Important Amplifier Characteristics Formulas PDF

Formulas
Examples
with Units

List of 21
Important Amplifier Characteristics Formulas

1) Amplifier Power Efficiency Formula

Evaluate Formula

Formula

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

Example with Units

$$88.3333 = 100 \cdot \left(\frac{7.95\,\text{W}}{9\,\text{W}} \right)$$

2) Base Junction Width of Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0085\,\text{cm} = \frac{0.12\,\text{cm}^2 \cdot 1.6\text{E-}19\,\text{C} \cdot 0.8\,\text{cm}^2/\text{s} \cdot 1\text{e}15\,1/\text{cm}^3}{1.809\,\text{mA}}$$

3) Current Gain of Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

$$1.1788 = \frac{3.23\,\text{mA}}{2.74\,\text{mA}}$$

4) Current Gain of Amplifier in Decibels Formula

Evaluate Formula

Formula

$$A_{i(dB)} = 20 \cdot \left(\log10\left(A_i \right) \right)$$

Example with Units

$$1.4229\,\text{dB} = 20 \cdot \left(\log10\left(1.178 \right) \right)$$

5) Differential Gain of Instrumentation Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

$$1.1333 = \left(\frac{7\,\text{k}\Omega}{10.5\,\text{k}\Omega} \right) \cdot \left(1 + \frac{8.75\,\text{k}\Omega}{12.5\,\text{k}\Omega} \right)$$

6) Differential Voltage in Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

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

7) Input Voltage at Maximum Power Dissipation Formula

Evaluate Formula

Formula

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

Example with Units

$$9.5693\,\text{V} = \frac{6.092\,\text{V} \cdot 3.1416}{2}$$

8) Input Voltage of Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

$$9.5726\,\text{V} = \left(\frac{28\,\text{k}\Omega}{28\,\text{k}\Omega + 1.25\,\text{k}\Omega}\right) \cdot 10\,\text{V}$$

9) Load Power of Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

$$8.0567\,\text{W} = \left(16.11\,\text{V} \cdot 493.49\,\text{mA}\right) + \left(-10.34\,\text{V} \cdot -10.31\,\text{mA}\right)$$

10) Load Resistance with respect to Transconductance Formula

Evaluate Formula

Formula

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

Example with Units

$$4.3122\,\text{k}\Omega = -\left(-0.352 \cdot \left(\frac{1}{2.04\,\text{S}} + 12.25\,\text{k}\Omega\right)\right)$$

11) Open Circuit Time Constant of Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

$$1.6667\,\text{s} = \frac{1}{0.6\,\text{Hz}}$$

12) Open-Circuit Transresistance Formula

Evaluate Formula

Formula

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

Example with Units

$$4.9635\,\text{k}\Omega = \frac{13.6\,\text{V}}{2.74\,\text{mA}}$$

13) Output Voltage for Instrumentation Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

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

14) Output Voltage Gain given Transconductance Formula

Evaluate Formula

Formula

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

Example with Units

$$-0.3673 = -\left(\frac{4.5\,\text{k}\Omega}{\frac{1}{2.04\,\text{S}} + 12.25\,\text{k}\Omega}\right)$$

15) Output Voltage of Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

$$13.599\,\text{V} = 1.421 \cdot 9.57\,\text{V}$$

16) Peak Voltage at Maximum Power Dissipation Formula

Evaluate Formula

Formula

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

Example with Units

$$6.0925\,\text{V} = \frac{2 \cdot 9.57\,\text{V}}{3.1416}$$

17) Power Gain of Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

$$0.8833 = \frac{7.95\,\text{W}}{9\,\text{W}}$$

18) Saturation Current Formula

Evaluate Formula

Formula

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

Example with Units

$$1.8095\,\text{mA} = \frac{0.12\,\text{cm}^2 \cdot 1.6\text{E-}19\,\text{C} \cdot 0.8\,\text{cm}^2/\text{s} \cdot 1\text{e}15\,1/\text{cm}^3}{0.0085\,\text{cm}}$$

19) Signal Voltage of Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

$$9.9972\,\text{V} = 9.57\,\text{V} \cdot \left(\frac{28\,\text{k}\Omega + 1.25\,\text{k}\Omega}{28\,\text{k}\Omega}\right)$$

20) Voltage Gain given Load Resistance Formula

Evaluate Formula

Formula

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

Example with Units

$$1.4202 = 0.99 \cdot \left(\frac{1}{\frac{1}{4.5\,\text{k}\Omega} + \frac{1}{12.209\,\text{k}\Omega}} \right) \Big/ 2.292\,\text{k}\Omega$$

21) Voltage Gain of Amplifier Formula

Evaluate Formula

Formula

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

Example with Units

$$1.4211 = \frac{13.6\,\text{V}}{9.57\,\text{V}}$$

Variables used in list of Amplifier Characteristics Formulas above

- $\%\eta_p$ 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)*

Constants, Functions, Measurements used in list of Amplifier Characteristics Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- constant(s): **[Charge-e]**, 1.60217662E-19 *Charge of electron*
- 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.*
- 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 (cm^2) *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 (cm^2/s) *Diffusivity Unit Conversion*
- Measurement: **Carrier Concentration** in 1 per Cubic Centimeter ($1/cm^3$) *Carrier Concentration Unit Conversion*
- Measurement: **Transconductance** in Siemens (S) *Transconductance Unit Conversion*

- 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)*

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