

ELECTRODE

The **ELECTRODE** statement specifies the placement of electrodes in a device structure.

ELECTRODE

```

NAME=<c> [VOID]
{ ( [ {TOP | BOTTOM | LEFT | RIGHT | INTERFAC | PERIMETE} ]
  [ {X.MIN=<n> | IX.MIN=<n>} ] [ {X.MAX=<n> | IX.MAX=<n>} ]
  [ {Y.MIN=<n> | IY.MIN=<n>} ] [ {Y.MAX=<n> | IY.MAX=<n>} ]
  [ { (ROTATE X.CENTER=<n> Y.CENTER=<n> R.INNER=<n> R.OUTER=<n>)
    | (POLYGON X.POLY=<a> Y.POLY=<a>)
  }
  ]
)
| [ X=<n> Y=<n> ]
| [REGION=<c>]
}
[MAJORITY]

```

Lattice Temperature AAM Parameters

[THERMAL]

Parameter	Type	Definition	Default	Units
NAME	char	The name of the electrode. A maximum of 200 electrodes are allowed in a device structure. Names must be less than 20 characters long, however a length of ten characters or less is recommended since names may be truncated to ten characters at certain places in the output listing. The Circuit analysis AAM also requires names of ten characters or less since the electrode name used by the program is constructed by concatenating the device name and the user-specified electrode name. synonym: NUMBER	none	
VOID	logical	Specifies that interior nodes and elements of a non-zero-area electrode are removed from the simulation grid.	false	
TOP	logical	Specifies that the electrode lies along the top edge of the device structure.	false	
BOTTOM	logical	Specifies that the electrode lies along the bottom edge of the device structure.	false	
LEFT	logical	Specifies that the electrode lies along the left edge of the device structure.	false	
RIGHT	logical	Specifies that the electrode lies along the right edge of the device structure.	false	
INTERFAC	logical	Specifies that the electrode lies along an insulator-semiconductor interface.	false	

Parameter	Type	Definition	Default	Units
PERIMETE	logical	Specifies that the electrode lies along the perimeter of the device structure.	false	
X . MIN	number	The minimum x location of the electrode.	The minimum x location for the device structure.	microns
IX . MIN	number	The minimum x node index of the electrode. synonym:IX . LOW	1	none
X . MAX	number	The maximum x location of the electrode.	The maximum x location for the device structure.	microns
IX . MAX	number	The maximum x node index of the electrode. synonym:IX . HIGH	The maximum x node index for the device structure.	none
Y . MIN	number	The minimum y location of the electrode.	The minimum y location for the device structure.	microns
IY . MIN	number	The minimum y node index of the electrode. synonym:IY . LOW	1	none
Y . MAX	number	The maximum y location of the electrode.	The maximum y location for the device structure.	microns
IY . MAX	number	The maximum y node index of the electrode. synonym:IY . HIGH	The maximum y node index for the device structure.	none
ROTATE	logical	Specifies that the electrode is rotated around a rotation center.	false	
X . CENTER	number	Specifies the x location of the rotation center.	none	microns
Y . CENTER	number	Specifies the y location of the rotation center.	none	microns
R . INNER	number	The inner radius (distance from the rotation center) of a circular electrode.	none	microns
R . OUTER	number	The outer radius (distance from the rotation center) of a circular electrode.	none	microns
POLYGON	logical	Specifies that the electrode is a polygon. The polygon vertices are defined by a pair of arrays: X . POLY and Y . POLY .	false	
X . POLY	array	Specifies an array of x coordinates of the polygon vertices. Number of the vertices should not exceed 40.	none	microns
Y . POLY	array	Specifies an array of y coordinates of the polygon vertices. Number of the vertices should not exceed 40.	none	microns
X	number	The x coordinate of a point which locates a region that is converted to an electrode.	none	microns
Y	number	The y coordinate of a point which locates a region that is converted to an electrode.	none	microns
REGION	char	The name of a region that is converted to an electrode.	none	

Parameter	Type	Definition	Default	Units
MAJORITY	logical	Specifies that the electrode forms a majority carrier contact only. The majority carrier quasi-Fermi level is set equal to the electrode potential. Minority carriers are unaffected by this electrode.	false	

Lattice Temperature AAM Parameters

THERMAL	logical	Specifies that this is a thermal electrode used to set the lattice temperature at this location. This parameter is only used with the Lattice Temperature AAM.	false	
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Description

The **ELECTRODE** statement serves to define the boundaries of an electrode within the device structure. Electrodes may be specified in any order.

Multiple **ELECTRODE** statements may be used to define the boundaries of a single electrode. The same electrode name may also be assigned to electrodes that are not in contact with each other within the device structure. This may be desired, for instance, if two electrodes are to be biased in exactly the same way.

See Also...

To further illustrate the **ELECTRODE** statement, refer to input file *mdex1 N-Channel MOSFET Examples*, Chapter 4, “Electrode Locations” on page 4-5.

Boundaries

The boundaries of an electrode can be specified in one of three ways:

- A bounding box, polygon, or a circular segment can be specified.
- A region name can be specified.
- A point within a region can be specified.

Bounding Box

A bounding box can be specified which defines bounds for the electrode boundaries. All nodes within these bounds become part of the electrode. The bounds may be defined using the following:

- Nodal indices
- Coordinate values
- Parameters **TOP**, **BOTTOM**, **LEFT**, **RIGHT**, **INTERFAC**, and **PERIMETE**.

Unspecified bounds default to the device edges. As an example, the following statements could be used to specify the electrodes for a MOSFET device:

```
ELECTROD NAME=Drain INTERFAC X.MIN=2.5
ELECTROD NAME=Gate TOP X.MIN=1.0 X.MAX=2.0
ELECTROD NAME=Source INTERFAC X.MAX=0.5
ELECTROD NAME=Substrate BOTTOM
```

Polygon

A polygon can be specified which defines boundaries of a electrode. The following statement could be used to specify a triangular electrode:

```
ELECTROD NAME=STRANGE POLYGON
+ X.POLY=(1, 2, 3)
+ Y.POLY=(1, 2, 1)
```

If both bounding box and polygon are provided in an **ELECTRODE** statement, then the electrode is defined only where the two overlap. Therefore, a bounding box can be used to truncate a polygonal electrode.

Rotation

A circular electrode can be defined by specifying a **ELECTRODE** parameter. The following statement could be used to specify a donut-shaped electrode with a center at $x=0$ and $y=0$, internal radius of 0.5 micron and external radius of 1 micron:

```
ELECTROD NAME=RING ROTATE
+ X.CENTER=0 Y.CENTER=0
+ R.INNER=0.5 R.OUTER=1
```

A zero internal radius would convert a donut-shaped electrode into a circular one.

If both bounding box and rotation are specified in an **ELECTRODE** statement, then the electrode is defined only where the two overlap. Therefore, a bounding box can be used to define segments of a circle or a donut.

Region Name

A region name may be specified that is converted to an electrode. In this case, every node in the specified region becomes part of the electrode. As an example, the following statement converts region named **Top_part** into an electrode. The electrode name in this example is arbitrarily chosen to be **Anode**.

```
ELECTROD NAME=Anode REGION=Top_part
```

Point Within a Region Specification

The method is very similar to the region name method. A coordinate pair (X,Y) is used to specify a point within a region. As in the previous case, every node in the region where the point (X,Y) is located becomes part of the electrode.

Electrode Nodes

The total number of nodes associated with all electrodes in the device structure must be less than

- 1000 for a 3200 node version of Medici
- 2500 for a 10000 node version of Medici
- 5000 for a 20000 node version of Medici.

The **VOID** parameter may be used to reduce the number of nodes associated with electrodes. When this parameter is specified, all interior nodes within a non-zero-thickness electrode are completely removed from the structure.

As an example, the following statement creates an electrode in the corner of a structure and then uses **VOID** to remove all the interior nodes.

```
ELECTROD NAME=Corner X.MAX=0.6 Y.MAX=0.6 VOID
```

Adding Electrodes to Existing Structures

An electrode can be added to an existing structure, or added to a structure created by TSUPREM-4 by following the **MESH** statement that reads in the structure with the appropriate **ELECTRODE** statements. For example, the following statements add a source and drain contact to a structure read from TSUPREM-4:

```
MESH IN.FILE=TS4FILE TSUPREM4  
ELECTROD NAME=Source INTERFAC X.MAX=0.5  
ELECTROD NAME=Drain INTERFAC X.MAX=2.5
```