

Important CMOS Circuit Characteristics Formulas PDF



Formulas Examples with Units

List of 15 Important CMOS Circuit Characteristics Formulas

1) Area of Source Diffusion Formula ↻

Formula

$$A_s = D_s \cdot W$$

Example with Units

$$5479.02 \text{ mm}^2 = 61 \text{ mm} \cdot 89.82 \text{ mm}$$

Evaluate Formula ↻

2) CMOS Critical Voltage Formula ↻

Formula

$$V_c = E_c \cdot L$$

Example with Units

$$2.7903 \text{ v} = 0.004 \text{ v/mm} \cdot 697.57 \text{ mm}$$

Evaluate Formula ↻

3) CMOS Mean Free Path Formula ↻

Formula

$$L = \frac{V_c}{E_c}$$

Example with Units

$$697.5 \text{ mm} = \frac{2.79 \text{ v}}{0.004 \text{ v/mm}}$$

Evaluate Formula ↻

4) Critical Electric Field Formula ↻

Formula

$$E_c = \frac{2 \cdot V_{\text{sat}}}{\mu_e}$$

Example with Units

$$0.0041 \text{ v/mm} = \frac{2 \cdot 10.12 \text{ mm/s}}{49.8 \text{ cm}^2/\text{V}^*\text{s}}$$

Evaluate Formula ↻

5) Depletion Region Width Formula ↻

Formula

$$L_d = L_{\text{pn}} - L_{\text{eff}}$$

Example with Units

$$11 \text{ mm} = 19 \text{ mm} - 8 \text{ mm}$$

Evaluate Formula ↻

6) Effective Capacitance in CMOS Formula ↻

Formula

$$C_{\text{eff}} = D \cdot \frac{i_{\text{off}} \cdot (10^{V_{\text{bc}}})}{N_g \cdot [\text{Boltz}] \cdot V_{\text{bc}}}$$

Example with Units

$$5.1379 \mu\text{F} = 1.3\text{E-}25 \cdot \frac{0.01 \text{ mA} \cdot (10^{2.02 \text{ v}})}{0.95 \cdot 1.4\text{E-}23/\text{K} \cdot 2.02 \text{ v}}$$

Evaluate Formula ↻



7) Effective Channel Length Formula ↻

Formula

$$L_{\text{eff}} = L_{\text{pn}} - L_{\text{d}}$$

Example with Units

$$7.99 \text{ mm} = 19 \text{ mm} - 11.01 \text{ mm}$$

Evaluate Formula ↻

8) Oxide Layer Thickness Formula ↻

Formula

$$t_{\text{ox}} = \epsilon_{\text{ox}} \cdot W_{\text{g}} \cdot \frac{L_{\text{g}}}{C_{\text{in}}}$$

Example with Units

$$4.9797 \text{ mm} = 149.79 \mu\text{F/mm} \cdot 0.285 \text{ mm} \cdot \frac{7 \text{ mm}}{60.01 \mu\text{F}}$$

Evaluate Formula ↻

9) Permittivity of Oxide Layer Formula ↻

Formula

$$\epsilon_{\text{ox}} = t_{\text{ox}} \cdot \frac{C_{\text{in}}}{W_{\text{g}} \cdot L_{\text{g}}}$$

Example with Units

$$149.7994 \mu\text{F/mm} = 4.98 \text{ mm} \cdot \frac{60.01 \mu\text{F}}{0.285 \text{ mm} \cdot 7 \text{ mm}}$$

Evaluate Formula ↻

10) PN Junction Length Formula ↻

Formula

$$L_{\text{pn}} = L_{\text{d}} + L_{\text{eff}}$$

Example with Units

$$19.01 \text{ mm} = 11.01 \text{ mm} + 8 \text{ mm}$$

Evaluate Formula ↻

11) Sidewall Perimeter of Source Diffusion Formula ↻

Formula

$$P_{\text{s}} = (2 \cdot W) + (2 \cdot D_{\text{s}})$$

Example with Units

$$301.64 \text{ mm} = (2 \cdot 89.82 \text{ mm}) + (2 \cdot 61 \text{ mm})$$

Evaluate Formula ↻

12) Transition Width of CMOS Formula ↻

Formula

$$W = \frac{C_{\text{mos}}}{C_{\text{gs}}}$$

Example with Units

$$89.8204 \text{ mm} = \frac{1.8 \mu\text{F}}{20.04 \mu\text{F}}$$

Evaluate Formula ↻

13) Voltage at Minimum EDP Formula ↻

Formula

$$V_{\text{edp}} = \frac{3 \cdot V_{\text{t}}}{3 - \alpha}$$

Example with Units

$$0.6667 \text{ v} = \frac{3 \cdot 0.3 \text{ v}}{3 - 1.65}$$

Evaluate Formula ↻

14) Width of Gate Formula ↻

Formula

$$W_{\text{g}} = \frac{C_{\text{in}}}{C_{\text{ox}} \cdot L_{\text{g}}}$$

Example with Units

$$0.2857 \text{ mm} = \frac{60.01 \mu\text{F}}{30.01 \mu\text{F/mm}^2 \cdot 7 \text{ mm}}$$

Evaluate Formula ↻



15) Width of Source Diffusion Formula

Formula

$$W = \frac{A_s}{D_s}$$

Example with Units

$$89.8197 \text{ mm} = \frac{5479 \text{ mm}^2}{61 \text{ mm}}$$

Evaluate Formula 



Variables used in list of CMOS Circuit Characteristics Formulas above

- μ_e **Mobility of Electron** (Square Centimeter per Volt Second)
- A_s **Area of Source Diffusion** (Square Millimeter)
- C_{eff} **Effective Capacitance in CMOS** (Microfarad)
- C_{gs} **MOS Gate Capacitance** (Microfarad)
- C_{in} **Input Gate Capacitance** (Microfarad)
- C_{mos} **MOS Gate Overlap Capacitance** (Microfarad)
- C_{ox} **Capacitance of Gate Oxide Layer** (Microfarad per Square Millimeter)
- D **Duty Cycle**
- D_s **Length of Source** (Millimeter)
- E_c **Critical Electric Field** (Volt per Millimeter)
- i_{off} **Off Current** (Milliampere)
- L **Mean Free Path** (Millimeter)
- L_d **Depletion Region Width** (Millimeter)
- L_{eff} **Effective Channel Length** (Millimeter)
- L_g **Length of Gate** (Millimeter)
- L_{pn} **PN Junction Length** (Millimeter)
- N_g **Gates on Critical Path**
- P_s **Sidewall Perimeter of Source Diffusion** (Millimeter)
- t_{ox} **Oxide Layer Thickness** (Millimeter)
- V_{bc} **Base Collector Voltage** (Volt)
- V_c **Critical Voltage in CMOS** (Volt)
- V_{edp} **Voltage at Minimum EDP** (Volt)
- V_{sat} **Velocity Saturation** (Millimeter per Second)
- V_t **Threshold Voltage** (Volt)
- W **Transition Width** (Millimeter)
- W_g **Gate Width** (Millimeter)
- α **Activity Factor**

Constants, Functions, Measurements used in list of CMOS Circuit Characteristics Formulas above

- **constant(s):** [BoltZ], 1.38064852E-23
Boltzmann constant
- **Measurement: Length** in Millimeter (mm)
Length Unit Conversion 
- **Measurement: Electric Current** in Milliampere (mA)
Electric Current Unit Conversion 
- **Measurement: Area** in Square Millimeter (mm²)
Area Unit Conversion 
- **Measurement: Speed** in Millimeter per Second (mm/s)
Speed Unit Conversion 
- **Measurement: Capacitance** in Microfarad (μF)
Capacitance Unit Conversion 
- **Measurement: Electric Field Strength** in Volt per Millimeter (V/mm)
Electric Field Strength Unit Conversion 
- **Measurement: Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
- **Measurement: Mobility** in Square Centimeter per Volt Second (cm²/V*s)
Mobility Unit Conversion 
- **Measurement: Oxide Capacitance Per Unit Area** in Microfarad per Square Millimeter (μF/mm²)
Oxide Capacitance Per Unit Area Unit Conversion 
- **Measurement: Permittivity** in Microfarad per Millimeter (μF/mm)
Permittivity Unit Conversion 



- ϵ_{ox} Permittivity of Oxide Layer (*Microfarad per Millimeter*)



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