



## *Independent Testing Confirms Accuracy*

**Merlin Power Systems** has developed proprietary battery monitoring technology that has advanced the technology in the field. This white paper describes the current practice of amp hour counting, Merlin's hybrid approach to monitoring, and independent tests that verify the accuracy of Merlin's DataCell II – the world's most accurate battery monitor available.

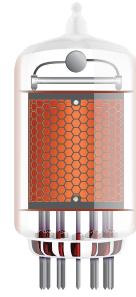
### **Amp Hour Counting**

Determining State of Charge (SoC) for lead-acid batteries is a difficult task. Prior to Merlin's hybrid approach to monitoring, the best practice was a technique termed amp hour counting. Amp hour counting tracks the power entering and leaving the battery and calculates the energy it is storing. It is analogous to calculating the level of water inside a tank by tracking the flow entering and leaving the tank.

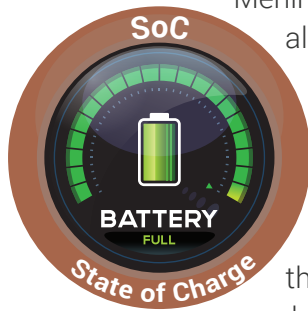
Amp hour counting is very accurate in the short term. However, it gradually becomes less accurate and after a few battery cycles the amp hour counter needs to be reset, or synchronized.



Amp hour counters are synchronized by fully recharging the batteries and setting the SoC to 100%. Many amp hour counters attempt to automatically synchronize by detecting when a full recharge of the batteries occurs. Unfortunately, this is an extremely rare occurrence in vehicle applications.



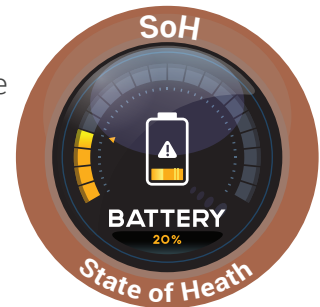
## Merlin's Hybrid Approach



Merlin has combined amp hour counting with a proprietary battery model and algorithm. In this hybrid approach, the short term accuracy of amp hour counting is integrated with the auto-synchronization of Merlin's model-based algorithm. Each technology complements the other's area of weakness. Amp hour counters are most reliable in the middle of charge / discharge cycles where battery models have their greatest error. The battery model provides very accurate SoC near the ends of the cycle where amp hour counters run out of synchronization. The combined accuracy of Merlin's hybrid approach is so great that it enables the calculation of State of Health (SoH) as well as SoC - a capability that neither approach can provide in isolation.

## Independently Tested

Merlin's flagship battery monitor, the DataCell II, was tested by one of the world's largest industrial battery manufacturer. A 100 Ah TPPL battery was subjected to charge and recharge cycles until the battery reached 80% of its rated capacity. During each of 35 cycles, the battery was subjected to a 100% depth of discharge test followed by a full recharge.



During testing, DataCell II was presented with some challenging conditions. It was initially configured with an incorrect value for the battery capacity. During the first few battery cycles, DataCell II correctly identified that its amp hour counting was therefore out of synchronization and relied upon its battery model. Despite the error, DataCell II maintained accuracy well within 10%. In subsequent cycles, DataCell II automatically corrected the erroneous battery capacity. Using the corrected capacity, DataCell II was able to synchronize the amp hour counter and bring SoC within 1% of the actual value. The manufacturer concluded that the DataCell II can produce SoC and SoH readings within 1% accuracy.

