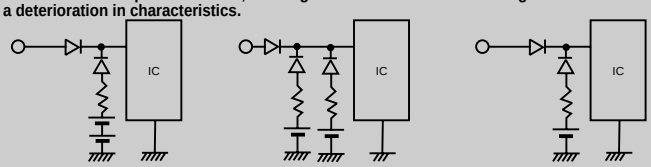
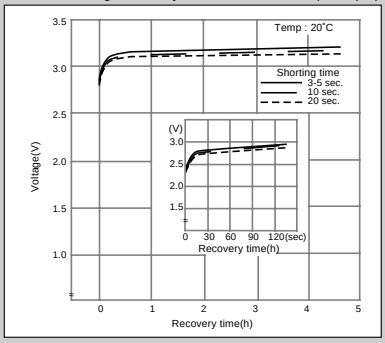
Safety Precautions for Using, Handling and Designing

Common to Both Primary and Rechargeable Batteries

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

Primary Batteries

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

■ Reverse current blocking diode

· Diode used: Use a silicon diode or Schottky diode having only a low reverse current (this current varies with temperature).

· Selection standard (in order to maintain the battery characteristics): The total allowable charging amount of a battery during its total usage period must be no greater than 3% of the nominal capacity of the battery for a coin-type battery or 1% for A cylindrical battery.

[Example]: When a CR2477 (1000mAh) coin-type battery is to be used for 5 years, a reverse current preventing diode with a reverse current of 0.7µ A or less is required.

<Calculation method>

1000mAh (CR2477) x ≦3% (coin-type battery) = ≦30mAh

30mAh ÷ usage period (5 years x 365 days x 24 hours) = 0.7µA

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

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

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

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

1. Use of protective resistor in series

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

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

2. Battery replacement

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

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

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

■ UL approval and maximum allowable charge current

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

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

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

Rechargeable Batteries

· Use of multiple batteries: Consult with Panasonic if two or more vanadium-lithium rechargeable batteries (VL batteries) or manganese-lithium rechargeable batteries (ML batteries) are to be used in series or in parallel.

· Charging: Details on the charge voltage, charge current and charge circuit are given for each type of battery.

· Conditions of UL approval: The maximum charge current must be restricted to 300mA when protective components have been subjected to short- or open-circuiting.

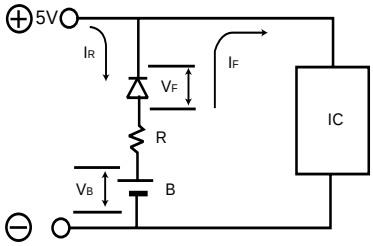
Design for Memory Back-up Use

■ Selecting batteries

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

■ Memory backup circuit and holding voltage

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



■ Reverse current blocking diode

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

Allowable total charging amount :

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

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