Panasonic Batteries

Valve-Regulated Lead Acid Batteries
Technical Handbook '03/'04

PDF File Technical Handbook

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.

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(notes)

1. This handbook is for specifying characteristics of storage batteries. Product prices, delivery terms and other details of business transactions are to be discussed with your representative.
2. Contents of this handbook are subject to change for improvement without prior notice to users. When considering use of the batteries described in this handbook, please confirm availability by contacting Panasonic.

Precautions for handling Valve-Regulated Lead-Acid Batteries

- This document should be read in its entirety and its contents fully understood before handling or using Panasonic rechargeable Valve-Regulated Lead-Acid batteries. If there are any questions, please contact Panasonic. Please keep this document available for reference. Due to the potential energy stored in the batteries, improper handling or use of the batteries by not observing the precautions listed in this document may result in bodily injury caused by electrolyte leakage, heat generation, or explosion.

* All descriptions are subject to modification without notice.

Degree of danger

1. DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

2. WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or injury.

3. CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or damage to equipment.

4. RECOMMENDATION

Recommended course of action to prevent a situation that could result in damage of quality, performance or reliability of the batteries, should they be mishandled.

(Remark 1) Even in cases where lead-acid batteries are handled improperly, a situation that will result in the immediate death of the user is highly unlikely. However, we have assumed the higher DANGER level situation instead of the WARNING and CAUTION levels because the high energy stored in batteries still implies a possibility of extreme hazard which might lead to serious injury.

(Remark 2) Serious injury here would include injury, loss of eyesight, burns, electric shocks, bone fractures and poisoning that will cause permanent damage or require hospitalization or intensive treatment over an extended period. Minor injury includes slight burns and electric shock. Property damage means damage to buildings and household effects including livestock and pets.

(Remark 3) RECOMMENDATION refers to the suggested means by which to protect batteries from impaired quality, performance and reliability.

Safety Precautions

1. Environment and condition of use

DANGER

(1) Do not load valve-regulated lead-acid batteries (hereinafter described as “the battery”) in airtight equipment. Use of the battery in airtight equipment may cause explosion of the equipment or injury.

WARNING

(1) Charge the battery using a specified charger or under the charging condition specified by Panasonic. Charging the battery under any other conditions may cause the battery to overheat, emit hydrogen gas, leak, ignite, or burst.

(2) When using the battery in medical equipment*, provide a back-up system other than the main battery. Failure of the main battery in the absence of a back-up power could lead to injury.

(3) Avoid direct contact of the battery with metallic containers; acid- and heat-resistant insulators should be employed. Leakage of the battery in the absence of insulators may cause problems such as release of fumes and ignition.

(4) Do not place the battery near a device that may cause sparks (such as a switch or a fuse). The battery may generate flammable gas when charged, so remember to keep the battery away from fire oran open flame to prevent any sparks from igniting or causing explosions.

(5) Avoid placing the battery near a heat-generating part (such as a transformer). Using the battery near a heat source may cause the battery to overheat, leak, ignite, or burst.

* The battery should only be used in non life critical medical equipment. When any medical equipment incorporating a Panasonic VRLA battery is planned, please notify Panasonic.

CAUTION

(1) The operating temperature range for the battery is specified below. Use of the battery at temperatures beyond this range may cause battery damage.

Normal operating temperature of the battery is 77°F (25°C).

When discharged (equipment in use): 5°F to 122°F (-15°C to 50°C)

When charged: 32°F to 104°F (0°C to 40°C)

During storage: 5°F to 104°F (-15°C to 40°C)

(2) Do not allow the battery to be immersed in or wetted with water/sea-water; as it may corrode the battery, ignite or create an electric shock hazard.

(3) Do not place or store the battery in an automobile in hot weather, under direct sunlight, in front of a stove, or near fire. Use or storage of the battery in these places may cause battery leakage, fire or bursting.

(4) Use of the battery in a dusty environment is not recommended, as it may cause the battery to short. The battery should be periodically checked when used in such an environment.

(6) In applications which use more than one battery, first make sure of correct mutual connections between batteries, and then connect the battery with the charger or the load. Make sure to firmly connect the (+) pole of the batteries to the (+) terminal of the charger or load, and the (-) pole to the (-) terminal in the same way. If the poles/terminals of the batteries, the charger and the load are connected improperly, explosion, ignition or damage to the batteries and/or equipment may occur, causing injury to personnel in some cases.

(7) Be extremely careful not to drop the battery onto feet to avoid the possibility of serious injury.

RECOMMENDATION

(1) Avoid sudden movements or applying shocks to the battery e.g. from dropping the battery. Damage and deterioration of battery characteristics may occur if the battery is dropped.

(2) Carefully check the life characteristics of the battery when in actual loaded mode. Life of the battery may vary greatly depending on charge/discharge conditions

2. Installation

DANGER

(1) Insulate metallic tools such as torque-wrenches and wrenches with a vinyl tape, etc. Using uninsulated tools may cause a short circuit, and the heat or sparks generated by the short circuit could result in burns, damage to the battery, or ignite an explosion.

(2) Do not place the battery in a closed room or near fire. Placing the battery in such a location could result in an explosion or fire due to hydrogen gas emitted by the battery.

WARNING

(1) Do not contact any plastic or resin containing a migrating plasticizer* with the batteries. Avoid using organic solvents such as thinner, gasoline, lamp oil, benzine and liquid detergent to clean the batteries. The use of any of the above materials may cause the containers and/or the covers (ABS resin) of the batteries to crack and leak, or could ignite. Avoid using material containing a migrating plasticizer by asking the manufacturer its contents.

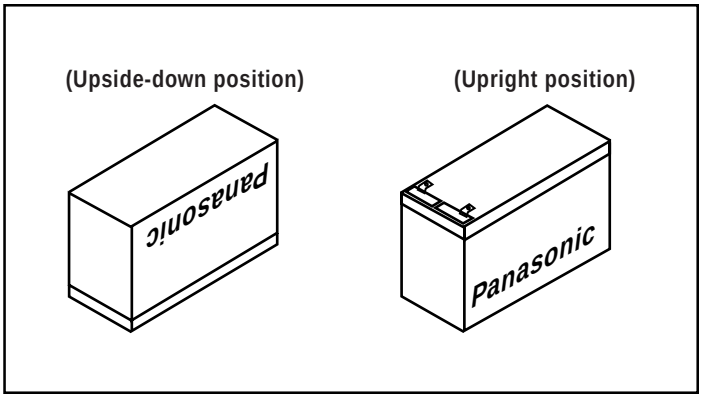
(2) Take safety measures such as wearing rubber gloves for insulation when handling a voltage of 45 V or higher. Operation without safety measures may result in electric shocks to the operator.

(3) Avoid placing the battery in an environment which is susceptible to floods. There is the possibility that if the battery is immersed in water, it may ignite or cause electric shocks to personnel.

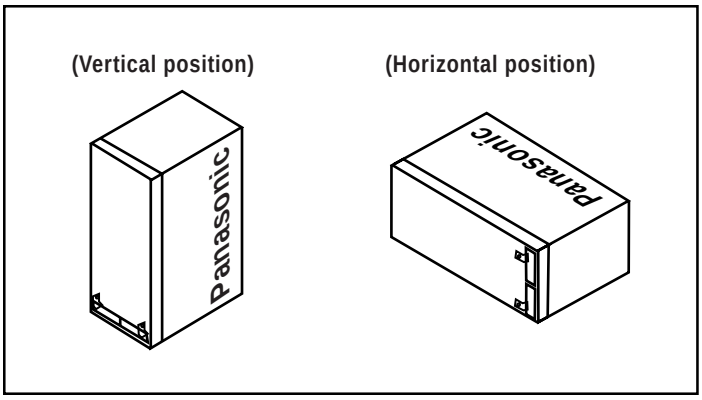
CAUTION

(1) When unpacking the battery, make sure to handle it gently. Rough handling may shock the battery, causing damage. Check that the battery is free from cracks, fractures, tipping and leakage.

(2) When loading the battery in equipment, mount it in the lower most section of the equipment in order to ensure easy checking, maintenance and replacement. Do not charge the battery in the inverted (upside-down) position: overcharging in the inverted position may cause battery leakage from the safety valve. The inverted position is demonstrated in the far left picture below where the letters “Panasonic” on the battery in the picture are inverted. The following illustrations are for explaining positions of the battery, not for showing accurate configurations for each type of battery.



* Examples of plastic or resin to avoid: Vinyl chloride, Oily rubber. Examples of acceptable types of plastic or resin: Polyolefin resin such as polypropylene or polyethylene.



(3) Do not carry the battery by hanging it from the terminal or the lead wire, as it may cause damage to the battery.
(4) When carrying the battery, exercise caution not to apply a strong shock to it by dropping it, jarring it or causing it to collide with other objects, as this may cause damage to the battery.
(5) Do not underestimate the weight of the battery. As it is heavy for its volume, careless handling of the battery may cause backache or other injuries to the operator.
(6) Do not bring covered wires containing plasticizer or non- rigid PVC sheets in contact with the battery. Do not apply organic solvents such as paint thinner, gasoline, kerosene and benzene or liquid detergents to the battery. When brought in contact with these materials, the battery case may crack, causing leakage of the battery.
(7) Do not cover the battery with a material which generates static electricity, such as a PVC sheet. A static charge may trigger fire or explosion
(8) In fastening bolts and nuts of the battery, observe the torque values specified: otherwise, sparks may be generated and damage of the terminal may occur. The fastening torque of bolts and nuts is as follows:

Bolt (nut) size (mm)			Fastening Torque		
Diameter	Pitch	Length	Nm	kg. cm.	lb. In.
M5 1.197(5)	0.031 (0.8)	0.591 ± 0.039 (15 ± 1)	2.0 ~ 2.9	20 ~ 30	17.3 ~ 26.0
M6 0.236(6)	0.039 (1.0)	0.7870.039 (20 ± 1)	3.9 ~ 5.4	40 ~ 55	34.6 ~ 47.6
M8 0.315(8)	0.049 (1.25)	0.7870.039 (20 ± 1)	7.8 ~ 9.8	80 ~ 100	69.3 ~ 86.6

(9) Apply insulation covers to terminals, joint parts, bolts and nuts of the battery in order to prevent electric shocks to personnel.
(10) When intending to use the battery in vibrating equipment such as motor cycles, engine driven bicycles and engine driven grass shears, please consult Panasonic in advance.
(11) Fasten the batteries firmly to the equipment to avoid the influence of vibration and/or physical shock.

RECOMMENDATION

(1) The battery and/or equipment should be installed by skilled personnel (specialists) such as personnel qualified for maintaining battery equipment. Handling of the battery by unskilled personnel may lead to dangerous errors.

3. Preparation Prior to Operation

DANGER

(1) Be sure to provide enough insulation around the lead wires and/or plates used between the batteries and the application. Insufficient insulation may cause an electric shock, heat generating from a short circuit(or excess current) may result in an injury, burn, smoke or ignition.

CAUTION

(1) Do not connect the battery directly to a power outlet or a cigarette lighter socket of an automobile without using a charger. Direct connection to power sources may cause battery leakage, heating or bursting.
(2) Turn off the switch of the circuit when connecting the battery to a charger or a load.
(3) If newly purchased batteries exhibit any irregularities in initial use, such as rusting, heating or other problems, they should not be used. Continued use of an irregular battery may lead to leakage, fire or bursting of the battery.

REQUEST

(1) Since the batteries tend to lose a part of their capacity due to self-discharge during shipment and storage, recharge the batteries before you use them after purchase or long-term storage in order to restore their full capacity. Check for the following conditions before recharging:

Charging method	Charging condition (at 25°C)
Constant voltage	• Regulation range of the controlled voltage: 7.25V to 7.45V/6V battery, 14.5V to 14.9V/12V battery; Initial current: 0.1CA to 0.4CA; Maximum charging time: 24 hours. • Short-time charge is possible when several batteries of the same model, under the same storage conditions can be charged in series. Otherwise they can be charged separately.
Constant current	• Charging current: 0.1CA • Charging time (hours)=[Amount of self-discharge (Ah)/0.1CA] x 120% • Rough estimation of amount of self-discharge is as follows (for an example): When the storage ambient temperature is lower than 25°C, and storage time is known, assume the following amount of self-discharge: [5%/month] x storage months • Multiply this by the rated capacity (at 20 hour rate) of the battery • Regardless of the above calculation, the charge time for a refresh charge must be less than 12 hours. • When the storage ambient temperature is higher than 25°C, please consult Panasonic.

4. Unspecified Use

CAUTION

(1) Do not place the batteries in an unspecified use or they may leak, ignite, or explode.

5. Method of use

DANGER

(1) The batteries must be charged using the specified charger or by maintaining the charging conditions indicated by Panasonic. If the batteries are charged under conditions other than those specified by Panasonic, they may leak, ignite or explode.

(2) Do not connect the (+) and (-) terminals of the battery to each other with a metallic material such as wire; do not allow tools such as pipe wrenches and wrenches to touch points of different voltages on the battery; and do not bring metallic necklaces or hair pins into contact with the battery or store them together with the battery. Failure to observe these precautions may cause the battery to overheat, emit hydro gen gas, leak, ignite, or burst.

WARNING

(1) Do not throw the battery in fire nor heat the battery. The battery may burst or generate a toxic gas if placed in contact with fire.

(2) Do not attempt to disassemble, remodel or destroy the battery, as it may cause battery leakage, fire or bursting, and could also create sulfuric acid spills from the battery resulting in possible burns to personnel and damage to the immediate environment.

CAUTION

(1) Check the battery for any sign of irregularities in appearance. If there is any damage to the battery case/cover such as cracks, deformation or leakage, replace the battery with a new one. If the battery appears dirty or dusty, clean it. If a battery of irregular appearance continues to be used, decrease of capacity, leakage of electricity, fumes, ignition or other problems may result.

(2) If any irregularity is found in areas such as the charge voltage and discharge characteristics of the battery, replace it.

(3) For safety, make sure to observe the following: Otherwise, leakage, ignition or an explosion of the battery may occur.
   1) Do not charge the battery with its (+) and (-) terminals and the (+) and (-) terminals of the charger connected in reverse.
   2) Do not apply a solder directly to the battery terminals. If direct soldering is unavoidable, please contact Panasonic in advance.
   3) Avoid mixed usage of batteries differing in type, manufacturer or history of use.
   4) Do not remove or damage the outer case of the battery.
   5) Do not apply strong shocks or jolts to the battery.

(4) Do not continue to charge the battery beyond the time specified in the instructions of use of the charger. If the battery is not fully charged even after being charged for a longer time than specified, discontinue charging and remove the battery from the charger. Charging for a longer time than specified may cause the battery to leak, ignite or burst.

(5) Do not discharge the batteries beyond the maximum values indicated in the specifications. If the batteries are discharged beyond the maximum values, they may leak, ignite or explode.

(6) Children should only use the battery under the guidance of an adult who should thoroughly instruct the child on its use. During use the adult should check that the battery is used exactly as instructed.

Keep the battery beyond the reach of small children. During charging or actual use of the battery, take caution not to allow small children to remove the battery from equipment.

PROPOSITION 65 WARNING

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. Wash hands after handling.

RECOMMENDATION

(1) The recommended cut-off voltage during discharge depends on the size of the discharge current. The relationship between the storage battery discharge current and the ideal discharge cut-off voltage is described in Panasonic specifications and technical handbooks.
Do not continue discharging to the point where the voltage drops below the recommended discharge cut-off voltage.
If a storage battery that was discharged below the recommended discharge cut-off voltage is recharged, the storage battery may generate heat which could deform it or cause condensation to form on the battery casing due to the evaporation of moisture from inside the battery. Discharging below the recommended discharge cut-off voltage may also accelerate the deterioration of the battery's performance characteristics.

(2) Avoid overdischarge, and charge the battery immediately after discharge. The instruction manual of the equipment should contain information telling the user not to overdischarge the battery and to charge the battery immediately after the use of the equipment (discharge). Even if discharge of the battery is stopped before voltage decreases to such a level that the battery-driven equipment stops being operational, deterioration of the battery may be accelerated by the so-called sulphation phenomenon if it is not recharged after use. The low voltage cut-off circuit should be designed so that it can completely cut off the discharge current including a weak current.

(3) If a charge method and a charge condition other than that described in the specification and the technical brochures is to be adopted, charge/discharge characteristics and life characteristics of the battery should be thoroughly checked in advance. The adoption of adequate charge methods and adequate charge conditions are crucial to ensure safe use of the battery and for fully utilizing the battery capacity.

(4) For the cycle operation of the battery (application of the battery as the main source of power by repeating charge and discharge), use a charger which operates by controlling either the charge period or charge quantity. Continue charging the battery for the time specified or until the charge completion lamp, if provided, indicates completion of charge. If charging is suspended before completion, the service life of the battery may be shortened.

(5) Avoid parallel charging of batteries in cycle use, as this may shorten the service life of the batteries by causing an imbalance in charge/discharge state among the batteries connected in parallel.

(6) During trickle or float charge of the battery, measure the total voltage with a high-accuracy voltmeter of Class 0.5 or better. If the voltage readout does not meet the specified value, investigate the reason and take proper measures. A total voltage that is lower than the specified value indicates insufficient charge which may reduce the battery capacity; a voltage higher than specified indicates an overcharge which may shorten service life of the battery or cause problems such as thermal runaway in some cases.

(7) Make sure to turn off the switch of the battery equipment after use, otherwise excessive discharge may cause deterioration in battery performance and shorten service life.

(8) When the equipment is not used for a long period, remove the battery from the equipment, charge it fully, and store it in a place where humidity is low. Unsatisfactory storage conditions may cause deterioration in battery performance, shorten service life and could cause rust to form on the terminals.

6. Maintenance and checking

WARNING

(1) Clean the battery with a slightly damp cloth, ensure there is no excess water on the cloth by squeezing it well. Do not use a dry cloth or a duster, as it may cause the battery to generate static electricity, leading to possible ignition and bursting of the battery.

(2) Replace the battery with a new one within the time period specified in the instruction manual or equipment.

• Follow the guideline which states the battery should be replaced when its capacity has decreased to 50% of the initial capacity (at an ambient temperature of 77°F (25°C) or below). In the trickle or float application of the battery (application as stand-by power) at an ambient temperature higher than 77°F (25°C), the period for which the battery can be used before replacement is shortened by a half for every 10°C rise of temperature. When the discharge current becomes higher than 0.25 CA, the run time and battery life is also shortened.

• The usable period for the battery is markedly shortened near the end of its service life (when discharge time has decreased to 50% of the initial). This is also the period when battery problems such as internal short, dry-up of electrolyte (increase in internal resistance) and corrosion of the cathode grids will occur. Replace the battery before these conditions are reached: if the battery continues to be used under these conditions, maximum discharge current will continue flowing, which may lead to thermal runaway or leakage.

CAUTION

(1) Do not apply organic solvents such as paint thinner, gasoline, kerosene and benzene or liquid detergents to the battery. If these are brought into contact with the battery case, it may crack, causing leakage.

RECOMMENDATION

(1) Keep the terminals of the battery clean. Dirty terminals may cause inadequate contact of the battery to the equipment body, leading to power failure or charge failure.

7. Emergency measures

WARNING

(1) The battery contains diluted sulfuric acid, a very toxic substance. If the battery leaks and the liquid inside spills on the skin or clothing, immediately wash it off with plenty of clean water. If the liquid splashes into eyes, immediately flush the eyes with plenty of clean water and consult a doctor. Sulfuric acid in the eyes may cause loss of eyesight and acid on the skin will cause burns.

CAUTION

(1) If any corrosion of the terminals, leakage or deformation of the case of the battery is found, do not use the battery and turn off the power supply. If a battery which is irregular or substandard in any way continues to be used, leakage, fire or bursting of the battery may occur and there is also a potential for electric shock.

8. Storage

CAUTION

(1) Store the battery in a stable position so as to keep the terminals of the battery away from any metallic or other conductive material (including items that may fall or drop onto the battery).

(2) Protect the battery from rain. If the terminals of the battery come into contact with water, they may corrode.

(3) Keep the battery in the upright position as a general rule, and do not apply abnormally strong vibrations or shocks to the battery. Transportation of the battery in an abnormal position or the application of abnormally strong vibrations or shocks to the battery may cause damage to the battery and the deterioration of characteristics.

(4) When storing the battery, remove it from the equipment or disconnect it from the charger or the load and keep it in a place where temperature is low. Do not store the battery under direct sunlight or in high temperatures (140°F (60°C) or higher) or in a highly humid atmosphere, because rusting, deterioration of performance and life of the battery may occur.

RECOMMENDATION

(1) During storage of the battery, charge it at least once every six months (when ambient temperature is 77°F (25°C) or below). Shorten the interval of charging to a half by every 50°F (10°C) rise of ambient temperature. The rate of self discharge of the battery doubles for each 5°F (10°C) rise of ambient temperature. If the battery has been stored for a long period in a discharged state, it may not be able to regain it's capacity even if it is recharged.

(2) If the battery is stored for a year or longer without being charged, its service life may be shortened.

(3) Store the battery after fully charging it, otherwise its service life may be shortened.

(4) Use the battery as soon as possible. The battery gradually deteriorates during storage and thus its decreased capacity may be irreversible even allowing when recharged.

9. Disposal of batteries

CAUTION

(1) In countries where there are legal or voluntary regulations on the recycling of rechargeable batteries, please provide written information on recycling of rechargeable batteries with the equipment, packaging, instruction manuals, etc.

(2) Adopt methods and measures for equipment design and battery mounting that will allow for easy removal of batteries for replacement and disposal.

(3) Used batteries are recyclable. When returning used batteries, insulate their terminals with adhesive tapes, etc., otherwise the residual electricity in used batteries may cause a fire or explosion.

(4) This battery is fully recyclable and should be accepted at any location that accepts common automotive starter batteries. Examples of places that accept these batteries are: County or municipal recycling drop-off centers, scrap metal dealers, and retailers sho sell automotive replacement lead acid starter batteries. In North America, non-consumers can call 1-800-SAV-LEAD for assistance in recycling.

Refer to the SAV-LEAD section in the back of this handbook for complete instructions.

Overview

Panasonic valve-regulated lead-acid batteries (VRLA battery) have been on the market for more than 30 years. The VRLA battery is a rechargeable battery which does not require adding water.
Based on AGM (Absorbed Glass Mat) technology with calcium grids, the batteries offer excellent high rate performance characteristics and increased life expectancy.

Our cumulative technological know-how has enabled us to respond to market requirements promptly by developing batteries such as trickle/cycle long life type and improving charging capabilities to allow for quick charging in 1 to 2 hours.
The VRLA battery covers a broad range of applications including, electric tools, UPS, emergency lighting and electric wheel chairs.

Battery Types and model numbers

For main power applications — Cycle long life type .....LC-XC

For main and standby power applications — Expected trickle life 3-5(approx. 5*) years..LC-R

For standby power applications
- Expected trickle life 3-5 (approx.5*) years...UP-RW
- Expected trickle life approx. 6(10) years*
  - Standard case .....LC-X
  - Flame-retardant case ..LC-P

Expected trickle life: Up to 50% of initial capacity under the following conditions:
Temperature: 77˚F (25˚C)
Discharge current: 0.25CA
Discharge ending voltage: 5.25V for 6V battery, 10.5V for 12V battery
Charge voltage: 6.85V for 6V battery, 13.7V for 12V battery

*Approximately 6 years at 20˚C, 0.1C

Construction and Electrolyte

- **Positive plates**

Positive plates are plate electrodes of which a grid frame of lead-tin-calcium alloy holds porous lead dioxide as the active material.

- **Negative plates**

Negative plates are plate electrodes of which a grid frame of lead-tin-calcium alloy holds spongy lead as the active material.

- **Electrolyte**

Diluted sulfuric acid is used as the medium for conducting ions in the electrochemical reaction in the battery.

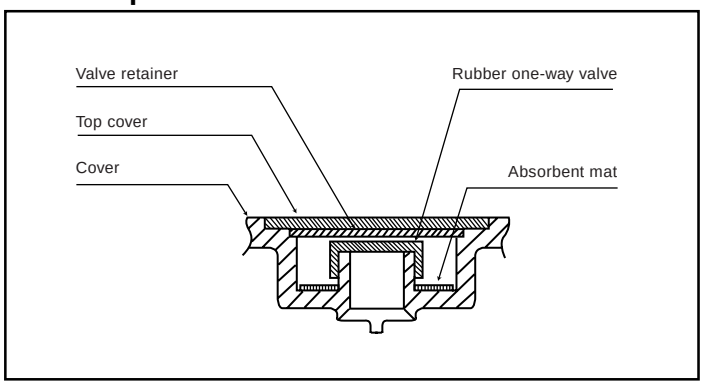
- **Separators**

The advanced micro porous Absorbed Glass Mat (AGM) separators retain electrolyte and prevent shorting between positive and negative plates. Separators adopt a non-woven fabric of fine glass fibers which is chemically stable in the diluted sulfuric acid electrolyte. Being highly porous, separators retain electrolyte for the reaction of active materials in the plates.

- **Valve (One way valve)**

The valve is comprised of a one-way valve made of material such as neoprene. When gas is generated in the battery under extreme overcharge conditions due to erroneous charging, charger malfunctions or other abnormalities, the vent valve opens to release excessive pressure in the battery and maintain the gas pressure within specific range (7.1 to 43.6 kPa). “The vent helps protect the battery from the danger of bursting. Since the rubber valve is instantly resealable, the valve can perform this function repeatedly whenever required.”

- **Example of Valve Construction**



During ordinary use of the battery, the vent valve is closed to shut out outside air and prevent oxygen in the air from reacting with the active material in the negative electrodes.

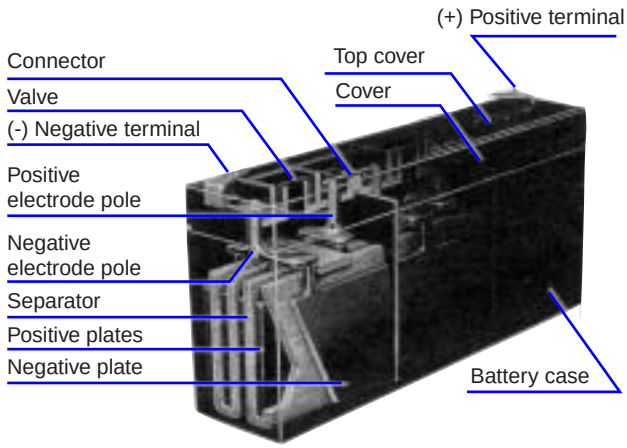
- **Positive and negative electrode terminals**

Positive and negative electrode terminals may be faston tab type, bolt fastening type, threaded post type, or lead wire type, depending on the type of the battery. Sealing of the terminal is achieved by a structure which secures long adhesive-embedded paths and by the adoption of strong epoxy adhesives. For specific dimensions and shapes of terminals, refer to the terminal dimensions page in the back of the technical handbook.

- **Battery case materials**

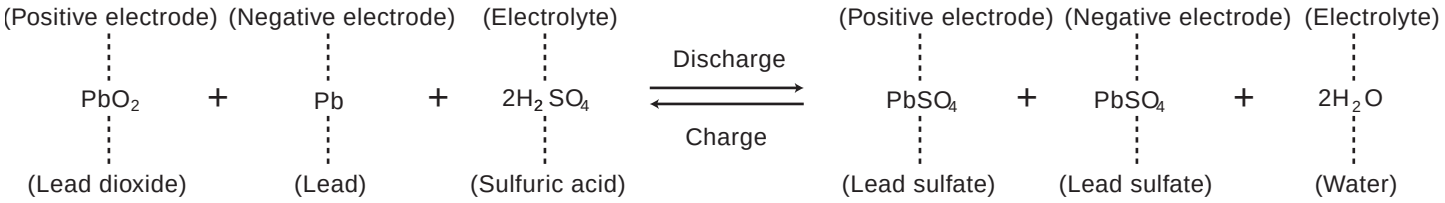
Materials of the body and cover of the battery case are ABS resins, unless otherwise specified.

Example of construction

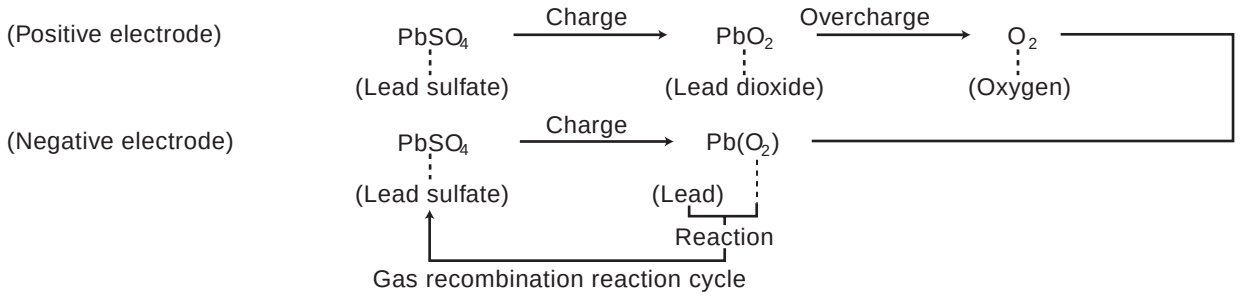


Electrochemical Reactions on Electrodes

The electrochemical reaction processes of the valve-regulated lead-acid battery (negative electrode recombination type) are described below.
Where “charge” is the operation of supplying the rechargeable battery with direct current from an external power source to change the active material in the negative plates chemically, and hence to store in the battery electric energy in the form of chemical energy. “Discharge” is the operation of drawing out electric energy from the battery to operate external equipment.



In the final stage of charging, an oxygen-generating reaction occurs at the positive plates. This oxygen transfers inside the battery, then is absorbed into the surface of the negative plates and consumed. These electrochemical reaction processes are expressed as follows.



Applications

- **Stand-by/Back-up power applications**
  - Communication equipment: base station, PBX, CATV, WLL, ONU, STB, etc.
  - Back-up for power failure: UPS, ECR, computer system back-up, sequencers, etc.
  - Emergency equipment: lights, fire and burglar alarms, radios, fire shutters, stop-position controls (for machines and elevators), etc.

- **Main power applications**
  - Communication equipment: transceivers
  - Electrically operated vehicles: picking carts, automated transports, electric wheelchairs, cleaning robots, electric automobiles, etc.
  - Tools and engine starters: grass shears, hedge trimmers, cordless drills, screwdrivers, jet-skis, electric saws, etc.
  - Industrial equipment/instruments and non life-critical medical equipment*: measuring equipment, non life-critical medical equipment (electrocardio-graph), etc.
  - Photography: camera strobes, VTR/VCR, movie lights, etc.
  - Toys and hobby: radio-controllers, motor drives, lights, etc.
  - Miscellaneous uses: integrated VTR/VCR, tape recorders, other portable equipment, etc.

*(Note) When any medical equipment incorporating a Panasonic VRLA battery is planned, please contact Panasonic.

Features

- **Leak-resistant structure**

A required-minimum quantity of electrolyte is impregnated into, and retained by, the positive and negative plates and the separators; therefore electrolyte does not flow freely. Also, the terminal has a sealed structure secured by long adhesive-embedded paths and by the adoption of strong epoxy adhesives which makes the battery leak-resistant. (Note) In stand-by/back-up uses, if the battery continues to be used beyond the point where discharge duration has decreased to 50% of the initial (i.e. life judgment criteria), cracking of the battery case may occur, resulting in leakage of the electrolyte.

- **Long service life**

Service life of our long-life series (LC-P, LC-X series) is approximately double that of the conventional LC-R series batteries (Temperature 25°C, discharge rate 0.25 CA/ 1.75V/cell, discharge frequency every 6 months, 2.30V/cell charge).

- **Easy maintenance**

Unlike the conventional batteries in which electrolyte can flow freely, VRLA batteries do not need specific-gravity checks of the electrolyte nor do they need to have water added; This makes the battery function fully and makes maintenance easy.

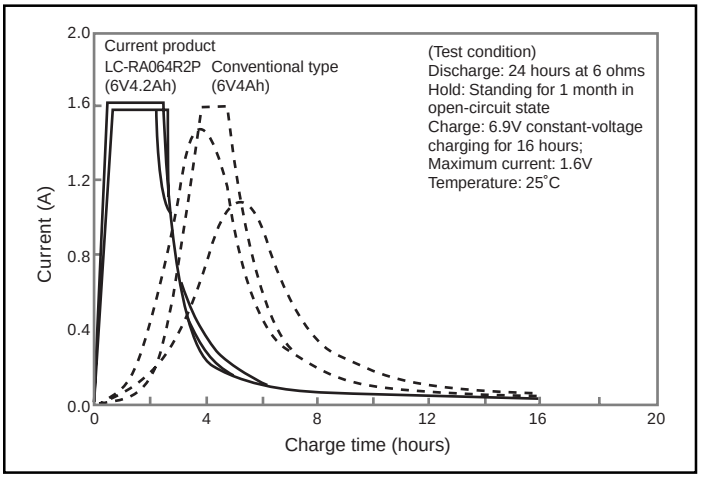
- **No sulfuric acid mist or gases**

Unlike the conventional batteries in which electrolyte can flow freely, VRLA batteries generate no sulfuric acid mist or gases under the use condition we recommend. In uses under conditions other than recommended, however, gas generation may occur, therefore do not design the battery housing with a closed structure.

- **Exceptional deep discharge recovery**

As seen in the figure on the next page, our VRLA battery shows exceptional rechargeablity even after deep discharge, which is often caused by failure to turn off the equipment switch, followed by standing (approx. 1 month at room temperature is assumed).

Example of rechargability after deep discharge and standing



Transportation

All of our lead acid batteries are unregulated by DOT for transportation by truck, rail, ocean and air transportation because they meet the requirements of 49 CFR 173.159 (d). The only transporation requirements are:

1) The battery must be securely packaged in such a way to prevent the possibility of short ciruiting.

2) The battery and the outer most packaging must be labeled “NONSPILLABLE” or “NONSPILLABLE BATTERY”.

All of our lead acid batteries are unregulated for air transportation because they meet the requirements of Special Provision--”A67” as promulgated by the International Air Transportation Association (IATA) and the International Civil Aviation Organization (ICAO). They also meet the Vibration and Pressure Differential Tests of the International Maritime Dangerous Goods (IMDG) regulations.

- **ISO 9001**

The quality systems at our Hamanako plant (Japan) have been recognized and registered by the Quality Assurance Corporate Registration System as conforming with ISO 9001.

- **ISO 9002**

The quality systems at our SLMB (China) and MBIA (Mexico) have been recognized and registered by the Quality Assurance Corporate Registration System as conforming with ISO 9002.

- **ISO 14001**

The Environmental Management Systems at our SLMB (China) plant has been approved with the ISO 14001.

- **JIS (Japan Industrial Standards)**

Our sealed lead-acid batteries comply with JIS C 8702.

- **UL recognition**

Our VRLA batteries fall into UL1989 (Standby Batteries). UL1989 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 VRLA 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.

- **VDE and other recognition**

The types of VRLA batteries which have acquired VDE (Germany) recognition are also listed.

Table of battery types which acquired local/overseas recognition

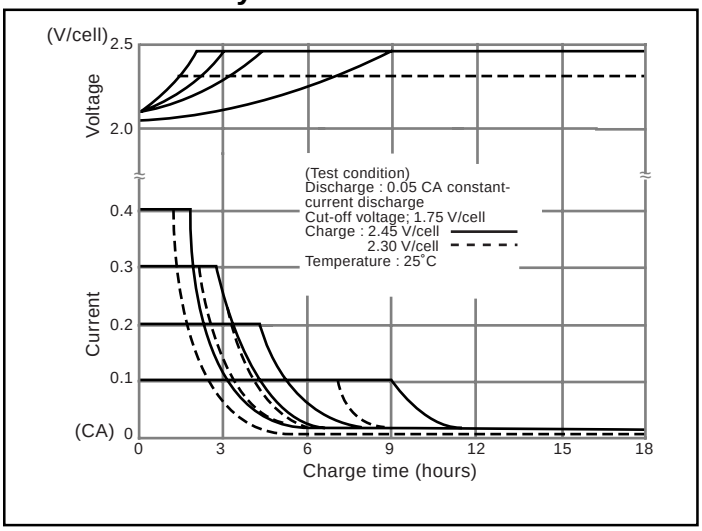
Standard/recognition	Contents	Recognition number	Recognized Models		
UL U.S. Safety standard	U.L. 1989 Standby Batteries	MH13723	LC-R061R3(a) LC-R063R4(a) LC-R064R2(a) LC-R067R2(a) LC-R0612(a) LC-R121R3(a) LC-R122R2(a) LC-R123R4(a) LC-R127R2(a) LC-RA1212P LC-RD1217(a) LC-LA1233(a) LC-SD122(a)	LC-SA122R3(a) LC-V067R2(a) LC-V0612(a) LC-V121R3(a) LC-V122R2(a) LC-V123R4(a) LC-V127R2(a) LC-V1212 LC-VD1217(a) LC-VA1233(a) LC-T122(a) LC-TA122(a) LC-P067R2(a) LC-P0612(a) LC-P127R2(a)	LC-X1220(a) LC-X1228(a) LC-X1242(a) LC-X1265(a) LC-XA12100(a) UP-RW1245(a) UP-RW1220(a) LC-XC1228(a) LC-XC1238(a) LC-RA064R2(a) LC-R1233(a) LC-PD1217
VDE German Safety Standard		G196049 G188151 G191053 G198048 G193046 G100001 G198049 B100002 G199090	LC-121R3PG LC-R127P/P1 LC-X1224APG/AP	LC-R122R2PG LC-R127R2PG/PG1 LC-X1238APG/AP LC-X1238PG/P	LC-R123R4PG LC-RA1212PG/PG1 LC-RA1212P/P1 LC-X1265PG/P

Additional configuration codes (alphabetic letters or numbers) may appear for (a) in the code numbers of UL recognized types.
(Note) These standards are also valid for old model numbers.

- **Charging**

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

Example of constant-voltage charge characteristics by current

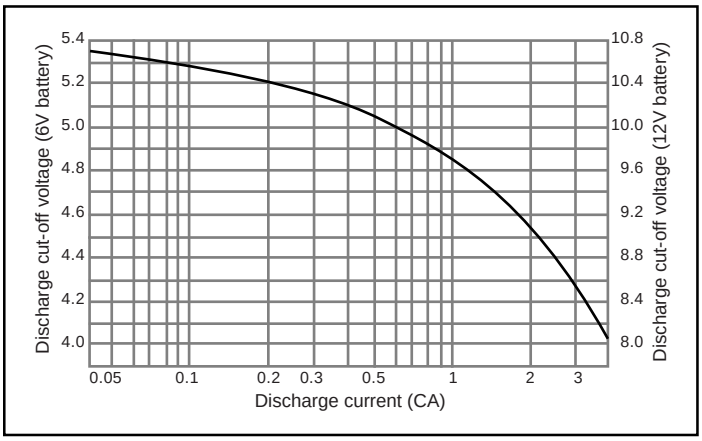


In order to fully utilize the characteristics of VRLA batteries, constant-voltage charging is recommended. For details of charging see page 19.

- **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

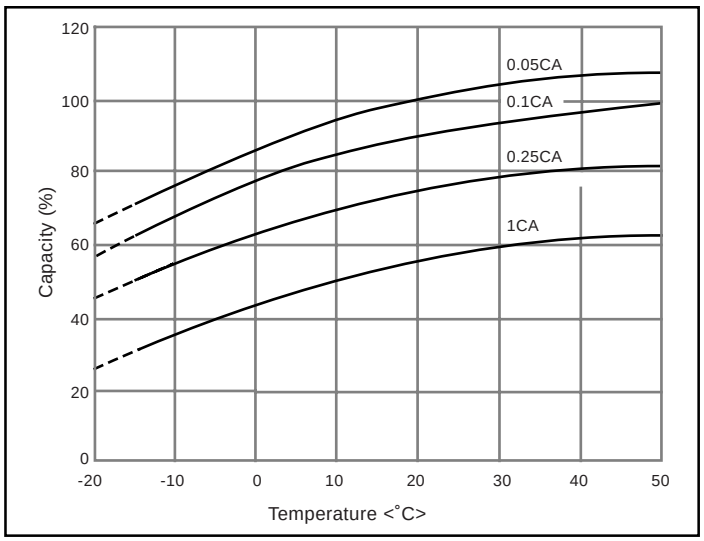
(1) Control the ambient temperature during discharge within the range from 5°F-122°F (-15°C to 50°C) for the reason described below.

(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 -5°F (-15°C). For the high temperature side, on the other hand, the discharge temperature should not exceed 122°F (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 VRLA 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 104°F (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: 5°F to 104°F (-15°C to 40°C) (preferably below 86°F (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)

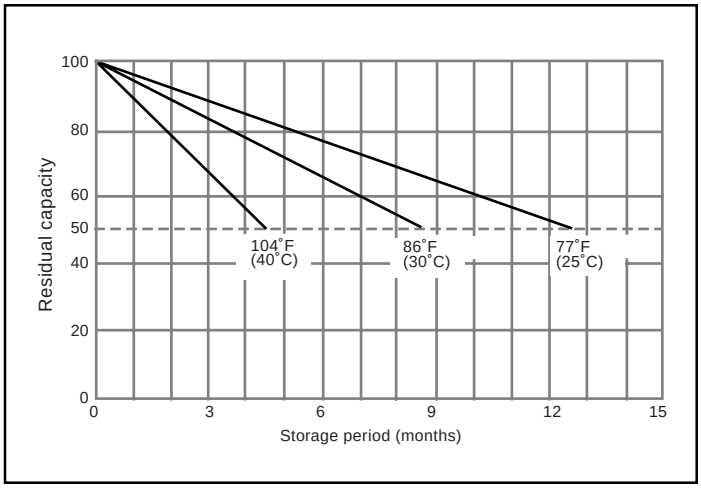
When it is unavoidable to store the battery for 3 months or longer, periodically recharge the battery at the intervals recommended in the table below depending on ambient temperature. Avoid storing the battery for more than 12 months.

Storage temperature	Interval of auxiliary charge (refresh charge)
Below 68°F (20°C)	9 months
68°F (20°C) to 86°F (30°C)	6 months
86°F (30°C) to 104°F (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. The self discharge rate almost doubles by each 10°C rise of storage temperature.

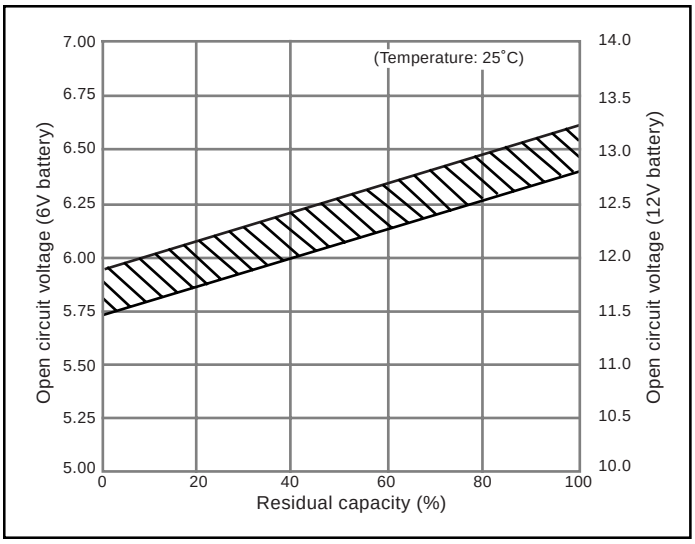
Residual capacity test result



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 77°F (25°C)



- **Temperature conditions**

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

Charge	32°F (0°C) ~ 104°F (40°C)
Discharge	5°F (-15°C) ~ 122°F(50°C)
Storage	5°F (-15°C) ~ 104°F (40°C)

- **Battery life**

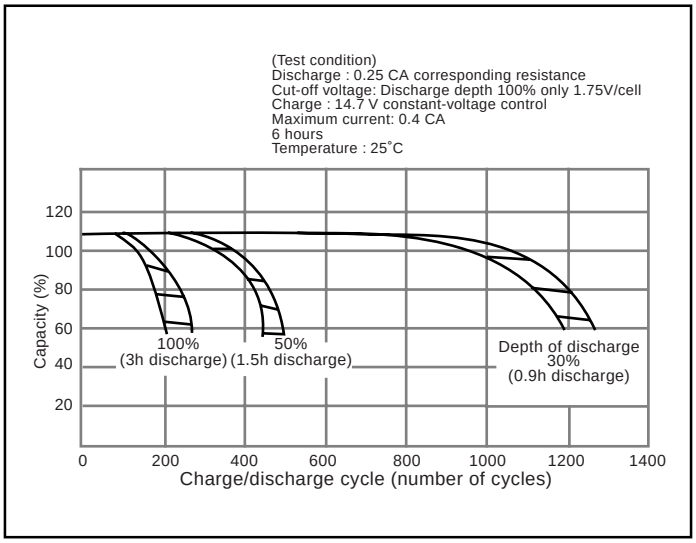
a) Cycle life

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 chart to the right.

This data is typical and tested at a well-equipped laboratory in a controlled environment.

Cycle times are different for each battery model. Cycle times can also differ from this data when using batteries under real conditions.

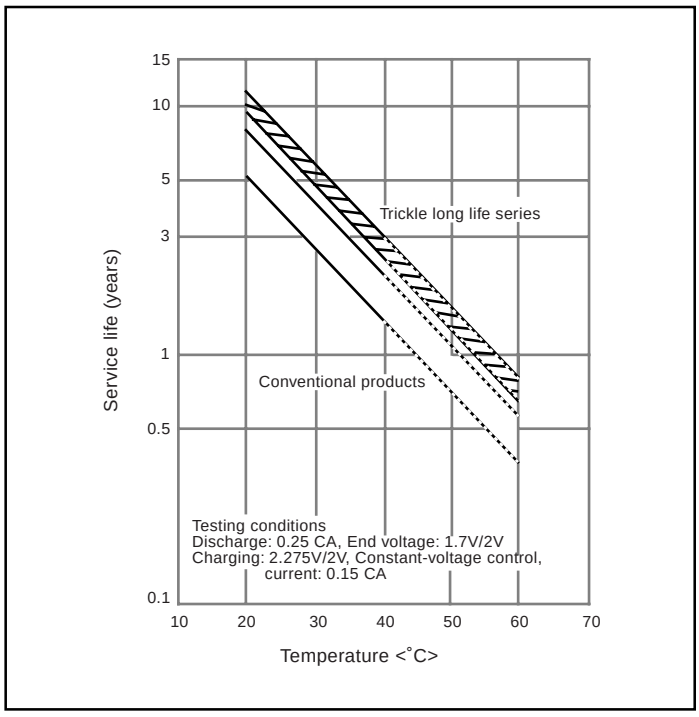
Cycle life vs. Depth of discharge



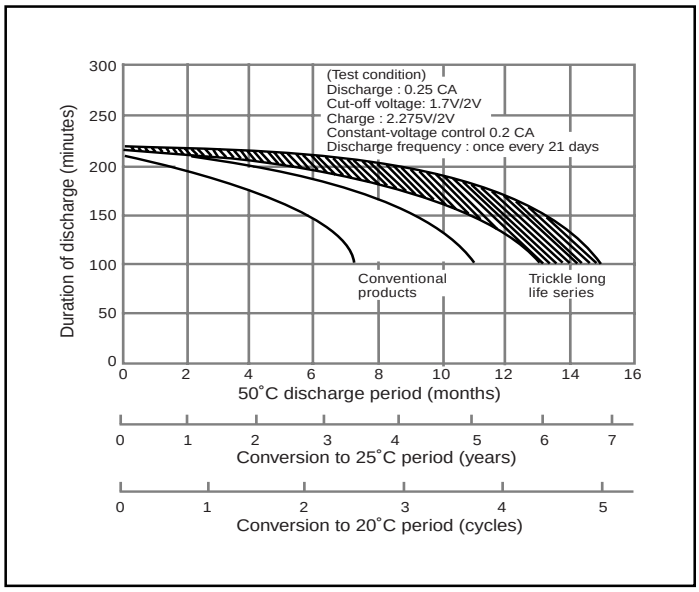
b) Trickle (Float) life

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.

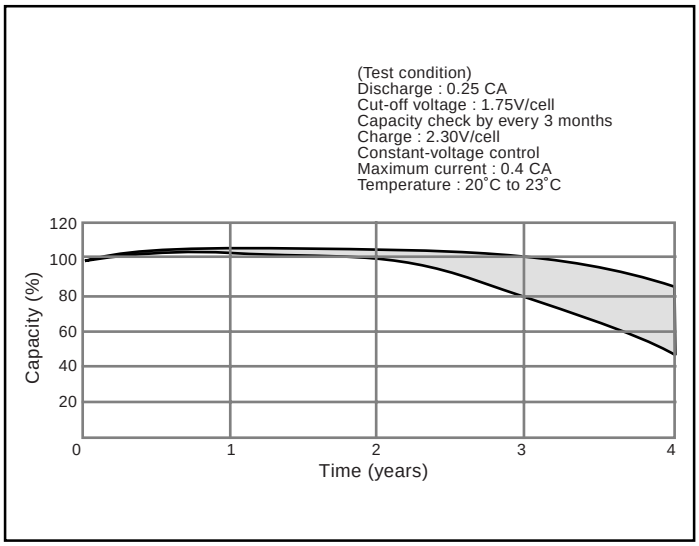
Influence of Temperature on Trickle life



Trickle life characteristics at 122°F (50°C)



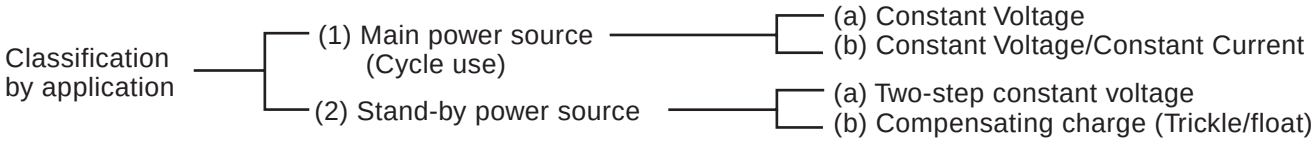
Trickle (Float) life characteristics (LC-R and LC-L)



Methods of Charging the Valve-Regulated Lead-Acid Battery

For charging the valve-regulated lead-acid battery, a well-matched charger should be used because the capacity or life of the battery is influenced by ambient temperature, charge voltage and other parameters.

Charging methods are dependent on battery applications, and the applications are roughly classified into main power application and stand-by/ back-up power applications.



(1) Main Power (Cycle use)

Cycle use is to use the battery by repeated charging and discharging in turn.

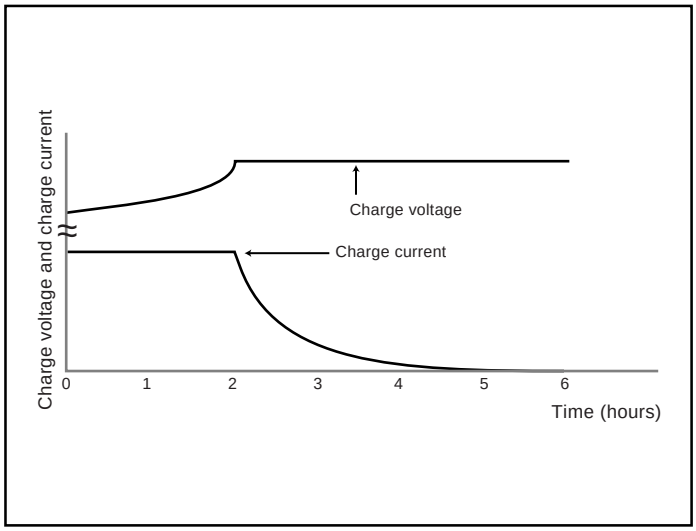
(a) Constant voltage charging method

This method is to charge the battery by applying a constant voltage between the terminals. When the battery is charged by applying a voltage of 2.45 V per cell (unit battery) at a room temperature of 20°C to 25°C, charging is complete when the charge current continues to be stable for three hours. Valve-Regulated lead-acid batteries can be overcharged without constant voltage control. When the battery is overcharged, the water in the electrolyte is decomposed by electrolysis to generate more oxygen gas than what can be absorbed by the negative electrode. The electrolyte is changed to oxygen gas and hydrogen gas, and lost from the battery system. As the quantity of electrolyte is reduced, the chemical reactions of charge and discharge become inefficient and hence the battery performance is severely deteriorated. Therefore, exact voltage control and proper charging time in constant voltage charging are essential for securing the expected life of the battery.

(b) Constant-voltage and constant-current charging method

This method charges the battery by controlling the current at 0.4 CA and controlling the voltage at 2.45V/per cell (unit battery) at a room temperature of 20°C to 25°C. Proper charging time is 6 to 12 hours depending on discharge rate.

Constant-voltage constant-current charge characteristics



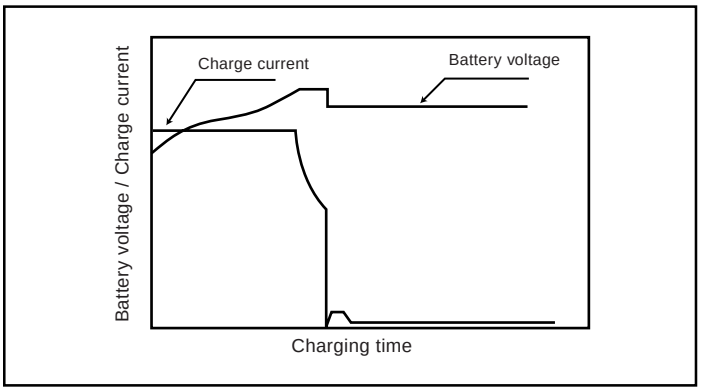
(2) Stand-by/Back-up use

The application load is supplied with power from AC sources in normal state. Stand-by/back-up use is to maintain the battery system at all times so that it can supply power to the load in case the AC input is disrupted (such as a power failure). There are two methods of charging for this use.

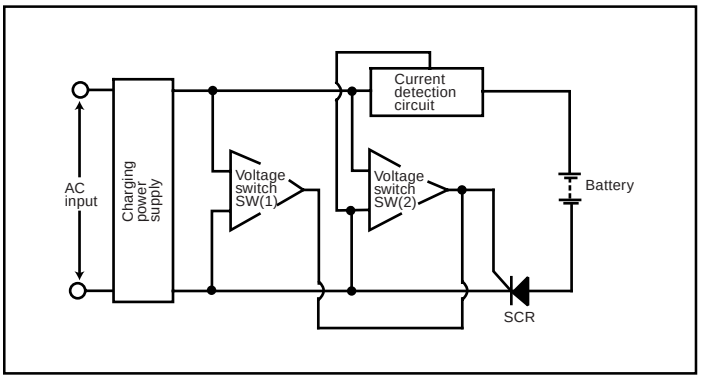
(a) Two-step constant voltage charge control method

Two-step constant voltage charge control method uses two constant-voltage devices. At the initial stage, the battery is charged by the first constant-voltage device SW(1) of high setup voltage (set-up for cycle charge voltage). When the charge current, the value of which is detected by the current-detection circuit, has reduced to the preset value, the device is switched over to the second SW(2) of low set-up voltage (setup for trickle charge voltage). This method has the advantage that the battery in trickle use can be charged in a comparatively short time for the next discharge.

Charging characteristics of the two-step constant voltage control charger



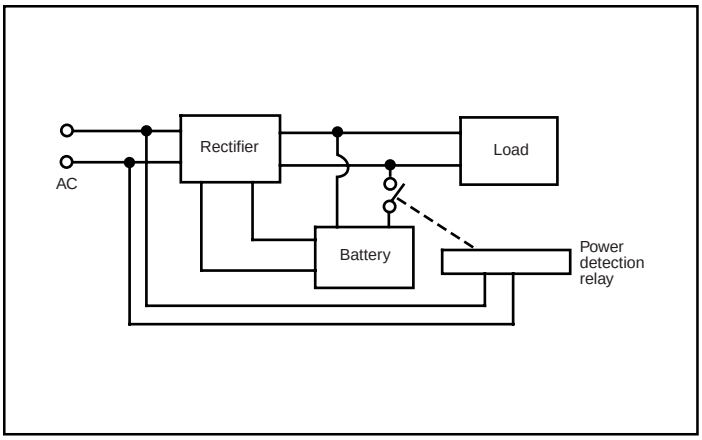
Block diagram of the two-step constant voltage control charger



(b) Compensating charge (Trickle charge)

In this charge system, the battery is disconnected from the load and kept charged with a small current only for compensating self discharge while AC power is alive. In case of power failure, the battery is automatically connected to the load and battery power is supplied. This system is applied mainly as a spare power source for emergency equipment. In this use, if rapid recovery of the battery after discharge is required, it is necessary to consider the recovery charge with a comparatively large current followed by trickle charge, or alternative measures. (See two-step constant voltage charge control method)
While the type and capacity of the battery is determined by the back-up time and the load (current consumption) during power failure, some reserve power should be taken into account considering such factors as ambient temperature, capability of the charger and depth of discharge.

Trickle charge system model

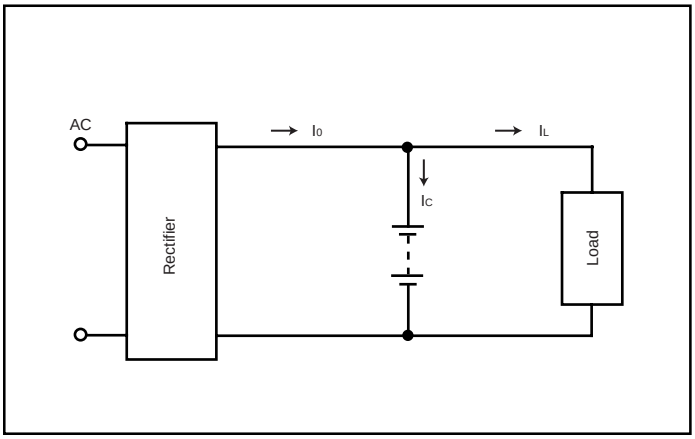


Precautions on charging (Trickle charge)

1. As the battery continues to be charged over a long period, a small difference in charging voltage may result in a significant difference in the battery life. Therefore, charge voltage should be controlled within a narrow range and with little variation for a long period.
2. As charge characteristics of the battery are dependent on temperature, compensation for temperature variation is required when the battery is used over a broad temperature range, and the system should be designed so that the battery and the charger are kept at the same temperature.

- **Float charge**
  Float system is the system in which the battery and the load are connected in parallel to the rectifier, which should supply a constant-voltage current.

Float charge system model



In the above-illustrated model, output current of the rectifier is expressed as:
$I_o = I_c + I_L$ where I_c is charge current and I_L is load current. Consideration should be given to secure adequate charging because, in fact, load current is not constant but irregular in most cases.

In the float system, capacity of the constant-voltage power source should be more than sufficient against the load. Usually, the rectifier capacity is set at the sum of the normal load current plus the current needed in order to charge the battery.

Precautions on charging (Float charge)

1. (a) in constant voltage charging (cycle use): Initial current should be 0.4 CA or smaller (C: rated capacity)
   (b) in constant voltage charging (trickle use): Initial current should be 0.15 CA or smaller (C: rated capacity)
2. Relation between standard voltage value in constant voltage charging and temperature is given in the Table.

Relation between standard voltage value in constant voltage charging and temperature

		0°C	25°C	40°C
Cycle use	6V	7.7	7.4	7.1
	12V	15.4	14.7	14.2
Trickle use	6V	7.1	6.8	6.7
	12V	14.1	13.7	13.4

Charging Methods and Applications of VRLA Batteries

Application/ Charging Method	Normal charging in 6 or more hours; Constant voltage control	Two-step constant voltage control	Constant current control
Cycle use	Control voltage: 7.25 to 7.45V/6V battery 14.5 to 14.9V/12V battery Initial current: 0.4 CA or smaller		
Trickle use	Control voltage: 6.8 to 6.9V/6V battery 13.6 to 13.8V/12V battery	Initial charging with current of approx. 0.15 CA, followed by switching voltage to trickle charge	
Float use	Control voltage: 6.8 to 6.9V/6V battery 13.6 to 13.8V/12V battery Float charging compensates for load fluctuations.		
Refresh charge (Auxiliary charge)*	When charging two or more batteries at a time, select only those which have been left under the same condition.		Charging with current of approx. 0.1 CA
Application example	General uses, Cellular phones (bag phones), UPS, Lanterns, Electric tools	Medical equipment, Personal radios	

Note * Refresh (auxiliary) charge amount should be 120 to 130 % of self-discharge amount. For details, please contact us.

Charging Considerations

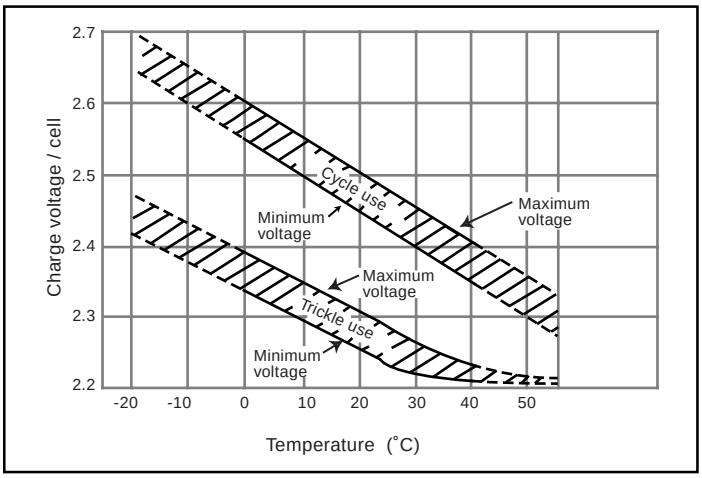
a) Temperature compensation of charge voltage

Charge voltage should be compensated to the ambient temperature near the battery, as shown by the figure below. Main reasons for the temperature compensation of charge voltage are to prevent the thermal runaway of the battery when it is used in high temperature conditions and to secure sufficient charging of the battery when it is used in low temperature conditions. Prolongation of service life of the battery by the above-described temperature compensation is expected as follows

- At 30°C: prolonged by approx. 5 %
- At 35°C: prolonged by approx. 10 %
- At 40°C: prolonged by approx. 15 %

In low temperature zones below 20°C, no substantial prolongation of the battery life can be expected by the temperature compensation of charge voltage.

Compensated voltage value



b) Charging time

Time required to complete charging depends on factors such as depth of discharge of the battery, characteristics of the charger and ambient temperature. For cycle charge, charging time can be estimated as follows:

(1) when charge current is 0.25 CA or greater:
Tch = Cdis / I + (3 to 5)

(2) when charge current is below 0.25 CA:
Tch = Cdis / I + (6 to 10) ,where

Tch : Charging time required (hours)
Cdis : Amount of discharge before this charging (Ah)
I : Initial charge current (A)

Time required for trickle charge ranges from 24 to 48 hours.

c) Charging temperature

(1) Charge the battery at an ambient temperature in the range from 0°C to 40°C.
(2) Optimum temperature range for charging is 5°C to 35°C.
(3) Charging at 0°C or below and 40°C or higher is not recommended: at low temperatures, the battery may not be charged adequately; at high temperatures, the battery may become deformed.
(4) For temperature compensation values, see a).

d) Reverse charging

Never charge the battery in reverse, as it may cause leakage, heating or bursting of the battery.

e) Overcharging

Overcharge is an additional charge after the battery is fully charged. Continued overcharging shortens the battery life. Select a charge method which is specified or approved for each application.

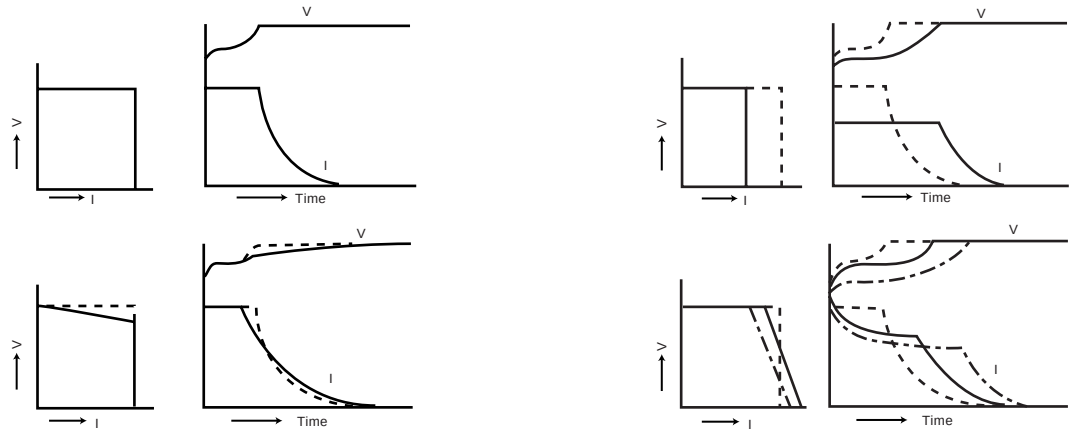
f) Charging before use

Recharge the battery before use to compensate for capacity loss due to self-discharge during storage. (See “Refresh charge” (auxiliary charge) table on page 22.)

- **Characteristics of constant voltage chargers**

Even with the same voltage set-up, charging time varies with output V-I characteristics.

Output V-I characteristics of the constant voltage charger vs. Charging pattern of the battery



Precautions

1) When adopting charging methods and charging conditions other than those described in the specifications or the brochures, thoroughly check charging/discharging characteristics and life characteristics of the battery in advance. Selection of appropriate methods and conditions of charging is essential for safe use of the battery and for fully utilizing its discharge characteristics.
2) In cyclic use of the battery, use a charger equipped with a charging timer or a charger in which charging time or charge amount is controlled by other means; otherwise, it will be difficult to judge the completion of the charge. Use of a charger as described above is recommended to prevent undercharge or overcharge which may cause deterioration of the battery characteristics.
3) Continue charging the battery for the specified time or until the charge completion lamp, if equipped, indicates completion of charging. Interruption of charging may cause a shortening of service life.
4) Do not recharge the fully charged battery repeatedly, as overcharge may accelerate deterioration of the battery.
5) In cyclic use of the battery, do not continue charging for 24 hours or longer, as it may accelerate deterioration of the battery.
6) In cyclic service of the battery, avoid charging two or more batteries connected in parallel simultaneously: imbalance of charge/discharge amount among the batteries may shorten the life of batteries.

VRLA battery (of 25 Ah or smaller capacity) safety test items

Item	Test method	Check point
1. Shock test (Drop test)	A fully charged battery is allowed to drop in the upright position from the height of 20 cm onto a hard board having a thickness of 10 mm or more. Test is repeated three times.	The battery should be free from noticeable breakage or leaks; and its terminal voltage should be held higher than the nominal voltage.
2. Vibration test	A vibration frequency 1000 times/minute and amplitude 4 mm is applied to the X-, Y- and Z-axis directions of a fully charged battery for 60 minutes respectively.	No battery part should be broken; the battery should be free from leaks; and its terminal voltage should be held higher than the nominal voltage.
3. Oven test	A fully charged battery is left standing in an atmosphere of 70°C for 10 hours.	The battery case should not be deformed; the battery should be free from leaks.
4. Coldproof test	A fully charged battery is connected to a resistor equivalent to 60 hour rate discharge and left for 4 days; then the battery is left standing in an atmosphere of -30˚C for 24 hours.	No crack should develop in the battery case; the battery should be free from leaks.
5. Heat cycle test	A fully charged battery is exposed to 10 cycles of 2 hours at -40°C and 2 hours at 65°C	No crack should develop in the battery case; the battery should be free from leaks.
6. Short circuit test	A fully charged battery connected with a small resistor of 10 ohms or less is allowed to discharge.	The battery must not burn nor burst.
7. Large current discharge test	A fully charged battery is allowed to discharge at 3CA to 4.8V/6V battery level. (This test is not applicable to batteries having a built-in thermostat)	The battery must not burn nor burst, and it should be free from battery case deformation, leaks and any irregularity in the internal connections.
8. Vent valve function test	A fully charged battery is submerged in liquid paraffin in a container, then overcharged at 0.4 CA. (UL1989)	Release of gas from the vent should be observed.
9. Overcharge test	A fully charged battery is overcharged at 0.1 CA for 48 hours, left standing for one hour, and allowed to discharge at 0.05CA to 5.25V/6V battery level.	No irregularity should be noticed in the battery appearance; the battery should retain 95% or more of the initial capacity.

(Note) The above safety notes apply only to standalone batteries, not to embedded batteries.

MODEL NUMBERS OF VALVE-REGULATED LEAD-ACID BATTERIES

Composition of Model Numbers.

Figure No.	1	2	3	4	5	6	7	8	9	10	11	12
Model No.	L	C	-	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗

⊗: Corresponding model number descriptions are listed below.
Please refer to the battery indexes for listings of available models.

No. 1 to 3:
Product codes: "LC" indicates Panasonic Sealed Lead-Acid batteries; "UP" indicates High Power Series.

No. 4:
Fixed single-figure code (alphabetic letter) indicating properties, shape, etc. of the battery

R : Small-sized VRLA products (under 33Ah)
V : Optional flame-retardant case for "R" types
P : Products combining trickle long life and flame-retardant battery case
X : Trickle long life products
XC : Cycle long life products

No. 5:
Single code (alphabetic letter) for dividing products of the same type and the same capacity but having different shapes. (This figure may be omitted when not applicable, then the proceeding codes are advanced.)

No. 5 to 7:
Double-figure fixed codes indicating nominal voltage by numerical value.

Examples:
2V = 02, 6V = 06, 12V = 12, 24V = 24, etc.

No. 7 to 10:
One- through four-figure (maximum) codes indicating capacity by numbers: decimal point is expressed by R (When some codes are not applicable, the proceeding codes are advanced.)

Examples:

Capacity (20 hour rate)	4Ah	7.2Ah	12Ah	3000Ah
	↓	↓	↓	↓
Model Number	4	7R2	12	3000

No. 8 to 12:
One- through five-figure (maximum) alphanumeric code for classifying products by terminal type, package form, destination code, etc.

Examples: **P: English label**
J: Japanese label
G: VDE certified products

Terminal Codes:

Description	Code*
Faston Tab Type 187/187 (+/–)	P
Faston Tab Type 250/250 (+/–)	P1
Faston Tab Type 250/187 (+/–)	P2

Terminal/Post Type	
Description	**Code**
Threaded Post Type (M5/M6)	AP
Bolt & Nut Type (M5/M6/M8)	P

* Examples for English labels.

Example 1:

LC—	P	12	7R2	P
Production division code	Trickle long life type, Flame retardant	12V	7.2Ah	English label (187 Terminal)

Example 2:

LC—	X	12	65	P
Production division code	Trickle long life type	12V	65Ah	English label (Bolt & Nut Terminal)

Example 3:

LC—	R	12	7R2	PG
Production division code	Small-sized SLA products (under 33Ah)	12V	7.2Ah	Products with VDE recognition (187 terminal)

Example 4:

UP—	R	W	12	45	P	1
Production division code	For standby power source	Watt	12V	The wattage at 2V, 10 minute rate discharge	English label	250 Terminal

BATTERY SELECTION CHART

Method of battery selection (Estimation of initial discharge time)

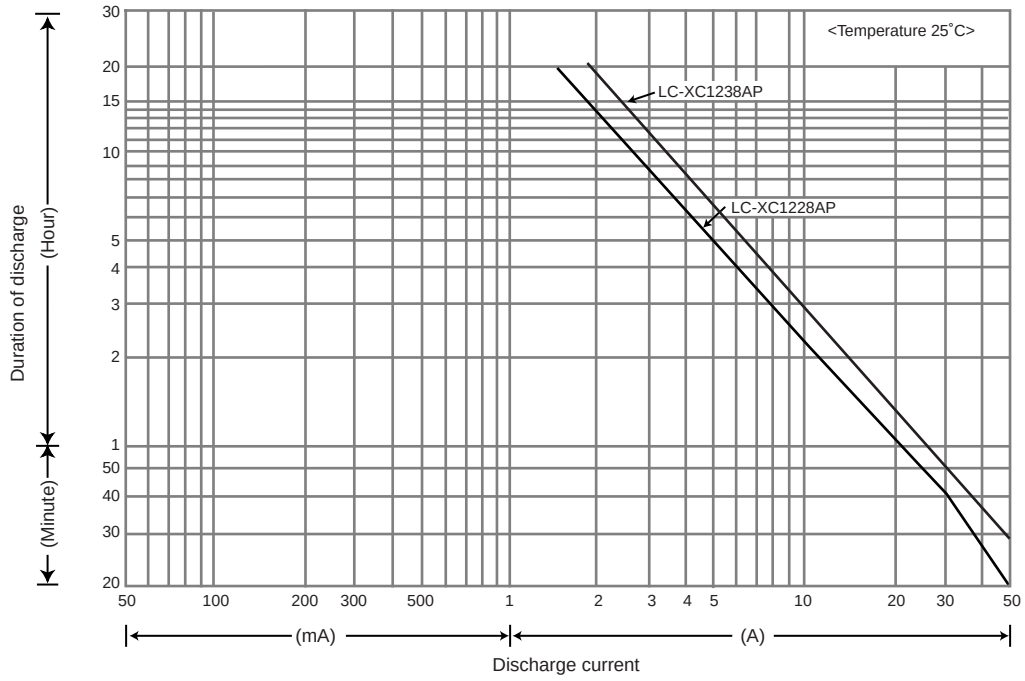
(1) Determine discharge current.

(2) Determine duration of discharge required.

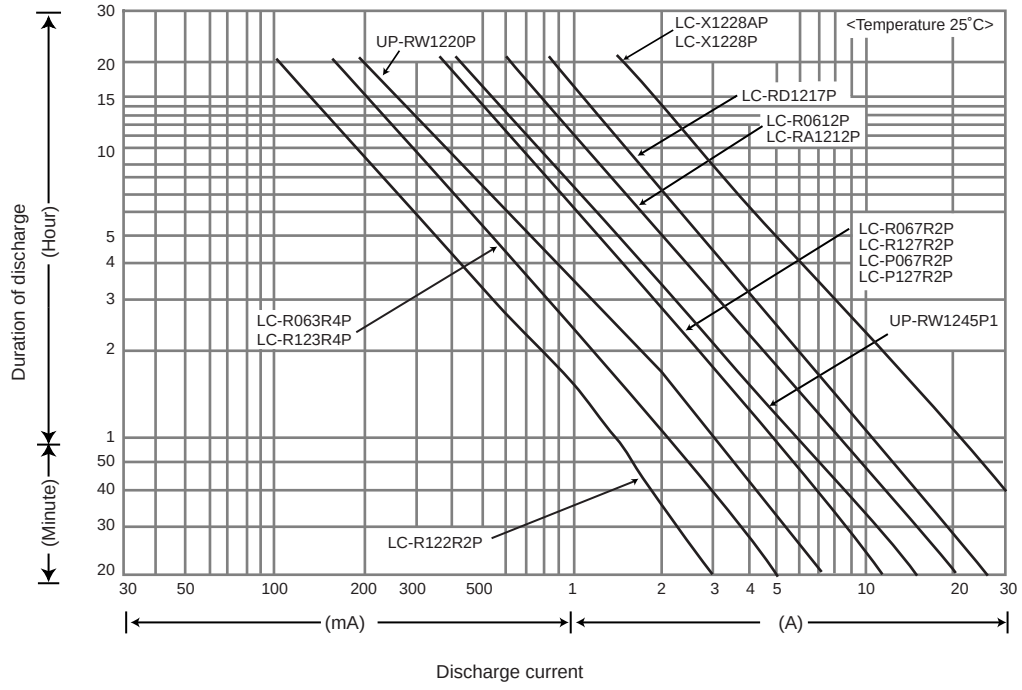
(3) Select batteries from the selection chart below.

Then, select a battery which meets the specification of the equipment in which the battery is loaded such as voltage, dimensions and mass, from the “Battery Index” on page 31 to 33.

VRLA battery for main power applications



VRLA battery for standby power applications (1.3 Ah to 28 Ah)



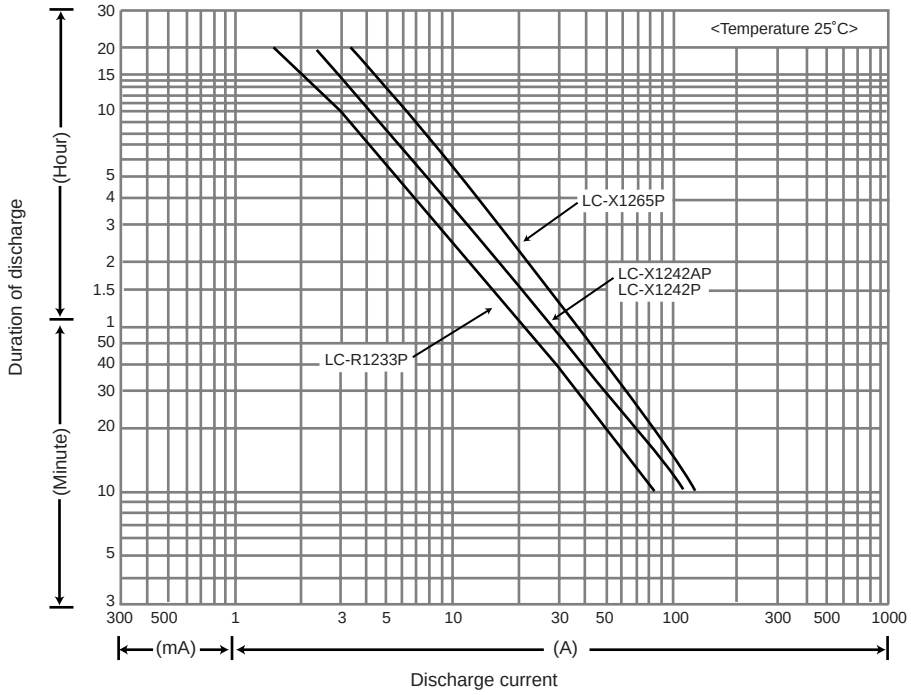
(4) Example

- Use condition: 2.9 A, 1.5 hours, 12 V; space allowable 100 mm x 160 mm x 105 mm
- 7.2 Ah is selected in the step (3).
- LC-R127R2P 94 mm x 151 mm x 100 mm is selected in the step (4).

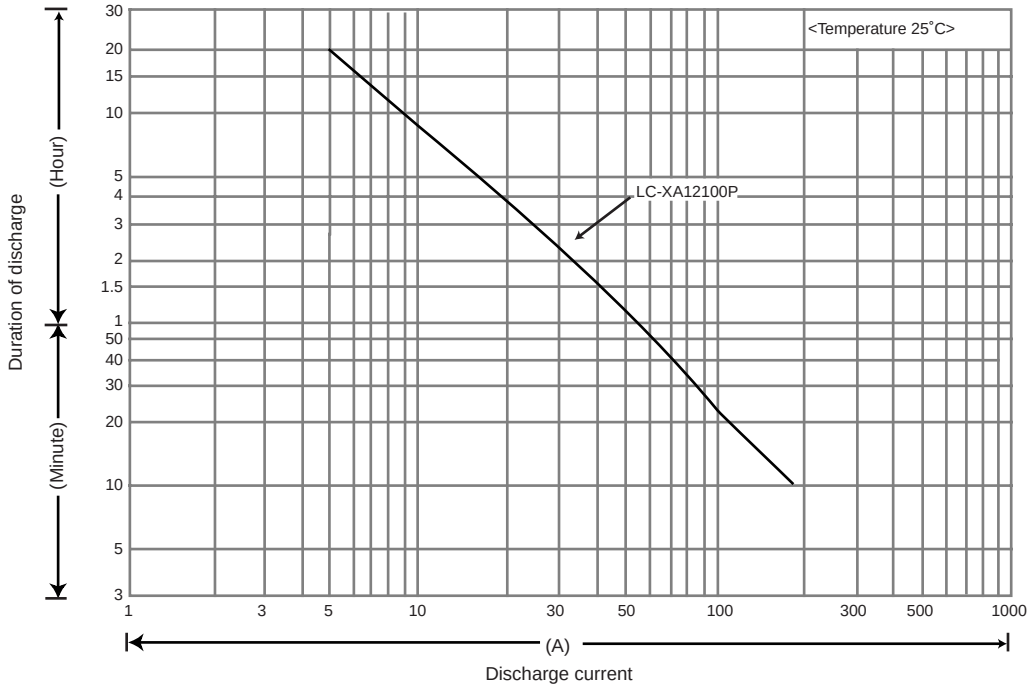
(5) Refer to Valve-Regulated Lead Acid Batteries: Individual Data Sheet for detailed discharge characteristics of the battery.

(Note) Data given are the average values obtained within three cycles of charge/discharge, not the mnimum values.

VRLA battery for standby power applications (33 Ah to 65 Ah)



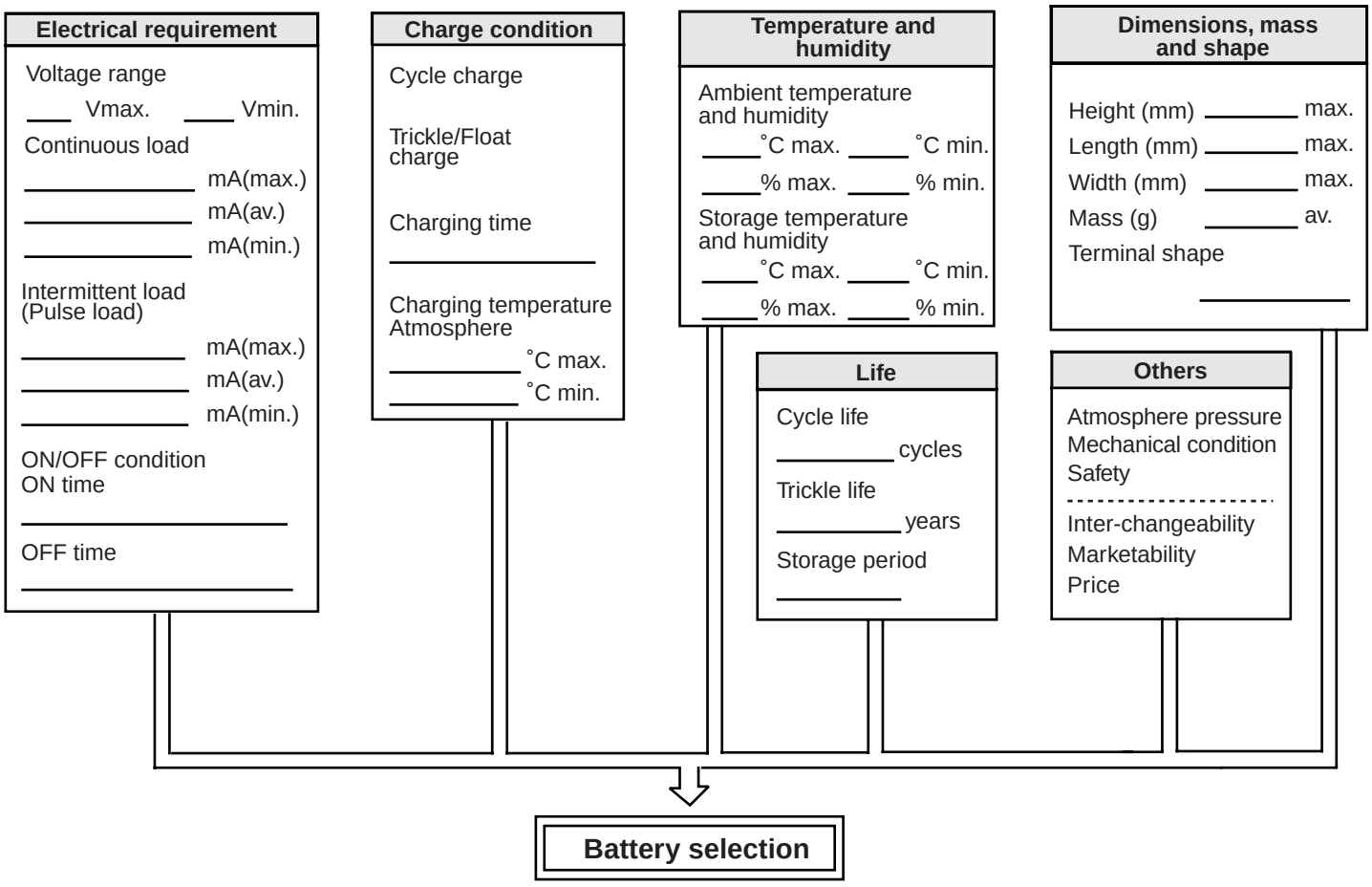
VRLA battery for standby power applications (100 Ah)



Steps for selecting batteries are described below.

- Study of required specifications (draft) Study the required specifications (draft) by checking the requirements for the battery with the battery selection criteria. Technical requirements for selecting the battery are presented below.

Technical requirements for battery selection



- **Battery selection**
  First, select several candidate batteries by referring to the technical brochures and data sheets of the batteries presently available. Then from the candidates select a battery which can meet as many of the ideal requirements as possible. In fact, however, battery selection can be seldom made so smoothly. Some removal or easing of the requirements may need to be considered first; then depending on the result, a proper battery should be selected from those presently available. This way of proceeding enables economic selection of the battery. Any questions at this stage should be refered to battery engineers in depth. Sometimes, new or improved batteries which are not carried in the brochures have become available, and an appropriate battery may be found among them. Usually, required specifications are finalized at this stage.

- **Request for improving or developing batteries**
  If no battery which will satisfy special requirements can be found by the above-described approach, requests for improving or developing new batteries should be made to our technical department, and these requests should be coordinated as quickly as possible to allow enough time for studying: the study takes usually 6 to 12 months or even longer depending on the request.

  In this section, guidelines for selecting appropriate batteries for specific equipment were mentioned. If further information regarding the battery selection is required, please contact us.

BATTERY INDEX FOR MAIN AND STANDBY POWER APPLICATIONS

Standard Type

Expected trickle life approx. 3 years…LC-R, LC-L series

Model Number	Nominal Voltage (V)	Rated capacity (Ah) (20 hour rate)	Expected trickle life (years)		Terminal types	Battery-case resin		Page
			at 25°C	at 20°C		Standard UL94HB	Flame-retardant UL94V-0	
LC-R061R3P	6	1.3	3-5	5	Faston 187	standard	N/A	33
LC-R121R3P	12	1.3	3-5	5	Faston 187	standard	N/A	34
LC-R122R2P	12	2.2	3-5	5	Faston 187	standard	N/A	35
LC-R123R4P	12	3.4	3-5	5	Faston 187	standard	N/A	36
LC-R063R4P	6	3.4	3-5	5	Faston 187	standard	N/A	37
LC-RA064R2P	6	4.2	3-5	5	Faston 187	standard	N/A	38
LC-R067R2P	6	7.2	3-5	5	Faston 187 or Faston 250	standard	N/A	39
LC-R127R2P	12	7.2	3-5	5	Faston 187 or Faston 250	standard	N/A	41
LC-R0612P	6	12.0	3-5	5	Faston 187 or Faston 250	standard	N/A	43
LC-RA1212P	12	12.0	3-5	5	Faston 187 or Faston 250	standard	N/A	45
LC-RD1217P	12	17.0	3-5	5	M5 bolt and nut	standard	optional	46
LC-R1233P	12	33.0	3-5	5	M6 bolt and nut	standard	optional	48

Notes:
- If used cyclically, so that the battery is repeatedly only partially discharged (by less than 30% of its rated capacity) and then recharged, the battery life may be drastically shortened, depending on the discharging conditions. Please consult Panasonic regarding the actual load pattern, recharging method, environmental conditions, etc.
- Please contact Panasonic for information on the country of origin of specific battery models.

High Power Series

High energy density and slim design for standby power applications

Model Number	Nominal Voltage (V)	Nominal capacity W/cell (10 minute rate)	Expected trickle life (years)		Terminal types	Battery-case resin		Page
			at 25°C	at 20°C		Standard UL94HB	Flame-retardant UL94V-0	
UP-RW1220P1	12	20W/2V	3-5	5	Faston 250	standard	optional	56
UP-RW1245P1	12	45W/2V	3-5	5	Faston 250	standard	optional	57

Notes:
- If used cyclically, so that the battery is repeatedly only partially discharged (by less than 30% of its rated capacity) and then recharged, the battery life may be drastically shortened, depending on the discharging conditions. Please consult Panasonic regarding the actual load pattern, recharging method, environmental conditions, etc.
- Please contact Panasonic for information on the country of origin of specific battery models.

Trickle Long Life Type

Overview

Our valve-regulated lead-acid battery “trickle long life” series was developed by studying and analyzing the factors which caused deterioration of conventional batteries in various aspects. Further, whereas conventional batteries needed separate bolts and nuts for connection, medium-capacity (28 to 42Ah) type batteries of this series adopt unique terminals which have been made into bolts (threaded post) for simpler installation and better safety; this makes replacement and connection of the batteries easier.
The safety and reliability of these batteries has been greatly improved through the adoption of flame-retardant resins. (For 2.0Ah and 20 to 100Ah, 94HB-equivalent resin is standard; 94V-0-equivalent resins are also available).

Features

- **Much longer trickle life compared with conventional batteries was achieved with the battery footprint unchanged.**
  Expected trickle life in the range from 2.0 to 100 Ah

Conventional	This series
3-5 years (at 25°C) approx. 5 years (at 20°C)	approx. 6 years (at 25°C) approx. 10 years (at 20°C) (discharge rate at 0.25CA)
approx. 2 years (at 25°C) approx. 3 years (at 20°C)	approx. 4 years (at 25°C) approx. 6 years (at 20°C) (discharge rate at 2CA)

Model Number	Nominal Voltage (V)	Rated capacity (Ah) (20 hour rate)	Expected trickle life (years)		Terminal types	Battery-case resin		Page
			at 25°C	at 20°C		Standard UL94HB	Flame-retardant UL94V-0	
LC-P067R2P	6	7.2	6	10	Faston 187 or Faston 250	N/A	standard	40
LC-P127R2P	12	7.2	6	10	Faston 187 or Faston 250	N/A	standard	42
LC-P0612P	6	12.0	6	10	Faston 187 or Faston 250	N/A	standard	44
LC-PD1217P	12	17.0	6	10	M5 bolt and nut	optional	standard	47
LC-X1220P	12	20.0	6	10	M5 bolt and nut	standard	N/A	49
LC-X1220AP	12	20.0	6	10	M5 threaded Post	optional	N/A	49
LC-X1228P	12	28.0	6	10	M5 bolt and nut	standard	optional	50
LC-X1228AP	12	28.0	6	10	M5 threaded Post	standard	optional	50
LC-X1242P	12	42.0	6	10	M5 bolt and nut	standard	optional	53
LC-X1242AP	12	42.0	6	10	M5 threaded Post	standard	optional	53
LC-X1265P	12	65.0	6	10	M5 bolt and nut	standard	optional	54
LC-XA12100P	12	100.0	6	10	M5 bolt and nut	standard	optional	55

Notes: • If used cyclically, so that the battery is repeatedly only partially discharged (by less than 30% of its rated capacity) and then recharged, the battery life may be drastically shortened, depending on the discharging conditions. Please consult Panasonic regarding the actual load pattern, recharging method, environmental conditions, etc.

• Please contact Panasonic for information on the country of origin of specific battery models.

Cycle Long Life Type

Overview

Our valve-regulated lead-acid battery “cycle long-life” type was developed in an effort to reduce the number of battery replacements. This battery can be used as the main power supply for a variety of products, including electric cars and electric lawn mowers.

Features

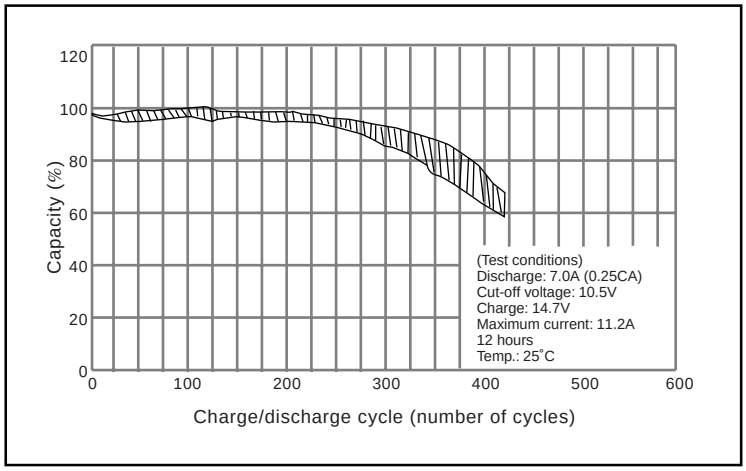
- **Much longer cycle life**
  Conventional approx. 150 cycles
  Cycle long life type approx. 400 cycles
  (Discharge at 0.25CA at 25°C)

Model Number	Nominal Voltage (V)	Rated capacity (Ah) (20 hour rate)	Expected trickle life (years)		Terminal types	Battery-case resin		Page
			at 25°C	at 20°C		Standard UL94HB	Flame-retardant UL94V-0	
LC-XC1228AP	12	28.0	---	---	M5 threaded Post	standard	N/A	51
LC-XC1238AP	12	38.0	---	---	M5 threaded Post	standard	N/A	52

Note: • Please contact Panasonic for information on the country of origin of specific battery models.

Characteristics

- **An example of cycle life at 25°C (LC-XC1228AP)**



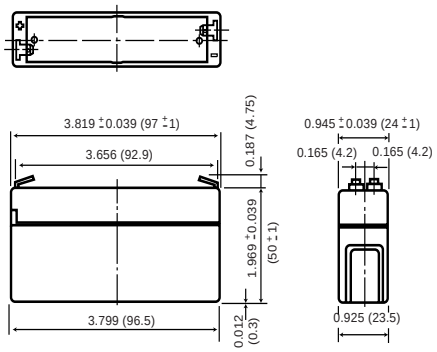
LC-R061R3P

Photo/Label for reference only.

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Dimensions (mm)

Terminal type: Faston 187



Battery case resin: Standard (UL94HB) Color is black.

Specifications

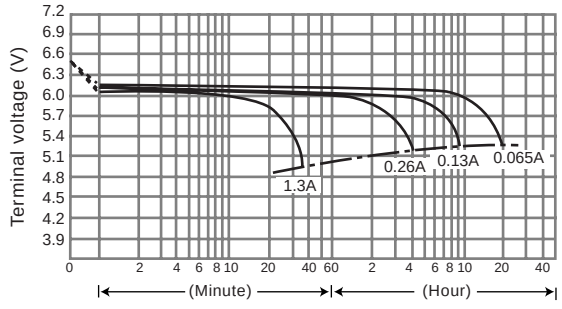
Nominal Voltage		6V
Rated Capacity (20 hour rate)		1.3Ah
Dimensions	Length	3.819 inches (97.0 mm)
	Width	0.945 inches (24.0 mm)
	Height	1.969 inches (50.0 mm)
	Total Height	2.165 inches (55.0 mm)
Approx. mass		.661 lbs. (0.30 kg)
Standard Terminals and Resin	UL94HB Faston 187	LC-R061R3P

Characteristics

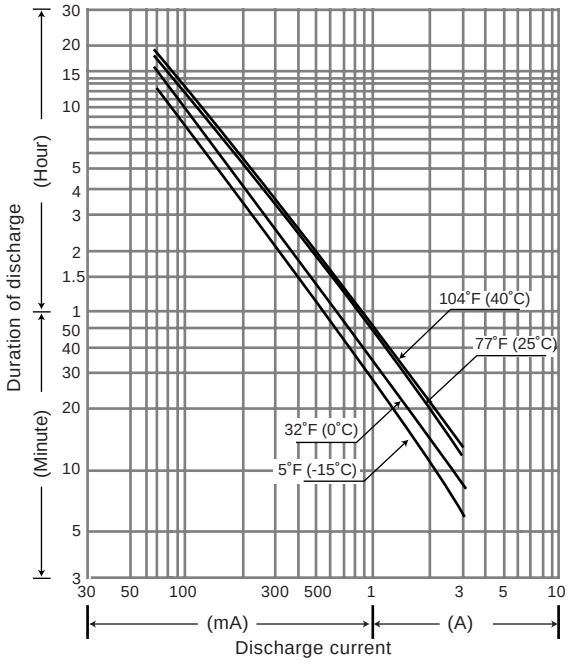
Capacity (note) 77˚F (25˚C)	20 hour rate (65mA) 10 hour rate (120mA) 5 hour rate (210mA) 1 hour rate (850mA)	1.3Ah 1.2Ah 1.05Ah 0.85Ah
	1.5 hour rate discharge Cut-off voltage 5.25 V	0.6A
Internal Resistance	Fully charged battery 77˚F (25˚C)	Approx. 50mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Cycle use (Repeating use)	initial current	0.52 A or smaller
	Control voltage	7.25V to 7.45V (per 6V cell 25˚C)
Charge Method (Constant Voltage) — Trickle use	initial current	0.195 A or smaller
	Control voltage	6.8V to 6.9V (per 6V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



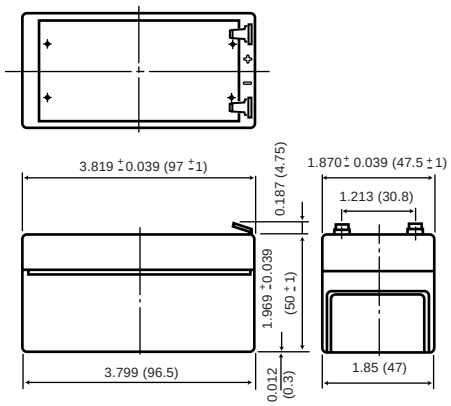
LC-R121R3P

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Photo/Label for reference only.

Dimensions (mm)

Terminal type: Faston 187



Battery case resin: Standard (UL94HB) Color is black.

Specifications

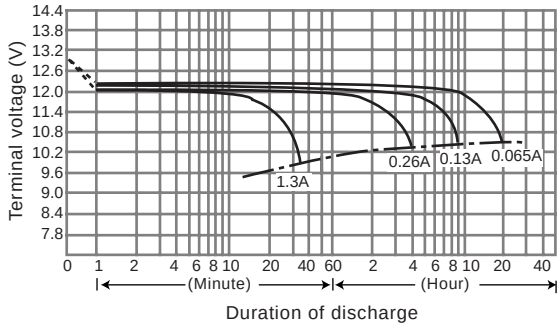
Nominal Voltage		12V
Rated Capacity (20 hour rate)		1.3Ah
Dimensions	Length	3.819 inches (97.0 mm)
	Width	1.870 inches (47.5 mm)
	Height	1.969 inches (50.0 mm)
	Total Height	2.165 inches (55.0 mm)
Approx. mass		1.30 lbs. (0.59 kg)
Standard Terminals and Resin	UL94HB Faston 187	LC-R121R3P

Characteristics

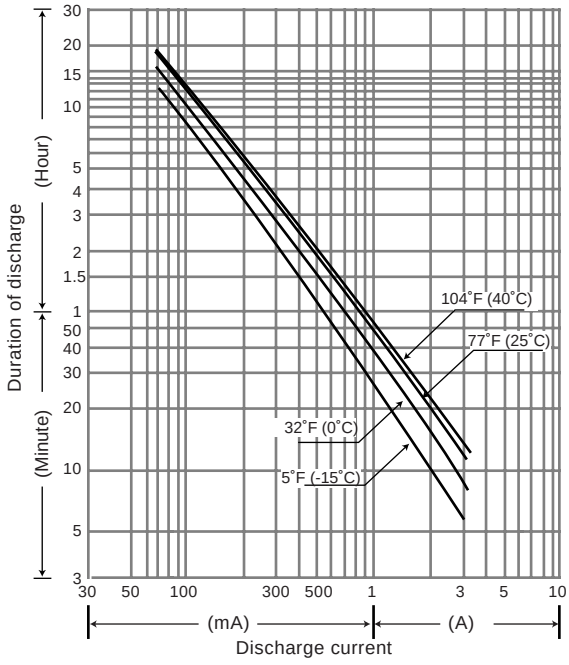
Capacity (note) 77˚F (25˚C)		20 hour rate (65mA) 10 hour rate (120mA) 5 hour rate (210mA) 1 hour rate (850mA)	1.3Ah 1.2Ah 1.05Ah 0.85Ah
		1.5 hour rate discharge Cut-off voltage 10.5 V	0.6A
Internal Resistance		Fully charged battery 77˚F (25˚C)	Approx. 90mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	Initial current	0.52 A or smaller
		Control voltage	14.5V to 14.9V (per 12V cell 25˚C)
	Trickle use	Initial current	0.195 A or smaller
		Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



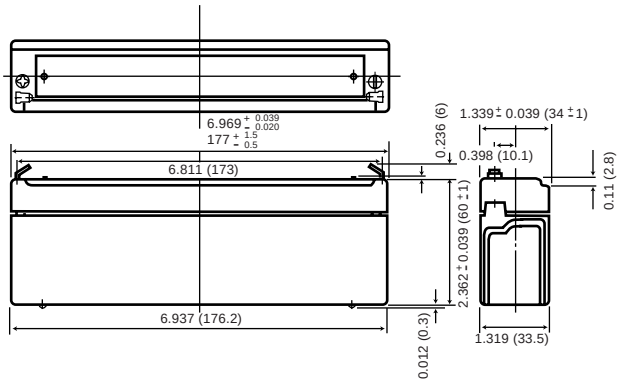
LC-R122R2P

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Photo/Label for reference only.

Dimensions (mm)

Terminal type: Faston 187

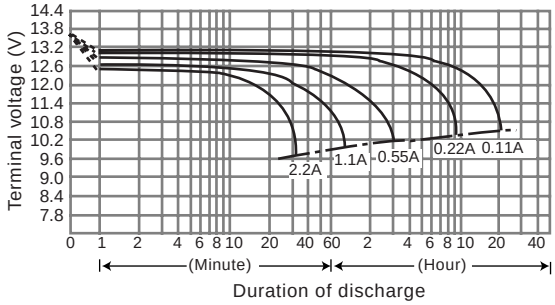


Battery case resin: Standard (UL94HB) Color is black.

Specifications

Nominal voltage		12V
Rated capacity (20 hour rate)		2.2Ah
Dimensions	Length	6.968 inches (177.0 mm)
	Width	1.339 inches (34.0 mm)
	Height	2.362 inches (60.0 mm)
	Total Height	2.598 inches (66.0 mm)
Approx. mass		1.76 lbs (0.80 kg)
Standard Terminals and Resin	UL94HB Faston 187	LC-R122R2P

Discharge characteristics 77°F (25°C) (Note)

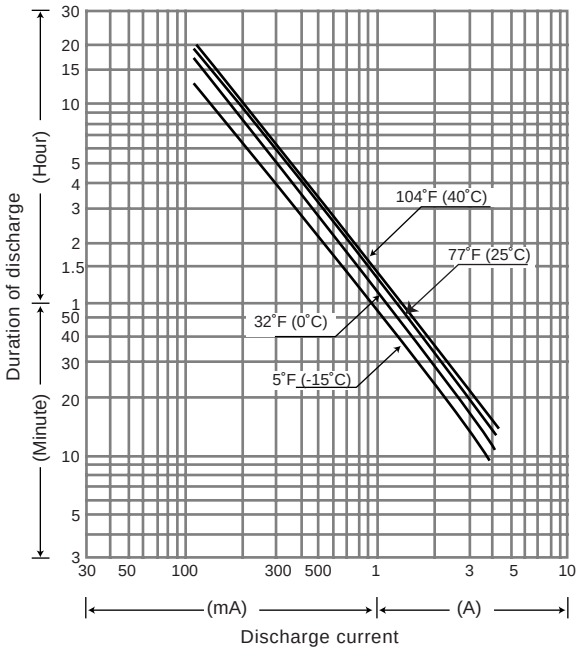


Characteristics

Capacity (note) 77°F (25°C)		20 hour rate (110mA) 10 hour rate (200mA) 5 hour rate (360mA) 1 hour rate (1300mA)	2.2Ah 2Ah 1.8Ah 1.3Ah
		1.5 hour rate discharge Cut-off voltage 10.5 V	0.95A
Internal resistance		Fully charged battery 77°F (25°C)	Approx. 70mΩ
Temperature dependency of capacity (20 hour rate)		104°F (40°C) 77°F (25°C) 32°F (0°C) 5°F (-15°C)	102% 100% 85% 65%
Self discharge 77°F (25°C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	Initial current	0.88 A or smaller
		Control voltage	14.5V to14.9 V (per 12V cell 25°C)
	Trickle use	Initial current	0.33 A or smaller
		Control voltage	13.6V to 13.8V (per 12V cell 25°C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

Duration of discharge vs. Discharge current (Note)



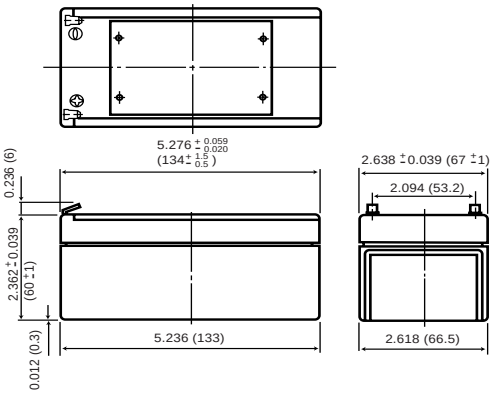
LC-R123R4P

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Photo/Label for reference only.

Dimensions (mm)

Terminal type: Faston 187



Battery case resin: Standard (UL94HB) Color is black.
Optional (UL94V-0) Color is grey.

Specifications

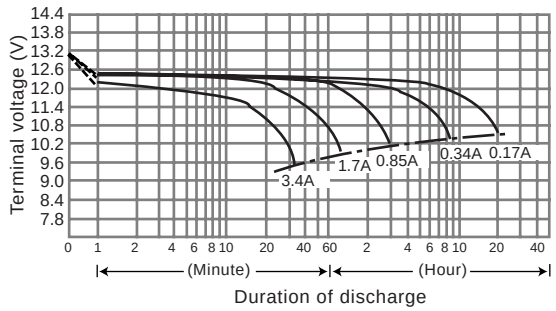
Nominal Voltage		12V
Rated Capacity (20 hour rate)		3.4Ah
Dimensions	Length	5.276 inches (134.0 mm)
	Width	2.638 inches (67.0 mm)
	Height	2.362 inches (60.0 mm)
	Total Height	2.598 inches (66.0 mm)
Approx. mass		2.65 lbs. (1.20 kg)
Standard Terminals and Resin	UL94HB Faston 187	LC-R123R4P

Characteristics

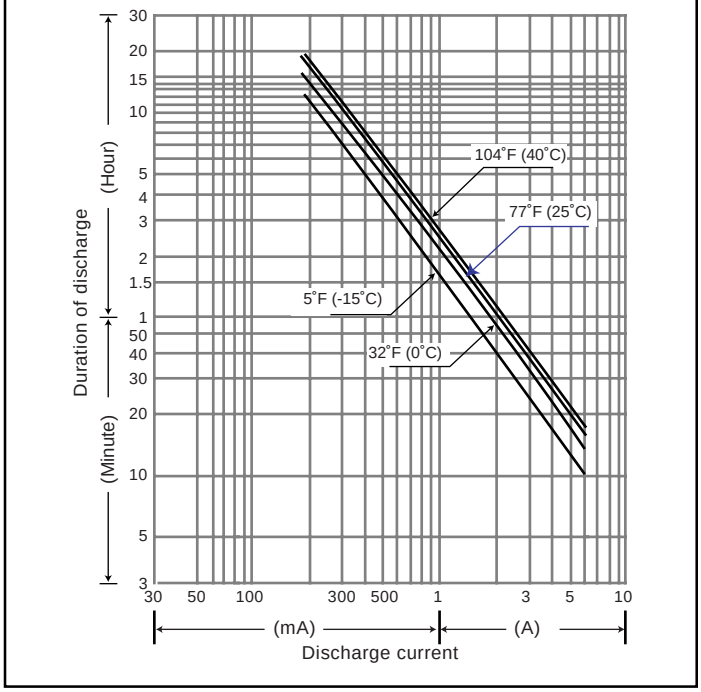
Capacity (note) 77°F (25°C)		20 hour rate (170mA) 10 hour rate (300mA) 5 hour rate (540mA) 1 hour rate (2100mA)	3.4Ah 3Ah 2.7Ah 2.1Ah
		1.5 hour rate discharge Cut-off voltage 10.5 V	1.5A
Internal resistance		Fully charged battery 77°F (25°C)	Approx. 60mΩ
Temperature dependency of capacity (20 hour rate)		104°F (40°C) 77°F (25°C) 32°F (0°C) 5°F (-15°C)	102% 100% 85% 65%
Self discharge 77°F (25°C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	Initial current	1.36 A or smaller
		Control voltage	14.5V to 14.9 V (per 12V cell 25°C)
	Trickle use	Initial current	0.51 A or smaller
		Control voltage	13.6V to 13.8V (per 12V cell 25°C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



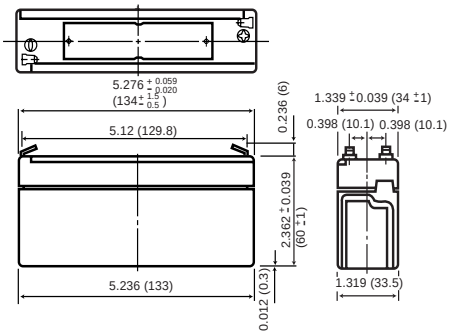
LC-R063R4P

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Photo/Label for reference only.

Dimensions (mm)

Terminal type: Faston 187

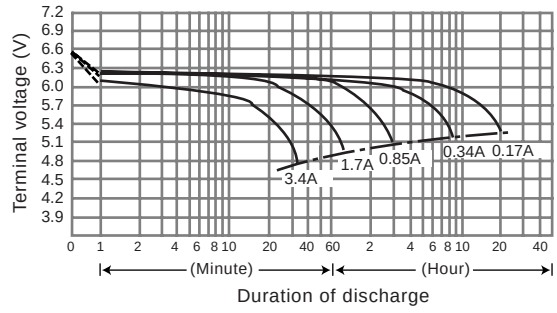


Battery case resin: Standard (UL94HB) Color is black.

Specifications

Nominal Voltage		6V
Rated Capacity (20 hour rate)		3.4Ah
Dimensions	Length	5.276 inches (134.0 mm)
	Width	1.339 inches (34.0 mm)
	Height	2.362 inches (60.0 mm)
	Total Height	2.598 inches (66.0 mm)
Approx. mass		1.37 lbs. (0.62 kg)
Standard Terminals and Resin	UL94HB Faston 187	LC-R063R4P

Discharge characteristics 77°F (25°C) (Note)

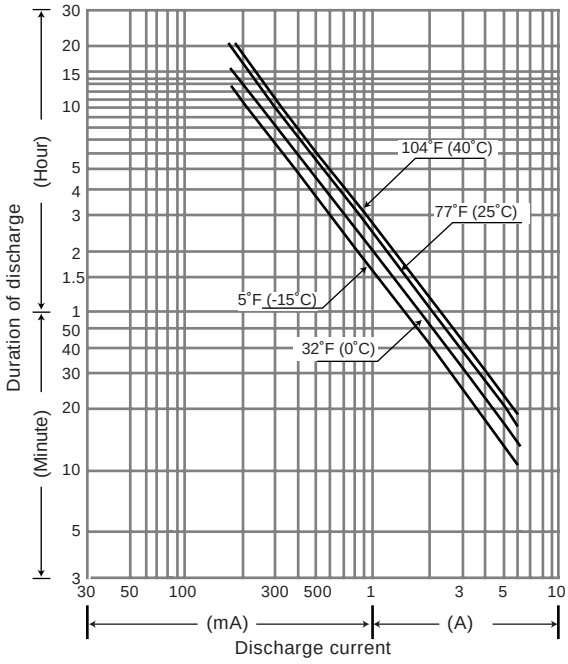


Characteristics

Capacity (note) 77˚F (25˚C)		20 hour rate (170mA) 10 hour rate (300mA) 5 hour rate (540mA) 1 hour rate (2100mA)	3.4Ah 3Ah 2.7Ah 2.1Ah
		1.5 hour rate discharge Cut-off voltage 5.25 V	1.5A
Internal Resistance		Fully charged battery 77˚F (25˚C)	Approx. 30mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	initial current	1.36 A or smaller
		Control voltage	7.25V to 7.45V (per 6V cell 25˚C)
	Trickle use	initial current	0.51 A or smaller
		Control voltage	6.8V to 6.9V (per 6V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

Duration of discharge vs. Discharge current (Note)

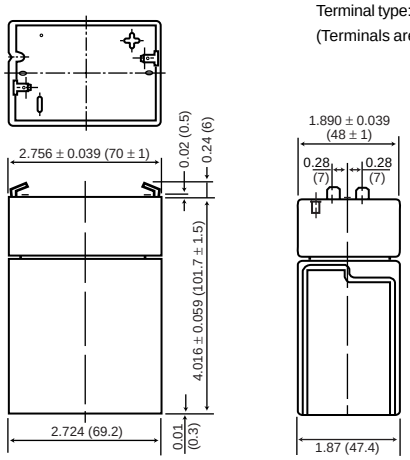


LC-RA064R2P

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Dimensions inch (mm)

Terminal type: Faston 187
(Terminals are dimpled: No hole)



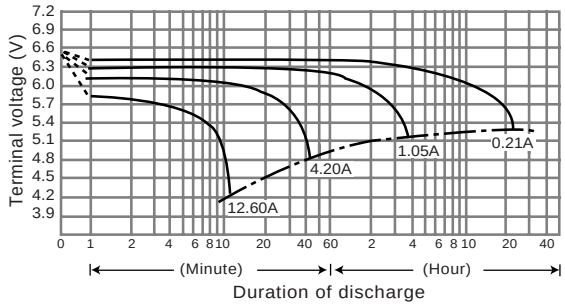
Battery case resin: Standard (UL94HB) Color is black.

Specifications

Nominal Voltage		6V
Rated Capacity (20 hour rate)		4.2Ah
Dimensions inch (mm)	**Total height**	4.255 inches (108mm)
	Height	4.016 inches (102mm)
	Length	2.756 inches (70mm)
	Width	1.890 inches (48mm)
Approx. mass		Approx. 1.72 lbs. (0.78kg)
Standard Terminals and Resin	UL94HB Faston 187	LC-RA064R2P

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

Discharge characteristics (77°F (25°C)) (Note)

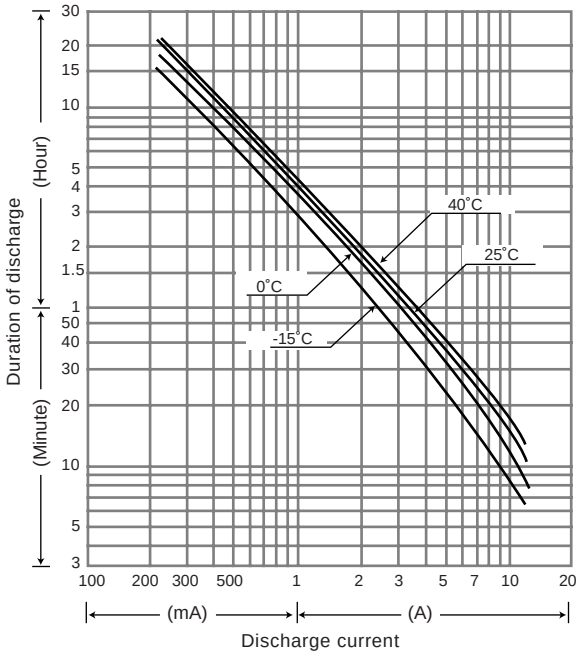


Characteristics

Capacity (note) (77˚F (25˚C))		20 hour rate (210mA) 10 hour rate (390mA) 5 hour rate (700mA) 1 hour rate (2800mA)	4.2Ah 3.9Ah 3.5Ah 2.8Ah
		1.5 hour rate discharge Cut-off voltage 5.25 V	2.2A
Internal Resistance		Fully charged battery (77˚F (25˚C))	Approx. 20mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge (77˚F (25˚C))		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	Initial current Control voltage	1.68 A or smaller Constant voltage; 7.25 to 7.45 V (per 6V cell 77˚F (25˚C))
	Trickle use	Initial current	4.20 A or smaller
		Control voltage	6.8 to 6.9V (per 6V cell 77˚F (25˚C))

(Note) The above characteristics data are average values obtained within three charge/discharge cycles not the minimum values.

Duration of discharge vs. Discharge current (Note)



LC-R067R2P

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Photo/Label for reference only.

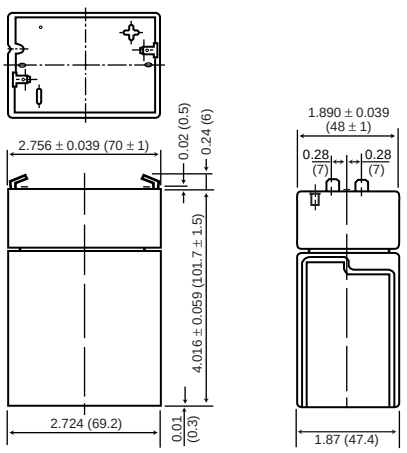
Specifications

Nominal Voltage		6V
Rated Capacity (20 hour rate)		7.2Ah
Dimensions	**Length**	5.945 inches (151.0 mm)
	Width	1.339 inches (34.0 mm)
	Height	3.702 inches (94.0 mm)
	Total Height*	3.937 inches (100.0 mm)
Approx. mass		2.78 lbs. (1.26 kg)
Standard Terminals and Resin	UL94HB Faston 187	LC-R067R2P
	UL94HB Faston 250	LC-R067R2P1
Optional Terminals and Resin	UL94HB Faston 187/250	♦ LC-R067R2P2

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

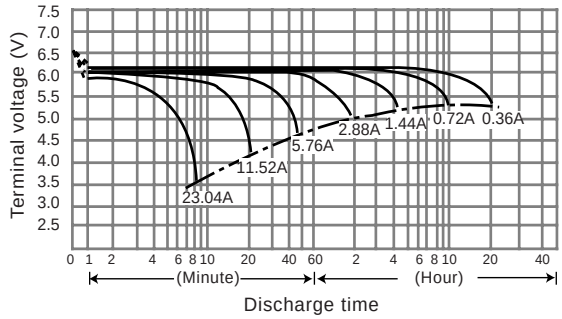
Dimensions (mm)

Terminal type: Faston 187 or Faston 250

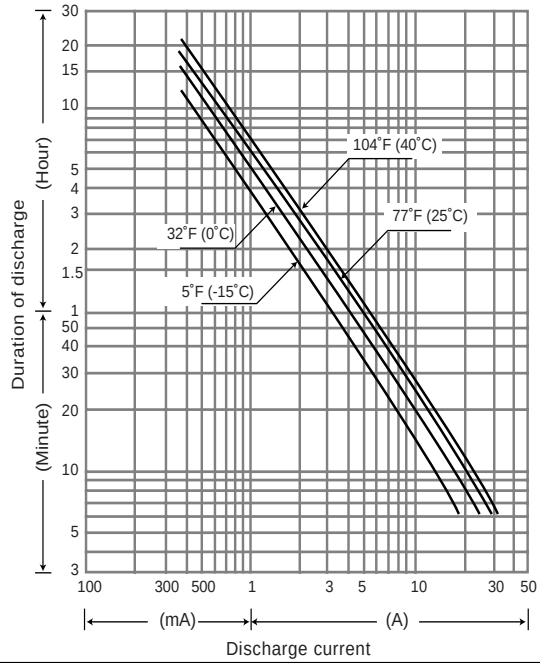


Battery case resin: Standard (UL94HB) Color is black.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



Characteristics

Capacity (note) 77˚F (25˚C)		20 hour rate (3650mA) 10 hour rate (680mA) 5 hour rate (1260mA) 1 hour rate (4900mA)	7.2Ah 6.8Ah 6.3Ah 4.9Ah
		1.5 hour rate discharge Cut-off voltage 5.25 V	3.5A
Internal Resistance		Fully charged battery 77˚F (25˚C)	Approx. 20mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	Initial current	2.88 A or smaller
		Control voltage	7.25V to 7.45V (per 6V cell 25˚C)
	Trickle use	Initial current	1.08 A or smaller
		Control voltage	6.8V to 6.9V (per 6V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

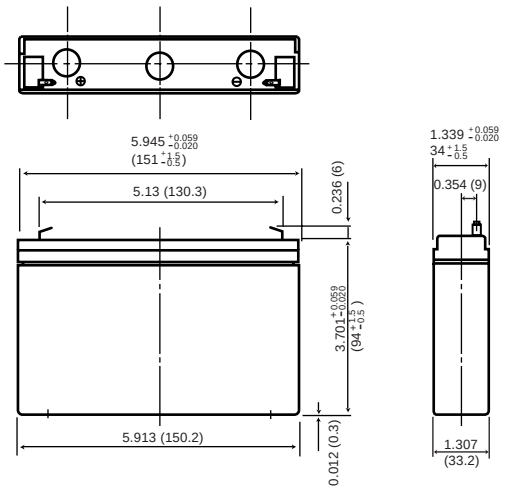
LC-P067R2P

For standby power supplies. Expected trickle life: Approx. 6 years at 25°C, Approx. 10 years at 20°C.

Photo/Label for reference only.

Dimensions (mm)

Terminal type: Faston 187 or Faston 250



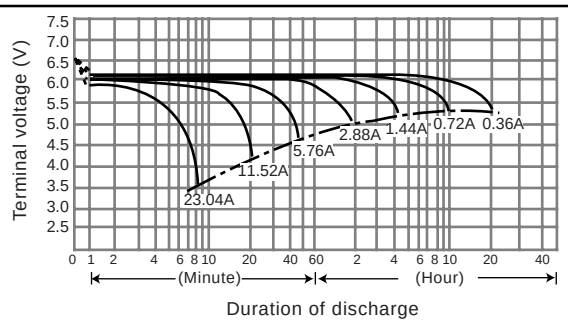
Battery case resin: Standard (UL94V-0) Color is grey.

Specifications

Nominal Voltage		6V
Rated capacity (20 hour rate)		7.2Ah
Dimensions	**Length**	5.945 inches (151.0 mm)
	Width	1.339 inches (34.0 mm)
	Height	3.702 inches (94.0 mm)
	Total Height*	3.937 inches (100.0 mm)
Approx. mass		2.86 lbs. (1.30 kg)
Standard Terminals and Resin	UL94V-0 Faston 250	LC-P067R2P1
Optional Terminals and Resin	UL94V-0 Faston 187	♦ LC-P067R2P

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

Discharge characteristics 77°F (25°C) (Note)

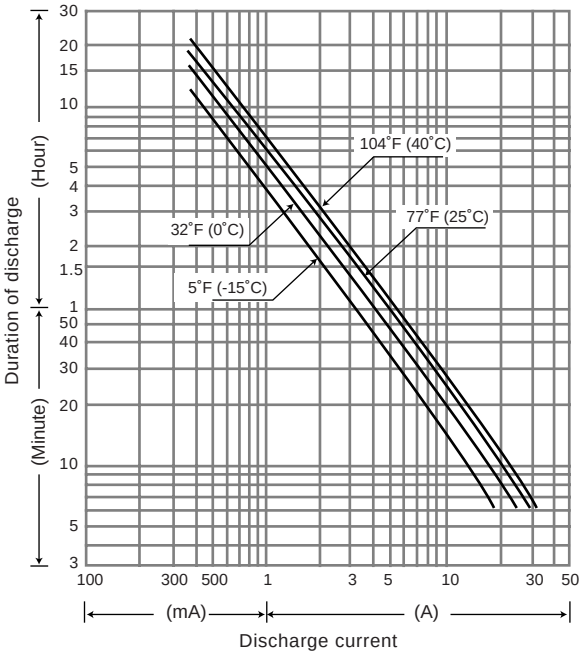


Characteristics

Capacity (note) 77˚F (25˚C)		20 hour rate (360mA) 10 hour rate (680mA) 5 hour rate (1260mA) 1 hour rate (4900mA)	7.2Ah 6.8Ah 6.3Ah 4.9Ah
		1.5 hour rate discharge Cut-off voltage 5.25 V	3.5A
Internal Resistance		Fully charged battery 77˚F (25˚C)	Approx. 20mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Trickle use	Initial current	1.08 A or smaller
		Control voltage	6.8V to 6.9V (per 6V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.
(Note) For cycle use of the battery, please contact us in advance.

Duration of discharge vs. Discharge current (Note)



LC-R127R2P

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Photo/Label for reference only.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		7.2Ah
Dimensions	Length	5.945 inches (151.0 mm)
	Width	2.539 inches (64.5 mm)
	Height	3.702 inches (94.0 mm)
	Total Height*	3.937 inches (100.0 mm)
Approx. mass		5.45 lbs. (2.47 kg)
Standard Terminals and Resin	UL94HB Faston 187	LC-R127R2P
	UL94HB Faston 250	LC-R127R2P1

* The total height with #250 terminal is 101.5mm.

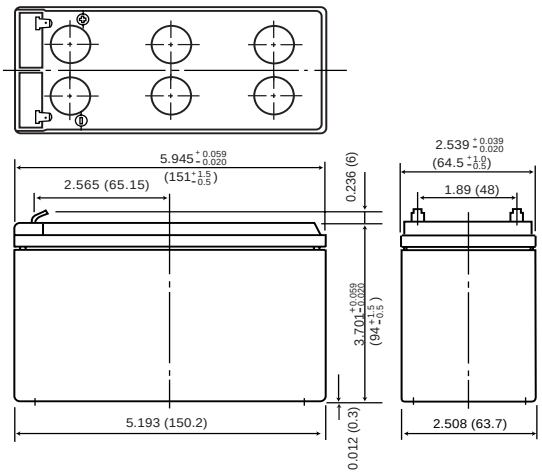
Characteristics

Capacity (note) 77˚F (25˚C)	20 hour rate (360mA) 10 hour rate (680mA) 5 hour rate (1260mA) 1 hour rate (4900mA)	7.2Ah 6.8Ah 6.3Ah 4.9Ah
	1.5 hour rate discharge Cut-off voltage 10.5 V	3.5A
Internal Resistance	Fully charged battery 77˚F (25˚C)	Approx. 40mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Cycle use (Repeating use)	Initial current	2.88 A or smaller
	Control voltage	14.5V to 14.9V (per 12V cell 25˚C)
Charge Method (Constant Voltage) — Trickle use	Initial current	1.08 A or smaller
	Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

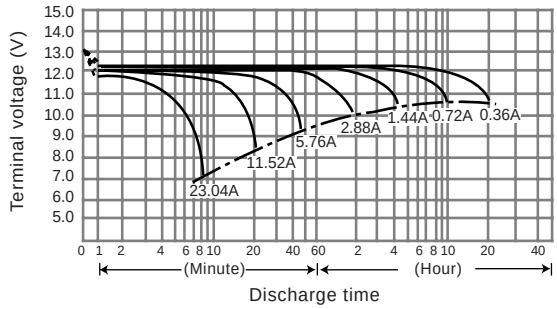
Dimensions (mm)

Terminal type: Faston 187 or Faston 250

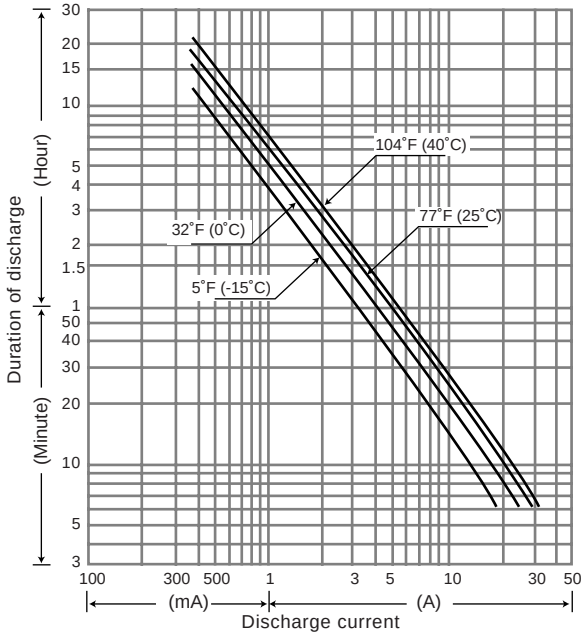


Battery case resin: Standard (UL94HB) Color is black.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



LC-P127R2P

For standby power supplies. Expected trickle life: Approx. 6 years at 25°C, Approx. 10 years at 20°C.

Photo/Label for reference only.

Specifications

Nominal Voltage		12V
Rated capacity (20 hour rate)		7.2Ah
Dimensions	**Length**	5.945 inches (151.0 mm)
	Width	2.539 inches (64.5 mm)
	Height	3.702 inches (94.0 mm)
	Total Height*	3.937 inches (100.0 mm)
Approx. mass		5.516 lbs. (2.50 kg)
Standard Terminals and Resin	UL94V-0 Faston 250	LC-P127R2P1
Optional Terminals and Resin	UL94V-0 Faston 187	♦ LC-P127R2P

* The total height with #250 terminal is 101.5mm.

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

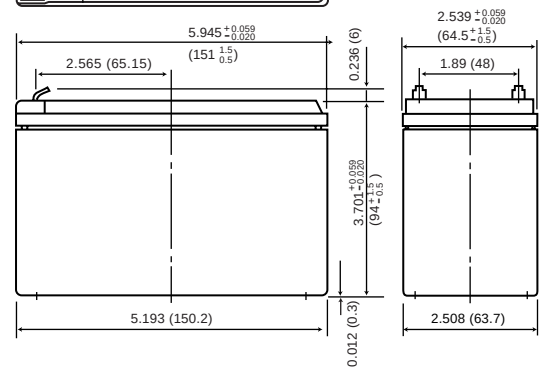
Characteristics

Capacity (note) 77˚F (25˚C)	20 hour rate (360mA) 10 hour rate (680mA) 5 hour rate (1260mA) 1 hour rate (4900mA)	7.2Ah 6.8Ah 6.3Ah 4.9Ah
	1.5 hour rate discharge Cut-off voltage 10.5 V	3.5A
Internal Resistance	Fully charged battery 77˚F (25˚C)	Approx. 40mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Trickle use	Initial current	1.08 A or smaller
	Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.
(Note) For cycle use of the battery, please contact us in advance.

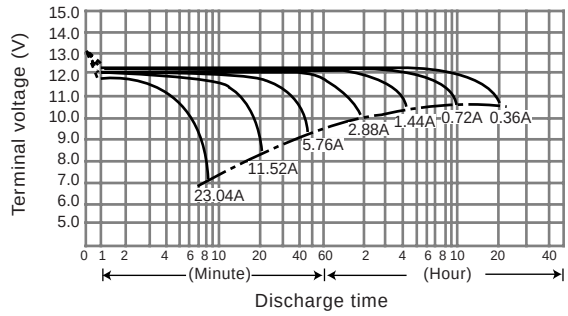
Dimensions (mm)

Terminal type: Faston 187 or Faston 250

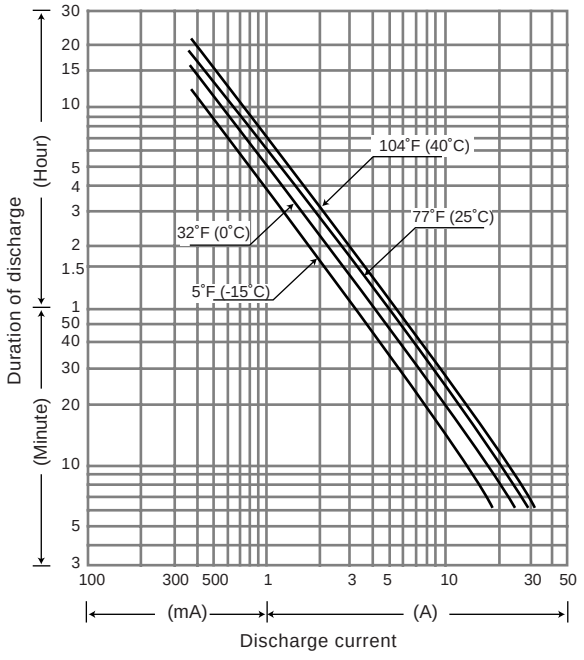


Battery case resin: Standard (UL94V-0) Color is grey.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



LC-R0612P

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Photo/Label for reference only.

Specifications

Nominal Voltage		6V
Rated Capacity (20 hour rate)		12.0Ah
Dimensions	**Length**	5.945 inches (151.0 mm)
	Width	1.969 inches (50.0 mm)
	Height	3.702 inches (94.0 mm)
	Total Height*	3.937 inches (100.0 mm)
Approx. mass		4.30 lbs. (1.95 kg)
Standard Terminals and Resin	UL94HB Faston 187	LC-R0612P
	UL94HB Faston 250	LC-R0612P1

* The total height with #250 terminal is 101.5mm.

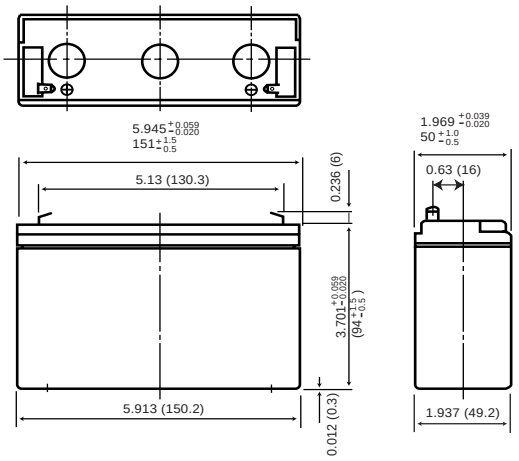
Characteristics

Capacity (note) 77˚F (25˚C)	20 hour rate (360mA) 10 hour rate (680mA) 5 hour rate (1260mA) 1 hour rate (4900mA)	12Ah 11.3Ah 10.4Ah 8.1Ah
	1.5 hour rate discharge Cut-off voltage 5.25 V	5.8A
Internal Resistance	Fully charged battery 77˚F (25˚C)	Approx. 15mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Cycle use (Repeating use)	Initial current	4.8 A or smaller
	Control voltage	7.25V to 7.45V (per 6V cell 25˚C)
Charge Method (Constant Voltage) — Trickle use	Initial current	1.8 A or smaller
	Control voltage	6.8V to 6.9V (per 6V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

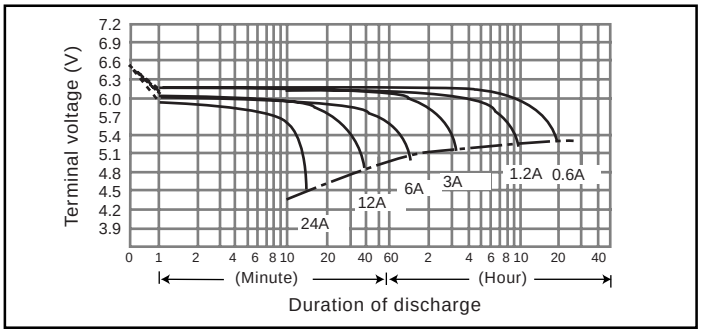
Dimensions (mm)

Terminal type: Faston 187 or Faston 250

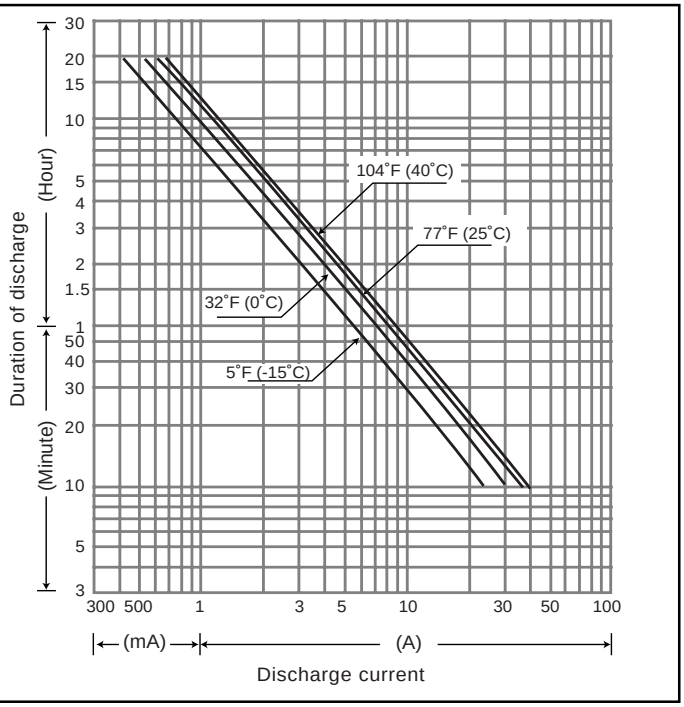


Battery case resin: Standard (UL94HB) Color is black.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



LC-P0612P

For standby power supplies. Expected trickle life: Approx. 6 years at 25°C, Approx. 10 years at 20°C.

Photo/Label for reference only.

Specifications

Nominal Voltage		6V
Rated capacity (20 hour rate)		12Ah
Dimensions	**Length**	5.945 inches (151.0 mm)
	Width	1.969 inches (50.0 mm)
	Height	3.702 inches (94.0 mm)
	Total Height*	3.937 inches (100.0 mm)
Approx. mass		4.4 lbs. (2.00 kg)
Standard Terminals and Resin	UL94V-0 Faston 250	LC-P0612P1
Optional Terminals and Resin	UL94V-0 Faston 187	♦ LC-P0612P

* The total height with #250 terminal is 101.5mm.
♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

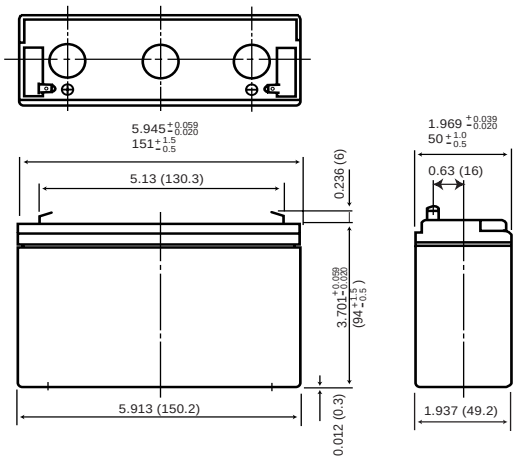
Characteristics

Capacity (note) 77˚F (25˚C)	20 hour rate (600mA) 10 hour rate (1130mA) 5 hour rate (2080mA) 1 hour rate (8100mA)	12Ah 11.3Ah 10.4Ah 8.1Ah
	1.5 hour rate discharge Cut-off voltage 5.25 V	5.8A
Internal Resistance	Fully charged battery 77˚F (25˚C)	Approx. 15mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Trickle use	Initial current	1.8 A or smaller
	Control voltage	6.8V to 6.9V (per 6V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.
(Note) For cycle use of the battery, please contact us in advance.

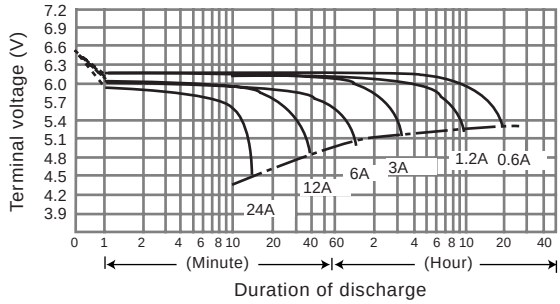
Dimensions (mm)

Terminal type: Faston 187 or Faston 250

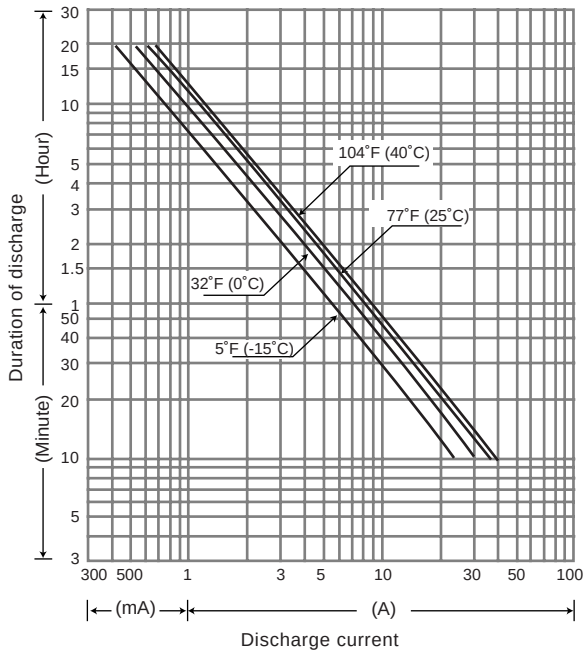


Battery case resin: Standard (UL94V-0) Color is grey.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



LC-RA1212P

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Photo/Label for reference only.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		12Ah
Dimensions	**Length**	5.945 inches (151.0 mm)
	Width	3.860 inches (98.0 mm)
	Height	3.702 inches (94.0 mm)
	Total Height*	3.937 inches (100.0 mm)
Approx. mass		8.36 lbs. (3.8 kg)
Standard Terminals and Resin	UL94HB Faston 187	LC-RA1212P
	UL94HB Faston 250	LC-RA1212P1

* The total height with #250 teminal is 101.5mm.

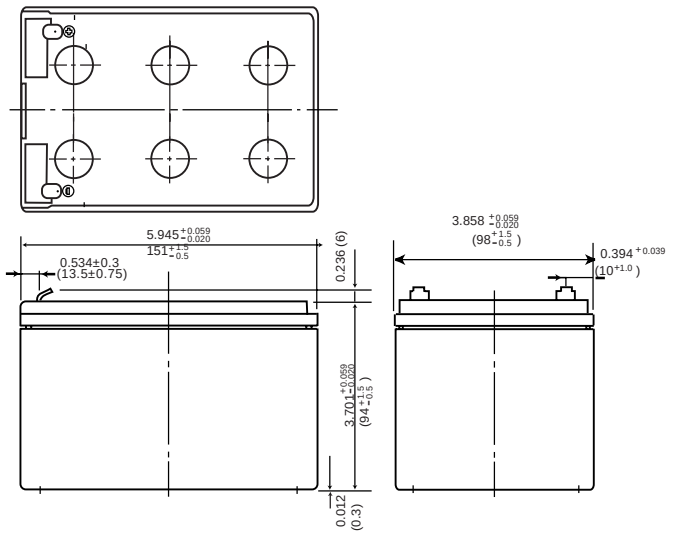
Characteristics

Capacity (note) 77˚F (25˚C)		20 hour rate (600mA) 10 hour rate (1130mA) 5 hour rate (2080mA) 1 hour rate (8100mA)	12Ah 11.3Ah 10.4Ah 8.1Ah
		1.5 hour rate discharge Cut-off voltage 10.5 V	5.8A
Internal Resistance		Fully charged battery 77˚F (25˚C)	Approx. 30mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	Initial current	4.8 A or smaller
		Control voltage	14.5V to 14.9V (per 12V cell 25˚C)
	Trickle use	Initial current	1.8 A or smaller
		Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

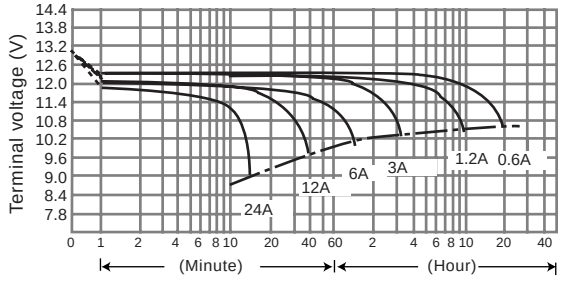
Dimensions (mm)

Terminal type: Faston 187 or Faston 250

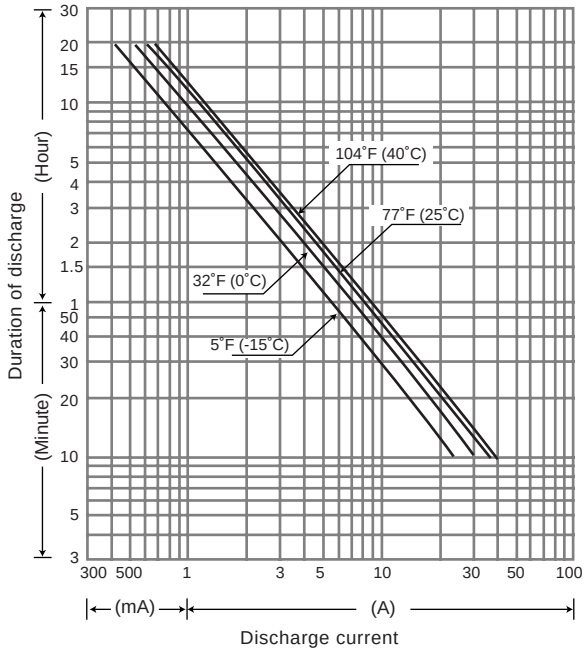


Battery case resin: Standard (UL94HB) Color is black.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



LC-RD1217P

For main and standby power supplies. Expected trickle life: Approx 3-5 years at 25°C, Approx. 5 years at 20°C.

Photo/Label for reference only.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		17Ah
Dimensions	**Length**	7.126 inches (181.0 mm)
	Width	2.992 inches (76.0 mm)
	Height	6.575 inches (167.0 mm)
	Total Height	6.575 inches (167.0 mm)
Approx. mass		14.34 lbs. (6.5 kg)
Standard Terminals and Resin	UL94HB M5 Bolt and Nut	LC-RD1217P

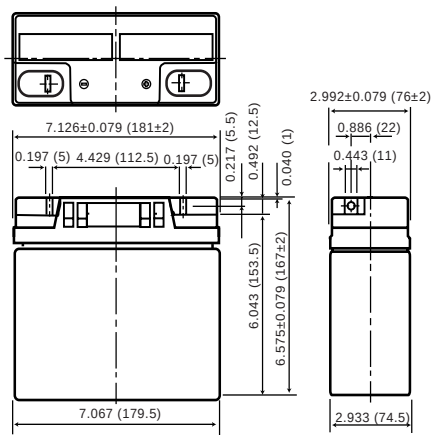
Characteristics

Capacity (note) 77°F (25°C)		20 hour rate (850mA) 10 hour rate (1500mA) 5 hour rate (2600mA) 1 hour rate (10000mA)	17Ah 15Ah 13Ah 10Ah
		1.5 hour rate discharge Cut-off voltage 10.5 V	7A
Internal resistance		Fully charged battery 77°F (25°C)	Approx. 12mΩ
Temperature dependency of capacity (20 hour rate)		104°F (40°C) 77°F (25°C) 32°F (0°C) 5°F (-15°C)	102% 100% 85% 65%
Self discharge 77°F (25°C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	Initial current	6.8 A or smaller
		Control voltage	14.5V to 14.9 V (per 12V cell 25°C)
	Trickle use	Initial current	2.55 A or smaller
		Control voltage	13.6V to 13.8V (per 12V cell 25°C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.
(Note) For cycle use of the battery, please contact us in advance.

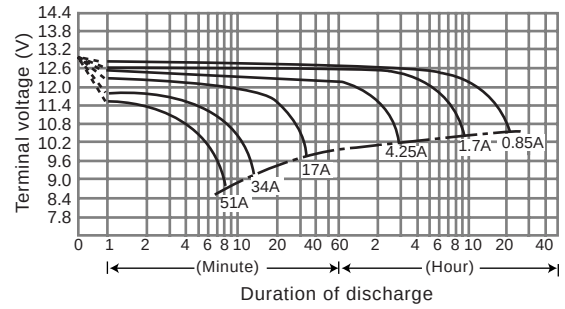
Dimensions (mm)

Terminal type: LC-RD1217P: M5 bolt and nut

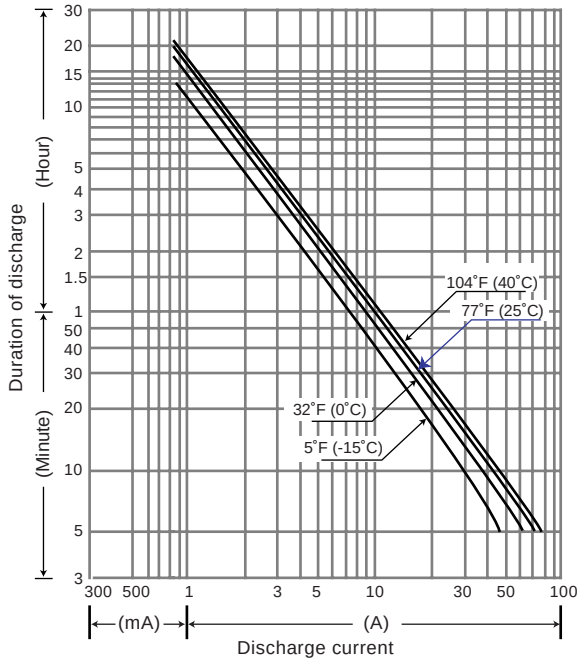


Battery case resin: Standard (UL94HB) Color is black.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



LC-PD1217P

Photo/Label for reference only.

For main and standby power supplies. Expected trickle life: Approx 6 years at 25°C, Approx. 10 years at 20°C.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		17Ah
Dimensions	Length	7.126 inches (181.0 mm)
	Width	2.992 inches (76.0 mm)
	Height	6.575 inches (167.0 mm)
	Total Height	6.575 inches (167.0 mm)
Approx. mass		14.34 lbs. (6.5 kg)
Standard Terminals and Resin	UL94V-0 M5 Bolt and Nut	LC-PD1217P
Optional Terminals and Resin	UL94HB M5 Bolt and Nut	♦ LC-XD1217P

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

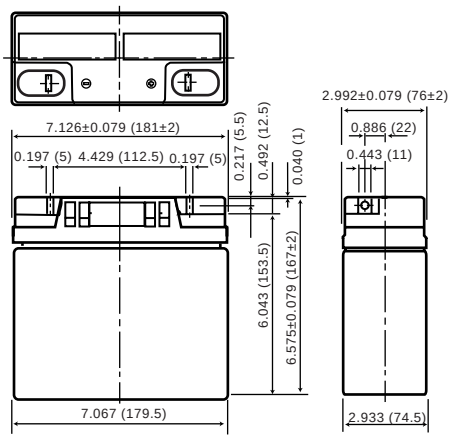
Characteristics

Capacity (note) 77˚F (25˚C)	20 hour rate (850mA) 10 hour rate (1500mA) 5 hour rate (2600mA) 1 hour rate (10000mA)	17Ah 15Ah 13Ah 10Ah
	1.5 hour rate discharge Cut-off voltage 10.5 V	7A
Internal Resistance	Fully charged battery 77˚F (25˚C)	Approx. 12mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Cycle use (Repeating use)	Initial current	6.8 A or smaller
	Control voltage	14.5V to 14.9V (per 12V cell 25˚C)
Charge Method (Constant Voltage) — Trickle use	Initial current	2.55 A or smaller
	Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.
(Note) For cycle use of the battery, please contact us in advance.

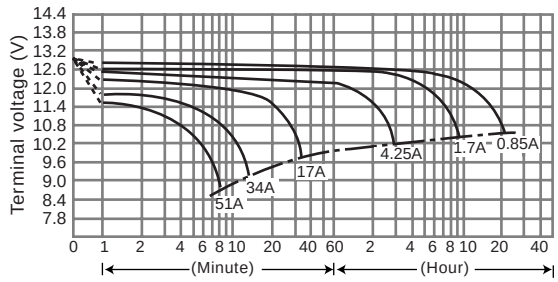
Dimensions (mm)

Terminal type: LC-PD1217P: M5 bolt and nut

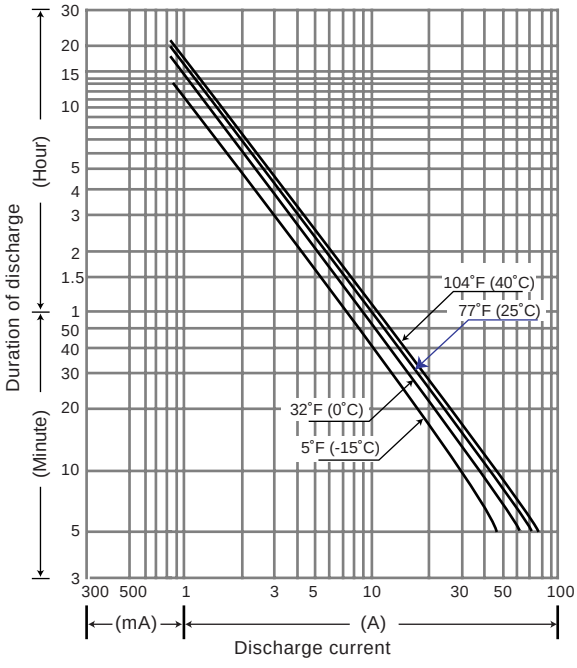


Battery case resin: Standard (UL94V-0) Color is grey.
Optional (UL94HB) Color is black.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



LC-R1233P

For main and standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Photo/Label for reference only.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		33Ah
Dimensions	Length	7.701 inches (195.6 mm)
	Width	5.118 inches (130.0 mm)
	Height	6.102 inches (155.0 mm)
	Total Height	7.087 inches (180.0 mm)
Approx. mass (lbs.)		26.5 (12.0 kg)
Standard Terminals and Resin	UL94HB M6 Bolt and Nut	LC-R1233P
	UL94V-0 M6 Bolt and Nut	♦ LC-V1233P

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

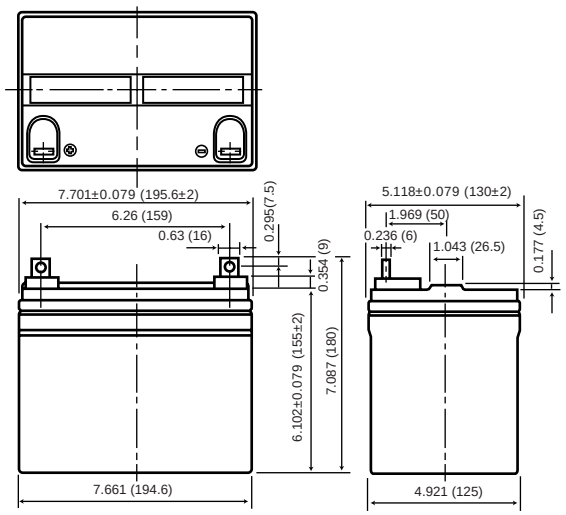
Characteristics

Capacity (note) 77˚F (25˚C)		20 hour rate (1.65A) 10 hour rate (3A) 5 hour rate (5.4A) 1 hour rate (20A)	33Ah 30Ah 27Ah 20Ah
		1.5 hour rate discharge Cut-off voltage 10.5 V	13.4A
Internal Resistance		Fully charged battery 77˚F (25˚C)	Approx. 7mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	Initial current	13.2 A or smaller
		Control voltage	14.5V to 14.9V (per 12V cell 25˚C)
	Trickle use	Initial current	4.95 A or smaller
		Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.
(Note) For cycle use of the battery, please consult us in advance.

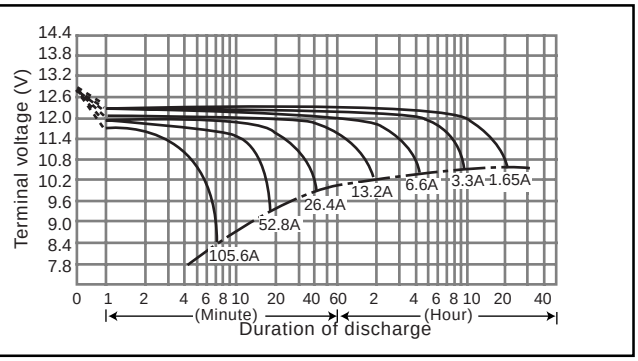
Dimensions (mm)

Terminal type: M6 bolt and nut

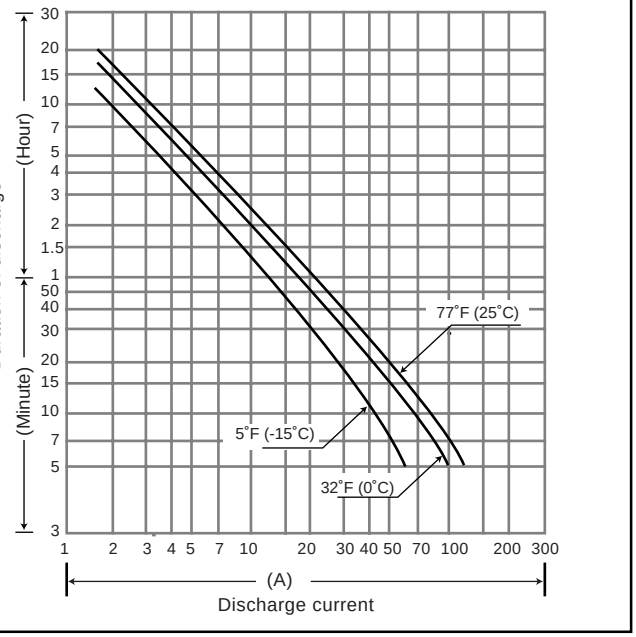


Battery case resin: Standard (UL94HB) Color is black.
Optional (UL94V-0) Color is grey.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



LC-X1220P/LC-X1220AP

Photo/Label for reference only.

(a) The photo and dimensions represent LC-X1220P.

For main and standby power supplies. Expected trickle life: Approx. 6 years at 25°C, Approx. 10 years at 20°C.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		20Ah
Dimensions	Length	7.126 inches (181.0 mm)
	Width	2.992 inches (76.0 mm)
	Height	6.575 inches (167.0 mm)
	Total Height	6.575 inches (167.0 mm)
Approx. mass		14.56 lbs. (6.6 kg)
Standard Terminals and Resin	UL94HB M5 Bolt and Nut	LC-X1220P
Optional Terminals and Resin	UL94HB Threaded Post	♦ LC-X1220AP

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

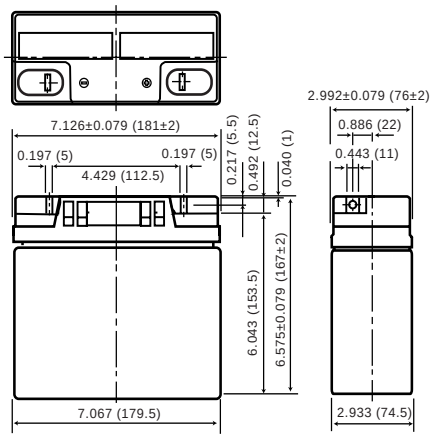
Characteristics

Capacity (note) 77˚F (25˚C)		20 hour rate (1.2A) 10 hour rate (2.2A) 5 hour rate (3.8A) 1 hour rate (14A)	20Ah 18Ah 16Ah 12Ah
		1.5 hour rate discharge Cut-off voltage 10.5 V	9.8A
Internal Resistance		Fully charged battery 77˚F (25˚C)	Approx. 11mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	Initial current	8 A or smaller
		Control voltage	14.5 V to 14.9 V (per 12V cell 25˚C)
	Trickle use	Initial current	3 A or smaller
		Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.
(Note) For cycle use of the battery, please contact us in advance.

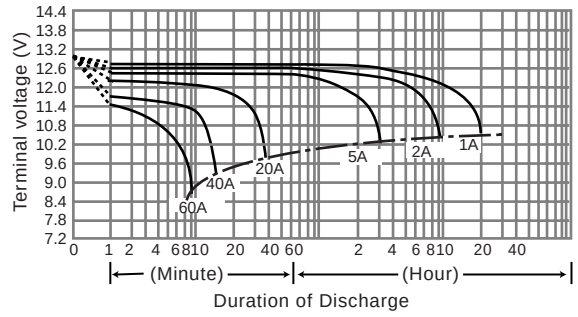
Dimensions (mm)

Terminal type: LC-X1220P: M5 bolt and nut
LC-X1220AP: M5 threaded post

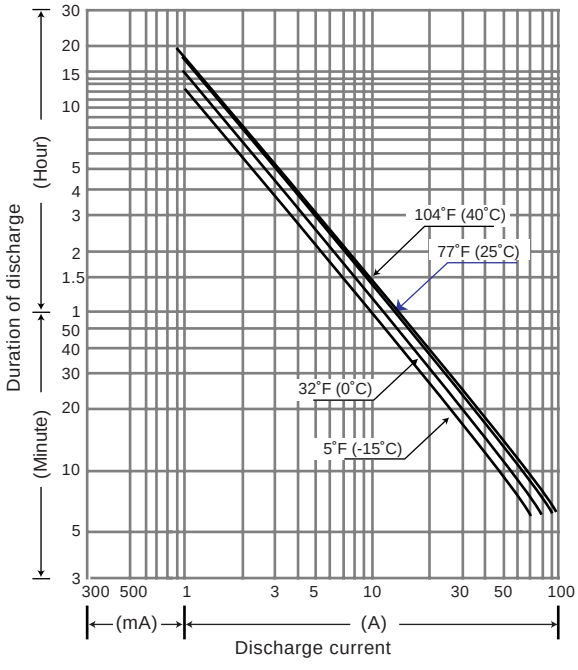


Battery case resin: Standard (UL94HB) Color is black.

Discharge characteristics 77°F (25°C) (Note)

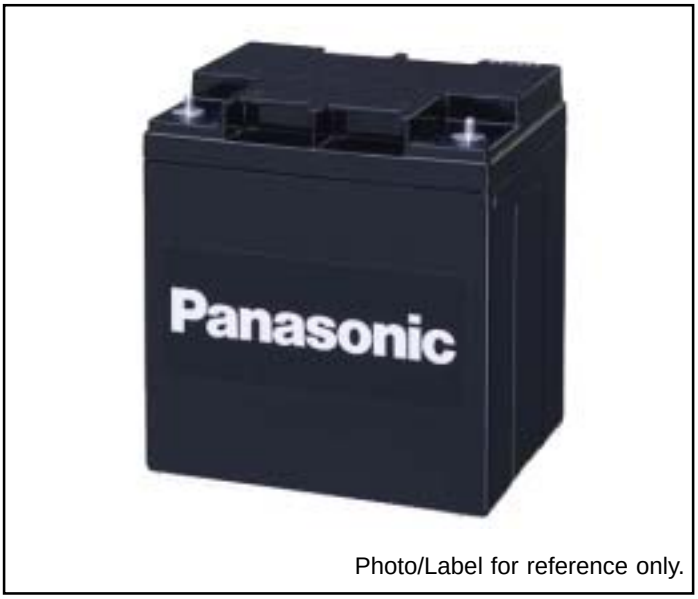


Duration of discharge vs. Discharge current (Note)



LC-X1228P/LC-X1228AP

For standby power supplies. Expected trickle life: Approx. 6 years at 25°C, Approx. 10 years at 20°C.

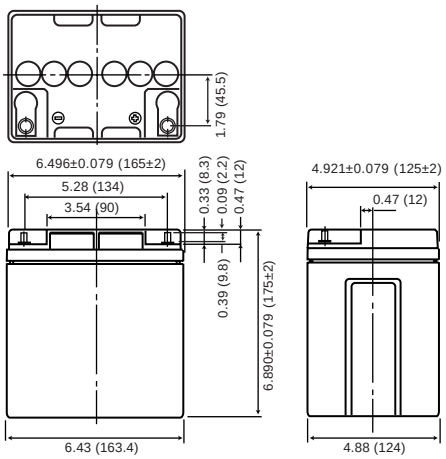


Photo/Label for reference only.

(a) The photo and dimensions represent LC-X1228AP.

Dimensions (mm)

Terminal type: LC-X1228AP: M5 threaded post
LC-X1228P: M5 bolt and nut



Battery case resin: Standard (UL94HB) Color is black.
Optional (UL94V-0) Color is grey.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		28Ah
Dimensions	**Length**	6.469 inches (165 mm)
	Width	4.921 inches (125 mm)
	Height	6.890 inches (175 mm)
	Total Height	LC-X1228AP 6.890 inches (175 mm) LC-X1228P 7.067 inches (179.5 mm)
Approx. mass		24.34 lbs. (11 kg)
Standard Terminals and Resin	UL94HB M5 Bolt and Nut	LC-X1228P
	UL94HB M5 Threaded Post	LC-X1228AP
Optional Terminals and Resin	UL94V-0 M5 Bolt and Nut	♦ LC-P1228P
	UL94V-0 M5 Threaded Post	♦ LC-P1228AP

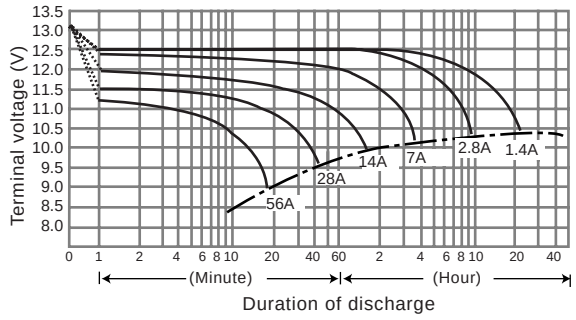
♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

Characteristics

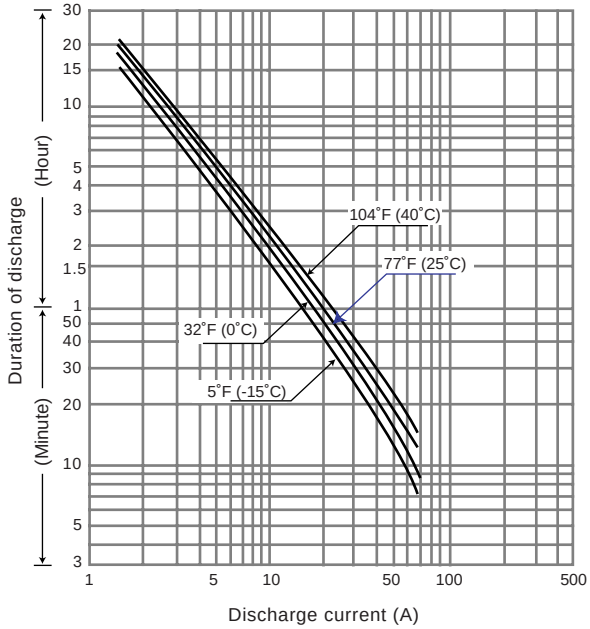
Capacity (note) 77˚F (25˚C)	20 hour rate (1.40A) 10 hour rate (2.65A) 5 hour rate (5.00A) 1 hour rate (21.0A)	28.0Ah 26.5Ah 25.0Ah 21.0Ah
	1.5 hour rate discharge Cut-off voltage 10.5 V	9.80A
Internal Resistance	Fully charged battery 77˚F (25˚C)	Approx. 6.0mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Trickle use	Initial current	4.20 A or smaller
	Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



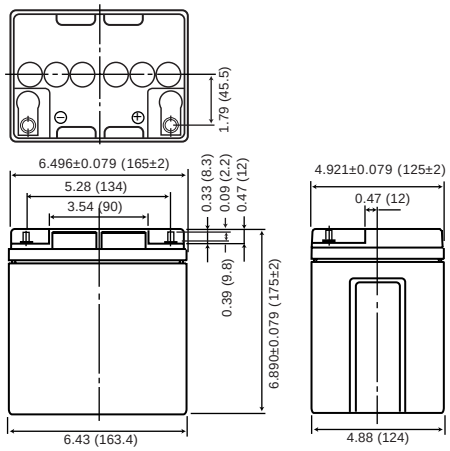
LC-XC1228AP

For main power supplies.
Cycle long life type.

Photo/Label for reference only.

Dimensions (mm)

Terminal type: LC-XC1228AP: M5 threaded post



Battery case resin: Standard (UL94HB) Color is black.

Specifications

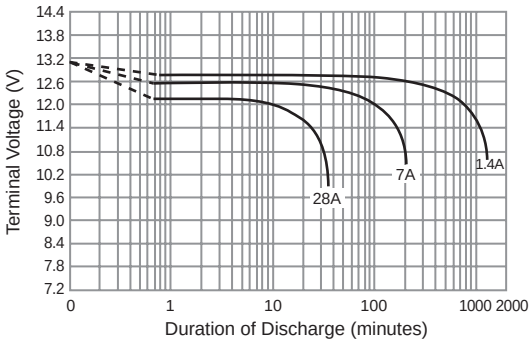
Nominal Voltage		12V
Rated Capacity (20 hour rate)		28Ah
Dimensions	**Length**	6.469 inches (165 mm)
	Width	4.921 inches (125 mm)
	Height	6.890 inches (175 mm)
	Total Height	6.890 inches (175 mm)
Approx. mass		24.34 lbs. (11 kg)
Standard Terminals and Resin	UL94HB M5 Threaded Post	LC-XC1228AP

Characteristics

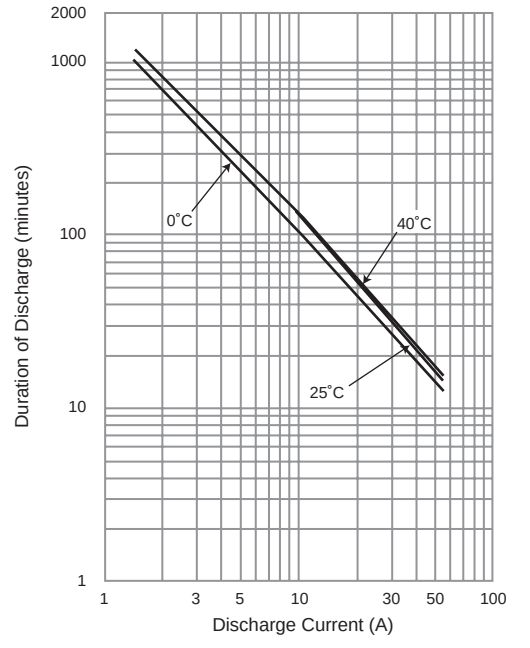
Capacity (note) 77˚F (25˚C)		20 hour rate (1.4A) 10 hour rate (2.65A) 5 hour rate (4.8A) 1 hour rate (18A)	28Ah 26.5Ah 24Ah 18Ah
		1.5 hour rate discharge Cut-off voltage 10.5 V	14A
Internal Resistance		Fully charged battery 77˚F (25˚C)	Approx. 10mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use (Repeating use)	Initial current	11.2 A or smaller
		Control voltage	14.5V to 14.9V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



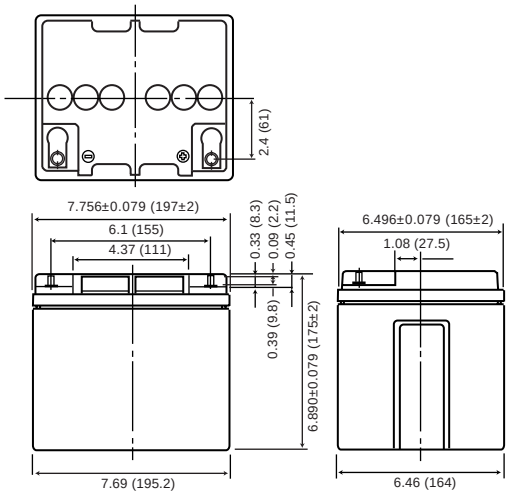
LC-XC1238AP

For main power supplies. Cycle long life type.

Photo/Label for reference only.

Dimensions (mm)

Terminal type: LC-XC1238AP: M5 threaded post



Battery case resin: Standard (UL94HB) Color is black.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		38Ah
Dimensions	**Length**	7.756 inches (197 mm)
	Width	6.496 inches (165 mm)
	Height	6.890 inches (175 mm)
	Total Height	6.890 inches (175 mm)
Approx. mass		35.2 lbs. (16.0 kg)
Standard Terminals and Resin	UL94HB M5 Threaded Post	LC-XC1238AP

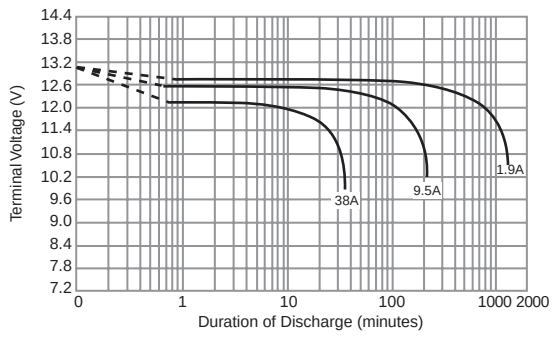
♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

Characteristics

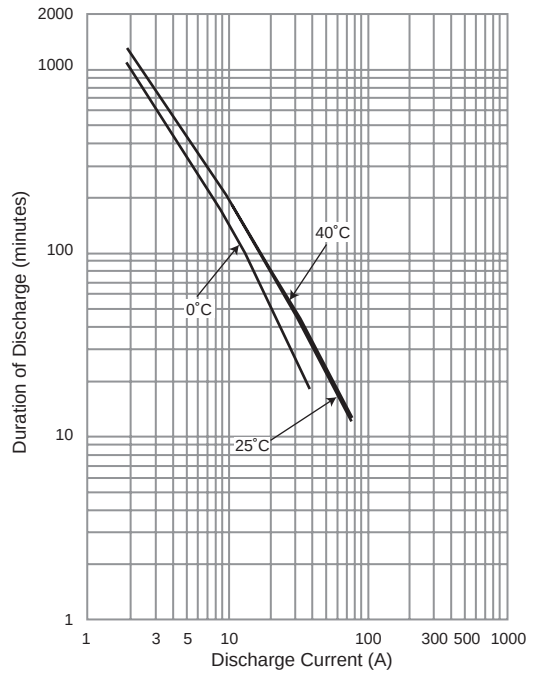
Capacity (note) 77˚F (25˚C)		20 hour rate (1.9A) 10 hour rate (3.6A) 5 hour rate (7.0A) 1 hour rate (23A)	38Ah 36Ah 35Ah 23Ah
		1.5 hour rate discharge Cut-off voltage 10.5 V	20A
Internal Resistance		Fully charged battery 77˚F (25˚C)	Approx. 9mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Cycle use	Initial current	15.2 A or smaller
		Control voltage	14.5V to 14.9V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



LC-X1242P/LC-X1242AP

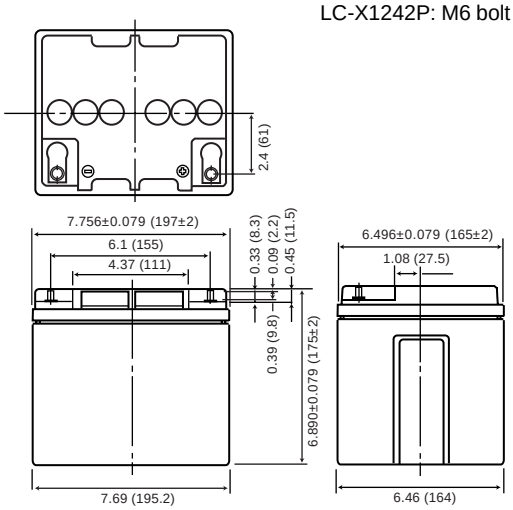
For standby power supplies. Expected trickle life: Approx. 6 years at 25°C, Approx. 10 years at 20°C.

Photo/Label for reference only.

(a) The photo and dimensions represent LC-X1242AP

Dimensions (mm)

Terminal type: LC-X1242AP: M5 threaded post
LC-X1242P: M6 bolt and nut



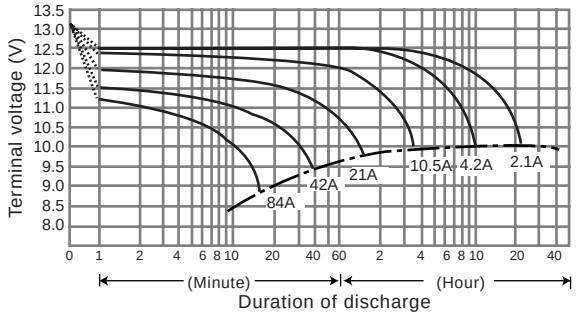
Battery case resin: Standard (UL94HB) Color is black.
Optional (UL94V-0) Color is grey.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		42Ah
Dimensions	**Length**	7.756 inches (197 mm)
	Width	6.496 inches (165 mm)
	Height	6.890 inches (175 mm)
	Total Height	LC-X1224AP: 6.890 inches (175 mm) LC-X1224P: 7.087 inches (180 mm)
Approx. mass		35.2 lbs. (16.0 kg)
Standard Terminals and Resin	UL94HB M6 Bolt and Nut	LC-X1242P
	UL94HB M5 Threaded Post	LC-X1242AP
Optional Terminals and Resin	UL94V-0 M6 Bolt and Nut	♦ LC-P1242P
	UL94V-0 M5 Threaded Post	♦ LC-P1242AP

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

Discharge characteristics 77°F (25°C) (Note)

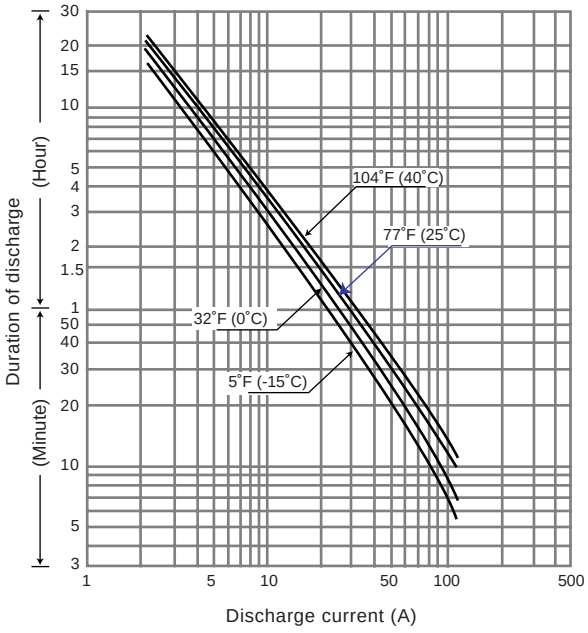


Characteristics

Capacity (note) 77˚F (25˚C)	20 hour rate (2.1A) 10 hour rate (4A) 5 hour rate (7.4A) 1 hour rate (26A)	42Ah 40Ah 37Ah 26Ah
	1.5 hour rate discharge Cut-off voltage 10.5 V	15.5A
Internal Resistance	Fully charged battery 77˚F (25˚C)	Approx. 7mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Trickle use	Initial current	6.3 A or smaller
	Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

Duration of discharge vs. Discharge current (Note)



LC-X1265P

For standby power supplies. Expected trickle life: Approx. 6 years at 25°C, Approx. 10 years at 20°C.

Photo/Label for reference only.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		65Ah
Dimensions	**Length**	13.799 inches (350 mm)
	Width	6.535 inches (166 mm)
	Height	6.890 inches (175 mm)
	Total Height	6.890 inches (175 mm)
Approx. mass		44.1 lbs. (20.0 kg)
Standard Terminals and Resin	UL94HB M6 Bolt and Nut	LC-X1265P
	UL94V-0 M6 Bolt and Nut	♦ LC-P1265P

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

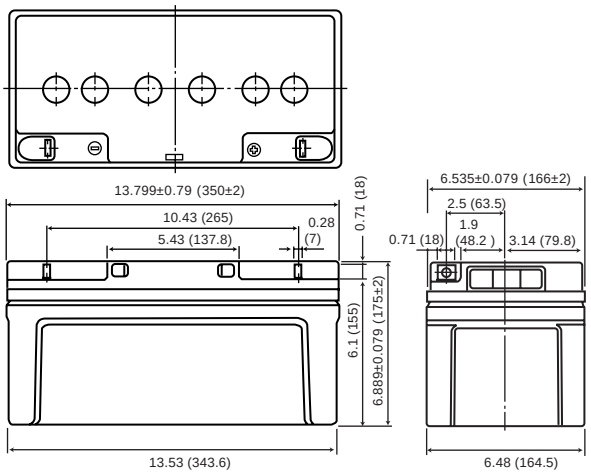
Characteristics

Capacity (note) 77˚F (25˚C)	20 hour rate (3.25A) 10 hour rate (5.9A) 5 hour rate (10.6A) 1 hour rate (40A)	65Ah 59Ah 53Ah 40Ah
	1.5 hour rate discharge Cut-off voltage 10.5 V	26A
Internal Resistance	Fully charged battery 77˚F (25˚C)	Approx. 7mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Trickle use	Initial current	9.75 A or smaller
	Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

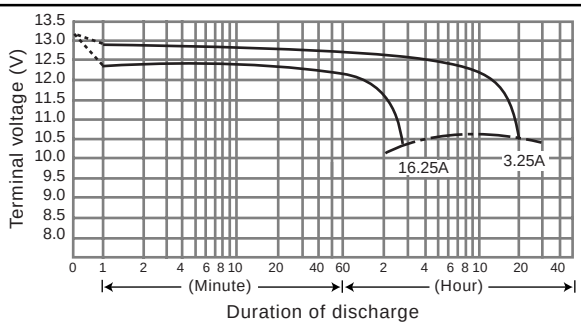
Dimensions (mm)

Terminal type: M6 bolt and nut

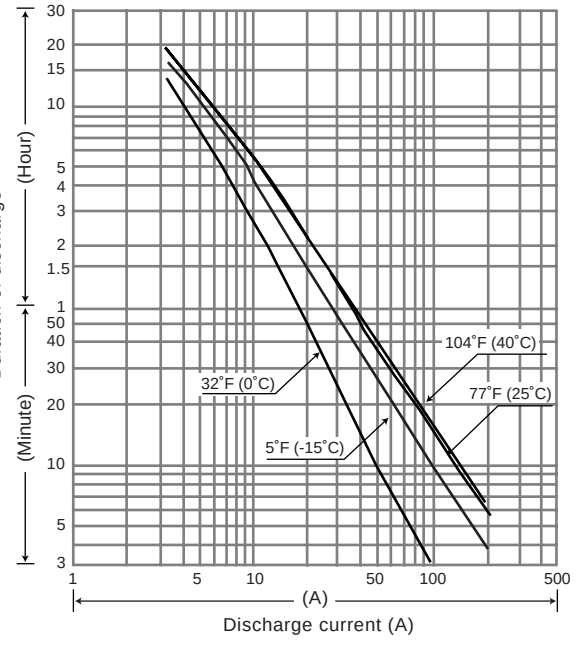


Battery case resin: Standard (UL94HB) Color is black.
Optional (UL94V-0) Color is grey.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



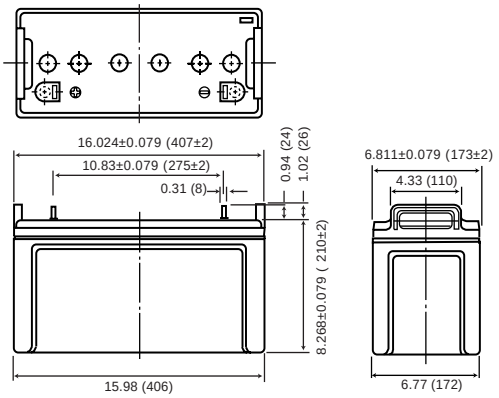
LC-XA12100P

For standby power supplies. Expected trickle life: Approx. 6 years at 25°C, Approx. 10 years at 20°C.

Photo/Label for reference only.

Dimensions (mm)

Terminal type: M8 bolt and nut



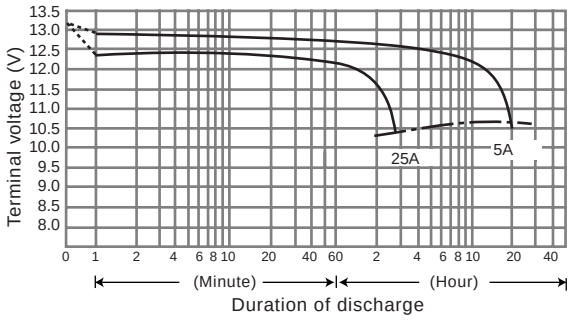
Battery case resin: Standard (UL94HB) Color is black.
Optional (UL94V-0) Color is grey.

Specifications

Nominal Voltage		12V
Rated Capacity (20 hour rate)		100Ah
Dimensions	**Length**	16.024 inches (407 mm)
	Width	6.811 inches (173 mm)
	Height	8.268 inches (210 mm)
	Total Height	9.291 inches (236 mm)
Approx. mass		72.8 lbs. (33 kg)
Standard Terminals and Resin	UL94HB M8 Bolt and Nut	LC-XA12100P
	UL94V-0 M8 Bolt and Nut	♦ LC-PA12100P

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

Discharge characteristics 77°F (25°C) (Note)

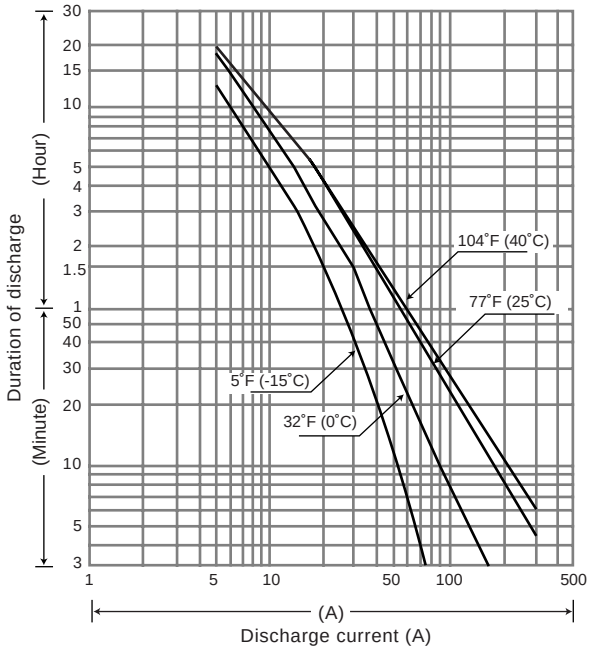


Characteristics

Capacity (note) 77˚F (25˚C)		20 hour rate (5A) 10 hour rate (9.8A) 5 hour rate (18A) 1 hour rate (55A)	100Ah 90Ah 90Ah 55Ah
		1.5 hour rate discharge Cut-off voltage 10.5 V	40A
Internal Resistance		Fully charged battery 77˚F (25˚C)	Approx. 4.5mΩ
Temperature dependency of capacity (20 hour rate)		104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)		Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage)	Trickle use	Initial current	15 A or smaller
		Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.

Duration of discharge vs. Discharge current (Note)



UP-RW1220P1

Photo/Label for reference only.

For standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Specifications

Nominal Voltage		12V
Nominal Capacity (watts/cell at 10 minute rate)		20W/2V
Dimensions	**Length**	5.512 inches (140.0 mm)
	Width	1.516 inches (38.5 mm)
	Height	3.701 inches (94.0 mm)
	Total Height	3.997 inches (101.5 mm)
Approx. mass		2.98 lbs. (1.35 kg)
Standard Terminals and Resin	UL94HB Faston 250	UP-RW1220P1
	UL94V-0 Faston 250	UP-VW1220P1

Characteristics

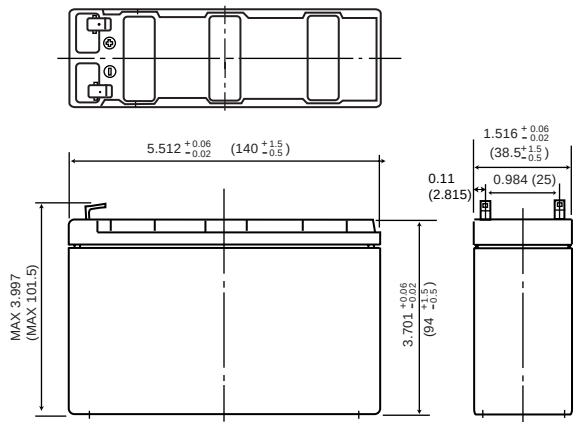
Capacity (note) 77˚F (25˚C) (9.6V Cutoff)	30 minute rate 15 minute rate 10 minute rate 5 minute rate	60W 95W 120W 190W
Internal resistance	Fully charged battery 77˚F (25˚C)	Approx. 35mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Trickle use	Initial current	1.35 A or smaller
	Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

Cutoff (per cell)	Discharge Runtime at 25˚C						
	3 min.	5 min.	7 min.	10 min.	15 min.	20 min.	30 min.
1.6V	245	190	150	120	95	80	60
1.7V	217	167	135	113	87	74	52
1.8V	177	137	115	102	82	66	47

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.
(Note) This battery is designed for high rate discharge and we do not specify 20 hour rate discharge capacity.
(Note) When specific condidtions are satisfied, this battery can be used for main power supplies. Please consult Panasonic.

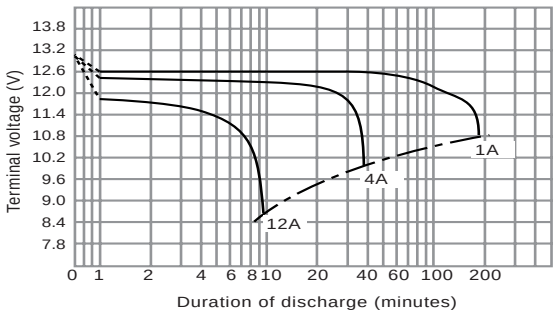
Dimensions (mm)

Terminal type: Faston 250

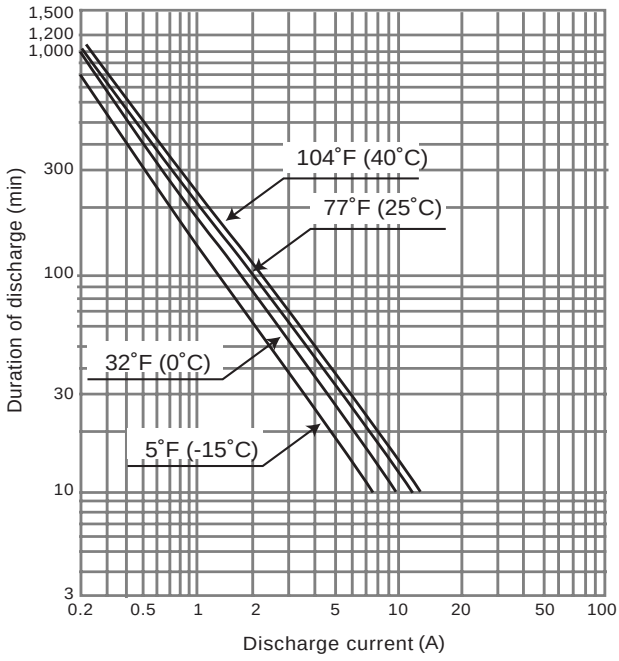


Battery case resin: Standard (UL94HB) Color is black.
Optional (UL94V-0) Color is grey.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



UP-RW1245P1

Photo/Label for reference only.

For standby power supplies.
Expected trickle life: 3-5 years at 25°C, Approx. 5 years at 20°C.

Specifications

Nominal Voltage		12V
Nominal Capacity (watts/cell at 10 minute rate)		45W/2V
Dimensions	**Length**	5.945 inches (151.0 mm)
	Width	2.540 inches (64.5 mm)
	Height	3.702 inches (94.0 mm)
	Total Height	3.997 inches (101.5 mm)
Approx. mass		5.738 lbs. (2.6 kg)
Standard Terminals and Resin	UL94HB Faston 250	UP-RW1245P1
Optional Terminals and Resin	UL94V-0 Faston 250	♦ UP-PW1245P1

♦ Please contact Panasonic for availability on optional items. Optional items may be subject to minimum order quantities.

Characteristics

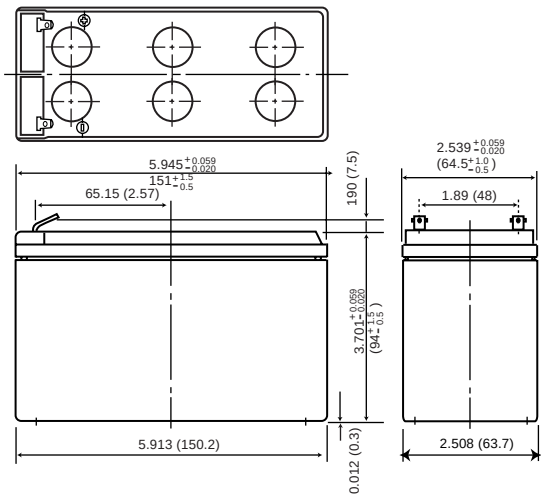
Capacity (note) 77˚F (25˚C) (9.6V Cutoff)	30 minute rate 15 minute rate 10 minute rate 5 minute rate	112W 195W 268W 410W
Internal resistance	Fully charged battery 77˚F (25˚C)	Approx. 21mΩ
Temperature dependency of capacity (20 hour rate)	104˚F (40˚C) 77˚F (25˚C) 32˚F (0˚C) 5˚F (-15˚C)	102% 100% 85% 65%
Self discharge 77˚F (25˚C)	Residual capacity after standing 3 months Residual capacity after standing 6 months Residual capacity after standing 12 months	91% 82% 64%
Charge Method (Constant Voltage) — Trickle use	Initial current	1.35 A or smaller
	Control voltage	13.6V to 13.8V (per 12V cell 25˚C)

Cutoff (per cell)	Discharge Runtime at 25˚C						
	3 min.	5 min.	7 min.	10 min.	15 min.	20 min.	30 min.
1.6V	530	410	340	268	200	159	112
1.7V	490	390	323	258	195	156	111
1.8V	440	350	290	234	180	146	109

(Note) The above characteristics data are average values obtained within three charge/discharge. Cycles not the minimum values.
(Note) This battery is designed for high rate discharge and we do not specify 20 hour rate discharge capacity.
(Note) When specific condidtions are satisfied, this battery can be used for main power supplies. Please consult Panasonic.

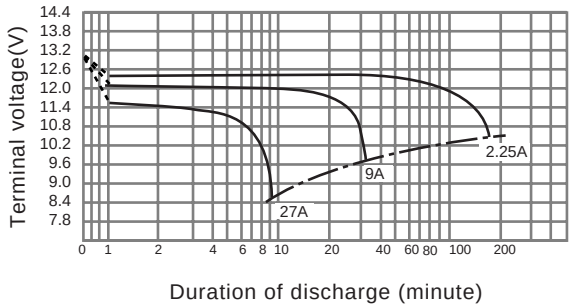
Dimensions (mm)

Terminal type: Faston 250

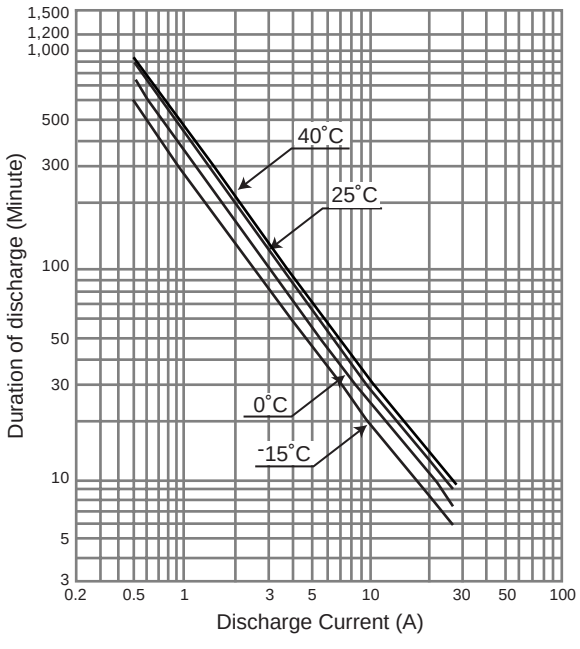


Battery case resin: Standard (UL94HB) Color is black.
Optional (UL94V-0) Color is grey.

Discharge characteristics 77°F (25°C) (Note)



Duration of discharge vs. Discharge current (Note)



TERMINAL DIMENSIONS

Terminal Data of the medium-capacity (17 to 100Ah) battery

Model No.	Terminal thickness A (1)	Height from battery case top		Terminal width	Hole diameter	Hole Position			Bolt			Type of Terminal
		B1 (1)	B2 (2)			Distance from top: E1 (1)	Distance from top: E2 (2)	Distance from terminal top: E3 (2)	Diameter F1 (3)	Pitch	Length F2 (3)	
LC-RD1217P	5.0 ± 0.3	1.0	---	11 ± 0.4	5.5 ± 0.3	6.5	---	5.5 ± 0.3	M5	P=0.8	15 ± 1.0	M5 bolt and nut
LC-PD1217P	---	1.0	---	11 ± 0.4	5.5 ± 0.3	6.5	---	5.5 ± 0.3	M5	P=0.8	15 ± 1.0	M5 bolt and nut
LC-X1220P	5.0 ± 0.3	1.0	---	11 ± 0.4	5.5 ± 0.3	6.5	---	5.5 ± 0.3	M5	P=0.8	15 ± 1.0	M5 bolt and nut
LC-X1220AP	---	1.7	---	---	---	---	---	---	M5	P=0.8	9.8	M5 threaded post
LC-X1228P	8.0 ± 0.5	4.5	16.5 ± 1.5	16 ± 0.8	6.5 ± 0.4	---	9 ± 1.0	7.5 ± 0.4	M5	P=0.8	15 ± 1.0	M5 bolt and nut
LC-X1228AP	---	2.2 ± 1.0	9.8 ± 1.5	---	---	---	---	---	M5	P=0.8	8.3 ± 1.0	M5 threaded post
LC-R1233P	6.0 ± 0.5	---	26.5 ± 1.5	16 ± 0.8	6.5 ± 0.4	---	19 ± 1.5	7.5 ± 0.4	M6	P=1.0	20 ±1.0	M5 bolt and nut
LC-X1242P	8.0 ± 0.5	5.0	16.5 ± 1.5	16 ± 0.8	6.5 ± 0.4	---	9 ± 1.0	7.5 ± 0.4	M6	P=1.0	20 ± 2.0	M5 bolt and nut
LC-X1242AP	---	1.7 ± 1.0	9.8 ± 1.5	---	---	---	---	---	M5	P=0.8	8.3 ± 1.0	M5 threaded post
LC-X1265P	7.0 ± 0.5	2.0 ± 1.0	18 ± 1.5	---	6.5+05-0.4	9.5 ± 1	---	7.5 ± 0.4	M6	P=1.0	20 ± 1.0	M6 bolt and nut
LC-XA12100P	8.0 ± 0.5	---	24 ± 1.5	---	6.5 ± 0.4	---	14 ± 1.0	10 ± 0.4	M8	P=1.25	20 ± 1.0	M8 bolt and nut

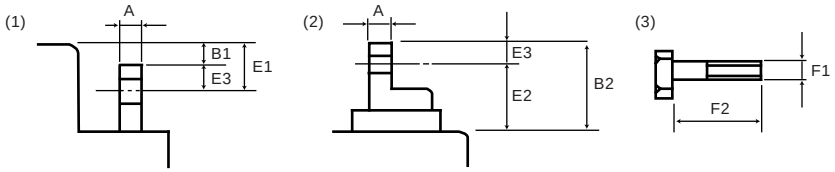
Units: mm

Cycle Long Life Series

LC-XC1228AP	---	2.2 ± 1.0	9.8 ± 1.5	---	---	---	---	---	M5	P=0.8	18.3 ± 1.0	M5 threaded post
LC-XC1238AP	---	2.2 ± 1.0	9.8 ± 1.5	---	---	---	---	---	M5	P=0.8	8.3 ± 1.0	M5 threaded post

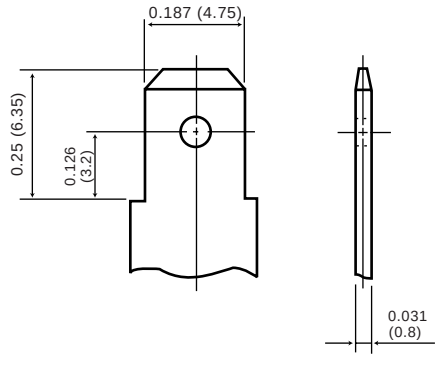
Units: mm

Bolt and Nut type (M5, M6, M8)

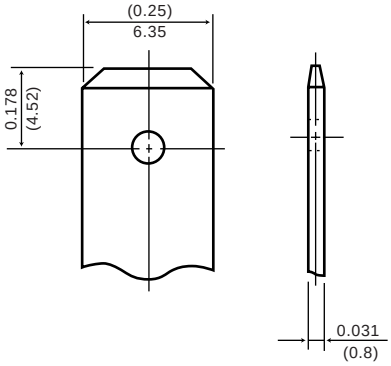


Terminal Dimensions Inch (mm)

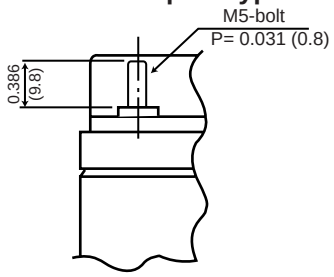
Faston tab type 187



Faston tab type 250



M5 threaded post type



Terminal Materials

Faston 187: Tin Plated Brass
Faston 250: Tin Plated Brass
Bolt & Nut: Lead Alloy*
Threaded Post: Tin Plated Brass

***Proposition 65 Warning**
Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. Wash hands after handling.

EXAMPLES OF BATTERY LABELS

The following label examples are for reference only. Label content may vary with country of manufacture and/or destination country. Please consult your local Panasonic sales office for label information on specific model numbers. Note: For product sold in North America, the following warning label will appear on batteries with bolt and nut terminals.

> **"Proposition 65 Warning"** Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. Wash hands after handling."

Sample of Rechargeable Valve-Regulated Lead-Acid Battery Label

Panasonic

Rechargeable Valve Regulated Lead-Acid Battery

Information specific to model number

LC-R1233P

(12V, 33Ah/20HR)

Constant Voltage Charge
Voltage regulation
Cycle use :14.5 - 14.9V (25˚C)
(Initial current : less than 13.2A)
Standby use : 13.6 -13.8V (25˚C)

NONSPILLABLE
IN THE U.S.A. CALL 1-800-SAV-LEAD
BATTERY MUST BE RECYCLED

LEAD RETURN
RECYCLE

CAUTION
* Do not charge in a gas tight container.
* Do not short the battery terminals.
* Do not incinerate.
* Flush with water at once if contact is made with electrolyte (Acid).

Pb

Matsushita Electric Industrial Co., Ltd. Made in China — *Country of manufacture*

Sample of Flame Retardant Valve-Regulated Lead-Acid Battery Label

Panasonic

Rechargeable Valve Regulated Lead-Acid Battery

Information specific to model number

LC-P0612P (6V, 12Ah/20HR)

FLAME RETARDANT 94V-0

Constant Voltage Charge
Voltage regulation

Standby use : 6.8 -6.9V (25˚C)

LEAD RETURN
RECYCLE

NONSPILLABLE
IN THE U.S.A.
CALL 1-800-SAV-LEAD
BATTERY MUST BE
RECYCLED

For batteries sold in North America only

CAUTION
* Do not charge in a gas tight container.
* Do not short the battery terminals.
* Do not incinerate.
* Flush with water at once if contact is made with electrolyte (Acid).

Pb

Matsushita Electric Industrial Co., Ltd. Made in China — *Country of manufacture*

SAV-LEAD RECYCLING PROGRAM

The proper disposal of spent VRLA batteries is becoming more of a critical issue, both from the viewpoint of environmental stewardship and from compliance with federal and state environmental regulations. Panasonic recognizes the burdens and responsibilities that have been placed on our customers to properly dispose of spent VRLA batteries and is proud to offer this voluntary nationwide battery recycling program, 1-800-SAV-LEAD, for the collection and recycling of valve-regulated lead acid batteries (VRLA).

Federal and State Requirements for Proper Disposal

Federal and State laws prohibit the improper disposal of all lead acid batteries. The battery end users (owners) are responsible for their batteries from the date of purchase through their ultimate disposal. The only legally acceptable method of disposal of lead acid batteries is to recycle them at Resource Conservation and Recovery Act (RCRA) approved secondary lead smelter. This Panasonic 1-800-SAV-LEAD Recycling Program will allow for you to arrange for the recycling of your VRLA batteries from anywhere in the United States. The Program will accept Panasonic and other VRLA batteries regardless of manufacturer. Panasonic will handle all VRLA batteries returned in an environmentally sound manner designed to comply with all applicable Federal and State laws and regulations. Panasonic will send batteries only to fully-permitted secondary lead smelters that we believe meet the highest environmental standards. Once the VRLA batteries are received by Panasonic, the cost to transport the batteries to the secondary lead smelter and the actual recycling costs will be borne by Panasonic.

Panasonic VRLA Recycling Program

1) We encourage all of our customers to serve as VRLA collection centers for your customers, thereby establishing a reverse distribution network between the end user and the secondary lead recycling facility.
2) All shipments to our national consolidation facility must he prepaid. No freight collect shipments will be accepted. All freight collect and non-VRLA batteries will be returned to the shipper.
3) Panasonic will maintain on file all necessary documentation for EPA reference. A copy will be provided upon request,
4) All batteries must be shipped, prepaid to our national consolidation site. Exception: schedule all full-truck-load shipments of VRLA batteries in advance.
   For current shipping information contact 1-800-SAV-LEAD, or download the latest information from www.panasonic.com/batteries and go to the “Environmental” link.
5) Only VRLA batteries that meet the U.S. Department of Transportation (DOT) “NON-SPILLABLE” (49 CFR 17.159d) requirements will be accepted by this program.
6) Panasonic reserves the right to alter or discontinue this program at any time.

Packaging Requirements

1) All VRLA batteries must be fully discharged and packaged in a manner as to insure safe handling and conform to all applicable DOT regulations. (49 CFR 173.159). A dab of silicon caulking or non-conductive tape on each terminal will ensure that no direct shorts occur during shipment.
2) VRLA battery shipments should be made in pallet quantities whenever possible.
3) Palletized shipments should be secured with metal bands or poly-wrapped with stack height limited to four (4) feet.
4) VRLA batteries shipped on pallets should be of uniform size or be stacked with the larger batteries on the bottom.
5) VRLA batteries should be stacked upright in a head-to-base arrangement. Each layer should be separated by cardboard to prevent accidental shorting.
6) Smaller quantities of VRLA batteries may be shipped via standard UPS. Be sure that each box does not exceed the UPS weight limit. A dab of silicon caulking or non-conductive tape on each terminal will ensure that no shorts occur during shipment.
7) The outside of every pallet and individual box must be labeled “NON-SPILLABLE” as required by DOT regulations. This label must be visible during transportation.

Special Note to Consumer Users of Panasonic VRLA Batteries

All Panasonic VRLA batteries are chemically identical to common automotive starter batteries and can be returned to any site that accepts automotive lead acid batteries for recycling. Examples include retailers of automotive batteries, automotive service centers, scrap metal dealers, etc.

For additional information on this program or information on how to recycle other Panasonic batteries please call your local Panasonic Battery Sales Group sales office.

Glossary of main battery terms

- **ABS RESIN**
  A plastic material largely used for the case and cover of batteries.
- **ABSORBENT GLASS MAT (AGM)**
  A highly porous material, absorbent micro fiberglass-mat mixed with polymer fibers that immobilizes the electrolyte and creates a situation where a spill of electrolyte is highly unlikely. The separator is located between the plates and immobilizes the electrolyte in the cell.
- **ACTIVE MATERIAL**
  The substance which electrochemically reacts in the electrode of batteries. Lead-acid batteries adopt lead dioxide for the positive electrode and spongy lead for the negative electrode.
- **AMBIENT TEMPERATURE**
  Average temperature in the vicinity of the battery.
- **AVAILABLE CAPACITY**
  The capacity actually available from a cell/ battery. The available capacity is the capacity of a battery when it discharges at a specified hour rate, and expressed in hour rate and Ah.
- **BOLT FASTENING TERMINAL**
  A type of battery terminals, to which lead wires are connected with bolts.
- **BUILT-IN THERMOSTAT**
  The built-in thermostat is a resettable switch built in a battery for temporarily cut off the battery circuit when the temperature of the battery exceeds a preset value or when the battery charges/discharges at a higher rate than predetermined.
- **CAPACITY**
  The electric capability of a battery. It usually means ampere- hour capacity expressed in Ah or C (coulomb).
- **CELL**
  The minimum battery unit which composes a storage battery. Nominal voltage of the cell of the lead-acid battery is 2 V.
- **CHARGE**
  The operation of supplying a battery with a DC current from an external power source to have the electrode active materials conduct chemical reactions then to store electric energy as chemical energy in the battery.
- **CHARGE ACCEPTANCE TEST**
  Test of batteries to check whether or not they are adequately recharged after discharge.
- **CHARGING EFFICIENCY**
  General term for ampere-hour efficiency and watt-hour efficiency. In many cases, however, it means the ampere-hour efficiency.
- **CONSTANT CURRENT CHARGE**
  A method of charging: to charge a battery with a constant current.
- **CONSTANT VOLTAGE CHARGE**
  A method of charging: to charge a battery by applying a constant voltage to the terminals.
- **C-RATE**
  A charge or discharge current rate expressed in A or mA. It is numerically the same as the hour rate capacity of a battery expressed in Ah of the rated capacity.
- **CUT-OFF VOLTAGE OF DISCHARGE**
  The terminal voltage of a battery at which discharging should be discontinued. This voltage depends on discharge current, type of electrodes and construction of battery.
- **CYCLE LIFE**
  The number of charge/discharge/rest cycles a cell/battery can provide. Cycle life is usually expressed by the number of cycles available before duration of discharge decreases to a half of the initial value.
- **DEPTH OF DISCHARGE**
  A value to express the state of discharge of a battery. The depth of discharge is generally expressed by the ratio of discharge amount to rated capacity of the battery.
- **DISCHARGE**
  To draw off the electric energy stored in a cell/ battery.

- **DISCHARGE RATE**
  The term to express the magnitude of discharge current. When assuming discharge current and time to discharge cut-off voltage t hours, this discharge is called t hour rate (tHR) discharge, and the current is called t-hour rate discharge current. When time t is minutes instead of hours, tMR is used.
- **DUTY CYCLE TEST**
  Test of batteries in ordinary use including charge, discharge and rest.
- **ELECTROLYTE**
  The medium which serves to conduct ions in the electrochemical reactions in batteries. The lead-acid battery adopts diluted sulfuric acid as the electrolyte.
- **ENERGY DENSITY**
  Energy available per unit Approx. mass or unit volume of a cell/ battery. Energy density is expressed in Wh/ kg or Wh/l.
- **FLOAT CHARGE**
  The system in which a constant voltage is continuously applied to a battery connected to a rectifier in parallel with a load to maintain the battery in charged state: on occurrence of power failure or load variation, the battery supplies power to the load without any short break.
- **GAS RECOMBINATION ABILITY**
  Capability of a battery to recombine (or absorb) internally generated oxygen gas at the negative plate. The greater this capability is, the larger the available charge current.
- **HIGH RATE DISCHARGE**
  A very rapid discharge of a battery. (In many cases it means discharging at approx. 1 CA or higher rate.)
- **INTERNAL PRESSURE**
  The pressure within a sealed battery. Internal pressure of a battery is increased by oxygen gas which is generated from the positive plate at the end of charging.
- **INTERNAL RESISTANCE**
  The resistance within a battery: it is the total of individual resistances of the electrolyte and the positive and negative plates. Internal resistance is simply measured with the current four-terminal method (1,000 Hz) and expressed in the composite value of resistance component and capacitor component.
- **INTERNAL SHORT-CIRCUIT**
  Touching of the positive and negative plates within a cell.
- **LIFE**
  The time period until a cell/battery loses its expected characteristics.
- **LOW MAINTENANCE**
  Low maintenance means that no watering nor equalizing charge is required in operating batteries.
- **LOW-VOLTAGE CUT-OFF**
  A circuitry designed to discontinue discharge of a battery at a predetermined voltage level.
- **MALE TAB**
  The metallic pieces which are attached to a VRLA battery as the terminals.
- **MEMORY EFFECT**
  A phenomenon where a temporary drop of discharge voltage is observed during deep discharge of an alkaline rechargeable battery which has been subjected to shallow charge/ discharge. Cycles or trickle charging over long time.
- **NEGATIVE PLATE**
  The battery electrode into which a current from the external circuit flows during discharging. The negative plate has lower electric potential than the positive plate to the electrolyte. The negative plate is incorporated with connection parts such as the electrode pole.
- **RATED CAPACITY**
  A nominal value of capacity of a cell/battery, which is a measure of electric capability. Rated capacity is rather approximate compared with rated capacity.

- **NOMINAL VOLTAGE**

  A nominal value to indicate the voltage of a cell battery. Generally, nominal voltage value of a battery is somewhat lower than its electromotive force. Nominal voltage of the lead-acid battery is 2.0 V per unit cell.

- **OPEN CIRCUIT VOLTAGE**
  Measured voltage of a cell/battery which is electrically disconnected from the external circuit.

- **OVERCHARGE**
  Continued charging of a fully charged cell/ battery. With batteries which require watering, overcharge causes electrolysis of water, resulting in rapid decrease of electrolyte. Generally, overcharge adversely influences battery life.

- **OVERDISCHARGE**
  Discharge of a battery to a voltage below a predetermined cut-off voltage.

- **PARALLEL CHARGE**
  Simultaneous charging of two or more batteries connected in parallel. In cyclic use of batteries, specifically, the parallel charge tends to cause an imbalance in charge state among the batteries, which may shorten their service life.

- **POLYPROPYLENE RESIN**
  A plastic material which is often used for the case and cover of batteries.

- **POSITIVE PLATE**
  The battery electrode from which a current flows to the external circuit during discharging. The positive plate has higher electric potential than the negative plate to the electrolyte. The positive plate is incorporated with connection parts such as the electrode pole.

- **QUICK CHARGE (RAPID CHARGE)**
  Charging in a short time with a large current.

- **RATED CAPACITY**
  The stated capacity of a battery; namely, the ampere-hour amount which can be drawn from the battery in fully charged state at a specified temperature, at a specified discharge rate, and to a specified cut-off voltage. The symbol CN may be used to express the rated capacity of N-hour rate.

- **RECHARGEABLE BATTERY**
  The rechargeable battery is a system comprising two different electrodes and an ion-conductive medium, which is capable of converting chemical energy to electric energy, and vice versa. It is also called a secondary battery.

- **REFRESH CHARGE (AUXILIARY CHARGE)**
  Charging of a battery mainly to compensate for its self discharge.

- **RESIDUAL CAPACITY**
  Residual capacity of a battery after partial discharge or after storage for long time.

- **RETAINER TYPE**
  A method to control flowing electrolyte in a battery with the retainer mat, etc..

- **REVERSE CHARGE**
  Charging of a battery with its polarity reversed. Namely, the battery discharges.

- **SELF DISCHARGE**
  Reduction in capacity of a battery while no current is drawn by the external circuit. Self discharge depends on temperature: amount of discharge approximately doubles by each (10°C) rise of ambient temperature.

- **SEALED LEAD-ACID BATTERY (SLA BATTERY)**
  See: Valve-regulated lead-acid battery. (VRLA)

- **SEPARATOR**
  A porous or microporous liquid-absorbent material which is installed between the battery electrodes for preventing short-circuit, securing the separation of the electrodes and retaining electrolyte. The separator should be resistant to oxidation and chemicals; it should excel in electric insulation and liquid-retention; and it should not disturb diffusion of the electrolyte and ionic conduction.

- **STANDBY USE**
  General term of constant stand-by battery systems. Batteries are kept charged by trickle/ float method at all times in preparation for unforeseen power disruptions.

- **TEMPERATURE COMPENSATION**
  Compensation of charge voltage for temperature variation of a cell/battery or in its vicinity. Qualitatively, charge voltage should be corrected to higher side for low temperatures and to lower side for high temperatures.

- **TERMINAL VOLTAGE AT DISCHARGE**
  The voltage of a battery during discharging.

- **THERMAL RUNAWAY**
  Such phenomena as an excessively high set-up voltage in constant-voltage charging of a battery and a very high battery temperature cause charge current to increase, which then raises the temperature further: this vicious cycle is called thermal runaway, which may, in the worst case, result in breakage of the battery due to heat.

- **TRICKLE CHARGE**
  To charge a battery in the state of disconnection from the load to compensate for its self discharge.

- **TRICKLE LIFE**
  The service life of a battery in the trickle use. Usually, the trickle life is the time expressed in years before the dischargeable time of the battery decreases to a half of the initial value.

- **UL**
  Abbreviation of Underwriters Laboratories Inc. in USA. The UL establishes various safety standards, and performs official recognition of materials, parts and products.

- **UPS (Uninterruptible Power Supply)**
  Equipment or system which is automatically connected to the load to supply power if the main power fails.

- **VALVE (ONE WAY VALVE)**
  A valve on each battery which automatically releases gas from the battery when internal pressure of the battery exceeds a predetermined value: it prevents breakage of the battery due to excessive internal pressure caused by the gas generated by charging or other reasons. The valve also serves to prevent outside air from entering batteries.

- **VALVE-REGULATED LEAD ACID (VRLA)**
  Valve-regulated (sometimes referred to as sealed, although it is technically incorrect) lead-acid batteries operate with the principle of gas recombination and immobilized electrolyte. The gases that are produced during normal operation are recombined in the battery reducing water loss. When pressure in the battery builds up, the valve opens at a predetermined value venting the gases and then reseals before battery pressure reaches atmospheric pressure.