Introduction to
N65 RC Extraction Techfile

V1.0d

PDKD

Mar. 2007

Outline

- N65 RC techfiles deployment
- Introduction of N65 BEOL modeling
- Corner modeling

N65 RC techfile official release summary

- **Please refer to pdf file in the same release package, *N65_RCtechfile_summary_Mar07.pdf* for detailed download information.**
- **Some latest RC techfiles are under developing and not released to TSMC ONLINE yet. If you can not find the latest version at TSMC ONLINE, please consult with your *TSMC account support team*.**

Supported EDA Tools for N65

- Star-RCXT (5 corners)
- Fire & Ice (5 corners)
- Assura-RCX (5 corners)
- Calibre xRC (5 corners)
- Quartz-RC (5 corners)
- Quickcap (5 corners) – by special request currently

Technical Support Information

- Please contact TSMC account, field technical support team or customer engineer if any issues

LP and Gplus RC Tech Files

- **Currently TSMC provides N65LP and N65Gplus RC tech files for various process flavors.**
  - **N65LP RC techfile for LP process.**
  - **N65Gplus RC techfile for both Gplus and G processes.**
  - **The interconnect model for various CLN65 processes are the same, except poly CD bias and Rsh.**
- **Poly CD bias of typical corner for various processes are listed as below:**

N65 Interconnect Model Difference		
Process Type	POLY CD bias	POLY Rsh
LP	0.059	14.95
G	0.047	15.3
G+	0.041	15.3

Influence of Poly CD Bias

- **The maximum differences between various processes are located at *minimum drawn width and space*:**

SPICE v1.0				
Capacitance unit: fF/um		**w:0.06um, s:0.12um**	**w:0.06um, s:0.24um**	**w:0.1um, s:0.24um**
Structure A PO1-FOX Total C	**N65LP**	**0.192 (9.09%)**	**0.125 (2.46%)**	**0.134 (2.29%)**
	N65G	**0.176 (0%)**	**0.122 (0%)**	**0.131 (0%)**
	N65G+	**0.170 (-3.41%)**	**0.117 (-4.10%)**	**0.129 (-1.53%)**
Structure A PO1-FOX Coupled C	**N65LP**	**0.0810 (10.66%)**	**0.0419 (3.97%)**	**0.0441 (2.80%)**
	N65G	**0.0732 (0%)**	**0.0403 (0%)**	**0.0429 (0%)**
	N65G+	**0.0702 (-4.10%)**	**0.0383 (-4.96%)**	**0.042 (-2.10%)**
Structure B M1-PO1-FOX Total C	**N65LP**	**0.198 (10.00%)**	**0.142 (4.41%)**	**0.157 (3.97%)**
	N65G	**0.180 (0%)**	**0.136 (0%)**	**0.151 (0%)**
	N65G+	**0.175 (-2.78%)**	**0.133 (-2.21%)**	**0.149 (-1.32%)**
Structure B M2-PO1-FOX Total C	**N65LP**	**0.189 (10.53%)**	**0.124 (5.08%)**	**0.134 (3.88%)**
	N65G	**0.171 (0%)**	**0.118 (0%)**	**0.129 (0%)**
	N65G+	**0.166 (-2.92%)**	**0.117 (-0.85%)**	**0.127 (-1.55%)**

Simulation data of Poly CD Bias on Std Cells

RC extraction					
Backend techfile			CLN65G	CLN65G+	CLN65LP
Version			V1.0	V0.1	V1.0
Library name			CLN65G		
Document No.			N/A		
Spice model version			V1.0		
Vt			SVT		
Operating voltage			1.0V		
TT/25C			ratio	ratio	ratio
Cells	Leakage	INVD1	1.00	1.00	1.00
	Delay	INVD1	1.00	1.01	1.04
	Internal	INVD1	1.00	0.99	1.01
21 cells path	Rise path frequency(GHz)		1.00	1.01	0.98
	Fall path frequency(GHz)		1.00	1.00	0.97
	Average		1.00	1.01	0.97
21 cells path	Rise path power(nW/MHz)		1.00	0.99	1.03
	Fall path power(nW/MHz)		1.00	0.99	1.04
	Average		1.00	0.99	1.03
11osc	FO1	INVD0	1.00	0.99	1.04
	FO3	INVD0	1.00	1.00	1.05
11 cell with interconnect	delay	INV	1.00	1.00	1.03
	power	INV	1.00	1.00	1.04
	freq	REG	1.00	1.00	0.98
	power	REG	1.00	1.00	1.03

*Impact analysis are made by TSMC/SCLP.

Introduction of N65 BEOL modeling

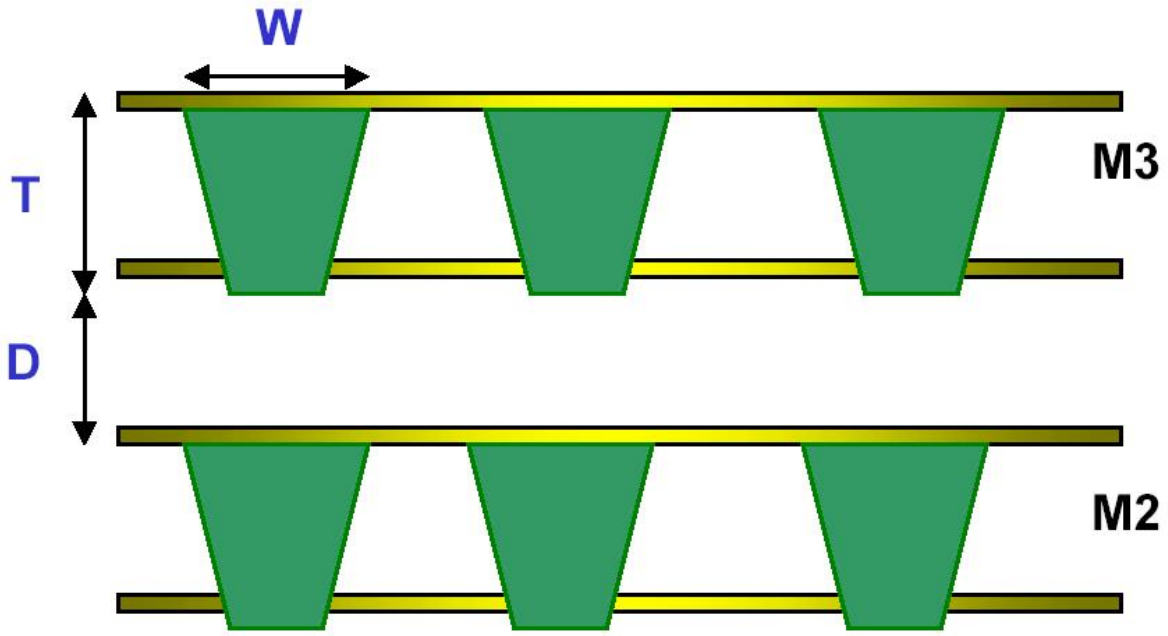
- **What are the differences of BEOL modeling methodology between N65 and N90 ?**
  - **In N90, the thickness of metal layers was modeled by a linear equation which is a function of density.**
    - $T_{si} = aD + b$
  - **In N65, the thickness(T_{si}) is now modeled by a polynomial equation which is a function of density and drawn width.**
    - $T_{si} / T_{minW\_minS} - 1 = a * D\text{^}4 + b * D\text{^}3 + c * D\text{^}2 + d * D + e$
    - **where a, b, c, d and e are also polynomials and be the function of drawn width**
  - **Detailed information please find the Spice Document as well**

Corner Modeling

- Typical corner
- C worst corner
- C best corner
- RC worst corner
- RC best corner

Process Variation Parameters in Corner Modeling

- Metal width variation (W)
- Metal thickness variation (T)
- IMD thickness variation (D)

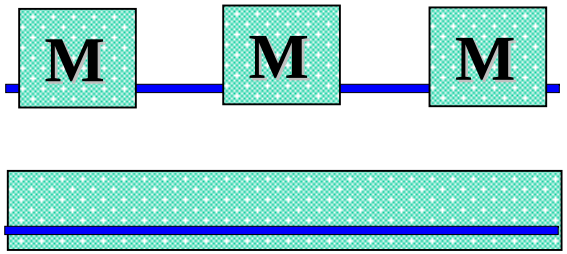


RC Corner Skew Definition

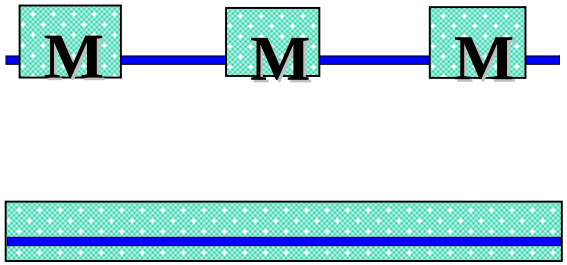
- There are 5 corners defined in N65 RC tech files
  - Typical
  - C worst corner (max width, max thickness, min IMD thickness)
  - C best corner (min width, min thickness, max IMD thickness)
  - RC worst corner (min width, min thickness, min IMD thickness)
  - RC best corner (max width, max thickness, max IMD thickness)

	Width (W)	Thickness (T)	IMD thickness (D)
Typical	typ	typ	typ
C worst	max(+)	max(+)	min(-)
C best	min(-)	min(-)	max(+)
RC worst	min(-)	min(-)	min(-)
RC best	max(+)	max(+)	max(+)

Interconnect Corners: Capacitance Dominant

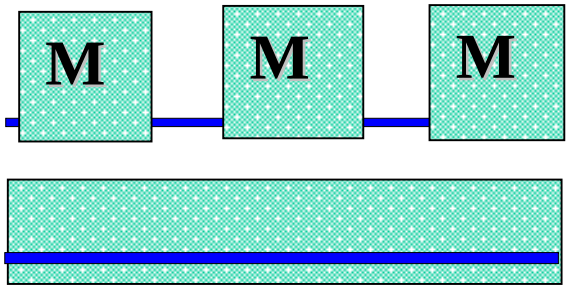


Typical



C-best case

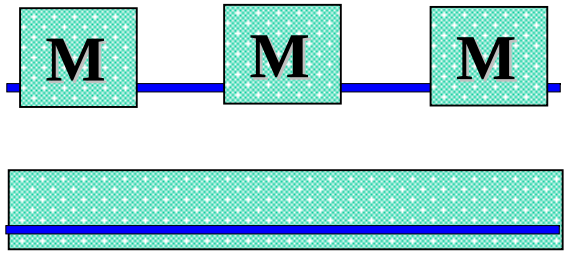
- Cc small
- Cb small



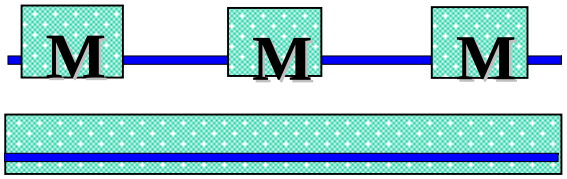
C-worst case

- Cc large
- Cb large

Interconnect Corners: Resistance Dominant

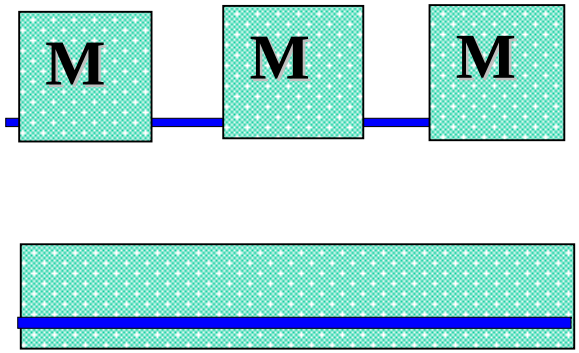


Typical



RC-worst case

- R large
- Cc small, and Cb large



RC-best case

- R small
- Cc large, and Cb small