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MOSFET Characteristics Formulas

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List of 16 MOSFET Characteristics Formulas

MOSFET Characteristics

1) Amplification Factor in Small Signal MOSFET Model

$$fx \quad A_f = g_m \cdot R_{out}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$ex \quad 2.25 = 0.5mS \cdot 4.5k\Omega$$

2) Bias Voltage of MOSFET

$$fx \quad V_{be} = V_{bias} + V_{de}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$ex \quad 8.3V = 5.3V + 3V$$

3) Body Effect on Transconductance

$$fx \quad g_{mb} = X \cdot g_m$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$ex \quad 0.1mS = 0.2 \cdot 0.5mS$$

4) Conductance in Linear Resistance of MOSFET

$$fx \quad G = \frac{1}{R_{ds}}$$

[Open Calculator !\[\]\(83bbbd261710c59db0214aa27b2edc0d_img.jpg\)](#)

$$ex \quad 6.024096mS = \frac{1}{0.166k\Omega}$$



5) Conductance of Channel of MOSFET using Gate to Source Voltage

$$\text{fx } G = \mu_s \cdot C_{\text{ox}} \cdot \frac{W_c}{L} \cdot (V_{\text{gs}} - V_{\text{th}})$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 6.0724\text{mS} = 38\text{m}^2/\text{V}^*s \cdot 940\mu\text{F} \cdot \frac{10\mu\text{m}}{100\mu\text{m}} \cdot (4\text{V} - 2.3\text{V})$$

6) Gate to Source Channel Width of MOSFET

$$\text{fx } W_c = \frac{C_{\text{oc}}}{C_{\text{ox}} \cdot L_{\text{ov}}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 9.957028\mu\text{m} = \frac{3.8\text{e-}7\mu\text{F}}{940\mu\text{F} \cdot 40.6\mu\text{m}}$$

7) Maximum Voltage Gain at Bias Point

$$\text{fx } A_{\text{vm}} = 2 \cdot \frac{V_{\text{dd}} - V_{\text{eff}}}{V_{\text{eff}}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 7.941176 = 2 \cdot \frac{8.45\text{V} - 1.7\text{V}}{1.7\text{V}}$$


8) Maximum Voltage Gain given all Voltages

$$\text{fx } A_{\text{vm}} = \frac{V_{\text{dd}} - 0.3}{V_t}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$\text{ex } 7.990196 = \frac{8.45\text{V} - 0.3}{1.02\text{V}}$$



9) MOSFET Transconductance given Oxide Capacitance 

$$fx \quad g_m = \sqrt{2 \cdot \mu_n \cdot C_{ox} \cdot \left(\frac{W_t}{L_t}\right) \cdot I_d}$$

Open Calculator 

$$ex \quad 2.286578S = \sqrt{2 \cdot 30m^2/V^*s \cdot 3.9F \cdot \left(\frac{5.5\mu m}{3.2\mu m}\right) \cdot 0.013A}$$

10) Saturation Voltage of MOSFET 

$$fx \quad V_{ds(s)} = V_{gs} - V_{th}$$

Open Calculator 

$$ex \quad 1.7V = 4V - 2.3V$$

11) Transconductance in MOSFET 

$$fx \quad g_m = \frac{2 \cdot i_d}{V_{ov}}$$

Open Calculator 

$$ex \quad 0.5mS = \frac{2 \cdot 0.08mA}{0.32V}$$

12) Transition Frequency of MOSFET 

$$fx \quad f_t = \frac{g_m}{2 \cdot \pi \cdot (C_{sg} + C_{gd})}$$

Open Calculator 

$$ex \quad 5.249174Hz = \frac{0.5mS}{2 \cdot \pi \cdot (8.16\mu F + 7\mu F)}$$



13) Threshold Voltage of MOSFET 

$$fx \quad V_{th} = V_{gs} - V_{eff}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 2.3V = 4V - 1.7V$$

14) Voltage Gain given Drain Voltage 

$$fx \quad A_v = \frac{i_d \cdot R_L \cdot 2}{V_{eff}}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 0.026353 = \frac{0.08mA \cdot 0.28k\Omega \cdot 2}{1.7V}$$

15) Voltage Gain given Load Resistance of MOSFET 

$$fx \quad A_v = g_m \cdot \frac{\frac{1}{\frac{1}{R_L} + \frac{1}{R_{out}}}}{1 + g_m \cdot R_s}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 0.026099 = 0.5mS \cdot \frac{\frac{1}{\frac{1}{0.28k\Omega} + \frac{1}{4.5k\Omega}}}{1 + 0.5mS \cdot 8.1k\Omega}$$

16) Voltage Gain using Small Signal 

$$fx \quad A_v = g_m \cdot \frac{1}{\frac{1}{R_L} + \frac{1}{R_{fi}}}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 0.026377 = 0.5mS \cdot \frac{1}{\frac{1}{0.28k\Omega} + \frac{1}{0.065k\Omega}}$$



Variables Used









- A_f Amplification Factor
- A_v Voltage Gain
- A_{vm} Maximum Voltage Gain
- C_{gd} Gate-Drain Capacitance (*Microfarad*)
- C_{oc} Overlap Capacitance (*Microfarad*)
- C_{ox} Oxide Capacitance (*Microfarad*)
- C_{ox} Oxide Capacitance (*Farad*)
- C_{sg} Source Gate Capacitance (*Microfarad*)
- f_t Transition Frequency (*Hertz*)
- G Conductance of Channel (*Millisiemens*)
- g_m Transconductance (*Millisiemens*)
- g_m Transconductance in MOSFET (*Siemens*)
- g_{mb} Body Transconductance (*Millisiemens*)
- i_d Drain Current (*Milliampere*)
- I_d Drain Current (*Ampere*)
- L Channel Length (*Micrometer*)
- L_{ov} Overlap Length (*Micrometer*)
- L_t Transistor's Length (*Micrometer*)
- R_{ds} Linear Resistance (*Kilohm*)
- R_{fi} Finite Resistance (*Kilohm*)
- R_L Load Resistance (*Kilohm*)



- R_{out} Output Resistance (Kilohm)
- R_s Source Resistance (Kilohm)
- V_{be} Total Instantaneous Bias Voltage (Volt)
- V_{bias} DC Bias Voltage (Volt)
- V_{dd} Supply Voltage (Volt)
- V_{de} DC Voltage (Volt)
- $V_{ds(s)}$ Drain and Source Saturation Voltage (Volt)
- V_{eff} Effective Voltage (Volt)
- V_{gs} Gate-Source Voltage (Volt)
- V_{ov} Overdrive Voltage (Volt)
- V_t Thermal Voltage (Volt)
- V_{th} Threshold Voltage (Volt)
- W_c Channel Width (Micrometer)
- W_t Transistor's Width (Micrometer)
- μ_n Electron Mobility (Square Meter per Volt per Second)
- μ_s Mobility of Electrons at Surface of Channel (Square Meter per Volt per Second)
- X Change in Threshold to Base Voltage



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **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:** **Length** in Micrometer (μm)
Length Unit Conversion 
- **Measurement:** **Electric Current** in Ampere (A), Milliampere (mA)
Electric Current Unit Conversion 
- **Measurement:** **Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement:** **Capacitance** in Microfarad (μF), Farad (F)
Capacitance Unit Conversion 
- **Measurement:** **Electric Resistance** in Kilohm ($\text{k}\Omega$)
Electric Resistance Unit Conversion 
- **Measurement:** **Electric Conductance** in Millisiemens (mS), Siemens (S)
Electric Conductance Unit Conversion 
- **Measurement:** **Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
- **Measurement:** **Mobility** in Square Meter per Volt per Second ($\text{m}^2/\text{V}\cdot\text{s}$)
Mobility Unit Conversion 



Check other formula lists

- **MOSFET Characteristics Formulas** 

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