




Li-Ion Batteries

USER MANUAL


**INSTRUCTIONS AND PRECAUTIONS
OF USE**

Applicable to Lithium-Ion battery packs made of:

**MP144350,
MP174865,
MP176065,
MP174565 IntegrationTM,
MP176065 IntegrationTM,
VL34480,
VL34570
VL37570**

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IMPORTANT NOTICE

Please read the present User Manual “Instructions and precautions of Use” thoroughly prior to any use, installation or maintenance of the battery.

All instructions contained herein must be carefully complied with.

Be aware that in the event any of the instructions contained in the present User Manual are not applied, any warranty given by Saft on the battery is void and Saft disclaims any liability for any and all direct, indirect, incidental or consequential damages or losses resulting thereof.



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SAFETY RECOMMENDATIONS

All the recommendations contained in this document must be strictly applied in order to ensure a safe and optimal use of the battery.

- (1) Misuse of the battery may lead it to overheat or ignite and cause serious injury. Make sure to follow the safety rules listed below:
 - Never short circuit the battery terminals
 - Do not open the battery
 - Do not reverse the polarity
 - Do not overcharge or overdischarge
 - Always comply with the voltage range given on the battery label
 - Do not disassemble the battery
 - Do not use the battery without its electronic management system
 - Do not subject the battery to excessive mechanical stresses
 - Do not expose the battery to water or condensation

- (2) Do not place the battery on or near fires, or other high temperature locations (> 70°C). Doing so may cause the battery to overheat or ignite. Using the battery in this manner may also result in a loss of performance and a shortened life expectancy.

- (3) Immediately disconnect the battery if, during operation, battery emits an unusual smell, feels hot, changes shape, or appears abnormal in any other way. Contact **Saft** if any of these problems are observed.

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1. SCOPE

The aim of this document is to provide instructions for the **use of Li-Ion battery packs made of MP144350, MP174865, MP176065, MP174565 Integration™, MP176065 Integration™, VL34480, VL34570 and VL37570, built by the Saft Lithium Battery Division.** It is fully applicable, except otherwise specified in any other Saft documentation.

2. DOCUMENTS

2.1 APPLICABLE DOCUMENTS

Relevant Product Specifications for single-cell batteries

MSDS for standard Li-ion cells and battery packs

2.2 REFERENCE DOCUMENTS

UL (Underwriters Laboratories Inc.):

Standard for Safety for Lithium Batteries:

UL 1642 - Fourth Edition dated September 19, 2005

UN (United Nations):

Model Regulations on the Transport of Dangerous Goods:

Ref. ST/SG/AC.10/1

Recommendations on the transport of dangerous goods:

Part III, sub-section 38.3, "Manual of Tests and Criteria"

Ref: ST/SG/AC.10/11

IEC (International Electrotechnical Commission):

Secondary Lithium cells and batteries for portable application:


IEC 61960 – First Edition – 2003

Electrical apparatus for explosive gas atmospheres:

Part 0: General requirements - IEC 60079-0

Part 11: Intrinsic safety "i" - IEC 60079-11

IEC62133 related to cell safety and performance

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3. GENERAL DEFINITIONS

- Battery Nominal Capacity (C in Ah) is the average capacity that can be drawn from a fresh unused battery, when discharged at 20°C at the reference test current of 0.2 x I_c, after a full charging under the conditions specified in § 4.2.1 hereafter.

The nominal capacity is written on the battery label.


I_c is the corresponding current of the nominal capacity (example: I_c = 6.8A for a battery rated at 6.8Ah)

- Battery Nominal Voltage (in V) is written on the battery label.
- Battery Nominal Energy (in Wh) is determined by calculation and is the result of [Nominal voltage x Nominal capacity].

The nominal energy is written on the battery label.

ACRONYMS

EOCV:	End Of Charge Voltage
IATA:	International Air Transport Association
OCV:	Open Circuit Voltage
MSDS:	Material Safety Data Sheet
SOC:	State Of Charge

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4. GENERAL OPERATING INSTRUCTIONS

4.1 UNPACKING HANDLING INSTALLATION CONNECTION AND START UP

Before the first utilization, it is recommended to fully charge the battery (even if its voltage is low or even 0V, since the battery protection circuit has probably gone into 'sleep mode').

4.2 BATTERY CHARGE

4.2.1 Charging conditions

The optimum range for charge is 10°C to 50°C.

The charge must be done as follows:

- First step, at constant current according to the battery label, until the voltage reaches the desired voltage according to the battery label,

Between 50 and 60°C, the optimum charge rate is C/5

Between 0 and 10°C, the optimum charge rate is C/5

Between -20°C and 0°C, the optimum charge rate is C/20.

- Second step, at constant voltage, until the current falls down to C/100 (or maximum 10 hours).

The maximum charging temperature range is between -20°C to +60°C.

Using the battery outside the above mentioned ranges of temperature, current or voltage, may seriously and definitively affect the performances.

4.2.2 Case of permanent charge (floating)


Permanent charging is defined as a continuously charge under the "Second step" condition as defined in § 4.2.1 above.

In the case of permanent charging is applied to the battery, the following optimum EOC voltage versus charging temperature, is to be used in order maximizing life time duration :

- 3.9V maximum at 60°C
- 4.0V maximum at 40°C
- 4.1V maximum at 20°C

Continuous charge at 4.2V must be forbidden in any case.

Using the battery outside the above mentioned ranges of temperature, current or voltage, may seriously and definitively affect the performances.

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4.3 BATTERY DISCHARGE

The discharge must be done in accordance with the discharged conditions (Current, temperature) defined for the concerned battery type, and reported on the battery label.

Discharge the battery in higher load or higher temperature than specified may damaged irreversibly the battery (presence of safety devices, as current acting fuses and/or thermal acting fuses) or may degrade its performances.



4.4 BATTERY STORAGE

4.4.1 Initial state of charge calculation

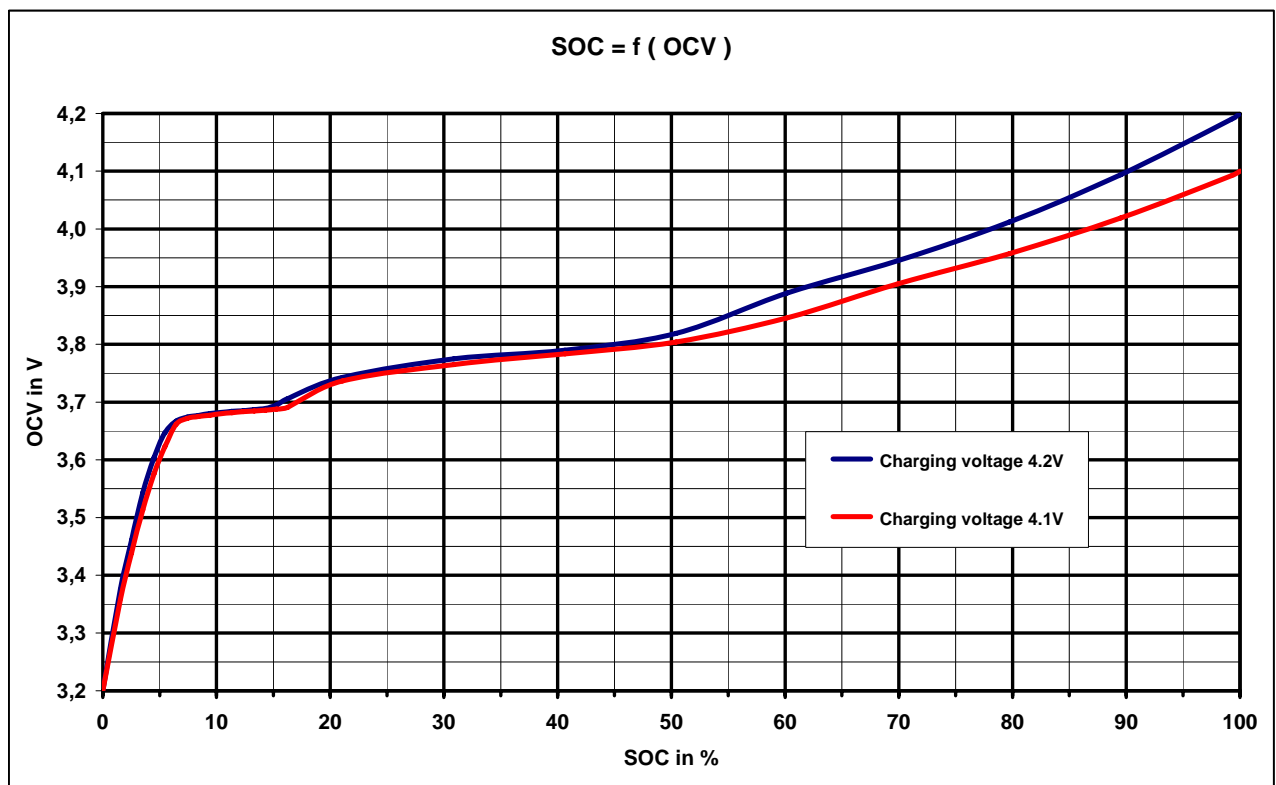
The right level of charge must be defined by taking into account:

- The storage period
- The maximum consumption of electronic devices
- The self-discharge of the cells (the higher the state of charge, the higher the rate of the self-discharge).

Depending on the storage duration, the Initial state of charge of batteries before storage must be between 15% and 50% of initial capacity, which correspond to an OCV of:

- For 15%: 3.69V / cell
- For 50%: 3.82V / cell


Typical cell self-discharge during the first year at 20°C is less than 5%, for a state of charge between 15 and 50%. For others condition, please consult Saft.



4.4.2 Minimum state of charge under storage

A minimum state of charge of 5% (corresponding to an OCV of 3.62V / cell) is required at the end of the storage period to avoid any further 'Overdischarge state'.

Note: Overdischarge ("cell under 2V") may seriously and definitively affect the performances.

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4.4.3 Warnings

If after storage, the battery voltage is low or even at 0V, the battery protection circuit has probably gone into 'sleep mode'.

In such a case, the battery must be charged up as soon as possible in order to avoid the voltage of one or more cells to fall below a level where the cell may be damaged.

Therefore, try to wake up the battery with an appropriate charger.

If the battery doesn't take the charge, the voltage of one or more cells has dropped below a level where it is forbidden to recharge and where the electronics protects the battery.

4.4.4 Temperature

Recommended conditions for storage are: from 0 to +30°C, in a dry and clean surface, and preferably in its original packaging.

Short excursions from -40°C up to +50°C are possible.

Excursion between +50 and 60°C may result in higher self-discharge, lower performances and swelling of inner cells.

4.4.5 Conditions for storage

During all significant storage periods, a battery must preferably be disconnected from any external load, unless it is proved that the device is in **switch off mode** and **doesn't draw any leakage current** from the battery.

For **short storage duration** (typically less than 3 months): follow § 4.4.2.


For **long storage duration** (typically over 3 months and less than 1 year) the following procedure should be applied:

- Check the battery voltage regularly, at least every 6 months.
- If necessary: recharge the battery (with 24 min at C/2 rate, 4.2V/cell). A recharge up to 50% is acceptable – see § 4.4.1 - **initial state of charge calculation**.
- For batteries without SMBus and with 1S circuit protection type, the minimum battery voltage before storage must be 3.69V / cell.
- For batteries with SMBus, gas gauge or other electronic type, please refer to SAFT vendor.

4.4.6 Conditions for de-storage

After long storage duration, and before operational use, it is recommended to:

- Fully discharge the battery to 0 V with a low current (about 0.5 to 1A) for rebalancing all cells to the lower state (for batteries built with 1S protection circuit).
- Preferably run a complete charge / discharge cycle for capacity recovery following the storage. If not done, it could need 2 to 3 cycles on use to recover the maximum capacity.
- Recharge at the full capacity before use

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5. SAFETY

The battery will operate safely if used in accordance with the recommendations contained in this manual.

5.1 PRECAUTION DURING USAGE

- During handling:
 - Do not open or dismantle
 - Do not expose to heat or flames
 - Keep the battery in the original packaging
 - Do not short circuit
 - Avoid metallic parts close to the terminal
 - Do not immerse
 - Do not drop or violently hit
 - Never weld directly on the unit casing

- During charge and discharge:
 - Exclusively use the specific charger designed for the battery or a universal Li-Ion charger
 - Do not reverse the polarities during charge
 - Use only for the purpose it has been designed for

5.2 INFORMATION IN CASE OF ACCIDENT

In case of battery exposition to abusive situation (fire, crush ...), the internal cells pressure could increase and could lead to the opening of the safety vent to allow venting. In this case, hot and harmful gases would be emitted. In this situation, refer to the recommendations actions included in the MSDS of the product range.

6. TRANSPORTATION

According to the transport regulation, Li-Ion batteries can be transported with specific packaging and with limited weight. See here under a summary of the existing rules at the issuing date of this document.

Product classification	Maximum net weight	
	Air passenger shipment	Air cargo
Not restricted for transportation Watt-hours rating is not more than 100Wh.	10 Kg	10 Kg
Restricted for transportation (Class 9). Watt-hours rating is more than 100Wh	5 Kg	35Kg

The UN number for shipping Li-Ion batteries is UN3480 (when transported alone). Please refer to the IATA packing instruction 965 for shipping UN3480 batteries.

The UN number for Li-Ion batteries contained in, or packed with, equipment is UN 3481. Please refer to the IATA packing instruction 966 for shipping UN3480 batteries packed with equipment. Please refer to the IATA packing instruction 967 for shipping UN3480 batteries contained in equipment.

In all cases, please refer to local rules for transportation.

7. DISPOSAL


Our batteries are designed and manufactured with high quality materials and components, which can be recycled and reused.

When this crossed-out wheeled bin symbol is attached to a product, it means the product is covered by the European Directive 2002/96/EC.

Please inform yourself about the local separate collection system for electrical and electronic products.

Please act according to your local rules and do not dispose your old products with your normal household waste. The correct disposal of your old product will help prevent potential negative consequences for the environment and human health.




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8. TROUBLESHOOTING

If your battery is experiencing a noticeable degradation, first check the possible causes and solution below.

CAUTION: IN ANY CASE, DO NOT OPEN THE BATTERY OR CUT THE SLEEVE.

Situation	Possible cause	Possible Solution
Battery OCV is 0V	Battery has seen or is in short circuit situation	Remove the short and charge the battery
	Thermal fuse is burned	No warranty can be applied if pack has been used out of its normal usage or conditions.
	Battery has been fully discharged and circuit protection stops the discharge of the cells.	Charge the battery in normal conditions
	Safety circuit breaker has operated because of charge or storage at high temperature.	No warranty can be applied if pack has been used out of its normal usage or conditions.
Battery is losing voltage by step of around 2.5V - 3V or discharged capacity is lower.	Some cells are unbalanced after a storage period or if battery temperature is not homogenous	Fully discharge the battery with a small current to balance all cells till 0V. Then recharge the pack. This cycle can be done several time to recover a standard capacity
The battery hasn't reached the full charge voltage but can't be charge anymore	Some cells are unbalanced after a storage period or if battery temperature is not homogenous	Fully discharge the battery with a small current to balance all cells till 0V. Then recharge the pack. This cycle can be done several time to recover a standard capacity
After several month or years of use, the capacity is much lower than at beginning	Several parameters impacts the battery life: <ul style="list-style-type: none"> - Storage in high temperature and or at full state. - cycle numbers more than 500 in standard SAFT conditions - calendar age - charge in low temperature with high rate 	The battery has reached its end of life See § Disposal
Battery stops the discharge prematurely.	Application may have high current pulses which lead protection circuit to open the discharge	Compare current pulse level and battery label. Refer to your vendor

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Situation	Possible cause	Possible Solution
SMBus displays wrong or inadequate information	SMBus circuit hasn't been calibrated before first use of the battery	Try to do a full cycle charge-discharge to initialise the SMBus.
	A short circuit occurred and erased the dynamic data like SOC	Try to do a full cycle charge-discharge to initialise the SMBus.
Cycle number given by SMBus doesn't change as expected	Not enough range between capacity charged and capacity discharged	Customer has to charge and discharge with an enough variation to increment the cycle number..

If the problem remains, please contact one of the Saft product sales contacts (The Worldwide product sales network is available on Saft website www.saftbatteries.com)

9. PACKMAKER WARNING

Design rules for making battery assembly
SAFT recommends

* to use the protection circuit called "1S"

* to fix mechanically cells to printed circuit board by other features then by the tab (sleeve, glue, resine)

On MP cell, maximum traction effort acceptable on each tab is 3 Kg

* to do not immerse by resin of glue, parts of the cell like current breaker or safety vent. This will compromise their efficiency in case of needs.

For using other type of protection circuit, please consult SAFT.

10. CHANGES

Saft reserves the right to revise this User Manual and make changes in the content thereof at any time without notice.