Confidential

File No. NCR18650

Issue Date : 2019/8/26

LITHIUM ION BATTERY SPECIFICATION

BATTERY CLASSIFICATION	LITHIUM ION BATTERY
PRODUCT CODE	
CLIENT	

Client Agreement:

Signature:	
Name in Block Letters:	
Date:	

* If there is no reply within 30 days following delivery, this document shall be presumed to be valid.

Panasonic Industrial Devices Sales Taiwan Co.,Ltd.

Battery Technology First Sect.

Battery Technology Dept.

1st Ind. Components Business Group

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1 Revision History

No.	Date	Class	Description		
(a)	2019/8/26	-	Issue	Dft.	Mick
				Chk.	K.Kobayashi
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				App.	

* Legend: A for Added, D for Deleted, R for Revised

2 Safety Instructions

The battery contains flammable materials such as organic solvents. Mishandling the battery may smoke, or an explosion and the battery's functionality will be seriously damaged. Protection circuitry cause fire, must be designed into the application device to protect the battery. Additionally, PIDSTW highly recommends adding these instructions to the owner's manual. Please read and check the following prohibited actions.

Danger

(1) Immersion
Do not immerse the battery in liquid such as water, beverages, or other fluids.
Exposure to liquid may damage the battery or the battery pack (including protection circuit). As a result, the battery may generate heat, smoke, catch fire, or explode.

(2) High Temperature
Do not use or place the battery near an open flame, heater or high temperature (above 80°C).
Subjecting the battery to high temperature may damage the polyolefin separator and can cause an internal short circuit. This may cause the battery to generate heat, smoke, catch fire or explode.

(3) Chargers and Charge Conditions
Do not use unauthorized chargers.
Only charge the battery within specified conditions (e.g., temperature range, voltage, and current).
Use of an unauthorized charger could cause the battery to generate heat, smoke, catch fire, or explode.

(4) Reverse Polarity
Do not attach or insert battery with polarity reversed.
A battery has polarity. If the battery does not easily fit into the charger or device, check the battery' s orientation. Do not force the battery into the battery compartment. If attached to the device with reversed polarity, the battery may generate heat, smoke, catch fire, or explode.

(5) Direct Connection
Do not connect the battery to an AC outlet or DC automotive plug.
The battery requires a specific charger. If the battery is connected directly to a power outlet, the battery may generate heat, smoke, catch fire, or explode.

(6) Use in Other Equipment
Do not use the battery in equipment for which it was not intended.
If the battery is used in unapproved applications or systems, the battery may become damaged and generate heat, smoke, catch fire, or explode.

(7) Incineration and Heat
Keep the battery away from heat and fire.
Heat will damage the battery and may cause it to generate heat, smoke, catch fire, or explode.

(8) Short-Circuit
Do not apply a short-circuit.
Do not connect the positive (+) and negative (-) terminals with a conductive material.
Do not carry or store the battery with any metal objects. If the battery is shorted, the shorting item may overheat and the battery may generate heat, smoke, catch fire, or explode.

(9) Impact
Avoid excessive impact to the battery.
Excessive impact may damage the battery. This may cause the battery to leak, generate heat, smoke, catch fire, or explode.

(10) Penetration
Do not penetrate the battery with a nail or strike with a hammer.
If subjected to a hard strike or penetrated by an object, the battery may be damaged or destroyed,thereby causing an internal short-circuit. This may cause the battery to generate heat, smoke, catch fire, or explode.

(11) Soldering
Do not directly solder to the battery.
Soldering directly to the battery could melt the separator or damage the gas release vent or other safety mechanisms. This may cause the battery to generate heat, smoke, catch fire, or explode.

(12) Disassembly
Do not disassemble the battery cell and battery pack.
Battery cell and/or battery pack may be deformed and damaged by disassembly.
Disassembly or modification of the battery cell and/or battery pack may damage the protection functions. This may cause the battery cell and/or battery pack to generate heat, smoke, catch fire, or explode.

(13) Charge near High Temperatures
Do not charge the battery near high temperature.
If the battery is charged while exposed to high temperature, the battery's protection circuit may activate and prevent charging, or fail and cause the battery to generate heat, smoke, catch fire, or explode.

Warning

(1) Ingestion
Keep away from small children.
Keep the battery away from small children. If the battery or any of its component parts is swallowed, seek medical attention immediately.

(2) Storage
Do not place the battery in or near a microwave or other cooking appliances.
If subjected to heat or electromagnetic radiation, the battery may leak, generate heat, smoke, catch fire, or explode.

(3) Mixed Use
Do not mix with other batteries.
The battery should not be used with other batteries having a different capacity, chemistry, or manufacturer. Doing so could cause the battery to generate heat, smoke, catch fire, or explode.

(4) Discoloration and Deformities
Do not use abnormal batteries.
Immediately stop using the battery if there are noticeable abnormalities, such as smell, heat,discoloration, or deformity. The battery may be defective and could generate heat, smoke, catch fire, or explode with continued use.

(5) Charging Time
Stop charging if the charging process cannot be finished.
If the battery can not finish the charging process within the specified time, halt the charging process.
The battery may generate heat, smoke, catch fire, or explode.

(6) Leakage ①
Do not use a leaking battery near open flame.
If the battery or liquid leaking from the battery has an irritating odor, the battery should be kept away from any open flame. If exposed to an open flame, the battery could ignite and explode.

(7) Leakage ②
Do not touch a leaking battery.
If liquid leaking from the battery gets into your eyes, immediately flush your eyes with clean water and seek medical attention. If left untreated, it will cause significant eye damage.

(8) Transport
Pack the battery securely for transport.
To prevent short-circuit or damage during transport, securely pack the battery in a case or carton.

Caution

(1) Static Electricity
The battery pack has a protection circuit. Do not use the battery where static electricity in excess of 100V is generated as it may damage the protection circuit. If the protection circuit fails, the battery performance and life to deteriorate.

(2) Charging Temperature Range
Only charge the battery at our specified temperature range. Charging outside of this temperature range may cause the battery to leak, generate heat, or result in serious damage. It may also cause the battery's performance and life to deteriorate.

(3) Manual
Read the manual before use. Keep for future reference.

(4) Charging Method
Read the charger's manual before use for proper charging method.

(5) First Time Usage
Please contact the supplier if the battery gives off an unusual odor, generates heat, or shows signs of rust prior to its initial use.

(6) Use by Children
Parents must explain how to use the system and the battery. Please check back periodically to ensure children are using the system and the battery correctly.

(7) Flammable Materials
Do not charge or discharge near flammable materials. Doing so could result in fire.

(8) Leakage
If electrolyte leaks from the battery and comes into contact with skin or clothing, immediately flush with water. Otherwise, it may cause skin irritation.

(9) Handling of Exposed Contacts or Conductors
If the battery pack has a system interface consisting of stripped lead wires or exposed contact plates, as polypropylene tape or polyvinylchloride tape. Failure to do so could result in an electrical shock; a short circuit causing the battery to generate heat, smoke, catch fire, or explode; or the combustion of other materials.

(10) Recycling
When disposing of the battery, recycle it according to local rules and regulations.

(11) Exposure to Direct Sunlight
Do not use or leave the battery in a location exposed to excessive heat.
If the battery is used such as in direct sunlight or in a car, doing so could cause the battery to leak, generate heat, smoke, catch fire, or explode. It may also cause the battery's performance and life to deteriorate.

3 Scope

This specification applies to the Lithium Ion Battery (Cylindrical type) NCR18650G for by .

Do not use this battery in applications other than described above.
If the battery was used in other applications, it may cause performance degradation and safety deterioration depending on the usage of the battery in the equipment.

Incorrect handling of the battery may cause potential hazards of overheat, smoke, fire, or explosion. Battery usage other than described above could result in bodily injury or property damage.

This Specification shall not apply to special applications requiring a high degree of quality and reliability where the failure or malfunction of the products may directly jeopardize life or cause threat of personal injury.
A non-exhaustive list of such applications includes: weapons, aircraft and aerospace equipment, aircraft electronics equipment, medical equipment (excluding Class 1 equipment), intrinsically safe equipment, electric vehicles, hybrid electric vehicles, and electric motorcycles (excluding electric bicycles).

4 Battery Classification and Product Code

▪4.1 Battery Classification	Lithium Ion Battery
▪4.2 Product Code	
▪4.3 Model Name	NCR18650G
▪4.4 Cell Type	NCR18650GA

5 Nominal Specifications

Item		Specifications	Notes
5.1 Rated Capacity	4.20V Charge	3300 mAh	0.67 A discharge at 20℃
	4.15V Charge*1	3190 mAh	
5.2 Capacity (Minimum)	4.20V Charge	3350 mAh	0.67 A discharge at 25℃
	4.15V Charge*1	3235 mAh	
5.3 Capacity (Typical)	4.20V Charge	3450 mAh	Reference only
	4.15V Charge*1	3360 mAh	
5.4 Nominal Voltage	4.20V Charge	3.60V	0.67 A discharge at 25℃
	4.15V Charge*1		
5.5 Discharging End Voltage		2.50V	
5.6 Charging Current	Low Temp.	838 mA or less	0 ~ +10°C
	Std. Temp.	1675 mA or less	+10 ~ +45°C
5.7 Charging Voltage	4.20V Charge	4.20 ± 0.03V	
	4.15V Charge*1	4.15 ± 0.03V	
5.8 Charging Time (Std.)		4.0 hours	
5.9 Continuous Discharge Current (Max.) * 2		5.025A (10A)	0 ~ +40°C
5.10 Internal Resistance		Less than 50mΩ	AC impedance 1 kHz
5.11 Weight		Less than 49.5g	
5.12 Operating Temperature	Charge	0~45°C	
	Discharge	-20 ~ +60°C	
5.13 Storage Conditions*3	Less than 1 month	-20 ~ +50°C	Recoverable Capacity: 80% * 4
	Less than 3 month	-20 ~ +40°C	
	Less than 1 year	-20 ~ + 20°C	

*1 Regarding Charging Voltage Control, please refer to Item 6 ”Charging control for Life End” and Item 11 “ Standard Charging Method”.

*2 The maximum discharge current for a single cell use. However after the battery pack assembly, maximum discharge current will be limited by a protection circuit or device.

*3 Amount of charging is 30%.

*4 Recoverable Capacity = $\frac{Discharge\ Time\ after\ Storage}{Initail\ Discharge\ Time} * 100$

The discharge time is measured by fully charging the battery at 25°C and then discharging it at a current of 0.67A to 2.50V per cell in series.

6 Charging Control for Life End

Safety and cycle characteristics of Lithium-ion batteries can be improved by reducing the voltage lower than the rated charging voltage.
Therefore, when designing the battery pack using this cell, Panasonic will request to reduce the charging voltage from the beginning.
Or Panasonic will request to add a function to reduce the charging voltage when the deterioration rate reaches a certain level.

6.1 During usage, if charging voltage can NOT be changed.
- The charging voltage should be reduced from the beginning.

6.2 During usage, if charging voltage can be changed.
- The charging voltage should be reduced before SOH (State of Health) reaches 70%.

∗ One of 6.1 or 6.2 above must be the mandatory item.

7 Electrical Characteristics

Item	Conditions	Criteria
7.1 Full Charge	[4.20V Charge] The battery is charged at 1.675A constant current until the voltage reaches 4.20V. The current is then reduced to keep a constant voltage of 4.20V. The total charging time is 4 hours at 25°C. [4.15V Charge] The battery is charged at 1.675A constant current until the voltage reaches 4.15V. The current is then reduced to keep a constant voltage of 4.15V. The total charging time is 4 hours at 25°C.	
7.2 Capacity	(1) Within 1 hour after fully charging at 25°C as per item 7.1, the battery is discharged at 0.67A continuously to 2.50V at 25°C.	[4.20V Charge] More than 300 min. [4.15V Charge] More than 289 min.
	(2) Within 1 hour after fully charging at 25°C as per item 7.1, the battery is discharged at 3.35A continuously to 2.50V at 25°C.	[4.20V Charge] More than 54 min. [4.15V Charge] More than 52 min.

Item	Conditions	Criteria
7.3 Cycle Life	[4.20V Charge] After the battery has been subjected to 300 repeated charge and discharge cycles (charged by CC-CV of 1.675A - 4.20V for 4 hours; discharged by CC of 3.35A to 2.50V at 25°C), the discharge time is measured as per Item 6.2, (2).	More than 38 min.
	[4.15V Charge] After the battery has been subjected to 300 repeated charge and discharge cycles (charged by CC-CV of 1.675A - 4.15V for 4 hours; discharged by CC of 3.35 A to 2.50V at 25°C), the discharge time is measured as per Item 7.2, (2).	More than 36 min.
7.4 Temperature Characteristics	(1) Within 1 hour after fully charging at 25°C as per item 7.1, the battery is stored at 0°C for 3 hours. The discharge time is then measured as per Item 7.2, (2) at 0°C.	[4.20V Charge] More than 30 min. [4.15V Charge] More than 28 min.
	(2) Within 1 hour after fully charging at 25°C as per item 7.1, the battery is stored at 60°C for 3 hours. The discharge time is then measured as per Item 7.2, (2) at 60°C.	[4.20V Charge] More than 50 min. [4.15V Charge] More than 48 min.
7.5 Storage at Fully Charged State	After fully charging at 25°C as per item 7.1, the battery is stored for 20 days at 60°C After storage, the battery is held at 25°C for 3 hours.Then, the discharge time is measured as per Item 7.2, (2).	[4.20V Charge] More than 30 min. [4.15V Charge] More than 28 min.
	Then, the same battery is fully charged again and discharged a second time and measured as per Item 7.2, (2) at 25°C.	[4.20V Charge] More than 40 min. [4.15V Charge] More than 38 min.
7.6 Storage at Full Discharge State	After fully charging at 25°C, the battery is discharged as per Item 7.2, (2). Then, the battery is stored for 20 days at 60°C. After storage, the battery is held at 25°C for 3.0 hours and is then fully charged as per Item 7.1 Then, the discharge time is measured as per Item 7.2, (2) at 25°C.	[4.20V Charge] More than 50 min. [4.15V Charge] More than 48 min.
7.7 Drop	After fully charging at 25℃, the cell is dropped 3 times in random directions from a height of 1m onto a flat surface of concrete.	No rupture, no fire

STANDARD TEST CONDITIONS:

All tests shall be conducted with new batteries delivered within the last 7 days. Tests shall be performed at a temperature of 25±2°C and a humidity of 65±20% (the standard temperature tolerance for Class 2 and the standard humidity tolerance for Class 20, respectively, as specified by JIS Z 8703, Standard Atmospheric Conditions for Testing). The precision of the voltmeter and ammeter used in the tests shall be higher than Class 0.5 as specified by JIS C 1102-2, Special Requirements for Ammeters and Voltmeters.

8 Design and Dimensions

The battery design is shown in the following documents or drawings.

- Drawing number NCR18650G, NCR18650G

9 Appearance

There shall be no such defects as followings, which may adversely affect commercial value of the cell:

- Scratch
- Rust
- Discoloration
- Dirt
- Deformation

10 State of Charge at Time of Shipment

At time of shipment, the battery's state of charge shall be 30% of its rated capacity or less.

11 Standard Charging Method

(1) The standard charge condition is a constant current – constant voltage method with a current of 1.675A and a maximum voltage of 4.20V. The charging process should be halted when either time, battery voltage, or current reach certain values.
However, the charging voltage should be reduced to 4.15V before SOH (State of Health) reaches 70%. Also, if SOH reaches 50~60%, further charging voltage reduction or alarm function for battery replacement should be installed. (Recommendation).
If the charging voltage cannot be changed during the usage, the charging voltage should be reduced to 4.15V from the beginning. (Mandatory)

(2) When the battery is in a state of over-discharge (the battery voltage is less than 2.0V per cell), the battery should be charged by a pre-charge circuit to prevent heat generation in the charge FETs.

(3) The pre-charging current should be approximately 335mA.Once the battery voltage reaches more than 2.5V per cell, the charger can resume the standard charging method. The pre-charge function should have a cut-off timer in order to detect a short circuit. If the voltage does not recover to over 2.5V per cell within the specified time, charging must be terminated.

(4) The current interrupt device (CID) may work if the battery is charged continuously after fully-charged and / or is charged at high temperature. Please consult PIDSTW for charging method instructions.

12 Precautions for Designing of Pedelecs, the Chargers and the Battery packs

Please comply with the following instructions during every stage of application, charger, battery pack design and assembly processes otherwise the battery may experience a deterioration of functionality, quality, and safety. In the worst case, the battery may generate heat, smoke, catch fire, or explode.

12.1 Precautions for Designing of Pedelecs and the Chargers

(1) Charge

- The battery is charged by a method of constant current-constant voltage.
- Regarding NCR18650G, the charging current should not exceed 1.675A/cell.
- The charging voltage should not exceed 4.20V/cell.

- The charging voltage is required to be set to less than 4.20V/cell with considering the accuracy of charger. However, when the charging voltage control is necessary, the charging voltage after the charging control should not exceed 4.15V/cell, and the charging voltage is required to be set to less than 4.18V/cell with considering the accuracy of charger. Even if the charger is failed, the total safety shall be secured.
- The charger shall be equipped with a pre-charge system.
- If battery voltage goes down to less than 2.50V/cell, the battery should be charged by pre-charge current of maximum 335mA. Once, the battery reached more than 2.50V/cell by the pre-charging, the charger can resume the standard charging method. However, if the battery voltage never recovers more than 2.50V/cell, the charger must be stopped and turned off.
- The charger shall be equipped a full charge detection.
- The charger shall detect the full-charged state by a timer, current detection or open circuit voltage detection. When the charger detects the full-charge, the charger shall stop charging. Do not apply the continuous charging (trickle charging) method.
- The charging temperature should be confined to the range 0°C to +45°C."
- It is recommended that charging should be stopped to avoid continuous charging, when either of the following conditions are met;
  - The charging current reaches approximately 67mA in CV mode.
  - The charging time reaches 4 hours in case of charging at 1.675A.

(2) Discharge

- The discharge current should not exceed 5.025A/cell.
- The discharge temperature should be between -20°C to + 60°C.
- The discharge end voltage should be more than 2.50V/cell.
  If cells are to be connected in series, please refer to Item 14.1.

(3) Over discharge

- Do not discharge the battery at less than 2.0V/cell.

(4) Design of Pedelecs and chargers.

- The cells should be kept away from heat generating electronic parts in order to avoid deterioration of battery performance.

(5) Strength of the battery pack enclosure

- The battery pack enclosure must be designed to have sufficient strength to resist damage from specified or typical expected mechanical stresses such as bending, twisting, and impact due to drop of application.

12.2 Precautions for Battery Pack Design

(1) Shape, mechanism and material of battery packs

- The battery pack should be designed so it cannot connect to unauthorized chargers.
- The battery pack should be designed so it cannot connect with unauthorized equipment and/or
- The terminal shape should be designed to avoid short circuit issues. In addition, the battery pack should be equipped with an over current protection function in order to prevent from external short circuit issues.
- The terminal shape and structure should be designed so that it cannot connect in backwards.
- The battery pack should be designed to prevent static electricity, electrolyte, or water ingress issues.
- The battery pack should be designed so the protection circuit functions can be inspected during the assembly process.
- The battery pack should be designed so electrolyte cannot reach to the protection cicuit board even if electrolyte leak out of the cells.

- The cells should be fixed by tape or glue in the case. If the battery pack is dropped, the cells should be protected against dents, deformations, and other mechanical stresses.
- Plastic cases should be closed with glue. If an ultra sonic welding method is applied to the case sealing, PIDSTW will not accept any responsibilities for any defects.
- The pack shall be designed so end users cannot remove or disassemble the cells.
- Improper usage may damage the gas release vent on the cell, which generates flammable gas. If the flammable gas is generated, the battery could ignite and explode. Therefore, the battery pack should be designed that the flammable gas doesn't stay inside the pack.
- The battery pack or module shall be designed for the functions of anti-thermal propagation and flame containment in all usage. For reference, the battery design items are shown as follows.

  - Gas management structure not to remain heated-gases.
  - Prevention of large current flow from other cells.
  - Prevention of heat transfer to neighbor cells.

(2) Protection circuit

The following protection circuit should be equipped in the battery pack:

- **Overcharge protection**
  We recommend the over charge protection engages when cell voltage reaches more than 4.25V/cell then, the current shall be shut down. However, when the charging control is necessary, the operation voltage of overcharge protection after the charging control is recommended to 4.20V/cell.
- **Over discharge protection**
  If cell voltage reaches approximately 2.20V/cell, we recommend that the over discharge protection circuit shuts down the discharge current and the circuit consuption current is set to less than 1μA.
- **Over current protection**
  If discharge current exceeds approximately 5.025A/cell, the over current protection will shut down the current.

(3) Electric circuit

- To avoid over discharge mode during long storage times, the consumption current of the battery protection circuit should be set as low as possible.

(4) Cell connection

- The cells should not be connected using a soldering process. In order to avoid any damages, cells pack's should be connected to lead plates by a spot welding method.

(5) Precautions on label

- The rating label should indicate required information and precautions.
- The precautions should be based on the information in section 2.

13 Storing Condition

13.1 Storage Temperature and Humidity (Within 3 months)

- Cells should be stored in a stable environment characterized by low-humidity (less than 70%RH), free of corrosive gasses, and an ambient temperature between -20°C and +40°C.
- To prevent rust, avoid conditions that can create condensation such as rapid fluctuations in the ambient.

13.2 Long Duration Storage

- When long duration storage cells should be stored in a stable environment characterized by low humidity (less than 70%RH), free of corrosive gasses, and an ambient temperature between -20°C and +20°C.
- To prevent rust, avoid conditions that can create condensation such as rapid fluctuations in the ambient.
- For long term storage, a discharged or partial charged state of charge per section 9 is recommended.

14 Handling Precautions for Lithium Ion Cells

- This section describes handling precautions for lithium ion cells which will be assembled as battery packs with . This battery pack consists of NCR18650GA .

14.1 Series Connections Precautions

- This information is described in the carton.
- In addition, the cell voltage should be checked prior to battery assembly and the voltage should be within 25mV.
- When cells are connected in series, use the same capacity rank and the charge date within 7days.

14.2 Inspection of the Battery Pack before Shipping

All battery packs shall be inspected for :

- Voltage
- Internal impedance
- Function of protection circuit
- Thermistor resistance
- Thermal fuse

14.3 Precautions on Pack Assembly

- Do not bring battery near or into contact with heat sources such as soldering irons.
- Do not allow any metal to come into direct contact with cells inside the battery pack compartment.
- Do not lift the core pack by holding the lead wires or the printed circuited board.
- Do not unnecessarily twist or bend the lead wires or the printed circuited board.
- Do not re-work the battery.
- Do not use potentially abnormal cells which have been dropped, shorted, or deformed during handling or assembly--even if no damage is readily apparent. Do not use cells giving off the odor of electrolyte.

15 Warranty Exemptions

- PIDSTWwill not be liable for any damages that are caused by violations of the prohibited matters (section 2) and the precautions (section 11, 13~15) in this specification. If some problem happen in the battery, please handle this matter under responsibility. PIDSTW will not be liable for any
- problems caused by design defects of the battery packs, Pedelecs, or chargers.
- PIDSTW will not accept return of any abnormal cells that were damaged due to any incorrect assembly process.

16 Remark of Safety Design

- PIDSTW has been addressing to enhance the quality and the reliability of battery cell, but we also require our customers to introduce the safety design into the battery pack for avoiding unsafety situation.
- The event such as abnormal heat generation, smoke, fire and explosion might happen due to the failure of battery cell and the use out of the specification.
  should discuss to the product manufacturer about having the safety design such as redundant design, the prevention design against the spread of the fire, and so on, in order to prevent the accident of injury, death, fire, social harm as the result of battery cell
- PIDSTW will not be liable for any damage due to slack safety design.

17 Other Remarks

- If there are problems in this specification, PIDSTW will take them into consideration.
- PIDSTW can discuss specification or precautions that are not described in this specification.
- Do not use the provided cells for other applications.

18 Battery Warranty Period

In the event a defect is found in the cell, PIDSTW will replace the defective cell only, not whole cells in pack and module, without cost in case that all the following conditions are met:

(i) The defect is found and reported to PIDSTW within 1 year from the date of shipment of the defective battery;

(ii) The defect is caused by the reasons attributable to PIDSTW, such as a defect in design or manufacture; and

(iii) It is clear by evidence data such as log or/and inspection data that the defect is not caused by the reasons attributable to any third party other than PIDSTW, such as any misuse of the battery or failure to comply with this specification.

(iv) , and PIDSTW accomplished and confirmed the above and finally agreed that the reasons of the defect attributable to PIDSTW.

19 Battery Safety and Reliability Requirements

In order to ensure the safety of the battery, please contact PIDSTW to discuss design of the application from a mechanical and electrical perspective. Also, if there are special usage conditions (for example: a large current load, a quick charge method, or a special usage pattern), please consult PIDSTW before finalizing the product specification.

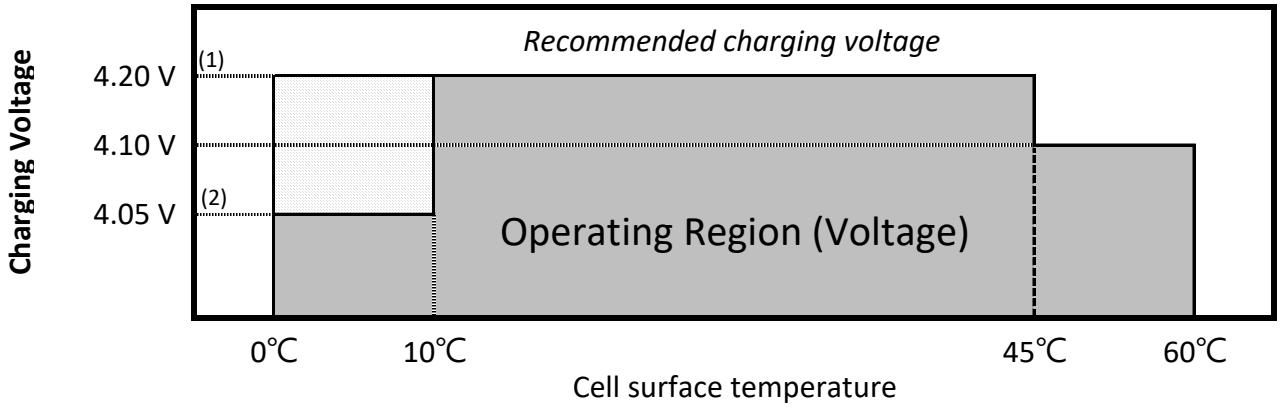
Appendix 1 <For Performance>

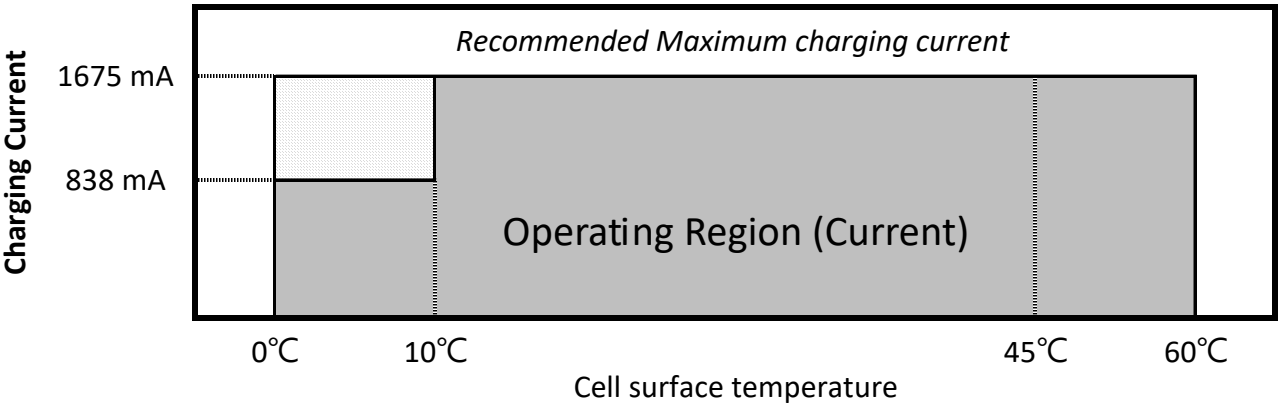
Regarding Operating Region for Performance, please follow the below condition.
The charging voltage and current should be lower than following Recommended charging voltage and Recommended maximum charging current in Table.1 for suppression of deterioration.

Model: [NCR18650G]

Table.1 Operating region (Cell surface temperature, voltage, current)

Temperature		Recommended charging voltage	Recommended Maximum charging current
0℃~10℃	(1)	4.20 V	838 mA
	(2)	4.05 V	1675 mA
10℃~45℃		4.20 V	1675 mA
45℃~60℃		4.10 V	1675 mA





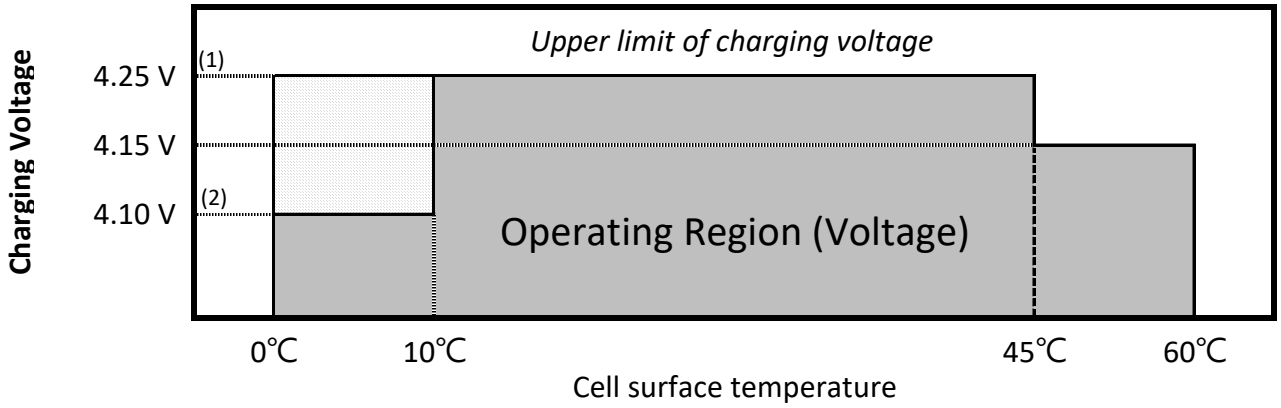
Appendix 2 <For Safety>

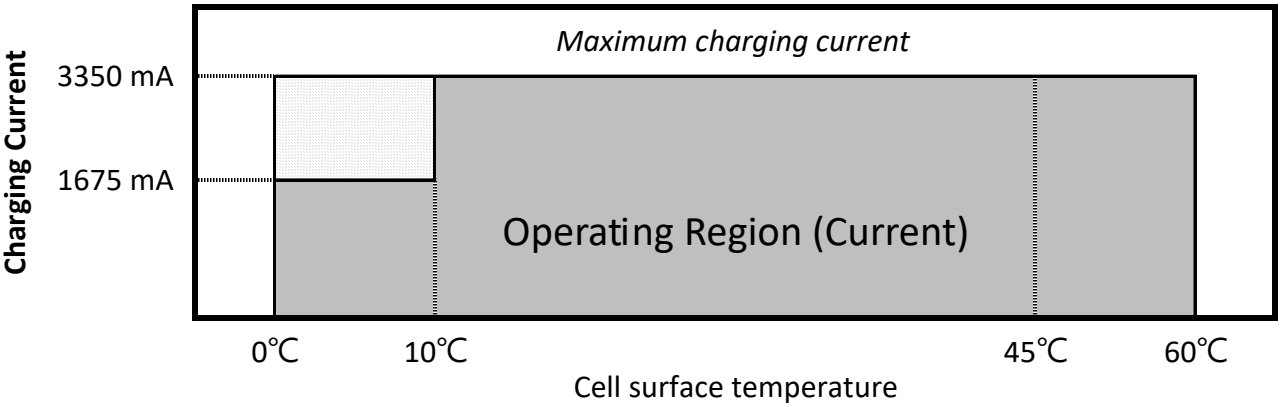
Regarding Operating Region for Safety please follow the below condition.
The charging voltage and current shall not exceed following Upper limit of charging voltage and Maximum charging current in Table.2 for safe use.

Model: [NCR18650G]

Table.2 Operating region (Cell surface temperature, voltage, current)

Temperature		Upper limit of charging voltage	Maximum charging current
0℃~10℃	(1)	4.25 V	1675 mA
	(2)	4.10 V	3350 mA
10℃~45℃		4.25 V	3350 mA
45℃~60℃		4.15 V	3350 mA

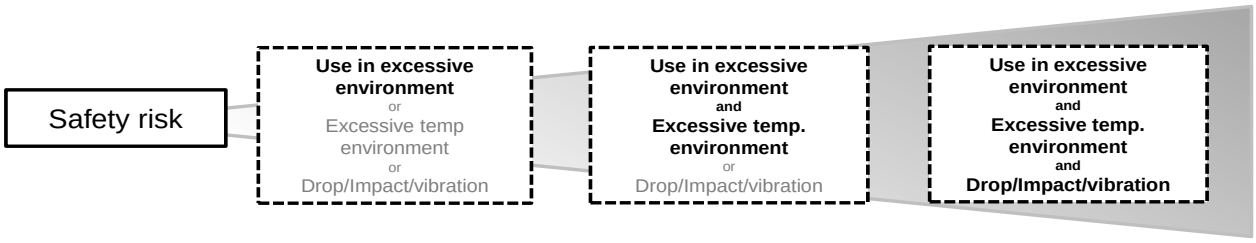




Safety risk associated with multiple factors

To reduce the safety risk associated with multiple factors, please ensure the safety of the battery packs by conducting severe and marginal tests.

<Example of multiple factors：Use in excessive environments>



- As multiple factors increase, safety risk will also increase
- Suggested action for

1) Confirmation the safety risk associated with multiple factors:
   Please make sure you to conduct severe and marginal test, based on actual and all foreseeable usage conditions.
   (i.e. Safety test after excessive temperature environment test, extension of test as in time and number for drop/impact/vibration)
2) Instructions to end users:
   Please make sure you warn your customers against inappropriate usage of the battery packs in the user's manual.

Important safety items about battery pack

- Please design the battery packs to ensure safety in case of any leakage of the battery cells.
- Please design the battery packs and systems to ensure safety of equipment and users in case the current is cut off.
- Please design the battery packs considering any impact, drop, shock, vibration, or electric shock in case of deterioration of battery pack components.

* Please consult with the final product manufacturer with respect to the assumed deterioration period, assumed drop, shock or vibration of the final products.

Safety risk of cells	Influence on battery pack	Check items
<Non operation>		
Dis-connection →	■Battery malfunction	・Safe design considering redundancy
<Unsafe operation>		
Leakage →	■External / internal short circuit ■Degradation of battery parts by corrosion	・Safe design against leakage
High Temp./flammable gas release →	■Cause of burning(High Temp. gas) ■Explosion by fire(Flammable gas)	・Anti-fire propagation / flame containment design ・Securing the gas release route
Internal / external short circuit →	■Deterioration of insulation ■Battery pack malfunction ■Abnormal heat generation, fire	・Charge control at the end of life ・Anti-fire propagation / flame containment design ・Safe design considering deterioration
Heat generation →	■ Reduction of resistant ■ Abnormal heat generation, fire	・Confirmation of usage temp. range ・Safe design considering deterioration
< Consideration of shape change / lowering strength / use environment of battery pack >		
	■Reduced tolerance (impact, drop, shock, electric shock) ■ External / internal short circuit ■ Electric shock or external short circuit caused by water immersion, dust, condensation.	・conducting safety tests considering the degraded conditions of battery cells and packs ・Safe design against water immersion, dust and condensation.