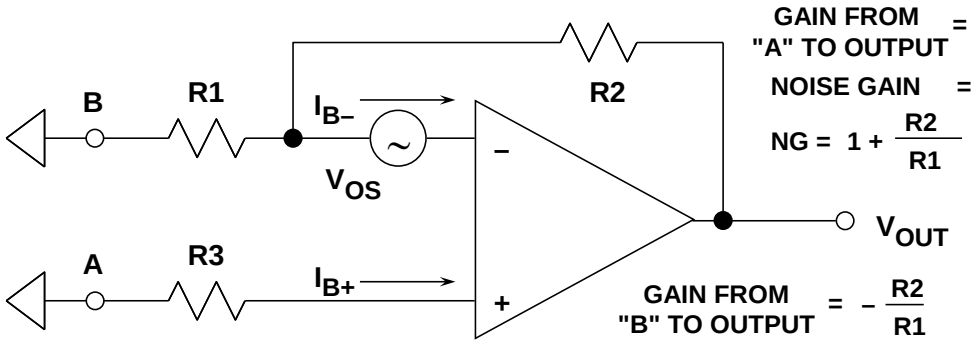
Op Amp Total Output Offset Voltage Calculations

CALCULATING TOTAL OUTPUT OFFSET ERROR DUE TO I_B AND V_{OS}

The equations shown in Figure 1 below are useful in referring all the offset voltage and induced offset voltage from bias current errors to the either the input (RTI) or the output (RTO) of the op amp. The choice of RTI or RTO is a matter of preference.



- OFFSET (RTO) = $V_{OS}\left[1 + \frac{R2}{R1}\right] + I_{B+} \cdot R3\left[1 + \frac{R2}{R1}\right] - I_{B-} \cdot R2$

- OFFSET (RTI) = $V_{OS} + I_{B+} \cdot R3 - I_{B-}\left[\frac{R1 \cdot R2}{R1 + R2}\right]$

FOR BIAS CURRENT CANCELLATION:

OFFSET (RTI) = V_{OS} IF $I_{B+} = I_{B-}$ AND $R3 = \frac{R1 \cdot R2}{R1 + R2}$

Figure 1: Op Amp Total Offset Voltage Model

The RTI value is useful in comparing the cumulative op amp offset error to the input signal. The RTO value is more useful if the op amp drives additional circuitry, to compare the net errors with that of the next stage.

In any case, the RTO value is simply obtained by multiplying the RTI value by the stage noise gain, which is 1 + R2/R1.

Before departing the topic of offset errors, some simple rules towards minimization might bear repetition:

- Keep input/feedback resistance values low, to minimize offset voltage due to bias current effects.
- Use a bias compensation resistance with VFB op amps *not* using internal bias compensation. Bypass this resistance, for lowest noise pickup.
- If a VFB op amp *does* use internal bias current compensation, *don't* use the compensation resistance.
- When necessary, use *external* offset trim networks, for lowest induced drift.
- Select an appropriate precision op amp specified for low offset and drift, as opposed to trimming.
- For high performance, low drift circuitry, watch out for thermocouple effects and used balanced, low thermal error layouts.

REFERENCES:

1. Hank Zumbahlen, *Basic Linear Design*, Analog Devices, 2006, ISBN: 0-915550-28-1. Also available as *Linear Circuit Design Handbook*, Elsevier-Newnes, 2008, ISBN-10: 0750687037, ISBN-13: 978-0750687034. Chapter 1.

2. Walter G. Jung, *Op Amp Applications*, Analog Devices, 2002, ISBN 0-916550-26-5, Also available as *Op Amp Applications Handbook*, Elsevier/Newnes, 2005, ISBN 0-7506-7844-5. Chapter 1.