Op-Amp Amplifier Gain: Inverting, Non-Inverting and Difference

Closed-loop gain, output voltage, input resistance and bandwidth of an ideal op-amp amplifier in the inverting, non-inverting or difference configuration.

Method: Ideal op-amp feedback amplifier relations

Input parameters

Unit system: SI

Parameter	Value	Unit
Configuration	Non-inverting	
Input (or ground) resistor R_1	10.000	kΩ
Feedback resistor R_2	47.000	kΩ
Input voltage (difference: $V_+ - V_-$)	0.25000	V
Op-amp gain–bandwidth product	1,000.0	kHz
Output swing limit (± supply less headroom)	13.500	V

Calculated results

Parameter	Value	Unit
Closed-loop voltage gain	5.7000	
Gain in decibels 20 log|A_v|	15.117	
Output voltage (clipped at the swing limit)	1.4250	V
Input resistance (ideal op-amp)	1.0000e+12	kΩ
Closed-loop bandwidth GBW/noise gain	175.44	kHz
Noise gain	5.7000	

Notes for this case

- Ideal op-amp: infinite open-loop gain and input resistance. Bandwidth from the gain–bandwidth product divided by the noise gain 1 + R_2/R_1 (single-pole op-amp).
- Non-inverting input resistance is that of the op-amp input itself (very high; shown as 10^{15} Ω).

Formula and method

$$\text{inverting}: \; A_v = -\frac{R_2}{R_1}, \quad \text{non}-\text{inverting}: \; A_v = 1 + \frac{R_2}{R_1}, \quad \text{difference}: \; A_v = \frac{R_2}{R_1}$$

$$f_{-3dB} = \frac{GBW}{1 + R_2/R_1}$$

Variables

configuration	Configuration	-
R_1	Input (or ground) resistor R_1	Ω
R_2	Feedback resistor R_2	Ω
V_{in}	Input voltage (difference: $V_+ - V_-$)	V
GBW	Op-amp gain–bandwidth product	1/s
V_{sat}	Output swing limit (± supply less headroom)	V
A_v	Closed-loop voltage gain	-

A_{dB}	Gain in decibels 20 log	A_v
V_{out}	Output voltage (clipped at the swing limit)	V
R_{in}	Input resistance (ideal op-amp)	Ω
f_{-3dB}	Closed-loop bandwidth GBW/noise gain	1/s
$1 + R_2/R_1$	Noise gain	-

Method and standards

Negative-feedback amplifier relations.

Assumptions and limits

- Ideal op-amp, single-pole frequency response, resistive feedback.

References

Ideal op-amp feedback amplifier relations

Report details

Report reference	FCC-4DRV-3BP0 (the same inputs always give the same reference)
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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/electronics/op-amp-gain

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Reopens the calculator with the inputs of this report.