

Automotive battery

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An **automotive battery** is a rechargeable battery that supplies electric energy to an automobile. Traditionally, this is called an SLI, for starting, lighting, ignition, and its main purpose is to start the engine. Once the engine is running, power for the car is supplied by the alternator. Typically, starting discharges less than three per cent of the battery capacity. SLI batteries are designed to release a high burst of current, measured in amperes, and then be quickly recharged. They are not designed for deep discharge, and a full discharge can reduce the battery's lifespan.^[1]

As well as starting the engine an SLI battery supplies the extra power necessary when the vehicle's electrical requirements exceeds the supply from the charging system. It is also a stabilizer, evening out potentially-damaging voltage spikes.^[2]

While the engine is running, most of the power is provided by the alternator, which includes a voltage regulator to keep the output between 13.5 and 14.5 V.^[3]

Modern SLI batteries are lead-acid type and provide 12.6 volts of direct current, nominally 12 V. The battery is actually six cells connected in series.^[4]

Battery electric vehicles are powered by a high-voltage electric vehicle battery, but they usually have an automotive battery as well, so that it can be equipped with standard automotive accessories which are designed to run on 12 V.



A typical 12 V, 40 Ah lead-acid car battery

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History

Early cars did not have batteries, as their electrical systems were limited. A bell was used instead of an electric horn, headlights were gas-powered, and the engine was started with a crank. Car batteries became widely used around 1920 as cars became equipped with electric starters. The sealed battery, which did not require refilling, was invented in 1971.^[5]

The first starting and charging systems were designed to be 6-volt and positive-ground systems, with the vehicle's chassis directly connected to the positive battery terminal.^[6] Today, all vehicles have a negative ground system. The negative battery terminal is connected to the car's chassis.

The Hudson Motor Car Company was the first to use a standardized battery in 1918 when they started using Battery Council International batteries. BCI is the organization that sets the dimensional standards for batteries.^[7]

Cars used a 6 V electrical system, and so had 6 V batteries until the mid-1950s. The changeover from 6 to 12 V happened when bigger engines with higher compression ratios required more electrical power to start.^[8] Smaller cars, which required less power to start stayed with 6 V longer, for example the Volkswagen Beetle in the mid-1960s and the Citroën 2CV in 1970.

In the 1990s a 42V electrical system standard was proposed. It was intended to allow more powerful electrically driven accessories, and lighter automobile wiring harnesses. The availability of higher-efficiency motors, new wiring techniques and digital controls, and a focus on hybrid vehicle systems that use high-voltage starter/generators has largely eliminated the push for switching the main automotive voltages.^[9]

Design

- Low-maintenance or maintenance-free: In the past, batteries required maintenance in the form of electrolyte refills. Modern batteries retain their fluid for the life of the battery. A weakness of these batteries is that they are very intolerant of a deep discharge, for example when the car battery is completely drained by leaving the lights on. This coats the lead plate electrodes with sulfate deposits and can reduce the battery's lifespan by a third or more.
- VRLA: also known as absorbed glass mat (AGM) batteries are more tolerant of deep discharge, but are more expensive.^[10]

Batteries are typically made of six galvanic cells in a series circuit. Each cell provides 2.1 volts for a total of 12.6 volts at full charge.^[11] Each cell of a lead storage battery consists of alternate plates of lead (cathode) and lead coated with lead dioxide (anode) immersed in an electrolyte of sulfuric acid solution.^[12] A 12 V lead-storage battery consists of six cells, each producing approximately 2 V. The actual standard cell potential is obtained from the standard reduction potentials. This causes a chemical reaction that releases electrons, allowing them to flow through conductors to produce electricity. As the battery discharges, the acid of the electrolyte reacts with the materials of the plates, changing their

surface to lead sulfate. When the battery is recharged, the chemical reaction is reversed: the lead sulfate reforms into lead dioxide. With the plates restored to their original condition, the process may be repeated.

Some vehicles use other starter batteries. the 2010 Porsche 911 GT3 RS has a lithium-ion battery as an option to save weight.^[13] Heavy vehicles may have two batteries in series for a 24 V system or may have series-parallel groups of batteries supplying 24 V.^[14]

Specifications:

- Physical format: batteries are grouped by physical size, type and placement of the terminals, and mounting style.^[10]
- Ampere-hours (A·h) is a unit related to the energy storage capacity of the battery. This rating is required by law in Europe.
- Cranking amperes (CA): the amount of current a battery can provide at 32 °F (0 °C). Cold cranking amperes (CCA) is the amount of current a battery can provide at 0 °F (−18 °C). Modern cars with computer controlled fuel-injected engines take no more than a few seconds to start and CCA figures are less important than they were in the days of carburetors.^[15]
- Hot cranking amperes (HCA) is the amount of current a battery can provide at 80 °F (26.7 °C). The rating is defined as the current a lead-acid battery at that temperature can deliver for 30 seconds and maintain at least 1.2 volts per cell (7.2 volts for a 12-volt battery).
- Reserve capacity minutes (RCM) is a battery's ability to sustain a minimum stated electrical load; it is defined as the time (in minutes) that a lead-acid battery at 80 °F (27 °C) will continuously deliver 25 amperes before its voltage drops below 10.5 volts.
- *Battery Council International group size* (BCI) specifies a battery's physical dimensions, such as length, width, and height. These groups are determined by the organization.
- In the United States there are codes on batteries to help consumers buy a recently produced one. When batteries are stored, they can start losing their charge. A battery made in October 2015 will have a numeric code of 10-5 or an alphanumeric code of K-5. “A” is for January, “B” is for February, and so on (the letter “I” is skipped).^[15]

Use and maintenance

Heat is the primary cause of battery failure as it accelerates corrosion inside the battery.^[16]

A vehicle with a flat battery can be jump started by the battery of another vehicle or by a portable battery booster, after which a running engine (but running faster than idle speed) will continue to charge the battery^[17] but it is preferable to use a battery charger.

Corrosion at the battery terminals can prevent a car from starting due to electrical resistance, which can be prevented by the proper application of dielectric grease.^[18]

Sulfation occurs when the electrodes become coated with a hard layer of lead sulfate which weakens the battery. It occurs when a battery is not fully charged and remains discharged.^[19] Sulfated batteries should be charged slowly to prevent damage.^[20]

SLI batteries are not designed for deep discharge, and their life is reduced when subjected to this.^[21]

Car batteries using lead-antimony plates require regular topping-up with pure water to replace water lost due to electrolysis and evaporation. By changing the alloying element to calcium, more recent designs have reduced the rate of water loss. Modern car batteries have reduced maintenance requirements, and may not provide caps for addition of water to the cells. Such batteries include extra electrolyte above the plates to allow for losses during the battery life.

Some battery manufacturers include a built-in hydrometer to show the state of charge of the battery.

The primary wear-out mechanism is the shedding of active material from the battery plates, which accumulates at the bottom of the cells and which may eventually short-circuit the plates

Environmental impact

Battery recycling of automotive batteries reduces the need for resources required for manufacture of new batteries, diverts toxic lead from landfills, and prevents risk of improper disposal. Once a lead acid battery ceases to hold a charge, it is deemed a used lead acid battery (ULAB), which is classified as hazardous waste under the Basel Convention. The 12-volt car battery is the most recycled product in the world, according to the United States Environmental Protection Agency. In the U.S. alone, about 100

million auto batteries a year are replaced, and 99 percent of them are turned in for recycling.^[22] However the recycling may be done incorrectly in unregulated environments. ULABs are shipped from industrialized countries to developing countries for disassembly and recuperation of the contents. About 97 per cent of the lead can be recovered. Pure Earth estimates that over 12 million third world people are affected by lead contamination from ULAB processing.^[23]



A positive (red) jumper cable connected to battery post. An optional hydrometer window is visible by the single jumper clamp. (The black negative jumper clamp is not shown.)

See also

- Car adapter
- Electric vehicle battery
- Lead-acid battery
- Rechargeable battery

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External links

- Car battery FAQ (<http://www.batteryfaq.org/>)
- Project Gutenberg eBook *The Automobile Storage Battery* by Otto A. Witte, 1922: Here [1] (<http://www.gutenberg.org/ebooks/29718>).

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