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Basic Transistor Devices Formulas

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List of 16 Basic Transistor Devices Formulas

Basic Transistor Devices

BJT

1) BJT Turn OFF Time

$$fx \quad T_{off} = T_s + T_f$$

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

$$ex \quad 3.399s = 1.549s + 1.85s$$

2) BJT Turn ON Time

$$fx \quad T_{on} = T_r + T_d$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

$$ex \quad 2.9s = 1.75s + 1.15s$$

3) Power Loss in BJT

$$fx \quad P_{loss} = E_{loss} \cdot f_{sw}$$

[Open Calculator !\[\]\(f1c5da15572e3e09d343161be98f508d_img.jpg\)](#)

$$ex \quad 187.5W = 0.125J \cdot 1.5kHz$$

4) Reverse Recovery Charge

$$fx \quad Q_{RR} = 0.5 \cdot I_{RR} \cdot t_{rr}$$

[Open Calculator !\[\]\(166772600a13ad0a433053f90fe45649_img.jpg\)](#)

$$ex \quad 0.040075C = 0.5 \cdot 35mA \cdot 2.29s$$



5) Reverse Recovery Current

$$\text{fx } I_{RR} = \sqrt{2 \cdot Q_{RR} \cdot \Delta I}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 35.00857\text{mA} = \sqrt{2 \cdot 0.04\text{C} \cdot 15.32\text{mA}}$$

6) Reverse Recovery Time

$$\text{fx } t_{rr} = \sqrt{2 \cdot \frac{Q_{RR}}{\Delta I}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 2.285155\text{s} = \sqrt{2 \cdot \frac{0.04\text{C}}{15.32\text{mA}}}$$

7) Softness Factor

$$\text{fx } S = \frac{t_b}{t_a}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 0.23511 = \frac{2.25\text{s}}{9.57\text{s}}$$



MOSFET

8) Current Ripple Factor

$$\text{fx } \text{CRF} = \left(\left(\frac{I_{\text{rms}}}{I_o} \right) - 1 \right)^{0.5}$$

[Open Calculator !\[\]\(23d9fc146e83b5c3013cfa32c784f8d5_img.jpg\)](#)

$$\text{ex } 0.894427 = \left(\left(\frac{90\text{mA}}{50\text{mA}} \right) - 1 \right)^{0.5}$$

9) Input Current Distortion Factor

$$\text{fx } \text{CDF} = \frac{I_{s1}}{I_s}$$

[Open Calculator !\[\]\(aa53ad6fea213b8b2226d3077e30533a_img.jpg\)](#)

$$\text{ex } 0.5 = \frac{8\text{mA}}{16\text{mA}}$$

10) Input Current Harmonic Factor

$$\text{fx } \text{CHF} = \sqrt{\left(\frac{1}{\text{CDF}^2} \right) - 1}$$

[Open Calculator !\[\]\(626ce8ac21792b9405bfddfea8e0c96a_img.jpg\)](#)

$$\text{ex } 1.732051 = \sqrt{\left(\frac{1}{(0.5)^2} \right) - 1}$$



11) MOSFET Turn Off Time

$$fx \quad T_{off} = T_{d-off} + T_f$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 3.4s = 1.55s + 1.85s$$

12) MOSFET Turn ON Time

$$fx \quad T_{on} = T_{d-on} + T_r$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 2.899s = 1.149s + 1.75s$$

13) Power Loss in MOSFET

$$fx \quad P_{loss} = I_d^2 \cdot R_{ds}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 187.425W = (105mA)^2 \cdot 17k\Omega$$

14) Rectification Ratio

$$fx \quad \eta = \frac{P_{DC}}{P_{AC}}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 0.625 = \frac{25W}{40W}$$



15) Transistor Aspect Ratio

$$\text{fx } WL = \frac{b_{\text{ch}}}{L_{\text{ch}}}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$\text{ex } 4.744186 = \frac{10.2\mu\text{m}}{2.15\mu\text{m}}$$

16) Voltage Ripple Factor

$$\text{fx } \text{VRF} = \frac{V_r}{V_{\text{DC}}}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$\text{ex } 0.333333 = \frac{5\text{V}}{15\text{V}}$$



Variables Used










- b_{ch} Width of Channel (Micrometer)
- **CDF** Input Current Distortion Factor
- **CHF** Input Current Harmonic Factor
- **CRF** Current Ripple Factor
- E_{loss} Energy Loss (Joule)
- f_{sw} Switching Frequency (Kilohertz)
- I_d Drain Current (Milliampere)
- I_o RMS Current DC Component (Milliampere)
- I_{rms} RMS Current (Milliampere)
- I_{RR} Reverse Recovery Current (Milliampere)
- I_s RMS Supply Current (Milliampere)
- I_{s1} RMS Supply Current Fundamental Component (Milliampere)
- L_{ch} Channel Length (Micrometer)
- P_{AC} AC Input Power (Watt)
- P_{DC} DC Power Output (Watt)
- P_{loss} Average Power Loss (Watt)
- Q_{RR} Reverse Recovery Charge (Coulomb)
- R_{ds} Drain Source Resistance (Kilohm)
- **s** Softness Factor
- t_a Forward Current Decay Time (Second)
- t_b Reverse Current Decay Time (Second)



- T_d Delay Time (Second)
- T_{d-off} MOSFET OFF Delay Time (Second)
- T_{d-on} MOSFET ON Delay Time (Second)
- T_f Fall Time (Second)
- T_{off} Turn OFF Time (Second)
- T_{on} Turn ON Time (Second)
- T_r Rise Time (Second)
- t_{rr} Reverse Recovery Time (Second)
- T_s Storage Time (Second)
- V_{DC} DC Output Voltage (Volt)
- V_r Ripple Voltage (Volt)
- V_{RF} Voltage Ripple Factor
- WL Aspect Ratio
- ΔI Change in Current (Milliampere)
- η Rectification Ratio











Constants, Functions, Measurements used

- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Length** in Micrometer (μm)
Length Unit Conversion 
- **Measurement:** **Time** in Second (s)
Time Unit Conversion 
- **Measurement:** **Electric Current** in Milliampere (mA)
Electric Current Unit Conversion 
- **Measurement:** **Energy** in Joule (J)
Energy Unit Conversion 
- **Measurement:** **Electric Charge** in Coulomb (C)
Electric Charge Unit Conversion 
- **Measurement:** **Power** in Watt (W)
Power Unit Conversion 
- **Measurement:** **Frequency** in Kilohertz (kHz)
Frequency Unit Conversion 
- **Measurement:** **Electric Resistance** in Kilohm ($\text{k}\Omega$)
Electric Resistance Unit Conversion 
- **Measurement:** **Electric Potential** in Volt (V)
Electric Potential Unit Conversion 



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