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## BATTERY CELL SELF-DISCHARGE RATE GROUPING TO ENCHANCE BATTERY LIFE (BSGTEBL)

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# Battery Cell Self-Discharge Rate Grouping to Enhance Battery Life (BSGTEBL)

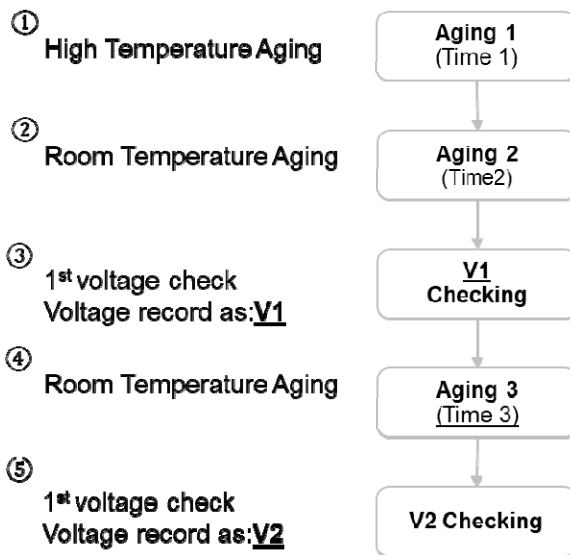
## Abstract

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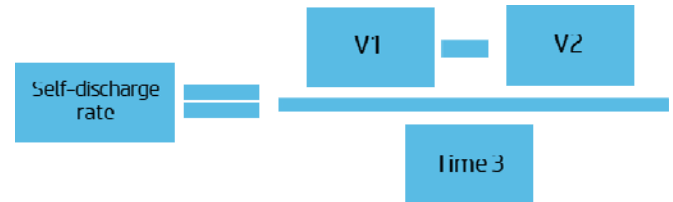
- **When battery is stored for a period (e.g. stored NB for a period), voltage of each cell in battery pack will result deviation. Higher the deviation (Delta V = voltage difference) higher inconsistency of voltage among each cell will be realized and finally leading to shorter battery life. This phenomenon is called “CIM (Cell imbalance)”.**
- **In order to decrease DeltaV (voltage difference), battery cells will be divided into several groups, then the consistency of each defined group with similar self-discharge rate.**
- **The general parameters used to group cells are open-circuit voltage (OCV), capacity, impedance. Self-discharge rate can be used as a grouping parameter to decrease battery cells DeltaV (voltage difference).**

## Self-Discharge Rate Measurement

### ❖ Self-discharge rate measure process



### ❖ Self-discharge rate calculation



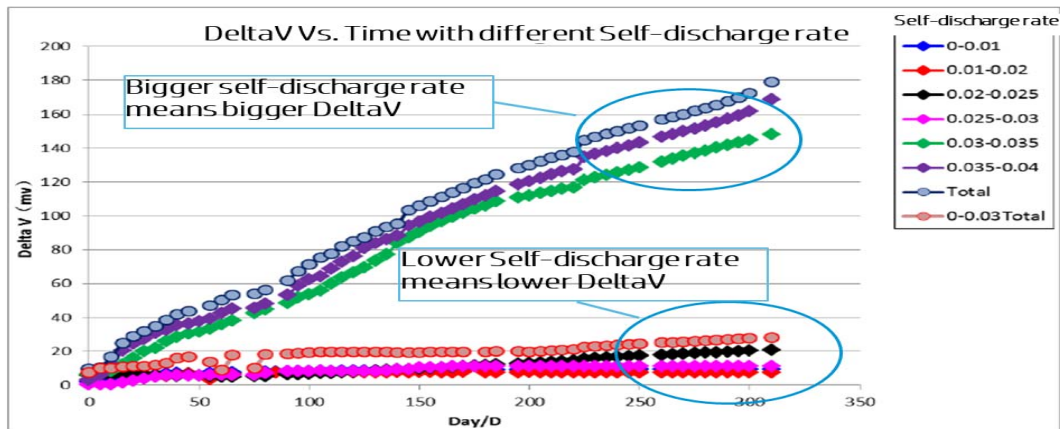
- **Self-Discharge rate measurement process is show as left picture.**
- **Self-discharge rate is calculated with right formula.**
- **Self-discharge rate unit is: mv/hour**
- **Self-discharge rate is used to measure battery cell self-discharge**
  - **For example: 0.03mv/hour means battery cell voltage decrease 0.03mv per hour.**
- **If cells Self-discharge rate are same, battery cell voltage should be similar after storage.**

## Self-discharge rate grouping to mitigate CIM (cell imbalance)

As shown in below picture:

- Bigger self-discharge rate takes bigger DeltaV
- Lower self-discharge rate takes lower DeltaV
- self-discharge rate grouping can help to decrease DeltaV, e.g.:
  - K-value < 0.03 as a group
  - K-value > 0.03 as a group

DeltaV: voltage difference



- Below table is general battery cell grouping parameter without Self-discharge.

	OCV	IR	Capacity
Group1	XX v+5mv	XX mΩ+5mΩ	XXmah+1%
Group2	XX v	XX mΩ	XX
Group3	XX v-5mv	XX mΩ-5mΩ	XXmah-1%

- Below table is battery cell grouping parameter with Self-discharge.

	OCV	IR	Capacity	self-discharge rate
Group1	XX v+5mv	XX mΩ+5mΩ	XXmah+1%	XX mv/hour + XX
Group2	XX v	XX mΩ	XX	XX mv/hour

<b>Group3</b>	<b>XX v-5mv</b>	<b>XX m<math>\Omega</math>-5m<math>\Omega</math></b>	<b>XXmah-1%</b>	<b>XX mv/hour-XX</b>
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### **Advantage**

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- **Enhance battery life by mitigating battery pack CIM.**
- **Saving cost on replacing battery by user to gain better user experience**

*Disclosed by Xiao Kai Mao, Jen-Hao Tai, Chien Kun Wang and Chang-Tai Lin, HP Inc.*