calculatoratoz.com

unitsconverters.com

MOS IC Fabrication Formulas

Calculators! Examples! Conversions!

Bookmark **calculatoratoz.com**, **unitsconverters.com**

Widest Coverage of Calculators and Growing - **30,000+ Calculators!**
Calculate With a Different Unit for Each Variable - **In built Unit Conversion!**
Widest Collection of Measurements and Units - **250+ Measurements!**

Feel free to SHARE this document with your friends!

Please leave your feedback here...

List of 15 MOS IC Fabrication Formulas

MOS IC Fabrication

1) Acceptor Dopant Concentration

Open Calculator

fx $$N_a = \frac{1}{2 \cdot \pi \cdot L_t \cdot W_t \cdot [Charge\text{-}e] \cdot \mu_p \cdot C_{dep}}$$

ex $$1E\hat{}32electrons/m^3 = \frac{1}{2 \cdot \pi \cdot 3.2\mu m \cdot 5.5\mu m \cdot [Charge\text{-}e] \cdot 400m^2/V*s \cdot 1.4\mu F}$$

2) Body Effect in MOSFET

Open Calculator

fx $$V_t = V_{th} + \gamma \cdot \left(\sqrt{2 \cdot \Phi_f + V_{bs}} - \sqrt{2 \cdot \Phi_f}\right)$$

ex $$3.962586V = 3.4V + 0.56 \cdot \left(\sqrt{2 \cdot 0.25V + 2.43V} - \sqrt{2 \cdot 0.25V}\right)$$

3) Channel Resistance

Open Calculator

fx $$R_{ch} = \frac{L_t}{W_t} \cdot \frac{1}{\mu_n \cdot Q_{on}}$$

ex $$3.463203\Omega = \frac{3.2\mu m}{5.5\mu m} \cdot \frac{1}{30m^2/V*s \cdot 0.0056electrons/m^3}$$

4) Critical Dimension

Open Calculator

$$CD = k_1 \cdot \frac{\lambda_l}{NA}$$

$$485.1883\text{nm} = 1.56 \cdot \frac{223\text{nm}}{0.717}$$

5) Depth of Focus

Open Calculator

$$DOF = k_2 \cdot \frac{\lambda_l}{NA^2}$$

$$1.301331\mu\text{m} = 3 \cdot \frac{223\text{nm}}{(0.717)^2}$$

6) Die Per Wafer

Open Calculator

$$DPW = \frac{\pi \cdot d_w^2}{4 \cdot S_d}$$

$$803.2481 = \frac{\pi \cdot (150\text{mm})^2}{4 \cdot 22\text{mm}^2}$$

7) Donor Dopant Concentration

Open Calculator

$$N_d = \frac{I_{sat} \cdot L_t}{[\text{Charge-e}] \cdot W_t \cdot \mu_n \cdot C_{dep}}$$

$$1.7\text{E}\hat{}23\text{electrons/m}^3 = \frac{2.015\text{A} \cdot 3.2\mu\text{m}}{[\text{Charge-e}] \cdot 5.5\mu\text{m} \cdot 30\text{m}^2/\text{V*s} \cdot 1.4\mu\text{F}}$$

8) Drain Current of MOSFET at Saturation Region

Open Calculator

fx $$I_d = \frac{\beta}{2} \cdot (V_{gs} - V_{th})^2 \cdot (1 + \lambda_i \cdot V_{ds})$$

ex $$0.013718A = \frac{0.0025S}{2} \cdot (2.45V - 3.4V)^2 \cdot (1 + 9 \cdot 1.24V)$$

9) Drift Current Density due to Free Electrons

Open Calculator

fx $$J_n = [Charge\text{-}e] \cdot n \cdot \mu_n \cdot E_i$$

ex $$53.83313\mu A = [Charge\text{-}e] \cdot 1E\hat{}6electrons/cm^3 \cdot 30m^2/V*s \cdot 11.2V/m$$

10) Drift Current Density due to Holes

Open Calculator

fx $$J_p = [Charge\text{-}e] \cdot p \cdot \mu_p \cdot E_i$$

ex $$0.071778A/mm^2 = [Charge\text{-}e] \cdot 1E\hat{}20electrons/m^3 \cdot 400m^2/V*s \cdot 11.2V/m$$

11) Equivalent Oxide Thickness

Open Calculator

fx $$EOT = t_{high\text{-}k} \cdot \left(\frac{3.9}{k_{high\text{-}k}}\right)$$

ex $$14.66814nm = 8.5nm \cdot \left(\frac{3.9}{2.26}\right)$$

12) Maximum Dopant Concentration

Open Calculator

fx $$C_s = C_o \cdot \exp\left(-\frac{E_s}{[BoltZ] \cdot T_a}\right)$$

ex $$4.9E\hat{}\text{-}9\text{electrons/cm}^3 = 0.005 \cdot \exp\left(-\frac{1E\hat{}\text{-}23J}{[BoltZ] \cdot 24.5K}\right)$$

13) MOSFET Unity-Gain Frequency

Open Calculator

fx $$f_t = \frac{g_m}{C_{gs} + C_{gd}}$$

ex $$37.41497\text{kHz} = \frac{2.2S}{56\mu F + 2.8\mu F}$$

14) Propagation Time

Open Calculator

fx $$T_p = 0.7 \cdot N \cdot \left(\frac{N+1}{2}\right) \cdot R_m \cdot C_l$$

ex $$0.778203s = 0.7 \cdot 13 \cdot \left(\frac{13+1}{2}\right) \cdot 542\Omega \cdot 22.54\mu F$$

15) Switching Point Voltage

Open Calculator

fx $$V_s = \frac{V_{dd} + V_{tp} + V_{tn} \cdot \sqrt{\frac{\beta_n}{\beta_p}}}{1 + \sqrt{\frac{\beta_n}{\beta_p}}}$$

ex $$19.15938\text{V} = \frac{6.3\text{V} + 3.14\text{V} + 25\text{V} \cdot \sqrt{\frac{18}{6.5}}}{1 + \sqrt{\frac{18}{6.5}}}$$

Variables Used

- C_{dep} Depletion Layer Capacitance *(Microfarad)*
- C_{gd} Gate Drain Capacitance *(Microfarad)*
- C_{gs} Gate Source Capacitance *(Microfarad)*
- C_l Load Capacitance *(Microfarad)*
- C_o Reference Concentration
- C_s Maximum Dopant Concentration *(Electrons per Cubic Centimeter)*
- **CD** Critical Dimension *(Nanometer)*
- d_w Wafer Diameter *(Millimeter)*
- **DOF** Depth of Focus *(Micrometer)*
- **DPW** Die Per Wafer
- E_i Electric Field Intensity *(Volt per Meter)*
- E_s Activation Energy for Solid Solubility *(Joule)*
- **EOT** Equivalent Oxide Thickness *(Nanometer)*
- f_t Unity Gain Frequency in MOSFET *(Kilohertz)*
- g_m Transconductance in MOSFET *(Siemens)*
- I_d Drain Current *(Ampere)*
- I_{sat} Saturation Current *(Ampere)*
- J_n Drift Current Density due to Electrons *(Microampere)*
- J_p Drift Current Density due to Holes *(Ampere per Square Millimeter)*
- k_1 Process Dependent Constant
- k_2 Proportionality Factor
- $k_{high\text{-}k}$ Dielectric Constant of Material

- L_t Transistor's Length *(Micrometer)*
- n Electron Concentration *(Electrons per Cubic Centimeter)*
- N Number of Pass Transistors
- N_a Acceptor Dopant Concentration *(Electrons per Cubic Meter)*
- N_d Donor Dopant Concentration *(Electrons per Cubic Meter)*
- NA Numerical Aperture
- p Hole Concentration *(Electrons per Cubic Meter)*
- Q_{on} Carrier Density *(Electrons per Cubic Meter)*
- R_{ch} Channel Resistance *(Ohm)*
- R_m Resistance in MOSFET *(Ohm)*
- S_d Size of Each Die *(Square Millimeter)*
- T_a Absolute Temperature *(Kelvin)*
- $t_{high\text{-}k}$ Thickness of Material *(Nanometer)*
- T_p Propagation Time *(Second)*
- V_{bs} Voltage Applied to Body *(Volt)*
- V_{dd} Supply Voltage *(Volt)*
- V_{ds} Drain Source Voltage *(Volt)*
- V_{gs} Gate Source Voltage *(Volt)*
- V_s Switching Point Voltage *(Volt)*
- V_t Threshold Voltage with Substrate *(Volt)*
- V_{th} Threshold Voltage with Zero Body Bias *(Volt)*
- V_{tn} NMOS Threshold Voltage *(Volt)*
- V_{tp} PMOS Threshold Voltage *(Volt)*
- W_t Transistor's Width *(Micrometer)*
- β Transconductance Parameter *(Siemens)*

- β_n NMOS Transistor Gain
- β_p PMOS Transistor Gain
- γ Body Effect Parameter
- λ_i Channel Length Modulation Factor
- λ_l Wavelength in Photolithography *(Nanometer)*
- μ_n Electron Mobility *(Square Meter per Volt per Second)*
- μ_p Hole Mobility *(Square Meter per Volt per Second)*
- Φ_f Bulk Fermi Potential *(Volt)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[BoltZ]**, 1.38064852E-23
  Boltzmann constant
- Constant: **[Charge-e]**, 1.60217662E-19
  Charge of electron
- Function: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Function: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Micrometer (µm), Nanometer (nm), Millimeter (mm)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Electric Current** in Ampere (A), Microampere (µA)
  Electric Current Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Frequency** in Kilohertz (kHz)
  Frequency Unit Conversion
- Measurement: **Capacitance** in Microfarad (µF)
  Capacitance Unit Conversion

- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Electric Conductance** in Siemens (S)
  Electric Conductance Unit Conversion
- Measurement: **Wavelength** in Nanometer (nm), Micrometer (µm)
  Wavelength Unit Conversion
- Measurement: **Surface Current Density** in Ampere per Square Millimeter (A/mm²)
  Surface Current Density Unit Conversion
- Measurement: **Electric Field Strength** in Volt per Meter (V/m)
  Electric Field Strength Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Mobility** in Square Meter per Volt per Second (m²/V*s)
  Mobility Unit Conversion
- Measurement: **Electron Density** in Electrons per Cubic Meter (electrons/m³), Electrons per Cubic Centimeter (electrons/cm³)
  Electron Density Unit Conversion

Check other formula lists

- MOS IC Fabrication Formulas
- Schmitt Trigger Formulas

Feel free to SHARE this document with your friends!

PDF Available in

English Spanish French German Russian Italian Portuguese Polish Dutch

5/10/2024 | 9:36:04 AM UTC

Please leave your feedback here...