE SUB2.SP TEST OF SUBCIRCUITS
.OPTION LIST ACCT
   V1 1 0 1
.PARAM P5 = 5 P2 = 10
.SUBCKT SUB1 1 2 P4 = 4
   R1 1 0 P4
   R2 2 0 P5
   X1 1 2 SUB2 P6 = 7
   X2 1 2 SUB2
.ENDS
*
.MACRO SUB2 1 2 P6 = 11
   R1 1 2 P6
   R2 2 0 P2
.EOM
   X1 1 2 SUB1 P4 = 6
   X2 3 4 SUB1 P6 = 15
   X3 3 4 SUB2
*
.MODEL DA D CJA = CAJA CJP = CAJP VRB = -20
   IS = 7.62E-18
+   PHI = .5 EXA = .5 EXP = .33
.PARAM CAJA = 2.535E-16 CAJP = 2.53E-16
.END
```

The preceding example defines two subcircuits: SUB1 and SUB2. These are resistor-divider networks, whose resistance values are parameters (variables). The X1, X2, and X3 statements call these subcircuits. Because the resistor values are different in each call, these three calls produce different subcircuits.

Example 2

```
.SUBCKT Inv a y Strength = 3
   Mp1 <MosPinList> pMosMod L = 1.2u
   W = ’Strength * 2u’
   Mn1 <MosPinList> nMosMod L = 1.2u
   W = ’Strength * 1u’
.ENDS
...
xInv0 a y0 Inv   $ Default devices: p device = 6u,
      $ n device = 3u
xInv1 a y1 Inv Strength = 5   $ p device = 10u,
   n device = 5u
xInv2 a y2 Inv Strength = 1   $ p device =  2u,
   n device = 1u
...
```

This example implements an inverter that uses a *Strength* parameter. By default, the inverter can drive three devices. Enter a new value for the *Strength* parameter in the element line to select larger or smaller inverters for the application.

Example 3

```
* Using string parameters
.subckt IBIS vccq vss out in
+ IBIS_FILE=str('file.ibs')
+ IBIS_MODEL=str('ibis_model')
ven en 0 vcc
B1 vccq vss out in en v0dq0 vccq vss
+ file= str(IBIS_FILE) model=str(IBIS_MODEL)
.ends
```

This example implements an IBIS model that uses string parameters to specify the IBIS file name and IBIS model name.

Description

You can create a subcircuit description for a commonly-used circuit, and include one or more references to the subcircuit in your netlist.

To define a subcircuit in your netlist, use the .SUBCKT statement.

When you use hierarchical subcircuits, you can pick default values for circuit elements in a .SUBCKT command. You can use this feature in cell definitions to simulate the circuit with typical values.

Use the .ENDS statement to terminate a .SUBCKT statement.

Argument	Definition
subnam	Specifies a reference name for the subcircuit model call.
n1 …	Node numbers for external reference; cannot be the ground node (zero). Any element nodes that are in the subcircuit, but are not in this list, are strictly local with three exceptions: • Ground node (zero). • Nodes assigned using BULK = node in MOSFET or BJT models. • Nodes assigned using the .GLOBAL statement.
parnam	A parameter name set to a value. Use only in the subcircuit. To override this value, assign it in the subcircuit call, or set a value in a .PARAM statement.
SubDefaultsList	*<SubParam1>=<Expression>* [*<SubParam2>=<Expression>*...]

See Also

.ENDS
.EOM
.MACRO
.MODEL.MODEL
.OPTION LIST
.PARAM

.TEMP

Syntax

```
.TEMP t1 <t2 <t3 ...>>
```

Example 1

```
.TEMP -55.0 25.0 125.0
```

The .TEMP statement sets the circuit temperatures for the entire circuit simulation. To simulate the circuit by using individual elements or model temperatures, HSPICE or HSPICE RF uses:

- Temperature as set in the .TEMP statement.
- .OPTION TNOM setting (or the TREF model parameter).
- DTEMP element temperature.

Example 2

```
.TEMP 100
D1 N1 N2 DMOD DTEMP=30
D2 NA NC DMOD
R1 NP NN 100 TC1=1 DTEMP=-30
.MODEL DMOD D IS=1E-15 VJ=0.6 CJA=1.2E-13
+ CJP=1.3E-14 TREF=60.0
```

In this example:

- The .TEMP statement sets the circuit simulation temperature to 100°C.
- You do not specify .OPTION TNOM so it defaults to 25°C.
- The temperature of the diode is 30°C above the circuit temperature as set in the DTEMP parameter.

That is:

- D1temp = 100°C + 30°C = 130°C.
- HSPICE or HSPICE RF simulates the D2 diode at 100°C.
- R1 simulates at 70°C.

Because the diode model statement specifies TREF at 60°C, HSPICE or HSPICE RF derates the specified model parameters by:

- 70°C (130°C - 60°C) for the D1 diode.
- 40°C (100°C - 60°C) for the D2 diode.
- 45°C (70°C - TNOM) for the R1 resistor.

Description

To specify the circuit temperature for an HSPICE or HSPICE RF simulation, use the .TEMP statement, or the TEMP parameter in the .DC, .AC, and .TRAN statements. HSPICE compares the circuit simulation temperature against the reference temperature in the .OPTION TNOM control. HSPICE or HSPICE RF uses the difference between the circuit simulation temperature and the TNOM reference temperature to define derating factors for component values.

In HSPICE RF, you can use multiple .TEMP statements to specify multiple temperatures for different portions of the circuit. HSPICE permits only one temperature for the entire circuit. Multiple definitions of the .TEMP statements in a circuit behave as a sweep function.

Note: HSPICE allows multiple .TEMP statements in the netlist, and performs multiple DC, AC or TRAN analyses for each temperature. Do not set the temperature to the same value multiple times.

Argument	Definition
t1 t2	Temperatures in ×C, at which HSPICE or HSPICE RF simulates the circuit.

See Also

.AC
.DC
.TEMP
.OPTION TNOM
.TRAN

.TF

Syntax

```
.TF ov srcnam
```

Example

```
.TF V(5,3) VIN
.TF I(VLOAD) VIN
```

For the first example, HSPICE or HSPICE RF computes the ratio of V(5,3) to VIN. This is the ratio of small-signal input resistance at VIN to the small-signal output resistance (measured across nodes 5 and 3). If you specify more than one .TF statement in a single simulation, HSPICE or HSPICE RF runs only the last .TF statement.

Description

The transfer function statement (.TF) calculates DC small-signal values for transfer functions (ratio of output variable to input source). You do not need to specify .OP.

The .TF statement defines small-signal output and input for DC small-signal analysis. When you use the .TF statement, HSPICE or HSPICE RF computes:

- DC small-signal value of the transfer function (output/input),.
- Input resistance.
- Output resistance.

.

Argument	Definition
ov	Small-signal output variable.
srcnam	Small-signal input source.

See Also

.DC

.TITLE

Syntax

```
.TITLE <string_of_up_to_72_characters>
```

or

```
<string_of_up_to_72_characters>
```

Example

```
.TITLE my-design_netlist
```

Description

You set the simulation title in the first line of the input file. HSPICE or HSPICE RF always reads this line, and uses it as the title of the simulation, regardless of the line's contents. The simulation prints the title verbatim in each section heading of the output listing file.

To set the title, you can place a `.TITLE` statement on the first line of the netlist. However, HSPICE or HSPICE RF does not *require* the `.TITLE` syntax.

In the second form of the syntax, the string is the first line of the input file. The first line of the input file is always the implicit title. If any statement appears as the first line in a file, simulation interprets it as a title, and does not execute it.

An `.ALTER` statement does not support using the `.TITLE` statement. To change a title for a `.ALTER` statement, place the title content in the `.ALTER` statement itself.

Argument	Definition
string	Any character string up to 72 characters long.

.TRAN

Syntax

Single-Point Analysis

```
.TRAN tincr1 tstop1 <tincr2 tstop2 ...tincrN tstopN>
+ <START = val> <UIC>
```

Double-Point Analysis

```
.TRAN tincr1 tstop1 <tincr2 tstop2 ...tincrN tstopN>
+ <START = val> <UIC>
+ <SWEEP var type np pstart pstop>

.TRAN tincr1 tstop1 <tincr2 tstop2 ...tincrN tstopN>
+ <START = val> <UIC>
+ <SWEEP var START="param_expr1"
+ STOP="param_expr2"
+ STEP="param_expr3">

.TRAN tincr1 tstop1 <tincr2 tstop2 ... tincrN tstopN>
+ <START=val> <UIC>
+ <SWEEP var start_expr stop_expr step_expr>
```

In HSPICE RF, you can run a parameter sweep around a single analysis, but the parameter sweep cannot change any `.OPTION` value.

Data-Driven Sweep

```
.TRAN DATA = datanm (HSPICE only; HSPICE RF does not support
the .TRAN DATA statement)

.TRAN tincr1 tstop1 <tincr2 tstop2 ...tincrN tstopN>
+ <START = val> <UIC> <SWEEP DATA = datanm>

.TRAN DATA = datanm<SWEEP var type np pstart pstop>(HSPICE
only; HSPICE RF does not support the .TRAN DATA statement)

.TRAN DATA=datanm <SWEEP var START="param_expr1"
+STOP="param_expr2" STEP="param_expr3">

.TRAN DATA=datanm
+ <SWEEP var start_expr stop_expr step_expr>
```

HSPICE RF supports the data-driven syntax only for parameter sweeps:

```
.tran AB sweepdata=name
```

Monte Carlo Analysis

```
.TRAN tincr1 tstop1 <tincr2 tstop2 ...tincrN tstopN>
+ <START = val> <UIC> <SWEEP MONTE = list<(>
+ <num1:num2> <num3> <num5:num6> <num7> <)> >
```

Optimization

```
.TRAN DATA = datanm OPTIMIZE = opt_par_fun
+ RESULTS = measnames MODEL = optmod
```

```
.TRAN  <DATA=filename> SWEEP OPTIMIZE=OPTxxx
+ RESULTS=ierr1 ... ierrn MODEL=optmod
```

Example 1

```
.TRAN 1NS 100NS
```

This example performs and prints the transient analysis, every 1 ns for 100 ns.

Example 2

```
.TRAN .1NS 25NS 1NS 40NS START = 10NS
```

This example performs the calculation every 0.1 ns for the first 25 ns; and then every 1 ns, until 40 ns. Printing and plotting begin at 10 ns.

Example 3

```
.TRAN 10NS 1US UIC
```

This example performs the calculation every 10 ns for 1 µs. This example bypasses the initial DC operating point calculation. It uses the nodal voltages, specified in the `.IC` statement (or by `IC` parameters in element statements) to calculate the initial conditions.

Example 4

```
.TRAN 10NS 1US UIC SWEEP TEMP -55 75 10
```

This example increases the temperature by 10 °C, through the range -55 °C to 75 °C. It also performs transient analysis for each temperature.

Example 5

```
.TRAN 10NS 1US SWEEP load POI 3 1pf 5pf 10pf
```

This example analyzes each load parameter value, at 1 pF, 5 pF, and 10 pF.

Example 6

```
.TRAN data = dataname
```

This example is a data-driven time sweep. It uses a data file as the sweep input. If the parameters in the data statement are controlling sources, then a piecewise linear specification must reference them.

Example 7

```
.TRAN 10NS 1US SWEEP MONTE = 10 firstrun = 11
```

This example performs the calculation every `10ns` for `1us`, from the 11th to 20th Monte Carlo trials.

Example 8

```
.TRAN 10NS 1US SWEEP MONTE = list(10 20:30 35:40 50)
```

This example performs the calculation every `10ns` for `1us`, at the 10th trial, then from the 20th to the 30th trial, followed by the 35th to the 40th trial, and finally at the 50th Monte Carlo trial.

Description

`.TRAN` starts a transient analysis, which simulates a circuit at a specific time.

Argument	Definition
DATA = datanm	Data name, referenced in the `.TRAN` statement (HSPICE only; not supported in HSPICE RF).
MONTE = val	Produces a specified number (*val*) of randomly-generated values. HSPICE uses them to select parameters from a *Gaussian*, *Uniform*, or *Random Limit* distribution (HSPICE only; not supported in HSPICE RF).
np	Number of points, or number of points per decade or octave, depending on what keyword precedes it.
param_expr...	Expressions you specify: *param_expr1...param_exprN*.

Argument	Definition
pincr	Voltage, current, element, or model parameter; or any temperature increment value. If you set the *type* variation, use *np* (number of points), not *pincr*.
pstart	Starting voltage, current, or temperature; or any element or model parameter value. If you set the *type* variation to POI (list of points), use a list of parameter values, instead of *pstart pstop.*
pstop	Final voltage, current, or temperature; or element or model parameter value.
START	Time when printing or plotting begins. The START keyword is optional: you can specify a start time without the keyword. If you use .TRAN with .MEASURE, a non-zero START time can cause incorrect .MEASURE results. Do not use non-zero START times in .TRAN statements when you also use .MEASURE.
SWEEP	Indicates that .TRAN specifies a second sweep.
tincr1…	Specifies the printing or plotting increment for printer output, and the suggested computing increment for post-processing.
tstop1…	Time when a transient analysis stops incrementing by the first specified time increment (*tincr1*). If another tincr-tstop pair follows, analysis continues with a new increment.
UIC	Uses the nodal voltages specified in the .IC statement (or in the *IC* = parameters of the various element statements) to calculate initial transient conditions, rather than solving for the quiescent operating point.
type	Specifies any of the following keywords: • DEC – decade variation. • OCT – octave variation (the value of the designated variable is eight times its previous value). • LIN – linear variation. • POI – list of points.

Argument	Definition
var	Name of an independent voltage or current source, any element or model parameter, or the TEMP keyword (indicating a temperature sweep). You can use a source value sweep, referring to the source name (SPICE style). However, if you specify a parameter sweep, a .DATA statement, and a temperature sweep, you must choose a parameter name for the source value, and subsequently refer to it in the .TRAN statement. The parameter name must not start with V or I.
firstrun	The *val* value specifies the number of Monte Carlo iterations to perform. The *firstrun* value specifies the desired number of iterations. HSPICE runs from num1 to num1+val-1.
list	The iterations at which HSPICE performs a Monte Carlo analysis. You can write more than one number after *list*. The colon represents "from ... to ...". Specifying only one number makes HSPICE run at only the specified point.

.UNPROTECT

Syntax

```
.UNPROTECT
```

Description

In HSPICE, the .UNPROTECT statement restores normal output functions that a .PROTECT statement restricted. HSPICE RF does not support the .UNPROTECT statement.

- Any elements and models located between .PROTECT and .UNPROTECT statements, inhibit the element and model listing from the LIST option.
- Neither the .OPTION NODE cross reference, nor the .OP operating point printout, list any nodes within the .PROTECT and .UNPROTECT statements.

See Also

.PROTECT

.VEC

Syntax

```
.VEC 'digital_vector_file'
```

Description

You can call a digital vector file from an HSPICE netlist. A digital vector file consists of three parts:

- Vector Pattern Definition section
- Waveform Characteristics section
- Tabular Data section.

The `.VEC` file must be a text file. If you transfer it between Unix and Windows, use *text* mode.

.WIDTH

Syntax

```
.WIDTH OUT = {80 |132}
```

Example

```
.WIDTH OUT = 132 $ SPICE compatible style
.OPTION CO = 132  $ preferred style
```

Description

Use the `.WIDTH` statement to define the print-out width in HSPICE.

Permissible values for `OUT` are `80` and `132`. You can also use `.OPTION CO` to set the `OUT` value.

Argument	Definition
OUT	Output print width.

3

Options in HSPICE Netlists

Describes the simulation options you can set using various forms of the `.OPTION` command.

You can set a wide variety of HSPICE simulation options using the `.OPTION` command. This chapter provides a list of the various options, arranged by task, followed by detailed descriptions of the individual options.

Options in this chapter fall into the following categories:

- AC Control Options
- Common Model Interface Options
- Verilog-A Options

General Control Options

.OPTION ACCT
.OPTION ACOUT
.OPTION ALT999 or ALT9999
OPTION ALTCC
.OPTION ALTCHK
.OPTION BEEP
.OPTION BINPRINT
.OPTION BRIEF
.OPTION CO
.OPTION INGOLD
.OPTION LENNAM
.OPTION LIST
.OPTION MEASDGT
.OPTION NODE
.OPTION NOELCK
.OPTION NOMOD
.OPTION NOPAGE
.OPTION NOTOP
.OPTION NXX
.OPTION OPTLST
.OPTION OPTS
.OPTION PATHNUM
.OPTION PLIM
.OPTION POST_VERSION
.OPTION SEARCH
.OPTION STATFL
.OPTION VERIFY

CPU Options

.OPTION CPTIME
.OPTION EPSMIN
.OPTION EXPMAX
.OPTION LIMTIM

Interface Options

.OPTION ARTIST
.OPTION CDS
.OPTION CSDF
.OPTION DLENCSDF
.OPTION MEASOUT
.OPTION MENTOR
.OPTION MONTECON
.OPTION POST
.OPTION POSTLVL
.OPTION POSTTOP
.OPTION PROBE
.OPTION PSF
.OPTION SDA
.OPTION ZUKEN

Analysis Options

.OPTION ASPEC
.OPTION NOISEMINFREQ
.OPTION SEED
.OPTION FFTOUT
.OPTION PARHIER
.OPTION SPICE
.OPTION LIMPTS

Error Options

.OPTION BADCHR
.OPTION DIAGNOSTIC
.OPTION NOWARN
.OPTION WARNLIMIT

Version Option

.OPTION H9007

Model Analysis Options

General Model Analysis Options

.OPTION DCAP
.OPTION HIER_SCALE
.OPTION TNOM
.OPTION MODSRH
.OPTION MODMONTE
.OPTION XDTEMP
.OPTION SCALE

MOSFET Model Analysis Options

.OPTION CVTOL
.OPTION DEFNRD
.OPTION DEFW
.OPTION DEFAD
.OPTION DEFNRS
.OPTION SCALM
.OPTION DEFAS
.OPTION DEFPD
.OPTION WL
.OPTION DEFL
.OPTION DEFPS
.OPTION WNFLAG

Inductor Model Analysis Options

.OPTION GENK
.OPTION KLIM

BJT and Diode Model Analysis Options

.OPTION EXPLI

DC Operating Point, DC Sweep, and Pole/Zero Options

DC Accuracy Options

.OPTION ABSH
.OPTION ABSI
.OPTION ABSMOS
.OPTION ABSTOL
.OPTION ABSVDC
.OPTION DI
.OPTION KCLTEST
.OPTION MAXAMP
.OPTION RELH
.OPTION RELI
.OPTION RELMOS
.OPTION RELV
.OPTION RELVDC

DC Matrix Options

.OPTION ITL1
.OPTION ITL2
.OPTION NOPIV
.OPTION PIVOT
.OPTION PIVREF
.OPTION PIVREL
.OPTION PIVTOL
.OPTION SPARSE

DC Pole/Zero I/O Options

.OPTION CAPTAB
.OPTION VFLOOR
.OPTION DCCAP
.OPTION OPFILE

DC Convergence Options

.OPTION CONVERGE
.OPTION CSHDC
.OPTION DCFOR
.OPTION DCHOLD
.OPTION DCSTEP
.OPTION DCON
.OPTION DCTRAN
.OPTION DV
.OPTION GMAX
.OPTION GMINDC
.OPTION GRAMP
.OPTION GSHDC
.OPTION GSHUNT
.OPTION ICSWEEP
.OPTION ITLPTRAN
.OPTION NEWTOL
.OPTION OFF
.OPTION RESMIN
.OPTION SYMB

DC Initialization Control Options

.OPTION ABSTOL
.OPTION CAPTAB
.OPTION CSHDC
.OPTION DCCAP
.OPTION DCFOR
.OPTION DCHOLD
.OPTION DCIC
.OPTION DCSTEP
.OPTION DV
.OPTION GDCPATH
.OPTION GRAMP
.OPTION GSHDC
.OPTION GSHUNT
.OPTION ICSWEEP
.OPTION ITLPTRAN
.OPTION ITL1
.OPTION ITL2
.OPTION KCLTEST
.OPTION MAXAMP
.OPTION NEWTOL
.OPTION NOPIV
.OPTION OFF
.OPTION PIVOT
.OPTION PIVREF
.OPTION PIVTOL
.OPTION RESMIN
.OPTION SPARSE

Transient and AC Small Signal Analysis Options

Transient/AC Accuracy Options

.OPTION ABSH
.OPTION ABSV
.OPTION ACCURATE
.OPTION DI
.OPTION GMIN
.OPTION GSHUNT
.OPTION RELQ
.OPTION RELTOL
.OPTION RELV

Transient/AC Speed Options

Transient/AC Timestep Options

Transient/AC Algorithm Options

.BIASCHK Options

Transient Control Options

Transient Control Method Options

.OPTION BYPASS
.OPTION CSHUNT
.OPTION DVDT
.OPTION GSHUNT
.OPTION INTERP
.OPTION ITRPRT
.OPTION MAXORD
.OPTION METHOD
.OPTION TRCON
.OPTION WACC

Transient Control Tolerance Options

.OPTION ABSH
.OPTION ABSV
.OPTION ABSVAR
.OPTION ACCURATE
.OPTION BYTOL
.OPTION CHGTOL
.OPTION DI
.OPTION FAST
.OPTION MAXAMP
.OPTION MBYPASS
.OPTION MU
.OPTION RELH
.OPTION RELI
.OPTION RELQ
.OPTION RELTOL
.OPTION RELV
.OPTION RELVAR
.OPTION SLOPETOL
.OPTION TIMERES
.OPTION TRTOL
.OPTION VNTOL

Transient Control Limit Options

.OPTION AUTOSTOP
.OPTION BKPSIZ
.OPTION DELMAX
.OPTION DVTR
.OPTION FS
.OPTION FT
.OPTION GMIN
.OPTION IMAX
.OPTION IMIN
.OPTION ITL3
.OPTION ITL4
.OPTION ITL5
.OPTION RMAX
.OPTION RMIN
.OPTION VFLOOR

Transient Control Matrix Options

.OPTION GMIN .OPTION PIVOT

Iteration Count Dynamic Timestep Options

.OPTION IMAX .OPTION IMIN

Input/Output Options

.OPTION INTERP .OPTION MEASFILE .OPTION OPTLST
.OPTION ITRPRT .OPTION MEASOUT .OPTION PUTMEAS
.OPTION MEASDGT .OPTION MEASSORT .OPTION UNWRAP
.OPTION MEASFAIL .OPTION MCBRIEF

AC Control Options

.OPTION ABSH .OPTION DI .OPTION RELH
.OPTION ACOUT .OPTION MAXAMP .OPTION UNWRAP

Common Model Interface Options

.OPTION CMIFLAG .OPTION CUSTCMI

Verilog-A Options

.OPTION SPMODEL .OPTION VAMODEL

.OPTION ABSH

Syntax

```
.OPTION ABSH=x
```

Description

Sets the absolute current change, through voltage-defined branches (voltage sources and inductors). Use this option with options `DI` and `RELH` to check for current convergence. The default is `0.0`.

See Also

.OPTION DI
.OPTION RELH

.OPTION ABSI

Syntax

```
.OPTION ABSI=x
```

Description

Sets the absolute error tolerance for branch currents in diodes, BJTs, and JFETs, during DC and transient analysis. Decrease `ABSI`, if accuracy is more important than convergence time.

To analyze currents less than 1 nanoamp, change `ABSI` to a value at least two orders of magnitude smaller than the minimum expected current.

The default is `1e-9` when `KCLTEST = 0` or `1e-6` for `KCLTEST = 1`.

See Also

.DC
.OPTION KCLTEST
.TRAN

.OPTION ABSMOS

Syntax

```
.OPTION ABSMOS=x
```

Description

Current error tolerance (for MOSFET devices) in DC or transient analysis. The ABSMOS setting determines whether the drain-to-source current solution has converged. The drain-to-source current converged if:

- The difference between the drain-to-source current in the last iteration, versus the present iteration, is less than ABSMOS, or
- This difference is greater than ABSMOS, but the percent change is less than RELMOS.

If other accuracy tolerances also indicate convergence, HSPICE or HSPICE RF solves the circuit at that timepoint, and calculates the next timepoint solution. For low-power circuits, optimization, and single transistor simulations, set ABSMOS = 1e-12. Default is 1e-6 (amperes).

See Also

.DC
.OPTION RELMOS
.TRAN

.OPTION ABSTOL

Syntax

```
.OPTION ABSTOL=x
```

Description

Sets the absolute error tolerance for branch currents for DC and transient analysis. Decrease ABSTOL, if accuracy is more important than convergence time. ABSTOL is the same as ABSI.

See Also

.DC
.OPTION ABSI
.TRAN

.OPTION ABSV

Syntax

```
.OPTION ABSV=x
```

Description

Sets absolute minimum voltage for DC and transient analysis. ABSV is the same as VNTOL.

- If accuracy is more critical than convergence, decrease ABSV.
- If you need voltages less than 50 microvolts, reduce ABSV to two orders of magnitude less than the smallest desired voltage. This ensures at least two significant digits.

Typically, you do not need to change ABSV, except to simulate a high-voltage circuit. A reasonable value for 1000-volt circuits is 5 to 50 millivolts. The default is 50 (microvolts).

You can use ABSV in HSPICE, but not HSPICE RF.

See Also

.DC
.OPTION VNTOL
.TRAN

.OPTION ABSVAR

Syntax

```
.OPTION ABSVAR=x
```

Description

Sets the absolute limit for the maximum voltage change, from one time point to the next. Use this option with `.OPTION DVDT`. If the simulator produces a convergent solution that is greater than ABSVAR, then HSPICE discards the solution, sets the timestep to a smaller value, and recalculates the solution. This is called a timestep reversal. The default is `0.5` (volts).

For additional information, see section “DVDT Dynamic Timestep Algorithm” in the *HSPICE Simulation and Analysis User Guide*.

You can use ABSVAR in HSPICE, but not in HSPICE RF.

See Also

.OPTION DVDT

.OPTION ABSVDC

Syntax

```
.OPTION ABSVDC=x
```

Description

Sets the minimum voltage for DC and transient analysis. If accuracy is more critical than convergence, decrease ABSVDC. If you need voltages less than 50 micro-volts, reduce ABSVDC to two orders of magnitude less than the smallest voltage. This ensures at least two digits of significance. Typically, you do not need to change ABSVDC, unless you simulate a high-voltage circuit. For 1000-volt circuits, a reasonable value is 5 to 50 millivolts.

The default is the `.OPTION VNTOL` setting (`VNTOL` default = 50 mV).

See Also

.DC
.OPTION VNTOL
.TRAN

.OPTION ACCT

Syntax

```
.OPTION ACCT

.OPTION ACCT=[1|2]
```

Example 1

```
.OPTION ACCT=2
```

The ratio of TOT.ITER to CONV.ITER is the best measure of simulator efficiency. The theoretical ratio is 2:1. In this example the ratio was 2.57:1. SPICE generally has a ratio from 3:1 to 7:1.

In transient analysis, the ratio of CONV.ITER to # POINTS is the measure of the number of points evaluated, to the number of points printed. If this ratio is greater than about 4:1, the convergence and time step control tolerances might be too tight for the simulation.

Description

The ACCT option in HSPICE generates a detailed accounting report.

Argument	Definition
.OPTION ACCT	Enables reporting.
.OPTION ACCT = 1 (default)	Is the same as ACCT, without arguments.
.OPTION ACCT = 2	Enables reporting, and matrix statistic reporting.

See Also

.DC
.TRAN

.OPTION ACCURATE

Syntax

```
.OPTION ACCURATE=x
```

Description

Selects a time algorithm that uses `LVLTIM = 3` and `DVDT = 2` for circuits such as high-gain comparators. Use this option with circuits that combine high gain and large dynamic range to guarantee accurate solutions in HSPICE or HSPICE RF. When set to `1`, this option sets these control options:

```
LVLTIM = 3
DVDT = 2
RELVAR = 0.2
ABSVAR = 0.2
FT = 0.2
RELMOS = 0.01
```

The default is `0`.

See Also

.OPTION ABSVAR
.OPTION DVDT
.OPTION FT
.OPTION LVLTIM
.OPTION RELMOS
.OPTION RELVAR

.OPTION ACOUT

Syntax

```
.OPTION ACOUT=x
```

Description

AC output calculation method for the difference in values of magnitude, phase, and decibels. Use these values for prints and plots. The default is 1.

The default (ACOUT = 1) selects the HSPICE method, which calculates the difference of the magnitudes of the values. The SPICE method, ACOUT = 0, calculates the magnitude of the differences in HSPICE.

You can use this option in HSPICE, but not in HSPICE RF.

.OPTION ALT999 or ALT9999

Syntax

```
.OPTION ALT999

.OPTION ALT9999
```

Description

This option was developed to allow the .GRAPH statement to create more output files when you ran .ALTER simulations.

This option is obsolete starting with version 2003.09. Without this option, HSPICE can now generate up to 10,000 unique files.

See Also

.ALTER
.GRAPH

OPTION ALTCC

Syntax

```
.OPTION ALTCC=x
```

Description

Enables HSPICE to only read the input netlist once for multiple `.ALTER` statements.

`ALTCC = 1` enables reading input netlist only once for multiple `.ALTER` statements.

`ALTCC = 0` or `-1` disables : HSPICE or HSPICE RF does not output a warning message during transient analysis. HSPICE or HSPICE RF outputs the results, after this transient analysis.

Note: You can use `.OPTION ALTCC` or `.OPTION ALTCC=1` to ignore parsing of an input netlist before an `.ALTER` statement in the process of standard cell library characterization only when an `.ALTER` statement changes parameters, source stimulus, analysis, or passive elements. Otherwise, this option is ignored.

See Also

.ALTER

.OPTION ALTCHK

Syntax

```
.OPTION ALTCHK=x
```

Description

By default, HSPICE automatically reports topology errors in the latest elements in your top-level netlist. It also reports errors in elements that you redefine by using the .ALTER statement (altered netlist).

To disable topology checking in redefined elements (that is, to check topology only in the top-level netlist, but not in the altered netlist), set:

```
.option altchk=0
```

By default, .OPTION ALTCHK is set to 1:

```
.option altchk=1
.option altchk
```

This enables topology checking in elements that you redefine using the .ALTER statement. HSPICE RF does not support .ALTER statements.

See Also

.ALTER

.OPTION ARTIST

Syntax

```
.OPTION ARTIST=x
```

Description

ARTIST = 2 enables the Cadence Analog Artist interface. This option requires a specific license.

.OPTION ASPEC

Syntax

```
.OPTION ASPEC=x
```

Description

Sets HSPICE or HSPICE RF to ASPEC-compatibility mode. When you set this option, the simulator reads ASPEC models and netlists, and the results are compatible. The default is `0` (HSPICE mode).

If you set ASPEC, the following model parameters default to ASPEC values:

- `ACM = 1`: Changes the default values for CJ, IS, NSUB, TOX, U0, and UTRA.
- *Diode Model:* `TLEV = 1` affects temperature compensation for PB.
- *MOSFET Model:* `TLEV = 1` affects PB, PHB, VTO, and PHI.
- *SCALM, SCALE:* Sets the model scale factor to microns for length dimensions.
- *WL:* Reverses implicit order for stating width and length in a MOSFET statement. The default (`WL=0`) assigns the length first, then the width.

See Also

.OPTION SCALE
.OPTION SCALM
.OPTION WL

.OPTION AUTOSTOP

Syntax

```
.OPTION AUTOSTOP
```

-or-

```
.OPTION AUTOSTOP='expression'
```

Example

```
.option autostop='m1&&m2||m4'
.meas tran m1  trig v(bd_a0)        val='ddv/2'       fall=1
targ v(re_bd)         val='ddv/2'      rise=1
.meas tran m2  trig v(bd_a0)         val='ddv/2'      fall=2
targ v(re_bd)         val='ddv/2'      rise=2
.meas tran m3  trig v(bd_a0)         val='ddv/2'      rise=2
targ v(re_bd)         val='ddv/2'      rise=3
.meas tran m4  trig v(bd_a0)         val='ddv/2'      fall=3
targ v(re_bd)         val='ddv/2'      rise=4
.meas tran m5  trig v(bd_a0)         val='ddv/2' rise=3   targ
v(re_bd)         val='ddv/2'      rise=5
```

In this example, when either m1 and m2 are obtained, or just m4 is obtained, the transient analysis ends.

Description

Stops a transient analysis in HSPICE or HSPICE RF, after calculating all `TRIG-TARG`, `FIND-WHEN`, and `FROM-TO` measure functions. This option can substantially reduce CPU time. You can use the `AUTOSTOP` option with any measure type. You can also use the result of the preceding measurement as the next measured parameter.

When using `.OPTION AUTOSTOP='expression'`, the 'expression' can only involve measure results, a logical AND (&&), or a logical OR(||). Using these types of expressions ends the simulation if any one of a set of `.MEASURE` statements succeeds, even if the others are not completed.

Also terminates the simulation, after completing all `.MEASURE` statements. This is of special interest when testing corners.

See Also

.MEASURE

.OPTION BADCHR

Syntax

```
.OPTION BADCHR
```

Description

Generates a warning, if it finds a non-printable character in an input file.

.OPTION BEEP

Syntax

```
.OPTION BEEP=x
```

Description

`BEEP = 1` sounds an audible tone when simulation returns a message, such as:

```
info: HSPICE job completed.
```

`BEEP = 0` turns off the audible tone.

.OPTION BIASFILE

Syntax

```
.OPTION BIASFILE=x
```

Example

```
OPTION BIASFILE='biaschk/mos.bias'
```

Description

If you use this option, HSPICE or HSPICE RF outputs the results of all `.BIASCHK` commands to a file that you specify. If you do not set this option, HSPICE or HSPICE RF outputs the `.BIASCHK` results to the **.lis* file.

See Also

.BIASCHK

.OPTION BIAWARN

Syntax

```
.OPTION BIAWARN=x
```

Example

```
.OPTION BIAWARN=1
```

Description

`BIAWARN = 1`: HSPICE or HSPICE RF immediately outputs a warning message when any local max bias voltage exceeds the limit during transient analysis. After this transient analysis, HSPICE or HSPICE RF outputs the results summary as filtered by noise.

`BIAWARN = 0` (default): HSPICE or HSPICE RF does not output a warning message during transient analysis. HSPICE or HSPICE RF outputs the results, after this transient analysis.

See Also

.TRAN

.OPTION BINPRINT

Syntax

```
.OPTION BINPRINT
```

Description

Outputs the binning parameters of the CMI MOSFET model. Currently available only for Level 57.

.OPTION BKPSIZ

Syntax

```
.OPTION BKPSIZ=x
```

Description

Sets the size of the breakpoint table. The default is `5000`. This is an old option, provided only for backward-compatibility.

.OPTION BRIEF

Syntax

```
.OPTION BRIEF=x
```

Description

Stops printback of the data file, until HSPICE or HSPICE RF finds an `.OPTION BRIEF = 0` or the `.END` statement. It also resets the `LIST`, `NODE`, and `OPTS` options, and sets `NOMOD`. `BRIEF = 0` enables printback. The `NXX` option is the same as `BRIEF`.

See Also

.END
.OPTION LIST
.OPTION NODE
.OPTION NXX
.OPTION OPTS

.OPTION BYPASS

Syntax

```
.OPTION BYPASS=x
```

Description

Bypasses model evaluations, if the terminal voltages do not change. Can be `0` (off), `1` (on), or `2` (applies to BSIM3v3 and BSIM4 in special cases). To speed-up simulation, this option does not update the status of latent devices. To enable bypassing, set `.OPTION BYPASS = 1` for MOSFETs, MESFETs, JFETs, BJTs, or diodes. Default = 1.

Use the BYPASS algorithm cautiously. Some circuit types might not converge, and might lose accuracy in transient analysis and operating-point calculations.

.OPTION BYTOL

Syntax

```
.OPTION BYTOL=x
```

Description

Specifies a voltage tolerance, at which a MOSFET, MESFET, JFET, BJT, or diode becomes latent. HSPICE does not update status of latent devices. The default = MBYPASS x VNTOL.

You can use this option in HSPICE, but not in HSPICE RF.

See Also

.OPTION MBYPASS
.OPTION VNTOL

.OPTION CAPTAB

Syntax

```
.OPTION CAPTAB
```

Description

Prints table of single-plate node capacitances for diodes, BJTs, MOSFETs, JFETs, and passive capacitors, at each operating point.

.OPTION CDS

Syntax

```
.OPTION CDS=x
```

Description

CDS = 2 produces a Cadence WSF (ASCII format) post-analysis file for Opus™. This option requires a specific license. The CDS option is the same as the SDA option.

See Also

.OPTION SDA

.OPTION CHGTOL

Syntax

```
.OPTION CHGTOL=x
```

Description

Sets a charge error tolerance, if you set `LVLTIM = 2`. Use `CHGTOL` with `RELQ` to set the absolute and relative charge tolerance for all HSPICE capacitances. The default is `1e-15` (coulomb).

See Also

.OPTION CHGTOL
.OPTION LVLTIM
.OPTION RELQ

.OPTION CMIFLAG

Syntax

```
.OPTION CMIFLAG
```

Description

This option signals to load the dynamically-linked Common Model Interface (CMI) library, libCMImodel.

See Also

.OPTION CUSTCMI

.OPTION CO

Syntax

```
.OPTION CO=<column_width>
```

Example

```
* Narrow print-out (default)
.OPTION CO=80
* Wide print-out
.OPTION CO=132
```

Description

The number of output variables that print on a single line of output, is a function of the number of columns. Use `.OPTION CO` to set the column width for print-outs in HSPICE.

HSPICE RF does not support the `.OPTION CO` statement.

You can set up to five output variables per 80-column output, and up to eight output variables per 132-column output withtwelve characters per column. HSPICE automatically creates additional print statements and tables for all output variables beyond the number that the `CO` option specifies. The default is `80`.

Argument	Definition
column_width	The number of characters in a single line of output.

See Also

.WIDTH

.OPTION CONVERGE

Syntax

```
.OPTION CONVERGE=x
```

Description

Invokes different methods to solve non-convergence problems.

- `CONVERGE = -1` : Use with `DCON = -1` to disable autoconvergence.
- `CONVERGE = 0` : Autoconvergence (default).
- `CONVERGE = 1` : Uses the Damped Pseudo Transient algorithm. If simulation does not converge within the set CPU time (in the `CPTIME` control option), then simulation halts.
- `CONVERGE = 2` : Uses a combination of `DCSTEP` and `GMINDC` ramping. Not used in the autoconvergence flow.
- `CONVERGE = 3` : Invokes the source-stepping method. Not used in the autoconvergence flow.
- `CONVERGE = 4` : Uses the gmath ramping method.

Even you did not set it in an `.OPTION` statement, the `CONVERGE` option activates if a matrix floating-point overflows, or if HSPICE or HSPICE RF reports a *timestep too small* error. The default is `0`.

If a matrix floating-point overflows, then `CONVERGE = 1`.

See Also

.OPTION DCON
.OPTION DCSTEP
.OPTION DCTRAN
.OPTION GMINDC

.OPTION CPTIME

Syntax

```
.OPTION CPTIME=x
```

Description

Sets the maximum CPU time, in seconds, allotted for this simulation job. When the time allowed for the job exceeds `CPTIME`, HSPICE prints or plots the results up to that point, and concludes the job. Use this option if you are uncertain how long the simulation will take, especially when you debug new data files. Default is `1e7` (400 days).

See Also

.OPTION LIMTIM

.OPTION CSDF

Syntax

```
.OPTION CSDF=x
```

Description

Selects Common Simulation Data Format (Viewlogic-compatible graph data file format).

.OPTION CSHDC

Syntax

```
.OPTION CSHDC=x
```

Description

The same option as CSHUNT; use only with the CONVERGE option.

You can use the CSHDC option in HSPICE, but not in HSPICE RF.

See Also

.OPTION CONVERGE
.OPTION CSHUNT

.OPTION CSHUNT

Syntax

```
.OPTION CSHUNT=x
```

Description

Capacitance added from each node to ground in HSPICE or HSPICE RF. Add a small `CSHUNT` to each node to solve internal timestep too small problems, caused by high-frequency oscillations or numerical noise. The default is `0`.

.OPTION CUSTCMI

Syntax

```
.OPTION CUSTCMI=x
```

Description

You set `.OPTION CUSTCMI=1` jointly with `.OPTION CMIFLAG` to turn on gate direct tunneling current modeling and instance parameter support for customer CMI. You set `.OPTION CUSTCMI=0` to turn off that feature.

See Also

.OPTION CMIFLAG

.OPTION CVTOL

Syntax

```
.OPTION CVTOL=x
```

Description

Changes the number of numerical integration steps when calculating the gate capacitor charge for a MOSFET by using `CAPOP = 3`. See the discussion of `CAPOP = 3` in the “Overview of MOSFETS” chapter of the *HSPICE Elements and Device Models Manual* for explicit equations and discussion.

You can use the `.OPTION CVTOL` statement in HSPICE, but not in HSPICE RF.

.OPTION D_IBIS

Syntax

```
.OPTION D_IBIS=’ibis_files_directory’
```

Example

```
.OPTION d_ibis='/home/user/ibis/models'
```

Description

The `.OPTION D_IBIS` option specifies the directory containing the IBIS files. If you specify several directories, then the simulation looks for IBIS files in the local directory (the directory from which you run the simulation). It then checks the directories specified through `.OPTION D_IBIS` in the order that `.OPTION` cards appear in the netlist. You can use the `D_IBIS` option to specify up to four directories.

.OPTION DCAP

Syntax

```
.OPTION DCAP
```

Description

Selects equations, which HSPICE or HSPICE RF uses to calculate depletion capacitance for Level 1 and 3 diodes, and BJTs. The *HSPICE Elements and Device Models Manual* describes these equations.

.OPTION DCCAP

Syntax

```
.OPTION DCCAP=x
```

Description

Generates C-V plots. Prints capacitance values of a circuit (both model and element), during a DC analysis. You can use a DC sweep of the capacitor to generate C-V plots. If not set, MOS device or voltage-variable compacitance values will not be evaluated and the printed value will be zero. The default is `0` (off).

See Also

.DC

.OPTION DCFOR

Syntax

```
.OPTION DCFOR=x
```

Description

Use with .OPTION DCHOLD and the .NODESET statement to enhance DC convergence.

DCFOR sets the number of iterations to calculate, after a circuit converges in the steady state. The number of iterations after convergence is usually zero so DCFOR adds iterations (and computation time) to the DC circuit solution. DCFOR ensures that a circuit actually, not falsely, converges. The default is 0.

See Also

.DC
.NODESET
.OPTION DCHOLD

.OPTION DCHOLD

Syntax

```
.OPTION DCHOLD=x
```

Description

Use DCFOR and DCHOLD together to initialize DC analysis. You can use the DCHOLD option in HSPICE, but not in HSPICE RF. DCFOR and DCHOLD enhance the convergence properties of a DC simulation. DCFOR and DCHOLD work with the .NODESET statement. The default is 1.

DCHOLD specifies how many iterations to hold a node, at the .NODESET voltage values. The effects of DCHOLD on convergence differ, according to the DCHOLD value, and the number of iterations before DC convergence.

If a circuit converges in the steady state in fewer than DCHOLD iterations, the DC solution includes the values set in .NODESET.

If a circuit requires more than DCHOLD iterations to converge, HSPICE or HSPICE RF ignores the values set in the .NODESET statement, and calculates the DC solution by using the .NODESET fixed-source voltages open circuited.

See Also

.DC
.NODESET
.OPTION DCFOR

.OPTION DCIC

Syntax

```
.OPTION DCIC=x
```

Description

If `DCIC=1` (default), each point in a DC sweep analysis acts like an operating point and all `.IC` commands in the netlist are used.

If `DCIC=0`, `.IC` commands in the netlist are ignored for DC sweep analysis.

See Also

.IC
.DC

.OPTION DCON

Syntax

```
.OPTION DCON=x
```

Description

If a circuit cannot converge, HSPICE or HSPICE RF automatically sets `DCON = 1`, and calculates the following:

$$DV = max\left(0.1, \frac{V_{max}}{50}\right), \text{ if DV = 1000}$$

$$GRAMP = max\left(6, \log_{10}\left(\frac{I_{max}}{GMINDC}\right)\right) \qquad ITL1 = ITL1 + 20 \cdot GRAMP$$

V_{max} is the maximum voltage, and I_{max} is the maximum current.

- If the circuit still cannot converge, HSPICE or HSPICE RF sets `DCON = 2`, which sets `DV = 1e6`.
- If the circuit uses discontinuous models or uninitialized flip-flops, simulation might not converge. Set `DCON = -1` and `CONVERGE = -1` to disable autoconvergence. HSPICE lists all non-convergent nodes and devices.

See Also

.OPTION CONVERGE
.OPTION DV

.OPTION DCSTEP

Syntax

```
.OPTION DCSTEP=x
```

Description

Converts DC model and element capacitors to a conductance to enhance DC convergence properties. HSPICE divides the value of the element capacitors by DCSTEP to model DC conductance. The default is 0 (seconds).

See Also

.DC

.OPTION DCTRAN

Syntax

```
.OPTION DCTRAN=x
```

Description

Invokes different methods to solve non-convergence problems. DCTRAN is an alias for CONVERGE.

See Also

.OPTION CONVERGE

.OPTION DEFAD

Syntax

```
.OPTION DEFAD=x
```

Description

The default MOSFET drain diode area in HSPICE. The default is `0`.

.OPTION DEFAS

Syntax

```
.OPTION DEFAS=x
```

Description

The default MOSFET source diode area in HSPICE. The default is `0`.

.OPTION DEFL

Syntax

```
.OPTION DEFL=x
```

Description

The default MOSFET channel length in HSPICE. The default is `1e-4m`.

.OPTION DEFNRD

Syntax

```
.OPTION DEFNRD=x
```

Description

The default number of squares for the drain resistor on a MOSFET. The default is `0`.

.OPTION DEFNRS

Syntax

```
.OPTION DEFNRS=x
```

Description

The default number of squares for the source resistor on a MOSFET. The default is `0`.

.OPTION DEFPD

Syntax

```
.OPTION DEFPD=x
```

Description

The default MOSFET drain diode perimeter in HSPICE. The default is `0`.

.OPTION DEFPS

Syntax

```
.OPTION DEFPS=x
```

Description

The default MOSFET source diode perimeter in HSPICE. The default is `0`.

.OPTION DEFW

Syntax

```
.OPTION DEFW=x
```

Description

The default MOSFET channel width in HSPICE. The default is `1e-4m`.

.OPTION DELMAX

Syntax

```
.OPTION DELMAX=x
```

Description

Sets the maximum Delta of the internal timestep. HSPICE automatically sets the DELMAX value, based on timestep control factors. The initial DELMAX value, shown in the HSPICE output listing, is generally not the value used for simulation.

You can use the DELMAX option in HSPICE, but not in HSPICE RF.

.OPTION DI

Syntax

```
.OPTION DI=x
```

Description

Sets the maximum iteration-to-iteration current change, through voltage-defined branches (voltage sources and inductors). Use this option only if the value of the ABSH control option is greater than 0. The default is `0.0`.

See Also

.OPTION ABSH

.OPTION DIAGNOSTIC

Syntax

```
.OPTION DIAGNOSTIC
```

Description

Logs the occurrence of negative model conductances.

.OPTION DLENCSDF

Syntax

```
.OPTION DLENCSDF=x
```

Description

If you use the Common Simulation Data Format (Viewlogic graph data file format) as the output format, this digit length option specifies how many digits to include in scientific notation (exponents), or to the right of the decimal point. Valid values are any integer from 1 to 10, and the default is 5.

If you assign a floating decimal point, or if you specify less than 1 or more than 10 digits, HSPICE or HSPICE RF uses the default. For example, it places 5 digits to the right of a decimal point.

.OPTION DV

Syntax

```
.OPTION DV=x
```

Description

Maximum iteration-to-iteration voltage change for all circuit nodes in both DC and transient analysis. High-gain bipolar amplifiers can require values of 0.5 to 5.0 to achieve a stable DC operating point. Large CMOS digital circuits frequently require about 1 volt. The default is `1000` (or `1e6` if `DCON = 2`).

See Also

.DC
.OPTION DCON
.TRAN

.OPTION DVDT

Syntax

```
.OPTION DVDT=x
```

Description

Adjusts the timestep, based on rates of change for node voltage. The default is 4.

- 0 - original algorithm
- 1 - fast
- 2 - accurate
- 3,4 - balance speed and accuracy
- You can use the DVDT option in HSPICE, but not in HSPICE RF. ACCURATE also increases the accuracy of the results.

For additional information, see section “DVDT Dynamic Timestep Algorithm” in the *HSPICE Simulation and Analysis User Guide*.

See Also

.OPTION ACCURATE

.OPTION DVTR

Syntax

```
.OPTION DVTR=x
```

Description

Limits voltage in transient analysis. The default is `1000`.

.OPTION EPSMIN

Syntax

```
.OPTION EPSMIN=x
```

Description

Specifies the smallest number that a computer can add or subtract, a constant value. The default is `1e-28`.

.OPTION EXPLI

Syntax

```
.OPTION EXPLI=x
```

Description

Current-explosion model parameter. PN junction characteristics, above the explosion current, are linear. HSPICE or HSPICE RF determines the slope at the explosion point. This improves simulation speed and convergence.

The default is `0.0 amp/AREAeff`.

.OPTION EXPMAX

Syntax

```
.OPTION EXPMAX=x
```

Description

Specifies the largest exponent that you can use for an exponential, before overflow occurs. Typical value for an IBM platform is 350.

.OPTION FAST

Syntax

```
.OPTION FAST
```

Description

Sets additional options, which increase simulation speed withminimal loss of accuracy.

To speed-up simulation, this option does not update the status of latent devices. Use this option for MOSFETs, MESFETs, JFETs, BJTs, and diodes. The default is 0.

You can use FAST in HSPICE, but not HSPICE RF.

A device is latent, if its node voltage variation (from one iteration to the next) is less than the value of either the BYTOL control option, or the BYPASSTOL element parameter. (If FAST is on, HSPICE sets BYTOL to different values for different types of device models.)

Besides the FAST option, you can also use the NOTOP and NOELCK options to reduce input pre-processing time. Increasing the value of the MBYPASS or BYTOL option, also helps simulations to run faster, but can reduce accuracy.

See Also

.OPTION BYTOL
.OPTION MBYPASS
.OPTION NOELCK
.OPTION NOTOP

.OPTION FFTOUT

Syntax

```
.OPTION FFTOUT=x
```

Description

Prints 30 harmonic fundamentals, sorted by size, THD, SNR, and SFDR, but only if you specify a `.OPTION FFTOUT` statement and a `.FFT freq=xxx` statement.

You can use the `.OPTION FFTOUT` statement in HSPICE, but not in HSPICE RF.

See Also

.FFT

.OPTION FS

Syntax

```
.OPTION FS=x
```

Description

Decreases Delta (internal timestep) by the specified fraction of a timestep (TSTEP) for the first time point of a transient. Decreases the FS value to help circuits that have timestep convergence difficulties. `DVDT = 3` uses FS to control the timestep.

$$Delta = FS \cdot [MIN(TSTEP, DELMAX, BKPT)]$$

- You specify `DELMAX`.
- `BKPT` is related to the breakpoint of the source.
- The `.TRAN` statement sets `TSTEP`. The default is `0.25`.

You can use `.OPTION FS` in HSPICE, but not HSPICE RF.

See Also

.OPTION DELMAX
.OPTION DVDT
.TRAN

.OPTION FT

Syntax

```
.OPTION FT=x
```

Description

Decreases Delta (the internal timestep), by a specified fraction of a timestep (TSTEP) for an iteration set that does not converge. If `DVDT = 2` or `DVDT = 4`, FT controls the timestep. The default is `0.25`.

See Also

.OPTION DVDT
.TRAN

.OPTION GDCPATH

Syntax

```
.OPTION GDCPATH[=x]
```

Description

Adds conductance to nodes having no DC path to ground. You use this option to help solve no DC path to ground problems. If you specify `GDCPATH` in a netlist without a value, that value is assumed to be `1e-15` (the default). The default is `0` when not specified.

.OPTION GENK

Syntax

```
.OPTION GENK=x
```

Description

Automatically computes second-order mutual inductance for several coupled inductors. The default is `1`, which enables the calculation.

.OPTION GMAX

Syntax

```
.OPTION GMAX=x
```

Description

Conductance in parallel with a current source for `.IC` and `.NODESET` initialization circuitry. Some large bipolar circuits require you to set `GMAX = 1` for convergence. The default is `100` (mho).

You can use `GMAX` in HSPICE, but not in HSPICE RF.

See Also

.IC
.NODESET

.OPTION GMIN

Syntax

```
.OPTION GMIN=x
```

Description

Minimum conductance added to all PN junctions for a time sweep in transient analysis. The default is `1e-12`.

.OPTION GMINDC

Syntax

```
.OPTION GMINDC=x
```

Description

Conductance in parallel to all pn junctions and MOSFET nodes except *gate* for DC analysis. `GMINDC` helps overcome DC convergence problems, caused by low values of off-conductance for pn junctions and MOSFETs. You can use `GRAMP` to reduce `GMINDC`, by one order of magnitude for each step. Set `GMINDC` between `1e-4` and the `PIVTOL` value. The default is `1e-12`.

Large values of `GMINDC` can cause unreasonable circuit response. If your circuit requires large values to converge, suspect a bad model or circuit. If a matrix floating-point overflows, and if `GMINDC` is `1.0e-12` or less, HSPICE or HSPICE RF sets it to `1.0e-11`. HSPICE or HSPICE RF manipulates `GMINDC` in auto-converge mode.

See Also

.DC
.OPTION GRAMP
.OPTION PIVTOL

.OPTION GRAMP

Syntax

```
.OPTION GRAMP=x
```

Description

HSPICE sets this value during auto-convergence (default is 0). Use GRAMP with the GMINDC option to find the smallest GMINDC value that results in DC convergence.

You can use GRAMP in HSPICE, but not HSPICE RF.

GRAMP specifies a conductance range, over which DC operating point analysis sweeps GMINDC. HSPICE replaces GMINDC values over this range, simulates each value, and uses the lowest GMINDC value where the circuit converges in a steady state.

If you sweep GMINDC between 1e-12 mhos (default) and 1e-6 mhos, GRAMP is 6 (value of the exponent difference, between the default and the maximum conductance limit). In this example:

- HSPICE first sets GMINDC to 1e-6 mhos, and simulates the circuit.
- If circuit simulation converges, HSPICE sets GMINDC to 1e-7 mhos, and simulates the circuit.
- The sweep continues until HSPICE simulates all values of the GRAMP ramp.

If the combined GMINDC and GRAMP conductance is greater than 1e-3 mho, false convergence can occur.

See Also

.DC
.OPTION GMINDC

.OPTION GSHDC

Syntax

```
.OPTION GSHDC=x
```

Description

Adds conductance from each node to ground when calculating the DC operating point of the circuit (`.OP`). The default is `0`.

You can use the `GSHDC` option in HSPICE, but not in HSPICE RF.

See Also

.OPTION GSHUNT

.OPTION GSHUNT

Syntax

```
.OPTION GSHUNT=x
```

Description

Adds conductance from each node to ground. The default is `0`. Add a small `GSHUNT` to each node to help solve Timestep too small problems caused by either high-frequency oscillations or numerical noise.

You can use the `GSHUNT` option in HSPICE, but not in HSPICE RF.

.OPTION H9007

Syntax

```
.OPTION H9007
```

Description

Sets default values for general-control options to correspond to values for HSPICE H9007D. If you set this option, HSPICE does not use the EXPLI model parameter.

See Also

.OPTION EXPLI

.OPTION HIER_SCALE

Syntax

```
.OPTION HIER_SCALE=x
```

Description

If you set the HIER_SCALE option, you can use the S parameter to scale sub-circuits.

- 0 interprets S as a user-defined parameter.
- 1 interprets S as a scale parameter.

.OPTION ICSWEEP

Syntax

```
.OPTION ICSWEEP=x
```

Description

Saves the current analysis result of a parameter or temperature sweep as the starting point in the next analysis in the sweep.

- If `ICSWEEP = 1` (default), the next analysis uses the current results.
- If `ICSWEEP = 0`, the next analysis does not use the results of the current analysis.

You can use `ICSWEEP` in HSPICE, but not in HSPICE RF.

.OPTION IMAX

Syntax

```
.OPTION IMAX=x
```

Description

Maximum timestep in timestep algorithms for transient analysis. IMAX sets the maximum iterations to obtain a convergent solution at a timepoint. If the number of iterations needed is greater than IMAX, the internal timestep (Delta) decreases, by a factor equal to the FT transient control option. HSPICE uses the new timestep to calculate a new solution. IMAX also works with the IMIN transient control option. IMAX is the same as ITL4. The default is 8.0.

You can use IMAX in HSPICE, but not HSPICE RF.

See Also

.OPTION FT
.OPTION IMIN
.OPTION ITL4

.OPTION IMIN

Syntax

```
.OPTION IMIN=x
```

Description

Minimum timestep in timestep algorithms for transient analysis. `IMIN` is the minimum number of iterations required to obtain convergence. If the number of iterations is less than `IMIN`, the internal timestep (Delta) doubles.

Use this option to decrease simulation times in circuits where the nodes are stable most of the time (such as digital circuits). If the number of iterations is greater than `IMIN`, the timestep stays the same, unless the timestep exceeds the `IMAX` option. `IMIN` is the same as `ITL3`. The default is `3.0`.

You can use `IMIN` in HSPICE, but not HSPICE RF.

See Also

.OPTION IMAX
.OPTION ITL3

.OPTION INGOLD

Syntax

```
.OPTION INGOLD=[0|1|2]
```

Example

```
.OPTION INGOLD=2
```

Description

By default, HSPICE or HSPICE RF prints variable values in engineering notation:

```
F = 1e-15   M = 1e-3
P = 1e-12    K = 1e3
N = 1e-9   X = 1e6
U = 1e-6    G = 1e9
```

In contrast to exponential form, engineering notation provides two to three extra significant digits, and aligns columns to facilitate comparison. To obtain output in exponential form, specify `.OPTION INGOLD = 1` or 2.

Argument	Definition	Defaults
INGOLD = 0 (default)	Engineering Format	1.234K 123M
INGOLD = 1	G Format (fixed and exponential)	1.234e+03 .123
INGOLD = 2	E Format (exponential SPICE)	1.234e+03 .123e-1

See Also

.OPTION MEASDGT

.OPTION INTERP

Syntax

```
.OPTION INTERP=x
```

Description

Limits output for post-analysis tools, such as Cadence or Zuken, to only the `.TRAN` timestep intervals. By default, HSPICE outputs all convergent iterations. `INTERP` typically produces a much smaller design *.tr#* file.

Use `INTERP = 1` with caution when the netlist includes `.MEASURE` statements. To compute measure statements, HSPICE uses the post-processing output. Reducing post-processing output can lead to interpolation errors in measure results.

When you run data-driven transient analysis (`.TRAN DATA`) in an optimization routine, HSPICE forces `INTERP=1`. HSPICE supports `.TRAN DATA`; HSPICE RF does not. All measurement results are at the time points specified in the data-driven sweep. To measure only at converged internal timesteps (for example, to calculate the AVG or RMS), set `ITRPRT=1`.

See Also

.MEASURE
.OPTION ITRPRT
.TRAN

.OPTION ITL1

Syntax

```
.OPTION ITL1=x
```

Description

Maximum DC iteration limit. Increasing this value rarely improves convergence in small circuits. Values as high as 400 have resulted in convergence for some large circuits with feedback (such as operational amplifiers and sense amplifiers). However, to converge, most models do not require more than 100 iterations. Set `.OPTION ACCT` to list how many iterations an operating point requires. The default is `200`.

See Also

.DC
.OPTION ACCT

.OPTION ITL2

Syntax

```
.OPTION ITL2=x
```

Description

Iteration limit for the DC transfer curve. Increasing this limit improves convergence, only for very large circuits. Default is `50`.

See Also

.DC

.OPTION ITL3

Syntax

```
.OPTION ITL3=x
```

Description

Minimum timestep in timestep algorithms for transient analysis. `ITL3` is the minimum number of iterations required to obtain convergence. If the number of iterations is less than `ITL3`, the internal timestep (Delta) doubles.

Use this option to decrease simulation times in circuits where the nodes are stable most of the time (such as digital circuits). If the number of iterations is greater than `IMIN`, the timestep stays the same, unless the timestep exceeds the `IMAX` option. `ITL3` is the same as `IMIN`. The default is `3.0`.

You can use `IMIN` in HSPICE, but not HSPICE RF.

See Also

.OPTION IMAX
.OPTION IMIN

.OPTION ITL4

Syntax

```
.OPTION ITL4=x
```

Description

Maximum timestep in timestep algorithms for transient analysis. ITL4 sets the maximum iterations to obtain a convergent solution at a timepoint. If the number of iterations needed is greater than ITL4, the internal timestep (Delta) decreases, by a factor equal to the FT transient control option. HSPICE uses the new timestep to calculate a new solution. ITL4 also works with the IMIN transient control option. ITL4 is the same as IMAX. The default is 8.0.

You can use IMAX in HSPICE, but not HSPICE RF.

See Also

.OPTION FT
.OPTION IMAX
.OPTION IMIN

.OPTION ITL5

Syntax

```
.OPTION ITL5=x
```

Description

Sets an iteration limit for transient analysis. If a circuit uses more than `ITL5` iterations, the program prints all results, up to that point. The default is `0.0`. allows an infinite number of iterations.

You can use the `ITL5` option in HSPICE, but not in HSPICE RF.

.OPTION ITLPTRAN

Syntax

```
.OPTION ITLPTRAN=x
```

Description

Controls the iteration limit used in the final try of the pseudo-transient method in OP or DC analysis. If simulation fails in the final try of the pseudo-transient method, enlarge this option. The default is `30`.

See Also

.DC
.OP

.OPTION ITLPZ

Syntax

```
.OPTION ITLPZ=x
```

Description

Sets the iteration limit for Pole/Zero analysis. The default is `100`.

You can use `ITLPZ` in HSPICE, but not in HSPICE RF.

.OPTION ITRPRT

Syntax

```
.OPTION ITRPRT
```

Description

Prints output variables at their internal time points. This option might generate a long output list.

.OPTION KCLTEST

Syntax

```
.OPTION KCLTEST=x
```

Description

Activates KCL (Kirchhoff's Current Law) test. increases simulation time, especially for large circuits, but very accurately checks the solution. The default is `0`.

If you set this value to 1, HSPICE or HSPICE RF sets these options:

- Sets `RELMOS` and `ABSMOS` options to `0` (off).
- Sets `ABSI` to `1e-6 A`.
- Sets `RELI` to `1e-6`.

To satisfy the KCL test, each node must satisfy this condition:

$$\left|\Sigma i_b\right| < RELI \cdot \Sigma\left|i_b\right| + ABSI$$

In this equation, the ibs are the node currents.

See Also

.OPTION ABSI
.OPTION ABSMOS
.OPTION RELI
.OPTION RELMOS

.OPTION KLIM

Syntax

```
.OPTION KLIM=x
```

Description

This option sets the minimum mutual inductance, below which automatic second-order mutual inductance calculation no longer proceeds. `KLIM` is unitless (analogous to coupling strength, specified in the K Element). Typical `KLIM` values are between .5 and 0.0. The default is `0.01`.

.OPTION LENNAM

Syntax

```
.OPTION LENNAM=x
```

Description

Maximum length of names in the printout of operating point analysis results. Default is 8, and the maximum x value=1024.

.OPTION LIMPTS

Syntax

```
.OPTION LIMPTS=x
```

Description

Number of points to print or plot in AC analysis. You do not need to set `LIMPTS` for DC or transient analysis. HSPICE spools the output file to disk. The default is `2001`.

See Also

.AC
.DC
.TRAN

.OPTION LIMTIM

Syntax

```
.OPTION LIMTIM=x
```

Description

Amount of CPU time reserved to generate prints and plots, if a CPU time limit (`CPTIME = x`) terminates simulation. The default is 2 (seconds), normally sufficient for short printouts and plots.

See Also

.OPTION CPTIME

.OPTION LIST

Syntax

```
.OPTION LIST
```

Description

This option produces an element summary of the input data to print, and calculates effective sizes of elements and the key values. The `BRIEF` option suppresses the `LIST` option.

See Also

.OPTION BRIEF
.OPTION UNWRAP
.OPTION VFLOOR

.OPTION LVLTIM

Syntax

```
.OPTION LVLTIM=x
```

Description

Selects the timestep algorithm for transient analysis.

- `LVLTIM = 1` (default) uses the `DVDT` timestep control algorithm.
- `LVLTIM = 2` uses the local truncation error (LTE) timestep control method. You can apply `LVLTIM = 2` to the TRAP method.
- `LVLTIM = 3` uses the `DVDT` timestep control method with timestep reversal.

The local truncation algorithm `LVLTIM = 2` (LTE) provides a higher degree of accuracy than `LVLTIM = 1` or 3 (`DVDT`). If you use this option, errors do not propagate from time point to time point, which can result in an unstable solution.

Selecting the GEAR method changes the value of `LVLTIM` to 2 automatically.

See Also

.OPTION CHGTOL
.OPTION DVDT
.OPTION FS
.OPTION FT
.OPTION RELQ

.OPTION MAXAMP

Syntax

```
.OPTION MAXAMP=x
```

Description

Sets the maximum current, through voltage-defined branches (voltage sources and inductors). If the current exceeds the MAXAMP value, HSPICE or HSPICE RF reports an error. The default is 0.0.

.OPTION MAXORD

Syntax

```
.OPTION MAXORD=x
```

Description

Maximum order of integration for the GEAR method in HSPICE. The x value can be either 1 or 2.

- MAXORD = 1 uses the backward Euler integration method.
- MAXORD = 2 (default) is more stable, accurate, and practical.

See Also

.OPTION METHOD

.OPTION MBYPASS

Syntax

```
.OPTION MBYPASS=x
```

Description

Computes the default value of the BYTOL control option:

```
BYTOL = MBYPASSxVNTOL
```

Also multiplies the RELV voltage tolerance. Set MBYPASS to about 0.1 for precision analog circuits.

- Default is 1 for DVDT = 0, 1, 2, or 3.
- Default is 2 for DVDT = 4.

See Also

.OPTION BYTOL
.OPTION DVDT
.OPTION RELV

.OPTION MCBRIEF

Syntax

```
.OPTION MCBRIEF=x
```

Description

Controls how HSPICE outputs Monte Carlo parameters.

- `MCBRIEF=0`: Outputs all Monte Carlo parameters (default)
- `MCBRIEF=1`: Does not output the Monte Carlo parameters
- `MCBRIEF=2`: Outputs the Monte Carlo parameters into a *.lis* file only.
- `MCBRIEF=3`: Outputs the Monte Carlo parameters into the measure files only.

.OPTION MEASDGT

Syntax

```
.OPTION MEASDGT=x
```

Description

Formats the .MEASURE statement output in both the listing file and the .MEASURE output files (*.ma0*, *.mt0*, *.ms0*, and so on).

The value of x is typically between 1 and 7, although you can set it as high as 10. The default is 4.0.

For example, if MEASDGT = 5, then .MEASURE displays numbers as:

- Five decimal digits for numbers in scientific notation.
- Five digits to the right of the decimal for numbers between 0.1 and 999.

In the listing (*.lis*), file, all .MEASURE output values are in scientific notation, so .OPTION MEASDGT=5 results in five decimal digits.

Use MEASDGT with .OPTION INGOLD=x to control the output data format.

See Also

.OPTION INGOLD
.MEASURE

.OPTION MEASFAIL

Syntax

```
.OPTION MEASFAIL=0|1
```

Description

You can assign this option the following values:

- `MEASFAIL=0`, outputs 0 into the *.mt#*, *.ms#*, or *.ma#* file, and prints failed to the listing file.
- `MEASFAIL=1` (default), prints failed into the *.mt#*, *.ms#*, or *.ma#* file, and into the listing file.

See Also

.MEASURE

.OPTION MEASFILE

Syntax

```
.OPTION MEASFILE=x
```

Description

Controls whether measure information outputs to single or multiple files when an `.ALTER` statement is present in the netlist. You can assign this option the following values:

- `MEASFILE=0`, outputs measure information to several files.
- `MEASFILE=1` (default), outputs measure information to a single file.

See Also

.ALTER
.MEASURE

.OPTION MEASSORT

Syntax

```
.OPTION MEASSORT=x
```

Description

In versions of HSPICE before 2003.09, to automatically sort large numbers of .MEASURE statements, you could use the .OPTION MEASSORT statement.

- .OPTION MEASSORT=0 (default; did not sort .MEASURE statements).
- .OPTION MEASSORT=1 (internally sorted .MEASURE statements).

You needed to set this option to 1 only if you used a large number of .MEASURE statements, where you needed to list similar variables together (to reduce simulation time). For a small number of .MEASURE statements, turning on internal sorting sometimes slowed-down simulation while sorting, compared to not sorting first.

Starting in version 2003.09, this option is obsolete. Now the measure performance is order independent, and HSPICE ignores this option.

See Also

.MEASURE

.OPTION MEASOUT

Syntax

```
.OPTION MEASOUT=x
```

Description

This option outputs `.MEASURE` statement values and sweep parameters into an ASCII file. Post-analysis processing (AvanWaves or other analysis tools) uses this <*design*>*.mt#* file, where # increments for each `.TEMP` or `.ALTER` block.

For example, for a parameter sweep of an output load, which measures the delay, the *.mt#* file contains data for a delay-versus-fanout plot. The default is `1`. You can set this option to `0` (off) in the *hspice.ini* file.

See Also

.ALTER
.MEASURE
.TEMP

.OPTION MENTOR

Syntax

```
.OPTION MENTOR=x
```

Description

`MENTOR = 2` enables the Mentor MSPICE-compatible (ASCII) interface. This option requires a specific license.

.OPTION METHOD

Syntax

```
.OPTION METHOD=GEAR|TRAP
```

Description

Sets the numerical integration method for a transient analysis to either GEAR or TRAP.

- To use GEAR, set `METHOD = GEAR`, which sets `LVLTIM = 2`.
- To change `LVLTIM` from 2 to 1 or 3, set `LVLTIM = 1` or 3, after the `METHOD = GEAR` option. This overrides `METHOD = GEAR`, which sets `LVLTIM = 2`.

TRAP (trapezoidal) integration usually reduces program execution time with more accurate results. However, this method can introduce an apparent oscillation on printed or plotted nodes, which might not result from circuit behavior. To test this, run a transient analysis by using a small timestep. If oscillation disappears, the cause was the trapezoidal method.

The GEAR method is a filter, removing oscillations that occur in the trapezoidal method. Highly non-linear circuits (such as operational amplifiers) can require very long execution times when you use the GEAR method.

Circuits that do not converge in trapezoidal integration, often converge if you use GEAR. Default is `TRAP` (trapezoidal).

Gear algorithm:

```
OPTION METHOD = GEAR
```

Backward-Euler:

```
OPTION METHOD = GEAR MU = 0
```

Trapezoidal algorithm (default):

```
OPTION METHOD = TRAP
```

See Also

.OPTION LVLTIM
.OPTION MU

.OPTION MODMONTE

Syntax

```
.OPTION MODMONTE=x
```

Description

If `MODMONTE=1`, then within a single simulation run, each device that shares the same model card and is in the same Monte Carlo index receives a different random value for parameters that have a Monte Carlo definition.

If `MODMONTE=0` (default), then within a single simulation run, each device that shares the same model card and is in the same Monte Carlo index, receives the same random value for its parameters that have a Monte Carlo definition.

.OPTION MODSRH

Syntax

```
.OPTION MODSRH=x
```

Example

```
example.sp:
* modsrh used incorrectly
.option post modsrh=1
xi1 net8 b c t6
xi0 a b net8 t6
v1 a 0 pulse 3.3 0.0 10E-6 1E-9 1E-9
+ 25E-6 50E-6
v2 b 0 2
v3 c 0 3
.model nch nmos level=49 version=3.2
.end
```

This input file automatically searches for t6.inc. If t6.inc includes the nch model, and you set MODSRH to 1, HSPICE or HSPICE RF does not load nch. Do not set MODSRH=1 in this type of file call. Use this option in front of the .MODEL card definition.

Description

If MODSRH=1, HSPICE or HSPICE RF does not load or reference a model described in a .MODEL statement, if the netlist does not use that model. This option shortens simulation run time when the netlist references many models, but no element in the netlist calls those models. The default is MODSRH=0. If MODSRH=1, then the read-in time increases slightly.

See Also

.MODEL

.OPTION MONTECON

Syntax

```
.OPTION MONTECON=x
```

Description

Continues a Monte Carlo analysis in HSPICE (not supported in HSPICE RF). Retrieves the next random value, even if non-convergence occurs. A random value can be too large or too small to cause convergence to fail. Other types of analysis can use this Monte Carlo random value.

.OPTION MU

Syntax

```
.OPTION MU=x
```

Description

This option defines the coefficient for trapezoidal integration. The value range is 0.0 to 0.5, and the default is `0.5`.

.OPTION NEWTOL

Syntax

```
.OPTION NEWTOL=x
```

Description

Calculates one or more iterations past convergence for every calculated DC solution and timepoint circuit solution. If you do not set `NEWTOL`, after HSPICE determines convergence, the convergence routine ends, and the next program step begins. The default is `0`.

You can use `NEWTOL` in HSPICE, but not in HSPICE RF.

.OPTION NODE

Syntax

```
.OPTION NODE=x
```

Example

```
1 M1:B D2:+ Q4:B

This sample part of a cross reference line indicates that the
bulk of M1, the anode of D2, and the base of Q4, all connect to
node 1.
```

Description

Prints a node cross reference table. The `BRIEF` option suppresses `NODE`. The table lists each node and all elements connected to it. A code indicates the terminal of each element. A colon (:) separates the code from the element name.

The codes are:

+ Diode anode
- Diode cathode
B BJT base
B MOSFET or JFET bulk
C BJT collector
D MOSFET or JFET drain
E BJT emitter
G MOSFET or JFET gate
S BJT substrate
S MOSFET or JFET source

See Also

.OPTION BRIEF

.OPTION NOELCK

Syntax

```
.OPTION NOELCK
```

Description

No element check; bypasses element checking to reduce pre-processing time for very large files.

.OPTION NOISEMINFREQ

Syntax

```
.OPTION NOISEMINFREQ=x
```

Description

The `.OPTION NOISEMINFREQ` command option specifies the minimum frequency of noise analysis. The default is `1e-5`. If the frequency of noise analysis is smaller than the minimum frequency, HSPICE automatically sets the frequency for `NOISEMINFREQ` in noise analysis.

.OPTION NOMOD

Syntax

```
.OPTION NOMOD
```

Description

Suppresses the printout of model parameters.

.OPTION NOPAGE

Syntax

```
.OPTION NOPAGE
```

Description

Suppresses page ejects for title headings.

.OPTION NOPIV

Syntax

```
.OPTION NOPIV=x
```

Description

Prevents HSPICE or HSPICE RF from automatically switching to pivoting matrix factors, if a nodal conductance is less than `PIVTOL`. `NOPIV` inhibits pivoting.

See Also

.OPTION PIVTOL

.OPTION NOTOP

Syntax

```
.OPTION NOTOP
```

Description

Suppresses topology checks to increase the speed for pre-processing very large files.

.OPTION NOWARN

Syntax

```
.OPTION NOWARN
```

Description

Suppresses all warning messages, except those generated from statements in `.ALTER` blocks.

See Also

.ALTER

.OPTION NUMDGT

Syntax

```
.OPTION NUMDGT=x
```

Description

This option controls the listing printout (*.lis*) accuracy. The value of *x* is typically between 1 and 7, although you can set it as high as 10. The default is `4.0`. This option does not affect the accuracy of the simulation.

This option does affect the results files (ASCII and binary) if you use the `.OPTION POST_VERSION = 2001` setting. The default setting of results files for printout accuracy is 5 digits.

See Also

.OPTION POST_VERSION

.OPTION NXX

Syntax

```
.OPTION NXX
```

Description

Stops printback of the data file, until HSPICE or HSPICE RF finds an `.OPTION BRIEF=0` or the `.END` statement. It also resets the `LIST`, `NODE` and `OPTS` options, and sets `NOMOD`. When `BRIEF=0`, it enables printback. `NXX` is the same as `BRIEF`.

See Also

.OPTION BRIEF
.OPTION LIST
.OPTION NODE
.OPTION OPTS

.OPTION OFF

Syntax

```
.OPTION OFF=x
```

Description

For all active devices, initializes terminal voltages to zero, if you did not initialize them to other values. For example, if you did not initialize both drain and source nodes of a transistor (using `.NODESET, .IC` statements, or connecting them to sources), then `OFF` initializes all nodes of the transistor to `0`.

HSPICE or HSPICE RF checks the `OFF` option, before element IC parameters. If you assigned an element `IC` parameter to a node, simulation initializes the node to the element `IC` parameter value, even if the `OFF` option previously set it to `0`.

You can use the `OFF` element parameter to initialize terminal voltages to `0` for specific active devices. Use the `OFF` option to help find exact DC operating-point solutions for large circuits.

See Also

.DC
.IC
.NODESET

.OPTION OPFILE

Syntax

```
.OPTION OPFILE=value
```

Description

The `OPFILE` option outputs the operating point information to a file. *`value`* can be `0` or `1`.

- If *`value`* is `1`, operating point information is output to a file named <*design*>.dp#.
- If *`value`* is `0`, the operating point information outputs to stdout.

.OPTION OPTLST

Syntax

```
.OPTION OPTLIST=x
```

Description

Outputs additional optimization information:

- `OPTLIST=0`: No information (default).
- `OPTLIST=1`: Prints parameter, Broyden update, and bisection results information.
- `OPTLIST=2`: Prints gradient, error, Hessian, and iteration information.
- `OPTLIST=3`: Prints all of the above and Jacobian.

.OPTION OPTS

Syntax

```
.OPTION OPTS
```

Description

Prints the current settings for all control options. If you change any of the default values of the options, the OPTS option prints the values that the simulation actually uses. The BRIEF option suppresses OPTS.

See Also

.OPTION BRIEF

.OPTION PARHIER

Syntax

```
.OPTION PARHIER = < GLOBAL | LOCAL >
```

Example

```
.OPTION parhier=<global | local>
.PARAM DefPwid = 1u
.SUBCKT Inv a y DefPwid = 2u DefNwid = 1u
   Mp1 <MosPinList> pMosMod L = 1.2u W = DefPwid
   Mn1 <MosPinList> nMosMod L = 1.2u W = DefNwid
.ENDS
```

This example explicitly shows the difference between local and global scoping for using parameters in sub-circuits.

Description

Use the `.OPTION OPTLST` parameter to specify scoping rules.

The default setting is `GLOBAL`.

See Also

.OPTION OPTLST

.OPTION PATHNUM

Syntax

```
.OPTION PATHNUM
```

Description

Prints subcircuit path numbers, instead of path names.

.OPTION PIVOT

Syntax

```
.OPTION PIVOT=x
```

Description

Selects a pivot algorithms. Use these algorithms to reduce simulation time, and to achieve convergence in circuits that produce hard-to-solve matrix equations. To select the pivot algorithm, set PIVOT as follows:

- PIVOT=0: Original non-pivoting algorithm.
- PIVOT=1: Original pivoting algorithm.
- PIVOT=2: Picks the largest pivot in the row.
- PIVOT=3: Picks the best pivot in a row.
- PIVOT=10 (default): Fast, non-pivoting algorithm; requires more memory.
- PIVOT=11: Fast, pivoting algorithm; requires more memory than PIVOT values less than 11.
- PIVOT=12: Picks the largest pivot in the row; requires more memory than PIVOT values less than 12.
- PIVOT=13: Fast, best pivot: faster; requires more memory than PIVOT values less than 13.

The fastest algorithm is PIVOT = 13, which can improve simulation time up to ten times, on very large circuits. However, PIVOT = 13 requires substantially more memory for simulation.

Some circuits with large conductance ratios, such as switching regulator circuits, might require pivoting.

If PIVTOL = 0, HSPICE or HSPICE RF automatically changes from non-pivoting to a row-pivot strategy, if it detects any diagonal-matrix entry less than PIVTOL. This strategy provides the time and memory advantages of non-pivoting inversion, and avoids unstable simulations and incorrect results. Use .OPTION NOPIV to prevent HSPICE or HSPICE RF from pivoting. For very large circuits, PIVOT = 10, 11, 12, or 13, can require excessive memory.

If HSPICE or HSPICE RF switches to pivoting during a simulation, it displays the message followed by the node numbers that cause the problem:

```
pivot change on the fly
```

Use `.OPTION NODE` to cross-reference a node to an element. The `SPARSE` option is the same as `PIVOT`.

See Also

.OPTION NODE
.OPTION NOPIV
.OPTION PIVREF
.OPTION PIVREL
.OPTION PIVTOL
.OPTION SPARSE

.OPTION PIVREF

Syntax

```
.OPTION PIVREF=x
```

Description

Pivot reference. Use `PIVREF` in `PIVOT = 11`, `12`, or `13` to limit the size of the matrix. The default is `1e+8`.

See Also

.OPTION PIVOT

.OPTION PIVREL

Syntax

```
.OPTION PIVREL=x
```

Description

Sets the maximum and minimum ratio of a row or matrix. Use only if `PIVOT = 1`. Large values for `PIVREL` can result in very long matrix pivot times. If the value is too small, however, no pivoting occurs. Start with small values of `PIVREL` by using an adequate (but not excessive) value for convergence and accuracy. The default is `1E-20` (max = 1e-20, min = 1).

See Also

.OPTION PIVOT

.OPTION PIVTOL

Syntax

```
.OPTION PIVTOL=x
```

Description

Absolute minimum value for which HSPICE or HSPICE RF accepts a matrix entry as a pivot. If `PIVOT=0`, `PIVTOL` is the minimum conductance in the matrix. The default is `1.0e-15`.

`PIVTOL` must be less than `GMIN` or `GMINDC`. Values that approach 1 increase the pivot.

See Also

.OPTION GMIN
.OPTION GMINDC
.OPTION PIVOT

.OPTION PLIM

Syntax

```
.OPTION PLIM
```

Description

Specifies plot size limits for current and voltage plots:

- Finds a common plot limit, and plots all variables on one graph, at the same scale
- Enables SPICE-type plots in HSPICE, which create a separate scale and axis for each plot variable

You can use SPICE-compatibility mode in HSPICE, but not in HSPICE RF.

This option does not affect postprocessing of graph data.

.OPTION POST

Syntax

```
.OPTION POST=[0|1|2|3|ASCII|BINARY]
```

Example

```
.OPTION POST=2
```

Description

Use an `.OPTION POST` statement to display high-resolution AvanWaves plots of simulation results, on either a graphics terminal or a high-resolution laser printer. Use `.OPTION POST` to provide output, without specifying other parameters. `POST` has defaults, which supply usable data to most parameters.

- `POST = 0`: Does not output simulation results.
- `POST = 1, BINARY`: (Default) Output format is binary.
- `POST = 2, ASCII`: Output format is ASCII.
- `POST = 3`: Output format is New Wave binary.

See Also

.OPTION POST_VERSION

.OPTION POSTLVL

Syntax

```
.OPTION POSTLVL=x
```

Example

```
.OPTION POSTLVL=2
```

This example limits the data written to the waveform file to only the second-level nodes.

Description

The `.OPTION POSTLVL` option limits the data to only the x level nodes, which is written to your waveform file.

.OPTION POST_VERSION

Syntax

```
.OPTION POST_VERSION=x
```

Description

Sets the post-processing output version:

- `x = 9007` truncates the node name in the post-processor output file to a maximum of 16 characters.
- `x = 9601` (default) sets the node name length for the output file consistent with the input restrictions (1024 characters), and limits the number of output variables to 9999.
- `x = 2001` shows the new output file header, which includes the right number of output variables rather than **** when the number exceeds 9999. This option also changes the number of digits precision in results files to match the value of `.OPTION NUMDGT` (when < 5).

If you set `.OPTION POST_VERSION = 2001 POST= 2` in the netlist, then HSPICE or HSPICE RF returns more-accurate ASCII results.

```
.option post_version=2001
```

To use binary values (with double precision) in the output file, include the following in the input file:

```
*****************************************
.option post (or post=1) post_version=2001
*****************************************
```

For more accurate simulation results, comment this format.

See Also

.OPTION NUMDGT
.OPTION POST

.OPTION POSTTOP

Syntax

```
.OPTION POSTTOP=n
```

Example

```
POSTTOP = 1
```

This example limits the data written to the waveform file to only the top-level nodes.

Description

The `.OPTION POSTTOP` option limits the data to only the data from the top n level nodes, which is written to your waveform file. If you do not specify either the `.OPTION PROBE` or the `.OPTION POSTTOP` options, then HSPICE outputs all levels.

To enable the waveform display interface, you also need the `.OPTION POST` option.

See Also

.OPTION POST
.OPTION PROBE

.OPTION PROBE

Syntax

```
.OPTION PROBE=x
```

Description

Limits post-analysis output to only variables specified in `.PROBE`, `.PRINT`, `.PLOT`, and `.GRAPH` statements. HSPICE RF supports `.PROBE` and `.PRINT` statements, but does not support `.PLOT` and `.GRAPH` statements. By default, HSPICE or HSPICE RF outputs all voltages and power supply currents in addition to variables listed in `.PROBE`, `.PRINT`, `.PLOT`, and `.GRAPH` statements. PROBE significantly decreases the size of simulation output files.

See Also

.GRAPH
.PLOT
.PRINT
.PROBE

.OPTION PSF

Syntax

```
.OPTION PSF=x
```

Description

Specifies whether HSPICE or HSPICE RF outputs binary or ASCII data when you run an HSPICE simulation from Cadence Analog Artist.

The value of *x* can be 1 or 2.

- If x is 2, HSPICE or HSPICE RF produces ASCII output.
- If `.OPTION ARTIST PSF = 1`, HSPICE produces binary output.

See Also

.OPTION ARTIST

.OPTION PURETP

Syntax

```
.OPTION PURETP=x
```

Description

Integration method to use for reversal time point. The default is `0`. If you set `PURETP=1`, then if HSPICE finds non-convergence, it uses TRAP (instead of B.E) for the reversed time point. Use this option with the `method=TRAP` statement to help some oscillating circuits to oscillate, if the default simulation process cannot satisfy the result.

.OPTION PUTMEAS

Syntax

```
.OPTION PUTMEAS=0|1
```

Description

The `.OPTION PUTMEAS` option controls the output variables, listed in the `.MEASURE` statement.

- `0`: Does not save variable values, which are listed in the `.MEASURE` statement, into the corresponding output file (such as *.tr#*, *.ac#* or *.sw#*). This option decreases the size of the output file.
- `1`: Default. Saves variable values, which are listed in the `.MEASURE` statement, into the corresponding output file (such as *.tr#*, *.ac#* or *.sw#*). This option is similar to the output of HSPICE 2000.4.

See Also

.MEASURE

.OPTION RELH

Syntax

```
.OPTION RELH=x
```

Description

Relative current tolerance, through voltage-defined branches (voltage sources and inductors). Use RELH to check current convergence, but only if the value of the ABSH control option is greater than zero. The default is 0.05.

You can use RELH in HSPICE, but not in HSPICE RF.

See Also

.OPTION ABSH

.OPTION RELI

Syntax

```
.OPTION RELI=x
```

Description

Sets the relative error/tolerance change, from iteration to iteration. This parameter determines convergence for all currents in diode, BJT, and JFET devices. (`RELMOS` sets tolerance for MOSFETs). This is the change in current, from the value calculated at the previous timepoint.

- Default = `0.01` for `.OPTION KCLTEST = 0`.
- Default = `1e-6` for `.OPTION KCLTEST = 1`.

See Also

.OPTION RELMOS
.OPTION KCLTEST

.OPTION RELMOS

Syntax

```
.OPTION RELMOS=x
```

Description

Sets the relative error tolerance (percent) for drain-to-source current, from iteration-to-iteration. This parameter determines convergence for currents in MOSFET devices. (`.OPTION RELI` sets the tolerance for other active devices.) Sets the change in current, from the value calculated at the previous timepoint. HSPICE or HSPICE RF uses the `.OPTION RELMOS` value, only if the current is greater than the `.OPTION ABSMOS` floor value. The default is `0.05`.

See Also

.OPTION ABSMOS
.OPTION RELI
.OPTION RELMOS

.OPTION RELQ

Syntax

```
.OPTION RELQ=x
```

Description

Used in the timestep algorithm for local truncation error (`LVLTIM = 2`). `RELQ` changes the timestep size. If the capacitor charge calculation (in the present iteration) exceeds that of the past iteration by a percentage greater than the `RELQ` value, then HSPICE reduces the internal timestep (Delta). The default is `0.01`.

You can use RELQ in HSPICE, but not in HSPICE RF.

See Also

.OPTION LVLTIM

.OPTION RELTOL

Syntax

```
.OPTION RELTOL=x
```

Description

Relative error tolerance for voltages. Use RELTOL with the ABSV control option to determine voltage convergence. Increasing RELTOL increases the relative error. RELTOL is the same as RELV. RELI and RELVDC options default to the RELTOL value. The default is 1e-3.

You can use the RELTOL and RELV options in HSPICE, but not in HSPICE RF.

See Also

.OPTION ABSV
.OPTION RELI
.OPTION RELV
.OPTION RELVDC

.OPTION RELV

Syntax

```
.OPTION RELV=x
```

Description

Sets the relative error tolerance for voltages. If voltage or current exceeds the absolute tolerances, a RELV test determines convergence. Increasing RELV increases the relative error. You should generally maintain RELV at its default value. RELV conserves simulator charge. For voltages, RELV is the same as RELTOL. The default is 1e-3.

See Also

.OPTION RELTOL

.OPTION RELVAR

Syntax

```
.OPTION RELVAR=x
```

Description

Use this option with ABSVAR, and the DVDT timestep algorithm. RELVAR sets the relative voltage change for LVLTIM = 1 or 3. If the node voltage at the current time point exceeds the node voltage at the previous time point by RELVAR, then HSPICE reduces the timestep, and calculates a new solution at a new time point. The default is 0.30 (30%).

For additional information, see section “DVDT Dynamic Timestep Algorithm” in the *HSPICE Simulation and Analysis User Guide*.

You can use the RELVAR option in HSPICE, but not in HSPICE RF.

See Also

.OPTION ABSVAR
.OPTION DVDT
.OPTION LVLTIM

.OPTION RELVDC

Syntax

```
.OPTION RELVDC=x
```

Description

Sets the relative error tolerance for voltages. If voltages or currents exceed their absolute tolerances, the RELVDC test determines convergence. Increasing RELVDC increases the relative error. You should generally maintain RELVDC at its default value. RELVDC conserves simulator charge. Default is RELTOL (RELTOL default = 1e-3).

See Also

.OPTION RELTOL

.OPTION RESMIN

Syntax

```
.OPTION RESMIN=x
```

Description

Minimum resistance for all resistors, including parasitic and inductive resistances. The default is `1e-5` (ohm), and the range is `1e-15` to `10` ohm.

.OPTION RISETIME

Syntax

```
.OPTION RISETIME=x
```

Description

Smallest risetime of a signal. Use this option only in transmission line models or HSPICE RF. In the U element, this equation determines the number of lumps:

$$MIN\left[20, 1 + \left(\frac{TDeff}{RISETIME}\right) \cdot 20\right]$$

TDeff is the end-to-end delay in a transmission line. The W element uses `RISETIME`, only if Rs or Gd is non-zero. In such cases, `RISETIME` determines the maximum signal frequency.

.OPTION RMAX

Syntax

```
.OPTION RMAX=x
```

Description

Sets the TSTEP multiplier, which controls the maximum value (DELMAX) for the Delta of the internal timestep:

```
DELMAX = TSTEP x RMAX
```

- The default is 5, if DVDT is 4 and LVLTIM is 1.
- Otherwise, the default is 2.

The maximum value is 1e+9, the minimum value is 1e-9. The recommended maximum value is 1e+5. Supported in HSPICE and HSPICE RF.

For a discussion about timestep control, see section “Timestep Control for Accuracy” in the *HSPICE Simulation and Analysis User Guide*.

See Also

.OPTION DELMAX
.OPTION DVDT
.OPTION LVLTIM

.OPTION RMIN

Syntax

```
.OPTION RMIN=x
```

Description

Sets the minimum value of Delta (internal timestep). An internal timestep smaller than `RMIN` x `TSTEP`, terminates the transient analysis, and reports an internal timestep too small error. If the circuit does not converge in `IMAX` iterations, Delta decreases by the amount you set in the `FT` option. The default is `1.0e-9`.

You can use RMIN in HSPICE, but not HSPICE RF.

See Also

.OPTION FT
.OPTION IMAX

.OPTION RUNLVL

Syntax

```
.OPTION RUNLVL=x
```

Description

The value for the .OPTION RUNLVL option controls the speed and accuracy trade-off. Higher values of RUNLVL result in higher accuracy and longer simulation times, while lower values give lower accuracy and faster simulation runtimes. The value of RUNLVL can be set to 0, 1, 2, 3, 4, 5, or 6.

The RUNLVL option setting controls the scaling of all simulator tolerances simulatenously and affects timestep control, convergence, and model bypass tolerances all at once. Higher values of RUNLVL result in smaller timestep sizes, and could result in more Newton-Raphson iterations in order to meet stricter error tolerances. The mode activated with RUNLVL affects only transient analysis.

When RUNLVL is set to

- 0, the algorithm turns off.
- 1, the simulation runs at the lowest simulation runtime.
- 3, is the default value.
- 5 or 6, corresponds to the HSPICE standard accurate mode. For most circuits, RUNLVL = 5 is similar to HSPICE standard accurate mode. RUNLVL = 6 has the highest accuracy.

If .OPTION ACCURATE is specified in the netlist together with RUNLVL, then the value of RUNLVL is limited to 5. In this case, specifying RUNLVL with a value smaller than 5 results in simulation running with RUNLVL = 5.

The RUNLVL option interacts with other options as follows:

1. The RUNLVL option, regardless of its position in the netlist, overrides the LVLTIM and DVDT timestep control mode options.
2. When RUNLVL is specified in the netlist, the default value of the BYPASS option is 1. Setting BYPASS = 0 disables model bypass, regardless of the order in which BYPASS and RUNLVL are set.
3. If .OPTION ACCURATE is set, then the RUNLVL value is limited to 5, and the default value of BYPASS is set to 0. This behavior is independent of the order of the RUNLVL, BYPASS, and ACCURATE options.

4. The tstep value specified with the `.TRAN` command affects timestep control when a `RUNLVL` option is used. Timestep values larger than tstep*RMAX use a tighter timestep control tolerance.

See Also

.OPTION ACCURATE
.OPTION BYPASS
.OPTION DVDT
.OPTION LVLTIM
.OPTION RELTOL
.TRAN

.OPTION SCALE

Syntax

```
.OPTION SCALE=x
```

Description

Element scaling factor in HSPICE or HSPICE RF. Scales parameters in element cards, by their value. The default is 1.

.OPTION SCALM

Syntax

```
.OPTION SCALM=x
```

Description

Model scaling factor in HSPICE or HSPICE RF. Scales model parameters by their value. The default is `1`. See the *HSPICE Elements and Device Models Manual* for parameters this option scales.

.OPTION SDA

Syntax

```
.OPTION SDA=x
```

Description

SDA = 2 produces a Cadence WSF (ASCII format) post-analysis file for Opus™. This option requires a specific license. The SDA is the same as the CDS option.

See Also

.OPTION CDS

.OPTION SEARCH

Syntax

```
.OPTION SEARCH = 'directory_path'
```

Example

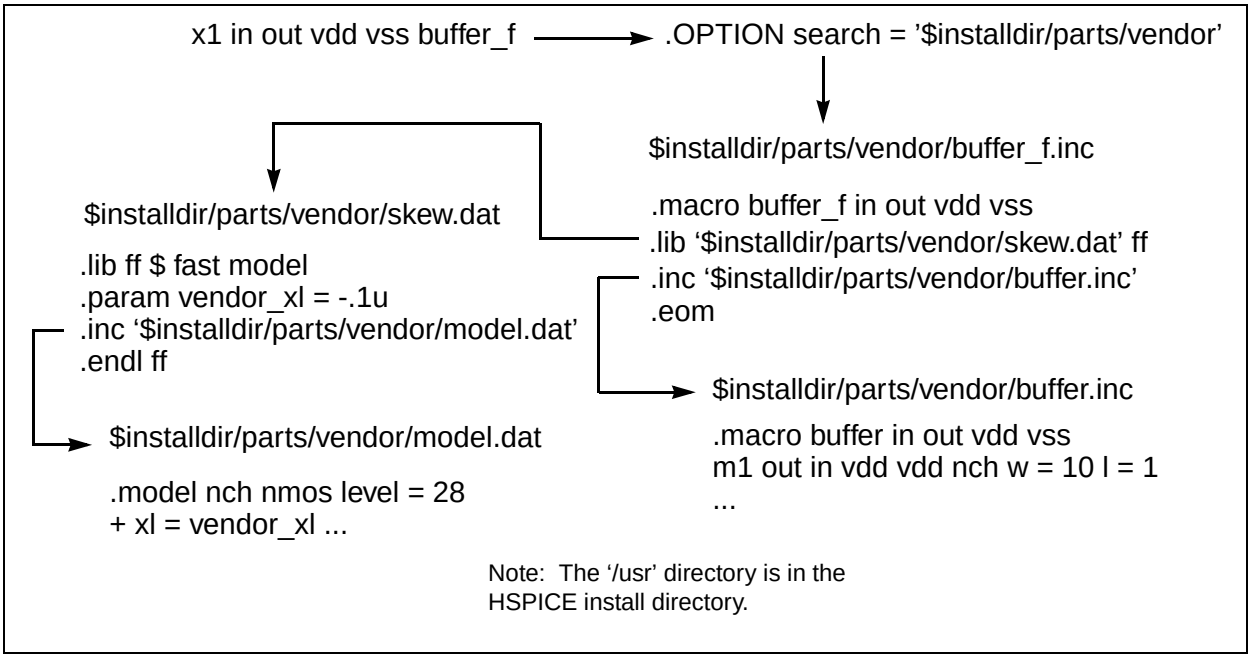
```
.OPTION SEARCH = '$installdir/parts/vendor'
```

Description

Use the `.OPTION SEARCH` statement to automatically access a library.

This example searches for models in the *vendor* subdirectory, under the `<$installdir>/parts` installation directory (see Figure 7). The *parts*/ directory contains the DDL subdirectories.

Figure 7 Vendor Library Usage



.OPTION SEED

Syntax

```
.OPTION SEED=x
```

Description

Starting seed for random-number generator in HSPICE Monte Carlo analysis (HSPICE RF does not support Monte Carlo analysis or the `.OPTION SEED` statement). The minimum value is 1; the maximum value is 259200.

.OPTION SLOPETOL

Syntax

```
.OPTION SLOPETOL=x
```

Description

Minimum value for breakpoint table entries in a piecewise linear (PWL) analysis. If the difference in the slopes of two consecutive PWL segments is less than the SLOPETOL value, HSPICE or HSPICE RF ignores the breakpoint for the point between the segments. The default is `0.75`.

.OPTION SPARSE

Syntax

```
.OPTION SPARSE=x
```

Description

The SPARSE option is the same as PIVOT.

See Also

.OPTION PIVOT

.OPTION SPICE

Syntax

```
.OPTION SPICE=x
```

Example 1

Example of general parameters, used with `.OPTION SPICE`:

```
TNOM = 27 DEFNRD = 1 DEFNRS = 1 INGOLD = 2
ACOUT = 0 DC
PIVOT PIVTOL = IE-13 PIVREL = 1E-3 RELTOL = 1E-3
ITL1 = 100
ABSMOS = 1E-6 RELMOS = 1E-3 ABSTOL = 1E-12
VNTOL = 1E-6
ABSVDC = 1E-6 RELVDC = 1E-3 RELI = 1E-3
```

Example 2

Example of transient parameters, used with `.OPTION SPICE`:

```
DCAP = 1 RELQ = 1E-3 CHGTOL-1E-14 ITL3 = 4 ITL4 = 10
ITL5 = 5000 FS = 0.125 FT = 0.125
```

Example 3

Example of model parameters, used with `.OPTION SPICE`:

```
For BJT: MJS = 0
For MOSFET, CAPOP = 0
LD = 0 if not user-specified   UTRA = 0 not used by SPICE for
LEVEL = 2   NSUB must be specified   NLEV = 0 for SPICE noise
equation
```

Description

Makes HSPICE compatible with Berkeley SPICE. HSPICE RF is C-based and not Fortran-based so it is not compatible with Berkeley SPICE. You can use `.OPTION SPICE` in HSPICE, but not in HSPICE RF. If you set this option, HSPICE uses the options and model parameters explained in the examples.

.OPTION SPMODEL

Syntax

```
.OPTION SPMODEL [= name]
```

Example 1

```
.option spmodel
```

This example disables the previous .OPTION VAMODEL, but has no effect on the other VAMODEL options if they are specified for the individual cells. For example, if .OPTION VAMODEL = vco has been set, the vco cell uses the Verilog-A definition whenever it is available until .OPTION SPMODEL = vco disables it.

Example 2

```
.option spmodel=chargepump
```

This example disables the previous .OPTION VAMODEL = chargepump, which causes all instantiations of chargepump to now use the subcircuit definition again.

Description

This option is for use in HSPICE with Verilog-A only. In this option, the name is the cell name that uses a SPICE definition. Each SPMODEL option can take no more than one name. Multiple names need multiple SPMODEL options.

.OPTION STATFL

Syntax

```
.OPTION STATFL=x
```

Description

Controls whether HSPICE creates a *.st0* file.

- `STATFL = 0` (default) outputs a *.st0* file.
- `STATFL = 1` suppresses the *.st0* file.

.OPTION SYMB

Syntax

```
.OPTION SYMB=x
```

Description

If you set the SYMB option to 1, HSPICE operates with a symbolic operating point algorithm to get initial guesses before calculating operating points. The default is 0.

.OPTION TIMERES

Syntax

```
.OPTION TIMERES=x
```

Description

Minimum separation between breakpoint values for the breakpoint table. If two breakpoints are closer together (in time) than the TIMERES value, HSPICE enters only one of them in the breakpoint table. The default is 1 ps.

You can use TIMERES in HSPICE, but not in HSPICE RF.

.OPTION TNOM

Syntax

```
.OPTION TNOM=x
```

Description

Reference temperature for HSPICE or HSPICE RF simulation. At this temperature, component derating is zero. The default is 25 °C. If you enable `.OPTION SPICE` (HSPICE only; HSPICE RF does not support this option), the default is 27 °C.

Note:

The reference temperature defaults to the analysis temperature if you do not explicitly specify a reference temperature.

See Also

.OPTION SPICE
.TEMP

.OPTION TRCON

Syntax

```
.OPTION TRCON=x
```

Description

Controls the speed of some special circuits. For some large non-linear circuits with large TSTOP/TSTEP values, analysis might run for an excessively long time. In this case, HSPICE might automatically set a new and bigger RMAX value to speed up the analysis for primary reference. In most cases, however, HSPICE does not activate this type of autospeedup process.

For autospeedup to occur, all three of the following conditions must occur:

- N1 (Number of Nodes) > 1,000
- N2 (TSTOP/TSTEP) >= 10,000
- N3 (Total Number of Diode, BJTs, JFETs and MOSFETs) > 300

Autospeedup is most likely to occur if the circuit also meets either of the following conditions:

- N2 >= 1e+8, and N3 > 500, or
- N2 >= 2e+5, and N3 > 1e+4
- `TRCON = 3`: enable auto-speedup only. HSPICE invokes auto-speed up if:
  - there are more than 1000 nodes, or
  - there are more than 300 active devices, or
  - Tstop/Tstep (as defined in .TRAN) > 1e8.

When auto-speedup is active, RMAX increases, and HSPICE can take larger timesteps.

- `TRCON = 2`: enables auto-convergence only.
  - HSPICE invokes auto-convergence if you use the default integration method (trapezoidal), and if HPSICE fails to converge, an “internal timestep too small” error is issued.
  - Auto-convergence sets `METHOD = gear`, `LVLTIM = 2`, and starts the transient simulation again from `time=0`.
- `TRCON = 1`: enables both auto-convergence and auto-speedup.

- `TRCON = 0`: disables both auto-convergence and auto-speedup (default).
- `TRCON = -1`: same as `TRCON = 0`.

`TRCON` also controls the automatic convergence process (autoconvergence) as well as the automatic speedup (autospeedup) processes in HSPICE. You cannot use `TRCON` in HSPICE RF. HSPICE also uses autoconvergence in DC analysis, if the Newton-Raphson (N-R) method fails to converge.

If the circuit fails to converge using the trapezoidal (TRAP) numerical integration method (for example, because of trapezoidal oscillation), HSPICE uses the GEAR method and LTE timestep algorithm to run the transient analysis again from `time=0`. This process is called autoconvergence.

Autoconvergence sets options to their default values before the second try:

```
METHOD=GEAR, LVLTIM=2, MBYPASS=1.0,
+ BYPASS=0.0, SLOPETOL=0.5,
+ BYTOL= min{mbypas*vntol and reltol}
```

`RMAX = 2.0` if it was 5.0 in the first run; otherwise RMAX does not change.

See Also

.OPTION BYPASS
.OPTION BYTOL
.OPTION MBYPASS
.OPTION RMAX
.OPTION SLOPETOL

.OPTION TRTOL

Syntax

```
.OPTION TRTOL=x
```

Description

Used in the timestep algorithm for local truncation error (`LVLTIM = 2`). HSPICE multiplies `TRTOL` by the internal timestep, which the timestep algorithm for the local truncation error generates. `TRTOL` reduces simulation time, and maintains accuracy. It estimates the amount of error introduced when the algorithm truncates the Taylor series expansion. This error reflects the minimum time-step to reduce simulation time and maintain accuracy. The range of `TRTOL` is 0.01 to 100; typical values are 1 to 10. If you set `TRTOL` to 1 (the minimum value), HSPICE uses a very small timestep. As you increase the `TRTOL` setting, the timestep size increases. The default is `7.0`.

You can use `TRTOL` in HSPICE, but not HSPICE RF.

See Also

.OPTION LVLTIM

.OPTION UNWRAP

Syntax

```
.OPTION UNWRAP
```

Description

Displays phase results for AC analysis in unwrapped form (with a continuous phase plot).HSPICE uses these results to accurately calculate group delay (HSPICE RF does not support group time delays in AC analysis output). It also uses unwrapped phase results to compute group delay, even if you do not set UNWRAP.

.OPTION VAMODEL

Syntax

```
.OPTION VAMODEL [=name]
```

Example 1

```
.option vamodel=vco
```

This example specifies a Verilog-A definition for all instantiations of the cell `vco`.

Example 2

```
.option vamodel=vco vamodel=chargepump
```

This example specifies a Verilog-A definition for all instantiations of the `vco` and `chargepump` cells.

Example 3

```
.option vamodel
```

This example instructs HSPICE to always use the Verilog-A definition whenever it is available.

Description

This option is for use in HSPICE with Verilog-A only. This option specifies that the *name* is the cell name that uses a Verilog-A definition rather than the subcircuit definition when both exist. Each `VAMODEL` option can take no more than one name. Multiple names need multiple `VAMODEL` options.

If a name is not provided for the `VAMODEL` option, HSPICE uses the Verilog-A definition whenever it is available. The `VAMODEL` option works on cell-based instances only. Instance-based overriding is not allowed.

.OPTION VERIFY

Syntax

```
.OPTION VERIFY=x
```

Description

This option is an alias for `.OPTION` LIST.

See Also

.OPTION LIST

.OPTION VFLOOR

Syntax

```
.OPTION VFLOOR=x
```

Description

Minimum voltage to print in output listing. All voltages lower than VFLOOR, print as 0. Affects only the output listing: VNTOL (ABSV) sets minimum voltage to use in a simulation.

See Also

.OPTION ABSV
.OPTION VNTOL

.OPTION VNTOL

Syntax

```
.OPTION VNTOL=x
```

Description

The VNTOL option is the same as the ABSV option.

See Also

.OPTION ABSV

.OPTION WACC

Syntax

```
.OPTION WACC=x
```

Description

This option is used to activate the dynamic step control algorithm for a W element transient analysis. WACC is a non-negative real value, which can be set between 0.0 and 10.0.

When WACC is positive, the dynamic step control algorithm is activated. Larger values result in higher performance with lower accuracy, while smaller values result in lower performance with better accuracy.

Use WACC = 1.0 for normal simulation and WACC = 0.1 for an accurate simulation. When WACC = 0.0, the original step control method is used with predetermined static breakpoints. Currently the default value is 0.0. For HSPICE RF, the default value for WACC is 0.5. If WACC is set as *0.0*, no control is added.

.OPTION WNFLAG

Syntax

```
.OPTION WNFLAG=[0|1]
```

Description

This option only applies to BSIM4 models. You use this option to select a bin model.

When an `.OPTION WNFLAG` instance parameter

- is not specified, the bin model specified by this option is used.
- is specified, its value is used.

Use `WNFLAG=1` (default) to select the bin model based on W (BSIM4 MOSFET channel width) per NF (number of device fingers) parameters.

Use `WNFLAG=0` to select the bin model based on total W.

.OPTION WARNLIMIT

Syntax

```
.OPTION WARNLIMIT=x
```

Description

Limits how many times certain warnings appear in the output listing. This reduces the output listing file size. *x* is the maximum number of warnings for each warning type. This limit applies to the following warning messages:

- MOSFET has negative conductance.
- Node conductance is zero.
- Saturation current is too small.
- Inductance or capacitance is too large.

The default is 1.

.OPTION WL

Syntax

```
.OPTION WL=x
```

Description

Reverses the order of the MOS element VSIZE. Default order is length-width; changes the order to width-length. The default is 0.

.OPTION XDTEMP

Syntax

```
.OPTION XDTEMP=value
```

Example

```
.OPTION XDTEMP
X1 2 0 SUB1 DTEMP=2
.SUBCKT SUB1 A B
R1 A B 1K DTEMP=3
C1 A B 1P
X2 A B sub2 DTEMP=4
.ENDS
.SUBCKT SUB2 A B
R2 A B 1K
.ENDS
```

In this example:

- X1 sets a temperature difference (2 degrees Celsius) between the elements within the subcircuit SUB1.
- X2 (a subcircuit instance of X1) sets a temperature difference by the DTEMP value of both X1 and X2 (2+4=6 degrees Celsius) between the elements within the SUB2 subcircuit. Finally, the DTEMP value of each element in this example is:

```
Elements DTEMP Value (Celsius)
X1 2
X1.R1 2+3 =5
X1.C1 2
X2 2+4=6
X2.R2 6
```

Description

The .OPTION XDTEMP statement defines how HSPICE interprets the DTEMP parameter, where value is either:

- 0 (the default), indicating a user-defined parameter, or
- 1 indicates a temperature difference parameter.

If you set .OPTION XDTEMP to 1, HSPICE adds the DTEMP value in the subcircuit call statement to all elements within the subcircuit, that use the DTEMP keyword syntax.

The DTEMP parameter is cumulative throughout the design hierarchy.

.OPTION ZUKEN

Syntax

```
.OPTION ZUKEN=x
```

Description

This option enables or disables the Zuken interface.

- If x is 2, enables the Zuken interactive interface.
- If x is 1 (default), disables this interface.

4

Commands in Digital Vector Files

Contains an alphabetical listing of the commands you can use in an digital vector file.

You can use the following commands in a digital vector file.

ENABLE	TDELAY	VIL
IO	TFALL	VNAME
ODELAY	TRISE	VOH
OUT or OUTZ	TRIZ	VOL
PERIOD	TSKIP	VREF
RADIX	TUNIT	VTH
SLOPE	VIH	

ENABLE

Syntax

ENABLE *controlling_signalname mask*

Argument	Definition
controlling_signalname	Controlling signal for bidirectional signals. Must be an input signal with a radix of 1. The bidirectional signals become output when the controlling signal is at state 1 (or high). To reverse this default control logic, start the control signal name with a tilde (~).
mask	Defines the bidirectional signals to which ENABLE applies.

Example

```
radix 144
io ibb
vname a x[[3:0]] y[[3:0]]
enable a 0 F 0
enable ~a 0 0 F
```

In this example, the *x* and *y* signals are bidirectional as defined by the *b* in the *io* line.

- The first enable statement indicates that *x* (as defined by the position of *F*) becomes output when the *a* signal is 1.
- The second enable specifies that the *y* bidirectional bus becomes output when the *a* signal is 0.

Description

The ENABLE statement specifies the controlling signal(s) for bidirectional signals. All bidirectional signals require an ENABLE statement. If you specify more than one ENABLE statement, the last statement overrules the previous statement, and HSPICE or HSPICE RF issues a warning message:

```
[Warning]:[line 6] resetting enable signal to WENB for bit 'XYZ'
```

IDELAY

Syntax

IDELAY *delay_value mask*

Argument	Definition
delay_value	Time delay to apply to the signals.
mask	Signals to which the delay applies. If you do not provide a mask, the delay value applies to all signals.

Example

```
RADIX 1 1 4 1234 11111111
IO i i o iiib iiiiiiii
VNAME V1 V2 VX[[3:0]] V4 V5[[1:0]] V6[[0:2]] V7[[0:3]]
+ V8 V9 V10 V11 V12 V13 V14 V15
TDELAY 1.0
TDELAY -1.2 0 1 F 0000 00000000
TDELAY 1.5 0 0 0 1370 00000000
IDELAY 2.0 0 0 0 000F 00000000
ODELAY 3.0 0 0 0 000F 00000000
```

This example does not specify the TUNIT statement so HSPICE or HSPICE RF uses the default, ns, as the time unit for this example. The first TDELAY statement indicates that all signals have the same delay time of 1.0ns. Subsequent TDELAY, IDELAY, or ODELAY statements overrule the delay time of some signals.

- The delay time for the V2 and Vx signals is -1.2.
- The delay time for the V4, V5[0:1], and V6[0:2] signals is 1.5.
- The input delay time for the V7[0:3] signals is 2.0, and the output delay time is 3.0.

Description

Defines an input delay time for bidirectional signals, relative to the absolute time of each row in the Tabular Data section.

HSPICE or HSPICE RF ignores IDELAY settings on output signals, and issues a warning message.

You can specify more than one TDELAY, IDELAY, or ODELAY statement.

- If you apply more than one TDELAY (IDELAY, ODELAY) statement to a signal, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning.
- If you do not specify the signal delays in a TDELAY, IDELAY, or ODELAY statement, HSPICE or HSPICE RF defaults to zero.

See Also

ODELAY
TDELAY
TUNIT

IO

Syntax

```
IO I | O | B | U     [I | O | B | U ...]
```

Argument	Definition
i	Input, which HSPICE or HSPICE RF uses to stimulate the circuit.
o	Expected output, which HSPICE or HSPICE RF compares with the simulated outputs.
b	Bidirectional vector.
u	Unused vector, which HSPICE or HSPICE RF ignores.

Example

```
io i i i bbbb iiiioouu
```

Description

The `IO` statement defines the type for each vector. The line starts with the `IO` keyword followed by a string of i, b, o, or u definitions. These definitions indicate whether each corresponding vector is an input (i), bidirectional (b), output (o), or unused (u) vector.

- If you do not specify the `IO` statement, HSPICE or HSPICE RF assumes that all signals are input signals.
- If you define more than one `IO` statement, the last statement overrules previous statements.

ODELAY

Syntax

```
ODELAY delay_value mask
```

Argument	Definition
delay_value	Time delay to apply to the signals.
mask	Signals to which the delay applies. If you do not provide a mask, the delay value applies to all signals.

Example

```
RADIX 1 1 4 1234 11111111
IO i i o iiib iiiiiiii
VNAME V1 V2 VX[[3:0]] V4 V5[[1:0]] V6[[0:2]] V7[[0:3]]
+ V8 V9 V10 V11 V12 V13 V14 V15
TDELAY 1.0
TDELAY -1.2 0 1 F 0000 00000000
TDELAY 1.5 0 0 0 1370 00000000
IDELAY 2.0 0 0 0 000F 00000000
ODELAY 3.0 0 0 0 000F 00000000
```

This example does not specify the TUNIT statement so HSPICE or HSPICE RF uses the default, ns, as the time unit for this example. The first TDELAY statement indicates that all signals have the same delay time of 1.0ns. Subsequent TDELAY, IDELAY, or ODELAY statements overrule the delay time of some signals.

- The delay time for the V2 and Vx signals is -1.2.
- The delay time for the V4, V5[0:1], and V6[0:2] signals is 1.5.
- The input delay time for the V7[0:3] signals is 2.0, and the output delay time is 3.0.

Description

Defines an output delay time for bidirectional signals relative to the absolute time of each row in the Tabular Data section.

HSPICE or HSPICE RF ignores ODELAY settings on input signals and issues a warning message.

You can specify more than one TDELAY, IDELAY, or ODELAY statement.

- If you apply more than one TDELAY (IDELAY, ODELAY) statement to a signal, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning.
- If you do not specify the signal delays in a TDELAY, IDELAY, or ODELAY statement, HSPICE or HSPICE RF defaults to zero.

See Also

IDELAY
TDELAY
TUNIT

OUT or OUTZ

Syntax

OUT *<output_resistance> mask*

Argument	Definition
<output_resistance>	Output resistance for an input signal. Default=0.
mask	Signals to which the output resistance applies. If you do not provide a mask, the output resistance value applies to all input signals.

Example

```
OUT 15.1
OUT 150 1 1 1 0000 00000000
OUTZ 50.5 0 0 0 137F 00000000
```

The first OUT statement in this example creates a 15.1 ohm resistor to place in series with all vector inputs. The next OUT statement sets the resistance to 150 ohms for vectors 1 to 3. The OUTZ statement changes the resistance to 50.5 ohms for vectors 4 through 7.

Description

The OUT and OUTZ keywords are equivalent, and specify output resistance for each signal (for which the mask applies); OUT (or OUTZ) applies only to input signals.

- If you do not specify the output resistance of a signal in an OUT (or OUTZ) statement, HSPICE or HSPICE RF uses the default (zero).
- If you specify more than one OUT (or OUTZ) statement for a signal, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning message.

The OUT (or OUTZ) statements have no effect on the expected output signals.

PERIOD

Syntax

PERIOD *time_interval*

Argument	Definition
time_interval	Time interval for the Tabular Data.

Example

```
radix 1111 1111
period 10
1000 1000
1100 1100
1010 1001
```

- The first row of the tabular data (1000 1000) is at time 0ns.
- The second row (1100 1100) is at 10ns.
- The third row (1010 1001) is at 20ns.

Description

The PERIOD statement defines the time interval for the Tabular Data section. You do not need to specify the absolute time at every time point. If you use a PERIOD statement without the TSKIP statement, the Tabular Data section contains only signal values, not absolute times. The TUNIT statement defines the time unit of the PERIOD.

RADIX

Syntax

RADIX <*number_of_bits*> [<*number_of_bits*>...]

Argument	Definition
<*number_of_bits*>	Specifies the number of bits in one vector in the digital vector file. You must include a separate <*number_of_bits*> argument in the RADIX statement for each vector listed in the file.

Example

```
; start of Vector Pattern Definition section
RADIX 1 1 4 1234 1111 1111
VNAME A B C[[3:0]] I9 I[[8:7]] I[[6:4]] I[[3:0]] O7 O6 O5 O4
+ O3 O2 O1 O0
IO I I I IIII OOOO OOOO
```

This example illustrates two 1-bit signals followed by a 4-bit signal, followed by one each 1-bit, 2-bit, 3-bit, and 4-bit signals, and finally eight 1-bit signals.

Description

The RADIX statement specifies the number of bits associated with each vector. Valid values for the number of bits range from 1 to 4.

Table 1 Valid Values for the RADIX Statement

# bits	Radix	Number System	Valid Digits
1	2	Binary	0, 1
2	4	–	0 – 3
3	8	Octal	0 – 7
4	16	Hexadecimal	0 – F

A digital vector file must contain only one RADIX command, and it must be the first non-comment line in the file.

SLOPE

Syntax

SLOPE [<*input_rise_time*> | <*input_fall_time*>] *mask*

Argument	Definition
<*input_rise_time*>	Rise time of the input signal.
<*input_fall_time*>	Fall time of the input signal.
mask	Name of a signal to which the SLOPE statement applies. If you do not specify a mask, the SLOPE statement applies to all signals.

Example 1

```
SLOPE 1.2
```

In this example, the rising and falling times of all signals are 1.2 ns.

Example 2

```
SLOPE 1.1 1100 0110
```

In this example, the rising/falling time is 1.1 ns for the first, second, sixth, and seventh signals.

Description

The SLOPE statement specifies the rise/fall time for the input signal. Use the TUNIT statement to define the time unit for this statement.

- If you do not specify the SLOPE statement, the default slope value is 0.1 ns.
- If you specify more than one SLOPE statement, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning message.

The SLOPE statement has no effect on the expected output signals. You can specify the optional TRISE and TFALL statements to overrule the rise time and fall time of a signal.

TDELAY

Syntax

TDELAY *delay_value mask*

Argument	Definition
delay_value	Time delay to apply to the signals.
mask	Signals to which the delay applies. If you do not provide a mask, the delay value applies to all signals.

Example

```
RADIX 1 1 4 1234 11111111
IO i i o iiib iiiiiiii
VNAME V1 V2 VX[[3:0]] V4 V5[[1:0]] V6[[0:2]] V7[[0:3]]
+ V8 V9 V10 V11 V12 V13 V14 V15
TDELAY 1.0
TDELAY -1.2 0 1 F 0000 00000000
TDELAY 1.5 0 0 0 1370 00000000
IDELAY 2.0 0 0 0 000F 00000000
ODELAY 3.0 0 0 0 000F 00000000
```

This example does not specify the TUNIT statement so HSPICE or HSPICE RF uses the default, ns, as the time unit for this example. The first TDELAY statement indicates that all signals have the same delay time of 1.0ns. Subsequent TDELAY, IDELAY, or ODELAY statements overrule the delay time of some signals.

- The delay time for the V2 and Vx signals is -1.2.
- The delay time for the V4, V5[0:1], and V6[0:2] signals is 1.5.
- The input delay time for the V7[0:3] signals is 2.0, and the output delay time is 3.0.

Description

Defines the delay time of both input and output signals relative to the absolute time of each row in the Tabular Data section.

You can specify more than one TDELAY, IDELAY, or ODELAY statement.

- If you apply more than one TDELAY (IDELAY, ODELAY) statement to a signal, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning.
- If you do not specify the signal delays in a TDELAY, IDELAY, or ODELAY statement, HSPICE or HSPICE RF defaults to zero.

See Also

IDELAY
ODELAY
TUNIT

TFALL

Syntax

TFALL *<input_fall_time> mask*

Argument	Definition
<input_fall_time>	Fall time of the input signal.
mask	Name of a signal to which the TFALL statement applies. If you do not specify a mask, the TFALL statement applies to all input signals.

Example

In the following example, the TFALL statement assigns a fall time of 0.5 time units to all vectors.

```
TFALL 0.5
```

In the following example, the TFALL statement assigns a fall time of 0.3 time units, overriding the older setting of 0.5 to vectors 2, 3, and 4 to 7.

```
TFALL 0.3 0 1 1 137F 00000000
```

In the following example, the TFALL statement assigns a fall time of 0.9 time units to vectors 8 through 11.

```
TFALL 0.9 0 0 0 0000 11110000
```

Description

The TFALL statement specifies the fall time of each input signal for which the mask applies. The TUNIT statement defines the time unit of TFALL.

- If you do not use any TFALL statement to specify the fall time of the signals, HSPICE or HSPICE RF uses the value defined in the *slope* statement.
- If you apply more than one TFALL statement to a signal, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning message.

TFALL statements have no effect on the expected output signals.

TRISE

Syntax

TRISE *<input_rise_time> mask*

Argument	Definition
<input_rise_time>	Rise time of the input signal.
mask	Name of a signal to which the TRISE statement applies. If you do not specify a mask, the TRISE statement applies to all input signals.

Example 1

```
TRISE 0.3
```

In this example, the TRISE statement assigns a rise time of 0.3 time units to all vectors.

Example 2

```
TRISE 0.5 0 1 1 137F 00000000
```

In this example, the TRISE statement assigns a rise time of 0.5 time units, overriding the older setting of 0.3 in at least some of the bits in vectors 2, 3, and 4 through 7.

Example 3

```
TRISE 0.8 0 0 0 0000 11110000
```

In this example, the TRISE statement assigns a rise time of 0.8 time units to vectors 8 through 11.

Description

The TRISE statement specifies the rise time of each input signal for which the mask applies. The TUNIT statement defines the time unit of TRISE.

- If you do not use any TRISE statement to specify the rising time of the signals, HSPICE or HSPICE RF uses the value defined in the *slope* statement.

- If you apply more than one `TRISE` statement to a signal, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning message.

`TRISE` statements have no effect on the expected output signals.

TRIZ

Syntax

`TRIZ <output_impedance>`

Argument	Definition
<output_impedance>	Output impedance of the input signal.
mask	Name of a signal to which the `TRIZ` statement applies. If you do not specify a mask, the `TRIZ` statement applies to all input signals.

Example

```
TRIZ 15.1Meg
TRIZ 150Meg 1 1 1 0000 00000000
TRIZ 50.5Meg 0 0 0 137F 00000000
```

- The first `TRIZ` statement sets the high impedance resistance globally, at 15.1 Mohms.
- The second `TRIZ` statement increases the value to 150 Mohms, for vectors 1 to 3.
- The last `TRIZ` statement increases the value to 50.5 Mohms, for vectors 4 through 7.

Description

The `TRIZ` statement specifies the output impedance, when the signal (for which the mask applies) is in *tristate*; `TRIZ` applies only to the input signals.

- If you do not specify the *tristate* impedance of a signal, in a `TRIZ` statement, HSPICE or HSPICE RF assumes 1000M.
- If you apply more than one `TRIZ` statement to a signal, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning.

`TRIZ` statements have no effect on the expected output signals.

TSKIP

Syntax

```
TSKIP <absolute_time> <tabular_data> ...
```

Argument	Definition
<*absolute_time*>	Absolute time.
<*tabular_data*>	Data captured at <*absolute_time*>.

Example

```
radix 1111 1111
period 10
tskip
11.0 1000 1000
20.0 1100 1100
33.0 1010 1001
```

HSPICE or HSPICE RF ignores the absolute times 11.0, 20.0 and 33.0, but HSPICE does process the tabular data on the same lines as those absolute times.

Description

The TSKIP statement specifies to ignore the absolute time field in the tabular data. You can then keep, but ignore, the absolute time field of each row in the tabular data, when you use the PERIOD statement.

You might do this, for example, if the absolute times are not perfectly periodic for testing reasons. Another reason might be that a path in the circuit does not meet timing, but you might still use it as part of a test bench. Initially, HSPICE or HSPICE RF writes to the vector file, using absolute time. After you fix the circuit, you might want to use periodic data.

TUNIT

```
TUNIT [fs|ps|ns|us|ms]
```

Argument	Definition
fs	femtosecond
ps	picosecond
ns	nanosecond (this is the default)
us	microsecond
ms	millisecond

Example

```
TUNIT ns
11.0 1000 1000
20.0 1100 1100
33.0 1010 1001
```

The `TUNIT` statement in this example specifies that the absolute times in the Tabular Data section are 11.0ns, 20.0ns, and 33.0ns.

Description

The `TUNIT` statement defines the time unit in the digital vector file, for PERIOD, TDELAY,IDELAY, ODELAY, SLOPE, TRISE, TFALL, and absolute time.

- If you do not specify the `TUNIT` statement, the default time unit value is ns.
- If you define more than one `TUNIT` statement, the last statement overrules the previous statement.

See Also

IDELAY
ODELAY
TDELAY

VIH

Syntax

`VIH <logic-high_voltage> mask`

Argument	Definition
<logic-high_voltage>	Logic-high voltage for an input signal. Default=3.3.
mask	Name of a signal to which the `VIH` statement applies. If you do not specify a mask, the `VIH` statement applies to all input signals.

Example

```
VIH 5.0
VIH 3.5 0 0 0 0000 11111111
```

- The first `VIH` statement sets all input vectors to 5V, when they are high.
- The last `VIH` statement changes the logic-high voltage from 5V to 3.5V, for the last eight vectors.

Description

The `VIH` statement specifies the logic-high voltage, for each input signal to which the mask applies.

- If you do not specify the logic high voltage of the signals, in a `VIH` statement, HSPICE or HSPICE RF assumes 3.3.
- If you use more than one `VIH` statement for a signal, the last statement over-rules previous statements. HSPICE or HSPICE RF issues a warning.

`VIH` statements have no effect on the expected output signals.

See Also

VIL
VOH
VOL
VTH

VIL

Syntax

VIL *<logic-low_voltage>*

Argument	Definition
<logic-low_voltage>	Logic-low voltage for an input signal. Default=0.0.
mask	Name of a signal to which the VIL statement applies. If you do not specify a mask, the VIL statement applies to all input signals.

Example

```
VIL 0.0
VIL 0.5 0 0 0 0000 11111111
```

- The first VIL statement sets the logic-low voltage to 0V, for all vectors.
- The second VIL statement changes the logic-low voltage to 0.5V, for the last eight vectors.

Description

The VILstatement specifies the logic-low voltage, for each input signal to which the mask applies.

- If you do not specify the logic-low voltage of the signals, in a VIL statement, HSPICE or HSPICE RF assumes 0.0.
- If you use more than one VIL statement for a signal, the last statement over-rules previous statements. HSPICE or HSPICE RF issues a warning.

VIL statements have no effect on the expected output signals.

See Also

VIH
VOH
VOL
VTH

VNAME

Syntax

VNAME *vector_name*[[*starting_index* : *ending_index*]]

Argument	Definition
<*vector_name*>	Name of the vector, or range of vectors.
starting_index	First bit in a range of vector names.
ending_index	Last bit in a range of vector names. You can associate a single name with multiple bits (such as bus notation). The opening and closing brackets and the colon are required; they indicate that this is a range. The vector name must correlate with the number of bits available. You can nest the bus definition inside other grouping symbols, such as {}, (), [], and so on. The bus indices expand in the specified order

Example 1

```
RADIX 1 1 1 1 1 1 1 1 1 1 1 1
VNAME V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11 V12
```

Example 2

```
VNAME a[[0:3]]
```

This example represents a0, a1, a2, and a3, in that order. HSPICE or HSPICE RF does not reverse the order to make a3 the first bit.

The bit order is MSB:LSB, which means most significant bit to least significant bit. For example, you can represent a 5-bit bus such as: {a4 a3 a2 a1 a0}, using this notation: a[[4:0]]. The high bit is a4, which represents 2^4. It is the largest value, and therefore is the MSB.

Example 3

```
RADIX 2 4
VNAME VA[[0:1]] VB[[4:1]]
```

HSPICE or HSPICE RF generates voltage sources with the following names:

```
VA0 VA1 VB4 VB3 VB2 VB1
```

- *VA0* and *VB4* are the MSBs.
- *VA1* and *VB1* are the LSBs.

Example 4

```
VNAME VA[[0:1]] VB<[4:1]>
```

HSPICE or HSPICE RF generates voltage sources with the following names:

```
VA[0] VA[1] VB<4> VB<3> VB<2> VB<1>
```

Example 5

```
VNAME VA[[2:2]]
```

This example specifies a single bit of a bus. This range creates a voltage source named:

```
VA[2]
```

Example 6

```
RADIX 444444
VNAME A[[0:23]]
```

This example generates signals named A0, A1, A2, ... A23.

Description

The VNAME statement defines the name of each vector. If you do not specify VNAME, HSPICE or HSPICE RF assigns a default name to each signal: V1, V2, V3, and so on. If you define more than one VNAME statement, the last statement overrules the previous statement.

VOH

Syntax

VOH *<logic-high_voltage> mask*

Argument	Definition
<logic-high_voltage>	Logic-high voltage for an output vector. Default=2.66.
mask	Name of a signal to which the VOH statement applies. If you do not specify a mask, the VOH statement applies to all output signals.

Example

```
VOH 4.75
VOH 4.5 1 1 1 137F 00000000
VOH 3.5 0 0 0 0000 11111111
```

- The first line tries to set a logic-high output voltage of 4.75V, but it is redundant.
- The second line changes the voltage level to 4.5V, for the first seven vectors.
- The last line changes the last eight vectors to a 3.5V logic-high output.

These second and third lines completely override the first VOH statement.

If you do not define either VOH or VOL, HSPICE or HSPICE RF uses VTH (default or defined).

Description

The VOH statement specifies the logic-high voltage, for each output signal to which the mask applies.

- If you do not specify the logic-high voltage in a VOH statement, HSPICE or HSPICE RF assumes 2.64.
- If you apply more than one VOH statement to a signal, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning.

VOH statements have no effect on input signals.

See Also

VIH
VIL
VOL
VTH

VOL

Syntax

VOL *<logic-low_voltage> mask*

Argument	Definition
<logic-low_voltage>	Logic-low voltage for an output vector. Default=0.64.
mask	Name of a signal to which the VOL statement applies. If you do not specify a mask, the VOL statement applies to all output signals.

Example

```
VOL 0.0
VOL 0.2 0 0 0 137F 00000000
VOL 0.5 1 1 1 0000 00000000
```

- The first VOL statement sets the logic-low output to 0V.
- The second VOL statement sets the output voltage to 0.2V, for the fourth through seventh vectors.
- The last statement increases the voltage further to 0.5V, for the first three vectors.

These second and third lines completely override the first VOL statement.

If you do not define either VOH or VOL, HSPICE or HSPICE RF uses VTH (default or defined).

Description

The VOL statement specifies the logic-low voltage, for each output signal to which the mask applies.

- If you do not specify the logic-low voltage, in a VOL statement, HSPICE or HSPICE RF assumes 0.66.
- If you apply more than one VOL statement to a signal, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning.

See Also

VIH
VIL
VOH
VTH

VREF

Syntax

VREF *<reference_voltage>*

Argument	Definition
<reference_voltage>	Reference voltage for each input vector. Default=0.

Example

```
VNAME v1 v2 v3 v4 v5[[1:0]] v6[[2:0]] v7[[0:3]] v8 v9 v10
VREF 0
VREF 0 111 137F 000
VREF vss 0 0 0 0000 111
```

When HSPICE or HSPICE RF implements these statements into the netlist, the voltage source realizes *v1*:

```
v1 V1 0 pwl(......)
```

as well as *v2*, *v3*, *v4*, *v5*, *v6*, and *v7*.

However, *v8* is realized by

```
V8 V8 vss pwl(......)
```

v9 and *v10* use a syntax similar to v8.

Description

Similar to the TDELAY statement, the VREF statement specifies the name of the reference voltage, for each input vector to which the mask applies. VREF applies only to input signals.

- If you do not specify the reference voltage name of the signals, in a VREF statement, HSPICE or HSPICE RF assumes 0.
- If you apply more than one VREF statement, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning.

VREF statements have no effect on the output signals.

VTH

Syntax

VTH *<logic-threshold_voltage>*

Argument	Definition
<logic-threshold_voltage>	Logic-threshold voltage for an output vector. Default=1.65.

Example

```
VTH 1.75
VTH 2.5 1 1 1 137F 00000000
VTH 1.75 0 0 0 0000 11111111
```

- The first VTH statement sets the logic threshold voltage at 1.75V.
- The next line changes that threshold to 2.5V, for the first 7 vectors.
- The last line changes that threshold to 1.75V, for the last 8 vectors.

All of these examples apply the same vector pattern, and both output and input control statements, so the vectors are all bidirectional.

Description

Similar to the TDELAY statement, the VTH statement specifies the logic threshold voltage, for each output signal to which the mask applies. The threshold voltage determines the logic state of output signals, for comparison with the expected output signals.

- If you do not specify the threshold voltage of the signals, in a VTH statement, HSPICE or HSPICE RF assumes 1.65.
- If you apply more than one VTH statement to a signal, the last statement overrules the previous statements, and HSPICE or HSPICE RF issues a warning.

VTH statements have no effect on the input signals.

See Also

VIH
VIL
VOH
VOL

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