Panasonic
ideas for life

NI-MH HANDBOOK

ENGLISH

INDUSTRIAL BATTERIES

Panasonic BATTERIES

SAFETY, LONG-LIFE AND POWER!

PANASONIC BATTERIES

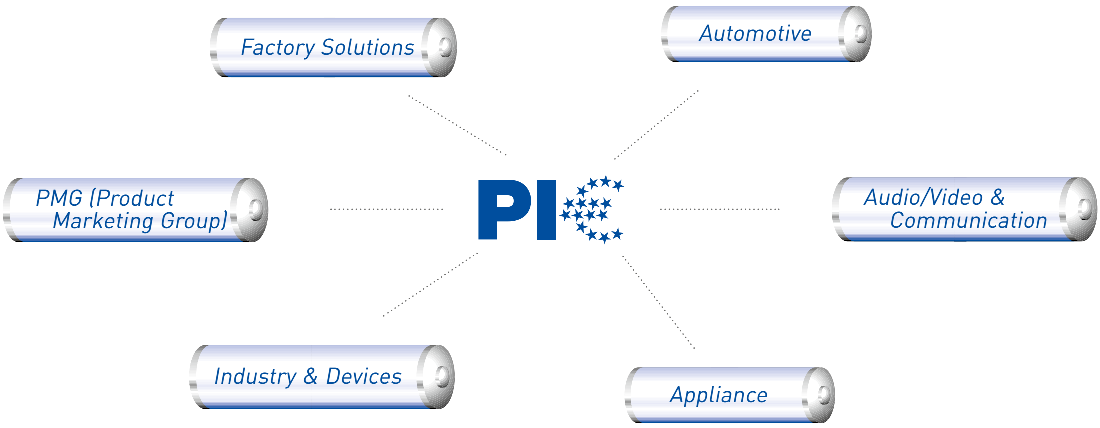
PANASONIC INDUSTRIAL EUROPE

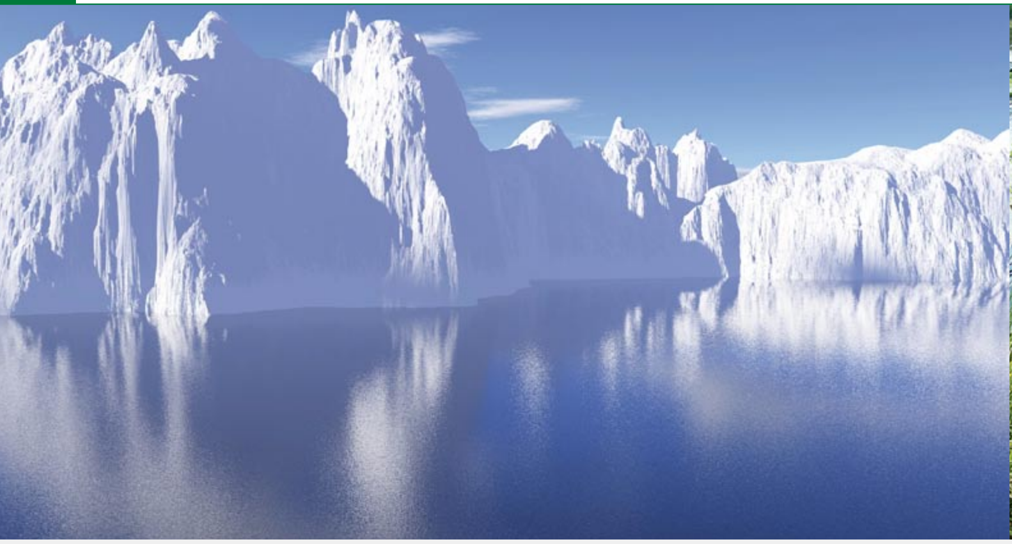
Panasonic Corporation, founded in Osaka 1918, is one of the world's largest manufacturers of quality electronic and electrical equipment. Its subsidiary, Panasonic Industrial Europe GmbH (PIE) deals with a wide diversified range of industrial products for all European countries. This company was formed 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.

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.

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.

PIE Organisation Divisions





PANASONIC LEADS THE WAY ... WITH ‘ECO IDEAS’

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.

Our energy will Drive eco Innovation.

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 CO_2 emissions from a household sector.

The concept of this ‘eco ideas’ House can be described as follows:

1. Virtually zero CO_2 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.

INDEX

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 selfdischarging.

SERVICE LIFE OF BATTERIES

Cycle life

Batteries used under proper conditions of charging and discharging can be used 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.

High alkaline-resistant metals	Low alkaline-resistant metals
Nickel, stainless steel, nickel-plated steel, etc.	Tin, aluminum, zinc, copper, brass, etc.

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

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), vaild 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.

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

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 at high temperatures. Improvements were made in existing Panasonic Ni-MH cells to the negative plate alloy and separator fiber density. A different electrolyte composition was achieved to improve performance. Superior long-life characteristics can be achieved when combined with appropriate intermittent charge control circuitry. The intermittent charge consumes 1/30th the electricity compared to trickle charge and more than doubles the expected life of the Ni-MH cells compared to 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-Trollies, Powertools, Grape-Cutters, Multimeters, Voting Machine, Barcode Readers, Handheld Scanners, Labelprinters, Vacuum Cleaners, Muscle Electro-Stimulations, Toothbrushes, etc.

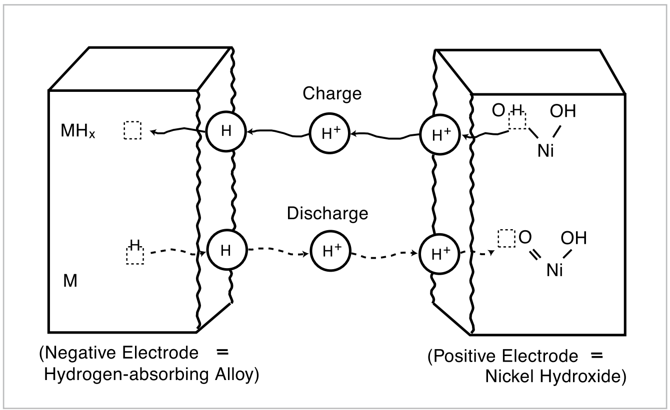
High temperature resistance (for back-up use)
Combined Solar Applications, Portable Medical Devices, POS Terminals, Emergency Light for buildings and trains, Elevator Safety Systems, etc.

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



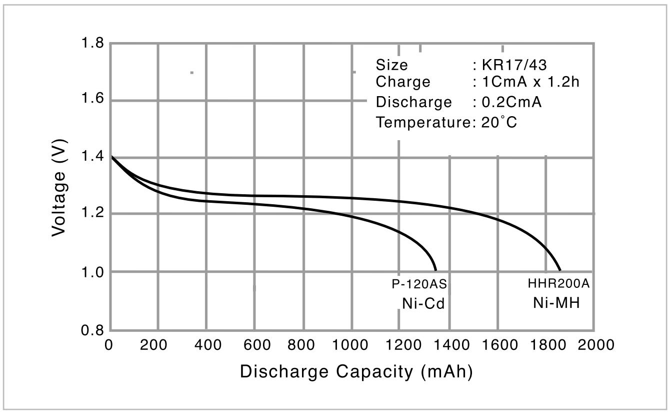
FEATURES

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.



Cycle life equivalent to 500 charge and discharge cycles

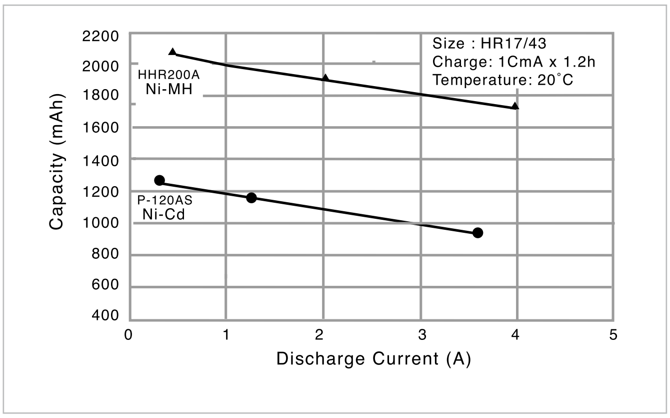
Like Ni-Cd batteries, Ni-MH batteries can be repeatedly charged and discharged for about 500 cycles. (example: IEC charge and discharge conditions)

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.



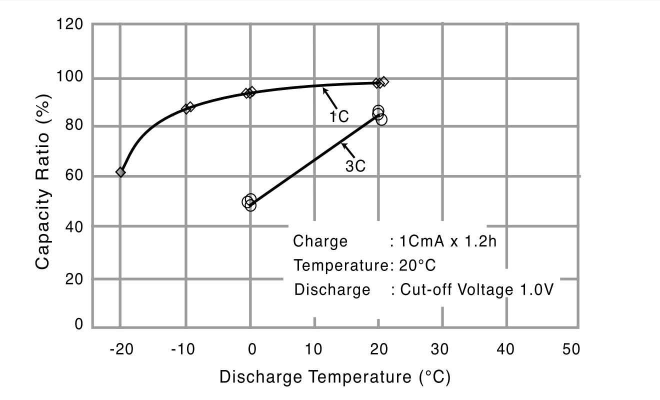
FIVE MAIN CHARACTERISTICS

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

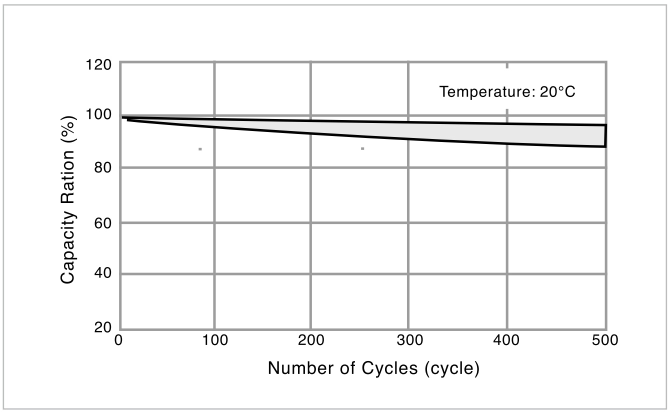
1. Charge characteristics

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

Discharge temperature characteristics



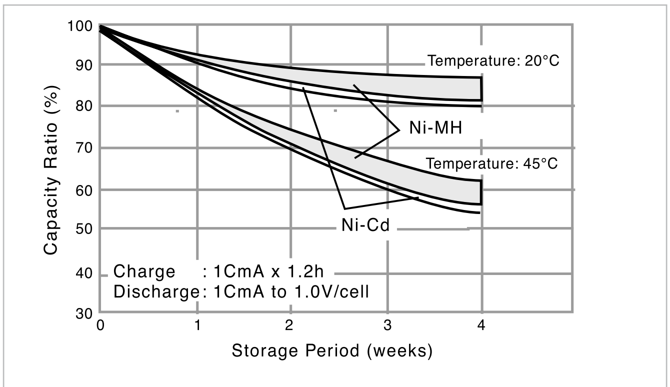
Cycle life characteristics



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 as the temperature or 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-resealing safety vent is activated to prevent battery damage.

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]	
1. Rapid charge current	Max. 1CmA to 0.5CmA
2. Rapid charge transition voltage restoration current	0.2 to 0.3CmA
3. Rapid charge start voltage	Approx. 0.8V/cell
4. Charge terminating voltage	1.8V/cell
5. ΔV value	5 to 10mV/cell
6. Battery temperature rising rate dT/dt value	1 to 2°C/min
7. Maximum battery temperature TCO	60°C (for L-A, L-fatA and SC size) 55°C (for A, AA and D size) 50°C (for QA, AAA and prismatic size)
8. Initial -ΔV detection disabling timer	5 to 10 min
9. Trickle current (after rapid charge)	0.033 to 0.05CmA
10. Rapid charge transfer timer	60 min
11. Rapid charge timer	90 min (at 1CmA charge)
12. Total timer	10 to 20 hours
13. Rapid charge temperature range	0° to 40°C

Example of a rapid charge system

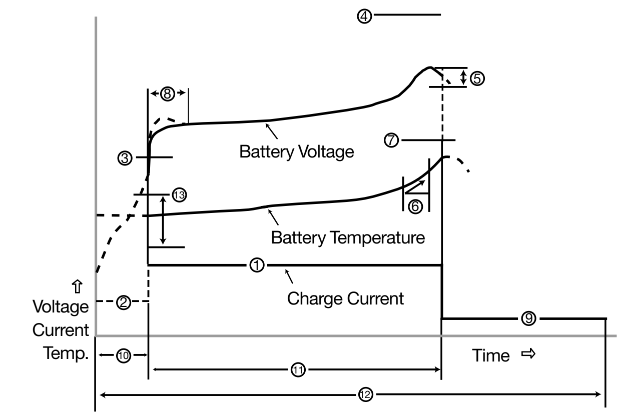


Fig 1

Basic pack configuration circuit

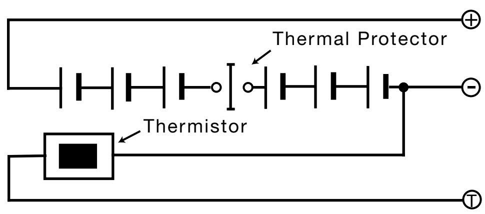


Fig 2

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*[2].

Intermittent timer charge: (See diagram) At the beginning of the charge, an IC timer is started and charging is activated at a current of 0.1lt 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.

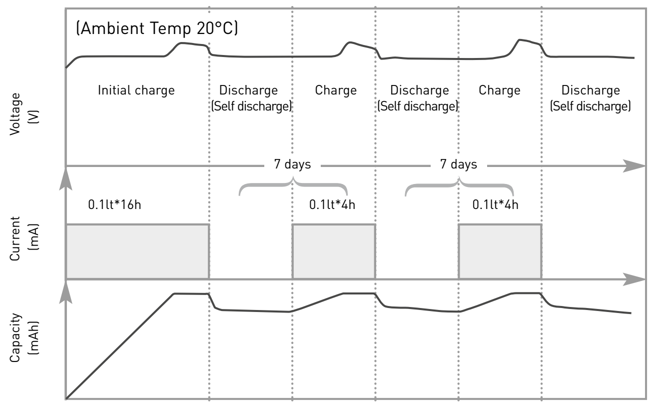
Example of intermittent timer charger system:

Average charge current: 0.1ltA

Re-charge time: 16 hours

Pulse charging can be used

Intermittent charge



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

*[2] Trickle charge is not recommended in general for Ni-MH batteries. Please consult Panasonic on any Ni-MH applications requiring trickle charge.

6 SPECIFICATION TABLE

CYLINDRICAL

Model	Diameter	Size	Nominal voltage (V)	Discharge capacity*1 (mAh)		Dimensions with tube (mm)		Approx. weight (g)	IEC	Page
				Average*2	Rated/min.	Diameter	Height			
HHR-70AAA/FT	AAA	AAA	1.2	730	700	10.5 +0/-0.7	44.5 +0/-1.0	12	HR11/45	21
HHR-75AAA/HT*3	AAA	AAA	1.2	730	700	10.5 +0/-0.7	44.5 +0/-1.0	12	HR11/45	22
HHR-80AAA/HT*3	AAA	AAA	1.2	780	750	10.5 +0/-0.7	44.5 +0/-1.0	13	HR11/45	23
HHR-35AA/FT	AA	2/3AA	1.2	390	350	14.5 +0/-0.7	28.5 +0/-1.0	10.5	-	24
HHR-120AA/FT	AA	4/5AA	1.2	1,220	1,150	14.5 +0/-0.7	43.0 +0/-1.0	23	HR15/43	25
HHR-70AA/FT	AA	AA	1.2	780	700	14.5 +0/-0.7	48.8 +0/-1.5	21	HR15/49	26
HHR-70AA/HT*4	AA	AA	1.2	780	700	14.5 +0/-0.7	50.5 +0/-1.5	21	HR15/49	27
HHR-110AA/FT	AA	AA	1.2	1,180	1,100	14.5 +0/-0.7	50.0 +0/-1.0	24	HR15/51	28
HHR-150AA/FT	AA	AA	1.2	1,580	1,500	14.5 +0/-0.7	50.0 +0/-1.0	26	HR15/51	29
HHR-210AA/HT*4	AA	AA	1.2	2,080	2,000	14.5 +0/-0.7	50.5 +0/-1.0	29	HR15/51	30
HHR-200A/FT	A	4/5A	1.2	2,040	2,000	17.0 +0/-0.7	43.0 +0/-1.5	32	HR17/43	31
HHR-210A/FT	A	A	1.2	2,200	2,100	17.0 +0/-0.7	50.0 +0/-1.5	38	HR17/50	32
HHR-380A/FT	A	L-A	1.2	3,800	3,700	17.0 +0/-0.7	67.0 +0/-1.5	53	HR17/67	33
HHR-450A/FT	A	LFat/A	1.2	4,500	4,200	18.2 +0/-0.7	67.0 +0/-1.5	60	-	34
HHR-200SCP/FT*5	SC	4/5SC	1.2	2,100	1,900	23.0 +0/-1.0	34.0 +0/-1.5	43	-	35
HHR-260SCP/FT*5	SC	SC	1.2	2,600	2,450	23.0 +0/-1.0	43.0 +0/-1.5	55	HR23/43	36
HHR-300SCP/FT*5	SC	SC	1.2	3,050	2,800	23.0 +0/-1.0	43.0 +0/-1.5	57	HR23/43	37

CYLINDRICAL FOR BACK-UP USE (HIGH TEMPERATURE TYPE)

Model	Diameter	Size	Nominal voltage (V)	Discharge capacity*1 (mAh)		Dimensions with tube (mm)		Approx. weight (g)	IEC	Page
				Average*2	Rated/min.	Diameter	Height			
HHR-60AAAH/FT	AAA	AAA	1.2	550	500	10.5 +0/-0.7	44.5 +0/-1.0	13	HR11/45	38
HHR-70AAH/FT	AA	AA	1.2	750	700	14.5 +0/-0.7	48.3 +0/-1.0	18	HR15/49	39
HHR-210AH/FT	A	A	1.2	2,050	1,900	17.0 +0/-0.7	50.0 +0/-1.5	36	HR17/50	40
HHR-330APH/FT*5	A	LFat/A	1.2	3,300	3,200	18.2 +0/-0.7	67.0 +0/-1.5	60	-	41
HHR-370AH/FT	A	LFat/A	1.2	3,700	3,500	18.2 +0/-0.7	67.0 +0/-1.5	60	-	42
HHR-250SCH/FT*5	SC	SC	1.2	2,650	2,500	23.0 +0/-1.0	43.0 +0/-1.5	55	HR23/43	43
HHR-300CH/FT*5	C	C	1.2	3,300	3,100	26.0 +0/-1.0	50.0 +0/-2.0	80	HR26/50	44

E-BLOCK

Model	Diameter	Nominal voltage (V)	Discharge capacity*1 (mAh)		Dimensions with tube (mm)			Approx. weight (g)	IEC
			Average*2	Rated/min.	Diameter	Height	Thickness		
HHR-9SRE/BA1	E-Block	8.4	175	170	26.0	48.5	16.3	42	-

Model number (example)

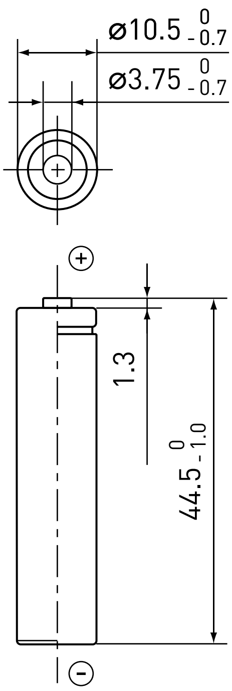
HHR-60AAAH/FT

- FT: Cap shape: This appendix is used when there is a flat top (HT stands for high top battery).
- H: Designed for high ambient temperature
- AAA: Diameter: AAA, AA, A
- 60: Multiply this by 10 to obtain the rated capacity (some exceptions)
- R: Round
- HH: Panasonic Nickel-Metal-Hydride battery

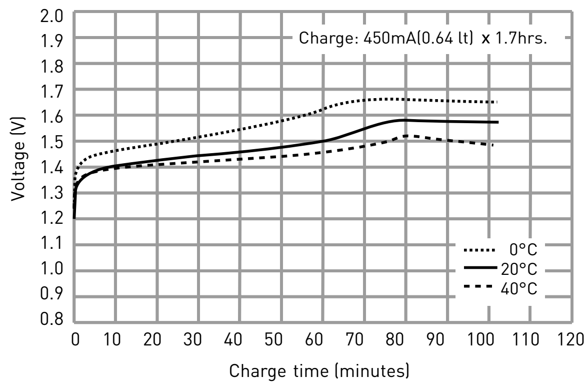
*1 After charging at 0.1CmA for 16 hours, discharging at 0.2CmA.
*2 For reference only.
*3 Compatible with consumer AAA size.
*4 Compatible with consumer AA size.
*5 For high power use applications such as Powertools.

HHR-75AAA/HT CYLINDRICAL AAA SIZE (HR11/45)

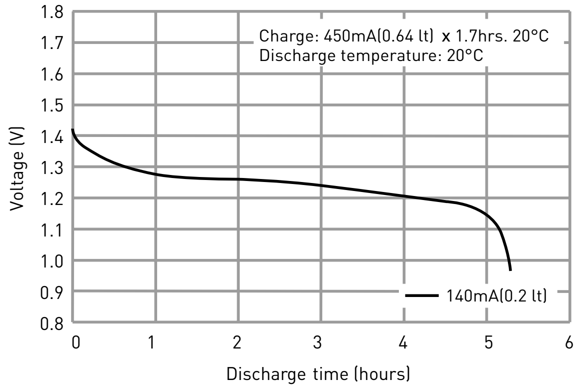
DIMENSIONS (MM)

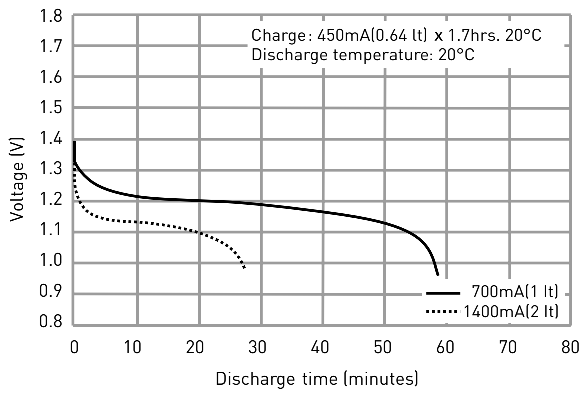


TYPICAL CHARGE CHARACTERISTICS



TYPICAL DISCHARGE CHARACTERISTICS





SPECIFICATIONS

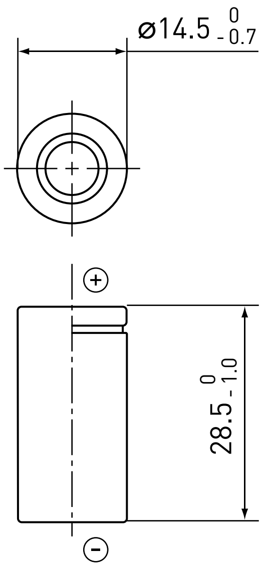
Name			HHR-75AAA/HT
Diameter (mm)			10.5 +0/-0.7
Height (mm)			44.5 +0/-1.0
Approximate weight (g)			12
Nominal voltage (V)			1.2
Discharge capacity*[1]		Average*[2] (mAh)	730
		Rated/min. (mAh)	700
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			35
Charge		Standard (mA x hrs.)	70 x 16
		Rapid*[3] (mA x hrs.)	450 x 1.7
Ambient temperature	Charge (°C)	Standard	0 to +45
		Rapid	0 to +40
	Discharge (°C)		-10 to +65
	Storage (°C)	<1 year	-20 to +35
		<6 months	-20 to +45
		<1 month	-20 to +55

*[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-35AA/FT CYLINDRICAL 2/3AA SIZE

DIMENSIONS (MM)

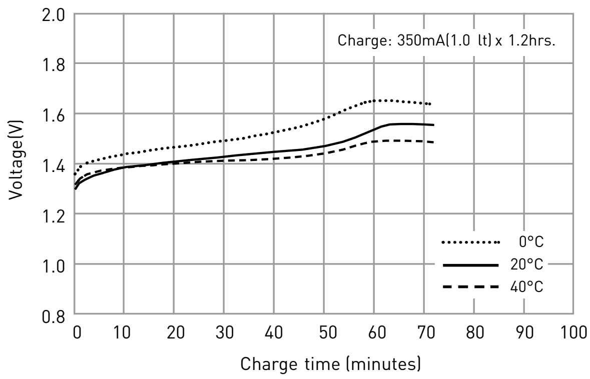


SPECIFICATIONS

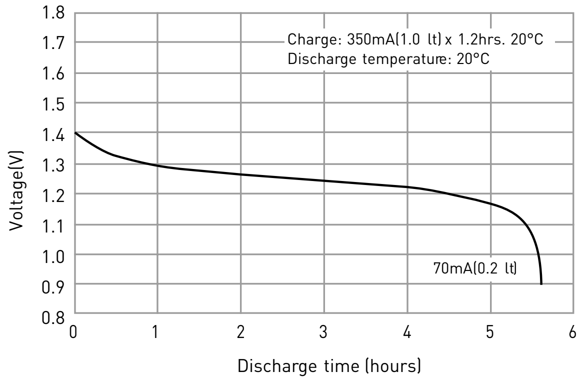
Name			HHR-35AA/FT
Diameter (mm)			14.5 +0/-0.7
Height (mm)			28.5 +0/-1.0
Approximate weight (g)			10,5
Nominal voltage (V)			1.2
Discharge capacity*[1]		Average*[2] (mAh)	390
		Rated/min. (mAh)	350
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			30
Charge		Standard (mA x hrs.)	35 x 16
		Rapid*[3] (mA x hrs.)	350 x 1.2
Ambient temperature	Charge (°C)	Standard	0 to +45
		Rapid	0 to +40
	Discharge (°C)		-10 to +65
	Storage (°C)	<1 year	-20 to +35
		<6 months	-20 to +45
		<1 month	-20 to +55

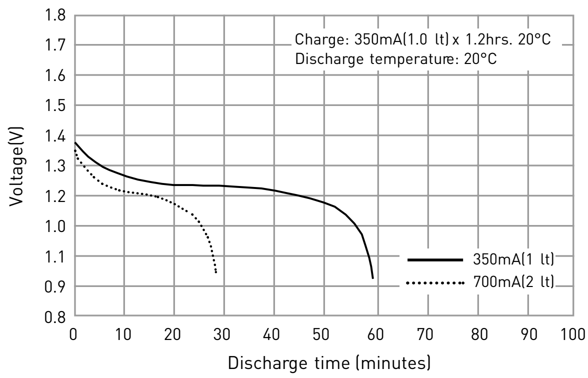
*[1] After charging at 0.1It for 16 hours, discharging at 0.2It.
*[2] For reference only.
*[3] Need specially designed control system. Please contact Panasonic for details.

TYPICAL CHARGE CHARACTERISTICS



TYPICAL DISCHARGE CHARACTERISTICS





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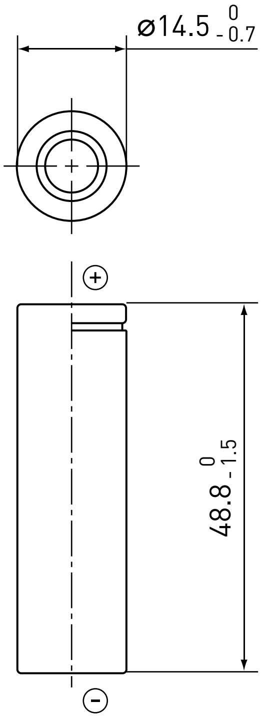
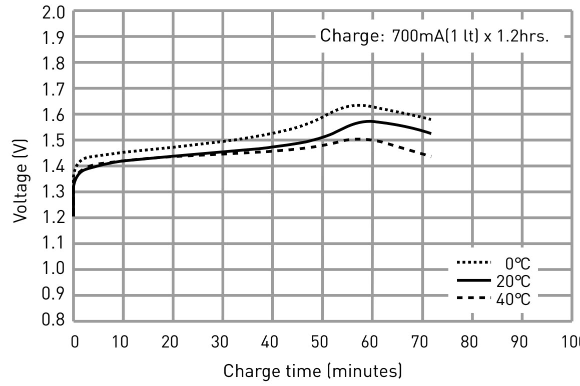
HHR-70AA/FT CYLINDRICAL AA SIZE (HR15/49)

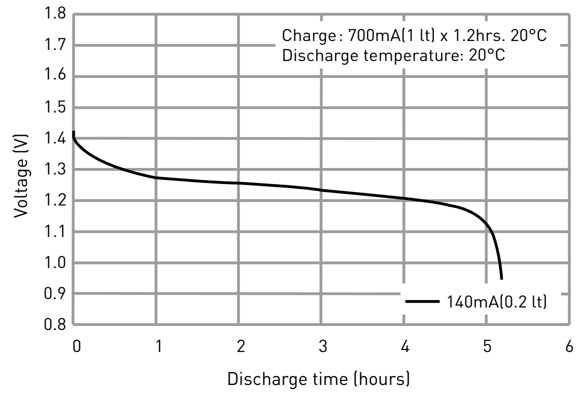
DIMENSIONS (MM)

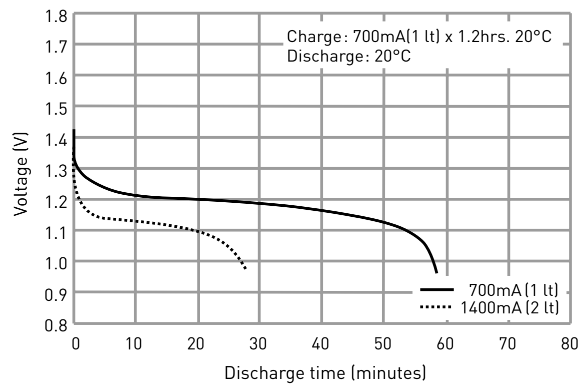


TYPICAL CHARGE CHARACTERISTICS



TYPICAL DISCHARGE CHARACTERISTICS





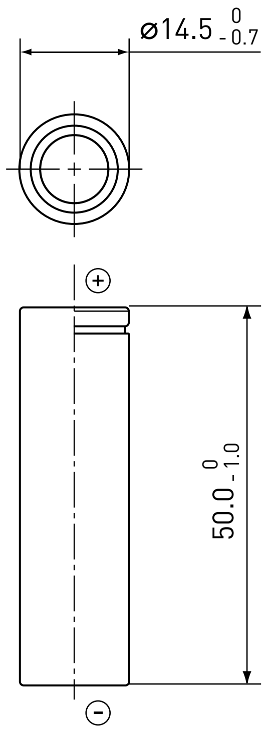
SPECIFICATIONS

Name			HHR-70AA/FT
Diameter (mm)			14.5 +0/-0.7
Height (mm)			48.8 +0/-1.5
Approximate weight (g)			21
Nominal voltage (V)			1.2
Discharge capacity*1		Average*2 (mAh)	780
		Rated/min. (mAh)	700
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			25
Charge		Standard (mA x hrs.)	70 x 16
		Rapid*3 (mA x hrs.)	700 x 1.2
Ambient temperature	Charge (°C)	Standard	0 to +45
		Rapid	0 to +40
	Discharge (°C)		-10 to +65
	Storage (°C)	<1 year	-20 to +35
		<6 months	-20 to +45
		<1 month	-20 to +55

*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.

HHR-110AA/FT CYLINDRICAL AA SIZE (HR15/51)

DIMENSIONS (MM)

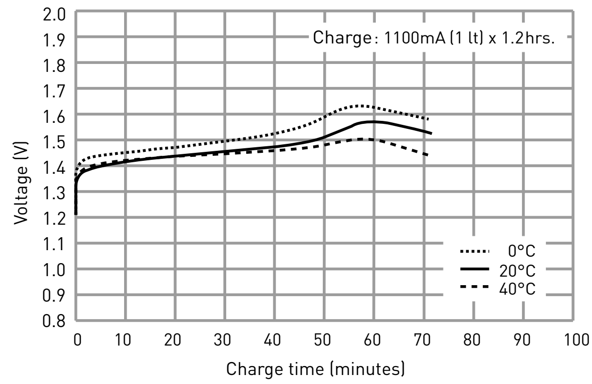


SPECIFICATIONS

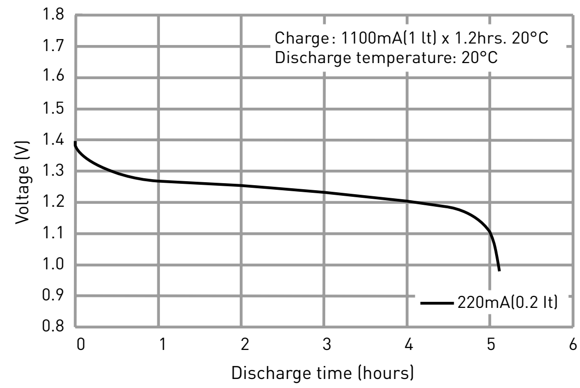
Name			HHR-110AA/FT
Diameter (mm)			14.5 +0/-0.7
Height (mm)			50.0 +0/-1.0
Approximate weight (g)			24
Nominal voltage (V)			1.2
Discharge capacity*[1]		Average*[2] (mAh)	1,180
		Rated/min. (mAh)	1,100
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			16
Charge		Standard (mA x hrs.)	110 x 16
		Rapid*[3] (mA x hrs.)	1,100 x 1.2
Ambient temperature	Charge (°C)	Standard	0 to +45
		Rapid	0 to +40
	Discharge (°C)		-10 to +65
	Storage (°C)	<1 year	-20 to +35
		<3 months	-20 to +45
		<1 month	-20 to +55

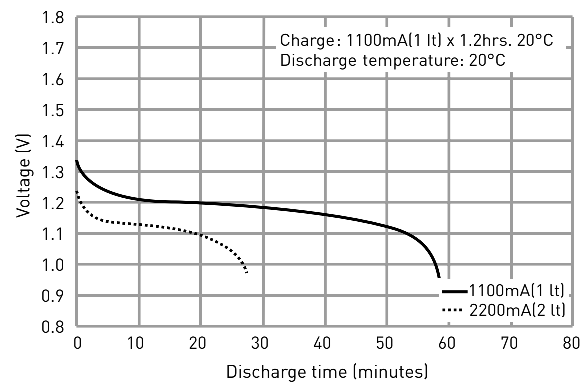
*[1] After charging at 0.1It for 16 hours, discharging at 0.2It.
*[2] For reference only.
*[3] Need specially designed control system. Please contact Panasonic for details.

TYPICAL CHARGE CHARACTERISTICS



TYPICAL DISCHARGE CHARACTERISTICS





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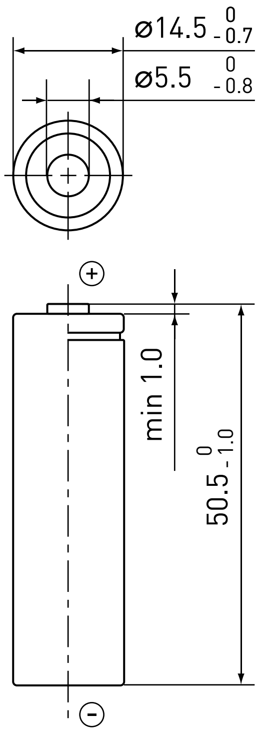
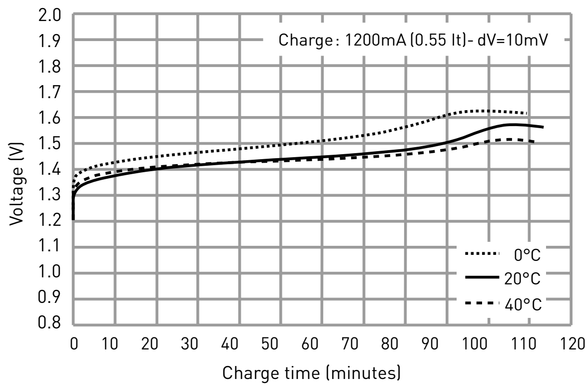
HHR-210AA/HT CYLINDRICAL AA SIZE (HR15/51)

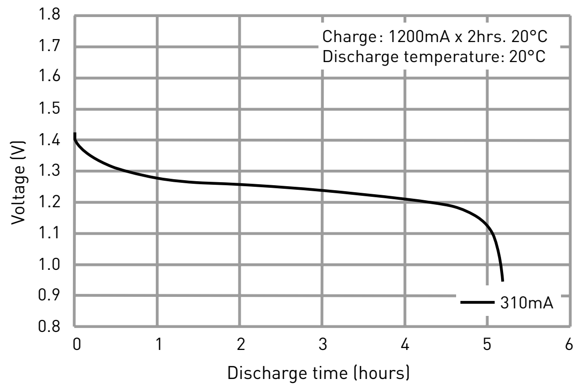
DIMENSIONS (MM)

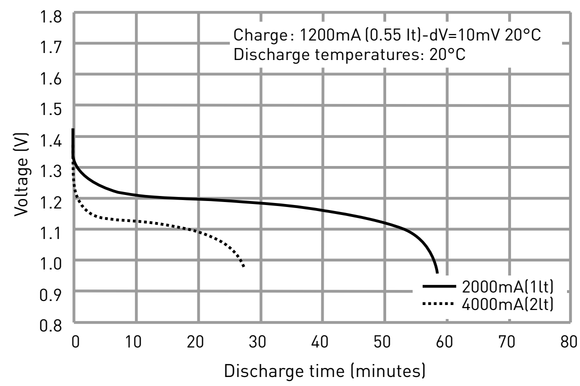


TYPICAL CHARGE CHARACTERISTICS



TYPICAL DISCHARGE CHARACTERISTICS





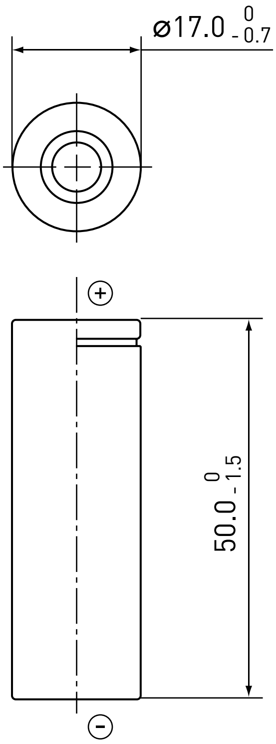
SPECIFICATIONS

Name			HHR-210AA/HT
Diameter (mm)			14.5 +0/-0.7
Height (mm)			50.5 +0/-1.0
Approximate weight (g)			29
Nominal voltage (V)			1.2
Discharge capacity*1		Average*2 (mAh)	2,080
		Rated/min. (mAh)	2,000
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			20
Charge		Standard (mA x hrs.)	200 x 16
		Rapid*3 (mA x hrs.)	1,200 x 2
Ambient temperature	Charge (°C)	Standard	0 to +45
		Rapid	0 to +40
	Discharge (°C)		-10 to +65
	Storage (°C)	<1 year	-20 to +35
		<3 months	-20 to +45
		<1 month	-20 to +55

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

HHR-210A/FT CYLINDRICAL A SIZE (HR17/50)

DIMENSIONS (MM)

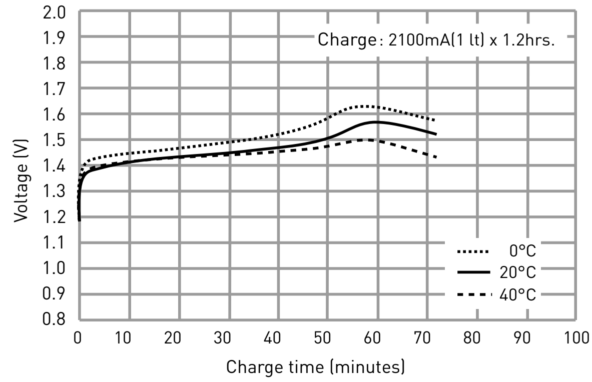


SPECIFICATIONS

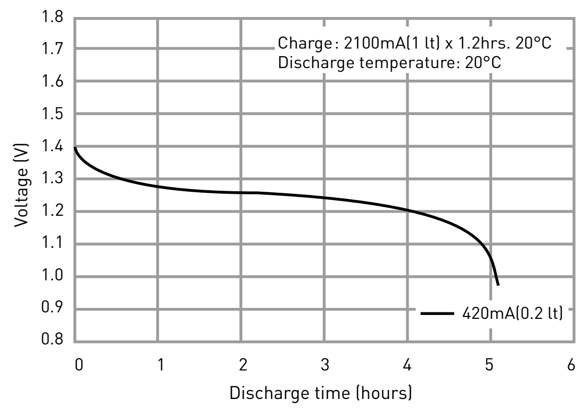
Name			HHR-210A/FT
Diameter (mm)			17.0 +0/-0.7
Height (mm)			50.0 +0/-1.5
Approximate weight (g)			38
Nominal voltage (V)			1.2
Discharge capacity*[1]		Average*[2] (mAh)	2,200
		Rated/min. (mAh)	2,100
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			20
Charge		Standard (mA x hrs.)	210 x 16
		Rapid*[3] (mA x hrs.)	2,100 x 1.2
Ambient temperature	Charge (°C)	Standard	0 to +45
		Rapid	0 to +40
	Discharge (°C)		-10 to +65
	Storage (°C)	<1 year	-20 to +35
		<3 months	-20 to +45
		<1 month	-20 to +55

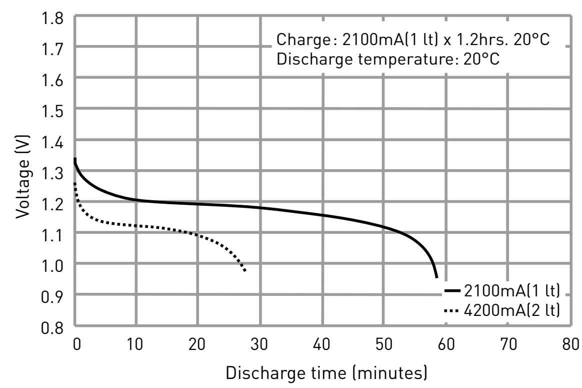
*[1] After charging at 0.1It for 16 hours, discharging at 0.2It.
*[2] For reference only.
*[3] Need specially designed control system. Please contact Panasonic for details.

TYPICAL CHARGE CHARACTERISTICS



TYPICAL DISCHARGE CHARACTERISTICS

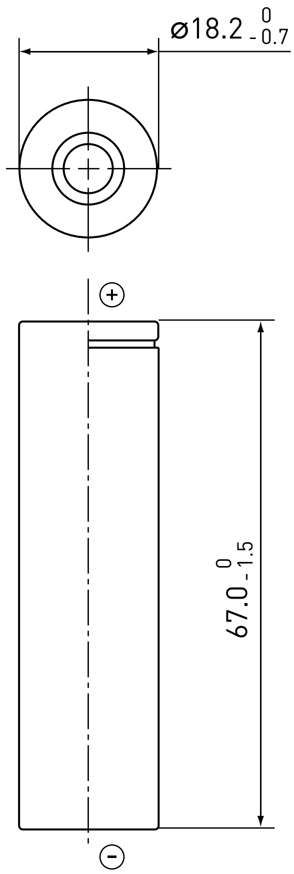




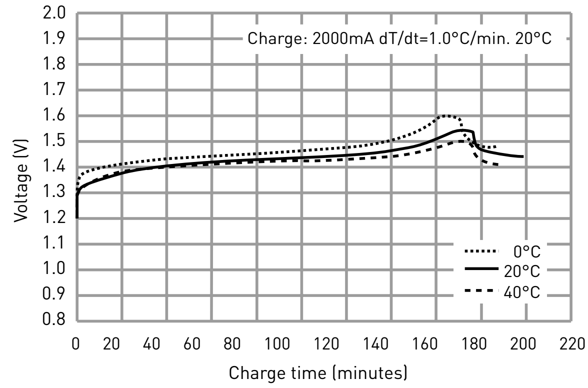
HHR-450A/FT

CYLINDRICAL LFAT/A SIZE

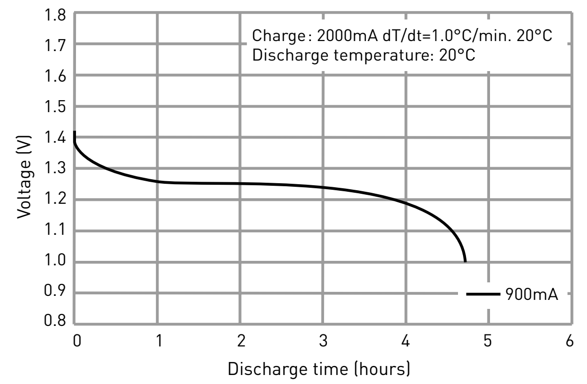
DIMENSIONS (MM)

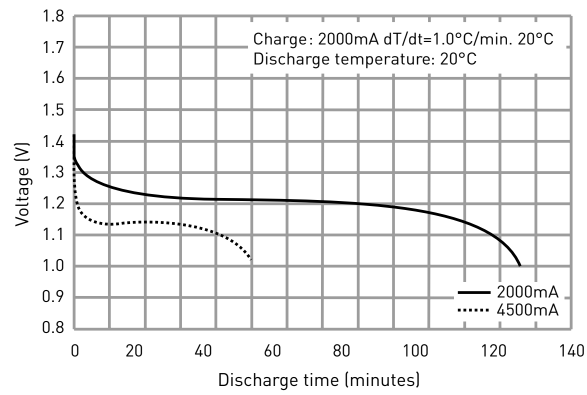


TYPICAL CHARGE CHARACTERISTICS



TYPICAL DISCHARGE CHARACTERISTICS





SPECIFICATIONS

Name			HHR-450A/FT
Diameter (mm)			18.2 +0/-0.7
Height (mm)			67.0 +0/-1.5
Approximate weight (g)			60
Nominal voltage (V)			1.2
Discharge capacity*1		Average*2 (mAh)	4,500
		Rated/min. (mAh)	4,200
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			25
Charge		Standard (mA x hrs.)	450 x 16
		Rapid*3 (mA dT/dt)	2,000 x 1.2
Ambient temperature	Charge (°C)	Standard	0 to +45
		Rapid	0 to +40
	Discharge (°C)		-10 to +65
	Storage (°C)	<1 year	-20 to +35
		<3 months	-20 to +45
		<1 month	-20 to +55

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

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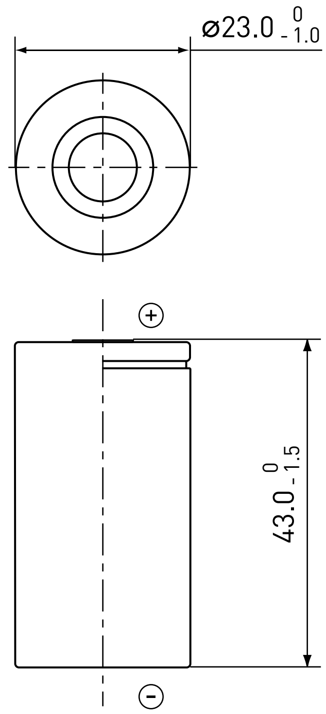
HHR-260SCP/FT CYLINDRICAL SC SIZE (HR23/43)

DIMENSIONS (MM)

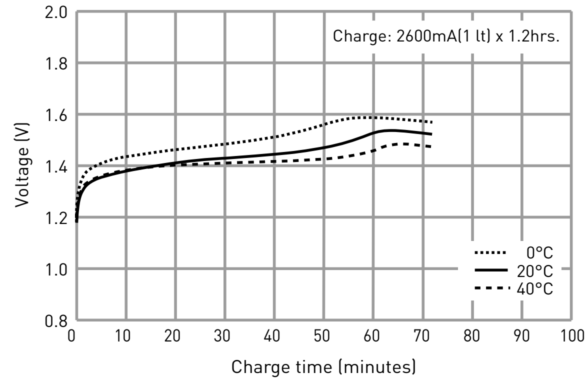


SPECIFICATIONS

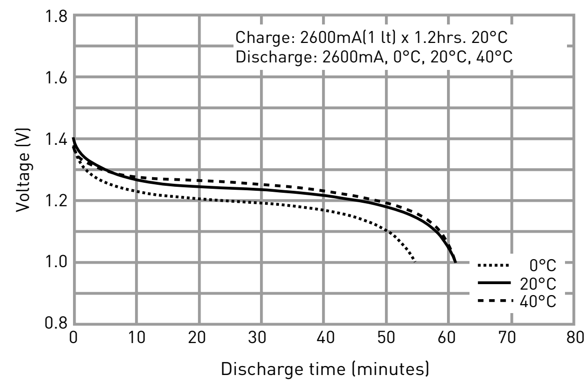
Name			HHR-260SCP/FT
Diameter (mm)			23.0 +0/-1.0
Height (mm)			43.0 +0/-1.5
Approximate weight (g)			55
Nominal voltage (V)			1.2
Discharge capacity*[1]		Average*[2] (mAh)	2,600
		Rated/min. (mAh)	2,450
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			5
Charge		Standard (mA x hrs.)	260 x 16
		Rapid*[3] (mA x hrs.)	2,600 x 1.2
Ambient temperature	Charge (°C)	Standard	0 to +45
		Rapid	0 to +40
	Discharge (°C)		-10 to +65
	Storage (°C)	<1 year	-20 to +35
		<3 months	-20 to +45
		<1 month	-20 to +55

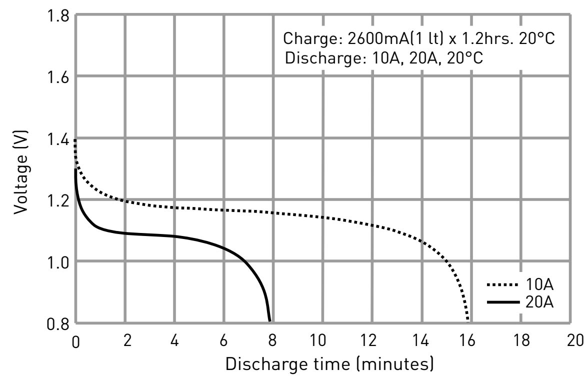
*[1] After charging at 0.1It for 16 hours, discharging at 0.2It.
*[2] For reference only.
*[3] Need specially designed control system. Please contact Panasonic for details.

TYPICAL CHARGE CHARACTERISTICS



TYPICAL DISCHARGE CHARACTERISTICS





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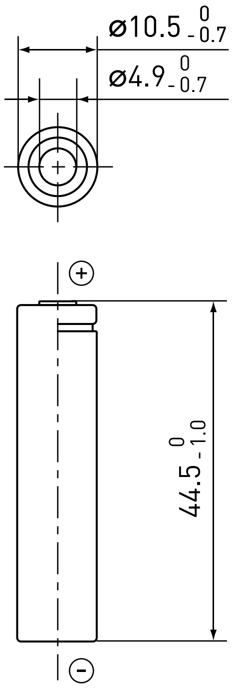
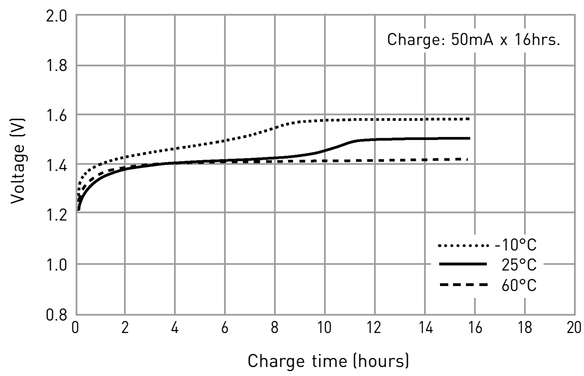
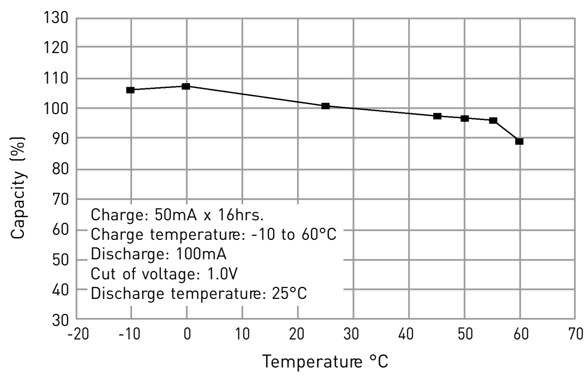
HHR-60AAAH/FT CYLINDRICAL AAA SIZE (HR11/45) FOR BACK-UP USE

DIMENSIONS (MM)



TYPICAL CHARGE CHARACTERISTICS



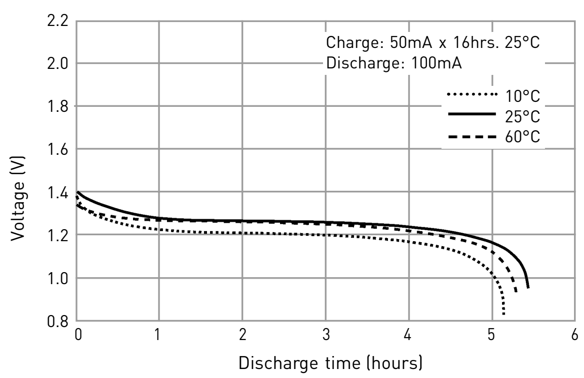


SPECIFICATIONS

Name			HHR-60AAAH/FT
Diameter (mm)			10.5 +0/-0.7
Height (mm)			44.5 +0/-1.0
Approximate weight (g)			13
Nominal voltage (V)			1.2
Discharge capacity*[1]		Average*[2] (mAh)	550
		Rated/min. (mAh)	500
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			35
Charge		Standard (mA x hrs.)	50 x 16
		Rapid*[3] (mA x hrs.)	250 x 2.4
		Low rate (mA x hrs.)	25 x 32
			17 x 48
Ambient temperature	Charge (°C)	Standard	-10 to +60
		Rapid	
		Low rate	-10 to +45
	Discharge (°C)		-10 to +60
	Storage (°C)	<1 year	-20 to +35
		<6 months	-20 to +45
		<1 month	-20 to +55
		<1 week	-20 to +65

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

TYPICAL DISCHARGE CHARACTERISTICS



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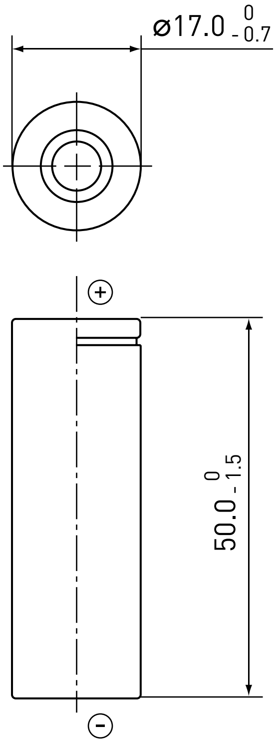
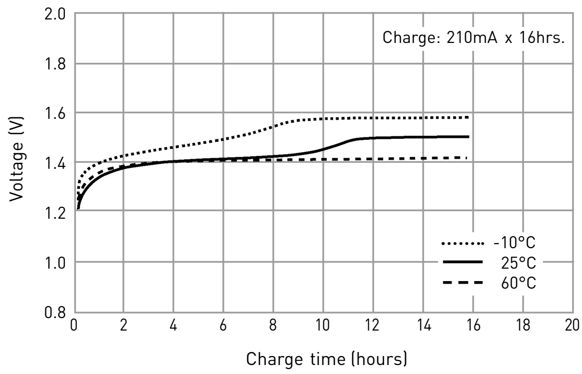
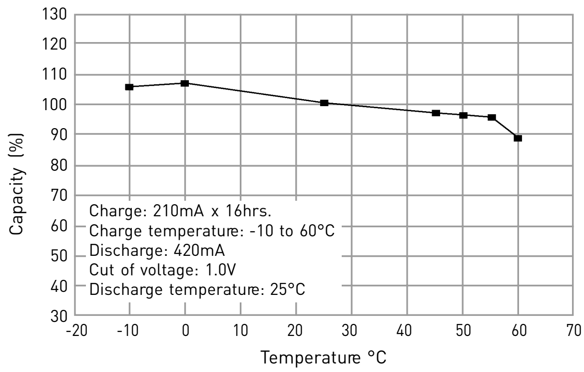
HHR-210AH/FT CYLINDRICAL A SIZE (HR17/50) FOR BACK-UP USE

DIMENSIONS (MM)



TYPICAL CHARGE CHARACTERISTICS

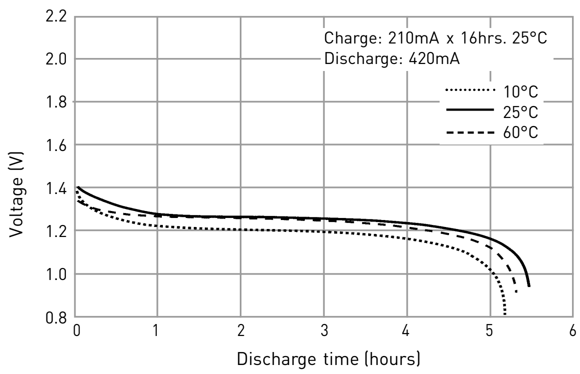




SPECIFICATIONS

Name			HHR-210AH/FT
Diameter (mm)			17.0 +0/-0.7
Height (mm)			50.0 +0/-1.5
Approximate weight (g)			36
Nominal voltage (V)			1.2
Discharge capacity*[1]		Average*[2] (mAh)	2,050
		Rated/min. (mAh)	1,900
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			20
Charge		Standard (mA x hrs.)	210 x 16
		Rapid*[3] (mA x hrs.)	1,000 x 2.3
		Low rate (mA x hrs.)	105 x 32
			70 x 48
Ambient temperature	Charge (°C)	Standard	-10 to +60
		Rapid	
		Low rate	-10 to +45
	Discharge (°C)		-10 to +60
	Storage (°C)	<1 year	-20 to +35
		<6 months	-20 to +45
		<1 month	-20 to +55
		<1 week	-20 to +65

TYPICAL DISCHARGE CHARACTERISTICS



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

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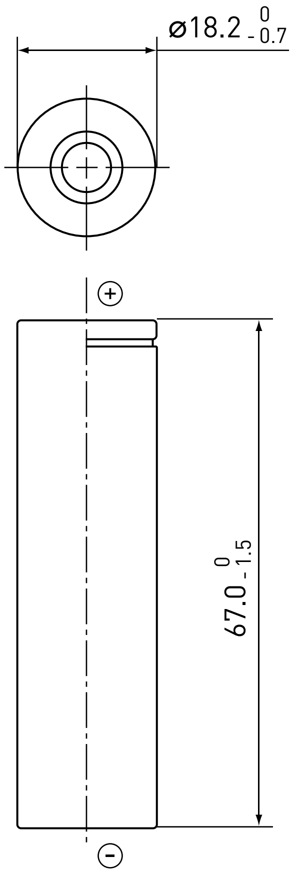
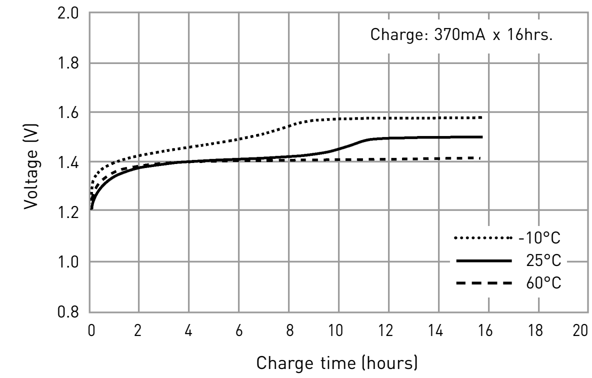
HHR-370AH/FT

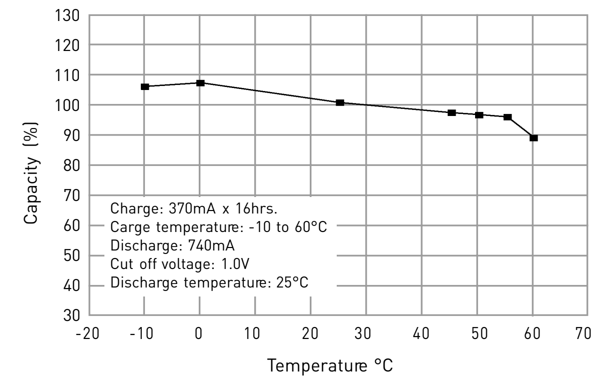
CYLINDRICAL LFAT/A SIZE FOR BACK-UP USE

DIMENSIONS (MM)



TYPICAL CHARGE CHARACTERISTICS



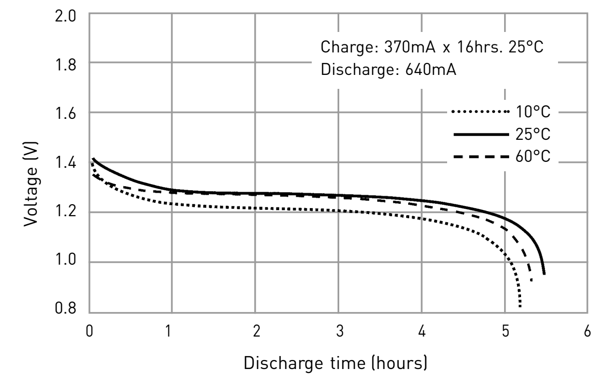


SPECIFICATIONS

Name			HHR-370AH/FT
Diameter (mm)			18.2 +0/-0.7
Height (mm)			67.0 +0/-1.5
Approximate weight (g)			60
Nominal voltage (V)			1.2
Discharge capacity*[1]		Average*[2] (mAh)	3,700
		Rated/min. (mAh)	3,500
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			20
Charge		Standard (mA x hrs.)	370 x 16
		Rapid*[3] (mA x hrs.)	3,000 x 2.4
		Low rate (mA x hrs.)	185 x 32
			123 x 48
Ambient temperature	Charge (°C)	Standard	-10 to +60
		Rapid	
		Low rate	-10 to +45
	Discharge (°C)		-10 to +60
	Storage (°C)	<1 year	-20 to +35
		<6 months	-20 to +45
		<1 month	-20 to +55
		<1 week	-20 to +65

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

TYPICAL DISCHARGE CHARACTERISTICS



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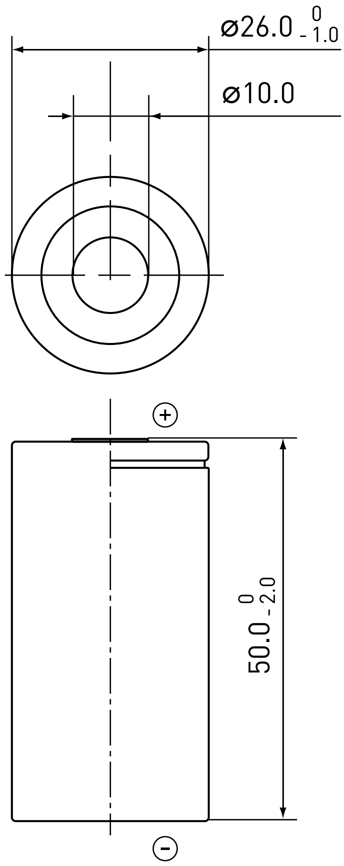
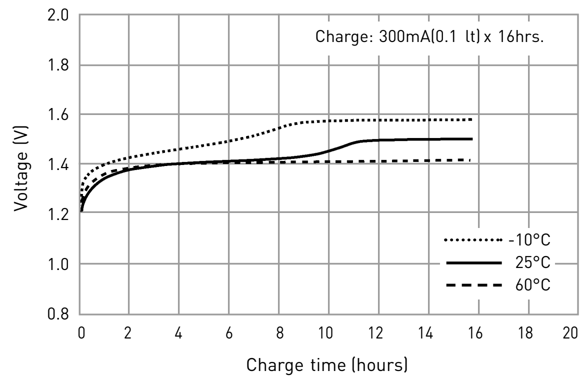
HHR-300CH/FT

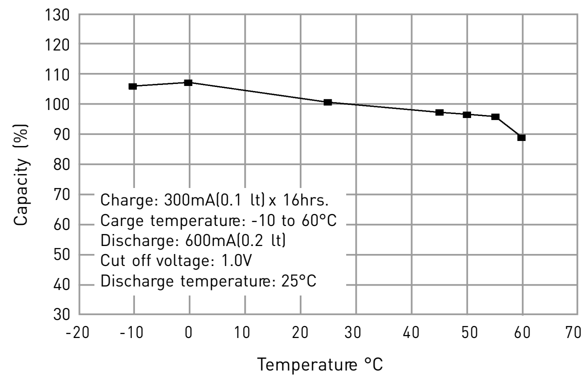
CYLINDRICAL C SIZE (HR26/50) FOR BACK-UP USE

DIMENSIONS (MM)



TYPICAL CHARGE CHARACTERISTICS



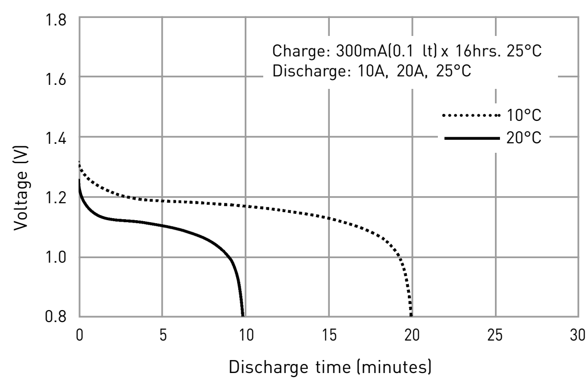


SPECIFICATIONS

Name			HHR-300CH/FT
Diameter (mm)			26.0 +0/-1.0
Height (mm)			50.0 +0/-2.0
Approximate weight (g)			80
Nominal voltage (V)			1.2
Discharge capacity*[1]		Average*[2] (mAh)	3,300
		Rated/min. (mAh)	3,100
Approx. internal impedanceat 1,000Hz at charged state (mΩ)			5
Charge		Standard (mA x hrs.)	300 x 16
		Rapid*[3] (mA x hrs.)	1,500 x 2.4
		Low rate (mA x hrs.)	150 x 32
			100 x 48
Ambient temperature	Charge (°C)	Standard	-10 to +60
		Rapid	
		Low rate	-10 to +45
	Discharge (°C)		-10 to +60
	Storage (°C)	<1 year	-20 to +35
		<6 months	-20 to +45
		<1 month	-20 to +55
		<1 week	-20 to +65

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

TYPICAL DISCHARGE CHARACTERISTICS



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.

GLOSSARY OF TERMS FOR NI-MH BATTERIES

STRUCTURAL-RELATED ITEMS

Active material
The electro-chemical materials of the electrodes. In rechargeable Ni-MH battery, 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 battery, a potassium hydroxide water solution is generally used as the electrolyte.

Hydrogen-absorbing alloy
Alloy which can absorb/release hydrogen reversibly. AB_5 or AB_2 type alloy is used for batteries. ($MmNi_5$) AB_5 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

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