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# Amplifier Characteristics Formulas

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# List of 21 Amplifier Characteristics Formulas

## Amplifier Characteristics

### 1) Amplifier Power Efficiency

Open Calculator

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

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

### 2) Base Junction Width of Amplifier

Open Calculator

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

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

Open Calculator

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

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

## 4) Current Gain of Amplifier in Decibels

Open Calculator

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

ex $$1.422906\text{dB} = 20 \cdot (\log 10(1.178))$$

## 5) Differential Gain of Instrumentation Amplifier

Open Calculator

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

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

## 6) Differential Voltage in Amplifier

Open Calculator

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

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

## 7) Input Voltage at Maximum Power Dissipation

Open Calculator

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

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

## 8) Input Voltage of Amplifier

Open Calculator

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

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

## 9) Load Power of Amplifier

Open Calculator

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

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

## 10) Load Resistance with respect to Transconductance

Open Calculator

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

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

## 11) Open Circuit Time Constant of Amplifier

Open Calculator

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

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

## 12) Open-Circuit Transresistance

Open Calculator

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

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

## 13) Output Voltage for Instrumentation Amplifier

Open Calculator

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

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

## 14) Output Voltage Gain given Transconductance

Open Calculator

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

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

## 15) Output Voltage of Amplifier

Open Calculator

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

ex $$13.59897\text{V} = 1.421 \cdot 9.57\text{V}$$

## 16) Peak Voltage at Maximum Power Dissipation

Open Calculator

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

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

## 17) Power Gain of Amplifier

Open Calculator

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

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

## 18) Saturation Current

Open Calculator

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

$$1.809517\text{mA} = \frac{0.12\text{cm}^2 \cdot [\text{Charge-e}] \cdot 0.8\text{cm}^2/\text{s} \cdot 1\text{e}15/\text{cm}^3}{0.0085\text{cm}}$$

## 19) Signal Voltage of Amplifier

Open Calculator

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

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

## 20) Voltage Gain given Load Resistance

Open Calculator

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

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

## 21) Voltage Gain of Amplifier

Open Calculator

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

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)*
- $\alpha$ Common Base Current Gain
- $\omega_p$ 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/cm³)
  *Carrier Concentration Unit Conversion*
- Measurement: **Transconductance** in Siemens (S)
  *Transconductance Unit Conversion*

## Check other formula lists

- **Amplifier Characteristics Formulas**
- **Amplifier Functions and Network Formulas**
- **BJT Differential Amplifiers Formulas**
- **Feedback Amplifiers Formulas**
- **Low Frequency Response Amplifiers Formulas**
- **MOSFET Amplifiers Formulas**
- **Operational Amplifiers Formulas**
- **Output Stages and Power Amplifiers Formulas**
- **Signal and IC Amplifiers Formulas**

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