



Ropla Elektronik Sp. z o.o.

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2013-8-1

DOC. No: AKY604040-0009

ADD: Ropla Elektronik Sp. z o. o. ul. Wyścigowa 53-011 Wrocław

## Specification Approval Sheet

**MODEL: AKY604040**

(920mAh 3.7V)

| Prepared By/Date | Checked By/Date | Checked By/Date | Approved By/Date |
|------------------|-----------------|-----------------|------------------|
| <b>Paul/8-1</b>  |                 |                 |                  |

|                   | Signature     | Date |
|-------------------|---------------|------|
| Customer Approval |               |      |
|                   | Company Name  |      |
|                   | Company Stamp |      |



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**1 Scope** This specification is applies to describe the related Battery product in this Specification and the Battery/cell supplied by Ropla Elektronik Sp. z o.o. only.

**2 Model: AKY604040**

**3 Cell Specification**

| No. | Items                       | Specifications  |       | Remark   |
|-----|-----------------------------|---|-------|--|
| 1   | Nominal Capacity            | 920mAh  |       | 0.2C Standard discharge                                  |
| 2   | Minimum Capacity            | 870mAh  |       |  |
| 3   | Nominal Voltage             | 3.7V  |       | Mean Operation Voltage                                   |
| 4   | Delivery voltage            | $\geq 3.8V$   |       | Within 10 days from Factory                              |
| 5   | Charge Voltage              | 4.2V $\pm$ 0.03V  |       | By standard charge method                                |
| 6   | Standard charging method    | 0.5C constant current,4.2V constant voltage charge to 4.2V,continue charging till current delaine to $\leq 0.01C$ |       | Time 2.0h(Ref)   |
| 7   | Charge current              | 0.5C  | 460mA | Standard charge, charge time:2.0h(Ref)                   |
|     |                             | 1.0C  | 920mA | Rapid Charge, charge time:1.0h(Ref)                      |
| 8   | Standard discharging method | 0.2C constant current discharge to 3.0V,  |       | /  |
| 9   | Cell Internal Impedance     | $\leq 50m\Omega$  |       | Internal resistance measured at AC 1KHz after 50% charge |
| 10  | Weight                      | $\leq 18.8g$  |       | /  |



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**3 Cell Specification (continuous)**

| No. | Items   | Specifications         |                        | Remark   |
|-----|---|------------------------|------------------------|--|
| 11  | Maximum charge current                            | 1C                     | 920mA                  | For continuous charging mod  |
| 12  | Maximum discharge current                         | 1C                     | 920mA                  | For continuous discharge mod   |
| 13  | Operation Temperature and relative humidity Range | Charge                 | 0~45°C<br>60±25%R.H.   | Charge at a very low temperature such as blew 0°C, will be get a lower capacity and reduce cycle life of the battery   |
|     |   | Discharge              | -20~60°C<br>60±25%R.H. |  |
| 14  | Storage temperature for a long time               | -20~25°C<br>60±25%R.H. |                        | Do not storage exceed half year. Must charge once when storage for half year. Must charge the battery which with protect circuit when storage for three mouthed. |

#### 4 Battery/Cell performance test Criteria

##### 4.1 Appearance inspection by visual

There shall be no such defect as flaw, crack, rust, leakage, which may adversely affect commercial value of battery.

##### 4.2 Environmental test condition

Unless otherwise specified, all test stated in this product specification are conduct at below test condition

Temperature: 20°C~25°C

Relative Humidity:60%±25% R.H.

##### 4.3 Cell Electrical characteristics

| No. | Item                               | Testing Method  | Requirements               |
|-----|------------------------------------|---|----------------------------|
| 1   | Fully Charged State                | CCCV or Constant current charge to 4.2V @1C follow by a constant voltage holding at 4.2V until current drops below 20±5mA.  |                            |
| 2   | Rated Capacity                     | CCCV at 4.2V (per 6.1.1) at room temp. (20±5°C), rest for 1-2 hrs then discharge at a constant current of 0.2C to 3.0V, testing will be terminated by either 5 cycles or any one discharge time exceeds 5 hrs | ≥920mAh                    |
| 3   | Cycle Life @25°C                   | Measure the capacity after 500 cycles with standard charge/discharge method at 0.25C to 3.0V cut-off voltage.   | ≥80%                       |
| 4   | Internal Impedance                 | Internal impedance is measured on a 50% charged battery at 1KHz AC at ambient temperature (20±2) °C.  | ≤50mΩ                      |
| 5   | Capacity Retention                 | Fully charge cells per 6.1.1, store them at (20±2)°C for 28 days, then discharge the cells to 3.0V at 0.2C.   | Discharge capacity ≥780mAh |
| 6   | High Temperature Characteristics   | Fully charge cells per 6.1.1, store them at (55±2)°C for 2 hours, then discharge the cells to 3.0V at 0.2C.   | Discharge capacity ≥780mAh |
| 7   | Low Temperature Characteristics    | Fully charge cells per 6.1.1, store them at (-10±2)°C for 16~24 hours, then discharge the cells to 3.0V at 0.2C.  | Discharge capacity ≥550mAh |
| 8   | Cell Voltage during Transportation | Check open circuit voltage (OCV) of cells prior to the delivery to customers.   | ≥3.75V                     |

**4.4 Mechanical characteristics**

| No | Items          | Test Method and Condition   | Criteria                          |
|----|----------------|---|-----------------------------------|
| 1  | Free fall test | The battery to be fully charged in accordance with standard charge condition, then drop the battery three times from a height of 1,0 m onto a concrete floor. The batteries are dropped so as to obtain impacts in random orientations.   | No Fire,                          |
| 2  | Vibration test | After standard charging, fixed the cell to vibration table and subjected to vibration cycling that the frequency is to be varied at the rate of 1Hz per minute between 10Hz and 55Hz, the excursion of the vibration is 1.6mm. The cell shall be vibrated for 30 minutes per axis of XYZ axes.  | No explosion, No leakage, No fire |
| 3  | Crush test     | Fully charged the battery in accordance with standard charge condition, the battery is to be crushed between two flat plates. Continuous to applied force on battery of 13kN(17.2Mpa),stopped until a pressure reading of 17.2Mpa is reached on the hydraulic ram   | No explosion,<br>No fire          |
| 4  | Shock test     | The fully charged battery is secured to the testing machine by means of a rigid mount which will support all mounting surfaces of the cell or battery. The battery is subjected to a total of three shocks of equal magnitude. The shocks are applied in each of three mutually perpendicular directions. At least one of them shall be perpendicular to a flat face. For each shock the cell or battery is accelerated in such a manner that during the initial 3 milliseconds the minimum average acceleration is 75 gn. The peak acceleration shall be between 125 gn and 175 gn. Cells or batteries are tested in an ambient temperature of 20~25°C | No explosion, No leakage, No fire |

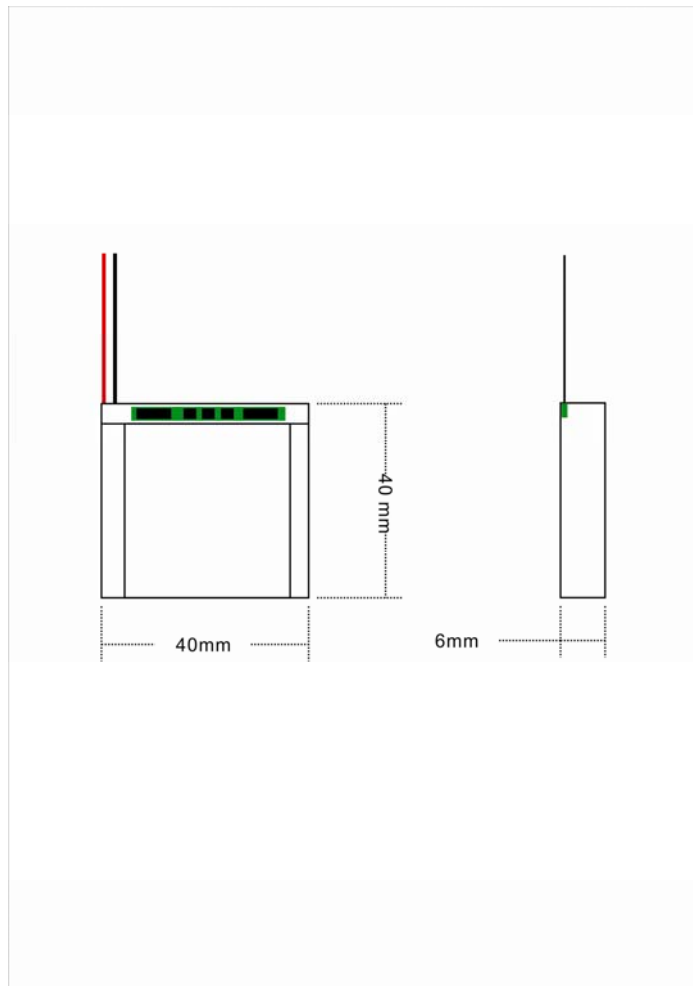
4.5 Safety performance

| No | Items                 | Test Method and Condition  | Criteria  |
|----|-----------------------|--|---|
| 1  | Thermal exposure test | Each fully charged cell, stabilized at room temperature, is placed in a circulating air-convection oven. The oven temperature is raised at a rate of 5 °C/min ± 2 °C/min to a temperature of 130 °C ± 2 °C. The cell remains at this temperature for 10 min before the test is discontinued. | No explosion, No fire   |
| 2  | Low pressure          | Each fully charged cell is placed in a vacuum chamber, in an ambient temperature of 20~25°C. Once the chamber has been sealed, its internal pressure is gradually reduced to a pressure equal to or less than 11,6 k Pa (this simulates an altitude of 15240 m) held at that value for 6 h.  | No explosion, No leakage, No fire   |
| 3. | Short test            | The fully charged battery is to be short-circuited by connecting the positive and negative terminals of the battery with resistance load not exceed 100m Ω. Tests are to be conducted at room temperature 20~25°C.   | No explosion, No fire<br>The Temperature of the Battery surface not exceeded than 150°C |
| 4  | Forced discharge test | A discharged cell is subjected to a reverse charge at 1c for 90 min.   | No explosion, No fire   |
| 5  | Over charge test      | After standard charge, continue to charge with a constant voltage 4.6V per a cell, holding 8h.   | No explosion, No fire, No leakage   |
| 6  | Soak Test             | Put the batteries into clean water, be soaked for 24 hours.  | No break, No fire   |



**5 Cell initial Dimensions**

| NO | Items     | Units: mm | Remark |
|----|-----------|-----------|--------|
| 1  | Thickness | 6.0       | Max.   |
| 2  | Width     | 40.5      | Max.   |
| 3  | Height    | 40.5      | Max.   |





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**6 Battery specifications**

| No. | Items   | Specifications  | Remark   |
|-----|---|---|--|
| 1   | Capacity for assembled cell discharging by 0.2C | $\geq 920\text{mAh}$  | Standard discharging method  |
| 2   | Battery Voltage                                 | $\geq 3.8\text{V}$  | Delivery voltage, Within 10 days from Factory                        |
| 3   | Standard charge condition                       | Charge with 0.5C constant current and <u>4.2V</u> constant voltage, charge to <u>4.2V</u> , continue charging till current delaine to $\leq 0.01\text{C}$ | Charge volage: $4.2\text{V} \pm 0.02\text{V}$<br>Charge current:0.5C |
| 4   | Standard discharging method                     | 0.2C constant current discharge to <u>3.0V</u> ,  | /  |
| 5   | Internal Impedance                              | Assemblage Impedance $\leq 50\text{m}\Omega$  | Measure two sides of the drawing line after assembling.              |

**7 PCM specification**

| Item                      | Symbol      | Content                              | Criterion                         |
|---------------------------|-------------|--------------------------------------|-----------------------------------|
| Over charge Protection    | $V_{DET1}$  | Over charge detection voltage        | $4.280 \pm 0.025V$                |
|                           | $tV_{DET1}$ | Over charge detection delay time     | $1.2 \pm 0.24S$                   |
|                           | $V_{REL1}$  | Over charge release voltage          | $4.080 \pm 0.050V$                |
|                           |             | Maximum charge current               | $\leq 1.0A$                       |
| Over discharge protection | $V_{DET2}$  | Over discharge detection voltage     | $2.90 \pm 0.073V$                 |
|                           | $tV_{DET2}$ | Over discharge detection delay time  | $144 \pm 28.8mS$                  |
|                           | $V_{REL2}$  | Over discharge release voltage       | $3.0 \pm 0.05V$                   |
| Over current protection   | $V_{DET3}$  | Over current detection voltage       | $3.1 \pm 0.078V$                  |
|                           | $I_{DP}$    | Over current detection current       | $2.0 \sim 4.0A$                   |
|                           | $tV_{DET3}$ | Detection delay time                 | $12 \pm 4.0mS$                    |
|                           |             | Release condition                    | Cut load                          |
|                           |             | Maximum continuous discharge current | $\leq 1.0A$                       |
| Short protection          |             | Detection condition                  | Exterior short circuit            |
|                           | $T_{SHORT}$ | Detection delay time                 | $230 \sim 500\mu S$               |
|                           |             | Release condition                    | Cut short circuit                 |
| Interior resistance       | $R_{SS}$    | Main loop electrify resistance       | $V_c=3.7V; R_{SS} \leq 70m\Omega$ |
| Current consumption       | $I_{DD}$    | Current consume in normal operation  | $8.0 \mu A$ Max                   |





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**9 PCM BOM LIST**

| No. | Description   | Vendor | Symbol | Spec. /model             | Unit | Pcs |
|-----|---------------|--------|--------|--------------------------|------|-----|
| 1   | Circuit board | FSW    | PCB    | P-1S2840CK (28*4-0.6-Sn) | pcs  | 1   |
| 2   | Resistance    | GJ     | R1     | 330/0603                 | pcs  | 1   |
| 3   | Resistance    | GJ     | R2     | 1K/0603                  | pcs  | 1   |
| 4   | Resistance    | GJ     | C1/C3  | 104/0603                 | pcs  | 2   |
| 5   | Resistance    | GJ     | C2     | 104/0402                 | pcs  | 1   |
| 6   | IC            | RICHO  | T1     | R5402N149KD/SOT23-6      | pcs  | 1   |
| 7   | MOS           | FS     | T2     | 8205/TSSOP-8             | pcs  | 1   |



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### 10 Battery Pack Dimensions

| NO | Items     | Units: mm |      | Remark |
|----|-----------|-----------|------|--------|
| 1  | Thickness | T         | 6.0  | Max.   |
| 2  | Width     | W         | 40.5 | Max.   |
| 3  | Height    | H         | 40.5 | Max.   |

#### BOM of Battery Pack

| NO | Part name   | Quantity | Unit | Remark                 |
|----|-------------|----------|------|------------------------|
| 1  | Cell        | 1        | ea   | AKYGA                  |
| 2  | Tape        | ~120~    | mm   |                        |
| 3  | Solder      | 0.2      | g    | Lead Free              |
| 4  | Lead        | 2        | pcs  | VCC,GND                |
| 5  | PCB         | 1        | pcs  | P-1S2840CK<149KD+8205> |
| 6  | Lead length | 2        | pcs  | UL1007#28AWG/15cm      |

## 11 Handling of Cells

### 11.1 Consideration of strength of film package

#### 1) Soft Aluminium foil

Easily damaged by sharp edge parts such as pins and needles, Ni-tabs, so don't strike by those sharp parts.

#### 2) Sealed edge may be damaged by heat above 100°C, bend or fold sealed edge.

### 11.2 Prohibition short circuit

Never make short circuit cell. It generates very high current which causes heating of the cells and may cause electrolyte leakage, gassing or explosion that is very dangerous.

The LIP tabs may be easily short-circuited by putting them on conductive surface.

Such outer short circuit may lead to heat generation and damage of the cell.

An appropriate circuitry with PCM shall be employed to protect accidental short circuit of the battery pack.

### 11.3. Mechanical shock

LIP cells have less mechanical endurance than metal-can-cased LIB.

Falling, hitting, bending, etc. may cause degradation of LIP characteristics.

### 11.4 Handling of tabs

The battery tabs are not so stubborn especially for aluminium tab.

Don't bend tab.

Do not bend tabs unnecessarily.

## 12 Notice for Designing Battery Pack

### 12.1 Pack toughness

Battery pack should have sufficient strength and the LIP cell inside should be protected from mechanical shocks.

### 12.2 Cell fixing

The LIP cell should be fixed to the battery pack by its large surface area.

No cell movement in the battery pack should be allowed.

### 12.3 Inside design

No sharp edge components should be inside the pack containing the LIP cell.

### 12.4 Tab connection

Ultrasonic welding or spot welding is recommended for LIP tab connection method.

Battery pack should be designed that shear force are not applied to the LIP tabs.

If apply manual solder method to connect tab with PCM, below notice is very important to ensure battery performance:

1) The solder iron should be temperature controlled and ESD safe;

2) Soldering temperature should not exceed 350°C;

3) Soldering time should not be longer than 3s;



4) Soldering times should not exceed 5 times, Keep battery tab cold down before next time soldering;

5) Directly heat cell body is strictly prohibited, Battery may be damaged by heat above approx. 100°C

12.5 For mishaps

Battery pack should be designed not to generate heat even when leakage occurs due to mishaps.

1) Isolate PCM (Protection Circuit Module) from leaked electrolyte as perfectly as possible.

2) Avoid narrow spacing between bare circuit patterns with different voltage.

(Including around connector)

LIP battery should not have liquid from electrolyte, but in case if leaked electrolyte touch bare circuit patterns, higher potential terminal material may dissolve and precipitate at the lower potential terminal, and may cause short circuit. The design of the PCM must have this covered.

**13 Notice for Assembling Battery Pack**

Shocks, high temperature, or contacts of sharp edge components should not be allowed in battery pack assembling process.

**14 Others**

14.1 Cell connection

1) Direct soldering of wire leads or devices to the cell is strictly prohibited.

2) Lead tabs with pre-soldered wiring shall be spot welded to the cells.

Direct soldering may cause damage of components, such as separator and insulator, by heat generation.

14.2 Prevention of short circuit within a battery pack

Enough insulation layers between wiring and the cells shall be used to maintain extra safety protection. The battery pack shall be structured with no short circuit within the battery pack, which may cause generation of smoke or firing.

14.3 Prohibition of disassembly

1) Never disassemble the cells

The disassembling may generate internal short circuit in the cell, which may cause gassing, firing, explosion, or other problems.

2) Electrolyte is harmful

LIP battery should not have liquid from electrolyte flowing, but in case the electrolyte come into contact with the skin, or eyes, physicians shall flush the electrolyte immediately with fresh water and medical advice is to be sought.





14.4 Prohibition of dumping of cells into fire

Never incinerate nor dispose the cells in fire. These may cause explosion of the cells, which is very dangerous and is prohibited.

14.5 Prohibition of cells immersion into liquid such as water

The cells shall never be soaked with liquids such as water, seawater, drinks such as soft drinks, juices, coffee or others.

14.6 Battery cells replacement

The battery replacement shall be done only by either cells supplier or device supplier and never be done by the user.

14.7 Prohibition of use of damaged cells

The cells might be damaged during shipping by shock. If any abnormal features of the cells are found such as damages in a plastic envelop of the cell, deformation of the cell package, smelling of an electrolyte, an electrolyte leakage and others, the cells shall never be used any more.

The Cells with a smell of the electrolyte or a leakage shall be placed away from fire to avoid firing or explosion.

**15 Storage of the Batteries**

The batteries should be stored at room temperature, charged to about 30% to 50% of capacity.

We recommend that batteries be charged about once per half a year to prevent over discharge.

**16 Other The Chemical Reaction**

Because batteries utilize a chemical reaction, battery performance will deteriorate over time even if stored for a long period of time without being used. In addition, if the various usage conditions such as charge, discharge, ambient temperature, etc. are not maintained within the specified ranges the life expectancy of the battery may be shortened or the device in which the battery is used may be damaged by electrolyte leakage. If the batteries cannot maintain a charge for long periods of time, even when they are charged correctly, this may indicate it is time to change the battery.

**17 Note**

Any other items which are not covered in this specification shall be agreed by both parties.