Button cell

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A **watch battery** or **button cell** is a small single cell battery shaped as a squat cylinder typically 5 to 25 mm in diameter and 1 to 6 mm high—like a button on a garment, hence the name. Button cells are used to power small portable electronics devices such as wrist watches, pocket calculators, artificial cardiac pacemakers, implantable cardiac defibrillators, and hearing aids. Lithium cells are generally similar but somewhat larger; they tend to be called either lithium cells or batteries or **coin cells** rather than button cells.

Button, coin, or watch cells

Devices using button cells are usually designed to use a cell giving a long service life, typically well over a year in continuous use in a wristwatch. Most button cells have low self-discharge and hold their charge for a long time if not used. Higher-power devices such as hearing aids, where high capacity is important and low self-discharge less so as the cell will usually be used up before it has time to discharge, may use zinc-air cells which have much higher capacity for a given size, but discharge over a few weeks even if not used.

Button cells are single cells, usually disposable primary cells. Common anode materials are zinc or lithium. Common cathode materials are manganese dioxide, silver oxide, carbon monofluoride, cupric oxide or oxygen from the air. Mercuric oxide button cells were formerly common, but are no longer available due to the toxicity and environmental hazard of mercury.

A metal can forms the bottom body and positive terminal of the cell. The insulated top cap is the negative terminal.

Cells of different chemical composition made in the same size are mechanically interchangeable. However, the composition can affect service life and voltage stability. Using the wrong cell may lead to short life or improper operation (for example, light metering on a camera requires a stable voltage, and silver cells are usually specified). Sometimes different cells of the same type and size and specified capacity in mAh are optimised for different loads by using different electrolytes, so that one may have longer service life, than the other if supplying a relatively high current.

Contents

Properties of different types

Silver cells may have very stable output voltage until it suddenly drops very rapidly at end of life. This varies for individual types; one manufacturer (Energizer) offers 3 silver oxide cells of the same size, 357-303, 357-303H,and EPX76, with capacities ranging from 150 to 200 mAh, voltage characteristics ranging from gradually reducing to fairly constant, and some stated to be for continuous low drain with high pulse on demand, others for photo use.

Mercury batteries also supply a stable voltage, but are now banned in many countries due to their toxicity and environmental impact.

Alkaline batteries are made in the same button sizes as other types, but typically provide less capacity and less stable voltage (it drops gradually in use) than more costly silver oxide or lithium cells. They are often sold as cheap watch batteries too, and sometimes by people who do not know the difference.[1]

Zinc-air batteries use air as the depolarizer and have much higher capacity than other types (they use air from the atmosphere which does not need to be supplied in the battery). A seal is removed before use to allow air to enter the cell; the cell will then self-discharge in a few weeks even if not used up.

For comparison, a cell of diameter 11.6 mm and height 5.4 mm from one reputable manufacturer has the following properties.[2] In many cases there are several batteries of the same chemistry and size with different capacities and properties; figures listed are merely indicative.

- Silver: capacity 200 mAh to an end-point of 0.9 V, internal resistance 5–15 ohms, weight 2.3 g
- Alkaline (manganese dioxide): 150 mAh (0.9), 3-9 ohms, 2.4 g
- Mercury 200 mAh, 2.6 g
- Zinc-air 620 mAh, 1.9 g

Examining datasheets for a manufacturer's range[2] may find a high-capacity alkaline cell with a capacity as high as one of the lower-capacity silver types; or a particular silver cell with twice the capacity of some particular alkaline cell. If the powered equipment requiring a relatively high voltage (e.g., 1.3 V) to operate correctly, a silver cell with a flat discharge characteristic will give *much* longer service than an alkaline cell—even if it has the same specified capacity in mAh to an end-point of 0.9 V. If some device seems to "eat up" batteries after the original supplied by the manufacturer is replaced, it may be useful to check the device's requirements and the replacement battery's characteristics. For digital calipers, in particular, some are specified to require at least 1.25 V to operate, others 1.38 V.[3][4]

Datasheets for some cheaper cells, particularly alkaline, are not available, so it is not possible to say whether capacities are about the same as for documented types.[5] Discussions on web forums suggest that they can be very poor.[6]

In some ways the size is the most important property of a button cell: cells of different chemistry are to a considerable extent interchangeable. In practice only cells of fairly similar voltages are made in any given size; there is no "CR1154" 3 V lithium battery mechanically interchangeable with a 1.5 V silver or alkaline size 1154 cell. Use of a battery of significantly higher voltage than equipment is designed for can cause permanent damage, but use of a cell of the right voltage but unsuitable characteristics can only lead to short battery life or failure to operate equipment.

Type designation

See also: Battery nomenclature

International standard IEC 60086-3 defines an alphanumeric coding system for "Watch batteries". Manufacturers often have their own naming system; for example, the cell called LR1154 by IEC standard is named AG13, LR44, 357, A76, and other names by different manufacturers. The IEC standard and some others encode the case size so that the numeric part of the code is uniquely determined by the case size; other codes do not encode size directly.

LR44 alkaline cell.

Examples of batteries conforming to the IEC standard are CR2032, SR516, and LR1154, where the letters and numbers indicate the following characteristics.

Electrochemical system

The first letter identifies the chemical composition of the battery, which also implies a nominal voltage:

Letter code	Common name	Positive electrode	Electrolyte	Negative electrode	Nominal voltage	End-point voltage
L	Alkaline	Manganese dioxide	Alkali	Zinc	1.5	1.0
S	Silver	Silver oxide	Alkali	Zinc	1.55	1.2
P	Zinc-air	Oxygen	Alkali	Zinc	1.4	1.2
C	Lithium	Manganese dioxide	Organic	Lithium	3	2.0
B		Carbon monofluoride	Organic	Lithium	3	2.0
G		Copper oxide	Organic	Lithium	1.5	1.2
M,N(withdrawn)	Mercury	Mercuric oxide	Alkaline	Zinc	1.35/1.40	1.1

For types with stable voltage falling precipitously at end-of-life (cliff-top voltage-versus-time graph), the end-voltage is the value at the "cliff-edge", after which it drops extremely rapidly. For types which lose voltage gradually (slope graph, no cliff-edge) the end-point is the voltage beyond which it is deemed that equipment will not work properly, typically 1.0 or 0.9 V.

Common names are conventional rather than uniquely descriptive; for example, a cell called a "silver [oxide] cell" rather than "alkaline" actually has an alkaline electrolyte.

"L", "S", and "C" type cells are today the most commonly used types in quartz watches, calculators, small PDA devices, computer clocks, and blinky lights. Miniature zinc-air batteries type "P" are used in hearing aids and medical instruments.

The second letter R indicates a round (cylindrical) form.

Letters do not provide reliable information; for example some modern "ML" and "LiR" button cells use rechargeable lithium technology, not mercury or alkaline disposable.

Package size

Package size of button batteries using standard names is indicated by a two-digit code representing a standard case size, or a three- or four-digit code representing the cell diameter and height. The first one or two digits encode the outer diameter of the battery in whole millimeters, rounded down; exact diameters are specified by the standard, and there is no ambiguity, e.g., any cell with an initial "9" is 9.5 mm in diameter, no other value between 9.0 and 9.9 is used. The last two digits are the overall height in tenths of a millimeter.

Diameter codes (1st 1 or 2 digits)

Number code	Nominal diameter (mm)	Tolerance
4	4.8	±0.15 mm
5	5.8	±0.15 mm
6	6.8	±0.15 mm
7	7.9	±0.15 mm
9	9.5	±0.15 mm
10	10.0	±0.20 mm
11	11.6	±0.20 mm
12	12.5	±0.25 mm
16	16	±0.25 mm
20	20	±0.25 mm
23	23	±0.50 mm
24	24.5	±0.50 mm

Several sizes of button and coin cell with two 9 V batteries as a size comparison.

Examples:

- CR2032: lithium, 20 mm diameter, 3.2 mm height
- SR516: silver, 5.8 mm diameter, 1.6 mm height
- LR1154/SR1154: alkaline/silver, 11.6 mm diameter, 5.4 mm height. The two-digit codes LR44/SR44 are often used for this size

Some coin cells, particularly lithium, are available in versions to solder into a circuit (typically to power very low current semiconductor memory ICs with configuration information for a device, for years), with different versions for vertical or horizontal mounting, and described by the same code. To add to the confusion, there may be rechargeable batteries of the same size and number—with different prefixes—in all three versions. E.g., there is a plug-in and a solder-in CR2032, a plug-in and three solder-in BR2330s in addition to CR2330s, and many rechargeables in 2032, 2330, and other sizes.[7]

Letter suffix

After the package code, the following additional letters may optionally appear in the type designation to indicate the electrolyte used:

- P: potassium hydroxide electrolyte
- S: sodium hydroxide electrolyte
- no letter: organic electrolyte

Also:

- W; the battery complies with all the requirements of the international IEC 60086-3[8] standard for watch batteries.

Other package markings

Apart from the type code described in the preceding section, watch batteries should also be marked with

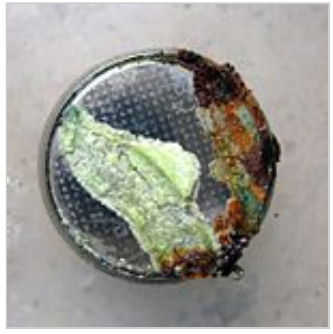
- the name or trademark of the manufacturer or supplier;
- the polarity (+);
- the date of manufacturing.

The manufacturing date can be abbreviated to the last digit of the year, followed by a digit or letter indicating the month, where O, Y, and Z are used for October, November and December, respectively (e.g., 01 = January 1990 or January 2000, 9Y = November 1999 or November 2009).

Type CR2032 watch battery (lithium anode, 3 V, 20.0 mm × 3.2 mm)

Common manufacturer code

A code used by some manufacturers is *AG* (alkaline) or *SG* (silver) followed by a number, where 1 equates to standard 621, 2 to 726, 3 to 736, 4 to 626, 5 to 754, 6 to 920 or 921, 7 to 926 or 927, 8 to 1120 or 1121, 9 to 936, 10 to 1130 or 1131, 11 to 721, 12 to 1142, and 13 to 1154. To those familiar with the chemical symbol for silver, "Ag", this may suggest incorrectly that AG cells are silver.

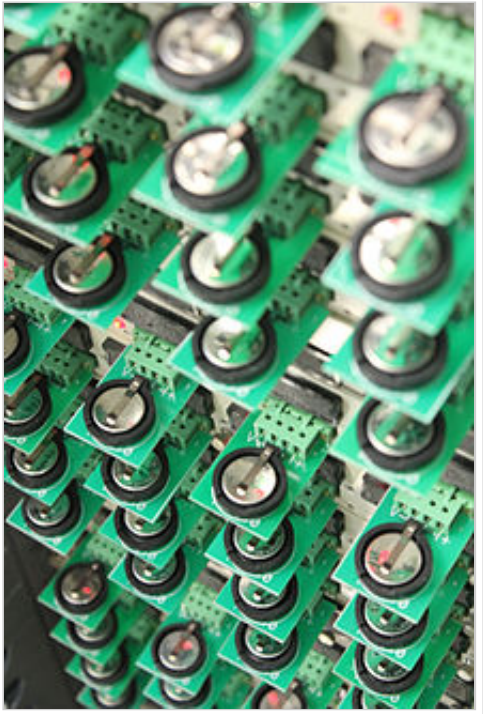

Leaked and corroded button cell

Common applications

- Electric wristwatches, both digital and analogue
- Calculators
- Hearing aids
- Some remote controls, especially for keyless entry
- Backup power for personal computer real time clocks and BIOS configuration data[9]
- Small PDA devices

- Various electronic toys (like tamagotchi, Pokémon Pikachu or a Pokéwalker and other various digital pet devices)
- Laser pointers
- Small LED flashlights
- Battery-operated children's books
- Glucometers
- Security tokens
- Cyclocomputers
- Red dot sights and electronic spotting scopes
- Manual cameras with light meters
- LED throwies
- Various video game cartridges or memory cards where battery-powered RAM is used to store data
- PCMCIA static RAM memory cards
- Solar/electric candles
- LED Bicycle head or tail lighting
- Digital thermometers

Rechargeable variants



Coin cells being tested

In addition to disposable (one use) button cells, rechargeable batteries in many of the same sizes are available, with lower capacity than disposable cells. Both disposable and rechargeable batteries are manufactured either to fit into a holder, or with solder tags for permanent connection. In equipment with a battery holder, either disposable or rechargeable batteries may be used, the voltage is compatible.

A typical use for a small rechargeable battery (in coin or other format) is to back up the settings of equipment which is normally permanently mains-powered, in the case of power failure. For example, many central heating controllers store operation times and similar information in volatile memory, lost in the case of power failure. It is usual for such systems to include a backup battery, either disposable in a holder (current drain is extremely low and life is long) or soldered-in rechargeable.[10]

Rechargeable NiCd button cells were often components of the backup battery of older computers; non-rechargeable lithium button cells with a lifetime of several years are used in later equipment.

Rechargeable batteries typically have the same dimension-based numeric code with different letters; thus CR2032 is a disposable battery; ML2032 and VL2032 are rechargeables that fit in the same holder if not fitted with solder tags. It is mechanically possible, though hazardous, to fit a disposable battery in a holder intended for

a rechargeable; holders are only fitted in parts of equipment only accessible by service personnel in such cases.

Health issues

Mercury or cadmium

Some button cells contain mercury or cadmium, which are toxic. In early 2013 the European Parliament Environment Committee voted for a ban on the export and import of a range of mercury-containing products such as button cells and other batteries to be imposed from 2020.[11][12]

Lithium

Lithium cells, if ingested, are highly dangerous. Small children are likely to swallow button cells, which are somewhat like sweets, often causing fatalities. In Greater Manchester, England, with a population of 2,700,000, two children between 12 months and six years old died and five suffered life-changing injuries in the 18 months leading up to October 2014. Coin cells of diameter 20 mm or greater cause the most serious injuries, even if not crushed. The damage is caused, not by the contents of the battery, but by the electric current it creates, which causes sodium hydroxide (caustic soda) to build up and burn through the oesophagus and into major blood vessels, which can cause fatal bleeding. Central Manchester University Hospital Trust warns that "a lot of doctors are unaware that this can cause harm".[13]

Counterfeits

There are many counterfeit batteries of all types, including button cells, branded and packaged as the product of a reliable manufacturer. They are often sold at a small fraction of the wholesale price of the genuine battery, although a higher price is not a guarantee of legitimacy. Many are poorly packaged, for example in simple blisters fixed on a cardboard backing where genuine ones are better-packaged. Reputable manufacturer Maxell says, without going into detail, that they are aware of fakes. They warn that they can cause injury and damage, and ask that they be contacted about fakes.[14] In a great many forums on Amazon and similar e-commerce sites there are insistent and repeated reports of batteries that fail after a very short time; the consumer reviews usually show a very high proportion of favourable reviews ("arrived very promptly ... work OK ... very cheap"), but a significant number of longer-term reviews give the lowest rating. Reviews of this nature are not considered reliable sources, but these reports are very widespread.[15]

One company has investigated Sony-branded watch and coin batteries in particular, and report that the most counterfeited include CR2032, CR2025, CR2016, SR626SW (377), andSR621SW (364). They show comparison photographs of card-packed real and counterfeit batteries on their Web site; they are very similar.[16]

See also

- Artificial cardiac pacemaker
- Battery recycling
- List of battery sizes
- Implantable cardioverter-defibrillator

Notes

1. [1] (http://www.amazon.co.uk/Hyundai-791-522-Alkaline-button/dp/B000N209OM) A card marked with the name Hyundai with 30 button cells in 5 sizes made in China, stating that they are alkaline but with pictures of watches, calculators, etc. is sold for prices ranging from about Rs217.5 to Rs870.01 in the UK
2. Energizer website (http://data.energizer.com/), with datasheets for many batteries of several chemistries
3. Buying Button Cells for Digital Calipers (http://www.truetex.com/buttons.htm)
4. Caliper Battery Life (http://www.davehylands.com/Machinist/Caliper-Batteries/)
5. [2] (http://www.amazon.co.uk/Hyundai-791-522-Alkaline-button/dp/B000N209OM) Alkaline button cells in a range of sizes are sold as made by Hyundai, but no technical information can be found
6. moneysavingexpert.com discussion reporting very poor performance of cheap button cells (http://forums.moneysavingexpert.com/showthread.php?t=1489411)
7. Panasonic CR battery data page (http://www.panasonic.com/industrial/batteries-oem/oem/primary-coin-cylindrical/br-cr.aspx), showing many batteries in plug-in and horizontal and vertical solder versions. The same site lists rechargeable cells with various chemistries, in the same sizes and options as disposable batteries of the same numeric code and hence mechanically interchangeable, though carrying risks of malfunctioning and damage.
8. IEC 60086-3 Standard for Watch Batteries (withdrawn) (http://webstore.iec.ch/p-preview/info_iec60086-3%7Bed2.0%7Den_d.pdf)
9. Torres, Gabriel (24 November 2004). "Introduction and Lithium Battery" (http://www.hardwaresecrets.com/article/81). *Replacing the Motherboard Battery*. hardwaresecrets.com. Retrieved June 20, 2013.
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13. BBC News:'Button battery' warning over child deaths in Manchester, 14 October 2014 (http://www.bbc.co.uk/news/uk-england-manchester-29610570)
14. Maxell: Micro watch batteries (http://www.maxellshop.com.au/Batteries/watch%20batteries)
15. A typical Amazon customer review thread on CR2032 batteries sold as Panasonic (http://www.amazon.co.uk/product-reviews/B002U00ZNK/ref=cm_cr_pr_hist_1?ie=UTF8&filterBy=addOneStar&showViewpoints=0&sortBy=bySubmissionDateDescending), with 74 out of 1122 reviews giving 1 or 2 stars
16. Microbattery.com: Stay Away From Counterfeit Sony Watch & Coin Batteries (http://www.microbattery.com/counterfeit-sony-watch-batteries)

References

- IEC 60086-3: Primary batteries — Part 3: Watch batteries. International Electrotechnical Commission, Geneva, 1995. (also: BS EN 60086-3:1996)
- Sample of data sheets available from Energizer (http://data.energizer.com) : CR2032 Technical Details (http://data.energizer.com/PDFs/cr2032.pdf) PDF (56.2 KiB)
- An Investigation of Alternatives to Miniature Batteries Containing Mercury (http://www.sustainableproduction.org/downloads/MaineDEPButtonBatteryReportFinal12-17-04.pdf) PDF (440 KiB)

External links

- Battery Equivalents: Button and Coin Types (http://highfields-arc.co.uk/beginner/gloss/batteryequiv2.htm) site no longer available - Jul 17, 2015
- Button cell and special battery crosslist (http://piles-bouton.com) in Francais
- DIRECTIVE 2006/66/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:266:0001:0014:en:PDF) PDF (407 Kb) 6 September 2006

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