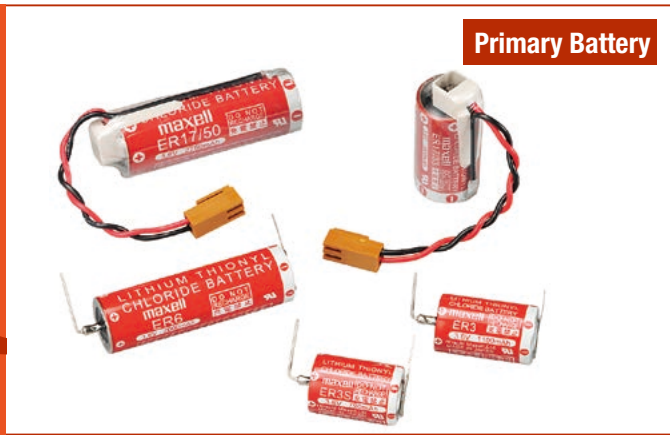


Li/Thionyl Chloride Battery (Li/SOCl₂)



LITHIUM THIONYL CHLORIDE BATTERY

Safety Instructions

This battery is a high energy density sealed battery containing dangerous (Lithium) and deleterious (Thionyl Chloride) materials. For this reason, improper handling of the battery could lead to distortion, leakage*, overheating, explosion, fire, or generation of irritating/corrosive gases, causing bodily injury or equipment trouble. Please observe the following instructions to prevent accidents.

For from your customers to your industrial waste processors (including recycled processor), please have them fully understand these instructions.

(* Leakage is defined as the unintentional escape of a liquid from a battery.)

Warnings – Handling

Do not recharge

■ Never swallow.

Always keep the battery out of the reach of infants and young children to prevent it from being swallowed. If swallowed, consult a physician immediately.

■ Never apply an excessive force to the positive terminal.

Because the positive terminal is sealed by a glass, subjecting this area to sudden jolts and excessive force (over 19.6 N) could destroy the glass seal. This could cause leakage and the generation of irritating/corrosive gases.

■ Never drop.

Dropping the battery could destroy the glass seal leading to leakage and the generation of irritating/corrosive gases.

■ Never weld the terminals or weld a wire to the body of the battery directly.

The heat of welding or soldering could cause the lithium to melt, or cause damage to the insulating material in the battery, leading to possible distortion, leakage, overheating, explosion, or fire, or generation of irritating/corrosive gases. When soldering the battery directly to equipment, solder only the tabs or leads. Even then, the temperature of the soldering iron must be below 350 deg. C and the soldering time less than 5 seconds. Do not use a soldering bath, because the circuit board with battery attached could stop moving or the battery could drop into the bath. Moreover do not use excessive solder, because the solder could flow to unwanted portions of the board, leading to a short-circuit or charging of the battery.

■ Never short-circuit the battery.

Do not allow the positive and negative terminals to short-circuit. Never carry or store the battery with metal objects such as a necklace or a hairpin. Do not take multiple batteries out of the package and pile or mix them when storing. Otherwise, this could lead to distortion, leakage, overheating, and explosion of the battery.

■ Never charge.

The battery is not designed to be charged by any other electrical

source. Charging could generate gas and internal short-circuiting, leading to distortion, leakage, overheating, explosion, fire, or generation of irritating/corrosive gases.

■ Never forcibly discharge.

Forcibly discharging by an external power source or other batteries could cause the voltage to fall below 0V (reversing the poles), generating gas inside the battery and leading to distortion, leakage, overheating, explosion, fire, or generation of irritating/corrosive gases.

■ Never heat.

Heating the battery to more than 100 deg. C could increase the internal pressure, causing distortion, leakage, overheating, explosion, fire, or generation of irritating/corrosive gases.

■ Never expose to open flames.

Exposing to flames could cause the lithium metal to melt, causing the battery to catch on fire and explode.

■ Never disassemble the battery.

Disassembly could generate the irritating/corrosive gases. In addition, the lithium metal inside the battery could overheat, leading to catch on fire.

■ Never deform.

Deforming could cause leakage, overheating, explosion, fire, or generation of irritating/corrosive gases.

■ Never reverse the positive and negative terminals when mounting.

Improper mounting of the battery could lead to short-circuiting, charging or forced-discharging. This could cause distortion, leakage, overheating, explosion, fire, or generation of irritating/corrosive gases.

■ Never use different batteries together.

Using different batteries together, i.e. different type or used and new or different manufacturer could cause distortion, leakage, overheating, explosion, fire, or generation of irritating/corrosive gases because of the differences in battery property. If using two or more batteries connected in series or in parallel even same batteries, please consult with Maxell before using.

■ Never allow liquid leaking from the battery to get in your eyes or mouth.

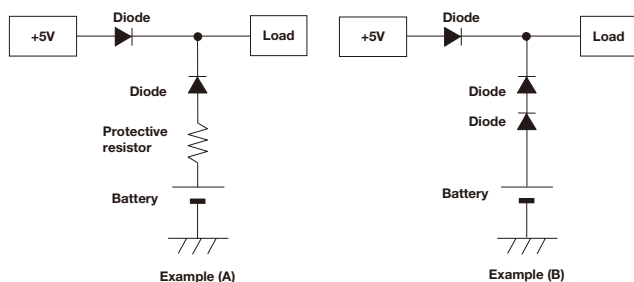
Because this liquid could cause serious damage, if it does come in contact with your eyes, flush them immediately with plenty of water and consult a physician. Likewise, if the liquid gets in your mouth, rinse immediately with plenty of water and consult a physician.

■ Never touch the battery electrodes.

Do not allow the battery electrodes to come in contact with your skin or fingers. Otherwise, the moisture from your skin could cause a discharge of the battery, which could produce certain chemical substances causing you to receive a chemical burns.

⚠ Warnings — Circuit Design for Back-up Use

This is a primary battery and cannot be charged. If used in memory or RTC back-up applications, be sure to use diodes to prevent charging from the main power source or other batteries, and a protective resistor to regulate the current as shown in the figure below. Note that the points described below should be taken into careful consideration when selecting diodes and protective resistors.



■ Supplied voltage to load

Because a diode and a resistor generate the voltage drop on operating, please take into consideration these voltage drops for supplied voltage to load.

■ Using diodes to prevent charging

Please choose diodes with leak current of no more than 0.5 μ A.

■ Using and setting protective resistors

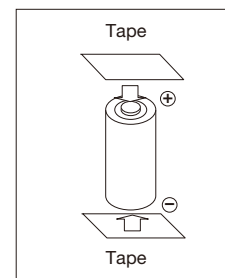
A protective resistor is used to prevent the battery from being charged by large surges of current during diode failure. Please set the resistor so that the maximum current shown in the right table is not exceeded. For example, say an ER6 battery is used in sample circuit (A) in combination with a main power source 5 volt. Since the permitted charge current is 100 μ A and this battery's voltage is 3.6V, let the resistor be $R \geq (5V-3.6V)/100\mu A=14k$ ohm, meaning that at least 14k ohm is required.

Type	Maximum Current
ER18/50	125 μ A
ER17/50	125 μ A
ER6	100 μ A
ER6C	100 μ A
ER17/33	70 μ A
ER3	50 μ A
ER3S	40 μ A

Note: If the diodes broke down, it is necessary for safety to replace them as soon as possible even though using a protective resistor. Considering the trouble of diodes and resistors, other safety measures should be incorporated in the circuit design.

⚠ Warnings — Disposal

The battery may be regulated by national or local regulation. Please follow the instructions of proper regulation. As electric capacity is left in a discarded battery and it comes into contact with other metals, it could lead to distortion, leakage, overheating, or explosion, so make sure to cover the (+) and (-) terminals with friction tape or some other insulator before disposal.



(Example of battery insulation)

⚠ Caution — Handling

■ Minimum transient voltage

The various tests have shown that the minimum transient voltage is influenced greatly by the actual conditions of use and storage. Therefore, please design your circuits using no more than the standard discharge current, taking into account the voltage drop due to the minimum transient voltage. Please consult with Maxell beforehand if you are unsure of anything.

■ Installing, removing, and disposing of batteries

- 1) When installing a battery in a device, make sure that the positive terminal is facing up, or at least to the side. As this battery uses liquid thionyl chloride as the positive active material, placing the positive terminal at the bottom will cause the thionyl chloride to become maldistributed, which could prevent the needed performance from being obtained when a large amount of current is used.
- 2) Please have the installation, removal, and disposal of this battery performed by a technician with a thorough understanding of the Warnings and Cautions on handling.
- 3) Please remove and dispose of the battery when device is no longer in use. If the battery is left in the device, electrolyte may leak from the battery generating irritating/corrosive gas.
- 4) If the sealed area is damaged in any way, corrosive and conductive electrolyte may leak from the battery. Please consider this when designing devices.

■ Storage

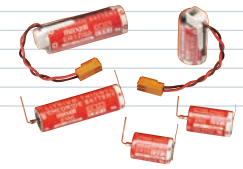
Avoiding storing the battery in direct sunlight, or in excessively hot and humid locations, and store it out of the way of rainwater and other adverse environmental elements.

■ Bundling

When bundling the battery with a product, be sure to use cushioning and other packing to protect the battery (and especially the positive terminal) from jolts and shocks during transportation.

- The ER battery is for industrial use only.
- When replacement is necessary, please contact the manufacturer of your equipment.

Lithium Thionyl Chloride Battery



Overview

This battery is ideal for such long-term applications as power for electronic devices and electric power, water, and gas meters, and especially as a backup power source for memory ICs.

Features

■ High 3.6-V voltage

The lithium thionyl chloride battery achieves a high voltage of 3.6 V.

■ Flat discharge characteristics

The change of internal resistance during discharge is minimal, allowing for flat discharge voltage until end of discharge life.

■ High energy density

Provides high energy density of 970m Wh/cm³ with discharge current of 100μA (ER6 type).

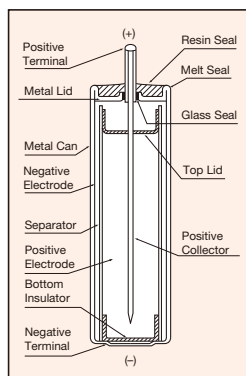
■ Wide usable temperature range

Can be used over a wide temperature range : -55 deg. C to +85 deg. C (please consult with Maxell if using in temperatures of -40 deg. C or less).

■ Superior long-term reliability

The extremely low self-discharge, together with the use of a hermetic seal, allows for stable use over long periods.

Construction



Principle and Reactions

The lithium thionyl chloride battery uses liquid thionyl chloride (SOCl₂) as its positive active material, and lithium (Li) as its negative active material. The reactions of the battery are shown below.

■ Battery reactions

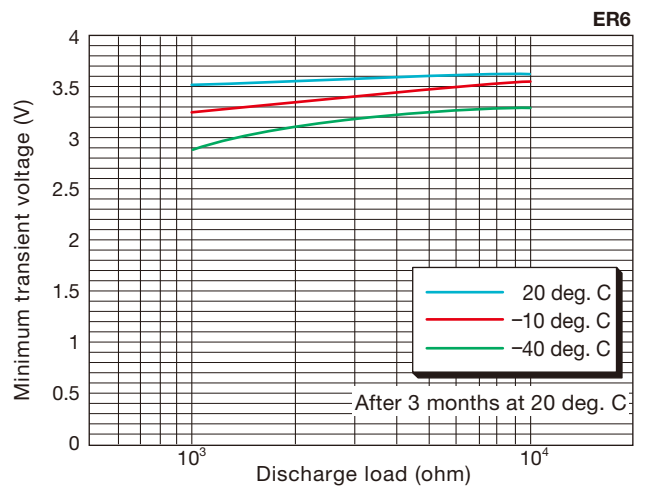
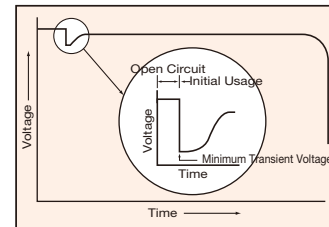
Positive reaction: $2\text{SOCl}_2 + 4\text{Li}^+ + 4\text{e}^- \rightarrow 4\text{LiCl} + \text{S} + \text{SO}_2$

Negative reaction: $\text{Li} \rightarrow \text{Li}^+ + \text{e}^-$

Total reaction: $2\text{SOCl}_2 + 4\text{Li} \rightarrow 4\text{LiCl} + \text{S} + \text{SO}_2$

Minimum transient voltage

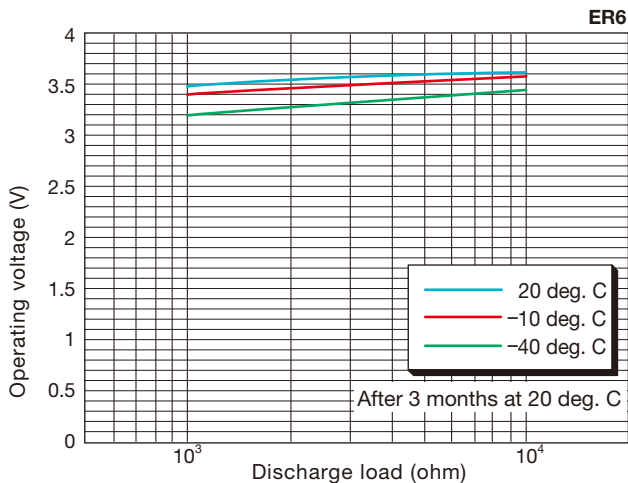
The lithium thionyl chloride battery has remarkably lower self-discharge when compared with conventional batteries. This is because a lithium chloride membrane is formed over the negative lithium surface, blocking reaction with the positive material. When first discharging after storage, resistance from this lithium chloride membrane may temporarily reduce the voltage at the initiation of discharge. The lowest voltage at this time is called minimum transient voltage, and the lower the temperature, and the larger the discharge current, the lower the voltage will be. Because minimum transient voltage is greatly influenced by storage time and conditions, it is necessary to take this into sufficient consideration when designing a device.



The figure above shows minimum transient voltage using a fresh battery.

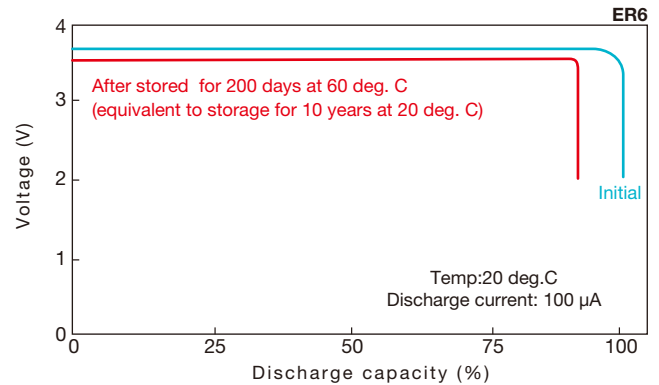
Relationship between Discharge Load and Operating Voltage

The operating voltage of a battery falls as the discharge load increases and temperature falls. In the case of initial use, an electric potential of at least 3V will be maintained even at temperatures of -40 deg. C at discharge of less than 1mA.



Storage Characteristics

The lithium thionyl chloride battery is made from chemically stable inorganic materials. Additionally, a sealing method employing a laser-welded seal structure and hermetic seal hinders the admittance of outside air. These features provide superior storage characteristics, holding down self-discharge to no more than 1% of capacity per year at normal temperatures.



UL Recognized Components

The lithium thionyl chloride battery is a UL (Underwriters Laboratories Inc.) recognized component. (Technician Replaceable)

Recognized models: ER18/50, ER17/50, ER6, ER6C, ER17/33, ER3, ER3S

Certification Number: MH12568

Applications

- OA Machines (Fax, Copiers, Printers)
- Medical Instruments, Cash Registers
- FA Instruments (Measuring Instruments, Onboard Microcomputers, Sensors)
- Electronic Meters (Water, Gas, Electricity)
- ETC (Electronic Toll Collection System)
- Home Fire/Smoke Alarm

Products

Model	ER18/50	ER17/50	ER6	ER6C	ER17/33	ER3	ER3S
Nominal Voltage (V)	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Nominal Capacity (mAh)**	3650	2750	2000	1800	1600	1100	790
Nominal Discharge Current (μ A)	125	125	100	100	75	40	35
Operating Temperature Range (deg. C)	-55 to +85	-55 to +85	-55 to +85	-55 to +85	-55 to +85	-55 to +85	-55 to +85
Dimensions*	Diameter (mm)	18	17	14.5	14.5	17.0	14.5
	Height (mm)	52.6	52.6	53.5	51	35	29.9
Weight (g)*	22	20	15	15	13	8	7

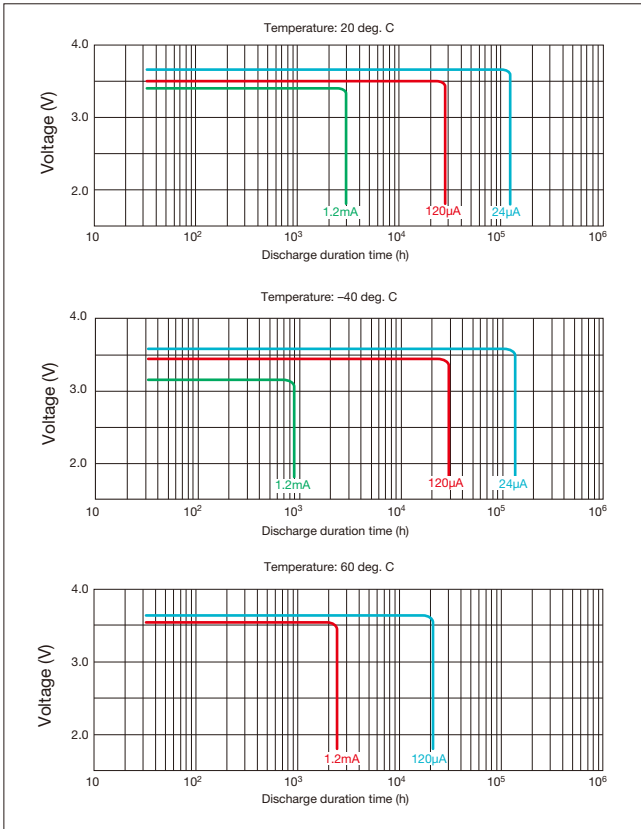
* Dimensions and weight are for the battery itself, but may vary depending on terminal specifications and other factors.

** Nominal capacity indicates duration until the voltage drops down to 3.0V when discharged at a nominal discharge current at 20 deg. C.

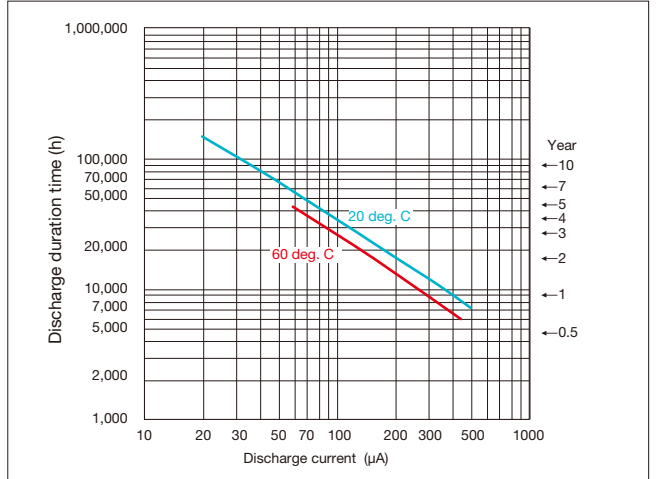
- Data and dimensions are just reference values. For further details, please contact your nearest Maxell dealer or distributor.

Characteristics (ER18/50)

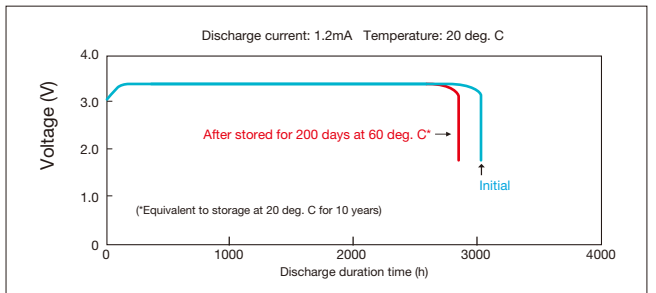
Discharge Characteristics



Relationship between Discharge Current and Duration Time

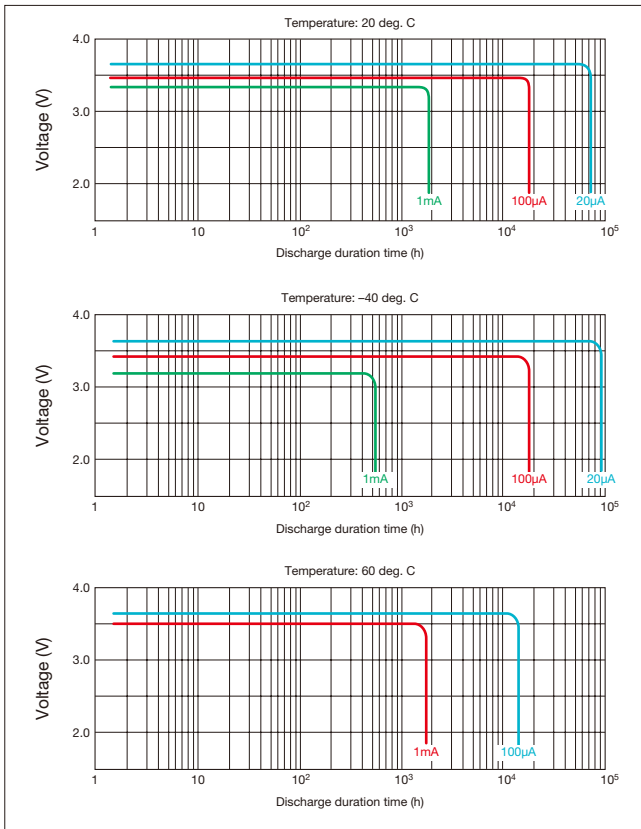


Storage Characteristics

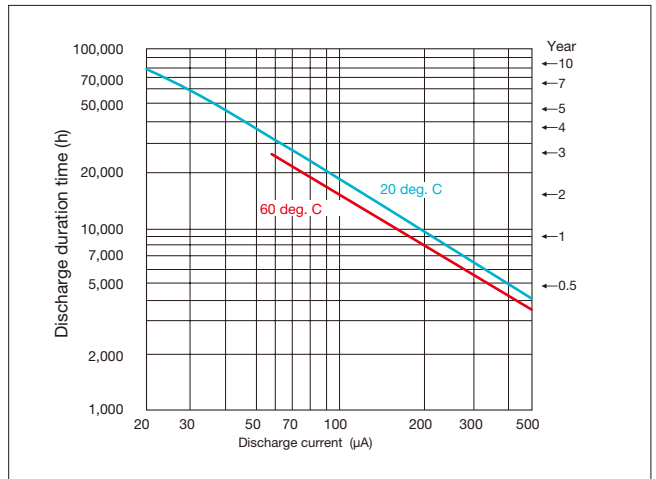


Characteristics (ER6)

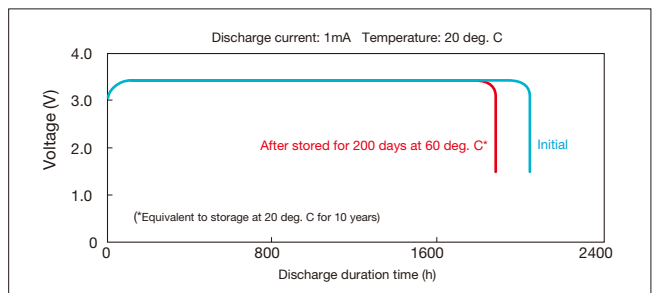
Discharge Characteristics



Relationship between Discharge Current and Duration Time



Storage Characteristics



ER6

External Dimensions with Terminals and Wire Connectors (unit : mm)

ER18/50 #2 PC	ER17/50 #2 PC	ER6 #2 PC	
ER6K-#17	ER6C #2 PC(2)	ER6C WKP	
<p>Housing: XHP-2 (JST) Contact: SXH-001GH-P0.6 (JST) Lead wire: AWG26 UL1007</p>		<p>Housing: HNC2-2.5S-2 (Hirose) Contact: HNC-2.5S-C-B (03) (Hirose) Lead wire: AWG26 UL1007</p>	
ER17/33 #2 PC	ER17/33 WKP	ER3 #2 PC	ER3S #2 PC
	<p>Housing: HNC2-2.5S-2 (Hirose) Contact: HNC-2.5S-C-B (03) (Hirose) Lead wire: AWG26 UL1007</p>		

The above are examples. Processing to meet customer requests is possible.

: Horizontal & Through hole Type

: Wire connector Type

: Tin plating

Visit our website for more information

<http://biz.maxell.com/en/>

Go to: Products > Primary Batteries > ER (Lithium Thionyl Chloride Battery)

Dangerous Goods Transportation Regulations for Lithium Cells and Batteries

Some transportation regulations have been recently revised and will come into effect after Jan. 1, 2015. The summary is shown in the following table. Please use updated Dangerous Goods Regulations listed in Normative Reference to confirm details.








■ The major revisions for air transport of lithium cells and batteries

(1) Lithium metal cells and batteries transported as cargo will be restricted to cargo aircraft only.

Note. The prohibition does not apply to lithium metal batteries packed with equipment (PI 969) or contained in equipment (PI 970).

(2) Gross mass will change to net quantity for both lithium ion cells and batteries (PI 965 Section IB) and lithium metal cells and batteries (PI 968 Section IB)

Technical instructions for lithium metal batteries (PI 968)

Section	Section II		Section IB	Section IA	
Lithium Metal Content	Cell: ≤ 0.3 g Battery: ≤ 0.3 g	Cell: ≤ 1.0 g Battery: ≤ 2.0 g	Cell: ≤ 1.0 g Battery: ≤ 2.0 g	Cell: > 1.0 g Battery: > 2.0 g	
Package Limits	Quantity	N/A	≤ 2 batteries or ≤ 8 cells	> 2 batteries or > 8 cells	N/A
	Net Weight	Cargo aircraft only 2.5 kg	Cargo aircraft only N/A	Cargo aircraft only 2.5 kg	Cargo aircraft only 35 kg
Classification	Exempted		Class 9		
Packaging	Strong outer packaging 1.2 M drop test			UN performance packaging	
Labels	 Note 1)	 Note 2)	 Note 3)	   	
Documents	Invoice (air waybill)* Additional documents***		Declaration for DG Air waybill** Additional documents***	Declaration for DG Air waybill**	
Training	Adequate instructions		DG training		

Note 1): Handling label Note 2): Cargo aircraft only label (necessary for lithium metal cells and batteries)

Note 3): Class 9 hazardous label

* The words "lithium metal batteries, in compliance with Section II of PI 968" and "Cargo Aircraft Only" or "CAO" must appear on the air waybill, when an air waybill is used. This description should appear in the "Nature and Quantity of Goods" box.





** The words "Dangerous Goods as per attached Shipper's Declaration" and "Cargo Aircraft Only" or "CAO" must appear in the air waybill's "Handling Information" column.

*** Additional documents must indicate:

- The package contains lithium metal cells or batteries;
- The package must be handled with care and that a flammability hazard exists if the package is damaged;
- Special procedures should be followed in the event the package is damaged, to include inspection and repacking if necessary; and
- A telephone number for additional information.

This information can be written in the Declaration for DG's "Additional Handling Information" column or on the air waybill.

Technical instructions for lithium-ion batteries (PI 965)

Section		Section II		Section IB	Section IA
Watt hour		Cell: ≤ 2.7 Wh Battery: ≤ 2.7 Wh	Cell: ≤ 20 Wh Battery: ≤ 100 Wh	Cell: ≤ 20 Wh Battery: ≤ 100 Wh	Cell: > 20 Wh Battery: > 100 Wh
Package Limits	Quantity	N/A	≤ 2 batteries or ≤ 8 cells	> 2 batteries or > 8 cells	N/A
	Net Weight	2.5 kg	N/A	10 kg Passenger and cargo aircraft	5 kg: Passenger aircraft 35 kg: Cargo aircraft
Classification		Exempted		Class 9	
Packaging		Strong outer packaging 1.2 M drop test			UN performance packaging
Labels					
Documents		Invoice (air waybill)* Additional documents***		Declaration for DG Air waybill** Additional documents***	Declaration for DG Air waybill**
Training		Adequate instructions		DG training	

* The words "Lithium ion batteries in compliance with section II of PI 965" must appear in the air waybill's "Nature and Quantity of Goods" box, when an air waybill is used. The words "Cargo Aircraft Only" or "CAO" must appear on the air waybill, when transported by cargo.

** The words "Dangerous Goods as per attached Shipper's Declaration" must appear in the air waybill's "Handling Information" column. The words "Cargo Aircraft Only" or "CAO" must appear on the air waybill, when transported by cargo.

*** Additional documents must indicate:

- The package contains lithium ion cells or batteries;
- The package must be handled with care and that a flammability hazard exists if the package is damaged;
- Special procedures should be followed in the event the package is damaged, to include inspection and repacking if necessary; and
- A telephone number for additional information.

This information can be written in the Declaration for DG's "Additional Handling Information" column or on the air waybill.

■ The major revisions for UN Model Regulations 18th Revised Edition

- (1) Damaged or defective cells or batteries shall be transported as "Class 9" hazardous goods according to Special Provision 376 and Packing Instruction P908 or LP904.
- (2) Cells and batteries transported for disposal or recycling shall be transported as "Class 9" hazardous goods according to Special Provision 377 and Packing Instruction P909.

The IMDG Code 2014 edition will contain the descriptions of these UN recommendations. The voluntary compliance date is Jan. 1, 2015. Compliance becomes mandatory on Jan. 1, 2016.

Although these revisions will be reflected in each country's regulations, some districts, countries or airlines may establish their own special requirements. Therefore the shipper shall confirm with the forwarder in advance.

Reference

Except for air transportation, the necessary requirements to transport lithium metal batteries or lithium-ion batteries as exempted from regulation (non-restricted goods) are as follows;

1. The minimum requirements to transport lithium metal batteries as non-restricted goods are as follows;

- a) Cells and batteries shall be manufactured under a quality management program.
- b) For a lithium metal or a lithium alloy cell, the lithium content must not be more than 1 g.
For a lithium metal or lithium alloy battery, the aggregate lithium content must not be more than 2 g.
- c) Each cell or battery must be of the type proven to meet the requirements of each test in the UN Manual of Tests and Criteria, 5th revised edition, Part III, sub-section 38.3.
- d) A battery handling label must be displayed on each package. A telephone number must be printed on the label for additional information.
- e) Each consignment must be accompanied by a document for transport with an indication that:
 - the package contains lithium metal cells or batteries;
 - the package must be handled with care and that a flammability hazard exists if the package is damaged;
 - special procedures should be followed in the event that the package is damaged, to include inspection and repackaging if necessary; and
 - a telephone number for additional information.
- f) Each package must be capable of withstanding a 1.2 m drop test.
- g) Except when batteries are installed in or packed with equipment, packages shall not exceed 30 kg gross mass.

2. The minimum requirements to transport the lithium-ion batteries as non-restricted goods are as follows;

- a) Cells and batteries shall be manufactured under a quality management program.
- b) For lithium-ion cells, the Watt-hour rating is not more than 20 Wh. For lithium-ion batteries, the Watt-hour rating is not more than 100 Wh. The Watt-hour rating must be marked on the outside of the battery case except for those manufactured before Jan. 1, 2009.
- c) Each cell or battery is of the type proven to meet the requirement of each test in the UN Manual of Tests and Criteria, 5th revised edition, Part III, sub-section 38.3.
- d) A battery handling label must be displayed on each package. A telephone number must be printed on the label for additional information.
- e) Each consignment must be accompanied by a document for transport with an indication that:
 - the package contains lithium-ion cells or batteries;
 - the package must be handled with care and that a flammability hazard exists if the package is damaged;
 - special procedures should be followed in the event the package is damaged, to include inspection and repackaging if necessary; and
 - a telephone number for additional information.
- f) Each package must be capable of withstanding a 1.2 m drop test.
- g) Except when batteries are installed in or packed with equipment, packages shall not exceed 30 kg gross mass.

Maxell will provide certificates for b) and c) as the need arises. Documentation for d) and e) needs to be prepared by the customer. If our package is used for transport, Maxell will provide the certificate for f) as the need arises. However, if the customer's package is used, the customer must confirm the package can withstand a 1.2 m drop test. Furthermore, even if our package is used for transport, the telephone number printed on the label must be changed to that of the sender (customer).

Major Normative Reference

UN (United Nations) Recommendations (Air, Marine, Overland transportation)

- UN (United Nations) Recommendations on the Transport of Dangerous Goods: Model Regulations 18th revised edition
- UN (United Nations) Recommendations on the Transport of Dangerous Goods: Manual of Test and Criteria 5th revised edition, Amendment 2

Air Transportation

- International Civil Aviation Organization (ICAO): Technical Instructions for Safety Transport of Dangerous Goods by Air, 2015-2016 edition
- International Air Transport Association (IATA): Dangerous Goods Regulations, 56th edition 2015

Marine Transportation

- International Maritime Organization (IMO): International Maritime Dangerous Goods (IMDG) Code, 2012 edition (This is applicable until Dec. 31, 2015)
- International Maritime Organization (IMO): International Maritime Dangerous Goods (IMDG) Code, 2014 edition (This is applicable on and after Jan. 1, 2015 and will be mandatory on and after Jan. 1, 2016)

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