

To : \_\_\_\_\_

## SPECIFICATION OF PRODUCT

**Rechargeable Li-ion Polymer Battery**  
**Model : SPB463450 (720mAh)**

Approved

### SAEHAN-ENERTECH. INC.

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### 1. Scope

This product specification has been prepared to specify the rechargeable lithium-ion polymer battery ('cell') to be supplied to the to **VK Corp.** by **SAEHAN-ENERTECH INC.**

### 2. Description and Model

- 2.1 Description            Cell (Rechargeable Lithium ion Polymer Battery )
- 2.2 Model                    SPB463450

### 3. Nominal Specifications

Item	Specification
3.1 Nominal Capacity	720mAh (0.2C discharge)
3.2 Charging Voltage	4.2V
3.3 Nominal Voltage	3.7V
3.4 Charging Method	CC-CV (constant voltage with limited current)
3.5 Charging Current	Standard charge: 360mA Rapid charge : 720mA
3.6 Charging Time	Standard charge : 3hours Rapid charge : 2.5hours
3.7 Max. Charge Current	720mA
3.8 Max. Discharge Current	1440mA
3.9 Discharge Cut-off Voltage	3.0V
3.10 Cell Weight	14g max
3.11 Cell Dimension	Thickness : 4.6mm max. (Initial fully charged cell) Width : 33.0mm max. Height : 50.0mm max.
3.12 Operating Temperature	Charge : 0 to 45°C Discharge: -20 to 60°C
3.13 Storage Temperature	1 year : -20~25°C(1*) 3 months : -20~45°C(1*) 1 month : -20~60°C(1*)

Note (1): If the cell is kept as ex-factory status(50% of charge),  
**the capacity recovery rate is more than 80%.**

#### 4. Outline Dimensions

See the attachment(Appendix 1)

#### 5. Appearance

There shall be no such defects as scratch, rust, discoloration, leakage which may adversely affect commercial value of the cell.

#### 6. Standard Test Conditions

##### 6.1 Environmental Conditions

Unless otherwise specified, all tests stated in this specification are conducted at temperature  $25\pm 5^{\circ}\text{C}$  and humidity  $65\pm 20\%$ .

##### 6.2 Measuring Equipment

(1) Ammeter and Voltmeter

The ammeter and voltmeter should have an accuracy of the grade 0.5 or higher.

(2) Slide caliper

The slide caliper should have 0.05 mm scale.

(3) Impedance meter

The impedance meter with AC 1kHz should be used.

#### 7. Characteristics

##### 7.1 Standard Charge

This "Standard Charge" means charging the cell with charge current 360mA and constant voltage 4.2V at  $25^{\circ}\text{C}$  for 3hours.

##### 7.2 Rated Charge

This "Rated Charge" means charging the cell with charge current 360mA and constant voltage 4.2V and 3h or 36mA cut-off at  $25^{\circ}\text{C}$ .

##### 7.3 Standard Discharge Capacity

The standard discharge capacity is the initial discharge capacity of the cell, which is measured with discharge current of 144mA with 3.0V cut-off at  $25^{\circ}\text{C}$  within 1 hour after the standard charge.

$$\text{Standard Discharge Capacity} \geq 720\text{mAh}$$

##### 7.4 Rated Discharge Capacity

The rated discharge capacity is the initial discharge capacity of the cell, which is measured with discharge current of 360mA with 3.0V cut-off at  $25^{\circ}\text{C}$  within 1 hour after the rated charge.

$$\text{Rated Discharge Capacity} \geq 700\text{mAh}$$

**7.5 Initial internal impedance**

Initial internal impedance measured at AC 1kHz after rated charge.

$$\text{Initial internal impedance} \leq 90\text{m}\Omega$$

**7.6 Charge Rate Capabilities**

Discharge capacity is measured with constant current 360mA and 3.0V cut-off after the cell is charged with 4.2V as follows.

Items	Charge Condition			
	0.2C (144mA)	0.5C (360mA)	1.0C (720mA)	2.0C (1440mA)
Cut-off	7hr or 0.1C	3hr or 0.1C	2.5hr or 0.1C	2.5h or 0.1C
Relative Capacity	100%	100%	95%	90%

Note: Percentage as an index of the rated discharge capacity (=700mAh) is 100%.

**7.7 Discharge Rate Capabilities**

Discharge capacity is measured with the various currents in under table and 3.0V cut-off after the rated charge.

Items	Discharge Condition			
	0.2C (144mA)	0.5C (360mA)	1.0C (720mA)	2.0C (1440mA)
Relative Capacity	100%	100%	95%	90%

Note: Percentage as an index of the rated discharge capacity (=700mAh) is 100%.

**7.8 Temperature Dependence of Discharge Capacity**

Capacity comparison at each temperature, measured with discharge constant current 360mA and 3V cut-off after the rated charge is as follows.

Charge Temperature	Discharge temperature					
	-20°C	-10°C	0°C	25°C	40°C	60°C
Relative Capacity	30%	70%	85%	100%	100%	95%

Note: If charge temperature and discharge temperature is not the same, the interval for temperature change is 4 hours.  
Percentage as an index of the rated discharge capacity (=700mAh) is 100%.

### 7.9 Temperature Dependence of Charge Capacity

Capacity comparison at each temperature, measured with discharge constant current 360mA and 3.0V cut-off after the rated charge is as follows.

Items	Charge temperature			Discharge temperature
	0°C	25°C	45°C	
Relative Capacity	80%	100%	100%	25°C

Note: If charge temperature and discharge temperature is not the same, the interval for temperature change is 4 hours.  
Percentage as an index of the rated discharge capacity (=700mAh) is 100%.

### 7.10 Cycle Life

Each cycle is an interval between the charge (charge current 700mA) with 2.5h or 0.1C cut-off and the discharge (discharge current 700mA) with 3.0V cut-off. Capacity is measured at 100cycles, 300cycles, 500cycles.

100cyc. Capacity    ≥ 630mAh (90% of the rated discharge capacity)  
300cyc. Capacity    ≥ 560mAh (80% of the rated discharge capacity)  
500cyc. Capacity    ≥ 490mAh (70% of the rated discharge capacity)

### 7.11 Storage Characteristics

Capacity after storage for 30days at 25°C after the rated charged, measured with discharge current 360mA with 3.0V cut-off at 25°C.

Capacity retention(after the storage) ≥ 630mAh (90% of the rated discharge capacity)

## 8. Mechanical Characteristics

### 8.1 Vibration Test

Test method: This means the endurance of the cell against vibration.

Frequency and amplitude : 10Hz → 55Hz → 10Hz / 0.8mm

Sweep speed : 1 ±0.055Hz/min

Criteria: No damage such as leakage , flame, or fire was allowed.

## 9. Environmental Characteristics

### 9.1 Thermal Shock

Test method: The Cell(rated charged) is repeatedly tested with 20 times heat cycling, which means maintaining the cell for 2hours at  $-40^{\circ}\text{C}$  and  $85^{\circ}\text{C}$  respectively. Inspect its appearance and measure its thickness right after thermal shock. Measure the recovered capacity by rated charge/discharge cycling after rated discharging(360mA, 3.0V cut-off) at  $25^{\circ}\text{C}$ .

Criteria: No leakage, No Fire  
Recovery > 490mAh (70% of the rated discharge capacity)

### 9.2 Humidity

Test method: The Cell(rated charged) is exposed to  $50^{\circ}\text{C}$ , 95%RH. for 10days. Inspect appearance and measure thickness right after humidity test. Measure the recovered capacity by rated charge/discharge cycling after rated discharging(360mA, 3.0V cut-off) at  $25^{\circ}\text{C}$ .

Criteria: No leakage  
Recovery > 630mAh (90% of the rated discharge capacity)

### 9.3 High Temperature Swelling

Test method: Cell(rated charged) is exposed to  $85^{\circ}\text{C}$  for 4hours. Measure thickness right after swelling test and the recovered capacity by rated charge/discharge cycling after rated discharging(360mA, 3.0V cut-off) at  $25^{\circ}\text{C}$ .

Criteria: No leakage, Cell thickness < 4.83 mm  
Recovery > 630mAh (90% of the rated discharge capacity)

## 10. Safety

### 10.1 Overcharge Test

Test method: To charge the standard charged cell with 12V and 720mA at  $25^{\circ}\text{C}$  for 2.5 hours.

Criteria: No fire, and no explosion.

### 10.2 External Short-circuit Test

Test method: To short-circuit the standard charged cell by connecting positive and negative terminal by less than  $50\text{m}\Omega$  wire for 2.5 hour.

Criteria: No smoke, No fire, and no explosion.

### 10.3 Reverse Charge Test

Test method: To charge reverse the standard charged cell with charge current

720mA for 2.5 hours.

Criteria: No fire, and no explosion.

### 10.4 Nail Penetrating Test

Test method: To penetrate the standard charged cell with a nail vertically through the center of wide plane(30 X 50mm).

Criteria: No fire, and no explosion.

### 10.5 Heating Test

Test method: To heat the standard charged cell at heating rate 5°C per minute up to 150°C and keep the cell in oven for 60 minutes.

Criteria: No fire, and no explosion within 10min.

### 10.6 Crush

Test method: To crush the standard charged cell with force of 13kN.  
(Crushed side is longitudinal and narrow axis.)

Criteria: No fire, and no explosion.

### 10.7 Impact

Test method: To place 7.9mm diameter bar across the center of standard charged cell, and drop 9.1kg weight from 61cm height onto the cell.  
(Impacted side is longitudinal and wide axis.)

Criteria: No fire, and no explosion.

## 11. Warranty

SAEHAN-ENERTECH, INC. will be responsible for replacing the cell against defects or poor workmanship for 6months from the date of shipping. Any other problem caused by malfunction of the equipment or unsuitable use of the cell is not under this warranty.

The warranty set forth in proper using and handling conditions described above and excludes in the case of a defect which is not related to manufacturing of the cell.

## 12. Others

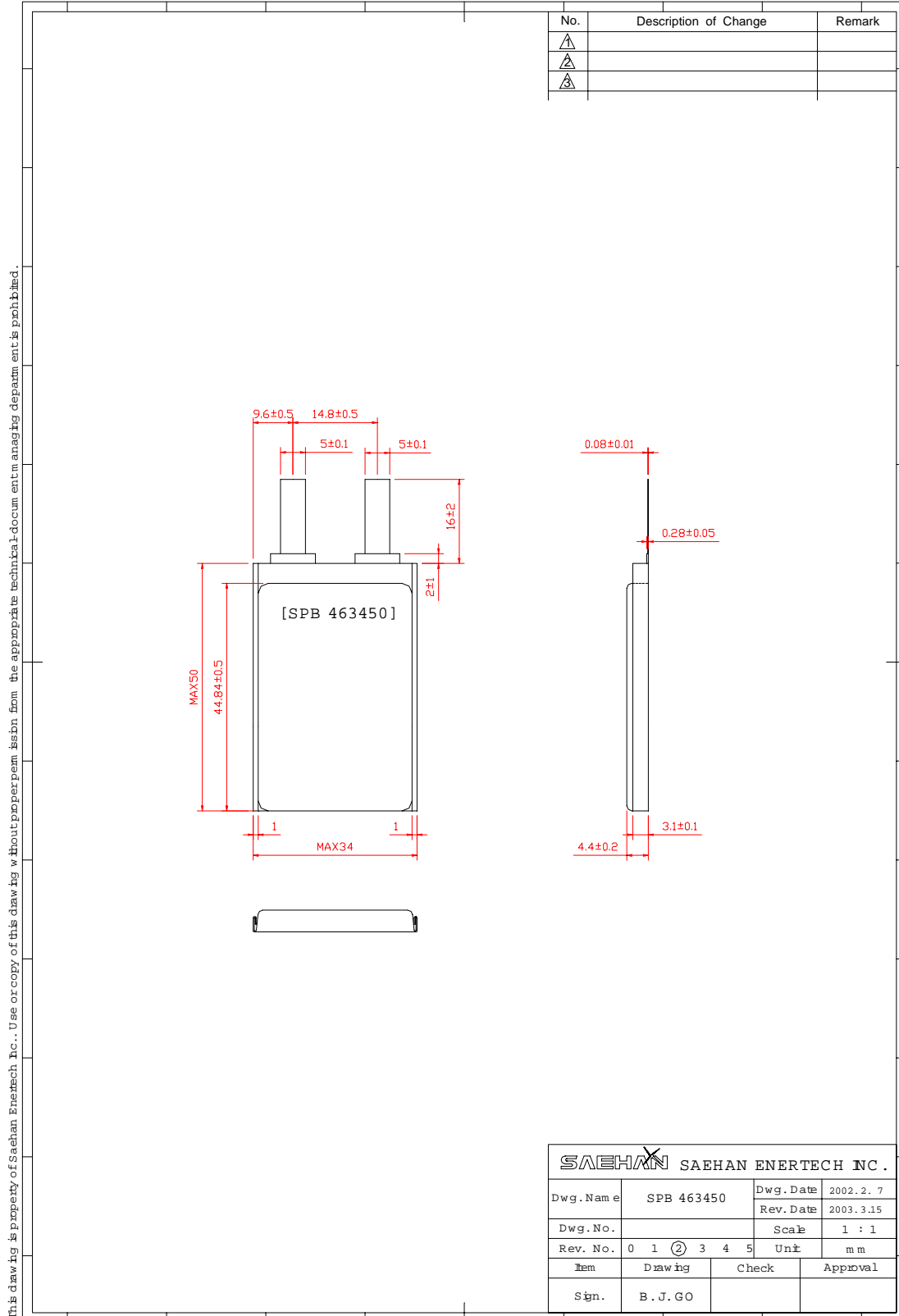
### 12.1 Storage for a long time

If the cell is kept for a long time(3months or more), It is strongly recommended that the cell is preserved at dry and low-temperature.

### 12.2 Other

Any matters that specifications does not have, should be conferred with between the both parties.

◆ **Out View drawing for SPB463450**



## Handling Instruction Guide for Li-ion Polymer Battery

### 1. General

The cells supplied by **SAEHAN-ENERTECH, INC.** have to be handle carefully according to the specification.

Here are some more to be followed.

### 2. Storage

The cell requested to be stored under the following conditions:

- a. Indoor storage in a cool circumstances without direct sun light.
- b. Store the cell in a dry location with low humidity, and a temperature range of  $-20^{\circ}\text{C}$  to  $+30^{\circ}\text{C}$ .

In case of the long term storage

- a. As long-term storage can accelerate battery self-discharge and lead to the deactivation of the cells. To minimize the deactivation effect, store the cell in a temperature range of  $+10^{\circ}\text{C}$  to  $+30^{\circ}\text{C}$ .
- b. When charging for the first time after long-term storage, deactivation of the cells have led to decreased capacity. Recover such cell to original performance through repeating several cycles of full charging and discharging.
- c. When store the cell for more than 6 month, charge at least once charging require per 6 months to prevent leakage and deterioration in performance due to self-discharging.

### 3. Charging

- a. Use suitable charger with the specified voltage and current. We strongly recommend the smart battery charger. We can recommend the usage or specification of the charger manufacturing.  
If you want to get the information about it, please contact us.
- b. Never attempt reverse charging. Charging with polarity reversed can cause a reversal in the cell polarity, causing gas pressure inside of the cell to rise, which can be lead to leakage of the cell.
- c. Avoid overcharging. Repeated overcharging can be lead to deterioration in cell performance. and over-heat occurred.
- d. Charging efficiency drops at temperatures above  $40^{\circ}\text{C}$ .

**4. Protection from unexpected damaged to the cell**

- a. (+) and/or (-) terminals must not be connected in metal wire, necklace, chaings.
- b. Do not drop cells from height in order to prevent them from possible malfunction or damage.
- c. Do not twist or bend cells in order to prevent possible damage.

**5. For Safety**

- a. Do not disassemble cells.
- b. Do not use the cell when something abnormal found such as smells, deformation, discoloration, and so on.
- c. When the electrolyte leakage occurs, do not touch the liquid.
- d. Once watered, cells may have potential malfunctions. Do not use those cells.
- e. Do not have cells in the hot-temperature (60°C or more).
- f. Do not put cells into fire.
- g. Do not crush/nail cells.
- h. Do not apply solder directly to cells.