Draft

HITACHI MAXELL ENERGY, LTD.
POWER BATTERY DIVISION

Specifications of
Lithium ion rechargeable cell
Item: INR18650PB2-T
Product Code: INR18650PB2-TW(E)

Customer
Date
Created by
Checked by
Approved by

Received by:

(Customer name & signature to be placed here)

REVISION HISTORY

Rev.	Modification(s)	Issue date	Created	Checked	Approved
1.0	First Release				

This specification will be subjected to change unless otherwise notice.

1. Scope and application

These specifications apply to the lithium ion rechargeable cells supplied by Hitachi Maxell Energy, Ltd.(Maxell) to (Customer). The cells described in these specifications are to be used for power-needed applications.

2. Product

Product name: Lithium ion rechargeable cell

Item: INR18650PB2-T

3. Product ratings & general specifications

No.	*Item*	*Specification*
1	Nominal voltage	3.7 V
2	Rated capacity*	1450 mAh
3	Charge voltage	4.20±0.05 V
4	Maximum charge current	4.0 A
5	Charge method	CC-CV (Constant Current - Constant Voltage)
6	Maximum discharge current**	25 A
7	Discharge end voltage	2.50 V
8	Charge temperature range	0 ～ +45℃
9	Discharge temperature range	-20 ～ +60℃
10	Storage environment	-20 ～ +50℃ within 30 days (shipped conditions)
11	Long term storage environment	-20 ～ +35℃ within 90 days (shipped conditions)
12	Relative humidity	65±20%
13	Maximum weight	42 g

* *When discharged at 2400 mA to 2.50 V after 1000 mA, 4.20 V CC-CV charge for 2 hours at 25℃*

** *Cycle characteristics at continuous maximum discharge current is not guaranteed.*

4. Dimensions & appearance

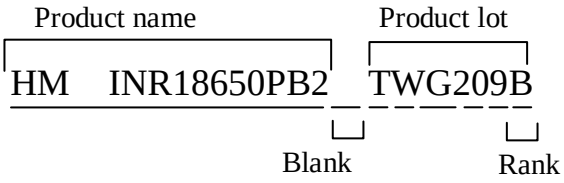
For detailed diagrams, refer to attached drawing, No. 0443418161 in Appendix A. Appearance shall be free from noticeable flaws, breaks, damage, discoloration and deformation.

Packaging & identification: For packaging specification, refer to attached drawing, No. 0443418168 in Appendix B. For identification, the manufacture code, country of origin and item name shall be indicated on the surface of the outer carton.

5. Manufacture code

The manufacture code, containing the product name and the product lot shall be indicated on the surface of the cell. For marking specification, refer to attached drawing, No. 0443418162 in Appendix C.

Example:



6. Required functions for charger and required protection functions

To ensure safety, the charger and the protection circuit should be used in combination with thermal fuse, thermistor or thermostat. The standard charging method is CC-CV (Constant Current - Constant Voltage).

6.1 Required functions for charger

No.	***Item***	***Condition***	***Notes***
1	Charging method	CC-CV	
2	Maximum charge current	4.0 A	Per cell
3	Rated charge voltage	4.20 V	Per cell
4	Maximum charge voltage	4.25 V	Per cell
5	Timer	5 hours charge	Current: 50 mA
6	Charge temperature	0～+45 ℃	

6.2 Required protection functions

No.	***Item***	***Condition***	***Notes***
1	Over-voltage Limit	4.25 V	Per Cell
2	Charge enable voltage	4.20 V	Per Cell
3	Under-voltage limit	2.0 V	Per Cell
4	Discharge enable voltage	2.0 V	Per Cell
5	Charge prohibition voltage	1.0 V	Per Cell
6	Over-current limit	40 A	within 1 second

7. Performance

The cell shall satisfy all electrical (Table 7.1), mechanical (Table 7.2) and safety (Table 7.3) characteristics as detailed below.

7.1 Electrical specifications

No.	*Item*	*Performance requirement*	*Conditions*	*Test methods*
1	Open circuit voltage	More than 3.60 V	Measured within 20 days of delivery	8.2(2)
2	Impedance	Less than 25 mΩ	AC 1KHz	8.3.2(3)
3	Discharge capacity	More than 36 min. discharge (more than 1450 mAh)	Discharge at 2400 mA	8.3.2(1)
4	Charge recovery	More than 30 min. discharge (more than 1230 mAh)	Stored at 20℃ for 28 days, Re-charge, Discharge at 2400 mA	8.3.2(2)
5	Endurance in cycles	More than 25 min. discharge (more than 1010 mAh)	After 300 cycles Discharge at 2400 mA	8.3.2(4)

7.2 Mechanical specifications

No.	*Item*	*Performance requirement*	*Conditions*	*Test Methods*
1	Drop	No explosion and no fire	Drop the cell onto a concrete surface	8.3.3(1)

7.3 Safety specifications

No.	*Item*	*Performance requirement*	*Conditions*	*Test Methods*
1	Terminal short circuit	No explosion and no fire	Short circuit with 10 mΩ load	8.3.4(1)

8. Testing

Initial testing shall be started within 20 days of delivery.

8.1 Test conditions

Unless otherwise specified, measurement shall be taken at a temperature of 25±2℃ and at a relative humidity of 65±20%.

8.2 Test equipment & instrumentation

Measuring instruments and devices shall include the following items:

(1) Dimensional measurements are to be carried out using a slide caliper whose

measuring range is from 0mm to 300mm with a precision of 1/20mm or greater.

(2) Voltage measurements are to be carried out using a DC voltmeter, capable of measuring from 0V to 20V. The precision of the voltmeter should be ±1 mV or greater. Input impedance should be greater than 10 MΩ.

(3) Discharge shall be executed using electronic load equipment. The required precision of the current is ±0.5% or greater.

(4) Impedance measurement shall be carried out using an LCR meter with 4 terminals at 1 KHz. To eliminate the direct current component, 1 μ F of capacitor in series to current pole should be added.

8.3 Test methods

8.3.1 Physical test methodology

(1) Appearance: Shall be inspected visually. The item should be inspected for noticeable flaws, breaks, damage, discoloration and deformation.

(2) Dimensions: The measuring instrumentation as specified in Section 8.2 should be used.

Note: All measurements which may possibly cause a short circuit should be carried out with an insulator inserted or the appropriate precautions being taken.

8.3.2 Chemical test methodology

Terminology

Standard charge: The cell shall be charged at 1000 mA of constant current and 4.20 V constant voltage for 2 hours. Standard charge means the state of the cell after completing the charge with these conditions.

Standard discharge: Refers to discharging of the cell at 2400 mA of constant current until the cell voltage reaches 2.50 V.

(1) Discharge capacity: Within one hour of standard charge, the duration time of

standard discharge shall be measured.

(2) Charge recovery: After standard charge, the sample cells should be stored at 20℃ for 28 days. After removal from storage standard discharge shall be performed and then completed standard charge shall be again performed and the duration time of standard discharge measured.

(3) Impedance: This measurement shall be conducted at AC 1KHz.

(4) Endurance in (charge/discharge) cycles: After 300 cycles of standard charge and discharge have been performed, discharge capacity shall again be measured to determine the endurance level of the cell.

8.3.3 Mechanical test methodology

(1) Drop tests: The sample cells shall be subjected to dropping from a height of one(1) meter onto a concrete surface. Drop tests are to be performed once for all three(3) surfaces of the cell. The appearance of the sample cells shall be inspected visually.

8.3.4 Safety test methodology

(1) Terminal short circuit: After standard charge, the (+) and (-) terminals are connected with 10 mΩ for 1 hour. After one hour has passed, a visual inspection is conducted on all cells being tested.

9. Condition at shipment

The charge state of cells when shipped from the factory is 35 - 45 % of the fully charged capacity.

10. Prior notice of change

In the case where specifications, materials, production processes, and control systems for the products are to be changed, Maxell will provide notice of the change in writing together with quality and reliability data (if required) to Customer in advance. Also, Customer will inform Maxell of any change requests and/or requirements in advance in writing.

11. Product liability

Customer is kindly requested to use the cell which is delivered from Maxell in strict accordance with this specification and any accompanying remarks or recommendations

made by Maxell. Improper usage of the cell may lead to accidents such as fire, which may occur due to the cell generating heat, catching fire or exploding. In no event shall Maxell be liable for any direct, indirect, punitive, incidental, special, consequential, or any other damages whatsoever arising out of or connected with the use or misuse of this product. Should the product prove defective following purchase and subsequent testing, and testing show that said defect resulted due to poor quality or workmanship by Maxell, Customer's sole responsibility shall be replacement of the defective product.

12. Limited warranty

(1) MAXELL WARRANTS TO CUSTOMER FOR A PERIOD OF TWELVE (12) MONTHS FROM THE DATE OF MANUFACTURE OF THE PRODUCTS THAT ALL PRODUCTS SOLD HEREUNDER SHALL (I) BE FREE FROM ANY DEFECTS IN DESIGN (IF SUCH DESIGN WAS CREATED BY MAXELL), MATERIAL OR WORKMANSHIP, AND (II) CONFORM TO THE SPECIFICATIONS. IN THE EVENT OF NON-CONFORMANCE CUSTOMER'S SOLE OPTION SHALL BE REPLACEMENT OF THE NON-CONFORMING PRODUCT.

THIS LIMITED WARRANTY COVERS NORMAL USE ONLY. MAXELL DOES NOT WARRANT AND IS NOT RESPONSIBLE FOR DAMAGES CAUSED BY MISUSE, ABUSE, NEGLECT, ACCIDENTS, UNAUTHORIZED SERVICE OR PARTS, PRODUCT MODIFICATIONS, OR THE COMBINATION OF MAXELL PRODUCTS WITH OTHER PRODUCTS. DAMAGE INCURRED DUE TO SHIPPING, HANDLING AND STORAGE DOES NOT CONSTITUTE A DEFECT UNDER THIS WARRANTY. MAXELL MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, AND EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES INCLUDING BUT NOT LIMITED TO NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

(2) CUSTOMER INDEMNIFIES AND HOLDS MAXELL HARMLESS AGAINST ANY CLAIM OR DAMAGES WHICH MAY ARISE IN CONNECTION WITH ASSEMBLED BATTERY.

13. Warnings required on battery pack

The following warnings or equivalent should be indicated on all battery packs:

(1) Use only chargers specified by the manufacturer.

(2) Do not disassemble, alter, short circuit, heat or throw the battery into fire.
(3) Do not use the battery for any purpose other than that specified.

14. Battery pack assembly precautions

Maxell recommends the following procedures be adhered to during the battery pack assembly to avoid any damage, burn, and performance failure of the battery. However, these recommendations are for Customer information only and Maxell makes no guarantees as to their accuracy, completeness or otherwise. Maxell will not guarantee against any defects or accidents caused by processing or assembly methods utilized by Customer under any circumstances.

14.1 Storage precautions

(1) The product contains chemical material. Storage under unsuitable conditions (high temperature, high humidity, etc.) may reduce initial performance (OCV, impedance, capacity, etc.).
(2) Use only the packing box provided.
(3) Do not store the product in a fully charged state.
(4) Do not store the product when an electrical load is connected to it.

14.2 Handling precautions

(1) Do not let the product terminals (+ and -) come into contact with any wires or metal (like a metal necklace or a hairpin) while they are being transported or stored together. In such a case, the product may be shorted, causing excessive current, which may result in heat generation, explosion, or fire.
(2) The product has a weak spot that was made intentionally (the gas release vent). Applying pressure to it and/or the terminals of the product may result in leakage or impedance increment.
(3) Do not use the product which has been dropped.
(4) Do not reuse the product which has been assembled (welding, etc) and then disassembled.

14.3 Welding precautions

(1) Improper welding conditions (abnormal pressure, etc.) may cause damage to the insulator of the product terminal and exterior seam, resulting in leakage. Damage of the terminals may result in impedance increment.
(2) Carefully examine welding conditions in advance, and carry out any welding under optimal conditions.

(3) Do not apply heavy pressure to the product.

14.4 Design of protection circuit

(1) Protection circuit shall be coated to prevent the contact with the electrolyte which comes from the cell inside.

(2) The voltage level of each cell block shall be monitored and the use of the cell shall be limited if the upper limited charging voltage is exceeded. Furthermore if the discharging voltage of an individual cell block drops lower than the lower limited discharging voltage, the discharge shall be ended.

14.5 Combination of batteries

(1) All batteries shall be combined by the same capacity rank within 4 weeks of product lot when customer assembles a battery pack with two or more batteries.

If you have any questions about battery pack assembly, please consult Maxell.

The following precautions, warnings and usage recommendations MAY appear in manuals and/or instructions for users, especially at the point of use.

HANDLING INSTRUCTIONS FOR LITHIUM ION RECHARGEABLE BATTERIES

Please read and follow the handling instructions for the battery before and during usage. Improper use of the battery may cause heat, fire, explosion, damage or capacity deterioration of the battery. The following are general cautions and guidelines only and as such may not include every possible usage scenario. The manufacturer will not be liable for actions taken or accidents caused by any usage not documented below.

Battery usage precautions

⚠ **WARNING!**
● The battery has a predetermined polarity. If the battery will not connect well to the charger or equipment, do not try to connect the battery forcefully. Check the polarity first. If the battery is connected in reverse, it will be charged in reverse, which may cause acid leakage, heat generation, explosion or fire due to abnormal chemical reactions.
● Do not heat or put the battery into a fire. If this is done, the insulator in the battery may melt, the safety vent and structure may be damaged which may lead to heat generation, explosion or fire.
● Do not connect, insert or install the battery reversed in positive (+) and negative (-) terminals in the charger or equipment. If the battery is connected in reverse, it is charged incorrectly and causes an excessive current during discharge. This may result in heat generation, explosion, or fire due to abnormal chemical reactions.
● Do not let the battery terminals (+ and -) come into contact with wires or any metal (like a metal necklace or a hairpin) while they are being transported or stored together. In such a case, the battery may be shorted, causing excessive current, which may result in heat generation, explosion, or fire.
● Do not apply heavy impact to the battery, throw or drop it. Strong impact may damage the protecting device, which may result in heat generation, explosion, or fire.
● Do not drive a nail, screw or other foreign object into a battery, hit it with a rock, hammer or other tool, or step, stamp or jump on the battery. In such a case, the battery may be deformed and shorted, and the protecting device may be damaged, which may cause heat generation, explosion, or fire.
● Do not solder the battery directly. Heat applied during soldering may damage the insulator or the safety vent and mechanism, which may result in acid leakage, heat generation, explosion, or fire.
● Do not disassemble or alter the battery. The battery contains a safety mechanism and a protecting device in order to avoid any danger. If these are damaged, heat, explosion or fire may be caused.
● Do not put the battery in a microwave oven, pressure cooker or any other electrical appliance. Sudden heat may damage the seal of the battery and may cause heat generation, explosion or fire.

●	Do not let leaked electrolyte come into contact with your eyes. If this occurs, immediately wash the area of contact with fresh water and seek help from a medical professional. If not treated promptly, such contact may cause serious injury.
●	Do not use the battery together with any other battery (such as dry batteries or primary batteries) of a different capacity, type and/or brand. If this is done, over-discharge during use, or over-charge during charge may occur and abnormal chemical reactions may cause heat generation, explosion, or fire.
●	If the battery leaks or emits a malodor, remove it from the vicinity of any fire immediately. The electrolyte may catch fire resulting in heat generation, explosion or fire.
●	When using the battery for the first time after purchase, if you find it to be rusty, abnormally hot, exhibiting a malodor or any other abnormal condition the battery may be defective and should not be used. It should be returned to the place of purchase.
●	In case young children use the battery, instruct them on the contents of the instructions and ensure the battery is correctly used at all times.
●	If the battery leaks and its electrolyte comes into contact with skin or clothing, wash it well with fresh water immediately. Leaving it alone may cause a rash on skin.
●	Carefully read the instructions of your equipment or device regarding the battery installation and removal from the equipment so as not to mishandle and waste the battery.
●	When the battery is expected to remain unused for an extended period, remove the battery from the equipment or device and store it in a less humid area.
●	Do not use or leave the battery in a place exposed to strong direct sunlight, in a car under the blazing sun, or in any high temperature area. Such high temperatures may cause acid leakage.
●	Store the battery in dry conditions with low humidity and away from any heat sources.
●	If you notice any malodor, unusual heat, discoloration, deformation, or any other change from what you are used to while using, charging or storing the battery, remove it from the equipment or charger and avoid using it. Using it in such a state may result in heat generation, explosion or fire.
●	Do not dip or wet the battery in water, seawater, or other liquids. If the protecting device assembled in the battery is damaged, the battery may be charged with an abnormal current and voltage, which may result in heat generation, explosion or fire.
●	Charge the battery every 6 months to the amount specified by the manufacturer, even if the battery is not currently being used. An excessive over-discharge may cause an abnormal chemical reaction, which may result in acid leakage or fire.
●	Do not place or leave the battery and equipment within the reach of children. Improper use of the battery may cause danger.

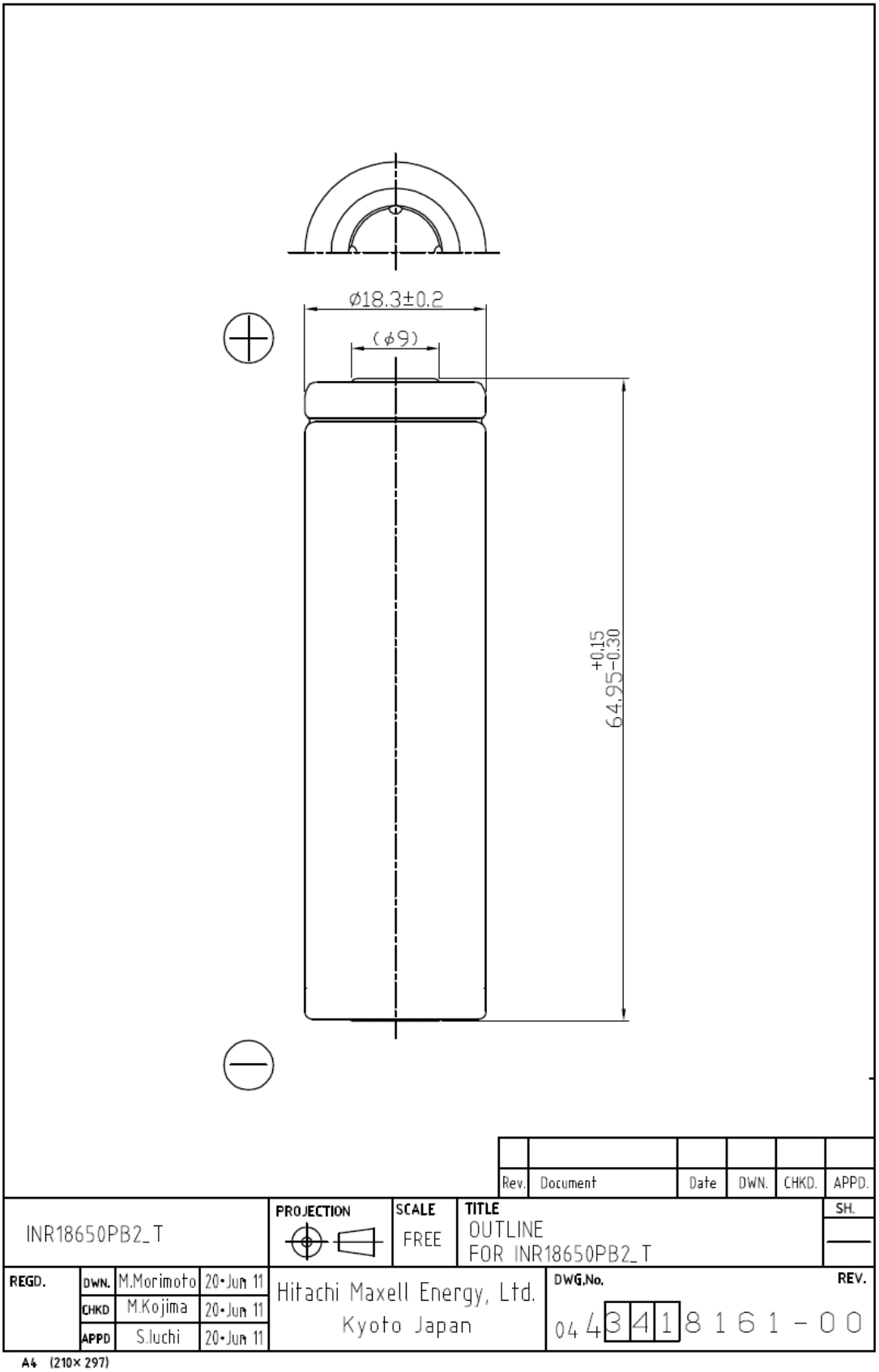
Battery charging precautions

⚠ **WARNING!**
● Do not use any battery charger not specified by the manufacturer and be sure to accurately follow the charging instructions specified by the manufacturer. If the battery is charged under abnormal conditions (such as high temperature, high voltage/current, or with an altered charger) which are not specified by the manufacturer, the battery may cause heat generation, explosion, or fire due to abnormal chemical reactions.
● Do not connect the battery directly to an electrical outlet or high voltage electrical source of any kind, such as that in a car. Applying such a high voltage may generate an excessive current, and result in an electric shock. In such a case, the battery may leak electrolyte, overheat, explode, or cause fire.
● Do not charge the battery in the vicinity of fires, in a car under the blazing sun or similar high temperature environments. High temperatures may cause damage of the protecting device in the battery, which may result in heat generation, explosion, or fire.
● Do not charge the battery in other than the following conditions. Otherwise, the battery might cause heat generation and/or become damaged: 0℃ ～ +45℃.
● Do not charge the battery for any duration greater than that specified within the instructions provided by the manufacturer.

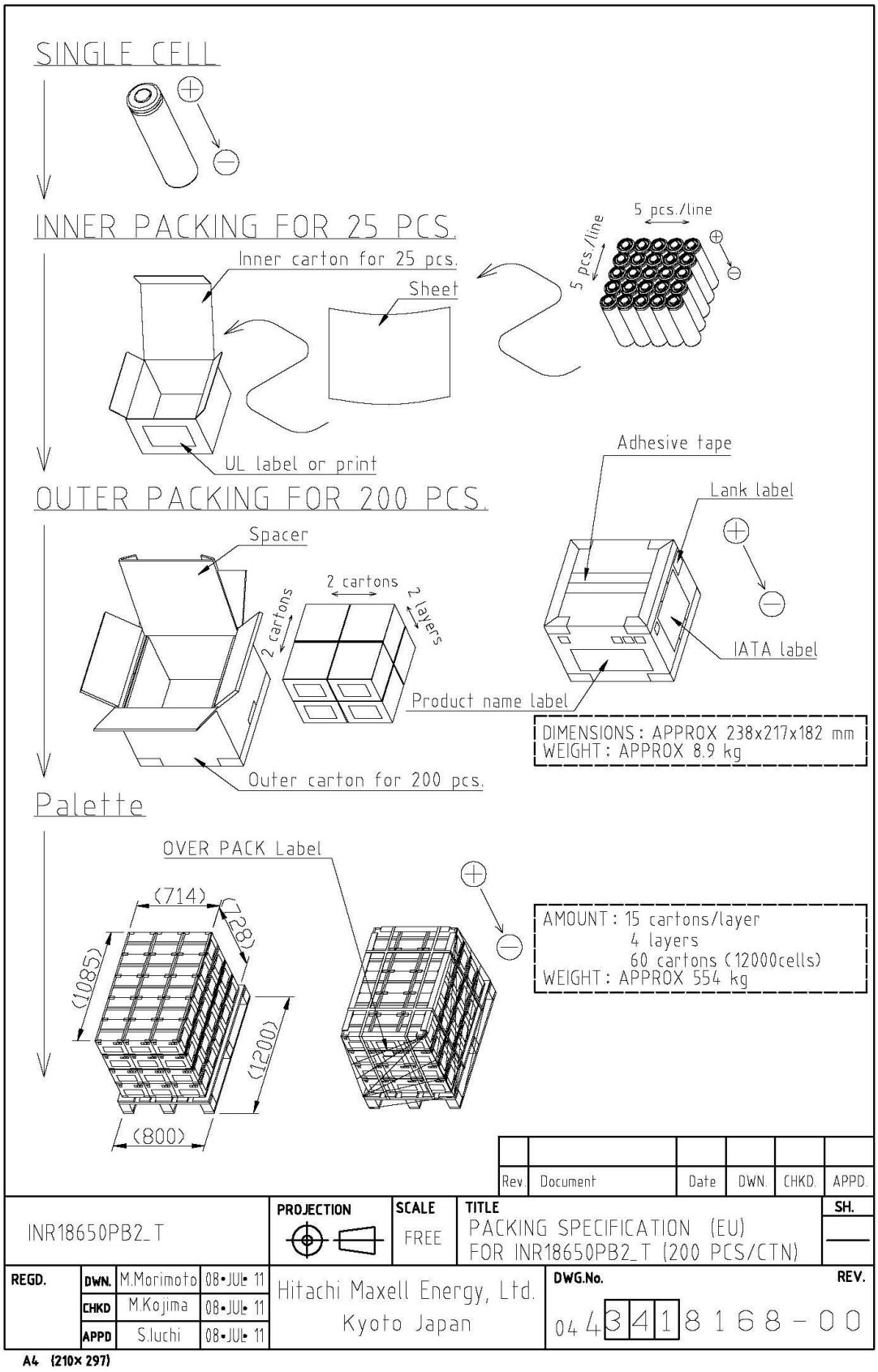
Battery discharge precautions

⚠ **WARNING!**
● Do not use the battery with any equipment or device other than those specified by the manufacturer. Any such practice may expose your equipment or device to an abnormal current, which may result in heat generation, explosion or fire.
● Do not discharge the battery in other than the following conditions: -20℃ ～ +60℃ Storage (less than a month): -20℃ ～ +50℃ (at 50% charge) Storage (more than a month): -20℃ ～ +35℃ (at 50% charge)
● Do not use or leave the battery anywhere in the vicinity of fires, heaters, or high temperature sources. Such high temperatures may cause heat generation, explosion or fire.

APPENDIX A: Product dimensions



APPENDIX B: Packaging specification



APPENDIX C: Manufacture Code