

Handling Precautions and Prohibitions for VARTA Microbattery GmbH Lilon Batteries and General Supply Notices

Subject to change without notice

Preface

Lithium batteries provide a high energy density which is often combined with a high rate capability to the benefit of the customer. Due to this excellent performance properties, Lithium batteries contain a certain safety risk. If short-circuited, heat and sometimes sparks may be generated. Mistreatment outside of the recommended limits can cause gas generation, leakage and fire.

This guideline "Handling Precautions and Prohibitions for VARTA Microbattery GmbH Lilon Batteries and General Supply Notices" shall be applied to all VARTA Lilon batteries which are manufactured by VARTA Microbattery GmbH and their component cells (i.e. LIP and LIC series). It shall be brought to the attention of all persons who handle the batteries.

Note (1):

The customer is requested **to contact VARTA Microbattery GmbH in advance**, if and when the customer needs other applications or operating conditions than those described in this document, because additional tests and experiments may be necessary to verify performance and safety under such conditions. VARTA Microbattery GmbH shall not be responsible for safety, performance, functionality, compatibility or fitness for a particular purpose unless such features have been expressly communicated and described in the specification.

Note (2):

VARTA Microbattery GmbH will take **no responsibility** for any accident when the cell is used under **other conditions than those described in this guideline**.

Note (3):

VARTA Microbattery GmbH will inform, in a written form, the customer of improvement(s) regarding proper use and handling of the cell, if it is deemed necessary.

Note (4):

Do not modify cells or batteries without prior written approval by VARTA.

1. Charging

1.1 Charging current

Charging current should **not exceed maximum charge current** specified in the Data Sheet.

Charging with higher current than recommended may cause damage to cell performance and safety features, and can lead to **heat generation or leakage**.

1.2 Charging voltage

Charging at above 4.250 V, which is the absolute maximum voltage, is strictly prohibited. The charging has to be done according to the data sheet. The charger shall be designed to conform with this condition. Use specified charger only.

Charging with higher voltage than specified may cause damage to cell performance and safety features, and can lead to ***fire, heat generation or cell leakage***.

1.3 Charging temperature

The cell shall be charged within the range of specified temperatures in the Data Sheet. If the cell is charged at a temperature out of the specified range, ***leakage, heat generation, or other damages*** may occur.

Repeated charging and discharging at high and low temperature may cause degradation of cell performance even within the specified temperature range.

1.4 Prohibition of reverse charging

Reverse charging is prohibited. The cell shall be connected correctly. The polarity has to be confirmed **before connecting** any wires. If the cell is connected improperly, it cannot be charged.

Reverse charging may cause damage to the cell(s) and may lead to a loss of cell performance and cell safety, which can lead to ***heat generation or leakage***.

1.5 Prohibition of trickle charging or continuous charging

Trickle charging or continuous charging are prohibited. Trickle charging conditions or continuous charging can lead to overcharging, generation of internal pressure and degeneration of the cell.

The cell shall be charged with constant current until 4.2V +/-50mV, then with constant voltage and tapering current. At approx. 0.02C current the charging has to stop.

Charging should restart only if capacity has been discharged from the cell, or the cell voltage has fallen itself below a voltage level of 4.0V

2. Discharging

2.1 Discharge current

The cell shall be discharged at **less or equal than the maximum discharge current** specified in the Data Sheet.

High discharge current may reduce the discharging capacity significantly, or cause ***overheating***.

2.2 Discharge temperature

The cell shall be discharged within the temperature range that is specified in the Data Sheet.

2.3 Overdischarging

It should be noted that the cell(s) may be overdischarged if the cell(s) is/are **not used for a long time**. In order to prevent overdischarging, the cell(s) shall be charged periodically to maintain about 3 V to 3.8 V.

Overdischarging may cause loss of cell performance, or damage battery function.

The application device shall be equipped with a device to prevent further discharging exceeding a **cutoff voltage** specified in the Data Sheet.

PCM overdischarge detection threshold/voltage **must not** be used as **cut-off voltage** for battery.

Also the charger shall be equipped with a device to control the recharging procedures as follows:

In case of overdischarging, the cell(s)/battery pack shall start with a low current (0.01 – 0.07 CmA) for 15-30 minutes, i.e. precharging, before rapid charging starts. The charging according to the Data Sheet shall be started after the individual cell voltage has risen above about 3 V within 15-30 minutes, which can be determined and controlled by the use of an appropriate timer for precharging.

In case the individual cell voltage does not rise to about 3 V within the pre-charging time, the charger shall have functions to stop the further continuous charging and display that the cell(s)/pack is in an abnormal state.

3. Protection Circuit Module (PCM)

3.1 The cell(s)/battery pack shall be provided with a **PCM** which can protect cell(s)/battery pack properly, e.g. in case of failing Charge Control Circuit.

3.2 PCM shall have functions of (i) overcharging prevention, (ii) over-discharging prevention, and (iii) over current prevention, to maintain safety and prevent significant deterioration of cell performance. The overcurrent can occur by external short circuit.

3.3 Overdischarge Prohibition

Overdischarge prevention function shall work to minimize a dissipation current to avoid further drop in cell voltage below 2.5 V or less per cell in either cell of the battery pack.

It is recommended that the dissipation current of PCM shall be designed to be minimized to 0.5 microamperes or less after the over-discharge prevention function activates.

The protection function shall monitor each cell of the battery pack for controlling current at all times.

4. Application

For the batteries approved by UL (File MH13654) the intended use is at ordinary temperatures where anticipated high temperature excursions are not expected to exceed 70°C. Nevertheless under reasonably foreseeable misuse conditions at temperatures up to 85°C over 4 hours no safety risk occurs.

4.1 User replaceable appliances

VARTA Lilon batteries can be used as user replaceable batteries if the following conditions are fulfilled:

a) The end product must be designed to prevent reverse polarity installation of the battery, or if the battery is reversed, the short or open circuiting of any protective component, one component at a time, shall not result in forced discharge of the battery.

b) The end product shall contain a permanent marking adjacent to the battery stating the following or equivalent:

„Replace battery with (Battery Manufacturer's name or endproduct manufacturer's name), Part No. () only. Use of another battery may present a risk of fire or explosion. See owner's manual for safety instructions“ or „The battery used in the (End Product Name) must be replaced at (End product manufacturers) service center only.“

If it is not feasible to include the above marking on the device, the marking may be included in the operating (or safety) instructions providing the battery compartment is marked with the following: „See operating (or safety) instructions for type of battery to be used.“

c) The instruction manual supplied with the end product shall also contain the above warning notice along with instructions to the user as to where replacement batteries can be obtained. The instruction manual shall also contain the following additional warning notice and information as to how to replace and dispose of a used battery:

- Caution: The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not disassemble, heat above 100°C (212°F) or incinerate.
- Complete instructions as to how to replace the battery ending with the statement: „Dispose of used battery promptly. Keep away from children.“

4.2 Technician replaceable appliances

If the conditions 4.1 a) - c) are not fulfilled VARTA Lilon batteries can be used only in devices where servicing of the battery circuit and replacement of the lithium battery will be done by a trained technician.

5. Storage

The cells shall be stored within a **proper temperature range** as specified in the Data Sheet. The state of charge shall be 50% of the nominal capacity; open circuit voltage OCV about 3.8 V. When stored for a long time, care has to taken that the battery voltage does not drop below the cut-off voltage due to self discharge (see 2.2).

6. Others

6.1 Cell connection

Soldering of wires **directly to the cell** is strictly prohibited.

Tabs with presoldered wiring shall be welded to the cells. Direct soldering may cause damage of components, such as separator and insulator, by heat.

6.2 Ultrasonic Welding of Battery Pack Casing

Ultrasonic welding of plastic lid to the plastic casing can be applied. However, the welding shall be done **avoiding the application of ultrasonic wave power directly to the cells and the PCM electronic**. Otherwise it may cause serious damage to the cells and/or PCM electronics.

6.3 Prevention of short circuit within a Battery Pack

Enough **insulation layer(s)** between wiring and the cells shall be used to maintain multiple safety protection.

The battery pack shall be designed to prevent short circuits within the battery pack. This is because that short circuits within the pack may cause **generation of smoke or fire**.

6.4 Assembly

- (1) Important!! Always avoid any possible contact of softpack/safety module with sharp objects, corners, or points which could puncture or damage it.
- (2) Avoid applying mechanical stress (such as tension, pressure, or rub-bing) to cell itself and softpack/safety module during assembly. Do not remove, disassemble any component from the original VARTA supply configuration.
- (3) Assembly and finishing processes to be done only with ESD protection conditions.
- (4) Do not subject softpack/safety module to higher temperatures than specified in datasheet provided.
- (5) Do not subject softpack/safety module to ultrasonic weld process vibration or energy.
- (6) Avoid accidental shortcircuit of softpack/safety module during assembly and finishing processes.
- (7) Avoid accidental mechanical damage to softpack/safety module during assembly and finishing processes.
- (8) Packaging for softpack/safety module assembly to be only with ESD-safe (anti-static) material.

6.5 Prohibition of Disassembly

- (1) Never disassemble the cells.
- (2) **Disassembling cells** may cause an internal short circuit in the cell, which could further **cause gassing, fire, or other problems**.

Harmful Electrolytes:

An electrolyte which leaks out from the cells is harmful to the human body. If the electrolyte comes into contact with the skin, eyes or other parts of body, the electrolyte shall **be flushed immediately with fresh water. Seek medical advice from a physician**.

6.6 Prohibition of short circuit

Never short circuit the cells. It causes generation of very high currents resulting in heating of the cells, which may cause electrolyte **leakage, gassing or fire**. An appropriate circuitry with PCM shall be employed to prevent accidental short circuit of the battery pack.

6.7 Prohibition of dumping of cells into fire

Never incinerate nor dispose of cells into fire.

6.8 Prohibition of cells immersion into liquid such as water

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

6.9 Battery cells replacement

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

6.10 Prohibition of use of damaged cells

Cells have a chance to be damaged during shipping by shocks, or other causes.

If any abnormal features of the cells are found such as: damage to a plastic envelope of the cell, deformation of the cell container, smell of electrolyte, an electrolyte leakage, or other abnormalities, the cells **shall not be used any more**.

Cells with a smell of electrolyte or leakage shall be kept away from fire to avoid **ignition**.

6.11 General supply notices and responsibilities

The customer agrees to manufacture, assemble, sell, transport and/or dispose of the Finished Products so that the health and safety of people, including workers and general public, and environmental protection can always be cared by applying the standard to be determined in compliance with the requirements therefore of the laws and regulations in the countries where the Finished Products are sold.

The customer shall be solely responsible for health, safety and environmental matters arising from its manufacture, assembly, sales, use, transportation and/or disposal of the Finished Products, and shall defend, indemnify, and hold VARTA Microbattery GmbH, its subsidiaries and customers, and its and their respective representatives and employees harmless from and against all costs, liabilities, claims, lawsuit, including but not limited to attorney's fees, with respect to any pollution, threat to the environment, or death, disease or injury to any person or damage to any property resulting, directly or indirectly, from the manufacture, assembly, purchase, sales, use, operation, transportation or disposal of the Finished Products; except to the extent that the customer shall be exempted from such obligation if and so long as the cause of such damage is attributable directly and solely to VARTA Microbattery GmbH.

6.12 Battery pack structure

- (1) Protection circuit shall be isolated from the cell to diminish damage from any electrolyte leakage which may occur by mishap. The battery pack shall as much as possible be designed to not allow leaked electrolyte access to protection circuit.
- (2) Battery case material tolerance for electrolyte shall be considered when battery case material is selected.

6.13 Protection circuit module design

- (1) Electrolyte has corrosive characteristics. Protection circuit module may not work correctly if exposed to electrolyte.
- (2) These points should be considered in protection circuit module design.
Main wiring patterns shall be separated from each other as much as possible.

Conductive patterns and connection terminals that are possible to be short-circuited by electrolyte leakage should be separated from each other as much as possible. Another method is coating the whole surface of the module by conformal coating material.

- (3) PCM contains CMOS devices! Make sure ESD protected workspace is used when handling PCMs.

7. Marking

The customer shall prepare comprehensive instructions and appropriate markings for end users.

The battery packs shall be provided with **packing and handling, or safety instructions** regarding cell usage, storage, and replacement, and shall be marked with information in accordance with applicable regulations. **The prohibitions mentioned in this document, regulations in UL 1642 (and other specifications) shall be clearly explained to the users.**

The markings shall also be done in accordance with requirements based on guidelines for rechargeable Lithium Ion batteries for maintaining safety of the cells.

Example for marking according to the UL 1642 regulation:

- (1) Mark the manufacturer's name, business name or trademark, and specified model name.
- (2) Use the word "Warning" or "Caution" and indicate the statement "Potential for Fire or Burning. Do Not Disassemble, Crush, Heat, or Burn" or equivalent.

- (3) Final product shall be marked with following statement or equivalent:
"Replacement may only be made with Battery Pack specified by the final product manufacturer, with correct Part Number. Fire or burning may occur if the customer uses Battery Pack other than specified by the final product manufacturer. The customer shall refer to the handling instruction issued by the final product manufacturer."

If it is not possible to mark the warnings mentioned above on the final products, the final product manufacturer shall mark and print the warnings in the handling or maintenance instructions or manuals of the products.

Specially the marking shall contain the advices in 4.1 and 4.2 according to the type of usage.

Customer:

Received and approved

Date Signature