

Batteries for practical circuit work

Why do you need specific batteries for practical circuit work?

It's very important to choose the correct batteries for circuit work because short circuits can occur. Short-circuited batteries can overheat becoming hot enough to cause a burn, melt plastic holders and insulation, as well as vent hot fumes and corrosive chemicals. A short-circuit happens if children directly connect the + and – terminals of the battery with a single wire.



Note: This guidance only applies to open circuit work not enclosed batteries inside equipment e.g. cameras, cordless drills, torches etc.

Which battery size and type is most suitable for practical circuit work?

For 1.5 volt batteries, we recommend:

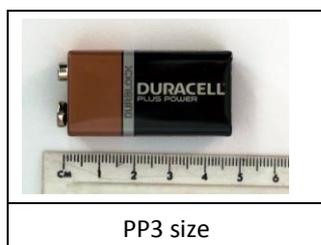
- sizes D, C, AA and AAA (sizes C and D are better)
- zinc-carbon or zinc-chloride batteries

We do not recommend alkaline or rechargeable types.

Battery sizes

The common cylindrical sizes are still widely known by an old American standard: the sizes (largest to smallest) are D, C, AA and AAA. These are all nominally 1.5 volts.

			
D size	C size	AA size	AAA size



Occasionally a PP3 size battery (nominally 9 volts) may be needed for a specific electricity project, for example in a commercial investigating circuits kit. As sourcing zinc chloride and zinc carbon PP3 batteries is very difficult, and because a brief short-circuit of a PP3 battery is unlikely to cause overheating, it is acceptable to use alkaline PP3s.

Note: This work requires at least moderate supervision to ensure the batteries are not directly connected to a single wire. Alkaline PP3 size batteries can become very hot under sustained short-circuits.

Battery types

The common battery types available in sizes D, C, AA, AAA and PP3 are: alkaline-manganese dioxide (often just called alkaline), zinc-carbon, zinc-chloride, lithium-iron disulfide (often just called lithium), nickel-metal hydride (NiMH) and nickel-cadmium (NiCd). The last two are designed to be rechargeable. The battery chemistry is not always stated on the labelling or packaging. Instead, some manufacturers use wording including: ultra, super, plus, extra, none of these tell you about the important part the battery chemistry.

Reason for choosing zinc-carbon and zinc-chloride batteries

These batteries are more tolerant of short-circuits than others and are less likely to become very hot. CLEAPSS tests revealed these batteries did become hot, but not to the extent they would cause a burn by touching them briefly.

None of this means a short-circuit is a good idea. If nothing else, it reduces the useful battery life.

Awareness of how short-circuits occur, control measures to combat short circuiting and moderate levels of supervision will help keep childrens' short-circuits to a minimum.

Less-suitable batteries for practical circuit work

We do not recommend using any of the following types for practical circuit work requiring D, C, AA or AAA sized batteries:

- Alkaline batteries (alkaline-manganese dioxide). During our tests good-quality alkaline batteries under short-circuit caused connectors and wires to smoulder and melt, giving off toxic fumes.
- Lithium batteries (lithium-iron disulfide) if the short-circuit were sustained, the battery would likely rupture and possibly catch fire. Sizes C and D are presently unavailable lithium batteries are also, comparatively, very expensive.
- Nickel-metal hydride (NiMH) and nickel-cadmium (NiCd or nicad) rechargeable batteries may seem attractive in reducing costs over time, and environmentally better, but the short-circuit current can be severe, causing wires and connectors to melt. The battery is likely to be permanently damaged by an extended short-circuit.

Purchasing batteries

Ensure your circuit work batteries state either zinc chloride or zinc carbon on them. UK supermarkets tend to stock alkaline and rechargeable types, zinc-carbon and zinc-chloride are becoming less common. Duracell does not manufacture zinc carbon or zinc-chloride types under the Duracell brand name.

You may find you need to use an educational equipment supplier e.g. TTS, Philip Harris, TimStar, SciChem etc, or an electronic components suppliers e.g. Rapid Electronics, RS Components, Farnell and Maplin. We advise that you do not buy your batteries from online auction sites, market stalls or car boot sales. We have also noticed that some budget sales websites described the battery type incorrectly.

Old stock zinc-carbon and zinc-chloride batteries will have a much reduced shelf-life, so check their sell-by date. Buy what you need for use over a term. Don't buy large stocks because the shelf-life of zinc-carbon and zinc-chloride batteries is not particularly long, typically ~ 2 years, but some much less. They progressively lose battery-life, then start to leak. Do not rely on claims that batteries are leak-proof.

Using the batteries

Avoid mixing new batteries in a circuit with ones that have been used a lot because this can cause battery leakage. When connecting more than one battery ensure they are all nose-to-tail, i.e. the + end of one connects to the - end of the next. Check the batteries for dents and other damage before they are used, and dispose of any that are not in good condition.

Tip - check battery voltages after use and dispose of zinc-carbon and zinc-chloride batteries where the voltage is below 0.9 volt.

Storing and disposal

Keep them in their original packaging until you are ready to use them and use older batteries first. Once opened keep the batteries in a plastic tray to reduce the chance of short-circuits, and store them in a cool, dry place. Consider removing batteries from equipment that remain unused for long periods of time, e.g. months or more.

Batteries which have become exhausted but are not damaged should be disposed of by recycling through any supermarket or community refuse site

Batteries gradually self-discharge then may start to leak corrosive materials, damaging the equipment they are in. This also applies to batteries marked leak-proof or similar. The picture left shows a battery (alkaline in this example) that had been left in unused equipment.



If you come across a leaky battery in equipment, wear disposable/rubber gloves and eye protection, then carefully remove the battery and put it in a sealable clear plastic bag for disposal labelled 'leaking zinc chloride (or equivalent) battery'. Use dampened kitchen-roll paper to remove the leaked material and put this into the bag with the batteries. When all the leaked material has been cleaned up, seal the bag and talk to your site manager about disposal. This could be alongside other hazardous waste

such as old fluorescent tubes.

Have a look at the equipment to assess any damage in case it needs repair or replacement.

For further information on all aspects of electricity search the CLEAPSS website using the terms batteries, electricity or circuits.