ML

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.

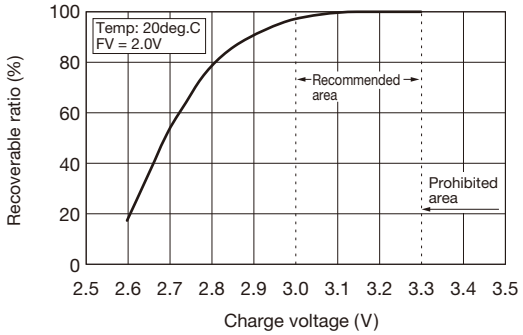
■ **Keep leaking batteries away from fire.**
If leakage is suspected or you detect a strong odor, keep the battery away from fire, because the leaked liquid could catch on fire.

■ **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 below.

Fig. 1 Charge Property



■ **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.

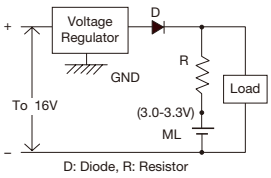


Table 2 Example of resistors

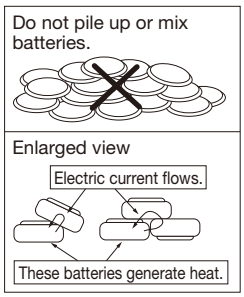
Model	Output Voltage of Voltage Regulator	
	3.1V	3.2V
ML2032	>550 ohm	>600 ohm
ML2016	>550 ohm	>600 ohm
ML1220	>1.1K ohm	>1.2K ohm

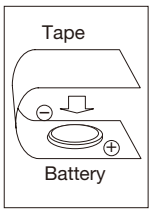
(How to select a protective resistor for the current control)
The maximum charge current flows in the battery when charged at an end voltage of 2V. Therefore, the value of the resistor is calculated using this equation:
(R) ≧ ((Output Voltage of Voltage Regulator) – 2) / (Nominal Charge Current)
For 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.

■ **Never over-discharge the battery.**
If the battery is over-discharged to below the specified voltage (2.0 V), it may not be rechargeable.

⚠ 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/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.

Lithium Manganese Dioxide Rechargeable Battery



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.

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

■ 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

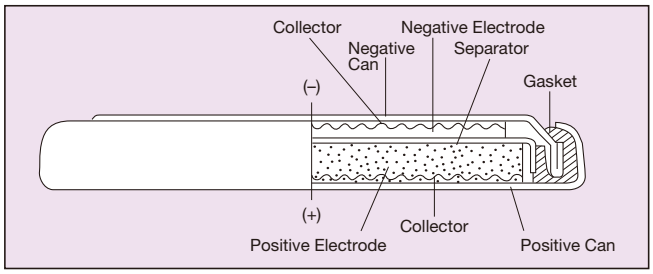
Self-discharge at 20 deg. C is no more than 2% per year. Supplies a nominal capacity of about 95% even when stored at 20 deg. C for roughly five years (according to accelerated test conducted by Maxell). And since organic electrolyte is used, the battery has superior leakage resistance.

■ Excellent floating characteristics

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

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

$$MnO_2+(Li\text{-}Al) \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftarrows}} LiMnO_2+Al$$

UL (Underwriters Laboratories Inc.) Recognized Components

Recognized models: ML2032, ML2016, ML1220
Certification Number: MH12568

Applications

- OA Machines (Fax, Copiers, Printers)
- Notebook PCs
- Desktop PCs
- Camcorders
- Digital Still Cameras
- Watches
- Medical Instruments, Cash Registers
- FA Instruments (Measuring Instruments, Onboard Microcomputers, Sensors)
- Electronic Meters (Water, Gas, Electricity)

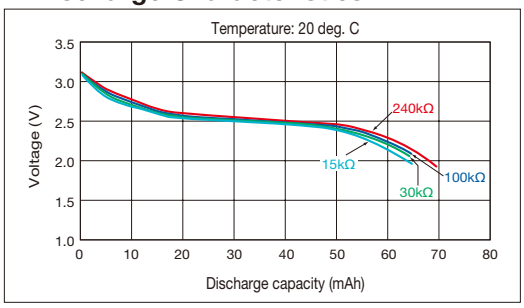
Products

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

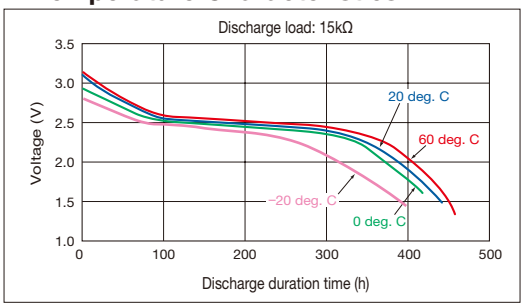
* Dimensions and weight are for the battery itself, but may vary depending on terminal specifications and other factors.
** Nominal capacity indicates duration until the voltage drops down to 2.0V when discharged at a nominal discharge current at 20 deg. C.
• Data and dimensions are just reference values. For further details, please contact your nearest Maxell dealer or distributor.

Characteristics (ML2032)

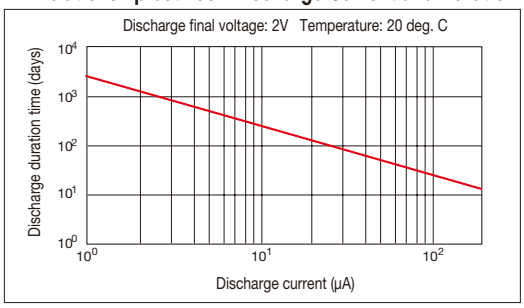
Discharge Characteristics



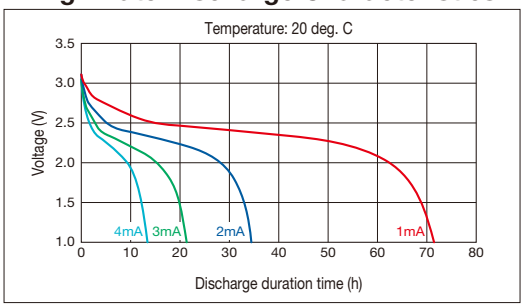
Temperature Characteristics



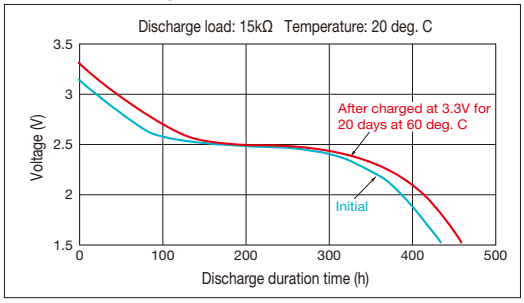
Relationship between Discharge Current and Duration Time



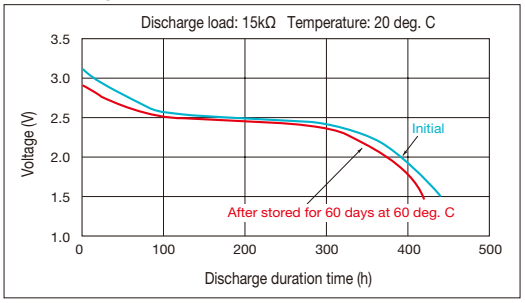
High Rate Discharge Characteristics



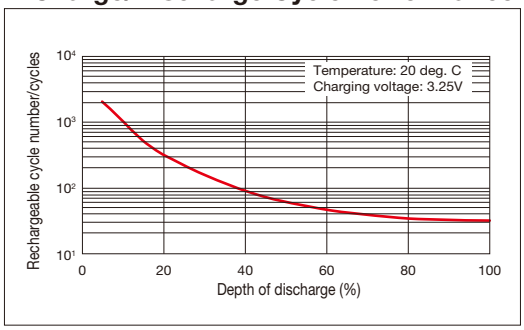
Over Charge Characteristics



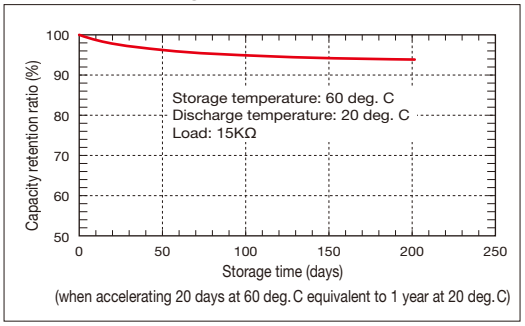
Storage Characteristics



Charge/Discharge Cycle Performance

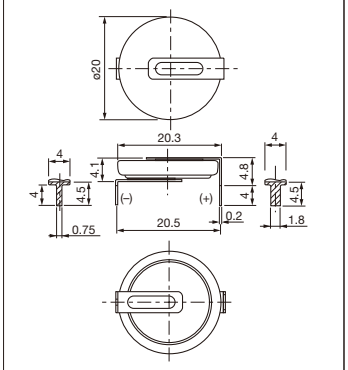


Self-discharge Characteristics

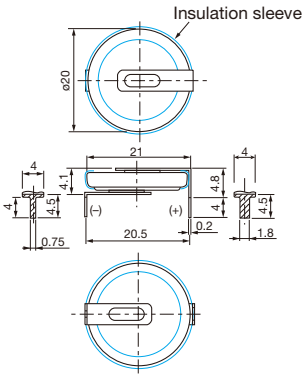


External Dimensions with Terminals and Wire Connectors (unit : mm)

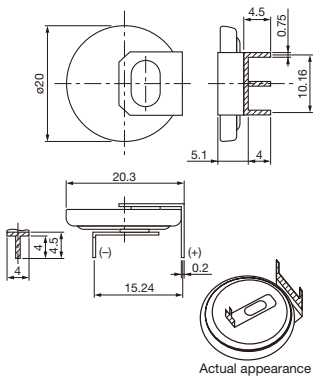
ML2032 T6



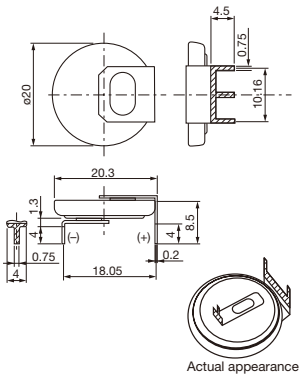
ML2032 T6 TUBE



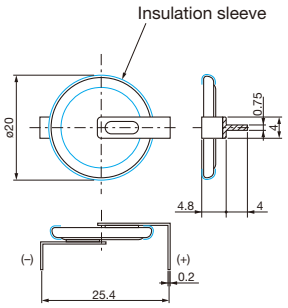
ML2032 T14



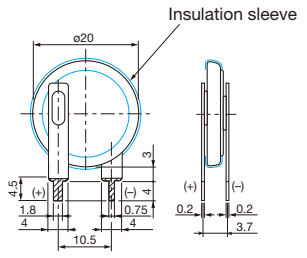
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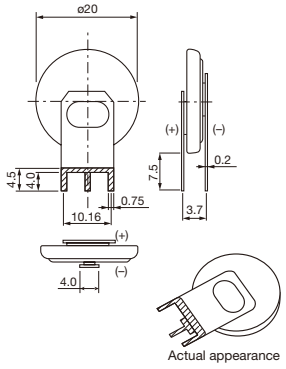
ML2032 T32



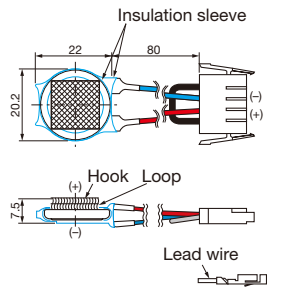
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ML2032 T26

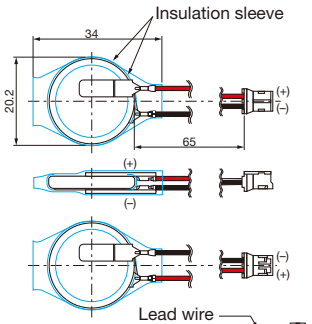


ML2032 WK



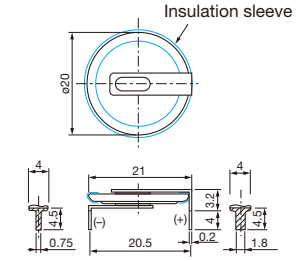
Housing: HNC2-2.5S-4 (Hirose)
Contact: HNC-2.5S-C-B (02) (Hirose)
Lead wire: AWG26 UL1007

ML2032 WK2

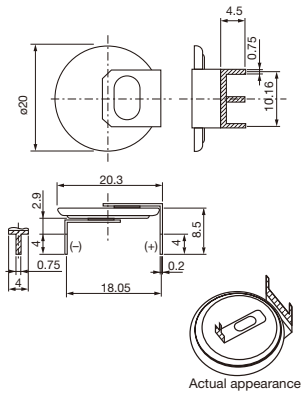


Housing: ZHR-2 (JST)
Contact: SZH-002T-P0.5 (JST)
Lead wire: AWG26 UL1571

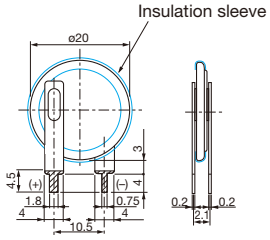
ML2016 T6



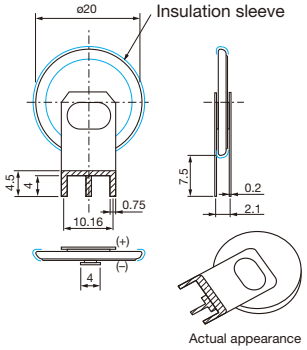
ML2016 T25



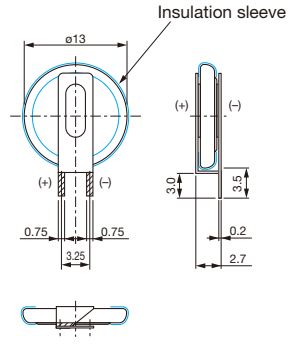
ML2016 T17



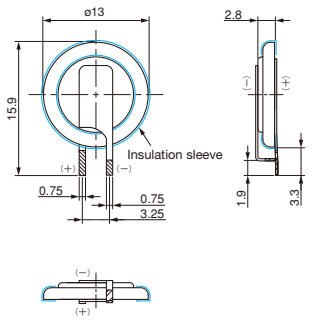
ML2016 T26



ML1220 T13



ML1220 T20



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

: Tin plating

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

Visit our website for more information
http://biz.maxell.com/en/
Go to: Products > Rechargeable Batteries > ML (Coin Type Lithium Manganese Dioxide Rechargeable 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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