cādence™

Virtuoso Visualization and Analysis XL User Guide

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Preface

The Virtuoso® Visualization and Analysis XL is an analog and mixed-signal waveform display tool. This user guide describes this tool in detail and explains how you can use the various features of this tool.

What the Virtuoso Visualization and Analysis XL Tool Does

The tool helps you analyze the data generated by your simulator.

The tool consists of the following components:

- Results Browser displays simulation data in the hierarchical arrangement of your design.
- Graph offers features that simplify the processing of your signal data.
- Calculator provides an extensive expression building capability that addresses the needs of a wide variety of analysis types.

Supported Data Formats

The Virtuoso Visualization and Analysis XL can interpret the following data formats.

Format	Description
PSF	Format created by Virtuoso® Spectre Circuit Simulator (including the Virtuoso® Spectre RF Simulation Option) and other simulators integrated into the Virtuoso® Analog Design Environment. From the IC6.1.0 release, the visualization and analysis tool can read files larger than 2G.
SST2	Format created by Virtuoso® AMS and Spectre Verilog Simulators. Spectre and UltraSim can also create this format. This format can also be created by the digital simulators, such as NCsim.

Format	Description
PSF XL	Format created by Virtuoso® Spectre Circuit Simulator (including the Virtuoso® Spectre RF Simulation Option) and other simulators integrated into the Virtuoso® Analog Design Environment. This waveform format is supported by Virtuoso Visualization and Analysis XL tool in IC6.1.3 and later releases. This format provides a very high compression rate for large circuit designs.
RTSF	Format created by Virtuoso® Spectre circuit simulator and UltraSim simulators. RTSF is a PSF XL extension that provides improved viewing performance in Virtuoso Visualization and Analysis XL tool. RTSF is a fast waveform format extension that can plot extremely large datasets (where signals have a large number of data points, for example 10 million) within seconds. This format is supported by Virtuoso Visualization and Analysis XL tool in IC6.1.2 and later releases. You can enable this format by using the `+rtsf` option along with PSF.
Touchstone	Format created by all simulator. This is an industry standard format and the Virtuoso Visualization and Analysis XL tool supports this format starting from IC6.1.4 ISR. The touchstone file is an ASCII file, also known as the *SnP* file, which includes a large signals S-parameter results. The touchstone files are of `.snp` extension, where `n` is the number of network ports of the device. For example, if the touchstone file contains the network parameters for a two port device, it has `.s2p` extension.

Note: The Virtuoso Visualization and Analysis XL tool does not support WSF format now.

Licensing Scheme for Virtuoso Visualization and Analysis XL

Following is the licensing scheme for the Virtuoso Visualization and Analysis XL tool:

Virtuoso Visualization and Analysis XL when opened from ADE L, XL, and GXL:

- Shares license tokens with ADE L, XL, or GXL.
- When you close the ADE window, the Virtuoso Visualization and Analysis XL continues to hold the ADE license tokens, which are in effect until all Virtuoso Visualization and Analysis XL windows are closed.

Virtuoso Visualization and Analysis XL when opened in stand-alone mode or from Virtuoso:

- Checks out either the Virtuoso Visualization and Analysis XL license or an ADE license tier, depending on the preferences you have set by using the `VIVA License Checkout Order` .cdsenv variable. By default, this variable is set to `ViVA, ADE`, which results in the following license check out tasks being performed:
    - ❑ Checks out the Virtuoso Visualization and Analysis XL license, if available.
    - ❑ If the check out operation in the previous step fails, you can choose between checking out an ADE license tier or two ADE GXL tokens, based on the order set in the `ADELicenseCheckoutOrder` .cdsenv variable, which controls the order in which ADE license tiers are checked out.

  If the `VIVALicenseCheckoutOrder` variable is set to `ADE, ViVA`, the license check out tasks are performed in the following order:
    - ❑ Checks out an ADE license tier or two ADE GXL tokens, based on the order set in the `ADELicenseCheckoutOrder` .cdsenv variable.
    - ❑ If the check out operation in the previous step fails, you can check out the Virtuoso Visualization and Analysis XL license.
- The license is released when all the Virtuoso Visualization and Analysis XL windows are closed.

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

Related Documents

For information about the related products, consult the sources listed below.

- *Virtuoso Analog Design Environment User Guide*
- *Virtuoso Simulator Measurement Description Language User Guide and Reference*

Installation, Environment, and Infrastructure

- For information about installing Cadence products, see *Cadence Installation Guide*.
- For information about Virtuoso Design Environment, see *Virtuoso Design Environment User Guide*.

- For information about the database SKILL functions, including data access functions, see the *Virtuoso Design Environment SKILL Reference*.
- For information about the library structure, library definitions file, and name mapping for data shared by multiple Cadence tools, see the *Cadence Application Infrastructure User Guide*.

Technology Information

- For information about how to create and maintain a technology file and display resource file, see the *Virtuoso Technology Data User Guide* and the *Virtuoso Technology Data ASCII Files Reference*.
- For information about how to access the technology file using SKILL functions, see the *Virtuoso Technology Data SKILL Reference*.

Virtuoso Tools

- For information about how to perform design tasks with the Virtuoso Layout Suite L layout editor, see the *Virtuoso Layout Suite L User Guide*
- For information on design rule driven editing, see the *Virtuoso Design Rule Driven Editing User Guide*.
- For information about a collection of general layout tools designed to streamline command sequences and solve specific issues common to custom mask designers, see the *Virtuoso Toolbox User Guide*.
- For information about how to use the Virtuoso Layout Suite wire editing capability, see “Interactive Wire Editing” in the *Virtuoso Space-based Router User Guide*.
- For information about how to use the automatic custom digital placer to place your design components, see the *Virtuoso Custom Digital Placer User Guide*.
- For information about creating parameterized cells using the graphical user interface or low-level SKILL functions, see the *Virtuoso Parameterized Cell Reference*.
- For information about Quick Cells, see the *Virtuoso Quick Cells User Guide*.
- For information about Component Description Format, see the *Component Description Format User Guide*.
- For information about how to route a design, see the *Virtuoso Chip Assembly Router Guide* and the *Virtuoso Space-based Router User Guide*.

- For information about how to stream mask data, see the *Design Data Translator's Reference*.
- For information about custom layout SKILL functions, see the *Virtuoso Layout Suite SKILL Reference*.

Third Party Tools <*Optional*>

To view any `.swf` multimedia files, you need:

- Flash-enabled web browser, for example, Internet Explorer 5.0 or later, Netscape 6.0 or later, or Mozilla Firefox 1.6 or later. Alternatively, you can download Flash Player (version 6.0 or later) directly from the Adobe website.
- Speakers and a sound card installed on your computer for videos with audio.

Typographic and Syntax Conventions

Special typographical conventions distinguish certain kinds of text in this document.

- Boldface words represent elements of the syntax that must be used exactly as presented. Such items include keywords, operators, and punctuation marks. For example,

  statefile

- Variables are set in italic font,

  maxDirectories

- Vertical bars indicate alternatives. You can choose to use any one of the items separated by the bars. For example,

  -graphattributesfile "*mygraph*"
  |**-readstatefile** **"true | false"**

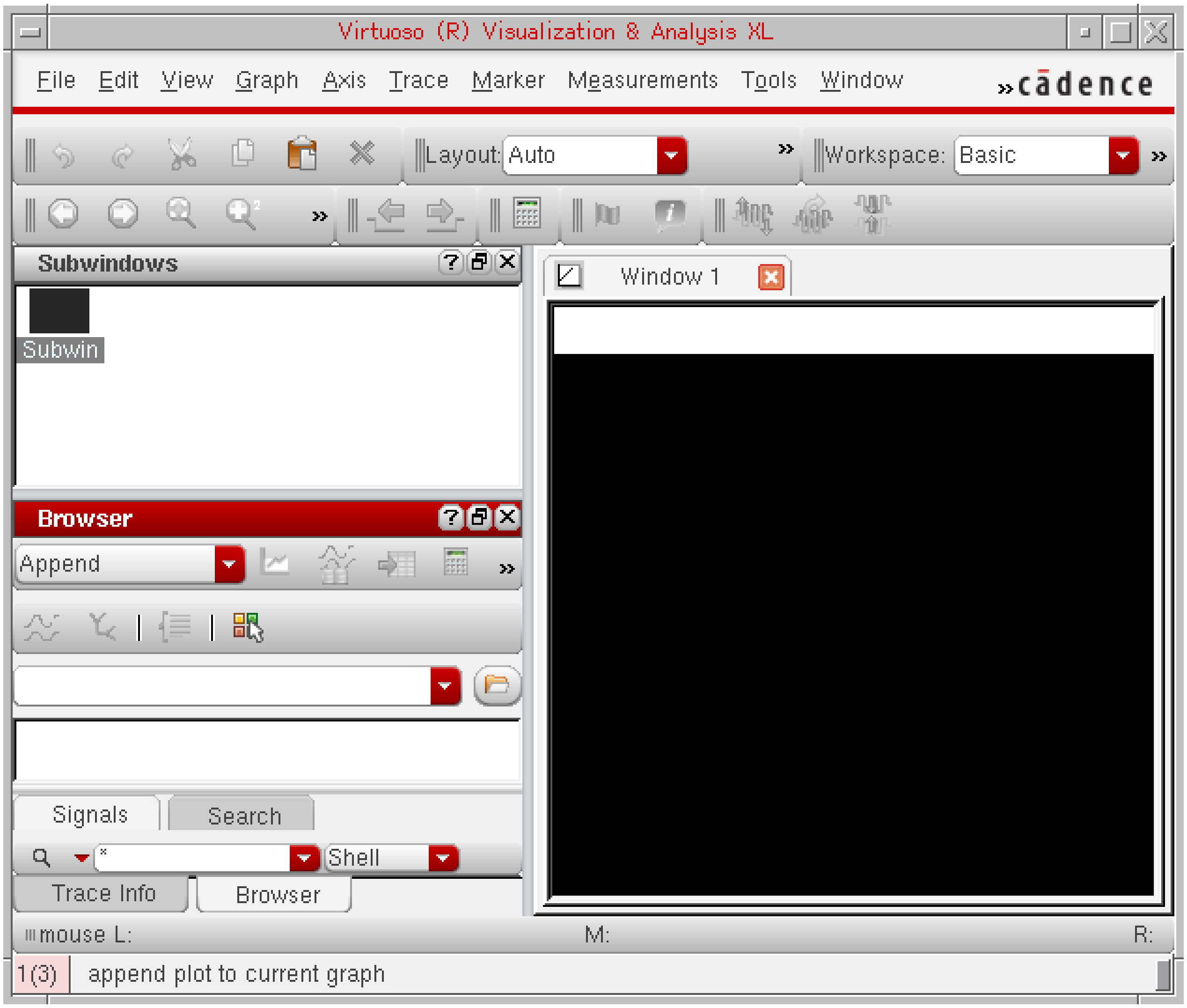
- Square brackets denote optional arguments. For example,

```
viva [-expr MDL]
```

1

Overview

You can use the Virtuoso Visualization and Analysis XL to browse, evaluate, analyze, and plot the simulation results.



Layout: Auto

Workspace: Basic

Append

Shell

1(3) append plot to current graph

Virtuoso Visualization and Analysis XL tool has the following three components:

- Results Browser
- Graph window
- Calculator

Results Browser is used to open the saved simulation results (signals). The signals are displayed in a hierarchical arrangement that corresponds to the hierarchy of your design, making it easy for you to locate and manage simulation data. For more information about the Results Browser, see Chapter 2, "Using the Results Browser,"

Graphs are displayed in the various graph windows and subwindows that can be opened in the graph display area in the Virtuoso Visualization and Analysis XL window. For detailed information about graphs, see Chapter 3, "Working with Graphs."

Calculator opens in a separate window and is used to create, store, and evaluate expressions for the signals displayed in the Results Browser. For detailed information about Calculator, see Chapter 4, "Working with the Calculator."

This chapter includes the following sections:

- Opening the Virtuoso Visualization and Analysis XL on page 24
- Closing the Virtuoso Visualization and Analysis XL on page 26
- Saving a Session on page 26
- Restoring a Session on page 27

Opening the Virtuoso Visualization and Analysis XL

You can start the tool either from within ADE or in the standalone mode. When you open the tool from within ADE, you work on the simulation results for the latest run. However, in the standalone mode, you work on the saved simulation results that can be accessed through the Results Browser.

This section includes the following topics:

- Opening the Tool in Stand-Alone Mode on page 25
- Opening the Tool Using CIW on page 25
- Opening the Tool Using Virtuoso® Analog Design Environment (ADE) on page 26

Opening the Tool in Stand-Alone Mode

To open the Virtuoso Visualization and Analysis XL window from CIW, do the following:

- Type the following command in a terminal window to open the tool in SKILL or Measurement Description Language (MDL) mode:

```
viva
     [-expr skill | mdl
     |-V
     |-W
     |-datadir
     |-mode XL]
```

Parameter	Description
`-h` or `-help`	Displays information about how to run the tool.
`-expr skill | mdl`	Specifies whether to start the tool in the SKILL or MDL mode.The default mode is SKILL.
`-v`	Displays the version number for the tool.
`-w`	Displays the subversion number for the tool.
`-datadir`	Specifies the data directory to be opened on startup.
`-mode XL`	Specifies the product mode to be used. This determines the license (ADE L or Virtuoso Visualization and Analysis XL) to be checked out. The default mode is XL.

Note: The command line options for the Virtuoso Visualization and Analysis XL tool are not case-sensitive.

The Virtuoso Visualization and Analysis XL window appears.

Opening the Tool Using CIW

To open the tool using CIW, first you need to open Virtuoso and then do the following to open different tools in Virtuoso Visualization and Analysis XL:

- To open the Virtuoso Visualization and Analysis XL tool:
  - ❑ Choose *Tools – Waveform.*

- To open the tool with the Results Browser displayed:
  - ❑ Choose *Tools – Results Browser.*
- To open the Virtuoso Visualization and Analysis XL Calculator:
  - ❑ Choose *Tools – Calculator*.

Opening the Tool Using Virtuoso® Analog Design Environment (ADE)

You can open the tool from within ADE L and XL.

To know about how to open the graph window from within ADE, see Opening the Graph Window from ADE L and ADE XL on page 67.

To know about how to open Results Browser from within ADE, see Opening the Results Browser from ADE on page 32.

To know about how to open Calculator from within ADE, see Opening the Calculator using ADE on page 278.

Closing the Virtuoso Visualization and Analysis XL

- To close the graph window:
  - ❑ In the graph window, choose *File – Close All Windows.*
  - ❑ Choose *File – Close Window*.

    Closes the active window. If there is only one open window, the *Close* command exits the tool.
- To close the Calculator window:
  - ❑ In the Calculator window, choose *File – Close*.

Saving a Session

When you save a session, the current state of the application is saved. When you reload a saved session, the same windows and settings as in the saved session come up. For more information about the graph attributes that are saved, see Saving and Loading Graphs on page 164.

Restoring a Session

To restore a previously saved session, type the following in an xterm window:

```
viva -statefile mystatefile.xml
```

where *`mystatefile`* is the name of your state file.

2

Using the Results Browser

You can use the Results Browser, which is opened as an assistant in the Virtuoso Visualization and Analysis XL window, to open the stored simulation results. Results Browser displays simulation results (signals) in a hierarchical arrangement that corresponds to the hierarchy of your design, making it easy for you to locate and manage simulation data.

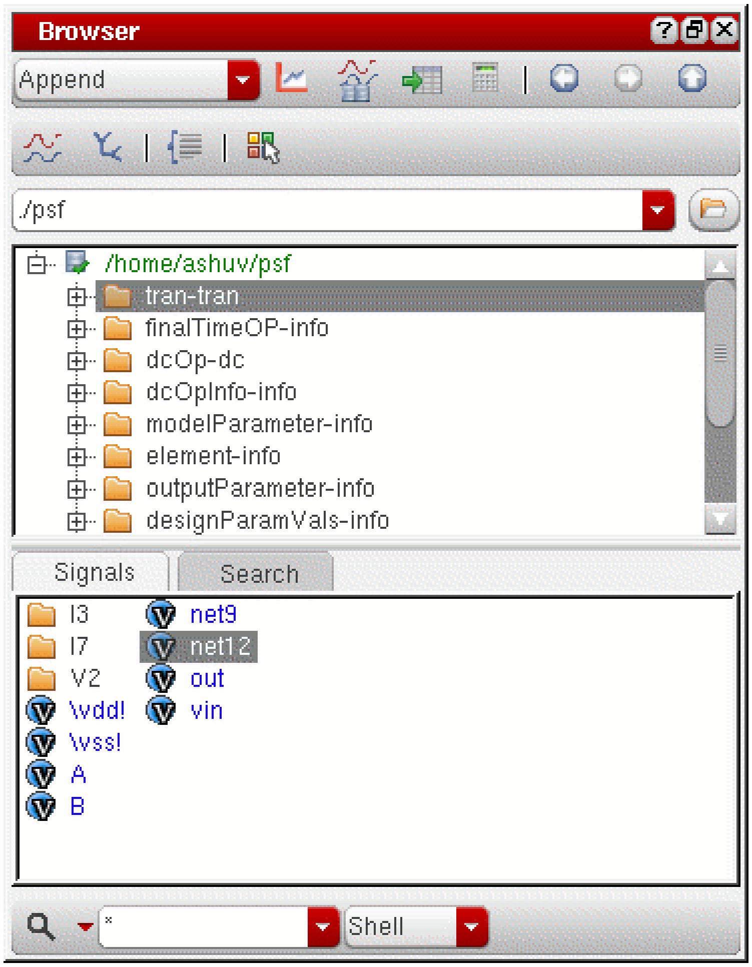
This chapter includes the following topics:

About the Results Browser

You use the Results Browser to access the simulation results that you save to work on later in a different session.

The results for each simulation are stored in a separate results directory. In addition, the results for different analysis types are stored in separate folders. For example, all simulation results for all transient analyses are contained in the `tran-tran` folder. The various signals in a results directory are displayed in the Results Browser in a hierarchy that is determined by the design.

Note: Starting IC6.1.5ISR3, the alias names for the analyses are displayed in the Results Browser. For example, the results directory name `tran-tran` has been changed to `tran`.



You can load multiple results directories in the Results Browser. The first directory that you load in the Results Browser becomes the in-context results directory. This means that the expressions in the Calculator are evaluated and the signals displayed in the graph are plotted by using the data available in the in-context results directory. To change the in-context results directory, see Changing In-Context Results Directory on page 42.

Important

Starting IC6.1.5, the Results Browser is opened as an assistant within the Virtuoso Visualization and Analysis XL window and the new browser is not available in the MDL mode.

Opening the Results Browser

The Results Browser is displayed as an assistant in Virtuoso Visualization and Analysis XL. You can open the Results Browser by using one of the following methods:

- Opening Results Browser in the Stand-Alone Mode on page 31
- Opening the Results Browser from Virtuoso on page 31
- Opening the Results Browser from ADE on page 32

Opening Results Browser in the Stand-Alone Mode

To open the Results Browser from Virtuoso Visualization and Analysis XL, do the following:

➡ Type the following in a terminal window:

```
viva -expr skill | mdl &
```

The *Virtuoso (R) Visualization & Analysis XL* window appears with the Results Browser displayed on the left. If you specify a data directory by using the `viva -dataDir` command, the directory is displayed in the Results Browser. Otherwise, the Results Browser is blank.

Note: Note: By default, Virtuoso Visualization and Analysis XL opens in the SKILL mode.

Opening the Results Browser from Virtuoso

To open the Results Browser from Virtuoso, do the following:

➡ In the CIW, choose *Tools – ADE L – Results Browser.*

The *Virtuoso (R) Visualization & Analysis XL* window appears with the Results Browser displayed on the left.

Opening the Results Browser from ADE

To open the Results Browser window from the Virtuoso® Analog Design Environment (ADE),

➡ In the ADE L or XL window, choose *Tools – Results Browser*.

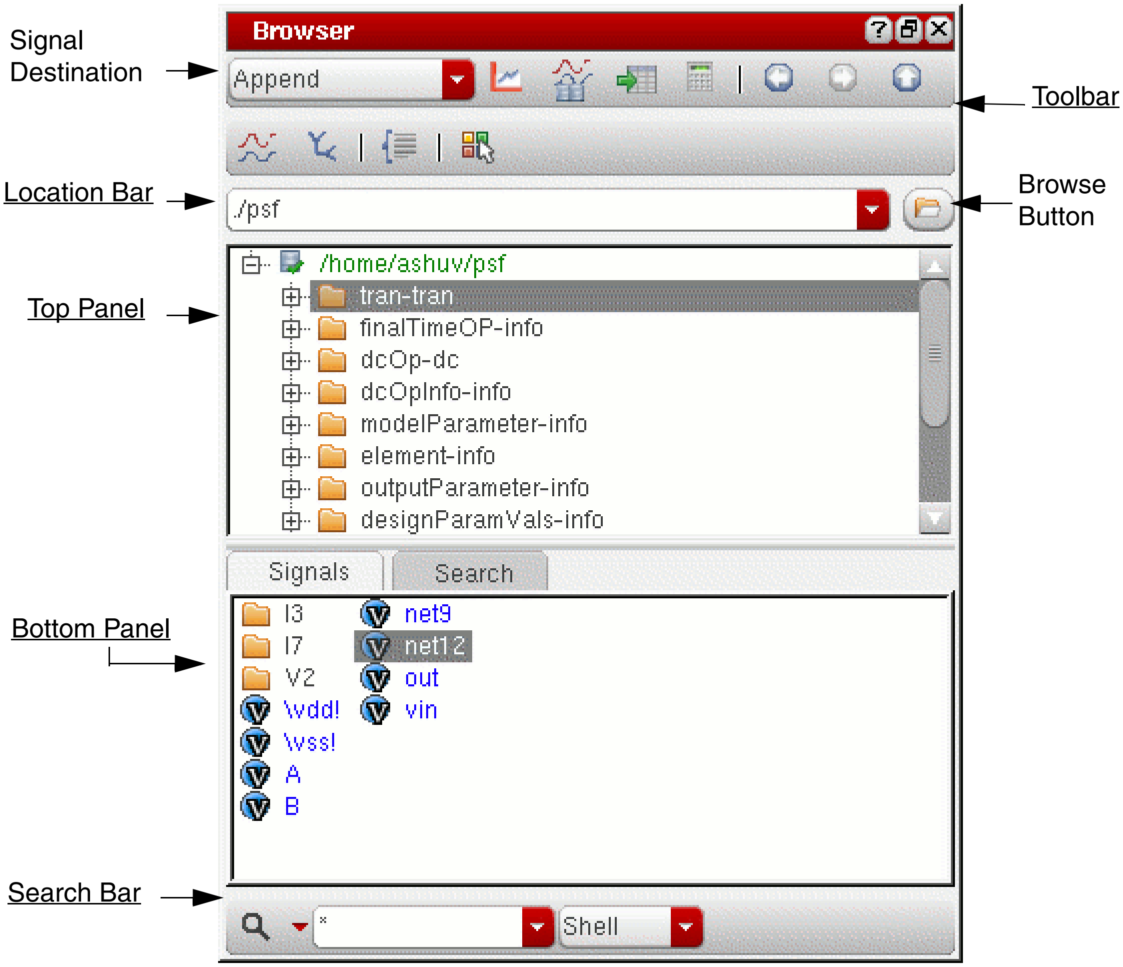
The *Virtuoso (R) Visualization & Analysis XL* window appears with the Results Browser displayed on the left.

If you open Virtuoso Visualization and Analysis XL after running a simulation in ADE, the Results Browser displays the current simulation results directory. Otherwise, the Results Browser is blank.

Results Browser Graphical User Interface

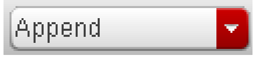
The Results Browser graphical user interface (GUI) consists of the following elements:

- Toolbar on page 33
- Location Bar on page 36
- Top Panel on page 36
- Bottom Panel on page 36
- Search Bar on page 37



Toolbar

The table below describes the toolbar buttons:

Button	Name	Description
	Signal Destination	Displays a list of destinations where a signal can be plotted—*Append*, *Replace*, *New Window*, and *New Subwindow*. By default the signal plot destination is *Append*. For more information, see Selecting the Signal Plot Destination on page 44.

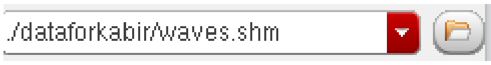
	Plot signal	Plots the selected signal in the specified window. For more information, see Plotting Signals on page 44.
	Plot signal from all DBs	Plots in the append mode the selected signal from all open results directory. This helps compare signals that are common to all open results directories. For more information, see Comparing Signals on page 57.
	Send to Table	Displays the signal data in the Virtuoso Visualization and Analysis XL Table.
	Send to Calculator	Opens the Calculator and displays the expression for the selected signal in the Calculator Buffer. For more information, see Chapter 4, “Working with the Calculator.”
	Previous	Moves the control to the previous results directory selected in the Results Browser. When you open a new session, this button is not available.
	Next	Moves to control to the next results directory opened in the Results Browser.
	Up to Parent Directory	Moves the control to one level up in the results directory hierarchy.
	Diff	Plots the difference of two signals in the graph window. For more information, see Plotting the Difference of Two Signals on page 55.
	Y Vs Y	Plots the Y Vs Y of two signals. For more information, see Plotting YvsY for Two Signals on page 52.
	Select Sweep Data	Enables you to select the range for the sweep data. For more information, see Selecting and Plotting Signals in a Data Range on page 48.
	Select Color	Enables you to change the default color of different signal types. For more information, see Changing Signal Color on page 41.

If the results directories contain the simulation results for an AC analysis, the Results Browser toolbar displays the following two additional drop-down lists:

Name	Options	Description
Graph Type		Available only for AC data
	Default	Plots the signal to the default graph type
	Rectangular	Plots the signal to a rectangular graph
	Histogram	Plots the signal to a histogram
	Polar	Plots the signal to a polar graph
	Impedance	Plots the signal to an impedance graph
	Admittance	Plots the signal to an admittance graph
	RealvsImag	Plots real versus imaginary
Graph Modifier		Available only for AC data
	Magnitude	Plots magnitude versus frequency
	Phase	Plots phase versus frequency
	WPhase	Plots wrapped phase versus frequency
	Real	Plots real versus frequency
	Imaginary	Plots imaginary versus frequency
	db10	Plots *db10* versus frequency
	db20	Plots *db20* versus frequency
	dbm	Plots *dbm* versus frequency

Location Bar

Lists the paths for the last 20 results directories opened in the Results Browser.



./dataforkabir/waves.shm

To open a results directory, select it in the drop-down list. To open a new results directory that was loaded earlier in the Results Browser, enter the path in the box, or click the *Browse* button on the right. For more information, see Opening a Results Directory on page 38.

Top Panel

The top panel displays all loaded results directories in a tree view. The ▤ symbol displayed before a results directory indicates the PSF directories.

Right-click a results directory in top left panel and choose any of the following commands:

- *Close Results*—To close the selected results directory.
- *Open Terminal*—To open a terminal at the selected directory.
- *Set Context*—To set the selected directory as the in-context results directory.

Bottom Panel

The bottom panel displays in a list view the contents of the selected database.

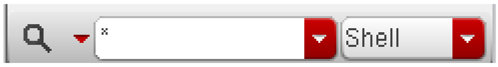
Right-click a signal in the bottom panel and choose any of the following commands:

- *Up One Level*—To moves up by one directory level.
- *Plot Signal*—To plot a signal in the specified graph window. By default, the signal is plotted in the append mode.
- *Plot from all DBs*—To plot in the append mode the selected signal from all the loaded results directory in the append mode to compare the signals. For more information, see Comparing Signals on page 57.
- *Export*—Exports a waveform. For more information, see Exporting Signals on page 58.
- *Calculator*—Opens the Calculator. For more information, see Chapter 4, “Working with the Calculator.”
- *Table*—This button is not available in IC6.1.5.

- *Diff*—Plots the difference of two signals. For more information, see Plotting the Difference of Two Signals on page 55.
- *YvsY*—Plots Y versus Y for two signals. For more information, see Plotting YvsY for Two Signals on page 52.
- *Append, Replace, New Subwindow, and New Window*—Specifies the plot destination. For more information, see Selecting the Signal Plot Destination on page 44.

Search Bar

Enables you to filter and search signals across multiple databases in the Results Browser.



For more information about filtering and searching signals, see Filtering and Searching For Signals on page 42.

DB Type Identifier

When you point to an open database in the Results Browser, the following information is displayed in the given order for the folders in the database.

- Format
- Analysis Type
- Description
- Date
- Simulator

Working with the Results Directory

This section describes how you can open a results directory, select signals in the results directory, and perform filtering and searching operations on the signals in the results directory.

- Opening a Results Directory on page 38
- Selecting Signals on page 40

- Filtering and Searching For Signals on page 42
- Updating Results Directory Data on page 44

Opening a Results Directory

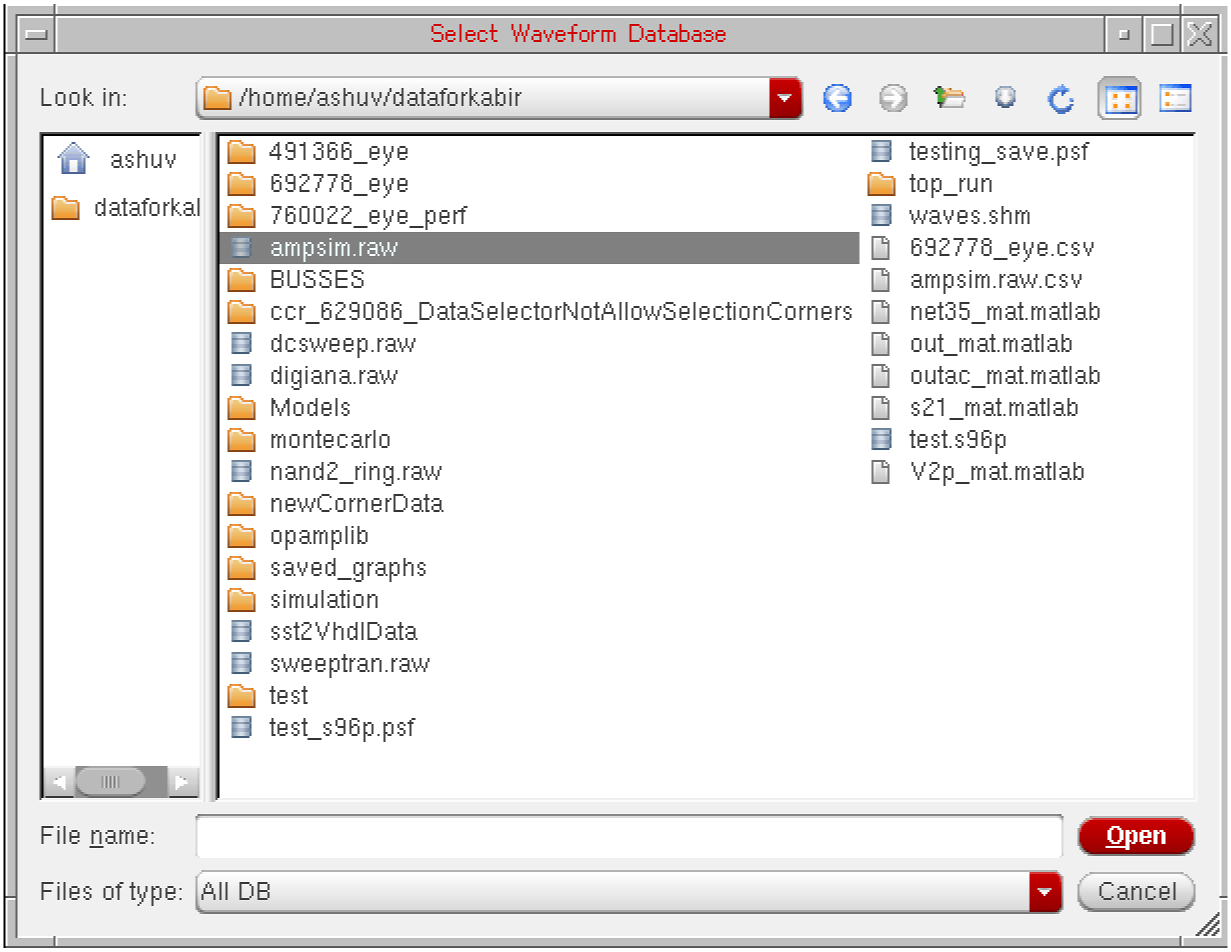
To open a results directory in the Results Browser, do one of the following:

- In the Results Browser window, type the results directory path in the location bar and press the `Enter` key.
- In the Results Browser window, select a path from the drop-down list. The drop-down list displays the paths for previously opened results directories. You can also click the browse button and select the required results directories.

  In the Virtuoso Visualization and Analysis XL window, do one of the following to open a results directory:

  - ❑ Choose *File – Open Results*.
  - ❑ Choose *Browser – Results – Open Results*.

The *Select Waveform Database* form appears. This form has two panes—the directory pane on the left displays the parent directories and the content pane on the right displays the files or directories contained in the parent directory that you open.



Look in: /home/ashuv/dataforkabir

491366_eye
692778_eye
760022_eye_perf
ampsim.raw
BUSSES
ccr_629086_DataSelectorNotAllowSelectionCorners
dcsweep.raw
digiana.raw
Models
montecarlo
nand2_ring.raw
newCornerData
opamplib
saved_graphs
simulation
sst2VhdlData
sweeptran.raw
test
test_s96p.psf
testing_save.psf
top_run
waves.shm
692778_eye.csv
ampsim.raw.csv
net35_mat.matlab
out_mat.matlab
outac_mat.matlab
s21_mat.matlab
test.s96p
V2p_mat.matlab

File name:

Files of type: All DB

In this form, do one of the following to select the required results directory:

❑ In the *Look In* field, browse to locate the results directory that you want to open. If required, you can open multiple results directories.

❑ Select the results directory that you want to open. You can select multiple directories at a time by using the `Ctrl` key.

The form includes the following three buttons in the upper-right corner:

❍ *Parent Directory*—To open the parent directory. This button is available if you have nested results directories.

❍ *Descend Inside Directory*—To view the contents of the parent directory and to move to the next-level directory.

   - *Refresh*—To refresh the results directories present in the selected location.
   - *List View*—To display directories in a list view.
   - *Detail View*—To display directories in the detail view.

- Click *Open.*

  The selected results directory is opened in the Results Browser in green and the icon is displayed next to the directory name to indicate that it is the in-context results directory.

Note: The Virtuoso Visualization and Analysis XL tool displays the icon next to the directories that contain simulation data.

Selecting Signals

In the Results Browser, the top pane displays the results directories and the bottom pane displays the datasets in the selected results directory.

Perform the following steps to select a signal in the Results Browser:

1. Double-click a results directory in the top panel.

   The results directory is expanded and the folders containing data from different analyses are displayed in the bottom panel.

   Note: The icon displayed next to a directory in a list a indicates that the directory contains subdirectories. You can double-click the directory to display or to hide the subdirectories.

2. Double-click the appropriate dataset folder.

   The signals are displayed in the bottom panel. Each signal has an icon displayed next to it, indicating the signal type.

   - V indicates a voltage signal
   - I indicates a current signal
   - indicates a digital signal
   - indicates a digital bus
   - indicates a power signal
   - indicates all other signal types
   - S indicates s-parameters

3. Right-click the signal and choose the command to either plot it or send it to the Calculator Buffer. For more information about these operations, see the following chapters:

- ❑ Graphs: Chapter 3, “Working with Graphs.”
- ❑ Calculator: Chapter 4, “Working with the Calculator.”

Selecting Multiple Signals

Do one of the following to select a set of consecutive signals:

- Click the first signal. Hold down the `Shift` key, and then click the final signal in the set.
- Drag the pointer to select a set of consecutive signals.

Do the following to select a set of non-consecutive signals:

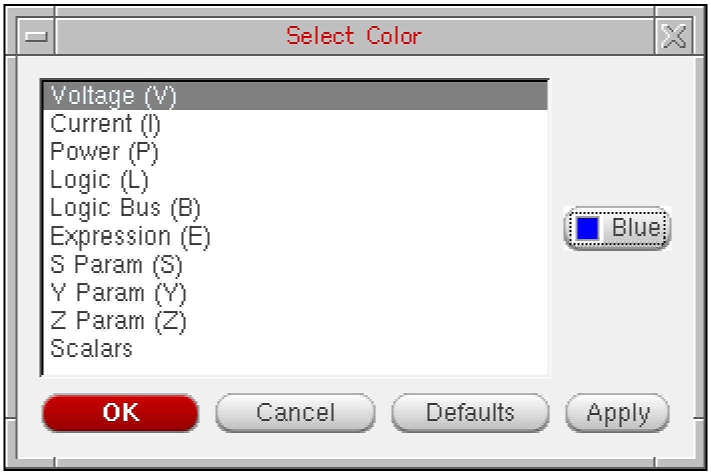
- Click the first signal. Hold down the `Ctrl` key, and click one by one the required signals.
- Drag to select appropriate signals.

Changing Signal Color

To differentiate between the various signal types, such as voltage, current, analog, and digital signals, you can change the color of signals. Do the following to change signal color:

1. Click the button on the Results Browser toolbar.

The *Select Color* form appears.



Select Color

Voltage (V)
Current (I)
Power (P)
Logic (L)
Logic Bus (B)
Expression (E)
S Param (S)
Y Param (Y)
Z Param (Z)
Scalars

2. In this form, select the signal type for which you want to change the color.

Note: Alternatively, select a signal and then click the button to open the *Select Color* form. The signal type that you have selected is highlighted in this form.

3. Click the color button and select the color you want to apply.
4. Click *OK*.

Changing In-Context Results Directory

The first results directory that you open in the Results Browser is set as the in-context results directory and displayed in green. The symbol is displayed to the left of the in-context results directory path.

To change the in-context results directory, open that results directory, which you want to make in-context, in the top panel and do one of the following:

- Right-click the results directory path and choose *Set Context.*
- Choose *Browser – Results – Set Context*.

The selected results directory becomes the in-context results directory.

Setting the in-context results directory plays an important role in performing the following tasks:

- Building expressions in the Calculator. For more information, see In Context Results DB on page 240.
- Reloading graphs in the graph window. For more information, see Reloading Graphs on page 174.

Filtering and Searching For Signals

You can filter signals in an open database by the signal type or by the signal name. When you open Virtuoso Visualization and Analysis XL from within ADE XL, you can also search for signals across all open datasets.

Filtering Signals

Do one of the following in the Results Browser to filter signals:

➡ In the 🔍 list, select one of the following:

Item	Description
All	Displays all signals
Logic	Displays logic (digital) signals
LogicBus	Displays logicbus (digital bus) signals
V	Displays voltage signals
I	Displays current signals
W	Displays power signals
Show hierarchical nodes	Displays folders containing signals

The available options are determined by the selected dataset. For example, the available options for an analog dataset are *All*, *V*, and *I*.

If you want folders that contain signals matching the search criteria to be displayed, ensure that the *Show hierarchical nodes* checkbox is selected.

Searching For Signals

You can search for a signal across multiple databases that are open in the Results Browser. Do the following to search for a signal:

- Type the search string in the *Specify Search Pattern* field, which is located at the bottom of the Results Browser.
- Select `RegExp` from the drop-down list to filter signals based on a regular expression.
- Click the 🔍 button.

  For example,

  - Type `v(dd|ss)` to search for all voltage signals that contain `vdd` and `vss` in their names.
  - Type `n[1-9]` to search for numbered nets.

  The signals that meet the specified search criteria are displayed in the bottom panel of the Results Browser.

Updating Results Directory Data

When you re-simulate your design, the Virtuoso Visualization and Analysis XL tool automatically refreshes the data directory if you perform an action that accesses the database. All new graphs that you create display the updated data, which helps you monitor long simulations. The graphs that are already open are not updated.

Plotting Signals

To plot a signal, right-click the signal in the Results Browser and choose *Plot Signal*. The signal is plotted in the specified graph window. For detailed information about how to create a graph, see Chapter 3, "Working with Graphs."

Note: You cannot plot scalar values in the graph window. Therefore, if you try to plot a scalar value from the Results Browser, a warning message is displayed on the CIW.

This section describes the available plot destination options and the graph types that you can use to display the plotted signal.

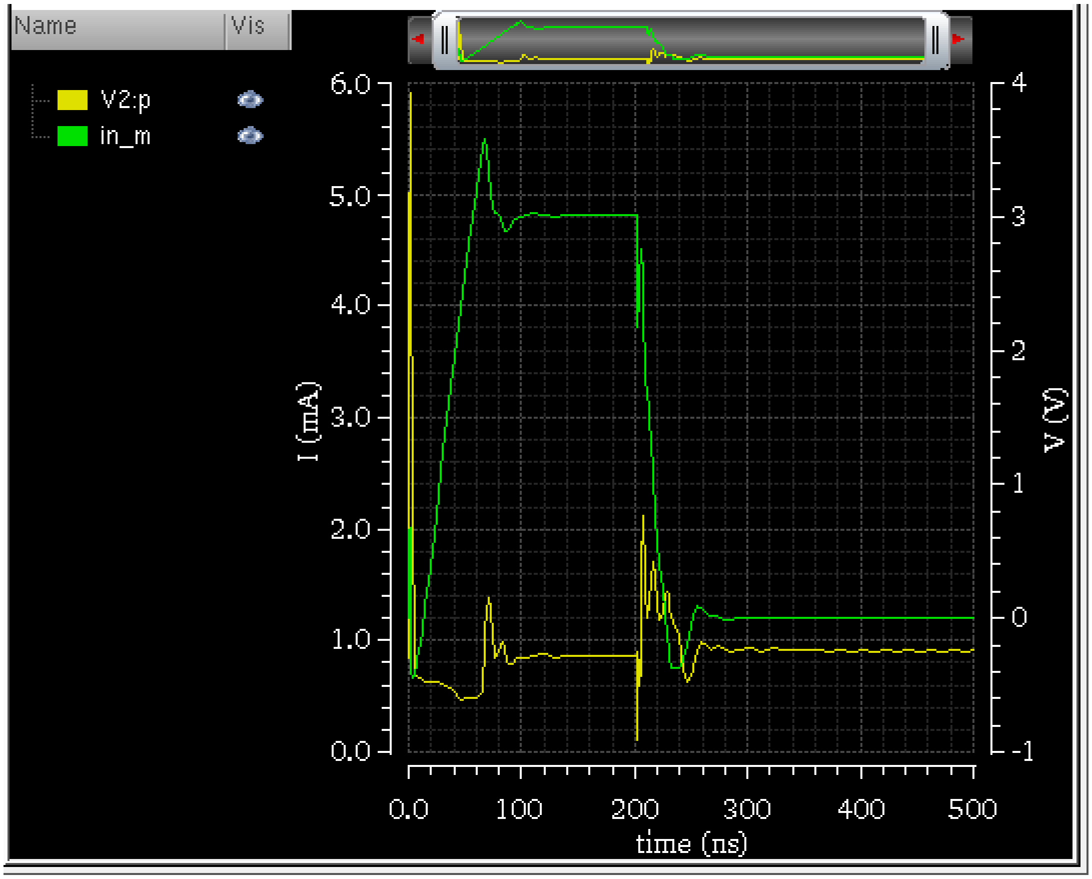
- Selecting the Signal Plot Destination on page 44
- Selecting the Graph Type on page 46

Selecting the Signal Plot Destination

The first graph that you plot in a session is displayed in a new graph window. If you already have a graph window open, you need to specify the destination to plot the new signal. This section describes the available destination options. For information about how to specify the signal destination, see step 2 in Selecting and Plotting Signals in a Data Range on page 48.

Appending to a Graph

You can append the trace for a signal to a graph that is already plotted in the graph window. If the traces share the same unit, the new trace is assigned to the same Y-axis. Otherwise, it is assigned to a new Y-axis. If the graph window already has four Y axes, or if the units do not match, the Virtuoso Visualization and Analysis XL tool plots the new signal in a new subwindow in that graph window.



The figure above shows the trace for the `V2:p` signal appended to the graph containing the trace for the `in_m` signal. The Y-axis unit for `in_m` is `V` and the Y-axis unit for V2:p is `mA`. Therefore, the trace for `V2:p` is assigned to a new Y-axis.

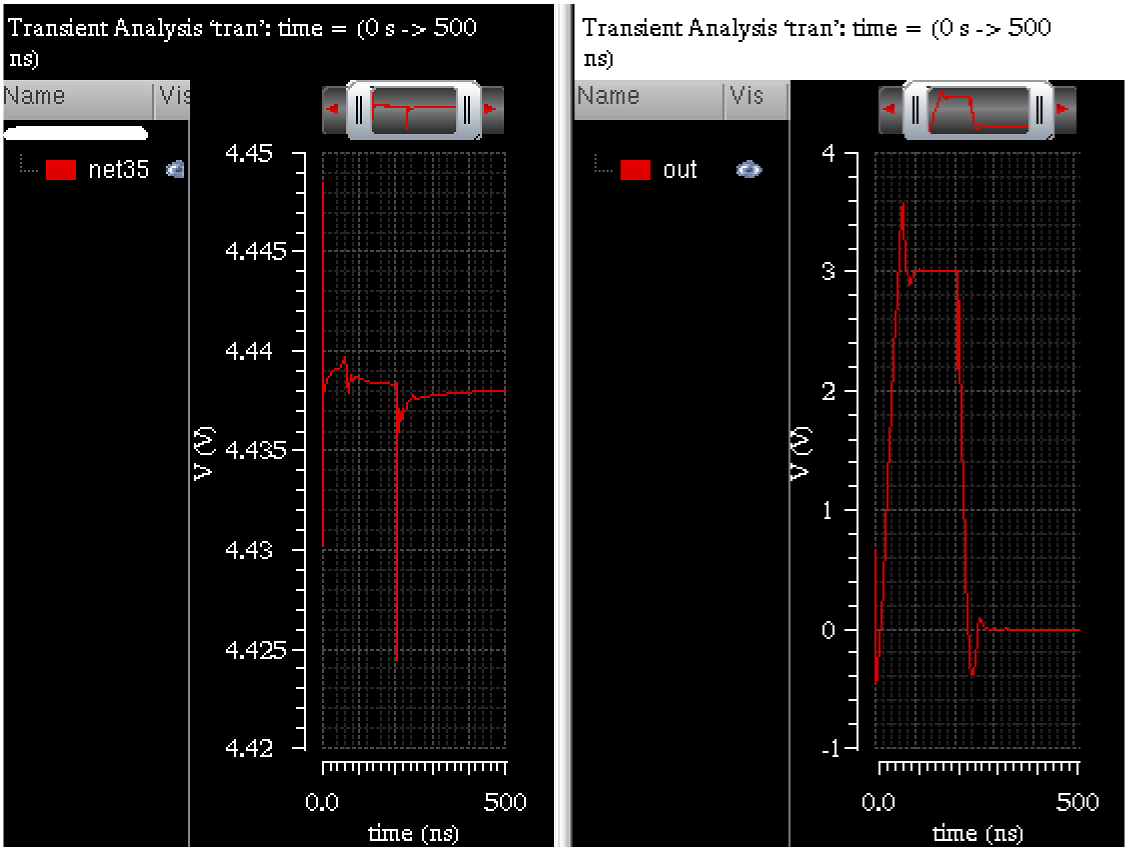
Replacing a Signal

You can plot a new signal to replace a signal or group of signals in the selected graph window or subwindow. The graph window or subwindow retains all its attributes. If the signal to be replaced contains markers, the markers are attached to the new trace if both signals have the same name.

If no graph window is open, a new graph window is created.

Plotting to a New Subwindow

You can plot a graph in a new subwindow within the selected graph window. The following figure shows the graph for the `V2:p` signal plotted in a subwindow.



Plotting to a New Window

You can plot a signal to a new graph window.

Selecting the Graph Type

You can use different graph types to represent different data types. The Virtuoso Visualization and Analysis XL tool supports rectangular, polar, admittance, impedance, and real versus imaginary graph types. Each dataset represents a specific analysis type and can be plotted only to a specific graph type.

This section describes the available graph types. For information about how to specify the graph type, see step 3 in Selecting and Plotting Signals in a Data Range on page 48.

Default

The default graph type is determined based on the type of data in the simulator data file. For example, the default graph type for transient data is rectangular.

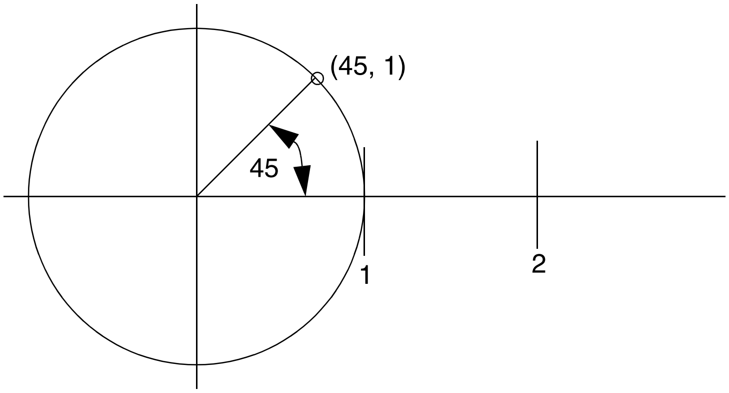
Rectangular Graphs

Transient and DC sweep data is always plotted in a rectangular graph. You can also plot portions of complex data in a rectangular graph by selecting the modifier: real, imaginary, magnitude, or phase. The Virtuoso Visualization and Analysis XL tool plots the selected modifier against the frequency.

Polar Graphs

Polar graphs represent data by using the polar coordinates system. Points are plotted at a given radial distance along a ray that creates a given angle with the positive X-axis.

The following example illustrates how you can plot a point (45 degrees, 1).



Admittance and Impedance Graphs

Admittance and impedance graphs are a direct graphical representation, in the complex plane, of the complex reflection coefficient. They reveal the complex impedance anywhere along a line.

The center of the chart normally represents 50 ohms but can be any impedance line you want—it is normalized to 1.0 units. Everything is scaled relative to the unit you choose. The nature of impedance is that of a real or resistive portion, and an imaginary, or reactive portion, combined in the Pythagorean style.

The circular graph has four goalposts spaced 90 degrees apart graphically and 45 degrees apart electrically. Two goalposts are resistive—one a short and the other an open—the left and right sides, respectively. The top and bottom posts are reactive, either inductive, or capacitive. Every point in between represents the various combinations resulting from a mismatched condition.

You can display either impedance or admittance grids in the Smith chart that you create—the grids are mirror images of each other.

Real Vs Imag

Real Vs Imag graphs plot the real part against the imaginary part. These graphs are available only for AC data.

Selecting and Plotting Signals in a Data Range

The data range feature in the Virtuoso Visualization and Analysis XL tool makes it easy to use a very large dataset efficiently by opening only the portion of the dataset that you need. You can specify a particular time range in a transient analysis, and then open the dataset and plot signals that fall within that range. For data families like corners or sweeps, you can load specific points in the analysis by using the data range feature.

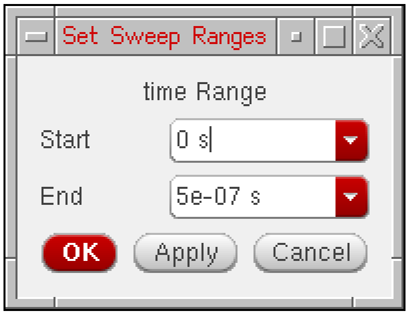
Any data filtered out by the data range is not available for plotting until it is enabled in the *Set Sweep Ranges* form, as described below.

Plotting a Signal over a Time Range

You can plot transient data over a time range. To specify the time range for a transient dataset, do the following:

1. Select a transient signal.
2. Click the {≣ button on the Results Browser toolbar.

The *Set Sweep Ranges* form appears.



Set Sweep Ranges

time Range

Start: 0 s

End: 5e-07 s

The *Start* and *End* fields display the signal range.

3. In the *Start* field, type the time at which you want the plot to begin.

   If you want the graph to be plotted from the first data point in the signal, select *Default* from the *Start* drop-down list.

4. In the *End* field, type the time at which you want the plot to end.

   If you want to display the time for the last data point in the signal, select *Default* from the drop-down.

5. Click *OK*.

6. Click 📉.

   The graph window appears with the graph plotted for the specified time range.

Plotting Parametric Sweep Data

A parametric analysis sweeps a parameter or a group of parameters and runs one or more analyses for each combination of parameters.The Virtuoso Visualization and Analysis XL tool helps you analyze the resulting data efficiently.

To plot a part of parametric swept data, do the following:

1. Select a parametric signal.

2. Click the {≡ button on the Results Browser toolbar.

   The *Set Sweep Ranges* form appears, displaying a list of inner sweep variables.

3. Select the values that you want to plot and click *OK*.

4. Click 📉.

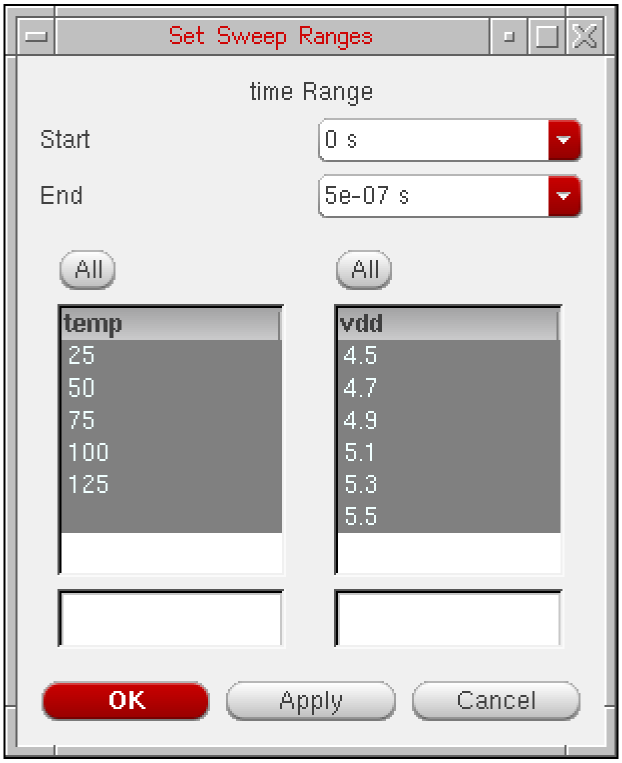
The graph window appears with graphs for all the combinations of sweep variables.

An Example of Plotting Data from a Parametric Sweep

To plot selected curves from the parametric data, do the following:

1. In the Results Browser window, open the data results for a parametric sweep.
2. Select a parametric signal in the results data directory.
3. Click the button.

   The *Set Sweep Ranges* form appears. The *Start* and *End* fields display the range of the signal. All the `temp` (temperature) and `vdd` (inner sweep variable) values are selected by default.



Set Sweep Ranges

time Range

Start: 0 s

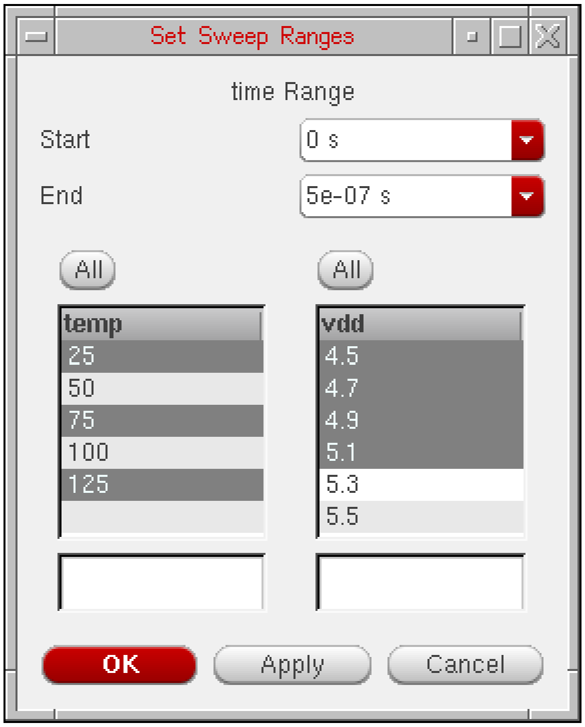
End: 5e-07 s

temp	vdd
25	4.5
50	4.7
75	4.9
100	5.1
125	5.3
	5.5

   Note: You can also use this form to filter and sort sweep variables by typing their values in the boxes at bottom.

4. In the *temp* list, click `25.0`, hold down the `Ctrl` key, and click `75.0`, and `125.0`.
5. In the *vdd* list, click `4.5`, hold down the `Shift` key, and click `5.1`.

The form now displays the data ranges as shown in the figure below.



Set Sweep Ranges

time Range

Start: 0 s

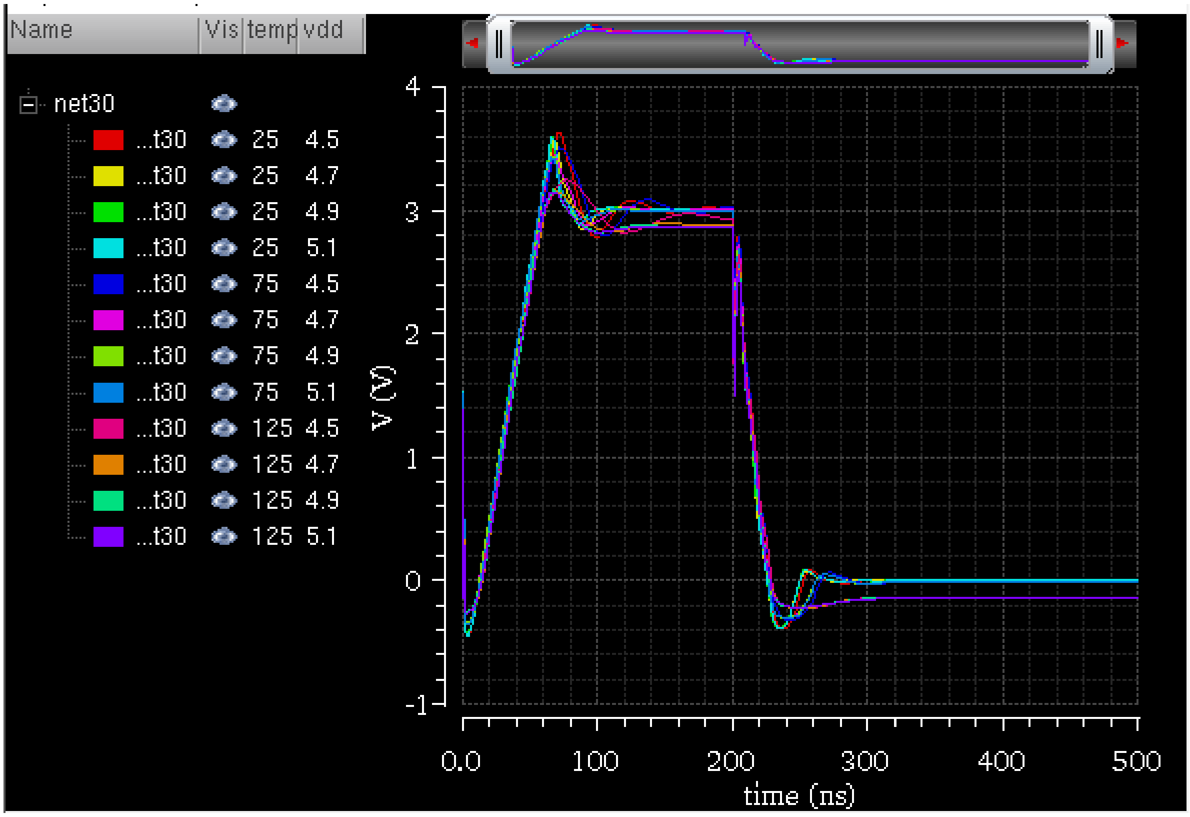
End: 5e-07 s

temp	vdd
25	4.5
50	4.7
75	4.9
100	5.1
125	5.3
	5.5

6. Click *OK*.

7. In the Results Browser window, right-click the `out` signal and choose *New Window*.

The graph window appears with the traces plotted for the parametric family. Each trace in the family is annotated by a sweep path that describes the parameter-value pair.



Name	Vis	temp	vdd
⊟ net30	👁		
🟥 ...t30	👁	25	4.5
🟨 ...t30	👁	25	4.7
🟩 ...t30	👁	25	4.9
🟦 ...t30	👁	25	5.1
🟦 ...t30	👁	75	4.5
🟪 ...t30	👁	75	4.7
🟩 ...t30	👁	75	4.9
🟦 ...t30	👁	75	5.1
🟥 ...t30	👁	125	4.5
🟧 ...t30	👁	125	4.7
🟩 ...t30	👁	125	4.9
🟪 ...t30	👁	125	5.1

Creating Special Plots

This section describes how to plot the YvsY and the difference of two signals. This section also describes how you can compare signals for various datasets contained in different results directories.

- Plotting YvsY for Two Signals on page 52
- Plotting the Difference of Two Signals on page 55
- Comparing Signals on page 57

Plotting YvsY for Two Signals

This section describes how to plot the Y-axis values of one signal versus the Y-axis values of another signal. You can plot YvsY to measure input offset voltage, which displays the offset between the input and output of the circuit.

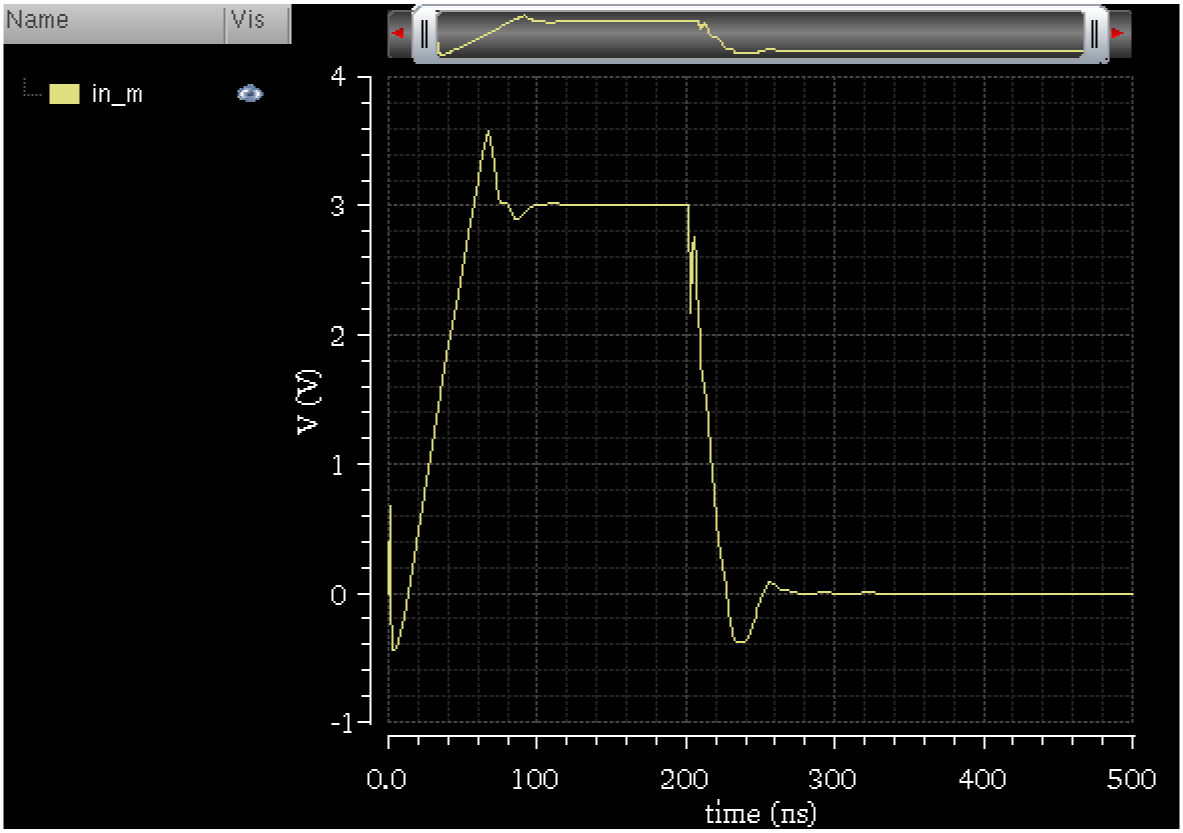
To plot YvsY, select a signal in the Results Browser and do one of the following:

- Click the Y button and select the second signal
- Select the second signal and click the Y button.

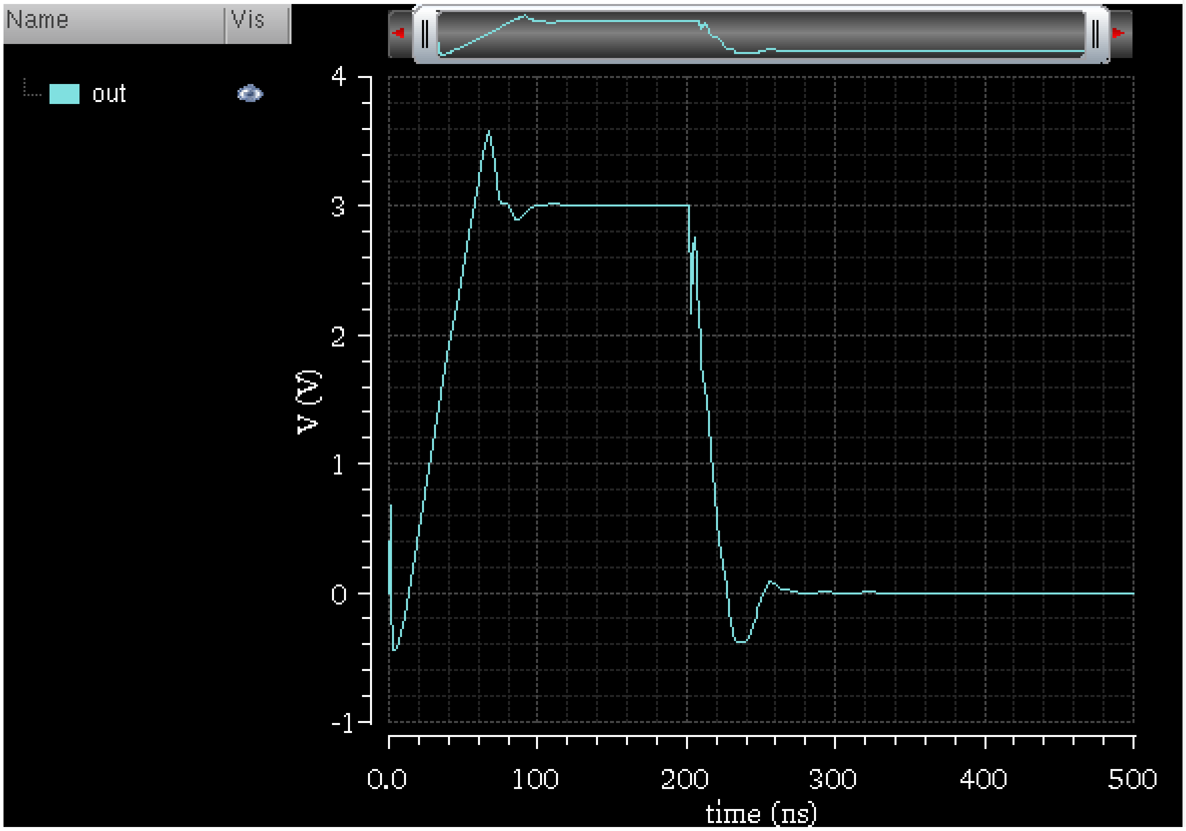
  The graph window appears with the trace plotted for Y versus Y.

Note: The YvsY plots cannot be created when the dataset includes parametric swept data. Therefore, the YvsY option is not available for signals resulted from a parametric sweep analysis.

The following figures illustrate the `out` and `in_m` signals.
Signal `in_m`:

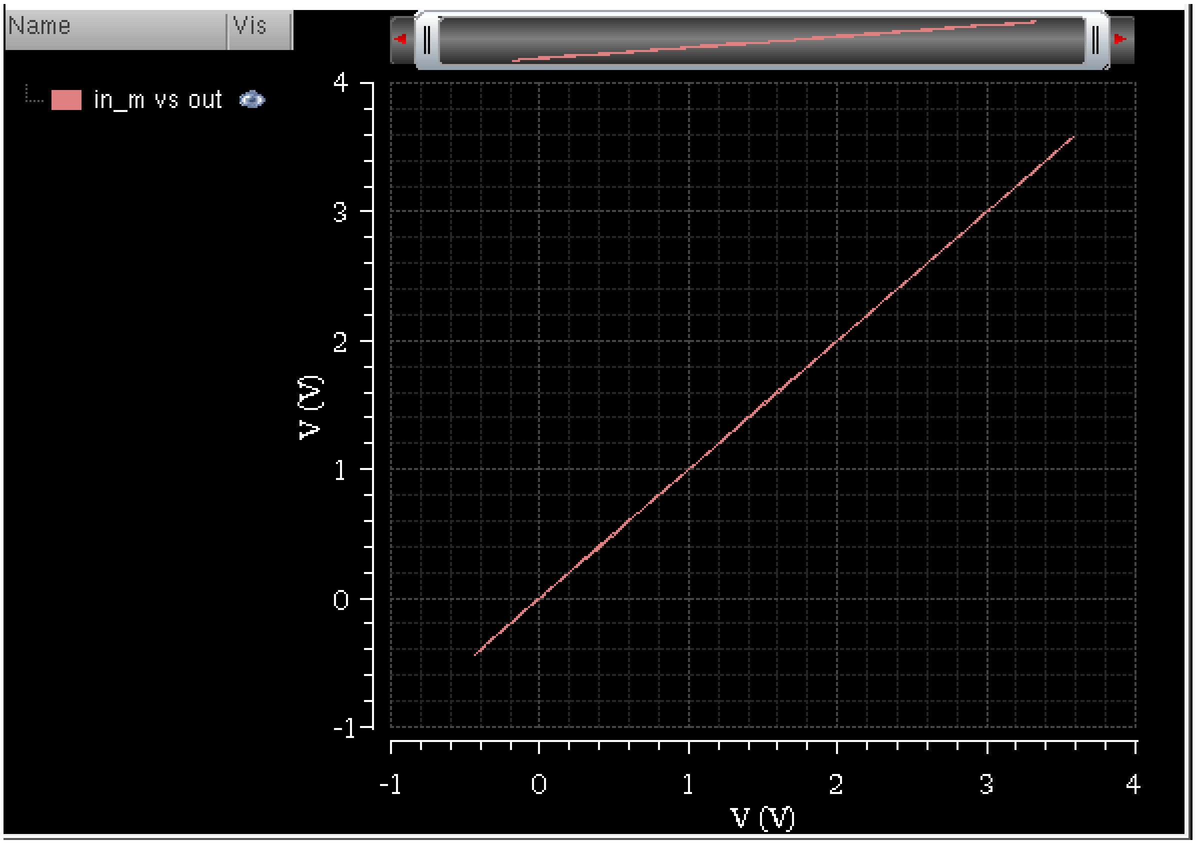


Signal `out`:



When you plot a YvsY graph for these signals, the result is a diagonal line because the signals are identical, as shown in the figure below.

YvsY for `in_m` and `out`:



Plotting the Difference of Two Signals

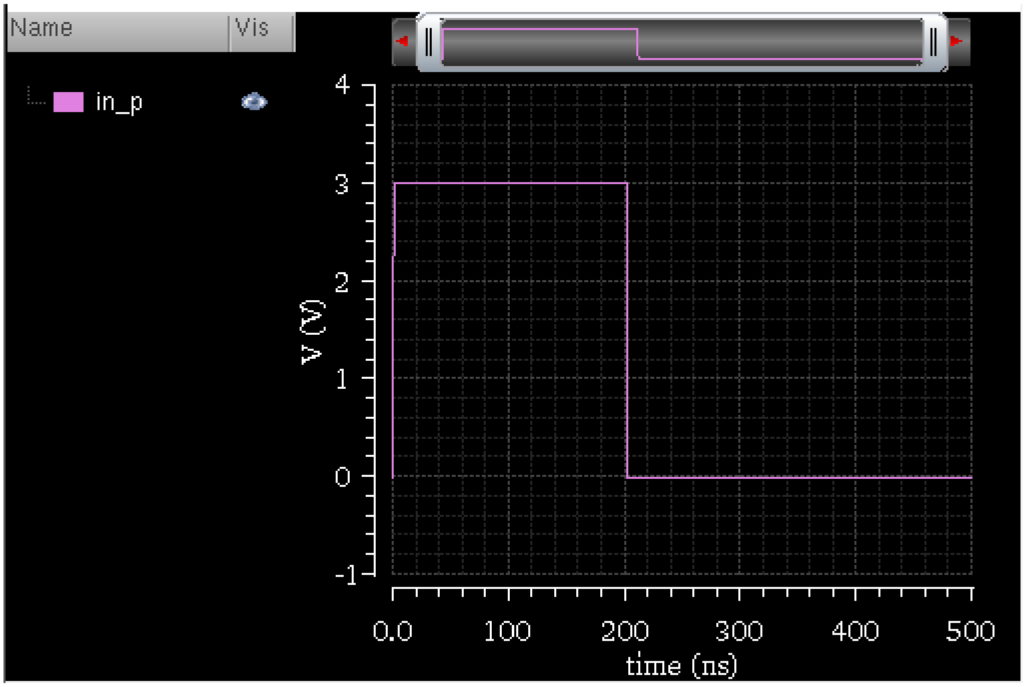
To plot the difference of two signals, select a signal in the Results Browser and do one of the following:

- Click the button and select the second signal.
- Select the second signal and click the button.

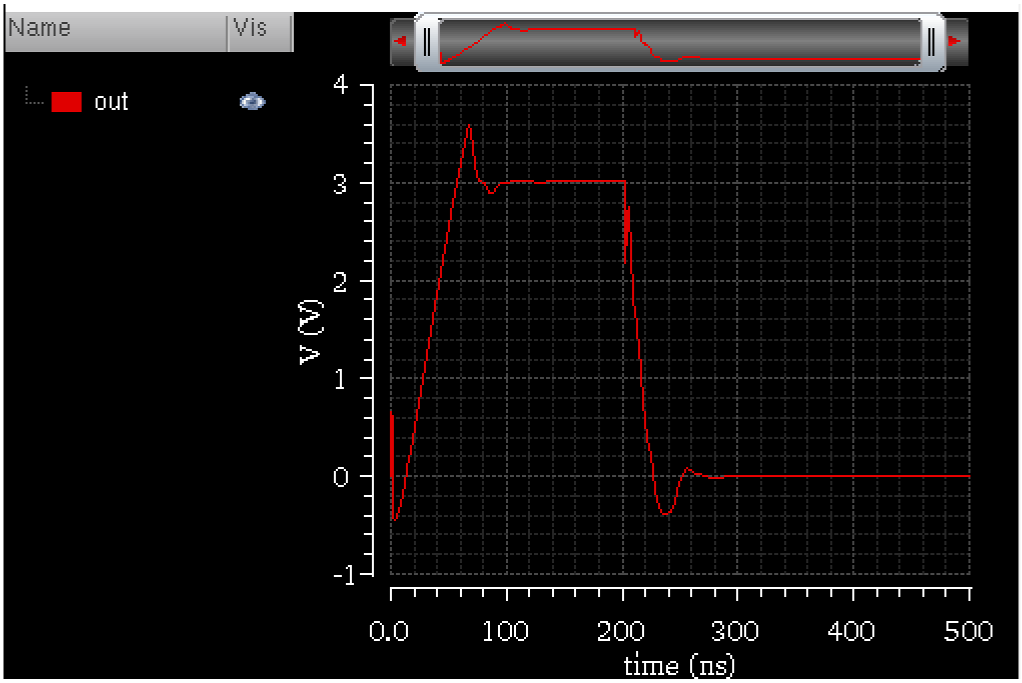
  The difference between the selected signals is plotted in a graph window.

The following figures illustrate an example:

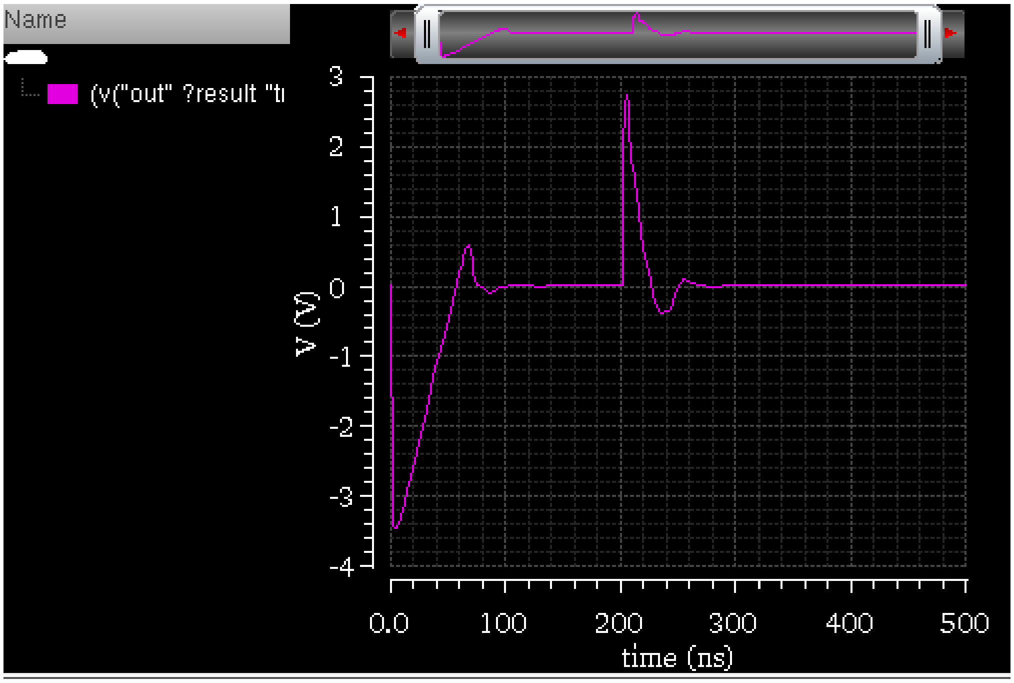
Signal `in_p`:



Signal `out`:



Difference `out` and `in_p`:



Comparing Signals

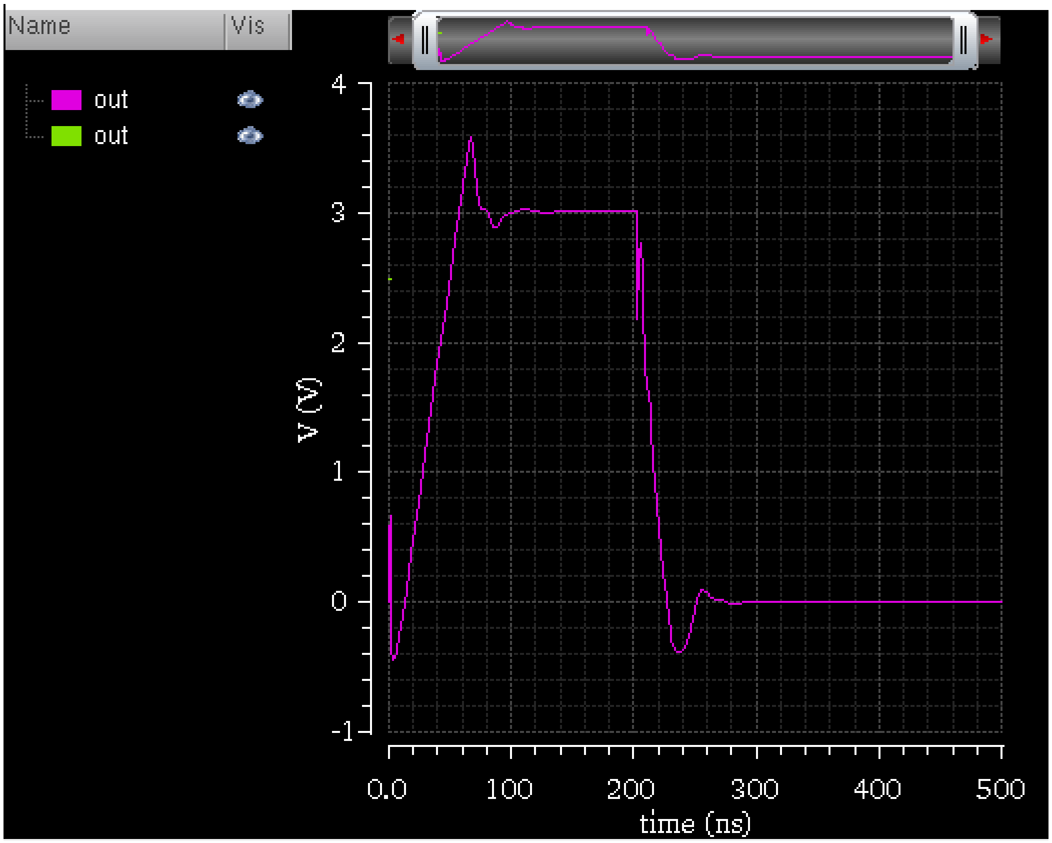
If you run multiple simulations on the same data type, multiple results directories containing the same signals with different values are generated.

You can open these results directories in the Results Browser to compare the signals contained in the results directories. The signals from all the results directories are plotted in a graph window in the append mode to facilitate comparison

You can use one of the following two ways to compare signals:

- Open the respective results directories and plot the signals, one by one, in the append mode in a graph window. This is a time consuming task.
- Right-click the signal in a results directory and choose the *Plot from all DBs*, or select a signal in a results directory and click on the Results Browser.

The figure below shows the `out` signal plotted from two different results directories. The two signals are overlapped because they have same data values.



Exporting Signals

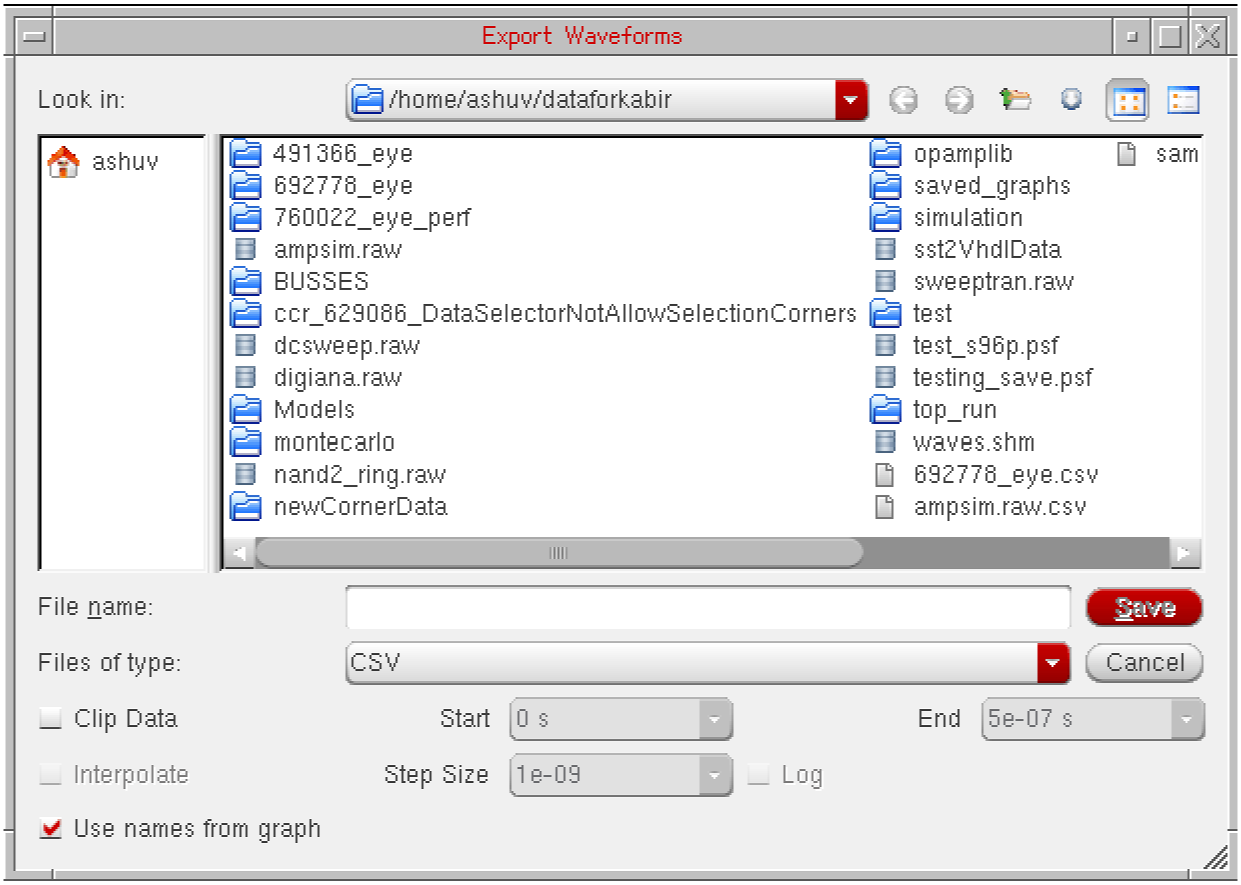
You can export signals from a results directory in a variety of formats and later load these signals in the required application. You can also save a part of the dataset by specifying the start and end values, or interpolate the data before saving it.

To export signals from a results directory, do one of the following:

- Right-click a signal in the Results Browser and choose *Export*. You can select multiple signals by holding down the `Ctrl` key while you click the required signals.

- In the Results Browser, select a signal, and then in the Virtuoso Visualization and Analysis XL window, choose *Browser – Results – Export*.

The *Export Waveforms* form appears.



Look in: /home/ashuv/dataforkabir

File name:

Files of type: CSV

□ Clip Data Start 0 s End 5e-07 s

□ Interpolate Step Size 1e-09 □ Log

☑ Use names from graph

In this form, do one of the following to export the selected a signal:

- In the *Look In* field, browse to locate the path of the data directory where you want to save the selected signal.

  The form includes the following three buttons in the upper-right corner:

  - *Parent Directory*—To open the parent directory. This button is available if you have nested results directories.
  - *Descend Inside Directory*—To view the contents of the parent directory and to move to the next-level directory.
  - *List View*—To display directories in a list view.
  - Detail View—To display directories in the detail view.

- In the *File name* field, specify a file name.

- ❑ In the *Files of type* field, select the file type. The file type (indicated by the file extension) determines the format in which the signal is saved. You can also specify the file type with the file name.

  The supported file types are as follows:

  - ❍ `CSV` (`Comma Separated Value)` format allows saved traces to be imported to spreadsheet and other tools.
  - ❍ `Matlab` format allows saved traces to be imported into Matlab. The Matlab format can be imported to Matlab by using the import wizard.
  - ❍ `SPECTRE` (`Spectre Input)` format allow saved traces to be used as inputs to the Spectre PWL input voltage or current sources.
  - ❍ `PSF` (`Parameter Storage Format`) format is available for use only in the Virtuoso Visualization and Analysis XL tool. The PSF format does not support digital data.
  - ❍ `SST2` format.
  - ❍ `VCSV` (`Visualization & Analysis File)` format (default) allows you to save traces that can be loaded from within the Virtuoso Visualization and Analysis XL tool for use in the future.

  Note: When multiple signals are selected, the signals are placed in a directory specified that you specify in the *Filename* field with each signal saved in a separate file.

- ❑ Select the *Clip Data* check box if you want to export a clip in the signal. Specify the clip start and end values in the *Start* and *End* fields.
- ❑ Select the *Interpolate* check box, if you want to export interpolated data. In the Step Size field, specify the step size. Select *Log* if you want to save the value by using a logarithmic scale.
- ❑ The *Use names from graph* check box is disabled when you export a signal from the Results Browser. If you export a trace from the graph, you can select this check box to use the trace names that are displayed on the graph. When this check box is not selected, you can enter any name
- ❑ Click *Open.*

  The selected signals are exported to the location that you specified.

Using the Calculator

You can use the Calculator to evaluate signals stored in a results directory in the Results Browser. To load the signal from the Results Browser to the Calculator, do one of the following:

- Right-click a signal and choose Calculator.
- Select a signal and click the 🖩 button.

  The Calculator window appears and the selected signal is displayed in the Buffer.

For more information, see Chapter 4, “Working with the Calculator.”

Supporting s-parameters

The Virtuoso Visualization and Analysis XL supports the industry standard Touchstone format that can read the data files created by any simulator. You can use the touchstone s-parameter file to plot the s-parameter and the L, Q, and R data. This format also helps plot nport s-parameter data if you use Spectre and SpectreRF as simulators.

The touchstone file is an ASCII file, also known as the SnP file, which includes a large signals S-parameter results. The touchstone files are of `.snp` extension, where n is the number of network ports of the device. For example, if the touchstone file contains the network parameters for a two port device, it has `.s2p` extension.

3

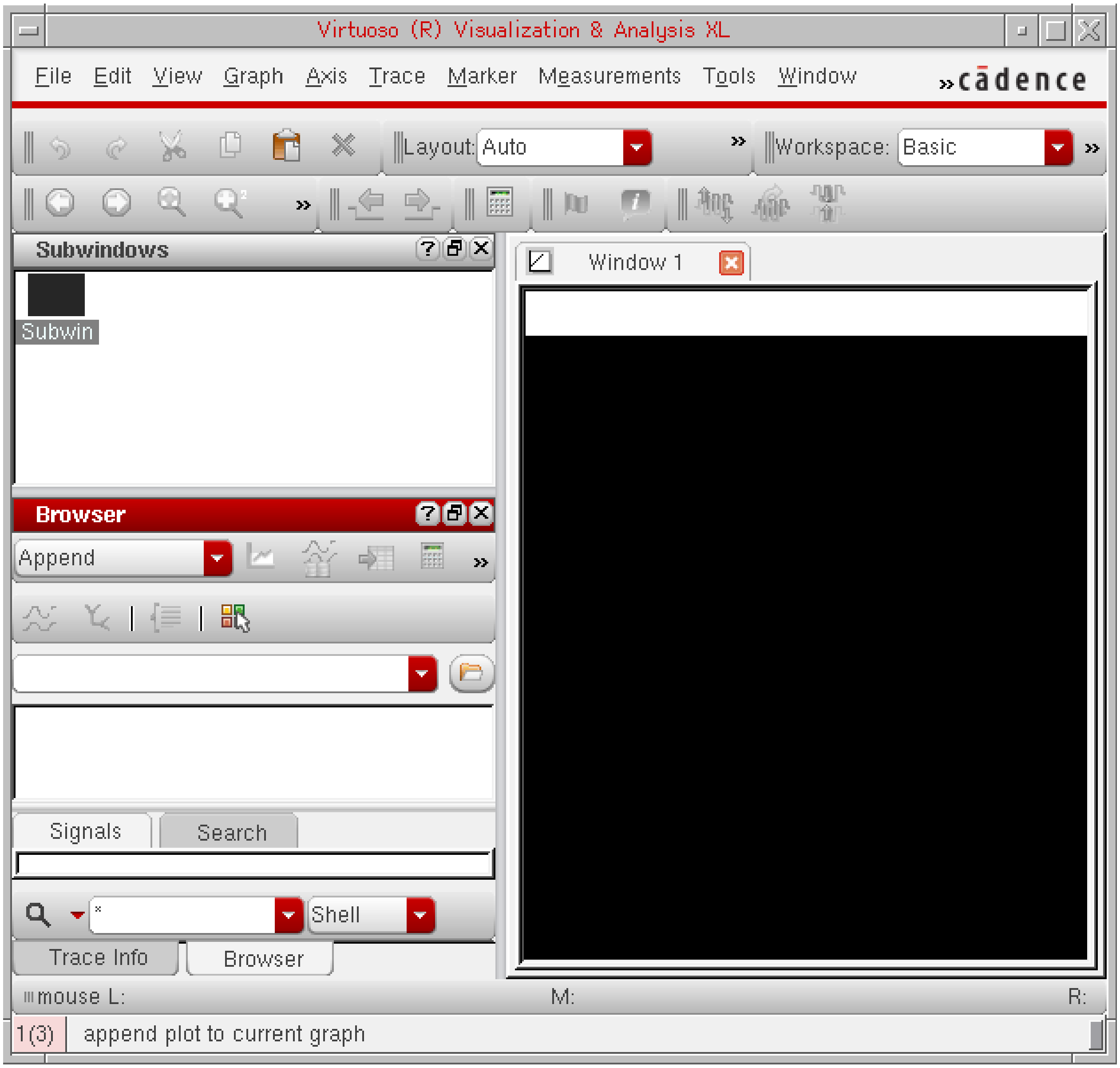
Working with Graphs

The Virtuoso Visualization and Analysis XL graph window is a tool that you use to present the simulation data in a graphical format.

This chapter includes the following topics:

About the Graph Window

Virtuoso Visualization and Analysis XL graph window is a tool that you use to present simulation data in a graphical format. This helps you analyze simulation results. The ability to plot multiple graphs at a time enables you to compare simulation results. You can also customize your graphs by changing the background color and layout, and add markers and labels to annotate the graphs.


Virtuoso (R) Visualization & Analysis XL
File Edit View Graph Axis Trace Marker Measurements Tools Window
cādence
Layout: Auto
Workspace: Basic
Subwindows
Subwin
Window 1
Browser
Append
Signals
Search
Shell
Trace Info
Browser
mouse L:
M:
R:
1(3)
append plot to current graph

When you run the tool for the first time in a new session, a default graph is opened in a tab named *Window 1*. You can rename the window tab names by double-clicking the tab name or by setting the `viva.graphFrame` .cdsenv variable. You can also close the tabs that are not required. In a window, you can open multiple subwindows.

The graph window terminology is explained below:

- Window—Window is the plotting area where you plot signals and open multiple subwindows. A window consists of a trace legend area, X-axis zoom and pan bar, dependent and independent axes, and graph objects. The window names appear on different window tabs, which means when you open a new window, it is opened in a new tab. You can also close and rename the windows if required.
- Subwindow or Graphs—A window can be divided into multiple subwindows, which include all properties of a window, such as trace legend area, pan bar, dependent and independent axes, and graph objects. The subwindow names are displayed in the Subwindows assistants or in the subwindows drop-down list on the Graph toolbar. By default, a new graph window always has one subwindow defined, which is listed in the Subwindows assistant. For example, *Subwin(1)* shown in the figure above. For more information about subwindows, see Subwindows on page 135.
- Strip—A subwindow can be further divided into different strips that include one or more signals. All the strips in a subwindow shares the same independent axis, and X-axis zoom and pan bar.
- Traces, markers, labels, and axes are the graph objects that can be inserted in a window, subwindow, or a strip.

In the graph window tool, you can also choose the assistants you want to display, which is defined by the selected workspace. The default workspace is *Classic*. For more information about Workspaces, see Working with Workspaces on page 137.

You can open the graph window from Virtuoso Visualization and Analysis XL or from the Analog Design Environment (ADE). If you open the graph Window from the Virtuoso Visualization and Analysis XL, you can work with previously saved simulation data. However, if you open the graph window from ADE, you work with the simulation data for the latest run. In both cases, when you select a signal, the graph window appears with the selected signal plotted.

Opening the Graph Window

You can use the following methods to open the graph window:

- Opening the Graph Window from Virtuoso Visualization and Analysis XL on page 67
- Opening the Graph Window from Virtuoso in Stand-Alone Mode on page 67

- Opening the Graph Window from ADE L and ADE XL on page 67

Opening the Graph Window from Virtuoso Visualization and Analysis XL

You can open the graph window in either SKILL or MDL mode from the Virtuoso Visualization and Analysis XL tool. By default, the graph window is opened in the SKILL mode.

Perform the following steps to open the graph window from Virtuoso Visualization and Analysis XL tool:

➡ Start the Virtuoso Visualization and Analysis XL tool by typing the following command in a terminal window:

```
viva -expr skill &
```

The *Virtuoso (R) Visualization and Analysis XL* appears.

Note: If you type only `viva &` in the terminal window, the default mode is SKILL.

For information about how to create a graph in the graph window, see Creating a Graph on page 87.

Opening the Graph Window from Virtuoso in Stand-Alone Mode

To open the graph window from Virtuoso in the stand-alone mode, perform the following step:

- From the CIW, choose *Tools – Analog Environment – Waveform.*

  The *Virtuoso (R) Visualization and Analysis XL* appears.

Opening the Graph Window from ADE L and ADE XL

You can run simulations in ADE L and ADE XL and plot the simulation results in the Virtuoso Visualization and Analysis XL graph window. The Virtuoso Visualization and Analysis XL graph window supports simulation analysis types such as transient, AC, DC, and RF measurement.

To open the graph from ADE L, do the following:

➡ In the ADE L window, choose *Tools – Waveform*.

The *Virtuoso Visualization and Analysis XL* appears.

The graph window also appears after a simulation is run in ADE L, displaying the output signals from the selected analysis types.

In ADE XL, after you run the simulation, you can specify whether you want to save the simulation results to a results database or plot the simulation results in a window. Each item that appears on the ADE XL *Outputs Setup* tab has a *Plot* check box and a *Save* check box. Select the *Plot* check box to display the selected outputs in the window after the simulation run is complete. Select the *Save* check box to save the selected output results to a results database.

Notice the following when you open the window by using ADE L and ADE XL:

- The graph window tab names in Virtuoso Visualization and Analysis XL correspond to the test names in ADE L and ADE XL.
- The subwindow titles display the measurement or analysis names.
- The subwindow titles also display the simulation time or measurement evaluation time.

Note: If you plot multiple graphs in ADE XL, the graphs for each test are plotted in separate window tabs, where as in Java graphs, the graphs are plotted in separate windows.

Graphical User Interface

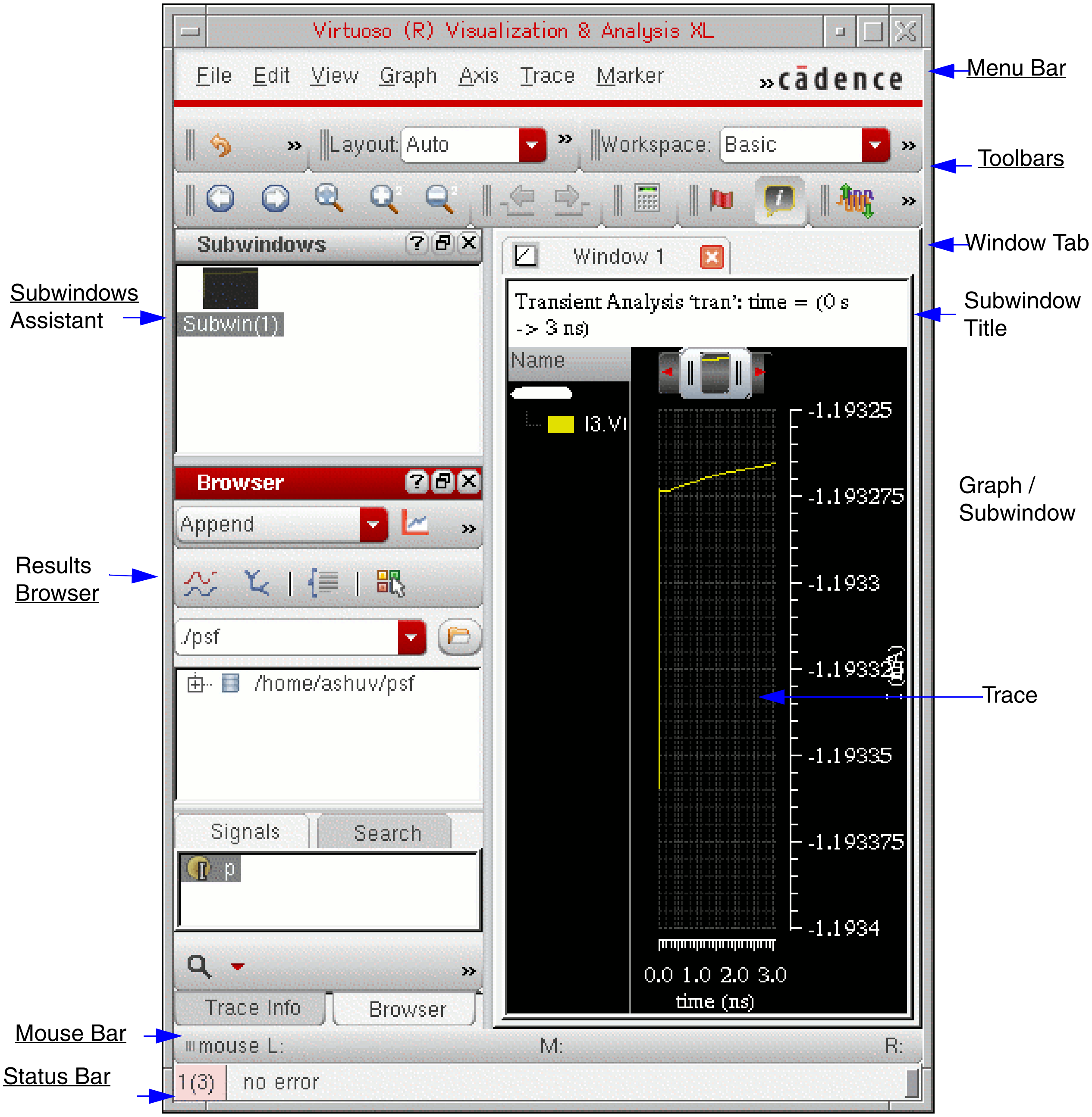
The Virtuoso Visualization and Analysis XL window user interface consists of a menu bar, toolbars, dockable assistants, and subwindows that are displayed according to the selected workspace. You can hide and show these GUI components based on the workspace you select. By default, the assistant panes appear on the left and the graphs appear in the display area on the right. When you plot a signal in the new window, a new window tab is created. You can click the tab to view the required graph and can rename window tabs by double-clicking the tab name. You can also close the window tabs that are not required.

In a window, you can open multiple subwindows. The subwindows includes all properties of a graph window and can be further divided into subwindows.

Note: By default, the window background is black. If required, you can set the background to white. For more information, see Setting the Graph Colors on page 95.

The Virtuoso Visualization and Analysis XL window includes the following elements:

- Menu Bar on page 69
- Toolbars on page 82
- Status Bar on page 86
- Assistants on page 86



Menu Bar

The menu bar has the following menus:

- File on page 70
- Edit on page 71

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- Graph on page 73
- Axis on page 74
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- Marker on page 77
- Measurement on page 78
- Tools on page 79
- Window on page 79
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File

The table below lists the *File* menu commands.

Command	Description
Open Results	Opens the *Select Waveform Database* form that you can use to select a results database. This form displays the current results directory.
Close Results	Closes the selected results directory in the Results Browser.
New Window	Opens a new graph window in the display area. This creates a new window tab.
New Subwindow	Opens a new subwindow in the active window.
Load Window	Loads a file containing a graph in the active window. For more information, see Loading a Graph on page 167.
Save Window	Saves the graph in the active window to a file. For more information, see Saving a Graph on page 165.
Save Window As	Saves a copy of the graph in the active window to a file. For more information, see Saving a Graph on page 165.

Command	Description
Reload	Updates data for all the traces in the active subwindow or all the subwindows. For more information, see Reloading Graphs on page 174.
Print	Sends the graph to a printer or saves the graph in a PDF or Postscript format. For more information, see Printing Graphs on page 181.
Save Image	Saves the graph displayed in the active window as an image file. For more information, see Printing Graphs on page 181.
Close Window	Closes the active window. If there is only one open window, the *Close* command exits the tool.
Close All Windows	Closes all windows and exits the tool.

Edit

The table below lists the *Edit* menu commands.

Command	Description
Undo	Undoes the most recent action in the active window.
Redo	Redoes the most recent action in the active window.
Cut	Moves the selected graph objects to the clipboard.
Copy	Copies the selected graph objects to the clipboard.
Paste	Pastes the contents of the clipboard to the selected location.
Delete	Deletes selected objects, such as labels, markers, traces, or graphs. **Note:** If no object is selected, a message appears confirming the deletion of the active subwindow. If only one window is open, the *Delete* command is not available.

Command	**Description**
Delete All	Deletes all the objects and graphs in the active window. If only one window is open, the *Delete All* command is not available.
Properties	Enables you to modify the properties of the recently selected graph object. By default, the graph properties form appears if you do not select any object.

View

The table below lists the *View* menu commands.

Command	**Description**
ZoomIn by 2	Zooms in the graph by a factor of two.
ZoomOut by 2	Zooms out the graph by a factor of two.
Fit	Returns the graph to the actual size to fit in the window.
Previous	Enables you to view the graph at the magnification specified before the last zoom in or zoom out command was run. You can use this option when you zoom in or out a graph multiple times.
Next	Undoes the *Previous* command. You can use this option when you zoom in or out a graph multiple times. **Note:** The *Next* and *Previous* commands help you navigate through the zoom and the pan stack.
Fit Trace	Returns the selected trace to its actual size to fit in the window. When you select this option, the X-axis zoom of all the strips is displayed in the actual size, where as the Y-axis zoom of only selected axis is changed
Fit Smith	Returns the selected Smith chart to its actual size so that it fits into the window.

Graph

The table below lists the *Graph* menu commands.

Command	Description
Layout	Specifies how subwindows are displayed in the active window. You can select the layout as *Auto*, *Vertical*, *Horizontal*, and *Card*. For more information about graph layouts, see Specifying the Graph Layout on page 90.
Display Type	Specifies the display type for the traces in a graph. Traces can be displayed as follows: ■ *Rectangular*—Displays the trace as a rectangular graph by joining all trace points. This is the default display type. ■ *Histogram*—Displays the trace as a histogram. If you select this option, the calculated values for number of samples, mean, and standard deviation are also displayed. ■ *Scatter*—Displays only the trace points. ■ *Real Vs Imag*—Plots the real part of the data against the corresponding imaginary part. This selection is available only for AC and RF data.
Add Label	Adds a label to the graph. For more information about graph labels, see Working with Graph Labels on page 156.
Freeze	Locks the graph from any data updates. For more information, see Freezing Graphs on page 113.
Visible	Shows or hides the active graph.
Split Current Strip	Splits the graph into as many strips as there are traces and displays each trace in the graph in a separate strip. You can also select this command from the Strip toolbar. For more information, see Working with Strips on page 146.
Plot to New Strip	Plots the selected trace in a new strip.

Command	Description
Combine All Analog Traces	Combines all the individual analog traces into a single graph. For more information, see Combining Graph Strips on page 148.
Filter By Sweep Var	Displays the traces for the selected sweep variable range.
Redraw	Refreshes the graph and plots the updated graph in the same window. This command also refreshes the trace legend area.
Properties	Sets the graph properties. You can set the general graph properties as well as the strip properties in the *Graph Properties* form that appears when you select *Properties*. For more information, see Editing Graph Properties on page 100.

Axis

The table below lists the *Axis* menu commands.

Note: These commands are available only if you select an axis in the graph.

Command	Description
Major Grids	Displays the major grid lines for the selected X or Y axis.
Minor Grids	Displays the minor grid lines for the selected X or Y axis.
Log	Displays the logarithmic scale for the selected X or Y axis.
Select Attached Traces	Selects all the traces that are attached to the axis you select.
Y vs Y	Displays the YvsY plot of the selected axis in the window. This command is available only for the sweep data. For more information, see Plotting YvsY Graph on page 162.

Command	Description
Swap Sweep Var	Enables you to swap sweep variables. This command is available only if you select the sweep data. For more information, see Swapping Sweep Variables on page 150.
Properties	Sets the attributes for the selected X or Y axis. For more information, see Editing Graph Axis Attributes on page 101.

Trace

The table below lists the *Trace* menu commands.

Command	Description
Symbols On	Displays symbols on individual data points for the selected trace. **Note:** This command is available only if you select one or multiple trace in the graph.
Select by Family	Selects all the traces with the parametric sweep data that belong to a family. When you enable this command, and select a trace in the family, all traces that belong to the same family are selected.
Strip by Family	Displays traces that belong to the same family in a single strip when you split traces into strips. If more than one family of traces are present, each family is displayed in a separate strip.
Fit Trace	Returns the selected trace to its actual size to fit in the window. When you select this option, the X-axis zoom of all the strips is displayed in the actual size, where as the Y-axis zoom of only selected axis is changed.
Disable Reload	Disables the reloading of a trace by locking the database context and the trace is not reloaded with new data when the in-context results directory is changed. For more information, see Disabling Trace Reload on page 180.
Select All	Selects all traces in a graph.

Command	Description
Delete All	Deletes all the traces displayed in the active graph. The independent axis, window title, and pan bar are not deleted.
Move to	Moves the selected trace to the following locations: ■ *New Window*—Moves the selected trace to a new window. ■ *New Subwindow*—Moves the selected trace to a new subwindow. ■ *New Strip*—Moves the selected traces to a new strip.
Copy to	Copies the selected trace to the following locations: ■ *New Window*—Copies the selected trace to a new window. ■ *New Subwindow*—Copies the selected trace to a new graph subwindow. ■ *New Strip*—Copies the selected trace to a new graph strip.
Bus	This command has the following options: *Create*—Creates a bus from the selected digital traces. For more information, see Creating a Bus on page 189. *Expand*—Expands a bus to its component signals. For more information, see Expanding a Bus on page 192. **Note:** This option is available only if you select a digital bus. *Collapse*—Collapses the bus components to display the complete bus. **Note:** This option is available only if you expand the bus.

Command	Description
Export	Exports the selected trace in the active window in a variety of formats and later loads it in the required application.
Properties	Enables you to specify properties of the selected trace. For more information, see Setting Trace Properties on page 143. **Note:** This option is available only if you select a trace in the graph.

Marker

The table below lists the *Marker* menu commands.

Command	Description
Tracking Cursor	Enables or disables the tracking cursor for the graph. When you move the mouse pointer on a trace or on a graph object, the tracking cursor displays the trace name and the graph object information.
Snap Tracking Cursor	Snaps the tracking cursor to the simulation points. When you move the mouse pointer on the simulation points on a trace, the tracking cursor displays the trace name and the graph object information
Create Marker	Creates a new marker for the trace in the graph. For more information, see Adding Markers on page 194.
Create Delta Marker	Creates a new delta marker. To create a delta marker, you need to place a point marker on the trace or select an existing point marker. For more information, see Adding AB Marker on page 205.
Show Child Labels	Shows or hides marker labels for the delta markers. For more information, see
Delete all	Deletes all the markers displayed in the active subwindow or a graph.
Export Table	Exports the selected marker information in a given format.

Command	Description
Properties	Specifies the properties for a marker. For more information, see Setting Marker Properties on page 199. **Note:** This command is available only if you select a marker on the graph.

Measurement

The table below lists the *Measurement* menu commands.

Command	Description
Eye Diagram	Plots an eye diagram for the selected graph. The eye diagram divides the waveforms into fixed time periods, which are then superimposed on each other. When you select this command, the Eye Diagram assistant appears. For more information, see Eye Diagram on page 124.
Spectrum	Plots a spectrum for the selected graph. When you select this command, the Spectrum assistant appears. For more information, see Spectrum on page 115.
Analog to Digital	Converts an analog signal into a corresponding digital signal. For more information, see Converting a Digital Signal to an Analog Signal on page 187. **Note:** This command is available only in the SKILL mode.
Digital to Analog	Converts a digital signal into a corresponding analog signal. For more information, see Converting an Analog Signal into a Digital Signal on page 185. **Note:** This command is available only in the SKILL mode.

Tools

The table below lists the *Tools* menu commands.

Command	Description
Calculator	Opens the Virtuoso Visualization and Analysis XL Calculator window. For detailed information about working with the Calculator, see Chapter 4, "Working with the Calculator."

Window

The table below lists the *Window* menu commands.

Command	Description
Assistants	Displays or hides the selected assistant panes. The available assistants are—Spectrum, Browser, Marker Toolbox, Eye Diagram, Trace Info, Marker Table, and Subwindows. For more information, see Assistants on page 86. For more information about assistant panes, see the *Virtuoso Design Environment User Guide*.
Workspaces	Displays, saves, loads, and configures the selected workspace. The available workspaces are—`Basic`, `Browser`, `Classic`, and `MarkerTable`. For more information, see Working with Workspaces on page 137. For more information about workspaces, see "Getting Started with Workspaces" in *Virtuoso Design Environment User Guide.*
Toolbars	Displays or hides the selected toolbars. The available toolbars are—Edit, View, Graph, Calculator, Snap, Marker, Strip, and Workspaces. For more information about toolbars, see Toolbars on page 82.

Browser

The table below lists the *Browser* menu commands.

Command	**Description**
Results	Includes the following Results Browser commands: ■ *Open Results*—Opens the results directory in the Results Browser. When you select this command, the *Select Waveform Database* form appears that you can use to select the results database. ■ *Export*—Exports a selected signal from the Results Browser. ■ *Close Results*—Closes the results directory in the Results Browser. This is available only if you select a results directory in the Results Browser. ■ *Reload*—Reloads the results directory that was last open into the Results Browser. ■ *Set Context*—Enables you to set the database in-context results directory, which you use to plot signals in the Results Browser. The first results directory that you load in the Results Browser is set as the in-context results directory.

Command	Description
Options	Includes the following commands: ■ *Graph Modifier*—Includes commands that you can use to specify how the graph is plotted: ❑ *Magnitude*—Plots magnitude versus frequency. ❑ *Phase*—Plots phase versus frequency. ❑ *WPhase*—Plots wrapped phase versus frequency. ❑ *Real*—Plots real value of the dependent data versus frequency. ❑ *Imaginary*—Plots imaginary value of the dependent data versus frequency. ❑ *dB10*—Plots *dB10* value of the dependent data versus frequency. ❑ *dB20*—Plots *dB20* value of the dependent data versus frequency. ❑ *dBm*—Plots mili dB value of the dependent data versus frequency. ■ *Plot Style*—Enables you to select the mode in which a graph is to be plotted. The signal in the graph can be plotted in the following modes: ❍ *Append*—Adds the signal to the selected graph. ❍ *Replace*—Replaces the signal in the selected graph with the new signal. ❍ *New Subwindow*—Plots the signal in a new subwindow within the active window. ❍ *New Window*—Plots the signal in a new window. ■ *Select Data*—Sets the sweep range for the data. When you select this command, the *Set Sweep Ranges* form appears. This command is available only if the dataset selected in the Results Browser supports ranging, such as the PSF transient dataset, or contains parametric sweep data.

Command	Description
	■ *Enable Fast Waveforms*—Enables the fast waveform format in which the Virtuoso Visualization and Analysis XL tool can render extremely large datasets within seconds.

Help

The table below lists the *Help* menu commands.

Command	Description
Contents	Displays the *Virtuoso Visualization and Analysis Tool User Guide.*
Cadence Online Support	Displays the Cadence customer support website in your default Web browser.
Online User Forum (cdnusers.org)	Displays the online users' forum website in your default Web browser
Known Problems and Solutions	Displays *Virtuoso Visualization and Analysis Tool Known Problems and Solutions.*
What's new	Displays *Virtuoso Visualization and Analysis Tool What's New.* ■ *In this Release*—Displays*Virtuoso Visualization and Analysis Tool What's New.* ■ *Videos*—Displays the What's New videos. ■ *Overview*—Displays the Virtuoso Visualization and Analysis XL Overview window.
About Visualization and Analysis	Displays the version number of the Virtuoso Visualization and Analysis XL tool.

Toolbars

The Virtuoso Visualization and Analysis XL has the following toolbars:

- Mouse Bar on page 83

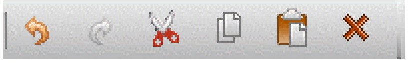
- Edit Toolbar on page 83
- View Toolbar on page 84
- Graph Toolbar on page 84
- Calculator Toolbar on page 84
- Snap Toolbar on page 85
- Marker Toolbar on page 85
- Strip Toolbar on page 85
- Workspace Toolbar on page 86

Mouse Bar

Displays at the bottom of the Virtuoso Visualization and Analysis XL window to indicate the left, middle, and right mouse movements.

Edit Toolbar

The Edit toolbar contains the following buttons:

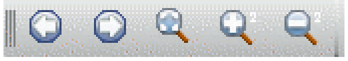


- Undo
- Redo
- Cut
- Copy
- Paste
- Delete

For information about these toolbar buttons, refer to the Edit menu commands.

View Toolbar

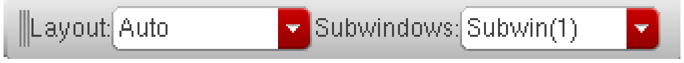
The View toolbar contains the following buttons:



- Previous
- Next
- Fit
- ZoomIn by 2
- ZoomOut by 2
- Fit Trace
- Fit Smith

For information about these toolbar buttons, refer to the View menu commands.

Graph Toolbar



Layout: Auto Subwindows: Subwin(1)

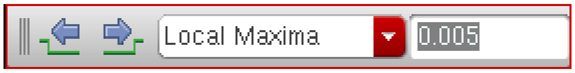
The Graph toolbar contains two drop-down list boxes:

- *Layout*—Lists the graph layouts that you can use to change the layout of the active window. A layout can be of type—*Auto, Vertical, Horizontal,* or *Card*. For more information about graph layouts, see Specifying the Graph Layout on page 90.
- *Subwindows*—Lists all the subwindows that are open in an active window. When you select a subwindow in this list, the selected subwindow is highlighted in the window as well as in the Subwindows assistant. For more information about subwindows, see Subwindows on page 135.

Calculator Toolbar

Displays the Calculator button to send the selected trace to the Calculator Buffer.

Snap Toolbar



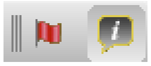
The Snap toolbar contains the following buttons:

- *Previous Edge*—Moves the selected marker to previous edge based on the snapping criteria selected.
- *Next Edge*—Moves the selected marker to the next edge based on the snapping criteria selected.
- Snapping Criterion—Displays the criterion based on which the selected marker is snapped.
- Value—Displays the value of the snapping criterion.

This toolbar is available for both analog and digital signals and the toolbar options work if you select a marker. For more information, see Snapping Markers on page 209.

Marker Toolbar

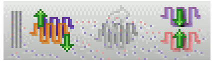
The Marker toolbar contains the following buttons:



- *Create Marker*—Creates a marker on the selected trace. For more information about how to create a marker, see Adding Markers on page 194.
- *Tracking Cursor*—Turns the tracking cursor on and off for the selected window. For more information, see Tracking Cursor on page 142.

Strip Toolbar

The Strip toolbar contains the following buttons:

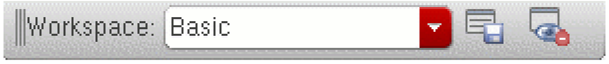


- *Split Current Strip*—Displays the traces in a window in individual strips. For more information, see Working with Strips on page 146.
- *New Strip*—Moves the selected trace to a new strip in the same window.

- *Combine All Analog Traces*—Displays all analog traces from individual strips to a single g. For more information, see Combining Graph Strips on page 148.

Workspace Toolbar

You can use the Workspace toolbar to work with the available workspaces.



For more information about workspaces, see Working with Workspaces on page 137.

Status Bar

The status bar displayed at the bottom of the window displays the following information:

- Warnings and error messages.
- Static information, such as the name of the toolbar button selected in the window.
- Dynamic information, such as the toolbar names are displayed when you perform mouse-hover on toolbars.

Assistants

The Virtuoso Visualization and Analysis XL includes the following assistants:

- Spectrum
- Browser
- Marker Toolbox
- Eye Diagram
- Horiz Marker Table
- Trace Info
- Vert Marker Table
- Subwindows

For detailed information about assistants, see Working With Assistants on page 114.

Creating a Graph

You can create a graph by plotting a signal selected in the Results Browser in the window. To group similar graphs or to compare two graphs, you can open multiple subwindows in a window.

To create a graph, perform the following steps:

1. In the Results Browser, open a results directory and select the signal you want to plot.
2. To select the window where you want to plot the signal, do one of the following:
    - Choose *Browser – Options – Plot Style.*

      The *Plot Style* can be of the following types:
        - *Append*—Adds a signal to the selected graph.
        - *Replace*—Replaces the graph in the active window with a new graph.
        - *New Window*—Plots the signals in a new window. When you create a graph for the first time, it is always displayed in a new window.
        - *New Subwindow*—Plots the graph in a new subwindow within the active window.
    - Right-click the required signal in the Results Browser and choose the destination graph. The plot options that appear on the shortcut menu are the same as those explained above.
3. After you specify the destination graph, do one of the following to plot the signal:
    - Double-click the signal.
    - Right-click the signal and select the *Plot Signal* option.
    - Click the 📉 button in the Results Browser.

   The graph appears in the selected destination window.

Note: You can also drag signals from the Results Browser to Subwindows assistant. If you drop the signal on a selected subwindow icon displayed in the Subwindows assistant, the signal is plotted in the selected subwindow in append mode. However, if you drop the signal anywhere in the Subwindows assistant, the signal is plotted in a new subwindow.

Customizing a Graph

After you have created a graph, you can customize it to analyze the graph data.

This section contains the following topics:

Determining the Active Window

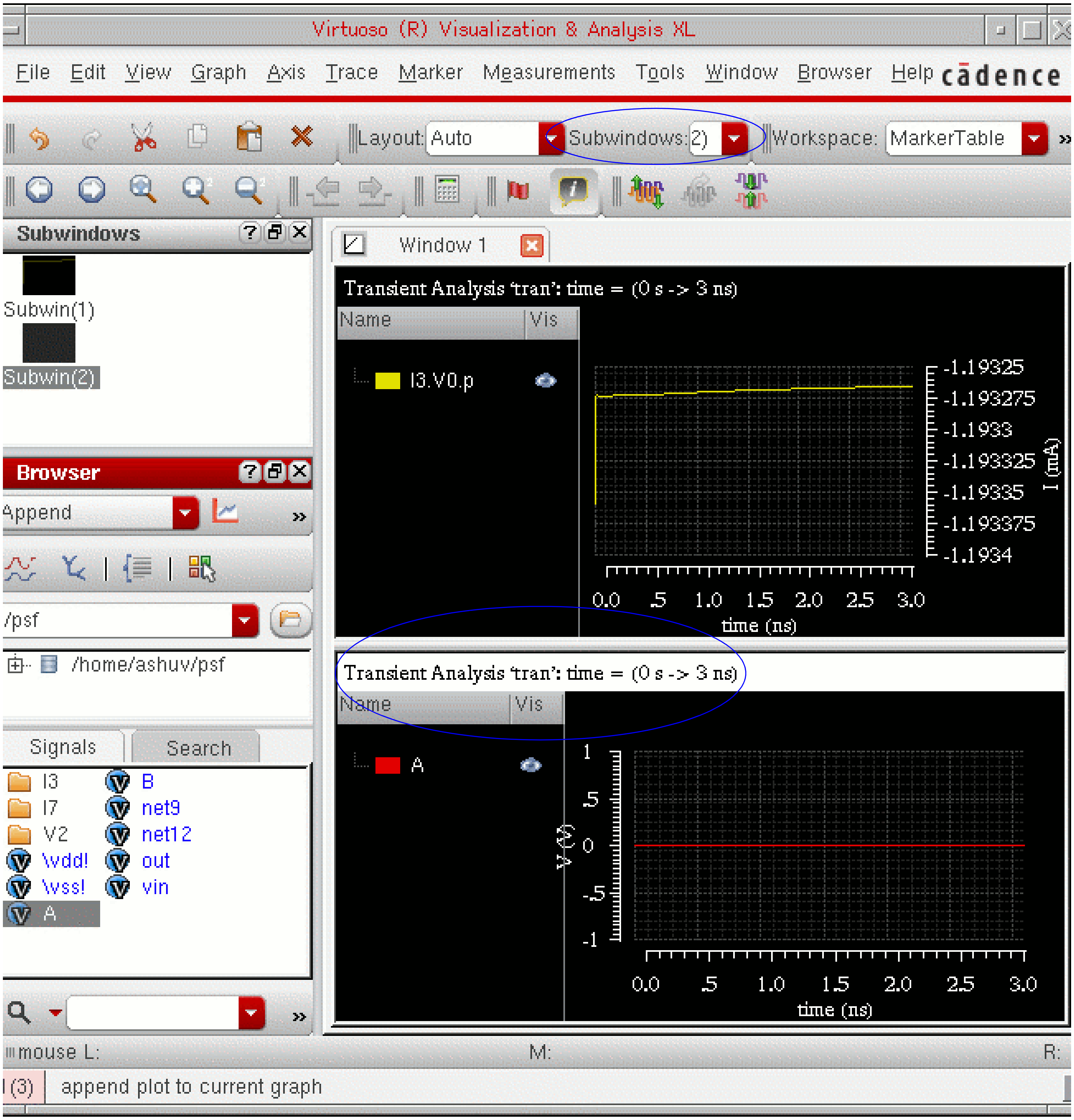
The active window tab appears white and the inactive window tabs appear grey. When you click a window tab, that window becomes active and the tab color changes to white.

Determining the Active Subwindow

A window can contain subwindows. The following features help you determine the active subwindow:

- The name of the subwindow displayed below the thumbnail image in the Subwindows assistant is highlighted in grey.
- The *Subwindows* drop-down list on the Graph toolbar displays the name of the active subwindow.

- In the active subwindow, the title displaying the simulation analysis type and the simulation run date and time. The title font is in contrast with the background.



Note: You can also make a graph active by clicking anywhere in the graph or by dragging a trace to the graph. For more information about dragging traces, see Dragging Traces on page 142.

Specifying the Graph Layout

A window can have several subwindows that are displayed in the specified layout.

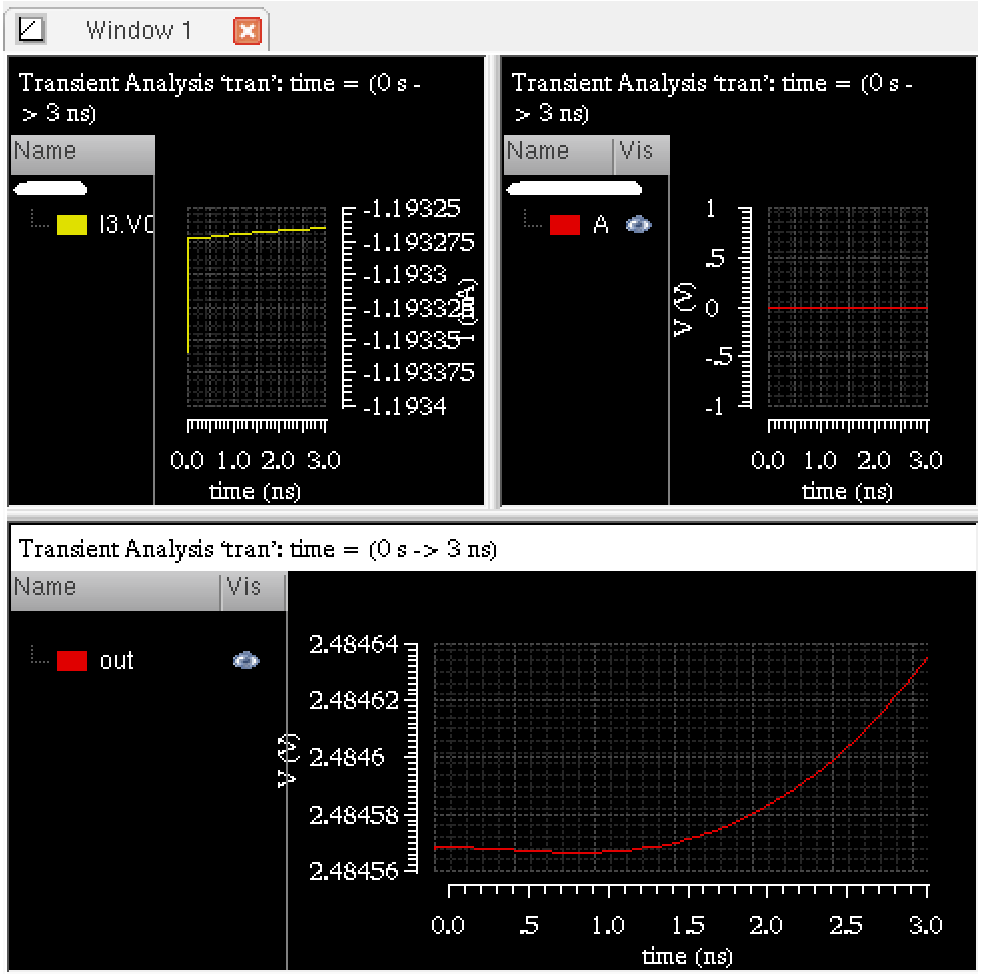
To specify the layout for subwindows, do one of the following:

- Choose *Graph – Layout* and select the layout that you want to apply.
- In the *Layout* drop-down list on the Graph toolbar, select the layout you want to apply.
- Right-click anywhere in the subwindow and choose the required layout from the *Layout* menu.

The following graph layouts are available:

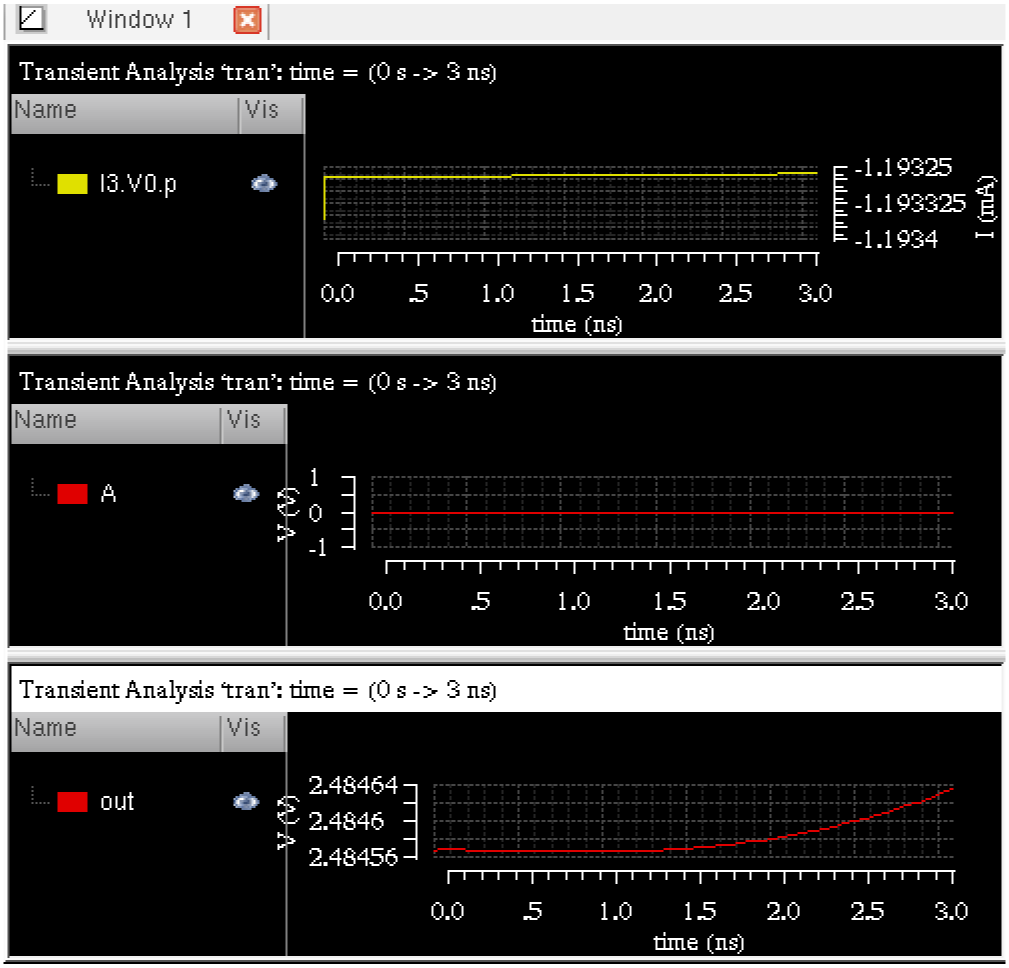
- *Auto*

This is the default layout. In this layout, subwindows are displayed by dividing the active window vertically and horizontally. The aspect ratio determines how the active window is divided. The following figure displays subwindows arranged in the auto graph layout.



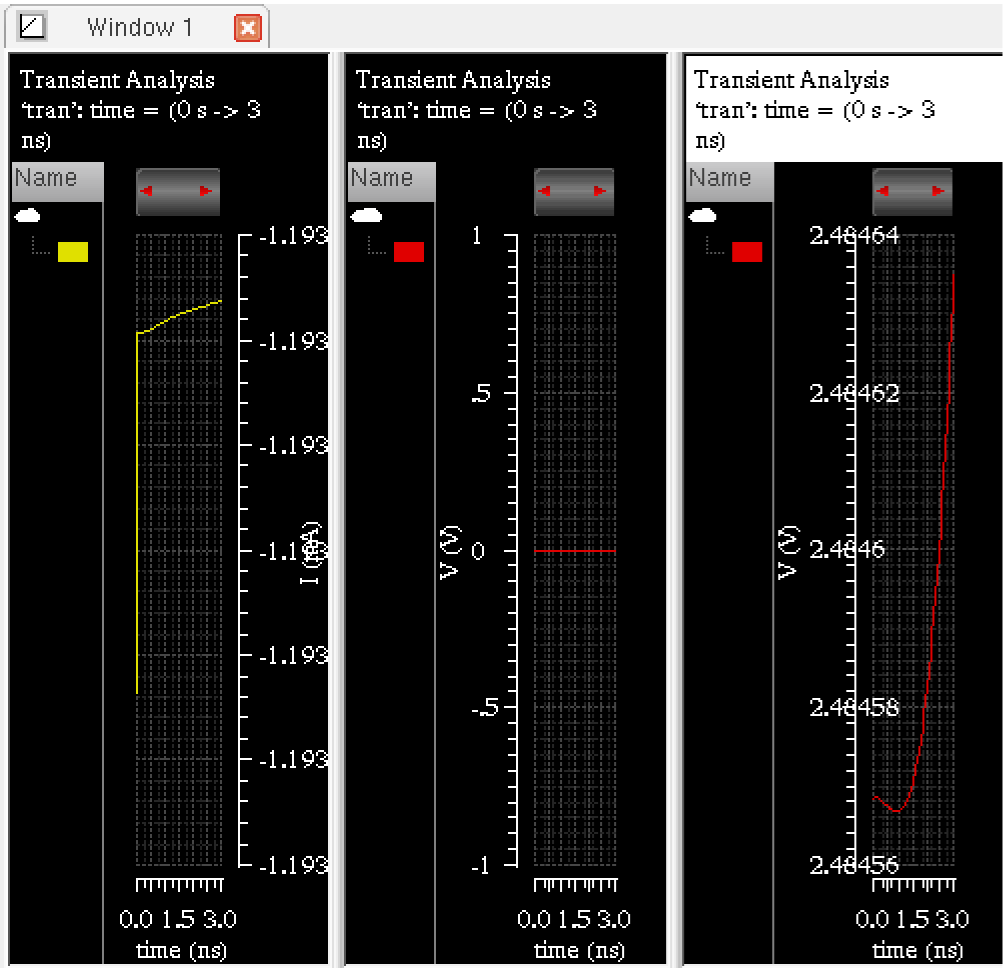
- *Vertical*

  In this layout, subwindows are displayed one below the other in the active window. The following figure displays subwindows arranged vertically.



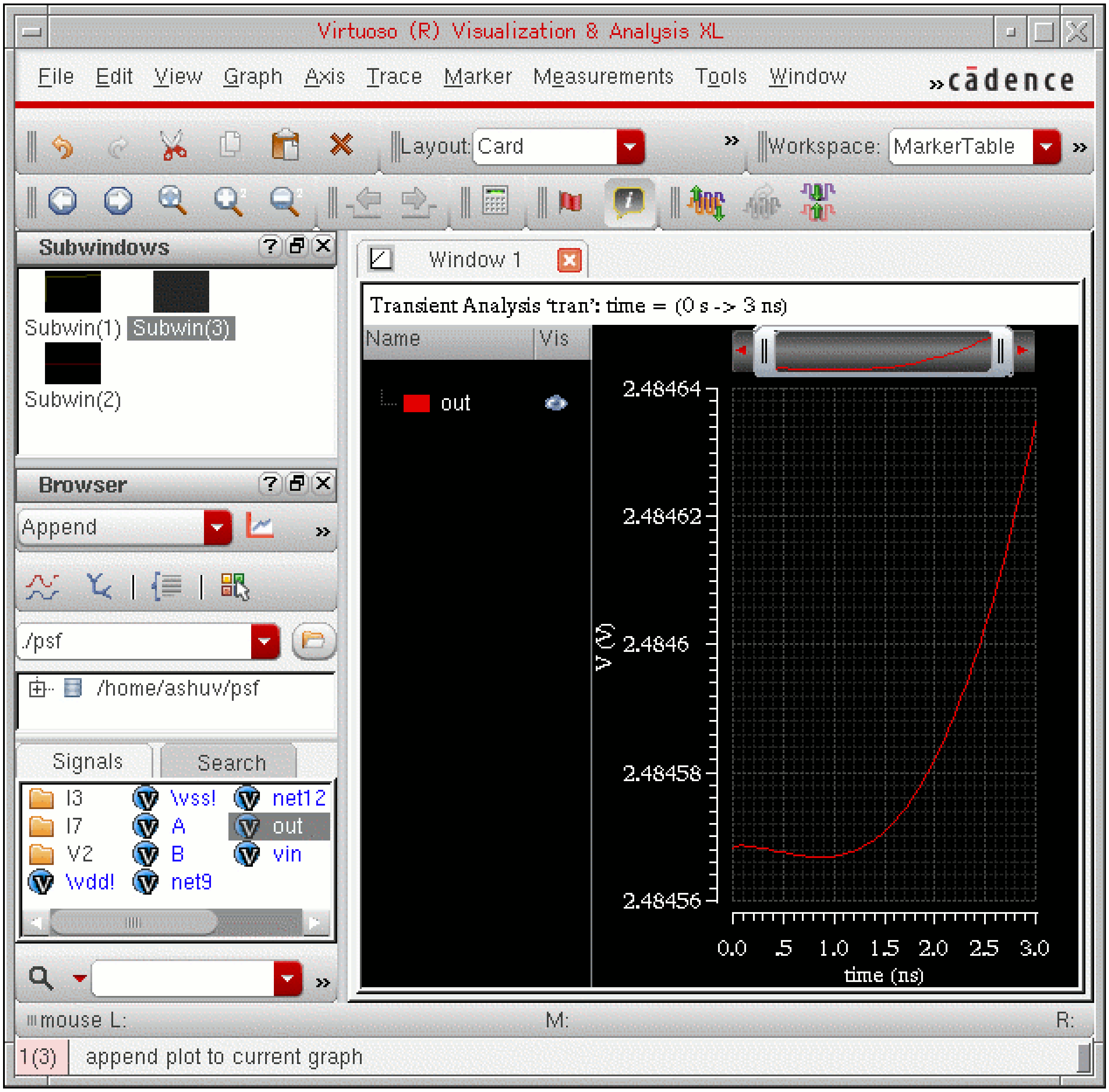
- *Horizontal*

  In this layout, subwindows are displayed side by side in the active window. The following figure displays subwindows arranged horizontally.



- *Card*

  In this layout, subwindows are stacked, like a deck of card, in the active window one on top of the other with only one graph is visible at a time. If you want to view another subwindow, you can select the required subwindow in the Subwindows assistant or in drop-down list on the subwindows toolbar. The following figure displays three subwindows arranged in the card layout.



Layout: Card

Workspace: MarkerTable

Transient Analysis 'tran': time = (0 s -> 3 ns)

mouse L: M: R:

1(3) append plot to current graph

Video

The video Using Subwindows in Qt Graph demonstrates how to change the graph layout and how to plot signals in different subwindows.

Setting the Graph Colors

The default color scheme for rectangular graphs is determined by the `viva.rectGraph background` and `viva.rectGraph foreground` variables in the `.cdsenv` file. The default color scheme for circular graphs is determined by the `viva.circGraph background` and `viva.circGraph foreground` variables in the `.cdsenv` file. The default color scheme is as follows:

- Black when you open the graph by using Virtuoso Analog Design Environment (ADE) mode or in the stand-alone SKILL mode
- White in the stand-alone MDL mode

To change the background color of a window, do the following:

1. In the window, choose *Graph – Properties.*
2. Click the *General* tab and select a background color in the *Color* field.

   Note: When you change the background color of the graph, Virtuoso Visualization and Analysis XL automatically adjusts the color contrast of various graph objects, such as traces, markers, labels, and tracking cursor to make them clearly visible on the graph.

Renaming and Closing Window

To rename a window, double-click the window tab and type the new name.

To close the window, close the window tab by clicking the cross button.

Handling Graph Objects

This section describes how you can select and delete a graph or its components, such as traces, axes, markers, and labels.

Selecting Objects

Click the graph or its component, such as trace, marker, or label, to select it. You can select multiple objects by holding down the `Ctrl` key while you click the required graph objects.

Deleting Objects

You can delete the objects, such as graphs, labels, markers, legends, and traces. You can also delete a window or a subwindow.

To delete an object, do the following:

1. Select the object you want to delete.
2. Choose *Edit – Delete*, or press the `Delete` key.

   The object selected in the window is deleted.

To delete all objects, select an object or a subwindow and do one of the following:

- Choose *Edit – Delete All.*
- Press `E`.

To delete all markers in a window, choose *Marker – Delete All* or press `Ctrl+E`.

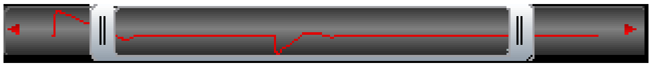
To delete all traces in a window, choose *Trace – Delete All* or press `Shift+E`.

Panning and Zooming Graphs

You can pan and zoom a graph by using the pan bar and scroll bar displayed in the graph window.

Panning a Graph

You can use the pan bar located at the top of the window to pan a graph. When you plot a signal in the graph, the width of the pan bar is adjusted so that the entire graph is visible. Resize the pan bar by dragging either end of the pan bar inward to view the required portion of a graph. The selected portion of the graph is zoomed in to display greater detail. When the size of the pan bar is less than maximum, drag the pan bar to the left or right to view portions of the graph that are currently outside the display area. You can also click anywhere in the pan bar area to move the pan bar to that location.



Alternatively, to pan a graph, do one of the following:

- Right-click anywhere in a graph and choose *View – Pan Left / Pan Right / Pan Up / Pan Down*.

- Press the arrow keys to pan the graph in the required direction.

Zooming a Graph

The Virtuoso Visualization and Analysis XL tool supports multiple zooming operations.

To zoom in or out a graph, choose one of the following options from the *View* menu or click the relevant button on the zoom toolbar.

- *ZoomIn by 2*

  Zooms in the graph by a factor of two. A vertical scroll bar appears on the right side to help view graph areas outside the current window. To move horizontally to view areas outside the window use the pan bar displayed on the top of the window.

- *ZoomOut by 2*

  Zooms out of the graph by a factor of two.

- *Fit*

  Fits the graph in the window. Alternatively, right-click the trace and choose *Fit Trace* to fit the graph in the window. You can also use the bind key `f` to perform the zoom fit.

- *Previous*

  Incrementally reverses a series of zoom and pan actions.

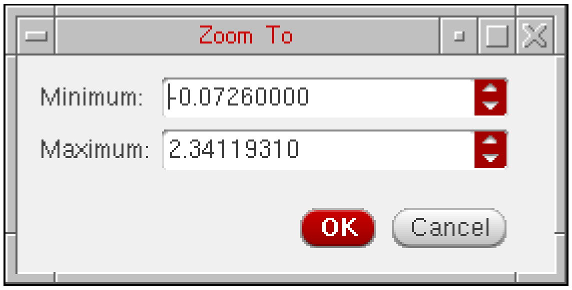
- Next

  Incrementally undoes the effect of the *Previous* command.

Alternatively, to pan and zoom in or out a graph, do the following:

- To pan a graph, right-click anywhere on the pan bar and choose one of the following options:

- ❑ *Zoom to*—Zooms out the graph according to the specified size of the pan bar. When you select this option, the *Zoom To* form appears. In this form, select the maximum and minimum values for the pan bar.



Minimum: -0.07260000

Maximum: 2.34119310

- ❑ *Zoom in X2*—Zooms in the graph in X direction by a factor of 2.
- ❑ *Zoom out X2*—Zooms out the graph in X direction by a factor of 2.
- ❑ *Fit X*—Fits the graph to the X-axis.

- ■ To zoom in or out a graph, right-click anywhere on the scroll bar that is displayed at the right and choose one of the following options:

  Note: Scroll bar appears only if you zoom out the graph or strip.

  - ❑ *Zoom to*—Zooms out the graph according to the specified size of the scroll bar. When you select this option, the *Zoom To* form appears. In this form, select the maximum and minimum sizes for the scroll bar.
  - ❑ *Zoom in X2*—Zooms in the graph in Y direction by a factor of 2.
  - ❑ *Zoom out X2*—Zooms out the graph in Y direction by a factor of 2.
  - ❑ *Fit X*—Fits the graph to the Y-axis.

Zooming In a Trace long X- and Y-Axis

To zoom in a trace along X- and Y-axis, hold down the mouse button and drag the pointer to select the area on the graph that you want to zoom in. When you release the mouse button, the area you selected is zoomed in.

To zoom in the trace along one axis, do the following:

1. Press bindkey `X` to zoom in the graph along the X-axis or press bindkey `Y` to zoom in the graph along the Y-axis.
2. Hold down the right mouse button and drag the pointer to select the graph area that you want to zoom in.

After you release the mouse button, the zoom is complete and the right mouse button zoom is reset to XY zoom, which means you can now zoom in or out the graph along both the axes.

Note: You cannot zoom in the graph by using the left mouse button. Also, ensure that you zoom the area toward the right of the Y-axis; otherwise, a shortcut menu appears.

Tip

If you have multiple strips in a window that you want to zoom in, place the pointer on the left or right edges of the strip container to start the zoom.

Panning And Zooming Graph With Mouse

To pan a graph with the help of mouse, perform the following steps:

1. Hold down the `Ctrl` and `Alt` keys simultaneously. Notice that the mouse pointer is changed to a hand symbol, which indicates that you pan the graph now.
2. Drag the mouse pointer to pan the graph in left or right direction.

Note: If a graph includes multiple strips, the panning procedure is performed on all the strips at the same time.

To zoom in or out a graph or a strip in Y direction with the help of mouse, do the following:

➡ Hold down the `Ctrl` key and move the mouse wheel button upward or downward.

If you move the wheel button upward, the selected strip is zoomed in, and if you move the wheel button downward, the selected strip is zoomed out. After the graph is zoomed in, a vertical scroll bar appears on the right side of the strip that you can use to view the remaining portion of the trace in the graph. You can also view the complete trace by using the mouse wheel button.

To zoom in or out all the strips in a graph in X direction, do the following:

➡ Hold down the `Shift` key and move the mouse wheel button.

When you move the wheel button upward, the selected strip is zoomed in, and if you move the wheel button downward, the selected strip is zoomed out.

Video

The video Panning and Zooming Qt Graph demonstrates how you can pan and zoom the Qt Graph.

Note: The zoom operations that you perform on the graph are added to a zoom stack and you can switch between the various zoom levels by selecting zoom commands in the View toolbar. The zoom stack can store maximum of 100 zoom operations.

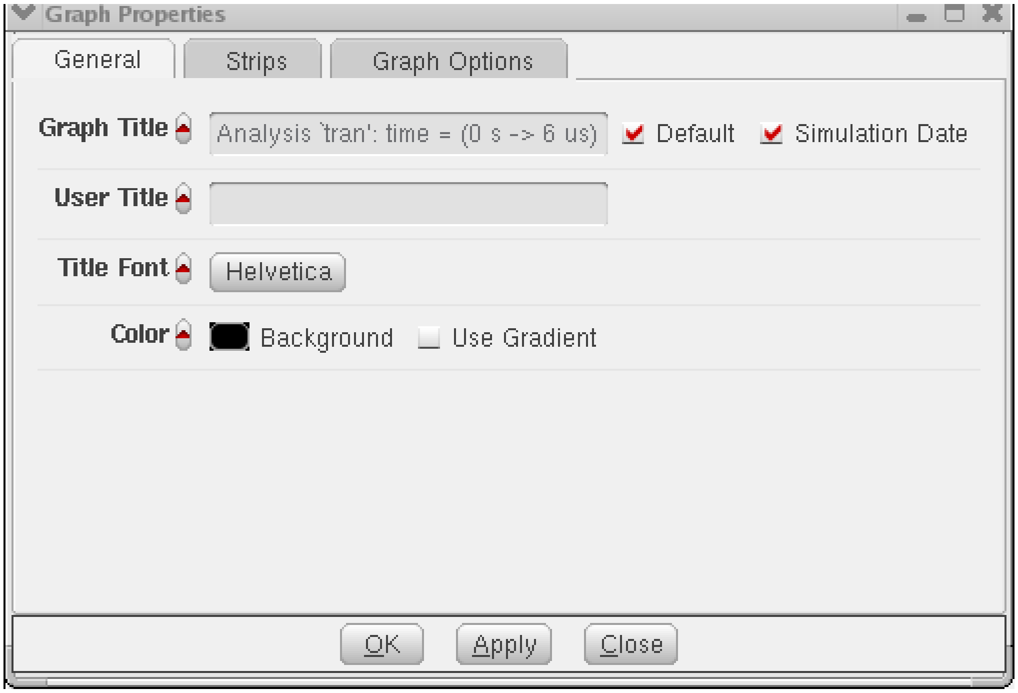
Editing Graph Properties

To set the properties of a graph, do one of the following:

- Choose *Graph – Properties.*
- Right-click anywhere in the window and choose *Graph Properties*.
- Double-click anywhere in the trace legend area.
- Press the bindkey `Shift+Q`.

  The *Graph Properties* from appears. This form includes three tabs—*General, Strips,* and *Graph Options.*

  Note: Double-click in the graph area does not open the graph properties form.



Graph Title: Analysis `tran': time = (0 s -> 6 us) ☑ Default ☑ Simulation Date

User Title:

Title Font: Helvetica

Color: ■ Background □ Use Gradient

On the *General* tab, specify the following values:

- *Graph Title*—The title of the graph that is displayed at the top of the graph. When you select the *Default* check box next to this field, you cannot edit the graph title or provide a new graph title. The default graph name includes the name of the analysis and the Y-axis name. If you want to include in the title the date on which the simulation was run or the measurement was evaluated to obtain the signal that you plotted in the graph, select the *Simulation Date* check box.

- ❑ *User Title*—A name for the window. You can edit this field if the default check box is not selected. Specify a name and click *OK*, this name is saved, and the *Graph Properties* form title is displayed as *Graph Properties for <graph-name>* when you open the form next time.
- ❑ *Title Font*—The font properties for the window title.
- ❑ *Color*—The background color for the selected window.

For information about the fields on the *Strips* tab, see Setting Strip Properties on page 148.

On the *Graph Options* tab, specify the following values:

- ❑ *Font*—The font properties for the graph and its components, such as labels, axes, and markers.
- ❑ *Notation*—The graph notation that can be `Scientific`, `Engineering`, and `Suffix`.
  Default value: `suffix`.
- ❑ *Reload using current context*—Select this check box if you want the graph to be reloaded with data from the current in-context results directory.
- ❑ *Legend position*—Set the trace legend position as `left` or `inside`.
  Default value: `left`.

- ■ Click *OK*.

Note: A red button is displayed with each form field in the properties form for graph and graph objects, which acts as a toggle switch. By default all the form fields are opened in the edit mode. If you click this button, you cannot edit the form fields.

Editing Graph Axis Attributes

The X-axis attributes set the attributes for the X-axis. The X-axis attributes provide a mechanism to easily create YvsY plots.

Note: Eye diagrams can also be plotted from the Calculator, while a limited version of YvsY plot is available from the Results Browser.

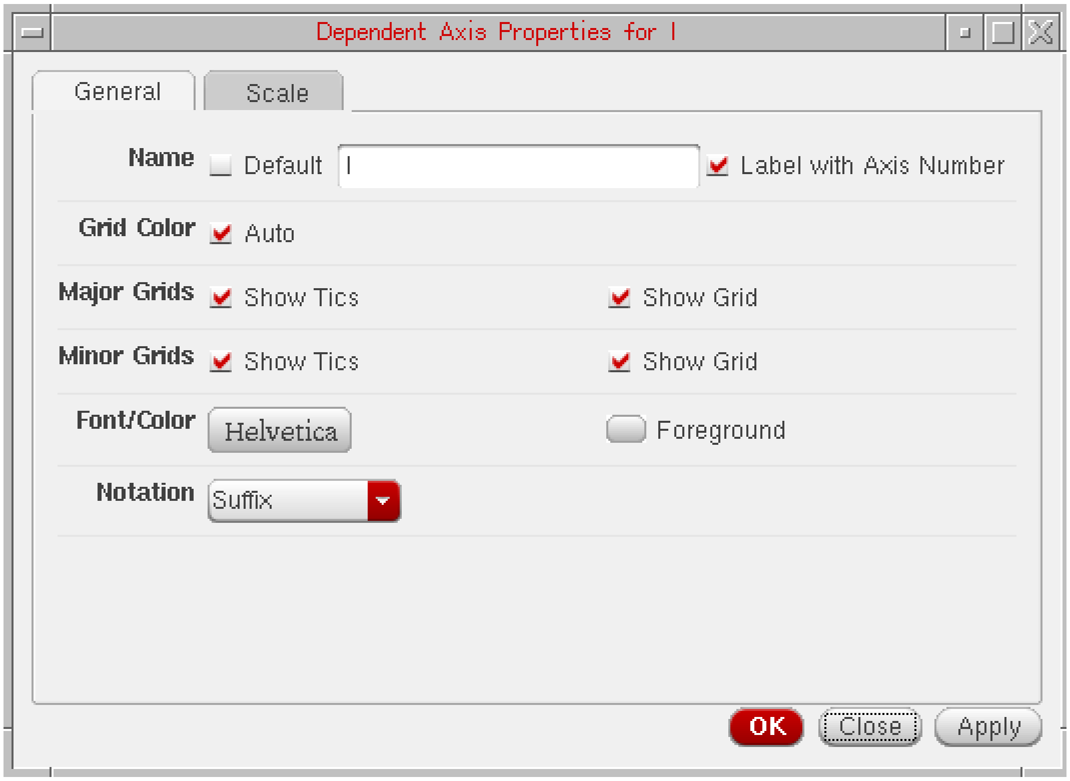
The default graph attributes are controlled by the values assigned to variables in the `.cdsenv` file. For more information, see Appendix A, "Virtuoso Visualization and Analysis XL Tool Environment Variables."

You can edit the attributes of the axes by doing one of the following:

- Double-click an axis in the window.
- Select an axis and choose *Axis – Properties*. You can select more than one axis in the subwindows by using the `Shift` key.
- Right-click an axis and choose *Axis Properties*.

  The *Independent Axis Properties for <X-axis-name>* form appears for X-axis and *Dependent Axis Properties for <Y-axis>* appears for Y-axis.

  This form includes two tabs—*General* and *Scale*.



Dependent Axis Properties for I

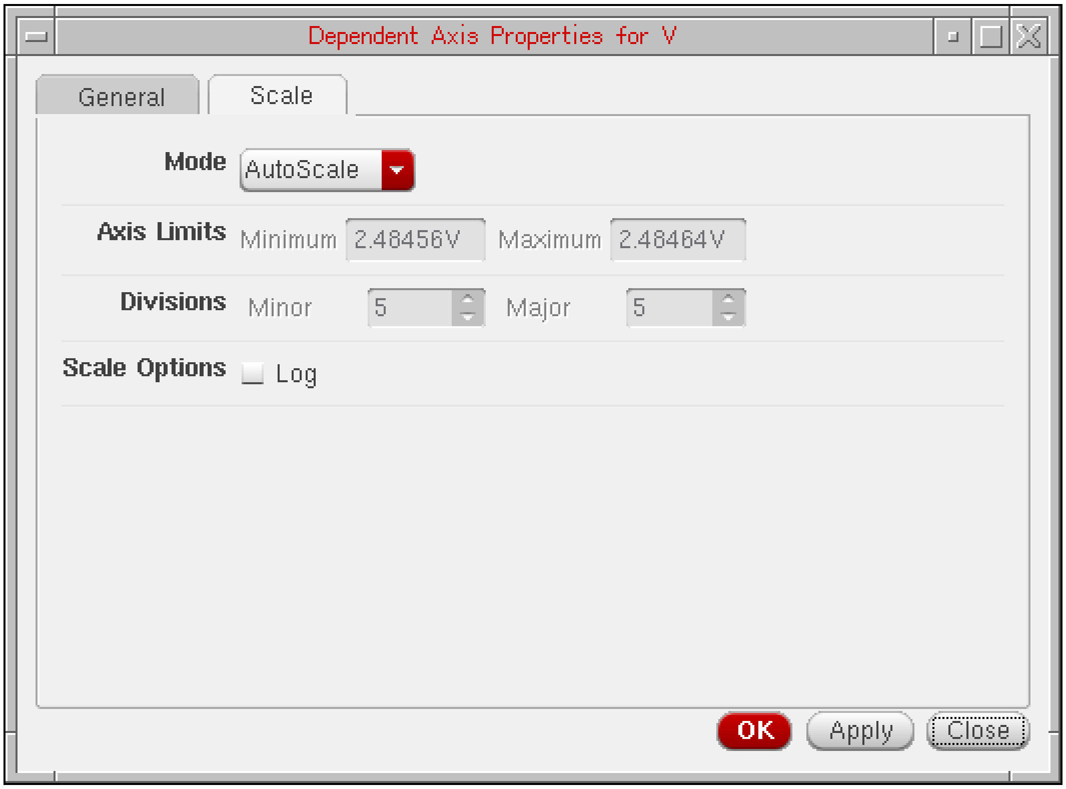
Name	☐ Default I	☑ Label with Axis Number
Grid Color	☑ Auto	
Major Grids	☑ Show Tics	☑ Show Grid
Minor Grids	☑ Show Tics	☑ Show Grid
Font/Color	Helvetica	Foreground
Notation	Suffix	

On the *General* tab, specify the following values:

- ❑ *Name*—The default name of the selected axis. You can change the name, if required. The changed axis name is displayed when you click *OK*. If you select the *Default* check box next to this field, you cannot change the axis name.

- *Label with Axis Number*—Select this check box if you want to display the axis number in the selected axis name. For more information about axis number, see Adding Multiple Y-Axes on page 107.
- *Grid Color*—Select to set the default grid color.
- *Major Grids*
  - *Show Tics*—Select to display the major axis divisions.
  - *Show Grid*—Select to display the major grids.
- *Minor Grids*
  - *Show Tics*—Select to display the minor grid divisions.
  - *Show Grid*—Select to display minor grids.
- *Font/Color*—The font of the axes labels and divisions.
- *Notation*—The notation displayed for the axis labels values. The available values are—`Engineering` and `Suffix`. Default value: `Suffix`.

On the *Scale* tab, specify the following values:



Dependent Axis Properties for V

General | Scale

Mode: AutoScale

Axis Limits: Minimum 2.48456V Maximum 2.48464V

Divisions: Minor 5 Major 5

Scale Options: □ Log

- ❑ *Mode*—The scaling mode as *AutoScale* or *Manual*.
- ❑ *Axis Limits*—The maximum and minimum range of the selected axis on which a signal can be plotted.

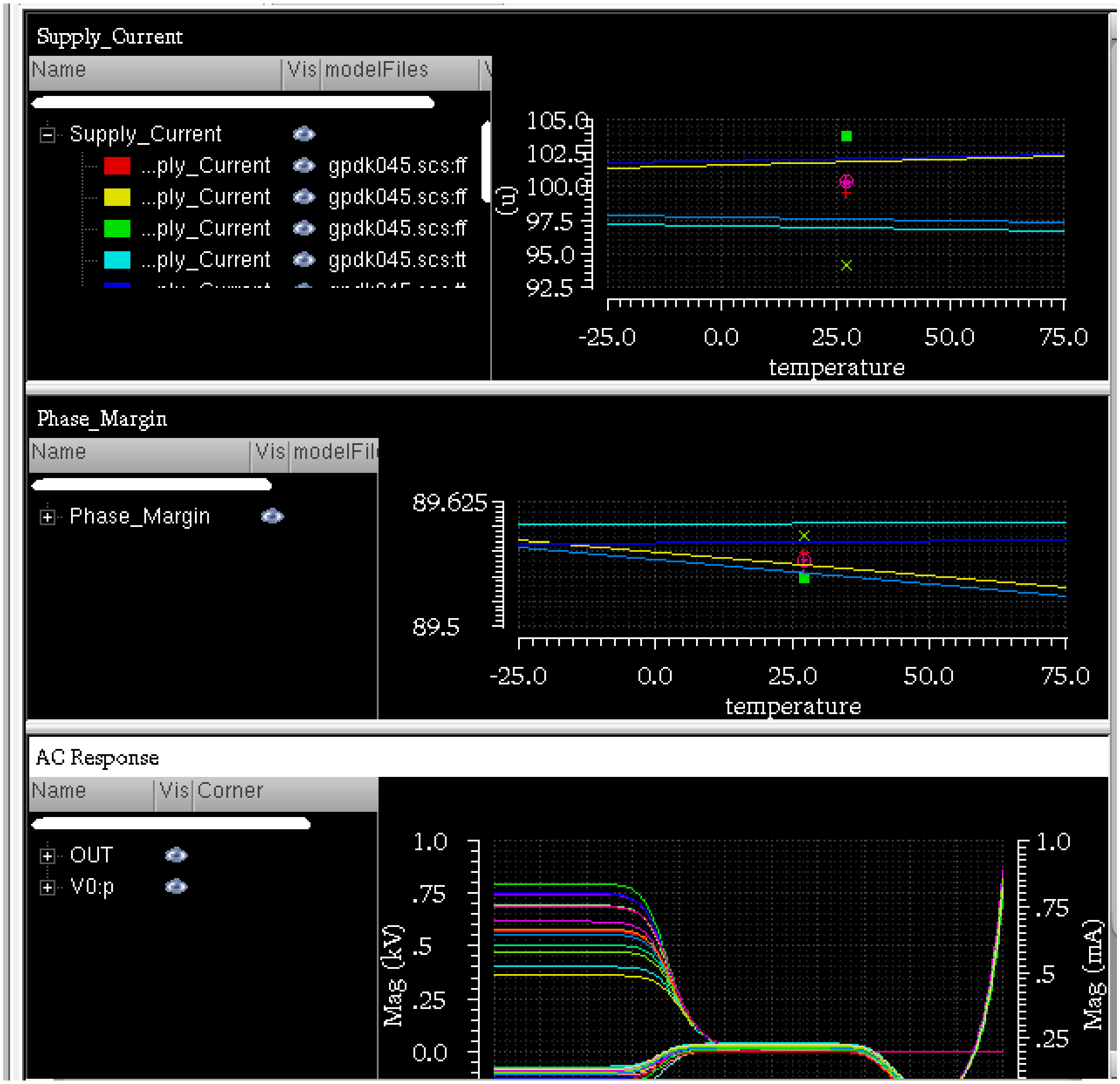
  Note: If you selected the *AutoScale* mode, you cannot change the axis limits. To change the axis limit, select the *Manual* option.
- ❑ *Divisions*—Specify the minor and major axis divisions for the selected axis. If you selected the *AutoScale* mode, you cannot change the axis divisions. To change the axis divisions, select the *Manual* option.
- ❑ *Scale Options*—Select the *Log* check box to display the axis in logarithmic scale.

■ Click *OK.*

Displaying X-Axis Labels in String Format

If you select the X-axis variable as model file or Corner while plotting the results for a simulation run in ADE XL for sweep data, the labels on X-axis are displayed in string format.

In the figure below, you can see the simulation results plotted in the graph window. The sweep variables for this simulation are—*VDD*, *modelFiles*, and *temperature*. This simulation also contains corner values. After you run the simulation, the different outputs are listed in the *Output* section of ADE XL. When you plot all the outputs, the waveforms are plotted in individual subwindows. See the figure below. Notice that the plots shown in the figure below have temperature as the sweep variable on X-axis. You can change the X-axis variable to *modelFiles*, *VDD*, or *Corner*. When you change the X-axis variable to *modelFiles* or *Corner*, the X-axis labels are displayed as string values.



Note: Labels with string values are not supported for transient data.

To change the sweep variable to *modelFiles* or *Corner*, do the following:

1. Right-click the X-axis and choose *Swap Sweep Var*.

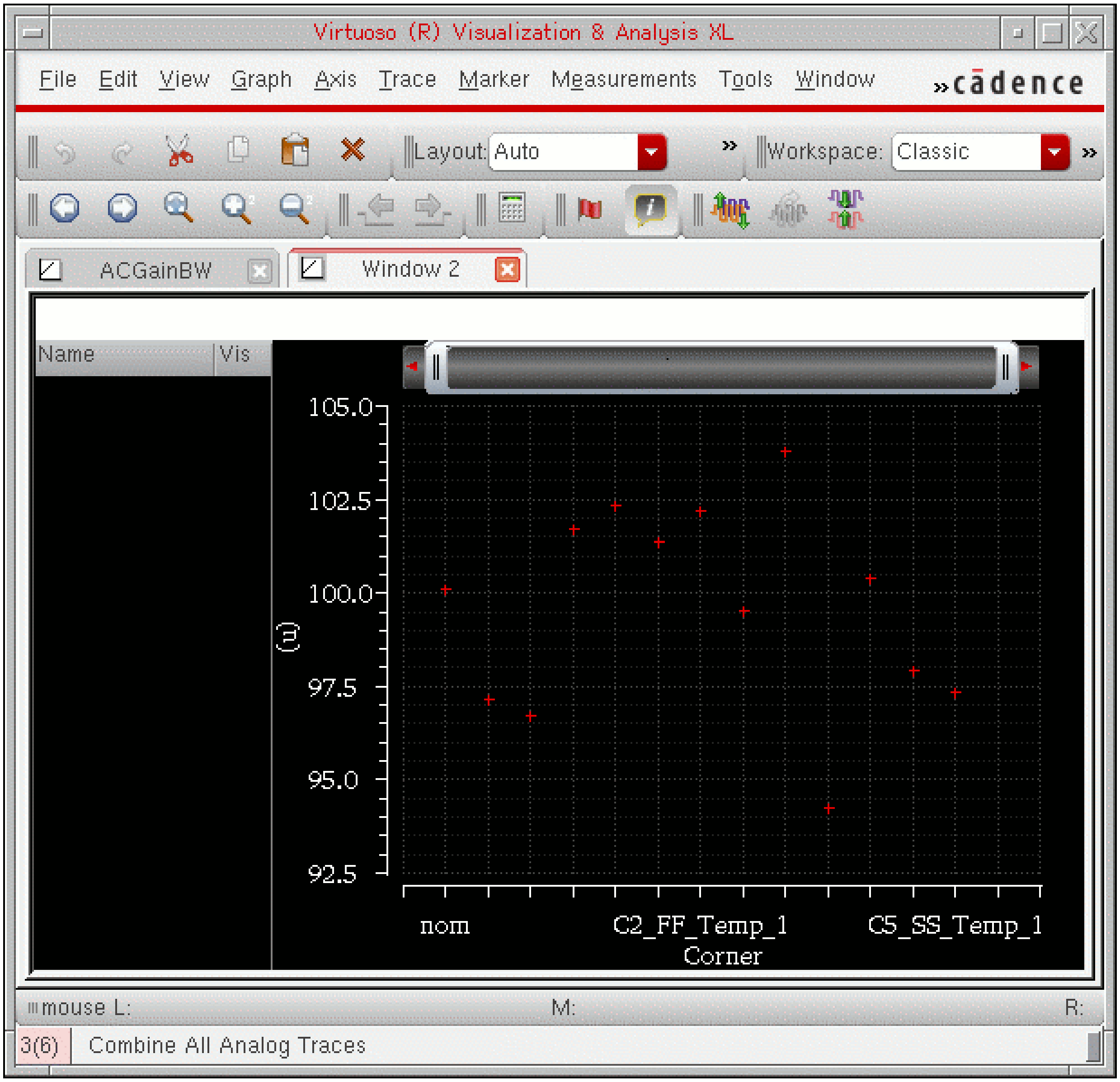
   The *Swap Sweep Var* form appears.

2. Select *modelFiles* or *Corner.*

   The graph is plotted with the selected variable displayed on X-axis.

   In the following figure, the sweep variable plotted on X-axis for `Supply_Current` plot, shown in the figure above, is changed to *Corner*. Notice that the X-axis labels for corners are displayed as string values and the trace is displayed as a sequence of points.

   Note: To display the trace as a continuous line, right-click the trace and choose *Type – Continuous line.*

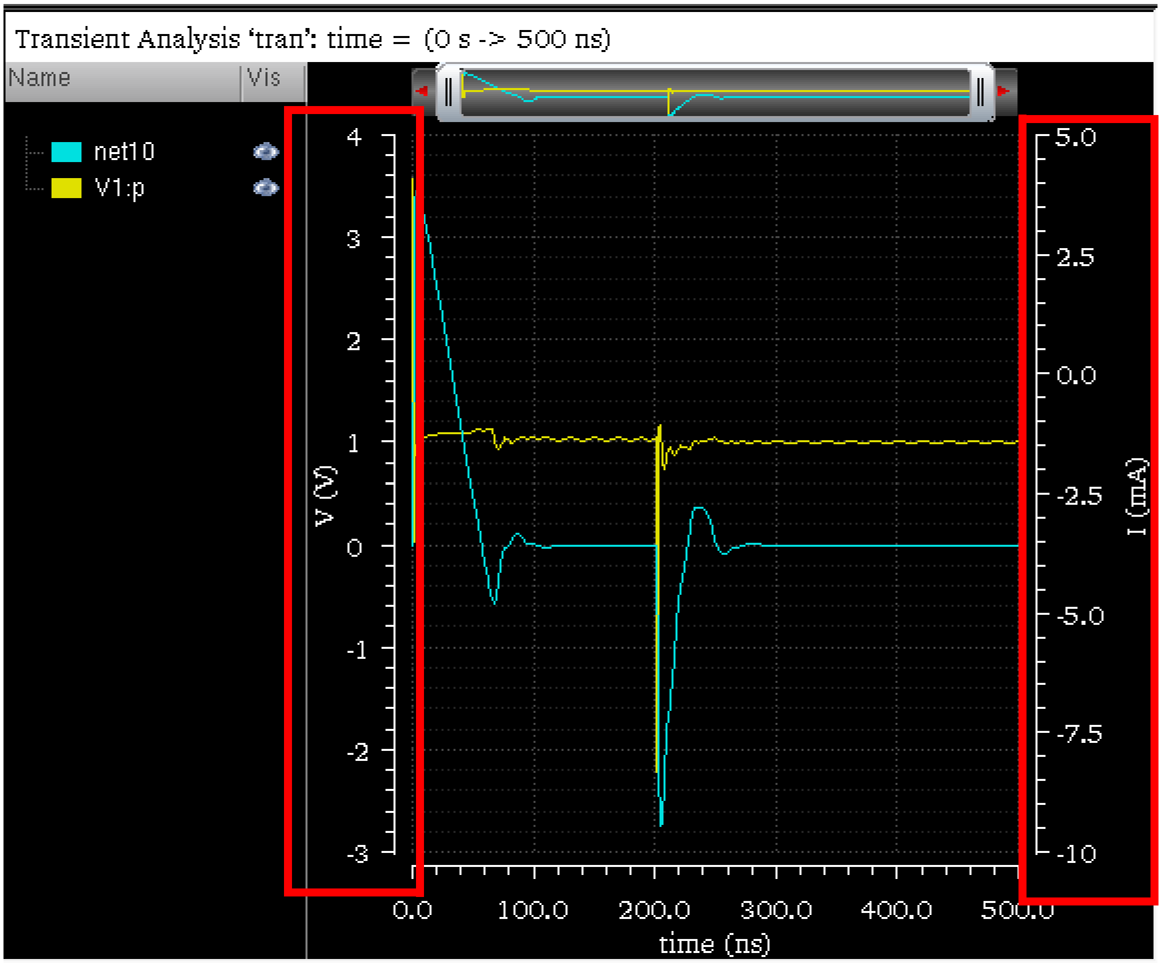


Also, note that the string for all the intercept points may not be visible on the X-axis when the trace is displayed in its normal size. To view any specific string for a data point, you need to zoom in the graph. For information about how to zoom and pan a graph, see Panning and Zooming Graphs on page 96.

If the string is long, it is displayed as an elided string with the ... symbol, for example, `CO_VDD...Temp_1`. To view the complete string, place the pointer on a data point.

Adding Multiple Y-Axes

From Results Browser or ADE, if you plot two or more signals that contain different Y-axis (dependent axis) data in the same window, the graph displays separate Y-axes for both the signals. For example, when the voltage (`net10`) and current (`V1:p`) signals are plotted in the same graph, the graph displays two Y-axes, displayed on the left and the right of the graph respectively, as shown in figure below:



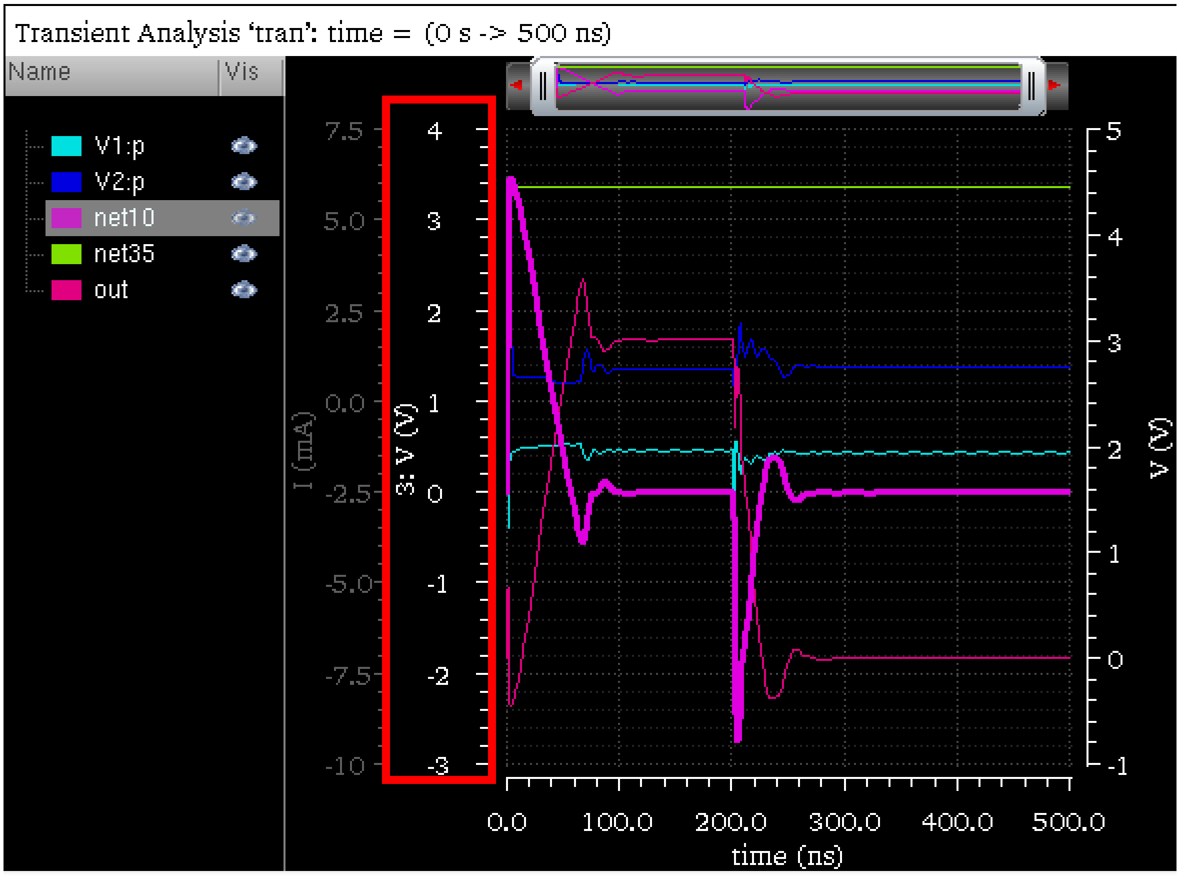
Note: A graph or a strip can have four Y-axes at the maximum.

When you have more than one trace plotted in a graph and you want to analyze a particular trace, you can move the selected trace to a new Y-axis. You can also change the Y-axis of a trace to another existing Y-axis if the graph contains two or more Y-axes. To know more about how to change the axis of a trace, see Changing Dependent Axis on page 109.

To assign a new Y-axis to the selected trace:

➡ Right-click the trace and choose *Change Y Axis – New*.

A new Y-axis is added in the graph and the selected trace is detached from the existing axis and is attached to the new axis. For example, the figure below contains five traces (two voltage and three current) plotted in a graph. When you assign a new Y-axis to the trace for the `net10` signal, the trace moves to a new Y-axis (`3: V(V)`) displayed on the left of the graph. The new axis is the third Y-axis in the graph; therefore, the axis number is 3.


Transient Analysis 'tran': time = (0 s -> 500 ns)

Important

If an axis does not have any traces attached to it, the axis is removed from the graph.

When you add a new Y-axis for a trace, the new axis name is displayed in the following format:

```
axis_number: axis_title(axis_unit)
```

For example, the above figure displays the following axis name for the new axis that you have added manually to the `net10` trace.

```
3: V(V)
```

where,

- `axis_number` is `3` because this is the third Y-axis in the graph
- `axis_title` is `V`, which indicates this is a voltage signal
- `axis_unit` is `V`, Volts.

By default, axis name displays the `axis_number`. To hide `axis_number` from the axis name, do one of the following:

- Right-click the axis and de-select the *Show Axis Number* check box.
- In the *Dependent Axis Properties* form, on the *General* tab, deselect the *Label with Axis Number* check box and click *OK*. To know how to open the *Dependent Axis Properties* form, see Editing Graph Axis Attributes on page 101.
- Choose *Axis – Axis Number*.

  The `axis_number` is removed from the selected axis name.

Changing Dependent Axis

If you have more than one Y-axis in a graph, you can change the Y-axis of the trace to another Y-axis. You can assign a common axis to the traces that have the same signal type. However, you cannot assign the same axis to signals of different data types. For example, a voltage signal cannot be assigned an axis of the signal representing current.

To change the Y-axis of a selected trace:

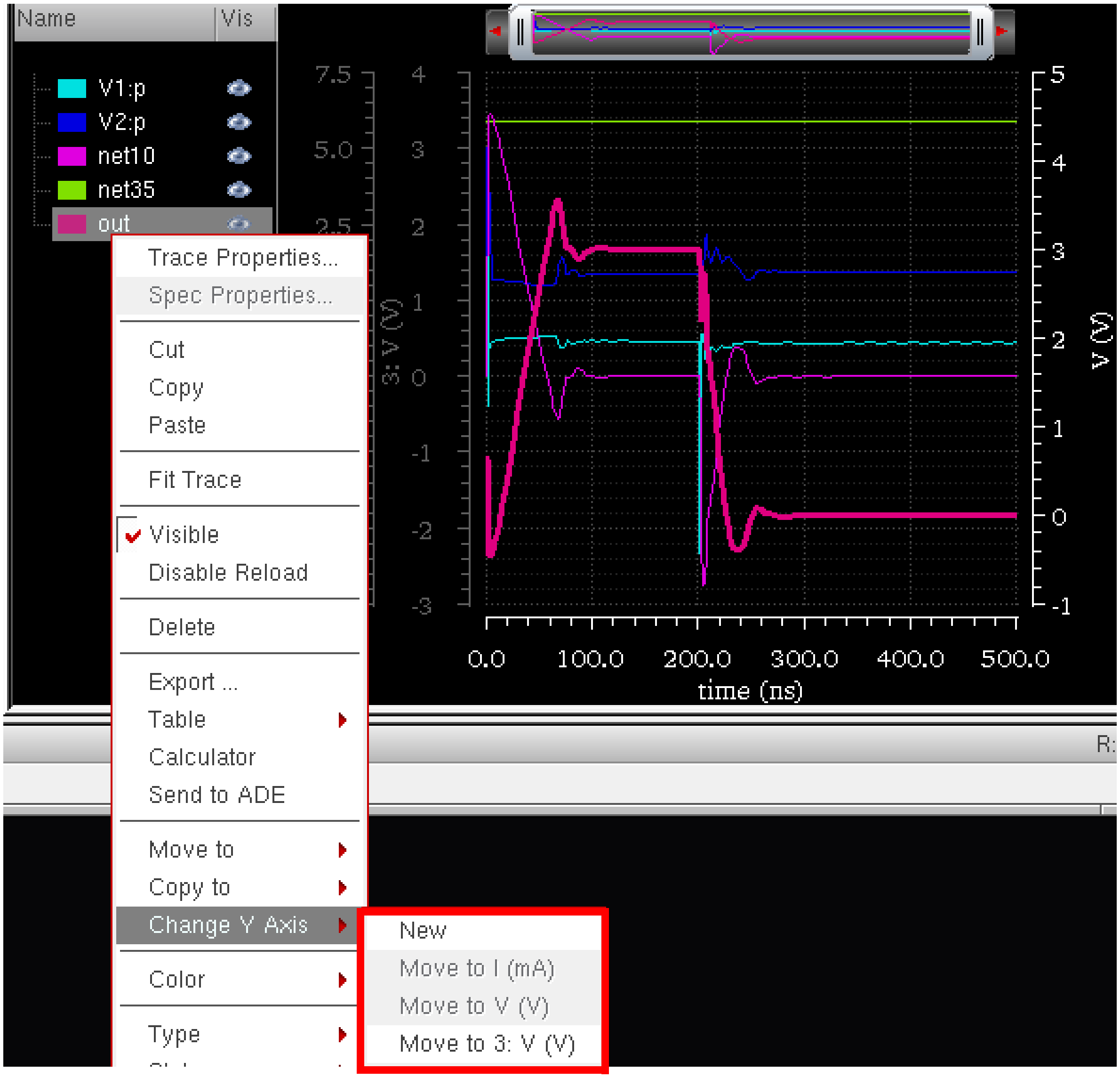
➡ Right-click the trace and choose *Change Y Axis – Move to axis_name*.

The shortcut menu displays the names for all the Y-axes that are currently visible in the graph. The name of the axis to which the trace is currently attached is disabled.

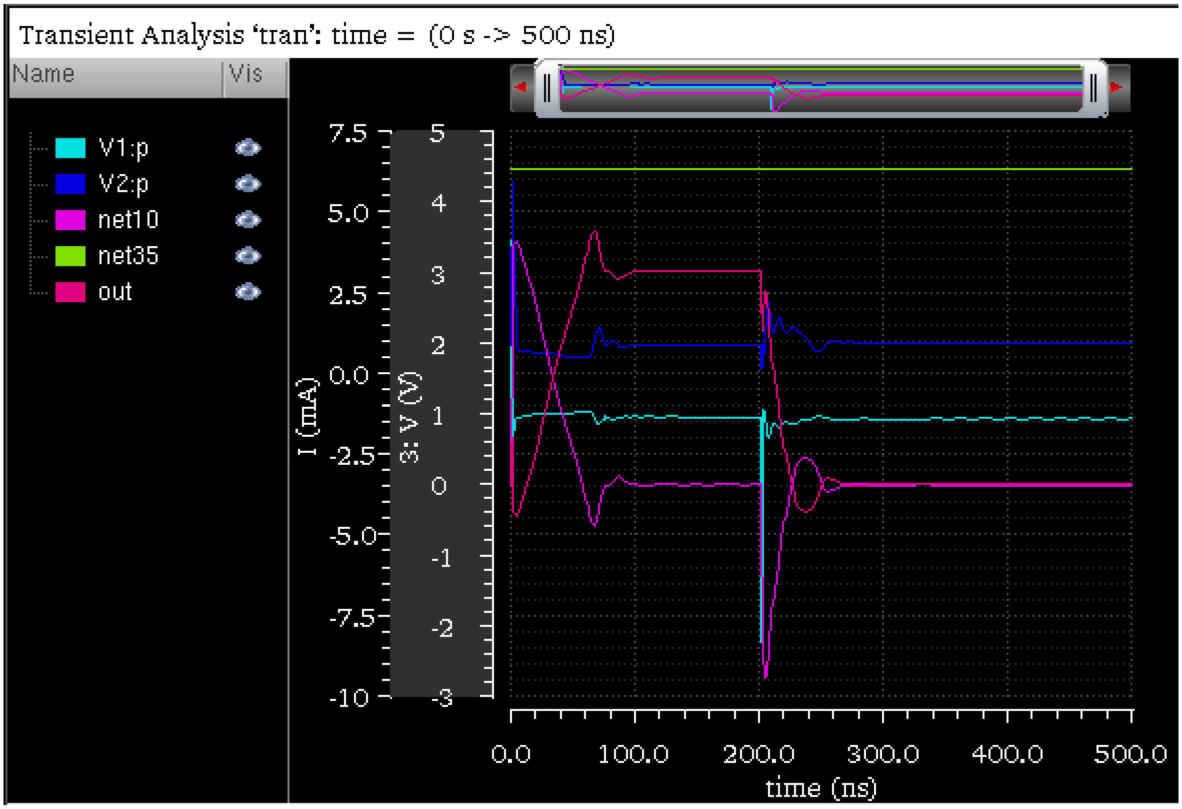
For example, in the following figure, the graph includes five traces:

- `V1:p`—Current signal plotted on `I(mA)` axis
- `V2:p`—Current signal plotted on `I(mA)` axis
- `net10`—Voltage signal plotted on `3:V(V)` axis
- `net35`—Voltage signal plotted on `V(V)` axis
- `out`—Voltage signal plotted on `V(V`) axis

The `net10`, `net35`, and `out` signals are the voltage signals. Therefore, you can move these signals to any axis that represents the voltage signal. In this example, you can move the `out` signal to only `3: V(V)` axis. The `I(mA)` axis is disabled in the shortcut menu because it is incompatible with the `out` signal. The `V(V)` axis is disabled because the `out` signal is already assigned to this axis.



When you move both the `out` and `net35` signals to the `3: V(V)` axis, the `V(V)` axis is removed from the graph because no signal is attached to this axis (see the figure below).

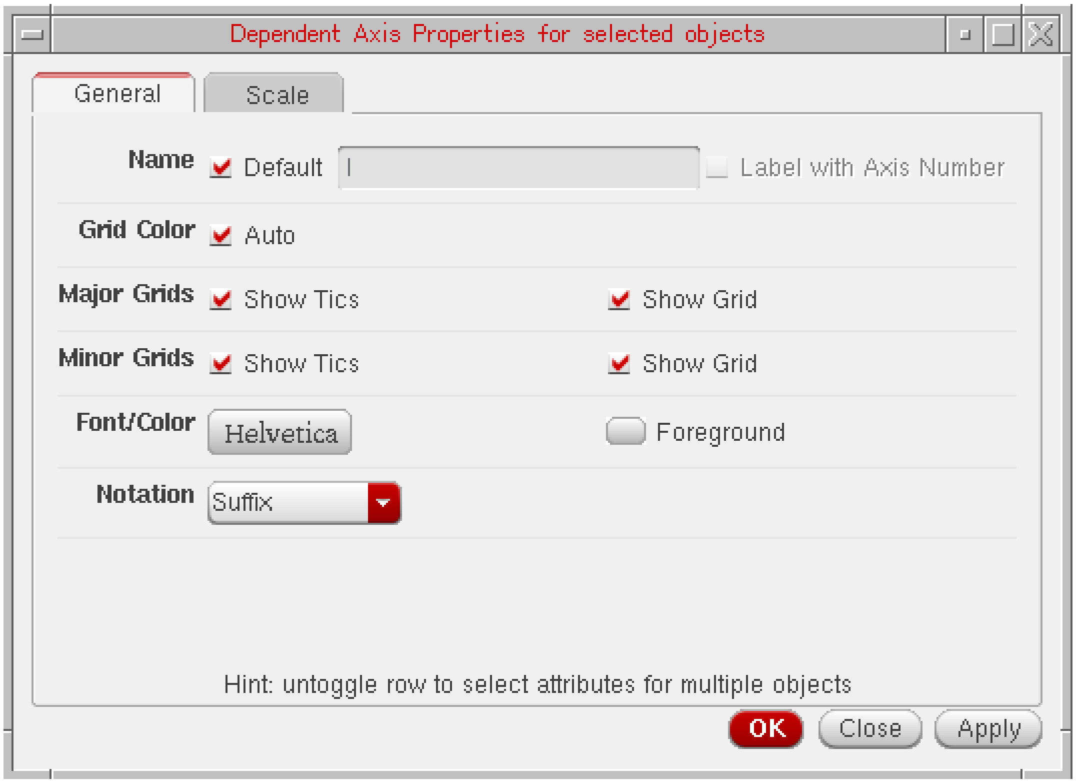


To find which traces are assigned to a particular axis, right-click the axis and choose *Select Attached Traces*. The traces attached to the selected axis are highlighted in the graph. Also, when you select a trace, only the axis for the selected trace is highlighted and all the other axes are dimmed.

To change the properties of all the dependent axis at the same time, do the following:

- Press the `Ctrl` key and click the axes for which you want to change the axis properties.
- Choose *Axis – Properties*.

The *Dependent Axis Properties for selected objects* form appears.



Dependent Axis Properties for selected objects

Name ☑ Default | ☐ Label with Axis Number

Grid Color ☑ Auto

Major Grids ☑ Show Tics ☑ Show Grid

Minor Grids ☑ Show Tics ☑ Show Grid

Font/Color Helvetica ○ Foreground

Notation Suffix

Hint: untoggle row to select attributes for multiple objects

For more information about the properties form fields, see Editing Graph Axis Attributes on page 101.

Freezing Graphs

You can freeze a graph to ensure that it does not change even when the simulation results in the data directory are reloaded. No signal can be added or removed from a frozen graph. If you try to append a signal to a frozen graph, it is plotted in a new subwindow. The graph operations like zooming and adding or moving markers are supported in a frozen graph.

Do one of the following to freeze a graph:

- In the window, choose *Graph – Freeze*.
- Right-click anywhere in the window and choose *Freeze Graph*. When you view the menu again, you see a red check mark displayed next to the option, indicating that the graph is frozen.

  A lock icon appears on the upper-right corner of the window tab indicating that the graph is frozen.

Evaluating Graph Expressions

The signals plotted in the window can have expressions associated with them. How expressions are evaluated in the window depends on whether you are in the SKILL or MDL mode.

SKILL Calculator

When you open a saved graph that contains expressions, the expressions are evaluated by default within the context of the current results directory.

For example, if you plot an expression from a results directory and save the graph and later select a different results directory. When you open the saved graph again, the expression in the graph is evaluated in the context of the new results directory.

In the ADE mode, you can set the `ignoreTokenContext` variable to `false` so that expressions from the saved graphs are evaluated in the context of the results directory in which the graph was saved.

MDL Calculator

When you open a saved graph that contains expressions, the expressions are evaluated within the context of the results directory in which the graph was saved.

Working With Assistants

The Virtuoso Visualization and Analysis XL includes the following assistants:

- Spectrum on page 115
- Browser on page 123
- Marker Toolbox on page 124
- Eye Diagram on page 124
- Horiz Marker Table on page 134
- Trace Info on page 134
- Vert Marker Table on page 135
- Subwindows on page 135

Note: You can hide or show assistants by using the `F11` key. Alternatively, click *the Toggle Assistants Visibility* button on the Workspace toolbar.

Spectrum

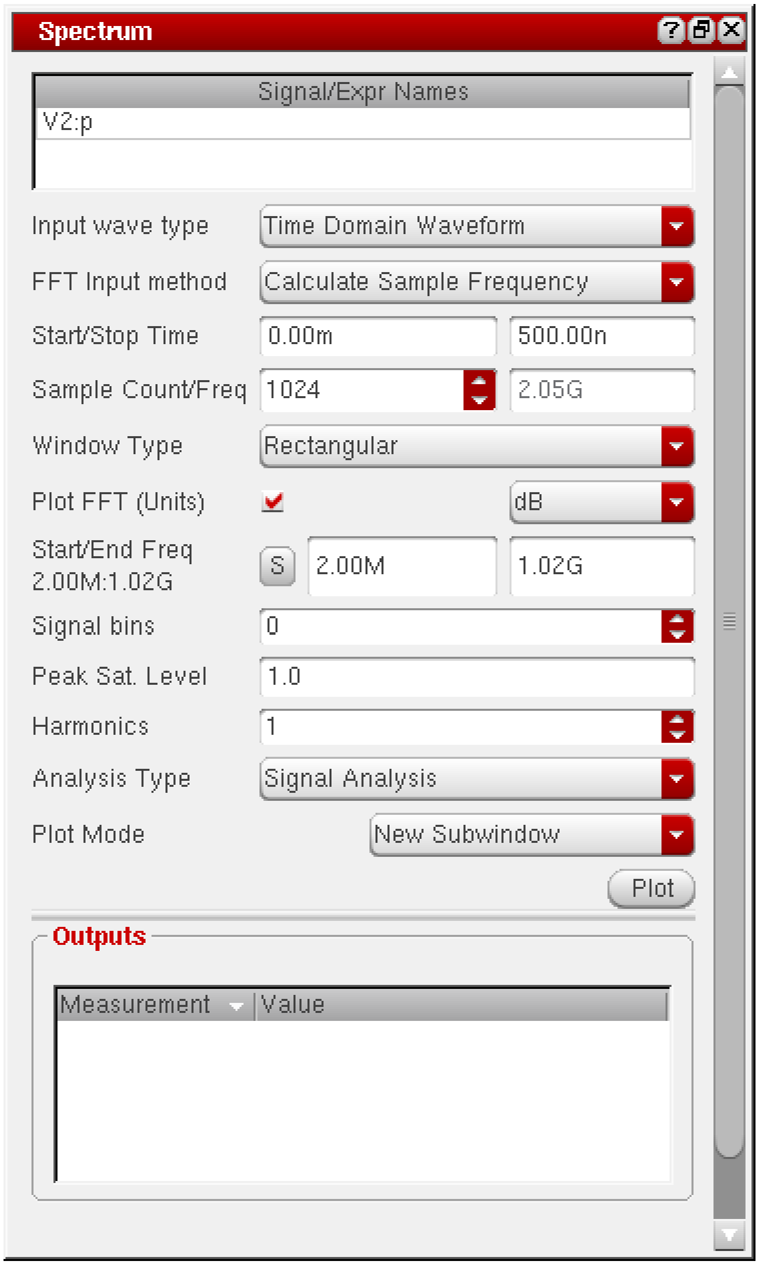
The Spectrum assistant is used to plot and calculate the Fast Fourier Transform (FFT) of a periodic waveform and its different measurements—Signal-to-Noise-and-Distortion Ratio (SINAD), Spurious Free Dynamic Range (SFDR), Effective Number of Bits (ENOB), and Signal-to-Noise Ratio (SNR without distortion)—for a given input signal. The spectrum measure is used for characterizing A-to-D converters and is typically supported for transient simulation data.

Note: In Virtuoso Visualization and Analysis XL, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) are the same.

To open the Spectrum assistant, select a signal in the window and do one of the following:

- Choose *Window – Assistants – Spectrum*.
- Choose *Measurements – Spectrum.*

The Spectrum assistant appears on the left in the window by default.



Signal/Expr Names: V2:p

Input wave type: Time Domain Waveform

FFT Input method: Calculate Sample Frequency

Start/Stop Time: 0.00m 500.00n

Sample Count/Freq: 1024 2.05G

Window Type: Rectangular

Plot FFT (Units): ☑ dB

Start/End Freq 2.00M:1.02G: S 2.00M 1.02G

Signal bins: 0

Peak Sat. Level: 1.0

Harmonics: 1

Analysis Type: Signal Analysis

Plot Mode: New Subwindow

Measurement	Value

The *Signal/Expr Names* field in the Spectrum assistant displays the name of the selected traces. The traces are displayed on the basis of their selection order; however, you can rearrange the trace order either by clicking the column header or by using the drag operation. The assistant has the following fields:

- *Input Wave Type*—Select the input wave type as `Time Domain Waveform` or `Frequency Domain Waveform`.

You can calculate the FFT for the time domain waveform. However, the frequency domain waveform is already an FFT waveform and is used only to calculate measurements. You can use the frequency domain waveform if you are running simulation with the Spectre Fourier component. The Spectre Fourier component performs a Fourier integral and outputs the results in the frequency domain.

- ❑ *FFT Input Method*—Select the Fast Fourier Transform (FFT) input method from the drop-down list box.

  If you select *Calculate Sample Frequency*, which is the default option, you need to specify the start and stop time. The Sample Count and Frequency fields display the values calculated based on the specified start and stop time.

  `Start Time` = Start time of the waveform
  `End Time` = End time of the waveform
  `Sample Frequency = SampleCount/(StopTime - StartTime)`

  If you select *Calculate Start Time*, you need to specify the stop time, sample count, and frequency. The *Start Time* field displays the value calculated based on the specified stop time, sample count, and frequency.

  `StartTime= StopTime - SampleCount/SampleFreq`

  If you select *Calculate Stop Time*, you need to specify the start time, sample count, and frequency. The *Stop Time* field displays the value that is calculated based on start time, sample count, and frequency that you specify.

- ❑ *Start/Stop Time*—Specify the start and stop time of the input time domain periodic waveform.

- ❑ *Sample Count/Freq*—Specify the sample count that is used to determine the number of frequency bins in the FFT waveform. Also, in the *Freq* field, specify the sampling frequency that determines the size of the frequency bin of the FFT waveform.

  The *Sample Count* value must be greater than zero and can include any integer that is a power of two. For a value that is not a power of two, the function rounds it up to the next closest power of two. By default, this field displays the number of data points in the selected signal.

  `SampleFrequency=SampleCount/(StopTime-StartTime)`

  `StartTime=StopTime-(SampleCount/SampleFreq)`

  `StopTime=Startime+(SampleCount/SampleFreq)`

- ❑ *Window Type*—Specify the window function that you can apply to the waveform, such as `Hanning` or `Kaiser`. By default, this field displays `Rectangular`. Some of these window types increase the amplitude of the signal. This helps in distinguishing the noise in the signal.

You can use `Rectangular` window type when you have an integer number of cycles. However, if you are simulating a sigma-delta modulator, you can use `Hanning` instead of `Rectangular` even when an integer number of cycles occur between `StartTime` and `EndTime`.

❑ *Plot FFT (units)*—Select this check box if you want to plot the FFT waveform. In the drop-down list to the right, select the values you want to plot in the FFT waveform. The values can be `dB`, `Imaginary`, `Magnitude`, and `Real`.

❑ *Start/End Freq*—Specify the lower limit and the upper limit of the frequency range for spectrum measures. By default, the lower limit field displays the first frequency point of the FFT and the upper limit field displays the last frequency point of the FFT.

To synchronize the start and end frequency values with the specified start and stop time, click the `S` button. You can also change the start and end frequency values, if required.

❑ *Signal Bins*—Specify the number of signal bins. When you select a window type, this field displays the default number of bins for the selected window type. For example, if you select the *Window Type* as `Kaiser` that has two signal bins, this field displays `2`. You can increase the number of signal bins to up to half the value of the sample count. For example, if the sample count is `16` for the window type `Kaiser`, you can increase the signal bin count in the *Signal Bins* field up to `8`. You cannot decrease the displayed signal bin value.

By default, this field displays zero to indicate the rectangular window type. This specifies the number of bins on each side of the signal bin or harmonic bin of the FFT waveform that are to be considered as part of the signal or harmonic.

Signal bin for `Hanning`, `Hamming`, `Cosine2` windows is 1.

Signal bins for `Blackman`, `ExtCosBell`, `Kaiser`, `Cosine4` signal bin are 2.

Signal bins for `HalfCycleSine`, `Half3CycleSine`, `HalfCycleSine3`, `Half6CycleSine`, `HalfCycleSine6`, `Parzen` signal bin are 3.

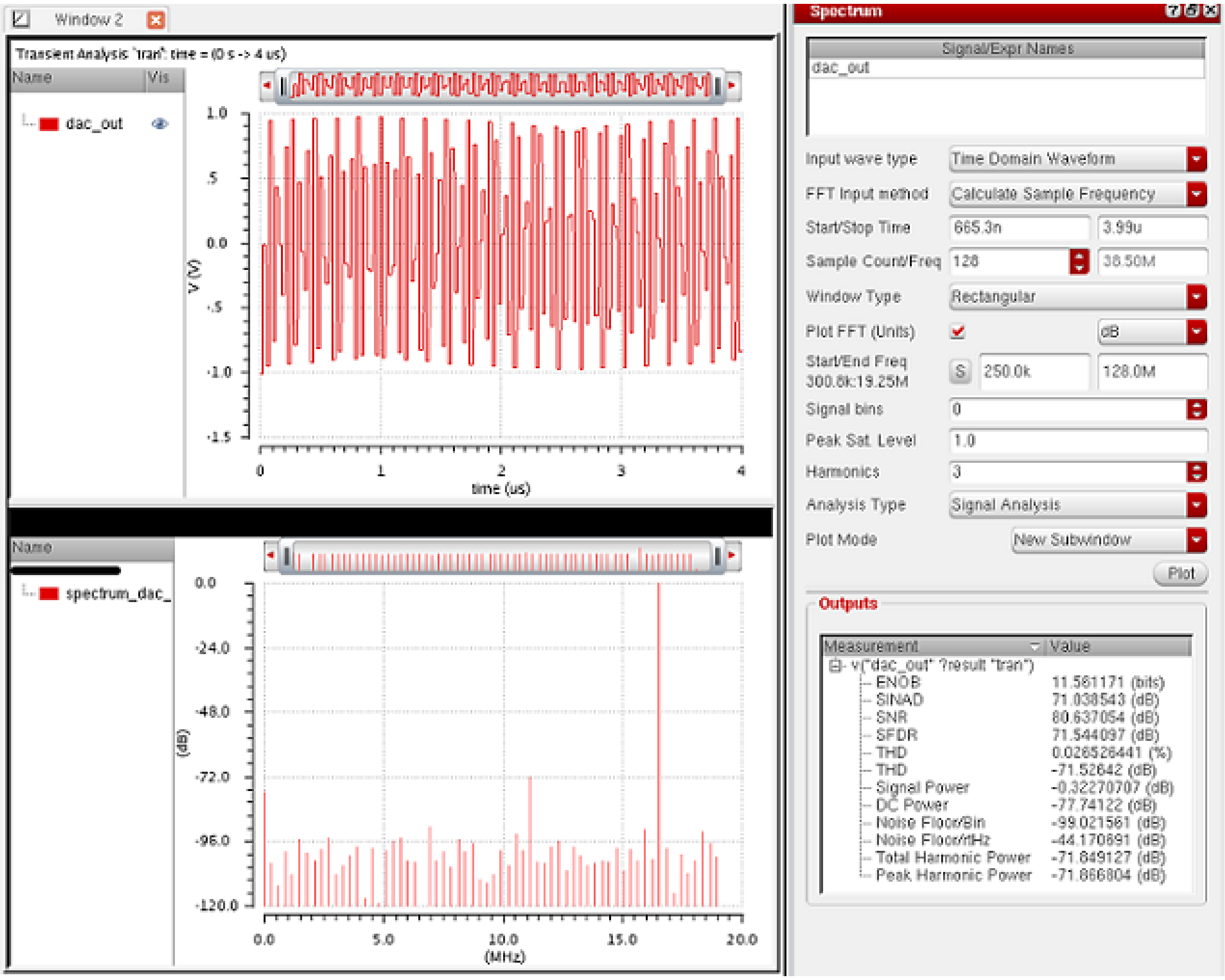
Bins are used to calculate the total signal power, `P_Noise`, and `P_distortion.`The `startBin` and `endBin` values are obtained from the start and end frequencies.

If you change the number of the signal bins, the measurements in the Outputs section are changed. For example, if you change the value of signal bins, the signal power and noise power are also changed. This also changes the SINAD and ENOB values.

- ❑ *Peak Sat. Level*—Specify the peak saturation level of the FFT waveform. Magnitude of the FFT wave is divided by the Peak Sat Level before using it in calculations.
- ❑ *Harmonics*—Specify the number of harmonics for the waveform that you want to plot. For example, If this variable is n, where n should be greater than 1 and the fundamental frequency is harmonic 1, the n harmonics are considered for the harmonic power calculation. The signal bins are used for calculating the harmonic power.

  For example, to calculate the total harmonic distortion (THD), if you set the *Harmonics* value to `n`, where `n` is greater than `1`, and the fundamental frequency is harmonic 1, the number of harmonics used to calculate THD is `2`,...,`n`. If `n=3`, the `2`nd and `3`rd harmonics are used to calculate THD.
- ❑ *Analysis Type*—Specify the analysis type as `Signal Analysis` or `Noise Analysis`. Based on the analysis type that you select, the measurement values are calculated and displayed in the *Outputs* section. If you want to use only the noise in the frequency domain waveform as input, select `Noise Analysis`. However, if you want to use both the signal and noise in the frequency domain waveform as input, select `Signal Analysis`.
- ❑ *Plot Mode*—Specify whether you want to append the FFT waveform to the existing graph, replace the existing graph, or plot the waveform in a new window or a subwindow.

- ❑ *Plot*—Click the *Plot* button to plot and evaluate the FFT waveform and its measurements.



Signal/Expr Names: dac_out

Input wave type: Time Domain Waveform

FFT Input method: Calculate Sample Frequency

Start/Stop Time: 665.3n 3.99u

Sample Count/Freq: 128 38.50M

Window Type: Rectangular

Plot FFT (Units): ☑ dB

Start/End Freq 300.8k:19.25M: S 250.0k 128.0M

Signal bins: 0

Peak Sat. Level: 1.0

Harmonics: 3

Analysis Type: Signal Analysis

Plot Mode: New Subwindow

Outputs

```
Measurement                     Value
⊟- v("dac_out" ?result "tran")
   |-- ENOB                     11.561171 (bits)
   |-- SINAD                    71.038543 (dB)
   |-- SNR                      80.637054 (dB)
   |-- SFDR                     71.544097 (dB)
   |-- THD                      0.026526441 (%)
   |-- THD                      -71.52642 (dB)
   |-- Signal Power             -0.32270707 (dB)
   |-- DC Power                 -77.74122 (dB)
   |-- Noise Floor/Bin          -99.021561 (dB)
   |-- Noise Floor/rtHz         -44.170891 (dB)
   |-- Total Harmonic Power     -71.849127 (dB)
   `-- Peak Harmonic Power      -71.866804 (dB)
```

Outputs

The *Outputs* section displays the following measurements and their values:

- *SINAD* (Signal to Noise and Distortion Ratio)
- *SNR* (Signal to Noise Ratio)
- *SFDR* (Spurious Free Dynamic Range)
- *ENOB* (Effective Number Of Bits)
- *Signal Power*

- *DC Power*
- *Noise Floor/Bin*
- *Noise Floor/rtHz*
- *Total Harmonic Power*
- *Peak Harmonic Power*

Calculations

- ENOB (Effective Number Of Bits)

  `ENOB = (SINAD - 1.763 - dB10(Max_Signal_Power))/6.02`

- SINAD (Signal to Noise and Distortion Ratio)—SINAD is the ratio of total signal power to the noise-plus-distortion power.

  `SINAD= P_Signal / (P_Noise + P_distortion)`

  - ❑ `P_Signal` is the total signal power and can be calculated as below:

    `P_Signal = arr[i] * arr[i] ;`

    `arr[i]` is an array and, `i` is from `(freq - signalBin)` to `(freq + signalBin)`

    `freq` = Frequency

  - ❑ `P_Noise` is the power of the noise excluding the power around the fundamental bin, the power around the harmonic bins, and the power at DC.

    `P_Noise = arr[i] * arr[i] ;`

    where, `i` is an array index that does not include the values from `(freq - signalBin)` to `(freq + signalBin).`

  - ❑ `P_distortion = noiseNonHarmPwr`

    `P_distortion` is the power of the distortion spurs up to the number specified by Harmonics. The algorithm also calculates the location of the aliased harmonics and includes the aliased harmonic power.

- SNR (Signal to Noise Ratio)

  `SNR = dB10(P_Signal/TotalNonHarmNoise)`

- SFDR (Spurious Free Dynamic Range)

SFDR is the strength ratio of the fundamental signal to the strongest spurious signal in the specified frequency band set by the Start and End frequency fields.

```
SFDR = dB10(Max_Signal_Power/max(maxNoise, maxHarmNoise))
```

`Max_Signal_Power` is the maximum value of y-vector in the total signal power calculation.

```
maxNoise = Max of arr[i];
```

where `i` is the index of array elements that were not considered while calculating total signal power, total harmonic power and power at DC. `MaxNoise` is the maximum noise component.

```
maxHarmNoise = Max(arr[i]) ;
```

where, `i` is the index of the harmonic.

- THD (Total Harmonic Distortion)

  ```
  THD = 100 * sqrt(total_Harmonic_Pwr/P_Signal)
  ```

  where, `total_Harmonic_Pwr` is the sum of all harmonic powers

- Signal Power

  ```
  SignalPower = dB10(P_Signal)
  ```

- DC Power

  ```
  dc_power= arrI[0]*arrI[0]+arrR[0]*arrR[0]
  ```

  `arrI` is Imaginary part and `arrR` is Real part

- Noise Floor/Bin

  ```
  NoiseFloor/Bin = dB10(TotalNonHarmNoise/anaBins)
  ```

  ```
  noiseNonHarmPwr = Sum of arr[i] * arr[i];
  ```

  where, `i` is the index of array elements which were not considered in the calculation of total signal power (the fundamental), total harmonic power, and DC.

  ```
  Average [noiseNonHarmPwr] = (noiseNonHarmPwr / n)
  ```

  where, `n` is the total number of bins used

  ```
  TotalNonHarmNoise = (noiseNonHarmPwr / n) * anaBins
  ```

  `anaBins` is length of the array `arr[]`

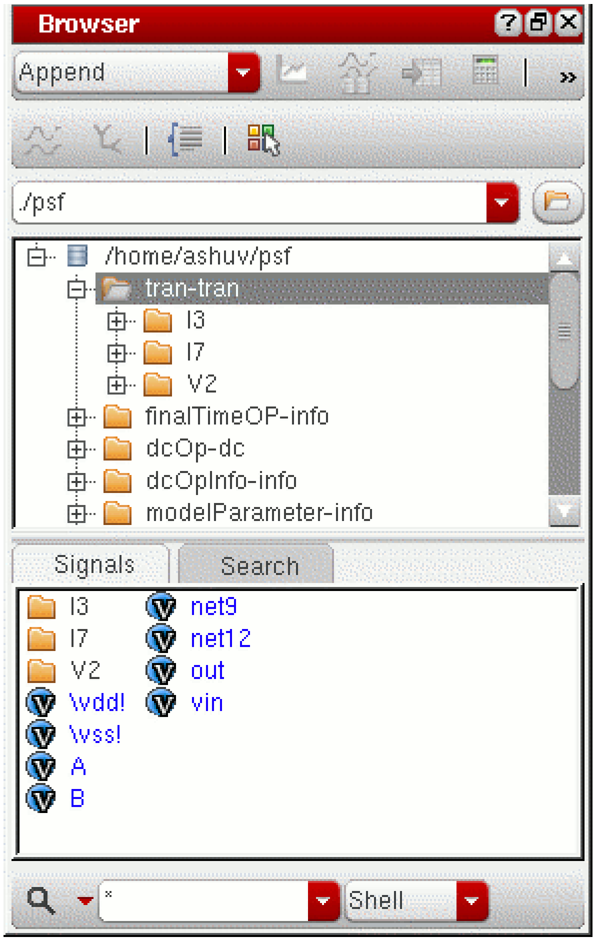
- Noise Floor/rtHz

```
NoiseFloor/rtHz = dB10((TotalNonHarmNoise/(anaBins-1))/binSize)
```

`binSize` is difference of the two nearest X points `(frequency - previousFrequency)` in the FFT wave.

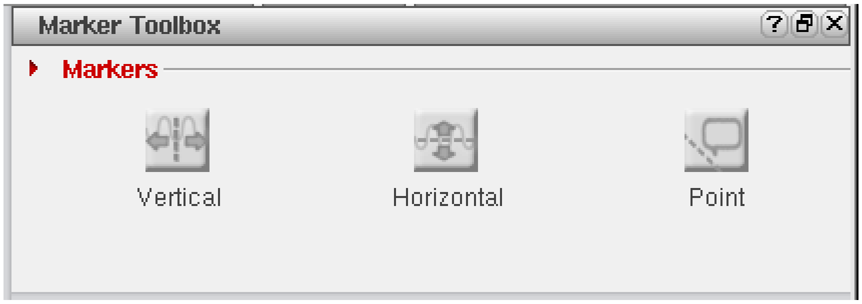
Browser

The Browser assistant displays the Results Browser that you can use to open simulation results saved earlier. To open the Results Browser, choose *Window – Assistants – Browser.* For more information about the Results Browser, see Chapter 2, “Using the Results Browser,”



Marker Toolbox

You use this assistant to add point, vertical, and horizontal markers to the trace. For more information about Marker Toolbox, see Adding Markers with Marker Toolbox on page 199.



Eye Diagram

You use the Eye Diagram assistant to create an eye. An eye diagram is a way of representing a digital data signal by repetitively sampling the signal and overlaying the repeated samples on the same X-axis.

The result is a plot that has many overlapping lines enclosing an empty space known as the eye. The quality of the receiver circuit is characterized by the dimension of the eye. An open eye means that the detector can distinguish between `1's` and `0's` in its input, while a closed eye means that a detector placed on `Vout` is likely to give errors for certain input bit sequences.

Example Circuit

The example described below is generated by using a Pseudo-Random Binary Sequence (PRBS) source in the Spectre and Verilog-A model that can add random amplitude variation and random delays to the edges.

Spectre Netlist prbs.scs

```
// prbs.scs
v1 (high 0) vsource type=prbs period=40n val0=0 val1=1 rise=0.3n \
   fall=0.3n delay=3n
vclk (clk 0) vsource type=pulse period=80n val0=0 val1=1 rise=0.3n \
   fall=0.3n delay=3n
del (withdelay high) randdelay sd=1n rise=0.3n
rl (withdelay jitter) resistor r=100
cl (jitter 0) capacitor c=50p
```

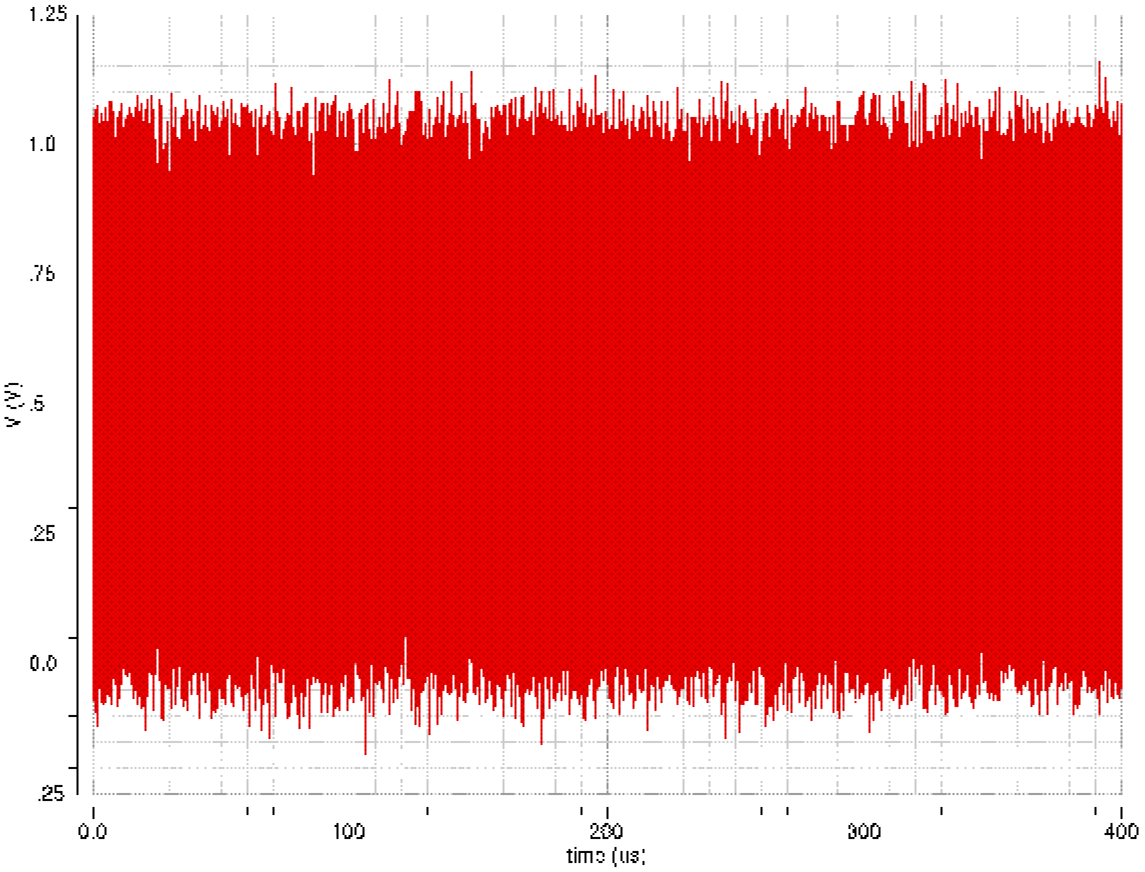
```
r1 (high 0) resistor r=1k
ahdl_include "randdelay.va"
tran tran stop=400u
```

Verilog-A model randdelay.va

```
// VerilogA for randdelay
`include "constants.h"
`include "discipline.h"
module randdelay (op,ip);
output op;
input ip;
electrical op,ip;
parameter real sd=2.0n;
parameter real gainsd=0.1;
parameter real del=5.0n;
parameter real rise=0.1n;
parameter real thresh=0.5;
parameter integer seed = 23133;
integer vseed;
real randnum,gain,delayed;
analog begin
@(cross(V(ip)-thresh)) begin
    randnum=$rdist_normal(vseed,0,1);
    randnum=randnum*sd+del;
    gain=$rdist_normal(vseed,0,1)*gainsd+1;
    if(randnum<0) randnum=0.0;
  end
delayed= transition(V(ip),randnum,rise,rise);
V(op) <+ gain*(delayed-thresh)+thresh;
end
endmodule
```

Note: To run the simulation in the example shown above, type `spectre prbs.scs`.

When you plot the `jitter` signal as shown in the previous example, which is the output of the PRBS source that has passed through the Verilog-A model to add random delay and amplitude variation and then passed through a simple RC filter, you get the following plot:



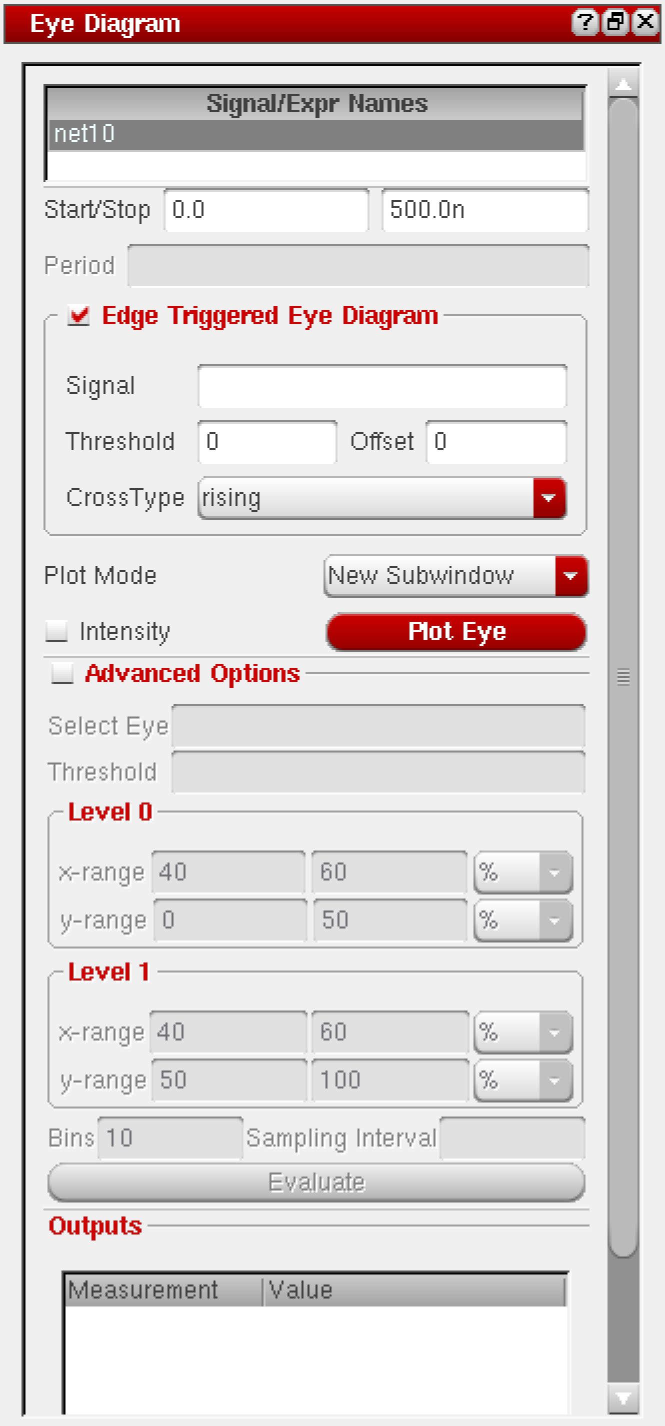
This plot does not show how much the original signal is distorted. The zoomed in waveform also does not help visualize the timing and amplitude variation in the data. These issues can be resolved by using the Eye Diagram assistant.

Opening the Eye Diagram Assistant

Select a signal in the window and do one of the following to open the Eye Diagram assistant:

- Choose *Measurements – Eye Diagram*.
- Choose *Window – Assistants – Eye Diagram.*

The *Eye Diagram* assistant appears on the right in the window.



Eye Diagram

Signal/Expr Names
net10

Start/Stop 0.0 500.0n

Period

☑ Edge Triggered Eye Diagram

Signal

Threshold 0 Offset 0

CrossType rising

Plot Mode New Subwindow

☐ Intensity

☐ Advanced Options

Select Eye

Threshold

Level 0

x-range 40 60 %

y-range 0 50 %

Level 1

x-range 40 60 %

y-range 50 100 %

Bins 10 Sampling Interval

Outputs

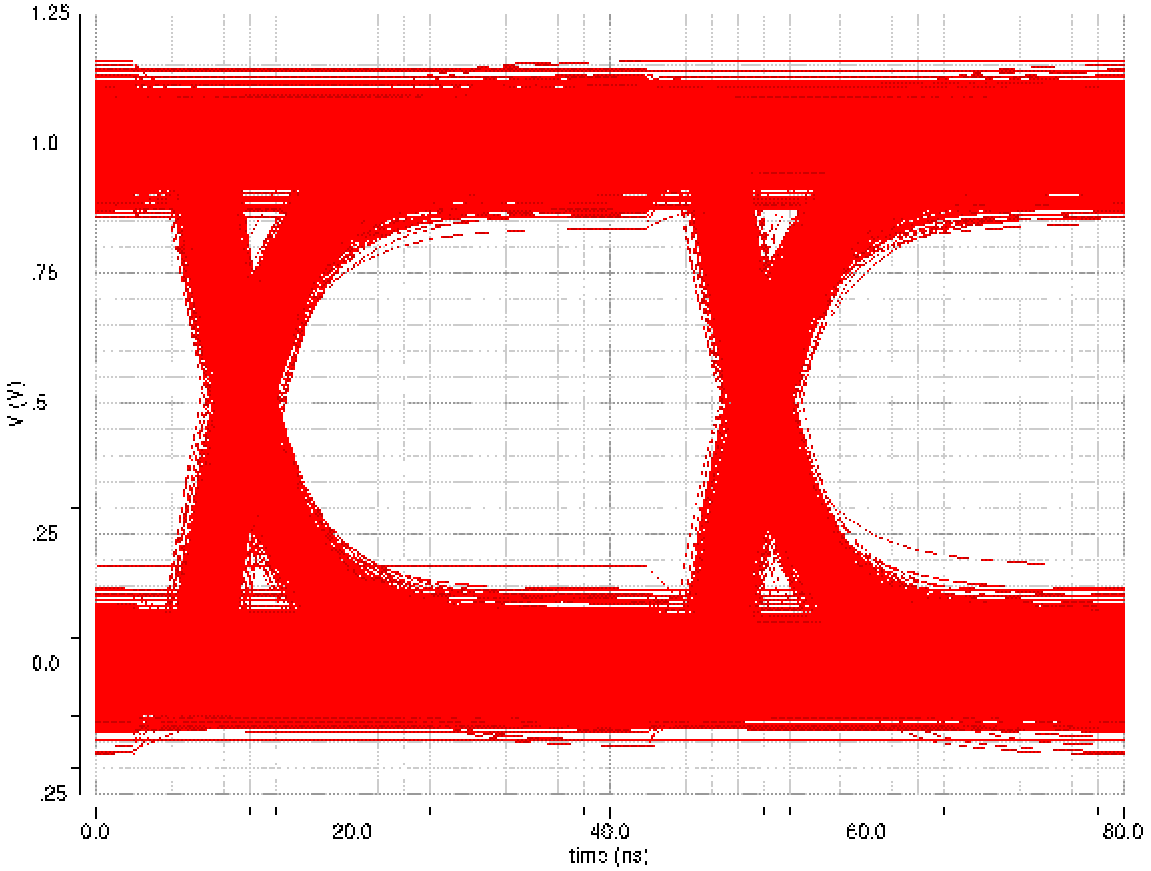
Measurement	Value

The Eye Diagram form has the following fields:

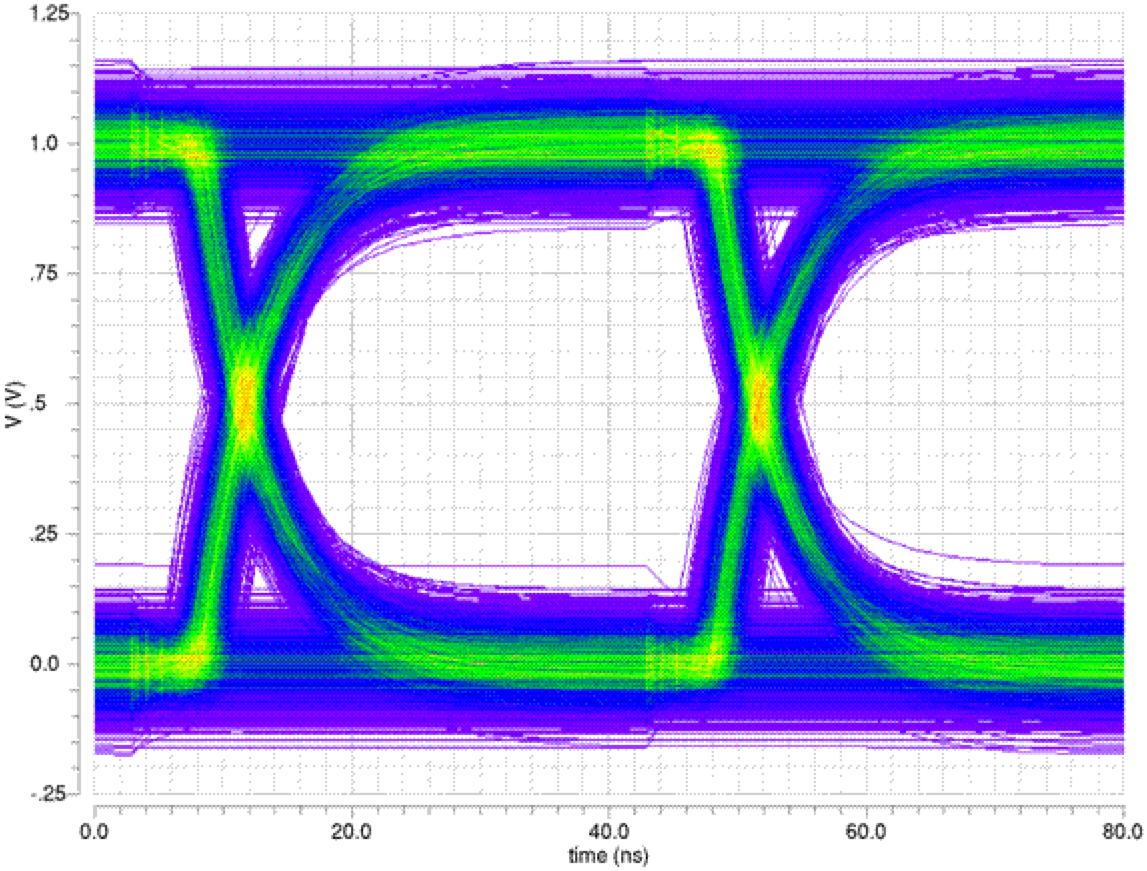
- ❑ The *Signal/Expr Names* field displays the name of the traces that you select in an active window. The traces are displayed on the basis of their selection order; however, you can rearrange the trace order either by clicking the column header or by using the drag operation. To delete the traces that are not required, select the traces and press the `Delete` key.
- ❑ In the *Start* field, specify the X-axis value from where the eye diagram plot needs to be plotted.
- ❑ In the *Stop* field, specify the X-axis value where the eye-diagram plot must end.
- ❑ In the *Period* field, specify the time period for the eye diagram. This is the period after that the X-axis starts repeating.
- ❑ Select the *Edge Triggered Eye Diagram* check box if you want to another signal to be triggered at the beginning of the eye diagram instead of a fixed period.

  For more information about how to plot the edge triggered eye diagram, see Edge Triggered Eye Diagram on page 130.
- ❑ In the *Plot Mode* list, specify whether you want to *append* the eye diagram to an existing graph, *replace* an existing graph with the eye diagram, or add the eye diagram to a *new subwindow* or a *new window*.
- ❑ Select the *Intensity* check box to highlight the intersection points of the eye diagram.
- ❑ Click the *Plot Eye* button to plot the eye diagram for the selected signal. By default, the name of the eye diagram is *eye_<signal-name>.*

If you do not select the *Intensity* check box and click *Plot Eye* to plot the graph, the following graph is opened in a new subwindow:



If you select the *Intensity* check box, the graph is displayed as shown below:



This graph helps find the extent of the amplitude variation and timing variation in the transitions. Colors displayed in the graph are used to show regions of greater density, which helps visualize the distribution of amplitude and timing variation.

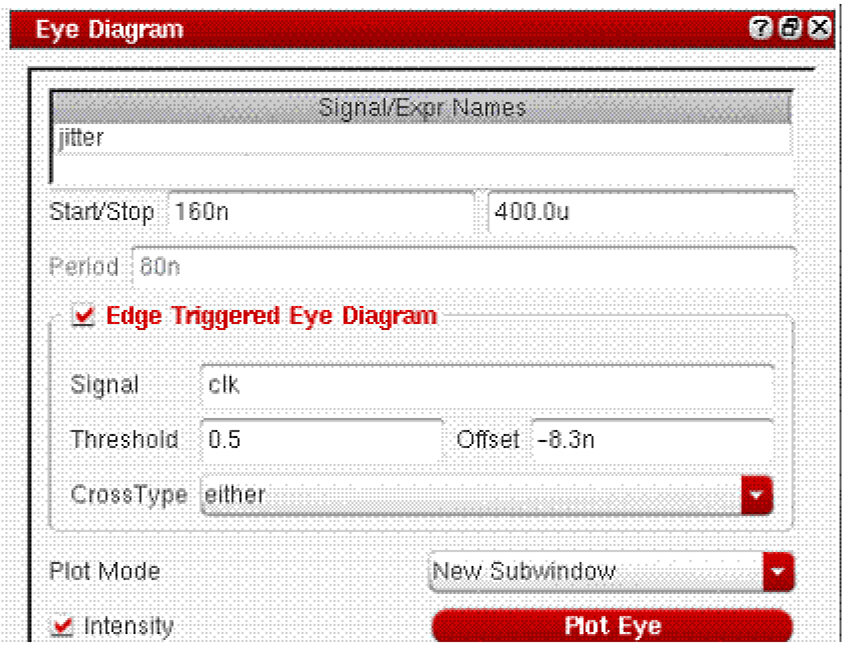
The hole in the middle of the graph is known as eye. The circuit or the system is considered bad if the hole is small.

Edge Triggered Eye Diagram

You can select the *Edge Triggered Eye Diagram* check box in the Eye Diagram assistant if you want another signal to be triggered at the beginning of the eye diagram instead of a fixed period. When you select this check box, the *Period* field becomes inactive. You also need to plot the signal that you want to use as a triggering signal.

When you select this check box, the *Signal*, *Threshold*, *Offset*, and *CrossType* fields are enabled.

- Click in the *Signal* field and select a signal that you want to use as a triggering signal. The selected signal name appears in this field.
- In the *Threshold* field, specify a threshold value. When a signal to be triggered crosses the specified threshold value in a given direction, the eye diagram starts a new period. You can specify direction in the *CrossType* field.
- In the *Offset* field, specify an offset value that is used to shift the phase of the eye. If you specify a positive value, the eye right is rotated by the specified amount of time and if you specify a negative value, the eye left is rotated by the specified amount of time.
- Select the *CrossType* as `rising`, `falling`, or `either`.



Signal/Expr Names: jitter

Start/Stop: 160n | 400.0u

Period: 80n

☑ Edge Triggered Eye Diagram

Signal: clk

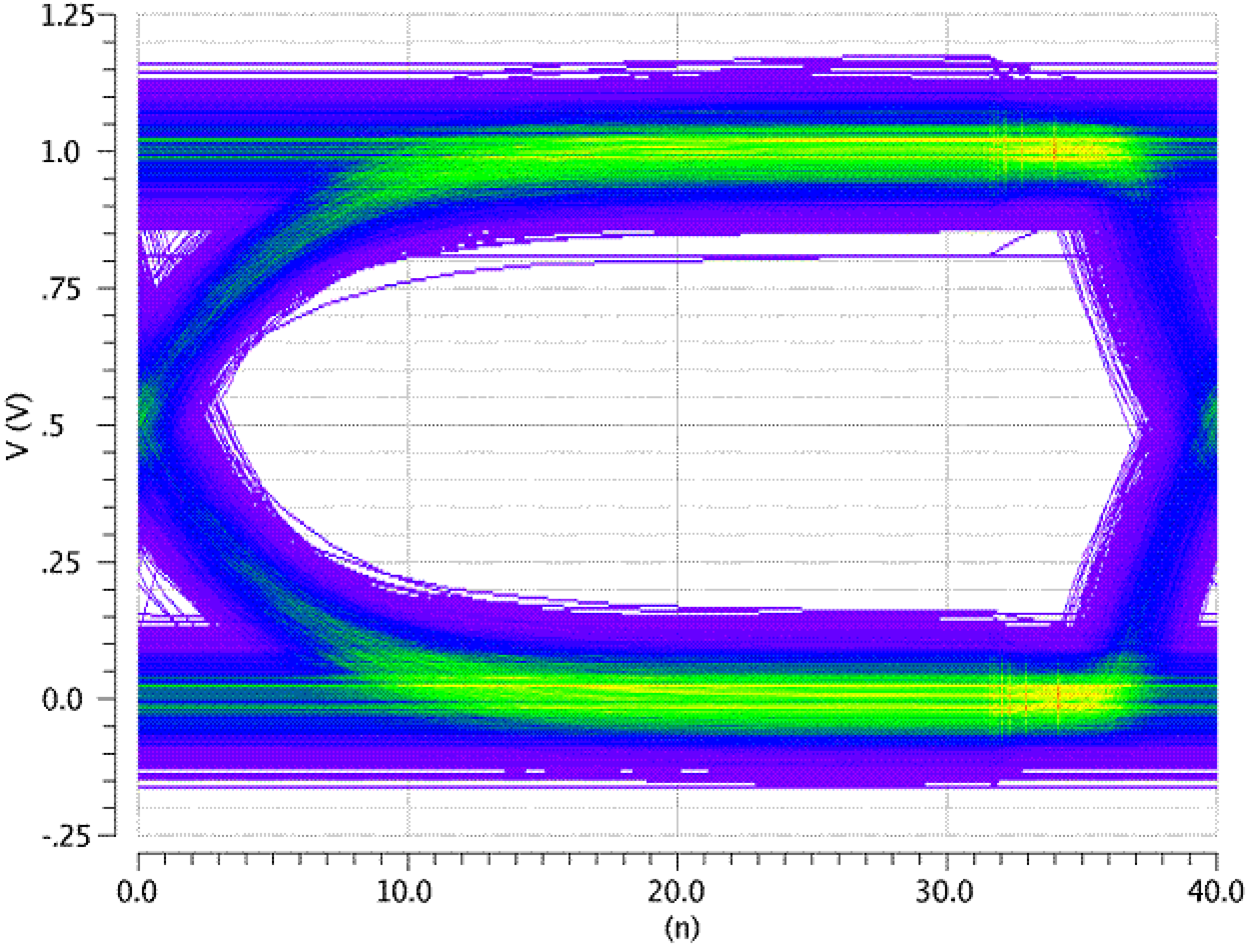
Threshold: 0.5 Offset: -8.3n

CrossType: either

Plot Mode: New Subwindow

☑ Intensity

When you click the *Plot Eye* button, the edge triggered eye diagram for the above specified values is plotted in a new subwindow as shown in the figure below:



Advanced Measurements

After you plot an eye diagram for the selected signal, you can specify the advanced options for the eye diagram. To specify the advanced options, select the eye diagram plot and select the *Advanced Option*s check box. This evaluates the vertical (`Max Vertical Opening Level 0`) or horizontal opening (`Max Horizontal Opening Level 1`) of the eye diagram.

The advanced measurements that can be calculated are based on performing statistical analysis of the eye diagram. Consider the signal you want to analyze as a sequence of 1's and 0's, with transitions between the two logic levels. As a result, it is required to analyze the distribution of the timing of transitions between 0 and 1 levels, and also to analyze the distribution of signal levels of the parts of the eye diagram representing 0 and 1 values.

The *Advance Options* section includes the following fields:

- The *Selected Eye* field displays the name of the selected eye diagram.
- In the *Threshold* field, specify the threshold value. The Y-axis level, such as voltage, represents the switching threshold of the signal is generally half of the signal range. This is used to compute the statistical information about the times (relative to the beginning of the eye diagram) at which the signal crosses the threshold level.
- In the *Level 0* field, specify X-range and Y-range to plot their vertical histograms for level 0 measurements.
- In the *Level 1* field, specify X-range and Y-range to plot their horizontal histograms for level 1 measurements.
- Click the *Evaluate* button to evaluate the vertical and horizontal opening of the eye diagram.
- In the *No of bins*, specify the signal bins you want to display in the eye diagram plot. These signals bins are used to form the horizontal (threshold crossing times) and vertical (amplitude variation) histograms.
- In the *Sampling Interval*, specify the time interval after which the signals are divided in the eye diagram plot. If this field is left blank, the data within the level 1 and level 0 regions are used to analyze the amplitude variation of the signal. This means there is some sensitivity to the actual spacing between the data points in the signal, which is caused by the variable time steps in the simulator. If the points are clustered in the curve portion, the distribution can be skewed. To perform the analysis, the sampling interval you specify in this field is divided into even time points.

After the evaluation is complete, the following additional output is displayed in the *Output* section of the Eye Diagram assistant:

- *Eye width*
- *Eye height*
- *Eye amplitude*
- *Eye SNR*
- *Level 1 standard deviation and mean*
- *Level 0 standard deviation and mean*

Setting Eye Diagram Properties

To change the trace properties of an eye diagram, right-click the eye diagram plot and choose *Trace Properties*. The *Eye Trace Properties for <eye_diagram_name>* form appears that includes the following fields:

- *Name*—Specify the name of the eye diagram trace. If you select the *Default* check box, it displays the default trace name.
- *Expression*—Specify an expression that you can associate with the selected eye diagram.
- *Color*—Specify the foreground color of the trace.

Edge Triggered Eye Diagram

You can plot the In order to use this, you must also plot the signal that you wish to use as the triggering signal. Check the Edge Triggered Eye Diagram checkbox on the assistant, and then click in the Signal field on the form. Select the trace on the graph that you wish to use as your triggering signal. Fill in a Threshold value; when the trigger signal crosses this threshold in the specified direction (specified using the Cross Type field), the eye diagram will start a new period. You may also specify an Offset which allows you to shift the phase of the eye; a positive value will rotate the eye right by that amount of time and a negative value will rotate the eye left by that amount of time.

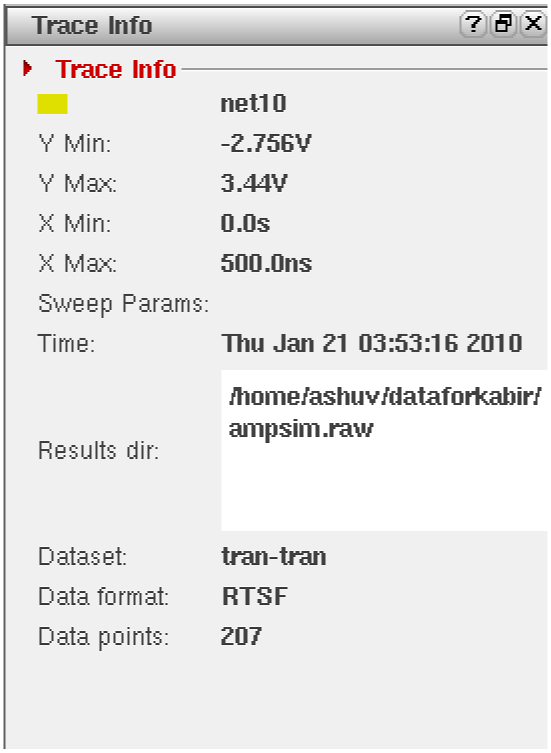
Using the clk signal in the results produced by the netlist above, with the assistant filled in as follows:

Horiz Marker Table

You use this assistant to view the interception data for horizontal markers in a table. For more information, see Displaying Intercept Data for Markers in Marker Tables on page 211.

Trace Info

You use this assistant to view information about the selected trace. To open the Trace Info, select a trace and choose *Window – Assistants – Trace Info*. The *Trace Info* assistant appears, displaying the *trace name and color, Y Min, Y Max, X Min, X Max, Sweep Params, Time, Results dir, Dataset, Data format,* and *Data points* for the selected trace. For more information about the data displayed in the trace panel, see Working with Traces on page 140.



Trace Info

Trace Info

🟨	net10
Y Min:	-2.756V
Y Max:	3.44V
X Min:	0.0s
X Max:	500.0ns
Sweep Params:	
Time:	Thu Jan 21 03:53:16 2010
Results dir:	/home/ashuv/dataforkabir/ampsim.raw
Dataset:	tran-tran
Data format:	RTSF
Data points:	207

Vert Marker Table

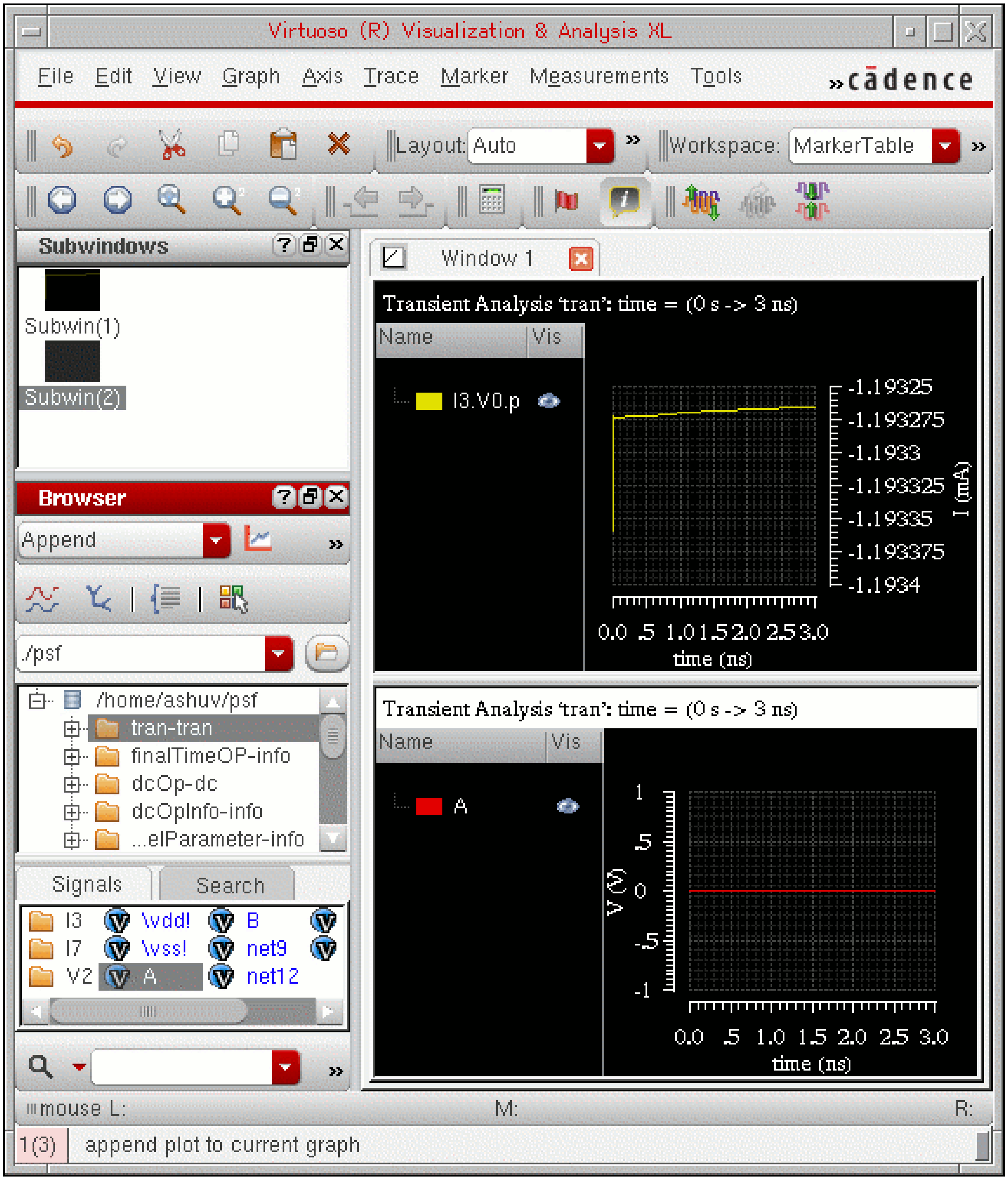
You use this assistant to view the interception data for vertical markers in a table. For more information, see Displaying Intercept Data for Markers in Marker Tables on page 211.

Subwindows

A subwindow is a graph that you can open within a window. The Subwindows assistant displays icons for all the subwindows that are open in a window. When you open a new window, the Subwindows assistant creates a default subwindow named `Subwin(1)`.

The title of a subwindow includes the analysis name. If a graph includes an expression, the expression name is displayed in the subwindow title.

You can specify the layouts to display subwindows in the window. For more information about graph layouts, see Specifying the Graph Layout on page 90.



To determine the active subwindow in a graph, see Determining the Active Subwindow on page 88.

To delete a subwindow, do one of the following:

- Right-click the graph in the subwindow and choose *Delete*.
- Select the subwindow you want to delete and choose *Edit – Delete*.
- Select the subwindow you want to delete and press the `Delete` key.
- Select the subwindow icon in the Subwindows menu and press the `Delete` key.

  The selected subwindow is deleted.

Working with Workspaces

A workspace is the arrangement of various assistants and the window settings that you specify while working with a graph. You can either use the available workspaces or create your own workspace while working in the window.

Workspace Types

The available workspaces are of four types:

- **Basic**—This workspace displayXs the following dockable assistants:
  - ❑ Subwindows
  - ❑ Results Browser
  - ❑ Graph
- **Browser**—This workspace displays the following dockable assistants:
  - ❑ Results Browser
  - ❑ Graph
- **Classic**—This workspace displays only the graph window.
- **MarkerTable**—This workspace displays the following dockable assistants:
  - ❑ Subwindows
  - ❑ Results Browser
  - ❑ Graph
  - ❑ Marker Table

If you open the tool in stand-alone mode, it is opened in the `Basic` workspace because in stand-alone mode you work on the saved simulation results.

If you open the tool from within ADE, it is opened in the `Classic` workspace because in ADE you work on the simulation results for the current run.

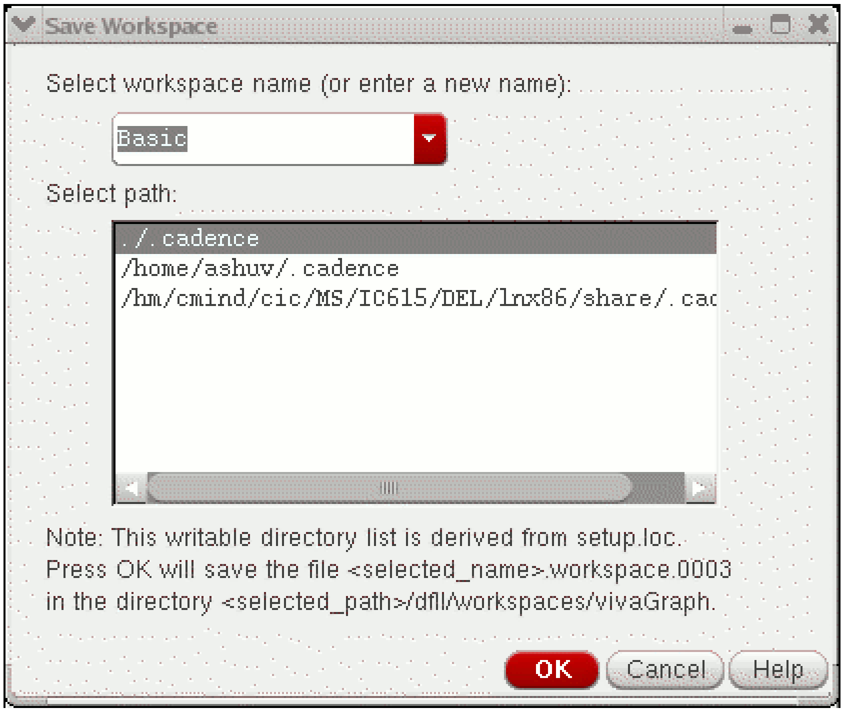
When you open a new Virtuoso Visualization and Analysis XL session from the same Virtuoso window, the workspace that you specified in the previous session is available.

Saving a Workspace

You can customize a workspace by selecting the assistants that you want to display from the *Window – Assistants* menu. You can then save the customized workspace by doing one of the following:

- Choose *Window – Workspaces – Save As.*
- On the Workspace toolbar, select the 💾 option.

  The *Save Workspace* form appears.



Save Workspace

Select workspace name (or enter a new name):

Basic

Select path:

```
./.cadence
/home/ashuv/.cadence
/hm/cmind/cic/MS/IC615/DEL/lnx86/share/.cac
```

Note: This writable directory list is derived from setup.loc.
Press OK will save the file <selected_name>.workspace.0003
in the directory <selected_path>/dfll/workspaces/vivaGraph.

In this form, specify the name with which you want to save the workspace and select the path where you want to save the workspace. You can specify a new name or can make changes to an existing workspace.

If you do not want to save the changes you made to the existing workspace, choose *Windows – Workspaces – Revert to Saved* to revert to the factory settings.

Loading a Workspace

To load a workspace, do one of the following:

- Choose *Windows – Workspaces – Load.*

  The *Load Workspace* form appears. In this form, select the workspace you want to load.

- On the Workspace toolbar, select the required workspace from the *Workspace* drop-down list box.

Deleting a Workspace

To delete a workspace, choose *Windows – Workspaces – Delete.*

The *Delete Workspace* form appears. Select the name of the workspace that you want to delete.

Setting the Default Workspace

To set a workspace as the default workspace, choose *Windows – Workspaces – Set Default.*

The *Default Workspace* form appears. Select the name of the workspace that you want to set as the default.

Showing and Hiding Assistants

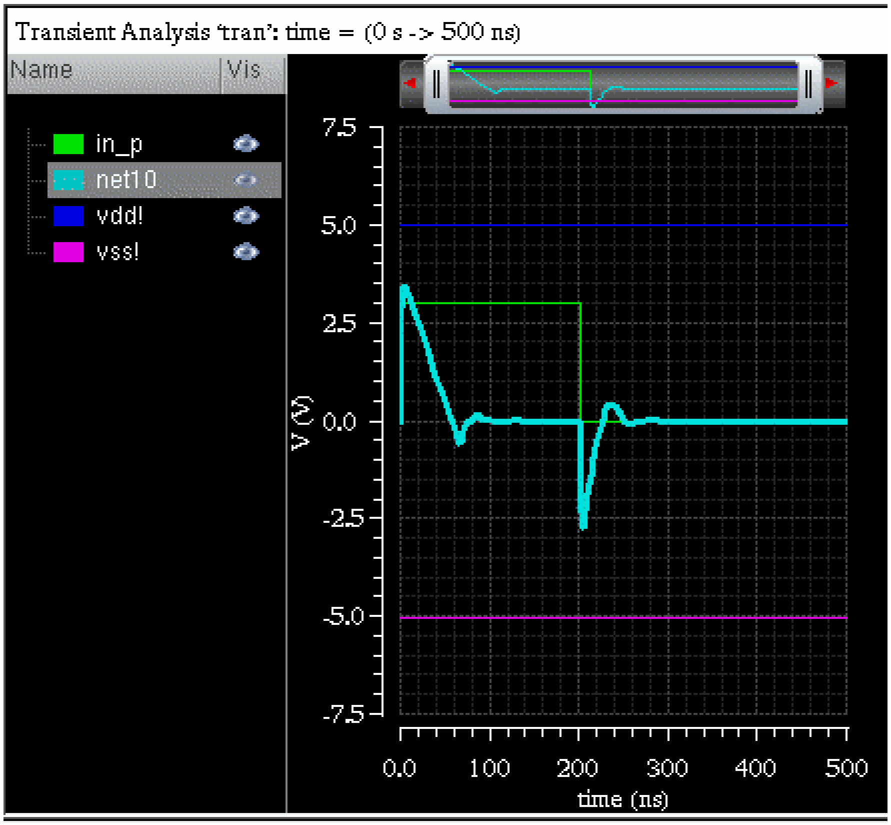
To show or hide the assistants in the workspace, do one of the following:

- Choose *Windows – Workspaces – Show/Hide Assistants*
- Press the `F11` key to hide or show the assistants.
- On the Workspace toolbar, select the option.

Working with Traces

A signal when plotted in the window is called a trace. Each trace in the window is displayed in a different color. The graph supports 18 unique colors. The information displayed in the area to the left of the trace is called the trace legend. A splitter line separates the trace and the trace legend area.

To highlight a trace in the window, select the legend corresponding to the trace or select the trace in the graph.


Transient Analysis 'tran': time = (0 s -> 500 ns)

The trace legend area displays the following information:

- The name and color of all the traces plotted in a graph.
- The corner names and sweep parameters from ADE L/XL in separate columns that can be sorted.
- The trace families, based on sweep parameters, in a hierarchical order. To view the analog traces in a family or the digital traces in a bus, click the + symbol in the trace legend area.

Each trace in the trace legend area displays a Visibility button 👁 that you can use to show or hide traces.

You can resize the trace legend area by dragging the dynamic splitter on the right. You can also adjust the width of each column in the trace legend area.

By default, the trace legend is displayed on the left of the graph. You can also move the trace legend inside the graph by using the *Graph Properties* form. For more information, see Editing Graph Properties on page 100.

You can select one or more traces in a graph by doing the following:

- To select a trace, click the trace in the graph or click the trace name in the trace legend area.
- To select all traces in a graph or a subwindow, press `Ctrl+Shift+A`.
- To select all traces in a strip, press `Ctrl+A`.

Note: The active strip is determined by a yellow bar displayed to the left of the trace legend area.

You can select a trace and choose one of the following *Trace* menu commands to manipulate traces in a window:

- *Symbols On*—Displays the symbols on the individual data points for the selected trace.
- *Select By Family*—Selects the traces from the parametric sweeps by family, instead of selecting an individual leaf.
- *Strip By Family*—Adds all the traces belonging to a family to a strip.
- *Select All*—Selects all the traces in a graph or in a strip in the active window or subwindow.
- *Delete All*—Deletes all the traces in the active window or subwindow. You can also use bind key `Ctrl+E` to delete all the traces in a window.
- *Move to*—Moves the selected trace to the following locations:
    - *New Window*—Moves the selected trace in a graph to a new window.
    - *New Subwindow*—Moves the selected trace in a graph to a new subwindow.
    - *New Strip*—Moves the selected trace in a graph to a new strip.
- *Copy to*—Copies the selected trace to the following locations:
    - *New Window*—Copies the selected trace to a new window.

  - ❑ *New Subwindow*—Copies the selected trace in a graph to a new subwindow.
  - ❑ *New Strip*—Copies the selected trace in a graph to a new graph strip. This is especially useful when you want to study a single trace separate from a set of parametric leaf waveforms. You can alter trace selection to select signals by family, rather than by selecting individual traces, by choosing *Trace - Select by Family*.

To show or hide traces, right-click the trace and choose *Visible*. The red check mark is displayed with this option indicating that the trace is visible.

Dragging Traces

Traces support the following drag-and-drop operations:

- You can drag traces from one window to another.
- You can drag traces from one subwindow to another. The window to which you drag a trace becomes the active window.
- You can drag traces from one strip to another.

Tracking Cursor

The tracking cursor displays the color and name of the trace and its X- and Y-axis values when you drag a trace. Do one of the following to display tracking information on the tracking cursor:

- Choose *Markers – Tracking Cursor*.
- Click the Tracking Cursor button on the Marker toolbar.

Hiding and Showing Traces

To show or hide a trace, do the following:

- Right-click a trace and select *Visible*.
- In the trace legend area, click the Visibility button (👁).

Deleting Traces

To delete a trace from a graph, subwindow, or strip, do one of the following:

- Select the trace and choose *Edit – Delete*, or press the `Delete` key.

- Right-click the trace and choose *Delete*.

To delete all traces in a subwindow, select a trace and do one the following:

- Choose *Trace – Delete All*
- Press `Shift+E`.

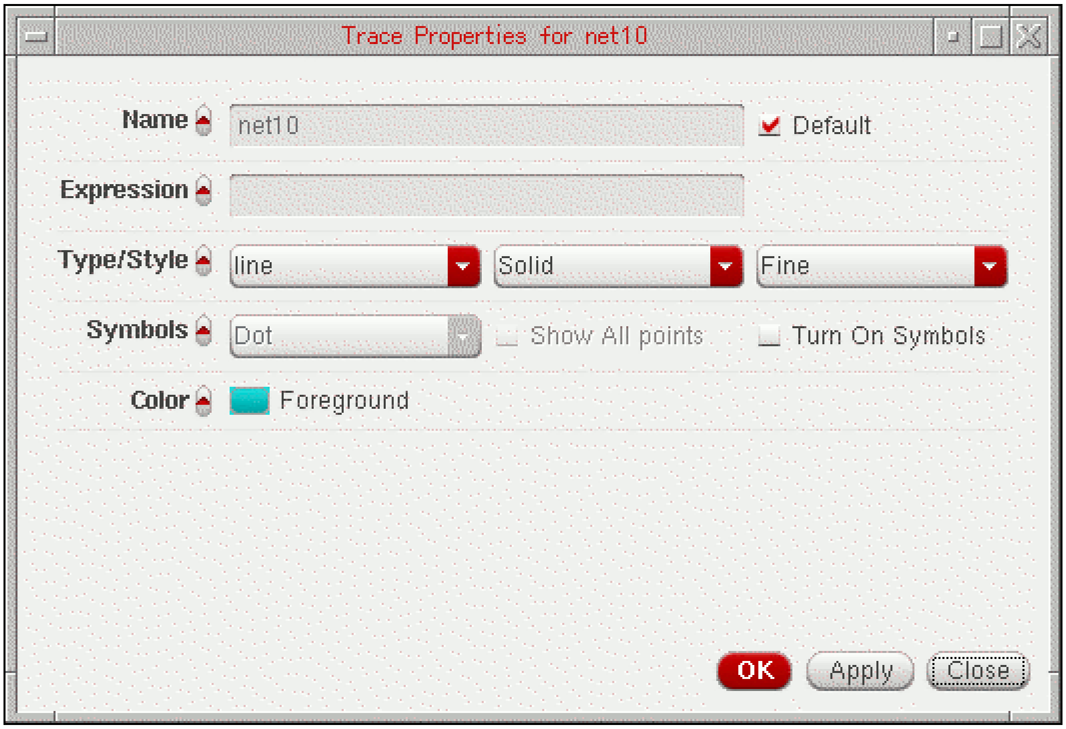
Setting Trace Properties

The default trace properties are controlled by the values assigned to variables in the `.cdsenv` file. For more information, see Appendix A, "Virtuoso Visualization and Analysis XL Tool Environment Variables."

Do one of the following to set the trace properties for a trace:

- Double-click a trace in the window.
- Select a trace and choose *Trace – Properties*.

  The *Trace Properties for <trace-name>* form appears.



Trace Properties for net10

Name: net10 ☑ Default

Expression:

Type/Style: line | Solid | Fine

Symbols: Dot ☐ Show All points ☐ Turn On Symbols

Color: Foreground

In this form, set the trace properties:

- ❑ In the *Name* field, type the name for the trace or select the *Default* check box to display the default trace name. When you select the *Default* check box, the *Name* field becomes unavailable. The *Name* and *Default* fields are not available if you select more than one trace.
- ❑ In the *Expression* field*,* type the expression associated with the selected trace or get the expression from the Calculator Buffer.
- ❑ In the *Type/Style* fields, do the following:
  - ❍ Specify whether you want to represent the trace by a *line*, *points*, *histogram*, *bar*, or *spectral*.
  - ❍ Specify whether you want the trace style to be *Solid*, *Dashed*, *Dotted*, or *DotDashed,* or *DashDotDot*.

  Note: The trace style option does not work for *Bars* and *Spectrum*.

  - ❍ Specify whether you want the trace to be *Fine*, *Medium*, *Thick* or *ExtraThick*.

  Note: The trace thickness option does not work for *Bars* and *Spectrum*.
- ❑ In the *Symbols* field, select the *All Points* check box to display data points on the trace and specify the number of points to be displayed.
- ❑ In the *Points per Symbol* field, specify whether you want data points to be displayed on the trace as symbols of *Point*, *Dot*, *Plus*, *Square*, *Box*, *X*, *Circle,* and so on*.*
- ❑ In the *Color* field, select the foreground color for the trace. Alternatively, you can also set the trace color by right-clicking the trace and selecting *Color.*
- ❑ Click *OK*.

Note: You can also select these properties by right-clicking a trace.

For more information about the selected trace, choose *Window – Assistants – Trace Info Panel*. The Trace Info Panel assistant appears, displaying the *Name, Max value, Min value,* and *Data points* of the selected trace.

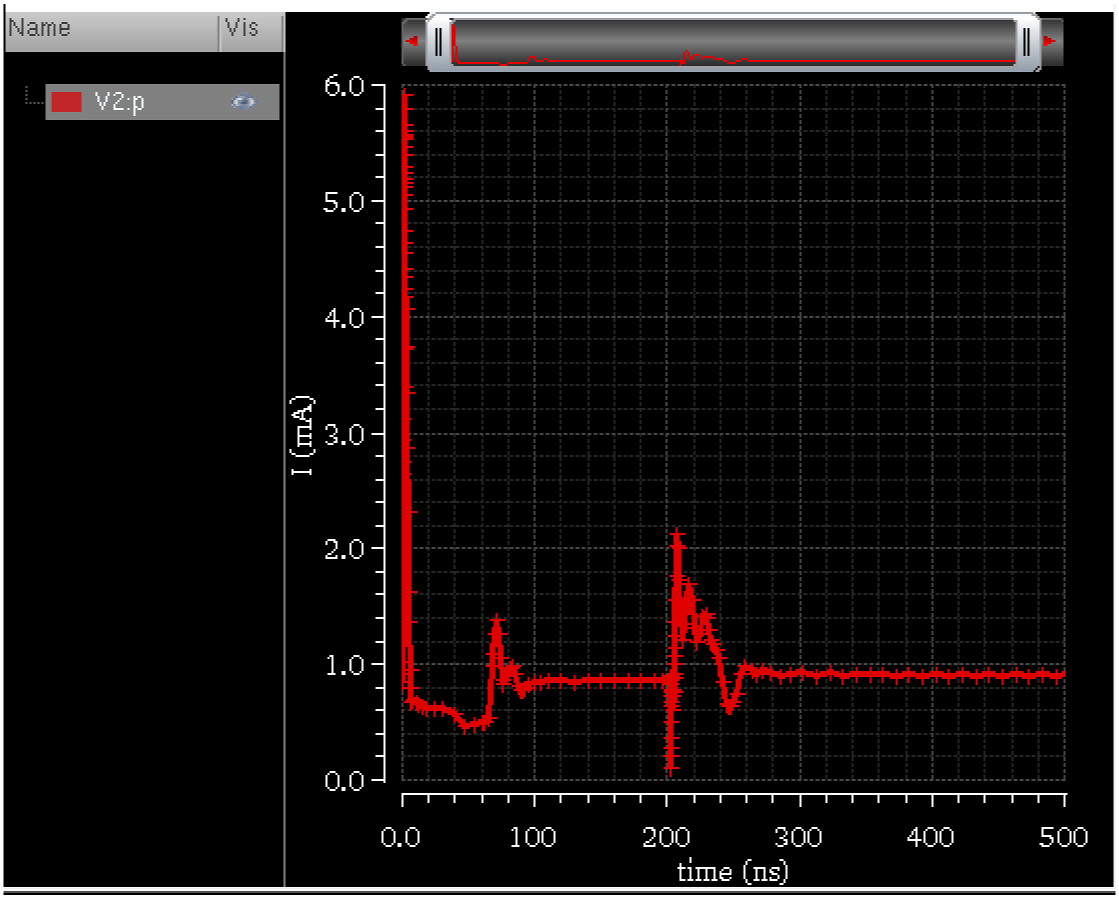
Displaying Symbols on a Trace

To display symbols for the data points on a trace, do one of the following:

➤ Select a trace and choose *Trace – Symbols On*.

You can control the symbol type and the number of data points that can be identified by the symbols. The symbol used for the trace is displayed next to the trace name.

The following figure illustrates how two traces can be distinguished by using symbols for the data points.



Exporting a Trace

To export a trace from the window in a variety of formats and later load it in the required application. You can also save a clipped part of the dataset by specifying the start and end values, or interpolate the data before saving it. By exporting a trace, you can also save the expressions associated with the trace.

To export the trace, do one of the following:

- Select the trace and choose *Trace — Export*.
- Right-click the trace and choose *Export*.

The *Export Waveforms* form appears. For detailed information about the fields in this form and how to save a trace using this form, see Exporting Signals on page 58.

Sending Trace Expressions to Calculator

To send the expression associated with a trace in the window to the Calculator, select the trace for which you want to send the expression to the Calculator and do one of the following:

- Choose *Tools – Calculator*.
- Right-click the trace and choose *Calculator*.

  The Calculator window appears with the expression for the selected signal displayed in the Buffer.

  You can select more than one trace by holding down the `Shift` or `Ctrl` key and clicking the traces you want to select. The most recently selected trace appears in the Buffer and the remaining traces are added to the Stack with the recently selected trace at the top of the stack.

Sending Traces to ADE

To include the expressions for the traces displayed in a graph directly to ADE L and XL output Setup tab, right-click a trace and choose *Send to ADE*. The expression for the selected trace is added to ADE as a new output and evaluated when you run the simulation.

You use this option if you want to evaluate the expression for the trace in the current simulation run in ADE.

Note: If you are using the Refresh feature in ADE L or XL, the traces that you include into ADE L or XL from the graph are also updated with the new simulation data.

Working with Strips

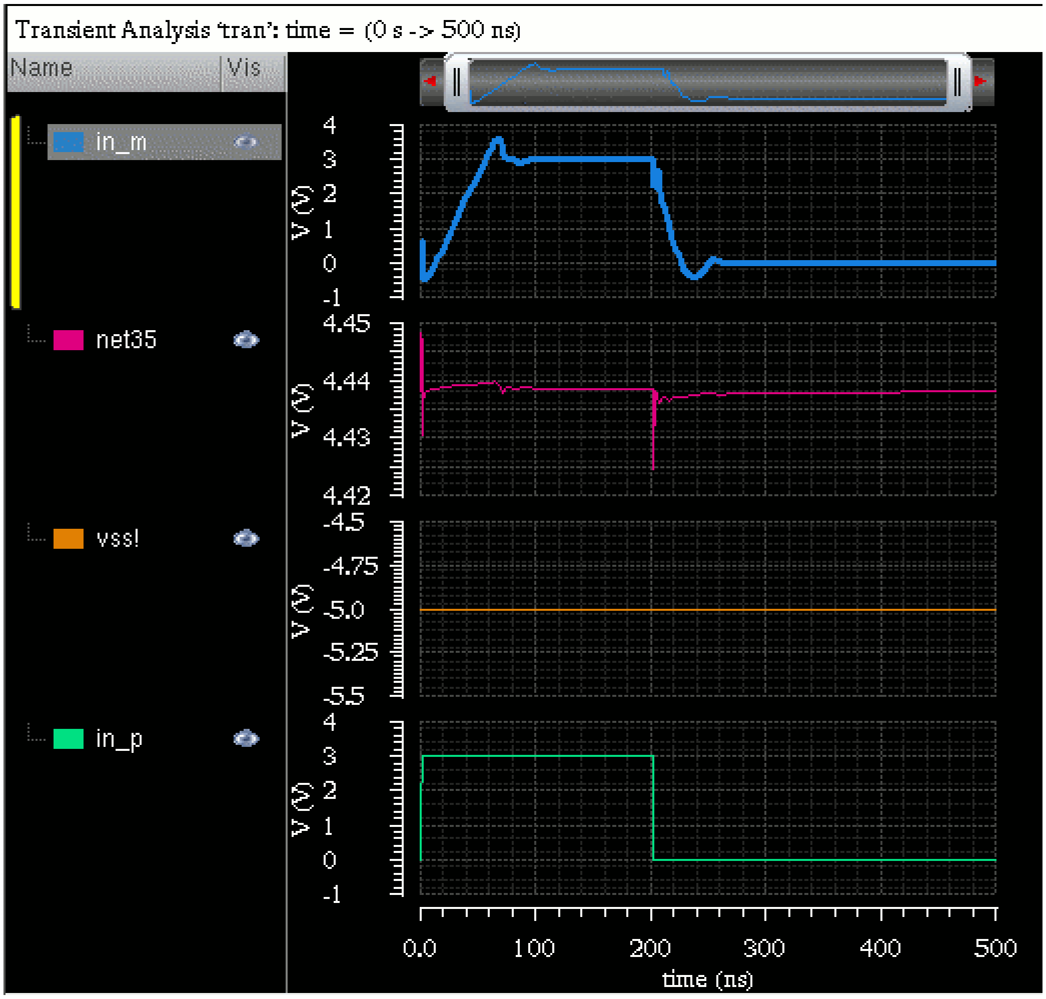
You can append multiple traces to a graph. If you want to view the individual traces, you can split the graph into strips that are arranged vertically. Each strip has its own Y-axis and shares the X-axis with the other strips. The window displays the trace legend separately for each individual strip.

To split the traces in a graph into strips, do one of the following:

- Choose *Graph – Split Current Strip*.
- Right-click anywhere in the window and choose *Split Current Strip*.

- Click the button on the Strip toolbar.

  Each trace in the graph is displayed in a separate strip.



The active strip is determined by a yellow bar displayed on the left of the strip. If you want to change the order in which the strips are displayed, drag the strips. You can drag a strip to any of the following locations:

- To a strip—the trace is appended to the strip.
- To an area outside the strip—the trace is placed in a new strip below the strip closest to the point to where you drag the strip.

  You can also resize the active analog strip by dragging the strip splitter.

Setting Strip Properties

To set the strip properties, do one of the following:

- Choose *Graph – Properties.*
- Right-click anywhere in the window and choose *Graph Properties*.

  The *Graph Properties* form appears. On the *Strip* tab, set the analog and digital height for the strips.

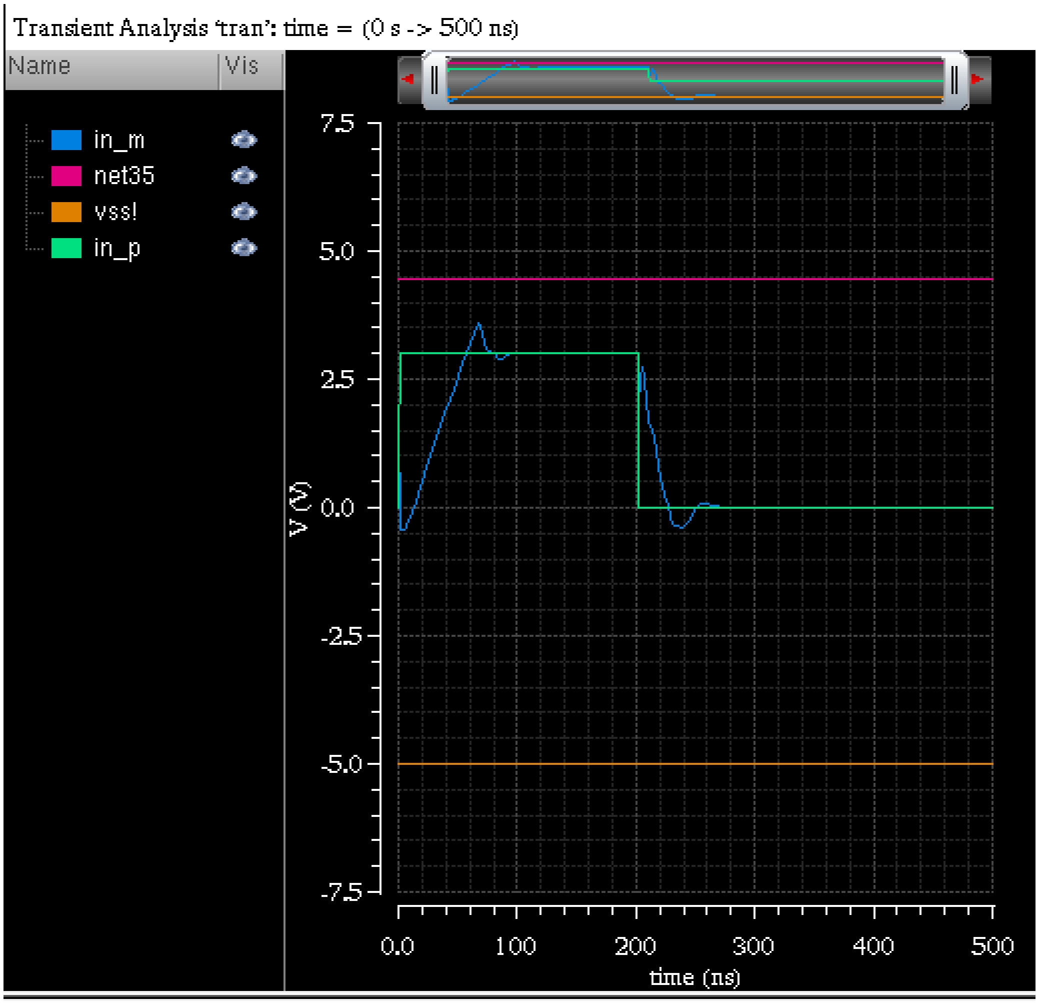
  In this form, you can set the minimum analog height and the minimum and maximum digital heights of strips. If you click the *Default* button, you cannot change the values of these fields, and the values that you have entered become the default values.
- Click *Apply,* and then click *OK*.

Combining Graph Strips

You can combine one or more strips by dragging them to a single strip. To combine multiple graph strips, do one of the following:

- Choose *Graph – Combine All Analog Traces*.
- Right-click anywhere in the window and choose *Combine All Analog Traces*.
- Click the button on the Strip toolbar.

The traces displayed in the various strips are combined into a single graph.



Locking and Unlocking Strips

You can lock and unlock a strip while splitting the traces into different strips.

To lock a strip, right-click anywhere in the window and choose *Lock Strip Size*. A red check mark is displayed before this command and a lock icon appears at the top right corner of the strip, displaying the strip in the locked mode. If you change the size of any other strip in the window, it does not change the size of the locked strip.

To unlock the strip, right-click anywhere in the window and choose *Lock Strip Size*. The lock icon is no longer displayed and you can resize the strip now.

Video

The Using Strip Charts in Qt Graph video demonstrates how to split and combine analog traces into strips, resize strips, plot the trace to a new strip, and split and combine traces from sweep data.

Working with Sweeps

To display the sweep data for a family in the same strip, choose *Trace – Strip by Family* before plotting the sweep data. Now, if you select to display traces in strips, each trace family is displayed in a separate strip.The trace legend area displays the traces in the family. Click the + sign to view all traces.

- To select an individual trace in the family, click the trace in the trace legend area.
- To select all the traces in the family, choose *Trace – Select By Family*. Now, when you select a signal in the trace legend area, the entire family is selected.

To display the traces from the sweep data in individual strips, ensure that the *Trace – Strip By Family* is not selected. Then, right-click anywhere in the graph and choose *Split Current Strip*.

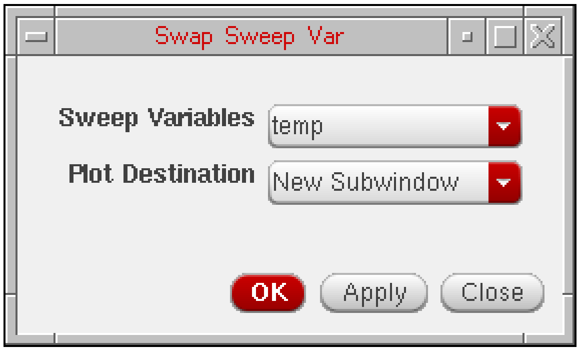
Swapping Sweep Variables

The sweep data can include multiple sweep variables; however, you can plot sweep data analysis results by using only two sweep variables at a time. If you want to plot the sweep data results with another variable, you can swap the X-axis variable with this variable.

To swap the sweep variables in the graph, do one the following

- Right-click the X-axis and choose *Swap Sweep Var.*
- Right-click anywhere in the window and choose *Swap Sweep Var*.

The *Swap Sweep Var* form appears. You cannot perform any action in the Virtuoso Visualization and Analysis XL window when the Swap Sweep Var form is open.



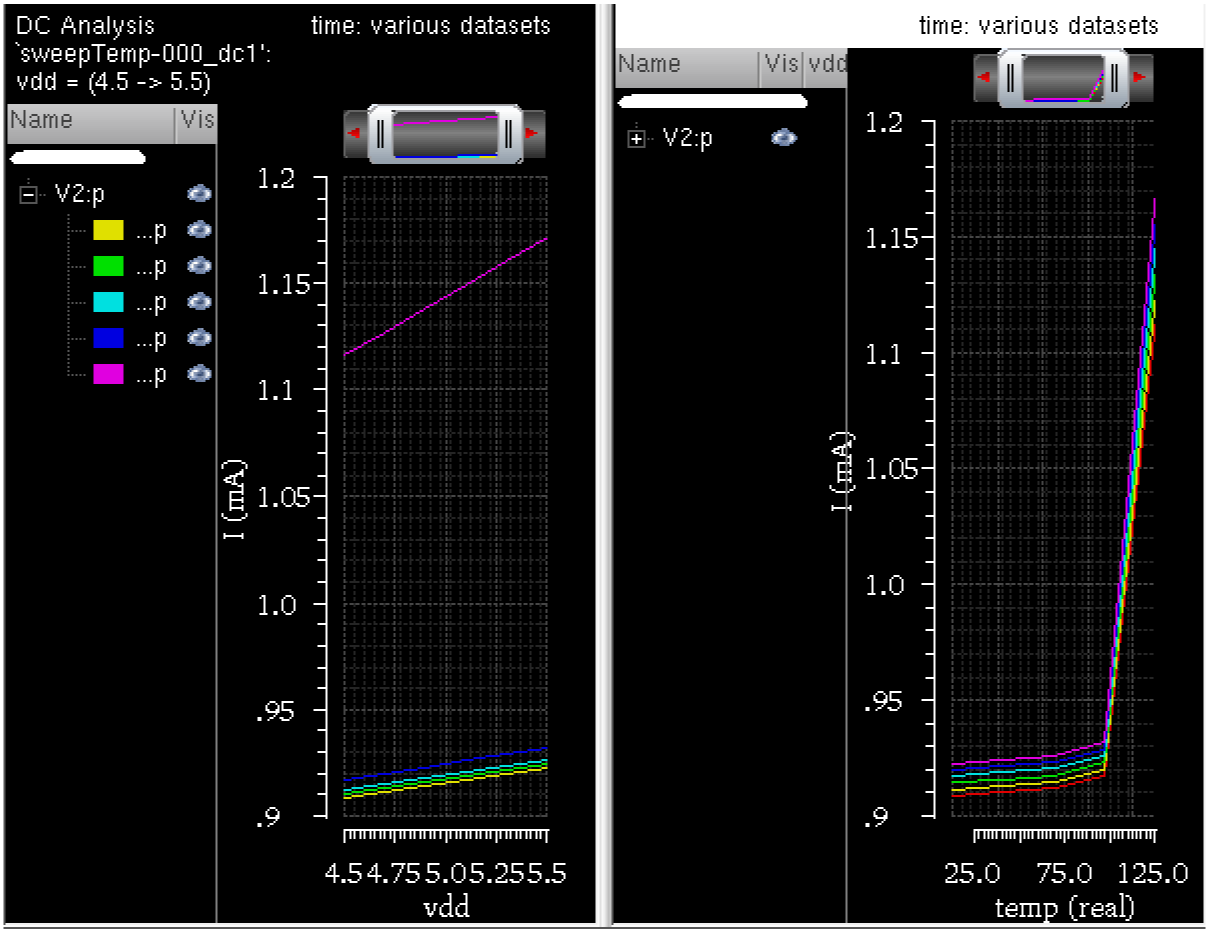
Sweep Variables: temp

Plot Destination: New Subwindow

The *Sweep Variables* drop-down list box in this form displays all the sweep variables. Now, perform the following steps:

- ❑ Select from the drop-down list the sweep variable that you want to swap and specify the plot destination that can be a new window or a subwindow.
- ❑ Click *OK*.

A new graph is created according to the swapped variable for the X-axis.

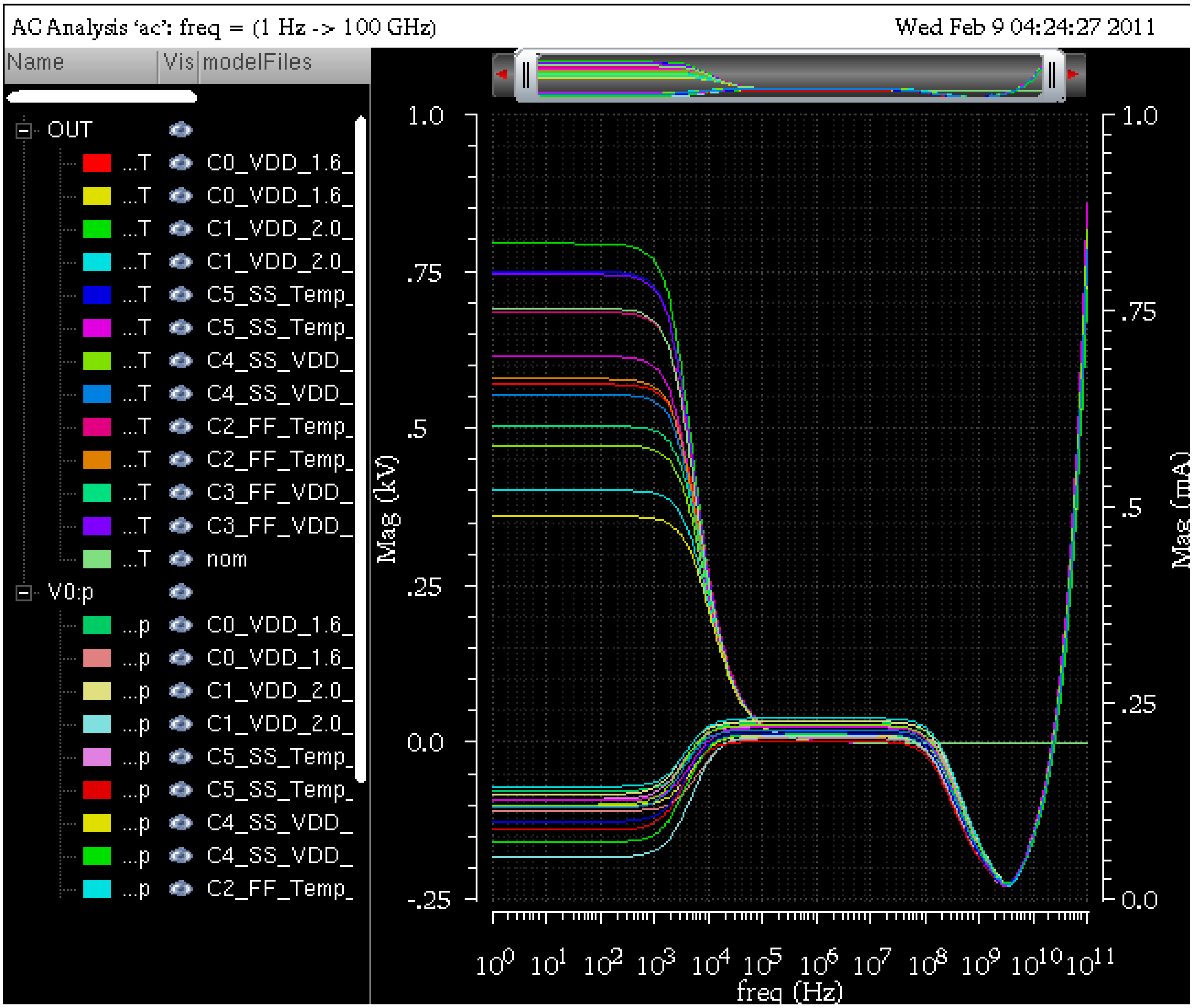


Filtering Traces Using Sweep Visibility Filter

To display in a graph specific traces that belong to a selected sweep data range, you can filter the traces by using the sweep visibility filter option. Filtering helps you analyze the simulation data in a specific sweep range.

The figure below shows the `OUT` and `V0:P` traces that are plotted after running a simulation is run in ADE XL for sweep data. The X-axis sweep variables for this simulation are—

modelFiles, *VDD*, *temperature*, *freq*, and *Corner*. The graph below is plotted with `freq` as the sweep variable on X-axis.

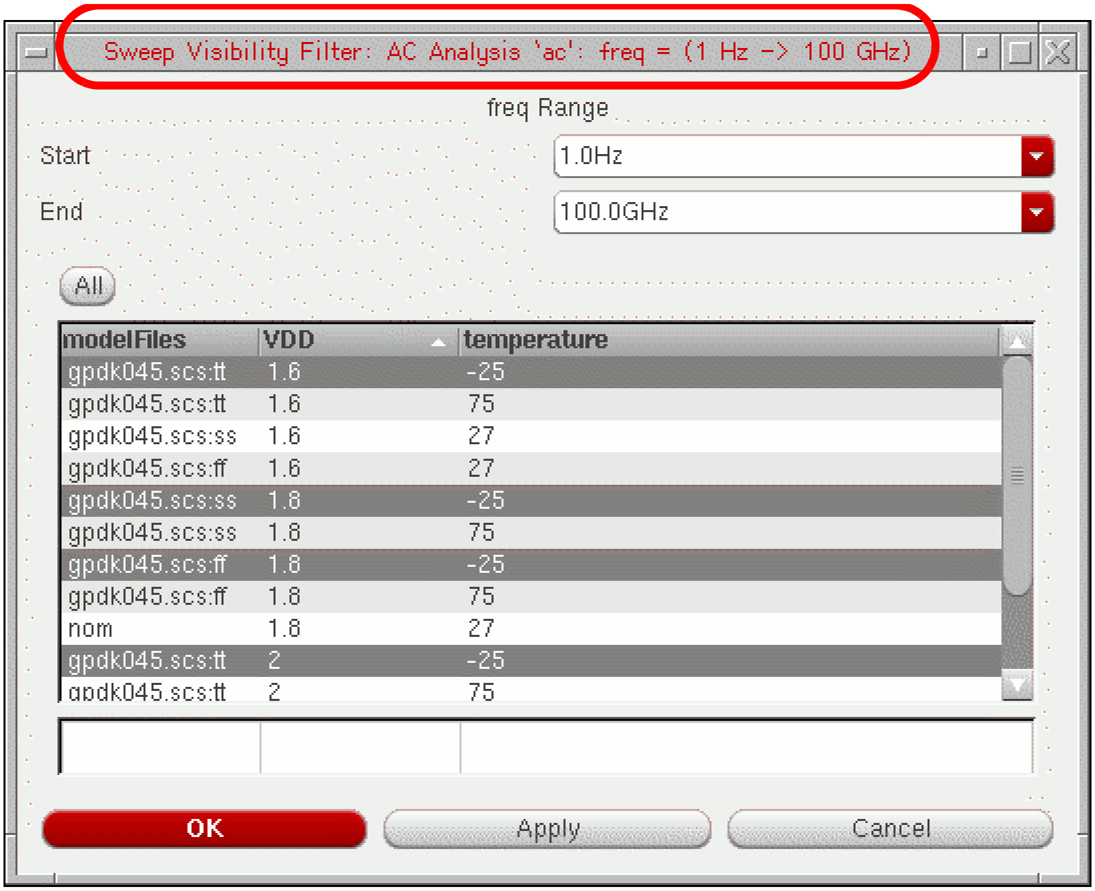


You can select different combinations of sweep variables to filter the visibility of traces that you want to display in the graph. For example, in the graph shown above, you can select a specific range of other sweep variables—*modelfiles*, *VDD*, and *temperature*—to filter traces. The traces that fall in the range you have selected are visible in the graph and the visibility of remaining traces is turned off.

To filter traces from sweep data, perform the following steps:

1. Choose *Graph – Filter By Sweep Var*.

The *Sweep Visibility Filter* form appears. The form name includes the subwindow name, as shown below.



Sweep Visibility Filter: AC Analysis 'ac': freq = (1 Hz -> 100 GHz)

freq Range

Start 1.0Hz

End 100.0GHz

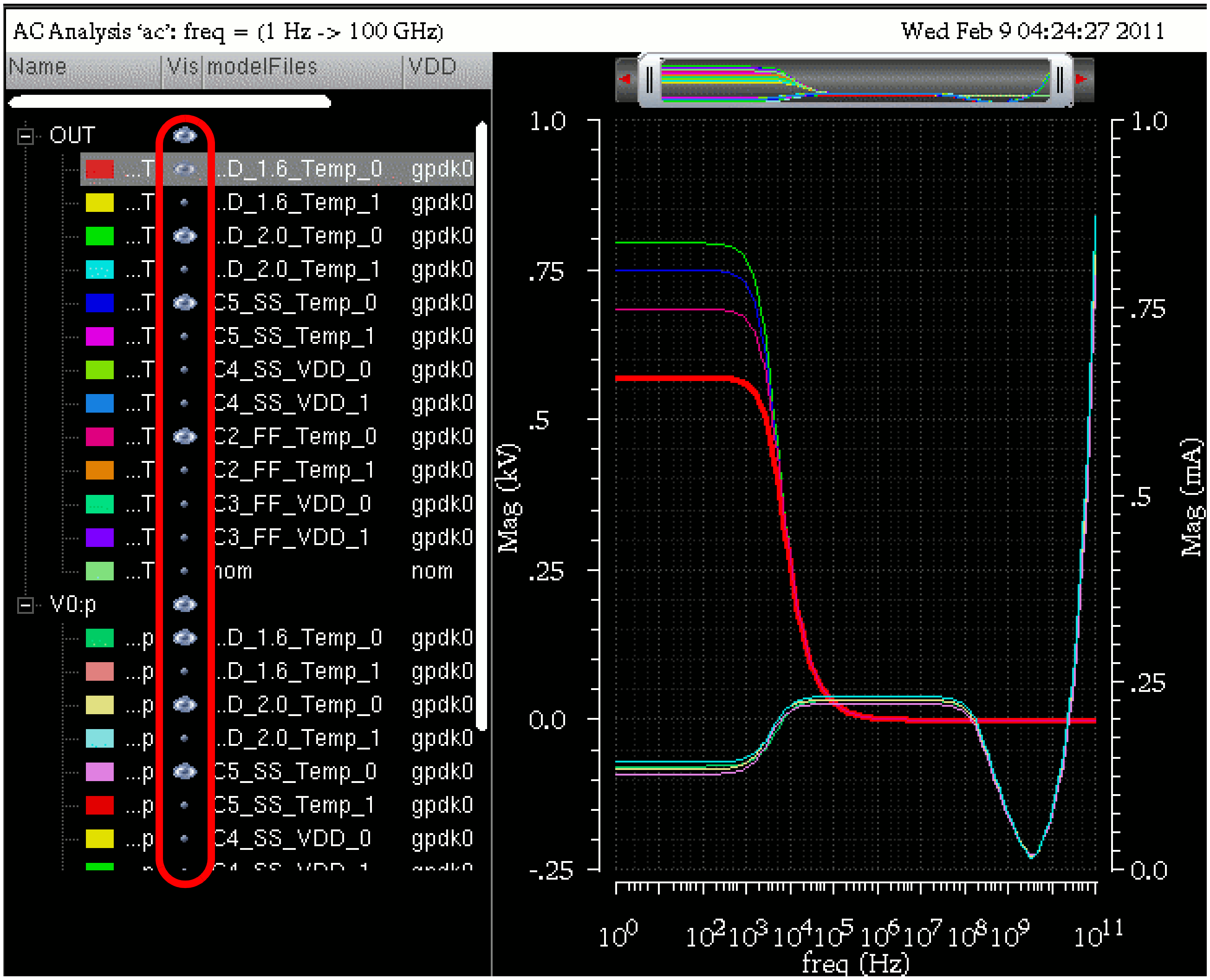
modelFiles	VDD	temperature
gpdk045.scs:tt	1.6	-25
gpdk045.scs:tt	1.6	75
gpdk045.scs:ss	1.6	27
gpdk045.scs:ff	1.6	27
gpdk045.scs:ss	1.8	-25
gpdk045.scs:ss	1.8	75
gpdk045.scs:ff	1.8	-25
gpdk045.scs:ff	1.8	75
nom	1.8	27
gpdk045.scs:tt	2	-25
gpdk045.scs:tt	2	75

2. Select the variable values for which you want to display traces in the graph. For example, the form displayed in the figure above shows the following four traces selected for the *modelFiles*:*VDD*:*temperature* combination:

```
gpdk045.scs:tt, 1.6, -25
gpdk045.scs:ss,1.8, -25
gpdk045.scs:ff, 1.8, -25
gpdk045.scs.tt, 2, -25
```

3. Click *Apply*.

The traces for the selected combination of *modelFiles*, *VDD* and *temperature* values are displayed in the graph.



AC Analysis ‘ac’: freq = (1 Hz -> 100 GHz) Wed Feb 9 04:24:27 2011

Name	Vis	modelFiles	VDD
⊟ OUT	👁		
🟥 ...T	👁	..D_1.6_Temp_0	gpdk0
🟨 ...T	•	..D_1.6_Temp_1	gpdk0
🟩 ...T	👁	..D_2.0_Temp_0	gpdk0
🟦 ...T	•	..D_2.0_Temp_1	gpdk0
🟦 ...T	👁	C5_SS_Temp_0	gpdk0
🟪 ...T	•	C5_SS_Temp_1	gpdk0
🟩 ...T	•	C4_SS_VDD_0	gpdk0
🟦 ...T	•	C4_SS_VDD_1	gpdk0
🟥 ...T	👁	C2_FF_Temp_0	gpdk0
🟧 ...T	•	C2_FF_Temp_1	gpdk0
🟩 ...T	•	C3_FF_VDD_0	gpdk0
🟪 ...T	•	C3_FF_VDD_1	gpdk0
🟩 ...T	•	nom	nom
⊟ V0:p	👁		
🟩 ...p	👁	..D_1.6_Temp_0	gpdk0
🟥 ...p	•	..D_1.6_Temp_1	gpdk0
🟨 ...p	👁	..D_2.0_Temp_0	gpdk0
🟦 ...p	•	..D_2.0_Temp_1	gpdk0
🟪 ...p	👁	C5_SS_Temp_0	gpdk0
🟥 ...p	•	C5_SS_Temp_1	gpdk0
🟨 ...p	•	C4_SS_VDD_0	gpdk0
🟩 ...p	•	C4_SS_VDD_1	gpdk0

Note: The visibility icon in the trace legend area is ON only for the selected combination of sweep variables, as shown in the figure above.

You can also filter traces by selecting the *Set Sweep Ranges* option in the Results Browser. For more information, see Selecting and Plotting Signals in a Data Range on page 48.

Working with Graph Labels

You can add labels in a graph to display information about the graph or a trace. You can also attach labels with markers. For information about how to attach and edit the labels on marker, see Adding Markers on page 194.

To add a graph label in a graph, do one of the following:

- Select a graph and choose *Graph – Label.*
- Right-click anywhere in the window and choose *Create Graph Label*.

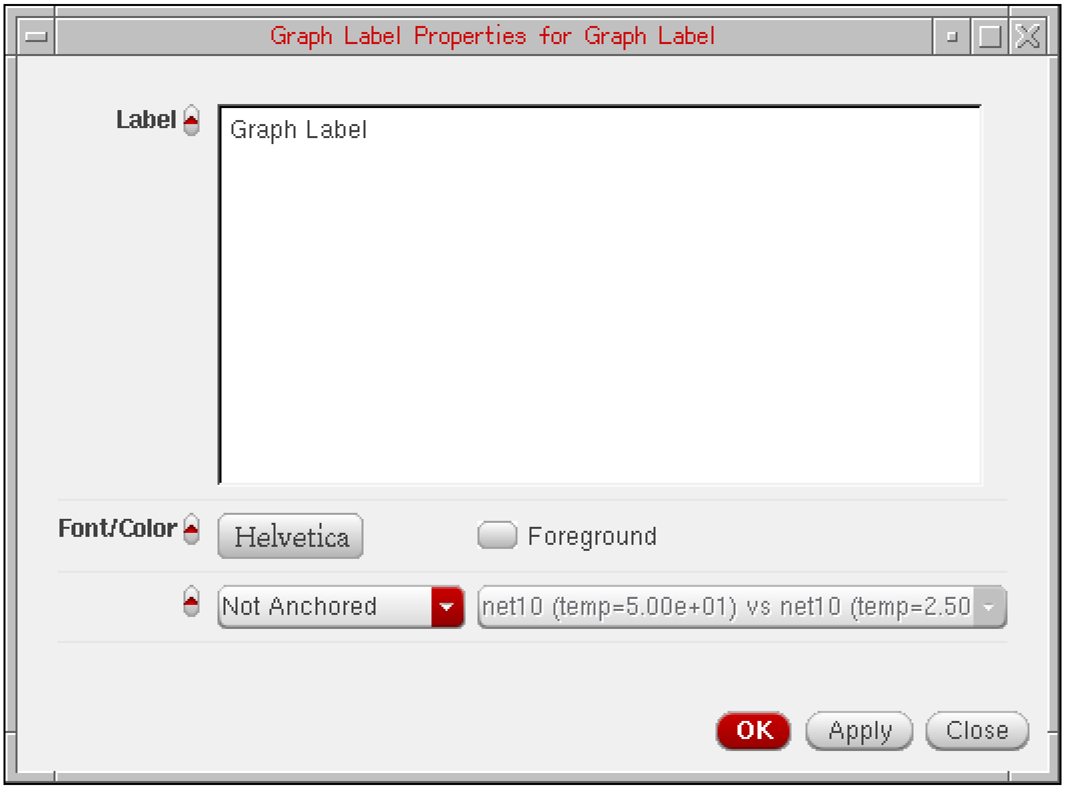
  A label is added to the graph you selected. By default, the label displays the string `Graph Label`. You can change the graph label by double-clicking the displayed string.

  Note: To add a new line in the graph label, press `Enter`. The new line and carriage return characters are also supported in the graph labels.

  To change the graph label properties, do one of the following:

  - ❑ Right-click the graph label and choose *Graph Label Properties*.
  - ❑ Select the label and press `Q`.

The *Graph Label properties for <Graph Label Name>* form appears.



Label: Graph Label

Not Anchored

net10 (temp=5.00e+01) vs net10 (temp=2.50

This form includes the following fields:

- *Label*—Displays the default graph label name. You can provide a new name for the label.
- *Font*—Specifies the font type.
- *Foreground*—Specifies the foreground and background color of the graph label.
- Drop-down list box to select whether the label is an anchored frame or attached to a trace. You can select the trace name in the drop-down.

- Click *OK* to save the changes you made.

Note: You can change the position of a graph label by dragging the graph label to a new location.

Deleting Graph Labels

To delete a graph label, do one of the following:

- Select a label and choose *Edit – Delete*, or press the `Delete` key.
- Right-click the label and choose *Delete*.

Creating Multiple Graph labels

To create multiple graph labels, right-click a label in the graph and choose *Copy*. Then, right-click any where in the window and choose *Paste*. A copy of the graph label is created. Drag one of the labels to the required new position. Using this method, you can create as many labels as you want.

Note: You cannot move a label that is attached to a marker.

Plotting WREAL Signals

Virtuoso Visualization and Analysis XL supports the plotting of WREAL (wire-real) signals, where the WREAL signals are by default plotted in the sample and hold plot type.

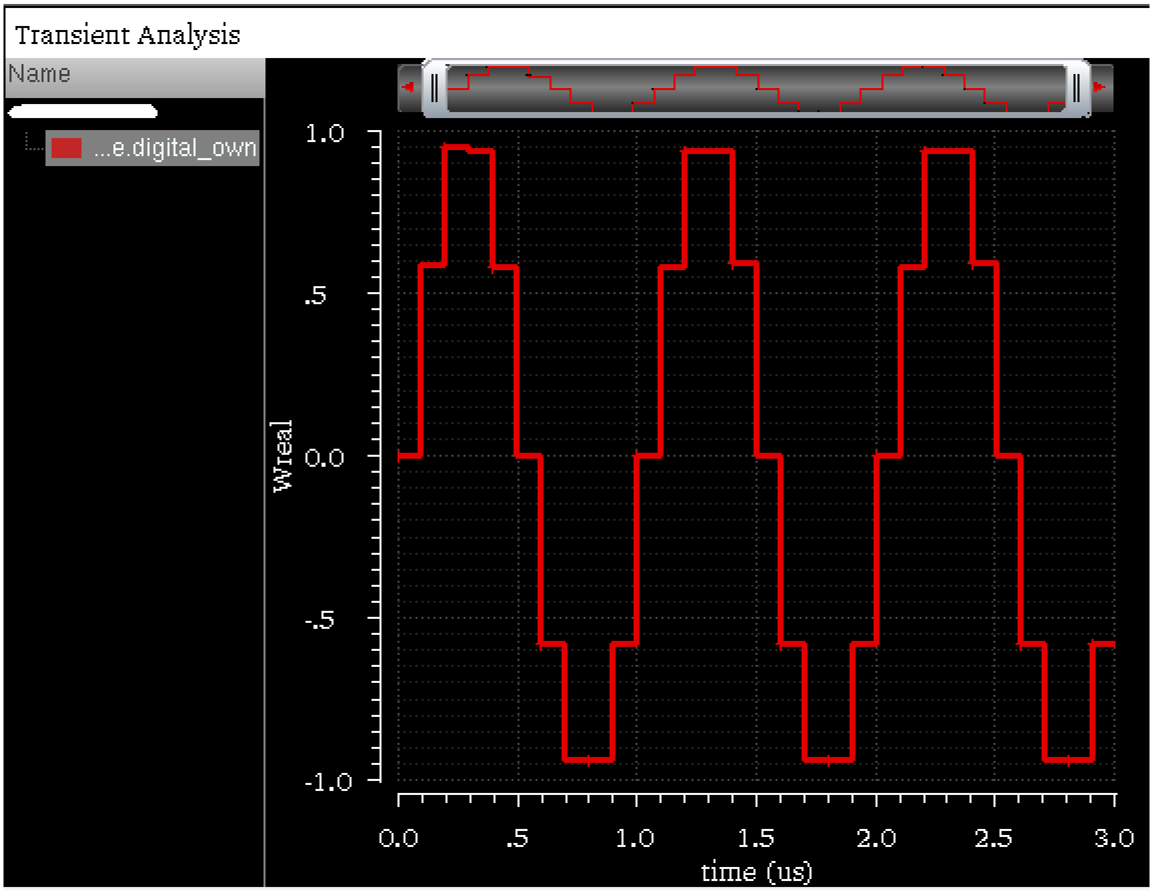
Important

> If you want to disable the WREAL plotting, set the `vivaWrealSupport` environment variable to `false`:
>
> ```
> setenv vivaWrealSupport false
> ```

Perform the following step to set the plot type of a trace to sample and hold:

➡ Right-click the trace for a WREAL signal and choose *Type – Sample Hold*.

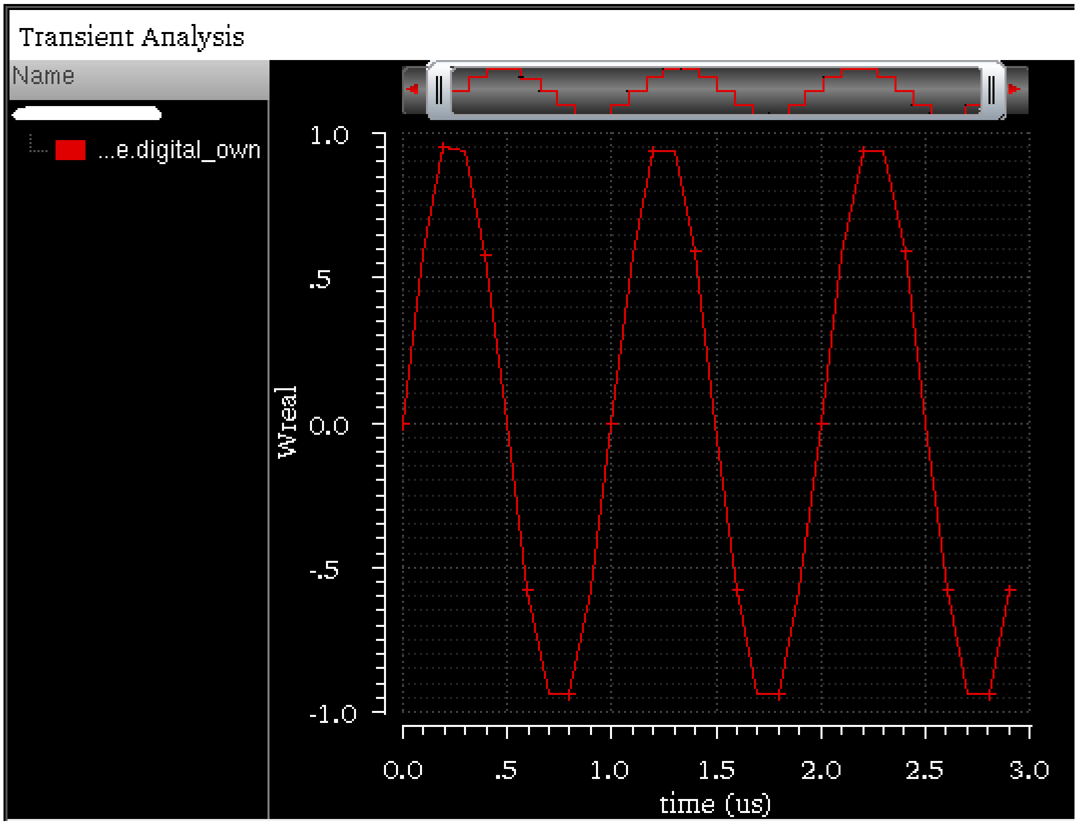
The following figure displays a WREAL signal plotted in the sample and hold plot type.



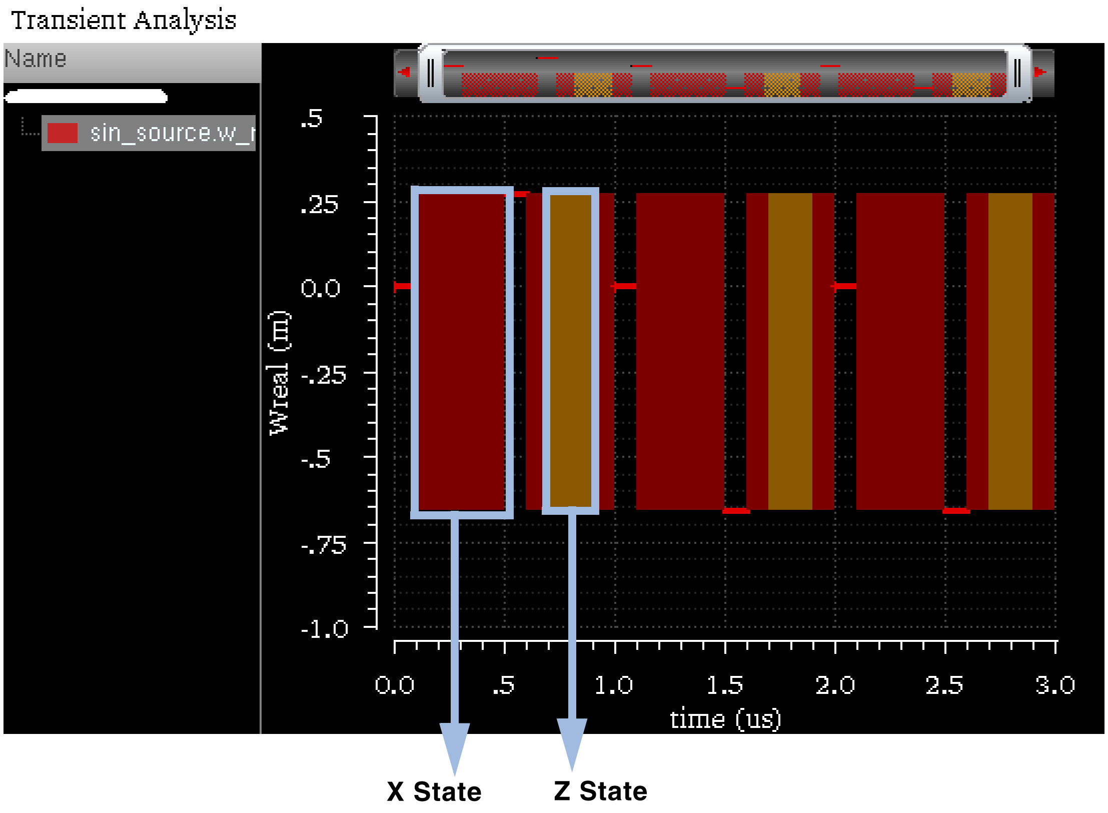
By default the data points are visible in the plots for the WREAL signals. To hide the data points, do one of the following:

- Choose *Trace – Symbols On*.
- Right-click the trace and deselect *Symbols On*.
- Right-click the trace and choose *Symbol – Symbols Off*.

To change the plot type to a continuous line, right-click the trace and choose *Type – Continuous line*.



WREAL plots includes a special depiction style to display the X and Z states. In the figure below, the red blocks indicate the X state and the yellow blocks indicate the Z state.



Limitations

Following are the limitations while plotting the WREAL signals:

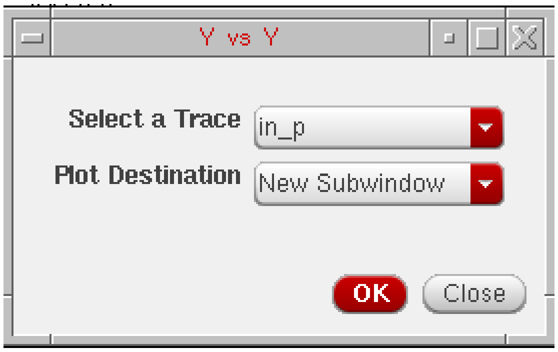
- The X and Z states are not visible when the trace is exported into a table.
- The X and Z states are not plotted when you plot the WREAL signal from ADE and Calculator.
- Single point WREAL signals are not displayed as a line.
- WREAL array data is not displayed as a group and each member of the array is displayed separately.
- Zooming a WREAL signal does not work properly.

Plotting YvsY Graph

To plot a YvsY graph for the sweep data, do the following:

- Right-click the X-axis and choose *YvsY.*

  The *YvsY* form appears. You cannot perform any action in the Virtuoso Visualization and Analysis XL window when the YvsY form is open.



Y vs Y

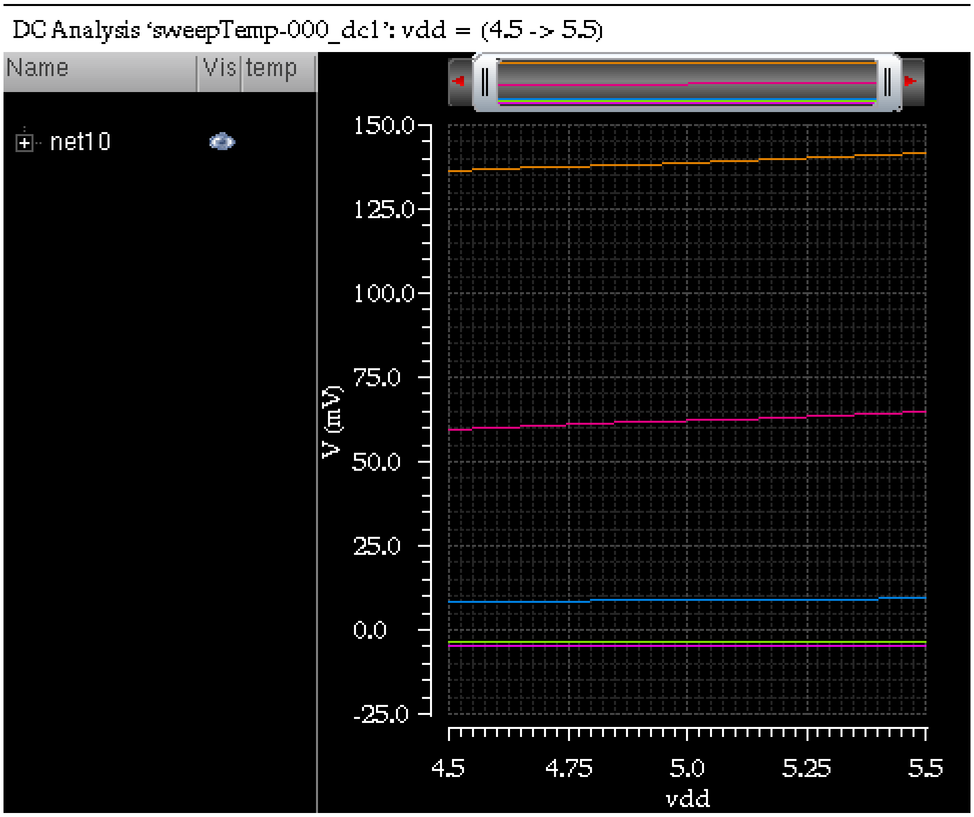
Select a Trace: in_p

Plot Destination: New Subwindow

- Select a trace in this form and specify the plot destination, which can be a new window or a subwindow.
- Click *OK.*

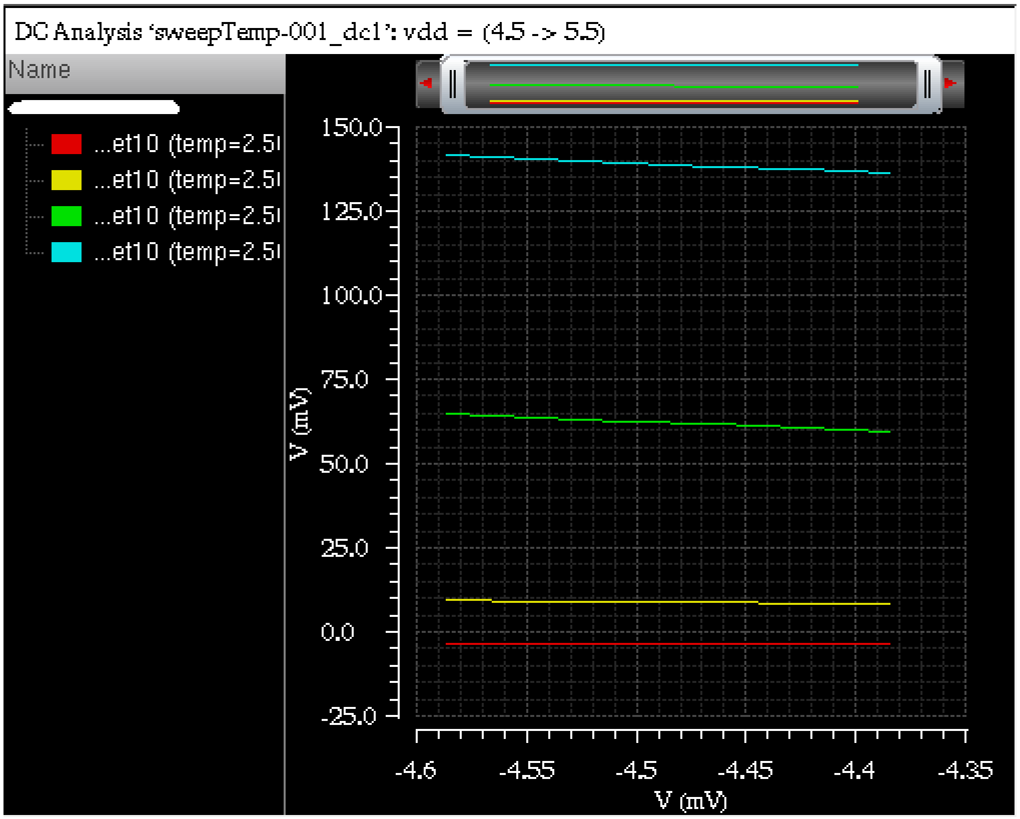
  The YvsY plot is created in the destination window that you select. For example, the YvsY plot for `net10` is displayed below.

Signal `net10`:



DC Analysis 'sweepTemp-000_dc1': vdd = (4.5 -> 5.5)

YvsY of `net10`:



Saving and Loading Graphs

You can save a graph to a file for future use. When you save a graph, the graph settings, such as zooming and panning, changing font type and font color, setting labels for X and Y axis, or changing the trace color are also saved with the graph file. As a result, you save on the effort required to customize the graph when you display the same graph again.

When you load the saved graph in a window and append a trace to that window, the new trace is displayed with the same window attributes.

Note: If you open a new graph in a subwindow, the graph appears in the default graph attributes.

This section includes the following topics:

- Saving a Graph on page 165
- Loading a Graph on page 167

- Saving a Graph as an Image on page 168

Saving a Graph

The graph is saved as an XML file with the `.grf` extension. The following information is saved with the graph:

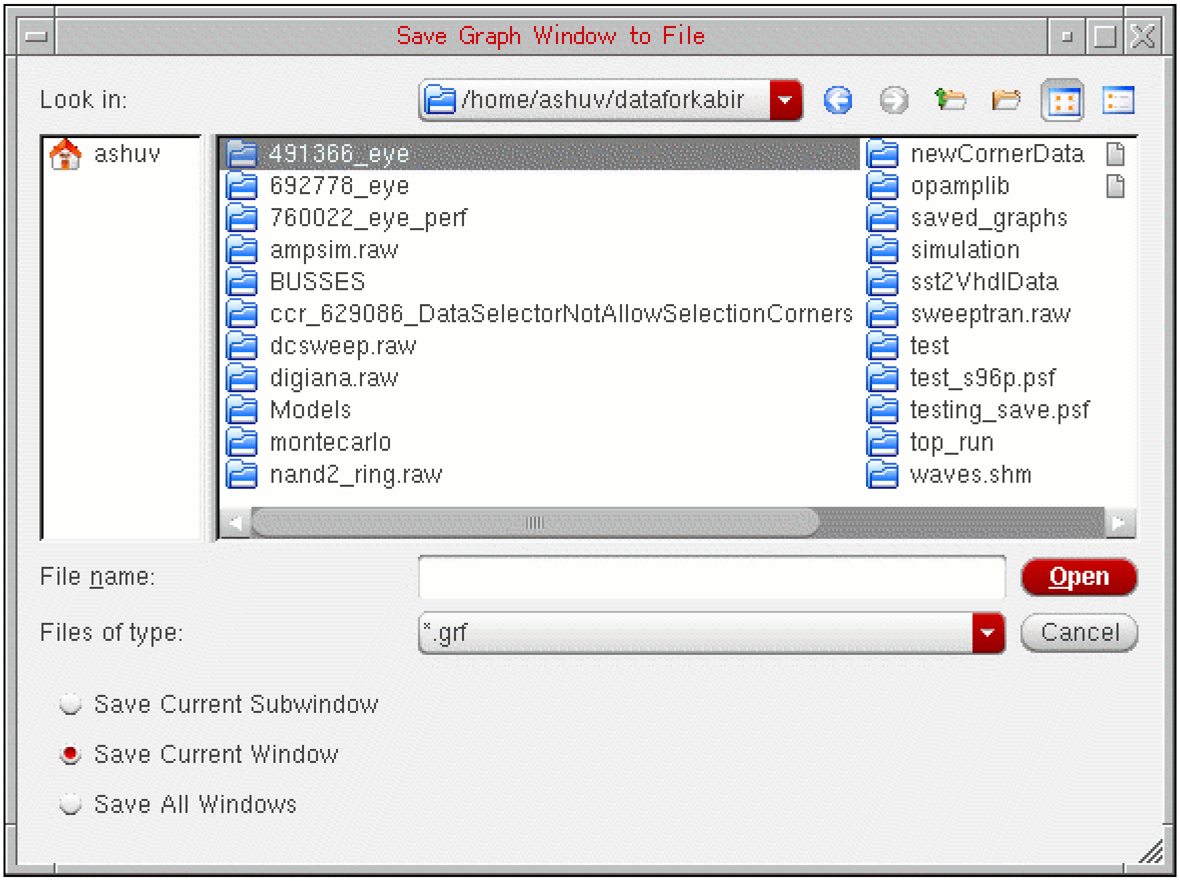
- The location of the data—data directory, data set, and trace name—and not the actual data. Therefore, if your simulation data changes between sessions, the graph reflects those changes.
- All graph objects and attributes, such as grids, background and foreground color, labels, and markers.

Save a group of windows with the file extension `.grf.group`.

To save a window, plot a signal in the window and do the following:

- Choose *File – Save Window As*, or press `Ctrl+S.`

The *Save Graph Window to File* form appears.



Look in: /home/ashuv/dataforkabir

ashuv

491366_eye
692778_eye
760022_eye_perf
ampsim.raw
BUSSES
ccr_629086_DataSelectorNotAllowSelectionCorners
dcsweep.raw
digiana.raw
Models
montecarlo
nand2_ring.raw
newCornerData
opamplib
saved_graphs
simulation
sst2VhdlData
sweeptran.raw
test
test_s96p.psf
testing_save.psf
top_run
waves.shm

File name:

Files of type: *.grf

○ Save Current Subwindow
● Save Current Window
○ Save All Windows

- In the *Look in* field, select the directory where you want to save the graph. The file extension is displayed as `.grf` in the *Files of Type* field.
- Now, do one of the following:
  - ❑ If you want to overwrite an existing graph file, select that graph file from the list box below the *Look in* field.
  - ❑ In the *File name* field, type a name for the graph file to which you want to save the graph.
- Select one of the following options:
  - ❑ *Save Current Subwindow*
  - ❑ *Save Current Window*
  - ❑ *Save All Windows*

When you select the *Save All Windows* option, the graphs are saved in a `.grf.group` file.

- Click *Save*.

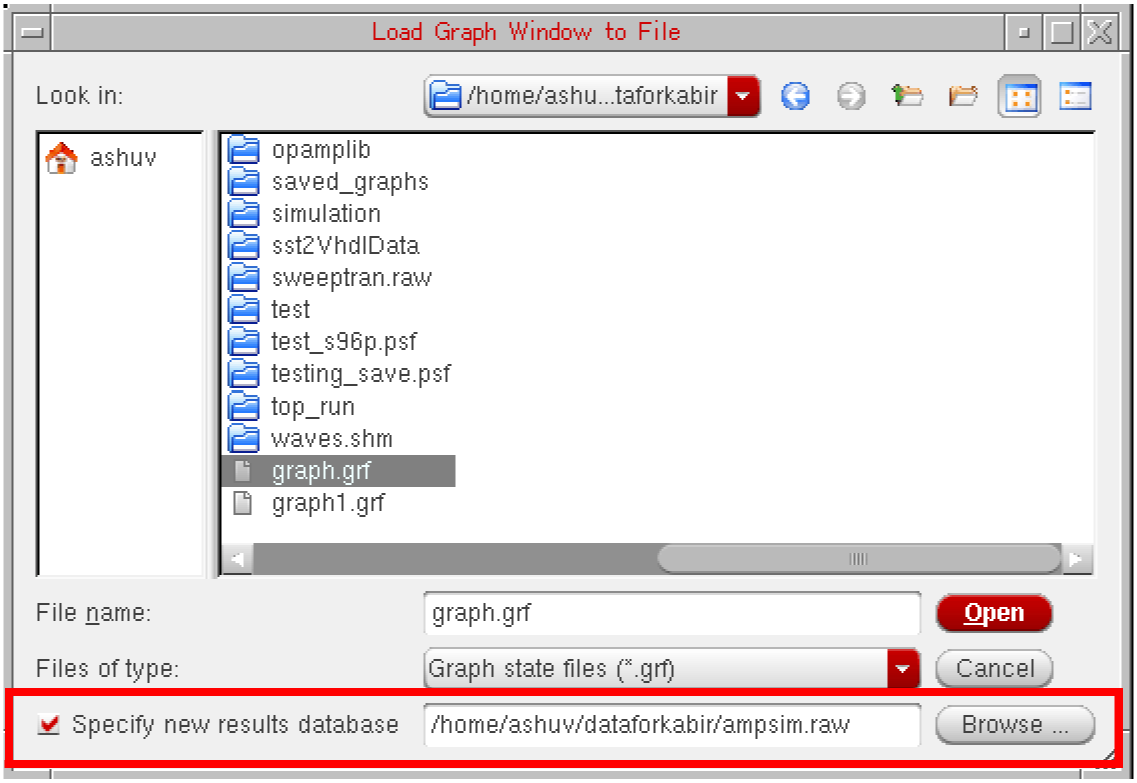
  The window that you selected is saved at the specified location.

Loading a Graph

Perform the following steps to load a graph that you have saved.

1. Choose *File – Load Window,* or press `Ctrl+L`.

   The *Load Graph Window to File* form appears.



Load Graph Window to File

Look in: /home/ashu...taforkabir

ashuv

opamplib
saved_graphs
simulation
sst2VhdlData
sweeptran.raw
test
test_s96p.psf
testing_save.psf
top_run
waves.shm
graph.grf
graph1.grf

File name: graph.grf

Files of type: Graph state files (*.grf)

☑ Specify new results database /home/ashuv/dataforkabir/ampsim.raw

   In the *Look in* field, select the directory in which the `.grf` file that you want to open exists.

   Select the *Specify new results database* check box and click the *Browse* button to load the same `.grf` file, either with the original data or different data.

2. Now, do one of the following:

- ❑ Select the graph file you want to open from the list box below the *Look in* field.
- ❑ In the *File name* field, type the name of the file you want to open.
- ❑ Select the `.grf` extension to display the graph files and `grf.group` file extension in the *Files of type* drop-down list box to select a graph file group. The extension for graph files is specified by the `filesuffix` variable in the `.cdsenv` file.
- ❑ Select the *Specify new results database* check box to plot the saved graph from a new results directory. Also, specify the name of the results directory from which you want to plot the graph. Ensure that the signal plotted in the saved graph exists in the results directory you specified.

  When you use this option, the saved graph is updated with the data from the new results directory and all the trace settings that you have applied to the saved graph are also retained. Hence, saved graphs can be used as a template when you reload a graph.

3. Click *Open*.

The saved graphs are displayed in a new window. This graph has all the attributes that you saved with the graph.

Note: If you have multiple windows open, loading a new window does not affect these windows.

Important

The `.grf` graph files saved from the previous IC6.1 releases, such as IC6.1.3, IC6.1.4, and the graph files saved from the IC6.1.5 Java graph cannot be loaded into the default graph in IC6.1.5.

Saving a Graph as an Image

If you save the graph as an image, the active graph or subwindow is saved with the trace legend area. You can insert the graph image into a document or print it.

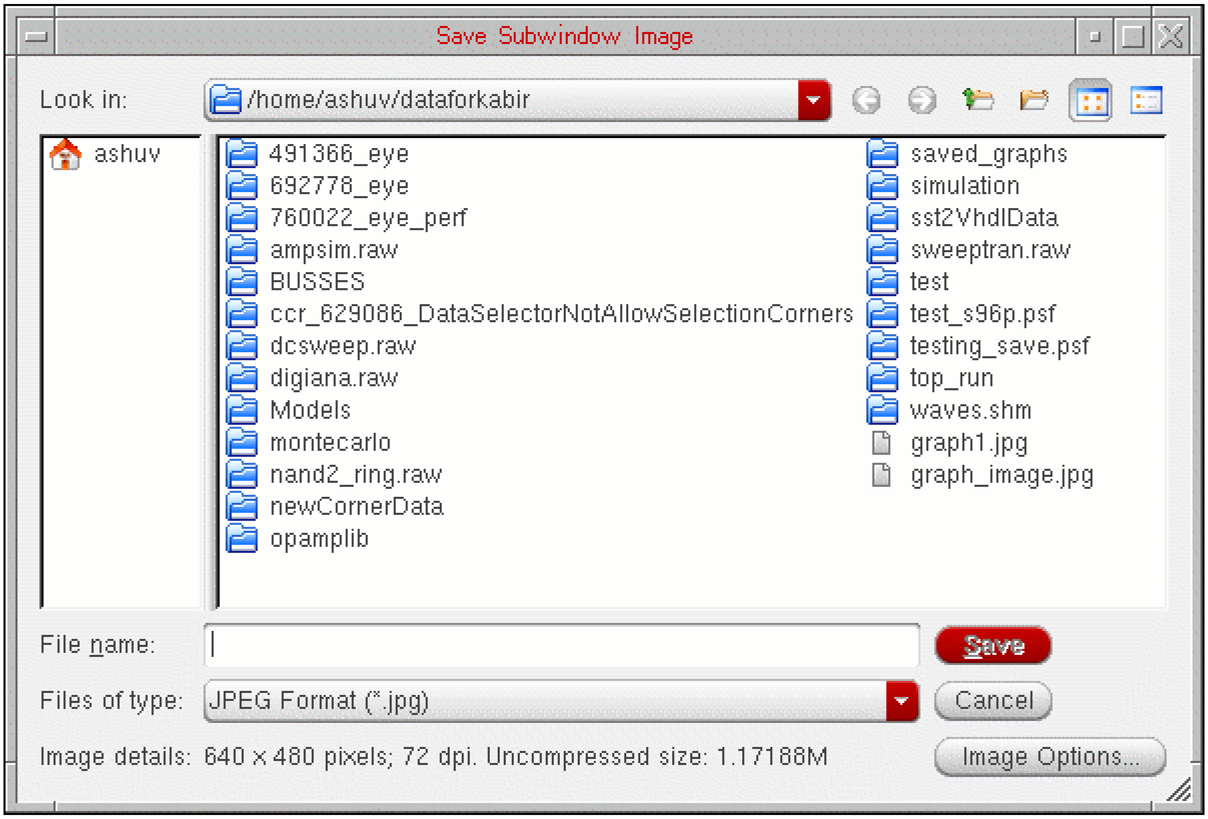
Note: You cannot load a graph image in a window.

The Virtuoso Visualization and Analysis XL tool provides several image formats to support a variety of applications and environments. While all image formats are functionally equivalent to binary storage formats, the size of a typical file varies greatly according to the format chosen. For example, a simple graph saved in the PNG format is typically less than 100 KB, while the same file saved in the TIFF or BMP format may exceed 1MB.

Perform the following steps to save a graph as an image file.

1. Plot a signal in a graph.
2. Choose *File – Save Image*

   The *Save Subwindow Image* form appears.



Save Subwindow Image

Look in: /home/ashuv/dataforkabir

ashuv

491366_eye
692778_eye
760022_eye_perf
ampsim.raw
BUSSES
ccr_629086_DataSelectorNotAllowSelectionCorners
dcsweep.raw
digiana.raw
Models
montecarlo
nand2_ring.raw
newCornerData
opamplib
saved_graphs
simulation
sst2VhdlData
sweeptran.raw
test
test_s96p.psf
testing_save.psf
top_run
waves.shm
graph1.jpg
graph_image.jpg

File name:

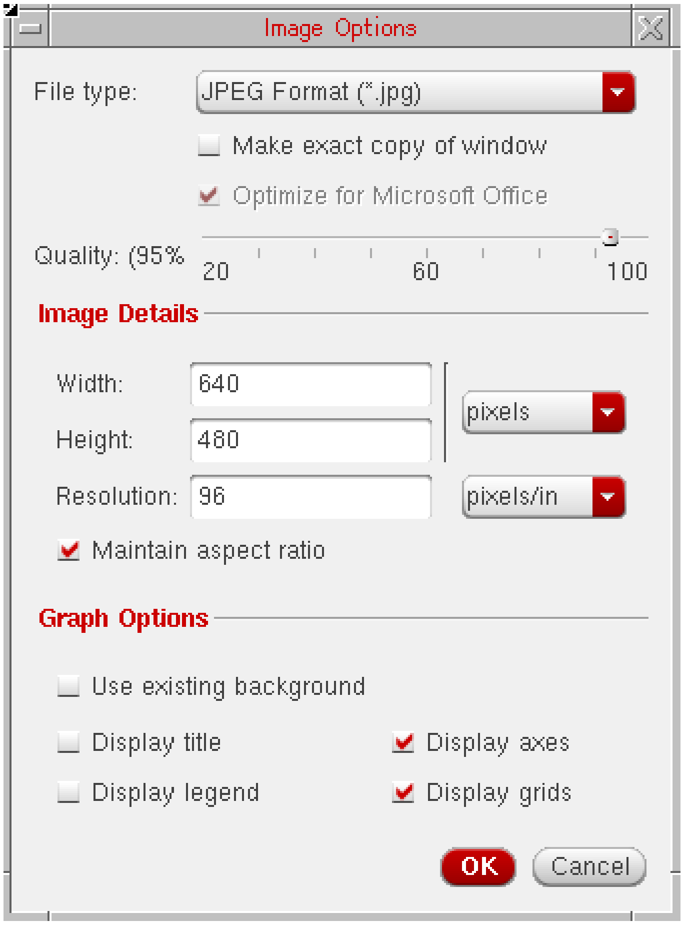
Files of type: JPEG Format (*.jpg)

Image details: 640 x 480 pixels; 72 dpi. Uncompressed size: 1.17188M

3. In the *Look in* field, browse to locate the directory where you want to save the image file.
4. In the *File name* field, type a name for the image file.
5. In the *Files of Type* drop-down list box, select the format in which you want to save the image file.

   By default, the file is saved in a format based on the file extension you specify. For example, if you type `output.png`, the file is saved in the PNG format. The image file can be saved with `.png`, `.bmp`, and `.tiff` (or `.tif`) file extensions. On the other hand, if you select *PNG (Best compressed)* and type `output.tiff`, the file is saved as `output.png`. Though PNG and TIFF files are compressed, there is no loss in image quality with these image formats.
6. Click the *Image Options* button at the bottom of the form to change attributes of the generated image.

The *Image Options* form appears.



File type: JPEG Format (*.jpg)

☐ Make exact copy of window

☑ Optimize for Microsoft Office

Quality: (95%

Image Details

Width: 640

Height: 480

pixels

Resolution: 96 pixels/in

☑ Maintain aspect ratio

Graph Options

☐ Use existing background

☐ Display title ☑ Display axes

☐ Display legend ☑ Display grids

This form includes the following fields:

- *File Type*—Specify the type of the image file. The image file type can include the following formats:
  - Windows Bitmap Format (*.bmp)
  - JPEG Format (*.jpg)
  - Portable Network Graphics (*.png)
  - Portable Pixmap Format (*.ppm)
  - Tagged Image File Format (*.tif)
  - X Pixmap Format (*.xpm)
  - Encapsulated PostScript (*.eps)

- ❍ Adobe PDF (*.pdf)
- ❍ Scalable Vector Graphics (*.svg)

The default file type is `JPEG Format`.

Note: The quality bar is activated only if the file type is `JPEG`.

- ❑ Under the *Image Details* section, specify the following image attributes:
  - ❍ *Width*—Specify the width of the image.
  - ❍ *Height*—Specify the height of the image

    You can select the units for the height and width from the drop-down list displayed at the right. The available units are `pixels`, `inch`, `cm`, `mm`, `picas`, and `points`. When you change the image units, the height and width values you have specified are automatically changed as per the selected units.
  - ❍ *Resolution*—Specify the resolution of the image. This field is unavailable if you select the image type in the vector format. Select the resolution type as `pixels/cm` or `pixels/in` from the drop-down list displayed at the right. When you change the resolution type, the height and width fields also change accordingly.
  - ❍ *Maintain Aspect Ratio*—The ratio of the width of the image to its height. Select this checkbox if you want to maintain the aspect ratio while modifying the height or width of the image.
- ❑ Under the *Graph Options* section, specify the following options:
  - ❍ *Use existing background*—Select this checkbox if you want to use the existing background in the graph image.
  - ❍ *Display title*—Select this checkbox if you want to display the graph title in the graph image.

Display legend—Select this checkbox if you want to display trace legend in the graph image.

  - ❍ *Display axes*—Select this checkbox if you want to display axes in the graph image.
  - ❍ *Display grids*—Select this checkbox if you want to display grids in the graph image.
- ❑ *Make exact copy of window*—Select this option if you want an exact snapshot of the graph that should include all the attributes of the graph as well as the zooming and panning properties. When you select this option, the *Image Details* and *Graph Options* fields are disabled.

- ❑ *Optimize for Microsoft Office*—Select this checkbox if you want to import the image in the Microsoft office application. This option is available when you select the image type as Encapsulated PostScript (*.eps). This option simplifies the image output so that it can be ready by Microsoft Office 2003 and 2007 applications.

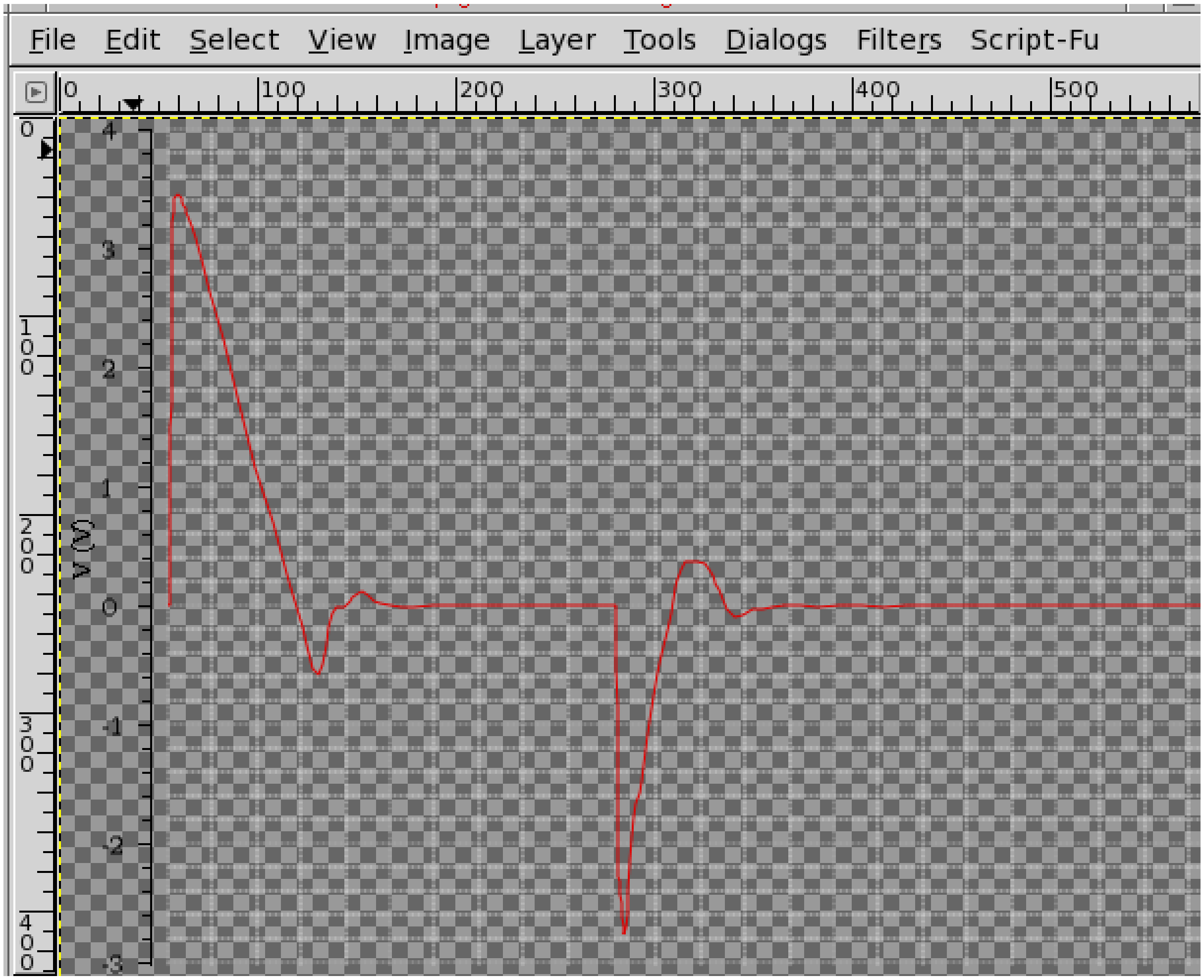
  Note: If you select this option, any embedded font information is not saved.

- ❑ Click *OK*.

1. Click *Save*.

   The graph is saved as an image file with the specified attributes.

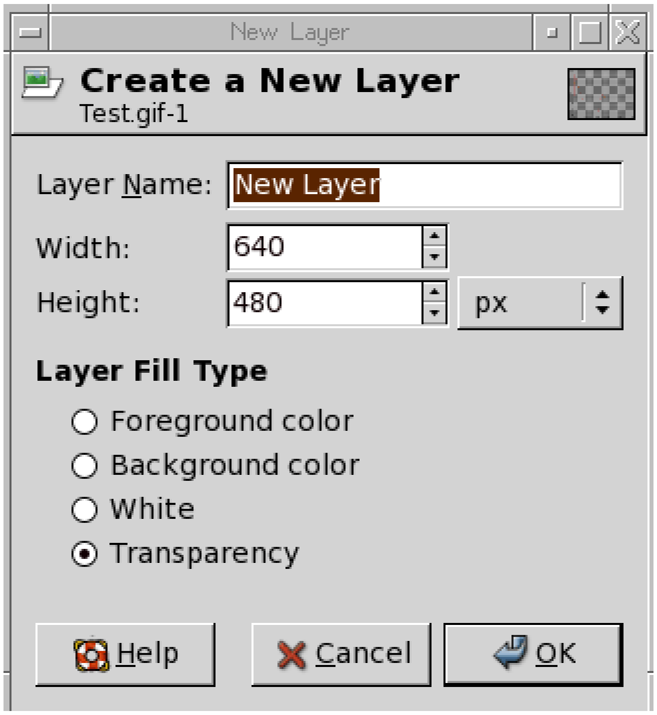
When you do not select the *Use existing background* option and save the graph as an image, the saved image is not readable. For example, when you open the saved image by using an image viewer, such as GIMP, the graph appears as shown in the figure below:



You can use the GIMP image viewer and editor to convert the image into a readable format by performing the following steps:

1. Choose *Layer – New Layer*.

   The *New Layer* form appears.



New Layer

Create a New Layer
Test.gif-1

Layer Name: New Layer

Width: 640

Height: 480 px

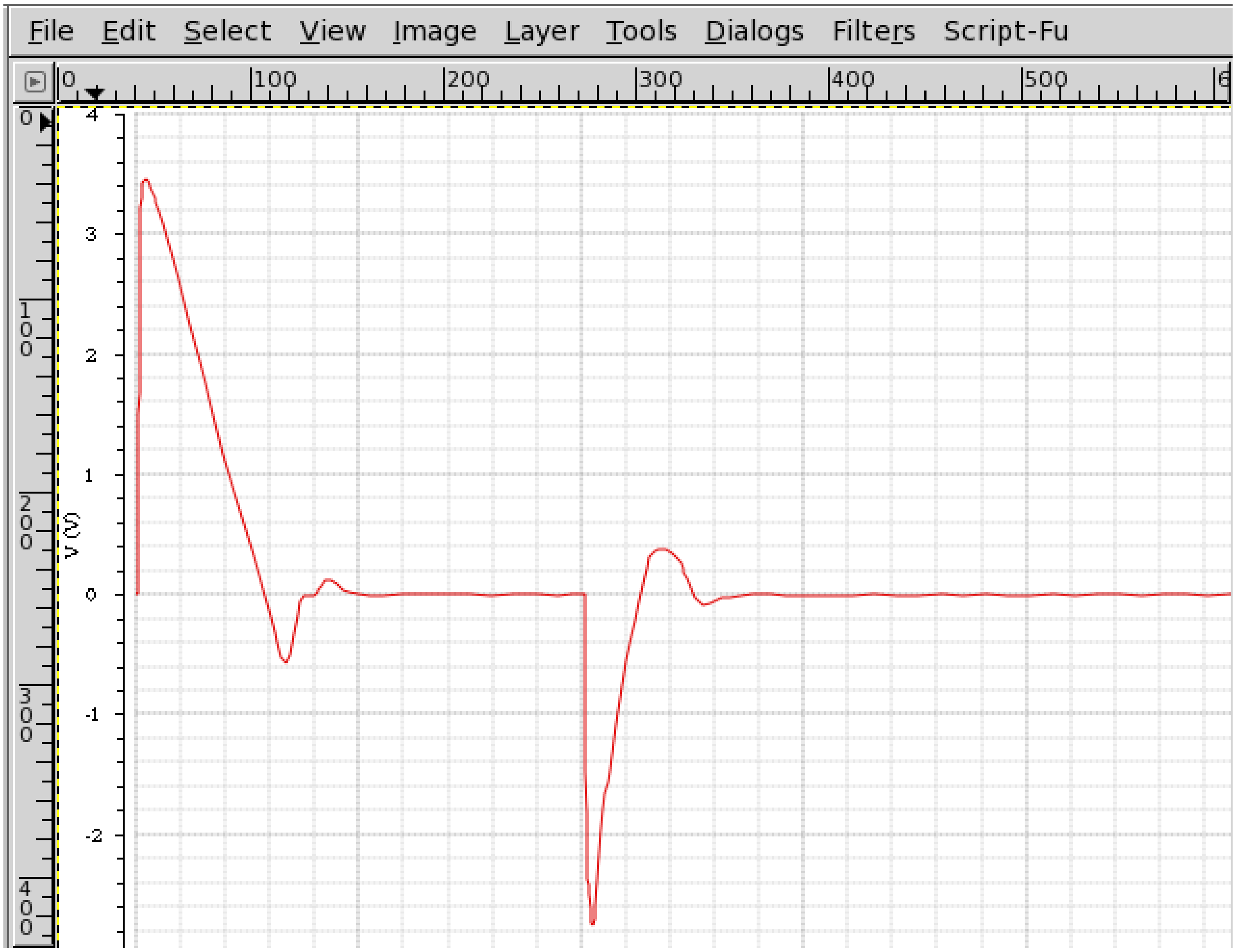
Layer Fill Type

○ Foreground color
○ Background color
○ White
● Transparency

2. In this form, in the select *Layer Fill Type* field as `Background` color and click *OK*.

   The image is filled with the white background color.

3. Choose *Layer – Stack – Layer to Bottom*. The image is now in readable format.



Reloading Graphs

Reloading a graph updates the already plotted traces with the latest simulation results based on the current in-context results directory. When you reload a graph, the settings that you have applied to a trace are also applied to the reloaded traces, such as, background color and font. For more information about the trace settings that are retained during reloading a graph, see Graph Settings Retained During Reloading on page 181.

You can reload a graph when you open the Virtuoso Visualization and Analysis XL tool in the stand-alone mode and also when you run the tool from ADE L and XL.

This section includes the following topics:

Reloading Graph When Opened in Stand-Alone Mode

In the stand-alone mode, you can reload an already open graph with the simulation results based on the current in-context results directory selected in the Results Browser.

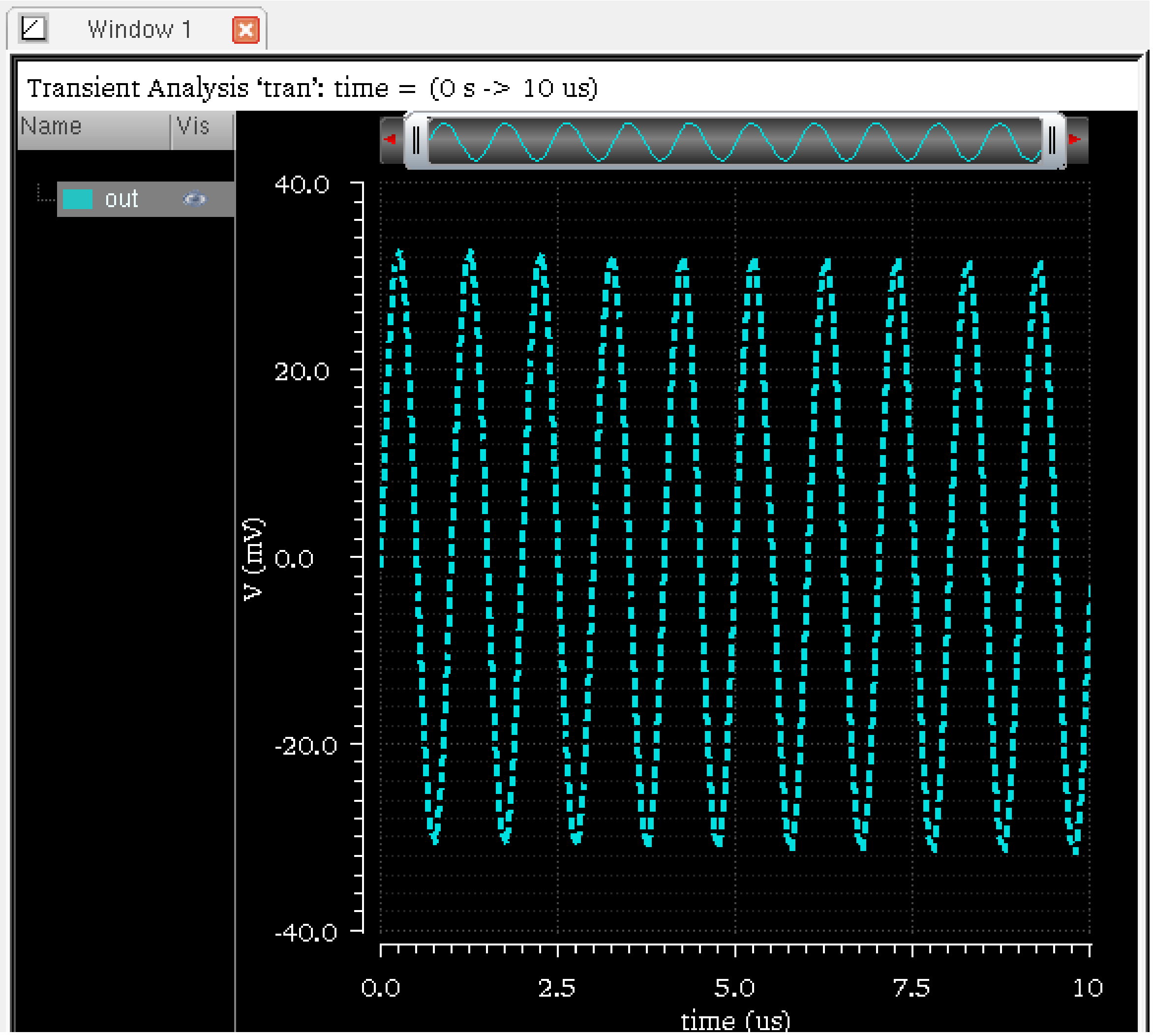
Following are the examples that describe how reloading works in the stand-alone mode:

Example 1

Consider the following scenario in which you plot a trace from a results directory, change the in-context results directory, and reload the trace with the data from a new in-context results directory.

1. Plot a signal, `out`, from an in-context results directory (`simulation1`) in a new window.

2. Set the trace *Style* to `Dot` (as shown in the figure below). Notice that the time range of the `out` signal varies from 0.0 to 10 microseconds.



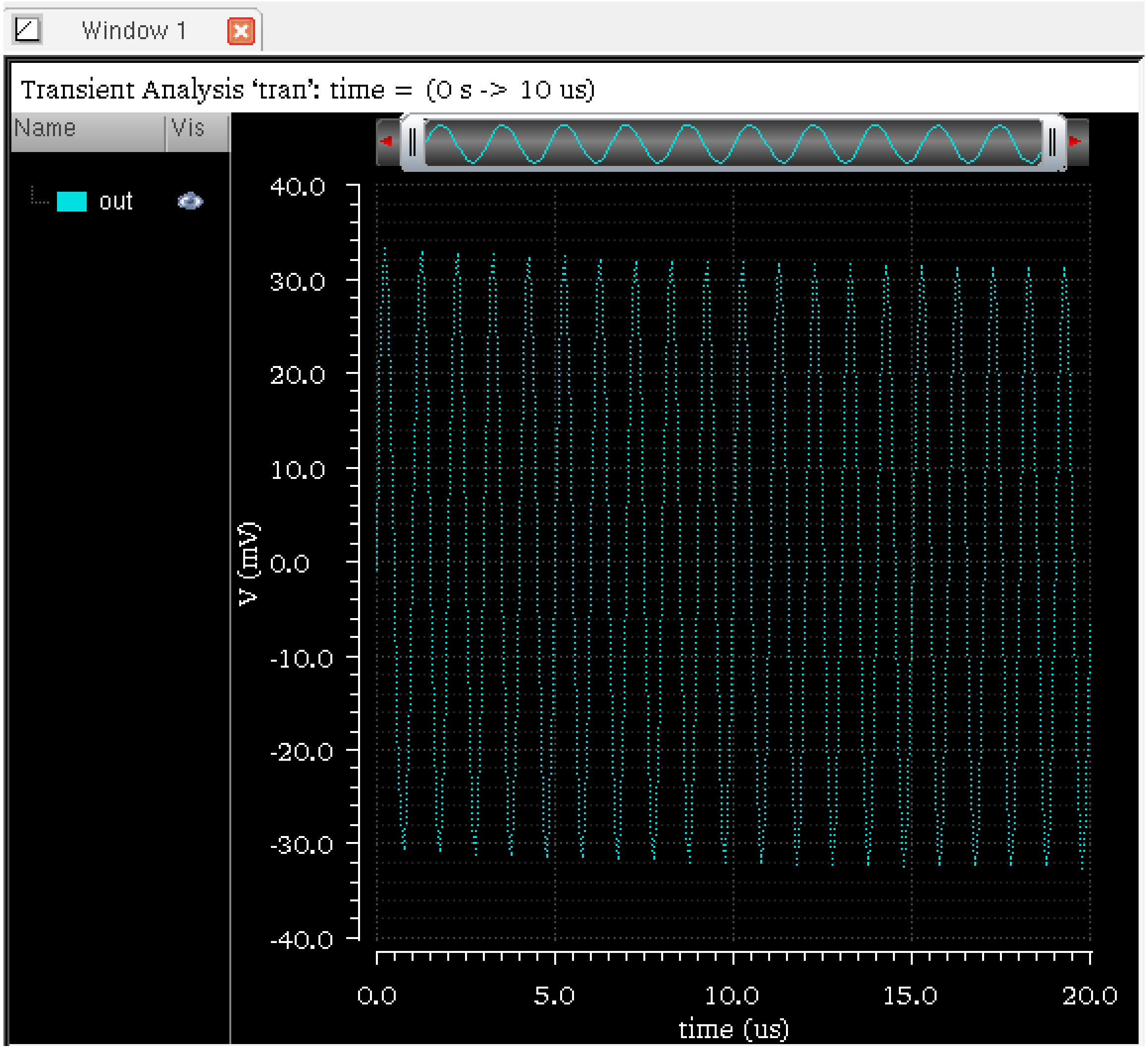
3. Open another results directory, `simulation2`, which contains the simulation results for the same design.

4. Set the database context to this new results directory, `simulation2`. For more information about how to change the in-context results directory, see Changing In-Context Results Directory on page 42.

5. Now, to reload the already plotted trace for the `out` signal from the previous results directory (`simulation1`) with the data from the new in-context results directory (`simulation2`), choose *File – Reload – Current Subwindow.*

Note: Alternatively, you can press `Ctrl+R` to reload graphs in the current window.

The trace for the `out` signal is reloaded using data from the latest in-context results directory, `simulation2`, and all the trace settings are retained (as shown in the figure below). Notice that the time range of the reloaded trace now varies from 0.0 to 20 microseconds.



To reload the traces in all the subwindows, choose *File – Reload – All Subwindows*. All the traces for the common signals are updated with data from the current in-context results directory and all the trace settings are retained.

Example 2

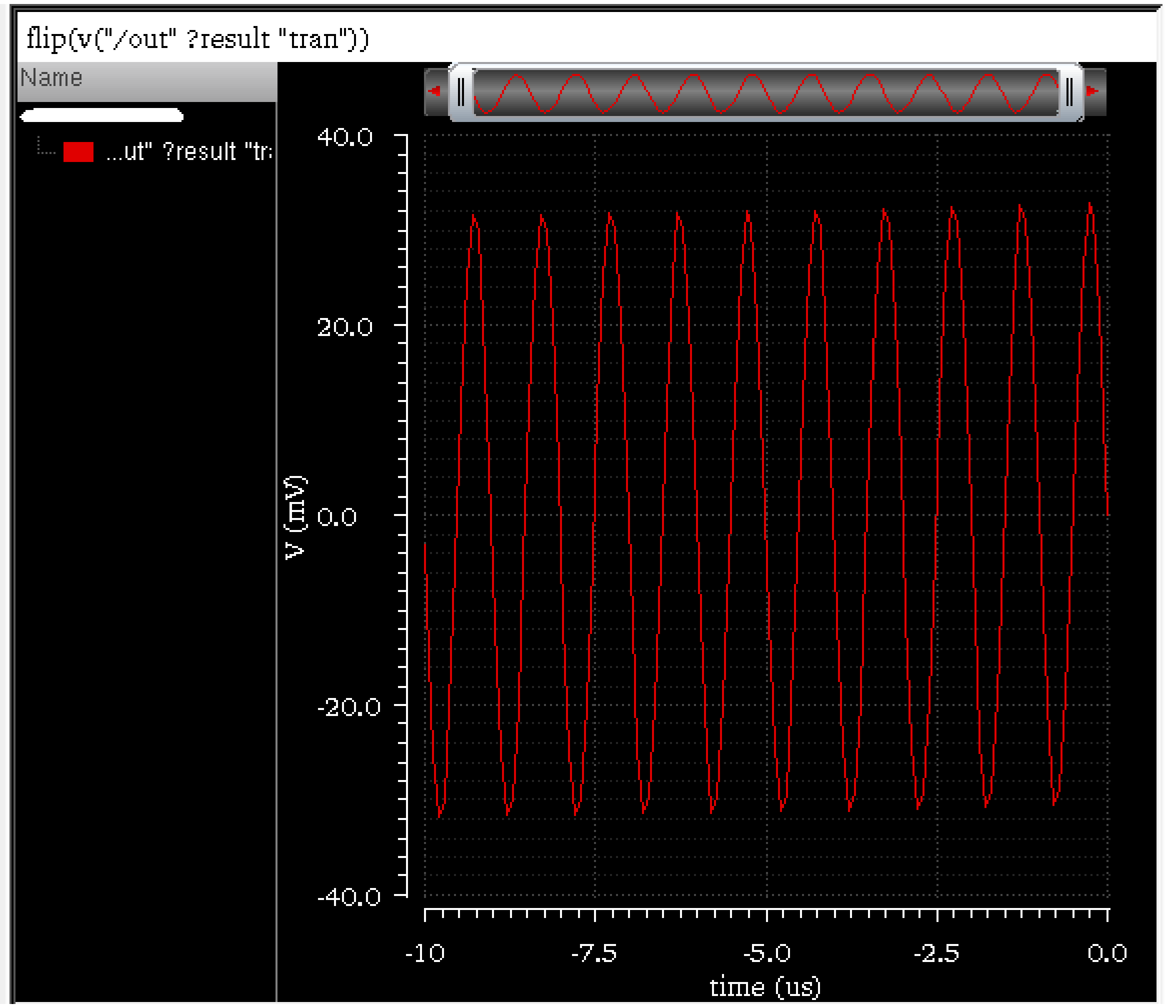
You can also reload the traces for expressions created in the Calculator. Consider the following scenario in which you plot a trace for an expression, change the in-context results directory in Results Browser, and then reload the plotted trace with the data from the new in-context results directory

1. In the Calculator, create an expression for the signal, `out`, from `simulation1` results directory. The following expression is displayed: `v("/out" ?result "tran")`.

   Note: `Simulation1` is the in-context results directory selected in the Results Browser.

2. Apply `flip` function to this expression. The expression changes to: `flip(v("/out" ?result "tran"))`

3. Now, evaluate this expression and plot the output in a new window. The following output trace is displayed:

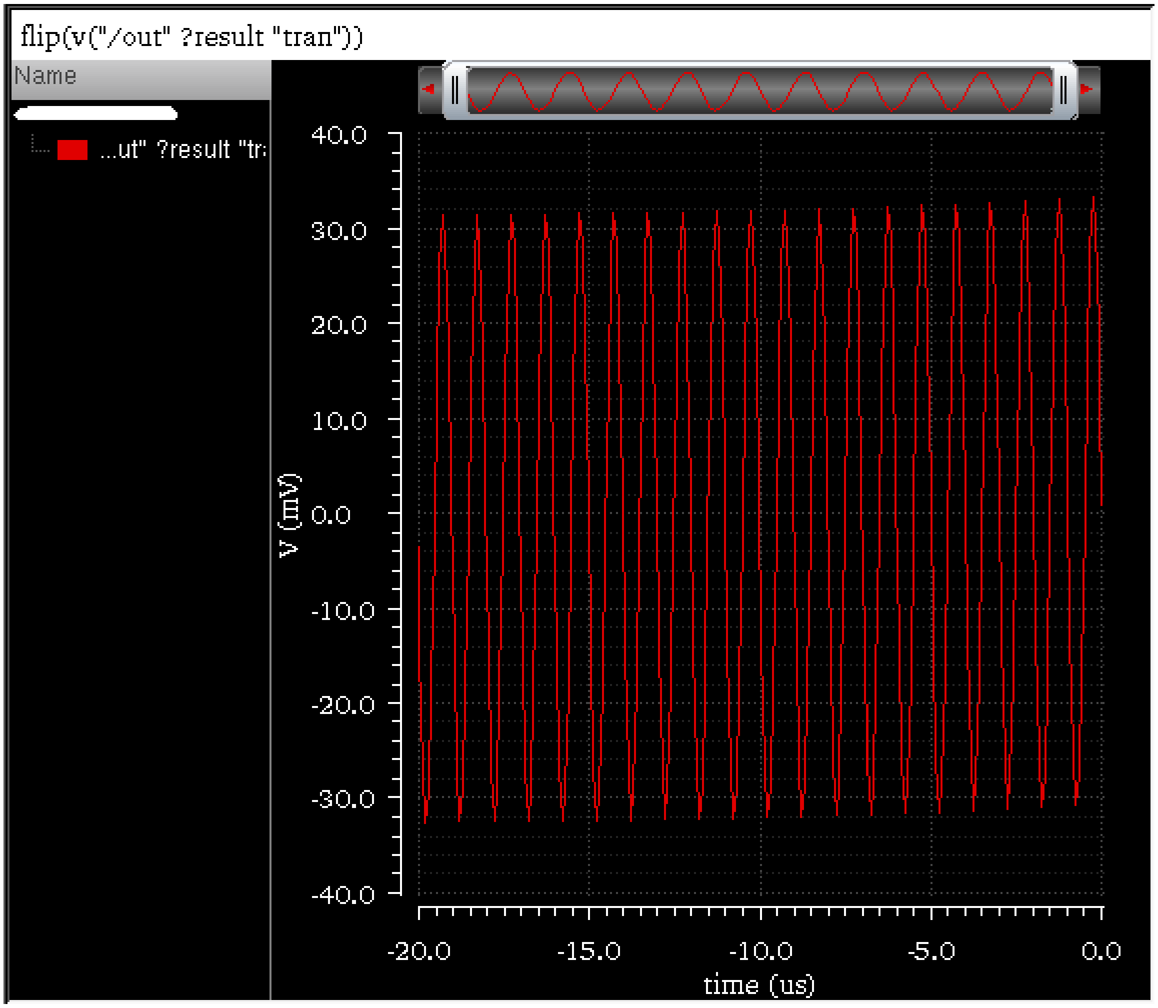


Notice that the time range of the output trace varies from -10 to 0.0 microseconds.

4. In the Results Browser, change the in-context results directory to `simulation2`, which contains the simulation results for the same design.

5. Choose *File – Reload – Current Window*.

   The trace for the expression you plotted earlier is updated with the data from the new in-context results directory (see figure below). Note that the time range of the updated trace now varies from -20 to 0.0 microseconds.



flip(v("/out" ?result "tran"))

If you create an expression for a signal from a results directory that is not set as the in-context results directory in Results Browser, the expression for this signal also displays the path of the results directory. For example,

```
v("/out" ?result "tran" ?resultsDir "./simulation_10/ampTest/
spectre/config/psf")
```

This indicates that the database context of this signal is specified within the expression. When you plot the expression, it is always plotted with the specified results directory. The context for this expression does not change with the change in the in-context results directory in the Results Browser; and therefore, when you perform *File – Reload* on this trace, it is not updated with the new data.

Reloading Graph When Opened From Within ADE L and XL

While working in ADE L and XL, you can use the Refresh plotting option to update already open graphs with current simulation results. This option retains all the trace settings that you have applied to the traces in open graphs.

Note: Only those open graphs are updated that are common in the current simulation run.

Note: You can also use *File – Reload* to reload the graphs plotted from within ADE L and XL based on the results from a new in-context results directory selected in the Results Browser.

To know more about refreshing graphs through ADE XL, see Refreshing Graphs in *Analog Design and Environment XL User Guide.*

To know more about refreshing graphs through ADE L, see Refreshing Graphs in *Analog Design and Environment L User Guide.*

Disabling Trace Reload

You can lock the database context of a trace to disable the trace reloading. You use this feature if you do not want to update the trace while reloading graphs with data from the in-context result directory.

Note: The trace for which you lock the database context are not updated when you do *File – Reload.*

To disable the reloading of a trace, do one of the following:

- Select the trace and choose *Trace – Disable Reload*.
- Right-click a trace and choose *Disable Reload*.

  A lock appears on the trace color symbol displayed in the subwindow title, which indicates that the context of the selected trace is locked and it is not updated when you reload traces with data from the in-context results directory.

Graph Settings Retained During Reloading

The Virtuoso Visualization and Analysis XL graph window saves and maintains the following settings for the graphs when you reload the graphs with the data from the latest in-context results directory:

- Trace color, type, style, width, or symbols
- Visibility status of graphs
- Axes settings
- Pan and zoom settings
- Graph layout
- Strip layout
- Markers and marker locations

Printing Graphs

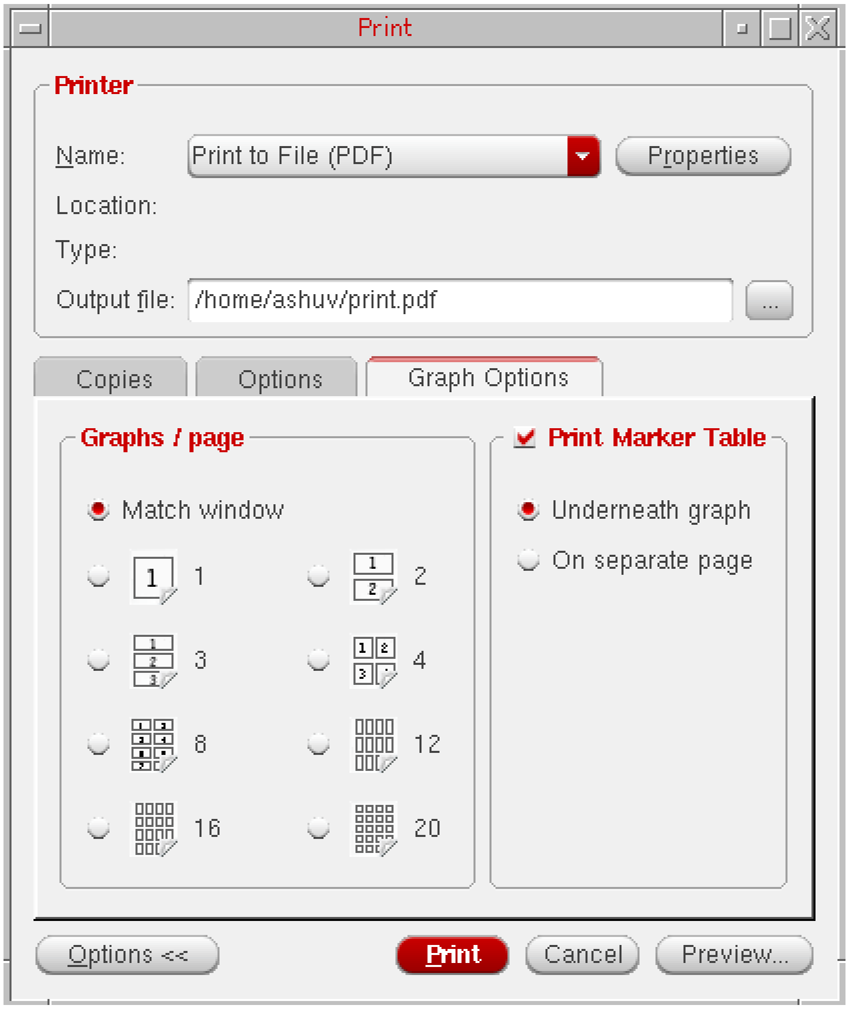
You can save a selected graph or all the graphs in the selected window to a file in PDF or Postscript (PS) format, and then print the graphs on a network printer that you have installed on your computer. The Postscript format is fully scalable and is used in many UNIX printers.

Before you print, you can use the print preview mode to see how the graph will look after it is printed.

Perform the following steps to print a graph:

- In the window, choose *File – Print*.

The *Print* form appears.



Printer

Name: Print to File (PDF)

Location:

Type:

Output file: /home/ashuv/print.pdf

Graphs / page

● Match window

○ 1 ○ 2

○ 3 ○ 4

○ 8 ○ 12

○ 16 ○ 20

☑ Print Marker Table

● Underneath graph

○ On separate page

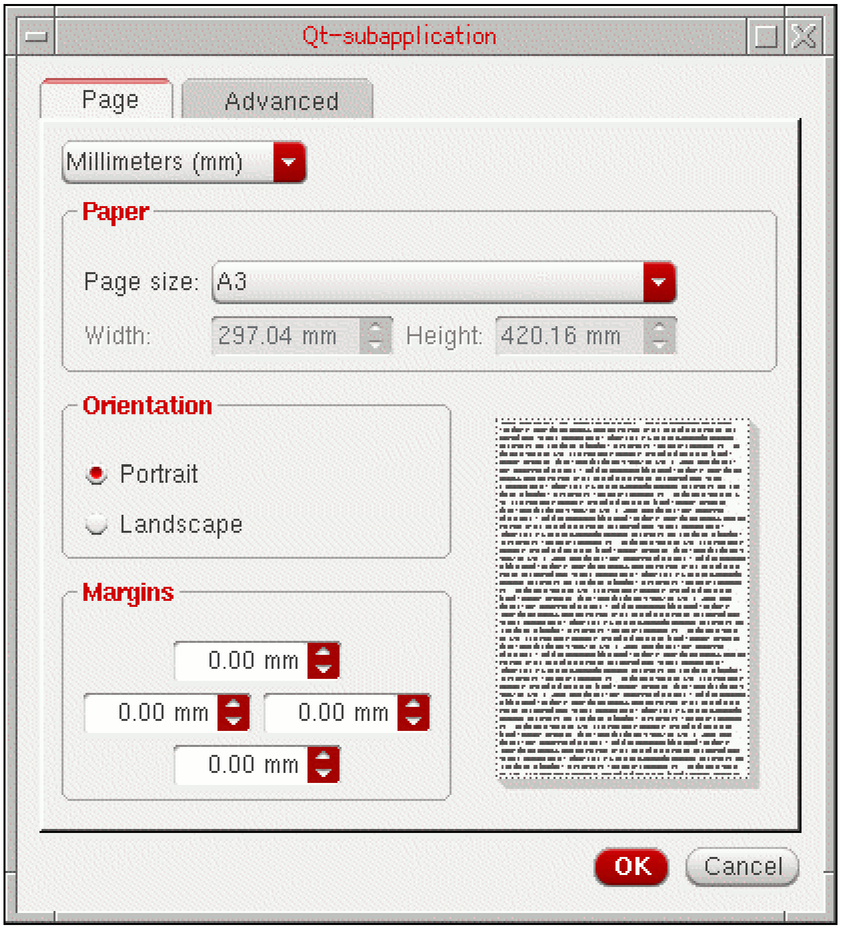
In the *Printer* group box, do the following:

- In the *Name* drop-down list box, specify the destination. The destination can be a PDF file or a Postscript file.

If you select *Print to file (PDF)*, the *Location* field displays *Local file* and the *Type* field displays *Write PDF file.* If you select *Print to file (Postscript)*, the *Location* field displays *Local file* and the *Type* field displays *Write Postscript file.*

- To set properties for the print job, click the *Properties* button next to the *Name* field.

The *Qt-subapplication* form appears. This form has two tabs—*Page* and *Advanced*. The *Advanced* tab is currently not available.



Millimeters (mm)

Page size: A3

Width: 297.04 mm Height: 420.16 mm

● Portrait

○ Landscape

0.00 mm

0.00 mm 0.00 mm

0.00 mm

- On the *Page* tab, specify the following fields:
  - Select the units, such as *Centimeters (cm),* or *Millimeters (mm)*, in which you want the paper size to be displayed.
  - In the *Paper* group box, select the required page size in the *Page size* drop-down list box. The *Width* and *Height* fields display the default paper settings for that page size in the specified units.

Note: The default settings are defined by the `LC_ALL` environment variable on your computer

  - In the *Orientation* group box, select the print orientation as *Portrait* or *Landscape*.
  - In the *Margin* group box, select the top, left, right, and bottom margins.

        - Click *OK* to save the settings.

- In the *Output file* field, specify the name and location of the output file. To specify a file at a location other than the default, click the browse button. By default, the name of the output PDF file is `print.pdf` and the name of the output postscript file is `print.ps`.
- Click the *Options* button to view the other printing options. When you click this button, two tabs are displayed in the *Print* form—C*opies* and *Options.*
    - On the *Copies* tab, do the following:
        - In the *Print range* group box, specify the range of pages that you want to print. By default, all pages are printed.
        - On the *Output Settings* tab, specify the number of copies you want to print. In addition, specify the type in which you want the pages to be printed—*Collate* or *Reverse*.
    - On the *Options* tab, do the following:
        - Specify *Duplex Printing* as *None, Long side*, or *Short side*.
        - Specify *Color Mode* as *Color* or *Grayscale*.
- On the *Graph Options* tab, do the following:
    - In the *Graphs/page*, specify how many graphs you want to print on a page.

      If you want to print all the subwindows in a PDF file in the same order in which they are arranged in the graph, select the *Match window* check box.
    - Select the *Print Marker Table* check box to print marker tables for the graphs. In addition, specify how you want the marker tables to be printed—*Underneath graph* or *on separate page*.
- Click *Preview* to generate the print preview.
- Click *Print*.

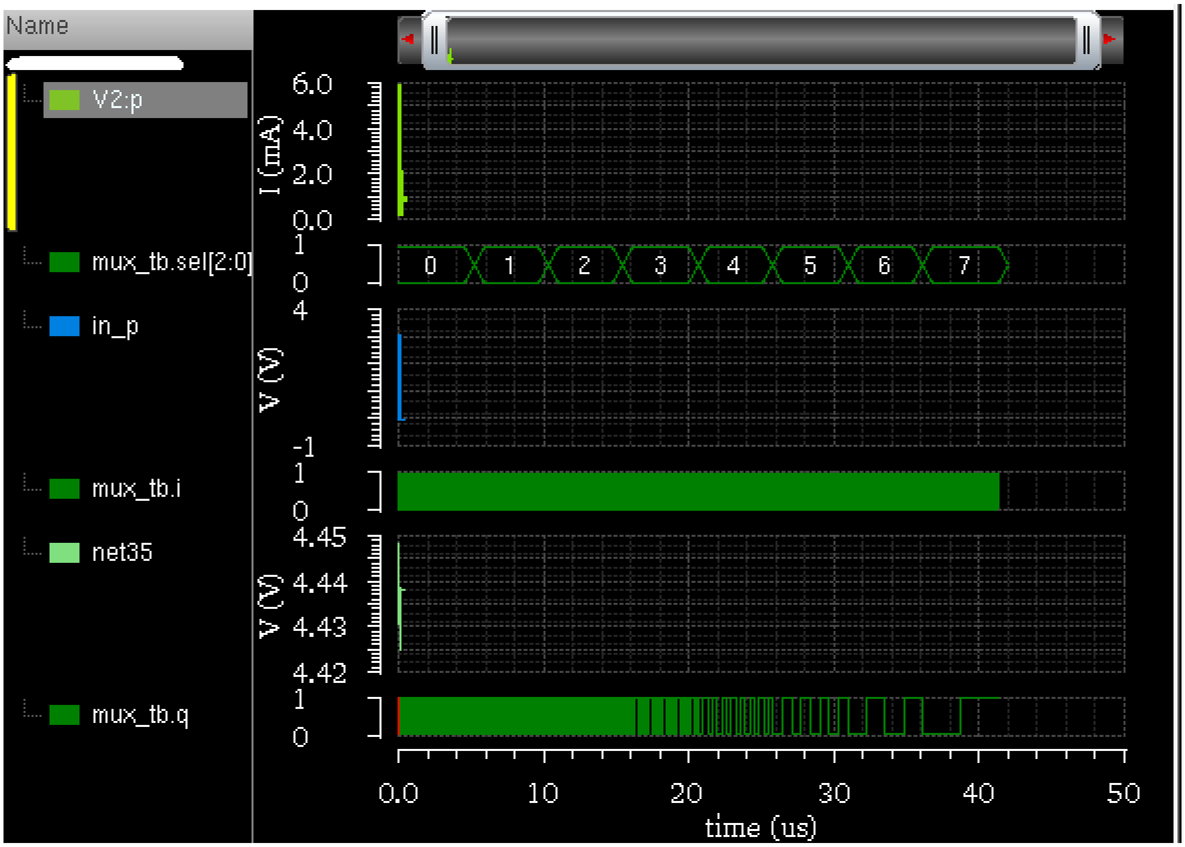
Supporting Mixed Signals

You can use the Virtuoso Visualization and Analysis XL tool to plot analog and digital signals together in one window. The multiple digital signals in a window are displayed in separate strips, while analog signals can be combined into a single strip. The digital signals are displayed in green by default.

To split the analog signals into different strips, see Working with Strips on page 146.

If you want to work with analog and digital signals at the same time, you can plot analog and digital signals in the same window. The signals are plotted in the order they are selected in the Results Browser or ADE.

You can also drag an analog signal to place it in between two digital signals. The analog signal that you drag is displayed in a different strip. You can also impose an analog signal on a digital signal. In this case, the strip height for a digital signal is adjusted according to the height of the analog signal.



You can convert analog signals into digital signals and digital signals into analog signals, if required.

Note: The Verilog and VHDL states are also displayed in specific colors to denote their strength and condition.

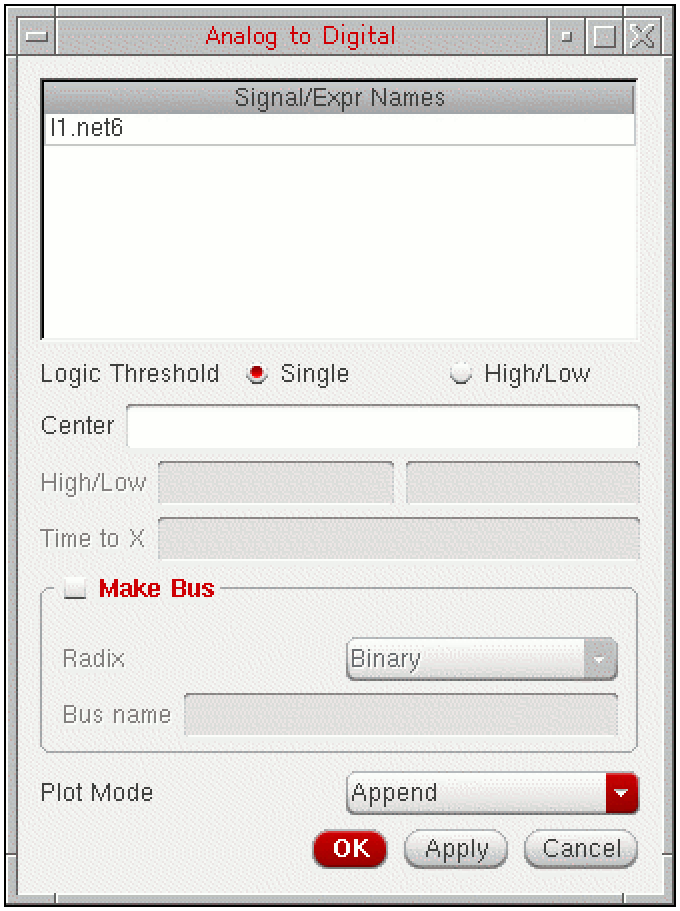
Converting an Analog Signal into a Digital Signal

In the stand-alone SKILL mode, you can create a digital representation of an analog signal.

To convert an analog signal into a digital signal, do the following:

1. In the graph, select a trace and choose *Measurements – Analog To Digital*. You can select more than one analog trace at a time.

   The *Analog to Digital* conversion form appears. This form displays the name of the selected analog signals. The signals are displayed on the basis of their selection order; however, you can rearrange the order either by clicking the column header or by using the drag operation. The assistant has the following fields



Signal/Expr Names
I1.net6

Logic Threshold ● Single ○ High/Low

Center

High/Low

Time to X

□ Make Bus

Radix Binary

Bus name

Plot Mode Append

2. In the *Logic Threshold* field, select *Single* or *High/Low*.

   ❑ If you select *Single*, you need to specify a *Center* value. Analog values equal to or greater than the specified center value are mapped to a digital value of 1. Analog values less than the center value are mapped to a logical value of 0.

   ❑ If you select *High/Low*, you need to specify a high and a low threshold value. All analog values equal to or greater than the high threshold value are mapped to a digital value of 1. All analog values equal to or less than the low threshold value are mapped to a logical value of 0.

The value *Time to X* puts a time limit on the interval that the signal may remain between the high and low threshold values before the signal is assigned a value of *X*.

3. If you want to make a bus of digital signals from the analog signal, select the *Make Bus* check box.
4. Then, select the radix type in the drop-down list and provide a bus name.
5. In the *Plot Mode* drop-down list box, select whether you want to *append* the digital trace to an existing graph, *replace* an existing graph with the digital graph, or add the digital trace to a *new subwindow* or *new window*.
6. Click *OK*.

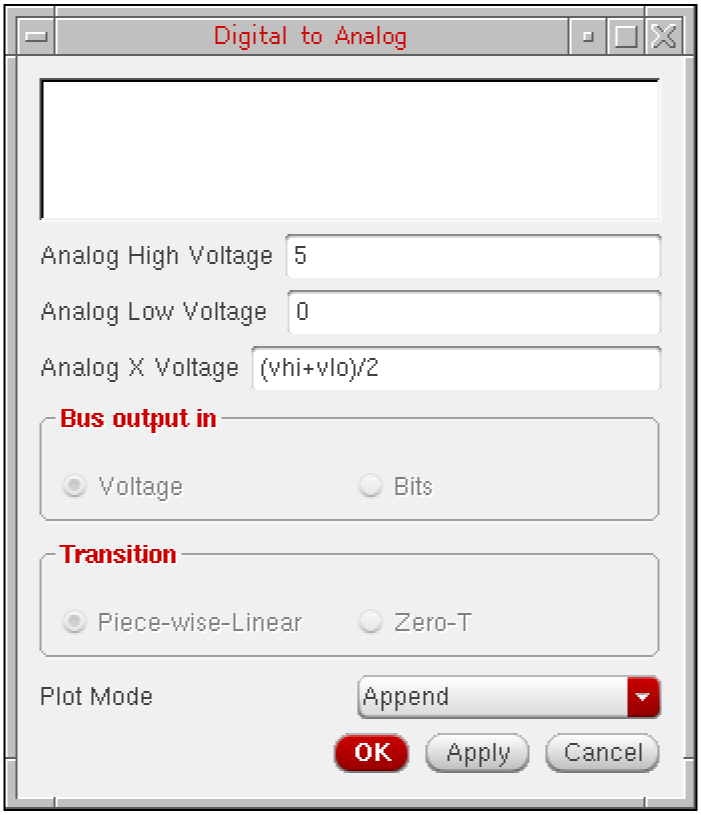
Converting a Digital Signal to an Analog Signal

In the stand-alone SKILL mode, you can also create an analog representation of a digital signal.

To convert a digital signal into an analog signal, do the following:

1. In the window, select a digital trace and choose *Measurements – Digital To Analog*. You can select more than one digital trace at a time.

   The *Digital to Analog* Conversion form appears. This form displays the digital signals you select. The signals are displayed on the basis of their selection order; however, you can rearrange the order either by clicking the column header or by using the drag operation. The assistant has the following fields:



Digital to Analog

Analog High Voltage: 5

Analog Low Voltage: 0

Analog X Voltage: (vhi+vlo)/2

Bus output in: ● Voltage ○ Bits

Transition: ● Piece-wise-Linear ○ Zero-T

Plot Mode: Append

2. In the *Analog High Voltage* field, specify the high analog value to which the digital value 1 (for single bit waveforms) or the maximum bus value is to be converted to. The default value is controlled by the `dToAHiVoltage` variable in the `.cdsenv` file. For more information, see Appendix A, "Virtuoso Visualization and Analysis XL Tool Environment Variables."

3. In the *Analog Low Voltage* field, specify the low analog value to which the digital value 0 (for single bit waveforms) or the minimum bus value is to be converted to. The default value is controlled by the `dToALoVoltage` variable in the `.cdsenv` file. For more information, see Appendix A, "Virtuoso Visualization and Analysis XL Tool Environment Variables."

4. In the *Analog X Voltage* field, specify the value to which state *X* of the digital wave is converted to. The `X` value may be given as a:

   ❑ Number

   ❑ Keyword `vhi`, `vlo`, or `vprev`, where

- ❍ `vhi` substitutes the X value with the value in the *Analog Hi Voltage* field.
- ❍ `vlo` substitutes the X value with the value in the *Analog Low Voltage* field.
- ❍ `vprev` implies that the previous (non-X) state, either `vhi` or `vlo` is used.

❑ Simple expression, such as `(vhi + vlo)/2`

5. In the *Bus Output in* group box, select *Voltage* to return the selected bus as a single analog signal or select *Bits* to return the selected bus as a wave list, which is one analog wave for each bus bit. The field is available only if you select a bus.
6. In the *Transition* group box, select *Piece-wise-Linear* to join the points in the analog waveform with straight lines or select *Zero-T* for voltage transitions in zero time.

   The *Transition* field is available only if the *Bus Output in* field is selected.
7. In the *Plot Mode* drop-down list box, specify whether you want to *append* the analog trace to an existing graph, *replace* an existing graph with the analog graph, or add the analog trace to a *new subwindow* or *new window*.
8. Click *OK*.

Working with Buses

A group of digital signals can be converted to a create a bus. You can expand a bus to view its component signals.

If you want to create a bus of analog signals, you need to convert the analog signals to the corresponding digital signals. For information about how to convert an analog signal to the corresponding digital signal, see Converting an Analog Signal into a Digital Signal on page 185. After the conversion is complete, you can create bus from the digital signals.

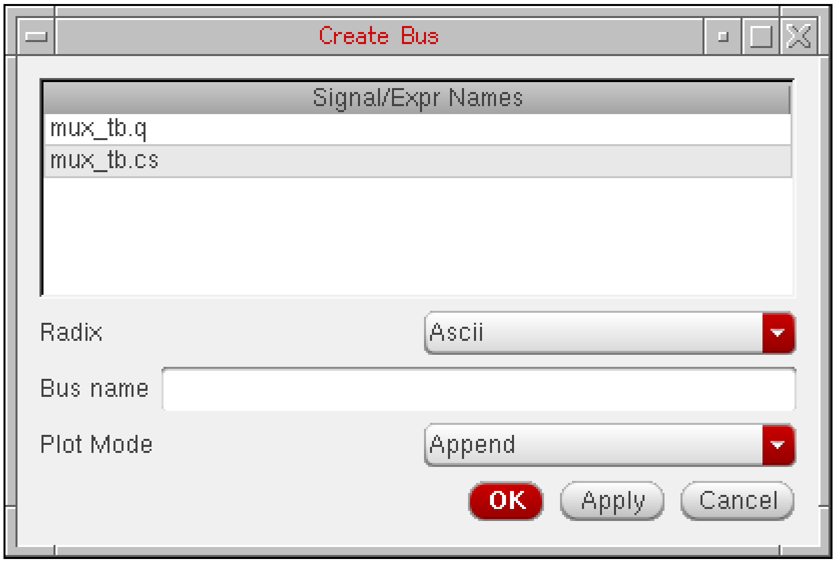
To combine the signal conversion and bus creation processes in a single step, you can select the *Make Bus* check box in the *Analog to Digital* conversion form, and specify a bus name while converting the analog signal to a digital signal.

Creating a Bus

To create a bus, do the following:

1. In a window, select the digital traces that you want to use to create a bus.
2. Choose *Trace – Bus – Create.*

The *Create Bus* form appears. This form displays the selected traces, which you use to create the bus, in the order of significance (top to bottom—from the least significant bit to the most significant bit). However, you can rearrange the trace order either by clicking the column header or by using the drag operation. The assistant has the following fields



Create Bus

Signal/Expr Names
mux_tb.q
mux_tb.cs

Radix: Ascii

Bus name:

Plot Mode: Append

3. In the *Create Bus* form, do the following:

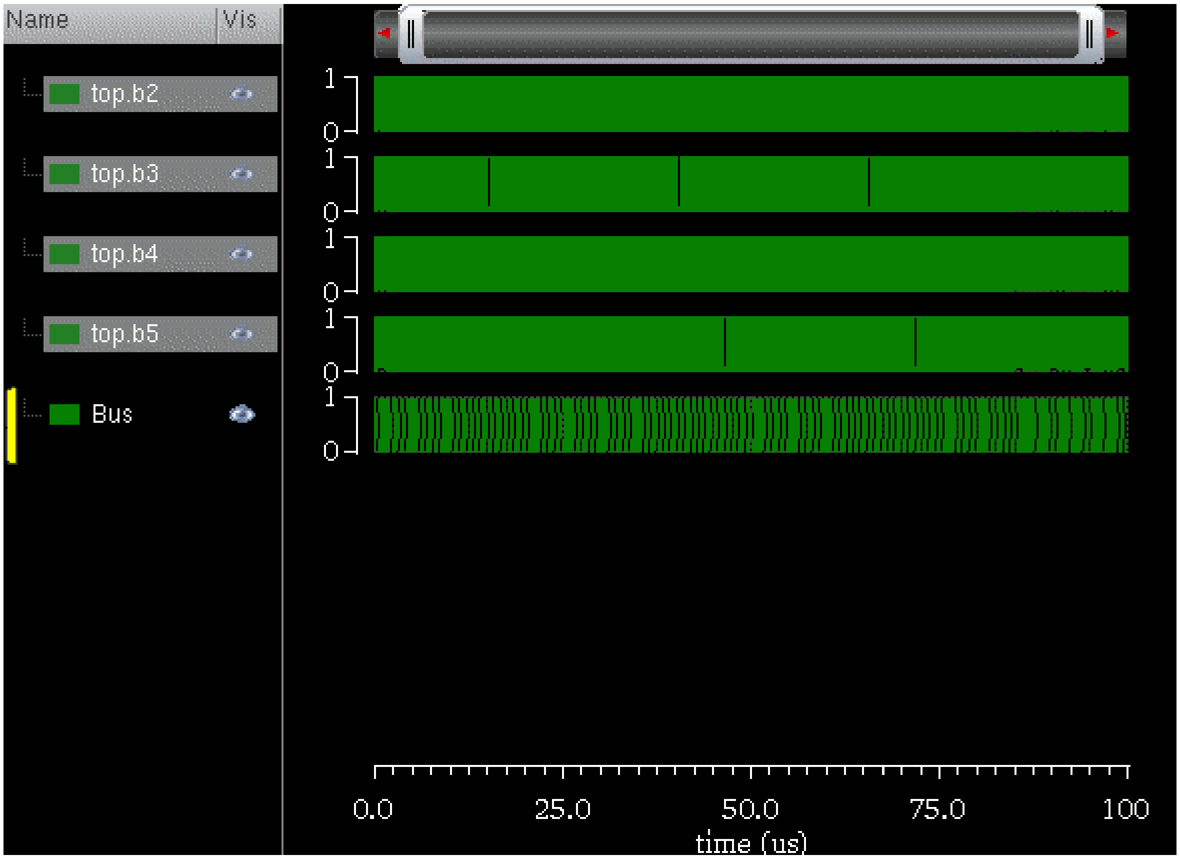
   a. Type a name for the bus in the *Bus Name* field.

   b. Select the *Radix* for the bus, such as Ascii, Binary, Hex. Alternatively, to change the radix type after a bus is created, right-click the bus and choose *Radix*.

   c. Specify whether you want the bus to be appended to the digital traces in the graph or to replace the selected traces in the *Plot Mode* field.

   d. Click *OK.*

The bus is created from the selected digital traces.



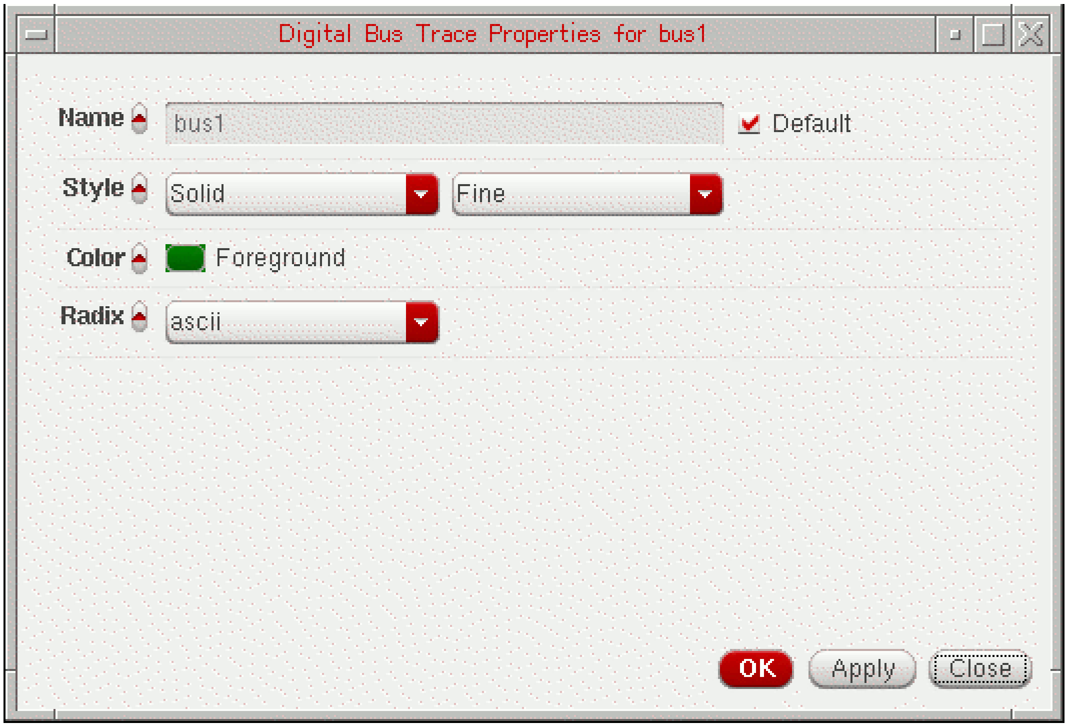
There are three states in which a signal can exist in the bus—Hi, Lo, and XZ, where X is a transition from Lo to Hi and Z is a transition from Hi to Lo. Following is the color pattern for the traces in a bus that belong to a particular state:

- If the bus is all Z values, it is displayed in orange.
- If the bus is all X values, it is displayed in red color rectangles.
- if the bus includes both X and Z values, it is displayed in yellow colored rectangles.

Setting Bus Properties

To set the properties of a digital bus, right-click the bus name and choose *Digital Bus Properties*.

The *Digital Bus Trace Properties for <Bus_Name>* form appears.



Digital Bus Trace Properties for bus1

Name: bus1 ☑ Default

Style: Solid, Fine

Color: 🟩 Foreground

Radix: ascii

This form displays the following information:

- *Name*—Displays the default name of the bus. You can change the bus name if the Default check box is not selected.
- *Style*—Specifies the bus signal properties, such as *Solid* and *Dash*, and specifies the thickness, such as *Fine* and *Medium.*
- *Color*—Specifies the foreground color of the bus.
- *Radix*—Specifies the radix type, such as *hex*, *binary*, and *octal*. You can also set the radix type by right-clicking the bus and choosing

Expanding a Bus

After you add a bus trace to the window, you can expand the bus to display the digital traces contained in the bus into individual strips.

To expand a bus, select the bus you want to expand and do one the following:

- Choose *Trace – Bus – Expand.*
- Right-click the bus or the bus name in trace legend area and choose *Expand*.

The window displays the individual digital traces in the selected bus and also displays the parent bus.

Note: After a bus is expanded, you cannot move, cut, drag, or delete the parent bus and the individual bits in the parent bus.

Collapsing a Bus

To collapse an expanded bus, select the bus you want to expand by selecting the bus name in the trace legend area and do one of the following:

- Choose *Trace – Bus – Collapse.*
- Right-click the bus or the bus name in trace legend area and choose *Expand*.

  The window displays only the bus of digital signals.

Working with Markers

A marker attaches a description to a point on the graph. The default label for a marker displays the X and Y coordinates of its intersection with the trace—if it is attached to the trace—or the coordinates of the point location of the marker. You can associate an expression with a marker label. The expression is evaluated when you place the marker on the graph and updated when you choose *File – Reload*.

If you use the replace mode to plot signals obtained from the simulation runs on the same design, the signals are updated with the new data and the expressions are re-evaluated.

This section includes the following topics:

- Marker Types on page 194
- Adding Markers on page 194
- Setting Marker Properties on page 199
- Working with Delta Markers on page 202
- Snapping Markers on page 209
- Customizing Markers on page 210

Marker Types

Markers are of five types:

- Point
- Vertical
- Horizontal
- Circular
- Delta
- AB Delta
- Spec

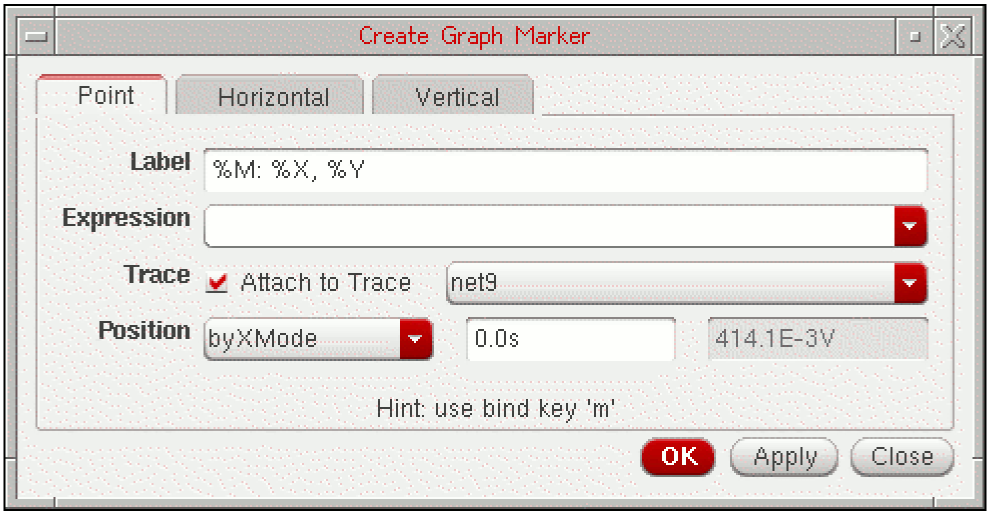
Adding Markers

You can add point, vertical, horizontal, and delta markers to a trace. The circular markers can be added to circular graphs that are obtained from AC analysis, Smith Charts, and polar plots.

To add markers to a trace, do the following:

➡ Select a point on the trace and choose *Marker – Create Marker*.

The *Create Graph Marker* form appears. This form includes various tabs that help to create rectangular markers—point, horizontal, and vertical.



Label: %M: %X, %Y

Expression:

Trace: ☑ Attach to Trace net9

Position: byXMode 0.0s 414.1E-3V

Hint: use bind key 'm'

Perform the following steps to create different types of markers:

- To add a point marker, click the *Point* tab. The following fields appear:

  - ❑ *Label*—Specify a label for the marker. You cannot insert multiline text in the marker labels. Use the format strings listed in the table below to create marker labels. These format strings are evaluated and inserted into the string when you place or edit a marker. As a result, labels can reference properties, such as marker coordinates, trace slope, trace name, and so on, or the result of a scalar expression.

    Note: Each marker label displays the default value set in the `defaultLabel` .cdsenv variable.

  The following table describes the available marker label format strings:

Marker Label	Description
%M	Marker name
%X	X-coordinate
%Y	Y-coordinate
%x	Second X-coordinate for delta markers
%y	Second Y-coordinate for delta markers
%W	Δx
%H	Δy
%S	Slope (Δx/Δy)
%N	Name of the trace
%E	Expression
%F	Frequency value

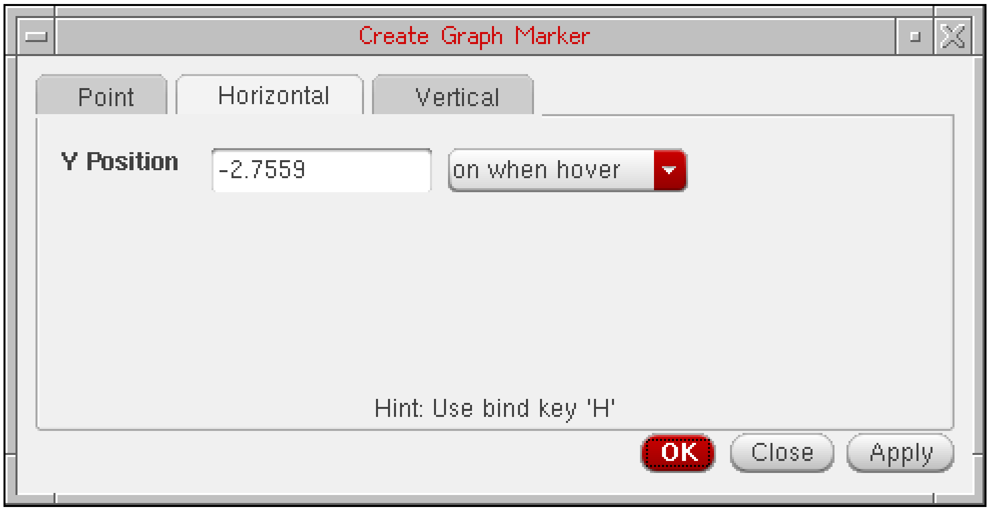
If you do not enter text in the *Label* field, the X- and Y-coordinates of the marker are displayed.

  - ❑ *Expression*—Select the expression you want to display in the marker label. Click the *Expression* arrow to view the *Buffer Contents* and all defined memories (in SKILL mode) or variables (in MDL mode). If you entered `%E` in the *Label* field, you can choose the memory or variable you want to use in your expression, or you can choose *Calculator Buffer.* If you choose a memory or variable, the expression associated with the selected memory or variable appears in the *Expression* field. If you choose *Calculator Buffer*, the expression in the Calculator Buffer appears in the *Expression* field.

- ❑ *Trace*—Select the *Attach to Trace* check box to attach the marker to the closest interpolated point on the trace. When multiple traces are appended to a graph, select the trace to which you want to attach the marker.

- ❑ *Position*—Select the marker position from the drop-down list box. You can specify the marker position `byX Mode`, `byY Mode`, and `byXY Mode`. The default value is `byX Mode`.

- ■ To add a horizontal marker, click the *Horizontal* tab.



Y Position -2.7559 on when hover

Hint: Use bind key 'H'

The following fields appear:

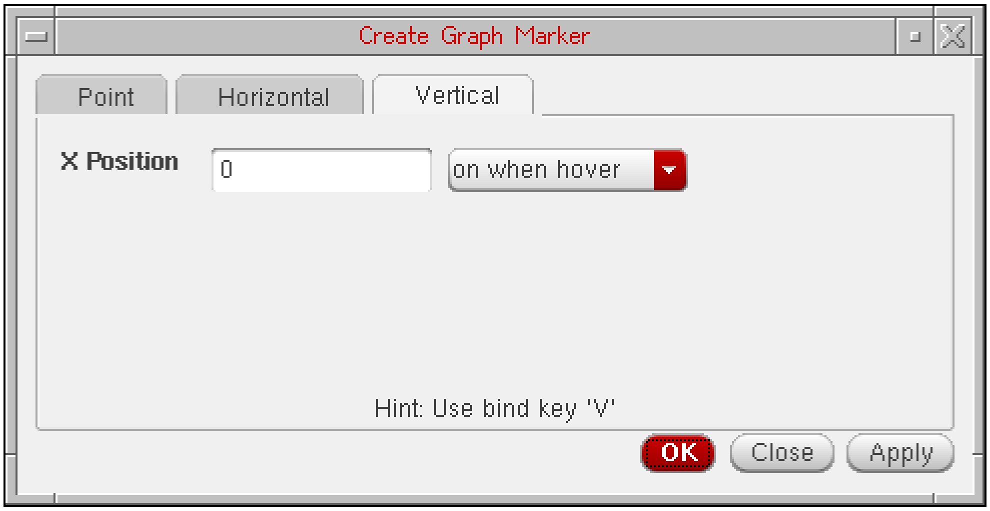
- ❑ *Label*—Select the marker label.

- ❑ *Expression*—Select the expression you want to display in the marker label.

- ❑ *Y Position*—Specify the position on the Y-axis where you want to create the marker. You can select a point on the trace; the Y-axis value of that point is displayed in this field. In the drop-down list box, select the event for which you want to display the horizontal marker.

The horizontal marker appears in a dash line style. To change the line style, right-click the marker and choose *Horizontal Marker Properties*. For more information see, Setting Marker Properties on page 199.

- To add a vertical marker, click the *Vertical* tab.



Create Graph Marker

X Position 0 on when hover

Hint: Use bind key 'V'

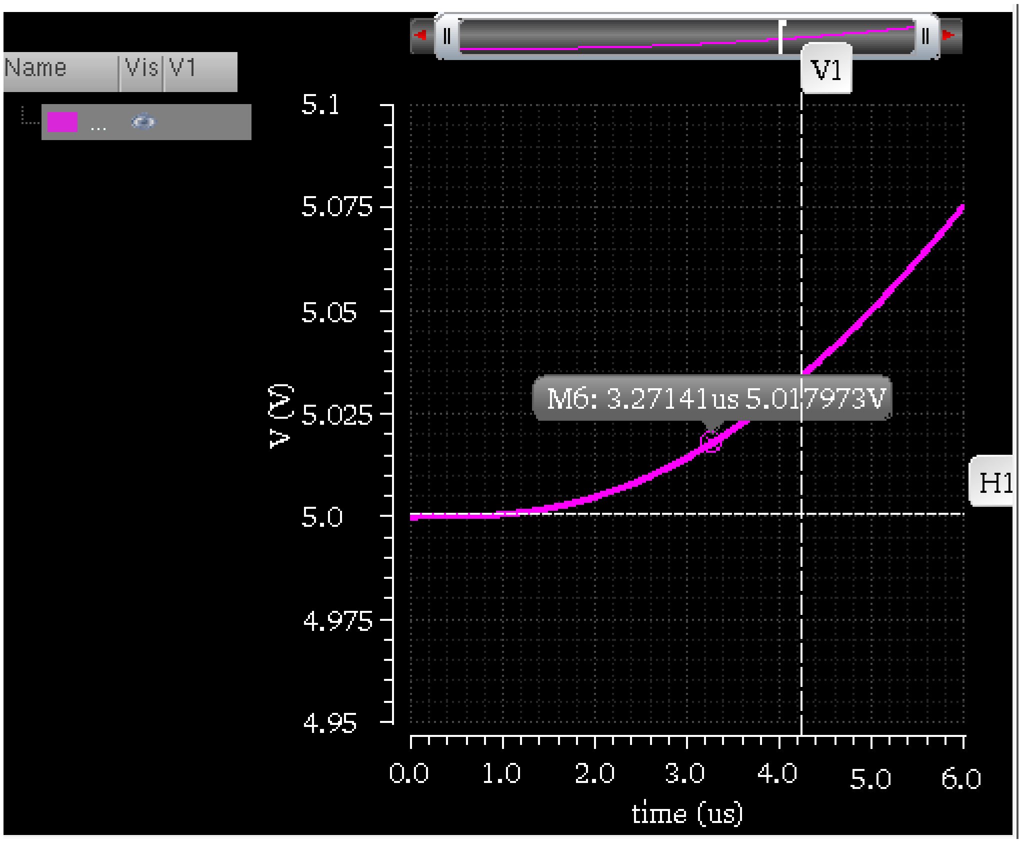
The following field appear:

- ❑ *X Position*—Specify the position on the X-axis where you want to create the marker. You can select a point on the trace; the X-axis value of that point is displayed in this field. In the drop-down list box, select the event for which you want to display the vertical marker.

The vertical marker appears in a dash line style. To change the line style, right-click the marker and choose *Vertical Marker Properties*. For more information see, Setting Marker Properties on page 199.

The horizontal and vertical markers show all the intercepts on all the traces across all the strips in a subwindow. To display the horizontal and vertical marker intercepts, right-click a horizontal or vertical marker and choose *Intercepts – Off/ On When Hover/ On*.

The following figure shows a point, vertical, and horizontal marker.



You can move the labels attached to the horizontal and vertical markers. To bring the marker labels back to their original position, right-click the horizontal or vertical markers and choose *Reposition Intercept Labels*.

Adding Vertical and Horizontal Markers on Point Marker Location

You can add a vertical or a horizontal marker at the same location where a point marker is placed.

To add a vertical marker, right-click the point marker and choose *Create Vertical Marker*.

To add a horizontal marker, right-click the point marker and choose *Create Horizontal Marker*.

Adding Markers with Bindkeys

To add a marker with the help of bindkeys, do the following:

1. Click a point on the graph where you want to place a marker.
2. Press one of the following keys:
   - ❑ `M`—Adds a point marker
   - ❑ `H`—Adds a horizontal marker
   - ❑ `V`—Adds a vertical marker

   A marker is placed on the trace based on the bindkey you use.

Adding Markers with Marker Toolbox

To add a vertical, horizontal, or point marker with the help of Marker Toolbox, do the following:

➡ Choose *Window – Assistants – Marker Toolbox*.

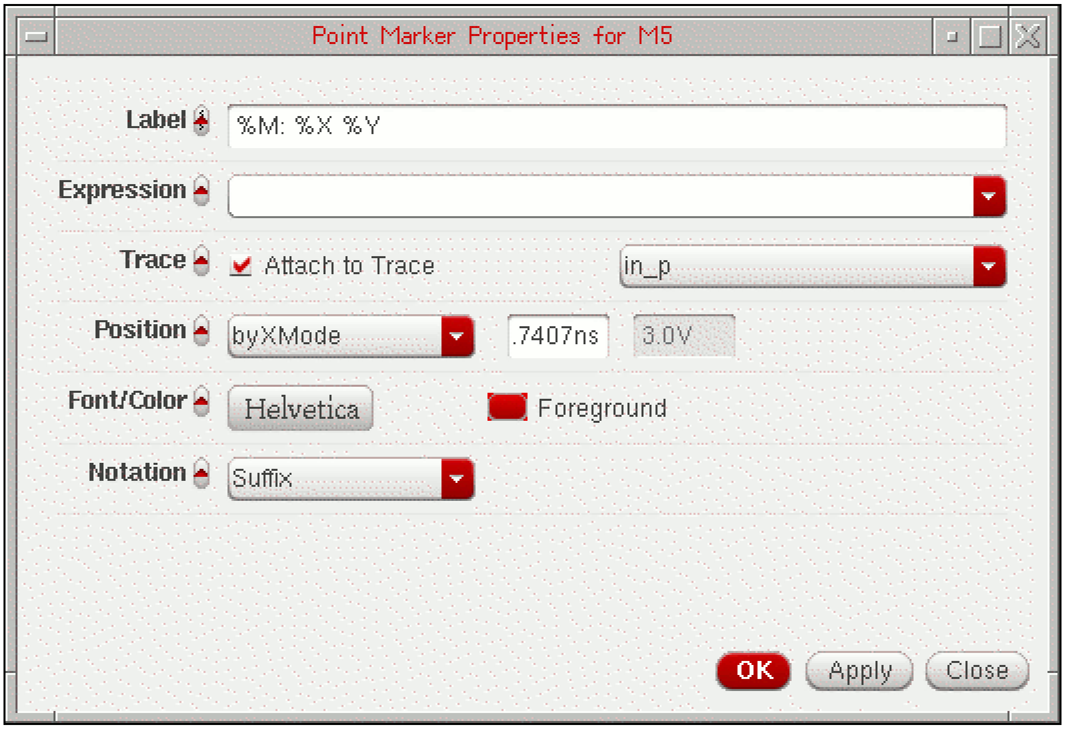
The *Marker Toolbox* assistant appears to the left of the window. It includes tools that you can use to add point, vertical, and horizontal markers. To create a marker, drag the tool to the required location.

Setting Marker Properties

To view or change the properties of markers, do one of the following.

- Double-click the marker.
- Right-click the marker and choose *Marker Properties*.

The *Marker Attribute Properties* form appears. The figure below shows the properties form for point marker.

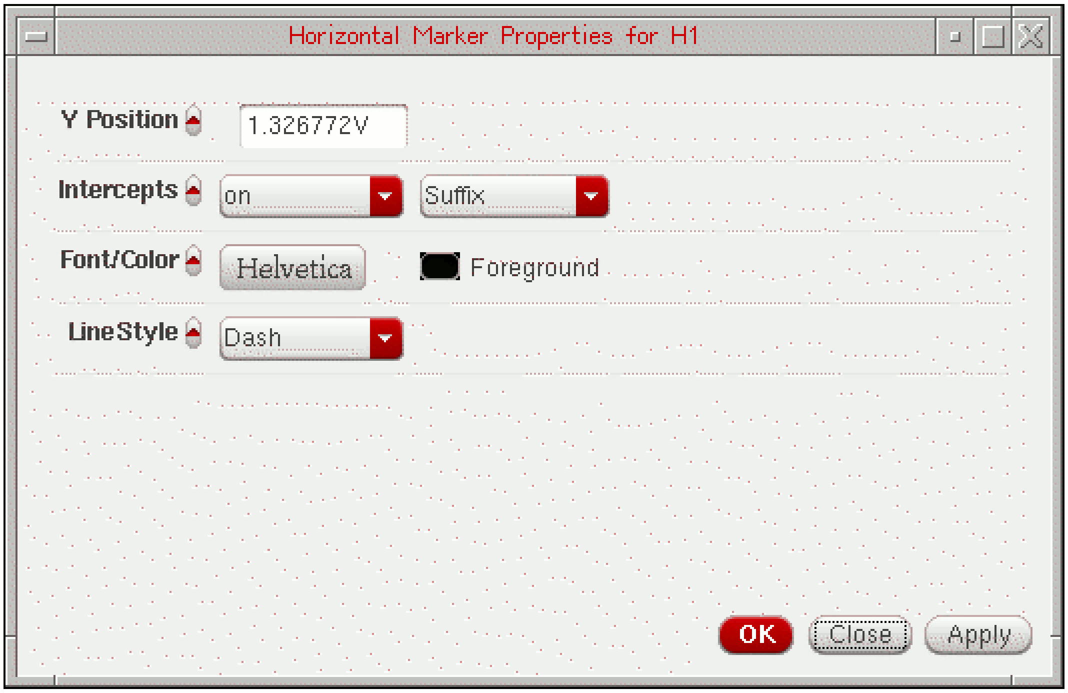


Point Marker Properties for M5

Label	%M: %X %Y		
Expression			
Trace	☑ Attach to Trace	in_p	
Position	byXMode	.7407ns	3.0V
Font/Color	Helvetica	Foreground	
Notation	Suffix		

- *Label*—Specify the label for the marker. For more information about marker labels, see Adding Markers on page 194.
- *Expression*—Specify the expression associated with the marker. For more information about expressions, see Adding Markers on page 194.
- *Trace*—Specify the name of the trace to which you want to attach the marker.
- *Position*—Specify X-axis and Y-axis position for point marker. By default, the position is `byX Mode`.
- *Font/Color*—Specify the font name, style, and size for the label.
- *Notation*—Specify the notation to be displayed on labels. The available options are—`Suffix`, `Engineering`, and `Scientific`. Default value: `Suffix`.

The properties form displays different fields based on the type of marker selected. The following fields are displayed for horizontal and vertical markers:



Horizontal Marker Properties for H1

Y Position: 1.326772V

Intercepts: on, Suffix

Font/Color: Helvetica, Foreground

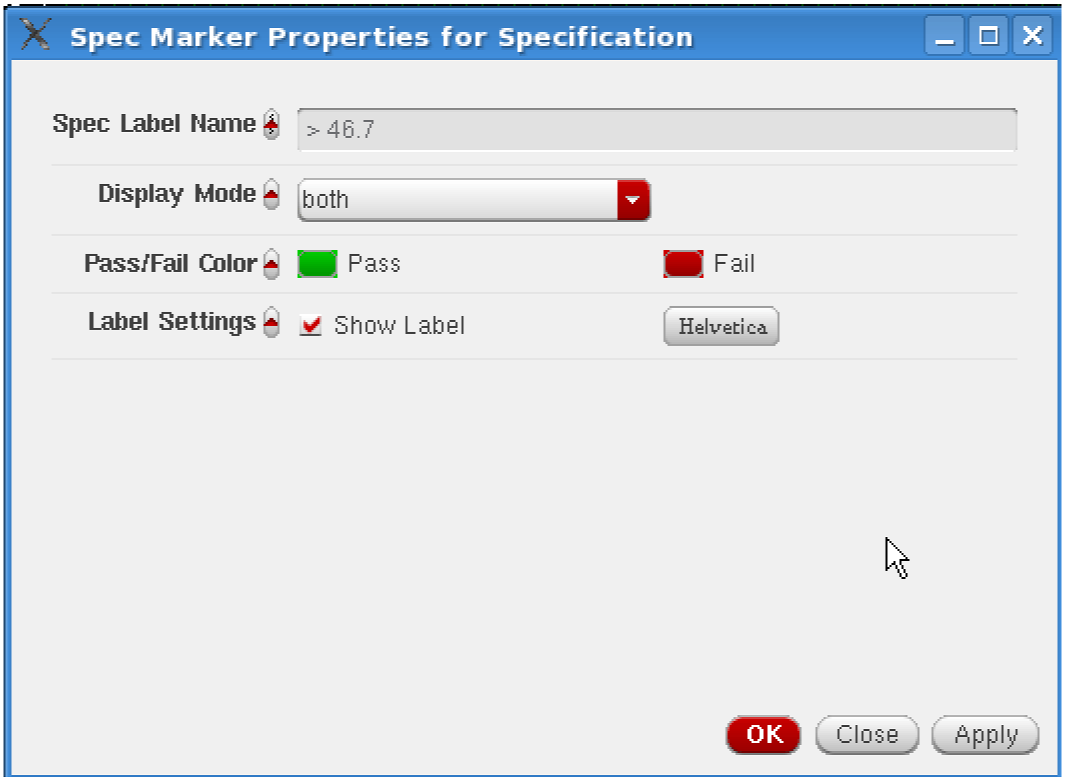
LineStyle: Dash

- *Y Position*—Specify the Y-coordinates where you want to place the horizontal marker. You can specify multiple Y-coordinates to place multiple horizontal markers at a time.
- *X Position*—Specify the X-coordinates of the point where you want to place the vertical marker. You can specify multiple X-coordinates to place multiple vertical markers at a time.
- *Intercepts*—Specify the event for the marker intercept label display.
- *Font/Color*—Specify the font name, style, and size for the label.
- *Foreground*—Select the foreground color for the symbol, the arrow and the label.
- *Line Style*—Specify the marker line style, such as dotted.

Setting Properties for Spec Markers

To view or change the properties of spec markers, right click on the corresponding trace and choose *Spec Properties*.

The *Spec Marker Properties for Specification* form is displayed, as shown in the following figure:



Spec Label Name: > 46.7

Display Mode: both

Pass/Fail Color: 🟩 Pass 🟥 Fail

Label Settings: ☑ Show Label Helvetica

In this form, you can edit the following properties:

- *Spec Label Name*—Shows the spec name that is displayed on the label.
- *Display Mode*—Specify the spec marker pass/fail display style.
- *Pass/Fail Color*—Specify the colors to shade pass or fail regions.
- *Label Settings*—Specify the font and display settings for spec marker labels.

If a graph contains multiple traces, spec marker properties cannot be changed for an individual trace. Changes in spec marker properties are applicable for all the traces of a graph.

Working with Delta Markers

Delta markers are used to mark the difference between two points in a graph. A delta marker joins two point markers in the same or different traces. To place a delta marker you must first place a point marker or select one. Delta markers can be moved or deleted independent of their point markers.

You can move either end of a delta marker; X and Y coordinates are updated accordingly. You can use delta markers to measure delays or use them with the min and max functions to measure peak-to-peak values.

This section includes the following topics:

Adding Delta Markers

You can create delta markers between two or more point, vertical, and horizontal markers on one or more traces. You can also create delta markers between two different marker types. For example, you can create delta marker between point markers and vertical markers.

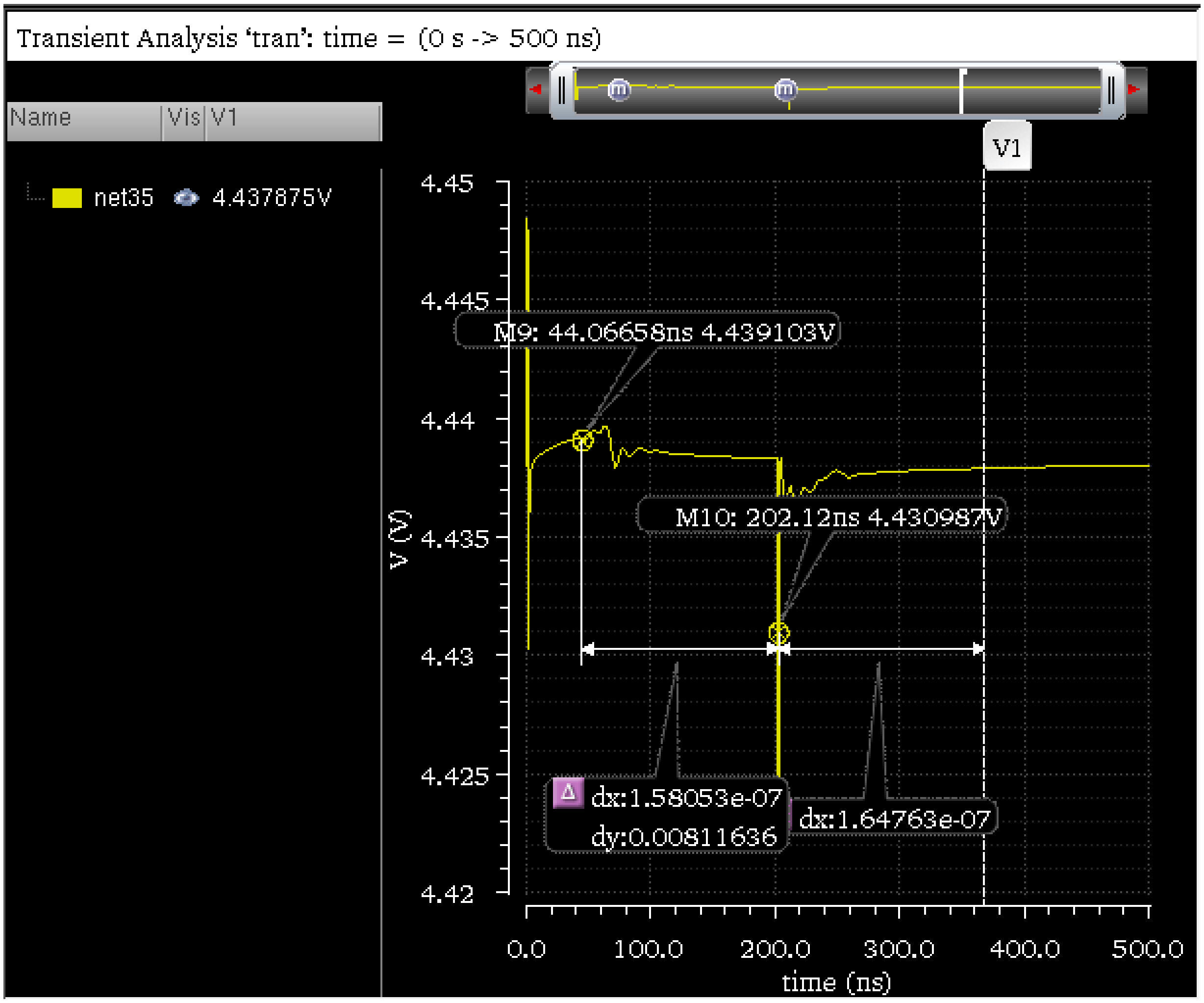
Following are the two methods that you can use to create multiple delta markers on a trace:

Method 1:

1. Add two or more point markers. To know how to create a point marker, see Adding a Point Marker on page 220.
2. Select all the point markers by holding down the `Ctrl` key and do one of the following:
   - ❑ Press the bindkey `Shift+D`.
   - ❑ Choose *Marker – Create Delta Marker*.

   The delta markers are created between all the selected point markers. The method can be applied to create delta markers between any combinations of point, vertical, and horizontal markers.

Note: You can add point, vertical, horizontal, delta, and AB markers in the eye diagram and spectrum plots. However, when you add a vertical or a horizontal marker in the eye diagram, the intercepts are not displayed in the plot.



Method 2:

1. Create a point marker. To know how to create a point marker, see Adding a Point Marker on page 220.

   The point marker you created remains selected.

2. Place the mouse pointer on the trace where you want to create the second marker. Note that you can create delta markers on multiple traces.

3. Press the bindkey `D`.

A new point marker is created at the same point where you placed the mouse pointer and a delta between this new marker and the previously created point marker is also created. This new marker is of the same type as the marker type of the previously selected marker. For example, if you created a point marker in step1, the new maker created after step2 is also a point marker.

You can repeat this method to create delta markers between multiple point markers. The last marker that you create remains selected.

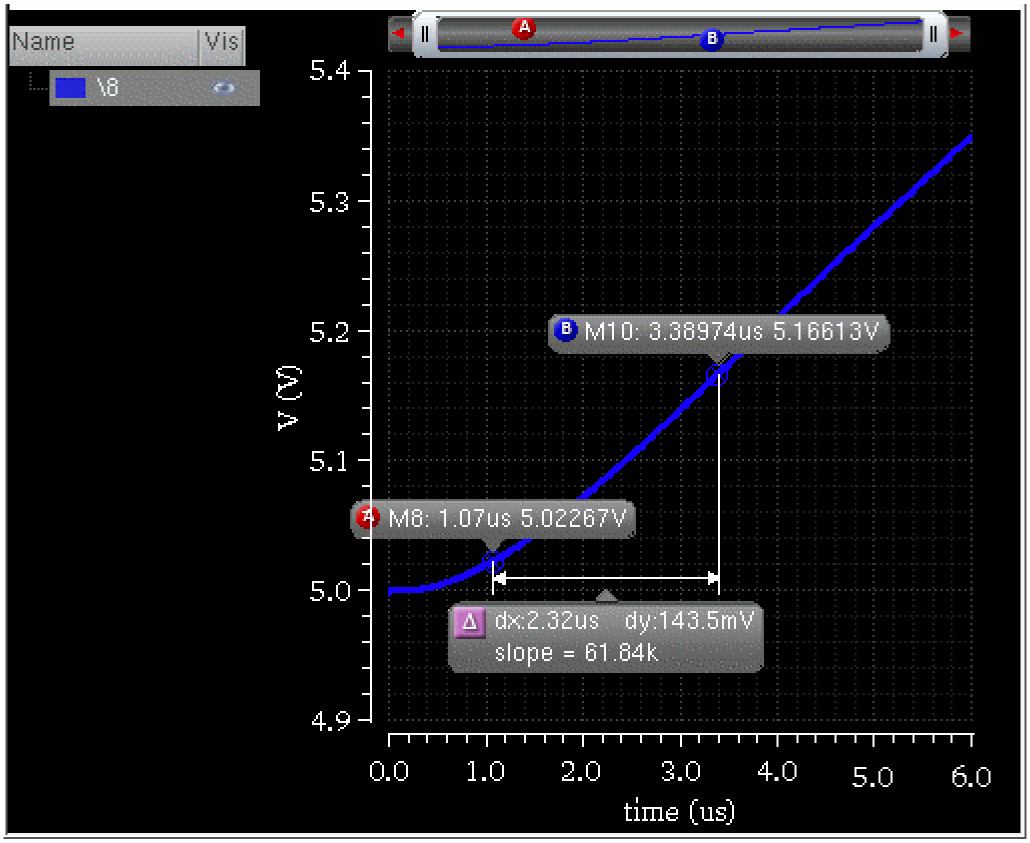
Repeat steps 2-3 to create delta marker between two or more vertical or horizontal markers.

Adding AB Marker

AB marker is a delta marker of XY type and displays the `dx`, `dy`, and the `slope` values. Do the following to add an AB marker to the trace with the help of bindkeys:

1. Move the mouse pointer to a location on the trace where you want to create an AB marker.
2. Press `A`.
3. Move the mouse pointer to another point on the trace to specify the second location for the delta marker.
4. Press `B`.

A delta marker of XY type appears on the graph. If one of the traces is a digital trace, the delta marker label displays only the `dx` value.



You can add multiple AB markers by repeating these steps.

Note: To convert an AB delta marker into a delta marker, right-click the delta marker line and choose *Convert A/B Marker to Delta*.

To show or hide the marker labels for the point markers in a delta marker, do one of the following:

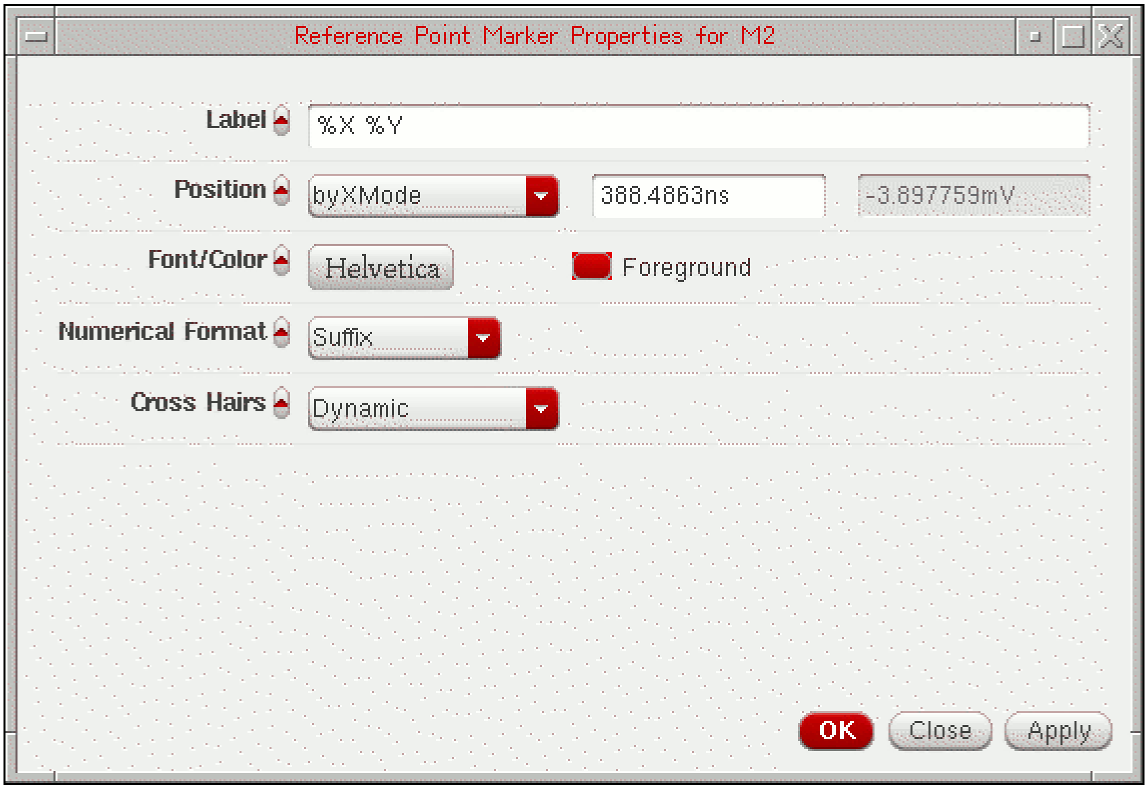
- Select the delta line and choose *Marker – Show Child Labels*.
- Right-click the delta line and choose *Show Child Labels.*

Setting AB Delta Marker Reference Point Properties

To view or change the properties of an AB delta marker, do one of the following:

- Double-click any of the two point markers that compose the delta marker.
- Right-click a point marker in the delta marker and choose *Marker – Properties*.

The *Reference Point Marker Attributes Properties* form appears.



Reference Point Marker Properties for M2

Label: %X %Y

Position: byXMode 388.4863ns -3.897759mV

Font/Color: Helvetica Foreground

Numerical Format: Suffix

Cross Hairs: Dynamic

This form includes the following fields:

- *Label*—Specify the label for the marker. For more information about marker labels, see Adding Markers on page 194
- *Position*—Specify the X and Y coordinates of the point marker. You can specify the position by XY, X, and Y modes.
- *Font/Color*—Specify the font type and font color for the marker label.
- *Numerical Format*—Specify the numerical format (notation) to be displayed on labels. The available options are—`Suffix`, `Engineering`, and `Scientific`. Default value: `Suffix`.
- *Cross Hairs*—Specify whether you want to display the X and Y intercepts for both point markers in the delta marker. If you select *Dynamic* in the *Cross Hairs* drop-down list box and click the point marker, the X and Y intercepts are displayed.

  Alternatively, to turn on the cross hairs for a delta marker, right-click one of the point markers and choose *Draw Cross Hairs – On/Off/Dynamic*.

Deleting Delta Markers

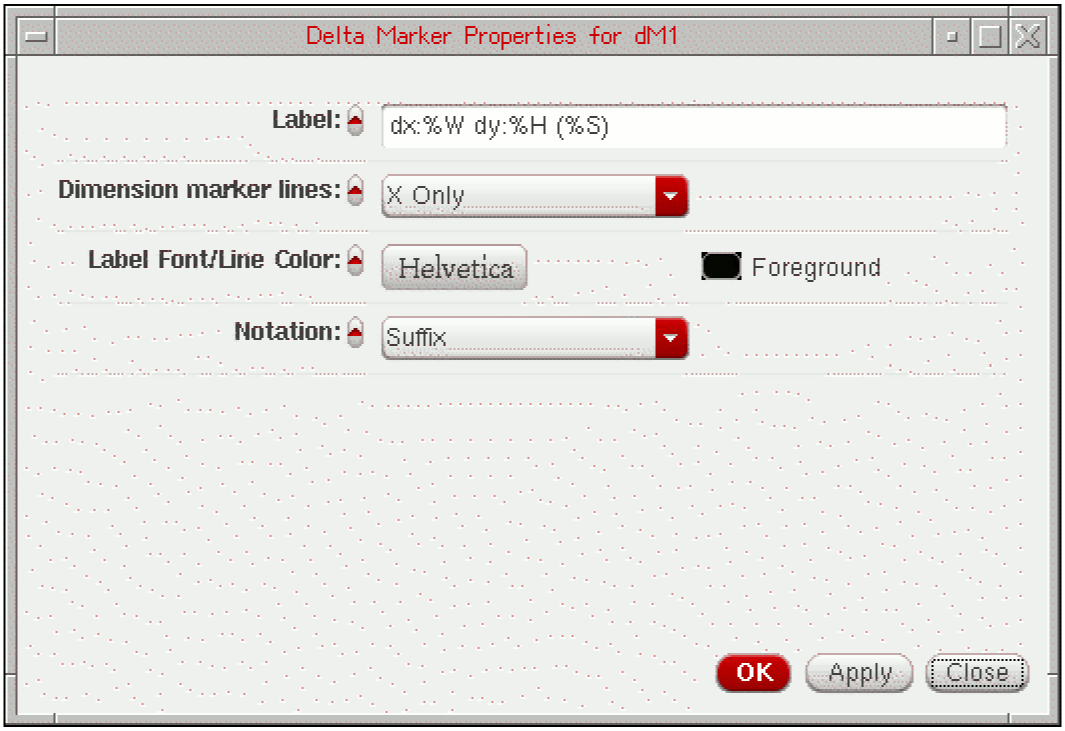
To delete the delta marker, right-click the line joining two point markers and choose *Delete*. All the delta markers are deleted.

To delete a particular set of delta marker, right-click the point marker which you want to delete and choose *Delete*. The selected point marker and the delta marker joining the point marker are deleted.

Editing Delta Marker Properties

To view or change the delta marker properties, do the following:

➡ Right-click the delta marker line joining two or more point markers and choose *Delta Marker Properties*. The *Delta Marker Properties for <delta marker name>* form appears.
.



Label: dx:%W dy:%H (%S)
Dimension marker lines: X Only
Label Font/Line Color: Helvetica ■ Foreground
Notation: Suffix

The form includes the following fields:

❑ *Label*—Specify the label for delta marker. For information about the values that you can use for marker labels, see Adding Markers on page 194.

❑ *Dimension Marker Lines*—Specify the X and Y-axis dimension lines for markers. To display the X-axis dimension line, select `X Only`. To display the Y-axis dimension line, select `Y Only`. To display both the X and Y-axis dimension lines, select `X and Y`.

- *Label Font/Line Color*—Specify the font properties for the label and also specify the dimension line color.
- *Notation*—Specify the notation to be displayed for the delta values on labels. The available options are—`Suffix`, `Engineering`, and `Scientific`.

Snapping Markers

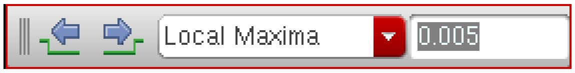
You can snap markers to analog and digital traces. In analog traces, you can also set the criteria based on which you want to snap markers, where as digital markers can be snapped only to the edge transitions, low to high and high to low. If the marker extends beyond the display area, the marker is panned automatically.

For digital traces or buses, the vertical, delta, and point markers can be snapped and for analog traces, the horizontal, vertical, delta, and point markers can be snapped based on the snapping criterion.

To set the snapping criteria to snap the markers to analog traces in the window, do the following:

1. Select a maker and choose a snapping criterion from the drop-down list box displayed on the snap toolbar based on which you want to snap the marker. For example, local maxima, local minima, and so on. By default, `Data Point` is selected in the drop-down list box.

   When you add a vertical or horizontal marker on a trace, the *Value* field displays the X-axis location of the selected marker. This field is updated automatically if you move the marker.



2. Specify a value for the selected snap criterion by which you want to snap the marker.
3. Then, to snap the marker to the next and previous snap points, do one of the following:
   - On the Snap toolbar, click the *Next Edge* and *Previous Edge* buttons.
   - Right-click the selected marker and choose *Next Edge* and *Previous Edge* respectively.
   - Press the `N` or `M` bindkeys to move to the next or previous edges, respectively.

The selected marker is snapped based on the snap criterion you selected. For example, if you select *Local Maxima* as the snap criterion, the marker is shifted to the maxima value (peak) local to the curve when you click the *Next Edge* button.

Local maxima is defined as the transition point when there is a change in the slope from the rising to falling edge starting from the marker's current position.

Local minima is defined as the transition point when there is a change in the slope from the falling to rising edge starting from the marker's current position.

At any point, the double derivative of a waveform should be zero to find the local maxima or the local minima. In some cases, waveform can have small abrupt rises and falls (wiggles) and the waveform appears flat with these small wiggles. However, these wiggles include a slope that goes from positive to negative or vice versa. A minimum size slope rule can be used to exclude the transition point associated with these tiny wiggle slopes. The exclusion rule states that the distance from local minima to local maxima or vice versa must be at least as great as some percentage of the dependant axis range. The default value for this percentage of dependant axis range is 0.5% (or 0.005). This value can be entered in a box right beside local maxima or local minima snap criterion.

For example, if the exclude rule value is 0%, then any transition from positive to negative slope will be considered as a local maxima or any transition from negative to positive slope will be considered as a local minima.

If the exclude rule value 1% (0.001), then the distance from local maxima to local minima or vice versa should be greater than 1% of the dependant axis.

The local maxima is calculated as the change in slope from rising to falling edge starting from the current marker position and the transition point is known as the local maxima.

The slope of the step, which is the ratio of local minima to local maxima, must be greater than the dependant axis range. By default, it is greater than by 0.5% or 0.005. If the slope is very small, the transition point can be ignored or excluded.

If you want to use the same snap criterion to snap a marker to more than one analog trace, select the maker and then hold down the `Ctrl` key and click the analog traces. Next, click the *Next Edge* or *Previous Edge* button to snap the marker to the snap points on the selected traces.

To snap digital markers, select the digital marker and click the *Next Edge* and *Previous Edge* buttons on the Snap toolbar.

Customizing Markers

This section includes the following topics:

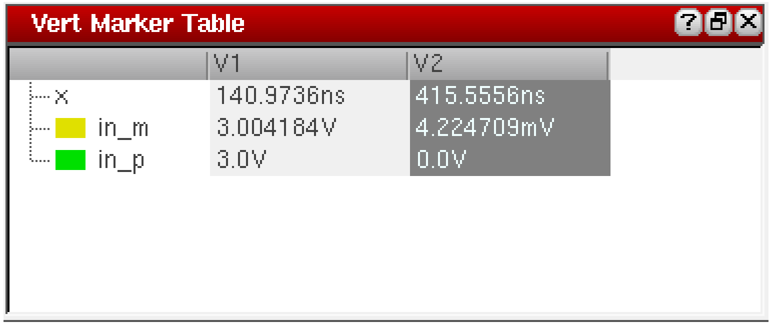
- Displaying Intercept Data for Markers in Marker Tables on page 211
- Deleting a Marker on page 213
- Editing a Marker on page 213
- Moving a Marker on page 213

Displaying Intercept Data for Markers in Marker Tables

To display the vertical marker intercepts, do the following:

➡ Choose *Window – Assistants – Vertical Marker Table*.

The *Vert Marker Table* assistant appears at the bottom of the window, displaying all vertical marker intercepts for each trace. When you add a vertical marker on a trace, the vertical marker intercepts for all the traces are displayed in the marker table.



	V1	V2
x	140.9736ns	415.5556ns
🟨 in_m	3.004184V	4.224709mV
🟩 in_p	3.0V	0.0V

In the vertical marker table, rows display the trace names and columns display the intercept points of each horizontal or vertical marker.

Note: The active vertical marker intercepts for each trace are also displayed in the trace legend area.

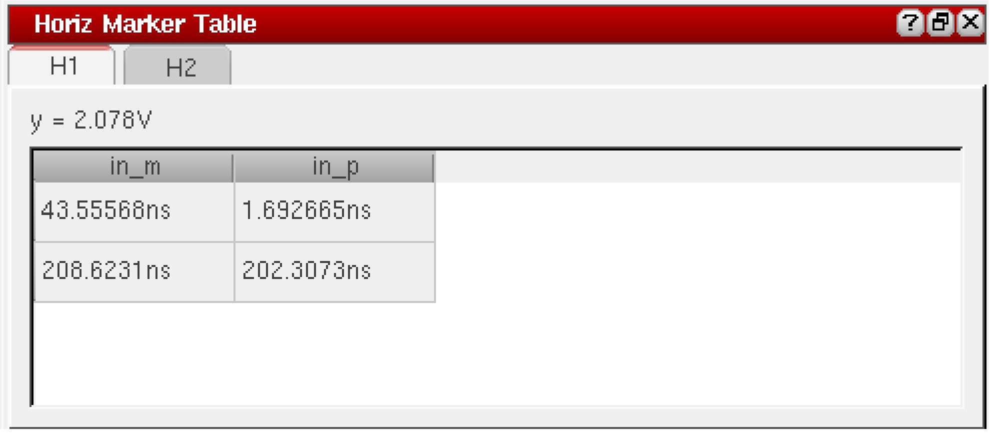
You use the horizontal marker table to view the trace intercepts for all the horizontal markers in a table.

To display the horizontal marker intercepts in a table, do the following:

➡ Choose *Window – Assistants – Horizontal Marker Table*.

The *Horiz Marker Table* form appears at the bottom of the window and displays the intercepts where horizontal marker intersects traces in the graph.

The horizontal marker table includes a separate tab for each horizontal marker. The marker table for the active horizontal marker is displayed. If you change the marker name, the tab name in the table is updated automatically.



y = 2.078V

in_m	in_p
43.55568ns	1.692665ns
208.6231ns	202.3073ns

Note: When you zoom-in a graph, the horizontal marker table lists only those intercepts that are visible in the zoomed-in portion of the graph. The horizontal marker table is updated only when you move the marker.

If the graph includes multiple Y-axes, do the following to change the axis of the horizontal marker:

➡ Right-click the marker and choose *Assign to Axis – axis-name*.

Horizontal marker now shows intercepts for the traces that are attached to the axis you select. The marker table is also updated with the new intercepts.

Exporting Markers

To export the vertical marker intercept data in a CSV file, do the following:

➡ Choose *Marker – Export – Vertical Marker*.

The *Export marker information* form appears. In this form, specify the name and location of the CSV file in which you want to save the vertical marker information and then click *Save*.

To export the horizontal marker intercept data in a CSV file, do the following:

➡ Choose *Marker – Export – Horizontal Marker.*

The *Save As* form appears. In this form, specify the name and location of the CSV file in which you want to save the horizontal marker information and then click *Save*.

Deleting a Marker

To delete a marker, do one of the following:

- Select a marker and choose *Edit – Delete*, or press the `Delete` key.
- Right-click a marker and choose *Delete*.

To delete all markers on a trace, select a marker and do one of the following:

- Choose *Edit – Delete All*
- Choose *Trace – Delete All*
- Press `Shift+E`.

To delete a AB delta marker, you can right-click any of the two point markers or the delta marker line and choose *Delete*. The A and B markers in the delta marker are deleted.

Editing a Marker

The default marker attributes are controlled by the values assigned to variables in the `.cdsenv` file. For more information, see Appendix A, "Virtuoso Visualization and Analysis XL Tool Environment Variables."

To edit a marker, double-click the marker. The *Marker Properties* form appears. Edit the required fields in this form. For more information about the fields, see Setting AB Delta Marker Reference Point Properties on page 206.

Moving a Marker

To move a point marker, drag the point marker anywhere on the trace.

To move a vertical marker, place the pointer on the vertical marker. When the pointer becomes a bidirectional arrow, drag the pointer along the X-axis to move the marker. Similarly, drag a horizontal marker along the Y-axis to move the marker.

Moving a Delta Marker

To move a delta marker, you can set the snap criterion on a point marker in the delta marker. You can then use the *Next Edge* and *Previous Edge* buttons to move the selected point marker in the delta marker.

Working with Circular Graphs

You can display complex data values from AC analysis in the form of Smith charts and polar plots. The Smith chart shows the unity circle that is R = 1 circle, the resistance circles, and the reactance circles.

This section includes the following topics:

- Creating a Circular Graph on page 214
- Adding Markers on Circular Graphs on page 218
- Zooming Circular Graphs on page 220
- Editing Circular Graph Properties on page 221
- Setting Smith Grid Properties on page 222

Creating a Circular Graph

To create a circular graph, do the following:

1. Open a results directory in the Results Browser, and then open the *ac-ac* analysis folder.

   The *Graph Type* drop-down list appears on the Results Browser toolbar.

2. Select a graph type from this list. The available graph types are—`Default`, `Rectangular`, `Histogram`, `Polar`, `Impedance`, `Admittance`, and `RealvsImag`.

   To create a polar plot, select the `Polar` graph type.

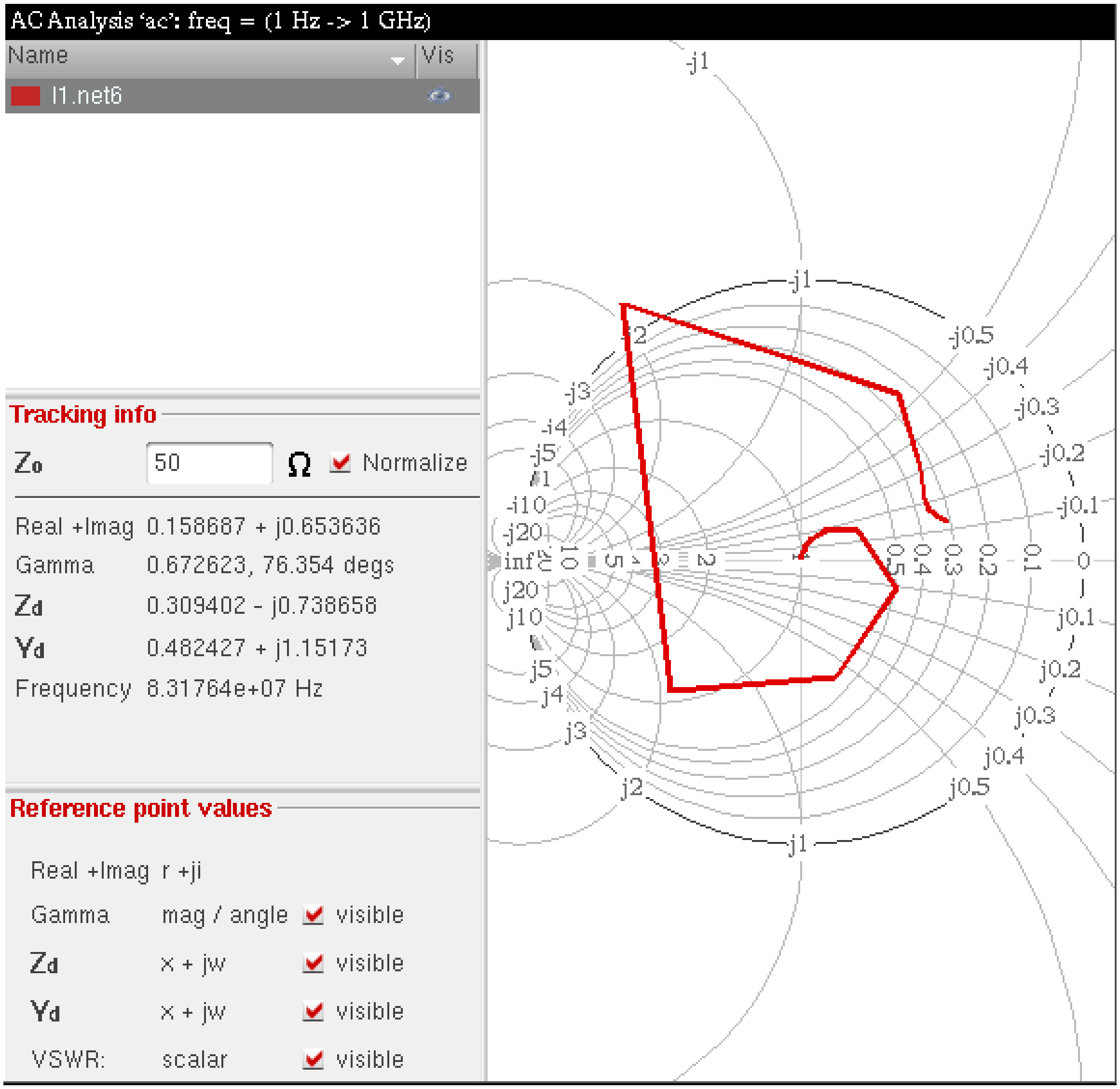
   To create a Smith chart, select either the `Impedance` or `Admittance` graph type.

   For more information about the graph types, see Selecting the Graph Type on page 46.

3. Plot a signal in the selected destination. For more information about how to plot a signal, see Plotting Signals on page 44.

   For information about how to select a plot destination, see Selecting the Signal Plot Destination on page 44.

The circular graphs can be of two types—Smith charts and polar graphs. The Smith chart can further be of two types—Impedance Smith Charts (Z Smith) and Admittance Smith Charts (Y Smith). The circular graph of type Z Smith is displayed in the figure below.



AC Analysis 'ac': freq = (1 Hz -> 1 GHz)

Name	Vis
🟥 I1.net6	👁

Tracking info

Z_0 50 Ω ☑ Normalize

Real +Imag	0.158687 + j0.653636
Gamma	0.672623, 76.354 degs
Z_d	0.309402 - j0.738658
Y_d	0.482427 + j1.15173
Frequency	8.31764e+07 Hz

Reference point values

Real +Imag	r +ji	
Gamma	mag / angle	☑ visible
Z_d	x + jw	☑ visible
Y_d	x + jw	☑ visible
VSWR:	scalar	☑ visible

After a Smith chart is plotted, the following sections are displayed in the trace legend area on the left:

- *Name*—Displays the trace name and trace color.
- *Visibility*—Controls the display of the trace. You can show or hide the trace by clicking the visibility button (👁).

- *Tracking Info*—Displays the following tracking information for the points that you click or point to:
  - *Zo*—Displays the characteristic impedance (`Zo`). The default `Zo` value is 50.
  - *Normalize*—Normalizes the readings. When you select the *Normalize* check box, the Smith reference values are multiplied with the impedance value that you specify in the `Zo` field.

    Note: When you change the `Zo` value and the *Normalize* check box is not selected, press `Tab` or `Enter` to update the reference vaues on the Smith chart.
  - *Real + Imag*—Displays the real and the imaginary values of the point selected on the trace
  - *Gamma*—Displays the magnitude and the angle of the selected point on the trace.
  - *Zd*—Displays the impedance of the point selected on the trace.
  - *Yd*—Displays the admittance of the point selected on the trace.
  - *Frequency*—Displays the frequency of the point selected on the trace.
- *Reference point values*—Displays the reference marker readout. The reference point readout includes *Real + Imag*, *Gamma*, *Zd* and *Yd* values of the reference point, and the Voltage Standing Wave Ratio (*VSWR*). The VSWR is a scalar value.

  The resistance and reactance circles, along with the reflection coefficient and VSWR circle are displayed on the graph. You can turn these values off and on by clicking the respective *visible* check boxes next to each field.

The default scale attributes for circular graphs are controlled by the values assigned to the variables in the `.cdsenv` file. For more information, see Appendix A, "Virtuoso Visualization and Analysis XL Tool Environment Variables."

Important

If you plot circular graphs that have the same plot type, the circular graphs are plotted in the same subwindow. For example, two Y-Smith or two Z- Smith can be plotted in the same window. However, if you plot graphs from different plot types, the graphs are plotted in a new subwindow. For example, Y-Smith and Z-Smith are plotted in two different subwindows.

Tracking Cursor

The tracking cursor displays the trace name, trace color, and frequency of the point you that you select or point to on the circular graph. For a Smith chart, the tracking cursor also displays the real and imaginary values. However, for polar plots, the tracking cursor displays the magnitude and angle, instead of the real and imaginary values.

The rest of the circular graph values are displayed dynamically in the various sections in the trace legend area.

To show or hide the tracking cursor, do one of the following:

- Right-click anywhere in the graph and choose Trace Marker Always Visible.
- Choose *Marker – Tracking Cursor*
- Click the ▦ button on the Marker toolbar.

You can also set the `traceMarkerDisplay` .cdsenv variable to display values for the tracking cursor, which is also called a trace marker. The following formats are supported to display the trace marker values:

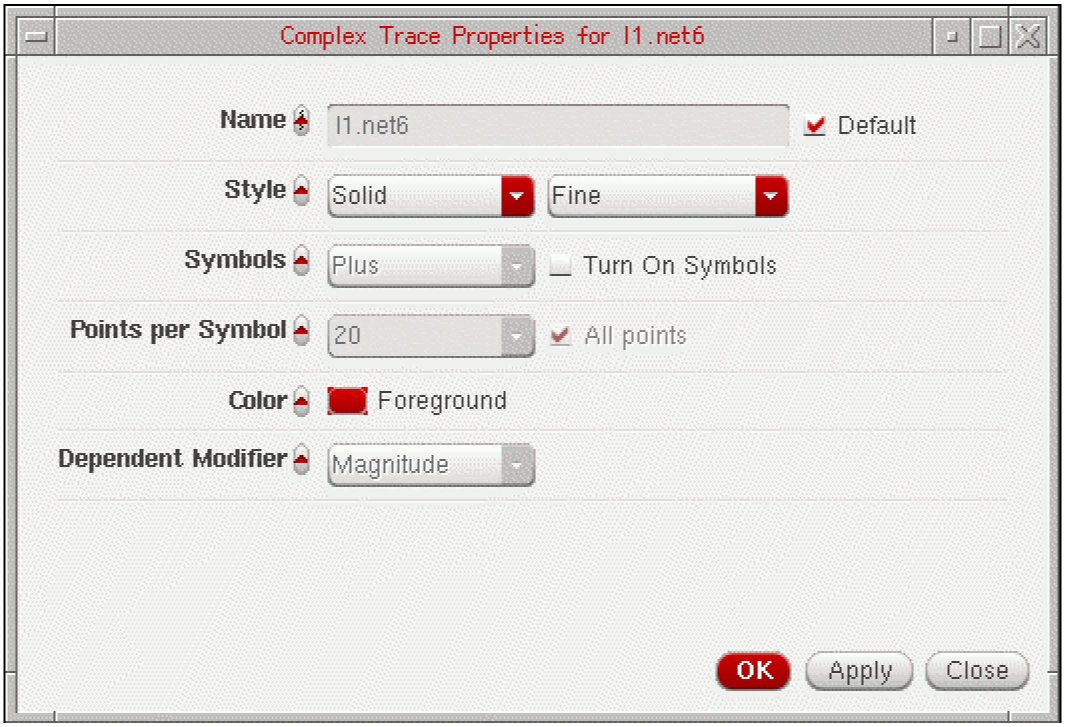
- `%C` —Displays the real and imaginary cartesian values
- `%Z`—Displays the impedance values, such as resistance and reactance
- `%A`—Displays the admittance values, such as conductance and susceptance
- `%R`—Displays the reflection coefficients, such as mag and angle
- `%P`—Displays the polar values, such as mag and angle
- `%F`—Displays the frequency value, which includes the independent axis data

Displaying Symbols on Circular Traces

To display symbols on a circular trace, do one of the following:

- Choose *Trace – Symbols On.*
- Right-click the trace and choose *Symbols On*.
- Right-click the trace and choose *Trace Properties*.

The *Complex Trace Properties for <trace-name>* form appears.



Complex Trace Properties for I1.net6

Name: I1.net6 ☑ Default

Style: Solid | Fine

Symbols: Plus □ Turn On Symbols

Points per Symbol: 20 ☑ All points

Color: 🟥 Foreground

Dependent Modifier: Magnitude

In this form, select the *Turn On Symbols* check box to display symbols on the trace. By default, the symbols are displayed for all trace points. To display symbols for a given number of trace points, specify the count in the *Points per Symbol* field.

After turning on the symbols, you can select the symbol type by doing one of the following:

- Right-click the trace and choose *Symbols,* and then select the symbol type that you want to apply
- Right-click the trace and choose *Trace Properties*.

  The *Complex Trace Properties for <trace-name>* form appears. In this form, select the symbol type from the *Symbol* drop-down list.

Adding Markers on Circular Graphs

You can add reference, point, circular, and delta markers on circular graphs. By default, the markers in the circular graphs are always visible. To hide the markers you can set the `tracemarkeralwaysvisible .cdsenv` variable to false.

Adding a Reference Marker

To add a reference maker on a circular graph, select a point on the trace and press the bindkey `R`. The reference maker is created from the center to the selected point. The readout for the reference marker—`Real + Imag`, `Gamma`, `Zd`, `Yd`, and `VSWR`—is displayed in the *Reference point values* section in the trace legend area.

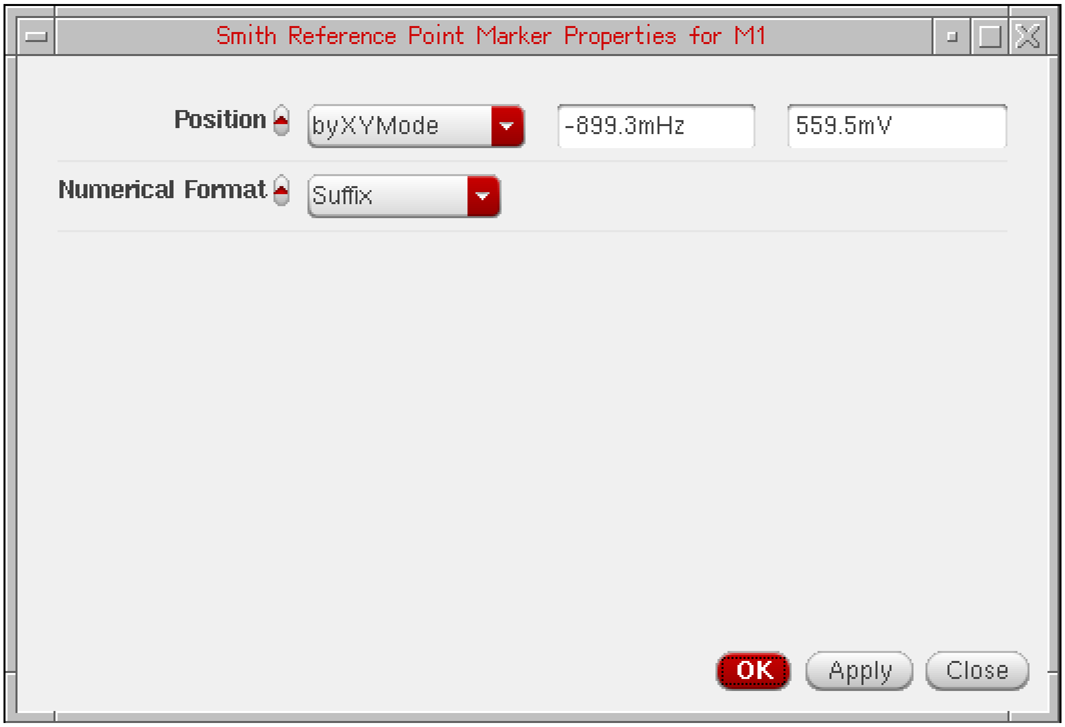
Note: You can add multiple reference markers on the circular graph. When you select a reference marker, the reference point values and graphical measurements change based on the circles and annotation for the selected reference point.

Setting Reference Marker Properties

To set the reference marker properties, right-click a reference marker and choose *Smith Ref Point Properties*.

The *Smith Reference Point Marker Properties for <marker-name>* form that includes the following fields appears:

- *Position*—Specify the X- and Y-axis coordinates where you want to place the reference marker.
- *Numerical Format*—Select the numerical format as `Scientific`, `Engineering`, and `Suffix`.



Smith Reference Point Marker Properties for M1

Position	byXYMode	-899.3mHz	559.5mV
Numerical Format	Suffix		

Adding a Point Marker

To add a point marker, do one of the following:

- Select the point on the trace where you want to add the point marker and press `M`.
- Press the bind key `M`.

  The point marker is created on the point you click on the trace.

  To change the point marker properties, right-click the point marker and choose Marker Properties. The *Point Marker Properties for <marker-name>* form appears. For more information about the point marker properties form fields, see Adding Markers on page 194.

Adding a Circular Marker

To add a circular marker, do the following:

➡ Choose *Marker – Create Marker*.

The *Create Graph Marker* form appears. On the *Circular* tab, in the *Position* field, specify the real and imaginary values for the circular marker. In the *Radius* field, specify the radius. For more information about the circular marker fields displayed in the *Create Graph Marker* form, see Adding Markers on page 194.

Deleting Markers

To delete a marker, see Deleting a Marker on page 213.

Zooming Circular Graphs

You can zoom in or out the circular graph by doing the following:

- To fit the circular graph to the data values, choose *View – Fit* or right-click anywhere on the circular graph and choose *Fit.*
- To fit the trace in the circular graph to the window, do one of the following:
  - ❑ Right-click the trace in the circular graph and choose *Fit Trace*.
  - ❑ Select the trace in the circular graph and choose *View – Fit Trace*.
  - ❑ Select the trace in the circular graph and choose *Trace – Fit Trace*.

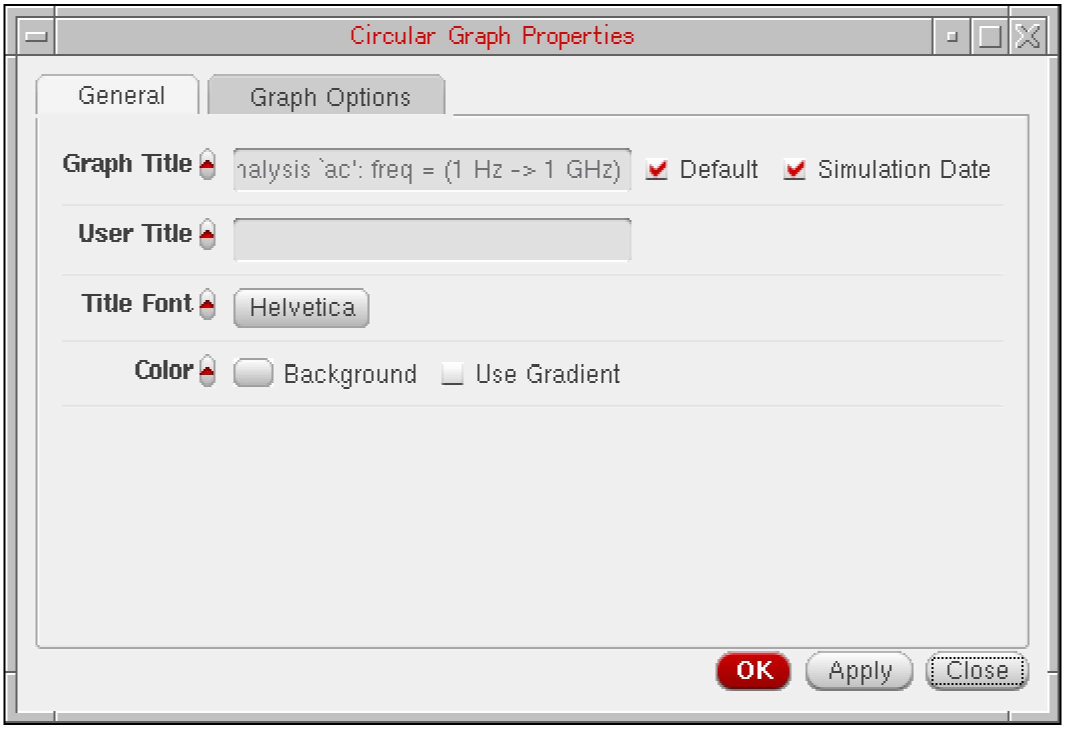
- To fit the circular graph to the Smith values, do one of the following:
  - Right-click anywhere on the circular graph and choose *Smith Fit*.
  - Choose *View – Fit Smith*.

Editing Circular Graph Properties

To set the properties of the circular graph, do one of the following

- Choose *Graph – Properties*.
- Right-click anywhere in the circular graph and choose *Smith Graph Properties* for a Smith chart and *Polar Graph Properties* for a polar graph.

  The *Circular Graph Properties* form appears.



Graph Title	ıalysis `ac': freq = (1 Hz -> 1 GHz) ☑ Default ☑ Simulation Date
User Title	
Title Font	Helvetica
Color	Background □ Use Gradient

This form includes the following two tabs:

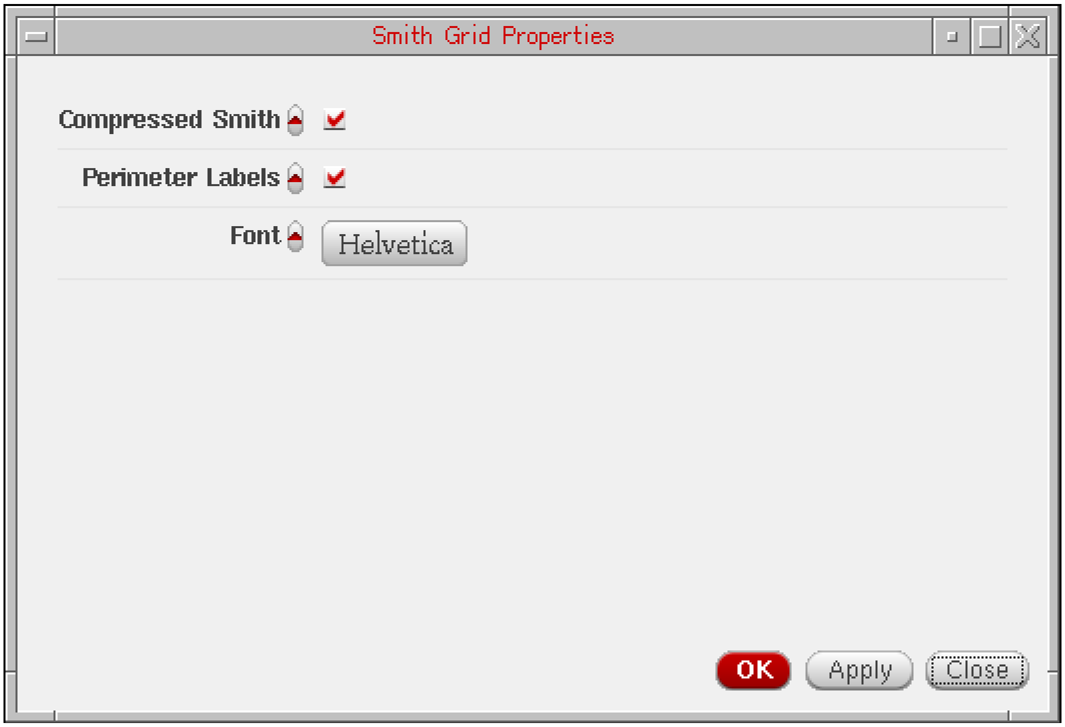
- *General*—For information about the fields displayed on the *General* tab, see Editing Graph Properties on page 100.
- *Graph Options*—Includes the following fields:
  - *Font*—Select the font properties of the Smith Chart.

  - *Notation*—Select the graph notation as `Scientific`, `Engineering`, or `Suffix`. Default value: `Suffix`.
  - *Grid Type*—Select the grid type as `Polar`, `Impedance`, or `Admittance`.
  - *Smith Data*—Specify the characteristic impedance Zo. Select the *Normalize Smith Value* check box if you want to normalize the Smith data values according to the impedance you specify.

- Click *OK.*

Setting Smith Grid Properties

To set the Smith grid properties, right-click a Smith chart and choose *Smith Grid Properties*. The *Smith Grid Properties* form appears.



Compressed Smith ☑

Perimeter Labels ☑

Font Helvetica

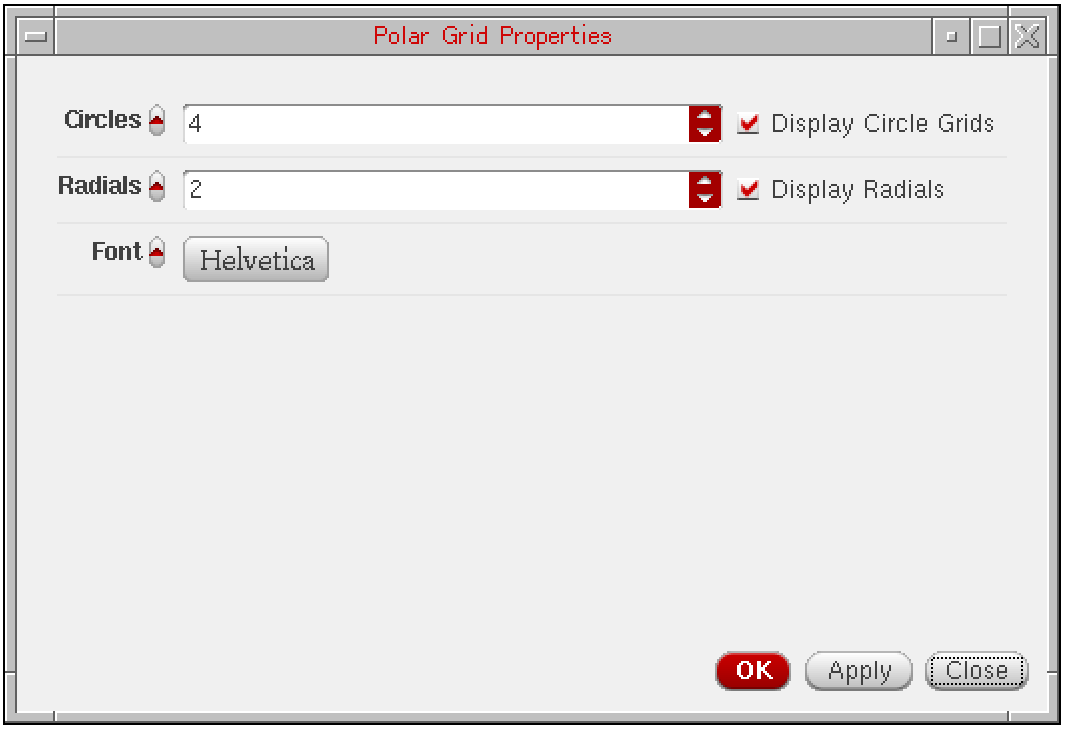
The form includes the following fields:

- *Compressed Smith*—Select this check box if you want to display the extra horizontal grid lines (arcs) outside the Smith chart boundary.
- *Perimeter Labels*—Select this check box if you want to display labels at arc intersections on the Smith unity circle.

- *Font*—Specify the font properties for the Smith chart labels.

Setting Polar Grid Properties

To set the polar grid properties, right-click a polar plot and choose *Polar Grid Properties*. The *Polar Grid Properties* form appears.



Polar Grid Properties

Circles 4 ☑ Display Circle Grids

Radials 2 ☑ Display Radials

Font Helvetica

This form includes the following fields:

- *Circles*—Specify the number of circles you want to draw on the polar grid. Select the *Display Circular Grid* check box if you want to display the circular grids.
- *Radials*—Specify the number of radials you want to draw in each quarter of the polar grid. Select the *Display Radials* check box if you want to display the radials in the polar graph.
- *Font*—Select the font properties for the polar grid labels.

Setting Dependent Modifiers for a Complex Trace

You can set the dependent modifiers for an AC or a complex dataset, such as Mag, dB10, dBm, and dB20. You can also calculate these modifiers based on the resulting eye diagram and the spectrum waveform.

To change the modifier for an AC or a complex dataset, do one of the following:

- Right-click the AC waveform and choose *Dependent Modifier – Magnitude/Phase/dB10/dB20/dBm/WrapPhase/Real/Imag*.

  The selected modifier is plotted in the window in which the graph was plotted.

- Right-click the AC waveform and choose *Trace Properties*.

  The *Complex Trace Properties* form appears. In this form, select from the *Dependent Modifier* drop-down list box the modifier you want to apply to the trace and click *OK*.

  The selected modifier is plotted in the window in which the circular graph was plotted.

Setting Bindkeys

A bindkey is a key or a sequence of key press events linked (bound) to a task. When you press the key or the sequence of keys, the associated task is performed. The Virtuoso Visualization and Analysis XL too provides a set of default bindkeys, which are displayed next to the relevant commands on the menus. These bindkeys can be overwritten or modified by a customized bindkey file.

The sample bindkey files are found at the following locations:

```
$CDSHOME/tools/dfII/samples/local/vivaBindKeys.il
```

```
$CDSHOME/tools/dfII/samples/local/vivaJavaBindKeys.il
```

This vivaJavaBindKeys.il file includes the bindkeys for the Java graph.

To view all the bindkeys for the Virtuoso Visualization and Analysis XL tool, choose *Help - Bindkey*. The *Bindkey Editor* appears that includes all the bindkeys for all applications, such as *vivaBrowser*, *vivaCalculator*, and *vivaGraph*.

You can map keystrokes to the tasks that you perform in the window. However, you cannot bind mouse actions to tasks. A task is defined as follows:

```
Task = { graph_task | menu_item_task | skill_function }
```

`graph_task` Specifies the task that the bindkey is linked to. You can link a bindkey to any of the following tasks: `marker`, `vertmarker`, `horizmarker`, `deltamarker`, `vertcursor`, `horizcursor`, `deltacursor`, `tracecopywin`, `tracemovewin`, `tracecopysubwin`, `tracemovesubwin`, `logscale`, `cut`, `copy`, `paste`, `delete`, `cancel`, `undo`, `cancel`, `traceinfo`, `pandown`, `panup`, `panleft`, `panright`, `zoom`, `zoomx`, `zoomy`, `zoomin`, and `zoomfit`

`menu_item_task` Specifies the item name in the following format `graph.`*`menu`*`.`*`submenu1`*`.`*`submenu2`*.
For example, panning to the right is defined as follows: `graph.zoom.pan.panright`.

`skill_function` Specifies the SKILL function call, such as `awvFitMenuCB`()
For information about SKILL functions, see the *SKILL Language Reference*.

A keystroke is defined as follows:

```
keystroke = simple_keystroke | composite_keystroke
```

`simple_keystroke` A single letter, number, symbol, or key name.
Examples: `a`, `2`, `@`, `Up`, `F1`

`composite_keystroke` The format is
`modifiers``<key>`*`simple_keystroke`*
where *`modifiers`* = `alt`, `ctrl`, `meta`, `shift`, `control`, `super`, `hyper`, `mod1`, `mod2`, `mod3`, `mod4`, `mod5`
Examples: `meta<key>Right`, `AltShift<key>F2`

4

Working with the Calculator

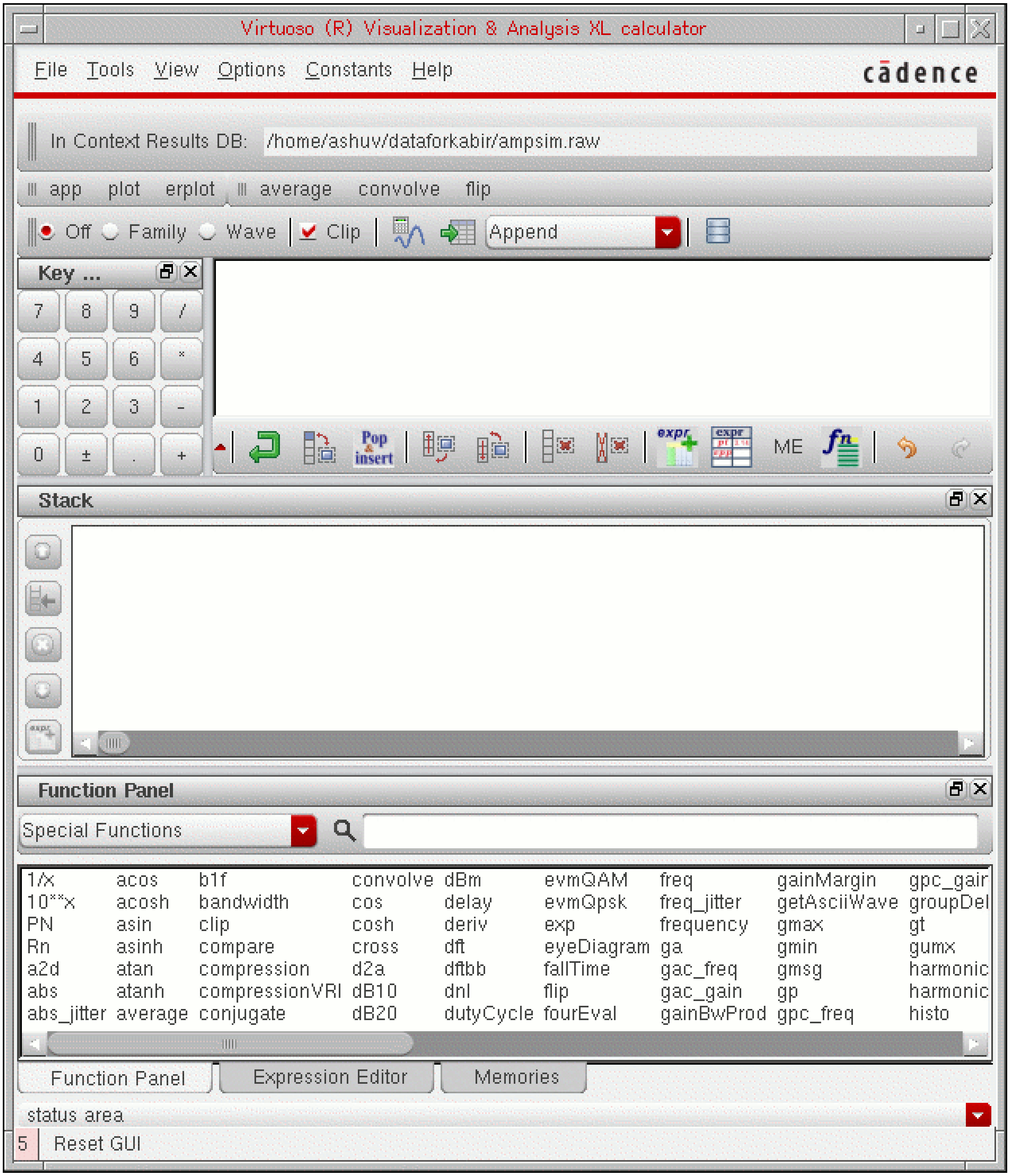
The Virtuoso® Visualization and Analysis XL Calculator is a tool that you use to perform calculations on the data generated by a simulator.

This chapter includes the following topics:

About the Calculator

Virtuoso Visualization and Analysis XL Calculator is a tool that you use to perform calculations on signals and datasets generated by a simulator. You can also use the

Calculator to build expressions on simulation data and can save these expressions for future use.



Virtuoso (R) Visualization & Analysis XL calculator

In Context Results DB: /home/ashuv/dataforkabir/ampsim.raw

● Off ○ Family ○ Wave ☑ Clip

Append

Special Functions

status area

5 Reset GUI

You can run the Calculator from Virtuoso Visualization and Analysis XL tool or from the Analog Design Environment (ADE). When you run the Calculator from Virtuoso Visualization and Analysis XL tool, you can open the Calculator either in the MDL or SKILL mode. In both the modes, you use the Results Browser to access simulation results. The simulation results are the signals generated after the simulation is run in a simulation environment, such as ADE and Spectre. To analyze these signals for a particular condition set, you can build expressions in the Calculator and evaluate them.

For example, if you want to calculate the difference between the output signal (`Vout`) and the input signal (`Vin`) for a simulation, you can build an expression `Vout-Vin` by using the Calculator. To build this expression, you can get the expressions for `Vin` and `Vout` using the Results Browser.

However, if you are working in ADE and want to build expressions for the latest simulation run to analyze design specifications, you can open the Calculator directly from ADE. You then build the required expressions in the Calculator and import the expressions to ADE before you run the simulation. The expressions are evaluated immediately after you run the simulation. The generated output helps you to modify the simulation circuit.

In ADE, you can use the Calculator to build expressions, which are then evaluated in ADE after the simulation is run. When you run the Calculator from Virtuoso Visualization and Analysis XL tool, you can use the Calculator to both build and evaluate expressions.

When you run the Calculator from Virtuoso Visualization and Analysis XL tool, you work on signals, whereas when you run the Calculator from ADE, you typically work on schematic objects, such as nets and terminals. In addition, when you run the Calculator from ADE, you can open the Results Browser from the Calculator and work on the saved simulation results, if required.

Calculator works in two modes —RPN Mode and Algebraic Mode. The two Calculator modes provide different sets of operations for building and evaluating expressions. The default Calculator type is set to RPN Mode.

Calculator contains various dockable assistants, a menu bar, a Buffer, and toolbars that you can use to build and evaluate expressions. For more details about these GUI elements, see Using the Calculator Graphical User Interface (GUI) on page 234.

Opening the Calculator Window

This section describes the different methods that you can use to open the Calculator.

- Opening the Calculator from Virtuoso Visualization and Analysis XL Tool on page 231

- ❑ Opening the Calculator from Virtuoso Visualization and Analysis XL in SKILL Mode on page 231
- ❑ Opening the Calculator from Virtuoso Visualization and Analysis XL in MDL Mode on page 233

- Opening the Calculator from CIW in Stand-Alone Mode on page 233
- Opening the Calculator from ADE on page 233

Opening the Calculator from Virtuoso Visualization and Analysis XL Tool

Depending upon the simulation environment you are working in, you can open the Calculator in the SKILL or MDL mode from the Virtuoso Visualization and Analysis XL tool. When you run the Virtuoso Visualization and Analysis XL tool, the Results Browser appears. In the Results Browser, you select the saved simulation results on which you want to build and evaluate expressions.

Opening the Calculator from Virtuoso Visualization and Analysis XL in SKILL Mode

Perform the following steps to open the Calculator from Virtuoso Visualization and Analysis XL in the SKILL mode:

1. Start the Virtuoso Visualization and Analysis XL tool by typing the following command in a terminal window:

   ```
   viva -expr skill &
   ```

   The Virtuoso Visualization and Analysis XL window appears. This window consists of Results Browser as an assistant.

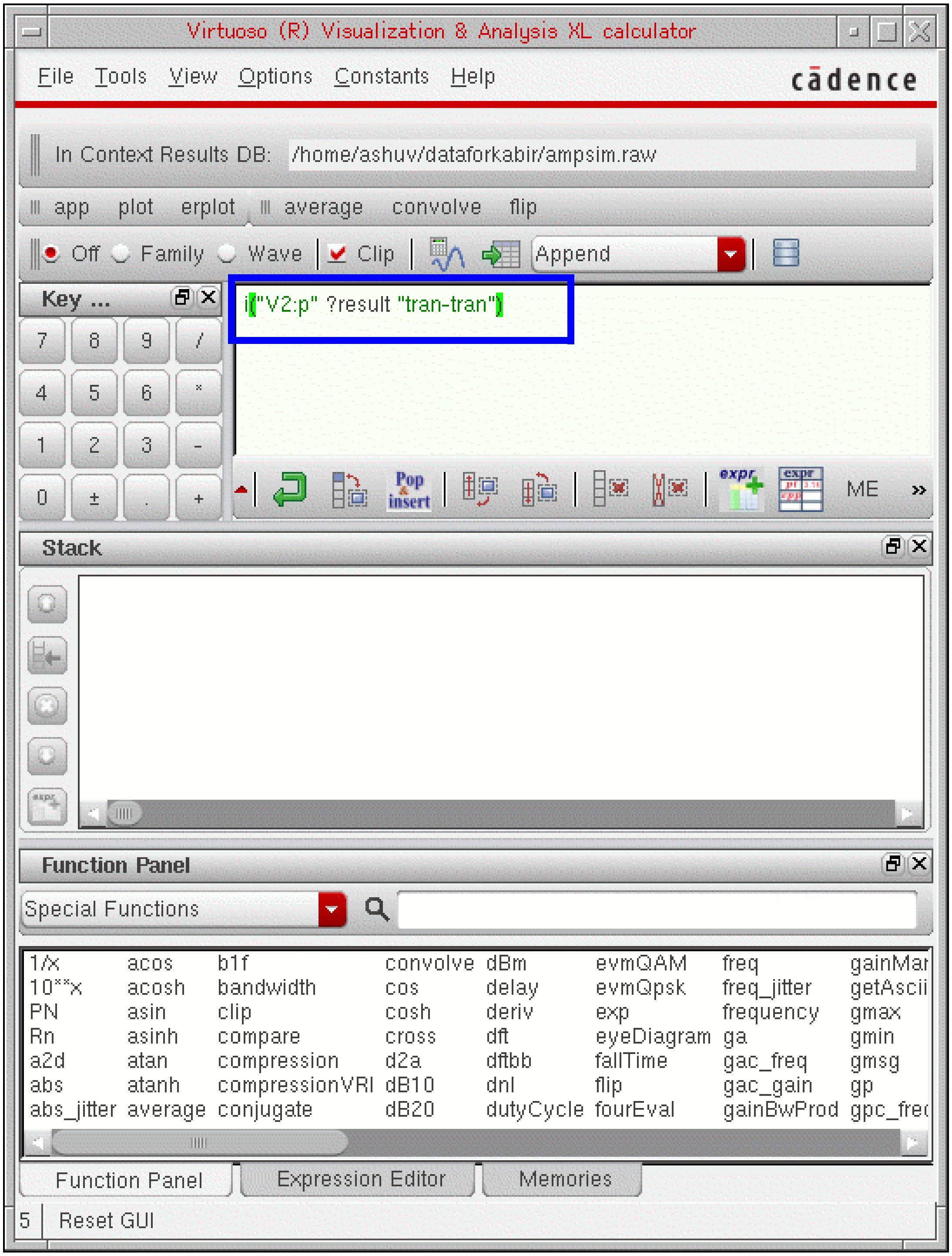
   Note: If you type only `viva &` in the terminal window, the default mode is SKILL.

2. In the Results Browser, select the required signal and do one of the following:

   - ❑ Right-click the signal and choose *Calculator*.
   - ❑ Choose *Tools – Calculator*.

   The Calculator window appears. The signal you have selected in the Results Browser appears in the Buffer.

See Selecting Signals and Waveforms to Build Expressions on page 261 to know how to select a signal in the Results Browser.



In Context Results DB: /home/ashuv/dataforkabir/ampsim.raw

```
i("V2:p" ?result "tran-tran")
```

Special Functions

Virtuoso (R) Visualization & Analysis XL calculator
File Tools View Options Constants Help
cādence
app plot erplot average convolve flip
● Off ○ Family ○ Wave ☑ Clip
Append
Key ...
7 8 9 /
4 5 6 *
1 2 3 -
0 ± . +
Pop & insert
expr
ME
»
Stack
Function Panel
1/x 10**x PN Rn a2d abs abs_jitter
acos acosh asin asinh atan atanh average
b1f bandwidth clip compare compression compressionVRI conjugate
convolve cos cosh cross d2a dB10 dB20
dBm delay deriv dft dftbb dnl dutyCycle
evmQAM evmQpsk exp eyeDiagram fallTime flip fourEval
freq freq_jitter frequency ga gac_freq gac_gain gainBwProd
gainMar getAscii gmax gmin gmsg gp gpc_freq
Function Panel
Expression Editor
Memories
5 Reset GUI

Note: To verify which result data directory is currently in use, view the *In Context Results DB* field in the Calculator window.

Opening the Calculator from Virtuoso Visualization and Analysis XL in MDL Mode

You can open the Calculator in MDL mode only if you are using the Spectre simulation environment. Perform the following steps to open the Calculator in the MDL mode:

1. Start the Virtuoso Visualization and Analysis XL tool by typing the following command in a terminal window:

   ```
   viva -expr mdl &
   ```

   The Virtuoso Visualization and Analysis XL window appears. This window consists of Results Browser as an assistant pane.

2. Select a signal for which you want to build expressions and do one of the following:

   a. Right-click the signal and choose *Calculator*.

   b. Choose *Tools – Calculator*.

   The Calculator window appears. The signal selected in the Results Browser appears in the Buffer. For more information about the Buffer, see Stack on page 251.

   See Selecting Signals and Waveforms to Build Expressions on page 261 to know how to select a signal in the Results Browser.

Note: In the IC 6.1.5 release, the Calculator is not available in the MDL mode. For information about running the Calculator in the MDL mode, see *WaveScan User Guide*, version 5.1.41.

Opening the Calculator from CIW in Stand-Alone Mode

To open the Calculator in the stand-alone mode, perform the following:

➡ In the CIW, choose *Tools – Calculator*.

The Calculator window appears. Click the ▤ button to open the Results Browser and select the signal for which you want to build expressions.

Opening the Calculator from ADE

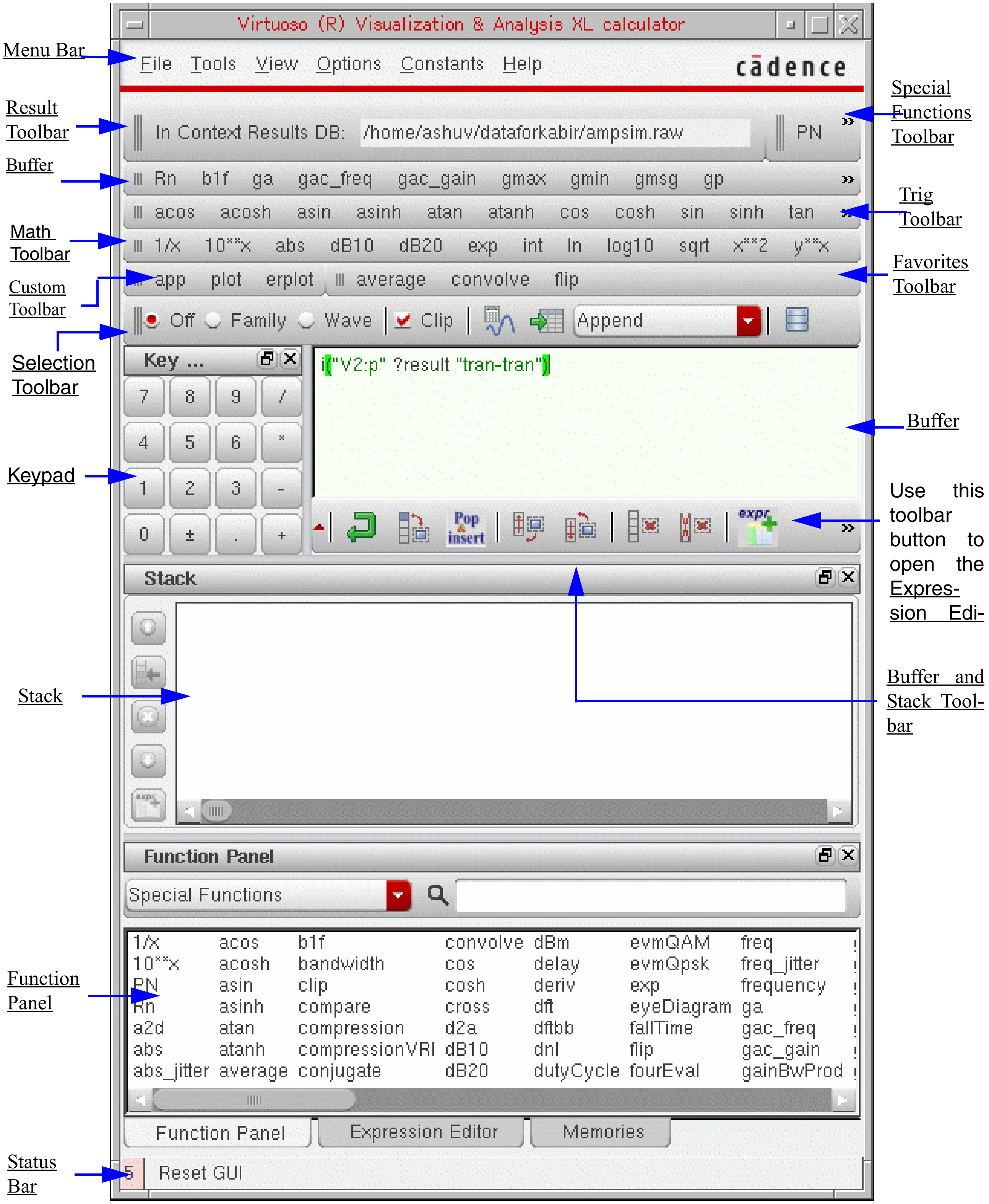
The Calculator can be opened in ADE L or ADE XL to build expressions to analyze simulation output. For detailed information about how to open and work with the Calculator in ADE, see Working with the Calculator in ADE on page 277.

Using the Calculator Graphical User Interface (GUI)

The Calculator graphical user interface (GUI) consists of various toolbars, a menu bar, a Buffer, a status bar, toolbars, and dockable assistants—Expression Editor, Function Panel, Stack, Keypad, and Memory Editor— that you use to build and evaluate expressions. You can show, hide, move, and place the dockable assistants and toolbars anywhere inside or outside the main Calculator window. For example, by default, the Keypad is placed in the lower-right corner of the Calculator window. However, if required, you can drag the Keypad to place it next to the Buffer. When you perform drag-and-drop operations on assistants and toolbars, they are automatically positioned according to the available space.

Choose *File – Reset GUI* anytime during the session to restore the default placement of toolbars and assistants.

Note: In the IC 6.1.5 release, the improved version of the Calculator helps you open more than one assistant simultaneously.



Virtuoso (R) Visualization & Analysis XL calculator
File Tools View Options Constants Help
cādence
PN
Rn b1f ga gac_freq gac_gain gmax gmin gmsg gp
acos acosh asin asinh atan atanh cos cosh sin sinh tan
1/x 10**x abs dB10 dB20 exp int ln log10 sqrt x**2 y**x
app plot erplot average convolve flip
● Off ○ Family ○ Wave ☑ Clip
Append
Key ...
7 8 9 /
4 5 6 *
1 2 3 -
0 ± . +
Pop & insert
expr
Stack
Function Panel
Special Functions
1/x acos b1f convolve dBm evmQAM freq
10**x acosh bandwidth cos delay evmQpsk freq_jitter
PN asin clip cosh deriv exp frequency
Rn asinh compare cross dft eyeDiagram ga
a2d atan compression d2a dftbb fallTime gac_freq
abs atanh compressionVRI dB10 dnl flip gac_gain
abs_jitter average conjugate dB20 dutyCycle fourEval gainBwProd
Function Panel
Expression Editor
Memories
5
Reset GUI
Menu Bar
Result Toolbar
Buffer
Math Toolbar
Custom Toolbar
Selection Toolbar
Keypad
Stack
Function Panel
Status Bar
Special Functions Toolbar
Trig Toolbar
Favorites Toolbar
Buffer
Buffer and Stack Toolbar

In Context Results DB: /home/ashuv/dataforkabir/ampsim.raw

i("V2:p" ?result "tran-tran")

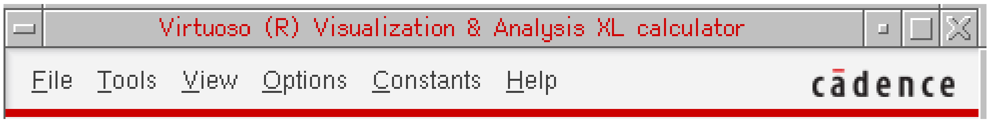
Use this toolbar button to open the Expression Editor

This topic describes the following components of the Virtuoso Visualization and Analysis XL Calculator.

- Menu Bar on page 236
- Toolbars on page 239
- Buffer on page 247
- Assistants on page 250

Menu Bar

The menu bar displays the various menus that contain commands for working with the Calculator.


Virtuoso (R) Visualization & Analysis XL calculator
File Tools View Options Constants Help
cādence

The table below lists a description of the various Calculator menus.

Menu Name	Commands	Description	For More Information, See
File			
	Reset GUI	Resets the Calculator GUI to default settings	
	Close	Closes the Calculator window	
Tools			
	Plot	Plots the signal in the selected graph window	Chapter 3, “Working with Graphs.”
	Table	Opens the Virtuoso Visualization and Analysis XL Table.	Working with the Calculator in ADE on page 277
	Browser	Opens the Results Browser window if you want to work on the saved simulation data in ADE	

Menu Name	Commands	Description	For More Information, See
	Send to ADEXL Test	Displays the expression created in the Buffer on the ADE XL *Output Setup* section	
View			
	Display Results Dir	Displays the *In Context Results DB* field on the Result Directory toolbar	Result Toolbar on page 240
	Show Keypad	Displays the Keypad in the lower-right corner of the Calculator window	
	Show Stack	Displays the Stack assistant, which lists expressions that you pushed into the Stack assistant from the Expression Editor and Buffer assistants	
	Math Toolbar	Displays the Math toolbar that includes mathematical functions such as ln and exp	
	Trig Toolbar	Displays the Trigonometry toolbar that includes trigonometric functions such as sin and cos	
	Custom Toolbar	Displays the Custom toolbar that includes buttons to select the mode in which you want to display the output	Custom Toolbar on page 243
	Schematic Selection Toolbar	Displays the Schematic Selection toolbar in ADE L and ADE XL	Schematic Selection Toolbar on page 244
	Configure Schematic Selection Toolbar	Displays the Configure Schematic Selection toolbar form, in which you select the types of simulation analyses, such as tran, ac, dc, and so on. The function buttons for the selected simulation analyses are displayed on the Schematic Selection toolbar.	
Options			

Menu Name	Commands	Description	For More Information, See
	Mode	Sets the Calculator mode *RPN Mode*—Sets the Calculator mode to RPN. Turning this option off changes the Calculator mode to Algebraic *Algebraic Mode*—Sets the Calculator mode to algebraic. Turning this option off changes the Calculator mode to RPN	Building Expressions in the Buffer on page 264
	Notation	Specifies the notation type to be used for displaying data. You can specify one of the following three notation types: *Engineering* - Displays data by using the engineering notation *Suffix* - Displays data by using the suffix notation *Scientific* - Displays data by using the scientific notation	
	Significant Digits	Sets the number of significant digits for the results displayed in the table	
	Edit color	Sets the colors for the various types of Buffer contents, including Results Dir, DataSet name, Calc Function, Node names, Data Access Functions, Number, Brackets, Operators, and Strings	
Constants		Displays a list of constants, such as boltzmann, charge, degPerRad, epp0, pi, twopi, and sqrt2. These constants are used while building expressions.	Adding Constants to Expressions on page 270
Help			
	Contents	Displays the *Virtuoso Visualization and Analysis Tool User Guide*	
	Cadence Online Support	Displays the Cadence customer support website in your default Web browser	

Menu Name	Commands	Description	For More Information, See
	Online User Forum (cdnusers.org)	Displays the online users' forum website in your default Web browser	
	Known Problems and Solutions	Displays *Virtuoso Visualization and Analysis Tool Known Problems and Solutions*	
	What's new	Displays *Virtuoso Visualization and Analysis Tool What's New*	
	About Visualization and Analysis	Displays the version number of the Virtuoso Visualization and Analysis XL tool	

Toolbars

Do one of the following to display the Calculator toolbars that are currently hidden:

➡ From the *View* menu, choose the toolbar you want to display.

➡ Right-click any toolbar and choose the toolbar you want to display.

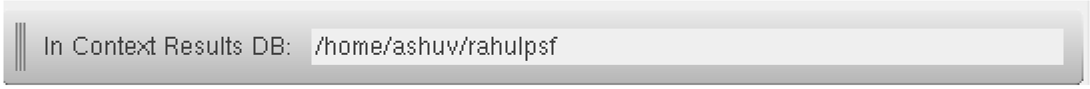
Calculator has the following toolbars:

- Result Toolbar on page 240
- Test Toolbar on page 244
- Special Functions Toolbar on page 241
- Buffer on page 247
- Trig Toolbar on page 242
- Math Toolbar on page 242
- Custom Toolbar on page 243
- Favorites Toolbar on page 243
- Schematic Selection Toolbar on page 244

- Selection Toolbar on page 244
- Buffer and Stack Toolbar on page 246

Result Toolbar

The Result toolbar displays the *In Context Results DB* field.



In Context Results DB: /home/ashuv/rahulpsf

In Context Results DB

You can set a results directory as the database context directory in the Results Browser. You build expressions using the data files stored in the results directory. A data file contains output signals that are generated after a simulation is run.

To set the database context directory, perform the following steps in the Results Browser:

- Open the results directory that you want to use to build expressions.
- Right-click the results directory name and choose *Set Context*.

  The database context is set to the selected directory and the *In Context Results DB* field on the Result toolbar in the Calculator displays the path of this directory.

  Note: The in-context results directory is displayed in green.

Important

It is recommended that you set the database context to the directory you want to use to build expressions because expressions created using any other result directory may result in an error when evaluated.

If you do not specify a database context directory, the results directory from which you select the first signal becomes the context results directory, and the directory path is displayed in the *In Context Results DB* field on the Result toolbar.

You can open multiple results directories in the Results Browser, but the *In Context Results DB* field displays the path of the database context directory. For example, if the database context directory is set to the `psf` results directory, this field displays the following value:

```
/home/ashuv/psf
```

Now, if you select a signal from the `psf` results directory, the corresponding expression in the Buffer does not include the results directory name.

```
v(I7.net7” ?result “tran-tran)
```

However, if you select a signal from a results directory that is not the database context directory, the corresponding expression in the Buffer includes the results directory name.

```
v(\\7.net7” ?result “tran-tran” ?resultsDir “./viva_psf)
```

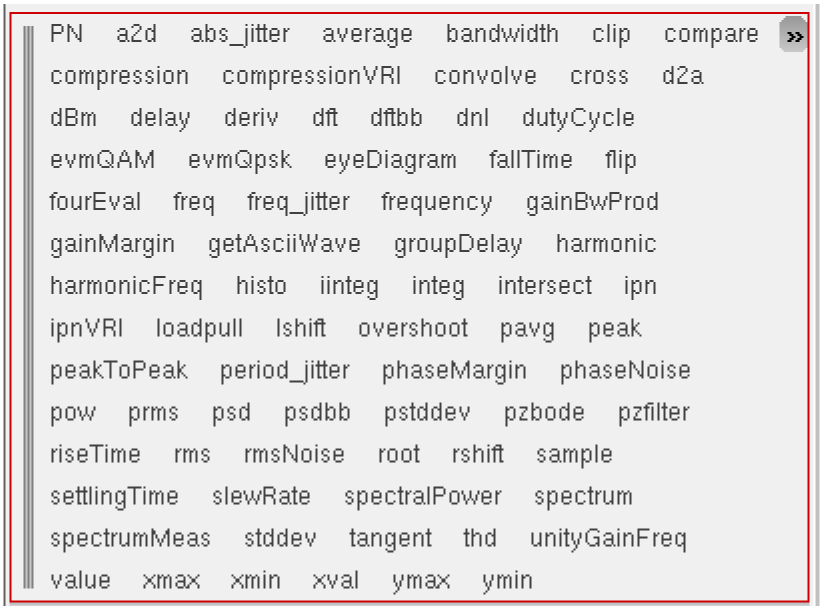
Here, `?resultsDir “./viva_psf”` is the name of the results directory from which the signal is selected.

Note: If the Calculator is opened from ADE, the *In Context Results DB* value is determined by the results directory currently selected in ADE.

Important

Starting IC6.1.5ISR3, when you create expressions, the expressions include alias name for the analysis to display the results directory name. For example, the expression `v(I7.net7” ?result “tran-tran)` is now displayed as `v(I7.net7” ?result “tran).`

Special Functions Toolbar

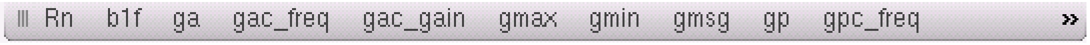

PN a2d abs_jitter average bandwidth clip compare »
compression compressionVRI convolve cross d2a
dBm delay deriv dft dftbb dnl dutyCycle
evmQAM evmQpsk eyeDiagram fallTime flip
fourEval freq freq_jitter frequency gainBwProd
gainMargin getAsciiWave groupDelay harmonic
harmonicFreq histo iinteg integ intersect ipn
ipnVRI loadpull lshift overshoot pavg peak
peakToPeak period_jitter phaseMargin phaseNoise
pow prms psd psdbb pstddev pzbode pzfilter
riseTime rms rmsNoise root rshift sample
settlingTime slewRate spectralPower spectrum
spectrumMeas stddev tangent thd unityGainFreq
value xmax xmin xval ymax ymin

The Special Functions toolbar displays all special functions, such as `a2d`, `average` and `bandwidth`. By default, this toolbar is hidden and when you select to show the toolbar, it is displayed next to the Result toolbar. To view the complete list of functions, click the arrow button on the toolbar.

The Function Panel displays the special functions by default.

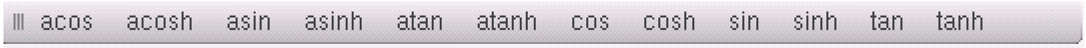
RF Functions Toolbar

This toolbar displays the set of RF functions, such as Rn, that can be used while building expressions in the Buffer. This toolbar is hidden by default.



Trig Toolbar

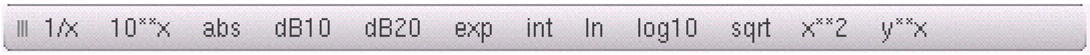
This toolbar displays the set of trigonometric functions, such as acos, that can be used while building expressions in the Buffer.



The Trig toolbar is hidden by default. You can set the `trigToolBar` `.cdsenv` variable to hide or show the toolbar.

Math Toolbar

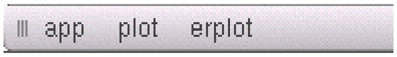
This toolbar displays the set of mathematical functions, such as log, that can be used while building expressions in the Buffer.



The Math toolbar is hidden by default. You can set the `mathToolBar` `.cdsenv` variable to hide or show the toolbar.

Custom Toolbar

This toolbar displays the modes in which the results generated by evaluating expressions can be plotted. With the Custom toolbar, you can also work on the expressions that are saved in Stack or Expression Editor. This toolbar is hidden by default.



app

When you click this button, the Buffer contents are appended to the expression table in the Expression Editor. The Buffer is populated with the latest entry in the Stack. To plot or calculate an expression listed in the expression table, select the expression and click the *Eval* button.

plot

When you click this button, the expression in the Buffer is plotted in the append mode in the selected graph window.

The *plot* command is also available in the *Tools* menu.

Note: This command overrides the option selected in the *plot destination* list box in the signal selection toolbar.

erplot

When you click this button, the Buffer contents are plotted in the selected graph in the replace mode.

Note: This button overrides the *plot destination* selected on the Selection toolbar.

Favorites Toolbar

The Favorites toolbar displays the functions that are set as favorite functions in the Function Panel. By default, this toolbar is displayed next to the Custom toolbar and does not contain any function. You can add frequently used functions to this toolbar for quick access.

To add a function to the Favorites toolbar:

➤ Right-click the function in the Function Panel and choose *Add to Favorites*.

To delete a function from the Favorites toolbar:

➤ Right-click the function in the Function Panel and choose *Delete From Favorites*.

When you add a function as a favorite, it is simultaneously added to the Favorites toolbar and to the *Favorites category* in the Function Panel.

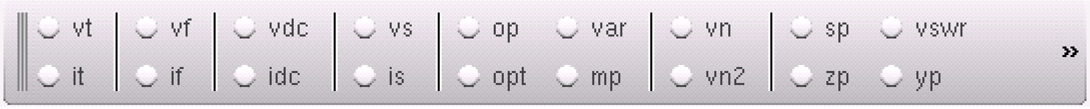
Test Toolbar

The Test toolbar is available only when the Calculator is opened from ADE L or ADE XL. For more information, see Test Toolbar on page 286.

Schematic Selection Toolbar

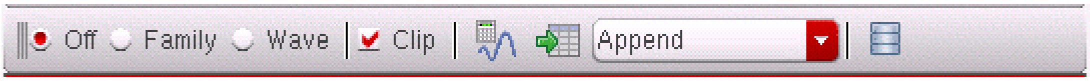
Note: The Schematic Selection toolbar is available only when the Calculator is opened from ADE L or ADE XL.

This toolbar displays a set of function buttons, such as *vt* (voltage transient), that you can apply to schematic objects to build expressions. For more information about the Schematic Selection toolbar, see Schematic Selection Toolbar on page 284.



Selection Toolbar

You can use the Selection toolbar to select a signal from the Results Browser or the graph window. The selected signal is displayed in the Buffer. You then use the tools available on the Selection toolbar to evaluate the selected signal and to define the simulation output format.



The Selection toolbar includes the following options:

Off

If selected, the Calculator does not import the following to the Buffer:

- Signals selected in the Results Browser
- Nets selected in the schematic design
- Traces selected in the waveform graph window

Family

If selected, it prompts you to select a signal from a parametric dataset in the Results Browser or a trace from a set of parametric leaf waveforms. This option is used to build expressions for the entire signal family.

Wave

If selected, it prompts you to select a signal in the Results Browser or a trace in the graph window. This option is used to build expressions for the selected trace.

Clip

If selected, the Calculator works on the visible x-axis range of the trace. When you plot the trace after selecting *Clip*, the graph window displays only the clipped part of the trace. If you want the Calculator to work on the complete trace, clear the *clip* check box before importing the signal to the Buffer.

The *Clip* check box is selected by default. However, you can use the `clipSelectionMode .cdsenv` variable to change the default behavior of the check box.

Note: All these options are selected by default. However, you can set the `signalSelection .cdsenv` variable to disable the options.

Evaluate & Plot Expression

This button is used to evaluate the expression displayed in the Buffer. If the result is scalar, it is displayed in the Buffer. If the result is a waveform, it is plotted in the graph window.

Send to Table

This button is used to display the results of the evaluated expressions in a table.

Plot Destination

You can use this drop-down list box to specify the window used to plot the result. The list has the following destination options:

- *Append* – Adds the result to the selected graph window
- *Replace* – Replaces the graph in the selected graph window (or subwindow) with the result
- *New Subwindow* – Plots the result in a new subwindow in the selected graph window

- *New Window* – Plots the result in a new graph window

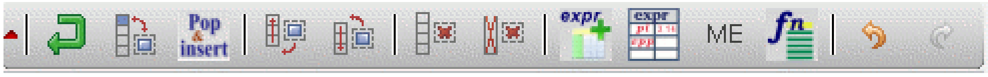
Open Browser

You can use this button to reopen the Results Browser.

Buffer and Stack Toolbar

This toolbar contains the buttons that help to perform operations on the Buffer and Stack contents. By default this toolbar is displayed below the Buffer and next to the keypad.

The table below describes all the toolbar buttons.



Button	Description
▾	Displays the Stack assistant
↵	Pushes the Buffer contents into the Stack
⇄	Swaps the Buffer contents and the first Stack item
Pop & insert	Pops the selected Stack item and appends it to the Buffer contents
↻	Moves the Buffer contents to the bottom of the Stack and moves the first Stack item to the Buffer
↺	Moves the Buffer contents to the top of the Stack and moves the last Stack item to the Buffer
☒	Clears the Buffer
☒	Clears the Buffer and the Stack
expr +	Adds the expression displayed in the Buffer to the Expression Editor
expr pi eps	Opens the Expression Editor
ME	Opens the Memory Editor in the Function Panel
fn	Displays the Function Panel

Button	Description
↶	Undo the last command. The maximum number of commands that can be undone is 8, which is set by the `undoStackSize .cdsenv` variable.
↷	Redo the last undo command.

Buffer

The Buffer provides an area where you can create or edit expressions that are used to analyze the output data or signals generated after a simulation is run. Buffer is a fixed assistant and is displayed next to the Keypad. When you select a signal from the Results Browser, the signal appears in the Buffer. You can now use this signal to build an expression.

While creating or editing expressions in the Buffer, you can use the Keypad, Stack, Function Panel, and Expression Editor assistants or use the keyboard.

After you have created or evaluated the expressions, you can save the expressions by moving them from the Buffer to the Stack, Expression Editor, or Memory Editor.

- To push the Buffer contents to the Stack, press *Enter* or select ⏎ on the Buffer and Stack toolbar.
- To move the Buffer contents to the Expression Editor, click the expr+ button on the Buffer and Stack toolbar.
- To move the Buffer contents to the Memory Editor, see Appendix G, "Memory Editor."

After you move the Buffer contents to the Stack, Expression Editor, or Memory Editor, the Buffer still displays those contents. When you provide a new input to the Buffer to build another expression, the Buffer displays the new entry.

To delete a single character in the Buffer, press the *Backspace* or *Delete* key.

If you want to edit an expression saved in the Stack, move the expressions to the Buffer. Expressions saved in the Expression Editor are edited in the expression table and expressions saved in the Memory Editor are edited in the memory table.

The Buffer supports the following features:

- Function Names Auto-Completion on page 248
- Multiline Expressions on page 248

- Color Coding on page 248
- Dependent Expressions on page 249
- Incomplete Parentheses, Quotation Marks, and Expressions on page 250

Function Names Auto-Completion

The Buffer supports auto-completion of function names. When you type the first three letters of a function name in the Buffer, all function names starting with these letters are displayed. You select the required function to complete the function name.

To display a list of functions starting with a particular letter, type the letter in the Buffer and press *Ctrl+E* from the keyboard.

Multiline Expressions

Long expressions that cannot fit in one line in the Buffer can be created as multiline expressions. To create multiline expressions, place the insertion point before the character where you want to start a new line and press *Alt+Enter* from the keyboard.

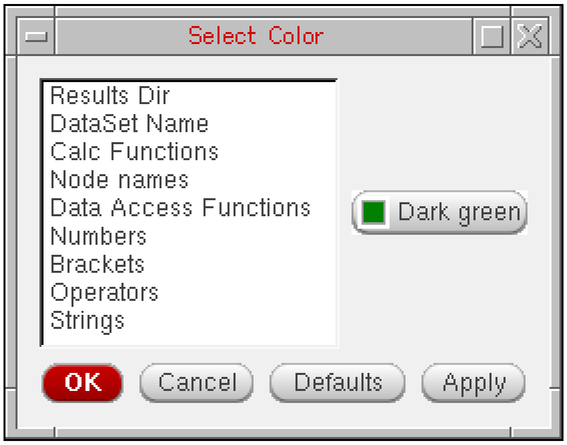
Multiline expressions are moved to the Stack or Expression Editor as a single expression. They are saved and maintained in multiple lines but are treated as a single expression when run.

Color Coding

To differentiate between the various parts of an expression in the Buffer, you can specify different display colors for different parts of the expression, such as results directory, dataset names, functions, node names, data access functions, numbers, brackets, operators, and strings.

1. To set the Buffer color coding, click *Options – Edit Buffer Color*.

The *Select Color* form appears.



2. Select the category for which you want to set the color.
3. Click the color button on the right to display the available color set.
4. Click the ellipses (...) button to expand the color set.
5. Select the required color.
6. Click *Apply.*

If you do not specify the color settings, the expression is displayed in the default color set.

Dependent Expressions

Dependent expressions are the expressions that contain more than one expression. For example, E2=4+E1, where E1=2+3. In this case E2 is a dependent expression because to evaluate the value of E2, you first need to calculate expression E1.

You can create dependent expressions using the Buffer and can store them in the expression table in the Expression Editor.

Note: To avoid errors, ensure that all expressions required to calculate a dependent expression exist in the expression.

For more information about how to work with dependent expressions, see Building Dependent Expressions on page 270.

Incomplete Parentheses, Quotation Marks, and Expressions

When you build an expression in the Buffer, the Calculator checks for missing parentheses, incomplete quotation marks, and incomplete expressions. For example, when you type the opening (left) parenthesis, it is highlighted in red to indicate that it needs to be closed. After you type the closing (right) parenthesis, the parenthesis pair is highlighted in green or in a color that you have configured for parentheses. If you do not correctly close a pair of parenthesis, the Buffer considers the expression as incomplete.

Similarly, expressions that do not contain the closing quotation mark are also considered incomplete, and the entire string after the opening quotation mark, including the quotation mark, is displayed in red. In addition, expressions ending with an operator are also considered incomplete.

You cannot push incomplete expressions to the Stack or Expression Editor. If you press *Enter* to move the incomplete expression in the Buffer to the Stack, the insertion point is placed in the next line in the Buffer assuming that you are building a multiline expression.

To check if all parenthesis pairs in an expression are complete, place the insertion point after each opening parenthesis and observe the color of the highlight—if the pair is complete, it is highlighted in green.

Note: While an expression is being built in the Buffer, the Buffer background color is set to light grey. This indicates that the expression in the Buffer is not yet complete and cannot be moved to the Stack. After the expression is complete, the background color changes to the default color.

Video

The Using Calculator Buffer - New Features video demonstrates the new features of the Calculator Buffer.

Assistants

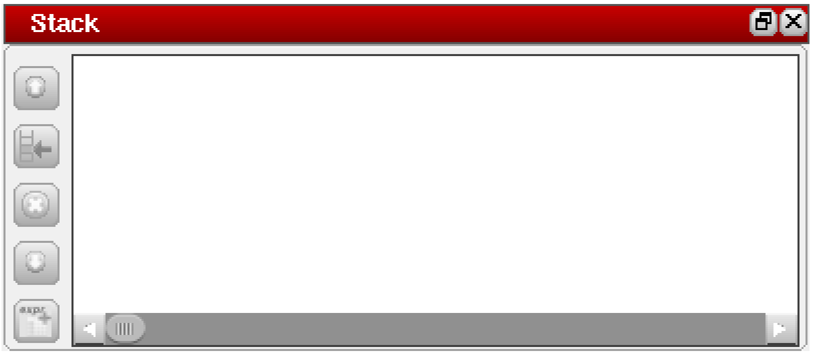
Calculator contains the following assistants, which help in building and evaluating expressions:

- Stack on page 251
- Function Panel on page 252
- Expression Editor on page 256
- Memory Editor on page 258
- Keypad on page 259

- Status Bar on page 260

Stack

Stack is an area where you can store the expressions created in the Buffer.



The table below describes the buttons available to the left of the Stack window.

Button	Description
⬆	Moves the selected item(s) up in the Stack.
⇐	Moves the selected item to the Buffer. Alternatively, you can double-click the selected Stack item to move it to the Buffer.
⊗	Deletes the selected item(s) from the Stack. Alternatively, you can also use the *Delete* key to delete the Stack items.
⬇	Moves the selected item(s) down in the Stack.

Pushing Expressions onto the Stack

After you make an entry into the Buffer, you can move the contents to the Stack. To push the current expression onto the Stack click the Enter key or the ↵ button.

Displaying the Stack

Click ▾| on the Buffer and Stack toolbar to show or hide the Stack.

Clearing Stack and Buffer

There are several ways to clear the Buffer and Stack:

- To remove an item from the Stack without deleting the item from the Buffer, press the *Delete* Key.
- To clear the Buffer without deleting the item from the Stack, click the button.
- To delete an item from both the Buffer and the Stack, click the button.

For more information about the buttons that help you perform Stack and Buffer operations, see the Buffer and Stack Toolbar on page 246.

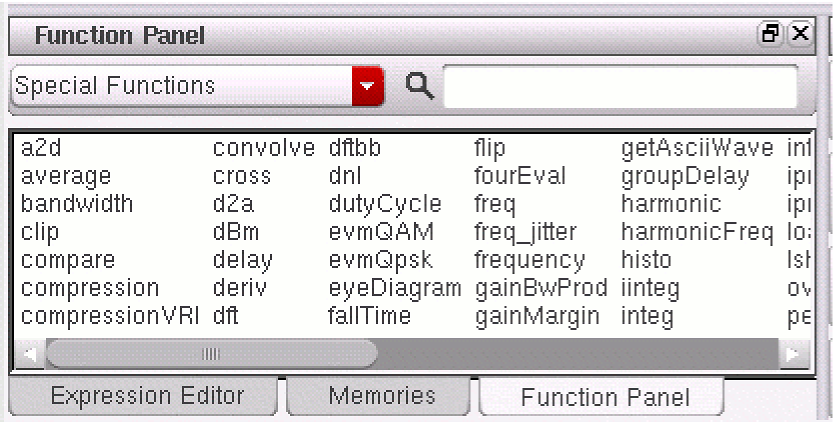
The `showStack .cdsenv` variable determines whether the Stack is displayed by default.

The default number of items stored in the Stack is 8. However, you can set the `StackSize .cdsenv` variable to define the Stack size.

Note: To differentiate between items in the Stack, alternate Stack rows are coded in different colors.

Function Panel

This assistant displays a list of functions. The functions displayed are determined by the function category selected in the Function Panel drop-down list box.



Function Categories in the SKILL Mode

The following table lists the function categories available in the SKILL mode.

Category	**Functions Available**
All	Displays all the available functions
Favorites	Displays the functions that you specify as favorites. To add a function to the *Favorites* list, right-click the required function in the Function Panel and choose *Add to Favorites.*
Math	1/x, 10**x, abs, dB10, dB20, exp, int, ln, log10, sqrt, x**2, and y**x
Modifier	db10, db20, imag, mag, phase, real, phaseDeg, phaseDegUnwrapped, phaseRad, phaseRadUnwrapped, and conjugate
RF Functions	Rn, b1f, ga, gac_freq, gac_gain, gmax, gmin, gmsg, gp, gpc_freq, gpc_gain, gt, gumx, kf, lsb, nc_freq, nc_gain, nf, nfmin, rn, s11, s12, s21, s22, and ssb
Special Functions	average, bandwitdth, clip, compare, compression, compressionVRI, convolve, cross, dBm, delay, deriv, dft, dftbb, dnl, dutyCyle, evmQAM, evmQpsk, eyeDiagram, falltime, flip, fourEval, freq, freq_jitter, frequency, gainBwProd, gainMargin, getAsciiWave, groupDelay, harmonic, harmonicFreq, histo, iinteg, integ, intersect, ipn, ipnVRI, lshift, overshoot, peak, peakToPeak, period_jitter, phaseMargin, phaseNoise,pow, psd, psdbb, pzbode, pzfilter, riseTime, rms, rmsNoise, root, rshift, sample, settlingTime, slewRate, spectralPower, spectrum, stddev, tangent, thd, unityGainFreq, value, xmax, xmin, xval, ymax, and ymin
Trigonometric	acos, acosh, asin, asinh, atan, atanh, cos, cosh, sin, sinh, tan, and tanh
AWD Programmed Keys	f1, f2, f3, f4, rf1, rf2, rf3, rf4, rf5, rf6, rf7, and rf8
SKILL User Defined Functions	Includes the functions you define. For more information, see Appendix E, "Defining New SKILL Functions,".
Memories	Displays the Memory Editor where you can save and build expressions. For more information, see Appendix G, "Memory Editor,".
Expressions	Displays the Expression Editor where you can save and build expressions. For more information, seeExpression Editor on page 256.

For more information about the listed above, see Appendix B, “Calculator Functions.”

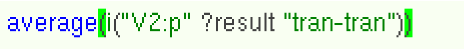
The category displayed by default in the Function Panel is *Special Functions.* You can change the default category by using the `defaultCategory .cdsenv` variable.

Using Functions in the Function Panel

The Function Panel has two types of functions:

1. Single parameter Function
2. Multi-parameter Function

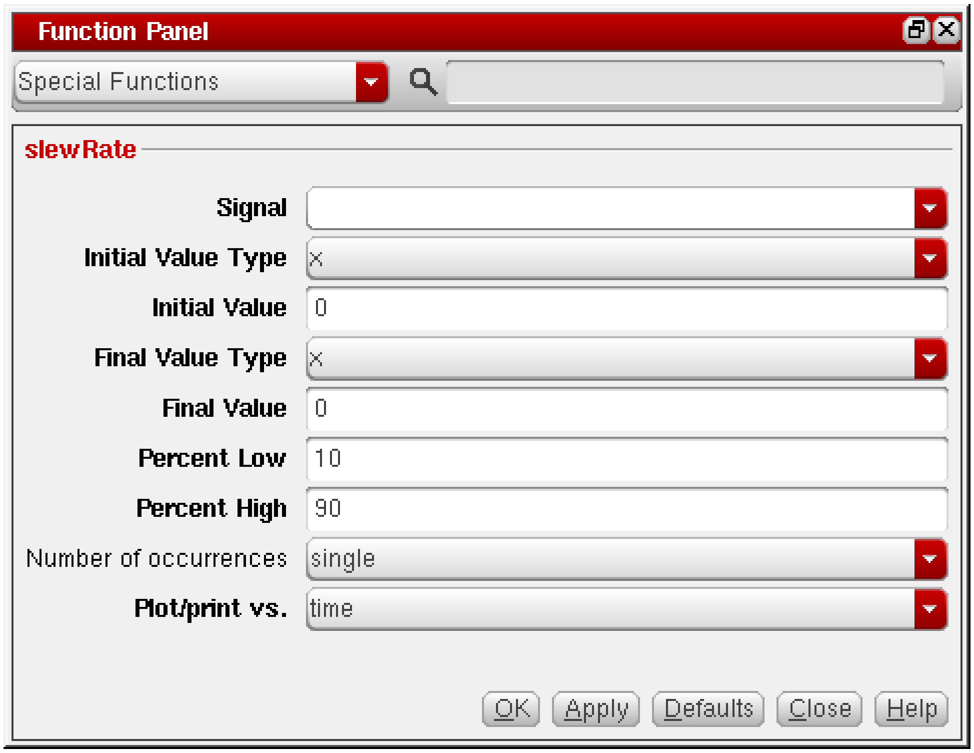
If you select a single-parameter function, it can be applied directly to the Buffer contents. For example, *average* is a single parameter function. When you select this function, it is displayed in the Buffer and the Buffer contents become the function arguments.



```
average(i("V2:p" ?result "tran-tran"))
```

If you select a multi-parameter function, the parameter panel for the function appears.

For example, if you select the multi-parameter function, `slewRate`, the various parameters that the function requires appear in the parameter panel, grouped under the function name as shown in the figure below. You can now specify the various parameter values. By default, the parameters contain the values that are set as defaults for that function.



Function Panel

Special Functions

slewRate

Signal:

Initial Value Type: x

Initial Value: 0

Final Value Type: x

Final Value: 0

Percent Low: 10

Percent High: 90

Number of occurrences: single

Plot/print vs.: time

The *Signal* drop-down list maintains a record of all previously selected signals in the current session. It also includes *Buffer* as one of the options. If you select *Buffer*, the Buffer contents are displayed as the *Signal* parameter value.

The default number of signals stored in the drop-down list is *8*. However, you can set the `signalHistorySize .cdsenv` variable to change the number of signals stored.

After you specify the parameter values for the selected function, you can do one of the following:

Action	**Description**
Click *OK*	Creates the expression, adds the expression to the Buffer, and again displays the list of functions in the Function Panel
Click *Apply*	Creates the expression, adds the expression to the Buffer, and keeps the parameter list for the same function open
Click *Defaults*	Discards the changes that you have made and resets the parameters to the default values

Action	Description
Click Close	Closes the parameter panel and displays the list of functions in the Function Panel
Click *Help*	Displays more information about the selected function

Searching for a Function

You can use the *Search* field in the Function Panel to search for any function.

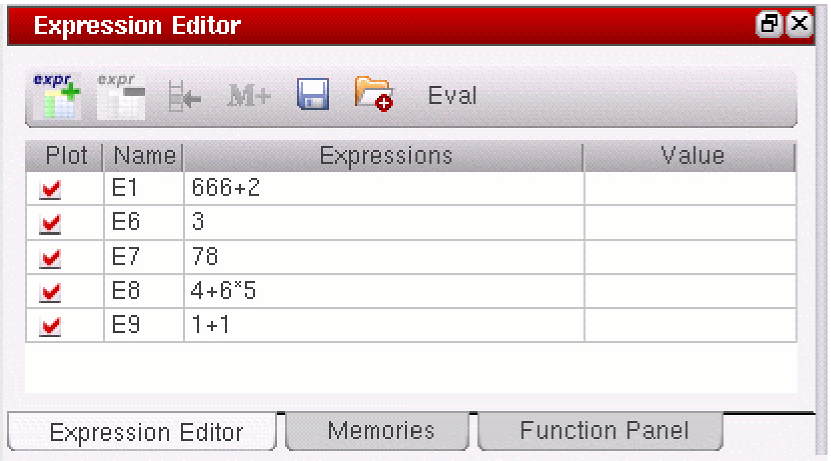
The function search supports category-based search. For example, if you select *Math* in the function category drop-down list and search for a specific function, the search is run only on the *Math* category. To search for a function all the categories, select *All*.

The function search also supports regular-expressions-based search, for example, you can specify *a* to search for the function names that contain the letter *a* or *A* and specify *^a* to search for function names that begin with the letter *a.*

To view the online help for a function, right-click the required function in the Function Panel and choose *Help.*

Expression Editor

You can move expressions from the Buffer or Stack assistants to the Expression Editor and can store them for future use. The Expression Editor stores expressions in an expression table.



Plot	Name	Expressions	Value
✓	E1	666+2	
✓	E6	3	
✓	E7	78	
✓	E8	4+6*5	
✓	E9	1+1	

To open Expression Editor, do one of the following:

➡ Click the EE button on the Buffer and Stack toolbar.

➡ Select *Expressions* from the list of functions categories in the Function Panel.

For information about the buttons in the Expression Editor, see the table below:

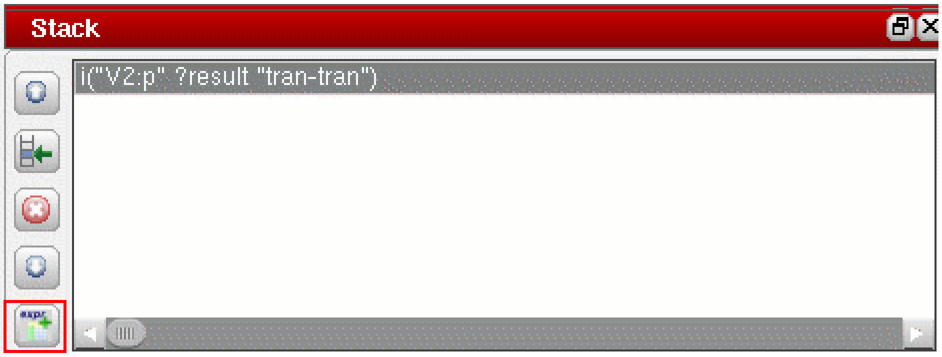
Button	**Description**
expr +	Adds the expression created in the Buffer to the Expression Editor
expr −	Deletes the selected expressions from the expression table
←	Copies the expression selected in the expression table to the Buffer
M+	Adds the expressions selected in the Expression Editor to the Memory Editor
💾	Saves the expressions selected in the Expression Editor to a file
📂	Restores expressions from a file
`Eval`	Evaluates the expression selected in the expression table. **Note:** To cancel the evaluation, press *Ctrl+C*

Adding Expressions to the Expression Editor

To add an expression to the Expression Editor, do one of the following:

- From the Buffer. click the button on the Buffer and Stack toolbar.

- From the Stack, select the required expression and click the *E+* button on the left to move the selected expression to the Expression Editor.



i("V2:p" ?result "tran-tran")

Note: You can also drag expressions from the Stack to the Expression Editor.

When you add an expression to the expression table, the Expression Editor associates a name (signal alias) with the expression—the default expression names are E1, E2, and E3, and so on. If required, you can modify the default expression names. Expression names support alphanumeric values and the first letter of an expression name must be an alphabet.

Editing Expressions in the Expression Editor

To edit an expression in the Expression Editor, double-click the row you want to edit.

Deleting Expressions from the Expression Editor

To delete an expression from the Expression Editor, select the expression you want to delete by selecting the check box associated with the expression and click the E- button or press the *Delete* key.

For more information about how to work with expressions in the Expression Editor, see Working with Expressions on page 261.

Memory Editor

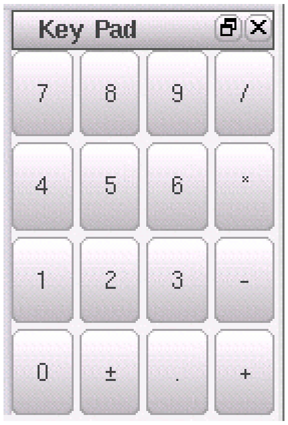
Important

Starting IC6.1.5 release, the Expression Editor is an improved version of the Memory Editor. Although the Memory Editor continues to be the part of the Calculator GUI, it is recommended that you use the Expression Editor to store and work with expressions.

Memory Editor can be used to store and edit expressions in a memory table. For more information about the Memory Editor, see Appendix G, “Memory Editor,”

Keypad

The Keypad contains buttons for numbers and simple arithmetic functions. If you define any function buttons, they too are displayed on the Keypad.



To define a function button and associate a function with it, type the following command in the CIW:

```
userButton=envSetVal(“wavescan.calculator” “userButtonX” ‘string
“button_name;function_name)
```

Here,

userButtonX defines button number that you want to map to a function. You can define a maximum of 12 function buttons. Therefore, the value of X can be a number from 1 through 12

button_name is the name of the function button that you want to display on the Keypad.

function_name is the name of the function that you want to associate with the button.

For example, if you want to display the *average* function on the Keypad with the button name *MyAvg*, in the CIW type:

```
userButton=envSetVal(“wavescan.calculator” “userButton1” ‘string
“MyAvg;average)
```

The defined function button is displayed on the Keypad.

The Keypad is displayed by default. You can change the default behavior by using the `showKeypad .cdsenv` variable.

Status Bar

The status bar displays the status of the action performed in the Calculator window. It also displays warning and error messages. An example is shown in the figure below.

```
> Parameter signal2 has no argument.
```

Setting Calculator GUI Using .cdsenv Variables

The variables in the `.cdsenv` file determine the default behavior of the Calculator. Thereafter, the local defaults override the `.cdsenv` variables if `usePreviousGuiSettings .cdsenv` is set to true:

Following are the environment variables that you use to define the settings for Calculator assistants:

- `showKeyPad`
- `showStack`
- `rpnMode`
- `clipSelectionMode`
- `signalSelection`
- `plotStyle`
- `defaultCategory`
- `mathToolBar`
- `TrigToolBar`
- `schematicToolBar`
- `schematicAnalyses`
- `userButton`
- `xLocation`
- `yLocation`

- width
- height

Note: If `usePreviousGuiSettings` is set to false, the `.cshrc` settings override the local defaults.

Working with Expressions

You can build expressions in the Calculator in the RPN and algebraic modes. After the expressions are created, you can edit, save, load, or delete them using the Expression Editor, Stack, and Buffer.

This section contains the following topics which explain how you can work with expressions:

- Selecting Signals and Waveforms to Build Expressions on page 261
- Building Expressions in the Buffer on page 264
- Building Dependent Expressions on page 270
- Saving Expressions on page 273
- Dragging Expressions across Buffer and Assistants on page 274
- Loading Expressions from an Expression File on page 275
- Evaluating and Plotting Expressions on page 276
- Working with the Calculator in ADE on page 277

Selecting Signals and Waveforms to Build Expressions

To build and evaluate an expression, you need to select a signal in the Results Browser or in the graph window. This section describes the following two ways that you can use to select signals:

- Selecting Signals from the Results Browser on page 261
- Selecting Traces from the Graph Window on page 263

Selecting Signals from the Results Browser

1. Ensure that the *Family*, which is a set of parametric leaf waveforms, or *Wave* option on the Selection toolbar is selected.

2. Choose *Tools – Browser*.

   The Results Browser window appears.

3. In the left panel of the Results Browser, double-click the required results directory.

   The associated datasets appear in the list view to the right.

   Note: You can double-click the directory to expand (display the subdirectories) or collapse (hide the subdirectories) it.

4. Double-click the required dataset.

   The associated signals are displayed.

5. Right-click the required signal and choose *Calculator*.

   The signal is displayed in the Buffer along with the dataset name. For example:

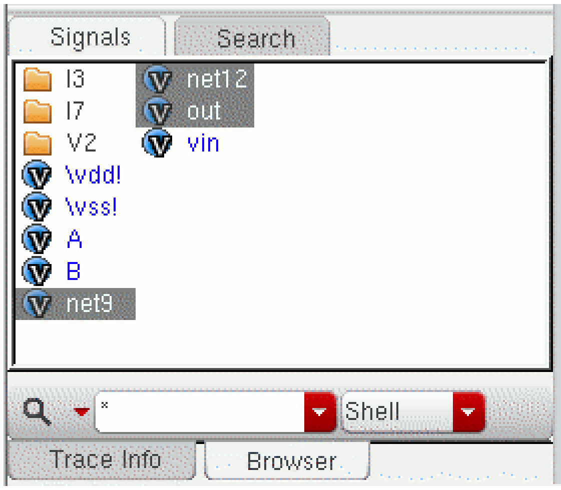
   ```
   v("vin" ?result "tran-tran")
   ```

   Here, `vin` is the name of the signal.

   `?result "tran-tran` is the dataset from which the signal is selected. This `tran-tran` dataset contains the signals generated during the transient analysis of a simulation.

When you send a signal from the Results Browser to the Calculator, the selected signal is displayed in the Buffer. Now, when you send another signal from the Results Browser to the Calculator, the previous signal is pushed onto the stack and the new signal is displayed in the Buffer.

When you select multiple signals in the Result Browser and send them to the Calculator window, the recently selected signal is displayed in the Buffer and all other signals are pushed to the Stack.



For example, if you select three signals in the order—`net9, net12`, and `out`— in the Results Browser (as shown in the figure), the signal `out` is displayed in the buffer and the signals `net9` and `net12` are pushed to the stack.

Selecting Traces from the Graph Window

Perform the following steps to select a trace:

1. Ensure that the *Wave* option on the Selection toolbar is selected.
2. In the graph window, select the trace for the signal you want to add to the Calculator. By default, the Calculator works on the visible X-axis range of a zoomed-in trace. If you want the Calculator to work on the complete trace, deselect the *clip* check box before importing the signal to the Buffer.

   An expression for the selected trace appears in the Buffer.

   ❑ If the selected trace is a leaf parametric waveform, an expression for the leaf is added to the Buffer.

   ❑ In the ADE, if the selected trace is the result of an evaluated expression, the SKILL function name for that trace is displayed in the Buffer.

To select a family of traces:

1. Ensure that the *Family* option on the Selection toolbar is selected.

2. In the graph window, select a parametric trace.

   An expression for the parametric family appears in the Buffer.

Building Expressions in the Buffer

You can build expression in the Calculator in the following two modes:

- RPN Mode
- Algebraic Mode

To set the Calculator to work in RPN or Algebraic mode, choose *Options – Mode – RPN Mode/Algebraic Mode*.

This section describes how to build expressions in the RPN and Algebraic modes, how to use functions from the Function Panel while building expressions, and how to add constants or design variables to the expressions.

- Building Expressions in the RPN Mode on page 264
- Building Expressions in the Algebraic Mode on page 265
- Examples of Building Expressions on page 266
- Adding Constants to Expressions on page 270
- Adding Design Variables to the Buffer on page 270

Building Expressions in the RPN Mode

RPN is the default Calculator mode, which can also be set by using the `rpnMode` `.cdsenv` variable.

In the RPN mode, you write expressions without using parenthesis to define priorities for evaluating operators.

To understand this better, consider the following expression:

```
(3 + 5) * (7 - 2)
```

In this expression, the parentheses tell you to first add 3 to 5, then subtract 2 from 7, and finally multiply the two results. In the RPN mode, you list the numbers and operators one after the other to form a stack, instead of using parentheses. For example, the above expression is written as follows in the RPN mode:

```
3 5 + 7 2 - *
```

To build this expression, you perform the following Buffer and Stack operations:

1. Add 3 to the Buffer and press *Enter* to push it to the Stack.
2. Add 5 to the Buffer.
3. Apply the + operation. This pops the topmost item, 3, from the Stack and moves it to the Buffer. The Buffer now has the following expression: 3+5. Now when you press any key from the keypad, this expression is pushed to the Stack.
4. Add 7 to the Buffer and push it to the Stack. The Stack contains: 7, 3+5
5. Add 2 to the Buffer.
6. Apply the - operation. This pops the topmost item, 7, from the Stack and moves it to the Buffer. The Buffer now contains the expression: 7-2.
7. Apply the * operation. This pops the topmost item, 3+5, from the Stack and moves it to the Buffer and the following expression is created in the Buffer: (3+5)*(7-2).

Important

> In the RPN mode, if the Buffer contains a complete expression and you click a number button on the Keypad, the expression is pushed to the Stack. However, if you press any key from the keyboard, the character associated with the key is appended to the expression in the Buffer.

Note: It is must to add parenthesis to the expression that you want to fetch from the Buffer.

Building Expressions in the Algebraic Mode

To change the Calculator mode to algebraic, choose *Options – Algebraic Mode*.

In the Algebraic mode you build expressions from left to right. When you click an operator or a function, the operator or function is added to the Buffer to the right of the cursor.

To build an expression in the Algebraic mode:

1. Ensure that the *Wave* button on the Selection toolbar is selected.
2. Select a signal. For more information, see Selecting Signals and Waveforms to Build Expressions on page 261
3. Click the function you want to use.

   ❑ If you select a single-parameter function, it appears in the Buffer.

❑ If you select a multi-parameter function, the parameter panel for the function appears. Enter the required information and click *OK*.

The expression is displayed in the Buffer. For more information, see Using Functions in the Function Panel on page 254.

4. On the Selection toolbar, click the button to evaluate the expression.

   If the expression evaluates to a scalar, the result appears in the Buffer. If the expression evaluates to a signal, the graph window appears with a trace for the evaluated expression.

Examples of Building Expressions

This section describes how you can build expressions in the RPN and Algebraic mode.

Example of Building Expressions in the RPN Mode

Suppose you want to build an expression in the RPN mode that multiplies two signals:

1. Select the first signal, `signal1`, from the Results Browser. The signal is displayed in the Buffer.
2. Select another signal, `signal2`, from the Results Browser. This pushes `signal1` to the Stack and the Buffer displays `signal2`.
3. Click `*` on the Keypad to multiply `signal1` and `signal2`. This pops `signal1` from the Stack and the following expression is created in the Buffer:

   ```
   signal1*signal2
   ```

4. Click on the Selection toolbar to evaluate the expression. If the result is a scalar, it is displayed in the Buffer. If the result is a waveform, it is plotted in the graph window.

Example of Building Expressions in the Algebraic Mode

To build the same expression in the Algebraic mode, you perform the following steps:

1. Select the first signal, `signal1`, from the Results Browser. The signal is displayed in the Buffer.
2. Press *Enter* to move `signal1` to the Stack.
3. Select another signal, `signal2`, from the Results Browser. The signal is displayed in the Buffer.

4. Click `*` on the Keypad to multiply `signal1` and `signal2`. The Buffer now contains the following expression: `Signal2*`

5. Pop `Signal1` from the Stack. This creates the following expression in the Buffer: `signal2*signal1`

6. Click on the Selection toolbar to evaluate the expression. If the result is a scalar, it is displayed in the Buffer. If the result is a waveform, it is plotted in the graph window.

Example of Building Expressions Using Functions in Function Panel

Suppose you want to build an expression for measuring the delay between an input and output signal by using the `delay` function. This example assumes you are working with the SKILL Calculator in the RPN mode:

1. Ensure that the *Wave* option on the selection toolbar is selected.

2. In the Results Browser window, right-click the required input signal and choose *Calculator*. The following signal is displayed in the Buffer.

   ```
   v("vin" ?result "tran-tran")
   ```

3. In the Function panel, select the `delay` function from the *Special Functions* category. The parameter panel for `delay` appears.

   In the parameter panel, `v("vin" ?result "tran-tran")`, which is the last selected signal, appears in the *Signal1* field.

4. In the Results Browser, right-click the `out` signal and choose *Calculator*. The following signal appears in the Buffer:

   ```
       v("out" ?result "tran-tran")
   ```

5. In the Function Panel, do the following:

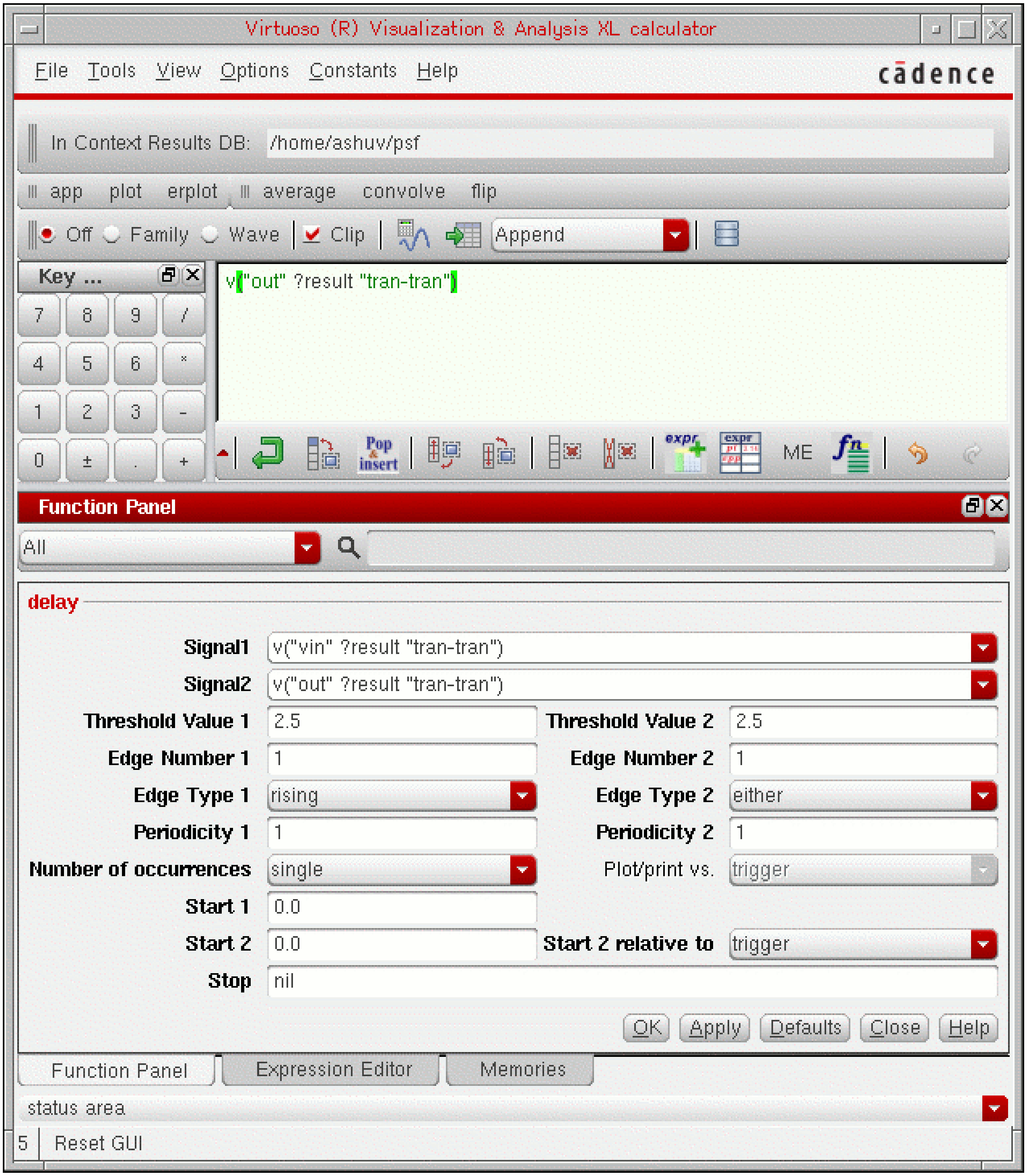
   a. In the *Signal 2* drop-down list, select *Buffer*. The Buffer content, which is the `out` signal that you selected, appears in *Signal2*.

   b. In the *Edge Type1* field, choose *rising*

   c. In the *Edge Type 2* field, choose *rising*.

Ensure that the following values appear in the parameter list:

Field Name	Value	Field Name	Value
Signal1	`vin`	*Edge Type 1*	*rising*
Signal2	`out`	*Threshold Value 2*	`2.5`
Threshold Value 1	`2.5`	*Edge Number 2*	`1`
Edge Number 1	`1`	*Edge Type 2*	*rising*


Virtuoso (R) Visualization & Analysis XL calculator
File Tools View Options Constants Help
cādence
app plot erplot average convolve flip
Off Family Wave Clip Append
Key ...
7 8 9 / 4 5 6 * 1 2 3 - 0 ± . +
Pop & insert
ME
Function Panel
All
OK Apply Defaults Close Help
Function Panel Expression Editor Memories
status area
Reset GUI

In Context Results DB: /home/ashuv/psf

● Off ○ Family ○ Wave ☑ Clip

```
v("out" ?result "tran-tran")
```

delay

Signal1	v("vin" ?result "tran-tran")		
Signal2	v("out" ?result "tran-tran")		
Threshold Value 1	2.5	Threshold Value 2	2.5
Edge Number 1	1	Edge Number 2	1
Edge Type 1	rising	Edge Type 2	either
Periodicity 1	1	Periodicity 2	1
Number of occurrences	single	Plot/print vs.	trigger
Start 1	0.0		
Start 2	0.0	Start 2 relative to	trigger
Stop	nil		

5 Reset GUI

6. Click *Apply*. The following expression appears in the Buffer:

```
delay(v("vin" ?result "tran-tran") 2.5 1 "rising" v("out" ?result
"tran-tran") 2.5 1 "rising" 0 0 nil nil)
```

7. Click on the Selection toolbar to evaluate the expression. If the result is a scalar, it is displayed in the Buffer. If the result is a waveform, it is plotted in the graph window.

Adding Constants to Expressions

To add a constant to an expression in the Buffer:

➤ From the *Constants* menu, select a constant. The constant appears in the Buffer.

For example, if you want to add the *Boltzmann* constant to a signal displayed in the Buffer, select *Bolzmann* from the *Constants* menu. *Boltzmann* appears in the Buffer and the signal is pushed to the top of the Stack. Apply the + operation. This pops the signal from the top of the Stack and builds the following expression in the Buffer:

```
v("\\vss! " ?result "tran-tran")+boltzmann
```

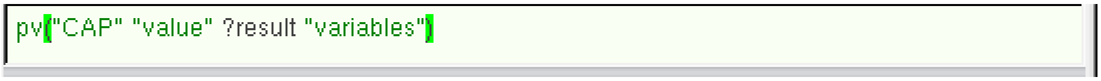
For more information about constants, see Appendix D, “Constants.”

Adding Design Variables to the Buffer

You can use design variables in the expressions when the Calculator is opened in the SKILL mode. When you open a simulation result in the Results Browser, the Results Browser displays a directory named *variables* that contains design variables for the simulation. To select design variables, do the following:

1. Select the *Wave* option on the Selection toolbar.
2. In the Results Browser, select the required design variable from the *variables* directory.

The selected design variable appears in the Buffer as shown in the figure below.



```
pv("CAP" "value" ?result "variables")
```

Building Dependent Expressions

Dependent expressions are the expressions that contain more than one expression.

Suppose you want to compare the clip results of input and output signals that are generated during transient analysis. To create a single expression for this task is a tedious process because the task is complex and requires you to perform multiple operations. Therefore, you can divide the task into subtasks and create separate expressions for each subtask. You can then use the names associated with the expressions for the various subtasks to create the final expression.

1. Select the input and output signals from the Results Browser. The expressions for the signals are displayed in the Buffer. Move the expressions for the signals from the Buffer to the Expression Editor and save them with names *sig1* and *sig2* in the expression table.

   sig1=v("in_p" ?result "tran-tran")

   sig2=v("out" ?result "tran-tran")

2. Next, in the Buffer, create expressions to apply the *clip* function on both the signals, *sig1* and *sig2*. Store the expressions created for the *clip* function in the Expression Editor with names *cl_s1* and *cl_s2*.

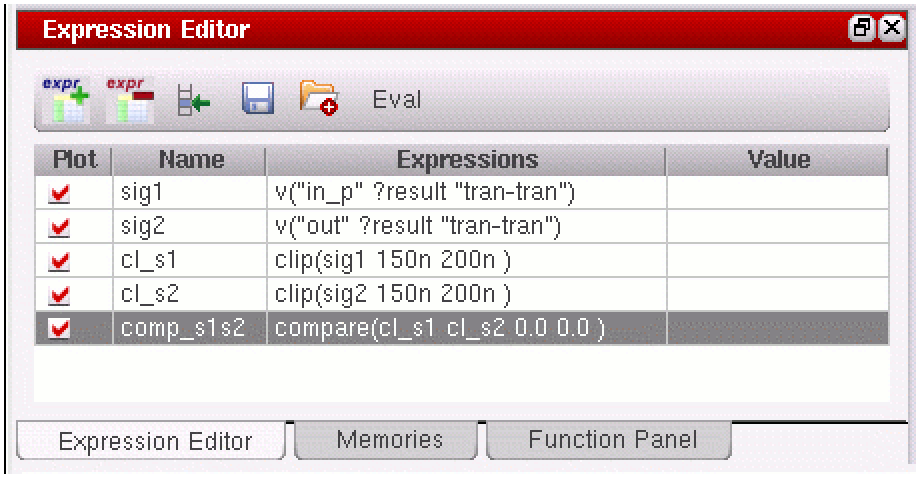
   cl_s1=clip(sig1 150n 200n)

   cl_s2="clip(sig2 150n 200n)

3. Finally, in the Buffer, create an expression to compare the clip results for *sig1* and *sig2* by using the expression names *cl_s1* and *cl_s2*. Move this expression from the Buffer to the Expression Editor and save it with the name *comp_s1s2.*

   comp_s1s2=compare(cl_s1 cl_s2 0.0 0.0)

The expressions created in the expression table for each step are shown in the figure below.



Plot	Name	Expressions	Value
✓	sig1	v("in_p" ?result "tran-tran")	
✓	sig2	v("out" ?result "tran-tran")	
✓	cl_s1	clip(sig1 150n 200n)	
✓	cl_s2	clip(sig2 150n 200n)	
✓	comp_s1s2	compare(cl_s1 cl_s2 0.0 0.0)	

From this example, you can see how dependent expressions simplify the task of creating long and complex expressions.

Note the following when you create dependent expressions:

- Expressions can be created in any order, irrespective of the dependencies. In the above example, it is not necessary to define expression *E1* before expression *E2*.
- An expression can be dependent on multiple expressions. For example, *E2=E1+E3*. Similarly, multiple expressions can be dependent on the same expression. For example, *E2=5*E1* and *E3=2+E1*. Here, both *E2* and *E3* are dependent on E1.
- While creating dependent expressions, ensure that there is no cyclic dependency between the expressions. The following are expressions with cyclic dependency because the expressions are dependent on each other:

  E1=2+E2,

  *E2=5*E1*
- While evaluating or plotting a dependent expression, it is not required to evaluate or plot all expressions on which the dependent expression is based.
- Error messages and warnings, if any, are displayed in the CIW.

By default, the *plot* check box in the expression table is selected for all expressions, indicating that the expressions have already been evaluated and plotted. If the expression is scalar, the result is displayed in the expression table and if the expression is a waveform, the result is plotted in the graph window.

To plot an expression again or to edit an expression, move the expression from the Expression Editor to the Buffer. To do this, deselect the plot check box and click the *Copy Expression to Calculator Buffer* button in the Expression Editor. This moves the expression name (signal alias) to the Buffer. To move the entire expression to the Buffer, drag the expression from the Expression Editor to the Buffer.

To evaluate expressions in the expression table, click the *Eval* button*.* The corresponding result column displays the results generated. If you do not want to evaluate any expression, clear the corresponding *plot* check box.

Important

Ensure that all expressions that are used in calculating a dependent expression exist in the expression table else an error occurs.

Video

The Building Dependent Expressions Using the Expression Editor video demonstrates how to create and use dependent expressions using the Expression Editor.

Saving Expressions

This section describes how you can save expression created in the Buffer to a file and to the Expression Editor and Memory Editor. This section covers the following topics:

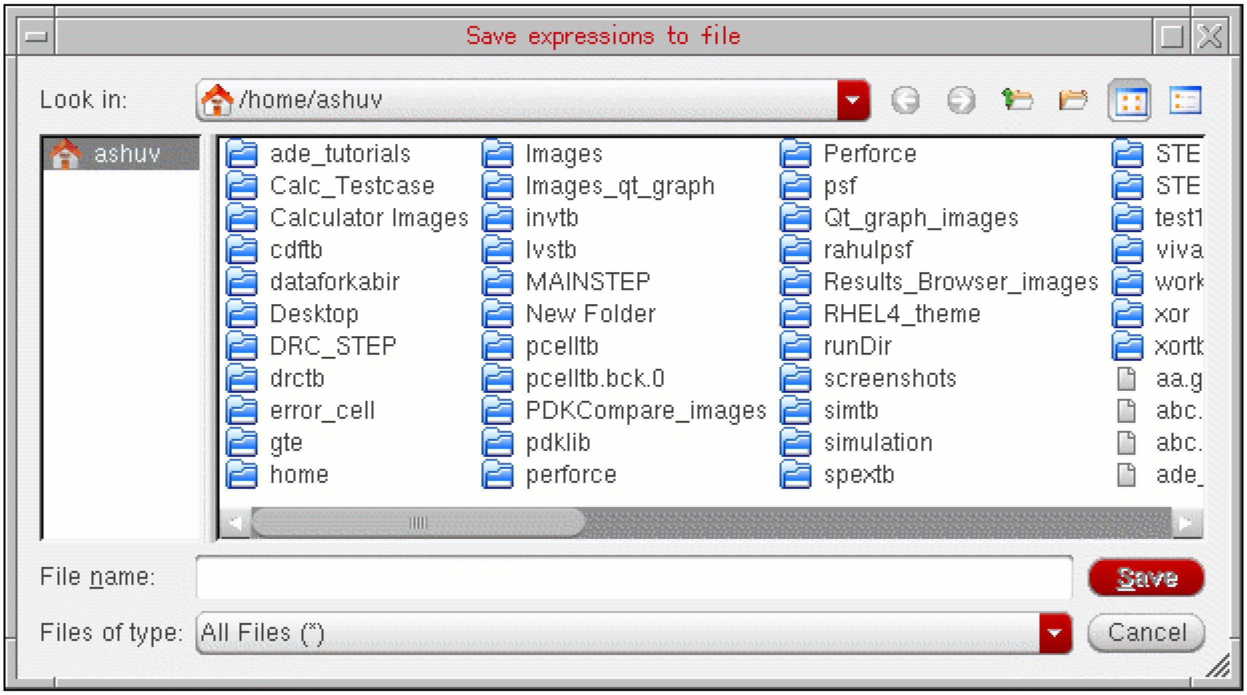
- Saving Expressions to a File on page 273
- Saving Expressions to the Expression Editor on page 274

Saving Expressions to a File

To save an expression in the Expression Editor to a file, perform the following steps:

1. In the Expression Editor, click the button.

   The *Save expressions to file* form appears.



Save expressions to file

Look in: /home/ashuv

File name:

Files of type: All Files (*)

2. In the *Look in* field, select the directory where you want to save the expression file.
3. Do one of the following:
   - ❑ To overwrite an existing expression file, select that file from the list box below the *Look in* field.
   - ❑ To create a new file, in the *File name* field, type a name for the expression file that you want to create.

4. Click *Save*.

   The Virtuoso Visualization and Analysis XL tool saves the expression list to the file.

To automatically save the expressions in the current session to the `defaultVarFileName` file when you close the Calculator or exit the Virtuoso Visualization and Analysis XL tool, set the `writeDefaultVarFileOnExit .cdsenv` variable to `true`.

To save expressions from the Memory Editor to a file, see Appendix G, "Memory Editor,"

Saving Expressions to the Expression Editor

You can save expressions created in the Buffer to the Expression Editor. To add an expression from the Buffer to the Expression Editor, click the button on the Buffer and Stack toolbar. For more information, see Expression Editor on page 256.

Dragging Expressions across Buffer and Assistants

Calculator supports the following drag-and-drop operations:

- You can drag expressions from the Expression Editor and place them into any text area. If you drag expressions outside the Calculator window without specifying any destination text file, you are prompted to provide a file name and its location. You can create a new text file or you can append expressions to an existing text file.
- You can drag expressions from the Expression Editor to the Buffer.
- You can drag expressions from the Stack to the Expression Editor to add these expressions to the expression table in the Expression Editor. However, you cannot drag expressions from the Expression Editor to add them to the Stack. To drag expressions from the Expression Editor to the Stack, you need to first drag the expressions from the Expression Editor to the Buffer. You can then press *Enter* to push the expressions to the Stack.
- If you drag multiple expressions at a time from the Expression Editor to the Buffer, the first expression is added to the Buffer and the remaining expressions are moved to the Stack.
- When you drag expressions from the Expression Editor or Stack to the Buffer, the expressions are appended to the current expression in the Buffer.

You cannot perform drag-and-drop operation on expressions in the Buffer. To move expressions from the Buffer to the Expression Editor or Stack, use Buffer and Stack toolbar buttons.

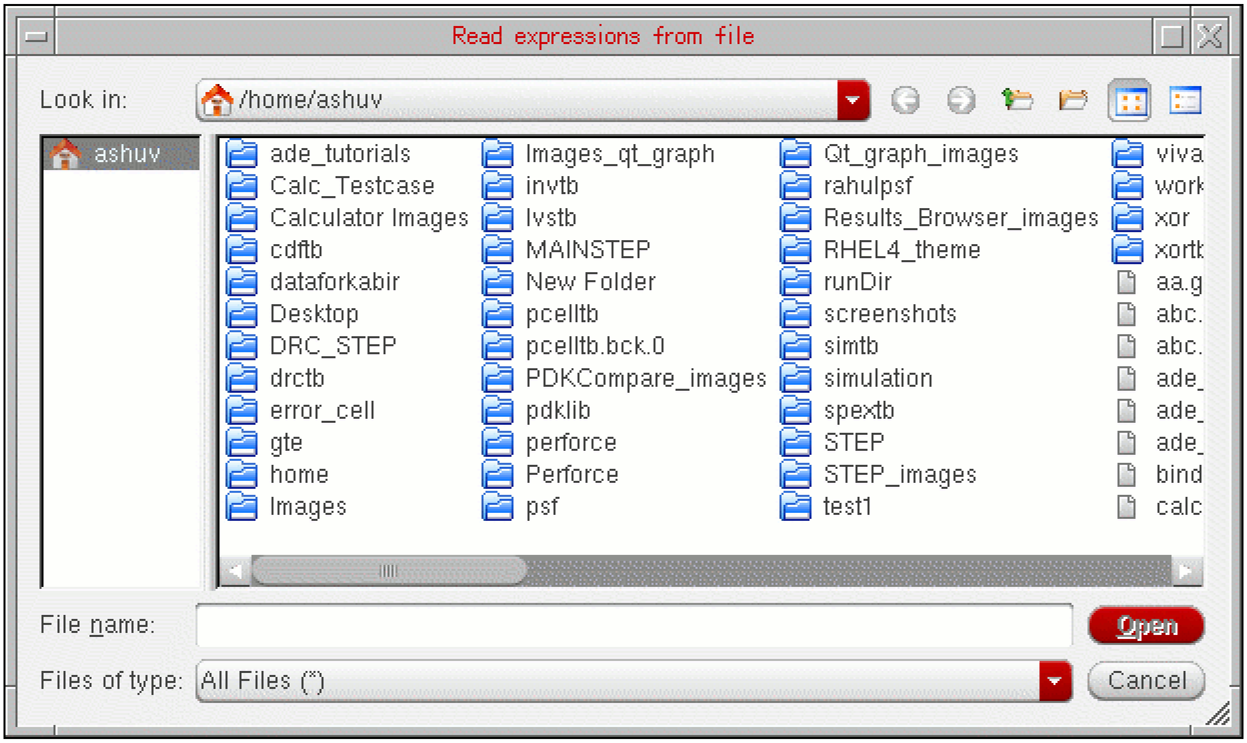
Loading Expressions from an Expression File

You can load an expression file to the expression table in the Expression Editor or to a memory table in the Memory Editor. The file that you load replaces the current set of expressions in a session, and you lose any unsaved information.

To load an expression file to the Expression Editor, perform the following steps:

1. In the Expression Editor, click .

   The *Read expressions from file* form appears.



Read expressions from file

Look in: /home/ashuv

File name:

Files of type: All Files (*)

2. In the *Look in* field, select the directory which contains the required expression file.

3. Do one of the following:

   ❑ From the list box below the *Look in* field, select the expression file you want to open.

   ❑ In the *File name* field, type the name of the file you want to open.

4. Click *Open*.

   The Virtuoso Visualization and Analysis XL tool loads the specified expression file.

If the `readDefaultVarFileOnStartup` `.cdsenv` variable is set to `true`, The Virtuoso Visualization and Analysis tool automatically loads the `defaultVarFileName` file.

To load an expression file to the Memory Editor, see Appendix G, “Memory Editor,”

Evaluating and Plotting Expressions

You can evaluate or plot the expressions in the Buffer and the Expression Editor. When you evaluate or plot expressions in the Buffer and if the result is a scalar, it is displayed in the Buffer. If the result is a waveform, it is displayed in the graph window.

When you evaluate or plot expressions in the Expression Editor and if the result is a scalar, it is displayed in the *Value* column in the expression table. If the result is a waveform, it is displayed in the graph window.

To evaluate and plot an expression in the Expression Editor,

1. In the Expression Editor, select the expressions you want to evaluate and plot by selecting the *plot* check box corresponding to the expression.
2. Click the Eval button.

   The Calculator evaluates and plots the selected expressions.

Displaying Results in a Table

You can display the results in a table after evaluating expressions.

On the Selection toolbar, you can use the following options to select the destination table where the results are displayed:

- *Append*—Adds the result to an existing table
- *Replace*—Replaces the existing table with the result
- *New Window*—Displays the result in a new table
- *New Subwindow*—Displays the result in a new table

You can display the expressions or results evaluated by the Buffer in a table.

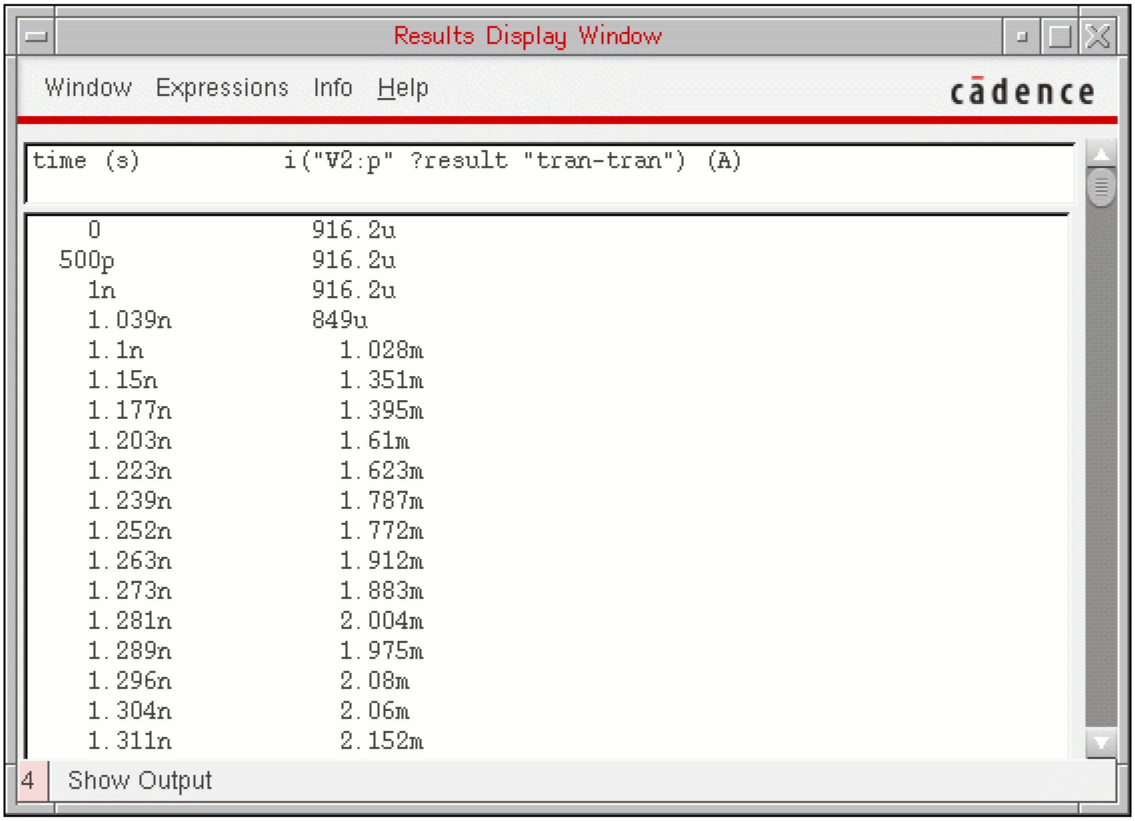
To display results in a table, do one of the following

➡ Click the ▦ button on the Selection toolbar.

The *Results Display Window* appears.

➡ Choose *Tools – Table.*

The *Results Display Window* appears.



```
time (s)          i("V2:p" ?result "tran-tran") (A)

    0               916.2u
  500p              916.2u
    1n              916.2u
    1.039n          849u
    1.1n              1.028m
    1.15n             1.351m
    1.177n            1.395m
    1.203n            1.61m
    1.223n            1.623m
    1.239n            1.787m
    1.252n            1.772m
    1.263n            1.912m
    1.273n            1.883m
    1.281n            2.004m
    1.289n            1.975m
    1.296n            2.08m
    1.304n            2.06m
    1.311n            2.152m
```

Working with the Calculator in ADE

While working in ADE, if you want to analyze simulation results, you can directly build expressions by opening the Virtuoso Visualization and Analysis XL Calculator from the ADE window and build expressions by using the simulation data generated during the latest run.

This section covers the following topics:

- Opening the Calculator using ADE on page 278
- Additional Features in ADE on page 284
- Working with Expressions in ADE on page 287
- Example of Building an Expression in ADE L on page 288

Opening the Calculator using ADE

When you open the Calculator from ADE, it displays some additional GUI components, such as Schematic Selection toolbar, Test toolbar. The Schematic Selection toolbar contains a set of standard functions, such as `vt` for voltage transient, that can be applied on the schematic objects, such as nets, terminals, and flip-flops, to build expressions. The Test toolbar contains the path of the simulation directories available for the current simulation run.

When you select a function on the Schematic Selection toolbar, the schematic design view opens. In the schematic design view, select a schematic object on which you want to perform this function. The complete expression for the selected function and the selected schematic object is created in the Buffer. For more information about how to select a schematic object, see Working with Expressions in ADE on page 287.

While working in the ADE environment, you can open the Calculator by using any of the following two methods:

- Opening the Calculator from ADE L on page 278
- Opening the Calculator from ADE XL on page 281

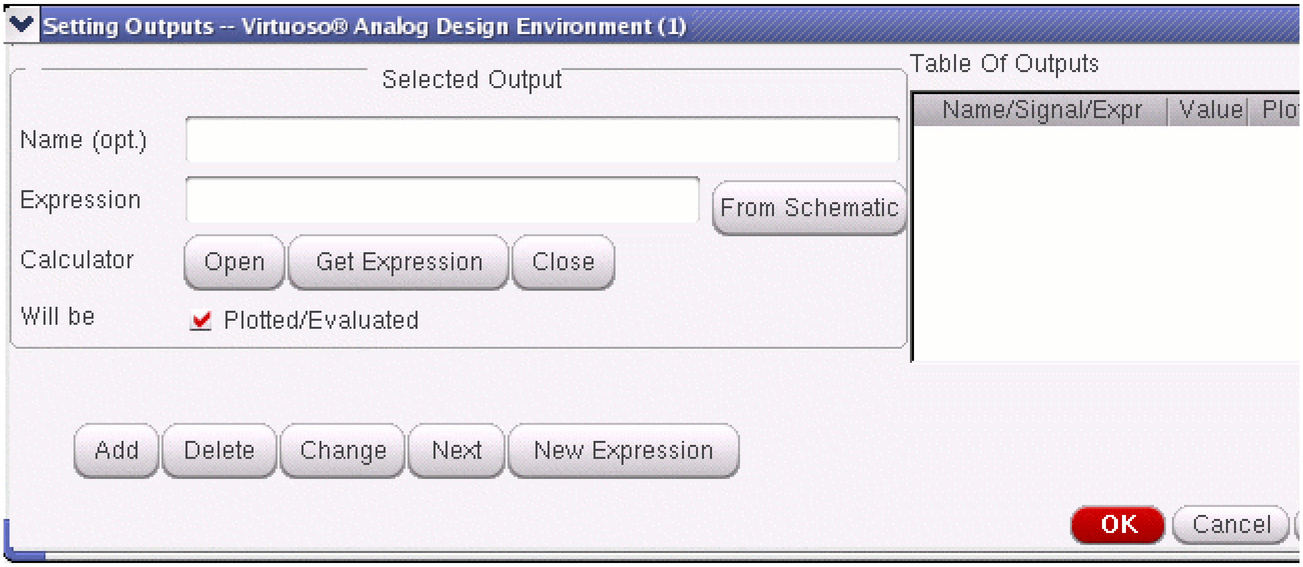
Opening the Calculator from ADE L

To open the Calculator from the ADE L, open ADE L and do one of the following:

➡ Choose *Tools – ADE L – Calculator*

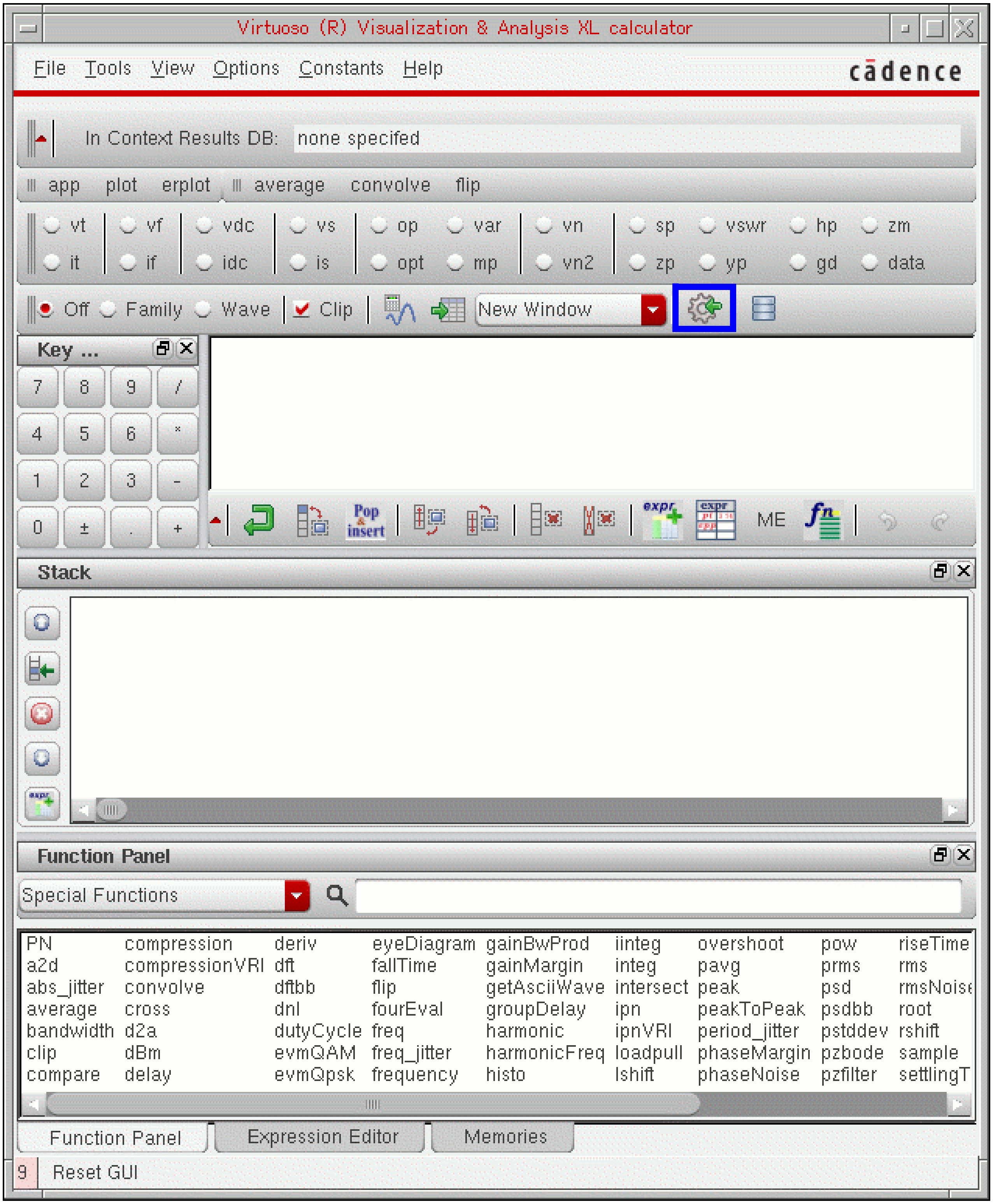
➡ In the ADE L Output Setup window:

a. Right-click anywhere in the *Name/Signal/Expr* column and choose *Edit*. The *Setting Outputs* window appears.



b. Click *Calculator – Open.*

The Calculator window appears. Notice the Schematic Selection toolbar and the Send to ADE button on the Selection toolbar in the figure below, which appear when the Calculator is opened from ADE L.



In Context Results DB: none specifed

New Window

Special Functions

Virtuoso (R) Visualization & Analysis XL calculator
File Tools View Options Constants Help
cādence
app plot erplot average convolve flip
vt vf vdc vs op var vn sp vswr hp zm
it if idc is opt mp vn2 zp yp gd data
● Off ○ Family ○ Wave ☑ Clip
Key ...
7 8 9 /
4 5 6 *
1 2 3 -
0 ± . +
Pop & insert
expr
ME
fn
Stack
Function Panel
PN a2d abs_jitter average bandwidth clip compare
compression compressionVRI convolve cross d2a dBm delay
deriv dft dftbb dnl dutyCycle evmQAM evmQpsk
eyeDiagram fallTime flip fourEval freq freq_jitter frequency
gainBwProd gainMargin getAsciiWave groupDelay harmonic harmonicFreq histo
iinteg integ intersect ipn ipnVRI loadpull lshift
overshoot pavg peak peakToPeak period_jitter phaseMargin phaseNoise
pow prms psd psdbb pstddev pzbode pzfilter
riseTime rms rmsNoise root rshift sample settlingT
Function Panel Expression Editor Memories
9 Reset GUI

To move the expression created in the Buffer to ADE L, click *Get Expression* in the *Setting Outputs* window of ADE L. The expression is displayed in the *Expression* field of the *Setting Outputs* window.

For more information about the Schematic Selection toolbar, see “Schematic Selection Toolbar” on page 244.

For more information about Send to ADE toolbar button, see Send to ADE Button on page 287.

For information about the Calculator menu and toolbar options, see “Using the Calculator Graphical User Interface (GUI)” on page 234.

Opening the Calculator from ADE XL

To open the Calculator in ADE XL, open the ADE XL window and do one of the following:

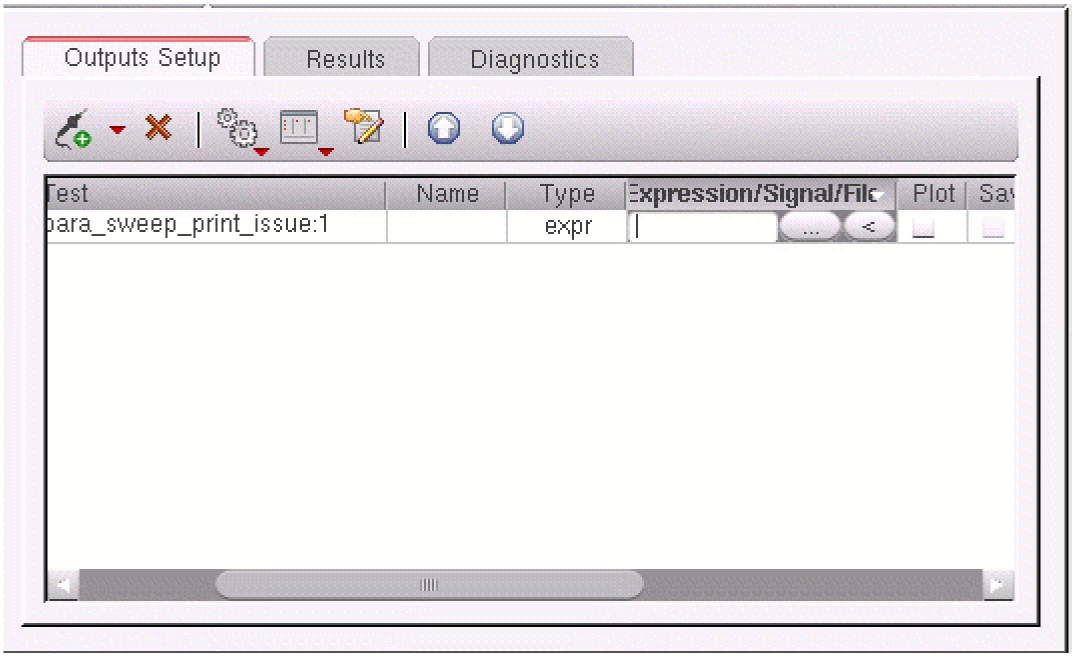
➡ Choose *Tools – Calculator*

Alternatively, you can open the Calculator window by clicking the 🖩 button in the ADE XL window.

➡ On the *Outputs Setup* tab:

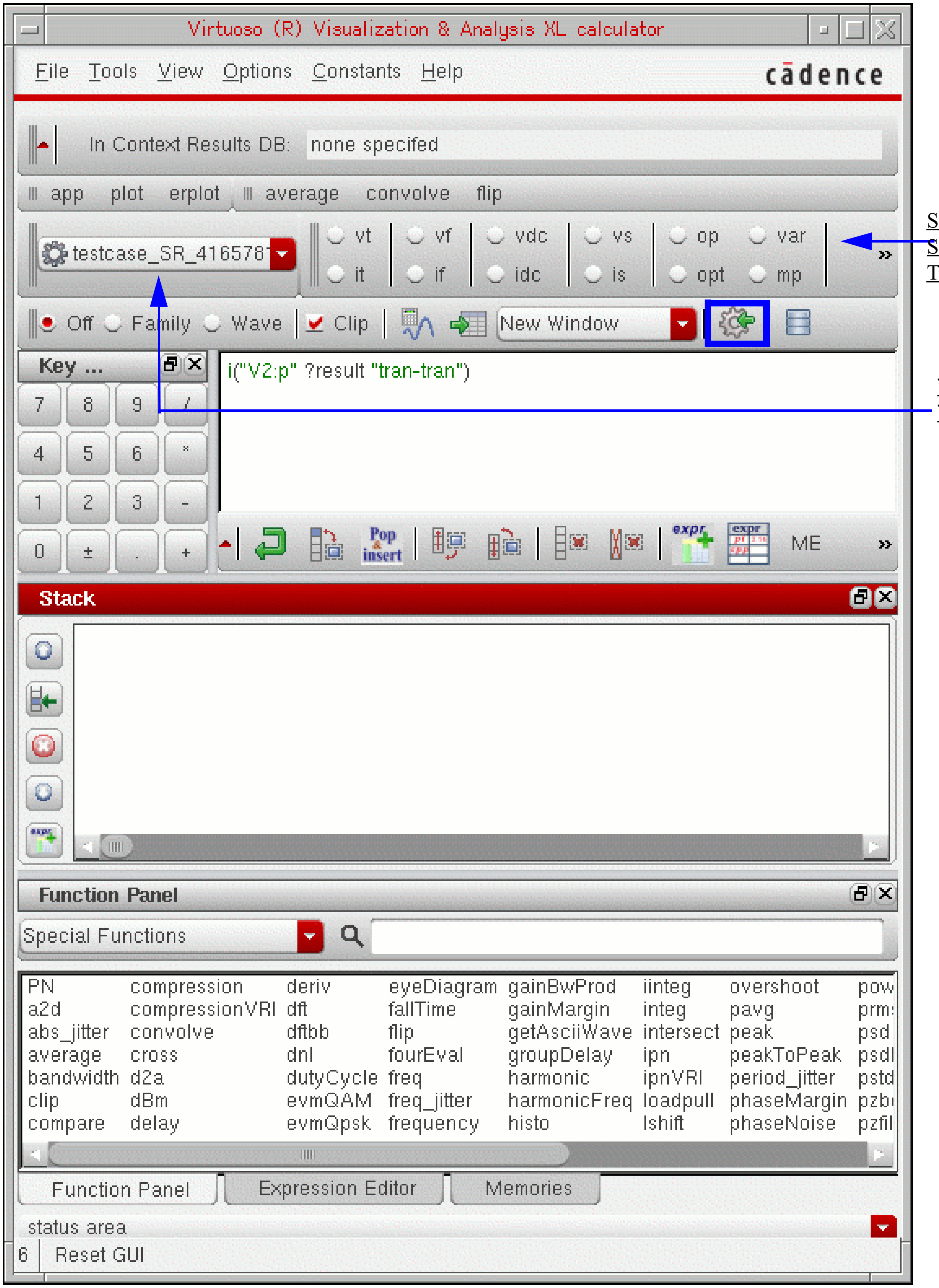
a. Select *Type* as *expr.*

b. Double-click anywhere in the *Expression/Signal/File* column and then click the ellipses (...) button.



Test	Name	Type	Expression/Signal/Fil	Plot	Sav
para_sweep_print_issue:1		expr		□	□

The Calculator window appears. Notice the Schematic Selection toolbar and the Test directory displayed on the Result toolbar in the figure below. Also, note an additional toolbar button on the Selection toolbar that can be used to send expressions displayed in the Buffer to the ADE XL Outputs Setup. These appear when the Calculator is opened from ADE XL. For more information, see Additional Features in ADE on page 284.



```
i("V2:p" ?result "tran-tran")
```

```
PN         compression    deriv      eyeDiagram  gainBwProd    iinteg     overshoot    pow
a2d        compressionVRI dft        fallTime    gainMargin    integ      pavg         prm:
abs_jitter convolve       dftbb      flip        getAsciiWave  intersect  peak         psd
average    cross          dnl        fourEval    groupDelay    ipn        peakToPeak   psdl
bandwidth  d2a            dutyCycle  freq        harmonic      ipnVRI     period_jitter pstd
clip       dBm            evmQAM     freq_jitter harmonicFreq  loadpull   phaseMargin  pzb
compare    delay          evmQpsk    frequency   histo         lshift     phaseNoise   pzfil
```

Schematic Selection Toolbar

Test Toolbar

After you have created the required expression in the Buffer, you can move the expression to ADE XL for evaluation. To move the expression to ADE XL, in the Calculator window, choose *Tools – Send to ADEXL Test*. The expression is displayed in the *Output Setup* window of ADE XL and is evaluated after you run the simulation.

In ADE XL, you can simultaneously work on multiple test directories in a session. To select a test directory, select it from the *Test* drop-down list in the Calculator window.

For more information about the Schematic Selection toolbar, see Schematic Selection Toolbar on page 284.

For more information about the Calculator menus and toolbar options, see "Using the Calculator Graphical User Interface (GUI)" on page 234.

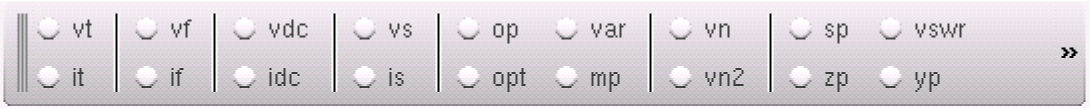
Additional Features in ADE

When you open the Calculator in ADE, the Calculator GUI displays the following additional features:

- Schematic Selection Toolbar on page 284
- Test Toolbar on page 286
- Send to ADE Button on page 287

Schematic Selection Toolbar

This toolbar displays a set of standard functions that can be applied on the schematic objects to build expressions. When you click a function button on the toolbar, the schematic design view appears. In the schematic design view, select a schematic object on which you want to apply the selected function. When you select the schematic object, an expression is created and displayed in the Buffer.



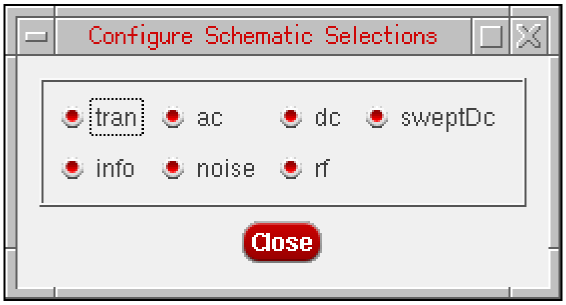
By default, the toolbar displays the function buttons for all simulation analyses types. However, you can configure the Schematic Selection toolbar to display function buttons for the selected analyses types.

To display the function button for a particular analysis type, do one of the following:

➡ Right-click in the toolbar area and choose *Configure selections*.

➡ Choose *View – Configure Schematic Selection Toolba*r.

The *Configure Schematic Selections* form appears. Select the simulation analyses types for which you want to display function buttons on the Schematic Selection toolbar.



● tran ● ac ● dc ● sweptDc

● info ● noise ● rf

Note: You can click the ▲ button shown in the Result toolbar to hide the Schematic Selection toolbar.

The following table lists the available function buttons:

Button	**Description**
vt	Transient voltage
it	Transient current
vf	Frequency voltage
if	Frequency current
vdc	DC voltage
idc	DC terminal current
vs	Source sweep voltage
is	Source sweep current (I compared to V graphs)
op	DC operating point
opt	Transient operating point
var	Design variables (ADE design variables). For information about using design variables with Calculator functions, see Adding Design Variables to Expressions on page 287

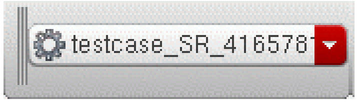
mp	Model parameter
vn	Noise voltage
vn2	Noise voltage square
sp	Scattering parameters
zp	Impedance parameters
vswr	Voltage standing wave ratio
yp	Admittance parameters
hp	H-parameters
gd	Group delay
zm	Input impedance if all other ports are matched
data	Plots a previous analysis

The Schematic Selection toolbar can also be displayed using the `schematicToolbar .cdsenv` variable.

The function buttons for all analyses types are displayed by default which can be changed by setting the `schematicAnalyses .cdsenv` variable.

Test Toolbar

This field is displayed on the left of the Schematic Selection toolbar if you open the Calculator from ADE XL.



The *Test* field lists the different set of results directories available in the current session, which you can use to build expressions. The results directory in which you are working currently is displayed on the *In Context Results DB* field. If you select another test directory from the *Test* list, the *In Context results DB* field displays continues to display the results directory for which the context in ADE XL is set.

The `displayContext.cdsenv` variable controls the display of the *Test* field.

Send to ADE Button

This toolbar button is displayed on the Selection toolbar.

You can use this toolbar button to move expressions that you create in the Buffer by using the simulation data for the current run to the ADE Outputs section for further analysis.

Working with Expressions in ADE

This section describes how to select a schematic object to build an expression and how to evaluate expressions in ADE.

Selecting Schematic Objects

Before you build an expression in the Calculator, you first need to select a schematic object in the schematic design view. After you select the schematic object, the corresponding expression is created in the Buffer.

Perform the following steps to select a schematic object:

1. On the Schematic Selection toolbar, click the required schematic function button.

   The schematic design view appears.

2. Select an object in the schematic design view. The function selected in the Calculator is applied to the selected schematic object and an expression is created in the Buffer.

   For some function, such as *var*, a form with additional options appears before the object is sent to the Buffer.

Adding Design Variables to Expressions

In ADE, you can add design variables from the schematic to the expression that you build in the Calculator.

To add a design variable to the expression, perform the following steps:

1. On the Schematic Selection toolbar, select the *var* option.

   The Virtuoso Schematic Editing window opens and a form named *Select an Instance* appears.

2. Select an instance on the schematic.

   The design variables for the instance are displayed in the *Select an Instance* form.

3. Select the design variable that you want to add to your expression and click *OK*.

   The selected design variable appears in the Buffer as follows:

   ```
   VAR("CAP")
   ```

Evaluating Expressions

You can load the expressions created using the Calculator into the ADE *Outputs Setup* window. The purpose of Virtuoso Visualization and Analysis XL Calculator in ADE is to build expressions for the current simulation run.

When the Calculator is opened from ADE, the expressions are based on the schematic objects; therefore the expressions cannot be evaluated in the Buffer. Instead the expressions are evaluated in ADE immediately after the simulation is run and the results are displayed in the ADE *Outputs Setup* window. You can use the results to analyze the circuit design. For more information about how to import results to the ADE, see Opening the Calculator using ADE on page 278.

Reloading Expressions using ADE

You can reload a saved expression in the Calculator while running simulation in ADE L and XL.

For example, if you run a simulation in ADE and create expressions in the Expression Editor, such as `E0 = VT("/vin")` and `E1 = E0 + 1`, where expression `E1` is dependent on `E0` and evaluate these expressions by clicking the *Eval* button in the Expression Editor. The output signals are plotted in a graph window.

Now, if you run the simulation again with different dataset values, the new values for `E0` and `E1` are generated in the ADE Outputs section. To update these expression values in the Virtuoso Visualization and Analysis XL graph window, choose *File – Reload*. The updated values for `E1` and `E0` are displayed in the graph window.

Example of Building an Expression in ADE L

Suppose you want to build an expression to calculate `dB20` of the magnitude of the frequency voltage of a schematic object, such as `net3`. For this, you perform the following steps:

1. In the ADE L *Setting Outputs* window, click *Calculator – Open*. The Virtuoso Visualization and Analysis XL Calculator appears.

2. In the Calculator window, select `vf` on the Schematic Selection toolbar. The schematic design view appears.

3. Select a schematic object, such as `net3`, in the schematic design view. The following expression is displayed in the Buffer:

   ```
   VF("/net3")
   ```

4. To calculate the magnitude, select the single parameter `mag` function from the *ALL* function category in the Function Panel. The Buffer now has the following expression:

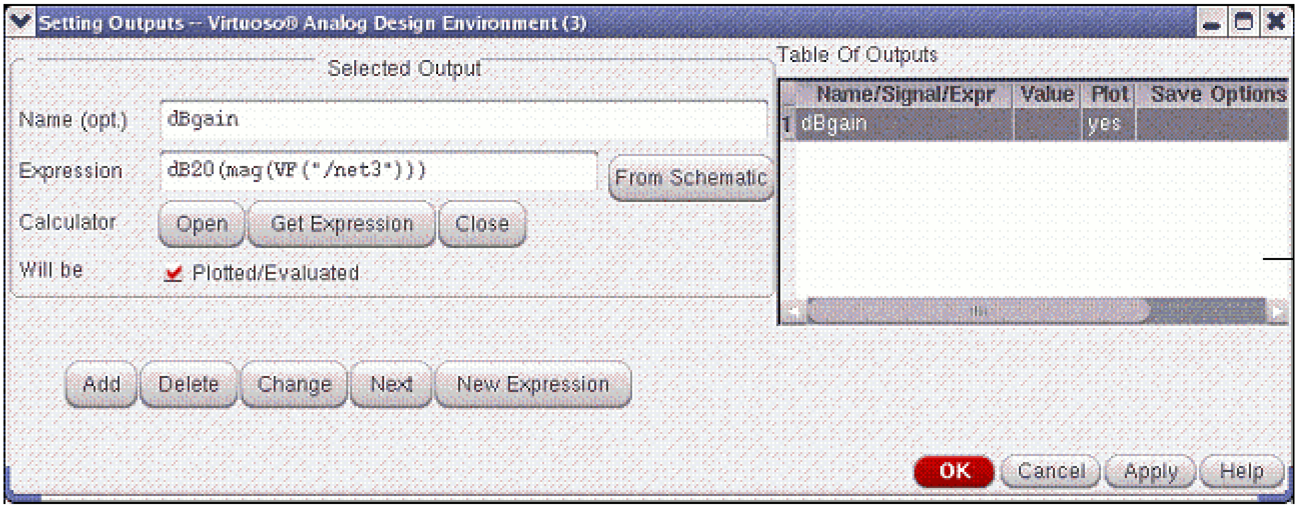
   ```
   mag(VF("/net3"))
   ```

5. To calculate `dB20`, select the single parameter `dB20` function in the *ALL* function category in the Function Panel. The expression in the Buffer is updated to:

   ```
   dB20(mag(VF("/net3")))
   ```

6. To move this expression to ADE L, click *Get Expression* in the ADE L *Setting Outputs* window. The expression is displayed in the *Expression* field in this window.

   Note: You can also save the expression in the Expression Editor that you have created. The expression is saved with an expression name. If the expression name already exists in ADE L, a warning message is displayed when you send the expression to ADE L.



Setting Outputs -- Virtuoso® Analog Design Environment (3)

Selected Output

Name (opt.) dBgain

Expression dB20(mag(VF("/net3")))

Will be ☑ Plotted/Evaluated

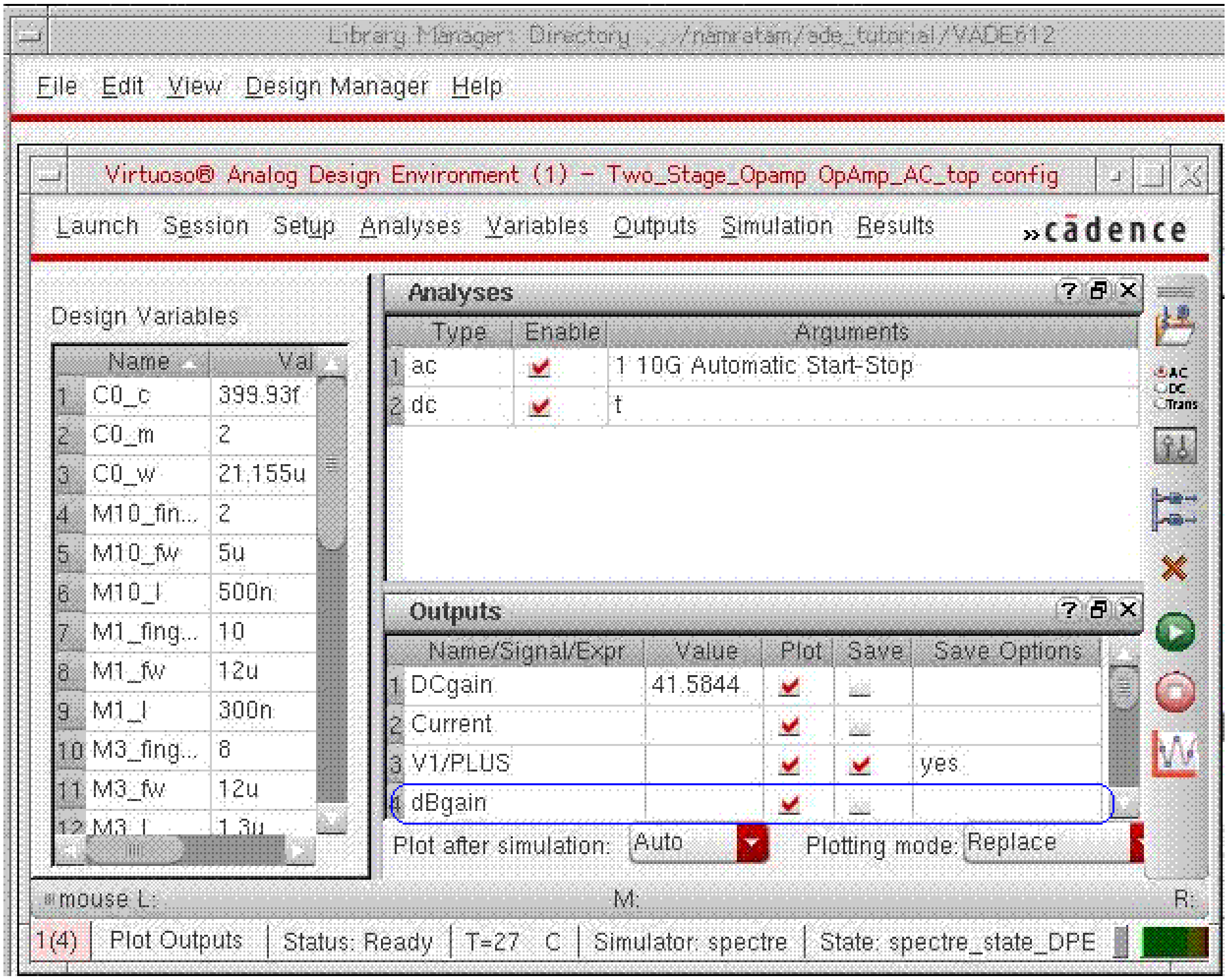
Table Of Outputs

	Name/Signal/Expr	Value	Plot	Save Options
1	dBgain		yes	

7. Enter a name for the expression in *Name (opt)* field and click *Add*. The expression is added to the *Table of Outputs*. The expression is also displayed in the *Outputs* section of the ADE L window.

Note: Follow the same sequence of steps to build an expression in the ADE XL.

You can similarly build more expressions. These expressions are added to the *Outputs* section of the ADE L window. After you run the simulation, all expressions are evaluated and the results are displayed in the *Value* column.


Library Manager: Directory .../namratam/ade_tutorial/VADE612
File Edit View Design Manager Help
Virtuoso® Analog Design Environment (1) - Two_Stage_Opamp OpAmp_AC_top config
Launch Session Setup Analyses Variables Outputs Simulation Results
»cadence
AC
DC
Trans

Design Variables

	Name	Val
1	C0_c	399.93f
2	C0_m	2
3	C0_w	21.155u
4	M10_fin...	2
5	M10_fw	5u
6	M10_l	500n
7	M1_fing...	10
8	M1_fw	12u
9	M1_l	300n
10	M3_fing...	8
11	M3_fw	12u
12	M3_l	1.3u

Analyses

	Type	Enable	Arguments
1	ac	✓	1 10G Automatic Start-Stop
2	dc	✓	t

Outputs

	Name/Signal/Expr	Value	Plot	Save	Save Options
1	DCgain	41.5844	✓	□	
2	Current		✓	□	
3	V1/PLUS		✓	✓	yes
4	dBgain		✓	□	

Plot after simulation: Auto Plotting mode: Replace

mouse L: M: R:

1(4) Plot Outputs | Status: Ready | T=27 C | Simulator: spectre | State: spectre_state_DPE

5

Working with Virtuoso Visualization and Analysis XL Table

Virtuoso Visualization and Analysis XL Table (Table) displays data for the selected traces or signals in a table for easy analysis.

This chapter includes the following topics:

Opening Table

You can open Table by using any of the following three methods:

- Opening Table from the Graph Window on page 292
- Opening Table from the Results Browser on page 294
- Opening Table from the Calculator on page 295

Opening Table from the Graph Window

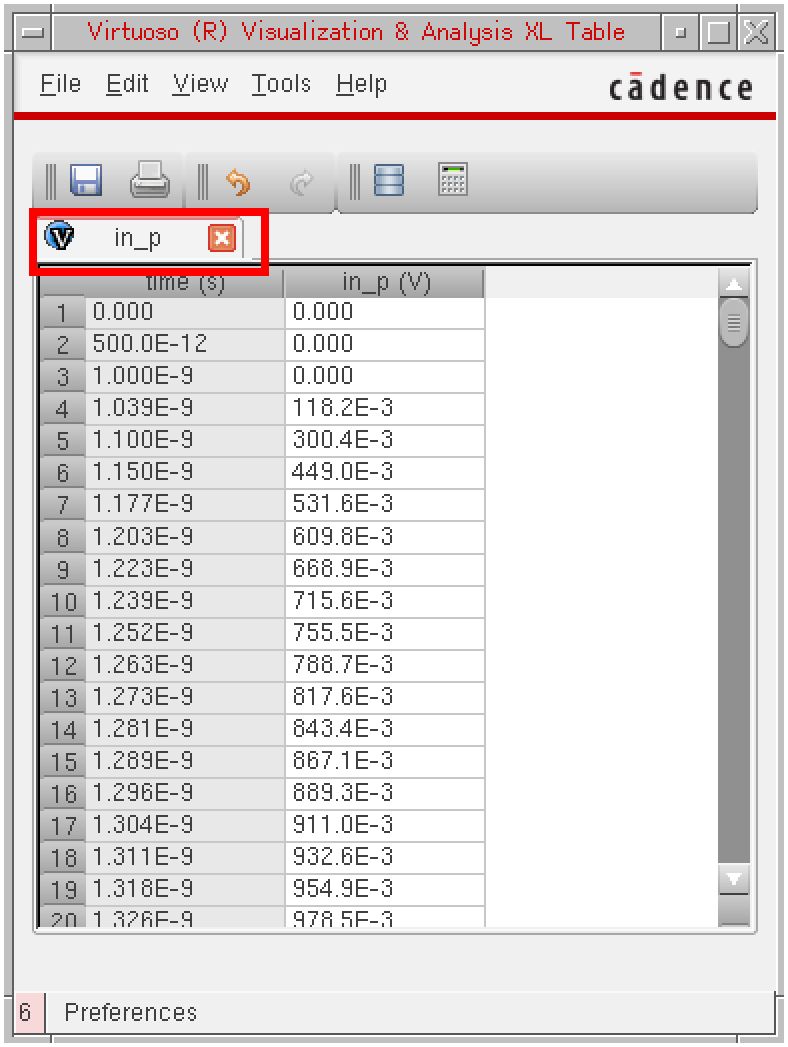
To open Table from the graph window:

- Select the required traces in the trace legend area.
- Right-click a selected trace and choose *Table – New Window/Append/Replace*.

  The *Virtuoso (R) Visualization & Analysis XL Table* window opens, as shown in the figure above.

  - ❑ If you select the destination as *New Window*, the trace data is displayed in a new table that is displayed on a new tab.
  - ❑ If you select the destination as *Append*, the trace data is appended to the table displayed on the active tab.
  - ❑ If you select the destination as *Replace*, the Table on the active tab is replaced with a new table.

Notice that the tab name contains the names of all the traces for which data is displayed in Table. You can also close the tabs if required.

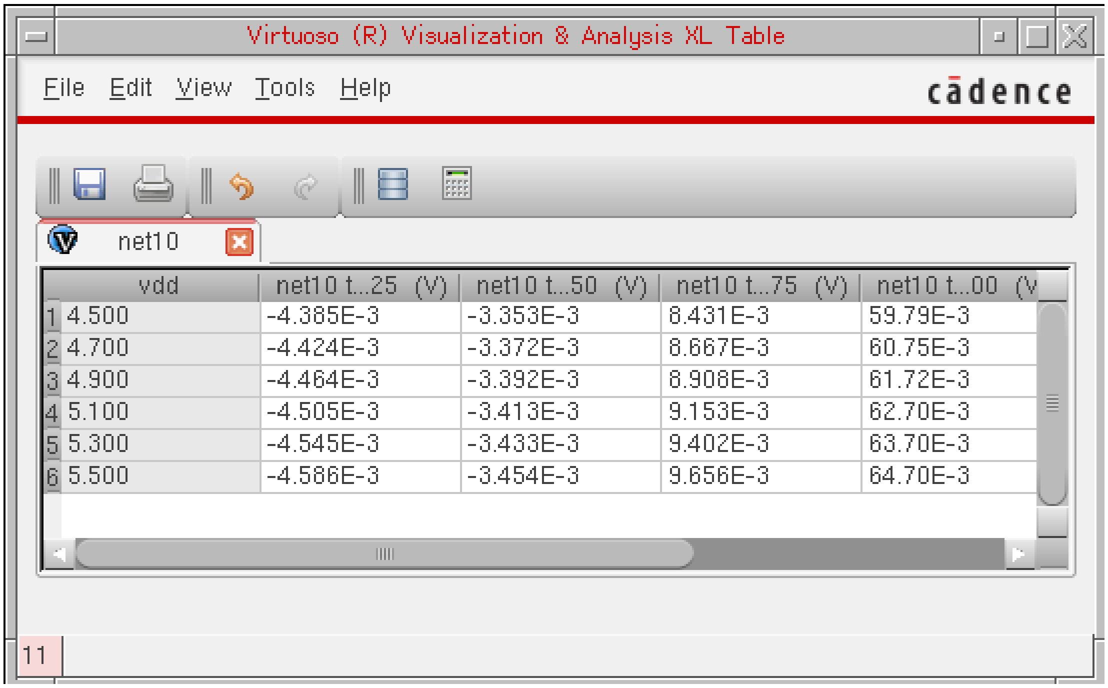

Virtuoso (R) Visualization & Analysis XL Table
File Edit View Tools Help
cādence
in_p
6
Preferences

	time (s)	in_p (V)
1	0.000	0.000
2	500.0E-12	0.000
3	1.000E-9	0.000
4	1.039E-9	118.2E-3
5	1.100E-9	300.4E-3
6	1.150E-9	449.0E-3
7	1.177E-9	531.6E-3
8	1.203E-9	609.8E-3
9	1.223E-9	668.9E-3
10	1.239E-9	715.6E-3
11	1.252E-9	755.5E-3
12	1.263E-9	788.7E-3
13	1.273E-9	817.6E-3
14	1.281E-9	843.4E-3
15	1.289E-9	867.1E-3
16	1.296E-9	889.3E-3
17	1.304E-9	911.0E-3
18	1.311E-9	932.6E-3
19	1.318E-9	954.9E-3
20	1.326E-9	978.5E-3

Note: If the X-axis values of a trace that you are appending to the table does not match the X-axis values of the trace already displayed in the table, the X-axis values for the new trace are added to a separate column. This happens when you display traces from different analyses, such as `AC` (contains frequency on the X-axis) and `tran` (contains time on the X-axis) analyses, in the same table. Parametric, Monte Carlo, and corner data, containing different X-axis values, is also displayed in Table by using the same method.

Viewing Results for Sweep Data

The traces from parametric sweep data display trace data for each sweep value. The figure below displays the trace results for sweep data.


Virtuoso (R) Visualization & Analysis XL Table
File Edit View Tools Help
cādence
net10
11

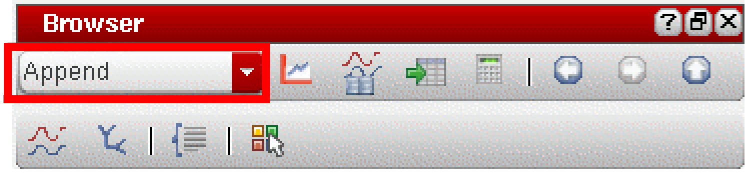
	vdd	net10 t...25 (V)	net10 t...50 (V)	net10 t...75 (V)	net10 t...00 (V
1	4.500	-4.385E-3	-3.353E-3	8.431E-3	59.79E-3
2	4.700	-4.424E-3	-3.372E-3	8.667E-3	60.75E-3
3	4.900	-4.464E-3	-3.392E-3	8.908E-3	61.72E-3
4	5.100	-4.505E-3	-3.413E-3	9.153E-3	62.70E-3
5	5.300	-4.545E-3	-3.433E-3	9.402E-3	63.70E-3
6	5.500	-4.586E-3	-3.454E-3	9.656E-3	64.70E-3

Opening Table from the Results Browser

To open Table from the Results Browser:

- Select the signals for which you want to display the data in Table. To select more than one signal, hold down the `Ctrl` key while you click each signal. After you have selected the signals, do one of the following:
  - ❑ Right-click a selected signal and choose *Table*.
  - ❑ Click the button on the Results Browser toolbar.
- From the drop-down list box on the Results Browser toolbar, as shown in the figure below, select the destination table where you want to display the signal data:
  - ❑ *Append*—Adds the result to an existing table
  - ❑ *Replace*—Replaces the existing table with the result
  - ❑ *New Window*—Displays the result in a new table

- ❑ *New Subwindow*—Displays the result in a new table



The *Virtuoso (R) Visualization & Analysis XL Table* window opens with the signal data displayed in a table, a specified.

Note: If the *Virtuoso (R) Visualization & Analysis XL Table* window is already open, the signal data is appended to the table displayed on the active tab.

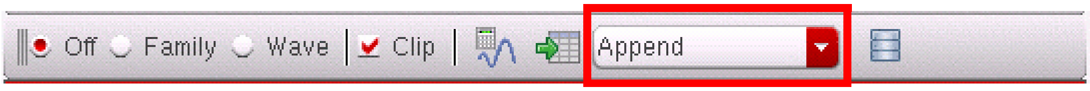
Opening Table from the Calculator

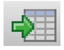
While using the Calculator, you can view in Table the data for the following:

- A signal contained in an expression in the Calculator Buffer
- An output signal obtained after evaluating an expression

To open Table from the Calculator:

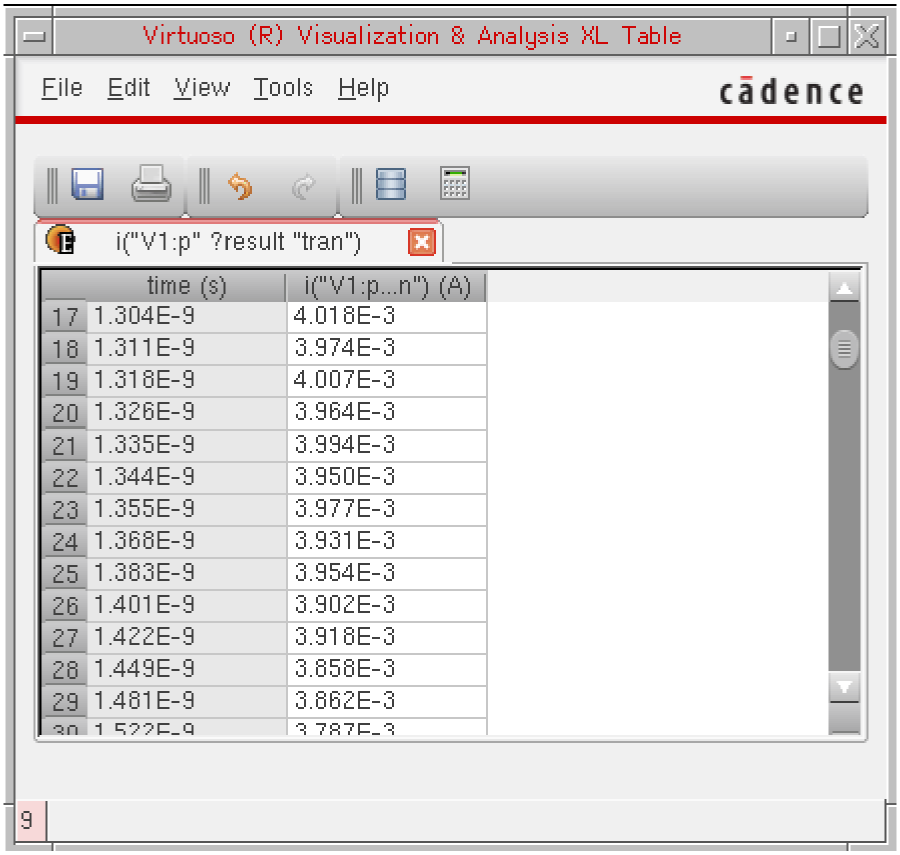
1. From the drop-down list box on the Selection toolbar, as shown in the figure below, select the destination table where you want to display the signal data:
   - ❑ *Append*—Adds the result to an existing table
   - ❑ *Replace*—Replaces the existing table with the result
   - ❑ *New Window*—Displays the result in a new table
   - ❑ *New Subwindow*—Displays the result in a new table



2. To display signals contained in the Calculator Buffer:
   - ❑ Choose *Tools – Table.*
   - ❑ Click the  button from the Selection toolbar.

   The *Virtuoso (R) Visualization & Analysis XL Table* window appears.

Note: To display the signals contained in the Expression Editor in the Table, you first need to move them to the Calculator Buffer.


Virtuoso (R) Visualization & Analysis XL Table
File Edit View Tools Help
cādence
i("V1:p" ?result "tran")
9

	time (s)	i("V1:p...n") (A)
17	1.304E-9	4.018E-3
18	1.311E-9	3.974E-3
19	1.318E-9	4.007E-3
20	1.326E-9	3.964E-3
21	1.335E-9	3.994E-3
22	1.344E-9	3.950E-3
23	1.355E-9	3.977E-3
24	1.368E-9	3.931E-3
25	1.383E-9	3.954E-3
26	1.401E-9	3.902E-3
27	1.422E-9	3.918E-3
28	1.449E-9	3.858E-3
29	1.481E-9	3.862E-3
30	1.522E-9	3.787E-3

For more information about Virtuoso Visualization and Analysis XL Calculator, see *Chapter 4, Working with the Calculator* in the *Virtuoso Visualization and Analysis XL User Guide*.

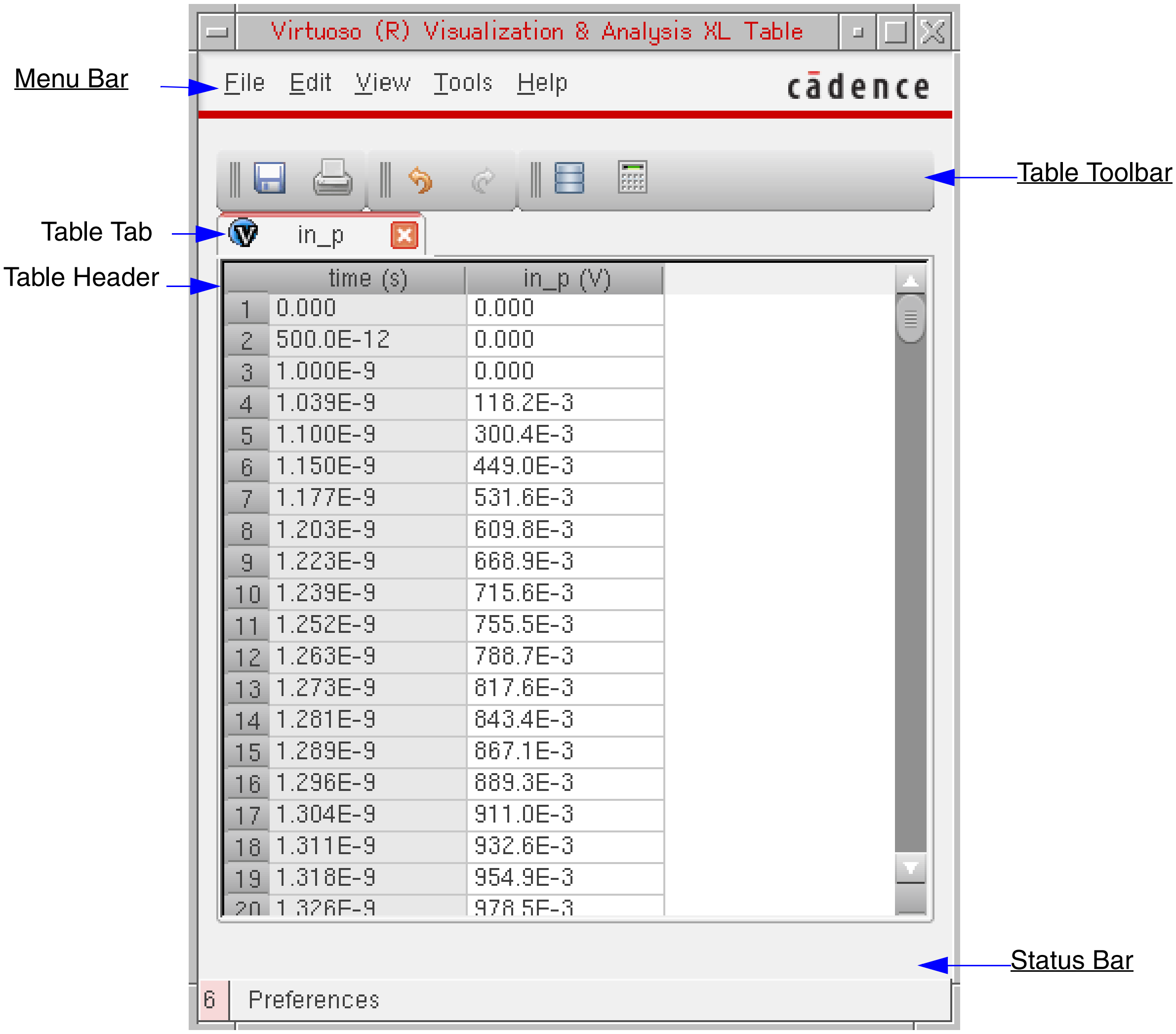
Table Graphical User Interface (GUI)

The Table graphical user interface (GUI) comprises a menu bar, a toolbar, and the tabs on which signal or trace data is displayed.

This section consists of the following topics:

- Menu Bar on page 297
- Table Toolbar on page 299
- Status Bar on page 301

- Shortcut Menu on page 301


Virtuoso (R) Visualization & Analysis XL Table
Menu Bar
File Edit View Tools Help
cādence
Table Toolbar
Table Tab
in_p
Table Header
Status Bar

	time (s)	in_p (V)
1	0.000	0.000
2	500.0E-12	0.000
3	1.000E-9	0.000
4	1.039E-9	118.2E-3
5	1.100E-9	300.4E-3
6	1.150E-9	449.0E-3
7	1.177E-9	531.6E-3
8	1.203E-9	609.8E-3
9	1.223E-9	668.9E-3
10	1.239E-9	715.6E-3
11	1.252E-9	755.5E-3
12	1.263E-9	788.7E-3
13	1.273E-9	817.6E-3
14	1.281E-9	843.4E-3
15	1.289E-9	867.1E-3
16	1.296E-9	889.3E-3
17	1.304E-9	911.0E-3
18	1.311E-9	932.6E-3
19	1.318E-9	954.9E-3
20	1.326E-9	978.5E-3

6 Preferences

Menu Bar

The following menus are available:

- *File*—Includes the following commands:

Command	Description
Save As CSV	Saves the table contents in the CSV format. For more information, see Saving Tables on page 302.

Command	Description
Print	Opens the *Print* form that is used to print the contents of the Table window. For more information, see Printing Tables on page 311.
Close	Closes the Table window.

- *Edit*—Includes the following commands:

Command	Description
Undo	Undoes the operations performed in the selected table.
Redo	Redoes the operations performed in the selected table. This coomand is available only when you perform an undo operation.
Preferences	Specifies the number of operations you want to undo and redo. You can specify upto maximum of 10 operations.

- *View*—Includes the following commands:

Command	Description
Hide	Hides the selected column. For more information, see Hiding and Displaying Columns on page 305.
Reveal	Displays the selected column. For more information, see Hiding and Displaying Columns on page 305.
Format	Sets the format attributes for the selected column. For more information, see Formatting Columns on page 306.
Sort	Sorts the selected column in the ascending or descending order. For more information, see Sorting Table Columns on page 307.
Transpose	Transposes the Table rows and columns. For more information, see Transposing Table Columns and Rows on page 308.

Command	Description
Default Column Order	Sets the default column order, in which the columns that contains X-axis data is displayed to the left of the columns containing the Y-axis data.

- *Tools*—Includes the following commands:

Command	Description
Browser	Opens the Results Browser window
Calculator	Opens the Calculator window

- *Help*—Includes the following commands:

Command	Description
Contents	Displays the *Virtuoso Visualization and Analysis* XL *Table* help
Cadence Online Support	Displays the Cadence customer support website in your default Web browser
Online User Forum (cdnusers.org)	Displays the online users' forum website in your default Web browser
Known Problems and Solutions	Displays *Virtuoso Visualization and Analysis XL Known Problems and Solutions*
What's New	Displays *Virtuoso Visualization and Analysis XL What's New*
About Visualization and Analysis	Displays the version number of the Virtuoso Visualization and Analysis XL

Table Toolbar

The Table has the following toolbars:

- File
- Edit
- Tools

File Toolbar

The following table describes the buttons available on the File toolbar:

Button	Name	Description
📂	Open CSV File	Opens the CSV file
💾	Save as CSV	Saves the table contents in the CSV format
🖨	Printer	Prints the contents of the selected Table window

Edit Toolbar

The following table describes the buttons available on the Edit toolbar:

Button	Name	Description
↶	Undo	Undo the actions performed in the selected Table window
↷	Redo	Redo the actions performed in the selected Table window.

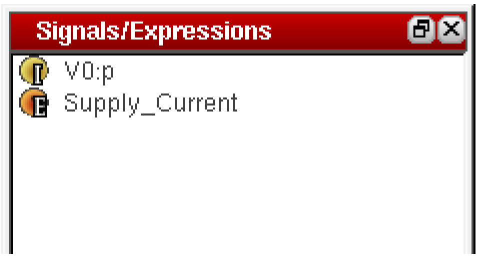
Tools Toolbar

The following table describes the buttons available on the Tools toolbar:

Button	Name	Description
☰	Results Browser	Opens the Result Browser as an assistant in the graph window
🖩	Calculator	Opens the Calculator window

To hide or display the toolbars, right-click anywhere on the toolbar or status bar and select the toolbars you want to display.

To view signal names or expression for traces, right-click the Table toolbar or the status bar and choose *Signals/Expressions*. The *Signal/Expressions* window appears on the left, displaying the signal names or expressions for which data is displayed in Table.



Note: You can also use this window to switch between the different tabs.

To rename a Table window tab name, double-click in it and specify a name. Drag the tabs to change their display order. To change the display order of columns, drag the column headers.

Status Bar

The status bar shown at the bottom of the table displays the actions you perform in the Table.

Shortcut Menu

The following commands are available on the shortcut menu that appears when you right-click a column in Table:

Command	Description
Hide Column	Hides the selected column. For more information, see Hiding and Displaying Columns on page 305.
Reveal Column	Shows the hidden columns. For more information, see Hiding and Displaying Columns on page 305.
Format	Sets the format attributes for the selected column. For more information, see Formatting Columns on page 306.
Sort	Sorts the selected column. For more information, see Sorting Table Columns on page 307.
Transpose	Transposes the Table columns and rows. For more information, see Transposing Table Columns and Rows on page 308.

Command	Description
Default Column Order	Sets the default column order, in which columns that contains X-axis data is displayed on the left of the columns containing the Y-axis data.
Change Column Color	Sets the background color of the selected column. For more information, see Changing Column Color on page 308.
Rename Header	Sets the header name of the selected column. For more information, see Renaming Column Headers on page 308.
Show Grid	Shows or hides the grids in the Table.
Copy to ClipBoard	Copies the content of the selected column to clipboard.
Merge X	Combines the selected columns that contain X-axis data. For more information, see Merging Columns on page 308.
Merge All X	Combines all the columns that contain the X-axis data. For more information, see Merging Columns on page 308.
Apply Range	Displays the values that fall in the specific range. For more information, see Filtering Table Data on page 309.
Value At	Displays the value at a particular point in the column. For more information, see Filtering Table Data on page 309.
Sample Values	Displays the rows X-axis values that match the specified set of sample values. For more information, see Filtering Table Data on page 309.
Resize Columns To Contents	Sets the width of all columns to ensure that the contents displayed in them are fully visible. For more information, see Resizing Columns and Rows on page 310.
Reset To Default Cell Size	Restores the default column and row size. This option does not restores the default column order. For more information, see Resizing Columns and Rows on page 310.

Saving Tables

You can save the table contents in the CSV as well as in the HTML format.

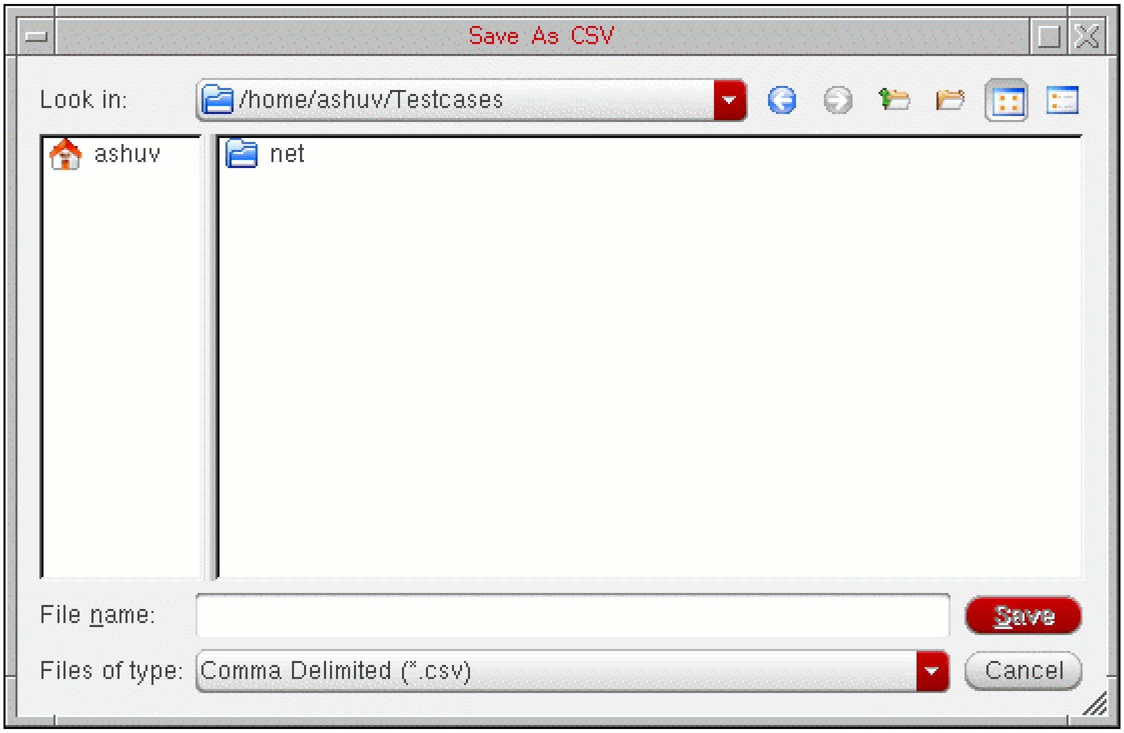
Saving Tables in CSV Format

You can save a table as a text file in the CSV format and import it into spreadsheets, such as Microsoft Excel.

To save a table in CSV format, do one of the following:

- Choose *File – Save As CSV*.

  The *Save As CSV* form appears.



  a. In the *Look in* field, select the directory where you want to save the text file.

  b. In the *File name* field, specify a name for the file to which you want to save the table contents.

  c. In the *Files of type* field, `.csv` is selected by default.

  d. Click *Save*.

  The table is saved as a text file, in the string format. The first line in the text file contains the column headers separated by commas. Each subsequent line contains a table row with the trace data values separated by commas.

Only those values that are displayed in the table are saved to the text file. For example, if you hide a column, and then save the table, the data in the hidden column is not saved in the text file.

The Table tab name is not saved when you save a table in the CSV format.

Selecting Columns

You can select any column in the table by clicking on it. To select multiple columns, hold down the `Control` or `Shift` key and click the columns that you want to select.

To de-select a column, hold down the `Ctrl` key and click a selected column.

To select the entire Table, click the corner button available at the left-most corner of the Table header.

To de-select the Table selection, click the corner button available at the bottom of the scroll bar.

Performing Undo and Redo

You can undo and redo a specific number of actions performed in a selected Table.

To undo an action, do one of the following:

- Choose *Edit – Undo*.
- Click the ↶ button on the Edit toolbar.

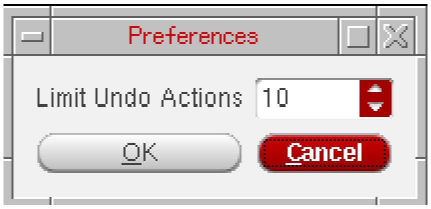
To redo an action, do one of the following:

- Choose *Edit – Redo*.
- Click the ↷ button on the Edit toolbar.

Do the following to specify a limit for the number of actions that you want to undo and redo:

- Choose *Edit – Preferences*.

The *Preferences* form appears.



Limit Undo Actions 10

- In the *Limit Undo Actions* list box, select the a limit upto which you want to undo and redo the actions. The maximum limit that you can specify is 10.
- Click *OK*.

  If you select 3 in this list box, you can undo upto the last 3 actions perfromed in the selected Table.

Note: The redo command becomes avaialble only when you undo the latest action in the Table.

Hiding and Displaying Columns

To hide columns, do one of the following:

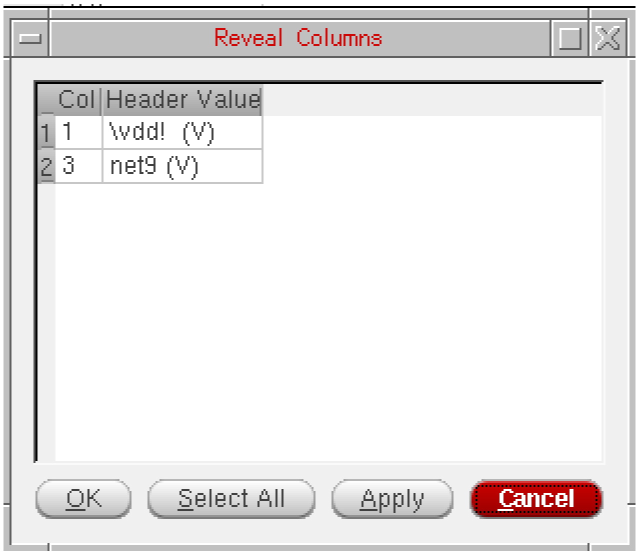
- Select the columns and choose *View – Hide*.
- Right-click a column and choose *Hide Column*.

  The selected columns are hidden.

To display columns that are hidden, do one of the following:

- Select any column and choose *View – Reveal*.
- Right-click any column and choose *Reveal Column*.

The *Reveal Columns* form appears. This form displays a list of all the columns that are hidden in the Table.



	Col	Header Value
1	1	\vdd! (V)
2	3	net9 (V)

- Select the columns that you want to show. To show all the columns, click Select All.
- Click *OK*.

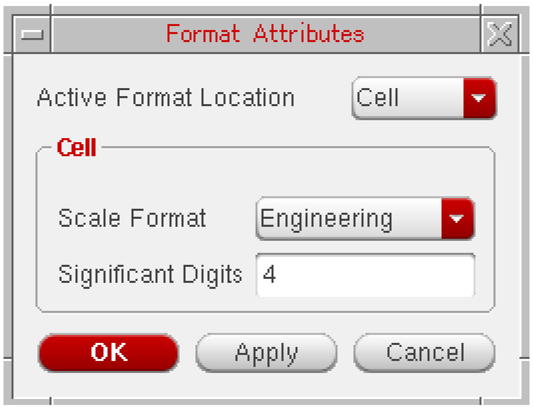
  The columns are displayed in the table.

Formatting Columns

To format a column, do one of the following:

- Select a column and choose *View – Format*.
- Right-click a column and choose *Format*.

The *Format Attributes* form appears.



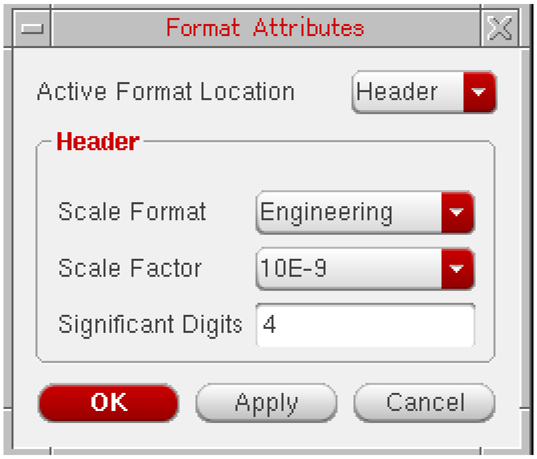
Format Attributes

Active Format Location: Cell

Cell

Scale Format: Engineering

Significant Digits: 4



Format Attributes

Active Format Location: Header

Header

Scale Format: Engineering

Scale Factor: 10E-9

Significant Digits: 4

- ❑ In the *Active Format Location* list*,* select the location as `Cell` or `Header`.
- ❑ In the *Scale Format* list*,* select `Scientific`, `Engineering`, or `Suffix`.

Note: The selected value is applied to all the cells in the column.

- ❑ In the *Scale Factor* field, specify the scaling factor, such as`10E-9`.

Note: You need to specify this value only if you select `Header` in step 3.

- ❑ In the *Significant Digit*s field, specify the number of significant digits to be displayed for the data. The maximum number of significant digits that you can specify is `16`.
- ❑ Click *OK*.

Sorting Table Columns

When you sort a column the first time, it is sorted in an ascending order. The next time you sort the same column, it is displayed in the descending order.

To sort the columns in a Table window, do one of the following:

- Select a column and choose *View – Sort*.
- Right-click the column you want to sort and choose *Sort*.

  When the column is sorted, an arrow key appears at the column header. You can press this arrow key to change the sorting order of the column.

Transposing Table Columns and Rows

To transpose Table columns and rows, do one of the following:

- Choose *View – Transpose*.
- Right-click anywhere in the Table and choose *Transpose*.

  The table columns and rows are transposed, which means the column information is displayed in rows and vice versa.

  Note: You cannot format a table after the rows and columns are transposed.

Changing Column Color

To change the background color of a column:

➡ Right-click a column and choose *Change Column Color*.

A drop-down list appears, from which you can choose the color that you want to apply to the background of the selected column.

Renaming Column Headers

Perform the following steps to rename the a column heading:

1. Right-click a column and choose *Rename Header*.

   The *Rename Header* form appears.
2. Type the new name that you want to set as the column header.
3. Click *OK*.

Merging Columns

Perform the following steps to merge two or more columns that contain the similar X-axis data:

1. Select the columns that you want to merge.
2. Right-click the selected columns and choose *Merge X*. This option is available only when you select two or more columns that contain similar X-axis data.

The selected columns are merged into a single column in the Table window. The merged column includes of both sets of X-axis values. The corresponding columns that contain Y-axis data get either interpolated or extrapolated.

To merge all columns that contain similar X-axis data:

➡ Right-click one of these columns and select *Merge All X*.

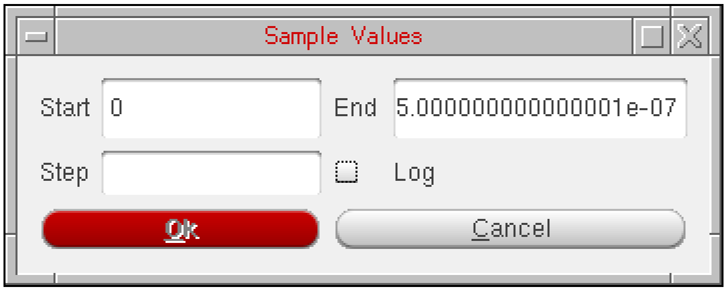
Note: This option is available if you have more than one X-axis data column in the Table window.

Filtering Table Data

To display in the table the data that matches a given set of sample values:

➡ Right-click a column that contains X-axis data and choose *Sample Values*.

The *Sample Values* form appears.



Start 0

End 5.000000000000001e-07

Step

□ Log

Specify the following values and click *OK*:

❑ *Start*—The starting value for samples

❑ *End*—The end value for samples

❑ *Step*—The step value

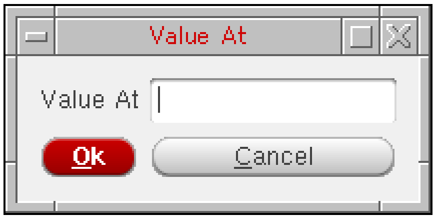
❑ *Log*—Select this check box to include the logarithmic values

All the X-axis values that match the specified set of sample values are displayed in the table

To find the Y-axis value at a particular point:

➡ Right-click a column that contains X-axis data and choose *Value At*.

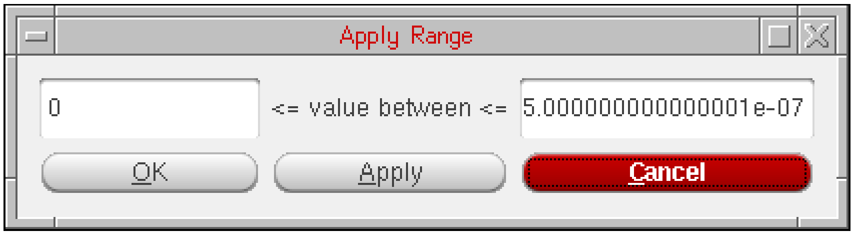
The *Value At* form appears. Specify the X-axis value for which you want to find the Y-axis value.



To display all the rows and columns in a table that fall within the specific range of values:

➡ Right-click a column that contains X-axis data and choose *Apply Range*.

The *Apply Range* form appears. Specify the start and end values for the range.



0 <= value between <= 5.0000000000000001e-07

Displaying Complex Data

To change the format of the complex data:

➡ Right-click the table column and choose *Display Complex As – Real/Imaginary/Real and Imaginary/Magnitude.*

Resizing Columns and Rows

To resize columns:

➡ Drag the right edge of a column header to the left or right to make the column narrower or wider respectively.

To resize rows:

➡ Drag the top or the bottom edges of rows in the first column to make the entire row narrower or wider respectively.

To set the column width equivalent to the data displayed in the column:

➡ Right-click anywhere in the table and choose *Resize Columns To Contents*.

To reset the column width and row height to their default values:

➡ Right-click anywhere in the table and choose *Reset To Default Cell Size*.

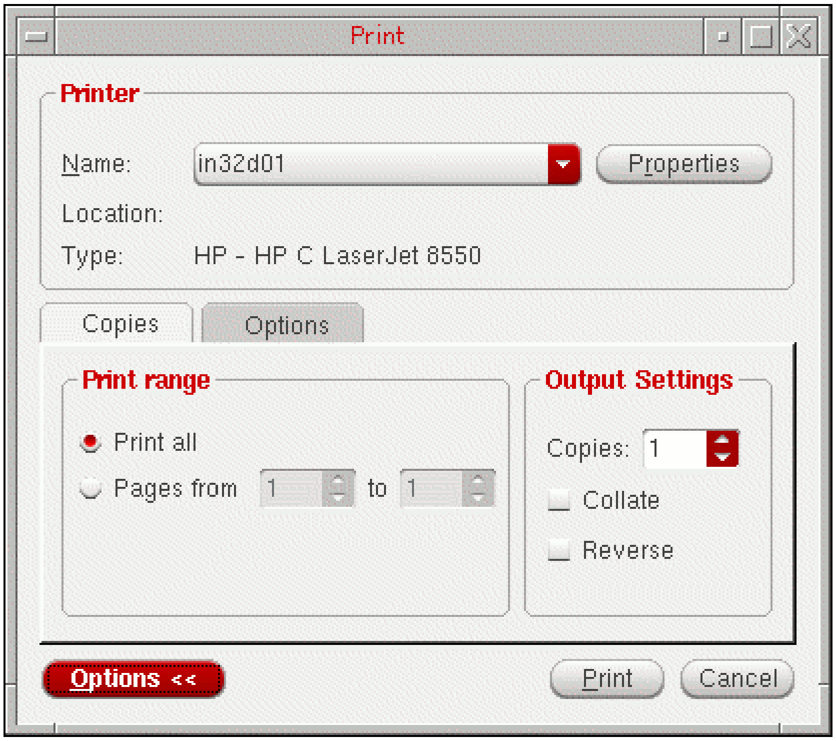
Printing Tables

Perform the following steps to print a selected table displayed in the Table window.

1. In the Table window, do the following

❑ Choose *File – Print*.

The *Print* form appears.



Name: in32d01

Location:

Type: HP - HP C LaserJet 8550

● Print all

○ Pages from 1 to 1

Copies: 1

□ Collate

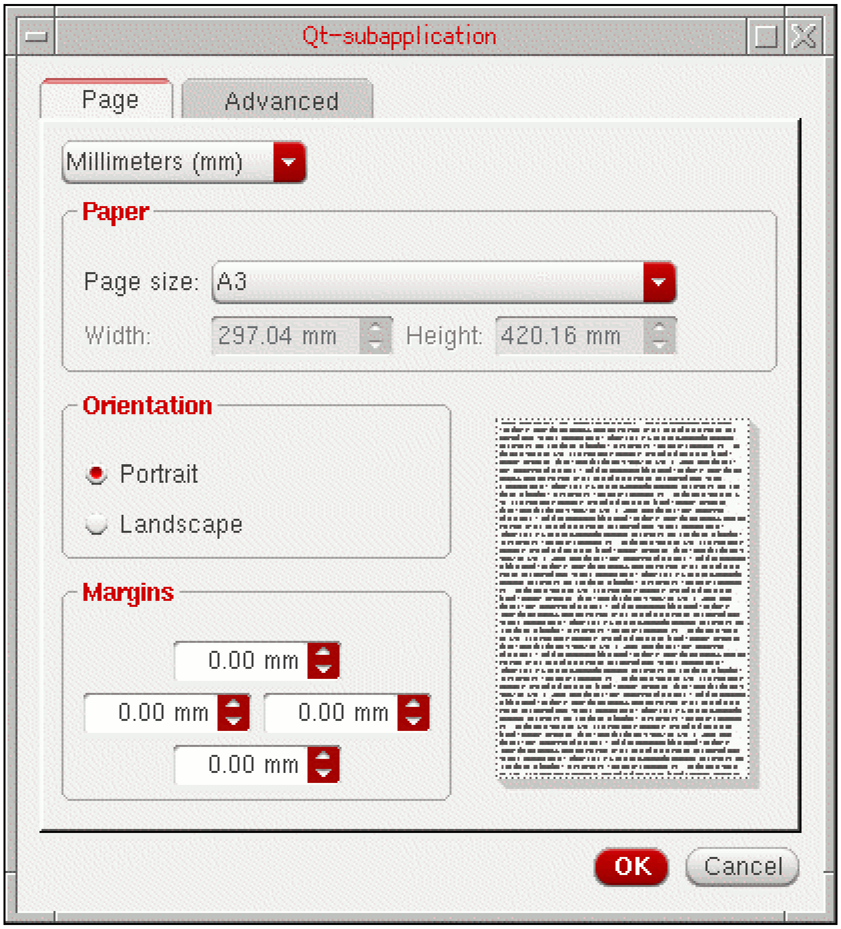
□ Reverse

2. In the *Printer* group box, do the following:

❑ In the *Name* drop-down list box, specify the printer name.

❑ To set properties for the print job, click the *Properties* button next to the *Name* field.

The *Qt-subapplication* form appears. This form has two tabs—*Page* and *Advanced*. The *Advanced* tab is currently not available.



Millimeters (mm)

Page size: A3

Width: 297.04 mm Height: 420.16 mm

● Portrait

○ Landscape

0.00 mm

0.00 mm 0.00 mm

0.00 mm

- On the *Page* tab, specify the following fields:
  - Select the units, such as *Centimeters (cm),* or *Millimeters (mm)*, in which you want the paper size to be displayed.
  - In the *Paper* group box, select the required page size in the *Page size* drop-down list box. The *Width* and *Height* fields display the default paper settings for that page size in the specified units.

  Note: The default settings are defined by the `LC_ALL` environment variable on your computer.

  - In the *Orientation* group box, select the print orientation as *Portrait* or *Landscape*.
  - In the *Margin* group box, select the top, left, right, and bottom margins.

        - Click *OK* to save the settings.

Note: If you have specified a printer name in *Destination*, this field becomes disabled.

- Click the *Options* button to view the other printing options. When you click this button, two tabs are displayed in the *Print* form—C*opies* and *Options.*
    - On the *Copies* tab, do the following:
        - In the *Print range* group box, specify the range of pages that you want to print. By default, all pages are printed.
        - On the Output Settings tab, specify the number of copies you want to print. In addition, specify the type in which you want the pages to be printed—*Collate* or *Reverse*.
    - On the *Options* tab, do the following:
        - Specify *Duplex Printing* as *None, Long side*, or *Short side*.
        - Specify *Color Mode* as *Color* or *Grayscale*.
- Click *Print*.

A

Virtuoso Visualization and Analysis XL Tool Environment Variables

The variables and values that specify the basic behavior of the components of the Virtuoso Visualization and Analysis XL are part of the `.cdsenv` file. For information about the order in which the tool reads the `.cdsenv` file, see Creating the .cdsenv File in Chapter 10 of the *Cadence Design FrameworkII User Guide*.

This appendix describes the Virtuoso Visualization and Analysis XL tool variables in the `.cdsenv` file. In each entry, the first column is the tool, the second column is the variable, the third column is the data type, and the fourth column contains the value to be used.

In the SKILL mode, you can use the `envGetVal` and `envSetVal` functions to retrieve and set the `.cdsenv` variables in the CIW. For more information on the CIW or the `envGetVal` and `envSetVal` functions, see Chapter 2 in the *Cadence User Interface SKILL Functions Reference*.

The environment variables for Results Browser and Calculator are included in the .cdsenv file at the following location:

```
./tools.lnx86/dfII/samples/wavescan/.cdsenv
```

The environment variables for graph are included in the .cdsenv file at the following location:

```
./tools.lnx86/dfII/samples/viva/.cdsenv
```

Graph Variables

The following tables list the environment variables for the Virtuoso Visualization and Analysis XL graph:

Graph Variables

```
viva.graph   titleFont       string "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.graph   subTitle           string ""        nil
viva.graph   displayDate        string "true"    nil
viva.graph   useDefaultTitle    string "true"    nil
viva.graph   defaultSubtitle    string "true"    nil
viva.graph   traceMarkerOn      string "true"    nil
viva.graph   snapOn             string "snapOff" nil
viva.graph   selectByFamily     string "false"   nil
viva.graph   useCurrentContext  string "true"    nil
```

Graph Frame Variables

```
viva.graphFrame     width           string "1000"    nil
viva.graphFrame     height          string "800"     nil
viva.graphFrame     autoTraceSelect string "true"    nil
viva.graphFrame     rightMouseZoom  string "false"   nil
viva.graphFrame     selectBySweep   string "false"   nil
viva.graphFrame     useSplitter     string "true"    nil
viva.graphFrame     title           string "Window"  nil
viva.graphFrame     graphMinWidth   string "200"     nil
viva.graphFrame     graphMinHeight  string "140"     nil
```

Rectangular Graph Variables_

```
viva.rectGraph foreground             string "white"    nil
viva.rectGraph background             string "black"    nil
viva.rectGraph useGradient            string "false"    nil
viva.rectGraph traceMarkerDisplay     string "(%X, %Y)" nil
viva.rectGraph referenceLinesOn       string "true"     nil
viva.rectGraph enableEdgeMeasurement  string "false"    nil
```

Strip Variables_

```
viva.rectGraph      stripChartOn       string "false" nil
viva.rectGraph     stripByFamily       string "false" nil
viva.rectGraph     stripHeight         string "50" nil
viva.rectGraph     minStripHeight      string "32" nil
viva.rectGraph     activeStripCue      string "Vertical Bar" nil
viva.rectGraph     activeStripCueColor string "yellow" nil
```

Digital Strip Variables

```
viva.rectGraph     digitalStripHeight    string "32" nil
viva.rectGraph     maxDigitalStripHeight string "40" nil
viva.rectGraph     minDigitalStripHeight string "32" nil
```

Circular Graph Variables

```
viva.circGraph     background              string "white" nil
viva.circGraph     foreground              string "black" nil
viva.circGraph     useGradient             string "false" nil
viva.circGraph     gridType                string "Polar" nil
viva.circGraph     traceMarkerDisplay      string "(R=%R, I=%I)
(M=%M, P=%P)"    nil
viva.circGraph     traceMarkerAlwaysVisible    string "false" nil
viva.circGraph     characteristicImpedance string "50"    nil
viva.circGraph     normalizeSmithValues    string "true"  nil
viva.circGraph     plotToSmithView         string "false" nil
```

Axis Variables

```
viva.axis     majorGridsOn        string "true"      nil
viva.axis     minorGridsOn        string "true"      nil
viva.axis     majorGridForeground string "gray"      nil
viva.axis     minorGridForeground string "lightGray" nil
viva.axis     autoAxisColor       string "true"      nil
viva.axis     foreground          string "white"     nil
viva.axis     background          string "black"     nil
viva.axis     font                string "Default,10,-
1,5,50,0,0,0,0,0"    nil
viva.axis     majorTicsOn         string "true"      nil
viva.axis     minorTicsOn         string "true"      nil
```

Dependent Axis Variables

```
viva.depAxis     baseAndToplineReferenceHint string "0.0,5.0" nil
viva.depAxis     threshold                   string "20,80"  nil
viva.depAxis     logScale                    string "false"  nil
viva.depAxis     forceOrigin                 string "false"  nil
viva.depAxis     notation                    string "suffix" nil
```

Independent Axis Variables

```
viva.indepAxis     logScale        string "false"  nil
viva.indepAxis     forceOrigin     string "false"  nil
viva.indepAxis     notation        string "suffix" nil
```

Trace Variables

```
viva.trace     hiliteColor           string "lime"          nil
viva.trace     useGlow               string "false"         nil
viva.trace     lineThickness         string "fine"          nil
viva.trace     lineStyle             string "solid"         nil
viva.trace     depModifier           string "Magnitude"     nil
viva.trace     indepModifier         string "Magnitude"     nil
viva.trace     symbolsOn             string "false"         nil
viva.trace     symbolStyle           string "plus"          nil
viva.trace     symbolCount           string "20"            nil
viva.trace     symbolCountAll        string "true"          nil
viva.trace     toplineOn             string "true"          nil
viva.trace     midlineOn             string "true"          nil
viva.trace     baselineOn            string "true"          nil
viva.trace     dToAHiVoltage         string "5.0"           nil
viva.trace     dToALoVoltage         string "0.0"           nil
viva.trace     dToAXVoltage          string "(vhi + vlo)/2" nil
viva.trace     dToAUnit              string "V"             nil
viva.trace     autoReferenceLines    string "true"          nil
viva.trace     baseAndtoplineReferenceHint   string "5.0"   nil
```

Digital Trace Variable

```
viva.digitalTrace     foreground      string "green" nil
```

Digital Bus Trace Variables

```
viva.digitalBusTrace     radix          string "hex"   nil
viva.digitalBusTrace     foreground     string "green" nil
```

Horizontal Marker Variables

```
viva.horizMarker     font                string "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.horizMarker     notation            string "suffix"      nil
viva.horizMarker     defaultLabel        string "%M"          nil
viva.horizMarker     foreground          string "black"       nil
viva.horizMarker     interceptStyle      string "OnWhenHover" nil
viva.horizMarker     lineStyle           string "dash"        nil
viva.horizMarker     snapPoint           string "Data Point"  nil
viva.horizMarker     snapPointDataValue  string "0.0"         nil
```

Vertical Marker Variables

```
viva.vertMarker     font                string "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.vertMarker     notation            string "suffix"      nil
viva.vertMarker     defaultLabel        string "%M"          nil
viva.vertMarker     foreground          string "black"       nil
viva.vertMarker     interceptStyle      string "OnWhenHover" nil
viva.vertMarker     lineStyle           string "dash"        nil
viva.vertMarker     snapPoint           string "Data Point"  nil
viva.vertMarker     snapPointDataValue  string "0.0"         nil
```

Point Marker Variables

```
viva.pointMarker     font                string "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.pointMarker     notation            string "suffix"       nil
viva.pointMarker     defaultLabel        string "%M: %X %Y"    nil
viva.pointMarker     foreground          string "black"        nil
viva.pointMarker     background          string "white"        nil
viva.pointMarker     circDefaultLabel    string "%M: %F Hz  %C" nil
viva.pointMarker     foreground          string "black"        nil
viva.pointMarker     snapPoint           string "Data Point"   nil
viva.pointMarker     snapPointDataValue string "0.0"           nil
vivs.pointMarker     drawCrossHairs      string "Dynamic"     nil
```

Reference Line Marker Variables

```
viva.referenceLineMarker interceptStyle   string "off"       nil
viva.referenceLineMarker lineStyle        string "Dot"       nil
viva.referenceLineMarker foreground       string "aquamarine" nil
viva.referenceLineMarker font             string "Default,8,-
1,5,55,0,0,0,0,0"  nil
viva.referenceLineMarker defaultLabel      string "%Y"        nil
viva.referenceLineMarker significantDigits string "8"         nil
```

Reference Point Marker Variables

```
viva.refPointMarker    font               string "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.refPointMarker    notation           string "suffix"    nil
viva.refPointMarker    defaultLabel       string "%X %Y"     nil
viva.refPointMarker    drawCrossHairs     string "Dynamic"   nil
viva.refPointMarker    circDefaultLabel   string "%F Hz  %C" nil
viva.refPointMarker    foreground         string "black"     nil
viva.refPointMarker    snapPoint          string "Data Point" nil
viva.refPointMarker    snapPointDataValue string "0.0"       nil
```

Spec Marker Variables

```
viva.specMarker     font         string   "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.specMarker     passcolor    string   "#00CC00"    nil
viva.specMarker     failcolor    string   "#CC0000"    nil
viva.specMarker     lineStyle    string   "solid"      nil
viva.specMarker     displayMode  string   "both"       nil
viva.specMarker     rule         string   "range"      nil
viva.specMarker     expression   string   ""           nil
```

Intercept Marker Variables

```
viva.interceptMarker     font         string "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.interceptMarker     foreground   string "black"    nil
viva.interceptMarker     background   string "white"    nil
```

Circle Marker Variables

```
viva.circleMarker     font          string "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.circleMarker     notation      string "suffix"     nil
viva.circleMarker     defaultLabel  string "%M: %X %Y"  nil
viva.circleMarker     foreground    string "black"      nil
viva.circleMarker     background    string "white"      nil
```

Delta Marker Variables

```
viva.multiDeltaMarker      defaultLabel    string "dx:%W dy:%H
(%S)" nil
viva.multiDeltaMarker      font            string "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.multiDeltaMarker      notation        string "suffix"    nil
viva.multiDeltaMarker      foreground      string "black"     nil
viva.multiDeltaMarker      deltaMeasure    string
"DeltaMeasureModeXOnly" nil
```

Transient Edge Marker Variables

```
viva.transEdgeMarker    font string "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.transEdgeMarker   notation            string "suffix" nil
viva.transEdgeMarker   defaultLabel        string "%M" nil
viva.transEdgeMarker   foreground          string "black" nil
viva.transEdgeMarker   lineStyle           string "dash" nil
viva.transEdgeMarker   snapPoint           string "Data Point" nil
viva.transEdgeMarker   snapPointDataValue string "0.0" nil
viva.transEdgeMarker   showMeasSummary     string "false" nil
```

Graph Label Variables

```
viva.graphLabel     font       string "Default,10,-
1,5,50,0,0,0,0,0" nil
viva.graphLabel     foreground string "white"      nil
viva.graphLabel     background string "lightGray"  nil
```

Probe Variables

```
viva.probe     font               string  Default,10,-
1,5,50,0,0,0,0,0" nil
viva.probe     foreground         string "black" nil
viva.probe     background         string "white" nil
viva.probe     autoTopBaseline    string "true"  nil
viva.probe     topLine            string "0.0"   nil
viva.probe     baseLine           string "0.0"   nil
viva.probe     autoMinMax         string "true"  nil
viva.probe     minValue           string "0.0"   nil
viva.probe     maxValue           string "0.0"   nil
```

Polar Grid Variables

```
viva.polarGrid     font              string "Default,10,-
1,5,50,0,0,0,0,0"    nil
viva.polarGrid     numCircles        string "4"           nil
viva.polarGrid     circlesOn         string "true"        nil
viva.polarGrid     circlesLabelsOn   string "true"        nil
viva.polarGrid     numRadials        string "2"           nil
viva.polarGrid     radialsOn         string "true"        nil
viva.polarGrid     radialsLabelsOn   string "true"        nil
```

Smith Grid Variables

```
viva.smithGrid     highlightUnitCircle string "true"       nil
viva.smithGrid     showAxes            string "true"       nil
viva.smithGrid     showOrigin          string "true"       nil
viva.smithGrid     showCurves          string "true"       nil
viva.smithGrid     showMinorCurves     string "true"       nil
viva.smithGrid     font                string "Default,10,-
1,5,50,0,0,0,0,0"    nil
viva.smithGrid     showPerimeterLabels string "true"       nil
```

Calculator Environment Variables

The following table lists the environment variables for the Calculator:

Calculator Variables

```
wavescan.calculator     usePreviousGuiSettings   string "true"
wavescan.calculator     rpnMode                  string "true"
wavescan.calculator     clipSelectionMode        string "true"
wavescan.calculator     displayContext           string "true"
wavescan.calculator     plotstyle                string "append"
wavescan.calculator     signalselection          string "off"
wavescan.calculator     familyMode               string "false"
wavescan.calculator     defaultCategory          string "Special 
Functions"
wavescan.calculator useSkill string "false" nil
wavescan.calculator useAwdResultsDisplay string "false" nil
wavescan.calculator     reportVarErrors          string "false"
wavescan.calculator     stackSize                string "8"
wavescan.calculator     undoStackSize            string "8"
wavescan.calculator     signalHistorySize        string "8"
wavescan.calculator     xLocation                string "600"
wavescan.calculator     yLocation                string "50"
wavescan.calculator     width                    string "640"
wavescan.calculator     height                   string "330"
wavescan.calculator     significantDigits        string "4"
wavescan.calculator     notation                 string "suffix"
wavescan.calculator     showKeypad               string "true"
wavescan.calculator sizeKeyPad string "small" nil
wavescan.calculator     showStack                string "true"
wavescan.calculator     mathToolBar              string "false"
wavescan.calculator     trigToolBar              string "false"
wavescan.calculator     schematicToolBar         string "true"
wavescan.calculator     schematicAnalyses        string "false"
```

User Button Variables

```
wavescan.calculator userButton1  string "user 1;undefined"  nil
wavescan.calculator userButton2  string "user 2;undefined"  nil
wavescan.calculator userButton3  string "user 3;undefined"  nil
wavescan.calculator userButton4  string "user 4;undefined"  nil
wavescan.calculator userButton5  string "user 5;undefined"  nil
wavescan.calculator userButton6  string "user 6;undefined"  nil
wavescan.calculator userButton7  string "user 7;undefined"  nil
wavescan.calculator userButton8  string "user 8;undefined"  nil
wavescan.calculator userButton9  string "user 9;undefined"  nil
wavescan.calculator userButton10 string "user 10;undefined" nil
wavescan.calculator userButton11 string "user 11;undefined" nil
wavescan.calculator userButton12 string "user 12;undefined" nil
```

Results Browser Environment Variables

The following tables list the environment variables for the Results Browser:

Results Browser Variables

```
wavescan.browser      historyLength              string "10"
wavescan.browser      plotStyle                  string "replace"
wavescan.browser      dataDirHome                string "./"
```

Results Browser

```
wavescan.application  docdirectory               string "./"
wavescan.application  readDefaultVarFileOnStartup string "false"
wavescan.application  writeDefaultVarFileOnExit  string "false"
wavescan.application  defaultVarFileName         string
".wsvariables"
wavescan.application  printer                    string ""
wavescan.application  papersize                  string "sticky"
wavescan.application mixedsignalmode string "false" nil
wavescan.application useBold string "false" nil
wavescan.application  enablertsf                 string "true"
```

Exp Handler Variable

```
wavescan.expressionHandler  ignoreTokenContext   string "true"
```

Graph Variables

This section describes the environment variables that are used to set the graph properties:

Graph Frame Variables

- `viva.graphFrame width string "1000" nil`
- `viva.graphFrame height string "800" nil`
- `viva.graphFrame autoTraceSelect string "true" nil`
- `viva.graphFrame rightMouseZoom string "false" nil`
- `viva.graphFrame selectBySweep string "false" nil`
- `viva.graphFrame useSplitter string "true" nil`
- `viva.graphFrame title string "Window" nil`

Below is the description of all the graph frame variables:

width

Controls the width of the Graph Window.

Syntax

`viva.graphFrame width string "`*`width_pixels`*`"`

Values

`width_pixels`	Width of the graph window. Default: Valid values: A positive integer

Example

```
viva.graphFrame width string "1000" nil
```

height

Controls the height of the Graph Window.

Syntax

```
viva.graphFrame height string "height_pixels"
```

Values

height_pixels	Height of the graphwindow. Default: Valid values: A positive intege

Example

```
viva.graphFrame height string "800" nil
```

autoTraceSelect

Specifies whether the tool selects the trace closest to the system cursor.

Syntax

```
viva.graphFrame autoTraceSelect string "true" | "false"
```

Values

`true`	The tool automatically selects the trace closest to the system cursor. This is the default value.
`false`	The tool does not select a trace automatically.

Example

```
viva.graphFrame autoTraceSelect string "true" nil
```

rightMouseZoom

Specifies whether you can use the right mouse button to zoom your graph.

Syntax

```
viva.graphFrame rightMouseZoom string "true" | "false"
```

Values

`true`	Use the right mouse button to zoom your graph.This is the default value.
`false`	Use the middle mouse button to zoom your graph. This enables the right mouse pop-up menu in the Graph Window.

Example

```
viva.graphFrame rightMouseZoom string "false" nil
```

selectBySweep

Specifies whether traces from parametric sweeps are selected by family or by individual leaf.

Syntax

```
viva.graphFrame selectBySweep string "true" | "false"
```

Values

`true`	The *Trace – Select by Family* command is selected.
`false`	The *Trace – Select by Family* command is not selected. This is the default value.

Example

```
viva.graphFrame selectBySweep string "false" nil
```

useSplitter

Syntax

`viva.graphFrame useSplitter string "true" | "false"`

Values

`true`	This is the default value.
`false`	

Example

```
viva.graphFrame useSplitter string "true" nil
```

title

Specifies the title of the graph window.

`viva.graphFrame title string "`*`window_title`*`"`

Values

`window_title`	The title for the graph window.

Example

```
viva.graphFrame title string "Window" nil
```

Graph Environment Variables

- `viva.graph titleFont string"Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.graph subTitle string "" nil`
- `viva.graph displayDate string "true" nil`
- `viva.graph useDefaultTitle string "true" nil`
- `viva.graph defaultSubtitle string "true" nil`

- `viva.graph traceMarkerOn string "true" nil`
- `viva.graph snapOn string "snapOff" nil`
- `viva.graph selectByFamily string "false" nil`
- `viva.graph useCurrentContext string "true" nil`

Rectangular Graphs Environment Variables

- `viva.rectGraph foreground string "white" nil`
- `viva.rectGraph background string "black" nil`
- `viva.rectGraph useGradient string "false" nil`
- `viva.rectGraph traceMarkerDisplay string "(%X, %Y)" nil`
- `viva.rectGraph referenceLinesOn string "true" nil`
- `viva.rectGraph enableEdgeMeasurement string "false" nil`

Strip Environment Variables

- `viva.rectGraph stripChartOn string "false" nil`
- `viva.rectGraph stripByFamily string "false" nil`
- `viva.rectGraph stripHeight string "50" nil`
- `viva.rectGraph minStripHeight string "32" nil`
- `viva.rectGraph activeStripCue string "Vertical Bar" nil`
- `viva.rectGraph activeStripCueColor string "yellow" nil`

Digital Strip Environment Variables

- `viva.rectGraph digitalStripHeight string "32" nil`
- `viva.rectGraph maxDigitalStripHeight string "40" nil`
- `viva.rectGraph minDigitalStripHeight string "32" nil`

Circular Graph Environment Variables

- `viva.circGraph background string "white" nil`
- `viva.circGraph foreground string "black" nil`
- `viva.circGraph useGradient string "false" nil`
- `viva.circGraph gridTypestring "Polar" nil`
- `viva.circGraph traceMarkerDisplay string "(R=%R, I=%I) (M=%M, P=%P)" nil`
- `viva.circGraph characteristicImpedance string "50" nil`
- `viva.circGraph normalizeSmithValues string "true" nil`
- `viva.circGraph plotToSmithView string "false" nil`
- `viva.circGraph traceMarkerAlwaysVisible string "false" nil`

  The `traceMarkerDisplay` environment variable is used to display values for the tracking marker (trace marker). The following formats are supported to display the trace marker values:

  - `%C` —Displays the real and imaginary cartesian values
  - `%Z`—Displays the impedance values, such as resistance and reactance
  - `%A`—Displays the admittance values, such as conductance and susceptance
  - `%R`—Displays the reflection coefficients, such as mag and angle
  - `%P`—Displays the polar values, such as mag and angle
  - `%F`—Displays the frequency value, which includes the independent axis data

Axis Environment Variables

- `viva.axis majorGridsOn string "true" nil`
- `viva.axis minorGridsOn string "true" nil`
- `viva.axis majorGridForeground string "gray" nil`
- `viva.axis minorGridForeground string "lightGray" nil`
- `viva.axis autoAxisColor string "true" nil`
- `viva.axis foreground string "white" nil`

- `viva.axis background string "black" nil`
- `viva.axis font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.axis majorTicsOn string "true"nil`
- `viva.axis minorTicsOn string "true" nil`

Dependent Axis Environment Variables

- `viva.depAxis baseAndToplineReferenceHint string "0.0,5.0" nil`
- `viva.depAxis threshold string "20,80" nil`
- `viva.depAxis logScale string "false" nil`
- `viva.depAxis forceOrigin string "false" nil`
- `viva.depAxis notation string "suffix" nil`

Independent Axis Environment Variables

- `viva.indepAxis logScale string "false" nil`
- `viva.indepAxis forceOrigin string "false" nil`
- `viva.indepAxis notation string "suffix" nil`

Trace Environment Variables

- `viva.trace hiliteColor string "lime" nil`
- `viva.trace useGlow string "false" nil`
- `viva.trace lineThickness tring "fine" nil`
- `viva.trace lineStyle string "solid" nil`
- `viva.trace depModifier string "Magnitude" nil`
- `viva.trace indepModifier string "Magnitude" nil`
- `viva.trace symbolsOn string "false" nil`
- `viva.trace symbolStyle string "plus" nil`
- `viva.trace symbolCount string "20" nil`

- `viva.trace symbolCountAll string "true" nil`
- `viva.trace toplineOn string "true" nil`
- `viva.trace midlineOn string "true" nil`
- `viva.trace baselineOn string "true" nil`
- `viva.trace dToAHiVoltage string "5.0" nil`
- `viva.trace dToALoVoltage string "0.0" nil`
- `viva.trace dToAXVoltage string "(vhi + vlo)/2" nil`
- `viva.trace dToAUnit string "V" nil`
- `viva.trace autoReferenceLines string "true" nil`
- `viva.trace baseAndtoplineReferenceHint string "5.0" nil`
- `viva.trace threshold string "20_80" nil`

Digital Trace Environment Variables

- `viva.digitalTrace foreground string "green" nil`

Digital Bus Trace Environment Variables

- `viva.digitalBusTrace radix string "hex" nil`
- `viva.digitalBusTrace foreground string "green" nil`

Horizontal Marker Environment Variables

- `viva.horizMarker font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.horizMarker notation string "suffix" nil`
- `viva.horizMarker defaultLabel string "%M" nil`
- `viva.horizMarker foreground string "black" nil`
- `viva.horizMarker interceptStyle string "OnWhenHover" nil`
- `viva.horizMarker lineStyle  string "dash" nil`
- `viva.horizMarker snapPoint string "Data Point" nil`

- `viva.horizMarker snapPointDataValue string "0.0" nil`

Reference Line Marker Environment Variables

- `viva.referenceLineMarker interceptStyle string "off" nil`
- `viva.referenceLineMarker lineStyle string "Dot" nil`
- `viva.referenceLineMarker foreground string "aquamarine" nil`
- `viva.referenceLineMarker font string "Default,8,-1,5,55,0,0,0,0,0" nil`
- `viva.referenceLineMarker defaultLabel string "%Y" nil`
- `viva.referenceLineMarker significantDigits string "8" nil`

Vertical Marker Environment Variables

- `viva.vertMarker font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.vertMarker notation string "suffix" nil`
- `viva.vertMarker defaultLabel string "%M" nil`
- `viva.vertMarker foreground string "black" nil`
- `viva.vertMarker interceptStyle string "OnWhenHover" nil`
- `viva.vertMarker lineStyle string "dash" nil`
- `viva.vertMarker snapPoint string "Data Point" nil`
- `viva.vertMarker snapPointDataValue string "0.0" nil`

Point Marker Environment Variables

- `viva.pointMarker font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.pointMarker notation string "suffix" nil`
- `viva.pointMarker defaultLabel string "%M: %X %Y" nil`
- `viva.pointMarker foreground string "black" nil`
- `viva.pointMarker background string "white" nil`
- `viva.pointMarker foreground string "black" nil`

- `viva.pointMarker snapPoint string "Data Point" nil`
- `viva.pointMarker snapPointDataValue string "0.0" nil`
- `viva.pointMarker drawCrossHairs string "Dynamic" nil`
- `viva.pointMarker circDefaultLabel string "%M: %F Hz  %C" nil`

  The following label formats are supported:

  - ❑ `%C`—Real and imaginary (complex)
  - ❑ `%P`—Gamma (polar)
  - ❑ `%Z`—Impedance
  - ❑ `%A`—Admittance
  - ❑ `%R`—Reflection
  - ❑ `%F`—Frequency

Reference Point Marker Environment Variables

- `viva.refPointMarker font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.refPointMarker notation string "suffix" nil`
- `viva.refPointMarkerdrawCrossHairs string "Off" nil`
- `viva.refPointMarker foreground string "black" nil`
- `viva.refPointMarker snapPoint string "Data Point" nil`
- `viva.refPointMarker snapPointDataValue string "0.0" nil`
- `viva.refPointMarker defaultLabel string "%X %Y" nil`
- `viva.refPointMarker circDefaultLabel string "%F Hz  %C" nil`

  The following label formats are supported:

  - ❑ `%C`—Real and imaginary (complex)
  - ❑ `%P`—Gamma (polar)
  - ❑ `%Z`—Impedance
  - ❑ `%A`—Admittance

- ❑ `%R`—Reflection

Specification Marker Environment Variables

- `viva.specMarker font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.specMarker passcolor string "#00CC00" nil`
- `viva.specMarker failcolor string "#CC0000" nil`
- `viva.specMarker lineStyle string "solid" nil`
- `viva.specMarker displayMode string "both" nil`
- `viva.specMarker rule string "range" nil`
- `viva.specMarker expression string "" nil`

Intercept Marker Environment Variables

- `viva.interceptMarker font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.interceptMarker foreground string "black" nil`
- `viva.interceptMarker lineStyle string "solid" nil`

Circle Marker Environment Variables

- `viva.circleMarker font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.circleMarker notation string "suffix" nil`
- `viva.circleMarker defaultLabel string "%M: %X %Y" nil`
- `viva.circleMarker foreground string "black" nil`
- `viva.circleMarker background string "white" nil`

Delta Marker Environment Variables

- `viva.multiDeltaMarker defaultLabel string "dx:%W dy:%H s:%S" nil`
- `viva.multiDeltaMarker font string "Default,10,-1,5,50,0,0,0,0,0" nil`

- `viva.multiDeltaMarker notation string "suffix" nil`
- `viva.multiDeltaMarker foreground string "black" nil`
- `viva.multiDeltaMarker deltaMeasure string "DeltaMeasureModeXOnly" nil`
- `viva.multiDeltaMarker showChildLabels string "true" nil`

Transient Edge Marker Environment Variables

- `viva.transEdgeMarker font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.transEdgeMarker notation string "suffix" nil`
- `viva.transEdgeMarker defaultLabel string "%M" nil`
- `viva.transEdgeMarker foreground string "black" nil`
- `viva.transEdgeMarker lineStyle string "dash" nil`
- `viva.transEdgeMarker snapPoint string "Data Point" nil`
- `viva.transEdgeMarker snapPointDataValue string "0.0" nil`
- `viva.transEdgeMarker showMeasSummary string "false" nil`

Graph Label Environment Variables

- `viva.graphLabel font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.graphLabel foreground string "white" nil`
- `viva.graphLabel background string "lightGray" nil`

Probe Environment Variables

- `viva.probe font string Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.probe foreground string "black" nil`
- `viva.probe background string "white" nil`
- `viva.probe autoTopBaseline string "true" nil`
- `viva.probe topLine string "0.0" nil`

- `viva.probe baseLine string "0.0" nil`
- `viva.probe autoMinMax string "true" nil`
- `viva.probe minValue string "0.0" nil`
- `viva.probe maxValue string "0.0" nil`

Polar Grid Environment Variables

- `viva.polarGrid font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.polarGrid numCircles string "4" nil`
- `viva.polarGrid circlesForeground string "gray" nil`
- `viva.polarGrid circlesOn string "true" nil`
- `viva.polarGrid circlesLabelsOn string "true" nil`
- `viva.polarGrid numRadials string "2" nil`
- `viva.polarGrid radialsOn string "true" nil`
- `viva.polarGrid radialsLabelsOn string "true" nil`

Smith Grid Environment Variables

- `viva.smithGrid highlightUnitCircle string "true" nil`
- `viva.smithGrid showAxes string "true" nil`
- `viva.smithGrid showOrigin string "true" nil`
- `viva.smithGrid showCurves string "true" nil`
- `viva.smithGrid showMinorCurves string "true" nil`
- `viva.smithGrid font string "Default,10,-1,5,50,0,0,0,0,0" nil`
- `viva.smithGrid showPerimeterLabels string "true" nil`

Results Browser Variables

historyLength

Specifies the maximum number of dataset paths saved in the *Location* pull-down in the Results Browser window.

Syntax

```
wavescan.browser historyLength string "maxDirectories"
```

Values

maxDirectories	Maximum number of data directories that fit in the *Location* field. Default: `10` Valid values: 0–20

plotstyle

Specifies the default plotting style for a new graph. This sets the default value for the plot style pull-down in the top right corner of the Results Browser window.

Syntax

```
wavescan.browser plotStyle string "Append" | "Replace" | "New SubWin" | "New
     Win"
```

Values

`append`	Appends the new graph to the current graph.
`replace`	Replaces the current graph with the new graph. This is the default value.
`newsub`	Plots the graph in a new subwindow.
`newwin`	Plots the graph in a new window.

dataDirHome

Specifies the default directory for the Choose Data Directory dialog box.

Syntax

```
wavescan.browser dataDirHome string "directory"
```

Values

directory	Directory which the Choose Data Directory dialog box defaults to. Default: `./`

Calculator Variables

usePreviousGuiSettings

Specifies whether the local defaults are to override the .cdsenv settings.

Syntax

```
wavescan.calculator usePreviousGuiSettings string "true" | "false"
```

Values

`true`	Local defaults for the following variables to override the `.cdsenv` settings: .`showKeyPad`, `showStack`, `rpnMode`, `clipSelectionMode`, `signalSelection`, `plotStyle`, `defaultCategory`, `mathToolBar`,`TrigToolBar`, `schematicToolBar`, `schematicAnalyses`, `userButton`, `xLocation`, `yLocation`, `width`, and `height`. This is the default value.
`false`	`.cdsenv` variable settings to override the local defaults.

rpnMode

Specifies whether the Calculator is in the rpn mode by default. You can change this setting through the Options menu in the Calculator window (*Options–Set RPN*).

Syntax

```
wavescan.calculator rpnMode string "true" | "false"
```

Values

`true`	Calculator is in rpn mode. This is the default value.
`false`	Calculator is in algebraic mode.

clipSelectionMode

Controls whether the *Clip* checkbox is selected by default in the Calculator window.

Syntax

```
wavescan.calculator clipSelectionMode string "true" |"false"
```

Values

`true`	The *Clip* checkbox is selected, hence the calculator works on the visible X-axis of a zoomed in trace. This is the default value.
`false`	The *Clip* checkbox is not selected, hence the calculator works on the complete trace.

displayContext

Specifies whether the test (in ADE XL mode) or results directory (in ADE L mode) is displayed.

Syntax

```
wavescan.calculator displayContext string "true" | "false"
```

Values

`true`

Test and *Results Dir* are displayed in the ADE XL mode. If there is no current test, only the results directory is displayed. In ADE L mode, the results directroy is displayed.
This is the default value.

`false`

Test and *Results Dir* are not displayed.

plotStyle

Controls the plot destination for graphs from the Calculator window.

Syntax

```
wavescan.calculator signalselection string "append" |"replace" | "new
    Subwindow" |"New Window"
```

Values

`append`	The trace is appended to an existing graph. This is the default value.
`replace`	The trace replaces the existing trace.
`new Subwindow`	The trace is plotted to a new subwindow.
`new Window`	The trace is plotted to a new window.

signalselection

Controls the *Selection choices* in the Calculator window.

Syntax

```
wavescan.calculator signalselection string "off" |"wave" | "family"
```

Values

`off`	Selection choice in the Calculator window is set to off. This is the default value.
`wave`	Selection choice in the Calculator window is set to *wave*.
`family`	Selection choice in the Calculator window is set to *family*.

familyMode

Controls whether the *Family* button is selected by default in the Calculator window.

Syntax

```
wavescan.calculator familyMode string "true" | "false"
```

Values

`true`	The *Family* button is selected.
`false`	The *Family* button is not selected. This is the default value.

defaultCategory

Specifies the function category to be displayed.

Syntax

```
wavescan.calculator displayContext string "All" | "Favorites" | "Math" |
     "Modifier" | "Programmed Keys" | "RF Functions" | "Special Functions" |
     "Trigonometric" | "AWD Programmed Keys" | "SKILL Defined User Functions"
     | "Memories"
```

Values

`All`	Displays all the functions.
`Favorites`	Displays your favorite functions.
`Math`	Displays the math functions.
`Modifier`	Displays the modifier functions.
`Programmed Keys`	Displays the programmed keys.
`RF Functions`	Displays the RF functions.
`Special Functions`	Displays the special functions. This is the default value.
`Trigonometric`	Displays the trigonometric functions.
`AWD Programmed Keys`	Displays the AWD programmed keys.
`SKILL Defined User Functions`	Displays the SKILL defined functions.
`Memories`	Displays the memories you created.

reportVarErrors

Controls whether the Calculator reports errors when validating an MDL expression that contains variables. This variable applies to ViVA only in the MDL mode.

Syntax

```
wavescan.calculator reportVarErrors string "true" | "false"
```

Values

`true`	Calculator reports errors when validating an MDL expression that contains variables.
`false`	Calculator does not report errors when validating an MDL expression that contains variables. This is the default value.

sizeKeyPad

Controls the size of buttons of numeric keypad. It can be defined in small, medium or large sizes.

Syntax

wavescan.caculator sizeKeyPad string "small" "medium" "large"

Values

small	Button size will be small. This is default value
medium	Button size will be 1.5 times of small buttons.
large	Button size will be 2 times of small buttons.

stackSize

Controls the maximum number of expressions displayed in the Calculator stack. A scrollable list is displayed after this number is exceeded.

Syntax

```
wavescan.calculator stackSize string "stack_number"
```

Values

stack_number	Number of expressions displayed in the Calculator. Default: 8 Valid values: 0–20

undoStackSize

Controls the maximum number of commands that can be undone.

Syntax

```
wavescan.calculator undoStackSize string "undo_stack_number"
```

Values

undo_stack_number	Number of commands that can be undone. Default: `8` Valid values: 0–20

signalHistorySize

Controls the maximum number of items stored in the *Signal* field drop-down.

Syntax

```
wavescan.calculator signalHistorySize string "signal_history_size"
```

Values

signal_history_size Number of items stored in the *Signal* field drop-down in the function panel of the Calculator.
Default: 8
Valid values: 0–20

xLocation

Controls the position where the Calculator window appears.

Syntax

```
wavescan.calculator xLocation string "x_position"
```

Values

x_position	Horizontal distance of the Calculator window from the left of the screen. Default: `600` Valid values: A positive integer.

yLocation

Controls the position of the Calculator window.

Syntax

```
wavescan.calculator yLocation string "y_position"
```

Values

y_position	Vertical distance of the Calculator window from the top of the screen. Default: 50 Valid values: A positive integer.

width

Controls the width of the calculator window.

Syntax

`wavescan.calculator width string "`*`width_pixels`*`"`

Values

`width_pixels`	Width of the Calculator window. Default: `640` Valid values: A positive integer greater than 640.

height

Controls the height of the Calculator window.

Syntax

```
wavescan.calculator height string "height_pixels"
```

Values

height_pixels	Height of the Calculator window. Default: `330` Valid values: A positive integer greater than 330.

showKeypad

Specifies whether the keypad is displayed.

Syntax

```
wavescan.calculator showKeypad string "true" | "false"
```

Values

`true`	Keypad is displayed. This is the default value.
`false`	Keypad is not displayed.

showStack

Specifies whether the stack (in RPN mode) or history (in Algebraic mode) is displayed.

Syntax

```
wavescan.calculator showStack string "true" | "false"
```

Values

`true`	Stack is displayed.
`false`	Stack is not displayed. This is the default value.

mathToolBar

Specifies whether the Math tool bar is displayed by default.

Syntax

```
wavescan.calculator schematicToolBar string "true" | "false"
```

Values

`true`	Math tool bar is displayed.
`false`	Math tool bar is not displayed. This is the default value

trigToolBar

Specifies whether the trigonometric tool bar is displayed by default.

Syntax

```
wavescan.calculator schematicToolBar string "true" | "false"
```

Values

`true`	Trigonometric tool bar is displayed.
`false`	Trigonometric tool bar is not displayed. This is the default value.

schematicToolBar

Specifies whether the schematic access buttons (in ADE L and ADE XL modes) are displayed.

Syntax

```
wavescan.calculator schematicToolBar string "true" | "false"
```

Values

`true`	Schematic access buttons are displayed. This is the default value
`false`	Schematic access buttons are not displayed.

schematicAnalyses

Controls the analyses for which the schematic access buttons (in ADE L and ADE XL modes) are displayed. This variable is active only when the schematicToolBar variable is set to True.

Syntax

```
wavescan.calculator displayContext string "tran" | "ac" | "dc" | "sweptDc" |
     "info" | "noise" | "rf"
```

Values

`tran`	Displays the *vt* and *i* buttons.
`ac`	Displays *vf* and *if* buttons.
`dc`	Displays the *vdc* and *idc* buttons.
`sweptDc`	Displays the *vs* and *is* buttons.
`info`	Displays the *op*, *var*, *opt*, and *mp* buttons.
`noise`	Displays the *vn* and *vn2* buttons.
`rf`	Displays the *sp*, *zp*, *vswr*, *yp*, *hp*, *gd*, *zm*, and *data* buttons.

userButton

Associates a function with the *user* button.

Syntax

```
wavescan.calculator userButton1 string "abbreviation;function_name" nil
wavescan.calculator userButton2 string "abbreviation;function_name" nil
wavescan.calculator userButton3 string "abbreviation;function_name" nil
wavescan.calculator userButton4 string "abbreviation;function_name" nil
wavescan.calculator userButton5 string "abbreviation;function_name" nil
wavescan.calculator userButton6 string "abbreviation;function_name" nil
wavescan.calculator userButton7 string "abbreviation;function_name" nil
wavescan.calculator userButton8 string "abbreviation;function_name" nil
wavescan.calculator userButton9 string "abbreviation;function_name" nil
wavescan.calculator userButton10 string "abbreviation;function_name" nil
wavescan.calculator userButton11 string "abbreviation;function_name" nil
wavescan.calculator userButton12 string "abbreviation;function_name" nil
```

Values

abbreviation	Name to be displayed on the user button. You can enter up to 6 characters for the abbreviation.
function_name	Function to be associated with the *user* button.

Example

```
wavescan.calculator userButton1 string "bw;bandwidth" nil
```

B

Calculator Functions

This chapter describes the functions in the function panel for both the SKILL and MDL modes.

Table B-1 Functions in the SKILL Mode

1/x

10**x

a2d

abs

abs_jitter

acos

acosh

asin

asinh

atan

atanh

average

b1f

bandwidth

clip

compare

compression

compression VRI

convolve

cos

cosh

cross

d2a

dB10

dB20

dBm

delay

deriv

dft

dftbb

dnl

dutycycle

evmQAM

evmQpsk

exp

eyeDiagram

fallTime (SKILL Mode)

flip

fourEval

freq

frequency

freq_jitter

ga

gac_freq

gac_gain

gainBwProd

gainMargin

getAsciiWave

gmax

gmin

gmsg

gp

gpc_freq

gpc_gain

groupDelay

gt

gumx

harmonic

harmonicFreq

histo

iinteg

imag

int

kf

loadpull

ln

log10

lsb

lshift

mag

nc_freq

nc_gain

nf

nfmin

overshoot

pavg

peak

peakToPeak

period_jitter

phase

phaseDeg

phaseDegUnwrapped

phaseMargin

phaseNoise

phaseRad

phaseRadUnwrapped

PN

pow

prms

psd

psdbb

pstddev

pzbode

pzfilter

real

riseTime

rms

rmsNoise

rn

root

rshift

s11

s12

s21

s22

sample

settlingTime

sin

sinh

slewRate

spectralPower

spectrum

spectrumMeas

sqrt

ssb

stddev

tan

tangent

Table B-2 Functions in the MDL Mode

- abs
- acos
- acosh
- angle
- argmax
- argmin
- asin
- asinh
- atan
- atanh
- avg
- bw
- ceil
- cfft
- clip
- conj
- convolve
- cos
- cosh
- cplx
- cross
- crosscorr
- crosses
- d2r
- db
- db10
- dBm
- deltax
- deriv
- dutycycle
- dutycycles
- exp
- falltime
- fft
- flip
- floor
- freq
- freq_jitter
- gainBwProd
- gainMargin
- groupdelay
- histo
- ifft
- iinteg
- imag
- int
- integ
- ln
- log10
- mag
- max
- min
- mod
- movingavg
- overshoot
- period_jitter
- ph
- phaseMargin
- pow
- pp
- psd
- pzbode
- pzfilter
- r2d
- real
- riseTime
- rms
- round
- sample
- settlingTime
- sign
- sin
- sinh
- slewRate
- snr
- sqrt
- stathisto
- tan
- tanh
- trim
- window
- xval
- yval

1/x

Returns the inverse value. This function is available only in the SKILL mode.

10**x

Returns the 10^x value. This function is available only in the SKILL mode.

a2d

Returns the digital form of an analog input waveform, which may be a scalar, list or family of waveforms or a string representation of expressions.

- *Signal* is the name of the analog signal.
- *Logic Threshold*—Select the logic voltage threshold as High/Low or Centre.
- *Voltage High/Low*—If you select the logic threshold as High/Low, provide the high and low voltage values. Any value higher than the Voltage High is the high state and any value lower than the Voltage Low is the low state.
- *Centre Voltage*—If you select the logic threshold as *Centre*, provide the centre voltage value. Any value higher than the centre voltage is the high state and any value lower than the centre voltage is the low state.
- *Time to X*—The value that determines logic X.

Example: `awvAnalog2Digital(v("net9" ?result "tran-tran") nil nil nil 1 "hilo" )`

abs

Returns the absolute value of a signal.

abs_jitter

Returns a waveform that contains the absolute jitter values in the input waveform for the given threshold. The output waveform can be expressed in degrees, radians, or unit intervals (UI). The absolute jitter can be plotted as a function of cycle number, crossing time, or reference clock time.

The function is available only in the SKILL mode.

- *Signal* is the name of the waveform, expression, or family of waveforms. The expression displayed in the Buffer can be added to this field by selecting *buffer*.
- *Cross Type* are the points at which the curves of the waveform intersect with the threshold. While intersecting, the curve may be either rising (`rising`) or falling (`falling`).
- *Threshold* is the threshold value at which the input waveform intersects to calculate the absolute jitter.
- *X-Unit* is the unit defined for X-axis of the output waveform. Specify whether you want to the output absolute jitter against *time* or *cycle*. Cycle numbers refer to the n'th occurrence where the waveform crosses the given threshold.
- *Y-Unit* is the unit defined for Y-axis of the output waveform. Specify whether you want to calculate the phase in degrees (*s*), radians (*rad)*, or unit intervals (*UI*).
- *Tnom* is the nominal time period of the input waveform. The waveform is expected to be a periodic waveform that contains noise. If you do not enter the *Tnom* value, the `abs_jitter` function finds the approximate average time period of the input waveform.

Defining the Absolute Jitter

For a given waveform $v(t), t_{start} \leq t \leq t_{end}$, that has the following properties:

- oscillating with expected nominal period, `T`,
- between minimum and maximum values, $v_{min} \leq v(t) \leq v_{max}$,
- rising and falling through a given threshold, v_{th}
- in time intervals, $t_k; 0 \leq k \leq N$

The absolute jitter for the waveform can be defined as: $J_a(k) = t_k - k \cdot T$

The period jitter of the waveform can be defined as:

$$J_p(k) = t_k - t_{k-1} - T = J_a(k) - J_a(k-1) = \frac{d}{dk} J_a(k)$$

The jitter can be expressed in the units of time (seconds) or in the units of phase (radians or unit intervals). These values can be converted by using the following formula:

$$J_a[s] = \frac{J}{T}[UI] = \frac{J}{T} \cdot 2\boldsymbol{\pi}[rad]$$

acos

Returns the arc cosine of a signal.

acosh

Returns the hyperbolic arc cosine of a signal.

angle

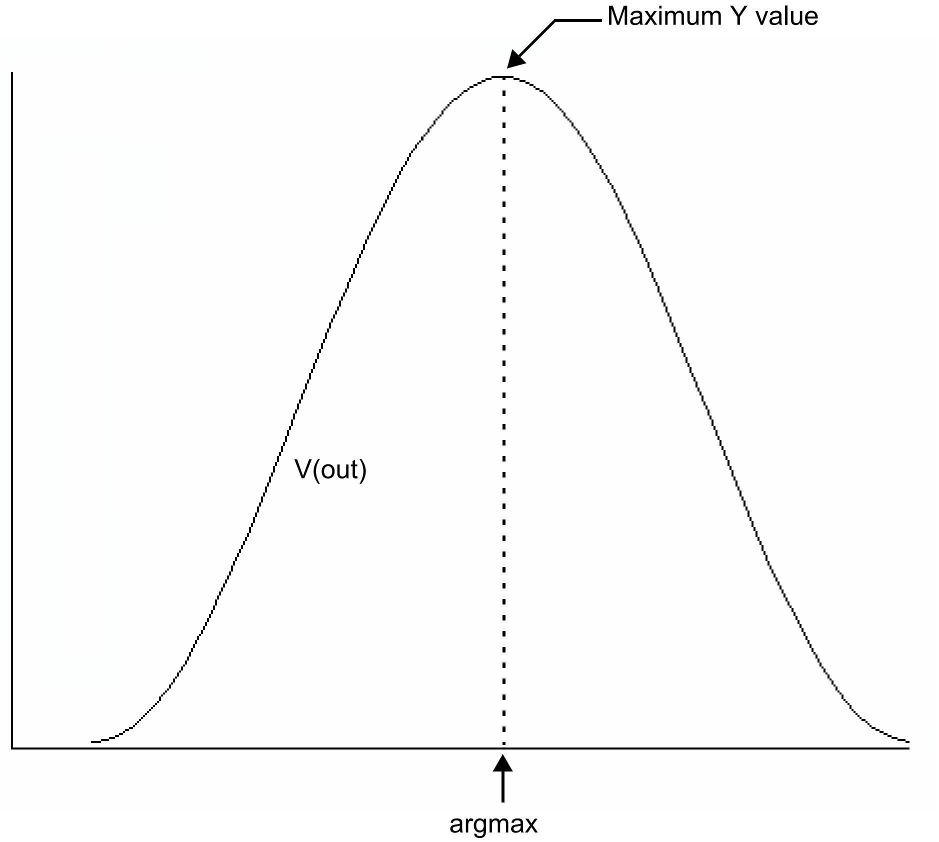
Returns the angle of a complex number in degrees. This function is available only in the MDL mode.

argmax

Returns the X value corresponding to the maximum Y value of a signal. This function is available only in the MDL mode.

If multiple X values are returned, the first one is used.

Example

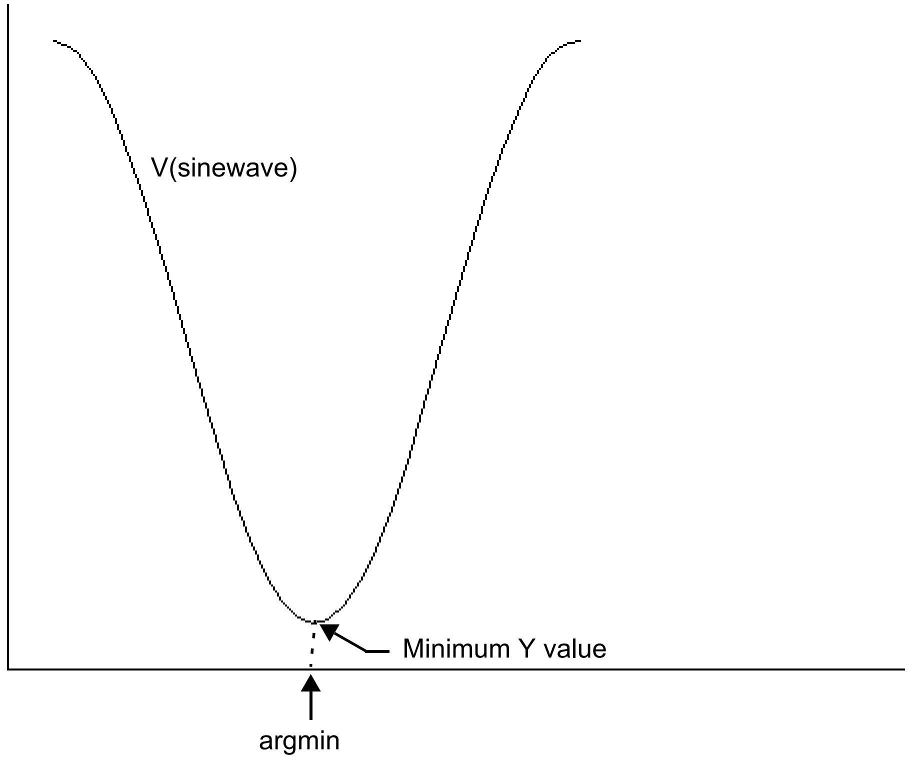


argmin

Returns the X value corresponding to the minimum Y value of a signal. This function is available only in the MDL mode.

If multiple X values are returned, the first one is used.

Example



asin

Returns the arc sine of a signal.

asinh

Returns the hyperbolic arc sine of a signal.

atan

Returns the arc tangent of a signal.

atanh

Returns the hyperbolic arc tangent of a signal.

average

Returns the average value of a signal.

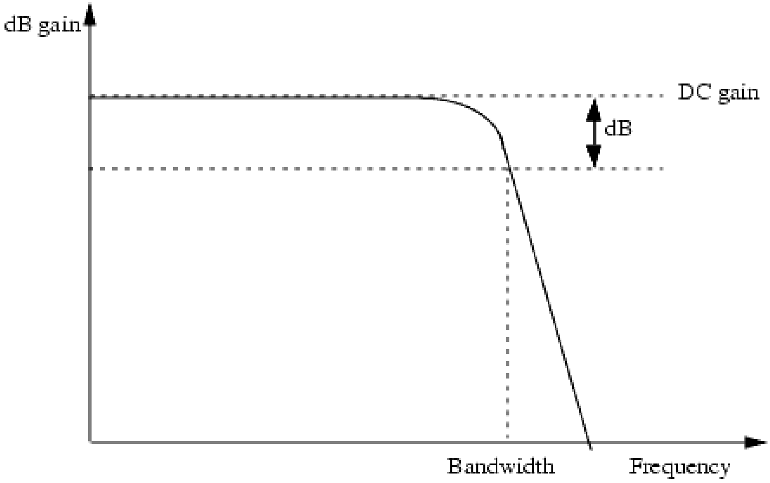
b1f

Returns the stability factor b1f. This function is available only in the SKILL mode.

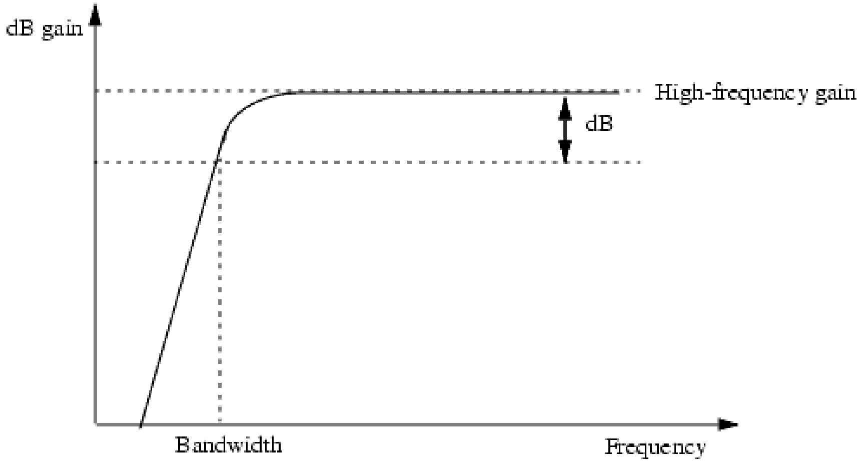
bw (bandwidth)

Calculates the bandwidth of a waveform. The output in MDL includes the unit, whereas in SKILL it does not.

- *Signal* is the name of the signal. In the SKILL mode, Virtuoso Visualization and Analysis XL wraps the signal with either the `mag`, `dB`, or `log` function. In the MDL mode, you need to wrap the signal name with the `mag`, `dB`, or `log` function, otherwise the tool returns an error.
- *Db* is the decibels down from the peak i.e. how far below the peak value you want to see data. In the SKILL mode, *Db* is a number equal to or greater than zero. In the MDL mode, *Db* is a number less than zero.
- *Response* is the response type.
  - ❑ When `'low`, computes the low-pass bandwidth by determining the smallest frequency at which the magnitude of the input waveform drops *`Db`* decibels below the DC gain. DC gain is obtained by zero-order extrapolation from the lowest or highest computed frequency, if necessary. An error occurs if the magnitude of the input waveform does not drop *`Db`* decibels below the DC gain.



  - ❑ When `'high`, computes the high-pass bandwidth by determining the largest frequency at which the magnitude of the input waveform drops *`db`* decibels below the gain at the highest frequency in the response waveform. An error occurs if the magnitude of the input waveform does not drop n decibels below the gain at high frequency.



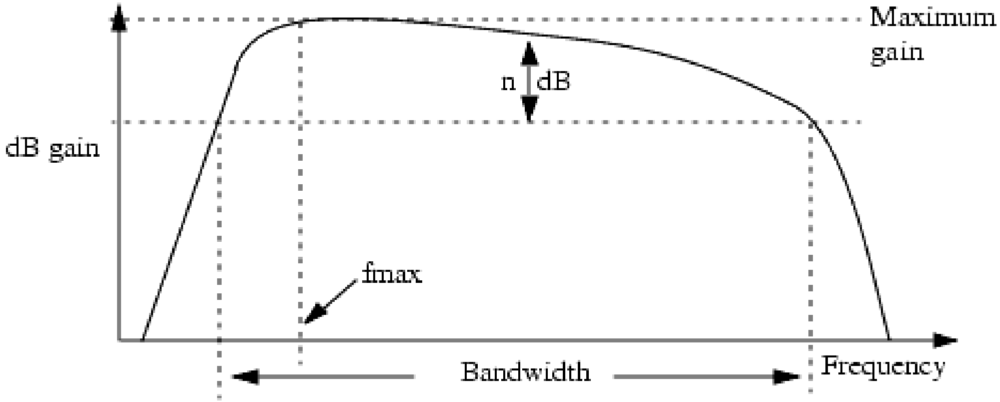
- ❑ When `'band`, computes the band-pass bandwidth by:

a. Determining the lowest frequency (`$f_{max}$`) at which the magnitude of the input waveform is maximized

b. Determining the highest frequency less than f_{max} at which the input waveform magnitude drops *Db* decibels below the maximum

c. Determining the lowest frequency greater than f_{max} at which the input waveform magnitude drops *Db* decibels below the maximum

d. Subtracting the value returned by step b from the value returned by step c. The value returned by step b or step c must exist.



ceil

Rounds a real number up to the closest integer value. This function is available only in the MDL mode.

cfft

Performs a Fast Fourier Transform on a complex time domain waveform and returns its frequency spectrum. The `cfft` function takes two time signals that in combination form a complex input signal. Available only in MDL mode.

- *sig_re* is the real part of the signal.
- *sig_im* is the imaginary part of the signal.
- *from* is the starting X value.
- *to* is the ending Y value.
- *numPoints* is the number of data points to be used for calculating the cfft. If this number is not a power of 2, it is automatically raised to the next higher power of 2.
- *window* is the algorithm used for calculating the cfft. In this release, only one algorithm is supported.
- *smoothing* is not supported in this release.

clip (SKILL)

Returns the portion of a signal between two points along the X-axis.You can use the clip function to restrict the range of action of other special functions of the calculator such as integ, rms, and frequency.

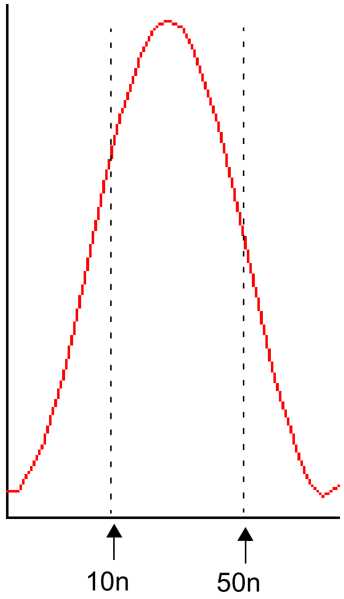
- *sig* is the name of the signal.
- *from* is the starting point on the X-axis.
- *to* is the ending point on the X-axis.

The clip function in the SKILL mode is similar to the trim function in MDL mode.

Example

The following diagram illustrates how the result with the values `clip(sig=V(sinewave), from=10n, to=50n )`

is determined.



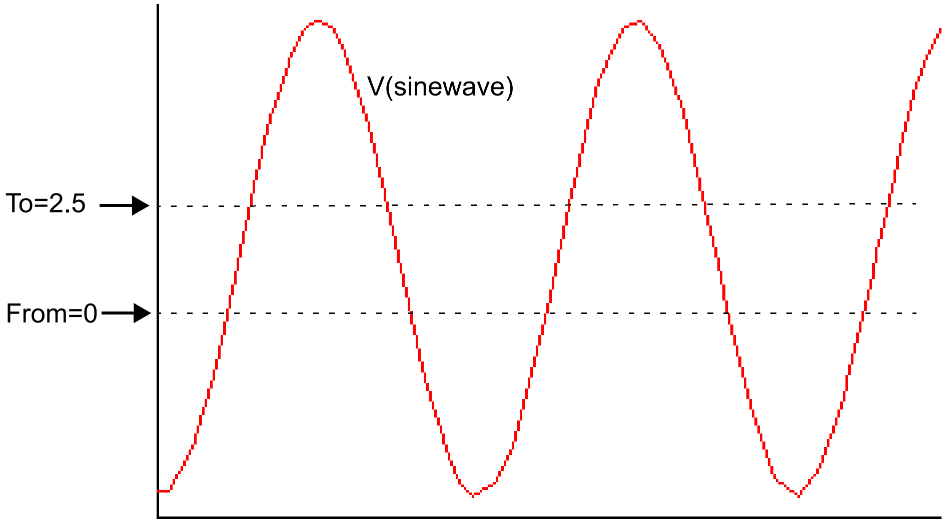
clip (MDL)

Returns the portion of a signal between two points along the Y-axis.

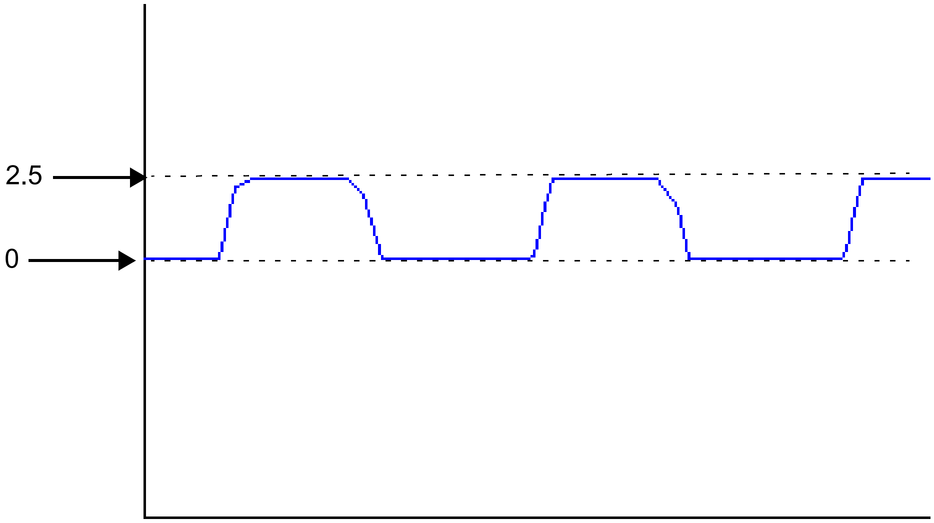
- *Signal* is the name of the signal.
- *From* is the starting point on the Y-axis.
- *To* is the ending point on the Y-axis.

Example

The following input signal



with the values *signal*=`V(sinewave)`, *From*=`0`, *To*=`2.5` is transformed into the following output signal.



compare

Compares the two given waveforms based on the specified values for absolute and relative tolerances. This function compares only the sections of the two waveforms where the X or independent axes overlap.

- *Signal1* is the name of the first signal.
- *Signal2* is the name of the second signal.
- *Absolute Tolerance* is the absolute tolerance.
- *Relative Tolerance* is the relative tolerance.

The following situations are possible:

- If neither relative nor absolute tolerance is specified, the function returns the difference of the two waveforms (Signal1 - Signal2).
- If only the absolute tolerance is specified, the function returns the difference of the two waveforms only when the absolute value of the difference is greater than the absolute tolerance (|Signal1 - Signal2| > f_abstol); otherwise it returns a zero waveform.
- If only the relative tolerance is specified, the function returns the difference of the two waveforms only when the absolute value of the difference is greater than the product of the relative tolerance and the larger of the absolute values of the two waveforms (|Signal1 - Signal2| > f_reltol * max(|Signal1|, |Signal2|)); otherwise it returns a zero waveform.
- If both relative and absolute tolerances are specified, the function returns the difference of the two waveforms only when the absolute value of the difference is greater than the sum of the separately calculated tolerance components (|Signal1 - Signal2| > f_abstol + f_reltol * max(|Signal1|, |Signal2|)); otherwise it returns a zero waveform.

Note: The function also compares parametric waveforms. However, for a successful comparison of parametric waveforms, the family tree structures of the two input waveforms should be the same. For both the input waveforms, the number of child waveforms at each level should also be the same, except at the leaf level where the elements are simple scalars.

compression

Returns the Nth compression point value of a waveform at the specified extrapolation point. This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *Harm Num* is the harmonic number.
- *Ext. Point (X)* is the extrapolation point of the waveform. The extrapolation point is the X-axis value.
- *Compression dB* specifies the compression coefficient (N).

compressionVRI

Performs an *N*th compression point measurement on a power waveform. This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *Harm Num* is the harmonic index of the waveform.
- *Ext. Point (X)* is the extrapolation point for the waveform. The default value is the minimum x value of the input voltage waveform.
  The extrapolation point is the coordinate value in dBm that indicates the point on the output power waveform where the constant-slope power line begins. This point should be in the linear region of operation.
- *Load Resistance* is the resistance. The default value is 50
- *Compression dB* specifies the delta (in dB) between the power waveform and the ideal gain line that marks the compression point. The default value is 1.

conjugate

Returns the conjugate of a complex number.

convolve

Returns a waveform consisting of the time domain convolution of two signals.

In the SKILL mode,

- *Signal1* is the name of the first signal.
- *Signal2* is the name of the second signal.
- *From* is the starting point (X-axis value) of the integration range.
- *To* is the end point (X-axis value) of the integration range.
- *type* specifies whether is the interpolation is linear or log.
- *By* is the step size.

Covolution is defined by the following equation:

$$\int_{from}^{to} f1(s)f2(t-s)ds$$

In the MDL mode,

- *sig1* is the name of the first signal.
- *sig2* is the name of the second signal.
- *n_interp_steps* is the number of steps for interpolating waveforms.

If you want to specify an integration range like the SKILL mode, you can use the trim function.

Covolution is defined by the following equation:

ifft(fft(f1(s)) * fft(f2(s)))

cos

Returns the cosine of a signal.

cosh

Returns the hyperbolic cosine of a signal.

cplx

Returns a complex number created from two real arguments. This function is available only in the MDL mode

- *R* is the value representing the real part.
- *I* is the value representing the imaginary part.

cross

Returns the X value where a signal crosses the threshold Y value.

In the SKILL mode,

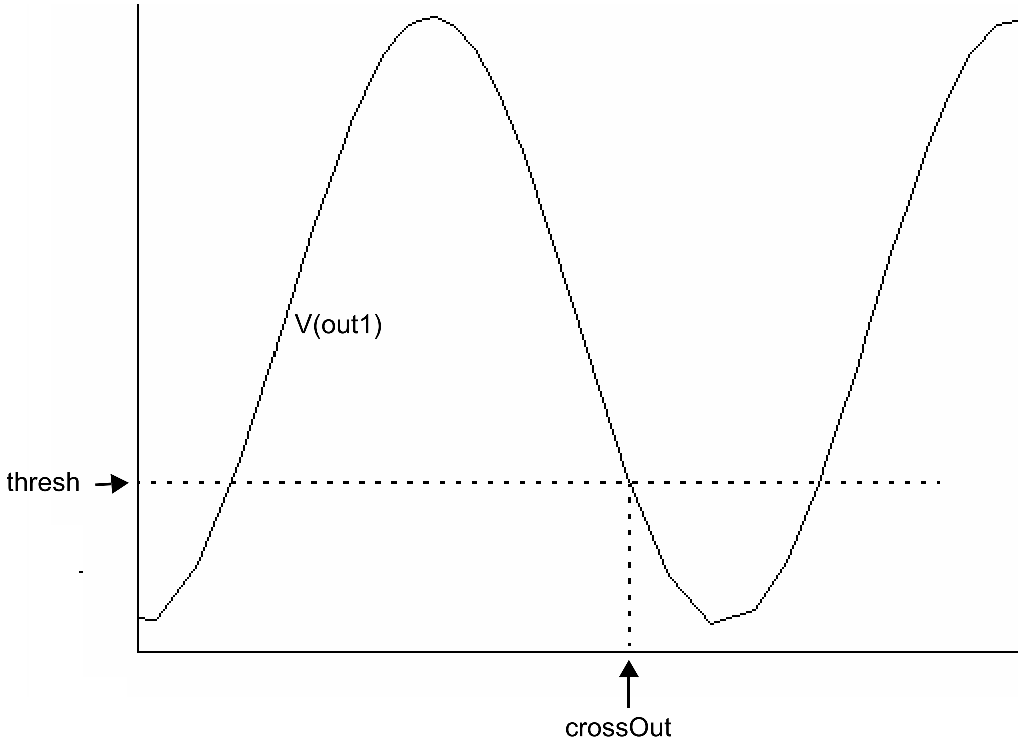
- *Signal* is the name of the signal.
- *Threshold Value* is the threshold to be crossed.
- *Edge Number* is the occurrence of the crossing. The first crossing is *Edge Number*=`1`, the second crossing is *Edge Number*=`2`, and so on. The value of *Edge Number* can be negative numbers: *Edge Number*=`-1` for the previous occurrence, *Edge Number*=`-2` for the occurrence before the previous occurrence, and so on.
- *Edge Type* is the direction of the crossing event. `rising` directs the function to look for crossings where the Y value is increasing, `falling` for crossings where the Y value is decreasing, and `either` for crossings in either direction.

In the MDL mode,

- *sig* is the name of the signal.
- *dir* is the direction of the crossing event. `'rise` directs the function to look for crossings where the Y value is increasing, `'fall` for crossings where the Y value is decreasing, and `'cross` for crossings in either direction.
- *n* is the occurrence of the crossing. The first crossing is *n*=`1`, the second crossing is *n*=`2`, and so on. The value of n can be negative numbers: *n*=`-1` for the previous occurrence, *n*=`-2` for the occurrence before the previous occurrence, and so on.
- *thresh* is the threshold to be crossed.
- *start* is the time at which the function is enabled.
- *xtol* is the absolute tolerance in the X direction.
- *ytol* is the absolute tolerance in the Y direction.
- *accuracy* specifies whether the function should use interpolation, or use iteration controlled by the absolute tolerances to calculate the value. `'interp` directs the function to use interpolation, and `'exact` directs the function to consider the xtol and yval values.

Example

The following diagram illustrates how the result is determined for the values *signal*=`V(out1)`, *Threshold Value*=`1`, *Edge Number*=`1`, and *Edge Type*=`falling`



crosscorr

Returns the cross correlation of the specified signals. This function is available only in the MDL mode.

When the input signals are double waveforms,

`crosscor` (*sig1*, *sig2*) = `convolve` (*sig1*, `flip`(*sig2*))

When one of the input signals is a complex waveform (*sig2* in the following case),

`crosscor` (*sig1*, *sig2*) = `convolve` (*sig1*,`flip`(`conj`(*sig2*)))

- *sig1* is the name of the first signal.
- *sig2* is the name of the second signal.
- *n_interp_steps* is the number of steps for interpolating waveforms.

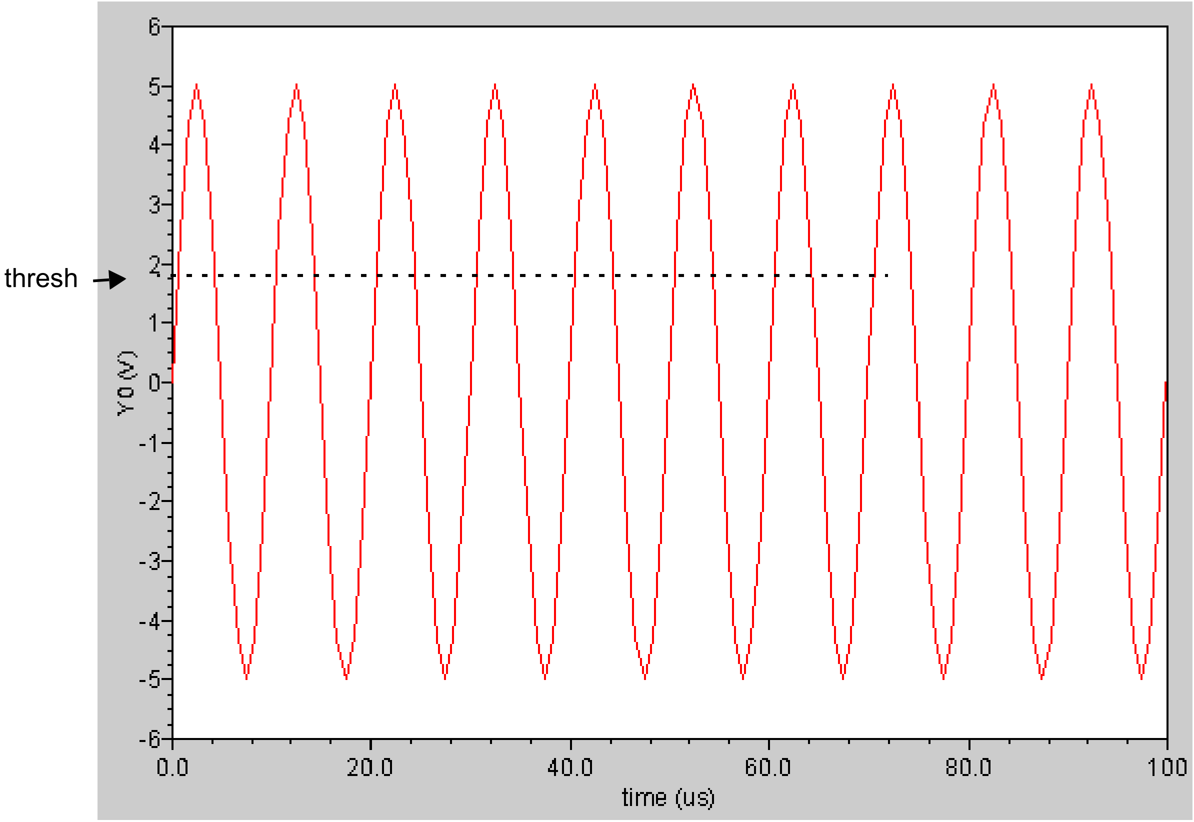
crosses

Returns the X values where a signal crosses the threshold Y value. This function is available only in the MDL mode.

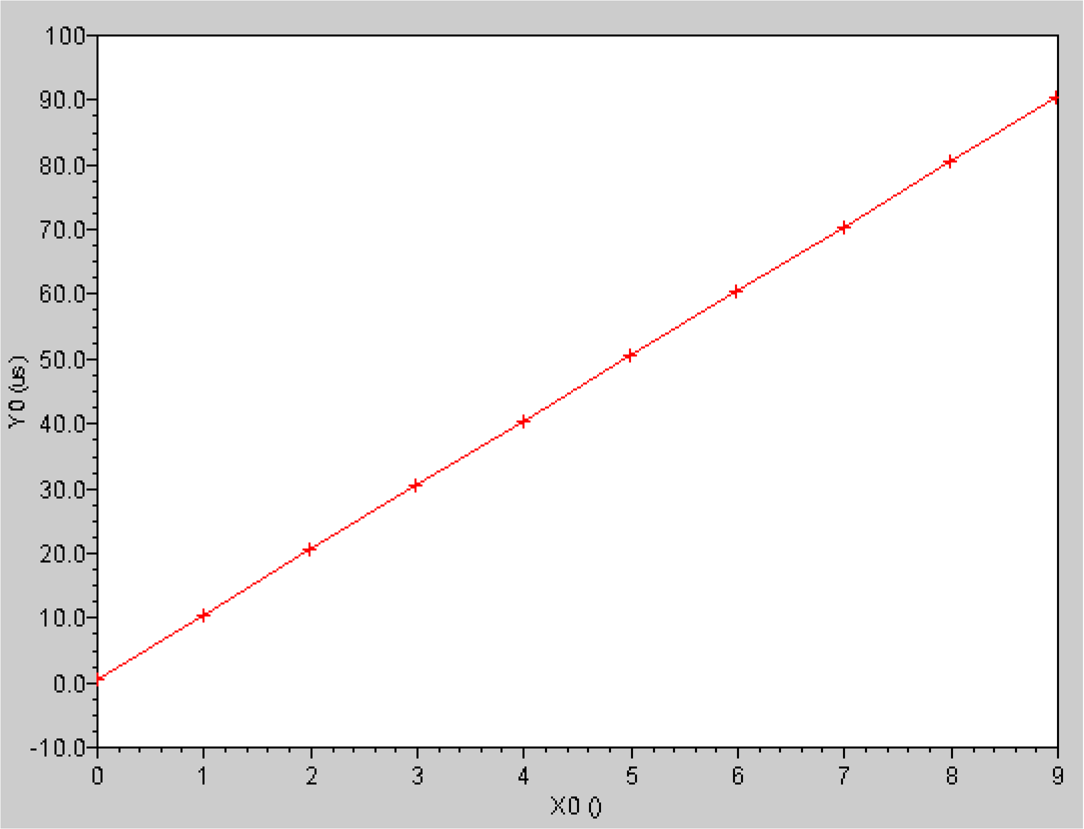
- *sig* is the name of the signal.
- *dir* is the direction of the crossing event. `'rise` directs the function to look for crossings where the Y value is increasing, `'fall` for crossings where the Y value is decreasing, and `'cross` for crossings in either direction.
- *n* is the occurrence of the crossing. If *n*=1, the function returns the first crossing and all subsequent crossings. If *n*=3, the function returns the third crossing and all subsequent crossings. The value of *n* can be negative numbers: if *n*=`-2`, only the last two crossings are returned.
- *thresh* is the threshold to be crossed.
- *start* is the time at which the function is enabled.
- *xtol* is the absolute tolerance in the X direction.
- *ytol* is the absolute tolerance in the Y direction.
- *accuracy* specifies whether the function should use interpolation, or use iteration controlled by the absolute tolerances to calculate the value. `'interp` directs the function to use interpolation, and `'exact` directs the function to consider the xtol and yval values.

Example

The following input signal with the values *sig*=`V(out)`, *dir*=`'rise`, and *thresh*=`1.0`



is transformed into the following output waveform.



d2a

Returns the analog output from a given digital waveform.

- *Signal* is the name of the waveform, expression, or family of waveforms. The expression displayed in the Buffer can be added to this field by selecting *buffer*.
- *Analog High Voltage* is the highest voltage value when the digital signal is in the high-state (1)
- *Analog Low Voltage* is the lowest analog value when the digital signal is in the low-state (0)
- In the *Analog X Voltage* field, specify the corresponding analog value to which you want to convert the state X of the digital waveform. This value can be a number or a string expression of `vhi` and `vlo`, such as `(vhi+vlo)/2`
- Select the *Busses output as* field to `Analog Voltage` or `Analog bits` if the given digital waveform is a bus.
- Select the *Transition* as `Piece-Wise-Liner` or `Zero-Terminated` if the given digital waveform is a bus.

Example: `awvDigital2Analog(v("net9" ?result "tran-tran") 5 0 "(vhi+vlo)/2" ?mode "busvalue" ?outWaveType "zeroT")`

d2r (degrees-to-radians)

Converts a waveform from degrees to radians. This function is available only in the MDL mode.

dB20

Converts a signal, in watts, to db where dB=20*log(x).

In the SKILL mode, this function is called dB20.

dB10

Converts a signal, in watts, to dB where dB=10*log(x).

dB20

Converts a signal, in watts, to dB where dB=20*log(x).

In the MDL mode, this function is called dB.

dBm

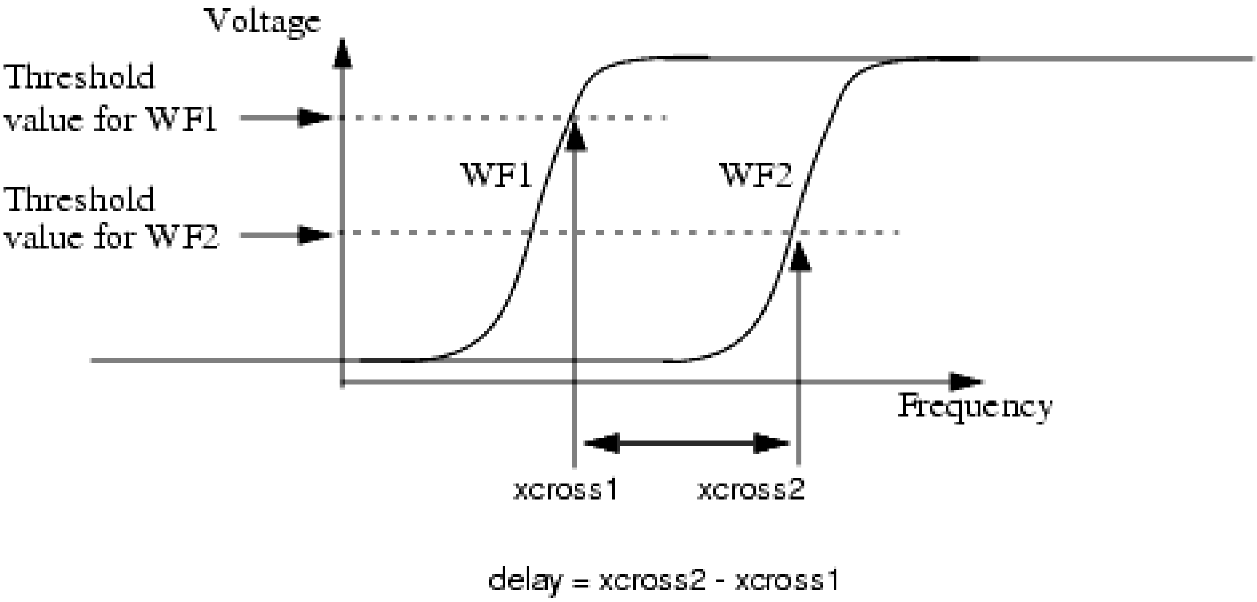
Converts a signal, in watts, to dbm where dbm=10*log(x)+30.

delay

Computes the delay between two points or multiple sets of points in a waveform using the cross function. This function is available only in the SKILL mode.

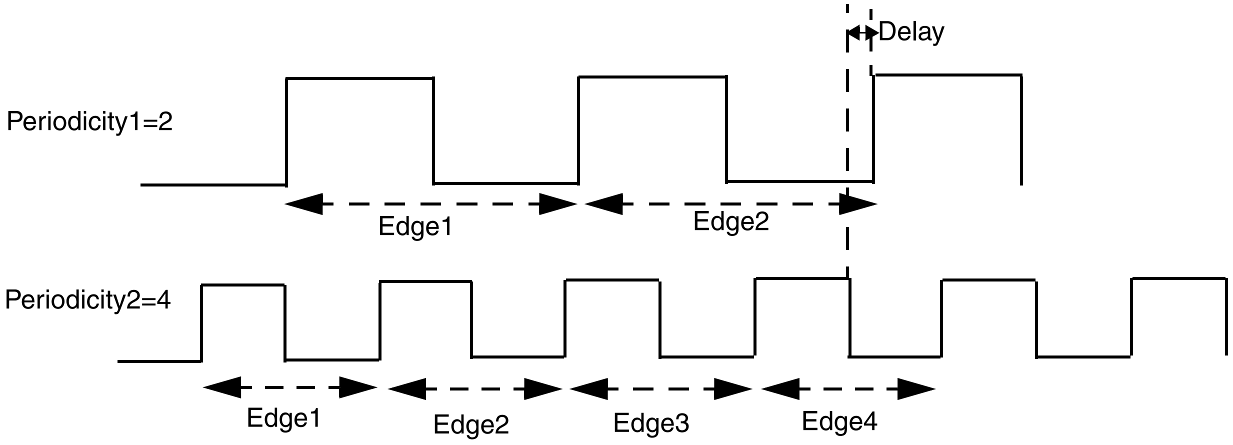
- *Signal1* is the name of the first signal.
- *Signal2* is the name of the second signal.
- *Threshold Value1* is the first threshold to be crossed.
- *Edge Number* 1 is the number that specifies which crossing is to be the trigger event. For example, if *Edge Number1=2*, the trigger event is the second edge of the first waveform with the specified type that crosses *Threshold Value 1*.
- *Edge Type1* is the direction of the first crossing event. `rising` directs the function to look for crossings where the Y value is increasing, `falling` for crossings where the Y value is decreasing, and `either` for crossings in either direction.
- *Periodicity 1* is the periodic interval for the first waveform. See Example 2 for details.
- *Threshold Value 2* is the second threshold to be crossed.
- *Edge Number* 2 is the number that specifies which crossing is to be the trigger event. For example, if *Edge Number2=2*, the trigger event is the second edge of the second waveform with the specified type that crosses *Threshold Value 2*.
- *Edge Type 2* is the direction of the second crossing event. `rising` directs the function to look for crossings where the Y value is increasing, `falling` for crossings where the Y value is decreasing, and `either` for crossings in either direction.
- *Periodicity 2* is the periodic interval for the second waveform. See Example 2 for details.
- *Number of occurences* specifies whether you want to retrieve only one occurrence of a delay event for the given waveform (*single*), or all occurrences of overshoot for the given waveform which you can later plot or print (*multiple*).
- *Plot/print vs.* specifies whether you want to retrieve delay data against *trigger* time, *target* time (or another X-axis parameter for non-transient data) or *cycle*. Cycle numbers refer to the n'th occurrence of the delay event in the input waveform.
  The value in this field is ignored when you specify *Number of Occurences* as *single*.
- *Start 1* is the time that specifies when the delay measurement is to be started.
- *Start 2* is the time to start observing the target event.
- *Start 2 relative to* specifies whether the Start 2 is relative to trigger or time.
- *Stop* is the time to stop observing the target event.

Example 1



Example 2

The delay algorithm for multiple occurrences returns the difference between the X points for the specified edges on the respective waveforms (with the specified periodicity). For example: if the edge number specified for both the waveform is 1 and periodicity is 2, then it will compute the difference between the 1,3,5,7 ... edges for both the waveforms.



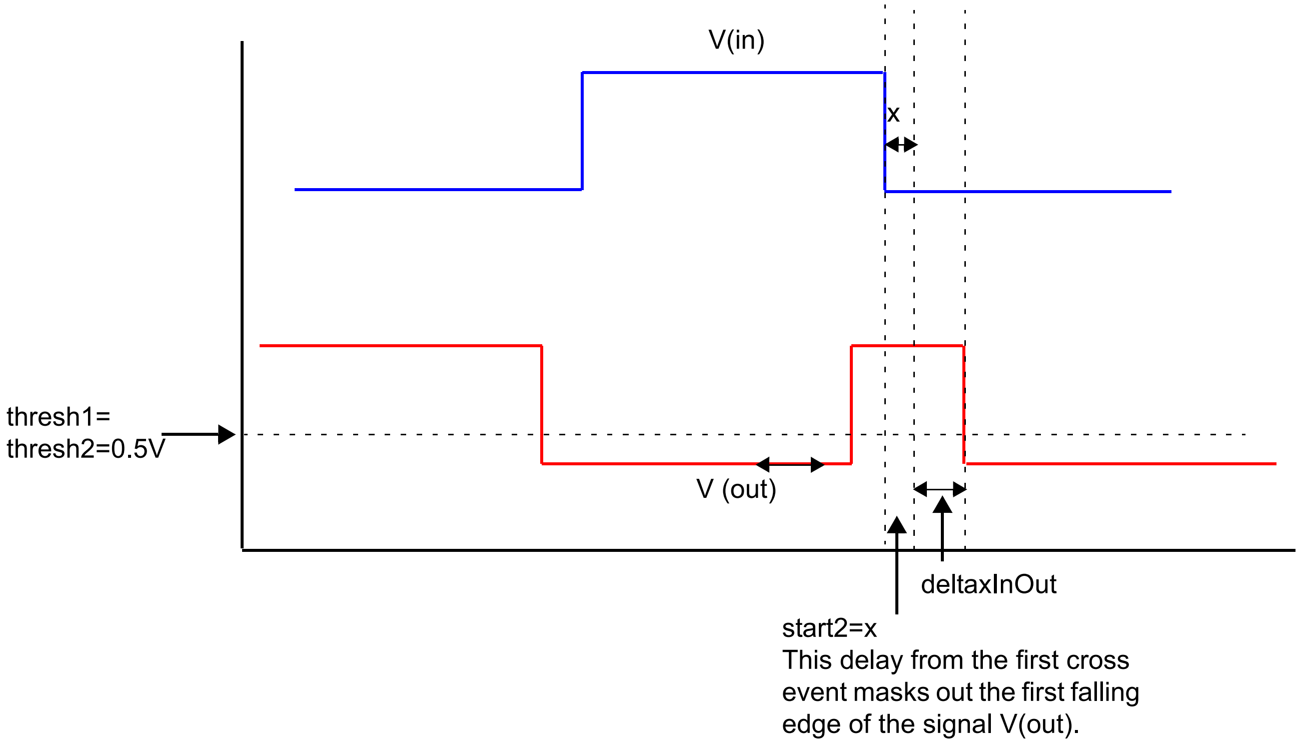
deltax

Returns the difference in the abscissas of two cross events. This function is available only in the MDL mode.

- *sig1* is the signal whose cross event begins the measurement interval.
- *sig2* is the signal whose cross event ends the measurement interval.
- *dir1* is the direction of the cross at the beginning of the measurement interval. `'rise` directs the function to look for crossings where the Y value is increasing, `'fall` for crossings where the Y value is decreasing, and `'cross` for crossings in either direction.
- *n1* is the occurrence of the crossing for the beginning of the measurement interval. The first crossing is n=1, the second crossing is n=2, and so on.
- *thresh1* is the Y value whose crossing begins the measurement interval.
- *start1* is the time at which the function is enabled.
- *dir2* is the direction of the cross at the end of the measurement interval. `'rise` directs the function to look for crossings where the Y value is increasing, `'fall` for crossings where the Y value is decreasing, and `'cross` for crossings in either direction.
- *n2* is the occurrence of the crossing for the end of the measurement interval. The first crossing is n=1, the second crossing is n=2, and so on.
- *thresh2* is the Y value whose crossing ends the measurement interval.
- *start2* is the offset from the time of the first cross event, where the function begins looking for the second cross event that ends the delay measurement.
- *xtol* is the absolute tolerance in the X direction.
- *ytol* is the absolute tolerance in the Y direction.
  Default: `1`
- *accuracy* specifies whether the function should use interpolation, or use iteration controlled by the absolute tolerances to calculate the value. `'interp` directs the function to use interpolation, and `'exact` directs the function to consider the xtol and yval values.
- *absstart2* specifies the time at which Virtuoso Visualization and Analysis XL should start looking for the second cross, instead of relative to the crossing of 1 (the *start2* parameter). You can use either the *start2* or *absstart2* parameter.

Example

The following diagram illustrates how the result is determined with the values *sig1*=`V(in)`, *sig2*=`V(out)`, *dir1*=`'fall`, *thresh1* = `0.5`, *dir2*=`'fall`, *thresh2*=`0.5`, *start2*=`x`



start2=x
This delay from the first cross event masks out the first falling edge of the signal V(out).

deriv

Returns the derivative of a signal.

This function is available only in the MDL mode.

dft (Discrete Fourier Transform)

This function is available only in the SKILL mode.

The tool which converts a temporal (time domain) description of a signal (real or complex) into one in terms of its frequency components is called the Fourier Transform. dft (Discrete Fourier Transform) is the discrete formulation of the Fourier Transform, which takes such regularly spaced data values (samples in time domain), and returns the value of the Fourier Transform for a set of values in frequency domain which are equally spaced. Most of the time, however, we work on real-valued signals only.

Consider a complex series (signal) *w(k)* with *N* samples of the form

w(0), w(1), w(2), ..., w(k), ..., w(N-1)

Further, assume that the series outside the range *0*, *N-1* is extended *N*-periodic, that is, *w(k) = w(k+N)* for all *k*. The dft of this series will be denoted *W(n)*, will also have *N* samples and will be defined as:

$$W(n) = \frac{1}{N}\sum_{k-0}^{N-1} w(k)\left(e^{-2\pi i k\frac{n}{N}}\right) \qquad \text{where } n=0, \ldots., N-1$$

- The first sample *W(0)* of the transformed series is the DC component, more commonly known as the average of the input series.
- The dft of a real series results in a symmetric series about the Nyquist frequency (described below).
- The highest positive (or negative) frequency sample is called the Nyquist frequency. This is the highest frequency component that should exist in the input series for the DFT to receive 'unpredictable' results. More specifically, if there are no frequencies above Nyquist frequency, the original signal can be exactly reconstructed from the samples. The Nyquist Theorem (or Shannon's Sampling Theorem) exactly specifies this – that for a band limited signal, you must sample at a frequency over twice the maximum frequency of the signal to reconstruct it from the samples.

While the dft transform above can be applied to any complex valued series, in practice for large series it can take considerable time to compute, the time taken being proportional to the square of the number of points (samples) in the series. A much faster algorithm has been developed by Cooley and Tukey called the FFT (Fast Fourier Transform). The only requirement of the most popular implementation of this algorithm (Radix-2 Cooley-Tukey) is that the number of points in the series be a power of 2 i.e. $N=2^n$.

Given *N* input points, the fft returns *N* frequency components, of which the first (*N/2 +1*) are valid. (The other components are mirror images and are considered invalid since the frequencies they represent do not satisfy the Nyquist Theorem above.) They start with the DC component, and are spaced apart by a frequency of (*1 / (n deltaT)*). The magnitude of the complex number returned is the frequency's relative strength.

The dft function computes the discrete Fourier Transform of the buffer by fft algorithm where *deltaT= (t2-t1) / N*. The waveform is sampled at the following *N* timepoints:

*t1, t1 + deltaT, t1 + 2 * deltaT, º, t1 + (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, (*t1 + (N - 1) * deltaT*), is (*t2 - deltaT*) rather than *t2*. The dft function assumes that *w(t1)* equals *w(t2)*.

- *Signal* is the name of the signal.
- *From* is the starting point of the range over which you want to compute the transform.
- *To* is the ending point of the range over which you want to compute the transform.
  Be sure to cover at least one complete period of your slowest frequency.
- *Number of Samples* is the number of samples you want to take in expanding the Fourier transform.
  This number should be a power of 2. If it is not, the system increases the value to the next higher power of 2. Sample at a rate that is at least twice your highest frequency component (the Nyquist rate). Pick a sampling rate high enough that closely spaced frequency components can be resolved.
- *Window Type* is the window you want to use.

  Valid values: `Blackman`, `Cosine2`, `Cosine4`, `ExtCosBell`, `HalfCycleSine`, `HalfCycleSine3`, `HalfCycleSine6`, `Hanning,Hamming`, `Kaiser`, `Parzen`, `Rectangular`, and `Triangular`.
  Default value: `Rectangular`.
- *Smoothing Factor* is the smoothing factor applicable to the Kaiser window only.
  The Smoothing Factor field accepts values from 0 to 15. The value 0 implies no smoothing and is equivalent to a rectangular window.
- *Coherent Gain* is 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`.

- *Coherent gain factor*
  When you do a dft, the applied *Window Type* (aside from the rectangular type) changes the signal's amplitude. Applying a coherent gain factor is a way to get consistent results regardless of the window type.

When you run the transient analysis, keep the maximum time step small enough to represent the highest frequency component accurately. The maximum time step should be smaller than the sampling period that you use for the dft of the time domain waveform. The samples in the dft will either hit a data point (calculated exactly by the simulator) or an interpolated point between two data points.

Choosing a maximum timestep during transient simulation that is smaller than the dft sampling period ensures that sampling maintains a resolution at least equal to that of the transient time-domain waveform.

The start and stop times should not coincide with the boundaries of the time-domain waveform. The boundary solutions might be imprecise and generate incorrect results if used in other calculations.

One of the uses of fast Fourier Transform windowing is to reduce discontinuities at window edges caused by having a nonintegral number of periods of a signal in a window. This removes the abrupt edges, making them fall off smoothly to zero, and can improve the validity of the fft components obtained. You can also use fft windowing to 'dig out' the details of signal components that are very close Gin frequency or that consist of both large and small amplitudes.

dftbb

This function is available only in the SKILL mode.

dftbb computes the Discrete Fourier Transform (fast Fourier transform) of a complex signal *z(t)= x(t) + j*y(t)*:

```
N-1

Z(n)= ReZ(n) +j*ImZ(n)=SUM[ z(k)*exp(-j*theta*n*k)],

k=0
```

where *theta=2*Pi/N; n=0, 1, ..., N-1*.

Both waveforms are sampled at the following *N* timepoints:

*t1, t1 + deltaT, t1 + 2 * deltaT, ..., t1 + (N - 1) * deltaT*

The output of dftbb*(waveform1, waveform2)* are *N* complex values.

The dftbb function is required because the dft function gives out the amplitudes (*sqrt(Re**2+Im**2)*) of dfts of real signals only – not Re and Im. Therefore, you cannot replace one dft of the complex signal *z(t)= i(t) + j*q(t)* with two dfts of two real signals *i(t)* and *q(t)*:

```
N-1

I(n)= ReI(n) +j*ImI(n)= SUM[ i(k)*exp(-j*theta*n*k)],

k=0

N-1

Q(n)= ReQ(n) +j*ImQ(n)= SUM[ q(k)*exp(-j*theta*n*k)],

k=0
```

and then compute:

```
ReZ(n)= ReI(n) - ImQ(n);

ImZ(n)= ImI(n) + ReQ(n); for n=0, 1, ..., N-1.
```

The above definition is for single-sided output waveforms. This holds true for double-sided output waveforms except that the previous output waveform is translated so that *n* varies from *-N/2* to *(N/2)-1*.

- Signal1 is the first waveform
- Signal2 is the second waveform.
- *From* is the starting point of the range over which you want to compute the transform.

- *To* is the ending point of the range over which you want to compute the transform.
  Be sure to cover at least one complete period of your slowest frequency.

- *Number of Samples* is the number of samples you want to take in expanding the Fourier transform.
  This number should be a power of 2. If it is not, the system increases the value to the next higher power of 2. Sample at a rate that is at least twice your highest frequency component (the Nyquist rate). Pick a sampling rate high enough that closely spaced frequency components can be resolved.

- *Window Type* is the window you want to use.
  Only the *Rectangular* window type is supported. Virtuoso Visualization and Analysis XL issues a warning if you create an expression by hand for a different window type and switches to the default *Rectangular* window type.

- *Smoothing Factor* is the smoothing factor applicable to the Kaiser window only.
  The Smoothing Factor field accepts values from 0 to 15. The value 0 implies no smoothing and is equivalent to a rectangular window.

- *Coherent Gain* is 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`.

- *Coherent gain factor*
  When you do a dftbb, the applied *Window Type* (aside from the rectangular type) changes the signal’s amplitude. Applying a coherent gain factor is a way to get consistent results regardless of the window type.

- *Spectrum Type* is a string that can be either singleSided or doubleSided. When *Spectrum Type* 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, the resultant waveform is symmetric to the Y-axis from -N/2 to N/2.

dnl

Computes the differential non-linearity of a transient simple or parametric waveform.

- *Waveform* is the name of the signal.
- *Sampling signal/list/step* is the signal used to obtain the points for sampling the *Waveform (*points at which the waveform crosses the threshold while either `rising` or `falling` as specified in the *cross Type* field with the *delay* added to them), list of domain values at which the sample points are obtained from the *Waveform,* or the sampling interval*.*
- *Cross Type* specifies the points at which the curves of the waveform intersect with the threshold. While intersecting, the curve may be either rising (`rising`) or falling (`falling`).
- *mode* specifies whether the threshold value is to be calculated by Virtuoso Visualization and Analysis XL (`auto`) or specified by you (`user`). The auto threshold is calculated as:

  Auto Threshold Value = integral of the waveform divided by the X range.
- *Threshold* is the threshold value against which the frequency is to be calculated. You need to specify the threshold value only if the *mode* is `auto`.
- *Delay* is the delay time after which the sampling begins.
- *Method* specifies whether the end-to-end (`end`) or straight line (`fit`) method is used
- *Unit* specifies whether the output waveform is to be output as an absolute value (`abs`) or multiples of least significant bit (`lsb`).
- *No. of Samples* specifies the samples used for calculating the non-linearity. If not specified, the samples are taken against the entire data window.

Note: For each of the three ways in which the sample points can be specified, only a few of the other optional arguments are meaningful,

- For *Sampling signal*, the fields *Cross Type*, *mode*, *Threshold*, *Delay*, *Method*, and *Units* are meaningful.
- For *list*, the fields *Method* and *Units* are meaningful.
- For *step*, the fields *Method*, *Units*, and *No. of samples* are meaningful.

dutycycle

Calculates the ratio of the time for which the signal remains high to the period of the signal. You should use this function on periodic signals only.

In the SKILL mode,

- *Waveform* is the name of the signal, expression, or family of waveforms.
- *mode* specifies whether the threshold value is to be calculated by Virtuoso Visualization and Analysis XL (`auto`) or specified by you (`user`). The auto threshold is calculated as:

  Auto Threshold Value = integral of the waveform divided by the X range.
- *threshold* is the threshold value. You need to specify the threshold value only if the *mode* is `user`.
- *Plot/print vs.* specifies whether X axis of the output waveform is *time* (or another X-axis parameter for non-transient data) or *cycle*.
- *Output Type* is the type of output. If set to `plot`, the output is a waveform; if set to `average`, the output is an average value. The default value is `plot`.

In the MDL mode.

- *sig* is the name of the signal.
- *theta* is the percentage that defines the logic high of the signal. A threshold value is calculated as follows:
  yThresh=theta/100*(Ymax+Ymin)
  The portion of the signal above yThresh is taken as high.

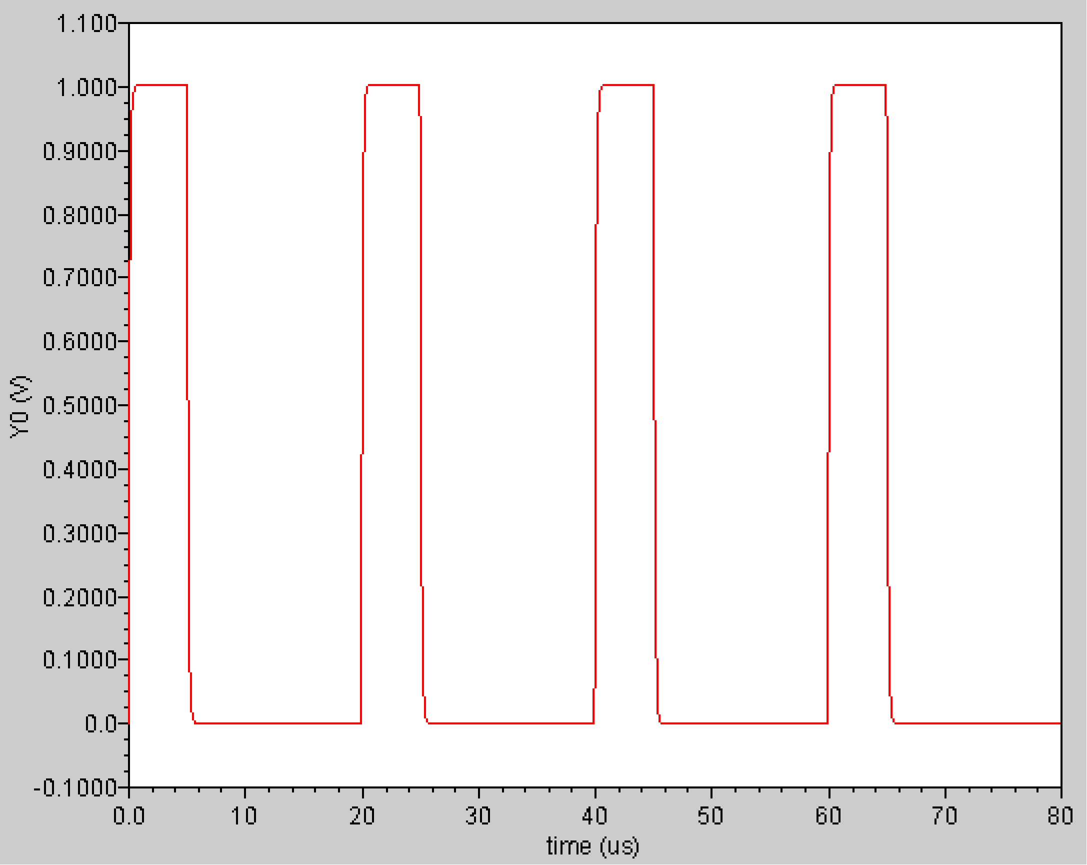
dutycycles

Returns the dutycycle of a nearly-periodic signal as a function of time. This function is available only in the MDL mode.

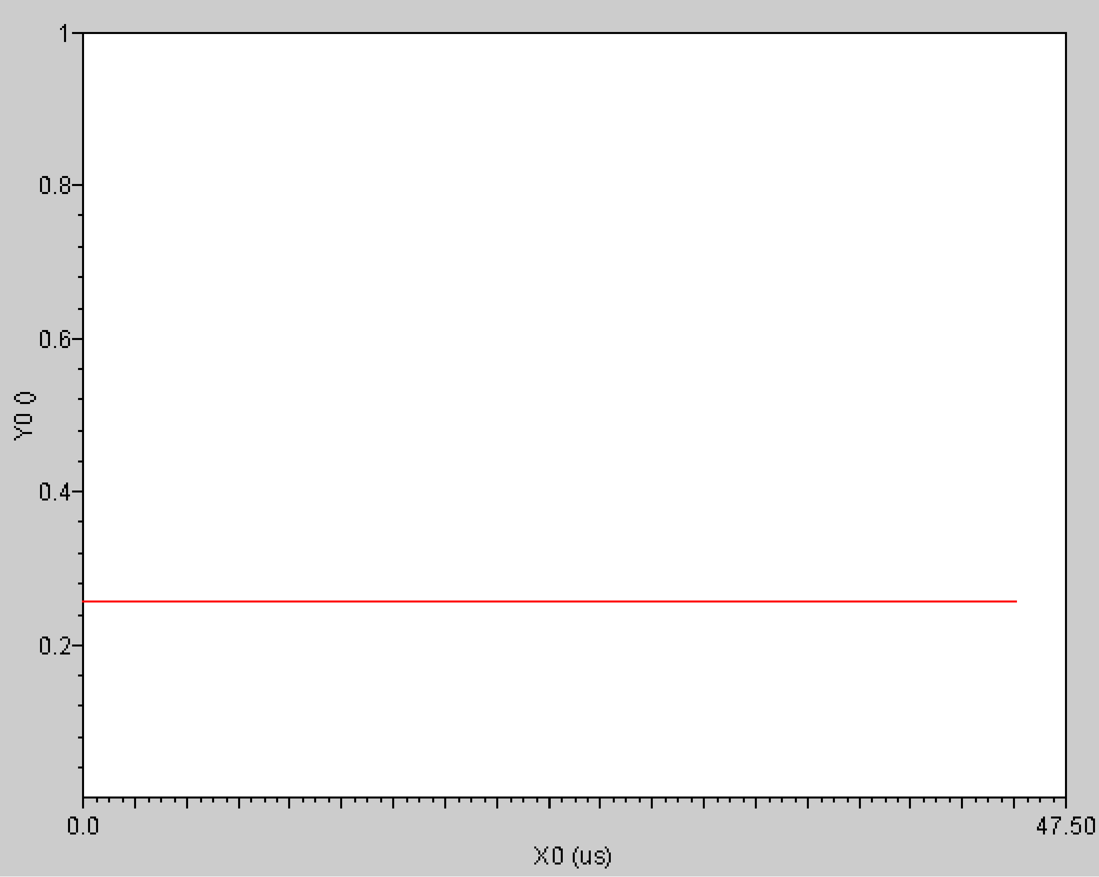
- *sig* is the name of the signal.
- *theta* is the percentage that defines the logic high of the signal. A threshold value is calculated as follows:
  yThresh=theta/100*(Ymax+Ymin)
  The portion of the signal above yThresh is taken as high.

Example

The following input signal with the values *sig*=`V(out)` and *theta*=`40`



transforms into the following output signal:



evmQAM

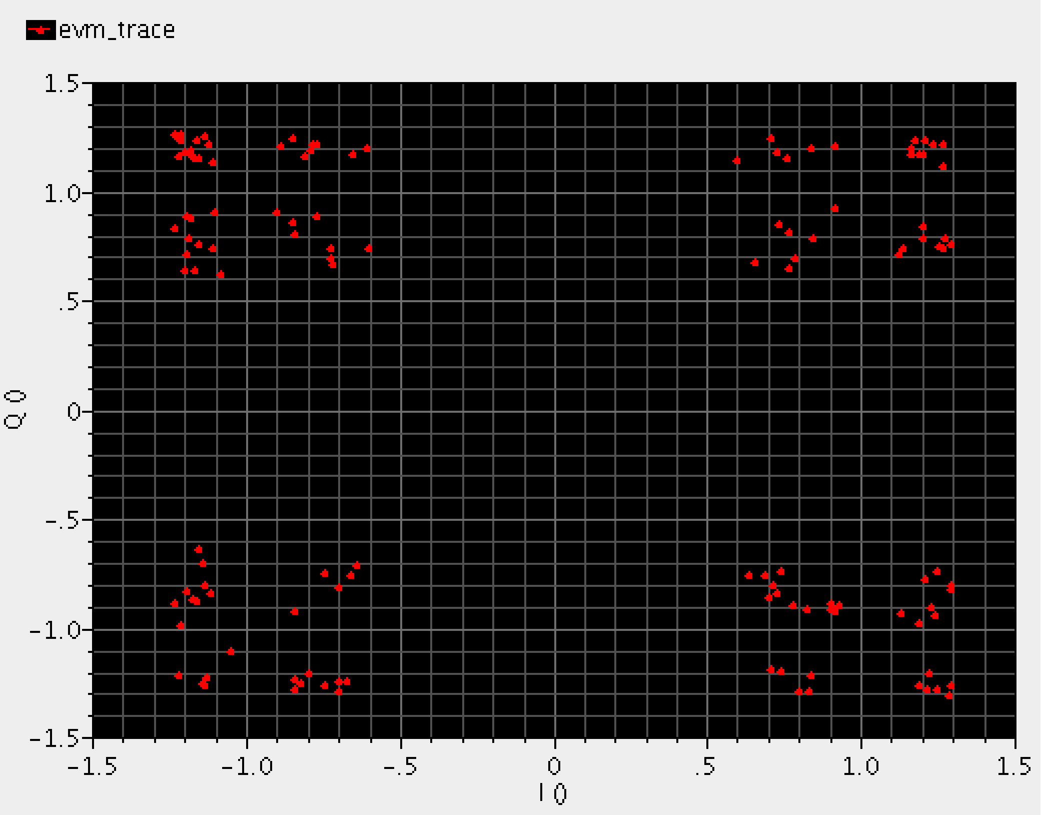
Processes the I and Q waveform outputs from the transient simulation run to calculate the Error Vector Magnitude (EVM) for multi-mode modulations. The function plots the I versus Q scatterplot. EVM is a useful measurement to describe the overall signal amplitude and phase modulated signal quality. It is based on a statistical error distribution normalized from an ideal digital modulation. Quadrature Amplitude Modulation (QAM) is a typical modulation scheme where EVM is useful. The EVM is calculated by detecting the I and Q signal levels corresponding to the four possible I and Q symbol combinations and calculating the difference between the actual signal level and the ideal signal level.

This function is not supported for families of waveforms.

The evmQAM function is available only in the SKILL mode.

- *I-Signal* is the waveform for the I signal.
- *Q-Signal* is the waveform for the Q signal.
- *Symbol Start* is the start time for the first valid symbol.
- *Symbol period* is the period for the symbol. Each period is represented by a data rate. The data rate at the output is determined by the particular modulation scheme being used. For example, if the data rate selected is 5.5 Mbps, it corresponds to a period of 181.8 ns.
- *Modulation Level* is the modulation level.
- *Normalize Display* normalizes the scatter plot to the ideal values +1 and -1 (for example, when superimposing scatter plots from different stages in the signal flow,

where the levels may be quite different but the you want to see relative degradation or improvement in the scatter).



evmQpsk

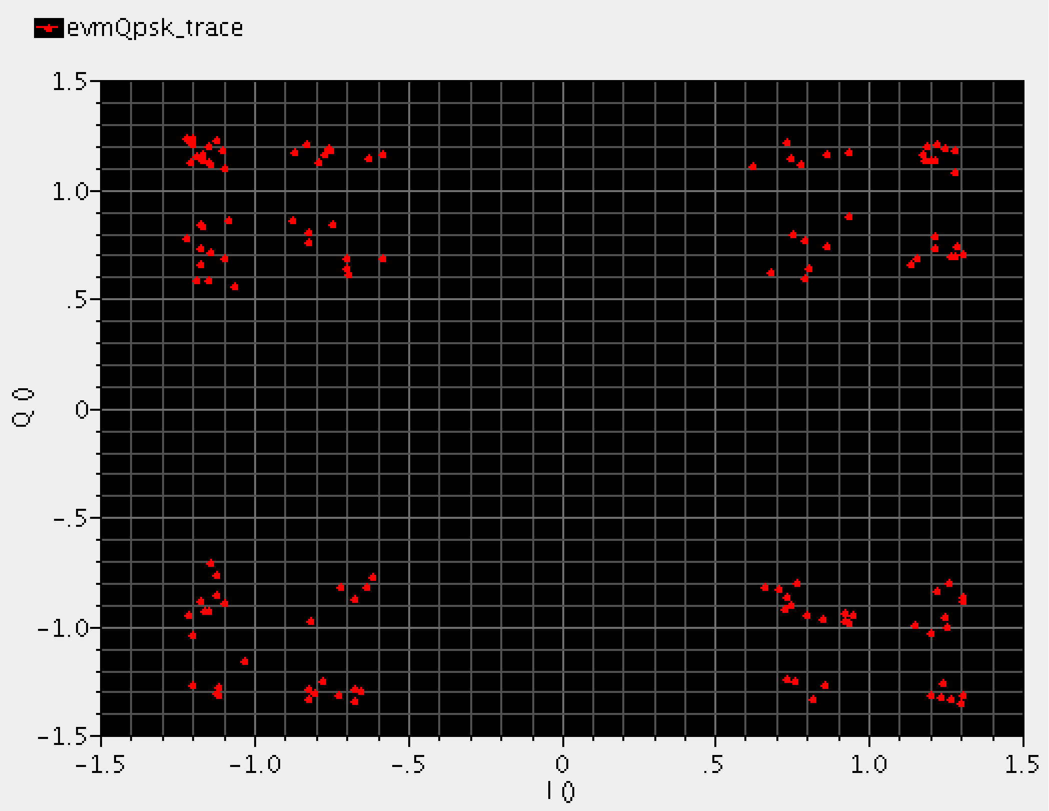
Processes the I and Q waveform outputs from the transient simulation run to calculate the Error Vector Magnitude (EVM) and plot the I versus Q scatterplot. EVM is a useful measurement to describe the overall signal amplitude and phase modulated signal quality. It is based on a statistical error distribution normalized from an ideal digital modulation. Quadrature Phase Shift Keying (QPSK) is a typical modulation scheme where EVM is useful. The EVM is calculated by detecting the I and Q signal levels corresponding to the four possible I and Q symbol combinations and calculating the difference between the actual signal level and the ideal signal level.

This function is not supported for families of waveforms.

This function is available only in the SKILL mode.

- *I-Signal* is the waveform for the I signal.
- *Q-Signal* is the waveform for the Q signal.
- *Symbol Start* is the start time for the first valid symbol.
- *Symbol period* is the period for the symbol. Each period is represented by a data rate. The data rate at the output is determined by the particular modulation scheme being used. For example, if the data rate selected is 5.5 Mbps, it corresponds to a period of 181.8 ns.
- *Auto Level Detect* `on` indicates that you want the amplitude (*Amplitude*) and DC offset (*Offset*) to be calculated automatically. *Amplitude* is calculated by averaging the rectified voltage level of the signal streams and DC *Offset* by averaging the sum of an equal number of positive and negative symbols in each signal stream. These values are used to determine the EVM value. If *Auto Level Detect* is set to `off`, you must specify values for the *Amplitude* and *Offset* fields.
- *Amplitude(V)* is the amplitude of the signal. You need to specify a value in this field only if *Auto Level Detect* is set to `off`.
- *Offset(V)* is the DC offset value. You need to specify a value in this field only if *Auto Level Detect* is set to `off`.
- *Normalize Display* normalizes the scatter plot to the ideal values +1 and -1 (for example, when superimposing scatter plots from different stages in the signal flow,

where the levels may be quite different but the you want to see relative degradation or improvement in the scatter).



exp

Returns the e^x value of a signal.

eyeDiagram

Gives an eye-diagram plot in which the waveform signal is divided into fixed time periods, which are then superimposed on each other. The result is a plot that has many overlapping lines enclosing an empty space known as the eye. The quality of the receiver circuit is characterized by the dimension of the eye. An open eye means that the detector can distinguish between `1's` and `0's` in its input, while a closed eye means that a detector placed on `Vout` is likely to give errors for certain input bit sequences.

This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *Start Time* is the X-axis value from where the eye-diagram plot is to begin.
- *Stop Time* is the X-axis value where the eye-diagram plot is to end.
- *Period* is the time period for the eye diagram.
- *Adv. Option*s specifies whether the vertical (`Max Vertical Opening`) or horizontal opening (`Max Horizontal Opening`) of the eye is to be calculated.

falltime

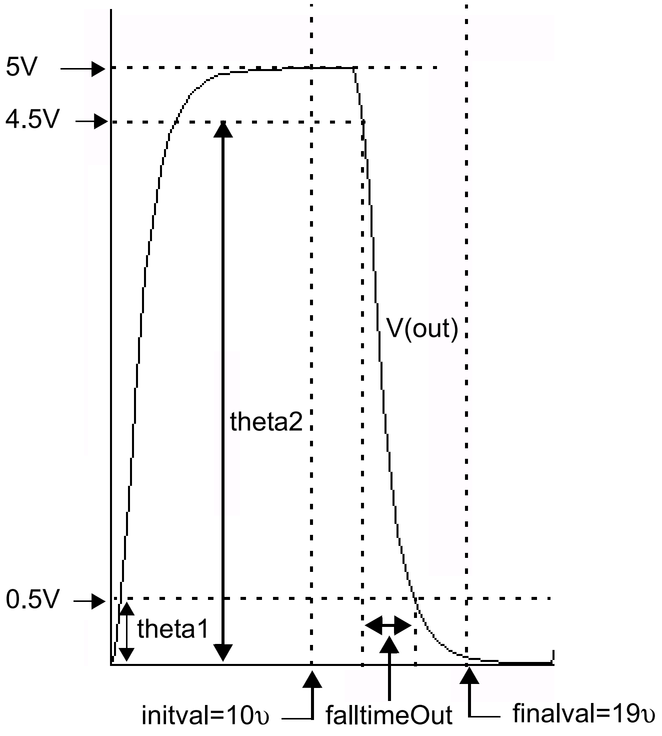
Returns the fall time for a signal measured between percent high and percent low of the difference between the initial and final values. The measurement is always done with ordinate values. This function is available only in the MDL mode.

- *arg* is the name of the signal.
- *initial* is the X value (if inittype is `'x`) or Y value (if inittype is `'y`) that starts the falltime interval.
- *finalval* is the X value (if inittype is `'x`) or Y value (if inittype is `'y`) that ends the falltime interval.
- *inittype* specifies whether the initial value is an X value (`'x)` or a Y value (`'y`).
- *finaltype* specifies whether the final value is an X value (`'x)` or a Y value (`'y`).
- *theta1* is the threshold high expressed as a percentage of the difference between the initial and final values.
- *theta2* is the threshold low expressed as a percentage of the difference between the initial and final values.
- *xtol* is the absolute tolerance in the X direction.
- *ytol* is the absolute tolerance in the Y direction.
- *accuracy* specifies that the function uses interpolation in the SKILL mode.

  In the MDL mode, *accuracy* specifies whether the function should use interpolation, or use iteration controlled by the absolute tolerances to calculate the value. `'interp` directs the function to use interpolation, and `'exact` directs the function to consider the xtol and yval values.

Example

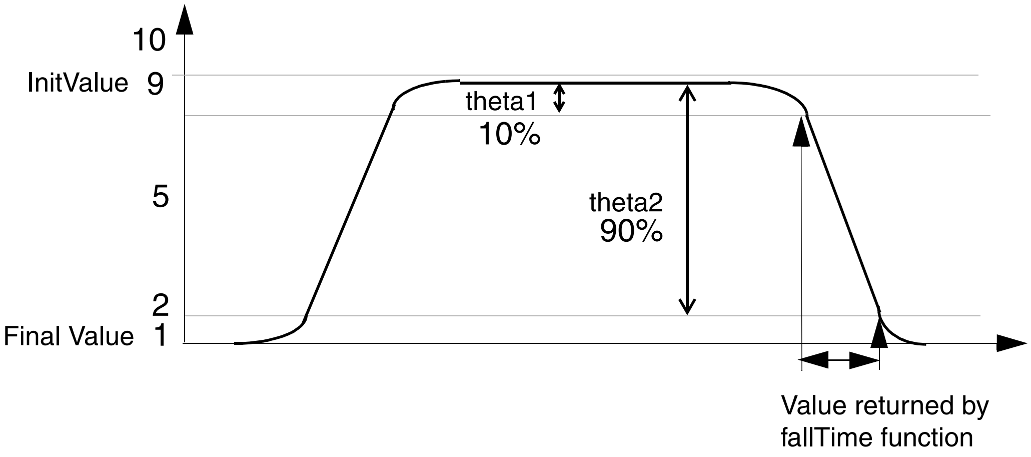
The following diagram illustrates how the result is determined with the values *arg*=`V(out)`, *initval*=`10υ`, *inittype*=`′x`, *finalval*=`19υ`, *finaltype*=`′x`, *theta1*=`10`, *theta2*=`90`



fallTime (SKILL Mode)

Returns the fall time measured between *`theta1`* (percent high) to *`theta2`* (percent low) of the difference between the initial value and the final value.

The `fallTime` function can also be used to compute the rise time if *`initVal`* is lower than *`finalVal`*.



- *Signal* is the name of the waveform.
- *Initial Value Type* is the initial value type used to start the computation. The options are y at x or y.
- *Initial Value* is the initial value at which the computation is to be started.
- *Final Value Type* is the final value type used to end the computation. The options are y at x or y.
- *Final Value* is the final value at which the computation is to be ended.
- *Percent High* is the percentage high difference between initial and final values.
- *Percent Low* is the percentage low difference between initial and final values.
- *Number of occurrences* is the number of occurrences of falls to be calculated. It can be single or Multiple.
- *Plot/print vs.* is the all falltime values to be calculated per cycle or time.

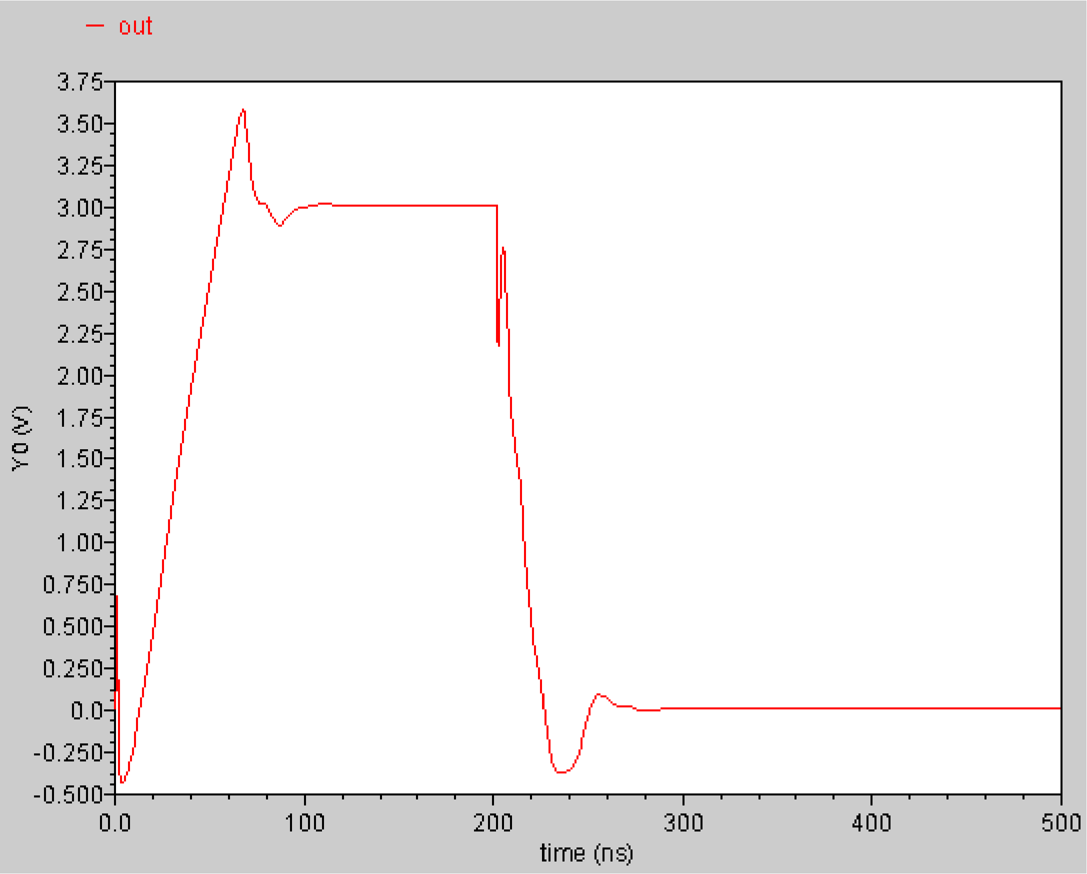
fft

Performs a Fast Fourier Transform on the signal and returns its frequency spectrum. This function is available only in the MDL mode.

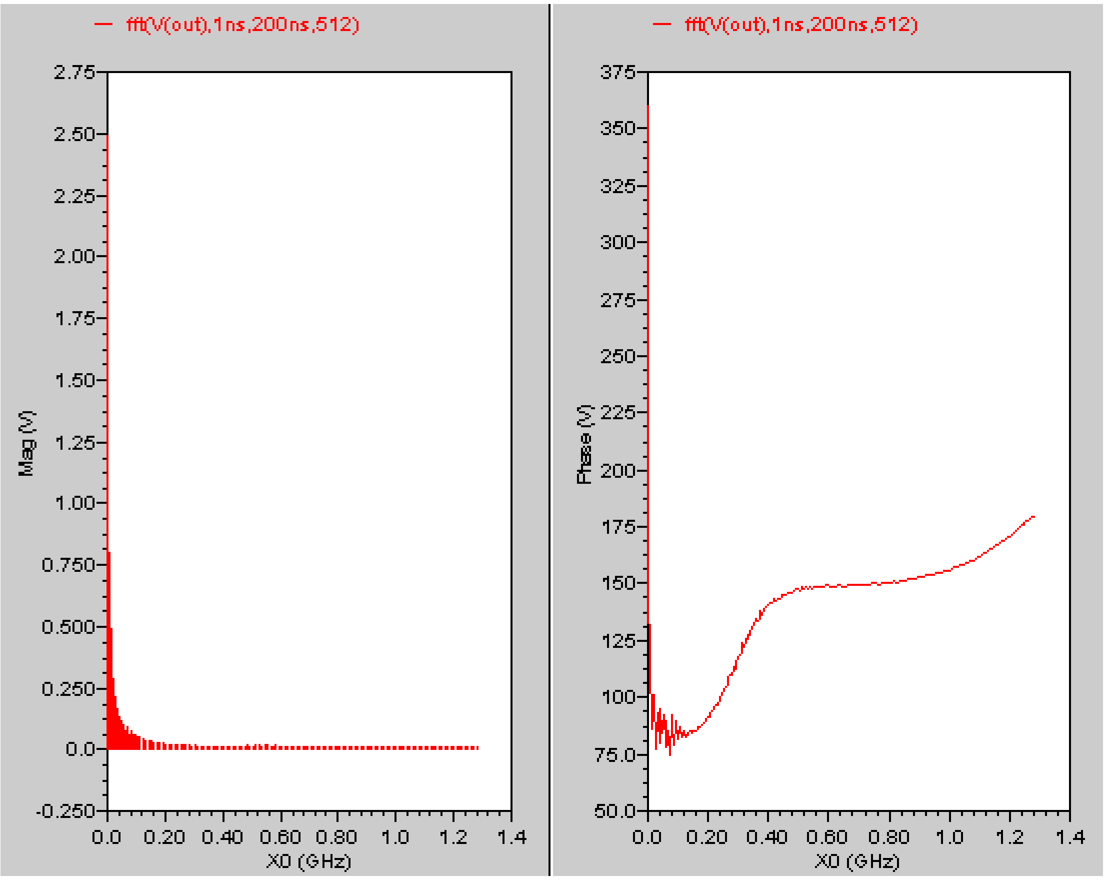
- *sig* is the name of the signal.
- *from* is the starting X value.
- `to` is the ending X value.
- *numPoints* is the number of data points to be used for calculating the fft. If this number is not a power of 2, it is automatically raised to the next higher power of 2.
- *window* is the algorithm used for calculating the fft. For more information, see `window`.

Example

The following input signal with the values *sig*`=V(out)`, f*rom*`=1ns`, *to*`=200ns`, *numpoints*`=512`, and *window*`='bartlett`



transforms into the following output signal. The left subwindow shows the magnitude part of the spectrum and the right subwindow shows the phase part.

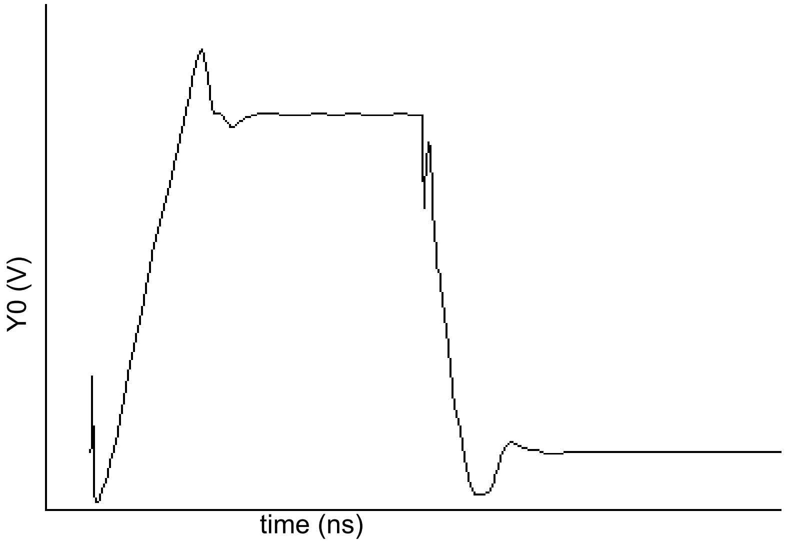


flip

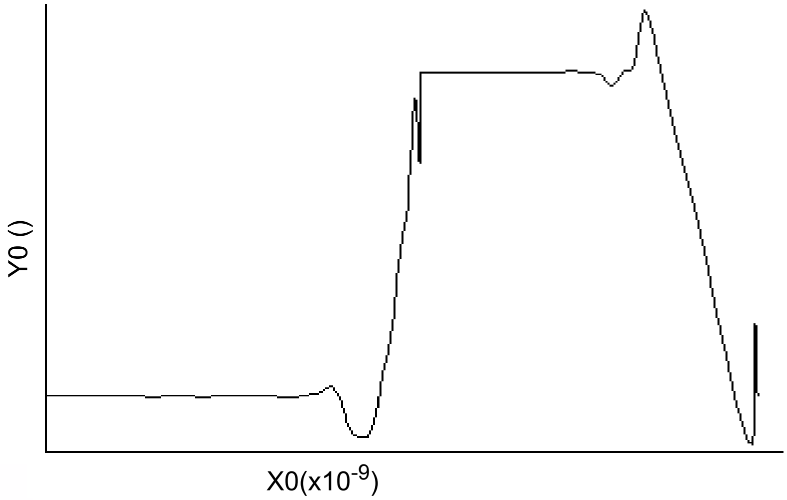
Returns a reversed version of a signal (rotates the signal along the Y-axis).

Example

The following input signal



is transformed into the following output signal.



floor

Rounds a real number down to the closest integer value. This function is available only in the MDL mode.

fourEval

Evaluates the Fourier series represented by the buffer expression. This function is an inverse Fourier transformation and thus the inverse of the dft function. It transforms the buffer expression from the frequency domain to the time domain.This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *From* is time at which you want to begin evaluating the series.
- *To* is time till which you want to evaluate the series.
- *By* is the increment.
- *Baseband* evaluates the baseband version of the inverse of the dft function by converting the unsymmetrical spectrum to a symmetrical one (when set to `on`).

freq

In the SKILL mode, `freq` returns a waveform representing the frequency of a signal versus time or cycle.

- *Signal* (*sig)* is the signal.
- *Edge Type* (*dir)* is the direction of the crossing event. *rising* directs the function to look for crossings where the Y value is increasing and *falling* for crossings where the Y value is decreasing.
- *Plot vs* specifies whether you want to retrieve frequency against *time* (or another X-axis parameter for non-transient data) or *cycle*. Cycle numbers refer to the n'th occurrence of the delay event in the input waveform.
- *Threshold Mode* specifies whether the threshold value is to be calculated by Virtuoso Visualization and Analysis XL (*auto*) or specified by you (*user*). The *auto* threshold is calculated as:

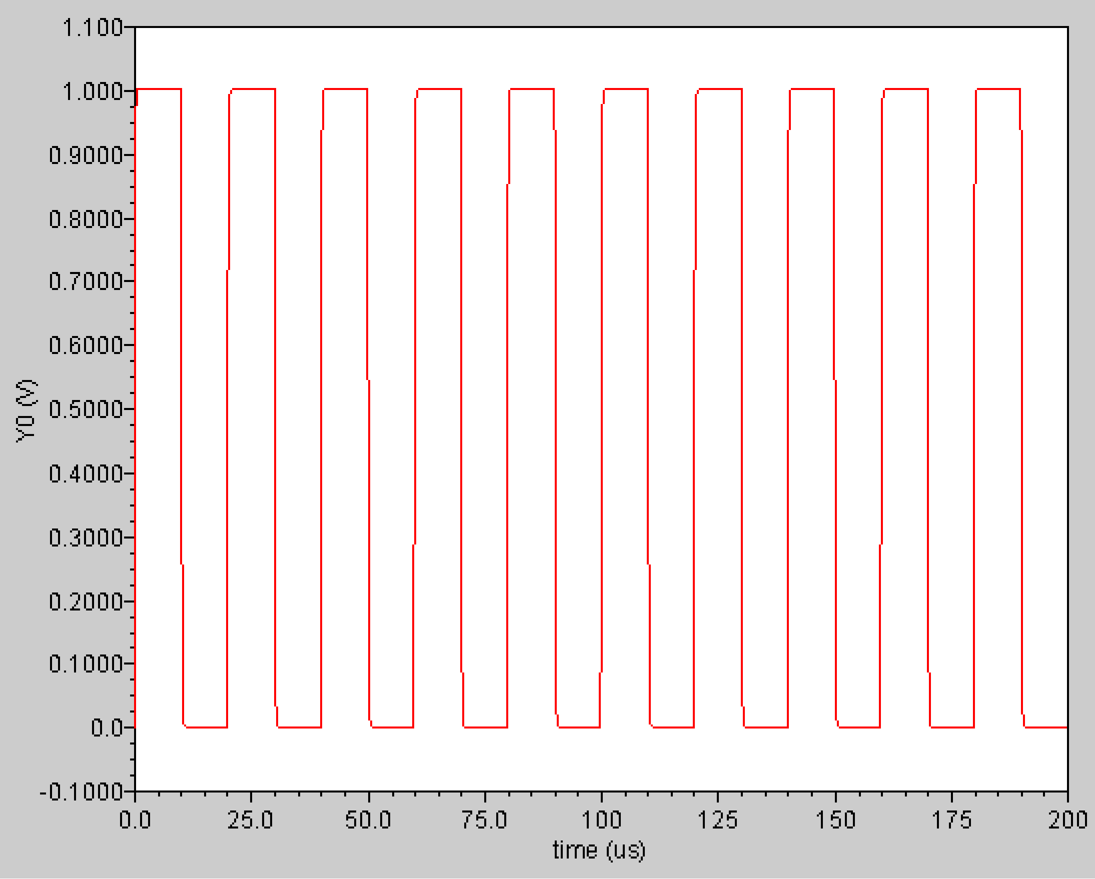
  Auto Threshold Value = integral of the waveform divided by the X range.
- *User Threshold Value* (*thresh)* is the threshold Y-axis value to be crossed. In SKILL mode this field is used available only if the *Threshold Mode* is *auto*.

In the MDL mode, `freq` returns a waveform representing the frequency of a signal versus time.

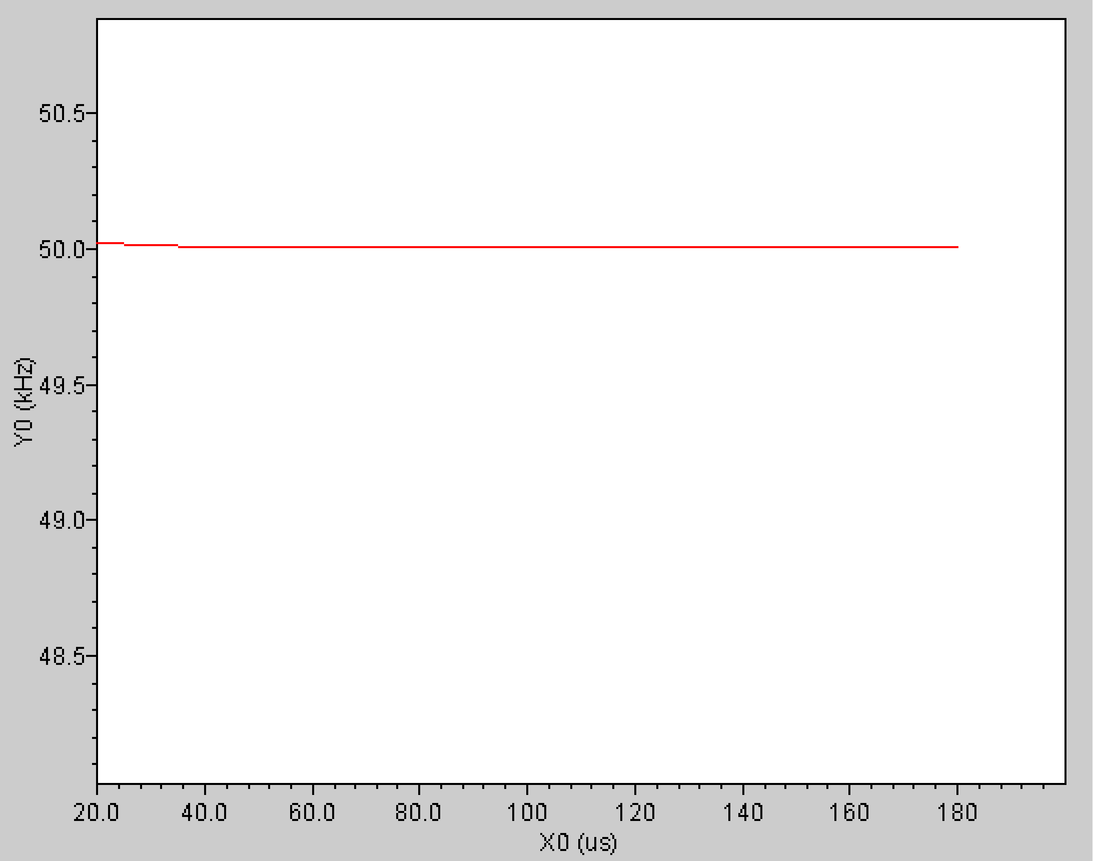
- *sig* is the signal.
- *thresh* is the threshold Y-axis value to be crossed.
- *dir* is the direction of the crossing event. rising directs the function to look for crossings where the Y value is increasing and falling for crossings where the Y value is decreasing.
- the (*thresh)* is the threshold Y-axis value to be crossed. In SKILL mode this field is used only if the *Threshold Mode* is *auto*.

Example:

The following input signal



is converted to the following output signal



frequency

Returns the average frequency of all cycles plotted. This function is available only in the SKILL mode.

$$\text{avgFreq} = \frac{\text{(total number of crosses - 1)}}{\text{(total x-range between the first cross and last cross)}}$$

where the threshold is defined as:

$$\text{threshold} = \frac{(\text{Ymax}+\text{Ymin})}{2} \text{ of the input waveform}$$

freq_jitter

Returns a waveform representing the deviation from the average frequency.

In the SKILL mode,

- *Waveform* is the name of the signal, expression, or family of waveforms.
- *Cross Type* is the points at which the curves of the waveform intersect with the threshold. While intersecting, the curve may be either rising (`rising`) or falling (`falling`).
- *mode* specifies whether the threshold value is to be calculated by Virtuoso Visualization and Analysis XL (`auto`) or specified by you (`user`). The auto threshold is calculated as:

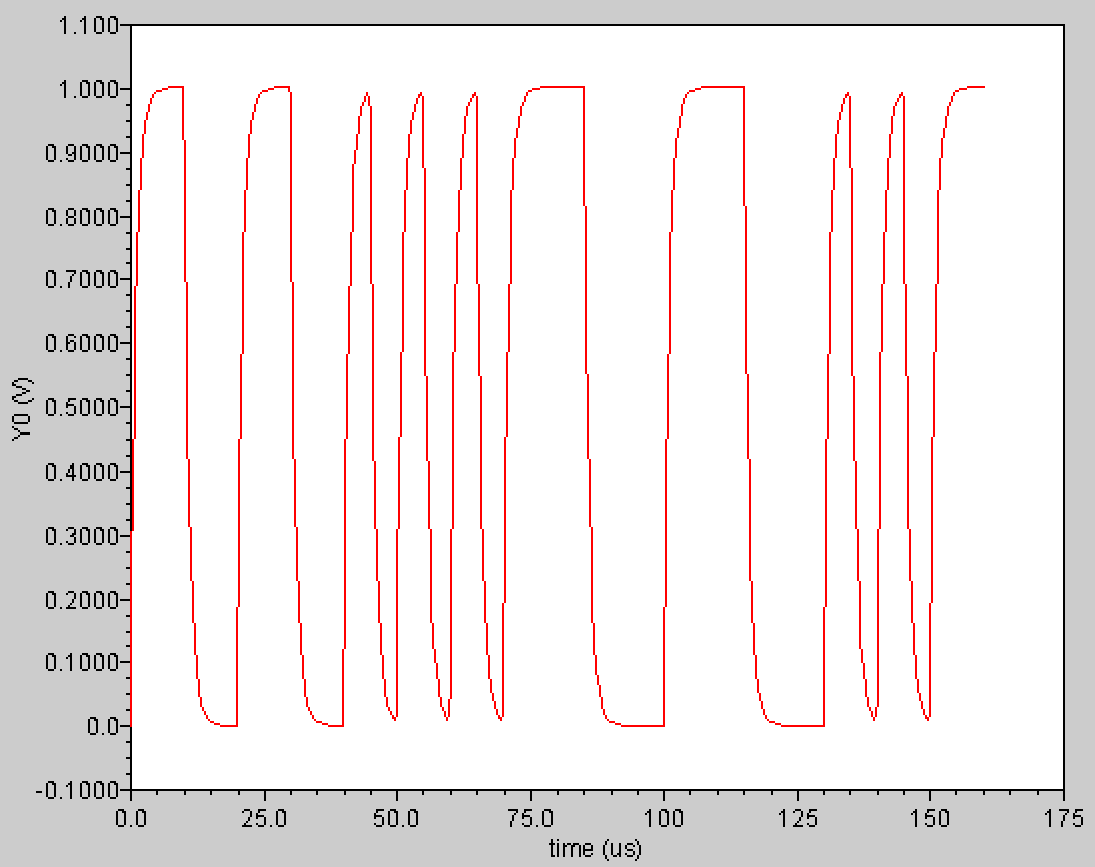
  Auto Threshold Value = integral of the waveform divided by the X range.
- *Threshold* is the threshold value against which the frequency is to be calculated. You need to specify the threshold value only if the *mode* is `user`.
- *Bin Size* is the width of the moving average window, The deviation of value at the particular point from the average of this window is the jitter.
  If *binsize*=0, all frequencies are used to calculate the average.
  If *binsize*=*N*, the last *N* frequencies are used to calculate the average.
- *Plot/print vs.* specifies whether you want to retrieve the frequency jitter against *time* (or another X-axis parameter for non-transient data) or *cycle*. Cycle numbers refer to the n'th occurrence of the delay event in the input waveform.
- *Output Type* is the type of output. If set to `sd`, the output is a standard deviation jitter. If set to `plot`, the output is a waveform. The default value is `plot`.

In the MDL mode,

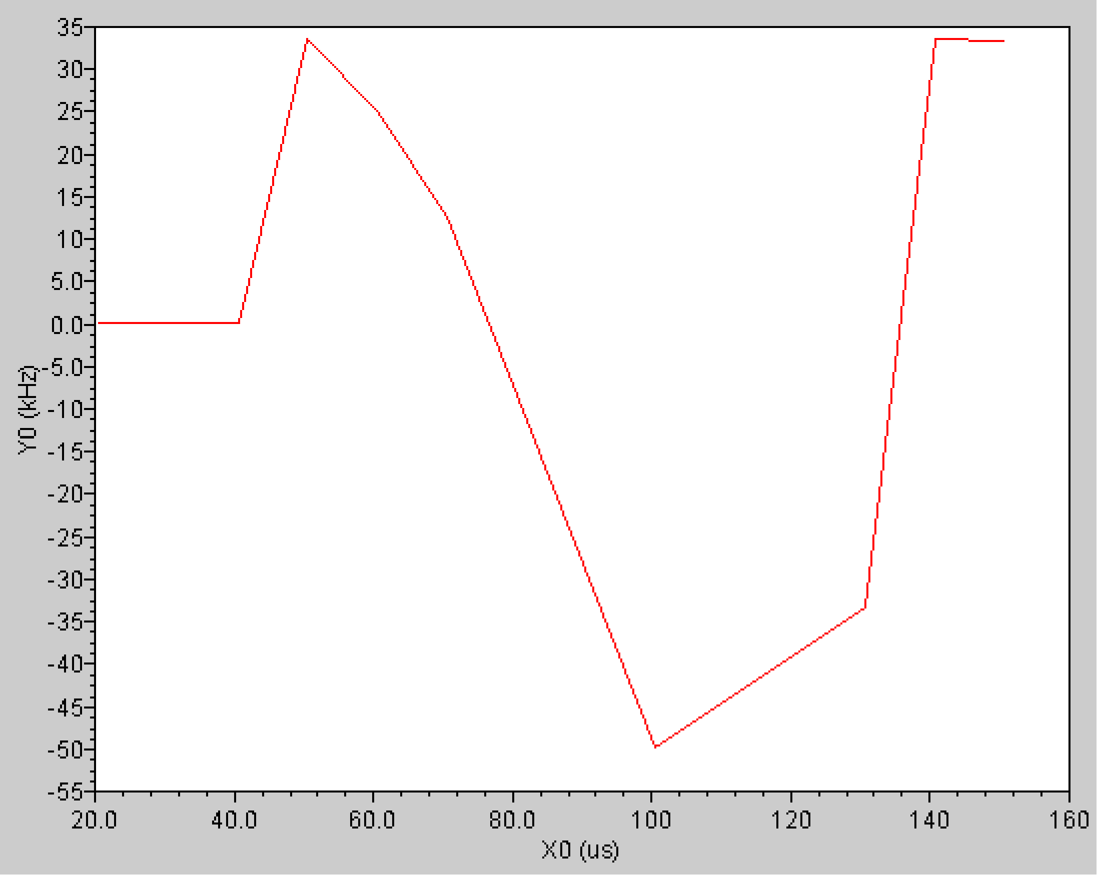
- *sig* is the name of the signal.
- *thresh* is the threshold Y-axis value to be crossed.
- *dir* is the direction of the crossing event.
- *binsize* is the integer used to calculate the average frequency of the signal.
  If *binsize*=0, all frequencies are used to calculate the average.
  If *binsize*=*N*, the last *N* frequencies are used to calculate the average.

Example

The following input signal with the values *sig*=`V(out)`, *thresh*=`0.5`, *dir*=`'rise`, *binsize*=`4`



is transformed into the following output signal



ga

Returns the available gain. This function is available only in the SKILL mode.

gac_freq

Returns the available power gain circles where the gain is fixed and frequency is swept. This function is available only in the SKILL mode.

- *Gain (dB)* is the specified gain.
- *Start* is the starting frequency.
- *Stop* is the ending frequency.
- *Step* is the frequency step size.

gac_gain

Returns the available power gain circles where the frequency is fixed and gain is swept. This function is available only in the SKILL mode.

- Frequency (Hz) is the specified frequency.
- *Start* is the starting gain.
- *Stop* is the ending gain.
- *Step* is the gain step size.

gainBwProd

Returns the product of DC gain and upper cutoff frequency for a low-pass type filter or amplifier.

gainMargin

Computes the gain margin of the loop gain of an amplifier.

The gain margin is calculated as the magnitude (in dB) of the gain at f0. The frequency f0 is the smallest frequency in which the phase of the gain provided is -180 degrees. For stability, the gain margin must be positive.

getAsciiWave

Returns a piecewise linear function from a column of x and y values in a file. This function is available only in the SKILL mode.

gmax

Returns the maximum available gain for a two port. This function is available only in the SKILL mode.

gmin

Returns the optimum noise reflection coefficient for NFmin. This function is available only in the SKILL mode.

gmsg

Returns the maximum stable power gain for a two port. This function is available only in the SKILL mode.

gp

Returns the power gain. This function is available only in the SKILL mode.

gpc_freq

Returns the operating power gain circles where the gain is fixed and frequency is swept. This function is available only in the SKILL mode.

- *Gain (dB)* is the specified gain.
- *Start* is the starting frequency.
- *Stop* is the ending frequency.
- *Step* is the frequency step size.

gpc_gain

Returns the operating power gain circles where the frequency is fixed and gain is swept. This function is available only in the SKILL mode.

- Frequency (Hz) is the specified frequency.
- *Start* is the starting gain.
- *Stop* is the ending gain.
- *Step* is the gain step size.

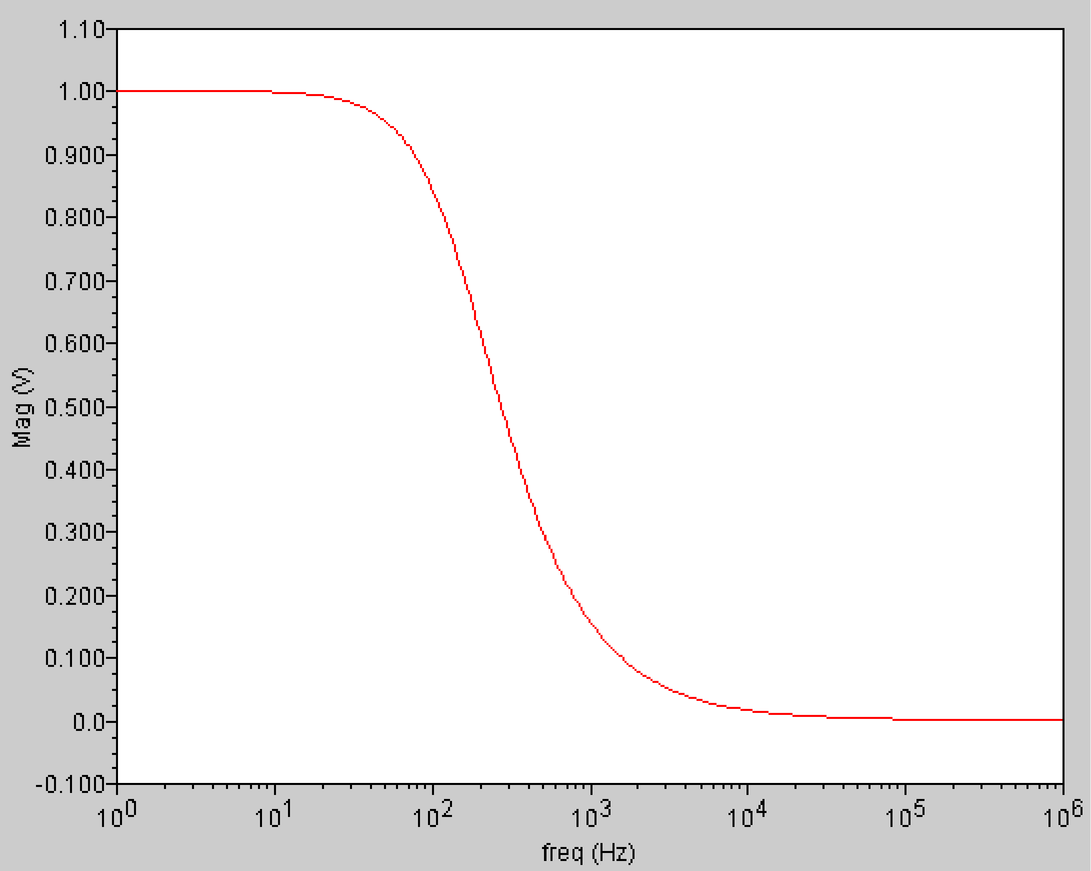
groupDelay

Computes the group delay of the expression in the buffer. 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:

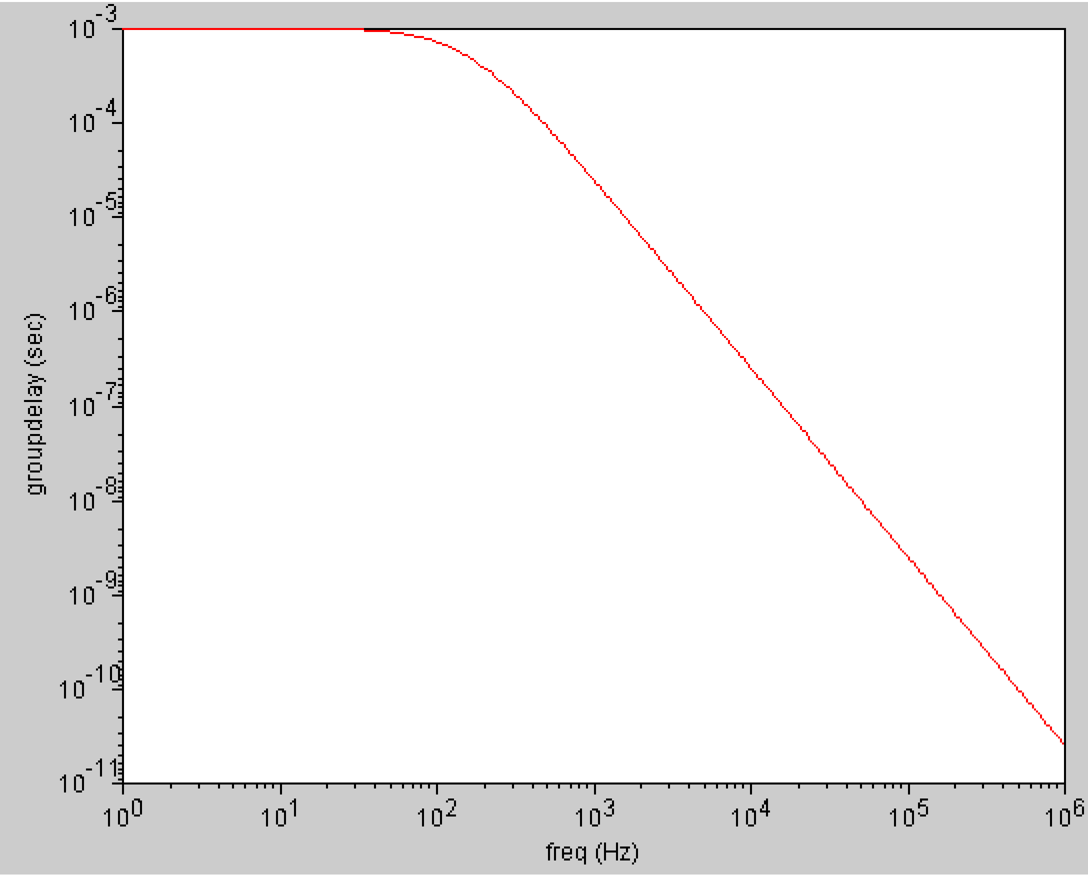
$$GroupDelay = \frac{d\phi}{d\omega} = \frac{d}{df}\left[\frac{phase(/netX)}{360}\right]$$

Example

The following input signal



is converted to the following output signal



gt

Returns the transducer gain. This function is available only in the SKILL mode.

gumx

Returns the maximum unilateral power gain for a two port. This function is available only in the SKILL mode.

harmonic

Returns the harmonic waveform of the specified harmonic. This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *Harmonic Number* is the index number that designates the harmonic information to be returned. For the pss, pac, and pxf analyses, the index is an integer. For the pdisto analysis, the index is a list of integers that correspond to the frequency names listed in the funds analysis parameter in the netlist. You can specify more than one harmonic number at a time.

Example

```
harmonic(v("/Pif" ?result "pss-fd.pss")1)
```

Returns the complex value of voltage.

harmonicFreq

Returns the frequency(s) of the harmonic waveform for the specified harmonic. This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *Harmonic Number* is the index number that designates the harmonic information to be returned. For the pss, pac, and pxf analyses, the index is an integer. For the pdisto analysis, the index is a list of integers that correspond to the frequency names listed in the funds analysis parameter in the netlist. You can specify more than one harmonic number at a time.

Example

```
harmonic(xval(v("/Pif" ?result "pss-fd.pss")),1)
```

Returns the frequency value of first harmonic.

histo

Returns a waveform that represents the statistical distribution of input data in the form of a histogram. The height of the bars (or bins) in the histogram represents the frequency of the occurrence of values within a specific period. Using the histo function, the range for capturing these frequencies can be specified through the *min* and *max* values.

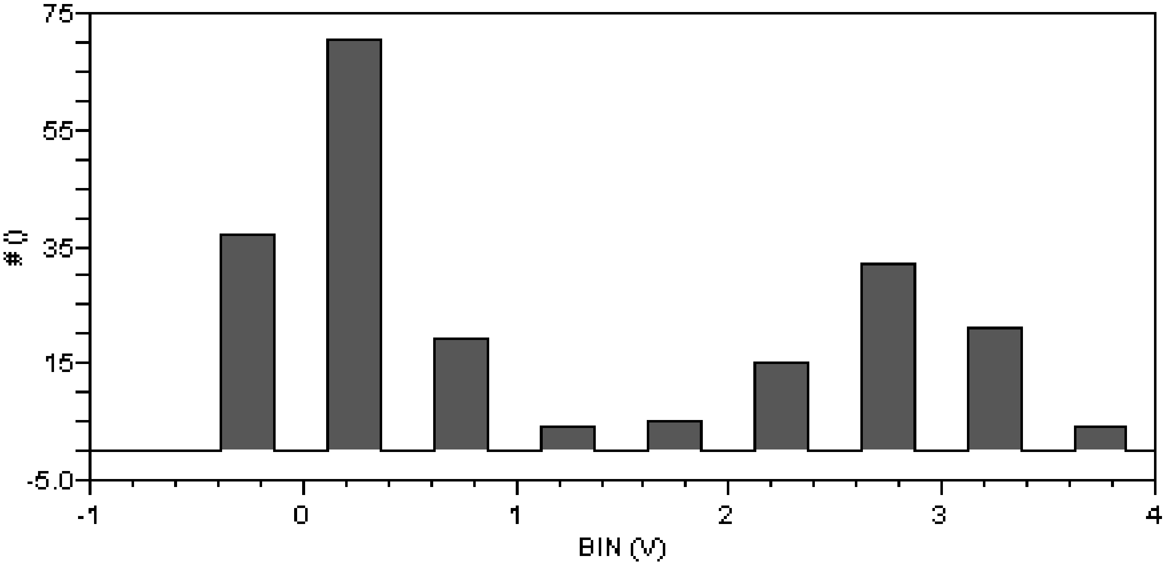
The histo function is available from the calculator. It is not supported within a Spectre MDL control file since it returns a scalar and not a waveform.

- *sig* is the waveform.
- *nbins* is the number of bins to represent the input data.
- *min* is the first value on the horizontal axis of the histogram. By default, it assumes the minimum value of the input waveform.
- *max* is the last value on the horizontal axis of the histogram. By default, it assumes the maximum value of the input waveform.

Example

The input values *sig*=`V(out)`, *nbins*=`10`, *min*=`-1.0`, *max*=`4.0`

creates a display with 10 bins that might look like this when the leftmost bin is empty.



ifft

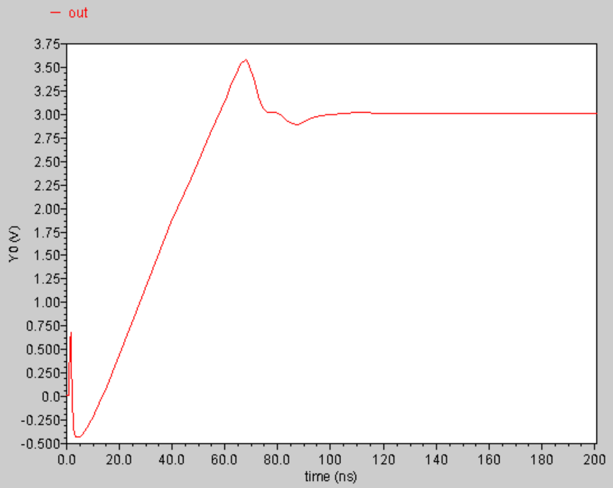
Performs an inverse Fast Fourier Transform on a frequency spectrum and returns the time domain representation of the spectrum. This function is available only in the MDL mode.

The frequency spectrum.

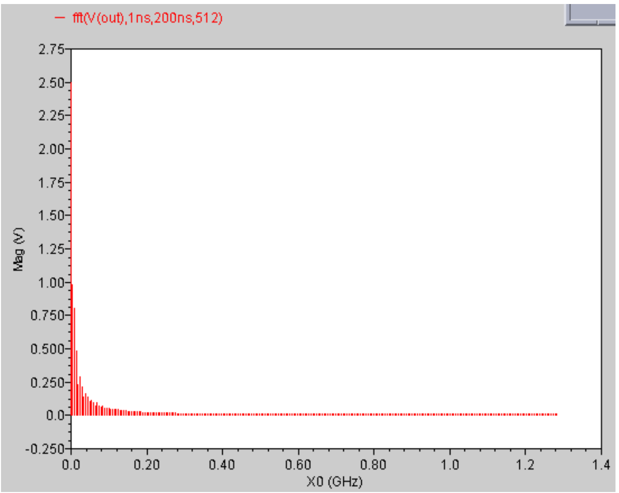
Example

The input signal on the left side with the values *sig*=`V(out)`, f*rom*=`1ns`, *to*=`200ns`, *npoints*=`512` results in the graph on the right side.

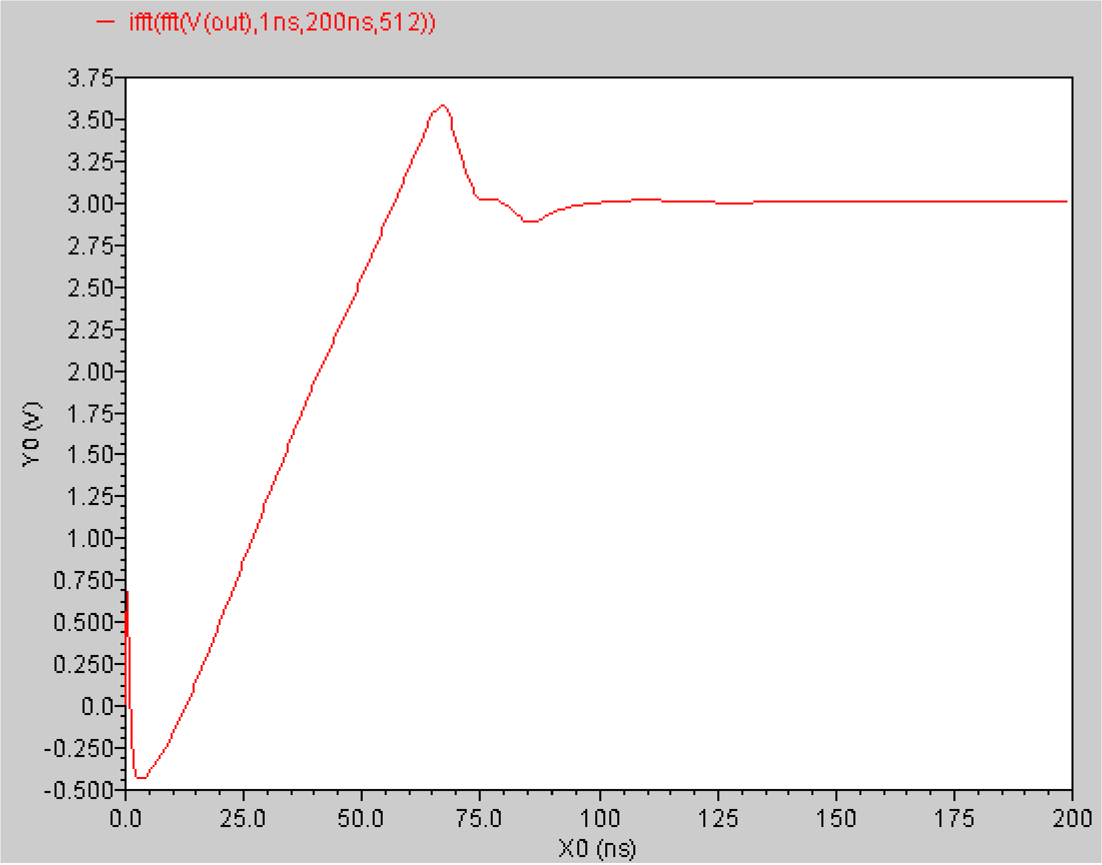
The signal `out`



Fast fourier transform of the signal `out`



Now if you perform an `ifft` with the values *sig*=`V(out)`, *from*=`1`ns, *to*=`200`ns, *npoints*=`512`, the result is the same as the original signal (`out`) – from 1ns to 200ns.

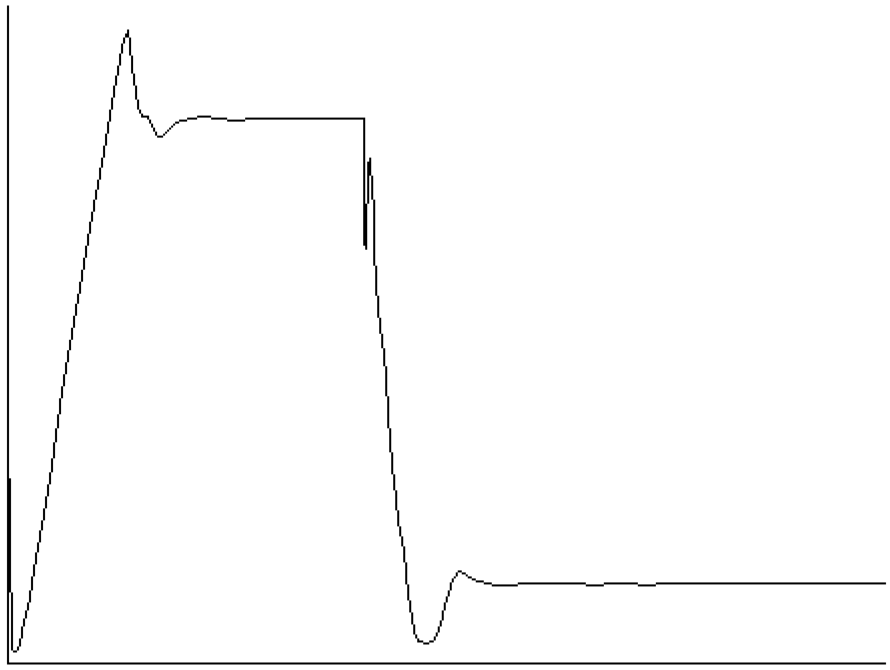


iinteg

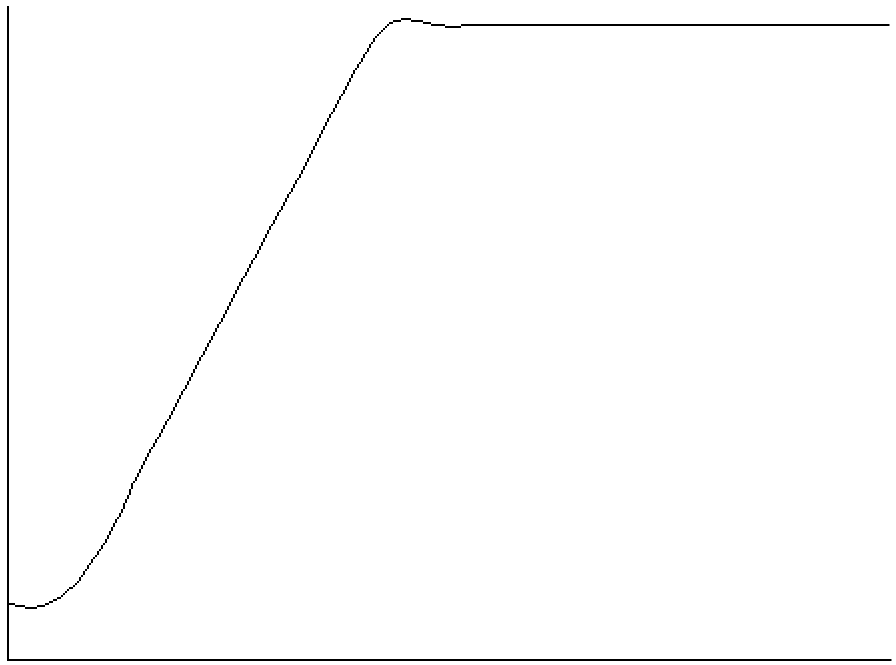
Returns the incremental area under the waveform.

Example

The following input signal



transforms into the following output signal



Each X value on the output trace is equal to the area under the input trace from start till that particular X-value.

im

Returns the imaginary part of a complex number. This function is available only in the MDL mode.

imag

Returns the imaginary component. This function is available only in the SKILL mode.

int

Returns the integer portion of a real value.

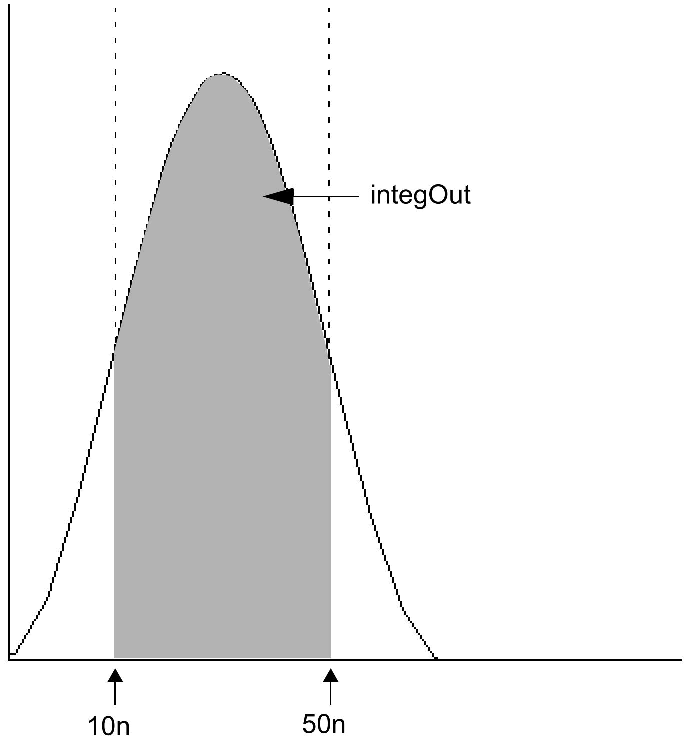
integ

Returns the area bounded under the curve.

Example

The following diagram illustrates how the result with the values `integ( trim(sig=V(sinewave), from=10n, to=50n ) )`

is determined. The result is equal to the shaded area in the graph.



intersect

Returns all the points at which two waveforms intersect each other. The intersect function can be used on families of traces swept on the same parameter names and values.

- *Signal1* is the name of the first waveform.
- *Signal2* is the name of the second waveform.

ipn

Plots the *N*th order intercept between two harmonics of a waveform that you define. This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *Spur Order* determines what order of interference is calculated for the spurious and reference waves. The default value `3` corresponds to the IP3 function. If you use a value other than 3, that order of interference is calculated between those two waves.
- *Spur Harmonic* is the harmonic number for the spurious waveform.
- *Extrapolation Point* is the extrapolation point for the IPN function. This is the X-axis value.
- *Reference Harmonic* is the harmonic number for the reference waveform.

ipnVRI

Performs an intermodulation *N*th-order intercept point measurement

You can 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 then 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 y coordinate (output referred).

- *signal* is the name of the signal.
- *Spur Harmonic* is the harmonic index for the spurious waveform.
- *Reference Harmonic* is the harmonic index for the reference waveform.
- *Spur Order* determines what order of interference is calculated for the spurious and reference waves. The default value `3` corresponds to the IP3 function. If you use a value other than 3, that order of interference is calculated between those two waves.
- *Extrapolation Point* is the extrapolation point for the IPN function. This is the X-axis value. The default is the minimum X-axis value of the input voltage waveform.
- *Load Resistance* is the resistance into the output port.
  To get the X-coordinate of the intercept, select *Input Referred IPN*. To get the Y-coordinate of the intercept, specify *Output Referred IPN*.
- *Circuit Input Power* specifies whether the input power is a variable sweep or a single point.

kf

Returns the stability factor K. This function is available only in the SKILL mode.

loadpull

Plots load pull contour for the given waveform of PSS analysis. This function works only for two-dimensional sweep PSS results. The inner sweep should be phase and the outer sweep should be magnitude.

- *Signal* is the name of the input waveform.
- *Max Value* is the largest value of the contour to be drawn. Default value is `nil`, which specifies that the largest value is to be taken from the results.
- *Min Value* is the smallest value of the contour to be drawn. Default value is `nil`, which specifies that the smallest value is to be taken from the results.
- *Number of Contours* is the number of points on the contour. Default value is `9`.
- *Close Contour* is *a* Boolean flag that specifies if a closed or open contour is to be drawn. If this field is set to `yes`, it specifies that a closed contour is to be drawn. If set to `no`, it specifies that an open contour is to be drawn.

Example: `awvRfLoadPull(i("V2:p" ?maxValue nil ?minValue nil ?numCont 9 ?closeCont nil)`

ln

Returns the natural logarithm of a signal.

log10

Returns the base 10 logarithm of a signal.

lsb (Load Stability Circles)

Returns the load stability circles. This function is available only in the SKILL mode.

- *Start (Hz)* is the start of the frequency range.
- *Stop (Hz)* is the end of the frequency range.
- *Step* is the increment for the frequency range.

lshift (Left Shift)

Shifts the data in the Graph Window to the left by the specified amount. A negative value shifts the data to the right. This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *Delta X* is the amount by which you want to shift the data.

mag

Returns the magnitude of a signal.

max

Returns the absolute value of a signal, or the maximum value of two real values. This function is available only in the MDL mode.

min

Returns the minimum value of a signal. This function is available only in the MDL mode.

mod

Returns the floating point remainder of the dividend divided by the divisor. The divisor cannot be zero. This function is available only in the MDL mode.

movingavg

Calculates the moving average for the specified signal. This function is available only in the MDL mode.

nc_freq (Noise Circles - Sweep Frequency)

Returns noise circles with fixed gain. This function is available only in the SKILL mode.

- Level (dB)
- *Start* is the starting frequency.
- *Stop* is the ending frequency.
- *Step* is the frequency step size.

nc_gain (Noise Circles - Sweep Level)

Returns noise circles with fixed frequency. This function is available only in the SKILL mode.

- Level (dB)
- *Start* is the starting gain.
- *Stop* is the ending gain.
- *Step* is the gain step size.

nf

Retrieves F from the PSF file. This function is available only in the SKILL mode.

nf=dB10(F)

where nf is the noise figure and F is the noise factor.

nfmin

Retrieves Fmin from the PSF file. This function is available only in the SKILL mode.

nfmin=dB10(Fmin)

where nfmin is the minimum noise figure and Fmin is the minimum noise factor.

overshoot

Returns the overshoot/undershoot of a signal as a percentage of the difference between initial and final values.

In the SKILL mode,

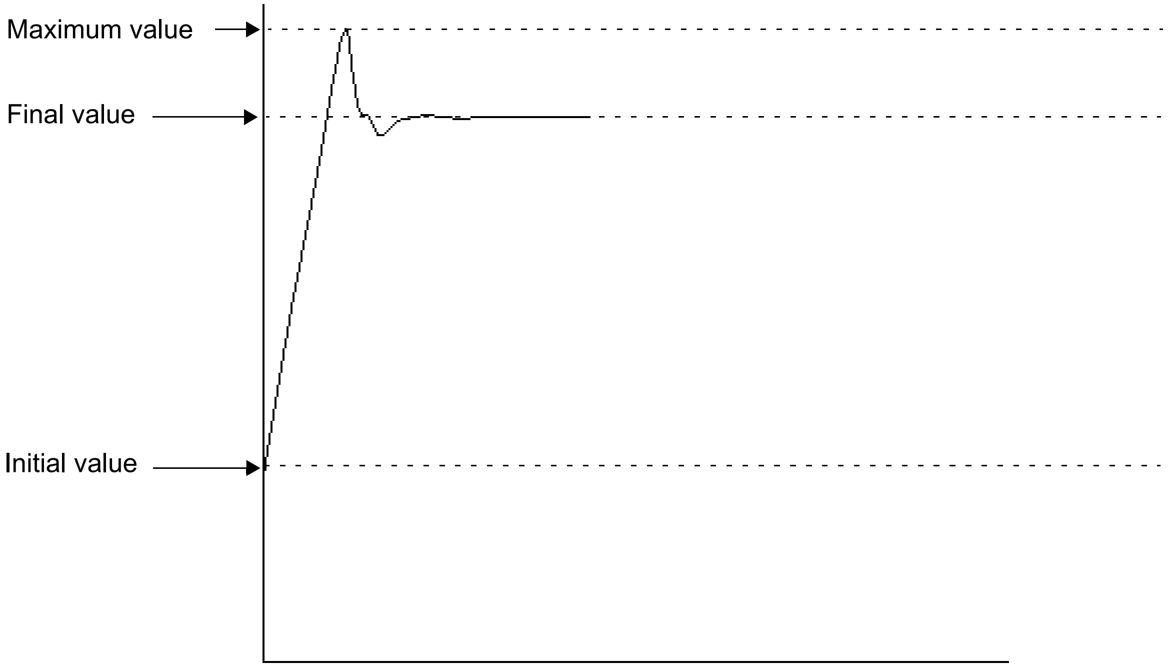
- *Signal* is the name of the signal.
- *Initial Value Type* specifies whether the initial value is the Y-axis value at the specified X-axis value (`y at x`) or Y-axis value (`y`).
- *Initial Value* is the initial value. To calculate the undershoot of a signal, the Initial Value should be higher than Final Value.
- *Final Value Type* specifies whether the final value is the Y-axis value at the specified X-axis value (`y at x`) or Y-axis value (`y`).
- *Final Value* is the final value.
- *Number of Occurences* specifies whether you want to retrieve only one occurrence of an overshoot event for the given waveform (*single*), or all occurrences of overshoot for the given waveform which you can later plot or print (*multiple*).
- *Plot/print vs* specifies whether you want to retrieve overshoot data against *time* (or another X-axis parameter for non-transient data) or *cycle*. Cycle numbers refer to the n'th occurrence of the delay event in the input waveform.
  The value in this field is ignored when you specify *Number of Occurences* as *single*.

In the MDL mode,

- *`sig`* is the name of the signal.
- *`initval`* is the initial value. To calculate the undershoot of a signal, the initval should be higher than finalval.
- *`finalval`* is the final value.
- *`inittype`* specifies whether the initial value is a time (`'x)` or voltage value (`'y)`.
- *`finaltype`* specifies whether the final value is a time (`'x)` or voltage value (`'y)`.

Example

The following diagram illustrates how the result is obtained with the values *signal*=`V(out)`, *Initial Value Type*=`y`, *Final Value Type*=`y`, *Initial Value*=`1`, and *Final Value*=`3`.



`OvershooutOut` is given by the following formula:

$$OvershooutOut = \frac{MaximumValue - FinalValue}{FinalValue - InitialValue}$$

pavg

Returns the periodic average of a family of signals for each time point.

- *Signal* is the name of the signal for which you want to calculate the periodic average.
- *From* is the start time from where you want to calculate the periodic average.
- *To* is the end time till you want to calculate the periodic average.
- *Period* is the difference between the end time and start time. This is an optional argument.
- *Sampling Factor*—Sampling factor, which can be increased to increase the accuracy of the output. Default value is `1`.

Equations:

The periodic average of an input waveform is calculated by using the following equations:

```
pavg (signal from to period (sfactor 1) )
```

```
pavg(tk) = average(sample( o_waveform(t), from tk, to N*T, linear, by
T))
```

where,

`o_waveform(t)` is the input waveform

`N` = `floor((to-from) / T)`

`T` = period

If the input waveform is a multi-dimensional waveform or a family of waveforms, the output is calculated as:

$$\text{pavg(tk)} = 1/\text{M} \sum_{j=0}^{M-1} \text{pavg(tk)[o\_waveform\_family[j]]}$$

where,

`o_waveform_family` is the input waveform family

`M` is the number of leaf waveforms in the family.

`o_waveform_family[j]` is the `j`th leaf waveform of the family of waveform represented by the input waveform.

It calculates the `pavg` on each leaf, and then averages over the number of leaves in the family of waveform. In this case the resultant is not a family of waveforms, but a normal waveform of dimension 1.

peak

Detects the peaks in the input waveform and returns the X and Y coordinates of these peak points in the form of a waveform. The peak function will not work for waveforms that comprise of complex numbers.

This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *From* is the initial point on the specified waveform to start determining the peaks. By default, the first point of the waveform is the starting point.
- *To* is the final point on the specified waveform up to which the peaks are to be determined. By default, the last point of the waveform is the end point.
- *X-Tolerance* is the distance on the X-axis within which all peaks are to be filtered. The default value is `0.0`.
- *Y-tolerance* is the distance on the Y-axis within which all peaks are to be filtered. The default value is `0.0`.

If only the *X-Tolerance* is specified, the peaks are filtered in the X-direction.

If only the *Y-Tolerance* is specified, the peaks are filtered in the Y-axis direction.

If both *X-Tolerance* and *Y-Tolerance* are specified, the filtering mechanism operates as follows:

1. The maximum peak is selected first.
2. All adjacent peaks in the neighborhood of both *X-Tolerance* in the X-axis direction and *Y-Tolerance* in the Y-axis direction are then filtered.
3. All the peaks in the rectangular window thus formed are filtered based on both *X-Tolerance* and *Y-Tolerance*.

Example

```
peak( sig=V(out), From=1n, To=20n, X-Tolerance=2n, Y-Tolerance=0.5 )
```

Out of all the peaks in the region starting from 1n to 20n, the function returns a waveform comprising of the peaks that satisfy the criteria of *X-Tolerance* (2n) and *Y-Tolerance* (0.5).

peakToPeak

Returns the difference between the maximum and minimum values of a waveform.

Example: `peakToPeak(v("net9" ?result "tran-tran"))`

Returns the difference between the maximum and minimum values of the waveform representing the voltage of the `net9` net.

period_jitter

Returns a waveform or a value representing the deviation from the average period.

In the SKILL mode,

- *Waveform* is the name of the signal, expression, or family of waveforms.
- *Cross Type* is the points at which the curves of the waveform intersect with the threshold. While intersecting, the curve may be either rising (`rising`) or falling (`falling`).
- *mode* specifies whether the threshold value is to be calculated by the Virtuoso Visualization and Analysis XL (`auto`) or specified by you (`user`). The auto threshold is calculated as:

  Auto Threshold Value = integral of the waveform divided by the X range.
- *Threshold* is the threshold value against which the period is to be calculated. You need to specify the threshold value only if the *mode* is `user`.
- *Bin Size* is the width of the moving average window. The deviation of value at the particular point from the average of this window is the jitter.
  If *binsize*=0, all periods are used to calculate the average.
  If *binsize*=*`N`*, the last *`N`* periods are used to calculate the average.
- *Plot/print vs.* specifies whether you want to retrieve the period jitter against *time* (or another X-axis parameter for non-transient data) or *cycle*. Cycle numbers refer to the n'th occurrence of the delay event in the input waveform.
- *Output Type* is the type of output. If set to `plot`, the output is a jitter waveform. If set to `sd`, the output is a standard deviation of the jitter waveform. The default value is `plot`.

In the MDL mode,

- *`sig`* is the name of the signal.
- *`thresh`* is the threshold Y-axis value defining the period of the signal.
- *`dir`* is the direction of the crossing event.
- *`binsize`* is the integer used to calculate the average period of the signal.
  If *binsize*=0, all periods are used to calculate the average.
  If *binsize*=*`N`*, the last *`N`* periods are used to calculate the average.

phase

Returns the phase of a signal in degrees.

phaseDeg

Calculates the wrapped phase in degrees of a waveform and returns a waveform.

Example: `phaseDeg(v("net9" ?result "tran-tran"))`

phaseDegUnwrapped

Calculates the unwrapped phase in degrees of a waveform and returns a waveform.

Example: `phaseDegUnwrapped(v("net9" ?result "tran-tran"))`

phaseMargin

Computes the phase margin of the loop gain of an amplifier.

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 smallest frequency where the gain is 1. For stability, the phase margin must be positive.

small-sig is the loop gain of interest over a sufficiently large frequency range.

phaseNoise

Plots the phase noise waveform for noise analysis results.

This function is available only in the SKILL mode.

- *Harmonic*—Specify a harmonic number.
- *Signal dataset*—Select the signal data set from the drop-down list.
  Available options: `pss_fd`, `hb_fd`, `hb_mt_fi`, and `qpss_fi`
- *Noise dataset*—Select the noise dataset from the drop-down list.
  Available options: `pnoise`, `pnoise_corr`, `pnoise_src`, `pnoise_xfersrc`, `hbnoise`, `hbnoise_xf`, `hbnoise_mt_xf`, `pnoise_hbnoise`, `qpnoise`, and `qpnoise_hbnoise`

Example

```
phaseNoise(2 "pss_fd" ?result "pnoise")
```

where,

- ❑ Harmonic number is 2,
- ❑ Signal dataset is `pss_fd`
- ❑ Noise dataset is `pnoise`

phaseRad

Calculates the wrapped (discontinuous) phase in radians of a waveform.

Example: `phaseRad(v("net9" ?result "tran-tran"))`

phaseRadUnwrapped

Calculates the unwrapped (continuous) phase in radians of a waveform and returns a waveform.

Example: `phaseRadUnwrapped(v("net9" ?result "tran-tran"))`

Takes the input waveform, representing the voltage of `net9`, and returns the waveform object representing the unwrapped phase in degrees.

PN

Returns a waveform for the transient phase noise of the input waveforms in decibels (`dBc/Hz`). Phase noise is defined as the power spectral density of the absolute jitter of an input waveform.

The function is available only in the SKILL mode.

- *Signal* is the name of the waveform, expression, or family of waveforms. The expression displayed in the Buffer can be added to this field by selecting *buffer*.
- *Cross Type* is the points at which the curves of the waveform intersect with the threshold. While intersecting, the curve may be either rising (`rising`) or falling (`falling`).
- *Threshold* is the threshold value against which the phase noise is to be calculated.
- *Tnom* is the nominal time period of the input waveform.
  Default value: `nil`.
- *Window Type* is the window you want to use. The following window types are supported—*Blakman, Cosine2, Cosine4, ExtCosBell, HalfCycleSine, HalfCycleSine3, HalfCycleSine6, Hanning, Kaiser, Parzen*, *Rectangular,* and *Triangular.* The default window type is *Rectangular*.
- *Smoothing Factor* is the smoothing factor applicable to only Kaiser window. The *Smoothing Factor* field accepts values from `0` to `15`. The value `0` implies no smoothing and is equivalent to a rectangular window.
- *Window Size* is the number of frequency domain points to be used while calculating the power spectral density. A larger window size results in an expected operation over fewer samples, which can result in larger variations in the phase noise. A small window size can smear out sharp steps in the phase noise that might really be present. For more information, see psd (Power Spectral Density) on page 511.
- *Detrending Mode* determines the expected trend for the underlying data while calculating the power spectral density. For more information, see psd (Power Spectral Density) on page 511.
- *Coherent Gain* is a scaling parameter. You can set the coherent gain as `none`, `default`, `magnitude`, `dB20`, or `dB10`*.* A non-zero value scales the power spectral density by 1/(Coherent Gain).
  Default value: `dB20`.
- *Coherent Gain Factor* is a scaling factor. If you choose *magnitude*, *dB20*, or *dB10*, then enter a scaling factor, a non-zero factor scales the power spectral density by 1/

(factor). Valid values for the factor are 0 < factor < 1. You can also use a value of 1 if you do not want the *Coherent Gain Factor* to be used.

- *Method Type* determines the algorithm you want to use to calculate the phase noise, which can be `Absolute Jitter Method` or `Direct Power Spectral Density Method`.
  Default value: `Absolute Jitter Method`.

Note: The *Window Type, Smoothing Factor, Window Size, Detrending Mode*, and *Coherent Gain Factor*, *Coherent Gain* arguments are used to calculate the power spectral density of the absolute jitter to obtain the phase noise.

Defining the Phase Noise

For a given waveform $v(t), t_{start} \le t \le t_{end}$, that has the following properties:

- oscillating with expected nominal period, `T`
- between minimum and maximum values, $v_{\min} \le v(t) \le v_{\max}$,
- rising and falling through a given threshold, v_{th}
- in time intervals, $t_k; 0 \le k \le N$

The phase noise, `P(f)`, can be represented as the spectral density (in decibels) of absolute jitter in phase units as a function of reference clock time:

$$P(f) = PSD\left\{\frac{J_a(k \cdot T)}{T}\right\}$$

where, `PSD` is the power spectral density.

pow

Returns the value of base raised to the power of exponent ($base^{exponent}$).

- *Base* is the name of the signal
- *Exponent* is the power value, which indicates how many times you want to multiply the signal.

Example:

```
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.

prms

Returns the periodic root mean square of a family of signals for each time point, which is the square root of the periodic average of the square of input waveform and can be represented as:

```
prms(o_waveform n_from n_to n_period n_sfactor) =
sqrt(pavg(o_waveform*o_waveform) from to period sfactor)
```

For more information about the `pavg` function, see pavg on page 494.

- *Signal* is the name of the signal for which you want to calculate the root mean square.
- *From* is the start time from where you want to calculate the periodic root mean square.
- *To* is the end time till you want to calculate the periodic root mean square.
- *Period* is the difference between the end time and start time.
- *Sampling Factor* can be increased in order to increase the accuracy of the outputs. Default value is `1`.

Equations:

```
prms(t)= sqrt( pavg( fam(t)**2  start_time end_time period sfactor))
```

where,

`pavg` is the periodic average

`fam(t)` is the family of `t` waveforms

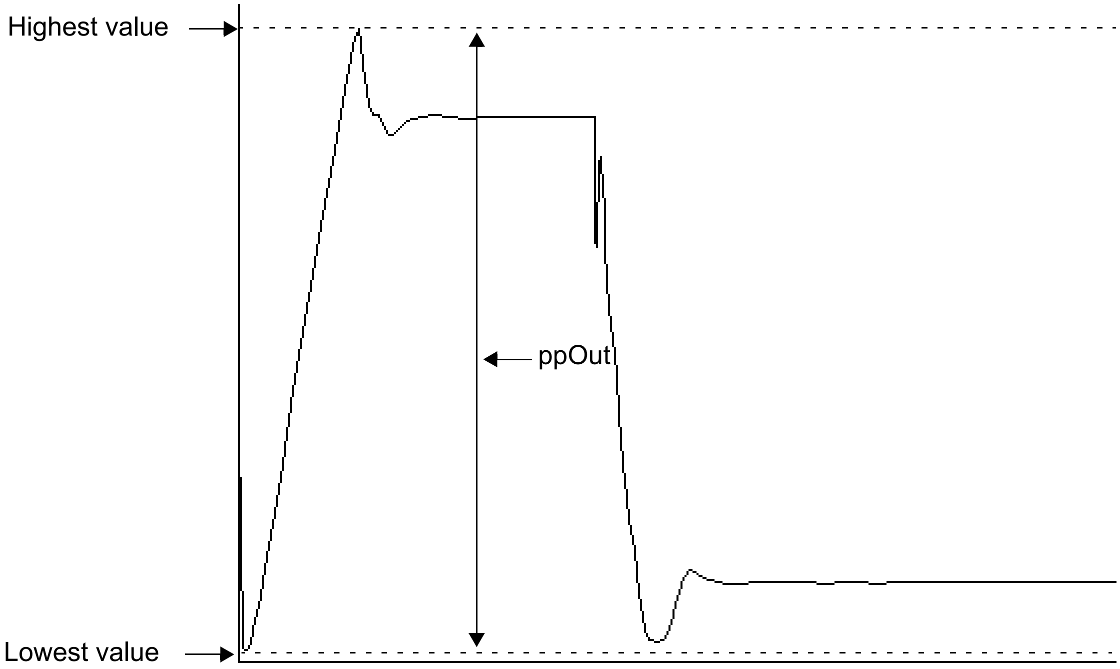
`period=end_time-start_time`

pp (peak-to-peak)

Returns the difference between the highest and lowest values of a signal. This function is available only in the MDL mode.

Example 1

The following diagram illustrates how the pp value is determined.



psd (Power Spectral Density)

Describes how the power (or variance) of a time series (signal) is distributed with frequency. Mathematically, it is defined as the Fourier Transform of the auto correlation sequence of the time series (signal). The waveform is first interpolated to generate evenly spaced data points in time. The spacing of the data points is the inverse of the *dft* sampling frequency. The *psd* is computed by first breaking up the time interval into overlapping segments. Each segment is multiplied, time point by time point, by the specified windowing function. The *dft* is performed on each windowed segment of the baseband waveform. At each frequency, the *dft*s from all segments are averaged together and the squared modulus of these averages gives the *psd*.

This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *From* is the starting time for the spectral analysis interval.
- *To* is the ending time for the spectral analysis interval.
- *Number* of Samples is the number of time domain points to be used.
- *Window Type* is the window you want to use. If you select *Kaiser*, type in a value for the Kaiser smoothing factor. The smoothing factor must be in the range 0 <= factor <= 15, where 0 is the same as using a rectangular window.
- *Smoothing Factor* applies only to the *Kaiser* window type.
- *Window Size* is 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
- *Detrending Mode*
  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 may 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.
- *Coherent Gain* is a scaling parameter. A non-zero value scales the power spectral density by 1/(Coherent Gain).Valid values: 0 < Coherent Gain < 1. You can use `1` if you do not want the scaling parameter to be used. Default value: `1`.

- *Coherent Gain Factor*
  If you choose *magnitude*, *dB20*, or *dB10*, then enter a scaling factor, a non-zero factor scales the power spectral density by 1/(factor). Valid values for the factor are 0 < factor < 1. You can also use a value of 1 if you do not want the *Coherent Gain Factor* to be used.

psdbb (Power Spectral Density Baseband)

Returns an estimate for the power spectral density of a waveform1+j * waveform2. This function is available only in the SKILL mode.

- *Signal1* is the first waveform.
- *Signal2* is the second waveform.
- *From* is the starting time for the spectral analysis interval
- *To* is the ending time for the spectral analysis interval
- *Number of Samples* is the number of time domain points to use. The maximum frequency in the Fourier analysis is proportional to the Number of Samples parameter and inversely proportional to the difference between the starting time and the ending time
- *Window Type* is the type of window you want to use. If you select the *Kaiser* window type, then type in a value for the Kaiser smoothing factor. The smoothing factor must be in the range 0 <= factor <= 15, where 0 is the same as using a rectangular window.
- *Smoothing Factor* applies only to the *Kaiser* window type.
- *Window Size* is 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
- *Detrending Mode*
  The psdbb function works by applying a moving windowed FFT to time-series data. If there is a deterministic trend to the underlying data, you may 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.
- *Coherent Gain* is a scaling parameter. A non-zero value scales the power spectral density by 1/(Coherent Gain).Valid values: 0 < Coherent Gain < 1. You can use `1` if you do not want the scaling parameter to be used. Default value: `1`.
- *Coherent Gain Factor*
  If you choose *magnitude*, *dB20*, or *dB10*, then enter a scaling factor, a non-zero factor scales the power spectral density by 1/(factor). Valid values for the factor are 0 < factor < 1. You can also use a value of 1 if you do not want the *Coherent Gain Factor* to be used.

pstddev

Returns the periodic standard deviation of a family of signals for each time point.

- *Signal* is the name of the signal for which you want to calculate the periodic standard deviation.
- *From* is the start time from where you want to calculate the periodic standard deviation.
- *To* is the end time till you want to calculate the periodic standard deviation.
- *Period* is the difference between the end time and start time. This is an optional argument.
- *Sampling Factor* can be increased in order to increase the accuracy of the outputs. Default value is `1`.

Equations

```
pstddev(tk) = stddev(sample( o_waveform(t), from tk, to N*T, linear,
by T))
```

where,

`o_waveform(t)` is the input waveform

`N` = `floor((to-from) / T)`

`T` = period

If the input waveform is a multi-dimensional waveform or a family of waveforms, the output is calculated as:

$$\mathrm{pstddev(tk)} = 1/\mathrm{M}\sum_{j=0}^{M-1}\mathrm{pstddev(tk)[o\_waveform\_family[j]]}$$

where,

`o_waveform_family` is the input waveform family

`M` is the number of leaf waveforms in the family.

`o_waveform_family[j]` is the `j`th leaf waveform of the family of waveform represented by the input waveform.

It calculates the `pstddev` on each leaf, and then averages over the number of leaves in the family of waveform. In this case the resultant is not a family of waveforms, but a normal waveform of dimension 1.

pzbode

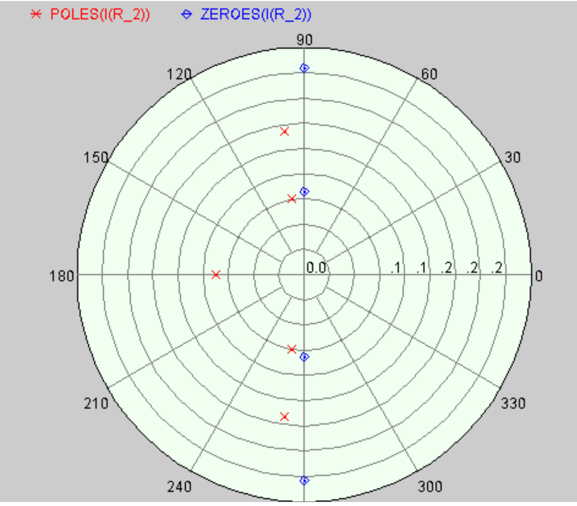
Calculates and plots the transfer function for a circuit from pole zero simulation data.

- *poles* is the poles from the simulation data.
- *zeroes* is the zeroes from the simulation data.
- *c* is the transfer gain constant.
- *minfreq* is the minimum frequency for the bode plot.
- *maxfreq* is the maximum frequency for the bode plot.
- *npoints* is the frequency interval for the bode plot, in points per decade.

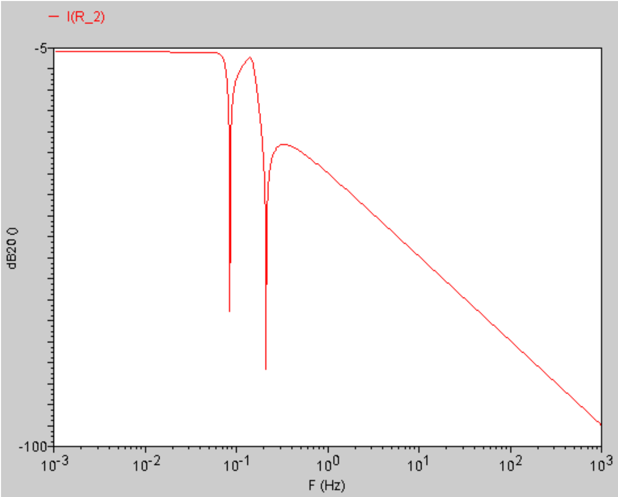
Example

The following diagram illustrates how the result with the values *poles*=`POLES<I<R_1>>`, *zeroes*=`ZEROES<I<R_1>>`, *c*=`I<R_1>\[K\]`, *minfreq*=`1e-3`, *maxfreq*=`1e3`, and *npoints*=`1000` is determined.

Polar Plot



Corresponding bode plot



pzfilter

Filters the poles and zeroes according to the specified criteria. The `pzfilter` function works only on pole zero simulation data.

- *poles* is the poles.
- *zeroes* is the zeroes.
- *maxfreq* is the frequency upto which the poles and zeroes are plotted.
- *reldist* is the relative distance between the pole and zero. Pole-zero pairs with a relative distance lower than the specified value are not plotted.
- *absdist* is the absolute distance between the pole and zero. Pole-zero pairs with an absolute distance lower than the specified value are not plotted.
- *minq* is the minimum Q-factor. Pole-zero pairs with a Q-factor less than the specified value are not cancelled. The equations that define the Q-factor of a complex pole or zero are described in the section below.

Note: If you do not specify *maxfreq*, *reldist*, *absdist*, or *minq*, `pzfilter` filters out the poles and zeroes with a frequency higher than 10 GHz (default value of *maxfreq*).

Equations Defining the Q-Factor of a Complex Pole or Zero

$$Re(X) < 0.0 \qquad Q = 0.5 \times \sqrt{[lm(X)/\ Re(X)]^2 + 1}$$

$$Re(X) = 0 \qquad UNDEFINED$$

$$Re(X) > 0.0 \qquad Q = -0.5 \times \sqrt{[lm(X)/\ Re(X)]^2 + 1}$$

Filtration Rules

- Real poles can be cancelled only by real zeroes. A real pole `P` is cancelled by a real zero `Z` if the following equation is satisfied:

  $$|P - Z| < absdist + \frac{|P + Z|}{2} \times reldist$$

- Complex poles and zeroes always occur in conjugated pairs. A pair of conjugated poles can only be canceled by a pair of conjugated zeroes. A pole pair `P1=a+jb`, `P2=a-jb` is cancelled by a zero pair `Z1=c+jd`, `Z2=c-jd`, if the following equation is satisfied:

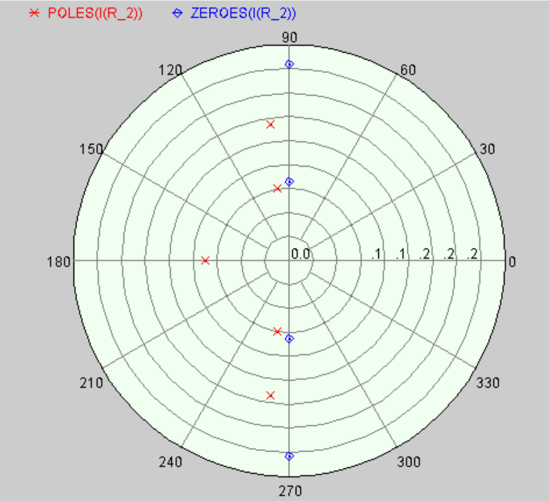
$$|P1 - Z1| = |P2 - Z2| = \sqrt{(a-c)^2 + (b-d)^2} < absdist + \frac{|a+c|}{2} \times reldist$$

- Poles in the right-half plane are never cancelled because they show the instability of the circuit.

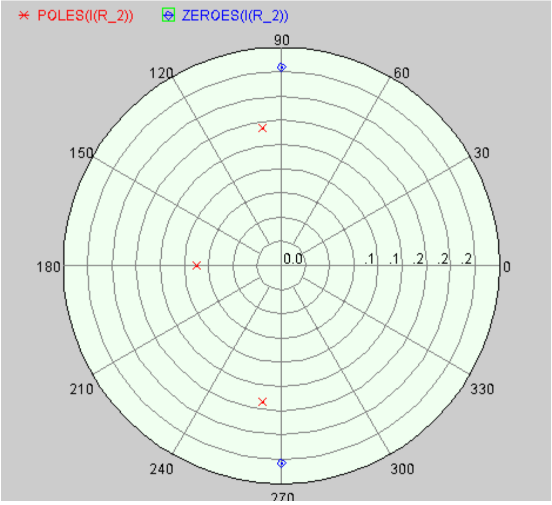
Example

The values *poles*=`POLES<I<R_2>>`, *zeroes*=`ZEROES<I<R_2>>`, *absdist*=`0.05`, and *minq*=`10000` filters pole-zero pairs with a relative distance of less than 0.05 Hz from the plot on the left side. In the filtered plot shown on the right side, two pole-zero pairs have been filtered out.

Original polar Plot



Filtered polar plot



r2d (radians-to-degrees)

Converts a scalar or waveform expressed in radians to degrees. This function is available only in the MDL mode.

re

Returns the real portion of a complex number. This function is available only in the MDL mode.

real

In SKILL, returns the real component of a signal.

In MDL, Creates a real number from an integer number.

risetime

Returns the rise time for a signal measured between percent low and percent high of the difference between the initial and final value.

In the SKILL mode,

- *Signal* is the of the signal.
- *Initial Value Type* specifies whether the initial value is the Y-axis value at the specified X-axis value (`y at x`) or Y-axis value (`y`).
- *Initial Value* is the value that starts the rise time interval.
- *Final Value Type* specifies whether the final value is the Y-axis value at the specified X-axis value (`y at x`) or Y-axis value (`y`).
- *Final Value* is the value that ends the rise time interval.
- *Percent Low* is the percent low.
- *Percent High* is the percent high.
- *Number of Occurences* specifies whether you want to retrieve only one occurrence of a risetime event for the given waveform (*single*), or all occurrences of risetime for the given waveform which you can later plot or print (*multiple*).
- *Plot/print vs* specifies whether you want to retrieve risetime data against *time* (or another X-axis parameter for non-transient data) or *cycle*. Cycle numbers refer to the n'th occurrence of the delay event in the input waveform.
  The value in this field is ignored when you specify *Number of Occurences* as *single*.

In the MDL mode,

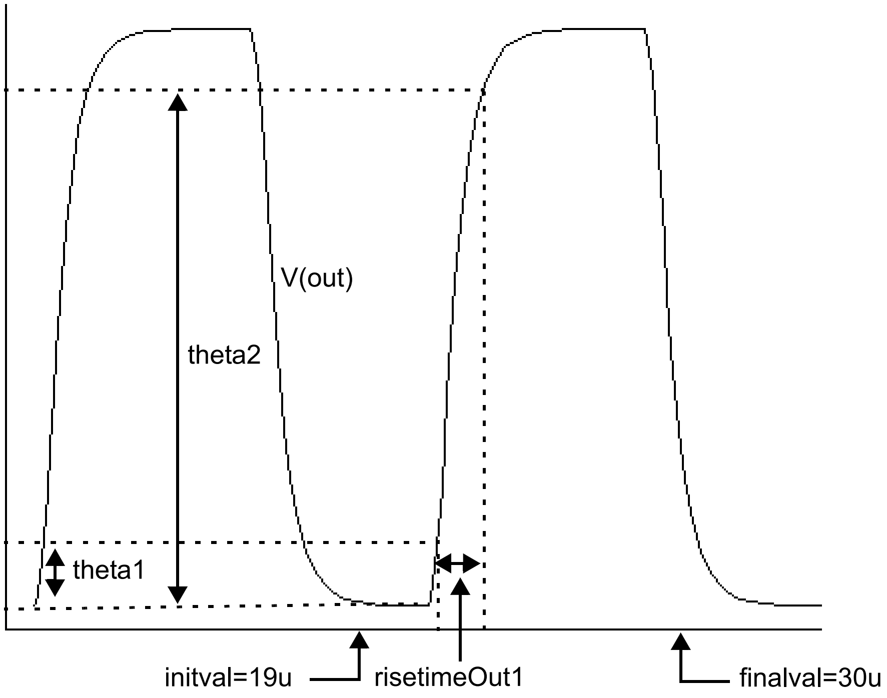
- *sig* is the name of the signal.
- *initval* is the X-axis (if inittype is `'x`) or Y-axis value (if inittype is `'y`) that starts the rise time interval. The measurement is always done in ordinate values.
- *finalval* is the X-axis (if inittype is `'x`) or Y-axis (if inittype is `'y`) that ends the rise time interval. The measurement is always done in ordinate values.
- *inittype* specifies whether the initial value is an X-axis (`'x`) or Y-axis value (`'y).`
- *finaltype* specifies whether the final value is an X-axis (`'x`) or Y-axis value (`'y)`
- *theta1* is the percent low.
- *theta2* is the percent high.

- *xtol* is the absolute tolerance in the X direction.
- *ytol* is the absolute tolerance in the Y direction.
- *accuracy* specifies that the function uses interpolation in the SKILL mode.

  In the MDL mode, *accuracy* specifies whether the function should use interpolation, or use iteration controlled by the absolute tolerances to calculate the value. `'interp` directs the function to use interpolation, and `'exact` directs the function to consider the xtol and yval values.

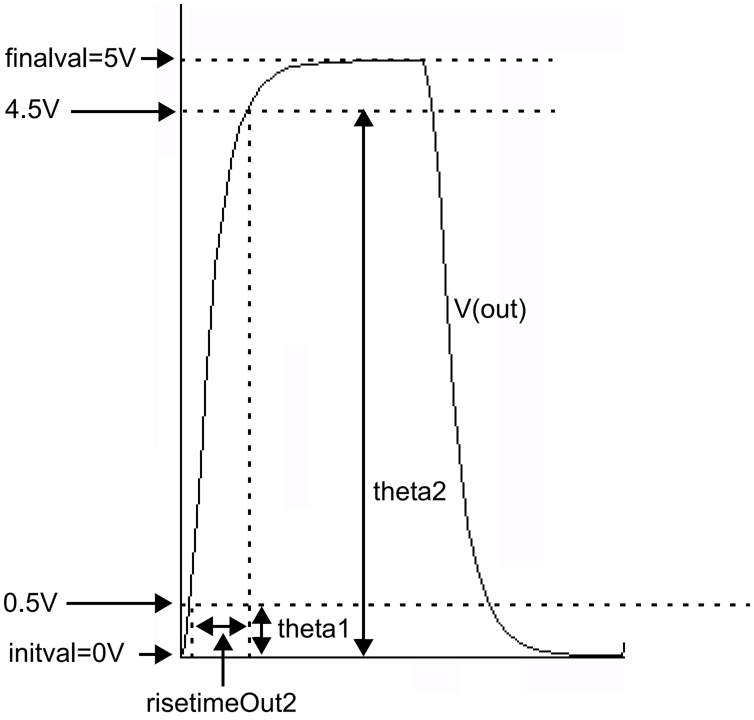
Example 1

The following diagram illustrates how the result with the values *signal*=`V(out)`, *Initial Value*=`19u`, *Final Value* =`30u`*, Initia Value Type*=`x`, *Final Value Type*=`x`, *Percent Low*=`10`, and *Percent High* =`90` is determined.



Example 2

The following diagram illustrates how the result with the values *signal*=`V(out)`, *Initial Value*=`0V`, *Final Value*=`5V`, *Initial Value Type*=`y`, *Final Value Type*=`y`, *Percent Low*=`10`, and *Percent High*=`90` is determined.



rms (root-mean-square)

Returns the root mean square of a signal.

The equation for rms is:

rms = sqrt(average(integ(f(x)**2)))

rmsNoise

Computes the integrated root-mean-square of the total output noise over the bandwidth specified in hertz in the *From* and *To* fields.This function is available only in the SKILL mode.

- *From* is the starting time for the measurement.
- *To* is the ending time for the measurement.

The equation for rmsNoise is:

rmsNoise = sqrt(integ(f(x)**2))

rn

Returns the normalized equivalent noise resistance. This function is available only in the SKILL mode.

root

Computes the value of x at which f(x) equals the specified threshold. This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *Threshold* is the waveform value at which to compute the root value.
- *Nth Root* is the root you want to see.

rshift

Shifts the data in the graph window to the right by the specified amount. A negative value shifts the data to the right. This function is available only in the SKILL mode.

- *Signal* is the name of the signal you want to right shift.
- *Delta X* is the amount by which you want to shift the data
- Example: `rshift(v("net9" ?result "tran-tran") 1 )`

round

Rounds a number to the closest integer value. This function is available only in the MDL mode.

s11

Returns 2-port S-parameters. This function is available only in the SKILL mode.

s12

Returns 2-port S-parameters. This function is available only in the SKILL mode.

s21

Returns 2-port S-parameters. This function is available only in the SKILL mode.

s22

Returns 2-port S-parameters. This function is available only in the SKILL mode.

sample

Returns a waveform representing a sample of the signal based on step size or points per decade.

In the SKILL mode,

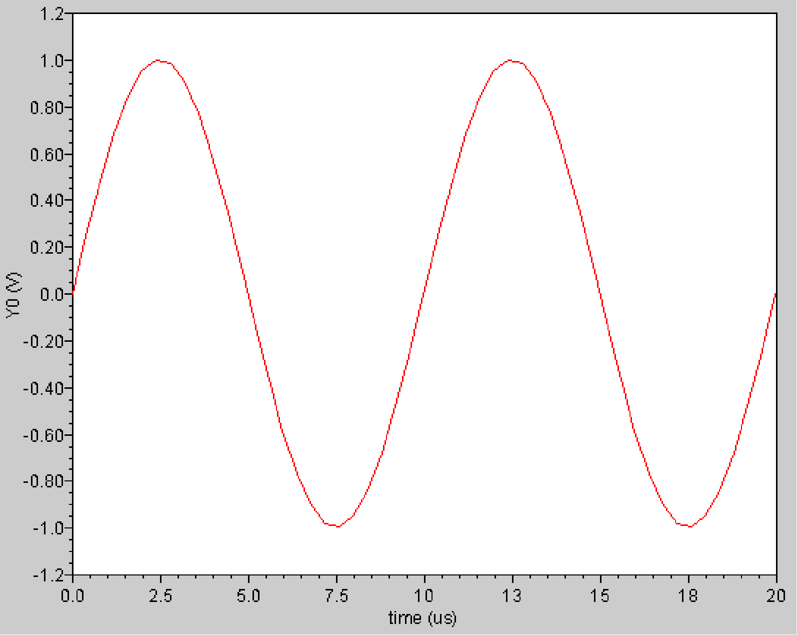
- *Signal* is the name of the signal.
- *From* is the X-axis value at which the sampling begins.
- *To* is the X-axis value at which the sampling stops
- *Type* specifies whether the sample should be linear or logarithmic.
- *By* specifies the step size for the sample (if *type* is `linear`) or the points per decade (if *type* is `logarithmic`).

In the MDL mode,

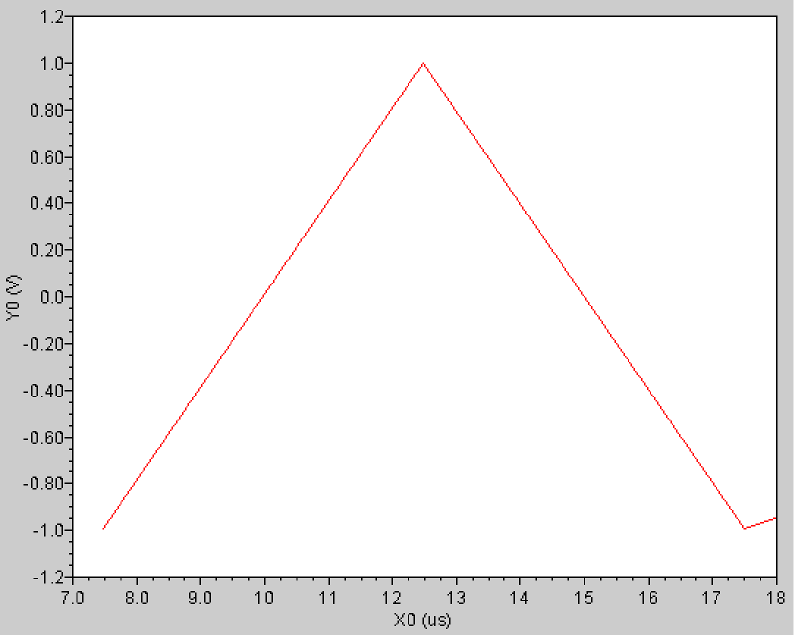
- *sig* is the signal.
- *from* is the X-axis value at which the sampling begins.
- *to* is the X-axis value at which the sampling stops.
- *type* specifies whether the sample should be linear or logarithmic.
- *by* specifies the step size for the sample(if *type* is `'linear`) or the points per decade (if *type* is `'logarithmic`)

Example

The following input signal with the values *signal*=`V(2)`, *From*=`7.5us`, *To*=`18us`, and *By*=`5us`, *type*=`'linear`



transforms into the following output signal



settlingTime

Calculates the time required by a signal to settle at a final value within a specified limit.

In the SKILL mode,

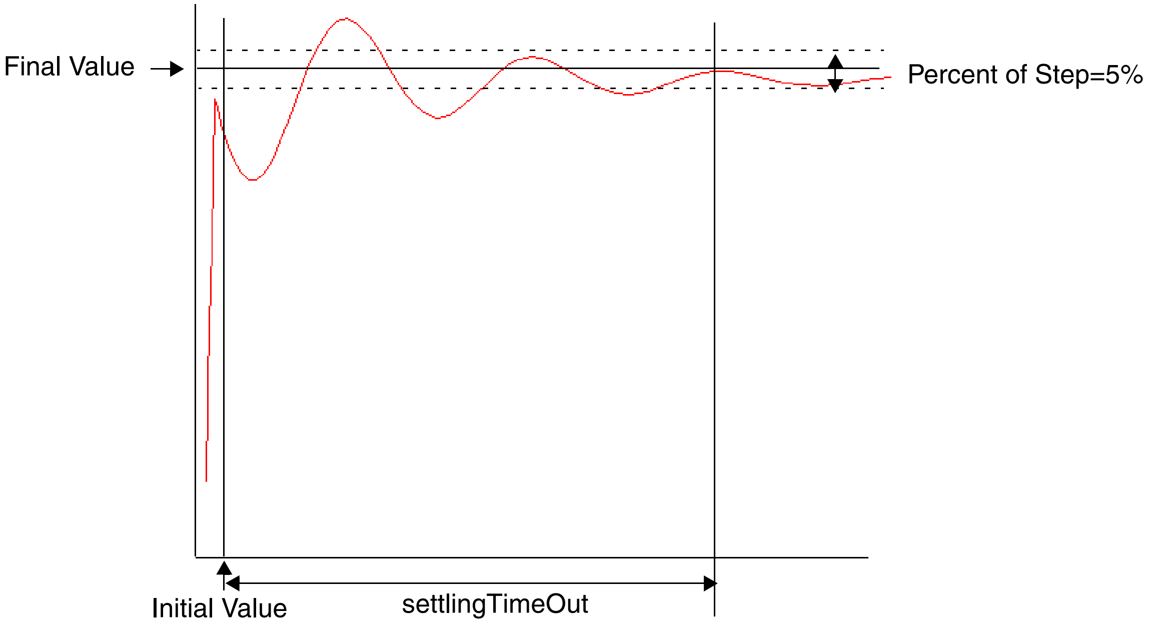
- *Signal* is the name of the signal.
- *Initial Value Type* specifies whether the initial value is the Y-axis value at the specified X-axis value (`y at x`) or Y-axis value (`y`).
- *Initial Value* is the starting value for the measurement.
- *Final Value Type* specifies whether the final value is the Y-axis value at the specified X-axis value (`y at x`) or Y-axis value (`y`).
- *Final Value* is the final value for the measurement.
- *Percent of Step* is the percentage of (*Final value* - *Initial Value*) within which the signal has to settle.
- *Number of Occurences* specifies whether you want to retrieve only one occurrence of a settlingtime event for the given waveform (*single*), or all occurrences of settlingtime for the given waveform which you can later plot or print (*multiple*).
- *Plot/print vs* specifies whether you want to retrieve settlingtime data against *time*(or another X-axis parameter for non-transient data) or *cycle*. Cycle numbers refer to the n'th occurrence of the delay event in the input waveform.
  The value in this field is ignored when you specify *Number of Occurences* as *single*.

In the MDL mode,

- *sig* is the name of the signal.
- *initval* is the starting value for the measurement.
- *finalval* is final value for the measurement.
- *inittype* specifies whether the initial value is an X-axis (`'x`) or Y-axis value (`'y).`
- *finaltype* specifies whether the final value is an X-axis (`'x`) or Y-axis value (`'y)`
- *theta* is the percentage of (*finalval*-*initval*) within which the signal has to settle.

Example

The following diagram illustrates how the result with the values *signal*=`V(out)`, *Initial Value Type*=`y`, *Initial Value*=`0`, *Final Value Type*=`y at x`, *Final Value*=`1.0`, and *Percent of Step*=`5` is determined.



sign

Returns a value that corresponds to the sign of a number. This function is available only in the MDL mode.

sin

Returns the sine of a signal.

sinh

Returns the hyperbolic sine of a signal.

slewrate

Computes the average rate at which the buffer expression changes from percent low to percent high of the difference between the initial value and the final value.

In the SKILL mode,

- *Signal* is the name of the signal.
- *Initial Value Type* specifies whether the initial value is an X-axis (`x`) or Y-axis value (`y`).
- *Initial Value* is the starting value for the measurement.
- *Final Value Type* specifies whether the final value is an X-axis (`x`) or Y-axis value (`y`).
- *Final Value* is the final value for the measurement.
- *Percent Low* is the percent low.
- *Percent High* is the percent high.
- *Number of Occurences* specifies whether you want to retrieve only one occurrence of a slewrate event for the given waveform (*single*), or all occurrences of slewrate for the given waveform which you can later plot or print (*multiple*).
- *Plot/print vs* specifies whether you want to retrieve slewrate risetime data against *time*(or another X-axis parameter for non-transient data) or *cycle*. Cycle numbers refer to the n'th occurrence of the delay event in the input waveform.
  The value in this field is ignored when you specify *Number of Occurences* as *single*.

In the MDL mode,

- *sig* is the name of the signal.
- *initval* is the starting value for the measurement.
- *finalval* is final value for the measurement.
- *inittype* specifies whether the initial value is an X-axis (`'x`) or Y-axis value (`'y).`
- *finaltype* specifies whether the final value is an X-axis (`'x`) or Y-axis value (`'y)`
- *theta1* is the percent low.
- *theta2* is the percent high.
- *xtol* is the absolute tolerance in the X direction.
- *ytol* is the absolute tolerance in the Y direction.

- *accuracy* specifies that the function uses interpolation in the SKILL mode.

  In the MDL mode, *accuracy* specifies whether the function should use interpolation, or use iteration controlled by the absolute tolerances to calculate the value. `'interp` directs the function to use interpolation, and `'exact` directs the function to consider the xtol and yval values.

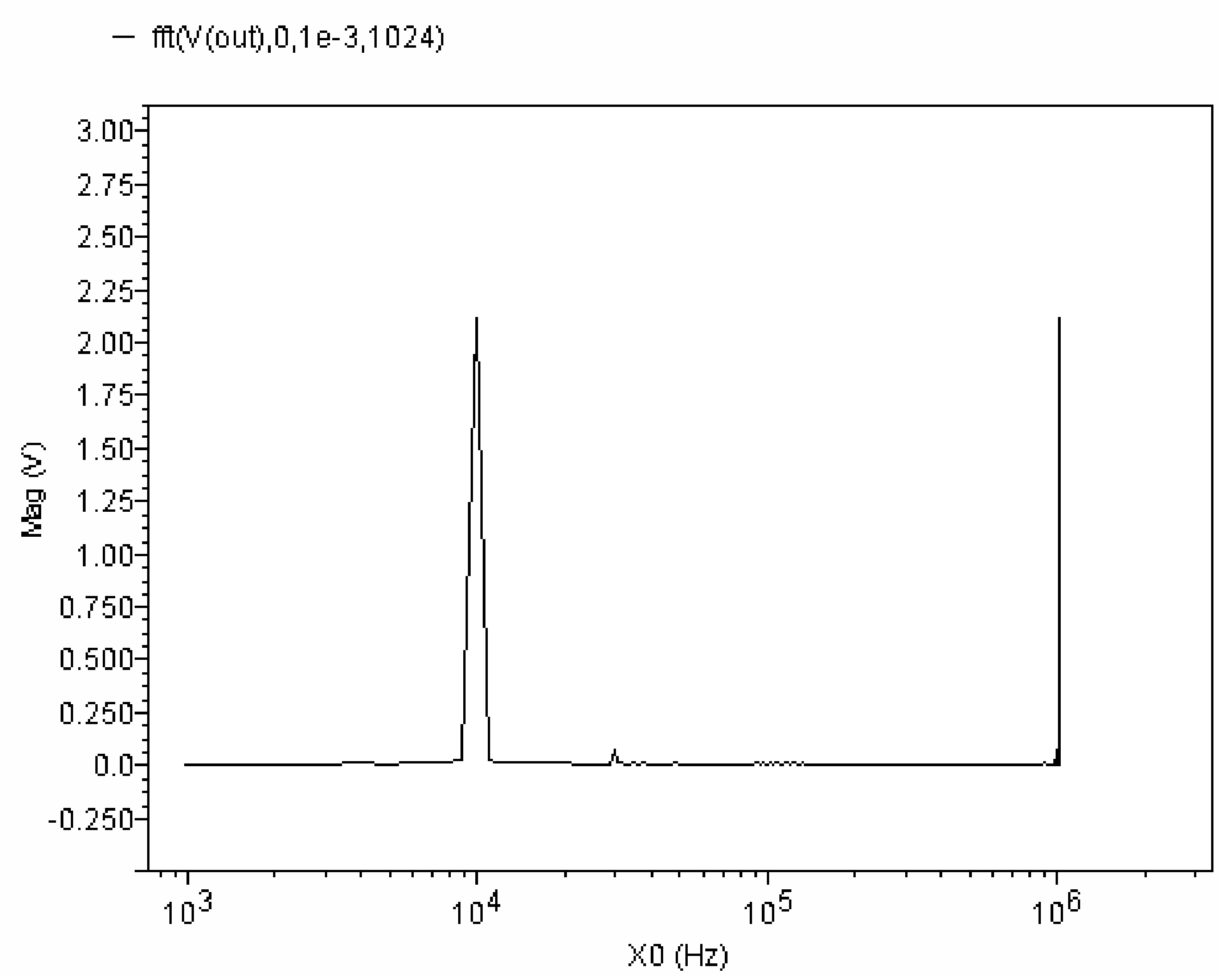
snr

Calculates the signal to noise ratio from a complex frequency based signal. This function is available only in the MDL mode.

- *sig* is the name of the signal.
- *sig_from* is the left window border of the signal. The *sig_from* value must be greater than or equal to *noise_from*.
- *sig_to* is the right window border of the signal. The *sig_to* value must be less than or equal to *noise_to*.
- *noise_from* is the left window border of the noise.
- *noise_to* is the right window border of the noise.

Example

You have the following frequency plot.



To determine the signal-to-noise ratio, you use the values

```
export real snr(fft(V(out),0,1e-3,1024),9e3,11e3,1,500e3)
```

which, in this case, returns

```
29.268026738835342dB
```

spectralPower

Plots the spectral power for the specified current waveform and voltage waveform. This function is available only in the SKILL mode.

- *Current waveform* is the current waveform for which you which you want to calculate the spectral power.
- *Voltage waveform* is the voltage waveform for which you which you want to calculate the spectral power.

spectrum

Calculates Signal-to-Noise-and-Distortion Ratio (SINAD), Spurious Free Dynamic Range (SFDR), Effective Number of Bits (ENOB), and Signal-to-Noise Ratio (without distortion) by using discrete fourier transform of any given input signal.

The spectrum measure is used for characterizing A-to-D converters and is typically supported for transient simulation data.

The spectrum function is available only in the SKILL mode.

- *Signal* is signal to be measured.
- *Number of Samples* is the number of sampled points used for the FFT.
  Valid values: Any integer power of two greater than zero. For a value that is not a power of two, the function rounds it up to the next closest power of two.
  Default value: Number of data points in the *Signal*.
- *Number of Noise bins* is the number of noise bins where the size of one bin is the reciprocal of the data window width. For example, 1 ms of transient data creates a bin size of 1 kHz.
  Valid values: Any integer power of two greater than or equal to zero.
  Default value: `0`, implying that no signal is spilling into the bins. A frequency band of bin-size times the number of bins is calculated and adjusted as a function of the selected window. Frequency components in each band to the left and right of the fundamental or the harmonics are set to zero and do not contribute to any output result.
- *Start Frequency* is the lower limit of frequency range for the spectrum measures.
  Default value: First frequency point of the FFT.
- *End Frequency* is upper limit of frequency range for the spectrum measures.
  Default value: Last frequency point of the FFT.
- *Window Type* is the windowing function applied to o_waveform.
  Valid values: `Blackman`, `Cosine2`, `Cosine4`, `ExtCosBell`, `HalfCycleSine`, `HalfCycleSine3`, `HalfCycleSine6`, `Hanning,` `Hamming`, `Kaiser`, `Parzen`, `Rectangular`, and `Triangular`.
  Default value: `Rectangular`.
- *ADC Span* is the full-scale span ignoring any DC offsets. This is used in ENOB calculation.
  Valid values: Any floating point number.
  Default value: If *ADC Span* is not specified or is nil, it is assumed to be 0 and is taken to be the peak-to-peak value of the fundamental.

- *Measure Type* is Result specifier.
  Valid values: sinad, sfdr(db), enob, and snhr.
  Default value: sinad

spectrumMeas

Calculates Signal-to-Noise-and-Distortion Ratio (SINAD), Spurious Free Dynamic Range (SFDR), Effective Number of Bits (ENOB), and Signal-to-Noise Ratio (without distortion) by using discrete Fourier transform of the clipped portion of any given input signal.

The spectrum measure is used for characterizing A-to-D converters and is typically supported for transient simulation data.

The spectrum function is available only in the SKILL mode.

- *Signal* is signal to be measured.
- *Start Time* is the time to start clipping the signal in time domain.
- *End time* is the time to end clipping in time domain.
- *Number of Samples* is the number of sampled points used for the FFT.
  Valid values: Any integer power of two greater than zero. For a value that is not a power of two, the function rounds it up to the next closest power of two.
  Default value: Number of data points in the *Signal*.
- *Number of Noise bins* is the number of noise bins where the size of one bin is the reciprocal of the data window width. For example, 1 ms of transient data creates a bin size of 1 kHz.
  Valid values: Any integer power of two greater than or equal to zero.
  Default value: `0`, implying that no signal is spilling into the bins. A frequency band of bin-size times the number of bins is calculated and adjusted as a function of the selected window. Frequency components in each band to the left and right of the fundamental or the harmonics are set to zero and do not contribute to any output result.
- *Start Frequency* is the lower limit of frequency range for the spectrum measures.
  Default value: First frequency point of the FFT.
- *End Frequency* is upper limit of frequency range for the spectrum measures.
  Default value: Last frequency point of the FFT.
- *Window Type* is the windowing function applied to o_waveform.
  Valid values: `Blackman`, `Cosine2`, `Cosine4`, `ExtCosBell`, `HalfCycleSine`, `HalfCycleSine3`, `HalfCycleSine6`, `Hanning, Hamming`, `Kaiser`, `Parzen`, `Rectangular`, and `Triangular`.
  Default value: `Rectangular`.
- *ADC Span* is the full-scale span ignoring any DC offsets. This is used in ENOB calculation.
  Valid values: Any floating point number.

Default value: If *ADC Span* is not specified or is nil, it is assumed to be 0 and is taken to be the peak-to-peak value of the fundamental.

- *Measure Type* is Result specifier.
  Valid values: sinad, sfdr(db), enob, and snhr.
  Default value: sinad

sqrt

Returns the square root of a signal.

ssb

Returns source stability circles. This function is available only in the SKILL mode.

- *Start (Hz)* is the start of the frequency range.
- *Stop (Hz)* is the end of the frequency range.
- *Step* is the increment.

stathisto

Creates a histogram from a signal. This function is available only in the MDL mode.

The stathisto function is available from the calculator. It is not supported within a Spectre MDL control file since it returns a scalar and not a waveform.

- *sig* is the waveform.
- *nbins* is the number of bins to be created.
- *min* is the value that specifies the smaller end point of the range of values included in the histogram.
- *max* is the value that specifies the larger end point of the range of values included in the histogram.
- *innerswpval* is the inner-most sweep parameter in the dataset. You use this parameter to slice through parametric waveforms to extract the data for the histogram.
  Default: The first available value of time in the dataset.

Example

Assume that you have the results of running a Monte Carlo analysis on top of a transient analysis, so that the inner-most swept variable is time. Now, for the particular value of time specified by the *`innerswpval`* argument specification, the `stathisto` function creates a histogram by analyzing all the Monte Carlo iterations and extracting from each one the value of the signal at the specified time.

For example, to create a histogram for the time 100ns, you might use the following statement.

```
stathisto(I(V10\:p),innerswpval=100e-9)
```

To create a histogram for the time 650ps, you might use the following statement.

```
stathisto(I(V10\:p),innerswpval=.65e-9)
```

stddev

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.This function is available only in the SKILL mode.

For example, if `y=f(x)`

$$stddev(y) = \frac{\int_{from}^{to} (y - average(y))^2}{to - from}$$

If you want a different range, use the clip function to clip the waveform to the range you want.

tan

Returns the tangent of a signal.

tangent (Tangent Line)

Plots a line that passes through x and y coordinates and the slope that you specify. This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *X Point* is the X-axis value you specify.
- *Y Point* is the Y-axis value you specify.
- *Slope* is the specified slope.

tanh

Returns the hyperbolic tangent of a signal.

thd (Total Harmonic Distortion)

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 A0, A1..., A*f* , ... Note that fundamental frequency *f* is the frequency contributing to the largest power in the signal. A0 is the complex coefficient for the DC component and Ai is the complex coefficient for the *i*th harmonic where *i≠0,f*. Then, total harmonic distortion is computed as:

$$\frac{\sqrt{\sum_{i = 1,\ i \neq 0,\ f} |A_i|^2}}{|A_f|} \times 100\%$$

This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *From* is the starting frequency.
- *To* is the ending frequency.
- *Number* of Samples is the number of time domain points to be used.
- *Fundamental (Hz)* is the fundamental frequency of the signal.

The accuracy of the total harmonic distortion measurement depends on simulator options and the analysis parameters. For an accurate measurement set the following simulation options:

Option	Suggested Value
RELTOL	1e-5
ABSTOL	1e-13
VNTOL	3e-8
TRTOL	1
METHOD	gear
MAXORD	3

Set the simulation timestep to be 1/100th of a cycle, and simulate for ten cycles. End the simulation slightly beyond the tenth cycle. When you use the calculator, measure during the tenth cycle by specifying the beginning of the cycle as the *From* time and the end as the *To* time.

trim

Returns the portion of a signal between two points along the X-axis. This function is available only in the MDL mode.

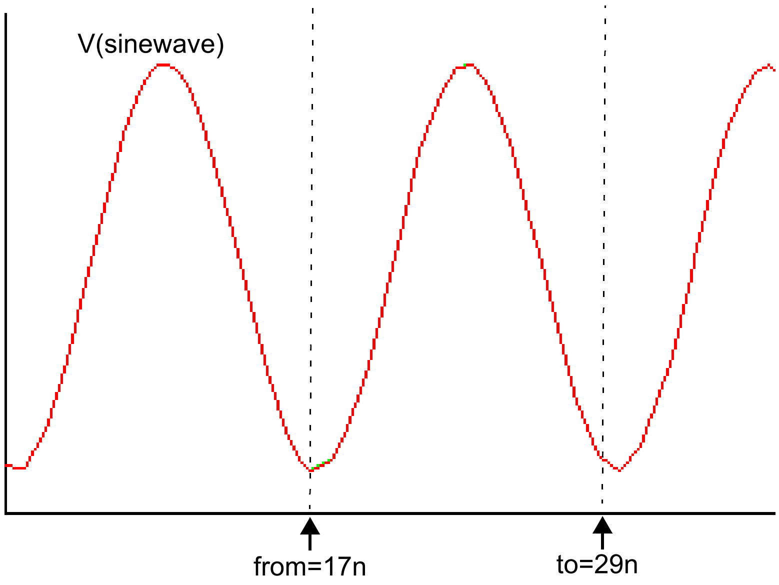
- *sig* is the name of the signal.
- *from* is the starting point on the X-axis.
- *to* is the ending point on the X-axis.

Example 1

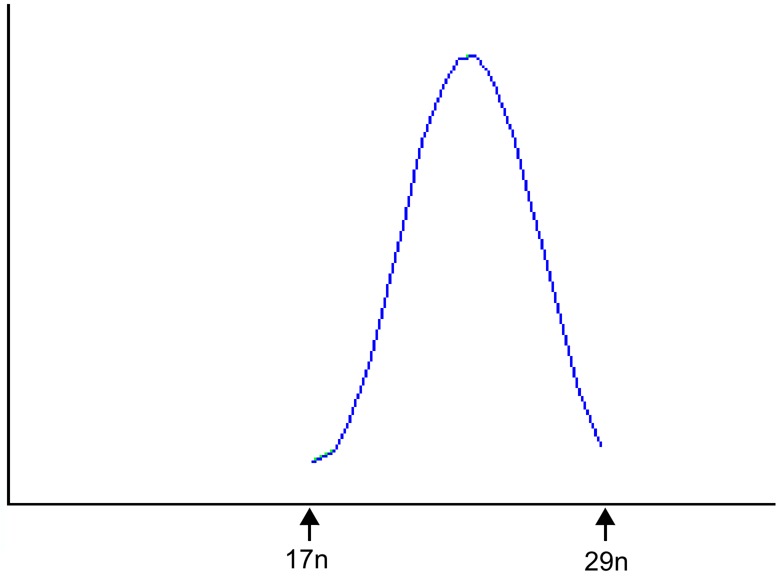
In Virtuoso Visualization and Analysis XL,

```
trim ( sig=V(sinewave), from=17n, to=29n )
```

transforms the following input signal



into the following output signal



value

Computes the Y-axis value of the waveform at the specified X-axis value.This function is available only in the SKILL mode.

- *Signal* is the name of the signal.
- *Interpolate At* is the X-axis value for which you want the Y-axis value to be computed.
- *Number of Occurences* specifies whether you want to retrieve only one occurrence of an interpolated value for the given waveform (single) or all interpolated values for the given waveform (multiple), which you can later plot or print.
- *Period* is the time between samples that result in the multiple Y values. You must specify this if you selected *multiple* in the *Number of Occurences* field.
- *Plot/print vs* specifies whether you want to retrieve value data against *time* (or another X-axis parameter for non-transient data) or *cycle*. Cycle numbers refer to the n'th occurrence of the delay event in the input waveform.
  The value in this field is ignored when you specify *Number of Occurences* as *single*.

window

Applies the specified window to a signal. This function is available only in the MDL mode.

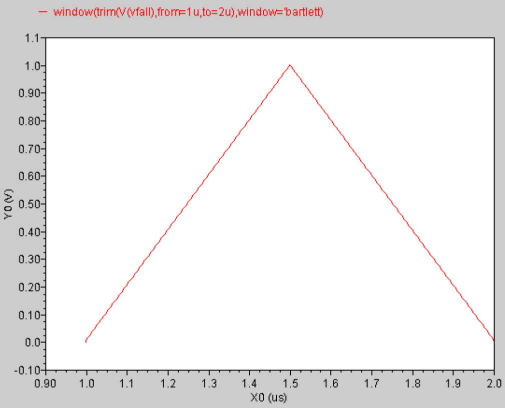
- *arg* is the name of the signal.
- *window* is the window to be applied.

Equations and Examples

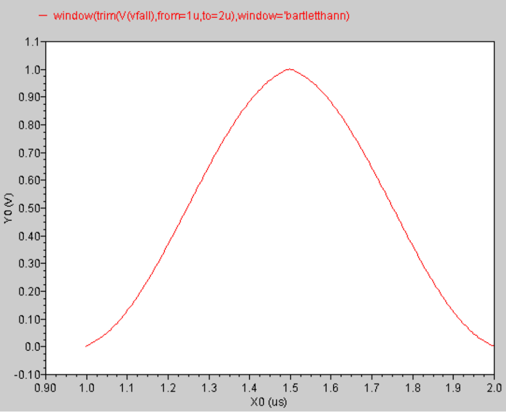
This section describes the equations used by each type of window and then shows an example. In the equations:

N = total number of waveform points

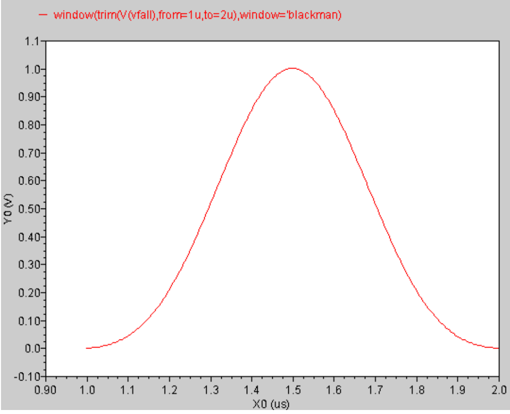
n = current waveform point

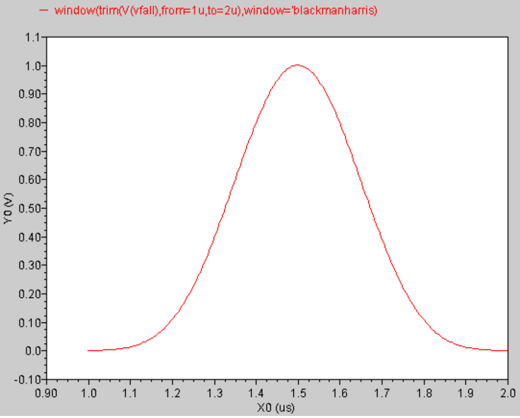
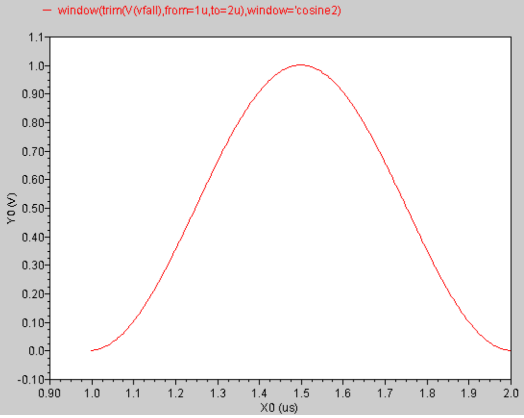
Window	Equation and Example	Where
`'rectangular`	$w(n) = 1$	
`'bartlett`	$w(n) = 1 - abs\left(2 \times \frac{n}{N} - 1\right)$	$0 \le n \le N$
	$w(n) = 0$	otherwise
		

Window	Equation and Example	Where
`'bartletthann`	$w(n) = 0.62 - 0.48 \times abs\left(\frac{n}{N} - 0.5\right) + 0.38 \times \cos\left(2 \times 'pi \times \left(\frac{n}{N} - 0.5\right)\right)$	0≤n≤N
	$w(n) = 0$	otherwise

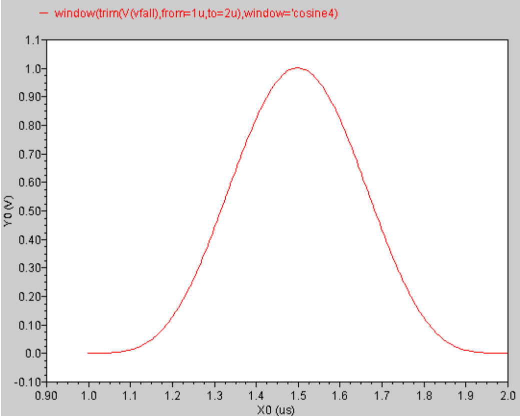


Window	Equation and Example	Where
`'blackman`	$'(n) = 0.42 - 0.50 \times \cos\left(2 \times 'pi \times \frac{n}{N}\right) + 0.08 \times \cos\left(4 \times 'pi \times \frac{n}{N}\right.$	0≤n≤N
	$w(n) = 0$	otherwise

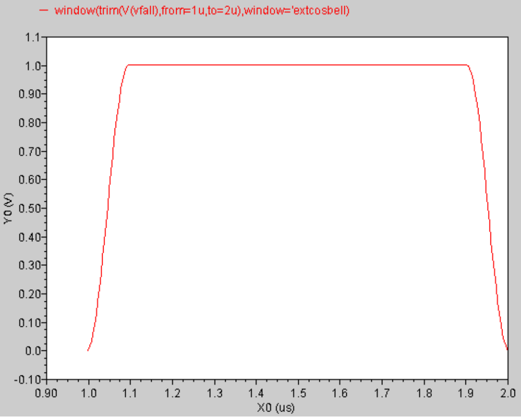


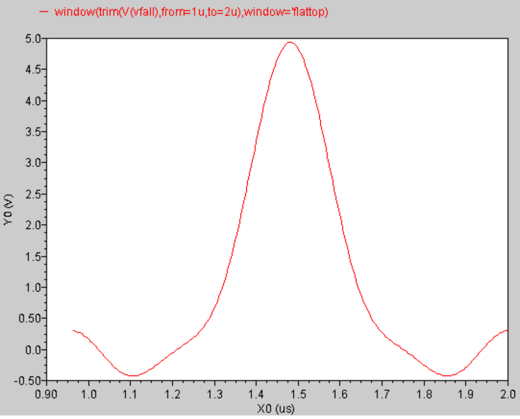
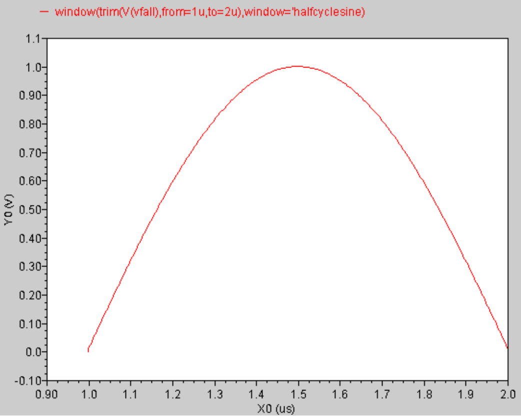
Window	Equation and Example	Where
`'blackmanharris`	$w(n) = 0.35875 - 0.48829 \times \cos\left(2 \times {'pi} \times \frac{n}{N}\right) + 0.14128 \times \cos\left(4 \times {'pi} \times \frac{n}{N}\right) + -0.01168 \times \cos\left(6 \times {'pi} \times \frac{n}{N}\right)$	0≤n≤N
	$w(n) = 0$	otherwise
	 	
`'cosine2`	$w(n) = 0.5 - 0.5 \times \cos\left(2 \times {'pi} \times \frac{n}{N}\right)$	0≤n≤N
	$w(n) = 0$	otherwise
	 	

Window	Equation and Example	Where
'cosine4	$v(n) = \left(0.5 - 0.5 \times \cos\left(2 \times '\,pi \times \frac{n}{N}\right)\right)^2$	$0 \le n \le N$
	$w(n) = 0$	otherwise



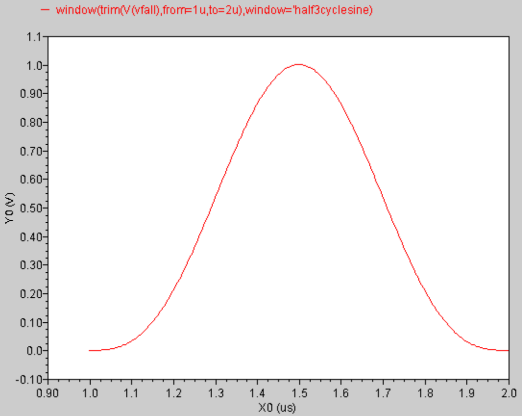
Window	Equation and Example	Where
'extcosbell	$w(n) = 0.5 - 0.5 \times \cos\left(10 \times '\,pi \times \frac{n}{N}\right)$	abs(n/N - 0.5) > 0.4
	$w(n) = 1$	otherwise



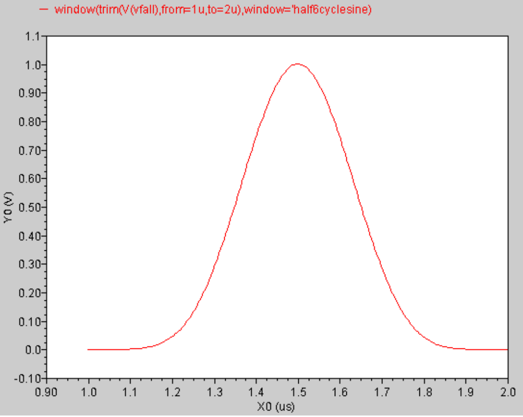
Window	Equation and Example	Where
`'flattop`	$'(n) = 1 - 1.93 \times \cos\left(2 \times {}'pi \times \frac{n}{N}\right) + 1.29 \times \cos\left(4 \times {}'pi \times \frac{n}{N}\right) - 0.388$ $\times \cos\left(6 \times {}'pi \times \frac{n}{N}\right) + 0.322 \times \cos\left(8 \times {}'pi \times \frac{n}{N}\right)$	$0 \le n \le N$
	$w(n) = 0$	otherwise
		
`'halfcyclesine`	$w(n) = \sin\left({}'pi \times \frac{n}{N}\right)$	$0 \le n \le N$
	$w(n) = 0$	otherwise
		

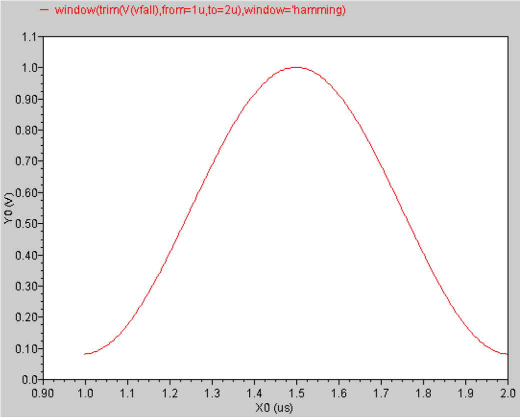
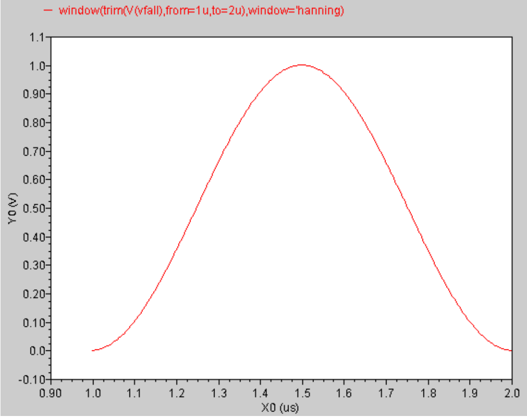
Window	Equation and Example	Where

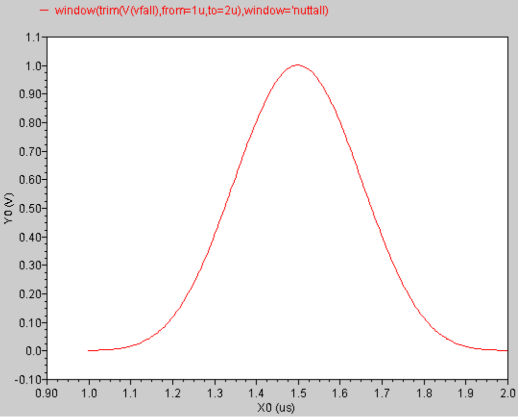
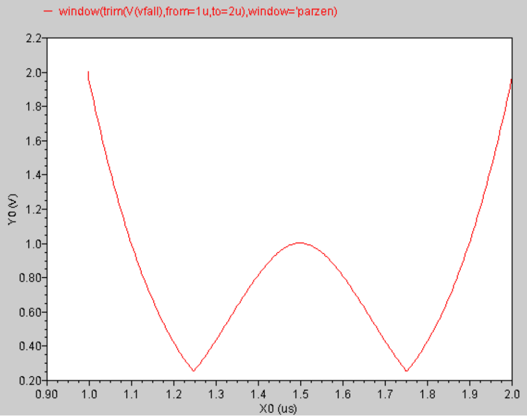
`'half3cyclesine`
and
`'halfcyclesine3`
	$w(n) = \left(\sin\left('\,pi \times \frac{n}{N}\right)\right)^3$
	$w(n) = 0$
		0≤n≤N
		otherwise

`'half6cyclesine`
and
`'halfcyclesine6`
	$w(n) = \left(\sin\left('\,pi \times \frac{n}{N}\right)\right)^6$
	$w(n) = 0$
		0≤n≤N
		otherwise

Window	Equation and Example	Where
`'hamming`	$w(n) = 0.54 - 0.46 \times \cos\left(2 \times {}'pi \times \frac{n}{N}\right)$	$0 \le n \le N$
	$w(n) = 0$	otherwise
		
`'hanning`	$w(n) = 0.5 - 0.5 \times \cos\left(2 \times {}'pi \times \frac{n}{N}\right)$	$0 \le n \le N$
	$w(n) = 0$	otherwise
		

Window	Equation and Example	Where
`'nuttall`	$w(n) = 0.3635819 - 0.4891775 \times \cos\left(2 \times {}'pi \times \frac{n}{N}\right) + 0.1365995 \times \cos\left(4 \times {}'pi \times \frac{n}{N}\right) - 0.0106411 \times \cos\left(6 \times {}'pi \times \frac{n}{N}\right)$	$0 \le n \le N$
	$w(n) = 0$	otherwise
	 	
`'parzen`	$w(n) = 1 - 6 \times abs\left(2 \times \frac{n}{N} - 1\right) + 6 \times abs\left(2 \times \frac{n}{N} - 1\right)$	abs(2*n/N-1)≤0.5
	$w(n) = 2 \times abs\left(2 \times \frac{n}{N} - 1\right)$	otherwise
	 	
`'triangular`	Same as `'bartlett`.	

unityGainFreq

Computes and reports the frequency at which the gain is unity. This function is available only in the SKILL mode.

x**2

Returns the x^2 value. This function is available only in the SKILL mode.

xmax

Computes the value of the independent variable x at which the expression attains its maximum value, that is, the value of x that maximizes y=f(x).

The maximum might occur at more than one point on the X-axis, so you must choose (in the *Nth Maximizer* field) which maximum value you want to see. The calculator returns the value of the *Nth Maximizer* counting from the left, that is, toward increasing X-axis values. If you enter a negative integer, the direction of search is reversed toward decreasing X-axis values (counting from the right).

This function is available only in the SKILL mode.

- *signal* is the name of the signal.
- *Nth Maximizer* is the maximum value of the expression.

xmin

This function is available only in the SKILL mode.

Computes the value of the independent variable x at which the expression has its minimum value, that is, the value of x that minimizes y=f(x).

The minimum might occur at more than one point on the x axis, so you must choose (in the *Nth Minimizer* field) which minimum value you want to see. The calculator returns the value of the *Nth Minimizer*, counting from the left, that is, toward increasing X-axis values. If you enter a negative integer, the direction of search is reversed toward decreasing X-axis values (counting from the right).

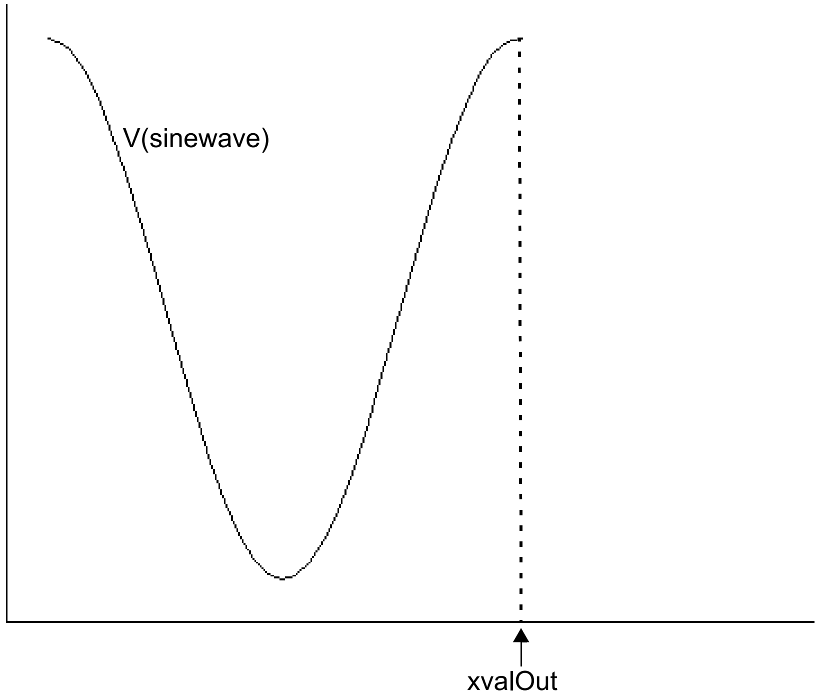
- *signal* is the name of the signal.
- *Nth Minimizer* is the minimum value of the expression.

xval

Returns the vector consisting of the X-axis values of the points in the signal.

Example

The following diagram illustrates this function.



y**x

Returns the y^x value. This function is available only in the SKILL mode.

ymax

Computes the maximum Y-axis value of the expression y=f(x). This function is available only in the SKILL mode.

ymin

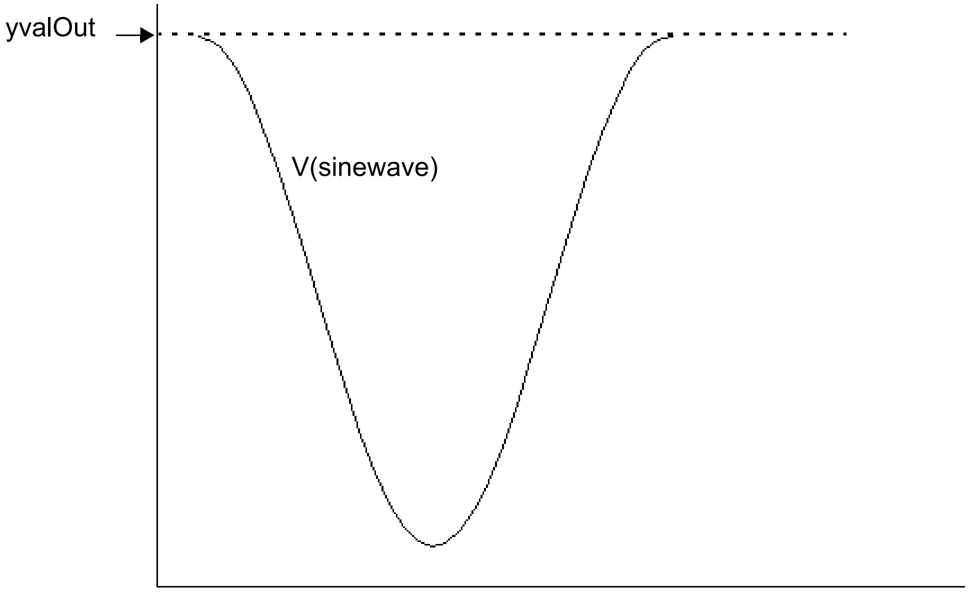
Computes the minimum Y-axis value of the expression y=f(x). This function is available only in the SKILL mode.

yval

Returns a vector consisting of the Y-axis values of the points in the signal. This function can also calculate the ordinate value at a specified abscissa value. This function is available only in the MDL mode.

Example

```
yvalOut = max ( yval( V(out) ) )
```



C

SKILL Functions

This chapter describes the SKILL functions that apply to the Virtuoso Visualization and Analysis XL tool.

awvPlotSignals

```
awvPlotSignals(signals ?plotStyle style ?graphType type [?graphModifier modifier]
     [waveType])
```

Description

Displays a signal in the graph window.

Arguments

`signals` List of signals to be plotted specified in the following format:
`(`*`list`* `(`*`list resultsDir1`* `(`*`list`* `(`*`list result1`*
`(`*`list signal1 signal2`* ...`)` ...`)` ...`)))`
Remember to put quotation marks before and after each signal name.

`style` Plot destination.
Valid values: `Append`, `Replace`, `New Window`, `New Subwindow`
Remember to put quotation marks before and after the style.

`type` Type of plot.
Valid values: `Default`, `Rectangular`, `Histogram`, `Polar`, `Impedance Admittance`, `RealvsImag`
Remember to put quotation marks before and after the graph type.

`modifier` X axis of graph for rectangular graphs
Valid values: `Magnitude`, `Phase`, `WPhase`, `Real`, `Imaginary`, `dB10`, `dB20`

`waveType` Specifies whether the signal is Y versus Y or not.
Valid values: `YvsY`, `nil`
This is an optional argument.

`lineStyle` Specifies the line style of the signal.
Valid values: Solid, Dotted, Dashed, Dotdashed
This is an optional argument

`lineThickness` Specifies the line thickness of the signal.
Valid values: Fine, Medium, Bold
This is an optional argument

Value Returned

Example

```
awvPlotSignals((("./ampsim.raw" (("ac-ac" ("net10"))))) "plotStyle" "Append"
"graphType" "Default")
```

awvPlotSimpleExpression

```
awvPlotSimpleExpression(expression @key [plotStyle style] [graphType type]
     [graphModifier modifier])
```

Description

Evaluates an expression and plots the resulting waveform.

Arguments

expression — Expression to be evaluated and plotted.

style — Plot destination.
Valid values: `Append`, `Replace`, `New Window`, `New Subwindow`
Remember to put quotation marks before and after the style.

type — Type of plot.
Valid values: `Default`, `Rectangular`, `Histogram`, `Polar`, `Impedance Admittance`, `RealvsImag`
Remember to put quotation marks before and after the graph type.

modifier — X axis of graph for rectangular graphs
Valid values: `Magnitude`, `Phase`, `WPhase`, `Real`, `Imaginary`, `dB10`, `dB20`

lineStyle — Specifies the line style of the signal.
Valid values: Solid, Dotted, Dashed, Dotdashed
This is an optional argument

lineThickness — Specifies the line thickness of the signal.
Valid values: Fine, Medium, Bold
This is an optional argument

Example

```
awvPlotSimpleExpression(getData(\net10\ ?result \tran-tran\ ?resultsDir \./
ampsim.raw\) - getData(\net35\ ?result \tran-tran\ ?resultsDir \./ampsim.raw\)
?plotStyle New Window ?graphType Default)
```

awvTableSignals

```
awvTableSignals(siglist@key [plotStyle style] [?graphModifier modifier])
```

Description

Displays a signal in the table window.

Arguments

`siglist`	List of signals to be plotted specified in the following format:
	`(`*`list`*` (`*`list resultsDir1`*` (`*`list`*` (`*`list result1`*
	`(`*`list signal1 signal2`*` ...) ...) ...)))`
	Remember to put quotation marks before and after each signal.

`style`	Plot destination. Valid values: `Table`, `Append`, `Replace`, `New Window`, `New Subwindow` Remember to put quotation marks before and after the style.
`modifier`	X axis of graph for rectangular graphs Valid values: `Magnitude`, `Phase`, `WPhase`, `Real`, `Imaginary`, `dB10`, `dB20`

Value Returned

`t`	If the signal is displayed in a table.
`nil`	Otherwise.

Example

```
awvTableSignals((("./ampsim.raw" (("ac-ac" ("net10"))))) "plotStyle" "Append")
```

calSetCurrentTest

```
calSetCurrentTest(testName) => t | nil
```

Description

Informs the calculator of the current test. When an access function (such as vt) is used from the calculator, it will display the schematic associated with the current test.

The tests are displayed in a drop-down in the calculator, which allows you to change the current test.

Arguments

testName	Name of current test.

Value Returned

`t`	If the current test is displayed
`nil`	Otherwise.

Example

```
calSetCurrentTest(opamplib:amptest:1)
```

rdbLoadResults

```
rdbLoadResults (sessionName resultsDir) => t | nil
```

Description

Loads the simulation results located at *`resultsDir`* into the browser associated with the specified *`sessionName`*.

Arguments

`sessionName`	Name of the session in which the results are to be loaded in the browser. Remember to put quotation marks before and after the session name.
`resultsDir`	Path to the location of the simulation results. Remember to put quotation marks before and after the path name.

Value Returned

`t`	If the simulation results are loaded.
`nil`	Otherwise.

Example

```
rdbLoadResults( "unbound" "./opamplib/ampTest/adexl/results/data/Interactive.267/
1/opamplib:ampTest:1/psf")
```

rdbReloadResults

`rdbReloadResults (sessionName resultsDir) => t | nil`

Description

Re-loads the simulation results located at *`resultsDir`* into the browser associated with the specified *`sessionName`*. It is desirable to reload results during the successive simulation runs.

Arguments

`sessionName`	ADE-L/XL `sessionName` or `unbound` if running the tool in standalone mode and the Results Browser window is open.
`resultsDir`	Path to the location of the simulation results. Remember to put quotation marks before and after the path name.

Value Returned

`t`	If the simulation results are re-loaded.
`nil`	Otherwise.

Example

```
rdbReloadResults( "unbound" list("/usr1/export/amptest/simulation/ampTest/
spectre/config/psf"))
```

rdbUnloadResults

`rdbUnloadResults (`*`sessionName resultsDir`*`) => t | nil`

Description

Unloads the simulation results located at *`resultsDir`* from the browser associated with the specified *`sessionName`*. It is desirable to unload results during the successive simulation runs to reduce resource consumption and remove clutter from the browser.

Arguments

`sessionName`	ADE-L/XL `sessionName` or `unbound` if running the tool in standalone mode and the Results Browser window is open.
`resultsDir`	Path to the location of the simulation results. Remember to put quotation marks before and after the path name.

Value Returned

`t`	If the simulation results are unloaded.
`nil`	Otherwise.

Example

```
rdbUnloadResults( "unbound" list("/usr1/export/amptest/simulation/ampTest/
spectre/config/psf"))
```

rdbSetCurrentDirectory

`rdbSetCurrentDirectory (`*`sessionName path`*`) => t | nil`

Description

The Results Browser associated with the specified *`sessionName`* navigates to the directory specified by *`path`*.

Arguments

`sessionName`	ADE-L/XL `sessionName` or `unbound` if running the tool in standalone mode and the Results Browser window is open.
`path`	Path to the simulation results hierarchy to be displayed. Remember to put quotation marks before and after the path name.

Value Returned

`t`	If the simulation results are displayed.
`nil`	Otherwise.

Example

```
rdbSetCurrentDirectory ("unbound" "./simulation/opampTest/spectre/schematic/psf/
tran-tran/V11")
```

rdbWriteToFormat

```
rdbSetCurrentDirectory (sessionName path format signals) => t | nil
```

Description

Outputs the specified signals from the browser associated with the specified `sessionName`.

Arguments

sessionName ADE-L/XL `sessionName` or `unbound` if running the tool in standalone mode and the Results Browser window is open.

path Path to the signals that are to be output. Remember to put quotation marks before and after the path name.

format Format in which the signals are to be output.
Valid values: `CSV` (Comma-Separated text), `VCSV` (Virtuoso Comma-Separated text), `PSF`, `SST2`, `Matlab`, `Spectre`
Remember to put quotation marks before and after the format.

signals List of signals to be output specified in the following format: `(list (list resultsDir1 (list (list result1 (list signal1 signal2 ...) ...) ...)))`. If you do not specify a signal name in this argument, the command outputs all the signals that are selected in the Results Browser.

Value Returned

`t` If the signals are displayed.

`nil` Otherwise.

Example

```
rdbWriteToFormat( "unbound" "/tmp/output.vcsv" "VCSV" '(("./simulation/opampTest/
spectre/schematic/psf" (("tran-tran" ("V11.p"))))))
```

rdbShowDialog

```
rdbShowDialog (sessionName path format signals) => t | nil
```

Description

Display and hides dialog boxes associated with the browser.

Arguments

sessionName	ADE-L/XL `sessionName` or `unbound` if running the tool in standalone mode and the Results Browser window is open.
path	Path to the signals that are to be output. Remember to put quotation marks before and after the path name.
format	Format in which the signals are to be output. Valid values: `CSV` (Comma-Separated text), `VCSV` (Virtuoso Comma-Separated text), `PSF`, `SST2`, `Matlab`, `Spectre` Remember to put quotation marks before and after the format.
signals	

Value Returned

`t`	If the specified dialog boxes are displayed or hidden.
`nil`	Otherwise.

Example

```
rdbShowDialog(unbound browser findResults show ((pathList ./ampsim.raw)))
```

vvDisplayCalculator

```
vvDisplayCalculator [(expr)] => t | nil
```

Description

Invokes the calculator within a window. If an expression is specified, the expression is displayed in the buffer.

Arguments

expr	Expression to be displayed in the calculator buffer. This is an optional argument. Remember to put quotation marks before and after the expression.

Value Returned

`t`	If the calculator is invoked.
`nil`	Otherwise.

Example

```
vvDisplayCalculator(vt(\/net10\))
```

vvDisplayBrowser

```
vvDisplayBrowser => t | nil
```

Description

Invokes the Results Browser within a window.

Value Returned

`t`	If the browser is invoked.
`nil`	Otherwise.

D

Constants

This chapter lists constants and their definitions for the SKILL and MDL modes.

Table D-1 Constants in the SKILL Mode

Constant	Definition
Boltzmann	1.380622e-23
charge	1.6021917e-19
degPerRad	57.2957795130823
epp0	8.854e-12
pi	3.14159265358979323846
sqrt2	1.41421356237309504880
twoPi	6.28318530717958647688

Table D-2 Constants in the MDL Mode

Integer Constants		
yes	Boolean true	1
no	Boolean false	0
Real Mathematical Constants		
pi	π	3.14159265
e	e	2.71828183
inf	∞	infinity

nan	Not a number (result of an invalid operation)	NaN

Real Physical Constants

q	Charge of an electron	$1.6021918 \cdot 10^{-19}$ C
c	Speed of light	$2.99792458 \cdot 10^{8}$ m/s
k	Boltzmann’s constant	$1.3806226 \cdot 10^{-23}$ J/K
h	Planck’s constant	$6.6260755 \cdot 10^{-34}$ J-s
eps0	Permittivity of a vacuum	$8.854187923944200 13968 \cdot 10^{-12}$ F/m
epsrsi	Relative permittivity of silicon	11.7
u0	Permeability of a vacuum	$\pi \times 4.0 \cdot 10^{-7}$ H/m
celsius0	0 celsius	273.15 K
micron		10^{-6} m
angstrom		10^{-10} m
avogadro	Avogadro’s number	$6.022169 \cdot 10^{23}$
logic0	The value of logic 0	0
logic1	The value of logic 1	5

E

Defining New SKILL Functions

You can define a function and add it to the *SKILL User Defined Functions* category in the calculator by following these steps:

1. Define the form that prompts for user-defined arguments to the function.
2. Define the syntax of the function in the callback procedure.
3. Register the function.

Defining a Form

The following example shows how to define an input form for a function that takes three arguments. The first argument is the buffer expression. The other two arguments are the boundaries of the range of the expression on which you want to operate.

```
procedure( CreateMyForm()
   let( ( fieldList a b )
    a = ahiCreateStringField(
        ?name 'from
        ?prompt "From"
        ?value ""
    )
    b = ahiCreateStringField(
        ?name 'to
        ?prompt "To"
        ?value ""
    )
    fieldList = list(
        list( a 5:0 120:25 40 )
        list( b 160:0 110:25 30 )
    )
    calCreateSpecialFunctionsForm( 'MyForm
        fieldList )))
```

In this example, the From and To fields are string fields created in a two-dimensional form specification for fieldList. The form is created by the call to `calCreateSpecialFunctionsForm`. This function creates and registers the form with the specified form symbol, MyForm.

Defining a Callback Procedure

You define a callback procedure that is called from the entry on the Calculator User Defined Functions category. Since this example uses a form to prompt for additional information required by the special function, the callback procedure is

```
procedure( MySpecialFunctionCB()
  calCreateSpecialFunction(
        ?formSym 'MyForm
        ?formInitProc 'CreateMyForm
        ?formTitle "Test"
        ?formCallback "calSpecialFunctionInput( 'test
        '(from to) )"
  )
)
```

In this procedure, a call is made to `calCreateSpecialFunction`, which creates and displays the form and then builds the expression in the buffer with the specified form fields.

Using Stack Registers in the Procedure

You can use the special symbol `’STACK` in the list of form fields to get expressions from the stack.

For example, if you want to insert a stack element between the From and To arguments in the special function expression, you can specify the callback line as follows:

```
?formCallback "calSpecialFunctionInput(’test ’(from STACK to))"
```

If your special function does not require a form to prompt for additional arguments, you can define your callback as follows:

```
procedure( MySpecialFunctionCB()
    calSpecialFunctionInput( ’test nil )
)
```

Registering the Function

You register the function and callback with the `calRegisterSpecialFunction`:

```
calRegisterSpecialFunction(
    list( "test" ’MySpecialFunctionCB )
)
```

The next time you open the calculator, the functions you defined appear in the User Defined Functions category.

Defining a Custom Function

Custom functions need to be supported for both single and multi-dimensional waveform (parametric) data.

A custom function example is shown below:

```
;; Function definition for myFunction to handle single dimension waveform data
defMethod( myFunction ( ( wf drIsWaveform ) )
     ;; your custom function code
)
;; Function definition for myFunction to handle multi-dimension waveform/parametric
waveform
;; This function calls the above method for each leaf of the parametric waveform
;; and returns a single/multi-dimensional waveform

defMethod( _averageMethod ( ( fam famIsFamily ) )
    famMap( 'myFunction fam )
)
```

SKILL User Interface Functions for the Calculator

For information on SKILL Functions for the calculator, refer to chapter 22 of the *Virtuoso Analog Design Environment SKILL Language Reference*.

F

Working With Function Templates

This chapter describes the function templates and how you can use them to create new functions in Virtuoso Visualization and Analysis XL Calculator with supporting examples.

Function Templates

Function templates are a mechanism to facilitate easier construction and addition of new functions in the Calculator. They are described in a prescribed format in function template file.

Virtuoso Visualization and Analysis XL uses these template files to perform the following tasks:

- Builds lists of function names, separated into categories and displays it in the GUI panel.
- Generates an expression using rules present in the template file.

Function Template Search Paths

Virtuoso Visualization and Analysis XL searches for function templates using csfsearchpath. The priority of searching a UDF GUI template will be:

1. `<CSF_SEARCH_PATHS>/measures`
2. `<CDS_INST_DIR>/tools/dfII/local/tools/wavescan/measures`
3. `<CDS_INST_DIR>/tools/dfII/etc/tools/wavescan/measures`

Virtuoso Visualization and Analysis XL function templates, shipped by Cadence, are stored at the following location:

`<CDS_INST_DIR>/tools/dfII/etc/tools/wavescan/measures`

Template Catalog Summary File

The template catalog summary file `.skeMeaseruesCatalog` lists the categories and the templates that exists in each category. Virtuoso Visualization and Analysis XL template catalog file is shipped in the following directory.

`<CDS_ROOT>/tools/dfII/etc/tools/wavescan/measures/.skeMeasuresCatalog`

Different categories are specified in-between the lines `skeBeginCategory` and `skeEndCategory`. The below example defines Math, Modifier, RF Functions, Special Function, and Trigonometric as the categories.

```
skeBeginCategory
Math
Modifier
RF Functions
Special Functions
```

```
Trigonometric
skeEndCategory
```

You can specify different functions within a category in between the lines:

```
skeBeginMeasures <Category Name> & skeEndCategory.
```

For example, function “Fourier Evaluation” of category “Special Functions can be defined as follows:

```
skeBeginMeasures.Special Functions
fourEval;"Fourier Evaluation"
skeEndMeasures
```

Creating a template file

To add a new function, write a template file for your function and override `.skeMeasuresCatalog` file.

To create a template file, perform the following steps:

1. Choose one of the two directories listed below where you want to store the new functions:
   - ❑ `<CSF_SEARCH_PATHS>/measures`
   - ❑ `<CDS_INST_DIR>/tools/dfII/local/tools/wavescan/measures`
2. After creating a directory named “`measures`” which is accessible to the complete project team, copy `<CDS_ROOT>/tools/dfII/etc/tools/wavescan/measures/.skeMeasuresCatalog` to `CSF_SEARCH_PATHS/measures/.skeMeasuresCatalog`.
3. Open `CSF_SEARCH_PATHS/measures/.skeMeasuresCatalog` for editing.
4. Add an entry of the new function in between `skeBeginMeasures &` `skeEndMeasures` tags of the category where the new function is required to belong.

   For example to add a function named ‘testfun’ in math category, add testfun; in between `skeBeginMeasures Math` & nearest `skeEndMeasures` line.

   Note: Current implementation doesn't merge the entries specified in separate `.skeMeasuresCatalog` files.

Working with Template File

Each Virtuoso Visualization and Analysis XL function template file describes a Calculator function. The template provides information such as:

- The function name
- The function’s categories
- Input parameters and default values
- Gui building tips such as adjacent row hints and parameter dependencies
- Tool tip information (currently ignored).
- Rules to build the function expression

The template is divided into following sections:

Header

Header describes the general function information such as the name, display name, description, and category list.

- **function name:** This is the name used to construct the expression
- **name:** This is the display name used as the dialog label in the function panel.
- **Category list:** Each template can belong to multiple categories. For example, the riseTime template could belong to “Special Functions” and “transient”. Currently we do not define categories according to analysis type. The current categories are:
  - ❑ Math
  - ❑ Modifier
  - ❑ RF Functions
  - ❑ Special Functions
  - ❑ Trigonometric

The Analysis Section

The analysis section describes how to generate the expression, the signal, and parameter arguments.

- **args:** Describe how to build the expression
- **signals:** Describe each signal argument:
  - prompt
  - tool tip
  - params. describe each parameter
  - prompt
  - tool tip
  - type
  - default value
  - required

Examples

Example 1: Sample template with single argument: average.ocn

Location:

`<CDS_INST_DIR>/tools/dfII/etc/tools/wavescan/measures/average.ocn`

```
 1;;; GUI builder information ;;;;;;;;;;;;;;;;;;;;;;;;;;
 2 ocnmRegGUIBuilder(
 3   '(nil
 4     function average
 5     name average
 6     description "Compute average of a waveform over its entire range."
 7     category ("Special Functions")
 8     analysis (nil
 9               general (nil
10                    args (signal)
11                    signals (nil
12                             signal (nil
13                                     prompt "Signal"
14                                     tooltip "signal to average"
15                                     )
16                    )
17                    inputrange t
18                    )
19     )
20     outputs (result)
21    )
22 )
```

~

- The function name used to build the expression is defined by line 4 (function average).
- Line 5 is the name used in the dialog label if a function panel is displayed. In this case the function signature takes a single argument (signal) and no function panel is required.

- Line 6 is a simple description that will be used at some point for bubble help. (This feature is not yet implemented).
- Line 7 is a set of category names. Typically each function belongs to a single category. Optionally a function can belong to multiple categories.
- Line 8 begins the analysis section.
- Line 10 is the args statement which provides the rule used by Virtuoso Visualization and Analysis XL to generate the function expression. The args statement is a list of ordered signal and parameter names and in our example contains a single item: signal. Therefore the signature looks something like: `average(VT("/net10"))`, it takes a single signal name

  The order in the args statement defines the order the parameter values will be named in the expression that is put into the buffer. This may or may not be the same order that is displayed in the function panel. Some functions require a more complex mechanism to describe the signature. The template mechanism provides a format statement that will be described in a later example.
- Line 11 starts the signal section. A function signature might contain multiple signal parameters (ex: the delay function).
- The single signal description begins at Line 12. Line 13 is the signal prompt used to name the signal parameter in the Function Panel. Line 14 is the signal tool tip. This is currently not used.

Example 2: Sample template with multiple arguments: delay.ocn

Location:

(<CDS_INST_DIR>/tools/dfII/etc/tools/wavescan/measures/delay.ocn)

```
       2 ;;;;;;;;;;;;;;;;;;;;;;;;;; GUI builder information
      ;;;;;;;;;;;;;;;;;;;;;;;;;;;

       3 ocnmRegGUIBuilder(

       4   '(nil

       5     function delay

       6     name delay

       7     description "delay "

       8     category ("Special Functions")

       9     analysis (nil

      10               tran  (nil
                    args (signal1 threshold1 edge1 type1 signal2 threshold2 edge2 type2 numberOfOccurences)
                      signals (nil
                               signal1 (nil
                                       prompt "Signal1"
                                       tooltip "signal to measure"
                                       )
                               signal2 (nil
                                       prompt "Signal2"
                                       tooltip "signal to measure"
                                       )
                      )
                      params (nil
                              threshold1 (nil
                                        prompt "Threshold Value 1"
                                        tooltip "Threshold Value 1"
                                        default 2.5
                                        type float
                                        min 0)
…
     periodicity1(nil
     prompt "Periodicity 1”
     tooltip "Periodicity 1"
     default 1
     type float )
 …
                              periodicity2 (nil
                                        prompt "Periodicity 2"
                                        tooltip "Periodicity 2"
                                        default 1
                                        type float
                               )
                               numberOfOccurences (nil
 72                                        prompt "Number of occurrences"
 73                                        tooltip "Occurrence choice"
 74                                        default single
 75                                     type ((single (0 0 nil nil)) (multiple
 (" %s  %s  t  %s " periodicity1 periodicity2 sweepName)))
 76                            )
 77                           sweepName (nil
 78                                        prompt "Plot/print vs."
79                            tooltip "Independent variable to plot against."
 80                                        required nil
 81                                        default trigger
 82                                        type (trigger target cycle)
 83                                        min 0)
 84                  )
```

The `delay` template is similar to `average.` Some differences:

- Line 11: The args description contains multiple parameters so a Function Panel will be built to describe this function.

  The signals section contains two signals named signal1 and signal2. The prompts (lines 14 and 18) will name the respective fields in the panel.

  This template contains parameters beginning at Line 22.

- Line 77: the parameter sweepName. Line 82 names the type: a simple list of cyclic choices. The default value (line 81) names the default choice to be initially displayed.

- Line 71: a much more complex example of a cyclic type parameter `(numberOfOccurances).`

  The cyclic type (Line 75) is a list of two choices: single and multiple:

  ```
  type ((single (0 0 nil nil)) (multiple (" %s  %s  t  %s " periodicity1
  periodicity2 sweepName)))
  ```

  Each choice has an associated value that describes what must be added to the expression signature.

  If you select “single”, then the value of numberOfOccurances put into the expression string is literally “0 0 nil nil”.

If you select “multiple”, the choice value is described by a formatted string and will look like: “<periodicity1> <periodicty2> t <sweepName>”. If the default values are used, then the choice resolves to: 1 1 t “trigger”.

Example 3: Signature described by a format statement: compression.ocn

Location:

```
(<CDS_INST_DIR>/tools/dfII/etc/tools/wavescan/measures/compress.ocn)
      9     analysis (nil

     10              general  (nil

     11                    ;; args (signal ...)

     12            format ("compression(dB20(harmonic(%s, %s)), ?x %s, ?compress
     %s)" signal harmNumber xpoint compressiondb)
```

The compression function is one of those examples where the expression does not conform to a simple rule of function name plus name/value pairs for the parameters. We have to use the format statement (line 12 above).

The format uses %s to substitute in the values of the named parameters (signal, harmNumber, xpoint, and compressiondb).

Example 4: Creating your own template

This example creates a template for calculator function named ‘trap’ that exists in a new category named ‘MyProject’.

Tip

To build a new template, it is advised to pick an existing similar template and modify it accordingly.

1. Define the function signature:

   - Function name
   - Signal parameters
   - Additional parameters

   For example to create a new function named trap with signature:

   ```
   trap(<signal> <from> <to>)
   ```

   The template signal section will contain a single signal named Signal. The parameter section will contain two parameters named From and To, both of type float.

2. Go to the source directory for template files:

   ```
   <CDS_INST_DIR>/tools/dfII/etc/tools/wavescan/measures
   ```

3. Find an existing similar template so that you don’t have to start from scratch. For example, if the new function trap was similar to existing function clip:

   ```
   % cp clip.ocn trap.ocn
   % chmod +w trap.ocn
   ```

4. Define the function information in the header section. Replace the information indicated in boldface below. Redefine the category name as MyProject.

   ```
    ocnmRegGUIBuilder(
   '(nil
    function trap
    name “trap function panel name”
    description "short tool tip description for trap function”
    category ("MyProject")
   ```

5. Define the args (or format) statement so we have a rule for building the expression.

   For the trap example, no change is required in the args statement that comes from the clip template.

```
args (signal From To)
```

6. Define the signal parameter in the signal section.

   For the trap example reuse the clip example. Change the tool tip as required.

```
                    signals (nil
                            signal1 (nil
                                    prompt "Signal"
                                    tooltip "signal to trap "
                                    )
```

7. Define the parameters

   For the trap example, reuse the parameter definitions from the clip template. Change the tool tip values as required

```
                params (nil
                        From (nil
                                prompt "From"
                                tooltip "Trap Start"
                                default 0
                                type float
                                min 0)
                         To (nil
                                prompt "To"
                                tooltip "End Trap Range"
                                default 0
                                type float
                                min 0)
                    )
```

8. Install the measures file into the template directory.

   Copy trap.ocn to `<USER_HOME>/measures` or `CSF_SEARCH_PATHS/measures`.

   For more information, please refer Function Template Search Paths.

9. Add entry in catalog file by doing following tasks:

   ❑ Install your new project catalog file.

```
% cp  <CDS_INST_DIR>/tools/dfII/etc/tools/wavescan/measures/
.skeMeasuresCatalog CSF_SEARCH_PATHS/measures.
```

For more information please refer Template Catalog Summary File.

- ❑ Edit your new project catalog file to add the new category and function name:
  - ❍ Add category name at line #2 after skeBeginCategory keyword
  - ❍ Add new category section before skeBeginMeasures.Math.

  Your `.skeMeasuresCatalog` file will look like as below:

```
skeBeginCategory
MyProject
Math
Modifier
RF Functions
Special Functions
Trigonometric
skeEndCategory
skeBeginMeasures.Project
trap;trap
skeEndMeasures
skeBeginMeasures.Math
exp;exp
dB20;dB20
```

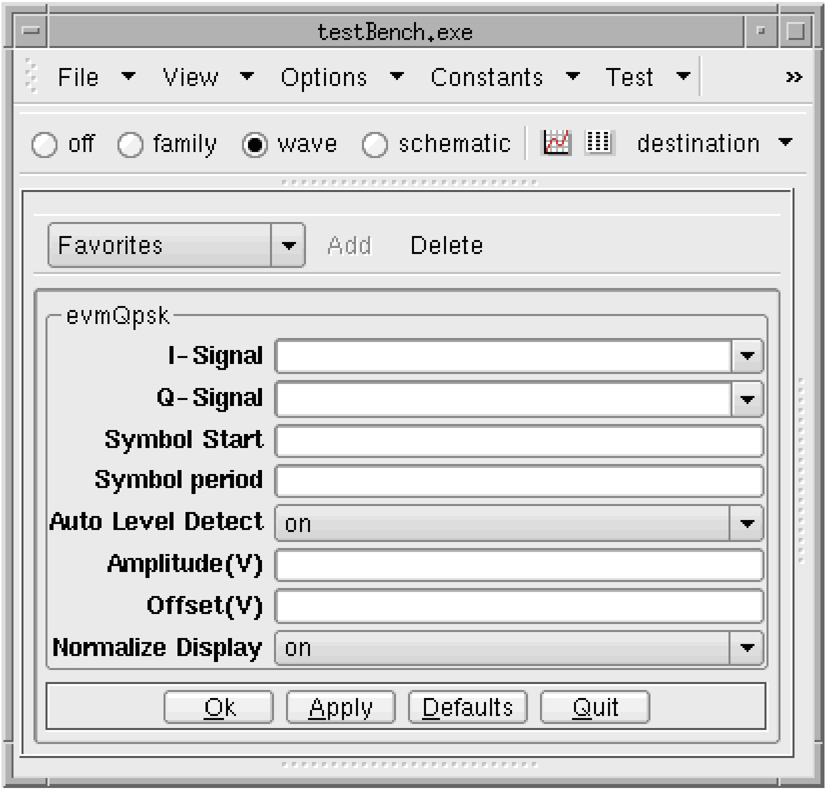
Now run Virtuoso Visualization and Analysis XL and open calculator, you should be able to see trap function added in special function category.

Advanced Features to provide GUI Hints

The template format supports the following advanced features:

- Sometimes it makes sense for two or more parameters to share the same row. An optional parameter property `gridRowHint <num>` directs Virtuoso Visualization and Analysis XL to layout all parameters with the same `gridRowHint value` on the same row.
- Sometimes a parameter controls whether one or more other parameters are enabled or disabled. An optional parameter property `guiEnableHint <target list>` controls whether other parameters are enabled.

Example: evm.ocn template (evmQpsk)



evmQpsk

I-Signal	
Q-Signal	
Symbol Start	
Symbol period	
Auto Level Detect	on
Amplitude(V)	
Offset(V)	
Normalize Display	on

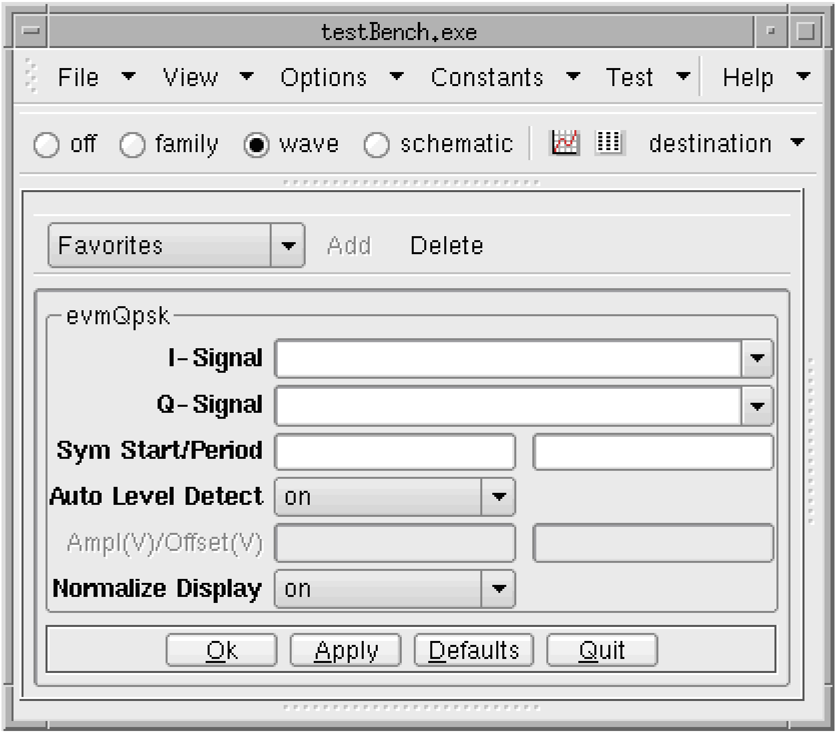
The above example is the GUI form for the original evmQpsk 6.1.0 template. The template contains no `gridRowHints` or `guiEnableHints`.

The next example shows how the two hint properties are used to:

- Place the Symbol Start and Symbol period parameters on the same row.
- Place the Amplitude and Offset parameters on the same row.

- The form has three columns instead of two to make the form more compact.
- The Auto Level Detect parameter will enable/disable the Amplitude and Offset parameters.

Example: evmQpsk with gridRowHint and gridEnableHints:



○ off ○ family ● wave ○ schematic

Auto Level Detect on

Normalize Display on

The following is a snippet of the evmQpsk template with modifications is italized:

```
delay (nil
    prompt "Sym Start/Period"
    tooltip "Symbol Start"
    type float
    required t
    guiRowHint 1
    min 0)
sampling (nil
    prompt ""
    tooltip "Symbol period"
    type float
    required t
    guiRowHint 1
    min 0)
```

Notes on template changes:

- The guiRowHint properties for delay and sampling have the same value (guiRowHint 1), so the prompt/value pairs for both parameters are put on the same row.
- Column 1 contains the prompt for the delay value. Column 3 is supposed to contain the prompt for the sampling value; however, I wanted to simplify the layout and have three columns instead of four. Look at the prompt value for the delay parameter: it actually describes BOTH the delay and sampling value fields. The prompt for the sampling parameter is set to an empty string (“”).

The following is a snippet of the evmQpsk template with modifications is italized:

```
Autoleveldetect(nil
    prompt "Auto Level Detect"
    tooltip "Auto Level Detect"
    type ( ("on" (t, nil, nil)) ("off" ("nil, %s, %s" voltage offset)))
    guiRowHint 2
    guiEnableHint ( (voltage off) (offset off) )
)
```

The autoleveldetect parameter is an enumerated type with values “on” and “off”. When it’s “on”, there is no need to specify two other parameters: voltage and offset because those values will be automatically calculated.

If you want the GUI fields representing these other parameters to be disabled when autoleveldetect is “on”. The guiEnableHint target list gives the name(s) of the other parameters to enable (voltage and offset). Each target is specified as a list: the first name is the target name, followed by the set of autoleveldetect values that will turn that target on.

Examine the first target list for autoleveldetect’s guiEnableHint:

```
guiEnableHint( (voltage off) (offset off))
```

This hint tells the GUI that when the autoleveldetect enumerated value is “off”, the gui for the voltage parameter can be enabled. For any other autoenablehint value, the gui for the voltage parameter will be disabled.

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Memory Editor

Important

It is recomended that you use Expression Editor to store and work with expressions because Memory Editor will be removed in a future release.

Memory Editor is a Virtuoso Visualization and Analysis XL Calculator assistant that can be used to store and edit expressions. The expressions in the Memory Editor are saved in a memory table in an ASCII file.

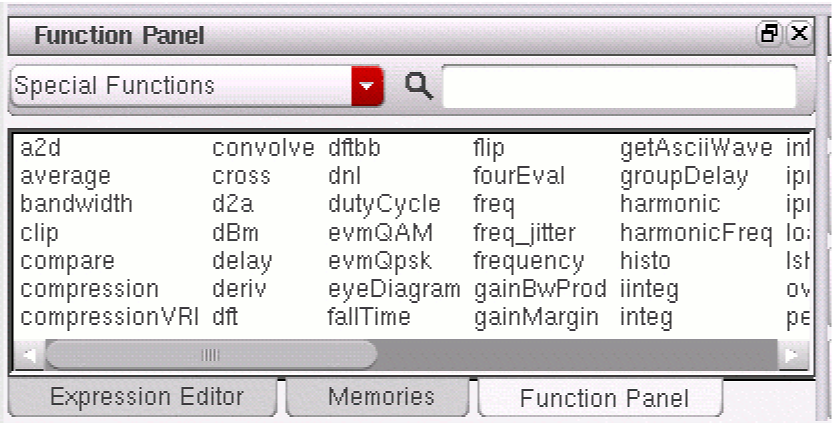
This appendix includes the following topics:

Opening the Memory Editor

You can open the Memory Editor by using one of the following methods:

- Select *Memories* function category in the Function Panel. The Memory Editor appears.

- Click the *Memories* tab in the Function Panel.

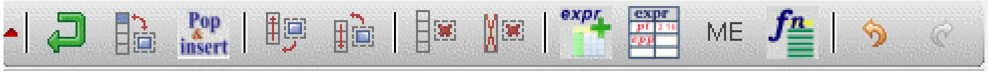


Function Panel

Special Functions

```
a2d            convolve  dftbb        flip        getAsciiWave   inl
average        cross     dnl          fourEval    groupDelay     ipl
bandwidth      d2a       dutyCycle    freq        harmonic       ipl
clip           dBm       evmQAM       freq_jitter harmonicFreq   lo:
compare        delay     evmQpsk      frequency   histo          lsl
compression    deriv     eyeDiagram   gainBwProd  iinteg         ov
compressionVRI dft       fallTime     gainMargin  integ          pe
```

- Click the ME button on the Buffer and Stack toolbar.



Adding Expressions to the Memory Editor

You can add expressions created in the Buffer to the Memory Editor. The expressions saved in the expression table in the Expression Editor can also be added to the memory table in the Memory Editor.

- To add the expression from the Buffer to the Memory Editor, click the M+ button on the Buffer and Stack toolbar. The expression is added to the memory table.
- To add an expression from the Expression Editor to the Memory Editor, select the expression in the expression table and click the M+ button. The expression is added to the memory table.

The table below lists the buttons available in the Memory Editor.

Button	Description
M+	Adds the expression created in the Buffer to the Memory Editor
M–	Deletes the selected expressions from the memory table

Button	Description
⇤	Copies the expression selected in the memory table to the Buffer
E+	Adds the expressions selected in the Memory Editor to the Expression Editor
💾	Saves the expressions selected in the Memory Editor to a file
📂	Restores expressions from a file

Memory Editor associates an expression name (alias) with each expression saved in the memory table. The default expression names are *M1*, *M2*, and so on. When you move an expression from the memory table to the Buffer, the associated expression name is displayed in the Buffer.

Editing Expressions in the Memory Editor

To edit an expression in the Memory Editor, double-click the expression in the memory table.

Adding Expressions from the Memory Editor to the Buffer

To add an expression from the Memory Editor to the Buffer, select the expression in the memory table and click the ⇤ button. The associated expression name is added to the Buffer.

Deleting Expressions from the Memory Editor

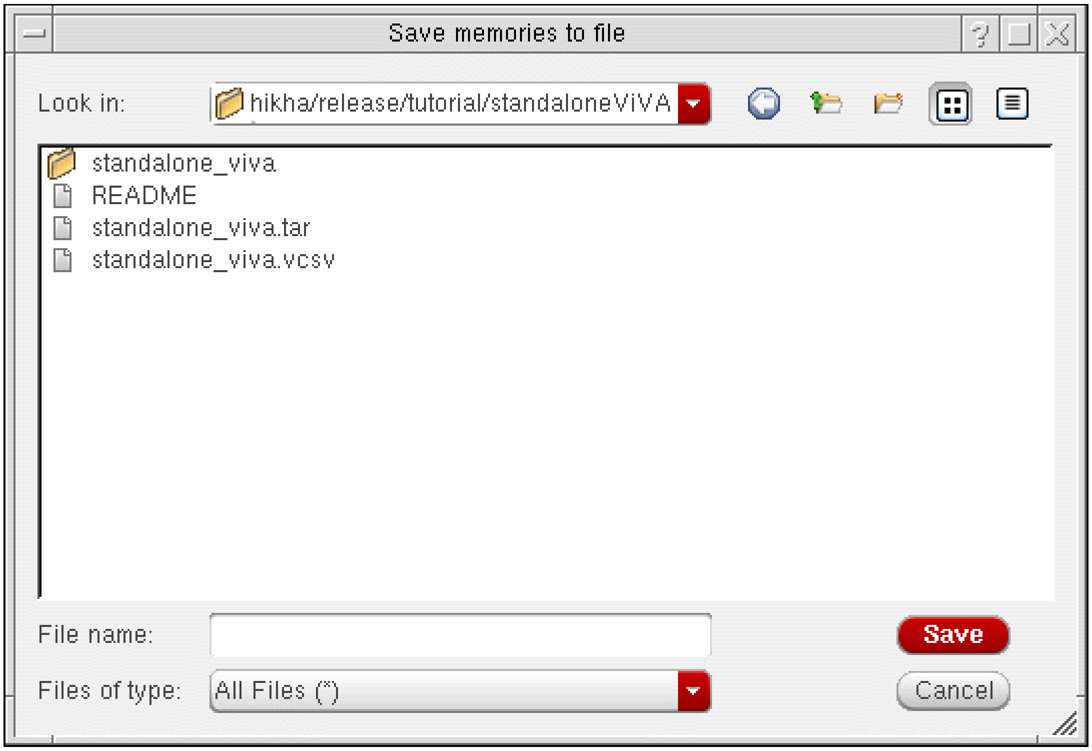
To delete an expression from the memory table, select the expression and click the M- button or press the *Delete* key.

Saving Expressions in the Memory Table to a File

To save the expressions in the Memory Editor to a file, perform the following steps:

1. In the Memory Editor, click the 💾 button.

The *Save expressions to file* form appears.



1. In the *Look in* field, select the directory where you want to save the expression file.
2. Do one of the following:
   - ❑ To overwrite an existing expression file, select that file from the list box below the *Look in* field.
   - ❑ To create a new file, in the *File name* field, type a name for the expression file that you want to create.
3. Click *Save*.

   The ViVA XL tool saves the expression list in the memory table to the file.

To automatically save the expressions in the current session to the `defaultVarFileName` file when you close the Calculator or exit the ViVA XL tool, set the `writeDefaultVarFileOnExit` `.cdsenv` variable to `true`.

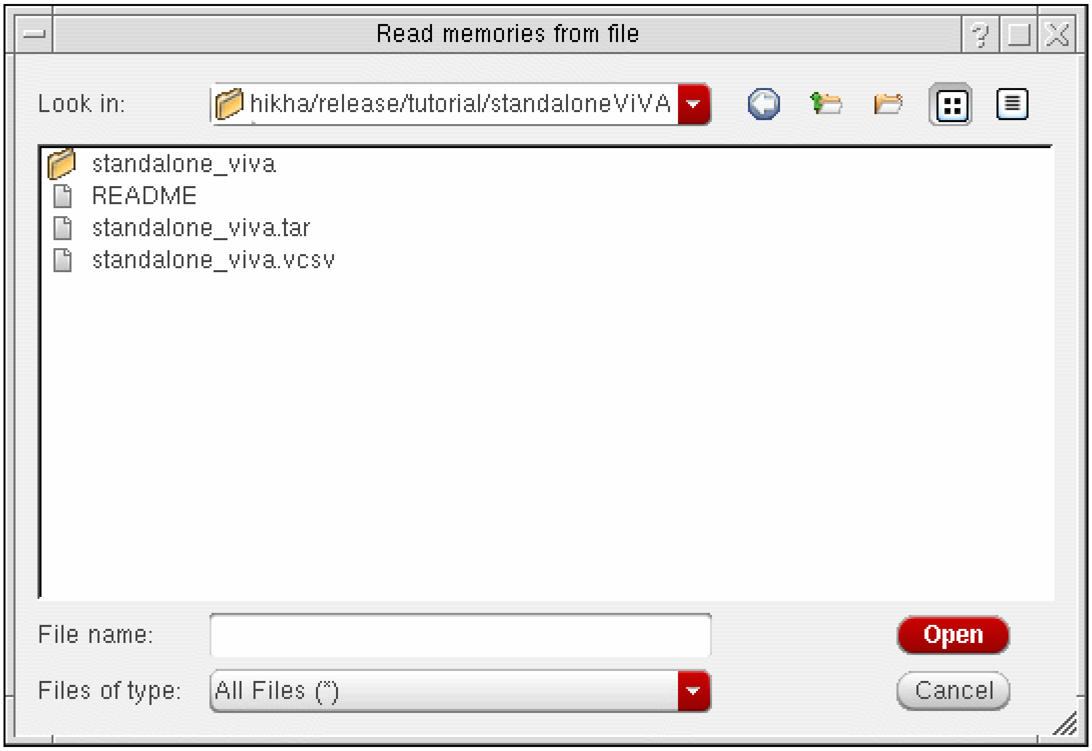
Loading an Expression File to the Memory Editor

You can load an expression file to the memory table in the Memory Editor. The file that you load replaces the current set of expressions in a session, and you lose any unsaved information.

To load an expression file to the Memory Editor, perform the following steps:

1. In the Memory Editor, click 📂 .

   The *Read memories from file* form appears.



Read memories from file

Look in: hikha/release/tutorial/standaloneViVA

File name:

Files of type: All Files (*)

2. In the *Look in* field, select the directory which contains the required expression file.
3. Do one of the following:
   - From the list box below the *Look in* field, select the expression file you want to open.
   - In the *File name* field, type the name of the file you want to open.
4. Click *Open*.

   The ViVA XL tool loads the specified expression file.

If the `readDefaultVarFileOnStartup` `.cdsenv` variable is set to `true`, The ViVA tool automatically loads the `defaultVarFileName` file.

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