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TECHNIQUES TO MITIGATE OFFSET ERROR OF ACS732 AND ACS733

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ABSTRACT

This application note describes techniques to help mitigate the offset error of the ACS732/3 through the use of software calibration. The use of software calibration allows for improved accuracy at the system level.

INTRODUCTION

The ACS732/3 is a high bandwidth (1 MHz) current sensor with a typical response time of 200 ns to a step input. These devices provide a compact, fast, and accurate solution for measuring high-frequency currents in DC/DC converters and other switching power applications. See the Allegro application note Differential Current Sensing with the 1 MHz Bandwidth ACS733 [1] for more details of the benefits of the ACS732/3.

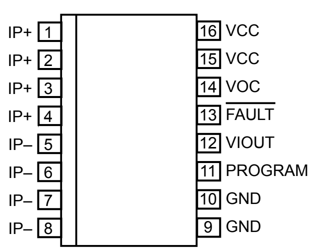

Figure 1: ACS732/3 Pinout in the LA 16-Pin SOICW Package

With a front end made up of a differential pair of Hall-effect transducers, the high bandwidth and fast response time of the ACS732/3 is primarily achieved by not chopping the Hall-effect transducers. The cost of not chopping the Hall-effect transducers is the offset error over temperature and over life is larger than other lower bandwidth Allegro current sensors.

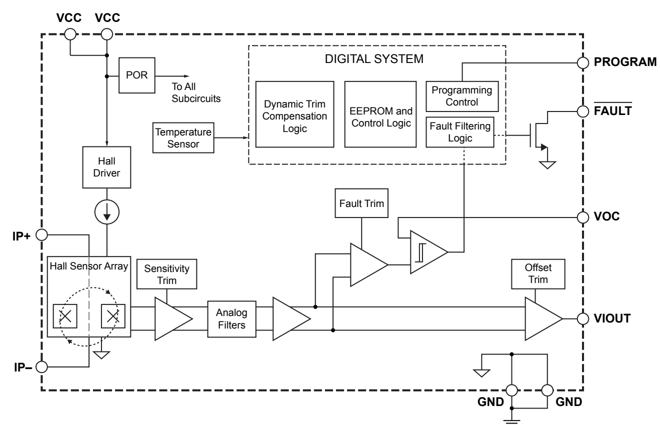

Figure 2: Functional Block Diagram

ACS732/3 OFFSET ERROR OVER TEMPERATURE AND LIFE

In the ACS732/3 datasheet [2], there are two parameters that specify the offset error: Voltage Offset Error and Offset Voltage Error Including Lifetime Drift. These parameters can be found in the Performance Characteristics table; there is a unique Performance Characteristics table for each available part number.

The Voltage Offset Error is defined as the deviation of the device output from its ideal quiescent value of 0.5 × V_{CC} (bidirectional) or 0.1 × V_{CC} (unidirectional) due to nonmagnetic causes.

The Offset Voltage Error Including Lifetime Drift is the same as the Offset Voltage Error but includes any change in the Voltage Offset Error over life.

[1] https://www.allegromicro.com/en/insights-and-innovations/technical-documents/hall-effect-sensor-ic-publications/an296154-differential-current-sensing.

[2] https://www.allegromicro.com/en/products/sense/current-sensor-ics/zero-to-fifty-amp-integrated-conductor-sensor-ics/acs732-3.

The lifetime change in the ACS732/3 offset error can be removed by adding in a zero current calibration at the system level that is performed occasionally throughout the device lifetime. An ideal time for this calibration is at power on or any time when the current in the IP bus of the ACS732/3 is known to be zero amperes.

SOFTWARE CALIBRATION

At the system level, a measurement of the ACS732/3 device output, or V_{IOUT}, should be taken when the current in the IP bus is known to be 0 A. This measurement should be stored in software and used as the new ideal Zero Current Output Voltage, $V_{IOUT(Q)}$.

OUTCOME OF PERFORMING AN OFFSET CALIBRATION

When an offset calibration is performed periodically throughout the lifetime of the ACS732/3 device, the Offset Voltage Error Including Lifetime Drift will be identical to the Voltage Offset error specification, thus reducing the error of the device over life.

If the offset calibration can be performed at a more frequent cadence, more of the offset error can be removed. For example, if an offset calibration is performed whenever the device temperature changes by more than 20°C, the offset error of the device will be nearly eliminated.

THE IMPACT OF OFFSET CALIBRATION ON TOTAL ERROR

Total error can be used as an approximation of the worst-case error that will be seen in application. By performing an offset calibration, the offset error of the ACS732/3 can be reduced, ultimately reducing the total error of the device and improving accuracy at the system level.

Equation 1 below can be used to determine the resulting Total Error limits after a calibration is implemented.

$E_{TOT(DRIFT)}$ is the typical datasheet value for Total Output Error Including Lifetime Drift in percent, $V_{OE(DRIFT)\,with\,calibration}$ is the new offset limit assuming the addition of a calibration in mV, $V_{OE(DRIFT)}$ is the typical datasheet value for Offset Voltage Error Including Lifetime Drift in mV, Sens is the typical datasheet value for the sensor sensitivity, and $I_{PR(MAX)}$ is the maximum current value of the device's sensing region.

Equation 1:

$$Total\ Error_{(with\ calibration)} = \sqrt{\left(E_{TOT(DRIFT)}\right)^2 + \left(\frac{V_{OE(DRIFT)_{with\ calibration}}}{Sens * I_{PR(\mathrm{MAX})}} * 100\%\right)^2 - \left(\frac{V_{OE(DRIFT)}}{Sens * I_{PR(\mathrm{MAX})}} * 100\%\right)^2}$$

Revision History

Number	Date	Description
–	September 3, 2020	Initial release
1	October 15, 2024	Fixed broken links (page 1)

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