PDHonline Course E278 (3 PDH)

Operational Amplifiers at Higher Frequencies

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Fundamentals Review and Glossary of Terms

A_{VOL} – Open-Loop Voltage Gain (amplification), specified by the Op Amp manufacturer. See the equation and Figure X1 below. Ideally, $A_{VOL} = \infty$

$$A_{VOL} = \frac{V_o}{V_{id}}$$

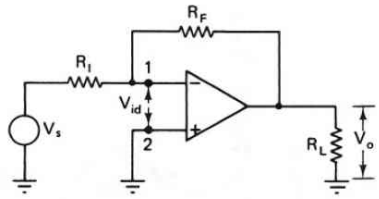

Figure X1 The Inverting Amplifier

A_V – Closed-Loop Voltage Gain (amplification). For the Inverting Amplifier, see the equation and Figure X1 above:

$$A_v = \frac{V_o}{V_s} \cong -\frac{R_F I}{R_1 I} \cong -\frac{R_F}{R_1}.$$

The negative sign means that V_o is out-of-phase with V_S.

For the Noninverting Amplifier, use equation

$$A_v = \frac{V_o}{V_s} \cong \frac{(R_F + R_1)I}{R_1 I} = \frac{R_F + R_1}{R_1} = \frac{R_F}{R_1} + 1.$$

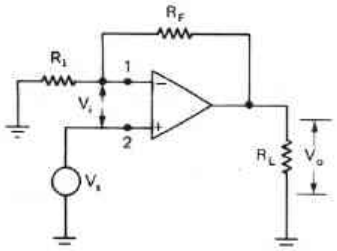

Figure X2 The Noninverting Amplifier

Bandwidth (BW) - The frequency range in which the Op Amp's gain does not drop by more than 0.707 or 3 dB of its dc value.

Buffering - Use of an isolating amplifier that prevents variation in load resistance from affecting the source of signal driving it.

Channel Separation - The ratio of the output signal voltage of a driven amplifier to the output signal voltage of an adjacent undriven amplifier on the same chip; usually expressed in decibels.

Chip - A small piece of semiconductor (monolith) in or on which an integrated circuit is built.

CMR (dB) - See Common-Mode Rejection Ratio.

Common-Mode Rejection Ratio (CMRR) - The ratio of the closed-loop gain A_v to the common-mode gain A_{cm}.. Called CMR (dB) when expressed in decibels. It's a manufacturer's specified parameter. Ideally CMRR = ∞.

$$\text{CMRR} = \frac{A_v}{A_{cm}}.$$

Common-Mode Input Voltage *(V_{cm})* - Input voltage, usually noise, that appears at both inputs of a differential or operational amplifier, simultaneously.

Common-Mode Output Voltage *(V_{cmo})* - The output voltage resulting from a voltage applied to both inputs simultaneously.

Common-Mode Gain *(A_{cm})* - The ratio of common-mode output voltage V_{cmo} to the common-mode input voltage V_{cm} of a differential or operational amplifier.

$$A_{cm} = \frac{V_{cmo}}{V_{cm}}.$$

Compensated - Term used to describe Op Amps that are internally compensated and have no provisions for nor require external compensation; also called internally compensated.

Drift - Changes in component or circuit *parameters* caused by changes in temperature, supply voltage, or time.

Effective Input Resistance *($R_{i(\text{eff})}$)* - Small-signal ac input resistance seen looking into the appropriate input with the other input grounded or common under closed-loop conditions. See Input Resistance R_i.

$$R_{i(\text{eff})} \cong \frac{1}{A_v/A_{VOL}R_i} = \left(\frac{A_{VOL}}{A_v}\right)R_i.$$

Effective Output Resistance ($R_{o(eff)}$) - Small-signal ac output resistance looking back into the output of an Op Amp under closed-loop conditions. See Output Resistance R_o.

$$R_{o(\text{eff})} \cong \left(\frac{A_v}{A_{VOL}}\right)R_o.$$

Gain-Bandwidth Product (A_vBW) - The product of a compensated Op Amp's closed-loop gain and its bandwidth with that gain.

Input Bias Current *(I_B)* - The average of the two dc input bias currents measured while both inputs are grounded. It's a manufacturer's specified parameter.

Input Offset Current *(I_{io})* - The difference in the two dc input bias currents measured while both inputs are grounded. It's a manufacturer's specified parameter.

Input Offset Voltage *(V_{io})* - The voltage that must be applied across the inputs to force the output to zero volts under open-loop conditions. It's a manufacturer's specified parameter.

Input Resistance *(R_i)* - Small-signal ac input resistance seen looking into the appropriate input with the other input grounded or common under open loop conditions. It's a manufacturer's specified parameter. Ideally, $R_i = \infty$

Output Resistance *(R_o)* - Small-signal ac output resistance looking back into the output of an Op Amp under open-loop conditions. Also see Closed-Loop output resistance. It's a manufacturer's specified parameter. Ideally $R_o = 0$.

Slew Rate (SR) - The minimum rate of change of the output voltage under large-signal conditions; usually listed in volts per microsecond.

Uncompensated - Op Amps that are not internally compensated, often referred to as having a tailored response. They require external compensating components; resistors and/or capacitors.

Unity Gain Bandwidth - Bandwidth when the Op Amp is wired to have a closed-loop gain of 1.