# Effect of Current Measurement Gain Error in Monitoring Battery's State of Health (SOH)

One of the main indicators of State of Health (SOH) in batteries is capacity fade. Monitoring the battery capacity as it deteriorates through cycling and time is necessary in order to properly determine State of Charge (SOC), as well as to keep an accurate picture of the battery's remaining life (end of life is typically determined at 80% of initial capacity).

One of the methods used by battery management systems (BMS) for measuring maximum battery capacity $Q_{\max}$ relies on the following relationship:

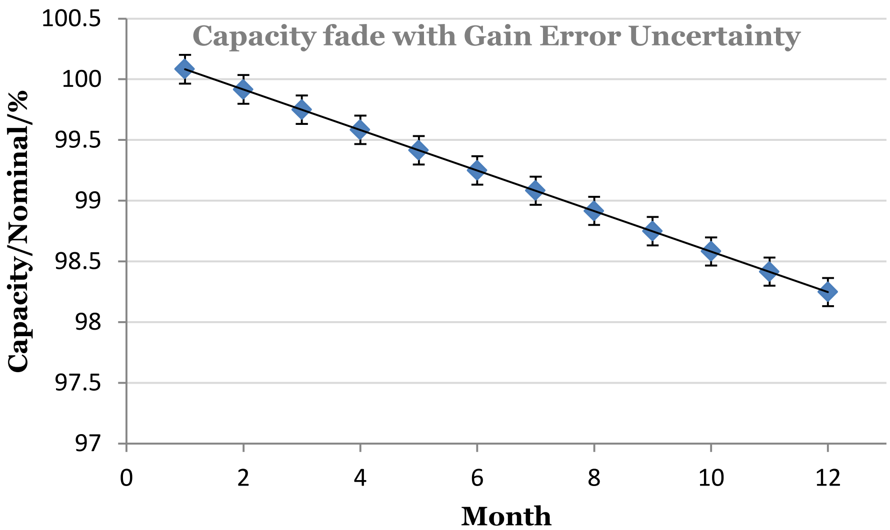
$Q_{\max} = \frac{\Delta Q}{\Delta SOC}$, where $\Delta SOC$ is the change in SOC caused by a change, $\Delta Q$, in battery charge.

The change in SOC is determined either by voltage measurements taken while the battery is at equilibrium or through other model-based methods. The change in the battery's charge is provided by Coulomb Counting.

The Gain Error has a significant impact in the accuracy of current measurements and subsequently in the accuracy of Coulomb Counting. Gain Error is typically expressed as a percentage of the measured value and in a current measurement system has two origins: One origin is from within the current measurement electronics and the second one is from shunt variation with temperature.

The Sendyne SFP10x family of current measurement ICs provide an un-calibrated Gain Error of less than 0.1 % at room temperature and less than 0.3 % over the whole temperature range (-40 $^{o}$C to +125 $^{o}$C). In addition, it provides calibration capabilities for both the Gain Error of the IC as well as the thermal error of the shunt. While individual calibration of each IC and shunt is a costly process, current measurement systems built around the Sendyne SFP10x can benefit from these programmable features by using standard calibration tables provided by Sendyne for specific IC and shunt combinations. Using this low cost method, production systems can achieve Gain Errors of less than 0.25 % for the entire IC and shunt system and over the full temperature range of -40 $^{o}$C to +125 $^{o}$C.

To verify the suitability of Sendyne SFP10x for SOH monitoring, a simulation was performed using successive Nissan Leaf "Depletion 55 mph" driving cycles, based on data provided by the Argonne National Laboratory Downloadable Dynamometer Database. A typical, 2 % capacity fade was projected for a period of 12 months using 80 % Depth of Discharge cycles. As illustrated in the following chart, the Sendyne SFP10x was clearly tracking battery deterioration within a 0.25 % uncertainty over the whole period of simulation.


Capacity fade with Gain Error Uncertainty
Capacity/Nominal/%
100.5
100
99.5
99
98.5
98
97.5
97
0
2
4
6
8
10
12
Month