Important Embedded System Formulas PDF

Formulas
Examples
with Units

List of 19
Important Embedded System Formulas

1) Performance Metrics Formulas

1.1) Acceleration Execution Time Formula

Evaluate Formula

Formula

$$t_{acc} = t_x + t_{rd} + t_w$$

Example with Units

$$16000\,\text{ms} = 3000\,\text{ms} + 7000\,\text{ms} + 6000\,\text{ms}$$

1.2) Baudrate Formula

Evaluate Formula

Formula

$$r = \frac{\text{Baud}}{T_{sec}}$$

Example with Units

$$10.4\,\text{bits} = \frac{13}{1250\,\text{ms}}$$

1.3) Compilation Formula

Evaluate Formula

Formula

$$C = E_{trnsl} + O$$

Example with Units

$$611 = 600\,\text{J} + 11$$

1.4) CPU Time for Useful Work Formula

Evaluate Formula

Formula

$$t_{use} = T \cdot U$$

Example

$$72 = 9 \cdot 8$$

1.5) CPU Utilization Formula

Evaluate Formula

Formula

$$U = \frac{t_{use}}{T}$$

Example

$$8 = \frac{72}{9}$$

1.6) Cyclomatic Complexity Formula

Evaluate Formula

Formula

$$M = N_{edges} - N_{nodes} + 2 \cdot N$$

Example

$$12 = 4 - 2 + 2 \cdot 5$$

1.7) Dynamic Power Consumption Formula

Evaluate Formula

Formula

$$P_{dyn} = \alpha \cdot C_{sw} \cdot f \cdot V_s^2$$

Example with Units

$$0.0272\,\text{kW} = 0.18 \cdot 1.25\,\text{F} \cdot 16\,\text{Hz} \cdot 2.75\,\text{V}^2$$

1.8) Execution Time Formula

Evaluate Formula

Formula

$$t_x = t_{acc} - \left(t_{rd} + t_w \right)$$

Example with Units

$$3000\,\text{ms} = 16000\,\text{ms} - \left(7000\,\text{ms} + 6000\,\text{ms} \right)$$

1.9) Number of Component in Graph Formula

Evaluate Formula

Formula

$$N = \frac{M - N_{edges} + N_{nodes}}{2}$$

Example

$$5 = \frac{12 - 4 + 2}{2}$$

1.10) Optimization Formula

Evaluate Formula

Formula

$$O = C - E_{trnsl}$$

Example with Units

$$11 = 611 - 600\,\text{J}$$

1.11) Read Time Formula

Evaluate Formula

Formula

$$t_{rd} = t_{acc} - \left(t_x + t_w \right)$$

Example with Units

$$7000\,\text{ms} = 16000\,\text{ms} - \left(3000\,\text{ms} + 6000\,\text{ms} \right)$$

1.12) Response Time Formula

Evaluate Formula

Formula

$$\Delta t_{res} = \Delta t_{spread} \cdot \tau_{thrm} + 2 \cdot \Delta t_{trans}$$

Example with Units

$$4.7072\,\text{ms} = 1.65\,\text{ms} \cdot 4.35\,\text{ms} + 2 \cdot 2.35\,\text{ms}$$

1.13) Total Available CPU Time Formula

Evaluate Formula

Formula

$$T = \frac{t_{use}}{U}$$

Example

$$9 = \frac{72}{8}$$

1.14) Translation Formula

Evaluate Formula

Formula

$$E_{trnsl} = C - O$$

Example with Units

$$600\,\text{J} = 611 - 11$$

1.15) Write Time Formula

Evaluate Formula

Formula

$$t_w = t_{acc} - \left(t_x + t_{rd} \right)$$

Example with Units

$$6000\,\text{ms} = 16000\,\text{ms} - \left(3000\,\text{ms} + 7000\,\text{ms} \right)$$

2) System Design Formulas

2.1) Frequency of PWM Formula

Evaluate Formula

Formula

$$f_{PWM} = \frac{1}{T_{on} + T_{off}}$$

Example with Units

$$0.2105\,\text{Hz} = \frac{1}{3500\,\text{ms} + 1251\,\text{ms}}$$

2.2) Number of Edges in Control Complexity Formula

Evaluate Formula

Formula

$$N_{edges} = M + N_{nodes} - 2 \cdot N$$

Example

$$4 = 12 + 2 - 2 \cdot 5$$

2.3) Performance Time Formula

Evaluate Formula

Formula

$$\Delta t_{pro} = \Delta t_{compute} + \left(2 \cdot \Delta t_{trans}\right)$$

Example with Units

$$11.7\,\text{ms} = 7\,\text{ms} + \left(2 \cdot 2.35\,\text{ms}\right)$$

2.4) Resolution of DAC or ADC Formula

Evaluate Formula

Formula

$$R = \frac{V_{max}}{2^n - 1}$$

Example with Units

$$0.119\,\text{V} = \frac{7.5\,\text{V}}{2^6 - 1}$$

Variables used in list of Embedded System Formulas above

- Δt_{pro} Performance Time *(Millisecond)*
- **Baud** Number of Signal Elements
- **C** Compilation
- C_{sw} Switched Capacitance *(Farad)*
- E_{trnsl} Translational Energy *(Joule)*
- **f** Frequency *(Hertz)*
- f_{PWM} Frequency of PWM *(Hertz)*
- **M** Cyclomatic Complexity
- **n** Bits for Digital Encoding
- **N** Number of Components
- N_{edges} Number of Edges
- N_{nodes} Number of Nodes
- **O** Optimization
- P_{dyn} Dynamic Power Consumption *(Kilowatt)*
- **r** Baud Rate *(Bit)*
- **R** Resolution *(Volt)*
- **T** Total Available CPU Time
- t_{acc} Acceleration Execution Time *(Millisecond)*
- T_{off} OFF Time *(Millisecond)*
- T_{on} ON Time *(Millisecond)*
- t_{rd} Read Time *(Millisecond)*
- T_{sec} Time in Seconds *(Millisecond)*
- t_{use} CPU Useful Time
- t_w Write Time *(Millisecond)*
- t_x Execution Time *(Millisecond)*
- **U** CPU Utilization
- V_{max} Maximum Voltage *(Volt)*
- V_s Supply Voltage *(Volt)*
- **α** Switching Activity Factor
- $\Delta t_{compute}$ Computation Time embedded *(Millisecond)*
- Δt_{res} Response Time *(Millisecond)*

Constants, Functions, Measurements used in list of Embedded System Formulas above

- Measurement: **Time** in Millisecond (ms)
  Time Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Power** in Kilowatt (kW)
  Power Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Data Storage** in Bit (bits)
  Data Storage Unit Conversion
- Measurement: **Capacitance** in Farad (F)
  Capacitance Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion

- Δt_{spread} Time Between Switching Activity *(Millisecond)*
- Δt_{trans} Transmission Time *(Millisecond)*
- τ_{thrm} Thermal Time Constant *(Millisecond)*

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