

LITHIUM MANGANESE DIOXIDE RECHARGEABLE BATTERY

Secondary Battery



LITHIUM MANGANESE DIOXIDE RECHARGEABLE BATTERY

Safety Instructions

This battery contains lithium, organic solvents, and other combustible materials. For this reason, improper handling of the battery could lead to distortion, leakage*, overheating, explosion, or fire, causing bodily injury or equipment trouble. Please observe the following instructions to prevent accidents. (* Leakage is defined as the unintentional escape of a liquid from a battery.)

⚠ Warnings — Handling

■ 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.

■ Do not replace.

Depending on the battery manufacturer, there might be major differences in performance even among the same types or models of batteries. If you are an equipment manufacturer and need to replace the battery, please use a new one of the same type and same model as the existing one. Because this is a rechargeable battery, its characteristics are completely different from a primary battery even though their shapes are alike. If a primary battery is installed in the circuit in place of a rechargeable battery, gas could be generated or the primary battery could be short-circuited by charging. This could lead to distortion, leakage, overheating, explosion, or fire. Please design your equipment so that the end user cannot replace the battery by mistake.

■ Never use two or more batteries connected in series or in parallel.

If batteries are connected together, it is very difficult to design a circuit to observe whether or not the batteries are charged at specified voltage or current as described in "Warning -Circuit Design".

■ Never reverse the positive and negative terminals when mounting.

Improper mounting of the battery could lead to equipment trouble or short-circuiting. This could cause distortion, leakage, overheating, explosion, or fire.

■ 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. Please be careful when installing the battery not to short-circuit it with metal portions of the equipment. Otherwise, this could lead to distortion, leakage, overheating, explosion, or fire.

■ Never heat.

Heating the battery to more than 100 deg. C could increase the internal pressure, causing distortion, leakage, overheating, explosion, or fire.

■ 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.

Do not disassemble the battery, because the separator or gasket could be damaged, leading to distortion, leakage, overheating, explosion, or fire.

■ 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. 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 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.

■ Keep leaking batteries away from fire.

If leakage is suspected or you detect a strong odor, keep the battery away from fire, because the leaked liquid could catch on fire.

■ 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

■ Never set the charge voltage above 3.3V.

Charging at a higher voltage could cause the generation of gas, internal short-circuiting, or other malfunctions, leading to distortion, leakage, overheating, explosion, or fire. For details, see the recommended circuits in the figure below.

■ Always charge at the nominal currents shown below.

Large surges of current could degrade the battery's characteristics, leading to distortion, leakage, overheating, explosion, or fire. To avoid excessive current at the initiation of charging, make sure to attach a protective resistor for current control. See the recommended circuits below.

Table 1 Nominal Charge Current by Model

Model	ML2032	ML2016	ML1220
Charge Current	2mA or lower	2mA or lower	1mA or lower

■ Recommended circuits

Please refer to the representative basic circuits shown below. If you have any questions about circuit design, please feel free to contact Maxell.

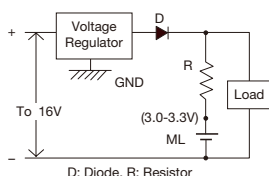


Table 2 Example of resistors

Model	Output Voltage of Voltage Regulator	
	3.1V	3.2V
ML2032	>550 ohm	>600 ohm
ML2016	>550 ohm	>600 ohm
ML1220	>1.1K ohm	>1.2K ohm

(How to select a protective resistor for the current control)

The maximum charge current flows in the battery when charged at an end voltage of 2V. Therefore, the value of the resistor is calculated using this equation:

$$(R) \geq ((\text{Output Voltage of Voltage Regulator}) - 2) / (\text{Nominal Charge Current})$$

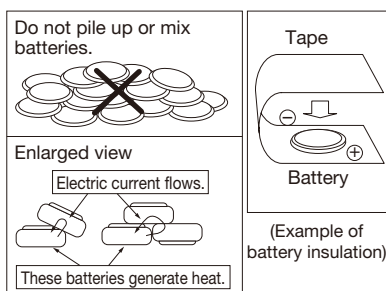
For example, the S-812C series, which has a maximum input voltage of 18V, or the S-817 series with a maximum input voltage of 10V (Seiko Instruments Inc.) can be used as a voltage regulator.

Note 1: If the main power source voltage is stable, the charge voltage can be allotted from main power source divided by the combination of resistors.

Note 2: Because the battery height must be changed by charge and discharge cycle, place a minimum of 1mm space between the battery and device or chassis.

⚠ 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.



⚠ Caution — Handling/Storage

■ Never expose the battery to ultrasonic sound.

Exposing the battery to ultrasonic sound may cause short-circuiting because the inside material is broken into pieces, leading to distortion, leakage, overheating, explosion, or fire.

■ Never subject the battery to severe shock.

Dropping, throwing or stomping on the battery may cause distortion, leakage, overheating, explosion, or fire.

■ Use the correct battery suitable for the equipment.

The battery may not be suitable for the specific equipment due to the using conditions or type of equipment. Please select the suitable battery according to the handling instructions of the equipment.

■ Never use or leave the battery in a hot place such as under the direct rays of the sun or in a car in hot weather.

If you do, this may cause distortion, leakage, overheating, explosion, or fire.

■ Never allow the battery to come in contact with water.

If it does, this may cause the battery to rust or lead to distortion, leakage, overheating, explosion, or fire.

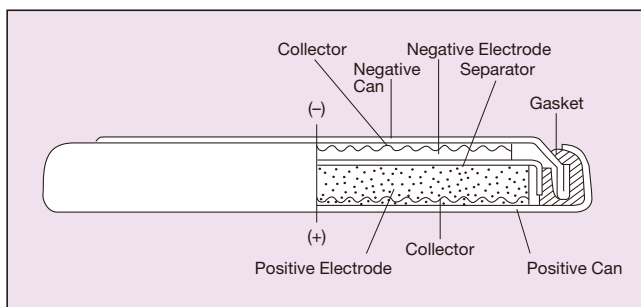
■ Never store the battery in a hot and highly humid environment.

Doing so may cause the performance of the battery to deteriorate. In certain environments, this may lead to distortion, leakage, overheating, explosion, or fire.

Overview

The coin type lithium manganese dioxide rechargeable battery is a small, lightweight rechargeable battery. This battery employs specially treated manganese dioxide for the positive material and a lithium-aluminum compound for the negative material. A specially formulated organic electrolyte is also used, yielding excellent discharge characteristics with low self-discharge.

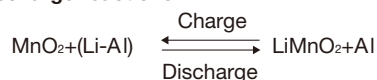
Construction



Principle and Reactions

The coin type lithium manganese dioxide rechargeable battery is a 3V battery using specially treated manganese dioxide for the positive material, a lithium-aluminum compound for the negative material and a specially formulated organic electrolyte solution.

■ Charge/Discharge reactions



Features

■ Approx. 2.5V operating voltage

The operating voltage is about twice that of nickel cadmium rechargeable batteries. Displays a high discharge voltage of 2.8V when at 10% of nominal capacity (depth of discharge is 10% or less), when charged at 3.0 to 3.3V.

■ Superior charge/discharge cycle characteristics (Fig. 2)

Achieves 1,000 cycles of discharging to 10% of nominal capacity (Depth of discharge = 10%). The total discharge capacity is quite high at 100 times nominal capacity (shipped fully charged).

■ Wide -20 deg. C to 60 deg. C usable temperature range

Demonstrates stable operating voltage in temperatures as low as -20 deg. C and as high as 60 deg. C.

■ Low self-discharge and superior leakage resistance (Fig. 3)

Self-discharge at 20 deg. C is no more than 2% per year. Supplies a nominal capacity of about 95% even when stored at 20 deg. C for roughly five years (according to accelerated test conducted by Maxell). And since organic electrolyte is used, the battery has superior leakage resistance.

■ Excellent floating characteristics (Fig. 4)

A specially formulated organic electrolyte is employed to provide stable discharge characteristics even if charged for a year at 3.3V at 20 deg. C (according to accelerated test conducted by Maxell).

■ Excellent high rate discharge characteristics (Fig. 5)

Fig. 1 Charge Property

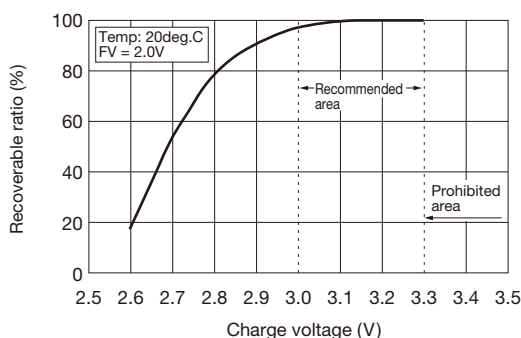


Fig. 2 Charge/Discharge Cycle Performance

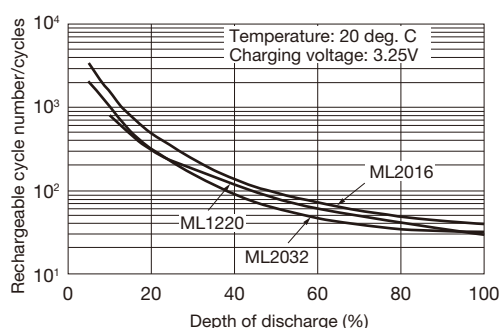
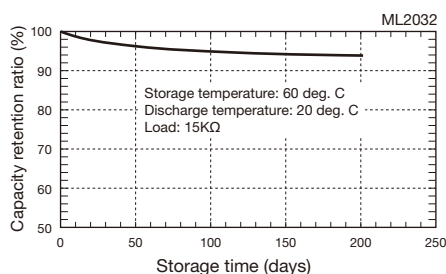
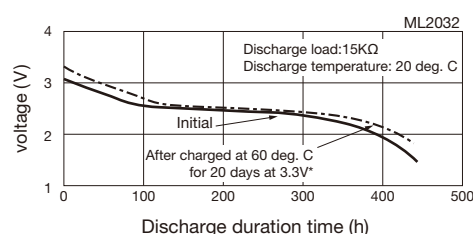


Fig. 3 Low Self-discharge



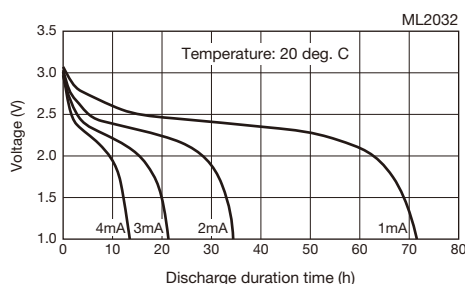
(when accelerating 20 days at 60 deg. C equivalent to 1 year at 20 deg. C)

Fig. 4 Overcharge Characteristics



* equivalent to storage at 20 deg. C for 1 year

Fig. 5 High Rate Discharge Characteristics



UL (Underwriters Laboratories Inc.) Recognized Components

Recognized models : ML2032, ML2016, ML1220

Certification Number : MH12568

Applications

- Mobile Phones ● PHS ● OA Machines (Fax, Copiers, Printers)
- Notebook PCs ● Desktop PCs ● PDAs ● Camcorders
- Digital Still Cameras ● Portable CD/MD Players ● Watches
- Medical Instruments, Cash Registers
- FA Instruments (Measuring Instruments, Onboard Microcomputers, Sensors)
- Electronic Meters (Water, Gas, Electricity)

Products

Model		ML2032	ML2016	ML1220
Nominal voltage (V)		3	3	3
Nominal capacity (mAh)**		65	25	15
Nominal discharge current (μA)		200	200	100
Charge, discharge cycle lifetime	Discharge depth of 10%	1,000 (6.5mAh discharge) (total capacity 6,500mAh)	1,500 (2.5mAh discharge) (total capacity 3,750mAh)	700 (1.5mAh discharge) (total capacity 1,050mAh)
	Discharge depth of 20%	300 (13mAh discharge) (total capacity 3,900mAh)	500 (5mAh discharge) (total capacity 2,500mAh)	300 (3.0mAh discharge) (total capacity 900mAh)
Operating temperature range (deg. C)		-20 to +60	-20 to +60	-20 to +60
Dimensions*	Diameter (mm)	20	20	12.5
	Height (mm)	3.2	1.6	2.0
Weight (g)*		3.0	1.8	0.8

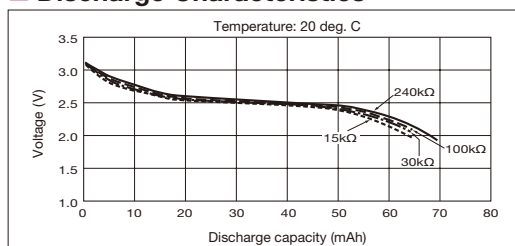
* Dimensions and weight are for the battery itself, but may vary depending on terminal specifications and other factors.

** Nominal capacity indicates duration until the voltage drops down to 2.0V when discharged at a nominal discharge current at 20 deg. C.

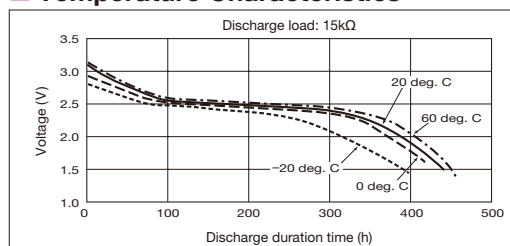
- Data and dimensions are just reference values. For further details, please contact your nearest Maxell dealer or distributor.

ML2032 (65mAh)

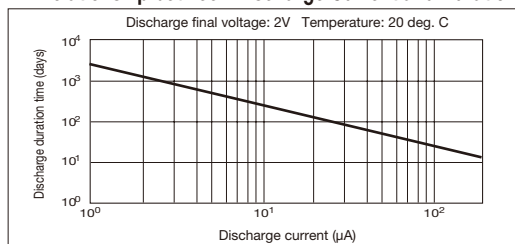
Discharge Characteristics



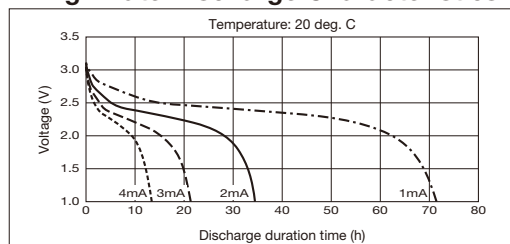
Temperature Characteristics



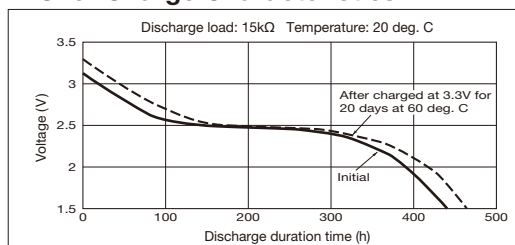
Relationship between Discharge Current and Duration Time



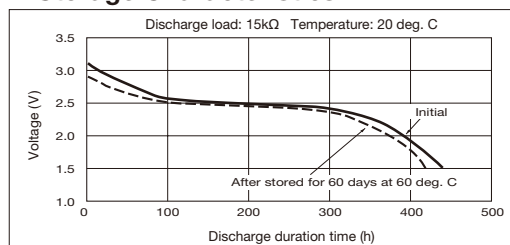
High Rate Discharge Characteristics



Over Charge Characteristics

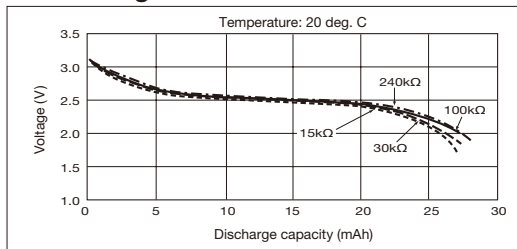


Storage Characteristics

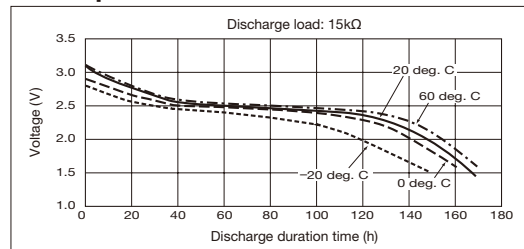


ML2016 (25mAh)

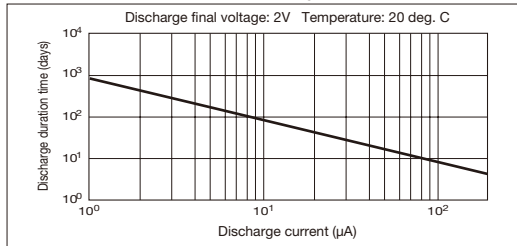
Discharge Characteristics



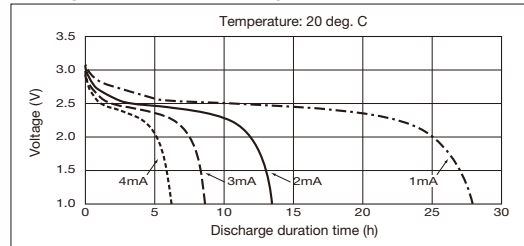
Temperature Characteristics



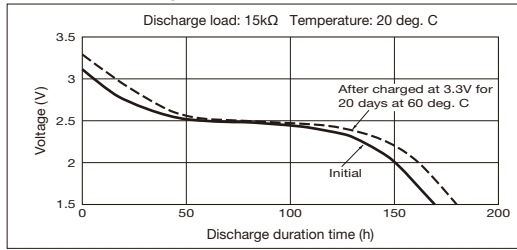
Relationship between Discharge Current and Duration Time



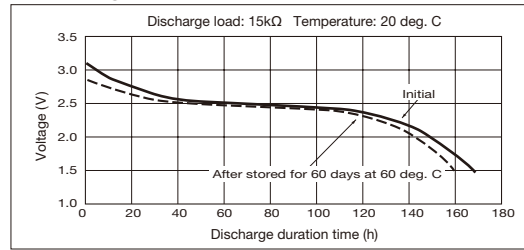
High Rate Discharge Characteristics



Over Charge Characteristics

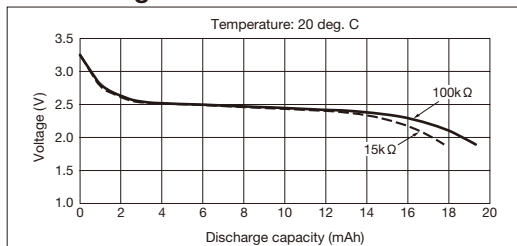


Storage Characteristics

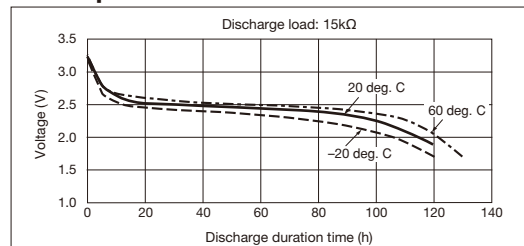


ML1220 (15mAh)

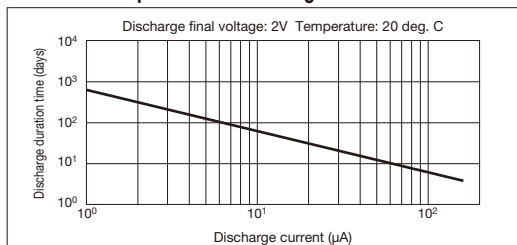
Discharge Characteristics



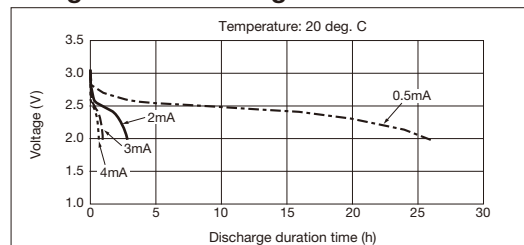
Temperature Characteristics



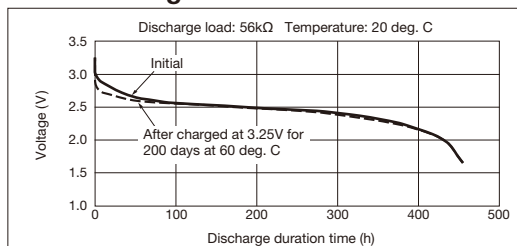
Relationship between Discharge Current and Duration Time



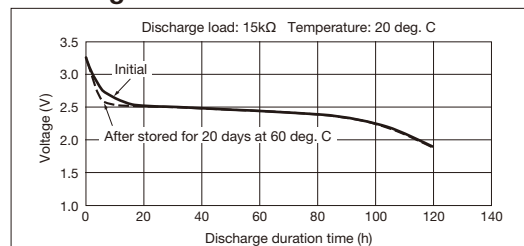
High Rate Discharge Characteristics



Over Charge Characteristics



Storage Characteristics



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

ML2032 T6	ML2032 T6 TUBE	ML2032 T14	ML2032 T25
ML2032 T32	ML2032 T17	ML2032 T26	ML2032 WK
			<p>Housing: HNC2-2.5S-4 (Hirose) Contact: HNC-2.5S-C-B (02) (Hirose) Lead wire: AWG26 UL1007</p>
ML2032 WK2	ML2016 T6	ML2016 T25	ML2016 T17
<p>Housing: ZHR-2 (JST) Contact: SZH-002T-P0.5 (JST) Lead wire: AWG26 UL1571</p>			
ML2016 T26	ML1220 T13	ML1220 T20	





- Horizontal & Through hole Type
- Horizontal & Surface mounting Type
- Vertical & Through hole Type
- Wire connector Type

Dangerous Goods Transportation Regulations for Lithium Cells and Batteries

Some transportation regulations have been recently revised and will come into effect after Jan. 1, 2013. Revised UN recommendations require cells and batteries to be manufactured under a quality management program. This requirement has been incorporated into the IMDG Code and ICAO TI/IATA DRG. Maxell factories have been certified for ISO 9001 and therefore meet this requirement.

- 1) Transportation except by air: Actual operation is the same as before. (see ref.)
- 2) Air transportation: Former packing instructions 965 and 968 have been divided into Section I (class 9 dangerous goods) and Section II (exempt from class 9 dangerous goods). The revised packing instructions consist of Section IA, Section IB and Section II. Section IA (class 9 dangerous goods) is almost the same as the former Section I. Former Section II is divided into Section IB (class 9 dangerous goods) and Section II (exempt from class 9 dangerous goods). The new Section IB covers items that were formerly exempted from regulation but which must be shipped as class 9 dangerous goods from 2013. A summary is shown in the following table. Please use updated IATA regulations (54th edition and later) to confirm details.

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
	Weight	2.5 kg net weight	N/A	2.5 kg gross weight Passenger and cargo aircraft	2.5 kg net weight (Pass.) 35 kg net weight (Cargo)
Classification		Exempted		Class 9	
Packaging		1.2 M drop test			UN performance packaging
Labels		 Note 1)	 Note 2)	 Note 3)	 Note 3)
Documents		Invoice (Air Waybill) Additional document		Air Waybill Additional document	Declaration for DG Air Waybill
Training		Adequate instructions		DG training	

Note 1): Handling label Note 2): Class 9 hazardous label

Note 3): Cargo aircraft only label 1) For USA: Label is required for Section IB or Section IA.

2) Not for USA: Label is required for Section IA and over 2.5 kg of packing weight.

Technical Instructions for lithium ion batteries (PI965)

Section		Section II		Section IB	Section IA
Watt Hour Rating		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
	Weight	2.5 kg net weight	N/A	10 kg gross weight Passenger and cargo aircraft	5 kg net weight (Pass.) 35 kg net weight (Cargo)
Classification		Exempted		Class 9	
Packaging		1.2 M drop test			UN performance packaging
Labels		 Note 4)	 Note 2)	 Note 3)	 Note 4)
Documents		Invoice (Air Waybill) Additional document		Air Waybill Additional document	Declaration for DG Air Waybill
Training		Adequate instructions		DG training	

Note 4): Cargo aircraft only label: Label is required for Section IA and over 2.5 kg of packing weight.

(Ref.)

Except air transportation, the necessary requirements to transport lithium metal batteries or lithium ion batteries as exempted from class 9 dangerous goods (non-restricted goods) are as follows;

1. The minimum requirements to transport lithium metal batteries;

- 1) 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.
- 2) Each cell or battery must be 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.
- 3) A battery handling label must be displayed on each package. A telephone number must be printed on the label for additional information.
- 4) 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 procedure 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.
- 5) Each package must be capable of withstanding a 1.2 m drop test.

2. The minimum requirements to transport lithium ion batteries;

- 1) 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 batteries manufactured before January 1, 2009.
- 2) 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.
- 3) A battery handling label must be displayed on each package. A telephone number must be printed on the label for additional information.
- 4) 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 procedure should be followed in the event the package is damaged, to include inspection and repackaging if necessary; and
a telephone number for additional information.
- 5) Each package must be capable of withstanding a 1.2 m drop test.

Maxell will provide certificates for 1) and 2) as the need arises. Documentation for 3) and 4) needs to be prepared by the customer. If our package is used for transport, Maxell will provide the certificate for 5) 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).

Certified Management Systems (Japan)

ISO 14001

The Maxell group has been certified for the ISO14001 Environmental Management System and has made efforts to reduce environmental impacts throughout the product lifecycle.



ISO14001
Hitachi Maxell, Ltd.
Certificate No.: EC97J1148
Registration Date: December 24, 1997
Recertification Date: December 15, 2011
Certificate Expiry: December 14, 2014
Scope of Registration: Development, design, manufacture, sales and related services of information media, batteries, parts, devices and electronic appliances

ISO9001



ISO9001
HITACHI MAXELL, LTD.
ENERGY DIVISION
MICRO BATTERY DEPARTMENT
Certificate Number: JQA-0986
Registration Date: September 29, 1995
Last Renewal Date: December 19, 2012
Expiry Date: December 18, 2015

Scope of Registration: The design/development and the manufacture of cylindrical alkaline battery, silver oxide battery, alkaline button battery, manganese dioxide lithium battery (coin type and cylindrical type), thionyl chloride lithium battery, manganese dioxide lithium rechargeable battery, titanium carbon lithium rechargeable battery and coin type lithium rechargeable battery.



ISO9001
HITACHI MAXELL, LTD.
ENERGY DIVISION
LITHIUM ION BATTERY DEPARTMENT
Certificate Number: JQA-3029
Registration Date: January 29, 1999
Last Renewal Date: December 27, 2011
Expiry Date: December 26, 2014

Scope of Registration:
• The design/development and manufacture of lithium-ion rechargeable battery.
• The design/development and manufacture (outsources) of lithium-ion rechargeable battery.

ISO/TS 16949



JQA-AU0078

ISO/TS16949
HITACHI MAXELL, LTD.
ENERGY DIVISION
MICRO BATTERY DEPARTMENT
ONO WORKS
Certificate Number: JQA-AU0078
Registration Date: January 7, 2005
Last Renewal Date: January 7, 2011
Expiry Date: January 6, 2014

Remote Supporting Functions: MAXELL EUROPE LTD.
MAXELL CORPORATION OF AMERICA

Scope of Registration: The design/development and manufacture of manganese dioxide lithium batteries (coin type) for automobile use.



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