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Signal and IC Amplifiers Formulas

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List of 17 Signal and IC Amplifiers Formulas

Signal and IC Amplifiers ⟱

IC Amplifiers ⟱

1) Emitter Resistance in Widlar Current Source ⟱

Open Calculator ⟱

$$fx \quad R_e = \left(\frac{V_{th}}{I_o} \right) \cdot \log 10 \left(\frac{I_{ref}}{I_o} \right)$$

$$ex \quad 0.909218 k\Omega = \left(\frac{25V}{5mA} \right) \cdot \log 10 \left(\frac{7.60mA}{5mA} \right)$$

2) Finite Output Resistance of IC Amplifier ⟱

Open Calculator ⟱

$$fx \quad R_{fo} = \frac{\Delta V_o}{\Delta I_o}$$

$$ex \quad 1.456522 k\Omega = \frac{1.34V}{0.92mA}$$

3) Intrinsic Gain of IC Amplifier ⟱

Open Calculator ⟱

$$fx \quad G_i = 2 \cdot \frac{V_e}{V_{ov}}$$

$$ex \quad 96 = 2 \cdot \frac{0.012V/\mu m}{250V}$$

4) Output Current 🔗

Open Calculator 🔗

$$fx \quad I_{out} = I_{ref} \cdot \left(\frac{I_{t2}}{I_{t1}} \right)$$

$$ex \quad 29.36364\text{mA} = 7.60\text{mA} \cdot \left(\frac{4.25\text{mA}}{1.1\text{mA}} \right)$$

5) Output Current of Wilson Current Mirror 🔗

Open Calculator 🔗

$$fx \quad I_o = I_{ref} \cdot \left(\frac{1}{1 + \left(\frac{2}{\beta^2} \right)} \right)$$

$$ex \quad 5.066667\text{mA} = 7.60\text{mA} \cdot \left(\frac{1}{1 + \left(\frac{2}{(2)^2} \right)} \right)$$

6) Output Resistance of Widlar Current Source 🔗

fx

Open Calculator 🔗

$$R_{wcs} = (1 + g_m) \cdot \left(\left(\frac{1}{R_e} \right) + \left(\frac{1}{R_{sbe}} \right) \right) \cdot R_{fo}$$

$$ex \quad 0.002085\text{k}\Omega = (1 + 0.25\text{S}) \cdot \left(\left(\frac{1}{0.909\text{k}\Omega} \right) + \left(\frac{1}{20\text{k}\Omega} \right) \right) \cdot 1.45\text{k}\Omega$$

7) Output Resistance of Wilson Current Mirror C

fx $R_{wcm} = \dfrac{\beta_1 \cdot R_{f3}}{2}$

Open Calculator C

ex $0.020625k\Omega = \dfrac{55 \cdot 0.75\Omega}{2}$

8) Output Resistance of Wilson MOS Mirror C

fx $R_o = (g_{m3} \cdot R_{f3}) \cdot R_{o2}$

Open Calculator C

ex $4.6875\Omega = (0.25S \cdot 0.75\Omega) \cdot 25\Omega$

9) Reference Current of IC Amplifier C

fx $I_{ref} = I_o \cdot \left(\dfrac{WL}{WL_1} \right)$

Open Calculator C

ex $7.5mA = 5mA \cdot \left(\dfrac{15}{10} \right)$

10) Reference Current of Wilson Current Mirror C

fx $I_{ref} = \left(1 + \dfrac{2}{\beta^2} \right) \cdot I_o$

Open Calculator C

ex $7.5mA = \left(1 + \dfrac{2}{(2)^2} \right) \cdot 5mA$

Signal Amplifier 📲

11) Current Transfer Ratio of Mirror with Base Current Compensation 📲

Open Calculator 📲

fx $I_o = I_{ref} \cdot \left(\dfrac{1}{1 + \frac{2}{\beta^2}} \right)$

ex $5.066667\text{mA} = 7.60\text{mA} \cdot \left(\dfrac{1}{1 + \frac{2}{(2)^2}} \right)$

12) Input Resistance in Small-Signal Operation of Current Mirrors 📲

Open Calculator 📲

fx $R_i = \dfrac{1}{g_m}$

ex $4\Omega = \dfrac{1}{0.25\text{S}}$

13) Output Voltage Gain of Active Loaded CE Amplifier 📲

Open Calculator 📲

fx $G_{ov} = -g_m \cdot R_o$

ex $-1.171875 = -0.25\text{S} \cdot 4.6875\Omega$

14) Overall Voltage Gain given Signal Source 🗗

Open Calculator 🗗

$$fx \quad G_{vt} = \frac{V_o}{S_i}$$

$$ex \quad 0.753541 = \frac{13.3V}{17.65V}$$

15) Signal Current 🗗

Open Calculator 🗗

$$fx \quad I_s = I_p \cdot \sin(\omega \cdot T)$$

$$ex \quad 2.616295mA = 3.7mA \cdot \sin(90deg/s \cdot 0.5s)$$

16) Voltage Gain of Amplifier with Current-Source Load 🗗

Open Calculator 🗗

$$fx \quad A_v = -g_m \cdot \left(\frac{1}{R_{f2}} + \frac{1}{R_{o2}} \right)$$

$$ex \quad \text{-}0.02087 = -0.25S \cdot \left(\frac{1}{23\Omega} + \frac{1}{25\Omega} \right)$$

17) Voltage Gain of Small-Signal Operation of Current Mirrors 🗗

Open Calculator 🗗

$$fx \quad G_{is} = \frac{g_{m2} \cdot V_{gs}}{I_{ss}}$$

$$ex \quad 0.047619 = \frac{0.25S \cdot 4V}{21A}$$

Variables Used

- A_v Voltage Gain of Amplifier

- G_i Intrinsic Gain

- G_{is} Short-Circuit Current Gain

- g_m Transconductance *(Siemens)*

- g_{m2} Transconductance 2 *(Siemens)*

- g_{m3} Transconductance 3 *(Siemens)*

- G_{ov} Output Voltage Gain

- G_{vt} Overall Voltage Gain

- I_o Output Current *(Milliampere)*

- I_{out} Output Current given Reference Current *(Milliampere)*

- I_p Current Peak Amplitude *(Milliampere)*

- I_{ref} Reference Current *(Milliampere)*

- I_s Signal Current *(Milliampere)*

- I_{ss} Small Signal Input Current *(Ampere)*

- I_{t1} Current in Transistor 1 *(Milliampere)*

- I_{t2} Current in Transistor 2 *(Milliampere)*

- R_e Emitter Resistance *(Kilohm)*

- R_{f2} Finite Output Resistance 1 *(Ohm)*

- R_{f3} Finite Output Resistance 3 *(Ohm)*

- R_{fo} Finite Output Resistance *(Kilohm)*

- **R_i** Input Resistance *(Ohm)*

- **R_o** Output Resistance *(Ohm)*

- **R_{o2}** Finite Output Resistance 2 *(Ohm)*

- **R_{sbe}** Small-Signal Input Resistance b/w Base-Emitter *(Kilohm)*

- **R_{wcm}** Output Resistance of Wilson Current Mirror *(Kilohm)*

- **R_{wcs}** Output Resistance of Widlar Current Source *(Kilohm)*

- **S_i** Input Signal *(Volt)*

- **T** Time in Seconds *(Second)*

- **V_e** Early Voltage *(Volt Per Micrometer)*

- **V_{gs}** Voltage across Gate and Source *(Volt)*

- **V_o** Output Voltage *(Volt)*

- **V_{ov}** Overdrive Voltage *(Volt)*

- **V_{th}** Threshold Voltage *(Volt)*

- **WL** Aspect Ratio

- **WL_1** Aspect Ratio 1

- **β** Transistor Current Gain

- **$β_1$** Transistor Current Gain 1

- **$ΔI_o$** Change in Current *(Milliampere)*

- **$ΔV_o$** Change in Output Voltage *(Volt)*

- **ω** Angular Frequency of Wave *(Degree per Second)*

Constants, Functions, Measurements used

- Function: **log10**, log10(Number)
  Common logarithm function (base 10)

- Function: **sin**, sin(Angle)
  Trigonometric sine function

- Measurement: **Time** in Second (s)
  Time Unit Conversion 🔗

- Measurement: **Electric Current** in Milliampere (mA), Ampere (A)
  Electric Current Unit Conversion 🔗

- Measurement: **Electric Resistance** in Kilohm (kΩ), Ohm (Ω)
  Electric Resistance Unit Conversion 🔗

- Measurement: **Electric Conductance** in Siemens (S)
  Electric Conductance Unit Conversion 🔗

- Measurement: **Electric Field Strength** in Volt Per Micrometer (V/µm)
  Electric Field Strength Unit Conversion 🔗

- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion 🔗

- Measurement: **Angular Frequency** in Degree per Second (deg/s)
  Angular Frequency Unit Conversion 🔗

Check other formula lists

- **Amplifier Characteristics Formulas** ⬀
- **Amplifier Functions and Network Formulas** ⬀
- **BJT Differential Amplifiers Formulas** ⬀
- **Feedback Amplifiers Formulas** ⬀
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