AWRDE QUICK REFERENCE

This file (*AWR_Quick_Reference.pdf*) is accessible within the Applied Wave Research Design Environment (AWRDE) by choosing **Help > Quick Reference**. You can save any document with this name in the AWRDE installation directory to use your own quick reference guide.

ADDITIONAL RESOURCES AVAILABLE

AWR KnowledgeBase: *http://www.appwave.com/download/kb.aspx*

1. Videos - Short videos on how to accomplish specific tasks; longer videos for training on specific topics.

2. Examples - Additional examples not included in the installation.

3. Solution Finders - Step-by-step guides to solve problems (licensing problems, understanding error messages, etc).

4. Application Notes - Articles written by the AWR technical staff to help you understand how to use the software.

5. Frequently Asked Questions (FAQs) - Answers to common customer questions.

6. Visual Basic Scripts - Examples of scripts written by the AWR technical staff.

7. Release Notes - Archive of release notes for previous versions of AWR software.

Example Website: *http://appwave.com/download/examples/default.aspx*

A single listing of all the examples shipped with the AWR installer. This site helps you find the example you are interested in without needing to open all of the examples. The website organization mirrors the organization of the examples in the program, making it easy to locate the example you want to view.

API References: *http://appwave.com/support/apidocs.aspx*

A must-have reference for anyone working with the API for AWR. This website includes a view of all the objects you can control from the API. It also includes an excellent guide to the API with many example of how to access different information.

PROJECT BROWSER AND DESIGN ENVIRONMENT

Design Environment

Use these keystrokes from anywhere in the AWRDE:

Hot Key	Description
F7	Opens the Optimizer dialog box window
Shift-F7	Displays a list of all variables used in a project
F8	Simulate
Ctrl-S	Saves a project
F9	Opens the Tuner
Ctrl-Tab	Cycles through AWRDE windows in one direction
Ctrl-Shift-Tab	Cycles through AWRDE windows in the opposite direction

Most actions can be customized to create your own hot key, toolbar button, or menu option. Choose **Tools > Customize** to add your own customizations.

Zooming and Scrolling

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

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

Project Browser

- **Open** an item: Double-click items to open them.
- **Add/Delete/Rename**: Right-click items to Add/Delete/Rename, Import/Export, Collapse/Expand, Link to, view an Options dialog box and more.
- **Model views** (while the **Elements** tab is active): Right-click in the lower window to change the model display. One of the most useful settings is the **Show Details** view.
- **Create an output equation identical to a measurement** by dragging and dropping a measurement into an Output Equations window.
- **Create a Window-in-a-Window** by dragging and dropping from the Element Browser to an active window.
- **Add a subcircuit or a layout to a schematic window** by right-clicking and then dragging and dropping a schematic.
- **Copy an item** by dragging it up to its parent category and dropping it (schematics/system diagrams, data files, EM structures, graphs and measurements only).
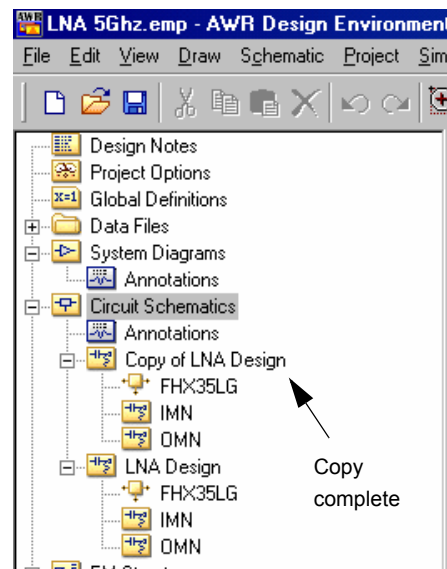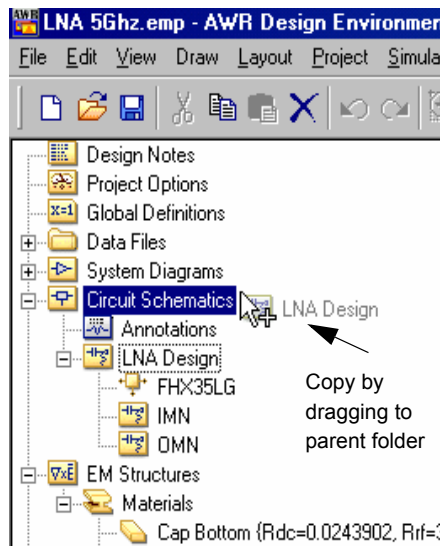
CIRCUIT SCHEMATIC / SYSTEM DIAGRAM

Shortcuts for common items:

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
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-T	Add text
Ctrl-A	Select all

Placing an Element

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:

Hot Key	Description
Right-click	Rotate counter-clockwise 90-degrees per click
Ctrl-Right-click	Rotate about the Y-axis
Shift-Right-click	Rotate about the X-axis

Note that all of the Zoom commands also work while placing an element.

Schematic / Diagram Connectivity

- **Create a wire**: Hovering over a model node changes the cursor to the wire tool. Left-click to start wiring.
- **Start a wire from the middle of another wire or node**: right-click to select wire and then choose **Add Wire**.
- **Remove a previous point:** Right-click while adding a wire to remove its previous point.
- **Show direction:** After starting a wire, the wire draws differently depending on the location of the cursor relative to the starting point.
- **Auto Wire Deletion**: When an element is deleted, by default the wires connected to it are also deleted. The auto deletion of dangling wires is a user-selectable option by choosing **Options > Project Options > Schematic/Diagrams > Auto wire cleanup.**
- **Net Highlight**: Select a wire, right-click and choose **Net Highlight On** to highlight a net through hierarchy in a different color.
- **Create Bus Net**: Select a wire, right-click and choose **Create BusNet**.
- **Edit Net Properties**: Select a wire, right-click and choose **Edit Net Properties** (circuit schematics only).
- **Disconnect an Element**: Press **Ctrl** and left-click on the element and then drag it to disconnect it from adjacent elements (wires are deleted).
- **Move an element orthogonally only**: Click on an element and press **Shift** while dragging the element to constrain its movement to horizontal and vertical directions from the original position.

Element Symbols

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

- **Edit element properties/parameters** (opens the Element Options dialog box)
- **Enable or disable selected elements**
- **Swap** an element with another element
- **Rotate** or **Flip** selected elements

- Change the view (**Zoom, View Area, View All**)
- Select the element in the **Layout View**
- Display the **Help** for the element

Element Selection

- **Restrict Selection:** Right-click anywhere over a circuit schematic or system diagram with nothing selected and choose **Restrict Selection** to display a dialog box to turn on or off different items for selection. When items are turned off for selection, those items are not selected with the following operations.
- Left-click a model to **select** that element.
- Hold down the **Shift** key to **select multiple models** or remove models from those selected.
- Left-click and drag to **select all elements inside your drawn selection area**.
- **Shift**-click and drag to **select all elements that are at least partially inside your drawn selection area**.
- Press **Ctrl-A** to **select all objects**.
- If elements overlap, **Ctrl-shift-click** cycles through the elements.

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 over a model parameter within the schematic to display a text box. Use the **Tab** key to move to the next parameter and **Shift-Tab** to move to a previous parameter.
- **Edit same parameter of many elements:** Select all of the elements to edit, right-click over any of the elements and choose **Properties**. All common model parameters can now be edited at once.
- **Replace an element**: Double-click on 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 on that model and choose **Replace Schematic Selection**. The **Preserve Parameters** option retains any common model parameter values. **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.
- 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.
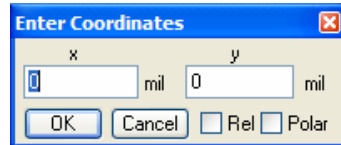
LAYOUT

Shortcuts for Common Items

Hot Key	Description
Ctrl-C	Copy selected item
Ctrl-X	Cut selected item
Ctrl-V	Paste selected item
Ctrl-Z	Undo last operation
Ctrl-T	Add text
Ctrl-A	Select all
Ctrl-E	Draw ellipse
Ctrl-L	Draw path

Hot Key	Description
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** to specify a location using relative or absolute coordinates.

- **Snap Shape:** Hold down **Ctrl** to snap the cursor to endpoints, midpoints, and edges during dragging, moving, stretching, and measuring operations.

Layout Selection

- **Restrict Selection:** Right-click anywhere over a layout and choose **Restrict Selection** to display a dialog box to turn on or off different items for selection. When items are turned off for selection, those items are not selected during the following operations.
- Left-click over a shape to **select** that shape.
- Hold down the **Shift** key to **select multiple objects** or remove objects from those selected.
- Hold down the **Shift-Ctrl** keys while **selecting a shape that overlaps other shapes** to cycle through the overlapping shapes.
- Left-click and drag to **select all objects inside your drawn selection area**.
- **Alt**-click and drag to **select all objects inside your drawn selection area except the object under the first click**.
- **Shift**-click and drag to **select all objects that are at least partially inside your drawn selection area**.
- Press **Ctrl-A** to **select all objects**.
- **Layout mode properties** under the **Layout** menu alters the selection mode between manual and auto-select. Auto-select selects any item you click on. Manual select requires the **Shift** key to select and deselect.

Helpful Operations

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

Measuring Distances

- **Measuring distances**: Display a temporary ruler to measure a distance when you click and drag. Choose **Draw > Measure,** the hotkey **Ctrl-D,** or the **Measure** 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 the **Ruler** toolbar button 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.

- **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, use the Layout Editor Mode toolbar button to quickly select different layout modes.

Routing MTRACE2, MCTRACE or MTRACEM Element:

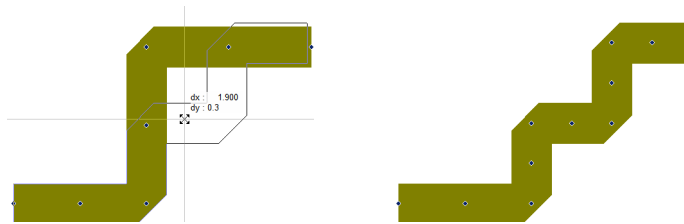- Double-click the cell to display "drag handles".

- When the cell is a straight line, drag the middle handle to add a "dogleg" bend.
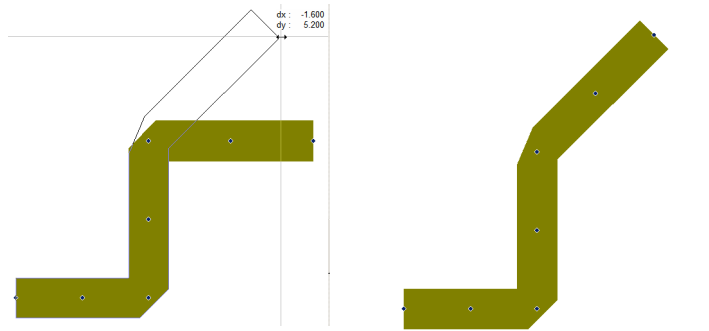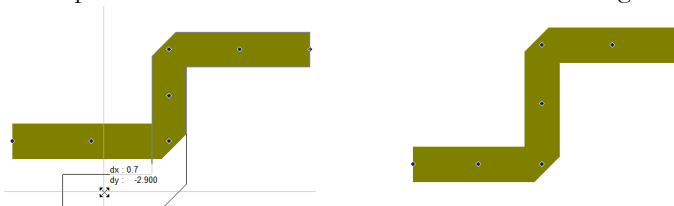
- Drag the endpoints to stretch or shrink the trace.

- With one or more bends, hold down **Ctrl** and drag a "midpoint" handle to add another bend.

- Hold down **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.

- Hold down **Shift** and drag a "midpoint" handle to stretch the trace *without* maintaining a constant length

- To redraw the trace from scratch, double-click the first endpoint (pin1, marked with a triangle). Click to place vertices, and double-click again to finish the trace. Note that the trace must be routed from only pin1 and the initial segment during a re-route must go in the same direction as the original initial segment; the entire trace must be re-routed, i.e. a segment can not be added from pin2. Click to place vertices, and double-click again to finish the trace. Pin 1 is denoted by a blue triangle on the layout.
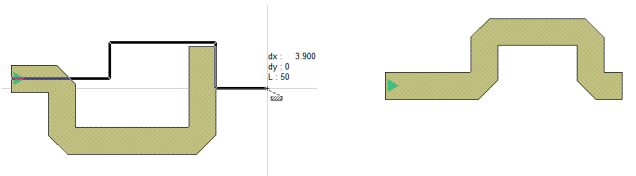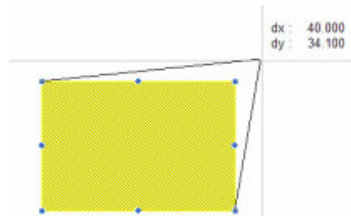
Stretching Layout Shapes

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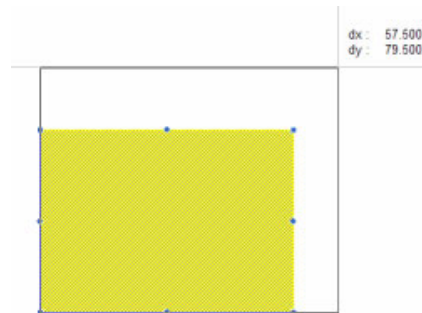
- Start dragging the element, then press **Shift** and drag the corner handles to stretch without angle snap.

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.**
- **Modify a measurement on a graph** by right-clicking over the graph and selecting **Modify Measurements**.
- **Change measurement order** in a graph by selecting the measurement in the Project Browser, holding down **Alt** and using the Up arrow and Down arrow keys on your keyboard.

Tabular Graphs

Change the display precision of tabular graph numbers by right-clicking over the graph and choosing **Properties** to display the Tabular Graph Format dialog box to specify options.

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 depend on the graph type. Most graphs support markers. Right-click a graph and choose **Add Marker** to add a marker. Right-click over a marker to view marker options.

Make 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 also allow a **search for min and max values** of the trace and the addition of more horizontal and vertical markers.

ELECTROMAGNETIC STRUCTURES

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

User Interface

With an EM structure window active, click the **Layout** tab in the lower left window to access controls for drawing and viewing EM structure layout objects.

By default, the Drawing Layers window is hidden 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 the Drawing Layer display window.

Viewing Mesh, Currents, and E-Fields

The following references apply only to 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 on the EM Structure in the Project Browser and choose **Add Annotation**.

Simulation Considerations

The following references apply only to simulation in EMSight.

The following are general guidelines. 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 will probably want to 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" located in the AWR Knowledge Base.
- **Types of ports:** To understand the different types of ports, see the example named "EM_Ports.emp" located in the AWR Knowledge Base.

EQUATIONS

- See the "Equation Syntax" section of the "Variables and Equations" chapter in the *MWO/AO User Guide* for a complete list of allowed **equation syntax**.
- To **view the value of a variable**, make a new equation which contains the variable name followed by a colon (**:**). For example, type the two equations X=2*4., X:. After you simulate, the second equation reads X:8.
- For any equation that is a variable (it is in the form of Var = Num, where Var is a variable name and Num is any number), you can **change the properties of the variable to use it for tuning, optimization and yield analysis**. Select the variable, right-click and choose **Properties** or press **Shift** and double-click the equation.
- You can **pass parameters to subcircuits** (although the layout is not parameterized). To define a parameter to pass to a schematic, create an equation in the schematic using << instead of an equal (=) sign. For instance, if you create a schematic that includes the equation X<<10., when you drop that schematic into another schematic as a subcircuit, it has the parameter X=10. (where 10 is the default value) and you can assign any value to X to pass to the subcircuit.
- If the parameter does not affect layout, select **Does not effect layout** in the Properties dialog box. If all parameters of a subcircuit have this property, the layout displays for the subcircuit.