

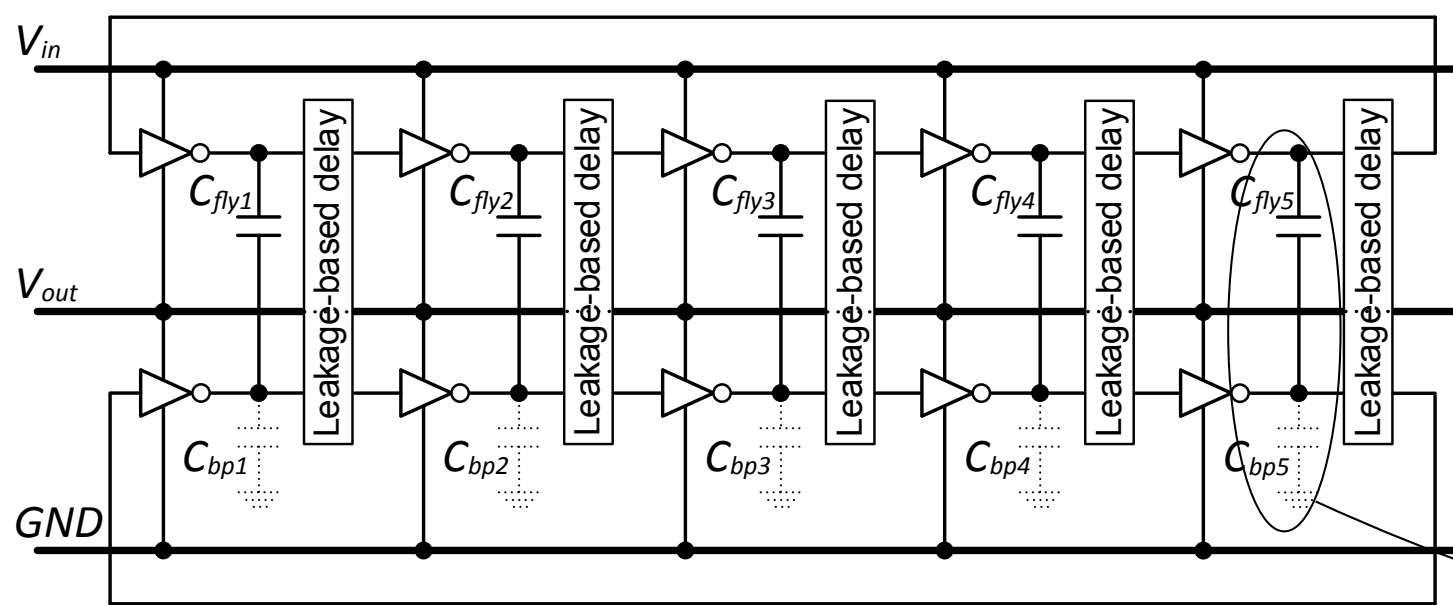
# Self-Oscillating Switched Capacitor Converter with Parasitic Charge Redistribution

S. Mileiko

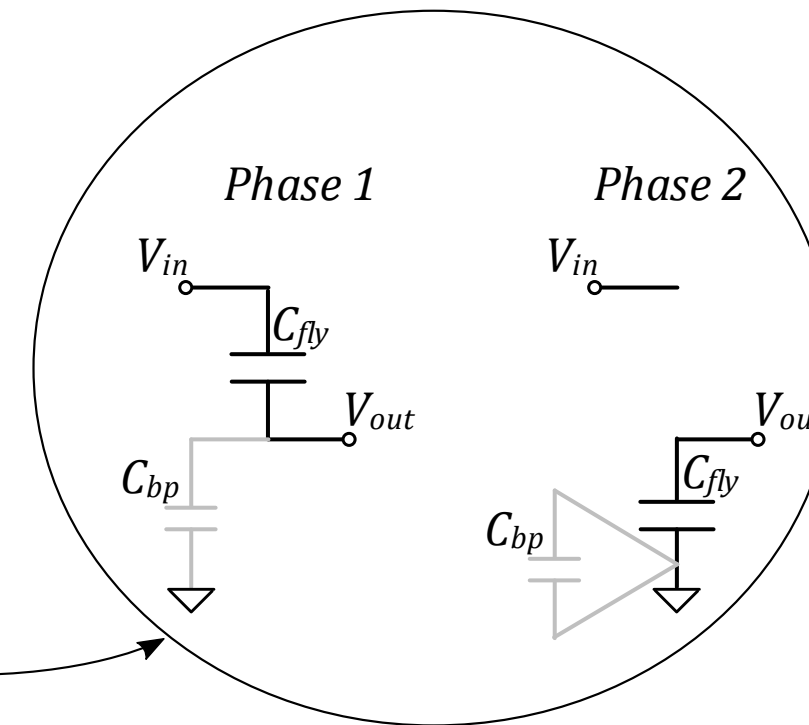
Supervisors: A. Yakovlev, D. Sokolov

## Introduction

Switched-capacitor DC-DC converters (SCCs) are used to supply electronic devices with different operating voltages. The main advantage of SCCs is their relatively small size: they can be implemented on the same chip with a target device.

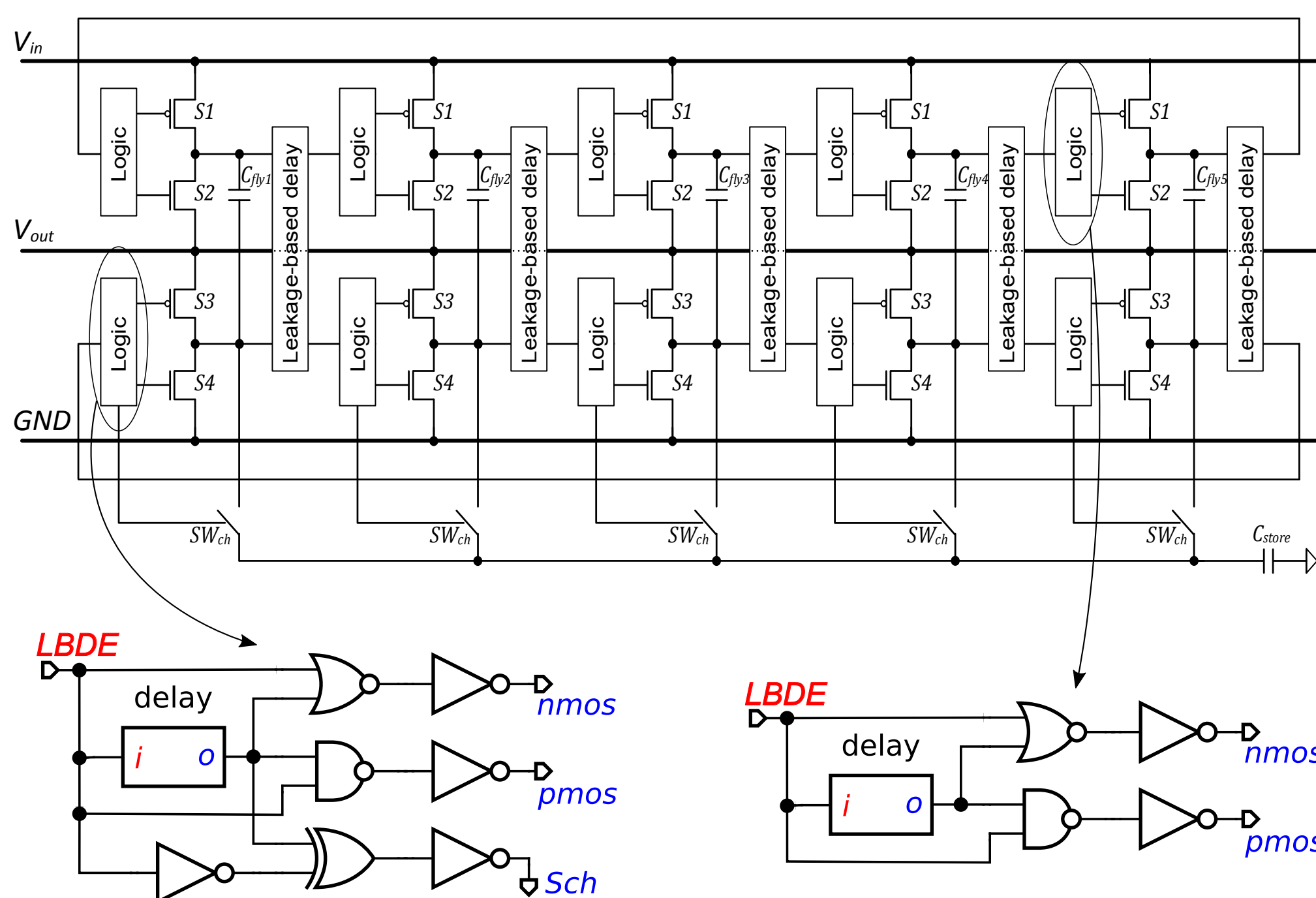


The main source of decrease in SCC efficiency are the losses associated with the bottom plate parasitic capacitance. This capacitance arises from the nature of the on-chip capacitors, and cannot be removed from the design.



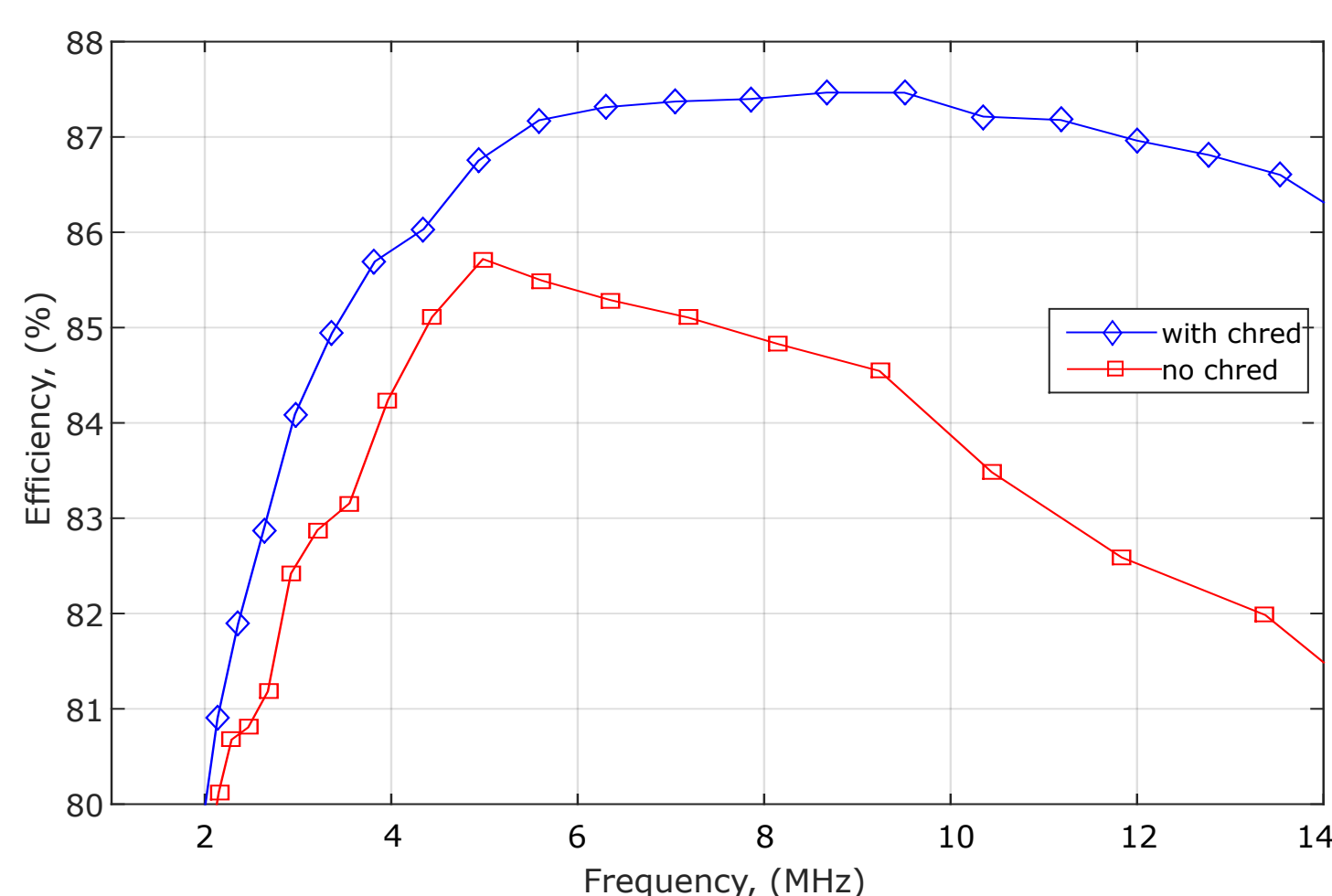
- In the phase 1 the bottom plate capacitor is charging from  $V_{out}$ .
- In the phase 2 it is discharging to the ground.
- This charge is being wasted at every switching cycle.

## Proposed approach



- Adding an extra capacitor  $C_{store}$  that stores the parasitic charge, and the charge recycling switches  $SW_{ch}$  that connect this capacitor to all the bottom plates of the flying capacitors.
- Introducing an intermediate phase, when all the power transistors of a certain stage are turned off, and the corresponding charge recycling switch  $SW_{ch}$  is turned on.
- When the stage switches from phase 1 to phase 2, the half of the charge from the bottom plate capacitor  $C_{bp}$  goes to the store capacitor, and remains in the system.
- When the stage switches from phase 2 to phase 1, the bottom plate capacitor  $C_{bp}$  is partially charged from the store capacitor, and requires less energy to complete the switching.
- This process is controlled by the additional logic blocks embedded in the system.

## Results



- The efficiency of the proposed self-oscillating SCC with the parasitic charge redistribution is higher than the state-of-the-art self-oscillating SCC.
- Although the improvement is not very significant for the single SCC cell, it can be much higher for the systems that are built of several simple SCCs.
- The efficiency improvement is more noticeable with higher switching frequencies.
- The method works better for the converters with larger flying capacitors, as it recycles more parasitic charge.