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UNDERSTANDING LINEARITY ERROR FOR THE ACS70310 ABOVE 2000 G

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INTRODUCTION

The ACS70310 datasheet specifies a field range of ±2000 G. However, there is no fundamental reason that the ACS70310 cannot be used to sense magnetic fields greater than 2000 G, provided that an increase in signal nonlinearity can be tolerated. A degeneration resistor is used to set the gain of the front-end amplifier inside the ACS70301. This resistor helps to lower the noise of the sensor, but causes the sensor signal path to saturate at ~3300 G. Many applications can tolerate use of the ACS70310 above 2000 G field levels, but it is important to note how fields greater than 2000 G affect the linearity error of the IC.

The goal of this applications note is to illustrate and discuss the linearity error of the ACS70310 when sensing fields greater than 2000 G. To explain IC behavior above 2000 G, several Monte Carlo simulations and a few measurements are shown.

DISCUSSION

The linearity error of the ACS70310 is highly dependent on the temperature of the device. This is shown in Figure 1. Because of this temperature dependency, simulations will focus at –40°C and a "worst-case" scenario will be reported for each case.

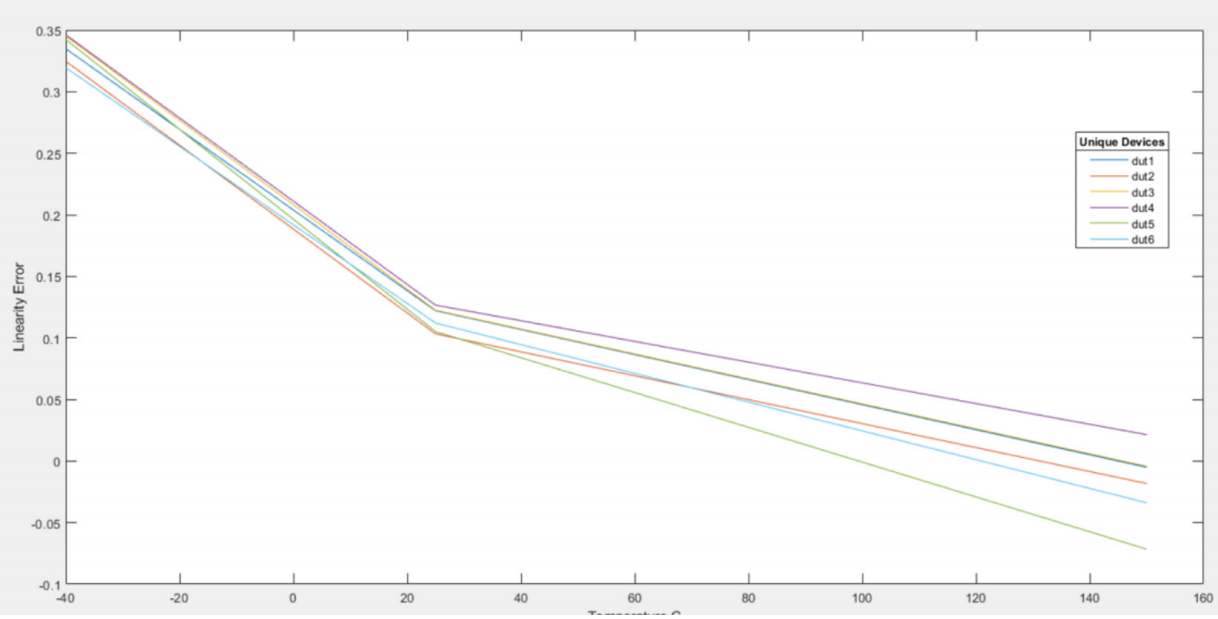

Figure 1: Measurement characterizing linearity error over temperature for six ACS70310 devices

A first solution to minimize linearity error would be to decrease the output range from 0.5-4.5 V to 1-4 V. By doing so, a worst-case linearity error of 1.33% can be achieved for a sensitivity of 0.5 mV/G or as low as 0.87% for sensitivity of 0.6 mV/G. Simulation results for this are shown in Figure 2. Using these sensitivities, the B-field sensed by the ACS70310 can slightly exceed 3000 G, but not exceed the saturation level of 3300 G.

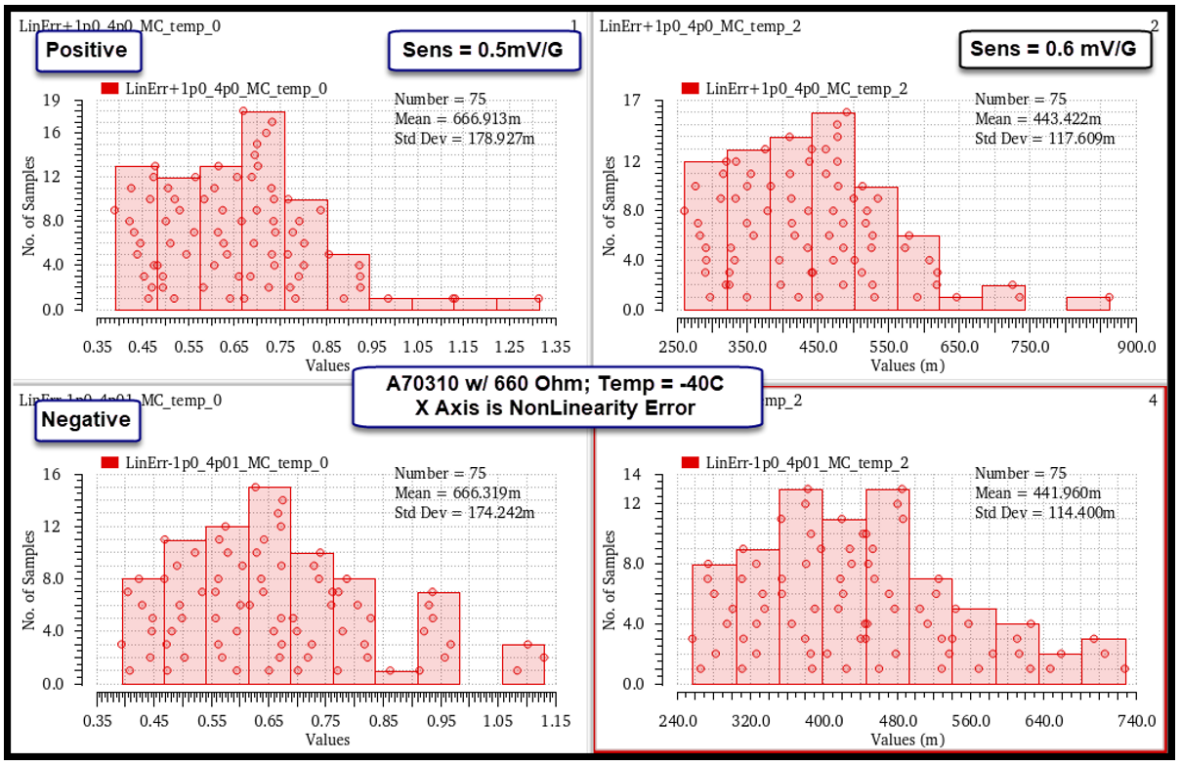

Figure 2: Histograms of linearity error at –40°C for (starting with top left) 0.5 mV/G positive currents, 0.6 mV/G positive currents, 0.5 mV/G negative currents, and 0.6 mV/G negative currents.

To fine tune performance, it is best to set the B-field range limits of the applications to ±3000 G and set the sensitivity to 0.667 mV/G. Simulations for this scenario are shown in Figure 3. The worst-case linearity error for this is 1.1%.

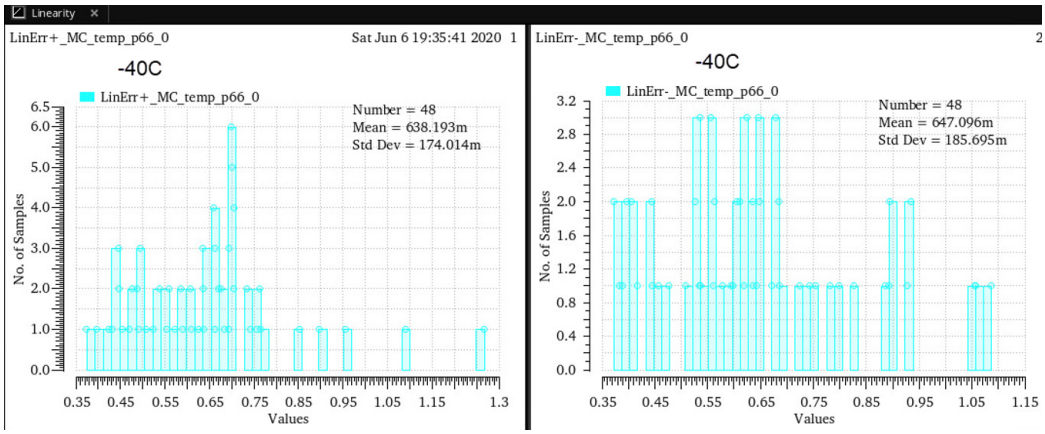

Figure 3: Histogram of linearity error at –40°C for (starting with left) 0.667 mV/G positive currents and 0.667 mV/G positive currents.

It is important to note that these Monte Carlo simulations are an absolute worst-case scenario for the errors. They incorporate several different manufacturing corners and are usually representative of scenarios that are worse than what will be observed with measured results. To show this, a simulation was conducted to correlate to the measured results in Figure 1. These results are displayed and compared in Table 1. This shows that errors calculated from simulations are approximately 30% higher than measured results.

Table 1: Correlation of simulation data to measured data in Figure 1.

Measured Error	< 0.35 %
Simulated Error	< 0.47 %

To conclude, for an ACS70310 with a sensitivity of 0.667 mV/G, this IC can operate up to 3000 G with a linearity error <1.1%, and will still have a linearity error <0.5 % under field levels of 2000 G.

Revision History

Number	Date	Description	Responsibility
–	August 18, 2020	Initial release	S. Rock, K. Snowdon

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