

The background of the slide is a detailed microchip layout. It features a grid of small squares representing the chip's surface. Overlaid on this grid are various circuit components and interconnects. Labels in yellow text identify specific blocks: 'RX' (Receiver), 'LO' (Local Oscillator), 'Buffer', 'Hybrid', 'Wilkinson' (referring to a Wilkinson power divider), and 'TX' (Transmitter). The layout is complex, showing the intricate routing of signals across the chip.

EECS 16B

Designing Information Devices and Systems II

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Module 1: Capacitors

EECS 16B

Reading Material

For the first ~10 classes we will loosely follow (optional)

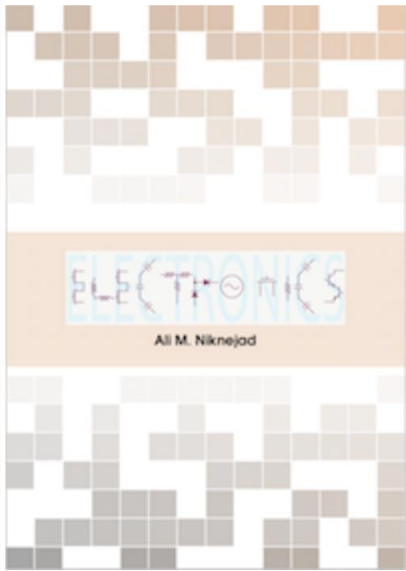
Electrical Engineering: Principles and Applications (6th Edition)

Allan R Hambley

- See notes link on the website

EE 16A and 105 “Readers”

- Mini-textbooks
- [105 reader](#) chapters 1-2 useful as a reference for this course (read it in the end or as we go along)



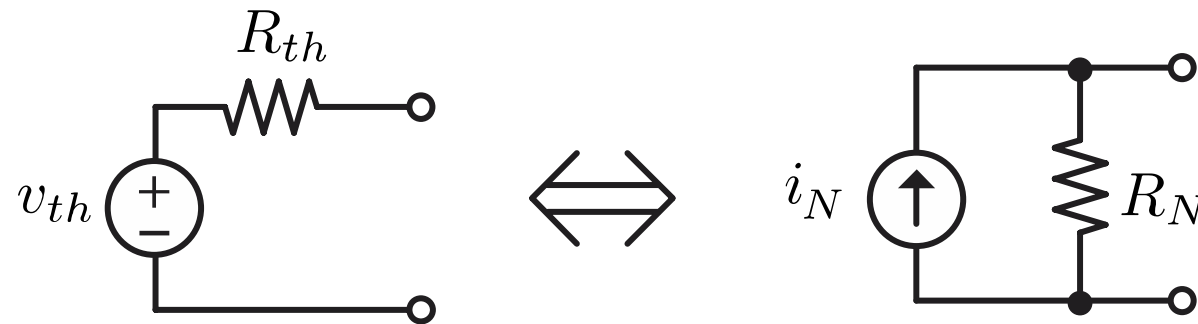
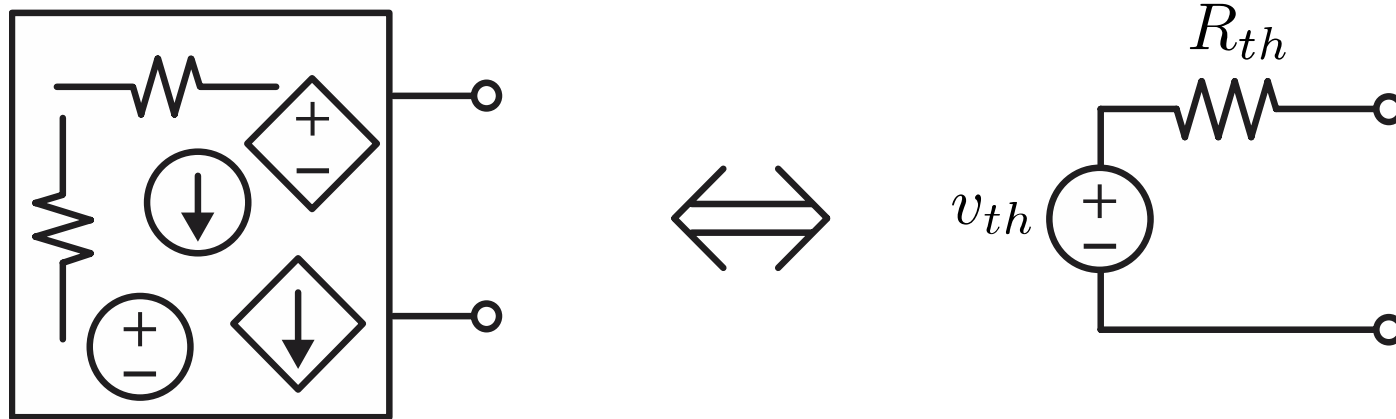
Electronics for Dogs

[16A Reader](#)

EE 16A Assumptions

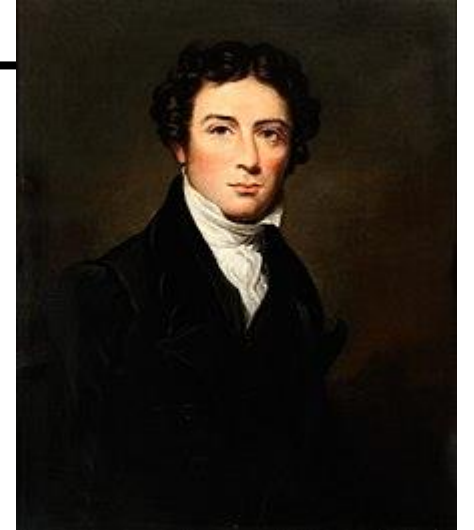
- Voltage, Charge, Current
- Energy, Power (?)
- Resistors, Voltage / Current Sources, Dependent Sources
- Capacitors (will review)
- KCL/KVL, Nodal Equations
- Voltage/Current Dividers
- Linearity, Superposition
- Norton/Thevenin Equivalents (Source Transformations)
- Loads / Source Resistance

Thevenin/Norton

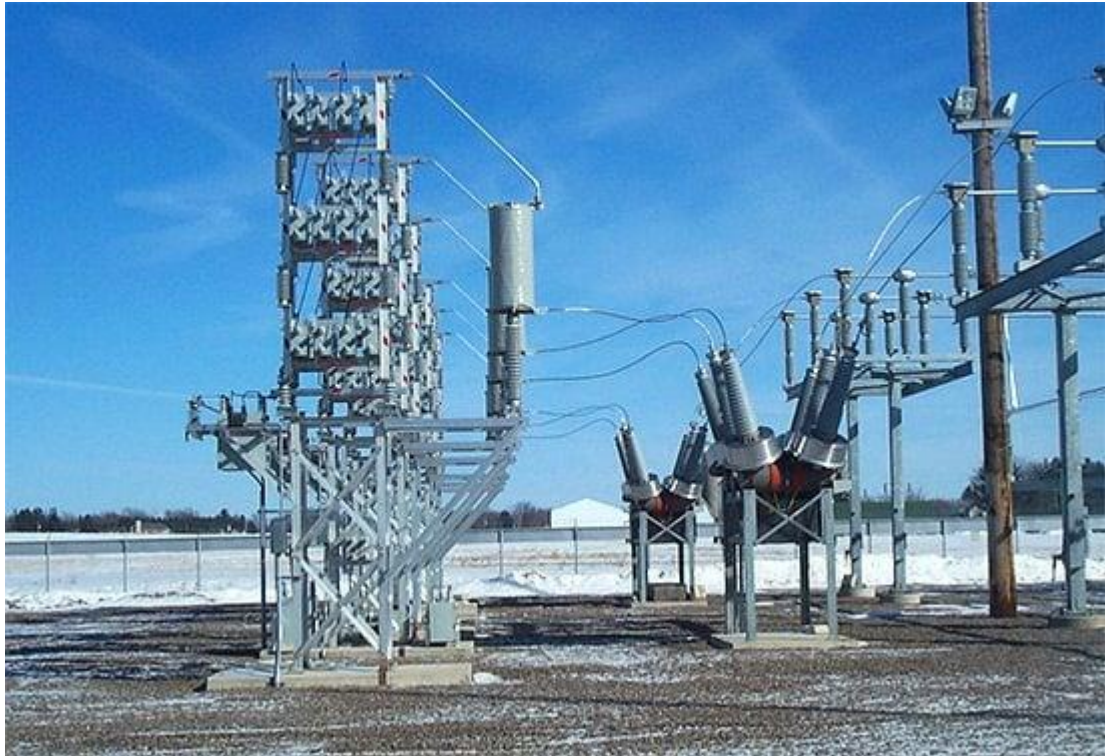


Capacitance

- Comes from the word “capacity”
- Units:
 - In “natural” units it’s simply a dimension
 - Faraday (in honor of Michael Faraday 1791-1867)
- Capacitance is the capacity to store charge



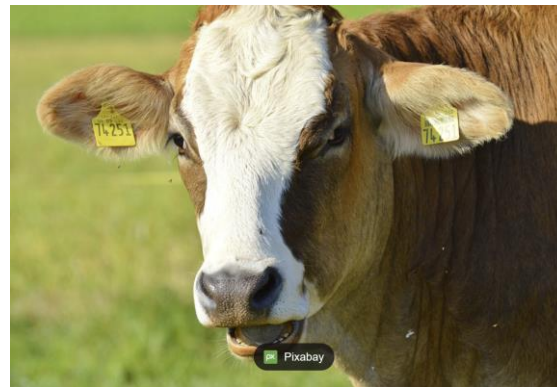
Capacitors



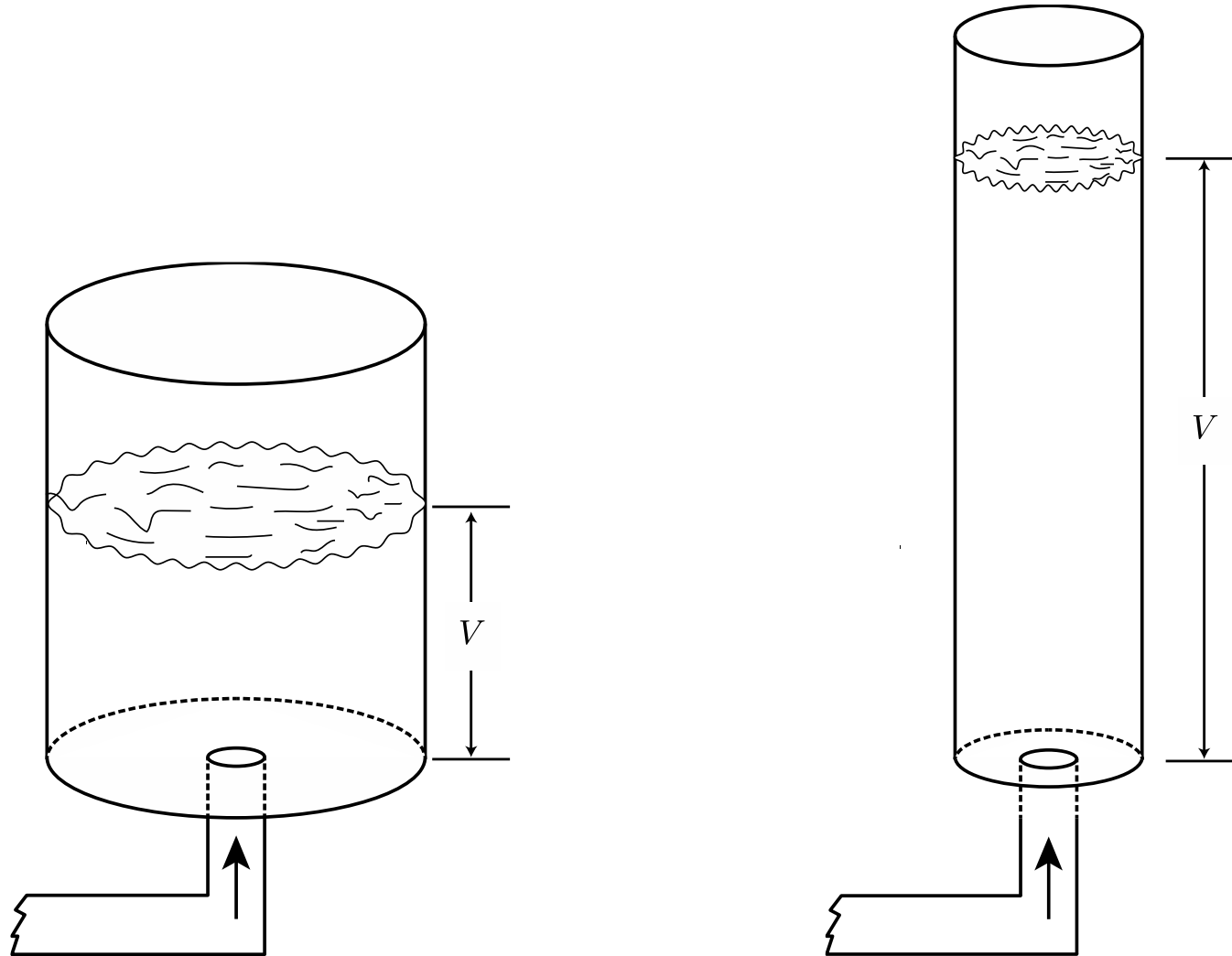
Voltage is Energy

Capacitor vs Battery vs Steak

- Capacitor for EV
 - 580 μF , 450V max voltage, 1 kg weight
 - 59 J
- Tesla 3rd generation battery
 - 333 Wh/kg = 1.1 MJ
- Beef Steak, 1kg
 - 10.5 MJ



Bathtub Analogy



Bathtub Analog – Where is inlet/outlet?

- Why does it matter?

Electrostatics Review

- Charge, Voltage (potential), Electric Field

What's the capacitance of a conductive sphere?

Review: Conductor

Review: Insulator

Preview: Semiconductor

Sphere Capacitance

Bus Analogy

Ground

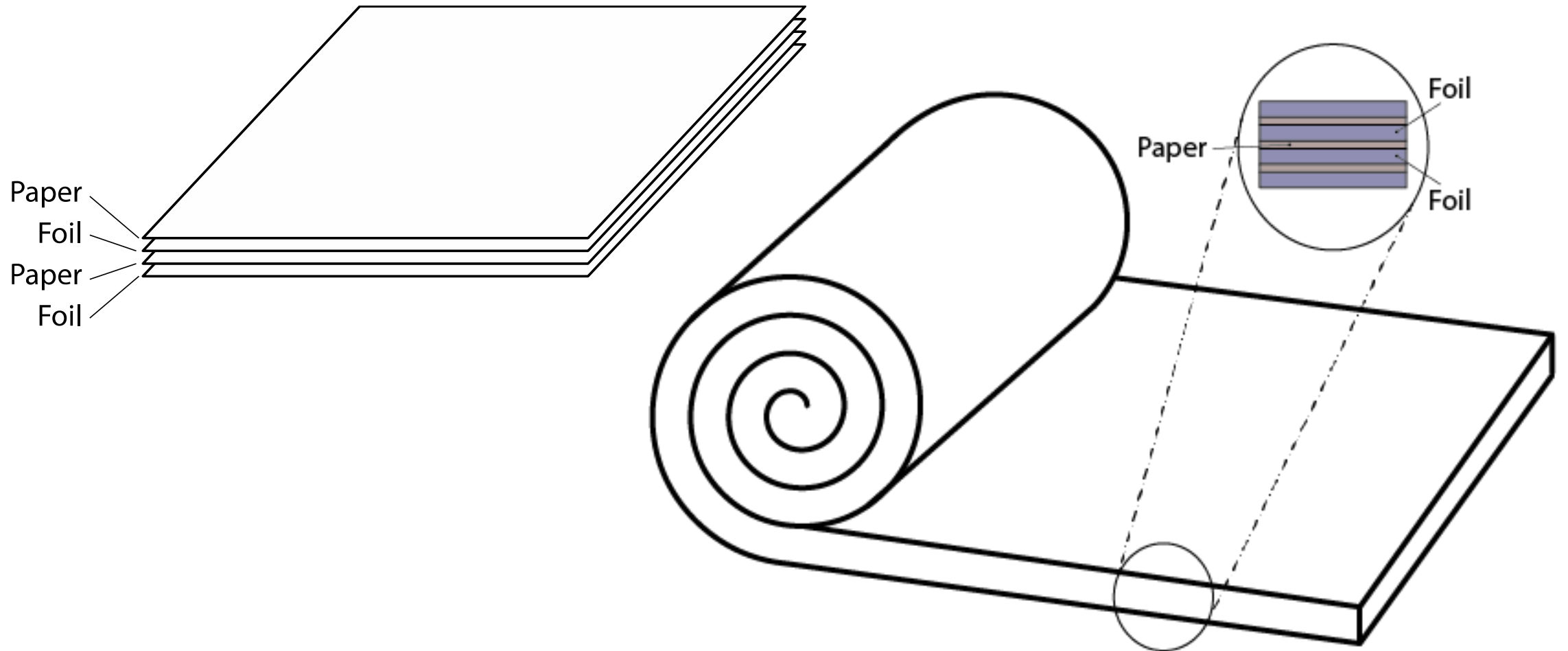
Capacitance Between Conductors

Double Decker Bus

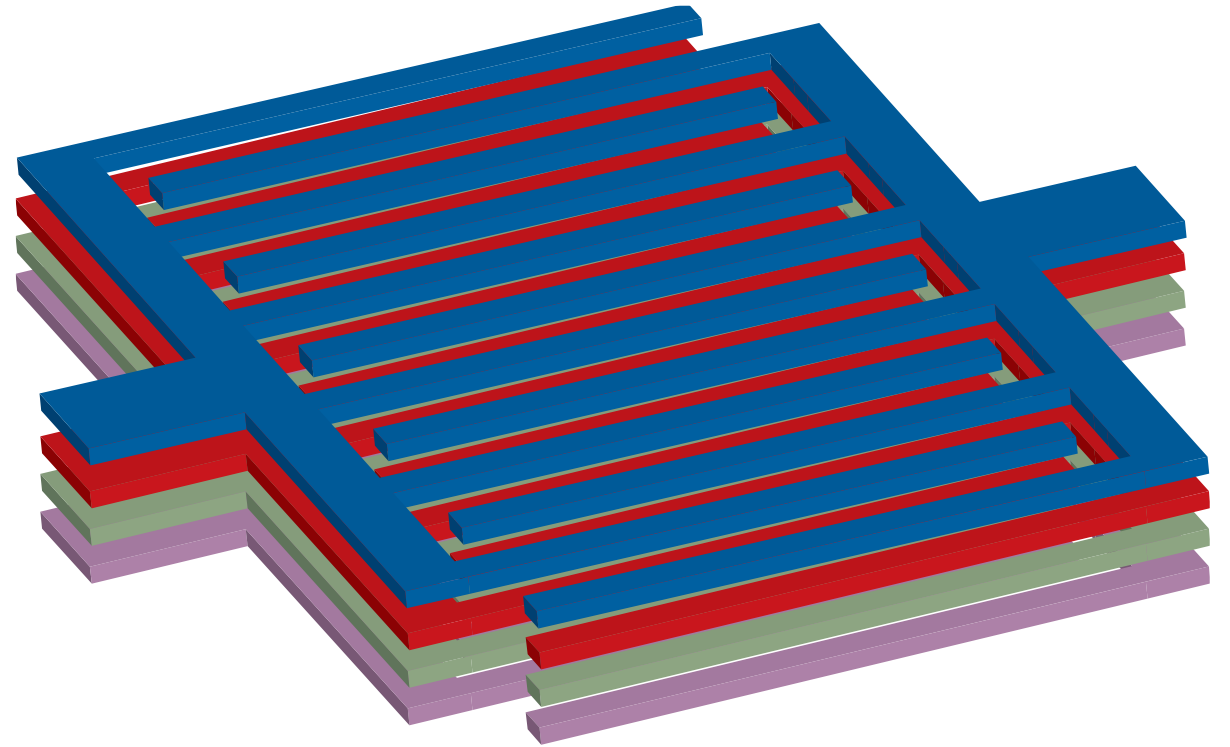
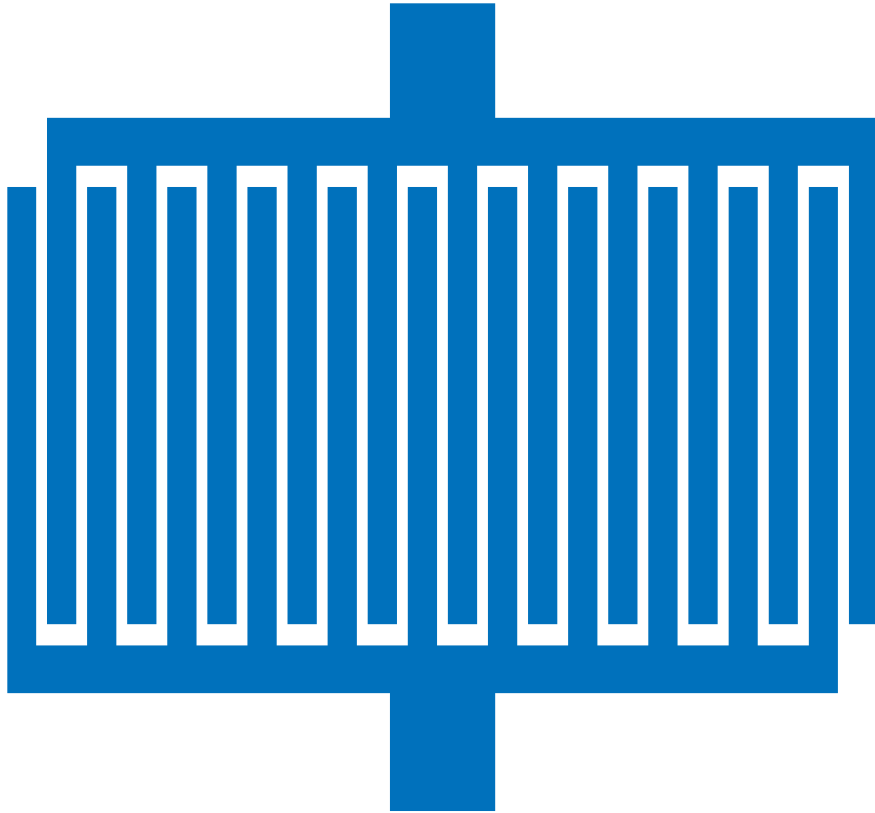


Parallel Plate Capacitor

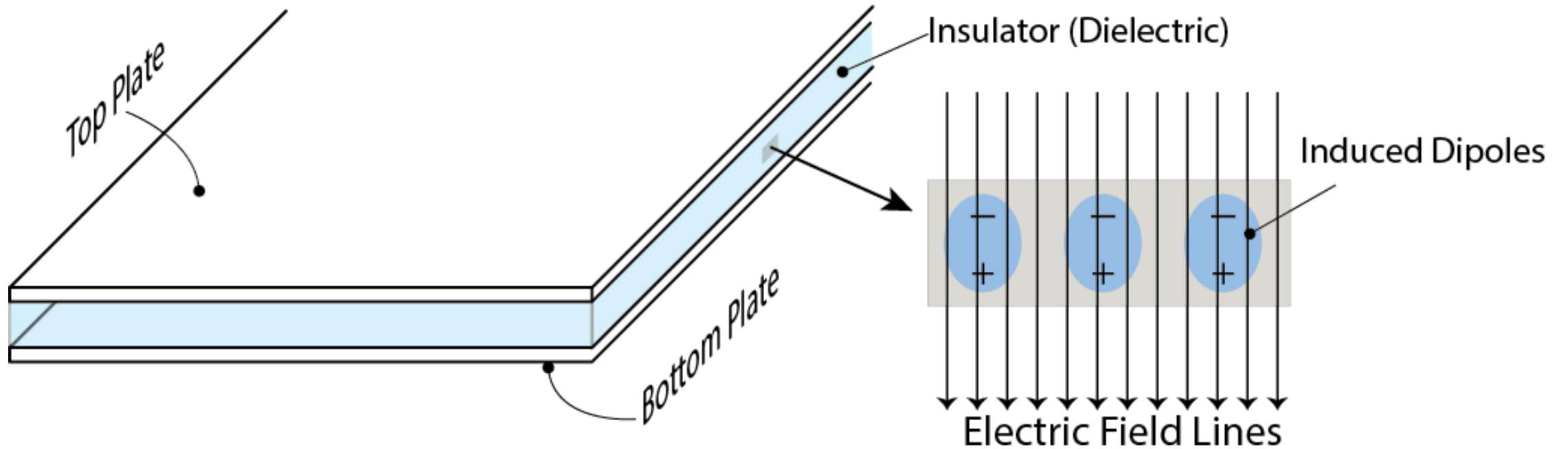
Capacitor Fabrication



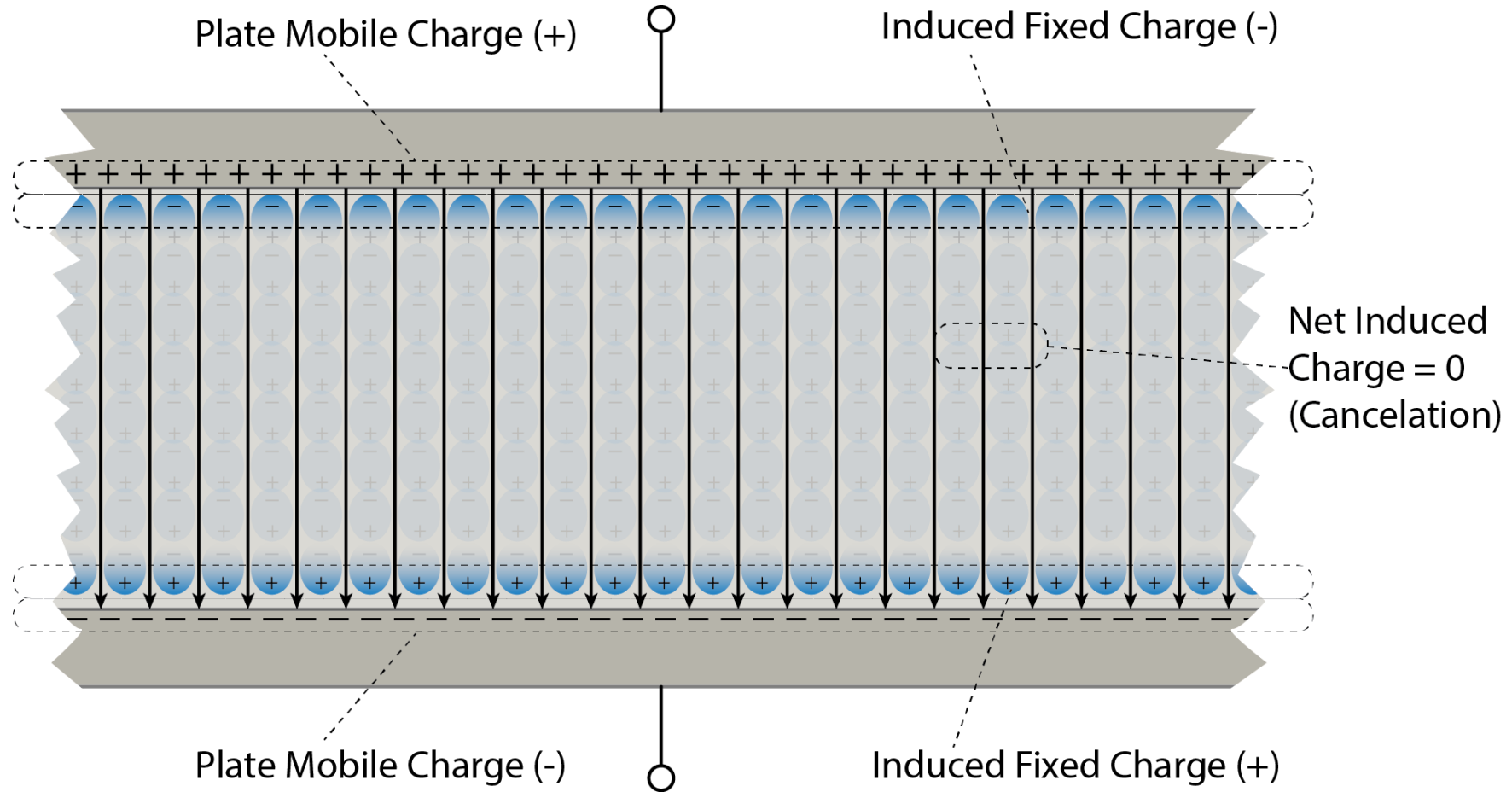
Integrated Circuit Capacitors



Induced Dipoles



Role of Dielectric

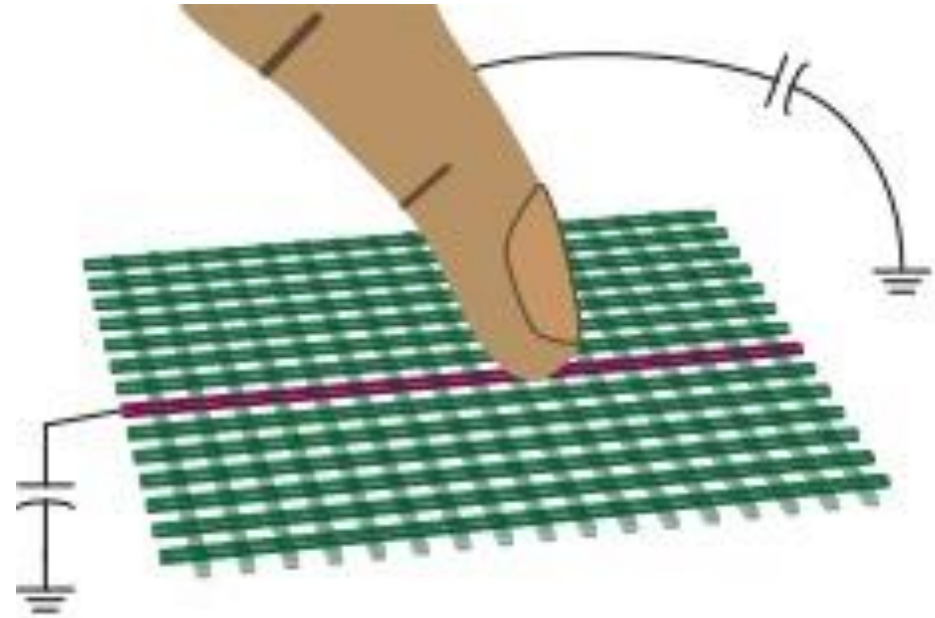
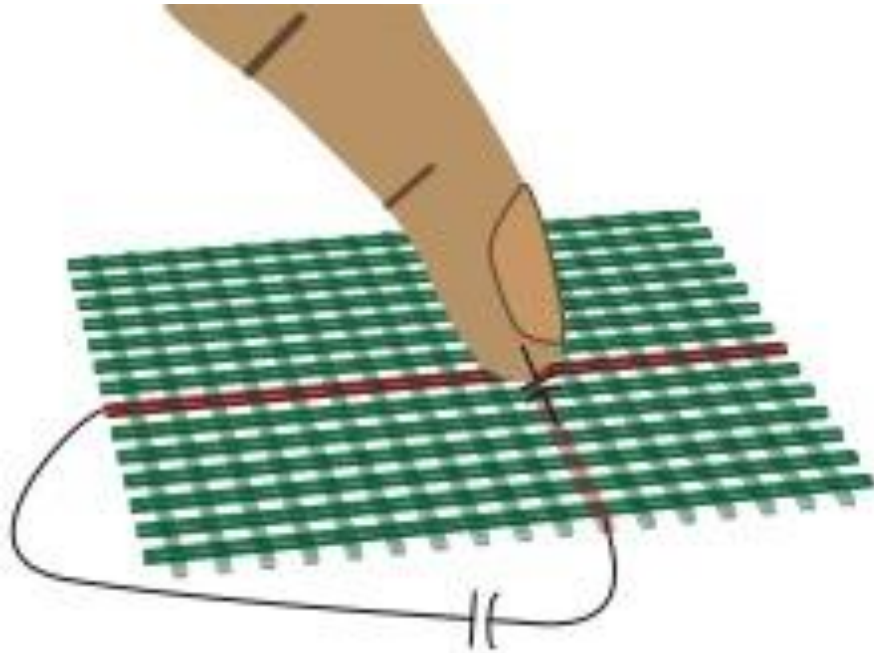


Capacitor Current

Energy

System of Conductors

Capacitors are Everywhere



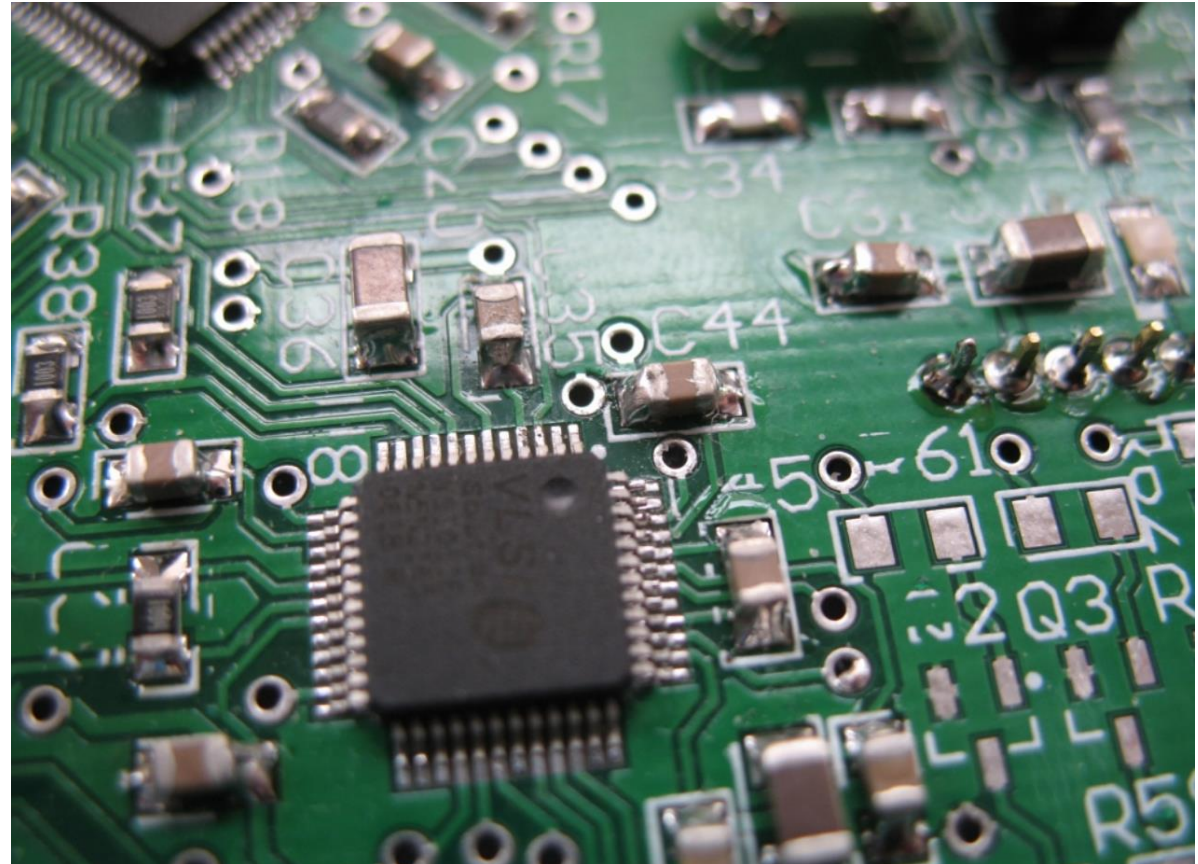
Parallel Capacitors

Series Capacitors

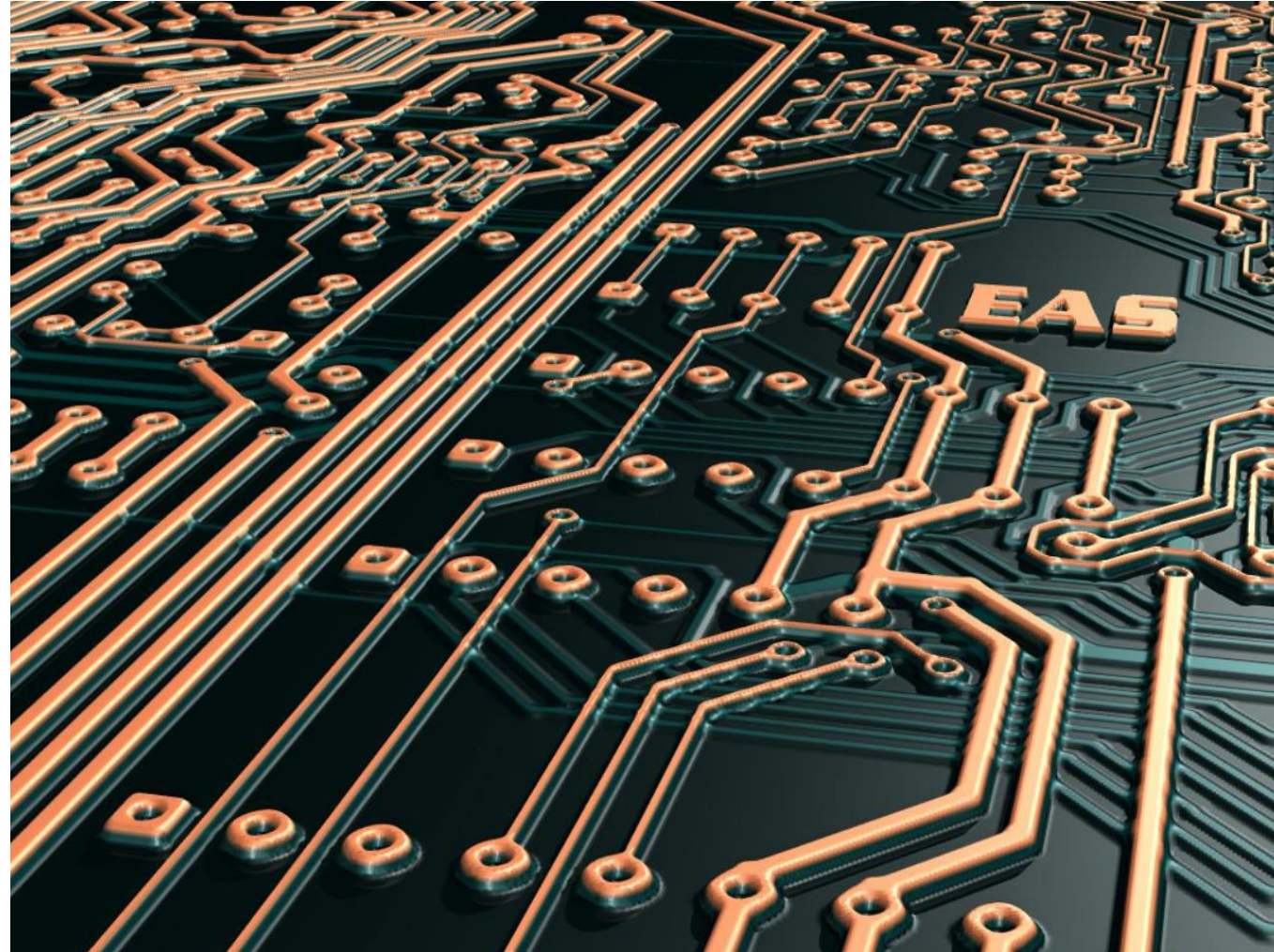
Series Capacitor: Physical Picture

Intentional Capacitors

- Capacitors act like tiny “batteries” that deliver current faster than actual supply
- Essential component in modern electronics



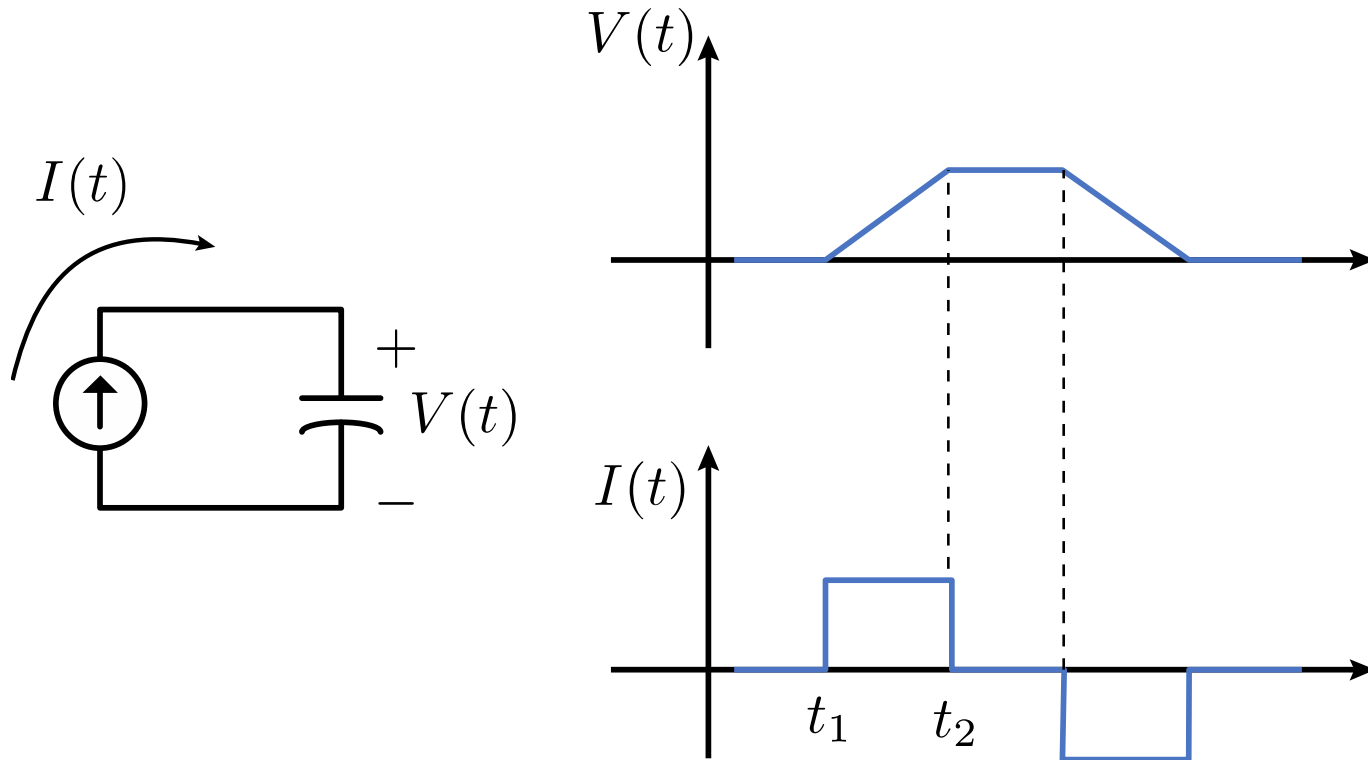
Unintentional Capacitors



Capacitor Discharge

- Water analogy
- Equations

Capacitor Discharge: Linear



Capacitor Has “Memory”

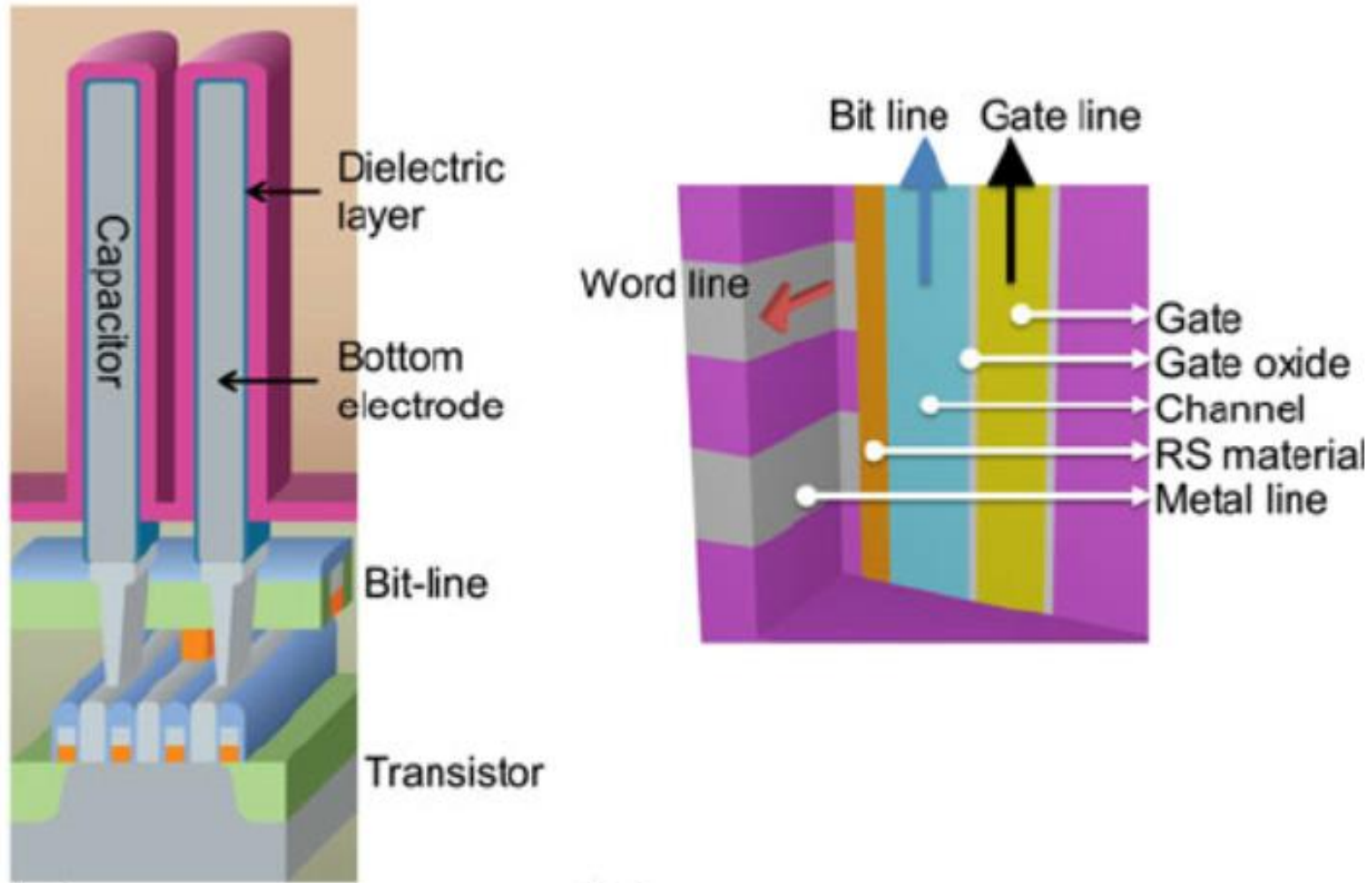
Circuit as a System

Linearity and Superposition

Memory

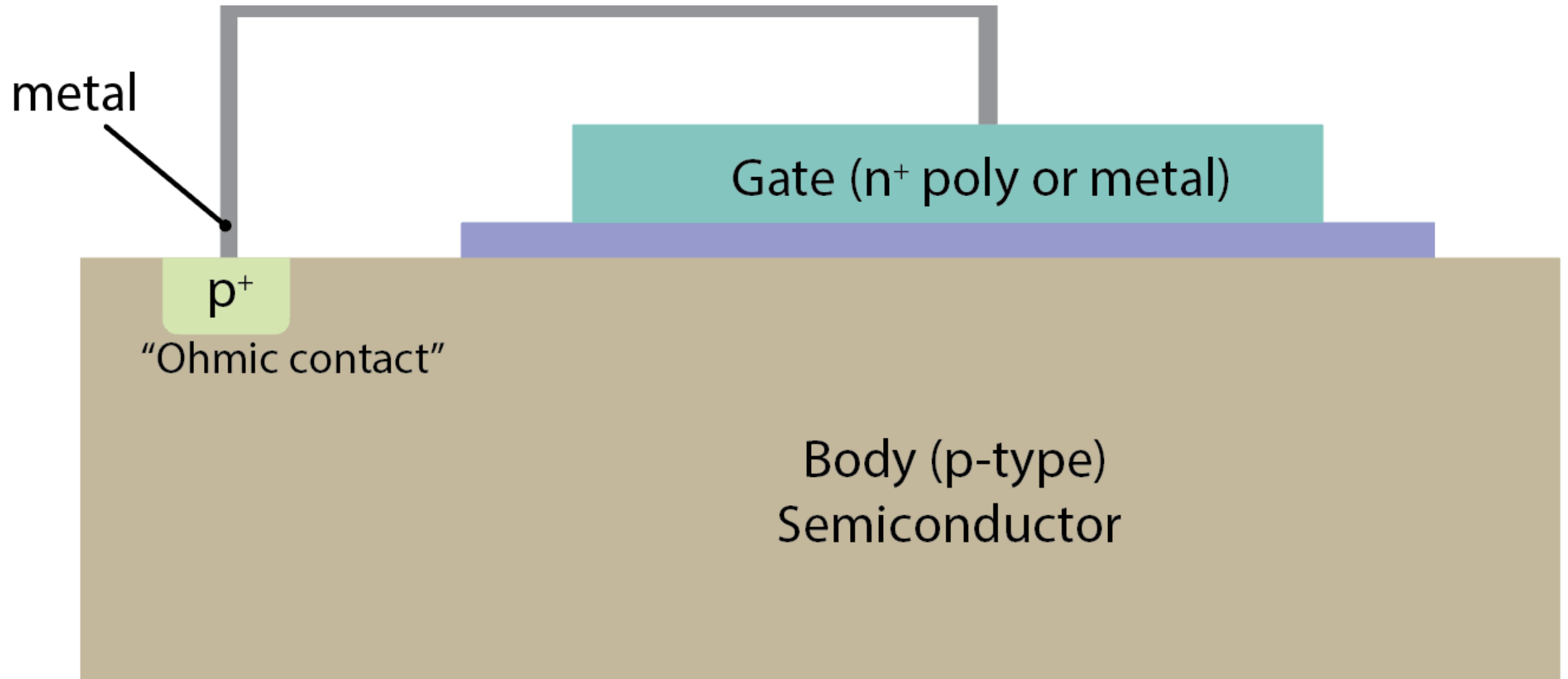
Causality

DRAM

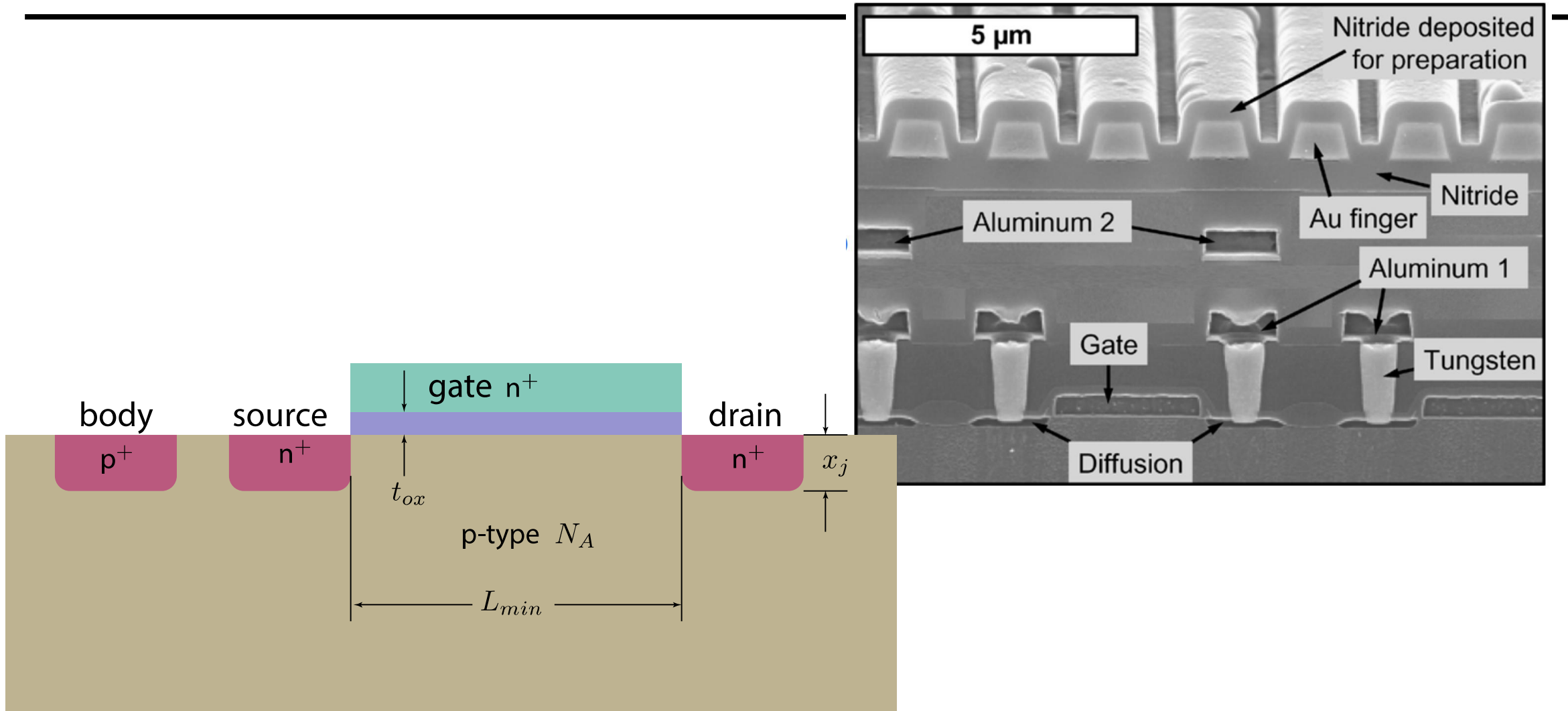


https://www.researchgate.net/figure/Schematic-diagrams-of-a-DRAM-cells-which-consist-of-a-cell-transistor-and-capacitor_fig1_258797946

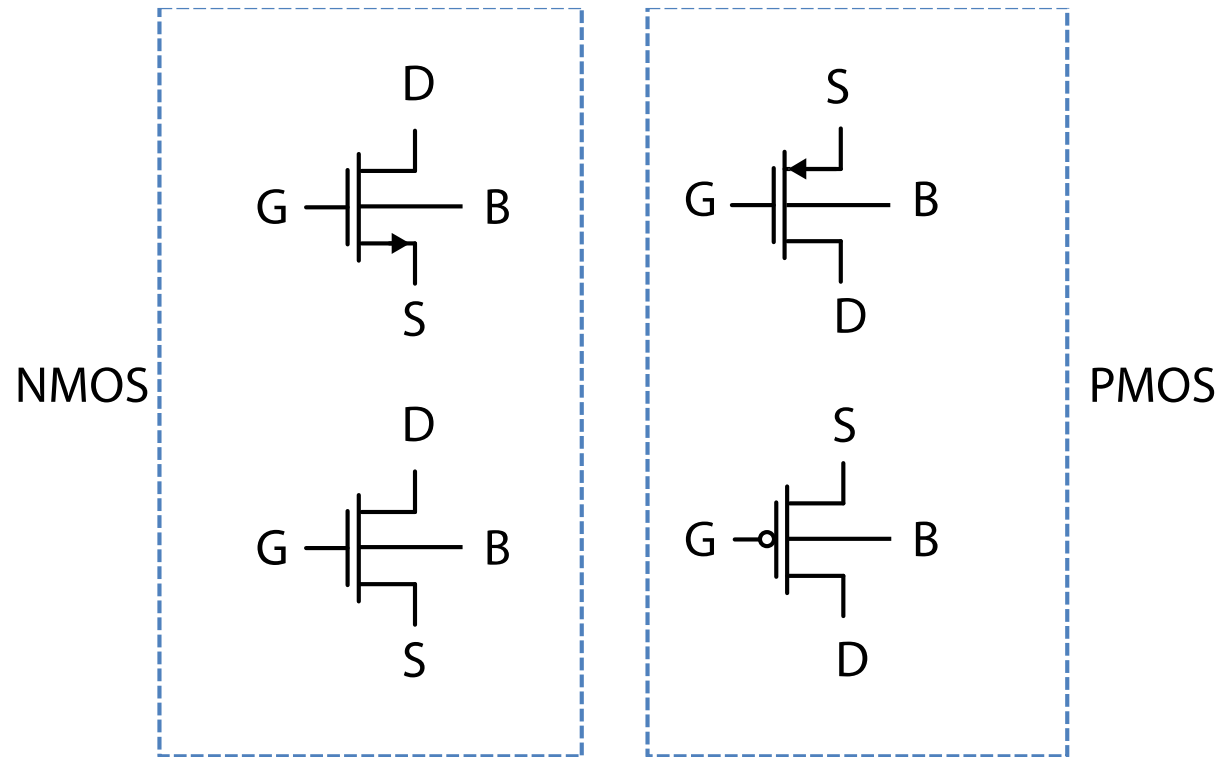
MOS Capacitor



Preview: Transistor



MOS Transistor Schematic



Transistor As Switch

Transistor as a Transconductor
