 Confidential  
Until:




## Delivery Specification

The Name of An Article: Lithium Ion Cell

Applied Article: NCR-B/T13SEB (NCR18650A)

Customer Signature

Lithium-ion Battery Business Unit  
Energy Company  
Panasonic Corporation

Approved	Checked	Prepared
		

## Prohibitions in Handling the Lithium-ion Cell

### 1. Scope

This document defines the Prohibitions in Handling the Lithium-ion cell which Panasonic Corporation Energy Company (hereinafter called Energy Company) supplies to your company. Energy Company is not responsible for the troubles caused by mishandling of the cell which is against the instructions in this document. When Energy Company finds new information which requires modification to the contents of this document, we will inform you again.

### 2. General Prohibitions in Handling the Lithium-ion Cell

(1) Mishandling of the cell may cause heat, explosion and fire. Be sure to observe the following.

- Do not throw the cell into fire or heat it.
- Do not use the cell with + and - in reversed.
- Do not connect + and - terminals with wire or other metal (Do not short-circuit the cell.).
- Do not pierce the cell with a nail, strike it with a hammer, step on it or otherwise subject it to strong impact.
- Do not directly solder to the cell.
- Do not allow the cell to be immersed in or wetted with water or sea-water.
- Do not put the cell into the microwave oven or high pressure container.

(2) Never disassemble or modify the cell. The safety mechanisms are incorporated in the cell to prevent danger. Damaged safety mechanism may cause heat, explosion and fire.

(3) Do not leave the cell in places of the high temperature like the side of a fire or stove or under strong direct sunlight. This may cause heat, explosion and fire. In addition, performances and service life of the cell may be deteriorated.

(4) Immediately stop using the cell, if you notice heat, discoloration, deformation, damage on external tube, or anything wrong, during use or storage of the cell. Move the cell away from a fire immediately when you notice a foul odor due to leakage.

(5) When electrolyte of the cell splashes into the eyes, immediately flush the eyes thoroughly with clean water without rubbing and take a medical treatment immediately. If appropriate procedures are not taken, this may cause a loss of sight.

### 3. Prohibitions in Charging the Lithium-ion Cell

(1) When the cell is charged, the specified charge method and current described in this document should be applied. If charge current exceeds the upper limit of the specified range, characteristics and safety of the cell could be deteriorated, or it may cause heat, explosion and fire.

(2) Charge voltage should be less than 4.20V. Even if you consider the voltage control accuracy, the maximum voltage of the cell should be 4.25V. If the charge voltage exceeds the upper limit of the specified range, characteristics of the cell could be remarkably deteriorated.

(3) The charge temperature range for the cell should be the specified range described in this specification.

The pack should be designed such that none of the cells exceed the specified temperature range described in this specification regardless of the pack layout, construction and/or usage.

(4) Make sure to include a system that will detect full charge (via timer and/or charge current value) and end charging.

Continuous charging, such as in trickle charge systems, is prohibited.

### 4. Prohibitions in Discharging the Lithium-ion Cell

(1) The discharge current should not exceed the designated current described in this specification. If the discharge current exceeds the specified value, discharge capacity could be extremely deteriorated or the cell could be heated.

(2) The discharge temperature range should be the specified value in this specification.

(3) When the cell is stored for a long term, the cell could become over discharged due to self discharge. The cell with voltage less than over-discharge-protection-reset-voltage should be charged with small current in a few minutes. If the cell voltage is not recovered to over- discharge-reset-voltage after small current charging in a few minutes, do not charge the cell again.

Energy Company will not be responsible for any claims, damages, or problems caused by or relating to Battery Packs, including infringement of intellectual property rights of third parties, product liability, violation of laws or rules (Electrical Appliance and Material Safety Law(Japan) or the like), obtaining product standard(UL1642, UN38.3 or the like), marking,matching and reliability of Battery Packs on actual set or unit application, taking of appropriate measure to prevent any and all cell propagation of cell ignition relating to the use of the cell ("Cell Propagation"). Cell Propagation includes, but shall not be limited to, the spread of ignition of a cell to contiguous cells.



Lithium Ion Cell  
NCR-B/T13SEB  
Specification

### 1. Application Range

This specification is applied to Lithium ion cells NCR-B/T13SEB which will be used for lithium ion battery packs to be manufactured by Shenzhen Syren Energy Technology Co.,Ltd..

For special applications in which quality and reliability are required, or if the failure or malfunction of the products may directly jeopardize life or cause threat of personal injury (such as for weapon, aircraft and aerospace equipment, aircraft electronics equipment, medical equipment(a part of class 2 equipment, class 3 or more equipment), explosion-proof equipment, electric vehicle, hybrid electric vehicle, and electric motor cycle(except electric bicycle)), this Specification shall not be applied.

### 2. Rated specification

2.1. Rated voltage:	3.6 V
2.2. Capacity:	
2.2.1. Rated capacity:	2900mAh (Min.cap. in quick charging, standard discharging(1) at 20°C)
2.2.2. Nominal capacity:	Min.2950mAh Typ.3070mAh(in quick charging, standard discharging(2) at 25°C)
2.3. Standard charging:	4.2V, 590mA,60mA end (Constant voltage, constant current) (Approval maximum charging voltage by tolerance : 4.25V)
2.4. Quick charging:	4.2V, 1475mA, 60mA end (Constant voltage, constant current) (Maximum charging voltage : 4.25V) Charging method and charger are only those designated. * If the cell voltage is <2.4V, charge current must be $\leq 0.1$ It.
2.5. Standard discharging:	
2.5.1. Standard discharging (1):	580mA (Constant current,2.5V end )
2.5.2. Standard discharging (2):	590mA (Constant current, 2.5V end )
2.6. Continuous allowable discharging current:	3540mA (45°C or under)
2.7. Temperature and humidity range:	0 to 45°C, 45 to 85%RH (in standard charging) 10 to 45°C, 45 to 85%RH (in quick charging) -20 to 60°C, 45 to 85%RH (in standard discharging)
2.8. Storage Temperature and humidity range:	-20 to 35°C, 45 to 85%RH (within 1 year) -20 to 40°C, 45 to 85%RH (within 6 months) -20 to 45°C, 45 to 85%RH (within 1 month) -20 to 50°C, 45 to 85%RH (within 1 week)

(Notes) The capacity recovery rate in the delivery state after storage is assumed to be 80% or more.

2.9. Volume Energy density:	620.2 Wh/l
-----------------------------	------------

(Notes) This value is calculated by rated capacity, rated voltage and cell volume without shrink tube.

### 3. Compliance

- 3.1. Maximum voltage at standard and quick charging: The cell voltage must not exceed 4.25V.  
Even if factoring charge voltage control accuracy,the maximum voltage must never exceed 4.25V with any charge method(including pulse charge).
- 3.2. Protection circuit overdischarge prohibition voltage: The cell voltage must not be below 2.0V.
- 3.3. Pack construction(restriction of cell quantity for the battery pack)  
Parallel •No limit. However the pack must pass an overcharge test. (parallel no. x quick charging current)  
Series •10 cells in series or less(more than 10 cells in series pack needs fuse.)  
•50V15A(750W) charge or less(More than 50V15A charge needs triple charge control.)

### 4. Structure

The cell consists of the positive electrode plate, negative electrode plate, separator, electrolyte, case and assembled sealing cap. The positive and negative electrode plates are housed in the case in the state being separated by the separator, and the assembled sealing cap is fit to the case. The assembled sealing cap houses the positive electrode terminal, current shut off mechanism and explosion-proof safety valve element, making the case the negative electrode terminal.

## 5. Test method and judgment criteria

### 5.1. Test condition

5.1.1. Cells to be used for testing are those delivered within 1 month and are not used.

Charging / Discharging states are the states Charging / Discharging at  $20\pm5^{\circ}\text{C}$  in quick charging / standard discharging(2), and being left not more than 24 hours.

5.1.2. Test state is Class 5 ( $20\pm5^{\circ}\text{C}$ ) standard temperature state and class 20 ( $65\pm20\%\text{RH}$ ) standard humidity state specified in JIS Z8703 (standard condition of the test state).

5.1.3. Test conditions are 5.1.1. and 5.1.2., unless otherwise specified.

### 5.2. Test instruments

The following instruments are used for the test.

5.2.1. Voltmeter: With precision 0.5mV or more.(Class 0.5 specified in JIS C1102)

5.2.2. Ammeter: With precision 0.5mA or more.(Class 0.5 specified in JIS C1102)

5.2.3. Height and thickness gauge: With precision 0.05mm or more.

5.2.4. Internal resistance meter: Those with 1kHz sinewave AC 4 terminal method.

5.2.5. Balance: Those with reciprocal sensibility 10mg or more.

### 5.3. Test method and judgment criteria:

Item	Test method	Judgment criteria
1. Indication Appearance	Visual check.	There are not excessive dirt, deformation and flaws.
2. Dimensions	Measured by calipers.	The data is in allowance of dimensions in appended drawing.
3. Weight	Measured by balance.	46.3g or less.
4. Open Circuit Voltage	Measure open circuit voltage within 1 hour after quick charging at $25^{\circ}\text{C}$ .	4.1V or more.
5. Internal Resistance	Measure internal resistance within 1 hour after quick charging at $25^{\circ}\text{C}$ .	48mΩ or less.
6. Nominal Capacity(Minimum)	Measure capacity by discharging in the standard discharging at $25^{\circ}\text{C}$ within 1 hour after quick charging at $25^{\circ}\text{C}$ .	2950mAh or more.
7. High Rate Discharging	Measure capacity by discharging (in the below condition) within 1 hour after quick charging at $25^{\circ}\text{C}$ . ●Discharging : 2950mA to 2.5V at $25^{\circ}\text{C}$	2508mAh or more.
8. High Temperature Discharging	Measure capacity by holding at $45\pm2^{\circ}\text{C}$ for 4 hours after quick charging at $25^{\circ}\text{C}$ and discharging in the below condition. ●Discharging : 2950mA to 2.5V	2508mAh or more.



9. Low Temperature Discharging	Measure capacity by holding at $0\pm 2^{\circ}\text{C}$ for 4 hours after quick charging at $25^{\circ}\text{C}$ and discharging in the below condition. ●Discharging : 2950mA to 2.5V	1962mAh or more.
10. Cycle Life	300 cycle charging/discharging is repeated in the below condition. ●Charging : 4.2V, 1475mA, 60mA end Constant voltage constant current ●Rest time : 20 min. between charging and discharging ●Discharging : 2950mA to 2.5V ●Temperature : $25\pm 2^{\circ}\text{C}$ Measure capacity on the 301 cycle after repeating of 1 cycle standard charging/ standard discharging.	1962mAh or more.
11. Storage	The capacity is measured by standard discharging at $25^{\circ}\text{C}$ after the below condition. Charged battery should be stored for 14 days at $60^{\circ}\text{C}$ then perform standard discharging and quick charging cycles for 2 cycles.	2065mAh or more.
	The capacity is measured by standard discharging at $25^{\circ}\text{C}$ after the below condition. Discharged battery should be stored for 14 days at $60^{\circ}\text{C}$ then perform quick charging cycles for 1 cycles.	2360mAh or more.
12. Leakage	After quick charging at $25^{\circ}\text{C}$ , the cell shall be left in a thermostatic oven. The inner temperature of the thermostatic oven, the time it is to be left as is, and the test procedure shall be as follows. Step.1: Leave the cell at $75\pm 2^{\circ}\text{C}$ for four hours. Step.2: Change the temperature to $20\pm 5^{\circ}\text{C}$ within 30 minutes and left the equipment for two hours. Step.3: Change the temperature to $-20\pm 2^{\circ}\text{C}$ within 30 minutes and the equipment shall be left for four hours. Step.4: Change the temperature to $20\pm 5^{\circ}\text{C}$ within 30 minutes and left the equipment for at least two hours. Step.5: Steps 1 to 4 repeat another four times. Store the charged cells at $20\pm 5^{\circ}\text{C}$ for seven days, and then conduct a visual inspection.	No leakage.
13. Vibration	Vibrate the cell in triaxial direction for 90 min. per axis in condition of frequency 10-55Hz (1Hz per 1 min.) and amplitude 1.5mm p-p.	No fire. No explosion.
14. Shock Drop	Drop the cell onto concrete board from 1m height 3 times.	No fire. No explosion.
15. Short Circuit	Short circuit the lead wire (resistance $80\pm 20\text{m}\Omega$ ) across + and - terminals of the cell after quick charging.	No fire. No explosion.

6. Product drawing

Refer to appended drawing.

7. Packing drawing

Refer to appended drawing.

8. Packing state

Charging capacity of delivered cells is about 1416mAh.

9. Prohibition and caution items in handling

Refer to the related pages.

10. Warranty of cell

10.1. The Cells are warranted to the descriptions contained in this Specification for a period of twelve(12) months from the date of receipt by Shenzhen Syren Energy Technology Co.,Ltd..

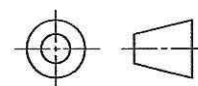
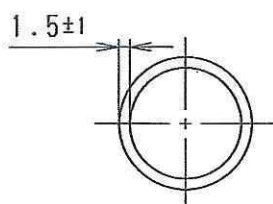
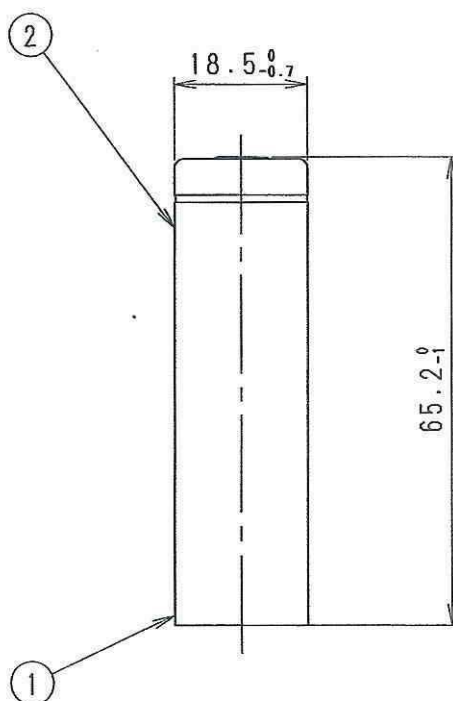
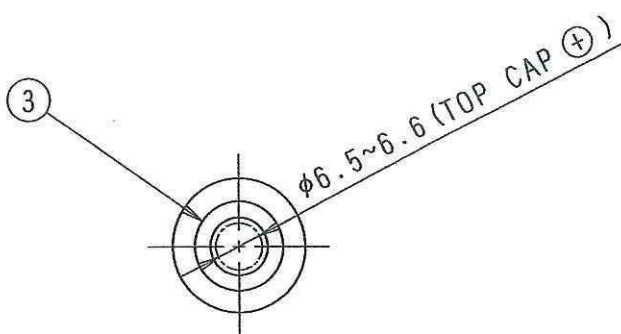
In the event that a Cell fails to comply with the Specifications and the cause of which was attributable to Panasonic Corporation Energy Company's (hereinafter called Energy Company) fault during the said warranty period, Energy Company will repair such non-conforming cells, or supply a replacement cell,either way agreed by both parties.

10.2. Energy Company's warranty shall not be applicable in the case where customer fails to carry out proper handling, operating, installation, testing, service and checkout of the cell and/or to follow the instructions, cautions, warnings, notes provided in this Specification, or other direction from Energy Company.

10.3. Energy Company can not be held responsible for problems resulting from circuit, battery pack and/or equipment matching issues.

10.4. Energy Company will bear responsibility for PL issues resulting from defects which are directly attributable to the cell. However, PL issues resulting from battery pack or equipment problems are the responsibility of the Shenzhen Syren Energy Technology Co.,Ltd. and compensation should come from Shenzhen Syren Energy Technology Co.,Ltd..

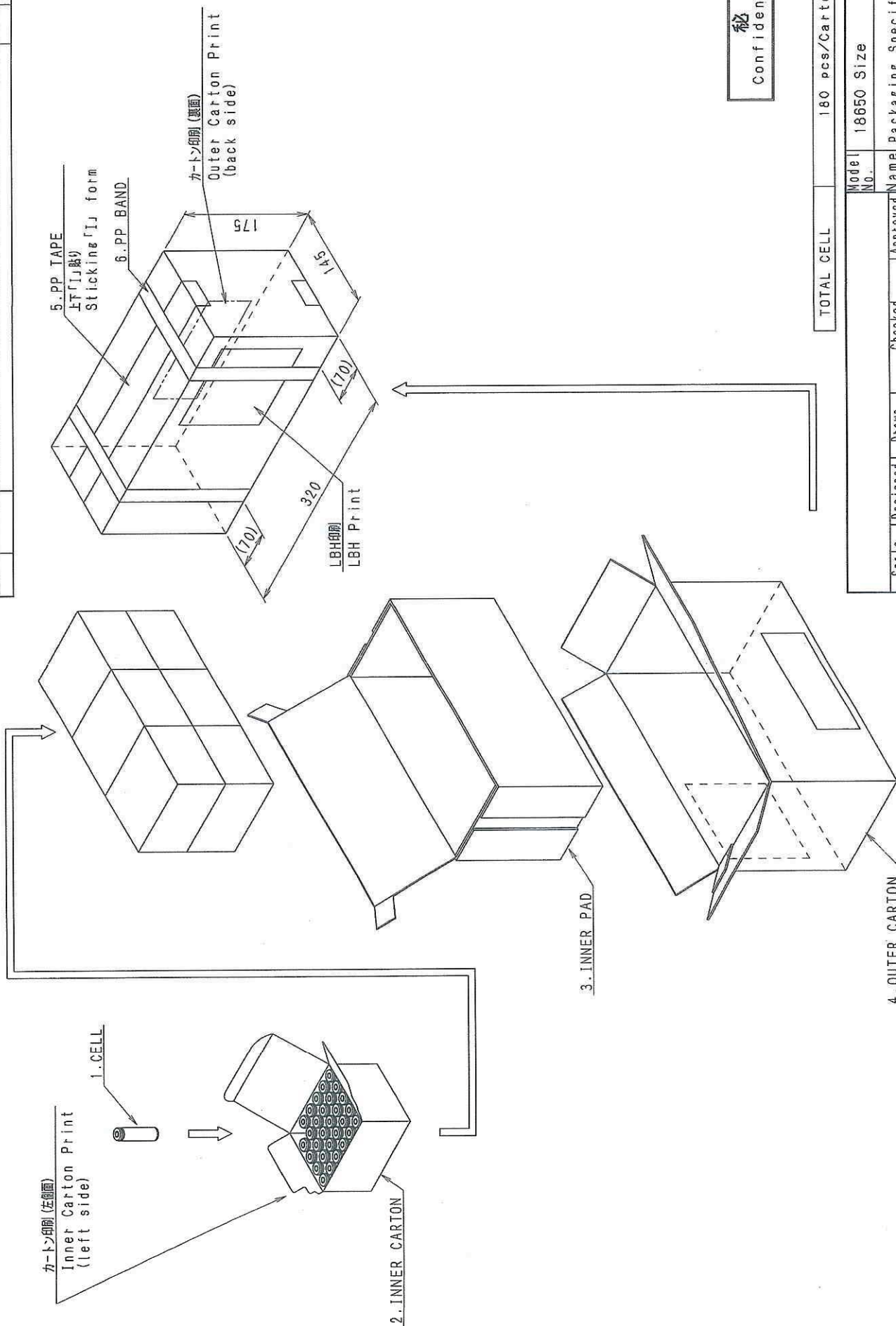
Symbol	Date	Revision	Signe	Checked



Unit:mm

③	INSULATOR	PAPER	1		
②	OUTER JACKET	SHRINK TUBE	1		Ver.2
①	CELL	NCR18650A	1		
Symbole	Name	Material	qt.	Process	Remark
Scale	Designed	Drawn	Checked	Checked	Approved
1:1	Sugimoto	Hara			
	10.Dec.24	10.Dec.24			
Model No.		NCR18650A			
Name		DIMENSION SKETCH			

Symbol	Date	Revision	Signed	Checked

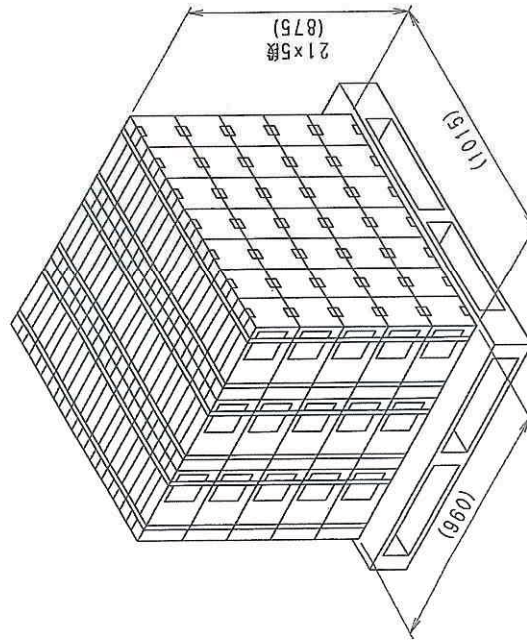
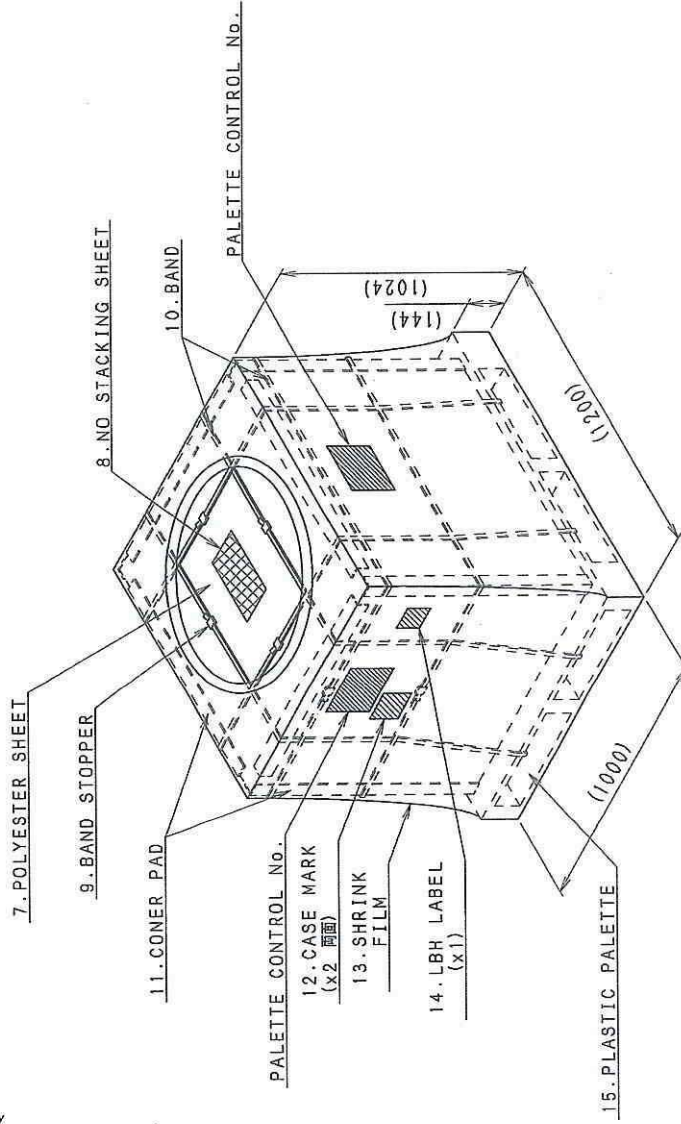
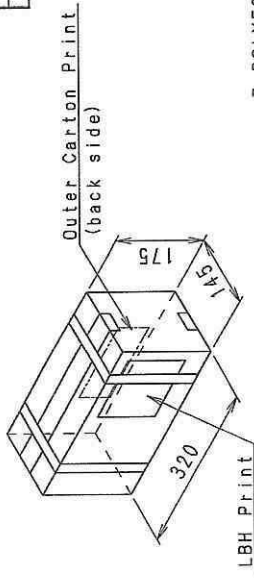


TOTAL CELL 180 pcs/Carton

Scale	Designed	Drawn	Checked	Approved	Name	Model No.
FREE	Suzimoto	Suzimoto				18650 Size
					Parts No.	Packaging Specification
	10-11-02	10-11-02				



Symbl	Date	Revision	Signed	Checked





【積載方法図】  
Loading Method

【シュリンク/ラベリング状態図】  
Shrink/Labeling Method

秘  
Confidential

TOTAL CARTON	105 pcs.
TOTAL CELL	18900 pcs.

						Model No.	18650 Size
Scale	Designed	Drawn	Checked	Approved	Name		Packaging Specification for Export
Free	Sueimoto	Sueimoto			Parts No.		
	10.11.02	10.11.02					

Issued on: Nov 10 2010

Name of Product												
Product Number	1	2	3	4	5	6	7	8	9	10	11	12
	N	C	R	-	B	/	T	1	3	S	E	B
Customer						Customer Number						
Third Area												

Lithium Ion Battery Business Unit

APPROVED	CHECKED	DRAWN
Miyata		Sugimoto

## Lithium Ion Battery Bill Of Material

N	No	PARTS NAME	Unit	Q'ty	Remarks
	1	BATTERY CELL(NCR18650A)	pcs	180	
	2	INNER CARTON	pcs	6/180	
	3	INNER PAD	pcs	1/180	
	4	OUTER CARTON	pcs	1/180	
	5	PP TAPE(W=48)	m	0.84/180	
	6	PP BAND	m	1.28/180	
	7	PE SHEET	pcs	1/18900	
	8	NO STACKING SHEET	pcs	1/18900	
	9	BAND STOPPER	pcs	6/18900	
	10	PP BAND	m	27/18900	
	11	CORNER PAD	pcs	8/18900	
	12	CASE MARK	pcs	2/18900	
	13	SHRINK WRAP(W=500)	m	25/18900	
	14	LBH LABEL	pcs	1/18900	
	15	PLASTIC PALETTE	pcs	1/18900	

## Packaging Specification

ModelNo	ITEM	VALUE	Unit	Remarks
BCR-B/T13	SIZE	320 × 145 × 175	mm	
		0.0081	m <sup>3</sup>	
	NET MASS	8.4	kg	
	GROSS MASS	approx.9.0	kg	
NCR-B/T13SEB	TOTAL CARTON	105	pcs	
	TOTAL Q'TY	18900	pcs	
	SIZE	1200 × 1000 × 1024	mm	
		1.229	m <sup>3</sup>	
	NET MASS	8.4 × 105=882	kg	
	CARTON MASS	63	kg	
	PALETTE MASS	10	kg	
	CORNER PAD MASS	2 × 8=16	kg	
	GROSS MASS	approx.971	kg	

NOTE:

Style Number:		Panasonic Corporation Energy Company		
SYS	DATE	Revision	Signed	Checked



Issued on: Nov 10 2010

Name of Product												
Product Number	1	2	3	4	5	6	7	8	9	10	11	12
	N	C	R	-	B	/	T	1	3	S	E	B
Customer						Customer Number						
Third Area												

Lithium Ion Battery Business Unit


APPROVED	CHECKED	DRAWN
Miyata		Sugimoto

## Carton Print Specification

### 【Inner Carton Print】

Model No.	<input type="text"/>	①	QR Code Area
UL Model No.	<input type="text"/>	②	
Date Code	<input type="text"/>	③	
Rank	<input type="text"/>	④	
Q'ty	<input type="text"/>	⑤	
Charge Date	<input type="text"/>	⑥	
Contol No	<input type="text"/>	⑦	

### 【Outer Carton Print】

Bar Code Area for internal management	
13figures Area of internal management	
MADE IN JAPAN	
MH12210 	
Model No.	①
UL Model No.	②
Date Code	③
Rank	④
Q'ty	⑤
Charge Date	⑥
Contol No	⑦

### 【Specification】

	① Model No	② UL Model No.	③ Date Code	④ Rank	⑤ Q'ty	⑥ Charge Date	⑦ Contol No
exp.	NCR-B/T13SEB	NCR18650A	* * - * *	*	30 (Inner) 180 (Outer)	* * * * * Day Month Year	* * * *

NOTE:

Style Number:		Panasonic Corporation Energy Company	
SYS	DATE	Revision	Signed
			Checked



GENERAL TOLERANCE	±0.2	Symbol	Date	Revision	Signed	Checked
		x				
		x				
		x				



注記)  
NOTE)

- 材質: 上質紙 64g/m<sup>2</sup>  
Material: PAPER 64g/m<sup>2</sup>
- 印刷のカケ、カスレ、ニジミ等のないこと。  
No short, scrape and blur of printing allowed.
- 印刷内容は版下データによる。版下データ: "BLA6AA03343\_081001\_OUT. PDF".  
Content of printing is referred to artwork data.  
Artwork data: "BLA6AA03343\_081001\_OUT. PDF".
- 印刷色: 黒、赤 (PANTONE186U)。  
Printing color: black, red (PANTONE186U)

letter and mark: black  
red hatching (PANTONE186U)

構成する材料は、パナソニック (株) が発行する下記の基準に従っていること。

- グリーン調達基準書
- 化学物質管理ランク指針

The material must comply with the following rules issued by Panasonic Corporation.

- Green Procurement Standards
- Chemical Substances Management

秘  
Confidential

		上質紙 64g/m <sup>2</sup> PAPER 64g/m <sup>2</sup>		裏面接着剤処理 Reverse side: Adhesive "PA-T1"	
Symbol	Name	Material	qt.	Process	Remark
				Model No.	
Scale	Designed	Drawn	Checked	Approved	Name LBH LABEL
1 : 1	Kurokawa	Kurokawa			Parts No. BLA6AA03343
	08-10-01	08-10-01			

## 1. Scope

This document defines the Compliance in Handling the Lithium-ion cell which Panasonic Corporation Energy Company (hereinafter called Energy Company) supplies to your company. Energy Company is not responsible for the troubles caused by mishandling of the cell which is against the instructions in this document. When Energy Company finds new information which requires modification to the contents of this document, we will inform you again.

## 2. Compliance in the Cell Storage

(1) Store the cell in the storage condition defined in this specification.

- Do not store the cell in places of high temperature or under direct sunlight.
- Do not store the cell in high humidity or in the place which may expose the cell to rain or water.
- Do not put any combustibles around the cell during storage.
- Do not store the cell in a discharge state of less than 10% or greater than 50%, when the cell is stored for a long term.
- The cell is a chemical product utilizing a chemical reaction, so the performance will be deteriorated not only through use but also with the passage of time even if it left unused.

## 3. Compliance in Disposal of the Lithium-ion Cell

(1) Dispose the damaged cell during the battery pack assembly process etc. after taking necessary steps to prevent external short-circuit by the following methods.

- After insulating the terminals of the cell with tape etc., dispose it under the law or ordinance of each local government.

(2) As for the charged cell, after discharging it with a resistor, dispose it by the above method.

## 4. Compliance for Marking

(1) Please indicate PSE mark on all battery packs subject to the Electrical Appliance and Material Safety Law (those containing cells with volumetric energy density of 400Wh/l or more and to be imported and /or sold in Japan.) Indication must include the notified company's name (registered trade-mark is also acceptable.), rated voltage, rated capacity and the PSE mark. (For Japan market.)

(2) Please indicate Lithium-ion cell safety cautions based on "Marking Guideline to ensure safety of storage batteries" (BAJ, Dec., 2007) on a battery pack, packing materials, and handling manuals. It should be indicated in the manner that users can completely and easily understand.

### <Marking on battery caution label : Energy Company Recommendation>

! DANGER	<p>Li-ion Rechargeable battery for *****.</p> <ul style="list-style-type: none"><li>• Use the charger approved by a manufacture of *****.</li><li>• Do not heat the battery or throw it into fire. Do not charge, use and leave the battery at the high temperature.</li><li>• Do not deform, short-circuit, disassemble and modify the battery.</li><li>• Do not allow the battery to be immersed in or wetted with water or sea-water.</li><li>• Do not subject the battery to a strong impact or throw it.</li></ul> <p>If you can't keep the above contents, it may cause heat, explosion and fire.</p>
----------	---

## 5. Compliance for Designing and Assembling the Battery Pack

(1) Design the battery pack to ensure insulating the wires in the battery pack with the insulation tape, etc. to prevent internal short-circuit. Because the cell's external tube could be damaged or deformed by external force or heat.

In anticipation of long-term or irregular usage, the basic design should be double insulation.

In the rare case that two or more prismatic cells will be stacked inside the battery pack, be certain to ensure insulation between cells to protect against abnormal swelling.

(2) Do not solder directly to the cell. If the cell is soldered directly, the insulation material may be melted or the safety mechanism may be damaged by heat.. This may cause heat, explosion and fire. Be sure to observe the following to prevent a damage caused by the heat of soldering.

- Spot-weld a connection tab with the pre-soldered lead wires to the cell
- Solder the connection tab which is already spot-welded to the cell. In this case, please be sure to consider tab length, shapes and the temperature / time conditions of soldering do not cause damages to the cell by heat.

(3) If the pack case is welded by ultrasonic welding, the condition should be set to keep the function of the cell and protection circuit normally.

(4) Protection circuit could be damaged by electrostatic discharge (ESD). Do anti-electrostatic treatment in the process of handling the protection circuit.



(5) Battery pack materials

- The battery case should be designed to resist the damaging effects of electrolyte. The battery case should comply with UL flammability resistance standard 94V-0.
- Use non-washable type solder.
- Other materials used should also meet UL standard.

(6) Process inspection - Be sure to implement the following inspection.

- Inspection on the function of protection circuit.
- Inspection on the voltage and the internal-resistance of the battery pack.
- Inspection on the resistance of the thermistor, in the case of the battery pack using the thermistor.
- Inspection on the outlook of the thermal fuse, in the case of the battery pack using the thermal fuse.

(7) When you design the battery pack, a sealed construction should not be applied. Design the battery pack so that the protection circuit or the cell in the battery pack can not be taken out easily by consumers.

(8) In the case of prismatic cells :

- When designing the battery pack using prismatic cells, please note that the thickness of the cell swells from the initial state of its shipment after use or storage.  
In the case of prismatic cell without protection device, a protection device should be placed in a position where the temperature can be monitored. During placement, avoid methods of connecting or placement that would cause stress to the protection device. PTC, etc. may not function normally under conditions of mechanical stress.

(9) In the case of assembling two or more cells :

- When assembling the battery pack, please use the cells in the same rank according to the rank indication of the cells.
- Please select cells with appropriate voltage so that the maximum voltage difference between the cells becomes less than 20mV.
- In case of high power (high drain) cell for power tool like as CGR18650CH/K/KA, CGR26650A/B cell , please keep any space between each cells like around 1mm distance.  
And charge and discharge should be controlled under specified condition described in this document (2. Rated specification) .

6. Compliance for the Protection Circuit and aspects that require attention

6—1. Compliance

(1) Protection Circuit should be incorporated within the battery pack to avoid deterioration of safety and performance

(2) Function of Protection Circuit

The Protection circuit should have the functions of over charge protection (Charge prohibition), over discharge protection (Discharge prohibition) and protection of over current which may occur by short-circuit on external terminals of the battery pack (Discharge prohibition).  
The necessity for the function of over current protection for charge should be judged by each application.

We recommend that the protection circuit has the function of temperature protection.

You shall comply with a design based on the protection circuit specification as below

- Over charge protection function should be designed such that the individual cell cannot charge over the specified voltage. This specified voltage needs to be set at 4.40V or less (within tolerance) in consideration of the voltage balance of among cells and charge voltage.  
(Ex. In case of 4.20V±0.04V/cell Charge voltage, the over charge protection is set up around 4.30V±0.05V)
- The over discharge protection function should be designed to stop discharging below specified voltage at each cell.  
This specified voltage value should be the over discharge protection voltage or more (mentioned in above specification) in consideration of the end of discharge voltage of the application and voltage balance of among the cells).  
(Ex. In case of 3.0V/cell end of discharge voltage for the application, the over discharge protection is around 2.3V to 2.5V.)
- Over current protection should have the function that the battery can not charge (discharge) at over specified charge (discharge) current.  
This specified current value is based on the charge (discharge) current for the application and acceptable maximum current for battery pack.
- The temperature protection for charge and discharge should have the function that when the battery temperature exceeds a specified temperature, the battery can not be charged (discharged).  
This specified temperature should be fixed by considering the temperature range for charge (discharge) in the battery specification .  
If the battery pack is not able to control the temperature range by itself, battery pack should be controlled with application.



(Ex. By using the thermister in the battery pack, the application should control the temperature range by detecting the temperature signal from battery pack's thermister.)

(3) Other requirements of the protection circuit

- In order to avoid deep discharge, the drain current from protection circuit should be less than 3.0μA at the over discharge protection voltage value or less than that mentioned within the battery specification.

- If the battery is unused for a long period of time, drain current can lead to deep discharge which may cause electrolyte leakage from the battery.

Measures should be taken such as coating the protection circuit, and locating the protection circuit as far as possible from the cell to prevent accidental contact with electrolyte

In order to avoid abnormal heat generation or fire incident caused by leaking electrolyte coming into contact with the protection circuit, please keep a gap between the protection circuit and cell as much as possible and then take a countermeasure to avoid this situation by applying a coating which has a resistant's to electrolyte (ex. silicon resin) on the protection circuit and so on. And the countermeasure needs to be tested to ensure its effectiveness within the actual product.

- \* Mechanical countermeasure like a partition may not be sufficient for this as the electrolyte has high invasive ability,

- \* In case of coating, it is important to consider not only the material but also the area, thickness and tolerance of coating. And also the condition for use may influence the effectiveness of the coating. So please evaluate this countermeasure to ensure its effectiveness.

- Protection circuit should be evaluated within the conditions of use (environment, long term) and confirm that it does not have remarkable deterioration of performance at that condition because the protection circuit and its function is critical for the safety of the battery pack.

(Ex. Test condition : 1000hours at 85deg.C, -25deg.C , 60deg.C/90% humidity

Heat impact :between -40deg.C and 80deg.C, 200cycles)

- \* Reliability test condition depends on the material, and to find the suitable test condition is very difficult. The test should be done by complex condition.

- The protection circuit should be confirmed to meet the requirements of the application. It is also requested that the protection circuit is fully evaluated to ensure that it does not miss-function from noise or rush current, also does not against ESD(Electrostatic Discharge) and EMC(Electromagnetic Compatibility).

(4) Redundancy design for safety

- In order to maintain safety when the protection circuit has a failure, other safety parts (Ex. thermal fuse, PTC) which are independent from the protection circuit should be set up in the battery pack by series connection.

- \* To check the cell specification because some cells have safety parts in the cell.

- In order to maintain a high level of safety, please take the countermeasure of multi-safety functions included in the application.

(Ex. Double protection system on the protection circuit, Total voltage monitoring from application)

6-2. Aspects that require attention

- Please pay attention to the recommend circuits for the Protection IC and technical reports from the parts supplier

- Please evaluate fully any new parts or parts from a new supplier, also including single device.

- In order to protect against the effects of ESD(Electrostatic Discharge) and EMC(Electromagnetic Compatibility), please pay attention to the design of PCB (Ex. circuit pattern layout, parts layout and etc)

- In order to avoid failure of the protection circuit by over current, external short circuit current and so on, please check the derating and ASO(area of safety operation) of parts.

- In order to avoid miss-function by noise or rush current, etc, please set up suitable detection delay timer and reset condition.

- If thermal fuse putt on the protection circuit, it close to FET in order to improve heat conductivity. And make both of them heat-united with heat conductive materials like thermal silicone.

- Please confirm that the protection circuit can work according to the design in detail.

- Please do 100% inspection of the protection functions in production process of protection circuit board.

Energy Company will not be responsible for any claims, damages, or problems caused by or relating to Battery Packs, including infringement of intellectual property rights of third parties, product liability, violation of laws or rules (Electrical Appliance and Material Safety Law(Japan) or the like), obtaining product standard(UL1642, UN38.3 or the like), marking,matching and reliability of Battery Packs on actual set or unit application, taking of appropriate measure to prevent any and all cell propagation of cell ignition relating to the use of the cell ("Cell Propagation"). Cell Propagation includes, but shall not be limited to, the spread of ignition of a cell to contiguous cells.