

Dynamis LI

Cells and Batteries

Technical Manual LTC Batteries

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Handling, Safety and Assembly of LTC batteries

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1 General Safety

In general, the use of a Lithium Thionyl Chloride Battery (LTC) shall be performed within the specified parameters of the manufacturer, given in each particular specification ("intended use").

In order to work properly throughout the expected life cycle DYNAMIS LTC cells are manufactured using design and techniques avoiding side reactions or physical effects reducing the performance of the cell.

Some of these features include a good thermal conductivity avoiding accumulation of heat (dissipation), as well as optimized electrode surfaces for both bobbin and spiral designs.

For spiral versions, PTCs can be used to limit the current.

2 Information for intended use

According to the International Standard IEC 60086-4, the term "intended use" is defined by a number of tests, which are to be passed by the primary cell or battery. The tests cover the typical conditions with respect to electrical and mechanical properties:

Discharge Test

The actual use of a primary battery is limited to discharge. The duration of such a test is given by the maximum current specified for each cell and/or the limiting resistor load

$$t_{disch} = Q_{nom} \times \frac{1}{I_{max}} = Q_{nom} \times \frac{U_{nom}}{R_{lim}}$$

where t_{disch} is the duration of the discharge test, Q_{nom} is the nominal capacity of the cell, I_{max} is the maximum discharge current specified (given by the nominal voltage U_{nom} divided by the limiting resistor load R_{lim}).

The test shall be carried out at standard test conditions such as 20 ± 2 °C ambient temperature (a second test @ 60 ± 2 °C), until complete discharge according to the spec. The "pass" conditions are: No leakage, no venting, no explosion and no fire.

Vibration Test

During the use vibrations may occur - e.g. during transport or in vibrating equipments. A standardized method to check stability of the design is a harmonic motion (sinusoidal) with the following limits:

- 0.8 mm amplitude = 1.6 mm total elongation;
- frequency spectrum from 10 to 55 Hz, accelerating @ 1 Hz/min;
- total test time between 90 and 100 minutes;
- three mutually independent directions (perpendicular to each other),
in case of only 2 axis of symmetry 2 directions perpendicular to each other are used.

For this test both undischarged and completely discharged batteries are used. The "pass" conditions are: No weight loss, no distortion, no leakage, no venting, no explosion and no fire.

Mechanical Shock Test

During the use or transport crash conditions may occur which shall not lead to any danger from the battery. Therefore, all 3 perpendicular axis are tested, each with 3 shocks of equal force. The shocks shall reach an acceleration of min 75 g_n as average during the first 3 seconds and peak between 125 g_n and 175 g_n.

For this test both undischarged and completely discharged batteries are used, in particular those having passed the vibration test before. The "pass" conditions are: No weight loss, no distortion, no leakage, no venting, no explosion and no fire.

Altitude Test

Low air pressure occurs during air transport, applies to stored batteries only. The storage conditions are 11.6 kPa or less air pressure for at least 6 h duration and standard temperature of 20±2 °C.

The "pass" conditions are: No leakage, no venting, no explosion and no fire.

Thermal Shock Test

This test covers the check of sealing integrity during rapid temperature changes as the roughest stress for the materials used.

The temperature profile is defined as:

75±2 °C for 48h > -20±2 °C for 6h > room temp. for 24h

The transfers ">" are performed with max. 5 minutes. The test batteries shall be taken from passed altitude test, the "pass" conditions are: The "pass" conditions are: No leakage, no venting, no explosion and no fire.

3 Information according reasonably foreseeable misuse

These tests are performed to check the safety limits of LTC batteries und conditions which must be avoided during the (specified) use of the batteries. These tests are roughly described only because advanced safety measures are mandatory for performing them. The tests are not intended to be performed by our customers, the descriptions are only for demonstration purposes.

Test	Basic Condition	Environmental Condition	Subject	Pass Condition
External Short Circuit	Discharge with less than 0.1Ω	$55 \pm 2 \text{ }^\circ\text{C}$	Batteries from Vibration/Shock and Altitude/Thermal Shock	No explosion No fire
Charge Test 1 (Reverse Assembly)	Charge by 3 undischarged batteries with R_{lim}	$20 \pm 2 \text{ }^\circ\text{C}$	Battery	No explosion No fire
Charge Test 2 (External Charge)	Charge by external power source while connected in series with R; $3x I_{R,max}$	$20 \pm 2 \text{ }^\circ\text{C}$	Battery	No explosion No fire
Overdischarge Test (One SOC lower than others in series conn.)	Series connection with R_{lim} and 3 undisch. batteries up to 24h	$20 + 2 \text{ }^\circ\text{C}$	Pre-discharged battery @ 50 % SOC	No explosion No fire
Free Fall Test	From height of 1m onto concrete floor, 6x each face	Room temp	Battery undischarged and 75% SOC	No explosion No fire
Crush Test (e.g. Waste Disposal Crushing)	Pressure 17 MPa / 13 kN force, selected directions	Room temp	Battery, one crush per sample	No explosion No fire
Thermal Abuse Test	Heat @ $5 \text{ }^\circ\text{C}/\text{min}$ up to $130 \text{ }^\circ\text{C}$, remain 10 min @ $130 \text{ }^\circ\text{C}$	See left	Battery	No explosion No fire

4 Information for safety

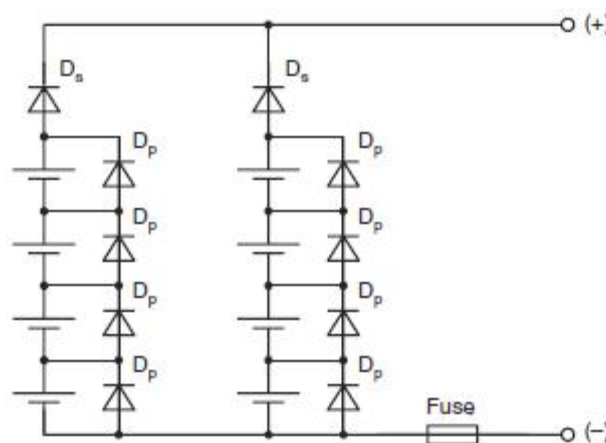
Based on the IEC 60086-4, the following safety information are given for both industrial and consumer use:

Charge protection

For assemblies such as memory back-up circuits etc. current limiting resistors and blocking diode shall be used, or other protective devices serving the same purpose. Charging from the main power source must be avoided this way.

Parallel connection

In cases parallel connection of primary cells can not be avoided, it is strongly recommended to use protective devices in order to protect each cells from misuse typical situations. The following figure gives a general overview for combinations:



Typical multi-cell battery pack with protective devices

Safety precautions during handling

- > Do not insert batteries in reverse polarity. Check thoroughly the "+" and "-" markings on battery and device
- > Do not short-circuit batteries, use original packaging as long as possible
- > Do not charge primary/LTC batteries
- > Do not force discharge primary/LTC batteries
- > Do not mix batteries (replace all at once within any assembly)
- > Do not leave discharged batteries in equipment
- > Do not overheat batteries
- > Do not weld or solder directly on batteries
- > Do not open batteries
- > Do not deform batteries
- > Do not expose batteries to fire or direct sunlight
- > Do not expose batteries to water or any other conductive liquid
- > Keep batteries out of the reach of children

5 Marking

DYNAMIS products are marked for identification and quality purposes as legally required.

The information given is the range of product (LTC is called "LITHIUM-LINE" or "LI-LINE"), the specific cell type, the nominal voltage and the size of the cell according to international standards, the polarity of the cell terminals and basic safety instructions. In addition, the labels contain the production code and the disposal symbol as legally required:



LTC cell marking example

The production code allows DYNAMIS to trace back any batch of cells to the manufacturing details.

6 Battery Packs

In addition to Chapter 4 more details are given with regard to the assembly of battery packs.

In general it is recommended that only qualified personnel should assemble battery packs, also the design of battery packs should be left to DYNAMIS.

Such details in terms of design and assembly are:

- Prevention of short circuits, either the whole pack or single cells;

Positioning of cells in a pack must be effective to protect from shorts, either by fixation or use of appropriate insulating materials. In particular this applies to multi-cell packs, for which shrink sleeves do not serve the fixation purpose sufficiently, for example.

- Prevention of overheating

Overheating may occur not only in cases of damaged cells but also due to the selection of wrong connectors. With respect to the max. short current specified the connectors must be conductive enough not to produce enough heat so that materials used for the assembly may melt. For larger packs and/or special arrangements the heat dissipation may not be sufficient. In such cases thermal fuses should be integrated.

- Prevention of charging

The use of blocking diodes in each string of cells connected in parallel is strongly recommended.

- Prevention of overdischarge

In cases single cells within a pack are more deeply discharged than others while the whole pack still operates normally, it may occur that these cells are in danger to be overdischarged. In order to prevent that by-pass diodes inserted in parallel with each cell are to be used.

- DYNAMIS advises her customers also not to replace single cells in a battery pack with cells of differing type, size and age compared to the others in that pack. Anyway, such differences must be avoided during assembly as well. Customers shall also refrain from using cells from different manufacturers within one battery pack. The technical differences used during manufacturing the cells create different behavior during discharges and may lead to situations described above.

The following list of features is given for assembly of battery packs:

- 1) Cells must be insulated from each other
- 2) All electrical connections and contacts must be fixed and insulated to prevent short circuits
- 3) Soldering or spot welding of tags are the only procedures for fixation of interconnections
- 4) Both soldering and spot welding must be performed under safe parameters in order not to damage the cells; direct spot-welding or soldering on cells must be avoided in any case
- 5) Larger cells, e.g. C-, D- or DD-cells shall be assembled and used in upright orientation

- 6) Pack-to-outside-connectors should provide keyed connection if possible, in order to prevent wrong polarity connection
- 7) Insulating or encapsulating materials should be used in sufficient quantity but on a level of minimum requirement to enable heat dissipation as effective as possible
- 8) Cell safety features such as safety vents must not be blocked in any way during assembly procedures
- 9) The materials used for assembly must be selected with regard to the environmental conditions of its intended use. This applies especially for battery packs which may be stressed by outside heat or mechanically. In such cases the design of the pack must be adapted with additional enforcements or insulation.
- 10) The design of the battery pack shall be verified for compliance with all relevant shipping and handling requirements, e.g. according to UN 38.3
- 11) For assembly procedures, materials and cells must be protected from damaging or potentially short-circuiting jewelry or similar items. Appropriate work protection is also advised for all steps.

7 Depassivation

Passivation is a naturally occurring process in Lithium metal batteries which actually enables its operational status over a comparably long period of time. The process may be described as an oxidation of Lithium metal surface. During discharge, the same process takes place but in a dissolving manner, meaning passivation leaves a thin layer of oxidized material on the surface. For most operations this property has no effect. But since this layer is removed during discharge a voltage drop occurs for a certain while. It disappears after the layer is dissolved and the normal discharge is running.

For voltage-sensitive operations the passivation layer may be removed before inserting the cell into the equipment. This removal procedure is called depassivation.

There are some different methods for depassivation:

For batteries not older than 6 to 12 months, temperature cycle and temporary short-circuit may be sufficient. This can be the treatment during wave soldering.

Manual handling of a small number of batteries may be short-circuiting for a few seconds.

A larger number of batteries may be treated with automated discharge procedures using approx. 2 mA/cm². This value is to be calculated for each cell type due to the different surface areas. The customer may ask DYNAMIS for advice. In fact, due to the huge number of different possible environmental condition combinations, a general precise procedure can not be described.

This is to be tried and adapted to the actual situation.

For batteries in installations, small basic currents may prevent the batteries from extensive passivation, so depassivation may not be needed.

8 Precautions for storage and handling

Refer also to MSDS_LI-Primary-04-2015

Handling

The following list of basic precautions shall be applied:

- Do not short-circuit LI batteries
- Do not recharge LI batteries
- Do not overdischarge LI batteries
- Do not incinerate LI batteries
- Do not expose LI batteries to higher temperatures than

specified

- Do not damage, crush or puncture LI batteries
- Do not open LI cells, do not disassemble LI battery packs
- Prevent LI cells from all conductive liquids, e.g. water
- Do not connect with reverse polarity
- Do not weld or solder the battery case

Storage

For storage of LI batteries, cool and dry rooms are recommended. A temperature below 35 °C is preferred. Do not store at higher temperatures than 70 °C.

Original packaging is the most recommended way of storage. Do not use anti-static bags or foam. Do not use metallic or other conductive materials for covering batteries.

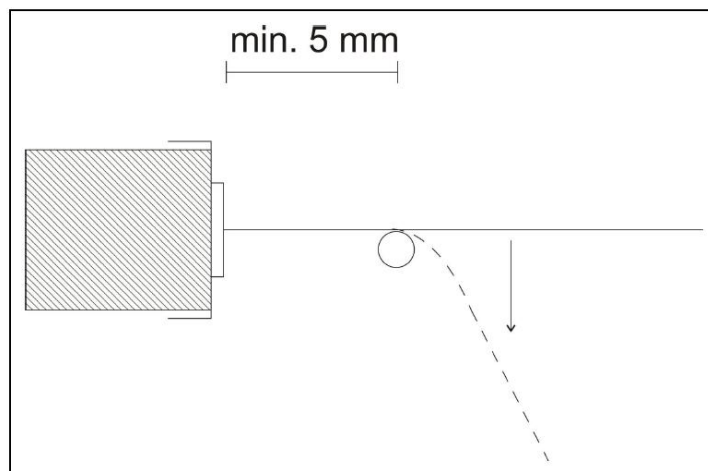
In case of fire, use class D extinguishers. Do not use water, sand or carbon dioxide for this purpose.

9 Mounting

For those batteries to be mounted on PCBs or similar, axial pin versions (/P) are available of LI cells. For sizes C and larger axial pin fixation is not recommended due to the size and weight of the cells.

A variety of pins suitable is available instead.

For the processing of axial pins DYNAMIS recommends a minimum distance for bending in order to ensure that the pins and their attachment to the cells remain undamaged and provide sufficient mechanical strength:



Also, a minimum radius of 0.8 mm is recommended to avoid breaking.

For all kinds of soldering pin-equipped LI cells the previous safety recommendations apply accordingly.