

Important BJT Differential Amplifiers Formulas PDF



Formulas
Examples
with Units

List of 19 Important BJT Differential Amplifiers Formulas

1) Current and Voltage Formulas

1.1) Base Current of Input Differential BJT Amplifier Formula

Formula

$$i_B = \frac{i_E}{\beta + 1}$$

Example with Units

$$0.2724 \text{ mA} = \frac{13.89 \text{ mA}}{50 + 1}$$

Evaluate Formula 

1.2) Base Current of Input Differential BJT Amplifier given Emitter Resistance Formula

Formula

$$i_B = \frac{V_{id}}{2 \cdot R_E \cdot (\beta + 1)}$$

Example with Units

$$0.2703 \text{ mA} = \frac{7.5 \text{ V}}{2 \cdot 0.272 \text{ k}\Omega \cdot (50 + 1)}$$

Evaluate Formula 

1.3) Collector Current of BJT Differential Amplifier given Emitter Current Formula

Formula

$$i_c = \alpha \cdot i_E$$

Example with Units

$$23.613 \text{ mA} = 1.7 \cdot 13.89 \text{ mA}$$

Evaluate Formula 

1.4) Collector Current of BJT Differential Amplifier given Emitter Resistance Formula

Formula

$$i_c = \frac{\alpha \cdot V_{id}}{2 \cdot R_E}$$

Example with Units

$$23.4375 \text{ mA} = \frac{1.7 \cdot 7.5 \text{ V}}{2 \cdot 0.272 \text{ k}\Omega}$$

Evaluate Formula 

1.5) Emitter Current of BJT Differential Amplifier Formula

Formula

$$i_E = \frac{V_{id}}{2 \cdot R_E + 2 \cdot R_{CE}}$$

Example with Units

$$13.8889 \text{ mA} = \frac{7.5 \text{ V}}{2 \cdot 0.13 \text{ k}\Omega + 2 \cdot 0.14 \text{ k}\Omega}$$

Evaluate Formula 

1.6) First Collector Current of BJT Differential Amplifier Formula

Formula

$$i_{C1} = \frac{\alpha \cdot i}{1 + e^{\frac{-V_{id}}{V_{th}}}}$$

Example with Units

$$934.9792 \text{ mA} = \frac{1.7 \cdot 550 \text{ mA}}{1 + e^{\frac{-7.5 \text{ V}}{0.7 \text{ V}}}}$$

Evaluate Formula 



1.7) First Emitter Current of BJT Differential Amplifier Formula

Formula

$$i_{E1} = \frac{i}{1 + e^{\frac{-V_{id}}{V_{th}}}}$$

Example with Units

$$549.9878 \text{ mA} = \frac{550 \text{ mA}}{1 + e^{\frac{-7.5 \text{ V}}{0.7 \text{ V}}}}$$

Evaluate Formula 

1.8) Input Bias Current of Differential Amplifier Formula

Formula

$$I_{\text{Bias}} = \frac{i}{2 \cdot (\beta + 1)}$$

Example with Units

$$5.3922 \text{ mA} = \frac{550 \text{ mA}}{2 \cdot (50 + 1)}$$

Evaluate Formula 

1.9) Maximum Input Common-Mode Range Voltage of BJT Differential Amplifier Formula

Formula

$$V_{\text{cm}} = V_i + \left(\alpha \cdot 0.5 \cdot i \cdot R_C \right)$$

Example with Units

$$78.3 \text{ V} = 3.5 \text{ V} + \left(1.7 \cdot 0.5 \cdot 550 \text{ mA} \cdot 0.16 \text{ k}\Omega \right)$$

Evaluate Formula 

1.10) Second Collector Current of BJT Differential Amplifier Formula

Formula

$$i_{C2} = \frac{\alpha \cdot i}{1 + e^{\frac{V_{id}}{V_{th}}}}$$

Example with Units

$$0.0208 \text{ mA} = \frac{1.7 \cdot 550 \text{ mA}}{1 + e^{\frac{7.5 \text{ V}}{0.7 \text{ V}}}}$$

Evaluate Formula 

1.11) Second Emitter Current of BJT Differential Amplifier Formula

Formula

$$i_{E2} = \frac{i}{1 + e^{\frac{V_{id}}{V_{th}}}}$$

Example with Units

$$0.0122 \text{ mA} = \frac{550 \text{ mA}}{1 + e^{\frac{7.5 \text{ V}}{0.7 \text{ V}}}}$$

Evaluate Formula 

2) DC Offset Formulas

2.1) Common Mode Gain of BJT Differential Amplifier Formula

Formula

$$A_{\text{cm}} = \frac{V_{\text{od}}}{V_{\text{id}}}$$

Example with Units

$$2.1333 = \frac{16 \text{ V}}{7.5 \text{ V}}$$

Evaluate Formula 



2.2) Common Mode Rejection Ratio of BJT Differential Amplifier in dB Formula

Formula

$$\text{CMRR} = 20 \cdot \log_{10} \left(\text{mod}_{\text{uS}} \left(\frac{A_d}{A_{\text{cm}}} \right) \right)$$

Evaluate Formula 

Example with Units

$$-18.382_{\text{dB}} = 20 \cdot \log_{10} \left(\text{mod}_{\text{uS}} \left(\frac{0.253_{\text{dB}}}{2.1} \right) \right)$$

2.3) Input Offset Current of Differential Amplifier Formula

Formula

$$I_{\text{os}} = \text{mod}_{\text{uS}} (I_{\text{B1}} - I_{\text{B2}})$$

Example with Units

$$5_{\text{mA}} = \text{mod}_{\text{uS}} (15_{\text{mA}} - 10_{\text{mA}})$$

Evaluate Formula 

2.4) Input Offset Voltage of BJT Differential Amplifier Formula

Formula

$$V_{\text{os}} = V_{\text{th}} \cdot \left(\frac{\Delta R_{\text{C}}}{R_{\text{C}}} \right)$$

Example with Units

$$0.0087_{\text{V}} = 0.7_{\text{V}} \cdot \left(\frac{0.002_{\text{k}\Omega}}{0.16_{\text{k}\Omega}} \right)$$

Evaluate Formula 

3) Resistance Formulas

3.1) Differential Input Resistance of BJT Amplifier Formula

Formula

$$R_{\text{id}} = \frac{V_{\text{id}}}{i_{\text{B}}}$$

Example with Units

$$27.7778_{\text{k}\Omega} = \frac{7.5_{\text{V}}}{0.27_{\text{mA}}}$$

Evaluate Formula 

3.2) Differential Input Resistance of BJT Amplifier given Common-Emitter Current Gain Formula

Formula

$$R_{\text{id}} = (\beta + 1) \cdot (2 \cdot R_{\text{E}} + 2 \cdot \Delta R_{\text{C}})$$

Evaluate Formula 

Example with Units

$$27.948_{\text{k}\Omega} = (50 + 1) \cdot (2 \cdot 0.272_{\text{k}\Omega} + 2 \cdot 0.002_{\text{k}\Omega})$$

3.3) Differential Input Resistance of BJT Amplifier given Small-Signal Input Resistance Formula

Formula

$$R_{\text{id}} = 2 \cdot R_{\text{BE}}$$

Example with Units

$$27.76_{\text{k}\Omega} = 2 \cdot 13.88_{\text{k}\Omega}$$

Evaluate Formula 



Formula

$$g_m = \frac{i_c}{V_{th}}$$

Example with Units

$$32.8571\text{ mS} = \frac{23\text{ mA}}{0.7\text{ V}}$$

Evaluate Formula 



Variables used in list of BJT Differential Amplifiers Formulas above

- **A_{cm}** Common Mode Gain
- **A_d** Differential Gain (Decibel)
- **CMRR** Common Mode Rejection Ratio (Decibel)
- **g_m** Transconductance (Millisiemens)
- **i** Current (Milliampere)
- **i_B** Base Current (Milliampere)
- **I_{B1}** Input Bias Current 1 (Milliampere)
- **I_{B2}** Input Bias Current 2 (Milliampere)
- **I_{Bias}** Input Bias Current (Milliampere)
- **i_C** Collector Current (Milliampere)
- **i_{C1}** First Collector Current (Milliampere)
- **i_{C2}** Second Collector Current (Milliampere)
- **i_E** Emitter Current (Milliampere)
- **i_{E1}** First Emitter Current (Milliampere)
- **i_{E2}** Second Emitter Current (Milliampere)
- **I_{os}** Input Offset Current (Milliampere)
- **R_{BE}** Base Emitter Input Resistance (Kilohm)
- **R_C** Collector Resistance (Kilohm)
- **R_{CE}** Collector Emitter Resistance (Kilohm)
- **r_E** Base Emitter Resistance (Kilohm)
- **R_E** Emitter Resistance (Kilohm)
- **R_{id}** Differential Input Resistance (Kilohm)
- **V_{cm}** Maximum Common Mode Range (Volt)
- **V_i** Input Voltage (Volt)
- **V_{id}** Differential Input Voltage (Volt)
- **V_{od}** Differential Output Voltage (Volt)
- **V_{os}** Input Offset Voltage (Volt)
- **V_{th}** Threshold Voltage (Volt)
- **α** Common Base Current Gain
- **β** Common Emitter Current Gain

Constants, Functions, Measurements used in list of BJT Differential Amplifiers Formulas above

- **constant(s):** **e** ,
2.71828182845904523536028747135266249
Napier's constant
- **Functions:** **log10**, log10(Number)
The common logarithm, also known as the base-10 logarithm or the decimal logarithm, is a mathematical function that is the inverse of the exponential function.
- **Functions:** **modulus**, modulus
Modulus of a number is the remainder when that number is divided by another number.
- **Measurement:** **Electric Current** in Milliampere (mA)
Electric Current Unit Conversion 
- **Measurement:** **Noise** in Decibel (dB)
Noise Unit Conversion 
- **Measurement:** **Electric Resistance** in Kilohm (k Ω)
Electric Resistance Unit Conversion 
- **Measurement:** **Electric Conductance** in Millisiemens (mS)
Electric Conductance Unit Conversion 
- **Measurement:** **Electric Potential** in Volt (V)
Electric Potential Unit Conversion 



- ΔR_c Change in Collector Resistance (Kilohm)



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