Deep-submicron

CMOS circuit design

Simulator in hands

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About Microwind and Dsch

The present book introduces the design and simulation of CMOS integrated circuits, and makes an extensive use of PC tools Microwind2 and Dsch2. These tools are freeware.
The web link is http://www.microwind.org

In memory…

In memory of John Uyemura

Contents

MULTIPLIERS

Value	*Name*	*Standard Notation*
10^{18}	***PETA***	P
10^{15}	***EXA***	E
10^{12}	***TERA***	T
10^{9}	***GIGA***	G
10^{6}	***MEGA***	M
10^{3}	***KILO***	K
10^{0}	**-**	-
10^{-3}	***MILLI***	m
10^{-6}	***MICRO***	u
10^{-9}	***NANO***	n
10^{-12}	***PICO***	p
10^{-15}	***FEMTO***	f
10^{-18}	***ATTO***	a
10^{-21}	***ZEPTO***	z

PHYSICAL CONSTANTS & PARAMETERS

<verify all >

Name	*Value*	*Description*
ε_0	8.85 e^{-12} Farad/m	Vacuum dielectric constant
ε_r SiO_2	3.9 - 4.2	Relative dielectric constant of SiO_2
ε_r Si	11.8	Relative dielectric constant of silicon
ε_r ceramic	12	Relative dielectric constant of ceramic
k	$1.381e^{-23}$ J/°K	Bolztmann's constant
q	$1.6e^{-19}$ Coulomb	Electron charge
μ_n	600 $V.cm^{-2}$	Mobility of electrons in silicon
μ_p	270 $V.cm^{-2}$	Mobility of holes in silicon
γ_{al}	36.5 10^6 S/m	Aluminum conductivity
γ_{si}	$4x10^{-4}$ S/m	Silicon conductivity
n_i	$1.02x10^{10}cm^{-3}$	Intrinsic carrier concentration in silicon at 300°K
ρ_{al}	0.0277 Ω.µm	Aluminum resistivity
γ_{cu}	$58x10^6$ S/m	Copper conductivity
ρ_{cu}	0.0172 Ω.µm	Copper resistivity
$\rho_{tungstène\ (W)}$	0.0530 Ω.µm	Tungsten resistivity
$\rho_{or\ (Ag)}$	0.0220 Ω.µm	Gold resistivity
μ_0	$1.257e^{-6}$ H/m	Vacuum permeability
T	300°K (27°C)	Operating temperature

Preface

The present book introduces the design and simulation of CMOS integrated circuits, in an attractive way thanks to user-friendly PC tool Microwind2 given in the companion CD-ROM of this book.

The chapters of this book have been summarized below. Chapter One describes the technology scale down and the major improvements allowed by deep sub-micron technologies. Chapter Two is dedicated to the presentation of the single MOS device, with details on simulation at logic and layout levels. The modeling of the MOS devices is introduced in Chapter Three. Chapter Four presents the CMOS Inverter, the 2D and 3D views, the comparative design in micron and deep-submicron technologies. Chapter Five deals specifically with interconnects, with information on the propagation delay and several parasitic effects. Chapter Six deals with the basic logic gates (AND, OR, XOR, complex gates), Chapter Seven the arithmetic functions (Adder, comparator, multiplier, ALU). The latches and counters are detailed in Chapter Eight, while Chapter Nine introduces the basic concepts of Field programmable Gate Arrays.

As for Chapter Ten, static, dynamic, non-volatile and magnetic memories are described. In Chapter Eleven, analog cells are presented, including voltage references, current mirrors, and the basic architecture of operational amplifiers. Chapter Twelve is dedicated to radio-frequency analog cells, with details on mixers, voltage-controlled oscillators, fast phase-lock-loops and power amplifiers. Chapter Thirteen focuses on analog-to-digital and digital to analog converter principles. The input/output interfacing principles are illustrated in Chapter Fourteen. The last chapter includes an introduction to silicon-insulator technology, before a prospective and a conclusion.
The detailed explanation of the design rules is in appendix A. The details of all commands are given in appendix B for the tool Microwind, and in appendix C for the tool Dsch. Appendix D includes a quick reference sheet for Microwind and Dsch, and Appendix E gives some abstract information about each technology generation, from 0.7µm down to 90nm.

Sonia DELMAS-BENDHIA, Etienne SICARD

Toulouse, Sept 2003