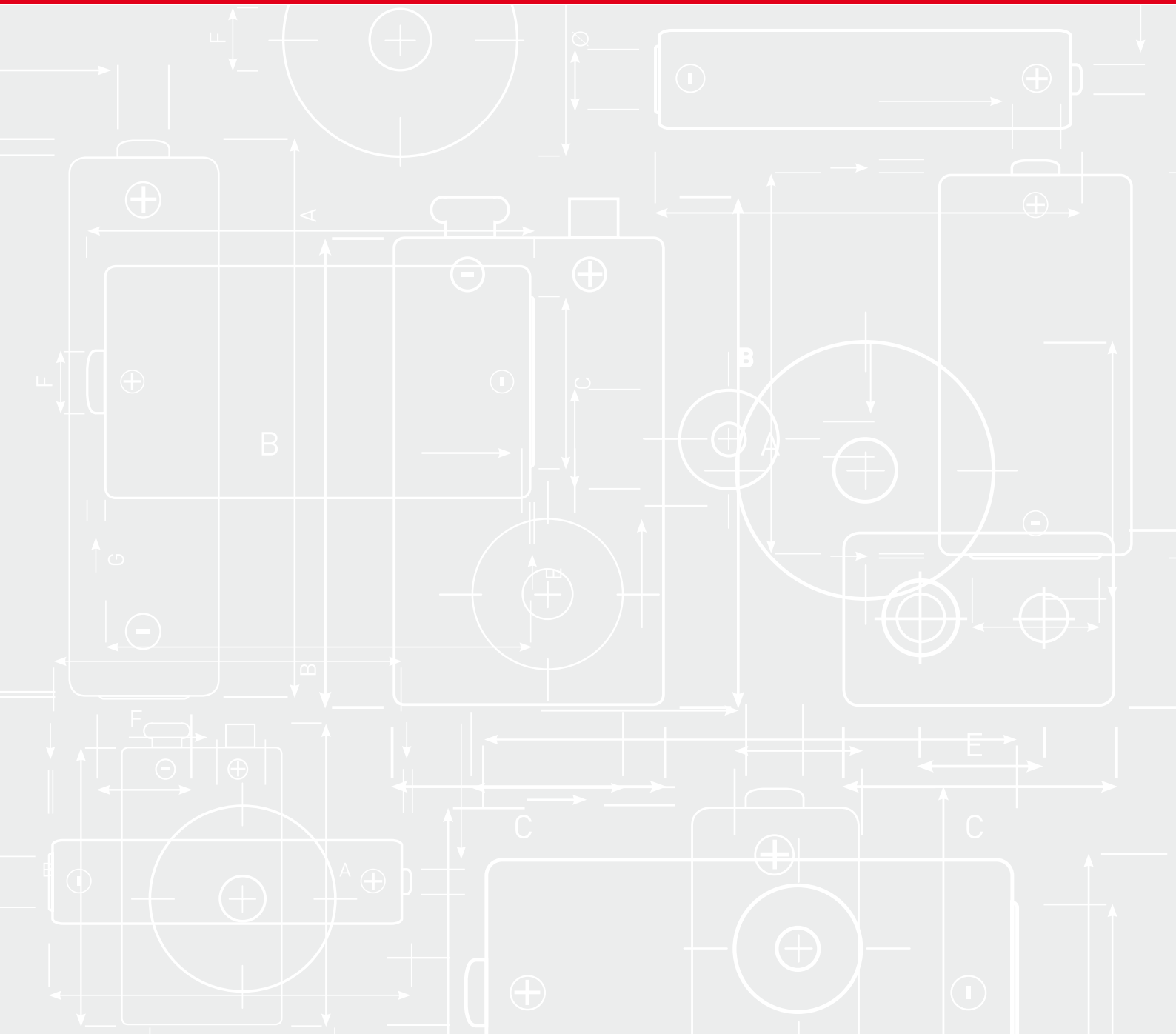


ALKALINE HANDBOOK

ENGLISH

INDUSTRIAL BATTERIES



SAFETY, LONG-LIFE AND POWER!

PANASONIC BATTERIES



PANASONIC INDUSTRIAL EUROPE FIND OUT HOW WE CAN POWER YOUR BUSINESS!

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, AV/Communication, Appliance, 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-Hydrate, 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 (PEC) started its production of Panasonic batteries in 1931. Today PEC is the most diversified global battery manufacturer with a network of 20 manufacturing companies in 14 countries. More than 16,000 employees are dedicated to the research and development of new batteries for a new world.

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

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



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.

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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 CO₂ emissions from a household sector.

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

1. Virtually zero CO₂ emissions in an entire house envisaged in three to five years into the future
 2. Synergy of technology and nature
- Aforementioned concepts shows that Panasonic is not only aware of its environmental responsibility moreover this Panasonic takes action.

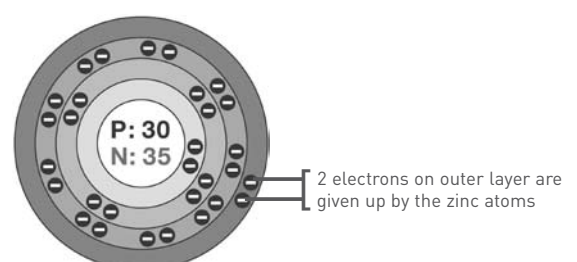
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1 INTRODUCTION

In this booklet we will describe the alkaline manganese batteries, which are basically made from the same basic materials as normal carbon-zinc 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 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 performance in terms of low temperature performance is much better too than 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).



ASSEMBLING LR6

Battery assembling

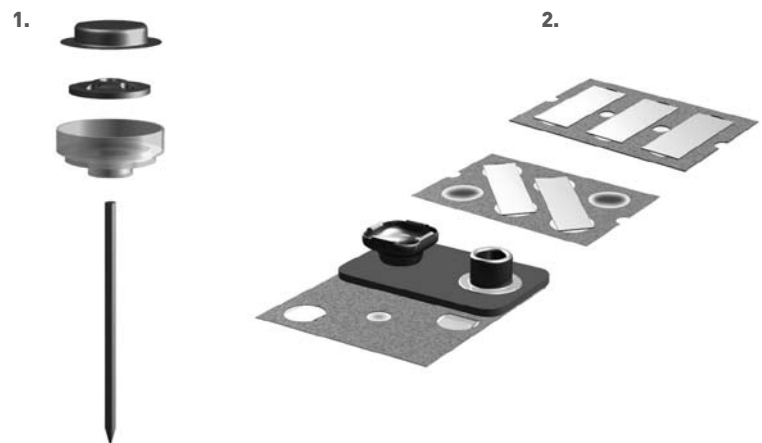
1. Separator and bottom insulator insert
2. Electrolyte pouring
3. Gelled-anode (negative pole) pouring
4. Collector insert and can curling



PARTS

Assembling battery components

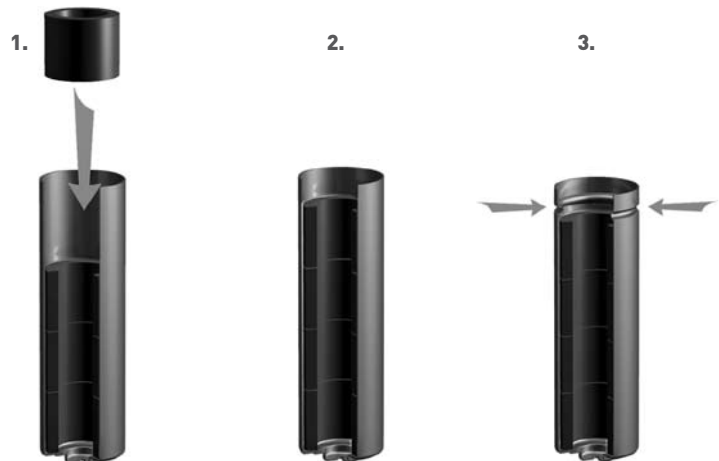
1. Collector unit
 - Bottomplate
 - Washer
 - PY seal
 - Nail
2. Contactstrips 6LR61
 - Lead A
 - Lead B
 - Snap 6LR61



CATHODE UNIT LR6

Mixtablets (+) pressing

1. Manganese dioxide-carbon tablet pressing (positive pole)
2. Tablet inserting and pressing
3. Can grooving



A. VOLTAGE AND CAPACITY

Voltage of alkaline batteries usually ranges between 1.55 and 1.65 Volt (open circuit voltage (OCV)), whereas 1.5 is considered to be the nominal voltage. The speed of voltage drop during use is determined by the type of appliance and the load (drain) which is put onto the battery.

Measuring the OCV of a battery is giving only a very rough and highly inefficient idea of battery capacity and/or freshness. The CCV (closed circuit voltage) where for a few seconds a load (depending on battery size) is put on the battery is giving a much better view on the status of the measured battery. **(If the voltage is still close to 1.5 the battery is still in relatively fresh condition, if the voltage is closer to 1.0 V, the battery is almost at the end of it's 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 will be translated as cut off voltage per cell.

(Example: a portable CD player which uses 2 cells and needs min. 2 volts to operate, so we will say the cut off voltage is 1.0 V per cell.)

The capacity of a battery is usually expressed in mAh (milli Ampere hour), whereas the actual drain in combination with the cut off voltage will determine the capacity in mAh for each individual use or appliance. It is not as simple as giving only 1 figure to know the actual capacity and/or behaviour of a battery for different ways of discharge. In order to have a clear view on battery capacity, one should give specific parameters at which the batteries can be tested or have a wider range of different discharge conditions to view the behaviour of battery performance.

Maximum battery capacity is limited by the weight and volume of the two main raw materials: zinc and manganese dioxide. Therefore an LR20 battery will last much longer than an LR6 battery just because there is much more active material inside.

Some batteries, like the 9 volt alkaline battery, are designed with 6 cylindrical batteries in series and are spotwelded together in order to assure a reliable performance during discharge.

Temperature is also important to determine the capacity and performance of a battery. Alkaline batteries are best suited to be used in temperature ranges from -10°C to $+45^{\circ}\text{C}$. In some cases the batteries can be reliable to deliver small currents at lower or higher temperatures as well, but this should be suspect to individual and careful testing. At higher temperatures the internal resistance of the battery will increase at a lesser speed, which will provide a better high drain performance.

B. DISCHARGE TYPES

As different ways of discharge we mainly consider:

Constant resistance (B)

The appliance keeps it's resistance constant in Ohm

Constant current (A)

The appliance keeps running on constant drain in A or mA

Constant Power (W)

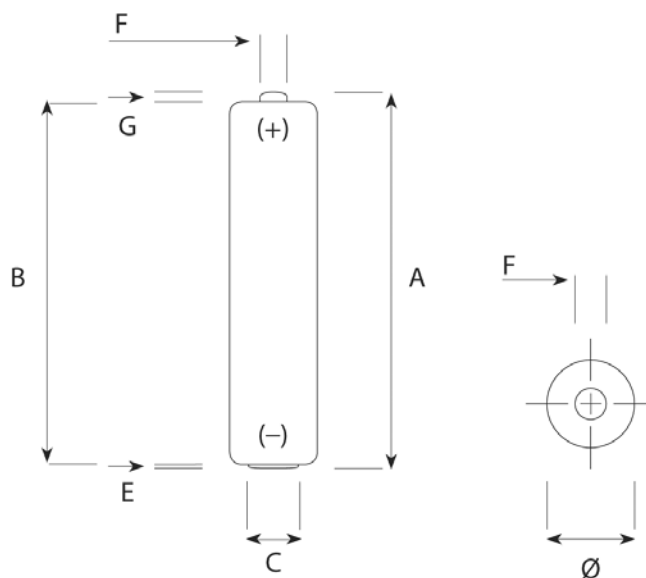
As the power should remain constant, the drain in Ampère will increase gradually during discharge as the voltage will decrease.

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

For this kind of discharge the increasing internal resistance towards the end of useful battery life will also largely determine the actual useful capacity of the batteries. Total capacity will of course also be strongly influenced by the cut off voltage.

The various discharge ways (continuous or intermittent) and loads (light or heavy) determine in a large way the actual performance one can draw out of a battery.

LR03AD POWERLINE



DIMENSIONS

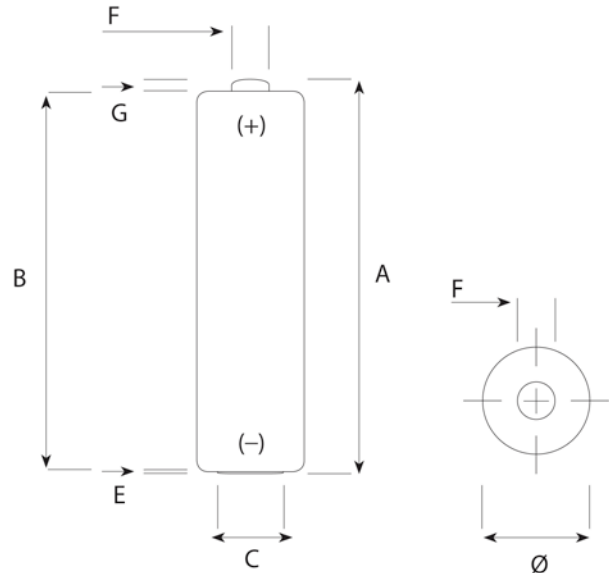
IEC Dimensions (mm)

Dimension	Max	Min
A	44.5	
B		43.3
C		4.3
E	0.5	
F	3.8	
G		0.8
Ø	10.5	9.5

SPECIFICATIONS

Name	LR03 / S / AAA / AM4 / MICRO / MN2400 / 24A / 24AC
Made in	Belgium
Type	Alkaline Foil
Nominal Voltage	1.5 Volt
Electrolyte	Potassium Hydroxide
Average weight	11.2 g
Storage temperature range	+10°C ~ + 25°C
Operating temperature range	-20°C ~ + 45°C
Average Impedance	+/- 135 m-Ohm @ 1kHz fresh
Heavy metals	No added mercury (Hg), Cadmium (Cd) or Lead (Pb)
Compliant to	IEC 60086 non dangerous goods regulation Nordic ecolabeling (white Swan) EC directive 91/157EC & 98/101EC
Recommended cut off voltage	0,8V per cell

LR6AD POWERLINE



DIMENSIONS

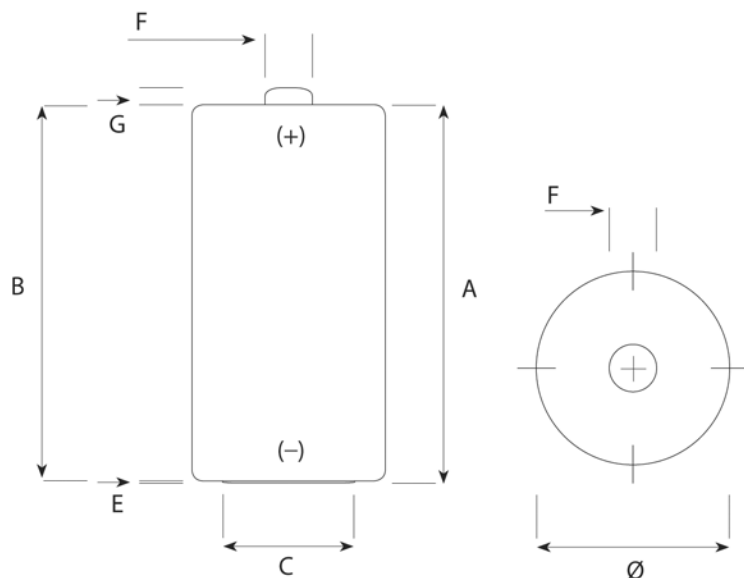
IEC Dimensions (mm)

Dimension	Max	Min
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	1.5 Volt
Electrolyte	Potassium Hydroxide
Average weight	23.3 g
Storage temperature range	+10°C ~ + 25°C
Operating temperature range	-20°C ~ + 45°C
Average Impedance	+/- 105 m-Ohm @ 1kHz fresh
Heavy metals	No added mercury (Hg), Cadmium (Cd) or Lead (Pb)
Compliant to	IEC 60086 non dangerous goods regulation Nordic ecolabeling (white Swan) EC directive 91/157EC & 98/101EC
Recommended cut off voltage	0,8V per cell

LR14AD POWERLINE



DIMENSIONS

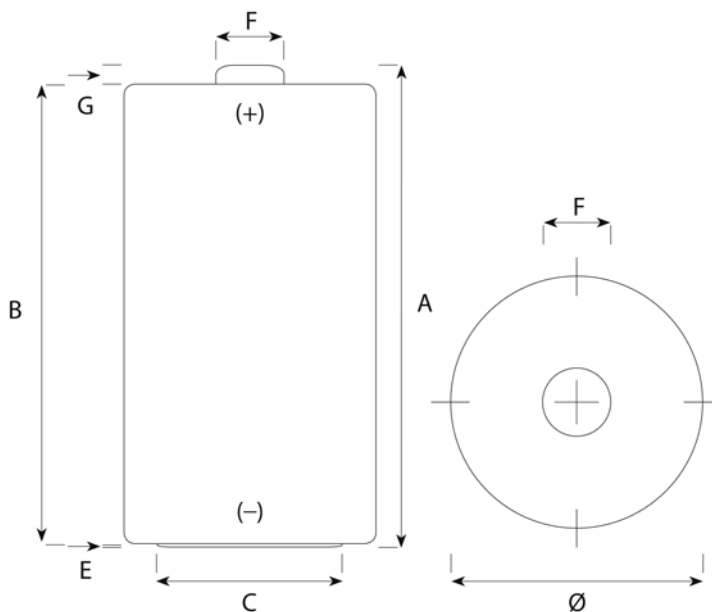
IEC Dimensions (mm)

Dimension	Max	Min
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	1.5 Volt
Electrolyte	Potassium Hydroxide
Average weight	69.5 g
Storage temperature range	+10°C ~ + 25°C
Operating temperature range	-20°C ~ + 45°C
Average Impedance	+/- 100 m-Ohm @ 1kHz fresh
Heavy metals	No added mercury (Hg), Cadmium (Cd) or Lead (Pb)
Compliant to	IEC 60086 non dangerous goods regulation Nordic ecolabeling (white Swan) EC directive 91/157EC & 98/101EC
Recommended cut off voltage	0,8V per cell

LR20AD POWERLINE



DIMENSIONS

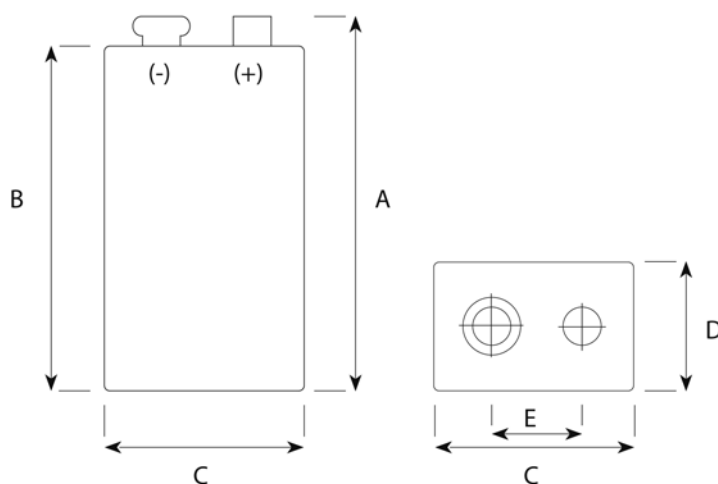
IEC Dimensions (mm)

Dimension	Max	Min
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	1.5 Volt
Electrolyte	Potassium Hydroxide
Average weight	142.7 g
Storage temperature range	+10°C ~ + 25°C
Operating temperature range	-20°C ~ + 45°C
Average Impedance	+/- 90 m-Ohm @ 1kHz fresh
Heavy metals	No added mercury (Hg), Cadmium (Cd) or Lead (Pb)
Compliant to	IEC 60086 non dangerous goods regulation Nordic ecolabeling (white Swan) EC directive 91/157EC & 98/101EC
Recommended cut off voltage	0,8V per cell

6LR61AD POWERLINE



DIMENSIONS

IEC Dimensions (mm)

Dimension	Max	Min
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	9 Volt
Electrolyte	Potassium Hydroxide
Average weight	44.3 g
Storage temperature range	+10°C ~ + 25°C
Operating temperature range	-20°C ~ + 45°C
Average Impedance	+/- 2.3 Ohm @ 1kHz fresh
Heavy metals	No added mercury (Hg), Cadmium (Cd) or Lead (Pb)
Compliant to	IEC 60086 non dangerous goods regulation Nordic ecolabeling (white Swan) EC directive 91/157EC & 98/101EC
Recommended cut off voltage	4,8V per battery

7 BATTERY STANDARDS

The denomination of the battery and the corresponding max. sizes used to be decided by different organisations like the ANSI (American National Standards Institute) or the JIS (Japan Industrial Standard) but are now concentrated in the IEC (International Electrotechnical Commission) standards.

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

With regard to the sizes, the manufacturers should make sure that the dimensions of the different batteries stay within the limits of the specified size indications of the IEC. In some cases these limits are rather wide, which can lead to non-conformity between certain devices

and certain battery brands. (depending if the manufacturer of the device used an actual battery – and which brand – or based himself on the IEC standards). Also the voltage of a single alkaline battery is regulated by IEC to be in between 1.58 and 1.65V (OCV).

It is recommended to provide battery space & contacts in a way that any IEC compliant battery can be used.

The IEC is also providing standard test criteria in order to have a global platform for all manufacturers to compare their products. The actual tests and test methods are periodically discussed with all manufacturers represented on the IEC committee in order to review the criteria based on new appliances or new technologies.

8 ADVICE

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Storage conditions

Alkaline batteries are best stored between +10 °C and +20 °C in order to obtain maximum shelf life. Storage at lower temperatures will not harm the performance, but the battery should slowly be brought to ambient temperature for optimal performance. Storage at high temperatures (→ 25 °C) can lead to accelerated deterioration of the chemicals inside the battery and eventually to leakage.

Charging of alkaline batteries

Alkaline batteries are not designed to be recharged in any way. Any attempt to charge the alkaline batteries (on purpose or by accident) can deviate the normal chemical process, causing excessive gassing and even overheating and leakage. Wrong insertion & reversing polarities can also charge batteries, as well as mixing different brands, chemistries or using old and new batteries together!!

Battery usage and handling

Avoid having batteries inside certain appliances over long periods (several months) without using or checking the

appliances regularly. Many appliances, even when turned off, still discharge the batteries with a small leak current and this might lead to an overdischarge situation.

Overdischarge (← 0.6 Volt / cell) can lead to gas generation and increase the volume of the manganese dioxide mass. These 2 effects combined can lead to internal pressure and result in vented batteries and leakage.

To avoid overdischarge:

- As an appliance manufacturer, make sure your technical design does not allow overdischarge of the batteries.
- As a user of electrical appliances, remove the batteries if you do not intend to use the appliances for long periods unless you check them regularly.

When changing the batteries, always change all of them at the same time. Do not mix brands or chemistries and be careful to respect polarities when inserting the new batteries!!

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
Vapor pressure (mm Hg)	Not applicable
Vapor 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 info on ingredients check nr. 2

12. ECOLOGICAL INFO

Not available

13. DISPOSAL CONSIDERATIONS

Batteries should be disposed of in accordance to local regulations. In case of doubt, contact your local Panasonic office to ask information. Avoid heating/burning in order to avoid explosion at exposure to excessive temperatures.

14. TRANSPORT INFO

These are "Batteries dry" and are not considered to be a „hazardous material“ per U.S. DOT (department of transportation regulations) or a "dangerous goods" per IATA (International Air Transport Association Regulations).

15. REGULATORY INFO

EC labeling	none
Risk Phrase	none
Safety Phrase	none

12 ALKALINE PACKAGING

Panasonic offers you a diversified range of standard packaging solutions for Alkaline batteries. Besides we are also able to offer tailor-made packaging. Please don't hesitate to contact us for your specific packaging requests.



Bulk (pizza-box)

Model Number	Size	Packaging	Packaging Description	psc/box	pcs/bundle	psc/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

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Small Box

Model Number	Size	Packaging	Packaging Description	psc/box	pcs/bundle	psc/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	psc/box	pcs/bundle	psc/pallet
LR6	AA	LR6AD/2P	2-shrink <small>(unsorted packed in carton box)</small>	200	200	20,000
LR6	AA	LR6AD/3P	3-shrink <small>(unsorted packed in carton box)</small>	600	600	28,800
LR03	AAA	LR03AD/2P	2-shrink <small>(unsorted packed in carton box)</small>	500	500	50,000
LR03	AAA	LR03AD/3P	3-shrink <small>(unsorted packed in carton box)</small>	450	450	45,000

Tailor-made packaging: If you have any further packaging wish such as particular carton boxes etc. it needs a reasonable quantity of battery demand. And it will take a certain time to evaluate the production procedure.

LITERATURE AND GENERAL PRODUCT INFORMATION

United Kingdom/Ireland

Panasonic Industrial Europe GmbH
Willoughby Road
Bracknell Berkshire
RG12 8FP
England
Phone: +44 1344 - 853260
Fax: +44 1344 - 853313

Italy

Panasonic Italia S.p.A.
Via Lucini 19
20125 Milano
Italy
Phone: +39 02 - 6788 - 232
Fax: +39 02 - 6788 - 207

Spain/Portugal

Panasonic Industrial Europe GmbH
Sucursal en España
Parque Empresarial @ Sant Cugat,
Via Augusta 15-25
Edificio B2 Planta 4 Oficina 17
08174 Sant Cugat del Vales
Barcelona
Spain
Phone: +34 93 - 504 30 10
Fax: +34 93 - 675 58 92

France

Panasonic France S.A.S
1 - 3 Avenue François Mitterrand
93218 Saint-Denis La Plaine, Cedex
France
Phone: +33 1 - 55 93 67 18
Fax: +33 1 - 55 93 67 90

Germany

(all other european countries)

Panasonic Industrial Europe GmbH
Winsbergring 15
22525 Hamburg
Germany
Phone: +49 40 - 85386 - 157
Fax: +49 40 - 85386 - 238

E-mail and Website for all countries

battery-solutions@eu.panasonic.com
<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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