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HW2 陳禹豪 電機 20

1. (a)w=6.067u ;l=0.2u (b)3.37 Vin=Vout=1/2\*VDD 時,PMOS 與 NMOS 都在 saturation region,且 Id,p=Id,n ,因 此與 PMOS 與 NMOS 的 mobility,(1+λ\*Vds),Vgs-Vov,unCox 有關,而影響最 大的是 mobility。PMOS 的λ,mobilty 大約是 2 到 3 倍, (1+λ\*Vds)是 NMOS 的 1 倍多 (c)

X 軸:Vin(Volts); Y 軸:Vout(Volts) (d)

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上圖 X 軸:Vin(Volts); Y 軸:Vout(Volts) 下圖 X 軸:Vin(Volts); Y 軸:Vout 對 Vin 微分 Vil:0.758 Voh:1.67 Vih:1.04 Vol:0.09 (e) NMh=Voh-Vih=0.63 NMl=Vil-Vol=0.668 (f) 2. (a)w=52.45u ;l=0.2u

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(b)29.14 約是 Q1 的 9 倍 並聯的 NMOS 提供 3 倍的電流,因此 PMOS 需要約 9 倍的 W 才能與 NMOS 並 聯提供相同的電流。 (c)

X 軸:Vin(Volts); Y 軸:Vout(Volts) (d) 上圖 X 軸:Vin(Volts); Y 軸:Vout(Volts) 下圖 X 軸:Vin(Volts); Y 軸:Vout 對 Vin 微分 Vil:0.774 Voh:1.67 Vih:1.03

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Vol:0.0891 sp (e) NMh=Voh-Vih=0.64 NMl=Vil-Vol=0.6849 NMh,NMl 均稍微增加, PMOS,NMOS 的 w/l 比值增加會讓 PMOS 的 Vov 對 Vsg 曲線的斜率變陡,讓 PMOS 在 triode region, NMOS 在 saturation region 的區域變長,讓 NMOS 在 triode region 及 PMOS 在 saturation region 的區域變長,因此 Vout/Vin 圖的中間 斜率變陡,NMh,NMl 均增加。 3. Process Temperature Tcdr tcdf tpdr tpdf TT 25°C 0.3ns 1.18ns 0.3ns 1.34ns FF -40°C 0.2ns 943ps 0.3ns 1.08ns SS 125°C 0.6ns 2.49ns 0.6ns 2.89ns SF 25°C 0.2ns 1.99ns 0.3ns 2.3ns FS 25°C 0.2ns 1.26ns 0.3ns 1.43ns

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TT 25°C: Best case for fall delay

Worst case for fall delay

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FF -40°C: Worst case for fall delay; Best case for rise delay

Best case for fall delay; worst case for rise delay

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SS 125°C: Worst case for fall delay

Best case for fall delay

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SF 25°C: Best case for fall delay; worst case for rise delay

Worst case for fall delay; Best case for rise delay

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FS 25°C: Best case for fall delay; worst case for rise delay

worst case for fall delay; Best case for rise delay

Hspice code: \*vlsi\_hw2\_3 .prot .lib 'cic018.l' TT .param pw=46.82u

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.unprot .option +post=1 +accurate=1 +runlvl=4 .temp 25

VB B1 GND 0 VS S1 GND 0 VDD D1 GND 1.8 Vin1 G1 GND PULSE(0 1.8 1ns 1ns 1ns 10ns 50ns) Vin2 G2 GND 0 \*\*Vin2 G2 GND PULSE(0 1.8 4ns 1ns 1ns 10ns 50ns) \*\*Vin3 G3 GND PULSE(0 1.8 7ns 1ns 1ns 10ns 50ns)

Cout Vout GND 1p

M1P D12 G2 D1 D1 P\_18 w='pw' l=0.18u m=1 \*\*0 \*\*1 M2P D23 G1 D12 D12 P\_18 w='pw' l=0.18u m=1 \*\*0 \*\*0 M3P Vout G2 D23 D23 P\_18 w='pw' l=0.18u m=1 \*\*1 \*\*0 M1N Vout G2 S1 B1 N\_18 w=1.8u l=0.2u m=1 M2N Vout G1 S1 B1 N\_18 w=1.8u l=0.2u m=1 M3N Vout G2 S1 B1 N\_18 w=1.8u l=0.2u m=1

.OP \*\*.DC Vin 0 1.8 0.01 \*\*.measure DC slope find V(Vout) when deriv('V(Vout)')=-1 \*\*.measure tran tprop trig V(Vout) val=0 rise=1 targ V(Vout) val=1.8 \*\*fall=1 .tran 0.11ps 90ns .ALTER .lib 'cic018.l' FF .TEMP -40 .ALTER .lib 'cic018.l' SS .TEMP 125 .ALTER .lib 'cic018.l' SF .TEMP 25

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