

**Πρόγραμμα Μεταπτυχιακών Σπουδών
στη Μικροηλεκτρονική**

Σχεδίαση Αναλογικών και Μικτών Ολοκληρωμένων Κυκλωμάτων

Προτεινόμενα βιβλία

Τίτλος	Συγγραφέας	Εκδότης
Design of Analog CMOS Integrated Circuits	Behzad Razavi	McGraw Hill
CMOS Analog Circuit Design 2 nd edition	P.E. Allen, D.R. Holberg	Oxford University Press
Analysis and Design of Analog Integrated Circuits 4 th edition	P.Gray, R. Hurst, St. Lewis, R. Mayer	Wiley and Sons Inc.
CMOS Circuit Design, Layout and Simulation	R. Baker, H. Li, D. Boyce	IEEE Press

What is Analog IC Design?

Analog IC design is the successful implementation of analog circuits and systems using integrated circuit technology.

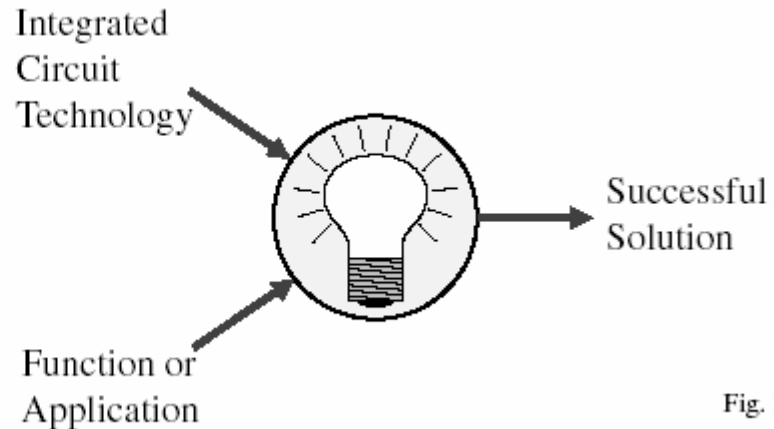


Fig. 1-1

Unique Features of Analog IC Design

- Geometry is an important part of the design
Electrical Design → *Physical Design* → Test Design
- Usually implemented in a mixed analog-digital circuit
- Analog is 20% and digital 80% of the chip area
- Analog requires 80% of the design time
- Analog is designed at the circuit level
- Passes for success: 2-3 for analog, 1 for digital

The Analog IC Design Flow

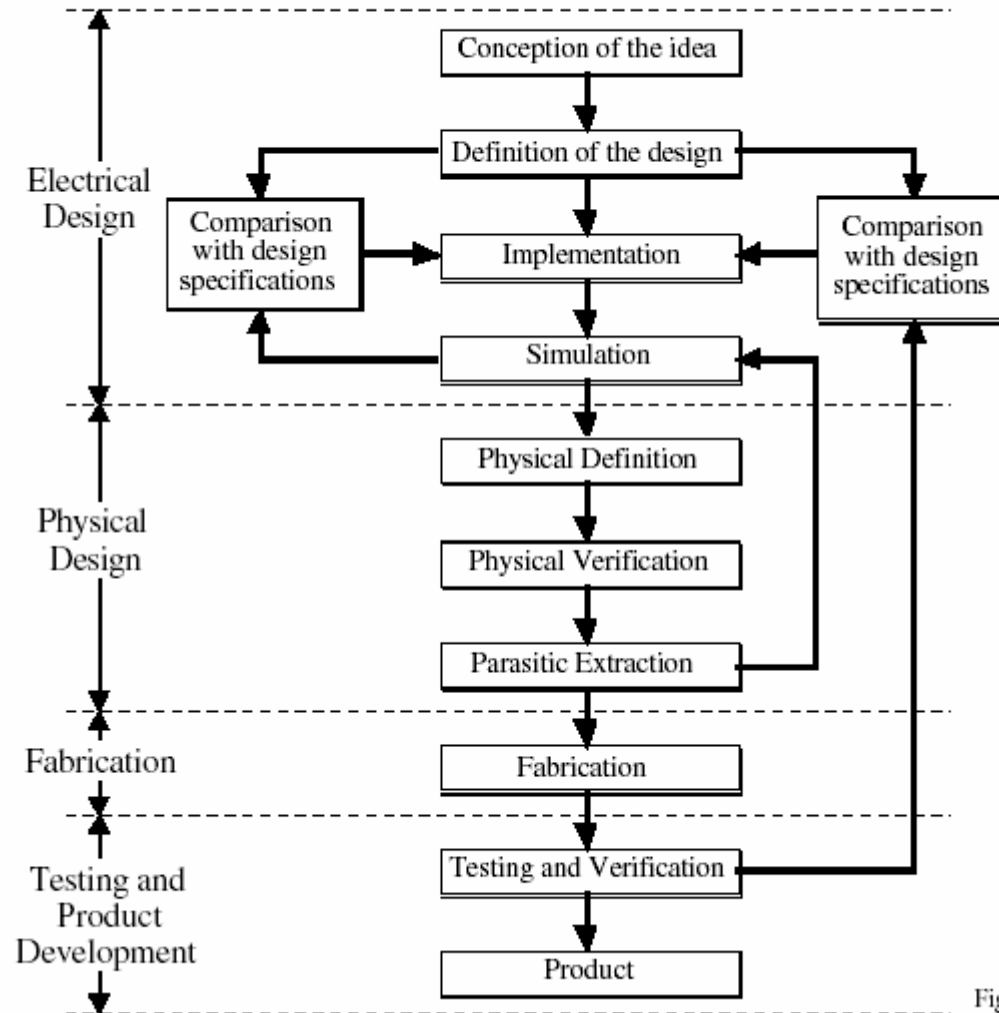


Fig. 1.1-2

Comparison of Analog and Digital Circuits

Analog Circuits	Digital Circuits
Signals are continuous in amplitude and can be continuous or discrete in time	Signal are discontinuous in amplitude and time - binary signals have two amplitude states
Designed at the circuit level	Designed at the systems level
Components must have a continuum of values	Component have fixed values
Customized	Standard
CAD tools are difficult to apply	CAD tools have been extremely successful
Requires precision modeling	Timing models only
Performance optimized	Programmable by software
Irregular block	Regular blocks
Difficult to route automatically	Easy to route automatically
Dynamic range limited by power supplies and noise (and linearity)	Dynamic range unlimited

Skills Required for Analog IC Design

- In general, analog circuits are more complex than digital
- Requires an ability to grasp multiple concepts simultaneously
- Must be able to make appropriate simplifications and assumptions
- Requires a good grasp of both modeling and technology
- Have a wide range of skills - breadth (analog only is rare)
- Be able to learn from failure
- Be able to use simulation correctly

Simulation “truths”:

- ◆ (Usage of a simulator) x (Common sense) \approx Constant
- ◆ Simulators are only as good as the models and the knowledge of those models by the designer
- ◆ Simulators are only good if you already know the answers

Trends in CMOS Technology

- Moore's law: The minimum feature size tends to decrease by a factor of $1/\sqrt{2}$ every three years.
- Semiconductor Industry Association roadmap for CMOS

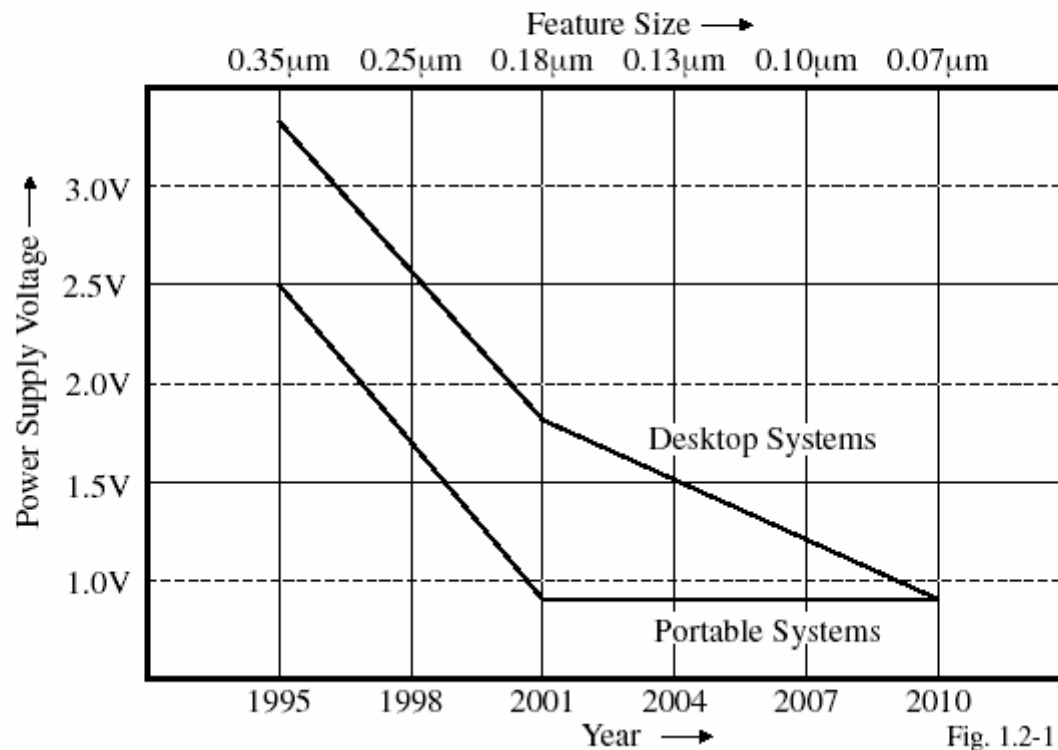


Fig. 1.2-1

Trends in CMOS Technology - Continued

Threshold voltages and power supply:

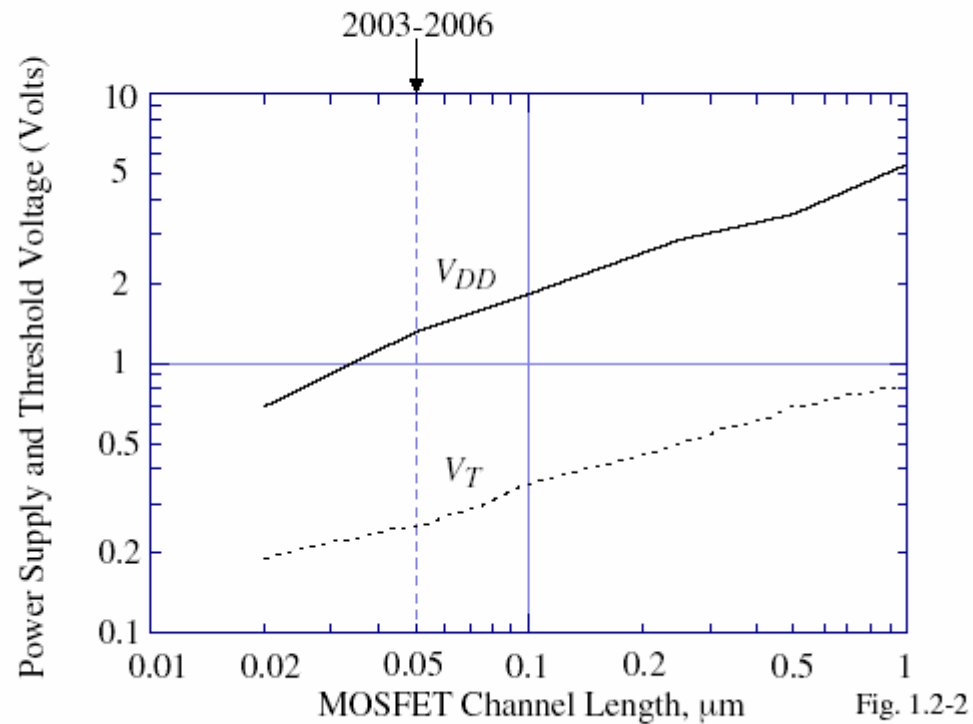


Fig. 1.2-2

Trends in IC Technology

Technology Speed Figure of Merit vs. Time:

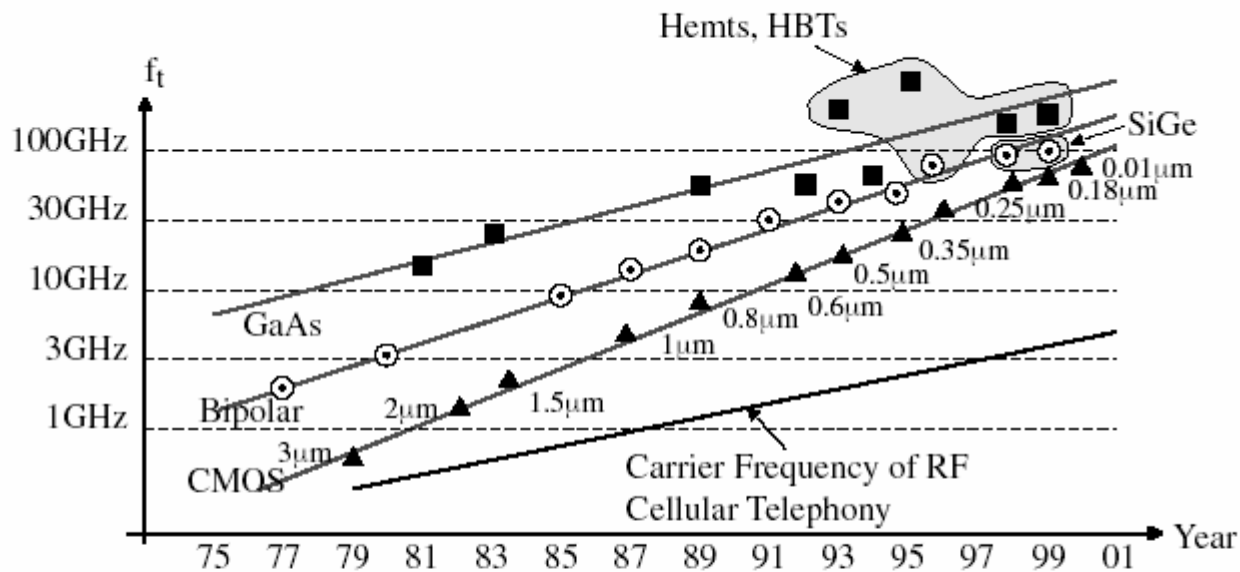


Fig. 1.2-3A

Estimated Frequency Performance based on Scaling:

Technology	f_t	f_{max}
0.35 micron	25GHz	40GHz
0.25 micron	40GHz	≈60-70GHz
0.18 micron	60GHz	≈90-100GHz

Analog IC Design has Reached Maturity

There are established fields of application:

- Digital-analog and analog-digital conversion
- Disk drive controllers
- Modems - filters
- Bandgap reference
- Analog phase lock loops
- DC-DC conversion
- Buffers
- Codecs
-
-
-

Existing philosophy regarding analog circuits:

“If it can be done economically by digital, don’t use analog.”

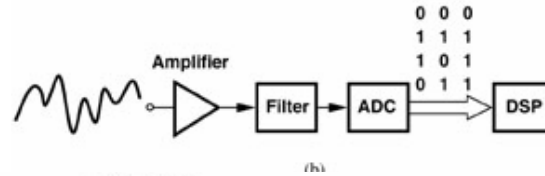
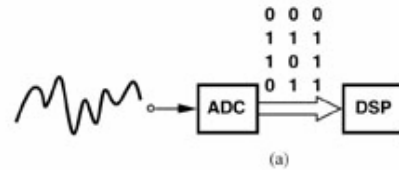
Consequently:

Analog finds applications where speed, area, or power have advantages over a digital approach.

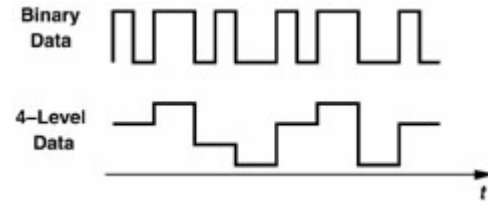
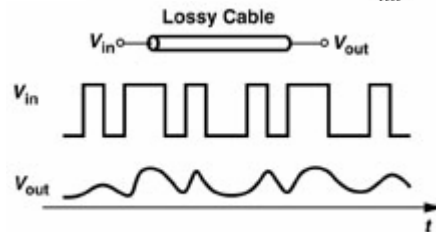
ΕΙΣΑΓΩΓΗ ΣΤΗΝ ΑΝΑΛΟΓΙΚΗ ΣΧΕΔΙΑΣΗ

Γιατί Αναλογικά;

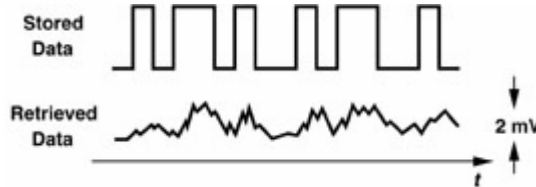
Επεξεργασία Φυσικών σημάτων.



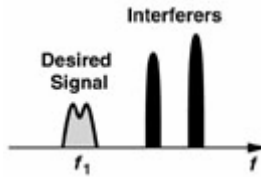
Ψηφιακές επικοινωνίες.



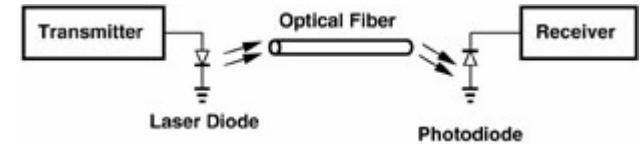
Ηλεκτρονικά Οδήγησης Δίσκων



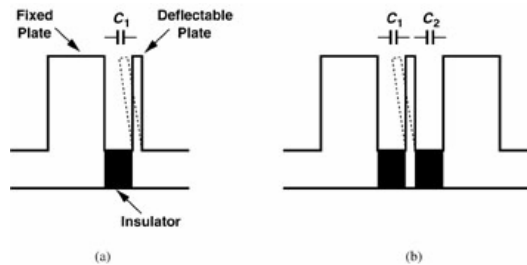
Ασύρματοι Δέκτες.



Οπτικοί Δέκτες.



Αισθητήρες.



Μικροεπεξεργαστές και Μνήμες.