

Important CMOS Power Metrics Formulas PDF



Formulas Examples with Units

List of 17 Important CMOS Power Metrics Formulas

1) Activity Factor Formula

Formula

$$\alpha = \frac{P_s}{C \cdot V_{bc}^2 \cdot f}$$

Example with Units

$$1.6255 = \frac{0.13 \text{ mW}}{4.9 \mu\text{F} \cdot 2.02 \text{ V}^2 \cdot 4 \text{ Hz}}$$

Evaluate Formula 

2) Capacitive Load Power Consumption Formula

Formula

$$P_L = C_L \cdot V_{cc}^2 \cdot f_0 \cdot S_{wo}$$

Example with Units

$$2.9443 \text{ mW} = 5.01 \mu\text{F} \cdot 1.55 \text{ V}^2 \cdot 61 \text{ Hz} \cdot 4.01$$

Evaluate Formula 

3) Contention Current in Ratioed Circuits Formula

Formula

$$i_{con} = \left(\frac{P_{st}}{V_{bc}} \right) - (i_{st} + i_g + i_j)$$

Example with Units

$$25.7515 \text{ mA} = \left(\frac{67.37 \text{ mW}}{2.02 \text{ V}} \right) - (1.6 \text{ mA} + 4.5 \text{ mA} + 1.5 \text{ mA})$$

Evaluate Formula 

4) Dynamic Power in CMOS Formula

Formula

$$P_{dyn} = P_{sc} + P_s$$

Example with Units

$$46.13 \text{ mW} = 46 \text{ mW} + 0.13 \text{ mW}$$

Evaluate Formula 

5) Gate Leakage through Gate Dielectric Formula

Formula

$$i_g = \left(\frac{P_{st}}{V_{bc}} \right) - (i_{st} + i_{con} + i_j)$$

Example with Units

$$4.5015 \text{ mA} = \left(\frac{67.37 \text{ mW}}{2.02 \text{ V}} \right) - (1.6 \text{ mA} + 25.75 \text{ mA} + 1.5 \text{ mA})$$

Evaluate Formula 



6) Gates on Critical Path Formula ↻

Formula

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

Example with Units

$$0.001 = 1.3\text{E-}25 \cdot \frac{0.01 \text{ mA} \cdot (10^{2.02\text{V}})}{5.1 \text{ mF} \cdot 1.4\text{E-}23\text{J/K} \cdot 2.02 \text{ V}}$$

Evaluate Formula ↻

7) Leakage Energy in CMOS Formula ↻

Formula

$$E_{\text{leak}} = E_t - E_s$$

Example with Units

$$7 \text{ pJ} = 42 \text{ pJ} - 35 \text{ pJ}$$

Evaluate Formula ↻

8) Output Switching at Load Power Consumption Formula ↻

Formula

$$S_{\text{wo}} = \frac{P_L}{C_L \cdot V_{cc}^2 \cdot f_o}$$

Example with Units

$$4.0042 = \frac{2.94 \text{ mW}}{5.01 \mu\text{F} \cdot 1.55 \text{ V}^2 \cdot 61 \text{ Hz}}$$

Evaluate Formula ↻

9) Power Supply Rejection Ratio Formula ↻

Formula

$$P_{\text{sr}} = 20 \cdot \log_{10} \left(\frac{V_{\text{in}}}{V_{\text{out}}} \right)$$

Example with Units

$$2.9635 \text{ dB} = 20 \cdot \log_{10} \left(\frac{7.23 \text{ V}}{5.14 \text{ V}} \right)$$

Evaluate Formula ↻

10) Short-Circuit Power in CMOS Formula ↻

Formula

$$P_{\text{sc}} = P_{\text{dyn}} - P_s$$

Example with Units

$$46 \text{ mW} = 46.13 \text{ mW} - 0.13 \text{ mW}$$

Evaluate Formula ↻

11) Static Power in CMOS Formula ↻

Formula

$$P_{\text{st}} = P_t - P_{\text{dyn}}$$

Example with Units

$$67.37 \text{ mW} = 113.5 \text{ mW} - 46.13 \text{ mW}$$

Evaluate Formula ↻

12) Subthreshold Leakage through OFF Transistors Formula ↻

Formula

$$i_{\text{st}} = \left(\frac{P_{\text{st}}}{V_{bc}} \right) - (i_g + i_{\text{con}} + i_j)$$

Example with Units

$$1.6015 \text{ mA} = \left(\frac{67.37 \text{ mW}}{2.02 \text{ V}} \right) - (4.5 \text{ mA} + 25.75 \text{ mA} + 1.5 \text{ mA})$$

Evaluate Formula ↻



13) Switching Energy in CMOS Formula ↻

Formula

$$E_s = E_t - E_{\text{leak}}$$

Example with Units

$$35 \text{ pJ} = 42 \text{ pJ} - 7 \text{ pJ}$$

Evaluate Formula ↻

14) Switching Power Formula ↻

Formula

$$P_s = \alpha \cdot (C \cdot V_{bc}^2 \cdot f)$$

Example with Units

$$0.132 \text{ mW} = 1.65 \cdot (4.9 \mu\text{F} \cdot 2.02 \text{ V}^2 \cdot 4 \text{ Hz})$$

Evaluate Formula ↻

15) Switching Power in CMOS Formula ↻

Formula

$$P_s = (V_{dd}^2) \cdot f \cdot C$$

Example with Units

$$0.1305 \text{ mW} = (2.58 \text{ V}^2) \cdot 4 \text{ Hz} \cdot 4.9 \mu\text{F}$$

Evaluate Formula ↻

16) Total Energy in CMOS Formula ↻

Formula

$$E_t = E_s + E_{\text{leak}}$$

Example with Units

$$42 \text{ pJ} = 35 \text{ pJ} + 7 \text{ pJ}$$

Evaluate Formula ↻

17) Total Power in CMOS Formula ↻

Formula

$$P_t = P_{st} + P_{dyn}$$

Example with Units

$$113.5 \text{ mW} = 67.37 \text{ mW} + 46.13 \text{ mW}$$

Evaluate Formula ↻



Variables used in list of CMOS Power Metrics Formulas above









- **C** Capacitance (Microfarad)
- **C_g** Capacitance of Gate to Channel (Millifarad)
- **C_L** External Load Capacitance (Microfarad)
- **D** Duty Cycle
- **E_{leak}** Leakage Energy in CMOS (Picojoule)
- **E_s** Switching Energy in CMOS (Picojoule)
- **E_t** Total Energy in CMOS (Picojoule)
- **f** Frequency (Hertz)
- **f_o** Output Signal Frequency (Hertz)
- **i_{con}** Contention Current (Milliampere)
- **i_g** Gate Current (Milliampere)
- **i_j** Junction Current (Milliampere)
- **i_{off}** Off Current (Milliampere)
- **i_{st}** Subthreshold Current (Milliampere)
- **N_g** Gates on Critical Path
- **P_{dyn}** Dynamic Power (Milliwatt)
- **P_L** Capacitive Load Power Consumption (Milliwatt)
- **P_s** Switching Power (Milliwatt)
- **P_{sc}** Short-Circuit Power (Milliwatt)
- **P_{sr}** Power Supply Rejection Ratio (Decibel)
- **P_{st}** CMOS Static Power (Milliwatt)
- **P_t** Total Power (Milliwatt)
- **S_{wo}** Output Switching
- **V_{bc}** Base Collector Voltage (Volt)
- **V_{cc}** Supply Voltage (Volt)
- **V_{dd}** Positive Voltage (Volt)
- **V_{in}** Input Voltage Ripple (Volt)
- **V_{out}** Output Voltage Ripple (Volt)
- **α** Activity Factor

Constants, Functions, Measurements used in list of CMOS Power Metrics Formulas above

- **constant(s): [BoltZ]**, 1.38064852E-23
Boltzmann constant
- **Functions: log10**, log10(Number)
The common logarithm, also known as the base-10 logarithm or the decimal logarithm, is a mathematical function that is the inverse of the exponential function.
- **Measurement: Electric Current** in Milliampere (mA)
Electric Current Unit Conversion ↻
- **Measurement: Energy** in Picojoule (pJ)
Energy Unit Conversion ↻
- **Measurement: Power** in Milliwatt (mW)
Power Unit Conversion ↻
- **Measurement: Noise** in Decibel (dB)
Noise Unit Conversion ↻
- **Measurement: Frequency** in Hertz (Hz)
Frequency Unit Conversion ↻
- **Measurement: Capacitance** in Microfarad (μF), Millifarad (mF)
Capacitance Unit Conversion ↻
- **Measurement: Electric Potential** in Volt (V)
Electric Potential Unit Conversion ↻



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