

Spec. No.	INR21700-48G	Version No.	Tentative
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SPECIFICATION OF PRODUCT

Tentative version (TBD)

for Lithium-ion rechargeable cell

Model : INR21700-48G

Oct., 2015

Samsung SDI Co., Ltd.
Battery Business Division

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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 Cell (lithium-ion rechargeable cell)

2.2 Model INR21700-48G

3. Nominal specifications

Item	Specification
3.1 Standard discharge capacity	Min. 4,700mAh (Typical 4,800mAh) - Charge: 0.3C(1440mA), 4.2V, 0.02C(96mA) cutoff @ RT - Discharge : 0.2C(960mA), 2.5V cutoff @ RT * 1C = 4,800mA
3.2 Standard discharge energy	Min. 17.04Wh (Typical 17.4Wh) - Charge: 0.3C(1440mA), 4.2V, 0.02C(96mA) cutoff @ RT - Discharge : 0.2C(960mA), 2.5V cutoff @ RT
3.3 Charging voltage	4.20V
3.4 Nominal voltage	3.6V (0.2C discharge)
3.5 Charging method	CC-CV (constant voltage with limited current)
3.6 Charging current	Standard charge: 1,440mA Rapid charge : 4,800mA ^{Note 1}
3.7 Charging time	Standard charge : 5hours Rapid charge : 2.5hours
3.8.1 Max. charge current	Refer to Fig. 1 ^{Note 1}
3.8.2 Max. pulse charge current	TBD
3.9.1 Max. discharge current	9,600mA (not for cycle life)
3.9.2 Max. pulse discharge current	35A for 10sec, 25A for 30sec, 18A for 60sec (ambient temperature 23℃)
3.10 Discharge cut-off voltage	2.50V
3.11 Cell weight	Max. : 69g
3.12 Cell dimension (W/O tube, W/O Washer)	Refer to cell drawing Fig. 2 Max. height to top : 70.15mm Max. height to crimping : 70.15mm Max. upper diameter : 21.1mm

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3.13 Operating temperature (Cell surface temperature)	Charge : 0 to 50°C (Fig. 1) Discharge: -20 to 60°C
3.14 Storage temperature	1 year : -20~25°C ^{Note 2} 3 months : -20~45°C ^{Note 2} 1 month : -20~55°C ^{Note 2}

Note (1): Rapid charge current of 4,800mA is not recommended for long life cycle.

Max charge current for reliable cycle life at T2~T4 region is 0.33C(1,584mA) in Fig.1, charge current of 0.3C (1,440mA) is recommended for long life cycle at standard temperature region.

Note (2): If the cell is kept as ex-factory status (30% of charge), the capacity recovery rate is more than 90%.

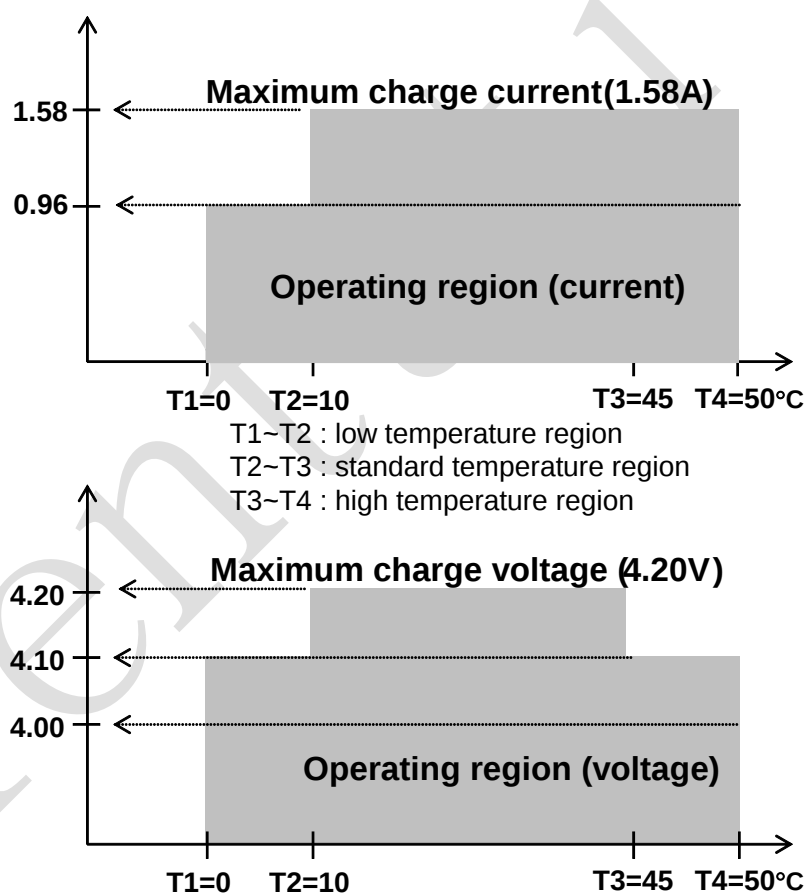


Fig. 1. Charging operating window for reliable cycle life.

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4. Outline dimensions

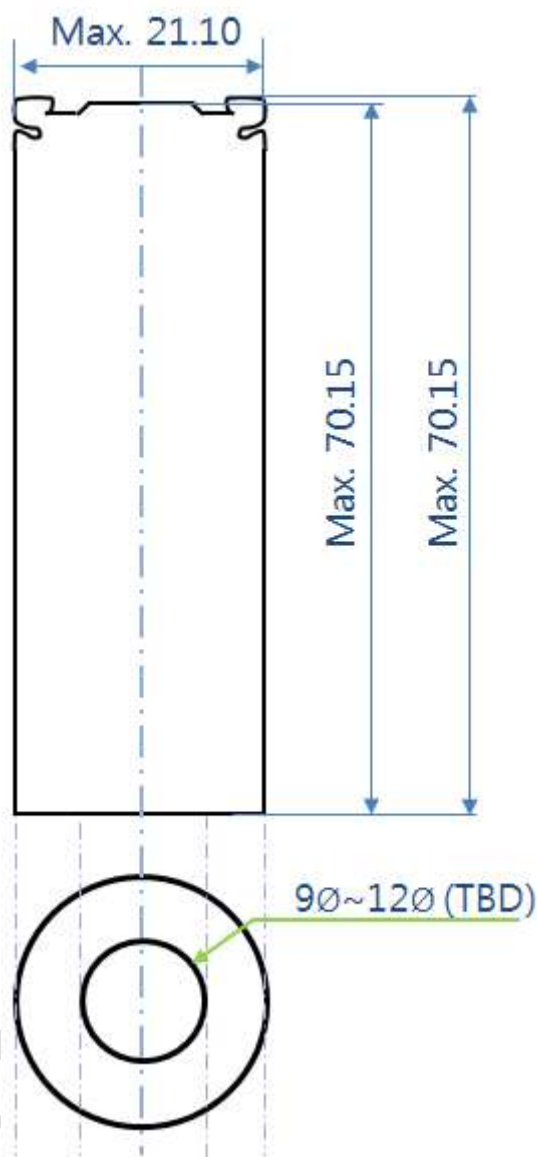


Fig. 2. Outline dimensions of INR21700-48G.

5. Bottom vent corrosion resistance

Corrosion under 2mm and no electrolyte leakage after 1,500 hrs of High Temperature (65°C) and Humidity (85% RH) Endurance test.

6. Standard test conditions

6.1 Environmental conditions

Unless otherwise specified, all tests stated in this specification are conducted at temperature $23 \pm 3^\circ\text{C}$ and humidity under 65%.

6.2 Measuring equipment

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- (1) Ammeter and Voltmeter
The ammeter should have an accuracy of the grade 0.5mA or higher.
The voltmeter should have an accuracy of the grade 0.5mV or higher.
- (2) Slide caliper
The slide caliper should have 0.05 mm scale or higher.
- (3) Impedance meter
The impedance meter with AC 1kHz should be used.
- (4) Weighing machine
The weighing machine should have an accuracy of the grade 0.001g or higher

7. Characteristics

7.1 Standard charge

This "Standard charge" means charging the cell with charge current 1440mA and constant voltage 4.2V at 23℃, 96mA cutoff.

7.2 Standard discharge capacity

The standard discharge capacity is the initial discharge capacity of the cell, which is measured with discharge current of 960mA with 2.5V cut-off at 23℃ within 1 hour after the "Standard charge". In this case the minimum capacity of the standard discharge capacity is 4,700mAh in warranty.

$$\text{Standard discharge capacity} \geq 4,700\text{mAh}$$

7.3 Standard discharge energy

The standard energy is the initial discharge energy of the cell, which is measured with discharge current of 960mA with 2.5V cut-off at 23℃ within 1 hour after the "Standard charge". In this case the minimum capacity of the standard discharge capacity is 17.04Wh in warranty.

$$\text{Standard discharge energy} \geq 17.04\text{Wh}$$

7.4.1 Initial internal impedance (AC resistance)

Initial internal impedance measured at AC 1kHz after Standard charge.

$$\text{Initial internal impedance} \leq 35\text{m}\Omega$$

7.4.2 DC impedance

DC impedance is measured at 50% SOC(state of charge) state.

After Standard charge, discharge with constant current of 2,400mA for 1hr followed by 30min rest time (Check voltage at this time – V1). Discharge with constant current of 2,400mA for 30sec (and check voltage at 10sec – V2)

$$\text{Initial DC impedance} = (V1-V2)[\text{mV}] / 2400[\text{mA}] \leq 50\text{m}\Omega$$

7.4.3 DC impedance growth (DCR (%) increase)

DC impedance growth means % increased DC impedance after cycle or storage test compared with initial DC impedance

$$\text{DCR (\%) increase} = [(*\text{DCR(f)} / **\text{DCR(i)}) - 1] \times 100$$

* DCR(i) : initial DC impedance, **DCR(f) : DC impedance after cycle or storage test

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7.5 Temperature dependence of discharge capacity

Discharge capacity comparison according to the discharging temperature, measured with constant current discharge at 23°C with 960mA and 2.5V cut-off after charging at the following temperatures,

Charge temperature	Discharge temperature			
23°C	-10°C	0°C	23°C	60°C
Relative capacity	70%	80%	100%	90%

Note: If the charge temperature and discharge temperature is not the same, the interval for temperature change is 3 hours.
Minimum capacity (4,700mAh) is 100% Percentage as an index of the relative capacity.

7.6 Temperature dependence of charge capacity

Discharge capacity comparison according to the charging temperature, measured with constant current discharge at 23°C with 960mA and 2.5V cut-off after charging at the following temperature is as follows,

	Charge temperature			Discharge temperature
	0°C	23°C	45°C	23°C
Relative capacity	70%	100%	80%	

Note: If charge temperature and discharge temperature is not the same, the interval for temperature change is 3 hours.
Minimum capacity (4,700mAh) is 100% Percentage as an index of the relative capacity.

7.7 Charge rate capabilities

Discharge capacity is measured with constant current 960mA and 2.5V cut-off after the cell is charged with 4.2V as follows.

	Charge Condition			
Current	0.2C (960mA)	0.3C (1,440mA)	0.5C (2,400mA)	1.0C (4,800mA)
Cut-off	7h or 0.05C	5h or 0.05C	3.0h or 0.05C	2.5h or 0.05C
Relative discharge capacity	100%	100%	95%	90%

7.8 Discharge rate capabilities

Discharge capacity according the discharging current is measured with 2.5V cut-off after the standard charge is as follows,

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	Discharge Condition			
Current	0.2C (960mA)	0.5C (2,400mA)	1C (4,800mA)	2C (9,600mA)
Relative capacity	100%	95%	90%	80%

Note: Minimum capacity(4,700mAh) is 100% as an index of the relative capacity.

7.9 Cycle life performance

Temperature		23℃	45℃
Charge (CC-CV)	Voltage	4.2 V	
	Current	1,440mA (0.3C)	
	Cut-off	240mA	
Discharge (CC)	Current	4,800mA (1.0C)	
	Cut-off	2.5V	
Cycle		500 cycles	500 cycles
Capacity		3,525mAh	3,290mAh
DC-IR (%) increase		60 %	70 %

7.9.1 Standard cycle life at room temperature with 4.2V

Each cycle is an interval between the charge current 1,440mA and constant voltage 4.2V at 23℃, with 240mA cutoff and the 4,800mA discharge of current with 2.5V cut-off. Both of DCR(i) and DCR(f) should be measured at 23℃

Capacity after 500cycles.

Capacity $\geq$ 3,525mAh (75% of the minimum standard capacity)

DCR(%) increase $\leq$ 60 %

7.9.2 Cycle life at high temperature of 45℃

Each cycle is an interval between the charge current 1,440mA and constant voltage 4.2V at 45℃, with 240mA cutoff and the 4,800mA discharge of current with 2.5V cut-off. Both of DCR(i) and DCR(f) should be measured at 45℃

Capacity after 500cycles.

Capacity $\geq$ 3,290mAh (70% of the minimum standard capacity)

DCR(%) increase $\leq$ 70 %

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7.10.1 Storage characteristics

Recoverable capacity after storage for 30days at 55℃ after the standard charged, measured with discharge current 960mA with 2.5V cut-off at 23℃.

$$\begin{aligned} \text{Capacity recovery(after the storage)} &\geq 4,230\text{mAh} \\ &\text{(90\% of minimum standard capacity)} \\ \text{DCR(\%)} \text{ increase} &\leq 30\% \end{aligned}$$

7.10.2 Storage characteristics

Recoverable capacity after storage for 1year at 20℃ after the standard charged, measured with discharge current 960mA with 2.5V cut-off at 23℃.

$$\begin{aligned} \text{Capacity recovery(after the storage)} &\geq 4,230\text{mAh} \\ &\text{(90\% of minimum standard capacity)} \\ \text{DCR(\%)} \text{ increase} &\leq 30\% \end{aligned}$$

7.11 Status of the cell as of ex-factory or outgoing inspection

The cell should be shipped in 30% charged state. In this case, OCV is from 3.520V to 3.620V.

8. Mechanical Characteristics

8.1 Drop Test

Test method: Each fully charged cell or battery is dropped three times from a height of 1.0 m onto a concrete floor. 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

(Test shall be performed with the following criteria IEC 62133)

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 10mV of OCV drop

9. Safety

9.1 Overcharge Test

Test method: To charge the standard charged cell with 12V and 3C(14,400mA) at 23℃ for 7 hours.

Criteria: No fire, and no explosion.

(Overcharge test shall be performed with the UL1642 standard)

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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 $80 \pm 20 \text{ m}\Omega$. The battery is to discharge until a fire or explosion is obtained, or until it has reached a completely discharged state of less than 0.2V and the battery case temperature has returned to $\pm 10^\circ\text{C}$ 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 $20 \pm 5^\circ\text{C}$ and at $55 \pm 5^\circ\text{C}$.

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(4,800mA) for 90 min at 23°C .

Criteria: No fire, and no explosion.

Forced discharge test shall be performed with the IEC62133 standard

9.4 Hot oven test

Test method: To heat the standard charged cell at heating rate of 5°C per minute up to 130°C and keep the cell in oven for 60 minutes.

Criteria: No fire, and no explosion.

9.5 Radiant heater test

Test method: Given the 10 C/min temperature ramping to $600 \pm 5^\circ\text{C}$, cell shall be inserted into the cell stand until it explodes.

Criteria: Fire or venting through up and bottom side accepted, but no side rupture

10. Warranty

Samsung SDI will be responsible for replacing the cell against defects or poor workmanship for 18 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. Transportation information

This product was tested and found to be in conformity with UN test (Manual of Tests and Criteria Rev.4, Part III subsection 38.3) for allowing shipping of the cells.

12. Storage for a long time

12.1 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 temperature below 25°C .

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13. Packaging

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Please contact following offices when you need any help including safety concerns.

Samsung SDI emergency contact information

■ **Samsung SDI Cheonan factory QA**

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