



# 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.

## <u>/</u> 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.



#### (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)  $\geq$  ((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.

## 🕂 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.

## 1 Caution — Handling/Storage

Use within the rated temperature range of -20 to +60 deg. C. Otherwise the battery's charge and discharge characteristics may be reduced.

#### 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.

# 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.



## **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<sub>2</sub>+(Li-Al) Charge LiMnO<sub>2</sub>+Al 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 (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

## Fig. 1 Charge Property



## Fig. 3 Low Self-discharge



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

## Fig. 5 High Rate Discharge Characteristics



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 3.3 V at 20 deg. C (according to accelerated test conducted by Maxell).

## Excellent high rate discharge characteristics (Fig. 5)

## Fig. 2 Charge/Discharge Cycle Performance



## Fig. 4 Overcharge 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	18	
Nominal Discharge Current (µA)		200	200	100	
Charge, Discharge		Discharge Depth of 10%	1,000 (6.5 mAh discharge) (total capacity 6,500 mAh)	1,500 (2.5 mAh discharge) (total capacity 3,750 mAh)	1,500(1.8 mAh discharge) (total capacity 2,700 mAh)
Cycle Lifetime		Discharge Depth of 20%	300 (13 mAh discharge) (total capacity 3,900 mAh)	500 (5 mAh discharge) (total capacity 2,500 mAh)	500 (3.6 mAh discharge) (total capacity 1,800 mAh)
Operating Temperature Range (deg. C)		-20 to +60	-20 to +60	-20 to +60	
Dimensions*	Diameter (mm)		20	20	12.5
Diffensions	Height (mm)		3.2	1.6	2.0
Weight (g)*		3.0	1.8	0.7	

\* 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 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



Relationship between Discharge Current and Duration Time



Over Charge Characteristics



# ML2016 (25mAh)



Relationship between Discharge Current and Duration Time







Temperature Characteristics



## High Rate Discharge Characteristics



## Storage Characteristics



## Temperature Characteristics



## High Rate Discharge Characteristics



Storage Characteristics



# ML1220 (18mAh)

## Discharge Characteristics



Relationship between Discharge Current and Duration Time



## Over Charge Characteristics



## Temperature Characteristics



## High Rate Discharge Characteristics



## Storage Characteristics



## LITHIUM MANGANESE DIOXIDE RECHARGEABLE BATTERY



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

## Dangerous Goods Transportation Regulations for Lithium Metal Cells and Batteries (\*)

The following are revised transportation regulations:

- International Civil Aviation Organization (ICAO) Technical Instructions (ICAO-TI), 2011-2012 edition Effective date: January 1, 2011
- International Maritime Organization (IMO) International Maritime Dangerous Goods (IMDG) Code, 2010 edition
   Effective date: January 1, 2012

It is important that necessary arrangements be made so that all those concerned are thoroughly informed of the revisions.

The minimum requirements necessary to transport as non-restricted goods are as follows;

- 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.
- 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<sup>\*1</sup> 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.
  - \*1 For air transport, the words "Not Restricted" and the above information must be indicated on the Air Waybill.
- 5) Each package must be capable of withstanding a 1.2 m drop test.

Maxell will offer the certificate of 1) and 2) as the need arises\*<sup>2</sup>. Documentation for 3) and 4) need to be prepared by the customer. If our package is used for transport, we offer the certificate for 5) as the need arises\*<sup>2</sup>.

\*<sup>2</sup> Please ask for the certificate through your normal purchase channels or sales representative.

(\*) Lithium metal cells and batteries: CR Cylindrical Type (Lithium Manganese Dioxide Batteries) Heat Resistant CR (Lithium Manganese Dioxide Batteries) CR Coin Type (Lithium Manganese Dioxide Batteries) ER (Lithium Thionyl Chloride Batteries) ML Coin Type (Lithium Manganese Dioxide Rechargeable Batteries) TC Button Type (Titanium Carbon Lithium Rechargeable Batteries)

## Dangerous Goods Transportation Regulations for Lithium-ion Cells and Batteries (\*)

The following are revised transportation regulations:

- International Civil Aviation Organization (ICAO) Technical Instructions (ICAO-TI), 2011-2012 edition Effective date: January 1, 2011
- International Maritime Organization (IMO) International Maritime Dangerous Goods (IMDG) Code, 2010 edition
   Effective date: January 1, 2012

It is important that necessary arrangements be made so that all those concerned are thoroughly informed of the revisions.

The minimum requirements necessary to transport as non-restricted goods are as follows;

- 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 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.
- A battery handling label must be displayed on each package. A telephone number must be printed on the label for additional information.

- Each consignment must be accompanied by a document for transport<sup>\*1</sup> 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.
  - \*1 For air transport, the words "Not Restricted" and the above information must be indicated on the Air Waybill.
- 5) Each package must be capable of withstanding a 1.2 m drop test.

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(\*) Lithium-ion cells and batteries: Prismatic lithium-ion rechargeable cells and batteries Cylindrical lithium-ion rechargeable cells and batteries Laminated type lithium-ion rechargeable cells and batteries Coin type lithium-ion rechargeable cells and batteries

NOTE: For laminated type lithium-ion rechargeable cells, the watt-hour rating is over 20 Wh and therefore the cells must be shipped as class 9 dangerous goods. For more information, see the latest version of ICAO TI, IATA DGR and IMDG Code.

# maxell

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