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Disclaimer: This document is still far from complete.

Symbolic To Real Conversion in Alliance

Contents

Symbolic Layout

Symbolic Components

A symbolic layout is, in practice, made of only of three objects:

Object	MBK	Explanation
Segments	`phseg`	Oriented segments with a width and an orientation.
VIAs & contacts	`phvia`	Boils down to just a point.
Big VIAs & Big Contacts	`phvia`	Point with a width and a height That is a rectangle of width by height centered on the VIA coordinates.

Each of thoses objects is associated to a *symbolic layer* which will control how the object is translated in many *real rectangles*.

| MBK	Layer Name	Usable By	Usage
`phseg`	NWELL	Segment	N Well
	PWELL	Segment	P Well
	NDIF	Segment	N Diffusion
	PDIF	Segment	P Diffusion
	NTIE	Segment	N Tie
	PTIE	Segment	P Tie
	NTRANS	Segment	N transistor, in ALLIANCE, a transistor is represented as a segment (it's grid).
	PTRANS	Segment	P transistor
	POLY	Segment	Polysilicium
	ALUx	Segment	Metal level *x*
	CALUx	Segment	Metal level *x*, that can be used by the upper hierarchical level as a connector. From the layout point of view it is the same as ALUx.
	TALUx	Segment	Blockage for metal level *x*. Will diseappear in the real layout as it is an information for the P&R tools only.
`phvia`	CONT_BODY_N	VIA, BIGVIA	Contact to N Well
	CONT_BODY_P	VIA, BIGVIA	Contact to P Well
	CONT_DIF_N	VIA, BIGVIA	Contact to N Diffusion
	CONT_DIF_P	VIA, BIGVIA	Contact to P Diffusion
	CONT_POLY	VIA, BIGVIA	Contact to polysilicium
	CONT_VIA	VIA, BIGVIA	Contact between metal1 and metal2
	CONT_VIAx	VIA, BIGVIA	Contact between metal *x* and metal *x+1*. The index is the the one of the bottom metal of the VIA.
	C_X_N	VIA	N transistor corner, to build transistor bend. Not used anymore in recent technos
	C_X_P	VIA	P transistor corner, to build transistor bend. Not used anymore in recent technos

Note

Not all association of object and symbolic layers are meaningful. For instance you cannot associate a contact to a `NTRANS` layer.

Note

The symbolic layer associated with blockages is prefixed by a `T`, for *transparency*, which may seems silly. It is for historical reasons, it started as a true transparency, but at some point we had to invert the meaning (blockage) with the rise of over-the-cell routing, but the name stuck…

Symbolic Segments

In ALLIANCE, segments are oriented (up, down, left, right). This disambiguate the left or right side when using the `LCW` and `RCW` rules in the `RDS` file. It allows to generate, if needed, asymetric object in the real layout file.
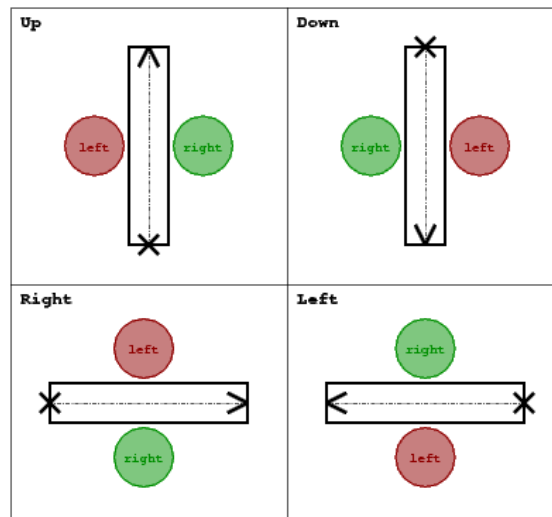
The RDS File

The RDS file control how a symbolic layout is transformed into it's real conterpart.

> **Note**
>
> **Unit used inside the RDS file:** all units are expressed in micrometers.

Alliance tools relying on the RDS file, and what layers are active for them:

Tool	Name	RDS Flags
Layout editor	`graal`	`ALL`
Design Rule Checker	`druc`	`ALL`, `DRC`
Electrical extractor	`cougar`	`ALL`, `EXT`
The symbolic to real layout translator	`s2r`	`ALL`

Physical Grid & Lambda Value

RDS file:

```
DEFINE   PHYSICAL_GRID   0.005
DEFINE   LAMBDA          0.09
```

Tells that the physical grid (founder grid) step is 0.005μm and the lambda has a value of 0.09μm. That is, one lambda is 18 grid steps.

We can distinguish two kind of RDS files:

- The *1μm* kind, odd segment widths and coordinates are allowed, but the `LAMBDA` value **must** represent an *even* number of foundry grid step.

- The *2μm* kind, segments widths and coordinates must all be even. And in that case the `LAMBDA` value can be any multiple of the foundry grid.
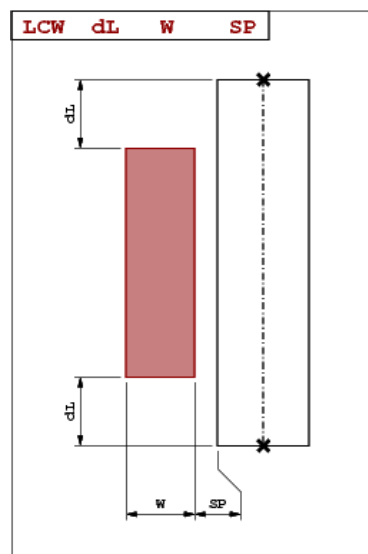
The `MBK_TO_RDS_SEGMENT` table

The `MBK_TO_RDS_SEGMENT` table control the way segments are translated into real rectangles. Be aware that we are translating *segments* and not *rectangles*. Segments are defined by their axis (source & target points) and their width. The geometrical transformations are described according to that model. Obviously, they are either horizontal or vertical.

The translation method of a symbolic segment is as follow:

1. The segment is translated into one or more physical rectangles. The generated rectangles depends on the tool which is actually using RDS and the flag for the considered real layer. For instance, real layers flagged with `DRC` will be generated for `s2r` (for the `cif` or `gds`) and `druc`, but will not be shown under `graal`.

2. Translation into one real layer. *First* the source & target coordinates and width of the symbolic segment are multiplied by the `LAMBDA` value to obtain a real segment. *Then* one of the `VW`, `LCW` or `RCW` transformation is applied to that segment to get the final real rectangle.

   - `VW` for Variable Width, expand the real layer staying centered from the original one. In those rules, the third number is not used, it is only here to make the life easier for the parser...
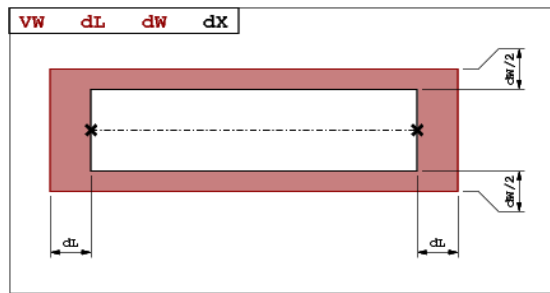
- `LCW` or `RCW` for Left/Right Constant Width, create an off-center rectangle of fixed width relatively to the real segment. Note that the `SP` number is the distance *between the edge* of the real segment and the edge of the generated real rectangle (*not* from the axis). It is often zero.

Examples:

```
TABLE MBK_TO_RDS_SEGMENT

    # (Case 1)
    ALU1        RDS_ALU1   VW  0.18  0.09   0.0   ALL

    # (Case 2)
    NDIF        RDS_NDIF   VW  0.18  0.0    0.0   ALL \
                RDS_ACTIV  VW  0.18  0.0    0.0   DRC \
                RDS_NIMP   VW  0.36  0.36   0.0   DRC

    # (Case 3)
    NTRANS      RDS_POLY   VW  0.27  0.00   0.0   ALL \
                RDS_GATE   VW  0.27  0.00   0.0   DRC \
                RDS_NDIF   LCW  0.0  0.27   0.0   EXT \
                RDS_NDIF   RCW  0.0  0.27   0.0   EXT \
                RDS_NDIF   VW  0.0   0.72   0.0   DRC \
                RDS_ACTIV  VW  0.0   0.72   0.0   ALL \
                RDS_NIMP   VW  0.18  1.26   0.0   DRC

    END
```

Case 1   the `ALU1` is translated in exacltly one real rectangle of `RDS_ALU1`, both ends are extended by 0.18µm and it's width is increased by 0.09µm.

Case 2   the `NDIF` will be translated into only one segment under `graal`, for symbolic visualization. And into three real rectangles for `s2r` and `druc`.

Case 3   the `NTRANS`, associated to a transistor is a little bit more complex, the generated shapes are different for the extractor `cougar` in one hand, and for both `druc` & `s2r` in the other hand.

- For the extractor (`EXT` & `ALL` flags) there will be four rectangles generateds:

    1. The gate (`RDS_GATE`)
    2. The left diffusion of the transistor (source or drain) (`RDS_NDIF`).
    3. The right diffusion of the transistor (drain or source) (`RDS_NDIF`).
    4. The active area (`RDS_ACTIV`).

    As the extractor must kept separate the source and the drain of the transistor, they are generated as two offset rectangles, using the `LCW` and `RCW` directives.

- For `s2r` and `druc` (`DRC` and `ALL`), five rectangles are generateds:

    1. The poly (`RDS_POLY`).
    2. The gate (`RDS_GATE`).
    3. The diffusion, as one rectangle that covers both the `LCW` and the `RCW` (`RDS_NDIF`).
    4. The active area (`RDS_ACTIV`).
    5. The N implantation (`RDS_NIMP`).

    In the layout send to the foundry, the source & drain are draw as one rectangle across the gate area (the transistor being defined by the intersection of both rectangles).

The `MBK_TO_RDS_VIA` table

This table is to translate *default* VIAs into real via. In the symbolic layout the default VIA is simply a point and a set of layers. All layers are converted in squares shapes centered on the VIA coordinate. The one dimension given is the size of the side of that square.

Note that although we are refering to VIAs, which for the purists are between two metal layers, this table also describe *contacts*.

Example:

```
TABLE MBK_TO_RDS_VIA

    CONT_DIF_P RDS_PDIF  0.54 ALL \
               RDS_CONT  0.18 ALL \
               RDS_ALU1  0.36 ALL \
               RDS_ACTIV 0.54 DRC \
               RDS_PIMP  0.90 DRC

    CONT_POLY  RDS_POLY  0.54 ALL \
               RDS_CONT  0.18 ALL \
               RDS_ALU1  0.36 ALL

    CONT_VIA   RDS_ALU1  0.45 ALL \
               RDS_VIA1  0.27 ALL \
               RDS_ALU2  0.45 ALL

END
```
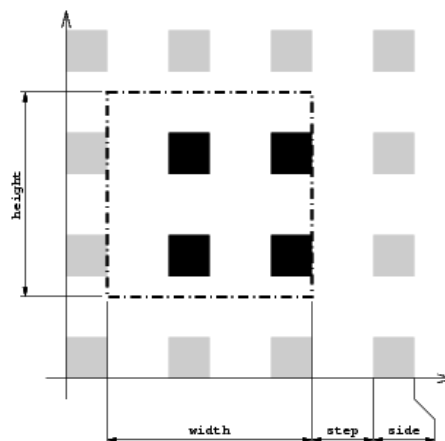
> **Note**
>
> **In CONT_DIF_P** you may see that only three layers will be shown under `graal`, but five will be generated in the `gds` layout.
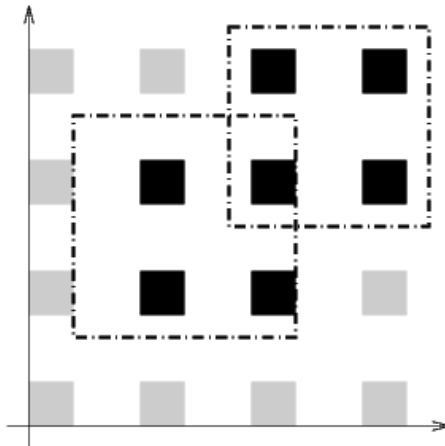
The `MBK_TO_RDS_BIGVIA_HOLE` table

In `s2r`, when generating BIGVIAs, the matrix of holes they contains is not draw relative to the position of the BIGVIA itself, but on a grid which is common througout all the design real layout. This is to allow overlap between two BIGVIA without risking the holes matrix to be not exactly overlapping. As a consequence, when visualizing the `gds` file, the holes may not be centerend inside one individual BIGVIA.

The `MBK_TO_RDS_BIGVIA_HOLE` table define the global hole matrix for the whole design. The first number is the individual hole side and the second the grid step (edge to edge). The figure below show the hole generation.

Example of BIGVIA overlap:

Example:

```
TABLE MBK_TO_RDS_BIGVIA_HOLE

    CONT_VIA   RDS_VIA1 0.27 0.27 ALL
    CONT_VIA2  RDS_VIA2 0.27 0.27 ALL
    CONT_VIA3  RDS_VIA3 0.27 0.27 ALL
    CONT_VIA4  RDS_VIA4 0.27 0.27 ALL
    CONT_VIA5  RDS_VIA5 0.36 0.36 ALL

END
```

> **Note**
>
> **BIGVIA demotion.** If the size of the bigvia is too small, there is a possibility that no hole from the global matrix will be under it. To avoid that case, if the either side of the BIGVIA is less than `1.5 * step`, the BIGVIA is demoted to a simple VIA.

The `MBK_TO_RDS_BIGVIA_METAL` table

This table describe how the metal part of a BIGVIA is expanded (for the hole part, see the previous table `MBK_TO_RDS_BIGVIA_HOLE`). The rule give for each metal:

1. The *delta-with* (have to ask Franck).

2. The *overhang*, the length the real rectangle is expanded on each side from the symbolic rectange.

Example:

```
TABLE MBK_TO_RDS_BIGVIA_METAL

    CONT_VIA  RDS_ALU1 0.0 0.09  ALL \
              RDS_ALU2 0.0 0.09  ALL

    CONT_VIA2 RDS_ALU2 0.0 0.09  ALL \
              RDS_ALU3 0.0 0.09  ALL

    CONT_VIA3 RDS_ALU3 0.0 0.09  ALL \
              RDS_ALU4 0.0 0.09  ALL

    CONT_VIA4 RDS_ALU4 0.0 0.09  ALL \
              RDS_ALU5 0.0 0.09  ALL
```

```
        CONT_VIA5 RDS_ALU5 0.0 0.09  ALL \
                  RDS_ALU6 0.0 0.18  ALL
    END
```

The `MBK_WIRESETTING` table

From a strict standpoint this table shouldn't be here but put in a separate configuration file, because it contains informations only used by the symbolic layout tools (`ocp`, `nero`, `ring`).

This table defines the cell gauge the routing pitch and minimal (symbolic) wire width and minimal spacing for the routers. They are patly redundant.

Example:

```
TABLE MBK_WIRESETTING

    X_GRID              10
    Y_GRID              10
    Y_SLICE             100
    WIDTH_VDD           12
    WIDTH_VSS           12
    TRACK_WIDTH_ALU8    0
    TRACK_WIDTH_ALU7    4
    TRACK_WIDTH_ALU6    4
    TRACK_WIDTH_ALU5    4
    TRACK_WIDTH_ALU4    3
    TRACK_WIDTH_ALU3    3
    TRACK_WIDTH_ALU2    3
    TRACK_WIDTH_ALU1    3
    TRACK_SPACING_ALU8  0
    TRACK_SPACING_ALU7  4
    TRACK_SPACING_ALU6  4
    TRACK_SPACING_ALU5  4
    TRACK_SPACING_ALU4  4
    TRACK_SPACING_ALU3  4
    TRACK_SPACING_ALU2  4
    TRACK_SPACING_ALU1  3

    END
```