# *Battery Pack Test Report*

## *UN38.3*

Customer: Lenovo

Pack Model: L16C4PB2

Nominal voltage: 15.2V

Nominal capacity: 55Wh/3646mAh

Configuration: 4S1P

Customer P/N: 5B10M55952

Celxpert P/N: 921300112

Cell Type: Sony US485490H5K 3646mAh

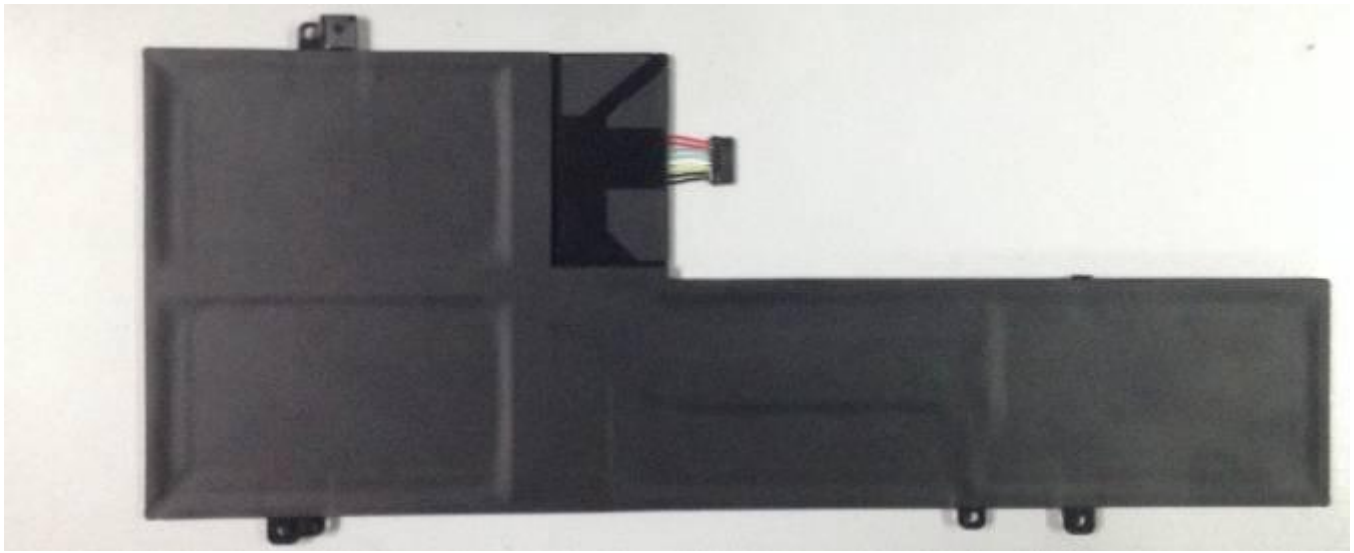
Jan.22 . 2018

Approved by_____

Reviewed by_____

Prepared by_____

Figure photo of the pack

# 1. UN38.3 Test Report

| Test Period | 2016/08/08~2016/09/02 | | Test Spec. | ST/SG/AC.10/11/Rev.5 Amend.2 | |
|---|---|---|---|---|---|
| Parts Name | Battery Pack | Application | NB | Quantity | Pack 16PCS/Cell 25pcs |

## 1.1 Test Summary

| Item | Test Item | Test Result | Details |
|---|---|---|---|
| T1 | Altitude simulation test (UN38.3-1) | Pass | Page 9 |
| T2 | Thermal test (UN38.3-2) | Pass | Page 10 |
| T3 | Vibration test (UN38.3-3) | Pass | Page 11 |
| T4 | Shock test (UN38.3-4) | Pass | Page 12 |
| T5 | Short Circuit test (UN38.3-5) | Pass | Page 13 |
| T6 | Crush Test (UN38.3-6) | Pass | Page 13 |
| T7 | Overcharge test (UN38.3-7) | Pass | Page 14 |
| T8 | Forced discharge test (UN38.3-8) | Pass | Page 15 |
| | | | |
| | | | |
| | | | |

**The battery pack passes UN38.3 test.**

### 1.2 Test sample list

| No. | Pack S/N | Test item | No. | Cell Num. | Test item |
|---|---|---|---|---|---|
| 1 | Sample No:1/16 | 38.3.1~5 | 1 | Sony US485490H5K 3646mAh | 38.3.6 |
| 2 | Sample No:2/16 | 38.3.1~5 | 2 | Sony US485490H5K 3646mAh | 38.3.6 |
| 3 | Sample No:3/16 | 38.3.1~5 | 3 | Sony US485490H5K 3646mAh | 38.3.6 |
| 4 | Sample No:4/16 | 38.3.1~5 | 4 | Sony US485490H5K 3646mAh | 38.3.6 |
| 5 | Sample No:5/16 | 38.3.1~5 | 5 | Sony US485490H5K 3646mAh | 38.3.6 |
| 6 | Sample No:6/16 | 38.3.1~5 | 6 | Sony US485490H5K 3646mAh | 38.3.8 |
| 7 | Sample No:7/16 | 38.3.1~5 | 7 | Sony US485490H5K 3646mAh | 38.3.8 |
| 8 | Sample No:8/16 | 38.3.1~5 | 8 | Sony US485490H5K 3646mAh | 38.3.8 |
| 9 | Sample No:9/16 | 38.3.7 | 9 | Sony US485490H5K 3646mAh | 38.3.8 |
| 10 | Sample No:10/16 | 38.3.7 | 10 | Sony US485490H5K 3646mAh | 38.3.8 |
| 11 | Sample No:11/16 | 38.3.7 | 11 | Sony US485490H5K 3646mAh | 38.3.8 |
| 12 | Sample No:12/16 | 38.3.7 | 12 | Sony US485490H5K 3646mAh | 38.3.8 |
| 13 | Sample No:13/16 | 38.3.7 | 13 | Sony US485490H5K 3646mAh | 38.3.8 |
| 14 | Sample No:14/16 | 38.3.7 | 14 | Sony US485490H5K 3646mAh | 38.3.8 |
| 15 | Sample No:15/16 | 38.3.7 | 15 | Sony US485490H5K 3646mAh | 38.3.8 |
| 16 | Sample No:16/16 | 38.3.7 | 16 | Sony US485490H5K 3646mAh | 38.3.8 |
| | | | 17 | Sony US485490H5K 3646mAh | 38.3.8 |
| | | | 18 | Sony US485490H5K 3646mAh | 38.3.8 |
| | | | 19 | Sony US485490H5K 3646mAh | 38.3.8 |
| | | | 20 | Sony US485490H5K 3646mAh | 38.3.8 |
| | | | 21 | Sony US485490H5K 3646mAh | 38.3.8 |
| | | | 22 | Sony US485490H5K 3646mAh | 38.3.8 |
| | | | 23 | Sony US485490H5K 3646mAh | 38.3.8 |
| | | | 24 | Sony US485490H5K 3646mAh | 38.3.8 |
| | | | 25 | Sony US485490H5K 3646mAh | 38.3.8 |

## 1.3 Test result

| Item | Test Item | Test specification | Judge criteria | Sample(s) |
|---|---|---|---|---|
| **T1** | Altitude Simulation (UN38.3-1) | 1-1. 4 batteries are standard charged. 4 batteries are 1C cycled 50 times, ending in fully charged state. All batteries weight is measured. The charged batteries voltage are measured and recorded.<br>1-2. Batteries shall be stored at a pressure of 11.6Kpa or less for at least six hours at ambient temperature 20+/-5 ℃.<br>1-3. Vacuum is released. All cells weight is measured. The charged cell voltage are measured and recorded. | No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%. | 4 packs are standard charged (Pack#1~4)<br>4 packs 50 cycled ending in fully charged states (Pack#5~8) |
| Test Period | | Start: 2016/08/08 End:2016/08/08 | | |
| Test Equipment | | 數位電表 Q153, 電子天平 Q090, 真空烘箱 Q0443 | | |
| Major Problem | | - | | |
| Warning Point | | - | | |
| Recommendation | | The battery packs pass the test. | | |

Raw Data

**Altitude Simulation Test on Charged Packs**

| No. | Before | | After | | voltage residue | mass loss | other event |
|---|---|---|---|---|---|---|---|
| | OCV (V) | Weight (g) | OCV (V) | Weight (g) | Volt (%) | Weight (%) | |
| 1 | 16.843 | 248.18 | 16.841 | 248.17 | 99.99% | 0.00% | O |
| 2 | 16.837 | 248.22 | 16.836 | 248.21 | 99.99% | 0.00% | O |
| 3 | 16.825 | 248.16 | 16.824 | 248.15 | 99.99% | 0.00% | O |
| 4 | 16.831 | 248.13 | 16.828 | 248.12 | 99.98% | 0.00% | O |
| 5 | 16.624 | 248.21 | 16.622 | 248.20 | 99.99% | 0.00% | O |
| 6 | 16.656 | 248.15 | 16.653 | 248.14 | 99.98% | 0.00% | O |
| 7 | 16.647 | 248.09 | 16.646 | 248.08 | 99.99% | 0.00% | O |
| 8 | 16.639 | 248.14 | 16.635 | 248.13 | 99.98% | 0.00% | O |

Note: L-Leakage ; V-Venting ; D-Disassembly ; R-Rupture ; F-Fire
O-No Leakage , No Venting , No Disassembly , No Rupture , No Fire

| Item | Test Item | Test specification | Judge criteria | Sample(s) |
|---|---|---|---|---|
| **T2** | Thermal test (UN38.3-2) | 2-1. Packs are stored for 6 hours at 72±2℃, followed by storage for 6 hours at -40±2℃. The maximum time interval between test temperature extremes is 30 minutes.<br><br>2-2.Repeat 2-1 for 10 times. Then store the packs at ambient for 24 hours. All packs weight are measured. The charged battery voltage are measured and recorded. | No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%. | 4 packs are standard charged (Pack#1~4)<br>4 packs 50 cycled ending in fully charged states (Pack#5~8) |

| | |
|---|---|
| Test Period | Start: 2016/08/10 End:2016/08/15 |
| Test Equipment | 數位電表 Q153, 電子天平 Q090, 冷熱衝擊機 Q0446 |
| Major Problem | - |
| Warning Point | - |
| Recommendation | The packs pass the test. |

Raw Data

**Thermal Test on Charged Packs**

| No. | Before | | After | | voltage residue | mass loss | other event |
|---|---|---|---|---|---|---|---|
| | OCV (V) | Weight (g) | OCV (V) | Weight (g) | Volt (%) | Weight (%) | |
| 1 | 16.841 | 248.17 | 16.772 | 248.12 | 99.59% | 0.02% | O |
| 2 | 16.836 | 248.21 | 16.760 | 248.15 | 99.55% | 0.03% | O |
| 3 | 16.824 | 248.15 | 16.749 | 248.09 | 99.55% | 0.02% | O |
| 4 | 16.828 | 248.12 | 16.754 | 248.08 | 99.56% | 0.02% | O |
| 5 | 16.622 | 248.20 | 16.551 | 248.15 | 99.57% | 0.02% | O |
| 6 | 16.653 | 248.14 | 16.578 | 248.09 | 99.55% | 0.02% | O |
| 7 | 16.646 | 248.08 | 16.578 | 248.02 | 99.59% | 0.02% | O |
| 8 | 16.635 | 248.13 | 16.560 | 248.07 | 99.55% | 0.02% | O |

Note: L-Leakage ; V-Venting ; D-Disassembly ; R-Rupture ; F-Fire
O-No Leakage , No Venting , No Disassembly , No Rupture , No Fire

| Item | Test Item | Test specification | Judge criteria | Sample(s) |
|---|---|---|---|---|
| **T3** | Vibration test (UN38.3-3) | 3-1. Packs are firmly secured to the platform of the vibration machine without distorting the packs in such a manner as to faithfully transmit the vibration. The vibration shall be a sinusoidal waveform with a logarithmic sweep between 7 and 200 Hz and back to 7 Hz traversed in 15 minutes. This cycle shall be repeated 12 times for a total of 3 hours for each of 3 mutually perpendicular to the terminal face.<br>3-2. The logarithmic frequency sweep is as follows:<br>7-18 Hz ➔ 1gn<br>18-50 Hz ➔ 0.8mm amplitude<br>50-200 Hz ➔ 8gn<br>3-3. All packs weight are measured. The charged packs voltage are measured and recorded. | No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%. | 4 packs are standard charged (Pack#1~4)<br>4 packs 50 cycled ending in fully charged states (Pack#5~8) |

| | |
|---|---|
| Test Period | Start: 2016/08/25 End:2016/08/26 |
| Test Equipment | 數位電表 Q153, 電子天平 Q090, 振動測試機 Q300 |
| Major Problem | - |
| Warning Point | - |
| Recommendation | The packs pass the test. |

Raw Data

**Vibration Test on Charged Packs**

| No. | Before | | After | | voltage residue | mass loss | other event |
|---|---|---|---|---|---|---|---|
| | OCV (V) | Weight (g) | OCV (V) | Weight (g) | Volt (%) | Weight (%) | |
| 1 | 16.772 | 248.12 | 16.765 | 248.08 | 99.96% | 0.02% | O |
| 2 | 16.760 | 248.15 | 16.753 | 248.12 | 99.96% | 0.01% | O |
| 3 | 16.749 | 248.09 | 16.741 | 248.05 | 99.95% | 0.02% | O |
| 4 | 16.754 | 248.08 | 16.746 | 248.04 | 99.95% | 0.01% | O |
| 5 | 16.551 | 248.15 | 16.543 | 248.12 | 99.95% | 0.01% | O |
| 6 | 16.578 | 248.09 | 16.572 | 248.04 | 99.96% | 0.02% | O |
| 7 | 16.578 | 248.02 | 16.569 | 247.99 | 99.95% | 0.01% | O |
| 8 | 16.560 | 248.07 | 16.553 | 248.04 | 99.96% | 0.01% | O |

Note: L-Leakage ; V-Venting ; D-Disassembly ; R-Rupture ; F-Fire
O-No Leakage , No Venting , No Disassembly , No Rupture , No Fire

| Item | Test Item | Test specification | Judge criteria | Sample(s) |
|---|---|---|---|---|
| **T4** | Shock test (UN38.3-4) | 4-1. Packs shall be secured to the testing machine by means of a rigid mount, which will support all mounting surfaces.<br>4-2. Packs shall be subjected to a half-sine shock of peak acceleration 150gn and pulse duration of 6 milliseconds. Each pack shall be subjected to 3 shocks in the positive direction followed by three shocks in the negative direction of three mutually perpendicularly mounting positions of the pack for a total of 18 shocks.<br>4-3. All batteries weight are measured. The charged cell voltage are measured and recorded. | No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%. | 4 packs are standard charged (Pack#1~4)<br>4 packs 50 cycled ending in fully charged states (Pack#5~8) |

| | |
|---|---|
| Test Period | Start: 2016/08/29 End:2016/08/29 |
| Test Equipment | 數位電表 Q153, 電子天平 Q090, 衝擊測試機 Q154 |
| Major Problem | - |
| Warning Point | - |
| Recommendation | The packs pass the test. |

Raw Data

**Shock Test on Charged Packs**

| No. | Before | | After | | voltage residue | mass loss | other event |
|---|---|---|---|---|---|---|---|
| | OCV (V) | Weight (g) | OCV (V) | Weight (g) | Volt (%) | Weight (%) | |
| 1 | 16.765 | 248.08 | 16.759 | 248.08 | 99.96% | 0.00% | O |
| 2 | 16.753 | 248.12 | 16.748 | 248.11 | 99.97% | 0.00% | O |
| 3 | 16.741 | 248.05 | 16.736 | 248.05 | 99.97% | 0.00% | O |
| 4 | 16.746 | 248.04 | 16.740 | 248.04 | 99.96% | 0.00% | O |
| 5 | 16.543 | 248.12 | 16.539 | 248.11 | 99.98% | 0.00% | O |
| 6 | 16.572 | 248.04 | 16.565 | 248.04 | 99.96% | 0.00% | O |
| 7 | 16.569 | 247.99 | 16.563 | 247.98 | 99.96% | 0.00% | O |
| 8 | 16.553 | 248.04 | 16.548 | 248.04 | 99.97% | 0.00% | O |

Note: L-Leakage ; V-Venting ; D-Disassembly ; R-Rupture ; F-Fire
O-No Leakage , No Venting , No Disassembly , No Rupture , No Fire

| Item | Test Item | Test specification | Judge criteria | Sample(s) |
|---|---|---|---|---|
| **T5** | Short Circuit Test (UN38.3-5) | 5-1.Packs are placed in to a 55±2℃ oven, and exterior packs temperature are monitored<br>5-2.When packs exterior reach 55±2℃, they are shorted by connecting terminals with a copper wire of resistance less than 100m Ohm.<br>5-4. The short was continued for more than 1hour or the cell temperature return to 55℃. The packs are observed for a further 6 hours. | No rupture, no disassembly, no explosion, no fire, no smoke. Packs exterior peak temperature <170℃. | 4 packs are standard charged (Pack#1~4)<br>4 packs 50 cycled ending in fully charged states (Pack#5~8) |
| Test Period | Start: 2016/08/31 End:2016/09/02 | | | |
| Test Equipment | 數位電表 Q153, 資料收集器 Q075, 烘箱 Q171 | | | |
| Recommendation | The packs pass the test. | | | |

Raw Data

**Short Circuit Test on Charged Packs**

| No. | Max. Temp.(℃) | Other event |
|---|---|---|
| 1 | 55.34 | O |
| 2 | 55.69 | O |
| 3 | 55.28 | O |
| 4 | 55.47 | O |
| 5 | 55.19 | O |
| 6 | 56.24 | O |
| 7 | 54.87 | O |
| 8 | 55.52 | O |

Note: D-Disassembly ; R-Rupture ; F-Fire
O- No Disassembly , No Rupture , No Fire

| Item | Test Item | Test specification | Judge criteria | Sample(s) |
|---|---|---|---|---|
| **T6** | Crush test/ Impact test (UN38.3-6) | 6-1.Cell's diameter > 20mm, Execution impact test. (A 9.1 Kg mass is to be dropped from a height of 61±2.5cm onto the sample.)<br><br>6-2.Cell's diameter < 20mm, Execution crush test (The cells are crushed with a 13 KN with the crush tester. Once the force is obtained it is to be released.) | External temperature of cell does not exceed 170℃ and there is no disassemb ly and no fire within 6 hours of the test. | 5 cells are 50% charged (Cell #1~5) |
| Test Period | Start: 2016/08/15 End:2016/08/15 | | | |
| Test Equipment | 數位電表 Q153, 資料收集器 Q152, 擠壓試驗機 Q437/撞擊測試機 Q231 | | | |
| Recommendation | The Cells pass the test. | | | |

Raw Data

**Crush Test on 50% Charged Cells**

| No. | Max. Temp.(℃) | Other event |
|---|---|---|
| 1 | 22.36 | O |
| 2 | 23.17 | O |
| 3 | 21.45 | O |
| 4 | 20.68 | O |
| 5 | 21.22 | O |

Note: D-Disassembly ; F-Fire / O-No Disassembly , No Fire

| Item | Test Item | Test specification | Judge criteria | Sample(s) |
|---|---|---|---|---|
| **T7** | Overcharge test (UN38.3-7) | 7-1. The charge current shall be twice the Spec's recommended maximum continuous charge current.<br>7-2.The minimum voltage of the test shall be as follows:<br>(a) When the Spec's recommended charge voltage is not more than 18V, the minimum voltage of the test shall be the lesser of two times the maximum charge voltage of the battery or 22V.<br>(b) When the Spec's recommended charge voltage is more than 18V, the minimum voltage of the test shall be 1.2 times the maximum charge voltage.<br>7-3. Tests are to be conducted at ambient temperature. The duration of the test shall be 24 hours. | No disassembly, no fire within seven days after the test. | 4 packs are fully charged (Pack#9~12)<br>4 packs are 50 times cycled ending in fully charged state (Pack #13~16) |

| | |
|---|---|
| Test Period | Start: 2016/08/25 End:2016/08/31 |
| Test Equipment | 數位電表 Q153, 資料收集器 Q078, 電源供應器 Q148/Q149/Q150 |
| Major Problem | - |
| Warning Point | - |
| Recommendation | The packs pass the test. |

Raw Data

**Overcharge Test on Charged Packs**

| No. | Charge Voltage(V) | Charge Current(A) | Max. Temp.(°C) | Other event |
|---|---|---|---|---|
| 9 | 22.0 V | 8.5 | 22.31 | O |
| 10 | | | 21.56 | O |
| 11 | | | 22.87 | O |
| 12 | | | 21.45 | O |
| 13 | | | 20.69 | O |
| 14 | | | 23.07 | O |
| 15 | | | 21.84 | O |
| 16 | | | 22.16 | O |

Note: D-Disassembly ; F-Fire / O-No Disassembly ,No Fire

| Item | Test Item | Test specification | Judge criteria | Sample(s) |
|---|---|---|---|---|
| **T8** | Forced discharge test (UN38.3-8) | Cell shall be forced discharged at ambient temperature by connecting it in series with a 12 V D.C. power supply at an initial current equal to the maximum discharge current Specified by the manufacturer. | No disassembly, no fire within seven days after the test. | 10 cells are first cycle in fully discharged states (Pack#6~15)<br>10 cells are after 50 cycles ending in fully discharged states (Pack #16~25) |
| Test Period | Start: 2016/08/17 End:2016/08/19 | | | |
| Test Equipment | 數位電表 Q153, 資料收集器 Q160, 電源供應器 Q147/Q236/Q237 | | | |
| Major Problem | - | | | |
| Warning Point | - | | | |
| Recommendation | The packs pass the test. | | | |

Raw Data

| Forced discharge are first cycle in fully discharged | | | Forced discharge are after 50 cycles ending in fully discharged | | |
|---|---|---|---|---|---|
| No. | Max. Temp.(℃) | Other event | No. | Max. Temp.(℃) | Other event |
| 6 | 36.54 | O | 16 | 39.17 | O |
| 7 | 28.93 | O | 17 | 36.54 | O |
| 8 | 42.85 | O | 18 | 33.82 | O |
| 9 | 40.12 | O | 19 | 25.62 | O |
| 10 | 33.94 | O | 20 | 40.07 | O |
| 11 | 38.75 | O | 21 | 31.16 | O |
| 12 | 39.11 | O | 22 | 30.84 | O |
| 13 | 26.63 | O | 23 | 29.67 | O |
| 14 | 28.09 | O | 24 | 31.32 | O |
| 15 | 31.28 | O | 25 | 38.43 | O |

Note:D-Disassembly ; F-Fire / O-No Disassembly , No Fire