SSCS Chipathon 2025

Spiking Blocks with gLayout

Team-Capibara-Analog

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Spiking Blocks with gLayout

Main Goal

Migrate some of the components at the GLayout Components Plan **from SKY130 to GF180 to assemble then as our neuron**

Which components:

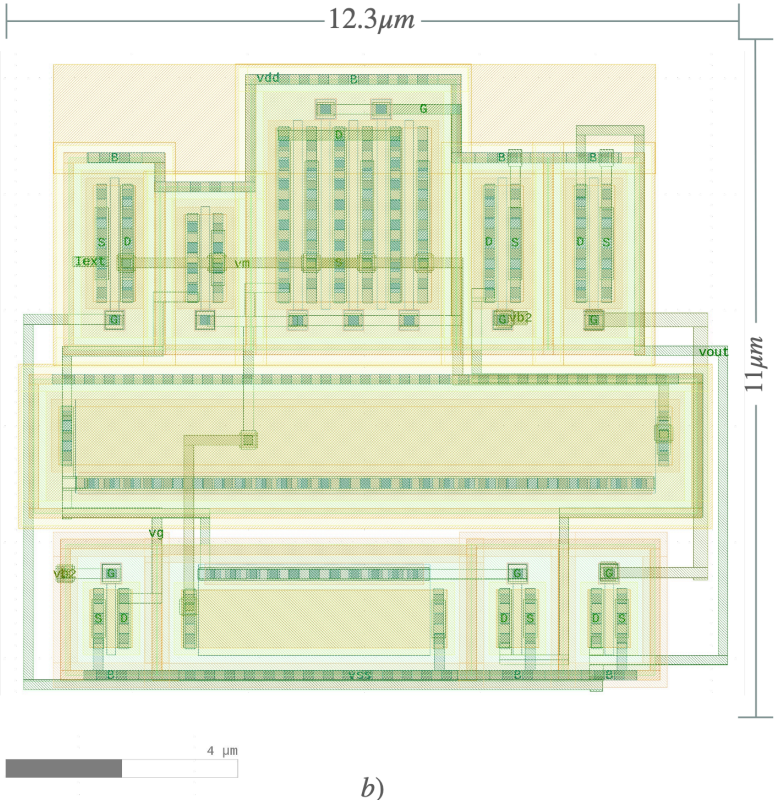
- Class B push-pull
- Common source amplifier
- Current Mirror
- Transmission Gate

https://docs.google.com/spreadsheets/d/1A_uOKMGtlIYUIwKEbsRSsxBDl7hbfN1CICvdhk3wykc/edit?gid=682350017#gid=682350017

Problem Statement

Design - High Level Proposal

- The layout of a single analog neuron can be done using current tools (xschem + magic + netgen)
- But each neuron geometry must be slightly different in order to properly encode an input signal into spikes
- No human power can draw a thousand different layouts for each neuron nor compose a layer
- **Use gLayout to craft our layout**

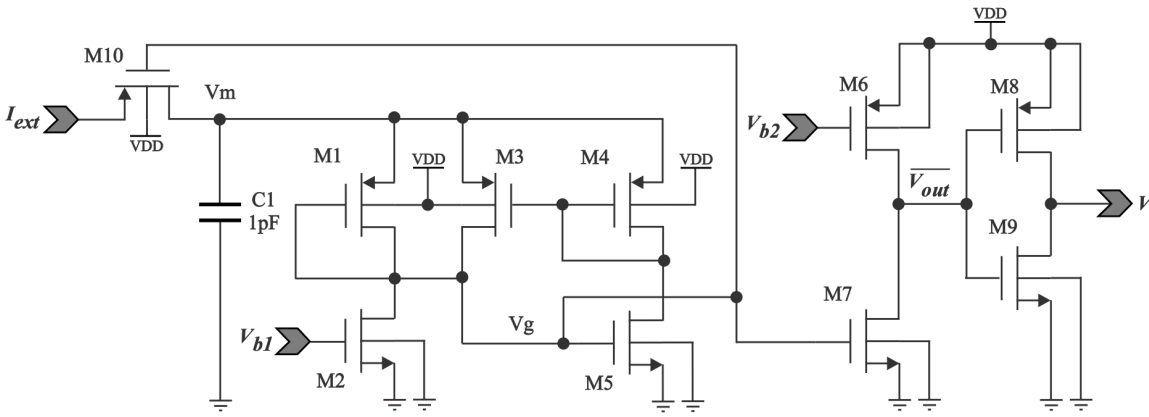


b)

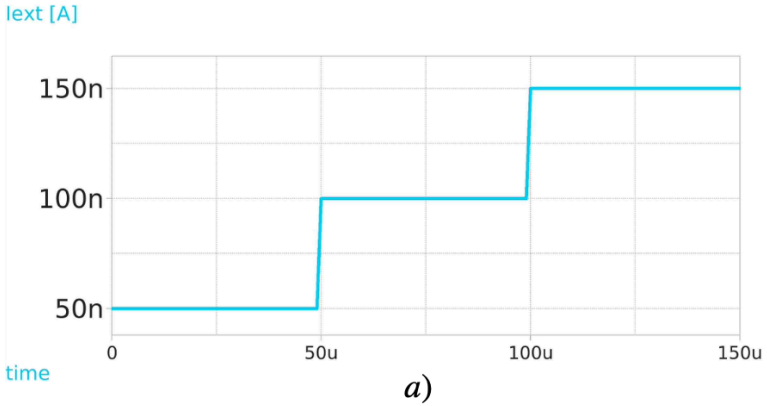
The layout of one neuron, without its capacitor C1

The spiking neuron prototype Application

- A 10 transistor + 1 Capacitor Neuron
- Each time a spike is produced, C1 is discharged through M5, and a spike is composed by M6-M9
- The neuron is composes
- If no current enters into I_{ext}, C1 discharges at a rate imposed by M2's geometry

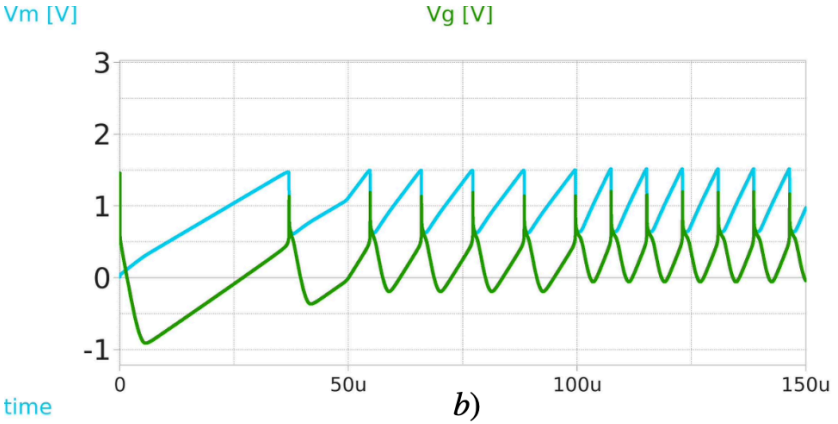


Input Current

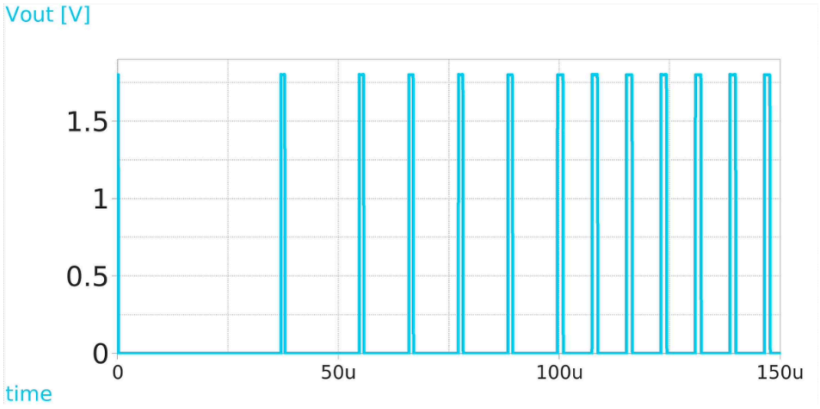


a)

Voltage of Internal nodes

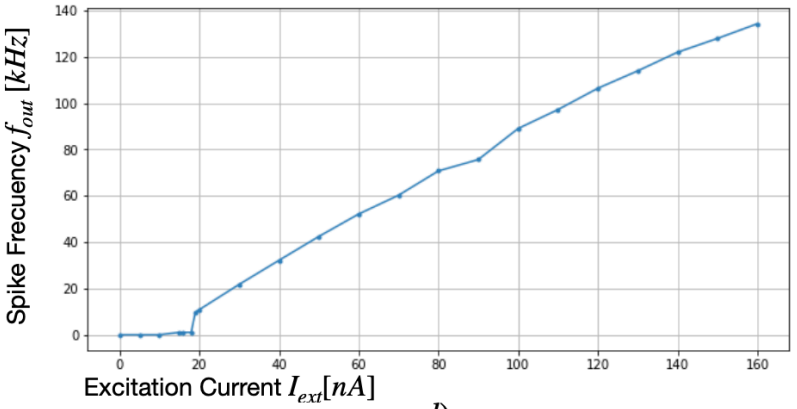


b)



c)

Output spikes

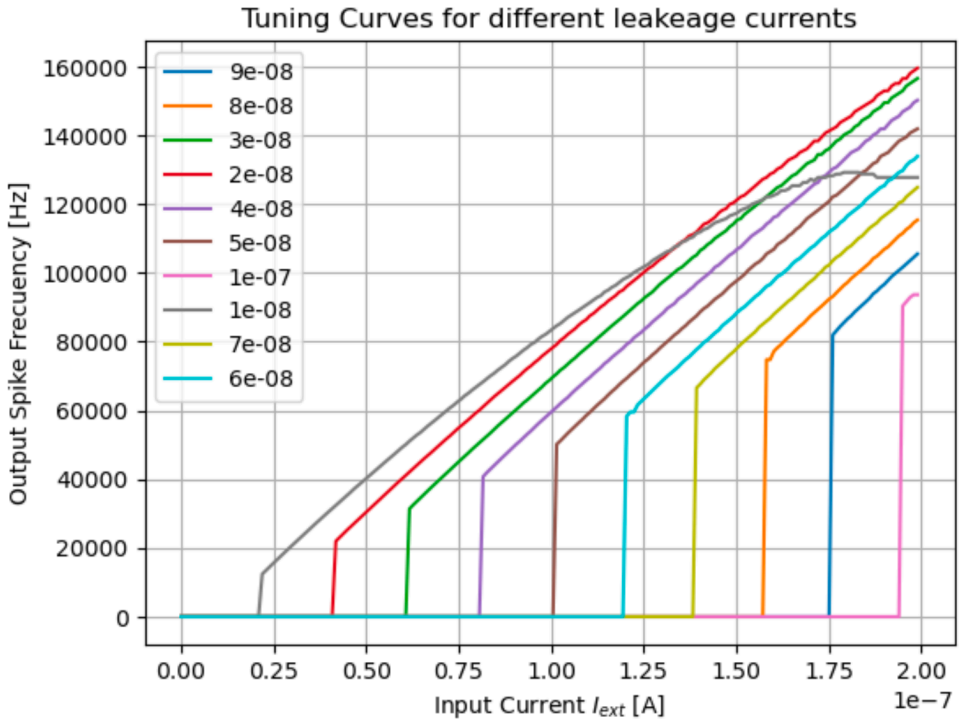


d)

Tuning Curve

The spiking neuron response Application

- The input current versus output spike frequency graph is called tuning curve
- Varying M2 and C1 geometries yield to different tuning curves
- For a layer in a spiking neural network, it is desired to distribute the riobase of each neuron in a normal distribution



Assemble of a spiking neuron layer

Application

- Once having neurons, it is desired to assembly then into a layer
- But, what about if we need hundreds-thousand of neurons in a layer?
- Each one with a different tuning curve

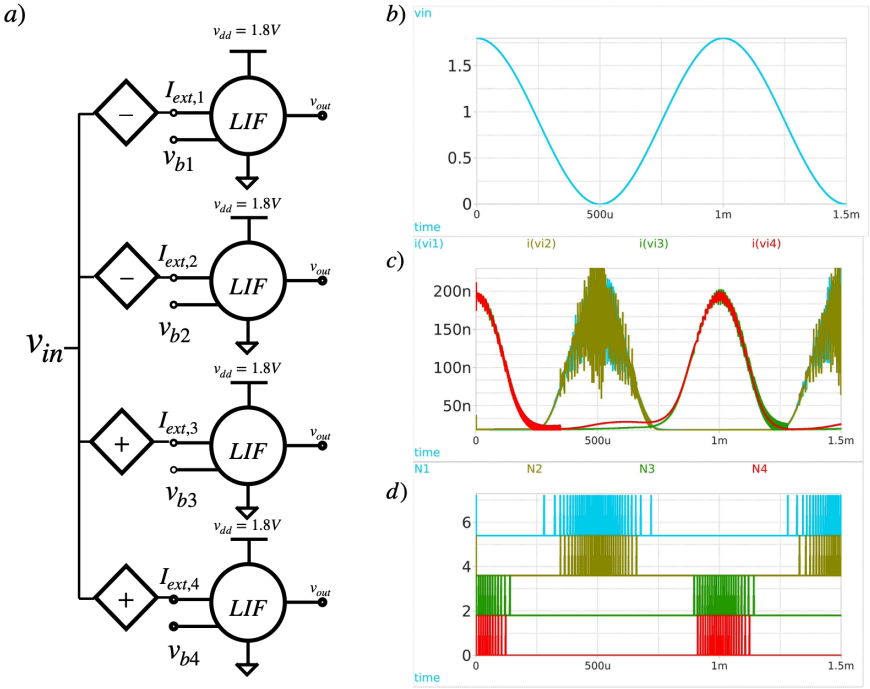


Figure 4.7: a) Testbench for a LIF four neurons, reacting to an input voltage signal. Each neuron has different leakeage current $I_{leak} = [10nA, 20nA, 30nA, 40nA]$ b) Input sinusoidal signal at $1000Hz$, between 0-1.8V. c)Resulting excitation current for each neuron, using a VCCS for each neuron two positive, two negative to provide negative and positive encoding. d)Spiking activity for all four neurons. Notice how some neurons turn on certain ranges of the input signal, while the rest for other regions.

References

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