

**NAME**

space3d - 3D hierarchical layout to circuit extractor

**SYNOPSIS**

**space3d** [all space options] [-3BUX] [-s scenefile] cell

**OPTIONS**

The following additional options can be specified:

- 3**      Use a boundary-element technique for 3-dimensional *capacitance* extraction. Use with **-c** or **-C** option.
- B**      Use a boundary-element technique to compute *substrate* resistances.
- U**      No calculation of Green's functions and no Schur matrix inversion.
- X**      Start tool *Xspace*(1ICD) to display the used mesh, etc.

**HIDDEN OPTIONS**

For hidden options a '%' sign needs to be specified after the first '-'. The following options can be specified:

- f**      Extract fine network (no nodes are eliminated).
- g**      Extract moments (use option -r and -C).
- m**      Enable monitor (produces a "mon.out" file).
- q**      Print recognized masks and elements.
- w**      Print statistics of recognized elements.
- Z**      Do only the prepass steps (no extract pass).
- 0**      Skip the mesh refinement pass(es).
- 2**      Skip all prepasses (only extract pass).
- L max\_depth**  
Extract cell tree to specified maximum depth.
- s scenefile**  
Output a *scene* description of the extraction process. This description contains drawing primitives which can be viewed using the tool *view3d*(1ICD). If the file name has no extension, then ".scn" is added.

**NOTICE**

This manual page only gives a brief introduction to *space3d*. It should in most cases be sufficient, however, for performing straight-forward extraction tasks. Other documentation is available, see below.

**DESCRIPTION**

*Space3d* is a 3D hierarchical layout to circuit extractor for 45 degree polygonal geometries. The program is capable of accurately extracting MOS and bipolar integrated circuits, including interconnect resistances and capacitances, and substrate resistances. Generally spoken, *space3d* extracts the circuits for all layout cells that are specified in the cell argument list. These circuits can then be directly simulated, for example, with *sls*(1ICD) or *spice*.

*Space3d* is an upgraded version of the fast *space* extractor. For all common behaviour see the manual page of *space*(1ICD) and the Space User's Manual for details. Note that *space3d* is using the *flat* extraction mode when using one of the following options: **-3**, **-B**, **-b** or **-X**.

**3D Capacitance Extraction (-3)**

*Space3d* can perform very accurate capacitance extraction by using a three-dimensional boundary element method. This is a numerical technique capable of numerically solving the Laplace equation which governs the electrical field around the interconnections wires on the IC. This capability is fully explained in a separate document, and is not discussed here any further.

**3D Substrate Extraction (-B)**

*Space3d* can perform very accurate substrate resistance and capacitance extraction by using a three-dimensional boundary element method. In modern analog circuits and mixed digital/analog circuits, coupling effects via the substrate can be an important cause of malfunctioning of the circuit. Therefore, the extraction of an accurate substrate model is very important.

**Element Definition File**

For 3D capacitance extraction the following special sections must be added to the technology file:

**vdimensions**

The vertical dimension list specifies for different conductors under different mask conditions (1) the distance between the ground plane (substrate) and the bottom of a mask conductor and (2) the thickness of that conductor.

**dielectrics**

The dielectric structure of the chip. The first dielectric layer starts at the bottom (ground plane) and all other layers start at a positive vertical position. Each layer has a relative permittivity value.

**eshapes** Optional, an edge shape list may be specified (see 3D Capacitance User's Manual).

**cshapes** Optional, a cross-over shape list may be specified (see 3D Capacitance User's Manual).

For 3D substrate resistance extraction the following special section must be added to the technology file:

**sublayers**

Specifies the conductivity of the substrate (see Substrate Resistance User's Manual).

For 3D substrate capacitance extraction the following special section must be added to the technology file:

**subcaplayers**

Specifies the relative permittivity of the substrate (see Substrate Resistance User's Manual).

**Parameter File**

Much of the operation of *space3d* is also under control of parameters that are specified in a parameter file.

The special 3D capacitance parameters start with a leading "**cap3d.**" (see 3D Capacitance User's Manual).

The special 3D substrate resistance parameters start with a leading "**sub3d.**" (see Substrate Resistance User's Manual).

**EXAMPLES**

To produce a transistor network for the cell *latch* including non-metal resistances and accurate substrate resistances and 2D couple capacitances, type:

```
% space3d -rBC latch
```

To produce a transistor network for the cell *latch* including non-metal resistances and with 3D couple capacitances, type:

```
% space3d -rC3 latch
```

**SPECIAL CONSIDERATIONS**

Before performing the actual extraction, beside the preprocessors, for accurate substrate extraction *space3d* first runs a prepass and after that the *makesubres(IICD)* and if requested the *makesubcap(IICD)* program.

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**FILES**

ICDPATH/share/lib/process/process/space.def.t  
default element definition file

ICDPATH/share/lib/process/process/space.def.p  
default parameter file

NELSISPROJECT/exp\_dat  
list of cells to be extracted

SPACE\_TMPDIR/space[12].xxxxxx  
green buffer temporary files

**SEE ALSO**

N.P. van der Meijs, A.J. van Genderen, F. Beeftink and P.J.H. Elias, "Space User's Manual", Delft University of Technology, Delft, The Netherlands.

N.P. van der Meijs and A.J. van Genderen, "Space Tutorial", Delft University of Technology, Delft, The Netherlands.

S. de Graaf, N.P. van der Meijs and A.J. van Genderen, "Space Tutorial Helios Version", Delft University of Technology, Delft, The Netherlands.

A.J. van Genderen and N.P. van der Meijs, "Space 3D Capacitance Extraction User's Manual", Delft University of Technology, Delft, The Netherlands.

A.J. van Genderen, N.P. van der Meijs and T. Smedes, "Space Substrate Resistance Extraction User's Manual", Delft University of Technology, Delft, The Netherlands.

helios(IICD), makesubcap(IICD), makesubres(IICD), space(IICD), tecc(IICD), view3d(IICD), Xspace(IICD).