MOSFET Amplifiers Formulas

List of 20 MOSFET Amplifiers Formulas

MOSFET Amplifiers

1) Zero Bias Junction Capacitance

Open Calculator

fx $$C_{j0} = \sqrt{\frac{\varepsilon_{si} \cdot [\text{Charge-e}]}{2} \cdot \left(\frac{N_A \cdot N_D}{N_A + N_D}\right) \cdot \frac{1}{\Phi_o}}$$

ex $$6.6E\hat{}\text{-}7F = \sqrt{\frac{11.7F/m \cdot [\text{Charge-e}]}{2} \cdot \left(\frac{1.32\text{electrons/cm}^3 \cdot 3.01\text{electrons/cm}^3}{1.32\text{electrons/cm}^3 + 3.01\text{electrons/cm}^3}\right) \cdot \frac{1}{2V}}$$

2) Zero Bias Sidewall Junction Capacitance

Open Calculator

fx $$C_{j0sw} = \sqrt{\frac{[\text{Permitivity-silicon}] \cdot [\text{Charge-e}]}{2} \cdot \left(\frac{N_{A(sw)} \cdot N_D}{N_{A(sw)} + N_D}\right) \cdot \frac{1}{\Phi_{osw}}}$$

ex $$1E\hat{}\text{-}7F = \sqrt{\frac{[\text{Permitivity-silicon}] \cdot [\text{Charge-e}]}{2} \cdot \left(\frac{0.35\text{electrons/m}^3 \cdot 3.01\text{electrons/cm}^3}{0.35\text{electrons/m}^3 + 3.01\text{electrons/cm}^3}\right) \cdot \frac{1}{0.000032V}}$$

Cascode Configuration

3) Downwards Resistance of Cascode Differential Half Circuit

Open Calculator

fx $$R_{on} = (g_m \cdot R_{02}) \cdot R'_1$$

ex $$1.3195k\Omega = (0.25mS \cdot 0.91k\Omega) \cdot 5.80k\Omega$$

4) Upwards Resistance of Cascode Differential Half-Circuit

Open Calculator

fx $$R_{op} = (g_m \cdot R_{02}) \cdot R_{01}$$

ex $$0.557375k\Omega = (0.25mS \cdot 0.91k\Omega) \cdot 2.45k\Omega$$

5) Voltage Gain of Cascode Differential Amplifier given Transconductance

Open Calculator

fx $$A_v = \frac{V_{od}}{V_{id}}$$

ex $$0.806452 = \frac{25V}{31V}$$

DC Offset

6) Current on Operation with Differential Input Voltage

Open Calculator

fx $$I_t = \frac{1}{2} \cdot (k'_n \cdot WL) \cdot (V_d - V_t)^2$$

ex $$0.62977\text{mA} = \frac{1}{2} \cdot (0.02\text{mS} \cdot 5) \cdot (23.049\text{V} - 19.5\text{V})^2$$

7) Maximum Differential Input Voltage of MOSFET given Overdrive Voltage

Open Calculator

fx $$V_{is} = \sqrt{2} \cdot V_{ov}$$

ex $$3.535534\text{V} = \sqrt{2} \cdot 2.50\text{V}$$

8) Offset Voltage of MOSFET with Current-Mirror Load

Open Calculator

fx $$V_{os} = -\frac{2 \cdot V_t}{\beta_{forced}}$$

ex $$-3.545455\text{V} = -\frac{2 \cdot 19.5\text{V}}{11}$$

9) Output Voltage of Voltage Amplifier

Open Calculator

fx $$V_{out} = V_s - (I_d \cdot R_L)$$

ex $$5.9792\text{V} = 6.6\text{V} - (8\text{mA} \cdot 0.0776\text{k}\Omega)$$

Differential Configuration

10) Differential Voltage Gain in MOS Differential Amplifier

Open Calculator

fx $$A_d = g_m \cdot \left(\frac{1}{\beta \cdot R'_1} + \left(\frac{1}{\frac{1}{\beta \cdot R'_2}} \right) \right)$$

ex $$7.009 = 0.25\text{mS} \cdot \left(\frac{1}{6.52 \cdot 5.80\text{k}\Omega} + \left(\frac{1}{\frac{1}{6.52 \cdot 4.3\text{k}\Omega}} \right) \right)$$

11) Input Offset Voltage of MOS Differential Amplifier

Open Calculator

fx $$V_{os} = \frac{V_o}{A_d}$$

ex $$3.54V = \frac{24.78V}{7}$$

12) Input Offset Voltage of MOS Differential Amplifier given Saturation Current

Open Calculator

fx $$V_{os} = V_t \cdot \left(\frac{I_{sc}}{I_s}\right)$$

ex $$3.561644V = 19.5V \cdot \left(\frac{0.8mA}{4.38mA}\right)$$

13) Input Offset Voltage of MOS Differential Amplifier when Aspect Ratio Mismatches

Open Calculator

fx $$V_{os} = \left(\frac{V_{ov}}{2}\right) \cdot \left(\frac{WL}{WL_1}\right)$$

ex $$3.531073V = \left(\frac{2.50V}{2}\right) \cdot \left(\frac{5}{1.77}\right)$$

14) Input Voltage of MOS Differential Amplifier on Small-Signal Operation

Open Calculator

fx $$V_{in} = V_{cm} + \left(\frac{1}{2} \cdot V_{is}\right)$$

ex $$13.765V = 12V + \left(\frac{1}{2} \cdot 3.53V\right)$$

15) Maximum Input Common-Mode Range of MOS Differential Amplifier

Open Calculator

fx $$V_{cmr} = V_t + V_L - \left(\frac{1}{2} \cdot R_L\right)$$

ex $$3.34V = 19.5V + 22.64V - \left(\frac{1}{2} \cdot 0.0776k\Omega\right)$$

16) Minimum Input Common-Mode Range of MOS Differential Amplifier

Open Calculator

fx $$V_{cmr} = V_t + V_{ov} + V_{gs} - V_L$$

ex $$3.36V = 19.5V + 2.50V + 4V - 22.64V$$

17) Total Input Offset Voltage of MOS Differential Amplifier given Saturation Current

Open Calculator

fx $$V_{os} = \sqrt{\left(\frac{\Delta R_c}{R_c}\right)^2 + \left(\frac{I_{sc}}{I_s}\right)^2}$$

ex $$3.543926\text{V} = \sqrt{\left(\frac{1.805\text{k}\Omega}{0.51\text{k}\Omega}\right)^2 + \left(\frac{0.8\text{mA}}{4.38\text{mA}}\right)^2}$$

18) Transconductance of MOS Differential Amplifier on Small-Signal Operation

Open Calculator

fx $$g_m = \frac{I_t}{V_{ov}}$$

ex $$0.25\text{mS} = \frac{0.625\text{mA}}{2.50\text{V}}$$

Gain

19) Common-Mode Current Gain of Controlled Source Transistor

Open Calculator

fx $$A_{cmi} = -\left(\frac{1}{2 \cdot g_m \cdot R_o}\right)$$

ex $$-1.574803 = -\left(\frac{1}{2 \cdot 0.25\text{mS} \cdot 1.27\text{k}\Omega}\right)$$

20) Common-Mode Gain of Controlled Source Transistor

Open Calculator

fx $$A_{cm} = 20 \cdot \log 10\left(\frac{V_{ss}}{V_{is}}\right)$$

ex $$6.251266\text{dB} = 20 \cdot \log 10\left(\frac{7.25\text{V}}{3.53\text{V}}\right)$$

Variables Used

- A_{cm} Common Mode Gain *(Decibel)*
- A_{cmi} Common-Mode Current Gain
- A_d Differential Gain
- A_v Voltage Gain
- C_{j0} Zero Bias Junction Capacitance *(Farad)*
- C_{j0sw} Zero Bias Sidewall Junction Potential *(Farad)*
- g_m Transconductance *(Millisiemens)*
- I_d Drain Current *(Milliampere)*
- I_s Saturation Current *(Milliampere)*
- I_{sc} Saturation Current for DC *(Milliampere)*
- I_t Total Current *(Milliampere)*
- k'_n Process Transconductance Parameter *(Millisiemens)*
- N_A Doping Concentration of Acceptor *(Electrons per Cubic Centimeter)*
- $N_{A(sw)}$ Sidewall Doping Density *(Electrons per Cubic Meter)*
- N_D Doping Concentration of Donor *(Electrons per Cubic Centimeter)*
- R_{01} Equivalent Resistance from Primary *(Kilohm)*
- R_{02} Equivalent Resistance from Secondary *(Kilohm)*
- R'_1 Resistance of Primary Winding in Secondary *(Kilohm)*
- R'_2 Resistance of Secondary Winding in Primary *(Kilohm)*
- R_c Collector Resistance *(Kilohm)*
- R_L Load Resistance *(Kilohm)*
- R_o Output Resistance *(Kilohm)*
- R_{on} Downwards Resistance of Cascode Differential *(Kilohm)*
- R_{op} Upwards Resistance of Cascode Differential *(Kilohm)*
- V_{cm} Common-Mode DC Voltage *(Volt)*
- V_{cmr} Common-Mode Range *(Volt)*
- V_d Voltage across Diode *(Volt)*
- V_{gs} Voltage between Gate and Source *(Volt)*
- V_{id} Differential Input Voltage *(Volt)*
- V_{in} Input Voltage *(Volt)*
- V_{is} Differential Input Signal *(Volt)*

- **V_L** Load Voltage *(Volt)*
- **V_o** Output DC Offset Voltage *(Volt)*
- **V_{od}** Differential Output Signal *(Volt)*
- **V_{os}** Input Offset Voltage *(Volt)*
- **V_{out}** Output Voltage *(Volt)*
- **V_{ov}** Effective Voltage *(Volt)*
- **V_s** Source Voltage *(Volt)*
- **V_{ss}** Small Signal *(Volt)*
- **V_t** Threshold Voltage *(Volt)*
- **WL** Aspect Ratio
- **WL_1** Aspect Ratio 1
- **β** Common Emitter Current Gain
- **β_{forced}** Forced Common-Emitter Current Gain
- **ΔR_c** Change in Collector Resistance *(Kilohm)*
- **ε_{si}** Permitivity of Silicon *(Farad per Meter)*
- **Φ_o** Built in Junction Potential *(Volt)*
- **Φ_{osw}** Built in Potential of Sidewall Junctions *(Volt)*

Constants, Functions, Measurements used

- Constant: **[Charge-e]**, 1.60217662E-19
  Charge of electron
- Constant: **[Permitivity-silicon]**, 11.7
  Permittivity of silicon
- Function: **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.
- Function: **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: **Noise** in Decibel (dB)
  Noise Unit Conversion
- Measurement: **Capacitance** in Farad (F)
  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: **Permittivity** in Farad per Meter (F/m)
  Permittivity Unit Conversion
- Measurement: **Electron Density** in Electrons per Cubic Centimeter (electrons/cm³), Electrons per Cubic Meter (electrons/m³)
  Electron Density Unit Conversion

Check other formula lists