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Output Stages and Power Amplifiers Formulas

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List of 17 Output Stages and Power Amplifiers Formulas

Output Stages and Power Amplifiers

Class A Output Stage

1) Bias Current of Emitter Follower

Open Calculator

fx $$I_b = \text{modulus}\frac{(-V_{cc}) + V_{CEsat2}}{R_L}$$

ex $$2.232\text{mA} = \text{modulus}\frac{(-7.52\text{V}) + 13.1\text{V}}{2.5\text{k}\Omega}$$

2) Drain Current of Class B Amplifier

Open Calculator

fx $$I_d = 2 \cdot \left(\frac{I_{out}}{\pi}\right)$$

ex $$0.014642\text{mA} = 2 \cdot \left(\frac{0.023\text{mA}}{\pi}\right)$$

3) Instantaneous Power Dissipation of Emitter-Follower

Open Calculator

fx $$P_I = V_{ce} \cdot I_c$$

ex $$13.5\text{mW} = 2\text{V} \cdot 6.75\text{mA}$$

4) Load Power of Output Stage

Open Calculator

$$P_{load} = P_s \cdot \eta_p$$

$$13.552\text{mW} = 24.2\text{mW} \cdot 0.56$$

5) Load Voltage

Open Calculator

$$V_L = V_{in} - V_{be}$$

$$0.25\text{V} = 7.5\text{V} - 7.25\text{V}$$

6) Peak Output Voltage Value at Average Load Power

Open Calculator

$$V\hat{}_o = \sqrt{2 \cdot R_L \cdot P_L}$$

$$9.486833\text{V} = \sqrt{2 \cdot 2.5\text{k}\Omega \cdot 18\text{mW}}$$

7) Power Conversion Efficiency of Class A Output Stage

Open Calculator

$$\eta_{pA} = \frac{1}{4} \cdot \left(\frac{V\hat{}_o^2}{I_b \cdot R_L \cdot V_{cc}} \right)$$

$$0.545515 = \frac{1}{4} \cdot \left(\frac{(9.5\text{V})^2}{2.2\text{mA} \cdot 2.5\text{k}\Omega \cdot 7.52\text{V}} \right)$$

8) Power Output Capability Factor

Open Calculator

fx $$\mathrm{CF} = \frac{\mathrm{P_{max}}}{\mathrm{V_d} \cdot \mathrm{I_{peak}}}$$

ex $$0.915852 = \frac{1300\mathrm{mW}}{15.6\mathrm{V} \cdot 90.99\mathrm{mA}}$$

9) Saturation Voltage between Collector-Emitter at Transistor 1

Open Calculator

fx $$\mathrm{V_{CEsat1}} = \mathrm{V_{cc}} - \mathrm{V_{max}}$$

ex $$4.01\mathrm{V} = 7.52\mathrm{V} - 3.51\mathrm{V}$$

10) Saturation Voltage between Collector-Emitter at Transistor 2

Open Calculator

fx $$\mathrm{V_{CEsat2}} = \mathrm{V_{min}} + \mathrm{V_{cc}}$$

ex $$13.52\mathrm{V} = 6\mathrm{V} + 7.52\mathrm{V}$$

11) Supply Power of Output Stage

Open Calculator

fx $$\mathrm{P_{out}} = 2 \cdot \mathrm{V_{cc}} \cdot \mathrm{I_b}$$

ex $$33.088\mathrm{mW} = 2 \cdot 7.52\mathrm{V} \cdot 2.2\mathrm{mA}$$

Class B Output Stage

12) Efficiency of Class A

Open Calculator

$$\eta = \frac{1}{2} \cdot \left(\frac{V_{out}}{V_{drain}} \right)$$

$$0.857143 = \frac{1}{2} \cdot \left(\frac{1.2V}{0.7V} \right)$$

13) Efficiency of Class B Output Stage

Open Calculator

$$\eta_a = \frac{\pi}{4} \cdot \left(\frac{\hat{V}_o}{V_{cc}} \right)$$

$$0.992192 = \frac{\pi}{4} \cdot \left(\frac{9.5V}{7.52V} \right)$$

14) Load Resistance of Class B Stage

Open Calculator

$$R_{classB} = \frac{2 \cdot \hat{V}_o \cdot V_{cc}}{\pi \cdot P_s}$$

$$1.879344k\Omega = \frac{2 \cdot 9.5V \cdot 7.52V}{\pi \cdot 24.2mW}$$

15) Maximum Average Power from Class B Output Stage

Open Calculator

$$P_{maxB} = \frac{1}{2} \cdot \left(\frac{V_{cc}^2}{R_L} \right)$$

$$11.31008\text{mW} = \frac{1}{2} \cdot \left(\frac{(7.52\text{V})^2}{2.5\text{k}\Omega} \right)$$

16) Maximum Power Dissipation in Class B Stage

Open Calculator

$$P_{Dmax} = \frac{2 \cdot V_{cc}^2}{\pi^2 \cdot R_L}$$

$$4.583803\text{mW} = \frac{2 \cdot (7.52\text{V})^2}{\pi^2 \cdot 2.5\text{k}\Omega}$$

17) Negative Half of Maximum Power Dissipation in Class B Stage

Open Calculator

$$P_{DNmax} = \frac{V_{cc}^2}{\pi^2 \cdot R_L}$$

$$2.291901\text{mW} = \frac{(7.52\text{V})^2}{\pi^2 \cdot 2.5\text{k}\Omega}$$

Variables Used

- **CF** Power Output Capability Factor
- I_b Input Bias Current *(Milliampere)*
- I_c Collector Current *(Milliampere)*
- I_d Drain Current *(Milliampere)*
- I_{out} Output Current *(Milliampere)*
- I_{peak} Peak Drain Current *(Milliampere)*
- P_{Dmax} Maximum Power Dissipation *(Milliwatt)*
- P_{DNmax} Negative Maximum Power Dissipation *(Milliwatt)*
- P_I Instantaneous Power Dissipation *(Milliwatt)*
- P_L Average Load Power *(Milliwatt)*
- P_{load} Load Power of Output Stage *(Milliwatt)*
- P_{max} Maximum Output Power *(Milliwatt)*
- P_{maxB} Maximum Power in Class B *(Milliwatt)*
- P_{out} Supply Power of Output Stage *(Milliwatt)*
- P_s Supply Power *(Milliwatt)*
- R_{classB} Load Resistance of Class B *(Kilohm)*
- R_L Load Resistance *(Kilohm)*
- V_{be} Base Emitter Voltage *(Volt)*
- V_{cc} Supply Voltage *(Volt)*
- V_{ce} Collector to Emitter Voltage *(Volt)*

- V_{CEsat1} Saturation Voltage 1 *(Volt)*
- V_{CEsat2} Saturation Voltage 2 *(Volt)*
- V_d Peak Drain Voltage *(Volt)*
- V_{drain} Drain Voltage *(Volt)*
- V_{in} Input Voltage *(Volt)*
- V_L Load Voltage *(Volt)*
- V_{max} Maximum Voltage *(Volt)*
- V_{min} Minimum Voltage *(Volt)*
- V_{out} Output Voltage *(Volt)*
- $\hat{V}_o$ Peak Amplitude Voltage *(Volt)*
- η Efficiency of Class A
- η_a Efficiency of Class B
- η_p Power Conversion Efficiency
- η_{pA} Power Conversion Efficiency of Class A

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **modulus**, modulus
  Modulus of number
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Electric Current** in Milliampere (mA)
  Electric Current Unit Conversion
- Measurement: **Power** in Milliwatt (mW)
  Power Unit Conversion
- Measurement: **Electric Resistance** in Kilohm (kΩ)
  Electric Resistance Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion

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