Specification of Product

1. Customer : 

2. Product : Lithium-ion Rechargeable Cell

3. SDI Model : INR18650-25R

4. Approved by

<table>
<thead>
<tr>
<th>Division</th>
<th>Signature</th>
<th>Date</th>
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5. Date of Application (YY/MM/DD) : 2016/04/15

6. Supplier : SAMSUNG SDI Co., Ltd.
Battery Business Division

<table>
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<tr>
<th>Issued</th>
<th>Checked</th>
<th>Approved</th>
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Benjamin Han
Assistant Engineer, CSG

Michael Rim
Director, CSG
1. **Scope**

   This product specification has been prepared to specify the rechargeable lithium-ion cell ('cell') to be supplied to the customer by Samsung SDI Co., Ltd.

2. **Description and model**

   2.1 **Description**  lithium-ion rechargeable cell  
   2.2 **Model name**  INR18650-25R  
   2.3 **Site**  Manufactured in Korea, Malaysia & China

3. **Nominal specifications** (*¹*)

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
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</thead>
</table>
   | 3.1 Standard discharge capacity           | Min. 2,500mAh  
   |                                          | - Charge: 0.5C(1.25A), 4.20V, 0.05C(125mA) cut-off @ RT  
   |                                          | - Discharge: 0.2C(500mA), 2.5V cut-off @ RT  
   |                                          | * 1C = 2,500mA                                                              |
   | 3.2 Rated discharge capacity              | Min. 2,450mAh  
   |                                          | - Charge: 4A, 4.20V, CCCV 100mA cut-off @ RT  
   |                                          | - Discharge: 10A, 2.5V cut-off @ RT                                           |
   | 3.3 Nominal voltage                       | 3.6V                                                                       |
   | 3.4 Standard charge                       | CCCV, 1.25A, 4.20V, 125mA cut-off                                          |
   | 3.5 Rated charge                          | CCCV, 4A, 4.20V, 100mA cut-off                                             |
   | 3.6 Charging time                         | Standard charge: 180min / 125mA cut-off (@ RT)  
   |                                          | Rated charge: 62min / 100mA cut-off (@ RT)                                   |
   | 3.7 Max. continuous discharge             | 20A (@ RT)                                                                 |
   | 3.8 Discharge cut-off voltage             | 2.5V (End of discharge)                                                     |
   | 3.9 Cycle life                            | Capacity ≥ 1,500mAh @ after 250cycles  
   |                                          | (60% of the standard capacity @ RT)                                         |
   |                                          | - Charge: 4.0A, 4.20V, CCCV 100mA cut-off @ RT  
   |                                          | - Discharge: 20A, 2.5V cut-off @ RT                                          |
   | 3.10 Recovery characteristics            | Capacity recovery(after the storage) ≥ 1,960mAh  
   |                                          | (80% of the rated capacity @ RT)                                            |
   |                                          | - Charge: 4A, 4.20V, CCCV 100mA cut-off @ RT  
   |                                          | - Storage: 30 days (@ 60°C)                                                 |
   |                                          | - Discharge: 10A, 2.5V cut-off @ RT                                          |
### Item Specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
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<tbody>
<tr>
<td>3.11 Cell weight</td>
<td>45.0g max</td>
</tr>
</tbody>
</table>
| 3.12 Cell dimension | Height : Max. 65.00 mm  
Diameter : Max. 18.40 mm |
| 3.13 Operating temperature\(^{(2)}\) | Charge : 0 to 45°C (Ambient)  
Discharge: -20 to 60°C (Ambient) |
| 3.14 Storage temperature\(^{(3)}\) | 1 year 0~23°C  
3 months 0~45°C  
1 month 0~60°C |

Note \(^{(1)}\): Protection function of the battery pack should be set within the specified charge, discharge and temperature range in the Cell Specification.

Note \(^{(2)}\): Discharge OTP (over temp. protection) should not be over 70°C of the cell surface temperature. Protection set should be based on the location of the cell surface with the highest temp increase part of the battery pack.

Note \(^{(3)}\): If the cell is kept as ex-factory status (30% of charge), the capacity recovery rate is more than 80%.
4. Outline dimensions

See the attachment (Fig. 1)

Max. 18.47mm

Max. 65.00mm

Unit : mm
With tube

Fig.1. Outline dimensions of INR18650-25R
5. Appearance
There shall be no such defects as scratch, rust, discoloration, leakage which may adversely affect commercial value of the cell.

6. Standard test conditions

6.1 Environmental conditions
Unless otherwise specified, all tests stated in this specification are conducted at temperature 23±3°C (@ RT) and humidity under 65%.

6.2 Measuring equipment
(1) Amp-meter and volt-meter
   The amp-meter and volt-meter should have an accuracy of the grade 0.5mA and mV or higher.
(2) Slide caliper
   The slide caliper should have 0.01 mm scale.
(3) Impedance meter
   The impedance meter with AC 1kHz should be used.

7. Characteristics

7.1 Standard charge
This "Standard charge" means charging the cell CCCV with charge current 0.5C (1,250mA), constant voltage 4.2V and 125mA cut-off in CV mode at 23°C for capacity.

7.2 Rated charge
Rated charge means charging the cell CCCV with charge current 4A and 100mA cut-off at 23°C

7.3 Standard discharge capacity
The standard capacity is the initial discharge capacity of the cell, which is measured with discharge current of 0.2C(500mA) with 2.5V cut-off at 23°C within 1hour after the standard charge.

   Standard discharge capacity ≥ 2,500mAh
Which complying to the minimum capacity of IEC61960 standard.
7.4 Rated discharge capacity
The rated capacity is the discharge capacity of the cell, which is measured with discharge current of 10A with 2.5V cut-off at 23°C within 1 hour after the rated charge.

Rated discharge capacity \( \geq 2,450 \text{mAh} \)

7.5 Initial internal impedance
Initial internal impedance measured at AC 1kHz after standard charge

Initial internal impedance \( \leq 18 \text{m}\Omega \)

7.6 Temperature dependence of discharge capacity
Capacity comparison at each temperature, measured with discharge constant current 10A and 2.5V cut-off after the rated charge is as follows.

<table>
<thead>
<tr>
<th>Discharge temperature</th>
<th>23°C</th>
<th>60°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: If charge temperature and discharge temperature is not the same, the interval for temperature change is 3 hours. Percentage as an index of the Rated discharge capacity at 23°C (\(=2,450 \text{mAh}\)) is 100%.

7.7 Temperature dependence of charge capacity
Capacity comparison at each temperature, measured with discharge constant current 10A and 2.5V cut-off after the rated charge is as follows.

<table>
<thead>
<tr>
<th>Charge temperature</th>
<th>Discharge temperature</th>
<th>23°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>23°C</td>
<td>50°C</td>
<td></td>
</tr>
<tr>
<td>Relative capacity</td>
<td>100%</td>
<td>95%</td>
</tr>
</tbody>
</table>

Note: If charge temperature and discharge temperature is not the same, the interval for temperature change is 3 hours. Percentage as an index of the Rated discharge capacity at 23°C (\(=2,450 \text{mAh}\)) is 100%.
7.8 Discharge rate capabilities
Discharge capacity is measured with the various currents in under table and 2.5V cut-off after the rated charge.

<table>
<thead>
<tr>
<th>Current</th>
<th>5A</th>
<th>10A</th>
<th>20A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Capacity</td>
<td>97%</td>
<td>100%</td>
<td>95%</td>
</tr>
</tbody>
</table>

Note: Percentage as an index of the Rated discharge capacity at 23°C (=2,450mAh) is 100%.

7.9 Cycle life
With rated charge and maximum continuous discharge.
Capacity after 250 cycles,

Capacity ≥ 1,500mAh (60% of the standard capacity at 23°C)

7.10 Recovery characteristics
Capacity after storage for 30 days at 60°C from the rated charge, measured with discharge current 10A with 2.5V cut-off at 23°C.

Capacity recovery (after the storage) ≥ 1,960mAh (80% of the rated capacity at 23°C)

7.11 Status of the cell as of ex-factory
The cell should be shipped in 3.43V ~ 3.58V Charging voltage range

8. Mechanical Characteristics

8.1 Drop test
Test method: Fully rated charged Cells drop onto the concrete floor from 1.0m height at a random direction 3 times. The cells or batteries are dropped so as to obtain impacts in random orientations. After the test, the sample shall be put on rest for a minimum of one hour and then a visual inspection shall be performed.

Criteria: No fire, no explosion.
Drop test shall be performed with the IEC62133 standard
8.2 Vibration test
  Test method: As to the UN transportation regulation (UN38.3), for each axis (X and Y axis with cylindrical cells) 7Hz→200Hz→7Hz for 15min, repetition 12 times totally 3hours, the acceleration 1g during 7 to 18Hz and 8g (amplitude 1.6mm) up to 200Hz.

Criteria: No leakage, with less than 10% of OCV drop
Vibration test shall be performed with the UN38.3 standard

9. Safety

9.1 Overcharge test
  Test method: Cell is to be discharged at a constant current of 0.5A to 2.5V. The cell is then to be charged with a 20V and 20A. Charging duration is to be 7 h.

Criteria: No fire, and no explosion.
Overcharge test shall be performed with the UL1642 standard

9.2 External short-circuit test
  Test method: Fully rated charged cell is to be short-circuited by connecting the positive and negative terminals of the battery with a circuit load having a resistance load of 80 ±20 mΩ. The battery is to discharge until a fire or explosion is obtained, or until it has reached a completely discharged state of less than 0.2 V and the battery case temperature has returned to ±10°C of ambient temperature. The return to near ambient of the battery (cell) casing in an indication of ultimate results. Tests are to be conducted at 20 ±5°C and at 55 ±5°C.

Criteria: No fire, and no explosion.
External short-circuit test shall be performed with the UL1642 standard

9.3 Forced discharge test
  Test method: A discharged cell is subjected to a reverse charge at 1.0C (2.5A) for 90 min.

Criteria: No fire, and no explosion.
Forced discharge test shall be performed with the IEC62133 standard
9.4 Heating test
   Test method: To heat up the standard charged cell at heating rate 5°C per minute up to 130°C and keep the cell in oven for 30 min.

   Criteria: No fire, and no explosion.
   Heating test shall be performed with the UL1642 standard (10 min) & GB31241 standard (30 min).

10. Warranty

   Samsung SDI will be responsible for replacing the cell against defects or poor workmanship for 15 months from the date of shipping. Any other problem caused by malfunction of the equipment or mix-use of the cell is not under this warranty.

   The warranty set forth in proper using and handling conditions described above and excludes in the case of a defect which is not related to manufacturing of the cell.

11. Others

11.1 Storage for a long time
   If the cell is kept for a long time (3 months or more), It is strongly recommended that the cell is preserved at dry and low-temperature.

11.2 Others
   Any matters that specifications do not have, should be conferred with between the both parties.