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AWR Design Environment™

Quick Reference

Advancing the wireless revolution™

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AWRDE QUICK REFERENCE

This version of the *Quick Reference Guide* is an abbreviated version used for printing. You can access the full version of this document in the AWR Design Environment (AWRDE) by choosing **Help > Quick Reference.** This menu command will open any document named *Quick_Reference.pdf* in the AWRDE installation folder.

ADDITIONAL RESOURCES AVAILABLE

These links are also available in the AWRDE from the **Help > AWR Web Site** menu.

1. AWR KnowledgeBase - http://www.awrcorp.com/download/kb.aspx
2. Example Website - https://awrcorp.com/download/examples80/default.aspx
3. Script Website - https://awrcorp.com/download/scripts/default.aspx
4. API References - http://awrcorp.com/support/apidocs.aspx

PROJECT BROWSER AND DESIGN ENVIRONMENT

Design Environment

Use these keystrokes from anywhere in the AWRDE:

Hot Key	Description
Ctrl-C	Copy selected item
Ctrl-X	Cut selected item
Ctrl-V	Paste selected item
Ctrl-Z	Undo last operation
Ctrl-Y	Redo last operation
F7	Open the Optimizer dialog box
Shift-F7	Display a list of all variables used in a project
F8	Simulate
Ctrl-S	Save a project
F9	Open the Tuner
Ctrl-Tab	Cycle through AWRDE windows in one direction
Ctrl-Shift-Tab	Cycle through AWRDE windows in the opposite direction

Most actions are customizable to create your own hot key, toolbar button, or menu option. Choose **Tools > Customize** to add your own customizations for toolbars and menus and **Tools > Hotkeys** to add your own hotkey commands.

Zooming and Scrolling

Hot Key	Description
Mouse Wheel	Scroll up and down
Shift-Mouse Wheel	Scroll right and left
Ctrl-Mouse Wheel	Zoom in (centers on the cursor) and out
Up Arrow	Scroll up
Down Arrow	Scroll down
Left Arrow	Scroll left
Right Arrow	Scroll right
Num -	Zoom out
Num +	Zoom in
Home	View All
Ctrl-W	View Area
End	View Previous

These commands are common to most window types (circuit schematic, system diagram, layout, EM layout, global equations and output equations).

Project Browser

- **Change model description views** in the Elements Browser by right-clicking in the lower left window to change the model display. The most useful setting is the **Show Details** view which provides the model name and a brief description of the model.
- **Wizards** can add functionality to the AWRDE. See the **Wizards** node of the Project Browser for available Wizards.
- **Open** an item by double-clicking it, or right-click in the Project Browser and choose **Open Project Item** to select an item to open from a list of all items in your project. In the Open Project Item dialog box, the list of items is filtered as you type, and the item that best matches your input is highlighted.
- **Open a specific example** by choosing **File > Open Example** or **Help > Open Example** to filter a list of examples by name or keyword. Press the **Ctrl** key and click over the column header on which you want to filter.
- **Show all previously opened projects** by choosing **File > More Projects** to display and filter a list of all projects you have opened; by rank, project (name), (date) last opened, or path. Press the **Ctrl** key and click over the column header on which you want to filter.
- **Browse to specific files and folders** by choosing **Help > Show Files/Directories** to open a Directories dialog box that displays all of the files and folders the AWRDE uses. Double-click a folder or file to open it.
- **Add/delete/rename** by right-clicking an item to display a menu with options to add, delete, rename, import/export, collapse/expand, link to, view properties for, and more.
- **Delete without confirmation** by pressing the **Shift** key while deleting Project Browser nodes (such as graphs or schematics) to bypass the default deletion confirmation.
- **Create an output equation identical to a measurement** by dragging and dropping a measurement from the Project Browser into the Output Equations window.
- **Copy an item** by dragging it up to its parent category in the Project Browser and dropping it (schematics/system diagrams, data files, EM structures, graphs and measurements only). The new item has the same root name appended with "_1" so it displays next to the original item in the Project Browser.
- **Add a subcircuit to a schematic window** by right-click dragging and dropping a schematic from the Project Browser on an open schematic window.

Window in Window

- **Create a window in a window** by dragging and dropping an item from the Project Browser to an active window. The cursor changes to allow you to click and drag to draw the desired window size.
- **Resize and align multiple windows** by first right-clicking the toolbar and choosing **Align** to display the Align toolbar with various alignment options, and then by selecting the window-in-window objects and the proper align command. You can also size each selected window identically.
- **Edit window-in-window views** by double-clicking the view or by selecting it, right-clicking and choosing **Activate View**. When editing these windows you are editing the original object (for example, the schematic or graph). Click once to select and move an object.

CIRCUIT SCHEMATIC / SYSTEM DIAGRAM

Shortcuts for common items:

Hot Key	Description
Ctrl-G	Add a ground connection (schematic only)
Ctrl-P	Add a port (schematic only)
Ctrl-E	Add an equation
Ctrl-K	Add a subcircuit
Ctrl-L	Add an element
Ctrl-T	Add text
Ctrl-A	Select all

Adding/Placing an Element

- **Add or place an element** by pressing **Ctrl-L** or choosing **Draw > More Elements** to filter a list of elements by name, description, or path. Press the **Ctrl** key and click over the column header on which you want to filter. While typing, the item that best matches

your filter is highlighted. You can press **Enter** or click **OK** to select that element for placement. You can also search using multiple words, for example, you can type "**micro line**" to display matches for both words. Note that the Add Circuit Element dialog box does not currently function for any PDK or vendor library models.

When you see the outline image of a symbol after dragging it from the Element Browser into the work area, or after you have copied and pasted an element, you can:

Keystroke	Description
Right-click	**Rotate** counter-clockwise 90-degrees per click
Ctrl-Right-click	**Mirror** about the Y-axis
Shift-Right-click	**Mirror** about the X-axis

NOTE: All of the Zoom commands also work while placing an element.

Schematic / Diagram Connectivity

- For models requiring a **substrate**, right-click the model and choose **Add Model Block**.
- **Start wiring** by hovering over a model node until the cursor changes to the Wire tool, then click to start wiring.
- **Start a wire from the middle of another wire or node** by right-clicking to select the wire and then choosing **Add Wire**.
- **Remove a previous point** by right-clicking when you are actively adding a wire.
- **Controlling wire direction:** After starting a wire, the wire draws differently depending on the location of the cursor relative to the starting point.
- Set **auto wire deletion** by selecting the **Auto wire cleanup** check box in the Project Options dialog box on the **Schematics/Diagrams** tab (choose **Options > Project Options**). When an element is deleted, the wires connected to it are also deleted when this option is selected. If not selected, the wires remain.
- **Highlight a net** by selecting a wire, right-clicking and choosing **Net Highlight On** to highlight a net through hierarchy in a different color. Any iNets in layout for these nets are also highlighted in this color.
- **Create a bus net** by selecting a wire, right-clicking and choosing **Create BusNet**.
- **Edit net properties** by selecting a wire, right-clicking and choosing **Edit Net Properties** (circuit schematics only).
- **Disconnect an element** by **Ctrl**-clicking the element and dragging it to disconnect it from adjacent elements (wires are deleted).
- **Move an element orthogonally only** by **Shift**-clicking an element while dragging it to constrain its movement to horizontal and vertical directions from the original position.

Custom Symbols

- **Create a custom symbol** using the Symbol Editor. Choose **Project > Circuit Symbols** to view the available symbol options.
- **Create a custom symbol for a subcircuit** using the **AWR Symbol Generator Wizard** located under the **Wizards** node of the Project Browser. These symbols can place nodes based on the schematic or layout representation of your subcircuit.

Element Selection

- **Restricted selection:** Right-click anywhere over a circuit schematic or system diagram with nothing selected and choose **Restrict Selection** to display a Restrict Selection dialog box to turn on or off different items for selection. When items are turned off they cannot be selected for the following operations.
- Click a model to select that element.
- **Shift**-click to **select multiple models** or remove models from those selected.
- Click and drag to **select all objects completely inside your drawn selection area**.
- **Shift**-click and drag to include in your selection all elements that are partially enclosed in your drawn selection area.
- Press **Ctrl-A** to select all objects.
- If elements overlap, **Ctrl**-shift-click to cycle through the elements.

Element Symbols on Schematics/System Diagrams

Select an element and right-click its symbol (not the parameter text) to display a menu to:

- **Edit element properties/parameters** in the Element Options dialog box.
- **Toggle enable or disable** of selected elements.
- **Swap** an element with another element.

- **Rotate** or **flip** selected elements.
- Change the view (**Zoom In/Out, View Area, View All**).
- Display the **Help** for the element.

Helpful Operations

- **Unit Modifiers:** Add the following standard unit modifiers to element models to simplify the entry of model parameters: a, f, p, n, u, m, c, d, mil, k, meg, g, t. These modifiers follow SPICE rules: they are not case sensitive, they must follow the number directly without a space in between, and any characters directly following the modifier are ignored.
- **Edit parameters in a schematic:** Double-click a model parameter within the schematic to display a text box. Press **Tab** to move to the next parameter and **Shift-Tab** to move to a previous parameter.
- **Edit the same parameter for many elements:** Select all of the elements to edit, right-click any of the elements and choose **Properties**. All common model parameters can be edited at once.
- **Replace an element:** Double-click the model name and type in a new name. For example, double-click "RES" and type "CAP" to replace a resistor with a capacitor.
- **Replace many elements:** Select all of the elements to replace, then in the Element Browser find the element with which to replace them. Right-click that model and choose **Replace Schematic Selection.** The **Preserve Parameters** option retains any common model parameter values while **Replace Parameters** uses the model's default parameters (this is useful when replacing with library elements).
- **Make a vector instance:** edit the ID and add the iteration count, for example change "ID=R1" to "ID=R1[0:3]" to make four resistors for simulation and layout.
- **Change element layout:** In the Element Options dialog box for each element, **Symbol** and **Layout** tabs allow changes to the element symbol and layout.

Tuning

-  **Tune Tool:** Click on a variable or parameter to make it tunable.
-  **F9:** Open the Variable Tuner with controls for each tunable parameter, or click the **Tune** button on the toolbar.
- Press the **Shift** key while tuning to **start a simulation** only when you release the mouse button.
- Press the **Ctrl** key while tuning to **update the layout at every tuner point** instead of when you release the mouse button.
- With the Variable Tuner open, click on the square at the top right of an item being tuned to **turn off an item for tuning**.
- If an element parameter is set for tuning but the element has not been constrained, the upper tuning limit is 2X the nominal value and the lower tuning limit is 0.5X the nominal value. You can change this by **setting constraint limits on each parameter**. If a parameter has constraints, those values are used as the tuning limits.

LAYOUT

Shortcuts for Common Items

Hot Key	Description
Ctrl-T	Add text
Ctrl-A	Select all
Ctrl-E	Draw ellipse
Ctrl-L	Draw path
Ctrl-P	Draw polygon
Ctrl-B	Draw rectangle
Ctrl-G	Toggle grid snap
Ctrl-O	Toggle orthogonal mode
Ctrl-D	Start measure tool

Common Operations

- **Coordinate Entry:** While drawing a rectangle, polygon, or path, or while dragging an object or placing a cell, press **Tab** or the **Space Bar** to specify a location using relative or absolute coordinates.
- **Snap Shape:** Press **Ctrl** to snap the mouse to endpoints, midpoints, and edges during dragging, moving, stretching, and measuring operations.

Layout Selection

- **Restricted selection:** Right-click anywhere over a layout with nothing selected and choose **Restrict Selection** to display a Restrict Selection dialog box to turn on or off different items for selection. When items are turned off they cannot be selected for the following operations.
- Click a shape to **select a shape**.
- Press **Shift** to **select multiple objects** or remove objects from those selected.
- Press **Ctrl-Shift** when **selecting a shape that overlaps other shapes** to cycle through the overlapping shapes.
- Click and drag to **select all objects inside your drawn selection area**.
- **Shift**-click and drag to include in your selection all objects that are partially enclosed in your drawn selection area.
- Press **Ctrl-A** to select all objects.
- Choose **Layout > Layout mode properties** to specify manual or auto-selection. **Auto select** selects any item clicked. **Manual select** requires a **Shift**-click to select and deselect objects.

Helpful Operations

- **Aligning Shapes:** Select all shapes to align, then choose **Draw > Align Shapes** to view alignment options. Note that the first item selected is the reference point for the alignment.
- **Boolean Operations:** Select all the shapes for the Boolean operations (AND,OR,XOR, etc), and choose **Draw > Modify Shapes** to view the operators.

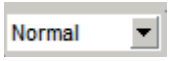
Measuring Distances

- **Temporary ruler:** Display a temporary ruler to measure a distance when you click and drag. Choose **Draw > Measure**, press **Ctrl-D**, or click the **Measure** button on the toolbar button to activate. When you release the mouse button the ruler goes away.
- **Layout ruler:** Display a set layout ruler to measure a distance when you click and drag. The layout ruler remains on the screen and has configurable properties. Choose **Draw > Layout Ruler** or click the **Ruler** button on the toolbar to activate. To configure ruler properties select the ruler, right-click and choose **Shape Properties**.
- **Dimension line:** Display dimension lines that show the distance between two selected points when you click and drag. Choose **Draw > Dimension Line** to activate. To configure dimension line properties, select the line, right-click and choose **Shape Properties**.

Layout Modes

Layout modes allow you to configure different layout settings and then easily switch amongst them while working in the Layout Editor (such as layer visibility, selection filters, drawing dim, and many more).

- **Layout Mode Setup:** To set up different layout modes, in a Layout window, choose **Layout > Layout Mode Manager** to open the Layout Mode Properties dialog box. Click **Edit** to view the Layout Editor Mode Setting dialog box with separate tabs and options for controlling different layout modes.
- **Layout Mode Selection:** In a Layout window, click the **Layout Editor Mode** toolbar button to quickly select different layout modes.



Routing MTRACE2, MCTRACE or MTRACEM Elements

- Double-click the cell to display "drag handles".
- When the cell is a straight line, drag the middle handle to add a "dogleg" bend.
- Drag the endpoints to stretch or shrink the trace.
- With one or more bends, press **Ctrl** and drag a "midpoint" handle to add another bend.
- Press **Ctrl** and drag an endpoint to change the angle of the last bend.
- Drag a "midpoint" handle to stretch the trace while maintaining a constant length.
- Press **Shift** and drag a "midpoint" handle to stretch the trace without maintaining a constant length.

- To redraw the trace from scratch, double-click on either end point. Click to place vertices, and double-click again to finish the trace. The entire trace must be re-routed; a segment cannot be added from pin2.

Stretching Layout Shapes

- Drag corner handles to stretch orthogonally.
- Start dragging the element, then press **Shift** and drag the corner handles to stretch without angle snap.

GRAPHS

Shortcuts for Common Items

Hot Key	Description
Ctrl-F	Freeze traces
Ctrl-U	Clear frozen traces
Ctrl-M	Add marker

Common Tasks

- **Save data from a graph** to a text file by choosing **Graph > Export Trace Data**.
- **Add a measurement on a graph** by right-clicking the graph and choosing **Add New Measurement**.
- **Modify a measurement on a graph** by right-clicking the graph and choosing **Modify Measurements**.
- **Change measurement order** in a graph by selecting the measurement in the Project Browser, then pressing **Alt** and using the up and down arrow keys on your keyboard.

Tabular Graphs

- **Change the display precision of tabular graph numbers** by right-clicking the graph and choosing **Properties** to display the Tabular Graph Format dialog box to specify options.
- **Change column header text** by right-clicking the graph and choosing **Properties** to display the Tabular Graph Format dialog box to change the display for each measurement.

Rectangular Graphs

- **Limit the axes of a rectangular graph** after the simulation is complete by right-clicking and choosing **Zoom Data**, and then clicking and dragging to define the area you want magnified. If you click and drag over the x-axis of the graph, this operation zooms only in the x-direction.
- **Reset the axis limits** by right-clicking and choosing **Restore Axis Setting**.

Markers

- Marker options are dependent on the type of graph. Most graphs support markers. Right-click a marker to view marker options.
- **Marker Reference:** Any other markers attached to the same trace show a delta value from the reference marker.
- **Search:** Search for values of the trace.
- **Rectangular Graphs:** Search for min and max values of the trace.
- **Rectangular Graphs:** Add horizontal and vertical line markers.

ELECTROMAGNETIC STRUCTURES

The AWRDE has its own EM simulator called EMSight. The AWRDE also has a socket for plugging 3rd-party EM tools into the environment.

User Interface

- In an EM structure window, click the **Layout** tab in the lower left to access controls for drawing and viewing EM structure layout objects in the Layout Manager.
- By default, the **Drawing Layers** pane is hidden from view and only the cross-section view displays. To display the **Drawing Layers**, click and drag on the bottom of the cross-section view window to expose this window.

Viewing Mesh, Currents, and E-Fields

(For simulation in EMSight) Currents and e-fields are viewed in the 3D view of an EM structure, while mesh can be viewed in the 2D or 3D view. These are added as annotations. To **add mesh, currents, and E-fields**, right-click the EM Structure in the Project Browser and choose **Add Annotation** to modify settings in the Add Annotation to the EM Structure dialog box.

Simulation Considerations

The following are general guidelines applicable to simulation in EMSight. If you are not comfortable with these, you should do simple experiments with your specific process technology so you can vary each of the following and compare results.

- **De-embedding distance:** You should de-embed 2X your substrate height or 2X your line width, whichever is greater.
- **Spacing to the sidewalls:** The sidewalls in EMSight are perfect ground, so you should space any lines at least 2X your substrate height from the edge. For antennas, you should probably space even further than this.
- **Top and bottom settings:** For a walk-through of these issues, see the example named *EM_top_and_bottom_enlcosure_effects.emp* by typing this name in the Open Example Project dialog box (choose **File > Open Example**).
- **Types of ports:** To understand the different types of ports, see the example named *EM_Ports.emp* by typing this name in the Open Example Project dialog box (choose **File > Open Example**).

EQUATIONS

- You can display the value of any equation by typing the name of the equation followed by the **:** symbol. When you simulate or press **F6** the variable will update to display the stored value of the variable.
- You can add multiple equations in one equation block. While typing an equation press **Ctrl+Enter** to create a new line in the equation.

Below is a list of all the function names used in the AWRDE. Please see the full documentation for a description of each function

Function	Function	Function	Function
_FREQ	_FREQH1	_FREQH1	_FREQH3
_TEMP	_TEMPK	abs(z)	acos(x)
acosh(x)	amax(x)	amin(x)	angle(z)
ans=x mod y	asin(x)	asinh(x)	asize(x)
assign_sweep(x, y)	assign_swpunit(x, unitType)	asum(x)	atan(x)
atan2(x, y)	atanh(x)	awg_dia(x)	bin(str)
ceil(x)	cint(x)	col()	complex(real, imag)
concat(a, b)	conj(z)	cos(x)	cosh(x)
cstr(x)	csum(x)	ctof(x)	ctok(x)
data_file(name, type, args)	DataFile(name, "c")	db(x)	db_pow(x)
dbpolar(dbMag, ang)	deg(x)	der(x, y)	exp(x)
fill(n, val)	find_index(x, val)	find_index_range(x, val1, val2)	floor(x)
fmod(x,y)	ftoc(x)	ftok(x)	heaviside(x)
hex(str)	histogram(x, bin_type)	hypot(x,y)	if(cond, trueval, falseval)
imag(z)	int(x)	integrate(x)	interp(type, x, y, new_x)
ktoc(x)	ktof(x)	lin(x)	lin_pow(x)
lin_reg(x)	log(x)	log10(x)	max(a, b)
min(a, b)	oct(str)	plot_vs(y, x)	points(start, stop, points)
polar(mag, ang)	pow(x,y)	rad(x)	real(z)
row()	sign(x)	sin(x)	sinh(x)
sqrt(x)	stack(n, vec)	stepped(start, stop, step)	str2dec(str, base)
subsweep(meas, x1, x2)	subsweepi(meas, start, count)	swpdec(start, stop, points)	swplin(start, stop, points)
swpoct(start, stop, points)	swpspan(center, span, points)	swpspanst(center, span, step)	swpstp(start, stop, step)
swpunit(x)	swpvals(x)	tan(x)	tanh(x)
transpose(x)	unwrap(x, d)	vfile(name)	vlen(x)