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Self Calibration of Wide Dynamic Range Bias Current Generators

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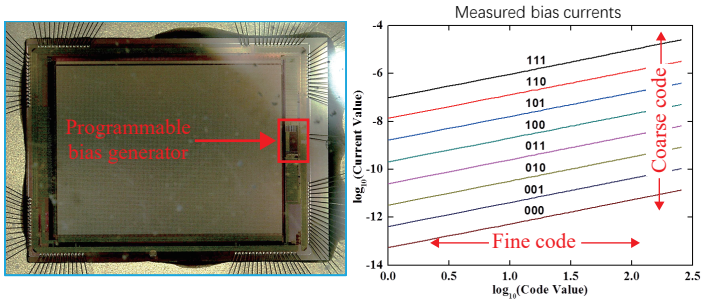
Abstract

This paper reports the use of an integrated measurement circuit based on spiking neuron and a scheme for calibrating biase currents by remapping bias values towards more uniform values. With the method presented in this paper, 1/σ mismatch of subthreshold currents is decreased by at least a factor of 3.

The firmware implementation completes calibration in about a minute and uses about 1kB of flash storage of calibration data.

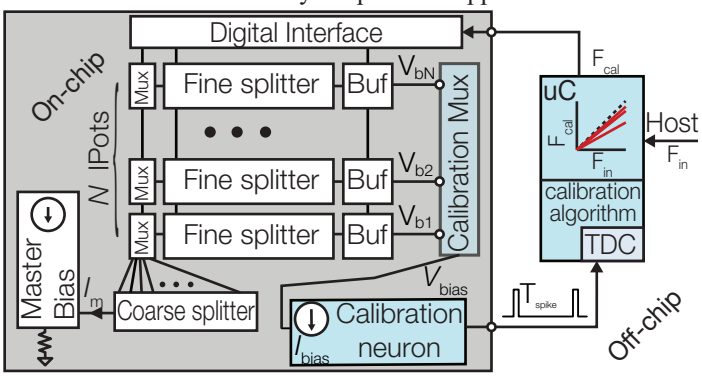
Introduction



Programmable bias generators have been included in neuromorphic event camera chip for a long time. [1] These bias generators can cover over 7 decade dynamic range. [2]

A master bias included on-chip is used to produce 8 coarse currents spaced by factors of 8. These coarse currents are mirrored to on-chip biases. Each bias then takes a fraction of the chosen coarse current with its fine splitter. [2] However, these bias currents can have random variation due to dopant fluctuation.

Previous calibration method "stochastic I-Pot" [3] is too slow and takes too much flash memory for practical application.



Calibration Methods

During Calibration

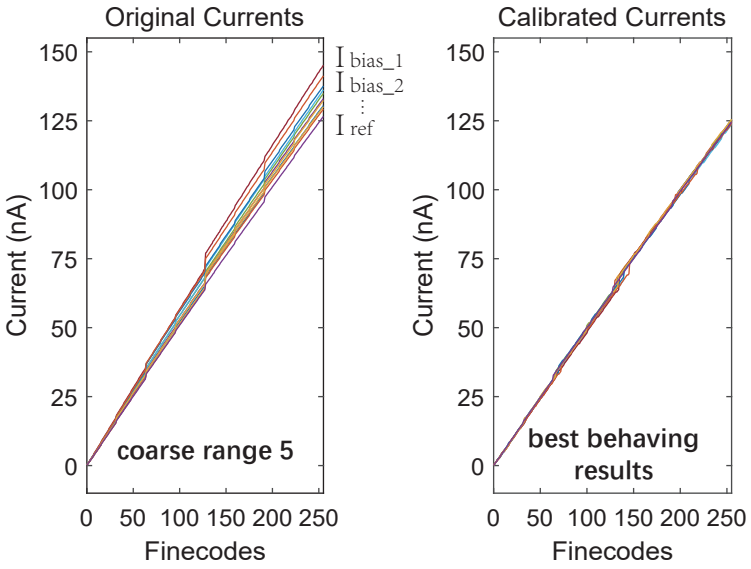
1. Measure the largest currents at all coarse ranges for all biases.
2. Find the smallest current in each group.
3. Calculate the scaling factors for each bias at all coarse ranges.
4. Store the scaling factors for future use.

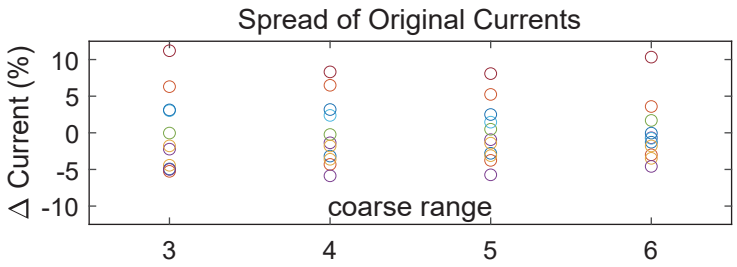
During Operation

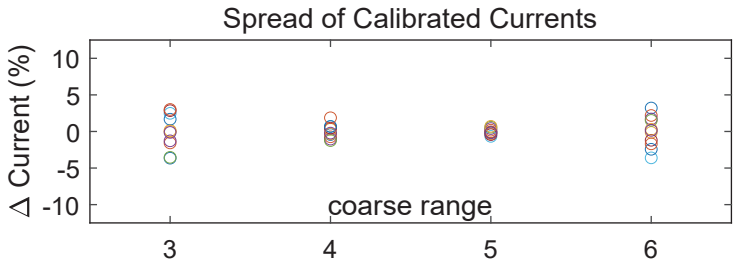
1. Read the scaling factors into system memory.
2. Calculate calibrated fine code on the fly.

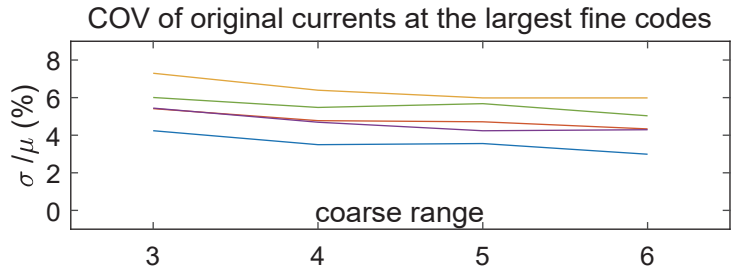
Results

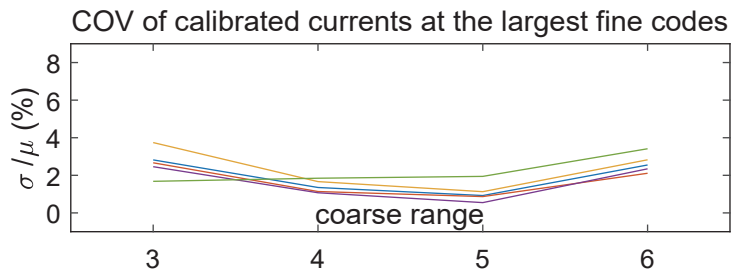
Overall, calibration improves matching by at least a factor of 3 (from 6% to 2%). This calibration could improve yield and uniformity of response of mass production neuromorphic chips.











References:
[1] Serrano-Gotarredona, R., L. . 2007. "The Stochastic I-Pot: A Circuit Block for Programming Bias Currents." IEEE Transactions on Circuits and Systems II: Express Briefs 54 (9): 760–64. https://doi.org/10.1109/TCSII.2007.900881 .
[2] Yang, M., S. C. Liu, C. Li, and T. Delbruck. 2012. "Addressable Current Reference Array with 170db Dynamic Range." 2012 IEEE International. https://ieeexplore.ieee.org/abstract/document/6271979/.
[3] Brandli, C., R. Berner, M. Yang, and S. C. Liu. 2014. "A 240× 180 130 Db 3 μs Latency Global Shutter Spatiotemporal Vision Sensor." IEEE Journal of Solid-State Circuits. https://ieeexplore.ieee.org/abstract/document/6889103/