Spec. No.	IFR18650-11Q	Version No.	1.1	Peter Kim, Lucy Kim

Revision History

Revision No.	Revision date	Page	Item	Description	Remark
1.0	Sept 27, 2010			Formulated first edition	
1.1	Oct 14, 2010		3.8, 7.6,7.8	Max Charge Current	

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1. Scope

This product specification has been prepared to specify the rechargeable lithium-ion cell ('cell') to be supplied to the customer by Samsung SDI Co., Ltd.

2. Description and model

2.1 Description lithium-ion rechargeable cell
2.2 Model IFR18650-11Q

3. Nominal Specifications

Item	Specification
3.1 Nominal discharge capacity	1100mAh (220mA, 2.0V discharge)
3.2 Standard discharge capacity	≥ 950mAh (10A, 2.0V discharge)
3.3 Charging voltage	3.6 ±0.1V Deviation from 3.6V: Possible decrease in capacity &/or cycle life
3.4 Nominal voltage (derived using EPTA Method)	3.2V
3.5 Charging method	CC-CV with 50mA cut-off Alternately CC – Step CC is acceptable
3.6 Charging current	Standard charge: 550mA
3.7 Charging time	Standard charge: 150min Rapid(Max.) charge : 50min
3.8 Maximum charge current (Charge current that will result in nominal cycle life performance as described in 7.8-1 of > 1000 cycles.)	1.5 A (ambient temperature 25°C, 1000cycle) 3.0 A (ambient temperature 25°C, min. 500cycle)
3.9 Max. discharge current (Continuous discharge current that will result in nominal cycle life performance as described in 7.8-1 of > 1000 cycles.)	10A
3.10 Discharge cut-off voltage	2.0V for cycle life (Cutoff voltage may be set to 0.5V but it may cause deterioration in cell performance.)
3.11 Cell weight	40.0±3.0 g
3.12 Cell dimension	Diameter : Φ18.15±0.1 mm Height : 64.80±0.15 mm
3.13 Operating temperature (Ambient temperature)	Charge: 5 to 45 °C Discharge: -10 to 60 °C
3.14 Cell temperature	Charge: 0 to 60 °C Discharge: -20 to 80 °C
3.15 Storage temperature (Suggested)	18months:-20~25°C(1*) 3months:25~45°C(1*)

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	1month :45~60°C(1*)

4. Outline dimensions

See the attachment (Fig. 1)

5. Appearance

There shall be no such defects as scratch, rust, discoloration, or leakage which may adversely affect commercial value of the cell. Any uncertainty arising out of the previous phrase shall be settled upon between consultation between both Black & Decker and Samsung.

5.1 Cell Sleeve Material

Cell sleeve material should maintain electrical insulation properties (i.e. not deform or shrink to expose cell can along longitudinal (length) direction) after storage for 2 hours at 150 °C.

6. Standard test conditions

6.1 Environmental conditions

Unless otherwise specified, all tests stated in this specification are conducted at temperature 25±5 °C and humidity 65±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 0.01 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 0.55A and constant voltage 3.6V 50mA cut-off at 25 °C.

7.2 Standard discharge capacity

The standard discharge capacity is the initial discharge capacity of the cell, which is measured with discharge current of 10A with 2.0V cut-off at 25 °C within 1hour after the standard charge.

Standard Discharge Capacity ≥ 950mAh

7.3 Initial internal impedance

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

Initial internal impedance 15.5 ±3.5mΩ*

*Tentative spec.: Specification can be changed by mutual agreement on request of either party

7.4 Temperature dependence of discharge capacity

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Capacity comparison at each temperature, measured with discharge constant current 10A and 2.0V cut-off after the standard discharge is as follows.

Discharge temperature			
-10 °C	0 °C	25 °C	60 °C
75%	80%	100%	100%

Note: If charge temperature and discharge temperature are not the same, the interval for temperature change is 3 hours.
Percentage as an index of the capacity at 25 °C (=950mAh) is 100%.

7.5 Temperature dependence of charge capacity

Capacity comparison at each temperature, measured with discharge constant current 10A and 2.0V cut-off after the standard charge is as follows.

	Charge temperature			Discharge temperature
	5 °C	25 °C	45 °C	25 °C
Relative Capacity	80%	100%	95%	

Note: If charge temperature and discharge temperature is not the same, the interval for temperature change is 3 hours.
Percentage as an index of the capacity at 25°C (=950mAh) is 100%

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7.6 Charge rate capabilities

Discharge capacity is measured with constant current 10A and 2.0V cut-off after the cell is charged to 3.6V as follows.

	Charge Condition	
Current	0.55A	Rapid 3.0A
Cut-off	50mA	50mA
Relative Capacity	100%	98%

Note: Percentage as an index of the capacity at 25°C and 0.55A charging (=950mAh) is 100%.

7.7 Discharge rate capabilities

Discharge capacity is measured with the various currents in table and 2.0V cut-off after the standard charge.

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	Discharge Condition				
Current	1.1A	5A	10A	20A	30A
Relative Capacity	103%	101%	100%	98%	95%

Note: Percentage as an index of the capacity at 25°C (=950mAh) is 100%.

7.8 Cycle life

7.8.1

Each cycle is an interval between the charge (charge current 1.5A) with 50mA cut-off and the discharge (discharge current 10A) with 2.0V cut-off.

Capacity after 1000cycles,

Capacity ≥ 710mAh (75% of the standard capacity at 25 °C)

7.8.2

Each cycle is an interval between the charge (charge current 3.0A) with 50mA cut-off and the discharge (discharge current 10A) with 2.0V cut-off.

Capacity after minimum 500cycles,

Capacity ≥ 830mAh (87.5% of the standard capacity at 25 °C)

7.9 Storage characteristics

Capacity after storage for 1 month at 60 °C from the standard charge, measured with discharge current 10A with 2.0V cut-off at 25 °C.

Capacity recovery (after the storage) ≥ 760mAh (80% of the capacity at 25 °C)

7.10 Status of the cell as of ex-factory

The cell should be shipped as requested by a customer

7.10.1 Hard Limit*: 3270±15 mV (~30 days)

≥3250 mV (~90 days)

≥3240 mV (~180 days)

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7.10.2 All cells in a given pack are to be in the soft limit.

Soft limit*: ≤ 9mV (Max-Min)

*Tentative spec.: Specification can be changed by mutual agreement on request of either party

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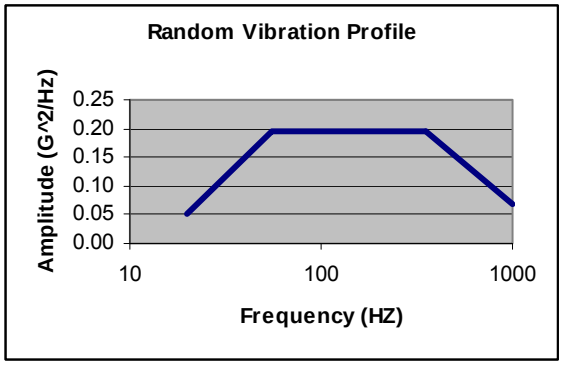
8. Mechanical Characteristics

8.1 UN test

Test method: UN Manual of Tests & Criteria Part III, Subsection 38.3.4.1~8.
Criteria: Pass

8.2 Vibration test

Vibration	1) Cell is tested as received. 2) Measure OCV and ACR. 3) Test is conducted at room temperature. 4) Cells held firmly and are tested in both horizontal and vertical orientations. 5) Random vibration conducted for 3 hours minimum with the following profile: **Frequency (HZ)** / **Amplitude (G^2/HZ)** 20 / 0.04997 55 / 0.1956 350 / 0.1956 1000 / 0.06988  	No leakage. No venting. ACR shall not change by > +/- 2 mOhm OCV shall not change by > +/ 1 % The OCV and ACR are to be measured after a 24 hour rest.

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9. Safety

9.1 Overcharge test

Test method: To charge with 3A to 34V at 25 °C for 2hr.
Criteria: No fire, and no explosion.

9.2 External short-circuit test

Test method: To short-circuit the standard charged cell (or 50% discharged cell) by connecting positive and negative terminal by less than or = 5mΩ wire for 10min.
Criteria: No fire, and no explosion.

9.3 Forced discharge test

Test method: To discharge the discharged cell (0% charged) with charge current 1.1A by -12V for 1 hour.
Criteria: No fire, and no explosion within 7 days.

9.4 Heating test

Test method: To heat up the standard charged cell at heating rate 5 °C per minute up to 150 °C and keep the cell in oven for 1hr.
Criteria: No fire, and no explosion.

10. Warranty

Samsung SDI will be responsible for replacing the cell against defects or poor workmanship for 18months from the date of shipping. Any other problem caused by malfunction of the equipment or misuse of the cell is not covered under this warranty. The warranty set forth with proper use and handling conditions described above and excludes cases of defects which are not related to manufacturing of the cell.

11. Others

11.1 Long-term storage

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.

11.2 Other

Any matter not called for in the specifications should be conferred with between both parties (Black and Decker and Samsung.)

12. ECN(Engineering Change Notice) of Product

Any change, which is related to cell chemistry, construction, material, or process shall be approved by Customer.

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13. Packing

See Fig.2,
Package Drawing

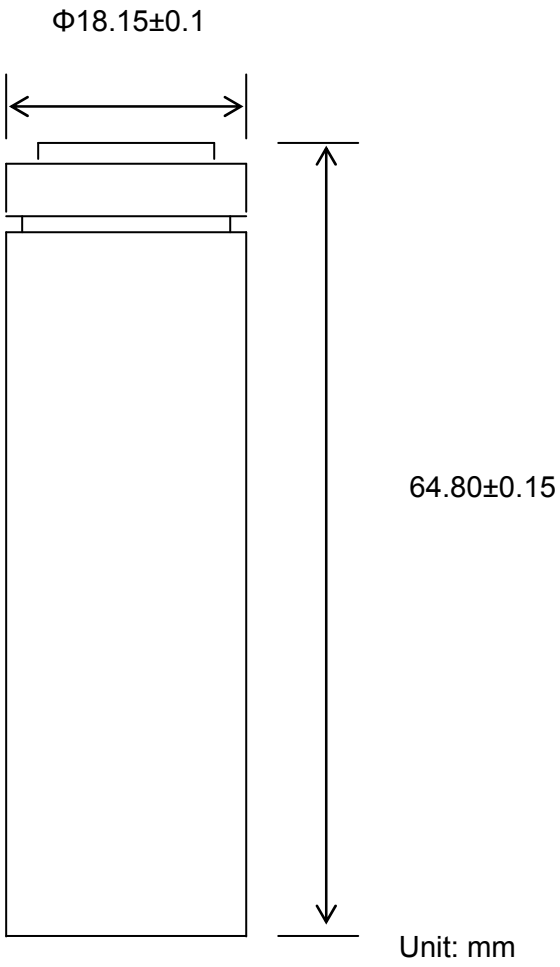

Fig.1. Outline dimensions of IFR18650-11Q

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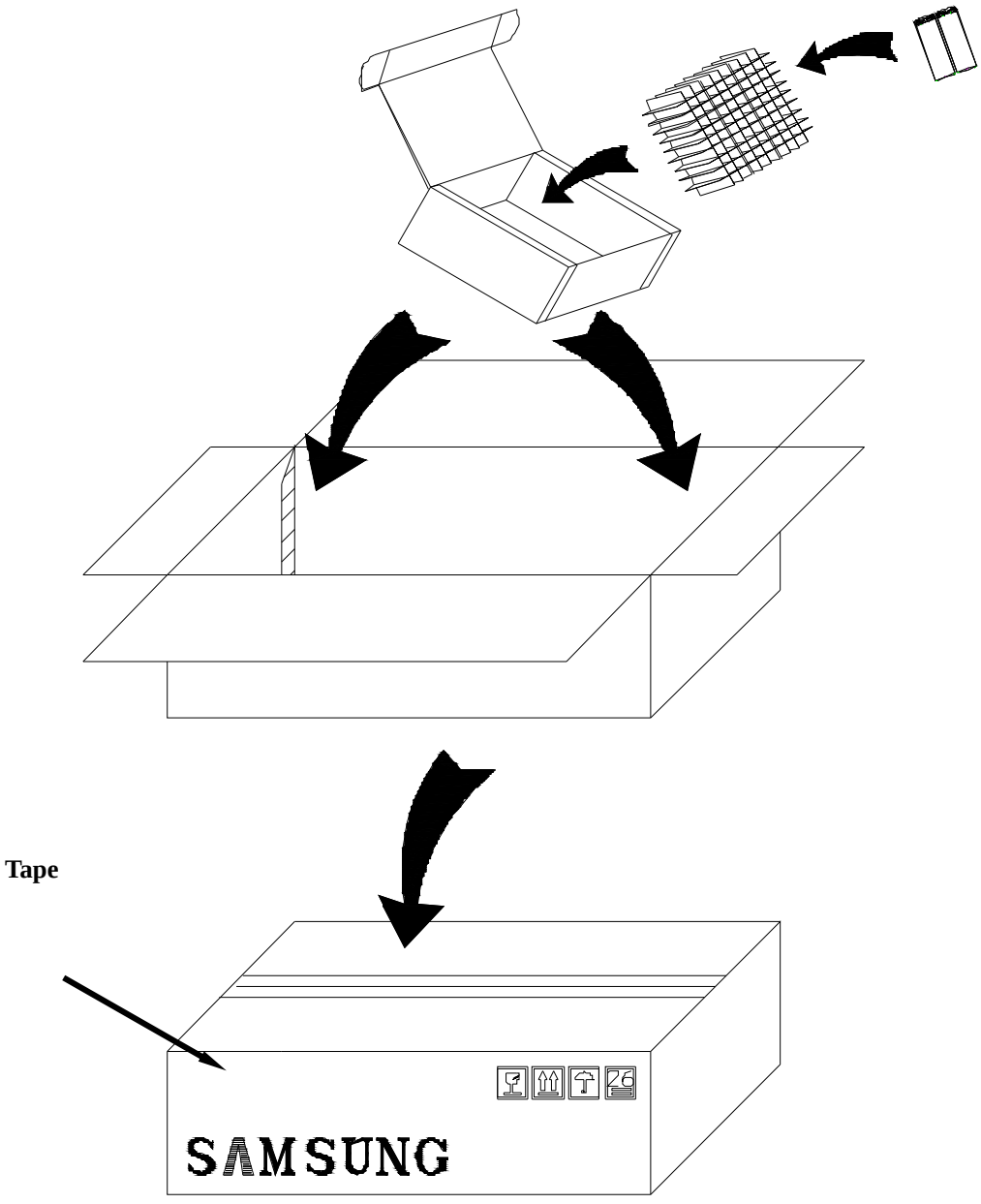

Fig.2. Package drawing

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Proper use and handling of lithium ion cells

See before using lithium-ion cell
Supplied by
Samsung SDI Co., Ltd.

1. General

This document has been prepared to describe the appropriate cautions and prohibitions, which the customer should take or employ when the customer uses and handles the lithium ion cell to be manufactured and supplied by Samsung SDI Co., Ltd., in order to obtain optimum performance and safety.

2. Charging

2.1 Charging current

Charging current shall be less than or equal too maximum charge current specified in the product specification.

2.2 Charging voltage

Charging voltage shall be less than or equal to that specified in the product specification.

2.3 Charging time

Continuous charging under appropriate voltage does not cause any loss of characteristics. It is recommended that a time-out timer function be incorporated in the charging system to suspend charging past a given time.

2.4 Charging temperature

The cell shall be charged within a range of specified temperatures in the product specification.

2.5 Reverse charging

The cell shall be connected, confirming that its poles are correctly aligned. Inverse charging should be strictly prohibited. If the cell is connected improperly, it may be damaged.

3. Discharging

3.1 Discharging

3.1.1 The cell should be discharged continuously at less than maximum discharge current specified in the product spec. The cell may be continuously discharged at a higher rate but with degradation of performance to be expected.

3.2 Discharging temperature

3.2.1 The cell shall be discharged within a range of temperatures specified in the product specification otherwise it may cause loss of characteristics.

3.3 Over-discharging

3.3.1 The system should be equipped with a device to prevent discharge exceeding discharging cut-off voltage specified in the product specification. (over-discharging)

3.3.2 Over-discharging may cause loss of performance, characteristics and

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cell function.

3.3.3 Over-discharging may occur by self-discharge if the cell is left for a very long time without any use.

3.3.4 The charging system should be equipped with a device to detect voltage of each cell block to determine recharging procedures.

4. Storage

4.1 Storage conditions

4.1.1 The cell should be stored within a range of temperatures specified in the product specification. Otherwise, it may cause loss of characteristics, leakage and/or rust.

4.2 Long-term storage

4.2.1 The cell should be used within a short period after charging because long-term storage may cause loss of capacity by self-discharging.

4.2.2. If long-term storage is necessary, the cell should be stored at lower voltage within a range specified in the product specification, because storage with higher voltage may cause more loss of characteristics.

5. Cycle life

5.1 Cycle life performance

5.1.1 The cell can be charged/discharged repeatedly up to times specified in the product specification with a certain level of capacity specified in the product specification.

5.1.2 Cycle life may be affected by conditions of charging, discharging, operating temperature, and/or storage.

6. Design of system

6.1 Connection between the cell and the battery

6.1 The cell should not be soldered directly with other cells. Namely, the cell should be welded with leads on its terminal and then be soldered with wire or leads otherwise, it may cause damage of cell components, such as separator and insulator, by heat generation.

6.2 Positioning the battery in the system

6.2.1 The battery should be positioned as possible as far from heat sources high temperature components otherwise, it may cause loss of characteristics.

6.2.3 The recommended spacing between the cells is more than 1mm.

6.3 External shock protection of the cell

6.3.1 The cells in the pack should be mechanically constrained and not loose in order to minimize movement by external shock.

6.4 Short-circuit protection of the cell

6.4.1 The cell should be equipped with an insulating sleeve to protect against a

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short-circuit event which may occur during transportation, battery assembly, and /or system operation.

6.4.2 If the cell sleeve is damaged by some cause such as outside impact, this may cause short-circuit with some wiring inside the battery.

6.5 Connection between the battery and charger/system

6.5.1 The battery should be designed to be connected only to the specified charger and system.

6.5.2 A reverse connection of the battery, even in the specified system, should be avoided by employing special battery design such as special terminals.

6.6 Pack design

6.6.1 For best performance, the current consumption of the battery pack should be less than 10uA (1P cell configuration) at sleep mode.

6.6.2 Cell Voltage monitoring system.
The system (Charger or Pack) should be equipped with a device to monitor the voltage of each of cell block and stop charging if max voltage threshold is reached.

6.6.4 The system should suspend operation if a condition such as over temperature, over voltage, or over current, is detected.

7. Battery pack assembly

7.1 Prohibition of usage of damaged cell

7.1.1 The cell should be inspected visually before battery assembly.

7.1.2 The cell should not be used if sleeve-damage, can-distortion, or electrolyte-smell is detected.

7.2 Terminals handling

7.2.1 Excessive force on the negative terminal should be avoided when external lead is welded.

7.3 Transportation

7.3.1 Careful precautions should be taken during transportation of the cell (for example to the battery pack manufacturer, to avoid damage to the cell.

8. Others

8.1 Disassembly

8.1.1 The cell should not be dismantled from the battery pack.

8.1.2 Internal short-circuit caused by disassembly may lead to heat generation or venting.

8.1.3 If electrolyte comes into contact with the skin or eyes, flush immediately with fresh water and seek medical advice.

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8.2 Short-circuiting

8.2.1 Short-circuit results in very high current which leads to heat generation.

8.2.2 An appropriate circuit should be employed to protect accidental short-circuiting.

8.3 Incineration

8.3.1 Incinerating and disposing of the cell in fire are strictly prohibited, because it may cause rupture and explosion.

8.4 Immersion

8.4.1 Soaking the cell in water is strictly prohibited, because it may cause corrosion and leakage and cell components to be damaged.

8.5 Mixing use

8.5.1 Mixing different types of cells or same types by different manufactures shall not be done. Doing so may lead to cell imbalance, cell rupture, or damage to the system due to different characteristics of the cells.

8.6 Battery exchange

8.6.1 Although the cell contains no environmentally hazardous component, such as lead or cadmium, the battery shall be disposed according to the local regulations.

8.6.2 It is recommended that the cell be disposed in a discharged state.

8.7 Caution

The Battery used in this device may present a risk of fire or chemical burn if mistreated.

Do not disassemble, expose to heat above 100 ^{o}C or incinerate it.

Replace battery with those of Samsung SDI only.

Use of another battery may cause a risk of fire or explosion.

Dispose of used battery promptly.

Keep battery away from children.

Do not disassemble and do not dispose of battery in fire.

8.8 Warning – Attached

Handling precaution and prohibitions of lithium Ion & lithium Ion polymer

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rechargeable cells and batteries

Inaccurate handling of lithium ion and lithium ion polymer rechargeable battery may cause leakage, heat, smoke, explosion, or fire. This could cause deterioration of performance or failure. Please be sure to follow instructions carefully.

1.1 Storage

Store the battery at low temperature (below 25 °C is recommended), low humidity, no dust and no corrosive gas atmosphere.

1.2 Safety precaution and prohibitions

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

[Danger!]

■ Electrical misusage

Use stipulated charger.

Use or charge the battery only in the stipulated application.

Don't charge the battery by an electric outlet directly.

Don't charge the battery reversely.

■ Environmental misusage

Don't leave the battery near fire or a heat source.

Don't throw the battery into a fire.

Don't store, charge, or use the battery under continuous conditions of over 60 °C ambient temperatures.

Don't immerse, throw, or wet the battery in water / seawater.

■ Others

Don't crush the battery.

Don’t store the battery in a pocket or a bag with metallic objects such as keys, necklaces, hairpins, coins, or screws unless mechanical or electrical countermeasures are in place to prevent shorting of the cells.

Don't short circuit (+) and (-) terminals with metallic object intentionally.

Don't pierce the battery with a sharp object such as a needle, screw drivers.

Don't heat partial area of the battery with heated objects such as soldering iron.

Don’t intentionally hit with heavy objects such as a hammer or weight.

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Don't step on the battery and throw or drop the battery on the hard floor to avoid mechanical shock.

Don't disassemble the battery or modify the battery design including electric circuit.

Don't solder on the battery directly.

Don't use seriously scared or deformed battery.

Don't put the battery into a microwave oven, dryer ,or high-pressure container.

Don't use or assemble the battery with other makers' batteries, different types and/or models of batteries such as dry batteries, nickel-metal hydride batteries, or nickel-cadmium batteries.

Don't use or assemble old and new batteries together.

[Warning!]

Stop charging the battery if charging isn't completed within the specified time.

Stop using the battery if the battery becomes abnormally hot, order, discoloration, deformation, or abnormal conditions is detected during use, charge, or storage.

Keep away from fire immediately when leakage or foul odors are detected. If liquid leaks onto your skin or cloths, wash well with fresh water immediately.

If liquid leaking from the battery gets into your eyes, don't rub your eyes and wash them with clean water and go to see a doctor immediately.

If the terminals of the battery become dirty, wipe with a dry cloth before using the battery.

The battery can be used within the following cell surface temperature ranges. Don't exceed these ranges.

Charge temperature ranges : $0^{o}C \sim 60^{o}C$

Discharge Temperature ranges : $-20^{o}C \sim 80^{o}C$

Store the battery at temperature below $60^{o}C$

Cover terminals with proper insulating tape before disposal.

[Caution!]

■ Electrical misusage

Battery must be charged with method agreed to by both parties (Black & Decker and Samsung.)

Charge current must be controlled by specified value in cell specification.

Cut-off voltage of charging must be equal to or less than 3.6V +/- 0.1 V to achieve best cycle life performance.

Do not discharge battery in an inappropriate way.

Cut-off voltage of full discharging and recharging must be over 2.0V to achieve best cycle life performance.

■ Others

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Keep the battery away from babies and children to avoid any accidents such as swallow.
If younger children use the battery, their guardians should explain the proper handling method and precaution before using.
Before using the battery, be sure to read the user's manual and precaution of it's handling.
Before using charger, be sure to read the user's manual of the charger.
Before installing and removing the battery from application, be sure to read user's manual of the application.
It is recommended to replace the battery when the use time becomes much shorter than usual.
It is recommended to cover the terminals with insulating tape before disposal.
If the battery is needed to be stored for an long period, battery should be removed from the application and stored in a place where humidity and temperature are low.
While the battery is charged, used and stored, keep it away from object materials with static electric charges.

Safety handling procedure for the transporter

■ Quarantine

Packages that are crushed, punctured or torn open to reveal contents should not be transported. Such packages should be isolated until the shipper has been consulted, provided instructions and, if appropriate, arranged to have the product inspected and repacked.

■ Spilled product

In the event that damage to packaging results in the release of cells or batteries, the spilled products should be promptly collected and segregated and the shipper should contact for instructions.

Design of positioning the battery pack in application and charger

To prevent the deterioration of the battery performance caused by heat, battery shall be positioned away from the area where heat is generated in the application and the charger.

Design of the battery pack

If you intend to adopt any device that will be electrically contacting the cell in the battery pack, please contact Samsung SDI to investigate any potential safety problems.
Multiple protection methods should be employed to prevent safety problems.

Please contact following offices when you need any help including safety concerns.

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Samsung SDI emergency contact information

■ **Samsung SDI Cheonan factory QA**

508, Sungsung-dong, Cheonan-si, Chungnam, Korea

Tel:(+82)070-7125-1837 Fax:(+82)41-560-3697

■ **Samsung SDI America office.**

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