

PRODUCT SPECIFICATION

Rechargeable Lithium Ion Battery

Model: INR21700M52V

For Promotion

[Notice]

1. The Product Identified in this Product Specification ("Cell" or "Product") is an industrial component part that is intended to be used **ONLY** for use in Battery Packs with protective circuitry.
2. LG Energy Solution, Ltd., as well as International Standards, **PROHIBITS** the use of a Cell outside of a Battery Pack FOR ANY REASON. USE OF A CELL OUTSIDE OF A BATTERY PACK CAN CAUSE SEVERE, DISFIGURING BURNS OR INJURIES.
3. Because of the risk of SEVERE INJURY, the Cells are **NOT** intended for use outside of a Battery Pack or for use as a stand-alone, removable, consumer-replaceable power source for any electrical device, including e-cigarettes, lanterns, flashlights, or other products.
4. Because of the risk of SEVERE INJURY, the Cells are intended **ONLY** for sale to and use by Battery Packers, Original Equipment Manufacturers, or Systems Integrators.
5. Because of the risk of SEVERE INJURY, LG Energy Solution, Ltd. strictly **PROHIBITS**:
 - Any use of a Cell outside of a Battery Pack
 - Any use of a Cell as a stand-alone, removable, or consumer-replaceable power source for any electrical device, including e-cigarettes, lanterns, flashlights, or other products.
 - Any sale or re-sale of this Product to any person or entity other than Battery Packers, Original Equipment Manufacturers, Systems Integrators, or other entity expressly authorized in writing by LG Energy Solution, Ltd. to receive the Cells.
 - Any sale to consumers, on-line marketplaces or any other distribution channel that could lead to sales to consumers.

**This document should only be used for engineer study and pre-discussion
before confirming the actual specification of Cell.**

Revision History

[illegible]

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1. General Information

1.1 Scope and Definitions

This Product Specification (this “Document”) defines the requirements of the rechargeable lithium ion battery cell (the “Cell”) to be supplied by LG Energy Solution, Ltd (“LG Energy Solution”). All conditions and criteria written in this Document are defined from fresh cellⁱ state.

1.1.1 “Cell” shall mean a basic electrochemical unit that contains electrodes, separator, and electrolyte that is the source of electrical energy by direct conversion of chemical energy, and which is intended to be an industrial component part of a battery pack.

1.1.2 “Battery Pack” or “Pack” shall mean a collection of cells, with housing, electrical connections, and protective circuitry for control and protection making it ready for use (the case could be either hard plastic or soft).

1.1.3 “Packer” shall mean any entity that assembles cells into battery packs.

1.1.4 “End Product Integrator” shall mean any entity that manufactures the final product, which may include OEMs, ODMs, and/or systems integrators.

1.2 Application: EV

※ The Cell can be used solely for the application(s) set forth in this Document and no other application than approved by LG Energy Solution is permitted for use without obtaining the express prior written consent/confirmation as well as the most current Product Specification from LG Energy Solution.

1.3 Product classification: Cylindrical rechargeable lithium ion battery cell

1.4 Model name: INR21700M52V

ⁱ Fresh cell: Cell produced from normal manufacturing process and is ready for shipping (ex-factory state)

2. Nominal Specificationⁱ

※ Charge/discharge condition for field use shall comply with usable cycle SOC in 2.4/2.6 and

4.2.4. Cycle life.

Item	Condition / Note	Specification
2.1 Energy ¹⁾	Charge/discharge * 1C=5000mA Charge (CC-CV) : 0.3C (1500mA), 4.20V, 50mA cut off, Charging time ³⁾ 4.5 h (one complete charge ²⁾) at 25°C Discharge (CC) : 0.2C (1000mA), 2.50V cut off at 25°C	Min. 18.34 Wh
2.2 Nominal Voltage	Average by Standard charge/discharge	3.69 V
2.3 Shipping Cell Voltage	State Of Charge ("SOC")	Below SOC 30 %
2.4 Charge voltage ¹⁾	2.1 Capacity measurement SOC Usable cycle SOC (in field use) In all measurements and operations of the Cell, the maximum closed circuit voltage shall not exceed the following value	4.20 V 4.1 V (refer to 4.2.4)
2.5 Max. Charge Current ⁴⁾ (complete full charge) ²⁾ (Atmosphere Temperature)	0 ~ 25 °C	0.3 C (1500 mA)
	25 ~ 45 °C	0.7 C (3500 mA)
2.6 Discharge cut off voltage ¹⁾	2.1 Capacity measurement SOC Usable cycle SOC (in field use) In all measurements and operations of the Cell, the minimum closed circuit voltage shall not drop below the following value	2.50 V 2.85 V (refer to 4.2.4)
2.7 Max. Discharge Current ⁴⁾ (complete full discharge) ²⁾ (Atmosphere Temperature) ¹⁾	-20 ~ 10 °C	0.5 C (2500 mA)
	10 ~ 25 °C	3.0 C (15000 mA)
	25 ~ 55 °C	1.5 C (7500 mA)
2.8 Safety Over Voltage (Permanent Failure)	Cell voltage including tolerance shall not exceed the 4.25 V to prevent any safety events. And cell performance can't be guaranteed between 4.20 V and 4.25 V	Max 4.25 V (Refer to 6.2)
2.9 Safety Under Voltage	Cell voltage including tolerance shall not	Min 2.00 V

ⁱ Nominal specification has been tested and determined in laboratory condition.

(Permanent Failure)	drop below the 2.00 V to prevent any safety events. And cell performance can't be guaranteed between 2.50 V and 2.00 V	(Refer to 6.2)
2.10 Weight	(Non-tubing cell)	67.4 ± 1.0 g
2.11.1 Operating Temperature ⁵⁾ (Atmosphere Temperature)	Charge	0 ~ 45 °C
	Discharge	-20 ~ 55 °C
2.11.2 Operating Temperature ⁵⁾ (Cell Surface Temperature)	Charge	0 ~ 50 °C
	Discharge	-20 ~ 70 °C
	* Max. cell surface temperature should be controlled by BMU protection unit below 50°C for charging and 70°C for discharging	
2.12 Storage Temperature ⁶⁾ (for shipping state ^{i*)} (Atmosphere Temperature)	1 month	-20 ~ 55 °C
	3 month	-20 ~ 45 °C
	1 year	-20 ~ 25 °C
	Recovery capacity ⁷⁾ after the storage ≥ 80% of minimum energy(or capacity)	
2.13 Storage Temperature ⁶⁾ (for fully charged state) (Atmosphere Temperature)	1 month	-20 ~ 45 °C
	6 month	-20 ~ 25 °C
	Recovery capacity ⁷⁾ after the storage ≥ 80 % of minimum energy(or capacity)	
2.14 Storage Humidity		Under 50 %

- Energy is determined in accordance with IEC62133 reference and LG Energy Solution product inspection result as of the date of manufacture by Standard Charge/Discharge condition (2.1). Energy may differ depending on the operating voltage range for field use and environmental conditions. To ensure safe use in field, Charge/discharge condition shall comply with usable cycle SOC described in 2.4/2.6 and 4.2.4 Cycle life.
- "Complete full charge/discharge" means that cell is charged/discharged from the discharge cut off voltage (2.6) to the charge voltage (2.4) without stopping for 1 cycle.
- "Charging time" is based on one complete charge from the 0~100% SOC. Contact and discuss with LG Energy Solution if **trickle/floating charge is required to maintain fully charged state. To avoid additional battery degradation by trickle charge, leakage current of total system (when connected to the charger, except self-discharge of battery itself) is recommended under 1mA per cell.
- The maximum charge (2.5) or discharge current (2.7) herein is the allowable current to operate cell without possibility of dramatic degradation of the cell or sudden internal changes such as CID activation. Continuous use of Cell with Max. discharge current may accelerate degradation; thus, the performance will not be guaranteed. The Cell shall not be fully discharged with Max. discharge current without temperature and voltage limits to avoid severe degradation, and must be

* Shipping state : About 30% capacity of fully charged state

** Trickle charge : In order to compensate for the self-discharge of the battery, it is charged with a small current while away from the load.

protected by proper protective functions such as current cut-off, derating and permanent failure to prevent any safety risks. For detailed Criteria for Cell basic properties (such as cycle life and capacity, etc), please refer to the explicit current conditions in each sections of this document. When reaching the temperature limits, discharge shall not be allowed until the cell surface temperature falls in the range of allowable discharge temperature (2.11.2 - discharge).

- 5) The operating temperature range defined in this section (2.11) is the maximum allowable range in which the battery cell can perform normal charge/discharge without sudden internal changes such as CID activation. However, even if the cell is charged / discharged within the above operating temperature range (2.11), characteristics of the cell such as capacity / voltage / internal resistance may be deteriorated depending on factors such as the accumulated number of charge / discharge cycles, usage time and diverse charge/discharge current profiles. For detailed Criteria for Cell basic properties (such as cycle life and capacity, etc), please refer to the explicit temperature conditions in each sections of this document.
- 6) The storage temperature and period range defined in this section (2.12 and 2.13) is the maximum allowable range in which the battery cell can perform normal charge/discharge without sudden internal changes such as CID activation. However, even if the cell storage (including the cell storage after assembled inside the final application in the field) is within the above (2.12 and 2.13) temperature and range, characteristics of the cell such as capacity / voltage / internal resistance may be deteriorated when compared to the fresh cell state (ex-factory state). It is highly recommended that the cell should be stored (including the cell storage after assembled inside the final application in the field) in the room temperature (25°C) and under the shipping SOC. For detailed Criteria for Cell basic properties (such as cycle life and capacity, etc), please refer to the explicit temperature conditions in each sections of this document.
- 7) Recovery Capacity shall be tested with standard charge and discharge conditions (2.1) after storage.

3. Appearance and Dimension

3.1 Appearance

There shall be no severe scratch, crack, rust, discoloration, dent, leakage, or other significant issue with the Cell's outer appearance.

3.2 Dimension

Diameter : $\leq 21.15 \text{ mm}$

Diameter is defined as the largest data value measured on the "A" area (4 mm from the top) of the Cell, measured by Vernier Calipers (Mitsutoyo (500-182-20)).

Height : $\leq 70.60 \text{ mm}$



4. Performance Specification

4.1 Test condition

4.1.1 Standard Charge

A “Standard Charge” is charging the Cell at constant current of 0.3 C rate (1500 mA) and constant voltage of 4.20 V at 25°C until the charge current is tapered to 250 mA.

4.1.2 Standard Discharge

A “Standard Discharge” is discharging the Cell at constant current of 0.2 C rate (1000 mA) at 25°C. The Discharge shall terminate when the voltage of the Cell reaches 2.50 V.

4.1.3 Charge Condition

Cells shall be charged at a constant current of 0.3 C (1500mA). The cell shall then be charged at constant voltage of 4.20V while tapering the charge current. Charging shall be terminated when the charging current has tapered to 50mA. For test purposes, charging shall be performed at 25°C.

4.2 Electrical Specification

Item	Condition	Specification
4.2.1 Initial AC Impedance	Cell shall be measured at 1kHz after charging per 4.1.3	14.5 ± 6 mΩ
4.2.2 Initial DC Impedance	Cell shall be charged per 4.1.1 and discharged to the SOC 50%. Measurement of internal impedance under DC loads at 0.5 C constant current for 10 sec at 25°C without any attachment of metal leads.	24.0 ± 6 mΩ
4.2.3 Initial Energy	Fresh Cells shall be charged per 4.1.3 and discharged per 4.1.2 within 1 hour after full charge.	≥ 18.34Wh
4.2.4 Cycle Life	Charge(CC/CV) : 0.3 C (1500 mA), 4.1 V, 250 mA cut-off, rest time 10 min. at 25°C Discharge(CC) : 0.5 C (2500 mA), 2.85 V cut-off, rest time 20 min. at 25°C	≥ 86 % of Initial Energy at 500 cycles

4.3 Environmental specification

Item	Condition		Specification
4.3.1 Storage Characteristics	The Cell shall be charged per 4.1.3 and stored in a temperature-controlled environment at 25°C for 30 days. After storage, cells shall be discharged per 4.1.2 to obtain the remaining energy.		Energy remain rate ≥ 90 % of 4.2.3
4.3.2 High Temperature Storage Test	The Cell shall be charged per 4.1.3 and stored in a temperature-controlled environment at 55 °C for 1 week. After storage, cells shall be discharged per 4.1.2 and cycled per 4.1.3 and 4.1.2 for 3 cycles to obtain recovered energy*.		No leakage, Energy recovery rate ≥ 80 % of 4.2.3
4.3.3 Temperature Dependency of Energy	The Cell shall be charged per 4.1.3 at 25 °C and discharged per 4.1.2 at the following temperatures.		
	Charge	Discharge	Energy
	25 °C	-10 °C	≥ 70 % of 4.2.3
		0 °C	≥ 80 % of 4.2.3
		25 °C	≥ 100 % of 4.2.3
		55 °C	≥ 95 % of 4.2.3

4.4 International Safety Specification

- The Cell satisfies UN38.3 regulation and UL2580.

* Remaining Capacity : After storage, cells shall be discharged with Std. condition(4.1.2) to measure the remaining capacity.

** Recovery Capacity : After storage, cells shall be discharged with Std condition(4.1.2), and then cells shall be charged with std. charge condition(4.1.3), and then discharged with Std. condition(4.1.2). This charge / discharge cycle shall be repeated three times to measure the recovery capacity.

5. Warranty

Warranty is valid for Cells used under the conditions of this Product Specification and the period lasts for 12 months from the assembly date of the Cell.

6. Warning, Caution and Prohibition

Warning for using the Cells: Mishandling, unapproved use, and/or inappropriate use of the Cells may cause heat, **disfiguring fire, burn, and/or severe injury**. Cells are for use only in Battery Packs and shall not be sold to or handled by individual consumers. Additionally, mishandling of the Cell could result in deterioration in performance. Be sure to observe the following:

6.1 Warning, Caution & Prohibition

- The Product identified in this Product Specification ("Cell") is an industrial component part that is intended for use **ONLY** in Battery Packs with protective circuitry. The Battery Pack contains protective circuitry that maintains the Cell in a safe operating condition.
- LG Energy Solution, Ltd., as well as International Standards, **PROHIBITS** the use of a Cell outside of a Battery Pack FOR ANY REASON. USE OF A CELL OUTSIDE OF A BATTERY PACK CAN CAUSE FIRE AND SEVERE, DISFIGURING BURNS OR INJURIES.
- Because of the risk of SEVERE INJURY, the Cells are **not** intended for use outside of a Battery Pack or for use as a stand-alone, removable, consumer-replaceable power source for any electrical device, including e-cigarettes, lanterns, flashlights, or other products.
- Because of the risk of SEVERE INJURY, the Cells are intended ONLY for sale to and use by Battery Packers, Original Equipment Manufacturers, or Systems Integrators. The Cell shall **not** be sold to or directly handled by individual consumers.
- Because of the risk of SEVERE INJURY, LG Energy Solution, Ltd. strictly **PROHIBITS**:
 - Any use of a Cell outside of a Battery Pack.
 - Any use of a Cell as a stand-alone, removable, or consumer-replaceable power source for any electrical device, including e-cigarettes, lanterns, flashlights, or other products.
 - Any sale or re-sale of this Product to any person or entity other than Battery Packers, Original Equipment Manufacturers, Systems Integrators, or other entity expressly authorized in writing by LG Energy Solution, Ltd. to receive the Cells.
 - Any sale to consumers, online marketplaces or any other distribution channel that could lead to sales to consumers.
- Be sure to request and confirm the most current Product Specification of the Cell in advance before the final stage of your design, purchase or production of a pack.
- Be sure to provide a copy of the Product Specification of the Cell to any of your customers and require them to understand and abide by this Product Specification.

- Do not use the Cell if the protective wrapper is damaged. (only for wrapped/tubed models)
- Removal of the Cell's protective wrapper or rewrapping of the Cell with a different wrapper is strictly PROHIBITED.
- Make sure to keep the Cell away from any metal objects. Do not allow the Cells to be maintained or carried in an unprotected manner.
- Do not use the Cell in high static energy environment where the protection device can be damaged.
- Do insulate between the Cell and metal plates or other conductive components to prevent an electrical short.
- Do not charge any Cell that has been overly discharged.
- Do not disassemble or reconstruct the Cell.
- Do not throw or cause impact to the Cell.
- Do not pierce a hole in the Cell with sharp materials. (i.e., nail, knife, pencil, drill)
- Do not solder on the surface of the Cell directly.
- Do not expose the Cell to direct sunlight/ heat/ fire.
- Do not put the Cell into high pressure condition.
- Do not use the Cell in reverse when assembling into the Battery Pack.
- Do not connect a Cell's positive (+) and negative (-) terminal with conductive materials.
- Do not use any Cell that has been submerged or become wet with water or sea-water.
- Do not expose Cells to intensive heat or force during welding process.
- Do not use old and new cells together in a Battery Pack and do not use different model Cells or Cells manufactured by different manufacturers in a Battery Pack.
- Do not use Cells that have experienced any dropping during the Battery Pack manufacturing process.

6.2 Caution, Warning, and Requirements for Battery Pack manufacturing

The Cell is intended and authorized for use ONLY in safely designed Battery Pack. The purpose of the Battery Pack is to provide protection and protective circuitry that maintains the Cell in a safe operating condition. The Battery Pack shall meet the following conditions to maintain Battery Pack and Cell safety and to ensure longer lasting performance of the Cells.

- The Battery Pack must meet all applicable UL and IEC safety standards.
- All Cells shall go through visual inspection and damaged Cells (e.g. damaged surface, damaged wrapper, can distortion, electrolyte leakage, rust etc.) must be filtered and eliminated prior to the Battery Pack manufacturing process.
- The Battery Packs must use Cells of the same model produced by LG Energy Solution. For better stability and performance of the Battery Packs, it is recommended to use Cells of the same manufacturing lots. If it is not possible, be sure to conduct voltage grading to Cells before pack manufacturing.
- The design of the Battery Pack and its structure shall be thoroughly reviewed such that it maintains the Cell

in the approved operating conditions and prevents Cell imbalance, over-charge, over-discharge, and short circuit.

- The Battery Pack should be designed with adequate protective circuitry to prevent any incidental or accidental short-circuit.
- The Battery Pack should be designed to allow charging only by the unique charger dedicated for the Battery Pack.
- The Battery Pack for multiple Cells shall be designed to monitor the voltage of each Cell and each Bank.
- The Battery Pack should be designed to install the Cells as far as possible from the application or system's heat source to prevent deterioration of the Cells. (e.g. cell imbalance, cycle degradation, etc.)
- The Battery Pack shall contain all of the applicable warnings required under UL or IEC safety standards.
- When the Battery Packs for any applications are assembled with the Cells, protective circuitry with protective functions required by LG Energy Solution must be designed into the Battery Packs and/or in the charger or charging adapter or system. Setting values for those protective functions should be discussed and confirmed by LG Energy Solution to prevent any safety risks.