



Specification No. APL-2013517

Edition No. 1.0

Cylindrical Li — ion Battery Pack

Product Specification

Model: 18650 3.7v 4400mAh

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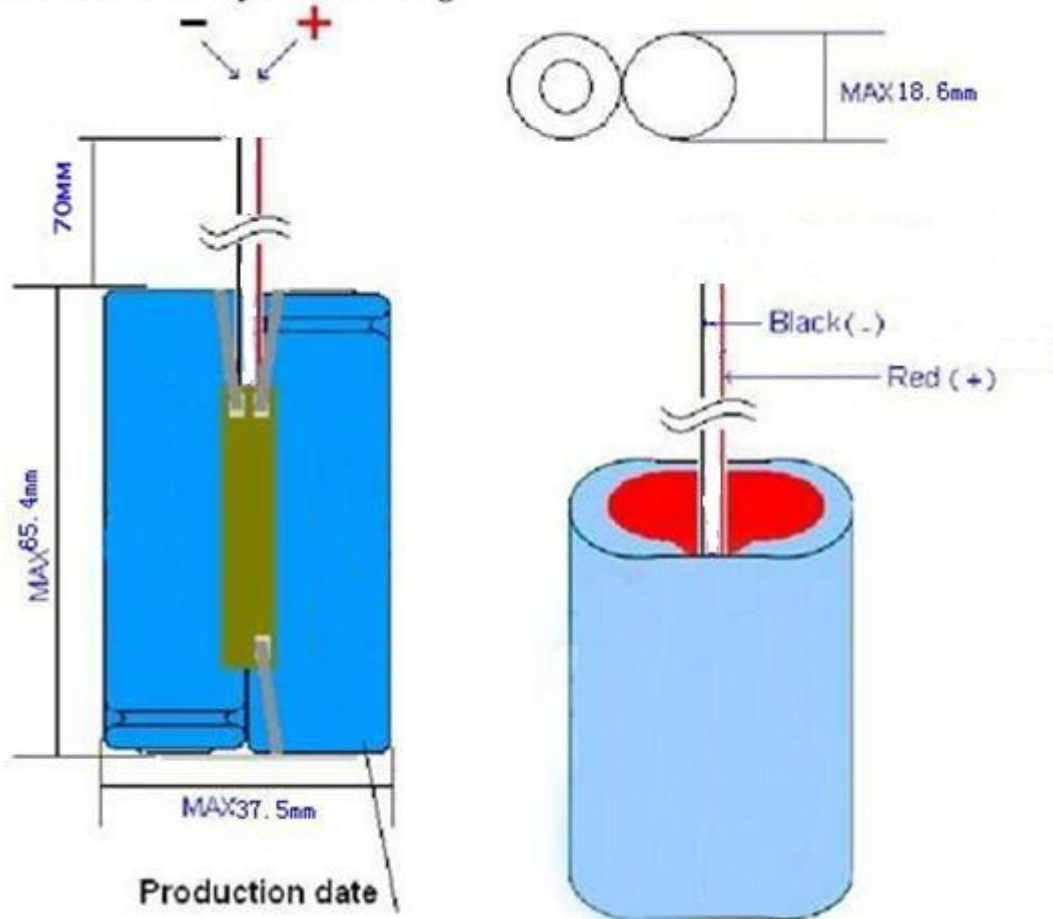
1.1 Li-ion Battery Pack Data Sheet

Type -----	Li-ion battery Pack
Model -----	ICR18650 2P 3.7V 4400mAh
Normal Voltage -----	3.7V
Weight -----	85 g (ref)
C5mAh -----	4400mAh
Charge voltage -----	4.20 ± 0.05V
Minimum discharge end voltage -----	2.75V
Maximum charge voltage -----	4.2V
Standard continuous charge current -----	0.2C5mA
Maximum continuous charge current -----	2200mA
Maximum continuous discharge current -----	4400mA
Capacity (20} C150C, 0.2Cs to 3.0V)	
Nominal capacity-----	4400mAh
Minimum capacity-----	4400mAh
Internal impedance(200C ± 50C AC Impedance 1 KHz) -----	≤260mf2
Charge and discharge conditions (20°C)	
Standard charge-----	Constant current and constant voltage (CC/CV)
Current=0.2CsmA Voltage=4.20V End Current=0.01CsmA	
Fast charge-----	Constant current and constant voltage (CC/CV)
Current=1500mA Voltage=4.20V End Current=0.01CsmA	
Standard discharge-----	Constant current (CC)
Current=0.2CsmA End Voltage=3.0V	
Operation conditions (recommended)	
Standard charge-----	0---45°C
Discharge-----	—20°C—60°C
Storage humidity	
Relative humidity-----	45-75
Temperature range for Storage (Percentage of recoverable capacity 80%)	
1 month-----	-20+60°C
3 months -----	-20+45°C
1 year-----	-20+20°C
Standard Test Conditions (Except additional quest)	
Temperature-----	20°C ± 50C
Relative humidity-----	—65 ± 20%

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1.2. Li-ion Battery Pack Drawing



1.3 Specification

Item	Specifications		Remark
Nominal Capacity	4400mAh ±5%		0.2C ₅ A discharge, 25°C
Nominal Voltage	3.7V		Average Voltage at 0.2C ₅ A discharge
Standard Charge Current	0.2 C ₅ A		Working temperature: 0~40°C
Max Charge Current	1C ₅ A		Working temperature: 0~40°C
Charge cut-off Voltage	4.2V		CC/CV
Standard Discharge Current	0.5C ₅ A		Working temperature: 25°C
Discharge cut-off Voltage	2.75V		
Cell Voltage	3.7-3.9V		When leave factory
Impedance	≤35mΩ		AC 1KHz after 50% charge,25°C
Weight	Approx:85.0g		
Storage temperature	≤1month	-10~45°C	Best 20±5°C for long-time storage
	≤3month	0~30°C	
	≤6month	20±5°C	
Storage humidity	65±20% RH		

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1.4 General Performance

Definition of Standard charging method: At $20 \pm 5^\circ\text{C}$, charging the cell initially with constant current $0.2C_5A$ till voltage 4.2V, then with constant voltage 4.2 till current declines to $0.05C_5A$.

Item		Test Methods	Performance
4.1	0.2C Capacity	After standard charging, laying the battery 0.5h, then discharging at $0.2C_5A$ to voltage 2.75V, recording the discharging time.	$\geq 300\text{min}$
4.2	1C Capacity	After standard charging, laying the battery 0.5h, then discharging at $1C_5A$ to voltage 2.75V, recording the discharging time.	$\geq 54\text{min}$
4.3	Cycle Life	Constant current $0.5C_5A$ charge to 4.2V, then constant voltage charge to current declines to $0.05C_5A$, stay 5min, constant current $0.5C_5A$ discharge to 2.75V, stay 5min. Repeat above steps till continuously discharging time less than 36min.	$\geq 500\text{times}$
4.4	Capability of keeping electricity	$20 \pm 5^\circ\text{C}$, After standard charging, laying the battery 28days, discharging at $0.2C_5A$ to voltage 2.75V, recording the discharging time.	$\geq 240\text{min}$

1.5 Environment Performance

Item		Test Methods	Performance
5.1	High temperature	After standard charging, laying the battery 4h at 60°C , then discharging at $0.2C_5A$ to voltage 2.75V, recording the discharging time.	$\geq 270\text{min}$
5.2	Low temperature	After standard charging, laying the battery 4h at -10°C , then discharging at $0.2C_5A$ to voltage 2.75V, recording the discharging time.	$\geq 210\text{min}$
5.3	Constant humidity and temperature	After standard charging, laying the battery 48h at $40 \pm 2^\circ\text{C}$, RH $93 \pm 2\%$. Recording $0.2C_5A$ discharging time	No distortion No electrolytes leakage $\geq 270\text{min}$
5.4	Temperature shock	After standard charging, battery stored at -20°C for 2 hours, then stored at 50°C for 2 hours. Repeat 10 times.	No electrolytes leakage

1.6 Mechanical Performance

Item		Test Methods	Performance
6.1	Vibration	After standard charging, put battery on the vibration table. 30 min experiment from X,Y, Z axis. Scan rate: 1 oct/min; Frequency 10-30Hz, Swing 0.38mm; Frequency 30-55Hz, Swing 0.19mm.	No influence to batteries' electrical performance and appearance.
6.2	Collision	After vibration test, batteries were laying on the vibration table about X, Y, Z axis. Max frequency acceleration: 100m/s^2 ; collision times per minutes: 40~80; frequency keeping time 16ms; all collision times 1000 ± 10 .	No influence to batteries' electrical performance and appearance.

.3	Drop	Random drop the battery from 10m height onto concrete one times.	No explosion or fire
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2.Safety Test

Test conditions: The following tests must be measured at flowing air and safety protection conditions. All batteries must standard charge and lay 24h.

Item		Test Methods	Performance
7.1	Over charge	At $20 \pm 5^{\circ}\text{C}$, charging batteries with constant current $3C_5A$ to voltage $5V$, then with constant voltage $5V$ till current decline to 0. Stop test till batteries' temperature 10°C lower than max temperature.	No explosion or fire
7.2	Over discharge	At $20 \pm 5^{\circ}\text{C}$, discharge battery with $0.2C_5A$ continuously 12.5h.	No explosion or fire
7.3	Short-circuit	At $20 \pm 5^{\circ}\text{C}$, connect batteries' anode and cathode by wire which impedance less than $50m\Omega$, keep 6h.	No explosion or fire
7.4	Extrusion	At $20 \pm 5^{\circ}\text{C}$, put the battery in two parallel steel broad, add pressure $13kN$.	No explosion or fire
7.5	Thermal shock	Put the battery in the oven. The temperature of the oven is to be raised at $5 \pm 1^{\circ}\text{C}$ per minute to a temperature of $130 \pm 2^{\circ}\text{C}$ and remains 60 minutes.	No explosion or fire

3. Cautions

3.1 Cautions of batteries' operation

The batteries must be careful of proceed the operation for it's soft package.

To assure product safety, describe the following precautions in the instruction manual of the equipment.

!Danger

Do not heat or throw battery into a fire.

Do not use, leave battery close to fire or inside of a car where temperature may be above 60°C . Also do not charge/discharge in such conditions.

Hairpins, coins, or screws. Do not store batteries with such objects.

Do not short circuit the (+) and (-) terminals with other metals.

Do not place battery in a device with the (+) and (-) in the wrong way around.

Do not hit with a hammer, step on or throw or drop to cause strong shock.

Do not disassemble or modify the battery.

Do not solder a battery directly.

Do not use a battery with serious scar or deformation.

!Warning

Do not use battery with dry cells and other primary batteries, or batteries of a different package, type, or brand.

Stop charging the battery if charging is not completed within the specified time.

During use, charge, or storage.

Keep away from fire immediately when leakage or foul odor is detected.

If liquid leaks onto your skin or clothes, wash well with fresh water immediately.

If liquid leaking from the battery gets into your eyes, do not rub your eyes. Wash them well with clean water and go to see a doctor immediately.

!Caution

Store batteries out of reach of children so that they are not accidentally swallowed.

Batteries have life cycles. If the time that the battery powers equipment becomes much shorter than usual, the battery life is at an end. Replace the battery with a new same one.

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Remove a battery whose life cycle has expired from equipment immediately.

When the battery is thrown away, be sure it is non-conducting by applying vinyl tape to the(+) And terminals.

When not using battery for an extended period, remove it from the equipment and store in a place with low humidity and low temperature.

While the battery pack is charged, used and stored, keep it away from objects or materials with static electric charges.

The battery can be used within the following temperature ranges. Do not exceed these ranges.

3.2 Standard Test Environment for polymer lithium-ion batteries

Environment temperature: $20 \pm 5^{\circ}\text{C}$ Humidity: 45-85%

3.3 Cautions of charge & discharge

3.4 charge

Charging current should be lower than values that recommend below. Higher current and voltage charging may cause damage to cell electrical, mechanical, safety performance and could lead heat generation or leakage.

- (1) Batteries charger should charging with constant current and constant voltage mode;
- (2) Charging current should be lower than (or equal to) $1C_5A$;
- (3) Temperature $0 \sim 40^{\circ}\text{C}$ is preferred when charging;
- (4) Charging voltage must be lower than 4.25V.

3.5. discharge

- (1) Discharging current must be lower than (or equal to) $2C_5A$;
- (2) Temperature $0 \sim 60^{\circ}\text{C}$ is preferred when discharging;
- (3) Discharging voltage must not be lower than 2.75V.

3.6. over-discharge

It should be noted that the cell would be at an over-discharge state by its self-discharge. In order to prevent over-discharge, the cell shall be charged periodically to keeping voltage between 3.7-3.9V. Over-discharge may cause loss of cell performance. It should be noted that the cell would not discharge till voltage lower than 2.75V.

4 Storage of polymer lithium-ion batteries

The environment of long-time storage:

Temperature: $20 \pm 5^{\circ}\text{C}$;

Humidity: 45-85%;

Batteries were 40~60% charged.

In case of over-discharge, batteries should be charged for one time every 3 months while storing. Batteries should be discharged and charged after being stored more than a year in order to activate it and restore energy. Please charge the battery with constant current $0.5C_5A$ for 1 hour so that it has some storage of charge for properly using.

Charge and discharge afresh to active and renew battery energy after storage above 1 year.

5. Transportation of polymer lithium-ion batteries

The batteries should transportation with 10~50% charged states.

6. Others

Please note cautions below to prevent cells' leakage, heat generation and explosion.

Prohibition of disassembly cells;

Prohibition of cells immersion into liquid such as water or seawater;

Prohibition of dumping cells into fire;

Prohibition of using damaged cells. The cells with a smell of electrolyte or leakage must be placed away from fire to avoid firing.

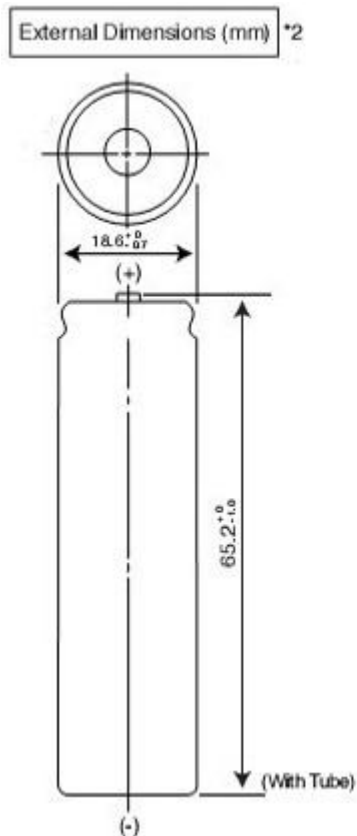
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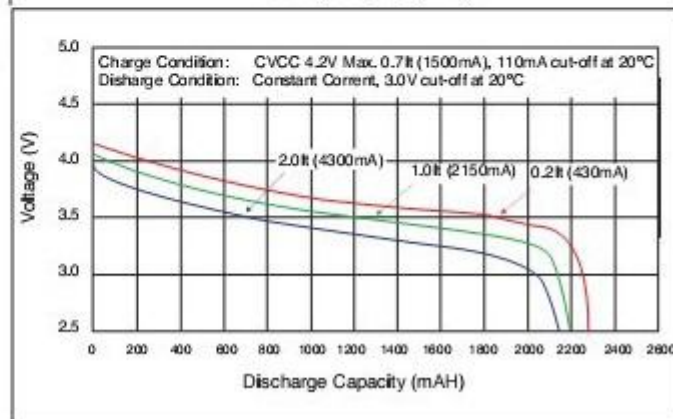
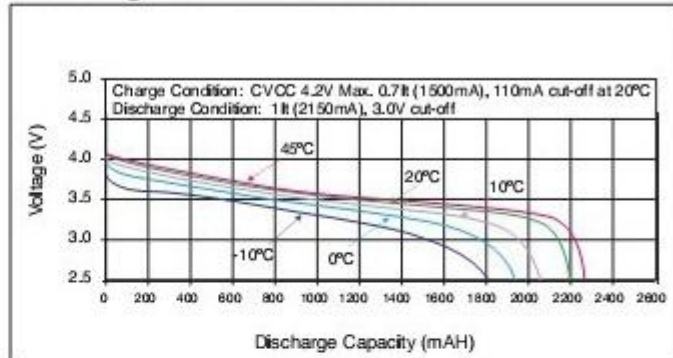
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7. Single cells specifications



Discharge Characteristics



Type description
System

Norminal Voltage

Typical Capacity(mAh)

Norminal Capacity(mAh)

Dimensions (mm)

Diameter(d)

Height (h)

Weight, approx.(g)

Charging Method

Charge Voltage(V)

Initial Charge Current(mA)

Charging Cut-off (a)or(b)

a)by time(h)

b)by min.current(mA)

Discharge Cut-off Voltage (v)

Max.continuous discharge current(mA)

Operating Temperature (°C)

Storage Temperature(°C)

Capacity Recovery Rate(%)

APL-18650 -2200mAh

Li-ion

3.7v(average)

2200(at c/5 from 4.2v to 2.75v at 20°C)

2200(at c/5 from 4.2v to 2.75v at 20°C)

18.40 Max.

65.0

46.0

Constant Current + Constant Voltage

4.20(+/-50mv)

standard Charge:1200

Rapid charge: 2200mAh

Stand Charge:3

Rapid Charge: 2.5

C/50

2.75

2600

Charge 0-45°C

Discharge -20-60°C

1 Year at -20 to 20°C >80

3 Months at -20 to 45°C >80

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1 Months at -20 to 60°C >80

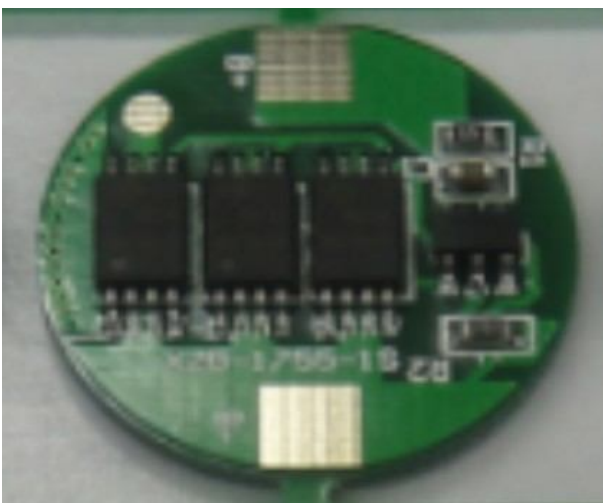
Impedance Initial(m Ω) <100@1kHz
Life Expectancy C/2 ,20°C(cycles) >380

After storage at initial cell voltage of 3.7 to 3.9v /cell, capacity C/5 measured at 20°C

8. PCM

ELECTRIC CHARACTERISTICS(at 25°C)

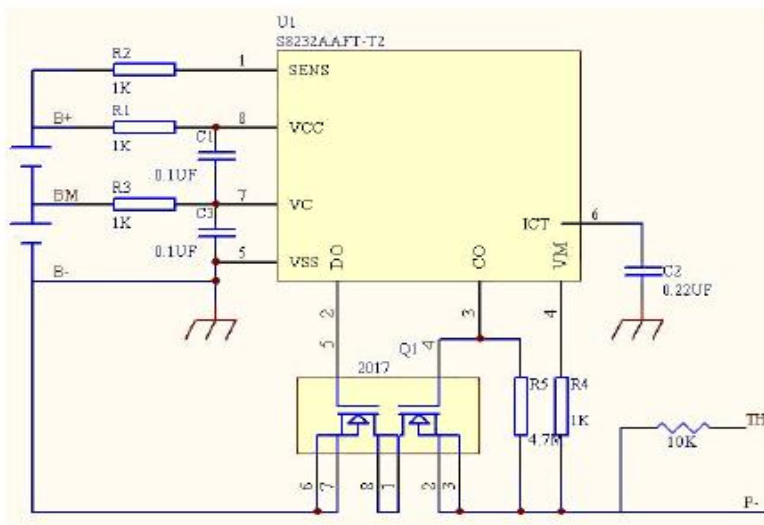
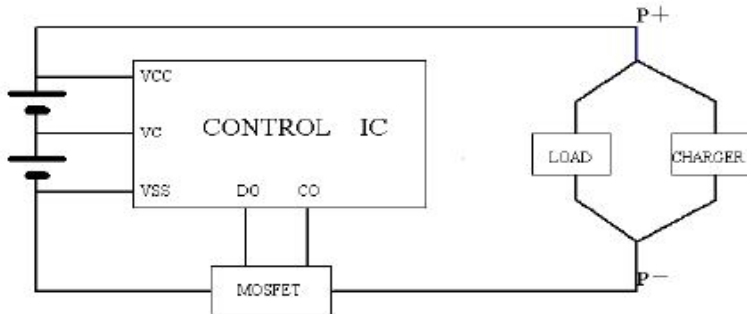
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|--|-----------------|
| 1) Overcharge Detection Voltage | 4.2V ± 150 mV |
| 2) Overcharge Release Voltage: | 4.05V ± 100mV |
| 3) Overdischarge Detection Voltage | 4.8V ± 160mV |
| 4) Overdischarge Release Voltage: | 3V ± 1200mV |
| 5) Overcurrent Detection Voltage: | 0.15V ± 120mV |
| 6) Overcurrent Detection: | 4.00A -- 7.00A |
| 7) Overcharge Detection Delay Time: | 0.55S -- 2.06S |
| 8) Overdischarge Detection Delay time: | 67 -- 141ms |
| 9) OverCurrent Detection Delay Time: | 6.3 -- 14.7ms |
| 10) Consumption Current | |
| --Operating mode: | Max 14.2 u A |
| --Power -- saving mode: | Max 0.2 u A |
| 11) Maximum Operating Temperature: | -40°C -- +85°C |
| 12) Maximum Storage Temperature: | -55°C -- +125°C |
| 13) Maximum Input Voltage: | 4.2VDC |
| 14) Maximum Charge Current: | 1.8A |



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3.2. CIRCUIT DIAGRAM



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9. Notice of Designing Battery Pack

9.1 Pack design

Battery pack should have sufficient strength and battery should be protected from mechanical shock. No sharp edge components should be inside the pack contains the battery.

9.2 PCM design

The overcharge threshold voltage should not be exceeding 4.25V.

The over-discharge threshold voltage should not be lower than 2.3V.

The PCM should have short protection function built inside.

9.3 Tab connection

Ultrasonic welding or spot welding is recommended to connect battery with PCM or other parts.

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

(1) The electric 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, keep battery tab cold down before next soldering;

(4) Soldering times should not exceed 5 times;

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

9.4 Cell fixing

The battery should be fixed to the battery pack by its large surface area. No cell movement in the battery pack should be allowed.

9.5 Cells replacement

The cell replacement should be done by professional people.

Prohibit short-circuit between cells' Al package and exterior component.