Component Converter

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Shaping Circuits (EEC 242), 2015

Outline

1. **Switched Capacitor Filters (SC-filters)**
   - Introduction
   - MOSFET
   - Switched Capacitor
   - Challenges
   - Implementation

2. **Generalized impedance Converter (GIC)**

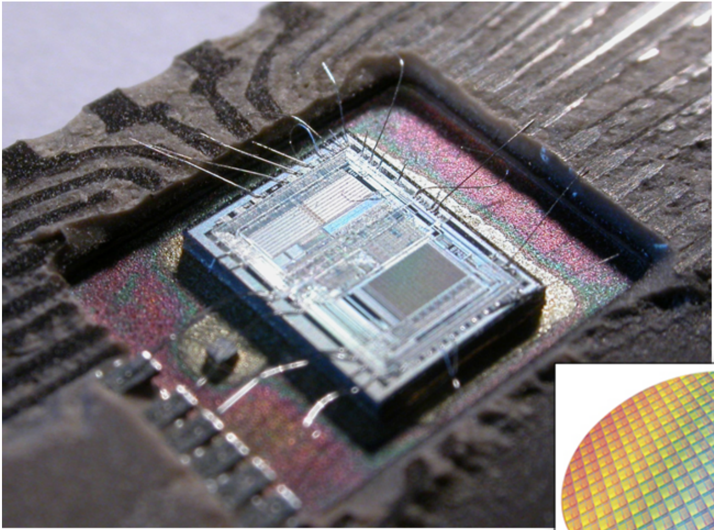
Section 1

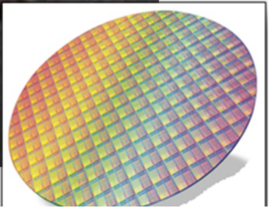
Switched Capacitor Filters (SC-filters)

Subsection 1

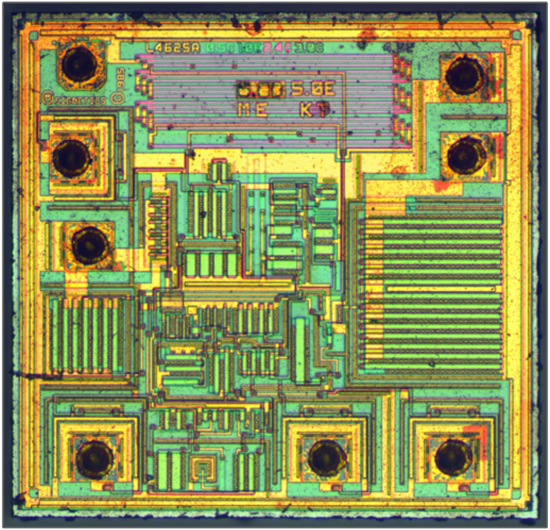
Introduction

What are the wafer and Die?

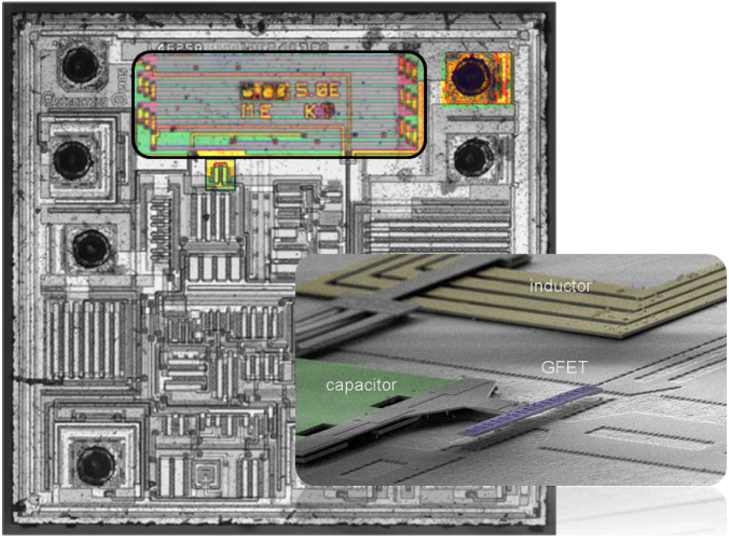




7555 is a CMOS version of 555 timer

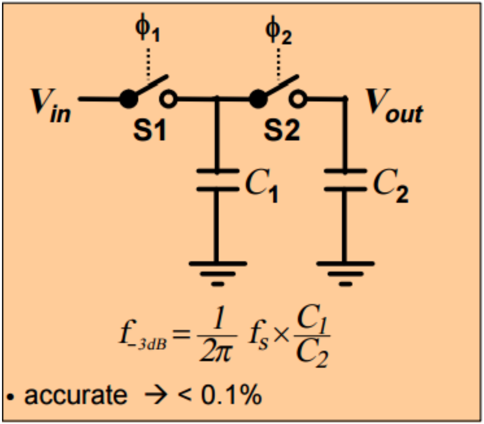


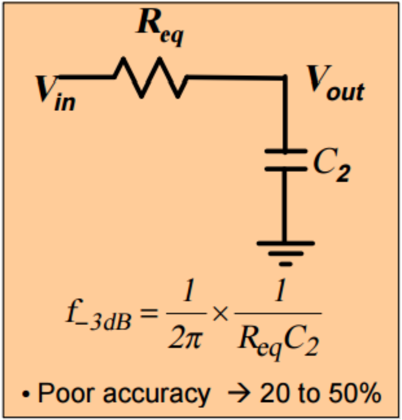
Resistor vs. Transistor vs. Pad



Switched Capacitor Features

- Suitable for IC design.
- inherent corner frequency accuracy (tight tolerance less than 0.1%).
- Very low power consumption.





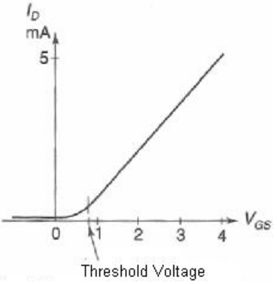
Subsection 2

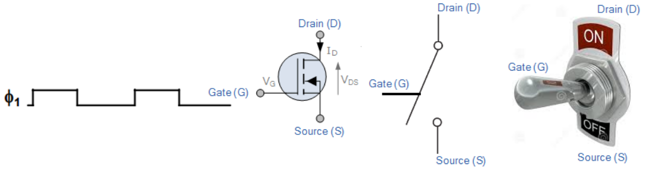
MOSFET

Enhacment Type

Operation

- The enhancement MOSFET is on at $V_{GS} > V_T$.
- The enhancement MOSFET is off at $V_{GS} < V_T$.





Subsection 3

Switched Capacitor

Equivelant resistor

@ ϕ_1 (Charging):

$$q_1 = CV_{in}$$

@ ϕ_2 (Discharging):

$$q_1 = CV_{out}$$

$$\Delta q = C(V_{in} - V_{out}) \qquad \div T$$

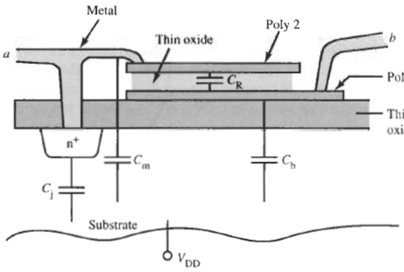
$$i \approx \frac{\Delta q}{T} = \Delta q f_c = Cf_c(V_{in} - V_{out})$$

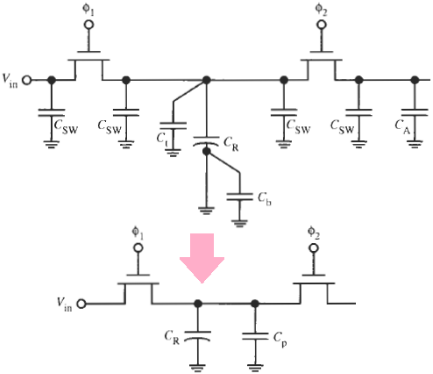
$$R_{eq} = \frac{(V_{in} - V_{out})}{i} = \frac{1}{Cf_c}$$

Subsection 4

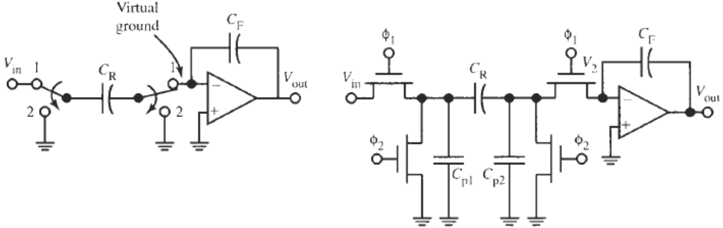
Challenges

Parasitic Capacitance of the MOSFET

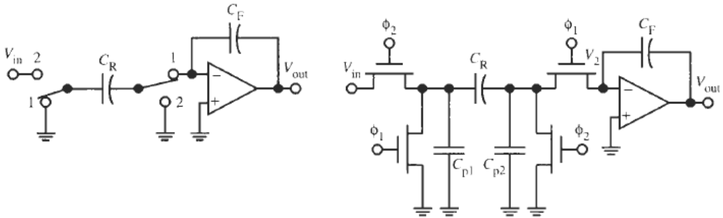




Parasitic insensitive circuits



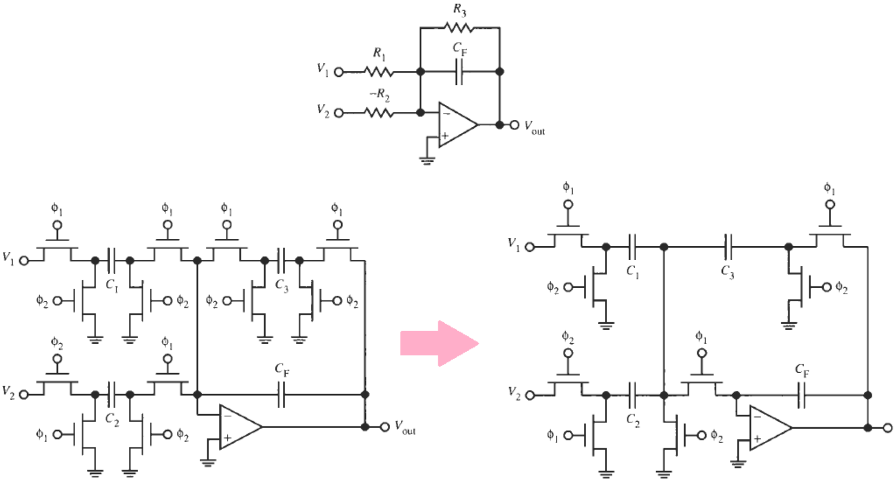
(a)



Subsection 5

Implementation

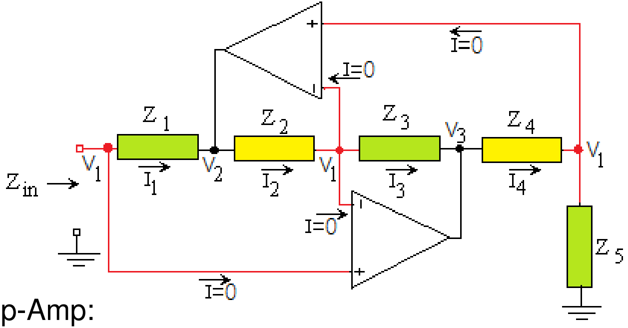
Redandant switches



Section 2

Generalized impedance Converter (GIC)

GIC circuit



For ideal Op-Amp:

$$V_o = A(V^+ - V^-) \qquad A = \infty$$

$$V^- = V^+$$

$$I_2 = I_3 \Rightarrow \frac{V_2 - V_1}{Z_2} = \frac{V_1 - V_3}{Z_3} \Rightarrow \boxed{V_2 = (1 + \frac{Z_2}{Z_3})V_1 - \frac{Z_2}{Z_3}V_3} \qquad (1)$$

$$I_4 = I_5 \Rightarrow \frac{V_3 - V_1}{Z_4} = \frac{V_1}{Z_5} \Rightarrow \boxed{V_3 = (1 + \frac{Z_4}{Z_5})V_1} \qquad (2)$$

Calculate z_{in}

$$\boxed{v_2 = (1 + \frac{z_2}{z_3})v_1 - \frac{z_2}{z_3}v_3} \qquad (1)$$

$$\boxed{v_3 = (1 + \frac{z_4}{z_5})v_1} \qquad (2)$$

By substituting (2) in (1):

$$v_2 = (1 + \frac{z_2}{z_3})v_1 - \frac{z_2}{z_3}(1 + \frac{z_4}{z_5})v_1$$

$$v_1 - v_2 = \frac{z_2 z_4}{z_3 z_5}v_1 \qquad \because z_{in} = \frac{v_1}{I_1}$$

$$\frac{v_1 - v_2}{z_1} = \frac{z_2 z_4}{z_1 z_3 z_5}v_1 = I_1$$

$$\therefore \boxed{z_{in} = \frac{z_1 z_3 z_5}{z_2 z_4} = \frac{odd}{even}}$$

L to GIC

$$\boxed{z_{in} = \frac{z_1 z_3 z_5}{z_2 z_4} = \frac{odd}{even}}$$

Select z_4 or $z_2 = \frac{1}{Sc}$ and rest of z=R $\therefore z_{in} = S\frac{R_1 R_3 R_5 C_4}{R_2}$
For sake of normalization:
$R_1 = R_2 = R_3 = 1\Omega$ and $C_4 = 1F \Rightarrow z_{in} = SR_5 = SL \Rightarrow \boxed{L = R_5}$

example

Example

MUST BE EARTHED COIL ONLY