Calibration Guide for CT110 and CT220

Referenced Devices

CT110, CT220

Introduction

All current sensors, no matter how expensive they are, or what materials they use, or even 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.

Ideal Transfer Line

Ideally, the sensor output follows a straight line, has a fixed slope, and crosses a fix 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.

$$Current = \frac{Voltage - b}{a}$$

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

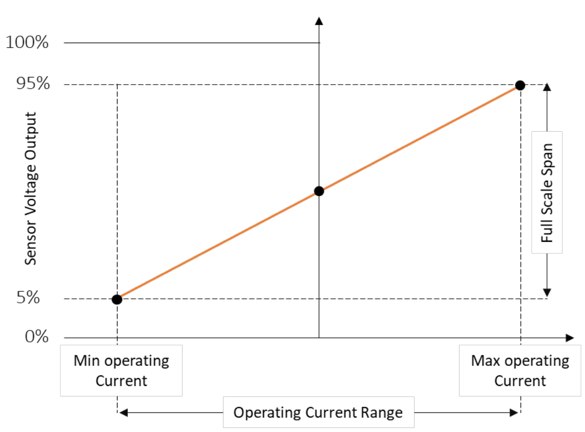

Figure 1 Ideal Transfer Line

Any deviation from this Ideal Line are considered sensor errors. More specifically Accuracy Errors as they related in the case of Crocus Technology's sensors to Gain and Offset errors.

Offset Error

Based on the Ideal Transfer Line, when no current is applied, the voltage output of the sensor should be equal to 50% of V_{DD}. On the datasheet, the user can find the spread (i.e. min-max) values of offsets of Crocus Technology's products.

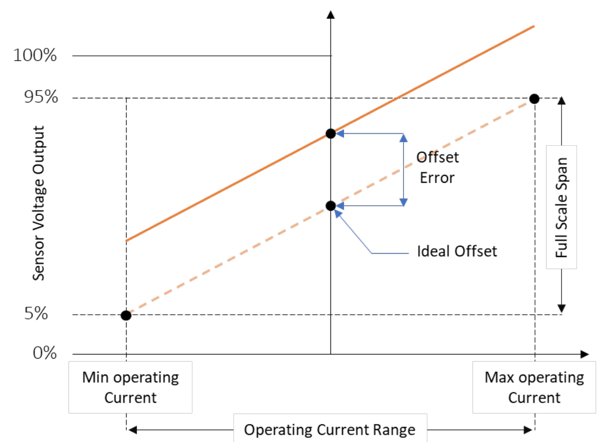

Figure 2 Exaggerated Offset Error.

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.

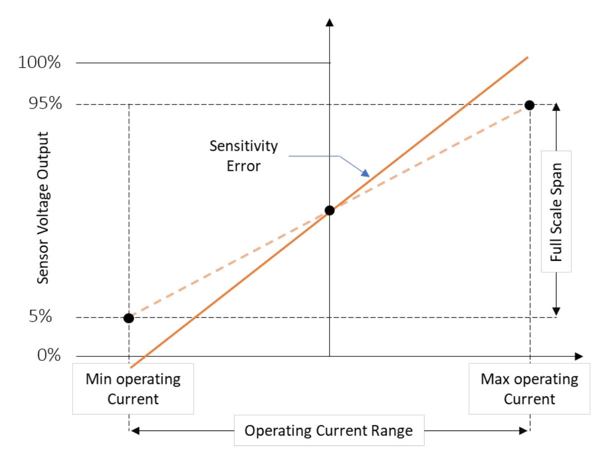

Figure 3 Exaggerated Gain Error

Calibration

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

Simple Offset Correction

Offset calibration is achieved simply by storing the voltage output of the sensor at zero flowing current.

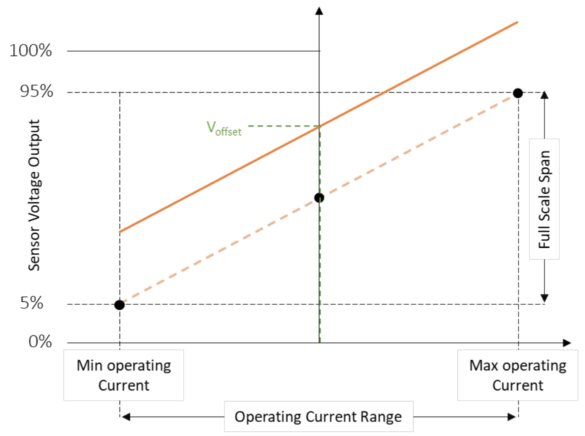

Figure 4 Simple Offset Calibration

This stored value V_{OFFSET} becomes the coefficient "b" in the linear transfer function:

$$Current = \frac{Voltage - b}{a}$$

Simple Gain Correction

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

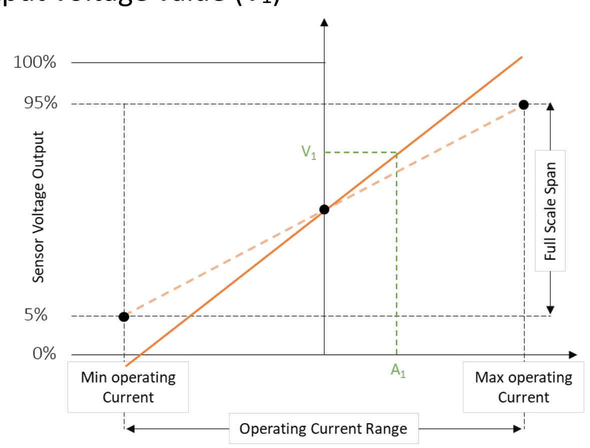

Figure 5 Simple Gain Calibration

The following equation is used to calculate the slope coefficient "a":

$$a = \frac{V_1 - V_{offset}}{A_1}$$

Recommended Offset and Gain Correction

For bi-directional current applications, the steps below are recommended for users trying to perform the best error correction of gain and offset.

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

It is recommended that the applied currents A_1 and A_2 are the absolute maximum and minimum operating current the sensor will see during its normal operations.
Also, $A_1 = -A_2$ for bi-directional current sensing.

$$a = \frac{V_1 - V_2}{A_1 - A_2} \qquad b = \frac{V_1 + V_2}{2}$$

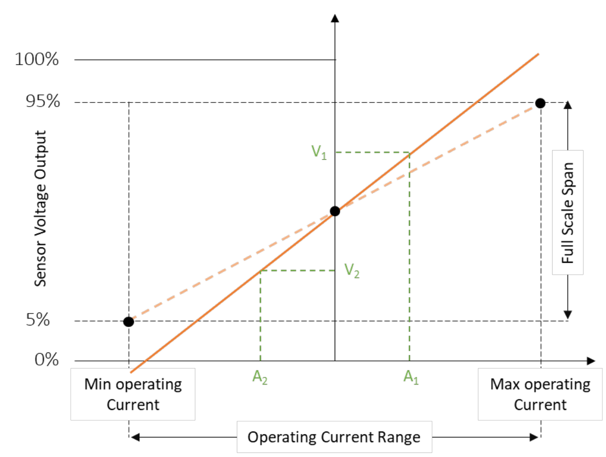

Figure 6 Gain Calibration

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

$$Current = \frac{Voltage - b}{a}$$