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Amplifier Characteristics Formulas

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List of 21 Amplifier Characteristics Formulas

Amplifier Characteristics

1) Amplifier Power Efficiency

$$\text{fx } \% \eta_p = 100 \cdot \left(\frac{P_L}{P_{in}} \right)$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$\text{ex } 88.33333 = 100 \cdot \left(\frac{7.95\text{W}}{9\text{W}} \right)$$

2) Base Junction Width of Amplifier

$$\text{fx } w_b = \frac{A_{be} \cdot [\text{Charge-e}] \cdot D_n \cdot n_{po}}{i_{sat}}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 0.008502\text{cm} = \frac{0.12\text{cm}^2 \cdot [\text{Charge-e}] \cdot 0.8\text{cm}^2/\text{s} \cdot 1\text{e}15/\text{cm}^3}{1.809\text{mA}}$$

3) Current Gain of Amplifier

$$\text{fx } A_i = \frac{I_o}{i_{in}}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 1.178832 = \frac{3.23\text{mA}}{2.74\text{mA}}$$



4) Current Gain of Amplifier in Decibels

$$fx \quad A_{i(dB)} = 20 \cdot (\log_{10}(A_i))$$

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

$$ex \quad 1.422906dB = 20 \cdot (\log_{10}(1.178))$$

5) Differential Gain of Instrumentation Amplifier

$$fx \quad A_d = \left(\frac{R_4}{R_3} \right) \cdot \left(1 + \frac{R_2}{R_1} \right)$$

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

$$ex \quad 1.133333 = \left(\frac{7k\Omega}{10.5k\Omega} \right) \cdot \left(1 + \frac{8.75k\Omega}{12.5k\Omega} \right)$$

6) Differential Voltage in Amplifier

$$fx \quad V_{id} = \frac{V_o}{\left(\frac{R_4}{R_3} \right) \cdot \left(1 + \frac{R_2}{R_1} \right)}$$

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

$$ex \quad 12V = \frac{13.6V}{\left(\frac{7k\Omega}{10.5k\Omega} \right) \cdot \left(1 + \frac{8.75k\Omega}{12.5k\Omega} \right)}$$

7) Input Voltage at Maximum Power Dissipation

$$fx \quad V_{in} = \frac{V_m \cdot \pi}{2}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 9.569291V = \frac{6.092V \cdot \pi}{2}$$



8) Input Voltage of Amplifier

[Open Calculator !\[\]\(dfbd6b3763a6d1d9afaa974f64e2e4b5_img.jpg\)](#)

$$fx \quad V_{in} = \left(\frac{R_{in}}{R_{in} + R_{si}} \right) \cdot V_{si}$$

$$ex \quad 9.57265V = \left(\frac{28k\Omega}{28k\Omega + 1.25k\Omega} \right) \cdot 10V$$

9) Load Power of Amplifier

[Open Calculator !\[\]\(ec9132f1d27c8919987d92907322654d_img.jpg\)](#)

$$fx \quad P_L = (V_{cc} \cdot I_{cc}) + (V_{ee} \cdot i_{ee})$$

$$ex \quad 8.056729W = (16.11V \cdot 493.49mA) + (-10.34V \cdot -10.31mA)$$

10) Load Resistance with respect to Transconductance

[Open Calculator !\[\]\(758ebdf4629c903da74c2e079717ae32_img.jpg\)](#)

$$fx \quad R_L = - \left(A_v \cdot \left(\frac{1}{g_m} + R_{se} \right) \right)$$

$$ex \quad 4.312173k\Omega = - \left(-0.352 \cdot \left(\frac{1}{2.04S} + 12.25k\Omega \right) \right)$$

11) Open Circuit Time Constant of Amplifier

[Open Calculator !\[\]\(248b91fcdac4810ffd15cf33fb6aec6f_img.jpg\)](#)

$$fx \quad T_{oc} = \frac{1}{\omega_p}$$

$$ex \quad 1.666667s = \frac{1}{0.6Hz}$$



12) Open-Circuit Transresistance

$$fx \quad r_{oc} = \frac{V_o}{i_{in}}$$

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

$$ex \quad 4.963504k\Omega = \frac{13.6V}{2.74mA}$$

13) Output Voltage for Instrumentation Amplifier

$$fx \quad V_o = \left(\frac{R_4}{R_3} \right) \cdot \left(1 + \frac{R_2}{R_1} \right) \cdot V_{id}$$

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

$$ex \quad 13.6V = \left(\frac{7k\Omega}{10.5k\Omega} \right) \cdot \left(1 + \frac{8.75k\Omega}{12.5k\Omega} \right) \cdot 12V$$

14) Output Voltage Gain given Transconductance

$$fx \quad A_v = - \left(\frac{R_L}{\frac{1}{g_m} + R_{se}} \right)$$

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

$$ex \quad -0.367332 = - \left(\frac{4.5k\Omega}{\frac{1}{2.04S} + 12.25k\Omega} \right)$$

15) Output Voltage of Amplifier

$$fx \quad V_o = G_v \cdot V_{in}$$

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

$$ex \quad 13.59897V = 1.421 \cdot 9.57V$$



16) Peak Voltage at Maximum Power Dissipation

$$\text{fx } V_m = \frac{2 \cdot V_{in}}{\pi}$$

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

$$\text{ex } 6.092451V = \frac{2 \cdot 9.57V}{\pi}$$

17) Power Gain of Amplifier

$$\text{fx } A_p = \frac{P_L}{P_{in}}$$

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

$$\text{ex } 0.883333 = \frac{7.95W}{9W}$$

18) Saturation Current

$$\text{fx } i_{sat} = \frac{A_{be} \cdot [\text{Charge-e}] \cdot D_n \cdot n_{po}}{w_b}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$\text{ex } 1.809517mA = \frac{0.12cm^2 \cdot [\text{Charge-e}] \cdot 0.8cm^2/s \cdot 1e15/cm^3}{0.0085cm}$$

19) Signal Voltage of Amplifier

$$\text{fx } V_{si} = V_{in} \cdot \left(\frac{R_{in} + R_{si}}{R_{in}} \right)$$

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487_img.jpg\)](#)

$$\text{ex } 9.997232V = 9.57V \cdot \left(\frac{28k\Omega + 1.25k\Omega}{28k\Omega} \right)$$



20) Voltage Gain given Load Resistance

[Open Calculator !\[\]\(feabb98897b440bc8695a03336a6e2df_img.jpg\)](#)

$$\text{fx } G_v = \alpha \cdot \left(\frac{\frac{1}{R_L} + \frac{1}{R_c}}{R_e} \right)$$

$$\text{ex } 1.420243 = 0.99 \cdot \left(\frac{\frac{1}{4.5\text{k}\Omega} + \frac{1}{12.209\text{k}\Omega}}{2.292\text{k}\Omega} \right)$$

21) Voltage Gain of Amplifier

[Open Calculator !\[\]\(642aa997563f9a325b310230bb5078b7_img.jpg\)](#)

$$\text{fx } G_v = \frac{V_o}{V_{in}}$$

$$\text{ex } 1.421108 = \frac{13.6\text{V}}{9.57\text{V}}$$



Variables Used











- $\% \eta_p$ Power Efficiency Percentage
- A_{be} Base Emitter Area (Square Centimeter)
- A_d Differential Mode Gain
- A_i Current Gain
- $A_{i(dB)}$ Current Gain in Decibels (Decibel)
- A_p Power Gain
- A_v Output Voltage Gain
- D_n Electron Diffusivity (Square Centimeter Per Second)
- g_m Transconductance (Siemens)
- G_v Voltage Gain
- I_{cc} Positive DC Current (Milliampere)
- i_{ee} Negative DC Current (Milliampere)
- i_{in} Input Current (Milliampere)
- I_o Output Current (Milliampere)
- i_{sat} Saturation Current (Milliampere)
- n_{po} Thermal Equilibrium Concentration (1 per Cubic Centimeter)
- P_{in} Input Power (Watt)
- P_L Load Power (Watt)
- R_1 Resistance 1 (Kilohm)
- R_2 Resistance 2 (Kilohm)





- R_3 Resistance 3 (Kilohm)
- R_4 Resistance 4 (Kilohm)
- R_C Collector Resistance (Kilohm)
- R_e Emitter Resistance (Kilohm)
- R_{in} Input Resistance (Kilohm)
- R_L Load Resistance (Kilohm)
- r_{oc} Open Circuit Transresistance (Kilohm)
- R_{se} Series Resistor (Kilohm)
- R_{si} Signal Resistance (Kilohm)
- T_{oc} Open Circuit Time Constant (Second)
- V_{CC} Positive DC Voltage (Volt)
- V_{EE} Negative DC Voltage (Volt)
- V_{id} Differential Input Signal (Volt)
- V_{in} Input Voltage (Volt)
- V_m Peak Voltage (Volt)
- V_o Output Voltage (Volt)
- V_{si} Signal Voltage (Volt)
- w_b Base Junction Width (Centimeter)
- α Common Base Current Gain
- ω_p Pole Frequency (Hertz)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Constant:** **[Charge-e]**, 1.60217662E-19 Coulomb
Charge of electron
- **Function:** **log10**, log10(Number)
Common logarithm function (base 10)
- **Measurement:** **Length** in Centimeter (cm)
Length Unit Conversion 
- **Measurement:** **Time** in Second (s)
Time Unit Conversion 
- **Measurement:** **Electric Current** in Milliampere (mA)
Electric Current Unit Conversion 
- **Measurement:** **Area** in Square Centimeter (cm²)
Area Unit Conversion 
- **Measurement:** **Power** in Watt (W)
Power Unit Conversion 
- **Measurement:** **Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement:** **Electric Resistance** in Kilohm (kΩ)
Electric Resistance Unit Conversion 
- **Measurement:** **Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
- **Measurement:** **Sound** in Decibel (dB)
Sound Unit Conversion 
- **Measurement:** **Diffusivity** in Square Centimeter Per Second (cm²/s)
Diffusivity Unit Conversion 



- **Measurement: Carrier Concentration** in 1 per Cubic Centimeter ($1/\text{cm}^3$)
Carrier Concentration Unit Conversion 
- **Measurement: Transconductance** in Siemens (S)
Transconductance Unit Conversion 



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- [Amplifier Functions and Network Formulas](#) 
- [BJT Differential Amplifiers Formulas](#) 
- [Feedback Amplifiers Formulas](#) 
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