CCLRC Technology

AIDA design study

Steve Thomas

ASIC Design Group

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Overview

Charge amplifier response to overload

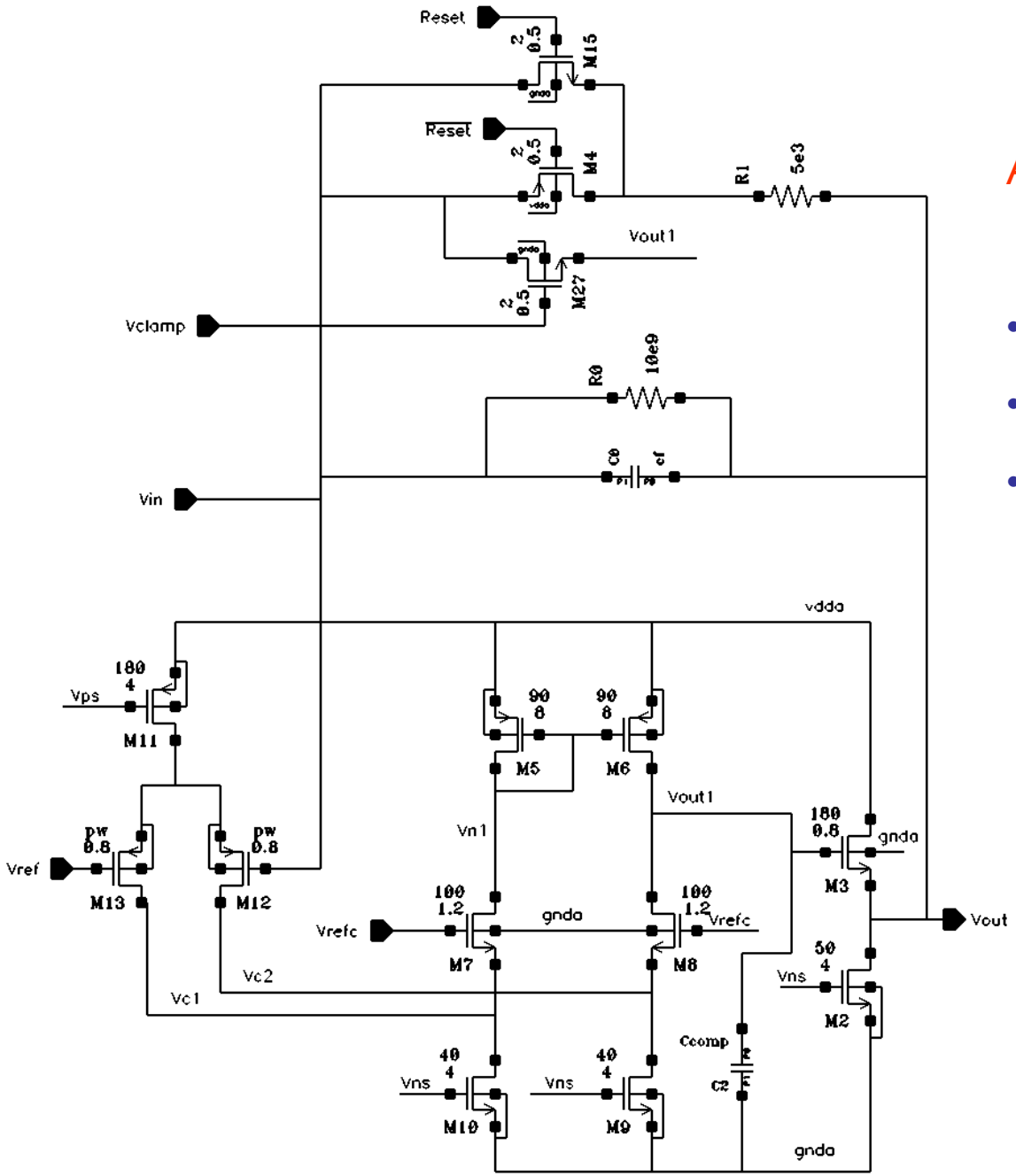
Parallel connection of low/high energy channels

Linearity

Additional circuitry -

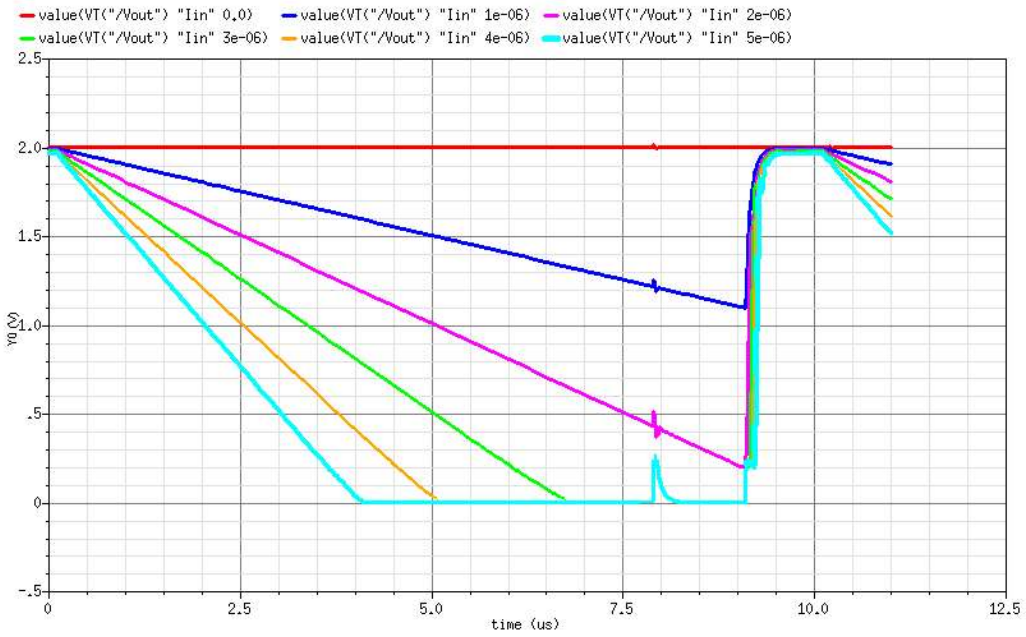
- comparator to monitor Vin
- latch for connection of high-energy channel

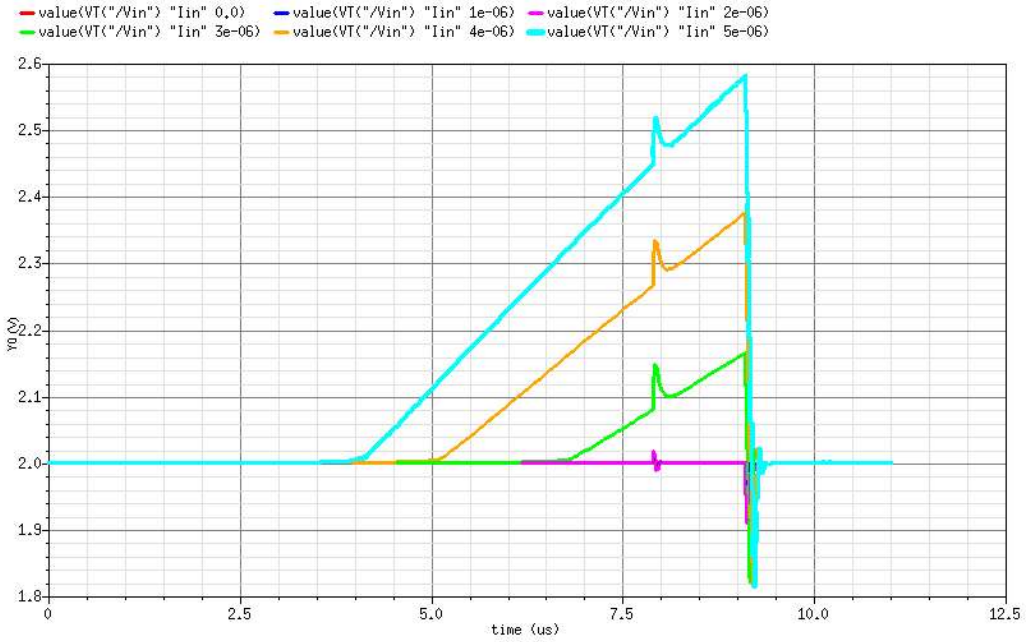
Conclusion - dual range possible



Amplifier circuit

- 10pF feedback
- Clamp transistor
- Low output drive (~300uA)



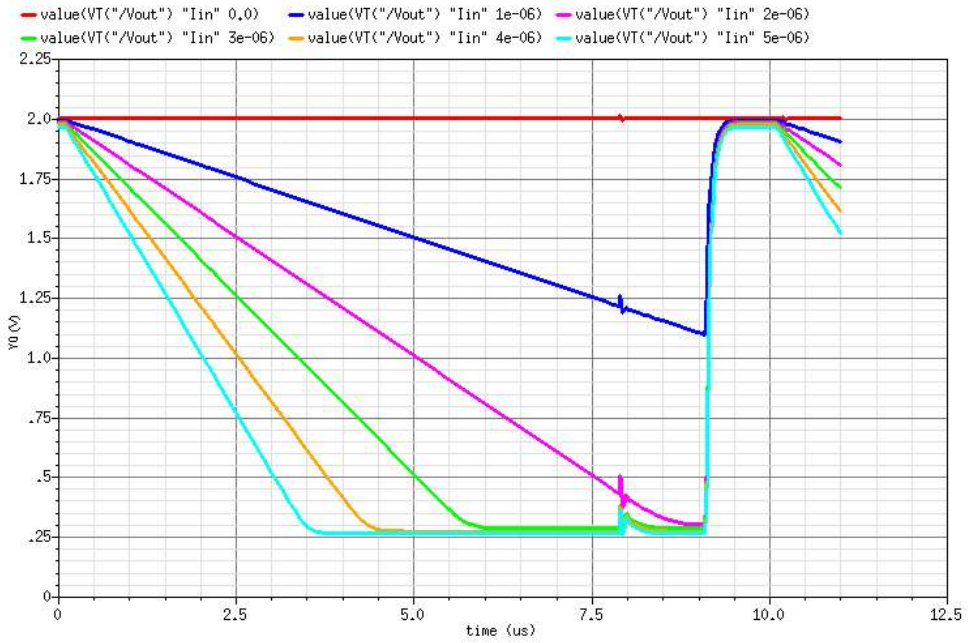


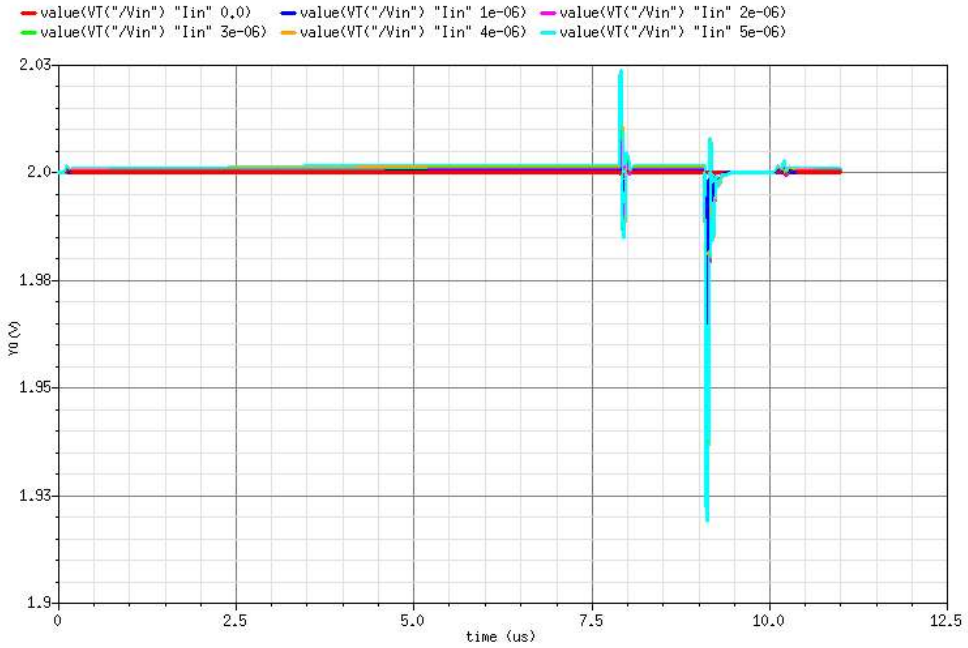
Constant current input:

Full-scale 1uA for 10us

0 to 5uA by 1uA steps

Clamp disabled



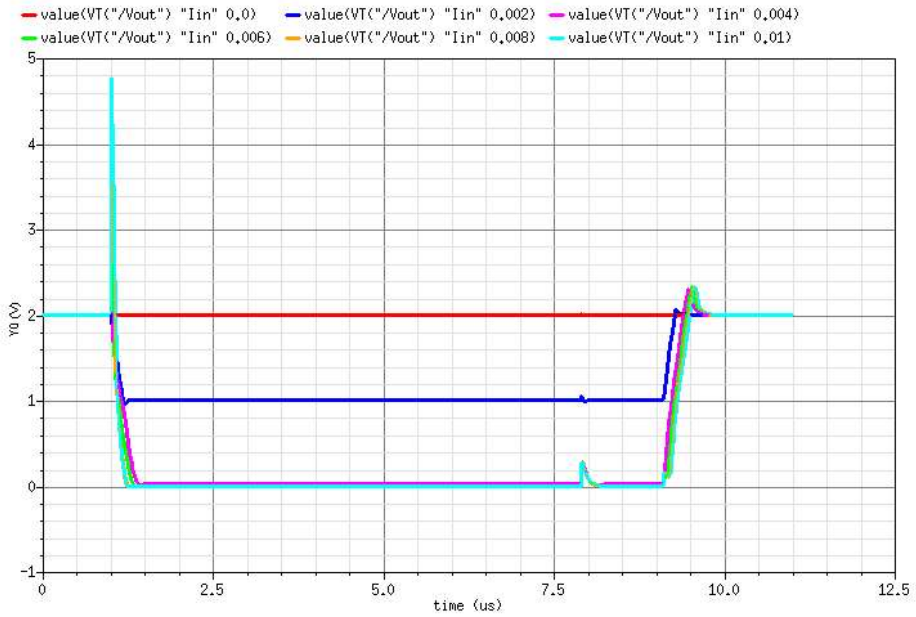


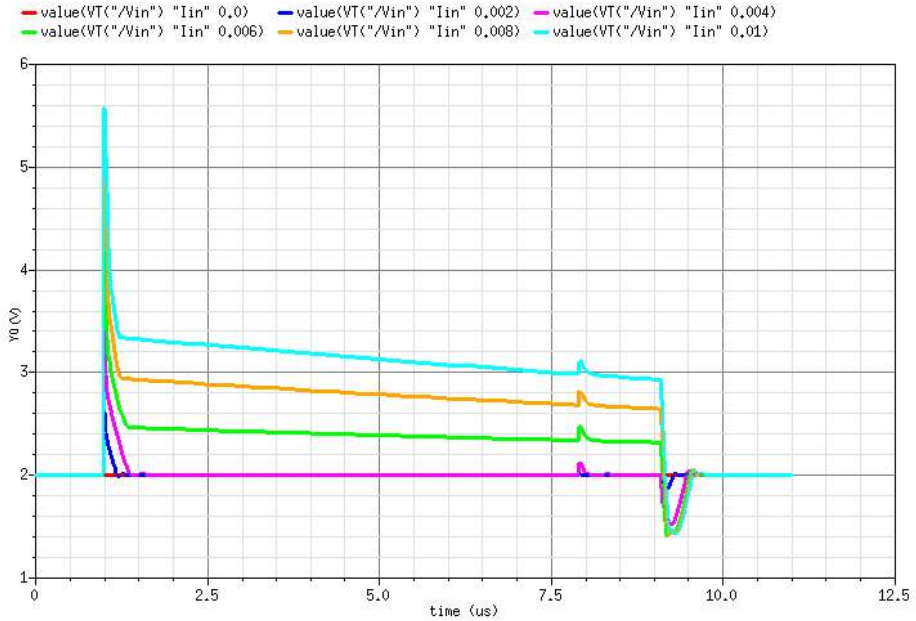
Constant current input:

Full-scale 1uA for 10us

0 to 5uA by 1uA steps

Clamp enabled



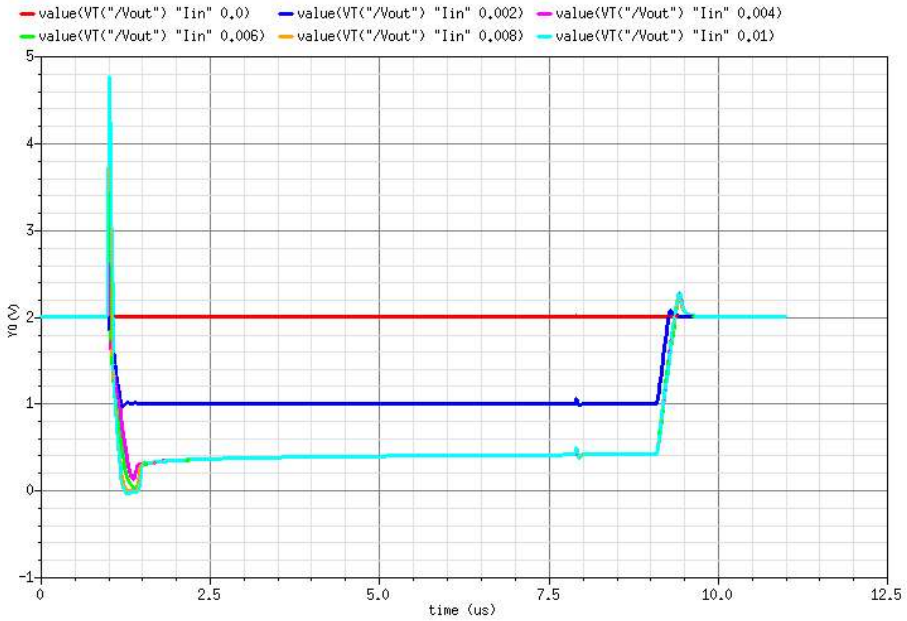


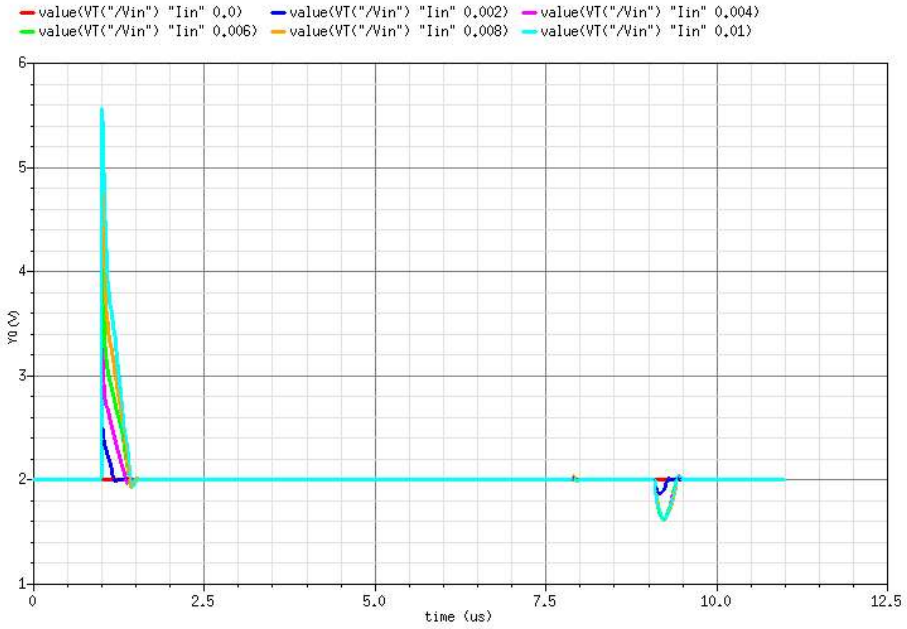
Pulse input:

Full-scale 2mA for 5ns

0 to 10mA by 2mA steps

Clamp disabled



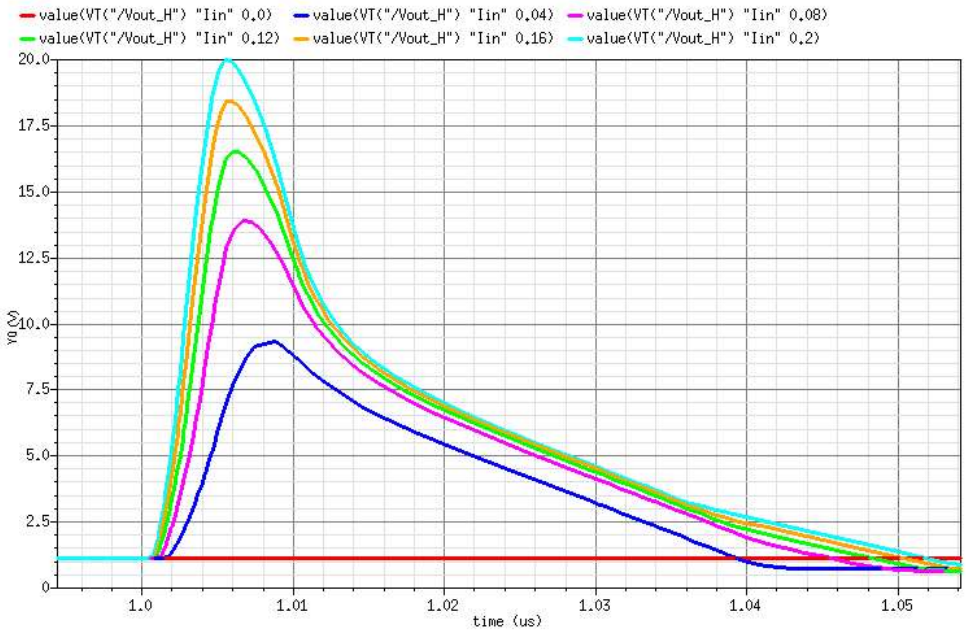


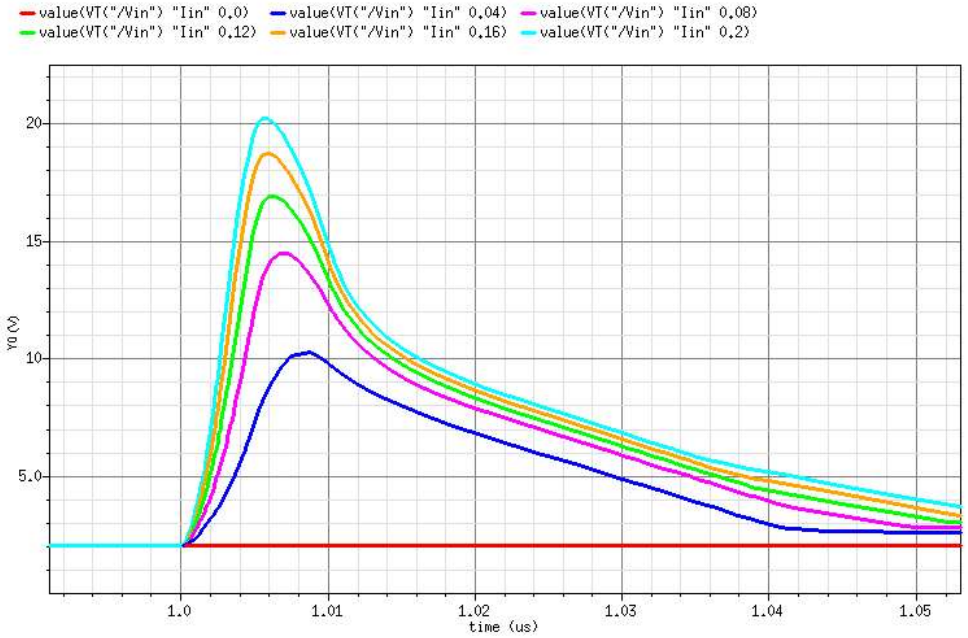
Pulse input:

Full-scale 2mA for 5ns

0 to 10mA by 2mA steps

Clamp enabled





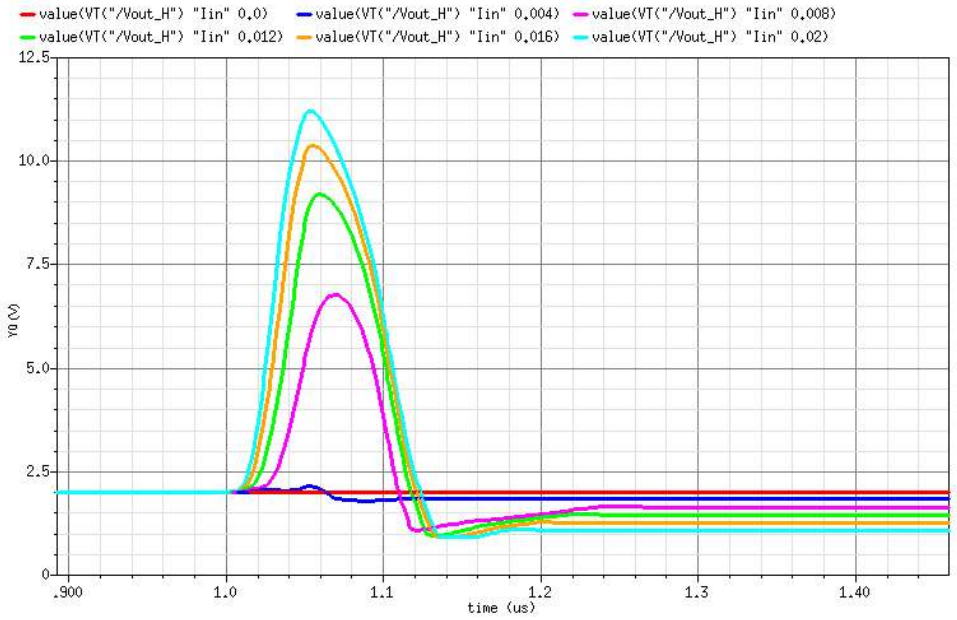
Pulse input:

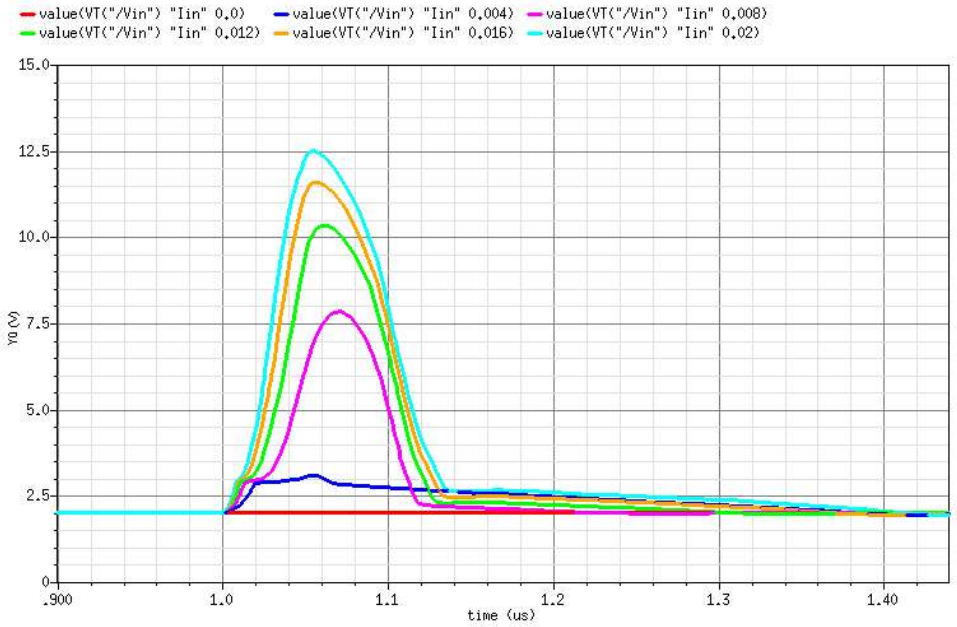
Full-scale 2mA for 5ns

Coupling resistor On

0-200mA for 5ns

Clamp enabled





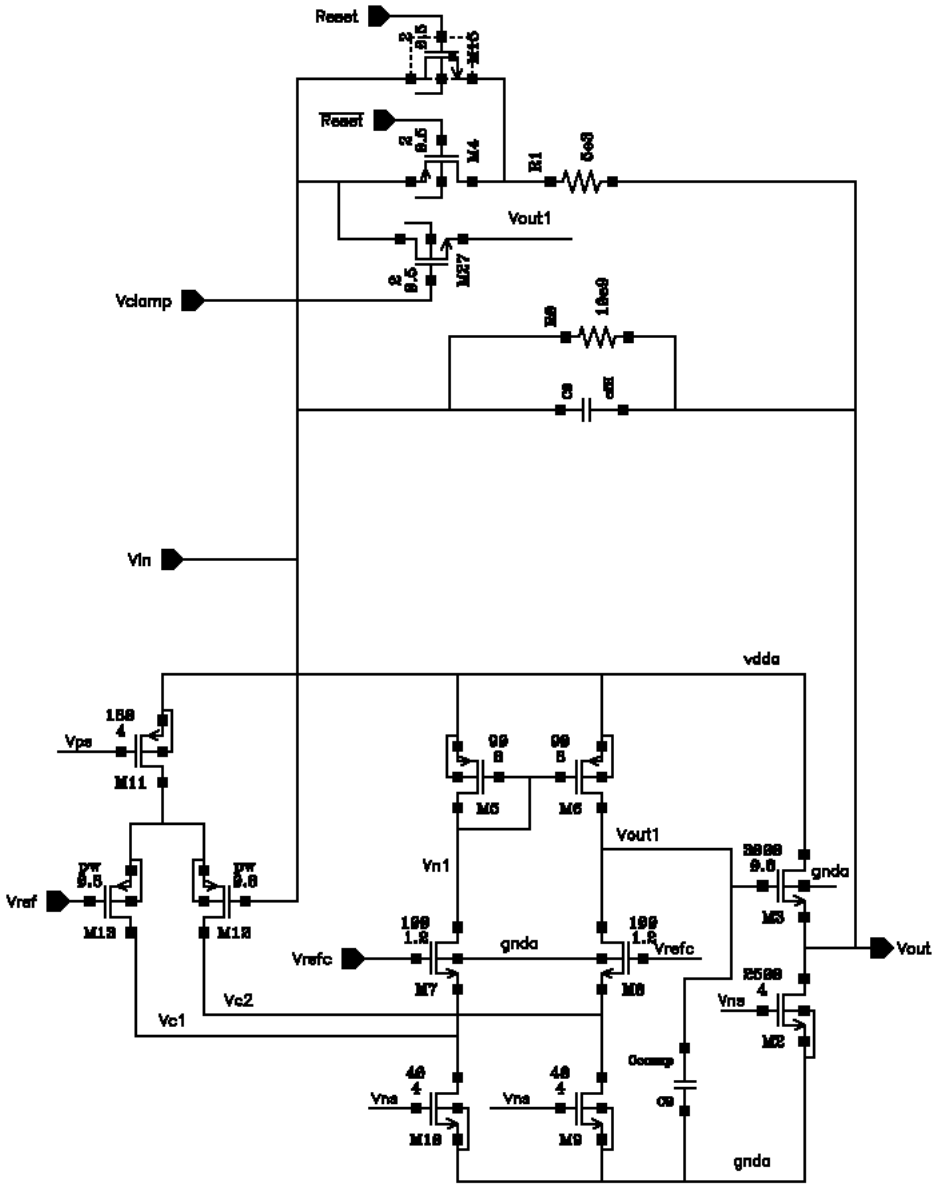
Pulse input:

Full-scale 0.2mA for 50ns

Coupling resistor On

0-20mA for 50ns

Clamp enabled



High-energy channel

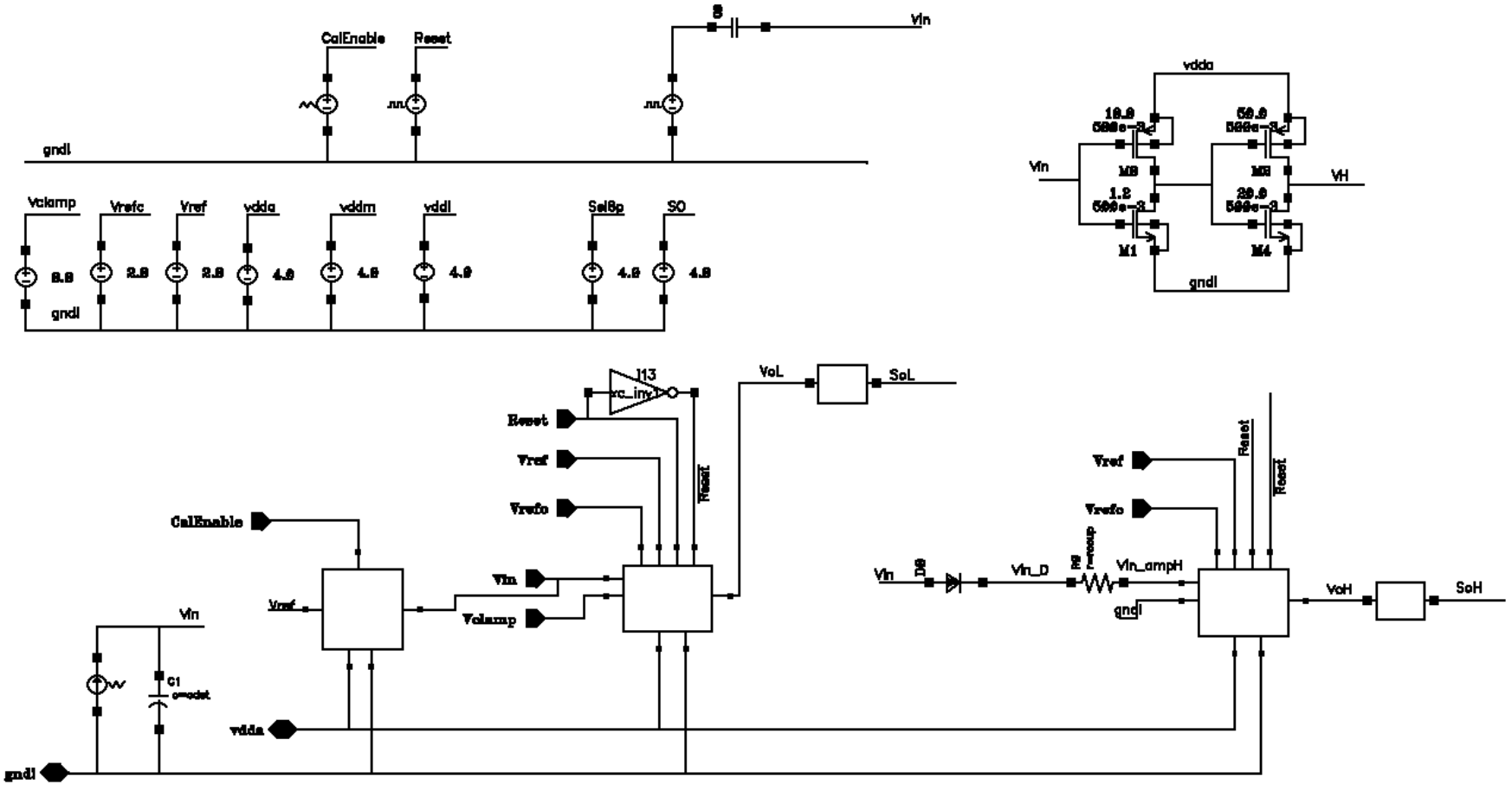
large output drive (20mA)

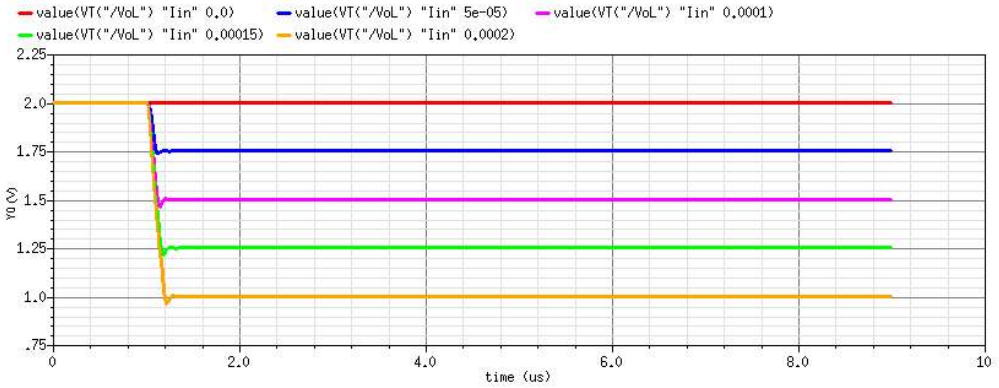
high-current follower

1nF feedback

Dual energy configuration

Parallel amplifier channels, with blocking diode

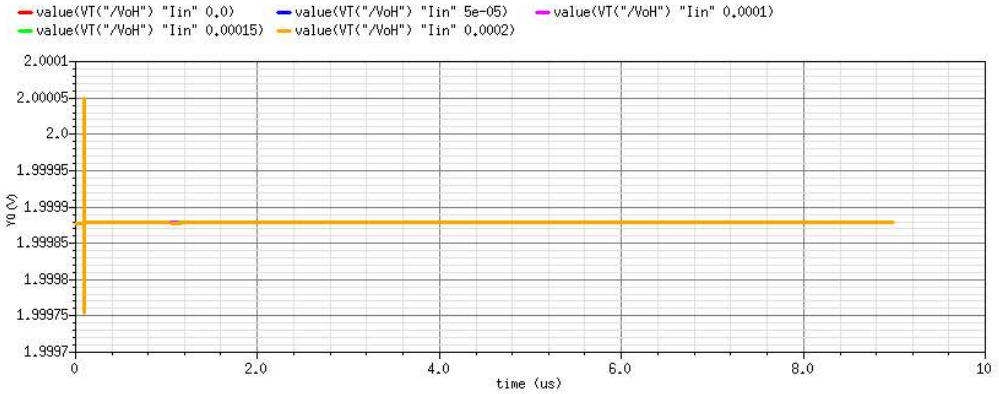




10pC input (200uA x 50ns)

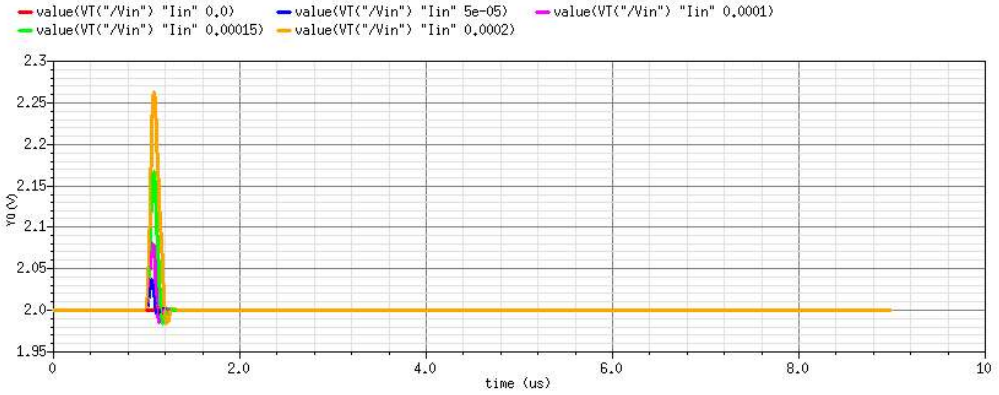
Vout (low-energy channel)

Full scale (1V) on 10pF



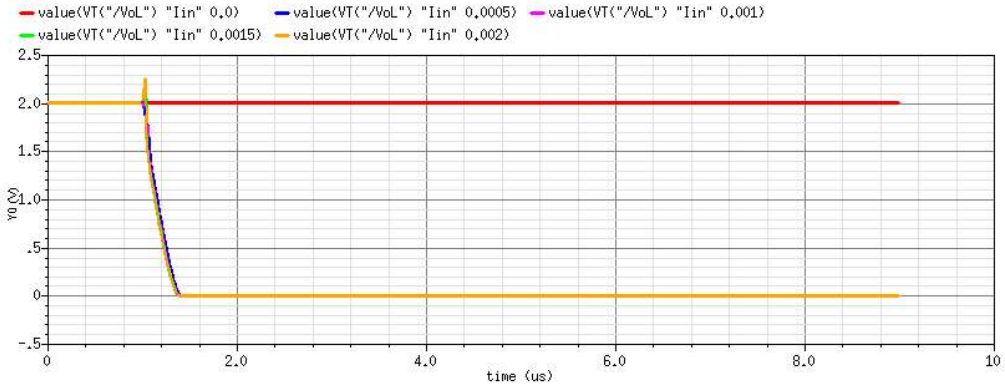
Vout (high-energy channel)

No response



Vin

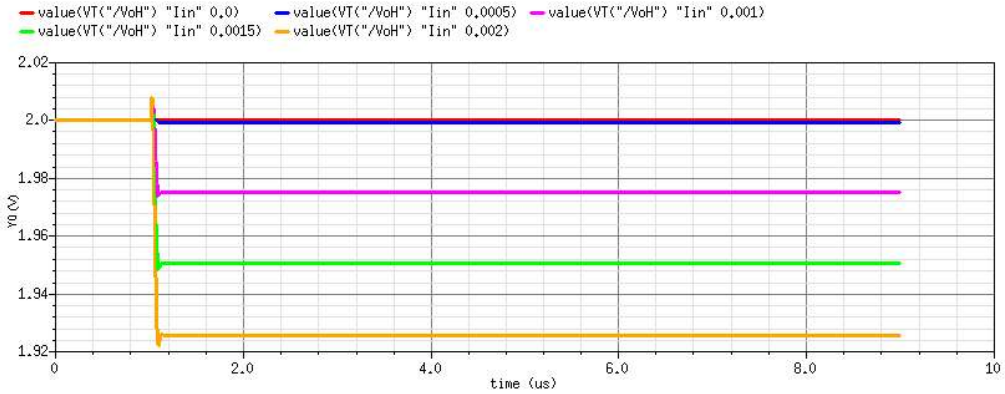
Fast recovery to 2V



100pC input (2mA x 50ns)

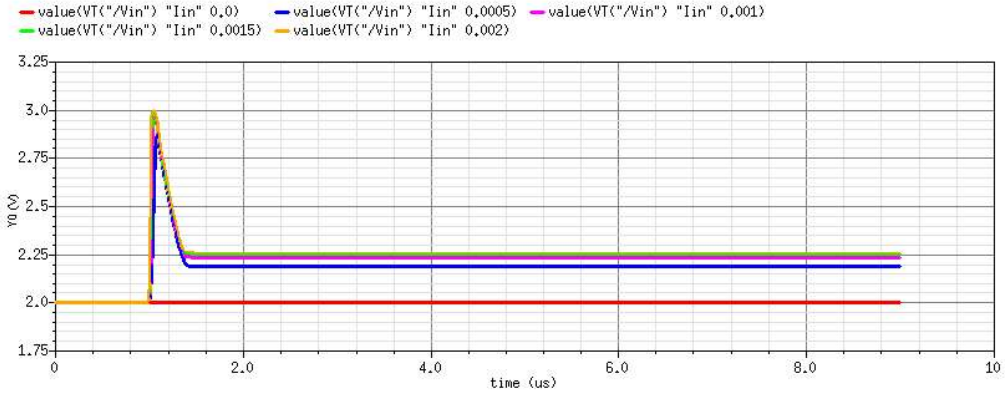
Vout (low-energy channel)

Amplifier saturation



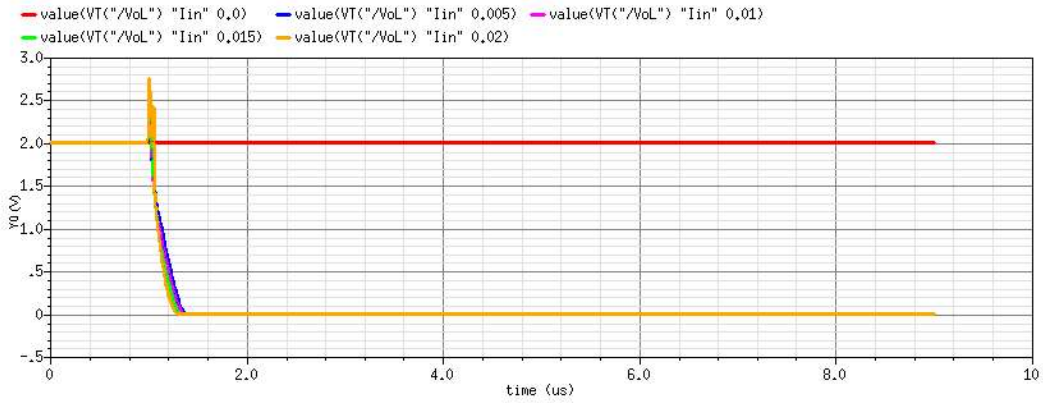
Vout (high-energy channel)

80mV on 1nF



Vin

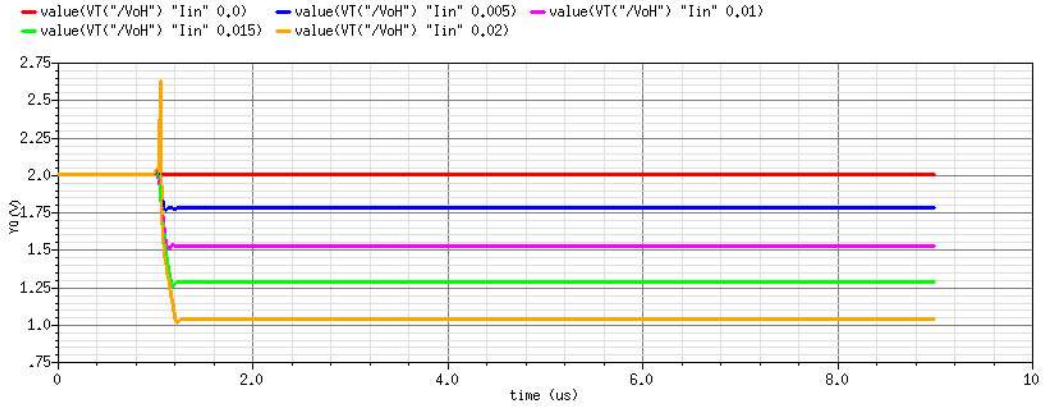
~0.25V steps



1nC input (20mA x 50ns)

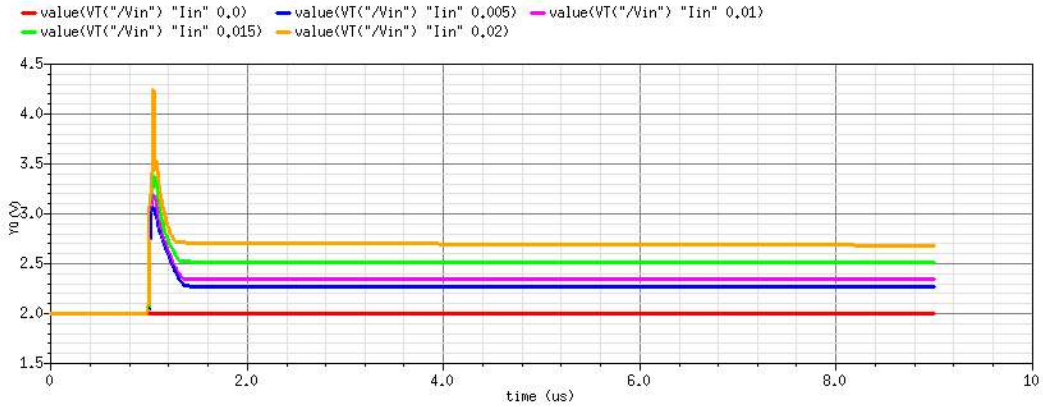
Vout (low-energy channel)

Amplifier saturation



Vout (high-energy channel)

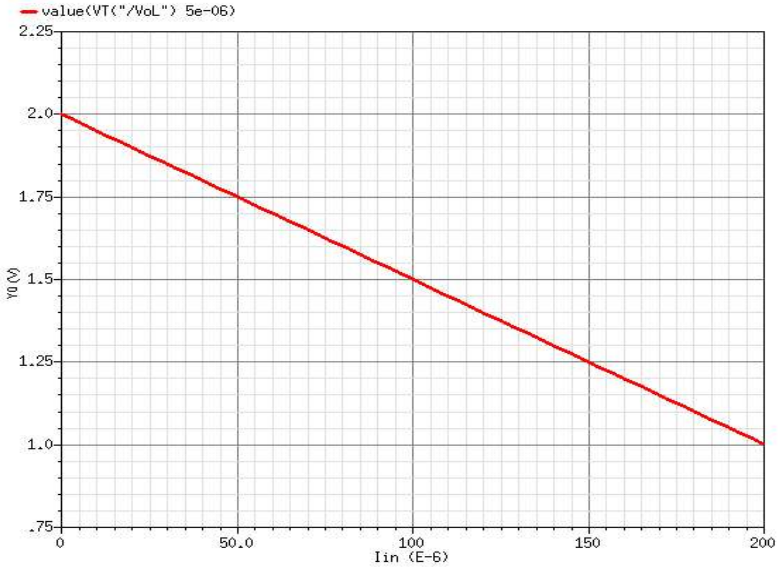
Full scale (1V) on 1nF

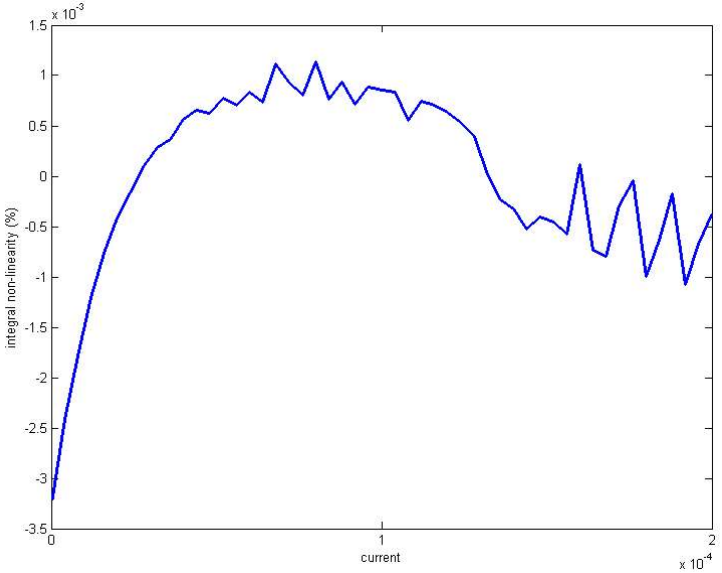


Vin

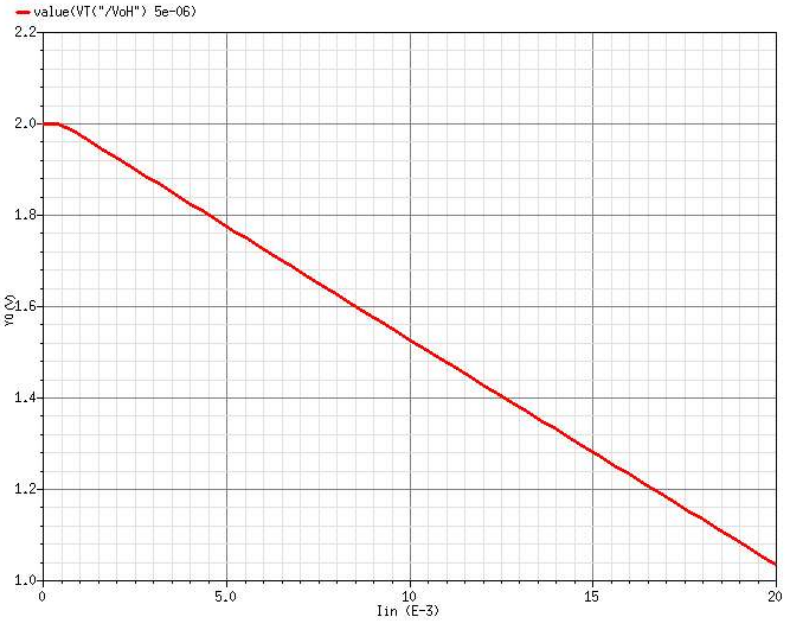
~0.25 - 0.6V steps

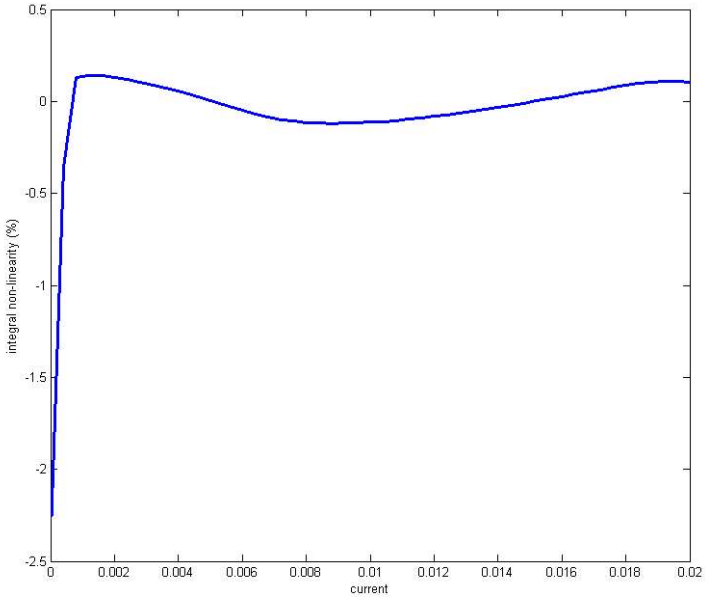
Linearity plot: 200uA on 10pF

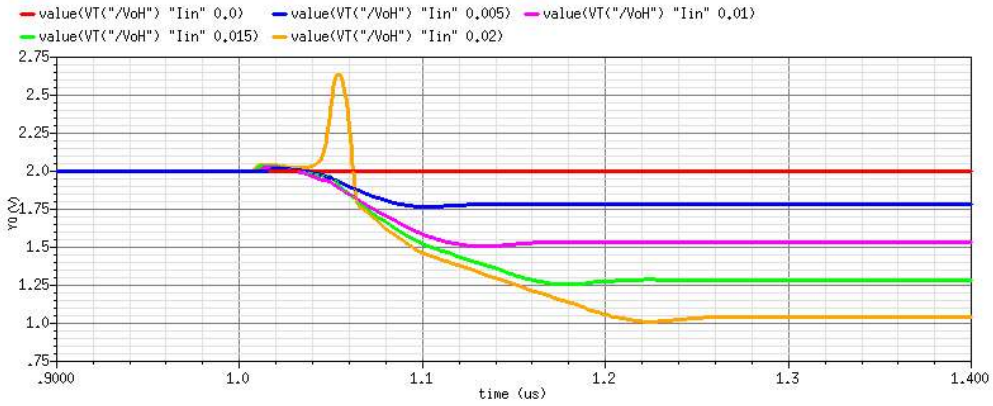




Linearity plot: 20mA on 1nF



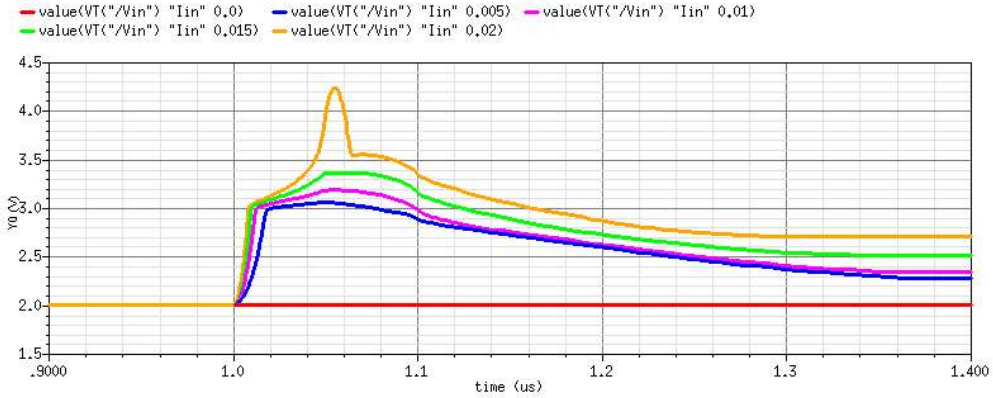




20mA onto 1nF

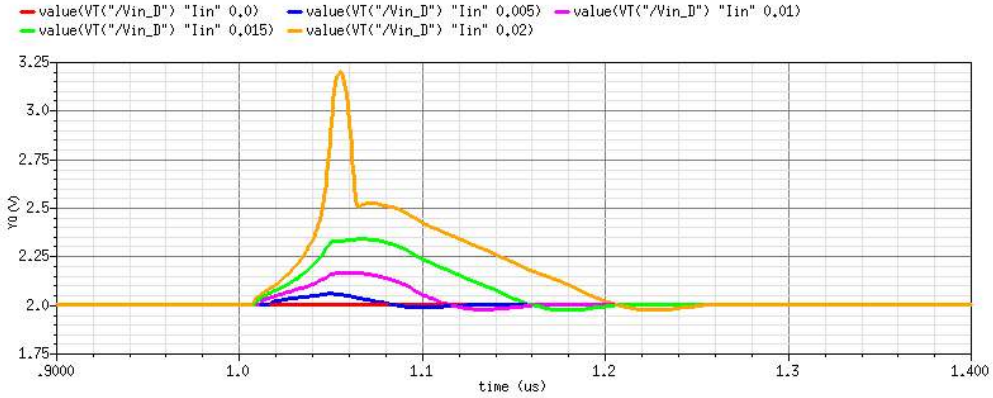
Vout

Full scale 1V



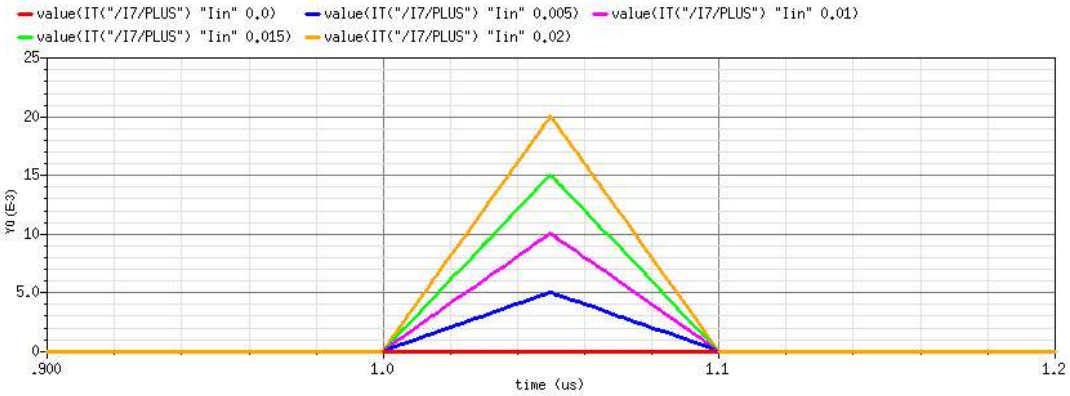
Vin (detector)

~0.25 - 0.6V steps



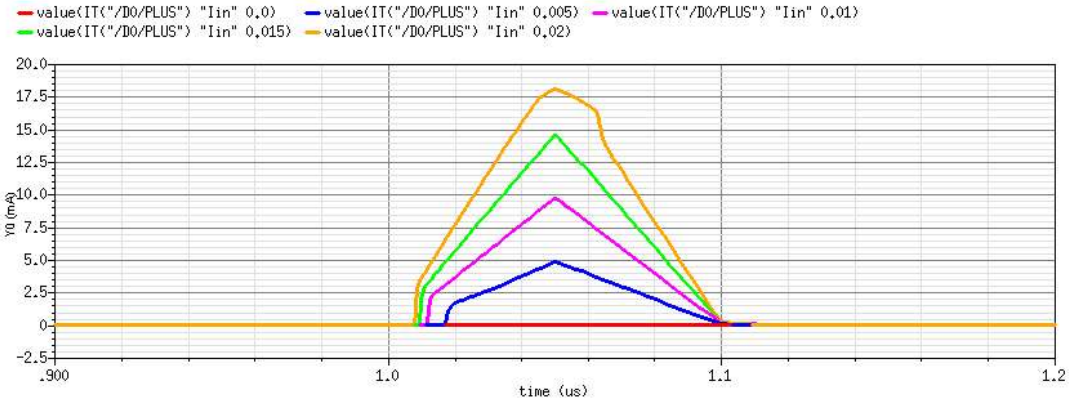
Vin (amplifier)

Recovery in ~0.25us

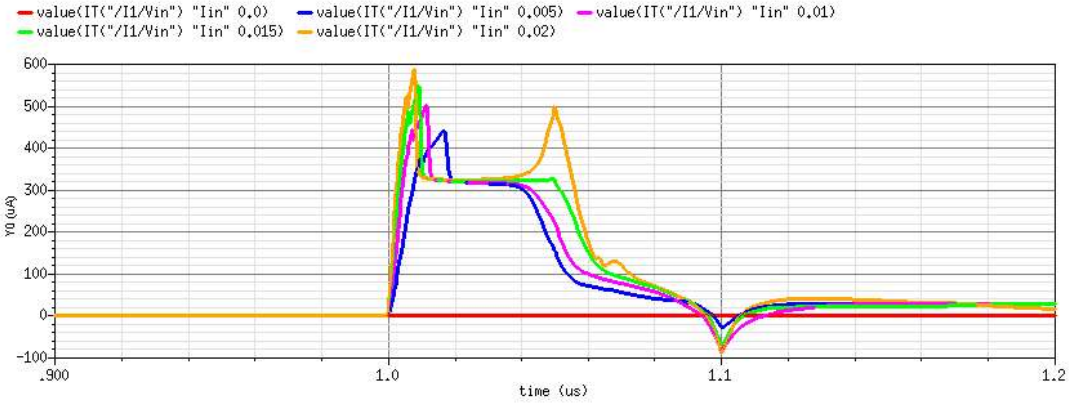


20mA pulse shape

Current source

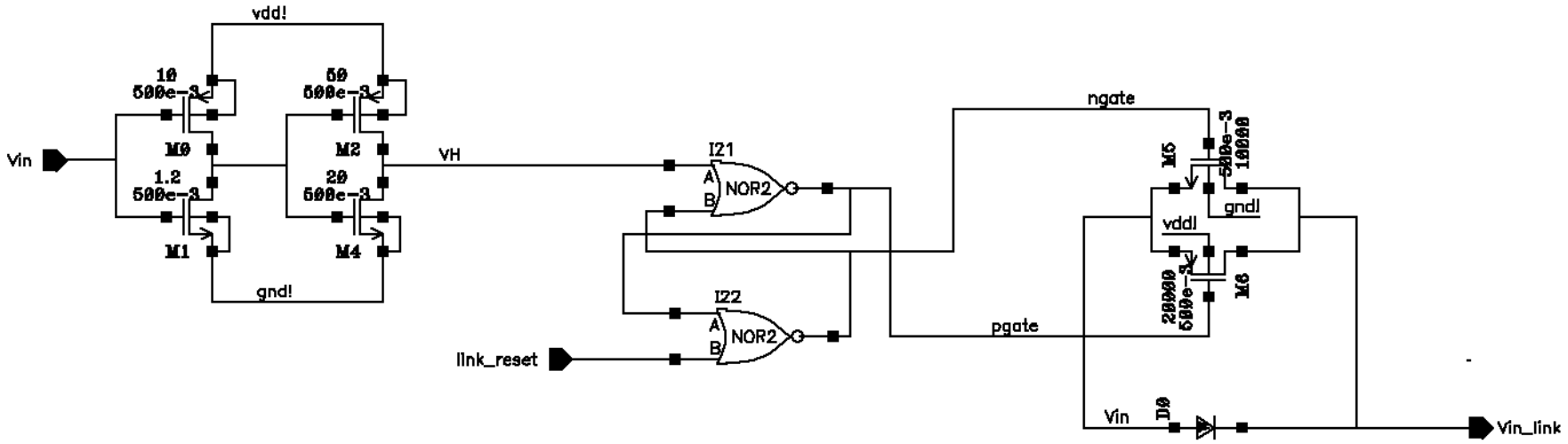


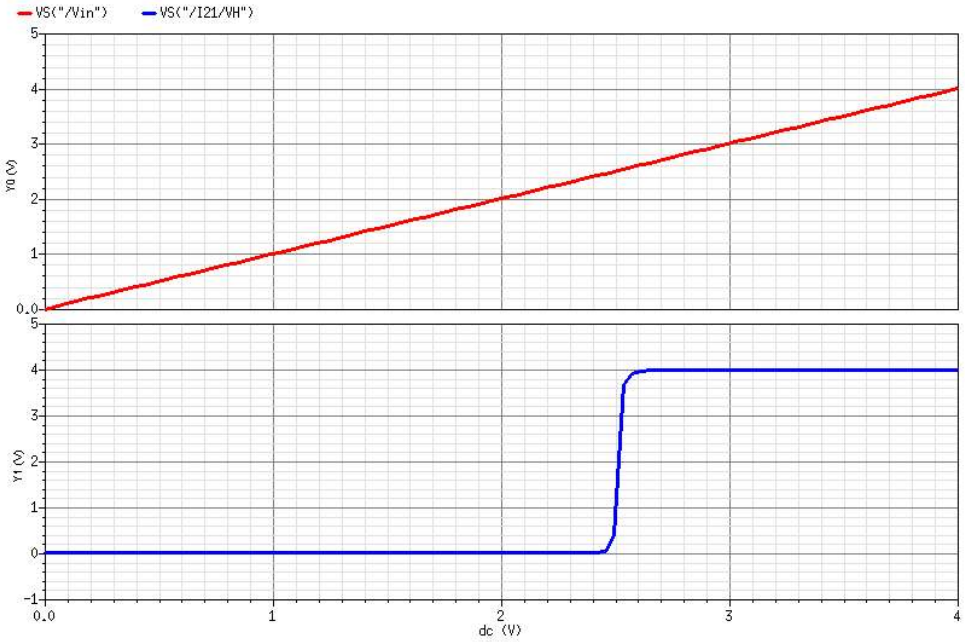
Diode current to high-energy amplifier channel



Current to low-energy amplifier channel

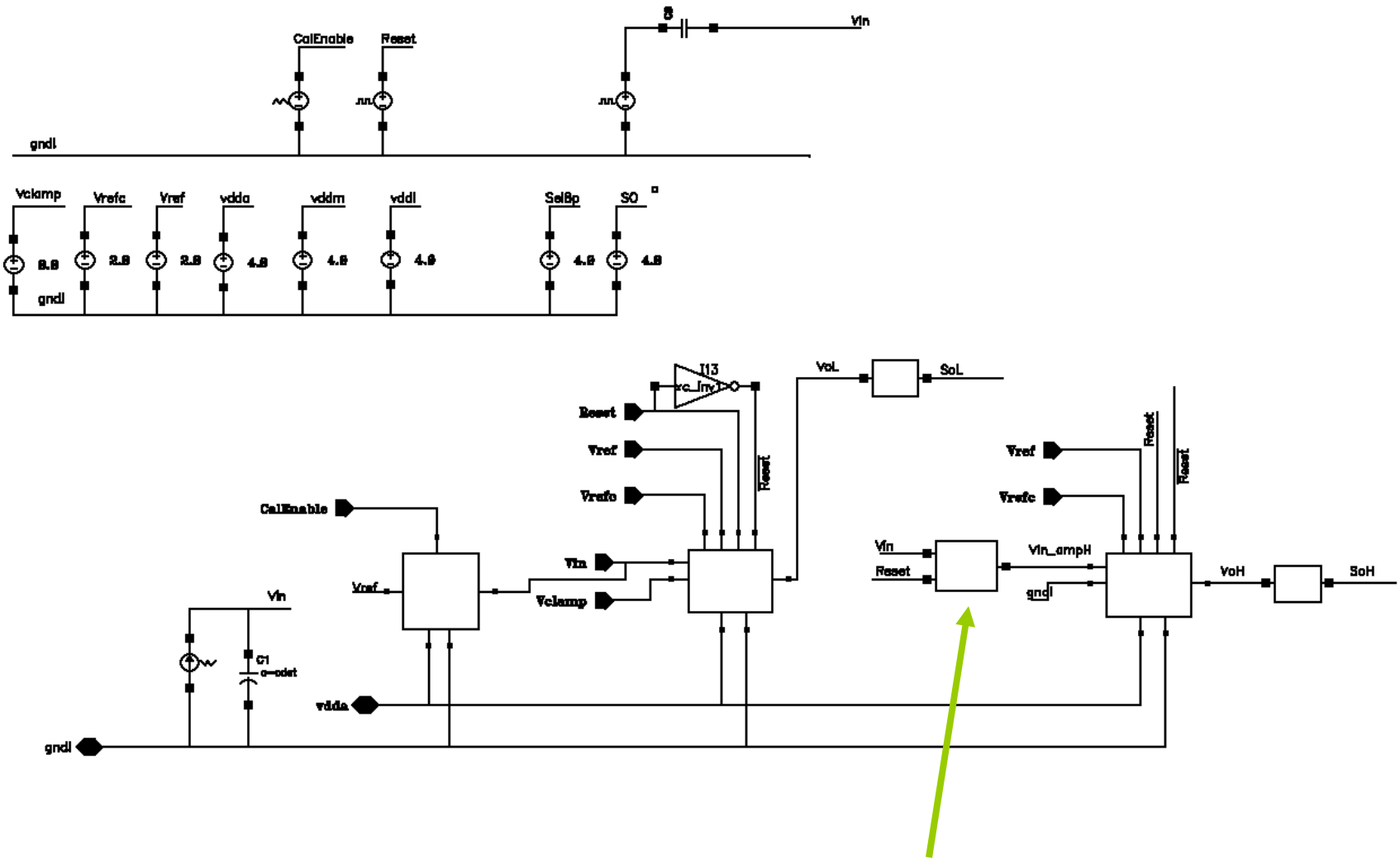
~300uA limit





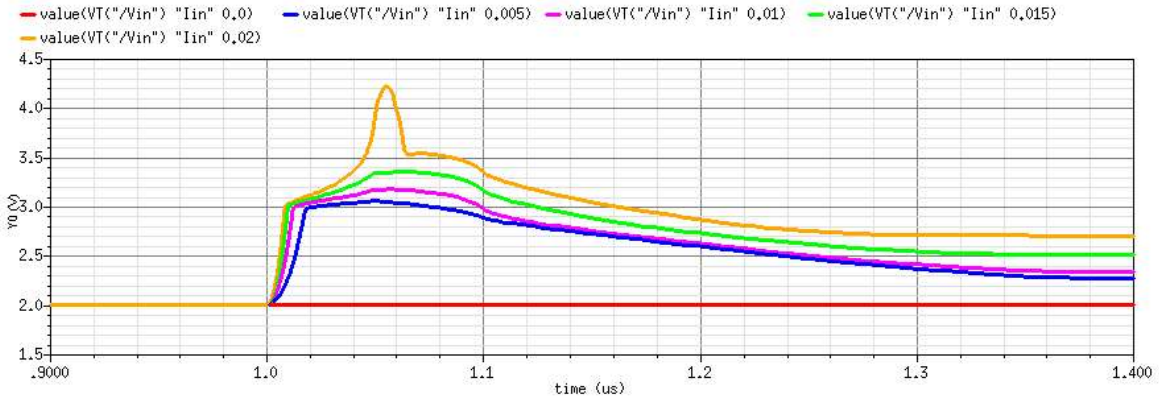
Circuit to reset diode -

- Vin>Vth resets SR latch
- pgate goes low, ngate goes high
- short circuit across diode, until latch is reset



Vin connected to high-energy channel by link circuit

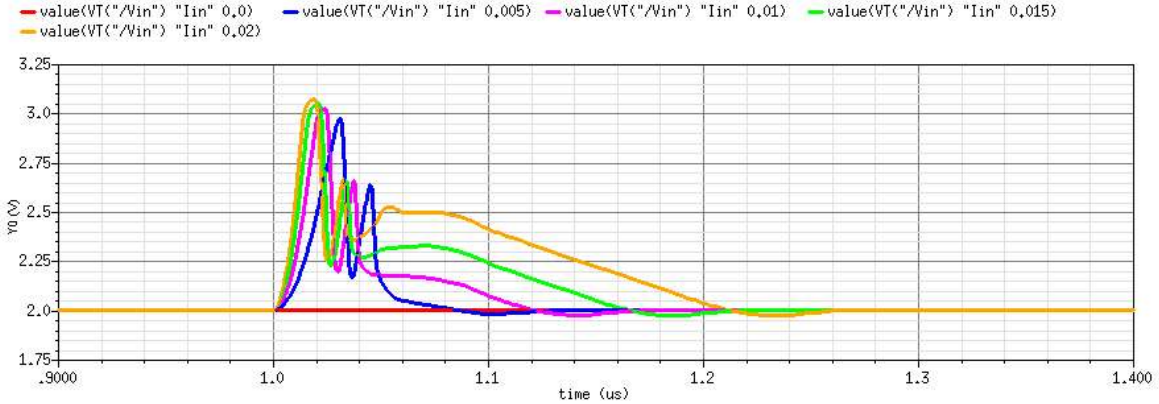
(diode in parallel with gated nmos/pmos switches)



20mA onto 1nF

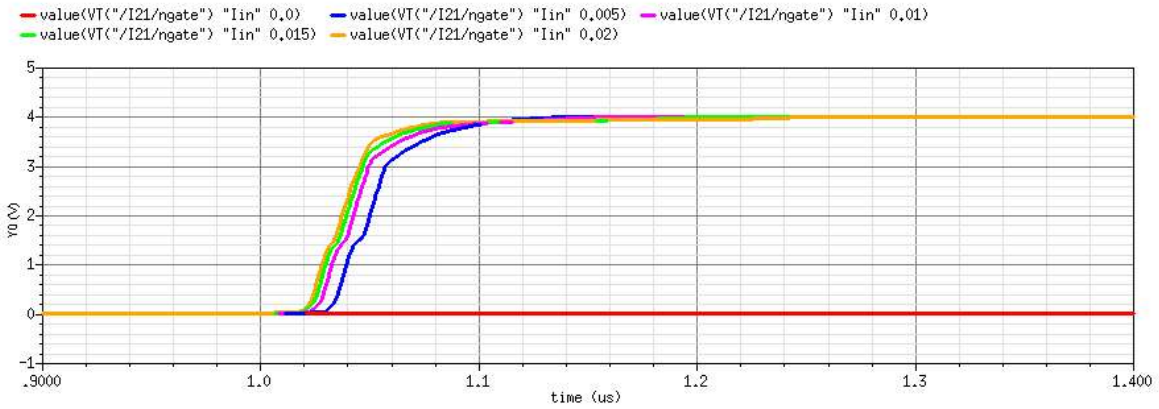
Vin (no diode reset)

long recovery time

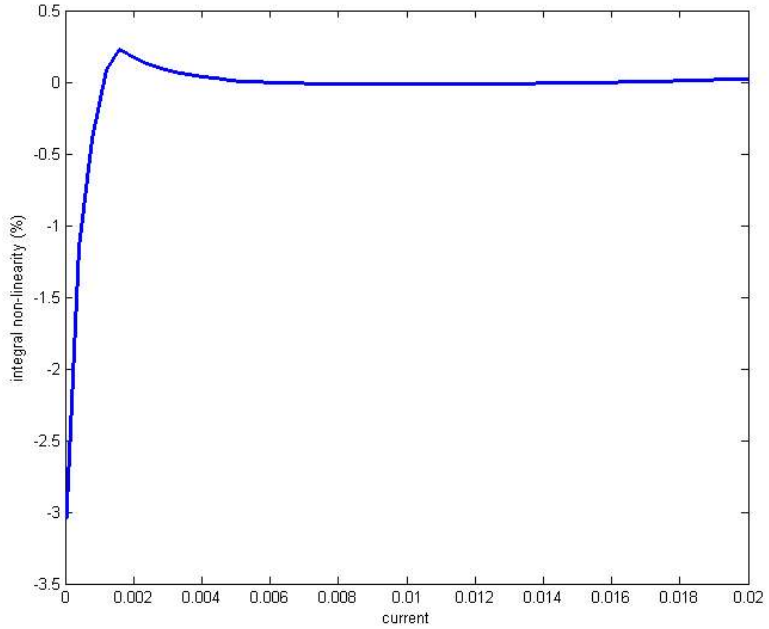


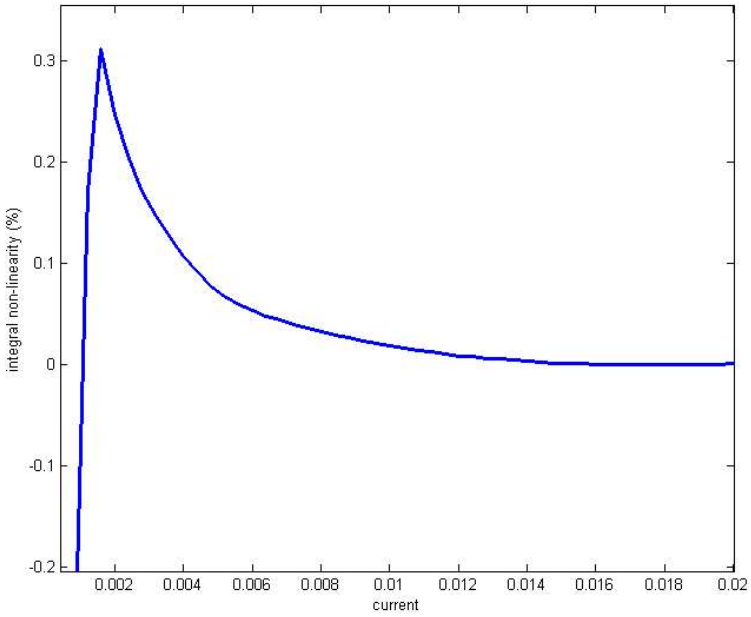
Vin (with diode reset)

~0.25us recovery



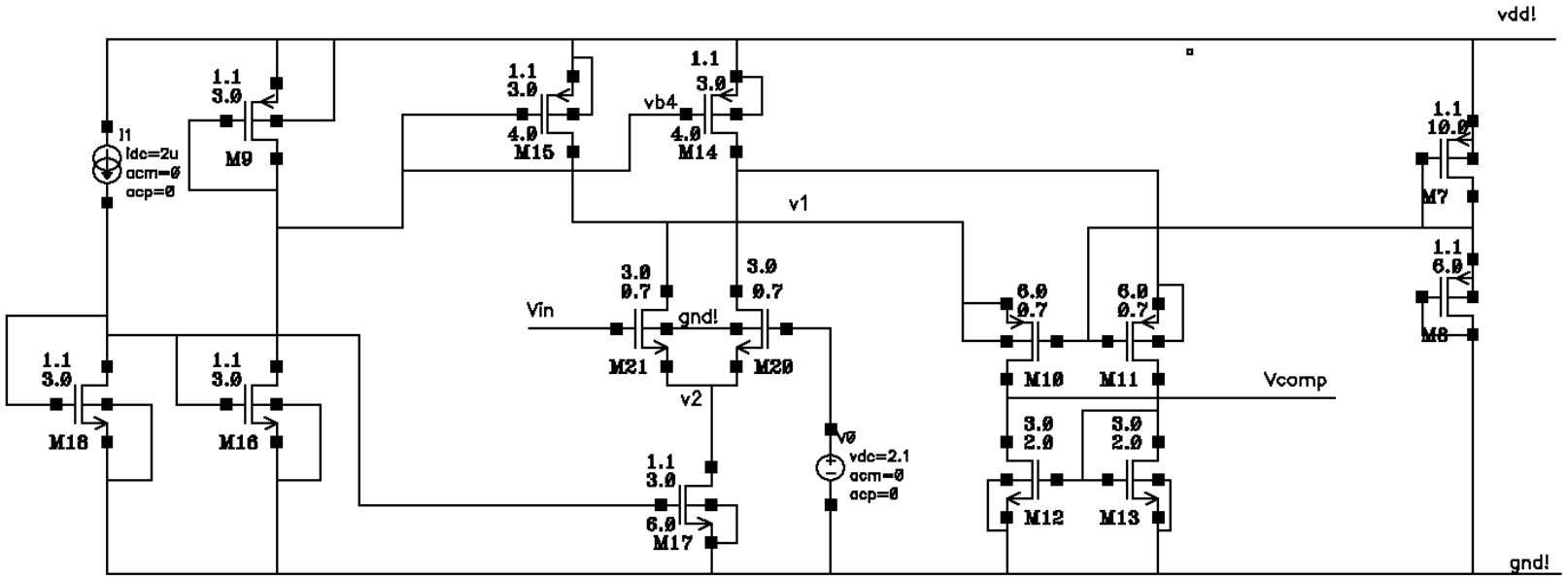
ngate (active high reset)

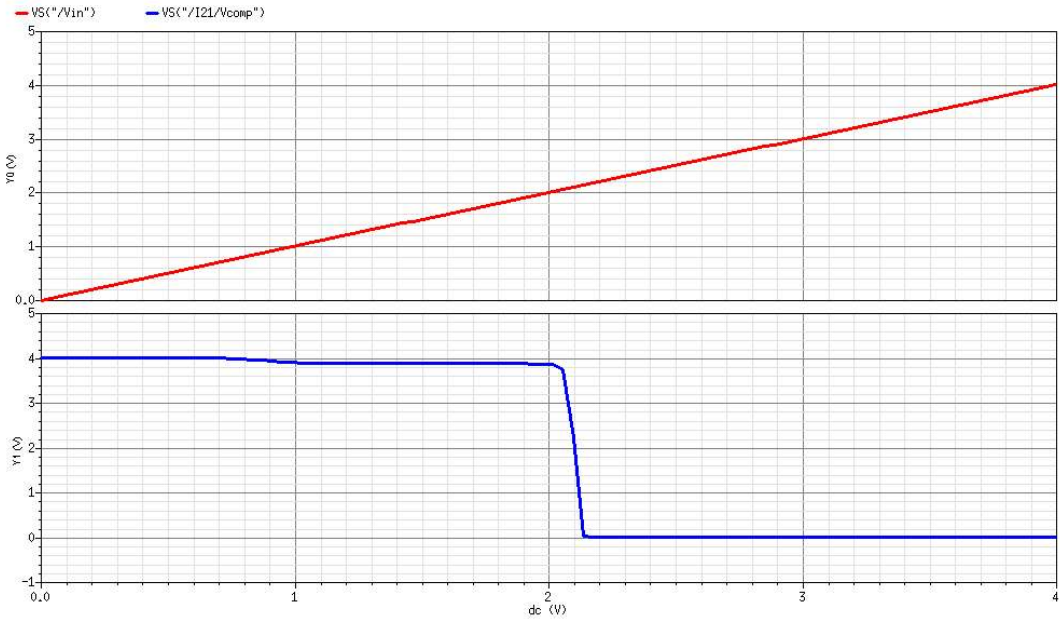




Linearity with diode reset -

- Isfit for top end of range
- within 0.1% over wide range

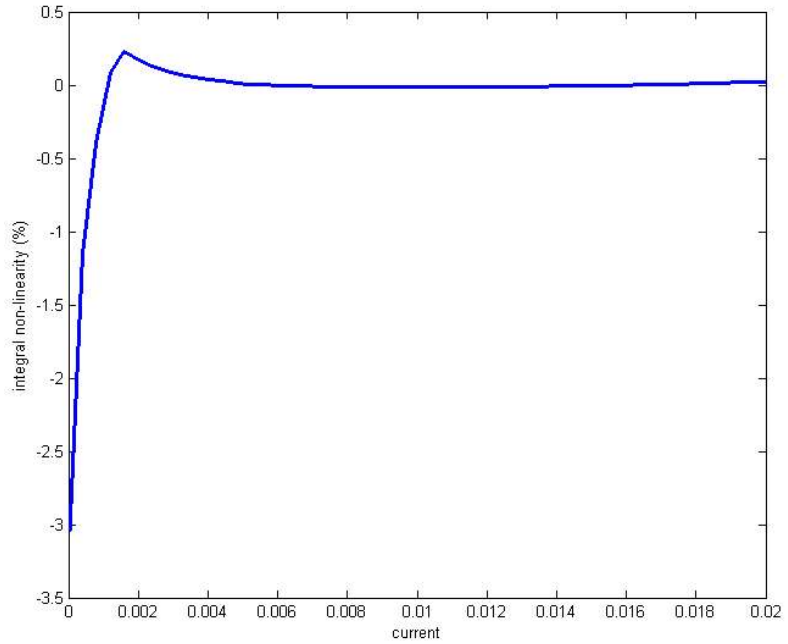




Improved comparator for diode reset -

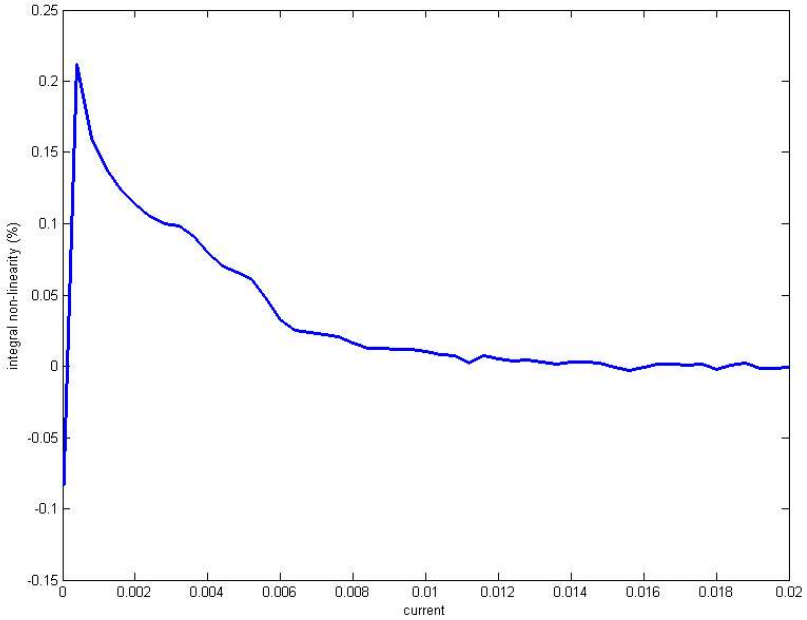
variable threshold

Vth = Vin + ~0.1V

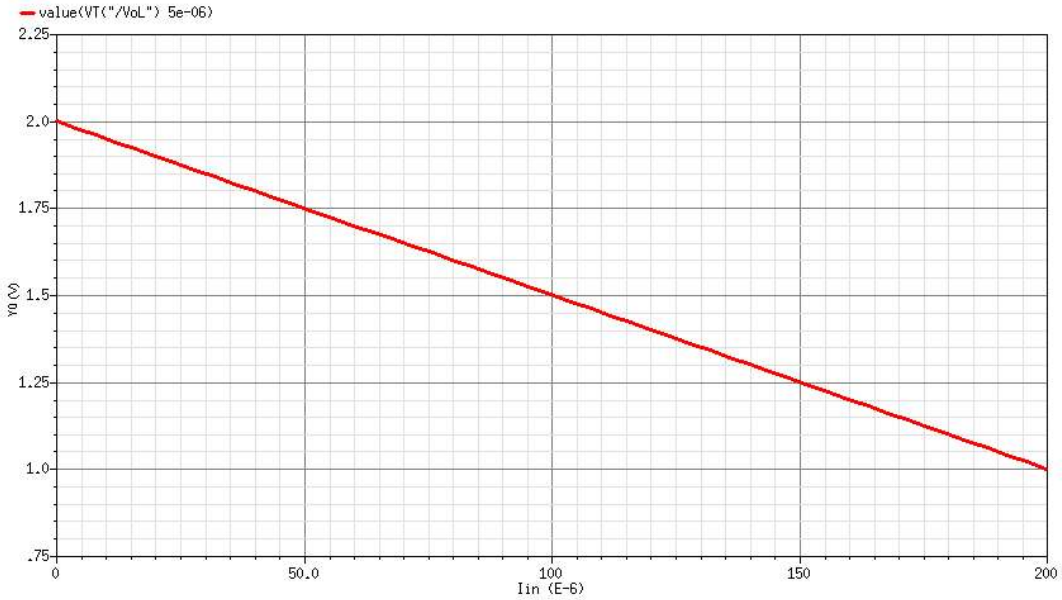


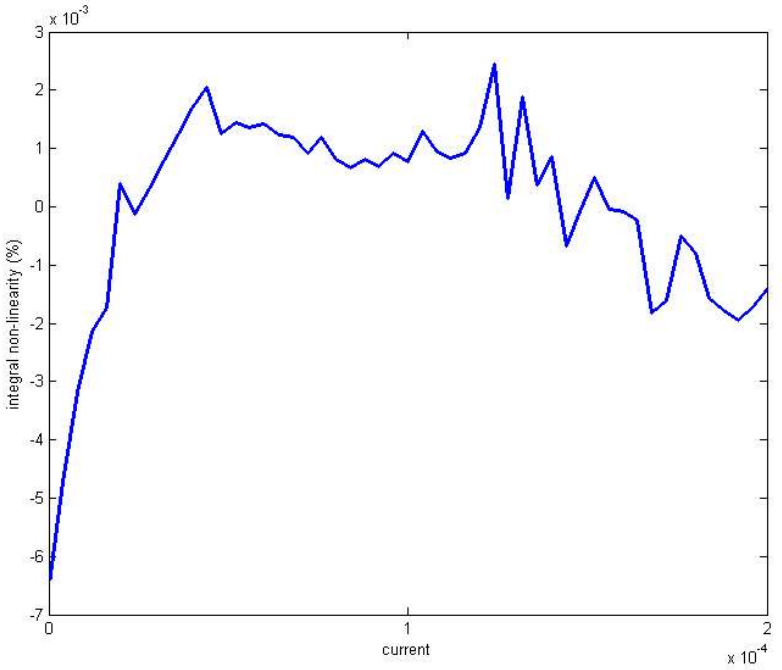
Linearity

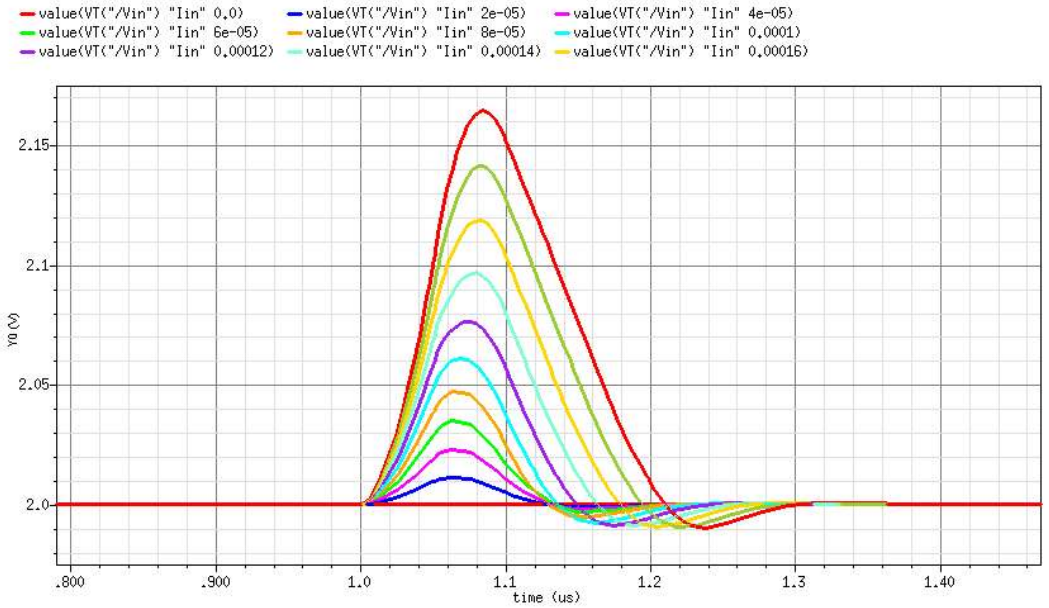
Original comparator Vth ~ 2.5V



New comparator Vth = 2.16V

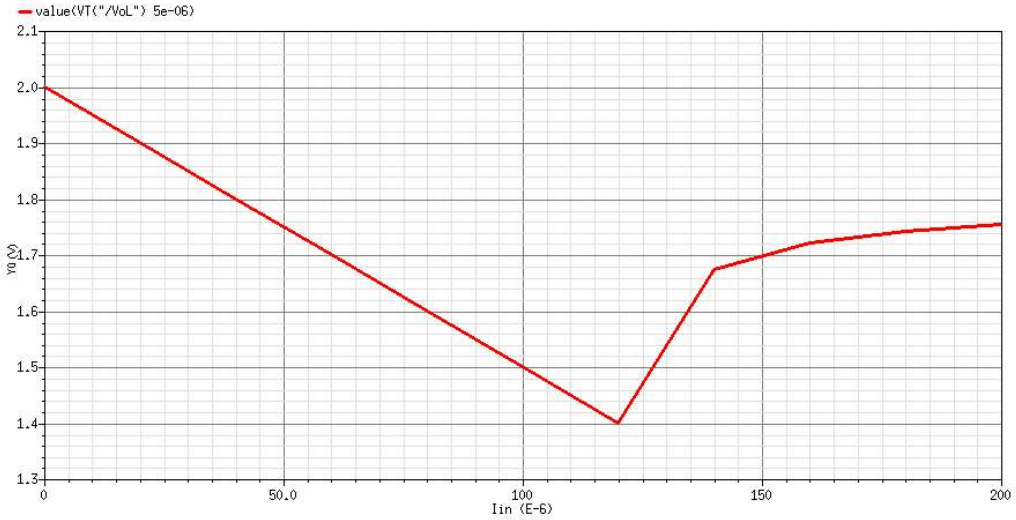


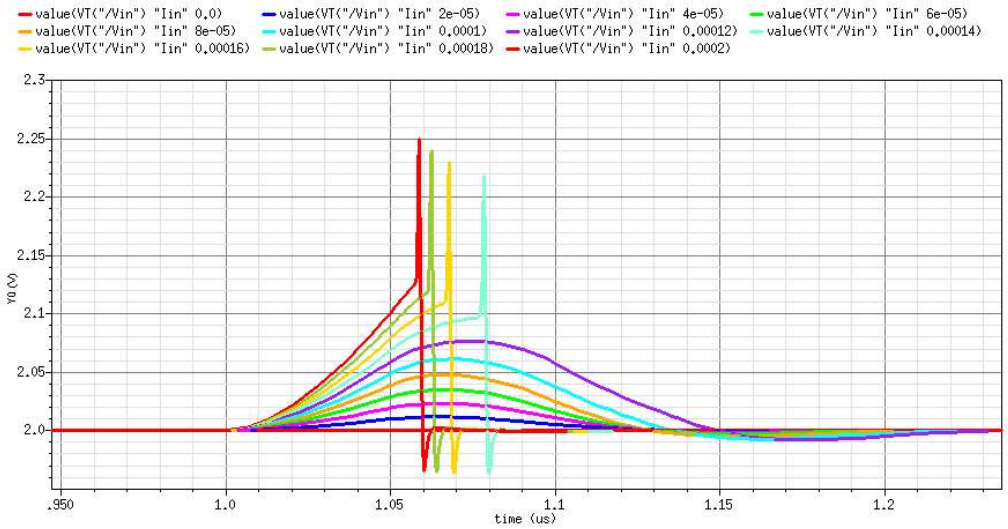




Linearity of low-energy channel

- Vth = 2.16V
- Comparator not active
- High-energy channel has no effect on low-energy linearity





Problem for Vth too low -

- Vth = 2.08V
- Comparator becomes enabled for Iin>120uA
- Vin reset to 2V, current flows into high-energy channel
- Threshold needs to be adjustable, as range of Vin will depend on external capacitance

Conclusions

- Dual energy range is achievable
- No reduction of linearity for low-energy channel
- Wide linear range for high-energy channel
- Adjustable threshold needed for connecting high-energy channel
- Results strongly dependent on detector current pulse shape