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# Embedded System Formulas

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# List of 19 Embedded System Formulas

## Embedded System

### Performance Metrics

#### 1) Acceleration Execution Time

$$fx \quad t_{acc} = t_x + t_{rd} + t_w$$

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2\_img.jpg\)](#)

$$ex \quad 16000ms = 3000ms + 7000ms + 6000ms$$

#### 2) Baudrate

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

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa\_img.jpg\)](#)

$$ex \quad 5.6\text{bits} = \frac{7}{1250ms}$$

#### 3) Compilation

$$fx \quad C = E_{trnsl} + O$$

[Open Calculator !\[\]\(f1c5da15572e3e09d343161be98f508d\_img.jpg\)](#)

$$ex \quad 611 = 600J + 11$$

#### 4) CPU Time for Useful Work

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

[Open Calculator !\[\]\(166772600a13ad0a433053f90fe45649\_img.jpg\)](#)

$$ex \quad 72 = 9 \cdot 8$$



5) CPU Utilization 

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

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

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

6) Cyclomatic Complexity 

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

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$\text{ex } 12 = 4 - 2 + 2 \cdot 5$$

7) Dynamic Power Consumption 

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

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$\text{ex } 0.027225\text{kW} = 0.18 \cdot 1.25\text{F} \cdot 16\text{Hz} \cdot (2.75\text{V})^2$$

8) Execution Time 

$$\text{fx } t_x = t_{\text{acc}} - (t_{\text{rd}} + t_w)$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

$$\text{ex } 3000\text{ms} = 16000\text{ms} - (7000\text{ms} + 6000\text{ms})$$

9) Number of Component in Graph 

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

[Open Calculator !\[\]\(aff7c69c44a5e015f18c35867ef3f5c3\_img.jpg\)](#)

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



## 10) Optimization

$$fx \quad O = C - E_{trnsl}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)

$$ex \quad 11 = 611 - 600J$$

## 11) Read Time

$$fx \quad t_{rd} = t_{acc} - (t_x + t_w)$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)

$$ex \quad 7000ms = 16000ms - (3000ms + 6000ms)$$

## 12) Response Time

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

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7\_img.jpg\)](#)

$$ex \quad 4.707178ms = 1.65ms \cdot 4.35ms + 2 \cdot 2.35ms$$

## 13) Total Available CPU Time

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

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b\_img.jpg\)](#)

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

## 14) Translation

$$fx \quad E_{trnsl} = C - O$$

[Open Calculator !\[\]\(40770d9ed6ed4f1222ebf89a1396e8b2\_img.jpg\)](#)

$$ex \quad 600J = 611 - 11$$



15) Write Time 

$$fx \quad t_w = t_{acc} - (t_x + t_{rd})$$

Open Calculator 

$$ex \quad 6000ms = 16000ms - (3000ms + 7000ms)$$

System Design 16) Frequency of PWM 

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

Open Calculator 

$$ex \quad 0.210526Hz = \frac{1}{3500ms + 1250ms}$$

17) Number of Edges in Control Complexity 

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

Open Calculator 

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

18) Performance Time 

$$fx \quad \Delta t_{pro} = \Delta t_{compute} + (2 \cdot \Delta t_{trans})$$

Open Calculator 

$$ex \quad 11.7ms = 7ms + (2 \cdot 2.35ms)$$



## 19) Resolution of DAC or ADC

[Open Calculator !\[\]\(eafc244b53721dd1ec133f0772f70fc7\_img.jpg\)](#)

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

$$\text{ex } 0.5V = \frac{7.5V}{2^4 - 1}$$



## Variables Used

- $\Delta t_{\text{pro}}$  Performance Time (Millisecond)
- **Baud** Number of Signal Elements
- **C** Compilation
- $C_{\text{sw}}$  Switched Capacitance (Farad)
- $E_{\text{trnsI}}$  Translational Energy (Joule)
- **f** Frequency (Hertz)
- $f_{\text{PWM}}$  Frequency of PWM (Hertz)
- **M** Cyclomatic Complexity
- **n** Bits for Digital Encoding
- **N** Number of Components
- $N_{\text{edges}}$  Number of Edges
- $N_{\text{nodes}}$  Number of Nodes
- **O** Optimization
- $P_{\text{dyn}}$  Dynamic Power Consumption (Kilowatt)
- **r** Baud Rate (Bit)
- **R** Resolution (Volt)
- **T** Total Available CPU Time
- $t_{\text{acc}}$  Acceleration Execution Time (Millisecond)
- $T_{\text{off}}$  OFF Time (Millisecond)
- $T_{\text{on}}$  ON Time (Millisecond)
- $t_{\text{rd}}$  Read Time (Millisecond)
- $T_{\text{sec}}$  Time in Seconds (Millisecond)










- $t_{\text{use}}$  CPU Useful Time
- $t_{\text{w}}$  Write Time (Millisecond)
- $t_{\text{x}}$  Execution Time (Millisecond)
- $U$  CPU Utilization
- $V_{\text{max}}$  Maximum Voltage (Volt)
- $V_{\text{s}}$  Supply Voltage (Volt)
- $\alpha$  Switching Activity Factor
- $\Delta t_{\text{compute}}$  Computation Time embedded (Millisecond)
- $\Delta t_{\text{res}}$  Response Time (Millisecond)
- $\Delta t_{\text{spread}}$  Time Between Switching Activity (Millisecond)
- $\Delta t_{\text{trans}}$  Transmission Time (Millisecond)
- $T_{\text{thrm}}$  Thermal Time Constant (Millisecond)






## Constants, Functions, Measurements used

- **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* 



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