Confidential

File No. NCR18650

Issue Date: 2015/1/15

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.

Portable Rechargeable Battery Business Division,
SANYO Electric Co.,Ltd.
Automotive & Industrial Systems Company
of Panasonic Group
Technical Service Group No.2
PA Business Development Team

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1 Revision History

No.	Date	Class	Description		
(0)	2015/1/15	—	Issue (Preliminary)	Dft.	T.Higami
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				App.	
				Dft.	
				Chk.	
				Chk.	
				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 cause fire, smoke, or an explosion and the battery's functionality will be seriously damaged. Protection circuitry must be designed into the application device to protect the battery. Additionally, SANYO 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.

Impact beyond specification 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.

Disassembly or modication of the battery may damage the protection circuit. This may cause the battery 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.

(14) Deformation

Do not use the battery with conspicuous damage or deformation.

It causes the generating heat, smoke, rupture or flame.

(15) Reverse Charge and Overdischarge

Do not reverse polarity (and terminals).

On charging, the battery is reverse-charged and abnormal chemical reaction occurs. And also, there may be case that unexpected large current flows on discharging. These cause the generating heat, smoke, rupture or flame.

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) Rust, 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) Exposure to Direct Sunlight

Do not use or leave the battery in a location exposed to excessive heat, such as in direct sunlight or in a car. Doing so could cause the battery to generate heat, smoke, catch fire, or explode. It may also cause the battery's performance and life to deteriorate.

(2) 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 may generate heat, catch fire, smoke, or explode.

(3) Charging Temperature Range

Only charge the battery between 10°C and 45°C. 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.

(4) Manual

Read the manual before use. Keep for future reference.

(5) Charging Method

Read the charger's manual before use for proper charging method.

(6) 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.

(7) 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.

(8) Flammable Materials

Do not charge or discharge near flammable materials. Doing so could result in fire.

(9) 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.

(10) Handling of Exposed Contacts or Conductors

If the battery pack has a system interface consisting of stripped lead wires or exposed contact plates, handle with due care. Temporarily insulate exposed contacts and conductors with an insulator such 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.

(11) Recycling

When disposing of the battery, recycle it according to local rules and regulations.

3 Scope

This specification applies to the Lithium Ion Battery NCR18650G

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		3300mAh	0.67A discharge at 20°C
5.2	Capacity (Minimum) *1		3350mAh	0.67A discharge at 25°C
5.3	Capacity (Typical)		3450mAh	Reference only
5.4	Nominal Voltage		3.6V	0.67A discharge
5.5	Discharging End Voltage		2.5V	
5.6	Charging Current (Std.)		1.675A	
5.7	Charging Voltage		4.20 ± 0.03V	
5.8	Charging Time (Std.)		4.0hours	
5.9	Continuous Discharge Current (Max.) *2,3		10A	0 ~ +40°C
5.10	Internal Resistance		less than 38mΩ	AC impedance 1 kHz
5.11	Weight		less than 49.5g	
5.12	Operating Temperature	Charge	10 ~ +45°C	
		Discharge	-20 ~ +60°C	
5.13	Storage Conditions	less than 1 month	-20 ~ +50°C	Recoverable Capacity: 80% *4
		less than 3 months	-20 ~ + 40°C	
		less than 1 year	-20 ~ + 20°C	

*1 Capacity is measured by the discharge at 0.67A until end voltage of 2.5V after fully charged at 25°C as described in the specification.

*2 Discharge at high rate or high temperature environment will accelerate the degradation of the battery capacity.

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

*4

$$\text{Recoverable Capacity} = \frac{\text{Discharge Time after Storage}}{\text{Initial Discharge Time}} * 100$$

The discharge time is measured by fully charging the battery at 25°C and then discharging it at a current of 0.67A to 2.5V per cell in series.

*5 Maximum cell surface temperature :The cell temperature must not exceed 70°C.

6 Electrical Characteristics

Item	Conditions	Criteria
6.1 Full Charge	The battery is charged at a 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 4.0 hours at 25°C.	
6.2 Capacity	(1) Within 1 hour after fully charging at 25°C as per item 6.1, the battery is discharged at 0.67A continuously to 2.5V at 25°C.	More than 300 min.
	(2) Within 1 hour after fully charging at 25°C as per item 6.1, the battery is discharged at 3.35A continuously to 2.5V at 25°C.	More than 54 min.
6.3 Cycle Life	After the battery has been subjected to 300 repeated charge and discharge cycles (charged by CC-CV of 1.675A-4.20V for 4.0 hours; discharged by CC of 3.35A to 2.5V at 25°C), the discharge time is measured as per Item 6.2, (2).	More than 38 min.
6.4 Temperature Characteristics	(1) Within 1 hour after fully charging at 25°C as per item 6.1, the battery is stored at 0°C for 3 hours. The discharge time is then measured as per Item 6.2, (2) at 0°C.	More than 30 min.
	(2) Within 1 hour after fully charging at 25°C as per item 6.1, the battery is stored at 60°C for 3 hours. The discharge time is then measured as per Item 6.2, (2) at 60°C.	More than 50 min.
6.5 Storage at Fully Charged State	After fully charging at 25°C per item 6.1, 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 6.2, (2).	More than 30 min.
	Then, the same battery is fully charged again and discharged a second time and measured as per Item 6.2, (2) at 25°C.	More than 40 min.
6.6 Storage at Full Discharged State	After fully charging at 25°C, the battery is discharged as per Item 6.2, (2). Then, 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 6.2, (2) at 25°C.	More than 50 min.

Item	Conditions	Criteria
6.7 Drop	After fully charging at 25°C, the cell is dropped 3 times in random directions from a height of 1 m 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*

7 Design and Dimensions

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

- Drawing number [NCR18650G 、AUR18650]

8 Appearance

The battery should have none of the following appearance issues obvious to the naked eye at time of delivery:

- Scratch
- Rust
- Discoloration
- Dirt
- Deformation
- Leakage

The battery should be in good condition.

9 State of Charge at Time of Shipment

The battery is shipped out with a state of charge that is approximately 48%*.

* The 48% capacity is the state of charge at the time that SANYO ships the battery. It is not the state of charge when receives the battery.

10 Precautions for Designing of the , the Chargers and the Battery packs.

10.1 Precautions for Designing of the Charger.

(1) Charge

- The battery is charged by a method of constant current-constant voltage.
- Regarding NCR18650G the charging current should not exceed 3.35A/cell.
- The charging voltage should not exceed 4.20V/cell.
- The charging voltage is required to be set to less than 4.23V/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 2.5V/cell, the battery should be charged by pre-charge current of maximum 0.33A. Once, the battery reached more than 2.5V/cell by the pre-charging, the charger can resume the standard charging method. However, if the battery voltage never recovers more than 2.5V/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 10°C to +45°C.

(2) Discharge

- The discharge current should not exceed 10A/cell.
- The discharge temperature should be between -20°C to +60°C.
- The discharge end voltage should be more than 2.5V/cell

(3) Over discharge

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

(4) Design of and chargers..

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

10.2 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 devices.
- 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 circuit 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, SANYO will not accept any responsibilities for any defects.
- The pack shall be designed so end users cannot remove or disassemble the cells.

(2) Protection circuit

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

- **Overcharge protection**
  For safety reason and in order not to shorten the cycle life, max overcharge protection voltage of each block should be under 4.25V/cell including tolerance.
- **Over discharge protection**
  If cell voltage reaches approximately 2.2V/cell, we recommend that the over discharge protection circuit shuts down the discharge current and the circuit consumption current is set to less than 1μA.
- **Over current protection**
  If discharge current exceeds approximately 10A/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 pack's 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 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.

11 Storing Condition

11.1 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℃ and +40℃.
- To prevent rust, avoid conditions that can create condensation such as rapid fluctuations in the ambient.

11.2 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℃ and +20℃.
- 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.

12 Handling Precautions for Lithium Ion Cells

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

12.1 Series Connections Precautions

- When the cells are connected in series, use the same rank cells. This information is described in the label on the carton. In addition, the cell voltage should be checked and the voltage should be within 20mV.

  * Lot number on carton label.

12.2 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

12.3 Precautions on Pack Assembly

- 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.
- 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 pouch 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 batter

13 Warranty Exemptions

- SANYO will not be liable for any damages that are caused by violations of the precautions in this specification
- SANYO will not be liable for any problems caused by design defects of the battery packs, Pedelecs, or chargers.
- SANYO will not accept return of any abnormal cells that were damaged due to any incorrect assembly process.

14 Other Remarks

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

15 Standard Charging Method

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.

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

The pre-charging current should be approximately 0.33A. 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.

The current interrupt device (CID) may activate if the battery is charged continuously after it has reached a fully-charged state or if the battery is charged at a high temperature. Please consult SANYO for instruction on the charge method.

16 Battery Warranty Period

Unless otherwise stated in the contract, the warranty period is limited to one year from date of shipment. Panasonic will replace batteries if it is clear that
there was a defect in Panasonic's manufacturing process and that the battery hasnot been misused.

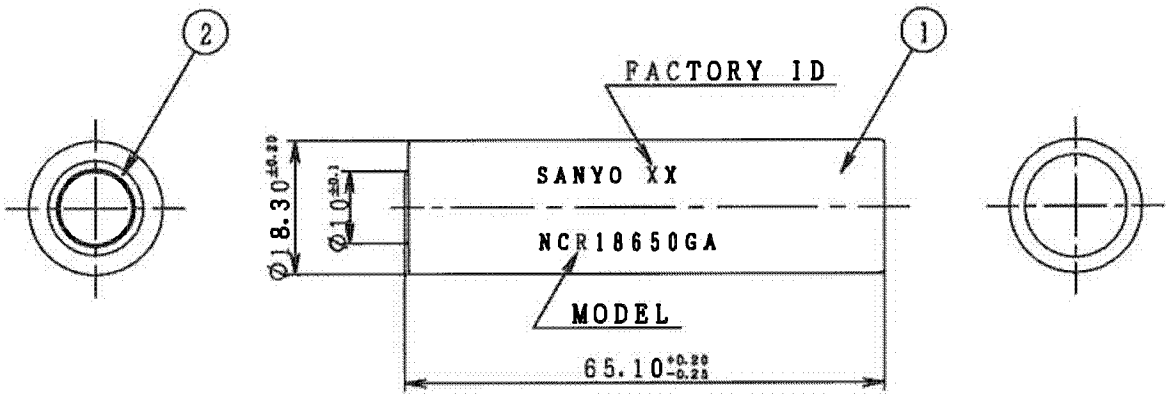
17 Battery Safety Requirements

In order to ensure the safety of the battery, please contact SANYO 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 SANYO before finalizing the product specification.

18 Document Terms (Tentative Specification)

- The expiration period for this document is 6 months from the cover date.
- If a new revision of the document is released, please return or destroy the previous revision.
- This document is still in a preliminary state. The contents are not yet fixed.

NO.	PART NAME	APPLICATION・PART CODE	QTY.	MATERIAL・SPECIFICATION	NOTE
	BATTERY		1	NCR18650GA	SHIPPING WITH CHARGE
1	TUBE		1	PET	PET TUBE RED
2	INSULATION RING		1	PAPER 0.25t	BLUE



NOTE.

1. STAMP LOT NO. ON THE TUBE.

   XXXX
   - DAY (1ST=01, 2ND, =02, ・・30TH=30, 31ST=31)
   - MONTH (JAN=1, FEB=2, ・・SEP=9, OCT=X, NOV=Y, DEC=Z)
   - YEAR ('96=6, '97=7, ・・'15=5, '16=6, ・・)

   EX.) JAN. 14. 2015・・・・・5114
2. LOT NO. IS EQUAL WITH CHARGING DATE.
3. STAMP "SANYO", FACTORY ID, & MODEL ON THE TUBE.
4. STAMP FACTORY ID ON THE TUBE AS SHOWN IN THE FOLLOWING TABLE. 1.

TABLE. 1

FACTORY ID	FACTORY
L	SANYO ENERGY HIGASHIURA CO., LTD.
TD	TSUNADENKI CO., LTD
C	CHUOU ELECTRIC CO., LTD

DRAWING NOT TO SCALE

SYM	DATE	DESCRIPTION
	JAN. 14. 2015	1st DRAWING (K. Yoshimoto)

DATE	JAN. 14. 2015	REMARK	
D R	K. Yoshimoto	MODEL:NCR18650G	材料・規格
CHK		CUSTOMER CODE:.	MATERIAL
CHK		TOLERANCE / WEIGHT Approx. g	処理・加工 / FINISH
ENG		UNIT mm	製品名 / PART NAME: 完成電池 / BATTERY PACK (finish goods)
APP	A. Komiyama	QTY 1 / SCALE 1/1	PART CODE / DRAWING NO: NCR18650G / Rev.

TOLERANCE	
250< L	±5
< L ≤	±
50< L ≤250	±4
18< L ≤ 50	±3
L ≤ 18	±2

Sanyo Electric Co., Ltd. Portable Rechargeable Battery Business Division A4