EE 435

Lecture 33

Current Steering DACs

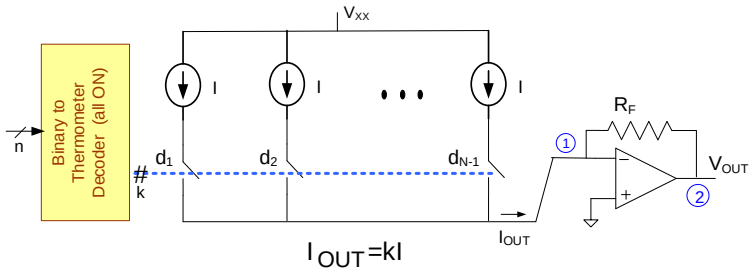
Review from Last Lecture

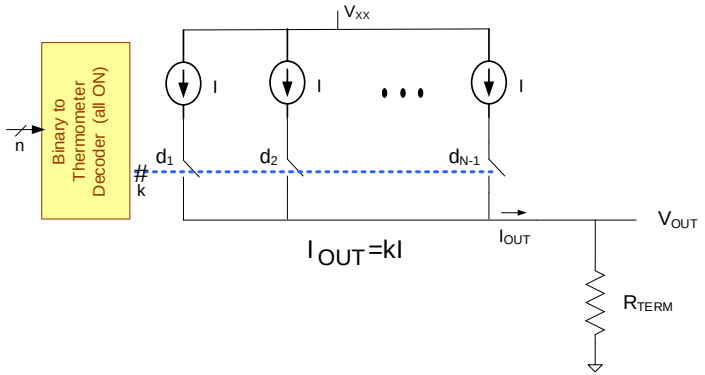
Current Steering DACs

Current will be “steered” to a resistive load (on chip)

Output could be a current (user supplies load)

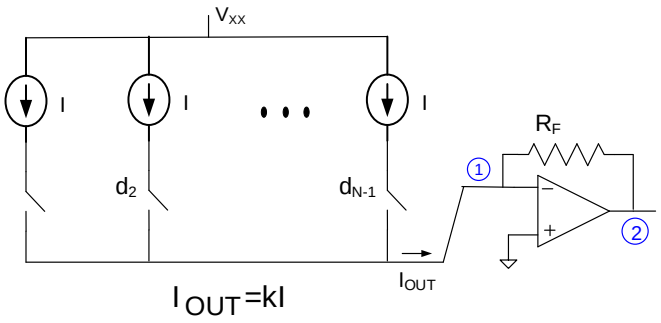
Basic Concept of Current Steering DACs

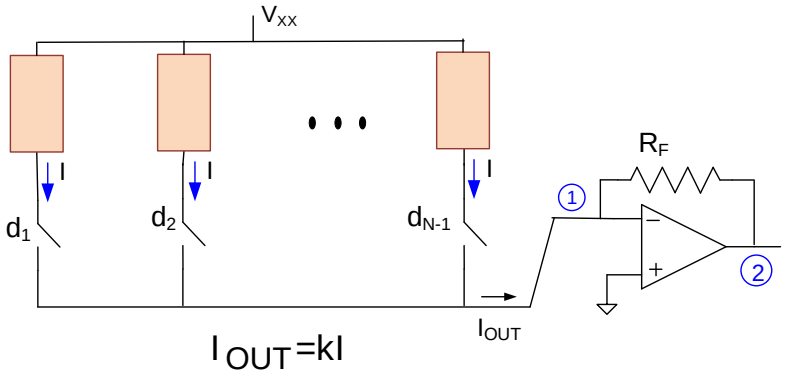




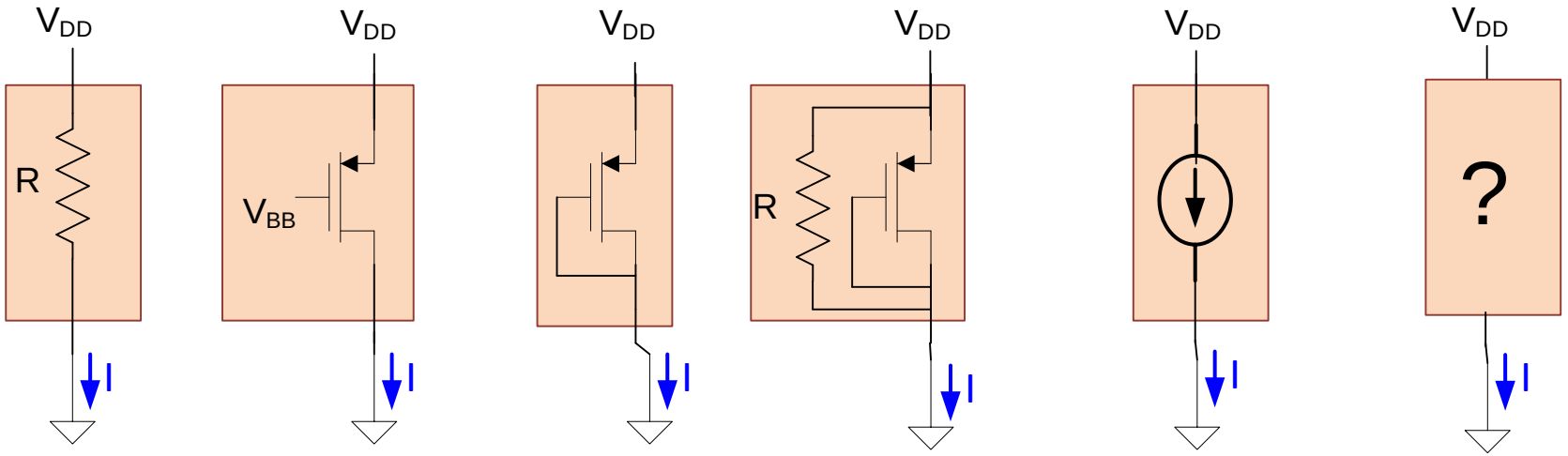
Review from Last Lecture

Current Steering DACs



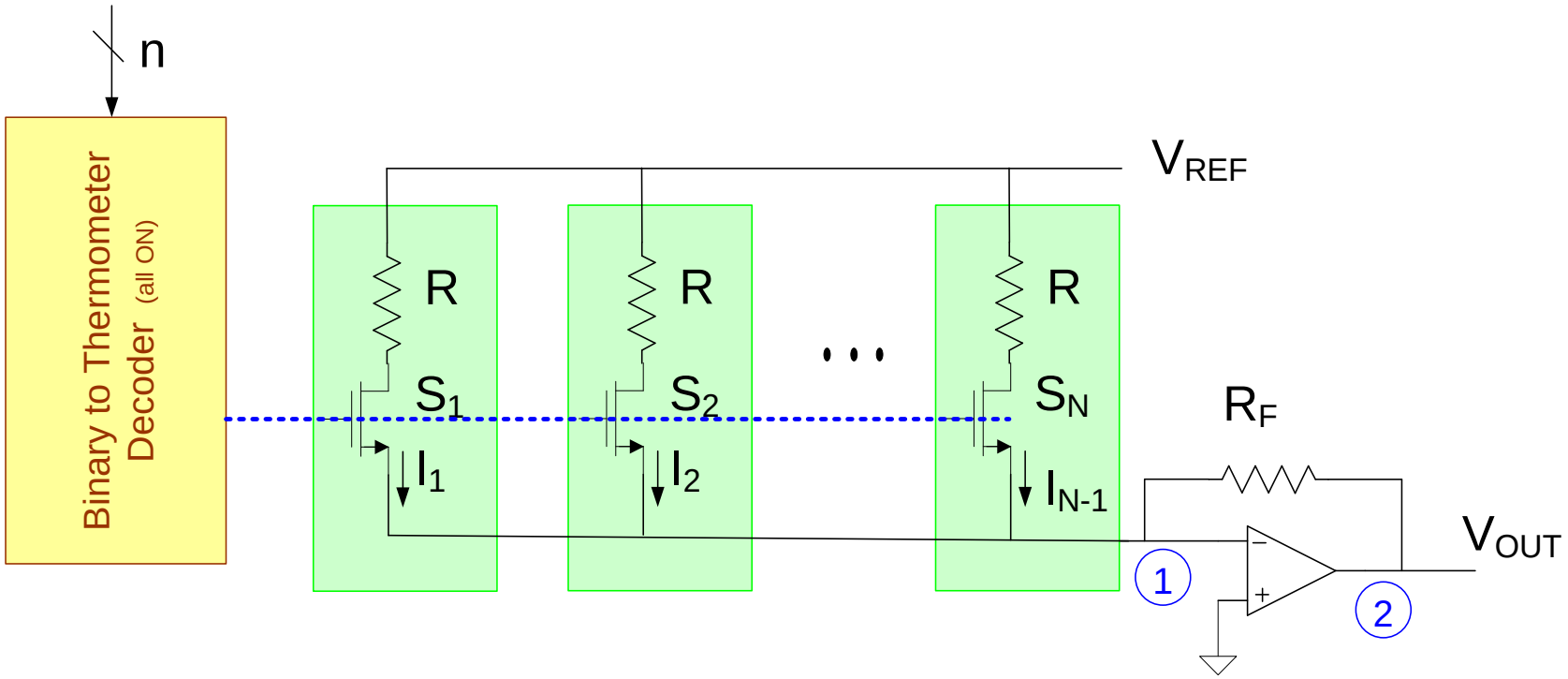


What is important is the current generated, not whether it comes from a “current source”



Many potential current generator blocks, just require that all be ideally identical

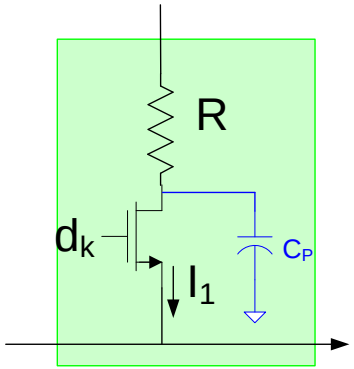
Current Steering DACs

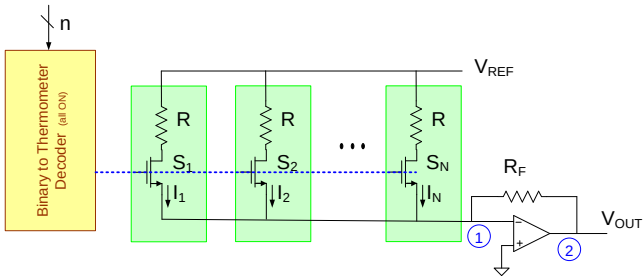


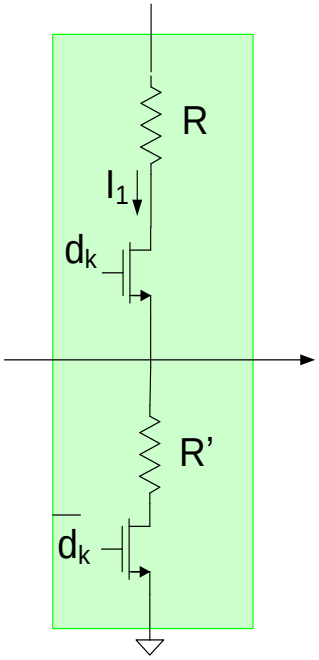
Transistor Implementation of Switches

Review from Last Lecture

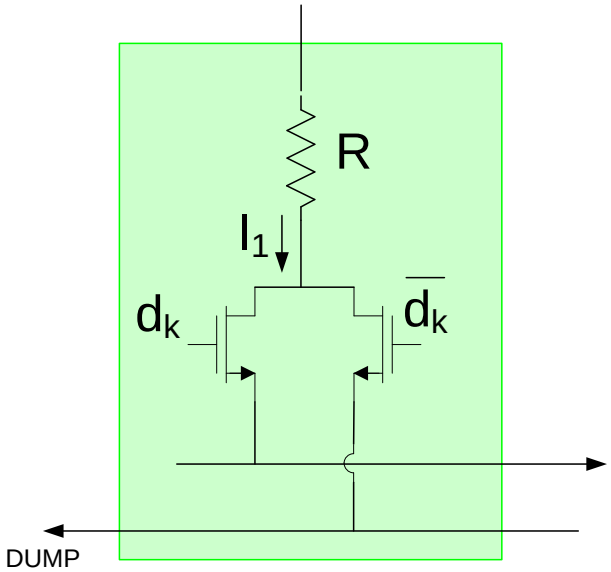
Current Steering DACs



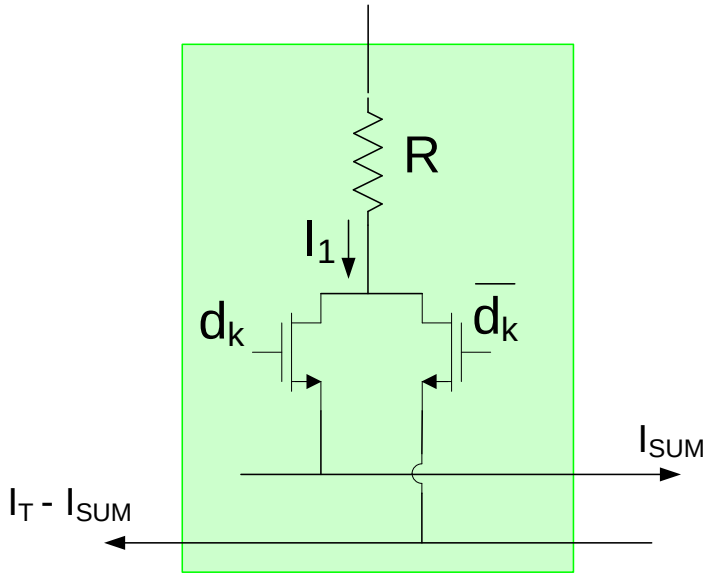




β Compensation



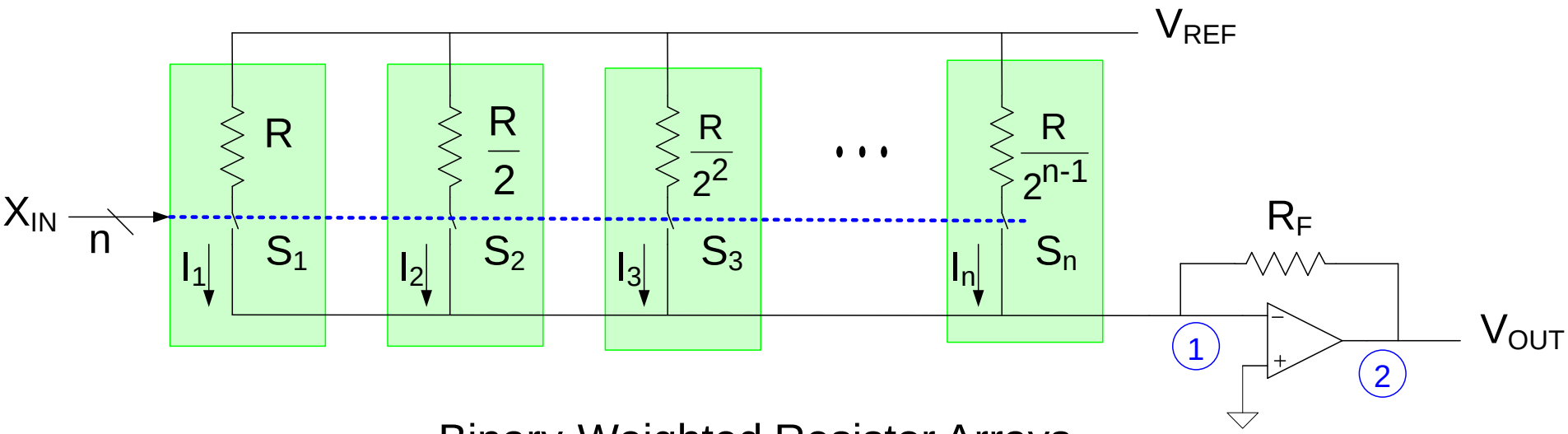
C_P Compensation



Differential Output

Review from Last Lecture

Current Steering DACs



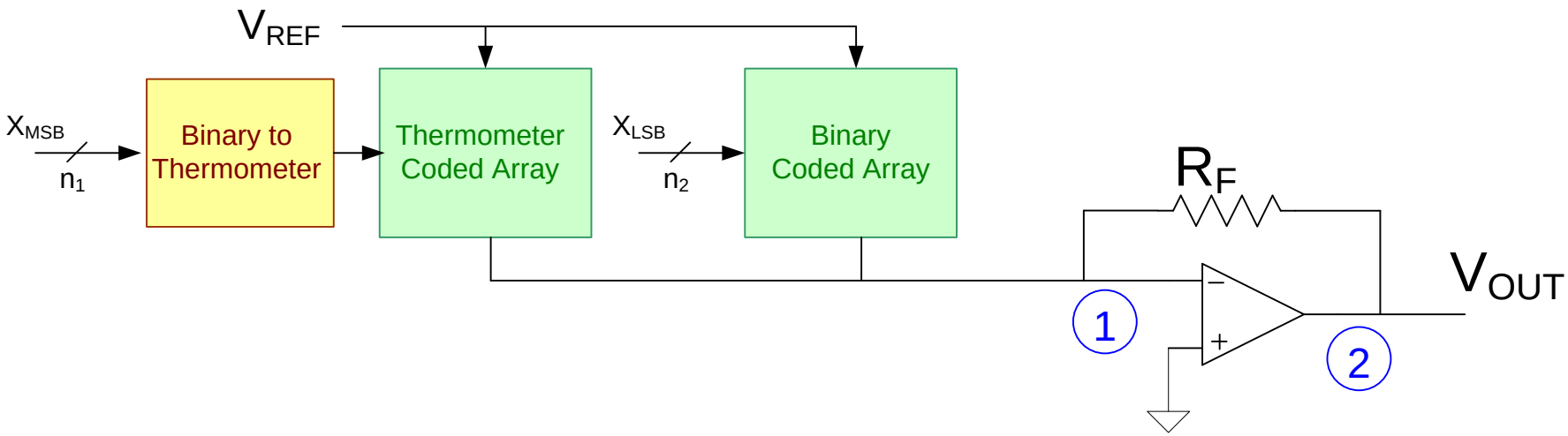
Binary-Weighted Resistor Arrays

- Need for decoder eliminated !
- DNL may be a major problem
- INL performance about same as thermometer coded if same unit resistors used
- Sizing and layout of switches is critical

Observe thermometer coding and binary weighted both offer some major advantages and some major limitations

Review from Last Lecture

Current Steering DACs

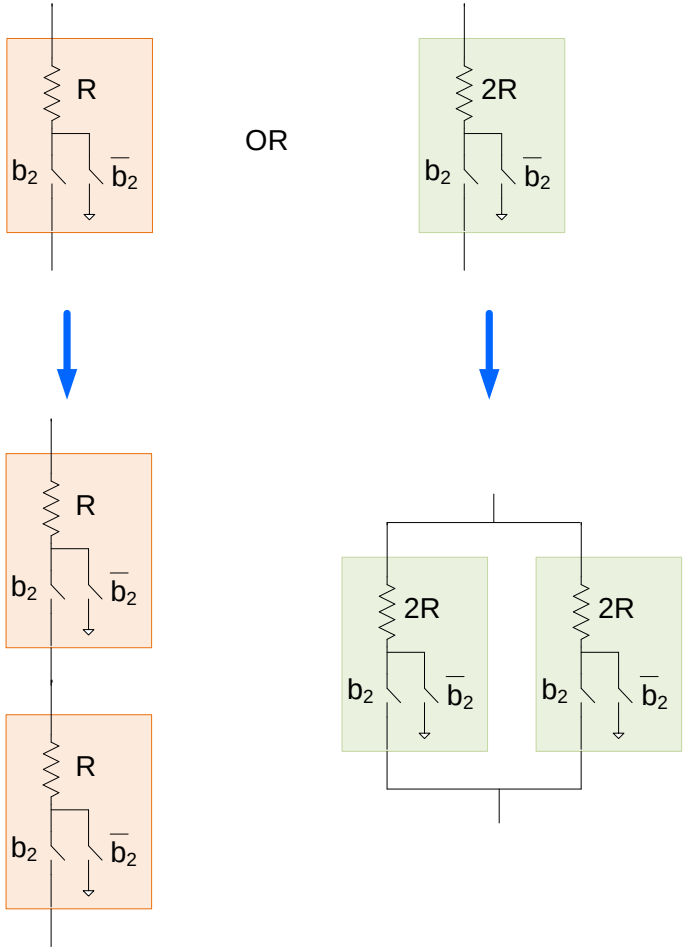


Segmented Resistor Arrays

- Combines two types of architectures
- Inherits advantages of both thermometer and binary approach
- Minimizes limitations of both thermometer and binary approach

R-2R Implementation

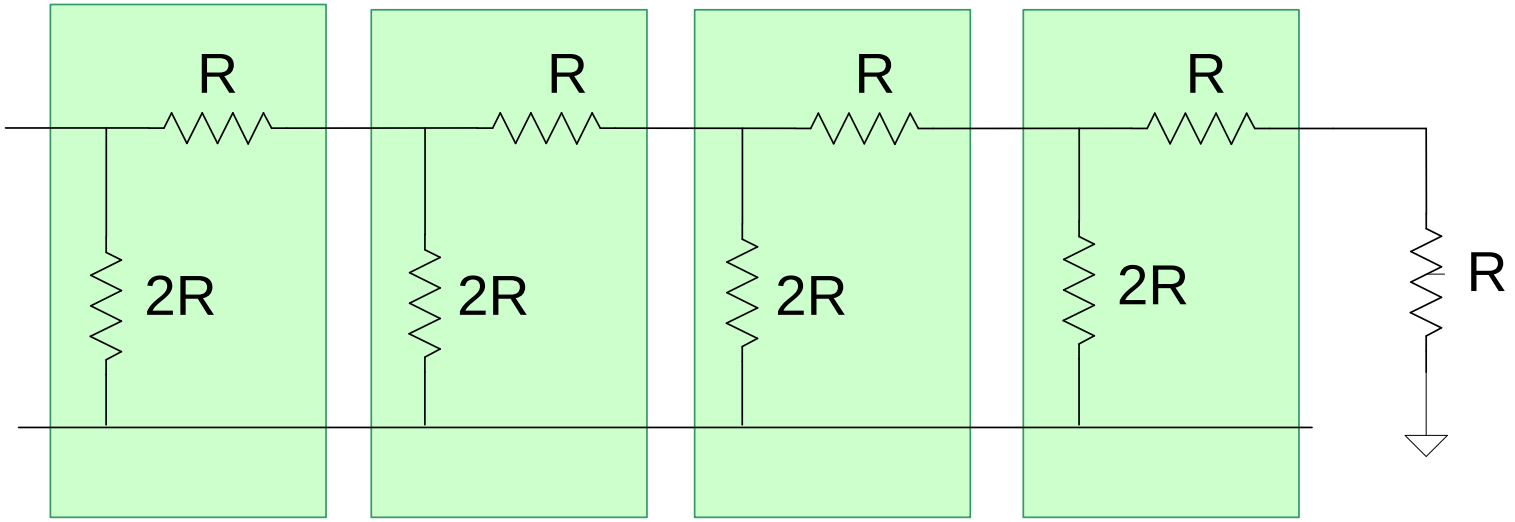
Review from Last Lecture



- Unit cell widely used
- Switch included in cell even if not switched!
- Code dependence of switch impedance of concern

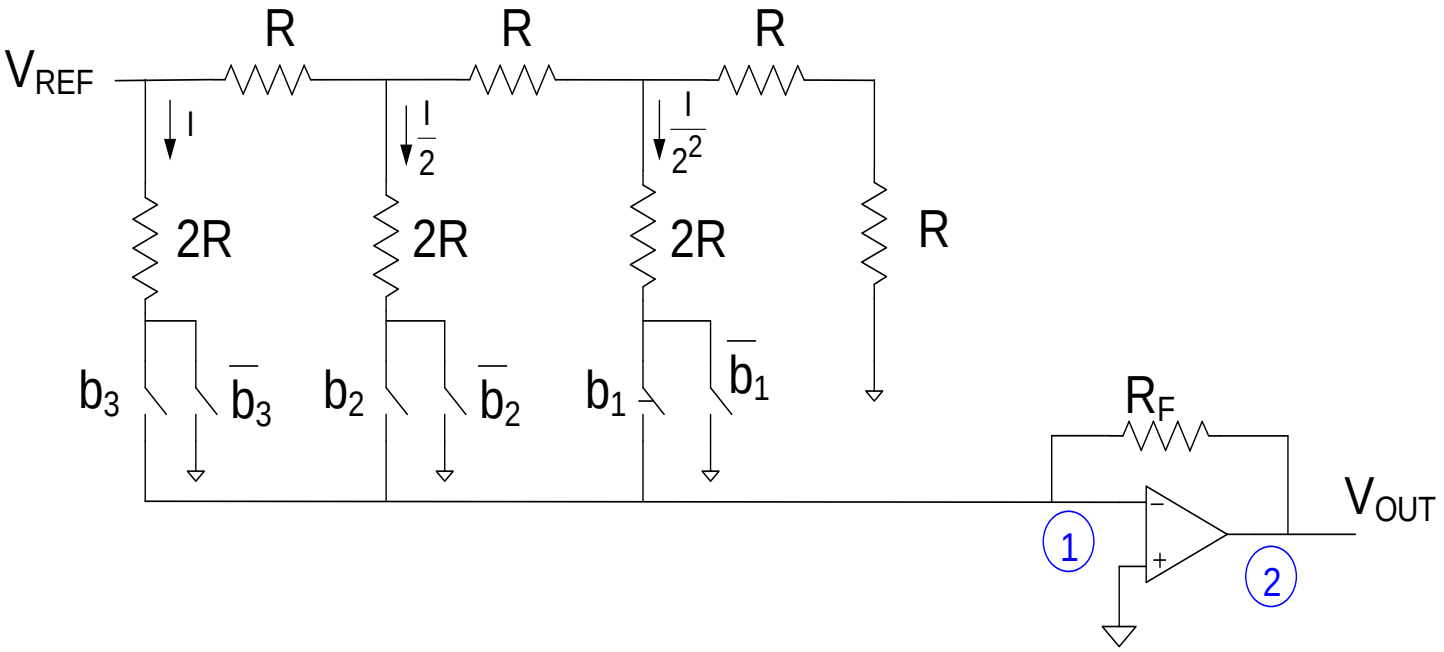
How can switch impedances be matched?

R-2R Resistor Arrays



- 4 bit-slices shown
- Can be extended to arbitrary number of bit slices
- Conceptually, area goes up linearly with number of bit slices

Current Steering DACs



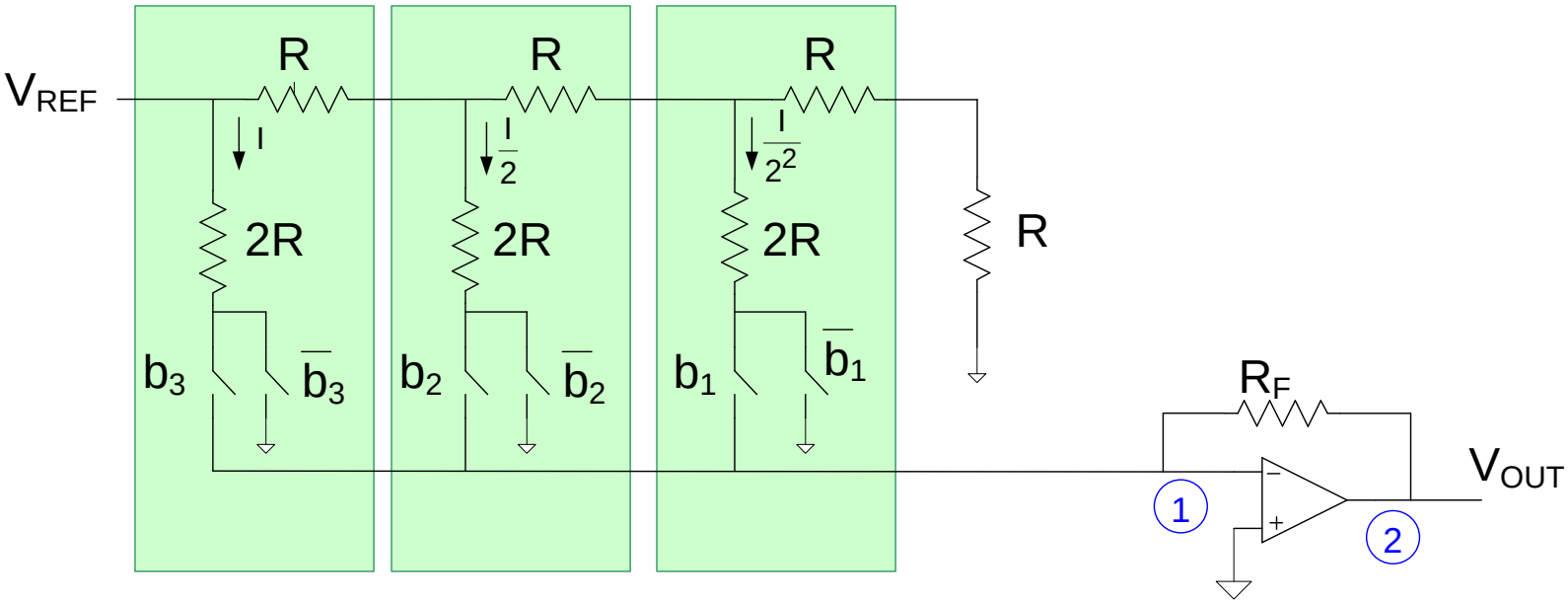
R-2R Resistor Arrays

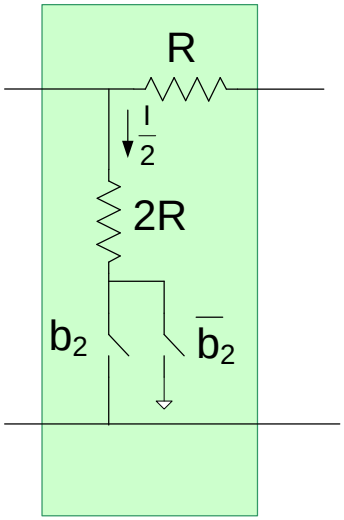
Node voltages ideally stay constant for any input code

Highly sensitive to nonlinearities in switches

How should switches be sized?

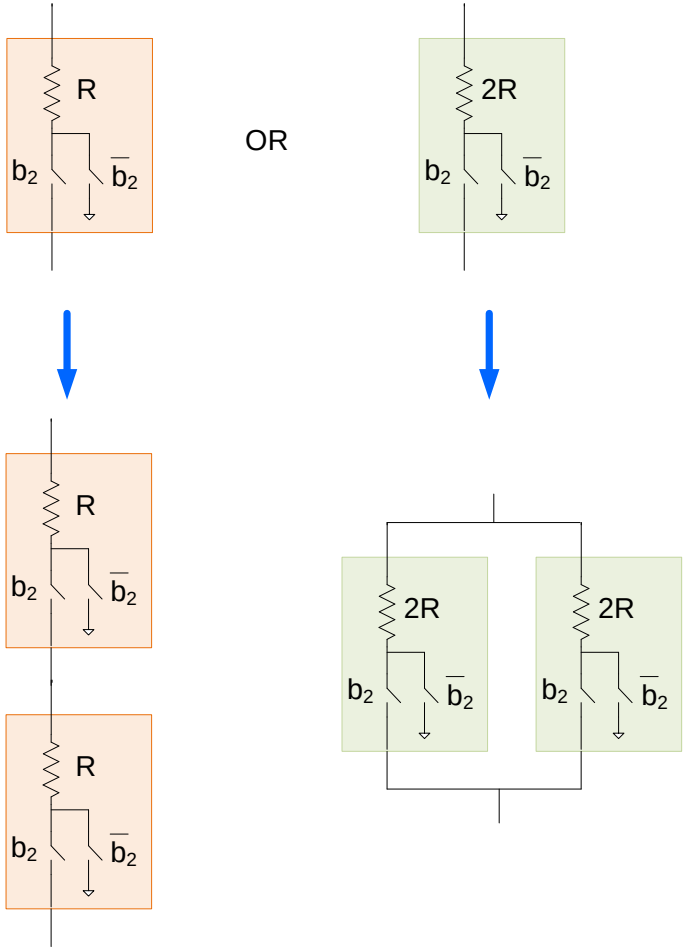
Current Steering DACs





R-2R Resistor Arrays

R-2R Implementation



- Unit cell widely used
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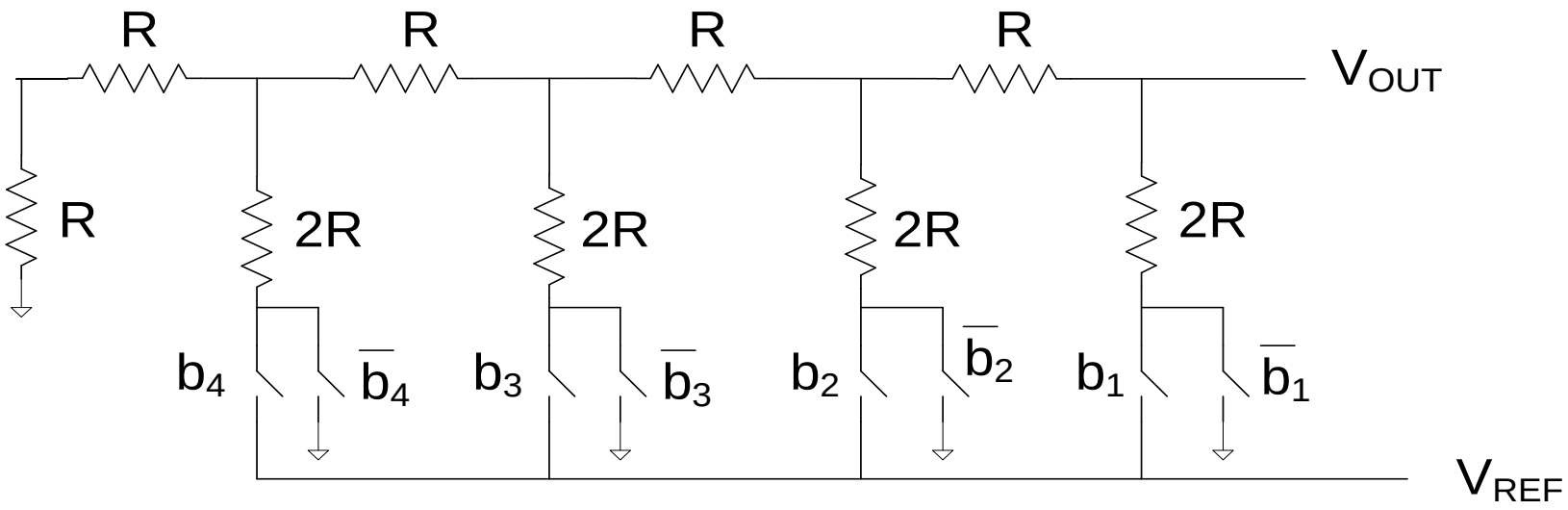
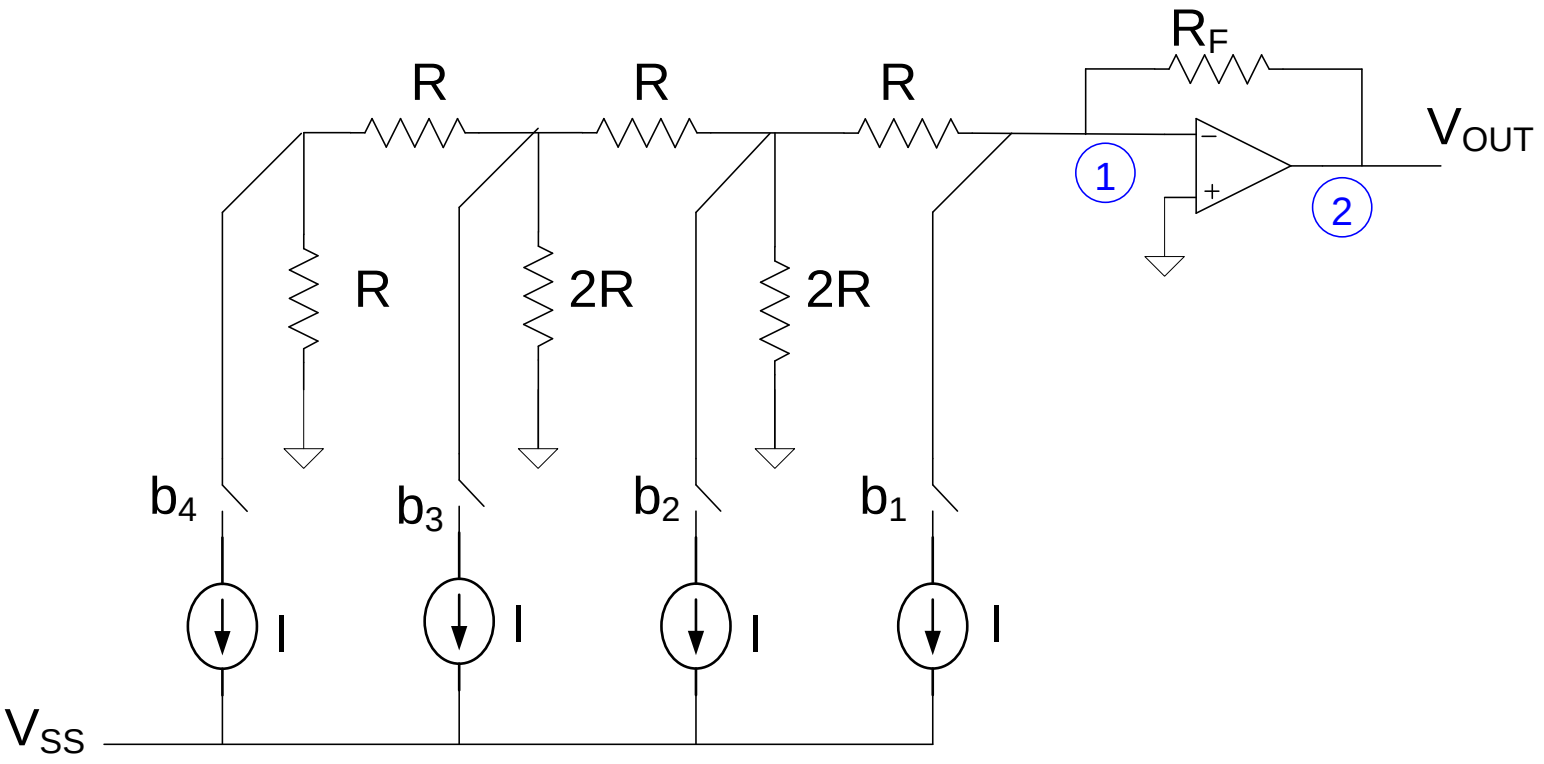
How can switch impedances be matched?

Another R-2R DAC



Node voltages change with input code

Another R-2R DAC



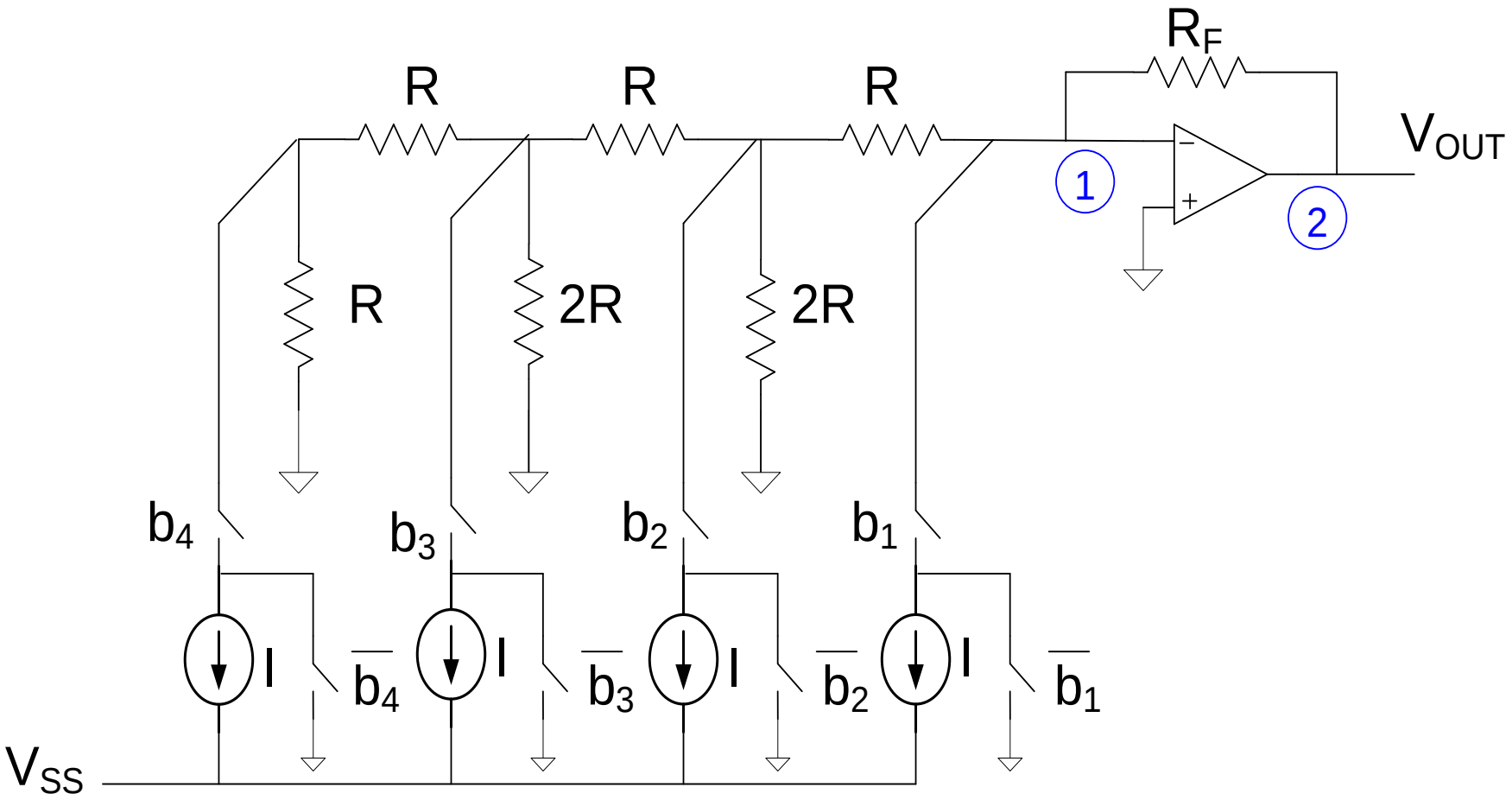
Requires matching both current sources and resistors

But switch impedance does not affect performance

β is independent of Boolean code

Node voltages in R/2R block must change for any input transitions

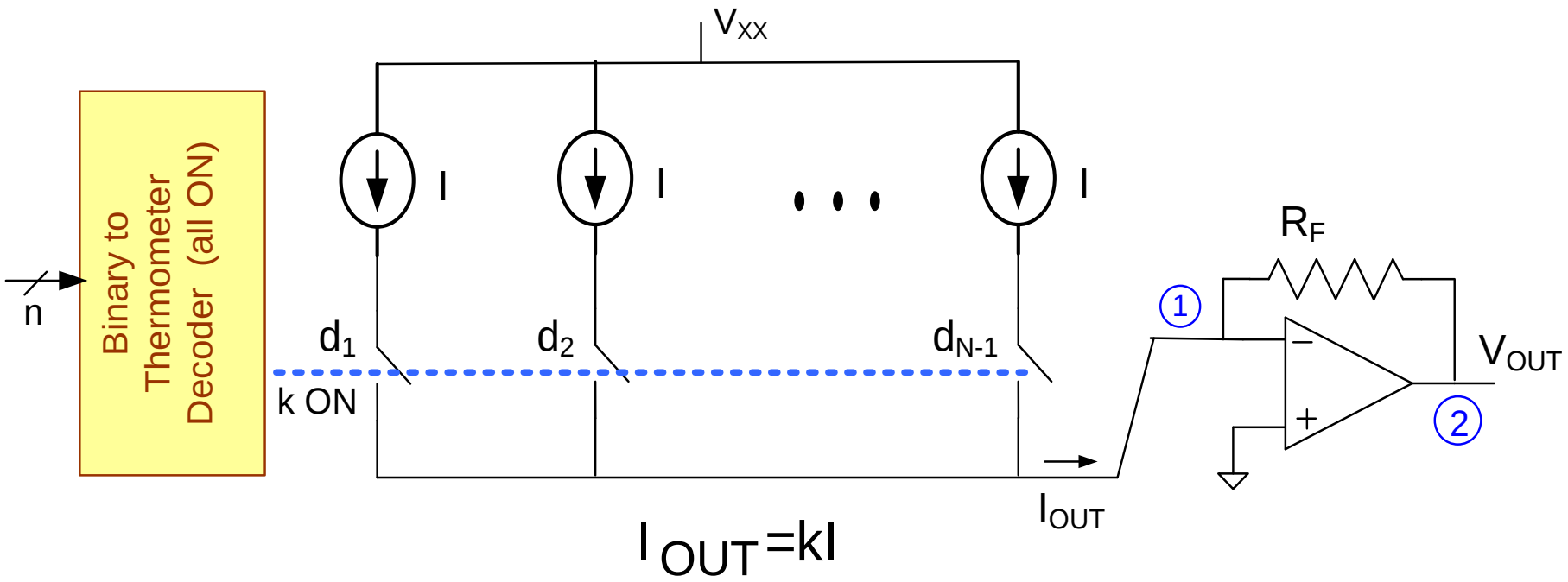
Another R-2R DAC

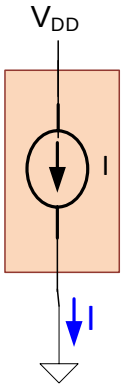


Clocks must be nonoverlapping

Does this offer any benefits over previous approach ?

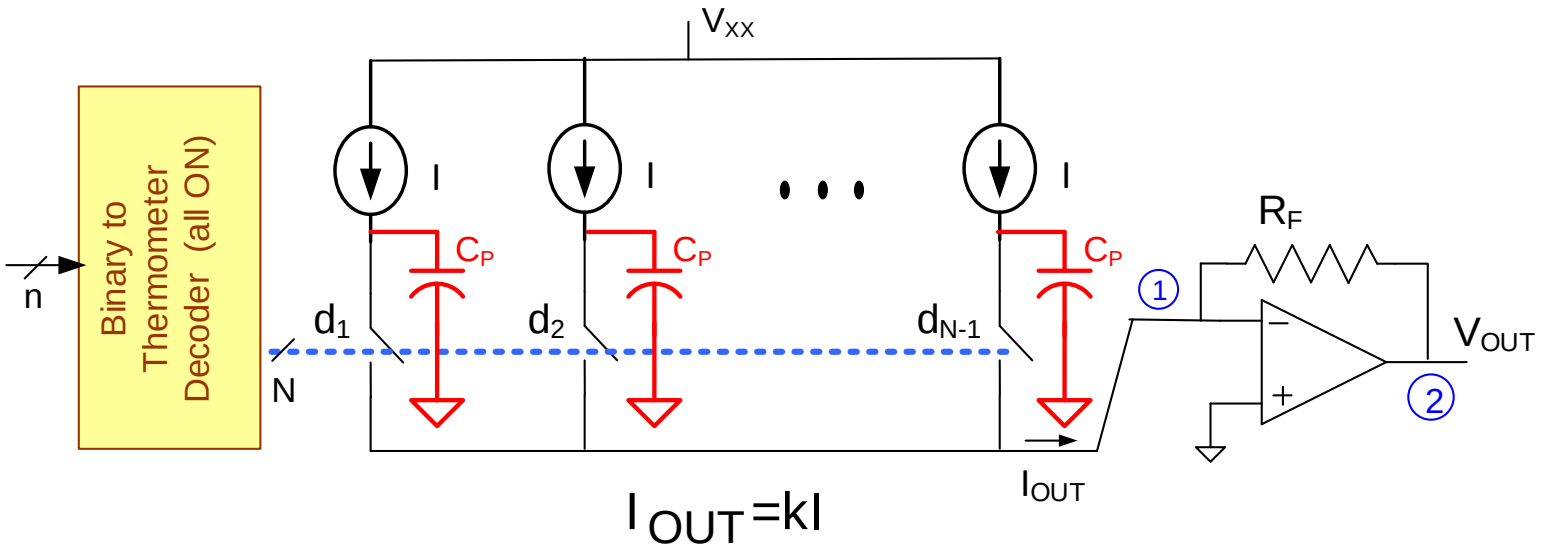
Current Steering DAC





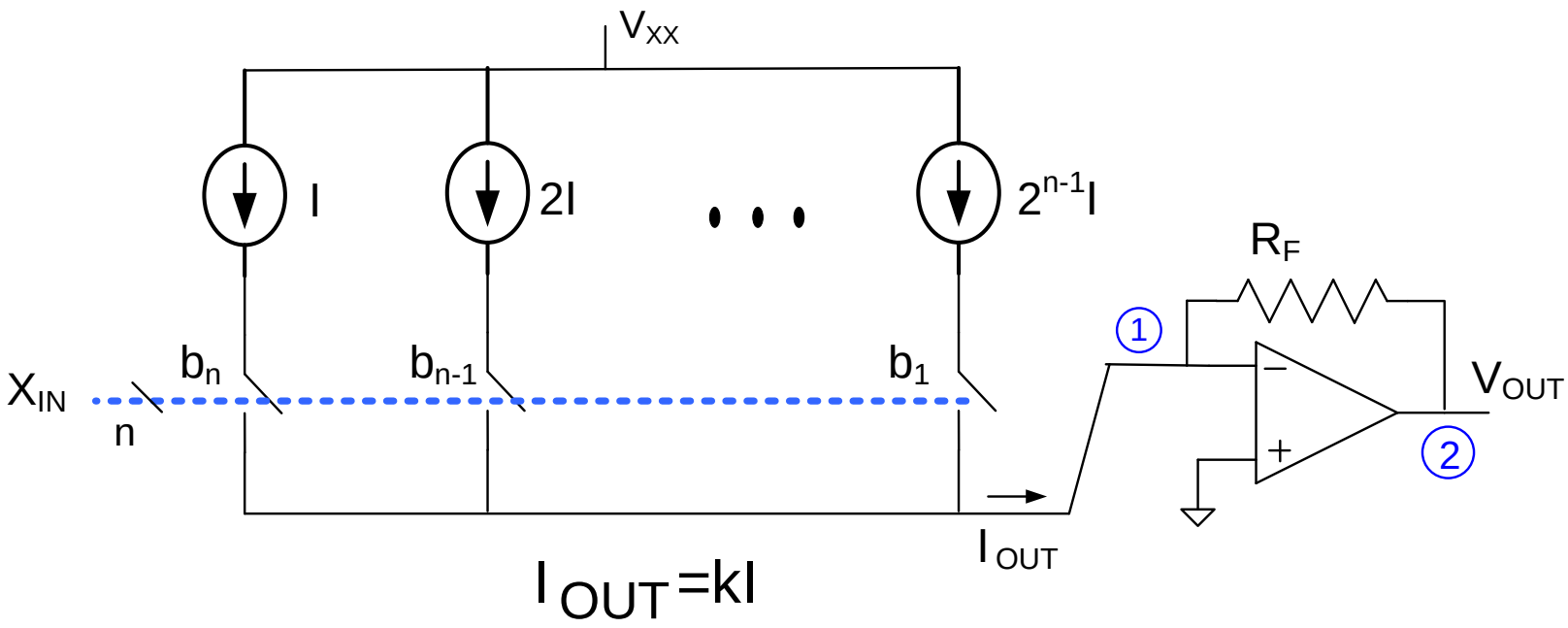
Switch impedance of little concern if current sources ideal

Current Steering DAC

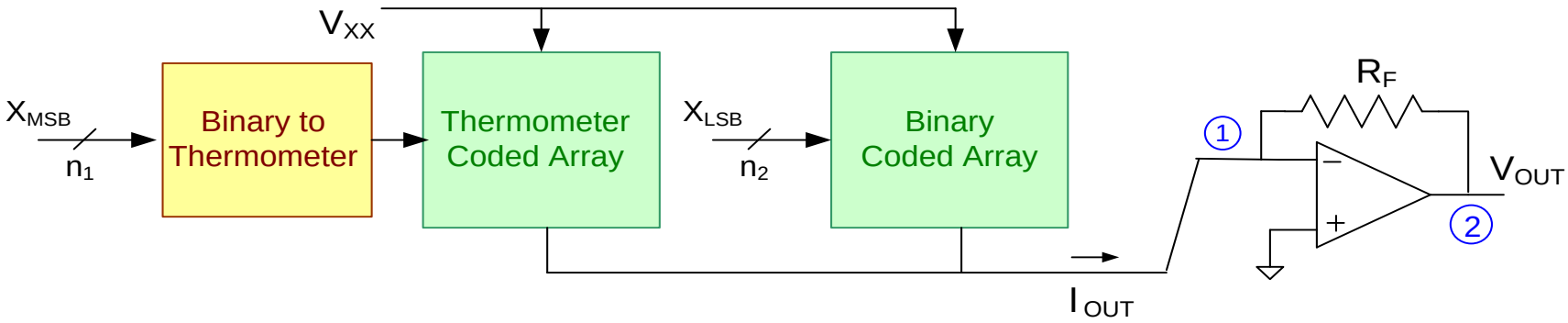


Critical parasitic capacitors in current-steering DAC

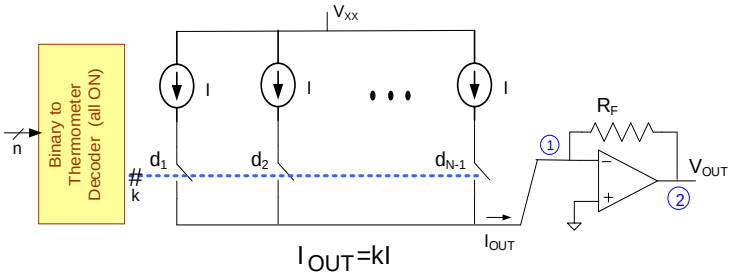
Current Steering DAC

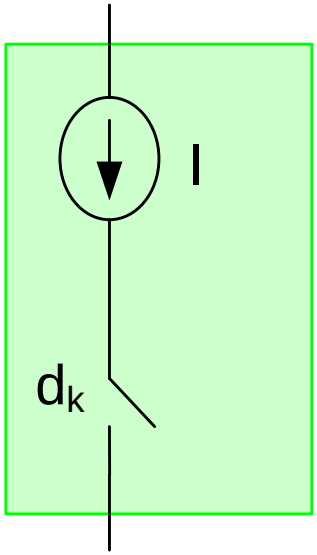


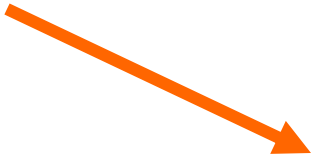
Current Steering DAC

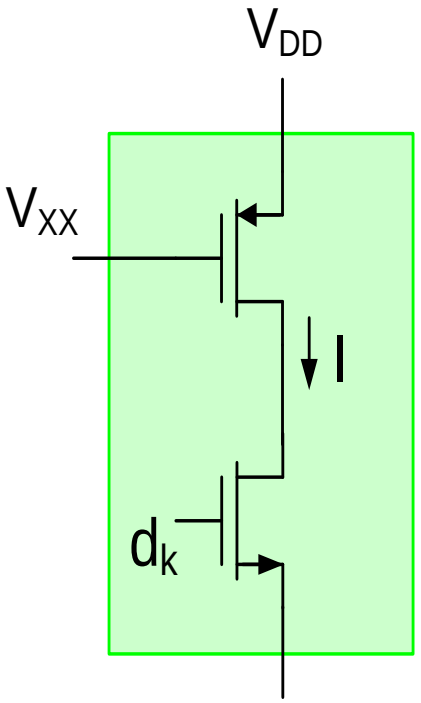


Current Steering DAC





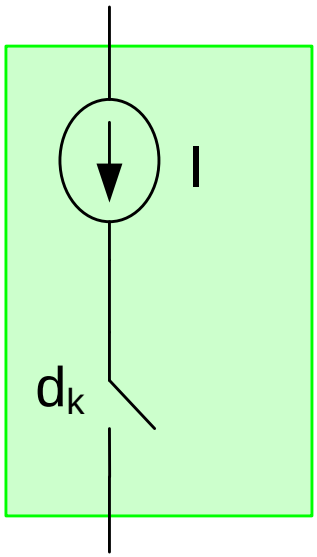


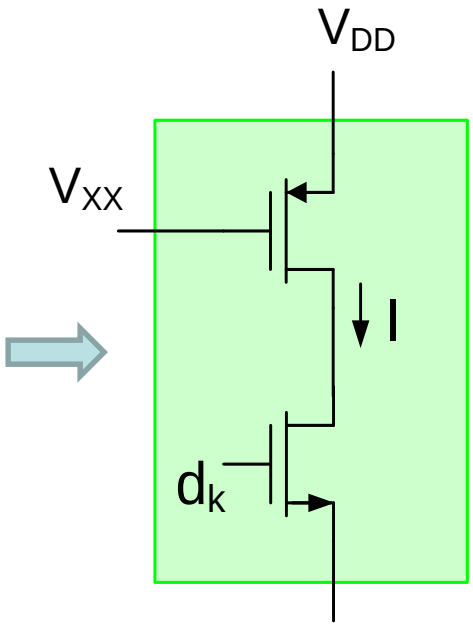


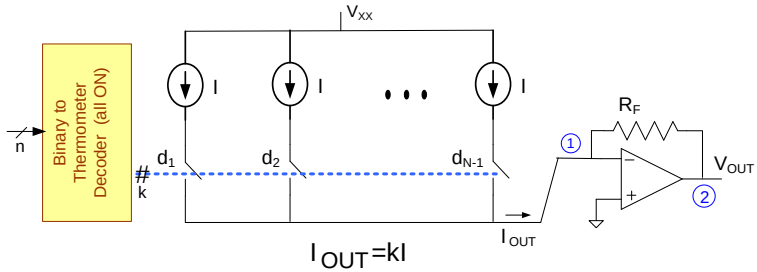
Is linearity or output impedance of current source of concern?

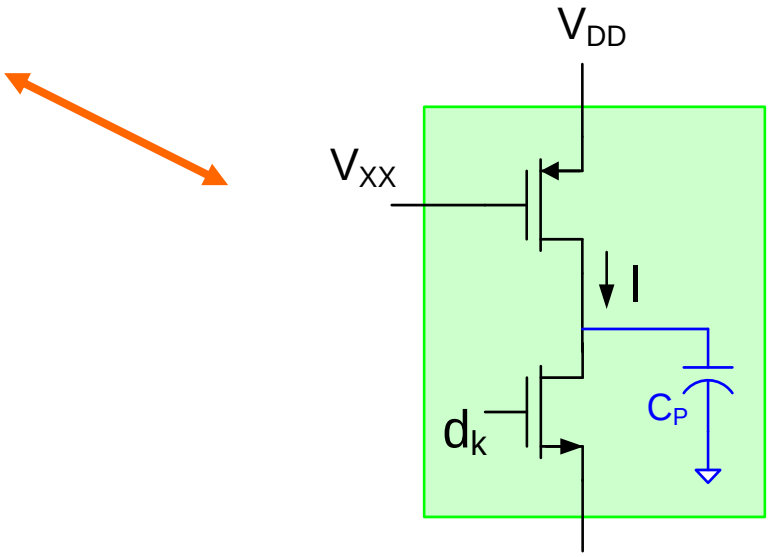
Not if individual slices are matched !

Current Steering DAC

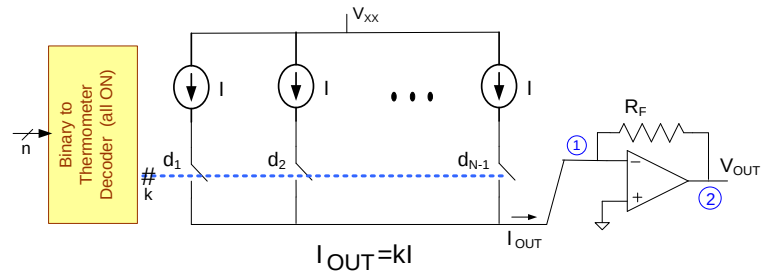


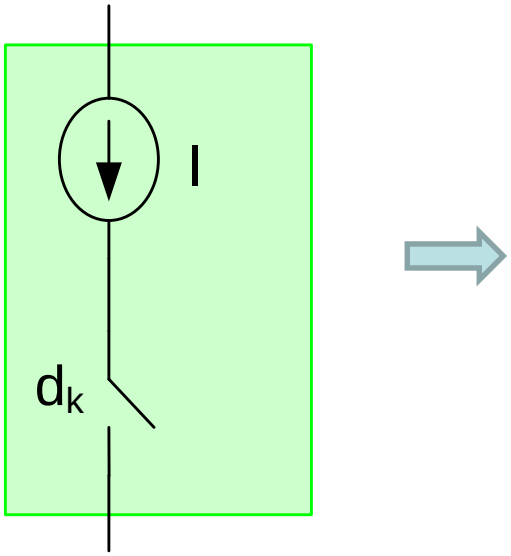


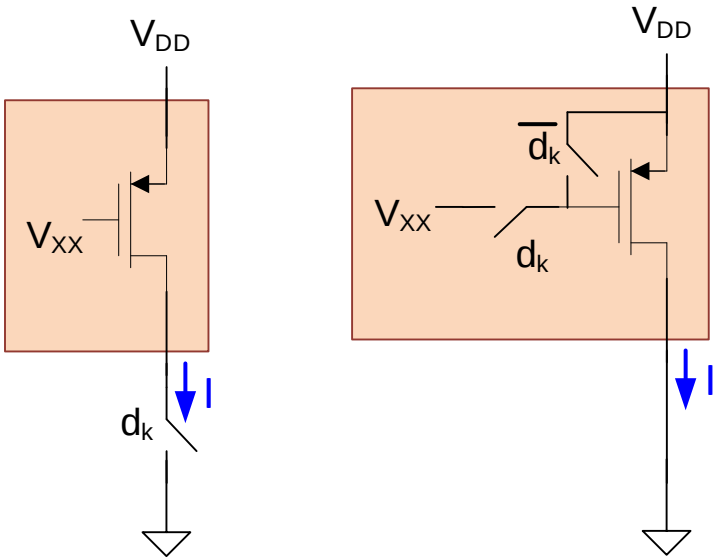




Current Steering DAC





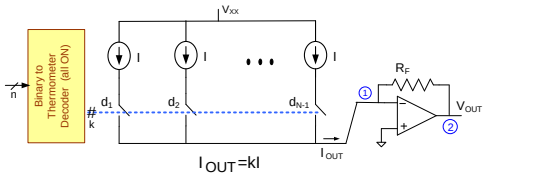


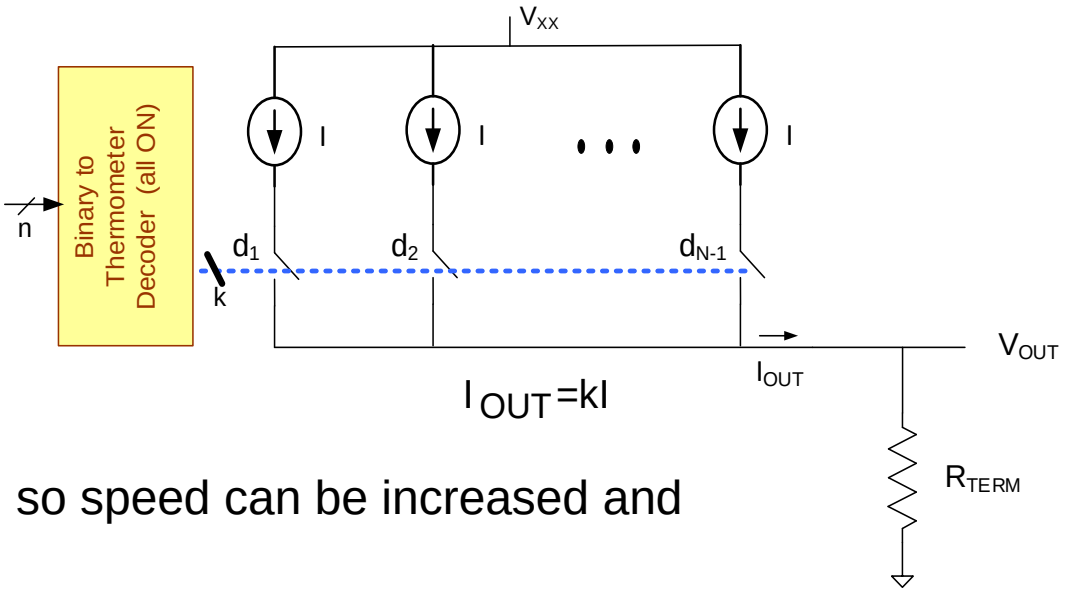
Which is better?

Effects of parasitic diffusion capacitance?

Effects of gate capacitance?

Current Steering DAC





Op Amp can be eliminated so speed can be increased and power reduced

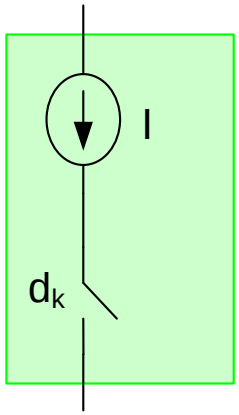
R_{TERM} often 50Ω or 100Ω

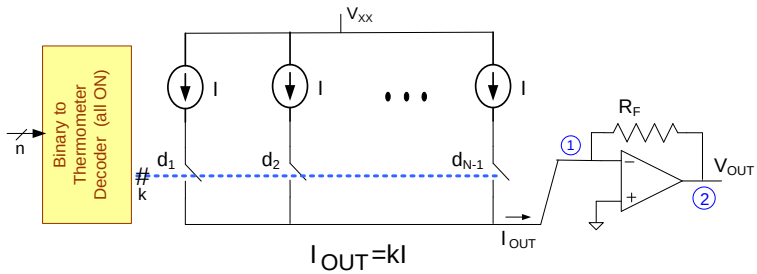
R_{TERM} can be internal or external

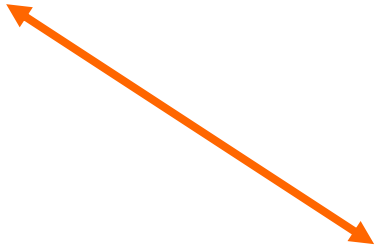
Switch impedance now of concern

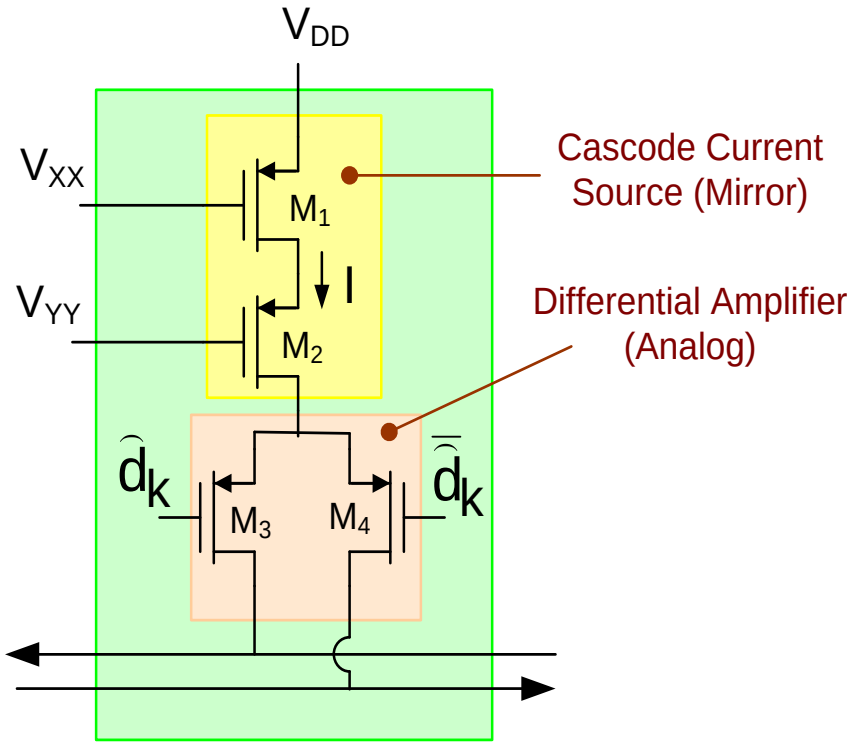
Output impedance of current sources now of concern

Current Steering DAC









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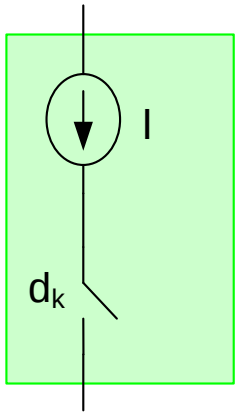

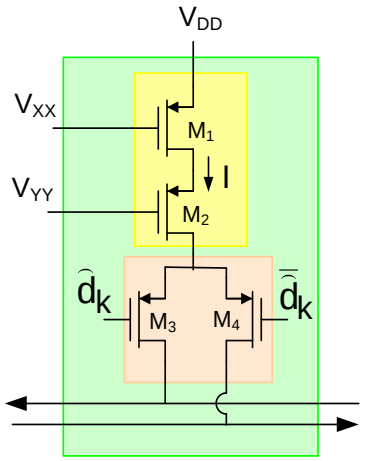

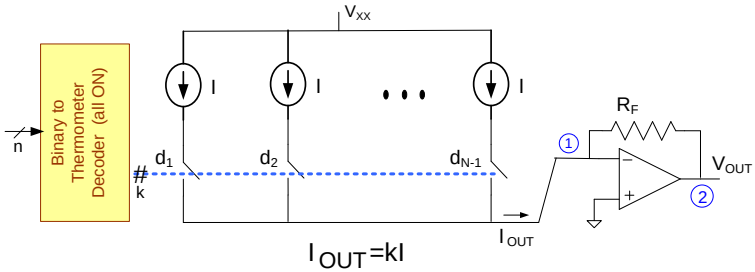

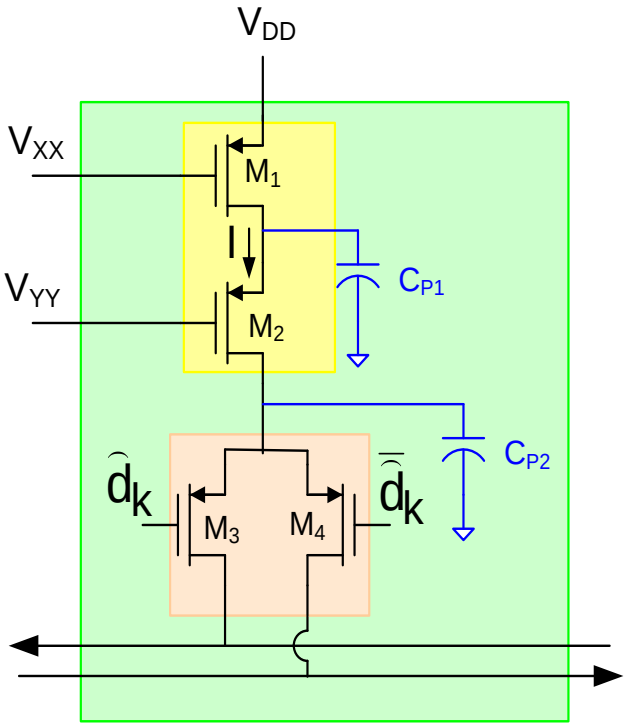

Stay Safe and Stay Healthy !

End of Lecture 33