Important CMOS Special Purpose Subsystem Formulas PDF

Formulas
Examples
with Units

List of 20
Important CMOS Special Purpose Subsystem Formulas

1) Capacitance of External Load Formula

Evaluate Formula

Formula

$$C_{out} = h \cdot C_{in}$$

Example with Units

$$42\,\text{pF} = 0.84 \cdot 50\,\text{pF}$$

2) Change in Frequency of Clock Formula

Evaluate Formula

Formula

$$\Delta f = \frac{h}{f_{abs}}$$

Example with Units

$$0.084\,\text{Hz} = \frac{0.84}{10\,\text{Hz}}$$

3) Change in Phase of Clock Formula

Evaluate Formula

Formula

$$\Delta\Phi_f = \frac{\Phi_{out}}{f_{abs}}$$

Example with Units

$$2.989 = \frac{29.89}{10\,\text{Hz}}$$

4) Delay for Two Inverters in Series Formula

Evaluate Formula

Formula

$$D_C = h_1 + h_2 + 2 \cdot P_{inv}$$

Example with Units

$$0.05\,\text{s} = 2.14\,\text{mW} + 31\,\text{mW} + 2 \cdot 8.43\,\text{mW}$$

5) Fanout of Gate Formula

Evaluate Formula

Formula

$$h = \frac{f}{g}$$

Example

$$0.8382 = \frac{3.99}{4.76}$$

6) Feedback Clock PLL Formula

Evaluate Formula

Formula

$$\Delta\Phi_c = \Delta\Phi_{in} - \Delta\Phi_{er}$$

Example

$$1.21 = 5.99 - 4.78$$

7) Gate Delay Formula

Evaluate Formula

Formula

$$G_d = 2^{N_{sr}}$$

Example with Units

$$4.5948\,\text{s} = 2^{2.2}$$

8) Input Clock Phase PLL Formula

Evaluate Formula

Formula

$$\Delta\Phi_{in} = \frac{\Phi_{out}}{H_s}$$

Example

$$5.99 = \frac{29.89}{4.99}$$

9) Invertor Electric Effort 1 Formula

Evaluate Formula

Formula

$$h_1 = D_C - \left(h_2 + 2 \cdot P_{inv}\right)$$

Example with Units

$$2.14\,\text{mW} = 0.05\,\text{s} - \left(31\,\text{mW} + 2 \cdot 8.43\,\text{mW}\right)$$

10) Invertor Electric Effort 2 Formula

Evaluate Formula

Formula

$$h_2 = D_C - \left(h_1 + 2 \cdot P_{inv}\right)$$

Example with Units

$$31\,\text{mW} = 0.05\,\text{s} - \left(2.14\,\text{mW} + 2 \cdot 8.43\,\text{mW}\right)$$

11) Invertor Power Formula

Evaluate Formula

Formula

$$P_{inv} = \frac{D_C - \left(h_1 + h_2\right)}{2}$$

Example with Units

$$8.43\,\text{mW} = \frac{0.05\,\text{s} - \left(2.14\,\text{mW} + 31\,\text{mW}\right)}{2}$$

12) Output Clock Phase PLL Formula

Evaluate Formula

Formula

$$\Phi_{out} = H_s \cdot \Delta\Phi_{in}$$

Example

$$29.8901 = 4.99 \cdot 5.99$$

13) PLL Phase Detector Error Formula

Evaluate Formula

Formula

$$\Delta\Phi_{er} = \Delta\Phi_{in} - \Delta\Phi_c$$

Example

$$4.78 = 5.99 - 1.21$$

14) Power Consumption of Chip Formula

Evaluate Formula

Formula

$$P_{chip} = \frac{\Delta T}{\Theta_j}$$

Example with Units

$$0.7973\,\text{mW} = \frac{2.4\,\text{K}}{3.01\,\text{K/mW}}$$

15) Series Resistance from Die to Package Formula

Evaluate Formula

Formula

$$\Theta_{jp} = \Theta_j - \Theta_{pa}$$

Example with Units

$$1.6\,\text{K/mW} = 3.01\,\text{K/mW} - 1.41\,\text{K/mW}$$

16) Series Resistance from Package to Air Formula

Evaluate Formula

Formula

$$\Theta_{pa} = \Theta_j - \Theta_{jp}$$

Example with Units

$$1.41\,\text{K/mW} = 3.01\,\text{K/mW} - 1.60\,\text{K/mW}$$

17) Stage Effort Formula

Evaluate Formula

Formula

$$f = h \cdot g$$

Example

$$3.9984 = 0.84 \cdot 4.76$$

18) Temperature Difference between Transistors Formula

Evaluate Formula

Formula

$$\Delta T = \Theta_j \cdot P_{chip}$$

Example with Units

$$2.399\,\text{K} = 3.01\,\text{K/mW} \cdot 0.797\,\text{mW}$$

19) Thermal Resistance between Junction and Ambient Formula

Evaluate Formula

Formula

$$\Theta_j = \frac{\Delta T}{P_{chip}}$$

Example with Units

$$3.0113\,\text{K/mW} = \frac{2.4\,\text{K}}{0.797\,\text{mW}}$$

20) Transfer Function of PLL Formula

Evaluate Formula

Formula

$$H_s = \frac{\Phi_{out}}{\Delta\Phi_{in}}$$

Example

$$4.99 = \frac{29.89}{5.99}$$

Variables used in list of CMOS Special Purpose Subsystem Formulas above

- C_{in} Input Capacitance *(Picofarad)*
- C_{out} Capacitance of External Load *(Picofarad)*
- D_C Delay of Chains *(Second)*
- f Stage Effort
- f_{abs} Absolute Frequency *(Hertz)*
- g Logical Effort
- G_d Gate Delay *(Second)*
- h Fanout
- h_1 Electric Effort 1 *(Milliwatt)*
- h_2 Electric Effort 2 *(Milliwatt)*
- H_s Transfer Function PLL
- N_{sr} N Bit SRAM
- P_{chip} Power Consumption of Chip *(Milliwatt)*
- P_{inv} Inverter Power *(Milliwatt)*
- Δf Change in Frequency of Clock *(Hertz)*
- ΔT Temperature Difference Transistors *(Kelvin)*
- $\Delta \Phi_c$ Feedback Clock PLL
- $\Delta \Phi_{er}$ PLL Error Detector
- $\Delta \Phi_f$ Change in Phase of Clock
- $\Delta \Phi_{in}$ Input Reference Clock Phase
- Θ_j Thermal Resistance between junction and Ambient *(Kelvin per Milliwatt)*
- Θ_{jp} Series Resistance from Die to Package *(Kelvin per Milliwatt)*
- Θ_{pa} Series Resistance from Package to Air *(Kelvin per Milliwatt)*
- Φ_{out} PLL Output Clock Phase

Constants, Functions, Measurements used in list of CMOS Special Purpose Subsystem Formulas above

- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Power** in Milliwatt (mW)
  Power Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Capacitance** in Picofarad (pF)
  Capacitance Unit Conversion
- Measurement: **Thermal Resistance** in Kelvin per Milliwatt (K/mW)
  Thermal Resistance Unit Conversion

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