

# Low-Power Spiking Neural Network with Clock-gating technique

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# Abstract

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- Design SNNs with and without clock gating
- Estimate power consumption
- Compare results

# Agenda

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- How much power consumption can be reduced
- How to do to apply clock gating
- When to apply clock gating



# Overview of power consumption of AI and SNNs

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## Power consumption of AI

- Uses a lot of electricity
- Damages environment
- Generates CO2

## Spiking Neural Networks (SNNs)

- Brain-inspired model
- Mimics biological neurons
- Communicates and computes using spikes



# Importance of energy efficiency and high power consumption in SNNs

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## Importance of energy efficiency

- Can become from 100 to 1,000 times more energy - efficient



Possible to put much more AI into chips

## High power consumption in SNNs hardware implementations

- Works more efficiently than non-neuromorphic systems
- However, affects the environment

# Objectives

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## ① Reduce power consumption maintaining accuracy

- Become energy-efficient
- Prevent from using electricity wastefully



## ② Reduce further by sacrificing accuracy

- Suppress of generation of CO<sub>2</sub>
- Work with ultra-low-power

# Clock Gating Overview (1)

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- Clock gating: technique for reducing dynamic power

## SNN

- conduct a large amount of computation
- need large-scale computational resources

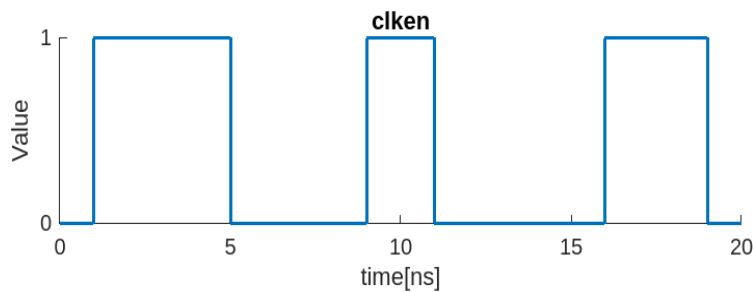
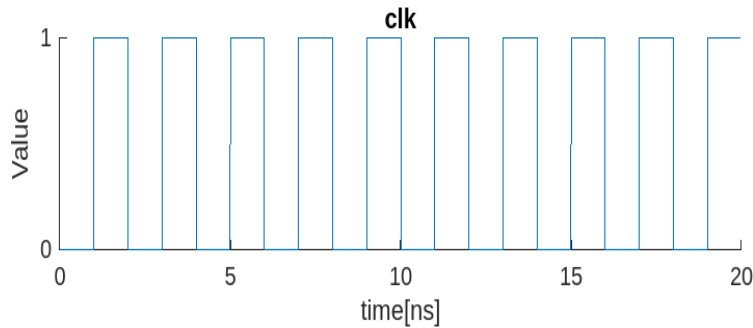


Application of clock gating

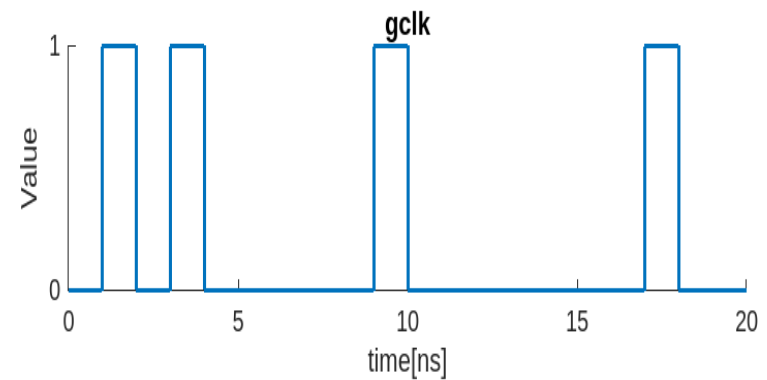
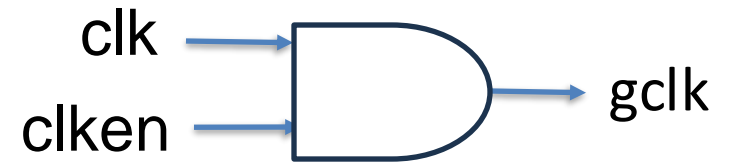
- Reduce operational expenses and environmental effect
- Increase Battery life



# Clock Gating Overview (2)



$$gclk = clk \wedge clken$$





# Methodology (1)

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- 1) Preparation codes of conventional circuit
- 2) Simulation
- 3) Synthesis
- 4) Post-synthesis simulation
- 5) Power estimation
- 6) Do the same tasks with clock-gated circuit

# Methodology (2)

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## How

- Introduce clock enable signal as input
- add cell to calculate gated clock signal

## Strategy

- Decide on standard to apply clock gating depending on the number of rising spikes



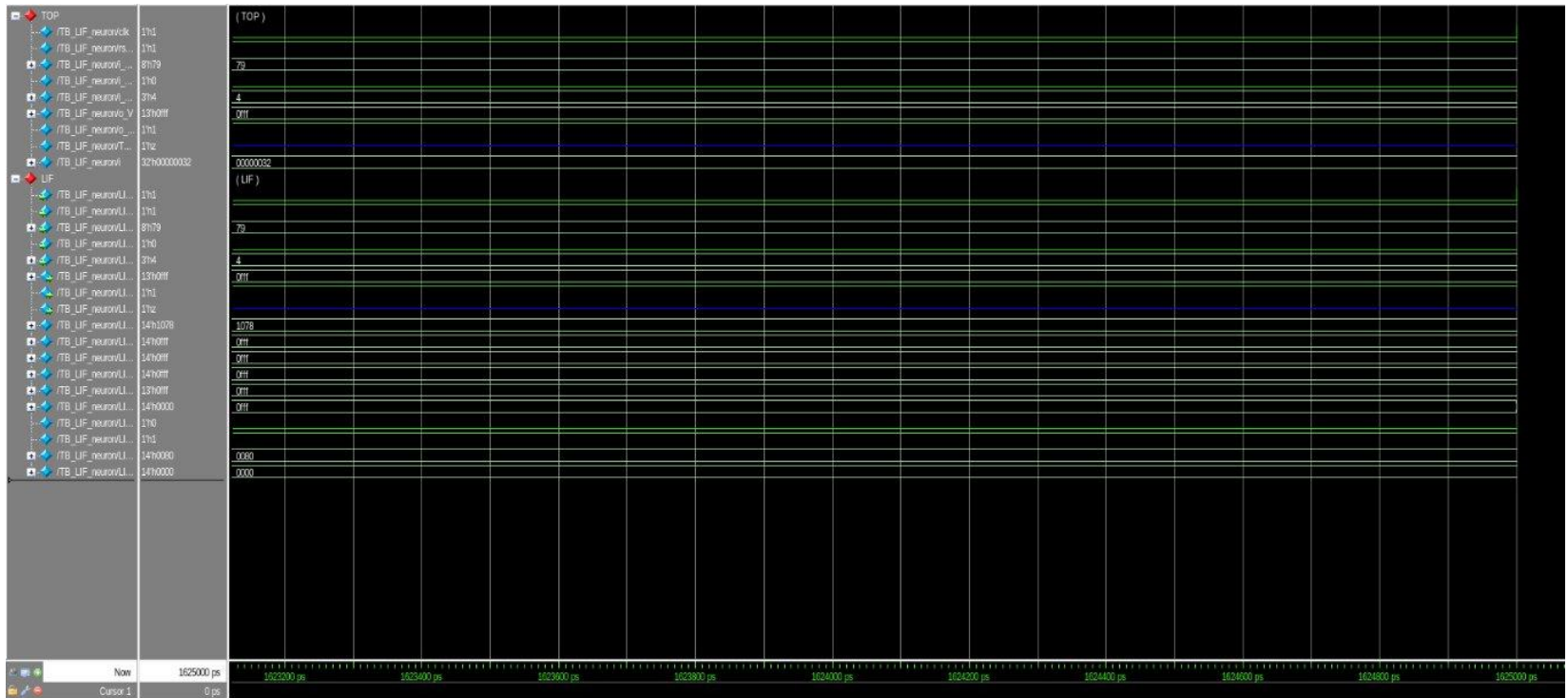
# Modification of code for SNN

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1. Follow tutorial (finished)
2. Apply clock gating technique
3. Estimate power consumption
4. Compare result of power consumption between original and clock-gated SNN

# Research Progress | Done

- Simulation of RTL code for SNN





# Research Progress | Doing

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- Application of clock gating to RTL code for SNN
- Graduation thesis



# Research Progress | Todo

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- Estimation of power consumption
- Comparison of results

# Schedule

Task	Deadline
Meeting	December 23
Graduation thesis	January





# Reference

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Thank you for your attention!