SKY130 layer map

This page lists the layers this course uses, from the bottom of the stack to the top. For each one it gives the name you type in Magic, the number the GDS file uses, and what the layer physically is.

The GDS numbers are written as `layer/datatype`. They come from the `calma` lines in `$PDK_ROOT/sky130A/libs.tech/magic/sky130A.tech`, and they're the numbers you see in KLayout's layer panel. The sheet resistances are the `resist` lines in the same file, converted from milliohms to ohms per square.

Magic	GDS	Physically	Sheet R
`nwell`	64/20	an n-type tub in the p-substrate	950 Ω/□
`pwell`	64/44 (marker)	the p-substrate itself. SKY130 has no p-well mask, so Magic draws a p-well only as a marker that lets it reason about the body, and the marker doesn't become a real layer.	4400 Ω/□
`ndiff`	65/20 + 93/44	n+ silicon at the surface	120 Ω/□
`pdiff`	65/20 + 94/20	p+ silicon at the surface	197 Ω/□
`ntap`	65/44 + 93/44	n+ silicon **inside the n-well**: a handle on the well	120 Ω/□
`ptap`	65/44 + 94/20	p+ silicon in the substrate: a handle on the substrate	197 Ω/□
`poly`	66/20	polysilicon on the thin gate oxide	48.2 Ω/□
`pfethvt`	78/44	the HVTP implant, which makes a PMOS high-threshold	—
`pc` (poly contact)	66/44 + 95/20	a tungsten plug from poly to li, plus the NPC blocking mask	—
`ndc` / `pdc` / `ntapc` / `ptapc`	66/44	the same plug, from silicon to li	—
`li`	67/20	local interconnect	**12.8 Ω/□**
`mcon`	67/44	plug from li to metal1	—
`m1`	68/20	metal1	**0.125 Ω/□**
`via1`	68/44	plug from metal1 to metal2	—
`m2`	69/20	metal2	0.125 Ω/□

Magic	GDS	Physically	Sheet R
via2 / m3	69/44 / 70/20	and upward, to metal5	

Reading the table

Diffusion and tap are the same GDS layer. diff is 65/20 and tap is 65/44, so they share one mask and differ only in datatype. Whether a piece of either one is n-type or p-type depends on which implant mask (nsdm 93/44 or psdm 94/20) covers it. Physically, a ptap and a pdiff are identical, and they differ only in where they sit: the tap in the substrate, the diffusion in an n-well. That's why the tap rules and the diffusion rules look so similar.

li is a hundred times more resistive than metal1. Its sheet resistance is 12.8 Ω/□, against 0.125 Ω/□ for metal1. A 10 µm li wire 0.17 µm wide is 59 squares long, so it has about **750 Ω** of resistance, while the same wire in metal1 has 7 Ω. That's why li is called *local* interconnect: it gets you from a transistor to the wire, and it isn't meant to be used as the wire itself.

Poly is a poor conductor. Its sheet resistance is 48.2 Ω/□. Poly is the gate, and you can use it as a short wire inside a cell, but it is never used for routing.

The contact ladder

There is exactly one legal route from the silicon up to the metal. The ladder below uses the PDK's layer names (licon1, li1, met1) rather than Magic's, with the GDS numbers in parentheses:

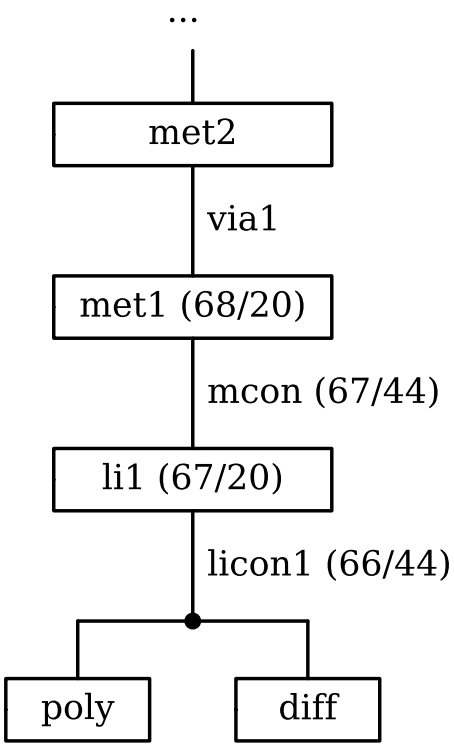


Figure 1: The contact ladder, with each layer's GDS number in parentheses.

That means you can't connect poly straight to metal1, or diffusion straight to metal2; you go up one step at a time. Every step is a plug of a fixed size, with enclosure rules at both ends.

Implant masks

`nsdm` (93/44) and `psdm` (94/20) decide whether a piece of active silicon is n+ or p+. In Magic you never paint them directly. You paint `ndiff` or `ptap`, and Magic generates the right implant when it writes the GDS. You'll still see them named in DRC messages, though:

```
NSDM width < 0.40um (diff/tap.5)
```

They also appear in the `MASKHINTS_NSDM` properties of the foundry's cells, which is where the library records hand-tuned implant shapes that Magic's automatic generation would not have produced.

The one implant you *do* paint is `hvtp` (78/44), as `pfethvt`, because nothing else in the layout says which threshold flavour you want for a PMOS.

Viewing layers in KLayout

```
klayout -nn $PDK_ROOT/sky130A/libs.tech/klayout/tech/sky130A.lyt yourfile.gds
```

The layer panel on the right lists every layer in the file with its numbers, and clicking a layer's eye icon hides it. The fastest way to see the standard-cell rows underneath a routed block is to hide everything above `met1`.

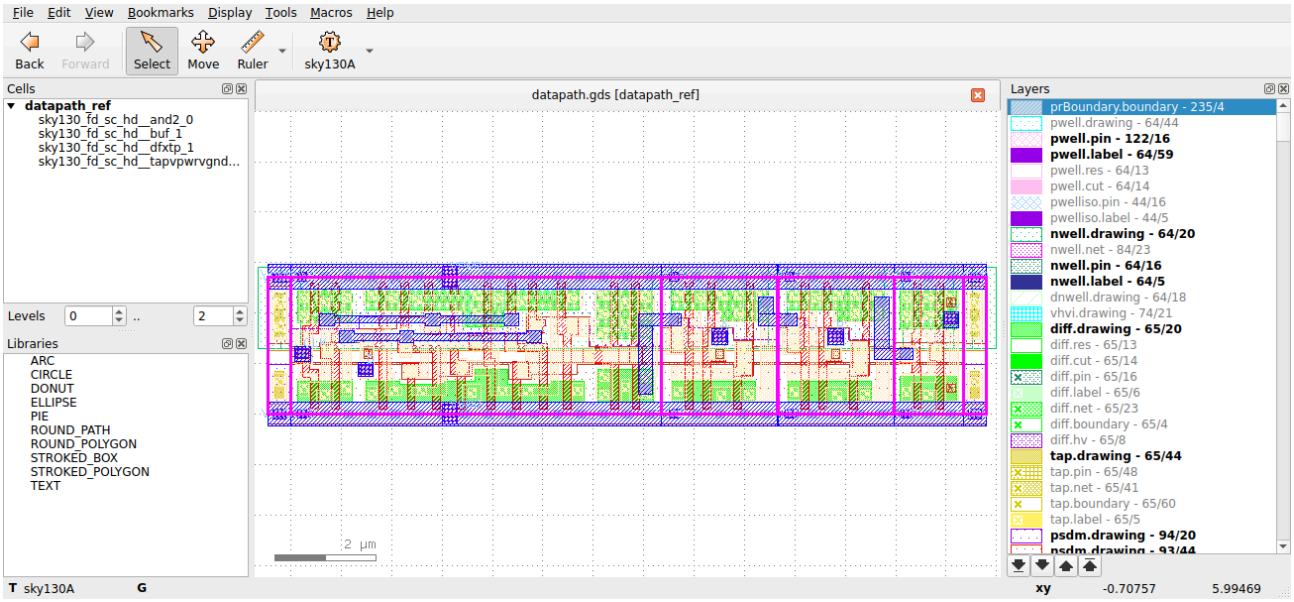


Figure 2: The capstone block as GDS

The capstone's GDS in KLayout. The cell tree on the left has `datapath_ref` at the top, with `and2_0`, `buf_1`, `dfxtp_1` and the tap cell under it, and the layer list on the right shows the numbers from the table above.