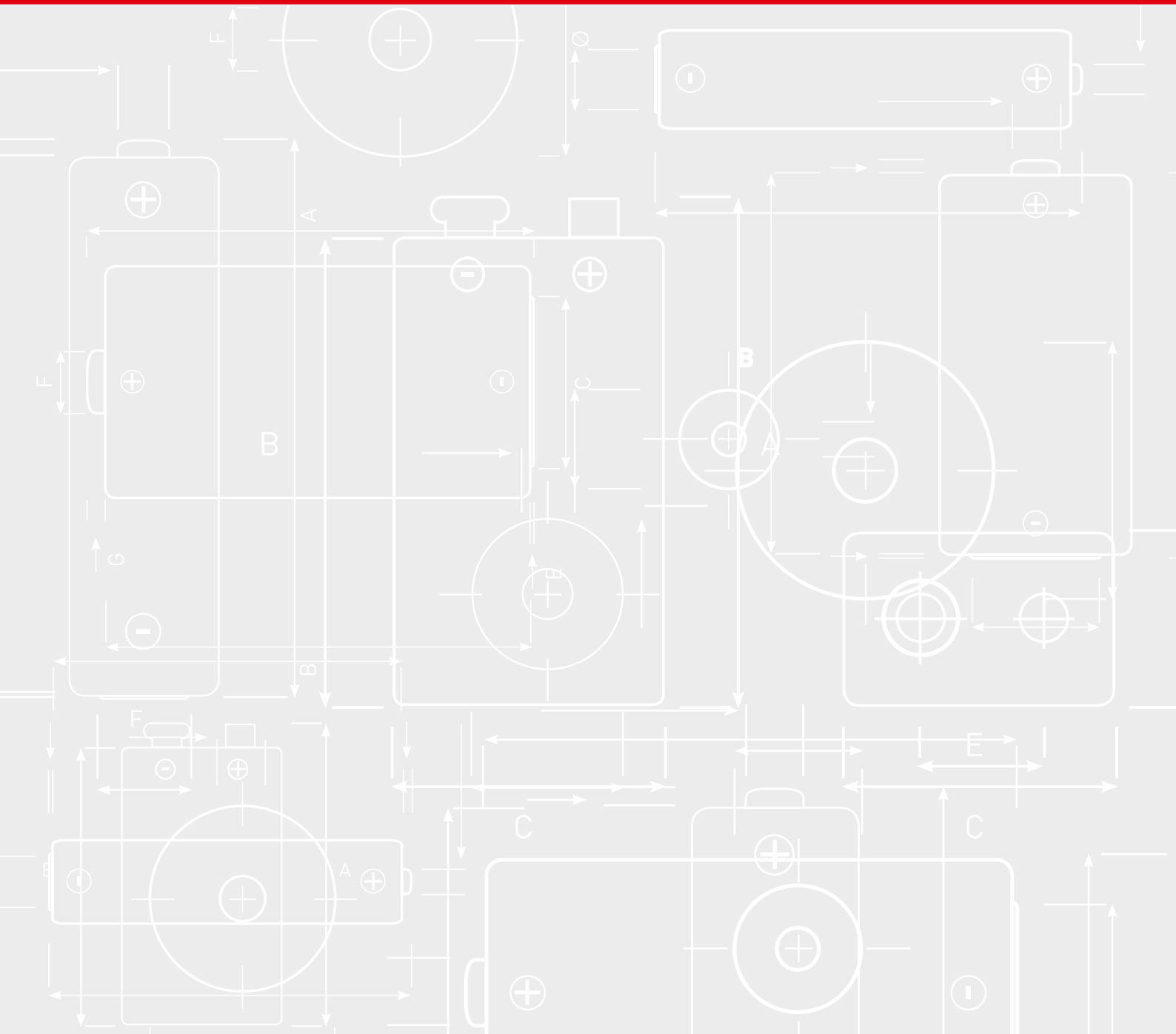


ALKALINE HANDBOOK

ENGLISH

INDUSTRIAL BATTERIES



Panasonic BATTERIES
Quality is our Business.

PANASONIC BATTERIES



PANASONIC INDUSTRIAL DEVICES SALES 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 Devices Sales Europe GmbH (PIDSEU) markets a diverse portfolio of industrial products throughout Europe. Formed in 1998 to strengthen Panasonic's pan-European industry operations, the company is now active in Automotive, Audio/Video & Communication, Appliance and Industry & Devices.



Panasonic quality - certified by authorised agencies.

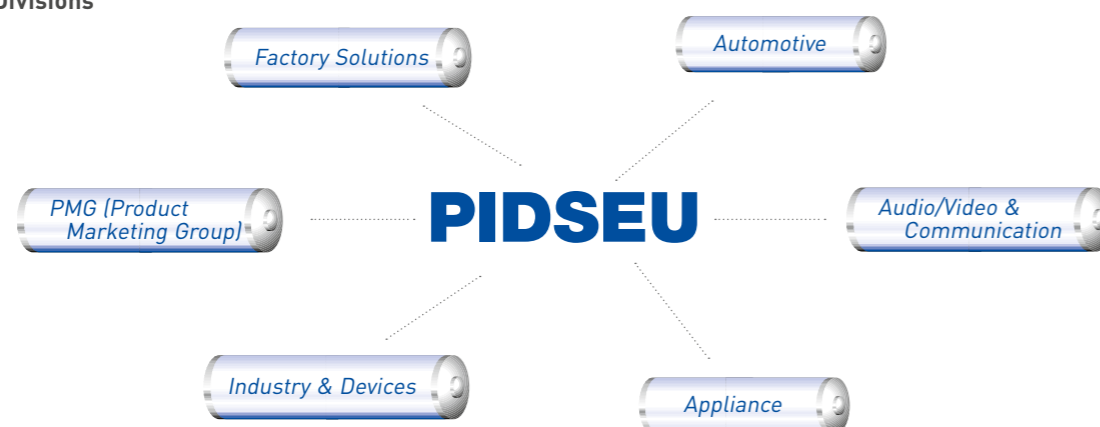
Panasonic offers a wide range of power solutions for portable and stationary applications. Our product range includes high reliability batteries such as Lithium-Ion, Lithium, Nickel-Metal-Hydrate, Valve-Regulated-Lead-Acid (VRLA), Alkaline and Zinc-Carbon. With this breadth and depth to the portfolio, we can power your business in virtually all applications.

Panasonic Energy Company (PEC) began manufacturing batteries in 1931. Today PEC is the most diversified global battery manufacturer worldwide, with a network of 16 manufacturing companies in 14 countries. The company has more than 12,600 employees, all dedicated to research, development and production of batteries for a new world.

Our production facilities use leading-edge manufacturing processes that meet the toughest quality standards. All our factories are certified to ISO standards – with ISO 9000 and ISO 14000 being the minimum benchmarks. This means each factory has its own quality and environmental management, and delivers products that measure up to toughest standards of reliability.

Most of our factories are also certified to OHSAS 18001 (Occupational Health and Safety Assessment Series), an international standard to assess the management system which organisations have in place for occupational safety. This confirms our factories have been proactive in putting the occupational health and safety of staff at the centre of the company's dealings. In addition our VRLA batteries are for example approved to German VdS standard and the US UL standard.

PIDSEU Organisation Divisions





PANASONIC LEADS THE WAY ... WITH 'ECO IDEAS'

Pursuing coexistence with the global environment in its corporate vision, Panasonic is committed to reducing the environmental impact in all its business activities. This is a key theme of its mid-term strategic plan. In its 'eco ideas' Strategy, which focuses in particular on rapid implementation of measures to prevent global warming, and worldwide promotion of 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 point. It would be no exaggeration to call this the 'Environmental Industrial Revolution'. Recognising the significance, in 2009 Panasonic established an 'eco ideas' House at the Panasonic Center in Tokyo to showcase ideas on how to help create a carbon-free society and reduce the CO₂ footprint in the household sector.

Illustrating how technology and the environment can synergise, the 'eco ideas' House shows how near-zero CO₂ emissions can be achieved in an entire house three to five years into the future. Panasonic is demonstrating that we are not only aware of our environmental responsibility but that we also take action.

'ECO IDEAS' FOR MANUFACTURING

Our plans

We will reduce CO₂ emissions across all our manufacturing sites.

Our goals

In each of our factories we aim to achieve a 10% reduction in CO₂ emissions.

Our measures

In our 'Clean Factory' program, our factories are evaluated with regard to CO₂ emission, waste disposal, recycling measures, chemical and water consumption. They are set performance targets based on these indicators.

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.

'ECO IDEAS' FOR PRODUCTS

Our plans

We will produce energy-efficient products.

Our goals

Panasonic aims to have at least 20 products with the 'Superior Green Products' classification available.

Our measures

The developers at Panasonic carry out an environmental impact assessment for all our products. Those which meet the highest environmental requirements in the industry with regard to energy efficiency are classified as a 'Superior Green Product' and awarded the Panasonic 'eco ideas' logo.

Example

We have eliminated highly toxic Lithium Thionyl Chloride from the production of our Lithium batteries. This substance is quite rightly classified as highly toxic and should never under any circumstances be released into the environment.

'ECO IDEAS' FOR EVERYBODY, EVERYWHERE

Our plans

We will promote environmental activities throughout the world.

Our goals

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

Our measures

Not only do we sponsor the work of the WWF in the Arctic, Panasonic has also launched other environmental initiatives such as ECO RELAY, in which hundreds of Panasonic employees all over the world volunteer several days of their time to eco-campaigns.

Example

Panasonic staged a dedicated "battery collection day" in Germany with the help of GRS Batterien (German Battery Recycling Association). The idea was to collect as many spent batteries as possible and raise awareness in communities about battery recycling – enabling the recovery of valuable commodities such as Zinc, Manganese and Iron.

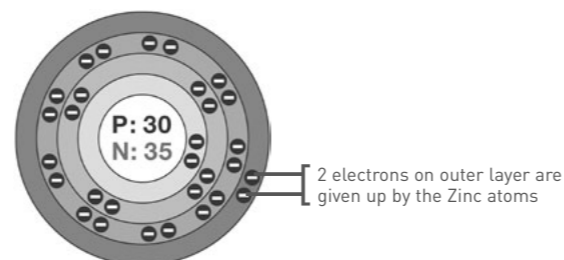
Chapter	Page
1 Introduction	6
2 Electro-chemical description	7
3 Construction	8
4 Performance	
Voltage and capacity	9
Discharge types	9
Shelf life	10
5 Applications	10
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1 INTRODUCTION

In this booklet we describe Alkaline Manganese batteries. These are basically made from the same materials as normal Zinc-Carbon batteries, but offer higher capacity and high drain performance, longer shelf life, better leakage resistance and superior low temperature behaviour.

The **cylindrical Alkaline battery** is composed of Manganese Dioxide (+), Zinc Powder (-) and Caustic Alkali (Potassium Hydroxide) as the electrolyte. These Alkaline batteries have a higher energy output than Zinc-Carbon batteries, a longer shelf life and better leakage resistance due to the use of purest materials to minimize self discharge. Their low-temperature performance is also much better than that of Zinc-Carbon batteries.

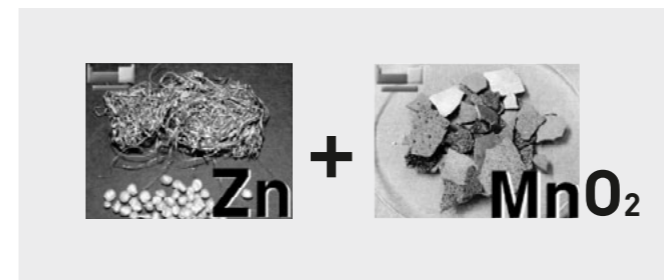
The actual electrical current is generated through an outside flow of electrons coming from the anode (Zinc), passing through the attached load and flowing back into the battery at the cathode (from the can into the Manganese Dioxide).



ELECTRO-CHEMICAL DESCRIPTION

The **negative electrode** or **anode** is composed of Zinc Powder in the shape of a mixed gel. The quality of the Zinc Powder and the size of the particles are carefully controlled to ensure there is a good wide surface area during the chemical reaction. This lowers the internal resistance, which is important in case of high drain discharges. Because it is the Zinc which is giving up electrons, thus creating a flow of electrical current, the anode is also the “capacity determining element”.

The **positive electrode** or **cathode** is made of Manganese Dioxide and is produced in the shape of tablets. Graphite and electrolyte (and small quantities of other additives) are added for better conductivity. This material is generated through an electrolytic process, ensuring the purity and richness of oxygen.



The **electrolyte** is a Potassium Hydroxide solution, which is Alkaline (base) and is present in the anode, cathode and separator (as all three are porous in nature) to assure high conductivity during discharge.

The **separator paper** divides the positive and negative parts of the battery to prevent internal short circuiting and immediate loss of energy. The separator paper is made of a special material that prevents anode particles from migrating inside the battery and causing self discharge.

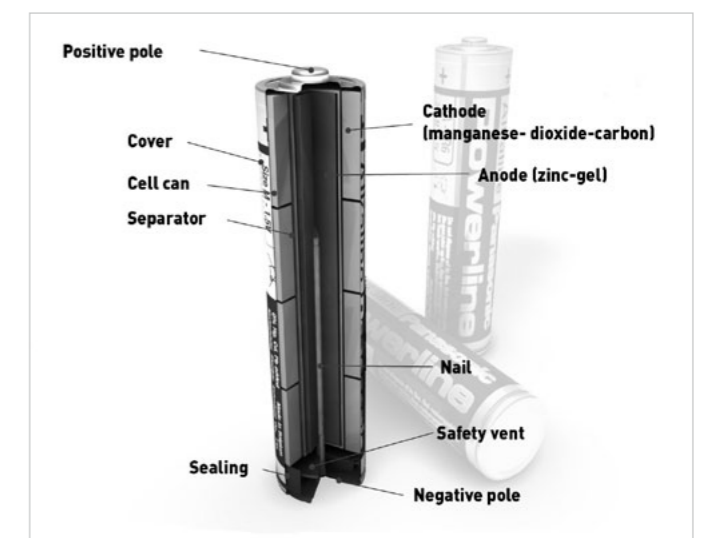
The **battery can** is made of nickel-plated steel and serves as the holder for the battery, and also as the cathode collector. Panasonic performs strict checks on the quality of its own in-house manufactured steel cans to provide thin but strong containers which can hold maximum volumes of active material both safely and reliably.

A **brass nail** connected to the bottomplate serves as the anode collector. It is important for this nail to be of an exact length and thickness to ensure the battery works properly.

A **moulded nylon seal** connected to the brass nail serves as a seal with an integrated safety venting mechanism. This vent ensures safe, controlled release of any excessive gas which could be generated by improper use of the battery (e.g. short circuiting, overheating, or if the battery is thrown on a fire or overcharged, or incorrectly inserted polarity-wise). Once the vent has opened, it will not close again; besides the escaping gas there is always the risk that a certain volume of the electrolyte will leak as well.

A **non-conductive** label provides the opportunity for cosmetic design on the batteries. The label also functions as an isolator between the large positive area of the steel can and the negative area of the bottomplate to avoid external short circuit.

Structure of Alkaline industrial batteries



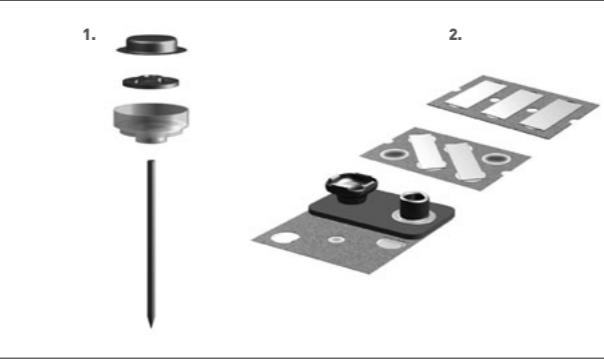
ASSEMBLING LR6

- Battery assembling**
1. Separator and bottom insulator insert
 2. Electrolyte pouring
 3. Gelled-anode (negative pole) pouring
 4. Collector insert and can curling



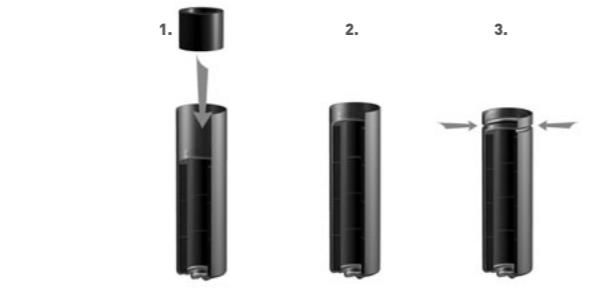
PARTS

- Assembling battery components**
1. Collector unit
 - Bottomplate
 - Washer
 - PY seal
 - Nail
 2. Contact strips 6LR61
 - Lead A
 - Lead B
 - Snap 6LR61



CATHODE UNIT LR6

- Mixtablets (+) pressing**
1. Manganese Dioxide carbon tablet pressing (positive pole)
 2. Tablet inserting and pressing
 3. Can grooving



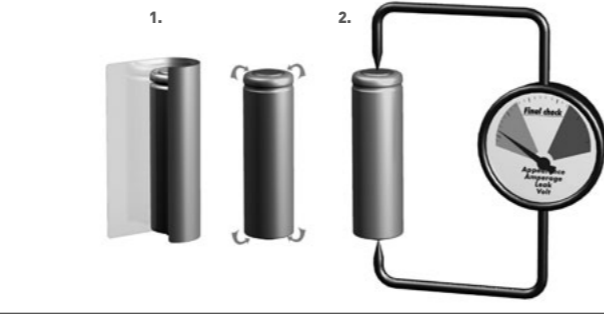
CAN PRODUCTION PROCEDURE

- Steel can production**
1. Cup making
 2. Can drawing
 3. Can trimming
 4. Washing and carbon coating



FINISHING LR6

- Battery finishing**
1. Labeling
 2. Final check on volt, amperage, leakage and appearance



VOLTAGE AND CAPACITY

The voltage of Alkaline batteries usually ranges between 1.55V and 1.65V OCV (Open Circuit Voltage). 1.5V is considered to be the nominal voltage. The speed of voltage decrease during use is determined by the type of appliance and the load (drain) which is put on the battery.

Measuring the OCV of a battery gives only a very rough idea of battery capacity and/or freshness. CCV (Closed Circuit Voltage), measured when the battery is on discharge, gives a much better view of the discharge status. (If the voltage is still close to 1.5V, the battery is still in relatively fresh condition; if the voltage is closer to 1.0V, the battery is nearing the end of its useful life.)

Every kind of appliance needs a minimum voltage to operate, and the level at which the appliance will stop is usually referred to as the "cut-off voltage". Even if several batteries are needed to operate an appliance, for battery test purposes the cut-off voltage is stated in terms of the cut-off voltage per cell. (Example: if we have a portable CD player which uses two cells and needs a least 2V to operate, the cut-off voltage is 1.0V per cell.)

The **capacity** of a battery is usually expressed in mAh (milli Ampere hour). The actual drain in combination with the cut-off voltage will determine the capacity in mAh for each individual use or appliance. It is impossible to put a single figure on how a battery will behave with regard to its capacity, since this depends on a range of parameters. To specify battery capacity precisely, one should give the exact parameters under which the batteries are to be tested, or have a wider range of different discharge conditions to view the battery performance.

The maximum battery capacity is determined by the weight and volume of the two main raw materials, Zinc and Manganese Dioxide. An LR20 battery will last much longer than an LR6 battery, simply because there is much more active material inside. Some batteries, like the 9V Alkaline battery, are designed with six cylindrical batteries in series and are spot-welded together to ensure reliable performance during discharge.

Temperature also plays a role in battery capacity and performance. Alkaline batteries are best suited for operating temperatures between -10°C and +45°C. In some cases the batteries can reliably deliver small currents at lower or higher temperatures as well, but this should be subject to careful testing under the specific conditions. At higher temperatures the internal resistance of the battery will increase at a lesser speed, which will provide better high drain performance.

DISCHARGE TYPES

We differentiate between the following types:

- Constant resistance (B)**
The appliance keeps its resistance constant in Ohm.
- Constant current (A)**
The appliance keeps running on constant drain in A or mA.
- Constant power (W)**
As the power should remain constant, the drain in Ampere will increase gradually during discharge as the voltage decreases.

Power (Watt) = Current (A) x Voltage (V)

In this case, the increasing internal resistance towards the end of the useful battery life will also determine the actual useful capacity of the batteries. The total capacity is of course also strongly influenced by the cut-off voltage.

The discharge (continuous or intermittent) and load (light or heavy) largely determine what performance can actually be obtained from a battery.

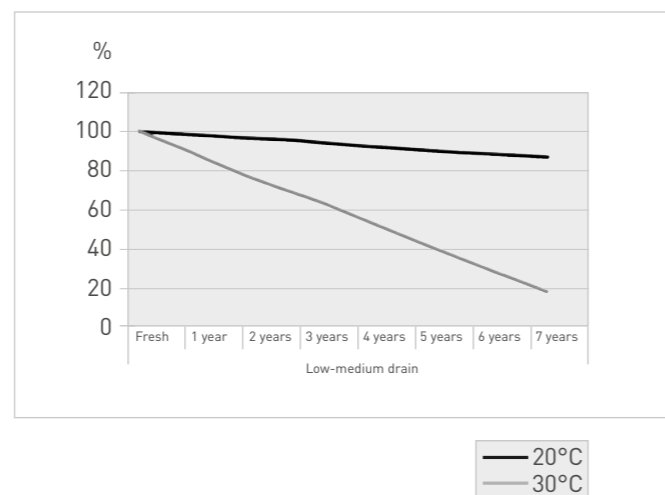
SHELF LIFE

The shelf life is the ability of a battery to maintain more or less the same performance over time. Alkaline batteries nowadays carry a freshness date of about five years from the date of production. This means that the service life on a specific discharge compared to a fresh battery of the same generation is expected to be over 70% compared to initial capacity testing. (If batteries have been stored appropriately in a controlled environment with constant temperature and humidity.)

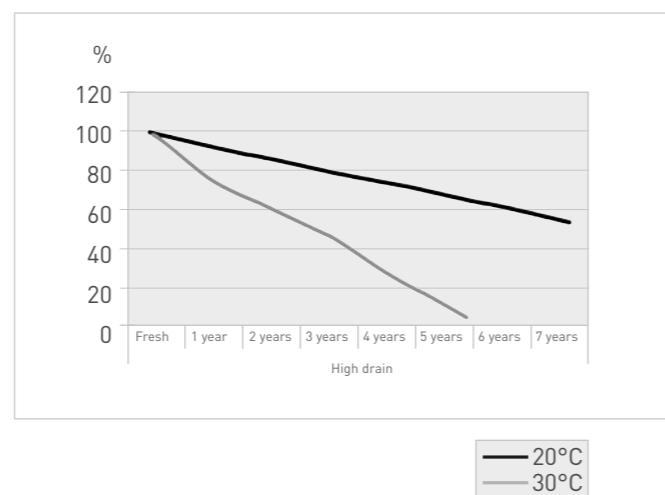
The shelf life is influenced by temperature, humidity and internal construction.

High temperature and high humidity will speed up the degradation of chemicals, which leads to greater capacity loss in a shorter time. Poor quality internal construction might also influence the degradation of chemicals, but mainly as a potential risk for internal short circuit and leakage over time. Yet another factor – and even more unpredictable – is that the electrolyte could cause non-metallic battery parts to deteriorate over time, resulting in leakage. Though there is little chance of this happening, it is still advisable to use Alkaline batteries within the first half of their expected shelf life.

Capacity loss estimation at low-medium drain

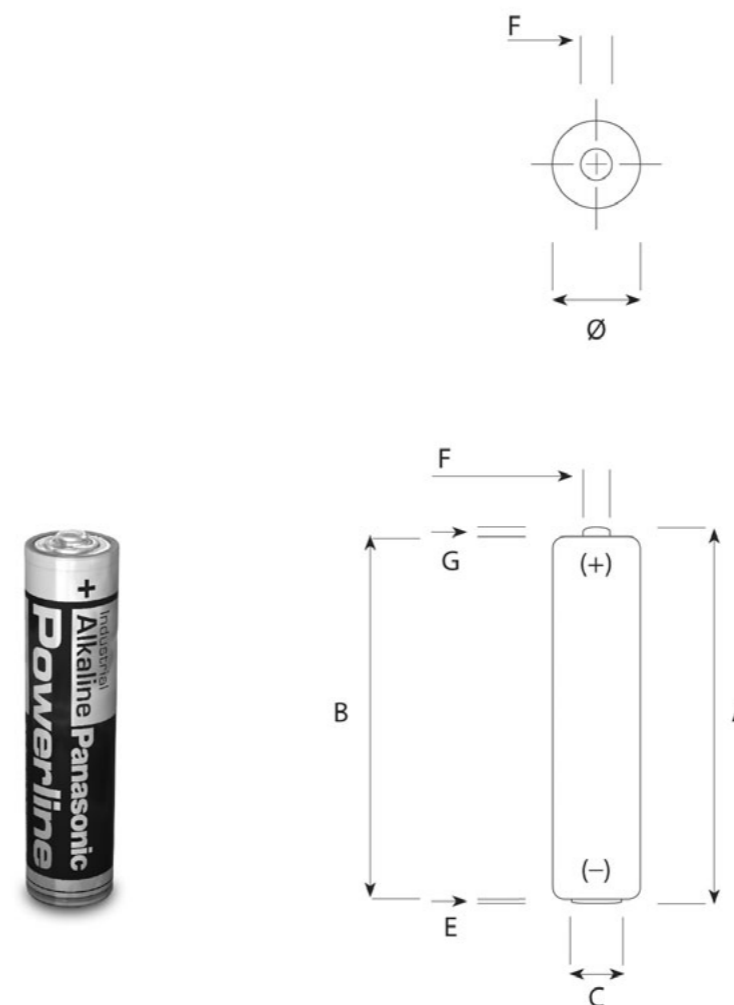


Capacity loss estimation at high drain



LR03AD POWERLINE

IEC DIMENSIONS (MM)



Dimensions	max. (mm)	min. (mm)
A	44.5	
B		43.3
C		4.3
E	0.5	
F	3.8	
G		0.8
Ø	10.5	9.5



Panasonic offers a comprehensive family of Alkaline batteries. This extensive range of products ensures power solutions for nearly all battery requirements. Whenever your portable device needs power, you can rely on our high quality battery technology solutions.

Applications which can be powered include:

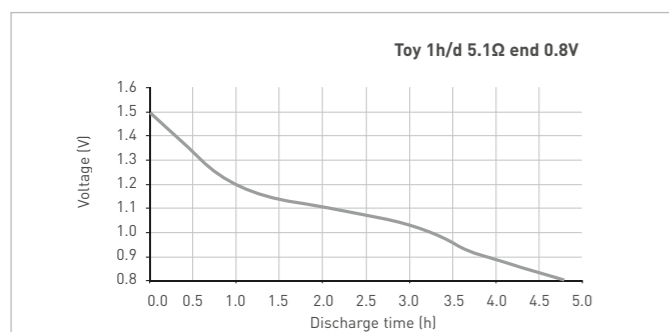
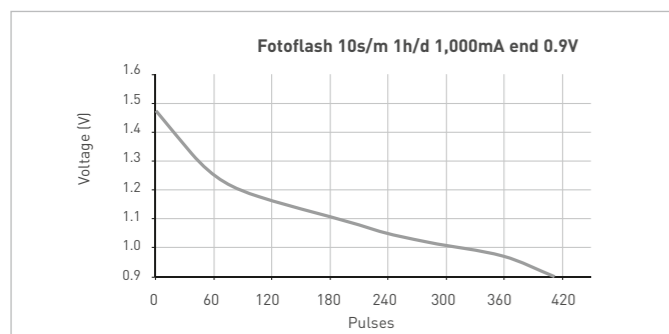
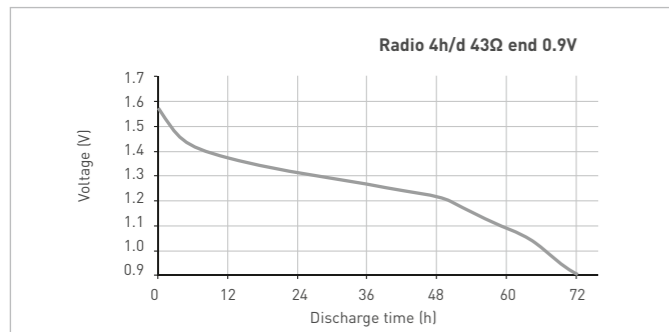
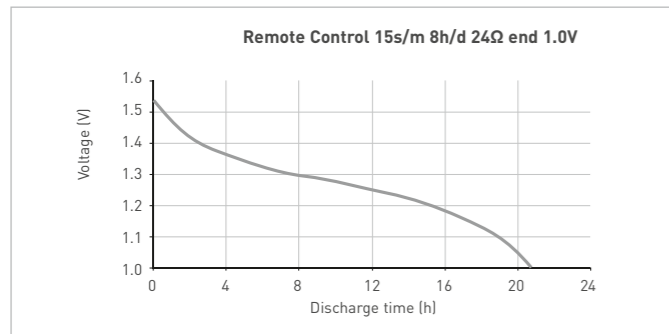
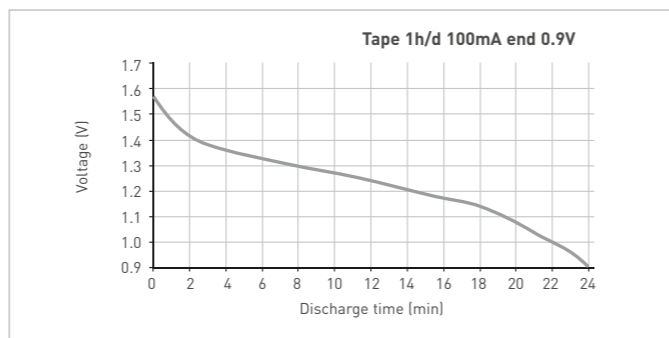
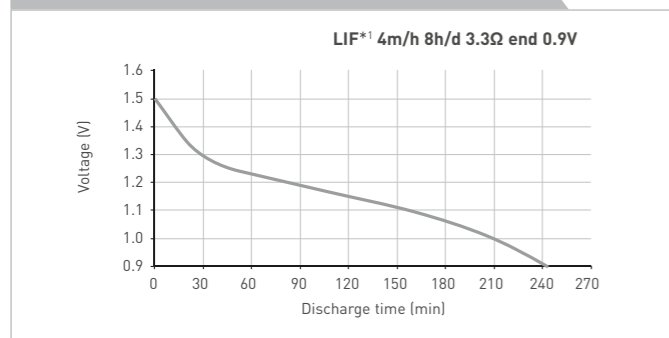
- Smoke detectors
- Portable audio devices
- Toys
- High energy flashlights
- Marine devices
- Highway telephones
- Door lock systems
- Medical equipment
- Buoyage
- Blood pressure meters
- Scales
- Analogue cameras
- Cleaning and hygiene services
- Seismic sensors

SPECIFICATIONS

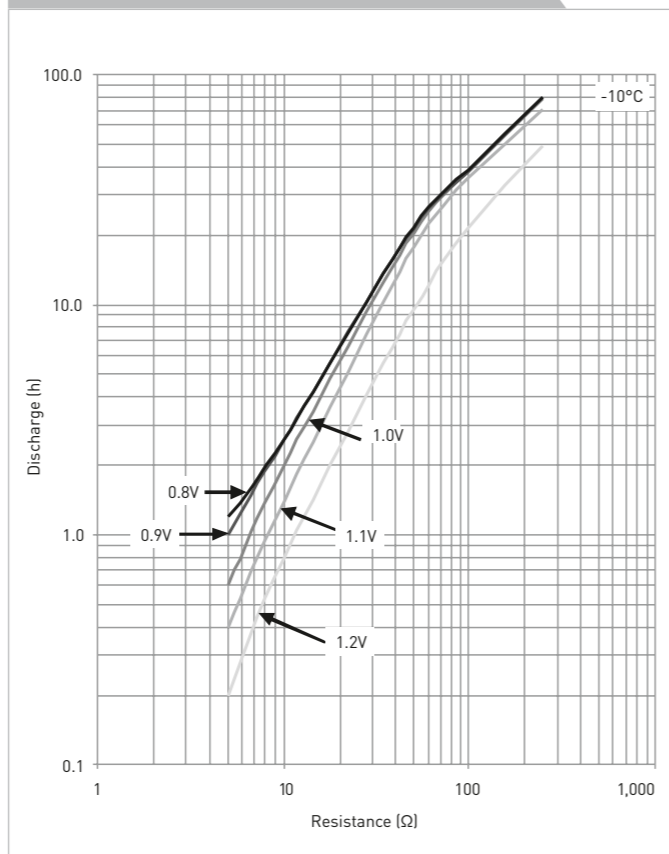
Name	LR03 / S / AAA / AM4 / MICRO / MN2400 / 24A / 24AC
Made in	Belgium
Type	Alkaline foil
Nominal voltage	1.5V
Electrolyte	Potassium Hydroxide
Average weight	11.2g
Storage temperature range	+10°C ~ +25°C
Operating temperature range	-20°C ~ +45°C
Average impedance	approx. 135mΩ @ 1kHz AC
Heavy metals	No added mercury (Hg), Cadmium (Cd) or Lead (Pb)
Compliant with	IEC 60086 Non-dangerous goods regulation Nordic Ecolabel (White Swan) version 3.7 EC directive 91/157EC, 98/101EC, 2006/66/EC
Recommended cut-off voltage	0.8V per cell

LR03AD POWERLINE

TYPICAL DISCHARGE VALUES

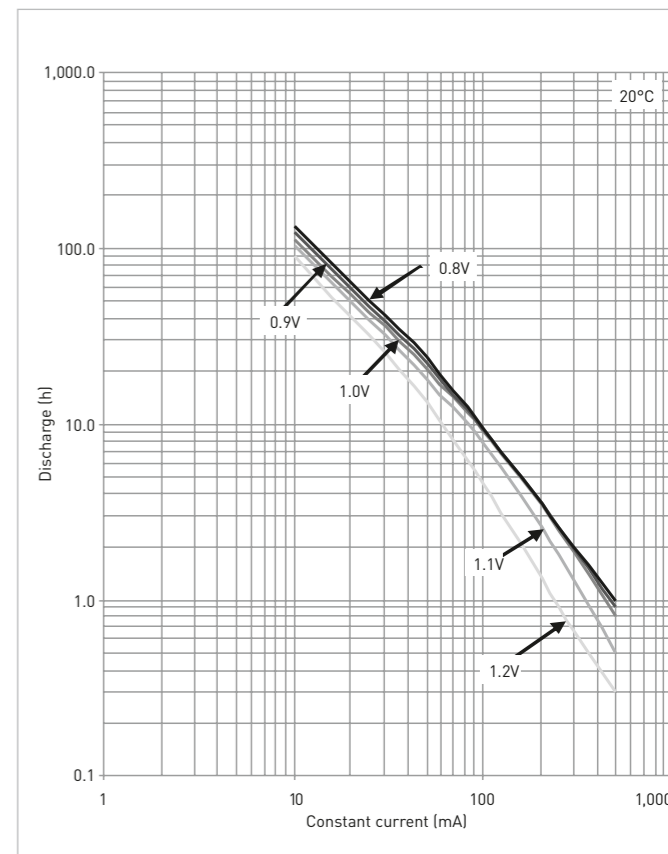
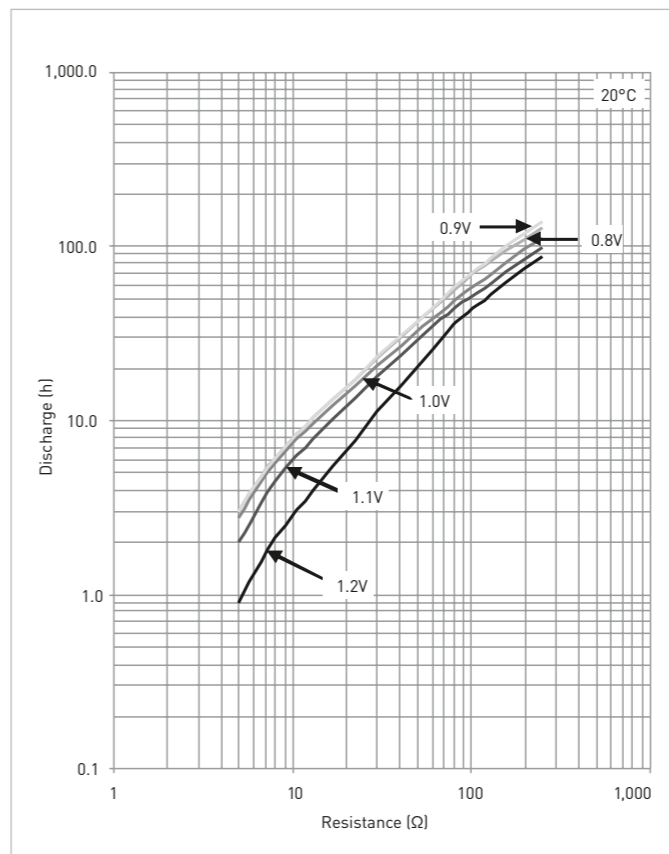
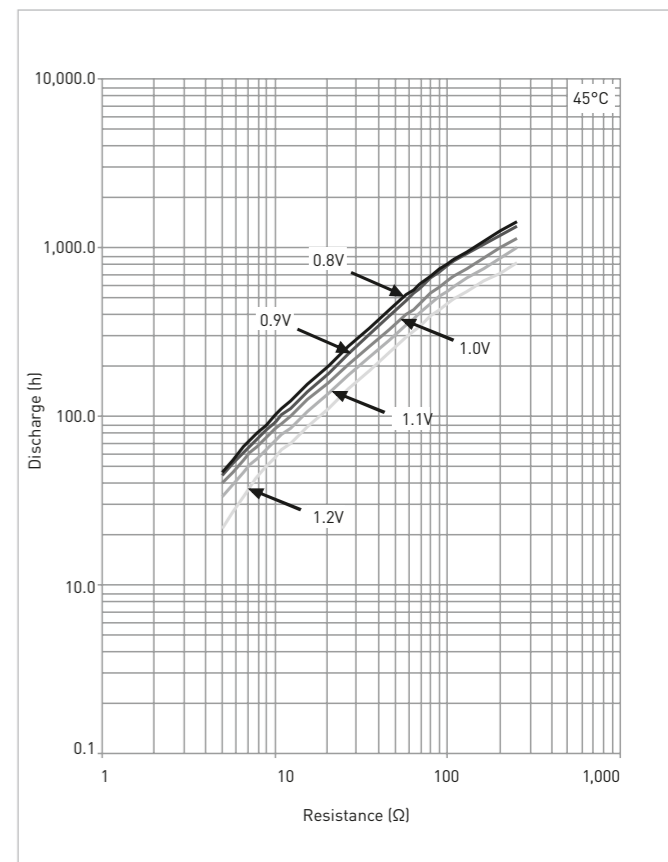
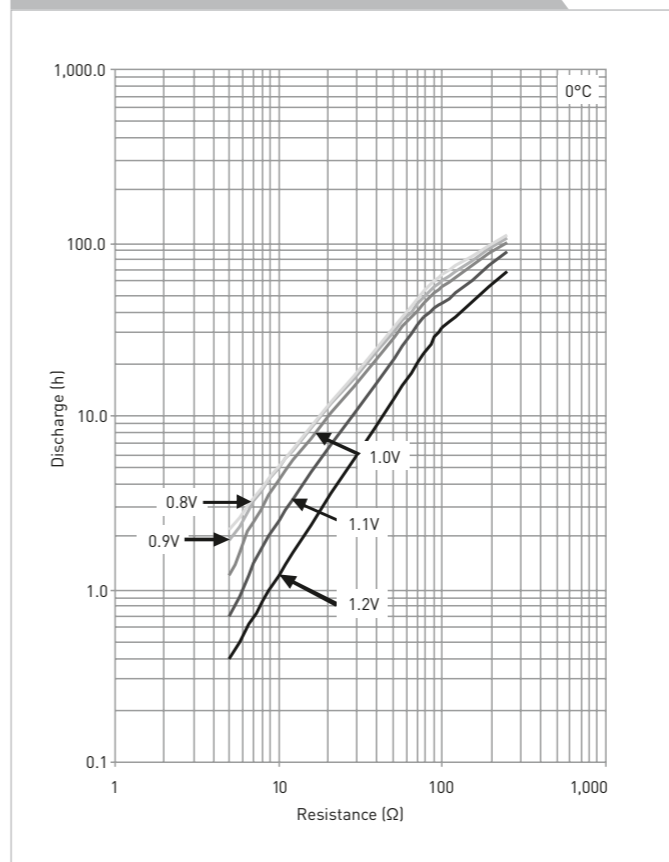


DISCHARGE TEMPERATURE CHARACTERISTICS



LR03AD POWERLINE

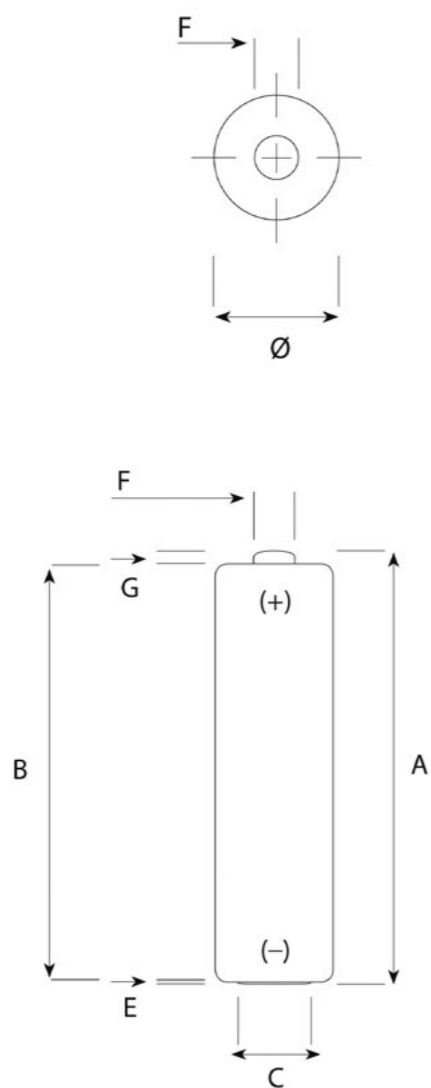
DISCHARGE TEMPERATURE CHARACTERISTICS



*1 Light intention flashlight

LR6AD POWERLINE

IEC DIMENSIONS (MM)



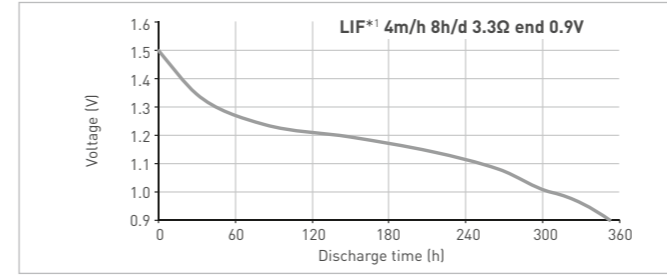
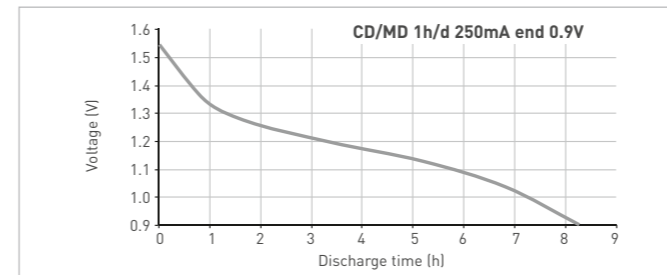
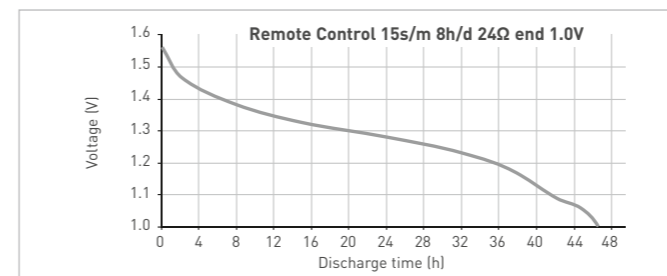
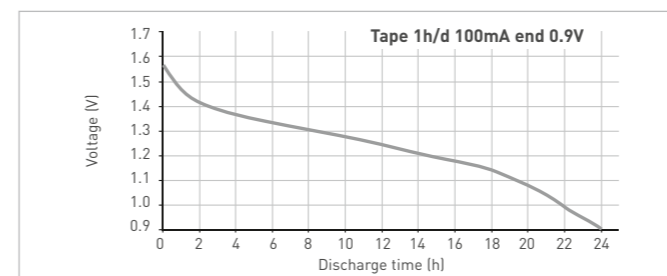
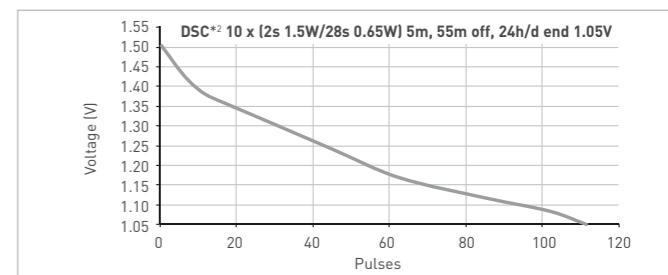
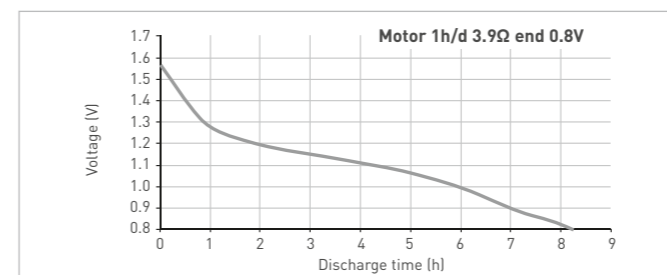
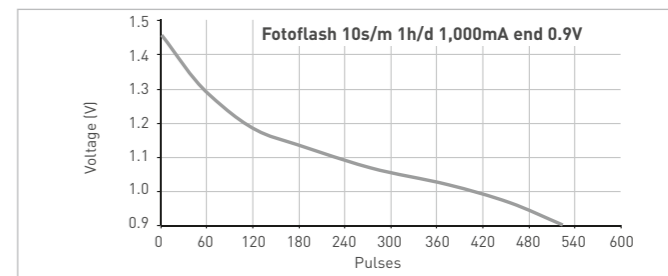
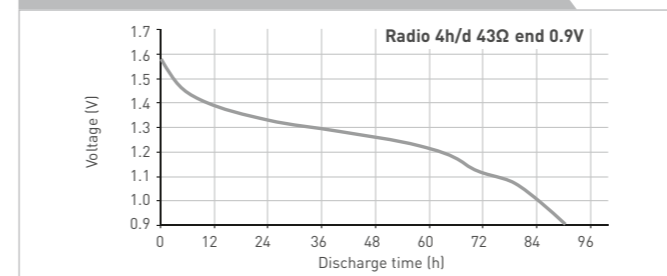
Dimensions	max. (mm)	min. (mm)
A	50.5	
B		49.2
C		7.0
E	0.5	
F	5.5	
G		1.0
Ø	14.5	13.5

SPECIFICATIONS

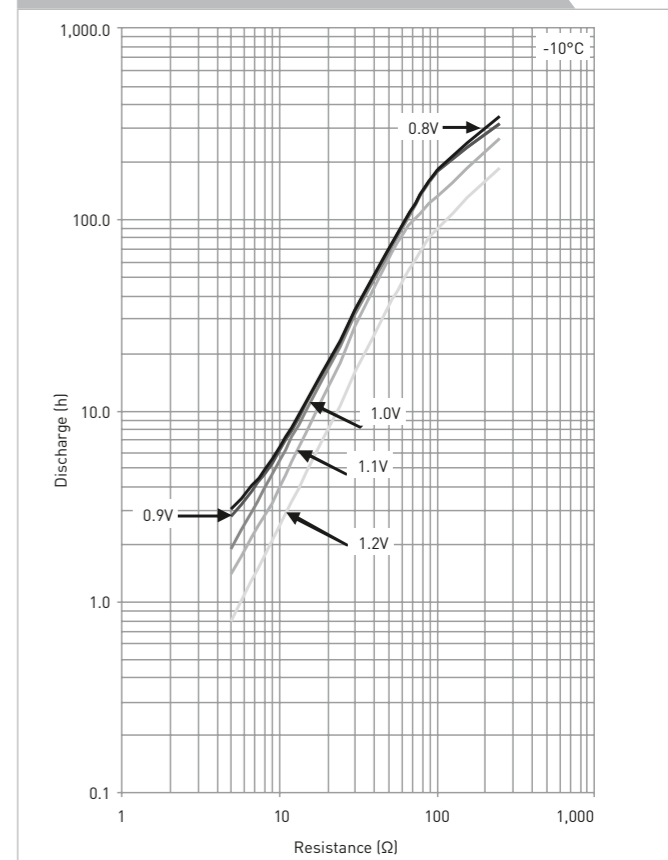
Name	LR6 / M / AA / AM3 / MIGNON / MN1500 / 15A / 15AC
Made in	Belgium
Type	Alkaline foil
Nominal voltage	1.5V
Electrolyte	Potassium Hydroxide
Average weight	23.3g
Storage temperature range	+10°C ~ +25°C
Operating temperature range	-20°C ~ +45°C
Average impedance	approx. 105mΩ @ 1kHz AC
Heavy metals	No added mercury (Hg), Cadmium (Cd) or Lead (Pb)
Compliant with	IEC 60086 non dangerous goods regulation Nordic Ecolabel (White Swan) version 3.7 EC directive 91/157EC, 98/101EC, 2006/66/EC
Recommended cut-off voltage	0.8V per cell

LR6AD POWERLINE

TYPICAL DISCHARGE VALUES



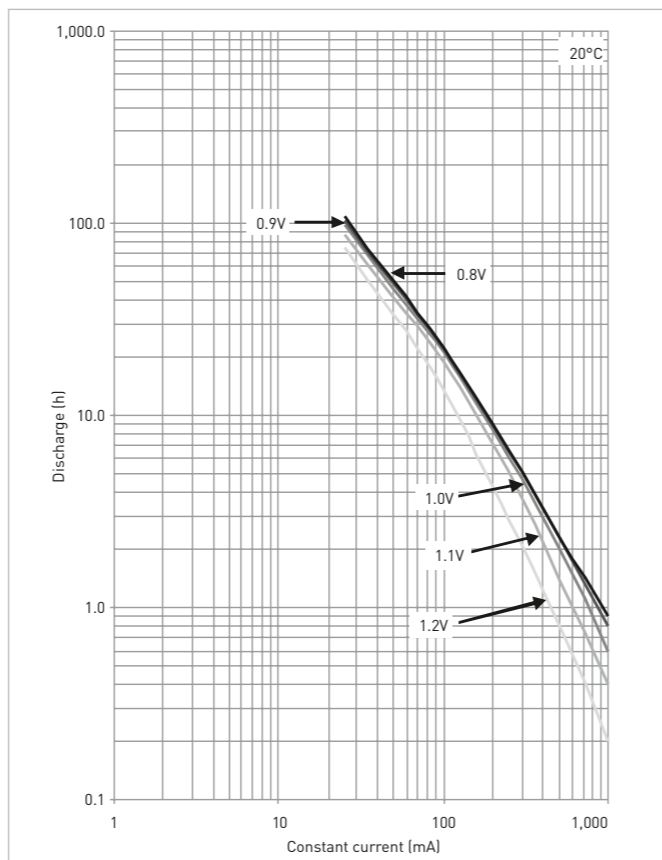
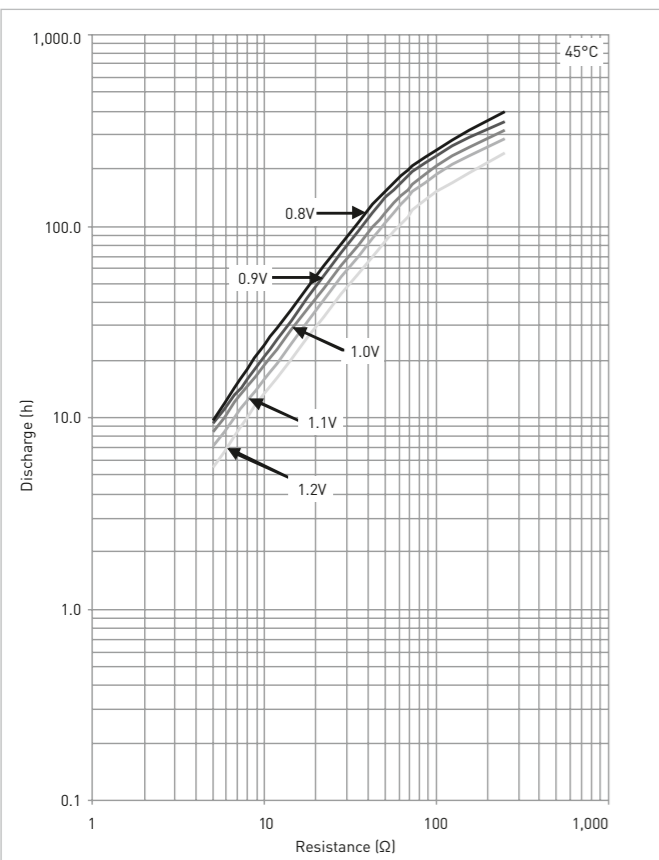
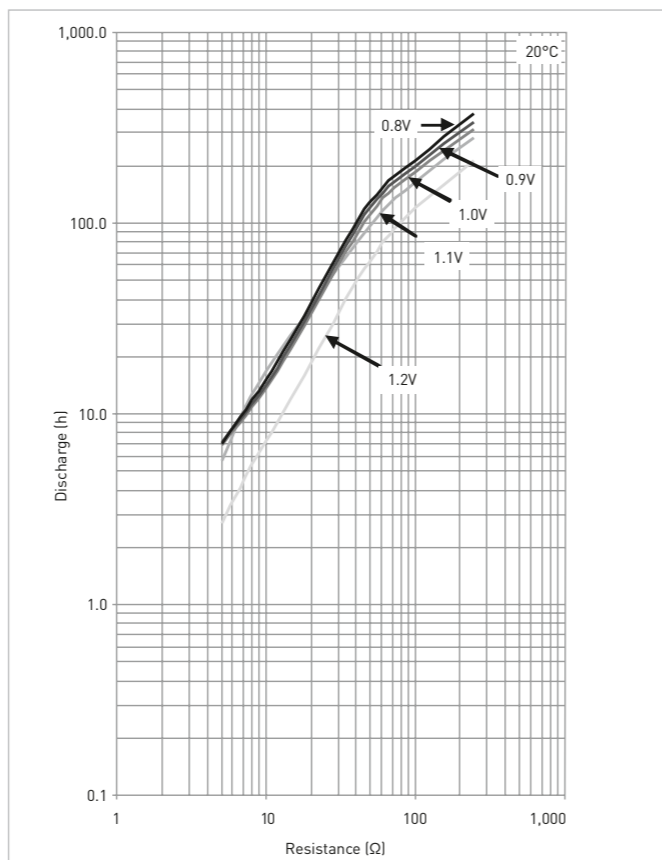
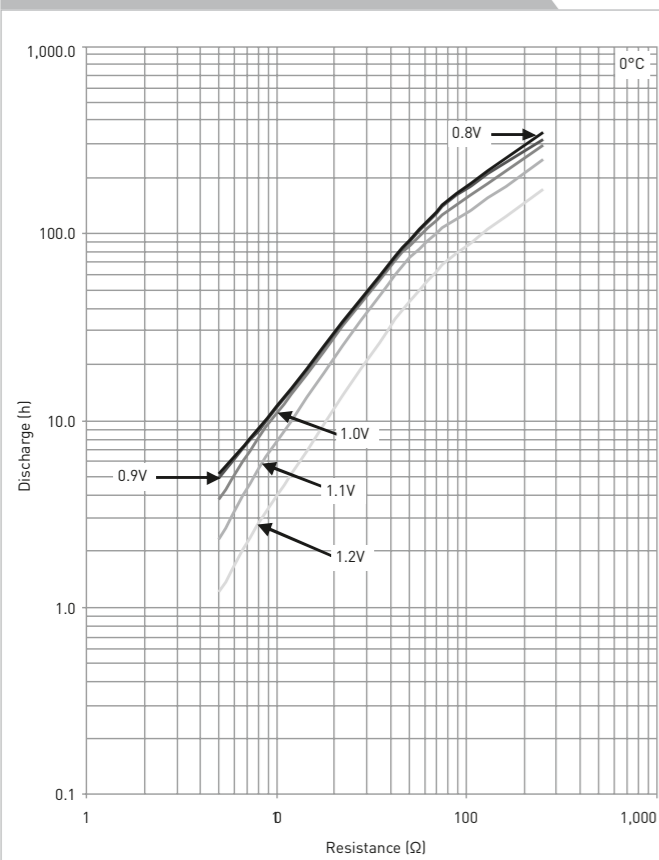
DISCHARGE TEMPERATURE CHARACTERISTICS



*1 Digital still camera *2 Light intention flashlight

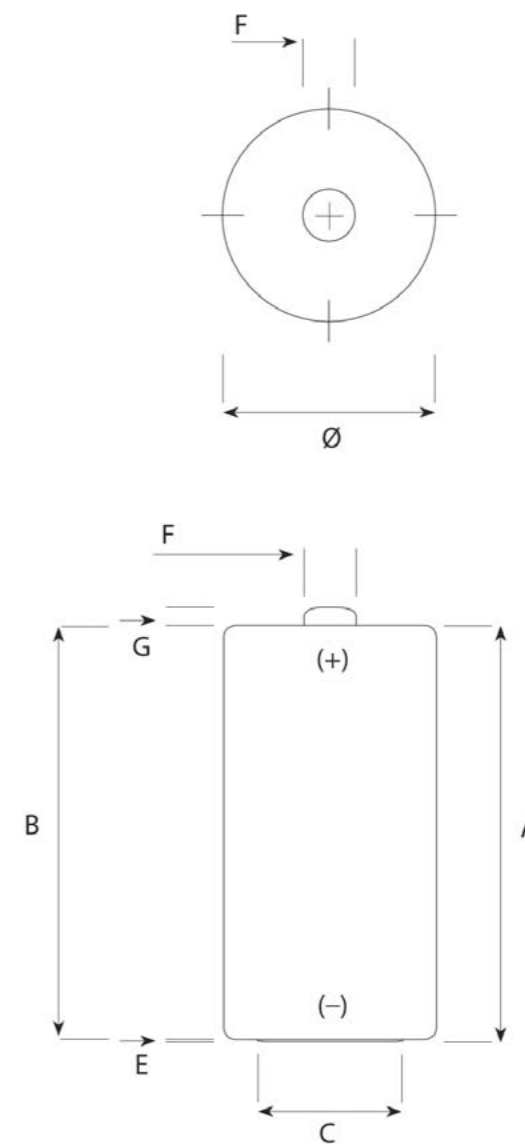
LR6AD POWERLINE

DISCHARGE TEMPERATURE CHARACTERISTICS



LR14AD POWERLINE

IEC DIMENSIONS (MM)



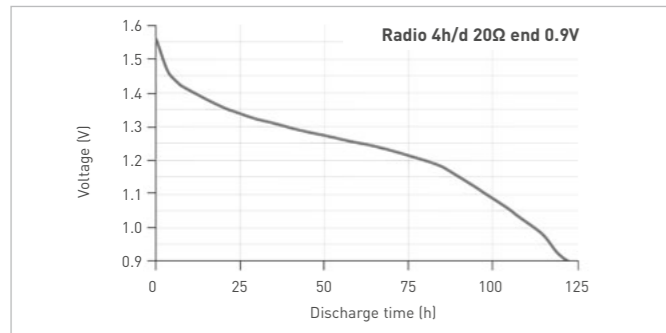
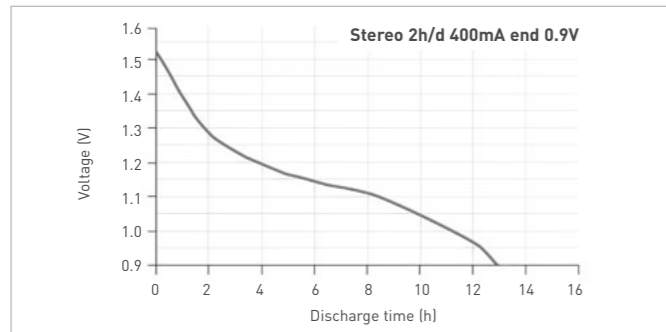
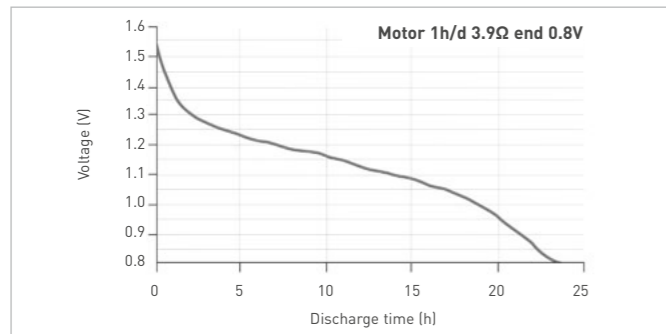
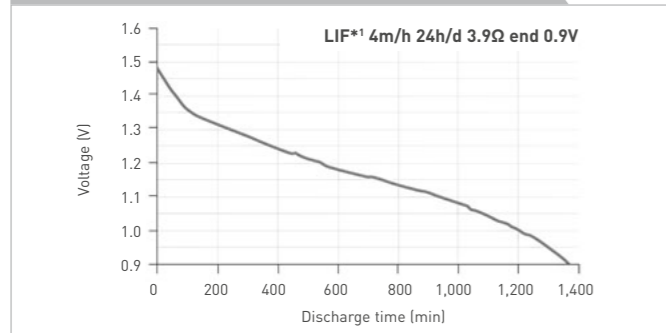
Dimensions	max. (mm)	min. (mm)
A	50.0	
B		48.6
C		13.0
E	0.9	
F	7.5	
G		1.5
Ø	26.2	24.9

SPECIFICATIONS

Name	LR14 / L / C / AM2 / BABY / MN1400 / 14A / 14AC
Made in	Belgium
Type	Alkaline foil
Nominal voltage	1.5V
Electrolyte	Potassium Hydroxide
Average weight	69.5g
Storage temperature range	+10°C ~ +25°C
Operating temperature range	-20°C ~ +45°C
Average impedance	approx. 100mΩ @ 1kHz AC
Heavy metals	No added mercury (Hg), Cadmium (Cd) or Lead (Pb)
Compliant with	IEC 60086 non dangerous goods regulation Nordic Ecolabel (White Swan) version 3.7 EC directive 91/157EC, 98/101EC, 2006/66/EC
Recommended cut-off voltage	0.8V per cell

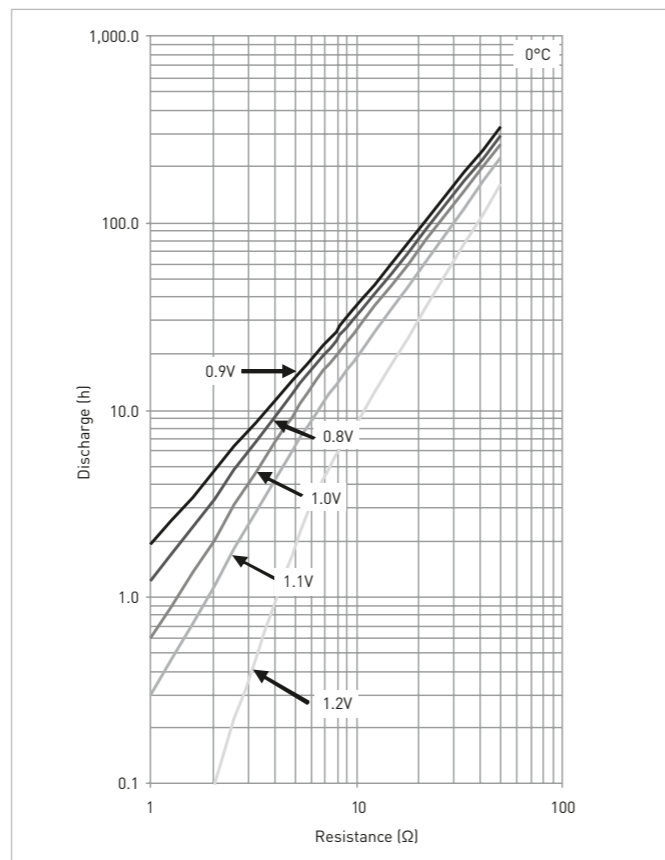
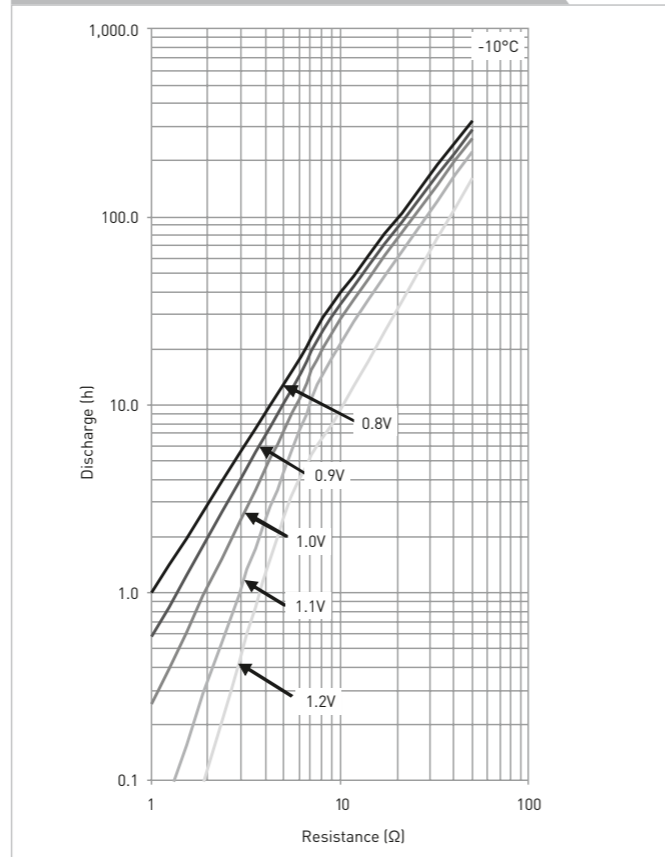
LR14AD POWERLINE

TYPICAL DISCHARGE VALUES



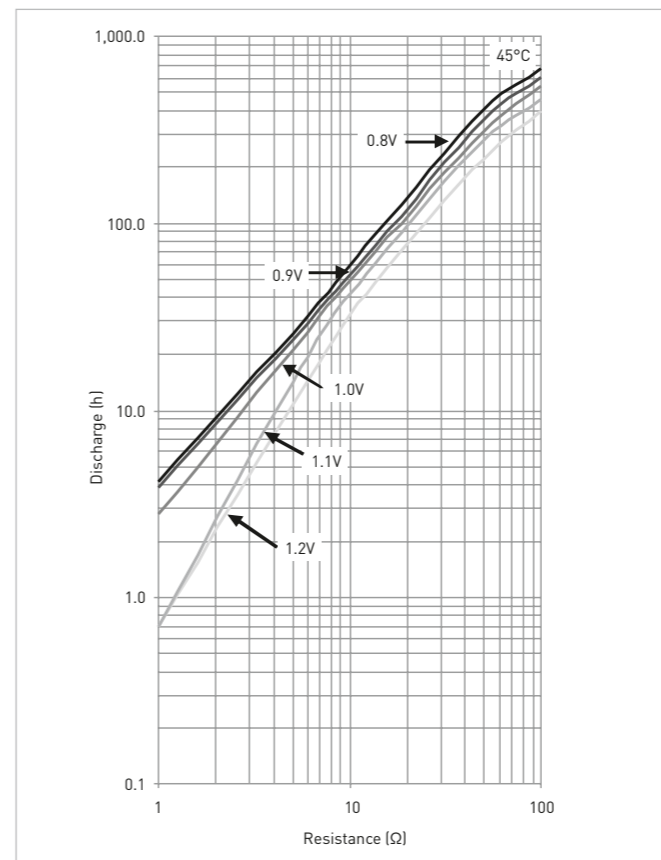
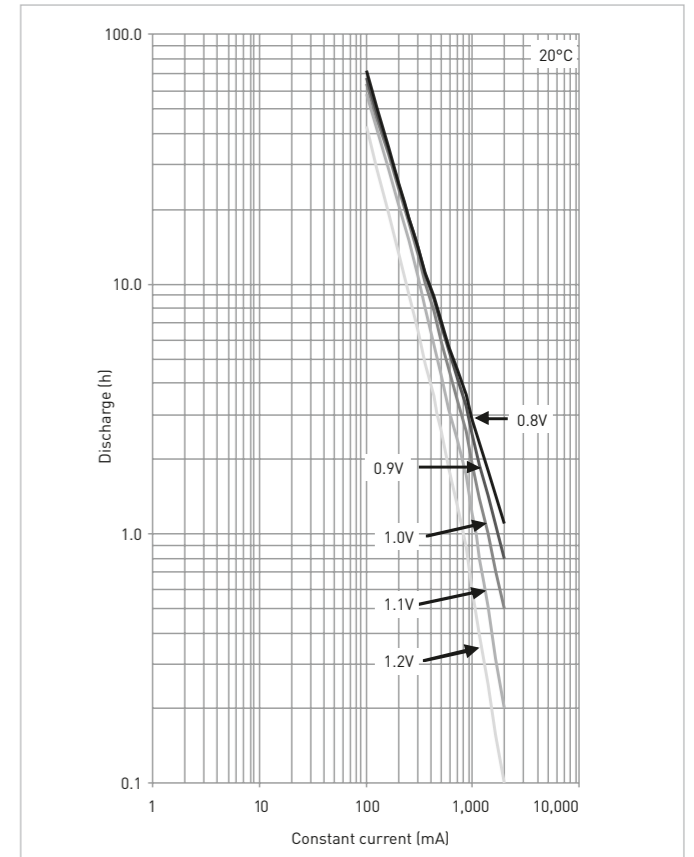
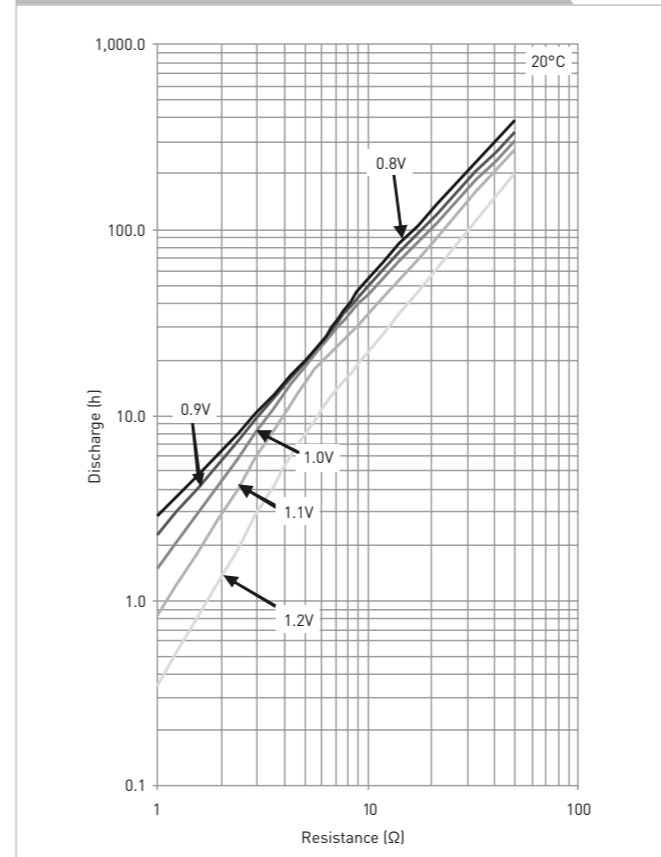
*1Light intention flashlight

DISCHARGE TEMPERATURE CHARACTERISTICS



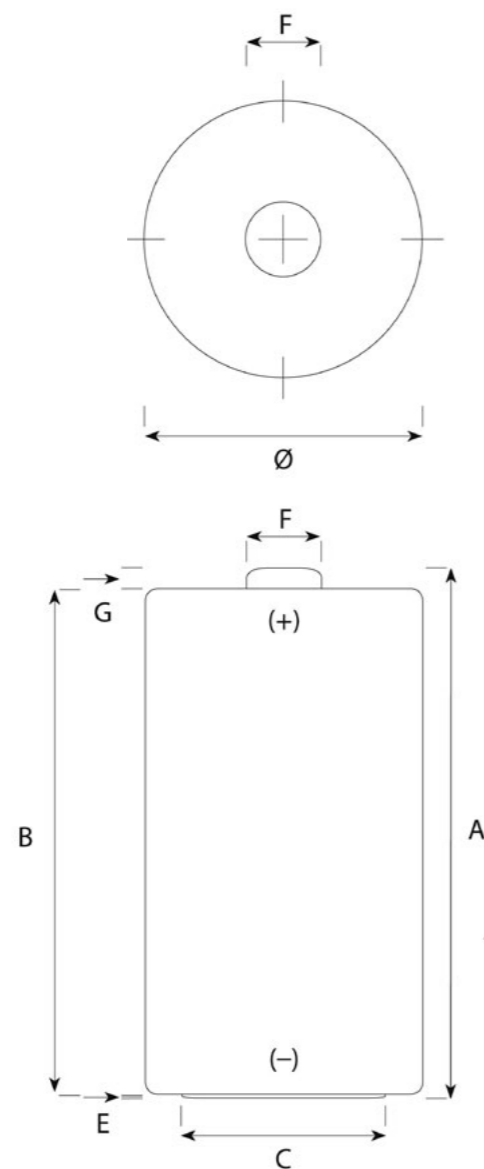
LR14AD POWERLINE

DISCHARGE TEMPERATURE CHARACTERISTICS



LR20AD POWERLINE

IEC DIMENSIONS (MM)



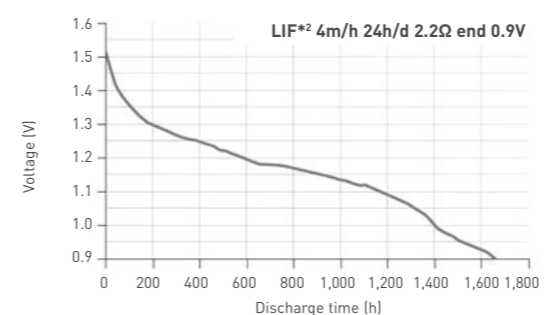
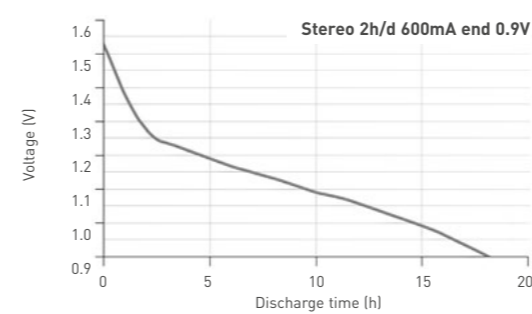
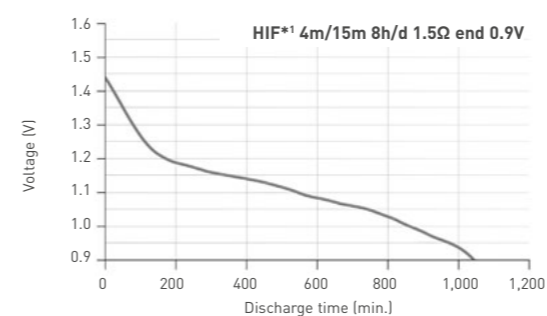
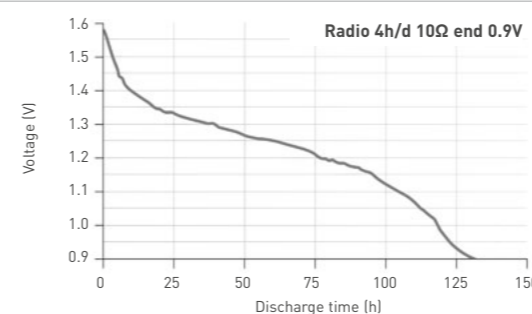
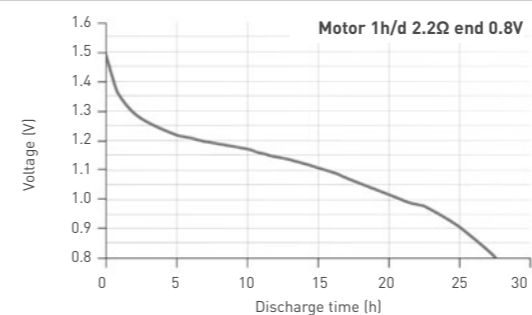
Dimensions	max. (mm)	min. (mm)
A	61.5	
B		59.5
C		18.0
E	1.0	
F	9.5	
G		1.5
Ø	34.2	32.3

SPECIFICATIONS

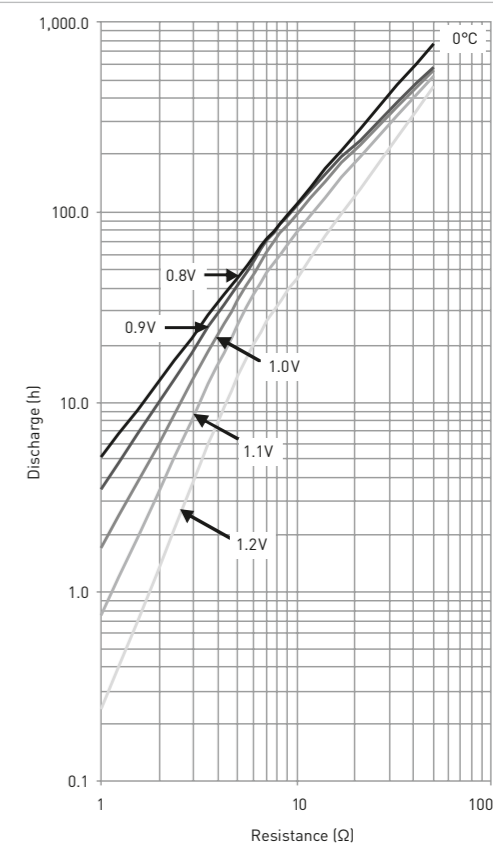
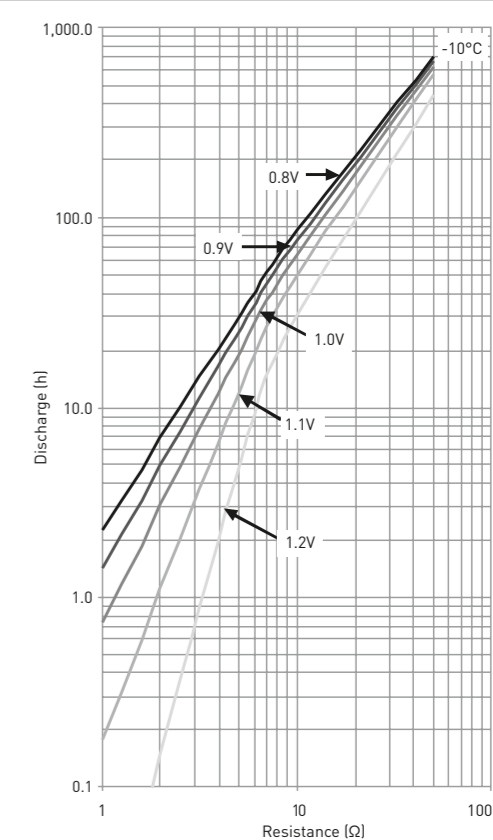
Name	LR20 / XL / D / AM1 / MONO / MN1300 / 13A / 13AC
Made in	Belgium
Type	Alkaline foil
Nominal voltage	1.5V
Electrolyte	Potassium Hydroxide
Average weight	142.7g
Storage temperature range	+10°C ~ +25°C
Operating temperature range	-20°C ~ +45°C
Average impedance	approx. 90mΩ @ 1kHz AC
Heavy metals	No added mercury (Hg), Cadmium (Cd) or Lead (Pb)
Compliant with	IEC 60086 non dangerous goods regulation Nordic Ecolabel (White Swan) version 3.7 EC directive 91/157EC, 98/101EC, 2006/66/EC
Recommended cut-off voltage	0.8V per cell

LR20AD POWERLINE

TYPICAL DISCHARGE VALUES



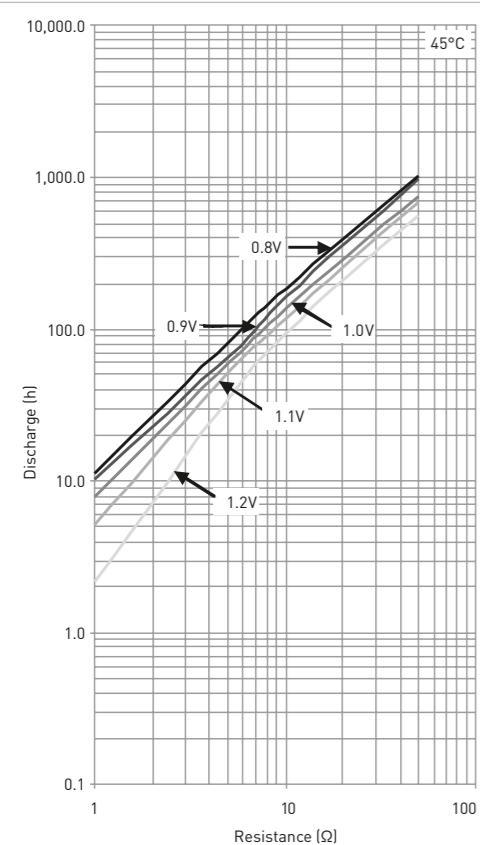
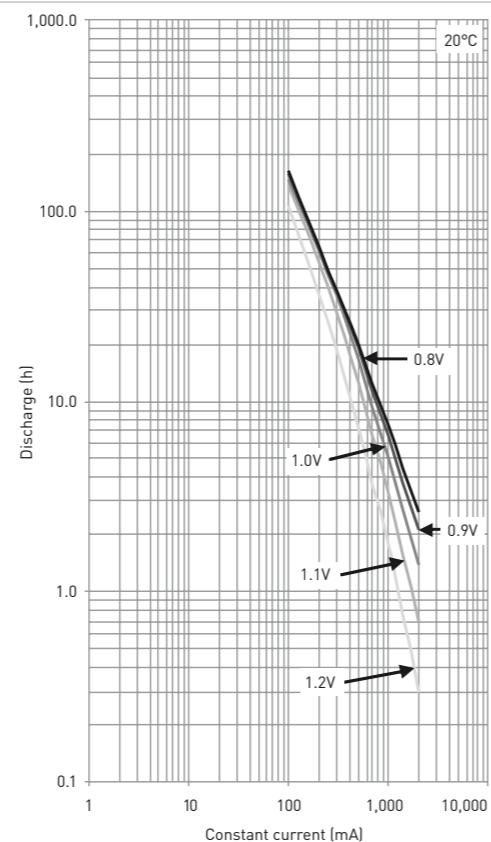
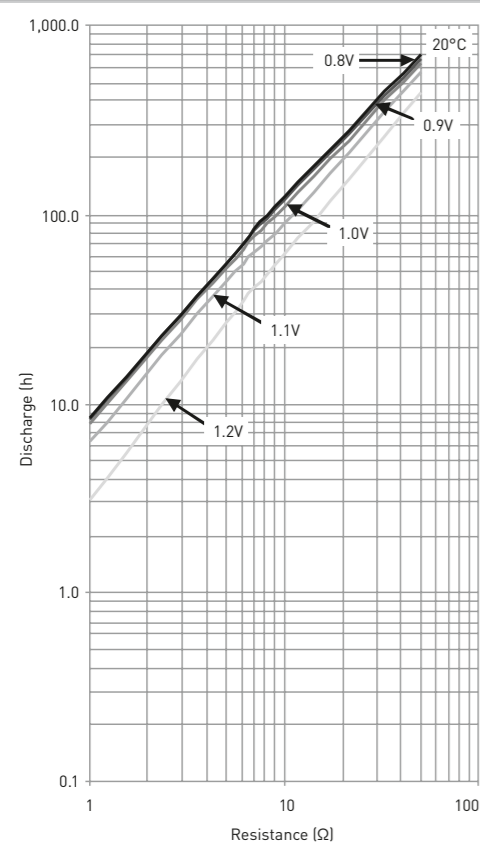
DISCHARGE TEMPERATURE CHARACTERISTICS



*1 High intention flashlight *2 Light intention flashlight

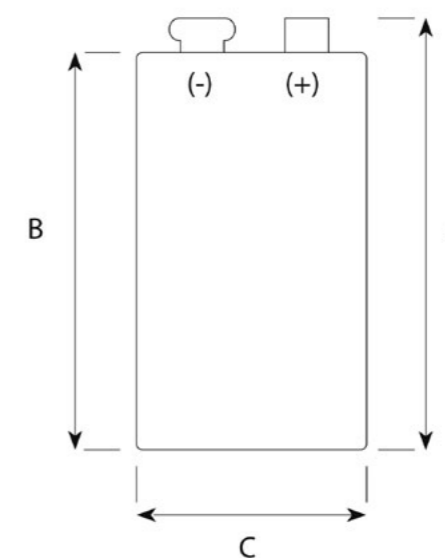
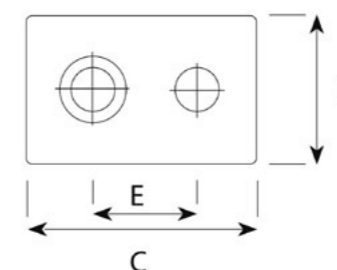
LR20AD POWERLINE

DISCHARGE TEMPERATURE CHARACTERISTICS



6LR61AD POWERLINE

IEC DIMENSIONS (MM)



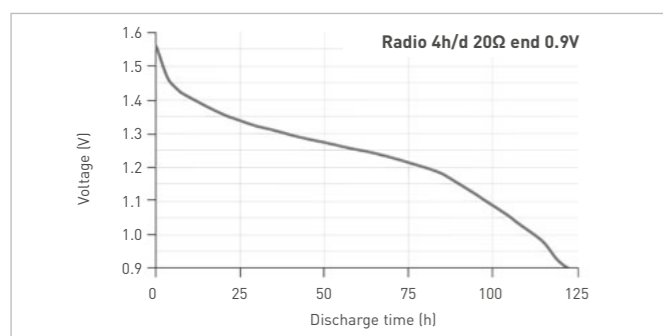
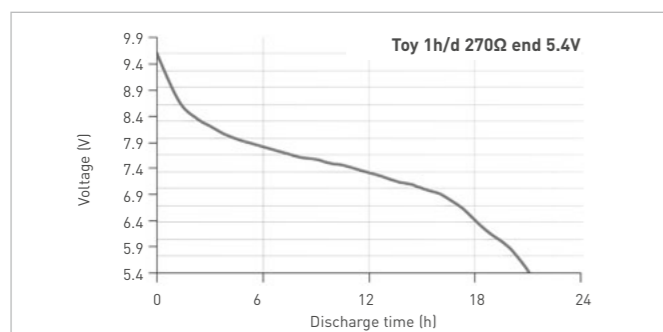
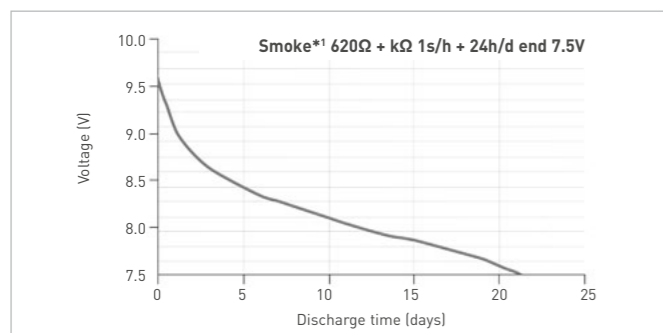
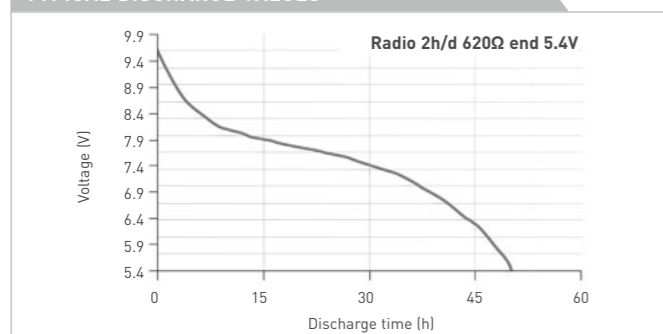
Dimensions	max. [mm]	min. [mm]
A	48.5	46.5
B	46.4	
C	26.5	24.5
D	17.5	15.5
E	12.95	12.45

SPECIFICATIONS

Name	9V / 6LR61 / 6AM6 / MN1604 / 1604A / 1604AC
Made in	Belgium
Type	Alkaline foil
Nominal voltage	9V
Electrolyte	Potassium Hydroxide
Average weight	44.3g
Storage temperature range	+10°C ~ +25°C
Operating temperature range	-20°C ~ +45°C
Average impedance	approx. 2.3Ω @ 1kHz AC
Heavy metals	No added mercury (Hg), Cadmium (Cd) or Lead (Pb)
Compliant with	IEC 60086 non dangerous goods regulation Nordic Ecolabel (White Swan) version 3.7 EC directive 91/157/EC, 98/101/EC, 2006/66/EC
Recommended cut-off voltage	4.8V per battery

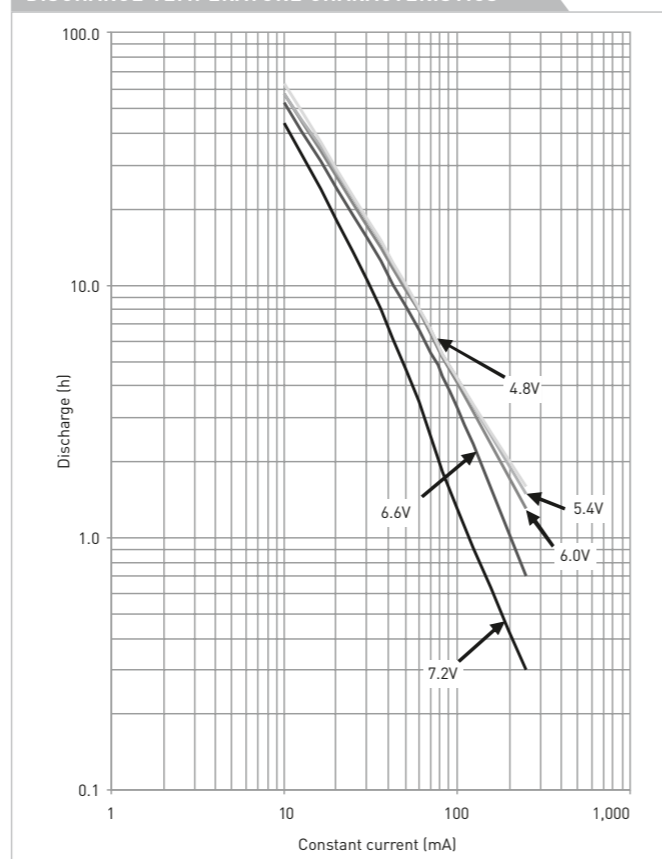
6LR61AD POWERLINE

TYPICAL DISCHARGE VALUES



*1 Smoke detector.

DISCHARGE TEMPERATURE CHARACTERISTICS



IEC

The IEC (International Electrotechnical Commission) is a world-wide standards organisation that prepares and publishes international standards for electrical and electronic technology, including batteries. These standards are technical guidelines that allow appliances and systems which store, use or produce electricity to work together safely, wherever in the world they are manufactured. With IEC standards being so widespread, battery space and contacts in appliances should be designed to enable the use of any IEC-compliant battery.

As a non-profit, non-governmental organisation, the IEC is made up of members (or national committees) from a wide range of countries, and IEC standards are adopted as national standards by its members.

The IEC cooperates closely with other standards organisations such as ISO and IEEE. It provides standards for battery denominations, size and voltage, testing methods, packaging, storage and appliance connections.

The sections below look at some of these areas.

BATTERY DENOMINATION STANDARDS

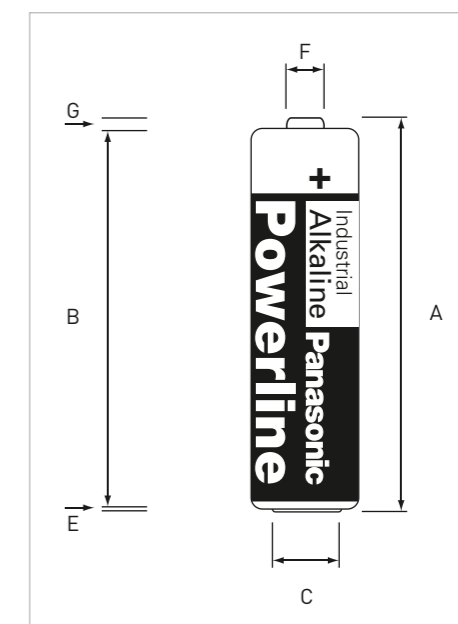
The denomination of the battery and the corresponding maximum sizes used to be decided by a number of different organisations such as ANSI (American National Standards Institute) or the JIS (Japan Industrial Standard). This work has now been concentrated in the IEC (International Electrotechnical Commission).

IEC	LR20	LR14	LR6	LR03	6LR61
ANSI	D	C	AA	AAA	9V
JIS	AM-1	AM-2	AM-3	AM-4	6AM-6

Manufacturers should ensure battery dimensions stay within the limits of the specified IEC standards for size. In some cases, however, these limits are rather wide, which can lead to non-conformity between certain devices and certain battery brands.

SIZE AND VOLTAGE STANDARDS

The voltage of a single Alkaline battery is regulated by IEC to be between 1.58V and 1.65V (OCV). IEC defines standard settings and deviations for all batteries. This ensures all manufacturers following these guidelines have products which comply with specific standards. A maximum voltage per battery category is also specified.



R6 - 1.725V max.

LR6 - 1.65V max.

TESTING STANDARDS

There are standard IEC tests and procedures for all types of batteries, considered to be average examples of market usage. Parameters such as average use and cut-off voltage are also decided by this commission. It usually takes months, even years, for IEC to adopt new tests, or change existing tests if this is shown to be necessary to reflect reality. Tests and test methods are periodically discussed with the manufacturers represented on the IEC committee in order to review the criteria based on new appliances or new technologies. Tests should be conducted on batteries which are not older than 60 days after production. Temperature should be controlled during storage as well as during discharge to +/- 2°C.

Testing standards by battery

LR20: Radio – Stereo – Motor – HIF

LR14: Radio – Stereo – Motor – LIF

LR6: Radio – Remote Control – Motor – Fotoflash – CD/MD – DSC – LIF – Tape

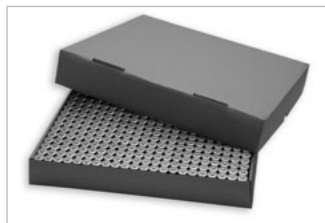
LR03: Radio – Remote Control – Fotoflash – LIF – Tape – Toy

6LR61: Radio – Toy – Smoke

PACKAGING STANDARDS

Packaging prevents mechanical damage to the products during transport, handling and stacking. Materials and pack designs are chosen to prevent electrical conduction, corrosion and ingress of moisture. During transport, shock and vibration should be kept to a minimum (gel overspill should be avoided).

Bulk (pizza-box)



Small box



STORAGE STANDARDS

The ambient conditions – particularly the temperature – have a major impact on storage quality. Batteries should normally be stored at temperatures between +10°C and +25°C, and the temperature should never exceed +30°C. Storage will improve if the temperature can be held at a consistently lower level (-10°C to +10°C), but at freezing conditions the batteries should have protective packaging to protect them from condensation when they are brought back to normal temperature. Batteries which have been cold-stored should be put into use as soon as possible after being brought back to ambient temperature (preferably during 24-hour conditioning).

Extreme humidity (over 95% and less than 40%) should be avoided, since this is detrimental to both the batteries and the packaging. Care should also be taken with point-of-sale conditions in shops. Batteries should not be exposed to direct sunlight or spotlight, and should be kept away from heat sources.

USAGE STANDARDS

When an appliance device needs new batteries, all the batteries in the appliance should be replaced at the same time, with fresh batteries of the same size. Care should be taken not to combine batteries of different brands, grades and technology.

Appliances should always be switched off after use (users should check that the power switch is in the “off” position). Batteries should be removed if the appliance is going to be out of use for longer periods (e.g. 14 days for the Nikon flashlight).

SAFETY

IEC 60086-part 5 is dedicated to safety, notably with regard to explosion risk. A range of tests are performed to verify safety:

- Storage after partial use
- Transportation shock
- Transportation vibration
- Climatic temperature cycling
- Incorrect installation
- External short circuit
- Overdischarge
- Free fall test

The outcome of all the tests should be: NO EXPLOSION. In other words, if there is a technical problem, the “safety unit” should work correctly, preventing the excessive gassing or swelling which would lead to explosion. Inevitably this can result in some degree of leakage.

CAPACITY OF ALKALINE BATTERIES

Battery capacity is typically expressed in terms of milli Ampere hours (mAh). This is an indication of how long a battery will provide service at a specific drain rate to a specific cut-off voltage. To specify battery capacity precisely, one should give the exact parameters under which the batteries are to be tested: discharge mode, cut-off voltage, temperature, aging time, etc.

In general, batteries will discharge more efficiently at lower drain rates (i.e. radio test) and thus will exhibit a higher capacity with respect to high drain rates (i.e. DSC test). The type of application, more specific a continuous or a pulse discharge mode, will also impact battery capacity. A very light duty cycle will typically allow the battery time to recover and extend service versus a continuous drain. The major contributing factor to this recovery is the migration of active materials within the battery into the reaction area thereby replacing depleted materials and reaction byproducts. The amount of additional service will depend on the drain rate, and the duty cycle (ON time and OFF time of the pulse). Actual testing is needed to determine the amount of additional service expected in pulse applications since there is no simple equation to accurately calculate the impact of duty cycle on service.

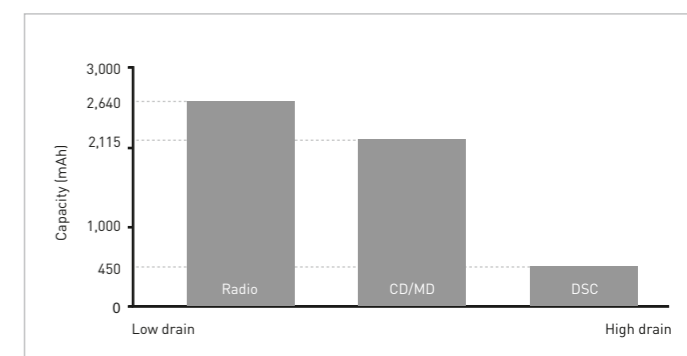
The application cut-off voltage will also impact the battery capacity. The higher the device cut-off voltage, the more of the battery’s capacity will be left in the battery unused. However, a minimum voltage cut-off of 0.8V per cell is recommended because of the increased chance of excessive internal gassing when Alkaline batteries are deeply discharged. Overdischarge will also incite the MnO₂ to get over-saturated, start expanding and increase the risk of high pressure inside the cells.

LR6 Powerline capacity high vs. low drain

IEC mode	Drain	Capacity (mAh)
Radio	low	2,640
CD/MD	middle	2,115 (-20%)
DSC	high	450 (-83%)

Why is it so difficult to give an Alkaline battery capacity?

Example LR6AD



1. IDENTIFICATION

Product name	Type	Manufacturer's name	Address
Powerline - Alkaline primary battery	LR20AD, LR14AD, LR6AD, LR03AD, 6LR61AD	Panasonic Energy Belgium N.V.	Havenlaan 6, B-3980 Tessenderlo, Belgium

2. INGREDIENTS

Ingredient name	Cas#	%
1. Manganese Dioxide	1313-13-9	25-45
2. Zinc	7440-66-6	10-20
3. Potassium Hydroxide	1310-58-3	3-9
4. Zinc oxide	1314-13-2	0-1
5. Graphite	7782-42-5	1-4
6. Steel	7439-89-6	10-30

3. HAZARD IDENTIFICATION

Critical hazards for human beings	If battery starts leaking, exposure to caustic ingredients is possible
Critical hazards to environment	Not applicable
Useful info	Keep away from children

4. FIRST AID MEASURES

Avoid skin and eye contact to avoid irritation and/or caustic burns/injury.

If leakage from battery contacts skin or eyes, flush immediately with copious quantity of water.

If problems arise, contact a physician for medical attention (especially in case of eyes!).

Ingestion is unlikely due to size of batteries, but in case this happens, a physician should be contacted at once to avoid damage to intestines caused by the unnatural object.

5. FIRE FIGHTING METHODS

Flash point (Method used)	Not applicable
Flammable limits	Lower Explosive Limit (LEL): not applicable - Upper Explosive Limit (UEL): not applicable
Extinguishing media	Dry powder, carbon dioxide, foam, dry sand
Special fire fighting procedures	Fire fighters should wear self-contained breathing apparatus.
Unusual fire and explosion hazards	Cells exposed to excessive heat, may cause electrolyte leakage or explosion

6. ACCIDENTAL RELEASE MEASURES

Personal: Safety officers should be notified in case of large spills. Caustic Potassium Hydroxide may exit from leaking batteries. Avoid contact to skin and/or eyes. Increase ventilation. Personnel cleaning up should wear appropriate protective clothing and gloves.

7. HANDLING AND STORAGE

Do not disassemble, try to charge or throw in fire.

Do not short circuit or install with reverse polarity.

Do not mix different battery systems, brands, or old and new batteries.

Do not remove battery label and do not carry batteries loose in pocket.

Store in dry places and at room temperature.

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

Respiratory protection (specific type)	Self-contained breathing apparatus as any fire situation
Ventilation → Local exhaust	Not applicable
Ventilation → Mechanical (general)	Not applicable
Ventilation → Specific	Not applicable
Ventilation → Others	Not applicable
Protective gloves	Not applicable
Eye protection	Not applicable
Other protective clothing or equipment	Not applicable

9. PHYSICAL AND CHEMICAL CHARACTERISTICS

Boiling point	Not applicable
Vapour pressure (mm Hg)	Not applicable
Vapour density	Not applicable
Specific gravity	Not applicable
Melting point	Not applicable
Evaporation rate (Butyl acetate =1)	Not applicable
Solubility in water	Not applicable
Appearance	Encased cylindrical or rectangular shape

10. STABILITY AND REACTIVITY

Stability	Stable
Incompatibility (materials to avoid)	Not applicable
Hazardous decomposition of BY-products	Oxides or fumes of Mn, Zn
Hazardous polymerization	Will not occur

11. TOXOLOGICAL INFORMATION

Not applicable to batteries as such: for detailed information on ingredients see no. 2.

12. ECOLOGICAL INFORMATION

Not available.

13. DISPOSAL CONSIDERATIONS

Batteries should be disposed of in accordance with local regulations. If you are uncertain how to proceed, contact your local Panasonic office to ask for information. Avoid heating/burning in order to avoid explosion at exposure to excessive temperatures.

14. TRANSPORT INFORMATION

These are "dry batteries" and are not considered to be a "hazardous material" as per U.S. DOT (Department Of Transportation Regulations) or a "dangerous goods" as per IATA (International Air Transport Association Regulations).

15. REGULATORY INFORMATION

EC labeling	None
Risk phrase	None
Safety phrase	None

16. OTHER INFO

The content of this PSDS is in accordance with 93/112/EEC directive and directive 91/155/EC.

Prepared by: Panasonic Energy Belgium NV, Havenlaan 6, 3980 Tessenderlo (+32-13-610511)

Fully aware that humankind has a special responsibility to respect and preserve the delicate balance of nature, we at Panasonic acknowledge our obligation to maintain and nurture the ecology of this planet. Accordingly, we pledge ourselves to the prudent, sustainable use of the Earth's resources and the protection of the natural environment while we strive to fulfil our corporate mission of contributing to enhanced prosperity for all. At Panasonic Energy Company (PEC) by regarding "working in harmony with the global environment" as a key management issue, each employee will be encouraged to voluntarily promote environmental preservation activities in all business areas.

Environmental Policy of Panasonic Energy Europe

The policy of our company is to contribute to society by serving our customers worldwide with our products and with our high-quality and highly reliable technology.

- Establish environmental management systems and pursue environmental preservation activities.
- Correctly understand the impact that company activities have on the environment and pursue unremitting environmental preservation activities which our technology and finances allow.
- Pursue external auditing of our operation based on an ISO 14000 environmental management system.
- Where applicable take action for resource and energy conservation, recycling and waste reduction.
- By offering environmental education and training to all employees, raise their awareness about environmental preservation.

ISO standards

PECBE produces LR20, LR14, LR6, LR03 and 6LR61 in Belgium and has following ISO certificates:

ISO 9001-2000 series

ISO 14001 series

IEC standards

Our batteries comply with following international standards:

IEC 60086-1

IEC 60086-2

IEC 60086-5

ANSI C18.1M

Panasonic offers you a wide range of standard packaging solutions for Alkaline batteries. We can also provide special packaging customised to your requirements. If you need tailor-made packaging, please get in touch with us.



BULK (PIZZA-BOX)

Model number	Size	Packaging	Packaging description	Units/box	Units/bundle	Units/pallet
LR20	D	LR20AD/B	bulk (pizza-box)	85	85	6,120
LR14	C	LR14AD/B	bulk (pizza-box)	80	80	11,520
LR6	AA	LR6AD/B	bulk (pizza-box)	500	500	36,000
LR03	AAA	LR03AD/B	bulk (pizza-box)	500	500	72,000
6LR61	9V	6LR61AD/B	bulk (pizza-box)	198	198	14,256



SMALL BOX

Model number	Size	Packaging	Packaging description	Units/box	Units/bundle	Units/pallet
LR20	D	LR20AD/4P	4-shrink	24	120	5,760
LR14	C	LR14AD/4P	4-shrink	24	120	10,560
LR6	AA	LR6AD/4P	4-shrink	48	240	34,560
LR03	AAA	LR03AD/4P	4-shrink	48	240	49,920
6LR61	9V	6LR61AD/1P	1-shrink	12	60	11,520



BIG BOX

Model number	Size	Packaging	Packaging description	Units/box	Units/bundle	Units/pallet
LR6	AA	LR6AD/2P	2-shrink (unsorted packed in carton box)	200	200	20,000
LR6	AA	LR6AD/3P	3-shrink (unsorted packed in carton box)	600	600	28,800
LR03	AAA	LR03AD/2P	2-shrink (unsorted packed in carton box)	500	500	50,000
LR03	AAA	LR03AD/3P	3-shrink (unsorted packed in carton box)	450	450	45,000

Customised packaging: if you need special types of packaging, please bear in mind that reasonable supply quantities are required, and it will also take a certain time to evaluate the production procedure.

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E-mail and Website for all countries

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<http://industrial.panasonic.com/eu>



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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