CALIBRATION GUIDE FOR CT110, CT220, AND CT450

By Allegro MicroSystems

INTRODUCTION

All current sensors—regardless of how expensive they are, what materials they use, or if they were factory calibrated—are susceptible to deviations from their ideal transfer line.

To extract the absolute best performance from any current sensing system, calibration is required.

REFERENCED DEVICES

CT110, CT220, CT450

IDEAL TRANSFER LINE

Ideally, the sensor output follows a straight line, has a fixed slope, and crosses a fixed offset point. This allows the user to apply a straightforward linear equation to extract the physical value being measured. In the case of a current sensor:

$$Current = (Voltage - b)/a,$$

where a is the slope, and b is the offset of the ideal curve. In a perfect sensor, both a and b coefficients can be simply looked up on the datasheet.

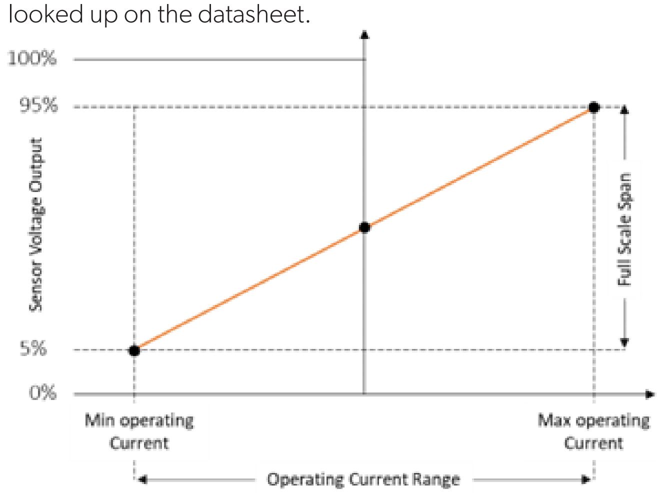

Figure 1: Ideal Transfer Line

Any deviation from this ideal line is considered a sensor error—more specifically, an accuracy error that relates to the gain and offset error when considered in terms of Allegro TMR sensors.

OFFSET ERROR

Based on the ideal transfer line, when current is not applied, the voltage output of the sensor should be equal to 50% of V_{DD}. For the spread (i.e., minimum and maximum) values of offsets, refer to the product datasheet.

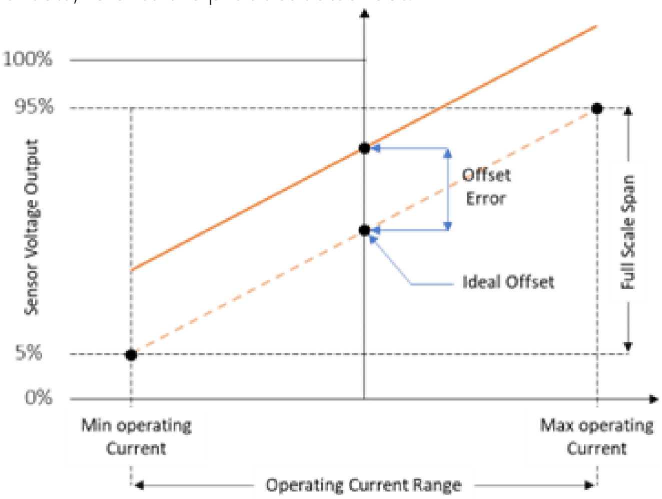

Figure 2: Exaggerated Offset Error.

GAIN ERROR

The ideal transfer line shows a line that reaches 95% of V_{DD} at the maximum operating current and 5% of V_{DD} at the minimum. The datasheet also shows the spread of the gain found on the sensors.

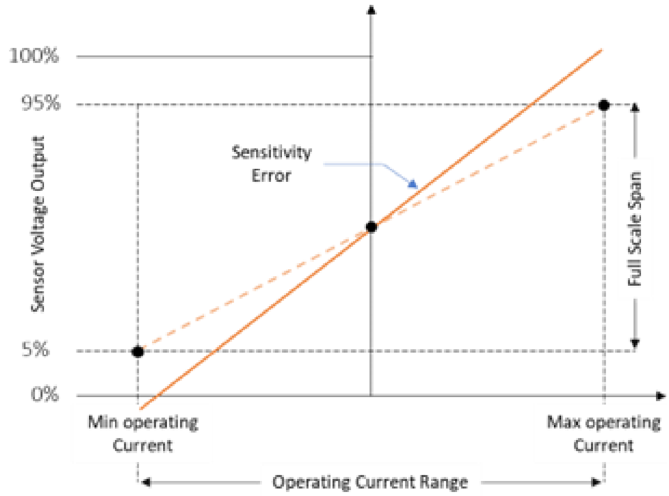

Figure 3: Exaggerated Gain Error

CALIBRATION

Different methods can be applied for offset and/or gain correction. The complexity of these methods leads to different calibration results: The higher the complexity, the better the error correction.

Simple Offset Correction

Offset calibration is achieved simply by storing the voltage output of the sensor at zero flowing current. This stored value, V_{OFFSET}, becomes coefficient b in the linear transfer function:

$$Current = (Voltage - b)/a.$$

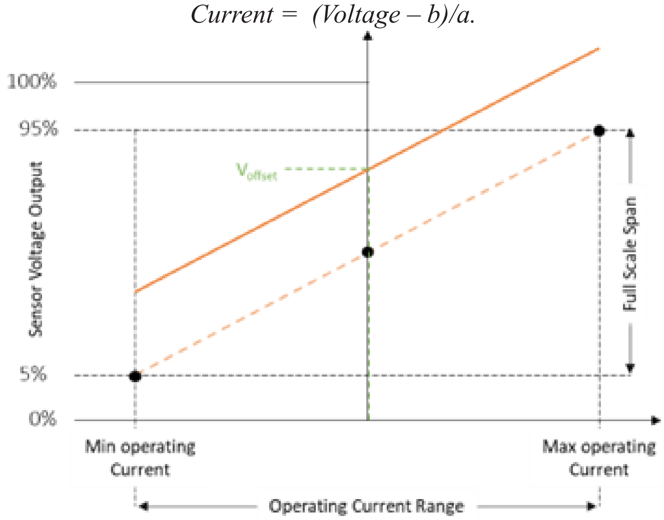

Figure 4: Simple Offset Calibration

Simple Gain Correction

Basic gain calibration can be achieved by applying a known current value (A_1) and measuring the sensor output voltage value (V_1)

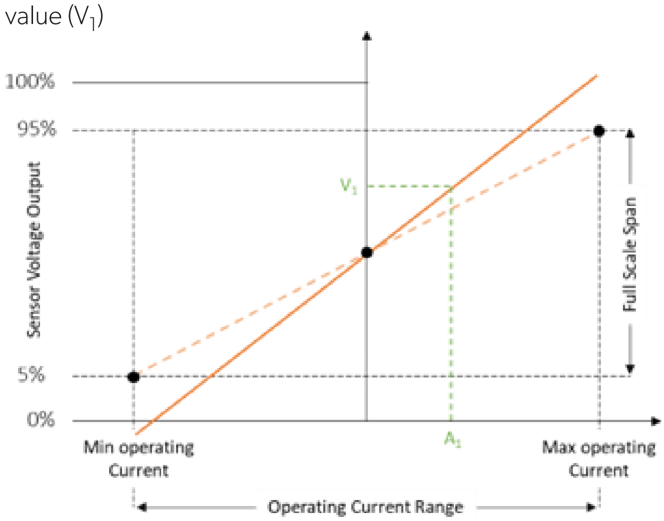

Figure 5: Simple Gain Calibration

Slope coefficient a is calculated as:

$$a = (V_1 - V_{offset})/A_1.$$

Recommended Offset and Gain Correction

For the best error correction of gain and offset in bidirectional current applications:

1. Apply a known current value (A_1) and measure the voltage output (V_1).
2. Apply a second current value (A_2) and measure the voltage output (V_2).
3. Calculate the slope using:

$$a = (V_1 - V_2)/(A_1 - A_2)$$
$$b = (V_1 + V_2)/2$$

It is recommended that the applied currents A_1 and A_2 be the absolute maximum and minimum operating current observed by the sensor during typical operations. It is also recommended that $A_1 = -A_2$ for bidirectional current sensing.

Both calculated coefficients a and b are then used to calculate the current:

$$Current = (Voltage - b)/a.$$

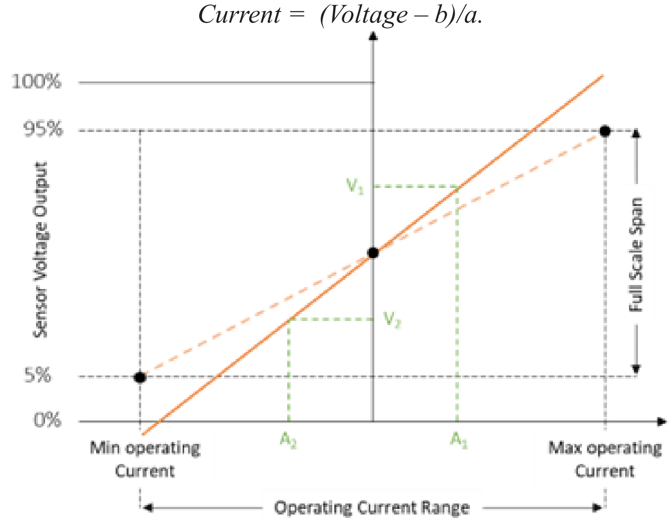

Figure 6: Gain Calibration

Revision History

Number	Date	Description	Responsibility
1	November 16, 2023	Document rebrand and minor editorial corrections	J. Henry