

Exide Training Graphic Assets

Module 01 | Lead-Acid Battery Basics

Edition 2
Revised 05.2021

Introduction

Module 01 | Lead-Acid Battery Basics

Exide Lead-Acid Batteries Training Modules

- Module 01 | Lead-Acid Battery Basics
- Module 02 | Battery Evolution and the Environment
- Module 03 | (LV) Light Vehicle Batteries
- Module 04 | (CV) Commercial Vehicle Batteries
- Module 05 | (MC) Motorcycle Batteries
- Module 06 | (ML) Marine Leisure Batteries
- Module 07 | Battery Testing and Installation
- Module 08 | Battery Handling, Storage and Recycling
- Module 09 | Battery Aftermarket

Important Notes regarding Exide Training Graphic Assets

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The battery works much harder than ever before!

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50 years ago



The past 10 years



Today

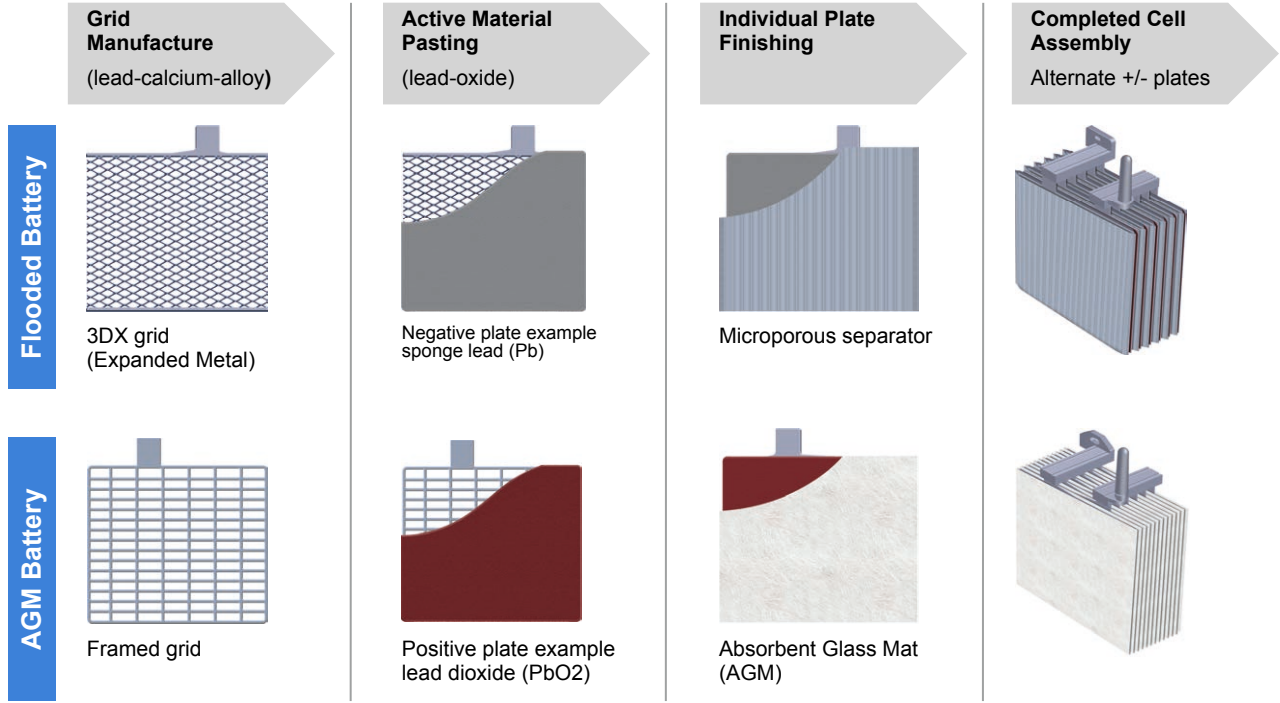


Basic electrical devices that included lighting, radio and window wipers

Over 100 control units, including climate control, electric windows/mirrors/seats, mobile communications, satellite navigation, high-quality sound/vision entertainment, enhanced safety features, automatic sensors, battery management control...

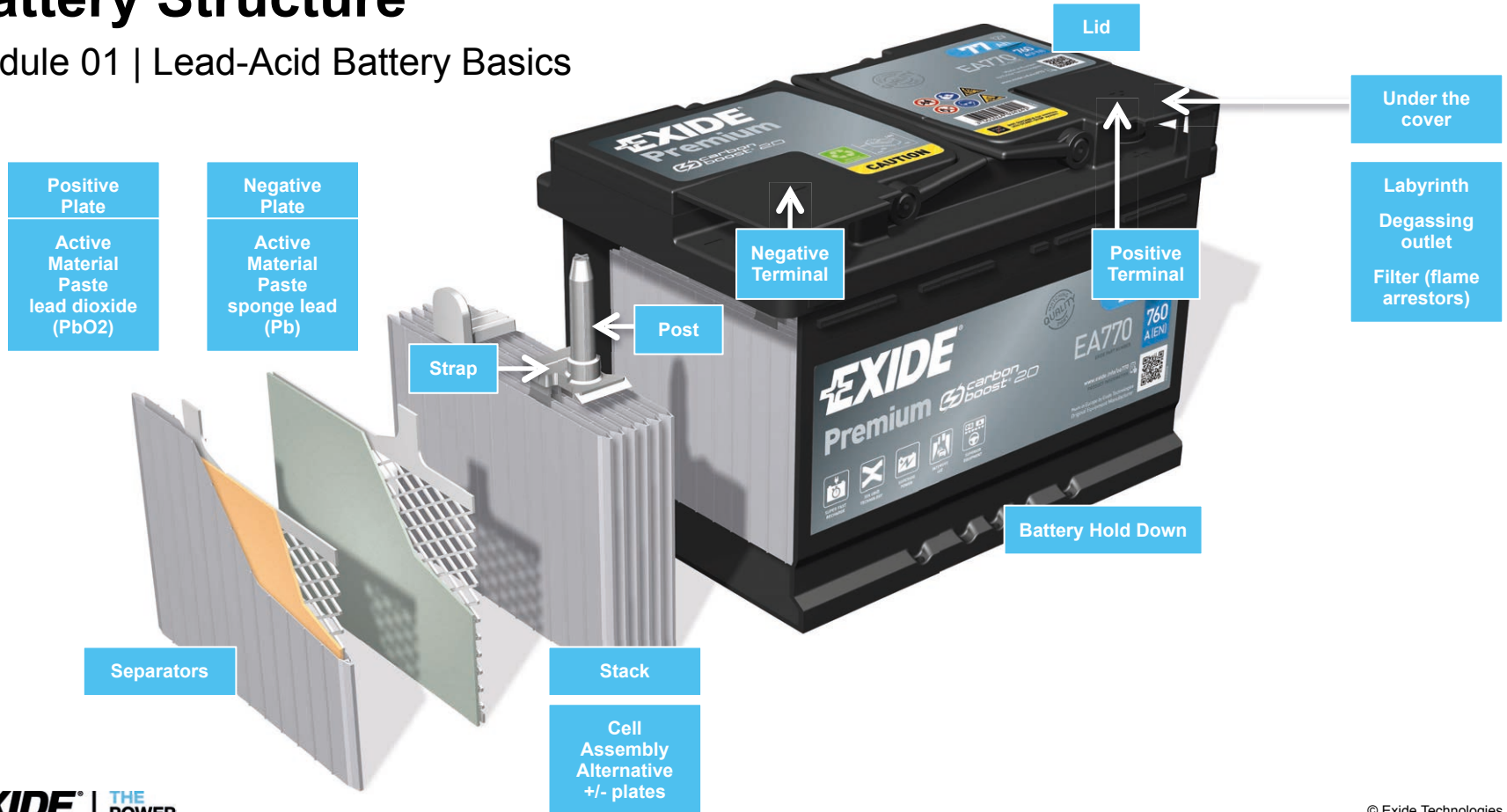
Construction of battery cells

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Battery Structure

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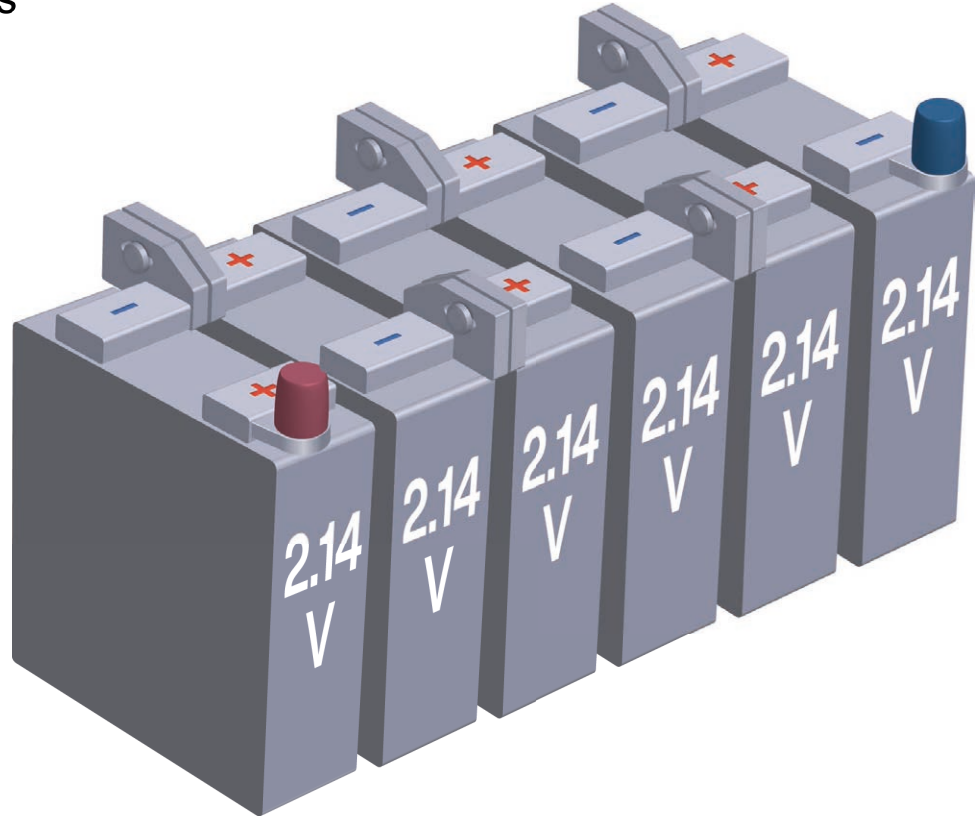
Cells connected in series

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Each cell produces 2.14 volts, regardless of the plate size and quality.

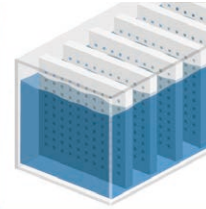
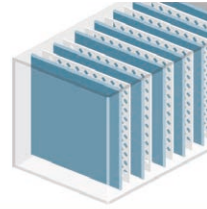
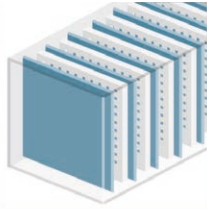
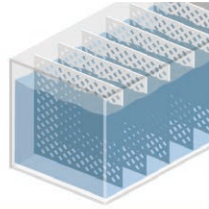
Modern automotive batteries consist of six cells connected in series to produce a total of 12.84 volts (6V batteries still exist but only on older vehicles).

$$6 \times 2.14 \text{ volts} = 12.84 \text{ volts}$$



Lead-Acid Battery Types

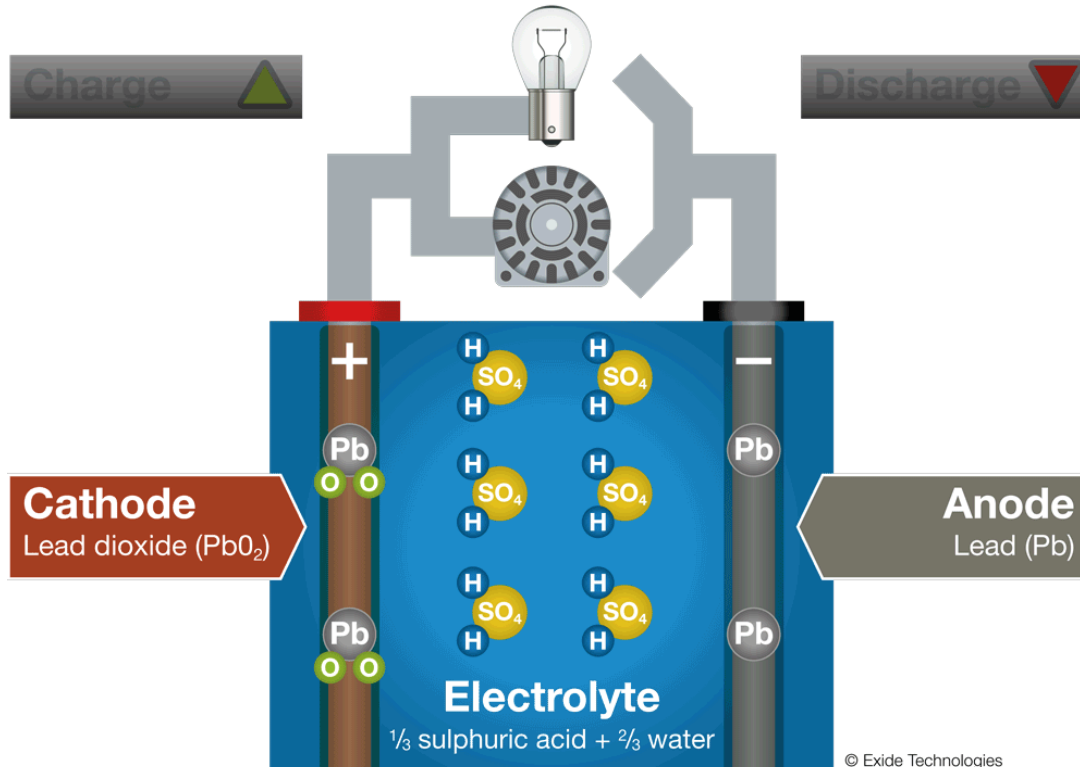
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Type		Conventional Flooded Battery	AGM Absorbent Glass Mat		EFB Enhanced Flooded Battery	GEL Deep Cycle Battery
Features	Grid Type +	3DX Grid	Framed Flat	Cast Orbital	3DX Grid	Cast Flat
	-	3DX Grid	Framed Flat	Cast Orbital	3DX Grid	Cast Flat
	Separators	Microporous Envelope	Absorbent Glass Mat	Absorbent Glass Mat	Polyethylene Envelope/Glass Mat	Polyethylene Envelope
	Electrolyte	Liquid	Absorbed	Absorbed	Liquid	GEL

Battery chemistry: how energy is generated

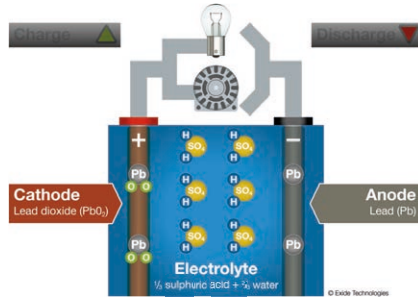
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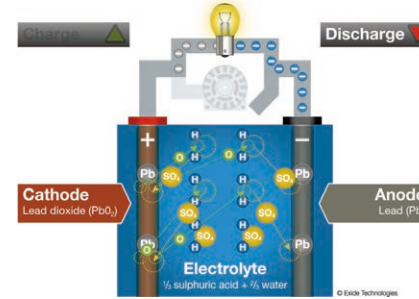
Animation
allow a few seconds
to load

Battery chemistry: how energy is generated

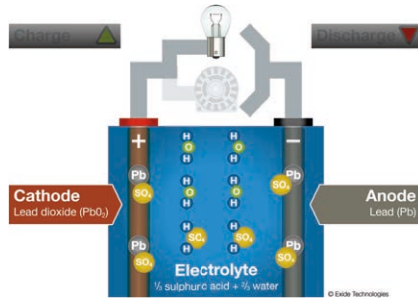
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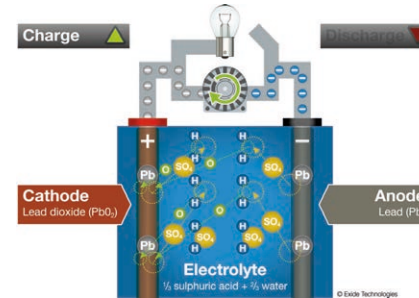
Fully charged



Discharging phase



Discharged battery



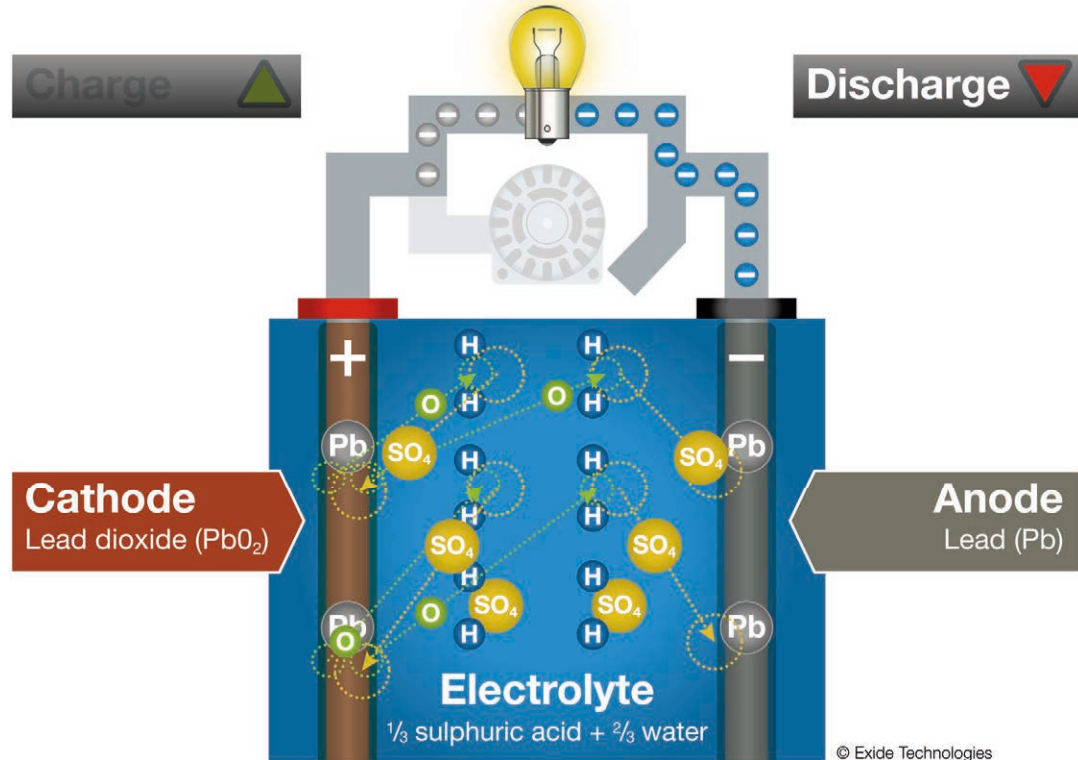
Charging phase

Battery chemistry: how energy is generated

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Discharging phase

- Lead Oxide (PbO_2) on the plate, combines with electrolyte (formed by Sulphuric Acid, H_2SO_4), forming Lead Sulfate (PbSO_4) and Water (H_2O).
- In this phase, the Lead Sulfate sediments on the battery plates, and the electrolyte (Sulphuric Acid), is replaced by water that is generated in the chemical reaction.

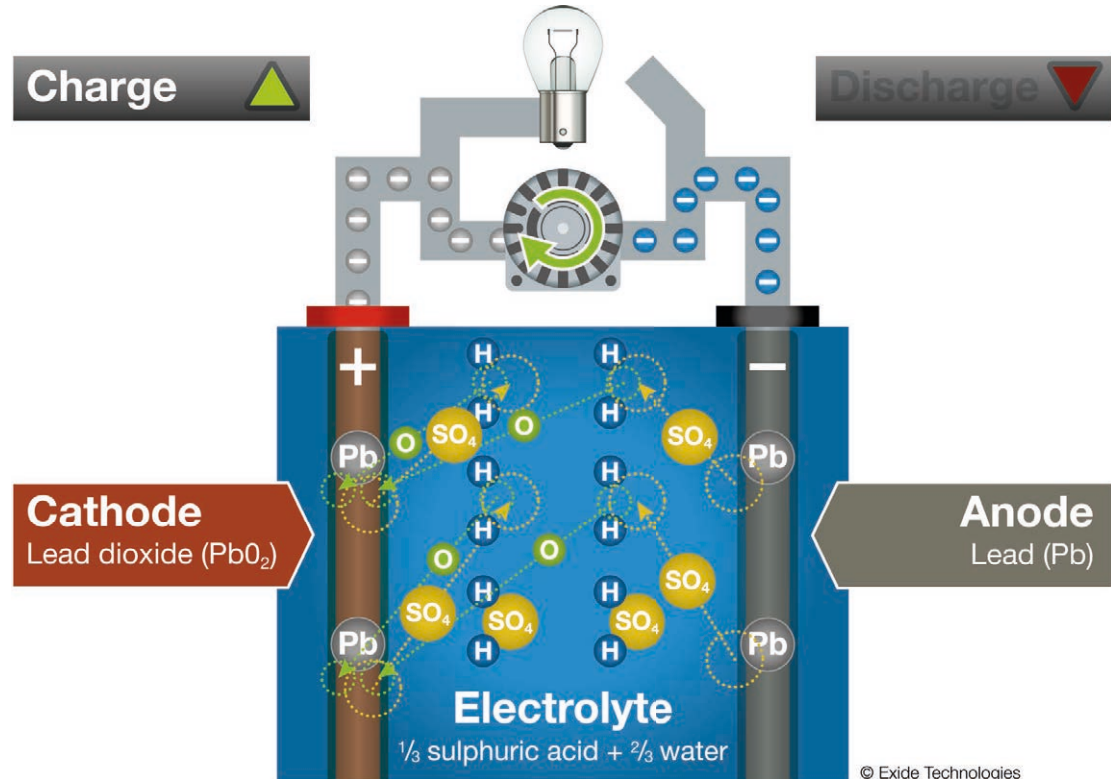


Battery chemistry: how energy is generated

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Charging phase

- Lead sulphate (PbSO_4) combines with Water (H_2O) and generate Pb, PbO_2 and H_2SO_4 (Sulphuric Acid).
- In this phase, the Lead Sulfate is removed from the battery plates, and the Sulphuric Acid substitutes water, bringing the electrolyte to its initial level.



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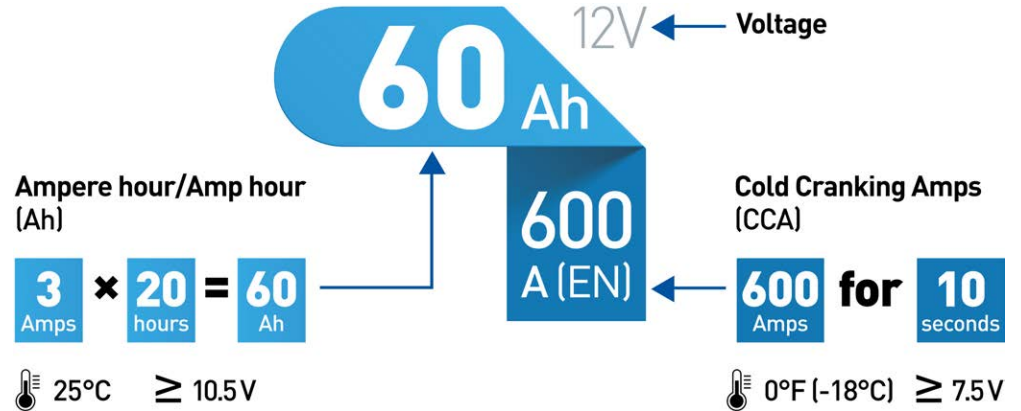
Battery Capacity – The numbers explained

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Electrical voltage (V)

With a few exceptions, current vehicles are only equipped with 12V starter batteries. It was not always the case which explains why some vintage cars that are still running require special 6V batteries.

In this situation it is inadvisable to install a 12V battery, as the electrical components would be destroyed by the higher voltage. Large commercial vehicles usually operate a 24V system. To achieve this two heavy-duty 12V batteries are connected in series.

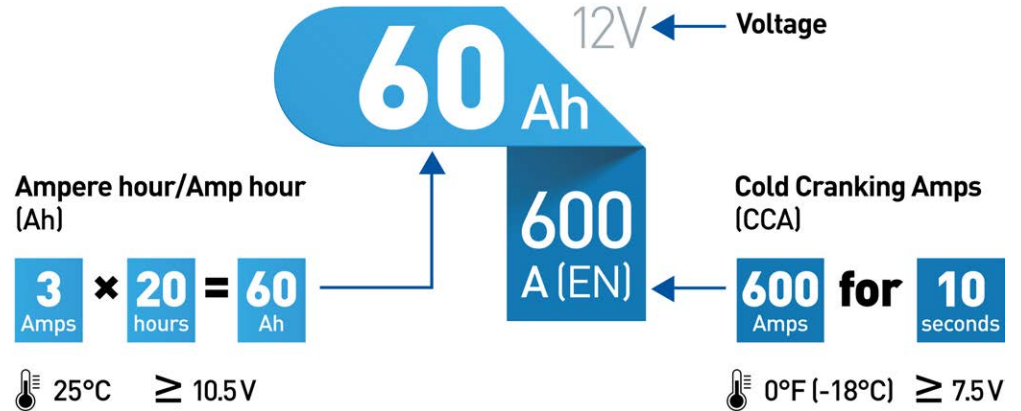


Battery Capacity – The numbers explained

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Ampere hour or Amp hour (Ah)

The Amp hour rating is a measure of the electrical energy stored in a battery. It is defined (for automotive applications) by the amount of energy, a battery can deliver continuously without recharging for 20 hours at 25°C, without falling below 10.5 volts. For example a 60Ah battery will deliver a current of 3A for 20 hours (3 x 20 = 60).



Battery Capacity – The numbers explained

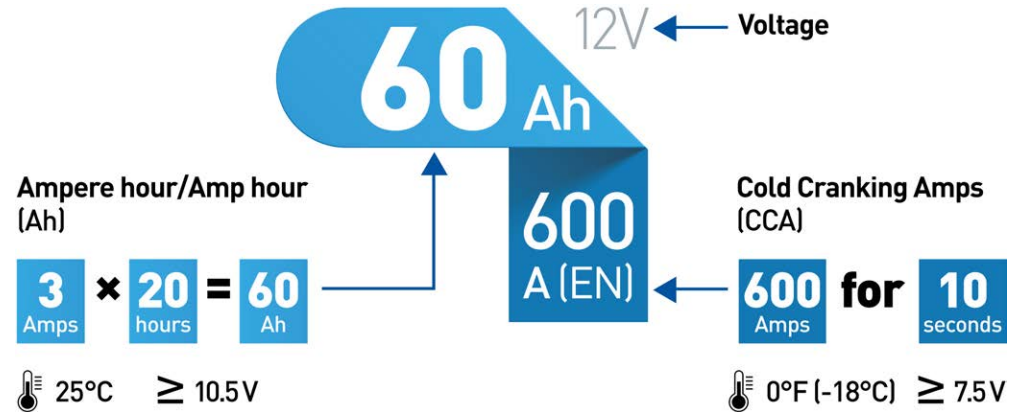
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Cold Cranking Amps (CCA)

CCA specifies the battery's ability to start an engine in cold temperatures. It is easier to crank (start) an engine in a warm environment than in a cold one.

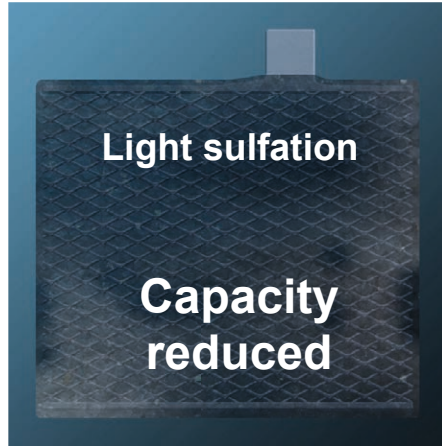
The rating refers to the current, a 12-volt battery can deliver at 0°F (-18°C) for 10 seconds whilst maintaining a voltage of at least 7.5 volts.

The higher the CCA rating, the greater the starting power of the battery. Replacement batteries should always be equal or exceed the OE battery in ratings. Fitting a new battery that has a lower CCA than the original equipment could result in poor performance.



Sulfation over the lifetime of the battery

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Additives such as Exide's Carbon Boost 2.0 in the Negative Active Mass (NAM) reduces the size of crystals that dissolve easier

The chemical reaction which allows to the battery to generate energy is reversible whilst the battery keeps an adequate charging level.

If the battery gets discharged too deeply, the Lead Sulfate sediments crystallise on the plates during the discharging phase. This can permanently affect performance and reduce battery life because the lead sulfate crystals will no longer be transformed in lead oxide during the charging phase.

Maintain the correct charge to avoid sulfation

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Danger

Below 12.3V the battery must be charged immediately.

Or at least within one week of discharge, otherwise the damage from sulfation will be irreversible.

Warning

At 12,5 V, the process is still reversible without permanent damage to the battery.

Providing charging is done immediately

Recommended

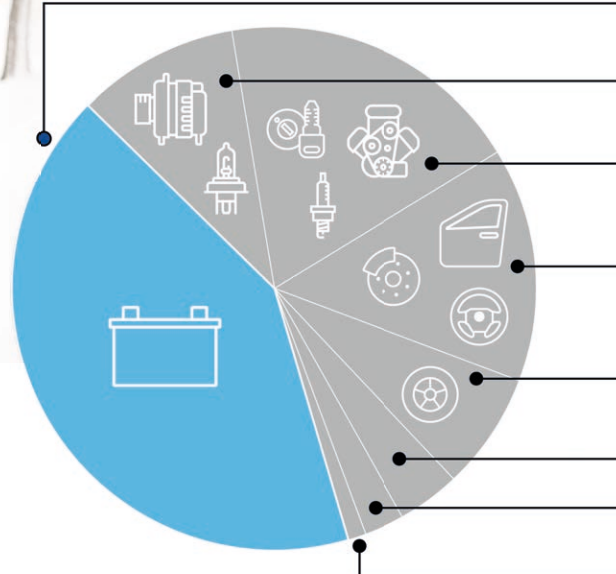
12.7 V is the optimum charge level.

All batteries in stock should not fall below 12,5V.

Batteries require regular testing and be charged when needed.

Most common cause of breakdown

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Most common cause of breakdown	
42%	Battery
11%	Other Electrical: Alternator, Starter, Lighting
17%	Engine Management (Injection, Ignition, Sensors)
15%	Bodywork, Steering, Brakes, Chassis
7%	Tyres
4%	Fuel System
2%	Cooling, Heating, Air
1%	Exhaust system, Particulate filter, Catalyst

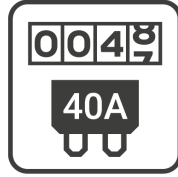
50% of breakdowns are caused by the vehicle's general electrical system

This percentage grows as the level of electrical equipment increases

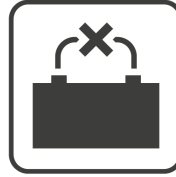
Source: ADAC Breakdown Statistics for Germany 2019

Main reasons for reduced battery life

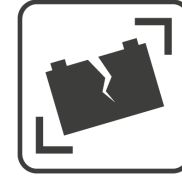
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**Short distance trips
with maximum loads**



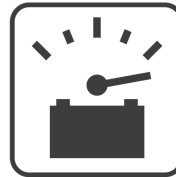
**Incorrect application
or short circuit**



**Loose fitting and
box damage**



**Prolonged periods
of self discharge**



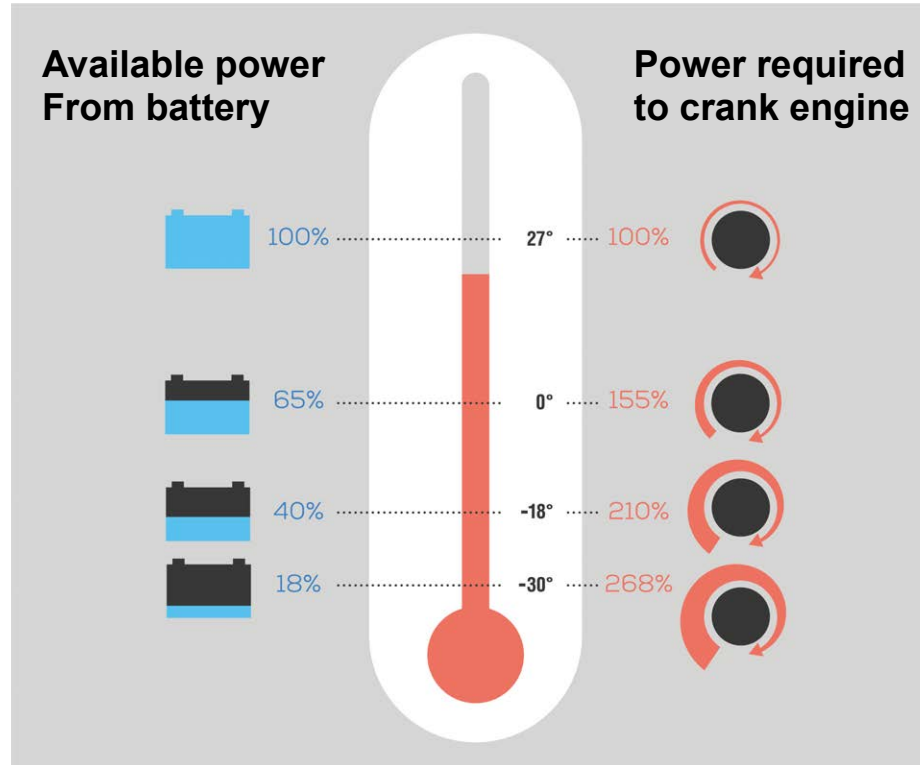
**Overcharging with
risk of drying out**



**Extreme
temperature**

How temperature affects engine starting

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Exide Technical Guide Lead-Acid Batteries

Exide Technologies has been at the forefront of Lead-Acid battery innovation since 1880 to the current day. The company was the inventor of the world's first starter battery in 1912 and more recently the first manufacturer to introduce AGM and EFB battery technology into the European aftermarket.

Exide's expertise and knowledge enabled the publication of the easy-to-understand Exide Technical Guide. The latest edition is available to view and download as a PDF at:

www.exidegroup.media/techguide

