Transportation

Our SLA batteries should be handled as common cargo for both air shipment (*1) and boat shipment (*2), as they can withstand electrolyte leakage during the vibration test, the differential atmospheric pressure test and the altitude test in accordance with the special requirements of transportation regulations specified by the international organizations (ICAO: International Commercial Aviation Organization and IMO: International Maritime Organization).
(*1: Special provision A67 *2: Special provision 238)

- **ISO9001**

After an evaluation by the JQA (Japan Quality Association), under their Quality Assurance Corporate Registration System, the quality system at our Hamanako plant, which is where we manufacture our sealed lead-acid batteries, was recognized and registered as conforming with ISO 9001-1994/BS EN ISO 9001:1994/EN-ISO 9001-1994/JIS Z9901-1994. (Registered certification number: JQA-1113 Date issued: December 28,1995)

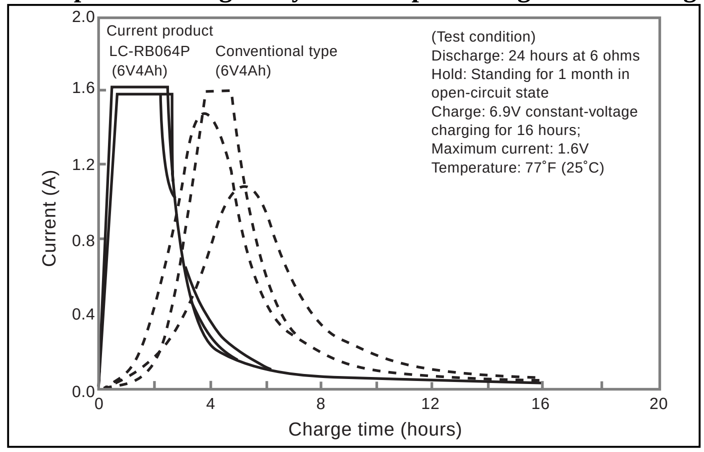
- **ISO 14001**

After an assessment by the JACO (Japan Audit and Certification Organization for Environment), the Environmental Management System at our HAMANAKO site was approved with the standard ISO 14001:1996 JIS Q 14001:1996. (Approval Certificate number: EC97J1085 Issue Date: 30/09/1997)

- **JIS (Japan Industrial Standards)**

Our sealed lead-acid batteries comply with JIS C 8702, and our MSE cathode absorption-type sealed batteries comply with JIS C 8707. (Some of the small-sized sealed lead-acid batteries conform with JIS.)

Example of rechargability after deep discharge and standing



- **UL recognition**

Our SLA batteries fall into UL924 Section 38 (Emergency Lights and Power Equipment). UL924 requires that the battery is free from the hazard of bursting, that is, when the battery is overcharged the vent valve opens to release internal pressure. UL-recognized types of SLA batteries to date are listed in the following table. A number of the recognized battery types are in use for such applications as emergency lights.

- **VdS and other recognition**

The types of SLA batteries which have acquired VdS (Germany) recognition and the Japanese recognition to date are also listed.

Table of battery types which acquired local/overseas recognition

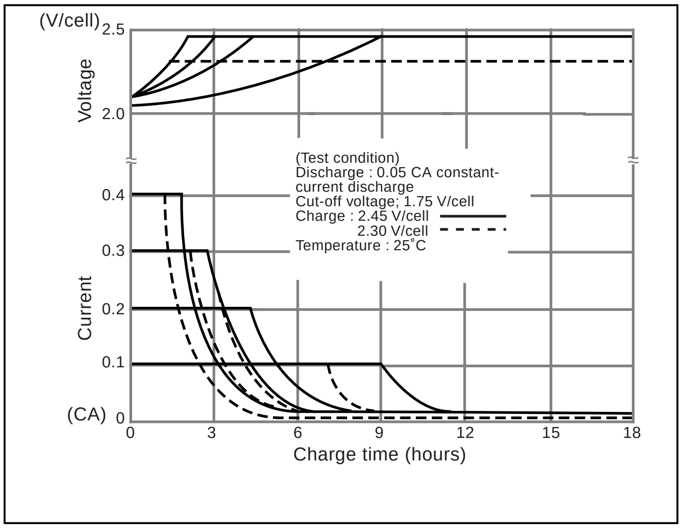
Standard/recognition	Contents	Recognition number	Recognized Models		
UL U.S. Safety standard	U.L.924. section 38 Emergency Lights and power Supplier	MH13723	LC-R061R3(a)	LC-VB064(a)	LC-X1224(a)
			LC-R063R4(a)	LC-V065(a)	LC-X1228(a)
			LC-R064R2(a)	LC-V067R2(a)	LC-X1238(a)
			LC-RB064(a)	LC-V0612(a)	LC-X1242(a)
			LC-R065(a)	LC-V121R3(a)	LC-X1265(a)
			LC-R067R2(a)	LC-V122R2(a)	LC-XA12100(a)
			LC-R0612(a)	LC-V123R4(a)	LC-N02500(a)
			LC-R121R3(a)	LC-VB124(a)	MSE-50-12(a)
			LC-Rl22R2(a)	LC-V125(a)	MSE-100-6(a)
			LC-Rl23R4(a)	LC-V127R2(a)	MSE-150(a)
			LC-RB124(a)	LC-V1212	MSE-200(a)
			LC-R125(a)	LC-VC1217(a)	MSE-300(a)
			LC-R127R2(a)	LC-VA1233(a)	MSE-500(a)
			LC-R129(a)	LC-T122(a)	MSE-1000(a)
			LC-R1212(a)	LC-TA122(a)	MSE-1500(a)
			LC-RC1217(a)	LC-P067R2(a)	MSE-2000(a)
			LC-LA1233(a)	LC-P0612(a)	MSE-3000(a)
			LC-SD122(a)	LC-P127R2(a)	
			LC-SA122R3(a)		
VdS German Safety Standard		G196049 G193046 G191053	LC-R121R3PG	LC-R127R2PG/1	LC-R123R4PG
		G188151 G195009 G198049	LC-Rl22R2PG	LC-RC1217PD	LC-X1224PG/APG

(1) Additional configuration codes (alphabetic letters or numbers) may appear for (a) in the code numbers of UL recognized types.
(2) Applications to VdS are currently pending for the LC-X1228(a), the LC-X1242(a). and the LC-X1265(a).
(note) These standards are also valid for old model numbers.

- **Charging**

Charge characteristics (constant voltage-constant current charging) of SLA batteries are exemplified below.

Example of constant-voltage charge characteristics by current



In order to fully utilize the characteristics of SLA batteries, constant-voltage charging is recommended. For details of charging see page 20.

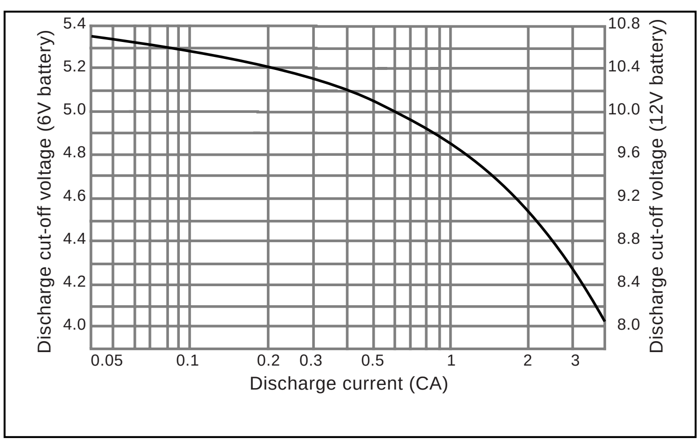
- **Discharging**

a) Discharge current and discharge cut-off voltage

Recommended cut-off voltages for 6V and 12V batteries consistent with discharge rates are given in the figure below. With smaller discharge currents, the active materials in the battery work effectively, therefore discharge cut-off voltages are set to the higher side for controlling overdischarge. For larger discharge currents, on the contrary, cut-off voltages are set to the lower side.

(Note) Discharge cut-off voltages given are recommended values.

Discharge current vs. Cut-off voltage



b) Discharge temperature

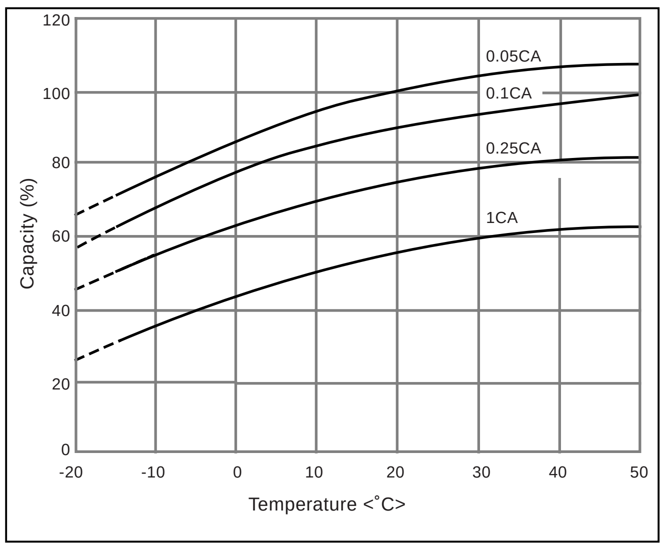
(1) Control the ambient temperature during discharge within the range from -15°C to 50°C for the reason described below.

(2) Batteries operate on electrochemical reaction which converts chemical energy to electric energy. The electrochemical reaction is reduced as the temperature lowers, thus, available discharge capacity is greatly reduced at temperatures as low as -15°C. For the high temperature side, on the other hand, the discharge temperature should not exceed 50°C in order to prevent deformation of resin materials which house the battery or deterioration of service life.

c) Effect of temperature on discharge characteristics

Available discharge capacity of the battery varies with ambient temperature and discharge current as shown in the figure below.

Discharge capacity by temperature and by discharge current



d) Discharge current

Discharge capability of batteries is expressed by the 20 hour rate (rated capacity). Select the battery for specific equipment so that the discharge current during use of the equipment falls within the range between 1/20 of the 20 hour rate value and 3 times that (1/20 CA to 3 CA): discharging beyond this range may result in a marked decrease of discharge capacity or reduction in the number of times of repeatable discharge. When discharging the battery beyond said range, please consult Panasonic in advance.

(Note) With some types of SLA batteries which have a built-in thermostat, the thermostat may automatically cut off the circuit when discharge current exceeds 4 A at the ambient temperature of 40°C; therefore, the maximum discharge current value should be the smaller one of either 4 A or 2 CA.

e) Depth of discharge

Depth of discharge is the state of discharge of batteries expressed by the ratio of amount of capacity discharged to the rated capacity.

- **Storage**

a) Storage condition

Observe the following condition when the battery needs to be stored.

(1) Ambient temperature: -15°C to 40°C (preferably below 30°C)
(2) Relative humidity: 25 to 85%
(3) Storage place free from vibration, dust, direct sunlight, and moisture.

b) Self discharge and refresh charge

During storage, batteries gradually lose their capacity due to self discharge, therefore the capacity after storage is lower than the initial capacity. For the recovery of capacity, repeat charge/discharge several times for the battery in cycle use; for the battery in trickle use, continue charging the battery as loaded in the equipment for 48 to 72 hours.

c) Refresh charge (Auxiliary charge)

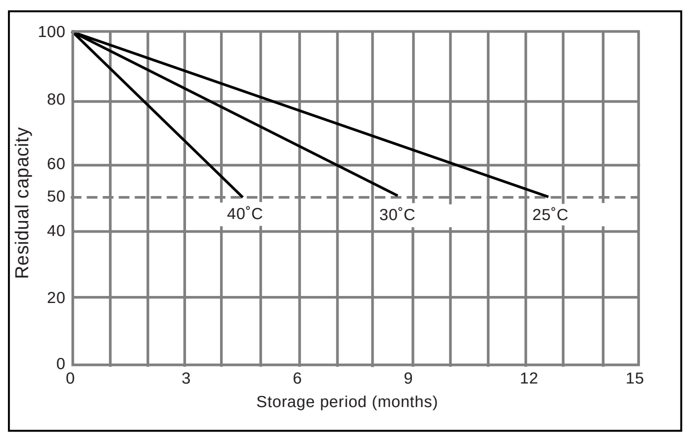
When it is unavoidable to store the battery for 3 months or longer, periodically recharge the battery at the intervals recommended in the table below depending on ambient temperature. Avoid storing the battery for more than 12 months.

Storage temperature	Interval of auxiliary charge (refresh charge)
Below 20°C	9 months
20°C to 30°C	6 months
30°C to 40°C	3 months

d) Residual capacity after storage

The result of testing the residual capacity of the battery which, after fully charged, has been left standing in the open- circuit state for a specific period at a specific ambient temperature is shown in the figure below. The self discharge rate is very much dependent on the ambient temperature of storage. The higher the ambient temperature, the less the residual capacity after storage for a specific period. Self discharge rate almost doubles by each 10°C rise of storage temperature.

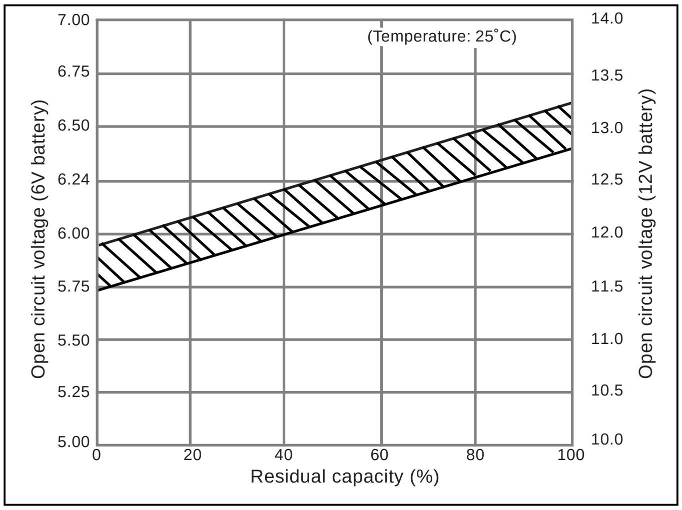
Residual capacity test result



e) Open circuit voltage vs. residual capacity

Residual capacity of the battery can be roughly estimated by measuring the open circuit voltage as shown in the Figure.

Open circuit voltage vs. Residual capacity 25°C



- **Temperature conditions**

Recommended temperature ranges for charging, discharging and storing the battery are tabulated below.

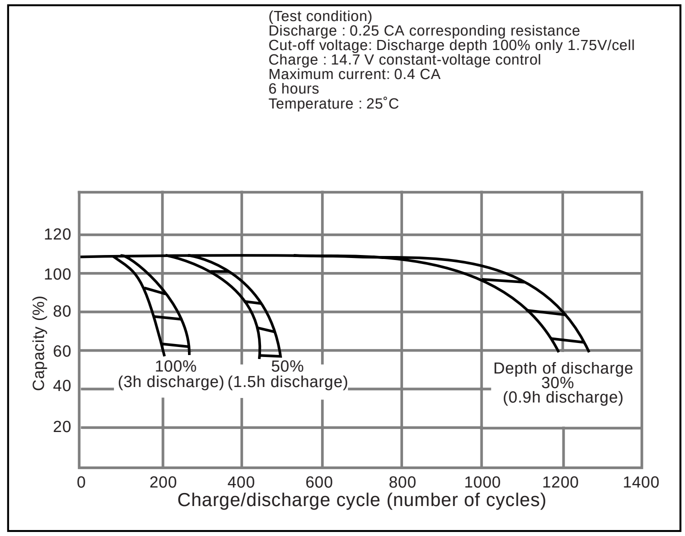
Charge	0°C ~ 40°C
Discharge	-15 °C ~ 50°C
Storage	-15 °C ~ 40°C

- **Battery life**

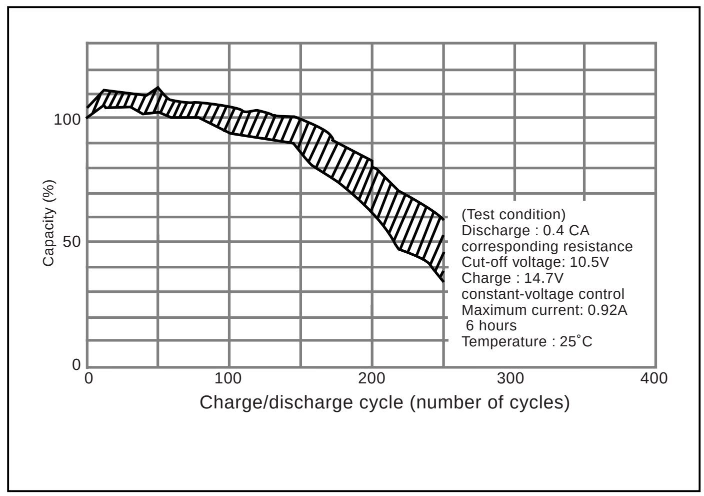
a) Cycle life

Cycle life (number of cycles) of the battery is dependent on the depth of discharge in each cycle. The deeper the discharge is, the shorter the cycle life (smaller number of cycles), providing the same discharge current. The cycle life (number of cycles) of the battery is also related to such factors as the type of the battery, charge method, ambient temperature, and rest period between charge and discharge. Typical cycle-life characteristics of the battery by different charge/discharge conditions are shown by the below figures.
This data is typical and tested at a well-equipped laboratory.
Cycle times are different for each battery model. Cycle times are also different from this data when using batteries under real conditions.

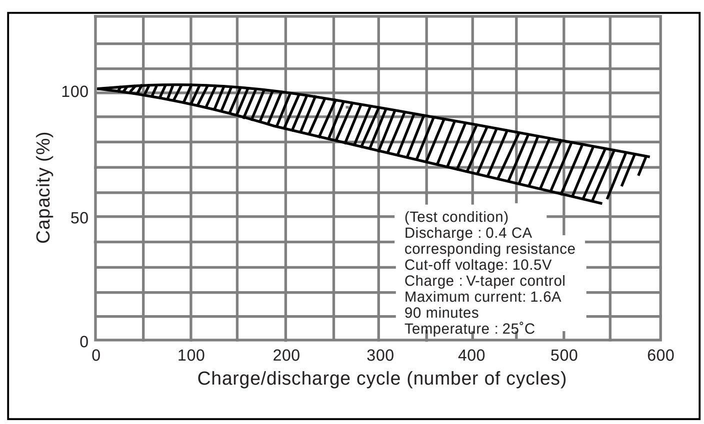
Cycle life vs. Depth of discharge



Constant-voltage cycle life characteristics (LC-SA122R3AU)



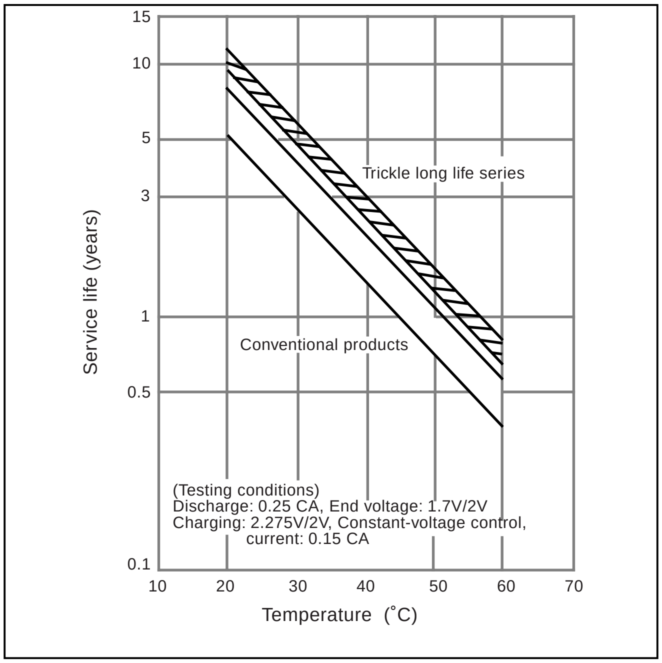
Rapid-charge cycle life characteristics (LC-SA122R3AU)



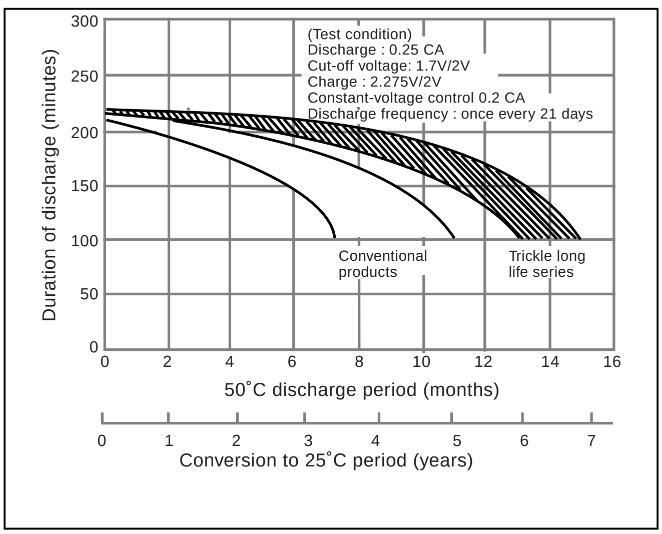
b) Trickle (Float) life

Trickle life of the battery is largely dependent on the temperature condition of the equipment in which the battery is used, and also related to the type of the battery, charge voltage and discharge current. The respective Figures show the influence of temperature on trickle life of the battery, an example of trickle (float) life characteristics of the battery, and the test result of the battery life in an emergency lamp.

Influence of Temperature on Trickle life



Trickle life characteristics at 50°C



Trickle (Float) life characteristics (LC-R and LC-L)