

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 <u>AD620</u> 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.

+10V V _{CM} = 5V	499Ω	MAXIMUM ERROR CONTRIBUTION, +25°C FULLSCALE: V _{IN} = 100mV, V _{OUT} = 10V		
	+ R _G	v _{os}	55µV ÷ 100mV	550ppm
	AD620B	I _{os}	350Ω × 0.5nA ÷ 100mV	1.8ppm
Z J	- REF	Gain Error	0.15%	1500ppm
\downarrow	G = 100	Gain Nonlinearity	40ppm	40ppm
350Ω, 100mV FS LOAD CELL		CMR Error	120dB 1ppm × 5V ÷ 100mV	50ppm
AD620B SPECS @ $+25^{\circ}C, \pm 15V$ $V_{OSI} + V_{OSO}/G = 55\mu V max$ $I_{OS} = 0.5nA max$ Gain Error = 0.15% Gain Nonlinearity = 40ppm 0.1Hz to 10Hz Noise = 280nVp-p CMR = 120dB @ 60Hz		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: <u>AD620B</u> Bridge Amplifier DC Error Budget

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

REFERENCES

- Hank Zumbahlen, *Basic Linear Design*, Analog Devices, 2006, ISBN: 0-915550-28-1. Also available as <u>Linear Circuit Design Handbook</u>, 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, <u>A Designer's Guide to Instrumentation Amplifiers</u>, 3rd Edition, Analog Devices, 2006.

Copyright 2009, Analog Devices, Inc. All rights reserved. Analog Devices assumes no responsibility for customer product design or the use or application of customers' products or for any infringements of patents or rights of others which may result from Analog Devices assistance. All trademarks and logos are property of their respective holders. Information furnished by Analog Devices applications and development tools engineers is believed to be accurate and reliable, however no responsibility is assumed by Analog Devices regarding technical accuracy and topicality of the content provided in Analog Devices Tutorials.