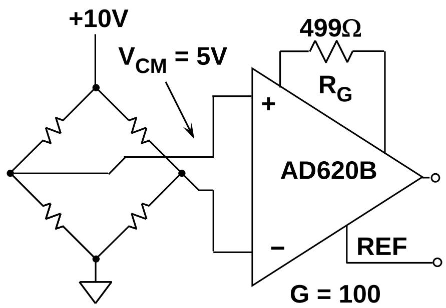
# In-Amp Bridge Circuit Error Budget Analysis

It is important to understand in-amp error sources in a typical application. Figure 1 below shows a 350 Ω load cell with a fullscale output of 100 mV when excited with a 10 V source. The AD620 is configured for a gain of 100 using the external 499 Ω gain-setting resistor. The table shows how each error source contributes to a total unadjusted error of 2145 ppm. Note however that the gain, offset, and CMR errors can all be removed with a system calibration. The remaining errors—*gain nonlinearity* and *0.1 Hz to 10 Hz noise*—cannot be removed with calibration and ultimately limit the system resolution to 42.8 ppm (approximately 14-bit accuracy). This example is of course just an illustration, but should be useful towards the importance of addressing performance-limiting errors such as gain nonlinearity and LF noise.




**AD620B SPECS @ +25°C, ±15V**
**$V_{OSI} + V_{OSO}/G$ = 55μV max**
**$I_{OS}$ = 0.5nA max**
**Gain Error = 0.15%**
**Gain Nonlinearity = 40ppm**
**0.1Hz to 10Hz Noise = 280nVp-p**
**CMR = 120dB @ 60Hz**

**MAXIMUM ERROR CONTRIBUTION, +25°C**
**FULLSCALE: $V_{IN}$ = 100mV, $V_{OUT}$ = 10V**

| | | |
|---|---|---|
| $V_{OS}$ | 55μV ÷ 100mV | 550ppm |
| $I_{OS}$ | 350Ω × 0.5nA ÷ 100mV | 1.8ppm |
| Gain Error | 0.15% | 1500ppm |
| Gain Nonlinearity | 40ppm | 40ppm |
| CMR Error | 120dB<br>1ppm × 5V ÷ 100mV | 50ppm |
| 0.1Hz to 10Hz 1/f Noise | 280nV ÷ 100mV | 2.8ppm |
| Total Unadjusted Error | ≈ 9 Bits Accurate | 2145ppm |
| Resolution Error | ≈ 14 Bits Accurate | 42.8ppm |

***Figure 1: AD620B Bridge Amplifier DC Error Budget***

A general-purpose amplifier (including in-amps) Error Budget Analysis tool is available on the Analog Devices' website as well as the Analog Bridge Wizard™ to assist in bridge circuit designs.

## 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 2.

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 2.

3. Charles Kitchin and Lew Counts, *A Designer's Guide to Instrumentation Amplifiers, 3rd Edition*, Analog Devices, 2006.