

PRODUCT SPECIFICATION

Rechargeable Lithium Ion Battery

Model: INR21700M58T

For (Promotion) only

[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 cell spec. **This document is NOT the final version.***

Revision History

[illegible]

Contents

Contents	3
1. General Information	4
1.1 Scope	
1.2 Application	
1.3 Product Classification	
1.4 Model Name	
2. Nominal Specification	4
2.1 Capacity / Energy	
2.2 Nominal Voltage	
2.3 Shipping Cell Voltage	
2.4 Standard Charge	
2.5 Max. Charge Voltage	
2.6 Max. Charge Current	
2.7 Standard Discharge	
2.8 Min. Discharge Voltage	
2.9 Max. Discharge Current	
2.10 Over Voltage Protection	
2.11 Under Voltage Protection	
2.12 Weight	
2.13 Operating (Atmosphere) Temperature	
2.14 Cell Surface Temperature	
2.15 Storage Temperature (for shipping state)	
2.16 Storage Temperature (for fully charge state)	
2.17 Storage Humidity	
3. Appearance and Dimension	7
3.1 Appearance	
3.2 Dimension	
4. Performance Specification	8
4.1 Test Condition	
4.2 Electrical Specification	
4.3 Environmental Specification	
4.4 Safety Specification	
5. Warranty	11
6. Warning, Caution and Prohibition.....	11

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 to *Robert Bosch GmbH* and etc. 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: LEV (E-bike) (Model name: 000000)

※ The Cell can be used solely for the application(s)/model(s) set forth in this Document and no other application 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: INR21700M58T (IEC designation: INR22/71)

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

2. Nominal Specification

Item	Condition / Note		Specification
2.1.1 Capacity	By Standard charge/discharge * Based on max. value within initial 10 cycles		Min. 5,570 mAh
2.1.2 Energy	By Standard charge/discharge * Based on max. value within initial 10 cycles		Min. 20.0 Wh
2.2 Nominal Voltage	Average by Standard charge/discharge		3.59V
2.3 Shipping Cell Voltage	State Of Charge (“SOC”)		Below SOC 30% (3.612V)
2.4 Standard Charge ¹⁾	Charging mode CC : Constant current CV : Constant voltage End Current (Cut off) Charging time (for one complete full charge)		CC/CV 1,120mA 4.20V 112mA <6.0h
2.5 Max. Charge Voltage			4.20V
2.6 Max. Charge Current (Complete full charge) ²⁾ * Based on operating temperature	0 ~ 10℃	4.2V cut-off	1,120mA
	10 ~ 50℃		2,700mA
	0 ~ 10℃	4.0V cut-off	1,500mA
	10 ~ 40℃		5,000mA
	* Caution : Even when charging with 5,000mA within the limits described above, continuously repeated cycles are not preferred. If the cycles exceeds 10 times, performance and safety can't be guaranteed. Please refer to footnote 2)		
2.7 Standard Discharge	Discharging mode CC : Constant current End Voltage(Cut off)		CC 1,120mA 2.50V
2.8 Min. Discharge Voltage			2.50V
2.9.1 Max. Discharge Current ²⁾ * Based on surface temperature	-20 ~ 70℃		12,500mA (Re-discharge below 50℃)**
	* If the battery cell is operated within the cell surface temperature limits stated in 2.14, it is safe to discharge the cell with currents up to 12,500mA in the operating temperature region of -20~60℃ stated in 2.13. This means that the cell should not be fully discharged with constant current of 12,500mA in the whole voltage range without temperature and voltage limits. The cell should be protected from		

	overheating by proper protective functions such as temperature cut-off, current derating and shut down before the cell surface temperature reaches limit. The cell performance cannot be guaranteed and accelerated aging is expected. ** Discharge shall not be allowed after reaching the temperature limits until cell has cooled down to less than 50 °C.	
2.9.2 Max. Discharge Current (Pulsed discharge) ²⁾ * Based on operating temperature	-20 ~ 0 °C	9,000mA, 15sec
	0 ~ 60 °C	15,000mA, 15sec
2.10 Over Voltage Protection	Cell voltage including tolerance shall not exceed the 4.25V to prevent any safety events. And cell performance can't be guaranteed between 4.20V and 4.25V	4.25V
2.11 Under Voltage Protection	Cell voltage including tolerance shall not drop below the 2.00V to prevent any safety events. And cell performance can't be guaranteed between 2.50V and 2.00V	2.00V
2.12 Weight	Without washer and tube	Max. 73.2g
2.13 Operating Temperature ³⁾ (Atmosphere or Chamber Temperature)	Charge	0 ~ 50 °C
	Discharge	-20 ~ 60 °C
2.14 Cell Surface Temperature	Charge	0 ~ 55 °C
	Discharge	-20 ~ 70 °C
	* Max. cell surface temperature should be controlled by BMU protection unit below 55 °C for charging and 70 °C for discharging. * Temperature cut-off function of the BMU should stop charging and discharging at a temperature below the given limits in order to ensure that the limits are never exceeded, including any measurement tolerances.	
2.15 Storage Temperature ⁴⁾ (for shipping state)	1 month	-20 ~ 60 °C
	3 month	-20 ~ 45 °C
	1 year	-20 ~ 25 °C
	Recovery energy ⁵⁾ after the storage ≥ 80% of minimum energy	

2.16 Storage Temperature ⁴⁾ (for fully charged state)	1 month	-20 ~ 60℃
	6 month	-20 ~ 25℃
	Recovery energy ⁵⁾ after the storage ≥80% of minimum energy	
2.17 Storage Humidity		25 ~ 50%

- 1) Charging time is based on one complete charge from the 0~100% SOC. Contact and discuss with LG Energy Solution if trickle charging is required to maintain fully charged state (ex. Trickle or floating charge).
- 2) The maximum continuous and pulsed charge or discharge current herein is the allowable current to operate cell without possibility of dramatic degradation of the cell. "Complete full charge" means that cell is charged from the minimum discharge voltage (refer to 2.8) to the max charge voltage (refer to 2.5) without stopping for 1 cycle. The charge and discharge current herein is the maximum allowable value in which the battery cell can perform normal charge/discharge without sudden internal changes such as CID activation. But this has nothing to do with guarantee of cycle performance and/or single cell degradation speed. More demanding cycling conditions (e.g. frequent/continuous discharging with 12.5A in high surface temperature) in field use will result in causing field issues such as accelerated aging, CID activation, cell imbalancing even if the cell is used within Max. discharge current limit. 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.
- 3) The operating temperature range defined in this section (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 is charged / discharged within the above (2.13) operating temperature range, 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.
- 4) The storage temperature and period range defined in this section (2.15 and 2.16) 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 (2.15 and 2.16) 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.
- 5) Recovery capacity / energy : After storage, cells shall be discharged with Std. discharge condition per 4.1.2, and then cells shall be charged with Std. charge condition per 4.1.1, and then discharged with Std. discharge condition per 4.1.2.

3. Appearance and Dimension

3.1 Appearance

- All cell external appearance criteria apply upon consumption of cells in addition to for fresh cells.
- Cells shall arrive nominally clean on all visible surfaces. Cells shall not exhibit signs of dirt, dust, pitch, electrolyte residue, haze, wax, oil, salt, powder, industrial fallout, contaminants, debris that could become loose, etc.
- Cells shall be free from defects that adversely affect commercial value of the cell.
- Refrain from removing the plastic wrap of the pallet until one day prior to the actual use (line input) as the cells are prone to external risks (such as rust on CANs) once exposed to open air.
- There shall be no severe scratch, crack, rust, discoloration, dent, leakage, or other significant issue with the Cell's outer appearance.
- The cell shall meet the rust and contamination requirements in the table below.

Appendix. Cosmetic limit table (Rust & Contamination)

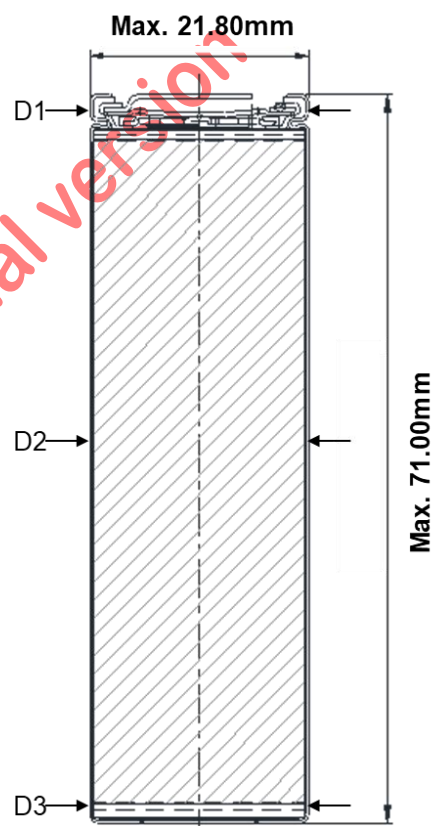
Position		Specification
Top	Positive pole 	• No Rust • No Contamination
	Other area	• No criteria except for the position specified above
Bottom	Negative pole 	• No Rust • Contamination (When Gray difference ≤ 45, Area $\leq 3\text{mm}^2$)
	Other area	• No criteria except for the position specified above

3.2 Dimension

- Diameter : 21.30 ~ 21.80 mm (D2), 21.30 ~ 21.70 mm (D1 / D3)

Diameter is defined as the largest and smallest data value measured on the “D1 / D3” area (1mm from the top / bottom) and “D2 area (30mm from the top) of the Cell, measured by Vernier Calipers (Mitsutoyo, 500-182-20).

- Height (Top~Bottom) : 70.50 ~ 71.00 mm



4. Performance Specification

4.1 Test condition

4.1.1 Standard Charge

A "Standard Charge" is charging the Cell at constant current of 1,120mAh and constant voltage of 4.20V at 25°C until the charge current is tapered to 112mA.

4.1.2 Standard Discharge

A "Standard Discharge" is discharging the Cell at constant current of 1,120mAh at 25°C. The Discharge shall terminate when the voltage of the Cell reaches 2.50V.

4.2 Electrical Specification

Item	Condition	Specification
4.2.1 Initial AC Impedance	Cell shall be measured at 1kHz after charging per 4.1.1	$\leq 15 \text{ m}\Omega$
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 6A constant current for 10 sec, 1A for 10 sec and 6A for 4 sec at 25°C without any attachment of metal leads. ($R_{DC} = (U_{15s} - U_{23s}) [V] / 5 [A]$)	$\leq 20 \text{ m}\Omega$
4.2.3 Initial Energy	Cells shall be charged per 4.1.1 and discharged per 4.1.2 within 1 hour after full charge. * Based on max. value within initial 10 cycles	$\geq 20.0\text{Wh}$
4.2.4 Cycle Life (2.7A/7.5A)	Charge(CC/CV) : 2,700mA, 4.1V, 100mA cut-off at 25°C Discharge(CC) : 7,500mA, 2.5V cut-off at 25°C * Rest : until $<30^\circ\text{C}$ or $>300\text{s}$ after eoch/eodch * Recovered capacity shall be measured by standard charge per 4.1.1 and standard discharge per 4.1.2.	Recovered Energy $\geq 80\%$ (of 20.3Wh) at 500cycles

4.3 Environmental specification

Item	Condition		Specification
4.3.1 Temperature Dependency of Energy	The Cell shall be charged per 4.1.1 at 25°C and discharged per 4.1.2 at the following temperatures.		
	Charge	Discharge	Energy
	25°C	-10°C 0°C 25°C 60°C	≥ 70% (of 20.0Wh) ≥ 80% (of 20.0Wh) ≥ 100% (of 20.0Wh) ≥ 95% (of 20.0Wh)

4.4 International Safety Specification

- The cell satisfies UN38.3, PSE, IEC62133-2 and UL1642(Technician replaceable) regulation

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.

- 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 directly with conductive materials to prevent the cell from external short.
- 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 Packs. 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.
- Damaged Cells (e.g. damaged surface, damaged wrapper, can distortion, electrolyte leakage, rust etc.) shall not be assembled into the Battery Pack.
- The Battery Packs must use Cells of the same model and same production date produced by LG Energy Solution. (Up to two consecutive lots after voltage grading can be used only for applications like EV.)
- 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.)
- When the Battery Packs for any applications are assembled with the Cells, protective circuitry with the following protective functions must be designed into the Battery Packs and/or in the charger or charging adapter or system.

(1) Over Voltage Protection Circuit

(2) Under Voltage Protection Circuit

(3) Over Charge Current Protection Circuit

(4) Over Discharge Current Protection Circuit

(5) Short Circuit Protection

(6) Over Temperature Protection Circuit

(7) Second Over Voltage Protection

(8) FET Failure Protection (in case FET is out of order)

(9) Cell Imbalance Protection Circuit (only for packs assembled with 2S configuration and over)

(10) Cell Voltage Balancing Function (only for packs assembled with 2S configuration and over)

※ The Pack must have protective functions equivalent to (9) and (10) for 1SnP configuration applications.

※ For better stability and performance of the Battery Packs, it is recommended to add cell balancing function

Detailed conditions for each function should reflect the contents specified in this document. If one or more of these function(s) is/are to be omitted from a Battery Pack, the Battery Pack Maker(s) or End Product Integrator(s) must inform LG Energy Solution of the omission.

- The Battery Pack shall contain all of the applicable warnings required under UL or IEC safety standards.