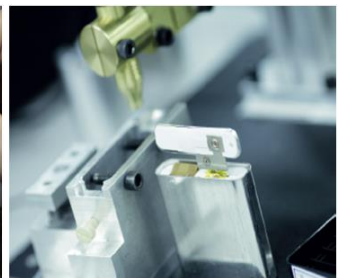
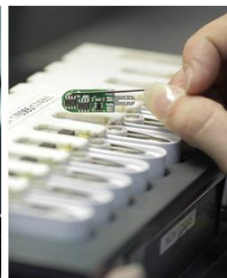
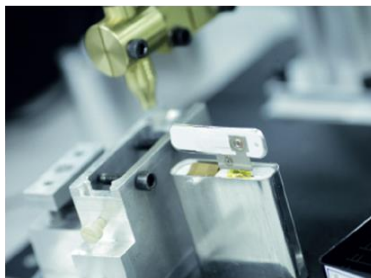



# Li-ion cells and batteries

User manual, instructions and precautions for use



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**Applicable to Lithium-ion cells and battery packs made from:**

MP 144350 xlr  
MP 174865 xlr  
MP 176065 xlr  
VL 34570 xlr

MP 174565 xtd  
MP 176065 xtd

MP 176065 xc

The information contained in this presentation is intended to be general guidance and interpretations of the regulations as of the date completed. It does not constitute legal advice and cannot substitute for obtaining legal advice related to specifics of individual situations and products. While every effort has been taken to accurately represent the information within the various regulations contained herein, Saft does not guarantee its accuracy or completeness. Information may contain errors, omissions, or outdated information. Saft makes no representations or warranties as to the completeness, accuracy, or currency of the information provided in this document. All data in relation to the life time and or performance of the cells and batteries provided herein are partly based on extrapolation and/or on our cumulated experience in similar cases, and is given for reference only. They do not constitute a binding commitment or any express or implied warranty of future performance from Saft. All rights to images and trademarks remain with their respective owners.

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Release	Date	PAGES or §	Evolution / Change	Author
1	2010.01.12	ALL	Initial Issue	
2	2010.07.07	6, 15	IEC62133 related to cell safety and performance Packmaker warning	
3	2013.04.11	14,16	Updated to reflect the changes in the UN Transport of Dangerous Goods – Manual of Tests and Criteria Fifth revised edition, Amendment 1	PITT. WM
(4) 5	2016.01.20		New products have been added Changes in advice and performance Updated to reflect the changes in: <ul style="list-style-type: none"> <li>• UN Transport of Dangerous Goods – Model Regulations,</li> <li>• UN Manual of Tests and Criteria</li> <li>• ICAO Technical Instructions</li> <li>• IATA DGR</li> <li>• IEC 62133-2: 2016</li> </ul>	PITT. WM GODON. A
6	2018.01.31	ALL	Removal of superseded products, changes in advice and performance, Li-ion product changes reflected from December 31, 2017	PITT. WM GODON. A

### 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 over-discharge
- 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, except for MP xtd > 85°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 and care of Li-Ion cells and batteries made from MP 144350 xlr, MP 174865 xlr, MP 176065 xlr, MP 174565 xtd, MP 176065 xtd, MP 176065 xc and VL 34570 xlr, manufactured and assembled by the Saft Civil Electronics Division.** This manual is fully applicable, except as otherwise specified in other relevant Saft documentation.

Saft cell product name	Saft internal cell designation	IEC 61960-3 cell designation
MP 144350 xlr	MP 144350 xlr	INP15/43/51
MP 174865 xlr	MP 174865 xlr	INP19/48/65
MP 176065 xlr	MP 176065 xlr	INP20/61/66
VL 34570 xlr	VL 34570 xlr	INR35/60
MP 174565 xtd	INT 174565 xtd	INP19/46/69
MP 176065 xtd	INT 176065 xtd	INP19/61/69
MP 176065 xc	INT 176065 xc	INP19/61/69

## 2. DOCUMENTS

### 2.1 APPLICABLE DOCUMENTS

Relevant Product Specifications for single-cell batteries

BIS (Battery Information Sheet) for standard Li-ion cells and batteries

SDS (Safety Data Sheet) for standard Li-ion cells and batteries (USA only)

### 2.2 REFERENCE DOCUMENTS

#### **UL (Underwriters Laboratories Inc.):**

Standard for Lithium Batteries:

UL 1642 - Fifth Edition, March 2012

#### **UN (United Nations):**

UN Recommendations on the Transport of Dangerous Goods; Model Regulations.

UN Recommendations on the Transport of Dangerous Goods; Manual of Tests and Criteria; Part III, sub-section 38.3.


#### **IEC (International Electrotechnical Commission):**

**IEC 61960-3.** Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for portable applications - Part: 3 - Prismatic and cylindrical lithium secondary cells and batteries.

**IEC 60079-0.** Electrical apparatus for explosive gas atmospheres, General requirements

**IEC 60079-11.** Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"

**IEC 62133-2.** Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications - Part 2: Lithium systems.

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### **3. GENERAL DEFINITIONS**

- Battery Nominal Capacity (Rated 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<sub>c</sub>, after a full charging under the conditions specified in § 4.2.1 hereafter.

The nominal capacity is written on the battery label.

I<sub>c</sub> is the corresponding current of the nominal capacity (example: I<sub>c</sub> = 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.

#### **3.1 ACRONYMS**

EOCV:	End Of Charge Voltage
IATA:	International Air Transport Association
OCV:	Open Circuit Voltage
SDS:	Safety Data Sheet (USA only)
BIS:	Battery Information Sheet
SOC:	State Of Charge
ICAO:	International Civil Aviation Organisation
Ah:	Ampere hour
C:	Nominal capacity of a cell or battery when as tested under IEC 61960.
V:	Volts used to express the nominal voltage of a cell or battery
Wh:	Watt hour; used to express the nominal energy of a cell or battery

## 4. GENERAL OPERATING INSTRUCTIONS

### 4.1 UNPACKING HANDLING INSTALLATION CONNECTION AND START UP

Before using the battery for the first time, it is recommended to fully charge the battery (even if its voltage is low or even 0.0V, since the battery protection circuit may have gone into 'sleep mode').

### 4.2 BATTERY CHARGE

#### 4.2.1 *Charging conditions*

Battery / cell type	Maximum charge <sup>[1]</sup>	Charging temp (°C) <sup>[2]</sup>	
	C rate <sup>[3]</sup>	Min	Max
MP 144350 xlr	~1C	0°	60°
	C/8	-20°	0°
	C/20	-30°	-20°
MP 174865 xlr	~1C	0°	60°
	C/8	-20°	0°
	C/20	-30°	-20°
MP 176065 xlr	~1C	0°	60°
	C/8	-20°	0°
	C/20	-30°	-20°
VL 34570 xlr	~1C	30°	60°
	C/2	0°	30°
	C/8	-10°	0°C
	C/10	-20°	-10°
	C/20	-30°	-20°
MP 176065 xc	~1C	0°	60°
	C/5	-30°	0°
MP 174565 xtd	C/5	60°	85°
	~1C	0°	60°
	C/5	-20°	0°
	C/20	-30°	-20°
MP 176065 xtd	C/5	60°	85°
	~1C	0°	60°
	C/5	-20°	0°
	C/20	-30°	-20°

[1] For charging parameters outside the recommendations in this table please consult with your local Saft office

[2] For temperatures outside of the values in this table please consult with your local Saft office

[3] The definition of the "C" rate is expressed as the battery nominal capacity expressed in Ampere hours.

The optimum operational temperature range for charging is according to the above table. Only charge with a (Constant Current / Constant Voltage) CC/CV profile as follows:



**Step 1.** At constant current, according to the battery label until the voltage reaches the desired voltage according to the information on the battery label and additionally, following the above table with respect to the environmental temperature and maximum charge rate (C) according to the different cell / battery type.

**Step 2.** At constant voltage, until the current falls to C/100 (or a maximum of 10 hours). Verify that the maximum / minimum charging temperature range is within the recommendations of the above table.

**Note:** Using the battery outside the above-mentioned ranges of temperature, current or voltage, may seriously and definitively affect the performance of the battery.

#### 4.2.2 Case of permanent charge (floating)

Permanent charging is defined as a continuously charge under the “Step 2” condition as defined in § 4.2.1 above.

Battery / cell type	Constant Voltage (V)	Charge temperature (°C) <sup>[1]</sup>	
	per cell <sup>[1]</sup>	Min	Max
MP 144350 xlr MP 174865 xlr MP 176065 xlr	4.2V	-20°	60°
VL 34570 xlr	4.1V	-20°	60°
	4.2V	-20°	40°
MP 174565 xtd	4.1V	-20°	85°
MP 176065 xtd	4.2 V	-20°	60°
MP 176065 xc	4.0V	-30°	60°
	4.2V	-30°	40°

[1] For float charging parameters outside the recommendations in this table please consult with your local Saft office

[2] For temperatures outside of the values in this table please consult with your local Saft office

In an application where permanent charging is applied to the battery, the following optimum Constant Voltage per cell, versus charging temperature in the above table, is recommended to maximize life time duration under floating conditions.

**Note:** Using the battery outside the above-mentioned ranges of temperature and float voltage, may seriously and definitively affect the batteries performance and/or lifetime.

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### 4.3 BATTERY DISCHARGE

When discharging a battery in its designed application, it is recommended that certain parameters are met (current, temperature and cut-off voltage) as listed in the below table. These parameters should be applied in accordance with the conditions defined for the specific battery type, which will be mentioned on the battery label. Discharging the battery outside the specified parameters may irreversibly damage the battery (or passive safety devices such as current activated fuses, thermally activated fuses, pressure activated circuit breaker) and/or degrade its performance and lifetime.

Battery / cell type	Maximum Discharge Current (C) <sup>[2]</sup>		Discharge Temperature <sup>[2]</sup>		Cut-off Voltage <sup>[3]</sup> (V)
	Continuous <sup>[1]</sup>	Pulse <sup>[1]</sup>	Min (C°)	Max (C°)	
<b>MP 174865 xlr</b>	2C	---	10°	60°	2.5
<b>MP 176065 xlr</b>	C	---	-30°	10°	2.5
<b>VL 34570 xlr</b>	C/5	---	-35°	-30°	2.5
[4] / [5]	[4]	[5]	-40°	-35°	2.5
<b>MP 144350 xlr</b> [4] / [5]	2C	---	15°	60°	2.5
	C	---	-20°	15°	2.5
	C/2	---	-30°	-20°	2.5
	C/5	---	-35°	-30°	2.5
	[4]	[5]	-40°	-35°	2.5
<b>MP 176065 xc</b>	~2C	---	0°	60°	2.5
	~1C	---	-40°	0°	2.5
	~C/5	---	-50°	-40°	2.5
<b>MP 174565 xtd</b> <b>MP 176065 xtd</b>	~C	~C	60°	85°	2.5
	~2C	~4C	0°	60°	2.5
	~C	---	-30°	0°	2.5

[1] Please consult with Saft for further information on this parameter  
[2] For operation outside these parameters, please consult with Saft  
[3] Maximum conditions of temperature, voltage and current may not be mutually inclusive for some applications  
[4] For discharges between -40°C and -35°C : please consult with Saft  
[5] For discharges Pulse maximum current : please consult with Saft

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### 4.4 BATTERY STORAGE

#### 4.4.1 Initial state of charge calculation

The correct level or state of charge must be defined by taking into account:

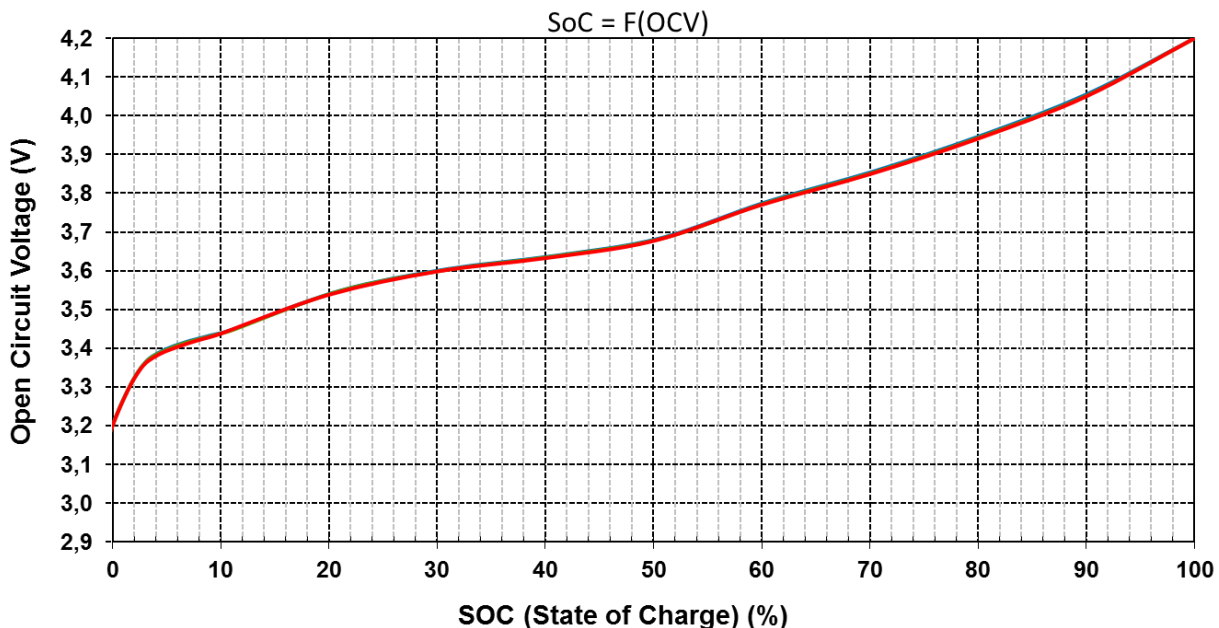
- The storage period
- The maximum consumption of peripheral electronic devices (parasitic current)
- The self-discharge of the cells (the higher the state of charge, the higher the rate of the self-discharge).

Depending on the storage duration, the initial state of charge of the battery before storage must be between 15% and 50% of nominal capacity, which corresponds to an OCV (for example MP xlr):

- For 15% state of charge: 3.51V / cell
- For 30% state of charge: 3.60V / cell (max SoC for air transportation)
- For 50% state of charge: 3.67V / 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 conditions, please consult Saft.

For MP 144350 xlr, MP 174865 xlr, MP 176065 xlr and VL 34570 xlr (Charging voltage 4.2V)



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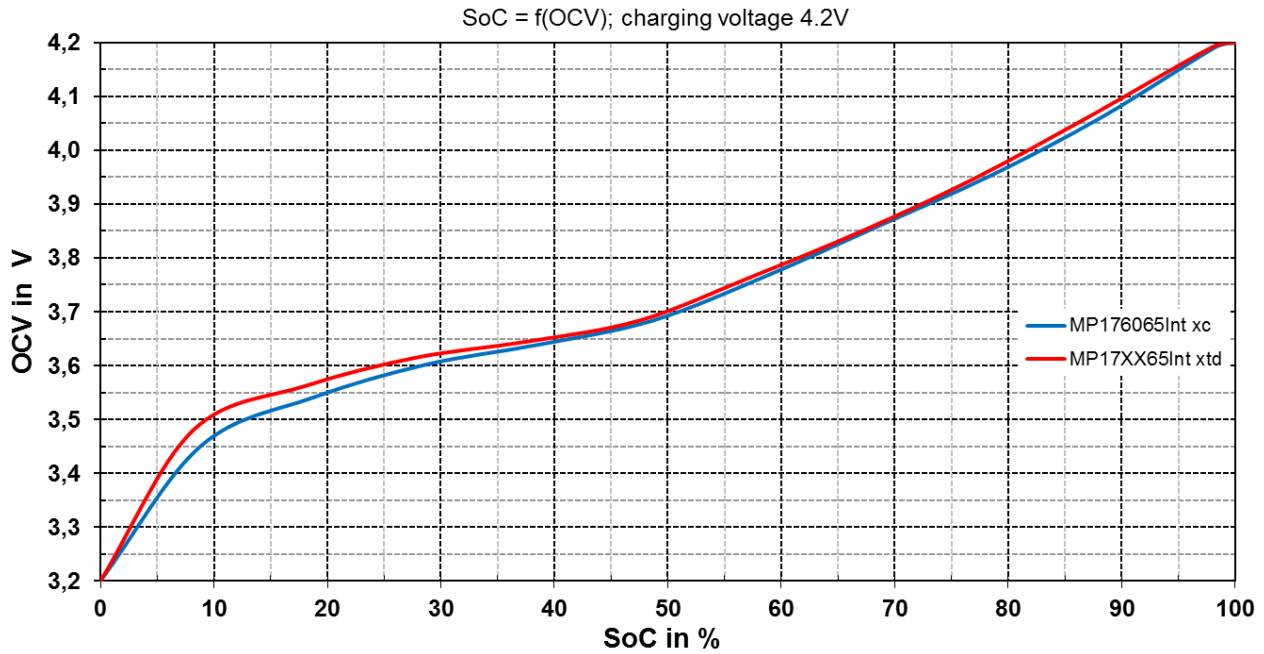
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For MP 174565 xtd, MP 176065 xtd and MP 176065 xc



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#### 4.4.2 Minimum state of charge under storage

A minimum state of charge is required at the end of the storage period to avoid an “over-discharge” condition.

- minimum state of charge of 10-15% corresponding to an OCV of 3.45V/cell - 3.51V/cell for MP 144350 xlr, MP 174865 xlr, MP 176065 xlr, VL 34570 xlr, MP 174565 xtd, MP 176065 xtd and MP 176065 xc

**Note:** Over discharge (any cell under 2.0V) may seriously and definitively affect the lifetime and future performance of the cell and/or battery.

#### 4.4.3 Warnings

If after storage, the battery voltage is low or even at 0V. (*At 0.0V the batteries protection circuit has probably gone into ‘sleep mode’*), the battery must be charged as soon as possible in order to avoid the voltage of one or more cells falling below a level where the cell may be damaged (under 2.0V).

Therefore, “wake up” (reset the low voltage cut-off) the battery by simply connecting an appropriate charger.

#### 4.4.4 Temperature

Recommended conditions for storage are; from 10°C to 30°C, out of direct sunlight, on a dry and clean surface, and preferably in its original packaging.

- Short excursions from -35°C up to +60°C are possible for the following cell / battery types;
  - MP 144350 xlr
  - MP 174865 xlr
  - MP 176065 xlr
  - VL 34570 xlr
- Short excursions from -35°C up to +85°C are possible for the following cell / battery types;
  - MP 174565 xtd
  - MP 176065 xtd
- Short excursions from -50°C up to +60°C are possible for the following cell / battery types;
  - MP 176065 xc

Excursions outside these temperature limits may result in higher self-discharge, lower performance and / or swelling of prismatic 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 **sleep mode** and **doesn’t draw any leakage (parasitic) 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:



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## **5. SAFETY**

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

### **5.1 PRECAUTIONS DURING USE**

→ 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 strike
- 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 for which it has been designed

### **5.2 INFORMATION IN CASE OF ACCIDENT**

In the case of battery being exposed to an abusive situation (fire, crush, shock, overcharge), the batteries internal cell pressure could quickly increase and lead to the opening of the safety vent. In this case, hot and potentially harmful gases may be emitted. In this situation, refer to the recommended actions included in the BIS (Battery Information Sheet) or SDS (Safety Data Sheet – USA only) for the product range. Available at <http://www.saftbatteries.com/solutions/support-services/documentation>

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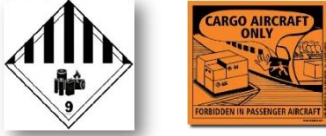
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## 6. TRANSPORTATION

With respect to the *UN Recommendations on the Transport of Dangerous Goods Model Regulations*, and the provisions set out in the *ICAO Technical Instruction for the Safe Transportation of Dangerous Goods by Air* and the *IATA Dangerous Goods Regulations (DGR)*, Li-Ion batteries can be transported in bulk with specific packaging and with quantity, weight, energy and State of Charge limits. Below is a brief summary only of the current rules at the issuing date of this document.


**NOTE:** If you are shipping Li-ion cells or batteries according to **UN3480** or **UN3481** (*Lithium ion batteries contained in equipment*) or (*Lithium ion batteries packed with equipment*) please refer to the relevant UN, ICAO, IATA, IMDG, ADR, DOT or FAA regulations before packing and shipping.

Li-ion Cells and Batteries	Maximum Weight	Labelling
Cells ≤ 20Wh = 8 cells UN3480 Packing Instruction 965 Section II Overpack is not permitted Declaration to include a statement that the cells/batteries are at ≤ 30% SoC	2.5kg Per package	
Batteries ≤ 100Wh = 2 batteries UN 3480 Packing Instruction 965 Section IB Overpack is not permitted Declaration to include a statement that the cells/batteries are at ≤ 30% SoC	2.5kg Per package	
Cells ≤ 20Wh, Batteries ≤ 100Wh UN 3480 Packing Instruction 965 Section IB Declaration to include a statement that the cells/batteries are at ≤ 30% SoC	10 kg Per package	
Cells > 20Wh, Batteries > 100Wh UN 3480 Packing Instruction 965 Section IA Declaration to include a statement that the cells/batteries are at ≤ 30% SoC	35 kg Per package	

In all cases, the responsibility for regulatory compliance when shipping lithium cells and batteries is incumbent upon the shipper.

Ensure that staff assigned to pack and ship lithium cells and batteries are correctly informed and trained according the requirements of the *UN Recommendations on the Transport of Dangerous Goods Model Regulations*.



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**Always check the current regulations and any local conditions that may affect the requirements for the safe and legal shipping of lithium cells and batteries prior to packing and shipping.**

## **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 in performance, first check the possible causes and solutions 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 or current operated fuse has opened.	No warranty can be applied if pack has been used out of its normal usage or conditions. This condition is not resettable
	Battery has been fully discharged and circuit protection stops the discharge of the cells.	Charge the battery as normal of the cell voltage is >2.0V and is recoverable.
	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. This condition is not resettable.
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 the 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 performed several times to recover the available 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 performed several times to recover the available capacity
After several months or years of use, the capacity is much lower than when new.	Several parameters impact the battery life: <ul style="list-style-type: none"> <li>- Storage in high temperature and or at a full state of charge.</li> <li>- cycles number &gt;800 in standard Saft designated conditions for MP xlr and &gt;2000 for MP xtd</li> <li>- calendar / floating age</li> <li>- charging in low temperatures with high rate of charge</li> </ul>	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. The protection circuit may be resettable, whereas a fuse is not. Refer to your vendor
SoC Indicator displays wrong or inadequate information	State of Charge (SoC) Indicator hasn't been calibrated before first use of the battery	Try to do a full cycle charge-discharge to initialise the SoC Indicator.
Ditto	A short circuit occurred and erased the dynamic data like SOC	Try to do a full cycle charge-discharge to initialise the SoC Indicator, depending on the model of SoC Indicator
Cycle number given by SoC Indicator 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 persists, please consult one of the Saft product contacts (the worldwide product sales network is available on Saft website [www.saftbatteries.com](http://www.saftbatteries.com) ).

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## **9. PACKMAKER WARNING**

Design rules for making battery assemblies; Saft recommends the following:

- Saft recommends the use of an individual electronic cell protection circuit referred to as a “**1S**” type. (per “**1**” cell, “**S**”eries connected).
- Saft recommends mechanically fixing the cells to a printed circuit board by the positive and negative tabs and not via methods using the sleeve, glue, encapsulation or adhesive resin.
- On the MP xtd, MP xc cells, the maximum traction force acceptable on each tab is 3.0 Kg
- Do not immerse in resin or glue, any parts of the parts of the cell which have a safety function such as the pressure activated current breaker or safety vent. This will compromise the efficiency of the safety features in the case of vent or critically destructive fault.
- For using other types and designs of protection circuits, please consult Saft.
- For cells of a prismatic design, it is normal that at the centre of the large flat side of the cell to increase in dimension over its cycle lifetime. The dimensional difference can also be influenced by aging, temperature and its application. This needs to be taken into consideration when designing a multiple cell battery product. Saft’s application engineers are available to assist in determining this factor for your batteries design.

## **10. CHANGES**

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