SAFETY, LONG-LIFE AND POWER!

PANASONIC BATTERIES

We are able to offer you a wide range of individual power solutions for portable and stationary applications. Our product range includes high reliability batteries such as Lithium-Ion, Lithium, Nickel-Metal-Hydride, Valve-Regulated-Lead-Acid (VRLA), Alkaline and Zinc-Carbon. Based on this battery range we can power your business in virtually all applications.

PIE organisation divisions

Panasonic Energy Company (PEC) started its battery production in 1931. Today PEC is the most diversified global battery manufacturer with a network of 16 manufacturing companies in 14 countries. More than 12,600 employees are dedicated to the research & development and in the production of new batteries for a new world.

When it comes to production our facilities employ leading edge manufacturing processes meeting the highest quality standards. Our factories are certified to ISO standards. This means that each factory has its own quality and environmental management. The ISO 9000 and ISO 14000 series are the minimum benchmarks that ensure our excellent product reliability.

Furthermore the majority of our factories is also certified to OHSAS 18001 (Occupational Health and Safety Assessment Series), an international standard for assessing a management system for occupational safety. This confirms that our factories have been proactive in putting the occupational health and safety of its staff at the centre of the company’s dealings. In addition our VRLA batteries are for example approved to German VdS standard and U.S. UL standard.

PIE Organisation Divisions

Panasonic Corporation, founded in Osaka 1918, is one of the world’s largest manufacturers of quality electronic and electrical equipment. Its subsidiary, Panasonic Industrial Europe GmbH (PIE) deals with a wide diversified range of industrial products for all European countries. This company was formed in 1998 to strengthen Panasonic’s Pan-European industry operation, and today is active in such different business fields as Automotive, Audio/Video & Communication, Appliance and Industry & Devices to satisfy its customer’s needs.
Pursuing coexistence with the global environment in its business vision, Panasonic places reduction of the environmental impact in all its business activities as one of the important themes in its mid-term management plan. In its ‘eco ideas’ Strategy, which focuses in particular on rapid implementation of measures to prevent global warming and global promotion of environmental sustainability management, Panasonic is advancing three key initiatives: ‘eco ideas’ for Manufacturing, ‘eco ideas’ for Products, and ‘eco ideas’ for Everybody, Everywhere.

The Panasonic ‘eco ideas’ House
We are approaching a global turning corner and it would not be an exaggeration to call it the Environmental Industrial Revolution. Based on this recognition, Panasonic has built an ‘eco ideas’ House on the premise of our showroom, Panasonic Center Tokyo in April 2009 in order to help create a carbon-free society and reduce CO2 emissions from a household sector.

The concept of this ‘eco ideas’ House can be described as follows:
1. Virtually zero CO2 emissions in an entire house envisaged in three to five years into the future
2. Synergy of technology and nature

Aforementioned concepts shows that Panasonic is not only aware of it’s environmental responsibility moreover this Panasonic takes action.

Example
The Wakayama Plant of the Energy Company is strengthening its management structure to cut CO2 emissions from the main production bases for Lithium-Ion batteries, which are a core component of Panasonic’s energy business. As a result, it has succeeded in roughly halving CO2 emissions per production unit, as well as sharply curbing an increase in CO2 emissions even as production has expanded.

Our energy will Drive eco Innovation.

The Panasonic ‘eco ideas’ House

Our plans
We will reduce CO2 emissions across all our manufacturing sites.

Our goals
In each of our factories a CO2 emissions of 10% reduction till 2010.

Our measures
Our factories are evaluated with regard to CO2 emission, waste disposal, recycling measures as well as chemical and water consumption within the scope of the ‘Clean Factory’ program and they are set performance targets according to these indicators.

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Our plans
We will produce energy-efficient products.

Our goals
In March 2010 at least 20 products with the ‘Superior Green Products’ classification should be available.

Our measures
The developers at Panasonic carry out an environmental impact assessment for all our products. Products that meet the highest environmental requirements in the branch with regard to conservation of energy and energy efficiency are classified as a ‘Superior Green Product’ and awarded the Panasonic logo ‘eco ideas’.

Example
We have dispensed with the use of highly toxic Lithium Thionyl Chloride in the production of our Lithium batteries. This is quite rightly classified as highly toxic and should never under any circumstances be released into the environment.

Our plans
We will encourage the spread of environmental activities throughout the world.

Our goals
Intensive commitment on the part of the company owners, international cooperations and involvement of the employees.

Our measures
Not only do we sponsor the work of the WWF for the Arctic, Panasonic has also launched a couple of other environmental initiatives such as the ECO RELAY initiative in which hundreds of colleagues the world over take part voluntarily for several days in environmental campaigns.

Example
With the support of the GRS Batterien (German Battery Recycling Association) Panasonic arranged a battery collection day with the aim of collecting as many of these spent energy sources as possible and giving out information about the recycling loop of batteries from which valuable raw materials such as Zinc, Manganese and Iron can be recovered.
In order to take full advantage of the properties of Ni-MH batteries and also to prevent problems due to improper use, please note the following points during the use and design of battery operated products.

**CHARGING**

**Charging temperature**
Charge batteries within an ambient temperature range of 0°C to 40°C. Ambient temperature during charging affects charging efficiency. As charging efficiency is best within a temperature range of 10°C to 30°C, whenever possible place the charger (battery pack) in a location within this temperature range.

At temperatures below 0°C the gas absorption reaction is not adequate, causing gas pressure inside the battery to rise, which can activate the safety vent and lead to leakage of alkaline gas and deterioration in battery performance.

Charging efficiency drops at temperatures above 40°C. This can disrupt full charging and lead to deterioration in performance and battery leakage.

**Parallel charging of batteries**
Sufficient care must be taken during the design of the charger when charging batteries connected in parallel. Consult Panasonic when parallel charging is required.

**Reverse charging**
Never attempt reverse charging. Charging with polarity reversed can cause a reversal in battery polarity causing gas pressure inside the battery to rise, which can activate the safety vent, lead to alkaline electrolyte leakage, rapid deterioration in battery performance, battery swelling or battery rupture.

**Overdischarge (deep discharge)**
Since overdischarging (deep discharge) damages the battery characteristics, do not forget to turn off the switch when discharging, and do not leave the battery connected to the equipment for long periods of time. Also, avoid shipping the battery installed in the equipment.

**Overcharging**
Avoid overcharging. Repeated overcharging can lead to deterioration in battery performance. (‘Overcharging’ means charging a battery when it is already fully charged.)

**Rapid charging**
To charge batteries rapidly, use the specified charger (or charging method recommended by Panasonic) and follow the correct procedures.

Trickle charging (continuous charging)
Trickle charging cannot be used with Ni-MH batteries, except specific high temperature batteries (please contact Panasonic to get more information). However, after applying a refresh charge using a rapid charge, use a trickle charge of 0.033CmA to 0.05CmA. Also, to avoid overcharging with trickle charge, which could damage the cell characteristics, a timer measuring the total charge time should be used.

Note: ‘CmA’
During charging and discharging, ‘CmA’ is a value indicating current and expressed as a multiple of nominal capacity. Substitute ‘C’ with the battery’s nominal capacity when calculating. For example, for a 1500mAh battery of 0.033CmA, this value is equal to 1/30 x 1500, or roughly 50mA.

**DISCHARGING**

**Discharge temperature**
Discharge batteries within an ambient temperature range of -10°C to +45°C.

Discharge current level (i.e. the current at which a battery is discharged) affects discharging efficiency. Discharging efficiency is good within a current range of 0.1CmA to 2CmA. Discharge capacity drops at temperatures below -10°C or above +45°C. Such decreases in discharge capacity can lead to deterioration in battery performance.

**Parallel charging of batteries**
Sufficient care must be taken during the design of the charger when charging batteries connected in parallel. Consult Panasonic when parallel charging is required.

**Reverse charging**
Never attempt reverse charging. Charging with polarity reversed can cause a reversal in battery polarity causing gas pressure inside the battery to rise, which can activate the safety vent, lead to alkaline electrolyte leakage, rapid deterioration in battery performance, battery swelling or battery rupture.

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PRECAUTIONS FOR DESIGNING DEVICES WITH NI-MH BATTERIES

STORAGE

Storage temperature and humidity (short-term)
Store batteries in a dry location with low humidity, no corrosive gases, and at a temperature range of -20°C to +45°C.
Storing batteries in a location where humidity is extremely high or where temperatures fall below -20°C or rise above +45°C can lead to the rusting of metallic parts and battery leakage due to expansion or contraction in parts composed of organic materials.

Long-term storage (1 year, -20°C to +35°C)
Because long-term storage can accelerate battery self-discharge and lead to the deactivation of reactants, locations where the temperature ranges between +10°C and +30°C are suitable for long-term storage.
When charging for the first time after long-term storage, deactivation of reactants may lead to increased battery voltage and decreased battery capacity. Restore such batteries to original performance by repeating several cycles of charging and discharging.
When storing batteries for more than 1 year, charge at least once a year to prevent leakage and deterioration in performance due to self-discharging.

SERVICE LIFE OF BATTERIES

Cycle life
Batteries used under proper conditions of charging and discharging can be used for 500 cycles or more. Significantly reduced service time in spite of proper charging means that the life of the battery has been exceeded.
Also, at the end of service life, an increase in internal resistance, or an internal short-circuit failure may occur. Chargers and charging circuits should therefore be designed to ensure safety in the event of heat generated upon battery failure at the end of service life.

Service life with long-term use
Because batteries are chemical products involving internal chemical reactions, performance deteriorates not only with use but also during prolonged storage.
Normally, a battery will last 2 years (or 500 cycles) if used under proper conditions and not overcharged or overdischarged. However, failure to satisfy conditions concerning charging, discharging, temperature and other factors during actual use can lead to shortened life (or cycle life) damage to products and deterioration in performance due to leakage and shortened service life.

DESIGN OF PRODUCTS WHICH USE BATTERIES

Connecting batteries and products
Never solder a lead wire and other connecting materials directly to the battery, as doing so will damage the battery’s internal safety vent, separator, and other parts made of organic materials. To connect a battery to a product, spot-weld a tab made of nickel or nickel-plated steel to the battery’s terminal strip, then solder a lead wire to the tab. Perform soldering in as short a time as possible. Use caution in applying pressure to the terminals in cases where the battery pack can be separated from the equipment.

Material for terminals in products using the batteries
Because small amounts of alkaline electrolyte can leak from the battery seal during extended use or when the safety vent is activated during improper use, a highly alkaline-resistant material should be used for a product’s contact terminals in order to avoid problems due to corrosion.

<table>
<thead>
<tr>
<th>High alkaline-resistant metals</th>
<th>Low alkaline-resistant metals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel, stainless steel, nickel-plated steel, etc.</td>
<td>Tin, aluminum, zinc, copper, bronze, etc.</td>
</tr>
</tbody>
</table>

(Note that stainless steel generally results in higher contact resistance.)

Temperature related the position of batteries in products
Excessively high temperatures (i.e. higher than 45°C) can cause alkaline electrolyte to leak from the battery, thus damaging the product and shorten battery life by causing deterioration in the separator or other battery parts. Install batteries far from heat-generating parts of the product. The best battery position is in a battery compartment that is composed of an alkaline-resistant material which isolates the batteries from the product’s circuitry. This prevents damage that may be caused by a slight leakage of alkaline electrolyte from the battery.

Discharge end voltage
The discharge end voltage is determined by the formula given below. Please set the end voltage of each battery at 1.1 volts or less.

\[
\text{Discharge end voltage} = \text{Number of batteries - 1} \times 1.2 \text{V}
\]

Overdischarge (deep discharging) prevention
Overdischarging (deep discharging) or reverse charging damages the battery characteristics. In order to prevent damage associated with forgetting to turn off the switch or leaving the battery in the equipment for extended periods, preventative options should be incorporated in the equipment.
At the same time, it is recommended that leakage current is minimized. Also, the battery should not be shipped inside the equipment.

PROHIBITED ITEMS REGARDING THE BATTERY HANDLING

Panasonic assumes no responsibility for problems resulting from batteries handled in the following manner.

Disassembly
Never disassemble a battery, as the electrolyte inside is strong alkaline and can damage skin and clothes.

Short-circuiting
Never attempt to short-circuit a battery. Doing so can damage the product and generate heat that can cause burns.

Overcharging at high currents and reverse charging
Never reverse charge or overcharge with high currents (i.e. higher than rated). Doing so causes rapid gas generation and increased gas pressure, thus causing batteries to swell or rupture. Charging with an unspecified charger or specified charger that has been modified can cause batteries to swell or rupture. Be sure to indicate this safety warning clearly in all operating instructions as a handling restriction for ensuring safety.

Installation in equipment (with an airtight battery compartment)
Always avoid designing airtight battery compartments. In some cases, gases (oxygen, hydrogen) may be given off, and there is a danger of the batteries bursting or rupturing in the presence of a source of ignition (sparks generated by a motor switch, etc.).

Use of batteries for other purposes
Do not use a battery in an appliance or purpose for which it was not intended. Differences in specifications can damage the battery or appliance.

PRECAUTIONS FOR DESIGNING DEVICES WITH NI-MH BATTERIES
PRECAUTIONS FOR DESIGNING DEVICES WITH NI-MH BATTERIES

Short-circuiting of battery packs
Special caution is required to prevent short circuits. Care must be taken during the design of the battery pack shape to ensure batteries cannot be inserted in reverse. Also, caution must be given to certain structures or product terminal shapes which can make short-circuiting more likely.

Using old and new batteries together
Avoid using old and new batteries together. Also avoid using these batteries with ordinary dry-cell batteries, Ni-Cd batteries or with another manufacturer’s batteries. Differences in various characteristic values, etc., can cause damage to batteries or the product.

OTHER PRECAUTIONS

Batteries should always be charged prior to use. Be sure to charge correctly.

NI-MH BATTERY TRANSPORTATION SITUATION*1

Transport by sea
Ni-MH batteries are classified as no dangerous goods under IMDG-Code 34-08 (International Maritime Dangerous Goods Code), valid until 31.12.2011. From 01.01.2012 new UN 3496 takes place under IMDG-Code 35-10 with Special Provision 963. Ni-MH batteries are then classified as dangerous goods in class 9. Batteries shall be securely packed and protected from short circuit. When loaded in a cargo transport unit with 100kg gross mass or more, special stowage is requested away from heat source. Furthermore an information on the IMO (International Maritime Organization) document is required.

Transport by air
As of today there are no fixed regulations for the worldwide transportation of Ni-MH batteries by air.

Transport by road
As of today there are no fixed regulations for the worldwide transportation of Ni-MH batteries by road.

FINAL POINT TO KEEP IN MIND

In order to ensure safe battery use and to prolong the battery performance, please consult Panasonic regarding charge and discharge conditions for use and product design prior to the release of a battery-operated product.

PRODUCT SAFETY DATA SHEET

Manufacturer
Name of Company: Panasonic Corporation Energy Company
Address: 1-1, Matsushita-cho, Moriguchi, Osaka 570-8511 Japan
Document number: PMH-PSDS-100129E
Issued: Jan, 29th, 2010

Name of product: Nickel-Metal-Hydride Storage Battery
(Model Name): The models described as HHR-*****

Substance identification
Substance: Nickel-Metal-Hydride Storage Battery
CAS No.: Not Specified.
UN Class: Classified as UN3028, but they are exempted from Dangerous Goods pursuant to UN Special Provision as below. Not restricted, as per Special Provision A123

[Special Provision 304] [UN Recommendations on the TRANSPORT OF DANGEROUS GOODS Model Regulations Volume 1. 15th revised edition] Battery, dry, containing corrosive electrolyte which will not flow out of the battery if the battery case is cracked are not subject to these Regulations provided the batteries are securely packed and protected against short-circuits. Examples of such batteries are: Alkali-Manganese, Zinc-Carbon, Nickel-Metal-Hydride and Nickel-Cadmium batteries.

Ecological information
Heavy metal quantity for cell: Hg < 0.5ppm  Measurement Analysis: Atomic Absorption Spectrometer
Cd < 5.0ppm  Measurement Analysis: Atomic Absorption Spectrometer
Pb < 40ppm  Measurement Analysis: Atomic Absorption Spectrometer

Transport information
1. During the transportation of a large amount of batteries by ship, trailer or railway, do not leave them in the places of high temperatures and do not allow them to be exposed to dew condensation.
2. Avoid transportation with the possibility of the collapse of cargo piles and the packing damage.
3. Protect the terminals of batteries and prevent them from short circuit so as not to cause dangerous heat generation.

Regulatory information
- ICAO Technical Instructions for the safe transport of dangerous goods by air
- IATA (A123) for air shipment and IMDG (Special Provision) for sea shipment under UN3028

Others

References
- Ni-Cd, Ni-MH Panasonic Catalogue and technical handbook.
- MSDS of Nickel hydro oxide and potassium hydro oxide and sodium hydro oxide from supplier.
- Recommendations on the TRANSPORT OF DANGEROUS GOODS Model Regulations Volume 1. 15th revised edition.

*1 The aforementioned information is subject to change without any notice.

*2 The aforementioned PSDS is only an extract. Please contact Panasonic to get the complete version.
OVERVIEW

More and more electric products with sophisticated functions require extremely compact and light battery solutions delivering a high level of energy density. To meet these needs Panasonic Ni-MH batteries have been developed and manufactured with nickel hydroxide for the positive electrode and hydrogen-absorbing alloys, capable of absorbing and releasing hydrogen at high-density levels, for the negative electrode. The Ni-MH battery technology is nowadays the Ni-Cd [nickel cadmium] successor technology for rechargeable and portable devices. All of our Ni-MH batteries are cadmium-free, in order not to be harmful to human beings and our environment.

CONSTRUCTION

Ni-MH batteries consist of a positive plate containing nickel hydroxide as its principal active material, a negative plate mainly composed of hydrogen-absorbing alloys, a separator made of fine fibers, an alkaline electrolyte, a metal case and a sealing plate provided with a self-resealing safety vent. Their basic structure is identical to that of Ni-Cd batteries. With cylindrical Ni-MH batteries, the positive and negative plates are divided by the separator, wound into a coil, inserted into the case, and sealed by the sealing plate through an electrically insulated gasket, see page 13. Panasonic expands the line of Ni-MH cells that are superior to standard Ni-MH products in applications with low-rate charge and more than doubles the expected life of the Ni-MH cells to those of Ni-Cd cells that have been trickle charged.

APPLICATIONS

Panasonic Ni-MH batteries can either be used for standard applications with a moderate ambient temperature or for applications which requires high temperature resistance.

Standard ambient temperature

E-Bikes, Pedelecs, Scooters, Golf-Trolleys, Powertools, Grape-Cutters, Multimeters, Voting Machine, Barcode Readers, Handheld Scanners, Labelprinters, Vacuum Cleaners, Muscle Electro-Stimulations, Toothbrushes, etc.

High temperature resistance (for back-up use)

Combined Solar Applications, Portable Medical Devices, POS Terminals, Emergency Light for buildings and trains, Elevator Safety Systems, etc.

THE PRINCIPLE OF ELECTROCHEMICAL REACTION INVOLVED IN Ni-MH BATTERIES

Hydrogen-absorbing alloys

Hydrogen-absorbing alloys have a comparatively short history which dates back about 20 years to the discovery of NiFe, MgNi and LaNi5 alloys. They are capable of absorbing hydrogen equivalent to about a thousand times of their own volume, generating metal hydrides and also of releasing the hydrogen that they absorbed. These hydrogen-absorbing alloys combine metal (A) whose hydrides generate heat exothermically to produce the suitable binding energy so that hydrogen can be absorbed and released at or around normal temperature and pressure levels. Depending on how metals A and B are combined, the alloys are classified in the following types: AB (TiFe, etc.), AB2 (ZnMn, etc.), AB3 (LaNi5, etc.) and A2B (Mg2Ni, etc.). From the perspective of charge and discharge efficiency and durability, the field of candidate metals suited for use as electrodes in storage batteries is now being narrowed down to AB2 type alloys in which rare-earth metals, especially metals in the lanthanum group, and nickel serve as the host metals; and to AB3 type alloys in which the titanium and nickel serve as the host metals. Panasonic is now focusing its attention on AB5 type alloys which feature high capacity, excellent charge and discharge efficiency, and excellent cycle life. It has developed, and is now employing its own MnNi5 alloy which uses Mn (misch metal – an alloy consisting of a mixture of rare-earth elements) for metal A.

As can be seen by the overall reaction given above, the chief characteristics of the principle behind a Ni-MH battery is that hydrogen moves from the positive to the negative electrode during charge and reverse during discharge, with the electrolyte taking no part in the reaction; which means that there is no accompanying increase or decrease in the electrolyte. A model of this battery’s charge and discharge mechanism is shown in the figure on the following page. These are the useful reactions taking place at the respective boundary reaction:

\[
\text{Overall reaction:} \quad \text{Ni(OH)}_2 + \text{M} \rightarrow \text{NiOOH} + \text{MH}_{ab} + \text{OH}^{-}
\]

Principle of electrochemical reaction involved in batteries

Ni-MH batteries employ nickel hydroxide for the positive electrode similar to Ni-Cd batteries. The hydrogen is stored in a hydrogen-absorbing alloy for the negative electrode, and an aqueous solution consisting mainly of potassium hydroxide for the electrolyte. Their charge and discharge reactions are shown below.

Positive electrode:

\[
\text{Ni(OH)}_2 \rightarrow \text{NiOOH} + \text{H}_2\text{O} + e^-
\]

Negative electrode:

\[
\text{M} + \text{H}_2\text{O} + e^- \rightarrow \text{MH}_{ab} + \text{OH}^-
\]

Overall reaction:

\[
\text{Ni(OH)}_2 + \text{M} \rightarrow \text{NiOOH} + \text{MH}_{ab}
\]

(M: hydrogen-absorbing alloy; \(\text{H}_{ab}\): absorbed hydrogen)
faces of the positive and negative electrodes, and to assist one in understanding the principle, the figure shows how the reactions proceed by the transfer of protons (H+).

The hydrogen-absorbing alloy negative electrode successfully reduces the gaseous oxygen given off from the positive electrode during overcharge by sufficiently increasing the capacity of the negative electrode which is the same method employed by Ni-Cd batteries.

By keeping the battery’s internal pressure constant in this manner, it is possible to seal the battery.

Schematic discharge of Ni-MH battery

Cycle life equivalent to 500 charge and discharge cycles
Like Ni-Cd batteries, Ni-MH batteries can be repeatedly charged and discharged for about 500 cycles. (example: IEC charge and discharge conditions)

Rapid charge in approx. 1 hour
Ni-MH batteries can be rapidly charged in about an hour using a specially designed charger.

Excellent discharge characteristics
Since the internal resistance of Ni-MH batteries is low, continuous high-rate discharge up to 3CmA is possible.

FEATURES

Similarity with Ni-Cd batteries
These batteries have similar discharge characteristics to those of Ni-Cd batteries.

Double the energy density of conventional batteries
Ni-MH batteries have approximately double the capacity compared with Panasonic’s standard Ni-Cd batteries.

Five MAIN CHARACTERISTICS

As with Ni-Cd batteries, Ni-MH batteries have five main characteristics: charge, discharge, storage life, cycle life and safety.

1. Charge characteristics
The charge characteristics of Ni-MH batteries are affected by current, time and temperature. The battery voltage rises when the charge current is increased or when the temperature is low. The charge efficiency differs depending on the current, time, temperature and other factors. Ni-MH batteries should be charged at a temperature ranging from 0°C to 40°C using a constant current of 1C or less. The charge efficiency is particularly good at a temperature of 10°C to 30°C. Repeated charge at high or low temperatures causes the battery performance to deteriorate. Furthermore, repeated overcharge should be avoided since it will downgrade the battery performance. Refer to the section on recommended charge methods for details on how to charge the batteries, see page 17-18.

2. Discharge characteristics
The discharge characteristics of Ni-MH batteries are affected by current, temperature, etc., and the discharge voltage characteristics are flat at 1.2V, which is almost the same as for Ni-Cd batteries. The discharge voltage and charge efficiency decrease in proportion as the current rises or the temperature drops. As with Ni-Cd batteries, repeated charge and discharge of these batteries under high discharge cut-off voltage conditions (more than 1.1V per cell) causes a drop in the discharge voltage (which is sometimes accompanied by a simultaneous drop in capacity). The discharge characteristics can be restored by charge and discharge to a discharge end voltage of down to 1.0V per cell.

Charge temperature characteristics at various charge rates

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**NI-MH BATTERIES**

**3. Storage characteristics**

These characteristics include self-discharge characteristics and restoration characteristics after long-term storage. When batteries are left standing, their capacity generally drops due to self-discharge, but this is restored by charge.

**Self-discharge characteristics**

Self-discharge is affected by the temperature at which the batteries are left standing and the length of time during which they are left standing. It increases in proportion to the temperature and the shelf-standing time increases. Panasonic’s Ni-MH batteries have excellent self-discharge characteristics.

**4. Cycle life characteristics**

The cycle life of these batteries is governed by the conditions under which they are charged and discharged, temperature and other conditions of use. Under proper conditions of use (example: IEC charge and discharge conditions), these batteries can be charged and discharged for more than 500 cycles.

**5. Safety**

When the internal pressure of these batteries rises due to overcharge, short-circuiting, reverse charge or other abuse or misuse, the self-sealing safety vent is activated to prevent battery damage.

**CHARGE METHODS FOR NI-MH BATTERIES**

**CHARGE METHODS**

Charge is the process of restoring a discharged battery to its original capacity. In order for a battery to be usable for a long period of time, it must be charged via the proper charge method. Various methods are used to charge rechargeable cells, but Panasonic recommends the charge methods described below to charge its Ni-MH batteries.

1. **Rapid charge current:** 1CmA (rapid charge temperature range: 0°C to 40°C). In order to exercise proper control to stop rapid charge, it is recommended that batteries be charged at over 0.5CmA but less than 1CmA. Charging batteries at a current in excess of 1CmA may cause the safety vent to be activated by a rise in the internal pressure of the batteries, thereby resulting in electrolyte leakage. When the temperature of the batteries is detected by a thermistor or other type of sensor, and their temperature is under 8°C or over 60°C at the commencement of the charge, then trickle charge, rather than rapid charge, must be performed. Rapid charge is stopped when any one of the values among the types of control described in (4), (5), (6), and (11) reaches the prescribed level.

2. **Allowing a high current:** to flow to excessively discharged or deep-discharged batteries during charge may make it impossible to sufficiently restore the capacity of the batteries. To charge excessively discharged or deep-discharged batteries, first allow a trickle current to flow, and then proceed with the rapid charge current once the battery voltage has risen.

3. **Rapid charge start voltage:** Approx. 0.8V/cell rapid charge transition voltage restoration current: 0.2 ~ 0.3CmA

4. **Upper battery voltage limit control:** Approx. 1.8V/cell. The charge method is switched over to trickle if the battery voltage reaches approximately 1.8V/cell due to trouble or malfunctioning of some kind.

5. **∆V value:** 5 to 10mV/cell. When the battery voltage drops from its peak to 5 to 10mV/cell during rapid charge, rapid charge is stopped, and the charge method is switched over to trickle charge.

6. **dT/dt value:** Approx. 1 to 2°C/min. When a rise in the battery temperature per unit time is detected by a thermistor or other type of temperature sensor during rapid charge, and the prescribed temperature rise is sensed, rapid charge is stopped and the charge method is switched over to trickle charge.

7. **Temperature cut-off (TCO):** 55°C (for A and AA size), 50°C (for AAA size), 60°C (for L-A, LfatA and SC size). The cycle life and other characteristics of batteries are impaired if the batteries are allowed to become too hot during charge. In order to safeguard against this, rapid charge is stopped and the charge method is switched over to trickle charge when the battery temperature has reached the prescribed level.

8. **Initial delay timer:** 10 min. This prevents the -∆V detection circuit from being activated for a specific period of time after rapid charge has commenced. However, the ∆t/∆t detection circuit is allowed to be activated during this time. As with Ni-Cd batteries, the charge voltage of Ni-MH batteries may show signs of swinging [pseudo - ∆V] when they have been kept standing for a long time or when they have discharged excessively, etc. The initial delay timer is needed to prevent charge from stopping (to prevent malfunctioning) due to this pseudo - ∆V.

9. **Trickle current:** 0.033 to 0.05CmA. When the trickle current is set higher, the temperature rise of the batteries is increased, causing the battery characteristics to deteriorate.

10. **Rapid charge transfer timer:** 60 min.

11. **Rapid charge timer:** 90 min. (at 1C charge)

12. **Total timer:** 10 to 20 hours. The overcharging of Ni-MH batteries, even by trickle charging, causes a deterioration in the characteristics of the batteries. To prevent overcharging by trickle charging or any other charging method, the provision of a timer to regulate the total charging time is recommended.

Note: The temperature and voltage of Ni-MH batteries vary depending on the shape of the battery pack, the number of cells, the arrangement of the cells and other factors. Therefore...
Panasonic should be consulted for more detailed information on the referenced charge control values. The charge methods described previously can be applied also when Ni-MH batteries are employed in a product, but Panasonic should be consulted for the control figures and other details.

Recommended Ni-MH battery charge system

1. Rapid charge current  Max. 1CmA to 0.5CmA
2. Rapid charge transition voltage  0.2 to 0.35CmA
3. Rapid charge start voltage  Approx. 0.18V/cell
4. Charge terminating voltage  1.8V/cell
5. SOE value  5 to 10% (initial)
6. Battery temperature rising rate  1 to 2°C/minute
7. Maximum battery temperature TCO  60°C (for L, A, L-16A and SC use)
8. Initial -∆V detection disabling timer  5 to 10 min
9. Trickle charge (after rapid charge)  0.033 to 0.05CmA
10. Rapid charge timer  60 min
11. Total timer  10 to 20 hours
12. Rapid charge transfer timer  60 min
13. Rapid charge temperature range  0°C to 40°C

Matching test is required because these values vary depending on rapid charge current, number of cells, configuration of battery pack, etc.

Ni-MH HIGH-TEMPERATURE SERIES RECOMMENDED CHARGE FOR BACK-UP POWER APPLICATIONS

The optimal charge system for the Ni-MH “H” Series for back-up power applications is an intermittent timer charge. An intermittent timer charge improves charge efficiency, extends battery life (vs. trickle charge) and reduces electricity consumption up to 30% compared to trickle charge.

Intermittent timer charge: (See diagram) At the beginning of the charge, an IC timer is started and charging is activated at a current of 0.1ltA until the timer stops and the charge is terminated. When the batteries self discharge down to a set point (1.3V), the timer charge is re-activated.

Example of an intermittent timer charge system:

- Average charge current: 0.1ltA
- Re-charge time: 16 hours
- Pulse charging can be used

Intermittent charge

Example of a rapid charge system

![Diagram of battery voltage, current, and temperature over time](Image)

Basic pack configuration circuit

![Diagram of battery pack configuration](Image)

Verifying the battery specifications required for the power supply of the device and use those conditions as the standards for battery selection. For reference, the technological factors concerning battery selection are shown below.

Battery selection

Using the catalogs and data sheets for the batteries currently produced and marketed, narrow down the number of candidates to a few battery types. From those candidates, select the one battery that most closely satisfies the ideal conditions required. In actual practice, the selection of a battery is rarely completed as easily as this. In most cases it is necessary to consider eliminating or relaxing some of the proposed specifications, and then select the most suitable battery from among those currently available to meet the adjusted conditions. This process makes it possible to select more economical batteries. If you have any doubts at this stage, consult closely with a battery engineer. In some cases, newly improved or newly developed batteries that are not yet listed in the catalog may be available. Normally the required specifications are also finalized at this stage.

TECHNOLOGICAL FACTORS CONCERNING BATTERY SELECTION

### Electrical characteristics

- Voltage range
  - $V_{\text{max}}$ $V_{\text{min}}$
- Load pattern
  - Continuous load
  - Intermittent load/pulse load
- Temperature and humidity conditions
  - Temperature and humidity during use
  - Temperature and humidity during storage

### Charge conditions

- Rapid charge
- Trickle float charge
- Charge time
- Charge temperature and atmosphere

### Temperature and humidity conditions

- Temperature and humidity during use
- Temperature and humidity during storage

### Size, weight and terminal type

- Diameter [mm] $[\text{max}]$
- Height [mm] $[\text{max}]$
- Length [mm] $[\text{max}]$
- Width [mm] $[\text{max}]$
- Mass [g] $[\text{av}]$
- Terminal type

### Battery life

- Operating life
- Storage period

### Others

- Atmospheric pressure
- Mechanical conditions
- Safety
- Interchangeability
- Marketability
- Price
### CYLINDRICAL

<table>
<thead>
<tr>
<th>Model</th>
<th>Diameter</th>
<th>Size</th>
<th>Nominal voltage (v)</th>
<th>Discharge capacity*1 (mAh)</th>
<th>Dimensions with tube (mm)</th>
<th>Approx. weight (g)</th>
<th>IEC</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHR-70AAA/FT</td>
<td>AAA</td>
<td>AAA</td>
<td>1.2</td>
<td>750</td>
<td>10.5 +0/-0.7</td>
<td>HR15/45</td>
<td>21</td>
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<tr>
<td>HHR-70AAA/HT**</td>
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</table>

* Multiply this by 10 to obtain the rated capacity (some exceptions)
*1 After charging at 0.1 CmA for 16 hours, discharging at 0.2 CmA.

### CYLINDRICAL FOR BACK-UP USE (HIGH TEMPERATURE TYPE)

<table>
<thead>
<tr>
<th>Model</th>
<th>Diameter</th>
<th>Size</th>
<th>Nominal voltage (v)</th>
<th>Discharge capacity*1 (mAh)</th>
<th>Dimensions with tube (mm)</th>
<th>Approx. weight (g)</th>
<th>IEC</th>
<th>Page</th>
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<td>AAA</td>
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<td>14.5 +0/-0.7</td>
<td>HR15/45</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>HHR-210A/FT</td>
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<td>A</td>
<td>1.2</td>
<td>2,050</td>
<td>17.0 +0/-0.7</td>
<td>HR17/30</td>
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<td>LFat/A</td>
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### E-BLOCK

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<th>Size</th>
<th>Nominal voltage (v)</th>
<th>Discharge capacity*1 (mAh)</th>
<th>Dimensions with tube (mm)</th>
<th>Approx. weight (g)</th>
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* Multiply this by 10 to obtain the rated capacity (some exceptions)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
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</tbody>
</table>

*1 After charging at 0.1 CmA for 16 hours, discharging at 0.2 CmA.
*2 For reference only.
*3 Need specially designed control system. Please contact Panasonic for details.
Battery performance and cycle life are strongly affected by how they are used. In order to maximize battery safety, please consult Panasonic when determining charge/discharge specs, warning label contents and design. The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

HHR-75AAA/HT CYLINDRICAL AAA SIZE (HR1450)

**DIMENSIONS (MM)**

- Diameter: 10.5 ± 0.7
- Height: 44.5 ± 1.0
- Approximate weight (g): 12
- Nominal voltage (V): 1.2
- Discharge capacity: 730 mAh
- Rated/min. (mAh): 702 mAh
- Approx. internal impedance (Ω), charged state (mΩ): 35

<table>
<thead>
<tr>
<th>Charge</th>
<th>Standard (mAh x hrs.)</th>
<th>Rapid (mAh x hrs.)</th>
<th>Standard (V)</th>
<th>Rapid (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (mAh)</td>
<td>70 ± 14</td>
<td>685 ± 1.0</td>
<td>0 ± 2</td>
<td>0 ± 2</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>0 to +45</td>
<td>0 to +45</td>
<td>-10 to +65</td>
<td>-10 to +65</td>
</tr>
<tr>
<td>Storage (°C)</td>
<td>&lt;1 year</td>
<td>-20 to +35</td>
<td>-20 to +65</td>
<td>-20 to +65</td>
</tr>
</tbody>
</table>

**SPECIFICATIONS**

- After charging at 0.1lt for 16 hours, discharging at 0.2lt.
- For reference only.
- Need specially designed control system. Please contact Panasonic for details.

**TYPICAL CHARGE CHARACTERISTICS**

- Charge: 450mA x 16h at 1.7mA x 1.7hrs.
- Discharge temperature: 20°C

**TYPICAL DISCHARGE CHARACTERISTICS**

- Charge: 1500mA x 16h at 1.7mA x 1.7hrs.
- Discharge temperature: 20°C

**HHR-80AAA/HT CYLINDRICAL AAA SIZE (HR1425)**

**DIMENSIONS (MM)**

- Diameter: 10.5 ± 0.7
- Height: 44.5 ± 1.0
- Approximate weight (g): 13
- Nominal voltage (V): 1.2
- Discharge capacity: 780 mAh
- Rated/min. (mAh): 793 mAh
- Approx. internal impedance (Ω), charged state (mΩ): 65

<table>
<thead>
<tr>
<th>Charge</th>
<th>Standard (mAh x hrs.)</th>
<th>Rapid (mAh x hrs.)</th>
<th>Standard (V)</th>
<th>Rapid (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (mAh)</td>
<td>75 ± 14</td>
<td>750 ± 1.2</td>
<td>0 ± 2</td>
<td>0 ± 2</td>
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<tr>
<td>Temperature (°C)</td>
<td>0 to +45</td>
<td>0 to +45</td>
<td>-10 to +65</td>
<td>-10 to +65</td>
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<tr>
<td>Storage (°C)</td>
<td>&lt;1 year</td>
<td>-20 to +35</td>
<td>-20 to +65</td>
<td>-20 to +65</td>
</tr>
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</table>

**SPECIFICATIONS**

- After charging at 0.1lt for 16 hours, discharging at 0.2lt.
- For reference only.
- Need specially designed control system. Please contact Panasonic for details.

**TYPICAL CHARGE CHARACTERISTICS**

- Charge: 190mA x 16h at 1.7mA x 1.7hrs.
- Discharge temperature: 20°C

**TYPICAL DISCHARGE CHARACTERISTICS**

- Charge: 1500mA x 16h at 1.7mA x 1.7hrs.
- Discharge temperature: 20°C

Battery performance and cycle life are strongly affected by how they are used. In order to maximize battery safety, please consult Panasonic when determining charge/discharge specs, warning label contents and design. The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
## Battery Performance

Battery performance and cycle life are strongly affected by how they are used. In order to maximize battery safety, please consult Panasonic when determining charge/discharge specs, warning label contents and design. The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

## Specifications

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<thead>
<tr>
<th>Name</th>
<th>HHR-35AA/FT</th>
<th>HHR-120AA/FT</th>
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<tr>
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<td>14.5 ±0.07</td>
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<tr>
<td>Height (mm)</td>
<td>28.5 ±0.10</td>
<td>43.0 ±0.13</td>
</tr>
<tr>
<td>Approximate weight (g)</td>
<td>10.5</td>
<td>14.5 ±0.2</td>
</tr>
<tr>
<td>Nominal voltage (V)</td>
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<td>1.2</td>
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<tr>
<td>Discharge capacity</td>
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<tr>
<td>Approx. internal impedance 1,000kHz at charged state (mΩ)</td>
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### Charge Characteristics

**Typical Charge Characteristics**

- Charge: 350mA (1.0 lt) x 1.2hrs. 20°C
- Charge: 1200mA (1 lt) x 1.2hrs. 20°C
- Charge: 2400mA (2 lt) x 1.2hrs. 20°C

### Discharge Characteristics

**Typical Discharge Characteristics**

- Discharge: 0.2lt x 1.2hrs. 20°C
- Discharge: 1.2lt x 1.2hrs. 20°C
- Discharge: 2.0lt x 1.2hrs. 20°C

### Storage Characteristics

- Storage temperature: -20 to +45°C
- Storage: 6 months
- Storage: 1 year

---

(1) After charging at 0.1lt for 16 hours, discharging at 0.2lt.
(2) For reference only.
(3) Need specially designed control system. Please contact Panasonic for details.

---

Battery performance and cycle life are strongly affected by how they are used. In order to maximize battery safety, please consult Panasonic when determining charge/discharge specs, warning label contents and design. The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
**HHR-70AA/FT**  CYLINDRICAL AA SIZE (HR15/49)

**Dimensions (MM)**

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<th>Height (mm)</th>
<th>Approximate weight (g)</th>
<th>Nominal voltage (V)</th>
<th>Discharge capacity*1</th>
<th>Rated/min. (mAh)</th>
<th>Approx. internal impedance 1,000kHz at charged state (mΩ)</th>
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</thead>
<tbody>
<tr>
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**Specifications**

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<tr>
<td>Height (mm)</td>
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<tr>
<td>Approximate weight (g)</td>
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<tr>
<td>Nominal voltage (V)</td>
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<tr>
<td>Discharge capacity*1</td>
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<td>Rated/min. (mAh)</td>
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</tr>
<tr>
<td>Approx. internal impedance 1,000kHz at charged state (mΩ)</td>
<td>25</td>
</tr>
</tbody>
</table>

**Typical Charge Characteristics**

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Charge time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>0.9</td>
<td>1</td>
</tr>
<tr>
<td>1.0</td>
<td>2</td>
</tr>
<tr>
<td>1.1</td>
<td>3</td>
</tr>
<tr>
<td>1.2</td>
<td>4</td>
</tr>
<tr>
<td>1.3</td>
<td>5</td>
</tr>
<tr>
<td>1.4</td>
<td>6</td>
</tr>
</tbody>
</table>

**Typical Discharge Characteristics**

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Discharge time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>0.9</td>
<td>1</td>
</tr>
<tr>
<td>1.0</td>
<td>2</td>
</tr>
<tr>
<td>1.1</td>
<td>3</td>
</tr>
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<td>4</td>
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<td>1.3</td>
<td>5</td>
</tr>
<tr>
<td>1.4</td>
<td>6</td>
</tr>
</tbody>
</table>

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---

**HHR-70AA/HT**  CYLINDRICAL AA SIZE (HR15/49)

**Dimensions (MM)**

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Height (mm)</th>
<th>Approximate weight (g)</th>
<th>Nominal voltage (V)</th>
<th>Discharge capacity*1</th>
<th>Rated/min. (mAh)</th>
<th>Approx. internal impedance 1,000kHz at charged state (mΩ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.5 +0/-0.7</td>
<td>50.5 +0/-1.5</td>
<td>21</td>
<td>1.2</td>
<td>780</td>
<td>700</td>
<td>25</td>
</tr>
</tbody>
</table>

**Specifications**

<table>
<thead>
<tr>
<th>Name</th>
<th>HHR-70AA/HT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>14.5 +0/-0.7</td>
</tr>
<tr>
<td>Height (mm)</td>
<td>50.5 +0/-1.5</td>
</tr>
<tr>
<td>Approximate weight (g)</td>
<td>21</td>
</tr>
<tr>
<td>Nominal voltage (V)</td>
<td>1.2</td>
</tr>
<tr>
<td>Discharge capacity*1</td>
<td>780</td>
</tr>
<tr>
<td>Rated/min. (mAh)</td>
<td>700</td>
</tr>
<tr>
<td>Approx. internal impedance 1,000kHz at charged state (mΩ)</td>
<td>25</td>
</tr>
</tbody>
</table>

**Typical Charge Characteristics**

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Charge time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>0.9</td>
<td>1</td>
</tr>
<tr>
<td>1.0</td>
<td>2</td>
</tr>
<tr>
<td>1.1</td>
<td>3</td>
</tr>
<tr>
<td>1.2</td>
<td>4</td>
</tr>
<tr>
<td>1.3</td>
<td>5</td>
</tr>
<tr>
<td>1.4</td>
<td>6</td>
</tr>
</tbody>
</table>

**Typical Discharge Characteristics**

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Discharge time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>0.9</td>
<td>1</td>
</tr>
<tr>
<td>1.0</td>
<td>2</td>
</tr>
<tr>
<td>1.1</td>
<td>3</td>
</tr>
<tr>
<td>1.2</td>
<td>4</td>
</tr>
<tr>
<td>1.3</td>
<td>5</td>
</tr>
<tr>
<td>1.4</td>
<td>6</td>
</tr>
</tbody>
</table>

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**HHR-210AA/HT** CYLINDRICAL AA SIZE (HR15/51)

**Dimensions (MM)**

| Diameter (mm) | Ø14.5 +0/-0.8 |
| Height (mm)   | 50.5 +0/-1.0  |
| Approximate weight (g) | 32 |
| Nominal voltage (V) | 1.2 |
| Discharge capacity | Average**4** +0/-(mAh) |
| | 2,000 |
| | Rate/min. +0/-(mAh) |
| | 2,000 |
| Approx. internal impedance at 1,000Hz at charged state (mΩ) | 20 |

**Specifications**

<table>
<thead>
<tr>
<th>Name</th>
<th>HHR-210AA/HT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge</td>
<td>Standard (mA x hrs.) 200 x 14</td>
</tr>
<tr>
<td>Charge (°C)</td>
<td>Standard 0 to +65</td>
</tr>
<tr>
<td>Discharge (°C)</td>
<td>10 to +65</td>
</tr>
<tr>
<td>Storage (°C)</td>
<td>&lt;3 months -20 to +65</td>
</tr>
</tbody>
</table>

**Typical Charge Characteristics**

Charge: 1200mA (0.55 It) x 10hrs. 20°C
Discharge temperature: 20°C

**Typical Discharge Characteristics**

Charge: 1200mA x 2hrs. 20°C
Discharge temperature: 20°C

---

**HHR-200A/FT** CYLINDRICAL 4/5A SIZE (HR17/43)

**Dimensions (MM)**

| Diameter (mm) | Ø17.0 +0/-1.0 |
| Height (mm)   | 43.0 +0/-1.5 |
| Approximate weight (g) | 32 |
| Nominal voltage (V) | 1.2 |
| Discharge capacity | Average**4** +0/-(mAh) |
| | 2,000 |
| | Rate/min. +0/-(mAh) |
| | 2,000 |
| Approx. internal impedance at 1,000Hz at charged state (mΩ) | 20 |

**Specifications**

<table>
<thead>
<tr>
<th>Name</th>
<th>HHR-200A/FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge</td>
<td>Standard (mA x hrs.) 200 x 14</td>
</tr>
<tr>
<td>Charge (°C)</td>
<td>Standard 0 to +65</td>
</tr>
<tr>
<td>Discharge (°C)</td>
<td>10 to +65</td>
</tr>
<tr>
<td>Storage (°C)</td>
<td>&lt;3 months -20 to +65</td>
</tr>
</tbody>
</table>

**Typical Charge Characteristics**

Charge: 1700mA (0.85 It) x 1.4hrs. 20°C
Discharge temperature: 20°C

**Typical Discharge Characteristics**

Charge: 1700mA (0.85 It) x 1.4hrs. 20°C
Discharge temperature: 20°C

---

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**HHR-210A/FT**  CYLINDRICAL A SIZE (Hr17/50)

**Dimensions (mm)**

- Diameter: 17.0 ±0.7
- Height: 50.0 ±1.5
- Approximate weight (p): 33

**Specifications**

- Nominal voltage (V): 1.2
- Discharge capacity: 2,200 (Rated/Min. mAh)
- Approx. internal impedance at 1,000Hz at charged state (mΩ): 20

**Typical Charge Characteristics**

Charge: 2,100mA (1lt) x 1.2hrs. 20°C

**Typical Discharge Characteristics**

Charge: 2,100mA (1lt) x 1.2hrs. 20°C

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**HHR-380A/FT**  CYLINDRICAL L-A SIZE (Hr17/67)

**Dimensions (mm)**

- Diameter: 17.0 ±0.7
- Height: 76.0 ±1.5
- Approximate weight (p): 53

**Specifications**

- Nominal voltage (V): 1.2
- Discharge capacity: 3,800 (Rated/Min. mAh)
- Approx. internal impedance at 1,000Hz at charged state (mΩ): 25

**Typical Charge Characteristics**

Charge: 2,800mA (2lt) x 1.0°C/min. 20°C

**Typical Discharge Characteristics**

Charge: 2,800mA (2lt) x 1.0°C/min. 20°C

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**HHR-450A/FT**

**Dimensions (mm)**
- Diameter: Ø18.2 ±0.1
- Height: 43.0 ±0.5

**Specifications**
- Name: HHR-450A/FT
- Diameter (mm): 18.2 ±0.1
- Height (mm): 43.0 ±0.5
- Nominal voltage (V): 1.2
- Discharge capacity: 4,500mAh
- Discharge rate (C): 0.1
- Storage temperature (°C): -20 to +35
- Approx. internal impedance: 250mΩ
- Charge time: 2000mA x 1.2hrs.

**Typical Charge Characteristics**
- Voltage (V) vs. Charge time [minutes]
- Charge: 2000mA x 1.2hrs.
- Discharge temperature: 20°C

**Typical Discharge Characteristics**
- Voltage (V) vs. Discharge time [minutes]
- Charge: 2000mA x 1.2hrs.
- Discharge temperature: 20°C

---

**HHR-200SCP/FT**

**Dimensions (mm)**
- Diameter: Ø23.0 ±0.1
- Diameter (mm): 23.0 ±0.1
- Height (mm): 43.0 ±0.1

**Specifications**
- Name: HHR-200SCP/FT
- Diameter (mm): 23.0 ±0.1
- Height (mm): 43.0 ±0.1
- Nominal voltage (V): 1.2
- Discharge capacity: 2,100mAh
- Discharge rate (C): 0.1
- Storage temperature (°C): -20 to +35
- Approx. internal impedance: 250mΩ
- Charge time: 2000mA x 1.2hrs.

**Typical Charge Characteristics**
- Voltage (V) vs. Charge time [minutes]
- Charge: 2000mA x 1.2hrs.
- Discharge temperature: 20°C

**Typical Discharge Characteristics**
- Voltage (V) vs. Discharge time [minutes]
- Charge: 2000mA x 1.2hrs.
- Discharge temperature: 20°C

---

Note:
- *3 Need specially designed control system. Please contact Panasonic for details.
- *2 For reference only.
- *1 After charging at 0.1It for 16 hours, discharging at 0.2It.
- Need specially designed control system. Please contact Panasonic for details.

---

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**HHR-260SCP/FT** CYLINDRICAL SC SIZE (HR23A) / HHR-300SCP/FT CYLINDRICAL SC SIZE (HR23A)

### Dimensions [mm]

- **Diameter (mm):** 23.0 0 1.0
- **Height (mm):** 57.0 ± 1.5
- **Approximate weight (g):** 57

### Specifications

- **Nominal voltage (V):** 1.2
- **Discharge capacity:*** Average (mAh): 2,600
  Rated (min. mAh): 2,450
- **Approx. internal impedance at 1,000Hz at charged state (mΩ):** 5

### Typical Charge Characteristics

- **Charge time (minutes):**
  - Standard: 2600mA (1 lt)  x 1.2hrs. 20°C
- **Storage (℃):**
  - 0°C: 1 month
  - 20°C: 3 months
  - 40°C: 3 months

### Typical Discharge Characteristics

- **Discharge time (minutes):**
  - Standard: 2600mA (1 lt)  x 1.2hrs. 20°C
- **Discharge capacity (mA):** 10A, 20A, 20°C

---

Battery performance and cycle life are greatly affected by how they are used. In order to maximize battery safety, please consult Panasonic when determining charge/discharge specs, warning label contents and design. The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

---

**HHR-260SCP/FT** CYLINDRICAL SC SIZE (HR23A) / HHR-300SCP/FT CYLINDRICAL SC SIZE (HR23A)

### Dimensions [mm]

- **Diameter (mm):** 23.0 0 1.0
- **Height (mm):** 57.0 ± 1.5
- **Approximate weight (g):** 57

### Specifications

- **Nominal voltage (V):** 1.2
- **Discharge capacity:*** Average (mAh): 3,000
  Rated (min. mAh): 2,800
- **Approx. internal impedance at 1,000Hz at charged state (mΩ):** 5

### Typical Charge Characteristics

- **Charge time (minutes):**
  - Standard: 3000mA (1 lt)  x 1.2hrs. 20°C
- **Storage (℃):**
  - 0°C: 1 month
  - 20°C: 3 months
  - 40°C: 3 months

### Typical Discharge Characteristics

- **Discharge time (minutes):**
  - Standard: 3000mA (1 lt)  x 1.2hrs. 20°C
- **Discharge capacity (mA):** 10A, 20A, 20°C

---

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HHR-60AAAH/FT  CYLINDRICAL AAA SIZE (HR11/45) FOR BACK-UP USE

**DIMENSIONS (MM)**

<table>
<thead>
<tr>
<th>Name</th>
<th>HHR-60AAAH/FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>10.5 ±0/-0.7</td>
</tr>
<tr>
<td>Height (mm)</td>
<td>44.5 ±0/-1.0</td>
</tr>
<tr>
<td>Approximate weight (g)</td>
<td>13</td>
</tr>
</tbody>
</table>

**Discharge capacity**

- Average [mAh]: 590
- Rated/Min. [mAh]: 790

**Approx. internal impedance 1,000Hz at charged state [mΩ]**

<table>
<thead>
<tr>
<th>Charge</th>
<th>Standard [mA x hrs.]</th>
<th>50 x 16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rapid [mA x hrs.]</td>
<td>250 x 2.4</td>
</tr>
<tr>
<td></td>
<td>Low rate [mA x hrs.]</td>
<td>25 x 32</td>
</tr>
</tbody>
</table>

**Nominal voltage (V):**

- 1.2

**TYPICAL CHARGE CHARACTERISTICS**

- Charge: 50mA x 16hrs.
- Temperature: -10°C to 60°C
- Discharge: 100mA

**TYPICAL DISCHARGE CHARACTERISTICS**

- Charge: 50mA x 16hrs.
- Temperature: -10°C to 60°C
- Discharge: 100mA

**SPECIFICATIONS**

- **Name**: HHR-70AAAH/FT
- **Diameter (mm)**: 14.5 ±0/-0.7
- **Height (mm)**: 68.3 ±0/-1.0
- **Approximate weight (g)**: 18

**Discharge capacity**

- Average [mAh]: 700
- Rated/Min. [mAh]: 900

**Approx. internal impedance 1,000Hz at charged state [mΩ]**

<table>
<thead>
<tr>
<th>Charge</th>
<th>Standard [mA x hrs.]</th>
<th>70 x 16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rapid [mA x hrs.]</td>
<td>350 x 2.4</td>
</tr>
<tr>
<td></td>
<td>Low rate [mA x hrs.]</td>
<td>35 x 32</td>
</tr>
</tbody>
</table>

**Nominal voltage (V):**

- 1.2

- After charging at 0.1I for 16 hours, discharging at 0.2I.
- For reference only.
- Need specially designed control system. Please contact Panasonic for details.

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---

HHR-70AAAH/FT  CYLINDRICAL AA SIZE (HR15/4F) FOR BACK-UP USE

**DIMENSIONS (MM)**

<table>
<thead>
<tr>
<th>Name</th>
<th>HHR-70AAAH/FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>14.5 ±0/-0.7</td>
</tr>
<tr>
<td>Height (mm)</td>
<td>48.3 ±0/-1.0</td>
</tr>
<tr>
<td>Approximate weight (g)</td>
<td>18</td>
</tr>
</tbody>
</table>

**Discharge capacity**

- Average [mAh]: 700
- Rated/Min. [mAh]: 900

**Approx. internal impedance 1,000Hz at charged state [mΩ]**

<table>
<thead>
<tr>
<th>Charge</th>
<th>Standard [mA x hrs.]</th>
<th>70 x 16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rapid [mA x hrs.]</td>
<td>350 x 2.4</td>
</tr>
<tr>
<td></td>
<td>Low rate [mA x hrs.]</td>
<td>35 x 32</td>
</tr>
</tbody>
</table>

**Nominal voltage (V):**

- 1.2

- After charging at 0.1I for 16 hours, discharging at 0.2I.
- For reference only.
- Need specially designed control system. Please contact Panasonic for details.

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**HHR-210AH/FT**
CYLINDRICAL A SIZE (HR17/50) FOR BACK-UP USE

**DIMENSIONS (MM)**

<table>
<thead>
<tr>
<th>Name</th>
<th>HHR-210AH/FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>17.0 ±0.7</td>
</tr>
<tr>
<td>Height (mm)</td>
<td>50.0 ±0.15</td>
</tr>
<tr>
<td>Approximate weight (g)</td>
<td>36</td>
</tr>
<tr>
<td>Nominal voltage (V)</td>
<td>1.2</td>
</tr>
<tr>
<td>Discharge capacity**</td>
<td>Average 5.5Ω (mS)</td>
</tr>
<tr>
<td>Approx. internal impedance at 1,000Hz at charged state (mΩ)</td>
<td>20</td>
</tr>
</tbody>
</table>

**SPECSIFICATIONS**

**TYPICAL CHARGE CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Capacity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>100</td>
</tr>
<tr>
<td>1.1</td>
<td>100</td>
</tr>
<tr>
<td>1.2</td>
<td>100</td>
</tr>
<tr>
<td>1.3</td>
<td>100</td>
</tr>
<tr>
<td>1.4</td>
<td>100</td>
</tr>
<tr>
<td>1.5</td>
<td>100</td>
</tr>
</tbody>
</table>

**TYPICAL DISCHARGE CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Discharge (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>330</td>
</tr>
<tr>
<td>1.0</td>
<td>165</td>
</tr>
</tbody>
</table>

**HHR-330APH/FT**
CYLINDRICAL LFAT/A SIZE FOR BACK-UP USE

**DIMENSIONS (MM)**

<table>
<thead>
<tr>
<th>Name</th>
<th>HHR-330APH/FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>18.2 ±0.7</td>
</tr>
<tr>
<td>Height (mm)</td>
<td>67.0 ±0.15</td>
</tr>
<tr>
<td>Approximate weight (g)</td>
<td>60</td>
</tr>
<tr>
<td>Nominal voltage (V)</td>
<td>1.2</td>
</tr>
<tr>
<td>Discharge capacity**</td>
<td>Average 5.5Ω (mS)</td>
</tr>
<tr>
<td>Approx. internal impedance at 1,000Hz at charged state (mΩ)</td>
<td>5.5</td>
</tr>
</tbody>
</table>

**SPECSIFICATIONS**

**TYPICAL CHARGE CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Capacity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>100</td>
</tr>
<tr>
<td>1.1</td>
<td>100</td>
</tr>
<tr>
<td>1.2</td>
<td>100</td>
</tr>
<tr>
<td>1.3</td>
<td>100</td>
</tr>
<tr>
<td>1.4</td>
<td>100</td>
</tr>
<tr>
<td>1.5</td>
<td>100</td>
</tr>
</tbody>
</table>

**TYPICAL DISCHARGE CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Discharge (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>330</td>
</tr>
<tr>
<td>1.0</td>
<td>165</td>
</tr>
</tbody>
</table>

* After charging at 0.1It for 16 hours, discharging at 0.2It.
* For reference only.
* Need specially designed control system. Please contact Panasonic for details.
**HHR-370AH/FT**

**Cylindrical LF/2A Size for Back-Up Use**

**Dimensions (mm)**

- Diameter: 18.2 ± 0.7
- Height: 67.0 ± 0.5

**Specifications**

- Name: HHR-370AH/FT
- Diameter (mm): 18.2 ± 0.7
- Height (mm): 67.0 ± 0.5
- Approximate weight (g): 60
- Nominal voltage (V): 1.2
- Nominal current (mA): 3,700
- Discharge capacity (Ah): 3,700
- Approx. internal impedance: 1,000Ω at charged state (mΩ): 20

**Charge Characteristics**

- Charge: 250mA x 16 hrs.
- Charge temperature: -10 to 60°C
- Discharge: 10A, 20A, 25°C
- Discharge temperature: 25°C
- Cut off voltage: 1.0V

**Typical Charge Characteristics**

- Voltage (V) vs. Capacity (%)

**Typical Discharge Characteristics**

- Discharge time (hours) vs. Discharge current (Ah)

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**HHR-250SCH/FT**

**Cylindrical SC Size (HR23/43) for Back-Up Use**

**Dimensions (mm)**

- Diameter: 23.0 ± 1.0
- Height: 40.0 ± 1.0

**Specifications**

- Name: HHR-250SCH/FT
- Diameter (mm): 23.0 ± 1.0
- Height (mm): 40.0 ± 1.0
- Approximate weight (g): 55
- Nominal voltage (V): 1.2
- Nominal current (mA): 2,400
- Discharge capacity (Ah): 2,400
- Approx. internal impedance: 1,000Ω at charged state (mΩ): 5

**Charge Characteristics**

- Charge: 250mA x 16 hrs.
- Charge temperature: -10 to 60°C
- Discharge: 500mA x 16 hrs.

**Typical Charge Characteristics**

- Voltage (V) vs. Capacity (%)

**Typical Discharge Characteristics**

- Discharge time (minutes) vs. Discharge current (Ah)

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Battery performance and cycle life are strongly affected by how they are used. In order to maximize battery safety, please consult Panasonic when determining charge/discharge specs, warning label contents and design. The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.
Battery performance and cycle life are strongly affected by how they are used. In order to maximize battery safety, please consult Panasonic when determining charge/discharge specs, warning label contents and design. The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

Purpose of packs
For the most part, Ni-MH batteries are used in battery packs when installed in products. When these batteries are used, the type of battery, number of cells, shape of the pack, constituent parts of the pack, etc., are determined by the specifications (voltage, load current) of the product. In addition, the charge specifications, space available in the battery compartment, operating conditions, etc., must also be considered. At Panasonic, we are working on the promotion of battery packs which emphasize the safety and reliability of the batteries. We customize packs in the shapes that satisfy the unique requirements of each of our customers. **Do not hesitate to contact us regarding your specific needs.**

L Type
The required number of single cells are arranged in a line in the axis of the batteries connected by connecting plates and packed together by heat-shrinkable tubing.

Composite L Type
Single cells connected in the L type configuration are further connected in two to five rows and packed together by heat-shrinkable tubing.

Shapes of battery packs (Typical & Standard Types)

F Type
The required number of single cells are arranged side by side along their diameter connected by nickel plates and packed together with heat-shrinkable tubing.

Composite F Type
Single cells are connected in the F type configuration but in two to five rows rather than one row and packed together by heat-shrinkable tubing.
**Glossary of Terms for Ni-MH Batteries**

**Structural-Related Items**

**Active material**
The electrochemical materials of the electrodes. In rechargeable Ni-MH batteries, nickel-hydroxide is the active material of the positive electrode and hydrogen-absorbing alloy is the active material of the negative electrode.

**Cell**
Each of the individual batteries which comprise a rechargeable battery.

**Electrolyte**
The medium through which ions are conducted during the electro-chemical reaction inside a rechargeable battery. In rechargeable Ni-MH batteries, a potassium hydroxide water solution is generally used as the electrolyte.

**Hydrogen-absorbing alloy**
Alloy which can absorb/release hydrogen reversibly. AB₂ or AB₅ type alloy is used for batteries. [MnNi₅] AB₅ type is employed in Panasonic’s products.

**Negative electrode**
The electrode that has a lower electrical potential than the positive electrode to which electrical current flows from the external circuit during the discharge of a storage battery.

**Nickel oxyhydroxide**
Expressed in chemical notation as NiOOH, this indicates that the positive electrode material of the Ni-MH battery is in a charged state. When in the discharged state, the positive electrode material becomes nickel hydroxide, or Ni(OH)₂.

**Pasted type electrode plate**
An electrode plate made by applying the active material [hydrogen-absorbing compound] in a paste form onto a nickel-plated steel porous plate. Used as the negative electrode.

**Positive electrode**
The positive electrode that has a higher electrical potential than the negative electrode from which electrical current flows to the external circuit during the discharge of a rechargeable battery.

**Safety vent**
Functions to release the gas when the internal pressure exceeds a predetermined level. In addition to preventing the absorption of external air into the rechargeable battery, this vent also prevents the rupture of the rechargeable battery that would result from the increase in the internal pressure caused by the generation of gas during charge or at other times.

**Separator**
A porous or micro-porous thin plate, cloth, bar or frame which is inserted as a spacer between the positive and negative electrode plates for the purpose of preventing short-circuits. The separator must be non-oxidizing, resistant to chemicals, and be an electrical insulator, and it must not obstruct in any way the ionic conduction or diffusion of the electrolyte. The separator also functions to retain the electrolyte.

**Electrical-Related Items**

**Capacity**
The electrical capacity of a rechargeable battery. Normally used to mean the capacity as measured in ampere-hours. Indicated in units of Ah [ampere hours] or C [coulombs].

**Charge efficiency**
A general term meaning either ampere-hour efficiency or watt-hour efficiency. More commonly used to mean ampere-hour efficiency.

**Charge level**
The amount of electricity used for charge. For constant current charge, it is the product of multiplying the current value by the charge time. Measured in units of ampere-hours (Ah).

**C (Coulomb)**
Used to express the amount of the charge or discharge current. Expressed by attaching the current units to a numerical multiple that represents the rated capacity of the battery. The charge and discharge current are generally expressed using a C multiple. For example, for a battery having a rated capacity of 1500mAh:
- 0.1CmA = 0.1 x 1500 = 150mA
- 0.2CmA = 0.2 x 1500 = 300mA

**Cut-off discharge voltage**
The voltage that indicates the limit at which discharge is completed. In practical use, this voltage is the limit to which the battery can be used.

**Electrolyte leakage**
The penetration of the electrolyte to the outside of the battery.

**Energy density**
The amount of energy that can be obtained per unit weight or per unit volume of a rechargeable battery. Unit: wh/kg, wh/l.

**Excessive discharge**
The discharge of a rechargeable battery to lower than the specified cut-off discharge voltage.

**High rate discharge**
Discharge at a relatively large current with respect to the battery capacity. Also called high efficiency discharge and high-current discharge.

**High voltage cut-off**
The voltage used to indicate the battery voltage. Generally refers to Ni-MH batteries.

**Nominal voltage**
The voltage used to indicate the battery voltage. Generally a value slightly lower than the electromotive force is used. For example, the nominal voltage of rechargeable Ni-MH batteries is 1.2V per cell.

**Open circuit voltage**
The voltage of a battery when that battery is electrically cut-off from the external circuit.

**Overcharge current**
Charge after the fully charged state has been reached. In a rechargeable battery that requires water replenishment, the electrolysis of the water causes a sharp decrease in the amount of electrolyte. Generally, the overcharge of a rechargeable battery will shorten the battery’s cycle life.

**Rapid charge**
Charge quickly using a large current.

**Rated capacity**
The standard value for the amount of electricity which can be obtained from the battery in a fully charged state at the specified temperature, discharge current, and cut-off discharge voltage. Measured in units of ampere-hours (Ah). Note that CN is used as a symbol to express the rated capacity at a rate of N hours.

**Reverse charge**
Charge with the polarities reversed. If the polarities are reversed, all of the electrical energy will be used to generate gas.

**Self-discharge**
A decrease in the capacity of a rechargeable battery without any discharge of current to the external circuit.

**Other Terms**

**Alkaline storage battery**
A storage battery that uses an alkaline water solution as its electrolyte. Generally refers to Ni-MH batteries.

**IEC Standards**
The standards established by the International Electrotechnical Commission (IEC).
Notice to Readers

It is the responsibility of each user to ensure that every battery application is adequately designed safe and compatible with all conditions encountered during use, and in conformance with existing standards and requirements. This literature contains information concerning cells and batteries manufactured by Panasonic Corporation. 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.

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