Errata

- Page 12. I state that "The primary advantage of current shunts (over Hall-effect sensors, described next) is that they have no offset at zero current, regardless of temperature." This is only approximately true, as J. Lull points out:

  > They do have an offset at zero current, due to thermoelectric effects, unless the entire shunt is isothermal—which it essentially never is.
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  > Most shunts use Manganin as the resistive material; Vishay lists the Seebeck coefficient for Manganin (relative to Copper) as about $-3\,\mu\text{V K}^{-1}$ (see `https://www.vishay.com/docs/49159/_power-metal-strip-shunts-current-shunts_pl0005-1801.pdf`).
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  > So while the offset due to thermoelectric effects is typically small (since the temperature difference between the ends of the resistive elements is typically small), it is not zero, and getting it into the low nV range would require extreme care to ensure both ends of the shunt are within a very few mK of each other. Ensuring that degree of temperature matching is never trivial, and certainly not something that can be assumed. And since offsets in the associated electronics can (with care) be driven well below 100 nV, the thermoelectric offset in the shunt can easily be the largest source of error in the measurement system, at low load current.
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  > Fluke reports (see `https://download.flukecal.com/pub/literature/p18-21.pdf`) (but without stating the sign) that brass too has a Seebeck coefficient of about $3\,\mu\text{V K}^{-1}$ relative to Copper, so any temperature gradient between a sense lead attachment and the associated brass/Manganin junction produces a small additional offset. But since the end-blocks themselves have high thermal conductance compared to the Manganin elements, the temperature gradients within the brass end-blocks seem likely to be an order of magnitude smaller than those along the Manganin elements.
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  > So while the offset of a shunt is typically small (on the order of 0.01 % to 0.001 % of range), it is not zero, and can be substantially larger than residual offsets in the shunt electronics. And that small offset can lead to substantial errors in coulometry over long periods.
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  > But if the shunt uses something other than Manganin as the resistive element, offsets due to thermoelectric effects could be far larger. So it's important that shunt selection for applications needing low offset include consideration of the materials used in the shunt.

  Note, that many BMS current-sensing solutions may not have sufficient resolution (volts per bit of A2D) to detect this thermoelectric effect. If there is sufficient resolution, then I believe that it can be calibrated out of a measurement using a simple temperature-dependent model of the thermoelectric-effect's influence on the total measurement. Thank you J. Lull!

- Page 12. I state that "If a coil is wrapped around a primary current-carrying conductor, the electromagnetic field produced by the conductor induces a secondary current in the coil. Hall-effect sensors measure this induced current to infer the primary current." This is overly simplified. There is no actual coil in many Hall-effect sensors, as J. Lull points out:

  > Current through the primary conductor creates a magnetic field surrounding the conductor. The primary conductor passes through a gapped magnetic core which concentrates the field produced by that current at the gap, and a Hall effect sensor measures the resulting field strength in the gap.
  > DigiKey has a nice diagram (reportedly from Honeywell) showing how a Hall effect current sensor works, at `https://www.digikey.com/en/articles/the-basics-of-current-sensors`.

- Page 26, last line of page. "get all the of the total energy" should be "get all of the total energy". Thank you N. Hillery.
- Page 27. Fig. 1.23, R should be $R_k^{(i)}$. Thank you N. Hillery.
- Page 34. The definition for s_k is incorrect. Hysteresis tends toward a positive voltage when charging and a negative voltage when discharging. Assuming that M_0 is positive, the equation should state:

$$s_k = \begin{cases} -\text{sgn}(i_k), & |i_k| > 0; \\ s_{k-1}, & \text{otherwise.} \end{cases}$$

  This error is persistent in this volume (and in Volume I also). Fortunately, the effect of instantaneous hysteresis is small, but it is worthwhile implementing the correct equations in your BMS algorithms. Please check everywhere that s_k is introduced to make sure that you have correctly accounted for instantaneous hysteresis. Thank you V. Yu for pointing this out.

- Page 136, paragraph immediately following Fig. 3.23, "the bottom rows represent the randomness of the **process** noise" should state "the bottom rows represent the randomness of the **sensor** noise". Thank you J. El Dusouqui for pointing this out.
- Page 259, just above the table. "thescenario" should be "the scenario". Thank you N. Hillery.
- Page 261: "recored" should be "recorded". Thank you N. Hillery.
- Page 277: "Consequently <u>so</u> less discharge power is available" should be "Consequently less discharge power is available". Thank you N. Hillery.