Important CMOS Delay Characteristics Formulas PDF

Formulas

Examples

with Units

List of 13
Important CMOS Delay Characteristics Formulas

1) Delay of 1-Bit Propagate Gates Formula

Formula

$$t_{pd} = T_{delay} - \left(\left(N_{gates} - 1 \right) \cdot t_{AO} + t_{XOR} \right)$$

Example with Units

$$70.9\,_{ns} = 300\,_{ns} - \left(\left(10 - 1 \right) \cdot 21.9\,_{ns} + 32\,_{ns} \right)$$

2) Delay of AND-OR Gate in Gray Cell Formula

Formula

$$t_{AO} = \frac{T_{delay} - t_{pd} - t_{XOR}}{N_{gates} - 1}$$

Example with Units

$$21.8889\,_{ns} = \frac{300\,_{ns} - 71\,_{ns} - 32\,_{ns}}{10 - 1}$$

3) Delay Rise Formula

Formula

$$T_d = t_{ir} + \left(R_{rise} \cdot C_d \right) + \left(t_{sr} \cdot t_{prev} \right)$$

Example with Units

$$98.484\,_{ns} = 2.1\,_{ns} + \left(7.68\,_{m\Omega} \cdot 12.55\,_{\mu F} \right) + \left(100\,_{ns} \cdot 5.6\,_{ns} \right)$$

4) Edge Rate Formula

Formula

$$t_e = \frac{t_r + t_f}{2}$$

Example with Units

$$6\,_{ns} = \frac{2.8\,_{ns} + 9.2\,_{ns}}{2}$$

5) Fall Time Formula

Formula

$$t_f = 2 \cdot t_e - t_r$$

Example with Units

$$9.2\,_{ns} = 2 \cdot 6\,_{ns} - 2.8\,_{ns}$$

6) Normalized Delay Formula

Formula

$$d = \frac{t_{pd}}{t_c}$$

Example with Units

$$221.1838 = \frac{71_{ns}}{0.321_{ns}}$$

7) Propagation Delay Formula

Formula

$$t_{pd} = d \cdot t_c$$

Example with Units

$$70.9988_{ns} = 221.18 \cdot 0.321_{ns}$$

8) Propagation Delay in Circuit Formula

Formula

$$t_{ckt} = \frac{t_{pHL} + t_{pLH}}{2}$$

Example with Units

$$8.16_{ns} = \frac{7_{ns} + 9.32_{ns}}{2}$$

9) Propagation Delay without Parasitic Capacitance Formula

Formula

$$t_c = \frac{t_{ckt}}{d}$$

Example with Units

$$0.0369_{ns} = \frac{8.16_{ns}}{221.18}$$

10) Rise Time Formula

Formula

$$t_r = 2 \cdot t_e - t_f$$

Example with Units

$$2.8_{ns} = 2 \cdot 6_{ns} - 9.2_{ns}$$

11) Small Deviation Delay Formula

Formula

$$\Delta T_{out} = K_{vcdl} \cdot \Delta V_{ctrl}$$

Example with Units

$$8 = 4 \cdot 2_v$$

12) VCDL Gain Formula

Formula

$$K_{vcdl} = \frac{\Delta T_{out}}{\Delta V_{ctrl}}$$

Example with Units

$$4 = \frac{8}{2_v}$$

13) Voltage-Controlled Delay Line Formula

Formula

$$\Delta V_{ctrl} = \frac{\Delta T_{out}}{K_{vcdl}}$$

Example with Units

$$2_v = \frac{8}{4}$$

Variables used in list of CMOS Delay Characteristics Formulas above

- C_d Delay Capacitance *(Microfarad)*
- d Normalized Delay
- K_{vcdl} VCDL Gain
- N_{gates} Gates on Critical Path
- R_{rise} Rise Resistance *(Milliohm)*
- t_{AO} Delay of AND OR Gate *(Nanosecond)*
- t_c Propagation Delay Capaitance *(Nanosecond)*
- t_{ckt} Circuit Propagation Delay *(Nanosecond)*
- T_d Delay Rise *(Nanosecond)*
- T_{delay} Critical Path Delay *(Nanosecond)*
- t_e Edge Rate *(Nanosecond)*
- t_f Fall Time *(Nanosecond)*
- t_{ir} Intrinsic Rise Delay *(Nanosecond)*
- t_{pd} Total Propagation Delay *(Nanosecond)*
- t_{pHL} Propagation Delay High to Low *(Nanosecond)*
- t_{pLH} Propagation Delay Low to High *(Nanosecond)*
- t_{prev} Delay Previous *(Nanosecond)*
- t_r Rise Time *(Nanosecond)*
- t_{sr} Slope Rise *(Nanosecond)*
- t_{XOR} XOR Gate Delay *(Nanosecond)*
- ΔT_{out} Small Deviation Delay
- ΔV_{ctrl} Voltage-Controlled Delay Line *(Volt)*

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

- Measurement: **Time** in Nanosecond (ns)
  Time Unit Conversion ↱
- Measurement: **Capacitance** in Microfarad (μF)
  Capacitance Unit Conversion ↱
- Measurement: **Electric Resistance** in Milliohm (mΩ)
  Electric Resistance Unit Conversion ↱
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion ↱

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