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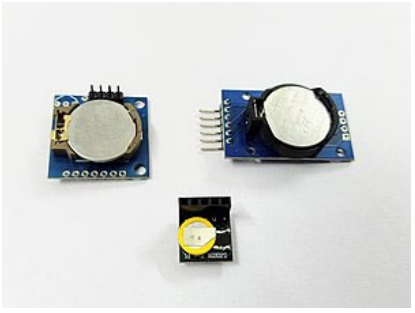
Button cell

A **watch battery** or **button cell** is a small single cell battery shaped as a squat cylinder typically 5 to 25 mm (0.197 to 0.984 in) in diameter and 1 to 6 mm (0.039 to 0.236 in) high — resembling a button. A metal can forms the bottom body and positive terminal of the cell. An insulated top cap is the negative terminal.

Button, coin, or watch cells

Button cells are used to power small portable electronics devices such as wrist watches, and pocket calculators. Wider variants are usually called **coin cells**. Devices using button cells are usually designed around 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. Relatively high-power devices such as hearing aids may use a zinc–air battery which have much higher capacity for a given size, but dry out after a few weeks even if not used.



Button cell use in RTC modules as power source

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 effects of mercury.

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 milliampere hour (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.

Button cells are very dangerous for small children. Button cells that are swallowed can cause severe internal burns and significant injury or death.[1][2]

Contents

Properties of cell chemistries

Alkaline batteries are made in the same button sizes as the other types, but typically provide less capacity and less stable voltage than more costly silver oxide or lithium cells.[3]

Silver cells may have a stable output voltage until it suddenly drops at end of life. This varies for individual types; one manufacturer (Energizer) offers three 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.

Zinc-air batteries use air as the depolarizer and have much higher capacity than other types, as they take that air from the atmosphere. Cells have an air-tight seal which must be removed before use; they will then dry out in a few weeks, regardless of use.

For comparison, the properties of some cells from one manufacturer with diameter 11.6 mm and height 5.4 mm were listed in 2009 as:[4]

- 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[4] may show 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 a particular alkaline cell. If the powered equipment requires 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 a 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 and others 1.38 V.[5][6]

While alkaline, silver oxide, and mercury batteries of the same size may be mechanically interchangeable in any given device, use of a cell of the right voltage but unsuitable characteristics can lead to short battery life or failure to operate equipment. Common lithium primary cells, with a terminal voltage around 3 volts, are not made in sizes interchangeable with 1.5 volt cells. Use of a battery of significantly higher voltage than equipment is designed for can cause permanent damage.

Type designation

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 the 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 in the IEC standard system identifies the chemical composition of the battery, which also implies a nominal voltage:

Letter code	Common name	Positive electrode	Electrolyte	Negative electrode	Nominal voltage (V)	End-point voltage (V)
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
Z	Nickel oxyhydroxide	Manganese dioxide, nickel oxyhydroxide	Alkali	Zinc	1.5	?
M, N (withdrawn)	Mercury	Mercuric oxide	Alkali	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 the voltage drops extremely rapidly. For types which lose voltage gradually (slope graph, no cliff-edge) the end-point is the voltage beyond which further discharge will cause damage to either the battery or the device it is powering, typically 1.0 or 0.9 V.

Common names are conventional rather than uniquely descriptive; for example, a *silver (oxide) cell* 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 – *P* type – are used in hearing aids and medical instruments. In the IEC system, larger cells may have no prefix for the chemical system, indicating they are zinc-carbon batteries; such types are not available in button cell format.

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

The standard only describes primary batteries. Rechargeable types made in the same case size will carry a different prefix not given in the IEC standard, for example some *ML* and *LiR* button cells use rechargeable lithium technology.

Package size

Package size of button batteries using standard names is indicated by a 2-digit code representing a standard case size, or a 3- or 4-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 (mm)
4	4.8	±0.15
5	5.8	±0.15
6	6.8	±0.15
7	7.9	±0.15
9	9.5	±0.15
10	10.0	±0.20
11	11.6	±0.20
12	12.5	±0.25
16	16.0	±0.25
20	20.0	±0.25
23	23.0	±0.50
24	24.5	±0.50
44	5.4	±0.20

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

Examples:

- CR2032: lithium, 20 mm diameter, 3.2 mm height
- CR2025: lithium, 20 mm diameter, 2.5 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 made with solder tabs for permanent installation, such as to power memory for configuration information of a device. The complete nomenclature will have prefixes and suffixes to indicate special terminal arrangements. For example, 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
- SW: low drain type for quartz watches (analog or digital) without light, alarm, or chronograph functions
- W: high drain type for all quartz watches, calculators and cameras. The battery complies with all

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