Important Operational Amplifiers Formulas PDF

Formulas
Examples
with Units

List of 18
Important Operational Amplifiers Formulas

1) Integrator & Difference Formulas

1.1) Common Mode Gain of Difference Amplifiers Formula

Evaluate Formula

Formula

$$A_{cm} = \left(\frac{R_4}{R_4 + R_3}\right) \cdot \left(1 - \left(\frac{R_2 \cdot R_3}{R_1 \cdot R_4}\right)\right)$$

Example with Units

$$0.1977 = \left(\frac{10.35\,\text{k}\Omega}{10.35\,\text{k}\Omega + 9.25\,\text{k}\Omega}\right) \cdot \left(1 - \left(\frac{8.75\,\text{k}\Omega \cdot 9.25\,\text{k}\Omega}{12.5\,\text{k}\Omega \cdot 10.35\,\text{k}\Omega}\right)\right)$$

1.2) Common Mode Rejection Ratio of Difference Amplifiers Formula

Evaluate Formula

Formula

$$CMRR = 20 \cdot \log10\left(\frac{A_d}{A_{cm}}\right)$$

Example with Units

$$10.9818\,\text{dB} = 20 \cdot \log10\left(\frac{0.7}{0.1977}\right)$$

1.3) Differential Gain of Difference Amplifier Formula

Evaluate Formula

Formula

$$A_d = \frac{R_2}{R_1}$$

Example with Units

$$0.7 = \frac{8.75\,\text{k}\Omega}{12.5\,\text{k}\Omega}$$

1.4) Gain of Feedback Operational Amplifier Formula

Evaluate Formula

Formula

$$A = \frac{1}{\beta}$$

Example

$$2.5 = \frac{1}{0.4}$$

1.5) Integrator Frequency Formula

Evaluate Formula

Formula

$$\omega_{in} = \frac{1}{R \cdot C}$$

Example with Units

$$2.2409\,\text{Hz} = \frac{1}{12.75\,\text{k}\Omega \cdot 35\,\mu\text{F}}$$

1.6) Output Voltage 1 of Difference Amplifier Formula

Evaluate Formula

Formula

$$V_1 = -\left(\frac{R_2}{R_1}\right) \cdot V_n$$

Example with Units

$$2.625\,\text{V} = -\left(\frac{8.75\,\text{k}\Omega}{12.5\,\text{k}\Omega}\right) \cdot -3.75\,\text{V}$$

1.7) Output Voltage 2 of Difference Amplifier Formula

Evaluate Formula

Formula

$$V_2 = \left(\frac{R_2}{R_1}\right) \cdot V_p$$

Example with Units

$$6.825\,\text{V} = \left(\frac{8.75\,\text{k}\Omega}{12.5\,\text{k}\Omega}\right) \cdot 9.75\,\text{V}$$

1.8) Output Voltage of Difference Amplifier Formula

Evaluate Formula

Formula

$$V_o = \left(\frac{R_2}{R_1}\right) \cdot \left(V_p - \left(V_n\right)\right)$$

Example with Units

$$9.45\,\text{V} = \left(\frac{8.75\,\text{k}\Omega}{12.5\,\text{k}\Omega}\right) \cdot \left(9.75\,\text{V} - \left(-3.75\,\text{V}\right)\right)$$

2) Inverting & Non-Inverting Formulas

2.1) Closed Loop Gain of Non Inverting Amplifier Circuit Formula

Evaluate Formula

Formula

$$A_c = 1 + \left(\frac{R_f}{R}\right)$$

Example with Units

$$1.1569 = 1 + \left(\frac{2\,\text{k}\Omega}{12.75\,\text{k}\Omega}\right)$$

2.2) Closed Loop Gain of Operational Amplifier Formula

Evaluate Formula

Formula

$$A_c = \frac{V_o}{V_i}$$

Example with Units

$$1.89 = \frac{9.45\,\text{V}}{5\,\text{V}}$$

2.3) Common Mode Input Signal of Operational Amplifier Formula

Evaluate Formula

Formula

$$V_{icm} = \frac{1}{2} \cdot \left(V_n + V_p\right)$$

Example with Units

$$3\,\text{V} = \frac{1}{2} \cdot \left(-3.75\,\text{V} + 9.75\,\text{V}\right)$$

2.4) Current in Finite Open-Loop Gain in Operational Amplifier Formula

Evaluate Formula

Formula

$$i = \frac{V_i + \frac{V_o}{A}}{R}$$

Example with Units

$$0.6886\,\text{mA} = \frac{5\,\text{V} + \frac{9.45\,\text{V}}{2.5}}{12.75\,\text{k}\Omega}$$

2.5) Differential Input Signal Formula

Evaluate Formula

Formula

$$V_{id} = V_p - \left(V_n \right)$$

Example with Units

$$13.5\,\text{V} = 9.75\,\text{V} - \left(-3.75\,\text{V} \right)$$

2.6) Integrator Frequency of Inverting Amplifier Formula

Evaluate Formula

Formula

$$\omega_{in} = \frac{1}{C \cdot R}$$

Example with Units

$$2.2409\,\text{Hz} = \frac{1}{35\,\mu\text{F} \cdot 12.75\,\text{k}\Omega}$$

2.7) Magnitude of Integrator Transfer Function Formula

Evaluate Formula

Formula

$$V_{oi} = \frac{1}{\omega \cdot C \cdot R}$$

Example with Units

$$0.2085\,\text{dB} = \frac{1}{10.75\,\text{rad/s} \cdot 35\,\mu\text{F} \cdot 12.75\,\text{k}\Omega}$$

2.8) Output Voltage of Finite Open-Loop Gain of Operational Amplifier Formula

Evaluate Formula

Formula

$$V_o = \left(i \cdot R - V_i \right) \cdot A$$

Example with Units

$$9.43\,\text{V} = \left(0.688\,\text{mA} \cdot 12.75\,\text{k}\Omega - 5\,\text{V} \right) \cdot 2.5$$

2.9) Output Voltage of Non Inverting Configuration Formula

Evaluate Formula

Formula

$$V_o = V_i + \left(\frac{V_i}{R_1} \right) \cdot R_2$$

Example with Units

$$8.5\,\text{V} = 5\,\text{V} + \left(\frac{5\,\text{V}}{12.5\,\text{k}\Omega} \right) \cdot 8.75\,\text{k}\Omega$$

2.10) Percentage Gain Error of Non Inverting Amplifier Formula

Evaluate Formula

Formula

$$E_{\%} = -\left(\frac{1 + \left(\frac{R'_2}{R'_1} \right)}{A_v + 1 + \left(\frac{R'_2}{R'_1} \right)} \right) \cdot 100$$

Example with Units

$$-22.4944 = -\left(\frac{1 + \left(\frac{4.3\,\text{k}\Omega}{5.80\,\text{k}\Omega} \right)}{6 + 1 + \left(\frac{4.3\,\text{k}\Omega}{5.80\,\text{k}\Omega} \right)} \right) \cdot 100$$

Variables used in list of Operational Amplifiers Formulas above

- **A** Open Loop Gain
- A_c Closed Loop Gain
- A_{cm} Common Mode Gain
- A_d Differential Mode Gain
- A_v Voltage Gain
- **C** Capacitance *(Microfarad)*
- **CMRR** CMRR *(Decibel)*
- $E_{\%}$ Percentage Gain Error
- **i** Current *(Milliampere)*
- **R** Resistance *(Kilohm)*
- R_1 Resistance 1 *(Kilohm)*
- R'_1 Resistance of Primary Winding in Secondary *(Kilohm)*
- R_2 Resistance 2 *(Kilohm)*
- R'_2 Resistance of Secondary Winding in Primary *(Kilohm)*
- R_3 Resistance 3 *(Kilohm)*
- R_4 Resistance 4 *(Kilohm)*
- R_f Feedback Resistance *(Kilohm)*
- V_1 Output Voltage 1 *(Volt)*
- V_2 Output Voltage 2 *(Volt)*
- V_i Input Voltage *(Volt)*
- V_{icm} Common Mode Input *(Volt)*
- V_{id} Differential Input Signal *(Volt)*
- V_n Negative Terminal Voltage *(Volt)*
- V_o Output Voltage *(Volt)*
- V_{oi} Magnitude of Opamp Transfer Function *(Decibel)*
- V_p Positive Terminal Voltage *(Volt)*
- **β** Feedback Factor
- **ω** Angular Frequency *(Radian per Second)*
- ω_{in} Integrator Frequency *(Hertz)*

Constants, Functions, Measurements used in list of Operational Amplifiers Formulas above

- Functions: **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.
- Measurement: **Electric Current** in Milliampere (mA)
  Electric Current Unit Conversion
- Measurement: **Noise** in Decibel (dB)
  Noise 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 Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Angular Frequency** in Radian per Second (rad/s)
  Angular Frequency Unit Conversion

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