



Exercise 3: LVS

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DEVICES & LAYERS



Devices

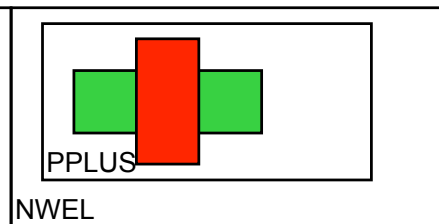
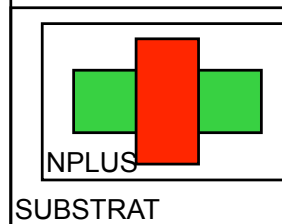
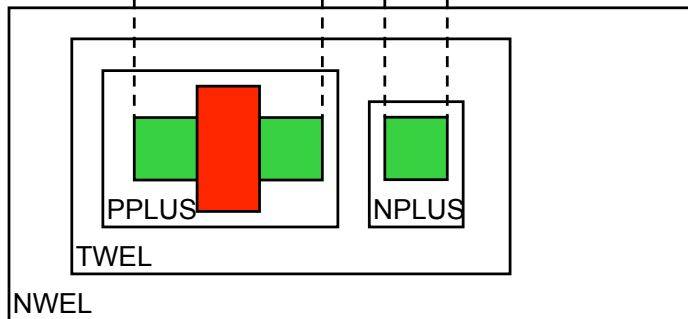
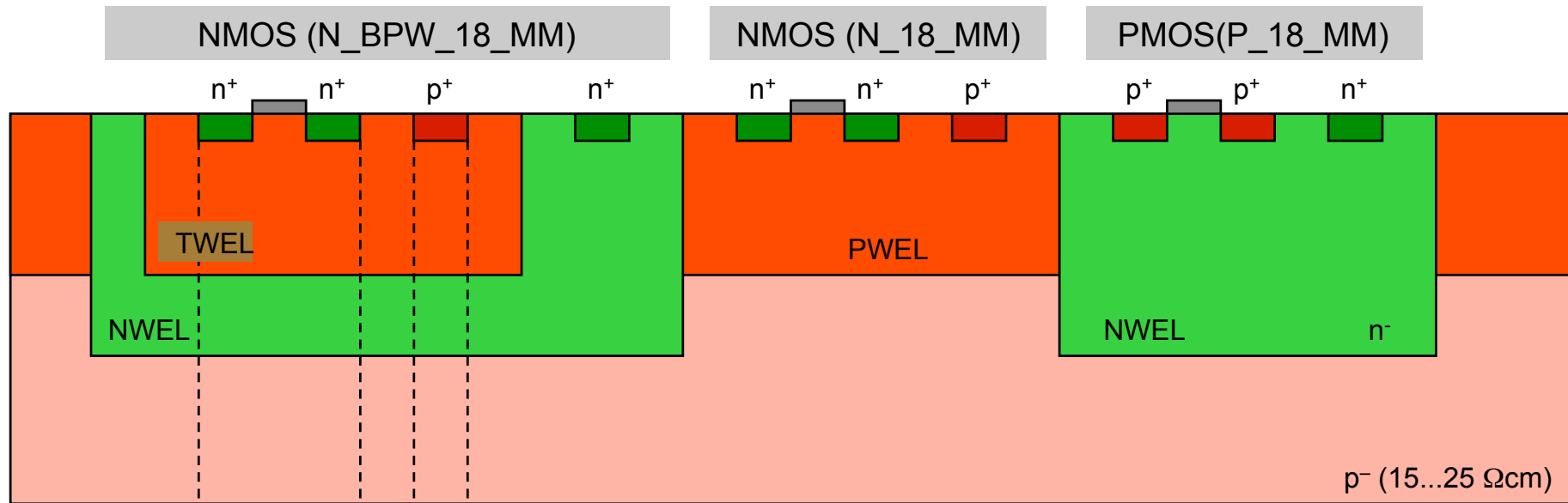
- The technology used offers several different NMOS and PMOS devices. For NMOS:

Cell

N_18_MM	(NMOS Gate Capacitor)
NCAP_MM	Normal NMOS
N_18_MM	3.3V Gate and Drain Capability (for pads)
N_33_MM	Devices in an N WELL / P WELL structure (For better isolation from substrate)
N_BPW_18_MM	
N_BPW_33_MM	Devices with lower thresholds
N_LV_18_MM	
N_LV_33_MM	Devices with close to zero Threshold
N_PO7W500_18_RF	
N_PO7W500_33_RF	
N_ZERO_18_MM	
N_ZERO_33_MM	
PAD_RF	



Cross Sections of Devices



Thicknesses:

p+	0.18...0.22 μm
n+	0.16...0.20 μm
PWEL	??? μm
TWEL	1.0...1.4 μm
NWEL	1.6...2.0 μm

 p-material
 n-material



Layers

- The most important *device* layers are

Layer	Purpose
DIFF	drawing
NWEL	drawing
PPLUS	drawing
NPLUS	drawing
PO1	drawing
CONT	drawing

DIFFUSION:
implanted regions. The type (n++ or p++) is fixed by
extra layers PPLUS or NPLUS

NWELL: Mostly for PMOS transistors

PPLUS: DIFFUSION surrounded by PPLUS is p++ region

NPLUS: DIFFUSION surrounded by NPLUS is n++ region

POLY1: gates and first interconnect layer

CONT: connections between POLY1 or between DIFFUSION
To first metal layer



Layers

- The *routing* layers are

Layer	Purpose
ME1	drawing
VI1	drawing
ME2	drawing
VI2	drawing
ME3	drawing
VI3	drawing
ME4	drawing
VI4	drawing
ME5	drawing
VI5	drawing
ME6	drawing
MMC	drawing
PAD	drawing

ME1: lowermost metal layer.
Connects to POLY1 or DIFFUSION via CONT

VI1 = VIA1: contacts metal1 to metal2

ME2: ...

M6: Topmost metal

MMC: Extra metal layer between M5 and M6 (!) for MiM-Caps

PAD: Opening in chip passivation, leaving access to ME6



Layers

- Some *other* layers are

Layer	Purpose
PAD	drawing
TEXT	drawing
PO1_CAD	TEXT
M1_CAD	TEXT
M2_CAD	TEXT
M3_CAD	TEXT
M4_CAD	TEXT
M5_CAD	TEXT
M6_CAD	TEXT
SYMBOL	MMSYMBOL
instance	drawing

TEXT: Can be used to comment layout
Not used for chip production

xx_CAD: used to label nets (see later)

SYMBOL: Used to mark active devices (see later)

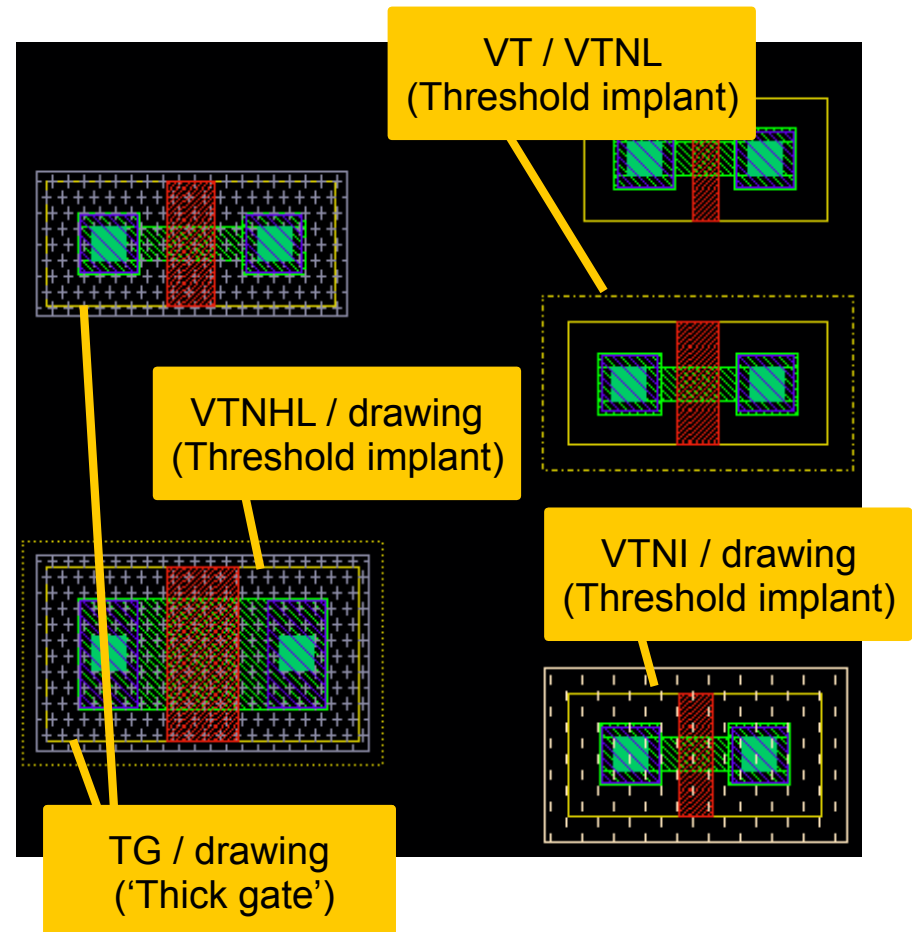
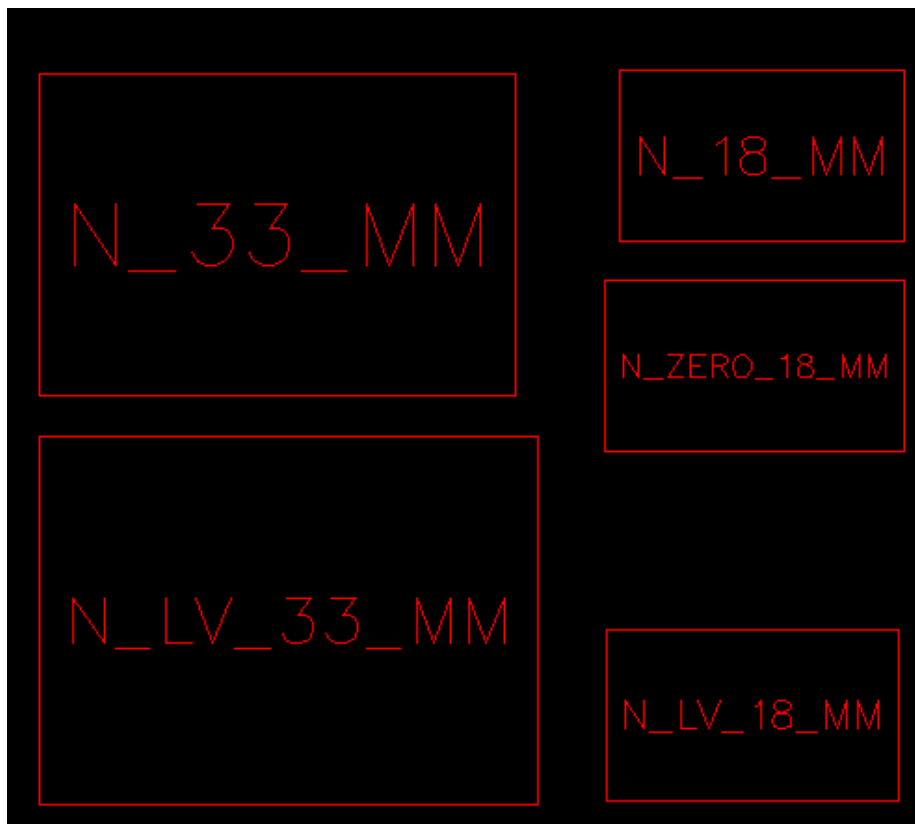
Instance: cadence layer. Used to display outline of a cell.
If drawn in a cell, defines outline to show
(otherwise, largest extent is used)

- There are many more layers, see ... *Edit Valid Layers* ...



Special Devices

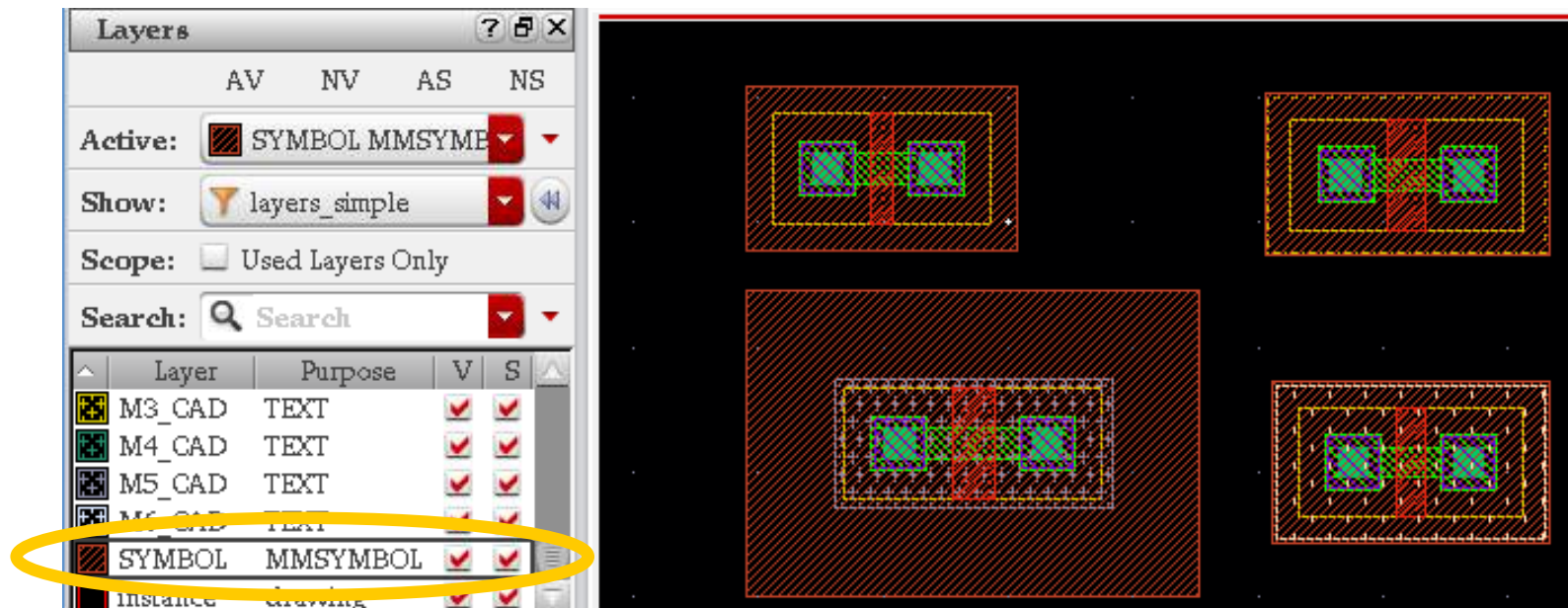
- The *various types* of NMOS / PMOS are identified by *extra layers* drawn on top of the device
- For the NMOS devices:





The SYMBOL layer

- In this technology *ALL* active devices *MUST* be surrounded by the SYMBOL (MMSYMBOL) layer
 - This is SYMBOL / MOL in 'active Layer Display'
- If this layer is missing, extraction does *not* find the device!
- Most of the time, this layer is set invisible
 - and can therefore be easily forgotten!



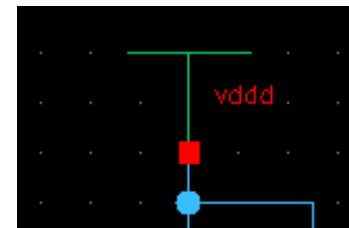


LVS



LVS: Layout Versus Schematic

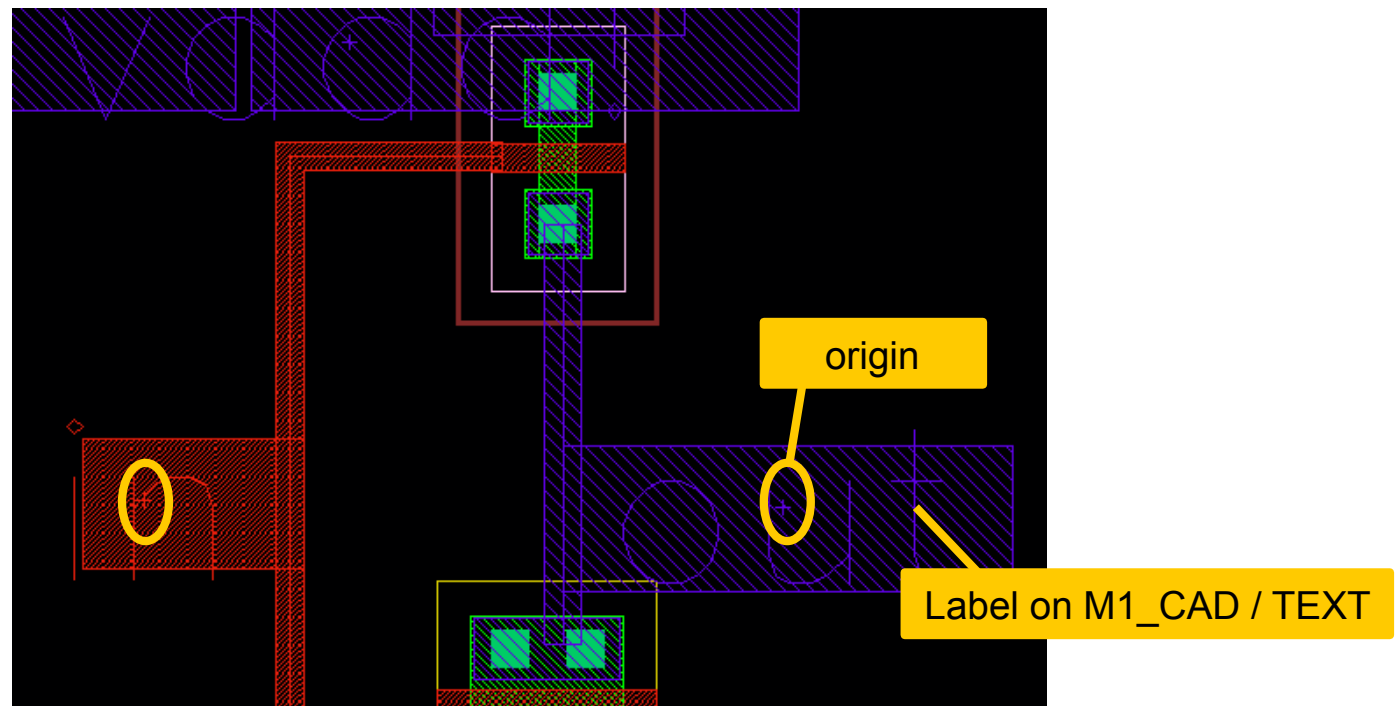
- The LVS Tool checks that a layout corresponds to a given schematic
- It has 3 steps
 1. Extraction of a netlist from the schematic
 2. Extraction of a netlist from the layout
 3. Comparison of both netlists
- The schematic is normally a 'schematic' view with the same cell name.
 - It can be a different view sometimes...
- Note that global nets are denoted by '!'.
 - For example, the vddd symbol from analogLib connects to net vddd!





Labels

- To help the LVS tool, the nets which are pins / supplies in the *schematic* should be *labelled* in the *layout*
- This is done by adding TEXT (Create → Label, 'l') on one of the PO1_CAD...M6_CAD/TEXT layers to a corresponding shape of the net
 - The ORIGIN of the label must touch the shape!





Starting LVS

- Select from the top menu Assura → Run LVS
 - Make sure *Rule Set LVS* is selected

The screenshot shows the Virtuoso Layout Suite interface. The top menu bar includes 'Options', 'Tools', 'Window', 'Assura', 'QRC', 'Optimize', and 'Help'. The 'Assura' menu is open, showing options like 'Open Run...', 'Open Cell...', 'Technology...', 'Rule Sets...', 'Setup', 'Run DRC...', 'Run altPSM...', and 'Run LVS...'. The 'Run LVS...' option is highlighted. Below the menu, the 'Run Assura LVS' dialog box is open. It has several sections:

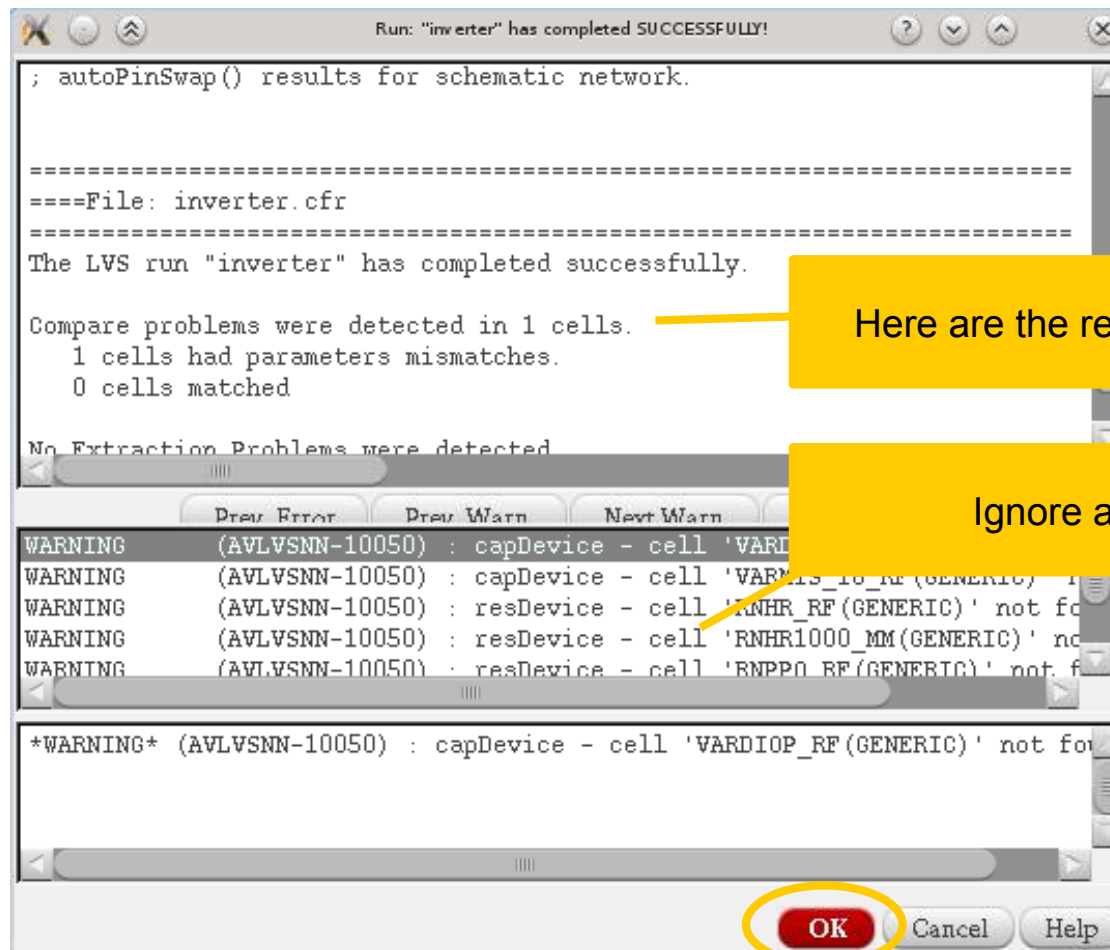
- Schematic Design Source:** 'DFII' dropdown, 'Use Existing Netlist' checkbox, 'Netlisting Options...' button. 'Library' is 'vlsi_lib', 'Cell' is 'inverter', and 'View' is 'schematic' (circled in yellow).
- Layout Design Source:** 'DFII' dropdown, 'Use Existing Extracted Netlist' checkbox. 'Library' is 'vlsi_lib', 'Cell' is 'inverter', and 'View' is 'layout' (circled in yellow).
- Run Name:** empty text field.
- Run Directory:** '/tmp/ASSURA-LVS-fischer'.
- Run Location:** 'local' dropdown.
- View Rules Files:** checked checkbox.
- Technology:** 'UMC_18_CMOS' dropdown.
- Rule Set:** 'LVS' dropdown (circled in yellow).
- Extract Rules:** unchecked checkbox (circled in yellow).
- Compare Rules:** unchecked checkbox (circled in yellow).
- Switch Names:** empty text field.

 A yellow callout box on the left contains the text 'Rules describing how Layout is extracted' and points to the 'Extract Rules' and 'Compare Rules' checkboxes.



LVS Overall Results

- If there are mismatches, you first get a warning window

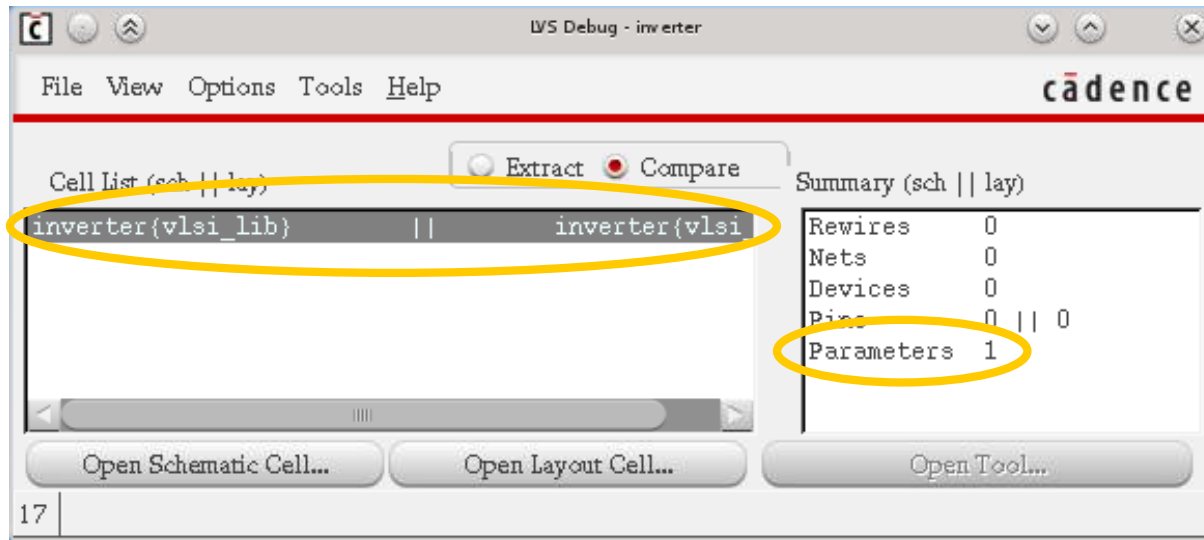


- Close it with **OK**

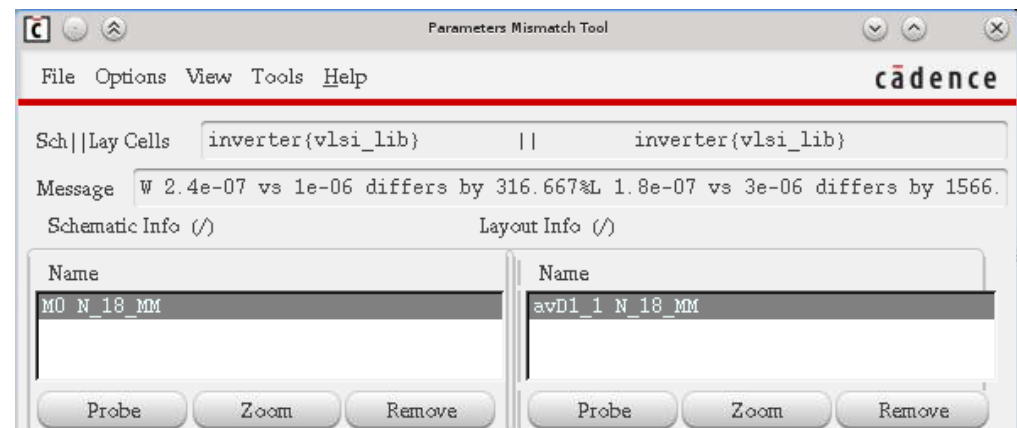


LVS Detail Results

- A new window opens
 - Select the cell to view error details



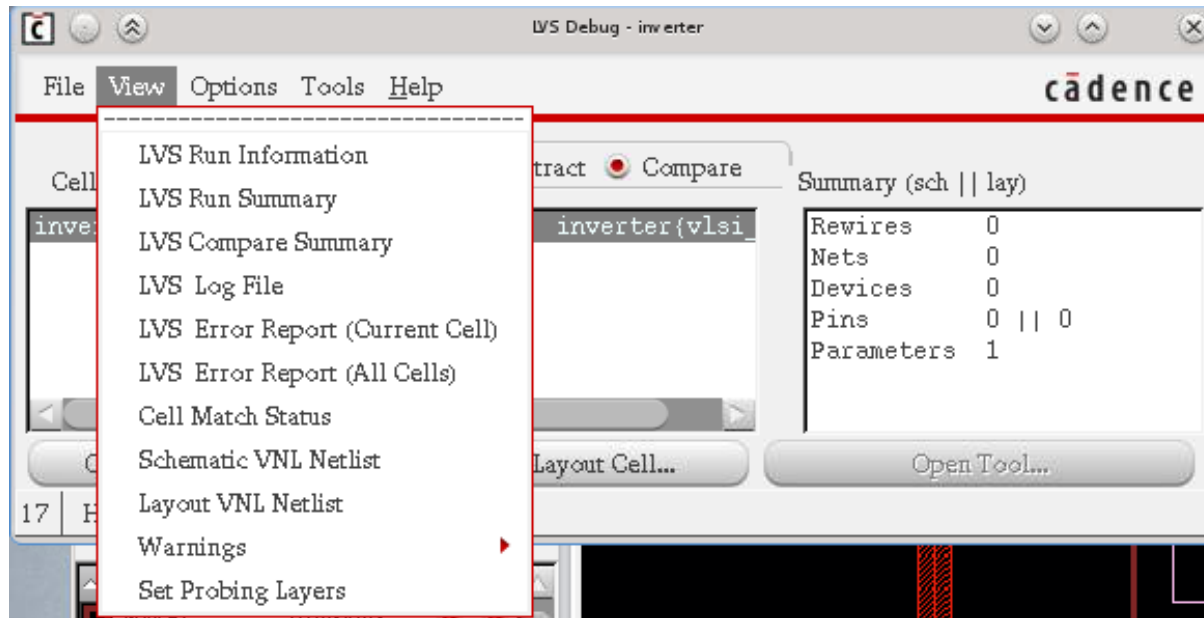
- Double click on the error type to see details
- Also use Options-> Show Details





Viewing the Netlists

- You can see the generated netlists in the 'View' section





EXERCISES



Exercise 3A: Inverter

- **Generate the schematic of an inverter**
 - Use the gnd symbol from analogLib for ground
 - Use the vddd symbol for the supply
 - Use an N_18_MM and a P_18_MM
 - Create pins for input and output

- **Make a layout of the inverter**
 - Do not try to make a nice layout (yet)
 - Use the MOS devices from lib UMC_18_CMOS
 - Make sure you add contacts ('o') to substrate and to the NWELL
 - Connect the substrate / well contacts to the correct supplies
 - Connect the gates / sources / drains correctly
 - Add label ('I') to input, output and the supplies

- **Start an LVS**



Exercise 3B: NAND3

- Repeat the same for a NAND3 gate