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Bruce Trump   Apr 11, 2012

Do you add a resistor to match the DC resistance at the inputs of your op amp circuits? Check the circuits in figure 1 below. Many of us were instructed to add Rb as "good practice," making its value equal to the parallel combination of R1 and R2. Let's look at the reason for this resistor and consider when it's appropriate and when not.
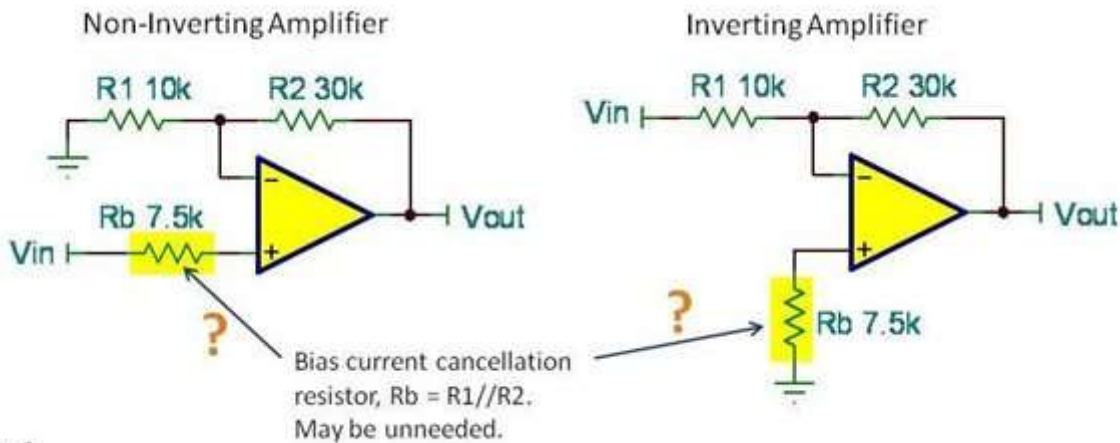

Figure 1.

The purpose of Rb is to reduce the voltage offset caused by input bias current. If both inputs have the same input bias current, equal current flowing through equal resistances will create equal and opposite offset voltages. Thus, input bias current will not contribute to the offset voltage of the circuit. The basic idea is has merit in some instances. But before adding Rb, is it always necessary?

Many times, the parallel resistance of R1 and R2 is low enough and input bias current is low enough that the offset created without Rb is insignificant. Before adding this resistor, calculate the error. Let's assume for this application that the input bias current of the op amp is 10nA. Without using Rb, the input-referred offset voltage due to input bias current will be...

Input offset Voltage due to Ib = (10nA) (7.5kΩ) = 75uV

Will 75uV of input offset affect your circuit? Many times the answer will be no, so why add the resistor. Consider the offset voltage of the op amp you are using. It may be pointless to be concerned with 75uV if, for example, the offset voltage specification of your op amp is1mV. So compare the error produced by input bias current to the offset voltage specification before routinely adding Rb to your circuit.

Transimpedance applications often use high feedback resistor values to amplify very small currents. Here again, you may be tempted to add Rb to balance the resistance at both inputs. But these

- applications generally use FET or CMOS-input op amps. With their very low input bias current, offset error is generally very small.
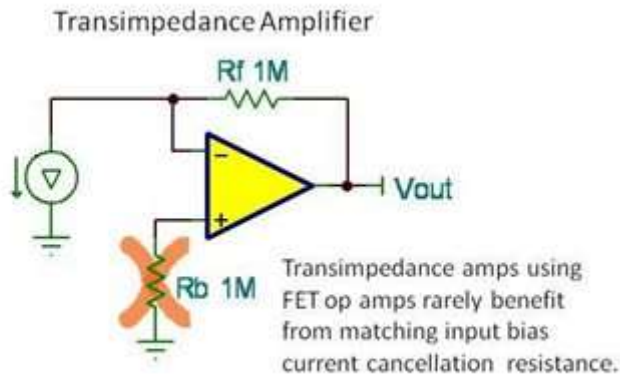

Figure 2.

Thermal noise produced by Rb and possible external noise pickup at this high impedance node may be additional reasons to eliminate Rb. With minimal error from input bias current, why add possible noise to the circuit?

There may occasionally be a clear and valid case for using a bias current cancellation resistor. But many circuits derive no significant benefit and may even suffer reduced performance. We will revisit this issue next week to consider certain op amps that never need bias current cancellation resistors.

Comments welcome and thanks for reading,

Bruce

💬 3 comments   👤 0 members are here

KALPESH SHELKE *over 5 years ago*
Hi Bruce,

I have a query.

Referring to page 31 of another TI document (training.ti.com/ti-precision-labs-op-amps-vos-and-ib, it was derived that in a non-inverting amplifier configuration the input bias current only flows through the feedback resistor (R2) and not through the resistor R1 (10K).

So in such a case, why should Rb be (R1||R2) and not R2.

Requesting the clarification.

Pete%20Semig *over 5 years ago*
Hello Kalpesh,

Great question! The use of R2||R1 yields the effects of Ib at the input of the device, which is also known as referred-to-input, or RTI. The use of just R2 (or Rf as used in the TI Precision Labs presentation), yields the effects of Ib at the output of the device, which is known as referred-to-output, or RTO. Another way to look at it is if you take the effect at the input, which uses R2||R1 and multiply that by the non-inverting gain

of the amplifier (which refers the effect to the output), you're left with just the feedback resistor: (R2*R1)/(R2+R1))*((R2+R1)/R1)=R2. Of course R2 is the same as Rf in the TI Precision Labs presentation.

Steve Judge *over 4 years ago*

Depending on your test strategy and the surrounding circuit, Rb's presence may be also (or entirely otherwise) supporting an independent in-circuit test of the amplifier.