

Energy ASIC for ECAL Upgrade II

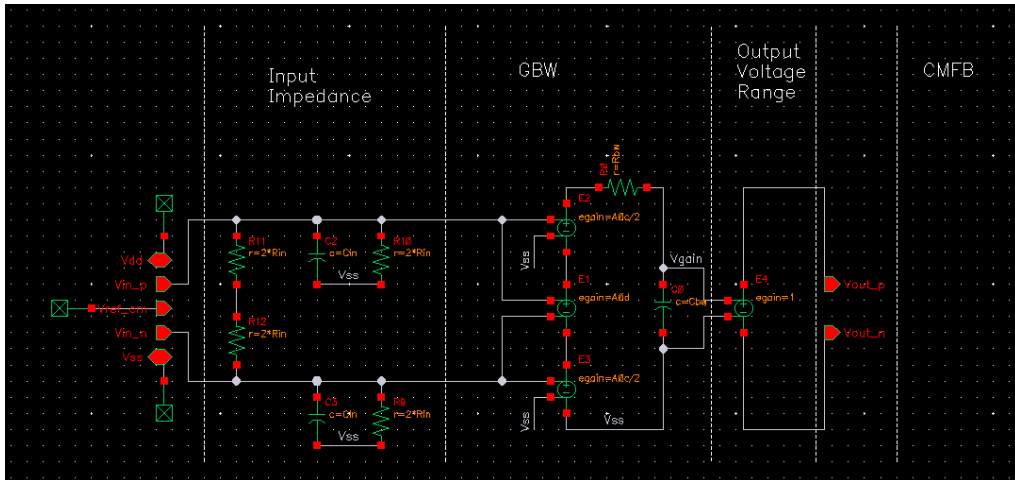
José Mazorra de Cos

Instituto de Física Corpuscular (CSIC-UV)

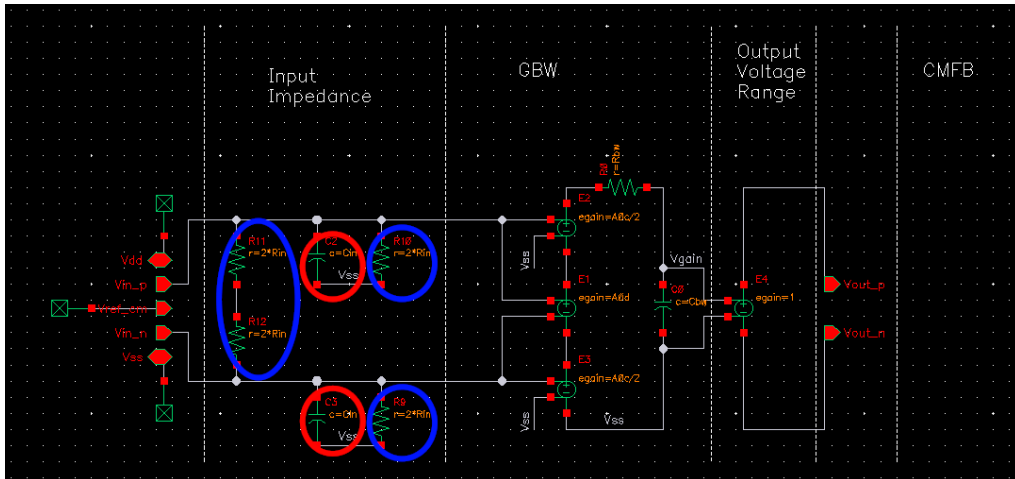


ECAL Upgrade II BCN-VLC - 3rd March 2023

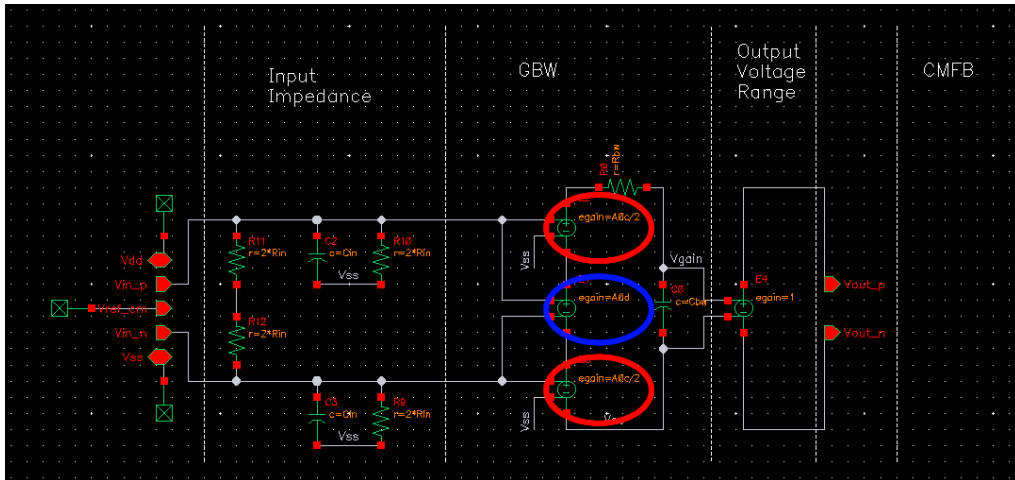
- Simple OTA macromodel derived from Sedra & Smith 2009 Appendix B.1.1.



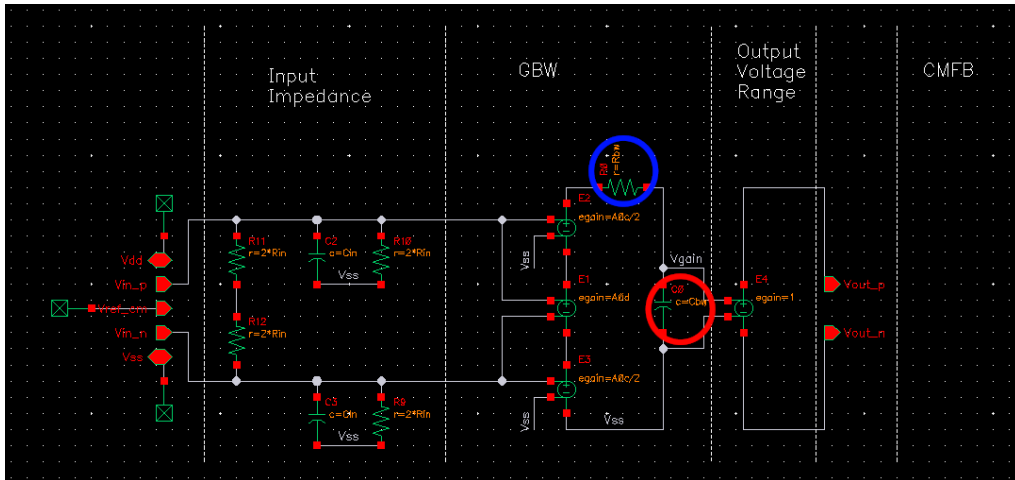
- Input capacitance and resistance, divided into differential and common.



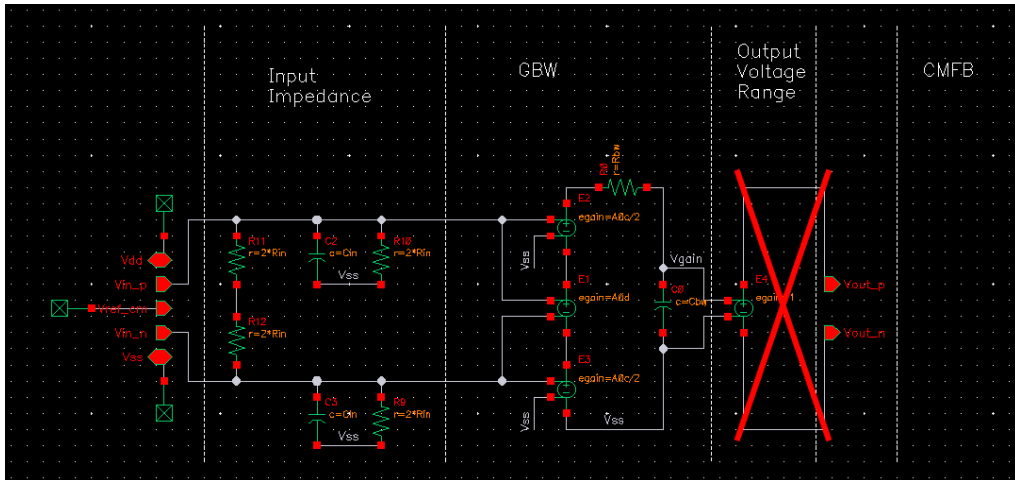
- Independent **common** and **differential** gain.



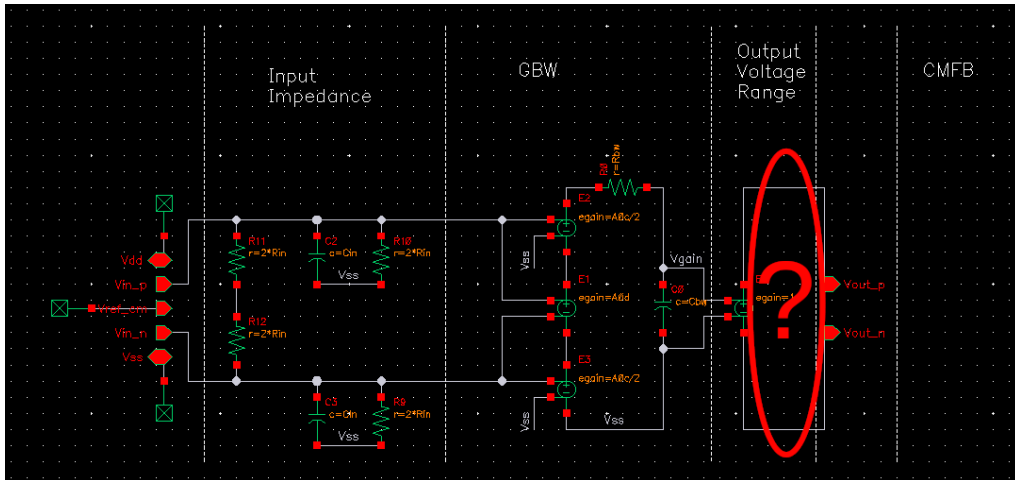
- Compensated OTA, dominant pole through simple RC network.



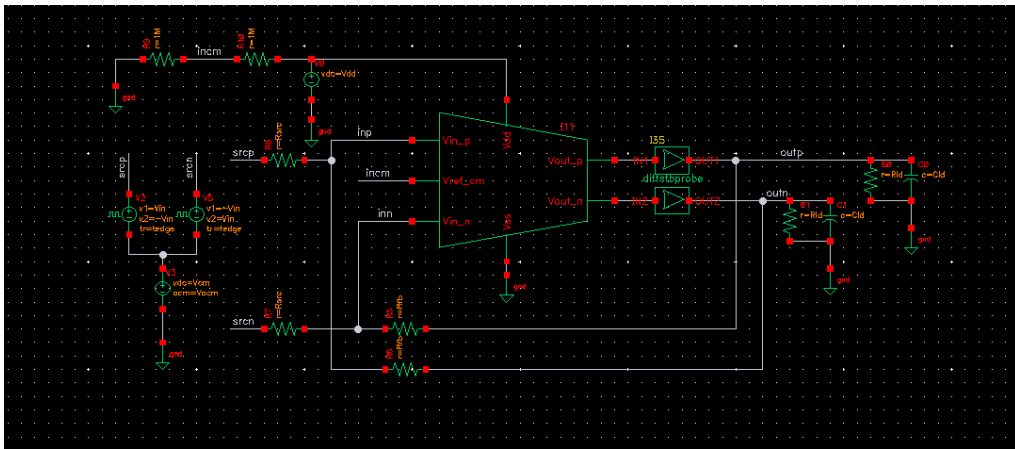
- Model missing non-linear effects such as slew rate or saturation.



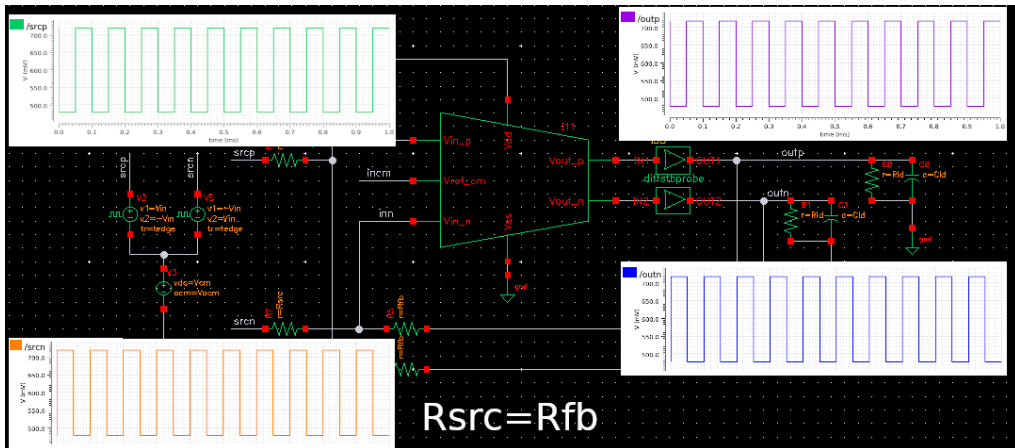
- NO output impedance, doubts in implementation for differential signal.



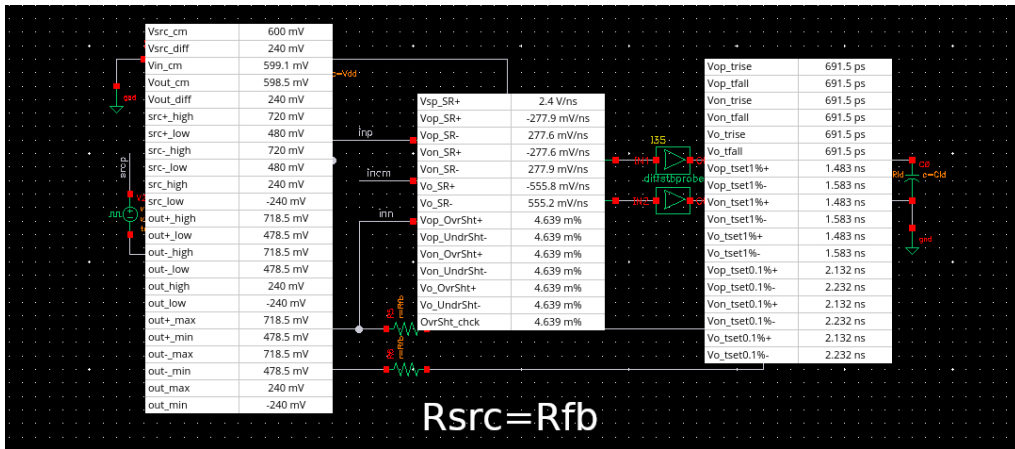
- Common testbench for DC, transient, AC and stability simulations.



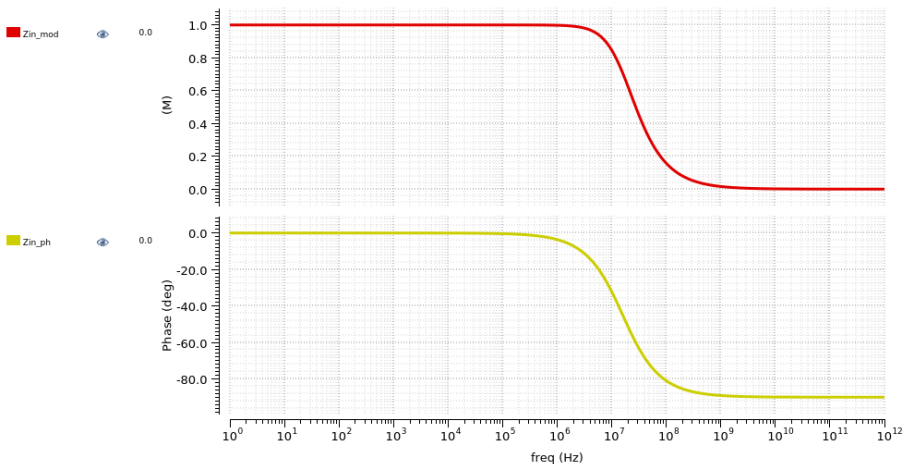
- Output signal replicates input signal, but without saturating.



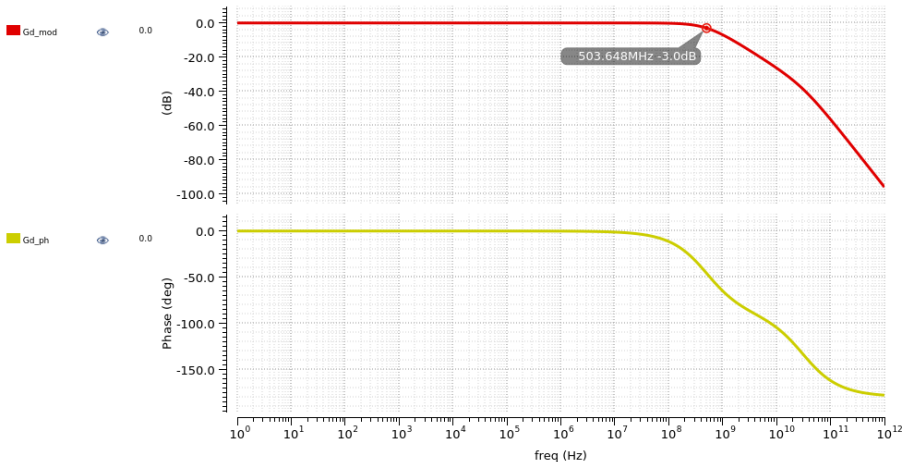
- Basic measurements implemented (overshoot, rise time, slew rate ...).



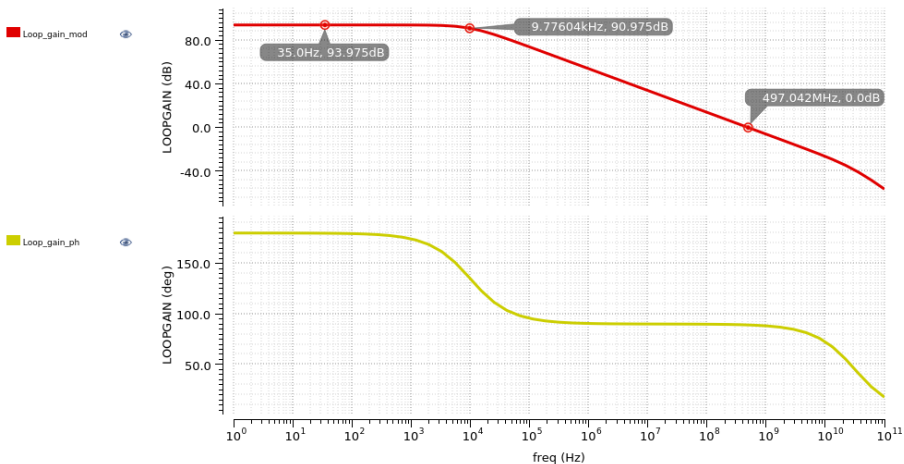
- With $R_{in}=1M\Omega$; $C_{in}=10fF$; $A_{0diff}=100k$; $A_{0cm}=1$; $R_{bw}=1k\Omega$; $C_{bw}=16nF$;



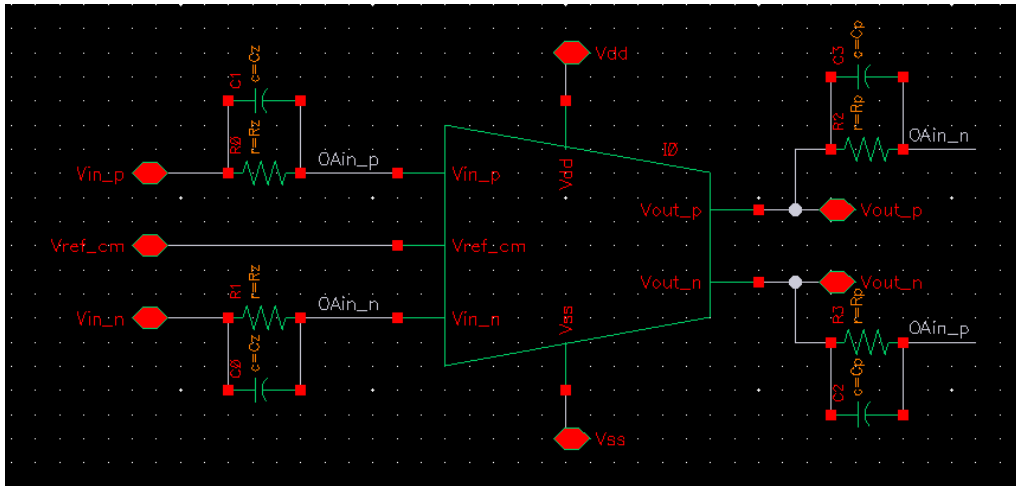
- With $R_{in}=1M\Omega$; $C_{in}=10fF$; $A_{0diff}=100k$; $A_{0cm}=1$; $R_{bw}=1k\Omega$; $C_{bw}=16nF$;



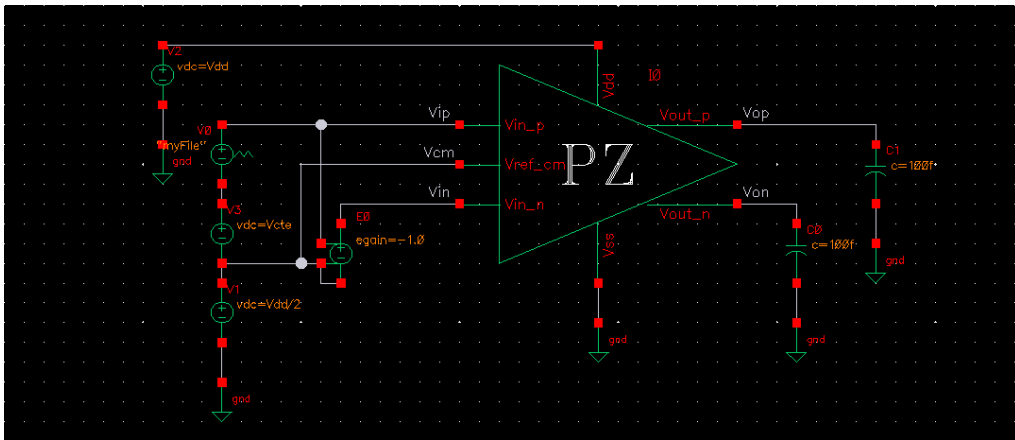
- With $R_{in}=1M\Omega$; $C_{in}=10fF$; $A_{0diff}=100k$; $A_{0cm}=1$; $R_{bw}=1k\Omega$; $C_{bw}=16nF$;



- OTA macromodel based shaper design still with ideal components.



- Testbench with parametric FLW source to select pulse shape.



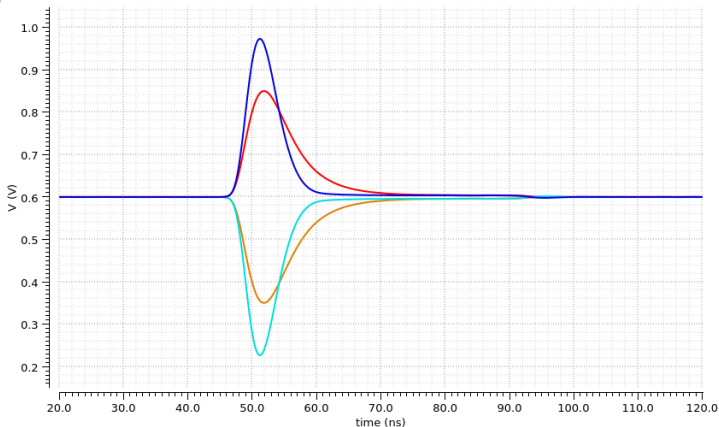
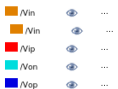
- Polystyrene shape almost fits clock period, but weird tail effect.

Transient Response

Tue Feb 21 13:13:37
2023

1

Name ...



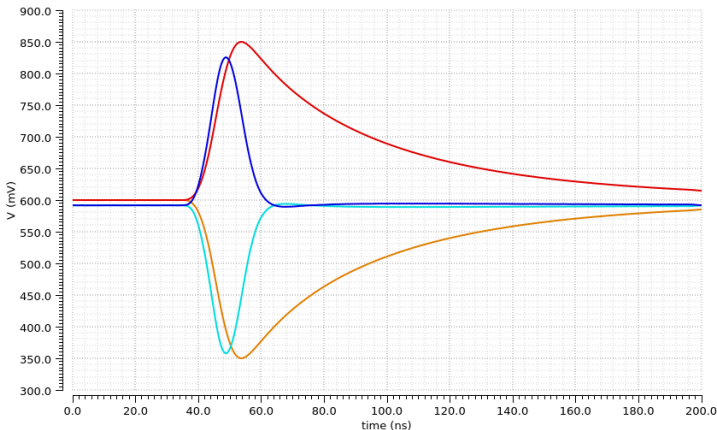
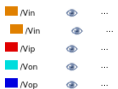
Vidf_pw2%	30.13 ns
Vidf_pk	500 mV
Vidf_area	4.692 nV-s
Vidf_A_PRE	-20.81 m%
Vidf_A_BX-1	-48 m%
Vidf_A_BX0	95.77 %
Vidf_A_BX1	4.518 %
Vidf_A_BX2	39.63 m%
Vidf_A_BX3	7.938 m%
Vidf_A_POST	-264.9 m%

Vdf_pw2%	15.11 ns
Vdf_pk	746.3 mV
Vdf_area	4.693 nV-s
Vdf_area_BX0	4.494 nV-s
Vdf_A_PRE	-33.9 m%
Vdf_A_BX-1	-42.21 m%
Vdf_A_BX0	96.93 %
Vdf_A_BX1	3.48 %
Vdf_A_BX2	-72.11 m%
Vdf_A_BX3	6.681 m%
Vdf_A_POST	-268.4 m%

- GFAG shape not fully available, but shaper reaches 25ns.

Transient Response

Name ...



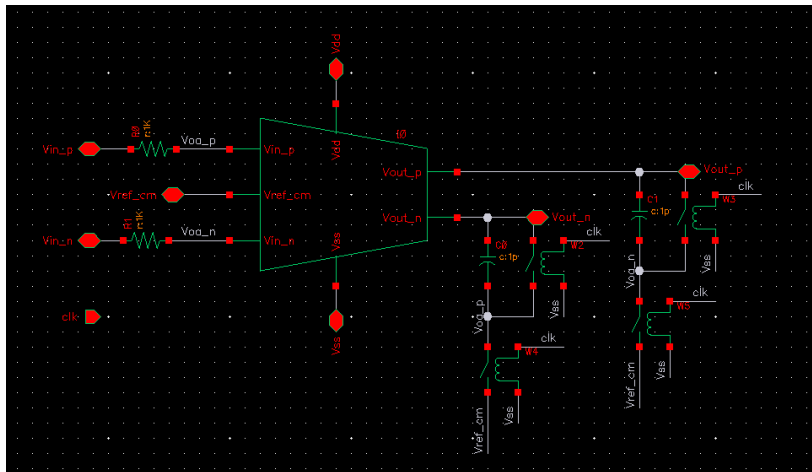
Tue Feb 21 13:13:37
2023

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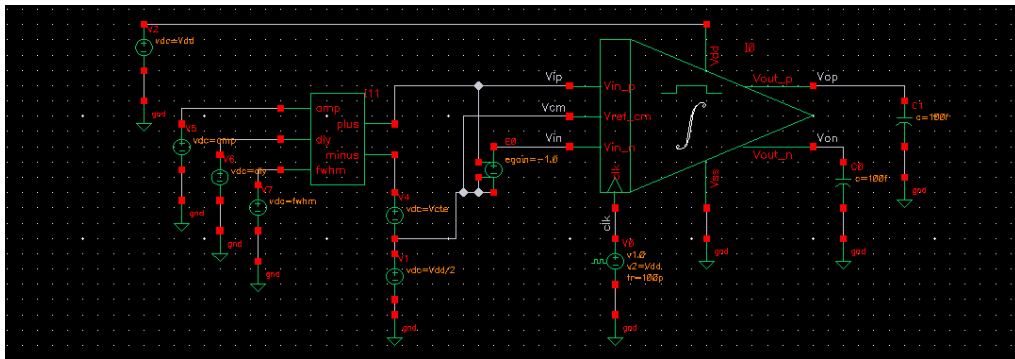
Vidf_pw2%	eval err
Vidf_pk	500 mV
Vidf_area	26.69 nV-s
Vidf_A_PRE	-3.436 m%
Vidf_A_BX-1	-11.68 m%
Vidf_A_BX0	28.6 %
Vidf_A_BX1	30.35 %
Vidf_A_BX2	17.45 %
Vidf_A_BX3	10.65 %
Vidf_A_POST	12.96 %

Vodf_pw2%	24.85 ns
Vodf_pk	467.6 mV
Vodf_area	5.988 nV-s
Vidf_area_BX0	7.635 nV-s
Vodf_A_PRE	-22.35 m%
Vodf_A_BX-1	-10.95 m%
Vodf_A_BX0	91.62 %
Vodf_A_BX1	488.4 m%
Vodf_A_BX2	2.099 %
Vodf_A_BX3	2.125 %
Vodf_A_POST	3.704 %

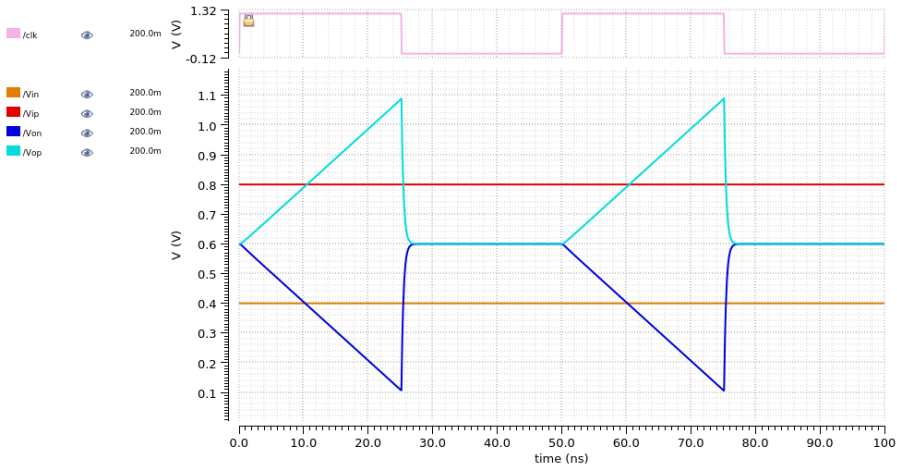
- OTA macromodel based integrator design still with ideal components.



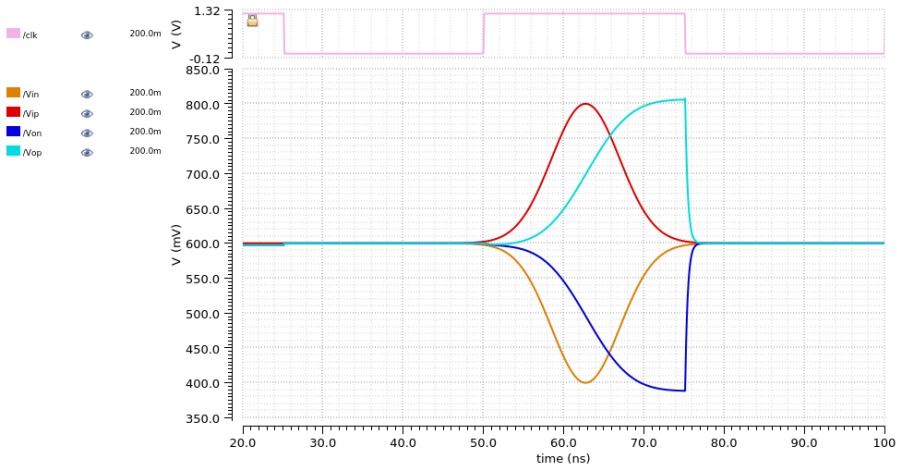
- Testbench with constant voltage and parametric gaussian pulse options.



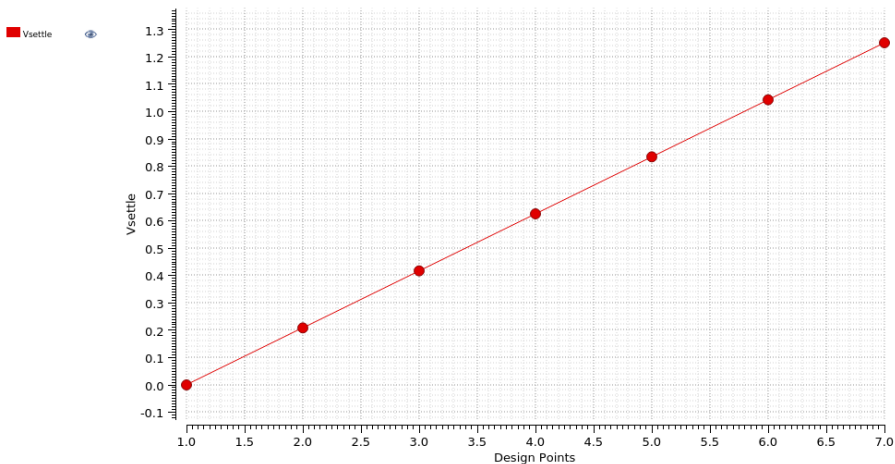
- Expected linear capacitor load but missing OTA saturation.



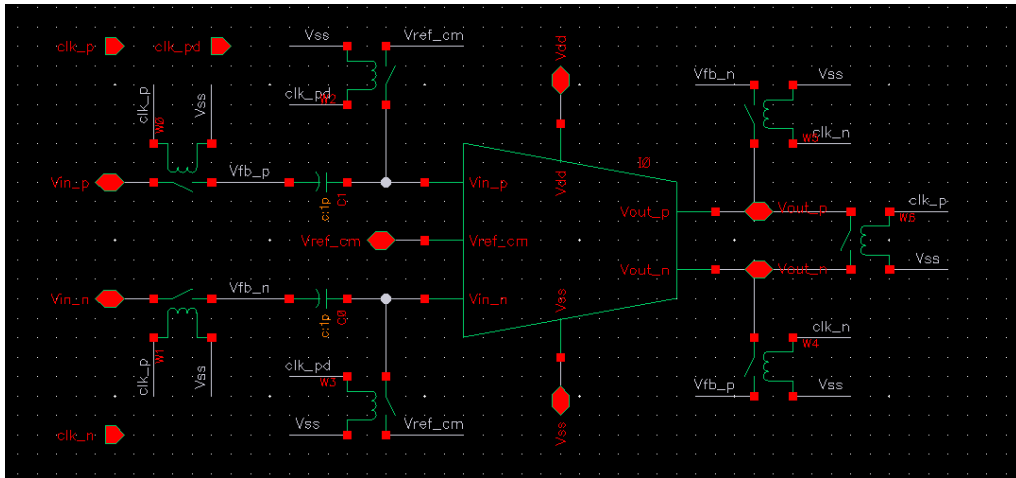
- Unity gain fitted for $\sigma=10\text{ns}$ gaussian centered in clock cycle.



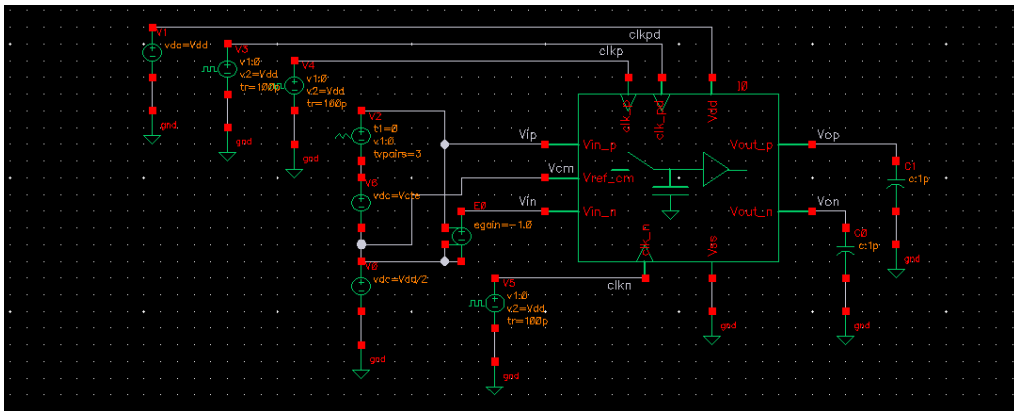
- As expected, ideal linearity with 0V:0.1V:0.6V pulse amplitude sweep.



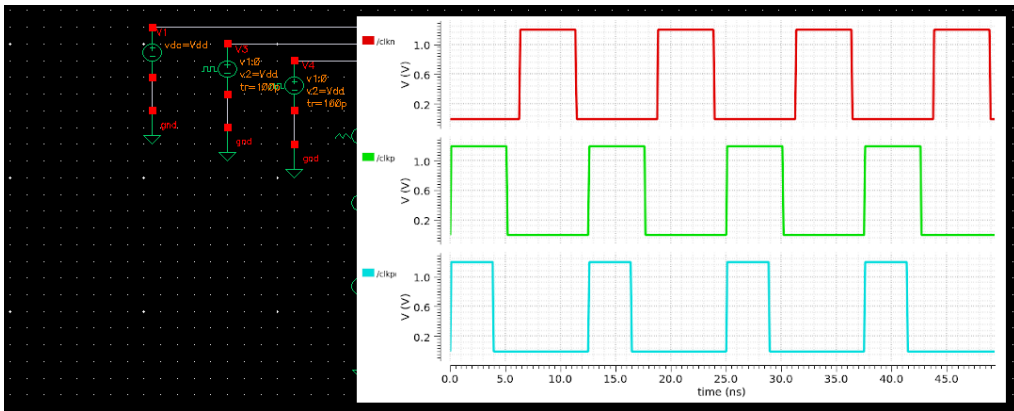
- OTA macromodel based T&H design with bottom plate disconnection.



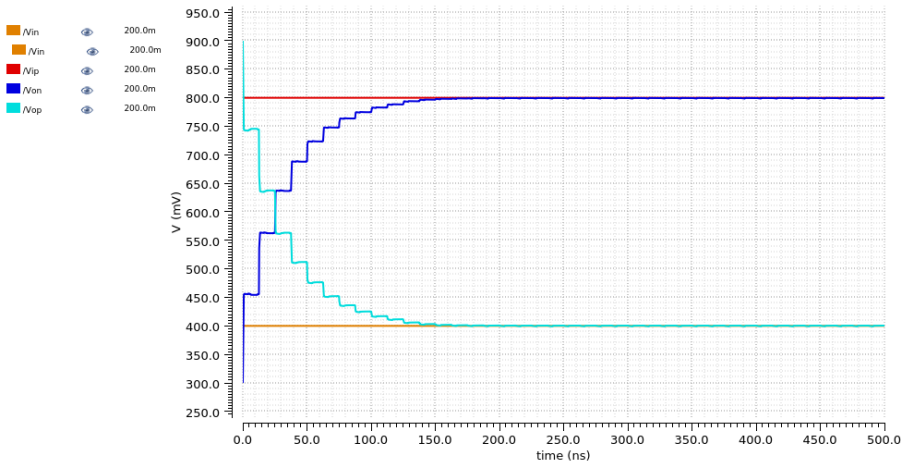
- Testbench with constant voltage and voltage ramp options.



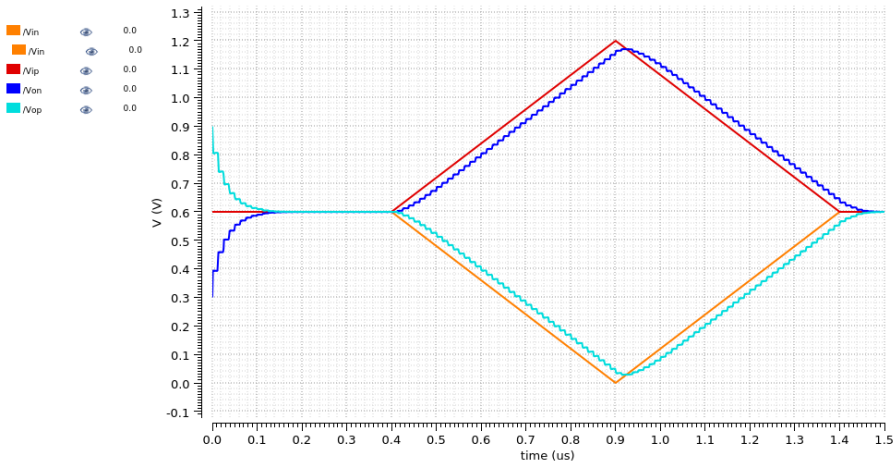
- Clock generation follows ICECAL but phase and pulse width estimated by eye.

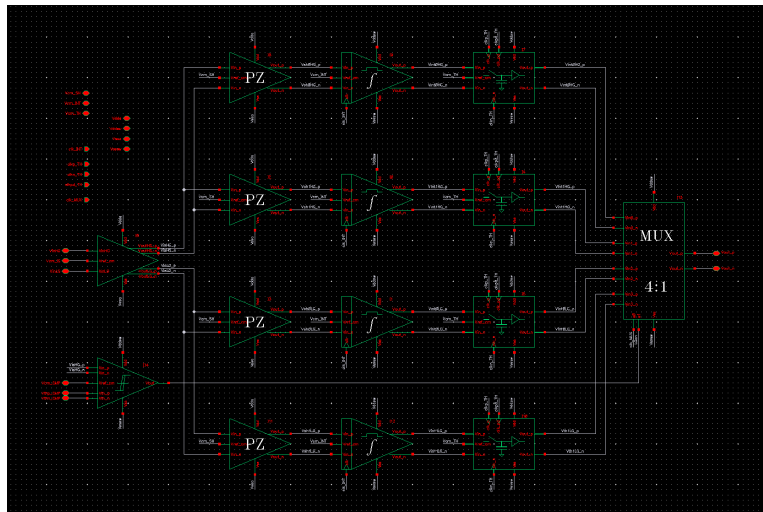


- Constant value simulation shows 200ns stabilization period.

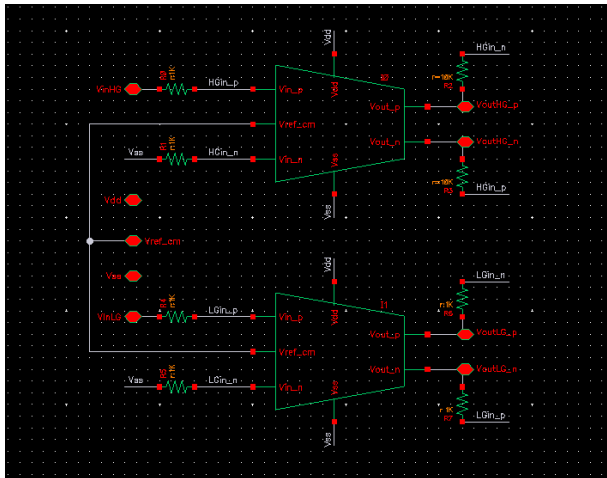


- Ramp simulation shows almost fixed offset through voltage range.

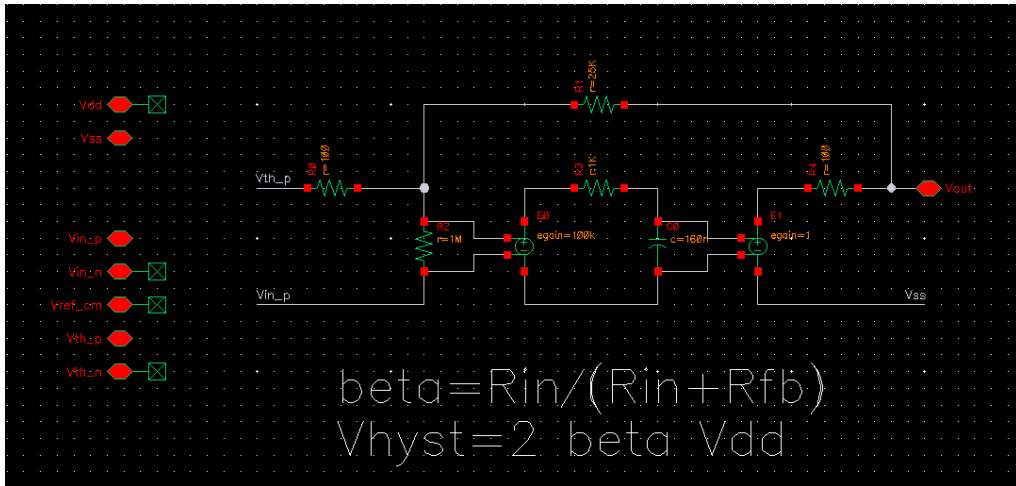




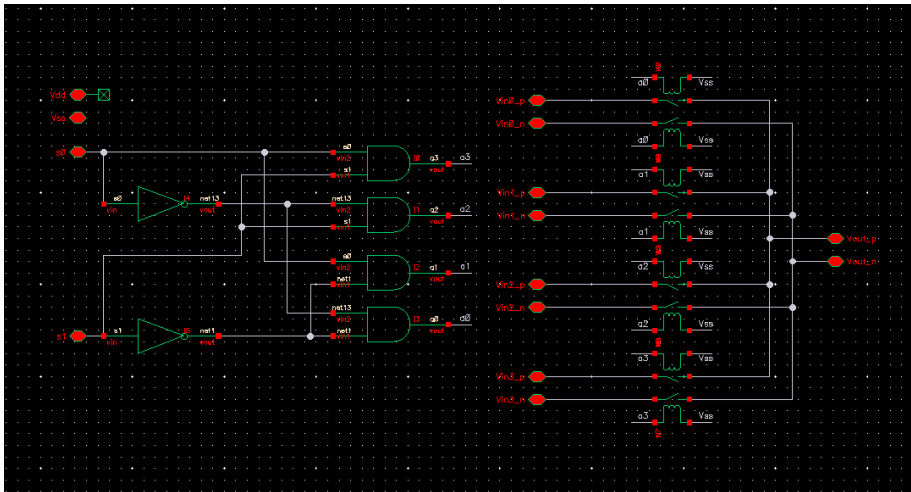
- OTA macromodel based double preamp design with 10x gain ratio.



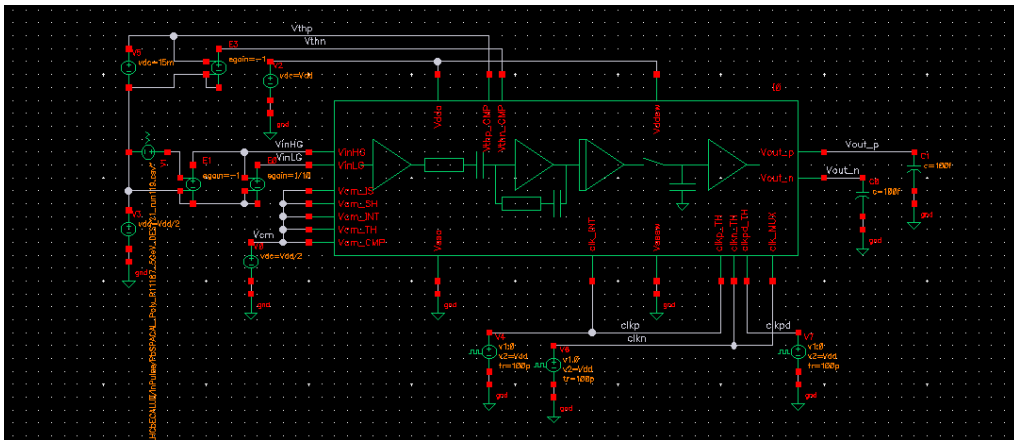
- Comparator macromodel with tunable hysteresis and ideal components.



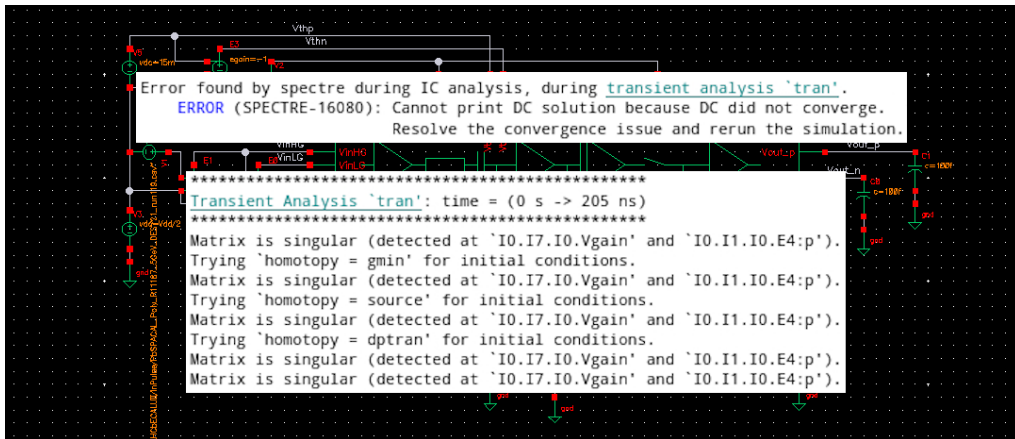
- Multiplexer macromodel with ideal components.



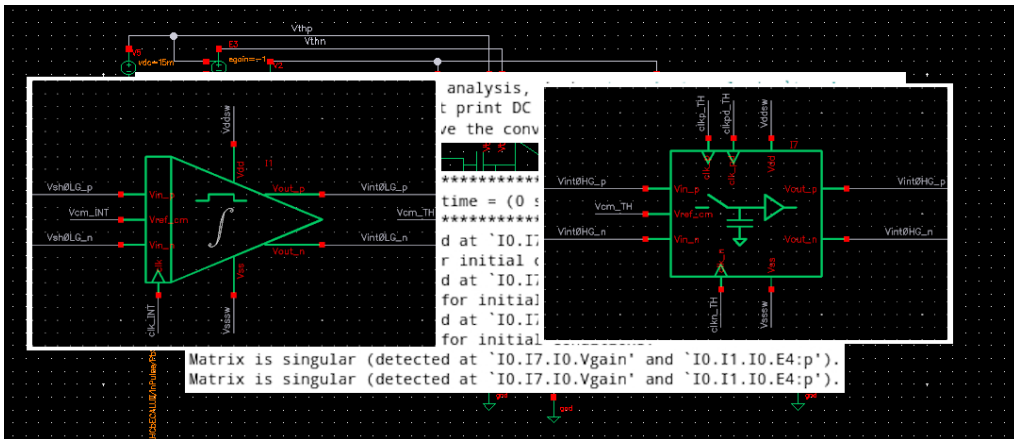
- Testbench developed for the full channel ...



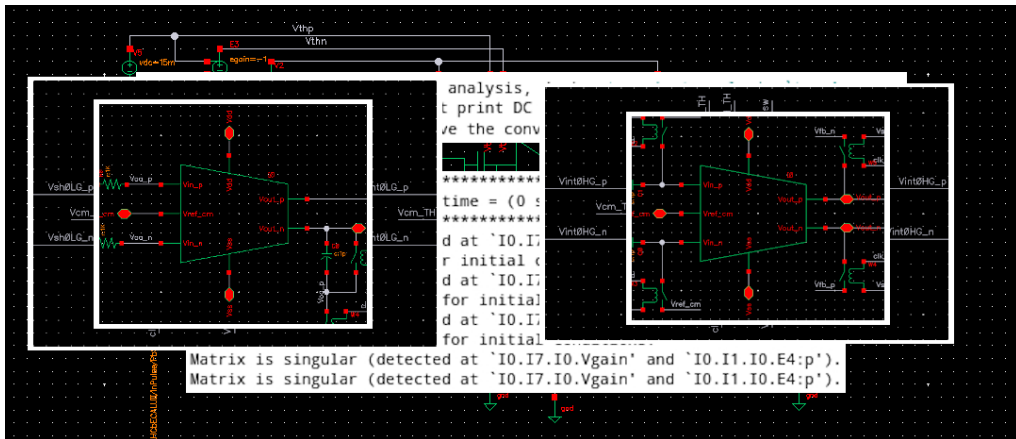
- but DC fails due to singular matrix in several blocks.



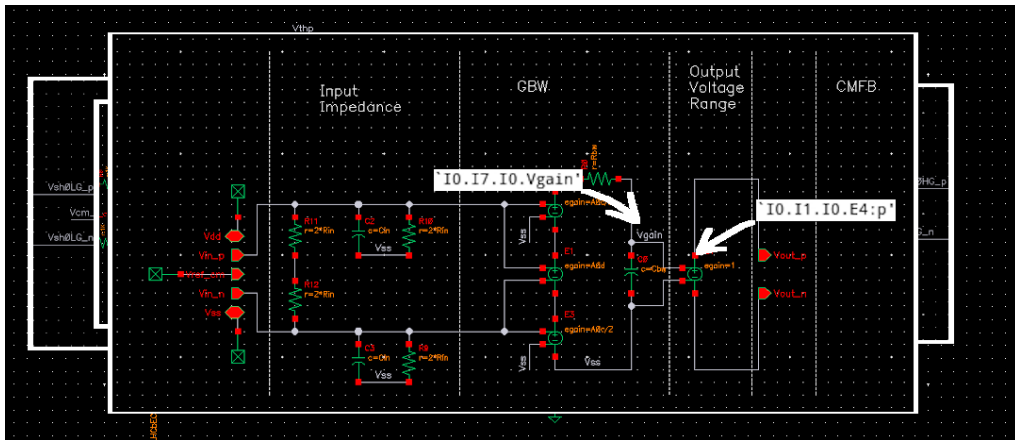
- Failing blocks are different and in separate signal paths.



- In all cases the issue is at the OTA macromodel ...



- specifically with the last source isolating the output from the dynamics.



Thanks a lot for your attention!

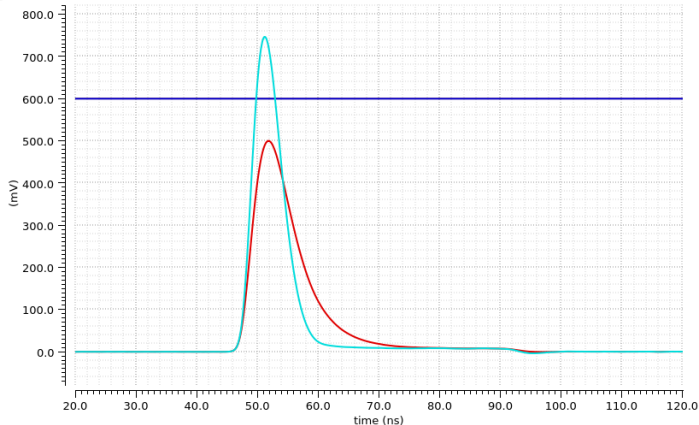
BACKUP

- Polystyrene shape almost fits clock period, but weird tail effect.

Vo_diff

Name ...File

■ Vi_cm ...SV
■ Vi_cm ...SV
■ Vi_diff ...SV
■ Vo_cm ...SV
■ Vo_diff ...SV



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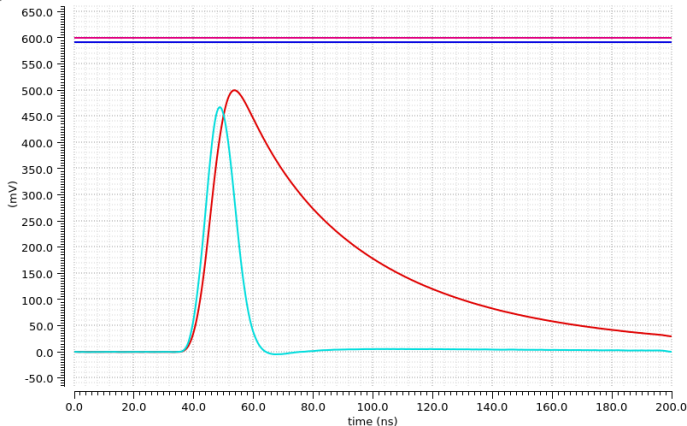
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Vo_diff

Name myFile

VI_cm	...	...5.csv
VI_cm	...	...5.csv
VI_diff	...	...5.csv
Vo_cm	...	...5.csv
Vo_diff	...	...5.csv



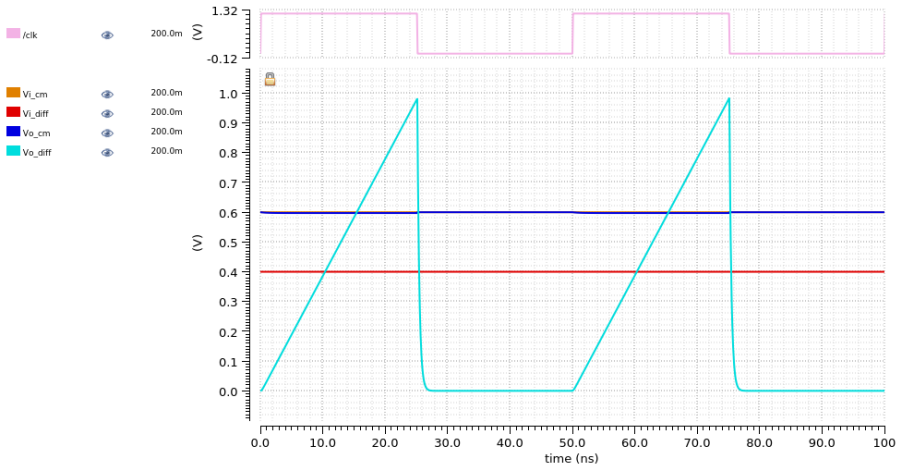
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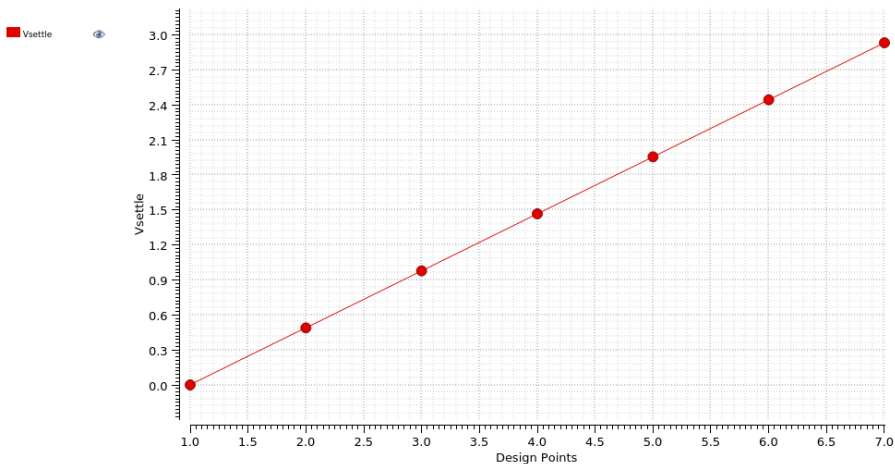
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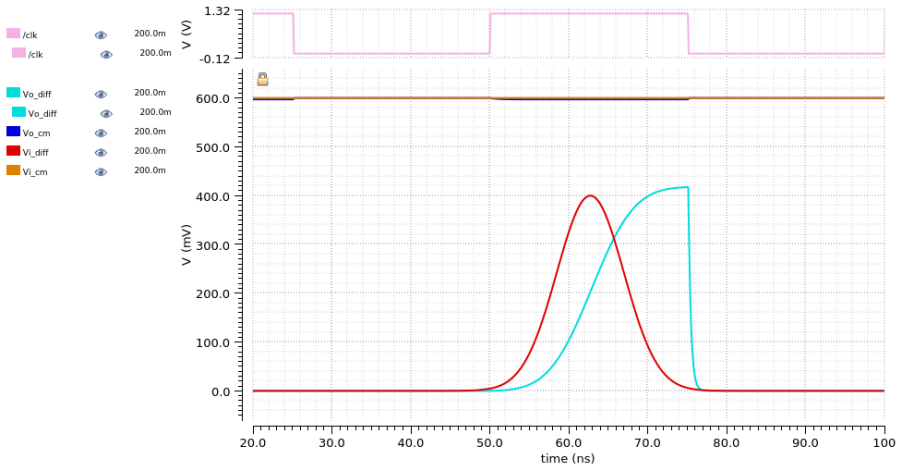
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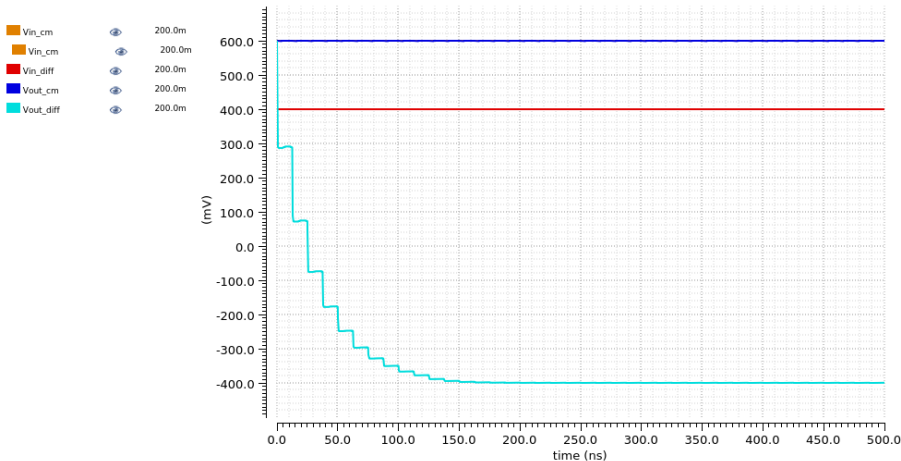
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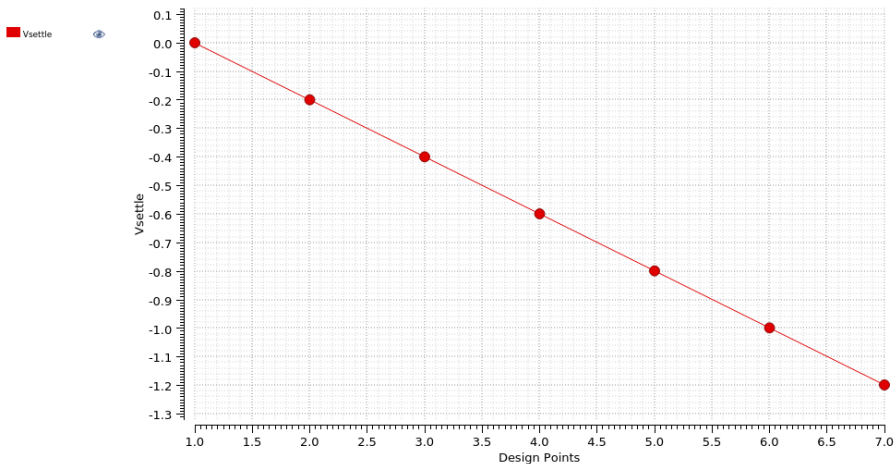
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