Important Array Datapath Subsystem Formulas PDF

Formulas
Examples
with Units

List of 19
Important Array Datapath Subsystem Formulas

1) Area of Memory Cell Formula

Evaluate Formula

Formula

$$A_{bit} = \frac{E \cdot A}{f_{abs}}$$

Example with Units

$$47.7198\,\text{mm}^2 = \frac{0.88 \cdot 542.27\,\text{mm}^2}{10\,\text{Hz}}$$

2) Area of Memory Containing N Bits Formula

Evaluate Formula

Formula

$$A = \frac{A_{bit} \cdot f_{abs}}{E}$$

Example with Units

$$542.2727\,\text{mm}^2 = \frac{47.72\,\text{mm}^2 \cdot 10\,\text{Hz}}{0.88}$$

3) Array Efficiency Formula

Evaluate Formula

Formula

$$E = \frac{A_{bit} \cdot f_{abs}}{A}$$

Example with Units

$$0.88 = \frac{47.72\,\text{mm}^2 \cdot 10\,\text{Hz}}{542.27\,\text{mm}^2}$$

4) Bit Capacitance Formula

Evaluate Formula

Formula

$$C_{bit} = \left(\frac{V_{dd} \cdot C_{cell}}{2 \cdot \Delta V}\right) - C_{cell}$$

Example with Units

$$12.3871\,\text{pF} = \left(\frac{2.58\,\text{V} \cdot 5.98\,\text{pF}}{2 \cdot 0.42\,\text{V}}\right) - 5.98\,\text{pF}$$

5) Carry-Increamentor Adder Delay Formula

Evaluate Formula

Formula

$$T_{inc} = t_{pg} + t_{gp} + \left(K - 1\right) \cdot T_{ao} + T_{xor}$$

Example with Units

$$27.3\,\text{ns} = 8.01\,\text{ns} + 5.5\,\text{ns} + \left(7 - 1\right) \cdot 2.05\,\text{ns} + 1.49\,\text{ns}$$

6) Carry-Looker Adder Delay Formula

Evaluate Formula

Formula

$$t_{cla} = t_{pg} + t_{gp} + \left(\left(n - 1 \right) + \left(K - 1 \right) \right) \cdot T_{ao} + T_{xor}$$

Example with Units

$$29.35\,\text{ns} = 8.01\,\text{ns} + 5.5\,\text{ns} + \left(\left(2 - 1 \right) + \left(7 - 1 \right) \right) \cdot 2.05\,\text{ns} + 1.49\,\text{ns}$$

7) Carry-Ripple Adder Critical Path Delay Formula

Evaluate Formula

Formula

$$T_{ripple} = t_{pg} + \left(N_{gates} - 1 \right) \cdot T_{ao} + T_{xor}$$

Example with Units

$$30\,\text{ns} = 8.01\,\text{ns} + \left(11 - 1 \right) \cdot 2.05\,\text{ns} + 1.49\,\text{ns}$$

8) Carry-Skip Adder Delay Formula

Evaluate Formula

Formula

$$T_{skip} = t_{pg} + 2 \cdot \left(n - 1 \right) \cdot T_{ao} + \left(K - 1 \right) \cdot t_{mux} + T_{xor}$$

Example with Units

$$34.3\,\text{ns} = 8.01\,\text{ns} + 2 \cdot \left(2 - 1 \right) \cdot 2.05\,\text{ns} + \left(7 - 1 \right) \cdot 3.45\,\text{ns} + 1.49\,\text{ns}$$

9) Cell Capacitance Formula

Evaluate Formula

Formula

$$C_{cell} = \frac{C_{bit} \cdot 2 \cdot \Delta V}{V_{dd} - \left(\Delta V \cdot 2 \right)}$$

Example with Units

$$5.9766\,\text{pF} = \frac{12.38\,\text{pF} \cdot 2 \cdot 0.42\,\text{V}}{2.58\,\text{V} - \left(0.42\,\text{V} \cdot 2 \right)}$$

10) Critical Delay in Gates Formula

Evaluate Formula

Formula

$$T_{gd} = t_{pg} + \left(n + \left(K - 2 \right) \right) \cdot T_{ao} + t_{mux}$$

Example with Units

$$25.81\,\text{ns} = 8.01\,\text{ns} + \left(2 + \left(7 - 2 \right) \right) \cdot 2.05\,\text{ns} + 3.45\,\text{ns}$$

11) Ground Capacitance Formula

Evaluate Formula

Formula

$$C_{gnd} = \left(\frac{V_{agr} \cdot C_{adj}}{V_{tm}} \right) - C_{adj}$$

Example with Units

$$2.9804\,\text{pF} = \left(\frac{17.5\,\text{V} \cdot 8\,\text{pF}}{12.75\,\text{V}} \right) - 8\,\text{pF}$$

12) Group Propagation Delay Formula

Evaluate Formula

Formula

$$t_{pg} = t_{tree} - \left(\log2\left(f_{abs}\right) \cdot T_{ao} + T_{xor}\right)$$

Example with Units

$$8\,\text{ns} = 16.3\,\text{ns} - \left(\log2\left(10\,\text{Hz}\right) \cdot 2.05\,\text{ns} + 1.49\,\text{ns}\right)$$

13) K-Input 'And' Gate Formula

Evaluate Formula

Formula

$$K = \frac{N_{carry}}{n}$$

Example

$$7 = \frac{14}{2}$$

14) Multiplexer Delay Formula

Evaluate Formula

Formula

$$t_{mux} = \frac{T_{skip} - \left(t_{pg} + \left(2 \cdot \left(n - 1\right) \cdot T_{ao}\right) - T_{xor}\right)}{K - 1}$$

Example with Units

$$3.9467\,\text{ns} = \frac{34.3\,\text{ns} - \left(8.01\,\text{ns} + \left(2 \cdot \left(2 - 1\right) \cdot 2.05\,\text{ns}\right) - 1.49\,\text{ns}\right)}{7 - 1}$$

15) N-Bit Carry-Skip Adder Formula

Evaluate Formula

Formula

$$N_{carry} = n \cdot K$$

Example

$$14 = 2 \cdot 7$$

16) N-Input 'And' Gate Formula

Evaluate Formula

Formula

$$n = \frac{N_{carry}}{K}$$

Example

$$2 = \frac{14}{7}$$

17) Tree Adder Delay Formula

Evaluate Formula

Formula

$$t_{tree} = t_{pg} + \log2\left(f_{abs}\right) \cdot T_{ao} + T_{xor}$$

Example with Units

$$16.31\,\text{ns} = 8.01\,\text{ns} + \log2\left(10\,\text{Hz}\right) \cdot 2.05\,\text{ns} + 1.49\,\text{ns}$$

18) Voltage Swing On Bitline Formula

Evaluate Formula

Formula

$$\Delta V = \left(\frac{V_{dd}}{2}\right) \cdot \frac{C_{cell}}{C_{cell} + C_{bit}}$$

Example with Units

$$0.4202\,\text{V} = \left(\frac{2.58\,\text{V}}{2}\right) \cdot \frac{5.98\,\text{pF}}{5.98\,\text{pF} + 12.38\,\text{pF}}$$

19) 'XOR' Delay Formula

Evaluate Formula

Formula

$$T_{xor} = T_{ripple} - \left(t_{pg} + \left(N_{gates} - 1\right) \cdot T_{ao}\right)$$

Example with Units

$$1.49\,\text{ns} = 30\,\text{ns} - \left(8.01\,\text{ns} + \left(11 - 1\right) \cdot 2.05\,\text{ns}\right)$$

Variables used in list of Array Datapath Subsystem Formulas above

- **A** Area of Memory Cell *(Square Millimeter)*
- A_{bit} Area of One Bit Memory Cell *(Square Millimeter)*
- C_{adj} Adjacent Capacitance *(Picofarad)*
- C_{bit} Bit Capacitance *(Picofarad)*
- C_{cell} Cell Capacitance *(Picofarad)*
- C_{gnd} Ground Capacitance *(Picofarad)*
- **E** Array Efficiency
- f_{abs} Absolute Frequency *(Hertz)*
- **K** K-Input AND Gate
- **n** N-Input AND Gate
- N_{carry} N-bit Carry Skip Adder
- N_{gates} Gates on Critical Path
- T_{ao} AND-OR Gate Delay *(Nanosecond)*
- t_{cla} Carry-Looker Adder Delay *(Nanosecond)*
- T_{gd} Critical Delay in Gates *(Nanosecond)*
- t_{gp} Group Propagation Delay *(Nanosecond)*
- T_{inc} Carry-Incrementor Adder Delay *(Nanosecond)*
- t_{mux} Multiplexer Delay *(Nanosecond)*
- t_{pg} Propagation Delay *(Nanosecond)*
- T_{ripple} Ripple Time *(Nanosecond)*
- T_{skip} Carry-Skip Adder Delay *(Nanosecond)*
- t_{tree} Tree Adder Delay *(Nanosecond)*
- T_{xor} XOR Delay *(Nanosecond)*
- V_{agr} Agressor Voltage *(Volt)*
- V_{dd} Positive Voltage *(Volt)*
- V_{tm} Victim Voltage *(Volt)*
- ΔV Voltage Swing on Bitline *(Volt)*

Constants, Functions, Measurements used in list of Array Datapath Subsystem Formulas above

- Functions: **log2**, log2(Number)
  The binary logarithm (or log base 2) is the power to which the number 2 must be raised to obtain the value n.
- Measurement: **Time** in Nanosecond (ns)
  Time Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Capacitance** in Picofarad (pF)
  Capacitance Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion

Download other Important CMOS Design and Applications PDFs

- Important Array Datapath Subsystem Formulas
- Important CMOS Circuit Characteristics Formulas
- Important CMOS Delay Characteristics Formulas
- Important CMOS Design Characteristics Formulas
- Important CMOS Inverters Formulas
- Important CMOS Power Metrics Formulas
- Important CMOS Special Purpose Subsystem Formulas
- Important CMOS Time Characteristics Formulas

Try our Unique Visual Calculators

- Percentage growth
- LCM calculator
- Divide fraction

Please SHARE this PDF with someone who needs it!

This PDF can be downloaded in these languages

English Spanish French German Russian Italian Portuguese Polish Dutch

7/9/2024 | 5:39:55 AM UTC