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LINEAR INTEGRATED CIRCUITS

PART-08

Op-Amp Characteristics & Performance Parameters

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Outline

1. Input Offset Voltage
2. Input Offset Current
3. Input Bias Current
4. Differential Input Resistance
5. Common Mode Rejection Ratio
6. Supply Voltage Rejection Ratio
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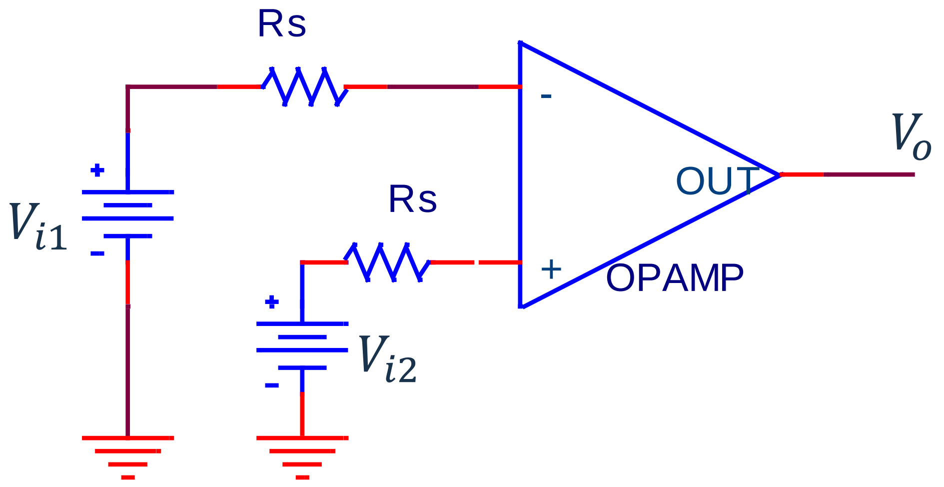
1. Input Offset Voltage

This is input voltage required to be applied at input terminals to get zero output voltage. Mathematically,

$$V_{io} = V_{i2} - V_{i1}$$

Typical V_{io} ranges in 100μV-10mV.

Smaller the V_{io} better is the Op-Amp IC

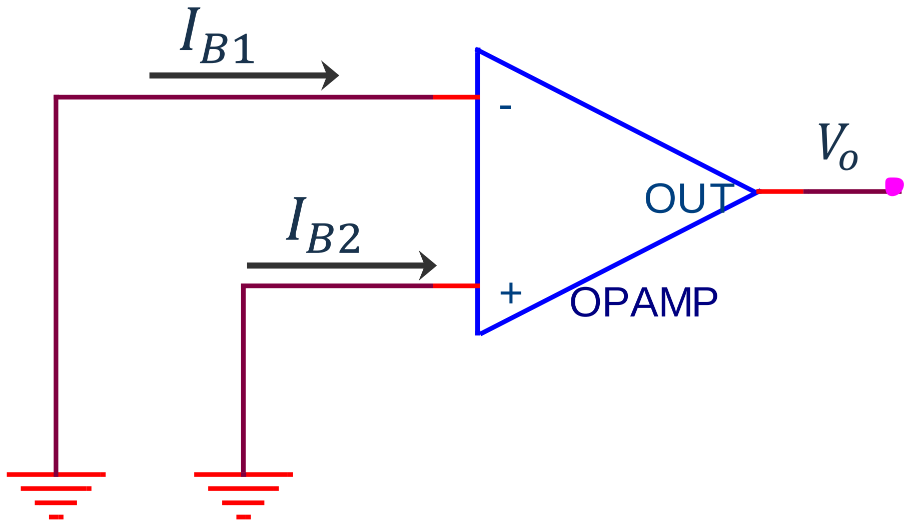


2. Input Offset Current

Input Offset Current is the algebraic difference between the input currents entering into inverting and non-inverting input terminals to make output voltage zero.

$$I_{io} = |I_{B1} - I_{B2}|$$

Typical I_{io} value is 5nA.

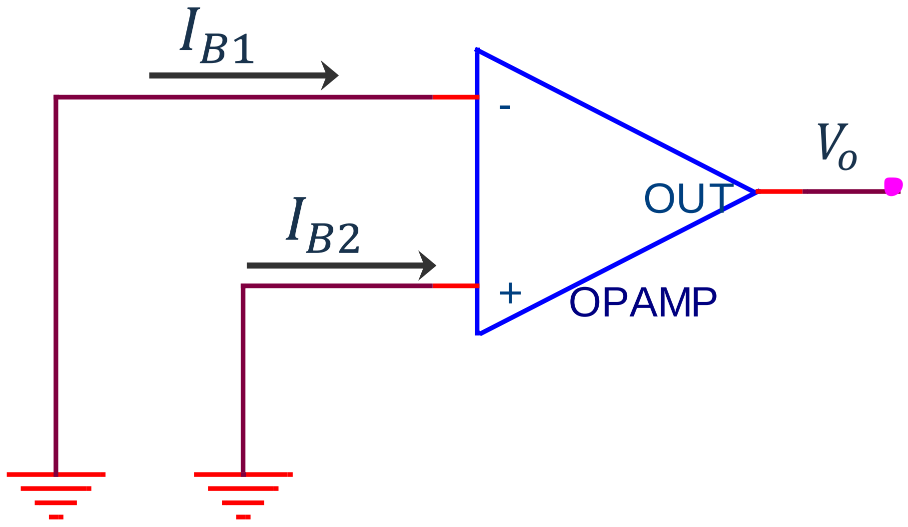


3. Input Bias Current

The average of the input currents that flows into inverting and non-inverting input terminals is called Input Bias Current

$$I_B = \frac{I_{B1} + I_{B2}}{2}$$

The maximum I_B =500nA.

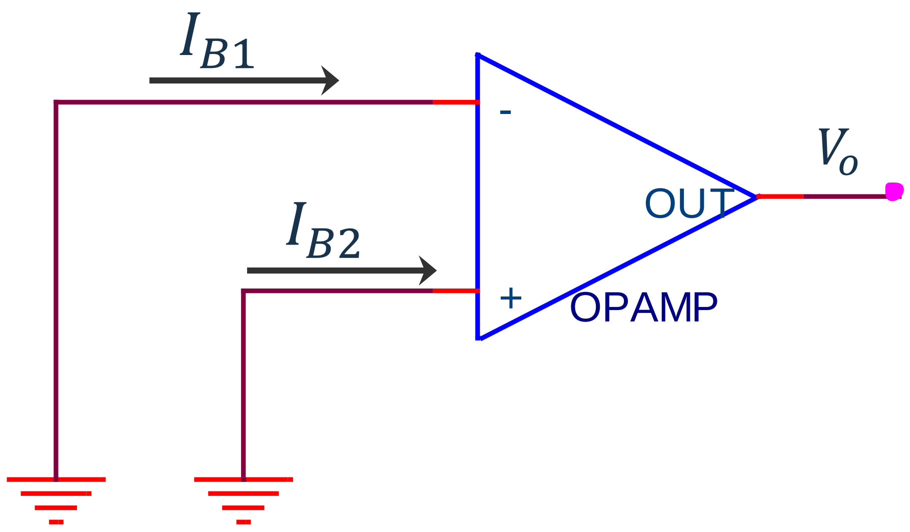


4. Differential Input Resistance

This is the resistance that can be measure at either of input terminals with respect to ground reference.

For IC 741C the input resistance, R_i =2MΩ

For FET based Op-Amp (μAF771), R_i =1000GΩ

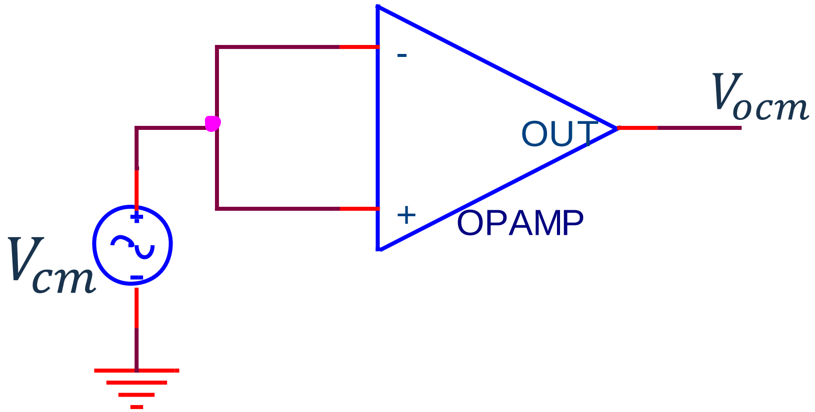


5. Common Mode Rejection Ratio

If V_{cm} is the common mode input voltage and V_{ocm} is corresponding output voltage (Ideally, V_{ocm} should be zero). Then common mode voltage gain $A_{cm} = \frac{V_{ocm}}{V_{cm}}$

CMRR is defined as the ratio of differential voltage gain to the common mode voltage gain. Mathematically,

$$\text{CMRR} = \frac{A_d}{A_{cm}}$$



Where A_d is differential voltage gain, $A_d = \frac{V_o}{V_+ - V_-}$,

Since, A_d is very large and A_{cm} is very small value

Therefore, CMRR is a very large quantity and usually, measured on dB scale

Typical CMRR ranges between 80dB to 120dB

6. Supply Voltage Rejection Ratio

SVRR is defined as the rate of change of input offset voltage V_{io} with respect to change in supply voltages. Mathematically,

$$\text{SVRR} = \frac{\Delta V_{io}}{\Delta V}$$

SVRR is measured separately for $+V_{CC}$ and $-V_{EE}$. SVRR on dB scale is given as

$$\text{SVRR} = 20 \log\left(\frac{\Delta V}{\Delta V_{io}}\right)$$

Typical SVRR for Op-Amp IC 741C is 150μV/V or 104dB.

Lower the SVRR better is the Op-Amp IC

7. Slew Rate

Slew Rate is defined as the maximum rate of change of output voltage with respect to time. Mathematically,

$$\text{Slew Rate} = \left.\frac{dV_o}{dt}\right|_{maximum} \text{V/µSec}$$

Slew Rate value indicates how rapidly the output of an Op-Amp can follow the changes in input signal.

Lower Slew Rate in Op-Amp IC 741C (0.5 V/µSec) limits its use in high frequency application, such as oscillators and filters, etc.

Whereas, high speed Op-Amp ICs such LM318 has high SR, i.e., 70V/µSec

8. Gain-Bandwidth Product

The Gain-Bandwidth product is the bandwidth of the Op-Amp when its voltage gain is unity.

Equivalent terms are:

- Closed loop bandwidth
- Unity gain bandwidth
- Small signal bandwidth

Gain-Bandwidth product of Op-Amp IC 741C is approximately 1MHz

High speed Op-Amp ICs such as LF351 & MC34001 do have Gain-Bandwidth product is 4MHz

Thank You

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