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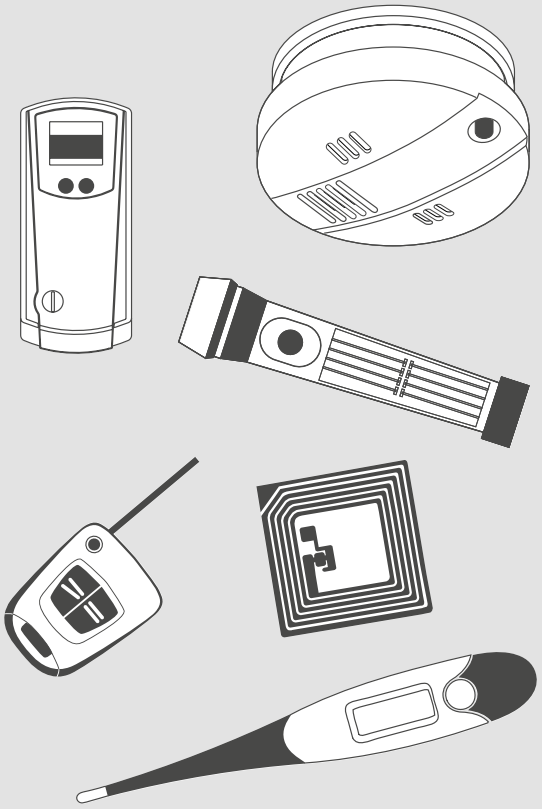
Panasonic

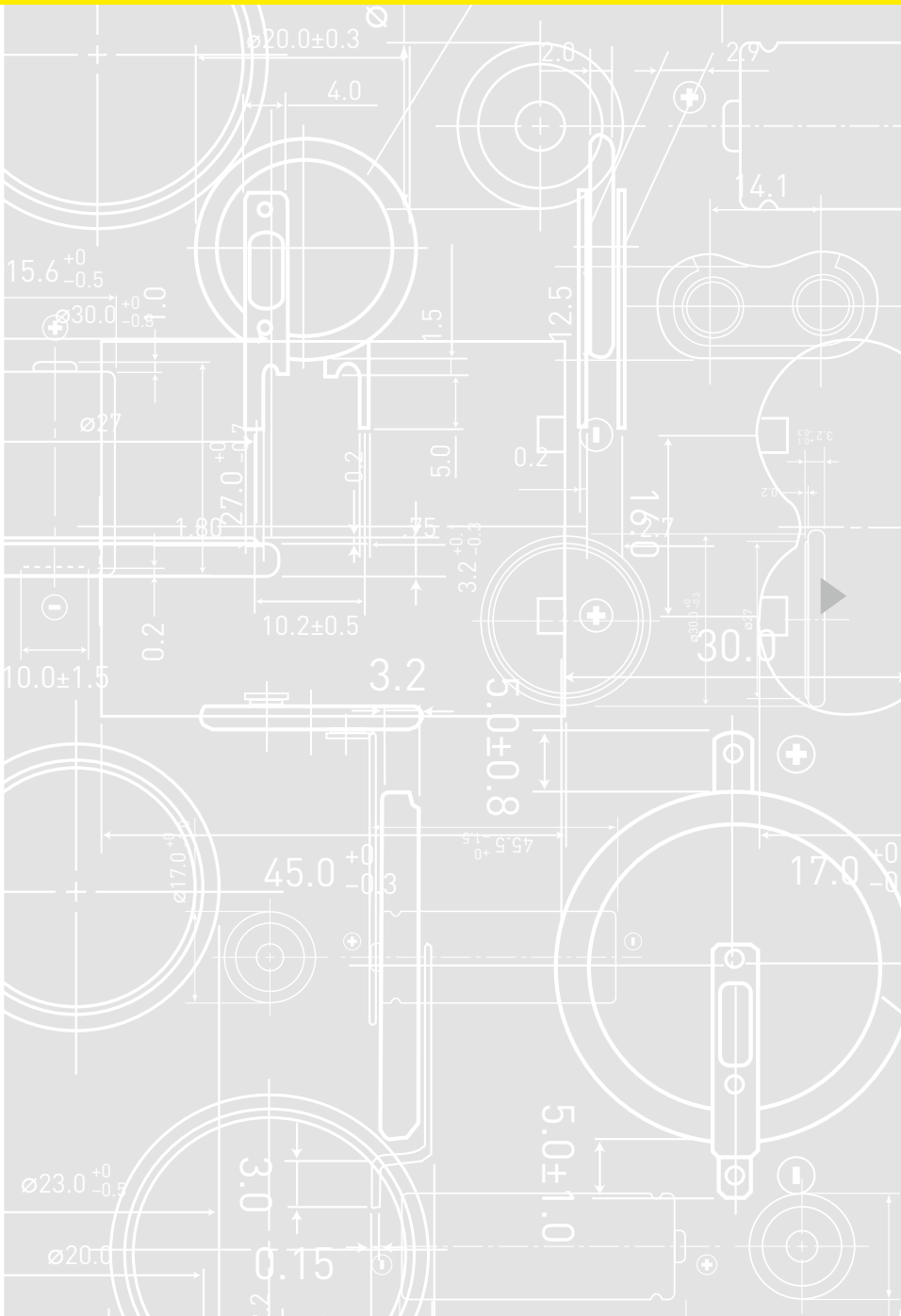
LITHIUM HANDBOOK

INDUSTRIAL BATTERIES FOR PROFESSIONALS

APPLICATIONS

- Electronic Toll Collection (ETC)
- RFID
- Emergency call (E-Call)
- Gas meter
- Heat cost allocator
- Door lock system
- Marine devices
- Scales
- Remote Keyless Entry (RKE)
- Watch
- Glucose meter
- Remote control
- Ticketing machine
- Digital thermometer
- Real Time Clock (RTC)
- Medical devices, etc.





Panasonic BATTERIES
Quality is our Business.

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⚠ 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

⚠ **Warning**

1. It may cause rupture or ignite.
   - Do not charge, short (an exception is to pass batteries through dipping solder) disassemble, deform or 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.

⚠ **Caution**

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

COIN TYPE LITHIUM BATTERIES

⚠ **Warning**

1. Do not charge, short (an exception is to pass batteries through dipping solder) disassemble, deform or 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.

⚠ **Caution**

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

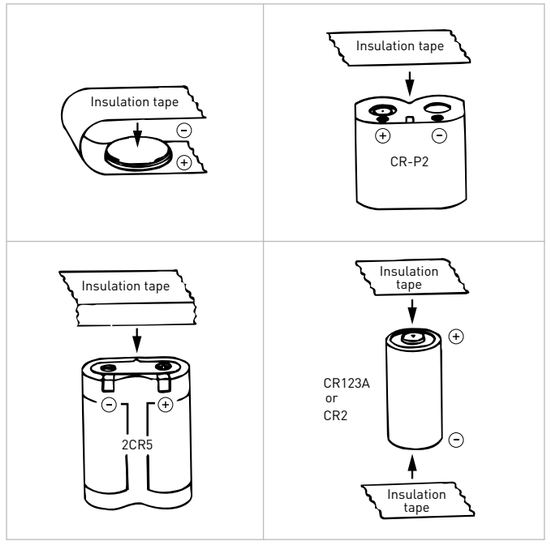
⚠ **Warning**

1. Do not short-circuit (an exception is to pass batteries through dipping solder), disassemble, deform or 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.

⚠ **Caution**

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)*1



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

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

LITHIUM & MICRO 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 coin type rechargeable 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-low current discharge applications in such products as electronic watches or applications as power supplies for IC memory back-up which require long-term reliability.

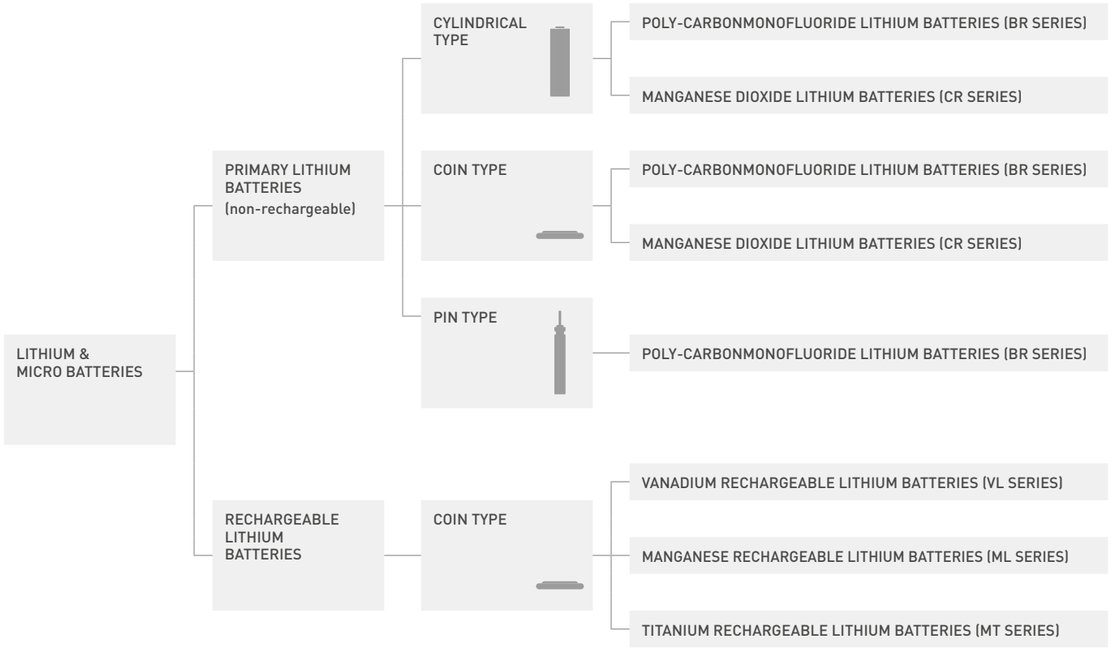
Panasonic has conducted repeated tests on the various safety and performance characteristics, plus the effects of environmental factors such as temperature. We have accumulated a wealth of corroborative data on the performance of our batteries which cannot be pinpointed by short-term accelerated tests. 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.

COMPARISON OF LITHIUM PRIMARY CHEMISTRY*1

Chemistry			BR	CR	ER
Material	Cathode		CF	MnO_2	$SOCl_2$
	Anode		Li metal	Li metal	Li metal
	Electrolyte		Organic electrolyte	Organic electrolyte	Organic electrolyte
Performance	Nominal voltage		3V	3V	3.6V
	Discharge capacity		+	+	+
	Voltage during discharge (Initial)	Low current	+	+	++
		High current	+	++	–
	Voltage during discharge (End of capacity)	Low current	++	+	++
		High current	+	++	–
	Pulse performance at low temperature	Initial	+	++	–
		End of life	++	+	–
	Storage performance		++	+	++*2
	Reliability		++	+	–*2
	Safety		++	++	–
Environment	Eco friendly		++	++	–*3

++ Very good capability
+ Good capability
- Not good capability

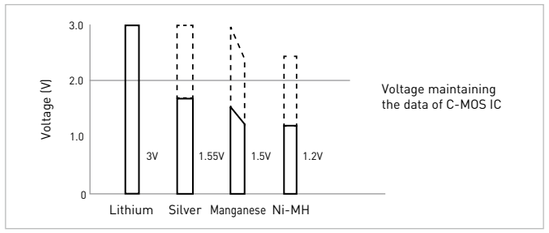
TYPES OF LITHIUM & MICRO BATTERIES



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
*1 Please contact Panasonic to get more detailed information about this technical comparison overview.
*2 Impedance is increasing due to the passivation phenomena.
*3 Harmful substances included.

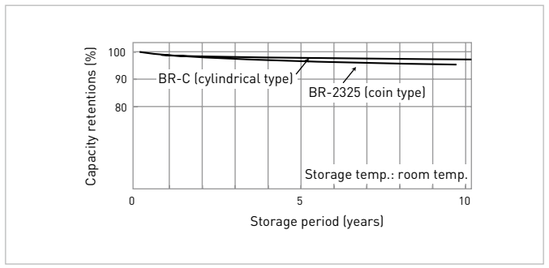
High voltage

The high energy density of Lithium batteries and their high voltage of 3V (there are 1.5V and 2V lineups also) 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.

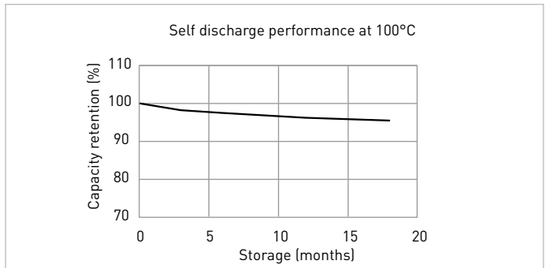


Low selfdischarge rate and superior storability

Since the substance that is chemically very stable is used for plus terminal as an active material (BR series: Poly-Carbon-monofluoride, CR series: Manganese Dioxide), if preservation conditions are proper, 90% of capacity remains even after ten years storage.



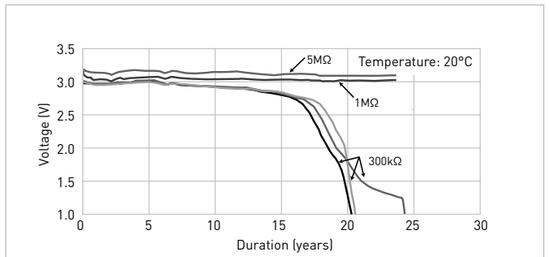
BR-2330A



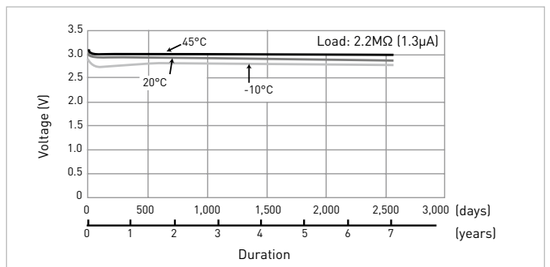
Long-term discharge

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

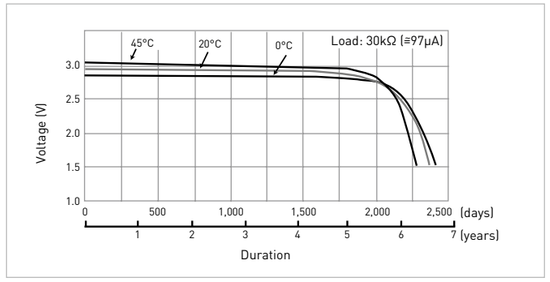
BR-2/3A



BR-2325



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.

Wide operating temperature range

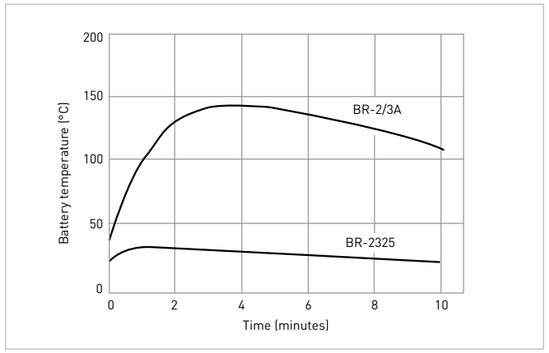
Due to the use of organic electrolytes with a solidifying point that is much lower than the aqueous solution electrolytes used in other types of batteries, Lithium batteries are capable

of operation in a wide range of temperatures. Not only do 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.

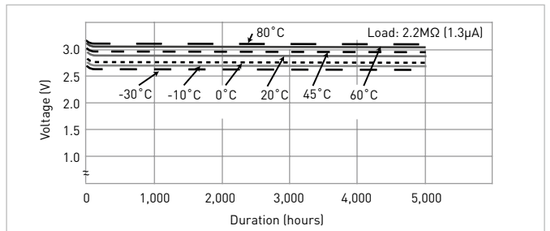
Superior safety

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.).

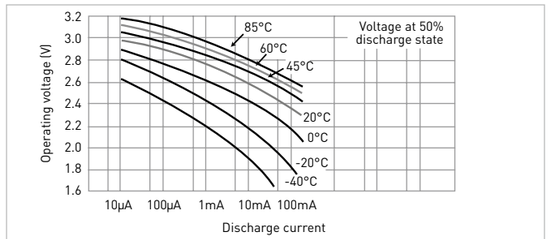
Battery surface temperature when short-circuited



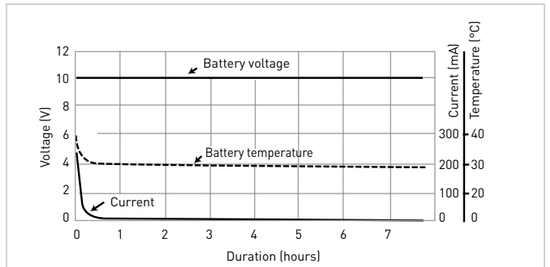
BR-2325 Operating voltage under high-resistance discharge



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

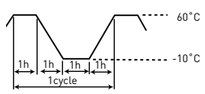
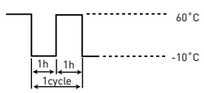


BR-2325 Charge resistance (10V consistent-voltage charge)

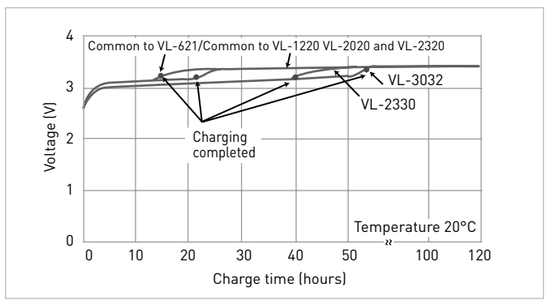


Leakage resistance test results

Model number	Conditions	60°C		45°C/90%		60°C/90%		Temp. cycle	Heat shock
	Storage	1 month	3 months	1 month	3 months	1 month	3 months	60 cycles	120 cycles
BR-2325		○	○	○	○	○	○	○	○
BR-2/3A		○	○	○	○	○	○	○	○

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

VL Charge characteristics



COIN TYPE RECHARGEABLE LITHIUM BATTERIES

Rechargeable Lithium 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	Primary battery		Rechargeable battery		
	Model	BR	CR	VL	ML	MT
Material	⊕ electrode	(CF)n	MnO_2	V_2O_5	LixMnOy	LixOy
	⊖ electrode	Li	Li	LiAl	LiAl	LixTiOy
Nominal voltage (V)		3.0	3.0	3.0	3.0	1.5
Operating temperature range (°C)		**Cylindrical:** -40 to +85 **Coin:** -30 to +80 **High operating temperature coin:** -40 to +125 **Pin:** -30 to +80	**Cylindrical:** -40 to +70 **Coin:** -30 to +60	-20 to +60	-20 to +60	-10 to +60
Self-discharge (per year) under standard conditions	Cylindrical type	0.5%	1.0%	2.0%	2.0%	2.0%
	Coin type	1.0%	1.0%			
Average discharge voltage (V)		–	–	2.85	2.5	1.2
Charge voltage (V)		–	–	3.25 to 3.55	2.8 to 3.2	1.6 to 2.6
Cut off voltage (V)		2.0	2.0	2.5	2.0	1.0
Charge-discharge cycles		–	–	**1,000** charge/discharge partly (charge/discharge for 10% of discharge depth)	**1,000** 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

Model		BR vs. CR
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.

Primary type

Industry	Application	Coin type: BR series	Coin type: BR-A series	Coin type: CR series	Cylindrical type: BR series	Cylindrical type: CR series for consumer	Cylindrical type: CR series for professionals	Pin type: BR series
Auto-motive	Electronic Toll Collection (ETC)		○		◎		◎	
	Emergency call (E-Call)				○	○	◎	
	Remote Keyless Entry (RKE)			◎				
	Tyre Pressure Monitoring System (TPMS)		◎					
Commu-nication	Advertising beacon					◎		
	Fax machine	○		◎				
	Personal digital assistant			◎				
Home appliance	Sanitary equipment					◎		
Marine	Emergency position indicating radio beacon			○	○	○	◎	
	Life jacket light			○	○	○	◎	
Medical	Digital thermometer	○		◎				
	Scales			◎				
Metering	Distance meter					○		○
	Electricity meter	◎		○				
	Heat cost allocator		◎		◎			
	Water meter	◎			◎		◎	
Security	Door lock system			◎		◎		
	Smoke detector				○		◎	
	Window monitoring system			◎	○	◎		
Others	Fishing equipment							◎
	Real Time Clock (RTC)	◎		○	◎			
	Tracking & RFID	○		◎	○		○	
	Vending machine			◎				
	Watch			◎				

Rechargeable type

Industry	Application	Coin type: VL series	Coin type: ML series	Coin type: MT series
Auto-motive	Remote Keyless Entry (RKE)	◎	○	
Commu-nication	Fax machine	◎	○	
Others	Calculator	○	○	
	Real Time Clock (RTC)	○	◎	
	Tracking & RFID	○	○	
	Vending machine	○	○	
	Watch			◎

◎ Recommended applications
○ Potential applications

SELECTING A BATTERY

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.

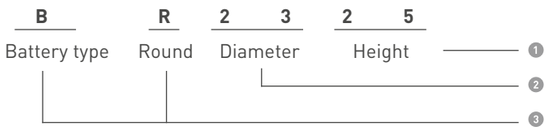
Requests for developing or improving batteries

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.

MODEL NUMBER

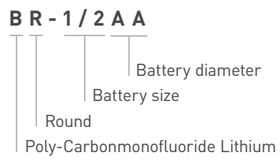
How to interpret the model numbers generally used for coin type Lithium batteries

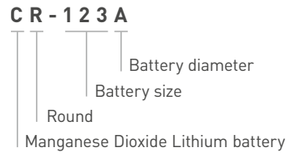
The model numbers are normally indicated using two upper-case English letters and a figure consisting of three or more digits as shown in the example below. This numbering system is supported by the Japan International Standard Committee of Clocks and Watches and is also an established practice in Japan.

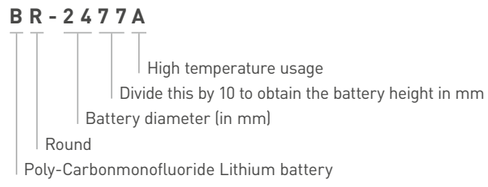


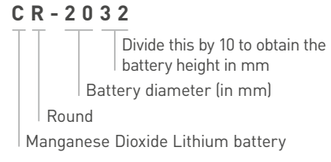
1. Figures to first decimal place with decimal point omitted (ex. 2.5mm)
2. Integers omitting fractions (ex. 23mm Dia.)
3. In accordance with JIS and IEC standards

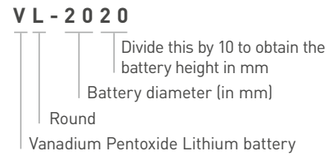
Examples



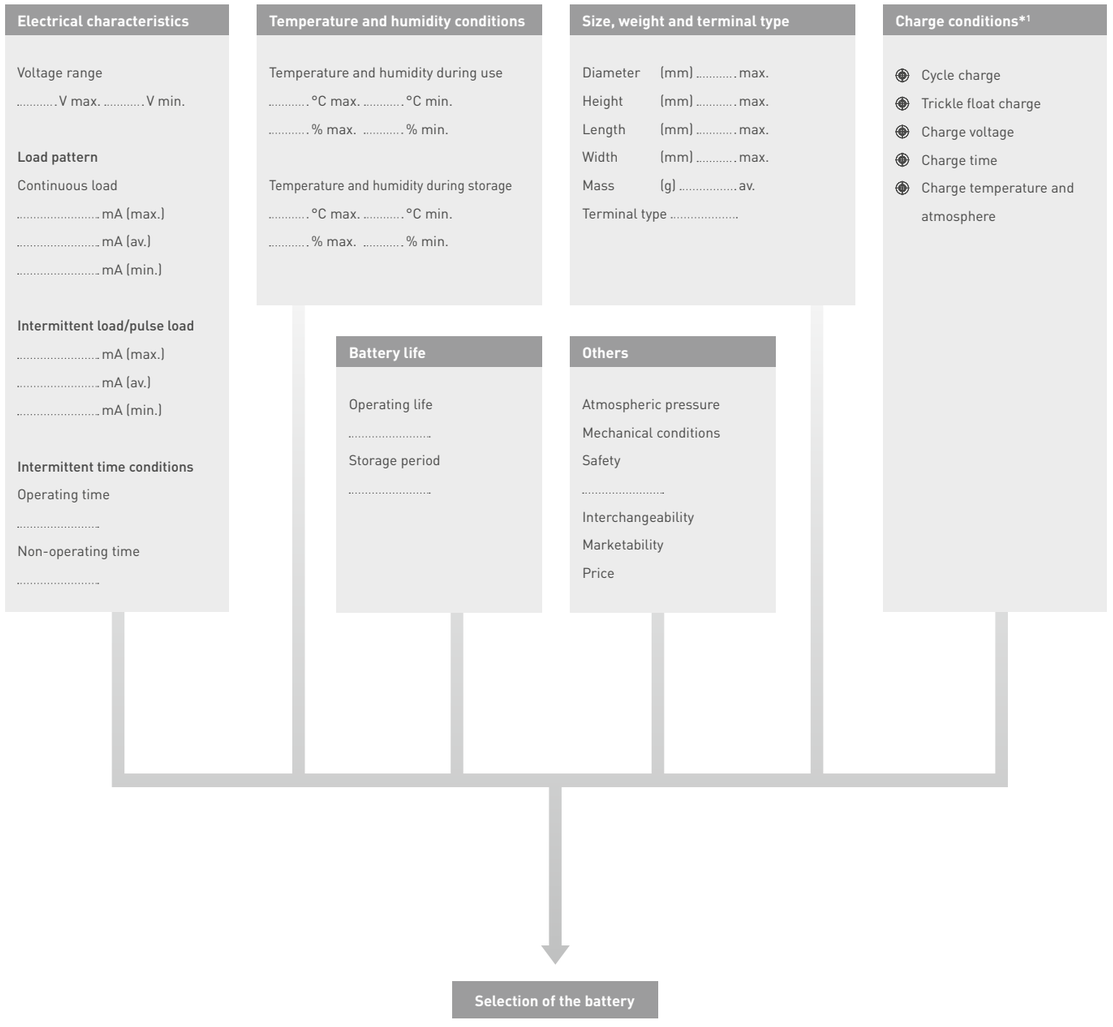








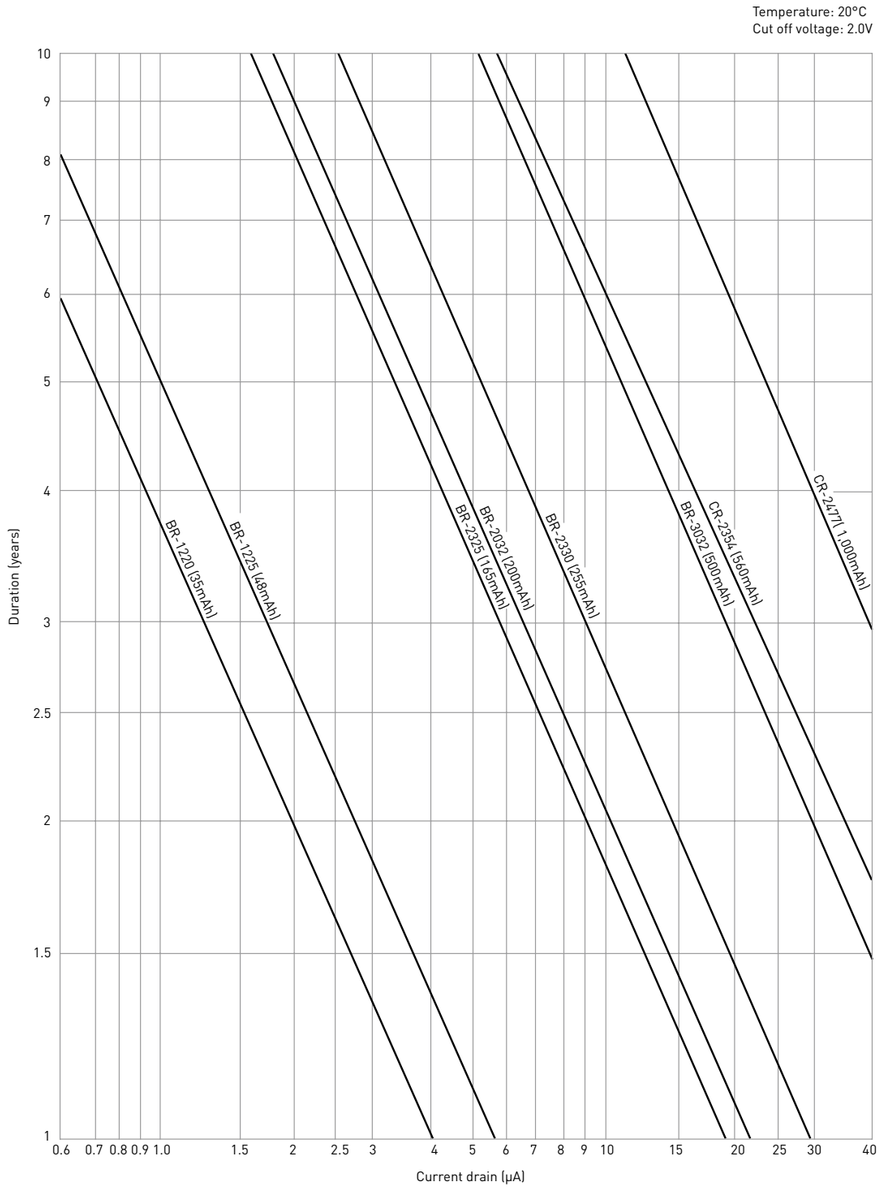
TECHNICAL CONDITIONS FOR SELECTING BATTERIES



*1 Only for rechargeable batterie

COIN TYPE PRIMARY LITHIUM BATTERIES (EXAMPLE)

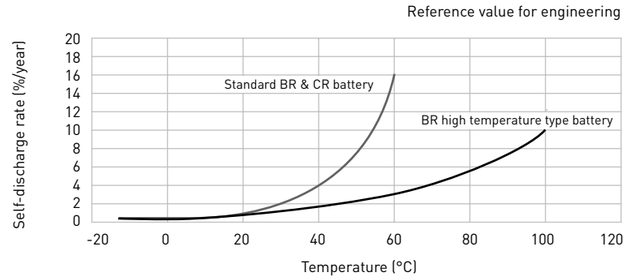
Discharge life as a function of operating current



General formula (rough value with 20°C, standard load)

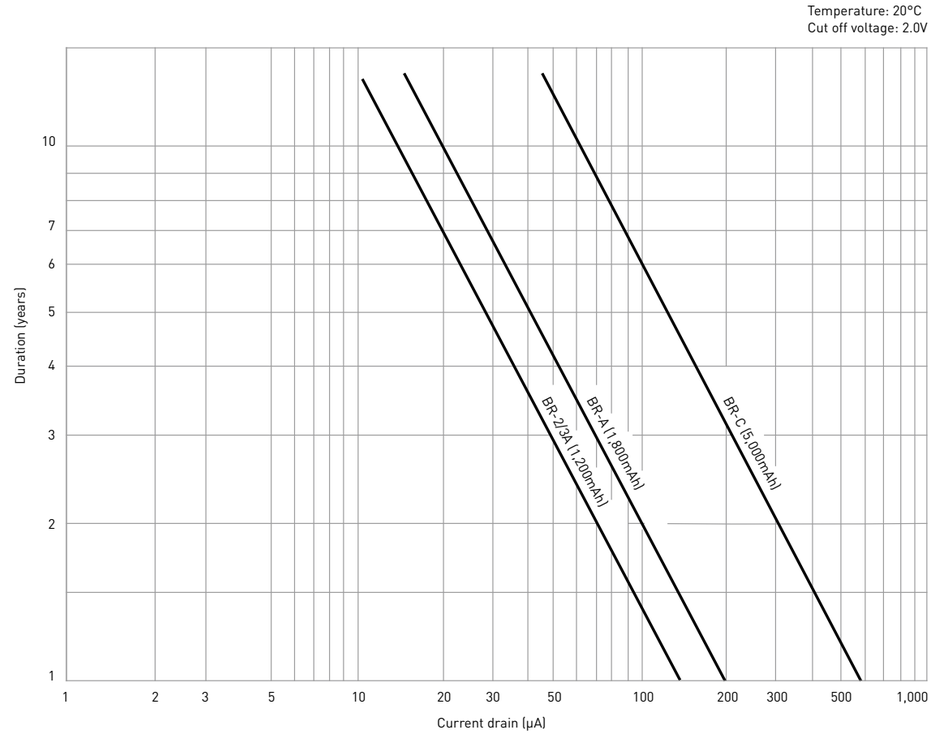
Calculation $\text{Duration (years)} = \dfrac{\text{Nominal capacity (mAh)}}{\text{Current drain (mA) x 24 (hours) x 365 (days)}}$

Self Discharge



CYLINDRICAL TYPE PRIMARY LITHIUM BATTERIES (EXAMPLE)

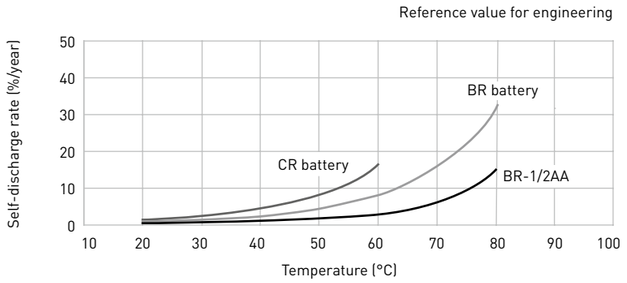
Discharge life as a function of operating current



General formula (rough value with 20°C, standard load)

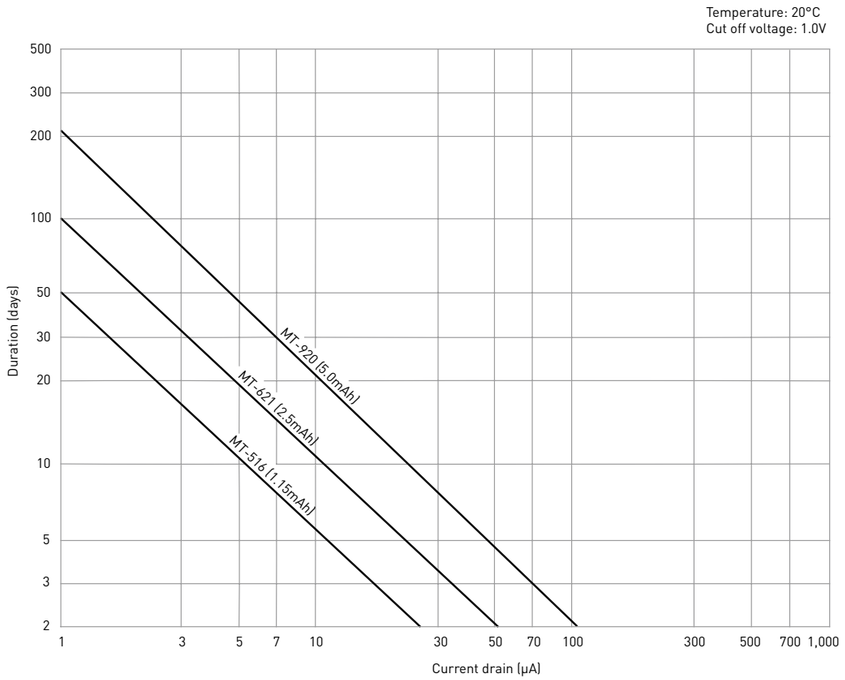
Calculation $\text{Duration (years)} = \dfrac{\text{Nominal capacity (mAh)}}{\text{Current drain (mA) x 24 (hours) x 365 (days)}}$

Self Discharge

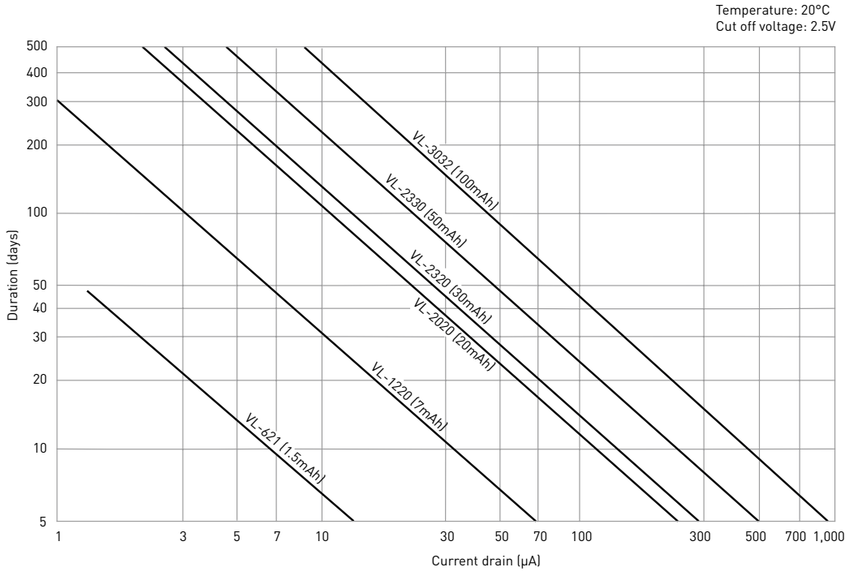


COIN TYPE RECHARGEABLE LITHIUM BATTERIES (EXAMPLE)

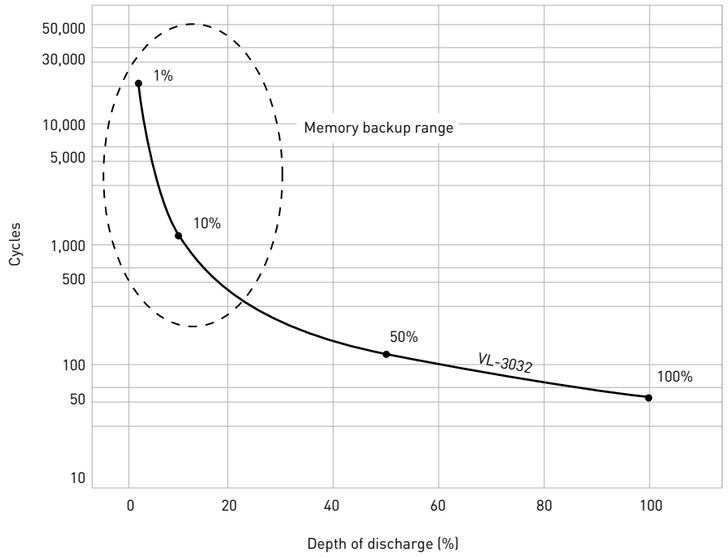
Discharge life as a function of operating current



Discharge life as a function of operating current



Cycle life

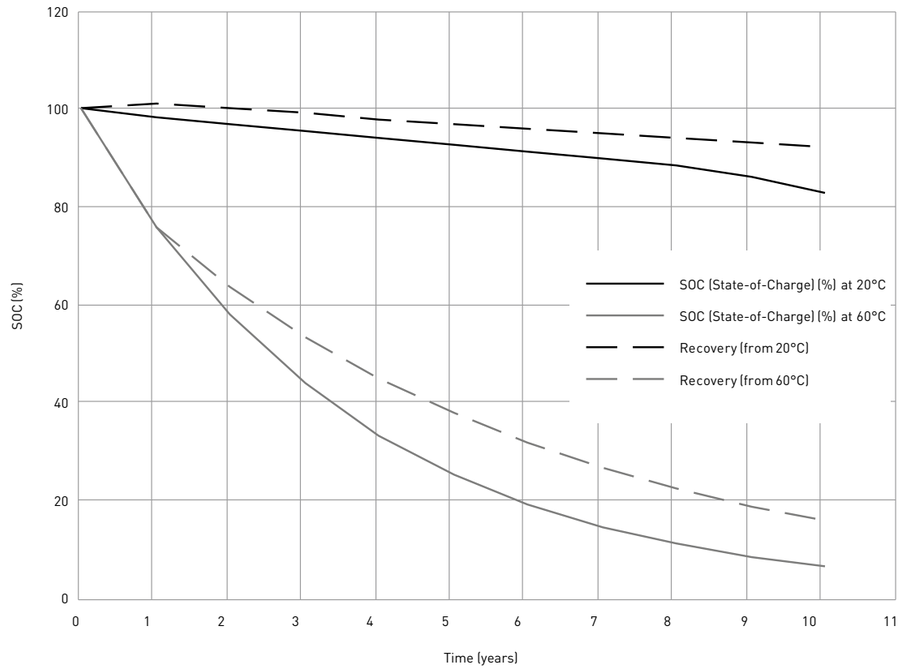


The number of cycles is defined with the batteries' remaining capacity ≥50%.

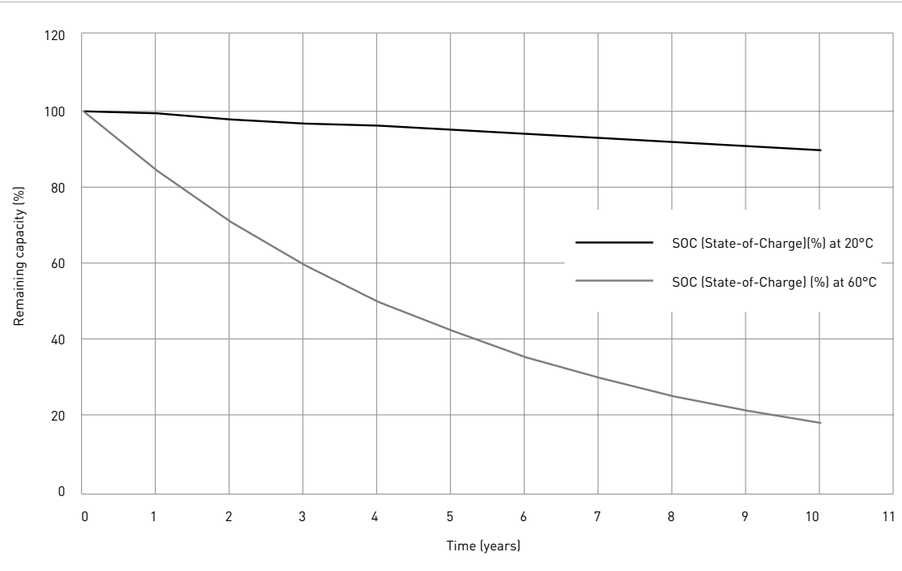
The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

CHARGE RETENTION AND TEMPERATURE DEGRADATION DEPENDENCIES

VL/ML residual capacity and recovery



VL/ML capacity degradation under float

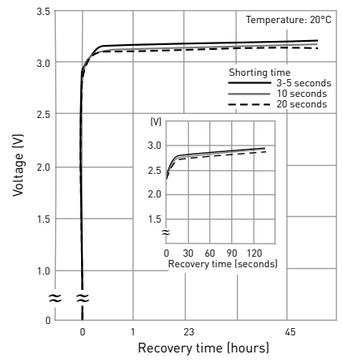


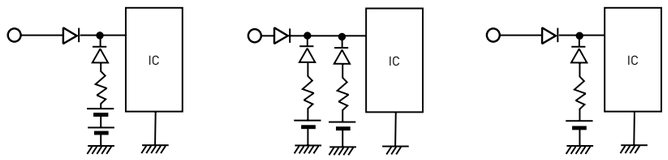
APPLICABLE BOTH PRIMARY AND RECHARGEABLE BATTERIES

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 1,000Hz 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.
	UL	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.
	Battery life	Prior to installation in the equipment, wipe the batteries and equipment terminals clean using a dry cloth, etc.
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. ◉ Adopt a construction which allows the gases to be vented. ◉ Give consideration to the impact and the effect on the environment in selecting the materials to be used.
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.).

Classification	Item	Precaution
Notes	Circuit design	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)





(A) 2-cell 6V usage (B) Parallel usage (C) UL conditions

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 low leak current diode (this current varies with temperature).

Selection standard

The total allowable charging amount of a battery during its total usage period must not be greater than 3% of the nominal capacity of the battery for a coin type battery or 1% for a cylindrical battery.

Example

When a CR-2477 (1,000mAh) coin type battery is to be used for 5 years, a reverse current preventing diode with a reverse current of 0.7μA or less is required.

Calculation method

1,000mAh (CR-2477) 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).

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 next page.

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 next page 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 next page 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.

RECHARGEABLE BATTERIES

Use of multiple batteries

Consult with Panasonic if two or more Vanadium rechargeable Lithium batteries (VL series) or Manganese rechargeable Lithium batteries (ML series) 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.

PRIMARY AND RECHARGEABLE BATTERIES

UL approval and maximum allowable charge current

	Shape	Model number	UL approval	Maximum abnormal charging current (mA)
Primary Lithium batteries	Cylindrical type BR series	BR-1/2AA	●	5
		BR-2/3A	●	10
		BR-2/3AG	●	10
		BR-A*1	●	15
		BR-AG*1	●	15
		BR-C*1	●	20
	Cylindrical type CR series	CR-2	●	20
		CR-123A	●	25
		2CR-5	●	25
		CR-P2	●	25
		CR-V3	●	25
	Cylindrical type CR series for industrial	CR-2/3AZ	●	25
		CR-AG*1	●	25
	Coin type BR series	BR-1220	●	3
		BR-1225	●	3
		BR-1632	●	4
		BR-2032	●	5
		BR-2325	●	5
		BR-2330	●	5
		BR-3032	●	5
	Coin type BR-A series	BR-1225A	●	3
		BR-1632A	●	4
		BR-2330A*1	●	5
		BR-2450A*1	●	5
		BR-2477A*1	●	5
	Coin type CR series	CR-1025	●	2
		CR-1216	●	3
		CR-1220	●	3
		CR-1612	●	3
		CR-1616	●	4
		CR-1620	●	4
		CR-1632	●	4
		CR-2012	●	10
		CR-2016	●	10
		CR-2025	●	10
		CR-2032	●	10
		CR-2330	●	10
		CR-2354	●	10
		CR-2412	●	10
		CR-2450	●	30
		CR-2477	●	10
		CR-3032	●	10
	Pin type BR series	BR-425	●	0.1
		BR-435	●	0.2
Rechargeable Lithium batteries	Coin type VL series	VL-621*1	●	300
		VL-1220	●	300
		VL-2020	●	300
		VL-2320	●	300
		VL-2330	●	300
		VL-3032	●	300
	Coin type ML series	ML-421	●	300
		ML-614	●	300
		ML-621	●	300
		ML-920	●	300
		ML-1220	●	300
		ML-2020*1	●	300
	Coin type MT series	MT-516	●	300
		MT-621	●	300
		MT-920	●	300

● UL approval

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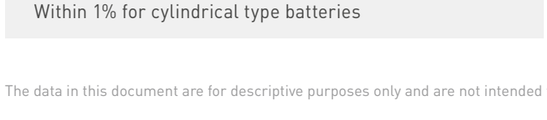
*1 Please read 'Conditions for compliance with UL Standard' carefully.

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 back-up circuit and holding voltage

The circuit typically used for memory back-up 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 diode with a low leak 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.

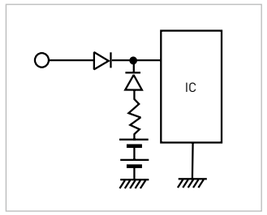
For example, assuming that a CR-2477 (1,000mAh) will be used in a memory back-up power supply for 5 years, charging by the leak current of the reverse current blocking diode should be no greater than 30mAh (= 3% of 1,000mAh), thus: 30mAh ÷ usage period (5 years x 365 days x 24 hours) = 0.7μA. In other words, a leak current blocking diode whose reverse current is not greater than 0.7μA must be selected.

Allowable total charging amount

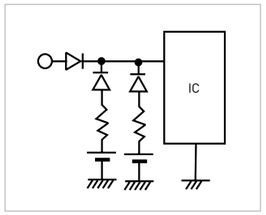
Within 3% for coin type batteries
Within 1% for cylindrical type batteries

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

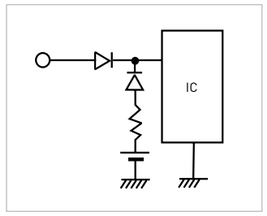
(A) 2-cell 6V usage



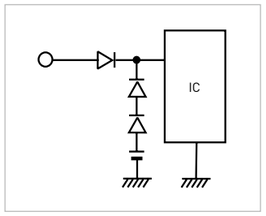
(B) Parallel usage



(C) UL conditions
(When a protective resistor has been inserted)

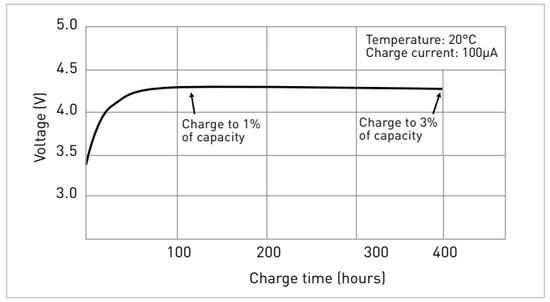


(D) UL conditions
(Protective diode)

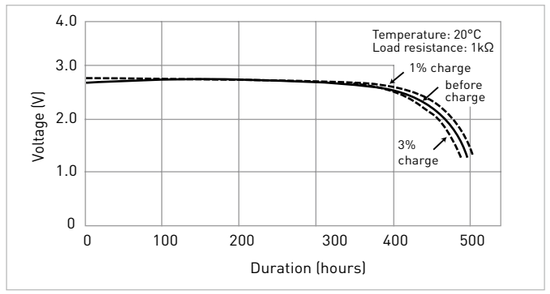


Charge test results assuming diode leakage current

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



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



STATE-OF-THE-ART LITHIUM PRIMARY BATTERIES

VIDEO

Scan QR code to view product series video.

Lithium battery technologies are becoming increasingly important. Due to their high voltage, low self-discharge and proven reliability, they can power a broad range of sophisticated applications. Innovative Lithium technologies by Panasonic are extremely long-lasting under severe conditions (BR series) or feature top pulse currents (CR series) with a 3-volt voltage.

POLY-CARBONMONOFLUORIDE LITHIUM BATTERIES (BR SERIES) – CYLINDRICAL TYPE LITHIUM BATTERIES

Our Panasonic Poly-Carbonmonofluoride Lithium batteries (BR series) are ideal for applications such as meters or smoke detectors which demand either long-term power supply reliability or need to handle a wide temperature range.

FEATURES

- Operating temperature range: between -40°C ~ +85°C
- Self discharge rate at 20°C is just 0.5% per year
- Superior long-term reliability
- Years of experience in production

APPLICATIONS

- Heat cost allocators
- Water & gas meters
- Car alarm
- Smoke detectors
- Tracking & RFID
- Marine devices, etc.

Model number*1	Electrical characteristics at 20°C		Dimensions with tube (mm)		Approx. weight (g)	IEC
	Nominal voltage (V)	Nominal*2 capacity (mAh)	Diameter	Total height		
BR-1/2AA*3	3	1,000	14.5	25.5	8.0	–
BR-2/3A	3	1,200	17.0	33.5	13.5	BR17335
BR-2/3AG	3	1,450	17.0	33.5	13.5	BR17335
BR-A	3	1,800	17.0	45.5	18.0	–
BR-AG	3	2,200	17.0	45.5	18.0	–
BR-C	3	5,000	26.0	50.5	42.0	–

3D ILLUSTRATION*4

1 Positive pole
2 Gasket
3 Separator
4 Cathode (Carbonmonofluoride)
5 Anode (Lithium)
6 Insulator
7 Tube
8 Positive pole platform
9 Cell can
10 Collector
11 Negative pole

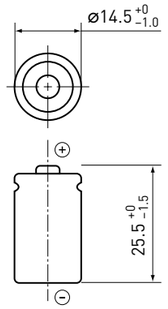
VIDEO

Scan QR code to view 3D animated video.

The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
*1 G indicates higher capacity versions.
*2 Capacity based on standard drain and cut off voltage down to 2.0V or 4.0V at 20°C.
*3 Operating temperature range is from - 40°C ~ + 100°C.
*4 The illustration shows only one example of Lithium battery structure.

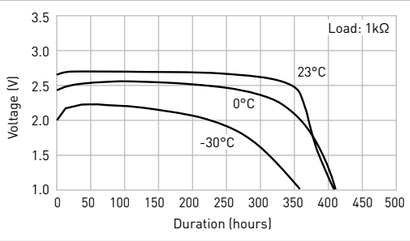
BR-1/2AA

DIMENSIONS (MM)

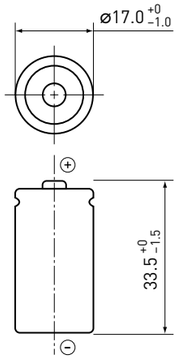


Model number	BR-1/2AA
Nominal voltage (V)	3
Nominal capacity (mAh)	1,000
Diameter (mm)	14.5
Total height (mm)	25.5
Discharging temperature range (°C)	-40 to +100
Weight (g)	8.0

DISCHARGE TEMPERATURE CHARACTERISTICS

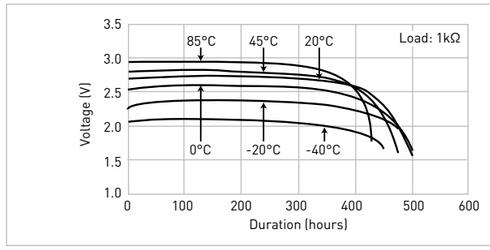


BR-2/3A

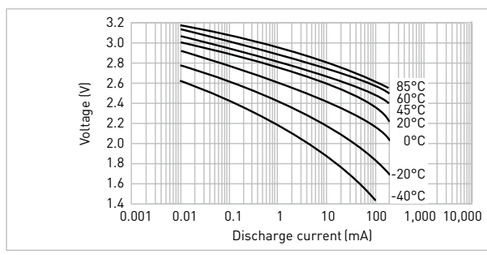


Model number	BR-2/3A
Nominal voltage (V)	3
Nominal capacity (mAh)	1,200
Diameter (mm)	17.0
Total height (mm)	33.5
Discharging temperature range (°C)	-40 to +85
Weight (g)	13.5

DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



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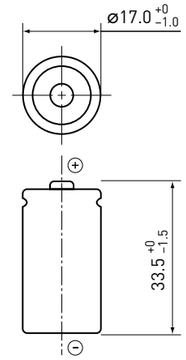
*1 Voltage at 50% discharge depth.

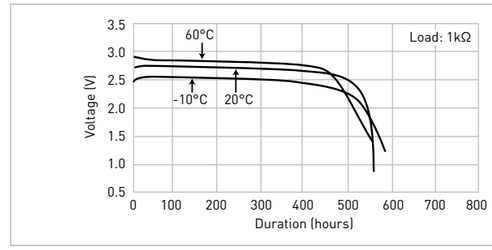
BR-2/3AG

DIMENSIONS (MM)

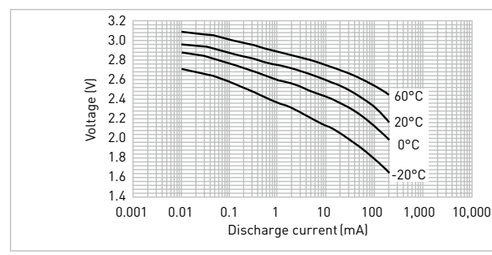


Model number	BR-2/3AG
Nominal voltage (V)	3
Nominal capacity (mAh)	1,450
Diameter (mm)	17.0
Total height (mm)	33.5
Discharging temperature range (°C)	-40 to +85
Weight (g)	13.5

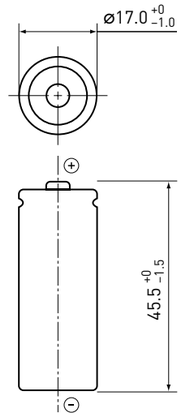
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1

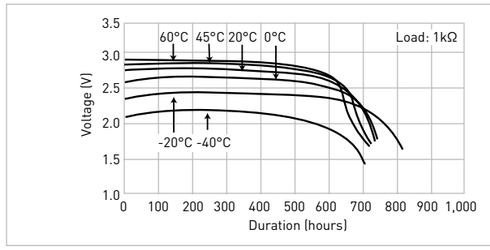


BR-A

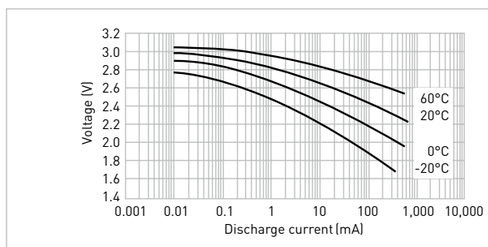


Model number	BR-A
Nominal voltage (V)	3
Nominal capacity (mAh)	1,800
Diameter (mm)	17.0
Total height (mm)	45.5
Discharging temperature range (°C)	-40 to +85
Weight (g)	18.0

DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1

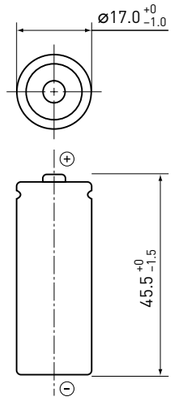


The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

*1 Voltage at 50% discharge depth.

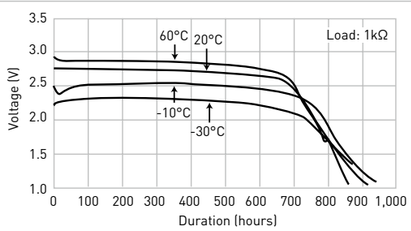
BR-AG

DIMENSIONS (MM)

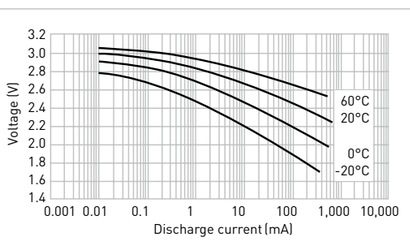


Model number	BR-AG
Nominal voltage (V)	3
Nominal capacity (mAh)	2,200
Diameter (mm)	17.0
Total height (mm)	45.5
Discharging temperature range (°C)	-40 to +85
Weight (g)	18.0

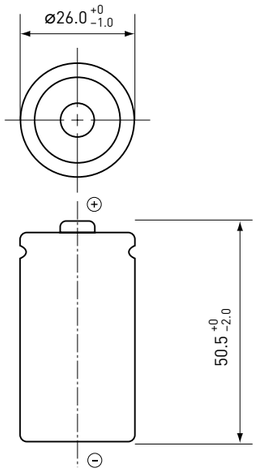
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1

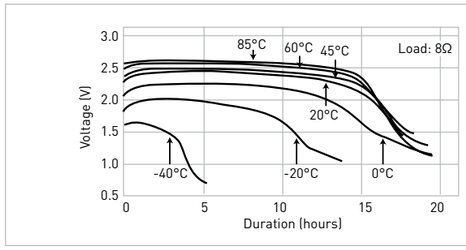


BR-C

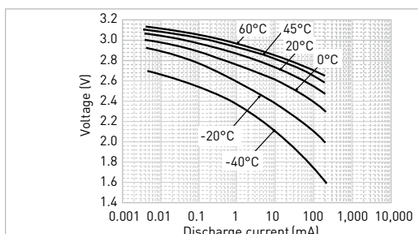


Model number	BR-C
Nominal voltage (V)	3
Nominal capacity (mAh)	5,000
Diameter (mm)	26.0
Total height (mm)	50.5
Discharging temperature range (°C)	-40 to +85
Weight (g)	42.0

DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

*1 Voltage at 50% discharge depth.

MANGANESE DIOXIDE LITHIUM BATTERIES (CR SERIES FOR CONSUMER) – CYLINDRICAL TYPE LITHIUM BATTERIES

Panasonic Photo-Lithium CR type cylindrical batteries come as either single cells or dual cell packs. All cylindrical type Manganese Dioxide (CR series) Lithium batteries feature a spiral structure. With the enlarged electrode surface areas, they permit a current as high as several amperes to be drawn.

FEATURES

- Operating temperature range: between -40°C ~ +70°C
- Good pulse capability
- Stable voltage level during discharge
- Self discharge rate at 20°C just 1% per year

APPLICATIONS

- Medical equipment
- Door lock systems
- Marine devices
- Cameras
- High energy flashlights
- Sanitary equipment, etc.

Model number	Electrical characteristics at 20°C		Dimensions with tube (mm)		Approx. weight (g)	IEC
	Nominal voltage (V)	Nominal*1 capacity (mAh)	Diameter	Total height		
CR-2*2	3	850	15.6	27.0	11	CR15H270
CR-123A*2	3	1,400	17.0	34.5	17	CR17345
2CR-5*2	6	1,400	34.0 x 17.0	45.0	38	2CR5
CR-P2*2	6	1,400	35.0 x 19.5	36.0	37	CRP2
CR-V3*2	3	3,300	28.4 x 14.4	52.0	39	–

3D ILLUSTRATION*3

1 Positive pole
2 Vent diaphragm
3 Gasket
4 Separator
5 Anode (Lithium)
6 Cathode (Manganese Dioxide)
7 Tube
8 Insulator
9 PTC (Positive Temperature Coefficient Device)
10 Collector
11 Cell can
12 Negative pole

The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

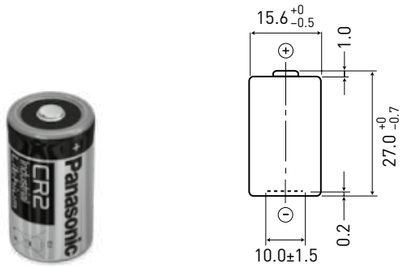
*1 Capacity based on standard drain and cut off voltage down to 2.0V or 4.0V at 20°C.

*2 In case of usage below 20mA discharge please consult Panasonic.

*3 The illustration shows only one example of Lithium battery structure.

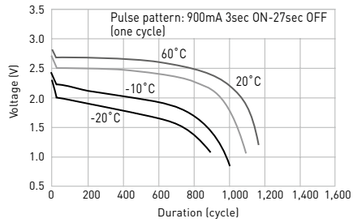
CR-2

DIMENSIONS (MM)

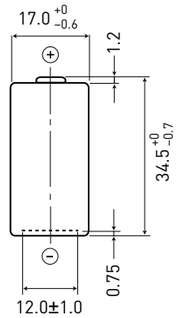


Model number	CR-2
Nominal voltage (V)	3
Nominal capacity (mAh)	850
Diameter (mm)	15.6
Total height (mm)	27.0
Discharging temperature range (°C)	-40 to +70*1
Weight (g)	11.0

DISCHARGE TEMPERATURE CHARACTERISTICS

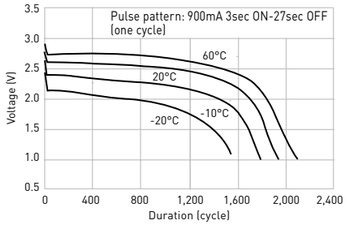


CR-123A



Model number	CR-123A
Nominal voltage (V)	3
Nominal capacity (mAh)	1,400
Diameter (mm)	17.0
Total height (mm)	34.5
Discharging temperature range (°C)	-40 to +70*1
Weight (g)	17.0

DISCHARGE TEMPERATURE CHARACTERISTICS

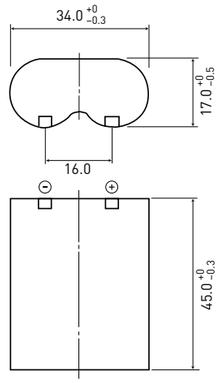


The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

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

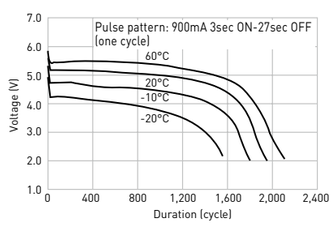
2CR-5

DIMENSIONS (MM)

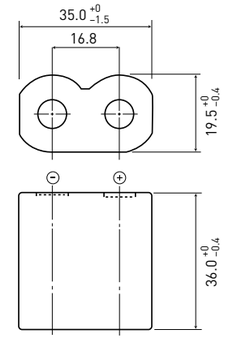


Model number	2CR-5
Nominal voltage (V)	6
Nominal capacity (mAh)	1,400
Diameter (mm)	34.0 x 17.0
Total height (mm)	45.0
Discharging temperature range (°C)	-40 to +70*1
Weight (g)	38.0

DISCHARGE TEMPERATURE CHARACTERISTICS

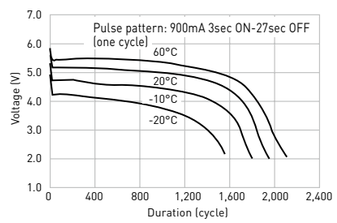


CR-P2



Model number	CR-P2
Nominal voltage (V)	6
Nominal capacity (mAh)	1,400
Diameter (mm)	35.0 x 19.5
Total height (mm)	36.0
Discharging temperature range (°C)	-40 to +70*1
Weight (g)	37.0

DISCHARGE TEMPERATURE CHARACTERISTICS

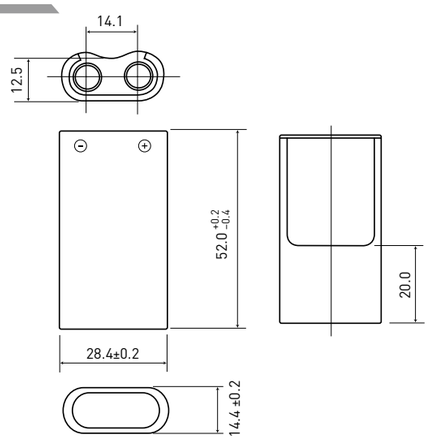


The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

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

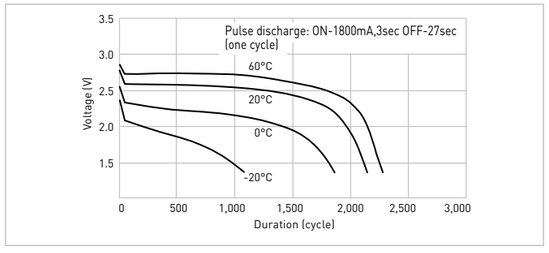
CR-V3

DIMENSIONS (MM)



Model number	CR-V3
Nominal voltage (V)	3
Nominal capacity (mAh)	3,300
Diameter (mm)	28.4 x 14.4
Total height (mm)	52.0
Discharging temperature range (°C)	-40 to +70*1
Weight (g)	39.0

DISCHARGE TEMPERATURE CHARACTERISTICS



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

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

MANGANESE DIOXIDE LITHIUM BATTERIES (CR SERIES FOR PROFESSIONALS) – CYLINDRICAL TYPE LITHIUM BATTERIES

Ideal for industrial equipment, this series offers both excellent high-rate discharge performance and a long service life of up to ten years.

FEATURES

- Stable impedance throughout battery life
- Operating temperature range: between -40°C ~ +70°C
  High discharge characteristics
- Long-term reliability
- Self discharge rate at 20°C is just 1% per year

APPLICATIONS

- Medical equipment
- E-Call
- Tracking & RFID
- Smoke detectors
- Alarm systems
- Marine devices, etc.

Model number	Electrical characteristics at 20°C		Dimensions with tube (mm)		Approx. weight (g)	IEC
	Nominal voltage (V)	Nominal*1 capacity (mAh)	Diameter	Total height		
CR-2/3AZ	3	1,600	17	33.5	17	–
CR-AG	3	2,400	17	45.5	24	–

3D ILLUSTRATION*2

1 Positive pole
2 Vent diaphragm
3 Tube
4 Anode (Lithium)
5 Separator
6 Cathode (Manganese Dioxide)
7 Insulator
8 PTC (Positive Temperature Coefficient Device)
9 Collector
10 Cell can
11 Negative pole

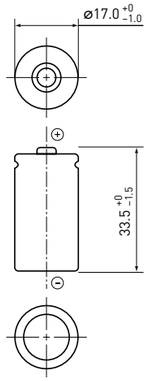
The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

*1 Capacity based on standard drain and cut off voltage down to 2.0V or 4.0V at 20°C.

*2 The illustration shows only one example of Lithium battery structure.

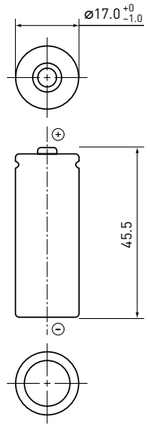
CR-2/3AZ

DIMENSIONS (MM)



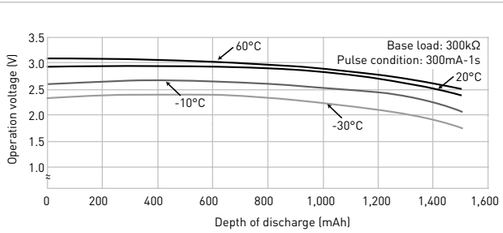
Model number	CR-2/3AZ
Nominal voltage (V)	3
Nominal capacity (mAh)	1,600
Diameter (mm)	17.0
Total height (mm)	33.5
Discharging temperature range (°C)	-40 to +70
Weight (g)	17.0

CR-AG

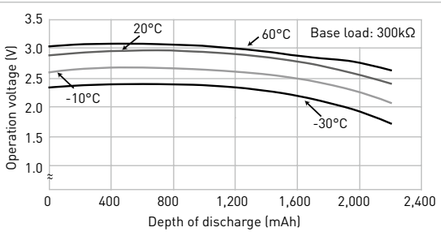


Model number	CR-AG
Nominal voltage (V)	3
Nominal capacity (mAh)	2,400
Diameter (mm)	17.0
Total height (mm)	45.5
Discharging temperature range (°C)	-40 to +70
Weight (g)	24.0

PULSE DISCHARGE PERFORMANCE



DISCHARGE TEMPERATURE CHARACTERISTICS



POLY-CARBONMONOFLUORIDE LITHIUM BATTERIES (BR SERIES) – COIN TYPE LITHIUM BATTERIES

Panasonic Lithium BR coin type batteries feature high energy density, and were developed and commercialized using Panasonic's extensive experience in battery technology. They exhibit stable performance under high ambient temperatures.

FEATURES

- Self discharge rate at 20°C is just 1.0% per year
- Wide operating temperature range: between -30°C ~ +80°C
- Superior long-term reliability
- Years of experience in production

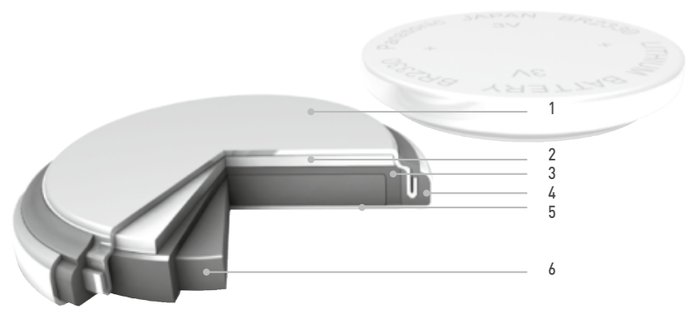
APPLICATIONS

- Tracking & RFID
- Memory back-up
- Meters, etc.

Model number	Electrical characteristics at 20°C		Dimensions with tube (mm)		Approx. weight (g)	IEC
	Nominal voltage (V)	Nominal*1 capacity (mAh)	Diameter	Total height		
BR-1220	3	35	12.5	2.0	0.7	–
BR-1225	3	48	12.5	2.5	0.8	BR1225
BR-1632	3	120	16.0	3.2	1.5	–
BR-2032	3	200	20.0	3.2	2.5	–
BR-2325	3	165	23.0	2.5	3.0	BR2325
BR-2330	3	255	23.0	3.0	3.2	–
BR-3032	3	500	30.0	3.2	5.5	–

3D ILLUSTRATION*2

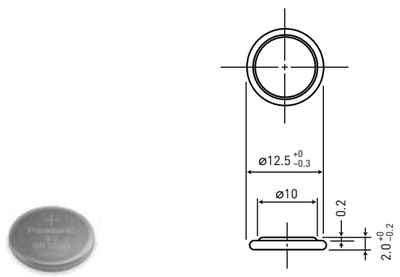
1. Negative pole
2. Anode (Lithium)
3. Separator
4. Gasket
5. Positive pole (cell can)
6. Cathode (Poly-Carbonmonofluoride)



*1 Based on standard drain and cut off voltage down to 2.0V at 20°C.
*2 The illustration shows only one example of Lithium battery structure.

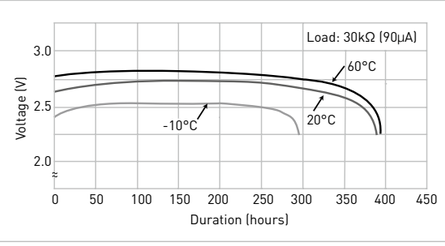
BR-1220

DIMENSIONS (MM)

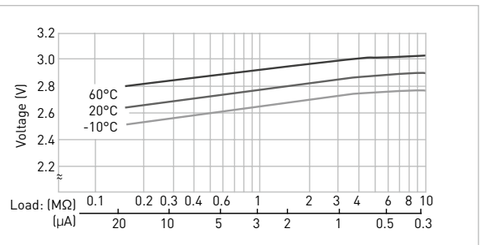


Model number	BR-1220
Nominal voltage (V)	3
Nominal capacity (mAh)	35
Diameter (mm)	12.5
Total height (mm)	2.0
Discharging temperature range (°C)	-30 to +80
Weight (g)	0.7

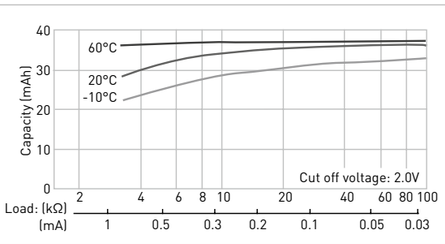
DISCHARGE TEMPERATURE CHARACTERISTICS



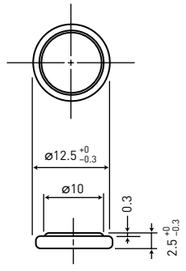
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

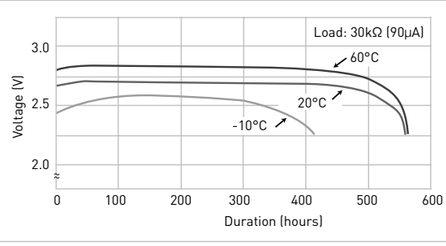


BR-1225

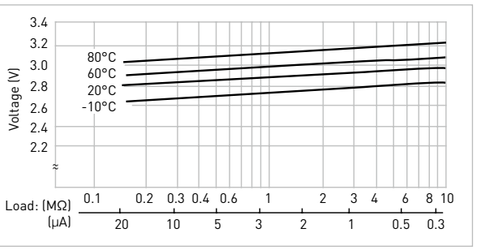


Model number	BR-1225
Nominal voltage (V)	3
Nominal capacity (mAh)	48
Diameter (mm)	12.5
Total height (mm)	2.5
Discharging temperature range (°C)	-30 to +80
Weight (g)	0.8

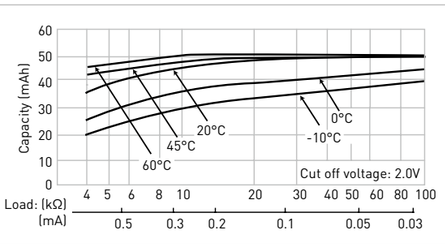
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE



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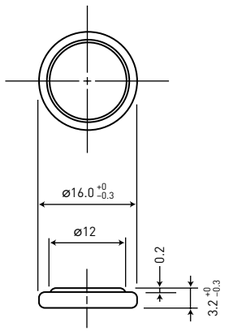
*1 Voltage at 50% discharge depth.

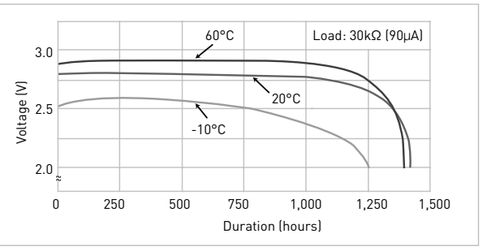
BR-1632

DIMENSIONS (MM)

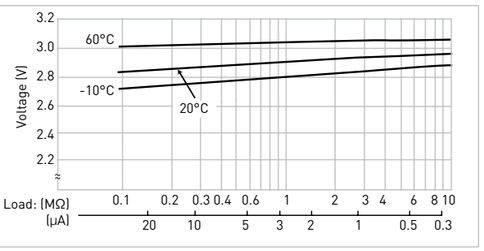


Model number	BR-1632
Nominal voltage (V)	3
Nominal capacity (mAh)	120
Diameter (mm)	16.0
Total height (mm)	3.2
Discharging temperature range (°C)	-30 to +80
Weight (g)	1.5

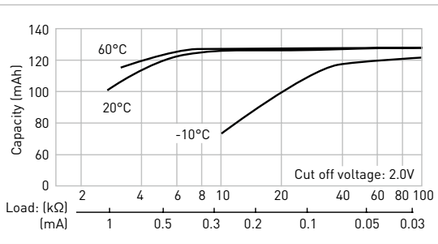
DISCHARGE TEMPERATURE CHARACTERISTICS



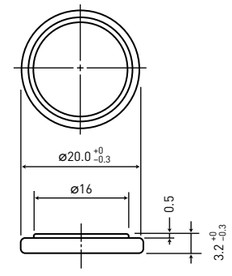
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

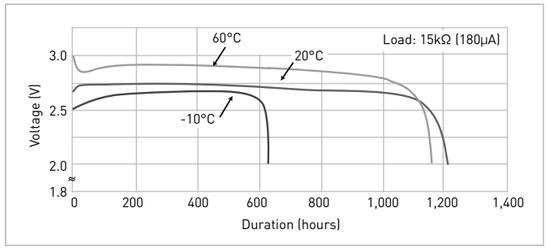


BR-2032

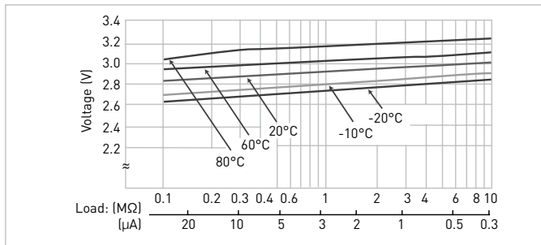


Model number	BR-2032
Nominal voltage (V)	3
Nominal capacity (mAh)	200
Diameter (mm)	20.0
Total height (mm)	3.2
Discharging temperature range (°C)	-30 to +80
Weight (g)	2.5

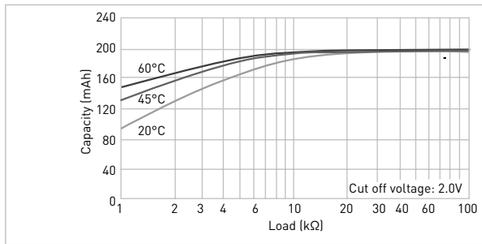
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

*1 Voltage at 50% discharge depth.

Lithium battery holders for BR-2032

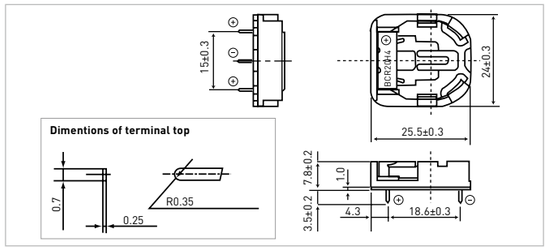
These battery holders are designed for sure and easy loading/removal of Panasonic coin type Lithium batteries in/from equipment enabling the batteries to fully exploit their capabilities as the back-up power supply in C-MOS RAM memory and microcomputer memory. All of the battery holders are designed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

BCR20H4

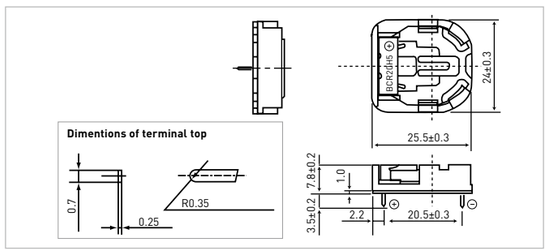
BCR20H5

BCR20V4

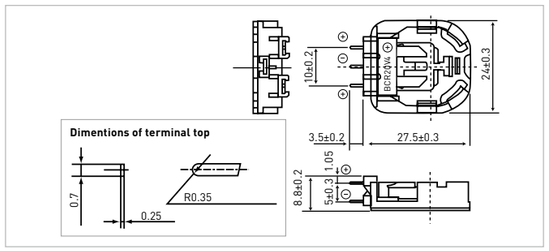
BCR20H4 (3 terminals)



BCR20H5 (2 terminals)



BCR20V4 (3 terminals)

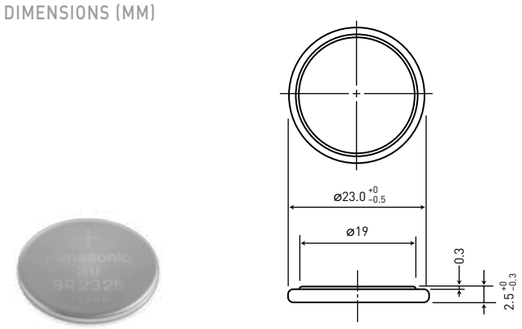


Precaution for washing battery holders

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.

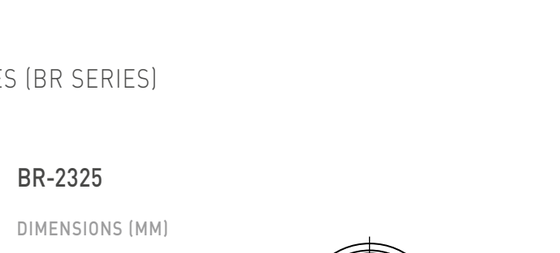
BR-2325

DIMENSIONS (MM)



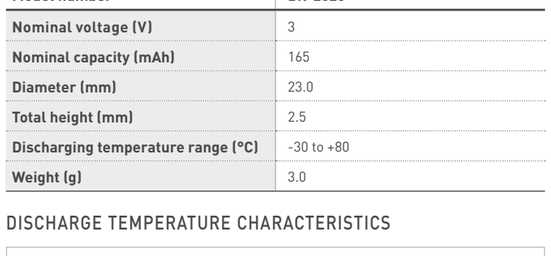
Model number	BR-2325
Nominal voltage (V)	3
Nominal capacity (mAh)	165
Diameter (mm)	23.0
Total height (mm)	2.5
Discharging temperature range (°C)	-30 to +80
Weight (g)	3.0

DISCHARGE TEMPERATURE CHARACTERISTICS



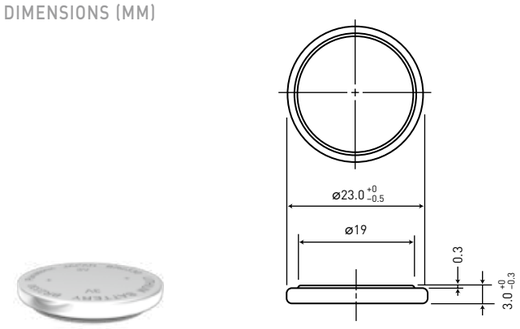
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1

CAPACITY VS. LOAD RESISTANCE



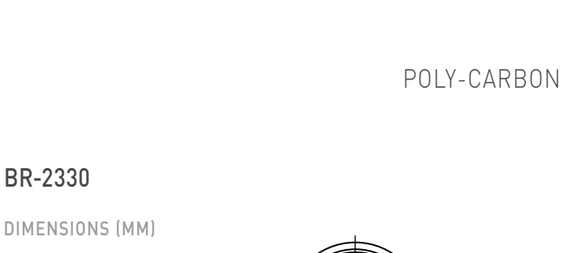
BR-2330

DIMENSIONS (MM)



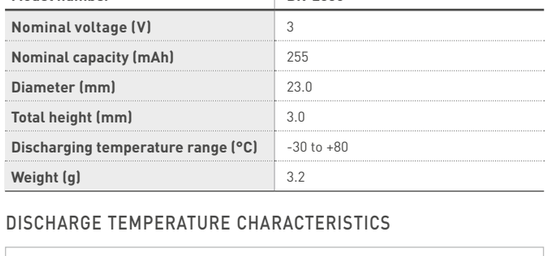
Model number	BR-2330
Nominal voltage (V)	3
Nominal capacity (mAh)	255
Diameter (mm)	23.0
Total height (mm)	3.0
Discharging temperature range (°C)	-30 to +80
Weight (g)	3.2

DISCHARGE TEMPERATURE CHARACTERISTICS

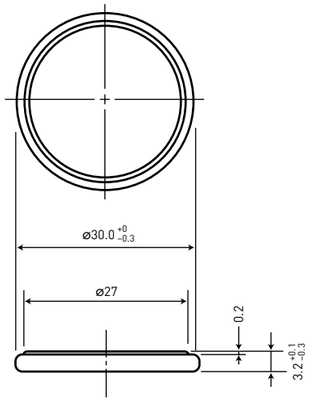


OPERATING VOLTAGE VS. DISCHARGE CURRENT*1

CAPACITY VS. LOAD RESISTANCE

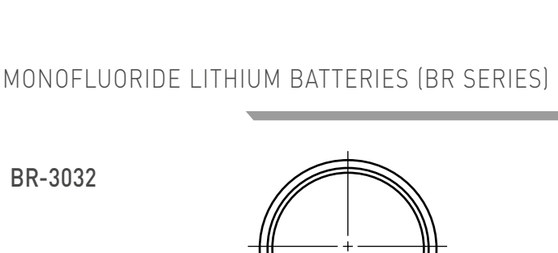


BR-3032



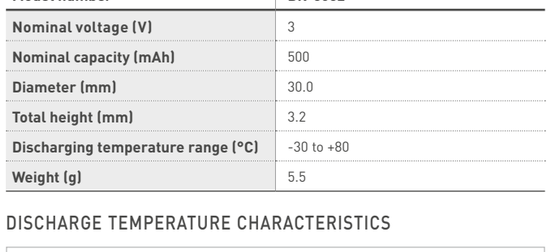
Model number	BR-3032
Nominal voltage (V)	3
Nominal capacity (mAh)	500
Diameter (mm)	30.0
Total height (mm)	3.2
Discharging temperature range (°C)	-30 to +80
Weight (g)	5.5

DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1

CAPACITY VS. LOAD RESISTANCE



*1 Voltage at 50% discharge depth.

The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

*1 Voltage at 50% discharge depth.

HIGH OPERATING TEMPERATURE POLY-CARBONMONO-FLUORIDE LITHIUM BATTERIES (BR-A SERIES) – COIN TYPE LITHIUM BATTERIES

The high energy density and the special material for gasket and separator make this battery series the ideal power supply in high ambient temperature applications.

FEATURES

- Superior design for high temperature applications -40°C ~ +125°C
- Outstanding long-term reliability
- Years of experience in production
- Self discharge rate at 20°C is just 0.5% per year

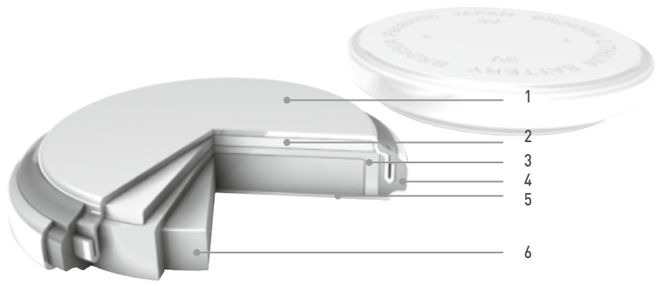
APPLICATIONS

- Tyre Pressure Monitoring Systems (TPMS)
- Electronic Toll Collection (ETC)
- Heat cost allocators, etc.

Model number	Electrical characteristics at 20°C		Dimensions with tube (mm)		Approx. weight (g)	IEC
	Nominal voltage (V)	Nominal*1 capacity (mAh)	Diameter	Total height		
BR-1225A*2	3	48	12.5	2.5	0.8	–
BR-1632A*2	3	120	16.0	3.2	1.5	–
BR-2330A*2	3	255	23.0	3.0	3.2	–
BR-2450A*2	3	550	24.5	5.0	5.9	–
BR-2477A*2	3	1,000	24.5	7.7	8.0	–

3D ILLUSTRATION*3

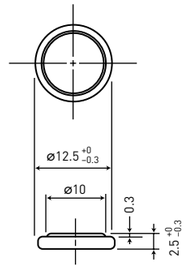
1 Negative pole
2 Anode (Lithium)
3 Separator
4 Gasket
5 Positive pole (cell can)
6 Cathode (Poly-Carbonmonofluoride)



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
*1 Based on standard drain and cut off voltage down to 2.0V at 20°C.
*2 Only batteries with terminals are available.
*3 The illustration shows only one example of Lithium battery structure.

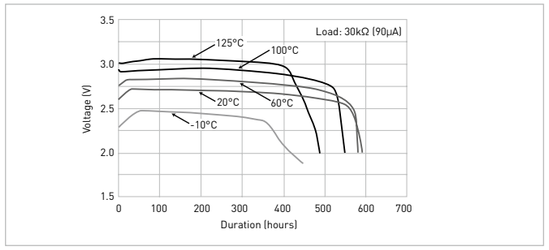
BR-1225A

DIMENSIONS (MM)

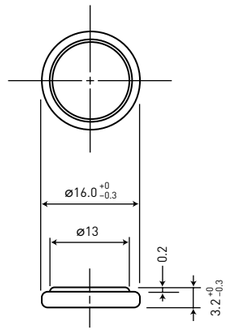


Model number	BR-1225A
Nominal voltage (V)	3
Nominal capacity (mAh)	48
Diameter (mm)	12.5
Total height (mm)	2.5
Discharging temperature range (°C)	-40 to +125
Weight (g)	0.8

DISCHARGE TEMPERATURE CHARACTERISTICS

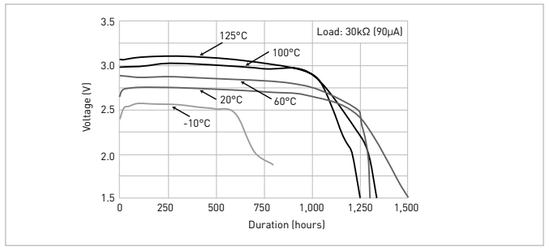


BR-1632A



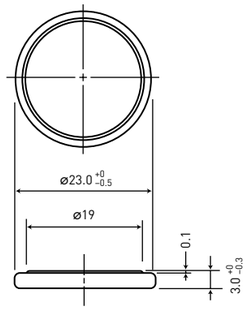
Model number	BR-1632A
Nominal voltage (V)	3
Nominal capacity (mAh)	120
Diameter (mm)	16.0
Total height (mm)	3.2
Discharging temperature range (°C)	-40 to +125
Weight (g)	1.5

DISCHARGE TEMPERATURE CHARACTERISTICS



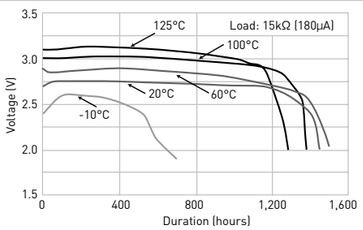
BR-2330A

DIMENSIONS (MM)

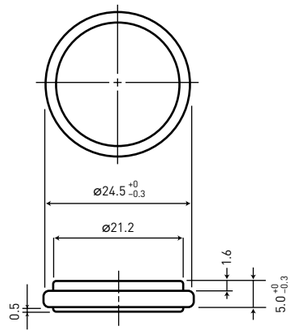


Model number	BR-2330A
Nominal voltage (V)	3
Nominal capacity (mAh)	255
Diameter (mm)	23.0
Total height (mm)	3.0
Discharging temperature range (°C)	-40 to +125
Weight (g)	3.2

DISCHARGE TEMPERATURE CHARACTERISTICS

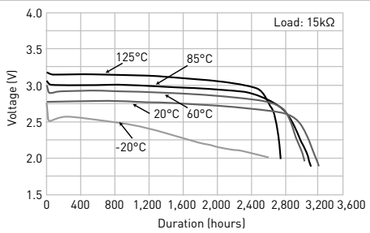


BR-2450A



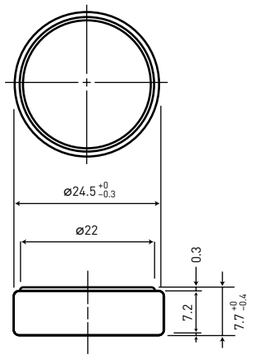
Model number	BR-2450A
Nominal voltage (V)	3
Nominal capacity (mAh)	550
Diameter (mm)	24.5
Total height (mm)	5.0
Discharging temperature range (°C)	-40 to +125
Weight (g)	5.9

DISCHARGE TEMPERATURE CHARACTERISTICS



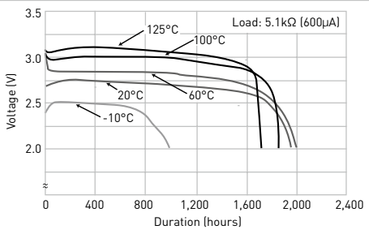
BR-2477A

DIMENSIONS (MM)



Model number	BR-2477A
Nominal voltage (V)	3
Nominal capacity (mAh)	1,000
Diameter (mm)	24.5
Total height (mm)	7.7
Discharging temperature range (°C)	-40 to +125
Weight (g)	8.0

DISCHARGE TEMPERATURE CHARACTERISTICS



MANGANESE DIOXIDE LITHIUM BATTERIES (CR SERIES) – COIN TYPE LITHIUM BATTERIES

These batteries have a proven track record of excellence in equipment requiring high currents. Additionally Panasonic has many years of manufacturing experience with this battery technology.

FEATURES

- Good pulse capability
- High discharge characteristics
- Stable voltage level during discharge
- Long-term reliability
- Self discharge rate at 20°C is just 1.0% per year
- Temperature range -30°C ~ +60°C

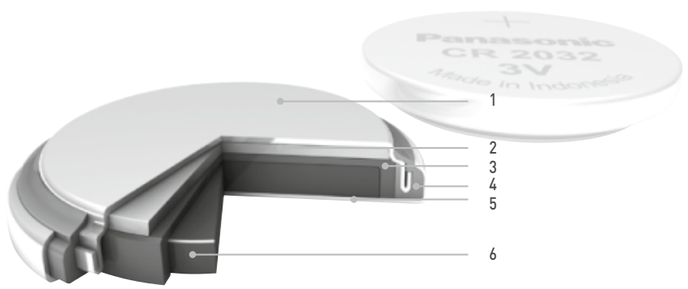
APPLICATIONS

- Remote Keyless Entry (RKE)
- Electricity meters
- Medical equipment
- Tracking & RFID,
- Vending machines,
- Price tags, etc.

Model number	Electrical characteristics at 20°C		Dimensions with tube (mm)		Approx. weight (g)	IEC
	Nominal voltage (V)	Nominal*1 capacity (mAh)	Diameter	Total height		
CR-1025	3	30	10.0	2.5	0.7	CR1025
CR-1216	3	25	12.5	1.6	0.7	CR1216
CR-1220	3	35	12.5	2.0	1.2	CR1220
CR-1612	3	40	16.0	1.2	0.8	–
CR-1616	3	55	16.0	1.6	1.2	CR1616
CR-1620	3	75	16.0	2.0	1.3	CR1620
CR-1632	3	140	16.0	3.2	1.8	–
CR-2012	3	55	20.0	1.2	1.4	CR2012
CR-2016	3	90	20.0	1.6	1.6	CR2016
CR-2025	3	165	20.0	2.5	2.5	CR2025
CR-2032	3	220	20.0	3.2	3.1	CR2032
CR-2330	3	265	23.0	3.0	4.0	CR2330
CR-2354	3	560	23.0	5.4	5.9	CR2354
CR-2412	3	100	24.5	1.2	2.0	–
CR-2450	3	620	24.5	5.0	6.3	CR2450
CR-2477	3	1,000	24.5	7.7	10.5	–
CR-3032	3	500	30.0	3.2	7.1	CR3032

3D ILLUSTRATION*2

1 Negative pole
2 Anode (Lithium)
3 Separator
4 Gasket
5 Positive pole (cell can)
6 Cathode (Manganese Dioxide)



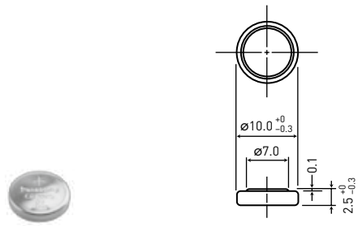
VIDEO

Scan QR code to view 3D animated video.

The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
*1 Based on standard drain and cut off voltage down to 2.0V at 20°C.
*2 The illustration shows only one example of Lithium battery structure.

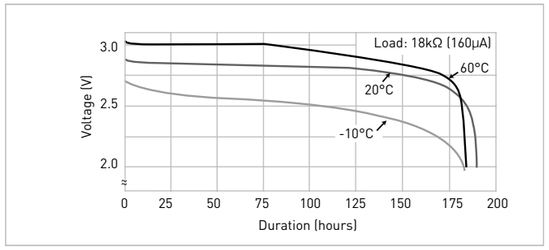
CR-1025

DIMENSIONS (MM)

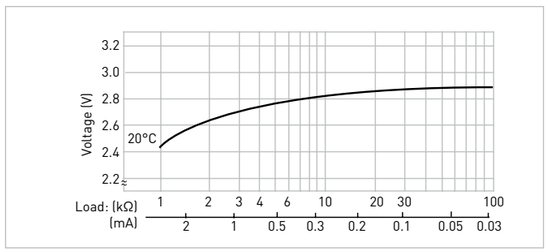


Model number	CR-1025
Nominal voltage (V)	3
Nominal capacity (mAh)	30
Diameter (mm)	10.0
Total height (mm)	2.5
Discharging temperature range (°C)	-30 to +60
Weight (g)	0.7

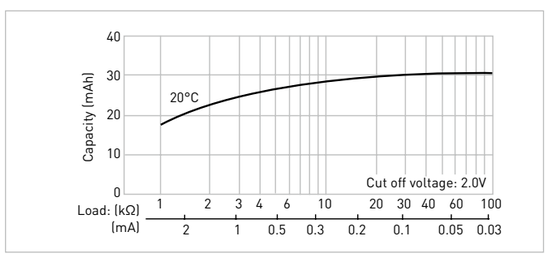
DISCHARGE TEMPERATURE CHARACTERISTICS



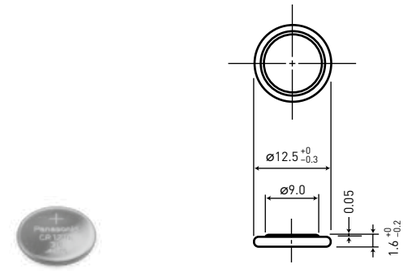
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

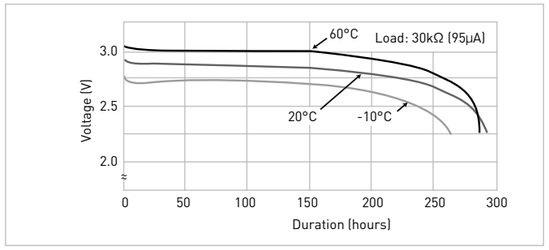


CR-1216

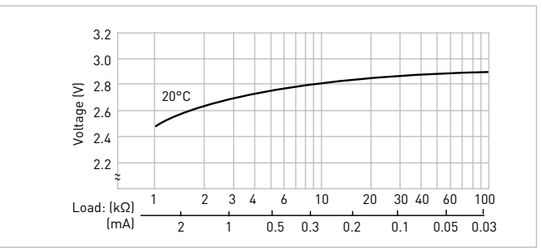


Model number	CR-1216
Nominal voltage (V)	3
Nominal capacity (mAh)	25
Diameter (mm)	12.5
Total height (mm)	1.6
Discharging temperature range (°C)	-30 to +60
Weight (g)	0.7

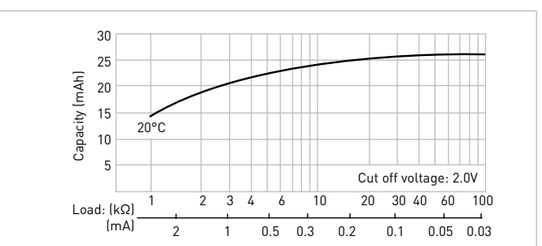
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



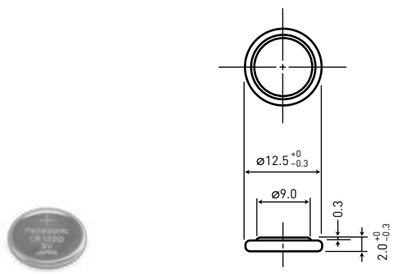
CAPACITY VS. LOAD RESISTANCE



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
*1 Voltage at 50% discharge depth.

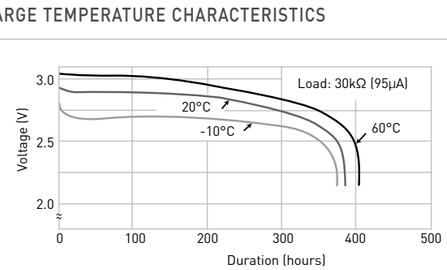
CR-1220

DIMENSIONS (MM)

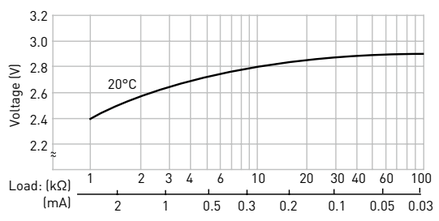


Model number	CR-1220
Nominal voltage (V)	3
Nominal capacity (mAh)	35
Diameter (mm)	12.5
Total height (mm)	2.0
Discharging temperature range (°C)	-30 to +60
Weight (g)	1.2

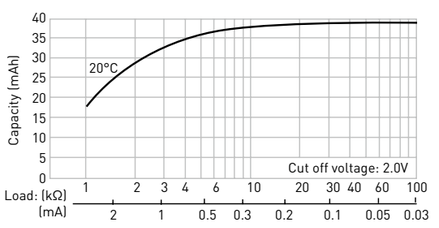
DISCHARGE TEMPERATURE CHARACTERISTICS



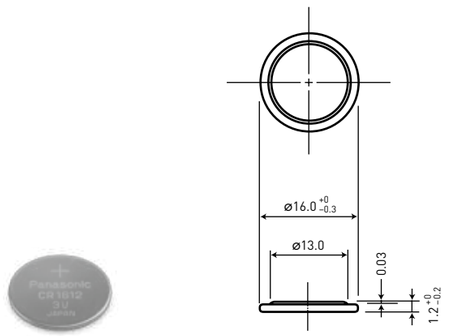
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

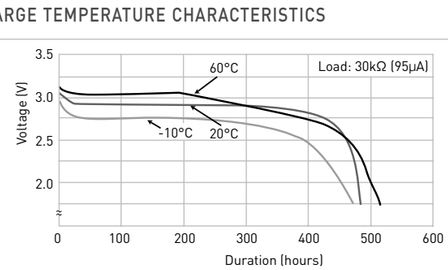


CR-1612

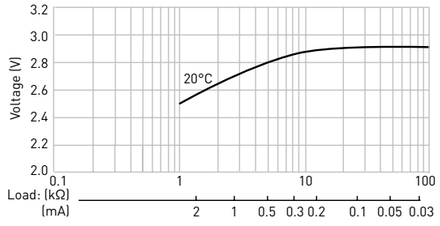


Model number	CR-1612
Nominal voltage (V)	3
Nominal capacity (mAh)	40
Diameter (mm)	16.0
Total height (mm)	1.2
Discharging temperature range (°C)	-30 to +60
Weight (g)	0.8

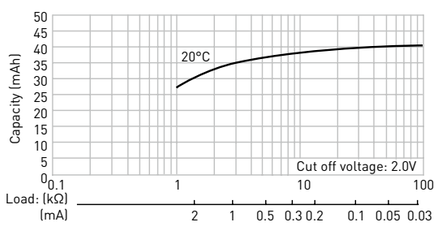
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1

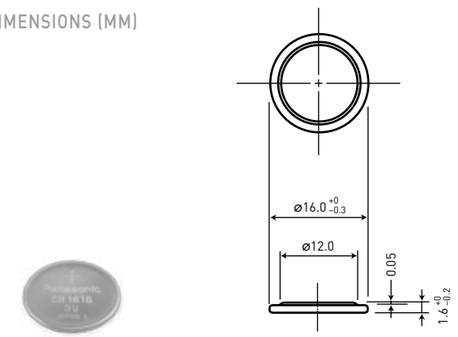


CAPACITY VS. LOAD RESISTANCE



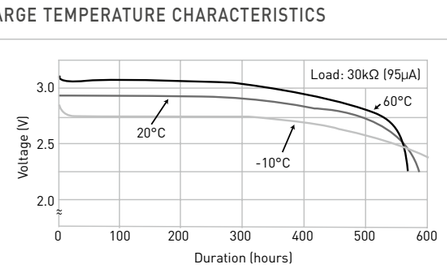
CR-1616

DIMENSIONS (MM)

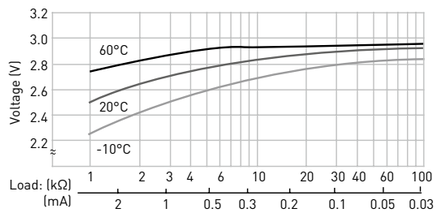


Model number	CR-1616
Nominal voltage (V)	3
Nominal capacity (mAh)	55
Diameter (mm)	16.0
Total height (mm)	1.6
Discharging temperature range (°C)	-30 to +60
Weight (g)	1.2

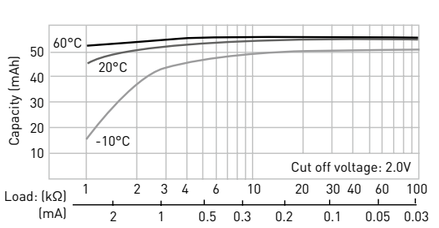
DISCHARGE TEMPERATURE CHARACTERISTICS



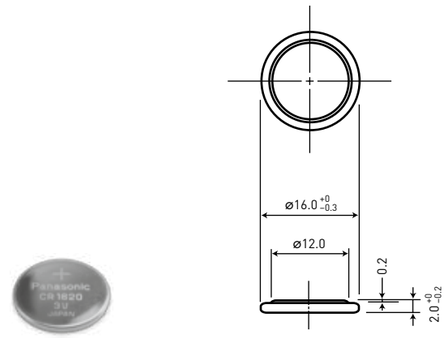
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

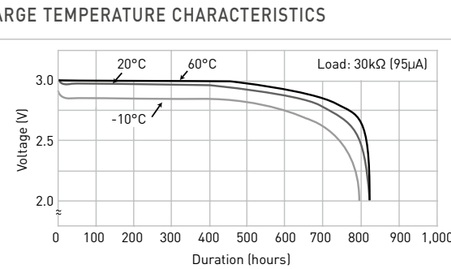


CR-1620

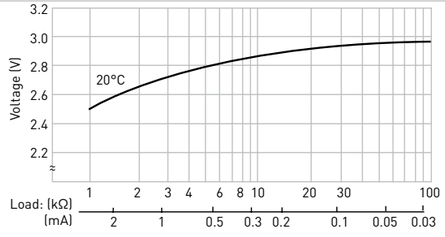


Model number	CR-1620
Nominal voltage (V)	3
Nominal capacity (mAh)	75
Diameter (mm)	16.0
Total height (mm)	2.0
Discharging temperature range (°C)	-30 to +60
Weight (g)	1.3

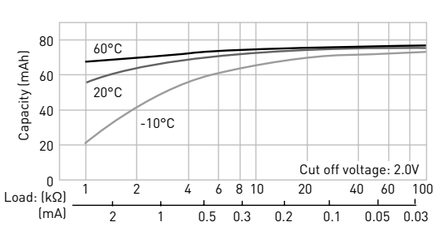
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

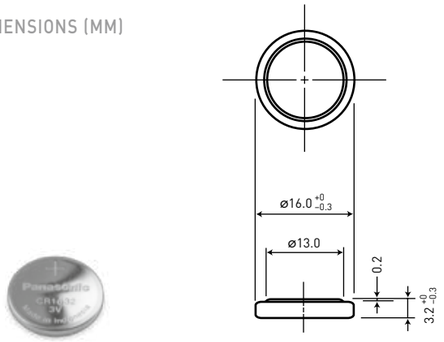


*1 Voltage at 50% discharge depth.

The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
*1 Voltage at 50% discharge depth.

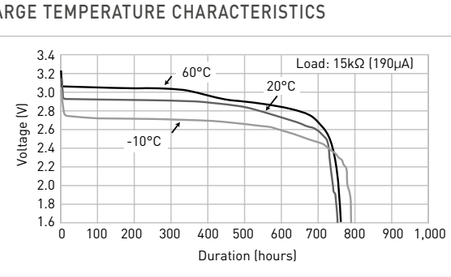
CR-1632

DIMENSIONS (MM)

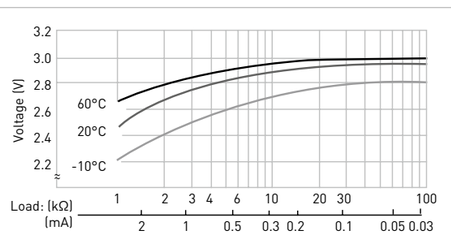


Model number	CR-1632
Nominal voltage (V)	3
Nominal capacity (mAh)	140
Diameter (mm)	16.0
Total height (mm)	3.2
Discharging temperature range (°C)	-30 to +60
Weight (g)	1.8

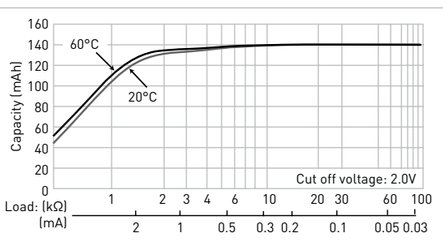
DISCHARGE TEMPERATURE CHARACTERISTICS



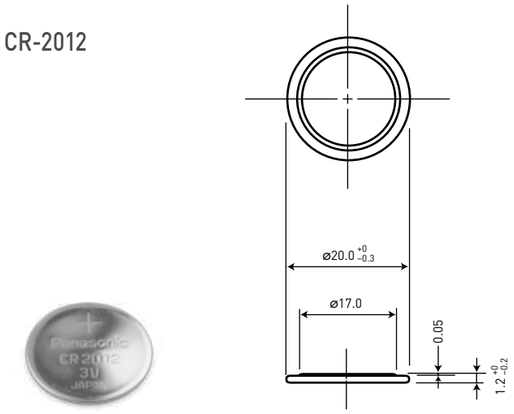
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

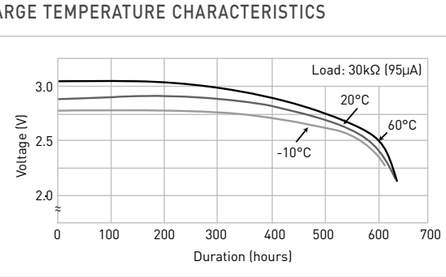


CR-2012

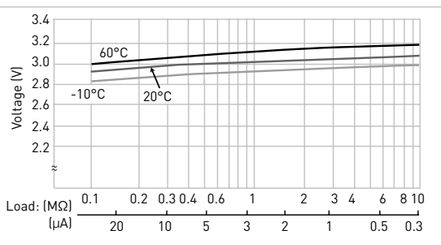


Model number	CR-2012
Nominal voltage (V)	3
Nominal capacity (mAh)	55
Diameter (mm)	20.0
Total height (mm)	1.2
Discharging temperature range (°C)	-30 to +60
Weight (g)	1.4

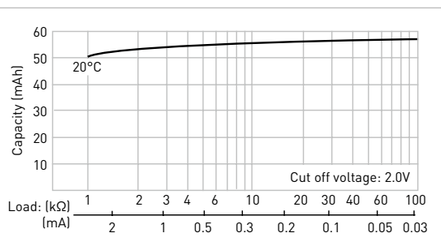
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1

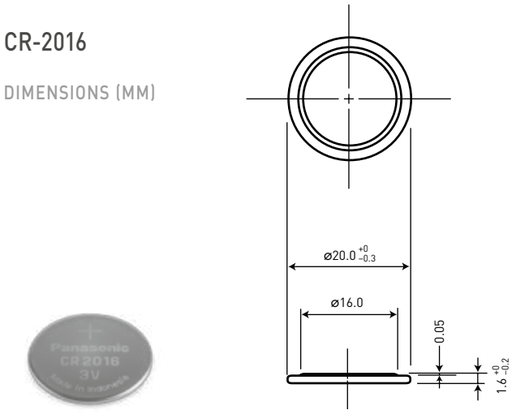


CAPACITY VS. LOAD RESISTANCE



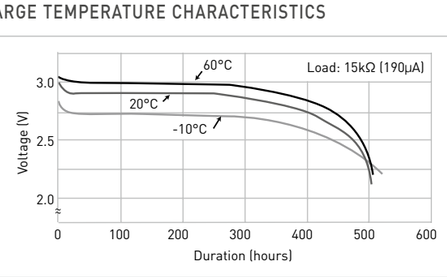
CR-2016

DIMENSIONS (MM)

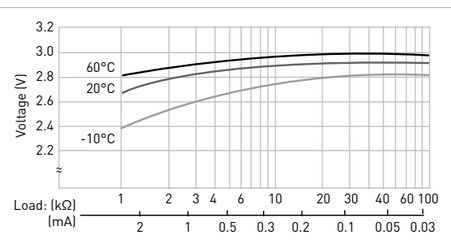


Model number	CR-2016
Nominal voltage (V)	3
Nominal capacity (mAh)	90
Diameter (mm)	20.0
Total height (mm)	1.6
Discharging temperature range (°C)	-30 to +60
Weight (g)	1.6

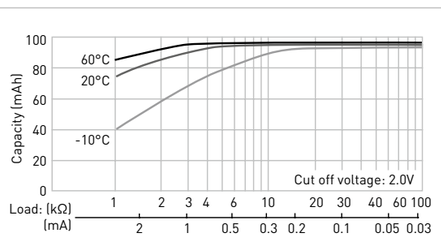
DISCHARGE TEMPERATURE CHARACTERISTICS



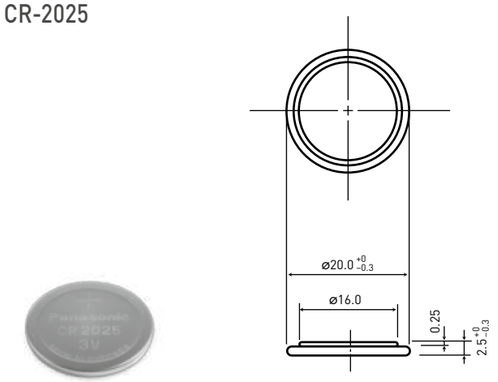
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

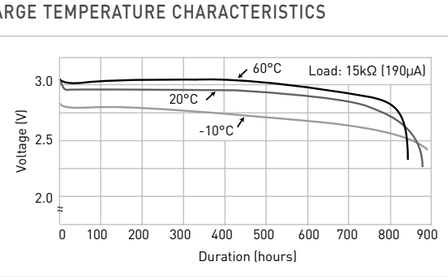


CR-2025

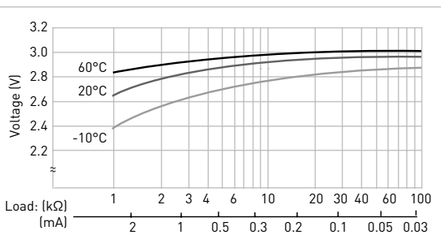


Model number	CR-2025
Nominal voltage (V)	3
Nominal capacity (mAh)	165
Diameter (mm)	20.0
Total height (mm)	2.5
Discharging temperature range (°C)	-30 to +60
Weight (g)	2.5

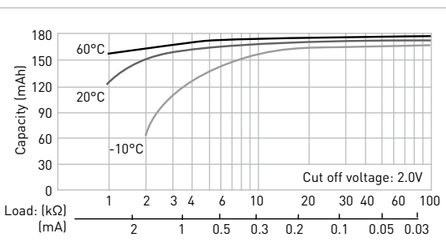
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE



*1 Voltage at 50% discharge depth.

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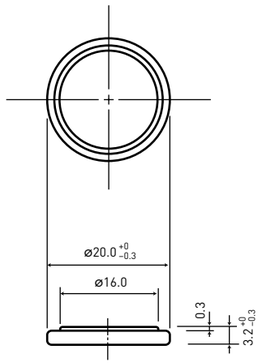
*1 Voltage at 50% discharge depth.

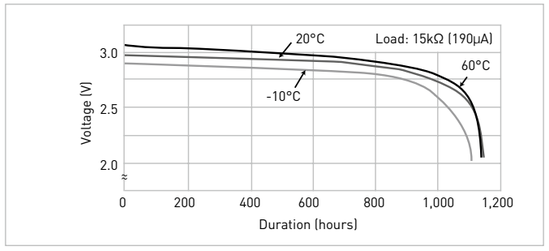
CR-2032

DIMENSIONS (MM)

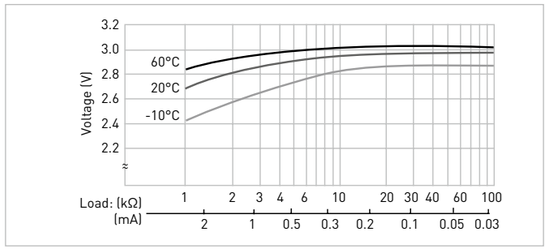


Model number	CR-2032
Nominal voltage (V)	3
Nominal capacity (mAh)	220
Diameter (mm)	20.0
Total height (mm)	3.2
Discharging temperature range (°C)	-30 to +60
Weight (g)	3.1

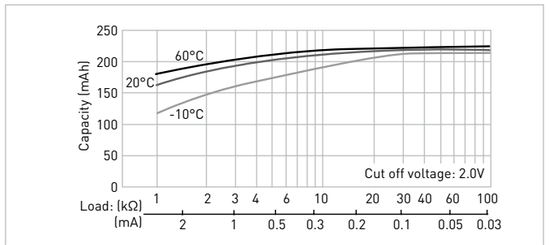
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE



Lithium battery holders for CR-2032

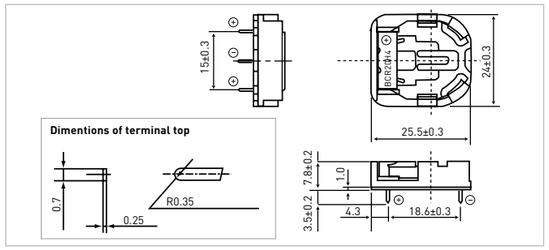
These battery holders are designed for sure and easy loading/removal of Panasonic coin type Lithium batteries in/from equipment enabling the batteries to fully exploit their capabilities as the back-up power supply in C-MOS RAM memory and microcomputer memory. All of the battery holders are designed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

BCR20H4

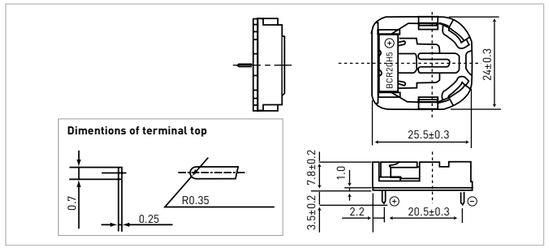
BCR20H5

BCR20V4

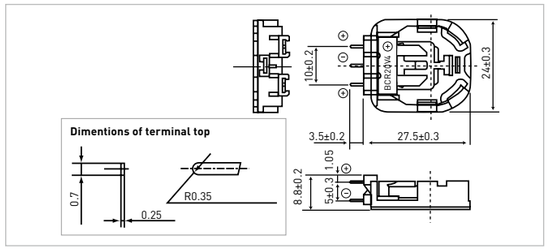
BCR20H4 (3 terminals)



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.

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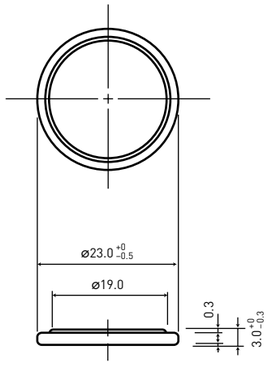
*1 Voltage at 50% discharge depth.

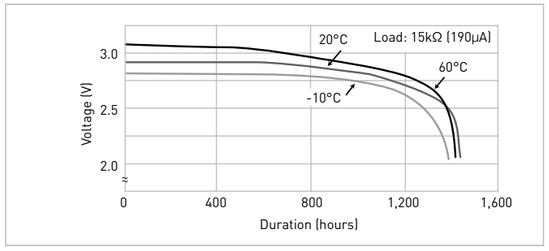
CR-2330

DIMENSIONS (MM)

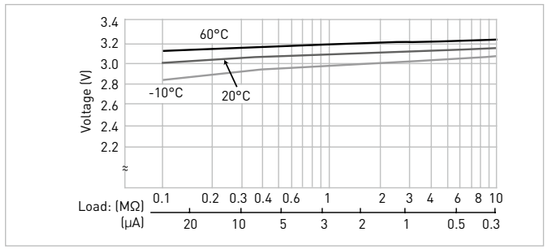


Model number	CR-2330
Nominal voltage (V)	3
Nominal capacity (mAh)	265
Diameter (mm)	23.0
Total height (mm)	3.0
Discharging temperature range (°C)	-30 to +60
Weight (g)	4.0

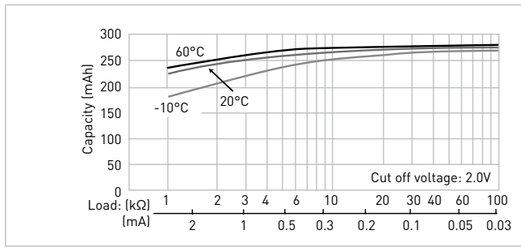
DISCHARGE TEMPERATURE CHARACTERISTICS



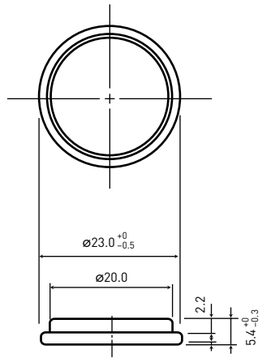
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

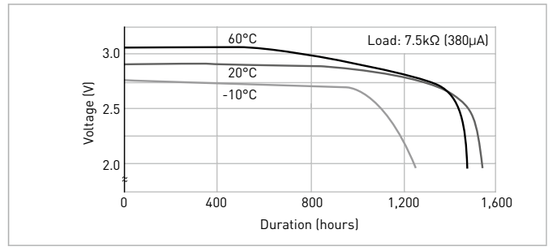


CR-2354

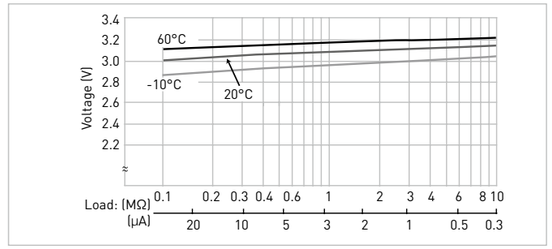


Model number	CR-2354
Nominal voltage (V)	3
Nominal capacity (mAh)	560
Diameter (mm)	23.0
Total height (mm)	5.4
Discharging temperature range (°C)	-30 to +60
Weight (g)	5.9

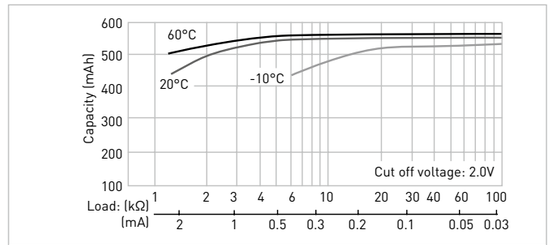
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*



CAPACITY VS. LOAD RESISTANCE

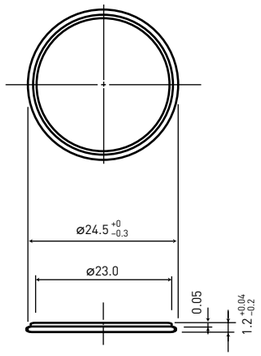


The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

*1 Voltage at 50% discharge depth.

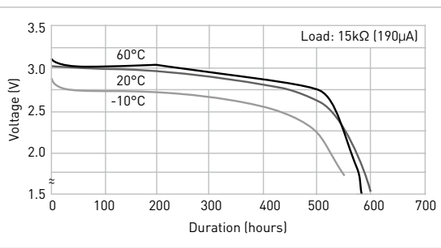
CR-2412

DIMENSIONS (MM)

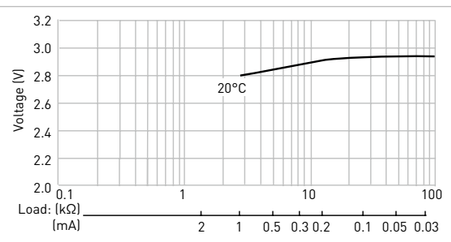


Model number	CR-2412
Nominal voltage (V)	3
Nominal capacity (mAh)	100
Diameter (mm)	24.5
Total height (mm)	1.2
Discharging temperature range (°C)	-30 to +60
Weight (g)	2.0

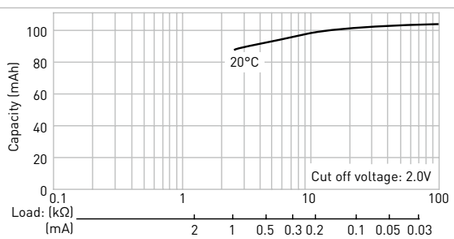
DISCHARGE TEMPERATURE CHARACTERISTICS



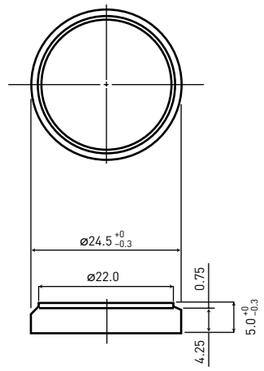
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

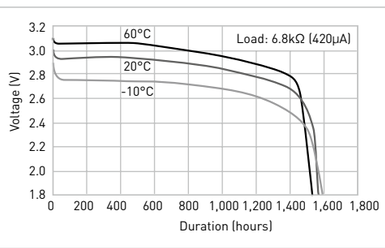


CR-2450

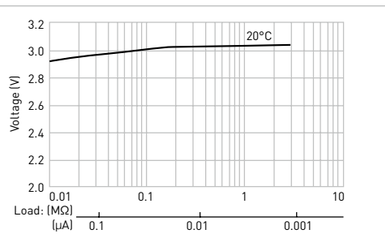


Model number	CR-2450
Nominal voltage (V)	3
Nominal capacity (mAh)	620
Diameter (mm)	24.5
Total height (mm)	5.0
Discharging temperature range (°C)	-30 to +60
Weight (g)	6.3

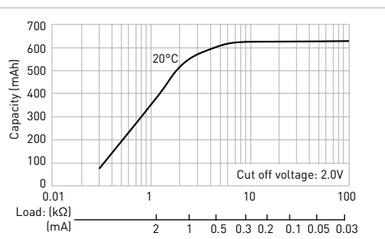
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



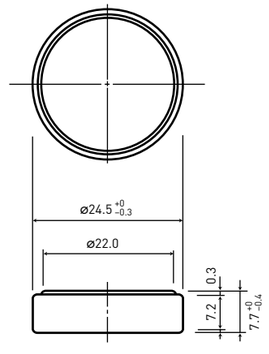
CAPACITY VS. LOAD RESISTANCE



*1 Voltage at 50% discharge depth.

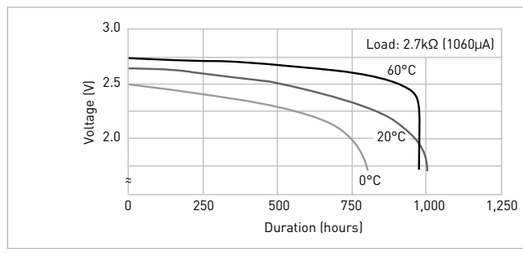
CR-2477

DIMENSIONS (MM)

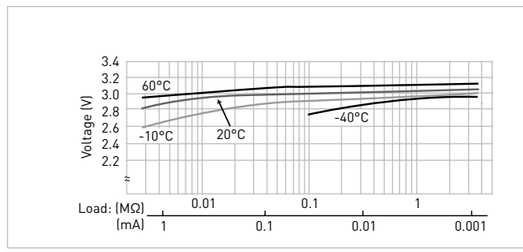


Model number	CR-2477
Nominal voltage (V)	3
Nominal capacity (mAh)	1,000
Diameter (mm)	24.5
Total height (mm)	7.7
Discharging temperature range (°C)	-30 to +60
Weight (g)	10.5

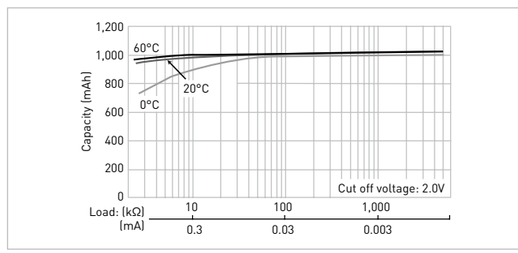
DISCHARGE TEMPERATURE CHARACTERISTICS



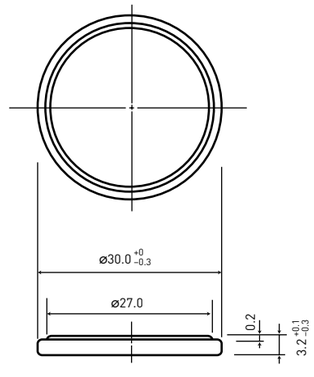
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE

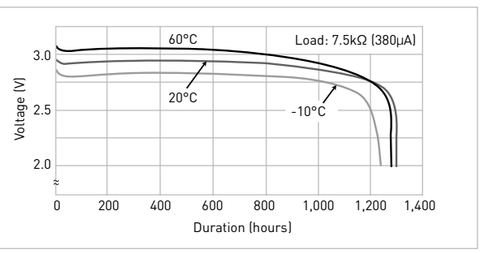


CR-3032

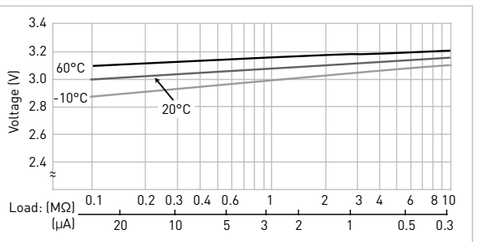


Model number	CR-3032
Nominal voltage (V)	3
Nominal capacity (mAh)	500
Diameter (mm)	30.0
Total height (mm)	3.2
Discharging temperature range (°C)	-30 to +60
Weight (g)	7.1

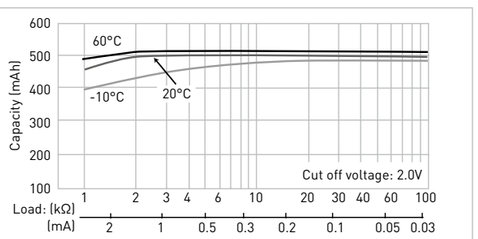
DISCHARGE TEMPERATURE CHARACTERISTICS



OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE



*1 Voltage at 50% discharge depth.

POLY-CARBONMONOFLUORIDE LITHIUM BATTERIES (BR SERIES) – PIN TYPE LITHIUM BATTERIES

Panasonic offers a unique pin shape and space-saving design to meet the requirements of small-scale applications.

FEATURES

- Superior design for high temperature applications -30°C ~ +80°C
- Outstanding long-term reliability
- Years of experience in production
- Self discharge rate at 20°C is just 0.5% per year

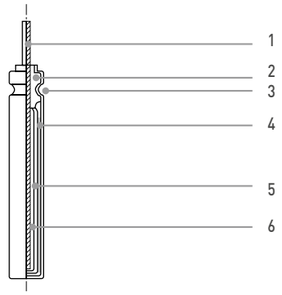
APPLICATIONS

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

Model number	Electrical characteristics at 20°C		Dimensions with tube (mm)		Approx. weight (g)	IEC
	Nominal voltage (V)	Nominal*1 capacity (mAh)	Diameter	Total height		
BR-425	3	25.0	4.2	25.9	0.6	–
BR-435	3	50.0	4.2	35.9	0.9	–

3D ILLUSTRATION*2

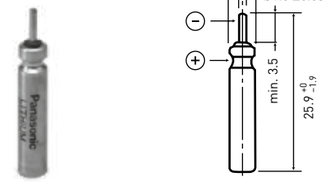
1 Anode cap
2 Gasket
3 Collector
4 Cathode (Poly-Carbonmonofluoride)
5 Separator
6 Anode (Lithium)



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
*1 Based on standard drain and cut off voltage down to 2.0V at 20°C.
*2 The illustration shows only one example of Lithium battery structure.

BR-425

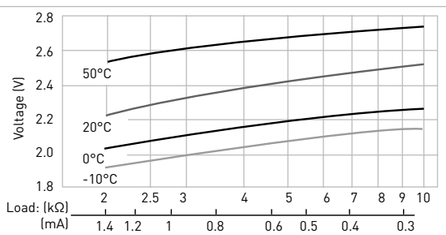
DIMENSIONS (MM)



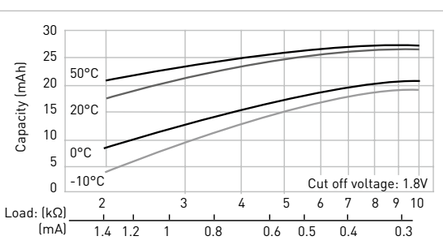
Model number	BR-425
Nominal voltage (V)	3
Nominal capacity (mAh)	25
Diameter (mm)	4.2
Total height (mm)	25.9
Discharging temperature range (°C)	-30 to +80
Weight (g)	0.6

DISCHARGE TEMPERATURE CHARACTERISTICS

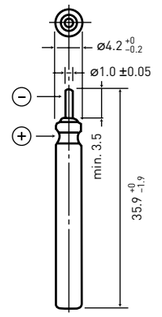
OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE



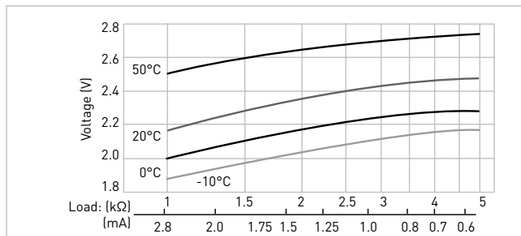
BR-435



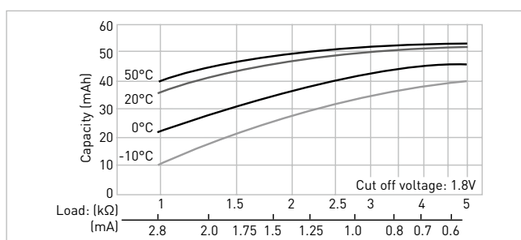
Model number	BR-435
Nominal voltage (V)	3
Nominal capacity (mAh)	50
Diameter (mm)	4.2
Total height (mm)	35.9
Discharging temperature range (°C)	-30 to +80
Weight (g)	0.9

DISCHARGE TEMPERATURE CHARACTERISTICS

OPERATING VOLTAGE VS. DISCHARGE CURRENT*1



CAPACITY VS. LOAD RESISTANCE



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
*1 Voltage at 50% discharge depth.

LITHIUM RECHARGEABLE COIN BATTERIES WITH REMARKABLE CHARACTERISTICS

VIDEO

Scan QR code to view product series video.

Panasonic rechargeable Lithium coin batteries are designed chiefly for memory back-up applications such as computers, fax machines or data terminals. They stay reliable through many charge-discharge cycles, boast a very low self-discharge rate and deliver superior long-term reliability.

VANADIUM RECHARGEABLE LITHIUM BATTERIES (VL SERIES) – COIN TYPE RECHARGEABLE LITHIUM BATTERIES

These high quality Lithium coin batteries feature vanadium oxide for the positive pole, Lithium alloy for the negative pole and a non-aqueous solvent for the electrolyte.

FEATURES

- Rechargeable Lithium technology
- Self discharge rate at 20°C is only 2.0% per year
- 1,000 charge-discharge cycles at 10% depth of discharge
- Superior long-term reliability
- Years of experience in production

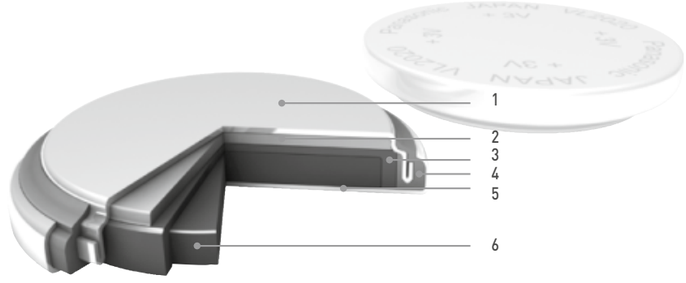
APPLICATIONS

- Real Time Clock (RTC)
- Tracking & RFID
- Remote Keyless Entry (RKE)
- Fax machines
- Remote control
- Mobile phones, etc.

Model number	Electrical characteristics at 20°C		Dimensions with tube (mm)		Approx. weight (g)	IEC
	Nominal voltage (V)	Nominal*1 capacity (mAh)	Diameter	Total height		
VL-621*2	3	1.5	6.8	2.1	0.3	–
VL-1220*2	3	7.0	12.5	2.0	0.8	–
VL-2020*2	3	20.0	20.0	2.0	2.2	–
VL-2320*2	3	30.0	23.0	2.0	2.7	–
VL-2330*2	3	50.0	23.0	3.0	3.5	–
VL-3032*2	3	100.0	30.0	3.2	6.2	–

3D ILLUSTRATION*3

1 Negative pole
2 Anode (Lithium Aluminium alloy)
3 Separator
4 Gasket
5 Positive pole (cell can)
6 Cathode (Vanadium Pentoxide)



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
*1 Based on standard drain and cut off voltage down to 2.0V at 20°C.
*2 Only battery with terminal are handled.
*3 The illustration shows only one example of Lithium battery structure.

CHARGING

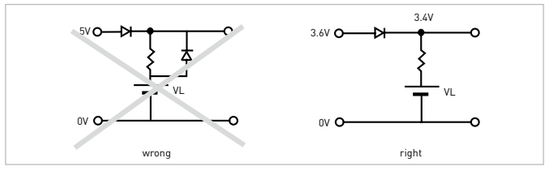
Charging circuits

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

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 constant current 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°C 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.
- It is not possible for the battery capacity to recover completely when the charging voltage is below the specification.

Recommended charging circuits - basic conditions

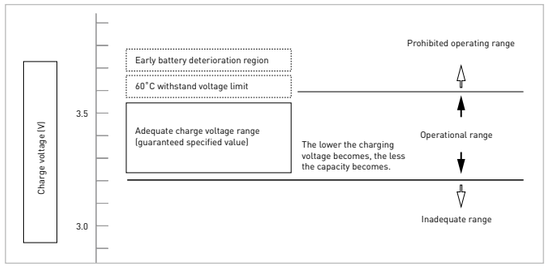
Charge voltage:	3.4V ± 0.15V
Charge current:	For a battery voltage of 3V
VL-621	Approx. 0.2mA or below
VL-1220	Approx. 0.5mA or below
VL-2020	Approx. 1.5mA or below
VL-2320, VL-2330	Approx. 2.0mA or below
VL-3032	Approx. 4.0mA or below

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

Mixed usage of batteries

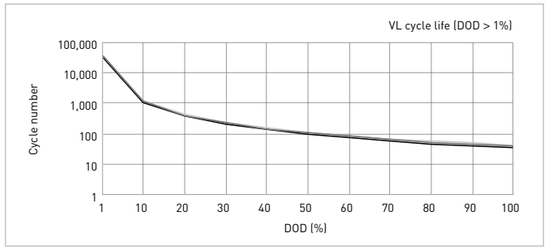
Do not use these batteries and Lithium primary batteries or other rechargeable batteries together, and do not use new batteries and old batteries together even if they are of the same type.

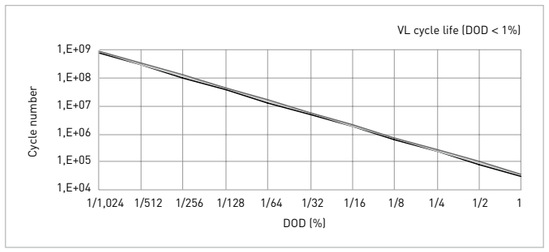
Influence of the charge voltage on VL batteries



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

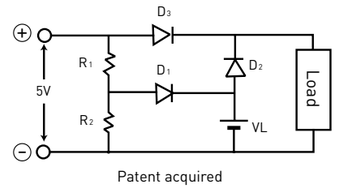
VL cycle life





*1 Consult with Panasonic concerning constant-current charging systems.

Reference: Examples of charging circuits

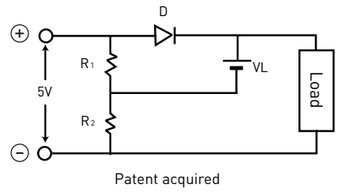


Patent acquired

Standard circuits

D_2: select a diode of small inverse current (I_R=1μA below/5V)
D_1, D_2: MA3X716 (Diode type code)
D_3: MA3X704, MA2J728

	R_1	R_2	Charge current (max.)
VL-621	2.2kΩ	5.6kΩ	0.2mA
VL-1220	750Ω	1.8kΩ	0.5mA
VL-2020	200Ω	510Ω	1.5mA
VL-2320, VL-2330	150Ω	390Ω	2.0mA
VL-3032	68Ω	180Ω	4.0mA



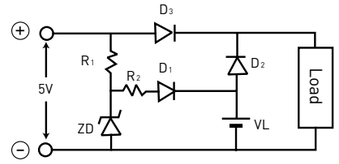
Patent acquired

Simple economical circuits

D: MA2J728 (Very small reverse current)

Load with 5V applied	**1mA below**	
D,Vf	**0~0.30V**	
	R_1	R_2
VL-621	6.2kΩ	2.4kΩ
VL-1220	1500Ω	560Ω
VL-2020	470Ω	180Ω
VL-2320, VL-2330	390Ω	150Ω
VL-3032	180Ω	68Ω

VF of D will be different from the value given above if a current in excess of 1mA flows to the load during operation. Compensation must be provided by the resistors in such cases.

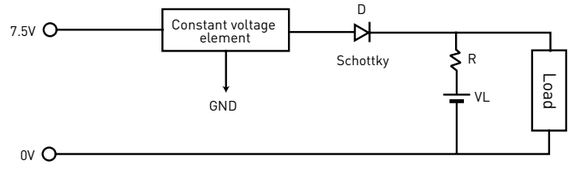


	ZD	D_1	R_1	
A	MAZ30360L	MA3X704	300Ω	Common to all types
B	MAZ30360H	MA2J728	270Ω	

Type		**VL-3032**	**VL-2330**	**VL-2320**	**VL-2020**	**VL-1220**	**VL-621**
R_2	**A**	Not required				470Ω	1.5kΩ
	B	Not required				560Ω	1.6kΩ

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

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

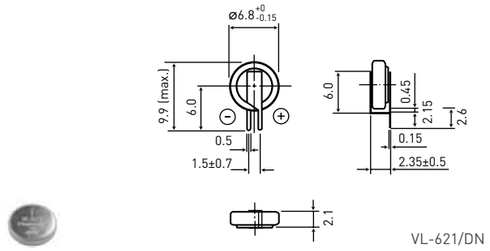


REG	D
3.7V	MA2J728

For details, refer to the constant voltage element specifications.

VL-621

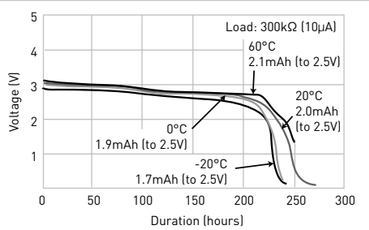
DIMENSIONS (MM)



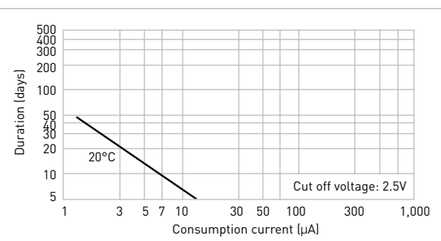
VL-621/DN

Model number	VL-621
Nominal voltage (V)	3
Nominal capacity (mAh)	1.5
Diameter (mm)	6.8
Total height (mm)	2.1
Discharging temperature range (°C)	-20 to +60
Weight (g)	0.3

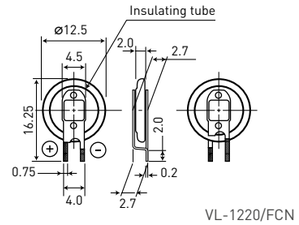
DISCHARGE TEMPERATURE CHARACTERISTICS



CONSUMPTION CURRENT VS. DURATION TIME



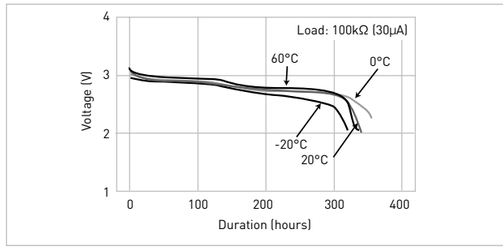
VL-1220



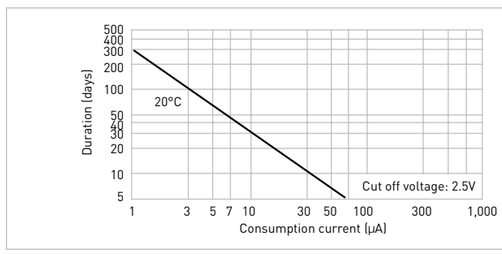
VL-1220/FCN

Model number	VL-1220
Nominal voltage (V)	3
Nominal capacity (mAh)	7.0
Diameter (mm)	12.5
Total height (mm)	2.0
Discharging temperature range (°C)	-20 to +60
Weight (g)	0.8

DISCHARGE TEMPERATURE CHARACTERISTICS

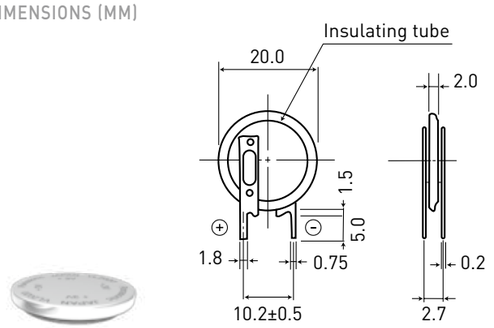


CONSUMPTION CURRENT VS. DURATION TIME



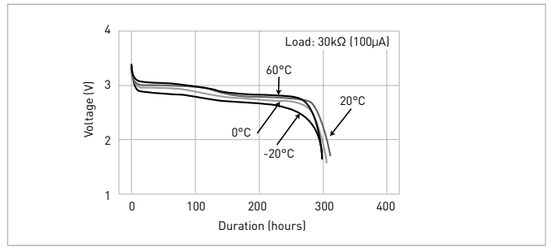
VL-2020

DIMENSIONS (MM)

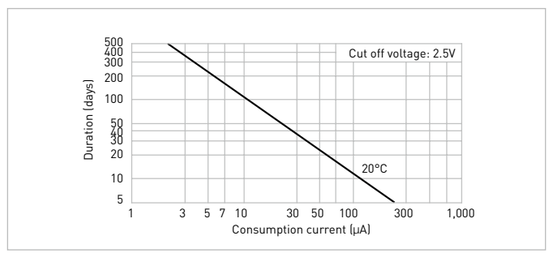


Model number	VL-2020
Nominal voltage (V)	3
Nominal capacity (mAh)	20.0
Diameter (mm)	20.0
Total height (mm)	2.0
Discharging temperature range (°C)	-20 to +60
Weight (g)	2.2

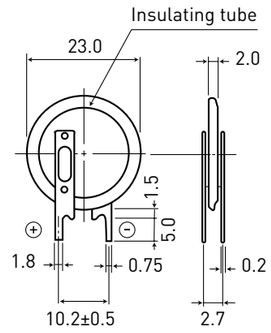
DISCHARGE TEMPERATURE CHARACTERISTICS



CONSUMPTION CURRENT VS. DURATION TIME

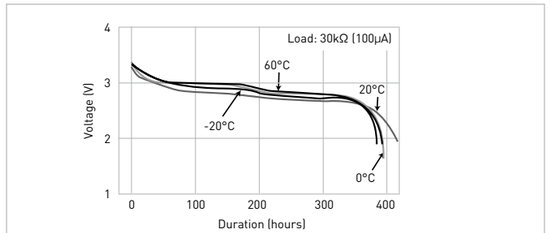


VL-2320

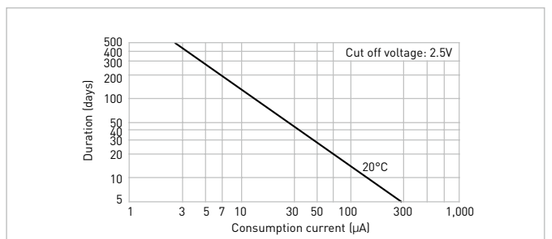


Model number	VL-2320
Nominal voltage (V)	3
Nominal capacity (mAh)	30.0
Diameter (mm)	23.0
Total height (mm)	2.0
Discharging temperature range (°C)	-20 to +60
Weight (g)	2.7

DISCHARGE TEMPERATURE CHARACTERISTICS

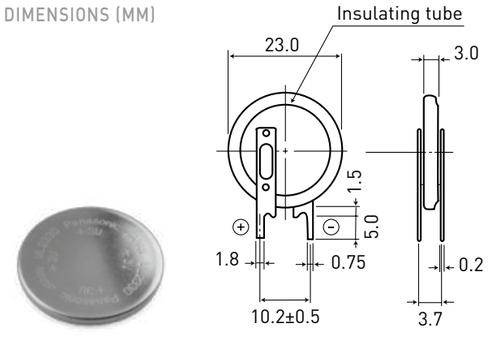


CONSUMPTION CURRENT VS. DURATION TIME



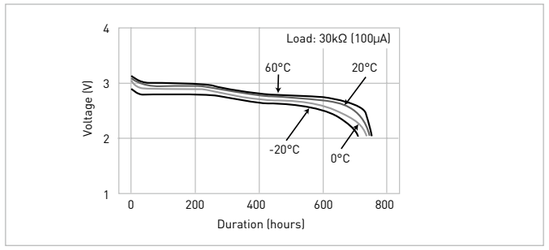
VL-2330

DIMENSIONS (MM)

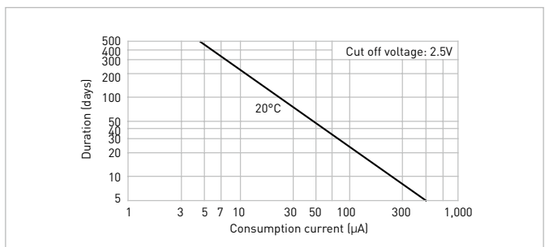


Model number	VL-2330
Nominal voltage (V)	3
Nominal capacity (mAh)	50.0
Diameter (mm)	23.0
Total height (mm)	3.0
Discharging temperature range (°C)	-20 to +60
Weight (g)	3.5

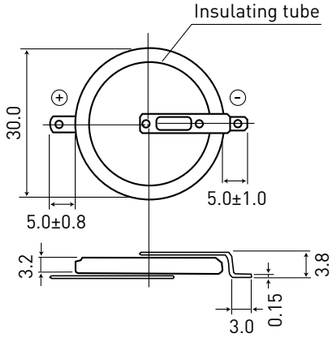
DISCHARGE TEMPERATURE CHARACTERISTICS



CONSUMPTION CURRENT VS. DURATION TIME

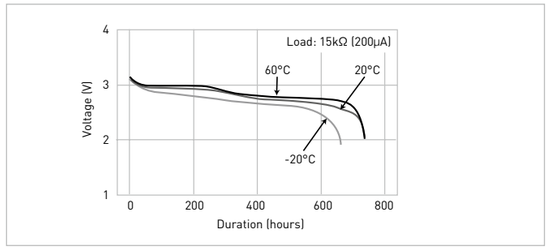


VL-3032

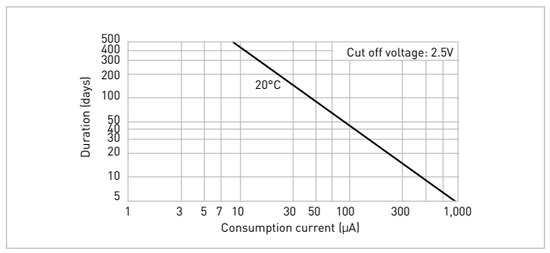


Model number	VL-3032
Nominal voltage (V)	3
Nominal capacity (mAh)	100.0
Diameter (mm)	30.0
Total height (mm)	3.2
Discharging temperature range (°C)	-20 to +60
Weight (g)	6.2

DISCHARGE TEMPERATURE CHARACTERISTICS



CONSUMPTION CURRENT VS. DURATION TIME



MANGANESE RECHARGEABLE LITHIUM BATTERIES (ML SERIES) – COIN TYPE RECHARGEABLE LITHIUM BATTERIES

These super compact rechargeable Lithium 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.

FEATURES

- Rechargeable Lithium technology
- Self discharge rate at 20°C is only 2.0% per year
- 1,000 charge-discharge cycles at 10% depth of discharge
- Superior long-term reliability
- Years of experience in production

APPLICATIONS

- Fax machine
- Memory back-up power supplies for mobile phones
- Tracking & RFID
- Pagers and other compact communications equipment
- Real Time Clock (RTC), etc.

Model number	Electrical characteristics at 20°C		Dimensions with tube (mm)		Approx. weight (g)	IEC
	Nominal voltage (V)	Nominal*1 capacity (mAh)	Diameter	Total height		
ML-421	3	2.3	4.8	2.1	0.1	–
ML-614	3	3.4	6.8	1.4	0.2	–
ML-621	3	5.0	6.8	2.1	0.2	–
ML-920	3	11.0	9.5	2.0	0.4	–
ML-1220	3	17.0	12.5	2.0	0.8	–
ML-2020	3	45.0	20.0	2.0	2.2	–

*1 Based on standard drain and cut off voltage down to 2.0V at 20°C.

CHARGING

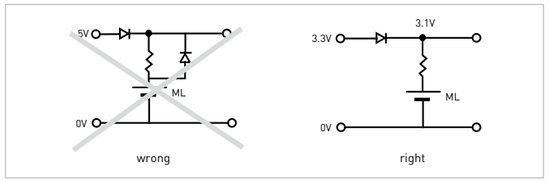
Charging circuits

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

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 constant current 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 to 3.2V at the temperature of -20°C to +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.
- It is not possible for the battery capacity to recover completely when the charging voltage is below the specification.

Recommended charging circuits - basic conditions

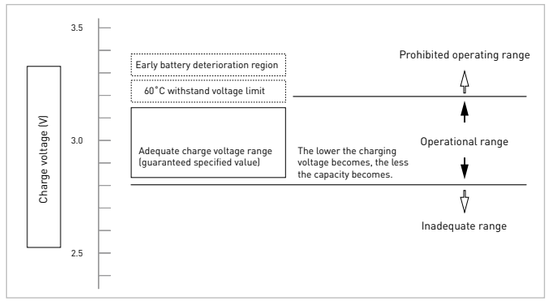
Fixed-voltage charge

Charge voltage:	2.8 to 3.2V (Standard voltage: 3.1V)
Charge current:	For a battery voltage of 2.5V
ML-421	Approx. 0.15mA or below
ML-614	Approx. 0.3mA or below
ML-621	Approx. 0.6mA or below
ML-920, ML-1220	Approx. 1.2mA or below
ML-2020	Approx. 3.0mA or below

Mixed usage of batteries

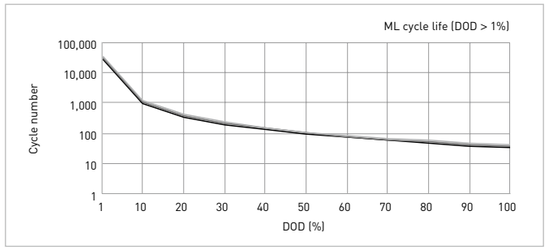
Do not use these batteries and Lithium primary batteries or other rechargeable batteries together, and do not use new batteries and old batteries together even if they are of the same type.

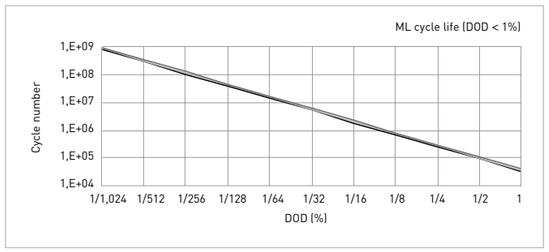
Influence of the charge voltage on ML batteries



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

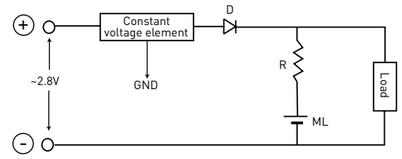
ML cycle life





*[1] Consult with Panasonic concerning constant-current charging systems.

Reference: Examples of charging circuits



When charging using another battery

ML-421

REG	D	R
3.2V	MA2J728	6.2kΩ
3.1V	MA2J728	5.1kΩ

ML-614

REG	D	R
3.2V	MA2J728	1.8kΩ
3.1V	MA2J728	1.5kΩ

ML-621

REG	D	R
3.2V	MA2J728	910Ω
3.1V	MA2J728	750Ω

ML-920

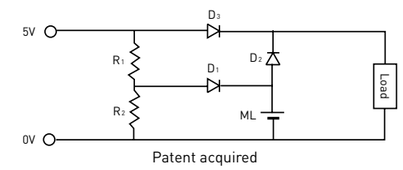
REG	D	R
3.2V	MA2J728	470Ω
3.1V	MA2J728	390Ω

ML-1220

REG	D	R
3.2V	MA2J728	470Ω
3.1V	MA2J728	390Ω

ML-2020

REG	D	R
3.2V	MA2J728	180Ω
3.1V	MA2J728	150Ω

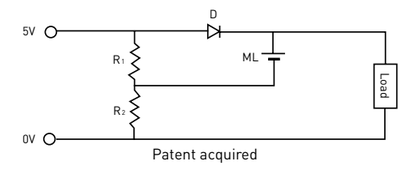


Patent acquired

Standard circuits

For D_2, select a diode of small inverse current (Ir=1μA/5V)
D_1, D_2: MA3X716 (Diode type code)
D_3: MA3X704, MA2J728

	R_1	R_2
ML-421	5.1kΩ	9.1kΩ
ML-614	2.7kΩ	5.1kΩ
ML-621	1.1kΩ	2.0kΩ
ML-920	680Ω	1.3kΩ
ML-1220	680Ω	1.3kΩ
ML-2020	180Ω	330Ω



Patent acquired

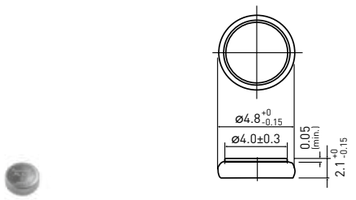
Simple economical circuits

Load	100μA below	
D,Vf	0~0.2V	
	R_1	R_2
ML-421	10kΩ	5.1kΩ
ML-614	5.1kΩ	2.7kΩ
ML-621	2.4kΩ	1.3kΩ
ML-920	1kΩ	510Ω
ML-1220	1kΩ	510Ω
ML-2020	330Ω	180Ω

VF of D will be different from the value given above if a current in excess of 10μA flows to the load during operation. Compensation must be provided by the resistors in such cases.

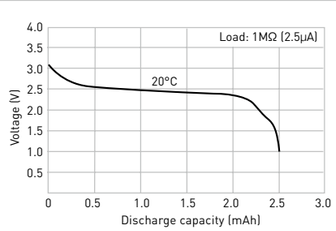
ML-421

DIMENSIONS (MM)

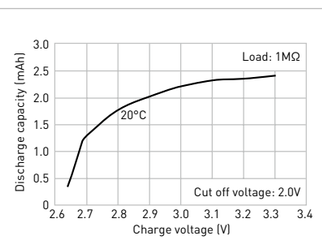


Model number	ML-421
Nominal voltage (V)	3
Nominal capacity (mAh)	2.3
Diameter (mm)	4.8
Total height (mm)	2.1
Discharging temperature range (°C)	-20 to +60
Weight (g)	0.1

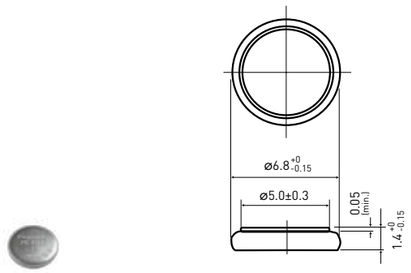
DISCHARGE CHARACTERISTICS



CHARGE VOLTAGE VS. DISCHARGE CAPACITY

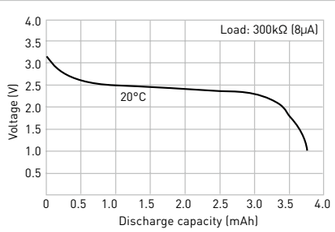


ML-614

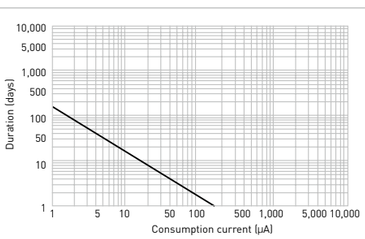


Model number	ML-614
Nominal voltage (V)	3
Nominal capacity (mAh)	3.4
Diameter (mm)	6.8
Total height (mm)	1.4
Discharging temperature range (°C)	-20 to +60
Weight (g)	0.2

DISCHARGE CHARACTERISTICS

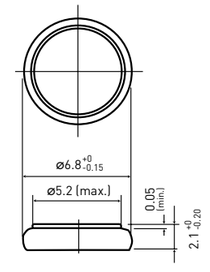


CONSUMPTION CURRENT VS. DURATION TIME



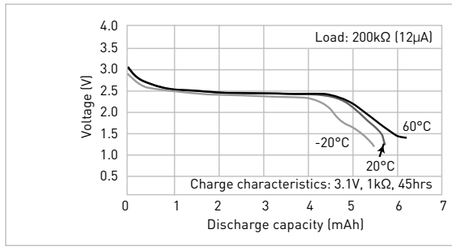
ML-621

DIMENSIONS (MM)

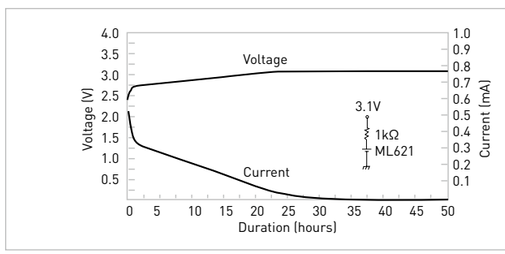


Model number	ML-621
Nominal voltage (V)	3
Nominal capacity (mAh)	5.0
Diameter (mm)	6.8
Total height (mm)	2.1
Discharging temperature range (°C)	-20 to +60
Weight (g)	0.2

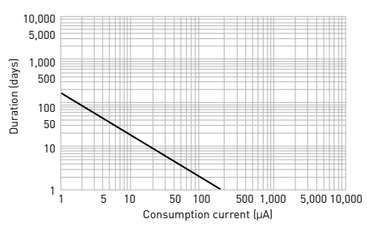
DISCHARGE CHARACTERISTICS



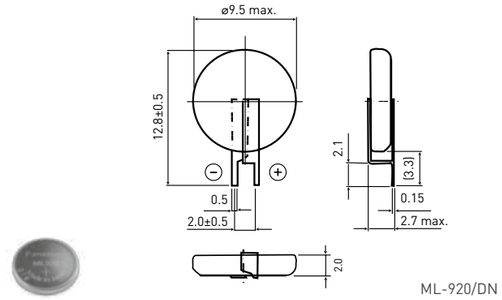
CHARGE CHARACTERISTICS



CONSUMPTION CURRENT VS. DURATION TIME



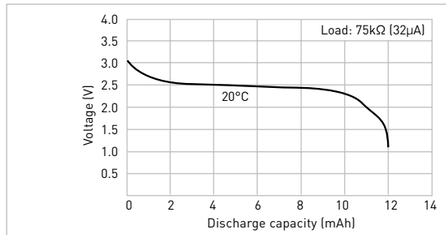
ML-920



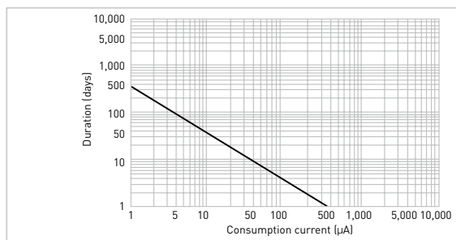
ML-920/DN

Model number	ML-920
Nominal voltage (V)	3
Nominal capacity (mAh)	11.0
Diameter (mm)	9.5
Total height (mm)	2.0
Discharging temperature range (°C)	-20 to +60
Weight (g)	0.4

DISCHARGE CHARACTERISTICS

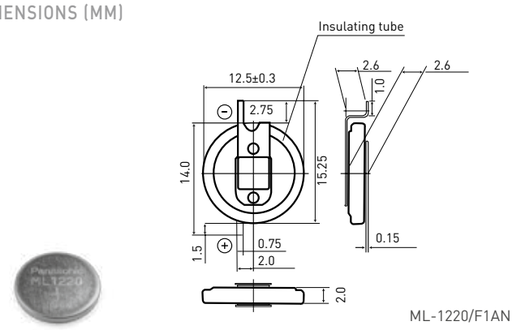


CONSUMPTION CURRENT VS. DURATION TIME



ML-1220

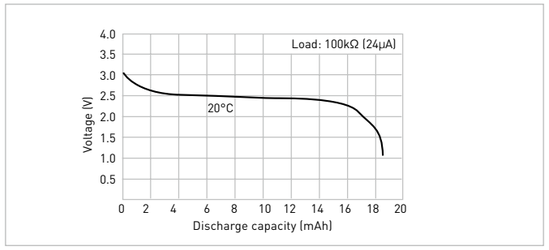
DIMENSIONS (MM)



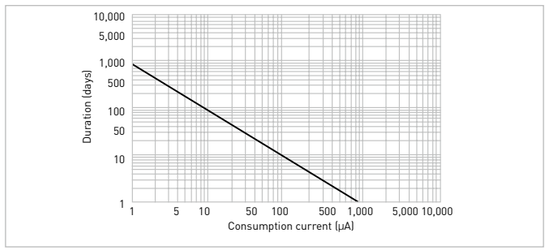
ML-1220/F1AN

Model number	ML-1220
Nominal voltage (V)	3
Nominal capacity (mAh)	17.0
Diameter (mm)	12.5
Total height (mm)	2.0
Discharging temperature range (°C)	-20 to +60
Weight (g)	0.8

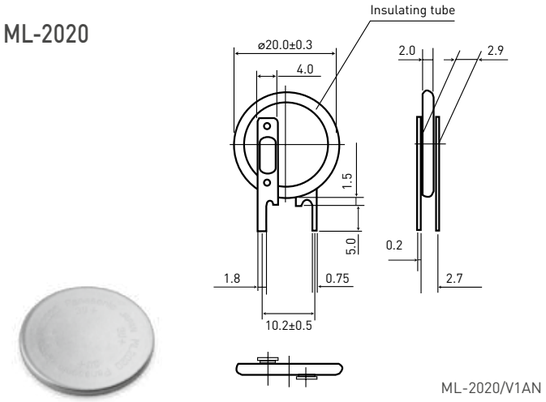
DISCHARGE CHARACTERISTICS



CONSUMPTION CURRENT VS. DURATION TIME



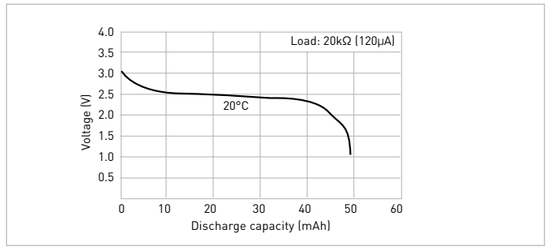
ML-2020



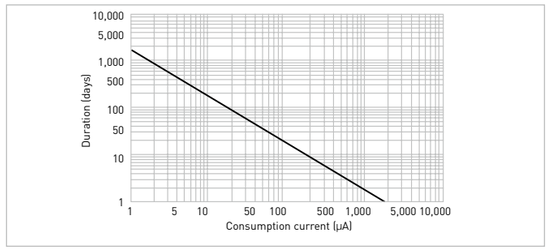
ML-2020/V1AN

Model number	ML-2020
Nominal voltage (V)	3
Nominal capacity (mAh)	45.0
Diameter (mm)	20.0
Total height (mm)	2.0
Discharging temperature range (°C)	-20 to +60
Weight (g)	2.2

DISCHARGE CHARACTERISTICS



CONSUMPTION CURRENT VS. DURATION TIME



TITANIUM RECHARGEABLE LITHIUM BATTERIES (MT SERIES) – COIN TYPE RECHARGEABLE LITHIUM BATTERIES

These coin type Manganese Titanium Rechargeable 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.

FEATURES

- Rechargeable Lithium technology
- Superior long-term reliability
- Years of experience in production
- 500 charge-discharge cycles up to 1V or discharge limit voltage (at 100% depth of discharge)

APPLICATIONS

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

Model number	Electrical characteristics at 20°C		Dimensions with tube (mm)		Approx. weight (g)	IEC
	Nominal voltage (V)	Nominal*1 capacity (mAh)	Diameter	Total height		
MT-516	1.5	1.8	5.8	1.6	0.2	–
MT-621	1.5	2.5	6.8	2.1	0.3	–
MT-920	1.5	5.0	9.5	2.0	0.5	–

*1 Based on standard drain and cut off voltage down to 2.0V at 20°C.

CHARGING

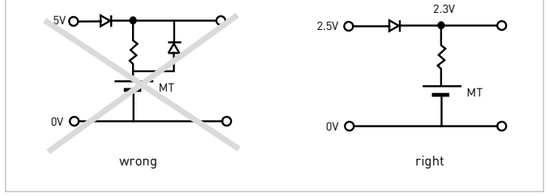
Charging circuits

Charging/discharging cycle	Approx. 500 times at 100% discharge depth to nominal capacity
Charging system*[1]	Constant-voltage charging. (Please strictly adhere to the specified charge voltage)
Operating temperature	-10°C to +60°C

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 constant current 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 1.8V to 2.6V at the temperature of -10°C to +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 3V, corrosion of the ⊕ terminal (case) may occur, causing leakage.
- 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: 1.8 to 2.6V (Standard voltage: 2.2V)

Charge current: For a battery voltage of 2.3V

MT-516 Approx. 0.36mA or below

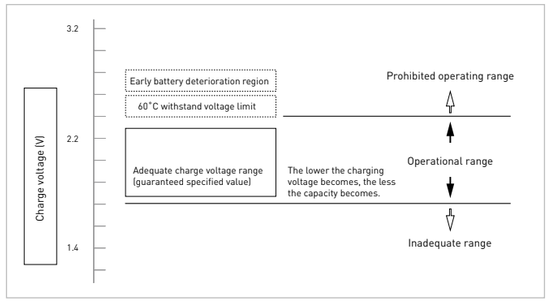
MT-621 Approx. 0.5mA or below

MT-920 Approx. 1.0mA 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.

Influence of the charge voltage on MT batteries

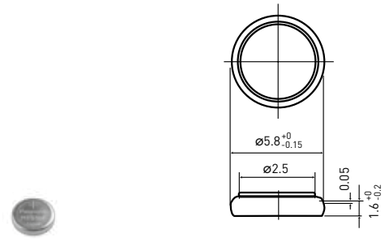


If the charge voltage goes beyond its adequate range, battery performance may deteriorate early. Be sure to observe the guaranteed charge voltage.

*[1] Consult with Panasonic concerning constant-current charging systems.

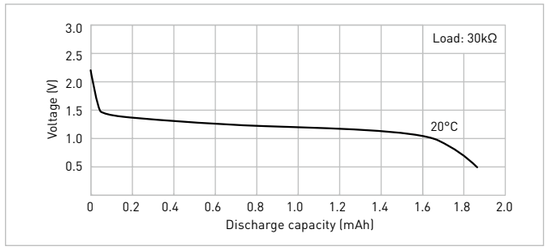
MT-516

DIMENSIONS (MM)

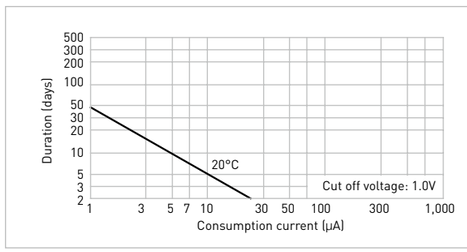


Model number	MT-516
Nominal voltage (V)	1.5
Nominal capacity (mAh)	1.8
Diameter (mm)	5.8
Total height (mm)	1.6
Discharging temperature range (°C)	-10 to +60
Weight (g)	0.2

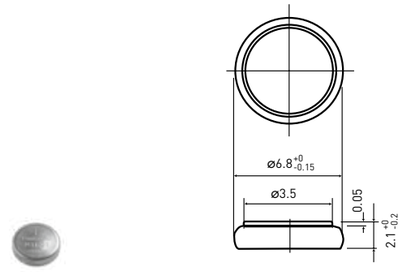
DISCHARGE CHARACTERISTICS



CONSUMPTION CURRENT VS. DURATION TIME

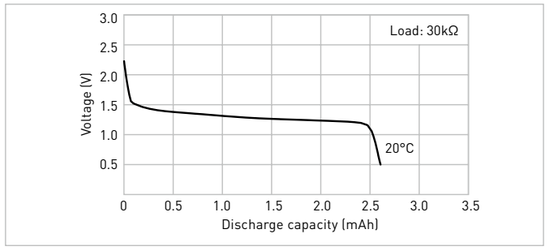


MT-621

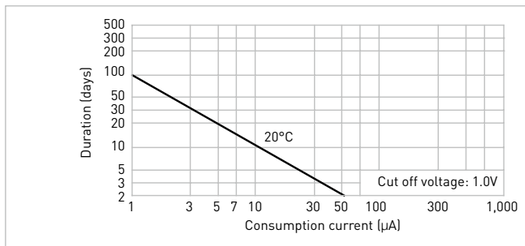


Model number	MT-621
Nominal voltage (V)	1.5
Nominal capacity (mAh)	2.5
Diameter (mm)	6.8
Total height (mm)	2.1
Discharging temperature range (°C)	-10 to +60
Weight (g)	0.3

DISCHARGE CHARACTERISTICS

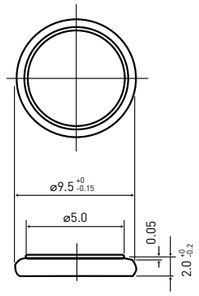


CONSUMPTION CURRENT VS. DURATION TIME



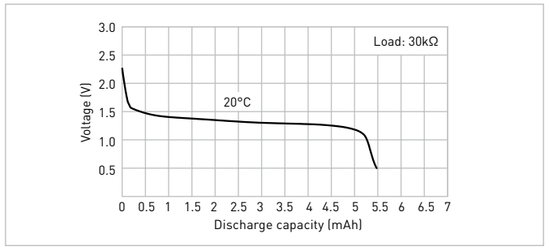
MT-920

DIMENSIONS (MM)

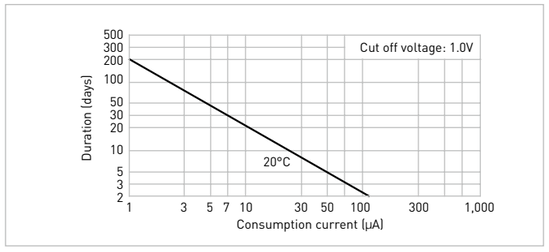


Model number	MT-920
Nominal voltage (V)	1.5
Nominal capacity (mAh)	5.0
Diameter (mm)	9.5
Total height (mm)	2.0
Discharging temperature range (°C)	-10 to +60
Weight (g)	0.5

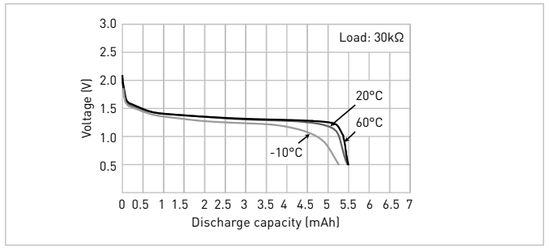
DISCHARGE CHARACTERISTICS



CONSUMPTION CURRENT VS. DURATION TIME



DISCHARGE TEMPERATURE CHARACTERISTICS



LONG-STANDING EXPERIENCE IN HIGH QUALITY WELDING AND SOLDERING METHODS

Due to Panasonic´s long experience in quality welding and soldering methods, our customers can always expect the best terminal solution for their application. Our comprehensive line-up of different terminal types covers nearly every requirement – and custom-made solutions are possible as well.

BATTERY TERMINALS

Terminal welding

For terminal welding on the battery, it is quite important to establish the best welding method and its best conditions in order to keep the strong weld strength without any damages on the battery performances. Panasonic mainly use the Laser welding method which is applicable to attach terminals on even quite small batteries that the spot welding hardly to do for. Therefore, our products can correspond exactly and flexibly to various applications. Also, we have established our own high reliable welding capability with a lot of amount of testing data to search the best weld condition for each various combinations of various battery sizes and terminal shapes, which can be provided for widespread equipments and devices.

Soldering on PCB

On the edge of all terminal, Tin plating is applied for increasing the reliability of soldering instead of the solder plate in order to consider influences on environments.

Complete Line-up

Panasonic offers a full range of batteries with terminals for various PCB mounting. Since the terminals come in a variety types, please contact Panasonic for further details. On the other hand, we also provide battery holders for some limited sizes.

SOLDERING LITHIUM BATTERIES

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. (Heat resistance BR type is 125°C)

Automatic dip-soldering bath

Soldering with a dip-soldering bath can be used by condition but do not allow the temperature of the battery bodies 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

Solder dipping bath temperature	Not exceed 260°C
Dipping duration	Within 5 sec.
Number of dipping	Within 2 times

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.'

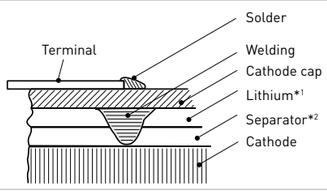
↓

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



The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

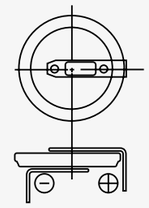
*1 Metal whose melting point is about 180°C

*2 Non woven cloth of polypropylene whose melting point is about 165°C

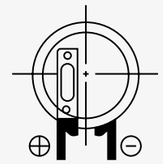
TERMINAL TYPES

Panasonic offers a broad range of different tabs for our Lithium batteries in order to meet all customer needs. In addition tailormade solutions are possible as well.

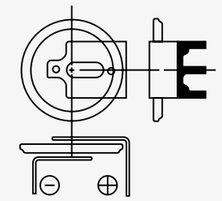
H TYPE



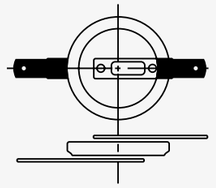
V TYPE



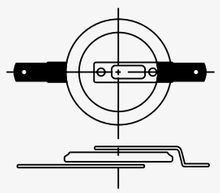
G TYPE



T TYPE

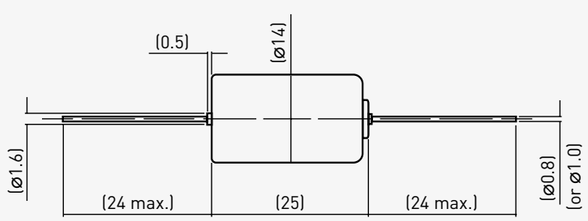


F TYPE



S TYPE

BR-1/2A With axial pin terminal



( ) : Reference dimension (unit: mm)

The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

PRODUCT CERTIFICATIONS

UL approved batteries

All our Lithium batteries are in compliance with UL 1642 (primary and secondary lithium batteries) - file number MH 12210. These requirements cover lithium batteries intended for use in technician-replaceable or user-replaceable applications.

FACTORY CERTIFICATIONS

All our production sites are ISO 9001 und ISO 14001 certified. Moriguchi, Japan and Jakarta, Indonesia sites are additionally certified towards TS 16949. Moriguchi, Japan is also certified according to OHSAS 18001.

APPLICABLE STANDARDS

IEC 60086-1

Standardization of primary batteries with respect to their electrochemical system, dimensions, nomenclature, terminal configurations, markings, test methods, typical performance, safety and environmental aspects.

Applicable products in this catalogue: BR-2/3A (BR17335), BR-2/3AG (BR17335), CR-2 (CR15H270), CR-123A (CR17345), 2CR-5 (2CR5), CR-P2 (CRP2), BR-1225 (BR1225), BR-2325 (BR2325), CR-1025 (CR1025), CR-1216 (CR1216), CR-1220 (CR1220), CR-1616 (CR-1616), CR-1620 (CR1620), CR-2012 (CR2012), CR-2016 (CR2016), CR-2025 (CR2025), CR-2032 (CR2032), CR-2330 (CR2330), CR-2354 (CR2354), CR-2450 (CR2450), CR-3032 (CR3032)

IEC 60086-2

Complements the general information and requirements of IEC 60086-1.

IEC 60086-3

Specifies dimensions, designation, methods of tests and requirements for primary batteries for watches.

Applicable products in this catalogue:

BR-1225 (BR1225), BR-2325 (BR2325), CR-1025 (CR1025), CR-1216 (CR1216), CR-1220 (CR1220), CR-1616 (CR-1616), CR-1620 (CR1620), CR-2012 (CR2012), CR-2016 (CR2016), CR-2025 (CR2025), CR-2032 (CR2032), CR-2330 (CR2330), CR-2354 (CR2354), CR-2450 (CR2450)

IEC 60086-4

Requirements for primary lithium batteries to ensure their safe operation under intended use and reasonably foreseeable misuse.

Applicable products in this catalogue: BR, CR

LITHIUM BATTERY TRANSPORTATION

The transportation of lithium batteries is regulated by the International Air Transport Association (IATA), the International Civil Aviation Organization (ICAO) and Accord européen relatif au transport international des marchandises Dangereuses par Route (ADR).

All batteries are approved in accordance to UN Spezial Provision SP 188 Manual of Tests & Criteria Part III Subsection 38.3.

Transport test related to UN 38.3 Revision 5 Amendment 2 reports are available on request.

Transport by road/rail

UN 3090 takes place under ADR/RID 2015.

Transport by sea

UN 3090 takes place under IMDG Code 2014.

Transport by air

UN 3090 takes place under IATA DGR 2015 56th Edition.

SECURITY EXPORT CONTROL

'Security export control' entails observing the legislation provided to maintain international peace and safety by preventing the proliferation of weapons of massive 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. Later, as part of a new export control regime, Russia and Eastern European countries joined with the previously affiliated nations of COCOM (Japan, America and Europe) and established the Wassenaar Arrangement for dual-use goods & technologies related to conventional weapons. According to the Export Trade Control Order revised by the Japanese Ministry of Economy, Trade & Industry in May 2008, batteries listed in this catalog are classified as 'batteries' not 'cells', and will therefore not be controlled by (7) in annex Table 1 to the Order. The above notwithstanding, these batteries may be subject to the regulations depending on their ultimate destination, application and other conditions. When a certificate of classification is required for exportation, etc. or if you have any queries, contact a Panasonic sales representative.

AVOIDING HAZARDS

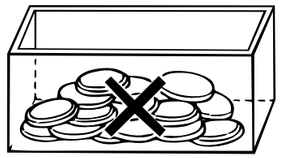
Case Study and Explanation

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.

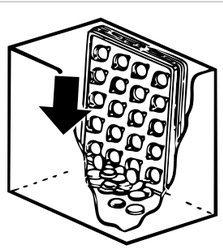
Case study: Ignition of batteries stacked together



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.

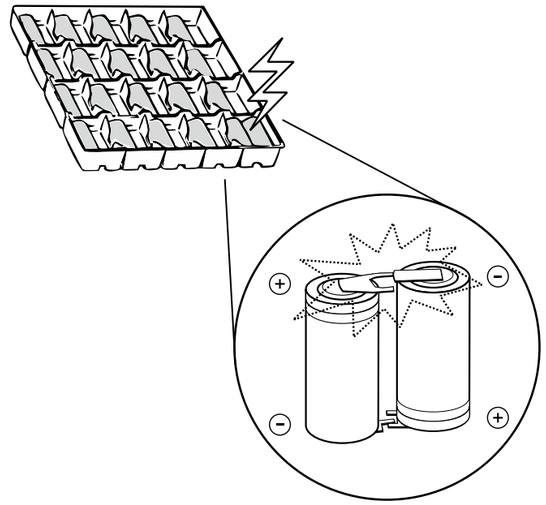
Case study: Bursting of batteries stacked on top of one another



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. 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 tubes to burst.

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



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.

PREVENTING QUALITY PROBLEMS

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 back-up 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 103 to 106Ω/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.

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.

Fig. 1 A terminal-mounted battery was inserted into a conductive mat. The battery charge was exhausted in several days.

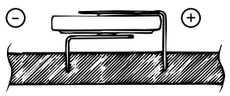


Fig. 2 Battery-mounted PC boards were inadvertently brought into contact with spacers and a conductive rubber sheet. The battery charge was exhausted.

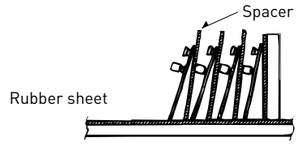


Fig. 3 A battery-mounted PC board was inadvertently brought into contact with a conductive resin case. The battery charge was exhausted.

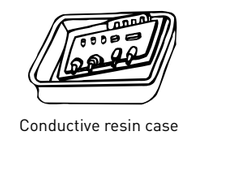
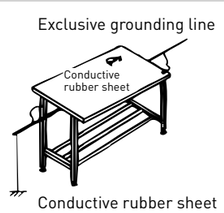


Fig. 4 A battery was placed directly on a rubber sheet spread over a worktable. The ⊕ and ⊖ terminals were in contact with the sheet and the battery charge was exhausted.



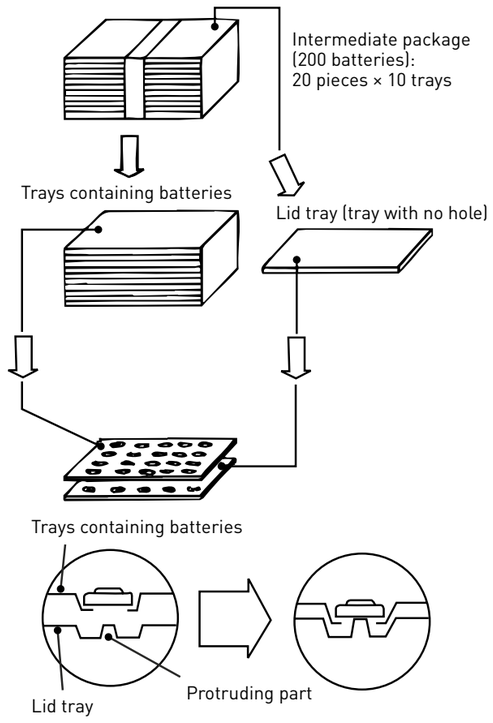
(2) Reduction of battery voltage and deterioration of capacity through contact between batteries

Incidents have been reported where terminal-mounted batteries for memory back-up 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

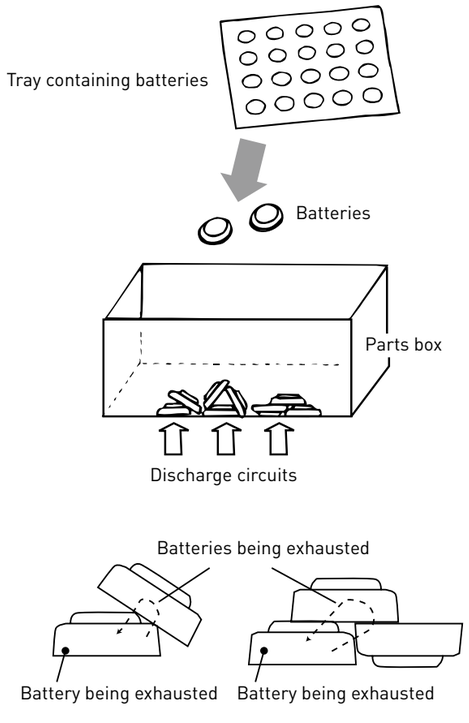
Utilize the tray lid in taking out batteries



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 back-up 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 CR-2032 and BR-2032, 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 1,000gf). (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 samples see Fig. 1-6

Fig. 1 Soldering

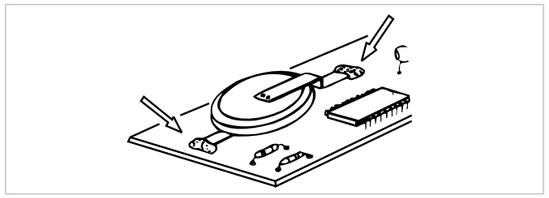


Fig. 2

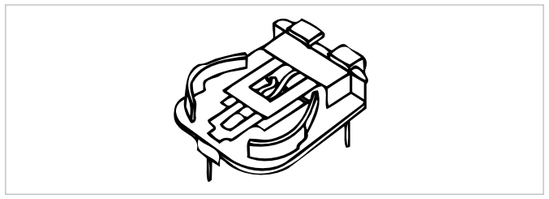


Fig. 3

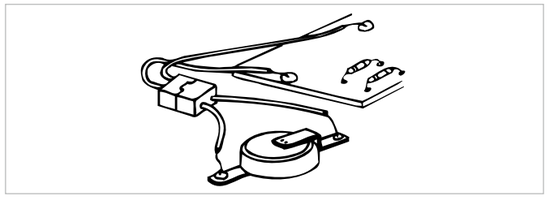


Fig. 4

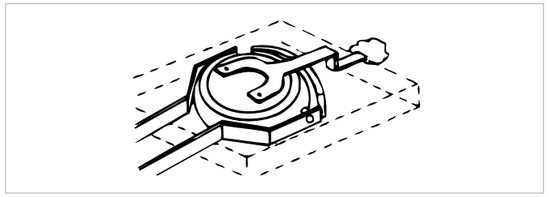


Fig. 5 Excessive load

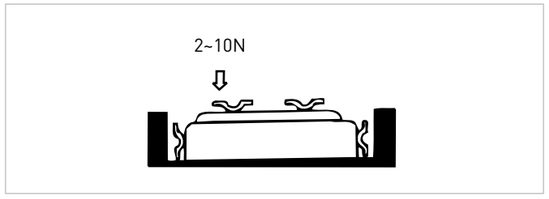
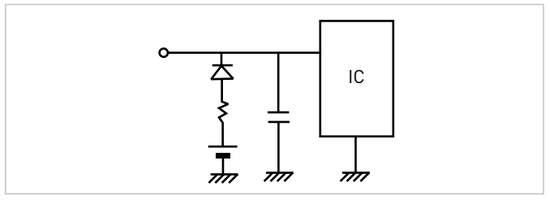


Fig. 6



Panasonic

ideas for life

Li-ion

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.

Lithium Ion Batteries

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Please see latest information at our web site
http://industrial.panasonic.com/jp/

※The contents of this handbook are subject to change without notice due to improvements.

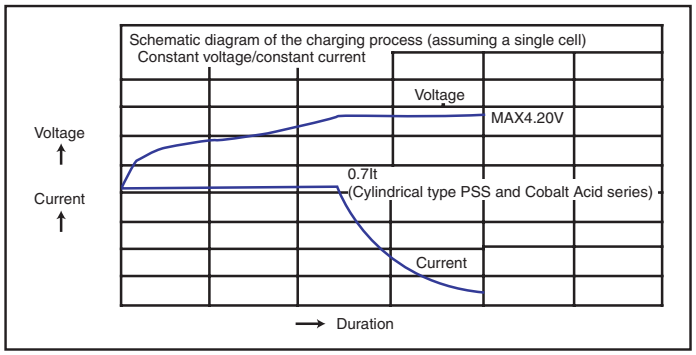
Notes and Precautions

• Safety Precautions for the Lithium Ion Batteries use and Designing Equipment.

In general, lithium ion batteries are used in battery-packs that contain both lithium ion batteries and battery safety circuits. Both items are sealed in a container made of a material such as resin so that the battery-pack cannot be easily disassembled.

1. Charging the Batteries

The “constant voltage/constant current ” method is used to charge lithium ion batteries. (See Figure below)



∗ It(A)=rated capacity(Ah)/1(h)

(1) Charge Voltage

The maximum voltage is 4.2 V x the number of cells connected in series.

(2) Charge Current

We recommend the following current.

NNP series Cylindrical type : 0.3 It , Prismatic type : 0.7 It

PSS and Cobalt acid series Cylindrical type : 0.7 It , Prismatic type : 1.0 It (or 0.7 It for certain models)

When the voltage per cell is 2.9V or less, charge using a charge current of 0.1It or less.

(contact Panasonic for information regarding pulse charging.)

(3) Charge Temperature

The batteries should be charged at temperatures between 0°C and 45°C.

(4) Reverse-polarity Charging

Verify the polarity of the batteries before charging to insure that they are never charged with the polarity reversed.

2. Discharging the Batteries

(1) Discharge Current

The current should be maintained at 1.0 It or less (contact Panasonic if you plan to discharge the batteries with a current in excess of 1.0 It).

(2) Discharge Temperature

The batteries should be discharged at a temperature between -10°C and +60°C.

(contact Panasonic if you plan to discharge the batteries at temperatures less than -10°C.)

(3) Discharge Termination Voltage

NNP series 2.5V per cel

PSS and Cobalt acid series 3.0V per cel

Avoid discharging at voltages less than these.

Overdischarge can damage the performance of the battery. Equip the unit with a mechanism to prevent overdischarge, especially in situations where the user may forget to turn the equipment off.

3. Equipment Design

(1) Installing Battery-Packs in the Equipment
To avoid damage to the battery-pack, make sure that the battery-pack is positioned away from heat sources in the equipment or in the battery charger.

(2) Mechanisms to Prevent Dropping
Be sure to use a battery-pack lock mechanism to prevent the battery-pack from being ejected when the equipment is dropped or receives a sudden impact.

(3) Preventing Short Circuits and Reversed Connections
Use a terminal structure that makes it unlikely that the terminals will be shorted by metallic necklaces, clips, hairpins, etc. Structure the battery and the terminals to the battery in such a way that the battery-pack cannot be put in backwards when installed in the charger or the equipment.

(4) Inclusion in Other Equipment
If the battery is built into other equipment, use caution to strictly avoid designing airtight battery compartments.

(5) Terminal Materials in the External Equipment
Use materials that are highly resistant to corrosion (such as nickel or nickel-coated copper). If contact resistance is an issue, we recommend that you use contact plating (such as gold plating) on the terminals.

4. Storing the Batteries

The batteries should be stored at room temperature, charged to about 30 to 50% of capacity.
We recommend that batteries be charged about once per year to prevent overdischarge.

5. Use of the Batteries

See the section on “Safety Precautions”

6. Other

(1) The Chemical Reaction
Because batteries utilize a chemical reaction they are actually considered a chemical product. As such, battery performance will deteriorate over time even if stored for a long period of time without being used. In addition, if the various usage conditions such as charge, discharge, ambient temperature, etc. are not maintained within the specified ranges the life expectancy of the battery may be shortened or the device in which the battery is used may be damaged by electrolyte leakage. If the batteries cannot maintain a charge for long periods of time, even when they are charged correctly, this may indicate it is time to change the battery.

(2) When exporting the batteries, they are likely to undergo the judgment on classification of strategic products according to the Export Trade Control Ordinance Please contact Panasonic.

7. Please Note

The performance and life expectancy of batteries depends heavily on how the batteries are used. In order to insure safety, be sure to consult with Panasonic in advance regarding battery charging and discharging specifications and equipment structures when designing equipment that includes these batteries.

Panasonic assumes no liability for problems that occur when the Notes and Precautions for use listed above are not followed.

Safety Precautions

1. When Using the Battery

⚠ DANGER

(1) Misusing the battery may cause the battery to get hot, explode, or ignite and cause serious injury. Be sure to follow the safety rules listed below:
- Do not place the battery in fire or heat the battery.
- Do not install the battery backwards so that the polarity is reversed.
- Do not connect the positive terminal and the negative terminal of the battery to each other with any metal object (such as wire).
- Do not carry or store the batteries together with necklaces, hairpins, or other metal objects.
- Do not penetrate the battery with nails, strike the battery with a hammer, step on the battery, or otherwise subject it to strong impacts or shocks.
- Do not solder directly onto the battery.
- Do not expose the battery to water or salt water, or allow the battery to get wet.

(2) Do not disassemble or modify the battery. The battery contains safety and protection devices which, if damaged, may cause the battery to generate heat, explode or ignite.

(3) Do not place the battery on or near fires, stoves, or other high-temperature locations. Do not place the battery in direct sunshine, or use or store the battery inside cars in hot weather. Doing so may cause the battery to generate heat, explode, or ignite. Using the battery in this manner may also result in a loss of performance and a shortened life expectancy.

(4) Do not insert the battery into equipment designed to be hermetically sealed. In some cases hydrogen or oxygen may be discharged from the cell which may result in rupture, fire or explosion.

⚠ WARNING

(1) Immediately discontinue use of the battery if, while using, charging, or storing the battery, the battery emits an unusual smell, feels hot, changes color, changes shape, or appears abnormal in any other way. Contact your sales location or Panasonic if any of these problems are observed.

(2) Do not place the batteries in microwave ovens, high-pressure containers, or on induction cookware.

(3) In the event that the battery leaks and the fluid gets into one's eye, do not rub the eye. Rinse well with water and immediately seek medical care. If left untreated the battery fluid could cause damage to the eye.

⚠ CAUTION

(1) If the device is to be used by small children, the caregiver should explain the contents of the user's manual to the children. The caregiver should provide adequate supervision to insure that the device is being used as explained in the user's manual.

(2) When the battery is worn out, insulate the terminals with adhesive tape or similar materials before disposal.

⚠DANGER

Be sure to follow the rules listed below while charging the battery. Failure to do so may cause the battery to become hot, explode, or ignite and cause serious injury.

· When charging the battery, either use a specified battery charger or otherwise insure that the battery charging conditions specified by Panasonic are met.
· Do not attach the batteries to a power supply plug or directly to a car's cigarette lighter.
· Do not place the batteries in or near fire, or into direct sunlight. When the battery becomes hot, the built-in safety equipment is activated,preventing the battery from charging further, and heating the battery can destroy the safety equipment and can cause additional heating, breaking, or ignition of the battery.

⚠WARNING

Do not continue charging the battery if it does not recharge within the specified charging time. Doing so may cause the battery to become hot, explode, or ignite.

2. While Charging

⚠ CAUTION

The temperature range over which the battery can be charged is 0°C to 45°C. Charging the battery at temperatures outside of this range may cause the battery to become hot or to break. Charging the battery outside of this temperature range may also harm the performance of the battery or reduce the battery's life expectancy.

3. When Discharging the Battery

⚠DANGER

Do not discharge the battery using any device except for the specified device. When the battery is used in devices aside from the specified device it may damage the performance of the battery or reduce its life expectancy, and if the device causes an abnormal current to flow, it may cause the battery to become hot, explode, or ignite and cause serious injury.

⚠ CAUTION

The temperature range over which the battery can be discharged is -10°C to 60°C. Use of the battery outside of this temperature range may damage the performance of the battery or may reduce its life expectancy.

To insure the safe use of this battery, contact Panasonic when designing a device that uses this battery.

Overview

∗A Lithium ion battery must include a safety unit(SU). Also for safety reasons cells are not sold individually.

Dedicated to support various types of mobile equipment with its high-energy density

Lithium Ion Batteries

■ Overview

The battery is a rechargeable battery best suited to mobile devices that require small-size, light weight and high performance. Its characteristics of high energy and high voltage (3.6V) powerfully fulfill these three key requirements. Its standard battery-pack, coupled with a charger, facilitates simple equipment design.

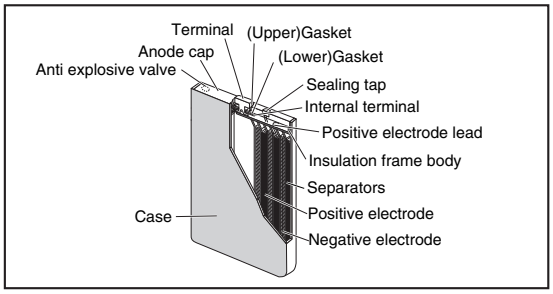
■ Characteristics

1. Less self-discharge (approx. 1/10) compared with a Ni-MH or Ni-Cd batteries as well as no memory effect.
2. A newly developed NNP∗ series is achieving both high capacity & safety by the use of new positive electrode & high reliable technology by the present charging system (4.2V)
   ∗NNP = Nickel oxide based New Platform
3. The PSS∗ series adopts nickel and the manganese in new positive elecrode. The safety of a battery to heat improved further.
   ∗PSS = Panasonic Solid Solution

■ Structure

A lithium-ion rechargeable battery consists of a spiral structure with 4 layers. A positive electrode activated by cobalt acid lithium, a negative electrode activated by special carbon, and separator are put together in a whirl pattern and stored in the case. It also incorporates a variety of safety protection systems such as a gas discharge valve which helps prevent the battery from exploding by releasing internal gas pressure if it exceeds the design limit.

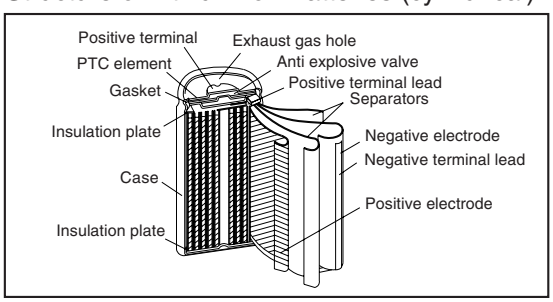
Structure of Lithium Ion Batteries (prismatic)



■ Safety

Our lithium ion batteries have acquired UL1642. Contact us for further details.

Structure of Lithium Ion Batteries (cylindrical)



■ Applications

Cellular phone, Note PC etc.
DVC/DSC/DVD/Portable LCD TV etc.
Portable CD player, MD player,Semiconductor-driven audio etc.

• Battery Reaction

The lithium ion battery makes use of lithium cobalt oxide (which has superior cycling properties at high voltages) as the positive electrode and a highly-crystallized specialty carbon as the negative electrode. It uses an organic solvent, optimized for the specialty carbon, as the electrolytic fluid.

The chemical reactions for charge and discharge are as shown below:

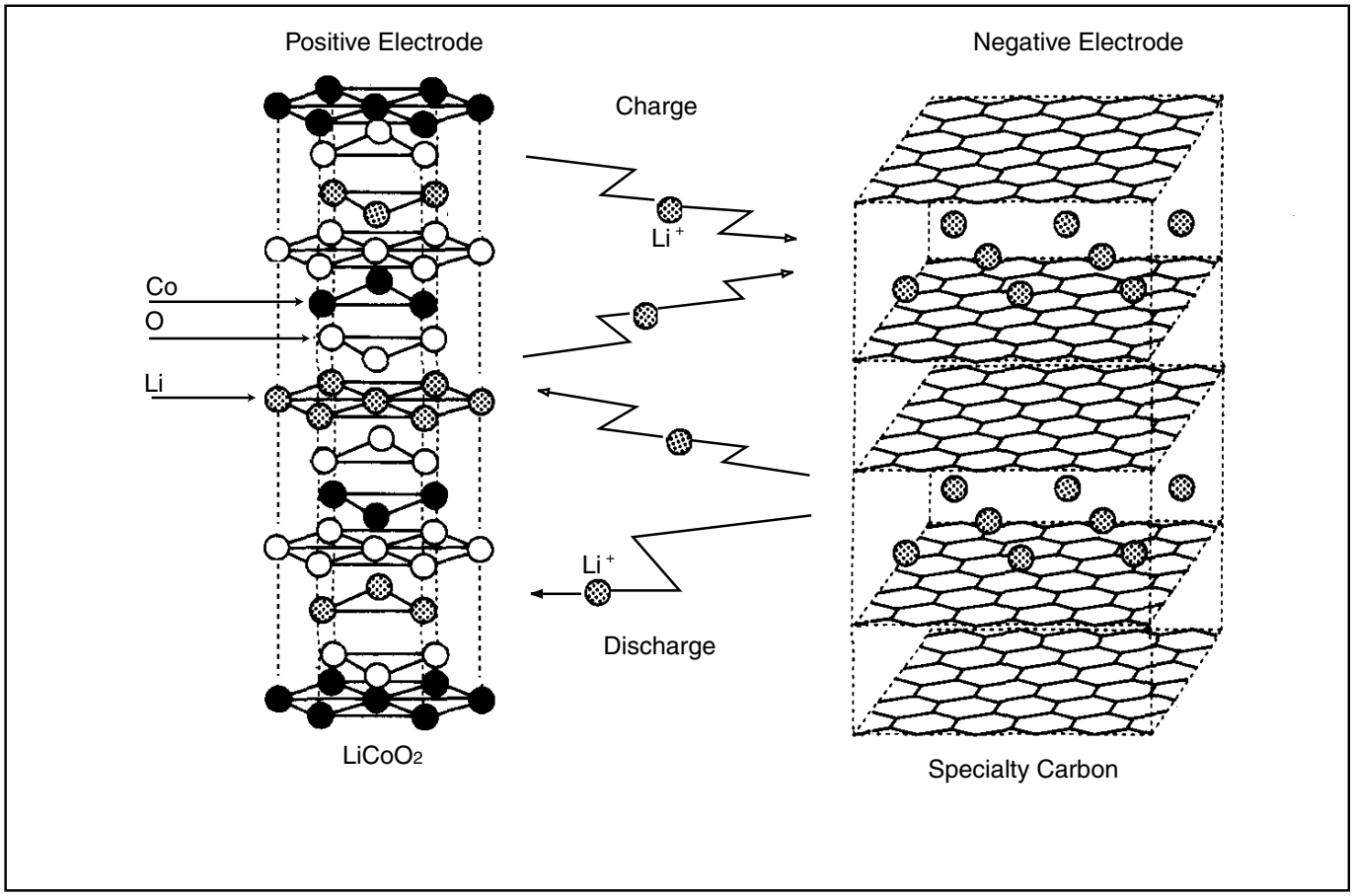
Positive Electrode $LiCoO_2 \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftharpoons}} Li_{1-x}\ CoO_2 + xLi^+ + xe^-$

Negative Electrode $C + xLi^+ + xe^- \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftharpoons}} CLix$

Battery as a Whole $LiCoO_2 + C \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftharpoons}} Li_{1-x}\ CoO_2 + CLix$

The principle behind the chemical reaction in the lithium ion battery is one where the lithium in the positive electrode lithium cobalt oxide material is ionized during charge, and moves from layer to layer in the negative electrode. During discharge, the ions move to the positive electrode and return to the original compound.

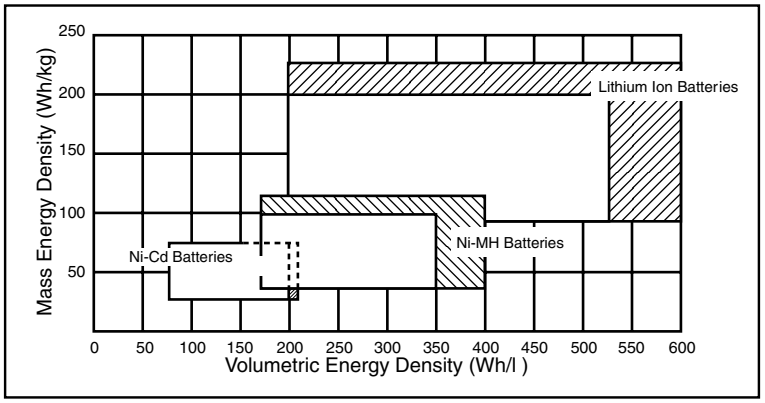
Schematic Diagram of the Chemical Reaction of the Lithium Ion Battery



Features

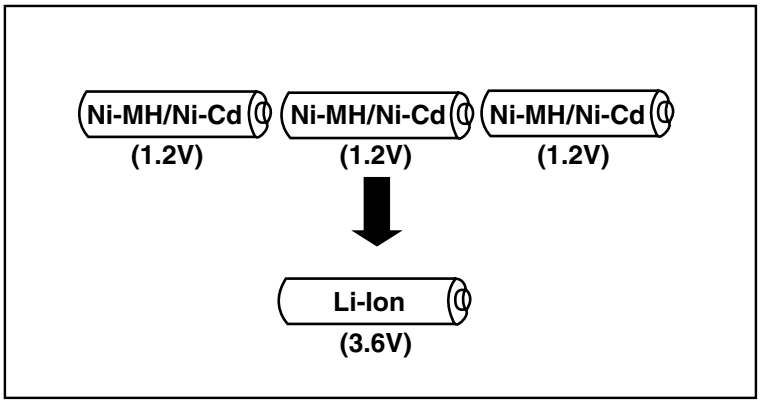
• High Energy Density

Because the lithium ion batteries are high voltage/light weight batteries, they boast a higher energy density than nickel metal hydride (Ni-MH) batteries or nickel cadmium (Ni-Cd) batteries.



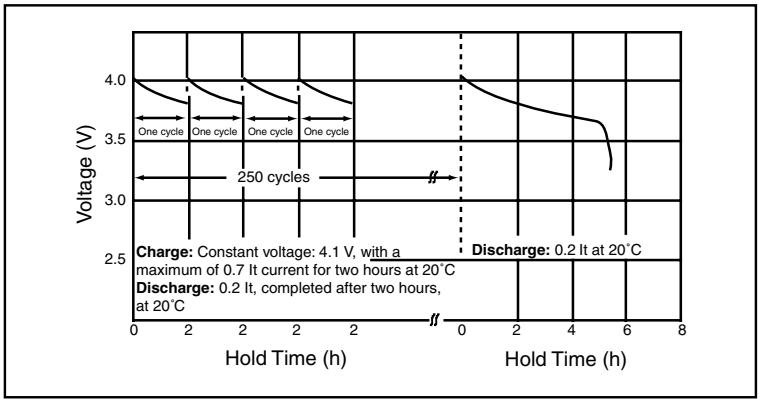
• High Voltage

Lithium ion batteries produce 3.6 volts, approximately three times the voltage of Ni-MH batteries or Ni-Cd batteries.
This will make it possible to make smaller, lighter equipment.



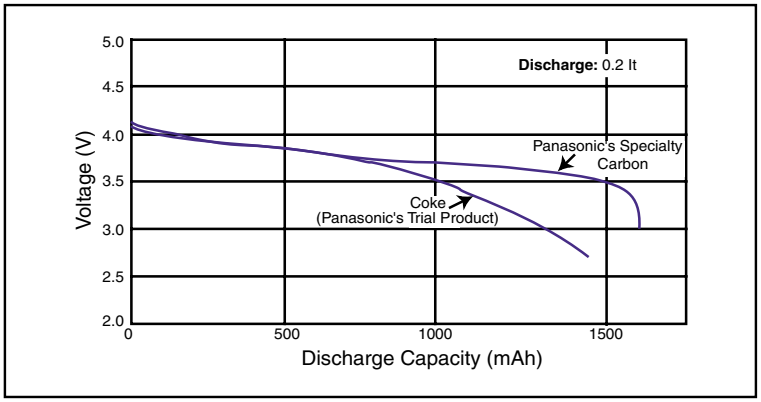
• No Memory Effect

Lithium ion batteries have none of the memory effects seen in Ni-Cd batteries
(“memory effect” refers to the phenomenon where the apparent discharge capacity of a battery is reduced when it is repetitively discharged incompletely and then recharged).



• Flat Discharge Voltage

The use of the specialty carbon creates an extremely flat discharge voltage profile, allowing the production of stable power throughout the discharge period of the battery.



*The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

Overcharge/Overdischarge/Overcurrent Safety Circuits

• The Functions of the Safety Circuits (typical functions)

The voltages listed below are typical values and are not guaranteed. The charge voltage varies according to model number.

1. The Overcharge Safety Function

The charge stops when the voltage per cell rises above 4.30 ± 0.05 V.
The charge restarts when the voltage per cell falls below 4.10 ± 0.05 V.

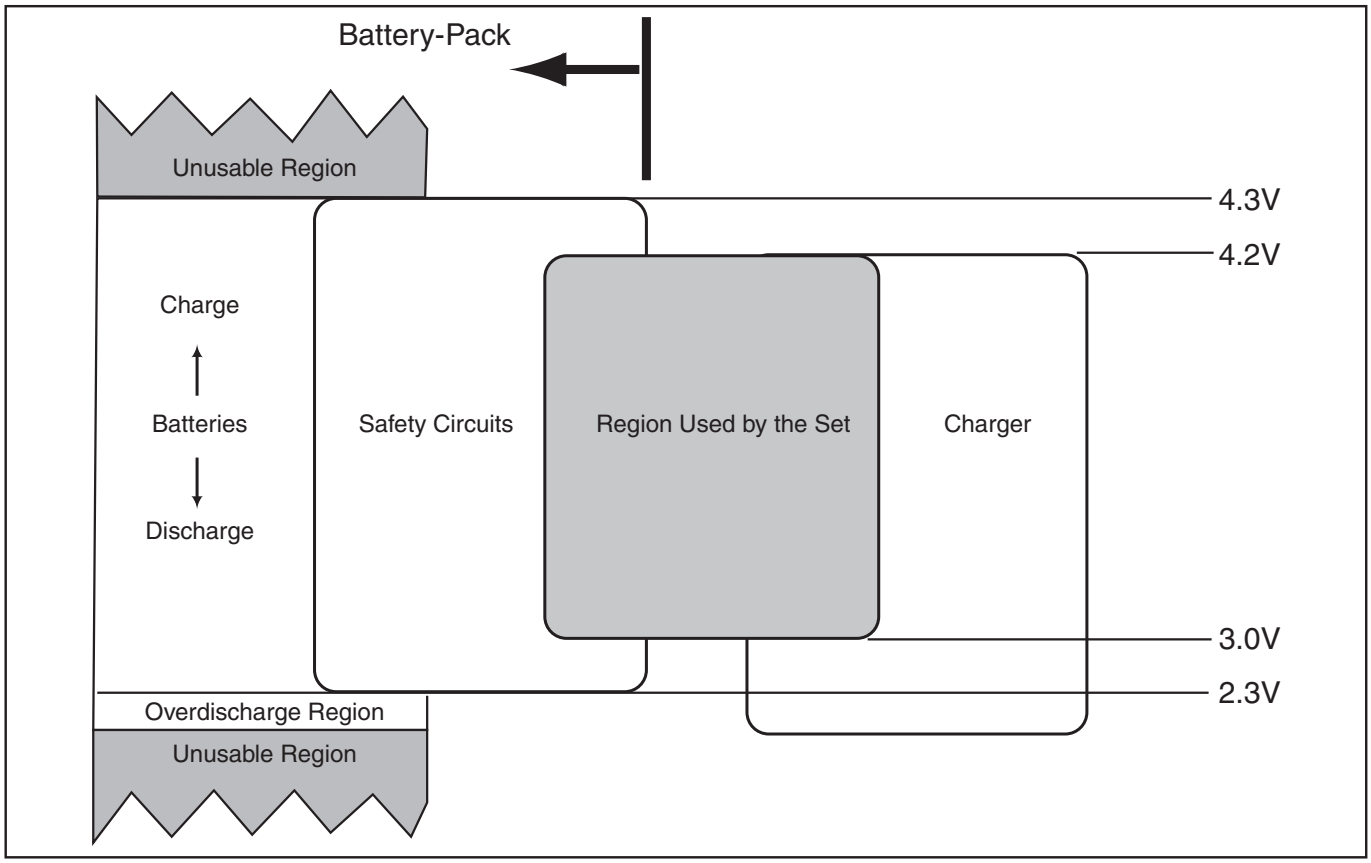
2. The Overdischarge Safety Function

The discharge stops when the voltage per cell falls below 2.3 ± 0.1 V.
The discharge restarts when the voltage per cell rises above 3.0 ± 0.1 V.
Contact Panasonic for infomation regarding NNP series.

3. The Overcurrent Safety Function

The discharge is stopped when the output terminals are shorted.
The discharge restarts when the short is removed.

• Reference Example of the Safety Circuits for PSS and Cobalt Acid Series



- The safety circuits in the diagram above are for overcharging, overdischarging, and overcurrent for a single cell battery-pack. Please consult Panasonic when two or more cells are connected or when actually using this or other circuits.

- **Battery-Pack Block Diagram (Reference Example)**

The diagram below shows a diagram of a lithium ion battery-pack. The battery-pack includes the batteries, the safety circuits, and thermistors.

1. The Safety Circuits

(1) The Controller IC

The controller IC measures the voltage for each cell (or for each parallel battery block) and shuts off a control switch to either prevent overcharging (if the voltage exceeds the specified voltage range) or to prevent overdischarging (if the voltage falls below the specified voltage range). Moreover, the voltage of the control switch is measured on both ends and in order to prevent overcurrent, control switches are shut off if the voltage exceeds specifications.

(2) The Control Switches

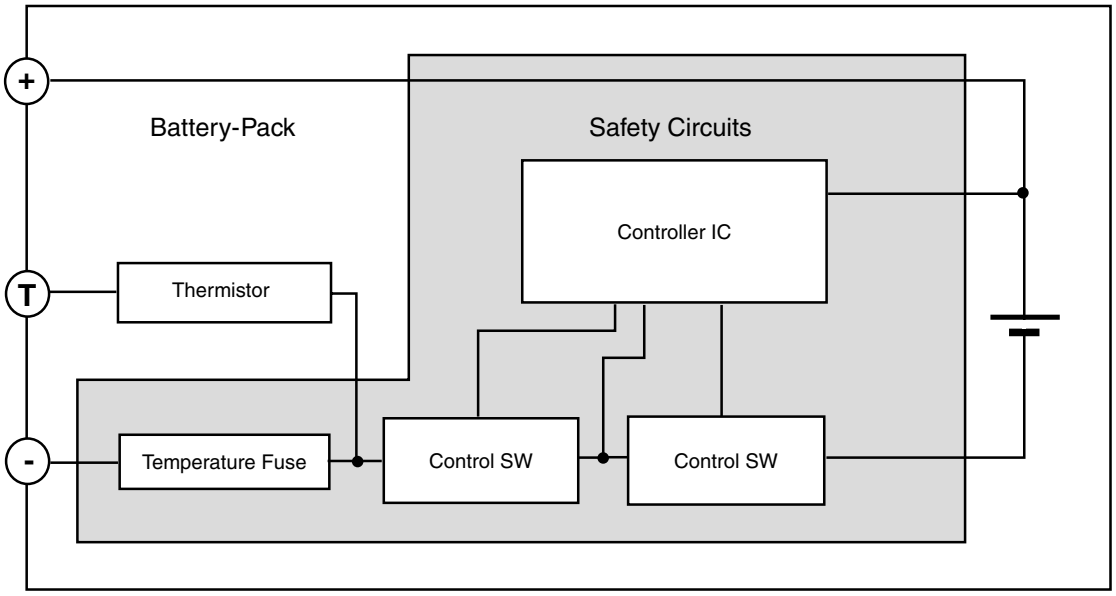
The control switches usually comprise FET structures, and they turn off the charge or discharge depending on the output of the controller IC.

(3) The Temperature Fuse (Reference Materials)

If the control switches experience abnormal heating, this fuse cuts off the current (non-restoring).

2. The Thermistors

The thermistors are included in order to accurately measure the battery temperature within the lithium ion battery-packs. The battery or charger measures the resistance value of the thermistor between the T-terminal and the negative terminal and during the charging process, controls the charge current along with controlling until the charge is terminated.



- The battery-pack must be equipped with a noise filter at the voltage detectors in the block diagram above to insure that outside noise does not cause the battery to malfunction. Please check against the final product
- Please include a total charge timer and a charge completion timer on the charging circuit in order to provide redundant safety control.

How to Charge the Batteries

We recommend the following charging process to insure the optimal performance of the lithium ion battery.

• Applicable Battery-Packs

The discussion below assumes that the battery-packs are equipped with internal safety circuits to prevent overcharging and overdischarging, and assumes that the battery is a single cell battery.

• Charging Method

The lithium ion battery can be charged by the constant voltage/constant current charging method found in the "Notes and Precautions" at the beginning of this document. (See page 22, "Notes and Precautions")

• Functions and Performance Required in the Charger (Recommendations)

(1) Charge Voltage
The voltage between the charging terminals should be no more than 4.20 V (Set this at 4.20 V (max) after taking into account fluctuations in power supply voltages, temperature deviations, etc.).

(2) Charge Current
Please refer to the following change current standards by series.

NNP series	Cylindrical type : 0.3 It , Prismatic type : 0.7 It.
PSS and Cobalt acid series	Cylindrical type : 0.7 It , Prismatic type : 1.0 It. (or 0.7 It for certain models)

(3) Ambient Temperature of the Battery-Pack During Charge
0°C to 45°C (Consult Panasonic if the battery-pack is to be used outside of this temperature range).

(4) Low-Voltage Battery-Pack Charge
When the voltage per cell is 2.9 V or less, charge using a charge current of 0.1 It or less.

(5) Termination of Charging
The system will determine that the battery is full by detecting the charge current.
Stop charging once the current has reached 0.1 It to 0.07 It. Note that there will be some degree of variation for each individual battery.

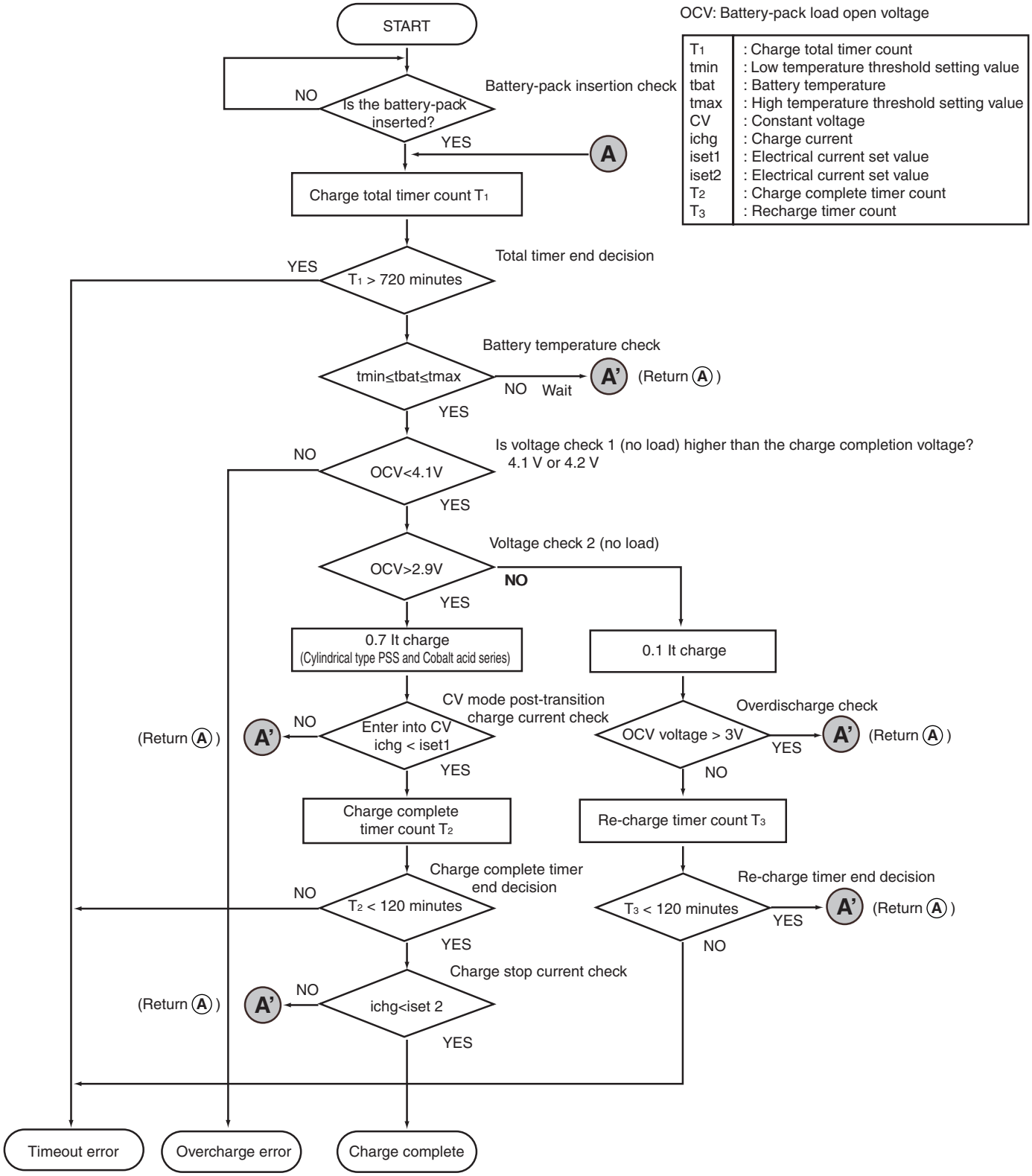
(6) Charge Timer
A total charge timer and a charge completion timer should be included.

(7) Countermeasures for Battery Problems
Select an overvoltage guard in the power supply so that there will be no excessive voltage applied to the battery even if there is a problem with the power supply.

- The discussion above assumes a single cell battery. If two or more cells will be used or if there are other situations, please consult with Panasonic.

Lithium Ion Battery-Pack Charge Flowchart (example)

Reference example of charging a single-cell lithium ion battery-pack



OCV: Battery-pack load open voltage

T_1	: Charge total timer count
tmin	: Low temperature threshold setting value
tbat	: Battery temperature
tmax	: High temperature threshold setting value
CV	: Constant voltage
ichg	: Charge current
iset1	: Electrical current set value
iset2	: Electrical current set value
T_2	: Charge complete timer count
T_3	: Recharge timer count

Battery-Pack Specification Checklist

Battery-Pack Specification Checklist

Fill in the blanks below to determine specifications when making inquiries or when ordering batteries.

1. Battery-Pack: General

1)	Schedule:	(1) Completion of design evaluation: Month:____ Year:____ (2) Completion of mass production evaluation: Month:____ Year:____ (3) Start of delivery: Month: ____ Year ____
2)	Number of units:	_____ k packs per month (Total volume: _____ k packs)
3)	Delivery Destination:	(1) Domestic (2) Overseas (Name of country: _____)
4)	Operating Temperature:	(1) Standard (where the standard is 0℃ to 45℃) (2) Custom (_____℃ to _____ ℃)
5)	Ambient Humidity:	(1) Standard (where standard is 45 to 85%, non-condensing) (2) Custom (_____ % to _____ %)
6)	Special Conditions for Use:	(1) No (2) Yes ((1) Automotive (2) Outdoors (3) Other (_____))
7)	Applicable Specifications:	(1) Electrical Appliance and Material Safety Law (2) UL (3) Other (_____)
8)	Applicable Recipient:	(1) Customer (2) Panasonic (3) Other (_____)
9)	Application:	(1) Portable telephone (2) AV equipment (_____) (3) Personal computer (4) Other (_____)
10)	FG (Fuel Gauge)	(1) Required (2) Not required (if required, fill in item 3)

2. Battery-Pack Basic Specifications

1)	Battery-Pack Configuration:	(1) Hard case (2) Soft pack (3) Other (_____)
2)	Battery-Pack Materials:	Specify (_____)
3)	Battery & Structure Used:	Please see P.33-34 (____ P x ____ S)
4)	Rated Capacity:	_____ mAh
5)	Charging Method:	(1) Fast (2) Standard (3) Other (_____)
6)	Charge Current:	_____A
7)	Charge Time:	_____ hours
8)	Discharge Ending Voltage:	_____ V
9)	Thermistor:	(1) Standard (Present/Absent) (Standard: 10 KΩ, 25℃) (2) Other (_____)
10)	Drop Strength:	(1) Present (_____ cm) (2) Absent
11)	Flame Retardants Requirements:	(1) Present (_____) (2) Absent
12)	Dimensions:	_____ width x _____ length x _____ height mm or less
13)	Weight:	_____ g or less
14)	Label:	(1) Not required (2) Required (Details of label specified elsewhere.)
15)	Terminal Configuration:	(_____)

3. Fuel Gauge Specifications

1)	Range of load currents:	(_____ mA to _____ mA)
2)	Load current waveform:	(1) Wave height _____ mA (2) Conductive period _____ mSec (3) Stop period _____ mSec
3)	Accuracy:	(1) ± 10% (2) ± 5% (3) Other (_____)
4)	Display method:	(1) LED (2) Communications (3) LED and communications (communications method _____)
5)	Mode change	(1) Not required (2) Required (Modes (suspend, etc.) (1) _____ (2) _____)
6)	Communications data:	(1) Remainder (2) Voltage (3) Current (4) Temperature (5) ID code (6) Other (_____)
7)	Charge function	(1) Not required (2) Required

Charger Specification Checklist

Charger Specification Checklist

Fill in the blanks below to determine specifications when making inquiries or when ordering.

1. General

1)	Start of Delivery:	Month:____ Year:____ Number of units: _____ per month (Total volume: _____ units)
2)	Delivery Destination:	(1) Domestic (2) Overseas (Name of country: _____)
3)	Operating Temperature:	(1) Standard (where standard is 0℃ to 45℃) (2) Custom (_____℃ to _____ ℃)
4)	Ambient Humidity:	(1) Standard (where standard is 45 to 85%, non-condensing) (2) Custom (_____ % to _____ %)
5)	Special Conditions for Use:	(1) No (2) Yes ((1) Automotive (2) Outdoors (3) Other (_____))
6)	Applicable Specifications:	(1) Electrical Appliance and Material Safety Law (2) UL (3) Other (_____)
7)	Applicable Recipient:	(1) Customer (2) Panasonic (3) Other (_____)
8)	Application:	(1) Portable telephone (2) AV equipment (_____) (3) Personal computer (4) Other (_____)

2. Basic Specifications

1)	Battery-Pack Compatibility:	Please see P.33-34 (___P x ___ S)
2)	Charging Method:	(1) Fast (2) Standard (3) Other (_____)
3)	Charge Current:	_____A (Consult Panasonic regarding charging conditions.)
4)	Charge Time:	_____ hours
5)	Charger Model:	(1) Pocket type (2) 1 Unit (3) 2 Units (4) Other (_____)
6)	Display LED:	No. of Units: _____
7)	Power Supply Voltage:	____ V/ ____Hz (Range of Fluctuation: ____ V to ____ V/ ____Hz to ____Hz)
8)	Drop strength:	_____ cm
9)	Dimensions:	_____ width x _____ length x _____ height mm or less
10)	Weight:	_____ g or less
11)	Label:	(1) Not required (2) Required (Details of label _____)

Glossary of Terminology

Term	meaning
Average Capacity	The amount of energy which can be obtained from a cell under set temperature, discharge current and cut-off voltage conditions. Measured in Ampere hours (Ah), or mAh.
Battery Life Characteristics	Characteristics shown according to the time needed for each charge / discharge cycle when cycling charge / discharge under set conditions. Also refered to as "cycle characteristics".
Capacity	A battery's electric potential. Usually means capacity in ampere hours, indicated by Ah or mAh.
Capacity Recovery Ratio	Ratio of the maximum capacity obtained from a cell under set conditions that has been stored for a fixed period of time and charged a fixed number of times, over average capacity (assumed value of 100).
Capacity Retention Ratio	Ratio of cell capacity measured under set conditions after storage for a fixed period of time, over average capacity (assumed value of 100).
Charge Capacity	Amount of energy used in charging a battery. For constant current charging, it is the product of current and chage time. Measured units called Ampere hours (Ah).
Cut-off voltage	Voltage which expresses the limit to end discharge.
Electrolyte Leakage	When electrolyte fluid from inside the battery leaks to the battery's outer surface.
Energy Density	The amount of energy which can be obtained from a single cell by weight or by volume. Measured in units of Wh / kg or Wh / l.
It	Represents "Current" and is defined as follows It(A)= Rated Capacity (Ah) / 1(h).
Large Current Discharge	Discharge with a relatively high current compared to the battery capacity. Also refered to as "high-rate" discharge.
Nominal Voltage	Voltage shown on the battery label.
Overcharge	Continued charging after the cell has reached a fully charged state. Overcharging a battery can adversery affect its safety and electrical characteristics.
Overdischarge	Continued discharge after cell voltage falls below the determined cut-off voltage.
Self-discharge	When battery capacity declines without current flowing to an outside circuit.
Unused Battery	An unused battery is defined as one produced less than 1 month ago, and has undergone less than 5 charge / discharge cycles.

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