



能元科技股份有限公司
E-One Moli Energy Corp.

Lithium-Ion Rechargeable Product
Approval Sheet

Customer: _____

Product: ☐ Cell ☐ Pack

Model: _____

Document No: _____ Revision: _____

Issue Date: _____

E-One Moli Energy Corp:

| | Sales/Marketing (Date) | QA (Date) | R&D (Date) | Originator (Date) |
|--|---------------------------|--------------|---------------|----------------------|
| | | | | |

Customer Signature: _____

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| 能元科技股份有限公司 E-One Moli Energy Corp. | Document Name | Cell Specifications of MOLICEL IMR18650E | | | | |
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1. SCOPE

This specification defines the characteristics of a lithium ion rechargeable cell, IMR18650E, 1.40Ah LiPF₆ Spinel - Graphite cell, manufactured by E-One Moli Energy.

2. SAFETY STANDARDS AND REGULATIONS

- 2.1 IEC 61960 International Electrotechnical Commission, Secondary Lithium Cells and Batteries for Portable Applications
- 2.2 IEC 62133 International Electrotechnical Commission, Safety Requirements for Portable Sealed Secondary Cells, and for Batteries made from them, for use in Portable Applications
- 2.3 IEC 62281 Safety of Primary and Secondary Lithium Cells during Transport
- 2.4 UL 1642 Standard for Safety of Lithium Batteries
- 2.5 UN ST/SG/AC.10/11/Rev 3 Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria

3. APPLIED PRODUCT NAME AND PRODUCT DESIGNATION

3.1 Name

Lithium ion rechargeable cell, 18650 size, LiPF₆ electrolyte, LiMn₂O₄ cathode.

3.2 Designation

I M R 18650 E

① ② ③ ④ ⑤

①: Indicates the negative electrode system.

The letter 'I' defines the lithium ion system with an intercalation electrode.

②: Indicates the positive electrode system.

The letter 'M' defines a manganese Spinel-based electrode.

③: Indicates the shape of the cell.

The letter 'R' defines a cylindrical (round) shaped cell.

④: Indicates the diameter and overall height of the cell.

First two numerical figures define the diameter (unit; mm).

18 = 18mm

Following three numerical figures define overall height (unit; 0.1 mm)

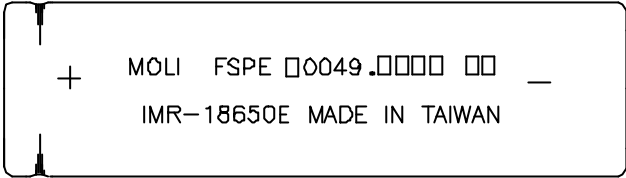
650 = 65mm.

⑤ Indicates the rated capacity of the cell.

The letter 'E' defines 1.40Ah rated capacity for 20A cells.

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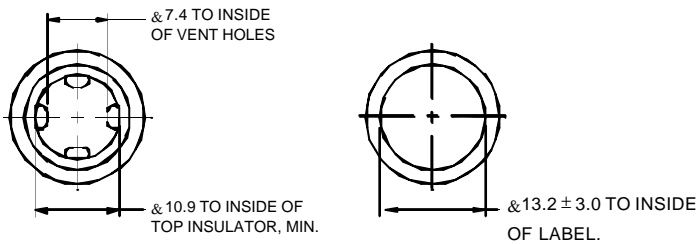
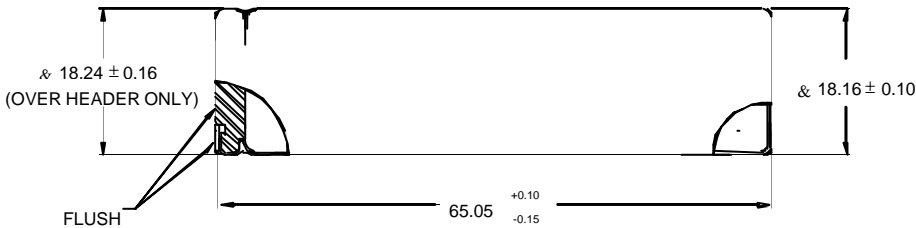
3.3 Cell Marking



| | |
|-----------------|---|
| Legend: | |
| MOLI: | Made by E-One Moli Energy. |
| FSPE.#####: | Product Development Specification Number. 70049 for Canada, 80049 for Taiwan |
| : | Cell lot number. |
| IMR-18650: | Model designation (refer to Section 3.2) |
| E: | Capacity designation (refer to Section 3.2) |
| MADE IN XXXXXX: | Cell is manufactured either in Taiwan or Canada. |
| + / -: | Cell polarity. |

4. CONSTRUCTION

- 4.1 Shape: Cylindrical
- 4.2 Dimensions:
 - Overall Height: 65.05 + 0.10/-0.15 mm
 - Diameter (incl. label) 18.24 ± 0.16 mm (top end), 18.16 ± 0.10 mm (bottom end)
- 4.3 Weight: < 44g



TOP VIEW BOTTOM VIEW
Finished Cell Dimension (Labeled, shipped state)

| | | | | | | |
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5. RATED SPECIFICATIONS

| Items | | Specifications | Remarks |
|-------|--|---|---|
| 1a | Rated charge | Limiting 1.4A and constant 4.2V charge for 90minutes at 23°C. | |
| 1b | Recommended charge | Limiting 1.4A and constant 4.2V charge for 90minutes at 23°C. | |
| 2 | Rated discharge | Constant 1.4 A discharge until 2.5V at 23°C. | |
| 3 | Rated capacity | 1.40Ah | Minimum of rated discharge capacity after rated charge of fresh cell. |
| 4 | Nominal voltage | 3.86V | Mean voltage during rated discharge after recommended. |
| 5 | Shipping voltage | 3.95V | Nominal. Approximate state of charge = 50%. |
| 6 | Internal resistance at shipping | <30mΩ | By AC 1 kHz within 3~4 hours after 50% discharge. |
| 7 | End of charge voltage | 4.20 ± 0.05V | |
| 8 | End of discharge voltage | 2.5V | Discharge voltage used for rated capacity and standard cycling. |
| 9 | Charging time | 90minutes | Rated and recommended charge. |
| 10 | Maximum continuous charging current | 6.5A | Present UL approval level. |
| | Maximum continuous discharging current | 20A | Maximum permitted discharge current to avoid skin temperature over 60 °C. |
| 11 | Operating temperature | Charging | 0 ~ 45 °C |
| | | Discharging | -20 ~ 60 °C |
| 12 | Storage temperature | <30 °C | Recommended temperature for long term storage is ≤23 °C. |
| 13 | Shelf life | 1 year | Typical value at 23 °C from ship state. |

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6. SAFETY PROTECTION FUNCTIONS

6.1 Safety Valve

Relieves pressure in event of excessive internal build up.

6.2 Electrical Disconnect

Non-resetting. Prevents excessive overcharge.

6.3 Meltable Separator

Prevents thermal runaway due to external short.

7. PERFORMANCE

7.1 Test Condition

7.1.1 The cells used in the following tests are sampled after 3-6 days storage and typically are tested after 1 standard cycle.

7.1.2 All tests are carried out at an ambient temperature between 15 °C and 30 °C, at a relative humidity between 45% and 85% except where otherwise noted.

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7.2 Performance

7.2.1 Electrical Performance

| Items | | | Typical | Conditions |
|-------|---|-------------|-----------|--|
| 1a) | Discharge capacity and energy (Rate capability) at 23°C | 20A | 1.40 Ah | Discharge capacity and energy to 2.5V after recommended charge. |
| | | | 4.70 Wh | |
| | | 15A | 1.44 Ah | Discharge capacity and energy to 2.5V after recommended charge. |
| | | | 5.05Wh | |
| | | 7.2A | 1.45 Ah | Discharge capacity and energy to 2.5V after recommended charge. |
| | | | 5.20 Wh | |
| | | 5A | 1.47 Ah | Discharge capacity and energy to 2.5V after recommended charge. |
| | | | 5.50 Wh | |
| | | 1.4A | 1.48 Ah | Discharge capacity and energy to 2.5V after recommended charge. |
| | | | 5.70 Wh | |
| 1b) | Discharge capacity and energy at 45°C | 1.4A | 1.45 Ah | Discharge capacity and energy to 2.5V after recommended charge. |
| | | | 5.60 Wh | |
| 2) | Discharge capacity and energy (Temp. capability) at 10A | 23°C | 1.45 Ah | Discharge capacity and energy to 2.5V after recommended charge. |
| | | | 5.25 Wh | |
| | | 0°C | 1.42 Ah | Discharge capacity and energy to 2.5V after recommended charge. |
| | | | 4.80 Wh | |
| | | -18°C | 1.40 Ah | Discharge capacity and energy to 2.5V after recommended charge. |
| | | | 4.55 Wh | |
| 3) | Rated energy density | Volumetric | 332 Wh/l | Calculated energy density based on maximum volume and weight specifications using 1.4A discharge to 2.5V at 23°C after recommended charge, at cycle 2. |
| | | Gravimetric | 132 Wh/kg | |
| 4) | Voltage Dip @ ~0.400Ah | 23°C | 3.27V | Lowest Voltage point in Voltage Dip at 25A to 2.5V after rated charge (C2). |
| 5) | Rate Map Impedance | 23°C | 0.0320hms | Maximum resistance of cell measured during 5A, 10A, 15A and 20A Discharge to 2.5V after rated charge (C2 to C5). |

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7.2.2 Storage Performance

| Items | | | | Typical | Conditions |
|-------|--------------------|------------------|------|---------|---|
| | | | DOD | | |
| 1) | Capacity retention | 23 °C 28 days | 0% | 91% | Rated discharge capacity after storage. Ah capacity ratio to before storage at rated discharge. (Storage: after recommended charge, i.e. 0% Depth of Discharge) |
| | | 45 °C 28 days | 0% | TBD | |
| | | 60 °C 7 days | 0% | 86% | |
| 2) | Capacity recovery | 23 °C 28 days | 0% | 96% | Rated discharge capacity after storage, rated discharge then recommended charge. Wh capacity ratio to before storage at rated discharge. |
| | | | 50% | TBD | |
| | | | 100% | TBD | |
| | | 45 °C 28 days | 0% | TBD | |
| | | | 50% | TBD | |
| | | | 100% | TBD | |
| | | 60 °C 7 days | 0% | 92% | |
| | | | 50% | TBD | |

TBD: To Be Determined

7.2.3Cycle Life

| Item | | | | | Typical | Conditions |
|------|------------|---------------|------|----|---------|---|
| 1) | Cycle life | 23 °C 4.2A | C100 | Wh | 92% | 4.2A discharge at 23 °C on cycle 100 and 200. Energy ratio to cycle 10 energy. (Cycling:4.2A charge, 4.2A discharge, at 23 °C) |
| | | | C200 | Wh | 85% | |
| | | 23 °C 7.2A | C100 | Wh | 89% | 7.2A discharge at 23 °C on cycle 100 and 200. Energy ratio to cycle 10 energy. (Cycling:1.4A charge, 7.2A discharge, at 23 °C) |
| | | | C200 | Wh | 82% | |

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7.2.4 Capacity reference table

| Discharge Temperature (°C) | Typical Capacity (Ah) at Various Rates | | | | |
|----------------------------|--|------|------|------|------|
| | 1.4A | 5A | 10A | 15A | 20A |
| -18 | 1.46 | 1.43 | 1.40 | NA | NA |
| -10 | TBD | TBD | TBD | NA | NA |
| 0 | 1.48 | 1.46 | 1.42 | 1.38 | NA |
| 23 | 1.48 | 1.47 | 1.45 | 1.44 | 1.40 |
| 45 | 1.45 | 1.44 | NA | NA | NA |
| 60 | 1.45 | NA | NA | NA | NA |

7.2.5 Environmental Performance

| Items | | Criteria | Typical | Conditions |
|-------|------------------------|---|--|--|
| 1) | Shock | No leakage, mass loss, no venting, disassembly, no rupture and no fire 90% voltage recovery. | No leakage, mass loss, no venting, disassembly, no rupture and no fire | Subject to 6 shocks/axis, 18 total, of peak acceleration of 150g and pulse duration of 6 ms. (UN method) |
| 2) | Drop proof | No leakage, weight loss, no vent, fire or explosion <30mg weight loss, 24Hr dAC Z = 5mOhm 24Hr dV = 25mV | No leakage, weight loss, no vent, fire or explosion No disconnect | Drop from a height of 3ft onto a concrete floor 3 times each for bottom, side and header orientations. |
| 3) | Vibration proof | No leakage, mass loss, no venting, disassembly, no rupture and no fire 90% voltage recovery. | No leakage, mass loss, no venting, disassembly, no rupture and no fire | Subject to 7~200Hz / 15min vibration, 12×15min/3 axes at an amplitude of 0.8mm (1.6mm total excursion). (UN method) |
| 4) | High temp. Storage | No leakage, no vent, fire or explosion | No leakage, no vent, fire or explosion | Rated discharge capacity after leaving at 85°C for 10h, rated discharge then rated charge. |
| 5) | High altitude exposure | No leakage, weight loss, no vent, fire or explosion 90% voltage recovery. | No leakage, weight loss, no vent, fire or explosion | Stored at a pressure of 11.6kPa for 6hrs at 20°C. (UN method) |

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7.3 Safety Performance

7.3.1 Environmental Endurance Performance

| Items | | Criteria | Typical | Conditions |
|-------|--------------------------------|----------------------|----------------------|---|
| 1) | -40°C , 85°C temperature cycle | No fire or explosion | No fire or explosion | (Storage: -40°C for 1h, 1h ramp to 85°C, 85°C for 1h, 1h ramp to -40°C. Repeat cycle 30 times) |
| 2) | Heating 150°C | No fire or explosion | No fire or explosion | Oven temperature is to be raised at a rate of 5°C (± 2°C) per minute to a temperature of 150°C. At 150°C dwell for 10 minutes. UL 1642 standard is to 130°C. |
| 3) | Incineration | No explosion | No explosion | Exposing to flame per UL1642. |

7.3.2 Electrical Endurance Performance

| Items | | Criteria | Typical | Conditions |
|-------|----------------------|---------------------------------------|----------------------|--|
| 1) | Short circuit @ 60°C | No fire or explosion Temp. < 150°C | No fire or explosion | External circuit impedance is <35mΩ. |
| 2) | UN Forced discharge | No fire or explosion | No fire or explosion | Discharge at a current of 10 A for 0.14 h. |
| 3) | Overcharge | No fire or explosion | No fire or explosion | Charging at a current of 3A to 15V from the fully charged state. |
| 3) | Overcharge Insulated | No fire or explosion | No fire or explosion | Charging at a current of 19.5A to 15V from the fully discharged state. |

7.3.3 Mechanical Endurance Performance

| Items | | Criteria | Typical | Conditions |
|-------|--------|----------------------|----------------------|---|
| 1) | Crush | No fire or explosion | No fire or explosion | Crush between two flat plates. Applied force is about 13kN. |
| 2) | Impact | No fire or explosion | No fire or explosion | Impact by 15.8mmφ bar of 9.1kg weight dropped from 61cm height on the flat surface. |

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8. REGULATORY COMPLIANCE

8.1 UL1642 recognized component.

8.2 Complies with UN amendments to the third revised edition of the recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria.

9. PRECAUTIONS FOR USING LITHIUM ION RECHARGEABLE CELL

The lithium ion rechargeable cell with high power and long life has played a significant role in the rising popularity of portable electronic products such as notebook, power tools, etc. E-One Moli Energy, a pioneer in lithium ion cell development and manufacturing in Taiwan, is capable of providing lithium ion cells with absolute safety, small size, high power, and long life. The precautions described below are important to assure the achievements of designed performance and safety.

9.1 Handling Precautions

9.1.1 Charging

The lithium ion rechargeable cell is to be charged by “constant current/constant voltage” method. The lithium ion cell is charged at a constant current (CC Mode) until the cell voltage reaches 4.2 V, followed by a constant voltage charge (CV Mode) at 4.2 V. The charging current at this constant voltage tapers off. As long as the tapering current is down to 2% of 1C rate current or the charging time at CV Mode reaches 1.5 hours (whichever comes first); the charge process is terminated.

1) Charge voltage:

Do not exceed the specified charge voltage (4.2V per single cell). If the cells are used in cell packs, the maximum voltage is 4.2 x N (N= number of cells connected in series) V.

2) Charge current:

Charge the cell at the specified charge current 6.5A or less.

3) Charge temperature:

Charge the cell at the temperature range of 0°C -45 °C. Due consideration should also be given to the arrangement of the cell pack so that it is in that temperature range even though it is effected by heat generated in the cell charger.

9.1.2 Reverse charging:

The cell must be prevented from the reverse-polarity charging.

9.1.3 Discharging

A lithium ion rechargeable cell starts to discharge at 4.2V and terminates at a cut off voltage of 2.5V.

1) Discharge current:

Discharge the cell at the specified discharge current 20A or less.

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2) Discharge temperature:

Discharge the cell at temperature range from -20°C to 60°C . At a temperature of -20°C or less, the cell will show a significant decrease in discharge capacity.

3) Discharge termination voltage/Over discharge:

Avoid discharge to voltage less than 2.5V per single cell. A leak current to the equipment may over discharge the cell, which may damage the performance of cell.

9.1.4 Long-term Storage

- 1) In case of long-term storage, store the cell at temperature range of $0\sim+30^{\circ}\text{C}$, low humidity, no corrosive gas atmosphere.
- 2) When storing the cell for a long period longer than one year, charge it at least once a year. And in this case, the cell is recommended to be charged to E-one Moli Energy, shipment charged state.
- 3) No condensation on the cell.

9.2 Safety Precautions

9.2.1 When using the cell

ⓘ WARNING

- 1) Mistreatment of a cell may cause the cell to generate heat, explode, or ignite and cause serious injury. Be sure to follow the safety rules as follows:
 - (1) Do not solder directly onto the cell.
 - (2) Do not place the cell in fire or heat the cell.
 - (3) Do not install the cell backwards so that the polarity is reversed.
 - (4) Do not expose the cell to water or salt water, or allow the cell to get wet.
 - (5) Do not carry or store the cells together with necklaces, hairpins or other metal objects.
 - (6) Do not place the cells in microwave ovens, high-pressure containers, or on induction cookware.
 - (7) Do not connect the positive terminal and the negative terminal of the cell to each other with any metal objects such as chains, coins or wire.
 - (8) Do not pierce the cell with nails, strike the cell with a hammer, step on the cell, or otherwise subject it to strong impacts or shocks.
- 2) Do not disassemble or modify the cell. The cell contains safety and protection devices, if damaged, may cause the cell to generate heat, explode or ignite.
- 3) Do not place the cell in or near fires, stoves, or other high-temperature locations. Do not place the cell in direct sunshine, or use or store the cell inside cars in hot weather. Doing so may cause the cell to generate heat, explode, or ignite. Using the cell in this manner may also result in a loss of performance and a shortened life expectancy.

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① CAUTION

- 4) If the device is to be used by small children, the caregiver should explain the contents of the user's manual to the children. The caregiver should provide adequate supervision to ensure that the device is being used as explained in the user's manual.
- 5) When the cell is worn out, insulate the terminals with adhesive tape or similar materials before disposal.
- 6) Immediately discontinue use of the cell if, while using, charging, or storing the cell, the cell emits an unusual smell, feels hot, changes color, changes shape, or appears abnormal in any other way. Contact your sales location or E-One Moli Energy if any of these problems are observed.
- 7) In the event that the cell leaks and the fluid gets into one's eye, do not rub the eye. Rinses well with water and immediately seek medical care. If left untreated the cell fluid could cause damage to the eye.

9.2.2 When charging the cell

① WARNING

- 1) Be sure to follow the rules listed below while charging the cell. Failure to do so may cause the cell to become hot, explode, or ignite and cause serious injury.
 - (1) Do not attach the cells to a power supply plug or directly to a car's cigarette plug.
 - (2) When charging the cell, either use a specified cell charger or otherwise ensure that the cell charging conditions specified by E-One Moli Energy are met.
 - (3) Do not place the cells in or near fire, or into direct sunlight. When the cell becomes hot, the built in safety equipment is activated, preventing the cell from charging further, and heating the cell can destroy the safety equipment and can cause additional heating, breaking, or ignition of the cell.
- 2) Do not continue charging the cell if it does not recharge within the specified charging time. Doing so may cause the cell to become hot, explode, or ignite.

① CAUTION

- 3) The temperature range over which the cell can be charged is 0°C to 45 °C. Charging the cell at temperatures outside of this range may cause the cell to become hot or to break. Charging the cell outside of this temperature range may also harm the performance of the cell or reduce the cell's life expectancy.

9.2.3 When Discharging the Cell

① WARNING

| | | | | | | |
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- 1) Do not discharge the cell using any device except for the specified device. When the cell is used in devices aside from the specified device it may damage the performance of the cell or reduce its life expectancy, and if the device causes an abnormal current to flow, it may cause the cell to become hot, explode, or ignite and cause serious injury.

① CAUTION

- 2) The temperature range over which the cell can be discharged is -20°C to 60°C (Consult E-One Moli Energy if you plan to discharge the cells at temperature less than -10°C). Use of the cell outside of this temperature range may damage the performance of the cell or may reduce its life expectancy.

Please note

E-One Moli Energy recommends that cells is assembled in a cell pack with protection circuit. Various of protection circuit modules are available for applications of multiple series and parallel configurations. In order to ensure safe use of cell, be sure to consult with E-One Moli Energy regarding charging and discharging specifications and contact E-One Moli Energy in advance when designing a device with this cell.

10. WARRANTY OF CELL

Warranty period is one year after factory delivery under normal conditions.

11. SHIPPING STATE OF CELL

The capacity of delivery cell is approximately at 50% of charging.

12. PACKING SPECIFICATION

The maximum quantity of the cells in a master carton is 100pcs.

13. AMENDMENT OF SPECIFICATION CONTENT

It is necessary to have mutual discussion before making any change of the specification.

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Fig. 1. Charge Characteristics for IMR18650E Cell.

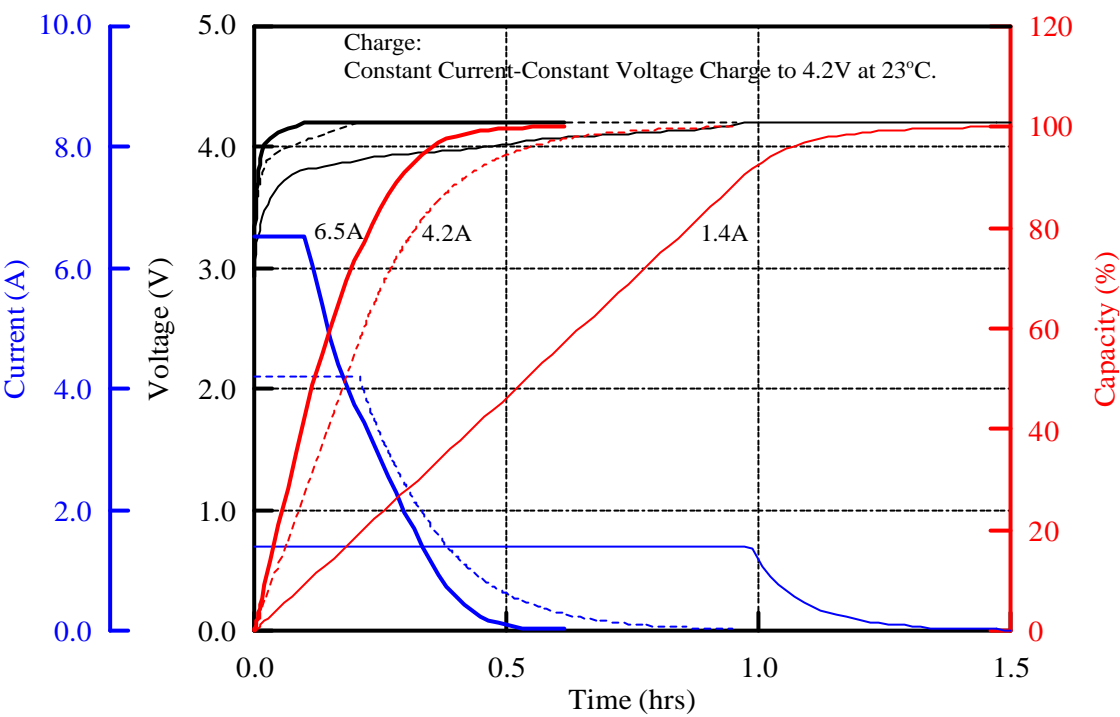


Fig. 2. Discharge Characteristics for IMR18650E Cell.

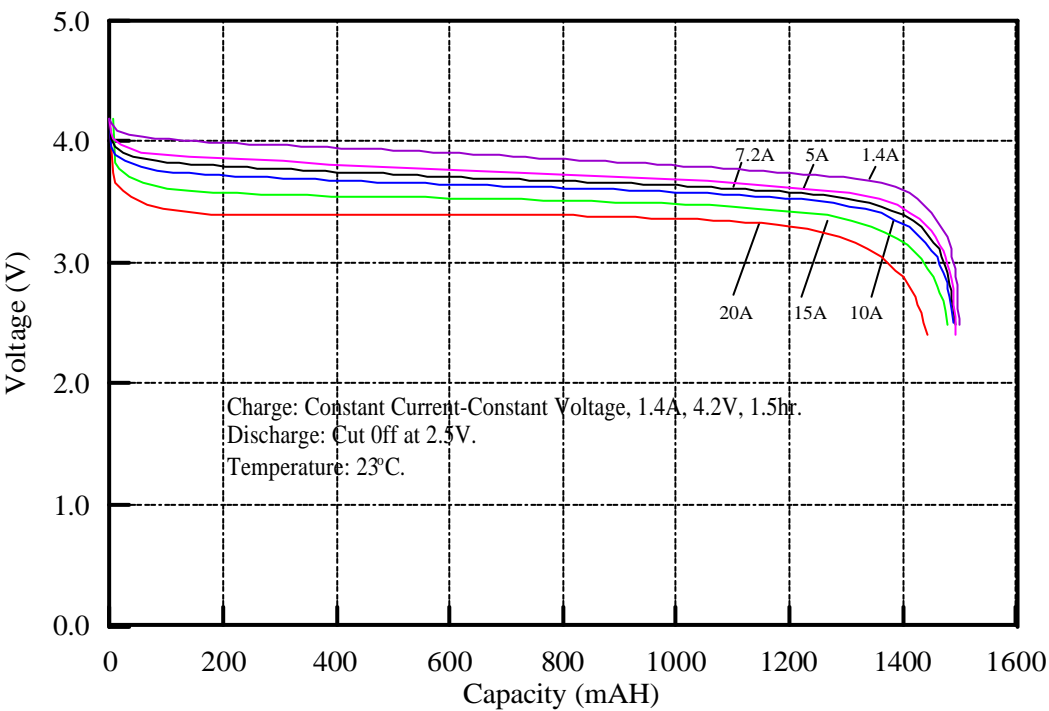


Fig. 3. Discharge Characteristics for IMR18650E Cell.

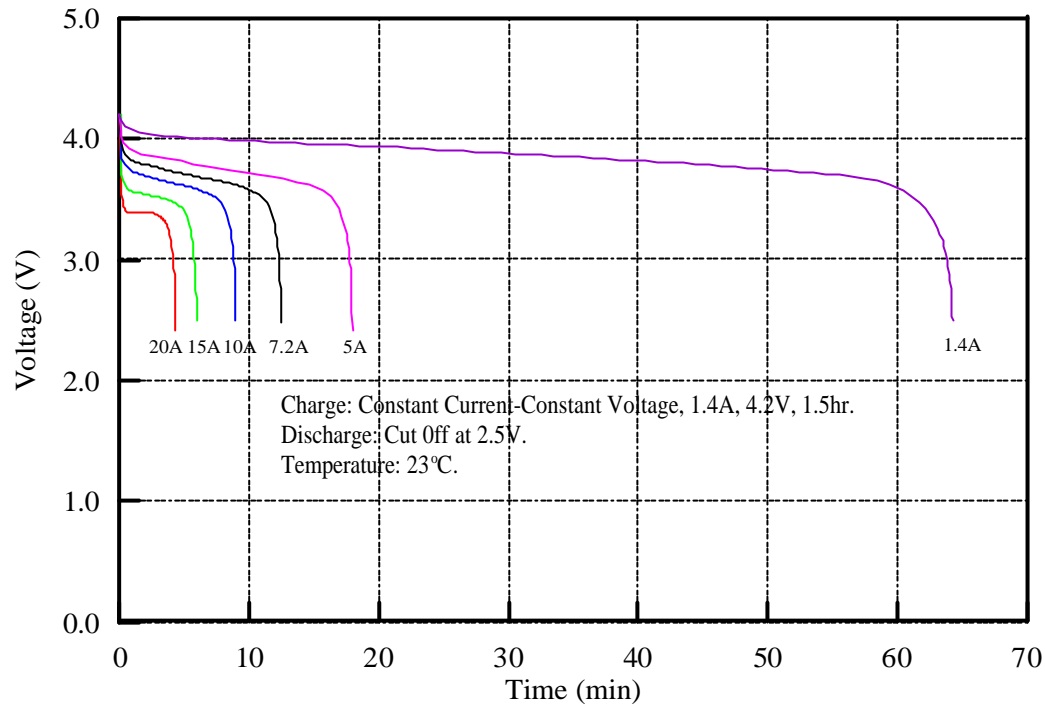
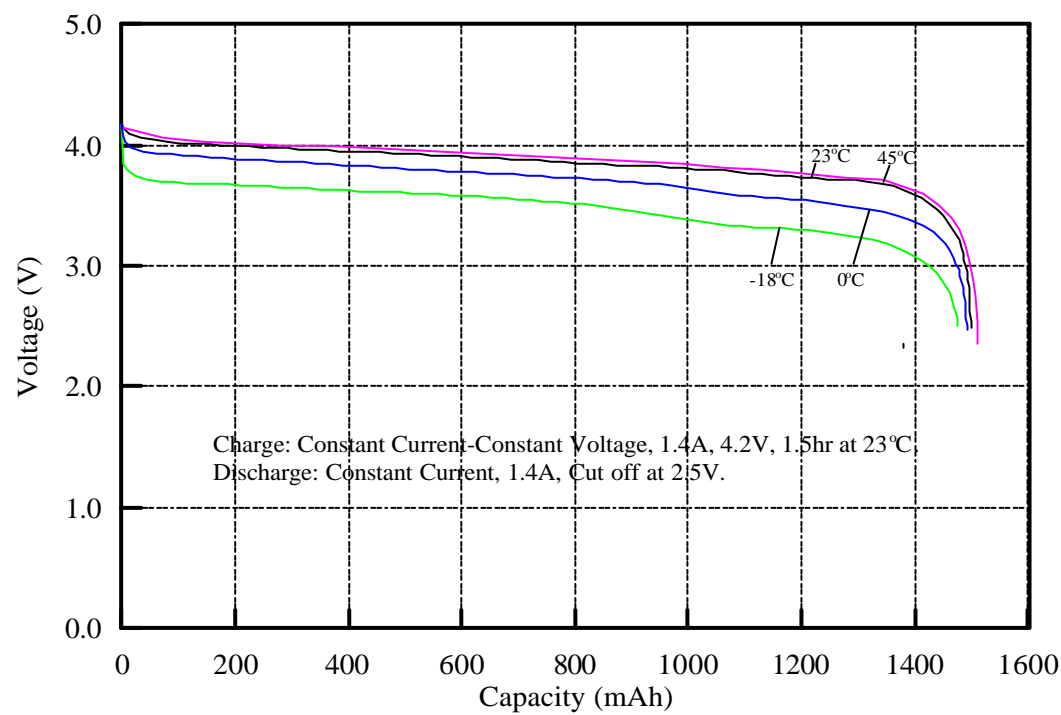


Fig. 4. 1C Discharge Temperature Characteristics for IMR18650E Cell.



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Fig. 5. 5A Discharge Temperature Characteristics for IMR18650E Cell.

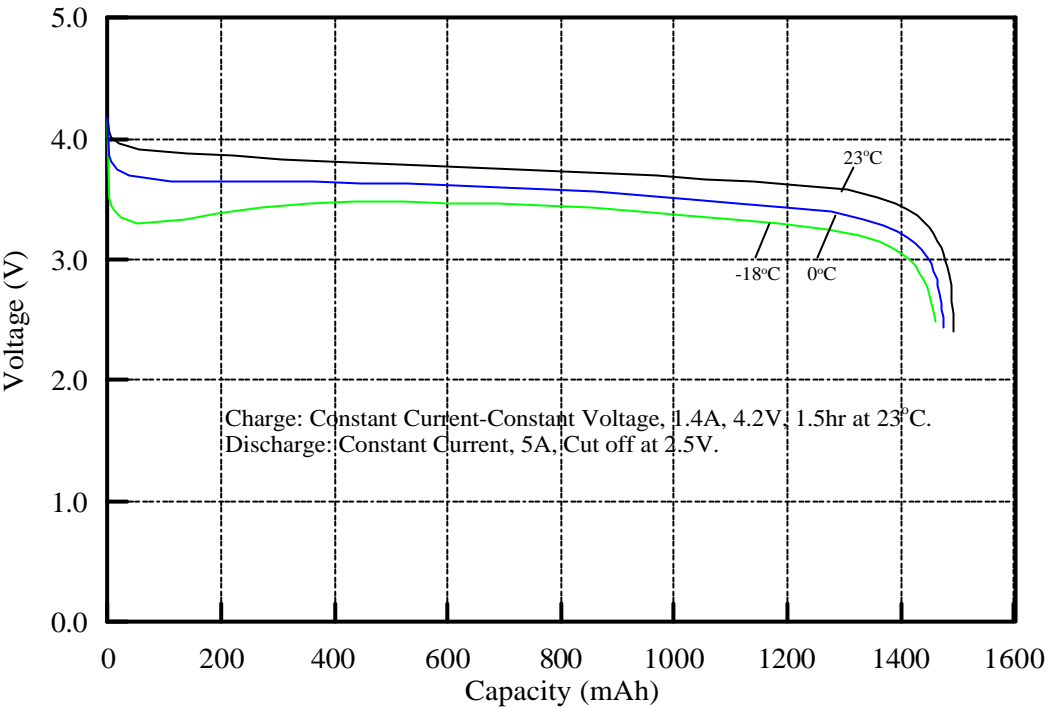
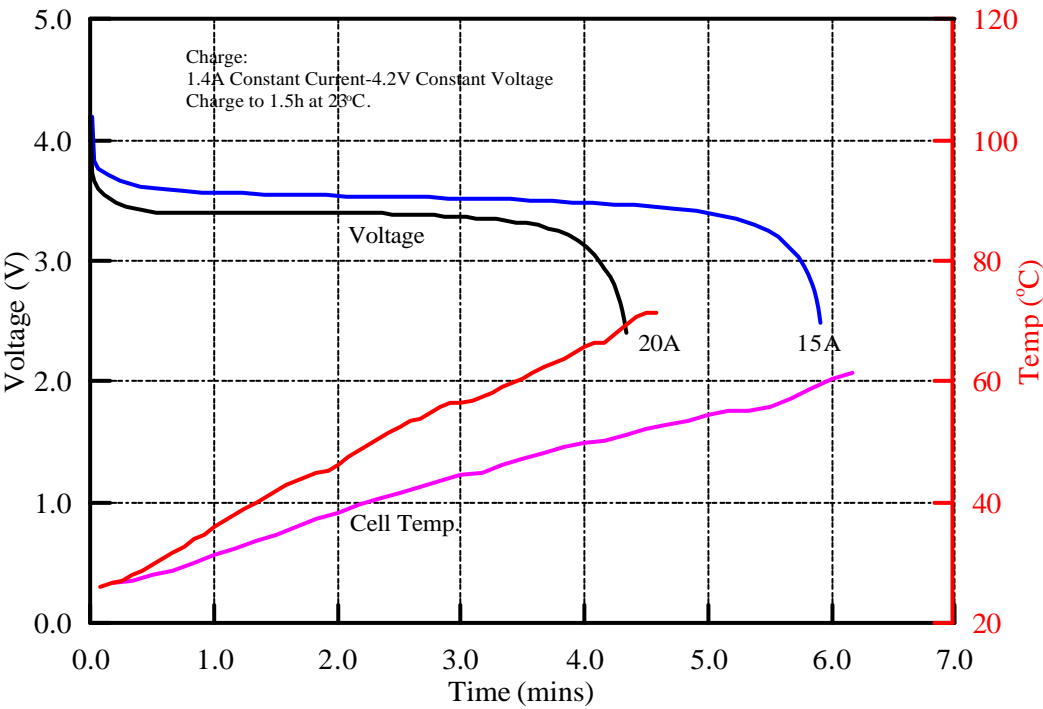


Fig. 6. 15A, 20A Discharge Characteristics for IMR18650E Cell.



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Fig. 7. Cycle Life Characteristics for IMR18650E Cell

