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Array Datapath Subsystem Formulas

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List of 19 Array Datapath Subsystem Formulas

Array Datapath Subsystem

1) Area of Memory Cell

Open Calculator

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

ex $$47.71976\text{mm}^2 = \frac{0.88 \cdot 542.27\text{mm}^2}{10\text{Hz}}$$

2) Area of Memory Containing N Bits

Open Calculator

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

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

3) Array Efficiency

Open Calculator

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

ex $$0.880004 = \frac{47.72\text{mm}^2 \cdot 10\text{Hz}}{542.27\text{mm}^2}$$

4) Bit Capacitance

Open Calculator

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

ex $$12.38714\text{pF} = \left(\frac{2.58\text{V} \cdot 5.98\text{pF}}{2 \cdot 0.42\text{V}} \right) - 5.98\text{pF}$$

5) Carry-Increamentor Adder Delay

Open Calculator

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

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

6) Carry-Looker Adder Delay

Open Calculator

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

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

7) Carry-Ripple Adder Critical Path Delay

Open Calculator

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

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

8) Carry-Skip Adder Delay

Open Calculator

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

$$34.3ns = 8.01ns + 2 \cdot (2 - 1) \cdot 2.05ns + (7 - 1) \cdot 3.45ns + 1.49ns$$

9) Cell Capacitance

Open Calculator

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

$$5.976552pF = \frac{12.38pF \cdot 2 \cdot 0.42V}{2.58V - (0.42V \cdot 2)}$$

10) Critical Delay in Gates

Open Calculator

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

$$25.81ns = 8.01ns + (2 + (7 - 2)) \cdot 2.05ns + 3.45ns$$

11) Ground Capacitance

Open Calculator

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

$$2.980392pF = \left(\frac{17.5V \cdot 8pF}{12.75V} \right) - 8pF$$

12) Group Propagation Delay

Open Calculator

fx $$t_{pg} = t_{tree} - (\log 2(f_{abs}) \cdot T_{ao} + T_{xor})$$

ex $$8.000047\text{ns} = 16.3\text{ns} - (\log 2(10\text{Hz}) \cdot 2.05\text{ns} + 1.49\text{ns})$$

13) K-Input 'And' Gate

Open Calculator

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

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

14) Multiplexer Delay

Open Calculator

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

ex $$3.946667\text{ns} = \frac{34.3\text{ns} - (8.01\text{ns} + (2 \cdot (2 - 1) \cdot 2.05\text{ns}) - 1.49\text{ns})}{7 - 1}$$

15) N-Bit Carry-Skip Adder

Open Calculator

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

ex $$14 = 2 \cdot 7$$

16) N-Input 'And' Gate

Open Calculator

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

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

17) Tree Adder Delay

Open Calculator

fx $$t_{tree} = t_{pg} + \log 2(f_{abs}) \cdot T_{ao} + T_{xor}$$

ex $$16.30995ns = 8.01ns + \log 2(10Hz) \cdot 2.05ns + 1.49ns$$

18) Voltage Swing On Bitline

Open Calculator

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

ex $$0.420163V = \left(\frac{2.58V}{2}\right) \cdot \frac{5.98pF}{5.98pF + 12.38pF}$$

19) 'XOR' Delay

Open Calculator

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

ex $$1.49ns = 30ns - (8.01ns + (11 - 1) \cdot 2.05ns)$$

Variables Used

- **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

- Function: **log2**, log2(Number)
  Binary logarithm function (base 2)
- 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

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