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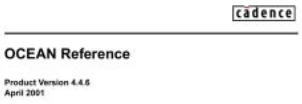
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OCEAN Reference

Product Version 4.4.6
April 2001

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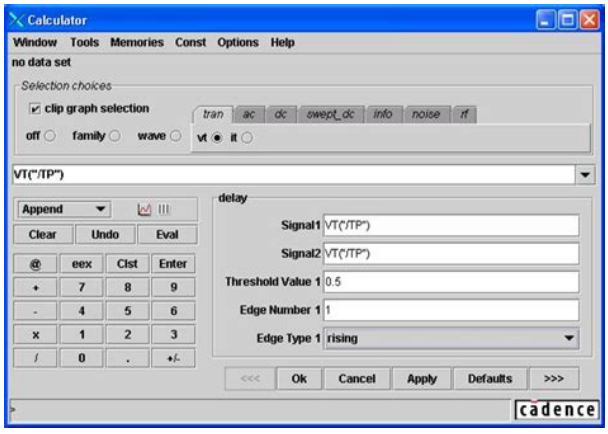

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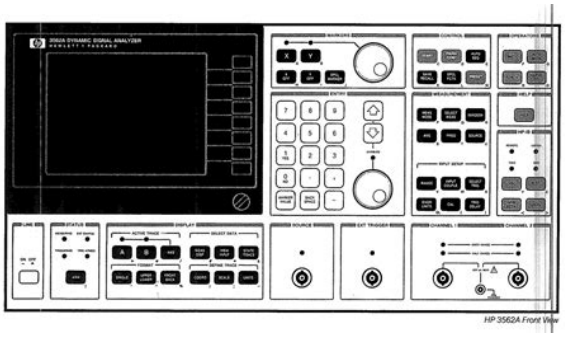
Waveform Calculator User Guide

Product Version 5.1.41
December 2005

Menus Mode buttons Special Functions menu Command to start the Results Browser Command for selecting curves in the Waveform Window Command for selecting a family of curves Commands for plotting and printing Commands for entering expressions from the schematic Keypad Functions Programmable function keys About the Algebraic and RPN Modes The calculator has both algebraic and Reverse Polish Notation RPN modes. The calculator uses the syntax rules you would expect from any scientific calculator.Using Keys Most keys and functions are available in both modes. Entering Constants To enter a constant into the buffer. Select the constant from the Constants menu. In Algebraic mode, the constant is added to the right side of the buffer. In RPN mode, the current buffer expression is pushed onto the stack, and the specified constant is placed in the buffer. The constants are pi, twoPi, sqrt2, degPerRad, charge, boltzmann, and epp0. These constants are internally defined in the Analog Expression Language AEL for expression evaluation. Refer to the Analog Expression Language Reference. Note Calculator expressions should be entered with the right syntax. In Calculator expressions, 2k, 2p etc.Also, any string of characters and not integers following say '2p', e.g. '2phfyhff' will be treated as '2p' only without any syntax errors. However,

expressions like ’2pghg45jk’ will throw syntax errors. The same caution also applies, while using any constant like ’pi’. December 2005 13 Product Version 5.1.41 Waveform Calculator User Guide Overview About Standard and RF Modes The calculator has standard and RF modes. In RF mode, the calculator keypad provides mathematical functions commonly used in RF circuit design. This document describes both the standard and RF modes. From the CIW, choose Tools Analog Environment Calculator. From Analog Design Environment Window, choose Tools Calculator.

Closing and Quitting the Calculator To close the Calculator window, but preserve the contents of the buffer and stack. To close the Calculator window and clear the buffer and stack. Use this command if you need to reinitialize the calculator. December 2005 15 Product Version 5.1.41 Waveform Calculator User Guide Overview December 2005 16 Product Version 5.1.41 Waveform Calculator User Guide 2 Using the Calculator Selecting Data There are three ways to bring simulation results into the calculator. Open the Results Browser. Schematic expression keys Click a net or pin in the schematic. Bring a curve from the Waveform Window into the buffer. Use these keys to print or plot what you select. December 2005 17 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator Selecting Data in a Schematic Window The schematic expression keys let you enter data into the calculator buffer by selecting objects in the Schematic window. Note To use the vn, var, op, opt, or mp functions, you must either select results or have just run a simulation.If more than one parameter is available for the expression and instance you picked, a form appears. Select the parameter you want from the List field and click OK. 3. When you have finished selecting objects, press the Esc key while the cursor is in the Schematic window. Choosing Parameters from Schematic Data To select a parameter in the schematic with a schematic expression key 1. Click an instance in the schematic. December 2005 18 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator 2. Choose the parameter you want from the List field. Note When you use the op, opt, mp, vn, or var functions, you must have just run a simulation, or you must choose select results from the Results menu in the Simulation window. Otherwise, the system does not know what to display. Choosing Voltages or Currents To select voltages in the schematic. Click wires. To select currents. Click square pin symbols, not wires.



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Never click the wire stub. December 2005 Click here to select the terminal current. Click anywhere on the wire to select the node voltage. 19 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator You can use the Selection Filter form to restrict selection to either pins or wires. Press F3 if the Selection Filter form did not appear. Selecting Curves in the Waveform Window Use the wave key to create an expression from a curve in the Waveform Window and place the expression into the calculator buffer. 1. Click wave in the calculator. 2. Click a curve in a Waveform Window. The waveform expression that the system enters in the calculator is the expression on the Waveform Window status banner at the tracking cursor location. Selecting a Parametric Set of Curves To select a parametric set of curves in the Waveform window 1. Click

family in the calculator. 2. In the Waveform window, click a curved part of the parametric wave. Isolating One Curve from a Waveform Group You can select a single curve from a parametric curve group in the Waveform Window. This lets you perform calculations on the single curve or display it separately on another set of axes. 1. In the Calculator, click wave. December 2005 20 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator 2. Click a parametric curve in the Waveform Window. The Waveform Window is erased, and the single curve appears. Selecting Simulation Results with the Results Browser To select waveform expressions from simulation output data in the Results Browser 1. Click browse in the calculator. The Browse Project Hierarchy form appears. 2. Enter the path to the project directory in the form and click OK. The Results Browser appears. 3. Click left in the Results Browser to expand the data hierarchy until you get to the scalar or waveform data you want to enter in the calculator buffer. December 2005 21 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator 4.

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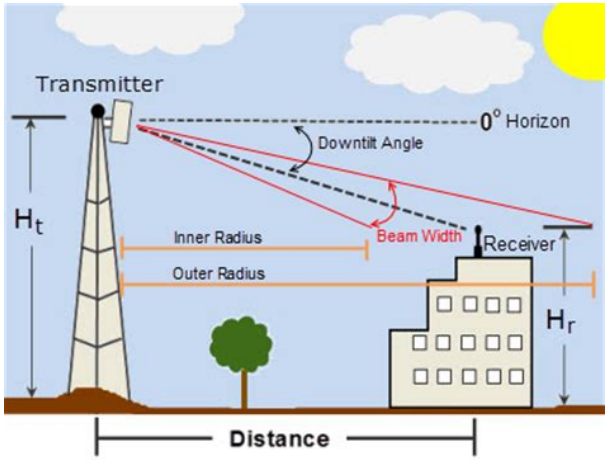


Click the scalar or waveform data to enter the expression for that data in the calculator buffer. You can expand a particular node down to the lowest level of the hierarchy. The following figure shows the file structure for simulation results in the Results Browser. The netlist directory contains textual information and the final netlist. The contents of the psf directory varies depending on the simulator you use. If you press the middle mouse button over a node, a menu of commands pops up. You can use these commands to perform actions on that node. The Results Browser also has a Commands menu in the banner that helps you manipulate the display of data and lets you close the Results Browser. Starting the Browser 1. To start the Results Browser, do one of the following. Click Browse on the Waveform Calculator form. December 2005 24 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator. For Analog Environment, from the CIW, choose Tools Analog Environment Results Browser. For Analog Environment, from Analog Design Environment Window, choose Tools Results Browser. The Browse Project Hierarchy form appears. Browse Project Hierarchy 2. Type in the path of a project directory containing simulation output files. If you just finished a simulation, the current data directory is shown. Otherwise, the form defaults to your home directory. 3. Click OK. The Results Browser appears. The Results Browser has a popup menu that lets you move through the file system and data hierarchy, perform commands on the file system and data, and display various properties of the data hierarchy. December 2005 25 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator. To display the Results Browser popup menu, press the middle mouse button over a node. Expand L Expand FS Plot R Expression Refresh Click a command for more help. Delete Rename. Properties.

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Create ROF Select Results Managing the Display The commands on the Results Browser menu help you manage the display of data. To place the root the vertical list of nodes on the left of the Results Browser hierarchy in the middle of the window. After you use the scroll bar to pan through the Results Browser nodes, you can use this command to return to the default configuration of the Results Browser. To move up a level in the Results Browser hierarchy. To redisplay the complete Results Browser hierarchy after you add new files to the file system with the browser open. You can also use this command to redraw the current Results Browser display. December 2005 26 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator The Filter form appears. 2. Enter a regular expression filter. This command is useful for simplifying the Results Browser display while browsing simulation results for large circuits. To keep the most recently expanded node in the center of the window. You can also use an environment variable, browserCenterMode, in your.cdsenv file to turn centering on or off. To turn centering on, add the following line to the.cdsenv file. asimenv.misc browserCenterMode boolean t To turn centering off which is the default add the following line to the.cdsenv file. asimenv.misc browserCenterMode boolean nil To close the Results Browser window. Redrawing the Browser To redraw the Results Browser display for the current level in the Results Browser hierarchy 1. Place the pointer over the current level in the Results Browser. 2. Press the middle mouse button and choose Refresh from the popup menu. Expanding Nodes In the Results Browser, a node represents an object that contains information. Scalar data numeric data and waveform objects are highlighted. To expand a node, click left on it. If you click a file node, the file contents appear in a file viewing window. You can use the window functions to manipulate the file.

If you click a directory node, the directory contents appear in the next level of the Results Browser hierarchy. If the directory contains simulation data, the data files open and the simulation data hierarchy expands. If you click a highlighted object, the scalar data or the expression for the waveform object is entered into the calculator buffer for mathematical processing. Note You can also expand a node by choosing the Expand L command from the Results Browser popup menu. To see an example of an expanded hierarchy of nodes containing simulation results, click here. December 2005 28 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator You can use the Expand FS command from the Results Browser popup menu to expand only the UNIX file system—not the psf hierarchy that the system uses to display simulation results. To expand the UNIX file system for a node. Press the middle mouse button over the node and choose Expand FS. The UNIX file system expands to show any directories or files under the node. Plotting Waveforms You can plot several waveforms from the same or different simulations in the Waveform Window. To plot a waveform object in the Waveform Window 1. Expand the Results Browser nodes until you see highlighted waveform data. Waveform data is in the psf directory, which is under the simulation

results for the simulator you chose. 2. Click right over the waveform data. The waveform data is plotted in the Waveform Window. When you plot a waveform this way, it is added to the existing waveforms in the Waveform Window. Note You can also use the Plot R command from the Results Browser popup menu to plot waveform objects in the Waveform Window. Copying Expressions into the Calculator To copy the expression for a Results Browser object to the calculator buffer. Click left over a highlighted object in the Results Browser. The expression for the object appears in the calculator buffer.



Note You can also use the Expression command from the Results Browser popup menu to enter expressions in the calculator buffer. A dialog box asks if you want to delete the file or directory. A warning message appears in the CIW if the node you select is not part of the file system. 3. Click OK on the dialog box. The directory or file is deleted from the file system. Renaming UNIX Files To rename a file or directory in the UNIX file system 1. Place the pointer over the file or directory you want to rename. 2. Press the middle mouse button and choose the Rename command from the popup menu. The Rename File or Directory form appears. December 2005 30 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator 3. Enter the new file or directory name and click OK. Displaying Properties You can view the properties associated with the simulation output data hierarchy and filter the properties so that only the simulation properties for a particular type of component appear. A property is an associated value, such as a DC operating point. 1. Place the pointer over a simulation output data object, which is any node under the psf directory. Simulation data is in the psf directory, which is under the simulation results for the simulator you chose. 2. Press the middle mouse button and choose the Properties command from the popup menu. The Properties Filter form appears. 3. Choose a Matching Type. Matching Type lets you choose the type of pattern matching. csh uses the same patternmatching tools used by the UNIX Cshell to match file names. This is the default. regexp uses the standard UNIX regular expression pattern matching syntax. 4. Change the filter string. You can change the default to match any string you want. The results appear in a text window. December 2005 31 Product Version 5.1.

41 Waveform Calculator User Guide Using the Calculator Using External Data You can use the Create ROF command to create a run object file, which lets you access external data generated by a standalone simulator. When you use the Analog Artist simulation environment to run simulations, this file is generated automatically for you. To create a run object file 1. Place the pointer over a directory that contains the external simulation data. 2. Press the middle mouse button and choose the Create ROF command from the popup menu. A run object file called runObjFile is created in the next level of the hierarchy. 3. Click left on the node containing the simulation results to expand it. Note You cannot see the run object file unless you use the Expand FS command to expand the file system. Selecting Results You can link data from a previous simulation to a schematic window. Then you can probe the schematic to compare the results of the previous simulation to current results. 1. Place the pointer over a node containing simulation results. 2. Press the middle mouse button and choose Select Results from the popup menu. The schematic window is redrawn and the CIW tells you that the simulation results for the node are selected. Plotting or Printing Results You can plot or print the value of the calculator buffer expression against an independent variable. You can plot or print only the expressions that are in the buffer, not the memories. You must recall memory expressions into the buffer to plot or print them. You can print or plot multiple expressions by separating each expression by a space using the app append function in RPN mode or the space key in algebraic mode. For example, December 2005 32 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator expr1 expr2 expr3 Plotting Expressions To erase the Waveform Window and plot the buffer expression. Click erplot in the calculator. To plot the buffer expression

without first erasing the Waveform Window.

Click plot in the calculator. For example, to plot the I vs. V curve after a DC sourcesweep analysis 1. In the calculator, click IS. 2. In the schematic, click the output terminal of the device. Terminals are the square symbols at the end of the wire stub. Now you have an expression in the buffer for the IV curve. 3. Click erplot in the calculator. The system opens a Waveform Window unless one is already open and draws the curve. Printing One Expression Value The print command prints the value of an expression at a single value of the independent variable. 1. Put the expression into the calculator buffer. 2. Click print. 3. If the expression is a waveform, enter the value of the independent variable. December 2005 33 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator The Results Display Window appears, displaying the results in numerical format. Note If the expression in the calculator buffer represents a parametric waveform, then the print button prints the value of the expression at the specified point for different sets of sweep parameters. Printing a Range of Expression Values The printvs command prints a table showing the value of the buffer expression over a range of independent variables. 1. Put the expression into the calculator buffer. 2. Click printvs. The Printvs Range form appears. 3. Type in the starting and ending values. Leave all of the fields blank to print the raw simulation data. 4. Optional Choose a linear or logarithmic range. 5. Enter the increment for the calculation in the By field. Note When results related to signals represent multibit buses, the printvs button prints the data corresponding to each bit. So, bit0 is x, bit1 is x, and bit4 is x. Setting the Range Calculation Increment You can set the range calculation increment in the Printvs Range form in several ways. If the range is linear, enter the increment. If the range is logarithmic, enter the number of points per decade.

To print the raw simulation data, leave all three fields blank. The result of the evaluation is displayed in the Results Display Window. Note If you specify range values outside the range of the original simulation data, the calculator extends the simulation endpoint values to the requested values using linear extrapolation, which can give misleading results. December 2005 35 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator Applying Waveform Transformations Shifting the X Axis L shift The lshift function shifts the X axis in the Waveform Window to the left by a specified amount. Use negative values to shift the X axis to the right. Before Lshift of 1 1 2 3 After Lshift of 1 4 5 1 2 3 4 5 In Algebraic Mode In algebraic mode you set up the waveform expression after selecting the lshift function. 1. From the Special Functions menu, choose lshift. The Left Shift form appears. 2. Enter a value in X axis units in the Delta X field, and click OK. December 2005 36 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator In RPN Mode In RPN mode the lshift function acts on the expression already in the buffer 1. From the Special Functions menu, choose lshift. The Left Shift form appears. 2. Enter a value in X axis units in the Delta X field and click OK. Y Axis Flip To flip a waveform around the y axis. From the Special Functions menu, choose flip. December 2005 37 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator Extrapolating and Interpolating Values When a point on the Xaxis is within the range of the waveform, its Y value is interpolated using first order linear interpolation. When a point is beyond the range of a waveform, constant extrapolation is applied to determine its Yvalue. In this case, the Yvalue is taken to be the same as that of the closest point on the waveform the starting point or the end point.

In the diagram below, the existing points in the waveform are marked with black dots, with the lines marked XL and XU pointing to the lower and upper limits, respectively, of the waveform. The vertical dotted lines A and C show examples of values being extrapolated. The vertical dotted line B shows an example of a value being interpolated. The extrapolated and interpolated points are marked by gray dots. Using Memories You can store the buffer in a memory and recall it later. You can also save the calculator memories to a file. Use the Memories menu to work with memories. The Memory Name form appears. 2. Type a name for the memory and click OK. There is no limit on the

number of memories you can use. The Recall Calculator Memories form appears. 2. Double click to select an expression, or highlight the expression and click OK. The recalled expression stays in the calculator memory pool. In Algebraic mode, the recalled expression is appended to the end of the buffer. The memory asfmem stores the buffer temporarily while you enter a special function expression. December 2005 39 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator In RPN mode when you recall a memory, any expression currently in the buffer is pushed onto the calculator stack. The Delete Calculator Memories form appears. 2. Double click to delete an expression, or highlight the expression and click OK. Saving and Loading Memories Use the Save command to write memories to a file. The Save Calculator Memories form or the Load Calculator Memories form appears. 2. Enter the path and name for the memory file. 3. Click OK. December 2005 40 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator Defining Functions and Function Keys Defining New Functions You can define a function and add it to the Special Functions menu with the following steps. 1. Define the form that prompts for userdefined arguments to the special function. 2.

Define the syntax of the special function in the callback procedure. 3. Register the special 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. The form is created by the call to calCreateSpecialFunctionsForm. This function creates and registers the form with the specified form symbol, MyForm. December 2005 41 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator Defining a Callback Procedure You define a callback procedure that is called from the entry on the Calculator Special Functions menu. 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. December 2005 42 Product Version 5.1.41 Waveform Calculator User Guide Using the Calculator SKILL User Interface Functions for the Calculator For SKILL Functions of Waveform Calculator, please refer to chapter 22 of Virtuoso Analog Design Environment SKILL Language Reference. Assigning Function Keys You can assign buffer and stack manipulation procedures to the four function keys f1, f2, f3, and f4. About the Buffer The buffer area stores data and expressions that you enter for the calculator to manipulate. You can edit the buffer contents by backspacing to delete unwanted characters. Note If you enter multiple expressions, separate them with one or more spaces. Using the Keypad, Functions, and Memories You can select numbers, functions, operators, and constants from the keypad. The calculator automatically adds the selection to the buffer. The functions on the keypad such as log make the entire buffer’s contents the argument of the functions.

For example, if the buffer contains expr1 and you select log, the following appears in the buffer logexpr1 Select a function when there is only one expression in the buffer. December 2005 45 Product Version 5.1.41 Waveform Calculator User Guide RPN Mode Entering Variables To enter a variable expression into the buffer 1. Select the var button from the Waveform Calculator form. The Select an Instance form appears. 2. On the schematic, choose an instance that uses this variable as a parameter value. 3. Choose the variable from the List cyclic button on the Select an Instance form. 4. Select OK. The expression appears in the buffer. Note To use the var function, you must either select results or have just run a simulation. The current buffer expression is pushed onto the stack, and the specified constant is placed in the buffer. Entering Multiple Expressions You can enter more than one expression into the buffer with the app append key. Each expression must be separated by a space, which you can enter from the keyboard. Many functions cannot operate on multiple expressions. Be careful not to enter one of these functions while you have more than one expression in the buffer. You can build the expressions separately in the stack and then combine them in the buffer with the app append key. December 2005 46 Product Version 5.1.41 Waveform Calculator User Guide RPN Mode Evaluating the Buffer Evaluating the buffer is useful only for expressions that contain scalar functions or variables. The Waveform Calculator evaluates expressions that contain

waveforms or undefined variables as NaN not a number. To evaluate an expression in the buffer after the arithmetic operations are performed on it. Select the Evaluate Buffer option. About the Stack Like a Reverse Polish Notation RPN scientific calculator, the Waveform Calculator uses a buffer and a stack to build and manipulate expressions.

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