Important Transistor Amplifier Characteristics Formulas PDF

Formulas
Examples
with Units

List of 18
Important Transistor Amplifier Characteristics Formulas

1) Amplifier Input of Transistor Amplifier Formula

Evaluate Formula

Formula

$$V_{ip} = R_{in} \cdot i_{in}$$

Example with Units

$$0.1505\,\text{V} = 0.301\,\text{k}\Omega \cdot 0.5\,\text{mA}$$

2) Current Entering Drain Terminal of MOSFET at Saturation Formula

Evaluate Formula

Formula

$$i_{ds} = \frac{1}{2} \cdot k'_n \cdot \left(\frac{W_c}{L}\right) \cdot \left(V_{ov}\right)^2$$

Example with Units

$$4.7249\,\text{mA} = \frac{1}{2} \cdot 0.2\,\text{A/V}^2 \cdot \left(\frac{10.15\,\mu\text{m}}{3.25\,\mu\text{m}}\right) \cdot \left(0.123\,\text{V}\right)^2$$

3) Current Flowing through Induced Channel in Transistor given Oxide Voltage Formula

Evaluate Formula

Formula

$$i_o = \left(\mu_e \cdot C_{ox} \cdot \left(\frac{W_c}{L}\right) \cdot \left(V_{ox} - V_t\right)\right) \cdot V_{ds}$$

Example with Units

$$14.6347\,\text{mA} = \left(0.012\,\text{m}^2/\text{V*s} \cdot 0.001\,\text{F/m}^2 \cdot \left(\frac{10.15\,\mu\text{m}}{3.25\,\mu\text{m}}\right) \cdot \left(3.775\,\text{V} - 2\,\text{V}\right)\right) \cdot 220\,\text{V}$$

4) DC Current Gain of Amplifier Formula

Evaluate Formula

Formula

$$A_{dc} = \frac{i_c}{i_b}$$

Example with Units

$$2.4313 = \frac{39.52\,\text{mA}}{16.255\,\text{mA}}$$

5) Drain Current of Transistor Formula

Evaluate Formula

Formula

$$i_d = \frac{V_{fc} + V_d}{R_d}$$

Example with Units

$$17.4556\,\text{mA} = \frac{5\,\text{V} + 1.284\,\text{V}}{0.36\,\text{k}\Omega}$$

6) Input Resistance of Common-Collector Amplifier Formula

Evaluate Formula

Formula

$$R_{in} = \frac{V_{fc}}{i_b}$$

Example with Units

$$0.3076\,\text{k}\Omega = \frac{5\,\text{V}}{16.255\,\text{mA}}$$

7) Input Resistance of Common-Gate Circuit Formula

Evaluate Formula

Formula

$$R_{in} = \frac{V_x}{i_x}$$

Example with Units

$$0.3034\,\text{k}\Omega = \frac{27\,\text{V}}{89\,\text{mA}}$$

8) Input Voltage given Signal Voltage Formula

Evaluate Formula

Formula

$$V_{fc} = \left(\frac{R_{fi}}{R_{fi} + R_{sig}}\right) \cdot V_{sig}$$

Example with Units

$$5.0668\,\text{V} = \left(\frac{2.258\,\text{k}\Omega}{2.258\,\text{k}\Omega + 1.12\,\text{k}\Omega}\right) \cdot 7.58\,\text{V}$$

9) Input Voltage in Transistor Formula

Evaluate Formula

Formula

$$V_{fc} = R_d \cdot i_d - V_d$$

Example with Units

$$5.016\,\text{V} = 0.36\,\text{k}\Omega \cdot 17.5\,\text{mA} - 1.284\,\text{V}$$

10) Instantaneous Drain Current using Voltage between Drain and Source Formula

Evaluate Formula

Formula

$$i_d = K_n \cdot \left(V_{ox} - V_t\right) \cdot V_{gs}$$

Example with Units

$$17.4891\,\text{mA} = 2.95\,\text{mA/V}^2 \cdot \left(3.775\,\text{V} - 2\,\text{V}\right) \cdot 3.34\,\text{V}$$

11) Output Resistance of Common Gate Circuit given Test-Voltage Formula

Evaluate Formula

Formula

$$R_{out} = \frac{V_x}{i_x}$$

Example with Units

$$0.3034\,\text{k}\Omega = \frac{27\,\text{V}}{89\,\text{mA}}$$

12) Overall Effective Voltage of MOSFET Transconductance Formula

Evaluate Formula

Formula

$$V_{ov} = \sqrt{2 \cdot \frac{i_{ds}}{k'_n \cdot \left(\frac{W_c}{L}\right)}}$$

Example with Units

$$0.1229\,\text{V} = \sqrt{2 \cdot \frac{4.721\,\text{mA}}{0.2\,\text{A/V}^2 \cdot \left(\frac{10.15\,\mu\text{m}}{3.25\,\mu\text{m}}\right)}}$$

13) Signal Current in Emitter given Input Signal Formula

Evaluate Formula

Formula

$$i_{se} = \frac{V_{fc}}{R_e}$$

Example with Units

$$74.6269\,\text{mA} = \frac{5\,\text{V}}{0.067\,\text{k}\Omega}$$

14) Test Current of Transistor Amplifier Formula

Evaluate Formula

Formula

$$i_x = \frac{V_x}{R_{in}}$$

Example with Units

$$89.701\,\text{mA} = \frac{27\,\text{V}}{0.301\,\text{k}\Omega}$$

15) Total Instantaneous Drain Voltage Formula

Evaluate Formula

Formula

$$V_d = V_{fc} - R_d \cdot i_d$$

Example with Units

$$-1.3\,\text{V} = 5\,\text{V} - 0.36\,\text{k}\Omega \cdot 17.5\,\text{mA}$$

16) Transconductance of Transistor Amplifiers Formula

Evaluate Formula

Formula

$$g_{mp} = \frac{2 \cdot i_d}{V_{ox} - V_t}$$

Example with Units

$$19.7183\,\text{mS} = \frac{2 \cdot 17.5\,\text{mA}}{3.775\,\text{V} - 2\,\text{V}}$$

17) Transconductance Parameter of MOS Transistor Formula

Evaluate Formula

Formula

$$K_n = \frac{i_d}{\left(V_{ox} - V_t\right) \cdot V_{gs}}$$

Example with Units

$$2.9518\,\text{mA/V}^2 = \frac{17.5\,\text{mA}}{\left(3.775\,\text{V} - 2\,\text{V}\right) \cdot 3.34\,\text{V}}$$

18) Transconductance using Collector Current of Transistor Amplifier Formula

Evaluate Formula

Formula

$$g_{mp} = \frac{i_c}{V_t}$$

Example with Units

$$19.76\,\text{mS} = \frac{39.52\,\text{mA}}{2\,\text{V}}$$

Variables used in list of Transistor Amplifier Characteristics Formulas above

- A_{dc} DC Current Gain
- C_{ox} Oxide Capacitance *(Farad per Square Meter)*
- g_{mp} MOSFET Primary Transconductance *(Millisiemens)*
- i_b Base Current *(Milliampere)*
- i_c Collector Current *(Milliampere)*
- i_d Drain Current *(Milliampere)*
- i_{ds} Saturation Drain Current *(Milliampere)*
- i_{in} Input Current *(Milliampere)*
- i_o Output Current *(Milliampere)*
- i_{se} Signal Current in Emitter *(Milliampere)*
- i_x Test Current *(Milliampere)*
- k'_n Process Transconductance Parameter *(Ampere per Square Volt)*
- K_n Transconductance Parameter *(Milliampere per Square Volt)*
- L Length of Channel *(Micrometer)*
- R_d Drain Resistance *(Kilohm)*
- R_e Emitter Resistance *(Kilohm)*
- R_{fi} Finite Input Resistance *(Kilohm)*
- R_{in} Input Resistance *(Kilohm)*
- R_{out} Finite Output Resistance *(Kilohm)*
- R_{sig} Signal Resistance *(Kilohm)*
- V_d Total Instantaneous Drain Voltage *(Volt)*
- V_{ds} Saturation Voltage between Drain and Source *(Volt)*
- V_{fc} Fundamental Component Voltage *(Volt)*
- V_{gs} Voltage between Gate and Source *(Volt)*
- V_{ip} Amplifier Input *(Volt)*
- V_{ov} Effective Voltage *(Volt)*

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

- 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: **Length** in Micrometer (µm)
  Length Unit Conversion
- Measurement: **Electric Current** in Milliampere (mA)
  Electric Current Unit Conversion
- Measurement: **Electric Resistance** in Kilohm (kΩ)
  Electric Resistance Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Mobility** in Square Meter per Volt per Second (m²/V*s)
  Mobility Unit Conversion
- Measurement: **Oxide Capacitance Per Unit Area** in Farad per Square Meter (F/m²)
  Oxide Capacitance Per Unit Area Unit Conversion
- Measurement: **Transconductance** in Millisiemens (mS)
  Transconductance Unit Conversion
- Measurement: **Transconductance Parameter** in Ampere per Square Volt (A/V²), Milliampere per Square Volt (mA/V²)
  Transconductance Parameter Unit Conversion

- V_{ox} Voltage across Oxide *(Volt)*
- V_{sig} Small Signal Voltage *(Volt)*
- V_t Threshold Voltage *(Volt)*
- V_x Test Voltage *(Volt)*
- W_c Width of Channel *(Micrometer)*
- μ_e Mobility of Electron *(Square Meter per Volt per Second)*

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