

# **Productivity Toolbox User Guide**

## **Polar Grid Utilities**

**February 2017**

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# 1 Introduction

In some applications (e.g. medical, automotive) not only the boards have a circular outline also placement and routing has to be done in a circular fashion. Doing these kinds of boards on the basis of a cartesian grid is time consuming and cumbersome.

**Polar Grid Utilities** is a toolkit that is exactly dedicated to this kind of application. Besides the capability to define a polar grid, it offers additional functions such as polar placement, polar routing and polar shapes including voids.

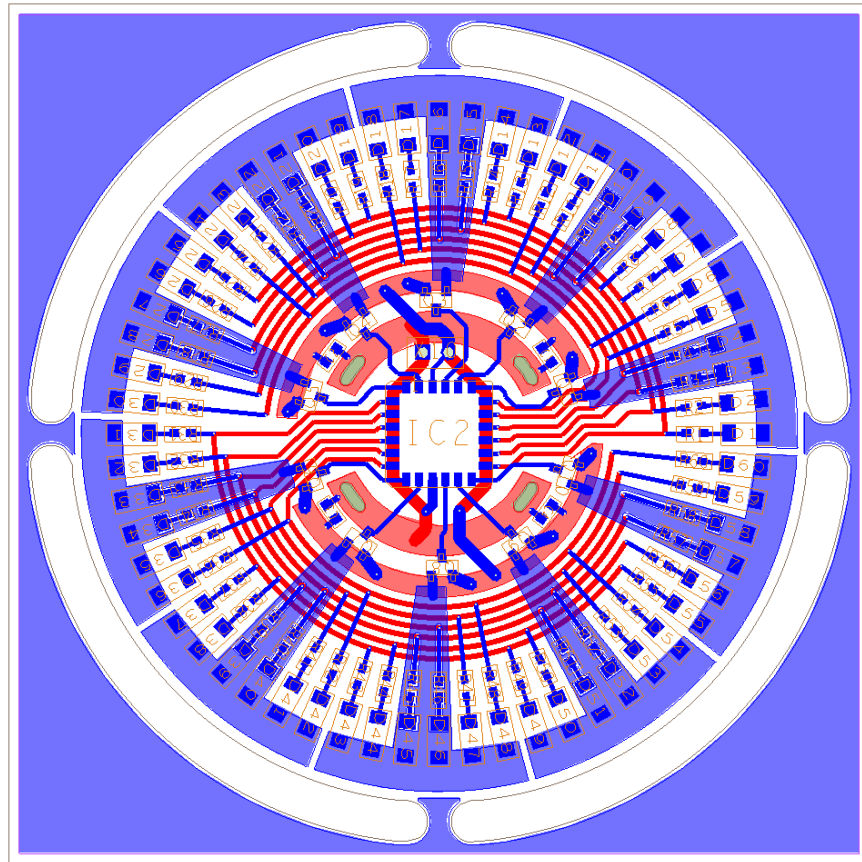


Figure 1: PCB with circular placement and routing

**Polar Grid Utilities** has the following features

- *Polar grid setup*
  - Define a new grid or update an existing grid
  - Support for coarse and fine grid
  - Fully parameterized
    - Angular settings
    - Radial settings
    - Support for coarse and fine grid
  - Grids are stored as format symbol in board database
    - Ability to move/copy
    - Ability to export for reuse purposes
- *Polar placement*
  - Special mode for placing component in circular/radial fashion
  - Snap to fine and/or coarse grid
  - Various alignment capabilities
  - Spinning on polar basis
- *Polar routing*
  - Special mode for drafting or routing in a circular/radial fashion
  - Snap to fine and/or coarse grid
  - Ability to follow radial and angular contour
  - Alternate path options (e.g. *Arc smart*)
- *Polar shapes and voids*
  - Special mode for creating shapes and voids in a polar grid
  - Snap to fine and/or coarse grid
  - Ability to follow radial and angular contour
  - Alternate path options (e.g. *Arc smart*)

The commands *Polar Route*, *Polar Place* and *Polar Shape* and *Polar Shape Void* are completely interactive. Of course the polar grid itself represented by lines or dots can be also used in conjunction with standard *PCB Editor* commands e.g. by using the context menu *Snap pick to -> Intersection*.

**Polar Grid Utilities** is accessible from Pulldown menu by selecting one of the submenu entries.

In the console command window the equivalent calls are

```
tbx polargrid setup
tbx polargrid place
tbx polargrid route
tbx polargrid shape
tbx polargrid void
```

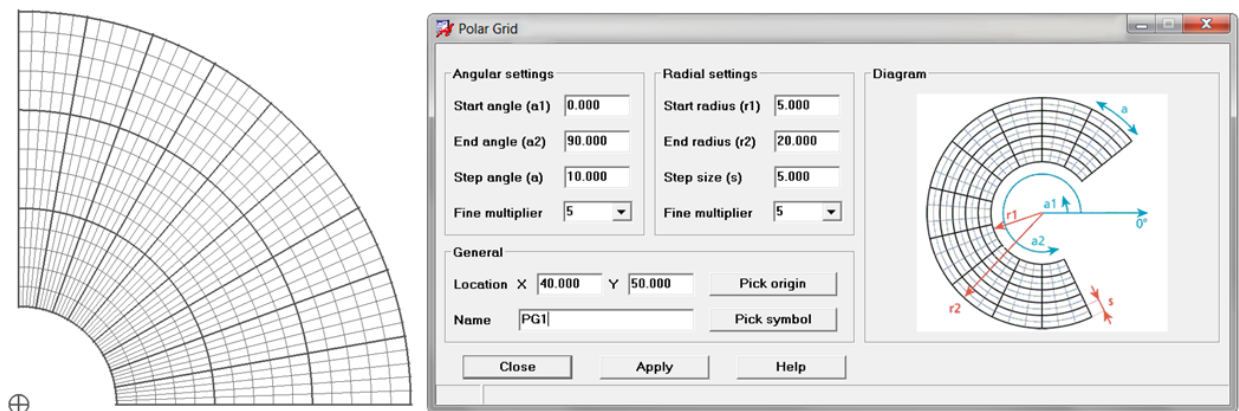
## 2 Polar Grid Setup

First a polar grid needs to be defined. After launching *Polar Grid – Setup Grid* a form appears.

**Figure 2: Polar grid setup, main form**

The procedure is as follows:

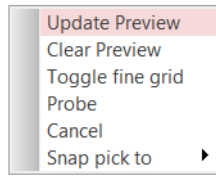
- Enter values for angular settings and radial settings regarding start value, end value and step size for angular and radial settings. These parameters apply to the coarse grid. The values for *Fine multiplier* further specifies fine grid settings by dividing the step values with the multiplier value. For example if *Step angle* is 10.0 degrees and *Fine multiplier* is 5, the fine grid has a resolution of 2.0 degrees.
- Enter coordinates for X and Y which specifies the origin of the polar grid. You may also use *Pick origin* and choose the origin by clicking in the canvas. Once the origin has been specified a dynamic preview will be generated in layout. Parameters can be changed, the preview will be updated and always reflects the current settings.



**Figure 3: Dynamic preview during parameter change**

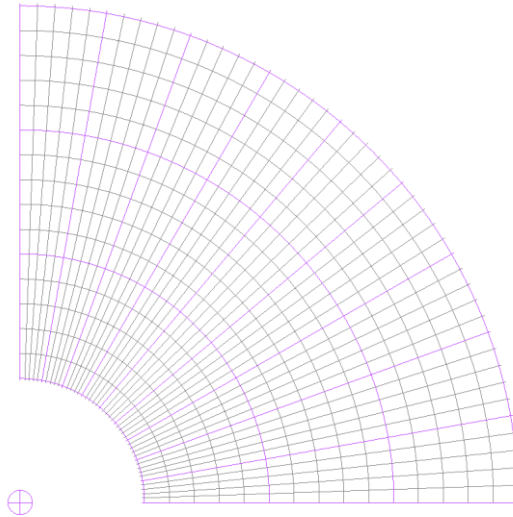
- You may use the context menu in order to
  - Clear the preview

- Update the preview
- Toggle the display of the fine grid



**Figure 4: Polar grid setup, context menu**

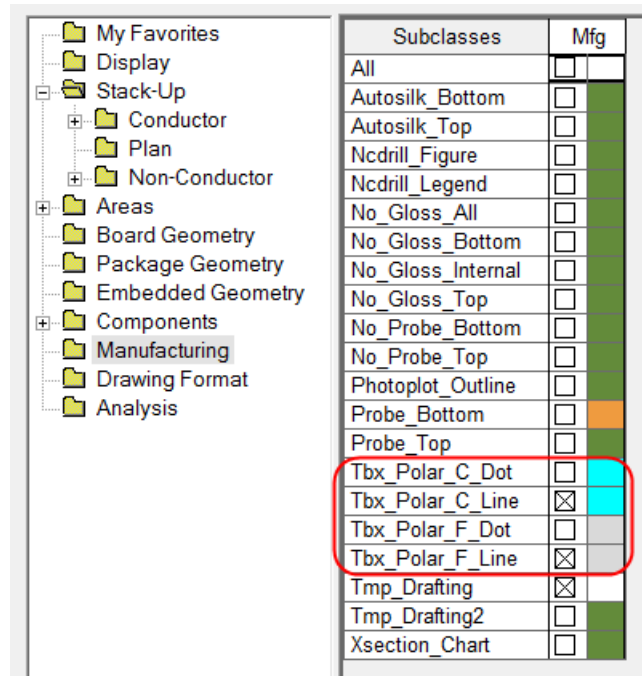
- Enter a name for polar grid.
- Click *Apply*, the final grid will be generated



**Figure 5: Polar grid symbol**

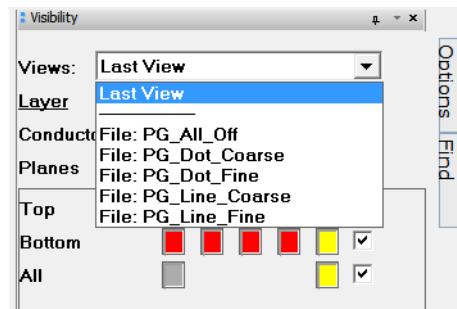
The polar grid is represented by a format symbol with an instance at the specified location. The name is equal to the value specified in the *Name* field. Data is available on 4 different layers:

- |                          |                                       |
|--------------------------|---------------------------------------|
| • Coarse grid line style | <i>MANUFACTURING/TBX_POLAR_C_LINE</i> |
| • Coarse grid dot style  | <i>MANUFACTURING/TBX_POLAR_C_DOT</i>  |
| • Fine grid line style   | <i>MANUFACTURING/TBX_POLAR_F_LINE</i> |
| • Fine grid dot style    | <i>MANUFACTURING/TBX_POLAR_F_DOT</i>  |



**Figure 6: Polar grid system layers**

For usability purposes color views will be generated in the current working directory. These color views can be used to switch on/off certain grid layers while working with *PCB Editor*.



**Figure 7: Polar grid color views**

- *PG\_All\_Off* Switch all polar grid layers off
- *PG\_Dot\_Coarse* Toggle display for coarse grid dots
- *PG\_Dot\_Fine* Toggle display for fine grid dots
- *PG\_Line\_Coarse* Toggle display for coarse grid lines
- *PG\_Line\_Fine* Toggle display for fine grid lines



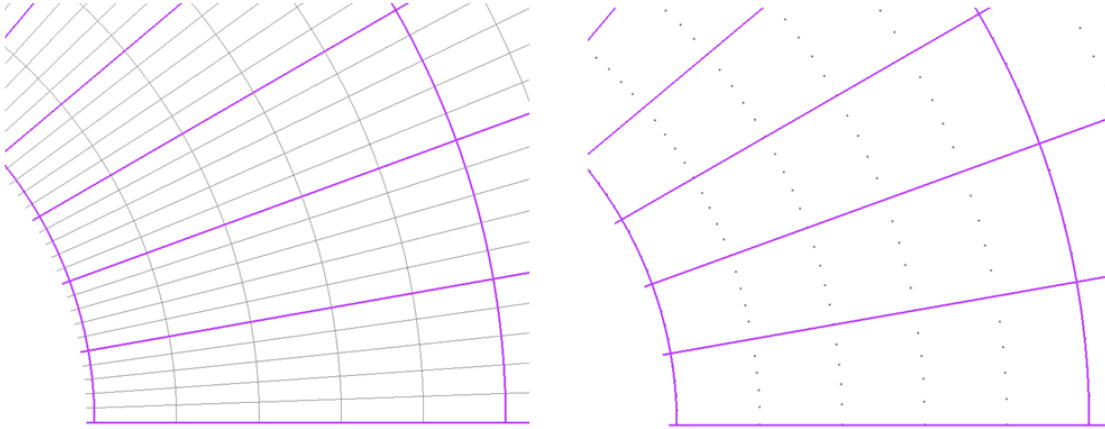


Figure 8: Polar grid styles



Note: Besides the ability to define a new grid it's also possible to edit an existing grid. In that case use *Pick symbol* button and select a polar grid symbol in the layout. The parameters are extracted. You may change the parameters now and select *Apply* to update the existing polar grid symbol.

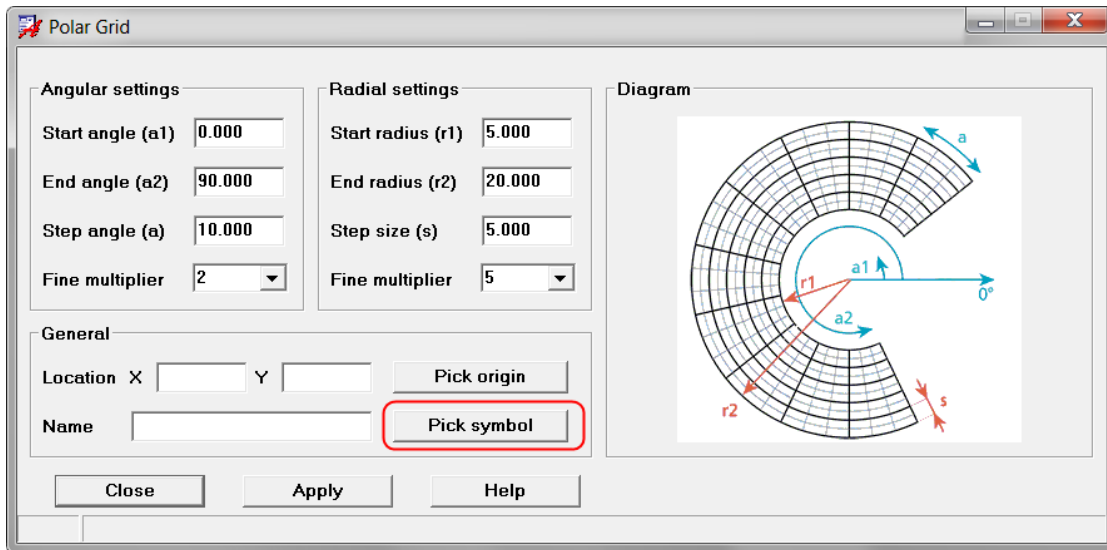


Figure 9: Polar grid setup, edit existing symbol



Note: In the context menu there is a *Probe* command, which lets you also extract parameters from existing symbols. The difference is that *Probe* is only used to derive parameters from a given symbol. The symbol itself is not touched while *Pick symbol* is mainly used for update purposes.



Note: You may have more than one polar grid symbol in the layout database. You can also use the *Edit – Copy* command to copy polar grid symbols.

### 3 Polar placement

The corresponding command for polar placement can be found under *Polar Grid – Place*. Command options are available in *Options* panel.

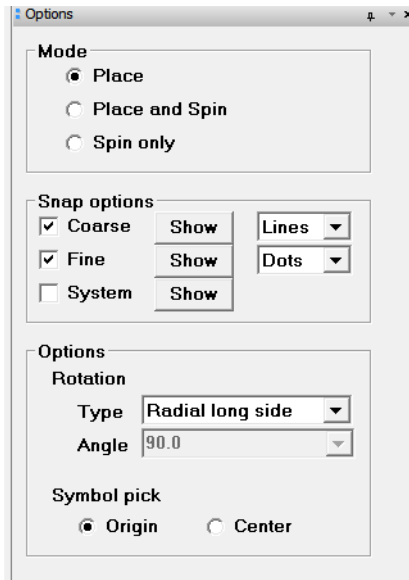


Figure 10: Polar placement options panel

#### 3.1 Placement modes

Polar placement can be driven in three different modes. The use model is completely interactive. In all cases a component needs to be selected first, differences only apply to spin operations:

- *Place*  
The component will be placed at destination location without further action.
- *Place and Spin*  
The component will be placed at destination location first, then user is asked to specify rotation through cursor dynamics.
- *Spin only*  
The selected component will be rotated at the current position through cursor dynamics.

## 3.2 Snap options

In the next section snap options can be specified. Use the corresponding checkboxes if you want to snap to coarse grid, fine grid or system grid.

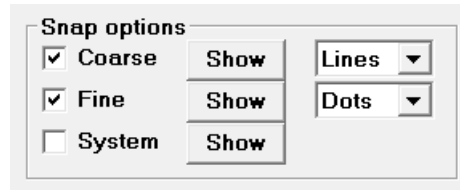


Figure 11: Snap options



Note: Snapping to coarse or fine grid takes places at the moment where you click nearby a polar grid location, not while moving the cursor. This behaviour is slightly different to cursor snapping while working with standard grid.

You may use the *Show* buttons to switch on and off the corresponding grids (toggle functionality). Furthermore you may specify how the coarse and fine grids shall be displayed (lines or dots).



Note: If system grid snapping is enabled, coarse and fine grid snapping will be disabled. Also, when enabling coarse or fine grid snapping, system grid snapping will be disabled.



Note: Snapping control and grid visibility control is handled separately. In other words polar grid layers may be switched on although snapping to polar grid had been disabled. The same behaviour applies to system grid.

## 3.3 Rotation and Alignment

In the following section additional options are provided.

- *Symbol pick*

This option specifies the point that acts as reference location of the component when attached to cursor. The choices are *Origin*, which refers to the origin as defined in the library while *Center* always uses the center of the component.

- *Rotation*

This option applies to component alignment with respect to current position in the polar grid. The available entries are different between *Place* mode on one side and *Place and Spin* and *Spin only* mode on the other side.

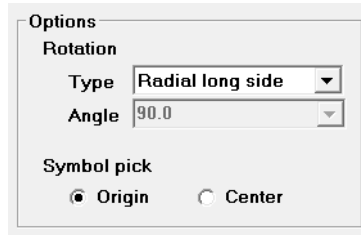


Figure 12: Polar placement options

In *Place* mode four different rotation options are available:

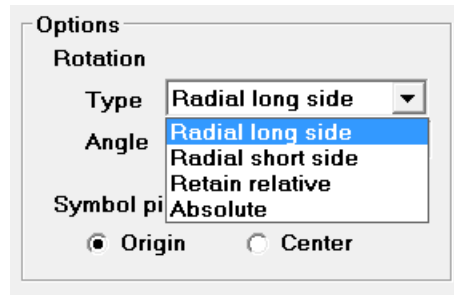


Figure 13: Polar placement alignment

- *Radial long side*

The rotation will be adjusted so that the angle of the longest side lies on the radial axis.

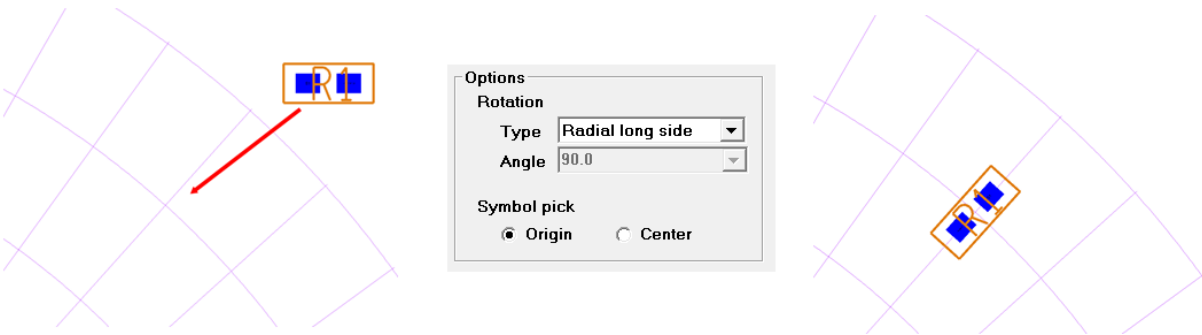


Figure 14: Radial long side rotation

- *Radial short side*  
The rotation will be adjusted so that the angle of the shortest side lies on the radial axis.

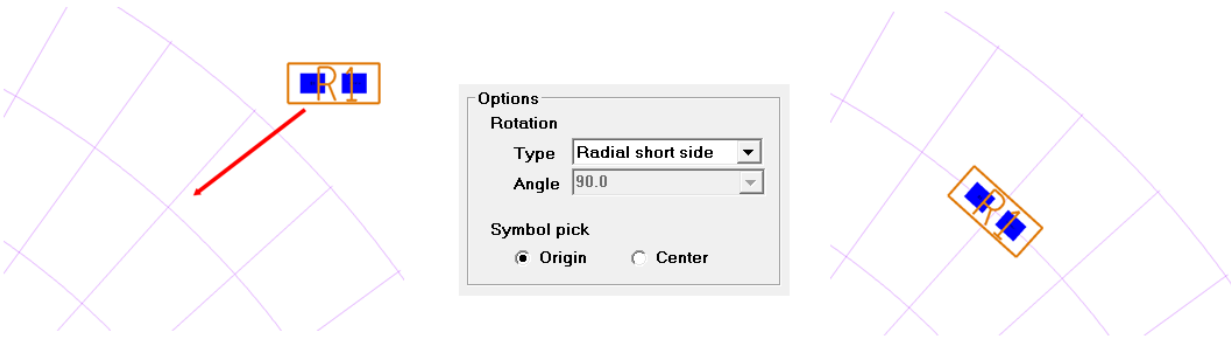


Figure 15: Radial short side rotation

- *Absolute*  
The rotation is fixed and can be specified in Angle field.

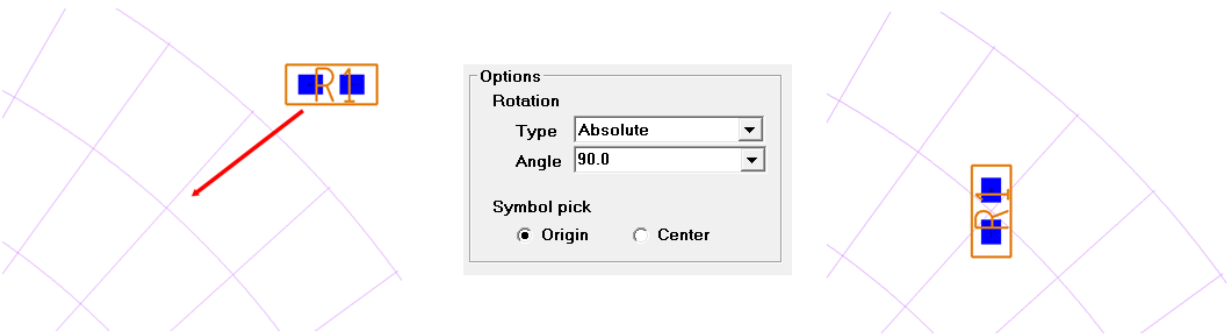
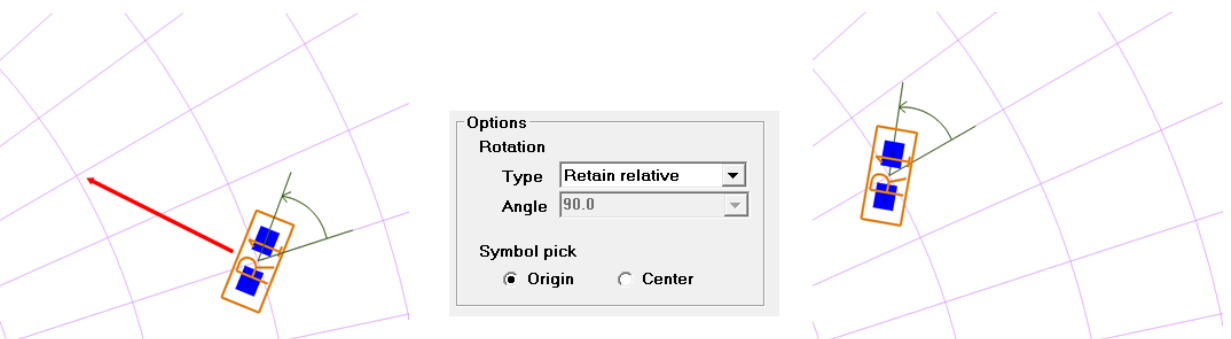


Figure 16: Absolute rotation

- *Retain relative*  
The current rotation will be retained. This option is useful if the initial relative rotation is not allowed to be changed when moving the component from one grid location to another.



Note: The green angle marker is just for illustration purposes and shows that the relative angle will not change.

In *Place and Spin* mode as well as in *Spin only* mode, the rotation options are different because rotation is now driven by user through cursor dynamics.

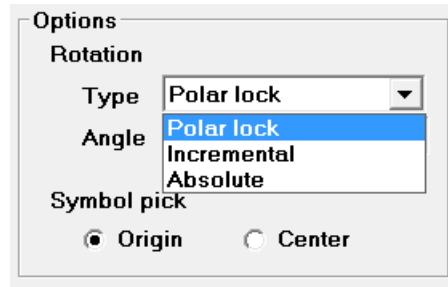


Figure 17: Polar lock option

- *Polar lock*  
This is the default option when spinning a component in a polar grid. The cursor locks to 90 degree increments relative to the radial grid angle at the current location.

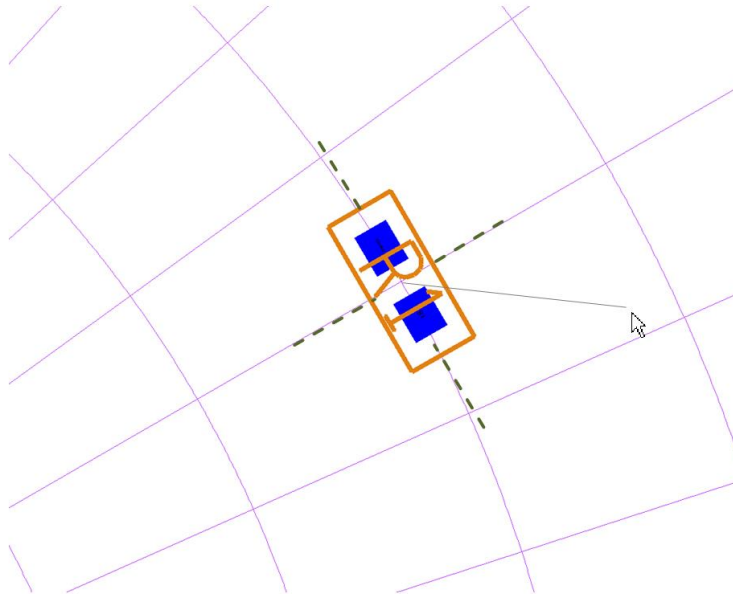


Figure 18: Polar lock example

- *Incremental*  
This option is identical to standard PCB Editor spin command
- *Absolute*  
This option is identical to standard PCB Editor spin command

## 4 Polar route

The corresponding command for polar routing can be found under *Polar Grid – Route*. Command options are available in *Options* panel.

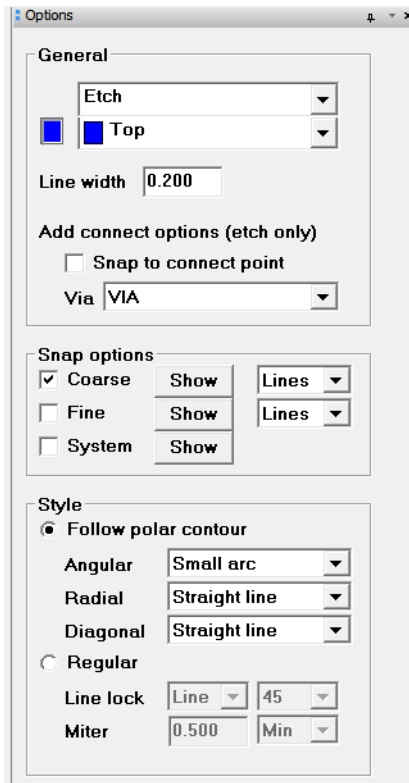


Figure 19: Polar route options panel

Basically there is no difference between routing lines on etch and non-etch layers. The underlying mechanism is the same. You simply specify the corresponding layer in the *Options* panel. However in case of etch layers there is an option *Snap to connect point* which is useful if you want to start routing from a pad, via or cline.



Note: If *Snap to connect point* is enabled, snapping to pin, vias and clines has highest priority. For example if a pin and a polar grid snap point are very close to each other the tool will always snap to the pin first.



Note: Values for line width and via padstack to be used need to be entered manually. Design rules are not honoured at this stage.

### 4.1 Snap options

Refer to section on page 8 for more details.

## 4.2 Style options

In this section the routing style can be further specified.

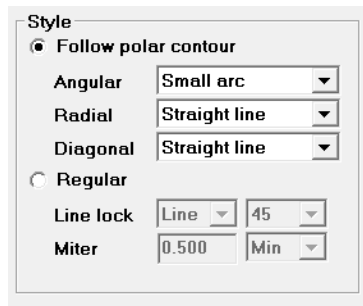


Figure 20: Polar route style options

There are two modes

- *Follow polar contour*  
The traces will follow the radial and angular lines of the polar grid. Special settings apply and are discussed below.

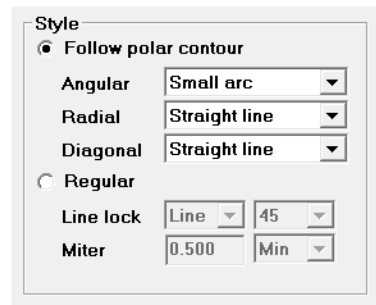
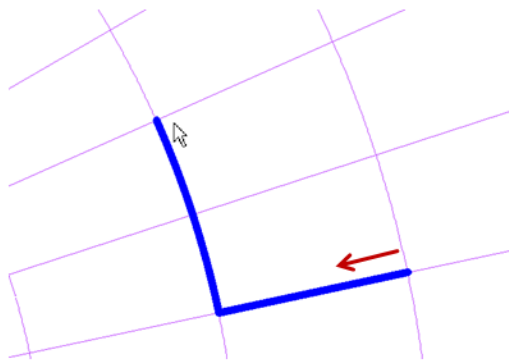


Figure 21: Follow polar contour mode

- *Regular*  
Line locking is more or less identical to standard routing command. This includes lines (off angle, 45 degrees and 90 degrees) with miter settings and arcs (off angle, 45 and 90 degrees) with radius settings.

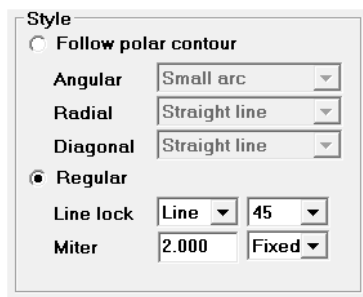
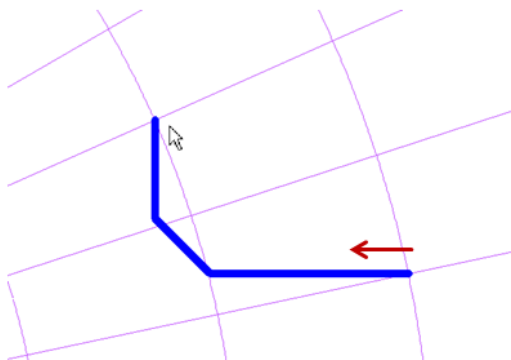
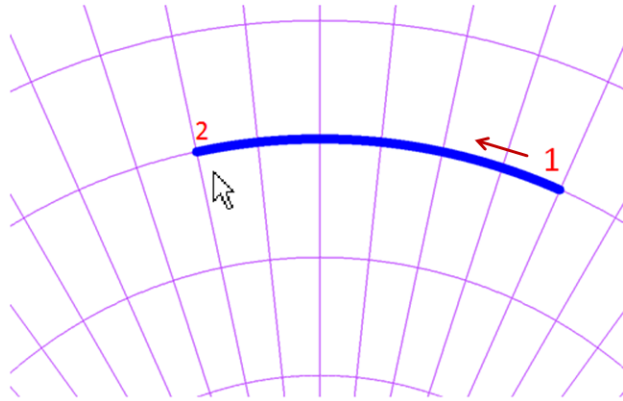


Figure 22: Regular route mode

In *Follow polar contour* mode we basically distinguish between three types of transitions

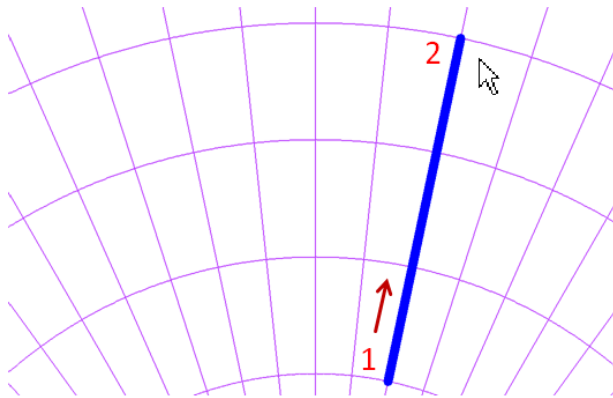


- *Angular*  
The radius of current and last polar grid location (pick) with respect to polar grid origin is identical.



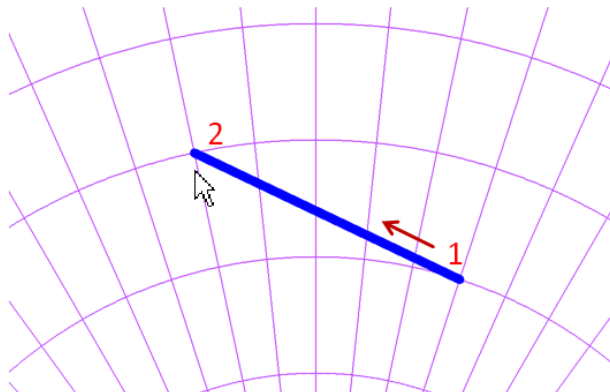
**Figure 23: Angular transition**

- *Radial*  
The angle of current and last polar grid location (pick) with respect to polar grid origin is identical.




**Figure 24: Radial transition**

- *Diagonal*  
Angle and radius of current and last polar grid location (pick) are different.



**Figure 25: Diagonal transition**

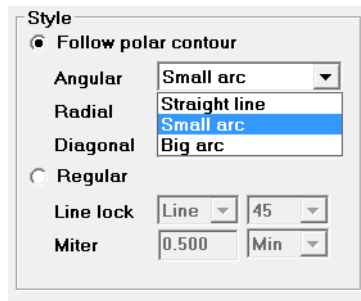


Note: While moving the cursor a dynamic rubber band is attached to cursor. This rubber band is always displayed as straight line, and does not reflect the actual style. The path structure according to style options is generated at the moment, when the user has specified next pick through left mouse button.

For each transition there an alternate style can be chosen

### 4.2.1 Angular transition styles

For angular transition there are three options



**Figure 26: Angular transition styles**

- **Small arc**

Always the small arc path will be drawn between first and second point.

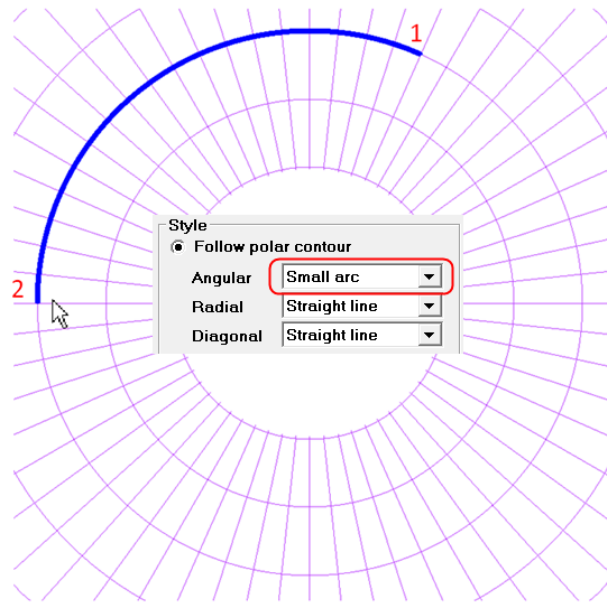


Figure 27: Small arc angular transition

- **Big arc**

Always the big arc path will be drawn between first and second point.

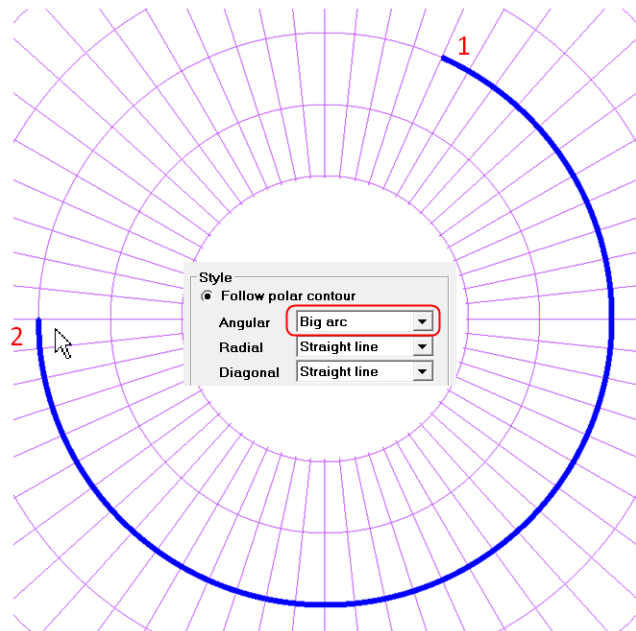


Figure 28: Big arc angular transition

- **Straight line**

A straight line will be drawn between first and second point.

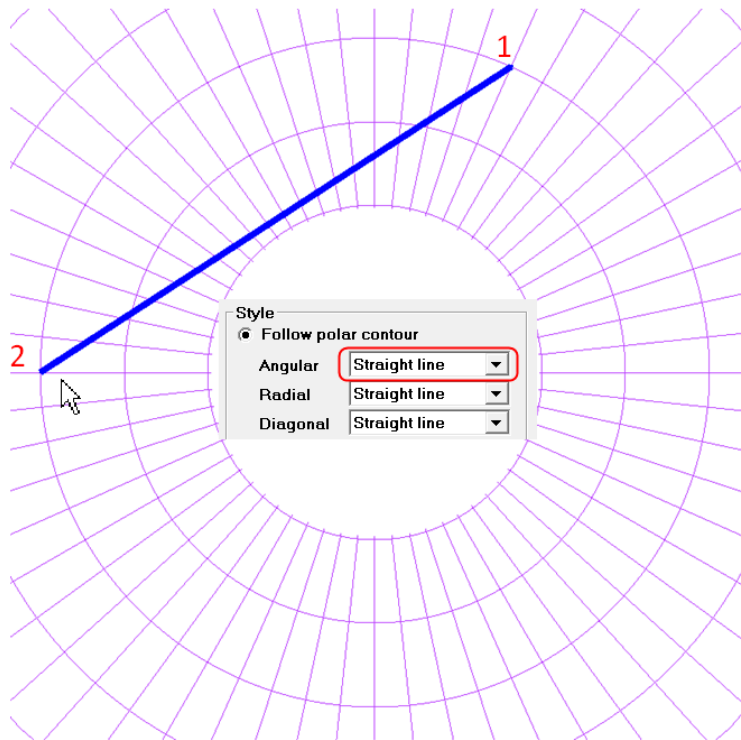


Figure 29: Straight line angular transition

## 4.2.2 Radial transition styles

For radial transition there are four options

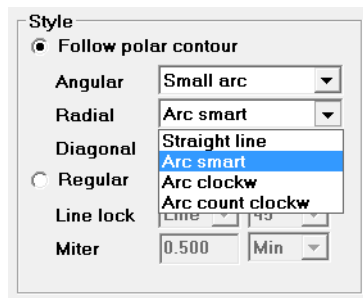


Figure 30: Radial transition styles

- **Straight line**

A straight line will be drawn between first and second point.

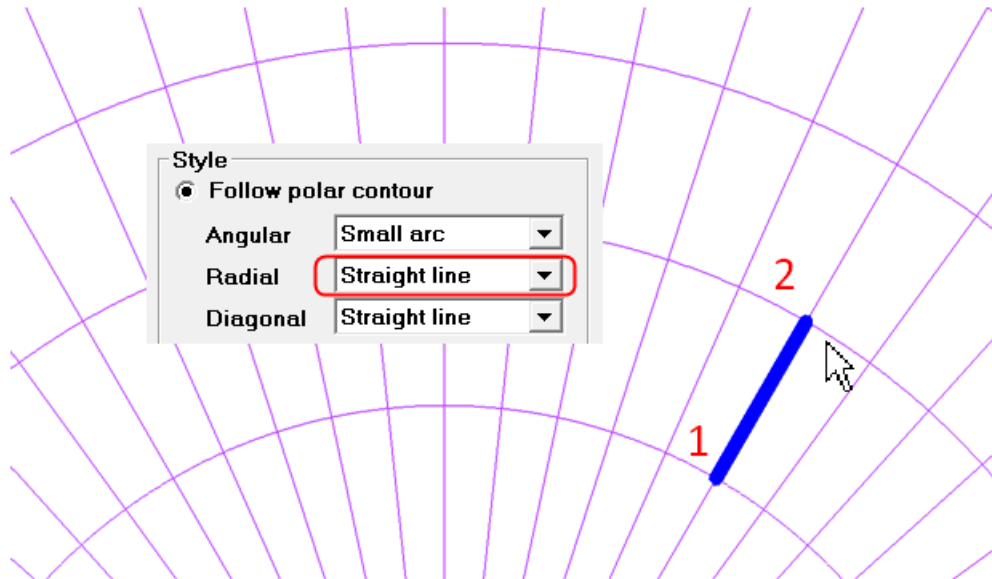


Figure 31: Straight line radial transition

- **Arc clockwise**

A clockwise arc will be drawn between first and second point. The radius is determined by the distance between the two points.

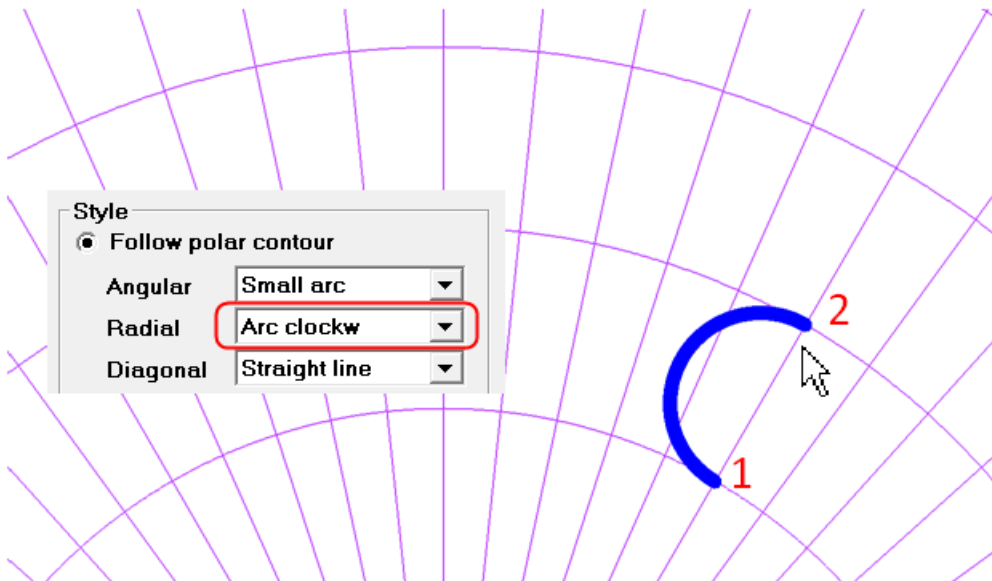


Figure 32: Arc clockwise radial transition

- **Arc counter clockwise**

A counter clockwise arc will be drawn between first and second point. The radius is determined by the distance between the two points.

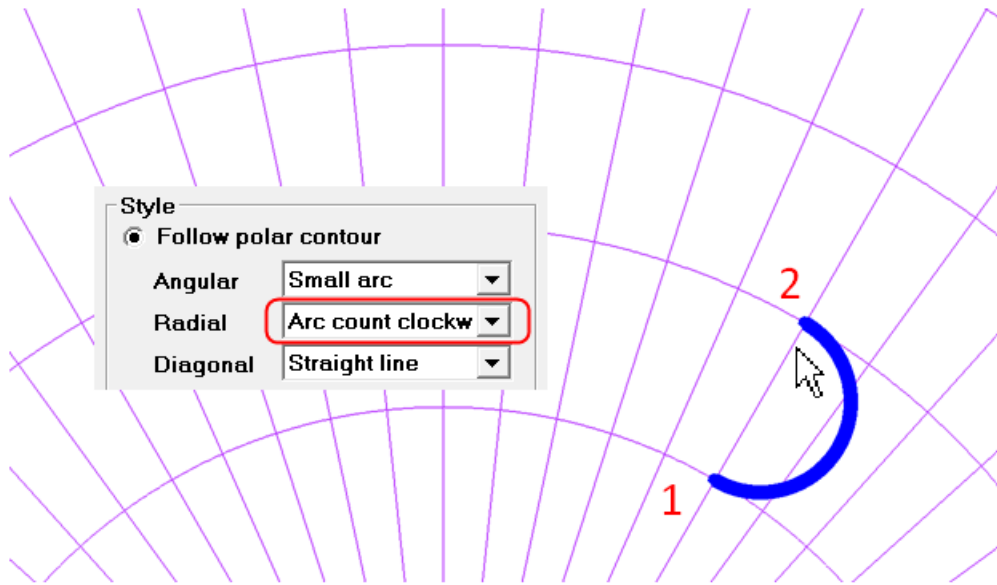


Figure 33: Arc counter clockwise radial transition

- **Arc smart**

This option is useful when the current radial transition is following a previous angular transition. In this case the direction (clockwise, counter clockwise) is determined in such way that always a smooth junction will be created.

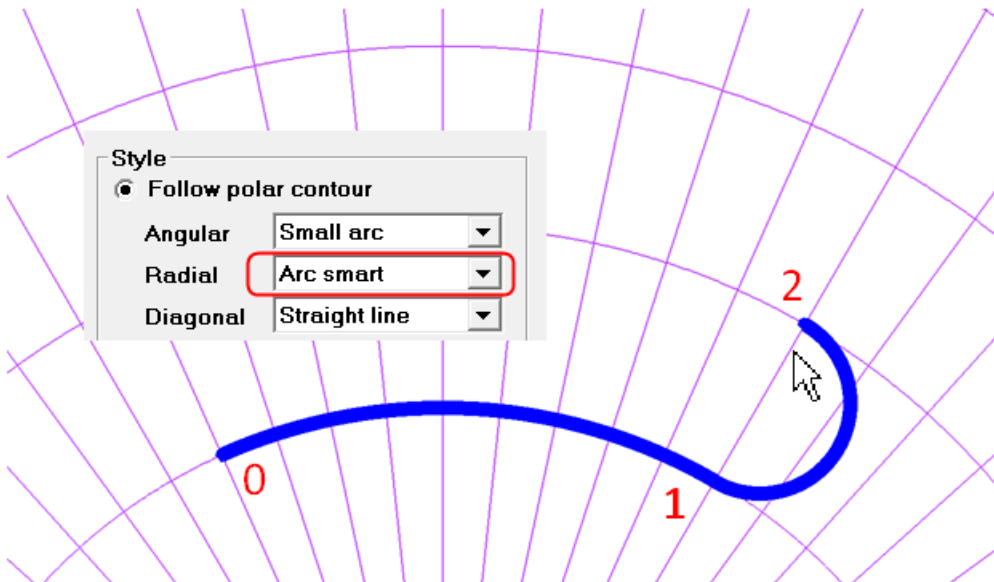


Figure 34: Arc smart radial transition



Note: The *Arc smart* option is very useful when routing a sequence of angular – radial transitions. The arc direction is always calculated in the right way. In the following example a path has been routed in one shot without changing any option.

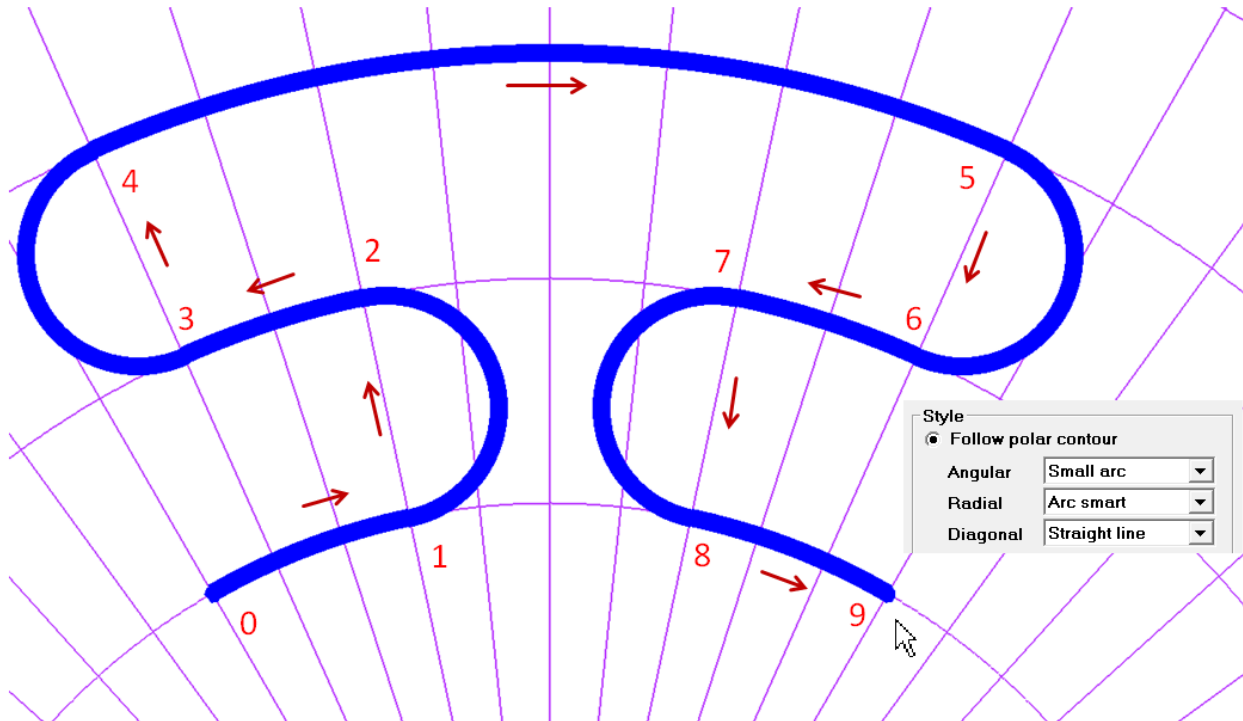


Figure 35: Example arc smart

### 4.2.3 Diagonal transition styles

For diagonal transition there are three options.

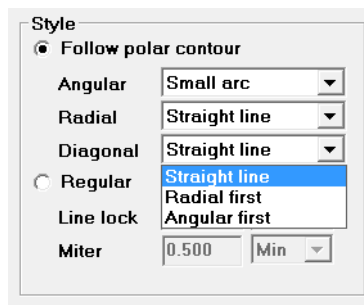


Figure 36: Diagonal transition styles

- **Straight line**

A straight line will be drawn between first and second point.

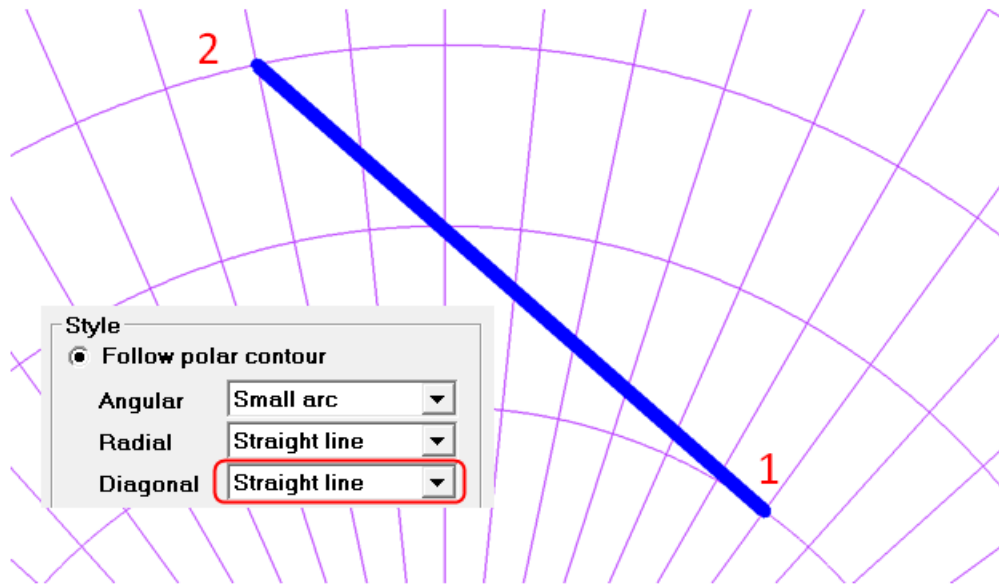


Figure 37: Straight line diagonal transition

- **Radial first**

From the start point a radial transition will be made first followed by an angular transition to the end point.

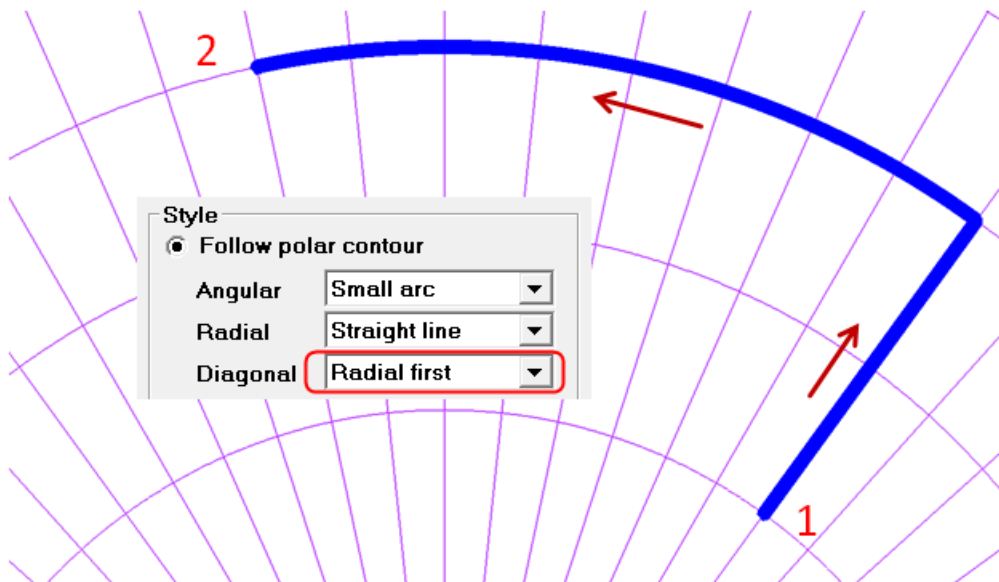


Figure 38: Radial first diagonal transition



- **Angular first**

From the start point a angular transition will be made first followed by a radial transition to the end point.

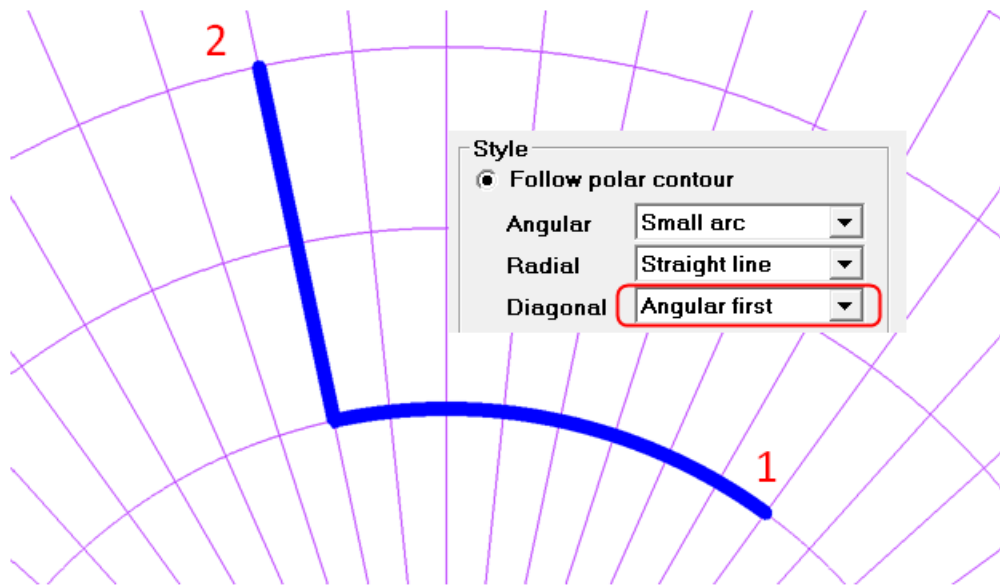


Figure 39: Angular first diagonal transition

### 4.3 Toggle current path

An alternate style for the current path can be chosen through context menu *RMB – Toggle current*. This command is useful if you want to change the style for a particular path without choosing *RMB – Oops* and changing the parameters in *Style options*. The following figure shows an example for toggling alternate styles for an angular transition.

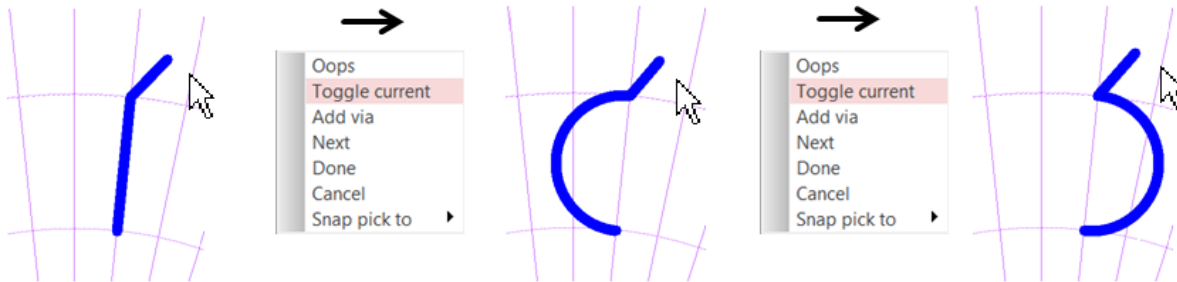


Figure 40: Example toggle current path

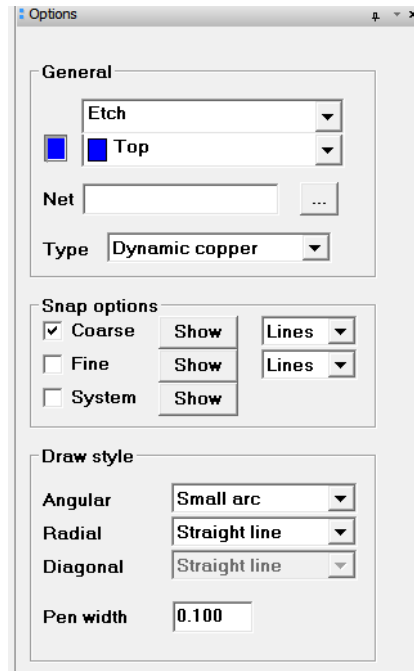
The available alternate styles are

- Angular transition
  - Straight line
  - Small arc
  - Big arc
- Radial transition
  - Straight line
  - Arc smart
  - Arc clockwise
  - Arc counter clockwise
- Diagonal transition
  - Straight line
  - Radial first with small arc
  - Angular first with small arc
  - Radial first with big arc
  - Angular first with big arc

As you can see for a diagonal transition there are two additional styles containing big arcs.

## 5 Polar shape

The corresponding command for polar shape can be found under *Polar grid – Shape*. Command options are available in *Options* panel.



**Figure 41: Polar shape options panel**

- Besides the layer on which the shape shall be created, a net can be assigned to the shape if a conductor layer has been chosen.
- The available shape styles are
  - *Dynamic copper*
  - *Static solid*
  - *Unfilled*



Note: The process of creating a shape may fail, if the shape style has not been properly specified. For example on a conductor layer you cannot create an unfilled shape.

- *Snap options* behavior is identical to polar placement and polar route commands. Refer to section on page 8 for more details.
- Also the *Draw style* options are identical to polar route command, except that *Diagonal* transition style has been locked to *Straight line*.
- Furthermore a pen width to be used when sketching the outline of the shape can be specified.



Note: The pen width is only for usability purposes and has no impact on the final shape



Note: The shape will be automatically created once you close the boundary by picking the start point again. You may also use the context menu *RMB – Close shape*

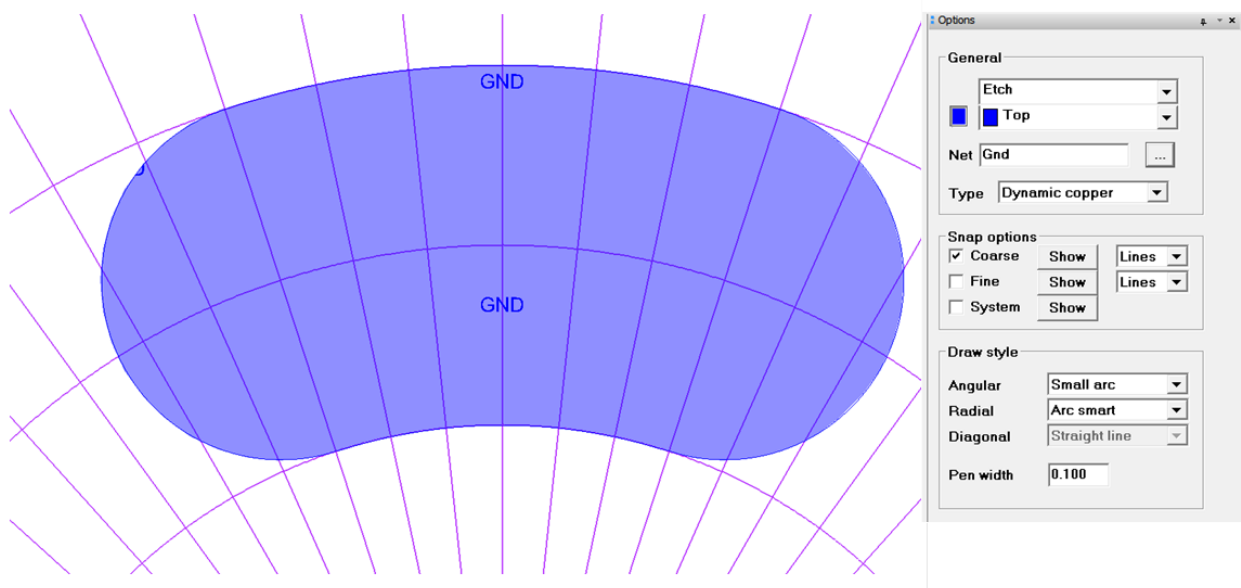
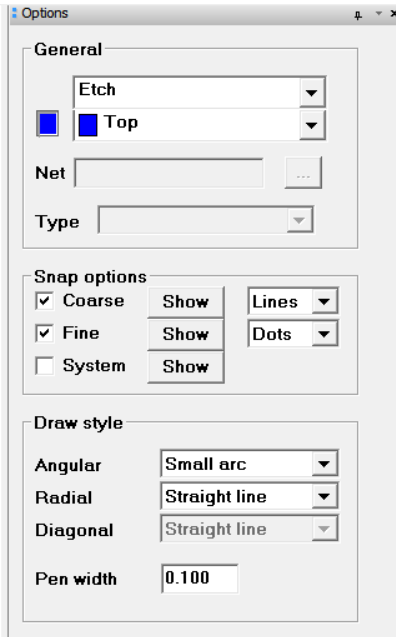


Figure 42: Polar shape example

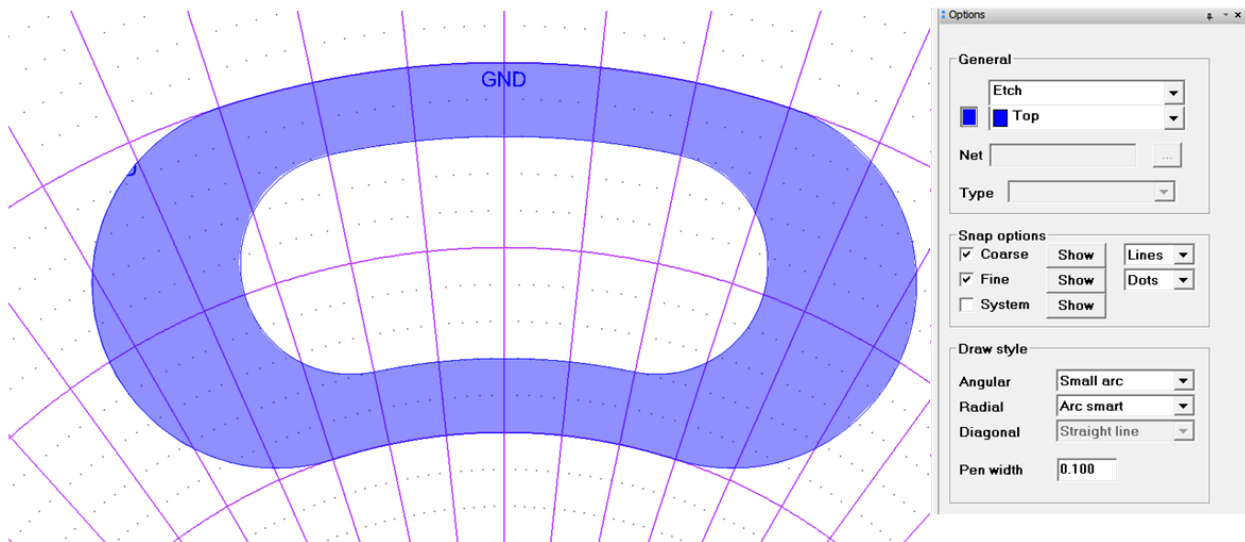
## 6 Polar shape void

The corresponding command for polar shapes can be found under *Polar grid – Shape Void*. Command options are available in *Options* panel.



**Figure 43: Polar shape void options panel**

- The use model is similar to polar shape command except that the shape to be voided needs to be selected first.



**Figure 44: Polar shape void example**