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CMOS Time Characteristics Formulas

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List of 17 CMOS Time Characteristics Formulas

CMOS Time Characteristics

1) Acceptable MTBF

Open Calculator

fx $$\mathrm{MTBF} = \frac{1}{\mathrm{P_{fail}}}$$

ex $$2.5 = \frac{1}{0.4}$$

2) Aperture Time for Falling Input

Open Calculator

fx $$\mathrm{t_{af}} = \mathrm{T_{setup0}} + \mathrm{T_{hold1}}$$

ex $$11.65\mathrm{ns} = 3.75\mathrm{ns} + 7.9\mathrm{ns}$$

3) Aperture Time for Rising Input

Open Calculator

fx $$\mathrm{t_{ar}} = \mathrm{T_{setup1}} + \mathrm{T_{hold0}}$$

ex $$14\mathrm{ns} = 5\mathrm{ns} + 9\mathrm{ns}$$

4) Hold Time at High logic

Open Calculator

fx $$\mathrm{T_{hold1}} = \mathrm{t_{af}} - \mathrm{T_{setup0}}$$

ex $$7.9\mathrm{ns} = 11.65\mathrm{ns} - 3.75\mathrm{ns}$$

5) Hold Time at Low logic

Open Calculator

fx $T_{hold0} = t_{ar} - T_{setup1}$

ex $9ns = 14ns - 5ns$

6) Initial Voltage of Node A

Open Calculator

fx $A_0 = V_m + a_0$

ex $18V = 8V + 10V$

7) Metastable Voltage

Open Calculator

fx $V_m = A_0 - a_0$

ex $8V = 18V - 10V$

8) Phase Detector Average Voltage

Open Calculator

fx $K_{pd} = \frac{i_{pd}}{\Phi_{err}}$

ex $3.079987V = \frac{499.93mA}{9.30^\circ}$

9) Probability of Synchronizer Failure

Open Calculator

fx $P_{fail} = \frac{1}{MTBF}$

ex $0.4 = \frac{1}{2.5}$

10) Setup Time at High Logic

Open Calculator

fx $T_{setup1} = t_{ar} - T_{hold0}$

ex $5ns = 14ns - 9ns$

11) Setup Time at Low Logic

Open Calculator

fx $T_{setup0} = t_{af} - T_{hold1}$

ex $3.75ns = 11.65ns - 7.9ns$

12) Small Signal Offset Voltage

Open Calculator

fx $a_0 = A_0 - V_m$

ex $10V = 18V - 8V$

13) XOR Phase Detector Current

Open Calculator

fx $i_{pd} = \Phi_{err} \cdot K_{pd}$

ex $499.9321mA = 9.30^\circ \cdot 3.08V$

14) XOR Phase Detector Phase

Open Calculator

fx $\Phi_{err} = \frac{V_{pd}}{K_{pd}}$

ex $9.301263^\circ = \frac{0.50V}{3.08V}$

15) XOR Phase Detector Phase with reference to Detector Current

Open Calculator

fx $$\Phi_{err} = \frac{i_{pd}}{K_{pd}}$$

ex $$9.299961^\circ = \frac{499.93mA}{3.08V}$$

16) XOR Phase Detector Voltage

Open Calculator

fx $$V_{pd} = \Phi_{err} \cdot K_{pd}$$

ex $$0.499932V = 9.30^\circ \cdot 3.08V$$

17) XOR Voltage NAND Gate

Open Calculator

fx $$V_x = \frac{C_y \cdot V_{bc}}{C_x + C_y}$$

ex $$0.881972V = \frac{3.1mF \cdot 2.02V}{4mF + 3.1mF}$$

Variables Used

- a_0 Small Signal Offset Voltage *(Volt)*
- A_0 Initial Node Voltage *(Volt)*
- C_x Capacitance 1 *(Millifarad)*
- C_y Capacitance 2 *(Millifarad)*
- i_{pd} XOR Phase Detector Current *(Milliampere)*
- K_{pd} XOR Phase Detector Average Voltage *(Volt)*
- **MTBF** Acceptable MTBF
- P_{fail} Probability of Synchronizer Failure
- t_{af} Aperture Time for Falling Input *(Nanosecond)*
- t_{ar} Aperture Time for Rising Input *(Nanosecond)*
- T_{hold0} Hold Time at Low Logic *(Nanosecond)*
- T_{hold1} Hold Time at High Logic *(Nanosecond)*
- T_{setup0} Setup Time at Low Logic *(Nanosecond)*
- T_{setup1} Setup Time at High Logic *(Nanosecond)*
- V_{bc} Base Collector Voltage *(Volt)*
- V_m Metastable Voltage *(Volt)*
- V_{pd} XOR Phase Detector Voltage *(Volt)*
- V_x XOR Voltage Nand Gate *(Volt)*
- Φ_{err} XOR Phase Detector Phase *(Degree)*

Constants, Functions, Measurements used

- Measurement: **Time** in Nanosecond (ns)
  Time Unit Conversion
- Measurement: **Electric Current** in Milliampere (mA)
  Electric Current Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Capacitance** in Millifarad (mF)
  Capacitance Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion

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