

Multiplier Power Usage

incl/config veg (21 stages)
not incl/SOS for inputs

jge/5-FEB-85

Upper

12 ⁴ / ₂	9 ⁸ / ₂		
4 ⁴ / ₂	3 ⁸ / ₂	1 ⁴ / ₄	
25 ⁴ / ₂	10 ⁸ / ₂	5 ⁴ / ₄	
6 ⁴ / ₂	2 ⁸ / ₂	1 ⁴ / ₄	2 ¹ / ₆ 2 ² / ₄
128 ⁴ / ₂	64 ⁸ / ₂		32 ⁶ / ₂
		1 ⁴ / ₄	2 ¹ / ₄
	6 ⁸ / ₂		
2 ⁴ / ₂	3 ⁸ / ₂	1 ⁴ / ₄	1 ³ / ₄
5 ⁴ / ₂	10 ⁸ / ₂		
1 ⁴ / ₂	2 ⁸ / ₂	1 ⁴ / ₄	

183. ⁴ / ₂	109. ⁸ / ₂	10. ⁴ / ₄	32. ⁶ / ₂
	1. ³ / ₄	2. ² / ₄	1. ² / ₆

$$\frac{183}{2} + \frac{109}{4} + 10 + \frac{32}{3} + \frac{4}{3} + 4 + 3 = 148 \square \text{ pullup}$$

Lower

36 ⁴ / ₂	27 ⁸ / ₂		
5 ⁴ / ₂	3 ⁸ / ₂	4 ¹ / ₄	2 ² / ₄
124 ⁴ / ₂	62 ⁸ / ₂		31 ⁶ / ₂
2 ⁴ / ₂	18 ⁸ / ₂		
⁴ / ₂	⁸ / ₂		3 ¹ / ₄
3 ⁴ / ₂			2 ¹ / ₄ 2 ¹ / ₆
2 ⁴ / ₂			2 ¹ / ₆
6 ⁴ / ₂			3 ² / ₄
8 ⁴ / ₂			

187. ⁴ / ₂	111. ⁸ / ₂	31. ⁶ / ₂	1. ⁴ / ₄ , 6. ² / ₄ , 3 ¹ / ₄ , 2. ² / ₆
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$$\frac{187}{2} + \frac{111}{4} + \frac{31}{3} + 1 + 12 + \frac{4}{3} + 6 = 152 \square \text{ pullup}$$

Clock Loads for Multiplier (incl. 21-bits of Config Reg)

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- Top - from left: ^{both HP same}
- P_x2 - 24λ² poly + 1CG + metal ≤ 1 pF/H
 - CFH_Bx2 - 32λ² poly + 2CG + metal ≤ 2 pF/H
 - CFL_Bx2 - 28λ² poly + 1CG + metal ≤ 1 pF/H
 - TrstHPh1 - 200λ² poly + 7½CG + metal ^(+2 BHP) _(+2 TH) ≤ 2 pF/H
 - Ph2 - 150λ² poly + 4½CG + metal ≤ 1.5 pF-U
 - + 20ff per fo. YLSB regs ≤ 1.7 pF-Ph
 - YLSB [• TrstHPh2 - ≤ 1.2 pF-Ph
 - A - UHP

- tree {
- TrstHPh1 - 50λ² + 3CG + metal ≤ 2 pF/H
 - Ph2 - 150λ² + 4½CG + metal ≤ 3 pF/H
 - TrstHPh1 - 26λ² + 1½CG + metal ≤ 1.5 pF/H

ALU Power, Clock, Global Input Loads

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global signals for ALU, loads per ALU leaf cell
from left:

- GND - 1 \square PU (+ from multiplier to left)
- Δ AG+SLSP2 - 34 λ^2 poly + 4CG + metal
- Δ AG+SLSP1 - 30 λ^2 poly + 4CG + metal
- o ACmpHPh2 - 22 λ^2 poly + 1 $\frac{1}{2}$ CG + metal
- o ACmpLPh2 - 22 λ^2 poly + 1 $\frac{1}{2}$ CG + metal
- Vdd - 2 $\frac{1}{4}$ \square PU
- o Ph2 - 26 λ^2 poly + 2CG + metal
- GND - 2 \square PU
- o CdEnHPh2 - 30 λ^2 poly + 1 $\frac{1}{2}$ CG + metal
- o Ph2 - 26 λ^2 poly + 1 $\frac{1}{2}$ CG + metal
- Vdd - 1 $\frac{1}{4}$ \square PU
- o CNewHPh2 - 30 λ^2 poly + 1 $\frac{1}{2}$ CG + metal
- GND - 1 $\frac{1}{2}$ \square PU
- Δ CG+CHSP1 - 28 λ^2 poly + 4CG + metal
- o CCmpLPh2 - 30 λ^2 poly + 1 $\frac{1}{2}$ CG + metal
- o CCmpHPh2 - 22 λ^2 poly + 1 $\frac{1}{2}$ CG + metal
- Vdd - 2 \square PU
- o BCmpLPh2 - 22 λ^2 poly + 2CG + metal
- o BCmpHPh2 - 30 λ^2 poly + 2CG + metal
- Δ Bb+ELSP1 - 28 λ^2 poly + 4CG + metal
- Δ Bb+MLSP1 - 26 λ^2 poly + 4CG + metal
- GND - 1 \square PU (+ From memory to right)

Δ SP1 signals $\leq 2pf$ per half-plane

o clox signals $\leq 1.5pf$ per half-plane

Upper

	core fg	STS	root	Tr5 stage		
Vdd	GND	Vdd	GND	Vdd	GND	Vdd
✓ 3 YSTCFg	✓ 3 STS stage	3 STS stage	$32^2_{2 \times 4}$	$32^2_{2 \times 4}$	$32^2_{8 \times 2}$	$32^2_{4 \times 2}$
✓ 1 Cfg	✓ 1 Root	1 Root	1 Root	$32^2_{8 \times 2}$	$32^2_{4 \times 2}$	
✓ 5 Cmg	✓ 5 TLSB	5 TLSB	5 TLSB		$32^1_{6 \times 2}$	$32^1_{6 \times 2}$
✓ 1 Cfg6	1 Yφ	2 Yφ	1 Yφ		4x4	4x4
	✓ 3 YSTCFg				2x4	2x4
	✓ 1 Cfg					
	✓ 5 Cmg					
	✓ 1 Cfg6					
$4 \cdot \frac{1}{2} + 5 \cdot 1$ $+ 3 \cdot \frac{1}{2} + 2$ ≈ 13		$13 + 3 \cdot 2^{3/4}$ $+ 3^{3/4} + 5 \cdot 4 + 9 \cdot \frac{1}{2}$ 55				

3 squares in upper to ALL GND rail

	cfg	STS	root	Tr5 stage		
Vdd	GND	Vdd	GND	Vdd	GND	Vdd
XSTφ	XSTφ		$31^2_{4 \times 2}$	$31^2_{4 \times 2}$		
XST9	XST9					
8.XST	8.XST			$31^2_{8 \times 2}$	$31^2_{8 \times 2}$	
	$34 \left(\begin{array}{l} 9 \cdot STS \\ STS \times 6 \end{array} \right)$	$9 \cdot STS$	$34 \left(\begin{array}{l} STS \times 0 \\ STS \times 0 \end{array} \right)$		$31^2_{4 \times 2}$	$31^2_{4 \times 2}$
					$31^2_{6 \times 2}$	$31^2_{6 \times 2}$
		7LSBφ49	7LSBφ49			
		4 YSLMφ	4 YHφ			
70	41	60	65	47	57	41

Multiplexer Power Usage
 includes config register (21 stages)
 doesn't include SBCs for input signals

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upper	lower					
3	9	STJ stage + X9	4 * 4/2	3 * 8/2		
1		STS stage Root	4 * 4/2	3 * 8/2	1 * 4/4	
5		STS stage TL SB	5 * 4/2	2 * 8/2	1 * 4/4	
	1	STS stage X0	5 * 4/2	3 * 8/2	1 * 4/4	2 * 2/4
1		STS stage Y0	6 * 4/2	2 * 8/2	1 * 4/4	1 * 2/6 1 * 2/6
32	31	Tv5 stage	4 * 4/2	2 * 8/2		1 * 6/2
1		Tv4 Quad Bot			1 * 4/4	1 * 2/4
	1	XSTCFg9	2 * 4/2	2 * 8/2		1 * 2/6
	8	XSTCFg		2 * 8/2		
	1	XSTCFg	1 * 4/2	1 * 8/2		1 * 3/4
	1	YLSB0	3 * 4/2			1 * 2/4 1 * 2/6
	1	YLSB1	2 * 4/2			1 * 2/6
	1	YLSB2	2 * 4/2			1 * 2/4
	1	YLSB3	2 * 4/2			1 * 2/4
	1	YLSB4	2 * 4/2			1 * 2/4
	1	YLSB9	2 * 4/2			
	4	YLSB10	2 * 4/2			
3		YSTCFg		2 * 8/2		
1		YSTCFg	2 * 4/2	3 * 8/2	1 * 4/4	1 * 3/4
5		YSTCFg Comp	1 * 4/2	2 * 8/2		
1		YSTCFg6	1 * 4/2	2 * 8/2	1 * 4/4	

total squares of pullup lower H8 = 152
 upper H8 = 148

ma (all on, 20kΩ/square) LHP = 38 ma UHP = 37 ma
 ma (all on, 50kΩ/square) LHP = 15 ma UHP = 15 ma

Multiplier SBs

MulCntl i

multiplier = MulCntl, MulTop, MulBot, MulVDDUp, MulVDDn

goes flush against GND rail on left of ALU

MulTop - for Tree64HSP1
 for TRootHSP1
 for YClvLSP2 (for YSuperTree)
 for PP outs of root tree node
 for TLSB<0:5>HSP1

MulBot - for YCHSP1
 for YLSBHSP1
 for YClvLSP2 (for YLSB registers)
 for XClvLSP2
 for TLSB<0:4>HSP1

globals -

4·Vdd, 4·Tust+Ph1 in Bot (3 in Top),
 2·Ph2, 3·GND (4 in Top going to it at bottom)
 1·CFHPx1, 1·CFLPx1, 1·Px2

interconnects - TrLnkHSP1 from Top to Bot

YCHSP1 from Bot to Top

YLSBHSP1 from Bot to Top

BDatLSP1 to YSuperTree and 2 tree halves

TRootHSP1 from YSuperTree to root node

XLSX1 between Top and Bottom

(Vdd, Ph2, XClv, YClv, sig, Tust, 5 LSB's, GND)

this multiplier includes 21 bits of ConfigReg and RNSelHSX1 generator; other inputs are ScInHSX1 and PAdd<0:5>HSX1, outputs RNEuLSX1 and RNSelHSX1

4410
3200

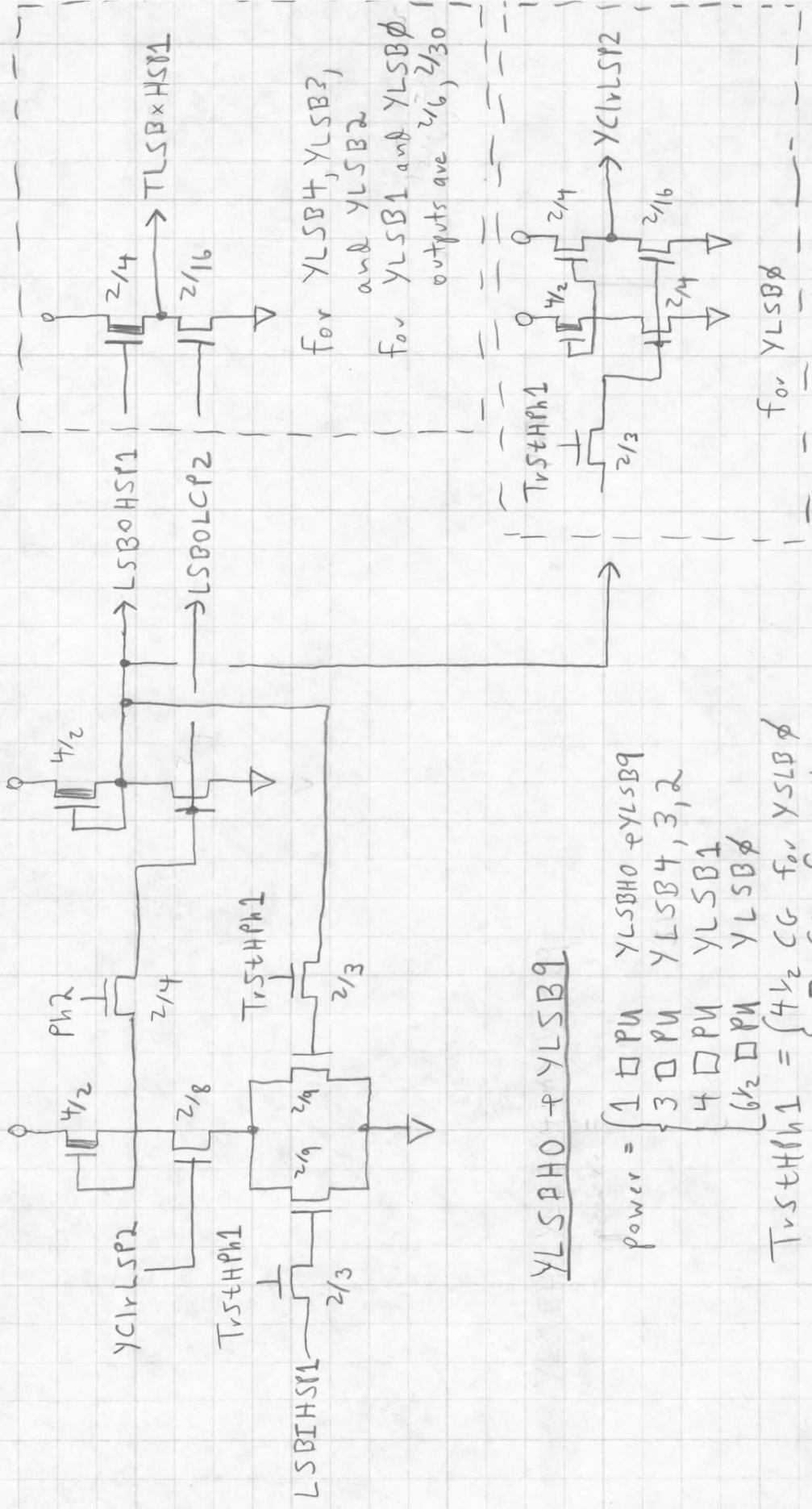
55.55

1-47.10

2-40.60

111,41
95,59
78,87
80,95
94,107

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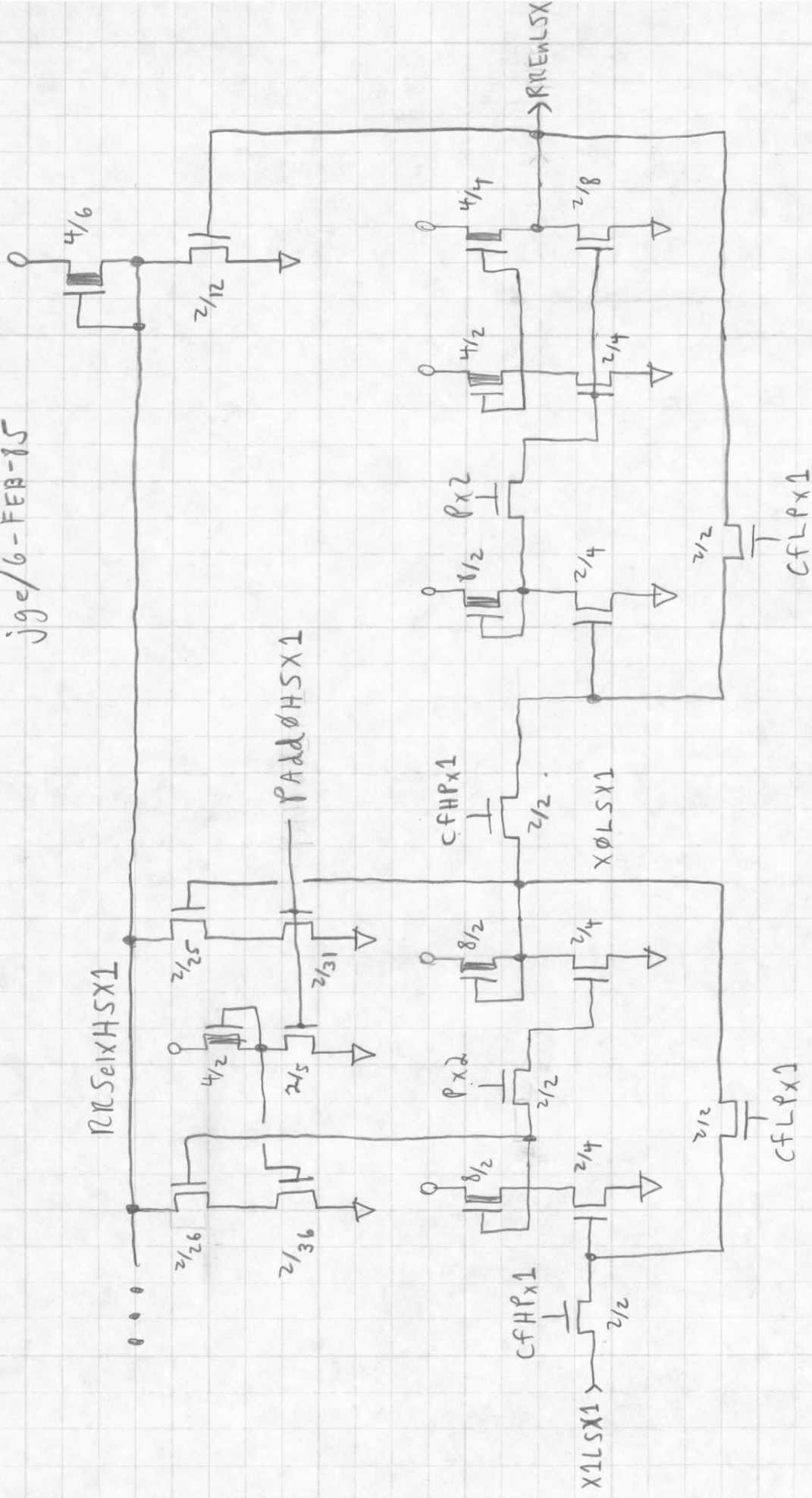


for YLSB4, YLSB3,
and YLSB2
for YLSB1 and YLSB0
outputs are 2/6, 2/30

YLSB0 + YLSB9

power = { 1 □ PM YLSB0 + YLSB9
3 □ PM YLSB4, 3, 2
4 □ PM YLSB1
6 1/2 □ PM YLSB0 }
TrstHPh1 = { 4 1/2 CG for YLSB0
3 CG for others }
Ph2 = 2 CG

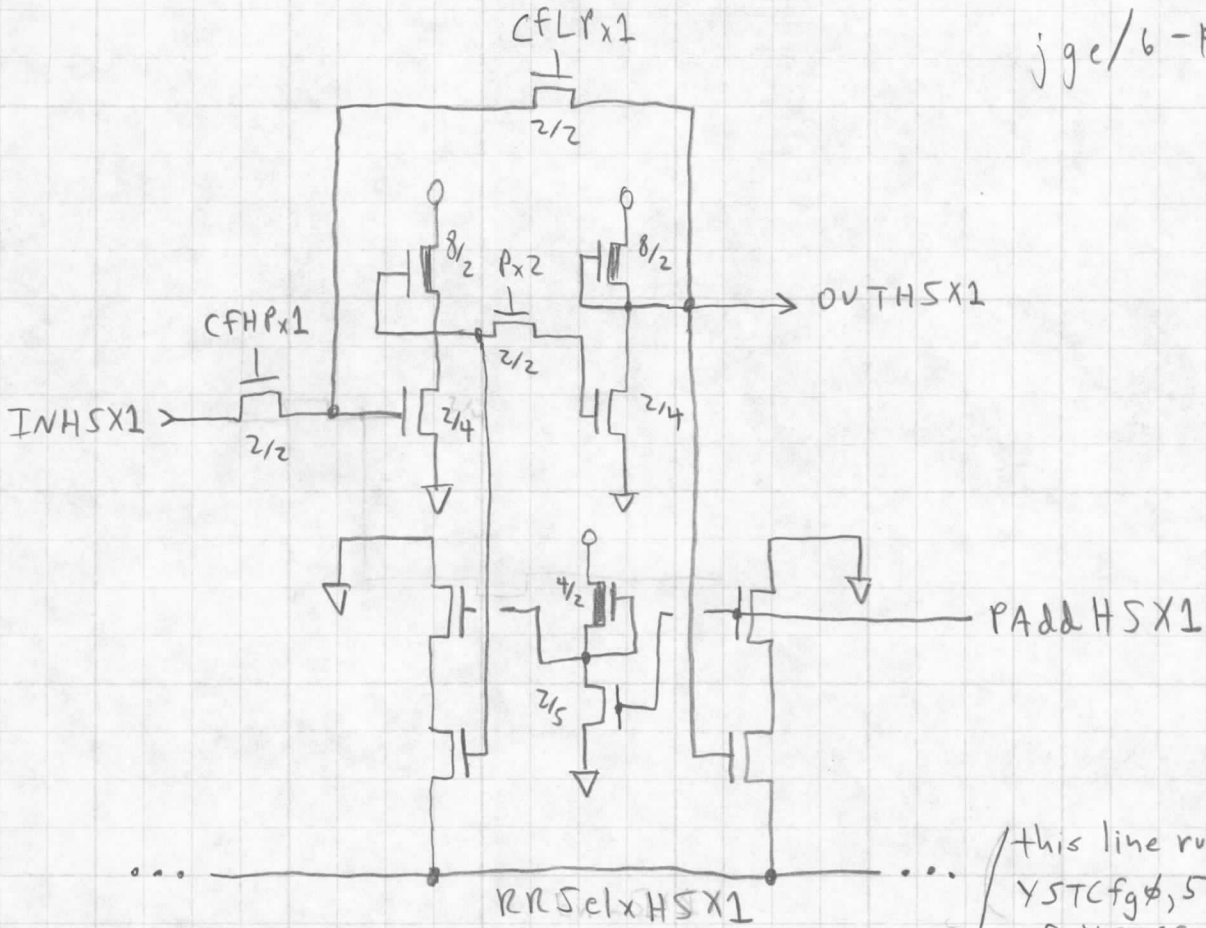
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YSTICfg

Power = 4 1/2 PW
 C1HPX1 = 2 CG
 CFLPX1 = 2 CG
 P2X2 = 2 CG

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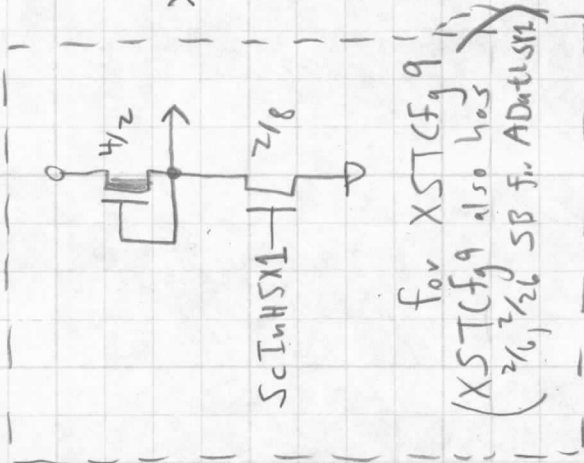


(this line runs thru YSTCf_g, 5 instances of YSTCf_gCmp, and YSTCf_g, forming a big NOR gate)

YSTCf_gCmp

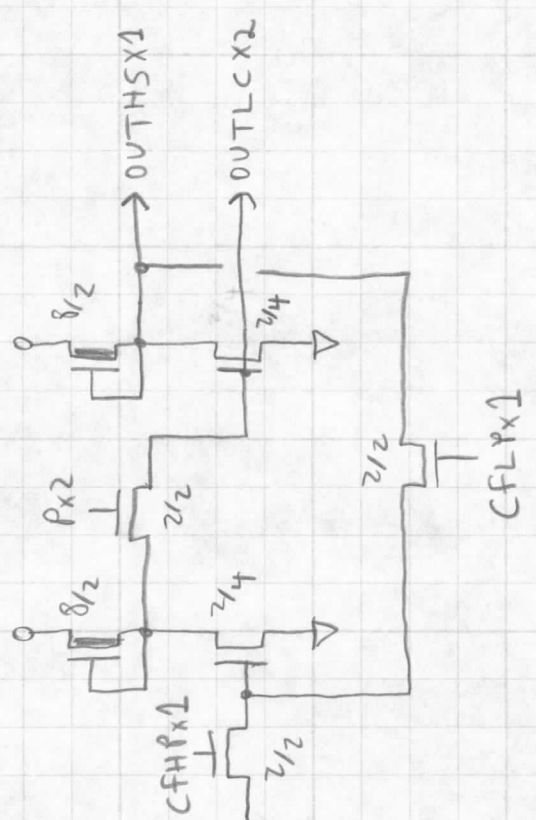
- power = 1 □ PU
- CFHPx1 = 1 CG
- CFLPx1 = 1 CG
- Px2 = 1 CG

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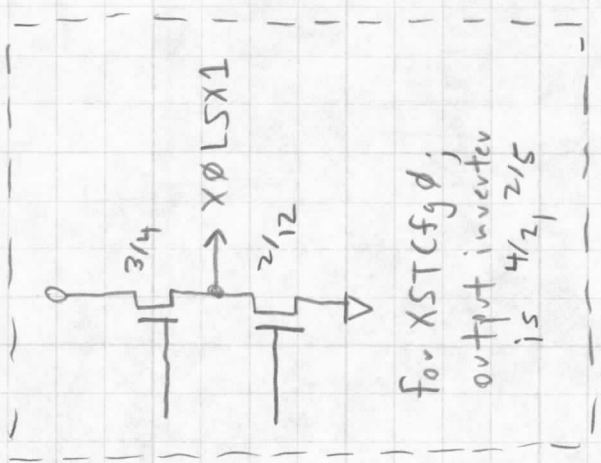
for XSTCF9
(XSTCF9 also has
 $2/6, 2/6$ SB for ADatLSH)

(YSTCF6 is similar to YSTCF9 but has $4/6, 2/12$ NTSB for PRScIHSX1)
power = 2 DPU
(XSTCF9 is similar to XSTCF9 but has $2/6, 2/6$ SB for ADatLSH)

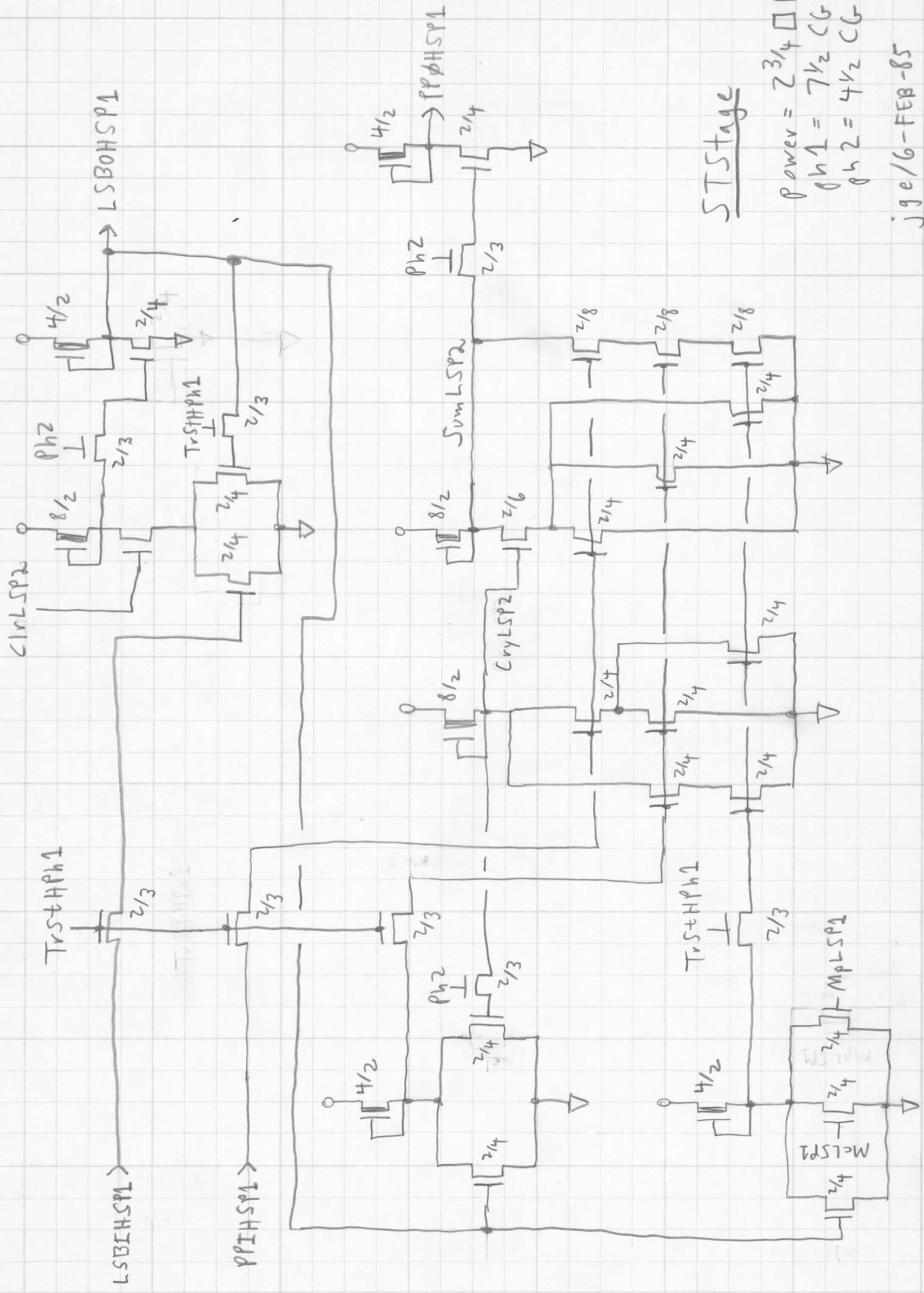


XSTCF9 + YSTCF9

power = $\begin{cases} 1/2 \text{ DPU for XSTCF9 + YSTCF9} \\ 2 1/2 \text{ DPU for XSTCF9} \\ 4 1/2 \text{ DPU for XSTCF9} \\ = 1 \text{ CG (1 1/2 CG for XSTCF9)} \end{cases}$
CFLPX1 = 1 CG
CFLYX1 = 1 CG
Px2 = 1 CG



for XSTCF9d;
output inverter is $4/2, 2/5$



STS stage

power = $2^{3/4} \square \mu$
 $Ph1 = 7^{1/2} CG$
 $Ph2 = 4^{1/2} CG$

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Derivatives of STS stage (1 of 2)

STS stage Root - same as STS stage,
but with $(4/4, 2/8)$ ISB
built using PPHSP1 inverter
power = $3^{3/4}$ \square PU
ph1 = $7\frac{1}{2}$ CG
ph2 = $4\frac{1}{2}$ CG

STS stage TL5B - $(4/4, 2/8)$ ISB built using
LSBOHSP1 inverter
pullup on LSB AOI becomes $4/2$
pulldowns " " " " $2/8$
power = 4 \square PU

STS stage XØ - $(2/4, 2/16)$ ISB to drive YLSBHSP1
built using LSBOHSP1 inverter
 $(4/4, 2/8)$ ISB to drive YCHSP1
built using PPHSP1 inverter
TrstHPh2 latch and complete ISB to
drive XClvLSP2 added
[inverter $(4/2, 2/7)$, output $(2/4, 2/16)$]

power = $8\frac{1}{4}$ \square PU
ph1 = $9\frac{1}{2}$ CG
ph2 = $4\frac{1}{2}$ CG

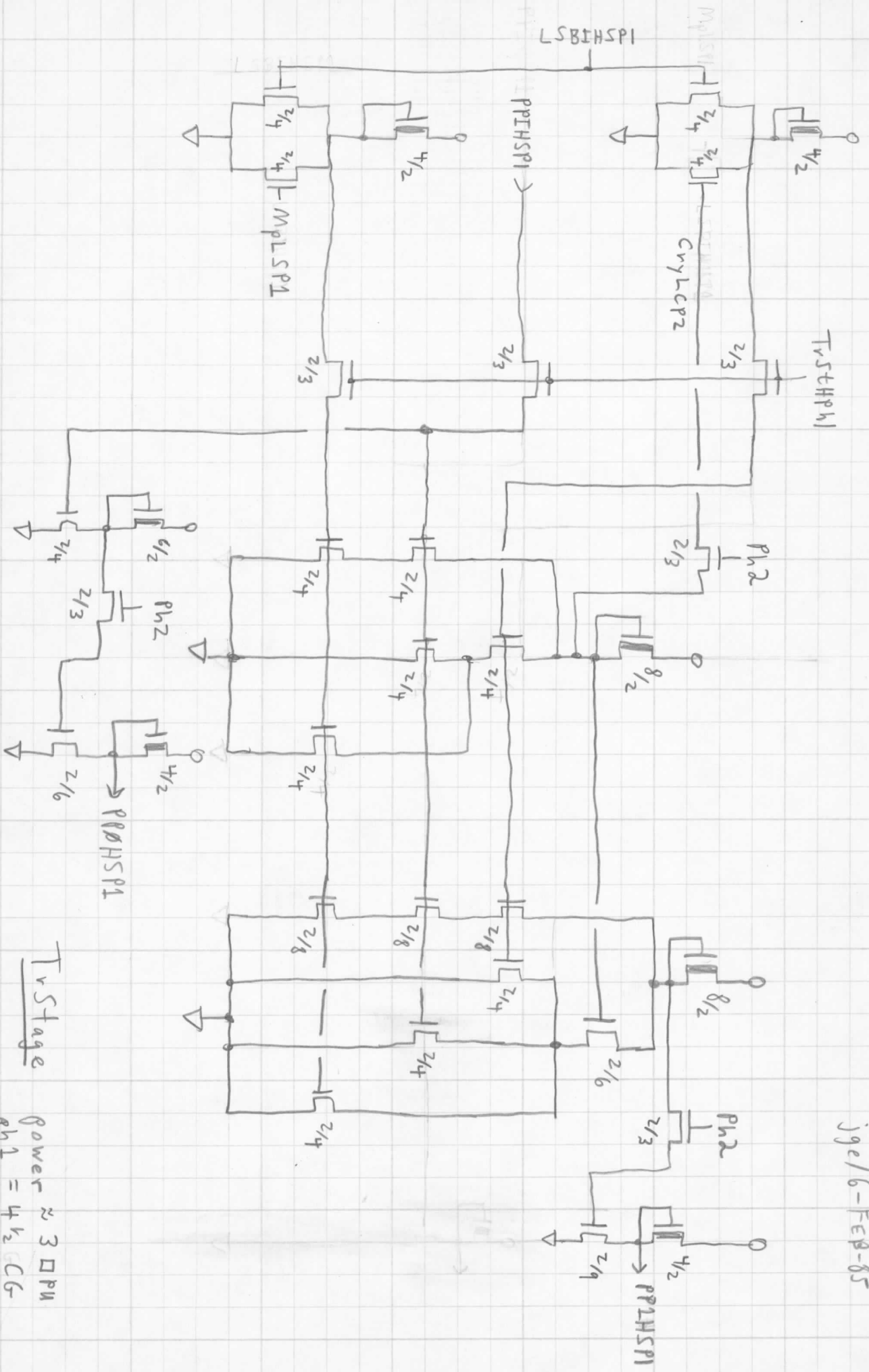
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Derivatives of STStage (2 of 2)

STStage YØ - ($4\frac{1}{4}, 2\frac{1}{8}$) ISB to drive Tree64HSP1
built using PPOHSP1 inverter
TrstHPh1 latch and complete ISB
to drive YC1rLSP2 added
[inverter ($4\frac{1}{2}, 2\frac{1}{4}$), output ($2\frac{1}{4}, 2\frac{1}{16}$)]
($2\frac{1}{6}, 2\frac{1}{24}$) ISB to drive TLSBØHSP1
built using LSBØHSP1 inverter
pullup on LSB AOI becomes $4\frac{1}{2}$
pulldwn " " " " $2\frac{1}{8}$

power = $9\frac{1}{2}$ DPH
ph1 = $9\frac{1}{2}$ CG
ph2 = $4\frac{1}{2}$ CG

STStage X9 - identical to STStage, but
rearranged to make room
for ~~ADattst1~~ superbuffer
in ~~XSTCFg9~~



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Tr5tHPh1

power $\approx 3 \text{ DPu}$
 $ph1 = 4 \frac{1}{2} \text{ CG}$
 $ph2 = 4 \frac{1}{2} \text{ CG}$

Tr5tHPh1 power

Derivatives of "TrStage" (L.F 1)

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TrUQuadPot - contains 4 instances of TrStage
(like TrUQuad) but has
an ISB to drive PP0HSP1 of
the root tree node built using
its PP0HSP1 inverter ($4/4, 2/8$)
and ISB to drive PP1HSP1 of
the root tree node built using
its PP1HSP1 inverter ($2/4, 2/16$)