OCEAN Reference

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Contents

Preface

The preface discusses the following:

Related Documents

The Open Command Environment for Analysis (OCEAN) is based on the Virtuoso® SKILL programming language. The following manuals give you more information about the SKILL language and other related products.

- The SKILL Language User Guide describes how to use the SKILL language functions, the SKILL++ functions, and the SKILL++ object system (for object-oriented programming).
- The SKILL Language Reference provides descriptions, syntax, and examples for the SKILL and SKILL++ functions.
- The SKILL++ Object System Functions Reference provides descriptions, syntax, and examples for the object system functions.
- The Virtuoso® Analog Design Environment User Guide explains how to design and simulate analog circuits.
- The Virtuoso® Mixed-Signal Circuit Design Environment User Guide explains how to design and simulate mixed-signal circuits.
- The Virtuoso® Analog Distributed Processing Option User Guide explains how to set up and run distributed processing for OCEAN and other Virtuoso® Analog Design Environment applications.

Typographic and Syntax Conventions

This list describes the syntax conventions used for the Virtuoso® Analog Design Environment SKILL functions.

`literal`	Nonitalic words indicate keywords that you must type literally. These keywords represent command (function, routine) or option names.
`argument` (*`z_argument`*)	Words in italics indicate user-defined arguments for which you must substitute a name or a value. (The characters before the underscore (_) in the word indicate the data types that this argument can take. Names are case sensitive. Do not type the underscore (*z_*) before your arguments.) For a listing of data types, see "Data Types Used in OCEAN" on page 24.
|	Vertical bars (OR-bars) separate possible choices for a single argument. They take precedence over any other character.
`[ ]`	Brackets denote optional arguments. When used with OR-bars, they enclose a list of choices. You can choose one argument from the list.
`{ }`	Braces are used with OR-bars and enclose a list of choices. You must choose one argument from the list.
…	Three dots (…) indicate that you can repeat the previous argument. If you use them with brackets, you can specify zero or more arguments. If they are used without brackets, you must specify at least one argument, but you can specify more. *`argument`*… Specify at least one, but more are possible. *`[argument]`*… Specify zero or more.
`,`…	A comma and three dots together indicate that if you specify more than one argument, you must separate those arguments by commas.
=>	A right arrow precedes the possible values that a SKILL function can return. This character is represented by an equal sign and a greater than sign.
/	A slash separates the possible values that can be returned by a SKILL function.

<yourSimulator>

Angle brackets indicate places where you need to insert the name of your simulator. Do not include the angle brackets when you insert the simulator name.

Important

The characters included in the list above are the only characters that are not typed literally. All other characters in the SKILL language are required and must be typed literally.

SKILL Syntax Examples

The following examples show typical syntax characters used in the SKILL language.

Example 1

```
list( g_arg1 [g_arg2] …
    )
    => l_result
```

Example 1 illustrates the following syntax characters.

list	Plain type indicates words that you must type literally.
g_arg1	Words in italics indicate arguments for which you must substitute a name or a value.
( )	Parentheses separate names of functions from their arguments.
_	An underscore separates an argument type (left) from an argument name (right).
[ ]	Brackets indicate that the enclosed argument is optional.
=>	A right arrow points to the return values of the function. Also used in code examples in SKILL manuals.
…	Three dots indicate that the preceding item can appear any number of times.

Example 2

```
needNCells(
    s_cellType | st_userType
    x_cellCount
    )
    => t/nil
```

Example 2 illustrates two additional syntax characters.

|	Vertical bars separate a choice of required options.
/	Slashes separate possible return values.

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Introduction to OCEAN

This chapter provides an introduction to Open Command Environment for Analysis (OCEAN). In this chapter, you can find information about

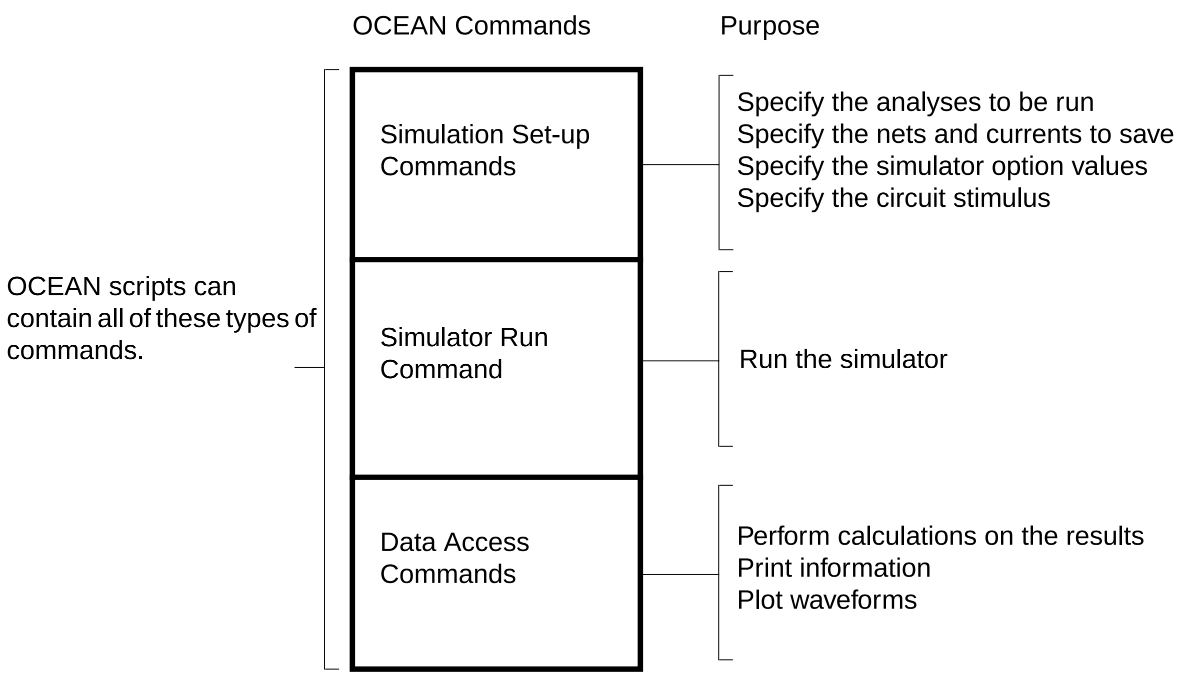
OCEAN lets you set up, simulate, and analyze circuit data. OCEAN is a text-based process that you can run from a UNIX shell or from the Command Interpreter Window (CIW). You can type OCEAN commands in an interactive session, or you can create scripts containing your commands, then load those scripts into OCEAN. OCEAN can be used with any simulator integrated into the Virtuoso® Analog Design Environment.

Typically, you use the Virtuoso® Analog Design Environment when creating your circuit (in Composer) and when interactively debugging the circuit. After the circuit has the performance you want, you can use OCEAN to run your scripts and test the circuit under a variety of conditions. After making changes to your circuit, you can easily rerun your scripts. OCEAN lets you

- Create scripts that you can run repeatedly to verify circuit performance
- Run longer analyses such as parametric analyses, Corners Analyses, and statistical analyses more effectively
- Run long simulations in OCEAN without starting the Virtuoso® Analog Design Environment graphical user interface
- Run simulations from a nongraphic, remote terminal

Types of OCEAN Commands

You can create OCEAN scripts to accomplish the full suite of simulation and data access tasks that you can perform in the Virtuoso® Analog Design Environment. An OCEAN script can contain three types of commands, as shown in the following figure.



All the parameter storage format (PSF) information created by the simulator is accessible through the OCEAN data access commands. (The data access commands include all of the Virtuoso® Analog Design Environment calculator functions.)

OCEAN Online Help

Online help is available for all the OCEAN commands when you are in an OCEAN session. To get help for a specific OCEAN command, type the following:

```
ocnHelp( 'commandName )
```

This command returns an explanation of the command and examples of how the command can be used.

To get a listing of all the different types of commands in OCEAN, type the following:

```
ocnHelp()
```

For more information, see “ocnHelp” on page 129.

OCEAN Syntax Overview

OCEAN is based on the Virtuoso® SKILL programming language and uses SKILL syntax. All the SKILL language commands can be used in OCEAN. This includes `if` statements, `case` statements, `for` loops, `while` loops, `read` commands, `print` commands, and so on.

The most commonly used SKILL commands are documented in this manual. However, you are not limited to these commands. You can use any SKILL routine from any SKILL manual.

Common SKILL Syntax Characters Used in OCEAN

This section provides an overview of some basic SKILL syntax concepts that you need to understand to use OCEAN. For more information about SKILL syntax, see Chapter 3, “Introduction to SKILL.”

Parentheses

Parentheses surround the arguments to the command. The command name is followed immediately by the left parenthesis, with no intervening space.

Examples

The following example shows parentheses correctly enclosing two arguments to the `path` command.

```
path( "~/simulation1/schematic/psf" "~/simulation2/schematic/psf" )
```

In the next example, the space after the command name causes a syntax error.

Syntax error.

```
path ( "~/simulation1/schematic/psf" "~/simulation2/schematic/psf" )
```

Quotation Marks

Quotation Marks are used to surround string values. A string value is a sequence of characters, such as `"abc"`.

In the following example, the directory names provided to the `path` command are strings, which must be surrounded by quotation marks.

```
path( "~/simulation1/schematic/psf" "~/simulation2/schematic/psf" )
```

Convention

In this manual, a SKILL convention is used to let you know when an argument must be a string. When you see the prefix *t_*, you must substitute a string value (surrounded by quotation marks) for the argument. Consider the following syntax statement:

desVar(*t_desVar1 g_value1 t_desVar2 g_value2*)

In this case, there are two string values that must be supplied: *t_desVar1* and *t_desVar2*. (The *g_* prefix indicates a different type of argument. For more information about prefixes, see Chapter 4, "Working with SKILL.")

Recovering from an Omitted Quotation Mark

Accidentally omitting a closing quotation mark from an OCEAN command can cause great confusion. For example, typing the incorrect command

```
strcat( "rain" "bow )
```

appears to hang OCEAN. In an attempt to recover, you type a `Control-c`. That gives you a prompt but it does not fix the problem, as you discover when you then type the correct command.

```
strcat( "rain" "bow" )
```

Again, you have to type a `Control-c` and OCEAN responds with another message.

```
^C*Error* parser: interrupted while reading input
```

If you find yourself in this situation, do not press a `Control-c`. Instead, recover by entering a quotation mark followed by a right square bracket (`]`). This procedure reestablishes a normal OCEAN environment and you can then reenter the correct command.

```
ocean> strcat( "rain" "bow )
"]
"rainbow ) "
ocean> strcat( "rain" "bow" )
"rainbow"
ocean>
```

Single Quotation Marks

The single quotation mark indicates that an item is a symbol. Symbols in SKILL correspond to constant enums in C. In the context of OCEAN, there are predefined symbols. The simulator that you use also has predefined symbols. When using symbols in OCEAN, you must use these predefined symbols.

Examples

In the following example, `tran` is a symbol and must be preceded by a single quotation mark. The symbol `tran` is predefined. You can determine what the valid symbols for a command are by checking the valid values for the command's arguments. For example, if you refer to "analysis" on page 75, you see that the valid values for the first argument include `'tran`.

```
analysis( ’tran … )
```

The list of items you can save with the `save` command is also predefined. You must choose from this predefined list. See "save" on page 111 and refer to the valid values for the *`s_saveType`* argument. The `’v` symbol indicates that the item to be saved is the voltage on a net.

```
save( ’v "net1" )
```

Convention

In this manual, a SKILL convention is used to let you know when an argument must be a symbol. When you see the prefix *`s_`*, you must substitute a symbol (preceded by a single quotation mark) for the argument. Consider the following syntax statement:

```
selectResults( s_resultsName ) => t/nil
```

In this case, there is one symbol that must be supplied: *`s_resultsName`*. For the `selectResults` command, there is a different mechanism that lets you know the list of predefined symbols. If you type the following command, with no arguments, the list of predefined symbols is returned: `results() => ( dc tran ac )`

Note: Depending on which results are selected, the values returned by the `results` command vary.

Question Mark

The question mark indicates an optional keyword argument, which is the first part of a keyword parameter. A keyword parameter has two components:

- The first component is the keyword, which has a question mark in front of it.
- The second component is the value being passed, which immediately follows the keyword.

Keyword parameters, composed of these keyword/value pairs, are always optional.

Examples

In the following example, all the arguments to the `analysis` command except `'tran` are keyword/value pairs and are optional.

Keyword Value passed

```
analysis( 'tran ?start 0 ?stop 1u ?step 1n )
```

For example, you can use `?center` and `?span` instead of `?start` and `?stop`. You also can omit `?start` altogether because it is an optional argument.

Convention

In this manual, a SKILL convention is used to let you know when arguments are optional. Optional arguments are surrounded by square brackets [ ]. In the following example, all of the keyword/value pairs are surrounded by square brackets, indicating that they are optional.

```
report([?output t_filename | p_port] [?type t_type] [?name t_name]
    [?param t_param] [?format s_reportStyle] ) => t/nil
```

Data Types Used in OCEAN

The following table shows the internal names and prefixes for the SKILL data types that are used in OCEAN commands.

Data Type	Internal Name	Prefix
floating-point number	flonum	f
any data type	general	g
linked list	list	l
integer, floating-point number, or complex number		n

Data Type	Internal Name	Prefix
user-defined type		o
I/O port	port	p
symbol	symbol	s
symbol or character string		S
character string (text)	string	t
window type		w
integer number	fixnum	x

For more information about SKILL datatypes, see Chapter 4, “Working with SKILL.”

OCEAN Return Values

You get return values from most OCEAN commands and can use these values in other OCEAN commands.

The following table shows some examples in which the return value from a command is assigned to a variable.

Assigning a Return Value to a Variable	Resulting Value for the Variable
`a=desVar("r1" 1k)`	a=1k
`a=desVar("r1" 1k "r2" 2k)`	a=2k
`a=desVar("r1")`	a=1k, assuming `r1` was set in a `desVar` command
`a=desVar("r2")`	a=2k, assuming `r2` was set in a `desVar` command

Design Variables in OCEAN

Design variables in OCEAN function as they do in the Virtuoso® Analog Design Environment. Design variables are not assigned in the order specified. Rather, they are reordered and then assigned. Consider the following example:

```
desVar( "a" "b+1" )
desVar( "b" 1 )
```

You might expect an error because a is assigned the value `b+1` before b is assigned a value. However, OCEAN reorders the statements and sends them as follows:

```
desVar( "b" 1 )
desVar( "a" "b+1" )
```

After the reordering, there is no error. (b is equal to `1` and a is equal to `2`.)

Suppose you run a simulation, then specify the following:

```
desVar("b" 2)
```

You might expect `a` to be equal to `2`, which was the last value specified. Instead, `a` is reevaluated to `b+1` or `3`.

This approach is similar to how the design variables are used in simulation. For example, consider a circuit that has the following resistor:

```
R1 1 0 resistor r=b
```

If you change the value of b, you expect the value of `R1` to change. You do not expect to have to netlist again or retype the `R1` instantiation.

This approach is used in the Virtuoso® Analog Design Environment. Users are not expected to enter design variables in a particular order. Rather, the design variables are gathered during the design variable search then reordered before they are used.

outputs() in OCEAN

Throughout this manual are examples of nets and instances preceded by a “`/`” as well as examples without the “`/`”. There is a significant difference between the two.

If you create a design in the Virtuoso® Analog Design Environment and save the OCEAN file, all net and instance names will be preceded with a “`/`”, indicating they are schematic names. The `netlist/amap` directory must be available to map these schematic names to names the simulator understands. (If your design command points to the raw netlist in the `netlist` directory, the `amap` directory is there.)

If you create a design or an OCEAN script by hand, or move the raw netlist from the `netlist` directory, the net and instance names might not be preceded with “`/`”. This indicates that simulator names are used, and mapping is not necessary.

If you are unsure whether schematic names or simulator names are used, after `selectResult(` *`S_resultsName`* `)`, type `outputs()` to see the list of net and instance names.

Note: Although you can move the raw netlist file from the `netlist` directory, it is not advised. There are other files in the `netlist` directory that are now required to run OCEAN.

Parametric Analysis

There are two ways you can run parametric analyses in OCEAN:

- You can use the `paramAnalysis` command (recommended approach).
- You can use a SKILL `for` loop.

Using the `paramAnalysis` command is an easier approach. With this command, you can set up any number of nested parametric analyses in an OCEAN script. The `paramRun` command runs all the parametric analyses. When the analysis is complete, the data can be plotted as a family of curves. The following example shows how you might use nested parametric analyses:

```
paramAnalysis( "rl" ?start 200 ?stop 600 ?step 200
    paramAnalysis( 'rs ?start 300 ?stop 700 ?step 200
    )
)
paramRun ()
```

In this example, the outer loop cycles through `r1`, and the inner loop cycles through `rs` as follows:

Loop through `r1` from 200 to 600 by 200.

Loop through `rs` from 300 to 700 by 200.

Run.

End the first loop.

End the second loop.

So, for `r1=200`, `rs` equals 300, 500 and then 700. Then, for `r1=400`, `rs` equals 300, 500, and then 700. Finally, for `r1=600`, `rs` equals 300, 500, and then 700

Use a SKILL `for` loop only if the `paramAnalysis` command is not adequate. You can use the SKILL `for` loop to set up any number of variable-switching runs. After all the simulations are complete, you have to work with the results directories individually. The following example shows how you might use SKILL loops for parametric analyses.

```
Cload = list( 2p 4p 6p 8p )
foreach( val  Cload
    desVar( "Cload" val )
    a=resultsDir( sprintf( nil "./demo/Cload=%g" val ) )
    printf( "%L", a )
    run( )
)
foreach( val  Cload
    openResults( sprintf( nil "./<dir>/Cload=%g" val ) )
    selectResults( 'ac )
    plot( vdb( "vout" ) )
)
```

Data Access Without Running a Simulation

You can retrieve and use data from previous simulations at any time by opening the data with the `openResults` command. After opening the data, you can use any data access commands on this data. For more information, see Chapter 7, "Data Access Commands."

You can use query commands such as `results`, `outputs`, and `dataTypes` to see what data is available to be opened.

Distributed Processing

You can use OCEAN distributed processing commands to run simulations across a collection of computer systems. The distributed processing commands allow you to specify where and when jobs are run and allow you to monitor and control jobs in a variety of ways. Using distributed commands, you can

- Submit one or more jobs to a distributed processing queue
- Specify a host or group of hosts on which to distribute jobs
- View the status of jobs
- Specify when a job will run or in what sequence a group of jobs will run
- Suspend and resume jobs
- Cancel jobs

For you to be able to use the distributed processing commands, your site administrator needs to set up the lists of machines to which jobs are submitted. Each list of machines is a group of hosts and is called a queue. Consult the Virtuoso® Analog Distributed Processing

Option User Guide for more information on how to configure systems for distributed processing. For information on the distributed processing commands for OCEAN, see Chapter 12, "OCEAN Distributed Processing Commands."

Blocking and Nonblocking Modes

You can configure jobs to run in blocking or nonblocking mode. In blocking mode, execution of subsequent OCEAN commands is halted until the job completes. In nonblocking mode, the system does not wait for the first job to finish before starting subsequent jobs.

Blocking Mode

You must run jobs in blocking mode to be able to use the data resulting from a job in a subsequent command in an OCEAN script or batch run.

For example, if you want to run a simulation, select the `tran` results from that simulation, and then plot them, you

1. Configure the simulation with setup commands
2. Run the simulation with the `run()` command
3. Select the desired results with the `selectResults( 'tran)` command
4. Plot the results with the `plot()` command

A job like the one in the example above must run in blocking mode so that the commands are processed sequentially. If the jobs in the example above are run in nonblocking mode, the `selectResult` command starts before the `run` command can return any data, and the `selectResult` command and the `plot` command cannot complete successfully.

Nonblocking Mode

If you are submitting several jobs that have no interdependencies, you can run them concurrently when `hostmode` is set to `distributed`.

For example, if you want to run two separate simulations as jobs, but do not want to wait until the first is complete before starting the second, you

1. Configure the first simulation with setup commands
2. Configure a second simulation with setup commands

In the example above, the script starts the first job and then starts the second job without waiting for the first job to finish.

If you are running several commands, and some of them are data access commands, you can use the wait command to block a single job. The `wait` command is needed between the simulation and the data access commands to ensure the desired simulation is complete before the data is accessed.

For example, if you want to run two separate simulations as jobs (`sim1` and `sim2`), and want to select and plot the results of the second simulation run, you

1. Configure the first simulation with setup commands
2. Run the simulation with a `run(?jobPrefix "sim1")` command
3. Configure a second simulation with setup commands
4. Run the second simulation with the `run( ?jobPrefix "sim2)` command
5. Cause the script to wait until the second simulation finishes before starting the `selectResults` command with the `wait(sim2)` command
6. Select the desired results with the `selectResults('tran)` command
7. Plot the results with the `plot( )` command

In the example above, the script starts the first job and then starts the second job without waiting for the first job to finish. When the script reaches the `wait` command, it pauses until the second simulation runs and then selects the results to plot.

Waveform Tool Selection

You can plot simulation results in the waveform tool of your choice. The Analog Design Environment now supports WaveScan in addition to AWD. Although WaveScan is the default, you can dynamically switch between the two waveform tools using the OCEAN function `ocnWaveformTool()` as follows:

```
ocnWaveformTool(‘awd)
```

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Using OCEAN

This chapter explains the different ways you can use OCEAN to perform simulation tasks. In this chapter, you can find information about

OCEAN Use Models

There are two ways you can use OCEAN:

- You can use OCEAN interactively to perform simple tasks.
- You can use OCEAN in batch mode and provide the name of an existing (or parameterized) script as a command line argument. OCEAN scripts can be created
    - From the Virtuoso® Analog Design Environment window with the command *Session – Save Script*
    - By hand (by you or someone else in your organization) with a text editor

  For information about creating scripts, see "Creating OCEAN Scripts" on page 35.

All the OCEAN commands are described in this manual, and online help is available for all these commands. For information about using the OCEAN online help, see "OCEAN Online Help" on page 20.

Note: The current version of OCEAN has some specific issues that are addressed in Appendix A, "OCEAN 4.4.6 Issues." Please refer to this appendix before using OCEAN.

Using OCEAN Interactively

You can run OCEAN from a UNIX prompt or from the Virtuoso® design framework II (DFII) Command Interpreter Window (CIW).

Note: The primary use model is to use OCEAN in a UNIX shell. Unless otherwise indicated, the rest of this chapter assumes that you are working from OCEAN in a UNIX shell.

Using OCEAN from a UNIX Shell

To start OCEAN from a UNIX prompt, type the following command:

```
ocean
```

This loads and reads your `.oceanrc` file.

You can place OCEAN commands in your `.oceanrc` file, which is similar to the `.cdsinit` file. OCEAN ignores your `.cdsinit` file at startup. If you want OCEAN to use any initialization options at startup, you must specify them in the `.oceanrc` file. This file can contain any valid OCEAN command, function or SKILL initialization routine (excluding graphical dfII references, such as bindkeys and so on, which are not applicable to OCEAN). If you do not want to specify any startup initialization options for OCEAN, you do not need to create or add an `.oceanrc` file.

The OCEAN prompt appears indicating that you have started OCEAN:

```
ocean>
```

If you do not see this prompt after starting OCEAN, press `Return`. If you still do not see this prompt, you may have redefined the prompt with the `setPrompt` command. (This does not affect OCEAN; the prompt just will not indicate OCEAN is running.)

Now you can start typing OCEAN commands interactively. For an example of interactive use, see "Interactive Session Demonstrating the OCEAN Use Model" on page 34.

To quit the OCEAN executable from UNIX, type the following command:

```
exit
```

OCEAN in Non-Graphical Mode

OCEAN is an executable shell script that calls the AWD workbench and passes all its command-line options to it using the following shell command:

```
#! /bin/sh -

exec awd -ocean "$@"
```

This makes OCEAN highly dependent on the UNIX shell environment.

You can run OCEAN in a non-graphical mode by using the `-nograph` option with the `ocean` command. This disables the graphical options of the software. This option is useful if OCEAN is started on a machine that does not have X-Windows running.

The `-nograph` option must only be used to replay logfiles that have been created interactively. For example, while using OCEAN with the `-nograph` option, your `oceanScript.ocn` file must have an `exit()` statement at the end. Otherwise, OCEAN hangs. The reason for this is that when the workbench is started in the non-graphical mode, it does not redirect standard I/O as it normally does; instead, it lets the SKILL human interface (HI) handle the standard I/O. HI expects an explicit `exit()` statement at the end of the OCEAN script and OCEAN exits only when it detects an `exit()` at EOF. The command is used as follows:

```
ocean -nograph < oceanScript.ocn > oceanScript.log
```

While using the `-nograph` option with `ocean`, if you find that simulation run messages are not being stored in the log file, check for the following environment variable in the `.cdsenv` file:

```
(envGetVal "spectre.envOpts" "firstRun" )
```

It must be set to `nil` as shown below for simulation run messages to be stored in it:

```
(envSetVal "spectre.envOpts" "firstRun" ’boolean nil)
```

For more information about this variable, see Appendix B of the *Virtuoso Analog Design Environment User Guide*.

Using OCEAN from the CIW

You can type OCEAN commands in the CIW after you bring up the Virtuoso® Analog Design Environment. (Starting the design environment loads the required OCEAN files.)

Your `.oceanrc` file is *not* automatically read when you start the DFII software (using the `icms` command). Therefore, you might want to load your `.oceanrc` file manually in the CIW if you need information that it contains.

Interactive Session Demonstrating the OCEAN Use Model

The following figure shows a typical set of simulation tasks that you might perform interactively in OCEAN with the corresponding commands.

Start OCEAN and specify your simulator.	`ocean` `simulator( 'spectre )`

Specify an AC analysis.	`analysis( 'ac ?start 1 ?stop 1000 ?lin 100 )`
	or
	`ac( 1 1000 "linear" 100 )`

Set a design variable.	`desVar( "rs" 1k )`
Perform the first simulation run.	`run( )`
Change a design variable.	`desVar( "rs" 2k )`
Perform the second simulation run	`run( )`

Specify a transient analysis.	`analysis( 'tran ?stop 1u ) (Spectre only)`
	or
	`tran( 0 1u 1n )`

Perform the third simulation run.	`run( )`

On the second and third run, the AC analysis runs because it is still active. If you do not want it to run, you must disable it with the following command:

```
delete( 'analysis 'ac )
```

The simulator is not called and run until the `run()` command is entered.

The commands can be given in any order, as long as they are all defined before the `run()` command.

Creating OCEAN Scripts

You can modify the included sample script files or create script files interactively from the Virtuoso® Analog Design Environment.

Creating Scripts Using Sample Script Files

You can create your own script files with a text editor using the sample scripts as examples, or you can make copies of the sample scripts and modify them as needed using a text editor. The scripts can be found in the following directory:

`your_install_dir``/tools/dfII/samples/artist/OCEAN`

Refer to the `README` file in this directory for information about the scripts.

Creating Scripts from the Analog Design Environment

When you perform tasks in the design environment, the associated OCEAN commands are automatically stored in the *`simulatorx`*`.ocn` file in your `netlist` directory. For example, if you start the Virtuoso software, open the Virtuoso® Analog Design Environment window, and run a simulation using the Cadence SPICE simulator, a `cdsSpice0.ocn` file is created in your `netlist` directory. You can load this `cdsSpice0.ocn` script as described in "Loading OCEAN Scripts" on page 38.

Selectively Creating Scripts

You can be selective about the information that is created in your `.ocn` script. The Virtuoso® Analog Design Environment has a feature that lets you create an OCEAN script based on the state of your current session. The following example illustrates how using this feature is different than using the automatic script generation feature.

Consider the following task flow:

1. Start the Virtuoso® Analog Design Environment.
2. Specify a DC analysis.
3. Select nets on the schematic to save.

4. Run the simulation.
5. Turn off the DC analysis.
6. Select a transient analysis.
7. Run the simulation.
8. Save the script from the Virtuoso® Analog Design Environment.

The script that is created, called `oceanScript.ocn` by default, contains only the selected nets, the transient analysis, and the run command. The script does not contain the DC analysis because it was turned off.

In contrast, the *simulator*`0.ocn` script, which is automatically created in the `netlist` directory, contains all of the commands, including the DC analysis and the current state of the analysis (on or off).

Creating a Script

To selectively create a script from the Virtuoso® Analog Design Environment,

1. Start the Virtuoso software with the executable you prefer; for example,

   ```
   icms&
   ```

   The CIW appears.

2. From the CIW, choose *Tools – Analog Environment – Simulation*.

   The Virtuoso® Analog Design Environment window appears.

3. Perform all of the design environment tasks that you want to capture in the script.
4. Choose *Session – Save Script*.

   The Save Ocean Script to File form appears.

5. Click *OK* to accept the default file name (`./oceanScript.ocn`), or change the name for the file and click *OK*.

   A script containing the OCEAN commands for the tasks you performed is created. For information about how to load this script, see "Loading OCEAN Scripts" on page 38.

Controlling What Is Included in Scripts

You can use `.cdsenv` variables to alter the OCEAN script that is created when you choose *Session – Create Script* in the Virtuoso® Analog Design Environment. One variable allows you to include default environment settings in a script, two other variables allow you to run procedures before and after a script is created.

Including Default Control Statements

To save every control statement, including default statements, in your OCEAN script, add the following line to your `.cdsenv` file.

```
asimenv.misc saveDefaultsToOCEAN boolean t
```

Setting `saveDefaultsToOCEAN` to `t` results in a complete dump of the current circuit design environment, defaults and all. Because the created OCEAN script contains all the settings, you might use this variable when you plan to archive a script, for example.

If `saveDefaultsToOCEAN` is not set to `t`, the created OCEAN script contains only those items that you explicitly set to some value other than their default.

Running Functions Before or After Creating a Script

The information in this section describes how you can specify functions to be run before or after a script is created. You can use these functions, for example, to add information at the beginning or end of a script. To use this capability follow these steps.

1. Decide when you want the functions to run.
   - ❑ Add the following line to your `.cdsenv` file to run the function *`preOceanFunc`* before the OCEAN script is created.

     ```
     asimenv.misc preSaveOceanScript string "preOceanFunc"
     ```

   - ❑ Add the following line to your `.cdsenv` file to run the function *`postOceanFunc`* after the OCEAN script is created.

     ```
     asimenv.misc postSaveOceanScript string "postOceanFunc"
     ```

2. Use the following syntax to specify the functions.

   ```
   preOceanFunc( session fp )
   postOceanFunc( session fp )
   ```

   In this syntax, *`session`* is the OASIS session and `fp` is the file pointer to the OCEAN script file. For guidance on determining the *`session`* to use, see the *Virtuoso® Analog Design Environment SKILL Language Reference*.

3. Load the functions in your `.cdsinit` file.

For example, you might add the following lines to your `.cdsenv` file.

```
asimenv.misc  preSaveOceanScript string "MYfirstProc"
asimenv.misc  postSaveOceanScript string "MYlastProc"
```

The functions `MYfirstProc` and `MYlastProc` might be defined like this.

```
procedure( MYfirstProc( session fp)
  fprintf(fp "; This will be the first line in the ocean script.\n")
)
procedure( MYlastProc( session fp)
  fprintf(fp "; This will be the last line in the ocean script.\n")
)
```

If these procedures are defined in a file called `myOceanProcs.il`, you can load them by adding to your `.cdsinit` file a command like the following.

```
load "myOceanProcs.il"
```

When you choose *Session – Create Script*, first the `preSaveOceanScript` procedure is called, then the OCEAN script is created, then the `postSaveOceanScript` procedure is called.

Loading OCEAN Scripts

You can load OCEAN scripts from OCEAN (in UNIX) or from the CIW.

From a UNIX Shell

To load an OCEAN script,

1. Type the following command to start OCEAN:

   ```
   ocean
   ```

   The OCEAN prompt appears.

2. Use the SKILL `load` command to load your script:

   `load( "`*`script_name`*`.ocn" )`

   Messages about the progress of your script appear.

From the CIW

To load an OCEAN script,

1. Start the Virtuoso software with the executable you prefer, for example

```
icms&
```

The CIW appears.

2. In the text entry field, use the SKILL `load` command to load your script:

   `load( "`*`script_name`*`.ocn" )`

   Messages about the progress of your script appear in the CIW.

Note: OCEAN does not read your `.cdsinit` file. If you want your `.cdsinit` file read, you must load it in your `.oceanrc` file.

Selecting Results

You may use OCEAN to run several simulations on the same design and save the results in different result directories. You can then use Artist to select the results and work with features like annotation etc.

Selecting Results Run from Worst Case Scripts for Cross-Probing or Back Annotating Operating Points

Assume that you have been using Ocean to create separate data directories for worst case corners or parameter sweeps. Also assume that the new directories you make are accessed with the `resultsDir()` ocean command in your Ocean script and that these directories are in the standard location where `psf` data is stored in Artist.

In Artist, `psf` data is stored in:

```
<runDir>/simulation/<testSchemName>/spectre/schematic/psf
```

where,

`runDir`	is the directory where you envoke `icfb&`
`testSchemName`	is your test schematic

This implies that your script should store the new directories under the `schematic` directory. Therefore, if c1, c2 and c3 are the worst case directories, they are located at:

```
<runDir>/simulation/<testSchemName>/spectre/schematic/c1
<runDir>/simulation/<testSchemName>/spectre/schematic/c2
<runDir>/simulation/<testSchemName>/spectre/schematic/c3
```

1. Choose *Artist -> Results -> Select*

2. The *Select Results* form opens. Click *Browse*. A Unix Browser form appears.
3. Navigate to the directory that contains your Ocean generated directories c1, c2, and c3.
4. Click *OK* on the Unix Browser form. Now the *Select Results* Form should show c1, c2 and c3.
5. Double click on c1, c2 or c3. Alternatively, you can also single click on c1, c2 or c3 and then choose *Update Results* and click *OK*. At this point the data is selected though there is no confirmation in the CIW. Now, you should be able to use *Artist -> Results -> Direct Plot* , *Artist -> Results -> Annotate* etc to see the results of that particular directory.

Selecting Results Run from Spectre Stand Alone

After running spectre standalone, you can select results using the *Results Browser* and use calculator to plot the results. However, this does not allow you to use Artist features like *Artist -> Results -> Direct Plot* or *Artist -> Results -> Annotate*.

Consider that your data is in

`<runDir>/simulation/<testSchemName>/spectre/schematic/psf.`

where,

`runDir`	is the directory where you envoke `icfb&`
`testSchemName`	is your test schematic

1. Choose *Artist -> Tools -> Results Browser* . A pop up box appears. Enter your design path up to the spectre directory.
2. Click *OK*, and the browser comes up.
3. Click on schematic directory. The psf directory should appear.
4. Click on the directory with the data in it, psf. When you click on the 'psf' directory you should see the tree expand with different results from your spectre stand alone simulation, e.g. tran.tran etc.
5. Place the mouse pointer over the 'psf' node in the tree and press down the middle mouse key and scroll down to "create ROF". You should now see the psf directory change, and an intermediate node comes up --Run1-- betweenpsf/ and the results.
6. Place the middle mouse pointer over the Run1 node, scroll down and select "Select Results".

Note: Even though there is a confirmation message in the CIW that the select was success, Artist is not synced up to allow cross-probing and back annotation of operating points.

7. You may now use *Artist -> Tools > Calculator* to select objects from the schematic. You can then choose 'plot' from the calculator, or different calculator operations.

   Note: You CAN use Artist -> Tools > Calculator but you CAN NOT use *Artist -> Results -> Direct Plot* or *Artist -> Results -> Annotate* etc.

Running Multiple Simulators

There are times when you might want to run more than one simulator. You might be benchmarking simulators or comparing results. In OCEAN, you can only use one simulator per OCEAN session. If you change simulators, you must start a new OCEAN session. This is because some OCEAN command arguments are simulator specific, and therefore change when the simulator changes. For example, the arguments to the `option` command are simulator specific. (No two simulators have the exact same options.) The analyses are typically simulator specific also.

OCEAN Tips

The information in this section can help you solve problems that you encounter while using OCEAN.

- While working in OCEAN, you might get the following SKILL error message:

  ```
  *Error* eval: unbound variable - nameOfVariable
  ```

  In this case, you need to see if you have an undeclared variable or if you are missing a single quotation mark (') or a quotation mark (") for one of your arguments. For example, the following command returns an error message stating that `fromVal` is an unbound variable because the variable has not been declared:

  ```
  analysis('tran ?from fromVal)
  ```

  However, the following pair of statements work correctly because `fromVal` has a value (is bound).

  ```
  fromVal=0
  analysis('tran ?from fromVal)
  ```

- If you get an error in an OCEAN session, you are automatically put into the SKILL debugger. In this case, you see a prompt similar to this:

```
ocean-Debug 2>
```

You can continue working. However, if you would like to get out of the debugger, you can type

```
debugQuit()
```

Now you are back to the normal prompt:

```
ocean>
```

- If it appears that OCEAN does not accept your input, or OCEAN appears to hang, then you may have forgotten to enter a closing quotation mark. Type `"]` to close all strings. For more information, and some examples, see "Recovering from an Omitted Quotation Mark" on page 22.
- In SKILL, the following formats are equivalent: `(one two)` and `one(two)`. Results might be returned in either format. For example, OCEAN might return `ac(tran)` or `(ac tran)`, but the two forms are equivalent.
- You can check your script for simple syntax errors by running SKILL lint. For example, you might use a command like

  ```
  sklint -file myScript.ocn
  ```

  From within OCEAN, you can run SKILL lint by typing the following at the OCEAN prompt:

  ```
  sklint(?file "yourOceanScript.ocn")
  ```

  Running SKILL lint helps catch basic errors, such as unmatched parentheses and strings that are not closed.

3

Introduction to SKILL

This chapter introduces you to the basic concepts that can help you get started with the Virtuoso® SKILL programming language. In this chapter, you can find information about

The Advantages of SKILL

The SKILL programming language lets you customize and extend your design environment. SKILL provides a safe, high-level programming environment that automatically handles many traditional system programming operations, such as memory management. SKILL programs can be immediately run in the Virtuoso environment.

SKILL is ideal for rapid prototyping. You can incrementally validate the steps of your algorithm before incorporating them in a larger program.

SKILL leverages your investment in Cadence technology because you can combine existing functionality and add new capabilities.

SKILL lets you access and control all the components of your tool environment: the User Interface Management System, the Design Database, and the commands of any integrated design tool. You can even loosely couple proprietary design tools as separate processes with SKILL's interprocess communication facilities.

Naming Conventions

The recommended naming scheme is to use uppercase and lowercase characters to separate your code from code developed by Cadence.

All code developed by Cadence Design Systems typically names global variables and functions with up to three lowercase characters, that signify the code package, and the name starting with an uppercase character. For example, `dmiPurgeVersions()` or *`hnlCellOutputs`*. All code developed outside Cadence should name global variables by starting them with an uppercase character, such as *AcmeGlobalForm*.

Arithmetic Operators

SKILL provides many arithmetic operators. Each operator corresponds to a SKILL function, as shown in the following table.

Sample SKILL Operators

Operators in Descending Precedence	Underlying Function
**	exponentiation
*	multiply
/	divide
+	plus
–	minus
==	equal
!=	nequal
=	assignment

Scaling Factors

SKILL provides a set of scaling factors that you can add to the end of a decimal number (integer or floating point) to achieve the scaling you want.

- Scaling factors must appear immediately after the numbers they affect. Spaces are not allowed between a number and its scaling factor.
- Only the first nonnumeric character that appears after a number is significant. Other characters following the scaling factor are ignored. For example, for the value 2.3mvolt, the *m* is significant, and the *volt* is discarded. In this case, *volt* is only for your reference.

- If the number being scaled is an integer, SKILL tries to keep it an integer; the scaling factor must be representable as an integer (that is, the scaling factor is an integral multiplier and the result does not exceed the maximum value that can be represented as an integer). Otherwise, a floating-point number is returned.

The scaling factors are listed in the following table.

Scaling Factors

Character	Name	Multiplier	Examples
Y	Yotta	1024	10Y [10e+25]
Z	Zetta	1021	10Z [10e+22]
E	Exa	1018	10E [10e+19]
P	Peta	1015	10P [10e+16]
T	Tera	10^{12}	10T [1.0e13]
G	Giga	10^{9}	10G [10,000,000,000]
M	Mega	10^{6}	10M [10,000,000]
K	Kilo	10^{3}	10K [10,000]
%	percent	10^{-2}	5% [0.05]
m	milli	10^{-3}	5m [5.0e-3]
u	micro	10^{-6}	1.2u [1.2e-6]
n	nano	10^{-9}	1.2n [1.2e-9]
p	pico	10^{-12}	1.2p [1.2e-12]
f	femto	10^{-15}	1.2f [1.2e-15]
a	atto	10-18	1.2a [1.2e-18]
z	zepto	10-21	1.2z [1.2e-21]
y	yocto	10-24	1.2y [1.2e-24]

Note: The characters used for scaling factors depend on your target simulator. For example, if you are using cdsSpice, the scaling factor for *M* is different than shown in the previous table, because cdsSpice is not case sensitive. In cdsSpice, *M* and *m* are both interpreted as 10^{-3}, so *ME* or *me* is used to signify 10^{6}.

Relational and Logical Operators

This section introduces you to

- Relational Operators: <, <=, >, >=, ==, !=
- Logical Operators: !, &&, ||

Relational Operators

Use the following operators to compare data values. SKILL generates an error if the data types are inappropriate. These operators all return `t` or `nil`.

Sample Relational Operators

Operator	Arguments	Function	Example	Return Value
<	numeric	lessp	`3 < 5` `3 < 2`	`t` `nil`
<=	numeric	leqp	`3 <= 4`	`t`
>	numeric	greaterp	`5 > 3`	`t`
>=	numeric	geqp	`4 >=3`	`t`
==	numeric string list	equal	`3.0 == 3` `"abc" == "ABc"`	`t` `nil`
!=	numeric string list	nequal	`"abc" != "ABc"`	`t`

Knowing the function name is helpful because error messages mention the function (`greaterp` below) instead of the operator (>).

```
1 > "abc"
Message: *Error* greaterp: can't handle (1 > "abc")
```

Logical Operators

SKILL considers `nil` as FALSE and any other value as TRUE. The and (&&) and or (||) operators only evaluate their second argument if it is required for determining the return result.

Sample Logical Operators

Operator	Arguments	Function	Example	Return Value

&&	general	and	`3 && 5`
			`5 && 3`
			`t && nil`
			`nil && t`
				`5`
				`3`
				`nil`
				`nil`

||	general	or	`3 || 5`
			`5 || 3`
			`t || nil`
			`nil || t`
				`3`
				`5`
				`t`
				`t`

The && and || operators return the value last computed. Consequently, both && and || operators can be used to avoid cumbersome `if` or `when` expressions.

The following example illustrates the difference between using && and || operators and using `if` or `when` expressions.

You do not need to use

```
If (usingcolor then
currentcolor=getcolor( )
else
currentcolor=nil
)
```

Instead use

```
currentcolor=usingcolor && getcolor( )
```

Using &&

When SKILL creates a variable, it gives the variable a value of `unbound` to indicate that the variable has not been initialized yet. Use the `boundp` function to determine whether a variable is bound. The `boundp` function

- Returns `t` if the variable is bound to a value

■ Returns `nil` if the variable is not bound to a value

Suppose you want to return the value of a variable `trMessages`. If `trMessages` is `unbound`, retrieving the value causes an error. Instead, use the expression

```
boundp( ’trMessages ) && trMessages
```

Using ||

Suppose you have a default name, such as `noName`, and a variable, such as `userName`. To use the default name if `userName` is `nil`, use the following expression:

```
userName || "noName"
```

SKILL Syntax

This section describes SKILL syntax, which includes the use of special characters, comments, spaces, parentheses, and other notation.

Special Characters

Certain characters are special in SKILL. These include the *infix* operators such as less than (<), colon (`:`), and assignment (=). The following table lists these special characters and their meaning in SKILL.

Note: All nonalphanumeric characters (other than _ and ?) must be preceded (*escaped*) by a backslash (\) when you use them in the name of a symbol.

Special Characters in SKILL

Character	Name	Meaning
`\`	backslash	Escape for special characters
`( )`	parentheses	Grouping of list elements, function calls
`[ ]`	brackets	Array index, super right bracket
`’`	single quotation mark	Specifies a symbol (quoting the expression prevents its evaluation)
`”`	quotation mark	String delimiter
`,`	comma	Optional delimiter between list elements

Special Characters in SKILL

Character	Name	Meaning
;	semicolon	Line-style comment character
+, –, *, /	arithmetic	For arithmetic operators; the /* and */ combinations are also used as comment delimiters
!,^,&,|	logical	For logical operators
<,>,=	relational	For relational and assignment operators; < and > are also used in the specification of bit fields
?	question mark	If first character, implies keyword parameter
%	percent sign	Used as a scaling character for numbers

White Space

White space sometimes takes on semantic significance and a few syntactic restrictions must therefore be observed.

Write function calls so the name of a function is immediately followed by a left parenthesis; no white space is allowed between the function name and the parenthesis. For example

`f(a b c)` and `g()` are legal function calls, but `f (a b c)` and `g ()` are illegal.

The unary minus operator must immediately precede the expression it applies to. No white space is allowed between the operator and its operand. For example

`-1`, `-a`, and `-(a*b)` are legal constructs, but `- 1`, `- a`, and `- (a*b)` are illegal.

The binary minus (subtract) operator should either be surrounded by white space on both sides or be adjacent to non-white space on both sides. To avoid ambiguity, one or the other method should be used consistently. For example:

`a - b` and `a-b` are legal constructs for binary minus, but `a -b` is illegal.

Comments

SKILL permits two different styles of comments. One style is block oriented, where comments are delimited by `/*` and `*/`. For example:

```
/* This is a block of (C style) comments
comment line 2
```

```
comment line 3 etc.
*/
```

The other style is line- oriented where the semicolon (`;`) indicates that the rest of the input line is a comment. For example:

```
x = 1           ; comment following a statement
; comment line 1
; comment line 2 and so forth
```

For simplicity, line-oriented comments are recommended. Block-oriented comments cannot be nested because the first `*/` encountered terminates the whole comment.

Role of Parentheses

Parentheses `( )` delimit the names of functions from their argument lists and delimit nested expressions. In general, the innermost expression of a nested expression is evaluated first, returning a value used in turn to evaluate the expression enclosing it, and so on until the expression at the top level is evaluated. There is a subtle point about SKILL syntax that C programmers, in particular, must be very careful to note.

Parentheses in C

In C, the relational expression given to a conditional statement such as `if`, `while`, and `switch` must be enclosed by an outer set of parentheses for purely syntactical reasons, even if that expression consists of only a single Boolean variable. In C, an `if` statement might look like

```
if (done) i=0; else i=1;
```

Parentheses in SKILL

In SKILL, parentheses are used for specifying lists, calling functions, delimiting multiple expressions, and controlling the order of evaluation. You can write function calls in prefix notation

`(fn2 arg1 arg2)` **or** `(fn0)`

as well as in the more conventional algebraic form

`fn2(arg1 arg2)` **or** `fn0()`

The use of syntactically redundant parentheses causes variables, constants, or expressions to be interpreted as the names of functions that need to be further evaluated. Therefore,

- Never enclose a constant or a variable in parentheses by itself; for example, `(1)`, `(x)`.
- For arithmetic expressions involving *infix* operators, you can use as many parentheses as necessary to force a particular order of evaluation, but never put a pair of parentheses immediately outside another pair of parentheses; for example, `((a + b))`: the expression delimited by the inner pair of parentheses would be interpreted as the name of a function.

For example, because `if` evaluates its first argument as a logical expression, a variable containing the logical condition to be tested should be written without any surrounding parentheses; the variable by itself is the logical expression. This is written in SKILL as

```
if( done then i = 0 else i = 1)
```

Line Continuation

SKILL places no restrictions on how many characters can be placed on an input line, even though SKILL does impose an 8,191 character limit on the strings being entered. The parser reads as many lines as needed from the input until it has read in a complete form (that is, expression). If there are parentheses that have not yet been closed or binary *infix* operators whose right sides have not yet been given, the parser treats carriage returns (that is, newlines) just like spaces.

Because SKILL reads its input on a form-by-form basis, it is rarely necessary to “continue” an input line. There might be times, however, when you want to break up a long line for aesthetic reasons. In that case, you can tell the parser to ignore a carriage return in the input line simply by preceding it immediately with a backslash (\).

```
string = "This is \
a test."
=> "This is a test."
```

Arithmetic and Logical Expressions

Expressions are SKILL objects that also evaluate to SKILL objects. SKILL performs a computation as a sequence of function evaluations. A SKILL *program* is a sequence of expressions that perform a specified action when evaluated by the SKILL interpreter.

There are two types of primitive expressions in SKILL that pertain to OCEAN: constants and variables.

Constants

A *constant* is an expression that evaluates to itself. That is, evaluating a constant returns the constant itself. Examples of constants are `123`, `10.5`, and `"abc".`

Variables

A *variable* stores values used during the computation. The variable returns its value when evaluated. Examples of variables are `a`, `x`, and `init_var`.

When the interpreter evaluates a variable whose value has not been initialized, it displays an error message telling you that you have an unbound variable. For example, you get an error message when you misspell a variable because the misspelling creates a new variable.

```
myVariable
```

causes an error message because it has been referenced before being assigned, whereas

```
myVariable = 5
```

works.

When SKILL creates a variable, it gives the variable an initial value of `unbound`. It is an error to evaluate a variable with this value because the meaning of `unbound` is that-value-which-represents-no-value. `unbound` is not the same as `nil`.

Using Variables

You do not need to declare variables in SKILL as you do in C. SKILL creates a variable the first time it encounters the variable in a session. Variable names can contain

- Alphanumeric characters
- Underscores (_)
- Question marks
- Digits

The first character of a variable must be an alphanumeric character or an underscore. Use the assignment operator to store a value in a variable. You enter the variable name to retrieve its value.

```
lineCount = 4              => 4
lineCount                  => 4
```

```
lineCount = "abc"         => "abc"
lineCount                 => "abc"
```

Creating Arithmetic and Logical Expressions

Constants, variables, and function calls can be combined with the *infix* operators, such as less than (<), colon (:), and greater than (>) to form arithmetic and logical expressions. For example: `1+2`, `a*b+c`, `x>y`.

You can form arbitrarily complicated expressions by combining any number of the primitive expressions described above.

4

Working with SKILL

This chapter provides information on using SKILL functions. It includes information on the types of SKILL functions, the types of data accepted as arguments, how data types are used, and how to declare and define functions. In this chapter, you can find information about

Skill Functions

There are two basic types of SKILL functions:

- *Functions* carry out statements and return data that can be redirected to other commands or functions.
- *Commands* are functions that carry out statements defined by the command and return `t` or `nil`. Some commands return the last argument entered, but the output cannot be redirected.

Data Types

SKILL supports several data types, including integer and floating-point numbers, character strings, arrays, and a highly flexible linked list structure for representing aggregates of data. The simplest SKILL expression is a single piece of data, such as an integer, a floating-point number, or a string. SKILL data is case sensitive. You can enter data in many familiar ways, including the following:

Sample SKILL Data Items

Data Type	Syntax Example
integer	5
floating point number	5.3
text string	`"Mary had a little lamb"`

For symbolic computation, SKILL has data types for dealing with symbols and functions.

For input/output, SKILL has a data type for representing I/O ports. The table below lists the data types supported by SKILL with their internal names and prefixes.

Data Types Supported by SKILL

Data Type	Internal Name	Prefix
array	array	a
boolean		b
floating-point number	flonum	f
any data type	general	g
linked list	list	l
floating-point number or integer		n
user-defined type		o
I/O port	port	p
symbol	symbol	s
symbol or character string		S
character string (text)	string	t
window type		w
integer number	fixnum	x

Numbers

SKILL supports the following numeric data types:

- Integers
- Floating-point

Both integers and floating-point numbers may use scaling factors to scale their values. For information on scaling factors, see "Scaling Factors" on page 44.

Atoms

An *atom* is any data object that is not a grouping or collection of other data objects. Built into SKILL are several special atoms that are fundamental to the language.

`nil` — The `nil` atom represents both a false logical condition and an empty list.

`t` — The symbol `t` represents a true logical condition.

Both `nil` and `t` always evaluate to themselves and must never be used as the name of a variable.

`unbound` — To make sure you do not use the value of an uninitialized variable, SKILL sets the value of all symbols and array elements initially to `unbound` so that such an error can be detected.

Constants and Variables

Supported constants and variables are discussed in "Arithmetic and Logical Expressions" on page 3-14.

Strings

Strings are sequences of characters; for example, `"abc"` or `"123"`. A string is marked off by quotation marks, just as in the C language; the empty string is represented as `""`. The SKILL parser limits the length of input strings to a maximum of 8,191 characters. There is, however, no limit to the length of strings created during program execution. Strings of more than 8,191 characters can be created by applications and used in SKILL if they are not given as arguments to SKILL string manipulation functions.

When typing strings, you specify

- Printable characters (except a quotation mark) as part of a string without preceding them with the backslash (\) escape character

- Unprintable characters and the quotation mark itself by preceding them with the backslash (\) escape character, as in the C language

Arrays

An *array* represents aggregate data objects in SKILL. Unlike simple data types, you must explicitly create arrays before using them so the necessary storage can be allocated. SKILL arrays allow efficient random indexing into a data structure using familiar syntax.

- Arrays are not typed. Elements of the same array can be different data types.
- SKILL provides run-time array bounds checking. The array bounds are checked with each array access during runtime. An error occurs if the index is outside the array bounds.
- Arrays are one dimensional. You can implement higher dimensional arrays using single dimensional arrays. You can create an array of arrays.

Allocating an Array of a Given Size

Use the `declare` function to allocate an array of a given size.

```
declare( week[7] )          => array[7]:9780700
week                        => array[7]:9780700
type( week )                => array
days = '(monday tuesday wednesday
         thursday friday saturday sunday)
for( day 0 length(week)-1
    week[day] = nth(day days))
```

- The `declare` function returns the reference to the array storage and stores it as the value of `week`.
- The `type` function returns the symbol *array*.

Concatenating Strings (Lists)

Concatenating a List of Strings with Separation Characters (buildString)

`buildString` makes a single string from the list of strings. You specify the separation character in the third argument. A null string is permitted. If this argument is omitted, `buildString` provides a separating space as the default.

```
buildString( '("test" "il") ".")        => "test.il"
buildString( '("usr" "mnt") "/")        => "usr/mnt"
buildString( '("a" "b" "c"))            => "a b c"
buildString( '("a" "b" "c") "")         => "abc"
```

Concatenating Two or More Input Strings (strcat)

`strcat` creates a new string by concatenating two or more input strings. The input strings are left unchanged.

```
strcat( "l" "ab" "ef" )     => "labef"
```

You are responsible for any separating space.

```
strcat( "a" "b" "c" "d" )     => "abcd"
strcat( "a " "b " "c " "d " ) => "a b c d "
```

Appending a Maximum Number of Characters from Two Input Strings (strncat)

`strncat` is similar to `strcat` except that the third argument indicates the maximum number of characters from *`string2`* to append to *`string1`* to create a new string. *`string1`* and *`string2`* are left unchanged.

```
strncat( "abcd" "efghi" 2)                => "abcdef"
strncat( "abcd" "efghijk" 5)              => "abcdefghi"
```

Comparing Strings

Comparing Two Strings or Symbol Names Alphabetically (alphalessp)

`alphalessp` compares two objects, which must be either a string or a symbol, and returns `t` if *`arg1`* is alphabetically less than *`arg2`*. `alphalessp` can be used with the `sort` function to sort a list of strings alphabetically. For example:

```
stringList = '( "xyz" "abc" "ghi" )
sort( stringList 'alphalessp ) => ("abc" "ghi" "xyz")
```

The next example returns a sorted list of all the files in the login directory:

```
sort( getDirFiles( "~" ) 'alphalessp )
```

Comparing Two Strings Alphabetically (strcmp)

`strcmp` compares two strings. (To simply test if two strings are equal or not, you can use the `equal` command.) The return values for `strcmp` are explained in the following table.

Return Value	Meaning
1	*`string1`* is alphabetically greater than *`string2`*.
0	*`string1`* is alphabetically equal to *`string2`*.
-1	*`string1`* is alphabetically less than *`string2`*.

```
strcmp( "abc" "abb" )=> 1
strcmp( "abc" "abc")=> 0
strcmp( "abc" "abd")=> -1
```

Comparing Two String or Symbol Names Alphanumerically or Numerically (alphaNumCmp)

`alphaNumCmp` compares two string or symbol names. If the third optional argument is not `nil` and the first two arguments are strings holding purely numeric values, a numeric comparison is performed on the numeric representation of the strings. The return values are explained in the following table.

Return Value	Meaning
1	*arg1* is alphanumerically greater than *arg2*.
0	*arg1* is alphanumerically identical to *arg2*.
-1	*arg2* is alphanumerically greater than *arg1*.

Declaring a SKILL Function

To refer to a group of statements by name, use the `procedure` declaration to associate a name with the group. The group of statements and the name make up a SKILL function.

- The name is known as the function name.
- The group of statements is the function body.

To run the group of statements, mention the function name followed immediately by `()`.

The `clearplot` command below erases the Waveform window and then plots a net.

```
procedure( clearplot( netname )
    clearAll( )
    plot( v (netName))
    )
```

Defining Function Parameters

To make your function more versatile, you can identify certain variables in the function body as formal parameters.

When you start your function, you supply a parameter value for each formal parameter.

Defining Local Variables (let)

Local variables can be used to establish temporary values in a function. This is done using the `let` statement. When local variables are defined, they are known only within the `let` statement and are not available outside the `let` statement.

When the function is defined, the `let` statement includes the local variables you want to define followed by one or more SKILL expressions. The variables are initialized to `nil`. When the function runs, it returns the last expression computed within its body. For example:

```
procedure( test ( x )
    let(( a b )
    a=1
    b=2
    x * a+b
    )
)
```

- The function name is `test`.
- The local variables are a and b.
- The local variables are initialized to `nil`.
- The return value is the value of `x * a + b`.

Skill Function Return Values

All SKILL functions compute a data value known as the return value of the function. Throughout this document, the right arrow (=>) denotes the return value of a function call. You can

- Assign the return value to a SKILL variable
- Pass the return value to another SKILL function

Any type of data can be a return value.

Syntax Functions for Defining Functions

SKILL supports the following syntax functions for defining functions. You should use the `procedure` function in most cases.

procedure

The `procedure` function is the most general and is easiest to use and understand.

The `procedure` function provides the standard method of defining functions. Its return value is the symbol with the name of the function. For example:

```
procedure( trAdd( x y )
    "Display a message and return the sum of x and y"
    printf( "Adding %d and %d ... %d \n" x y x+y )
    x+y
    ) => trAdd
trAdd( 6 7 ) => 13
```

Terms and Definitions

function, procedure
: In SKILL, the terms *procedure* and *function* are used interchangeably to refer to a parameterized body of code that can be executed with actual parameters bound to the formal parameters. SKILL can represent a function as both a hierarchical list and as a function object.

argument, parameter
: The terms *argument* and *parameter* are used interchangeably.

	The actual arguments in a function call correspond to the formal arguments in the declaration of the function.
expression	A use of a SKILL function, often by means of an operator supplying required parameters.
function body	The collection of SKILL expressions that define the function's algorithm.

5

OCEAN Environment Commands

The following OCEAN environment commands let you start, control, and quit the OCEAN environment.

appendPath

```
appendPath( t_dirName1 ... [t_dirNameN])
     => t_dirNameN/nil
```

Description

Appends a new path to the end of the search path list. You can append as many paths as you want with this command.

Arguments

t_dirName1	Directory path.
t_dirNameN	Additional directory path.

Value Returned

t_dirNameN	Returns the last path specified.
`nil`	Returns `nil` and prints an error message if the paths cannot be appended.

Example

```
appendPath( "/usr/mnt/user/processA/models" )
=> "/usr/mnt/user/processA/models"
```

Adds `/usr/mnt/user/processA/models` to the end of the current search path.

```
appendPath( "/usr/mnt/user/processA/models" "/usr/mnt/user/processA/models1")
=> "/usr/mnt/user/processA/models"
```

Adds `/usr/mnt/user/processA/models` and `/usr/mnt/user/processA/models1` to the end of the current search path.

path

```
path( t_dirName1 ... [t_dirNameN])
     => l_pathList/nil
```

Description

Sets the search path for included files.

This command overrides the path set earlier using any of these commands: path, appendPath, or prependPath.

Using this command is comparable to setting the Include Path for the direct simulator, or the `modelPath` for socket simulators in the Virtuoso® Analog Design Environment user interface. You can add as many paths as you want with this command.

Arguments

t_dirName1	Directory path.
t_dirNameN	Additional directory path.

Value Returned

l_pathList	Returns the entire list of search paths specified.
`nil`	Returns `nil` and prints an error message if the paths cannot be set.

Examples

```
path( "~/models" "/tmp/models" )
=> "~/models" "/tmp/models"
```

Specifies that the search path includes `/models` followed by `/tmp/models`.

```
path()
=> "~/models" "/tmp/models"
```

Returns the search path last set.

prependPath

```
prependPath( t_dirName1 ... [t_dirNameN])
     => undefined/nil
```

Description

Adds a new path to the beginning of the search path list. You can add as many paths as you want with this command.

Arguments

t_dirName1	Directory path.
t_dirNameN	Additional directory path.

Value Returned

undefined	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if the paths cannot be added.

Examples

```
prependPath( "/usr/mnt/user/processB/models" )
=> "/usr/mnt/user/processB/models"
```

Adds `/usr/mnt/user/processB/models` to the beginning of the search path list.

```
prependPath( "/usr/mnt/user/processB/models" "/usr/mnt/user/processB/models2")
=> "/usr/mnt/user/processB/models"
```

Adds `/usr/mnt/user/processB/models` and `/usr/mnt/user/processB/models2` to the beginning of the search path list.

```
prependPath()
=> "/usr/mnt/user/processB/models" "~/models" "/tmp/models"
```

Returns the search path last set.

setup

```
setup( [?numberNotation s_numberNotation] [?precision x_precision]
     [?reportStyle s_reportStyle] [?charsPerLine x_charsPerLine]
     [?messageOn g_messageOn] )
     => t/nil
```

Description

Specifies default values for parameters.

Arguments

s_numberNotation

Specifies the notation for printed information.
Valid values: `'suffix`, `'engineering`, `'scientific`, `'none`
Default value: `'suffix`

The format for each value is `'suffix`: `1m`, `1u`, `1n`, etc.; `'engineering`: `1e-3`, `1e-6`, `1e-9`, etc.; `'scientific`: `1.0e-2`, `1.768e-5`, etc.; `'none`.

The value `'none` is provided so that you can turn off formatting and therefore greatly speed up printing for large data files.

x_precision

Specifies the number of significant digits that are printed.
Valid values: `1` through `16`
Default value: 6

s_reportStyle

Specifies the format of the output of the report command.
Valid values: `spice`, `paramValPair`
Default value: `paramValPair`

The spice format is:

	Param1	Param2	Param3
Name1	value	value	value
Name2	value	value	value
Name3	value	value	value

The paramValPair format is:

Name1
Param1=value Param2=value Param3=value

Name2
Param1=value Param2=value Param3=value

Name3
Param1=value Param2=value Param3=value

x_charsPerLine Specifies the number of characters per line output to the display.
Default value: `80`

g_messageOn Specifies whether error messages are turned on.
Valid values: `t`, `nil`
Default value: `t`, which specifies that messages are turned on.

Value Returned

`t` Returns `t` if the value is assigned to the name.

`nil` Returns `nil` if there is a problem.

Examples

```
setup( ?numberNotation ’engineering )
=> t
```

Specifies that any printed information is to be in engineering mode by default.

```
setup( ?precision 5 )
=> t
```

Specifies that 5 significant digits are to be printed.

```
setup(?numberNotation ’suffix ?charsPerLine 40 ?reportStyle ’spice ?messageOn t)
```

Sets up number notation to `suffix` format, characters per line to `40`, reporting style to `Spice`, and error message to `ON`.

6

Simulation Commands

The following OCEAN simulation commands let you set up and run your simulation.

ac

```
ac( g_fromValue g_toValue g_ptsPerDec )
     => undefined/nil

ac( g_fromValue g_toValue t_incType g_points )
     => undefined/nil
```

Description

Specifies an AC analysis.

To know more about this analysis, see the simulator-specific user guide.

Arguments

g_fromValue	Starting value for the AC analysis.
g_toValue	Ending value.
g_ptsPerDec	Points per decade.
t_incType	Increment type. Valid values: For the Spectre® circuit simulator, `"Linear"`, `"Logarithmic"`, or `"Automatic"`. For other simulators, `"Linear"` or `"Logarithmic"`.
g_points	Either the linear or the logarithmic value, which depends on *t_incType*.

Value Returned

undefined	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if the analysis is not specified.

Examples

```
ac(1 10000 2)
```

Specifies an AC analysis from 1 to 10,000 with 2 points per decade.

```
ac(1 10000 "Linear" 100)
```

Specifies an AC analysis from 1 to 10,000 by 100.

```
ac(1 5000 "Logarithmic" 10)
```

Specifies an AC analysis from `1` to `5000` with `10` logarithmic points per decade.

analysis

```
analysis( s_analysisType [?analysisOption1 g_analysisOptionValue1]…
    [?analysisOptionN g_analysisOptionValueN])
    => undefined/nil
```

Description

Specifies the analysis to be simulated.

You can include as many analysis options as you want. Analysis options vary, depending on the simulator you are using. To include an analysis option, replace *analysisOption1* with the name of the desired analysis option and include another argument to specify the value for the option. If you have an AC analysis, the first option/value pair might be `[?from 0]`.

Note: Some simplified commands are available for basic SPICE analyses. See the `ac`, `dc`, `tran`, and `noise` commands. Use the `ocnHelp( ’analysis )` command for more information on the analysis types for the simulator you choose.

Arguments

s_analysisType

Type of the analysis. The valid values for this argument depend on the analyses that the simulator contains.
The basic SPICE2G-like choices: `‘tran`, `‘dc`, `‘ac`, and `‘noise`.

?*analysisOption1*

Analysis option. The analysis options available depend on which simulator you use. (See the documentation for your simulator.) If you are using the Spectre® circuit simulator, see the information about analysis statements in the Spectre Circuit Simulator Reference manual for analysis options you can use.

g_analysisOptionValue1

Value for the analysis option.

?*analysisOptionN*

Any subsequent analysis option. The analysis options that are available depend on which simulator you use. (See the documentation for your simulator.)

g_analysisOptionValueN
Value for the analysis option.

Value Returned

undefined	The return value for this command/function is undefined.
nil	Returns nil and prints an error message if there is a problem specifying the analysis.

Examples

```
analysis( 'ac ?start 1 ?stop 10000 ?lin 100 )
```

For the Spectre® circuit simulator, specifies that an AC analysis be performed.

```
analysis( 'tran ?start 0 ?stop 1u ?step 10n )
```

Specifies that a transient analysis be performed.

```
analysis('dc ?oppoint "rawfile" ?save "allpub"
    ?param "temp" ?start -50 ?stop 100 )
```

Sweeps temperature for the Spectre® circuit simulator.

```
analysis('dc ?saveOppoint t )
```

Saves the DC operating point information for the Spectre® circuit simulator.

```
analysis('xf ?start 0 ?stop 100 ?lin 2 ?dev "v3" ?param "dc" ?freq 1 ?probe "v4")
```

Sets the Spectre transfer function analysis.

```
analysis('sens ?analyses_list list("dcOp" "dc" "ac") ?output_list list("I7:3"
"OUT")
```

Sets the Spectre sensitivity analysis.

```
analysis( 'noise ?start 1 ?stop 10e6 ?oprobe "V4" )
```

Sets the Spectre noise analysis.

```
analysis( 'dcmatch ?oprobe "/PR1" )
analysis( 'dcmatch ?param "temp" ?start "24" ?stop "26 ?lin "5" )
```

Sets the Spectre dcmatch analysis.

```
analysis('pz ?freq "2"  ?readns "./abc"  ?oppoint "rawfile" ?fmax "4500000000"
?zeroonly "no"  ?prevoppoint "no"  ?restart "no" ?annotate "no"  ?stats "no"  )
```

Sets the Spectre pz analysis.

```
analysis('stb ?start "10"  ?stop "10G"  ?dec "10" ?probe "/PR1"  ?prevoppoint "yes"
?readns "./abc"  ?save "lvl" ?nestlvl "1"  ?oppoint "logfile"  ?restart "yes"
?annotate "no" ?stats "yes"  )
```

Sets the Spectre stability analysis.

```
analysis('pss ?fund "100M"  ?harms "3"  ?errpreset "moderate"  )
```

Sets the Spectre pss RF analysis.

```
analysis('pnoise ?start "1K"  ?stop "30M"  ?log "20" ?maxsideband "3"
?oprobe "/rif"  ?iprobe "/rf" ?refsideband "0"  )
```

Sets the Spectre pnoise RF analysis.

```
analysis('pac ?sweeptype "relative"  ?relharmnum ""  ?start "700M" ?stop "800M"
?lin "5"  ?maxsideband "3")
```

Sets the Spectre pac RF analysis.

```
analysis('pxf ?start "10M"  ?stop "1.2G"  ?lin "100" ?maxsideband "3"  ?p "/Plo"
?n "/gnd!"  )
```

Sets the Spectre pxf RF analysis.

```
analysis('qpss ?funds list("flo" "frf")  ?maxharms list("0" "0")
?errpreset "moderate" ?param "prf"  ?start "-25"  ?stop "-10"  ?lin "5"  )
```

Sets the Spectre qpss RF analysis.

```
analysis('qpac ?start "920M"  ?stop ""  ?clockmaxharm "0"  )
```

Sets the Spectre qpac analysis.

```
analysis('sp  ?start "100M"  ?stop "1.2G"  ?step "100" ?donoise "yes"
?oprobe "/PORT0" ?iprobe "/RF"  )
```

Sets the Spectre sp (S - parameter) analysis.

createFinalNetlist

```
createFinalNetlist()
     => t/nil
```

Description

Creates the final netlist for viewing purposes. The netlist also can be saved but is not required to run the simulator.

Note: This command works only for socket simulators, such as spectreS. For direct simulators, such as spectre, use `createNetlist` instead.

Arguments

None.

Value Returned

`t`	Returns `t` if the final netlist is created.
`nil`	Returns `nil` and prints an error message otherwise.

Example

```
createFinalNetlist()
```

Creates the final netlist for the current simulation run.

createNetlist

```
createNetlist( [?recreateAll b_recreateAll] [?display b_display] )
     => t_filename/nil
```

Description

Creates the simulator input file.

If the design is specified as lib/cell/view, this command netlists the design, if required, and creates the simulator input file. When the `b_recreateAll` argument is set to `t` and the design is specified as lib/cell/view, all the cells in the design hierarchy are renetlisted, before creating the simulator input file. If the design is specified as netlist file, that netlist is included in the simulator input file. Also see the design function.

When the `b_display` option is set to `t` (or `nil`) the netlist file is displayed (or undisplayed) to the user. By default, `b_display` it set to `'t` (true).

Note: This command does not work with socket simulators.

Arguments

b_recreateAll	If set and the design is specified as lib/cell/view, the entire netlist is recreated.

Value Returned

t_fileName	Returns the name of the simulator input file on success.
`nil`	otherwise `nil` is returned

Examples

```
createNetlist()
=> "/usr/foo/netlist/input.scs"
```

Creates simulator input file for the current simulation run.

```
design( ?lib "test" ?cell "mytest" ?view "spectre")
```

```
createNetlist( ?recreateAll t )
=>"/usr/foo/netlist/input.scs"
```

Netlists and creates simulator input file for the current simulation run.

```
design( ?lib "test" ?cell "mytest1" ?view "spectre")
createNetlist( ?recreateAll t ?display nil )
=>"/usr/foo/netlist/input.scs"
```

Netlists and creates simulator input file for the given simulation run but does not display the `input.scs` file in a new window which may be annoying to the user. By default `?display` option is set to `'t` meaning netist file would be displayed. This can be turned ON/OFF via `?display` set to `t/nil`

converge

```
converge( s_convName t_netName1 f_value1 ... [t_netNameN f_valueN])
    => undefined/nil
```

Description

Sets convergence criteria on nets.

To know more about convergence, refer to the chapter *Helping a Simulation to Converge* of the *Virtuoso Analog Design Environment User Guide*.

Arguments

s_convName	Name of the convergence type. Valid values are one of `nodeset ic and forcenode`. Note that `forcenode` is not supported for the spectre and spectreS simulators.
t_netName1	Name of the net to which you want to set convergence criteria.
f_value1	Voltage value for the net
t_netNameN	Name of the additional net
f_value	Voltage value for the additional net

Value Returned

undefined	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if the function fails

Examples

```
converge( 'ic "/I0/net1" 5 )
```

Sets the convergence name for the initial condition `net1` to 5 volts.

```
converge( 'nodeset "/I0/net1" 5 )
```

Sets the convergence name for nodeset of `net1` to 5 volts.

dc

```
dc( t_compName [ t_compParam ] g_fromValue g_toValue g_byValue )
     => undefined/nil
```

Description

Specifies a DC sweep analysis with limited options. If other analysis options are needed, use the `analysis` command.

To know more about this analysis, see the simulator-specific user guide.

Note: *`t_compParam`* is valid only for the spectre, spectreS, spectreVerilog and spectreSVerilog simulators.

Arguments

`t_compName`	Name of the source (or component, for the Spectre® circuit simulator) to sweep.
`t_compParam`	For the Spectre® circuit simulator, the component parameter to be swept.
`g_fromValue`	Starting value for the DC analysis.
`g_toValue`	Ending value.
`g_byValue`	The increment at which to step through the analysis.

Value Returned

`undefined`	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if the analysis is not specified.

Examples

```
dc("v1" "dc" 0 5 1)
dc("r1" "r" 0 5 1)
```

Specifies two DC sweep analyses for the Spectre® circuit simulator.

```
dc("v1" 0 5 1)
```

Specifies one DC sweep analysis for a simulator other than the Spectre® circuit simulator.

definitionFile

```
definitionFile( t_fileName [t_fileName2 ... t_fileNameN ])
     => l_fileNames/nil
```

Description

Specifies definitions files to be included in the simulator input file.

Definitions files define functions and global variables that are not design variables. Examples of such variables are model parameters or internal simulator parameters. To know more about definitions files, see the section *Using a Definitions File* in *Chapter 3* of the *Virtuoso Analog Design Environment User Guide*.

Note: This command does not work with socket simulators.

Arguments

t_fileName	The name of the definition file that would typically contain functions or parameter statements.

Value Returned

l_fileNames	A list of the file names specified; returned on success.
`nil`	Otherwise `nil` is returned.

Example

```
definitionFile( "functions.def” “constants.def" )
=> ("functions.def” “constants.def")
```

Includes `functions.def` and `constants.def` files in the simulator input file.

```
definitionFile( )
=> ("functions.def" "constants.def")
```

Returns the definition files set earlier.

delete

```
delete( s_command [g_commandArg1] [g_commandArg2] … )
     => t/nil
```

Description

Deletes all the information specified.

The *s_command* argument specifies the command whose information you want to delete. If you include only this argument, all the information for the command is deleted. If you supply subsequent arguments, only those particular pieces of information are deleted as opposed to deleting all the information for that command.

Arguments

s_command	Command that was initially used to add the items that are now being deleted. Valid values: `analysis`, `desVar`, `path`, `save`, `ic`, `forcenode`, `monteCarlo`, `monteExpr`, `nodeset`, `optimizeGoal`, `optimizeVar`, `optimizeAlgoControl`, `optimizePlotOption` Using `delete( 'monteCarlo )` turns off the `monteCarlo` command and sets everything back to the defaults.
g_commandArg1	Argument corresponding to the specified command.
g_commandArg2	Additional argument corresponding to the specified command.

Value Returned

`t`	Returns `t` if the information is deleted.
`nil`	Returns `nil` if there is an error.

Examples

```
delete( 'save )
=> t
```

Deletes all the saves.

```
delete( 'save 'v )
=> t
```

Deletes *only* the nets. The rest of the information can be saved in subsequent simulations.

```
delete( 'save "net23" )
=> t
```

Deletes only `net23`. The rest of the information can be saved in subsequent simulations.

```
delete( 'monteCarlo )
=> t
```

Turns off the monteCarlo command and sets everything back to the defaults.

design

```
design( t_cktFile )
     => t_cktFile/nil

design( t_lib t_cell t_view )
     => (t_lib t_cell t_view)/nil

design( t_lib t_cell t_view t_mode )
     => (t_lib t_cell t_view)/nil
```

Description

Specifies the name of the design to be simulated.

Note: You can use the *lib*, *cell*, *view* version of the `design` command only if you are running OCEAN within `icms`, `msfb`, or `icfb`. You cannot use this version of the command within the OCEAN process itself.

Arguments

t_cktFile	For the direct simulator, the name of the netlist. The name must end in `netlist`. Note that the `netlistHeader` and `netlistFooter` files are also needed in the same directory. For socket simulators, this is the name of the raw circuit file. If generated in the Virtuoso® Analog Design Environment, the file is named `design.c` and is found in the `netlist` directory. Otherwise, *cktFile* is a pre-existing netlist file from another source. In this case, you might need to remove the `.cards` from the netlist because the OCEAN commands are converted to `.cards` and appended to the final netlist. The simulator might give an error or warning if the `.cards` are read twice.
t_lib	Name of the Virtuoso® Analog Design Environment library that contains the design.
t_cell	Name of the design.
t_view	View of the design (typically `schematic`).
t_mode	The mode in which the design should be opened. The value can be `r`, `w` or a, representing `read`, `write` and `append`,

respectively. The default mode is `append`. Read-only designs can be netlisted only by direct netlisters, and not socket. The `w` mode should not be used as it overwrites the design.

Value Returned

t_cktFile Returns the name of the design if successful.

l_(lib cell view)
Returns the name of the view for an Virtuoso® Analog Design Environment design if successful.

`nil` Returns `nil` and prints an error message if there is a problem using the specified design.

Examples

For the Spectre® circuit simulator,

```
design( "netlist" )
=> netlist
```

specifies that `netlist`, a netlist file, be used in the simulation.

For the spectreS simulator,

```
design( "simple.c" )
=> simple.c
```

specifies that `simple.c`, a raw circuit file, be used in the simulation.

```
design( "tests" "simple" "schematic" )
=> (tests simple schematic)
```

Specifies that the `schematic` view of the `simple` design from your `tests` library be used in the simulation.

```
design("mylib" "ampTest" "schematic" "a")
=> (mylib ampTest schematic)
```

Specifies that the `schematic` view of the `ampTest` design from your `mylib` library be appended to the simulation.

```
design()
=> (mylib ampTest schematic)
```

Returns the lib-cell-view being used in the current session. If a design has not been specified, it returns `nil`.

desVar

```
desVar( t_desVar1 f_value1 … [t_desVarN f_valueN])
     => undefined/nil
```

Description

Sets the values of design variables used in your design. You can set the values for as many design variables as you want.

To know more about design variables, refer to the chapters *Design Variables and Simulation Files for Direct Simulation* and *Design Variables and Simulation Files for Socket Simulation* of the *Virtuoso Analog Design Environment User Guide*.

Arguments

t_desVar1	Name of the design variable.
f_value1	Value for the design variable.
t_desVarN	Name of an additional design variable.
f_valueN	Value for the additional design variable.

Value Returned

undefined	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if the assignments fail.

Examples

```
desVar( )
```

Returns the design variables set last, if any. Otherwise, it returns `nil`.

```
desVar( "rs" 1k )
```

Sets the `rs` design variable to `1k`.

```
desVar( "r1" "rs" "r2" "rs*2" )
```

Sets the `r1` design variable to `rs`, or `1k`, and sets the `r2` design variable to `rs*2`, or `2k`.

```
a = evalstring( desVar( "rs")) / 2
```

Sets a to `1k/2` or `500`.

Note: `evalstring` is necessary because `desVar` returns a string.

envOption

```
envOption( s_envOption1 g_value1 … [ s_envOptionN g_valueN ] )
     => undefined/nil
```

Description

Sets environment options.

Use the OCEAN online help command `ocnHelp('envOption)` to get the list of environment options. To specify an include file, use the `includeFile` command, not the `envOption` command. To set a model path, use the `path` command, not the `envOption` command.

To know more about environment options, see the section *Environment Options* in *Chapter 2* of the *Virtuoso Analog Design Environment User Guide*.

Arguments

s_envOption1	Name of the first environment option to set.
g_value1	Value for the option.
s_envOptionN	Name of an additional environment option to set.
g_valueN	Value for the option.

Value Returned

undefined	The return value for this command/function is undefined.
`nil`	Returns `nil` if there are problems setting the option.

Examples

```
envOption( 'paramRangeCheckFile "./myDir/range.check" )
```

Sets the `paramRangeCheckFile` environment option.

```
envOption( 'initFile "./myDotSFiles/init" )
```

Sets the `initFile` environment option.

```
envOption( 'updateFile "./myDotSFiles/update" )
```

Sets the `updateFile` environment option.

forcenode

```
forcenode( t_netName1 f_value1 … [t_netNameN f_valueN] )
     => undefined/nil
```

Description

Holds a node at a specified value.

To know more about convergence, refer to the chapter *Helping a Simulation to Converge* of the *Virtuoso Analog Design Environment User Guide*.

Note: This is not available for the spectre and spectreS simulators. Refer to the documentation for your simulator to see if this feature is available for your simulator.

Arguments

t_netName1	Name of the net.
f_value1	Voltage value for the net.
t_netNameN	Name of an additional net.
f_valueN	Voltage value for the net.

Value Returned

undefined	The return value for this command/function is undefined.
nil	Returns `nil` and prints an error message.

Example

```
forcenode( "net1" 5 "net34" 2 )
```

Sets the force nodes of `"net1"` to 5 and `"net34"` to 2.

ic

```
ic( t_netName1 f_value1 … [t_netNameN f_valueN] )
     => undefined/nil
```

Description

Sets initial conditions on nets in a transient analysis.

To know more about convergence, refer to the chapter *Helping a Simulation to Converge* of the *Virtuoso Analog Design Environment User Guide*.

Arguments

t_netName1	Name of the net.
f_value1	Voltage value for the net.
t_netNameN	Name of an additional net.
f_valueN	Voltage value for the net.

Value Returned

undefined	The return value for this command/function is undefined.
nil	Returns nil and prints an error message.

Example

```
ic( "/net1" 5 "/net34" 2 )
```

Holds the nodes of `"/net1"` at 5 and `"/net34"` at 2.

includeFile

```
includeFile( t_fileName )
     => t_fileName/nil
```

Description

Includes the specified file in the final netlist of the simulator for the current session.

Notes:

1. This command is not available for the direct simulator. Use the `modelFile` or `stimulusFile` command instead.
2. Using this command is comparable to using the Environment Options form of the Virtuoso® Analog Design Environment to name an include file and specify that the syntax for the file be that of the target simulator. If you want the include file to be in Cadence-SPICE circuit simulator syntax, you must edit the raw netlist file (which has a `.c` or `.C` suffix), and manually add the include file.

Arguments

t_fileName	Name of the file to include in the final netlist.

Value Returned

t_fileName	Returns the name of the file if successful.
`nil`	Returns `nil` and prints an error message otherwise.

Example

```
includeFile( "~/projects/nmos" )
=> "~/projects/nmos"
```

Includes the `nmos` file in the final netlist of the simulator for the current session.

```
includeFile()
=>"~/projects/nmos"
```

Returns the includeFile, if one was set earlier. Otherwise, it returns `nil`.

modelFile

```
modelFile( [g_modelFile1 [g_modelFile2 …]] )
     => l_modelFile
```

Description

Specifies model files to be included in the simulator input file.

This command returns the model files used. When model files are specified through the arguments, the model files are set accordingly. Use of full paths for the model file is recommended.

Arguments

g_modelFile1	This argument can be a string to specify the name of the model file.
g_modelfile2	This argument can be a list of two strings to specify the name of the model file and the name of the section.

Value Returned

l_modelfile	A list of all the model file/section pairs.
`nil`	Returned when no file section pairs have been specified with the current call or a previous call of this command. The `nil` value is also returned when an error has been encountered.

Example

```
modelFile( "bjt.scs" "nmos.scs" )
=>( ("bjt.scs" "") ("nmos.scs" "") )

modelFile( "bjt.scs" '("nmos.scs" "typ") 'my_models )
=> ( ("bjt.scs" "") ("nmos.scs" "typ") ("my_models" "") )

modelFile()
=> ( ("bjt.scs" "") ("nmos.scs" "") )
```

Returns the modelFile, if one was set earlier. Otherwise, it returns `nil`.

nodeset

```
nodeset( t_netName1 f_value1 … [t_netNameN f_valueN])
     => undefined/nil
```

Description

Sets the initial estimate for nets in a DC analysis, or sets the initial condition calculation for a transient analysis.

To know more about convergence, refer to the chapter *Helping a Simulation to Converge* of the *Virtuoso Analog Design Environment User Guide*.

Arguments

t_netName1	Name of the net.
f_value1	Voltage value for the net.
t_netNameN	Name of an additional net.
f_valueN	Voltage value for the net.

Value Returned

undefined	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message otherwise.

Example

```
nodeset( "net1" 5 "net34" 2 )
```

Sets the initial estimates of `"net1"` to `5` and `"net34"` to `2`.

noise

```
noise( t_output t_source )
     => undefined/nil
```

Description

Specifies a noise analysis.

Note: This command cannot be used with the spectre, spectreS, spectreVerilog and spectreSVerilog simulators.

Arguments

t_output	Output node.
t_source	Input source.

Value Returned

undefined	The return value for this command/function is undefined.
nil	Returns `nil` and prints an error message If there is a problem specifying the analysis.

Example

```
noise( "n1" "v1" )
```

Specifies a noise analysis.

ocnDisplay

```
ocnDisplay([?output t_filename | p_port] s_command [g_commandArg1]
     [g_commandArg2] … )
     => t/nil
```

Description

Displays all the information specified.

The *s_command* argument specifies the command whose information you want to display. If you include only this argument, all the information for the command displays. If you supply subsequent arguments, only those particular pieces of information display as opposed to displaying all the information for that command. If you provide a filename as the `?output` argument, the `ocnDisplay` command opens the file and writes the information to it. If you provide a port (the return value of the SKILL `outfile` command), the `ocnDisplay` command appends the information to the file that is represented by the port.

Arguments

t_filename	File in which to write the information. The `ocnDisplay` command opens the file, writes to the file, then closes the file. If you specify the filename without a path, the `ocnDisplay` command creates the file in the directory pointed to by your Skill Path. To find out what your Skill path is, type `getSkillPath()` at the OCEAN prompt.
p_port	Port (previously opened with `outfile`) through which to append the information to a file. You are responsible for closing the port. See the outfile command for more information.
s_command	Command that was initially used to add the items that are now being displayed. Valid values: Most simulation setup commands. The commands that are supported include design, analysis, tran, ac, dc, noise, netlistDir, resultsDir, temp, option, desVar, path, includeFile, modelFile, stimulusFile, definitionFile, saveOption, envOption, keep, save, converge, ic, forcenode, nodeset, simulator, setup, restore, param, optimizeVar, optimizeAlgoControl, optimizePlotOption, cornerDesVar, monteCarlo, and monteOutputs.
g_commandArg1	Argument corresponding to the specified command.

g_commandArg2	Additional argument corresponding to the specified command.

Value Returned

`t`	Displays the information and returns `t`.
`nil`	Returns `nil` and prints an error message if there are problems displaying the information.

Examples

```
ocnDisplay( ’optimizeGoal )
=> t
```

Displays all the `optimizeGoal` information.

```
ocnDisplay( ’analysis ’tran )
=> t
```

Displays only transient analyses.

```
ocnDisplay( ’save )
=> t
```

Displays all the keeps.

```
ocnDisplay( ?output myPort ’analyis )
=> t
```

Displays and writes all the analyses to the port named `myPort`.

ocnGetWaveformTool

```
ocnGetWaveformTool()
     => t_toolName
```

Description

Returns the waveform tool name.

Value Returned

t_toolName	The waveform tool being used.

Example

```
ocnGetWaveformTool()
=> awd
```

Specifies that the current waveform tool is AWD.

ocnWaveformTool

```
ocnWaveformTool( s_waveformTool )
     => t/nil
```

Description

Sets the specified tool as the waveform tool.

Arguments

s_waveformTool	Either one of the waveform tools, `awd` or `wavescan`, which you want to set for the current session.

Value Returned

`t`	Indicates that the specified waveform tool has been set.
`nil`	Returns `nil` if there is a problem setting the specified waveform tool.

Example

```
ocnWaveformTool( 'wavescan )
=> t
```

Sets WaveScan as the current waveform tool.

off

```
off( s_command [g_commandArg1] [g_commandArg2] … )
     => t/nil
```

Description

Turns off the specified information.

This command is currently available only for the analysis and restore commands. The first argument specifies the command whose information you want to turn off. If you include only this first argument, all the information for the command is turned off. If you supply subsequent arguments, only those particular pieces of information are turned off as opposed to turning off all the information for that command. The information is not deleted and can be used again.

Arguments

s_command	Command that was initially used to add the items that are now being turned off. Valid value: `restore`
g_commandArg1	Argument corresponding to the specified command.
g_commandArg2	Additional argument corresponding to the specified command.

Value Returned

`t`	Returns `t` if the information is turned off.
`nil`	Returns `nil` and prints an error message if there are problems turning off the information.

Examples

```
off( 'restore )
=> t
```

Turns off the `restore` command.

```
off( restore 'tran )
=> t
```

Turns off the transient `restore` command.

option

```
option( [?categ s_categ] s_option1 g_value1 [s_option2 g_value2] … )
     => undefined/nil
```

Description

Specifies the values for built-in simulator options. You can specify values for as many options as you want.

Arguments

s_categ	Type of simulator to be used. Valid values: `analog` if the options are for an analog simulator, `digital` for a digital simulator, or `mixed` for a mixed-signal simulator Default value: `analog`
s_option1	Name of the simulator option.
g_value1	Value for the option.
s_option2	Name of an additional simulator option.
g_value2	Value for the option.

Value Returned

undefined	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if there are problems setting the option.

Examples

```
option( ’abstol 1e-10 )
```

Sets the `abstol` option to `1e-10`.

```
option( ’delmax 50n )
```

Sets the `delmax` option to `50n`.

```
option()
```

Returns the category list for simulation options, including analog, digital, and mixed.

```
option(?categ 'analog)
```

Returns all the simulator options for the analog simulator currently set. For example, if the set simulator is spectre, it returns the valid simulator options for spectre.

restore

```
restore( s_analysisType t_filename )
     => undefined/nil
```

Description

Tells the simulator to restore the state previously saved to a file with a `store` command.

This command is not available for the Spectre® circuit simulator, with which you can use the store/restore options: `readns`, `readforce`, `write`, or `writefinal`.

Note: `Restore` is available for the cdsSpice and hspiceS simulators.

Arguments

s_analysisType	Type of the analysis. Valid values: `dc` or `tran`
t_filename	Name of the file containing the saved state.

Value Returned

undefined	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if there are problems restoring the information.

Examples

```
restore( 'dc "./storeFile" )
=> ./storeFile
```

Initializes the simulator to the state saved in the `storeFile` file.

```
restore( 'tran "./tranStoreFile" )
=> ./tranStoreFile
```

Initializes the simulator to the state of a transient analysis saved in the `tranStoreFile` file.

resultsDir

```
resultsDir( t_dirName )
     => undefined/nil
```

Description

Specifies the directory where the PSF files (results) are stored.

If you do not specify a directory with this command, the PSF files are placed in `../psf` to the `netlist` directory.

Note: The directory you specify with `resultsDir` is also where the *`simulator`*`.out` file is created.

Note: Some simulators are designed to *always* put their results in a specific location. For these simulators, `resultsDir` has no effect. You might use this command when you want to run several simulations using the same design and want to store each set of results in a different location. If this command is not used, the results of an analysis are overwritten with each simulation run.

Arguments

`t_dirName`	Directory where the PSF files are to be stored.

Value Returned

`undefined`	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if there is a problem with that directory.

Example

```
resultsDir("~/simulation/ckt/spectreS/schematic/psf")=>
    "~/simulation/ckt/spectreS/schematic/psf"
```

Specifies the `psf` directory as the directory in which to store the PSF files.

```
resultsDir() => "~/simulation/ckt/spectreS/schematic/psf"
```

Returns the results directory.

run

```
run( [analysisList] [?jobName t_jobName] [?host t_hostName]
     [?queue t_queueName] [?startTime t_startTime] [?termTime t_termTime]
     [?dependentOn t_dependentOn] [?mail t_mailingList] [?block s_block]
     [?notify s_notifyFlag] )
     => s_jobName/nil

run( )
     =>t_dirName/nil

run(_analysisType1 … s_analysisTypeN)
     => t_dirName/nil
```

Description

Starts the simulation or specifies a time after which an analysis should start.

If distributed processing is not available on the system or is not enabled, parameters specific to distributed processing (such as host, job name, and queue) are ignored and the simulation runs locally. If distributed processing is available and is enabled, the environment default values are used if not specified in the `run` command arguments. The environmental default values are stored in the `.cdsenv` file.

Do not use the `run` command to start the following kinds of analyses. Instead, use the command that is specific to the analysis.

To start	Use this command
parametric analyses	paramRun
corners analyses	cornerRun
Monte Carlo analyses	monteRun
optimizations	optimizeRun

Arguments

analysisList — List of analyses to be run with the `run` command.

Note: The following arguments apply only when distributed mode is enabled.

t_jobName — If the name given is not unique, an integer is appended to create a unique job name.

t_hostName	Name of the host on which to run the analysis. If no host is specified, the system assigns the job to an available host.
t_queueName	Name of the queue. If no queue is defined, the analysis is placed in the default queue.
t_startTime	Desired start time for the job. If dependencies are specified, the job does not start until all dependencies are satisfied.
t_termTime	Termination time for job. If the job has not completed by the specified termination time, the job is aborted.
t_dependentOn	List of jobs on which the specified job is dependent. The job is not started until dependent jobs are completed.
t_mailingList	List of users to be notified when the analysis is complete.
s_block	When *s_block* is not set to `nil`, the OCEAN script halts until the job is complete. Default value: `nil`
s_notifyFlag	When not set to `nil`, the job completion message is echoed to the OCEAN interactive window. Default value: `t`
s_analysisType1	Name of a prespecified analysis to be simulated.
s_analysisTypeN	Name of another prespecified analysis to be simulated.

Value Returned

s_jobName	Returns the job name of the job submitted. The job name is based on the `jobName` argument. If the job name submitted is not unique, a unique identifier is appended to the job name. This value is returned for nonblocking distributed mode.
t_dirName	Returns the name of the directory in which the results are stored. This value is returned for local and blocking distributed modes.

`nil`	Returns `nil` and prints an error message if there is an error in the simulation. In this case, look at the *`yourSimulator`*`.out` file for more information. (This file is typically located in the `psf` directory.)

Examples

```
run( )
=> t
```

Starts the simulation.

```
run('tran, 'ac)
```

Runs only the `tran` and `ac` analyses.

```
run('dc)
```

Runs only the `dc` analysis.

```
run( ?jobName ?block "nil")
=> 'reconFilter
```

Returns a job name of `reconFilter` for the specified job and runs that job if distributed processing is enabled. The job is submitted nonblocking. The actual job name is returned.

```
run( ?queue "fast" )
```

Submits the current design and enabled analyses as a job on the `fast` queue, assuming that distributed processing is available and enabled.

```
run( ?jobName "job1" ?queue "fast" ?host "menaka" ?startTime "22:59"
?termTime "23:25" ?mail "preampGroup")
```

Submits the current design and enabled analyses as a jobName `job1` on the fast queue host `menaka` with the job start time as `22:59` and termination time as `23:25`. A mail will be sent to preampGroup after the job ends.

save

```
save( [?categ s_categ] s_saveType [t_saveName1] … [t_saveNameN] )
     => undefined/nil
```

Description

Specifies the outputs to be saved and printed during simulation.

When specifying particular outputs with `saveName`, you can include as many outputs as you want. If you want to turn off the default of `save`, `'allv`, use the `delete( 'save )` command.

Arguments

s_categ

Type of simulator to be used.
Valid values: `analog`, `digital`
Default value: `analog`
Note: `digital` is not available.

s_saveType

Type of outputs to be saved.
Valid values:

Valid Values	Description
`v`	Specifies that a list of subsequent net names be kept.
`i`	Specifies that a list of subsequent currents be kept.
`all`	Specifies that all nets and all currents are to be saved.
`allv`	Specifies that all voltages are to be saved.
`alli`	Specifies that all currents are to be saved.

Default value: `allv`

t_saveName1

Name of the net, device, or other object.

t_saveNameN

Name of another net, device, or object.

Value Returned

`undefined`	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if there is a problem keeping the outputs.

Examples

```
save( ’v "net34" "net45" )
```

Saves the outputs for `net34` and `net45`.

```
save( ’i "R1" "/Q1/b" )
```

Saves the currents for `R1` and `Q1/b`.

```
save( ’all )
```

Saves all the nets and currents.

```
save( ’i "q1:b" "r1:p" "mn1:d" )
```

For the spectre simulator, saves the current through the specified devices.

```
save( ?categ ’analog ’v "/vin" "/vout" )
```

Saves the output for `vin` and `vout`.

```
save( ’i "i(q1,b)" "i(r1)" "i(mn1,d)" )
```

For the Cadence-SPICE circuit simulator, saves the current through the same devices.

saveOption

```
saveOption([s_option1 g_optionValue1]…[s_optionN g_optionValueN])
     => undefined/nil
```

Description

Specifies save options to be used by the simulator.

You can include as many save options as you want. To include a save option, replace *s_option1* with the name of the desired save option and include another argument to specify the value for the option.

When you use the `saveOption` command without specifying any arguments, the command returns a list of option and value pairs.

Save options vary, depending on the simulator and interface that you are using. If you are using the Spectre® circuit simulator, for example, you can type the following at an OCEAN prompt to see which options you can set with the `saveOption` command:

```
simulator('spectre)
ocnHelp('saveOption)
```

See the Spectre Circuit Simulator User Guide for more information on these options.

Note: The `saveOption` command does not work with socket simulators. If you are using a socket simulator, you must instead specify save options with the `save` command described in "save" on page 111.

Arguments

s_option1
: Save option. The save options that are available depend on which simulator you use. (See the documentation for your simulator.)

g_optionValue1
: Value for the save option.

s_optionN
: Any subsequent save option. The save options that are available depend on which simulator you use. (See the documentation for your simulator.)

`g_optionValueN`

Value for the save option.

Value Returned

`undefined`	The return value for this command/function is undefined.
`nil`	Returns `nil` if there are problems specifying options.

Example

```
saveOption( ’save "lvl" ’nestlvl 10 ’currents "selected"
    ’useprobes "yes" ’subcktprobelvl 2 ?saveahdlvars "all")
```

simulator

```
simulator( s_simulator )
     => s_simulator/nil
```

Description

Starts an OCEAN session and sets the simulator name for that session. The previous session (if any) is closed and all session information is cleared.

Arguments

s_simulator	Name of the simulator.

Value Returned

s_simulator	Returns the name of the simulator.
`nil`	Returns `nil` and prints an error message if the simulator is not registered with the Virtuoso® Analog Design Environment through OASIS. If the simulator is not registered, the simulator from the preceding session is retained.

Examples

```
simulator( 'spectre )
=> spectre
```

Specifies that the Spectre® circuit simulator be used for the session.

```
simulator( 'spectreVerilog )
=> spectreVerilog
```

Specifies that spectreVerilog be used for the session.

```
simulator()
=> spectreVerilog
```

Returns the simulator that you set for the session. If a simulator was not specified, it returns `nil`.

stimulusFile

```
stimulusFile( t_fileName [t_fileName2 … t_fileNameN ] [?xlate b_xlate] )
     => l_fileNames/nil
```

Description

Specifies stimulus files to be used by the simulator.

When the *b_xlate* variable is set to `t`, the schematic net expressions [#net] and instance name expression [$instance] in the stimulus file are mapped into simulator names before including. When a netlist is specified as the design, this option must be set to `nil`.

Note: This command does not work with socket simulators.

Arguments

t_fileName	The name of the stimulus file to be included.
t_fileName2…t_fileNameN	The names of the additional stimulus files to be included.
b_xlate	If set to `t`, net and instance expressions are translated to simulator names. The default value of the *b_xlate* variable is `t`.

Value Returned

l_fileNames	A list of the stimulus file names is the output if the command is successful.
`nil`	Otherwise `nil` is returned

Example

```
stimulusFile( "tran.stimulus rf.stimulus" ?xlate nil)
=> ("tran.stimulus rf.stimulus")
```

Includes `tran.stimulus` and `rf.stimulus` in the simulator input file. No net and instance expressions are translated.

```
stimulusFile()
=> ("tran.stimulus" "rf.stimulus")
```

Returns the stimulusFile, if one was set earlier. Otherwise, it returns `nil`.

store

```
store( s_analysisType t_filename )
     => t_filename/nil
```

Description

Requests that the simulator store its node voltages to a file.

You can restore this file in a subsequent simulation to help with convergence or to specify a certain starting point. This command is not available for the Spectre® circuit simulator, with which you can use the store/restore options: `readns`, `readforce`, `write`, or `writefinal`.

Note: `store` is available for the cdsSpice and hspiceS simulators.

Arguments

s_analysisType	Type of the analysis. Valid values: `dc` or `tran`
t_filename	Name of the file in which to store the simulator's node voltages.

Value Returned

t_filename	Returns the filename.
`nil`	Returns `nil` and prints an error message if there are problems storing the information to a file.

Examples

```
store( 'dc "./storeFile" )
=> ./storefile
```

Stores the simulator's node voltages in a file named `storeFile` in the current directory.

```
store( 'tran "./tranStoreFile" )
=> ./transtorefile
```

Stores the node voltages for a transient analysis in a file named `tranStoreFile` in the netlist (design) directory unless a full path is specified.

temp

```
temp( f_tempValue )
     => f_tempValue/nil
```

Description

Specifies the circuit temperature.

Arguments

f_tempValue	Temperature for the circuit.

Value Returned

f_tempValue	Returns the temperature specified.
`nil`	Returns `nil` and prints an error message if there are problems setting the temperature.

Example

```
temp( 125 )
=> 125
```

Sets the circuit temperature to 125.

```
temp()
=> 125
```

Gets the value you had set for the circuit temperature. If you have not set a value for the temperature, it returns the default value.

tran

```
tran( g_fromValue g_toValue g_byValue )
     => g_byValue/nil

tran( g_toValue)
     => undefined/nil
```

Description

Specifies a transient analysis with limited options. If other analysis options are needed, use the analysis command.

To know more about this analysis, see the simulator-specific user guide.

Note: The second instance of the `tran` command is valid only with the spectre, spectreS, spectreVerilog and spectreSVerilog simulators.

Arguments

g_fromValue	Starting time for the analysis.
g_toValue	Ending time.
g_byValue	Increment at which to step through the analysis.

Value Returned

undefined	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if the analysis is not specified.

Examples

```
tran( 1u)
=> "1e-06"
```

Specifies a transient analysis to 1u for the Spectre® circuit simulator

```
tran( 0 1u 1n )
=> "1e-09"
```

Specifies a transient analysis from 0 to 1u by increments of 1n.

7

Data Access Commands

The data access commands let you open results and select different types of results to analyze. You can get the names and values of signals and components in the selected results, and you can print different types of reports.

In this chapter, you can find information on the following data access commands

dataTypes

```
dataTypes()
     => l_dataTypes/nil
```

Description

Returns the list of data types that are used in an analysis previously specified with `selectResult`.

Arguments

None.

Value Returned

l_dataTypes	Returns the list of data types.
`nil`	Returns `nil` and an error message if the list of datatypes cannot be returned.

Example

```
selectResult( 'dcOp )
dataTypes() => ( "node" "vs" "resistor" "bjt" )
```

Returns the data types used in the selected file, in this case, `dcOp`.

getData

```
getData( t_name [?result s_resultName [?resultsDir t_resultsDir]] )
     => x_number/o_waveform/nil
```

Description

Returns the number or waveform for the signal name specified.

The type of value returned depends on how the command is used.

Arguments

t_name	Name of the signal.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

x_number	Returns an integer simulation result.
o_waveform	Returns a waveform object. A waveform object represents simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
`nil`	Returns `nil` and an error message if the value cannot be returned.

Examples

```
getData( "/net6" ) => drwave:25178234
```

Returns the number or waveform for `net6`. In this example, the return value is equivalent to `v( "/net6" )`.

```
getData( "/V1" ?result 'ac )
=> drwave:96879364
```

Returns the number or waveform for `V1`. In this example, the return value is equivalent to: `i( "/V1" ?result 'ac )`.

```
selectResult( 'tran ) =>
ocnPrint( getData( "net1" ) ) =>
```

The `getData( "net1" )` command passes a waveform to the `ocnPrint` command. The `ocnPrint` command then prints the data for the waveform. In this example, the return value is equivalent to:
`(v( "net1" ))`.

```
ocnPrint( getData( "net1" ?result 'tran ?resultsDir "./simulation/testcell/
spectre/schematic/psf")
```

Returns a signal on `net1` for the `tran` result strored in the path `"./simulation/testcell/spectre/schematic/psf"`.

getResult

```
getResult ( [?result s_resultName [?resultsDir t_resultsDir]] )
     => o_results/nil
```

Description

Gets the data object for a specified analysis without overriding the status of any previously executed `selectResult()` or `openResults()` commands.

Returns the data object for a particular analysis similar to the `selectResult()` function does. Unlike the `selectResult()` function, all subsequent data access commands will not internally use this information.

Arguments

s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

o_results	Returns the object representing the selected results.
`nil`	Returns `nil` and an error message if there are problems accessing the analysis.

Example

```
getResult( ?result 'tran )
```

i

```
i( t_component [?result s_resultName [?resultsDir t_resultsDir]] )
    => o_waveform/nil
```

Description

Returns the current through the specified component.

Arguments

t_component	Name of the component.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

o_waveform	Returns a waveform object. A waveform object represents simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.).
`nil`	Returns an error message and `nil` if there is a problem.

Examples

```
selectResult( 'tran )
i( "/R1" )
```

Returns the current through the `R1` component.

```
ocnPrint( i( "/R1" ) )
```

Prints the current through the `R1` component.

```
ocnPrint( i( "/R1" ?result ’dc ) )
```

Prints the current through the `R1` component with respect to the `dc` swept component.

```
ocnPrint( i( "/R1" ?resultsDir "./test2/psf" ?result ’dc ) )
```

Prints the current through the `R1` component with respect to `dc` for the results from a different run (stored in `test2/psf`).

ocnHelp

```
ocnHelp( [?output t_filename | p_port][s_command] )
     => t/nil
```

Description

Provides online help for the specified command.

If no command is specified, provides information about how to use help and provides the different categories of information contained in the help library. If you provide a filename as the `?output` argument, the `ocnHelp` command opens the file and writes the information to it. If you provide a port (the return value of the SKILL `outfile` command), the `ocnHelp` command appends the information to the file that is represented by the port. If you do not specify `?output`, the output goes to standard out (stdout).

Arguments

t_filename	File in which to write the information. The `ocnHelp` command opens the file, writes to the file, and closes the file. If you specify the filename without a path, the `ocnHelp` command creates the file in the directory pointed to by your Skill Path. To find out what your Skill path is, type `getSkillPath()` at the OCEAN prompt.
p_port	Port (previously opened with `outfile`) through which to append the information to a file. You are responsible for closing the port. See the outfile command for more information.
s_command	Command for which you want help.

Value Returned

`t`	Displays the online help and returns `t`.
`nil`	Returns `nil` and an error message if help cannot be displayed.

Examples

```
ocnHelp()
=> t
```

Displays information about using online help.

```
ocnHelp( 'analysis )
=> t
```

Displays help for the `analysis` command.

```
ocnHelp( ?output "helpInfo" )
=> t
```

Writes information about using online help to a file named `helpInfo`.

openResults

```
openResults( s_jobName | t_dirName [g_enableCalcExpressions])
     => t_dirName/nil
```

Description

Opens simulation results stored in PSF files or opens the results from a specified job, depending on which parameter is called.

When `openResults` passes a symbol, it interprets the value as a job name and opens the results for the specified job. *`s_jobName`* is a job name and is defined when a `run` command is issued.

When `openResults` passes a text string, it opens simulation results stored in PSF files in the specified directory. The results must have been created by a previous simulation run through OCEAN or the Virtuoso® Analog Design Environment. The directory must contain a file called `logFile` and might contain a file called `runObjFile`. When you perform tasks in the design environment, the `runObjFile` is created. Otherwise, only `logFile` is created.

If you want to find out which results are currently open, you can use `openResults` with no argument. The directory for the results that are currently open is returned.

Note: If you run a successful simulation with distributed processing disabled, the results are automatically opened for you. Also, a job name is generated by every analysis, even if distributed processing is not enabled.

Arguments

`s_jobName` — The name of a distributed process job. *`s_jobName`* is a job name and is defined when a `run` command is issued.

`t_dirName` — The directory containing the PSF files.

`g_enableCalcExpressions` — An optional argument, which when set to `t`, allows the evaluation of Calculator expressions. For this argument to work, the directory mentioned in *`t_dirName`* must be an ADE data directory; it must have the psf directory under it and the psf directory must contain `runObjFile`.

Value Returned

t_dirName	The directory containing the PSF files.
`nil`	Returns `nil` and an error message if there are problems opening the results.

Examples

```
openResults( "./simulation/opamp/spectre/schematic/psf" )
=> "./simulation/opamp/spectre/schematic/psf"
```

Opens the results in the `psf` directory within the specified path.

```
openResults( "./psf" )
=> psf
```

Opens the results in the `psf` directory in the current working directory.

```
openResults( "./psf" t )
=> psf
```

Opens the results in the psf directory in the current working directory. It also allows the evaluation of the Calculator expression.

outputParams

```
outputParams( t_compType [?result s_resultName [?resultsDir t_resultsDir]] )
     => l_outputParams/nil
```

Description

Returns the list of output parameters for the specified component.

You can use the dataTypes command to get the list of components for a particular set of results.

Note: You can use any of the parameters in *outputParams* as the second argument to the pv command.

Arguments

t_compType	Name of a component.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

l_outputParams	Returns the list of parameters.
`nil`	Returns `nil` and an error message if there are no associated parameters or if the specified component (`compType`) does not exist.

Example

```
selectResult( 'dcOp )
dataTypes() => ( "node" "vs" "resistor" "bjt" )
outputParams( "bjt" )
```

Selects the `dcOp` results, returns the list of components for these results, and returns the list of output parameters for the `bjt` component.

```
outputParams("bjt" ?result 'dcOp ?resultsDir "./psf")
```

Returns a list of output parameters for the bjt component for dcOp (dc analysis with save dc operating point) results stored at the location `./psf`.

outputs

```
outputs( [?result s_resultName [?resultsDir t_resultsDir]]
     [?type t_signalType])
     => l_outputs/nil
```

Description

Returns the names of the outputs whose results are stored for an analysis. You can plot these outputs or use them in calculations.

Arguments

s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.
t_signalType	Data type of the signal.

Value Returned

l_outputs	Returns the list of outputs.
`nil`	Returns `nil` and an error message if there are problems returning the names of the stored outputs.

Example

```
outputs()
=> ( "net13" "net16" "net18" )
```

Returns the names of the outputs for the PSF file selected with `selectResult`.

```
outputs( ?type "V" )
```

Returns all the signal names that are node voltages. The dataType (signal) returns the data type of the signal.

```
outputs(?result "tran" ?resultsDir "./psf")
=> ( "net11" "net15" "net17")
```

Returns the names of the outputs for the tran results stored at the location `./psf`.

phaseNoise

```
phaseNoise( g_harmonic S_signalResultName [?result s_noiseResultName
     [?resultsDir t_resultsDir]] )
     => o_waveform/nil
```

Description

Returns the phase noise waveform which is calculated using information from two PSF data files.

This command should be run on the results of the Spectre pss-pnoise analysis.

Arguments

g_harmonic	List of harmonic frequencies.
S_signalResultName	Name of the result that stores the signal waveform. Use the `results()` command to obtain the list results.
s_noiseResultName	Name of the result that stores the "positive output signal" and "negative output signal" noise waveforms. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the S_noiseResultName argument. Both the S_signalResultName and S_noiseResultName arguments are read from this directory. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

o_waveform	Waveform representing the phase noise.
`nil`	Returns `nil` if there is an error.

Example

```
plot(phaseNoise(0 "pss-fd.pss"))
phaseNoise(1 "pss_fd" ?result "pnoise" ?resultsDir “./PSF")
```

pv

```
pv( t_name t_param [?result s_resultName [?resultsDir t_resultsDir]] )
    => g_value/nil
```

Description

Returns the value for the specified component parameter. You can use the outputParams command to get the list of parameters for a particular component.

Arguments

t_name	Name of the node or component.
t_param	Name of the parameter.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

g_value	Returns the requested parameter value.
`nil`	Returns `nil` and prints an error message.

Examples

```
selectResult( 'dcOp )
pv( "/Q19" "ib" )
```

For the `Q19` component, returns the value of the `ib` parameter.

```
pv( "/Q19" "ib" ?resultsDir "./test2/psf" )
```

For the `Q19` component, returns the value of the `ib` parameter for the results from a different run (stored in `test2/psf`).

```
pv( "/Q19" "ib" ?result "dcOp" ?resultDir "./test1/psf")
```

Returns the value of the `ib` parameter for the `Q19` component for the `dcOp` results stored at the location `./test1/psf`.

resultParam

```
resultParam( S_propertyName [?result s_resultName [?resultsDir t_resultsDir]] )
     => L_value/nil
```

Description

Returns the value of a header property from the selected result data.

Arguments

s_propertyName

Name of the parameter

s_resultName — Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.

t_resultsDir — Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.

Value Returned

L_value — Value of the parameter. The data type depends on the data type of the parameter.

`nil` — Returns `nil` and an error message if there are problems returning the results.

Examples

```
resultParam("positive output signal" ?result "pnoise.pss")
=> "pif"
resultParam("negative output signal" ?result "pnoise.pss")
=> "0"
```

Returns the name of the positive and negative output signals from PSS-noise analysis result. In this case, the data type of the returned value is a string.

```
resultParam("port1.r.value" ?result "sp")
```

```
=> 40.0
resultParam("port2.r.value" ?result "sp")
=> 40.0
```

Returns the reference impedance of the ports in a two-port network from the S-parameter analysis result. In this case, the data type of the returned value is a floating point number.

```
resultParam("positive output signal" ?result "pnoise.pss" ?resultsDir "./psf")
=> "0"
```

Returns the names of the positive output signals from the PSS-noise analysis results stored at the location `./psf`.

results

```
results( [ ?resultsDir t_resultsDir ] )
     => l_results/nil
```

Description

Returns a list of the type of results that can be selected.

Arguments

t_resultsDir	Directory containing the PSF files (results). When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

l_results	Returns the list of result types.
nil	Returns `nil` and an error message if there are problems returning the results.

Example

```
results()
=> ( dc tran ac )
```

Returns the list of results available.

```
results("./psf")
```

Returns a list of results stored at the location `./psf`.

selectResult

```
selectResult( S_resultsName [n_sweepValue])
     => o_results/nil
```

Description

Selects the results from a particular analysis whose data you want to examine.

The argument that you supply to this command is a data type representing the particular type of analysis results you want. All subsequent data access commands use the information specified with `selectResult`.

Note: Refer to the results command to get the list of analysis results that you can select.

Arguments

s_resultsName	Results from an analysis.
n_sweepValue	The sweep value you wish to select for an analysis.

Value Returned

o_results	Returns the object representing the selected results.
`nil`	Returns `nil` and an error message if there are problems selecting the analysis.

Examples

```
selectResult( 'tran )
```

Selects the results for a transient analysis.

```
sweepValues(3.0 3.333333 3.666667 4.0 4.333333 4.666667 5.0 )
selectResult("tran" "3.333333")
```

The `sweepValues` command prints a list of sweep values.

The `selectResult` command selects a specific value for a transient analysis.

```
selectResult( 'tran )
```

Selects the results for a transient analysis.

```
paramAnalysis("supply" ?start 3 ?stop 5 ?step 1.0/3)
```

```
paramRun("supply")
selectResult(( 'tran car( sweepValues() )
```

Selects the data corresponding to the first parametric run.

Note: `selectResult('tran)` would select the entire family of parametric data.

sp

```
sp( x_iIndex x_jIndex [?result s_resultName [?resultsDir t_resultsDir]] )
    => o_waveform/nil
```

Description

Returns S-parameters for N port networks.

This command should be run on the results of the Spectre sp (S-parameter) analysis.

Arguments

x_iIndex	The `i`th index of the coefficient in the scattering matrix.
x_jIndex	The `j`th index of the coefficient in the scattering matrix.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

o_waveform	Waveform object representing the S-parameter.
`nil`	Returns `nil` if there is an error.

Examples

```
s21 = sp(2 1)
s12 = sp(1 2)
plot(s21 s12)

s11 = sp(1 1 ?result "sp" ?resultsDir "./simResult/psf")
```

Returns the S-parameter `s11` for results of S-parameter(sp) analysis stored at the location `./simResult/psf`.

sweepNames

```
sweepNames( [o_waveForm] [?result s_resultName [?resultsDir t_resultsDir]] )
    => l_sweepName/nil
```

Description

Returns the names of all the sweep variables for either a supplied waveform, a currently selected result (via selectResult()) or a specified result.

Arguments

o_waveForm	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*). When this argument is used, the t_resultsDir and s_resultName arguments are ignored.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

l_sweepName	Returns a list of the sweep names.
`nil`	Returns `nil` and prints an error message if the sweep names cannot be returned.

Example

```
selectResult('tran)
```

```
sweepNames()
=> ( "TEMPDC" "time" )
```

Returns a list of sweep variables for the selected results. In this case, the return values indicate that the data was swept over temperature and time.

```
sweepNames(?result 'ac)
=> ("TEMPDC" "freq")
```

```
sweepNames()
=> ("TEMPDC" "time")
```

```
w = VT("/vout")
sweepNames( w )
=> ( "r" "time")
```

Returns the sweep variables for the waveform `w`.

```
sweepNames(?result 'ac ?resultsDir "./test/psf")
=> ("TEMPDC" "freq")
```

Returns the sweep variables for the results of the ac analysis stored at the location `./test/psf`.

sweepValues

```
sweepValues( [o_waveForm] )
     => l_sweepValues/nil
```

Description

Returns the list of sweep values of the outermost sweep variable of either the selected results or the supplied waveform. This command is particularly useful for parametric analyses.

Arguments

o_waveForm	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)

Value Returned

l_sweepValues	Returns the list of sweep values.
`nil`	Returns `nil` and an error message if the list of sweep values cannot be returned.

Example

```
sweepValues()
=> ( -50 -15 20 55 90.0 )
```

Returns a list of sweep values for the selected results. In this case, the return values indicate the temperature over which the data was swept.

```
w = VT("/vout")

sweepNames( w )
=> ( "r" "time" )

sweepValues( w )
=> ( 2000 4000 6000 )
```

Returns a list of sweep values for the wave `w`. In this case, the return values indicate the resistance over which the data was swept.

sweepVarValues

```
sweepVarValues( [t_varName] [?result s_resultName [?resultsDir t_resultsDir]]
     => l_sweepName/nil
```

Description

Returns the list of sweep values for a particular swept variable name. This command is particularly useful for parametric analyses.

Arguments

t_varName	Name of the specific variable from which the values are retrieved.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

l_sweepValues	Returns the list of sweep values.
`nil`	Returns nil and an error message if the list of sweep values cannot be returned.

Examples

```
selectResult('tran)

sweepNames()
=> ("TEMPDC" "Vsupply" "time")

sweepVarValues("TEMPDC")
=> (0 32)
```

```
sweepNames(?result ’ac)
=> ("TEMPDC" "Vsupply" "freq")
sweepVarValues("Vsupply" ?result ’ac)
=> (5 12 15)
sweepNames(?result ’ac ?resultsDir "./simResult/psf")
=> ("TEMPDC" "freq")
sweepVarValues("TEMPDC" ?result ’ac ?resultsDir "./simResult/psf")
=> (-15 20 55)
```

v

```
v( t_net [?result s_resultName [?resultsDir t_resultsDir]] )
     => o_waveform/nil
```

Description

Returns the voltage of the specified net.

Arguments

t_net	Name of the net.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

o_waveform	Returns a waveform object. A waveform object represents simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.).
`nil`	Returns an error message and `nil` if there is a problem.

Example

```
selectResult('tran)
v( "/net56" )
```

Returns the voltage for `net56`.

```
ocnPrint( v( "/net56" ) )
```

Prints tabular information representing the voltage for `net56`.

```
ocnPrint( v( "net5" ?result 'dc ) )
```

Prints the voltage of `net5` with respect to the `dc` swept component.

```
ocnPrint( v( "net5" ?resultsDir "./test2/psf" ?result 'dc ) )
```

Prints the voltage of `net5` with respect to `dc` for the results from a different run (stored in `test2/psf`).

vswr

```
vswr( x_index [?result s_resultName [?resultsDir t_resultsDir]] )
    => o_waveform/nil
```

Description

Computes the voltage standing wave ratio.

This function is a higher level wrapper for the OCEAN expression

```
(1 + mag( s( x_index x_index ))) / (1 - mag( s( x_index x_index )))
```

This command should be run on the results of the Spectre sp (S-parameter) analysis.

Arguments

x_index	Index of the port.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

o_waveform	Waveform object representing the voltage standing wave ratio.
`nil`	Returns an error message or `nil` if there is a problem.

Example

```
plot( vswr(2) )
vswr1 = vswr(1 ?result "sp" ?resultsDir "./simResult/psf")
```

Returns the voltage standing wave ratio value at port `1` for the results of S-parameter(sp) analysis stored at the location `./simResult/psf`.

zm

```
zm( x_index [?result s_resultName [?resultsDir t_resultsDir]] )
     => o_waveform/nil
```

Description

Computes the port input impedance.

The `zm` function is computed in terms of the S-parameters and the reference impedance. This function is a higher level wrapper for the OCEAN expression

```
(1 + s( x_index x_index )) / (1 - s( x_index x_index ))
    * or( zref( x_index ) 50)
```

This command should be run on the results of the Spectre sp (S-parameter) analysis.

Arguments

x_index	Index of the port.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

o_waveform	Waveform object representing the port input impedance.
`nil`	Returns an error message and `nil` if there is a problem.

Example

```
plot(zm(2))
zm1 = zm(1 ?result "sp" ?resultsDir "./simResult/psf")
```

Returns input impedance at port `1` for results of S-parameter (sp) analysis stored at the location `./simResult/psf`.

zref

```
zref( x_portIndex [?result s_resultName [?resultsDir t_resultsDir]] )
     => f_impedance/nil
```

Description

Returns the reference impedance for an N-port network.

This command should be run on the results of the Spectre sp (S-parameter) analysis.

Arguments

x_portIndex	Index of the port.
s_resultName	Results from an analysis. When specified, this argument will only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.
t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

Value Returned

f_impedance	Reference impedance.
`nil`	Returns an error message and `nil` if there is a problem.

Example

```
Zref = zref(2)
zref1 = zref(1 ?result "sp" ?resultsDir "./simResult/psf")
```

Returns the reference impedance at port `1` for the results of S-parameter(sp) analysis stored at the location `./simResult/psf`.

8

Plotting and Printing Commands

This chapter contains information on the following plotting and printing commands:

This chapter also includes a topic, Plotting and Printing SpectreRF Functions in OCEAN on page 212.

addSubwindow

```
addSubwindow()
     => x_subwindowID/nil
```

Description

Adds a subwindow to the current Waveform window and returns the number for the new subwindow, which is found in the upper right corner.

Arguments

None.

Value Returned

x_subwindowID	Returns the window ID of the new subwindow.
`nil`	Returns `nil` and an error message if there is no current Waveform window.

Example

```
addSubwindow()
=>3
```

Adds a new subwindow to the Waveform window.

addSubwindowTitle

```
addSubwindowTitle( x_windowtitle)
     => t/nil
```

Description

Adds a title to the current subwindow in the active window. The current subwindow is defined using the `currentSubwindow` command.

Arguments

`x_windowtitle`	User-defined title for the subwindow.

Value Returned

`t`	The user-supplied name of the current subwindow.
`nil`	Returns `nil` if the title is not created.

Example

```
addSubwindowTitle( "waveform 2")
=> t
```

Adds the title `waveform 2` to the selected subwindow.

addTitle

```
addTitle( x_windowtitle)
     => t/nil
```

Description

Adds a title to the current active OCEAN window. The current window is defined using the `currentWindow` command.

Arguments

`x_windowtitle`
User-defined title for the window.

Value Returned

`t` The user-supplied name of the current window.

`nil` Returns `nil` if the title is not created.

Example

```
addTitle( “waveform 1” )
=> t
```

Adds the title `waveform 1` to the selected window.

addWaveLabel

```
addWaveLabel( x_waveIndex l_location t_label [?textOffset l_textOffset]
     [?color x_color] [?justify t_justify] [?fontStyle t_fontStyle]
     [?height x_height] [?orient t_orient] [?drafting g_drafting]
     [?overBar g_overbar])
     => s_labelId/nil
```

Description

Attaches a label to the specified waveform curve in the current subwindow.

Arguments

x_waveIndex	Integer identifying the waveform curve.
l_location	List of two waveform coordinates that describe the location for the label.
t_label	Label for the waveform.
l_textOffset	An offset of the label from *l_location*, in screen units of the current subwindow. If *l_textOffset* is not specified, it defaults to `0:0` and the label is displayed at the location. If *l_textOffset* is specified, the label is offset from the location and a directional arrow is drawn from the label to the location. For example, if the offset is specified as `0:20`, the label is drawn 20 units above the location and a directional label is drawn from the label to the location. This feature is useful to label points on a waveform and not obstruct the waveform.
x_color	Label color specified as an index in the technology file. Default value: `10`
t_justify	Justification, which is specified as `"upperLeft"`, `"centerLeft"`, `"lowerLeft"`, `"upperCenter"`, `"centerCenter"`, `"lowerCenter"`, `"upperRight"`, `"centerRight"`, or `"lowerRight"`. Default value: `"lowerLeft"`
t_fontStyle	Font style, which is specified as `"euroStyle"`, `"gothic"`, `"math"`, `"roman"`, `"script"`, `"stick"`, `"fixed"`,

	`"swedish"`, `"raster"`, or `"milSpec"`. Default value: the font style of the current subwindow
x_height	Height of the font. Default value: the font height of the current subwindow
t_orient	Orientation of the text, specified as either `"R0"` or `"R90"`. Default value: `"R0"`
g_drafting	Boolean that specifies whether the label stays backwards or upside-down. If set to `t`, a backwards or upside-down label is displayed in a readable form. If set to `nil`, a backwards or upside-down label stays the way it is. Default value: `t`
g_overbar	Boolean that specifies whether underscores in labels are displayed as overbars. If set to `t`, underscores in labels are displayed as overbars. If set to `nil`, underbars are displayed as underbars. Default value: `nil`

Value Returned

s_labelId	Returns an identification number for the waveform label.
`nil`	Returns `nil` if there is an error.

Example

```
addWaveLabel( 1 list( 0 0.5 ) "R5 = " )
```

Attaches the `"R5 = "` label to the specified coordinates on waveform curve `1`.

```
addWaveLabel( 2 list( 0 0.5 )  "R_6 = " ?textOffset  0:20 ?justify "lowerCenter"
?fontStyle "roman" ?height 10 ?orient "R20" ?drafting t ?overbar t)
```

Attaches the label `"R6 = "` to the specified coordinates on waveform curve. The label specifications are as follows: Justification – `lowerCenter`, Font Style – `roman`, Font Height – `10`, and Orientation – `R20`.

The label will be displayed in a readable form. The underscore in the label will be displayed as an overbar.

addWindowLabel

```
addWindowLabel( l_location t_label )
     => s_labelId/nil
```

Description

Displays a label in the current subwindow. The location for the label is specified with a list of two numbers between 0 and 1.

Arguments

l_location	List of two waveform coordinates that describe the location for the label. Valid values: `0` through `1`
t_label	Label for the waveform.

Value Returned

s_labelId	Returns an identification number for the subwindow label.
`nil`	Returns `nil` if there is an error.

Example

```
label = addWindowLabel( list( 0.75 0.75 ) "test" )
```

Adds the `test` label to the current subwindow at the specified coordinates and stores the label identification number in `label`.

clearAll

```
clearAll()
     => t/nil
```

Description

Erases the contents of the current Waveform window and deletes the waveforms, title, date stamp, and labels stored in internal memory.

Arguments

None.

Value Returned

`t`	Returns `t` if the waveform information is deleted.
`nil`	Returns `nil` and an error message if there is no current Waveform window.

Example

```
clearAll()
=> t
```

Erases the contents of the current Waveform window.

clearSubwindow

```
clearSubwindow()
     => t/nil
```

Description

Erases the contents of the current subwindow.

Arguments

None.

Value Returned

`t`	Returns `t` if the contents of the subwindow are erased.
`nil`	Returns `nil` and an error message otherwise.

Example

```
clearSubwindow()
=> t
```

Erases the contents of the current subwindow.

currentSubwindow

```
currentSubwindow( x_subwindow )
     => t/nil
```

Description

Specifies *x_subwindow* as the current subwindow.

Arguments

x_subwindow	Number of the subwindow, found in the upper right corner, that is to become the current subwindow.

Value Returned

`t`	Returns `t` when the subwindow is set to *x_subwindow*.
`nil`	Returns `nil` if there is an error.

Example

```
currentSubwindow( 2 )
```

Specifies subwindow 2 as the current subwindow.

currentWindow

```
currentWindow( w_windowId )
     => w_windowId/nil
```

Description

Specifies *w_windowId* as the current Waveform window.

Arguments

w_windowId	Waveform window ID.

Value Returned

w_windowId	Returns the current Waveform window ID.
nil	Returns nil and an error if the current window cannot be set.

Example

```
currentWindow( window(2) )
```

Specifies window 2 as the current Waveform window.

dbCompressionPlot

```
dbCompressionPlot(o_wave x_harmonic x_extrapolationPoint
     [?compression x_compression] )
     => t/nil
```

Description

Plots the *n*th compression point plot. The *x_compression* argument is optional and defaults to 1 for 1dB compression, if omitted.

This command should be run on the results of the Spectre swept pss analysis.

Arguments

o_wave — The waveform for which to plot the compression.

x_harmonic — Harmonic frequency index.

x_extrapolationPoint
The extrapolation point.

x_compression
The amount of dB compression.
Default value: `1`

Value Returned

`t` — Returns `t` if the point is plotted

`nil` — returns `nil` if there was an error

Example

```
dbCompressionPlot(v("/Pif") 2 -25)
```

Plots a `1 dB` compression point plot for the waveform `v("/Pif")`.

```
dbCompressionPlot(v("/Pif") 2 -25 ?compression 3)
```

Plots a `3 dB` compression point plot for the waveform `v("/Pif")`.

dcmatchSummary

```
dcmatchSummary([?resultsDir t_resultsDir] [?result S_resultName]
     [?output t_fileName | p_port] [?paramValues ln_paramValues]
     [?deviceType ls_deviceType] [?variations ls_variations]
     [?includeInst lt_includeInst] [?excludeInst lt_excludeInst]
     [?truncateData n_truncateData] [?truncateType s_truncateType]
     [?sortType ls_sortType])
     => t_fileName/p_port/nil
```

Description

Prints a report showing the mismatch contribution of each component in a circuit. If you specify a directory with resultsDir, it is equivalent to temporarily using the `openResults` command. The `dcmatchSummary` command prints the results for that directory and resets the `openResults` command to its previous setting. If you specify a particular result with `resultName`, it is equivalent to temporarily using the `selectResult` command on the specified results. The `dcmatchSummary` command prints the results and resets the `selectResult` command to its previous setting.

This command should be run on the results of the Spectre dcmatch analysis.

Arguments

t_resultsDir	The directory containing the dcmatch-analysis results.
S_resultName	Results from an analysis for which you want to print the dcmatchSummary report.
t_fileName	File in which to write the information. The dcmatchSummary command opens the file, writes to the file and closes the file. If you specify the filename without a path, the dcmatchSummary command creates the file in the directory pointed to by your Skill Path. To find out what your Skill path is, type `getSkillPath()` at the OCEAN prompt.
p_port	Port (previously opened with `outfile`) through which to append the information to a file. You are responsible for closing the port. See the outfile command for more information.
ln_paramValues	List of values for swept parameters at which the dcmatchSummary is to be printed. In case there is just one swept parameter the value can be specified as is.

ls_deviceType List of device type strings to be included. Valid values are a list of strings or `'all` or a single device name. Default value is `'all`.

ls_variations An association list containing the device name and the associated variations to print. You can also specify the value ‘all to print all available variations for a device. Default value is `‘all`. For Example: `'( (“bsim3v3” (“sigmaOut” “sigmaVth”)) (“resistor” (“sigmaOut”))`

lt_includeInst List of instance name strings to definitely include in the dcmatchSummary.

lt_excludeInst List of instance name strings to exclude in the dcmatchSummary.

x_truncateData Specifies a number that the truncateType argument uses to define the components for which information is to be printed.

s_truncateType Specifies the method that is used to limit the data being included in the report

Valid Values	Description	Sample Values for truncateData
'top	Saves information for the number of components specified with truncateData. The components with the highest contributions are saved.	10
'relative	Saves information for all components that have a higher contribution than truncateData * maximum. Where maximum is the maximum contribution among all the devices of a given type	1.9n
‘absolute	Saves information for all the components in the selected set whose contribution are more than truncateData.	0.1

‘none	Saves information for all the components.	Not required

ls_sortType — Specifies how the printed results are to be sorted. The valid values are nil, ’name, ’output.

Value Returned

t_fileName — Returns the name of the port.

p_port — Returns the name of the file.

`nil` — Returns `nil` and an error message if the summary cannot be printed.

Examples

```
dcmatchSummary( ?result ’dcmatch-mine )
```

Prints a report for non-swept DC-Mismatch analysis.

```
dcmatchSummary( ?resultsDir "/usr/simulation/lowpass/spectre/schematic" ?result
’dcmatch)
```

Prints a report for non-swept DC-Mismatch analysis for the results from a different run (stored in the schematic directory).

```
dcmatchSummary( ?resultsDir "/usr/simulation/lowpass/spectre/schematic" ?result
’dcmatch ?paramValues ‘(25) )
```

Prints a report for swept DC-Mismatch analysis at swept parameter value of 25.

```
dcmatchSummary( ?result dcmatch-mine ?output "./summary.out")
```

Prints a report for non-swept DC-Mismatch analysis in the output file `summary.out`.

```
dcmatchSummary( ?paramValues 25 ?deviceType "bsim3v3" ?variations ’(("bsim3v3"
("sigmaOut "sigmaVth" )))
```

Prints a report for swept DC-Mismatch analysis at swept parameter value of 25 for bsim3v3 deviceType and sigmaOut and sigmaVth variations.

```
dcmatchSummary( ?paramValues 25 ?truncateType ’top ?truncateData 1)
```

Prints a report for swept DC-Mismatch analysis at swept parameter value of 25 printing only the component having the highest contribution.

```
dcmatchSummary( ?paramValues 25 ?sortType ’name )
```

Prints a report for swept DC-Mismatch analysis at swept parameter value of 25 sorted on name.

deleteSubwindow

```
deleteSubwindow()
     => t/nil
```

Description

Deletes the current subwindow from the current Waveform window.

Arguments

None.

Value Returned

`t`	Returns `t` if the current subwindow is deleted.
`nil`	Returns `nil` and an error message if there is no current subwindow.

Example

```
deleteSubwindow()
=> t
```

Deletes the current subwindow from the Waveform window.

deleteWaveform

```
deleteWaveform( {x_index | all_string } )
     => t/nil
```

Description

Deletes the specified waveform curve or all the waveform curves from the current subwindow of a Waveform window.

Arguments

x_index	Integer identifying a particular waveform curve.
all_string	The string "all" specifying that all waveform curves are to be deleted.

Value Returned

t	Returns t if the curves are deleted.
nil	Returns nil and an error message if the curves are not deleted.

Examples

```
deleteWaveform( '1 )
=> t
```

Deletes waveform 1 from the current subwindow.

```
deleteWaveform( "all" )
=> t
```

Deletes all the curves from the current subwindow.

displayMode

```
displayMode( t_mode )
     => t/nil
```

Description

Sets the display mode of the current subwindow.

Arguments

t_mode	String representing the display mode for the subwindow. Valid values: `strip`, `smith`, or `composite`

Value Returned

`t`	Returns `t` when the display mode of the subwindow is set.
`nil`	Returns `nil` and an error message if the display mode cannot be set.

Example

```
displayMode( "composite" )
=> t
```

Sets the current subwindow to display in `composite` mode.

getAsciiWave

```
getAsciiWave( t_filename x_xColumn x_yColumn [x_xskip] [x_yskip])
    => o_wave/nil
```

Description

Reads in an Ascii file of data and generates a waveform object from the specified data. The X-axis data must be real numbers. The Y-axis data can be real or complex values. Complex values are represented as `(real imag)` or `complex(real imag)`. This function skips blank lines and comment lines. Comments are defined as lines beginning with a semicolon.

Arguments

t_filename	The name of the Ascii file to be read in.
x_xColumn	The column in the data file that contains the X-axis data.
x_yColumn	The column in the data file that contains the Y-axis data.
x_xskip	The number of lines to skip in the X column.
x_yskip	The number of lines to skip in the Y column.

Value Returned

o_wave	The DRL waveform object
`nil`	Returns `nil` if the function fails.

Example

```
getAsciiWave("~/mydatafile.txt " 1 2 )
=> drwave:32538648
```

Reads in an ascii file `~/mydatafile.txt`, which has x-axis data in the first column and y-axis data in the second column, and returns a DRL waveform object.

```
getAsciiWave("~/mydatafile.txt " 1 2 ?xskip 1 ?yskip 2)
=> drwave:32538656
```

Reads in an ascii file `~/mydatafile.txt`, which has x-axis data in the first column and y-axis data in the second column and skips `1` line in the `xcolumn` and 2 lines in the `ycolumn`, and returns a DRL waveform object.

graphicsOff

```
graphicsOff()
     => t/nil
```

Description

Disables the redrawing of the current Waveform window.

You might use this command to freeze the Waveform window display, send several plots to the window, and then unfreeze the window to display all the plots at once.

Arguments

None.

Value Returned

`t`	Returns `t` if redrawing is disabled.
`nil`	Returns `nil` if there is an error, such as there is no current Waveform window.

Example

```
graphicsOff()
=> t
```

Disables the redrawing of the Waveform window.

graphicsOn

```
graphicsOn()
     => t/nil
```

Description

Enables the redrawing of the current Waveform window.

Arguments

None.

Value Returned

`t`	Returns `t` if redrawing is enabled.
`nil`	Returns `nil` if there is an error, such as there is no current Waveform window.

Example

```
graphicsOn()
=> t
```

Enables the redrawing of the current Waveform window.

hardCopy

```
hardCopy(w_windowId)
     => t/nil
```

Description

Sends a Waveform window plot to a printer.

Note: You must first set any plotting options with the `hardCopyOptions` command.

Arguments

w_windowId	The window ID of the waveform window whose plot is to be printed. The default value is the window ID of the current window.

Value Returned

`t`	Returns `t` if successful.
`nil`	Returns `nil` if there is an error.

Example

```
hardCopy()
=> t
```

Sends a waveform plot to the printer.

```
w = newWindow()
plot(v("/vout"))
hardCopy(w)
```

Sends the waveform plot of `w` to the printer.

hardCopyOptions

```
hardCopyOptions( [?hcNumCopy x_hcNumCopy] [?hcDisplay t_hcDisplay]
     [?hcOrientation s_hcOrientation] [?hcOutputFile g_hcOutputFile]
     [?hcPaperSize t_hcPaperSize] [?hcPlotterName t_hcPlotterName]
     [?hcTmpDir t_hcTmpDir] )
     => g_value/nil
```

Description

Sets Waveform window hardcopy plotting options.

The option takes effect for any Waveform window or subwindow that is opened after the option is set.

Arguments

x_hcNumCopy — The number of copies to plot.
Valid values: any positive integer
Default value: `1`

t_hcDisplay — The display name.
Valid values: defined in the technology file
Default value: `"display"`

s_hcOrientation
The plot orientation.
Valid values: `'portrait`, `'landscape`, `'automatic`
Default value: `'automatic`

g_hcOutputFile
Name of the output file.
Valid values: a string or `nil`
Default value: `nil`

t_hcPaperSize
The plot paper size.
Valid values: specified in `.cdsplotinit`
Default value: specified in `.cdsplotinit`

t_hcPlotterName
The name of the plotter.

	Valid values: specified in `.cdsplotinit` Default value: specified in `.cdsplotinit`
t_hcTmpDir	The name of a temporary directory to be used for scratch space. Valid values: name of a temporary directory Default value: `"/usr/tmp"`

Value Returned

g_value	Returns the new value of the option.
`nil`	Returns `nil` if there is an error.

Examples

```
hardCopyOptions( ?hcNumCopy 1 )
```

Plots one copy of the window or subwindow.

```
hardCopyOptions(?hcNumCopy 3 ?hcOutputFile "myOutFile")
```

Plots three copies of the window or subwindow and sends them to the file `myOutFile`.

```
hardCopyOptions(?hcNumCopy 2 ?hcOrientation 'portrait ?hcOutputFile "myOutfile")
```

Plots 2 copies of the window in `portrait` orientation and sends them to the file `myOutFile`.

ip3Plot

```
ip3Plot( o_wave x_sigHarmonic x_refHarmonic x_extrapolationPoint )
     => t/nil
```

Description

Plots the IP3 curves.

This command should be run on the results of the Spectre swept pss and pac analysis.

Refer to the chapter *Simulating Mixers* of the *SpectreRF User Guide* for more information on ip3Plot.

Arguments

o_wave	Waveform for which to plot the ip3.
x_sigHarmonic	Index of the third order harmonic.
x_refHarmonic	Index of the first order (fundamental) harmonic.
x_extrapolationPoint	Extrapolation point.

Value Returned

`t`	Returns `t` if the curves are plotted.
`nil`	Returns `nil` if there is an error.

Example

```
ip3Plot(v("/net28") 47 45 -25)
```

newWindow

```
newWindow()
     => w_windowID/nil
```

Description

Creates a new Waveform window and returns the window ID.

Arguments

None.

Value Returned

w_windowId	Returns the window ID of the new Waveform window.
`nil`	Returns `nil` and an error message if the new Waveform window cannot be created.

Example

```
newWindow()
=> window:3
```

Creates a new Waveform window that is numbered 3 in the upper right corner.

noiseSummary

```
noiseSummary(s_type [?result s_resultName [?resultsDir t_resultsDir]]
     [?frequency f_frequency] [?weight f_weight] [?output t_fileName | p_port]
     [?noiseUnit t_noiseUnit] [?truncateData x_truncateData]
     [?truncateType s_truncateType] [?digits x_digits]
     [?percentDecimals x_percentDecimals] [?from f_from] [?to f_to]
     [?deviceType ls_deviceType] [?weightFile t_weightFile])
     => t_fileName/p_port/nil
```

Description

Prints a report showing the noise contribution of each component in a circuit.

This command should be run on the results of the Spectre noise analysis.

Arguments

s_type — Type of noise-analysis results for which to print the report. Valid values: `spot`, to specify noise at a particular frequency, or `integrated`, to specify noise integrated over a frequency range.

s_resultName — Results from an analysis. When specified, this argumentwill only be used internally and will not alter the current result which was set by the selectResult command. The default is the current result selected with the selectResult command.

t_resultsDir — Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument. When specified, this argument will only be used internally and will not alter the current results directory which was set by the openResults command. The default is the current results directory set by the openResults command.

f_frequency — Frequency value of interest.

f_weight — Waveform representing the function with which the integral is weighted.
Default value: `1.0`

t_fileName — File in which to write the information. The `noiseSummary` command opens the file, writes to the file, and closes the file. If you specify the filename without a path, the `noiseSummary` command creates the file in the directory pointed to by your Skill Path. To find out what your Skill path is, type `getSkillPath()` at the OCEAN prompt.

p_port — Port (previously opened with `outfile`) through which to append the information to a file. You are responsible for closing the port. See the outfile command for more information.

t_noiseUnit — Specifies the type of noise unit to be saved. Valid values: `"V^2"` for `V^2/Hz` or `"V"` for `V/sqrt( Hz )`

x_truncateData — Specifies a number that the `truncateType` argument uses to define the components for which information is to be printed.

s_truncateType — Specifies the method that is used to limit the data being included in the report.

Valid Values	Description	Sample Values
`'top`	Saves information for the number of components specified with `truncateData`. The components with the highest contributions are saved.	`10`
`'level`	Prints components which have noise contribution higher than that specified by `?truncateData`.	`10u`
`'relative`	Prints components which have noise contribution (percent) higher than that specified by `?truncateData`.	`.1`
`'none`	Saves information for all the components.	

x_digits — Number of significant digits with which the contributors are printed.

x_percentDecimals — Number of decimals printed for any relative contribution.

f_from — For integrated noise, the start value for frequency.

f_to — For integrated noise, the end value for frequency.

ls_deviceType — List of device type strings to be included.
Valid values: a list of strings or `'all`

t_weightFile — Absolute or relative path of the file that contains information about weights. This data is used to compute weighted noise. If the values are provided for both parameters, `weight` and `weightFile`, the value for `weight` gets precedence..

Value Returned

t_fileName — Returns the name of the port.

p_port — Returns the name of the file.

`nil` — Returns `nil` and an error message if the summary cannot be printed.

Examples

```
noiseSummary( 'integrated ?result 'noiseSweep-noise )
```

Prints a report for an integrated noise analysis.

```
noiseSummary( 'integrated ?resultsDir
    "/usr/simulation/lowpass/spectre/schematic"
    ?result 'noise)
```

Prints a report for an `integrated` noise analysis for the results from a different run (stored in the `schematic` directory).

```
noiseSummary( 'spot ?resultsDir
    "/usr/simulation/lowpass/spectre/schematic"
    ?result 'noise ?frequency 100M )
```

Prints a report for a `spot` noise analysis at a frequency of `100M`.

```
noiseSummary('integrated ?truncateType 'none ?digits 10
?weightFile "./weights.dat")
```

Prints the weighted noise for an integrated noise analysis using information in the `weight` file `weights.dat`.

```
noiseSummary('integrated ?output "./NoiseSum1" ?noiseUnit "V" ?truncateData 20
?truncateType 'top ?from 10 ?to 10M ?deviceType list("bjt" "mos" "resistor"))
```

Prints a report for an integrated noise analysis in the frequency range `10-10M` for `20` components with deviceType `bjt`, `mos` or `resistor`.

ocnPrint

```
ocnPrint( [?output t_filename | p_port] [?precision x_precision]
     [?numberNotation s_numberNotation] [?numSpaces x_numSpaces]
     [?width x_width] [?from x_from] [?to x_to] [?step x_step] o_waveform1
     [o_waveform2 ...] )
     => t/nil
```

Description

Prints the text data of the waveforms specified in the list of waveforms.

If you provide a filename as the `?output` argument, the `ocnPrint` command opens the file and writes the information to it. If you provide a port (the return value of the SKILL `outfile` command), the `ocnPrint` command appends the information to the file that is represented by the port. There is a limitation of *ocnPrint* for precision. It works upto 30 digits for the Solaris port and 18 digits for HP and AIX.

Arguments

t_filename
File in which to write the information. The `ocnPrint` command opens the file, writes to the file, and closes the file. If you specify the filename without a path, the OCEAN environment creates the file in the directory pointed to by your Skill Path. To find out what your Skill path is, type `getSkillPath()` at the OCEAN prompt.

p_port
Port (previously opened with `outfile`) through which to append the information to a file. You are responsible for closing the port. See the <u>outfile</u> command for more information.

x_precision
The number of significant digits to print. This value overrides any global precision value set with the `setup` command.
Valid values: `1` through `16`
Default value: 6

s_numberNotation
The notation for printed information. This value overrides any global format value set with the `setup` command.
Valid values: `'suffix`, `'engineering`, `'scientific`, `'none`
Default value: `'suffix`

The format for each value is `'suffix`: `1m`, `1u`, `1n`, etc.; `'engineering`: `1e-3`, `1e-6`, `1e-9`, etc.; `'scientific`: `1.0e-2`, `1.768e-5`, etc.; `'none`.

The value `'none` is provided so that you can turn off formatting and therefore greatly speed up printing for large data files. For the fastest printing, use the `'none` value and set the `?output` argument to a filename or a port, so that output does not go to the CIW.

x_numSpaces	The number of spaces between columns. Valid values: 1 or greater Default value: 4
x_width	The width of each column. Valid values: 4 or greater Default value: 14
x_from	The start value at x axis for the waveform to be printed.
x_to	The end value at x axis for the waveform to be printed.
?step	The step by which text data to be printed is incremented.
o_waveform1	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
o_waveform2	Additional waveform object.

Value Returned

`t`	Returns `t` if the text for the waveforms is printed.
`nil`	Returns `nil` and an error message if the text for the waveforms cannot be printed.

Examples

```
ocnPrint( v( "/net56" ) )
=> t
```

Prints the text for the waveform for the voltage of `net56`.

```
ocnPrint( vm( "/net56" ) vp( "/net56" ) )
=> t
```

Prints the text for the waveforms for the magnitude of the voltage of `net56` and the phase of the voltage of `net56`.

```
ocnPrint( ?output "myFile" v( "net55" ) )
=> t
```

Prints the text for the specified waveform to a file named `myFile`.

```
ocnPrint( ?output "./myOutputFile" v("net1") ?from 0 ?to 0.5n ?step 0.1n )
```

Prints the text for the specified waveform from `0` to `0.5n` on the x axis in the incremental steps of `0.1n`.

ocnYvsYPlot

```
ocnYvsYPlot([?wavex o_wavex ?wavey o_wavey] [?exprx o_exprx ?expry o_expry]
     [?title l_titleList] [?color l_colorList])
     => wave/nil
```

Description

Plots a wave against another wave or an expression against another expression.

This is currently supported for a family of waveforms generated from simple parametric simulation results data. It is not supported for a family of waveforms generated from parametric simulation with paramset, Corners or MonteCarlo results data.

Arguments

o_wavex	Reference wave against which the wave provided needs to be plotted.
o_wavey	Wave to be plotted against the reference wave.
o_exprx	Reference expression against which the expression provided needs to be plotted.
o_expry	Expression to be plotted against the reference expression.
l_titleList	List of waveform titles. If the waveform is simple, only one label will be required. If the waveform is param, a list of labels needs to be provided.
l_colorList	List of waveform colors. If the waveform is simple, only one color will be required. If the waveform is param, a list of colors needs to be provided.

Value Returned

`wave`	Returns the waveform specified.
`nil`	Returns `nil` if the plot could not be generated.

Examples

```
wy = VT("/vout")
wx = VT("/vin")
ex = "VT('/vin')"
ey = "VT('/vout')"
ocnYvsYplot(?wavex wx ?wavey wy ?titleList '("simpleWave") ?colorList '(3))
```

Plots wave wy against wave wx with the title being simpleWave and the color being 3.

```
ocnYvsYplot(?exprx ex ?expry ey ?titleList '("simpleWave") ?colorList '(3))
```

Plots expression ey against expression ex with the title being simpleWave and the color being 3.

plot

```
plot( o_waveform1 [o_waveform2 ...] [?yNumber l_yNumberList] [?expr l_exprList]
     )
     => t/nil
```

Description

Plots waveforms in the current subwindow. If there is no Waveform window, this command opens one.

Arguments

o_waveform1	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
o_waveform2	Additional waveform object.
l_yNumberList	List that specifies the Y axes where the waveforms are to be plotted. The number of Y axes must match the number of waveform objects specified. Valid values: `1`, `2`, `3`, and `4`
l_exprList	List of strings used to give names to the waveform objects.

Value Returned

`t`	Returns `t` if the waveforms are plotted.
`nil`	Returns `nil` and an error message if the waveforms cannot be plotted.

Examples

```
plot(v( "/net56" ) )
```

Plots the waveform for the voltage of `net56`.

```
plot( vm( "/net56" ) vp( "/net56" ) )
```

Plots the waveforms for the magnitude of the voltage of `net56` and the phase of the voltage of `net56`.

```
plot( v( "OUT" ) i( "VFB" ) ?expr list( "voltage" "current" ) )
```

Plots the waveforms, but changes one legend label from `v("OUT")` to `voltage` and changes the other legend label from `i("VFB")` to `current`.

```
plot( v( "OUT" ) i( "VFB" ) ?yNumber list( 1 2 ) )
```

Plots the waveforms `v( "OUT" )` and `i( "VFB" )` on the Y axes `1` and `2`, respectively.

plotStyle

```
plotStyle( S_style )
     => t/nil
```

Description

Sets the plotting style for all the waveforms in the current subwindow.

If the plotting style is `bar` and the display mode is `smith`, the plotting style is ignored until the display mode is set to `strip` or `composite`.

Arguments

`S_style` Plotting style for the subwindow.
Valid values: `auto`, `scatterplot`, `bar`, `joined`

Argument	Description
`auto`	The appropriate plotting style is automatically chosen.
`scatterplot`	Data points are not joined.
`bar`	Vertical bars are drawn at each data point that extend from the point to the bottom of the graph.
`joined`	Each data point is joined to adjacent data points by straight-line segments.

Value Returned

`t` Returns `t` if the plotting style is set.

`nil` Returns `nil` and an error message if the plotting style is not set.

Example

```
plotStyle( 'auto )
=> t
```

Sets the plot style to `auto`.

pzPlot

```
pzPlot( [?resultsDir t_resultsDir] [?result S_resultName] [?plot S_toPlot]
     [?freqfilter f_fval] [?realfilter f_rval])
     =>t/nil
```

Description

Plots a report showing the poles and zeros of the network. If you specify a directory with `resultsDir`, the *pzPlot* command plots the results for that directory. The *`S_toPlot`* option can be used to plot only poles, only zeros or both poles and zeros information.

This command should be run on the results of the Spectre pz (pole-zero) analysis.

Arguments

`t_resultsDir`	Directory containing the results. If you specify a directory with resultsDir, the *pzPlot* command plots the results for that directory.
`S_resultName`	Pointer to results from the analysis for which you want to plot the report.
`S_toPlot`	Use this option to plot only poles, only zeros or both poles and zeros information. Valid values: `'poles`, `'zeros`, `'polesZeros`.
`f_fval`	Maximum pole and zero frequency value to filter out poles and zeros that are outside the frequency band of interest (FBOI) and that do not influence the transfer function in the FBOI.
`f_rval`	Real value which is used to filter out poles and zeros whose real value are less than or equal to the value specified.

Value Returned

`t`	Returns `t` if it plots a report.
`nil`	Returns `nil` otherwise.

Examples

```
pzPlot(?resultsDir "/usr/simulation/lowpass/spectre/schematic" ?result ’pz)
```

Plots a report for all the poles and zeros for the specified results.

```
pzPlot(?resultsDir "/usr/simulation/lowpass/spectre/schematic" ?plot ’poles)
```

Plots a report containing only poles for the specified results.

```
pzPlot( ?plot ’zeros ?realfilter -1.69e-01)
```

Plots a report for all those zeros whose real values are greater than the real value specified.

```
pzPlot( ?plot ’polesZeros ?freqfilter 2.6e-01 )
```

Plots a report for all those poles and zeros whose frequency is within the frequency band of interest (2.6e-01).

pzSummary

```
pzSummary( [?resultsDir t_resultsDir] [?result S_resultName]
     [?print S_toPrint] [?freqfilter f_fval] [?realfilter f_rval] )
     =>t/nil
```

Description

Prints a report with the poles and zeros of the network. If you specify a directory with `resultsDir`, the *pzSummary* command prints the results for that directory. Use the *S_toPrint* option to print only poles, only zeros or both poles and zeros information.

This command should be run on the results of the Spectre pz (pole-zero) analysis.

Arguments

t_resultsDir	Directory containing the results. If you specify a directory with resultsDir, the *pzSummary* command plots the results for that directory.
S_resultName	Pointer to results from the analysis for which you want to print the report.
S_toPlot	Use this option to plot only poles, only zeros or both poles and zeros information. Valid values: `'poles`, `'zeros`, `'polesZeros`.
f_fval	Maximum pole and zero frequency value to filter out poles and zeros that are outside the frequency band of interest (FBOI) and that do not influence the transfer function in the FBOI.
f_rval	Real value which is used to filter out poles and zeros whose real value are less than or equal to the value specified.

Value Returned

`t`	Returns `t` if it prints a report.
`nil`	Returns `nil` otherwise.

Examples

```
pzSummary(?resultsDir "/usr/simulation/lowpass/spectre/schematic" ?result 'pz)
```

Prints a report for all the poles and zeros for the specified results.

```
pzSummary(?resultsDir "/usr/simulation/lowpass/spectre/schematic" ?print 'poles)
```

Prints a report containing only poles for the specified results.

```
pzSummary( ?print 'zeros ?realfilter -1.69e-01)
```

Prints a report for all those zeros whose real values are greater than the real value specified.

```
pzSummary( ?print 'polesZeros ?freqfilter 2.6e-01 )
```

Prints a report for all those poles and zeros whose frequency is within the frequency band of interest (2.6e-01).

removeLabel

```
removeLabel( l_id )
     => t/nil
```

Description

Removes the label, or all the labels identified in a list, from the current subwindow.

Arguments

l_id	List of labels to remove.

Value Returned

`t`	Returns `t` when the label or labels are removed.
`nil`	Returns `nil` if there is an error.

Examples

```
label = addWindowLabel( list( 0.75 0.75 ) "test" )
```

Adds the `"test"` label to the current subwindow at the specified coordinates and stores the label identification number in `label`.

```
removeLabel( label )
```

Removes the label whose identification number is stored in `label`. In this case, the `"test"` label is removed.

report

```
report([?output t_filename | p_port] [?type t_type] [?name t_name]
     [?param t_param] [?format s_reportStyle] [?report s_reportStyle]
     [?maxLineWidth charsPerLine])
     => t/nil
```

Description

Prints a report of the information contained in an analysis previously specified with `selectResult`.

You can use this command to print operating-point, model, or component information. If you provide a filename as the `?output` argument, the `report` command opens the file and writes the information to it. If you provide a port (the return value of the SKILL `outfile` command), the `report` command appends the information to the file that is represented by the port.

Note: You can use the `dataTypes` command to see what types of reports you can choose. For Spectre® circuit simulator operating points, be sure to choose `dcOp` and `opBegin`.

Arguments

t_filename	File in which to write the information. The `report` command opens the file, writes to the file, and closes the file. If you specify the filename without a path, the OCEAN environment creates the file in the directory pointed to by your Skill Path. To find out what your Skill path is, type `getSkillPath()` at the OCEAN prompt.
p_port	Port (previously opened with `outfile`) through which to append the information to a file. You are responsible for closing the port. See the <u>outfile</u> command for more information.
t_type	Type of information to print, such as all bjts.
t_name	Name of the node or component.
t_param	Name of the parameter to print. It is also a list.
s_reportStyle	Specifies the format of the output. Valid values: `spice` and `paramValPair` Default value: `paramValPair`

The `spice` format looks like this:

	Param1	Param2	Param3
Name1	value	value	value
Name2	value	value	value
Name3	value	value	value

The `paramValPair` format looks like this:

Name1
Param1=value Param2=value Param3=value

Name2
Param1=value Param2=value Param3=value

Name3
Param1=value Param2=value Param3=value

`charsPerLine` Number of characters to be printed per line.

Value Returned

`t` Returns `t` if the information is printed.

`nil` Returns `nil` and an error message if the information cannot be printed.

Examples

```
selectResult( dcOp )
= > t
```

```
report()
```

Prints all the operating-point parameters.

```
report( ?type "bjt" )
= > t
```

Prints all the `bjt` operating-point parameters.

```
report( ?type "bjt" ?param "ib" )
= > t
```

Prints the `ib` parameter for all bjts.

```
report( ?type "bjt" ?name "/Q1" ?param "ib" )
= > t
```

Prints the `ib` parameter for the `bjt` named `Q1`.

```
report( ?output "myFile" )
=> t
```

Prints all the operating-point parameters to a file named `myFile`.

```
report( ?output myAlreadyOpenedPort )
=> t
```

Prints all the operating-point parameters to a port named `myAlreadyOpenedPort`.

The `report()` can also be used by providing the set of parameters as a list as follows:
`Type : bsim3v3`
`Params : cdg cgb gm ids`
report(?type "bsim3v3" ?param "cdg")
report(?type "bsim3v3" ?param ’("cdg" "cgb"))
report(?type "bsim3v3" ?param ’("cdg" "cgb" "gm" "ids"))

```
report( ?format ’spice ?maxLineWidth 200 )
=> t
```

Prints the report in spice format wrapping at column 200.

xLimit

```
xLimit( l_minMax )
     => t/nil
```

Description

Sets the X axis display limits for the current subwindow. This command does not take effect if the display mode is set to `smith`.

Arguments

l_minMax	List of two numbers in waveform coordinates that describe the limits for the display. The first number is the minimum and the second is the maximum. If this argument is set to `nil`, the limit is set to `auto`.

Value Returned

`t`	Returns `t` when the X axis display limits are set.
`nil`	Returns `nil` and an error message if the X axis display limits are not set.

Example

```
xLimit( list( 1 100 ) )
=> t
```

Sets the X axis to display between 1 and 100.

yLimit

```
yLimit( l_minMax [?yNumber x_yNumber] [?stripNumber x_stripNumber])
     => t/nil
```

Description

Sets the Y axis display limits for the waveforms associated with a particular Y axis and strip in the current subwindow.

If you do not specify *x_stripNumber*, the limits are applied when the subwindow is in `composite` mode.

Arguments

l_minMax	List of two numbers in waveform coordinates that describe the limits for the display. The first number is the minimum and the second is the maximum. If this argument is set to `nil`, the limit is set to `auto`.
x_yNumber	Specifies the Y axis that will have limited display with the range specified by *l_minMax*. Valid values: `1` through `4`
x_stripNumber	Specifies the strip in which the y display is to be limited as specified by *x_yNumber*. Valid values: `1` through `20`

Value Returned

`t`	Returns `t` if the Y axis display limits are set.
`nil`	Returns `nil` and an error message if the Y axis display limits cannot be set.

Example

```
yLimit( list( 4.5 7.5 ) ?yNumber 1 )
=> t
```

Sets Y axis `1` to display from `4.5` to `7.5`.

```
yLimit( list( 4.5 7.5 ) ?yNumber 1 ?stripNumber 3)
```

Sets Y axis `1` to display from `4.5` to `7.5` in `stripNumber 3`.

Plotting and Printing SpectreRF Functions in OCEAN

You can access SpectreRF functions in OCEAN by using the `getData` function and then plot or print them in OCEAN using the `ocnPrint` and `plot` functions.

To take an example, after performing a spectre sp analysis in the Artist environment, click *Results – Direct Plot – S-param*. In the S-Parameter Results form, select the function and other options that you want to plot. Also, select the *Add to Outputs* option under the *Plot* button. Then, click *OK*. The expression will be added to the *Outputs* pane of the Artist environment. When all the desired expressions are created in the *Outputs* pane, use the *ADE – Session – Save Script* command to create the OCEAN script for these plots.

To plot the expression in OCEAN, use the following command:

```
plot(<expression in Output pane>)
```

For example,

```
plot(Gmax())     for Gmax in S-parameter analysis
```

You can print the functions using the `ocnPrint` command. For example:

```
ocnPrint( Gmax() Kf() )
```

After a spectre sp noise analysis, use the following command to access the sp noise data.

```
selectResult("sp_noise")
```

A sample OCEAN script to help you print or plot NFmin (minimum noise figure), N F (noise figure), and RN (noise resistance) results follows. Plotting NNR (normalized noise resistance) is very similar to plotting RN.

```
; start ocean with SpectreS as the simulator.
simulator( 'spectreS )
; if you wanted to use Spectre as the simulator, then
; simulator( 'spectre )
;specify design and model path
design(  "/usr1/mnt4/myhome/simulation/myckt/spectreS/schematic/netlist/
myckt.c")
path( "/usr1/mnt4/myhome/models" )
; specify analysis used:  sp with noise
analysis('sp ?start "100M"  ?stop "10G"  ?donoise "yes"
?oprobe "/PORT1"  ?iprobe "/PORT0"  )
;set design variables
desVar(   "r2" 37)
desVar(   "r1" 150)
;set temperature
temp( 25 )
```

```
;run sp noise analysis with the above desVar list.
run()
printf("\n simulation has finished.")
printf("\n selecting sp noise results")
selectResult("sp_noise")
printf("\n print NFmin and plot NF")
NFmin = getData("NFmin")
NF = getData("NF")
ocnPrint( NFmin )
plot( NF )
printf("\n plot Rn")
Rn = getData("RN" ?result "sp_noise")
plot( Rn ?expr '( "Rn" ) )
exit
```

For more information, see the section *Periodic Noise Analysis* and the appendix *Plotting Spectre S-Parameter Simulation Data* in the *SpectreRF User Guide*.

For more information on these functions, click these links: getData, sp, ocnPrint,and plot.

9

OCEAN Aliases

The aliases in this chapter provide you with shortcuts to commonly used pairs of commands. By default, these aliases operate on results previously selected with selectResult. However, you can also use an alias on a different set of results. For example, to specify a different set of results for the `vm` alias, use the following syntax.

`vm( t_net [?result s_resultName] )`

where *s_resultName* is the name of the datatype for the particular analysis you want.

You can use the `vm` alias on results stored in a different directory as follows:

`vm( t_net [?resultsDir t_resultsDir] [?result s_resultName] )`

where *t_resultsDir* is the name of a different directory containing PSF results, and *s_resultName* is the name of a datatype contained in that directory. (If you specify another directory with *t_resultsDir*, you must also specify the particular results with *s_resultName*.)

List of Aliases

Alias	Syntax	Description
`vm`	vm(*t_net [*?resultsDir *t_resultsDir][*?result *s_resultname]*) => *o_waveform*/ nil	Aliased to `mag(v())`. Gets the magnitude of the voltage of a net.
`vdb`	vdb(*t_net [*?resultsDir *t_resultsDir][*?result *s_resultname]*) => *o_waveform*/ nil	Aliased to `db20(v())`. Gets the power gain in decibels from net `in` to net `out`.
`vp`	vp(*t_net [*?resultsDir *t_resultsDir][*?result *s_resultname]*) => *o_waveform*/ nil	Aliased to `phase(v())`. Gets the phase of the voltage of a net.

List of Aliases, *continued*

`vr`	`vr(` *`t_net [`*?resultsDir *`t_resultsDir][`*?result *`s_resultname]`*`)` => *`o_waveform`*/ `nil`	Aliased to `real(v())`. Gets the real part of a complex number representing the voltage of a net.
`vim`	`vim(` *`t_net [`*?resultsDir *`t_resultsDir][`*?result *`s_resultname]`*`)` => *`o_waveform`*/ `nil`	Aliased to `imag(v())`. Gets the imaginary part of a complex number representing the voltage of a net.
`im`	`im(` *`t_component [`*?resultsDir *`t_resultsDir][`*?result *`s_resultName]`*`)` => o*`_waveform`*/ `nil`	Aliased to `mag(i())`. Gets the magnitude of the AC current through a component.
`ip`	`ip(` *`t_component [`*?resultsDir *`t_resultsDir][`*?result *`s_resultName]`*`)` => o*`_waveform`*/ `nil`	Aliased to `phase(i())`. Gets the phase of the AC current through a component.
`ir`	`ir(` *`t_component [`*?resultsDir *`t_resultsDir][`*?result *`s_resultName]`*`)` => o*`_waveform`*/ `nil`	Aliased to `real(i())`. Gets the real part of a complex number representing the AC current through a component.
`iim`	`iim(` *`t_component [`*?resultsDir *`t_resultsDir][`*?result *`s_resultName]`*`)` => o*`_waveform`*/ `nil`	Aliased to `imag(i())`. Gets the imaginary part of a complex number representing the AC current through a component.

10

Predefined Functions and Waveform (Calculator) Functions

This chapter contains information about the following functions. Some additional predefined data access commands are described in the Virtuoso® Analog Design Environment SKILL Language Reference manual.

Predefined Arithmetic Functions

Several functions are predefined in the Virtuoso® SKILL language. The full syntax and brief definitions for these functions follows the table.

Predefined Arithmetic Functions

Synopsis	Result
General Functions	
`add1(n)`	n + 1
`abs`	| n |
`sub1(n)`	n – 1
`exp(n)`	e raised to the power n
linRg(*n_from*, *n_to*, *n_by*)	Returns list of numbers in linear range from *n_from* to *n_to* in *n_by* steps
`log(n)`	Natural logarithm of n
logRg(*n_from*, *n_to*, *n_by*)	Returns list of numbers in log10 range from *n_from* to *n_to* in *n_by* steps
`max(n1 n2 …)`	Maximum of the given arguments
`min(`*n1 n2* …`)`	Minimum of the given arguments
`mod(`*x1 x2*`)`	*x1* modulo *x2*, that is, the integer remainder of dividing *x1* by *x2*
`round(`*n*`)`	Integer whose value is closest to *n*
`sqrt(`*n*`)`	Square root of *n*

Predefined Arithmetic Functions

Synopsis	Result
Trigonometric Functions	
`sin(`*n*`)`	sine, argument *n* is in radians
`cos(`*n*`)`	cosine
`tan(`*n*`)`	tangent
`asin(`*n*`)`	arc sine, result is in radians
`acos(`*n*`)`	arc cosine
`atan(`*n*`)`	arc tangent
Random Number Generator	
`random(`*x*`)`	Returns a random integer between 0 and *x*-1. If `random` is called with no arguments, it returns an integer that has all of its bits randomly set.
`srandom(`*x*`)`	Sets the initial state of the random number generator to *x*.

abs

```
abs( n_number )
     => n_result
```

Description

Returns the absolute value of a floating-point number or integer.

Arguments

n_number	Floating-point number or integer.

Value Returned

n_result	The absolute value of *n_number*.

Example

```
abs( -209.625)
=> 209.625
abs( -23)
=> 23
```

acos

```
acos( n_number )
     => f_result
```

Description

Returns the arc cosine of a floating-point number or integer.

Arguments

n_number	Floating-point number or integer.

Value Returned

f_result	Returns the arc cosine of *n_number*.

Example

```
acos(0.3)
=> 1.266104
```

add1

```
add1( n_number )
     => n_result
```

Description

Adds 1 to a floating-point number or integer.

Arguments

n_number	Floating-point number or integer to increase by 1.

Value Returned

n_result	*n_number* plus 1.

Example

```
add1( 59 )
=> 60
```

Adds 1 to 59.

asin

```
asin( n_number )
     => f_result
```

Description

Returns the arc sine of a floating-point number or integer.

Arguments

n_number	Floating-point number or integer.

Value Returned

f_result	The arc sine of *n_number*.

Example

```
asin(0.3)
=> 0.3046927
```

atan

```
atan( n_number )
     => f_result
```

Description

Returns the arc tangent of a floating-point number or integer.

Arguments

n_number	Floating-point number or integer.

Value Returned

f_result	The arc tangent of *n_number*.

Example

```
atan(0.3)
=> 0.2914568
```

cos

```
cos( n_number )
     => f_result
```

Description

Returns the cosine of a floating-point number or integer.

Arguments

n_number	Floating-point number or integer.

Value Returned

f_result	The cosine of *n_number*.

Examples

```
cos(0.3)
=> 0.9553365
cos(3.14/2)
=> 0.0007963
```

exp

```
exp( n_number )
     => f_result
```

Description

Raises *e* to a given power.

Arguments

n_number	Power to raise *e* to.

Value Returned

f_result	The value of e raised to the power *n_number*.

Examples

```
exp( 1 )
=> 2.718282
exp( 3.0 )
=> 20.08554
```

linRg

```
linRg( n_from n_to n_by )
     => l_range/nil
```

Description

Returns a list of numbers in the linear range from *n_from* to *n_to* incremented by *n_by*.

Arguments

n_from	Smaller number in the linear range.
n_to	Larger number in the linear range.
n_by	Increment value when stepping through the range.

Value Returned

l_range	List of numbers in the linear range.
nil	Returned if error.

Example

```
range = linRg(-30 30 5)
(-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30)
```

log

```
log( n_number )
     => f_result
```

Description

Returns the natural logarithm of a floating-point number or integer.

Arguments

n_number	Floating-point number or integer.

Value Returned

f_result	The natural logarithm of *n_number*.

Example

```
log( 3.0 )
=> 1.098612
```

logRg

```
logRg( n_from n_to n_by )
     => l_range/nil
```

Description

Returns a list of numbers in the log10 range from *n_from* to *n_to* advanced by *n_by*.

The list is a geometric progression where the multiplier is 10 raised to the 1/*n_by* power. For example if *n_by* is 0.5, the multiplier is 10 raised to the 2nd power or 100.

Arguments

n_from	Smaller number in the linear range.
n_to	Larger number in the linear range.
n_by	Increment value when stepping through the range.

Value Returned

l_range	List of numbers in the linear range.
nil	Returned if error.

Example

```
logRg(1 1M 0.5)
(1.0 100.0 10000.0 1000000.0)
```

max

```
max( n_num1 n_num2 [n_num3 …] )
     => n_result
```

Description

Returns the maximum of the values passed in. Requires a minimum of two arguments.

Arguments

n_num1	First value to check.
n_num2	Next value to check.
[*n_num3*…]	Additional values to check.

Value Returned

n_result	The maximum of the values passed in.

Examples

```
max(3 2 1)
=> 3
```

```
max(-3 -2 -1)
=> -1
```

min

```
min( n_num1 n_num2 [n_num3 …] )
     => n_result
```

Description

Returns the minimum of the values passed in. Requires a minimum of two arguments.

Arguments

n_num1	First value to check.
n_num2	Next value to check.
[*n_num3*…]	Additional values to check.

Value Returned

n_result	The minimum of the values passed in.

Examples

```
min(1 2 3)
=> 1
```

```
min(-1 -2.0 -3)
=> -3.0
```

mod

```
mod( x_integer1 x_integer2)
     => x_result
```

Description

Returns the integer remainder of dividing two integers. The remainder is either zero or has the sign of the dividend.

Arguments

x_integer1	Dividend.
x_integer2	Divisor.

Value Returned

x_result	The integer remainder of the division. The sign is determined by the dividend.

Example

```
mod(4 3)
=> 1
```

random

```
random( [x_number] )
     => x_result
```

Description

Returns a random integer between `0` and *`x_number`* minus `1`.

If you call `random` with no arguments, it returns an integer that has all of its bits randomly set.

Arguments

x_number	An integer.

Value Returned

x_result	Returns a random integer between `0` and *`x_number`* minus `1`.

Example

```
random( 93 )
=> 26
```

round

```
round( n_arg )
     => x_result
```

Description

Rounds a floating-point number to its closest integer value.

Arguments

n_arg	Floating-point number.

Value Returned

x_result	The integer whose value is closest to *n_arg*.

Examples

```
round(1.5)
=> 2
round(-1.49)
=> -1
round(1.49)
=> 1
```

sin

```
sin( n_number )
     => f_result
```

Description

Returns the sine of a floating-point number or integer.

Arguments

n_number	Floating-point number or integer.

Value Returned

f_result	The sine of *n_number*.

Examples

```
sin(3.14/2)
=> 0.9999997
```

```
sin(3.14159/2)
=> 1.0
```

Floating-point results from evaluating the same expressions might be machine-dependent.

sqrt

```
sqrt( n_number )
     => f_result
```

Description

Returns the square root of a floating-point number or integer.

Arguments

n_number	Floating-point number or integer.

Value Returned

f_result	The square root of *n_number*.

Examples

```
sqrt( 49 )
=> 7.0
```

```
sqrt( 43942 )
=> 209.6235
```

srandom

```
srandom( x_number )
     => t
```

Description

Sets the seed of the random number generator to a given number.

Arguments

x_number	An integer.

Value Returned

t	This function always returns `t`.

Example

```
srandom( 89 )
=> t
```

sub1

```
sub1( n_number )
     => n_result
```

Description

Subtracts 1 from a floating-point number or integer.

Arguments

n_number	Floating-point number or integer.

Value Returned

n_result	Returns *n_number* minus 1.

Example

```
sub1( 59 )
=> 58
```

Subtracts 1 from 59.

tan

```
tan( n_number )
     => f_result
```

Description

Returns the tangent of a floating-point number or integer.

Arguments

n_number	Floating-point number or integer.

Value Returned

f_result	The tangent of *n_number*.

Example

```
tan( 3.0 )
=> -0.1425465
```

Waveform (Calculator) Functions

The calculator commands are described in this section.

average

```
average( o_waveform )
     => n_average/o_waveformAverage/nil
```

Description

Computes the average of a waveform over its entire range.

Average is defined as the integral of the expression `f(x)` over the range of `x`, divided by the range of `x`.

For example, if `y=f(x)`, `average(y)=`

$$\frac{\int_{from}^{to} f(x)dx}{to - from}$$

where `from` is the initial value for `x` and `to` is the final value.

Arguments

o_waveform — Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)

Value Returned

n_average — Returns a number representing the average value of the input waveform.

o_waveformAverage — Returns a waveform (or family of waveforms) representing the average value if the input is a family of waveforms.

`nil` — Returns `nil` and an error message otherwise.

Example

```
average( v( "/net9" ) )
```

Gets the average voltage (Y-axis value) of `/net9` over the entire time range specified in the simulation analysis.

awvPlaceXMarker

```
awvPlaceXMarker(w_windowId n_xLoc [?subwindow x_subwindowId])
     => t_xLoc/t/nil
```

Description

Places a vertical marker at a specific x-coordinate in the optionally specified subwindow of the specified window.

Arguments

w_windowId	Waveform window ID.
n_xLoc	The x-coordinate at which to place the marker.
x_subwindowId	Waveform subwindow ID.

Value Returned

t_xLoc	Returns a string of x-coordinates if the command is successful and the vertical marker info form is opened.
`t`	Returns this when the command is successful but the vertical marker info form is not opened.
`nil`	Returns `nil` or an error message.

Examples

```
awvPlaceXMarker( window 5)
=> "5"
```

Vertical marker info form is opened when the command is executed.

```
awvPlaceXMarker( window 6 ?subwindow 2)
=> t
```

Vertical marker info form is not opened.

awvPlaceYMarker

```
awvPlaceYMarker(w_windowId n_yLoc [?subwindow x_subwindowId])
     => t_yLoc/t/nil
```

Description

Places a horizontal marker at a specific y-coordinate in the optionally specified subwindow of the specified window.

Arguments

w_windowId	Waveform window ID.
n_yLoc	The y-coordinate at which to place the marker.
x_subwindowId	Waveform subwindow ID.

Value Returned

t_yLoc	Returns a string of y-coordinates if the command is successful and the horizontal marker info form is opened.
t	Returns this when the command is successful but the horizontal marker info form is not opened.
nil	Returns `nil` or an error message.

Examples

```
awvPlaceYMarker( window 5)
=> "5"
```

Horizontal marker info form is opened when the command is executed.

```
awvPlaceYMarker( window 6 ?subwindow 2)
=> t
```

Horizontal marker info form is not opened.

b1f

```
b1f( o_s11 o_s12 o_s21 o_s22 )
     => o_waveform/nil
```

Description

Returns the alternative stability factor in terms of the supplied parameters.

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22.

Value Returned

o_waveform	Waveform object representing the alternative stability factor.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
s11 = sp(1 1)
s12 = sp(1 2)
s21 = sp(2 1)
s22 = sp(2 2)
plot(b1f(s11 s12 s21 s22))
```

bandwidth

```
bandwidth( o_waveform n_db t_type )
     => n_value/o_waveform/nil
```

Description

Calculates the bandwidth of a waveform.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_db	Positive number that defines the bandwidth.
t_type	Type of input filter. Valid values: `"low"`, `"high"` or `"band"`.

Value Returned

n_value	Returns a number representing the value of the bandwidth if the input argument is a single waveform.
o_waveform	Returns a waveform (or family of waveforms) representing the bandwidth if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
bandwidth( v( "/OUT" ) 3 "low")
```

Gets the 3 dB bandwidth of a low-pass filter.

```
bandwidth( v( "/OUT" ) 4 "band" )
```

Gets the 4 dB bandwidth of a band-pass filter.

clip

```
clip( o_waveform n_from n_to )
     => o_waveform/nil
```

Description

Restricts the waveform to the range defined by *n_from* and *n_to*.

You can use the clip function to restrict the range of action of other commands. If *n_from* is `nil`, *n_from* is taken to be the first X value of the waveform, and if *n_to* is `nil`, *n_to* is taken to be the last X value of the waveform. If both *n_to* and *n_from* are `nil`, the original waveform is returned.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_from	Starting value for the range on the X axis.
n_to	Ending value for the range on the X axis.

Value Returned

o_waveform	Returns a waveform object if the input argument is a waveform object or returns a family of waveforms if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
x = clip( v( "/net9" ) 2m 4m )
plot( x )
```

Plots the portion of a waveform that ranges from 2 ms to 4 ms.

```
plot( clip( v( "/net9" ) nil nil ) )
```

Plots the original waveform.

```
plot( clip( v( "/net9" ) nil 3m ) )
```

Plots the portion of a waveform that ranges from 0 to 3 ms.

compression

```
compression( o_waveform  [ ?x f_x ]  [ ?y f_y ]  [ ?compression f_compression ]
     [ ?io s_measure ] )
     => f_compPoint/nil
```

Description

Performs an *n*th compression point measurement on a power waveform.

The `compression` function uses the power waveform to extrapolate a line of constant slope (dB/dB) according to a specified input or output power level. This line represents constant small-signal power gain (ideal gain). The function finds the point where the power waveform drops *n* dB from the constant slope line and returns either the X coordinate (input referred) value or the Y coordinate (output referred) value.

Arguments

o_waveform — Waveform object representing output power (in dBm) versus input power (in dBm).

f_x — The X coordinate value (in dBm) used to indicate the point on the output power waveform where the constant-slope power line begins. This point should be in the linear region of operation.
Default value: Unless *f_y* is specified, defaults to the X coordinate of the first point of the *o_waveform* wave.

f_y — The Y coordinate value (in dBm) used to indicate the point on the output power waveform where the constant-slope power line begins. This point should be in the linear region of operation.
Default value: Unless *f_x* is specified, defaults to the Y coordinate of the first point of the *o_waveform* wave.

f_compression — The delta (in dB) between the power waveform and the ideal gain line that marks the compression point
Default value: `1`

s_measure — Symbol indicating whether the measurement is to be input referred (`'input`) or output referred (`'output`)
Default value: `'input`

Value Returned

f_compPoint	Depending on the setting of *s_measure*, returns either input referred or output referred compression point.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
xloc = compression( wave ?x -25 ?compress 1)
yloc = compression( wave ?x -25 ?measure "Output")

; Each of following returns a compression measurement:

compression(dB20(harmonic(v("/Pif" ?result "pss_fd") 2)))

compression(dbm(harmonic(spectralPower(v("/Pif"
    ?result "pss_fd")/ 50.0
    v("/Pif" ?result "pss_fd")) 2)))

compression(dbm(harmonic(spectralPower(v("/Pif"
    ?result "pss_fd")/resultParam("rif:r"
    ?result "pss_td") v("/Pif"
    ?result "pss_fd")) 2)))

compression(dbm(harmonic(spectralPower(i("/rif/PLUS"
    ?result "pss_fd") v("/Pif" ?result "pss_fd")) 2))
    ?x -25 ?compress 0.1 ?measure "Output")
```

compressionVRI

```
compressionVRI( o_vport x_harm [?iport o_iport] [?rport f_rport]
     [?epoint f_epoint] [?gcomp f_gcomp] [?measure s_measure] )
     => o_waveform/n_number/nil
```

Description

Performs an *n*th compression point measurement on a power waveform.

Use this function to simplify the declaration of a compression measurement. This function extracts the specified harmonic from the input waveform(s), and uses `dBm(spectralPower((i or v/r),v))` to calculate a power waveform. The function passes this power curve and the remaining arguments to the `compression` function to complete the measurement.

The `compression` function uses the power waveform to extrapolate a line of constant slope (dB/dB) according to a specified input or output power level. This line represents constant small-signal power gain (ideal gain). The function finds the point where the power waveform drops *n* dB from the constant slope line and returns either the X coordinate (input referred) value or the Y coordinate (output referred) value.

Arguments

o_vport	Voltage across the output port. This argument must be a family of spectrum waveforms (1 point per harmonic) created by parametrically sweeping an input power (in dBm) of the circuit.
x_harm	Harmonic index of the voltage wave contained in *o_vport*. When *o_iport* is specified, also applies to a current waveform contained in *o_iport*.
o_iport	Current into the output port. This argument must be a family of spectrum waveforms (1 point per harmonic) created by parametrically sweeping an input power (in dBm) of the circuit. When specified, the output power is calculated using voltage and current. Default value: `nil`
f_rport	Resistance into the output port. When specified and *o_iport* is `nil`, the output power is calculated using voltage and resistance. Default value: `50`

f_epoint	The X coordinate value (in dBm) used to indicate the point on the output power waveform where the constant-slope power line begins. This point should be in the linear region of operation. Default value: the X coordinate of the first point of the *o_waveform* wave
f_gcomp	The delta (in dB) between the power waveform and the ideal gain line that marks the compression point. Default value: `1`
s_measure	Symbol indicating if measurement is to be input referred (`'input`) or output referred (`'output`). Default value: `'input`

Value Returned

o_waveform	Returns a waveform when *o_waveform1* is a family of waveforms.
f_number	Returns a number when *o_waveform1* is a waveform.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
Each of the following returns a compression measurement:
compressionVRI(v("/Pif" ?result "pss_fd") 2)
compressionVRI(v("/Pif" ?result "pss_fd") 2
    ?rport resultParam("rif:r" ?result "pss_td"))
compressionVRI(v("/Pif" ?result "pss_fd") 2
    ?iport i("/rif/PLUS" ?result "pss_fd") ?epoint -25
    ?gcomp 0.1 ?measure "Output")
```

compressionVRICurves

```
compressionVRICurves( o_vport x_harm [?iport o_iport] [?rport f_rport]
     [?epoint f_epoint] [?gcomp f_gcomp] )
     => o_waveform/nil
```

Description

Constructs the waveforms associated with an *n*th compression measurement.

Use this function to simplify the creation of waveforms associated with a compression measurement. This function extracts the specified harmonic from the input waveform(s), and uses `dBm(spectralPower((i or v/r),v))` to calculate a power waveform.

The `compressionVRICurves` function uses the power waveform to extrapolate a line of constant slope (1dB/1dB) according to a specified input or output power level. This line represents constant small-signal power gain (ideal gain). The function shifts the line down by *n* dB and returns it, along with the power waveform, as a family of waveforms.

This function only creates waveforms and neither performs a compression measurement nor includes labels with the waveforms. Use the `compression` or `compressionVRI` function for making measurements.

Arguments

o_vport — Voltage across the output port. This argument must be a family of spectrum waveforms (1 point per harmonic) created by parametrically sweeping an input power (in dBm) of the circuit.

x_harm — Harmonic index of the wave contained in *o_vport*. When *o_iport* is specified, also applies to a current waveform contained in *o_iport*.

o_iport — Current into the output port. This argument must be a family of spectrum waveforms (1 point per harmonic) created by parametrically sweeping an input power (in dBm) of the circuit. When specified, the output power is calculated using voltage and current
Default value: `nil`

f_rport — Resistance into the output port. When specified and *o_iport* is `nil`, the output power is calculated using voltage and

	resistance. Default value: `50`
`f_epoint`	The X coordinate value (in dBm) used to indicate the point on the output power waveform where the constant-slope power line begins. This point should be in the linear region of operation. Default value: the X coordinate of the first point of the *`o_waveform`* wave
`f_gcomp`	The delta (in dB) between the power waveform and the ideal gain line that marks the compression point. Default value: `1`

Value Returned

`o_waveform`	Returns a family of waveforms containing the output power and tangent line.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
Each of following examples returns curves related to a compression measurement:
compressionVRICurves(v("/Pif" ?result "pss_fd") 2)
compressionVRICurves(v("/Pif" ?result "pss_fd") 2
    ?rport resultParam("rif:r" ?result "pss_td"))
compressionVRICurves(v("/Pif" ?result "pss_fd") 2
    ?iport i("/rif/PLUS" ?result "pss_fd") ?epoint -25
    ?gcomp 0.1)
```

conjugate

```
conjugate( {o_waveform | n_x} )
     => o_waveform/n_y/nil
```

Description

Returns the conjugate of a waveform or number.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_x	Complex or imaginary number.

Value Returned

o_waveform	Returns the conjugate of a waveform if the input argument is a waveform.
n_y	Returns the result of *n_x* being mirrored against the real axis (X axis) if the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Example

For this example, assume that the first three statements are true for the `conjugate` function that follows them.

```
x=complex(-1 -2)
real(x) = -1.0
imag(x) = -2.0
conjugate(x) = complex(-1, 2)
```

Returns the conjugate of the input complex number.

complex

```
complex( f_real f_imaginary )
     => o_complex
```

Description

Creates a complex number of which the real part is equal to the real argument, and the imaginary part is equal to the imaginary argument.

Arguments

f_real	The real part of the complex number.
f_imaginary	The imaginary part of the complex number.

Value Returned

o_complex	Returns the complex number.

Example

```
complex( 1.0 2.0 )
=> complex( 1, 2 )
```

complexp

```
complexp( g_value )
     => t/nil
```

Description

Checks if an object is a complex number. The suffix p is added to the name of a function to indicate that it is a predicate function.

Arguements

g_value	A skill object.

Values Returned

t	Returns t when *g_value* is a complex number.
nil	Returns nil if there is an error.

Example

```
complexp( (complex 0 1) )
=> t
complexp( 1.0 )
=> nil
```

convolve

```
convolve( o_waveform1 o_waveform2 n_from n_to t_type n_by )
     => o_waveform/n_number/nil
```

Description

Computes the convolution of two waveforms.

Convolution is defined as

$$\int_{from}^{to} f1(s)f2(t-s)ds$$

`f1` and `f2` are the functions defined by the first and second waveforms.

Note: The `convolve` function is numerically intensive and might take longer than the other functions to compute.

Arguments

o_waveform1	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
o_waveform2	Additional waveform object.
n_from	Starting point (X-axis value) of the integration range.
n_to	Ending point (X-axis value) of the integration range.
t_type	Type of interpolation. Valid values: `"linear"` or `"log"`.
n_by	Increment.

Value Returned

o_waveform	Returns a waveform object representing the convolution if one of the input arguments is a waveform. Returns a family of waveforms if either of the input arguments is a family of waveforms.
n_number	Returns a value representing the convolution if both of the input arguments are numbers.
nil	Returns nil and an error message otherwise.

Example

```
sinWave = expr( n sin( n ) linRg( 0 20 0.01 ) )
triWave = artListToWaveform( ’( ( -4, 0 ) ( -3, 1 ) ( -2, 0 ) ( -1, -1 ) ( 0, 0 )
( 1, 1 ) ( 2, 0 ) ( 3, -1 ) ( 4, 0 ) )
plot( convolve( sinWave triWave 0 10 "linear" 1 ) )
```

Gets the waveform from the convolution of the sine waveform and triangle waveform within the range of 0 to 10.

cPwrContour

```
cPwrContour( o_iwave o_vwave x_harm [?iwaveLoad o_iwaveLoad]
     [?vwaveLoad o_vwaveLoad] [?maxPower f_maxPower] [?minPower f_minPower]
     [?numCont x_numCont] [?refImp f_refImp] [?closeCont b_closeCont]
     [?modifier s_modifier] )
     => o_waveform/nil
```

Description

Constructs constant power contours for Z-Smith plotting. The trace of each contour correlates to reference reflection coefficients that all result in the same power level.

The *x_harm* harmonic is extracted from all the input waveforms. Power is calculated using the `spectralPower` function. The reference reflection coefficients are calculated using voltage, current, and a reference resistance.

Arguments

o_iwave	Current used to calculate power, expected to be a two-dimensional family of harmonic waveforms.
o_vwave	Voltage used to calculate power, expected to be a two-dimensional family of harmonic waveforms.
x_harm	Harmonic index of the waves contained in *o_iwave* and *o_vwave*.
o_iwaveLoad	Current used to calculate reflection coefficient, expected to be a two-dimensional family of harmonic waveforms. Default value: *o_iwave*
o_vwaveLoad	Voltage used to calculate reflection coefficient, expected to be a two-dimensional family of harmonic waveforms. Default value: *o_vwave*
f_maxPower	Maximum power magnitude value for contours. Default value: automatic
f_minPower	Minimum power magnitude value for contours. Default value: automatic

x_numCont	Total number of contours returned. Default value: 8
f_refImp	Reference resistance used to calculate reflection coefficients. Default value: `50`
b_closeCont	Boolean indicating when to close the contours. When `nil`, largest segment of each contour is left open. Default value: `nil`
s_modifier	Symbol indicating the modifier function to apply to the calculated power. The modifier function can be any single argument OCEAN function such as `'db10` or `'dBm`. Default value: `'mag`

Value Returned

o_waveform	Returns a family of waveforms (contours) for Z-Smith plotting.
`nil`	Returns `nil` and an error message otherwise.

Examples

The following example plots constant output power contours according to output:

```
cPwrContour(i("/I8/out" ?result "pss_fd") v("/net28"
    ?result "pss_fd")1)
```

The following example plots constant output power contours according to output reflection coefficients:

```
cPwrContour(i("/I8/out" ?result "pss_fd") v("/net28"
    ?result "pss_fd") 1 ?maxPower 0.002 ?minPower 0.001 ?numCont 9)
```

The following example plots constant input power contours according to output reflection coefficients:

```
cPwrContour(i("/C25/PLUS" ?result "pss_fd") v("/net30"
    ?result "pss_fd") 1 ?iwaveLoad i("/I8/out" ?result "pss_fd")
    ?vwaveLoad v("/net28" ?result "pss_fd") ?refImp 50.0
    ?numCont 9 ?modifier "mag")
```

cReflContour

```
cReflContour( o_iwave o_vwave x_harm [?iwaveLoad o_iwaveLoad]
     [?vwaveLoad o_vwaveLoad] [?maxRefl f_maxRefl] [?minRefl f_minRefl]
     [?numCont x_numCont] [?refImp f_refImp] [?closeCont b_closeCont] )
     => o_waveform/nil
```

Description

Constructs constant reflection coefficient magnitude contours for Z-Smith plotting. The trace of each contour correlates to reference reflection coefficients that all result in the same reflection coefficient magnitude.

The *x_harm* harmonic is extracted from all the input waveforms. Reflection coefficient magnitude is calculated using voltage, current, reference resistance, and the `mag` function. The reference reflection coefficients are calculated separately by using voltage, current, and a reference resistance.

Arguments

o_iwave	Current used to calculate reflection coefficient magnitude, expected to be a two-dimensional family of spectrum waveforms.
o_vwave	Voltage used to calculate reflection coefficient magnitude, expected to be a two-dimensional family of spectrum waveforms.
x_harm	Harmonic index of the waves contained in *o_iwave* and *o_vwave*.
o_iwaveLoad	Current used to calculate reference reflection coefficient, expected to be a two-dimensional family of harmonic waveforms. Default value: *o_iwave*
o_vwaveLoad	Voltage used to calculate reference reflection coefficient, expected to be a two-dimensional family of spectrum waveforms. Default value: *o_vwave*
f_maxRefl	Maximum reflection coefficient magnitude value for contours. Default value: automatic
f_minRefl	Minimum reflection coefficient magnitude value for contours. Default value: automatic

x_numCont	Total number of contours returned. Default value: 8
f_refImp	Reference resistance used to calculate reflection coefficients. Default value: `50`
b_closeCont	Boolean indicating when to close the contours. When `nil`, the largest segment of each contour is left open. Default value: `nil`

Value Returned

o_waveform	Returns a family of waveforms (contours) for Z-Smith plotting.
`nil`	Returns `nil` and an error message otherwise.

Examples

The following example plots constant output reflection coefficient contours according to output reflection coefficients:

```
cReflContour(i("/I8/out" ?result "pss_fd") v("/net28"
    ?result "pss_fd") 1)
```

The following example plots constant output reflection coefficient contours according to output reflection coefficients:

```
cReflContour(i("/I8/out" ?result "pss_fd") v("/net28"
    ?result "pss_fd") 1 ?maxRefl 0.7 ?minRefl 0.1 ?numCont 7)
```

The following example plots constant output reflection coefficient contours according to output reflection coefficients:

```
cReflContour(i("/C25/PLUS" ?result "pss_fd")
    v("/net30" ?result "pss_fd") 1
    ?iwaveLoad i("/I8/out" ?result "pss_fd")
    ?vwaveLoad v("/net28" ?result "pss_fd") ?refImp 50.0
    ?numCont 9)
```

cross

```
cross( o_waveform n_crossVal x_n s_crossType )
     => o_waveform/g_value/nil
```

Description

Computes the X-axis value at which a particular crossing of the specified edge type of the threshold value occurs.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_crossVal	Y-axis value at which the corresponding values of X are calculated.
x_n	Number that specifies which X value to return. If *x_n* equals `1`, the first X value with a crossing is returned. If *x_n* equals 2, the second X value with a crossing is returned, and so on. If you specify a negative integer for *x_n*, the X values with crossings are counted from right to left (from maximum to minimum).
s_crossType	Type of the crossing. Valid values: `'rising`, `'falling`, `'either`.

Value Returned

o_waveform	Returns a waveform if the input argument is a family of waveforms.
g_value	Returns the X-axis value of the crossing point if the input argument is a single waveform.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
cross( v( "/net9" ) 2.5 2 'rising )
```

Gets the time value (X axis) corresponding to specified voltage `"/net9"=2.5V` (Y axis) for the second rising edge.

```
cross( v( "/net9" ) 1.2 1 'either )
```

Gets the time value (X axis) corresponding to specified voltage `"/net9"=1.2V` (Y axis) for the first edge, which can be a rising or falling edge.

db10

```
db10( {o_waveform | n_number} )
     => o_waveform/n_number/nil
```

Description

Returns 10 times the log10 of the specified waveform object or number. This function can also be written as dB10.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_number	Number.

Value Returned

o_waveform	Returns a waveform object if the input argument is a waveform object or returns a family of waveforms if the input argument is a family of waveforms.
n_number	Returns a number if the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
db10( ymax( v( "/net9" ) ) )
```

Returns a waveform representing `log10(ymax(v("/net9"))` multiplied by 10.

```
db10( 1000 )
=> 30.0
```

Gets the value `log10(1000)` multiplied by 10, or 30.

db20

```
db20( {o_waveform | n_number} )
     => o_waveform/n_number/nil
```

Description

Returns 20 times the log10 of the specified waveform object or number. This function can also be written as dB20.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_number	Number.

Value Returned

o_waveform	Returns a waveform object if the input argument is a waveform object or returns a family of waveforms if the input argument is a family of waveforms.
n_number	Returns a number if the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
db20( ymax( v( "/net9" ) ) )
```

Returns a waveform representing 20 times `log10(ymax(v("/net9"))`.

```
db20( 1000 )
=> 60.0
```

Returns the value of 20 times `log10( 1000 )`, or 60.

dbm

```
dbm( {o_waveform | n_number} )
     => o_waveform/n_number/nil
```

Description

Returns 10 times the log10 of the specified waveform object plus 30. This function can also be written as dBm.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)
n_number	Number.

Value Returned

o_waveform	Returns a waveform object if the input argument is a waveform object or returns a family of waveforms if the input argument is a family of waveforms.
n_number	Returns a number if the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Example

```
dbm( ymax( v( "/net9" ) ) )
```

Returns a waveform representing 10 times `log10(ymax(v("/net9"))` plus 30.

delay

```
delay( ?wf1 o_wf1 ?value1 n_value1 ?edge1 s_edge1 ?nth1 x_nth1 ?td1 n_td1
     ?wf2 o_wf2 ?value2 n_value2 ?edge2 s_edge2 ?nth2 x_nth2 {[?td2 n_td2] |
     [?td2r0 n_td2r0]} ?stop n_stop )
     => o_waveform/n_value/nil
```

Description

Calculates the delay between a trigger event and a target event.

The `delay` command computes the delay between two points using the `cross` command.

Arguments

o_wf1	First waveform object.
n_value1	Value at which the crossing is significant for the first waveform object.
s_edge1	Type of the edge that must cross *n_value1*. Valid values: `'rising`, `'falling`, `'either`
x_nth1	Number that specifies which crossing is to be the trigger event. For example, if *x_nth1* is 2, the trigger event is the second edge of the first waveform with the specified type that crosses *n_value1*.
n_td1	Time at which to start the delay measurement. The simulator begins looking for the trigger event, as defined by *o_wf1*, *n_value1*, *t_edge1*, and *x_nth1*, only after the *n_td1* time is reached.
o_wf2	Second waveform object.
n_value2	Value at which the crossing is significant for the second waveform.
s_edge2	Type of the edge for the second waveform. Valid values: `'rising`, `'falling`, `'either`
x_nth2	Number that specifies which crossing is to be the target event. For example, if *x_nth2* is 2, the target event is the second edge

	of the second waveform with the specified type that crosses *n_value2*.
n_td2	Time to start observing the target event. *n_td2* is specified relative to the trigger event. This parameter cannot be specified at the same time as *n_td2r0*. The simulator begins looking for the target event, as defined by *o_wf2*, *n_value2*, *t_edge2*, and *x_nth2*, only after the *n_td2* time is reached. If you specify neither *n_td2* nor *n_td2r0*, the simulator begins looking for the target event at `t = 0`.
n_td2r0	Time to start observing the target event, relative to `t = 0`. Only applicable if both *o_wf1* and *o_wf2* are specified. This parameter cannot be specified at the same time with *n_td2*. The simulator begins looking for the target event, as defined by *o_wf2*, *n_value2*, *t_edge2*, and *x_nth2*, only after the *n_tdr0* time is reached. If you specify neither *n_td2* nor *n_td2r0*, the simulator begins looking for the target event at `t = 0`. `?td2 and ?td2r0 take precedence over other options.`
n_stop	Time to stop observing the target event.

Value Returned

o_waveform	Returns a waveform representing the delay if the input argument is a family of waveforms.
n_value	Returns the delay value if the input argument is a single waveform.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
delay( ?wf1 wf1 ?value1 2.5 ?nth1 2 ?edge1 'either ?wf2 wf2 ?value2 2.5 ?nth2 1
?edge2 'falling )
```

Calculates the delay starting from the time when the second edge of the first waveform reaches the value of 2.5 to the time when the first falling edge of the second waveform crosses 2.5.

```
delay( ?td1 5 ?wf2 wf2 ?value2 2.5 ?nth2 1 ?edge2 'rising ?td2 5)
```

Calculates the delay starting when the time equals 5 seconds and stopping when the value of the second waveform reaches 2.5 on the first rising edge 5 seconds after the trigger.

```
delay( ?wf1 wf2 ?value1 2.5 ?nth1 1 ?edge1 'rising ?td1 5 ?wf2 wf2 ?value2 2.5 ?nth2
1 ?edge2 'rising ?td2 0)
```

Waits until after the time equals 5 seconds, and calculates the delay between the first and the second rising edges of *wf2* when the voltage values reach 2.5.

deriv

```
deriv( o_waveform )
     => o_waveform/nil
```

Description

Computes the derivative of a waveform with respect to the X axis.

Note: After the second derivative, the results become inaccurate because the derivative is obtained numerically.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)

Value Returned

o_waveform	Returns a waveform object representing the derivative with respect to the X axis of the input waveform. Returns a family of waveforms if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Example

```
plot( deriv( v( "/net8" ) ) )
```

Plots the waveform representing the derivative of the voltage of `"/net8"`.

dft

```
dft( o_waveform n_from n_to x_num [t_windowName [n_param1]] )
     => o_waveform/nil
```

Description

Computes the discrete Fourier transform and fast Fourier transform of the input waveform.

The waveform is sampled at the following *n* timepoints:

```
from, from + deltaT, from + 2 * deltaT,…,
from + (N - 1) * deltaT
```

The output of `dft` is a frequency waveform, `W(f)`, which has `(N/2 + 1)` complex values—the DC term, the fundamental, and `(N/2 - 1)` harmonics.

Note: The last time point, `(from + (N - 1) * deltaT)`, is `(to - deltaT)` rather than `to.` The `dft` command assumes that `w(from)` equals `w(to)`.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_from	Starting value for the `dft` computation.
n_to	Ending value for the `dft` computation.
x_num	Number of timepoints. If *x_num* is not a power of 2, it is forced to be the next higher power of 2.
t_windowName	Variable representing different methods for taking a `dft` computation. Valid values: `Rectangular`, `ExtCosBell`, `HalfCycleSine`, `Hanning` or `Cosine2`, `Triangle` or `Triangular`, `Half3CycleSine` or `HalfCycleSine3`, `Hamming`, `Cosine4`, `Parzen`, `Half6CycleSine` or `HalfCycleSine6`, `Blackman`, or `Kaiser`.

For more information about *windowName*, see the information about Discrete Fourier Transform (dft) in the *Virtuoso® Analog Design Environment User Guide*.

n_param1 — Smoothing parameter.
Applies only if the *t_windowName* argument is set to Kaiser.

Value Returned

o_waveform — Returns a waveform representing the magnitude of the various harmonics for the specified range of frequencies. Returns a family of waveforms if the input argument is a family of waveforms.

nil — Returns nil and an error message otherwise.

Example

```
plot( dft( v( "/net8" ) 10u 20m 64 "rectangular" ) )
```

Computes the discrete Fourier transform, fast Fourier transform, of the waveform representing the voltage of "/net8". The computation is done from 10u to 20m with 64 timepoints. The resulting waveform is plotted.

dftbb

```
dftbb( o_waveform1 o_waveform2 f_timeStart f_timeEnd x_num
     ?windowName t_windowName ?smooth x_smooth ?cohGain f_cohGain
     ?spectrumType s_spectrumType)
     => o_waveformComplex/nil
```

Description

Computes the discrete Fourier transform (fast Fourier transform) of a complex signal.

Arguments

o_waveform1	Time domain waveform object with units of volts or amps.
o_waveform2	Time domain waveform object with units of volts or amps.
f_timeStart	Start time for the spectral analysis interval. Use this parameter and `f_timeEnd` to exclude part of the interval. For example, you might set these values to discard initial transient data.
f_timeEnd	End time for the spectral analysis interval.
x_num	The number of time domain points to use. The maximum frequency in the Fourier analysis is directly proportionate to `x_num` and inversely proportional to the difference between `f_timeStart` and `f_timeEnd`.
t_windowName	The window to be used for applying the moving window FFT. Valid values: `Rectangular`, `ExtCosBell`, `HalfCycleSine`, `Hanning`, `Cosine2`, `Triangle` or `Triangular`, `Half3CycleSine` or `HalfCycleSine3`, `Hamming`, `Cosine3`, `Cosine4`, `Parzen`, `Half6CycleSine` or `HalfCycleSine6`, `Blackman`, or `Kaiser`. Default value: `Hanning`.
x_smooth	The Kaiser window smoothing parameter. If there are no requests, there is no smoothing. Valid values: `0 <= x_smooth <= 15` Default value: `1`
f_cohGain	A scaling parameter. A non-zero value scales the power spectral density by 1/(f_cohGain). Valid values: `0 <= f_cohGain <= 1`. You can use `1` if you do

	not want the scaling parameter to be used. Default value: `1`
t_spectrumType	A string that can be either `singleSided` or `doubleSided`. When this option is single-sided, the resultant waveform is only on one side of the y axis starting from 0 to N-1. When it is double-sided, it is symmetric to the Y axis from -N/2 to N/2.

Value Returned

o_waveformComplex	The discrete Fourier transform for baseband signals of the two waveforms returned when the command is successful.
`nil`	Returns `nil` and an error message otherwise.

Example

```
dftbb(VT("/net32") VT("/net11") , 0, 16m, 12000, ?windowName ’Hanning,?smooth 1,
?cohGain 1, ?spectrumType "SingleSided")
```

eyeDiagram

```
eyeDiagram ( o_waveform n_start n_stop n_period )
     => o_waveform/nil
```

Description

This function gives an eye-diagram plot of the input waveform signal. It returns the waveform object of the eye-diagram plot.

Arguments

n_start	x-axis start value from where the eye-diagram plot is to commence
n_stop	x-axis stop value where the eye-diagram plot will terminate
n_period	period value

Value Returned

o_waveform	Returns a waveform object representing the eye-diagram plot of the input waveform
nil	Returns `nil` and an error message otherwise

Example

```
eyeDiagram( v("/out" ) 0n 500n 12.5n)
```

flip

```
flip( o_waveform )
    => o_waveform/nil
```

Description

Returns a waveform with the X vector values negated.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)

Value Returned

o_waveform	Returns a waveform object representing the input waveform mirrored about its Y axis. Returns a family of waveforms if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Example

```
plot( flip( v("/net4") ) )
```

Plots the waveform for the voltage of `"/net4"` with the X vector values negated.

fourEval

```
fourEval( o_waveform n_from n_to n_by )
     => o_waveform/nil
```

Description

Evaluates the Fourier series represented by an expression.

This function is an inverse Fourier transformation and thus the inverse of the `dft` command. The `fourEval` function transforms the expression from the frequency domain to the time domain.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_from	Starting point on the X axis at which to start the evaluation.
n_to	Increment.
n_by	Ending point on the X axis.

Value Returned

o_waveform	Returns a waveform object representing the inverse Fourier transformation of the input waveform. Returns a family of waveforms if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Example

```
plot( fourEval( v( "/net3" ) 1k 10k 10 )
```

Plots the waveform representing the inverse Fourier transformation of the voltage of `"/net3"` from `1k` to `10k`.

frequency

```
frequency( o_waveform )
     => o_waveform/n_value/nil
```

Description

Computes the reciprocal of the average time between two successive midpoint crossings of the rising waveform.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)

Value Returned

o_waveform	Returns a waveform representing the frequency of a family of waveforms if the input argument is a family of waveforms.
n_value	Returns a number representing the frequency of the specified waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
frequency( v( "/net12" ) )
```

Returns the frequency of `"/net12"`.

ga

```
ga( o_s11 o_s12 o_s21 o_s22 [ ?gs n_gs] )
     => o_waveform/nil
```

Description

Returns the available gain in terms of the supplied parameters and the optional source reflection coefficient (Gs).

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22.
n_gs	Source reflection coefficient. Default value: `0`

Value Returned

o_waveform	Waveform object representing the available gain.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
s11 = sp(1 1)
s12 = sp(1 2)
s21 = sp(2 1)
s22 = sp(2 2)
plot(ga(s11 s12 s21 s22))
```

gac

```
gac( o_s11 o_s12 o_s21 o_s22 g_level g_frequency )
     => o_waveform/nil
```

Description

Computes the available gain circles.

The *g* data type on *g_level* and *g_frequency* allows either the level or the frequency to be swept while the other remains fixed.

Arguments

o_s11 — Waveform object representing s11.

o_s12 — Waveform object representing s12.

o_s21 — Waveform object representing s21.

o_s22 — Waveform object representing s22.

g_level — Level in dB. It can be specified as a scalar or a vector. If it is specified as a vector, the level is swept. The `linRg` function can be called to generate a linear range. For example, `linRg( -30 30 5 )` is the same as `list(-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30)` and the *g_level* argument can be specified as either of the above. In that case, an available gain circle is calculated at each one of the 13 levels.

g_frequency — Frequency, which can be specified as a scalar or a linear range. If it is specified as a linear range, the frequency is swept. The linear range is specified as a list with three values: the start of the range, the end of the range, and the increment. For example, `list(100M 1G 100M)` specifies a linear range with the following values:

{ 100M, 200M, 300M, 400M, 500M, 600M, 700M, 800M, 900M, 1G }

In that case, an available gain circle is calculated at each one of the 10 frequencies.

Value Returned

`o_waveform`	Waveform object representing the available gain circles.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
s11 = sp(1 1 ?result "sp")
s12 = sp(1 2 ?result "sp")
s21 = sp(2 1 ?result "sp")
s22 = sp(2 2 ?result "sp")
plot(gac(s11 s12 s21 s22 linRg(-30 30 5) 900M))
```

gainBwProd

```
gainBwProd( o_waveform )
     => o_waveform/n_value/nil
```

Description

Calculates the gain-bandwidth product of a waveform representing the frequency response of interest over a sufficiently large frequency range.

Returns the product of the zero-frequency-gain and 3dB-gain-frequency.
.

$$\text{gainBwProd (gain)} = A_o * f2$$

The gain-bandwidth product is calculated as the product of the DC gain A_o and the critical frequency f2. The critical frequency f2 is the smallest frequency for which the gain equals $1/\sqrt{2}$ times the DC gain A_o.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)

Value Returned

o_waveform	Returns a waveform representing the gain-bandwidth product for a family of waveforms if the input argument is a family of waveforms.
n_value	Returns a value for the gain-bandwidth product for the specified waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
gainBwProd( v( "/OUT" ) )
```

Returns the gain-bandwidth product for the waveform representing the voltage of the `"/OUT"` net.

gainMargin

```
gainMargin( o_waveform [b_stable])
     => o_waveform/n_value/nil
```

Description

Computes the gain margin of the loop gain of an amplifier.

The first argument is a waveform representing the loop gain of interest over a sufficiently large frequency range. This command returns the dB value of the waveform when its phase crosses negative pi.

```
gainMargin( gain ) = 20 * log10( value( gain f0 ) )
```

The gain margin is calculated as the magnitude of the gain in dB at f0. The frequency f0 is the lowest frequency in which the phase of the gain provided is -180 degrees. For stability, the gain margin will be negative when b_stable is set to nil. If b_stable value is set to t, then a stable design will have a positive value.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
b_stable	Boolean optional value that takes the value `nil` by default.

Value Returned

o_waveform	Returns a waveform representing the gain margin for a family of waveforms if the input argument is a family of waveforms.
n_value	Returns the value for the gain margin of the specified waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
gainMargin( v( "/OUT" ) ) = -9.234
gainMargin( v( "/OUT" ) nil ) = -9.234
gainMargin( v( "/OUT" ) t ) =  9.234
```

gmax

```
gmax( o_s11 o_s12 o_s21 o_s22 )
     => o_waveform/nil
```

Description

Returns the maximum power gain in terms of the supplied parameters.

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22.

Value Returned

o_waveform	Load reflection coefficient.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
s11 = sp(1 1)
s12 = sp(1 2)
s21 = sp(2 1)
s22 = sp(2 2)
plot(gmax(s11 s12 s21 s22))
```

gmin

```
gmin( o_Gopt o_Bopt f_zref )
     => o_gminWave/nil
```

Description

Returns the optimum noise reflection coefficient in terms of *o_Gopt*, *o_Bopt*, and *f_zref*.

`gmin` is returned as follows:

```
yOpt = o_Gopt + (complex 0 1) * o_Bopt
return ( 1 / f_zref(1) - yOpt ) / ( 1 / f_zref(1) + yOpt )
```

Arguments

o_Gopt	Waveform object representing the optimum source conductance.
o_Bopt	Waveform object representing the optimum source susceptance.
f_zref	Reference impedance.

Value Returned

o_gminWave	Waveform object representing the optimum noise reflection coefficient.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
Gopt = getData("Gopt")
Bopt = getData("Bopt")
Zref = zref(1 ?result "sp")
plot(gmin(Gopt Bopt Zref))
```

gmsg

```
gmsg( o_s11 o_s12 o_s21 o_s22 )
     => o_waveform/nil
```

Description

Returns the maximum stable power gain in terms of the supplied parameters.

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22.

Value Returned

o_waveform	Waveform object representing the maximum stable power gain.
`nil`	Returns `nil` and an error message otherwise.

Example

```
s11 = sp(1 1)
s12 = sp(1 2)
s21 = sp(2 1)
s22 = sp(2 2)
plot(gmsg(s11 s12 s21 s22))
```

gmux

```
gmux( o_s11 o_s12 o_s21 o_s22 )
     => o_waveform/nil
```

Description

Returns the maximum unilateral power gain in terms of the supplied parameters.

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22.

Value Returned

o_waveform	Waveform object representing the maximum unilateral power gain.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
s11 = sp(1 1)
s12 = sp(1 2)
s21 = sp(2 1)
s22 = sp(2 2)
plot(gmux(s11 s12 s21 s22))
```

gp

```
gp( o_s11 o_s12 o_s21 o_s22 [?gl n_gl] )
     => o_waveform/nil
```

Description

Computes the power gain in terms of the S-parameters.

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22
n_gl	Load reflection coefficient. Default value: 0

Value Returned

o_waveform	Waveform object representing the power gain.
`nil`	Returns `nil` and an error message otherwise.

Example

```
s11 = sp(1 1)
s12 = sp(1 2)
s21 = sp(2 1)
s22 = sp(2 2)
plot(gp(s11 s12 s21 s22))
```

Note: gl is an imaginary number which should be input in the following format:

```
gp( s11 s12 s21 s22 ?gl complex(<realPart> <imagPart>))
```

gpc

```
gpc( o_s11 o_s12 o_s21 o_s22 g_level g_frequency )
     => o_waveform/nil
```

Description

Computes the power gain circles.

The *g* datatype on *g_level* and *g_frequency* allows either the level or the frequency to be swept while the other remains fixed.

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22.
g_level	Level in dB. It can be specified as a scalar or a vector. If it is specified as a vector, the level is swept. The `linRg` function can be called to generate a linear range. For example, `linRg( -30 30 5 )` is the same as `list(-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30)` and the *g_level* argument can be specified as either. In that case, a power gain circle is calculated at each one of the 13 levels.
g_frequency	The frequency. It can be specified as a scalar or a linear range. If it is specified as a linear range, the frequency is swept. The linear range is specified as a list with three values: the start of the range, the end of the range, and the increment. For example, `list(100M 1G 100M)` specifies a linear range with the following values: { 100M, 200M, 300M, 400M, 500M, 600M, 700M, 800M, 900M, 1G } In that case, a power gain circle is calculated at each one of the 10 frequencies.

Value Returned

o_waveform	Waveform object representing the power gain circles.
`nil`	Returns `nil` and an error message otherwise.

groupDelay

```
groupDelay( o_waveform )
     => o_waveform/nil
```

Description

Computes the group delay of a waveform.

This command returns the derivative of the phase of *o_waveform* / 2pi. Group delay is defined as the derivative of the phase with respect to frequency. Group delay is expressed in seconds.

It is calculated using the `vp` function as shown below:

$$\text{Group Delay} = \frac{d\phi}{d\omega} = \frac{d}{df}\left[\frac{phase(\text{/netX})}{360}\right]$$

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)

Value Returned

o_waveform	Returns a waveform representing the group delay of the specified waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
plot( groupDelay( v( "/net3" ) ) )
```

Plots the waveform representing the group delay of the voltage of `"/net3"`.

gt

```
gt( o_s11 o_s12 o_s21 o_s22 [ ?gs n_gs] [ ?gl n_gl] )
     => o_waveform/nil
```

Description

Returns the transducer gain in terms of the supplied parameters and the optional source reflection coefficient (Gs) and the input reflection coefficient (Gl).

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22.
n_gs	Source reflection coefficient. Default value: 0
n_gl	Input reflection coefficient. Default value: 0

Value Returned

o_waveform	Waveform object representing the transducer gain.
nil	Returns nil and displays a message if there is an error.

Examples

```
s11 = sp(1 1)
s12 = sp(1 2)
s21 = sp(2 1)
s22 = sp(2 2)
plot(gt(s11 s12 s21 s22))
```

Note: gl is an imaginary number which should be input in the following format:

```
gt( s11 s12 s21 s22 ?gl complex(<realPart> <imagPart>))
```

harmonic

```
harmonic( o_waveform h_index )
     => o_waveform/g_value/nil
```

Description

Returns the waveform for a given harmonic index.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)
h_index	The index number that designates the harmonic information to be returned. For the `'pss`, `'pac`, and `'pxf` analyses, the index is an integer number. For the `'pdisto` analysis, the index is a list of integers that correspond with the frequency names listed in the `funds` analysis parameter in the netlist. If more than one *h_index* is desired at one time, a list can be specified.

Value Returned

o_waveform	Returns a waveform (when a single *h_index* is specified) or family of waveforms (when more than one *h_index* is specified) if the input argument is a family of waveforms.
g_value	Returns the harmonic value if the input is a single waveform with the X values being harmonics
`nil`	Returns `nil` and displays a message if there is an error.

Examples

For each of the following commands:

```
harmonic(v("/net49" ?result "pss-fd.pss") 1)
harmonic(v("/Pif" ?result "pdisto-fi.pdisto") list(1 -1))
```

Each result is a complex number.

For each of the following commands:

```
harmonic(v("/net54" ?result "pac-pac") 1)
harmonic(v("/net51" ?result "sweeppss_pss_fd-sweep") list(8))
harmonic(v("/Pif" ?result "sweeppss_pac-sweep") -8)
harmonic(v("/net36" ?result "sweeppdisto_pdisto_fi-sweep") '(1 -1))
```

Each result is a waveform.

For each of the following commands:

```
harmonic(v("/net54" ?result "pac-pac") list(1 5))
harmonic(v("/net51" ?result "sweeppss_pss_fd-sweep") '(1 8))
harmonic(v("/Pif" ?result "sweeppss_pac-sweep") list(-8 0))
harmonic(v("/net36" ?result "sweeppdisto_pdisto_fi-sweep") '((1 -1) (2 -2) (-1 2)))
```

Each result is a family of waveforms.

Neither of the following commands should be entered:

```
harmonic(v("/net49" ?result "pss-fd.pss") list(0 1))
harmonic(v("/Pif" ?result "pdisto-fi.pdisto") '((1 -1) (-1 2)))
```

Each resulting waveform is not in a useful format.

harmonicFreqList

```
harmonicFreqList( [?resultsDir t_resultsDir] [?result S_resultName])
     => n_list/nil
```

Description

Returns a list of lists, with each sublist containing a harmonic index and the minimum and maximum frequency values that the particular harmonic ranges between.

If both of these frequency values are the same, just one frequency value is returned.

Arguments

t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the *resultName* argument.
S_resultName	Results from an analysis.

Value Returned

n_list	Returns a list of lists. For the 'pss, 'pac, and 'pxf analyses, the first element of each sublist is an integer number. For the 'pdisto analysis, the first element of each sublist is a list of integers that correspond with the frequency names listed in the funds analysis parameter in the netlist. For all sublists, the remaining entries are the minimum and maximum frequency values that the particular harmonic ranges between. If both of these frequency values are the same, just one frequency value is returned.
nil	Returns nil if no harmonics are found in the data.

Examples

For each of the following commands:

```
harmonicFreqList( ?result "pss-fd.pss" )
harmonicFreqList( ?result "pac-pac" )
harmonicFreqList( ?result "sweeppss_pss_fd-sweep" )
harmonicFreqList( ?result "sweeppss_pac-sweep" )
```

Each result is a list of integers.

For each of the following commands:

```
harmonicFreqList( ?result "pdisto-fi.pdisto" )
harmonicFreqList( ?result "sweeppdisto_pdisto_fi-sweep" )
```

Each result is a list of lists, with each sublist containing a combination of integer numbers that correspond with the frequency names listed in the `funds` analysis parameter in the netlist. These names can also be extracted from the PSF data by using the `resultParam` function to find the `’largefundname` and `’moderatefundnames` values. For example:

```
strcat(resultParam( ’largefundname ?result "pdisto-fi.pdisto" ) " "
resultParam( ’moderatefundnames ?result "pdisto-fi.pdisto" ))
```

Returns a string representing the order of the frequency names.

harmonicList

```
harmonicList( [?resultsDir t_resultsDir] [?result S_resultName] )
    => n_list
```

Description

Returns the list of harmonic indices available in the *resultName* or current result data.

Arguments

t_resultsDir	Directory containing the PSF files (results). If you supply this argument, you must also supply the resultName argument.
S_resultName	Results from an analysis.

Value Returned

n_list	Returns a list of harmonic indices. For the 'pss, 'pac, and 'pxf analyses, the index is an integer number. For the 'pdisto analysis, the index is a list of integers that correspond with the frequency names listed in the 'funds analysis parameter in the netlist.
nil	Returns nil if no harmonics are found in the data.

Examples

For each of the following commands:

```
harmonicList( ?result "pss-fd.pss" )
harmonicList( ?result "pac-pac" )
harmonicList( ?result "sweeppss_pss_fd-sweep" )
harmonicList( ?result "sweeppss_pac-sweep" )
```

Each result is a list of integers.

For each of the following commands:

```
harmonicList( ?result "pdisto-fi.pdisto" )
harmonicList( ?result "sweeppdisto_pdisto_fi-sweep" )
```

Each result is a list of lists, with each sublist containing a combination of integer numbers that correspond with the frequency names listed in the `'funds` analysis parameter in the netlist. These names can also be extracted from the PSF data by using the `'resultParam` function to find the `'largefundname` and `'moderatefundnames` values. For example:

```
strcat(resultParam( 'largefundname ?result "pdisto-fi.pdisto" ) " "
resultParam( 'moderatefundnames ?result "pdisto-fi.pdisto" ))
```

Returns a string representing the order of the frequency names.

iinteg

```
iinteg( o_waveform )
     => o_waveform/nil
```

Description

Computes the indefinite integral of a waveform with respect to the X-axis variable.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)

Value Returned

o_waveform	Returns a waveform representing the indefinite integral of the input waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
plot( iinteg( v( "/net8" )))
```

Computes the indefinite integral of the waveform representing the voltage of `"/net8"`.

imag

```
imag( {o_waveform | n_input} )
    => o_waveformImag/n_numberImag/nil
```

Description

Returns the imaginary part of a waveform representing a complex number or returns the imaginary part of a complex number.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_input	Complex number.

Value Returned

o_waveformImag	Returns a waveform when the input argument is a waveform.
n_numberImag	Returns a number when the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
imag( v( "/net8" ) )
```

Returns a waveform representing the imaginary part of the voltage of `"/net8"`. You also can use the `vim` alias to perform the same command, as in
`vim( "net8" )`.

```
x=complex( -1 -2 ) => complex(-1, -2)
imag( x ) => -2.0
```

Creates a variable `x` representing a complex number, and returns the real portion of that complex number.

integ

```
integ(o_waveform,[n_intial_limit,n_final_limit])
     => o_waveform/n_value/nil
```

Description

Computes the definite integral of the waveform with respect to a range specifed on the X-axis of the waveform. The result is the value of the area under the curve over the range specified on the X-axis.

You should specify either both the limits or neither. In case you do specify the limits, they become the end points of the range on the X-axis for definite integration. If you do not specify the limits, then the range for definite integration is the entire range of the sweep on the X-axis.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
initial_limit_n	Initial limit for definite integration.
final_limit_n	Final limit for definite integration.

Value Returned

o_waveform	Returns a waveform representing the definite integral for a family of waveforms if the input argument is a family of waveforms.
n_value	Returns a numerical value representing the definite integral of the input waveform if the input argument is a single waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
integ( v( "/out" ) )
```

Returns the definite integral of the waveform representing the voltage of `"/out"` over its entire range.

```
integ( VT( "/out" ),12.5n,18n)
```

Returns the definite integral of the waveform representing the voltage of `"/out"` within a specified range.

ipn

```
ipn( o_spurious o_reference [ f_ordspur f_ordref f_epspur f_epref b_psweep
     s_measure ] )
     => o_waveform/f_number/nil
```

Description

Performs an intermodulation *n*th-order intercept measurement.

The data for this measurement can be either a single input power value or a parametric input power sweep.

From each of the spurious and reference power waveforms (or points), the `ipn` function extrapolates a line of constant slope (dB/dB) according to the specified order and input power level. These lines represent constant small-signal power gain (ideal gain). The `ipn` function calculates the intersection of these two lines and returns the value of either the X coordinate (input referred) or Y coordinate.

Arguments

o_spurious	Waveform or number representing the spurious output power (in dBm).
o_reference	Waveform or number representing the reference output power (in dBm).
f_ordspur	Order or slope of the spurious constant-slope power line. Default value: `3`
f_ordref	Order or slope of the reference constant-slope power line. Default value: `1`
f_epspur	Value (in dBm) used to indicate the point where the spurious constant-slope power line begins. If *b_psweep* `is t`, this value is the input power value of the point on the *o_spurious* waveform, otherwise this value is paired with the *o_spurious* value to define the point. This point should be in the linear region of operation. (If *b_psweep* `is t`, *f_spspur* defaults to the X coordinate of the first point of the *o_spurious* wave; if *s_measure* is `'input`, a number must be specified.)

f_epref — Value (in dBm) used to indicate the point where the reference constant-slope power line begins. If *b_psweep* is `t`, this value is the input power value of the point on the *o_reference* waveform, otherwise this value is paired with the *o_reference* value to define the point. This point should be in the linear region of operation. (If *b_psweep* is `t`, *f_epref* defaults to the X coordinate of the first point of the *o_reference* wave; if *s_measure* is `'input`, a number must be specified.)

b_psweep — Boolean indicating that the input power to the circuit was a parametric sweep. The power sweep must both be in dBm and be performed at the lowest parametric level.
Default value: `t`

s_measure — Name indicating if measurement is to be input referred (`'input`) or output referred (`'output`).
Default value: `'input`

Value Returned

o_waveform — Depending on setting of *b_psweep* and the dimension of the input waveforms, returns either a waveform or a family of waveforms.

f_number — If *o_spurious* and *o_reference* are numbers or they are waveforms when *b_psweep* is `t`, returns a number.

`nil` — Returns `nil` and an error message otherwise.

Examples

```
spurWave = db20(harmonic(wave signalHarmonic))
refWave = db20(harmonic(wave referenceHarmonic))
xloc = ipn( spurWave refWave 3.0 1.0 -25 -25 )
yloc = ipn( spurWave refWave 3.0 1.0 -25 -25 t "Output")
```

Computes the IP3 point for the given wave.

Each of the following examples returns an ip3 measurement.

```
ipn(dB20(harmonic(v("/Pif" ?result "pss_fd") 9))
    dB20(harmonic(v("/Pif" ?result "pss_fd") 8)))
```

```
ipn(dbm(harmonic(spectralPower(v("/Pif" ?result "pss_fd")/50.0
    v("/Pif" ?result "pss_fd")) 9))
```

```
    dbm(harmonic(spectralPower(v("/Pif" ?result "pss_fd")/50.0
    v("/Pif" ?result "pss_fd")) 8)))
ipn(dbm(harmonic(spectralPower(v("/Pif" ?result "pss_fd")
    /resultParam("rif:r" ?result "pss_td")
    v("/Pif" ?result "pss_fd")) 9))
    dbm(harmonic(spectralPower(v("/Pif" ?result "pss_fd")
    /resultParam("rif:r" ?result "pss_td")
    v("/Pif" ?result "pss_fd")) 8)))
ipn(dbm(harmonic(spectralPower(i("/rif/PLUS" ?result "pss_fd")
    v("/Pif" ?result "pss_fd")) 9))
    dbm(harmonic(spectralPower(i("/rif/PLUS" ?result "pss_fd")
    v("/Pif" ?result "pss_fd")) 8))
    3. 1. -25 -25 t "Output")
ipn(dbm(harmonic(spectralPower(v("/Pif" ?result "pac")
    /resultParam("rif:r" ?result "pss_td")
    v("/Pif" ?result "pac")) -21))
    dbm(harmonic(spectralPower(v("/Pif" ?result "pac")
    /resultParam("rif:r" ?result "pss_td")
    v("/Pif" ?result "pac")) -25)))
```

ipnVRI

```
ipnVRI( o_vport x_harmspur x_harmref [?iport o_iport] [?rport f_rport]
     [?ordspur f_ordspur] [?epoint f_epoint] [?psweep b_psweep] [?epref f_epref]
     [?ordref f_ordref] [?measure s_measure] )
     => o_waveform/f_number/nil
```

Description

Performs an intermodulation *n*th-order intercept point measurement.

Use this function to simplify the declaration of an ipn measurement. This function extracts the spurious and reference harmonics from the input waveform(s), and uses `dBm(spectralPower((i or v/r),v))` to calculate the respective powers. The function passes these power curves or numbers and the remaining arguments to the `ipn` function to complete the measurement.

From each of the spurious and reference power waveforms (or points), the `ipn` function extrapolates a line of constant slope (dB/dB) according to the specified order and input power level. These lines represent constant small-signal power gain (ideal gain). The `ipn` function calculates the intersection of these two lines and returns the value of either the X coordinate (input referred) or the Y coordinate.

Arguments

o_vport	Voltage across the output port. This argument must be a family of spectrum waveforms (1 point per harmonic), with the option of containing a parametric input power sweep (in dBm).
x_harmspur	Harmonic number of the spurious voltage contained in *o_vport*. When *o_iport* is specified, also applies to a current waveform contained in *o_iport*.
x_harmref	Harmonic index of the reference voltage contained in *o_vport*. When *o_iport* is specified, also applies to a current waveform contained in *o_iport*.
o_iport	Current into the output port. This argument must be a family of spectrum waveforms (1 point per harmonic), with the option of containing a parametric input power sweep (in dBm). When specified, power is calculated using voltage and current.
f_rport	Resistance into the output port. When specified and *o_iport* is `nil`, the output power is calculated using voltage and

	resistance. Default value: `50`
f_ordspur	Order or slope of the spurious constant-slope power line. Default value: `3`
f_epoint	Value (in dBm) used to indicate the point where the spurious constant-slope power line begins. If *b_psweep* is `t`, this value is the input power value of the point on the *o_spurious* waveform, otherwise this value is paired with the *o_spurious* value to define the point. This point should be in the linear region of operation. Default value: If *b_psweep* is `t`, the lowest input power value; if *s_measure* is `'input`, a number must be specified.
b_psweep	Boolean indicating that the input power to the circuit was a parametric sweep. The power sweep must be in dBm and must be performed at the lowest parametric level. Default value: `t`
f_epref	Value (in dBm) used to indicate the point where the reference constant-slope power line begins. If *b_psweep* is `t`, this value is the input power value of the point on the *o_reference* waveform, otherwise this value is paired with the *o_reference* value to define the point. This point should be in the linear region of operation. Default value: If *f_epoint* is not `nil`, *f_epoint*; else if *b_psweep* is `t`, the X coordinate of the first point of the *o_reference* wave; else if *s_measure* is `'input`, a number must be specified.
f_ordref	Order or slope of the reference constant-slope power line. Default value: `1`
s_measure	Symbol indicating if measurement is to be input referred (`'input`) or output referred (`'output`). Default value: `'input`

Value Returned

o_waveform	Depending on the setting of *b_psweep* and the dimension of input waveform(s), the `ipnVRI` function returns either a waveform or a family of waveforms.

`f_number`	Depending on the setting of *`b_psweep`* and the dimension of input waveform(s), the `ipnVRI` function returns a number.
`nil`	Returns `nil` and an error message otherwise.

Example

Each of following examples returns an ip3 measurement:

```
ipnVRI(v("/Pif" ?result "pss_fd") 9 8)

ipnVRI(v("/Pif" ?result "pss_fd") 9 8
    ?rport resultParam("rif:r" ?result "pss_td"))

ipnVRI(v("/Pif" ?result "pss_fd") 9 8
    ?iport i("/rif/PLUS" ?result "pss_fd") ?epoint -25
    ?measure "Output")

ipnVRI(v("/Pif" ?result "pac") -21 -25
    ?rport resultParam("rif:r" ?result "pss_td"))
```

ipnVRICurves

```
ipnVRICurves( o_vport x_harmspur x_harmref [?iport o_iport] [?rport f_rport]
     [?ordspur f_ordspur] [?epoint f_epoint] [?psweep b_psweep] [?epref f_epref]
     [?ordref f_ordref] )
     => o_waveform/nil
```

Description

Constructs the waveforms associated with an ipn measurement.

Use this function to simplify the creation of waves associated with an ipn measurement. This function extracts the spurious and reference harmonics from the input waveform(s), and uses `dBm(spectralPower((i or v/r),v))` to calculate the respective powers.

From each of the spurious and reference power waveforms (or points), the `ipnVRICurves` function extrapolates a line of constant slope (dB/dB) according to the specified order and input power level. These lines represent constant small-signal power gain (ideal gain). The function returns these lines and power waveforms (when present) as a family of waveforms.

This function only creates waveforms and does not perform an ipn measurement or include labels with the waveforms. Use the `ipn` or `ipnVRI` function for making measurements.

Arguments

o_vport — Voltage across the output port. This argument must be a family of spectrum waveforms (1 point per harmonic), with the option of containing a parametric input power sweep (in dBm).

x_harmspur — Harmonic index of the spurious voltage contained in *o_vport*. When *o_iport* is specified, also applies to a current waveform contained in *o_iport*.

x_harmref — Harmonic index of the reference voltage contained in *o_vport*. When *o_iport* is specified, also applies to a current waveform contained in *o_iport*.

o_iport — Current into the output port. This argument must be a family of spectrum waveforms (1 point per harmonic), with the option of containing a parametric input power sweep (in dBm). When specified, power is calculated using voltage and current.

f_rport	Resistance into the output port. When specified and *o_iport* is `nil`, the output power is calculated using voltage and resistance. Default value: `50`
f_ordspur	Order or slope of the spurious constant-slope power line. Default value: `3`
f_epoint	Value (in dBm) used to indicate the point where the spurious constant-slope power line begins. If *b_psweep* is `t`, this value is the input power value of the point on the *o_spurious* waveform, otherwise this value is paired with the *o_spurious* value to define the point. This point should be in the linear region of operation. Default value: If *b_psweep* is `t`, the X coordinate of the first point of the *o_spurious* wave; otherwise a number must be specified.
b_psweep	Boolean indicating that the input power to the circuit was a parametric sweep. The power sweep must be in dBm and must be performed at the lowest parametric level. Default value: `t`
f_epref	Value (in dBm) used to indicate the point where the reference constant-slope power line begins. If *b_psweep* is `t`, this value is the input power value of the point on the *o_reference* waveform, otherwise this value is paired with the *o_reference* value to define the point. This point should be in the linear region of operation. Default value: If *f_epoint* is not `nil`, *f_epoint*; else if *b_psweep* is `t`, the X coordinate of the first point of the *o_reference* wave; else a number must be specified.
f_ordref	Order or slope of the reference constant-slope power line. Default value: `1`

Value Returned

o_waveform	A family of waveforms that contains the spurious and reference tangent lines, and when *b_psweep* is `t`, contains the spurious and reference waveforms.
`nil`	Returns `nil` and an error message otherwise.

Examples

Each of following examples returns curves related to an ip3 measurement:

```
ipnVRICurves(v("/Pif" ?result "pss_fd") 9 8)
```

```
ipnVRICurves(v("/Pif" ?result "pss_fd") 9 8
    ?rport resultParam("rif:r" ?result "pss_td"))
```

```
ipnVRICurves(v("/Pif" ?result "pss_fd") 9 8
    ?iport i("/rif/PLUS" ?result "pss_fd") ?epoint -25)
```

```
ipnVRICurves(v("/Pif" ?result "pac") -21 -25
    ?rport resultParam("rif:r" ?result "pss_td"))
```

kf

```
kf( o_s11 o_s12 o_s21 o_s22 )
     => o_waveform/nil
```

Description

Returns the stability factor in terms of the supplied parameters.

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22.

Value Returned

o_waveform	Waveform object representing the stability factor.
`nil`	Returns `nil` if there is an error.

Examples

```
s11 = sp(1 1)
s12 = sp(1 2)
s21 = sp(2 1)
s22 = sp(2 2)
plot(kf(s11 s12 s21 s22))
```

ln

```
ln( {o_waveform | n_number} )
     => o_waveform/f_number/nil
```

Description

Gets the base-e (natural) logarithm of a waveform or number.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_number	Number.

Value Returned

o_waveform	Returns a waveform object representing the base-e (natural) logarithm of the input waveform if the input argument is a waveform object, or returns a family of waveforms if the input argument is a family of waveforms
f_number	Returns a number if the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
ln( v( "/net9" ) )
```

Gets a waveform that is calculated as the natural logarithm of the input waveform.

```
ln(ymax(v("/net9")))
```

Gets a waveform that is calculated as the natural logarithm of the following: `ymax(v("/net9"))`.

```
ln(100)
=> 4.60517
```

Gets the natural logarithm of 100.

log10

```
log10( {o_waveform | n_number} )
     => o_waveform/n_number/nil
```

Description

Gets the base-10 logarithm of a waveform or a number.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)
n_number	Number.

Value Returned

o_waveform	Returns a waveform object if the input argument is a waveform object or returns a family of waveforms if the input argument is a family of waveforms.
n_number	Returns a number that is calculated as the base-10 logarithm of the input number.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
log10( v( "/net9" ) )
```

Gets a waveform that is calculated as the base-10 logarithm of the input waveform.

```
log10( ymax( v( "/net9" ) ) )
```

Gets a waveform representing the base-10 logarithm of `ymax(v("/net9"))`.

```
log10( 100 )
=> 2.0
```

Gets the base-10 logarithm of 100, or 2.

lsb

```
lsb( o_s11 o_s12 o_s21 o_s22 g_frequency )
     => o_waveform/nil
```

Description

Computes the load stability circles.

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22.
g_frequency	Frequency. It can be specified as a scalar or a linear range. If it is specified as a linear range, the frequency is swept. The linear range is specified as a list with three values: the start of the range, the end of the range, and the increment. For example, `list(100M 1G 100M)` specifies a linear range with the following values: `{ 100M, 200M, 300M, 400M, 500M, 600M, 700M, 800M, 900M, 1G }` In that case, a load stability circle is calculated at each one of the 10 frequencies

Value Returned

o_waveform	Waveform object representing the load stability circles.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
plot(lsb(s11 s12 s21 s22 list(800M 1G 100M)))
```

lshift

```
lshift( o_waveform n_delta )
     => o_waveform/nil
```

Description

Shifts the waveform to the left by the delta value.

This command is the inverse of the `rshift` command.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_delta	Value by which the waveform is to be shifted.

Value Returned

o_waveform	Returns a waveform object representing the input waveform shifted to the left. Returns a family of waveforms if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Example

```
plot( lshift( v( "/net8" ) 30u ) )
```

Shifts the waveform representing the voltage of `"/net8"` to the left by `30u` and plots the resulting waveform.

mag

```
mag( {o_waveform | n_number} )
     => o_waveform/n_number/nil
```

Description

Gets the magnitude of a waveform or number.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_number	Number.

Value Returned

o_waveform	Returns a waveform object if the input argument is a waveform object or returns a family of waveforms if the input argument is a family of waveforms.
n_number	Returns a number if the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
mag( v( "5" ) )
```

Gets the magnitude of the waveform representing the voltage at net 5. You can also use the `vm` alias to perform the same command, as in `vm( "5" )`.

```
mag( i( "VFB" ) )
```

Gets the magnitude of the waveform representing current through the VFB component. You can also use the `im` alias to perform the same command, as in `im( "VFB" )`.

```
mag( -10 ) => 10
```

Returns the magnitude of `-10`.

nc

```
nc( o_Fmin o_Gmin o_rn g_level g_frequency )
    => o_waveform/nil
```

Description

Computes the noise circles.

Arguments

o_Fmin	Waveform object representing the minimum noise factor.
o_Gmin	Waveform object representing the optimum noise reflection.
o_rn	Waveform object representing the normalized equivalent noise resistance.
g_level	Level in dB. It can be specified as a scalar or a vector. The level is swept, if it is specified as a vector. The `linRg` function can be called to generate a linear range. For example, `linRg( -30 30 5 )` is the same as `list(-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30)` and the *g_level* argument can be specified as either of the above. In that case, a noise circle is calculated at each one of the 13 levels.
g_frequency	Frequency. It can be specified as a scalar or a linear range. The frequency is swept if it is specified as a linear range. The linear range is specified as a list with three values: the start of the range, the end of the range, and the increment. For example, `list(100M 1G 100M)` specifies a linear range with the following values: { 100M, 200M, 300M, 400M, 500M, 600M, 700M, 800M, 900M, 1G } In that case, a noise circle is calculated at each one of the 10 frequencies.

Value Returned

o_waveform	Waveform object representing the noise circles.

`nil` Returns `nil` and an error message otherwise.

Examples

```
Gopt = getData("Gopt")
Bopt = getData("Bopt")
Zref = zref(1 ?result "sp")
Gmin = gmin(Gopt Bopt Zref)
Fmin = getData("Fmin")
rn = getData("NNR")
NC = nc(Fmin Gmin rn 10 list(100M 1G 100M))
displayMode("smith")
smithType("impedance")
plot(NC)
```

overshoot

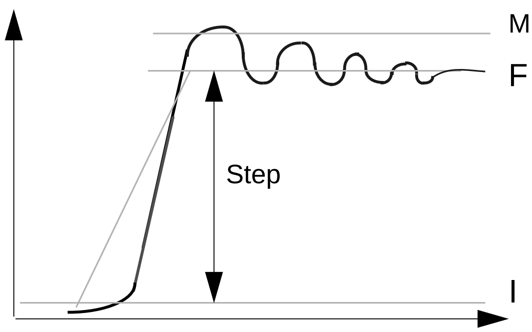
```
overshoot( o_waveform n_initVal g_initType n_finalVal g_finalType )
     => o_waveform/n_value/nil
```

Description

Computes the percentage by which an expression overshoots a step going from the initial value to the final value you enter.

This command returns the overshoot of *o_waveform* as a percentage of the difference between the initial value and the final value.

In the equation below, M represents Maximum Value of the peak wave, F represents Final Value of the settled wave, and I represents Initial Value of the wave.



$$\text{Overshoot} = \frac{(M - F)x100}{F - I}$$

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_initVal	Initial X value at which to start the computation.
g_initType	Specifies how *initVal* functions. Valid values: a non-nil value specifies that the initial value is taken to be the value of the waveform, interpolated at *initVal*, and the waveform is clipped from below, as follows: *o_waveform* = `clip(` *o_waveform* `initVal nil )`

`nil` specifies that *initVal* is defined by the X value entered. (The command gets the Y value for the specified X value and uses that value for *initVal*.)

n_finalVal — Final value at which to end the computation.

g_finalType — Specifies how *finalVal* functions.
Valid values: a non-nil value specifies that the final value is taken to be the value of the waveform, interpolated at *finalVal*, and the waveform is clipped from above, as follows:

```
o_waveform = clip( o_waveform nil finalVal )
```

`nil` specifies that *finalVal* is defined by the X value entered. (The command gets the Y value for the specified X value and uses that value for *finalVal*.)

Value Returned

o_waveform — Returns a waveform (or family of waveforms) representing the amount of overshoot in comparison to the whole signal if the input argument is a family of waveforms.

n_value — Returns a value for the amount of overshoot in comparison to the whole signal if the input is a single waveform.

`nil` — Returns `nil` and an error message otherwise.

Example

```
overshoot( v( "/net8" ) 7n t 3.99u t )
```

Returns the value of the overshoot for the waveform representing the voltage of `"/net8"`.

peakToPeak

```
peakToPeak( o_waveform )
     => o_waveform/n_value/nil
```

Description

Returns the difference between the maximum and minimum values of a waveform.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)

Value Returned

o_waveform	Returns a waveform or a family of waveforms if the input argument is a family of waveforms.
n_value	Returns the difference between the maximum and minimum values of a waveform if the input argument is a single waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
peakToPeak( v( "/net2" ) )
```

Returns the difference between the maximum and minimum values of the waveform representing the voltage of the `"/net2"` net.

phase

```
phase( {o_waveform | n_number} )
     => o_waveform/n_number/nil
```

Description

Gets the phase of the waveform or number.

The `phase` command is similar to the phaseDegUnwrapped command and returns the unwrapped phase in degrees.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_number	Number.

Value Returned

o_waveform	Returns a waveform object if the input argument is a waveform object or returns a family of waveforms if the input argument is a family of waveforms.
n_number	Returns a number if the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
phase( v( "5" ) )
```

Gets the phase of the waveform representing the voltage at net 5. You can also use the `vp` alias to perform the same command, as in `vp( "5" )`.

```
phase( i( "VFB" ) )
```

Gets the phase of the waveform representing the current through the `VFB` component. You can also use the `ip` alias to perform the same command, as in `ip( "VFB" )`.

```
phase( -2.0 ) => 180.0
```

Gets the phase of -2.

phaseDeg

```
phaseDeg( {o_waveform | n_number} )
     => o_waveform/n_number/nil
```

Description

Calculates the wrapped phase in degrees of a waveform and returns a waveform.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_number	Number.

Value Returned

o_waveform	Returns a waveform object representing the wrapped phase in degrees of the input waveform. Returns a family of waveforms if the input argument is a family of waveforms.
n_number	Returns a number if the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Example

```
phaseDeg( v( "vout" ) )
```

Takes the input waveform, representing the voltage of the `"vout"` net, and returns the waveform object representing the wrapped phase in degrees.

phaseDegUnwrapped

```
phaseDegUnwrapped( {o_waveform | n_number} )
     => o_waveform/n_number/nil
```

Description

Calculates the unwrapped phase in degrees of a waveform and returns a waveform.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_number	Number.

Value Returned

o_waveform	Returns a waveform object representing the unwrapped phase in degrees of the input waveform. Returns a family of waveforms if the input argument is a family of waveforms.
n_number	Returns a number if the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Example

```
phaseDegUnwrapped( v( "vout" ) )
```

Takes the input waveform, representing the voltage of the `"vout"` net, and returns the waveform object representing the unwrapped phase in degrees.

phaseMargin

```
phaseMargin( o_waveform )
     => o_waveform/n_value/nil
```

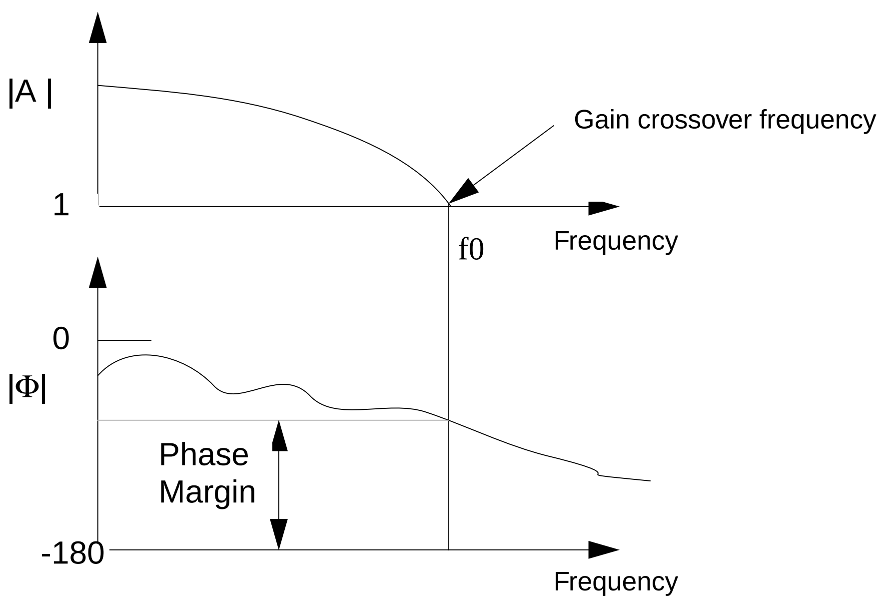
Description

Computes the phase margin of the loop gain of an amplifier.

You supply a waveform representing the loop gain of interest over a sufficiently large frequency range.

phaseMargin(gain) = 180 + phase(value(gain f0))

The phase margin is calculated as the difference between the phase of the gain in degrees at f0 and at -180 degrees. The frequency f0 is the lowest frequency where the gain is 1. For stability, the phase margin must be positive.



Arguments

o_waveform Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)

Value Returned

o_waveform	Returns a waveform representing the phase margin of the loop gain of an amplifier for a family of waveforms if the input argument is a family of waveforms.
n_value	Returns the value (in degrees) equivalent to the phase margin of the input waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
phaseMargin( v( "/OUT" ) )
```

Returns the phase margin for the waveform representing the voltage of the `"/OUT"` net.

phaseRad

```
phaseRad( {o_waveform | n_number} )
     => o_waveform/n_number/nil
```

Description

Calculates the wrapped (discontinuous) phase in radians of a waveform.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)
n_number	Number.

Value Returned

o_waveform	Returns a waveform representing a discontinuous value (in radians) for the phase of the input waveform. Returns a family of waveforms if the input argument is a family of waveforms.
n_number	Returns a number when the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Example

```
plot( phaseRad( v( "/OUT" ) ) )
```

Returns the wrapped phase of the waveform representing the voltage of the `"/OUT"` net.

phaseRadUnwrapped

```
phaseRadUnwrapped( o_waveform )
     => o_waveform/nil
```

Description

Calculates the unwrapped (continuous) phase in radians of a waveform and returns a waveform.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)

Value Returned

o_waveform	Returns a waveform representing the unwrapped (continuous) value for the phase of the input waveform in radians. Returns a family of waveforms if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Example

```
plot( phaseRadUnwrapped( v( "/OUT" ) ) )
```

Returns the unwrapped phase of the waveform representing the voltage of the `"/OUT"` net.

pow

```
pow( {o_waveformBase | n_numberBas} {o_waveformExpn | n_numberExpn} )
     => o_waveform/n_result/nil
```

Description

Takes the exponent of a given waveform or number.

Arguments

o_waveformBase
Waveform object to be used as the base for the expression.

o_waveformExpn
Waveform object to be used as the exponent for the expression.

n_numberBase Number to be used as the base for the expression.

n_numberExpn Number to used as the exponent for the expression.

Value Returned

o_waveform Returns a family of waveforms if one of the input arguments is a family of waveforms or returns a waveform if one of the input arguments is a waveform (and none is a family).

n_result Returns a number if both the input arguments are numbers.

nil Returns `nil` and an error message otherwise.

Examples

```
pow( average( v( "/net9" ) ) 0.5 )
```

Gets the square root of the average value of the voltage at `"/net9"`.

```
pow( 2 3 )
=> 8
```

Gets the value of 2 to the third power, or 8.

```
pow( -2 2 )
=> 4
```

Gets the value of -2 to the second power.

```
pow( 2.5 -1.2 )
=> 0.3330213
```

Gets the value of 2.5 to the power of -1.2.

psd

```
psd( o_waveform f_timeStart f_timeEnd x_num ?windowName t_windowName
     ?smooth x_smooth ?cohGain f_cohGain ?windowsize x_windowsize
     ?detrending t_detrending)
     => o_waveformReal/nil
```

Description

Returns an estimate for the power spectral density of *o_waveform*. If *x_windowsize* is not a power of 2, it is forced to the next higher power of 2. If *x_num* is less than *x_windowsize*, *x_num* is forced to *x_windowsize*.

Arguments

o_waveform	Time domain waveform object with units of volts or amps.
f_timeStart	Starting time for the spectral analysis interval. Use this parameter and *f_timeEnd* to exclude part of the interval. For example, you might set these values to discard initial transient data.
f_timeEnd	Ending time for the spectral analysis interval.
x_num	The number of time domain points to use. The maximum frequency in the Fourier analysis is proportional to *x_num* and inversely proportional to the difference between *f_timeStart* and *f_timeEnd*. Default value: `512`
t_windowName	The window to be used for applying the moving window FFT. Valid values: `'Blackman`, `'Cosine2`, `'Cosine4`, `'ExtCosBell`, `'HalfCycleSine`, `'Half3CycleSine` or `'HalfCycleSine3`, `'Half6CycleSine` or `'HalfCycleSine6`,`'Hamming`, `'Hanning`, `'Kaiser`, `'Parzen`, `'Rectangular`, `'Triangle` or `'Triangular`. Default value: `'Hanning`
x_smooth	The Kaiser window smoothing parameter. The `0` value requests no smoothing. Valid values: 0 <= *x_smooth* <= 15. Default value: `1`

f_cohGain — A scaling parameter. A non-zero value scales the power spectral density by 1/(*f_cohGain*).
Valid values: 0 < *f_cohGain* < 1 (You can use 1 if you do not want the scaling parameter to be used)
Default value: 1

x_windowsize — The number of frequency domain points to use in the Fourier analysis. A larger window size results in an expectation operation over fewer samples, which leads to larger variations in the power spectral density. A small window size can smear out sharp steps in the power spectral density that might really be present.
Default value: 256

t_detrending — The detrending mode to use.
Valid values: 'mean, 'linear, 'none
Default value: 'none

The psd function works by applying a moving windowed FFT to time-series data. If there is a deterministic trend to the underlying data, you might want to remove the trend before performing the spectral analysis. For example, consider analyzing phase noise in a VCO model. Without the noise, the phase increases more or less linearly with time, so it is appropriate to set the detrending mode to 'linear. To subtract an average value, set the detrending mode to 'mean. Where the spectrum of raw data is desired, set the detrending mode to 'none.

Value Returned

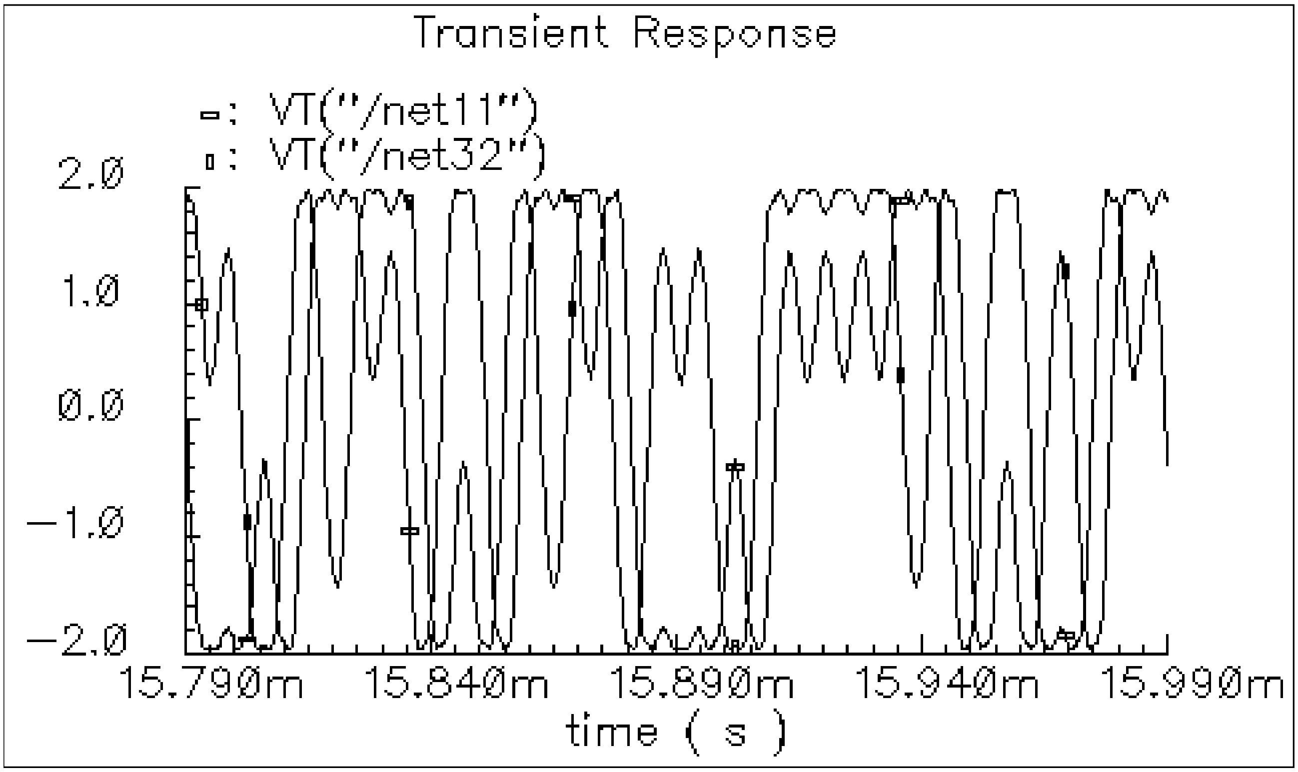
o_waveformReal — The power spectral density waveform returned when the command is successful.

nil — Returns nil when the command fails.

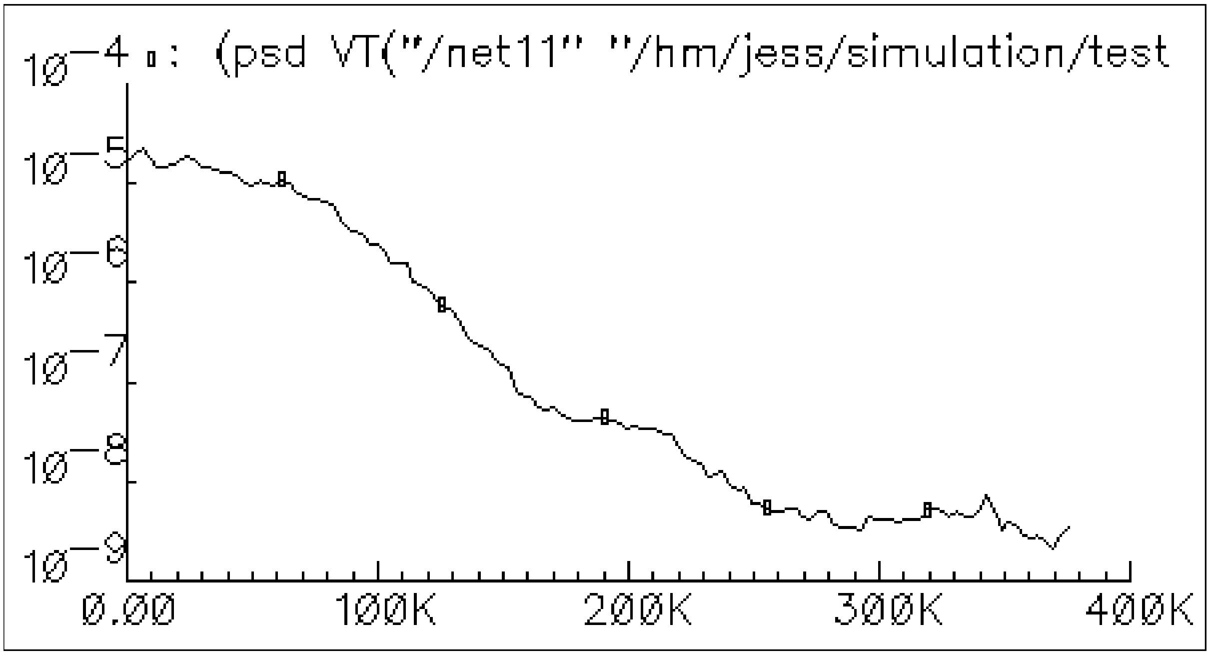
Example

```
psd(VT("/net32" "/hm/test_bench/spectre/schematic"), 0, 16m, 12000,
    ?windowName 'Hanning,?smooth 1, ?windowSize 256,
    ?detrending 'None, ?cohGain 1)
```

Consider applying this command to one of the waveforms in the following illustration.



The result is the following spectrum, which is displayed with a logarithmic vertical scale.



psdbb

```
psdbb( o_waveform1 o_waveform2 f_timeStart f_timeEnd x_num
     ?windowName t_windowName ?smooth x_smooth ?cohGain f_cohGain
     ?windowsize x_windowsize ?detrending t_detrending)
     => o_waveformReal/nil
```

Description

Returns an estimate for the power spectral density of *o_waveform1+j*o_waveform2*. If *x_windowsize* is not a power of 2, it is forced to the next higher power of 2. If *x_num* is less than *x_windowsize*, *x_num* is forced to *x_windowsize*.

Arguments

o_waveform1	Time domain waveform object with units of volts or amps.
o_waveform2	Time domain waveform object with units of volts or amps.
f_timeStart	Starting time for the spectral analysis interval. Use this parameter and *f_timeEnd* to exclude part of the interval. For example, you might set these values to discard initial transient data.
f_timeEnd	Ending time for the spectral analysis interval.
x_num	The number of time domain points to use. The maximum frequency in the Fourier analysis is proportional to *x_num* and inversely proportional to the difference between *f_timeStart* and *f_timeEnd*.
t_windowName	The window to be used for applying the moving window FFT. Valid values: `'Blackman`, `'Cosine2`, `'Cosine4`, `'ExtCosBell`, `'HalfCycleSine`, `'Half3CycleSine` or `'HalfCycleSine3`, `'Half6CycleSine` or `'HalfCycleSine6`,`'Hamming`, `'Hanning`, `'Kaiser`, `'Parzen`, `'Rectangular`, `'Triangle` or `'Triangular`. Default value: `'Hanning`
x_smooth	The Kaiser window smoothing parameter. `0` requests no smoothing. Valid values: 0 <= *x_smooth* <= 15. Default value: `1`

f_cohGain — A scaling parameter. A non-zero value scales the power spectral density by 1/(*f_cohGain*).
Valid values: 0 < *f_cohGain* < 1 (You can use `1` if you do not want the scaling parameter to be used)
Default value: `1`

x_windowsize — The number of frequency domain points to use in the Fourier analysis. A larger window size results in an expectation operation over fewer samples, which leads to larger variations in the power spectral density. A small window size can smear out sharp steps in the power spectral density that might really be present.

t_detrending — The detrending mode to use.
Valid values: `'mean`, `'linear`, `'none`
Default value: `'none`

The `psd` function works by applying a moving windowed FFT to time-series data. If there is a deterministic trend to the underlying data, you might want to remove the trend before performing the spectral analysis. For example, consider analyzing phase noise in a VCO model. Without the noise, the phase increases more or less linearly with time, so it is appropriate to set the detrending mode to `'linear`. To subtract an average value, set the detrending mode to `'mean`. Where the spectrum of raw data is desired, set the detrending mode to `'none`.

Value Returned

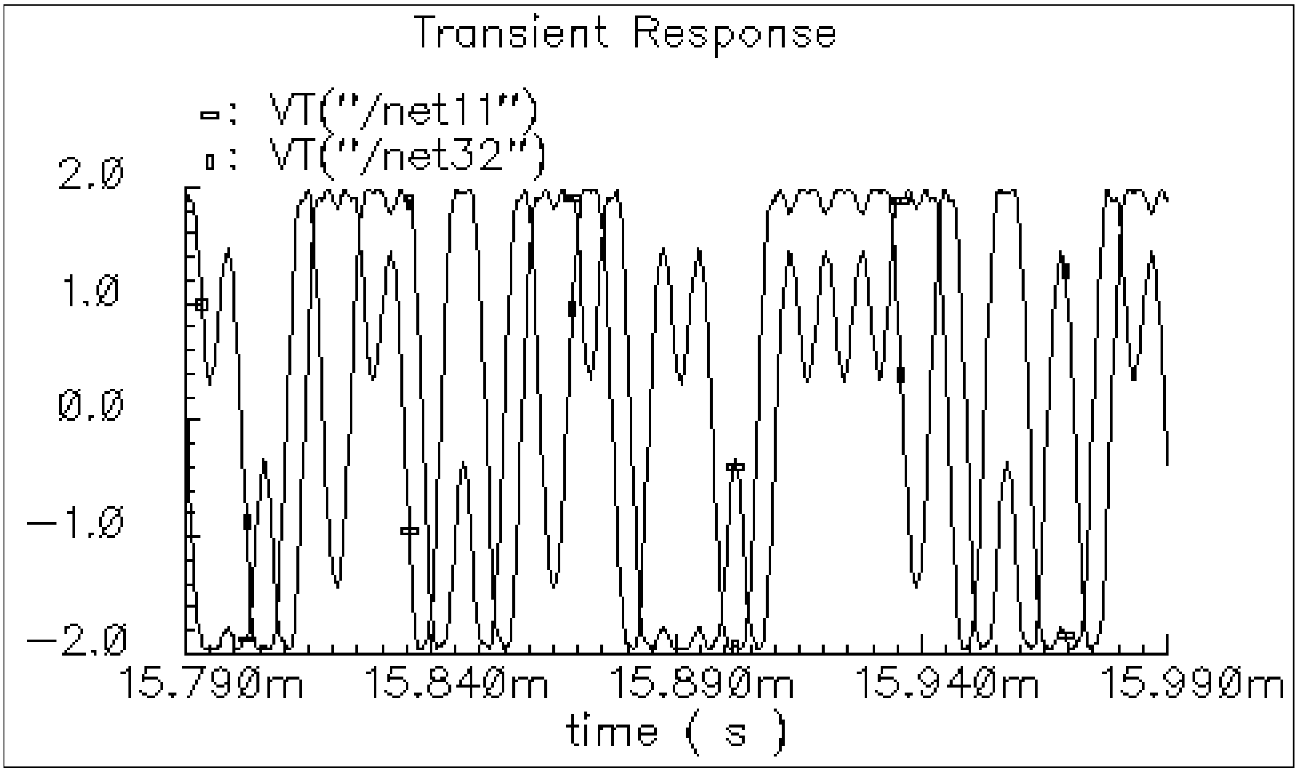
o_waveformReal — The power spectral density waveform returned when the command is successful.

`nil` — Returns `nil` when the command fails.

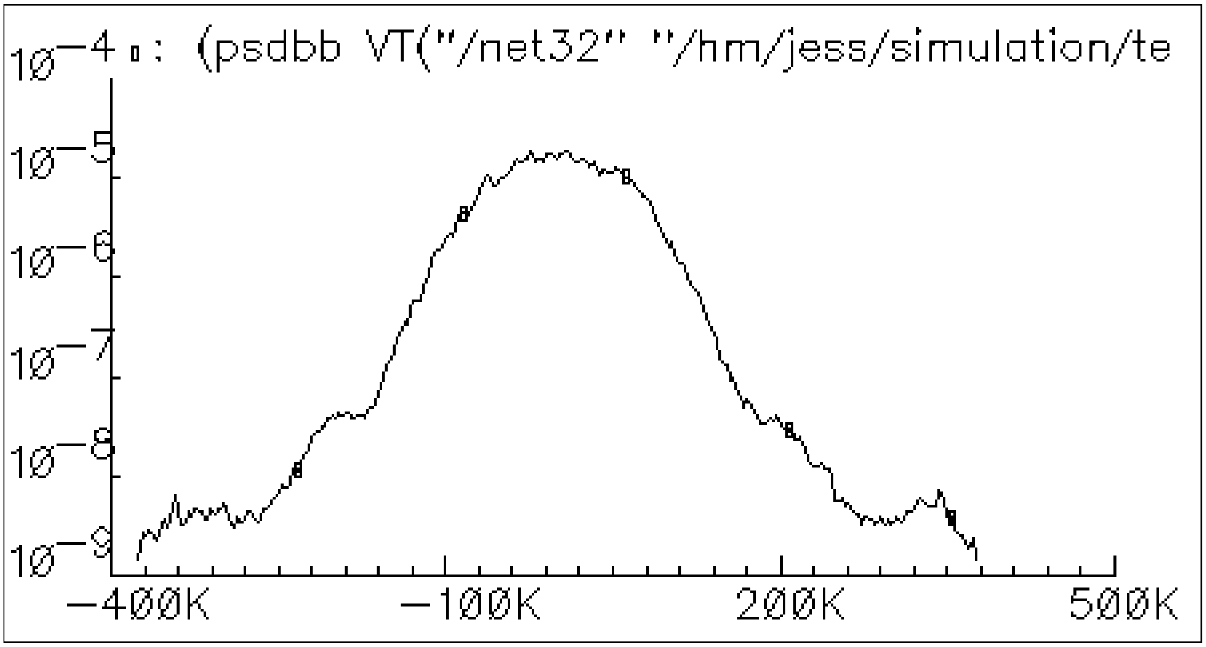
Example

```
psdbb(VT("/net32" "/hm/test_bench/spectre/schematic"),
    VT("/net11" "/hm/test_bench/spectre/schematic"), 0, 16m, 12000,
    ?windowName 'Hanning,?smooth 1, ?windowSize 256,
    ?detrending 'None, ?cohGain 1)
```

Consider applying this command to both of the waveforms in the following illustration.



The result is the following spectrum, which is displayed with a logarithmic vertical scale.



real

```
real( {o_waveform | n_input} )
     => o_waveformReal/n_numberReal/nil
```

Description

Returns the real part of a waveform representing a complex number, or returns the real part of a complex number.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_input	Complex number.

Value Returned

o_waveformReal	Returns a waveform when the input argument is a waveform.
n_numberReal	Returns a number when the input argument is a number.
`nil`	Returns `nil` and an error message otherwise.

Example

```
real( v( "/net8" ) )
```

Returns a waveform representing the real part of the voltage of `"/net8"`. You also can use the `vr` alias to perform the same command, as in `vr( "net8")`.

```
x=complex( -1 -2 ) => complex(-1, -2)
real( x ) => -1.0
```

Creates a variable x representing a complex number, and returns the real portion of that complex number.

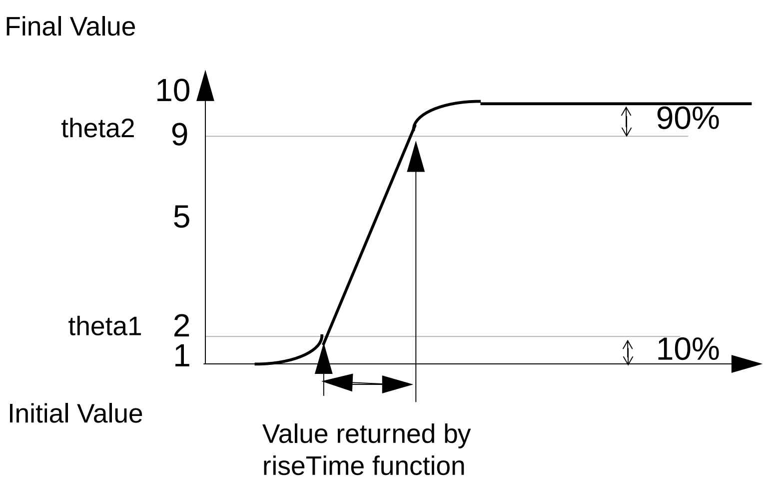
riseTime

```
riseTime( o_waveform n_initVal g_initType n_finalVal g_finalType n_theta1
     n_theta2 )
     => o_waveform/n_value/nil
```

Description

Returns the rise time measured between *theta1* (percent low) to *theta2* (percent high) of the difference between the initial value and the final value.

The `riseTime` function can also be used to compute the fall time if *initVal* is higher than *finalVal*.



Arguments

o_waveform — Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)

n_initVal — Initial value at which to start the computation.

g_initType — Specifies how *n_initVal* functions.
Valid values: a non-nil value specifies that the initial value is taken to be the value of the waveform, interpolated at *n_initVal*, and the waveform is clipped from below as follows:

o_waveform = clip(*o_waveform* *g_initVal* nil)

nil specifies that *n_initVal* is defined by the X value entered. (The command gets the Y value for the specified X value and uses that value for *n_initVal*.)

n_finalVal — Final value at which to end the computation.

g_finalType — Specifies how the *n_finalVal* argument functions. Valid values: a non-nil value specifies that the final value is taken to be the value of the waveform, interpolated at *n_finalVal*, and the waveform is clipped from above, as follows:

o_waveform = clip(*o_waveform* nil *n_finalVal*)

nil specifies that the *n_finalVal* argument is defined by the X value entered. (The command gets the Y value for the specified X value and uses that value for *n_finalVal*.)

n_theta1 — Percent low.

n_theta2 — Percent high.

Value Returned

o_waveform — Returns a waveform representing the rise time for a family of waveforms if the input argument is a family of waveforms.

n_value — Returns a value for the rise time if the input is a single waveform.

nil — Returns nil and an error message otherwise.

Examples

```
riseTime( v( "/net8" ) 0 t 2 t 10 90 )
```

Computes the rise time for the waveform representing the voltage of "/net8" from 0 to 2.

For the next example, assume that v is the following sinusoidal waveform:

```
sin( 2 * pi * time)
riseTime( v 0.25 t 0.5 t 10 90)
```

Computes the fall time of the first falling edge from 1 to 0.

rms

```
rms( o_waveform )
     => o_waveform/n_value/nil
```

Description

Returns the root-mean-square value of a waveform.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:XXXXX`.)

Value Returned

o_waveform	Returns a waveform representing the root-mean-square value for a family of waveforms if the input argument is a family of waveforms.
n_value	Returns a value for the root-mean-square value for the specified waveform if the input is a single waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
rms( v( "/out" ) )
```

Returns the root-mean-square value of the waveform representing the voltage of the `"/out"` net.

rmsNoise

```
rmsNoise( n_from n_to )
     => o_waveform/n_value/nil
```

Description

Computes the integrated root-mean-square noise over the specified bandwidth.

Arguments

n_from	Frequency in hertz that specifies the minimum value for the bandwidth.
n_to	Frequency in hertz that specifies the maximum value for the bandwidth.

Value Returned

o_waveform	Returns a waveform (or a family of waveforms) representing the integrated root-mean-square noise if the data being analyzed is parametric.
n_value	Returns a value for the integrated root-mean-square noise if the data being analyzed is from a single simulation run.
`nil`	Returns `nil` and an error message otherwise.

Example

```
rmsNoise( 100 100M )
=> 250e-6
```

Computes the integrated root-mean-square noise from `100` to `100M`.

root

```
root( o_waveform n_rootVal x_n )
    => o_waveform/n_value/l_value/nil
```

Description

Returns the *n*th X value at which the Y value equals the specified Y value (*rootVal)*.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: drwave:*XXXXX*.)
n_rootVal	Y value of interest.
x_n	Number that specifies which X value to return. If n equals 1, the first X value that crosses over the Y *rootVal* is returned. If n equals 2, the second X value that crosses over the Y *rootVal* is returned, and so on. If you specify a negative integer for n, the X values that cross the *rootVal* are counted from right to left (from maximum to minimum). If you specify n as 0, the list of root values is returned.

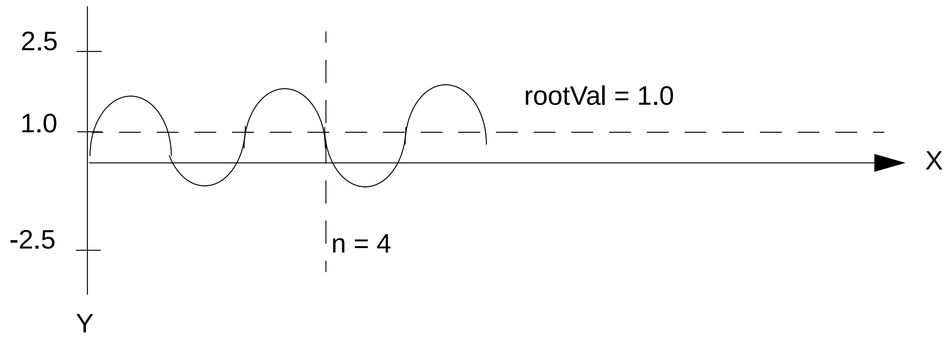
Value Returned

o_waveform	Returns a waveform if the input argument is a family of waveforms.
n_value	Returns an X value when the input argument is a single waveform.
l_value	Returns a list of all the root values when n is 0.
nil	Returns nil and an error message otherwise.

Example

```
root( v( "vout" ), 1.0, 4 )
```

Returns the X value for the point at which the waveform curve crosses the 1.0 Y value for the fourth time.



rshift

```
rshift( o_waveform n_delta )
     => o_waveform/nil
```

Description

Shifts the waveform to the right by the *n_delta* value.

This command is the inverse of the `lshift` command.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_delta	Value by which the waveform is to be shifted.

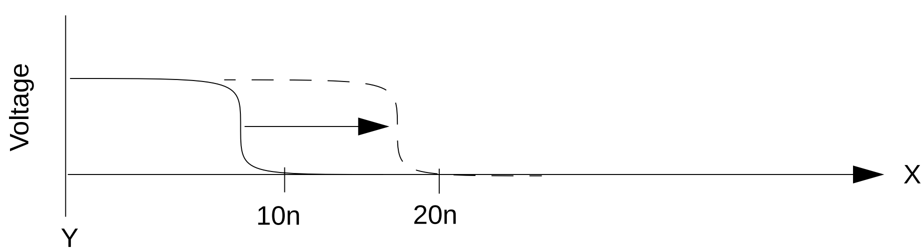
Value Returned

o_waveform	Returns a waveform object. Returns a family of waveforms if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Example

```
rshift( v( "vout" ) ) 10n )
```

Shifts the waveform representing the voltage through the `"vout"` net to the right by `10n`.



sample

```
sample( o_waveform n_from n_to t_type n_by )
     => o_waveform/n_number/nil
```

Description

Samples a waveform at the specified interval.

You can use this function to reduce the time it takes to plot waveforms that have many data points. If you sample a waveform beyond its range, you get the final value of the waveform. You can use this function to demodulate a signal. Consider an AM modulated sine wave. Assume the carrier frequency is 1 GHz, and the modulation frequency is 1 MHz. If the waveform is sampled every 1 ns, the resulting signal is cleanly demodulated (the 1 GHz carrier is completely eliminated by the sampling).

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_from	Starting value for the sampling.
n_to	Ending value for the sampling.
t_type	Type of the sampling. Valid values: `"linear"` or `"log"`
n_by	Interval at which to sample.

Value Returned

o_waveform	Returns a waveform representing the sampling you specified.
n_number	Returns a number if the output contains only one point.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
sample( v( "vout" ) 0 50n "linear" 0.1n )
```

Takes a linear sample of the waveform representing the voltage of the `"vout"` net.

```
sample( v( "vout" ) 0 100m "log" 10 )
```

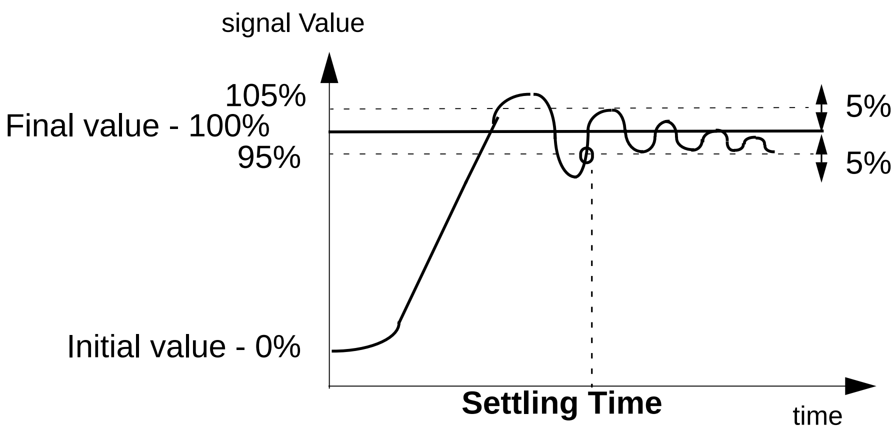
Takes a logarithmic sample of the waveform representing the voltage of the `"vout"` net.

settlingTime

`settlingTime(` *`o_waveform n_initVal g_initType n_finalVal g_finalType n_theta`* `)`
`=>` *`o_waveform/n_value/`*`nil`

Description

The settling time is the time by which the signal settles within the specified Percent of step (theta) of the difference beween the Final Value and Initial Value from the Final Value.



Note: The above graph represents the `Initial value` of the signal as `0%` and `Final value` as `100%`. The `Percent of Step` is taken as `5%`.

Arguments

`o_waveform` Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)

`n_initVal` Initial value at which to start the computation.

`g_initType` Specifies whether the values entered are X values or Y values. Valid values: `t` specifies that *`initVal`* is defined by the X value entered; `nil` specifies that *`initVal`* is defined by the Y value entered

`n_finalVal` Final value at which to start the computation.

g_finalType — Specifies whether the values entered are X values or Y values. Valid values: `t` specifies that *finalVal* is defined by the X value entered; `nil` specifies that *finalVal* is defined by the Y value entered

n_theta — Percent of the total step.

Value Returned

o_waveform — Returns a waveform representing the settling time for a family of waveforms if the input argument is a family of waveforms.

n_value — Returns a value for the settling time for the specified waveform if the input is a single waveform.

`nil` — Returns `nil` and an error message otherwise.

Example

```
settlingTime( v("/out" ) 0 t 2 t 90 )
```

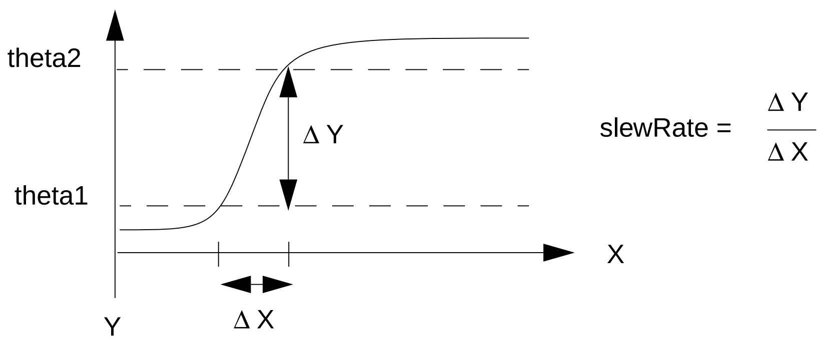
Computes the time required for the waveform representing the voltage of the `"/out"` net to settle within 90 percent of the step from 0 to 2.

slewRate

```
slewRate( o_waveform n_initVal g_initType n_finalVal g_finalType n_theta1
     n_theta2 )
     => o_waveform/n_value/nil
```

Description

Computes the average rate at which an expression changes from *theta1* (percent low) to *theta2* (percent high) of the difference between the initial value and final value.



Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_initVal	Initial X-axis value at which to start the computation.
g_initType	Specifies whether the values entered are X values or Y values. Valid values: `t` specifies that *initVal* is defined by the X value entered; `nil` specifies that *initVal* is defined by the Y value entered
n_finalVal	Final value at which to end the computation.
g_finalType	Specifies whether the values entered are X values or Y values. Valid values: `t` specifies that *finalVal* is defined by the X value entered; `nil` specifies that *finalVal* is defined by the Y value entered
n_theta1	Percent low (percentage of the total step).

n_theta2	Percent high (percentage of the total step).

Value Returned

o_waveform	Returns a waveform representing the slew rate for a family of waveforms if the input argument is a family of waveforms.
n_value	Returns a value for the slew rate for the specified waveform if the input is a single waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
slewRate( v( "vout" ) 10n t 30n t 10 90 )
```

Computes the slew rate for the waveform representing the voltage of the `"vout"` net from `10n` to `30n`.

```
slewRate( v( "vout" ) 0 nil 10 nil 5 95 )
```

Computes the slew rate for the waveform representing the voltage of the `"vout"` net from 0 to 10. In this example, the initial value and final value are entered as Y values.

spectralPower

```
spectralPower( o_current o_voltage )
    => o_power/nil
```

Description

Returns the spectral power given the spectral current and voltage.

To obtain a list of the harmonic frequencies, use `harmonicList`.

Arguments

o_current	Waveform representing the current. The current can be obtained by calling the `i` data access function for the desired terminal.
o_voltage	Waveform representing the voltage. The voltage can be obtained by calling the `v` data access function for the desired net. To obtain meaningful results, the terminal used to obtain the current must be a member of the net used to obtain the voltage.

Value Returned

o_power	Waveform representing the power of the net.
`nil`	Returns `nil` if there is an error.

Example

```
plot(db10(spectralPower(i("/PORT0/PLUS") v("/net28"))))
```

Plots power of the output `"/net28"`. `"/PORT0/PLUS"` is a member of `"/net28"`.

ssb

```
ssb( o_s11 o_s12 o_s21 o_s22 g_frequency )
     => o_waveform/nil
```

Description

Computes the source stability circles.

Arguments

o_s11	Waveform object representing s11.
o_s12	Waveform object representing s12.
o_s21	Waveform object representing s21.
o_s22	Waveform object representing s22.
g_frequency	Frequency. It can be specified as a scalar or a linear range. The frequency is swept if it is specified as a linear range. The linear range is specified as a list with three values: the start of the range, the end of the range, and the increment. For example, `list(100M 1G 100M)` specifies a linear range with the following values: `{ 100M, 200M, 300M, 400M, 500M, 600M, 700M, 800M, 900M, 1G }` In that case, a source stability circle is calculated at each one of the 10 frequencies.

Value Returned

o_waveform	Waveform object representing the source stability circles.
`nil`	Returns `nil` and an error message otherwise.

Example

```
plot(ssb(s11 s12 s21 s22 list(800M 1G 100M)))
```

stddev

```
stddev( o_waveform )
     => n_stddev/o_waveformStddev/nil
```

Description

Computes the standard deviation of a waveform (or a family of waveforms) over its entire range. Standard deviation (stddev) is defined as the square-root of the variance where variance is the integral of the square of the difference of the expression f(x) from average (f(x)), divided by the range of x.

For example, if `y=f(x)`

$$stddev(y) = \sqrt{\frac{\int_{from}^{to} (y - average(y))^2}{to - from}}$$

Arguments

o_waveform	Waveform object or family of waveforms representing simulation results that can be displayed as a series of points. (A waveform object identifier looks like this: drwave:XXXXX)

Value Returned

n_stddev	Returns a number representing the standard deviation value of the input waveform.
o_waveformStddev	Returns a waveform representing the average value if the input is a family of waveforms.
`nil`	Returns `nil` or an error message.

Example

```
stddev( v( "/net9" ) )
```

Gets the standard deviation of the voltage (Y-axis value) of `/net9` over the entire time range specified in the simulation analysis.

tangent

```
tangent( o_waveform [ ?x n_x ] [ ?y n_y ] [ ?slope n_slope ] )
     => o_waveform/nil
```

Description

Returns the tangent to a waveform through the point (*n_x*, *n_y*) with the given slope.

Arguments

o_waveform	Waveform object representing the wave.
n_x	X coordinate of the point. The default value is the X coordinate of the first point on the wave.
n_y	Y coordinate of the point. The default value is the Y coordinate at the given or default X coordinate.
n_slope	Slope of the line. Default value: `1.0`

Value Returned

o_waveform	Wave object representing the line.
`nil`	Returns `nil` if there is an error.

Example

```
refLine
=> tangent(refWave ?x -25 ?slope 1.0)
```

thd

```
thd( o_waveform n_from n_to x_num n_fund)
     => o_waveform/n_thdValue/nil
```

Description

The thd function computes the percentage of total harmonic content of a signal with respect to the fundamental frequency.

The computation uses the dft function. Assume that the *dft* function returns complex coefficients A_0, A_1..., A_f , ... Please note that fundamental frequency ***f is the frequency contributing to the largest power in the signal.*** A_0 is the complex coefficient for the DC component and A_i is the complex coefficient for the ***i***th harmonic where $i \neq 0,\ f$. Then, total harmonic distortion is computed as:

$$\frac{\sqrt{\sum_{i = 1,\, i \neq 0,\, f} \left|A_i\right|^2}}{\left|A_f\right|} \times 100\%$$

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
n_from	Starting value for the computation.
n_to	Ending value for the computation.
x_num	Number of timepoints. If *x_num* is not a power of 2, it is forced to be the next higher power of 2.
n_fund	Fundamental Frequency of the signal. If it is nil or zero then the non-zero frequency contributing to the largest power in the signal is used as the fundamental frequency. Otherwise, the harmonic frequency nearest to its value is used as the fundamental frequency.

Value Returned

o_waveform	Returns a waveform representing the absolute value of the total harmonic distortion if the input argument is a family of waveforms.
n_thdValue	Returns the absolute value of the total harmonic distortion of the input waveform.
`nil`	Returns `nil` and an error message otherwise.

Example

```
plot( thd( v( "/net8" ) 10u 20m 64 0 ) )
```

Computes the absolute value of the total harmonic distortion for the waveform representing the voltage of "/net8". The computation is done from 10u to 20m with 64 time points using the non-zero frequency contributing to the largest power in the signal as the fundamental frequency. The resulting waveform is plotted.

```
plot( thd( v( "/net8" ) 10u 20m 64 90 ) )
```

Computes the absolute value of the total harmonic distortion for the waveform representing the voltage of "/net8". The computation is done from 10u to 20m with 64 timepoints using a harmonic frequency, whose absolute difference w.r.t 90 is minimum, as the fundamental frequency. The resulting waveform is plotted.

value

```
value( o_waveform [s_name] g_value )
     => o_waveform/g_value/nil
```

Description

Returns the Y value of a waveform for a given X value.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)
s_name	The name of the innermost or outermost sweep variable. If the sweep variable name is not supplied, the innermost sweep variable is used.
g_value	Value (X value) at which to provide the Y value. If a string has been defined for a value or set of values, the string may be used instead of the value.

Value Returned

o_waveform	Returns a waveform or a family of waveforms if the input argument is a family of waveforms.
g_value	Returns the Y value if the input argument is a single waveform.

Note: For parametric sweeps, the value might be a waveform that can be printed with the `ocnPrint` command.

`nil`	Returns `nil` and an error message if the value cannot be printed.

Examples

```
value( v( "/net18" ) 4.428e-05 )
```

Prints the value of `"/net18"` at `time=4.428e-05`. This is a parametric sweep of temperature over time.

```
value( v( "/OUT" )'TEMPDC 20.0 )
```

Returns `drwave:`*`XXXXX`*, indicating that the result is a waveform.

```
print( value( v( "/OUT" )'TEMPDC 20.0 ) )
```

Prints the value of `v( "/OUT" )` at every time point for `TEMPDC=20`.

xmax

```
xmax( o_waveform x_numberOfPeaks )
     => o_waveform/g_value/l_value/nil
```

Description

Computes the value of the independent variable (X) at which the Y value attains its maximum value.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
x_numberOfPeaks	Specifies the *n*th X value corresponding to the maximum Y value. For example, if *x_numberOfPeaks* is `3`, the X value corresponding to the third maximum Y value is returned. If you specify a negative integer for *x_numberOfPeaks*, the X values are counted from right to left (from maximum to minimum). If *x_numberOfPeaks* is `0`, `xmax` returns a list of X locations.

Value Returned

o_waveform	Returns a waveform (or a family of waveforms) if the input argument is a family of waveforms.
g_value	Returns the X value corresponding to the peak specified with *x_numberOfPeaks* if the input argument is a single waveform.
l_value	Returns a list of X locations when *x_numberOfPeaks* is `0` and the input argument is a single waveform.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
xmax( v( "/net9" ) 1 )
```

Gets the time value (X-axis value) at which the voltage of `"/net9"` attains its first peak value.

```
xmax( v( "/net9" ) 0 )
```

Gets the list of time values (X-axis values) at which the voltage of `"/net9"` attains each of its peak values.

xmin

```
xmin( o_waveform x_numberOfValleys )
     => o_waveform/g_value/l_value/nil
```

Description

Computes the value of the independent variable (X) at which the Y value attains its minimum value.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*XXXXX*.)
x_numberOfValleys	Specifies the *n*th X value corresponding to the minimum Y value. For example, if *x_numberOfValleys* is `3`, the X value corresponding to the third minimum Y value is returned. If you specify a negative integer for *x_numberOfValleys*, the X-values are counted from right to left (from maximum to minimum). If *x_numberOfValleys* is `0`, `xmin` returns a list of X locations.

Value Returned

o_waveform	Returns a waveform (or a family of waveforms) if the input argument is a family of waveforms.
g_value	Returns the X value corresponding to the valley specified with *x_numberOfValleys* if the input argument is a single waveform.
l_value	Returns a list of X locations when *x_numberOfValleys* is `0` and the input argument is a single waveform.
`nil`	Returns `nil` and an error message otherwise.

Examples

```
xmin( v( "/net9" ) 1 )
```

Gets the time value (X axis) at which the voltage of `"/net9"` has its first low point or valley.

```
xmin( v( "/net9" ) 0 )
```

Gets the list of time values (X axis) at which the voltage of `"/net9"` has low points or valleys.

xval

```
xval( o_waveform )
     => o_waveform/nil
```

Description

Returns a waveform whose X vector and Y vector are equal to the input waveform's X vector.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)

Value Returned

o_waveform	Returns a waveform if the input argument is a single waveform. Returns a family of waveforms if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Example

```
xval( v( "/net8" ))
```

Returns a waveform in which the X vector for the voltage of `"/net8"` is also used for the Y vector.

ymax

```
ymax( o_waveform )
     => n_max/o_waveformMax/nil
```

Description

Computes the maximum value of the waveform's Y vector.

A waveform consists of an independent-variable X vector and a corresponding Y vector.

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)

Value Returned

n_max	Returns a number representing the maximum value of Y if the input argument is a single waveform.
o_waveformMax	Returns a waveform (or family of waveforms) representing the maximum value of Y if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Example

```
ymax( v( "/net9" ) )
```

Gets the maximum voltage (Y value) of `"/net9"`.

ymin

```
ymin( o_waveform )
     => n_min/o_waveformMin/nil
```

Description

Computes the minimum value of a waveform's Y vector.

(A waveform consists of an independent-variable X vector and a corresponding Y vector.)

Arguments

o_waveform	Waveform object representing simulation results that can be displayed as a series of points on a grid. (A waveform object identifier looks like this: `drwave:`*`XXXXX`*.)

Value Returned

n_min	Returns a number representing the minimum value of Y if the input argument is a single waveform.
o_waveformMin	Returns a waveform (or family of waveforms) representing the minimum value of Y if the input argument is a family of waveforms.
`nil`	Returns `nil` and an error message otherwise.

Example

```
ymin( v( "/net9" ) )
```

Gets the minimum voltage (Y value) of `"/net9"`.

11

Advanced Analysis

The OCEAN commands for advanced analyses let you run parametric analysis, corners analysis, Monte Carlo analysis, and Optimization. This chapter includes setup commands for these analyses and the special data-access or plot commands that are used for these analyses.

The following sections contain the commands and other information relating to advanced analyses.

Parametric Analysis Commands

These commands set up a parametric analysis. When you run a parametric analysis, you can plot the resulting data as a family of curves.

paramAnalysis

```
paramAnalysis( t_desVar [?start n_start] [?stop n_stop] [?center n_center]
     [?span n_span] [?step f_step] [?lin n_lin] [?log n_log]  [?dec n_dec]
     [?oct n_oct] [?times n_times] [?spanPercent n_spanPercent]
     [?values l_values] [o_paramAnalysis])
     => undefined/nil
```

Description

Sets up a parametric analysis.

Groups the PSF data so that it can be plotted as a family of curves when the analysis is finished. The commands can be nested as shown in the syntax of the command.

If you specify more than one range, the OCEAN environment uses the following precedence to select a single range to use.

n_start, *n_stop*	highest precedence
n_center, *n_span*	↓
n_center, *n_spanPercent*	lowest precedence

Similarly, if you specify more than one step control, the OCEAN environment uses the following precedence.

f_step	ghest precedence
n_lin	↓
n_dec	
n_log	
n_oct	
n_times	lowest precedence

To run the analysis, use the `paramRun` command described in "paramRun" on page 382.

Arguments

t_desVar	Name of the design variable to be swept.
n_start	Beginning value for the design variable.

n_stop	Final value for the design variable.
n_center	Center point for a range of values that you want to sweep.
n_span	Range of values that you want to sweep around the center point. For example, if *n_center* is 100 and *n_span* is 20 then the sweep range extends from 90 to 110.
f_step	Increment by which the value of the design variable changes. For example, if *n_start* is `1.0`, *n_stop* is `2.1`, and *f_step* is `0.2`, the parametric analyzer simulates at values 1.0, 1.2, 1.4, 1.6, 1.8, and 2.0.
n_lin	The number of steps in the analysis. The parametric analyzer automatically assigns equal intervals between the steps. With this option, there is always a simulation at both *n_start* and *n_stop*. The value for the *n_ lin* argument must be an integer greater than 0. For example, if *n_start* is `0.5`, *n_stop* is `2.0`, and *n_lin* is 4, the parametric analyzer simulates at values 0.5, 1.0, 1.5, and 2.0.
n_log	The number of steps between the starting and stopping points at equal-ratio intervals using the following formula: $log\ multiplier = (n\_stop/n\_start)^{(n\_log\ \text{-}1)}$ The number of steps can be any positive number, such as 0.5, 2, or 6.25. Default value: 5 For example, if *n_start* is 3, *n_stop* is 15, and *n_log* is 5, the parametric analyzer simulates at values 3, 4.48605, 6.7082, 10.0311, and 15. The ratios of consecutive values are equal, as shown below. 3/4.48605 = 4.48605/6.7082 = 6.7082/10.0311 = 10.0311/15 = .67
n_dec	The number of steps between the starting and stopping points calculated using the following formula:

$$decade\ multiplier = 10^{1/n\_dec}$$

The number of steps can be any positive number, such as 0.5, 2, or 6.25.
Default value: 5

For example, if *n_start* is 1, *n_stop* is 10, and *n_dec* is 5, the parametric analyzer simulates at values 1, 1.58489, 2.51189, 3.98107, 6.30957, and 10.

The values are 10^0, $10^{.2}$, $10^{.4}$, $10^{.6}$, $10^{.8}$, and 10^1.

n_oct

The number of steps between the starting and stopping points using the following formula:
The number of steps can be any positive number, such as 0.5, 2, or 6.25.
Default value: 5

For example, if *n_start* is 2, *n_stop* is 4, and *n_oct* is 5, the parametric analyzer simulates at values 2, 2.2974, 2.63902, 3.03143, 3.4822, and 4.

These values are 2^1, $2^{1.2}$, $2^{1.4}$, $2^{1.6}$, $2^{1.8}$, and 2^2.

$$octave\ multiplier = 2^{1/(n\_oct)}$$

n_times

A multiplier. The parametric analyzer simulates at the points between *n_start* and *n_stop* that are consecutive multiples of *n_times*.

For example, if *n_start* is 1, *n_stop* is 1000, and *n_times* is 2, the parametric analyzer simulates at values 1, 2, 4, 8, 16, 32, 64, 128, 256, and 512.

n_spanPercent

Range specified as a percentage of the center value. For example, if *n_center* is 100 and *n_spanPercent* is 40, the sweep range extends from 80 to 120.

l_values — List of values to be swept. You can use *l_values* by itself or in conjunction with *n_start*, *n_stop*, and *f_step* to specify the set of values to sweep.

o_paramAnalysis — Value returned from another `paramAnalysis` call used to achieve multidimensional parametric analysis.

Value Returned

undefined — The return value for this command is undefined.

`nil` — Returns `nil` and prints an error message if there are problems setting the option.

Examples

```
paramAnalysis( "rs" ?start 200 ?stop 1000 ?step 200
    ?values '(1030 1050 1090) )
```

Sets up a parametric analysis for the `rs` design variable. The swept values are 200, 400, 600, 800, 1000, 1030, 1050, and 1090.

```
paramAnalysis( "rl" ?start 200 ?stop 600 ?step 200
    paramAnalysis( "rs" ?start 300 ?stop 700 ?step 200
    )
)
```

Sets up a nested parametric analysis for the `rl` design variable.

```
paramAnalysis("temp" ?start -50 ?stop 100 ?step 50)
```

Sets up a parametric analysis for temperature.

paramRun

```
paramRun( [s_paramAnalysis] )
     => t/nil
```

Description

Runs the specified parametric analysis.

If you do not specify a parametric analysis, all specified analyses are run. Distributed processing must be enabled using the `hostmode` command before parametric analyses can be run in distributed mode.

When the `paramRun` command finishes, the PSF directory contains a file named `runObjFile` that points to a family of data. To plot the family, use a normal `plot` command. For example, you might use `plot(v("/out"))`.

For information about specifying a parametric analysis, see the `paramAnalysis` command described in "paramAnalysis" on page 378.

Arguments

s_paramAnalysis	Parametric analysis.

Value Returned

`t`	Returned if successful.
`nil`	Returns `nil` and prints an error message if unsuccessful.

Example

```
paramRun() => t
```

Runs all specified parametric analyses.

```
rsAnalysis = paramAnalysis("CAP" ?values '(10 20))
paramRun('rsAnalysis)
```

OR

```
rsAnalysis = paramAnalysis("CAP" ?values '(10 20) paramAnalysis("RES" ?values '(10
20 )))
paramRun('rsAnalysis)
```

Runs the `rs` parametric analysis.

Corners Analysis Commands

The corners analysis commands let you set up and run analyses to measure circuit performance with respect to variations in a semiconductor manufacturing process. This section lists the commands that you can use to configure and run corners analyses in the OCEAN environment. The following manuals provide more information on corners analysis.

- Advanced Analysis Tools User Guide
- Virtuoso® Analog Design Environment SKILL Language Reference

The corners analysis commands follow.

cornerDesVar

```
cornerDesVar(t_cornerName t_desVarName t_value)
     => t/nil
```

Description

Sets the design variable value for the specified corner.

Arguments

t_cornerName	Name of the corner.
t_desVarName	Name of the design variable.
t_value	Value of the design variable.

Value Returned

`t`	Returned if successful.
`nil`	Returns `nil` and prints an error message.

Example

```
cornerDesVar("slow" "vcc" "5")
```

Sets the value of `vcc` to 5 for corner `slow`.

cornerMeas

```
cornerMeas()
     => t/nil
```

Description

Displays all the predefined enabled measurements from a Design Customization file, either graphically (plot) or textually (print), according to your choices.

Each measurement is plotted or printed in a separate subwindow.

Arguments

None.

Value Returned

`t`	Returned if successful.
`nil`	Returns `nil` and prints an error message.

Example

```
cornerMeas()
```

cornerRun

```
cornerRun( [t_cornerName1 t_cornerName2 …] [?jobName t_jobName] [?host
     t_hostName] [?queue t_queueName] [?startTime t_startTime]
     [?termTime t_termTime] [?dependentOn t_dependentOn] [?mail t_mailingList]
     [?block s_block] [?notify s_notifyFlag] )
     => t/s_jobName/nil
```

Description

Runs the corner analysis that has been predefined in the `.pcf` and `.dcf` files and selected via the `selectProcess` command. If specific corners are specified, only those corners run; otherwise all the corners run.

You can load your `.pcf` and `.dcf` files with the `loadPcf` and `loadDcf` commands. See the Virtuoso® Analog Design Environment SKILL Language Reference for information on these commands.

Arguments

t_cornerName	A specific corner to be run. If you do not specify one or more corners, then all the enabled corners run.

Note: The following arguments are valid only when running in distributed processing mode.

t_jobName	Used as the basis of the job name. The value entered for *t_jobName* is used as the job name and return value if the run command is successful. If the name given is not unique, a number is appended to create a unique job name.
t_hostName	Name of the host on which to run the analysis. If no host is specified, the system assigns the analysis to an available host.
t_queueName	Name of the queue. If no queue is defined, the analysis is placed in the default queue (your home machine).
t_startTime	Desired start time for the job. If dependencies are specified, the job does not start until all dependencies are satisfied.
t_termTime	Termination time for job. If the job is not completed by *t_termTime*, the job is terminated.

t_dependentOn

List of jobs on which the specified analysis is dependent. The analysis is not started until after dependent jobs are complete.

t_mailingList

List of users to be notified by e-mail when the analysis is complete.

s_block — When *s_block* is not `nil`, the OCEAN script halts until the job is complete.
Default value: `nil`

s_notifyFlag — When *notifyFlag* is not `nil`, a job completion message is echoed to the OCEAN interactive window.
Default value: `t`

Value Returned

`t` — Returned if successful.

s_jobName — For a distributed process, the job name specified or assigned by the system to the analysis.

`nil` — Returns `nil` and prints an error message.

Examples

```
cornerRun()
```

Runs all corners analysis defined in the `.pcf` and `.dcf` files and selected by the `selectProcess` command.

```
cornerRun( ?startTime 10 ?host "mach14" ?mail "preampGroup")
```

Runs all corners analysis defined in the `.pcf` and `.dcf` files and selected by the `selectProcess` command in distributed mode with a *startime* of `10`, using `mach14` as *host*, and notifying the mail group `preampGroup` when the analysis is complete.

cornerRunTemp

```
cornerRunTemp(t_cornerName t_value)
     => t/nil
```

Description

Sets the analysis temperature (in degrees Celsius) to be used for a corner.

Arguments

t_cornerName	Name of the corner.
t_value	Temperature value in degrees Celsius.

Value Returned

`t`	Returned if successful.
`nil`	Returns `nil` and prints an error message.

Example

```
cornerRunTemp("slow" "50")
```

Sets the temperature to `50` for corner `slow`.

residual

```
residual(x_scalarExpression ?upper x_upperValue ?target x_targetValue
     ?lower x_lowerValue)
     => t/nil
```

Description

Creates a residual plot of the given scalar expression given the upper and lower performance bounds and target.

Arguments

x_scalarExpression	Scalar expression from a corners analysis.
x_upperValue	Upper performance bound.
x_targetValue	Target value.
x_lowerValue	Lower performance bound.

Value Returned

`t`	Returned if successful.
`nil`	Returns `nil` and prints an error message.

Example

```
residual( bandwidth(v("net1"), 3, "low") ?upper 5 ?target 2.5 ?lower 0)
```

Creates a residual plot of `v("net1")` with an upper boundary of `5`, a target of `2.5`, and a lower boundary of `0`.

selectProcess

```
selectProcess(t_processName)
    => t/nil
```

Description

Selects one of the processes already loaded with a `loadPcf` or `loadDcf` command.

Arguments

`t_processName`	Name of the process, as specified in the `.pcf` or `.dcf` file with the `corAddProcess` function.

Value Returned

`t`	Returned if successful.
`nil`	Returns `nil` and prints an error message.

Example

```
selectProcess("fab6")
```

Selects the process `fab6`.

Monte Carlo Analysis Commands

The commands for running Monte Carlo in the OCEAN environment are as follows.

correlationTable

```
correlationTable(?suppress x_suppress)
     => t/nil
```

Description

Prints the correlation between all pairs of declared `monteExpr` expressions.

Pairs of the same expression, which have a correlation value of 1.0, are excluded. This exclusion means that the `correlationTable` command prints only the off-diagonal terms in the correlation matrix.

Arguments

`x_suppress`

Suppresses the printing for correlations less than this value.
Default value: `.5`

Value Returned

`t`	Returned if successful.
`nil`	Returned otherwise.

Example

```
correlationTable()
```

dataFilter

```
dataFilter(t_monteExprName ( {?sigma x_sigma  | ?upper x_upper ?lower x_lower}
     ?filterBy s_filterBy ) )
     => t/nil
```

Description

Eliminates bad data points (*outliers)* from a Monte Carlo data set.

Arguments

`t_monteExprName`

The `monteExpr` name with the appended swept parameter.

`x_sigma`

Filters data lying outside an established sigma point from the mean. For instance, you might filter data lying outside 3 standard deviations (sigma) from the mean. You can specify *`x_sigma`* or you can specify *`x_upper`* and *`x_ lower`*, but you cannot specify both.
Default value: 3

`x_upper`

Filters data that is greater than an upper numerical limit.
Default value: `inf`

`x_lower`

Filters data that is less than a lower numerical limit.
Default value: `-inf`

`s_filterBy`

Type of filter to be used. This setting affects all of your data so you only need to specify the type of filter once.
Valid values: `'dataSet`, `'point`
Default value: `'dataSet`

`'dataSet` ignores all measurements for a point if the value of any of the measurements for that point is outside the filter limits.

`'point` filters an outlying point only from the specific measurement that recorded the outlying point.

Value Returned

`t` Returned if successful.

`nil` Returned otherwise.

Example

```
dataFilter('bandwidth ?upper 10Mhz
    ?lower 0.1Mhz ) ;For nominal 1Mhz
dataFilter('bandwidth ?sigma 3 )
```

The second example sets the upper limit to
mean(bandwidth) + 3*sigma(bandwidth)
and sets the lower limit to
mean(bandwidth) - 3*sigma(bandwidth)

histogram

```
histogram( t_monteExprName ?type s_type ?numBins x_numBins ?density b_density )
    => t/nil
```

Description

Plots a histogram of Monte Carlo data.

This command plots to an individual subwindow. The value of the `s_type` argument determines the style of the line. Setting `b_density` to `t` causes the `histogram` command to plot a smooth distribution curve for the data.

Arguments

t_monteExprName
The `monteExpr` name with the appended swept parameter.

s_type
Style of line to be used.
Valid values: `'standard`, `'passFail`, `'cumulativeLine`, `'cumulativeBox`
Default value: `'standard` (if you do not specify *s_type*)

`'standard` prints a bar graph of the output versus parameter.

`'passFail` requires that specification limits be specified. This option plots a bar graph where the runs that pass are shown in green and the runs that fail are shown in red.

`'cumulativeLine` uses a *joined* line style to plot the cumulative distribution function. The cumulative distribution function is the area under the standard histogram bars.

`'cumulativeBox` plots the same information as the `'cumulativeLine` option but uses a *bar* plotting style.

x_numBins
Number of bins to be used for the histogram.
Default value: `10`

b_density
If set to `t`, plots the probability density function for the data. Valid values: `t` or `nil`.

Value Returned

`t`	Returned if successful.
`nil`	Returned otherwise.

Example

```
monteExpr( "bw" 'bandwidth( v("vout"),3,"low") )
monteExpr( "DCgain" 'ymax( vdb("vout") ) )

histogram( "bw_27" )
histogram( "bw_27" ?numBins 12 ?density t )
```

iterVsValue

```
iterVsValue( t_monteExprName ?outputFormat s_outputFormat)
     => t/nil
```

Description

Prints the value of every scalar measurement for each Monte Carlo iteration.

Arguments

t_monteExprName

The `monteExpr` name with the appended swept parameter.

s_outputFormat

The output format for the printout.
Valid values: `'sorted`, `'unsorted`
Default value: `'sorted`

`'sorted` sorts the output from highest to lowest value.

`'unsorted` prints the values without sorting.

Value Returned

`t`	Returned if successful.
`nil`	Returned otherwise.

Example

```
iterVsValue( "bw_27" )
```

monteCarlo

```
monteCarlo(
     [?numIters x_numIters] [?startIter x_startIter]
     [?analysisVariation s_analysisVariation] [?sweptParam t_sweptParam]
     [?sweptParamVals l_sweptParamVals] [?saveData saveData] [?append b_append]
     )
     => t/nil
```

Description

Sets up a Monte Carlo analysis.

To run the analysis, use the `monteRun` command described in “monteRun” on page 405.

Arguments

x_numIters	Number of iterations (runs). Default value: `100`
x_*startIter*	Starting iteration. Default value: `1`

Note: *x_startIter* must not be `1` when

- You want to append to existing data. For example, you run 100 Monte Carlo analyses and then want to run 100 more in addition to the previous 100. In this case, *x_startIter* must be `101`. If *x_startIter* is `1`, the same results are recalculated as before.
- You want to rerun a particular run. In this case, *startIter* must be the number of that particular run.

s_analysisVariation	Analysis variations. Valid values: `'process`, `'mismatch`, `'processAndMismatch` Default value: `'process`
t_sweptParam	Design variable (or temperature) that can be swept with Monte Carlo. Default value: `none` (this is the inner loop)

t_sweptParamVals
List of values of *sweptParam*.

saveData Indicates when to save data to allow family plots.
Default value: `nil`

b_append Appends the new results to data from a previous Monte Carlo run.
Default value: `nil`

Value Returned

`t` Returned if successful.

`nil` Returned otherwise.

Example

```
monteCarlo()
```

Sets up a Monte Carlo analysis using some of the defaults.

```
monteCarlo(?numRuns 300 ?analysisType 'processAndMismatch ?sweptParam temp
?sweptParamVals list(-50, 0, 50) ?nomRun n)
```

monteCorrelate

```
monteCorrelate( {t_param1 … t_paramN | t_deviceName1 … t_deviceNameN}
     f_correlationValue)
     => t/nil
```

Description

Specifies a correlation coefficient for a list of process parameters or a list of devices specified in individual subcircuits.

Use this command to specify matched pairs of devices or to specify mismatch of devices in excess of that specified for the process. You must not mix devices and parameters on the same command line.

Arguments

f_correlationValue
Value of the correlation coefficient that describes the correlation among the listed parameters or devices.

t_param1 Name of the first process parameter to be correlated.

t_paramN Name of another process parameter to be correlated.

t_deviceName1 Name of the first device to be correlated.

t_deviceName2 Name of another device to be correlated.

Value Returned

`t` Returned if successful.

`nil` Returned otherwise.

Example

```
monteCorrelate("cje_27 bw_27" 0.8)
```

monteDisplay

```
monteDisplay()
     => undefined/nil
```

Description

Displays the currently defined Monte Carlo analysis, including all expressions that are defined.

Arguments

None.

Value Returned

undefined	The return value for this command/function is undefined.
`nil`	Returns `nil` and prints an error message if the analysis is not specified.

Example

```
monteDisplay()
```

monteExpr

```
monteExpr( t_monteExprName s_expression )
     => t/nil
```

Description

Sets up the Monte Carlo scalar expressions that are used to create the histogram file.

Arguments

t_monteExprName	Name of the expression.
s_expression	Expression.

Value Returned

`t`	Returned if successful.
`nil`	Returned otherwise.

Example

```
monteExpr( "bw" ’bandwidth( v(\"net7\") 3 \"low\") )
```

monteOutputs

```
monteOutputs()
     => t/nil
```

Description

Returns the names of the `monteExpr` expressions, concatenating the `monteExprName` set in the `monteExpr` command with the value of the swept variable.

If no variable is swept, the `monteOutputs` command concatenates the default temperature to the `monteExprName`. For example, the returned name might be `bw_27`.

Arguments

None.

Value Returned

`t`	Returned if successful.
`nil`	Returned otherwise.

Example

```
monteOutputs()
```

monteResults

```
monteResults(?dataFileName t_scalarDataFile ?paramFileName t_parameterFile)
     => t/nil
```

Description

Initializes the Monte Carlo data analysis tools.

The `monteResults` command reads in the specified data and parameter files, opens a new Waveform window, and adds a statistical analysis menu to the Waveform window. The menu items are equivalent to those found on the *Monte Carlo Results* menu in the Virtuoso® Analog Design Environment.

Arguments

t_scalarDataFile

Name of scalar data file to be read in.
Default value: `mcdata`

t_parameterFile

Name of parameter file associated with scalar data.
Default value: `mcparam`

Value Returned

`t`	Returned if successful.
`nil`	Returned otherwise.

Examples

```
monteResults()
monteResults( ?dataFileName "myData" ?paramFileName "myParams" )
```

monteRun

```
monteRun(
     [?jobName t_jobName] [?host t_hostName] [?tasks x_tasks]
     [?queue t_queueName] [?startTime t_startTime] [?termTime t_termTime]
     [?dependentOn t_dependentOn] [?mail t_mailingList] [?block s_block]
     [?notify s_notifyFlag] )
     => s_jobName/nil/t
```

Description

Runs a Monte Carlo analysis previously set up with the `monteCarlo` and `monteExpr` commands.

The `monteRun` command runs all the Monte Carlo processes defined in the `.pcf` and `.dcf` files. You can load your `.pcf` and `.dcf` files with the `loadPcf` and `loadDcf` commands. See the *Artist SKILL Language Reference Manual* for information on these commands.

Arguments

Note: Arguments to the `monteRun` command are valid only when running in distributed (processing) mode.

t_jobName	Used as the basis of the job name. The value entered for *t_jobName* is used as the job name and return value if the `run` command is successful. If the name given is not unique, a value is appended to create a unique job name.
t_hostName	Name of the host on which to run the analysis. If no host is specified, the system assigns the analysis to an available host.
x_tasks	Number of tasks in which to divide the Monte Carlo job. Default value: calculated from your setup
t_queueName	Name of the queue. If no queue is defined, the analysis is placed in the default queue (your home machine).
t_startTime	Desired start time for the job. If dependencies are specified, the job does not start until all dependencies are satisfied.
t_termTime	Termination time for job. If the job has not completed by *t_termTime*, the job is terminated.

t_dependentOn	List of jobs on which the specified analysis is dependent. The analysis is not started until after dependent jobs are complete.
t_mailingList	List of users to be notified when the analysis is complete.
s_block	When *s_block* is not `nil`, the OCEAN script halts until the job is complete. Default value: `nil`
s_notifyFlag	When *s_notifyFlag* is not `nil`, a job completion message is echoed to the OCEAN interactive window. Default value: `t`

Value Returned

`t`	Returned if successful.
`nil`	Returned otherwise.
s_jobName	For a distributed process, the job name that the system specified or assigned to the analysis.

Example

```
monteRun()
```

Runs all the Monte Carlo analyses defined in the `.pcf` and `.dcf` files.

monteSelectResults

```
monteSelectResults( ?mcdataFileName t_mcdataFileName
     ?paramFileName  t_paramFileName )
     => t/nil
```

Description

Selects the specified mcdata file, which is the file that contains the scalar data.

Before you use this command, you must have access to mcdata and param files, either produced by an earlier successful Monte Carlo simulation or pointed to by a previous `openResults()` command.

Arguments

t_mcdataFileName

The name of the mcdata file.
Default value: `mcdata`

t_paramFileName

The name of the param file.
Default value: `param`

Value Returned

`t`	Returned if successful.
`nil`	Returned otherwise.

Example

```
monteSelectResults()
monteSelectResults(?mcdataFileName mcdataRun2
    ?paramFileName paramRun2)
```

scatterplot

```
scatterplot(t_monteExprName_X t_monteExprName_Y ?bestFit b_bestFit )
     => t/nil
```

Description

Plots different statistical measurements against each other so you can determine whether there is a relationship between two parameters.

Tightly correlated parameters show linear relationships.

Arguments

t_monteExprName_X
: The `monteExpr` name with the appended swept parameter for the X-axis variable.

t_monteExprName_Y
: The `monteExpr` name with the appended swept parameter for the Y-axis variable.

b_bestFit
: If `t`, the `scatterplot` command computes and draws on the plot the best fitting straight line through the data. The best line is defined as the line that minimizes the sum of squares of the distances between the data points and the line.

Value Returned

`t`	Returned if successful.
`nil`	Returned otherwise.

Example

```
monteExpr( "bw" 'bandwidth( v("vout"), 3, "low") )
monteExpr( "DCgain" 'ymax( vdb("vout") ) )
scatterplot( "bw_27" "DCgain_27" ?bestFit t )
```

specLimits

```
specLimits(t_monteExprName ( {?sigma x_sigma  | ?upper x_upper ?lower x_lower}
     ) )
     => t/nil
```

Description

Sets specification limits for yield analysis and histograms.

You can set specification limits for each of your measured values and then analyze how many runs are outside those limits (pass/fail) or you can analyze the spec sensitivity of measured quantities to changing input parameters.

You can specify limits using *x_upper* and *x_lower* options, or you can use the *x_sigma* option to have limits calculated for you based on a specified number of standard deviations of the actual data.

Note: You can specify *x_sigma* or you can specify *x_upper* and *x_lower*, but you cannot specify both.

Arguments

t_monteExprName
The `monteExpr` name with the appended swept parameter.

x_sigma Identifies data lying outside an established sigma point from the mean. For instance, you might identify data lying outside 3 standard deviations (sigma) from the mean.

x_upper Identifies data that is greater than this value.

x_lower Identifies data that is less than this value.

Value Returned

`t` Returned if successful.

`nil` Returned otherwise.

Example

```
specLimits("bw_27" ?upper 15E+06 ?lower 5+06)
```

yield

```
yield( s_type ?exprList l_monteExprName  ?suppress x_suppress )
     => t/nil
```

Description

Prints simple, conditional, or multiconditional yield statistics for the Monte Carlo data set.

Arguments

s_type

The type of statistics to print.
Valid values: `'simple`, `'conditional`, or `'multiconditional`

`'simple` prints the yields for each measurement. Based upon the specification limits you set, the `'simple` option prints the percentage of *pass* runs compared to the total number of Monte Carlo runs. For example, you set your specification limits for bandwidth, run 100 runs, and find that 60 of the runs pass the specification limits. For this example, the `yield` command calculates and displays a yield of 60% for bandwidth. The command also displays the total yield number, which is used when you have multiple measurements, each with its own limits. Total yield is the total percentage of *pass* runs where every parameter is within its specification limits for a Monte Carlo run.

`'conditional` prints conditional yields. To use a conditional yield, you specify a single measurement against which all other measurements are compared. The `'conditional` option first sorts all of the Monte Carlo runs and picks out only the runs where the specified measurement passes. These passing runs are the starting point for the conditional yield calculation. So, in the bandwidth example above, instead of using 100 runs, the tool uses 60 runs as the base. Next, all of the other measurements are analyzed. For example, you have a second measurement called `maximum_25`. Out of the base 60 runs, `maximum_25` passes 30 times. It has a conditional yield of 50%. In addition to the conditional yield, the tool prints the total yield (based on all Monte Carlo runs) and the difference between the conditional and total yield numbers.

`'multiconditional` prints multiconditional yields. As in calculating the conditional yield, multiconditional yields are calculated from a base set of passing runs. However, instead of using one parameter to build the base set, for multiconditional yields you use two. Only runs where both measurements pass become part of the base set. All other measurements are then compared against that base.

l_monteExprName

The `monteExpr` name with the appended swept parameter.

x_suppress

If *s_type* is `'simple`, suppresses the printing for yields greater than this percentage of the value.
Default value: `98`

If *s_type* is `'conditional` or `'multiconditional`, suppresses the printing for delta yields less than this percentage of the value.
Default value: `98`

Value Returned

`t` Returned if successful.

`nil` Returned otherwise.

Example

```
yield('simple ?exprList  '("bw_27" "slew_27") ?suppress 70)
yield('conditional ?exprList '("max_27" "slew_27") )
yield('multiconditional ?exprList '("max_27" "slew_27") )
```

Optimization Commands

The commands for running optimization in the OCEAN environment are as follows.

optimizeAlgoControl

```
optimizeAlgoControl( ?relDelta x_relDelta ?relFunTol  x_relFunTol ?relVarTol
     x_relVarTol )
     => undefined/nil
```

Description

Changes the internal algorithm controls.

Arguments

x_relDelta	Finite difference relative perturbation. Default value: `.005`
x_relFunTol	Relative function convergence tolerance. Default value: `.0001`
x_relVarTol	Relative variable convergence tolerance. Default value: `.0001`

Value Returned

undefined	The return value for this function is not defined.
`nil`	Returns `nil` and an error message if there was a problem.

Example

```
optimizeAlgoControl(?relDelta .05)
```

optimizeGoal

```
optimizeGoal( t_name t_expr s_direction x_target x_acceptable [?percent
     b_percent] )
     => undefined/nil
```

Description

Sets up the goals for optimization.

Arguments

t_name	Name of the goal.
t_expr	Expression defining the goal.
s_direction	Valid values: `'max`, `'min`, `'match`, `'le` or `'ge` Default value: `'match`
x_target	The value to be matched or the lower or upper bound (depending on *s_direction*).
x_acceptable	Number or a waveform specifying the acceptable value. When a waveform is entered, each target point has its own acceptable value. Both *x_target* and *x_acceptable* must be expressions. The expression returns a number or a waveform.
b_percent	Specifies whether the *x_acceptable* field is a percentage of the target. When this is specified, *x_acceptable* is ignored.

Value Returned

undefined	The return value for this command is not defined.
`nil`	Returns `nil` and an error message if there was a problem.

Example

```
optimizeGoal( "bandwidth" 'bandwidth(v("/out") 3 "low") 'le 18M 15M )
```

optimizePlotOption

```
optimizePlotOption(
     ?auto b_auto ?varHist b_varHist ?scalHist b_scalHist
     ?funcObjHist b_funcObjHist ?numIter x_numIter ?fontSize x_fontSize
     ?width x_width ?height x_height ?xloc xloc ?yloc yloc )
     => undefined/nil
```

Description

Sets the plot options used to view the optimization iterations.

Arguments

b_auto	If set to `t`,auto plots after each iteration. Default value: `t`
b_varHist	If set to `t`, displays the history of the variables. Default value: `t`
b_scalHist	If set to `t`, displays the history of the scalars. Default value: `t`
b_funcObjHist	If set to `t`, displays the history of the functional objectives. Default value: `t`
x_numIter	Number of waveforms to display. There is one waveform stored available per functional iteration. Default value: 5
x_fontSize	Font size used in the Waveform window. Default value: 9
x_width	Width of the Waveform window. Default value: `630`
x_height	Height of the Waveform window. Default value: `376`
xloc	Specifies the top boundary of the optimize window when it is opened in the windowing environment. Default value: `511`

yloc	Specifies the left boundary of the optimize window when it is opened in the windowing environment. Default value: `377`

Value Returned

undefined	The return value is for this value is not defined.
`nil`	Returns `nil` and an error message if there was a problem setting plot options.

Example

```
optimizePlotOption(?delta .05)
```

optimizeRun

```
optimizeRun(?goals l_goalNames ?vars l_varNames ?numIter  x_numIter
     ?algo s_algoName ?continue b_continue)
     => t/nil
```

Description

Runs the optimizer using the goals specified with the `optimizeGoal` command.

Arguments

l_goalNames	Names of the goals to be used with this run of the optimizer. If none are specified, all declared goals are used.
l_varNames	Names of the variables to be used with this run of the optimizer. If none are specified, all declared variables are used.
x_numIter	Number of iterations that you want the optimizer to perform.
s_algoName	Algorithm that you want to use. Valid values: `'lsq`, `'cfsqp`, `'auto`
b_continue	`t` indicates that this `optimizeRun` needs to continue from the previous `optimizeRun` (using the last design variables calculated from the last `optimizeRun`).

Value Returned

`t`	If the command was successful.
`nil`	Returns `nil` and an error message if there was a problem.

Example

```
optimizeRun()
     optimizeRun(?goals '("bandwidth" "slewrate" )
         ?vars '("rs" vs") ?numIter 5)
     optimizeRun( ?numIter 5 ?continue t )
```

Continues the previous `optimizeRun` for another 5 iterations.

optimizeVar

```
optimizeVar( t_name x_initVal x_minVal x_maxVal )
     => undefined/nil
```

Description

Specifies the design variables to be used with optimization.

Arguments

t_name	Name of the design variable.
x_initVal	Initial value of the variable.
x_minVal	Lower bound of the variable.
x_maxVal	Upper bound of the variable.

Value Returned

undefined	The return value for this function is not defined.
`nil`	Returns `nil` and an error message if there was a problem.

Example

```
optimizeVar( "res" 100 ?minVal 1 ?maxVal 1000 )
```

12

OCEAN Distributed Processing Commands

The Open Command Environment for Analysis (OCEAN) distributed processing commands let you run OCEAN jobs across a collection of computer systems.

This chapter contains information on the following commands:

This chapter also provides sample OCEAN scripts that optimally use these commands. See the section Sample Scripts on page 433.

For detailed information on distributed processing, refer to Virtuoso® Analog Distributed Processing Option User Guide.

deleteJob

```
deleteJob( t_jobName [t_jobName2 t_jobName3 … t_jobNameN] )
     => t/nil
```

Description

Removes a job or series of jobs from the text-based job monitor.

Deleted jobs are no longer listed in the job monitor. The `deleteJob` command applies only to ended jobs.

Arguments

t_jobName	Name used to identify the job.
t_jobname2…t_jobnameN	Additional jobs that you want to delete.

Value Returned

`t`	Returns `t` if successful.
`nil`	Returns `nil` and prints an error message if unsuccessful.

Example

```
deleteJob( 'myckt)
=> t
```

Deletes the `myckt` job.

digitalHostMode

```
digitalHostMode( {'local | 'remote} )
     => t/nil
```

Description

For mixed-signal simulation, specifies whether the digital simulator will run locally or on a remote host.

Arguments

`'local`	Sets the simulation to run locally on the user's machine.
`'remote`	Sets the simulation to run on a remote host. If you use this argument, you must specify the host name by using the `digitalHostName` command.

Value Returned

`t`	Returns `t` if successful.
`nil`	Returns `nil` and prints an error message if unsuccessful.

Example

```
digitalHostMode( 'local )
```

Sets the digital simulator to run locally on the user's host.

digitalHostName

```
digitalHostName( t_name )
     => t/nil
```

Description

For mixed-signal simulation, specifies the name of the remote host for the digital simulator.

When you use the `digitalHostMode('remote)` command, use this command to specify the name of the remote host.

Arguments

`t_name`	Name used to identify the host for the digital simulator.

Value Returned

`t`	Returns `t` if successful.
`nil`	Returns `nil` and prints an error message if unsuccessful.

Example

```
digitalHostName( "digitalhost" )
```

Indicates that the digital simulator runs on the host called `digitalhost`.

hostMode

```
hostMode( { 'local | 'remote | 'distributed } )
     => t/nil
```

Description

Sets the simulation host mode.

The default value for `hostMode` is specified in the `asimenv.startup` file with the `hostMode` environment variable.

Arguments

`'local`	Sets the simulation to run locally on the user's machine.
`'remote`	Sets the simulation to run on a remote host queue. For this release, the remote host is specified in the `.cdsenv` file.
`'distributed`	Sets the simulation to run using the distributed processing software.

Value Returned

`t`	Returns `t` if successful.
`nil`	Returns `nil` and prints an error message if unsuccessful.

Example

```
hostMode( 'distributed )
=> t
```

Enables distributed processing on the current host.

hostName

```
hostName( t_name )
     => t/nil
```

Description

Specifies the name of the remote host.

When you use the `hostMode('remote)` command, use this command to specify the name of the remote host.

Arguments

t_name	Name used to identify the remote host.

Value Returned

`t`	Returns `t` if successful.
`nil`	Returns `nil` and prints an error message if unsuccessful.

Example

```
hostName( "remotehost" )
```

Specifies that the host called `remotehost` is to be used for remote simulation.

killJob

```
killJob( t_jobName [t_jobName2 t_jobName3 … t_jobNameN] )
     => t/nil
```

Description

Stops processing of a job or a series of jobs.

The job might still show up in the job monitor, but it cannot be restarted. Use the `deleteJob` command to remove the job name from the job server and job monitor.

Arguments

t_jobName Name used to identify the job.

t_jobname2…t_jobnameN
Additional jobs that you want to stop.

Value Returned

`t` Returns `t` if successful.

`nil` Returns `nil` and prints an error message if unsuccessful.

Example

```
killJob( 'myckt )
=> t
```

Aborts the job called `myckt`. If the job is in the queue and has not started running yet, it is deleted from the queue.

monitor

```
monitor( [?taskMode s_taskMode] )
     => t/nil
```

Description

Monitors the jobs submitted to the distributed system.

Arguments

s_taskMode	When not `nil`, multitask jobs are expanded to show individual jobs. A multitask job is one that contains several related jobs.

Value Returned

`t`	Returns `t` if successful.
`nil`	Returns `nil` and prints an error message if unsuccessful.

Example

```
monitor( ?taskMode t )
```

Displays the name, host, and queue for all pending tasks sorted on a queue name.

remoteDir

```
remoteDir( t_path )
     => t/nil
```

Description

Specifies the project directory on the remote host to be used for remote simulation.

When you use the `hostMode('remote)` command, use this command to specify the project directory on the remote host.

Arguments

t_path	Specifies the path to the project directory on the remote host to be used for remote simulation.

Value Returned

`t`	Returns `t` if successful.
`nil`	Returns `nil` and prints an error message if unsuccessful.

Example

```
remoteDir( "~/simulation" )
```

Specifies that the project directory is `~/simulation`.

resumeJob

```
resumeJob( t_jobName [t_jobName2 t_jobName3 … t_jobNameN] )
     => t/nil
```

Description

Resumes the processing of a previously suspended job or series of jobs. The `resumeJob` command applies only to jobs that are suspended.

Arguments

t_jobName	Name used to identify the job.
t_jobName2…t_jobNameN	Additional jobs that you want to resume

Value Returned

`t`	Returns `t` if successful.
`nil`	Returns `nil` and prints an error message if unsuccessful.

Example

```
resumeJob( ’myckt )
=> t
```

Resumes the `myckt` job that was halted with the `suspendJob` command.

suspendJob

```
suspendJob( t_jobName [t_jobName2 t_jobName3 … t_jobNameN] )
     => t/nil
```

Description

Suspends the processing of a job or series of jobs. The `suspendJob` command applies only to jobs that are pending or running.

Arguments

t_jobName Name used to identify the job.

t_jobName2…t_jobnameN
Additional jobs that you want to suspend.

Value Returned

`t` Returns `t` if successful.

`nil` Returns `nil` and prints an error message if unsuccessful.

Example

```
suspendJob( 'myckt )
=> t
```

Suspends the job called `myckt`.

wait

```
wait( jobName [jobName2 jobName3 … jobNameN] )
     => t/nil
```

Description

Postpones processing of a script until the specified jobs complete. This command is ignored if distributed processing is not available.

The `wait` command is very useful when you use the non-blocking mode of distributed processing and you want to do some post-processing, such as selecting and viewing results after a job is completed. The `wait` command is not required when you use the blocking mode of distributed processing. To know more about blocking and non-blocking modes of DP, refer to Virtuoso® Analog Distributed Processing Option User Guide.

Arguments

t_jobName	Name used to identify the job. The job name is user defined or system generated, depending on how the user submitted the job.
t_jobName2…t_jobnameN	Additional jobs that you want to postpone.

Value Returned

`t`	Returns `t` if successful.
`nil`	Returns `nil` and prints an error message if unsuccessful.

Example

```
wait( 'myckt1 )
=> t
```

Postpones execution of all subsequent OCEAN commands until the job `myckt1` completes.

Sample Scripts

This section provides sample scripts for the following:

- To submit multiple jobs and show the use of the dependentOn argument in one job
- To set up and run a simple analysis in blocking mode and select results
- To set up and run a parametric analysis in blocking mode and select results
- To set up and run a Corners analysis in blocking mode and select results
- To set up and run a montecarlo analysis in blocking mode and select results
- To submit multiple jobs without using wait or selecting results
- To submit multiple jobs using wait and selection of results

To submit multiple jobs and show the use of the dependentOn argument in one job

This script can be used to submit multiple jobs while using the `dependentOn` argument in one of these jobs.

```
; set up the environment for the jobs
simulator( ’spectre )
hostMode( ’distributed )
design(  "/home/simulation/test2/spectre/schematic/netlist/netlist")
resultsDir( "/home/simulation/test2/spectre/schematic" )
analysis(’tran ?stop "5u"  )
temp( 27 )

jobList = nil

; starting first job
jobList = append1( jobList run( ?queue "test" ?host "menaka" ) )

analysis(’tran ?stop "50u")

; starting second job
jobList = append1( jobList run(?jobName "job_2" ?queue "test" ?host "menaka"))

analysis(’tran ?stop "10u")

; starting third job, which is dependent on job_2
```

```
jobList= append1(jobList run(?jobName "disable" ?queue "test" ?dependentOn
                symbolToString(car(last(jobList)))))

; wait for all the jobs to complete
wait((append1 last(jobList) nil))

; open and plot the results of the jobs
openResults( car(last(jobList)))
selectResult( 'tran )
newWindow()
plot(getData("/net61") )

openResults( nth(1 jobList))
selectResult('tran)
newWindow()
plot(getData("/net61") )
```

To set up and run a simple analysis in blocking mode and select results

```
; set up the environment for Simple Analysis
simulator( 'spectre )
hostMode( 'distributed )
design(
"/home/amit/Artist446/simulation/ampTest/spectre/schematic/netlist/netlist" )
resultsDir( "/home/Artist446/simulation/ampTest/spectre/schematic" )
modelFile(
    '("/home/Artist446/Models/myModels.scs" "")
)
analysis( 'tran ?stop "3u" )
desVar( "CAP" 0.8p )
temp( 27 )

; submit the job in blocking mode, to the queue test and machine menaka
run(?queue "test" ?host "menaka" ?block t)

; select and plot the results
selectResult( 'tran )
plot(getData("/out"))
```

To set up and run a parametric analysis in blocking mode and select results

```
; set up the environment for parametric analysis.
simulator( 'spectre )
hostMode( 'distributed )
design(
"/home/amit/Artist446/simulation/ampTest/spectre/schematic/netlist/netlist")
resultsDir( "/home/amit/Artist446/simulation/ampTest/spectre/schematic"
)
modelFile(
    '("/home/amit/Artist446/Models/myModels.scs" "")
)
analysis('tran ?stop "3u"  )
desVar(   "CAP" 0.8p    )
temp( 27 )
paramAnalysis("CAP" ?values '(1e-13 2.5e-13 4e-13 ))

; submit the job in blocking mode, to the queue test and machine menaka
paramRun(?queue "fast" ?host "menaka" ?block t)

; select and plot the results
selectResult( 'tran )
plot(getData("/out") )
```

To set up and run a Corners analysis in blocking mode and select results

```
; set up the environment for corners analysis
simulator('spectre)
design("./netlist/netlist")
hostMode( 'distributed )
analysis('tran ?stop 50n)
keep('allv)
definitionFile("model")
loadPcf("./singleNumeric.pcf")
loadDcf("./singleNumeric.dcf")

; submit the job in blocking mode, to the queue test and machine menaka
cornerRun( ?block t ?queue "fast" ?host "menaka" )

; select and print/plot the results
selectResults('tran)
plot v("2")
```

```
ocnPrint v("2")
```

To set up and run a montecarlo analysis in blocking mode and select results

```
; set up the environment for montecarlo analysis
simulator( ’spectre )
hostMode( "distributed" )
design("./spectre/netlist/netlist")
resultsDir( "./spectre" )
path("./spectre/netlist" )
modelFile( ’("spectreLib.scs" "statistics"))
definitionFile( "update" "init" "lowpassStats")
analysis(’ac ?start "1"  ?stop "100M"  )
desVar(   "rout2" 3K    )
desVar(   "rout1" 1K    )
desVar(   "rin2" 5K     )
desVar(   "rin1" 1K     )
desVar(   "cloop" .001u )
desVar(   "cin" .017u   )
temp( 27 )
monteCarlo( ?numIters "100" ?startIter "1"
    ?analysisVariation "Process Only" ?sweptParam "None"
    ?sweptParamVals "27" ?saveData t
    ?nomRun nil ?append nil)
monteExpr( "bw" "bandwidth(VF('OUT') 3 'low')" )
monteExpr( "phase" "value(phase(VF('OUT')) 100000)" )
monteExpr( "db20" "value(dB20(VF('OUT')) 100000)" )

; submit the job in blocking mode, to the queue test and machine menaka
monteRun( ?block t ?queue "fast" ?host "menaka" )

; Initializes the Monte Carlo data analysis tools
monteResults()
```

To submit multiple jobs without using wait or selecting results

```
; set up the environment for the jobs
simulator( ’spectre )
hostMode( ’distributed )
design(
"/home/Artist446/simulation/ampTest/spectre/schematic/netlist/netlist")
```

```
resultsDir( "/home/Artist446/simulation/ampTest/spectre/schematic" )
modelFile(
    '("/home/Artist446/Models/myModels.scs" "")
)

; setup and submit first job
analysis('tran ?stop "3u"  )
desVar(   "CAP" 0.8p    )
temp( 27 )
run(?queue "SUN5_5032" ?host "menaka")

; setup and submit second job
analysis('ac ?start "1M"  ?stop "2M"  )
analysis('tran ?stop "3u"  )
desVar(   "CAP" 0.8p    )
temp( 27 )
run(?queue "SUN5_5032" ?host "menaka")
```

To submit multiple jobs using wait and selection of results

```
; set up the environment for the jobs
simulator( 'spectre )
hostMode( 'distributed )
design(
"/home/Artist446/simulation/ampTest/spectre/schematic/netlist/netlist")
resultsDir( "/home/Artist446/simulation/ampTest/spectre/schematic" )
modelFile(
    '("/home/Artist446/Models/myModels.scs" "")
)

; initialize jobList to nil
jobList = nil

; setup and submit first job
analysis('tran ?stop "3u"  )
desVar(   "CAP" 0.8p    )
temp( 27 )
jobList = append1( jobList run(?queue "SUN5_5032" ?host "menaka") )

; setup and submit second job
analysis('ac ?start "1M"  ?stop "2M"  )
```

```
analysis('tran ?stop "3u"  )
desVar(   "CAP" 0.8p    )
temp( 27 )
jobList = append1( jobList run(?queue "SUN5_5032" ?host "menaka"))

; wait for both the jobs to finish
wait( (append1 jobList nil) )

; open and plot the result of first job
openResults( (car jobList))
selectResult( 'tran )
plot(getData("/out") )

; open and plot the result of second job
openResults( (cadr jobList))
selectResult( 'tran )
plot(getData("/out") )
selectResult( 'ac )
plot(getData("/out") )

; delete the jobs
foreach( x jobList deleteJob( x ) )
```

13

Language Constructs

There are three types of SKILL language constructs:

- Conditional statements

  Conditional statements test for a condition and perform operations when that condition is found. These statements are `if`, `unless`, and `when`.

- Selection statements

  A selection statement allows a list of elements, each with a corresponding operation. A variable can then be compared to the list of elements. If the variable matches one of the elements, the corresponding operation is performed. These statements include `for`, `foreach`, and `while`.

- Iterative statements

  Iterative statements repeat an operation as long as a certain condition is met. These statements include `case` and `cond`.

  This chapter contains information on the following statements

if

```
if( g_condition g_thenExpression [g_elseExpression] )
    => g_result
```

Description

Evaluates *g_condition*, typically a relational expression, and runs *g_thenExpression* if the condition is true (that is, its value is non-nil); otherwise, runs *g_elseExpression*.

The value returned by `if` is the value of the corresponding expression evaluated.

Arguments

g_condition — Any Virtuoso® SKILL language expression.

g_thenExpression — Any SKILL expression.

g_elseExpression — Any SKILL expression.

Value Returned

g_result — Returns the value of *g_thenExpression* if *g_condition* has a non-nil value. The value of *g_elseExpression* is returned otherwise.

Examples

```
x = 2
if( x > 5 1 0 )
=> 0
```

Returns `0` because `x` is less than `5`.

```
a ="npn"
if(( a == "npn" ) print( a ) ) "npn"
=> nil
```

Prints the string `npn` and returns the result of `print`.

```
x = 5
if( x "non-nil" "nil" )
=> "non-nil"
```

Returns "non-nil" because x was not nil. If x was nil, "nil" would be returned.

```
x = 7
if( x > 5 1 0 )
=> 1
```

Returns 1 because x is greater than 5.

unless

```
unless( g_condition g_expr1 … )
     => g_result/nil
```

Description

Evaluates a condition. If the result is true (non-nil), it returns `nil`; otherwise it evaluates the body expressions in sequence and returns the value of the last expression.

The semantics of this function can be read literally as “unless the condition is true, evaluate the body expressions in sequence.”

Arguments

g_condition	Any SKILL expression.
g_expr1…	Any SKILL expression.

Value Returned

g_result	Returns the value of the last expression of the sequence *g_expr1* … if *g_condition* evaluates to `nil`.
`nil`	Returns `nil` if *g_condition* evaluates to non-nil.

Examples

```
x = -123
unless( x >= 0 println( "x is negative" ) -x )
=> 123
```

Prints `"x is negative"` as a side effect.

```
unless( x < 0 println( "x is positive ") x)
=> nil
```

Returns `nil`.

when

```
when( g_condition g_expr1 … )
     => g_result/nil
```

Description

Evaluates a condition.

If the result is non-nil, evaluates the sequence of expressions and returns the value of the last expression. Otherwise, returns `nil`.

Arguments

g_condition	Any SKILL expression.
g_expr1…	Any SKILL expression.

Value Returned

g_result	Returns the value of the last expression of the sequence *g_expr1* … if *g_condition* evaluates to non-nil.
`nil`	returns `nil` if the *g_condition* expression evaluates to `nil`.

Examples

```
x = -123
when( x < 0 println( "x is negative" ) -x )
=> 123
```

Prints `"x is negative"` as a side effect.

```
when( x >= 0 println( "x is positive" ) x)
=> nil
```

Returns `nil`.

for

```
for( s_loopVar x_initialValue x_finalValue g_expr1 [g_expr2 …] )
     => t
```

Description

Evaluates the sequence *g_expr1 g_expr2* … for each loop variable value, beginning with *x_initialValue* and ending with *x_finalValue*.

First evaluates the initial and final values, which set the initial value and final limit for the local loop variable named *s_loopVar*. Both *x_initialValue* and *x_finalValue* must be integer expressions. During each iteration, the sequence of expressions *g_expr1 g_expr2* … is evaluated and the loop variable is then incremented by one. If the loop variable is still less than or equal to the final limit, another iteration is performed. The loop ends when the loop variable reaches a value greater than the limit. The loop variable must not be changed inside the loop. It is local to the `for` loop and would not retain any meaningful value upon exit from the `for` loop.

Note: Everything that can be done with a `for` loop can also be done with a `while` loop.

Arguments

s_loopVar	Name of the local loop variable that must not be changed inside the loop.
x_initialValue	Integer expression setting the initial value for the local loop variable.
x_finalValue	Integer expression giving final limit value for the loop.
g_expr1	Expression to evaluate inside loop.
g_expr2 …	Additional expressions to evaluate inside loop.

Value Returned

`t`	This construct always returns `t`.

Examples

```
sum = 0

for( i 1 10
    sum = sum + i
    printf( "%d" sum ))
=> t
```

Prints 10 numbers and returns `t`.

```
sum = 0

for( i 1 5
    sum = sum + i
    println( sum )
    )
=> t
```

Prints the value of `sum` with a carriage return for each pass through the loop:

```
1
3
6
10
15
```

foreach

```
foreach( s_formalVar g_exprList g_expr1 [g_expr2 …] )
     => l_valueList

foreach( (s_formalVar1…s_formalVarN) g_exprList1… g_exprListN g_expr1
     [g_expr2 …] )
     => l_valueList

foreach( s_formalVar g_exprTable g_expr1 [g_expr2 …])
     => o_valueTable
```

Description

Evaluates one or more expressions for each element of a list of values.

The first syntax form,

`foreach(` *s_formalVar g_exprList g_expr1* `[`*g_expr2* …`] )`
`=>` *l_valueList*

evaluates *g_exprList*, which returns a list *l_valueList*. It then assigns the first element from *l_valueList* to the formal variable *s_formalVar* and processes the expressions *g_expr1 g_expr2* … in sequence. The function then assigns the second element from *l_valueList* and repeats the process until *l_valueList* is exhausted.

The second syntax form,

`foreach( (`*s_formalVar1…s_formalVarN*`)` *g_exprList1… g_exprListN g_expr1*
`[`*g_expr2* …`] )=>` *l_valueList*

can iterate over multiple lists to perform vector operations. Instead of a single formal variable, the first argument is a list of formal variables followed by a corresponding number of expressions for value lists and the expressions to be evaluated.

The third syntax form,

`foreach(` *s_formalVar g_exprTable g_expr1* `[`*g_expr2* …`])`
`=>` *o_valueTable*

can be used to process the elements of an association table. In this case, *s_formalVar* is assigned each key of the association table one by one, and the body expressions are evaluated each iteration. The syntax for association table processing is provided in this syntax statement.

Arguments

s_formalVar	Name of the variable.
g_exprList	Expression whose value is a list of elements to assign to the formal variable *s_formalVar*.
g_expr1 g_expr2 ...	Expressions to execute.
g_exprTable	Association table whose elements are to be processed.

Value Returned

l_valueList	Returns the value of the second argument, *g_exprList*.
o_valueTable	Returns the value of *g_exprTable*.

Examples

```
foreach( x '( 1 2 3 4 ) println( x ) )
1
2
3
4
=> ( 1 2 3 4 )
```

Prints the numbers 1 through 4 and returns the second argument to `foreach`.

```
foreach( key myTable printf( "%L : %L" key myTable[key] ) )
```

Accesses an association table and prints each key and its associated data.

```
( foreach ( x y ) '( 1 2 3 ) '( 4 5 6 ) ( println x+y ) )
5
7
9
=> ( 1 2 3 )
```

Uses `foreach` with more than one loop variable.

Errors and Warnings

The error messages from `foreach` might at times appear cryptic because some `foreach` forms get expanded to call the mapping functions `mapc`, `mapcar`, `mapcan`, and so forth.

while

```
while( g_condition g_expr1 … )
=> t
```

Description

Repeatedly evaluates *`g_condition`* and the sequence of expressions *`g_expr1`* … if the condition is true.

This process is repeated until *`g_condition`* evaluates to false (`nil`). Note that because this form always returns `t`, it is principally used for its side effects.

Note: Everything that can be done with a `for` loop can also be done with a `while` loop.

Arguments

`g_condition`	Any SKILL expression.
`g_expr1`	Any SKILL expression.

Value Returned

`t`	Always returns `t`.

Example

```
i = 0
```

```
while( (i <= 10) printf("%d" i++) )
=> t
```

Prints the digits 0 through 10.

case

```
case( g_selectionExpr l_clause1 [l_clause2 …] )
     => g_result/nil
```

Description

Evaluates the selection expression, matches the resulting selector values sequentially against comparators defined in clauses, and runs the expressions in the matching clause.

Each `l_clause` is a list of the form (`g_comparator` `g_expr1` [`g_expr2`…]), where a comparator is either an atom (that is, a scalar) of any data type or a list of atoms. Comparators are always treated as constants and are never evaluated. The `g_selectionExpr` expression is evaluated and the resulting selector value is matched sequentially against comparators defined in `l_clause1` `l_clause2`…. A match occurs when either the selector is equal to the comparator or the selector is equal to one of the elements in the list given as the comparator. If a match is found, the expressions in that clause and that clause only (that is, the first match) are run. The value of `case` is then the value of the last expression evaluated (that is, the last expression in the clause selected). If there is no match, `case` returns `nil`.

The symbol `t` has special meaning as a comparator: it matches anything. It is typically used in the last clause to serve as a default case when no match is found with other clauses.

Arguments

g_selectionExpr
An expression whose value is evaluated and tested for equality against the comparators in each clause. When a match is found, the rest of the clause is evaluated.

l_clause1 An expression whose first element is an atom or list of atoms to be compared against the value of *g_selectionExpr*. The remainder of the *l_clause* is evaluated if a match is found.

l_clause2… Zero or more clauses of the same form as *l_clause1*.

Value Returned

g_result Returns the value of the last expression evaluated in the matched clause.

`nil` Returns `nil` if there is no match.

Example

```
cornersType = "min"

type = case( cornersType
            ("min" path("./min"))
            ("typ" path("./typ"))
            ("max" path("./max"))
            (t println("you have not chosen an appropriate
                corner")))
            => path is set to "./min"
```

Sets `path` to `./min`.

cond

```
cond( l_clause1 … )
     => g_result/nil
```

Description

Examines conditional clauses from left to right until either a clause is satisfied or there are no more clauses remaining.

This command is useful when there is more than one test condition, but only the statements of one test are to be carried out. Each clause is of the form `( g_condition g_expr1… )`. The `cond` function examines a clause by evaluating the condition associated with the clause. The clause is satisfied if *g_condition* evaluates to non-nil, in which case expressions in the rest of the clause are evaluated from left to right, and the value returned by the last expression in the clause is returned as the value of the `cond` form. If *g_condition* evaluates to `nil`, however, `cond` skips the rest of the clause and moves on to the next clause.

Arguments

l_clause1	Each clause must be of the form `(g_condition g_expr1…)`. When *g_condition* evaluates to non-nil, all the succeeding expressions are evaluated.

Value Returned

g_result	Returns the value of the last expression of the satisfied clause.
`nil`	Returns `nil` if no clause is satisfied.

Example

```
procedure( test(x)
    cond(((null x) (println "Arg is null"))
        ((numberp x) (println "Arg is a number"))
        ((stringp x) (println "Arg is a string"))
        (t (println "Arg is an unknown type")))
)
test( nil )
=> nil; Prints "Arg is null".
test( 5 )
=> nil; Prints "Arg is a number".
test( ’sym )
=> nil; Prints "Arg is an unknown type".
```

Tests each of the arguments according to the conditions specified with `cond`.

14

File Commands and Functions

This chapter contains information on the following commands:

close

```
close( p_port )
     => t
```

Description

Drains, closes, and frees a port.

When a file is closed, it frees the `FILE*` associated with *`p_port`*. Do not use this function on `piport`, `stdin`, `poport`, `stdout`, or `stderr`.

Arguments

`p_port`	Name of port to close.

Value Returned

`t`	The port closed successfully.

Example

```
p = outfile( "~/test/myFile" ) => port:"~/test/myFile"
close( p )
=> t
```

Drains, closes, and frees the `/test/myFile` port.

fscanf

```
fscanf( p_inputPort t_formatString [s_var1 ...]  )
     => x_items/nil
```

Description

Reads input from a port according to format specifications and returns the number of items read in.

The results are stored into corresponding variables in the call. The `fscanf` function can be considered the inverse function of the `fprintf` output function. The `fscanf` function returns the number of input items it successfully matched with its format string. It returns `nil` if it encounters an end of file.

The maximum size of any input string being read as a string variable for `fscanf` is currently limited to 8 K. Also, the function `lineread` is a faster alternative to `fscanf` for reading Virtuoso® SKILL objects.

The common input formats accepted by `fscanf` are summarized below.

Common Input Format Specifications

Format Specification	Types of Argument	Scans for
%d	fixnum	An integer
%f	flonum	A floating-point number
%s	string	A string (delimited by spaces) in the input

Arguments

`p_inputPort` Input port to read from.

`t_formatString` Format string to match against in the reading.

`s_var1`… Name of the variable in which to store results.

Value Returned

x_items	Returns the number of input items it successfully read in. As a side effect, the items read in are assigned to the corresponding variables specified in the call.
`nil`	Returns `nil` if an end of file is encountered

Example

```
fscanf( p "%d %f" i d )
```

Scans for an integer and a floating-point number from the input port `p` and stores the values read in the variables `i` and `d`, respectively.

Assume a file `testcase` with one line:

```
hello 2 3 world
```

```
x = infile("testcase")
=> port:"testcase"
```

```
fscanf( x "%s %d %d %s" a b c d )
=> 4
```

```
(list a b c d) => ("hello" 2 3 "world")
```

gets

`gets( s_variableName [p_inputPort] ) => t_string/nil`

Description

Reads a line from the input port and stores the line as a string in the variable. This is a macro.

The string is also returned as the value of `gets`. The terminating newline character of the line becomes the last character in the string.

Arguments

s_variableName
Variable in which to store the input string.

p_inputPort Name of input port.
Default value: `piport`

Value Returned

t_string Returns the input string when successful.

`nil` Returns `nil` when the end of file is reached.
(*s_variableName* maintains its last value.)

Example

Assume the `test1.data` file has the following first two lines:

```
#This is the data for test1
0001 1100 1011 0111
p = infile("test1.data") => port:"test1.data"
gets(s p) => "#This is the data for test1"
gets(s p) => "0001 1100 1011 0111"
s => "0001 1100 1011 0111"
```

Gets a line from the `test1.data` file and stores it in the variable `s`. The `s` variable contains the last string stored in it by the `gets` function.

infile

```
infile( S_fileName )
     => p_inport/nil
```

Description

Opens an input port ready to read a file.

Always remember to close the port when you are done. The file name can be specified with either an absolute path or a relative path. In the latter case, the current SKILL path is used if it is not `nil`.

Arguments

S_fileName	Name of the file to be read; it can be either a string or a symbol.

Value Returned

p_inport	Returns the port opened for reading the named file.
`nil`	Returns `nil` if the file does not exist or cannot be opened for reading.

Examples

```
in = infile( "~/test/input.il" ) => port:"~/test/input.il"
close( in )
=> t
```

Closes the `/test/input.il` port.

Opens the input port `/test/input.il`.

```
infile("myFile") => nil
```

Returns `nil` if `myFile` does not exist according to the current setting of the SKILL path or exists but is not readable.

load

```
load( t_fileName [t_password])
     => t
```

Description

Opens a file and repeatedly calls `lineread` to read in the file, immediately evaluating each form after it is read in.

This function uses the file extension to determine the language mode (`.il` for SKILL, `.ils` for SKILL++, and `.ocn` for a file containing OCEAN commands) for processing the language expressions contained in the file. For a SKILL++ file, the loaded code is always evaluated in the top-level environment.

`load` closes the file when the end of file is reached. Unless errors are discovered, the file is read in quietly. If `load` is interrupted by pressing `Control-c`, the function skips the rest of the file being loaded.

SKILL has an autoload feature that allows applications to load functions into SKILL on demand. If a function being run is undefined, SKILL checks to see if the name of the function (a symbol) has a property called `autoload` attached to it. If the property exists, its value, which must be either a string or an expression that evaluates to a string, is used as the name of a file to be loaded. The file should contain a definition for the function that triggered the autoload. Processing proceeds normally after the function is defined.

Arguments

t_fileName — File to be loaded. Uses the file name extension to determine the language mode to use.
Valid values:

`.ils`	Means the file contains SKILL++ code.
`.il`	Means the file contains SKILL code.
`.ocn`	Means the file contains OCEAN commands (with SKILL or SKILL++ commands)

t_password — Password, if *t_fileName* is an encrypted file.

Value Returned

`t` — Returns `t` if the file is successfully loaded.

Example

```
load( "test.ocn" )
```

Loads the `test.ocn` file.

```
procedure( trLoadSystem()
    load( "test.il" ) ;;; SKILL code
    load( "test.ils" );;; SKILL++ code
    ) ; procedure
```

You might have an application partitioned into two files. Assume that `test.il` contains SKILL code and `test.ils` contains SKILL/SKILL++ code. This example loads both files.

newline

```
newline( [p_outputPort] )
     => nil
```

Description

Prints a newline (backslash n) character and then flushes the output port.

Arguments

p_outputPort	Output port. Defaults value: `poport`

Value Returned

`nil`	Prints a newline and then returns `nil`.

Example

```
print( "Hello" ) newline() print( "World!" )
"Hello"
"World!"
=> nil
```

Prints a newline character after `Hello`.

outfile

```
outfile( S_fileName [t_mode] )
     => p_outport/nil
```

Description

Opens an output port ready to write to a file.

Various print commands can write to this file. Commands write first to a character buffer, which writes to the file when the character buffer is full. If the character buffer is not full, the contents are not written to the file until the output port is closed or the `drain` command is entered. Use the close or `drain` command to write the contents of the character buffer to the file. The file can be specified with either an absolute path or a relative path. If a relative path is given and the current SKILL path setting is not `nil`, all directory paths from SKILL path are checked in order, for that file. If found, the system overwrites the first updatable file in the list. If no updatable file is found, it places a new file of that name in the first writable directory.

Arguments

S_fileName	Name of the file to open or create.
t_mode	Mode in which to open the file. If a, the file is opened in append mode; If `w`, a new file is created for writing (any existing file is overwritten). Default value: `w`

Value Returned

p_outport	An output port ready to write to the specified file.
`nil`	returns `nil` if the named file cannot be opened for writing. An error is signaled if an illegal mode string is supplied.

Examples

```
p = outfile( "/tmp/out.il" "w" )
=> port:"/tmp/out.il"
```

Opens the `/tmp/out.il` port.

```
outfile( "/bin/ls" )
=> nil
```

Returns `nil`, indicating that the specified port could not be opened.

printf

```
printf( t_formatString [g_arg1 ...] )
     => t
```

Description

Writes formatted output to *poport*, which is the standard output port.

The optional arguments following the format string are printed according to their corresponding format specifications. Refer to the "Common Output Format Specifications" table for `fprintf` in the *SKILL Language User Guide.*

`printf` is identical to `fprintf` except that it does not take the *p_port* argument and the output is written to `poport`.

Arguments

t_formatString
: Characters to be printed verbatim, intermixed with format specifications prefixed by the "%" sign.

g_arg1…
: Arguments following the format string are printed according to their corresponding format specifications.

Value Returned

`t`
: Prints the formatted output and returns `t`.

Example

```
x = 197.9687 => 197.9687
printf( "The test measures %10.2f." x )
```

Prints the following line to `poport` and returns `t`.

```
The test measures 197.97. => t
```

println

```
println( g_value [p_outputPort] )
     => nil
```

Description

Prints a SKILL object using the default format for the data type of the value, and then prints a newline character.

A newline character is automatically printed after printing *g_value*. The `println` function flushes the output port after printing each newline character.

Arguments

g_value	Any SKILL value.
p_outputPort	Port to be used for output. Default value: `poport`

Value Returned

`nil`	Prints the given object and returns `nil`.

Example

```
for( i 1 3 println( "hello" ))
"hello"
"hello"
"hello"
=> t
```

Prints hello three times. `for` always returns `t.`

A

OCEAN 4.4.6 Issues

For the 4.4.6 release of OCEAN, there are some restrictions and requirements.

The netlist file that you specify for the Spectre® circuit simulator interface with the design command must be `netlist`. The full path can be specified. For example, `/usr/netlist` is acceptable. The `netlistHeader` and `netlistFooter` files are searched in the same directory where the netlist is located. Cadence recommends that you use the netlist generated from the Virtuoso® Analog Design Environment. Netlists from other sources can also be used, as long as they contain only connectivity. You might be required to make slight modifications.

- Cadence recommends full paths for the Spectre simulator model files, definition files, and stimulus files.
- The Cadence SPICE circuit simulator is still used to parse netlists for socket interfaces (spectreS and cdsSpice, for example). Therefore, the netlist that you specify with the design command must be in Cadence SPICE syntax. Cadence recommends that you use the raw netlist generated from the Virtuoso® Analog Design Environment. Netlists from other sources can also be used, as long as they can pass through Cadence SPICE. You might be required to make slight modifications.
- Any presimulation commands that you specify are appended to the final netlist (as is currently the case in the design environment). Therefore, if you have control cards already in your netlist, and specify simulation setup commands, you might duplicate control cards, which causes a warning or an error from the simulator. You might want to remove control cards from your netlist file to avoid the warnings.
- Models, include files, stimulus files, and PWLF files must be found according to the path specified with the path command.

Mixed-Signal in OCEAN 4.4.6

All of the analog OCEAN features are available in mixed-signal. This means you can set up analyses, change options, change the path, and so forth.

There are limitations in the area of mixed-signal simulation.

- If mixed-signal simulation is run using a standalone OCEAN tool, then the complete netlist must be created before running the simulation. The netlist can be created using Affirma Analog Design Environment or by specifying the design as lib-cell-view using the ocean command `design` in CIW of the workbench followed by the OCEAN commands `createNetlist` and `run`.

  For example:

  ```
  design("mylib" "ampTest" "schematic")

  ; design using lib-cell-view can only be specified in CIW of
  workbench

  createNetlist()

  run()
  ```

- If mixed-signal simulation is run using OCEAN commands in the CIW of the workbench, then the design should be specified as lib-cell-view.

  Otherwise, if the design is specified as the path to the netlist, for example as `design( "./simulation/ampTest/specter/netlist"`, then the complete netlist should be created before running the simulation using the procedure specified above.

In the 4.4.6 release, there are no commands that operate on Verilog-XL final netlists. If you need to change anything in the final netlist, you must make those changes by hand.

However, you can change any of the command line arguments that are sent to the Verilog-XL simulator. This means you can change any of the digital options or any of the mixed-signal options. To see what these options are, choose *Simulation – Options – Digital* in the Virtuoso® Analog Design Environment window.

For example, you can change acceleration, keep nodes, and library files.

For detailed information, please refer to the Virtuoso® Mixed-Signal Circuit Design Environment User Guide.

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