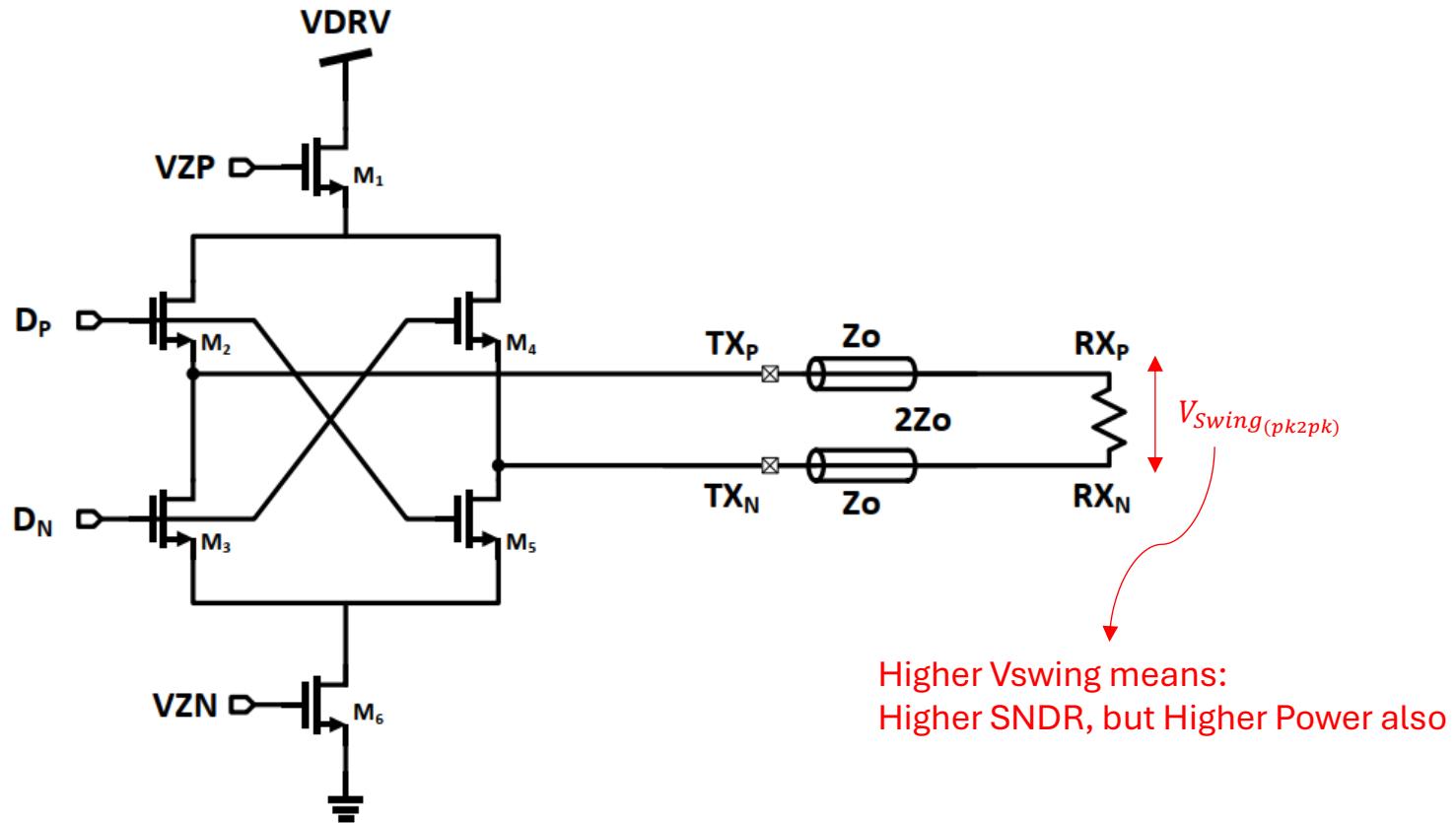


Tx Driver - VM

1 Gbps

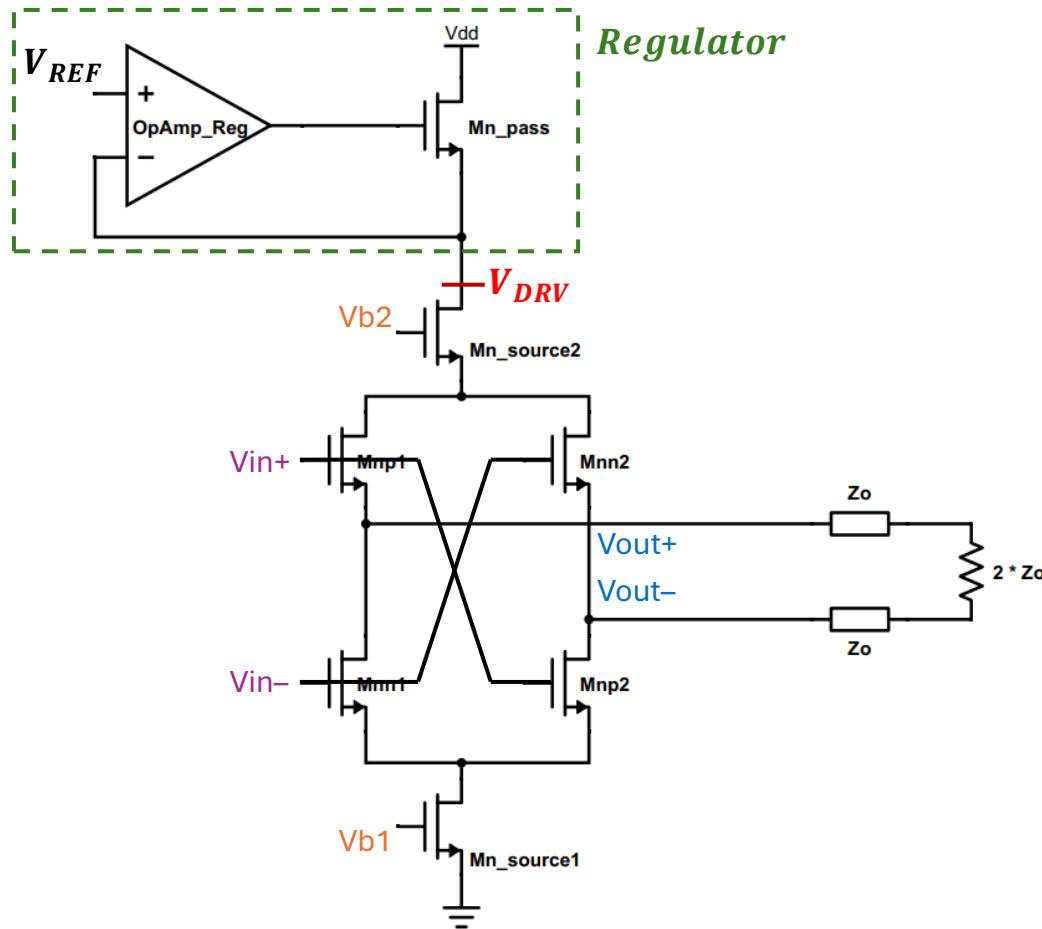
Muhammad Aldacher

Voltage-Mode Driver (VM)



1) Without Replica

$$V_{\text{Swing}_{(pk2pk)}} = V_{\text{DRV}} = V_{\text{REF}}$$



For $V_{\text{Swing}_{(pk2pk)}} = 500 \text{ mV}$:

$$V_{\text{REF}} = V_{\text{DRV}} = 500 \text{ mV}$$

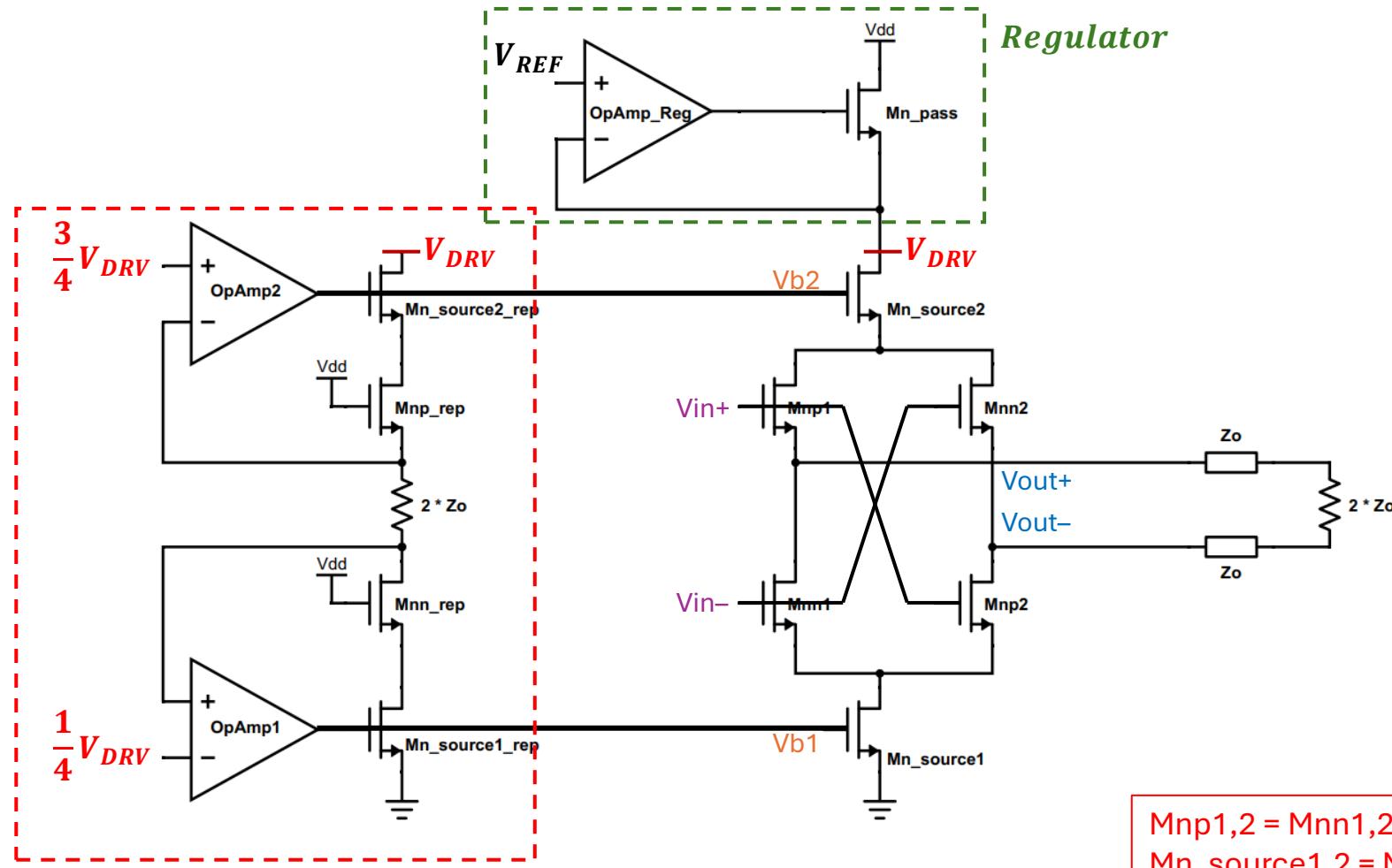
Device Sizing:

- Input devices (Mnp1,2 & Mnn1,2) act as switches, so we should increase W (reducing R_{ON}) to improve headroom.
- Bias devices (Mn_source1,2) should have their W & gate voltages Vb1,2 adjusted so that the output voltages would be at $\frac{3}{4} V_{\text{DRV}}$ & $\frac{1}{4} V_{\text{DRV}}$.

$M_{\text{np1,2}} = M_{\text{nn1,2}}$:	$L = L_{\text{MIN}}$, $m = 100x$
$M_{\text{source1,2}}$:	$L = L_{\text{MIN}}$, $m = 200x$

2) With Replica

$$V_{Swing(pk2pk)} = V_{DRV} = V_{REF}$$



- For the L of the Bias devices ($M_{source1,2}$), We can use minimum L, because the feedback loops in the replica branch will adjust the currents to give the correct output swing anyway.

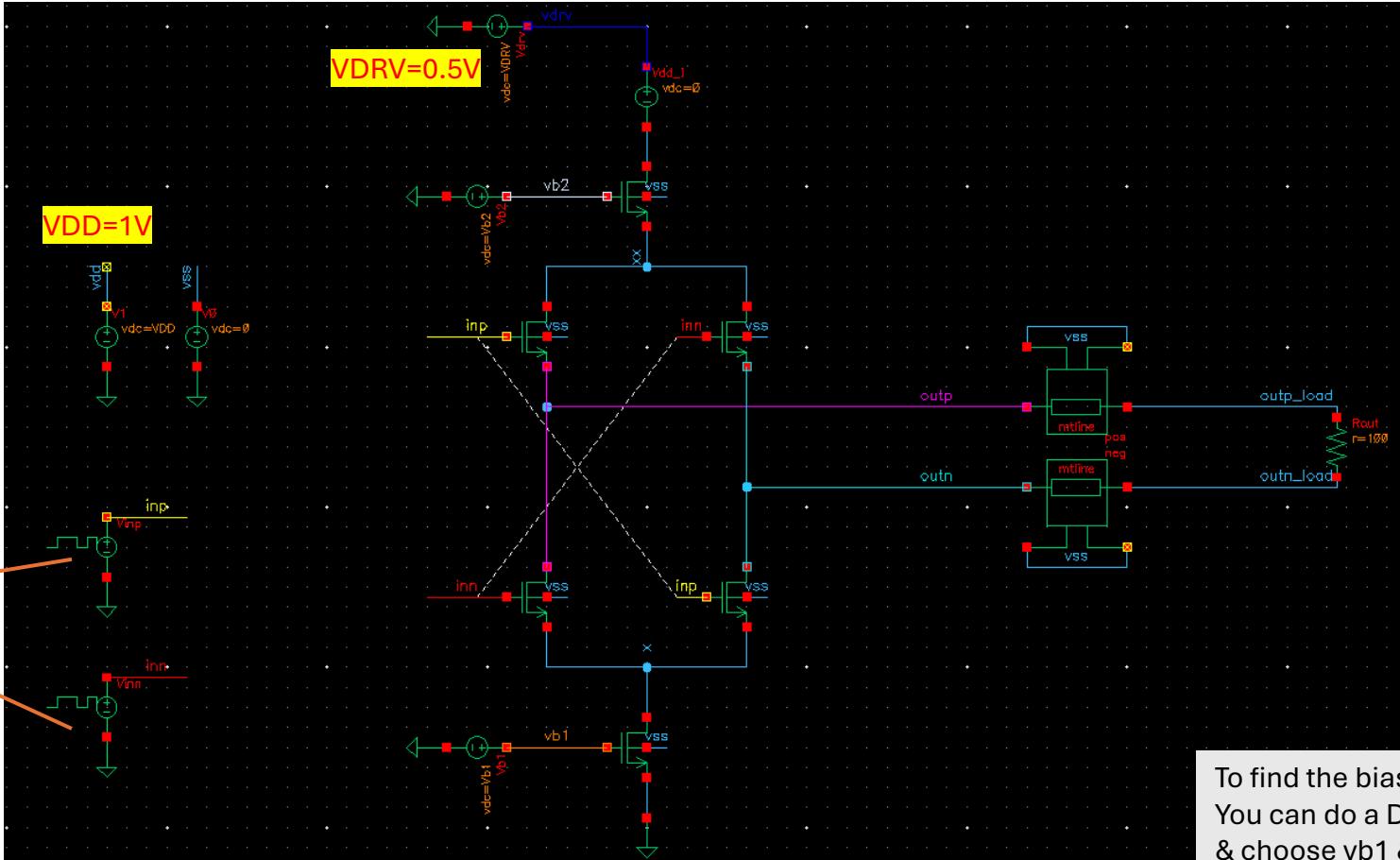
$M_{np1,2} = M_{nn1,2} = M_{np1,2_rep} = M_{nn1,2_rep} : L = L_{MIN} , m=100x$
 $M_{source1,2} = M_{source1,2_rep} : L = L_{MIN} , m=200x$

Testbenches & Setups

- VDD = 1V
- Data-Rate = 1 Gb/s
- VSWING = 0.5V (pk2pk)

Testbench

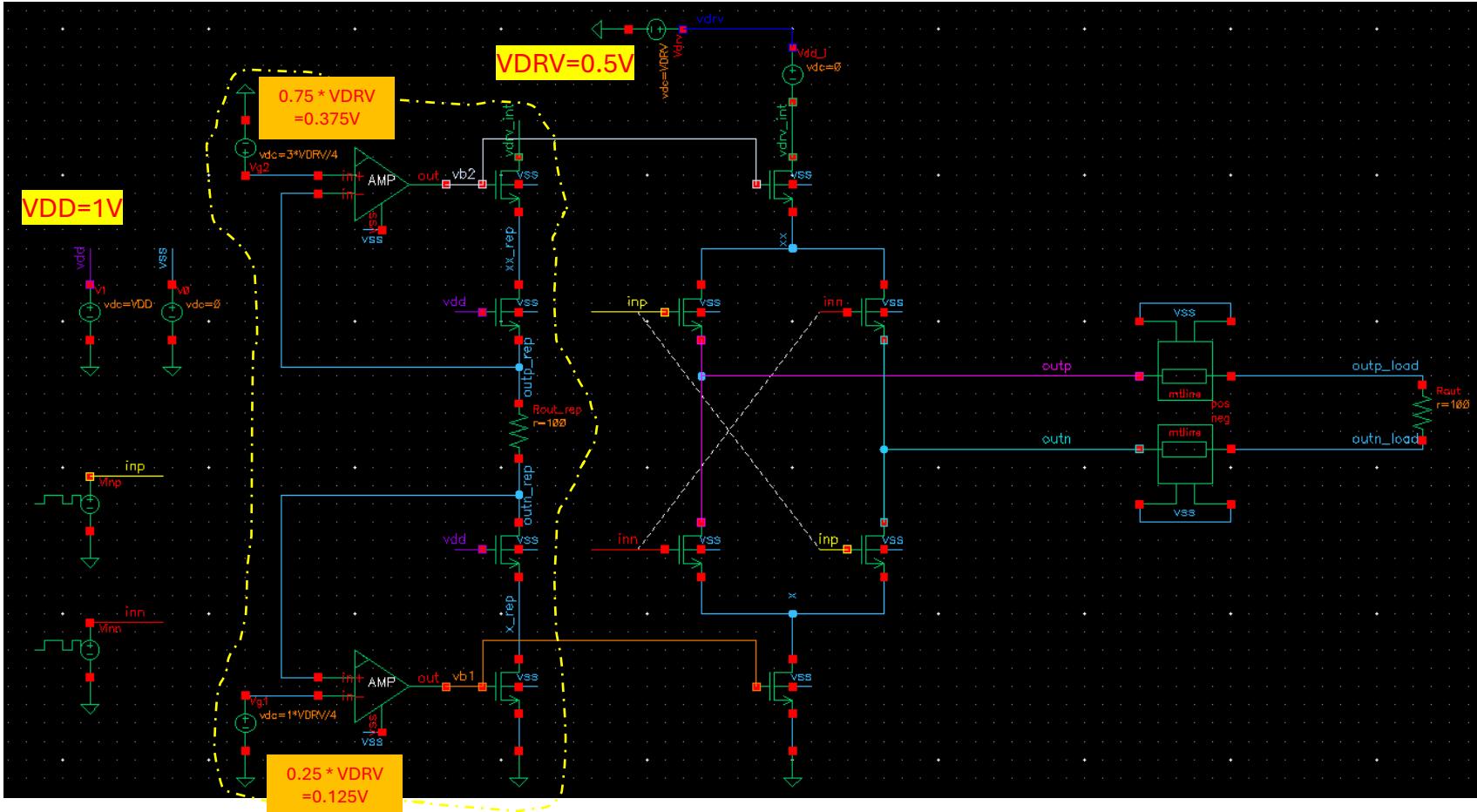
A) Without Replica



To find the bias voltages $vb1$ & $vb2$,
You can do a DC-sweep with $inp=1$ & $inn=0$,
& choose $vb1$ & $vb2$ that would give outputs
of $\frac{3}{4} VDRV$ & $\frac{1}{4} VDRV$.

Testbench

B) With Replica



Channel Settings (mtline)

→ For Zo = 50 Ohms:

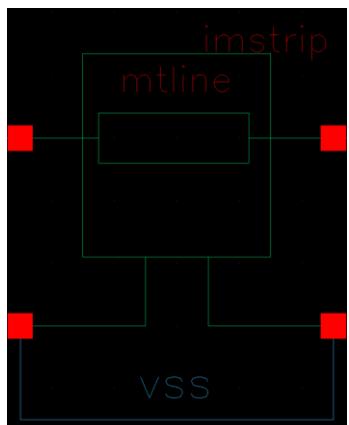
$$Z_0 \approx \frac{87}{\sqrt{\epsilon_r + 1.41}} \ln \left(\frac{5.98 H}{0.8 W + T} \right)$$

Dielectric_const = ϵ_r = 4.8

Dielectric_thickness = H = 360u

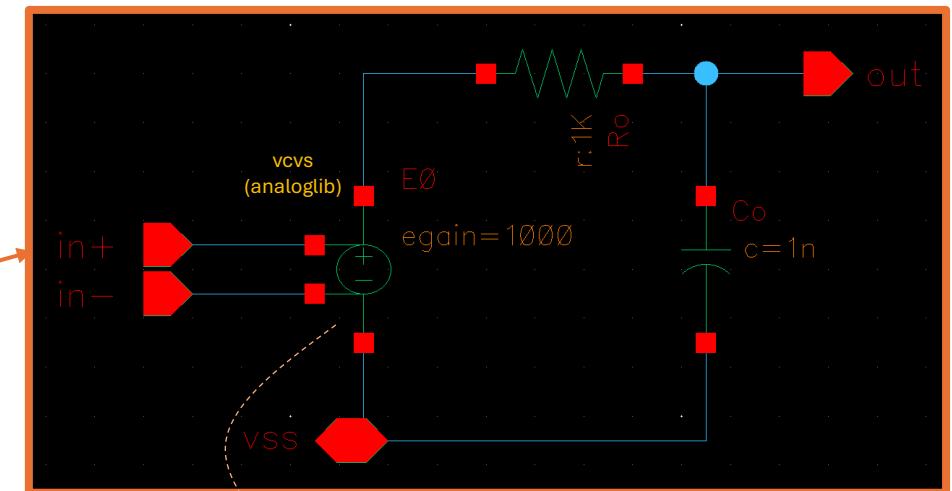
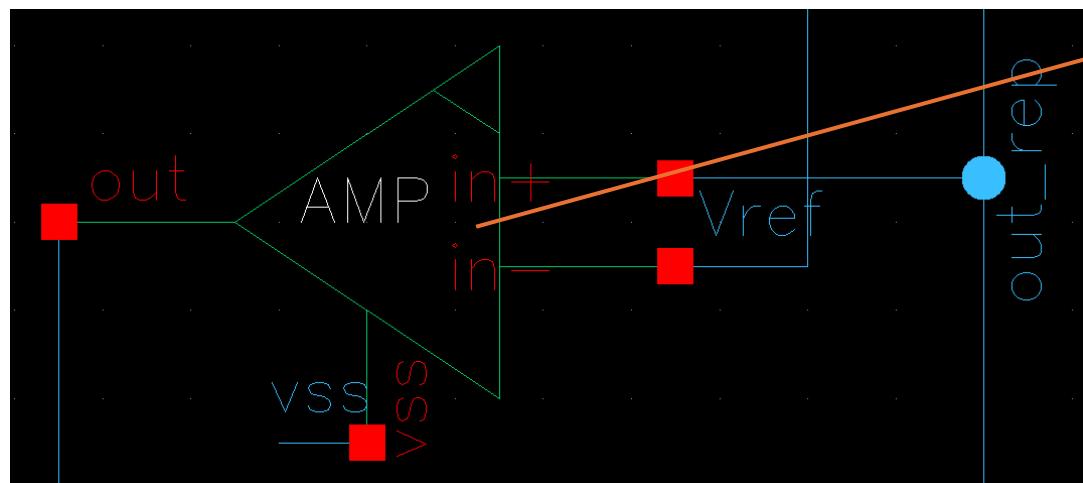
Line_width = W = 625u

Line_thickness = T = 17.78u



CDF Parameter	Value
Library Name	analogLib
Cell Name	mtline
Num of lines (excluding ref1)	
Model name	
Physical length	100m M
Multiplicity factor	1
Max signal frequency	
Type of Input	FieldSolver
Generate noise?	no
Transmission line type	microstrip
Model type	wideband
Rel dielectric const of layer	4.8
Dielectric layer thickness	360u
Signal line width	625u
Signal line thickness	17.78u
Signal line spacing	

Ideal OpAmp



Library Name: **analogLib**

Cell Name: **vcvs**

CDF Parameter	Value
Type of transfer char	<input checked="" type="radio"/> Linear <input type="radio"/> PWL
Smoothing Factor	
Voltage gain	1000
Multiplier	
Maximum Output Voltage	1
Minimum Output Voltage	0

Simulation Setup

Name	Value
Filter	Filter
Tests	
tran	
Simulator	spectre
Analyses	
tran	0 VAR("sim_time")
Click to add analysis	
Design Variables	
Click to add test	
Global Variables	
sim_time	1000n
VDD	1
Vsw_pk2pk	500m
VDRV	Vsw_pk2pk
Vb2	665m
Vb1	280m
Click to add variable	
Parameters	
Corners	
Nominal	
TT	
Click to add corner	

Choosing Analyses -- ADE Assembler

Analysis tran dc ac
 noise xf sens
 dcmatch acmatch stb
 pz lf sp
 envlp pss pac
 pstb pnoise pxf
 psp qpss qpac
 qpnoise qpxf qpsp
 hb hbac hbstb
 hbnoise hbsp hbxf

Transient Analysis

Stop Time

Accuracy Defaults (errpreset)

Transient Noise

Dynamic Parameter

HV_solution

Enabled Options...

OK Cancel Defaults Apply Help

Time Step Algorithm State File Output EM/IR Output

SIMULATION INTERVAL PARAMETERS

start

outputstart

TIME STEP PARAMETERS

step

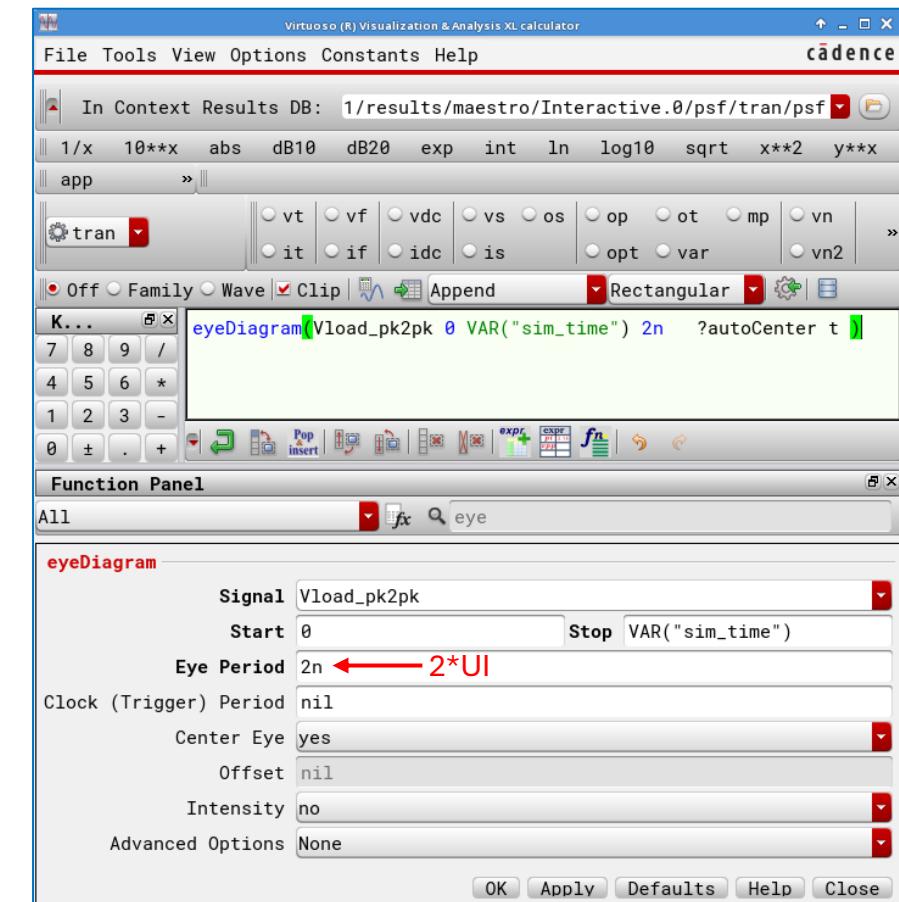
maxstep

minstep

Measurements

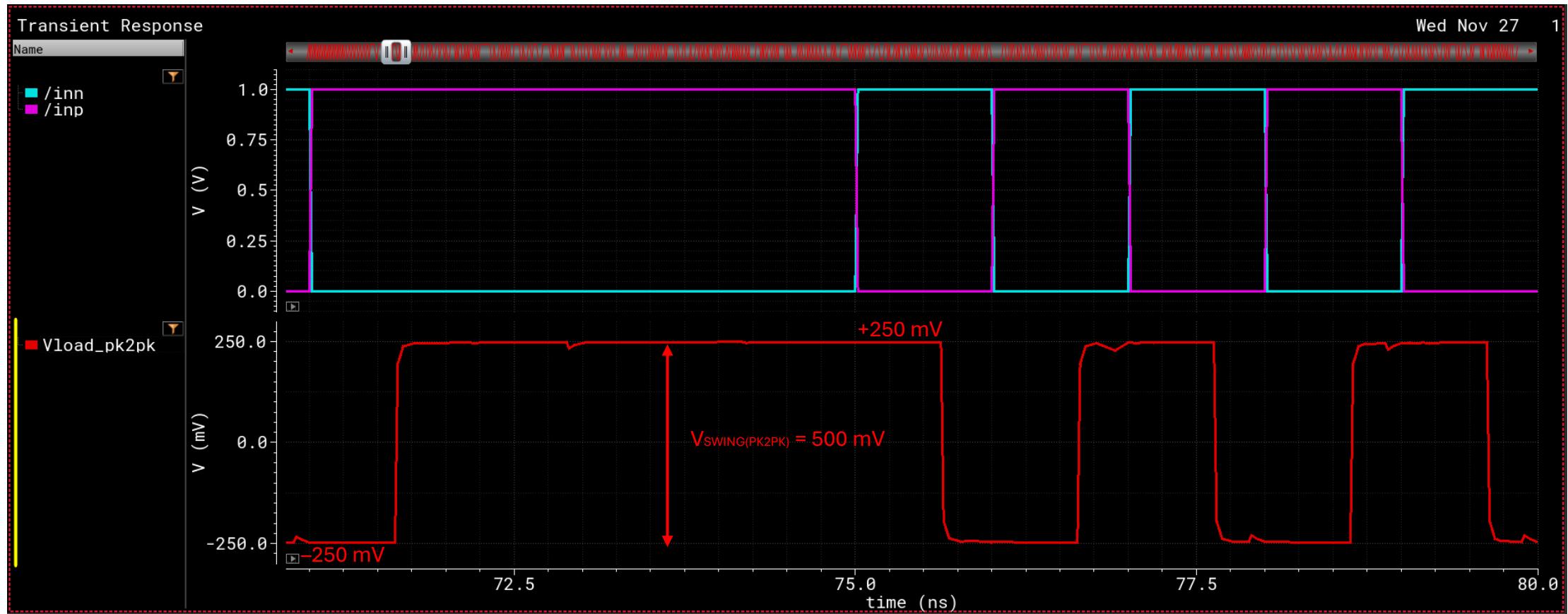
Name	Type	Details	EvalType
*** Voltages ***	expr		point
	signal	/inp	point
	signal	/inn	point
	signal	/outp	point
	signal	/outn	point
	signal	/outp_load	point
	signal	/outn_load	point
	signal	/x	point
	signal	/xx	point
	signal	/vdrv	point
	signal	/vb2	point
	signal	/vb1	point
	signal	/x_rep	point
	signal	/xx_rep	point
	signal	/outp_rep	point
	signal	/outn_rep	point
*** Currents ***	expr		point
/Vdd_I/PLUS_I	signal	... /Vdd_I/PLUS	point
/Rout/PLUS_I	signal	... /Rout/PLUS	point
*** Outputs ***	expr		point
Vtxout_pk2pk	expr	(VT("/outp") - VT("/outn"))	point
Vtxout_eye	expr	eyeDiagram(Vtxout_pk2pk 0 VAR("sim_time") 2e-09 ?autoCenter t)	point
Vload_pk2pk	expr	(VT("/outp_load") - VT("/outn_load"))	point
Vload_eye	expr	eyeDiagram(Vload_pk2pk 0 VAR("sim_time") 2e-09 ?autoCenter t)	point

eyeDiagram(VT("/outp_load")-VT("/outn_load") 0 VAR("sim_time") 2n ?autoCenter t)

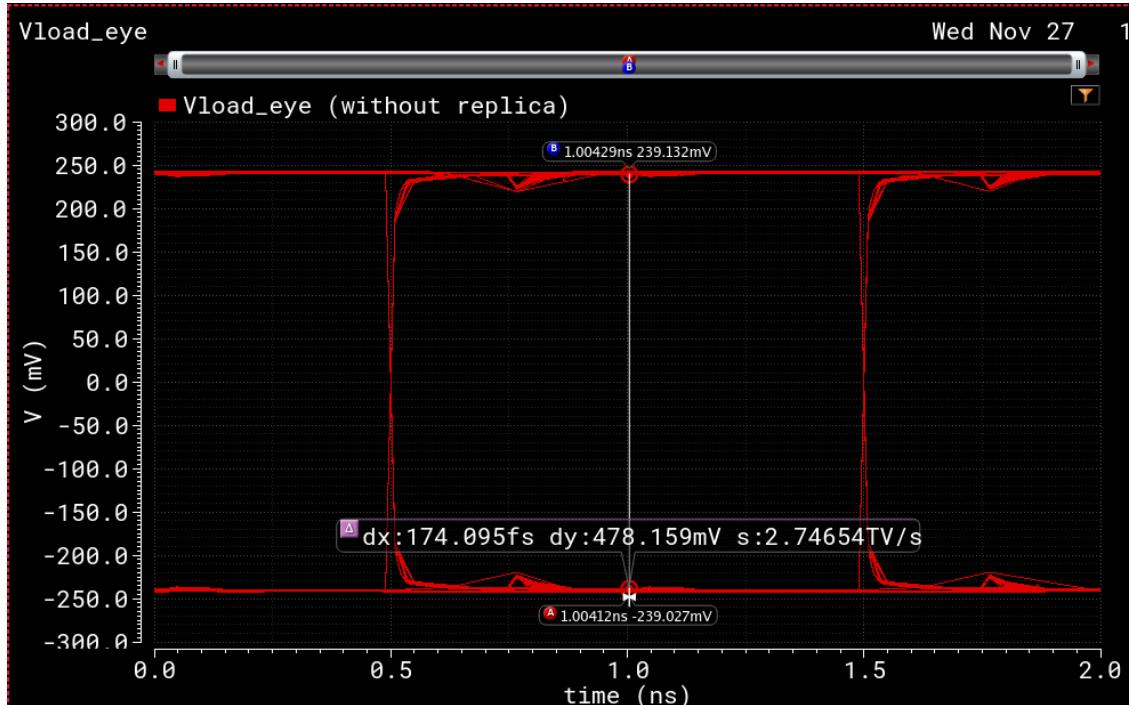


Simulations & Results

Waveforms

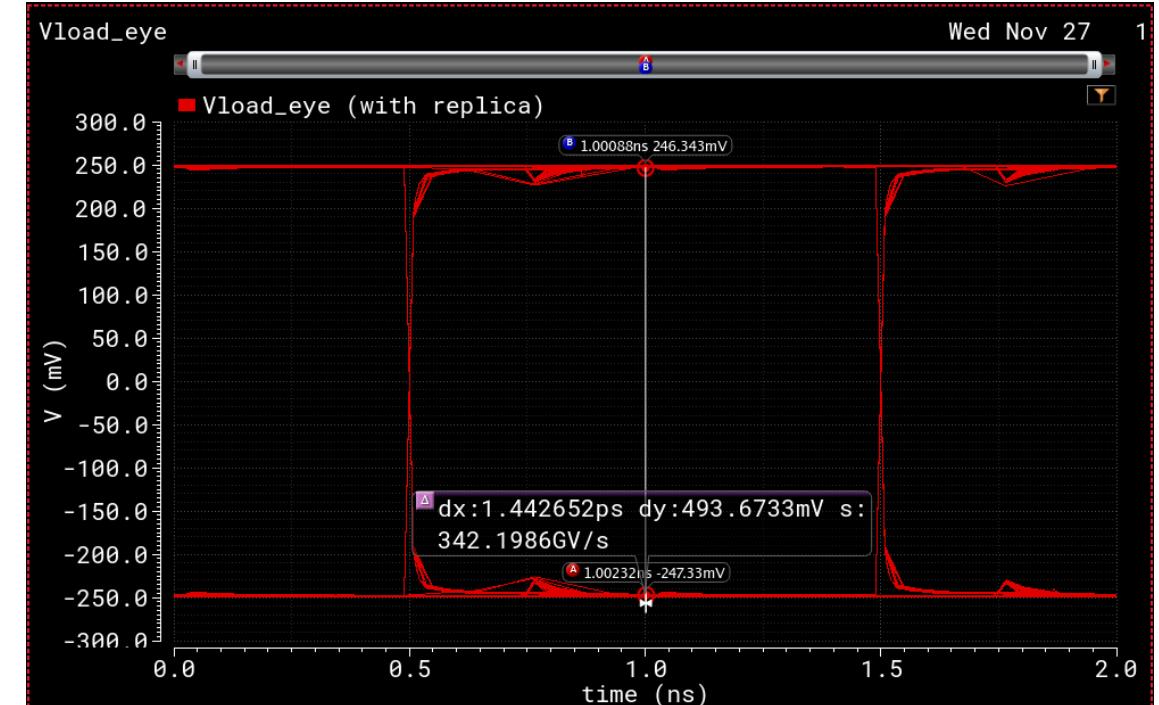


Waveforms (Eye-Diagrams)



No Replica:

$$V_{SW(\text{pk2pk})} = 478.16 \text{ mV}$$



With Replica:

$$V_{SW(\text{pk2pk})} = 493.67 \text{ mV}$$

→ More Accurate Swing, at the expense of additional power drawn by an extra branch & the OpAmps

(For more info on how to measure Eye Diagrams)

Current Consumption

- Total current drawn = 5 mA
 - (2.5 mA from main driver + 2.5 mA from Replica branch)
 - (OpAmps not included)