Panasonic

Batteries - Create A New World

2002

Lithium-Batteries

Technical Handbook

Lithium

International English

NOTICE TO READERS

It is the responsibility of each user to ensure that each battery application system is adequately designed safe and compatible with all conditions encountered during use, and in conformance with existing standards and requirements. Any circuits contained herein are illustrative only and each user must ensure that each circuit is safe and otherwise completely appropriate for the desired application.

This literature contains information concerning cells and batteries manufactured by Matsushita Battery Industrial Co., Ltd. This information is generally descriptive only and is not intended to make or imply any representation guarantee or warranty with respect to any cells and batteries. Cell and battery designs are subject to modification without notice. All descriptions and warranties are solely as contained in formal offers to sell or quotations made by Matsushita Battery Industrial Co., Ltd., Panasonic Sales Companies and Panasonic Agencies.

INDEX

<Notes>
(1) This handbook sets forth the battery characteristics of lithium batteries. Details of product prices, delivery lead time and other transaction conditions will be determined through discussions to be held separately.
(2) The contents of this handbook are subject to change without notice due to improvements. Before studying the use of the lithium batteries described in this handbook in your products, check with Matsushita Battery Industrial Co., Ltd. Industrial/Systems Sales & Marketing Division ahead of time.
(3) With lithium batteries, different product number suffixes are used for different destinations. Inquire separately for details.

⚠ Safety Warnings and Precautions

Please be sure to observe the following warnings. As batteries contains flammable substances such as lithium or other organic solvents, they may cause heating, rupture or ignition.

■ Cylindrical type lithium batteries

1. It may cause rupture or ignite.
- Do not charge, short , (an exception is to pass batteries through dipping solder)disassemble, deform, heat batteries. Do not throw batteries into fire.
- Do not connect the (+) and (-) electrodes to each other with metal or wire. Do not carry or store batteries together with a metallic necklace, etc.
- Avoid inversed connection of (+) and (-) terminals to devices.
- Avoid mixed use of new and old batteries or batteries of other series.
- Avoid direct soldering to batteries.

2. When discarding batteries, insulate the (+) and (-) terminals of batteries with insulating tape, etc.(see Fig.1) When disposed of improperly, lithium batteries may short, causing them to become hot, burst or ignite.
3. Keep batteries out of reach of small children. Should a child swallow a battery, consult a physician immediately.

Keep batteries away from direct sunlight, high temperature, and high humidity.

■ Coin type lithium batteries

1. Do not charge, short, (an exception is to pass batteries through dipping solder) disassemble, deform, heat batteries. Do not throw batteries into fire .
2. Keep batteries out of reach of small children. Should a child swallow a battery, consult a physician immediately.
3. When discarding batteries, insulate the (+) and (-) terminals of batteries with insulating tape, etc.(See Fig.1)
   When disposed of improperly, lithium batteries may short, causing them to become hot, burst or ignite.

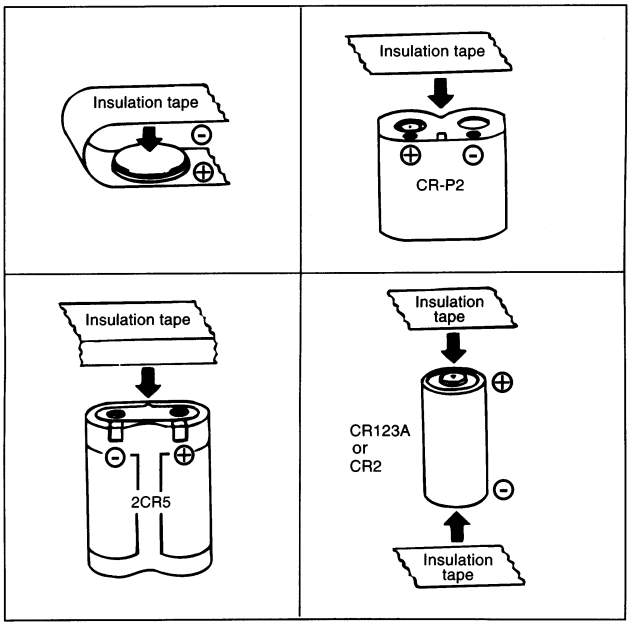
1. Be sure to connect the (+) and (-) electrodes correctly.
2. Avoid mixed use of batteries, i.e. new, used or different types.
3. Avoid direct soldering to batteries.
4. Keep batteries away from direct sunlight, high temperature, and high humidity.

■ Coin type rechargeable lithium batteries

1. Do not charge, short, (an exception is to pass batteries through dipping solder)disassemble, deform, heat batteries. Do not throw batteries into fire.
2. Do not charge rechargeable batteries with a higher voltage than specified.
3. Keep batteries out of reach of small children. Should a child swallow a battery, consult a physician immediately.
4. When discarding batteries, insulate the (+) and (-) terminals of batteries with insulating tape, etc. (see Fig. 1)
   When disposed of improperly, lithium batteries may short, causing them to become hot, burst or ignite.

1. Be sure to connect the (+) and (-) electrodes correctly.
2. Avoid mixed use of batteries, i.e. new, used or different types.
3. Avoid direct soldering to batteries.
4. Keep batteries away from direct sunlight, high temperature, and high humidity.

Fig.1 When disposing batteries
(Example of insulating)



* Discharge circuits will be made by the contact of batteries, which may cause heating, rupture, or ignition of batteries.

Chapter 1

Lithium Batteries:Overview

INDEX

Introduction

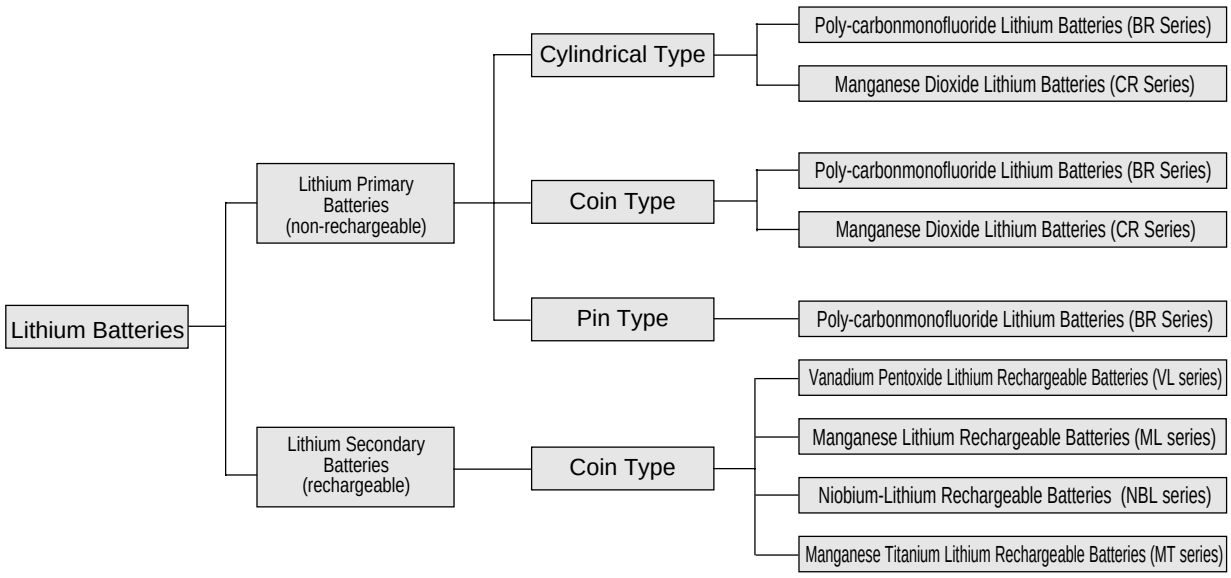
Lithium Batteries : Types and Features

Ever since Panasonic became the first company in the world to develop and commence the mass production of lithium batteries for consumer products in 1971, Panasonic has launched a series of lithium batteries in many shapes and sizes including cylindrical types, coin types and pin types. Panasonic has also successfully introduced rechargeable coin-type lithium batteries to the market for applications such as memory back-up or watches.

Today, lithium batteries have a proven track record of opening up a host of new fields where conventional batteries cannot be used. Applications range from high-current discharge applications typified by 35 mm cameras to ultra-lowcurrent discharge applications in such products as electronic watches or applications as power supplies for IC memory backup which require long-term reliability.

Panasonic has conducted repeated tests on the various safety and performance characteristics, plus the effects of environmental factors such as temperature. We have accumulated a wealth of corroborative data on the performance of our batteries which cannot be pinpointed by short-term accelerated tests.As a result, Panasonic batteries have won approval under the UL safety standards in the United States and wide recognition throughout the world for their high reliability and safety.

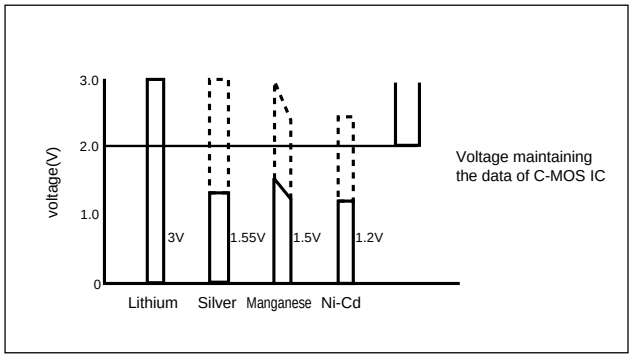
Types of Lithium Batteries



Lithium Batteries : General Features

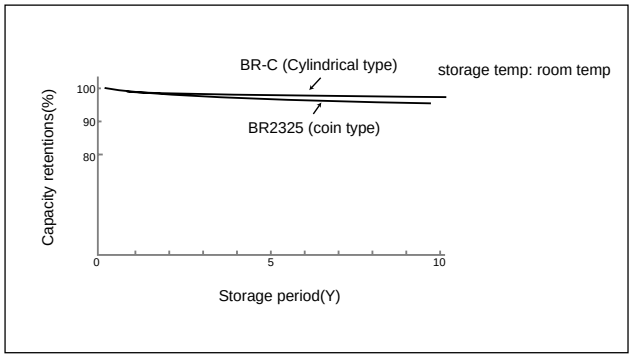
■ High voltage

The high energy density of lithium batteries and their high voltage of 3V make them ideally suited for use in all kinds of products where the trend is to achieve increasing miniaturization. A single lithium battery can replace two, three or more conventional batteries. The figure on the right shows the number of cells required to provide the C-MOS IC data holding voltage for each type of battery.



■ Low self-deterioration rate and superior storability

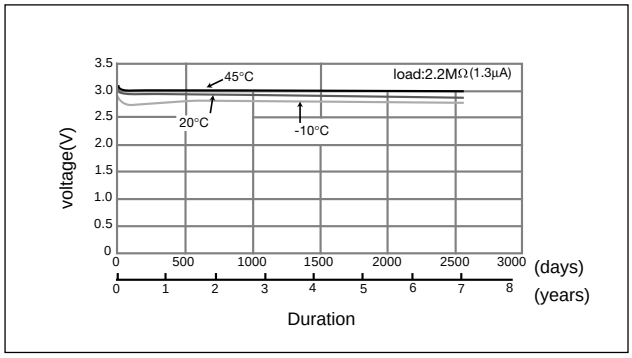
Since lithium batteries employ substances for the cathode active material(such as poly-carbonmonofluoride for the BR series and manganese dioxide for the CR series that are chemically very stable), storage life is more than five times that of conventional batteries, with more than 90% residual capacity after 10 years of storage.



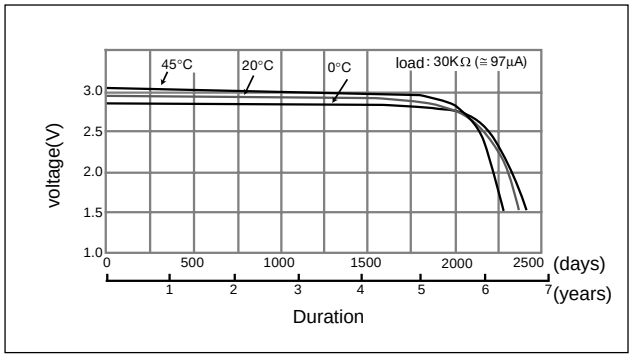
■ Long-term discharge

Long-term discharge has been verified at all operating temperatures under low-load discharge conditions.

BR2325

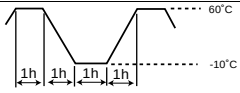
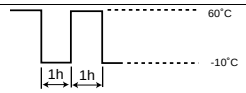


BR-C



■ Outstanding electrolyte leakage resistance

Lithium batteries employ organic electrolytes with minimum creeping so they are vastly superior in terms of leakage resistance under environmental changes compared to other types of batteries that employ aqueous solution electrolytes. The batteries achieve stable characteristics under high temperature and humidity conditions (45°C, 90%RH, 60°C, 90 %RH), and even under heat shock which constitutes the severest challenge for batteries.

Leakage resistance evaluation items	Test conditions
High-temperature storage	60˚C
High-temperature High-humidity storage	45˚C / 90%RH 60˚C / 90%RH
Temperature cycle	
Heat shock	

Leakage resistance test results

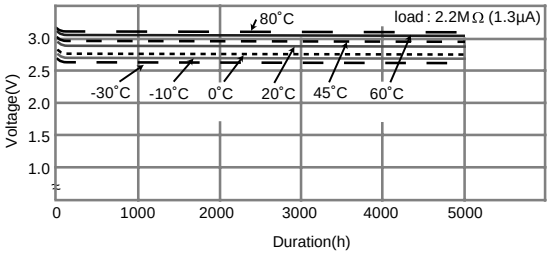
Conditions / Storage / Model	60˚C		45˚C/90%		60˚C/90%		Temp. cycle	Heat shock
	1 month	3 month	1 month	3 month	1 month	3 month	60 cycle	120 cycle
BR2325	○	○	○	○	○	○	○	○
BR-2/3A	○	○	○	○	○	○	○	○

■ Wide operating temperature range

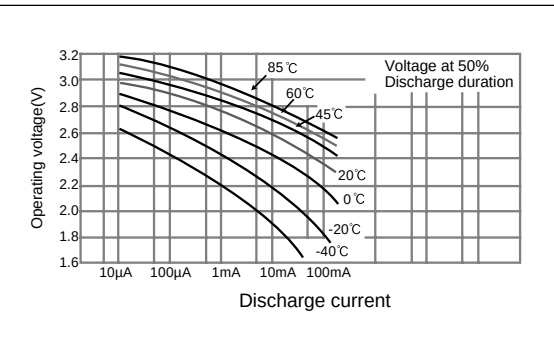
Due to the use of organic electrolytes with a solidifying point that is much lower than the aqueous solution electrolytes used in other types of batteries, lithium batteries are capable of operation in a wide range of temperatures.

Not only the high operating temperature BR series cells use a special engineering plastic as the material for the gasket and separator instead of the conventional polyolefin resin but its operating temperature range has also been significantly increased by employing an electrolyte with a high boiling point.

BR2325 Operating voltage under high-resistance discharge



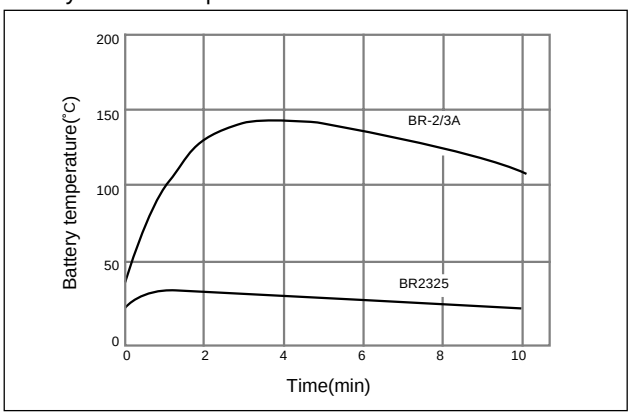
BR-2/3A Current drain vs. operation voltage



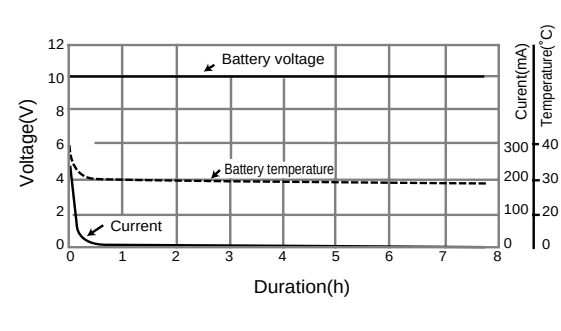
■ Superior safety

Lithium batteries feature stable substances for the active materials and a structural design that assures safety and, as such, their superior safety has been verified from the results of repeatedly subjecting them to a number of different safety tests. As a result, Panasonic's lithium batteries have been approved under the safety standard (UL1642) of UL (Underwriters Laboratories Inc.).

Battery surface temperature when short-circuited



BR2325 Charge resistance characteristics (10V consistent-voltage charge)



Rechargeable Coin Type Lithium Batteries

■ Lithium rechargeable batteries come with excellent characteristics and high reliability.

Long-term reliability
High capacity
Low self-discharge rate
Resistance to continuous discharge
Resistance to over discharge

Comparison Table of Lithium Battery Types

Item \ Type / Model		Non-rechargeable battery		Rechargeable battery			
		BR	CR	VL	ML	NBL	MT
Material	(+)electrode	(CF) n	MnO_2	V_2O_5	LixMnOy	Nb_2O_5	LixMnOy
	(-)electrode	Li	Li	LiAl	LiAl	LiAl	LixTiOy
Nominal voltage		3	3	3	3	2.0	1.5
Operating temperature range(°C)		cylindrical : -40 ~ +85 coin : -30 ~ +80 high operating temperature coin : -30 ~ +125 pin : -30 ~ +80	cylindrical : -40 ~ +70 coin : -30 ~ +60	-20～+60	-20～+60	-20～+60	-20～+60
Self-discharge (per year) under standard conditions	Cylindrical type	0.5%	1.0%	2.0%	2.0%	2.0%	5.0%
	Coin type	1.0%	1.0%				
Average discharge voltage(V)				2.85	2.5	1.5	1.2
Charge voltage(V)				3.25～3.55	2.8～3.2	1.8～2.5	1.6～2.6
Cut-off voltage(V)				2.5	2.0	1.0	1.0
Charge-discharge cycles				**1000** charge/discharge partly (charge/discharge for 10% of discharge depth)	**1000** charge/discharge partly (charge/discharge for 10% of discharge depth)	**1000** charge/discharge partly (charge/discharge for 10% of discharge depth)	**500** charge/discharge up to 1V or discharge limit voltage (charge/discharge for 100% of discharge depth)

Comparison Between BR and CR

		BR	CR
Electrolyte		Organic electrolyte	
Performance	Discharge capacity	BR＝CR	
	Voltage during discharging	BR＜CR (Higher)	
	Flatness of discharge voltage	(Flatter) BR＞CR	
	Load characteristics	BR＜CR (Superior)	
	Storage properties (self-discharge) ＜60°C ＞60°C	 (Less self-discharge) BR≧CR (Less self-discharge & stable) BR＞CR	

Notes: In terms of their characteristics, the CR series provides a slightly higher voltage during discharge than the BR series. BR batteries, compared with CR batteries, show more stable characteristics with less discharge voltage variations. These characteristics should be taken into consideration when selecting a battery for each application.

Applications

Usage		Type of Battery (See below for a description of items 1~10)									
		Coin type							Cylindrical type		Pin type
		Non-rechargeable type			Rechargeable type				Non-rechargeable type		
		1	2	3	4	5	6	7	8	9	10
Watches	Analog	○		○							
	Digital	○		○							
	Clocks	○		○							
	Rechargeable watches							◎			
Calculators		○		○							
Cameras	AE cameras								○	○	
	Flashes									◎	
	Digital cameras									◎	
Games	Portable game players			◎							
	Memory back up	○		○							
Small card devices				○							
IC tags				○							
IC cards		○		○							
Memory back up (small load)		◎	○	○	◎	◎	◎	○	◎	○	
Medical equipment		○							○	○	
Electronics thermometers				○							
Car equipment	Keyless entry			○	○						
	Memory back up		○								
Meters									◎	○	
Electronic organizers				○							
Household use	Shaver									○	
	Lights			○						○	
	Solar remote control				○						
Business use	Communication equipment								○		
	Test equipment								○		
Fishing equipment	Electronic float with lightning diode										○
	Light for a pole										○
	Lighted lures										○

1 : Poly-carbonmonofluoride Lithium Battery
2 : High operating temperature Poly-carbonmonofluoride Lithium Battery
3 : Manganese Dioxide Lithium Battery
4 : Vanadium Pentoxide Lithium Rechargeable Battery
5 : Manganese Lithium Rechargeable Battery
6 : Niobium-Lithium Rechargeable Battery
7 : Manganese Titanium Lithium Rechargeable Battery
8 : Poly-carbonmonofluoride Lithium Battery
9 : Manganese Dioxide Lithium Battery
10 : Poly-carbonmonofluoride Lithium Battery

◎ Recommended applications
○ Potential applications

Model Number

■ How to interpret the model numbers generally used for coin-type lithium batteries

The model numbers are normally indicated using two upper-case English letters and a figure consisting of three or more digits as shown in the example below.

Example

B	R	2	3	2	5
Battery type	Round	Diameter		Height	

Figures to first decimal place with decimal point omitted(ex.2.5mm)
Integers omitting fractions(ex.23mm Dia.)
In accordance with JIS and IEC standards

The above numbering system is supported by the Japan International Standard Committee of Clocks and Watches and is also an established practice in Japan.

Selecting a Battery

■ Selecting batteries

The steps for selecting the batteries for the power supplies of specific equipment are summarized below.

● **Preparation of required specifications (draft)**

The required specifications (draft) are studied by checking the requirements for the batteries to be used as the power supplies of the specific equipment and their conditions against the battery selection standards. The technical requirements for battery selection are shown in the table below for reference purposes.

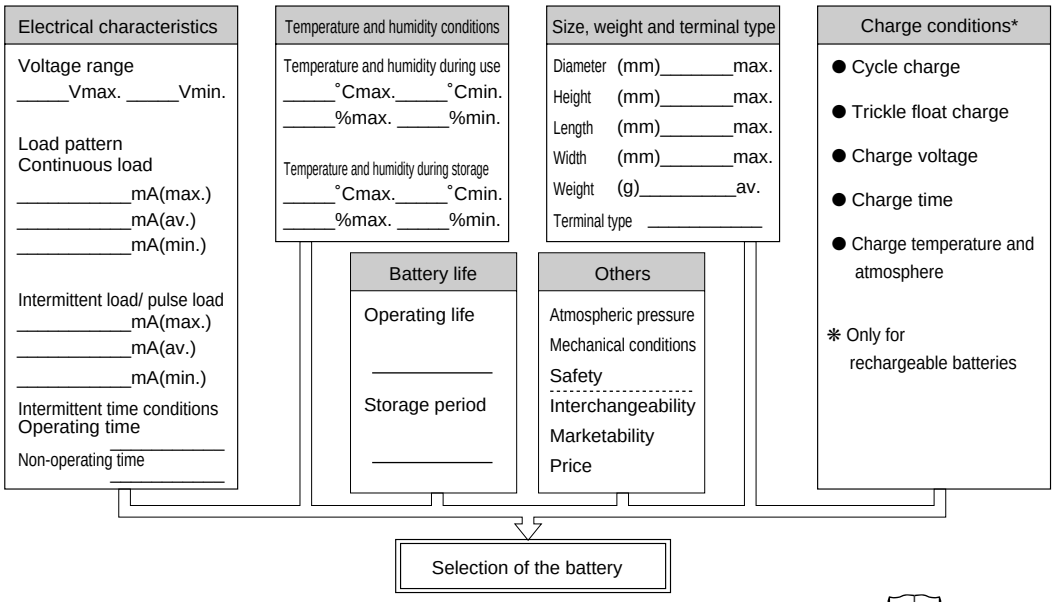
● **Selection of a battery**

Select several candidate batteries by referring to the catalogs and data sheets of batteries which are currently manufactured and marketed. From this short list, select the battery which will best meet the ideal level of the requirements. In actual practice, however, the "perfect" battery is seldom found by this method, instead, the basic procedure followed should be to examine the possibility of finding a compromise or partial compromise with the required specifications (draft) and then make a selection under the revised requirements from the batteries currently manufactured and marketed. Such a procedure enables batteries to be selected more economically. Questions and queries arising at this stage should be directed to our battery engineers. Sometimes, although it may not be shown in the catalog, the appropriate battery has become available through recent development or improvement. As a rule, the required specifications are finalized at this stage.

● **Requests for developing or improving batteries**

If the battery that meets the essential and specific requirements cannot be found through the selection process described above, a request for battery development or improvement should be made to our technical Department. A request like this should be coordinated as early as possible to allow for a sufficient study period. While this period depends on the nature of the request and the difficulties involved, a lead time of at least 6 to 12 months is usually required.

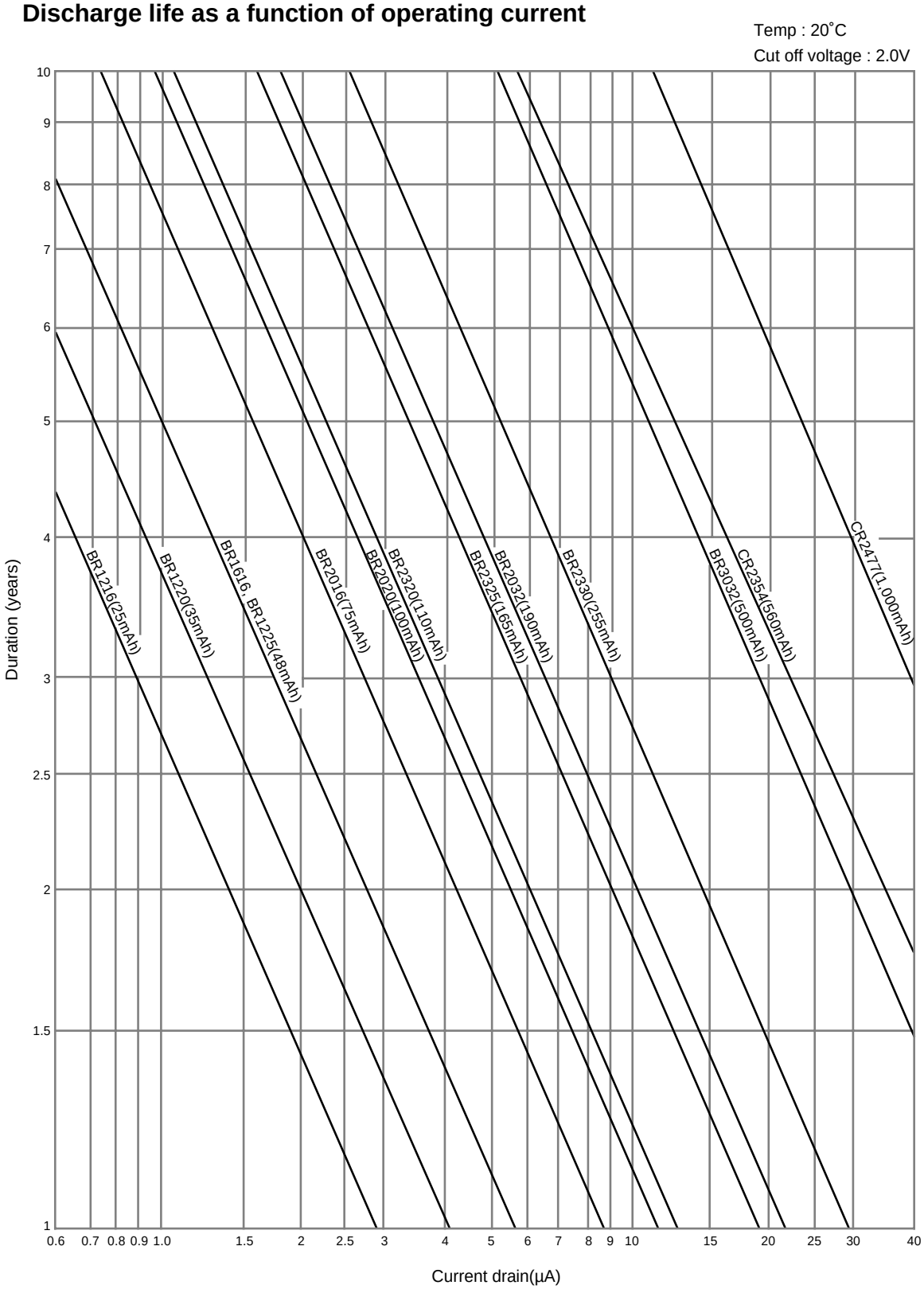
■ Technical conditions for selecting batteries



Battery Selector Chart

Coin Type Lithium Non-rechargeable Batteries (Example)

Discharge life as a function of operating current



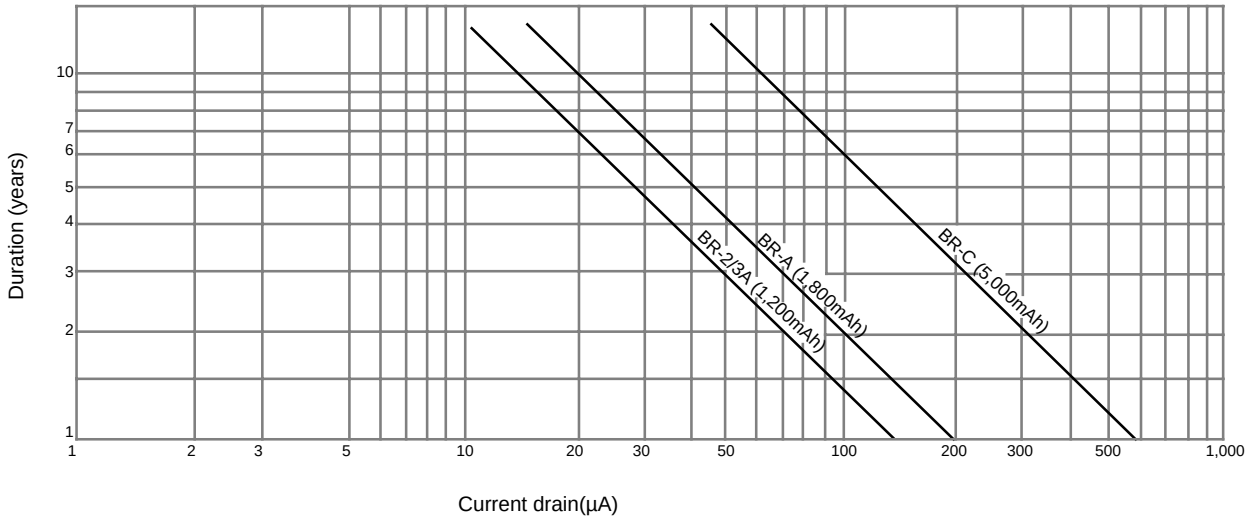
Calculation

$$\text{Duration (years)} = \frac{\text{Nominal capacity(mAh)}}{\text{Current drain (mA)} \times 24\text{(hours)} \times 365\text{(days)}}$$

Cylindrical Type Lithium Non-rechargeable Batteries (Example)

Discharge life as a function of operating current

Temp : 20˚C
Cut off voltage : 2.0V



Calculation

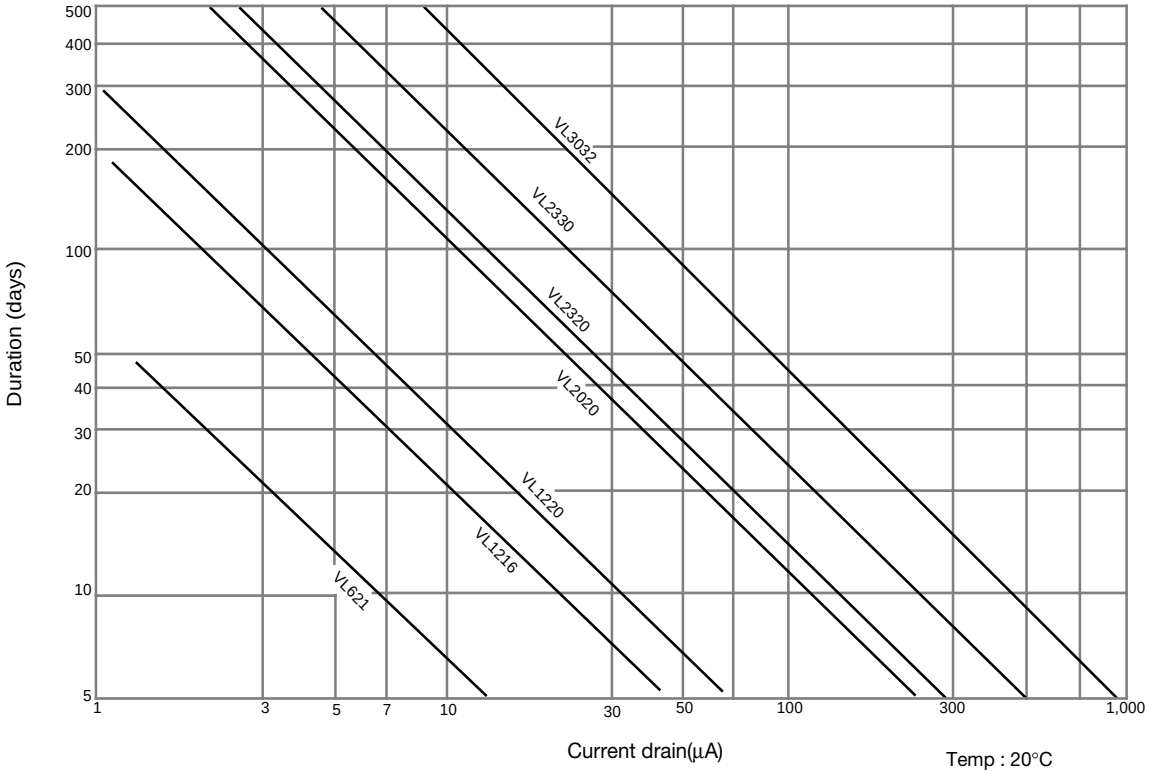
$$\text{Duration (years)} = \frac{\text{Nominal capacity(mAh)}}{\text{Current drain(mA)} \times 24\text{(hours)} \times 365\text{(days)}}$$

Battery Selector Chart

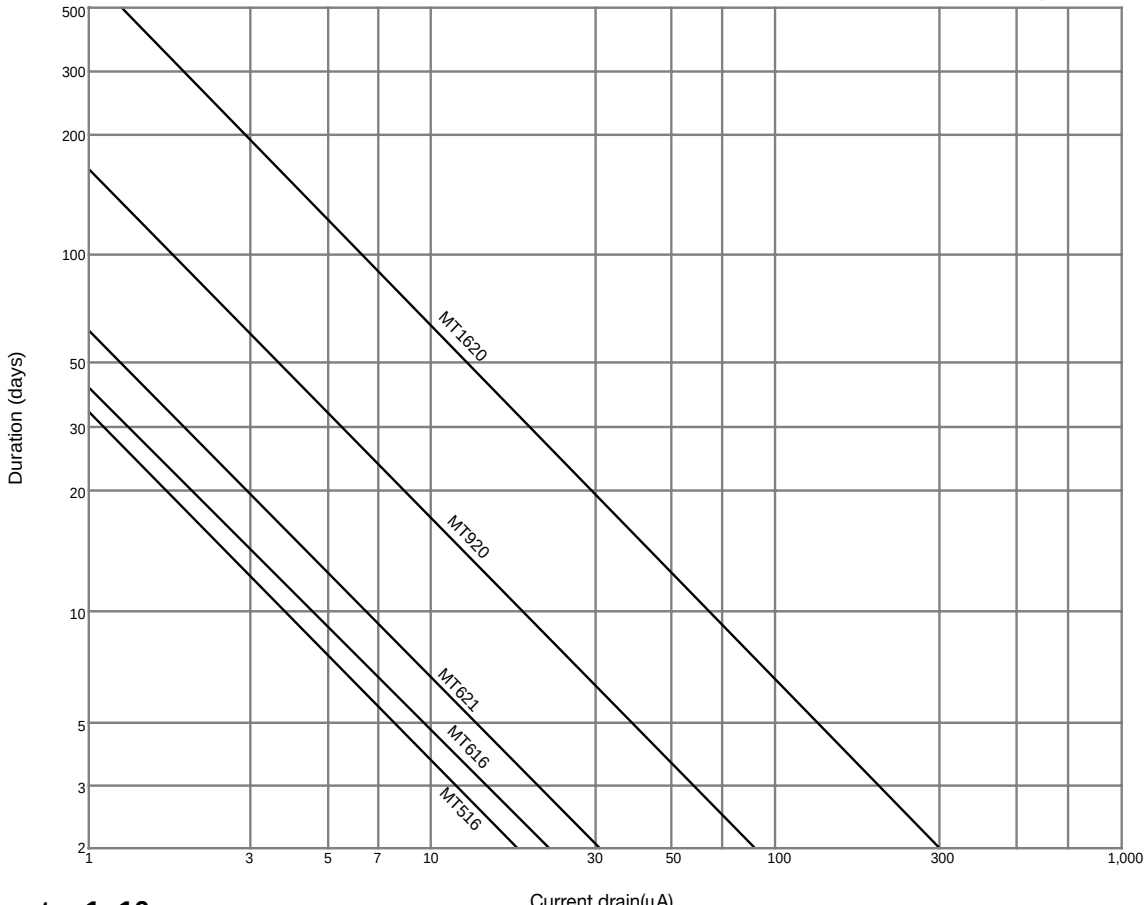
Coin Type Lithium Rechargeable Batteries (Example)

Discharge life as a function of operating current

Temp : 20°C
Cut off voltage : 2.5V

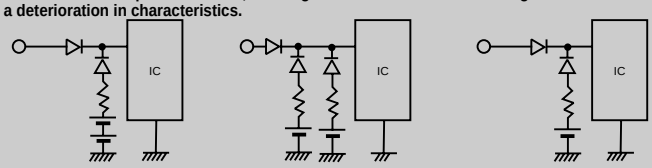
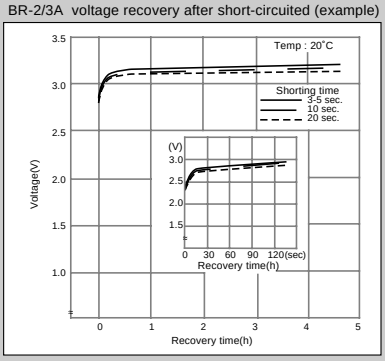


Temp : 20°C
Cut off voltage : 1.0V



Safety Precautions for Using, Handling and Designing

Common to Both Primary and Rechargeable Batteries

Classification	Item	Precaution
Batteries	Voltage measurement	To measure the battery voltage, use an instrument with an input resistance of 10MΩ or higher.
	Internal resistance measurement	To measure the internal resistance, use a 1000Hz AC instrument.
	Electrical characteristics check	Even minimal shorting causes the battery voltage to drop, requiring a period of time for the voltage to recover. Checking the voltage characteristics before the voltage has sufficiently recovered in such a situation may result in a misjudgment of battery voltage.
	Cleaning	Prior to installation in the equipment, wipe the batteries and equipment terminals clean using a dry cloth, etc.
	Washing and drying	- Washing: Use of a conductive detergent causes batteries to discharge, the battery voltage to drop and the battery performance to deteriorate in other ways. Be sure to use a non-conductive detergent. - Drying: The heat produced when the temperature of the battery units rises above 85˚C deforms the gaskets and causes electrolyte leakage and a deterioration in performance. Be sure to dry batteries only for short periods of time at temperatures below 85˚C.
	Mounting	- Ensure that dust and other foreign substance will not cause shorting between the poles. - When handling batteries, wear finger covers or gloves made of rubber, cotton, etc. to protect the batteries from dirt.
	U L	Strictly comply with the conditions outlined on the next page.
	Use of multiple batteries	Give sufficient consideration to safety in design when a multiple number of batteries are to be used. Consult with Panasonic concerning packs of multiple batteries.
	Simultaneous use of other types of batteries	When other types of batteries are also to be used in the some equipment, design the circuitry in such a way that the current (leakage current) from the other batteries will not flow to the lithium batteries. (This applies to primary batteries.)
	Use of batteries in series or in parallel	This requires special circuitry:Please consult with Panasonic. Do not use lithium batteries together with different types of batteries in series or in parallel. (This applies to rechargeable batteries.)
	Battery life	Take precautions in design since the internal resistance increases when batteries approach the end of their service life.
Battery compartments in equipment	Design	- Ensure that the batteries can be replaced easily and that they will not fall out of position. - Give consideration to the battery dimensions, tolerances, etc. - Give consideration to the shape of (+) and (-) electrodes of the batteries and their tolerances to prevent installation in reverse. - Clearly indicate on the battery compartment the type of batteries to be used and their correct installation direction (polarities). - Limit the electrical circuits inside the battery compartment only to the circuits relating to the battery contacts. - With the exception of the terminal areas, insulate the battery compartment from the electrical circuits. - Take steps to minimize any damage to the equipment resulting from electrolyte leakage from the battery compartment. - Batteries should be free from leakage of liquids, which can damage equipment and spoil the contact at terminals, making the operation of equipment unstable.
	Battery layout and construction and materials of compartment	- Take steps to ensure the batteries are not located heat generating component in the equipment. Installing batteries near a heat source will heat up the batteries, causing thermal deformation of the gasket and resulting in electrolyte leakage and a deterioration in characteristics.  1. 2-cell 6V usage 2. Parallel usage 3. UL conditions - Adopt a construction which allows the gases to be vented. (When a protective resistor has been inserted) - Give consideration to the impact and the effect on the environment in selecting the materials to be used. (For primary batteries)
Contacts and connection terminals	Contact point materials	Use nickel-plated iron or nickel-plated stainless steel for the contact points.
	Contact pressure of contacts	In order to ensure stable contact, use the following levels of contact as a general guideline: 5N to 15N for cylindrical types 2N to 10N for coin types.
	Shape of terminals	Use of Y-shaped terminals (2-point contact) for both the (+) and (-) electrodes yield stable contact.
	Connection terminals	If lead wires and connection terminals such as tab terminals are required for the batteries, consult with Panasonic since we offer a range of external terminals (connectors, etc.).
Notes		(1)Shorting causes the battery voltage to drop to about 0V before slowly recovering from the open state. It takes time for the initial voltage to be restored. Notice that measuring the open-circuit voltage immediately after shorting may lead to a misjudgment that the battery is abnormal. The figure on the right illustrates how voltage recovers after shorting. (2)Reverse current preventing diodes.Since lithium primary batteries are not rechargeable, use of a reverse current preventing diode and a protective resistor in series is required where there is the possibility of charging in the equipment circuit. Use a silicon diode or Schottky diode with a low reverse current as the reverse current preventing diode. To maintain the characteristics of a coin-type lithium battery, the total charging amount of the battery during its total usage period must be kept within 3% of the nominal capacity of the battery. BR-2/3A voltage recovery after short-circuited (example) 

Primary Batteries

Since lithium primary batteries are not rechargeable, use a reverse current blocking diode and a protective resistor in series where there is the possibility of charging in the equipment circuit.

■ Reverse current blocking diode

· Diode used: Use a silicon diode or Schottky diode having only a low reverse current (this current varies with temperature).
· Selection standard (in order to maintain the battery characteristics): The total allowable charging amount of a battery during its total usage period must be no greater than 3% of the nominal capacity of the battery for a coin-type battery or 1% for A cylindrical battery.
[Example]: When a CR2477 (1000mAh) coin-type battery is to be used for 5 years, a reverse current preventing diode with a reverse current of 0.7µ A or less is required.
<Calculation method>
1000mAh (CR2477) x ≦3% (coin-type battery) = ≦30mAh
30mAh ÷ usage period (5 years x 365 days x 24 hours) = 0.7µA

■ Use of protective resistor in series: Selection and installation (UL Standard)

A resistor must be installed in series with the battery to limit the charge current which will flow to the battery in case of destruction in continuity of the reverse current preventing diode. The maximum allowable current is specified for each battery size in the table at the right, and the resistance value of the protective resistor is determined as: R>V ÷ I (where "I" is the maximum allowable charge current specified by UL).

* This circuit is also recommended for products which are not UL-approved.

Conditions for UL Standard (Contact Panasonic for further details.)

1. Use of protective resistor in series

[Selection] Select the protective resistor in such a way that the charge current which will flow to the battery when the diode is destroyed is less than the value given in the table on the right.

[Installation] To protect the battery from being charged in the event of the destruction of the diode, install a protective resistor in series with the battery.

2. Battery replacement

[Replacement by qualified engineer]These batteries are intended for use as a part of an electrical circuit in equipment and any battery with an asterisk " * " in the table on the right should only be replaced by a qualified engineer.

[Replacement by user]Those lithium batteries which are not accompanied by an asterisk " * " in the table on the right and which include the use of up to four of them in series or in parallel may be replaced by users provided that the conditions specified by the UL Standard are met.

[Use in series or in parallel]In replacing up to four batteries, the batteries must all be replaced with new ones at the same time. Set the maximum allowable charge current to within the current permitted by the number of batteries in series or in parallel.

■ UL approval and maximum allowable charge current

The batteries below were approved by UL, File No. MH12210 As of April, 2000

Shape	Model number	UL approval as of April,2000 (File No. MH12210)	Maximum allowable charge current (mA)
Cylindrical type BR series	*BR-C	○	20
	*BR-A	○	15
	BR-2/3A	○	10
	BR-2/3AH	○	10
	BR-2/3AG	○	10
	*BR-AG	○	15
	*BR-AH	○	15
Cylindrical type CR series	CR2	○	20
	CR123A	○	25
	2CR5	○	25
	CR-P2	○	25
	CR-AG	○	25
	CR-2/3AG	○	25
	CR-V3p	○	25
	CR-V6p	○	25
Coin type BR series	*BR3032	○	5
	*BR2330	○	5
	BR2325	○	5
	BR2320	○	5
	*BR2032	○	5
	*BR2020	○	5
	BR2016	○	4
	BR1632	○	4
	BR1616	○	4
	BR1225	○	3
	BR1220	○	3
	BR1216	○	3
	*BR2477A	○	5
	*BR2330A	○	5
	BR1632A	○	4
	BR1225A	○	3
Coin type CR series	*CR3032	○	10
	*CR2477	○	10
	CR2450	○	30
	CR2412	○	4
	*CR2354	○	10
	*CR2330	○	10
	*CR2320	○	5
	CR2032	○	5
	CR2025	○	5
	CR2016	○	4
	CR2012	○	4
	CR1632	○	4
	CR1620	○	4
	CR1616	○	4
	CR1612	○	3
	CR1220	○	3
	CR1216	○	3
	CR1212	○	2
	CR1025	○	2
Pin type BR series	BR435	○	0.2
	BR425	○	0.1
Coin type VL series (Rechargeable battery)	VL621	○	300
	VL1216	○	300
	VL1220	○	300
	VL2020	○	300
	VL2320	○	300
	VL3032	○	300
Coin type ML series (Rechargeable battery)	ML612	○	300
	ML614	○	300
	ML616	○	300
	ML621	○	300
	ML920	○	300
	ML1220	○	300
	ML2020	○	300

*Please read "Conditions for compliance with UL Standard" carefully

Rechargeable Batteries

· Use of multiple batteries: Consult with Panasonic if two or more vanadium-lithium rechargeable batteries (VL batteries) or manganese-lithium rechargeable batteries (ML batteries) are to be used in series or in parallel.
· Charging: Details on the charge voltage, charge current and charge circuit are given for each type of battery.
· Conditions of UL approval: The maximum charge current must be restricted to 300mA when protective components have been subjected to short- or open-circuiting.

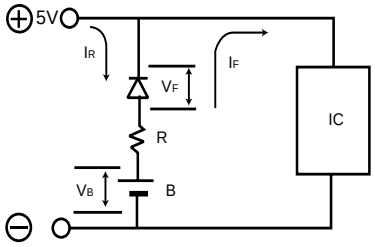
Design for Memory Back-up Use

■ Selecting batteries

When selecting batteries, give consideration to such factors as the current consumption of the equipment in which the batteries are to be used, the expected life of the batteries, and temperature in the operating environment. At low operating environment temperatures, the consumption current of the ICs drops but the discharge voltage of the batteries will also decrease. Also it is important to note that the capacity deterioration of batteries in long-term use becomes significant at high operating environment temperatures.

■ Memory backup circuit and holding voltage

The circuit typically used for memory backup is shown in the figure on the right. The memory holding voltage is expressed as: $V_B - V_F - I_F \times R >$ memory holding voltage of IC.



■ Reverse current blocking diode

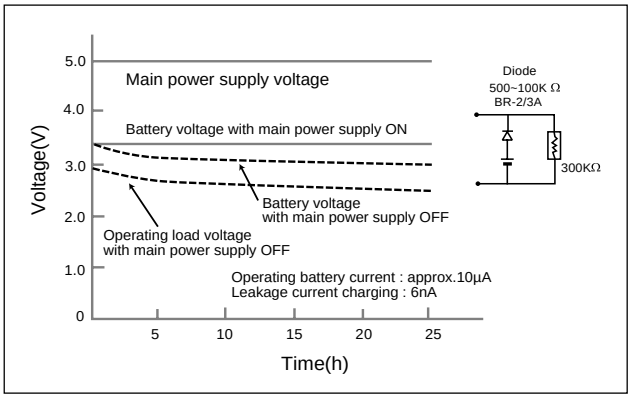
Since lithium primary batteries are not rechargeable, use of a reverse current blocking diode and a protective resistor in series is required where there is the possibility of charging in the equipment circuit. Use a silicon diode or Schottky diode with a low reverse current as the reverse current blocking diode. To maintain the characteristics of a coin-type lithium battery, the total charging amount of the battery during its total usage period must be kept within 3% of the nominal capacity of the battery. For example, assuming that a CR2477 (1000mAh) will be used in a memory backup power supply for 5 years, charging by the reverse current of the reverse current blocking diode should be no greater than 30mAh (=3% of 1000mAh), thus: 30mAh ÷ usage period (5 years x 365 days x 24 hours) = 0.7µA. In other words, a reverse current blocking diode whose reverse current is not greater than 0.7µA must be selected.

Allowable total charging amount :	Within 3% for coin-type batteries Within 1% for cylindrical type batteries

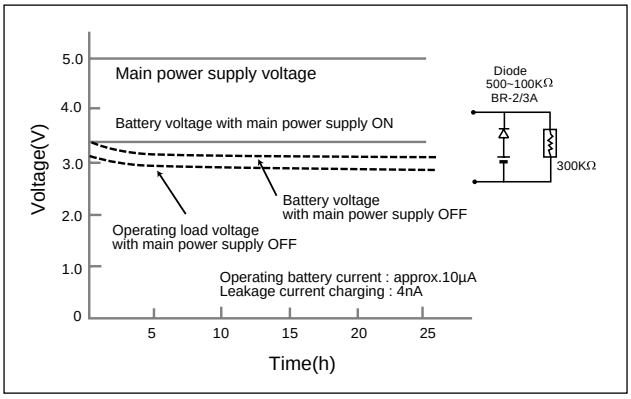
Note that the reverse current of reverse current blocking diodes varies with temperature.

■ Example of Voltage Characteristics

Using a typical silicone diode

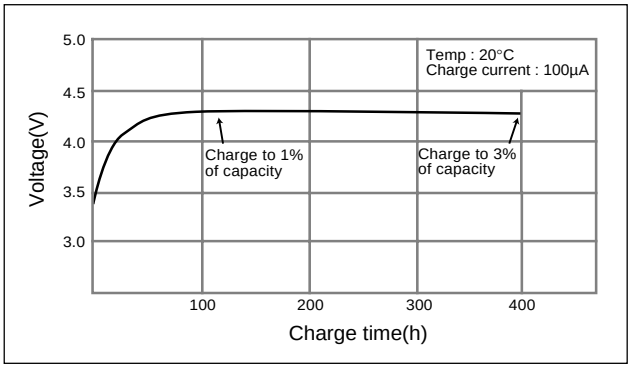


Using a Shottky barrier diode

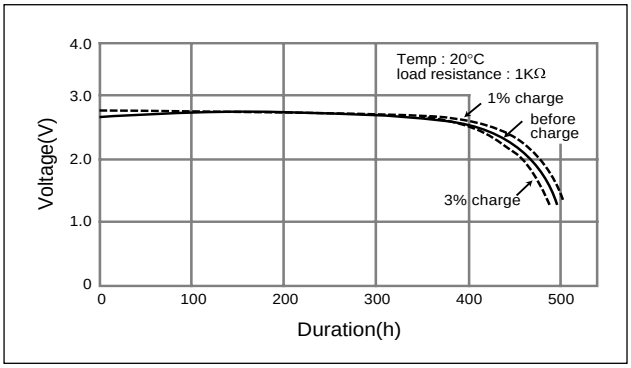


■ Charge test results assuming diode leakage current

BR-2/3A (Cylindrical type) Charge test



BR-2/3(cylindrical type) Discharge test after charging



Chapter 2

Lithium Primary Batteries

INDEX

2-1 Cylindrical Type Lithium Batteries

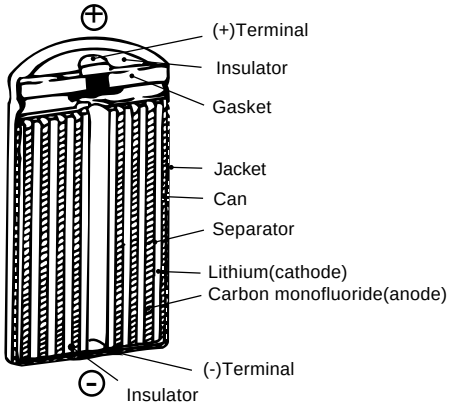
2-1-1 Poly-carbonmonofluoride Lithium Batteries (BR series)

Features

Ever since their market launch in 1973, our Poly-carbonmonofluoride (BR series) lithium batteries have accumulated a proven track record and figured prominently as the batteries used in cameras. In addition, their long-term operating performance that spans some 10 years makes them the ideal choice as power supplies for products such as meters and they continue to lead the way in applications that demand long-term reliability.

Construction

All cylindrical type Poly-carbonmonofluoride (BR series) lithium batteries feature a spiral structure, and by enlarging the surface areas of the positive and negative electrodes they allow a current as high as several amperes to be drawn.



Structure of Cylindrical type BR series Lithium battery (Spiral type)

Applications

- Various memory backup power supplies
- Camera power supplies
- Equipment for use in low-temperature regions
- Water meters, gas meters and power meters
- Rescue and emergency equipment
- Communications equipment, measuring instruments, meteorological observation equipment

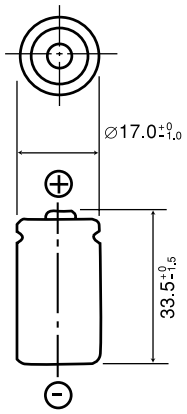
General Specifications

Model No.	Electrical characteristics (20°C)			Dimensions(mm)		Weight(g)	JIS	IEC
	Nominal voltage(V)	*Nominal capacity(mAh)	Continuous drain(mA)	Diameter	Height			
BR-2/3A	3	1,200	2.5	17.0	33.5	13.5	-	-
BR-2/3AH	3	1,350	2.5	17.0	33.5	13.5	-	-
BR-2/3AG	3	1,450	2.5	17.0	33.5	13.5	-	-
BR-A	3	1,800	2.5	17.0	45.5	18.0	-	-
BR-AH	3	2,000	2.5	17.0	45.5	18.0	-	-
BR-AG	3	2,200	2.5	17.0	45.5	18.0	-	-
BR-C	3	5,000	5.0	26.0	50.5	42.0	-	-

* Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0V at 20°C.

BR-2/3A

■ Dimensions(mm)

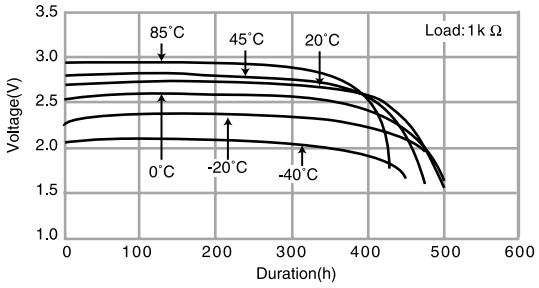


Weight: 13.5g

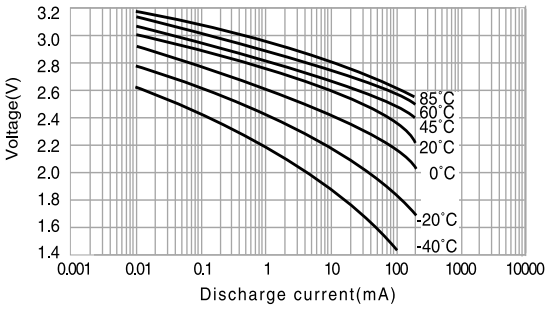
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	1,200
Continuous standard load(mA)	2.5
Operating temperature(˚C)	-40 ~ +85

■ Temperature Characteristics

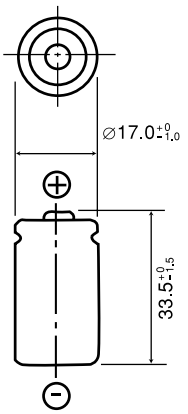


■ Operating voltage vs. Discharge current
(voltage at 50% discharge depth)



BR-2/3AH

■ Dimensions(mm)

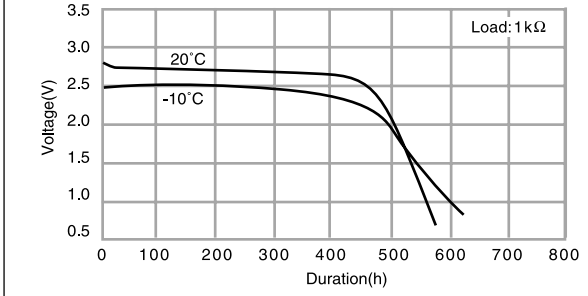


Weight: 13.5g

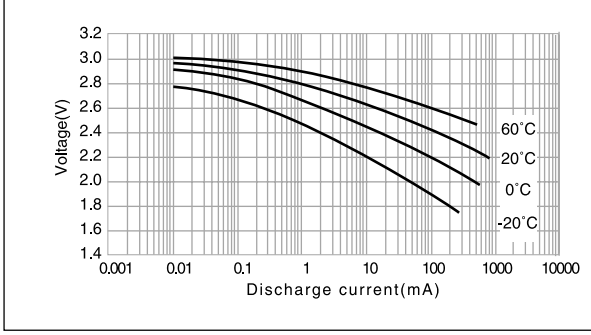
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	1,350
Continuous standard load(mA)	2.5
Operating temperature(˚C)	-40 ~ +85

■ Temperature Characteristics

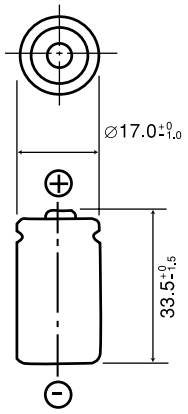


■ Operating voltage vs. Discharge current
(voltage at 50% discharge depth)



BR-2/3AG

■ Dimensions(mm)

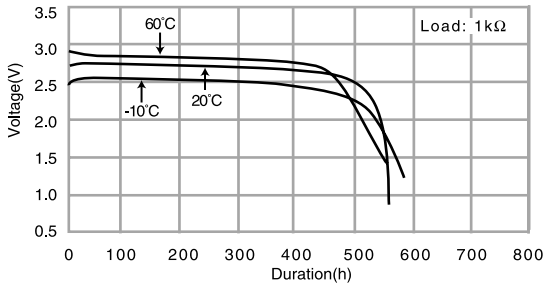


Weight: 13.5g

■ Specification

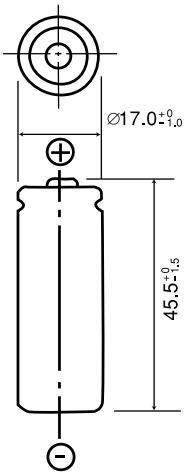
Nominal voltage(V)	3
Nominal capacity(mAh)	1,450
Continuous standard load(mA)	2.5
Operating temperature(˚C)	-40 ~ +85

■ Temperature Characteristics



BR-A

■ Dimensions(mm)

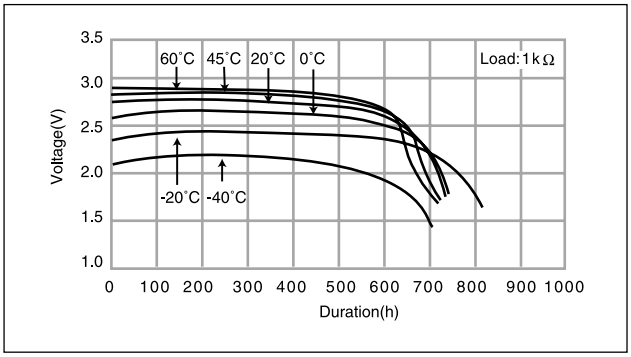


Weight: 18.0g

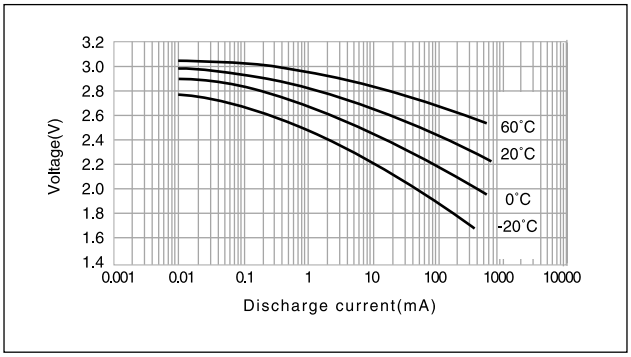
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	1,800
Continuous standard load(mA)	2.5
Operating temperature(˚C)	-40 ~ +85

■ Temperature Characteristics

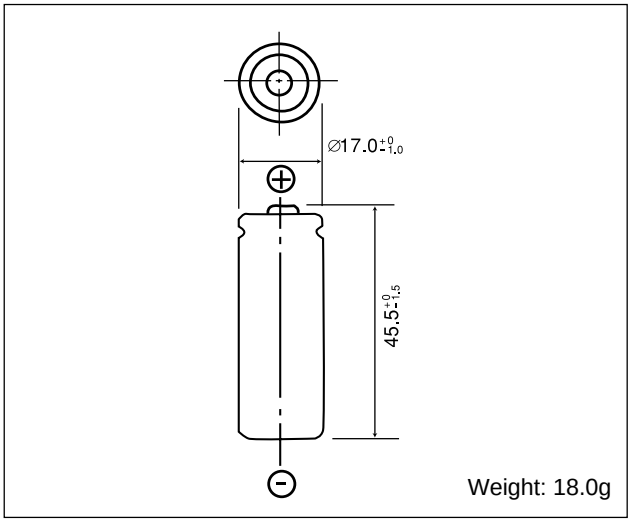


■ Operating voltage vs. Discharge current
(voltage at 50% discharge depth)



BR-AH

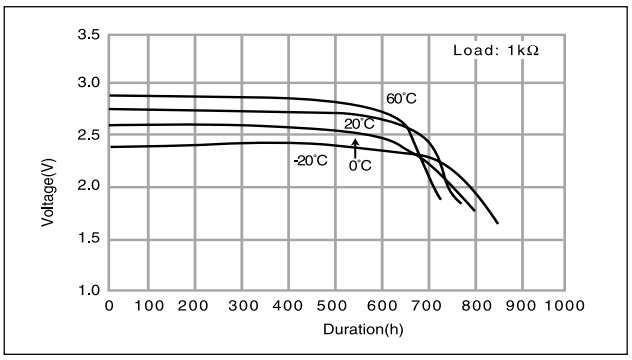
■ Dimensions(mm)



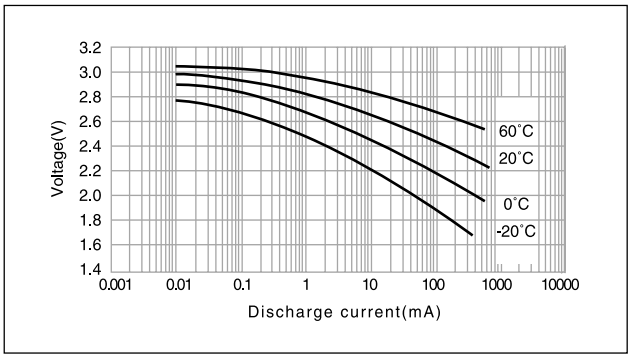
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	2,000
Continuous standard load(mA)	2.5
Operating temperature(˚C)	-40 ~ +85

■ Temperature Characteristics

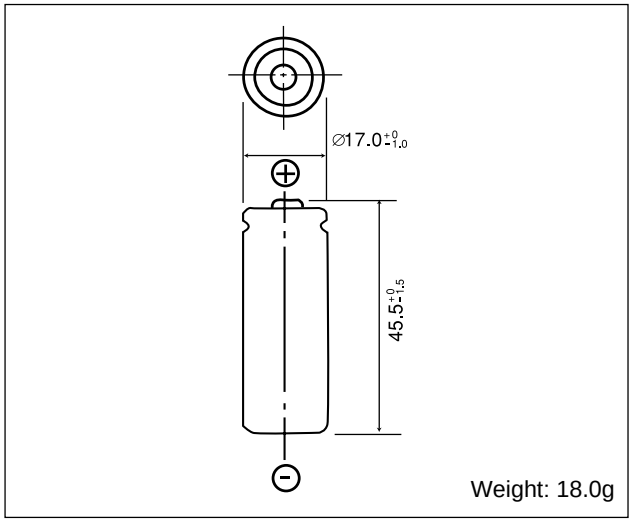


■ Operating voltage vs. Discharge current
(voltage at 50% discharge depth)



BR-AG

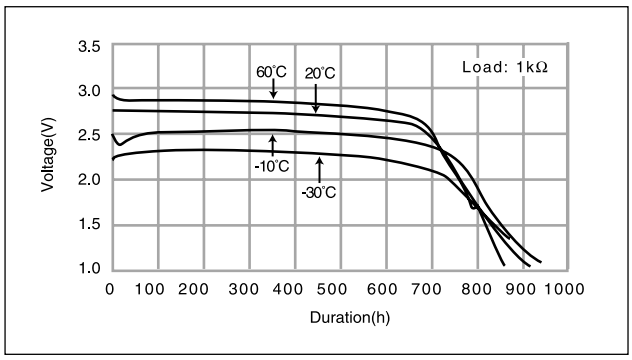
■ Dimensions(mm)



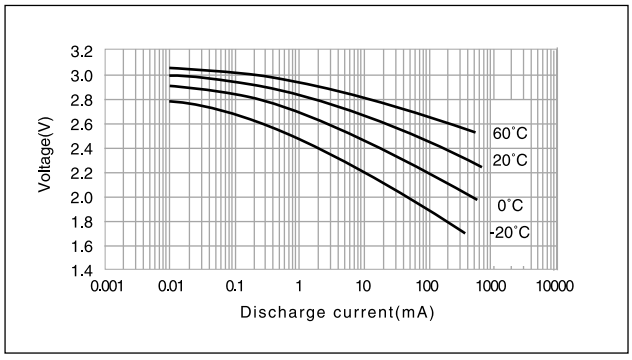
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	2,200
Continuous standard load(mA)	2.5
Operating temperature(˚C)	-40 ~ +85

■ Temperature Characteristics

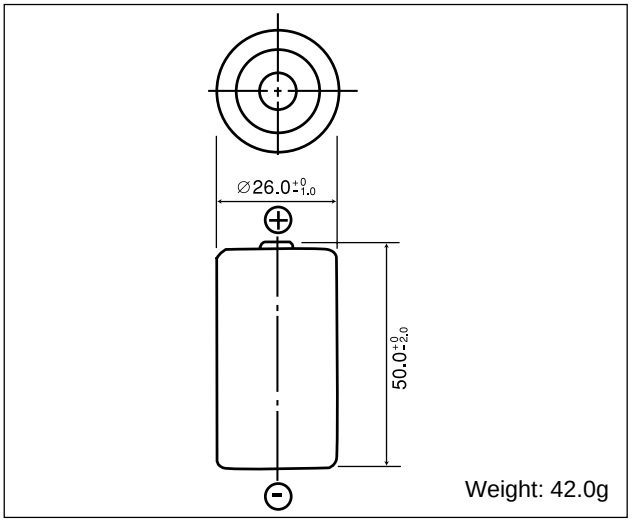


■ Operating voltage vs. Discharge current
(voltage at 50% discharge depth)



BR-C

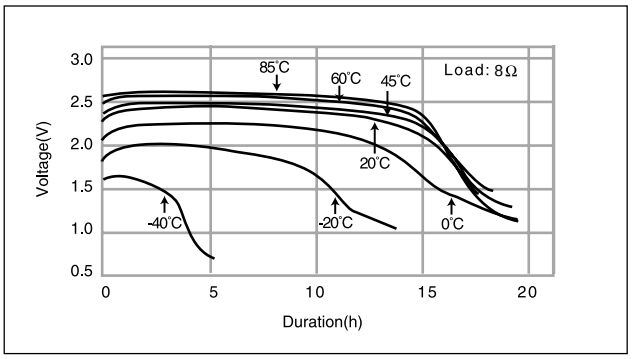
■ Dimensions(mm)



■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	5,000
Continuous standard load(mA)	5.0
Operating temperature(˚C)	-40 ~ +85

■ Temperature Characteristics



2-1 Cylindrical Type Lithium Batteries

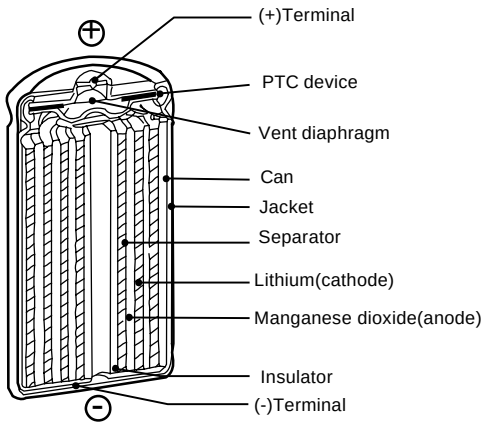
2-1-2 Manganese Dioxide Lithium Batteries (CR Series)

Features

These lithium batteries come as either single cells or dual cell packs. Pack batteries are packaged in a resin case enabling easy replacement by users and their development was pioneered by Panasonic.
Note:Batteries with the same design are also available on the consumer/retail market.

Construction

All cylindrical type manganese dioxide (CR series) lithium batteries feature a spiral structure, and by enlarging the surface areas of the positive and negative electrodes they allow a current as high as several amperes to be drawn.



Applications

- Cameras, Camera flash units, Shavers, Electric toothbrushes, Lights, Toys, etc.

* Be sure to consult with Panasonic before using batteries in products other than the above applications or before using two or more batteries together.

General Specifications

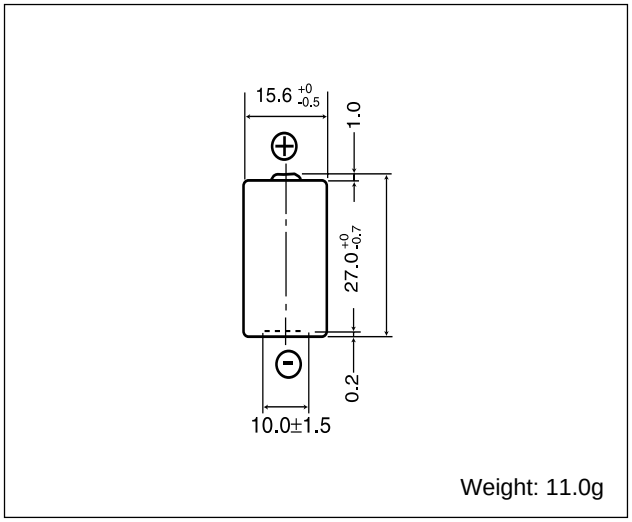
Model No.	Electrical characteristics (20°C)			Dimensions(mm)		Weight(g)	JIS	IEC
	Nominal voltage(V)	*Nominal capacity(mAh)	Continuous drain(mA)	Diameter	Height			
CR2	3	750*	20	15.6	27.0	11.0	-	-
CR123A	3	1,300*	20	17.0	34.5	17.0	-	CR17345

Model No.	Electrical characteristics (20°C)			Dimensions(mm)			Weight(g)	JIS	IEC
	Nominal voltage(V)	*Nominal capacity(mAh)	Continuous drain(mA)	Length	Width	Height			
2CR5	6	1,300**	20	34.0	17.0	45.0	38.0	-	2CR5
CR-P2	6	1,300**	20	35.0	19.5	36.0	37.0	-	CR-P2
CR-V3p	3	3,000*	200	28.6	14.6	52.2	39.0	-	-
CR-V6p	6	1,500**	100	28.6	14.6	52.2	39.0	-	-

* Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0V at 20°C.
** Nominal capacity shown above is based on standard drain and cut off voltage down to 4.0V at 20°C.

CR2

■ Dimensions(mm)



Weight: 11.0g

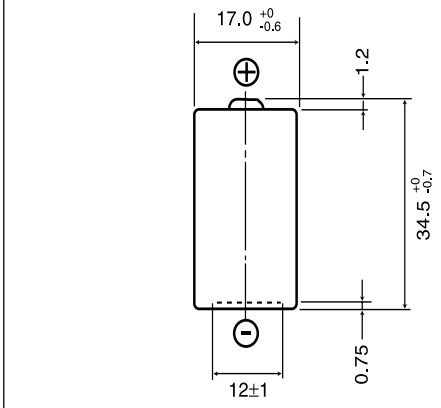
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	750
Continuous standard load(mA)	20
Operating temperature(˚C)	-40 ~ +70*

* Please consult Panasonic for use below and above -20°C to +60°C.

CR123A

■ Dimensions(mm)

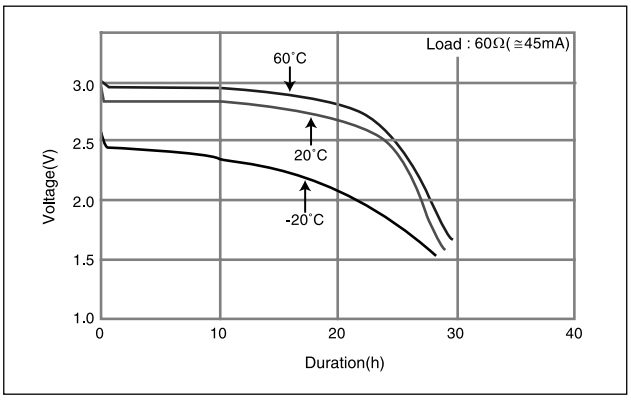


Weight: 17.0g

■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	1,300
Continuous standard load(mA)	20
Operating temperature(˚C)	-40 ~ +70*

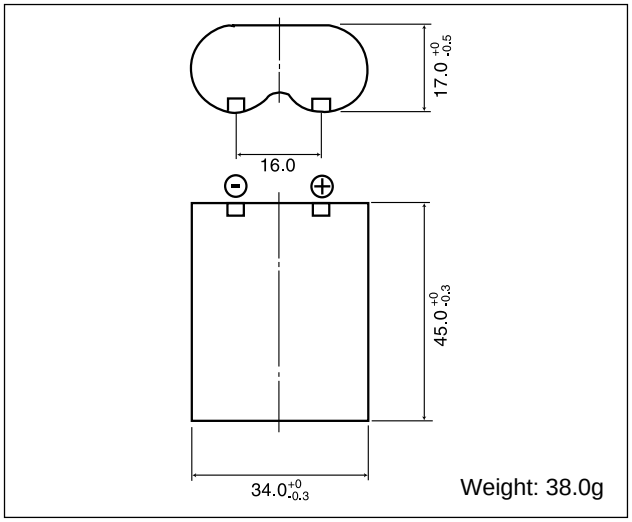
■ Temperature Characteristics



* Please consult Panasonic for use below and above -20°C to +60°C.

2CR5

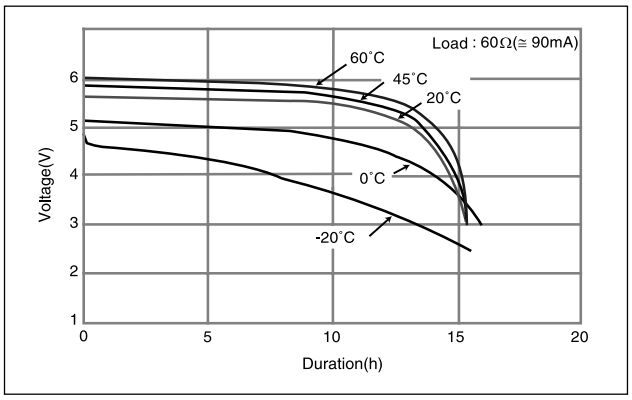
■ Dimensions(mm)



■ Specification

Nominal voltage(V)	6
Nominal capacity(mAh)	1,300
Continuous standard load(mA)	20
Operating temperature(˚C)	-40 ~ +70*

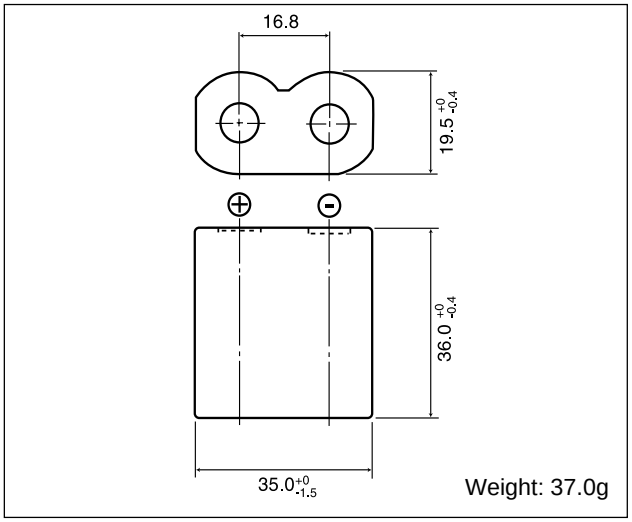
■ Temperature Characteristics



* Please consult Panasonic for use below and above -20°C to +60°C.

CR-P2

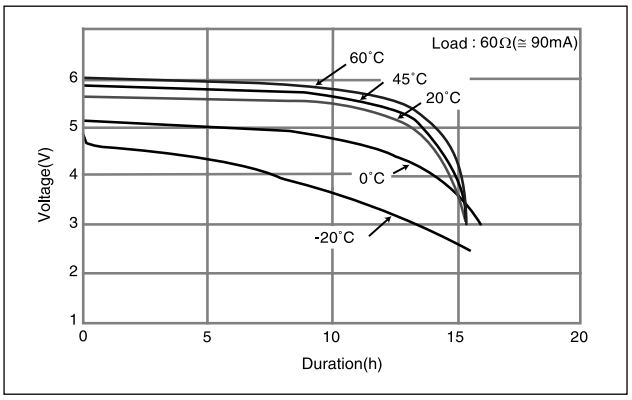
■ Dimensions(mm)



■ Specification

Nominal voltage(V)	6
Nominal capacity(mAh)	1,300
Continuous standard load(mA)	20
Operating temperature(˚C)	-40 ~ +70*

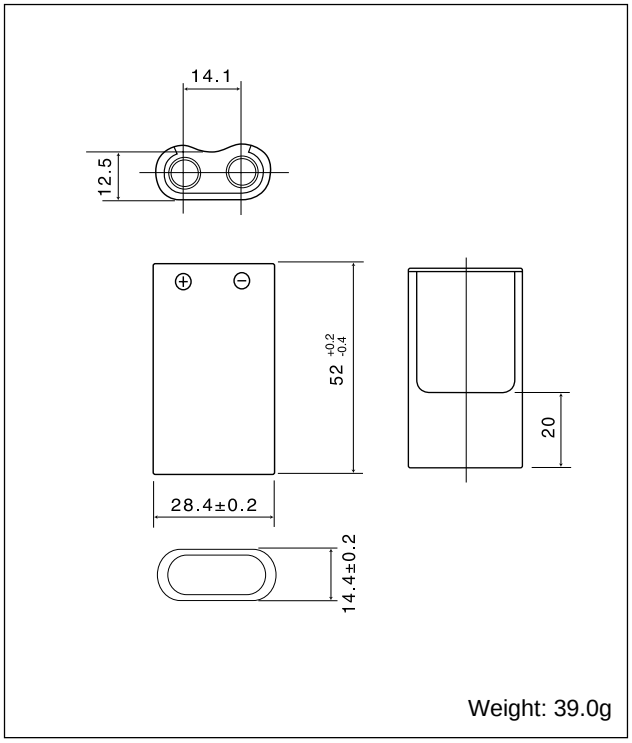
■ Temperature Characteristics



* Please consult Panasonic for use below and above -20°C to +60°C.

CR-V3p

■ Dimensions(mm)

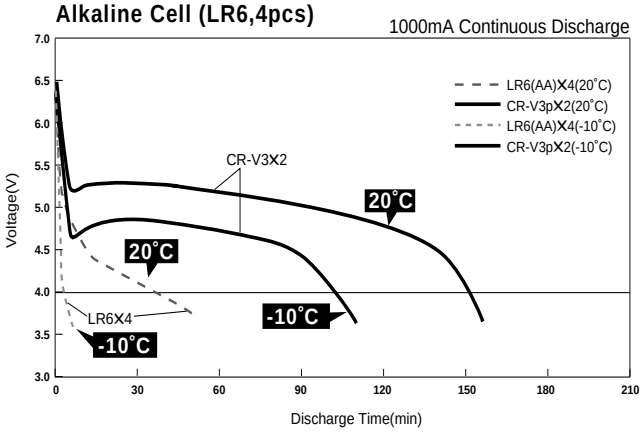


Weight: 39.0g

■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	3,000
Continuous standard load(mA)	200
Operating temperature(˚C)	-40 ~ +70*

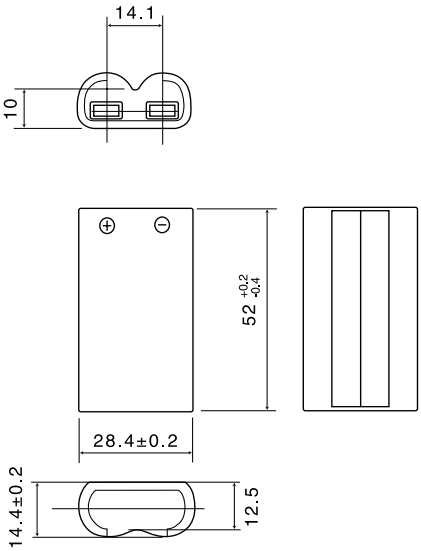
Discharge Characteristics of CR-V3p(2pcs)and"AA" Alkaline Cell (LR6,4pcs)



∗ Please consult Panasonic for use below and above -20°C to +60°C.

CR-V6p

■ Dimensions(mm)

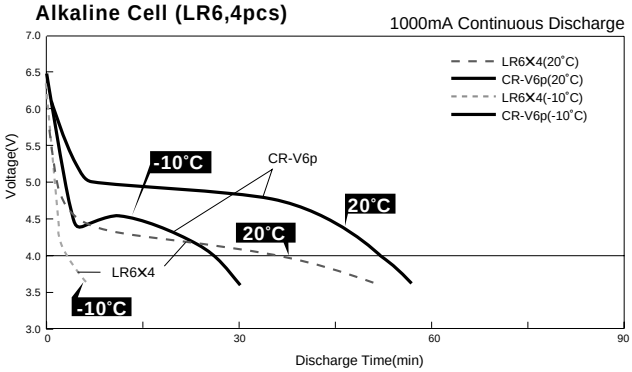


Weight: 39.0g

■ Specification

Nominal voltage(V)	6
Nominal capacity(mAh)	1,500
Continuous standard load(mA)	100
Operating temperature(˚C)	-40 ~ +70*

Discharge Characteristics of CR-V6p(1pc)and"AA" Alkaline Cell (LR6,4pcs)



∗ Please consult Panasonic for use below and above -20°C to +60°C.

2-2 Coin Type Lithium batteries

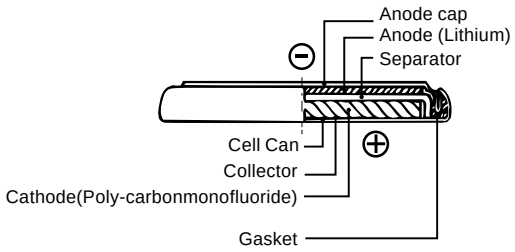
2-2-1 Poly-carbonmonofluoride Lithium Batteries (BR series)

Features

These batteries feature a high energy density and were developed and commercialized via Panasonic's extensive experience and battery technology. They exhibit stable performance under relatively high environmental temperatures.

Construction

Cutaway view



Applications

- Electronic watches (digital and analog)
- Memory backup power supplies in various equipment (provided with tab terminals)
- Electronic calculators, cameras, electronic notebooks
- Electronic thermometers
- Various other compact cordless appliances with low power consumption

Note: Always confirm that the battery to be used is suitable for the intended application before purchase and /or use.

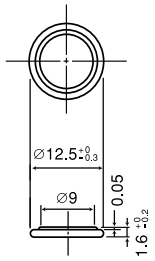
General Specifications

Model No.	Electrical characteristics (20°C)			Dimensions(mm)		Weight(g)	JIS	IEC
	Nominal voltage(V)	*Nominal capacity(mAh)	Continuous drain(mA)	Diameter	Height			
BR1216	3	25	0.03	12.5	1.6	0.6	-	-
BR1220	3	35	0.03	12.5	2.0	0.7	-	-
BR1225	3	48	0.03	12.5	2.5	0.8	-	BR1225
BR1616	3	48	0.03	16.0	1.6	1.0	-	-
BR1632	3	120	0.03	16.0	3.2	1.5	-	-
BR2016	3	75	0.03	20.0	1.6	1.5	-	BR2016
BR2020	3	100	0.03	20.0	2.0	2.0	-	BR2020
BR2032	3	190	0.03	20.0	3.2	2.5	-	-
BR2320	3	110	0.03	23.0	2.0	2.5	-	BR2320
BR2325	3	165	0.03	23.0	2.5	3.2	-	BR2325
BR2330	3	255	0.03	23.0	3.0	3.2	-	-
BR3032	3	500	0.03	30.0	3.2	5.5	-	BR3032

* Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0V at 20°C.

BR1216

■ Dimensions(mm)

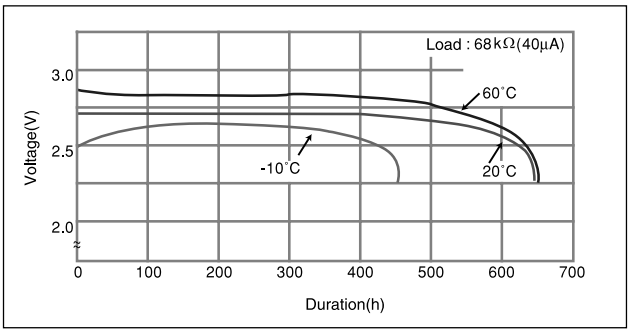


Weight: 0.6g

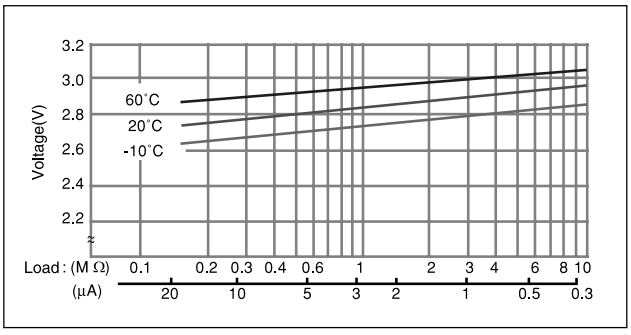
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	25
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

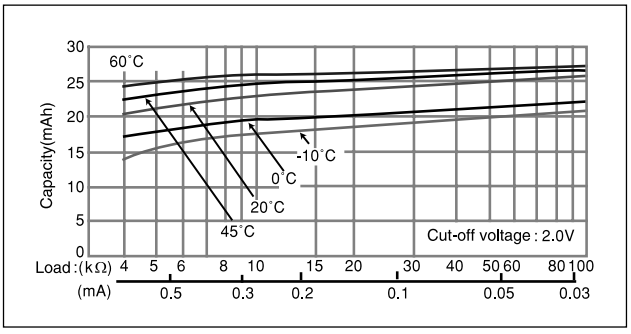
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

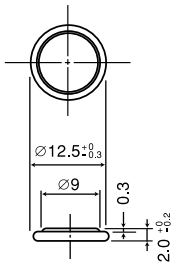


■ Capacity vs. load resistance



BR1220

■ Dimensions(mm)

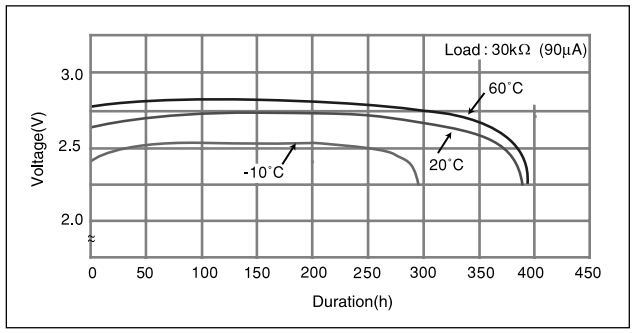


Weight: 0.7g

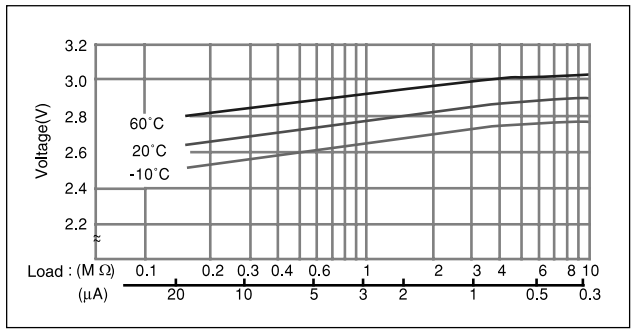
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	35
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

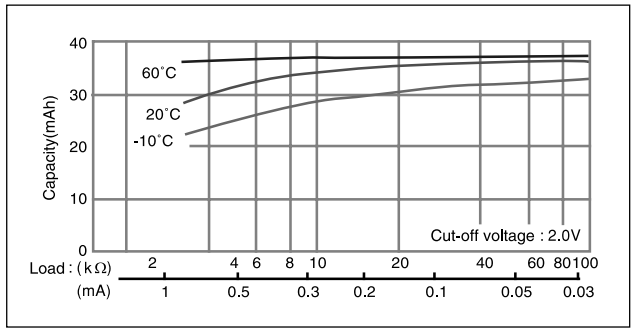
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

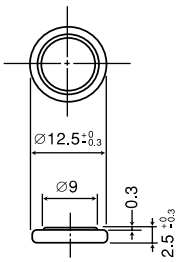


■ Capacity vs. load resistance



BR1225

■ Dimensions(mm)

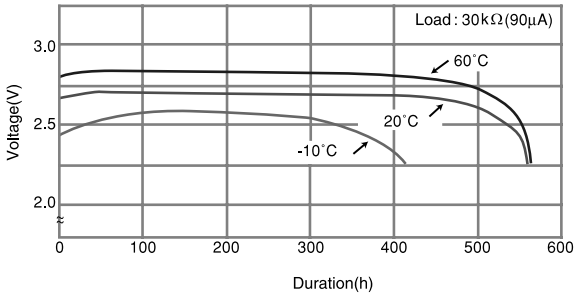


Weight: 0.8g

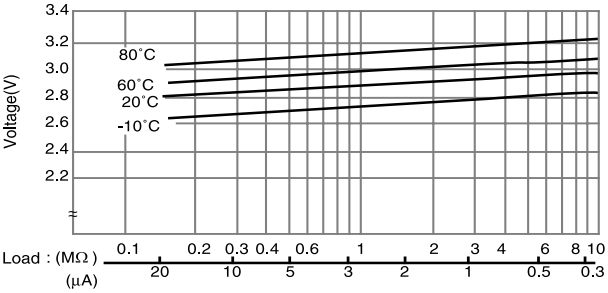
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	48
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

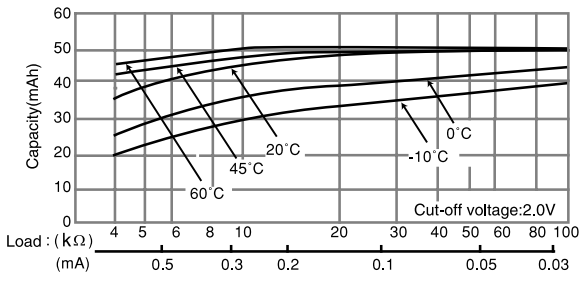
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

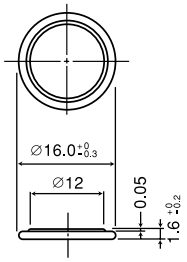


■ Capacity vs. load resistance



BR1616

■ Dimensions(mm)

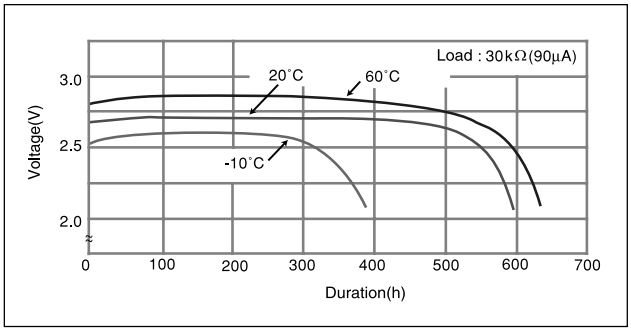


Weight: 1.0g

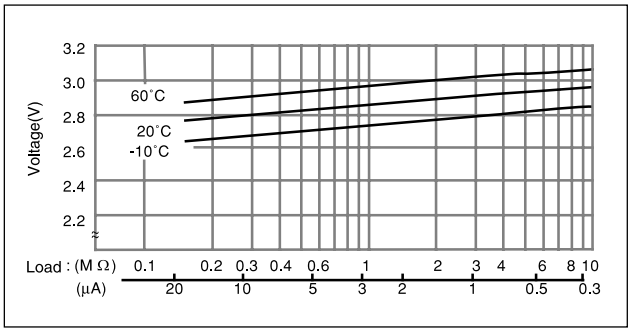
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	48
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

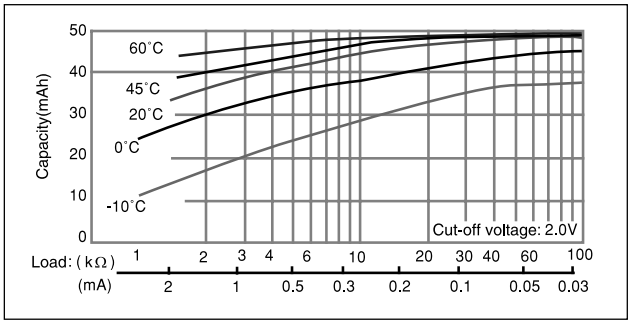
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

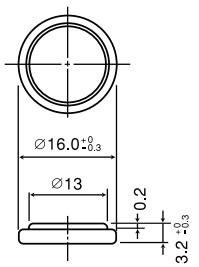


■ Capacity vs. load resistance



BR1632

■ Dimensions(mm)

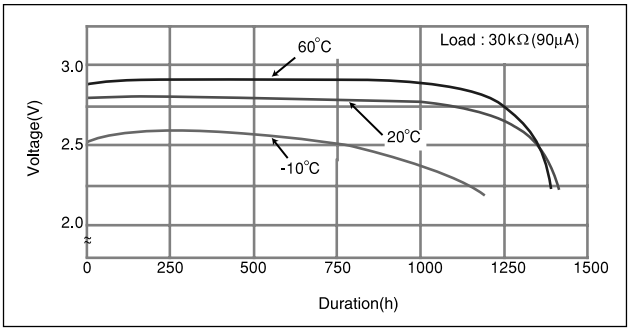


Weight: 1.5g

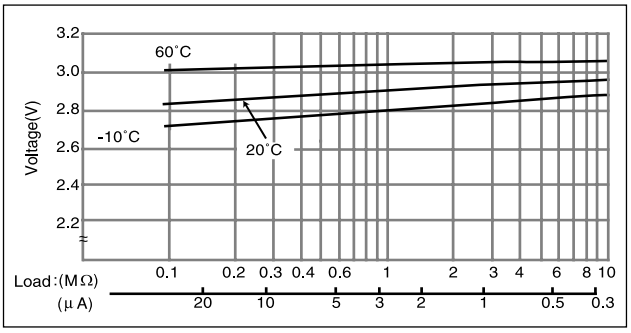
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	120
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

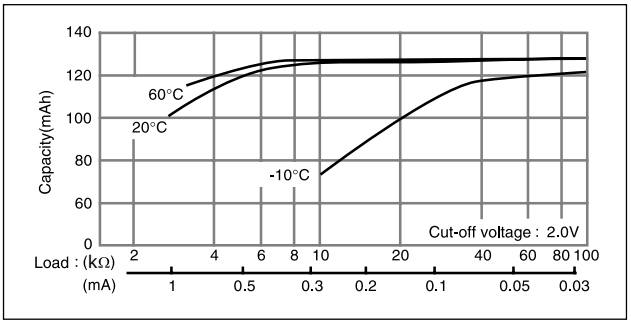
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

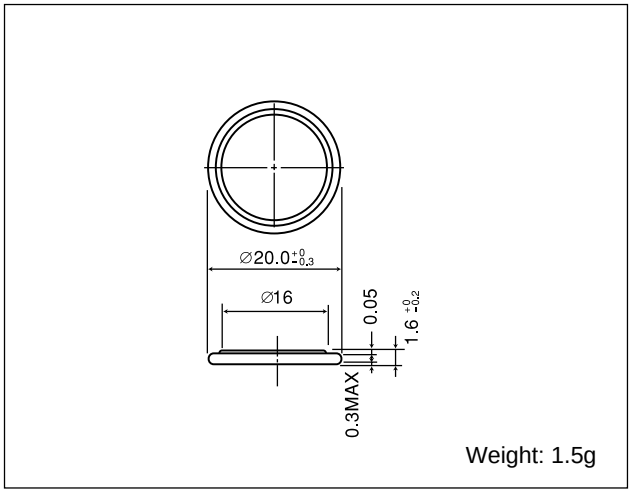


■ Capacity vs. load resistance



BR2016

■ Dimensions(mm)

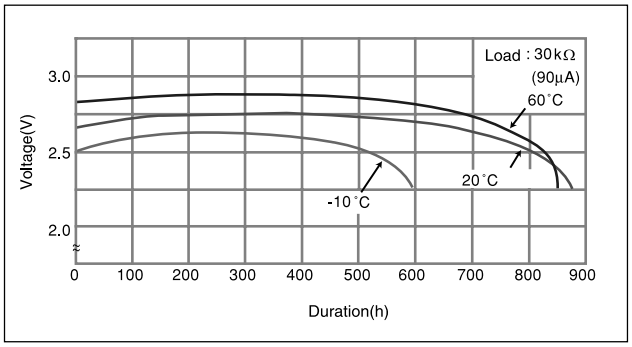


Weight: 1.5g

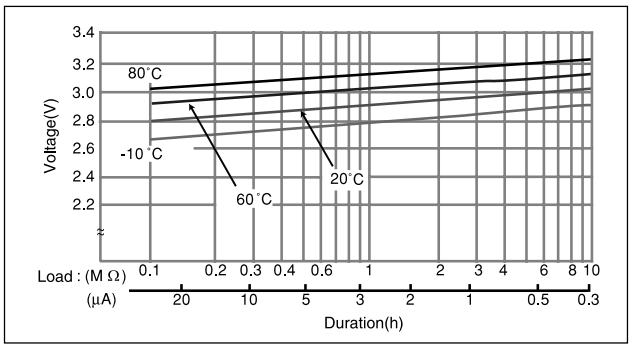
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	75
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

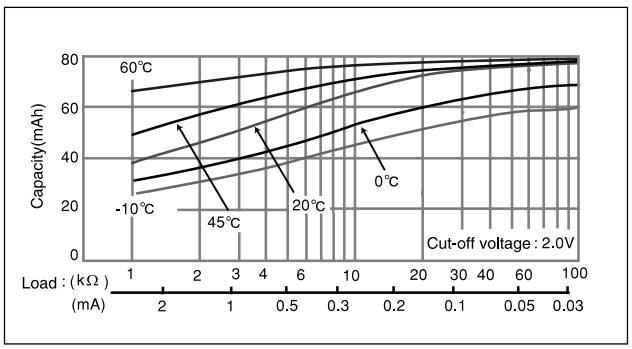
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

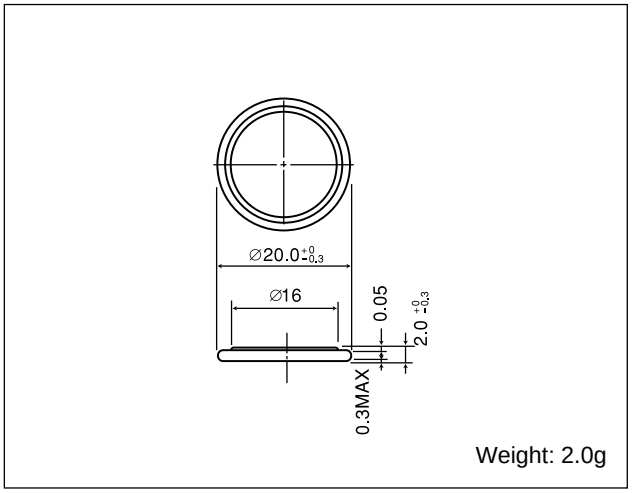


■ Capacity vs. load resistance



BR2020

■ Dimensions(mm)

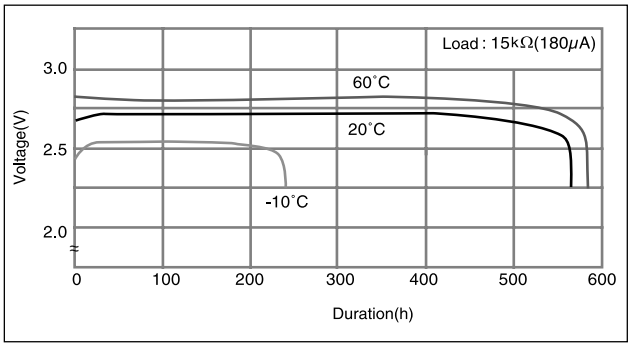


Weight: 2.0g

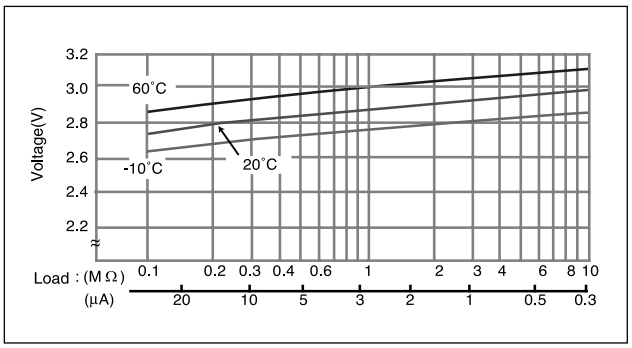
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	100
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

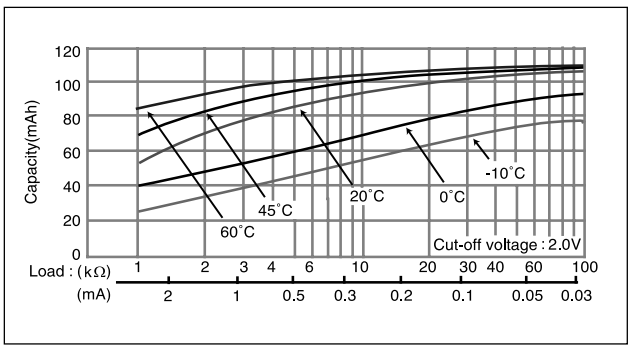
■ Temperature Characteristics



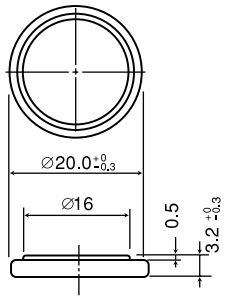
■ Operating voltage vs. load resistance(voltage at 50% discharge depth)



■ Capacity vs. load resistance



■ Dimensions(mm)

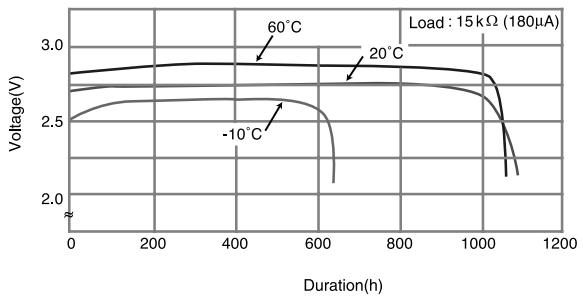


Weight: 2.5g

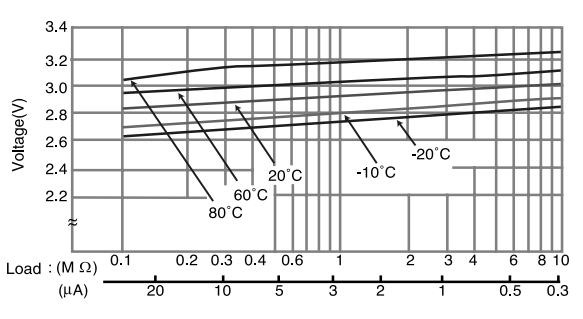
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	190
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

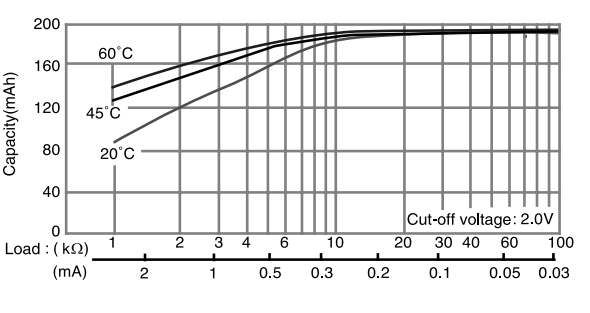
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)



■ Capacity vs. load resistance

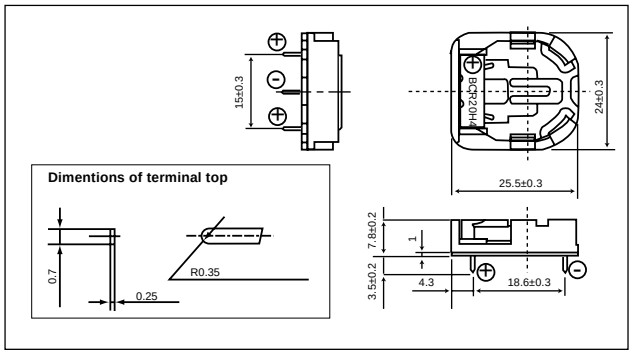


Lithium Battery Holders for BR2032

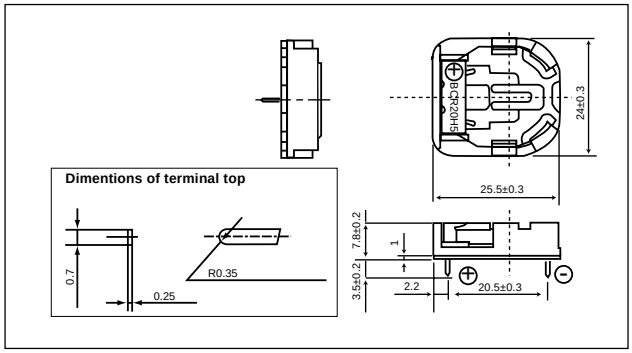
These battery holders are designed for sure and easy loading/removal of Panasonic coin type lithium batteries in/from equipment enabling the batteries to fully exploit their capabilities as the backup power supply in C-MOS RAM memory and microcomputer memory. All of the battery holders are designed to prevent inverted insertion of the battery.

BCR20H4 BCR20H5 BCR20V4

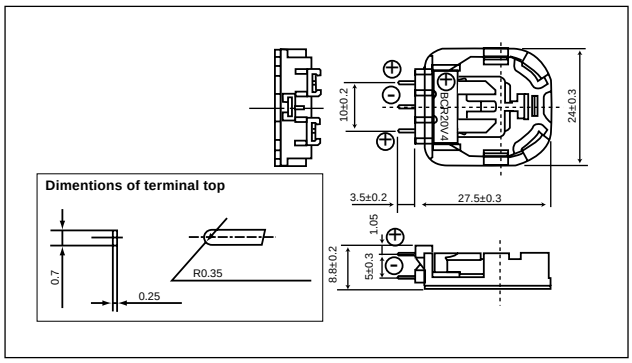
BCR20H4 (3 terminals)



BCR20H5 (2 terminals)



BCR20V4 (3 terminals)

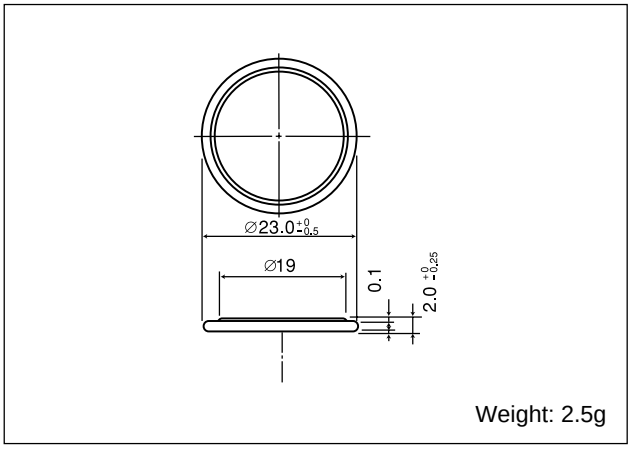


■ Precaution for washing battery holders

The battery holders can be adversely affected by some detergents use in the circuit board washing process and may result in cracks forming in the holder. Please test the holders in your washing process before use.

BR2320

■ Dimensions(mm)

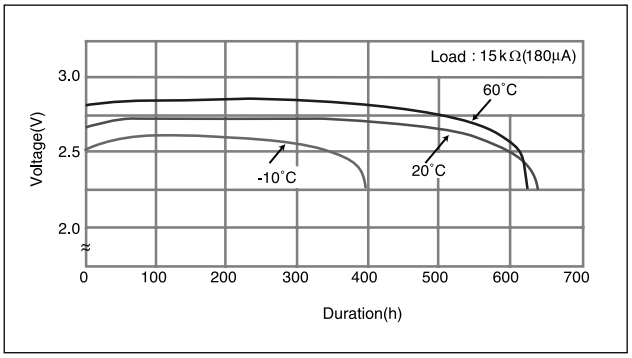


Weight: 2.5g

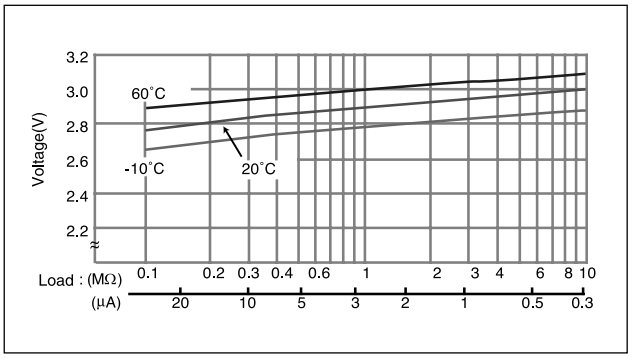
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	110
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

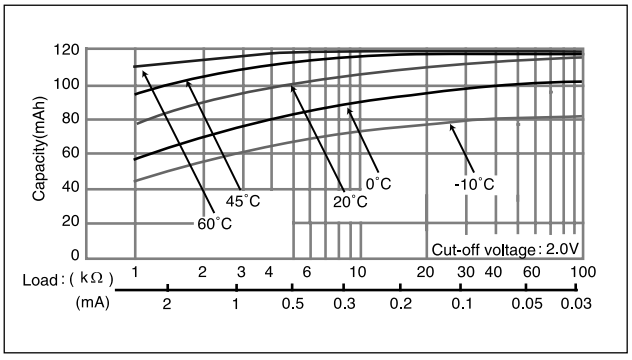
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

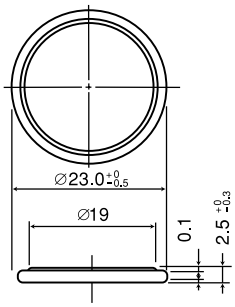


■ Capacity vs. load resistance



BR2325

■ Dimensions(mm)

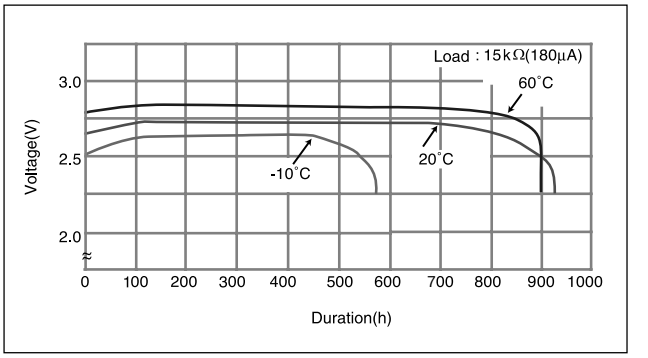


Weight: 3.2g

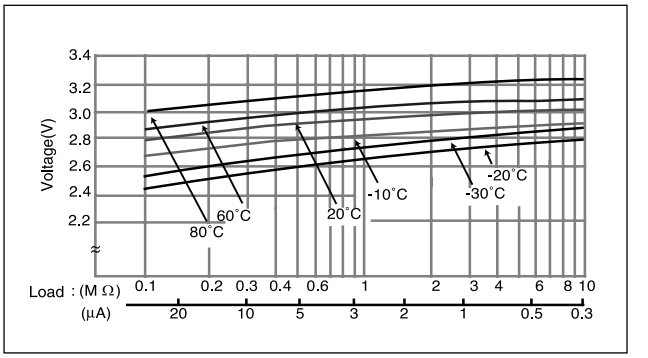
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	165
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

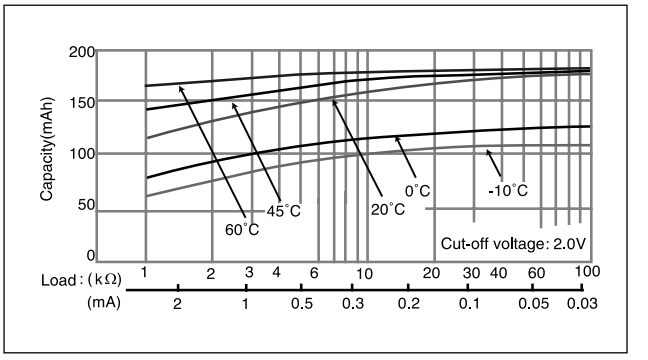
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

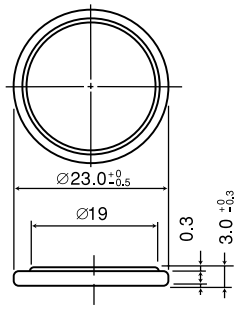


■ Capacity vs. load resistance



BR2330

■ Dimensions(mm)

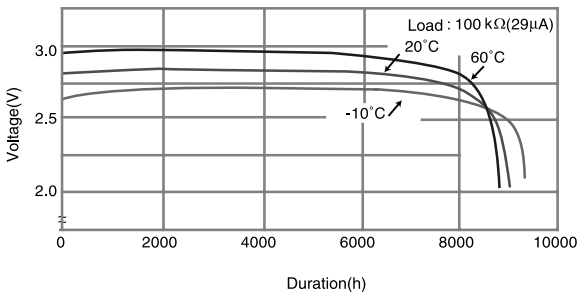


Weight: 3.2g

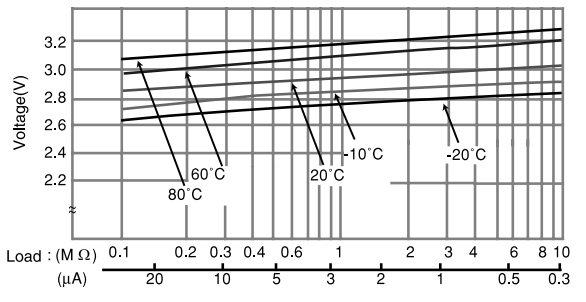
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	255
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

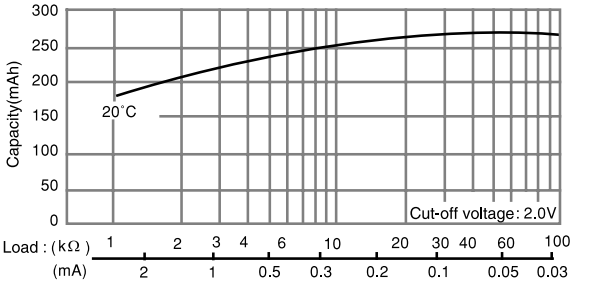
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

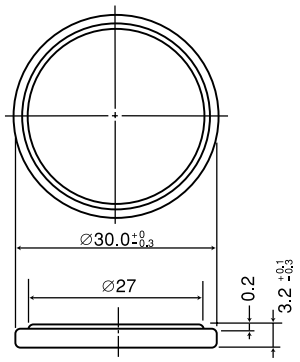


■ Capacity vs. load resistance



BR3032

■ Dimensions(mm)

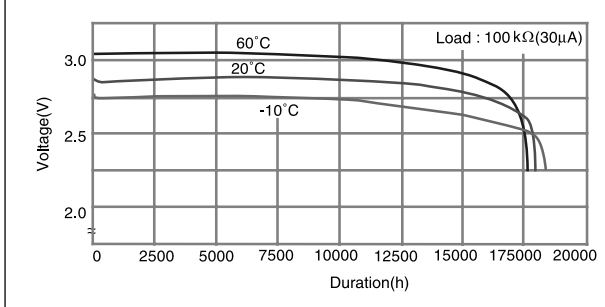


Weight: 5.5g

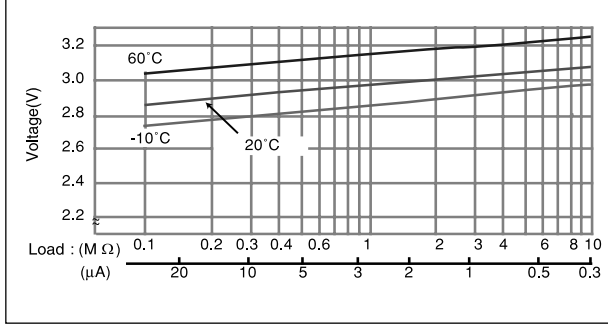
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	500
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +80

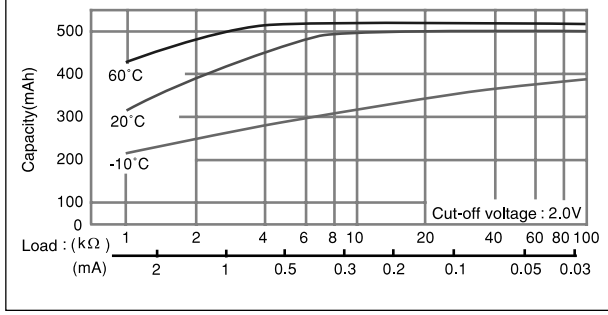
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)



■ Capacity vs. load resistance



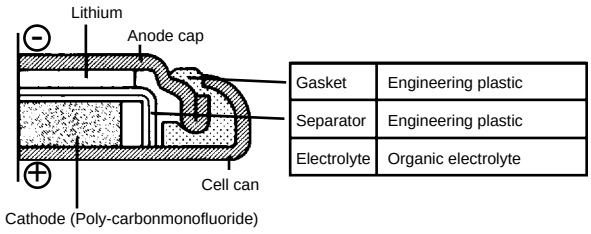
2-2 Coin Type Lithium Batteries

2-2-2 High Operating Temperature Poly-carbonmonofluoride Lithium Batteries (BR "A" series)

Features

The materials for the gasket and separator featured in these coin-type lithium batteries have been replaced with a special engineering plastic and the operating temperature range has been significantly increased by employing an electrolyte with a high boiling point.

Construction



Gasket	Engineering plastic
Separator	Engineering plastic
Electrolyte	Organic electrolyte

Applications

- Memory backup power supplies in office automation equipment, factory automation equipment, home electrical appliances, etc.
- Power supplies for meters of various kinds

Note: Always confirm that the battery to be used is suitable for the intended application before purchase and/or use.

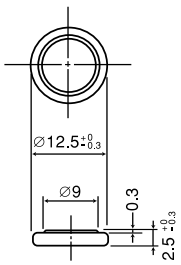
General Specifications

Model No.	Electrical characteristics (20°C)			Dimensions (mm)		Weight (g)	JIS	IEC
	Nominal voltage(V)	*Nominal capacity(mAh)	Continuous drain(mA)	Diameter	Height			
BR1225A*1	3	48	0.03	12.5	2.5	0.8	-	-
BR1632A*1	3	120	0.03	16.0	3.2	1.5	-	-
BR2330A	3	255	0.03	23.0	3.0	3.2	-	-
BR2450A	3	600	0.03	24.5	5.0	5.9	-	-
BR2477A	3	1000	0.03	24.5	7.7	8.0	-	-

* Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0V at 20°C.
*1 Ready for mass production

BR1225A

■ Dimensions(mm)

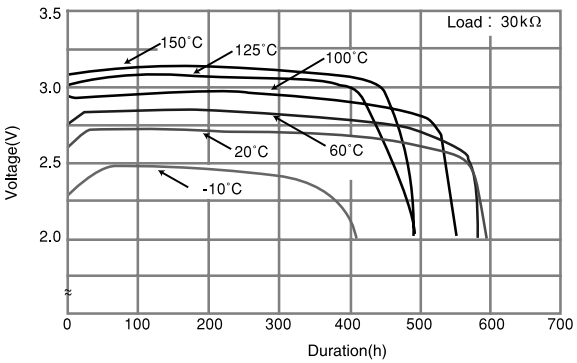


Weight 0.8g

■ Specification

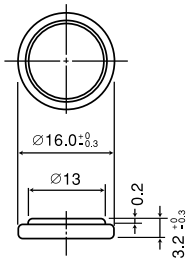
Nominal voltage(V)	3
Nominal capacity(mAh)	48
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +125

■ Temperature Characteristics



BR1632A

■ Dimensions(mm)

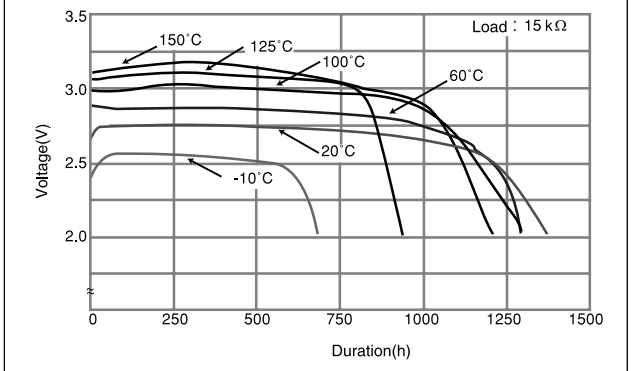


Weight 1.5g

■ Specification

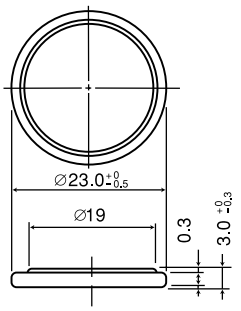
Nominal voltage(V)	3
Nominal capacity(mAh)	120
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +125

■ Temperature Characteristics



BR2330A

■ Dimensions(mm)

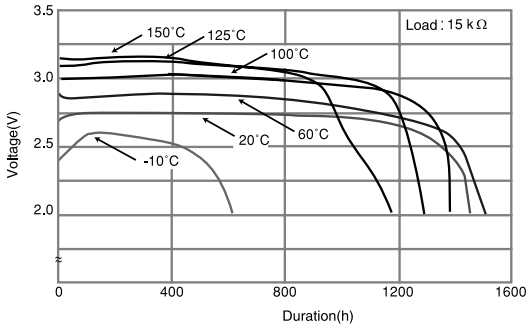


Weight 3.2g

■ Specification

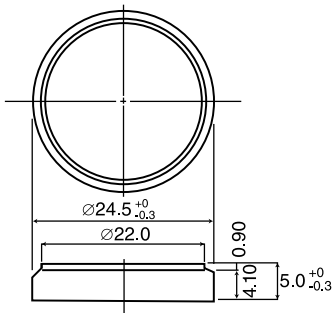
Nominal voltage(V)	3
Nominal capacity(mAh)	255
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +125

■ Temperature Characteristics



BR2450A

■ Dimensions(mm)



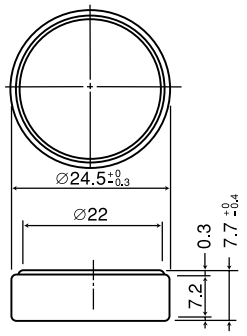
Weight 5.9g

■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	600
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +125

BR2477A

■ Dimensions(mm)

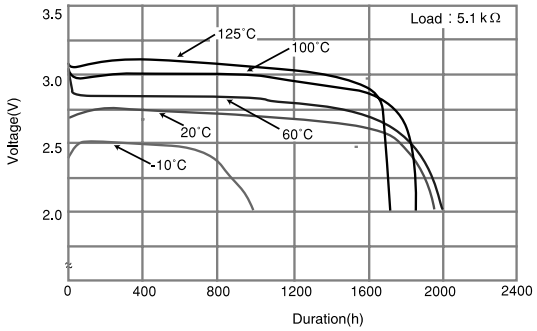


Weight 8.0g

■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	1,000
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +125

■ Temperature Characteristics



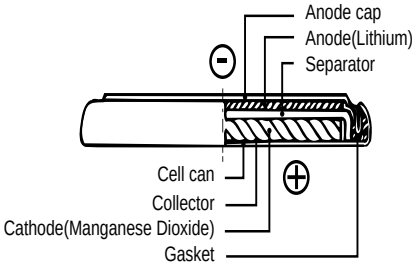
2-2 Coin Type Lithium Batteries

2-2-3 Manganese Dioxide Lithium Batteries (CR Series)

Features

As with the BR series of coin-type lithium batteries, these batteries feature a high energy density, and they were developed and commercialized via Panasonic's extensive experience and battery technology.
These batteries have proven to be especially useful in equipment requiring relatively high currents.

Construction



Applications

- Digital watches
- Portable game machines
- Electronic notebooks, etc.

Note: Always confirm that the battery to be used is suitable for the intended application before purchase and/or use.

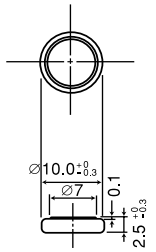
General Specifications

Model No.	Electrical characteristics (20°C)			Dimensions(mm)		Weight(g)	JIS	IEC
	Nominal voltage(V)	*Nominal capacity(mAh)	Continuous drain(mA)	Diameter	Height			
CR1025	3	30	0.1	10.0	2.5	0.7	CR1025	CR1025
CR1216	3	25	0.1	12.5	1.6	0.7	CR1216	CR1216
CR1220	3	35	0.1	12.5	2.0	1.2	CR1220	CR1220
CR1612	3	40	0.1	16.0	1.2	0.8	-	-
CR1616	3	55	0.1	16.0	1.6	1.2	CR1616	CR1616
CR1620	3	75	0.1	16.0	2.0	1.3	-	CR1620
CR1632	3	125	0.1	16.0	3.2	1.8	-	-
CR2004(Under development)	3	12	0.03	20.0	0.4	0.6	-	-
CR2012	3	55	0.1	20.0	1.2	1.4	CR2012	CR2012
CR2016	3	90	0.1	20.0	1.6	1.6	CR2016	CR2016
CR2025	3	165	0.2	20.0	2.5	2.5	CR2025	CR2025
CR2032	3	220	0.2	20.0	3.2	3.1	CR2032	CR2032
CR2320	3	130	0.2	23.0	2.0	3.0	CR2320	CR2320
CR2330	3	265	0.2	23.0	3.0	4.0	CR2330	CR2330
CR2354	3	560	0.2	23.0	5.4	5.9	-	CR2354
CR2404(Under development)	3	18	0.03	24.5	0.4	0.8	-	-
CR2412	3	100	0.2	24.5	1.2	2.0	-	-
CR2450	3	620	0.2	24.5	5.0	6.3	CR2450	CR2450
CR2477	3	1000	0.2	24.5	7.7	10.5	-	-
CR3032	3	500	0.2	30.0	3.2	7.1	-	CR3032

* Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0V at 20°C.

CR1025

■ Dimensions(mm)

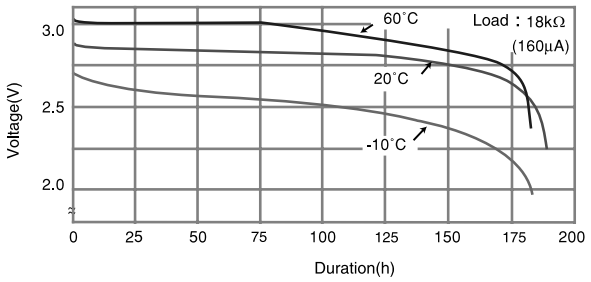


Weight: 0.7g

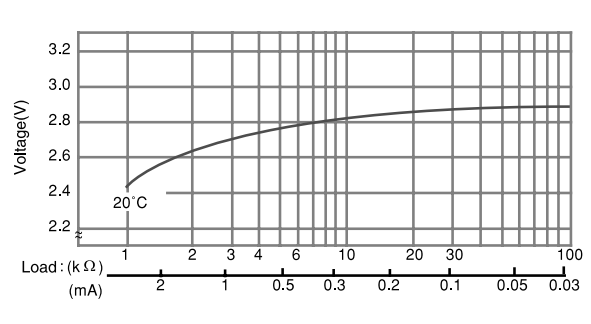
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	30
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-30 ~ +60

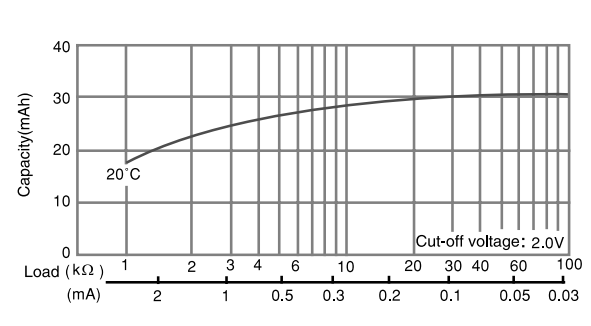
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

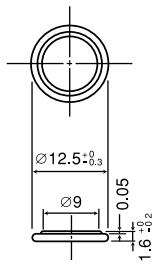


■ Capacity vs. load resistance



CR1216

■ Dimensions(mm)

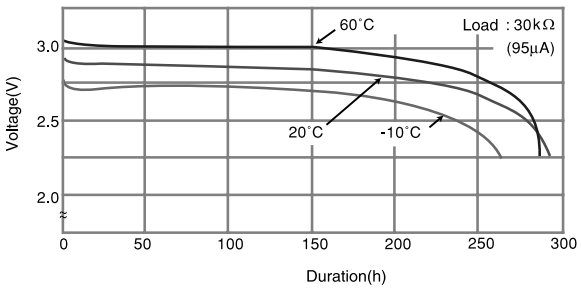


Weight: 0.7g

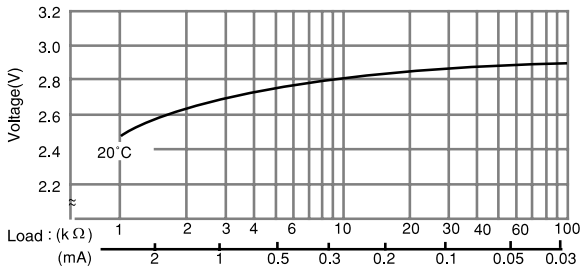
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	25
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-30 ~ +60

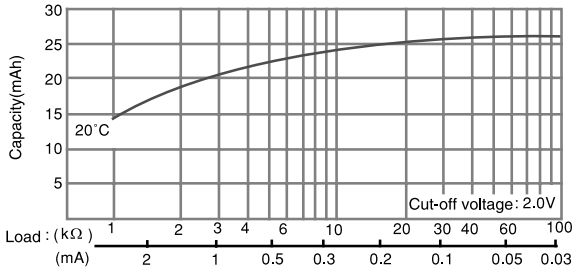
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

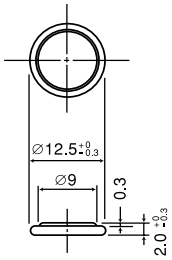


■ Capacity vs. load resistance



CR1220

■ Dimensions(mm)

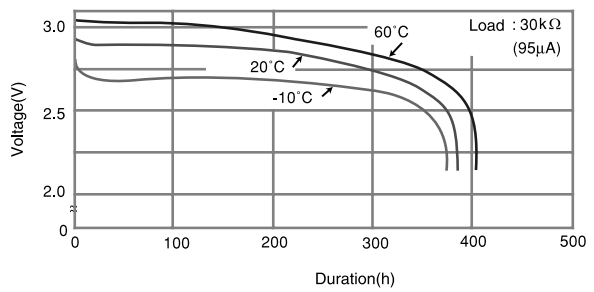


Weight: 1.2g

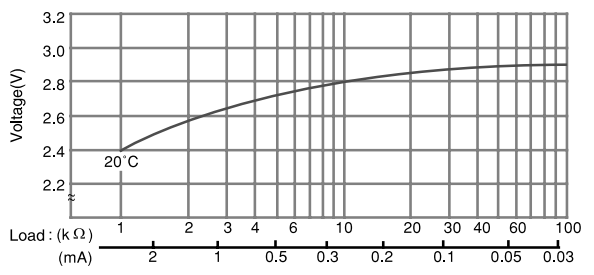
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	35
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-30 ~ +60

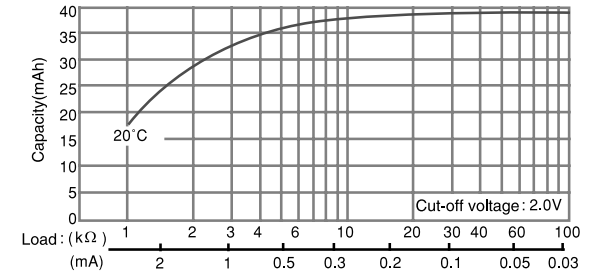
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

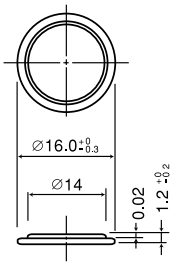


■ Capacity vs. load resistance



CR1612

■ Dimensions(mm)

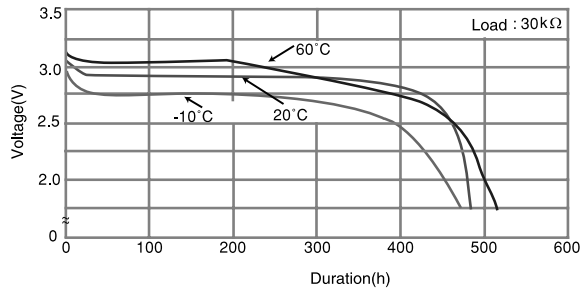


Weight: 0.8g

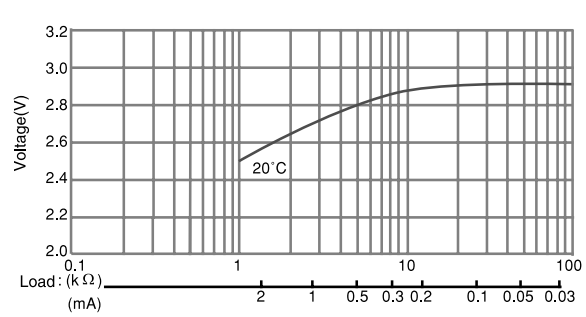
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	40
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-30 ~ +60

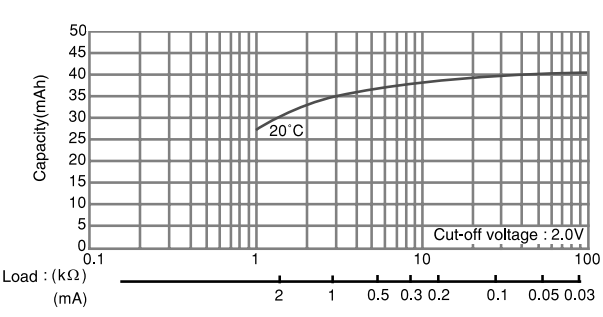
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

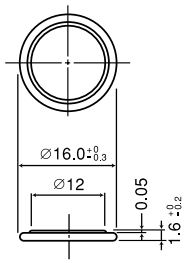


■ Capacity vs. load resistance



CR1616

■ Dimensions(mm)

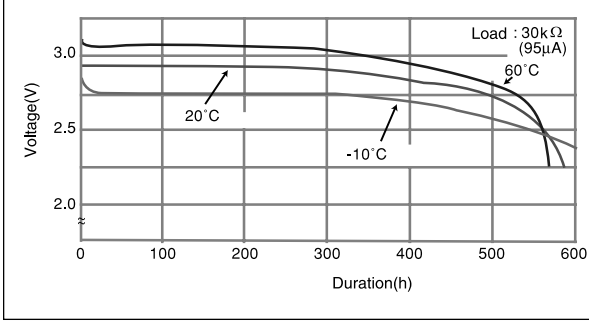


Weight: 1.2g

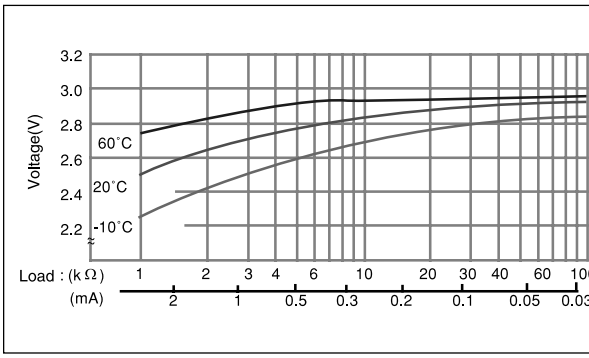
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	55
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-30 ~ +60

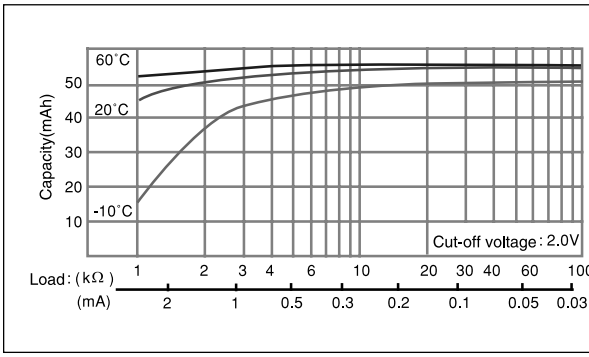
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

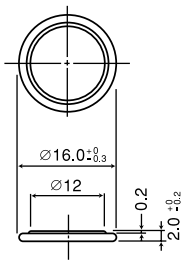


■ Capacity vs. load resistance



CR1620

■ Dimensions(mm)

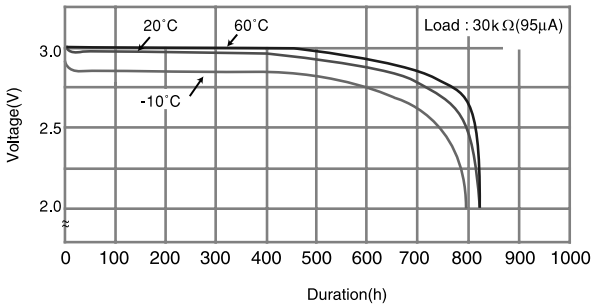


Weight: 1.3g

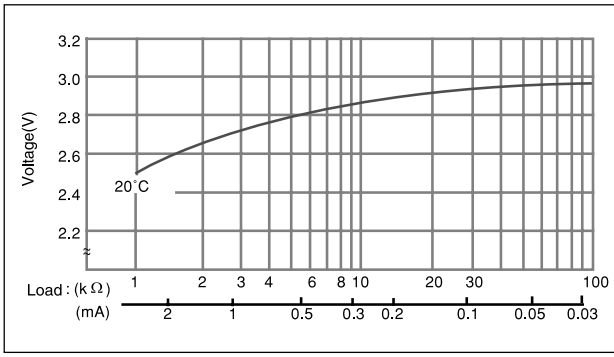
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	75
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-30 ~ +60

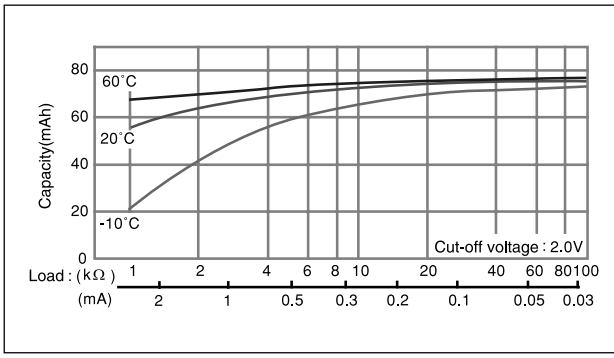
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

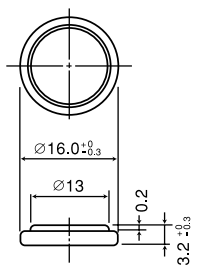


■ Capacity vs. load resistance



CR1632

■ Dimensions(mm)

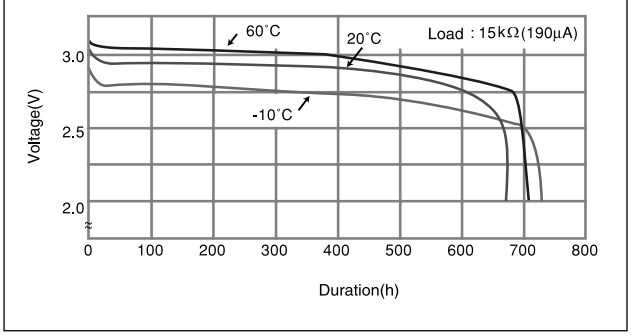


Weight: 1.8g

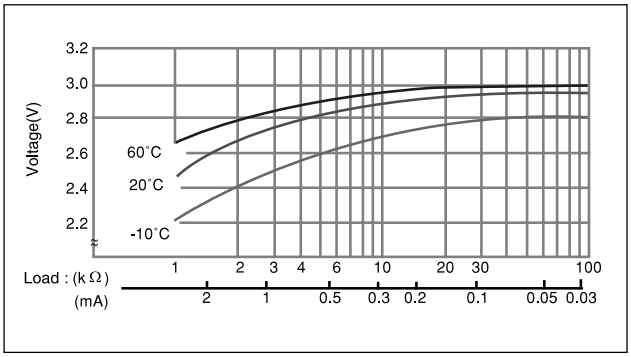
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	125
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-30 ~ +60

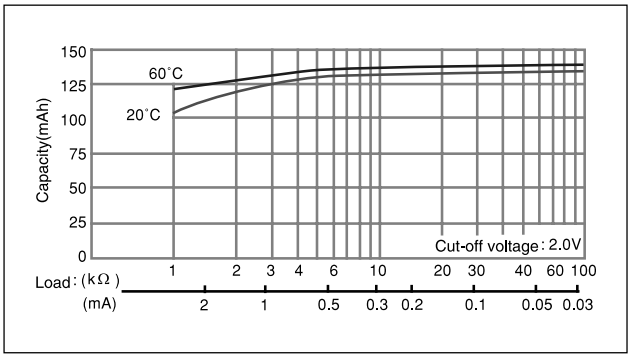
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

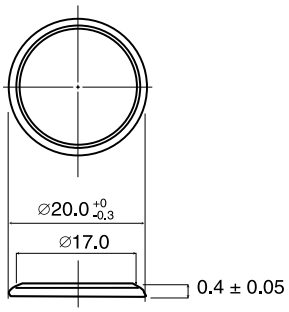


■ Capacity vs. load resistance



CR2004

■ Dimensions(mm)

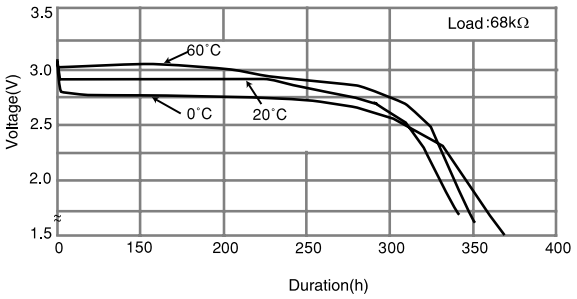


Weight: 0.6g

■ Specification

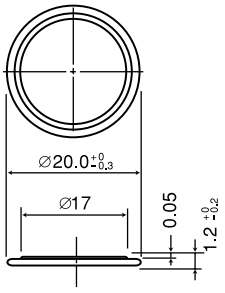
Nominal voltage(V)	3
Nominal capacity(mAh)	12
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +60

■ Temperature Characteristics



CR2012

■ Dimensions(mm)

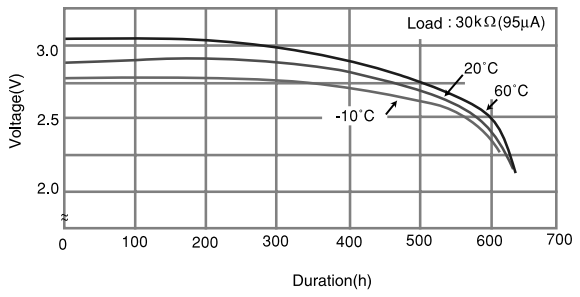


Weight: 1.4g

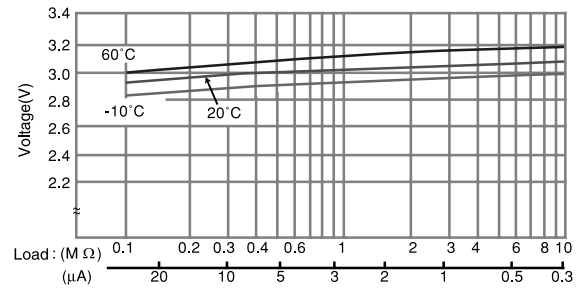
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	55
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-30 ~ +60

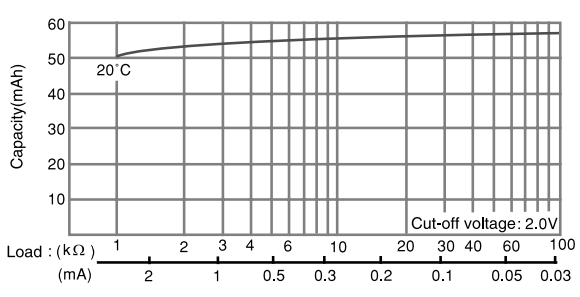
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

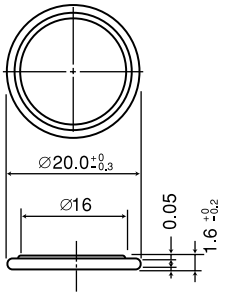


■ Capacity vs. load resistance



CR2016

■ Dimensions(mm)

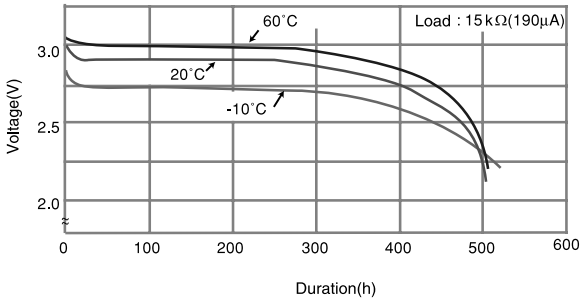


Weight: 1.6g

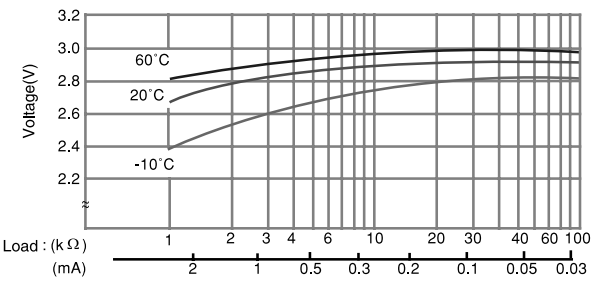
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	90
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-30 ~ +60

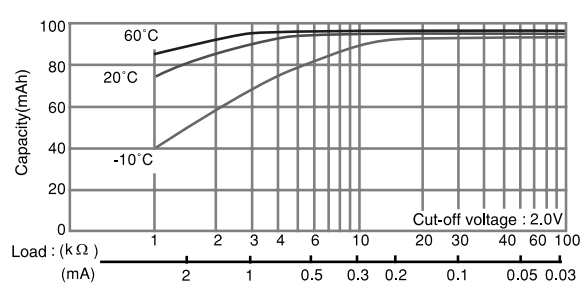
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

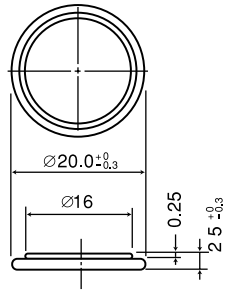


■ Capacity vs. load resistance



CR2025

■ Dimensions(mm)

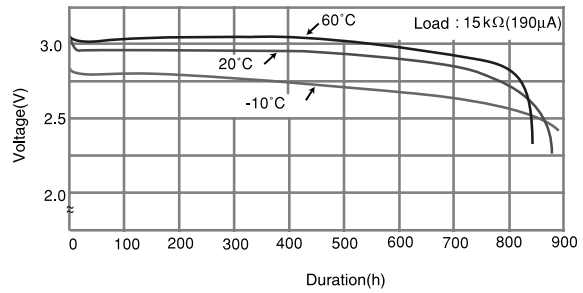


Weight: 2.5g

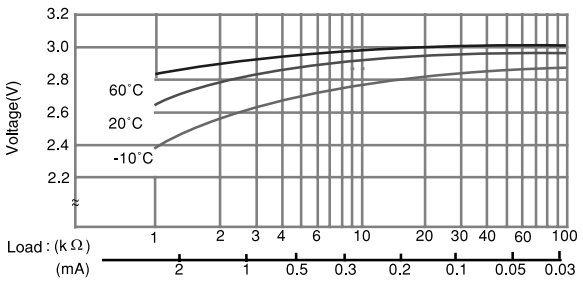
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	165
Continuous standard load(mA)	0.2
Operating temperature(˚C)	-30 ~ +60

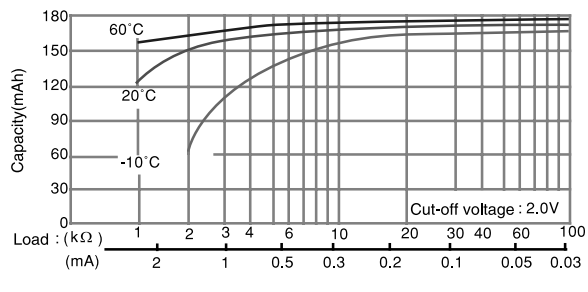
■ Temperature Characteristics



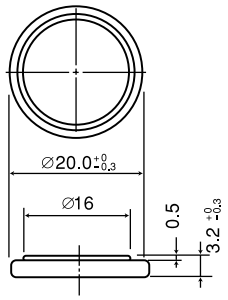
■ Operating voltage vs. load resistance(voltage at 50% discharge depth)



■ Capacity vs. load resistance



■ Dimensions(mm)

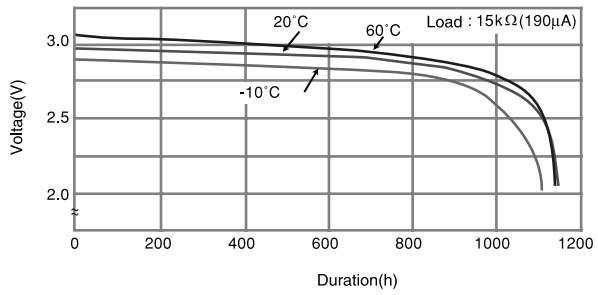


Weight: 3.1g

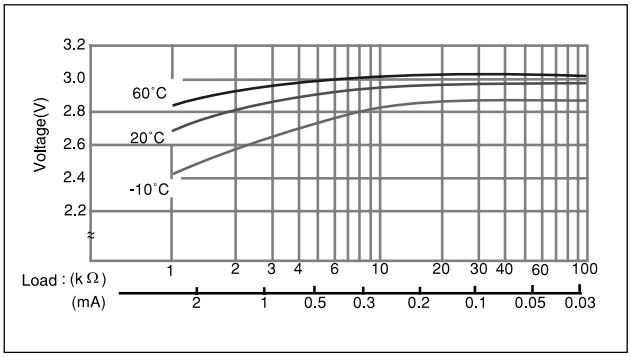
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	220
Continuous standard load(mA)	0.2
Operating temperature(˚C)	-30 ~ +60

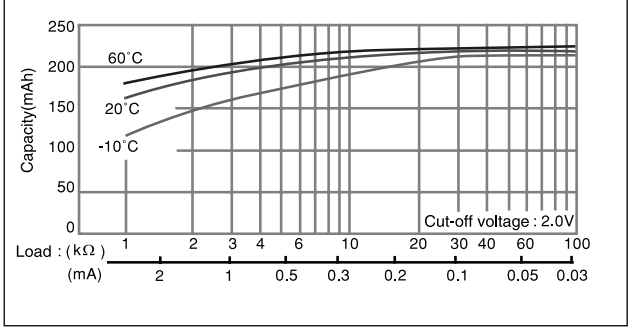
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)



■ Capacity vs. load resistance

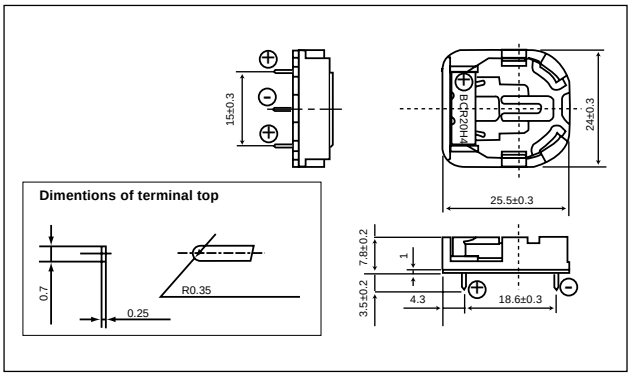


Lithium Battery Holders for CR2032

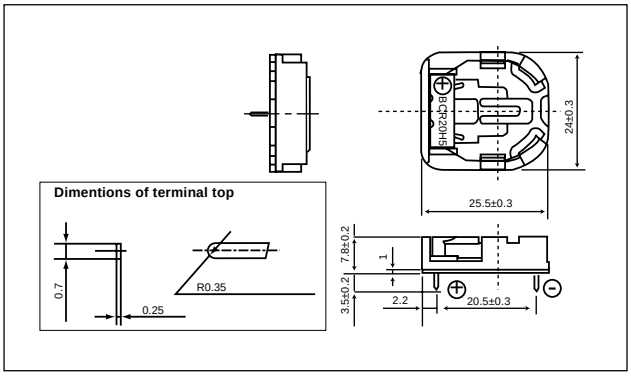
These battery holders are designed for sure and easy loading / removal of Panasonic coin type lithium batteries in / from equipment enabling the batteries to fully exploit their capabilities as the backup power supply in C-MOS RAM memory and microcomputer memory. All of the battery holders are designed to prevent inverted insertion of the battery.

BCR20H4 BCR20H5 BCR20V4

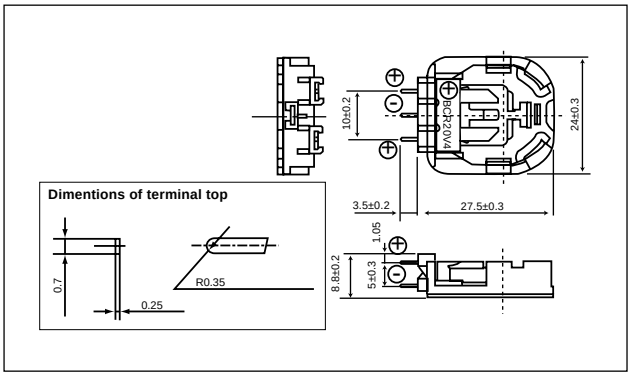
BCR20H4 (3 terminals)



BCR20H5 (2 terminals)



BCR20V4 (3 terminals)

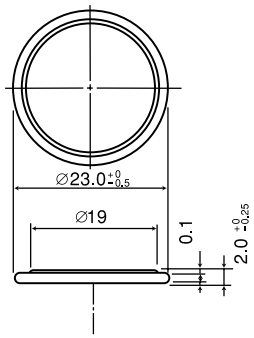


■ Precaution for washing battery holders

The battery holders can be adversely affected by some detergents use in the circuit board washing process and may result in cracks forming in the holder. Please test the holders in your washing process before use.

CR2320

■ Dimensions(mm)

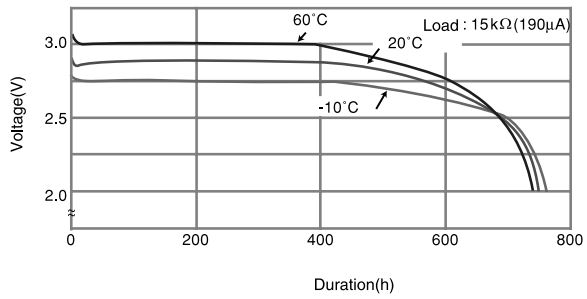


Weight: 3.0g

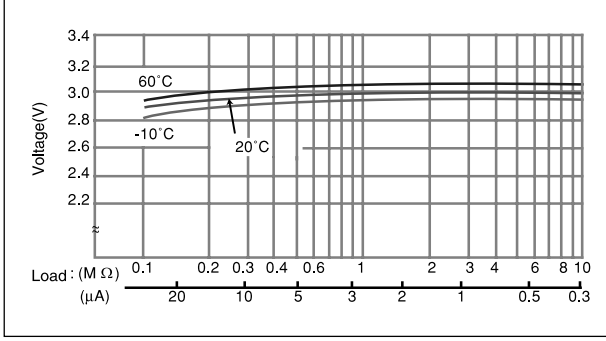
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	130
Continuous standard load(mA)	0.2
Operating temperature(˚C)	-30 ~ +60

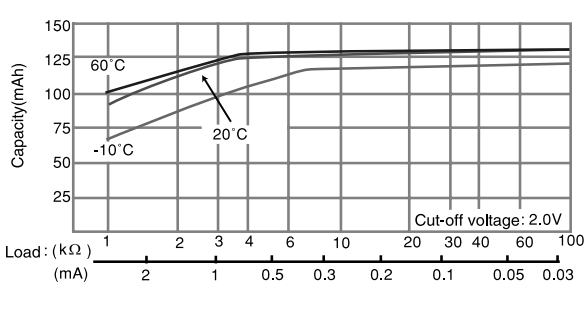
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

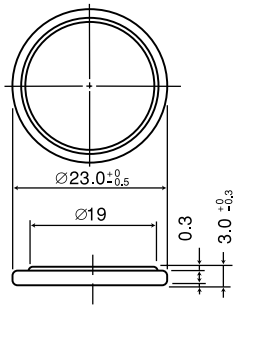


■ Capacity vs. load resistance



CR2330

■ Dimensions(mm)

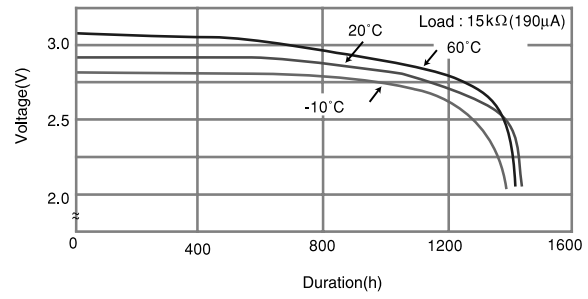


Weight: 4.0g

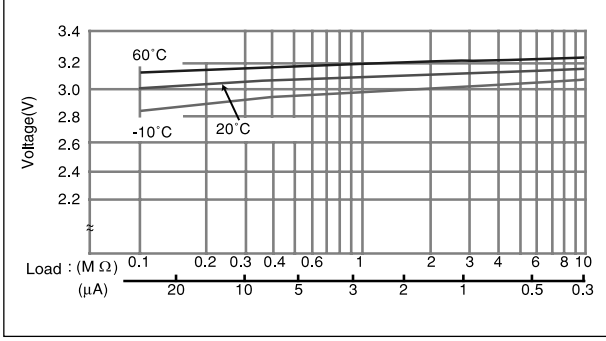
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	265
Continuous standard load(mA)	0.2
Operating temperature(˚C)	-30 ~ +60

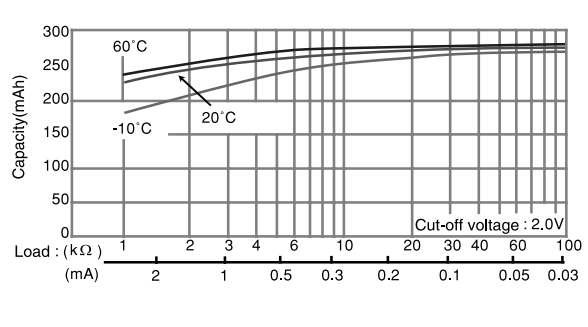
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

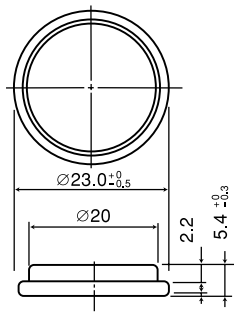


■ Capacity vs. load resistance



CR2354

■ Dimensions(mm)

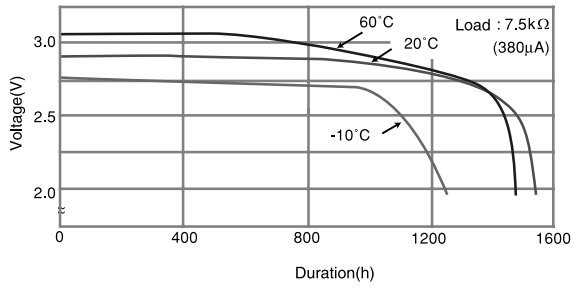


Weight: 5.9g

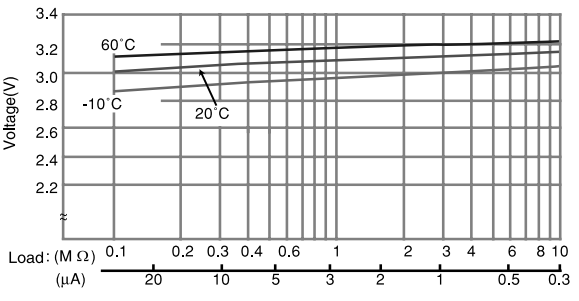
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	560
Continuous standard load(mA)	0.2
Operating temperature(˚C)	-30 ~ +60

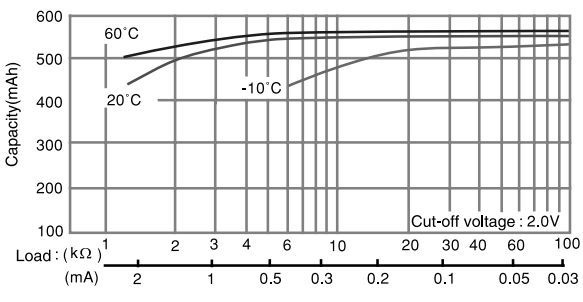
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

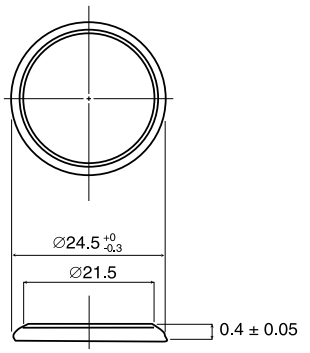


■ Capacity vs. load resistance



CR2404

■ Dimensions(mm)

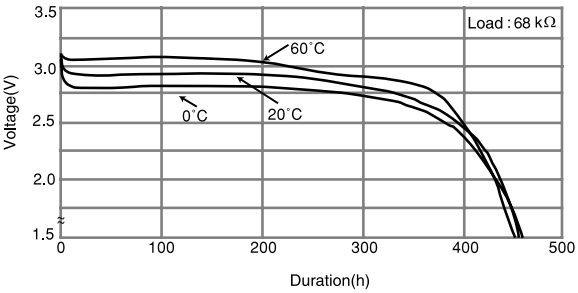


Weight: 0.8g

■ Specification

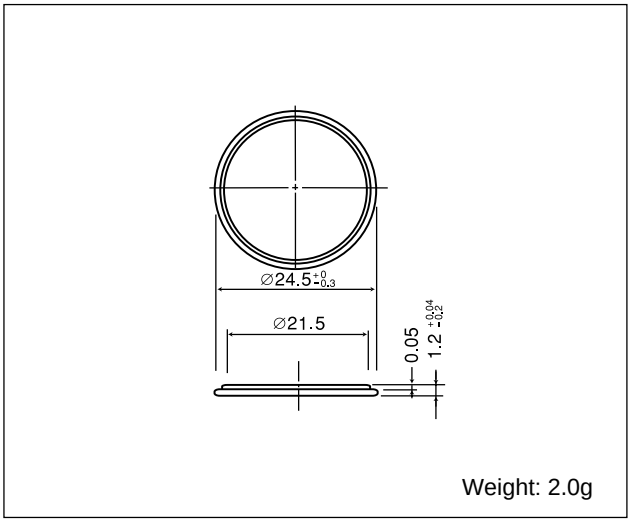
Nominal voltage(V)	3
Nominal capacity(mAh)	18
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-30 ~ +60

■ Temperature Characteristics



CR2412

■ Dimensions(mm)

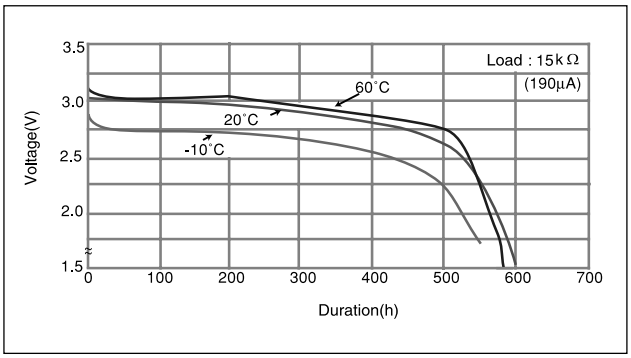


Weight: 2.0g

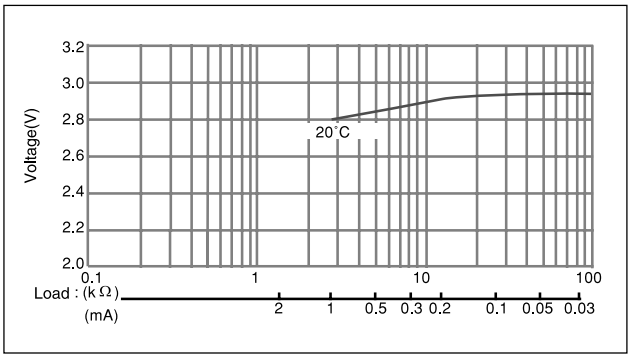
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	100
Continuous standard load(mA)	0.2
Operating temperature(˚C)	-30 ~ +60

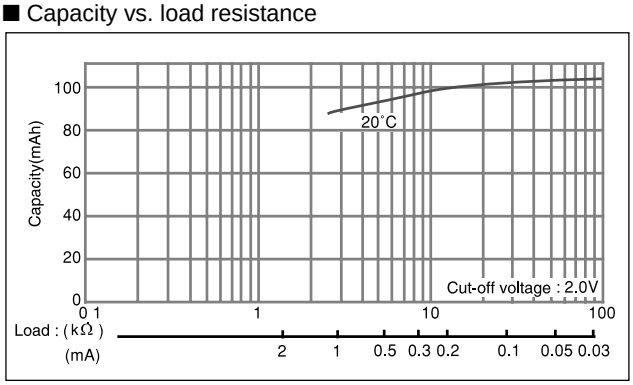
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

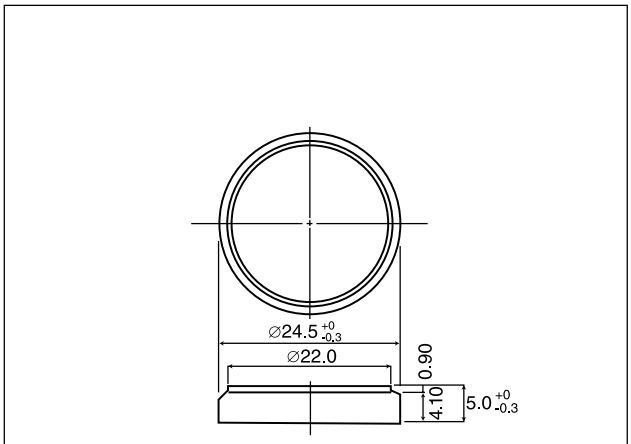


■ Capacity vs. load resistance



CR2450

■ Dimensions(mm)

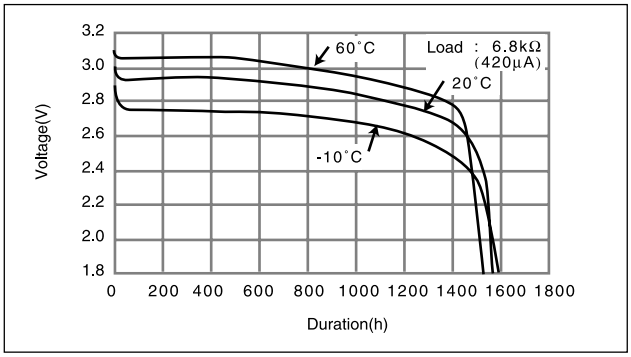


Weight: 6.3g

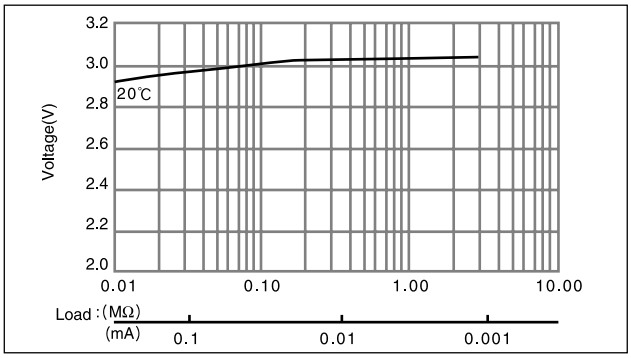
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	620
Continuous standard load(mA)	0.2
Operating temperature(˚C)	-30 ~ +60

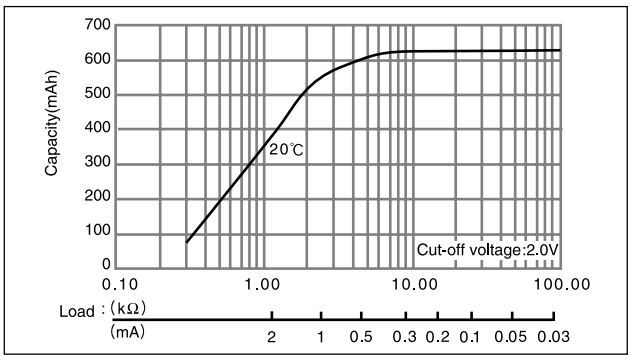
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

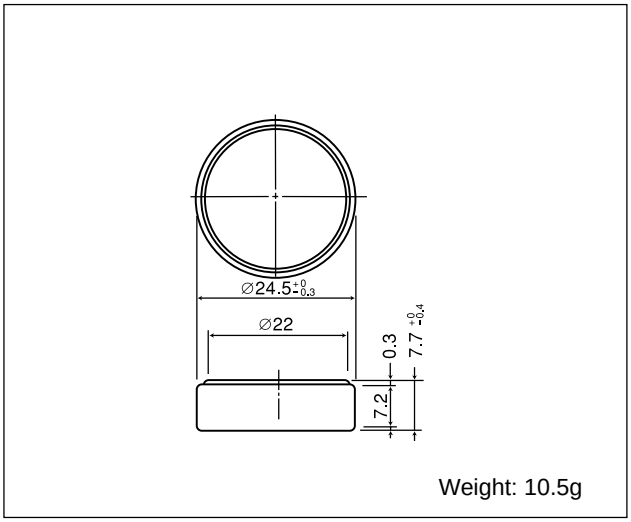


■ Capacity vs. load resistance



CR2477

■ Dimensions(mm)

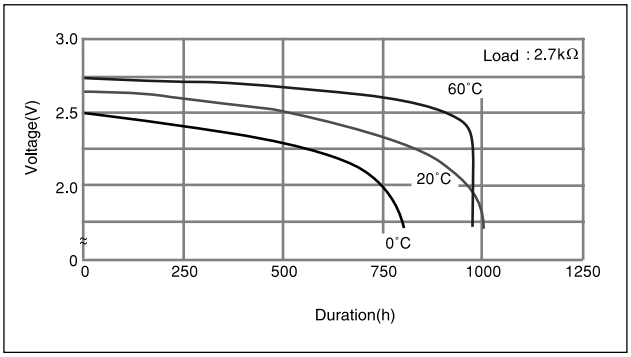


Weight: 10.5g

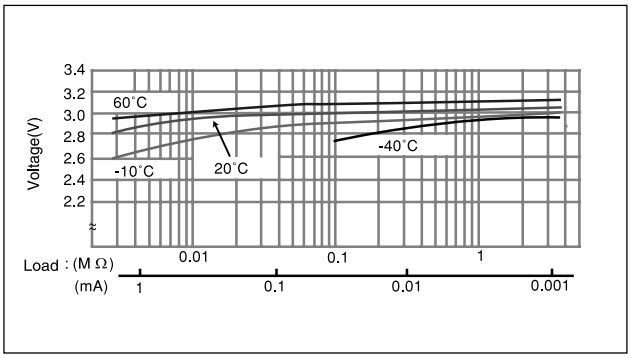
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	1,000
Continuous standard load(mA)	0.2
Operating temperature(˚C)	-30 ~ +60

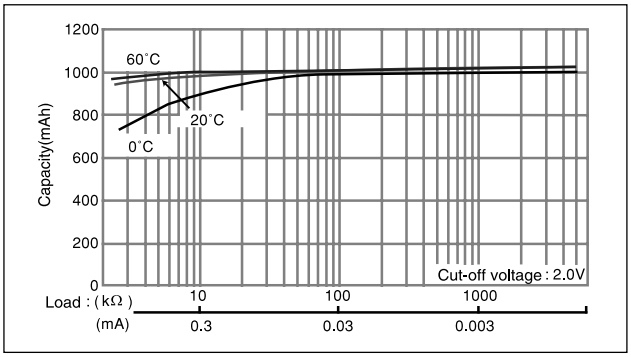
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

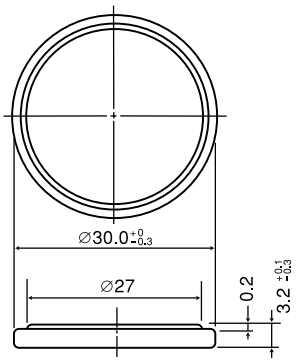


■ Capacity vs. load resistance



CR3032

■ Dimensions(mm)

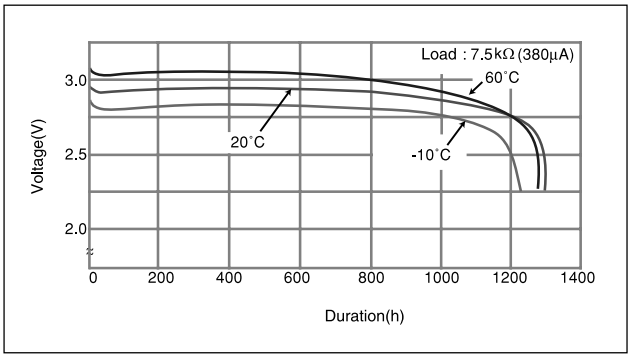


Weight: 7.1g

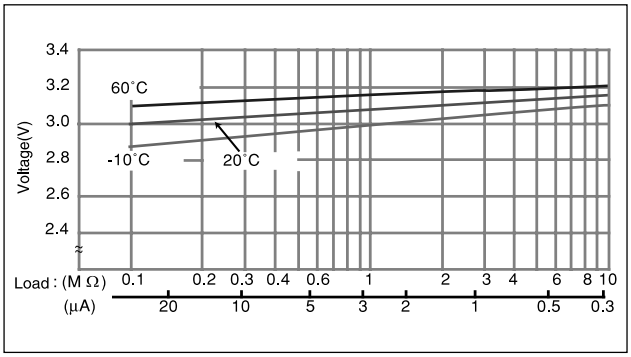
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	500
Continuous standard load(mA)	0.2
Operating temperature(˚C)	-30 ~ +60

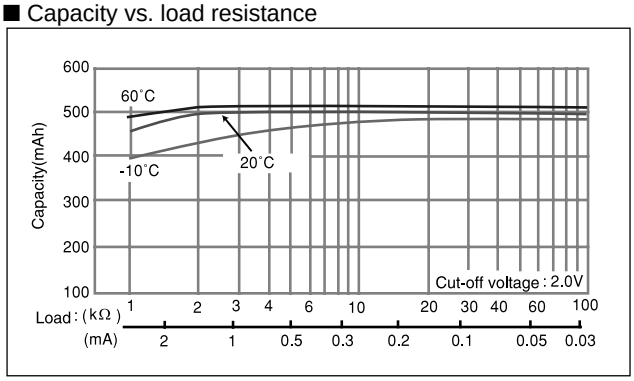
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)



■ Capacity vs. load resistance



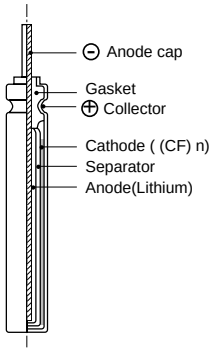
2-3 Pin Type Lithium Batteries

Poly-carbonmonofluoride Lithium Batteries (BR Series)

Features

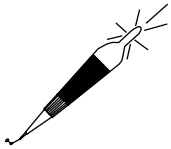
These slim-line pin-type lithium batteries are contained in an aluminum casing and were originally developed by Panasonic. A single cell lithium pin battery can light an LED.

Construction



Applications

- LED-type night fishing floats
- Various illumination products
- Fishing pole tip lights
- Toys



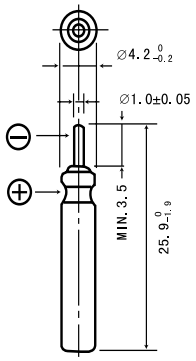
General Specifications

Model No.	Electrical characteristics (20°C)			Dimensions(mm)		Weight(g)	JIS	IEC
	Nominal voltage(V)	*Nominal capacity(mAh)	Continuous drain(mA)	Diameter	Height			
BR425	3	25	0.5	4.2	25.9	0.55	-	-
BR435	3	50	1.0	4.2	35.9	0.85	-	-

* Nominal capacity shown above is based on standard drain and cut off voltage down to 2.0V at 20°C.

BR425

■ Dimensions(mm)

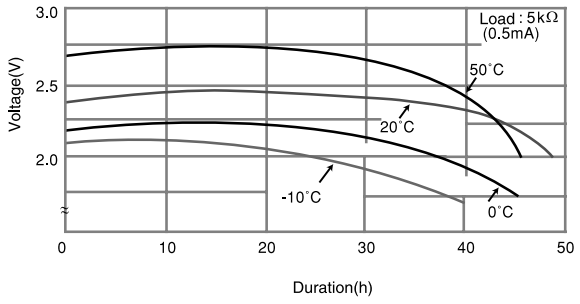


Weight: 0.55g

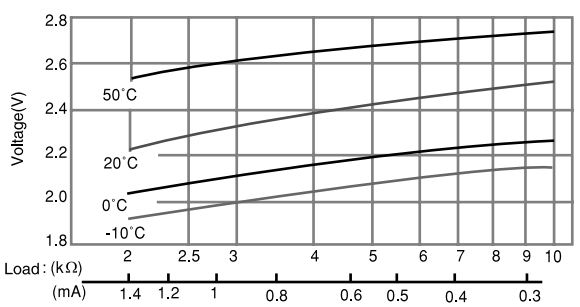
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	25
Continuous standard load(mA)	0.5
Operating temperature(˚C)	-30 ~ +80

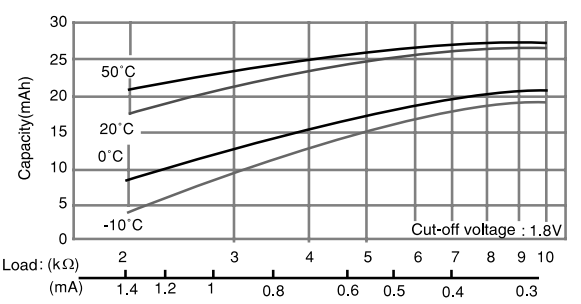
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)

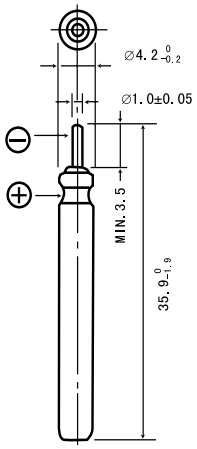


■ Capacity vs. load resistance



BR435

■ Dimensions(mm)

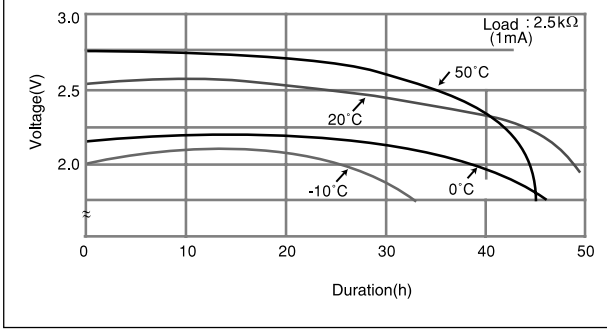


Weight: 0.85g

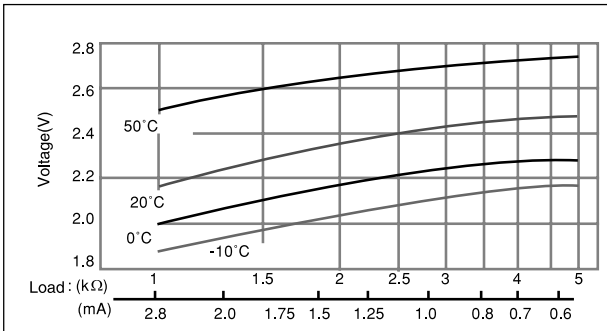
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	50
Continuous standard load(mA)	1
Operating temperature(˚C)	-30 ~ +80

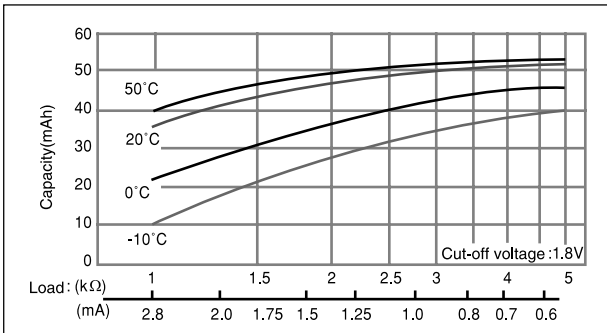
■ Temperature Characteristics



■ Operating voltage vs. load resistance(voltage at 50% discharge depth)



■ Capacity vs. load resistance



Chapter 3

Rechargeable Coin Type Lithium Batteries

INDEX

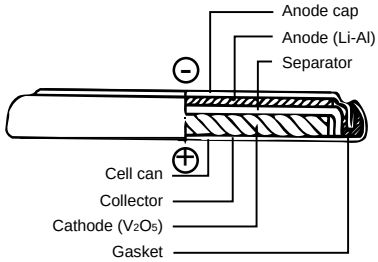
3-1 Vanadium Pentoxide Lithium Coin Type Batteries (VL series)

Vanadium Pentoxide Lithium Rechargeable Batteries (VL series)

Features

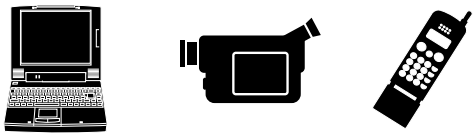
These completely new coin-type lithium batteries feature vanadium oxide for the positive pole, lithium alloy for the negative pole and a non-aqueous solvent for the electrolyte.

Construction



Applications

- Memory backup power supplies for office automation equipment (personal computers, fax machines, etc.), audio-video equipment (VTRs, etc.), communications equipment (mobile phones, etc.), etc.
- Hybrid systems with solar batteries (solar remote controllers, etc.)



General Specifications

Model No.	Electrical characteristics (20°C)			Dimensions (mm)		Weight (g)	JIS	IEC
	Nominal voltage (V)	*Nominal capacity (mAh)	Continuous drain (mA)	Diameter	Height			
VL621	3	1.5	0.01	6.8	2.1	0.3	-	-
VL1216	3	5.0	0.03	12.5	1.6	0.7	-	-
VL1220	3	7.0	0.03	12.5	2.0	0.8	-	-
VL2020	3	20.0	0.07	20.0	2.0	2.2	-	-
VL2320	3	30.0	0.10	23.0	2.0	2.8	-	-
VL2330	3	50.0	0.10	23.0	3.0	3.7	-	-
VL3032	3	100.0	0.20	30.0	3.2	6.3	-	-

* Nominal capacity shown above is based on standard drain and cut off voltage down to 2.5V at 20°C.

Charging

■ Charging circuits

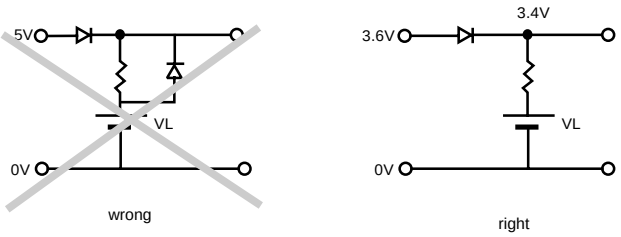
Charging/discharging cycle	Approx. 1,000 times at 10% discharge depth to nominal capacity
Charging system*	Constant-voltage charging.(Please strictly adhere to the specified charge voltage)
Operating temperature	-20 °C ~ + 60 °C

* Consult with Panasonic concerning constant-current charging systems.

The charging circuit is crucial in terms of ensuring that full justice will be done to the battery characteristics. Consider it carefully as the wrong charging circuit can cause trouble.

■ Precautions regarding the charge voltage setting

Under no circumstances should trickle charging, which is used for nickel-cadmium batteries, be used. Ignoring this precaution will cause the battery voltage to rise to about 5V, resulting in a deterioration of performance.



■ Charge voltage range

If a fixed-charging method is applied, please adhere to the specified charging voltage.

The guaranteed value over an operating temperature range from -20 to +60°C is 3.4V ± 0.15V.

(Actual value: 3.4V ± 0.20V)

* If the charging voltage exceeds the specifications, the internal resistance of the battery will rise and may cause battery deterioration. Also,with a charge voltage around 4V, corrosion of the (+) terminal (case) may occur, causing leakage. ("Influence of the charge voltage on VL batteries" in Chapter 3-59.)
* It is not possible for the battery capacity to recover completely when the charging voltage is below the specification.

■ Recommended charging circuits

● Basic conditions

Charge voltage: 3.4V±0.15V

Charge current: For a battery voltage of 3V

VL621	Approx. 0.2 mA or below
VL1216, VL1220	Approx. 0.5 mA or below
VL2020	Approx. 1.5 mA or below
VL2320, VL2330	Approx. 2.0 mA or below
VL3032	Approx. 4.0 mA or below

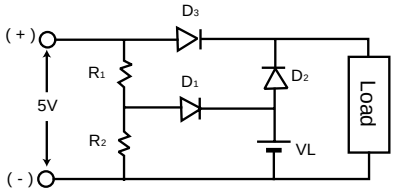
(It is permissible for the current to increase beyond the above level when the battery voltage drops below 3V.)

■ Mixed usage of batteries

Do not use these batteries and lithium primary batteries or other rechargeable batteries together, and do not use new batteries and old batteries together even if they are of the same type.

● Reference: Examples of 5-V charging circuits

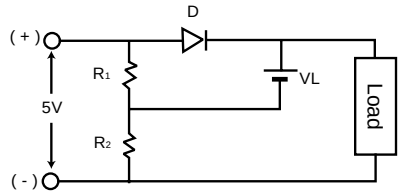
① Standard circuits



For D_2, select a diode of small inverse current (I_R=1μA below / 5V)
D_1, D_2 : MA716(Diode type code)
D_3 : MA704, MA700

	R_1	R_2
VL621	2.2kΩ	5.6kΩ
VL1220, VL1216	750Ω	2000Ω
VL2020	200Ω	510Ω
VL2320, VL2330	150Ω	390Ω
VL3032	68Ω	160Ω

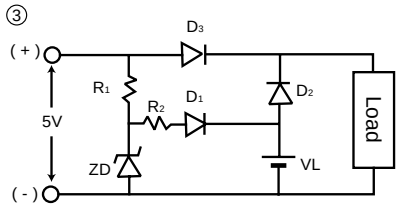
② Simple economical circuits



D : MA700 (Very small inverse current)

Load with 5V applied	100μA~10mA		100μA below	
D,Vf	0.2V~0.6V		0~0.2V	
	R_1	R_2	R_1	R_2
VL621	8.2kΩ	2.4kΩ	6.8kΩ	2.7kΩ
VL1220, VL1216	2000Ω	510Ω	1500Ω	560Ω
VL2020	1300Ω	330Ω	470Ω	180Ω
VL2320, VL2330	1100Ω	270Ω	390Ω	150Ω
VL3032	510Ω	120Ω	180Ω	68Ω

③

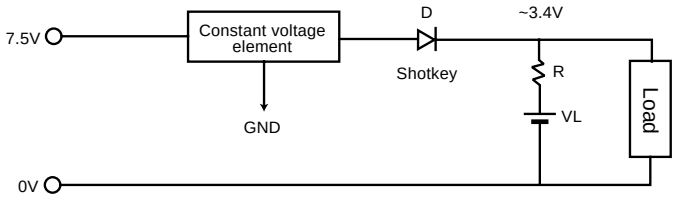


	ZD	D_1	R_1	
A	MA3036L	MA704	300Ω	Common to all types
B	MA3036H	MA700	270Ω	

Type		VL3032	VL2330	VL2320	VL2020	VL1220	VL1216	VL621
R_2	A	Not required				470Ω		1.5kΩ
	B	Not required				560Ω		1.6kΩ

For D_2, select a diode of small inverse current (I_R=1μA below / 5V)

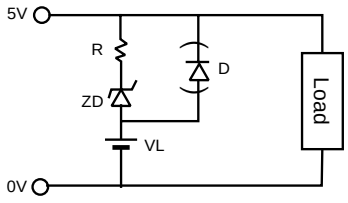
④ For minimizing current leakage due to resistance, etc., as when charging by another battery.



REG	D
3.7V	MA700

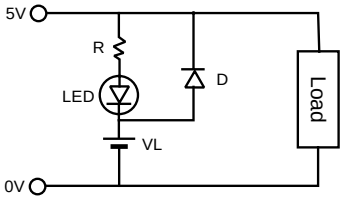
For details, refer to the constant voltage element specifications

⑤ Zener control



ZD : HZ2ALL
R : 43Ω/VL2320
68Ω/VL2020
＊D : MA700 or MA704
＊ Patent pending

⑥ LED control

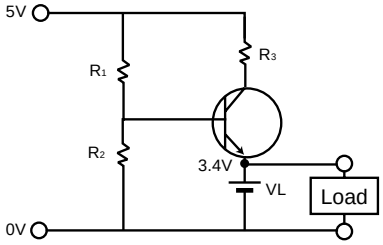


LED
R=51Ω for VL2320
＊D : MA700 or MA704

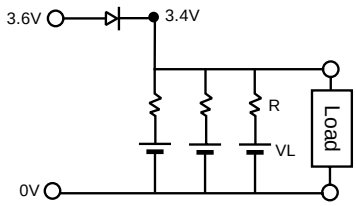
Select a diode having an inverse current as small as possible. (I_R=1μA below / 5V)

⑦ Transistor control(for VL2320)

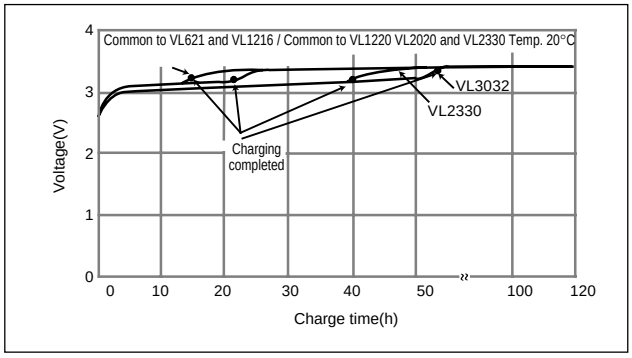
R_1: 4.3kΩ R_2 : 15.0kΩ R_3 : 680Ω



⑧ Parallel circuit

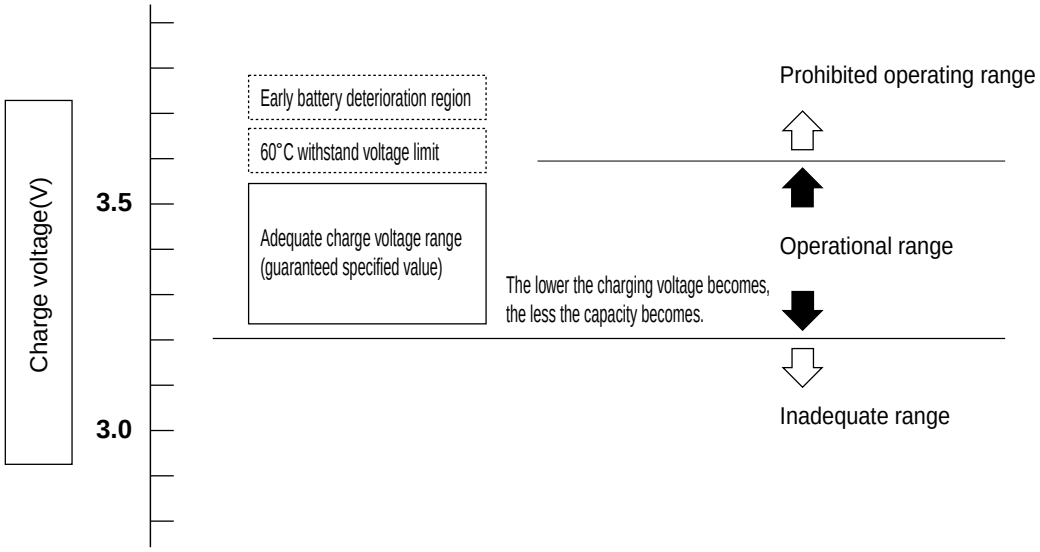


● Charging characteristics



● Influence of the charge voltage on VL batteries

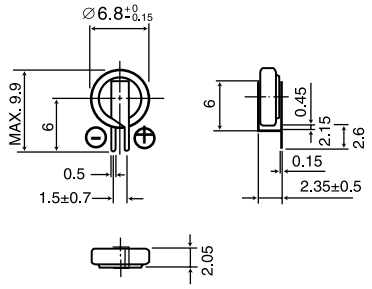
If the charge voltage goes beyond its adequate range, battery performance may deteriorate early. Be sure to observe the guaranteed charge voltage.



VL621

■ Dimensions(mm)

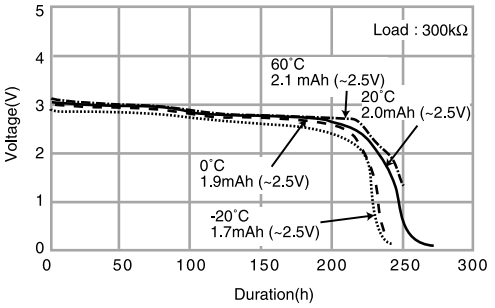
(VL621 / F9D)



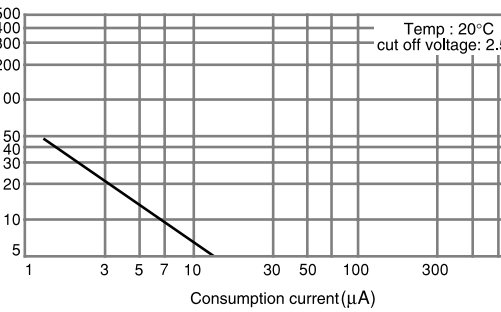
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	1.5
Continuous standard load(mA)	0.01
Operating temperature(˚C)	-20 ~ +60

■ Discharge Temperature Characteristics



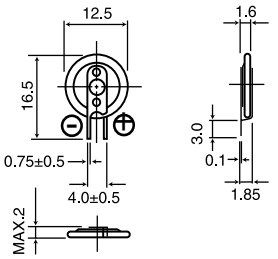
■ Consumption current vs. Duration time



VL1216

■ Dimensions(mm)

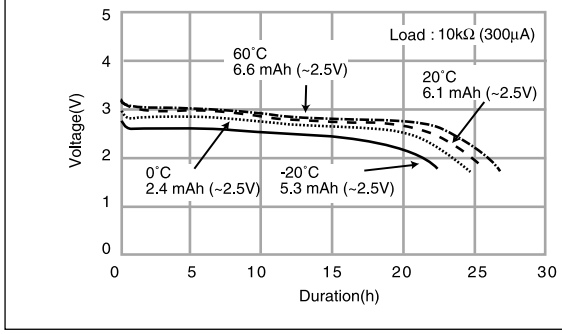
(VL1216 / 1F5U)



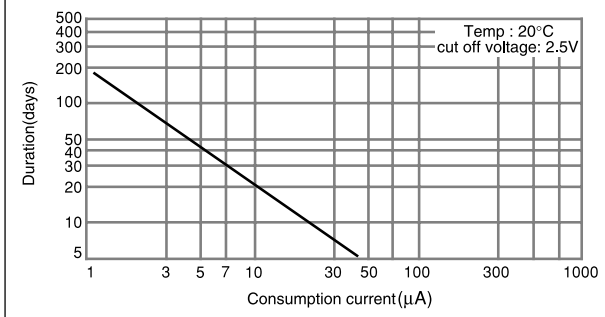
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	5.0
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-20 ~ +60

■ Discharge Temperature Characteristics



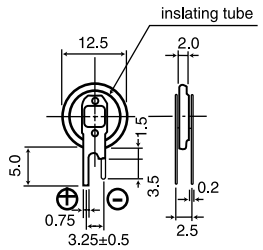
■ Consumption current vs. Duration time



VL1220

■ Dimensions(mm)

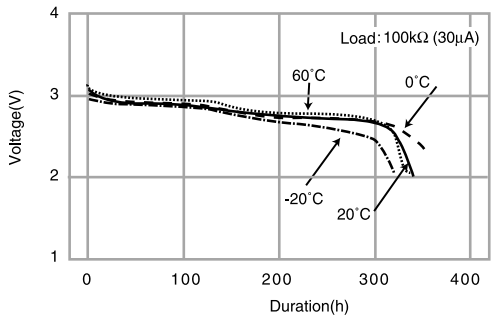
(VL1220 / 1F5U)



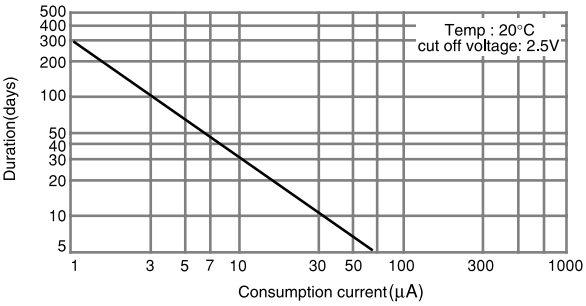
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	7.0
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-20 ~ +60

■ Discharge Temperature Characteristics



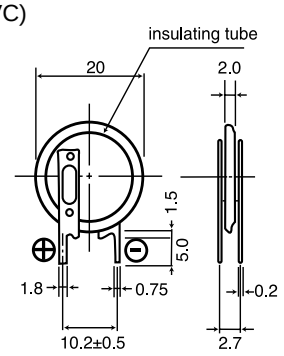
■ Consumption current vs. Duration time



VL2020

■ Dimensions(mm)

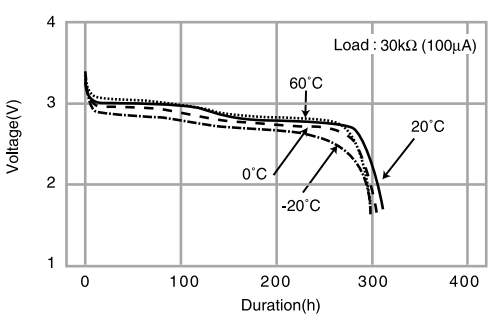
(VL2020 / 1VC)



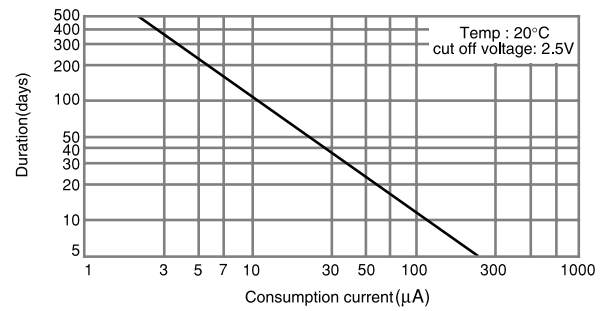
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	20.0
Continuous standard load(mA)	0.07
Operating temperature(˚C)	-20 ~ +60

■ Discharge Temperature Characteristics



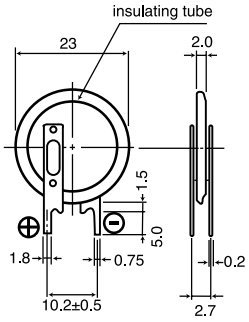
■ Consumption current vs. Duration time



VL2320

■ Dimensions(mm)

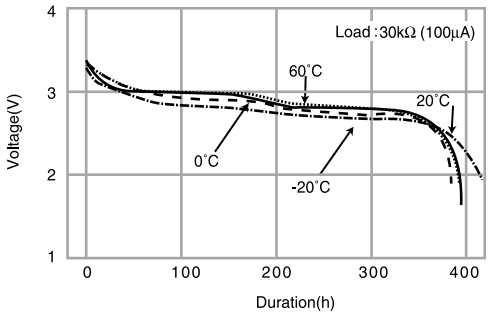
(VL2320 / 1VC)



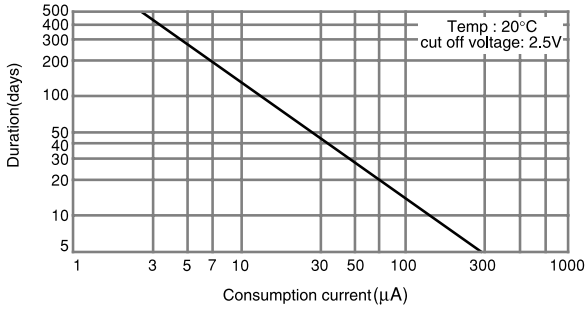
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	30.0
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-20 ~ +60

■ Discharge Temperature Characteristics



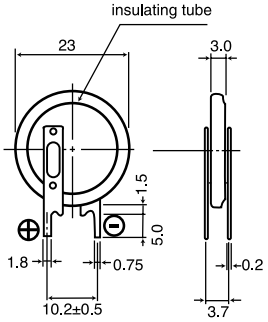
■ Consumption current vs. Duration time



VL2330

■ Dimensions(mm)

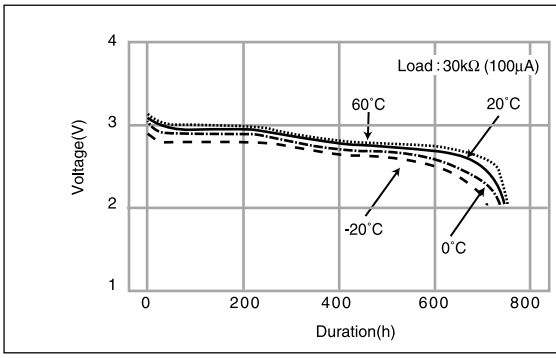
(VL2330 / 1VC)



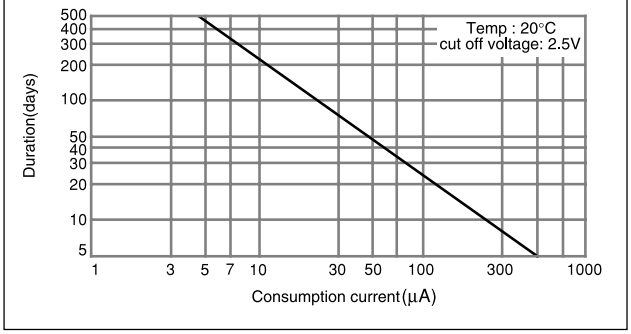
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	50.0
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-20 ~ +60

■ Discharge Temperature Characteristics



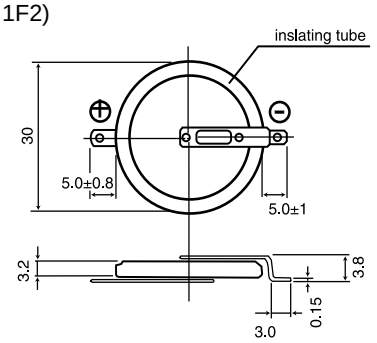
■ Consumption current vs. Duration time



VL3032

■ Dimensions(mm)

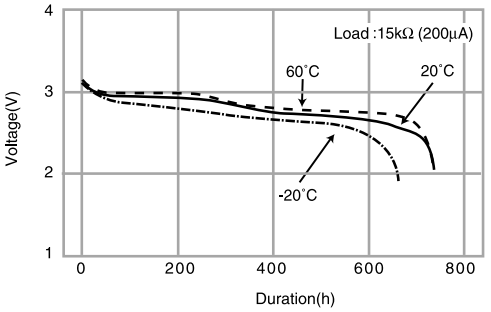
(VL3032 / 1F2)



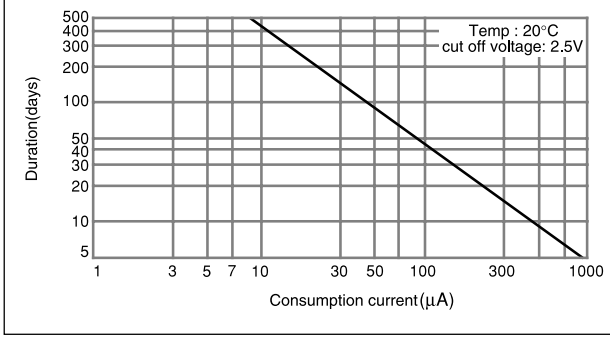
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	100.0
Continuous standard load(mA)	0.2
Operating temperature(˚C)	-20 ~ +60

■ Discharge Temperature Characteristics



■ Consumption current vs. Duration time



3-2 Manganese Lithium Coin Type Batteries (ML series)

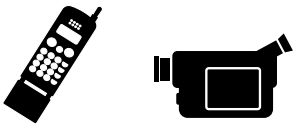
Manganese Lithium Rechargeable Batteries (ML series)

Features

These super compact lithium rechargeable batteries feature a manganese compound oxide for the positive electrode, a lithium/aluminum alloy for the negative electrode and a special non-aqueous solvent for the electrolyte. They can easily be incorporated into circuits where 3V ICs are used to save space.

Applications

- Memory backup power supplies for mobile phones, memory cards, pagers and other compact communications equipment, data terminals and office automation equipment



General Specifications

Model No.	Electrical characteristics (20°C)			Dimensions(mm)		Weight(g)	JIS	IEC
	Nominal voltage(V)	*Nominal capacity(mAh)	Continuous drain(mA)	Diameter	Height			
ML612S	3	2.6	0.01	6.8	1.2	0.15	-	-
ML614S	3	3.4	0.01	6.8	1.4	0.17	-	-
ML616S	3	2.9	0.01	6.8	1.6	0.2	-	-
ML621S	3	5.0	0.01	6.8	2.1	0.3	-	-
ML920S	3	11.0	0.03	9.5	2.0	0.5		
ML1220	3	17.0	0.03	12.5	2.0	0.8		
ML2020	3	45.0	0.10	20.0	2.0	2.2	-	-
ML2430(Under development)	3	120.0	0.30	24.5	3.0	4.0		

*Nominal capacity shown above is based on standard drain and cut off voltagedown to 2.0V at 20°C.

Charging

■ Charging circuits

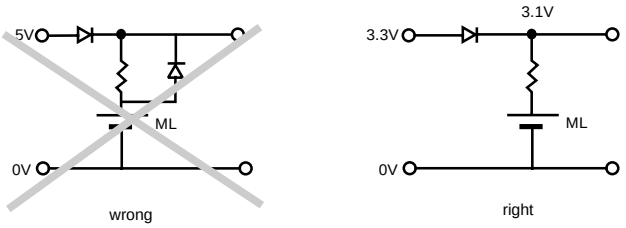
Charging/discharging cycle	Approx. 1,000 times at 10% discharge depth to nominal capacity
Charging system*	Constant-voltage charging.(Please strictly adhere to the specified charge voltage)
Operating temperature	-20 °C ~ + 60 °C

* Consult with Panasonic concerning constant-current charging systems.

The charging circuit is crucial in terms of ensuring that full justice will be done to the battery characteristics. Consider it carefully as the wrong charging circuit can cause trouble.

■ Precautions regarding the charge voltage setting

Under no circumstances should trickle charging, which is used for nickel-cadmium batteries, be used.
Ignoring this precaution will cause the battery voltage to rise to about 5V, resulting in a deterioration of performance.



■ Charge voltage range

If a fixed-charging method is applied, please adhere to the specified charging voltage.
Guaranteed voltage is 2.8V ~ 3.2V at the temperature of -20°C~60°C.

* If the charging voltage exceeds the specifications, the internal resistance of the battery will rise and may cause battery deterioration. Also, with a charge voltage around 4V, corrosion of the (+)terminal (case) may occur, causing leakage. ("Influence of the charge voltage on ML batteries" on the back.)
* It is not possible for the battery capacity to recover completely when the charging voltage is below the specification.

■ Recommended charging circuits

● Basic conditions

Fixed-voltage charge
Charge voltage: 2.8~3.2V (Standard voltage: 3.1V)
Charge current: For a battery voltage of 2.5V

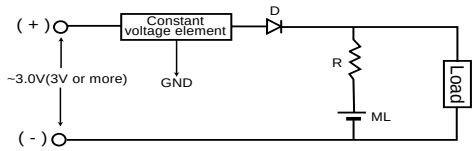
ML612S,ML614S,ML616S	Approx. 0.3 mA or below
ML621S	Approx. 0.6 mA or below
ML920S	Approx. 1.2 mA or below
ML1220	Approx. 1.2 mA or below
ML2020	Approx. 3.0 mA or below

■ Mixed usage of batteries

Do not use these batteries and lithium primary batteries or other rechargeable batteries together, and do not use new batteries and old batteries together even if they are of the same type.

● Reference: Examples of 5-V charging circuits

①



When charging using another battery

ML612S, ML614S, ML616S

REG	D	R
3.2V	MA700	1.8KΩ
3.1V	MA700	1.5KΩ

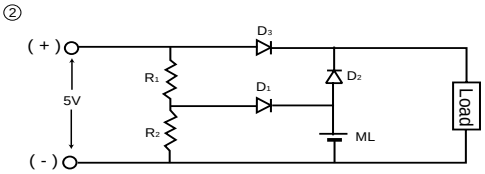
ML621S

REG	D	R
3.2V	MA700	910Ω
3.1V	MA700	750Ω

ML2020

REG	D	R
3.2V	MA700	180Ω
3.1V	MA700	150Ω

②



Standard circuits

For D_2 , select a diode of small inverse current

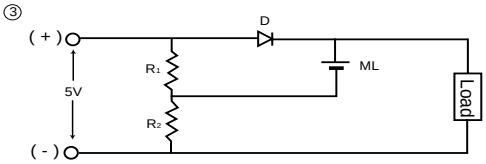
D_1, D_2 : MA716(Diode type code)

D_3 : MA704, MA700

(I_R=1μA/5V)

	R_1	R_2
ML612S, ML614S ML616S	2.7k Ω	5.1k Ω
ML621S	1.1kΩ	2.0k Ω
ML2020	180Ω	330 Ω

③



Pat No.JP284170

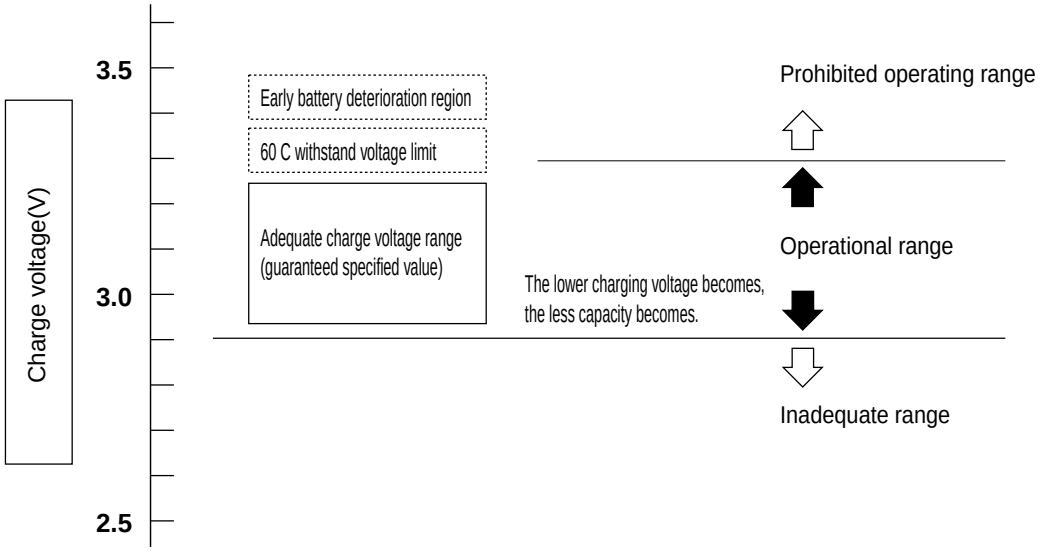
Simple economical circuits D : MA700 : Very small inverse current

Load	100μA below	
D,Vf	0~0.2V	
	R_1	R_2
ML612S, ML614S ML616S	5.1kΩ	2.7kΩ
ML621S	2.4kΩ	1.3kΩ
ML2020	330 Ω	180 Ω

* VF of D will be different from the value given above if a current in excess of 100μA flows to the load during operation. Compensation must be provided by the resistors in such cases.

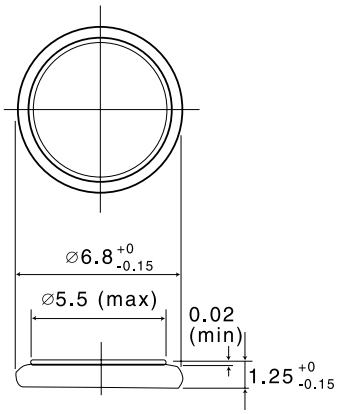
● Influence of the charge voltage on ML batteries

If the charge voltage goes beyond its adequate range, battery performance may deteriorate early. Be sure to observe the guaranteed charge voltage.



ML612S

■ Dimensions(mm)

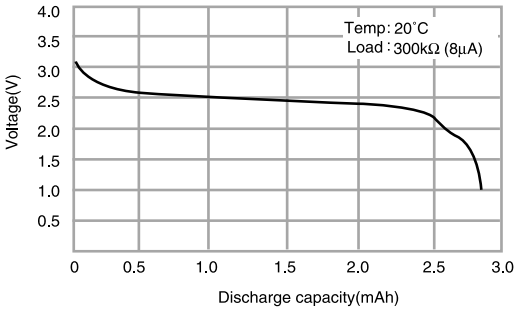


Weight: 0.15g

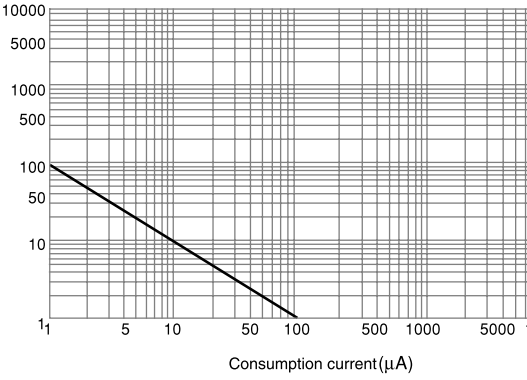
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	2.6
Continuous standard load(mA)	0.01
Operating temperature(˚C)	-20 ~ +60

■ Discharge characteristics

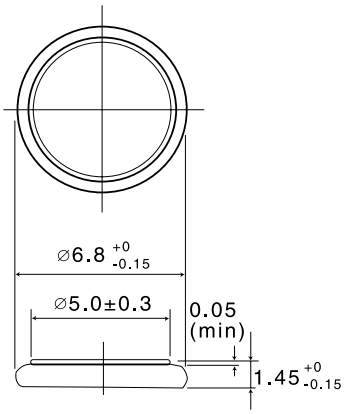


■ Consumption current vs. Duration time



ML614S

■ Dimensions(mm)

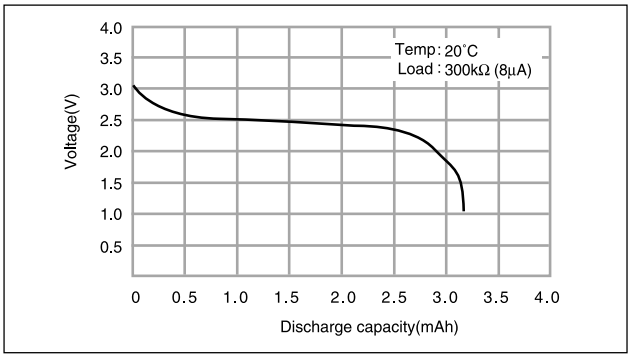


Weight: 0.17g

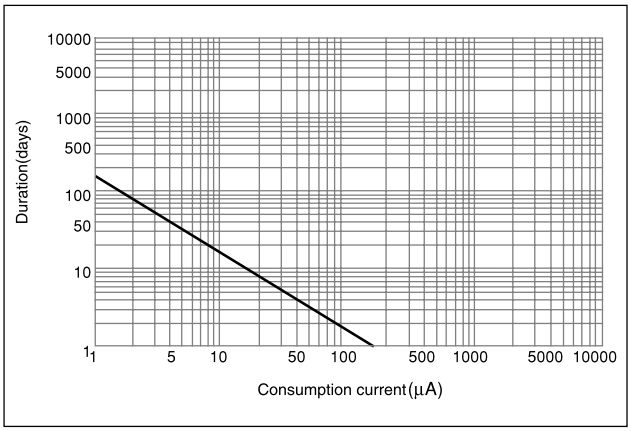
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	3.4
Continuous standard load(mA)	0.01
Operating temperature(˚C)	-20 ~ +60

■ Discharge characteristics

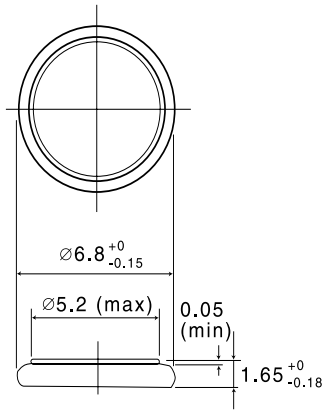


■ Consumption current vs. Duration time



ML616S

■ Dimensions(mm)

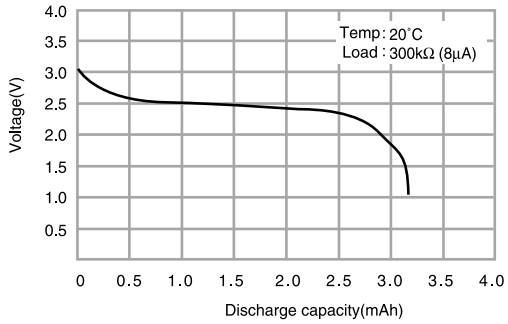


Weight: 0.20g

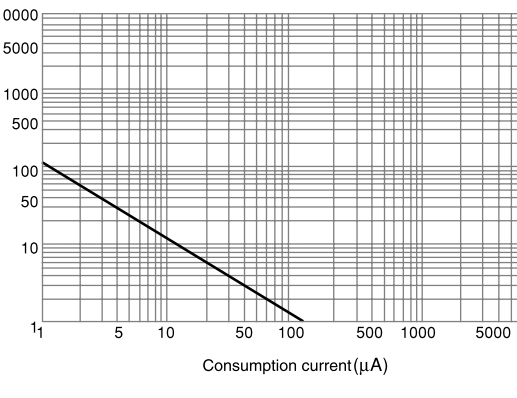
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	2.9
Continuous standard load(mA)	0.01
Operating temperature(˚C)	-20 ~ +60

■ Discharge characteristics



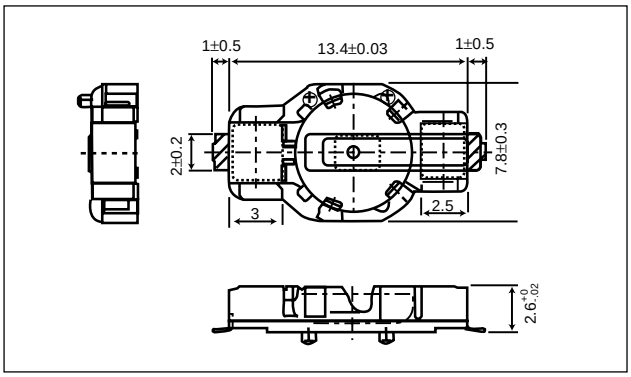
■ Consumption current vs. Duration time



Lithium Battery Holders for ML616S

These battery holders are designed for sure and easy loading/removal of Panasonic coin type lithium batteries in/from equipment enabling the batteries to fully exploit their capabilities as the backup power supply in C-MOS RAM memory and microcomputer memory. All of the battery holders are designed to prevent inverted insertion of the battery.

BML06H1

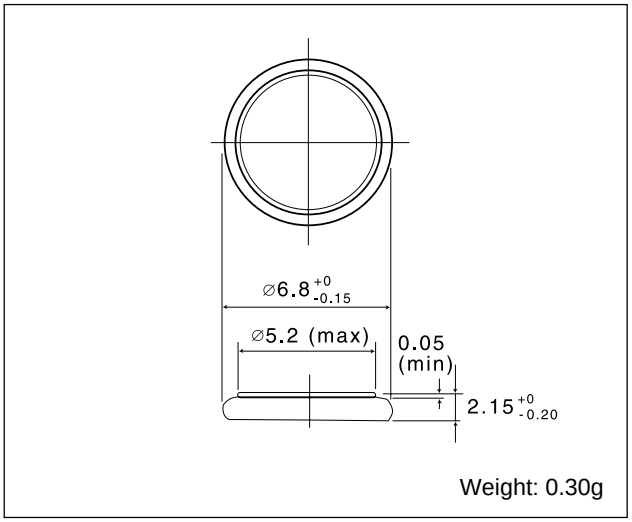


■ Precaution for washing battery holders

The battery holders can be adversely affected by some detergents used in the circuit board washing process and may result in cracks forming in the holder. Please test the holders in your washing process before use.

ML621S

■ Dimensions (mm)

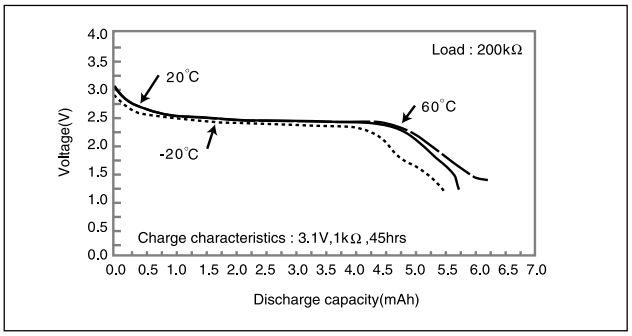


Weight: 0.30g

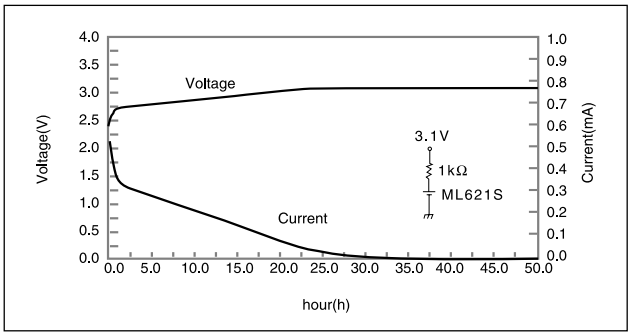
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	5
Continuous standard load(mA)	0.01
Operating temperature(˚C)	-20 ~ +60

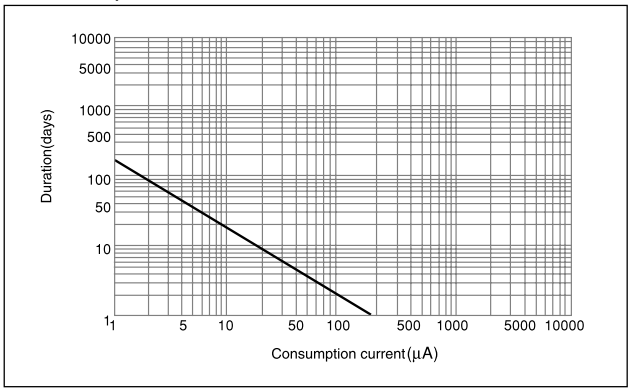
■ Discharge characteristics



■ Charge / discharge characteristics



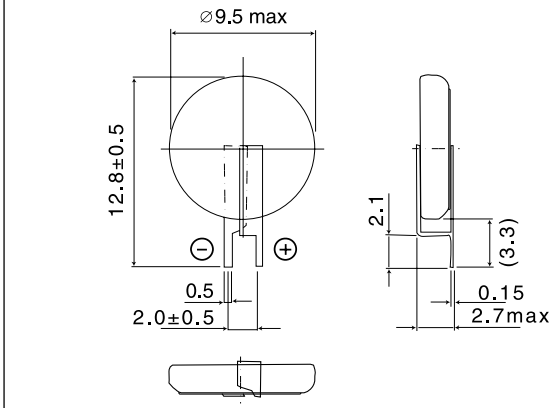
■ Consumption current vs. Duration time



ML920S

■ Dimensions (mm)

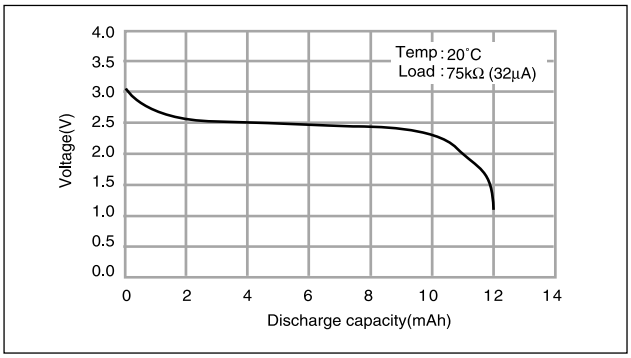
(ML920S / F9D)



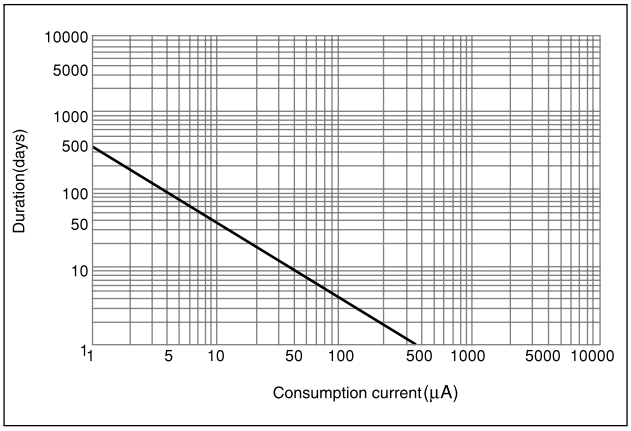
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	11.0
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-20 ~ +60

■ Discharge characteristics



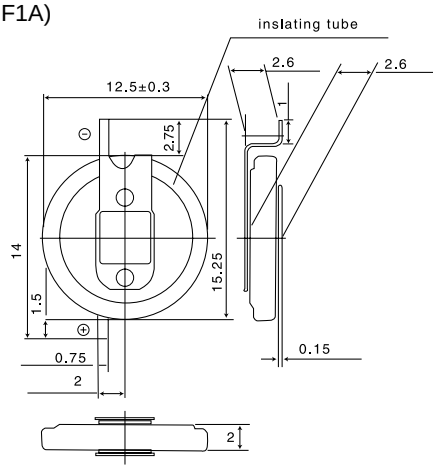
■ Consumption current vs. Duration time



ML1220

■ Dimensions(mm)

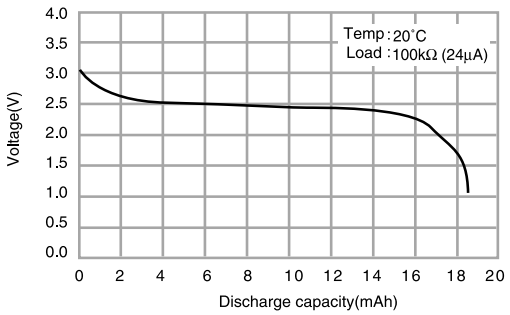
(ML1220 / F1A)



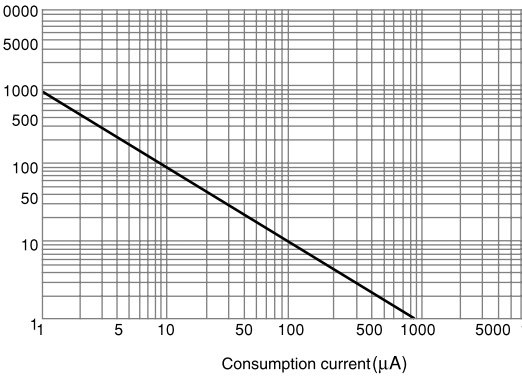
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	17.0
Continuous standard load(mA)	0.03
Operating temperature(˚C)	-20 ~ +60

■ Discharge characteristics



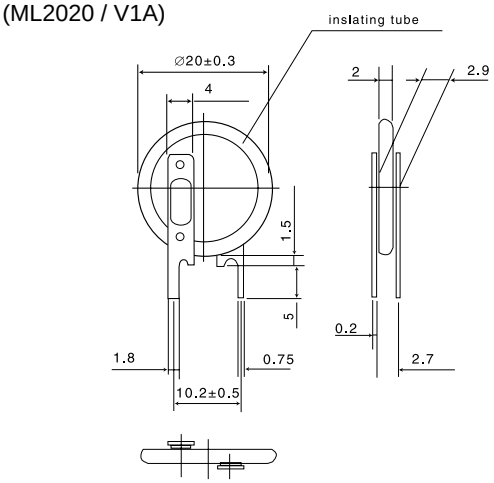
■ Consumption current vs. Duration time



ML2020

■ Dimensions(mm)

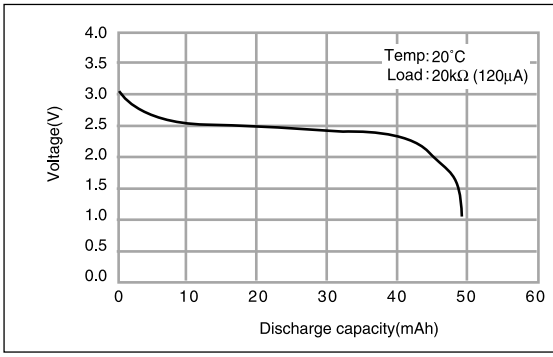
(ML2020 / V1A)



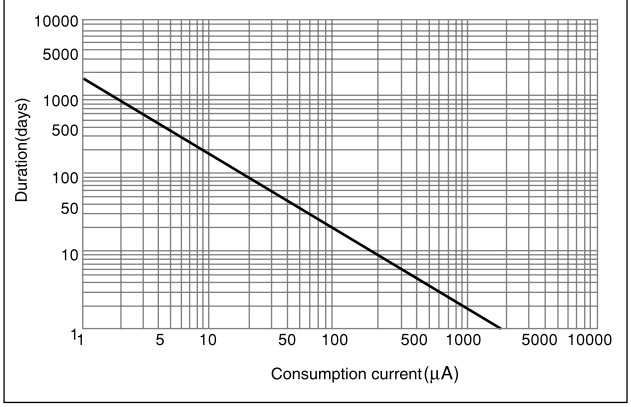
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	45
Continuous standard load(mA)	0.1
Operating temperature(˚C)	-20 ~ +60

■ Discharge characteristics



■ Consumption current vs. Duration time



ML2430(Under development)

■ Dimensions(mm)

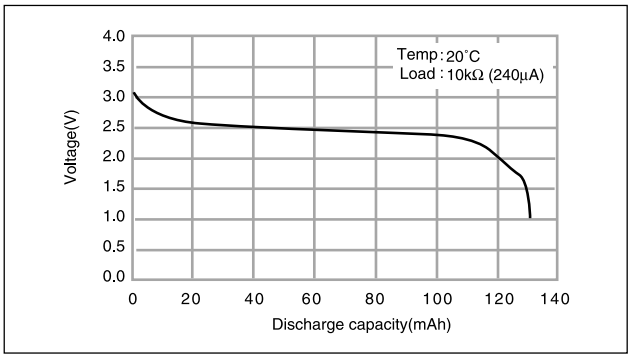
Under development

Weight: 4.0g

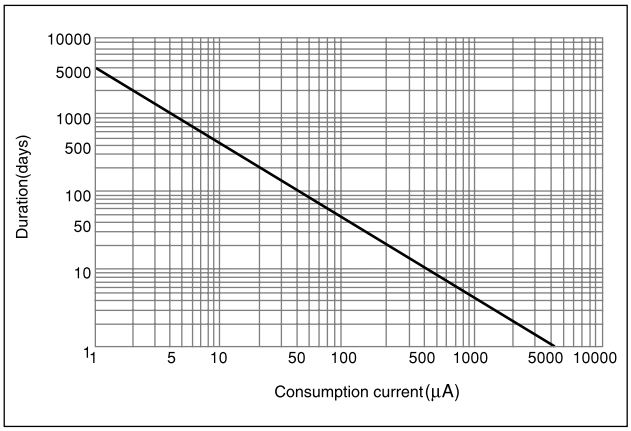
■ Specification

Nominal voltage(V)	3
Nominal capacity(mAh)	120
Continuous standard load(mA)	0.3
Operating temperature(˚C)	-20 ~ +60

■ Discharge characteristics



■ Consumption current vs. Duration time



3-3 Niobium-Lithium Coin Type Batteries (NBL series)

Niobium-Lithium Rechargeable Batteries (NBL series)

Features

The NBL series eliminates the need for a voltage boosting circuit since they can be charged at a low voltage. They help to simplify charging circuits.

Applications

- Memory backup power supplies for mobile phones using ICs which reduce the voltage to lower levels and which are driven at 2.5V or so.

General Specifications

Model No.	Electrical characteristics (20°C)			Dimensions(mm)		Weight(g)	JIS	IEC
	Nominal voltage(V)	*Nominal capacity(mAh)	Continuous drain(mA)	Diameter	Height			
NBL621	2	4	0.01	6.8	2.1	0.25	-	-

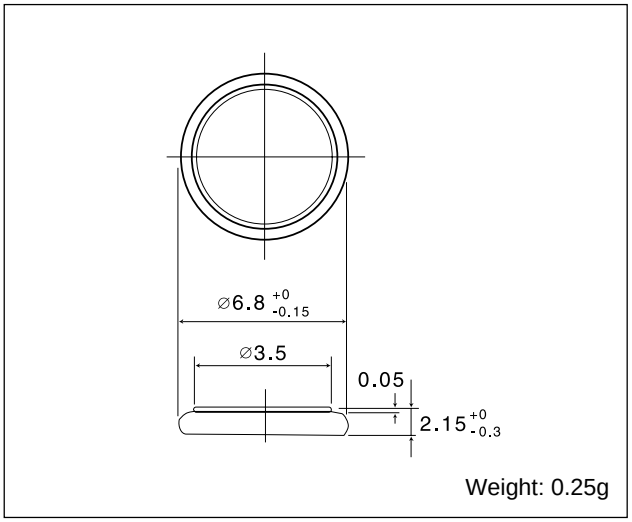
*Nominal capacity shown above is based on standard drain and cut off voltage down to 1.0V at 20°C.

Charging

Consult Panasonic for charging conditions.

NBL621

■ Dimensions(mm)

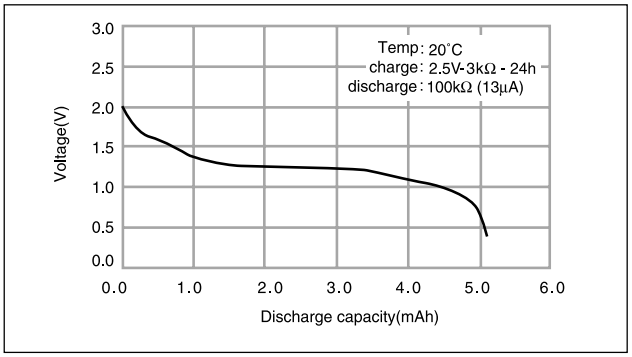


Weight: 0.25g

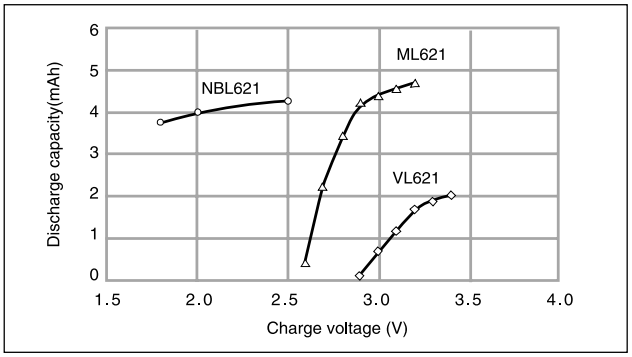
■ Specification

Nominal voltage(V)	2
Nominal capacity(mAh)	4
Continuous standard load(mA)	0.01
Operating temperature(˚C)	-20 ~ +60

■ Discharge characteristics



■ Recovered capacity (According to charge voltage)



3-4 Manganese Titanium Lithium Coin Type Batteries (MT series)

Manganese Titanium Lithium Rechargeable Batteries (MT series)

Features

These coin-type manganese titanium lithium coin batteries use a lithium-manganese complex oxide for the positive pole and a special lithium-titanium complex oxide for the negative pole. They provide a capacity which is more than 10 times that of capacitors of the same size.

Applications

- Main power supplies in compact products such as rechargeable watches
- Memory backup power supply for pagers, timers, etc.

General Specifications

Model No.	Electrical characteristics (20°C)			Dimensions(mm)		Weight(g)	JIS	IEC
	Nominal voltage(V)	*Nominal capacity(mAh)	Continuous drain(mA)	Diameter	Height			
MT516	1.5	0.9	0.05	5.8	1.6	0.15	-	-
MT616	1.5	1.05	0.05	6.8	1.6	0.20	-	-
MT621	1.5	2.5	0.05	6.8	2.1	0.25	-	-
MT920	1.5	4.0	0.10	9.5	2.0	0.45	-	-
MT1620	1.5	11.0	0.50	16.0	2.0	1.25	-	-

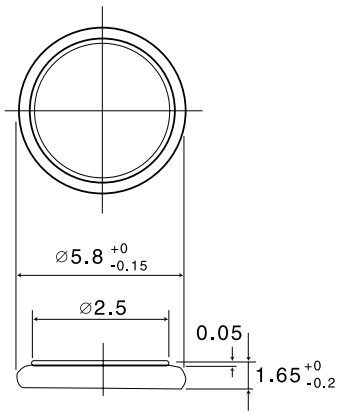
*Nominal capacity shown above is based on standard drain and cut off voltage down to 1.0V at 20°C.

Charging

Consult Panasonic for charging conditions.

MT516

■ Dimensions (mm)

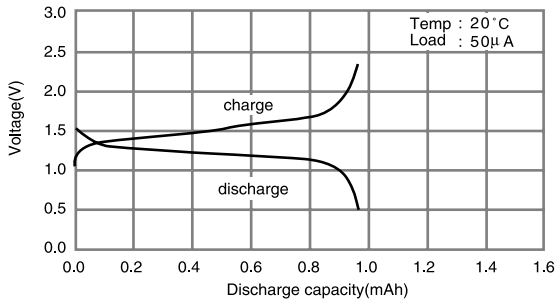


Weight: 0.15g

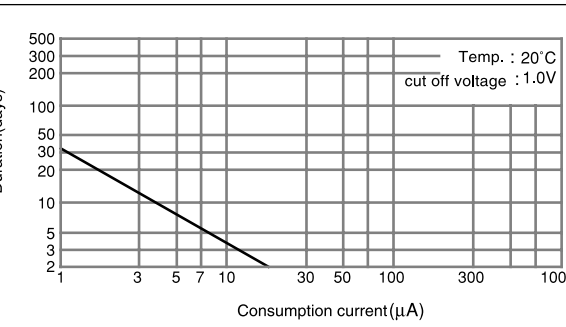
■ Specification

Nominal voltage(V)	1.5
Nominal capacity(mAh)	0.9
Continuous standard load(mA)	0.05
Operating temperature(˚C)	-20 ~ +60

■ Charge / discharge characteristics

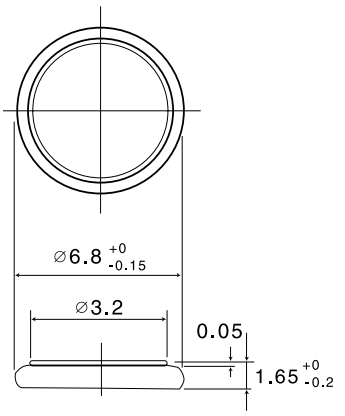


■ Consumption current vs. Duration time



MT616

■ Dimensions (mm)

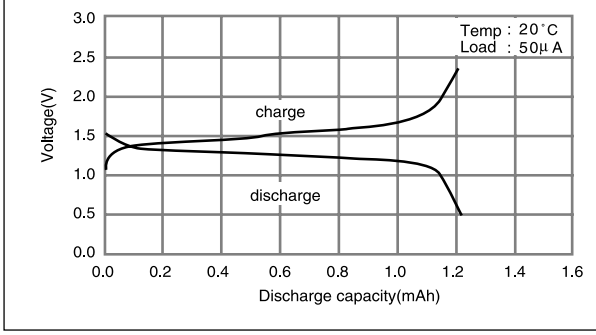


Weight: 0.20g

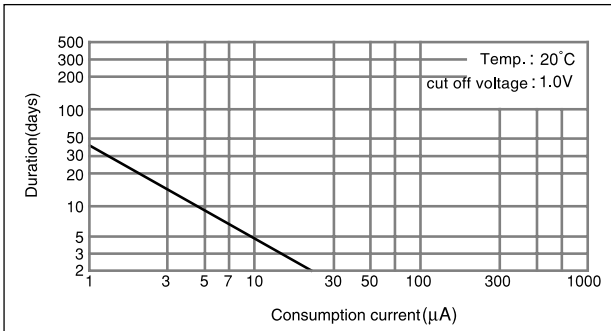
■ Specification

Nominal voltage(V)	1.5
Nominal capacity(mAh)	1.05
Continuous standard load(mA)	0.05
Operating temperature(˚C)	-20 ~ +60

■ Charge / discharge characteristics

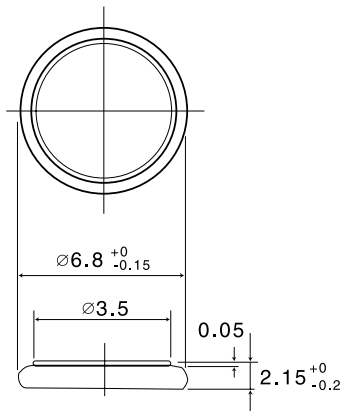


■ Consumption current vs. Duration time



MT621

■ Dimensions (mm)

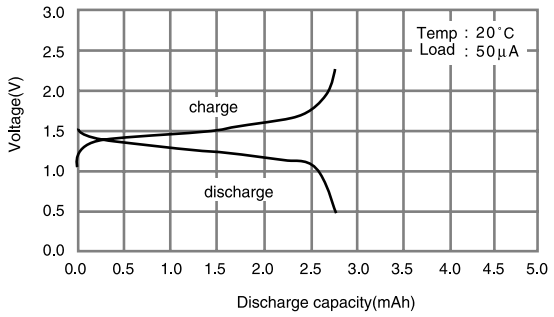


Weight: 0.25g

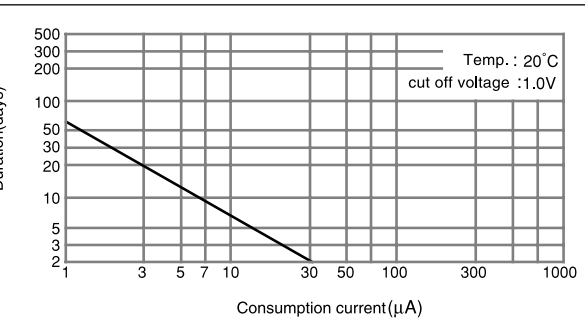
■ Specification

Nominal voltage(V)	1.5
Nominal capacity(mAh)	2.5
Continuous standard load(mA)	0.05
Operating temperature(˚C)	-20 ~ +60

■ Charge / discharge characteristics

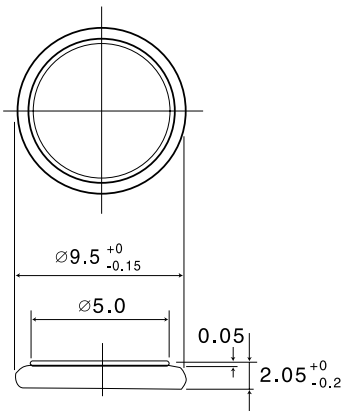


■ Consumption current vs. Duration time



MT920

■ Dimensions (mm)

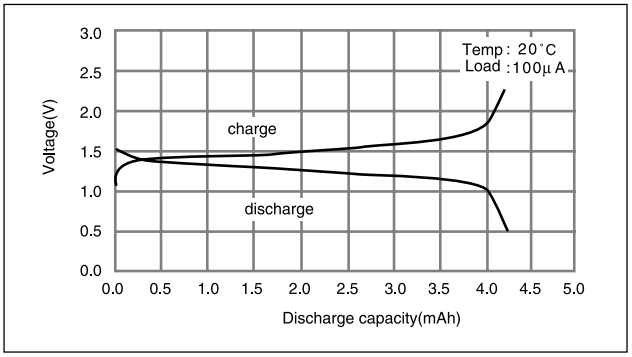


Weight: 0.45g

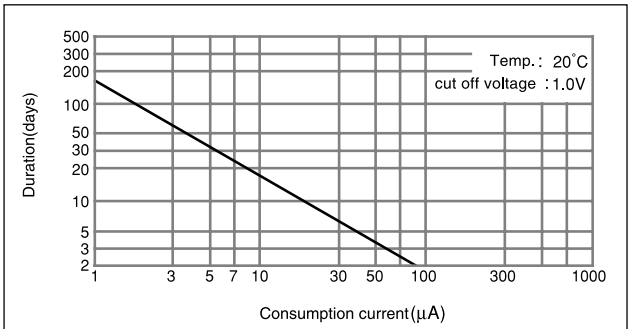
■ Specification

Nominal voltage(V)	1.5
Nominal capacity(mAh)	4.0
Continuous standard load(mA)	0.10
Operating temperature(˚C)	-20 ~ +60

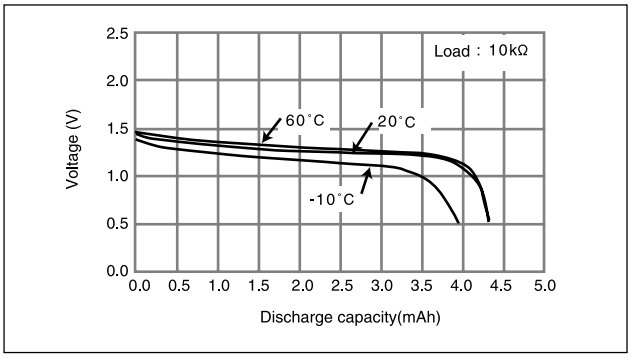
■ Charge / discharge characteristics



■ Consumption current vs. Duration time

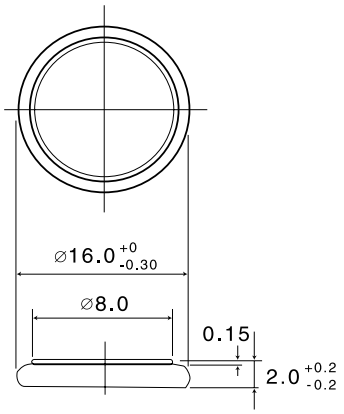


■ Discharge characteristics



MT1620

■ Dimensions (mm)

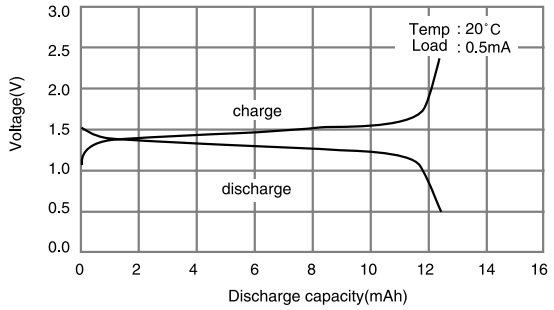


Weight: 1.25g

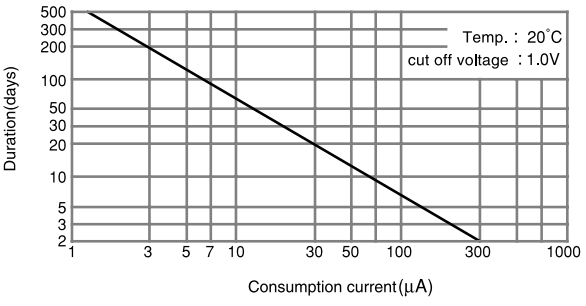
■ Specification

Nominal voltage(V)	1.5
Nominal capacity(mAh)	11.0
Continuous standard load(mA)	0.50
Operating temperature(˚C)	-20 ~ +60

■ Charge / discharge characteristics



■ Consumption current vs. Duration time



Chapter 4

Batteries with Terminals and Soldering Lithium Batteries

INDEX

Batteries with Terminals

Highly Reliable Terminal Welding

(1) Using a laser to weld terminals

Panasonic uses a laser welding method to weld the terminals onto the batteries so they can be mounted onto PC boards by soldering. This method has the effect of boosting the tensile strength accompanying a welding strength to approximately 100N (approx.10kgf) compared with 20N to 50N (approx. 2 to 5 kgf) yielded by the conventional resistance welding method. The method also more or less cuts in half the individual variations occurring in the welding. Furthermore, it enables terminals to be welded onto thin batteries, such as those with a thickness of 1.6 mm, and it improves compatibility with many other uses. This highly reliable terminal soldering method can be used in a wide range of applications, obviating eliminating the need for reinforcement or other such means.

(2) Execution of pre-soldering

The tips of the terminals are pre-soldered in order to enhance the reliability of the soldering.

Complete Line-up

Panasonic offers a full range of batteries with terminals for PCB mounting. Since the terminals come in a variety of types, please contact Panasonic for further details. A more limited selection of simple battery holders to support the batteries is also available.

Soldering

(1) Using a soldering iron

Do not allow the soldering iron to make direct contact with the bodies of the batteries. Proceed with the soldering quickly within 5 seconds while maintaining the iron tip temperature at about 350°C, and do not allow the temperature of the battery bodies to exceed 85°C.

(2) Automatic dip-soldering bath

Soldering with a dip-soldering bath can be used but do not allow the temperature of the battery bodies to exceed 85°C. It is important to note, depending on the temperature conditions inside the dipping device,that the battery body temperature may rise after dipping due to the residual heat retained. When a post-dipping temperature rise is observed, review the temperature conditions and consider a dipping time reduction or a way of forcibly cooling the batteries after dipping.

Basic conditions	
Dip-soldering bath temperature	260˚C or less
Dipping time	Within 5 sec.
Number of dips	Not more than 2

* Consult Panasonic if the battery body temperature will exceed 85°C.

⚠ Never Use Reflow Soldering

Never use reflow soldering since doing so directly heats the battery surface to high temperatures, causing electrolyte leakage, deterioration of battery characteristics and risking bursting or ignition.

Cautions

Example where the terminals were soldered straight onto a coin-type lithium battery, the terminals were connected to a PC board or other electronic components, and the heat generated by the soldering adversely affected the battery, resulting in a deterioration of the battery characteristics:

The heat generated when terminals are mounted using solder causes lithium to melt.

↓

The separator melts and becomes perforated.

↓

The positive and negative poles are welded together, causing "internal shorting."

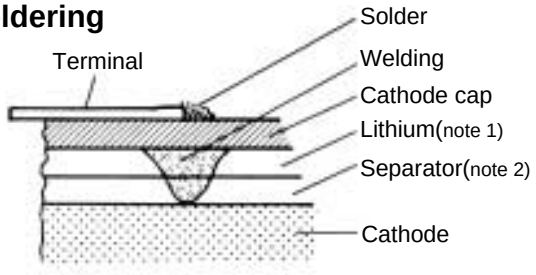
↓

In terms of the battery characteristics, the open-circuit voltage and electrical capacity are both reduced.

↓

The battery loses its functions or it bursts in rare cases.

Soldering



(note 1)Metal whose melting point is about 180°C
(note 2)Non woven cloth of polypropylene whose melting point is about 165°C

Chapter 5

Standards and Regulations

INDEX

QS9000 / ISO9001 Approval

The Lithium & Micro Battery Division has acquired certification under ISO9001, the international standard for quality assurance, for its cylindrical type lithium batteries and coin-type lithium batteries.

In addition, we have acquired certification under QS-9000, the quality standard for the automobile manufacturing industry, for its coin-type lithium primary batteries.

QS-9000

The QS-9000 standard was established by the "Big Three" U.S. automakers (Daimler-Chrysler, Ford and GM) on the basis of the ISO9001 international standard governing quality assurance but with additional requirements of their own.

A company which has been certified under this standard can supply highly reliable products by incorporating into its quality system proven "predictive management" techniques which are substantiated by numerical data from a customer satisfaction survey, failure mode and effects analysis (FMEA), process capability analysis, measurement systems analysis, etc. which are required under the standard.

Transporting Lithium Batteries

■ **Regulations for transporting lithium batteries (only batteries which have a solid cathode electrode are listed)**

(as of March / 2000)

Name of regulations		ICAO IATA		IMDG	Highway, Railway
Means of transportation		airplane	air cargo	ship	DOT
Application range		international		international	United States
A	Total weight of lithium battery	1g or less	1g or less	1g or less	1g or less
	Total weight of lithium battery pack	2g or less	2g or less	2g or less	2g or less
B	Total weight of lithium battery	5g or less	5g or less	5g or less	5g or less
	Total weight of lithium battery pack	25g or less	25g or less	25g or less	25g or less
C	Total weight of lithium battery	12g or less	12g or less	12g or less	12g or less
	Total weight of lithium battery pack	500g or less	500g or less	500g or less	500g or less
	Total weight of a carton	500g or less	500g or less	500g or less	500g or less
		Up to 5kg of batteries can be carried if they are packed in a container which is approved 2nd class by UN.	Up to 35kg of batteries can be carried if they are packed in a container which is approved 2nd class by UN.	Up to 250kg of batteries can be carried if they are packed in a container which is approved 2nd class by UN.	DOT;49CFR173.185

A: The batteries listed above are not subject to these restrictions provided that they satisfy the A45 conditions,IATA.

B: The batteries listed above are not subject to these restrictions provided that they have been certified as satisfying the test standards specified in the U.N. recommendation and as not falling under the classification of hazardous items.

C: The batteries listed above can be transported provided that they satisfy the conditions stipulated by the laws and regulations listed below and that they meet the packaging standards.

The regulation above is an extract of the latest version. See the original for details.

U N (United Nations)

ICAO (International Civil Aviation Organization)

IATA (International Air Transport Association)

IMO (International Marin Organization)

DOT (Department Of Transportation)

This section of the catalog is quoted by transportation hazards issued by the organizations shown above.

Security Export Control

"Security export control" entails observing the legislation provided to maintain international peace and safety by preventing the proliferation of weapons of mass destructions (nuclear weapons, chemical warfare weapons, biological weapons and missiles) and the excessive buildup of conventional weapons. COCOM, the committee that imposed controls on exports to the Communist bloc, was disbanded on March 31, 1994. However, the items, etc. which were restricted by COCOM are still the target of the restrictions but they are now also subject to some amendments which were made in September 1996.

Lithium batteries are on the list of items subject to the Export and Trade Control Regulation (Item 7 in annex Table 1) but all the products mentioned in this catalog are exempt from these regulations.

The above notwithstanding, these batteries may be subject to the regulations depending on their ultimate destination, application and other conditions.

When a non-exemption/exemption certificate is required for exportation, etc. or if you have any queries, contact a Panasonic sales representative.

Chapter 6

Avoiding Hazards and Preventing Quality Problems

INDEX

Avoiding Hazards

Case Study and Explanation

To store batteries, place each of the batteries in the sections provided on the designated tray in such a way that they will not make contact with one another.

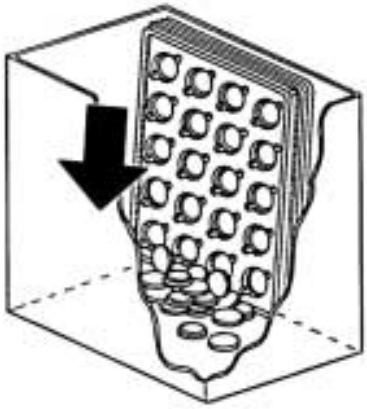
Ignition

2,000 new batteries were taken out from the 20-piece tray containers and thrown randomly into a cardboard box where they were stacked on top of one another. About 30 minutes later, smoke was seen emanating from the batteries followed by ignition several minutes after that.

Case study: Ignition of batteries stacked together

Rupture

This particular case involves batteries which were packed in trays and destined for OEMs. The batteries were packed in an intermediate package consisting of 10 trays with each tray containing 20 (or 40) batteries, and the trays were stacked on top of each other. The intermediate package (of the 10 trays) was opened at the distribution stage of our operations, and five of the trays were delivered to one customer. Since the trays were stored at an angle inside the box, the batteries fell out of their positions on the trays and became stacked up on the bottom inside the small box. As a result, some of the batteries burst.

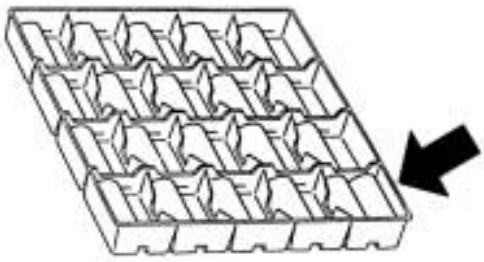


Case study: Bursting of batteries stacked on top of one another

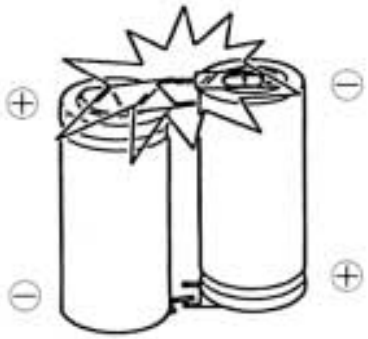
Generating Heat

21 cylindrical type lithium batteries with tab terminals were placed in a 20 piece tray--one battery more than the capacity of the 20-piece tray shown in the figure--two of the batteries were placed together with their poles reversed. As a result, the tab terminals came into contact with each other, causing external shorting, and the temperature of the two batteries rose dramatically, generating heat and causing the halon tubes to burst.

Since two batteries were placed in a space (indicated by ⬅) allocated to one battery, their terminals made contact with each other, and external shorting resulted.



➡ an enlargement



Generating heat and deterioration of capacity

To store batteries, place each of the batteries in the sections provided on the designated tray in such a way that they will not make contact with one another.

Reduction of Battery Voltage and Deterioration of Capacity

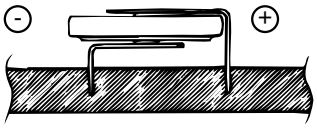
(1) Reduction of battery voltage and deterioration of capacity through contact with antistatic conductive materials

Incidents have been reported where terminal-mounted batteries for memory backup or coin-type lithium batteries have come into contact with antistatic conductive materials, thus forming external discharge circuits and leading to voltage drops or capacity deterioration.

In manufacturing plants using ICs, LSI and other semiconductor components, thoroughgoing antistatic measures are taken. Various protective materials are used to prevent static: most of them have special compounds of carbon, aluminum foil and other metals and are therefore conductive. These protective materials are used, for example, in the form of packaging bags, trays, mats, sheets, films, corrugated boards and resin cases.

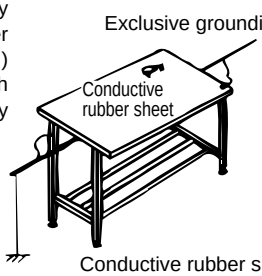
A protective material may have a resistance ranging from 10^3 to 10^6 Ω/cm, for instance. This means that if the (+) and (-) terminals of a battery come into contact with this material, a current ranging from several milliamperes to several microamperes will flow and the battery will discharge, causing voltage drop and capacity deterioration.

A terminal-mounted battery was inserted into a conductive mat. The battery charge was exhausted in several days.

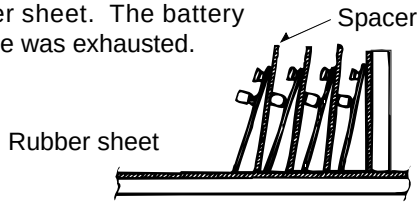


Conductive mat

A battery was placed directly on a rubber sheet spread over a worktable. The (+) and (-) terminals were in contact with the sheet and the battery charge was exhausted.



Battery-mounted PC boards were inadvertently brought into contact with spacers and a conductive rubber sheet. The battery charge was exhausted.



When batteries are to be used near protective materials, take every possible care to ensure that the (+) and (-) terminals of the batteries or PC boards, etc. on which batteries are mounted do not touch these protective materials directly.

A battery-mounted PC board was inadvertently brought into contact with a conductive resin case. The battery charge was exhausted.

Conductive resin case

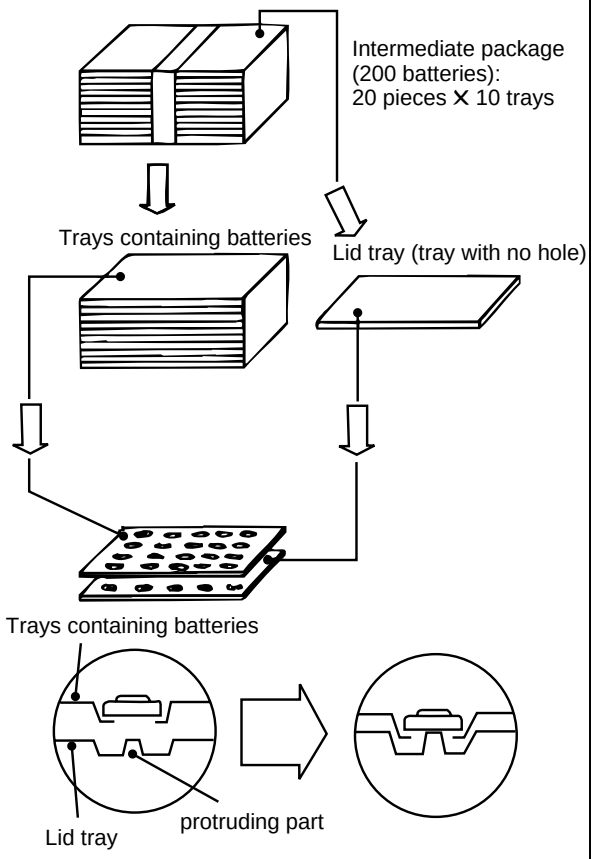
(2) Reduction of battery voltage and deterioration of capacity through contact between batteries

Incidents have been reported where terminal-mounted batteries for memory backup or coin-type lithium batteries have come into contact each other, thus forming discharge circuits (shorted state) and leading to voltage drops or capacity deterioration. Observe the following precautions.

1. Remove the batteries from the tray one at a time.
   If the tray is turned upside down, the batteries will come into contact with each other, forming discharge circuits.
2. Do not place batteries randomly in a parts box or other container.
   Discharge circuits will be formed by multiple batteries coming into contact numbers of the batteries, causing the batteries to discharge and drain.

○ Recommended procedures

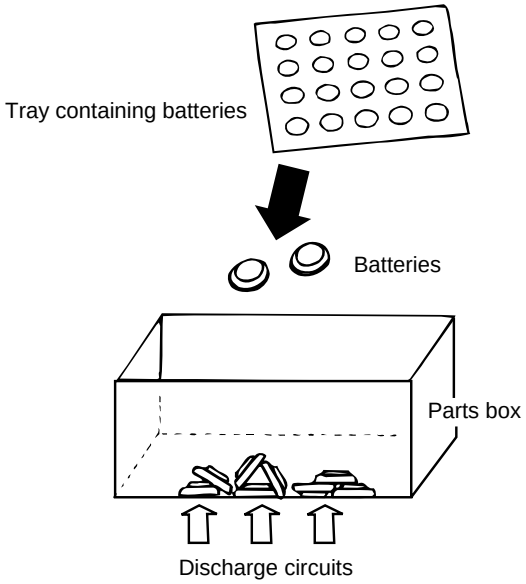
*Utilize the tray lid in taking out batteries

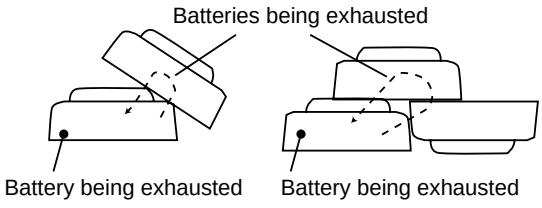


*Lay a tray lid flat and place a tray containing batteries on top of it: batteries are pushed up by protrusions of the lid tray so that they can be easily picked up with fingers.

× Prohibited procedures

*Do not throw batteries randomly into a parts box by turning over trays containing batteries.





*Contact of batteries with each other forms discharge circuits, thus the batteries are drained.

Memory Erasure Problems

Coin-type lithium batteries are often used as the power supplies for memory backup in various equipment. However problems with the erasure of valuable data in the memory due to improper contact between the batteries and equipment have been reported.

1. When batteries are to be used continuously for a prolonged period.

●Select tab terminal-mounted batteries, and solder the tabs to the battery connection terminals of the equipment. (See Fig. 1)

●When batteries need to be replaced, use a battery holder (see Fig. 2) or battery with lead wire connectors (see Fig. 3). Battery holders made by Panasonic (exclusively for the CR2032 and BR2032, see Fig. 2) are available for use.

2. When batteries need to be replaced in the short term, select batteries with no terminals or lead wire connectors.

●Use of Y-shaped terminals (2-point contact) for both the (+) and (-) poles as the shape of the connection terminals in the equipment helps to achieve a more stable contact. (See Fig. 4)

The contact pressure of the contacts should be no less than 2 to 10N (approx. 200 to 1000 gf). (See Fig. 5)

●To prevent momentary contact failure of several milliseconds in the circuit, the use of a tantalum capacitor, etc. with a capacitance of several microfarads is effective. (See Fig. 6)

●For the connection terminals of the equipment, use iron or stainless steel with nickel plating at the very least. Gold-plating is more suitable when the contact resistance must be reduced.

Note: Do not touch batteries with bare hands because perspiration (salt), body oil etc. will increase the surface resistance which may lead to defective contact.

<Reference Sample>

Fig.1: soldering

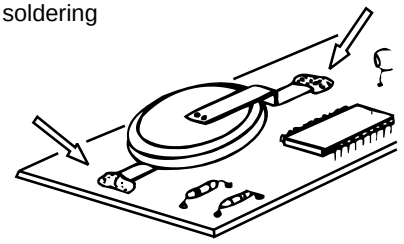


Fig. 2

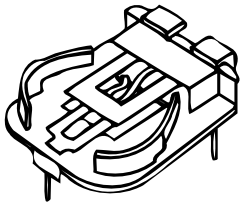


Fig. 3

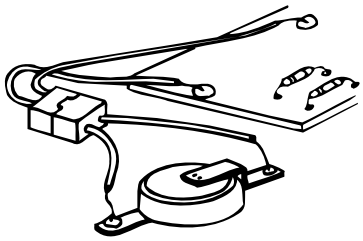


Fig. 4

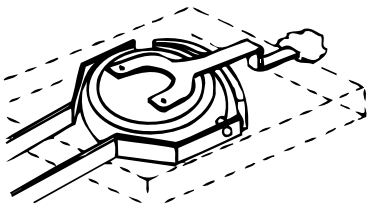


Fig. 5: excessive load

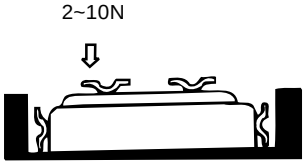
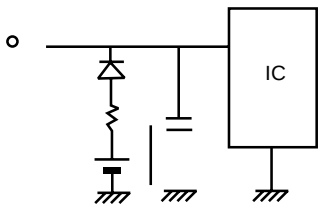


Fig. 6



Panasonic

Batteries - Create A New World

For Literature and General Product Information:

United Kingdom/Ireland
Panasonic Industrial Europe GmbH
Willoughby Road
Bracknell Berkshire
RG12 8FP
England
Tel: +44 1344-853262
Fax: +44 1344-853724

Spain
Panasonic Industrial Europe GmbH
Avda. Josep Tarradellas, 20-30, 5°
08029 Barcelona - Spain
Tel: +34 93-494 92 42
Fax: +34 93-419 89 31

Italy
Panasonic Industrial Europe GmbH
Via Lucini 19
20125 Milano
Tel: +39 02-6788-232
Fax: +39 02-6788-207

France
Panasonic Industrial Europe GmbH
270 avenue du Président Wilson
93218 Saint Denis La Plaine
Tel: +33 1-49 46 44 10
Fax: +33 1-49 46 42 20

Germany (all other european countries)
Panasonic Industrial Europe GmbH
Winsbergring 15
22525 Hamburg
Tel: +49 40-85 386-157
Fax: +49 40-85 386-160

E-mail and Website for all countries:
battery-solutions@panasonic-industrial.com
www.panasonic-industrial.com/batteries

For more details, please contact:

Panasonic