

## ***BM2 ROM Update for UV Conditions***

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### **CHANGELOG**

Rev.	Date	Author	Comments
A	20230511	AEK	Initial revision.

### **Applies To**

All BM2 batteries in the field as of May, 2023.

### **Description of Problem**

When a pre-updated BM2 is allowed to discharge down to its undervoltage (UV) limit without its RBF or Separation inhibits in place, its recovery when a charger is (re-)applied can be on the order of *many tens of minutes or hours*, before full-rate (re-)charging begins. This occurs because of an incorrect internal parameter associated with charging at UV levels.



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**Note** There is no evidence that this UV shutdown results in damage to the BM2's individual cells. The BM2 was sleeping (correctly) during the entire time it was shut down.

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### **Severity**

Pumpkin considers this to be an issue of *moderate* severity, and *requires* that all BM2 users perform this update.

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**Note** End-users who are uncomfortable performing this update can send their units back to Pumpkin for the update, at the end-user's expense.

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## Update Procedure

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**Note** The update must be performed on a BM2 with a minimum 10% state of charge (SoC). The update will require that the BM2 be restarted. The update can be applied while the BM2 is charging, discharging or at rest.

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The update procedure patches two parameters in the BM2's gas gauge Flash ROM. These two parameters are related to charging operations.

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**Note** The two new Flash ROM values of the update are written to nonvolatile memory in the BM2; therefore this update procedure need only be successfully applied once.

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## Before Updating

Prior to performing the update, issue the following two commands to the BM2, and note the responses:

```
BM2:TEL? 9,ASCII
BM2:TEL? 90,ASCII
```

The first telemetry query returns the BM2's (average) voltage, and the second returns the BM2's pack voltage. The pack voltage is likely to be far off of the average voltage, often by a factor of 2 or more.

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**Example** An *unpatched* 4S2P BM2 returned 16246(mV) for the average voltage and 4850(mV) for the pack voltage.

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## 4S2P (16.8V) Configurations

Issue the following commands to the BM2 over I2C:

```
BM2:NVM UNLOCK,12345
BM2:BQF WRITE,104,12,2,89,154
BM2:BQF WRITE,68,8,2,39,16
SUP:RES NOW
```

Or alternatively, issue these commands to the BM2 via its CLI:

```
cd ..
cd NVM
unlock
cd ..
cd SCPI
BM2:BQF WRITE,104,12,2,89,154
BM2:BQF WRITE,68,8,2,39,16
SUP:RES NOW
```

## Verifying the Update

Issue the following two commands (again) to the BM2 after it has restarted, and note the responses:

```
BM2:TEL? 9,ASCII
BM2:TEL? 90,ASCII
```

*Confirm that the returned values are within 1000mV of each other. This confirms that the update was successful, assuming that the exact command parameters above were successfully written to the Flash ROM.*

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**Example** A patched 4S2P BM2 returned 16256(mV) for the average voltage and 16536(mV) for the pack voltage.

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## Fixed In

All BM2s leaving the factory in May 2023 and later.

## Additional Notes

### Pack Voltage

The pack voltage will not match the (average) voltage, though it will be closest to the average voltage when the BM2 is in a state of rest. The pack voltage value is most useful when assessing the zero-volt / trickle-charging status of the BM2.

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**Note** During normal operation, *end-users should ignore the pack voltage* (telemetry item 90) and must *never* make any operational decisions based on the pack voltage.

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## Zero-volt / Trickle Charging

The BM2 automatically enters a special mode when charging and when the cells inside are at or below the minimum BM2 voltage and/or the cell UV threshold. This is the so-called zero-volt / trickle charging mode, and it limits the current into the cells to just a few tens of mA until all of the cell voltages rise above the BM2's cell UV threshold (with hysteresis). Unlike normal charging, no blue LEDs will blink on the SoC indicator when this is happening.

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**Tip** The best way to discern that the BM2 is in the zero-volt / trickle-charging mode is to observe that the current into the BM2 is

on the order of a few tens of mA and that the BM2's voltage and SoC are very low. This information can be cleaned via a **BM2:TEL? 10,ascii** command.

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## Post-Update Recovery from a UV Shutdown

When an uninhibited BM2 detects that it has reached its shutdown voltage, it implements a ultra-low-power sleep mode. In this mode, the current consumed is considerably less than the cells' self-discharge rate. However, in cases where a BM2 is left in this state for *months* at a time or longer, the cell voltages will all gradually decrease further, taking them all further below the UV charging threshold.

When a charger is applied to the BM2, the system wakes up and assess the safety of the cell voltages vs. a safe current limit; until the cells can be safely charged with high currents, the charging current is severely limited. As soon as all of the cells reach the UV charging threshold, then the charging current is allowed to increase to the safest allowed value, the blue SoC LEDs will begin blinking, etc.