Important Multi Stage Amplifiers Formulas PDF

Formulas
Examples
with Units

List of 20
Important Multi Stage Amplifiers Formulas

1) 3-DB Frequency in Design Insight and Trade-Off Formula

Evaluate Formula

Formula

$$f_{3dB} = \frac{1}{2 \cdot \pi \cdot \left(C_t + C_{gd} \right) \cdot \left(\frac{1}{\frac{1}{R_L} + \frac{1}{R_{out}}} \right)}$$

Example with Units

$$50.1549\,\text{Hz} = \frac{1}{2 \cdot 3.1416 \cdot \left(2.889\,\mu\text{F} + 1.345\,\mu\text{F} \right) \cdot \left(\frac{1}{\frac{1}{1.49\,\text{k}\Omega} + \frac{1}{1.508\,\text{k}\Omega}} \right)}$$

2) Amplifier Gain given Function of Complex Frequency Variable Formula

Evaluate Formula

Formula

$$A_m = A_{mid} \cdot K$$

Example with Units

$$12.224\,\text{dB} = 32 \cdot 0.382$$

3) Break Frequency of Source Follower Formula

Evaluate Formula

Formula

$$f_b = \frac{1}{\sqrt{c}}$$

Example with Units

$$104.0313\,\text{Hz} = \frac{1}{\sqrt{0.0000924}}$$

4) Constant 2 of Source Follower Transfer Function Formula

Evaluate Formula

Formula

$$b = \left(\frac{\left(C_{gs} + C_{gd} \right) \cdot C_t + \left(C_{gs} + C_{gs} \right)}{g_m \cdot R_L + 1} \right) \cdot R_{sig} \cdot R_L$$

Example with Units

$$1.1881 = \left(\frac{\left(2.6\,\mu\text{F} + 1.345\,\mu\text{F} \right) \cdot 2.889\,\mu\text{F} + \left(2.6\,\mu\text{F} + 2.6\,\mu\text{F} \right)}{4.8\,\text{mS} \cdot 1.49\,\text{k}\Omega + 1} \right) \cdot 1.25\,\text{k}\Omega \cdot 1.49\,\text{k}\Omega$$

5) Dominant Pole Frequency of Differential Amplifier Formula

Evaluate Formula

Formula

$$f_p = \frac{1}{2 \cdot \pi \cdot C_t \cdot R_{out}}$$

Example with Units

$$36.5318\,\text{Hz} = \frac{1}{2 \cdot 3.1416 \cdot 2.889\,\mu\text{F} \cdot 1.508\,\text{k}\Omega}$$

6) Dominant Pole-Frequency of Source-Follower Formula

Evaluate Formula

Formula

$$f_{dp} = \frac{1}{2 \cdot \pi \cdot b}$$

Example with Units

$$0.1349\,\text{Hz} = \frac{1}{2 \cdot 3.1416 \cdot 1.180}$$

7) Drain Resistance in Cascode Amplifier Formula

Evaluate Formula

Formula

$$R_d = \frac{1}{\frac{1}{R_{in}} + \frac{1}{R_t}}$$

Example with Units

$$0.2971\,\text{k}\Omega = \frac{1}{\frac{1}{0.78\,\text{k}\Omega} + \frac{1}{0.480\,\text{k}\Omega}}$$

8) Frequency of Differential Amplifier given Load Resistance Formula

Evaluate Formula

Formula

$$f_t = \frac{1}{2 \cdot \pi \cdot R_L \cdot C_t}$$

Example with Units

$$36.9731\,\text{Hz} = \frac{1}{2 \cdot 3.1416 \cdot 1.49\,\text{k}\Omega \cdot 2.889\,\mu\text{F}}$$

9) Gain Bandwidth Product Formula

Evaluate Formula

Formula

$$GB = \frac{g_m \cdot R_L}{2 \cdot \pi \cdot R_L \cdot \left(C_t + C_{gd}\right)}$$

Example with Units

$$180.4307\,\text{Hz} = \frac{4.8\,\text{mS} \cdot 1.49\,\text{k}\Omega}{2 \cdot 3.1416 \cdot 1.49\,\text{k}\Omega \cdot \left(2.889\,\mu\text{F} + 1.345\,\mu\text{F}\right)}$$

10) Gain Factor Formula

Evaluate Formula

Formula

$$K = \frac{A_m}{A_{mid}}$$

Example with Units

$$0.3812 = \frac{12.2\,\text{dB}}{32}$$

11) Gate to Source Capacitance of Source Follower Formula

Evaluate Formula

Formula

$$C_{gs} = \frac{g_m}{f_{tr}}$$

Example with Units

$$2.6002\,\mu\text{F} = \frac{4.8\,\text{mS}}{1846\,\text{Hz}}$$

12) Input Resistance of CC CB Amplifier Formula

Evaluate Formula

Formula

$$R_t = (\beta + 1) \cdot (R_e + R'_2)$$

Example with Units

$$0.4807\,\text{k}\Omega = (0.005 + 1) \cdot (0.468\,\text{k}\Omega + 0.0103\,\text{k}\Omega)$$

13) Overall Voltage Gain of CC CB Amplifier Formula

Evaluate Formula

Formula

$$A_v = \frac{1}{2} \cdot \left(\frac{R_t}{R_t + R_{sig}} \right) \cdot R_L \cdot g_m$$

Example with Units

$$0.9922 = \frac{1}{2} \cdot \left(\frac{0.480\,\text{k}\Omega}{0.480\,\text{k}\Omega + 1.25\,\text{k}\Omega} \right) \cdot 1.49\,\text{k}\Omega \cdot 4.8\,\text{mS}$$

14) Power Gain of Amplifier given Voltage Gain and Current Gain Formula

Evaluate Formula

Formula

$$A_p = A_v \cdot A_i$$

Example

$$3.6926 = 0.998 \cdot 3.70$$

15) Short Circuit Transconductance of Differential Amplifier Formula

Evaluate Formula

Formula

$$g_{ms} = \frac{i_{out}}{V_{id}}$$

Example with Units

$$2.0325\,\text{mS} = \frac{5\,\text{mA}}{2.46\,\text{V}}$$

16) Signal Voltage in High Frequency Response of Source and Emitter Follower Formula

Evaluate Formula

Formula

$$V_{out} = (i_t \cdot R_{sig}) + V_{gs} + V_{th}$$

Example with Units

$$28.7802\,\text{V} = (19.105\,\text{mA} \cdot 1.25\,\text{k}\Omega) + 4\,\text{V} + 0.899\,\text{V}$$

17) Total Capacitance of CB-CG Amplifier Formula

Evaluate Formula

Formula

$$C_t = \frac{1}{2 \cdot \pi \cdot R_L \cdot f_{out}}$$

Example with Units

$$12.0832\,\mu\text{F} = \frac{1}{2 \cdot 3.1416 \cdot 1.49\,\text{k}\Omega \cdot 8.84\,\text{Hz}}$$

18) Transconductance of CC-CB Amplifier Formula

Evaluate Formula

Formula

$$g_m = \frac{2 \cdot A_v}{\left(\frac{R_t}{R_t + R_{sig}} \right) \cdot R_L}$$

Example with Units

$$4.8281\,\text{mS} = \frac{2 \cdot 0.998}{\left(\frac{0.480\,\text{k}\Omega}{0.480\,\text{k}\Omega + 1.25\,\text{k}\Omega} \right) \cdot 1.49\,\text{k}\Omega}$$

19) Transconductance of Source-Follower Formula

Evaluate Formula

Formula

$$g_m = f_{tr} \cdot C_{gs}$$

Example with Units

$$4.7996\,\text{mS} = 1846\,\text{Hz} \cdot 2.6\,\mu\text{F}$$

20) Transition Frequency of Source-Follower Transfer Function Formula

Evaluate Formula

Formula

$$f_{tr} = \frac{g_m}{C_{gs}}$$

Example with Units

$$1846.1538\,\text{Hz} = \frac{4.8\,\text{mS}}{2.6\,\mu\text{F}}$$

Variables used in list of Multi Stage Amplifiers Formulas above

- A_i Current Gain
- A_m Amplifier Gain in Mid Band *(Decibel)*
- A_{mid} Mid Band Gain
- A_p Power Gain
- A_v Voltage Gain
- **b** Constant B
- **c** Constant C
- C_{gd} Gate to Drain Capacitance *(Microfarad)*
- C_{gs} Gate to Source Capacitance *(Microfarad)*
- C_t Capacitance *(Microfarad)*
- f_{3dB} 3 dB Frequency *(Hertz)*
- f_b Break Frequency *(Hertz)*
- f_{dp} Frequency of Dominant Pole *(Hertz)*
- f_{out} Output Pole Frequency *(Hertz)*
- f_p Pole Frequency *(Hertz)*
- f_t Frequency *(Hertz)*
- f_{tr} Transition Frequency *(Hertz)*
- g_m Transconductance *(Millisiemens)*
- g_{ms} Short Circuit Transconductance *(Millisiemens)*
- **GB** Gain Bandwidth Product *(Hertz)*
- i_{out} Output Current *(Milliampere)*
- i_t Electric Current *(Milliampere)*
- **K** Gain Factor
- R'_2 Resistance of Secondary Winding in Primary *(Kilohm)*
- R_d Drain Resistance *(Kilohm)*
- R_e Emitter Resistance *(Kilohm)*
- R_{in} Finite Input Resistance *(Kilohm)*
- R_L Load Resistance *(Kilohm)*
- R_{out} Output Resistance *(Kilohm)*

Constants, Functions, Measurements used in list of Multi Stage Amplifiers Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **sqrt**, sqrt(Number) *A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- Measurement: **Electric Current** in Milliampere (mA) *Electric Current Unit Conversion*
- Measurement: **Frequency** in Hertz (Hz) *Frequency Unit Conversion*
- Measurement: **Capacitance** in Microfarad (µF) *Capacitance Unit Conversion*
- Measurement: **Electric Resistance** in Kilohm (kΩ) *Electric Resistance Unit Conversion*
- Measurement: **Electric Conductance** in Millisiemens (mS) *Electric Conductance Unit Conversion*
- Measurement: **Electric Potential** in Volt (V) *Electric Potential Unit Conversion*
- Measurement: **Sound** in Decibel (dB) *Sound Unit Conversion*

- R_{sig} Signal Resistance *(Kilohm)*
- R_t Resistance *(Kilohm)*
- V_{gs} Gate to Source Voltage *(Volt)*
- V_{id} Differential Input Signal *(Volt)*
- V_{out} Output Voltage *(Volt)*
- V_{th} Threshold Voltage *(Volt)*
- β Common Emitter Current Gain

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