



ROAD PATROL TRAINING FOR EXCELLENCE

2023
Slovenia



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Battery Technology, 17th - 20th Pedro Freitas, Melvyn Haring

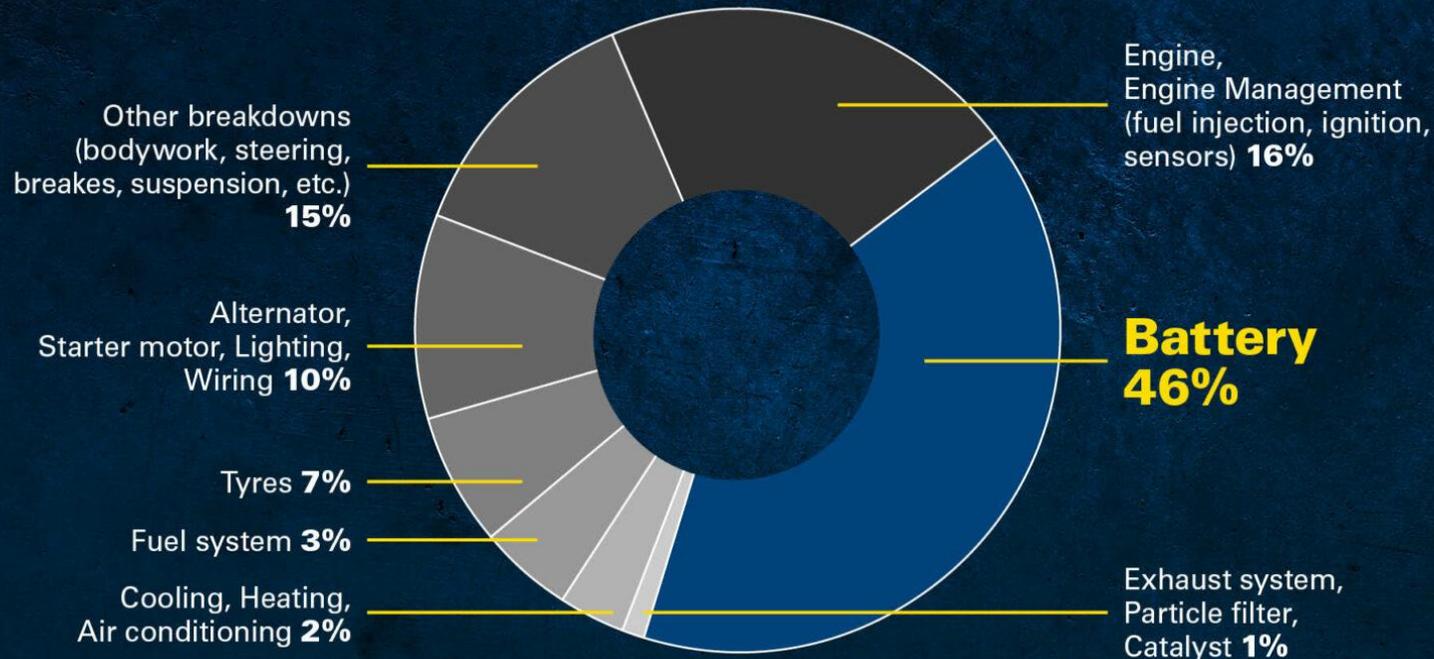
PROGRAM, CONTENTS OF THE WORKSHOP

- Battery technologies and Start/Stop Systems
- Specific charging voltages
- Battery faults
- The influence of temperature, and other factors
- Battery breakdown diagnosis, step-by-step, (Always test first, then jumpstart or recharge)
- The importance of a charging current acceptance test.
- From ICE to HEV and BEV, from 12V to 48V
- 12 Volt batteries and Electric Vehicles, a new role and function for the 12V battery?

Questions to start with

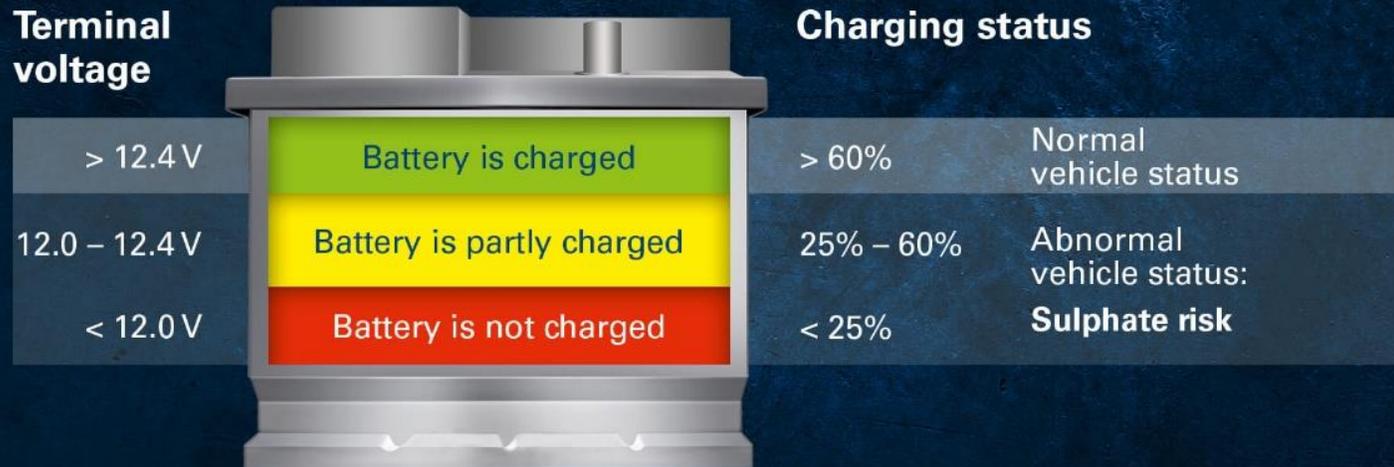
- Battery technologies and systems, which systems do you know?
- Charging voltages according to the specific battery technologies?
- You arrive at a breakdown, and you test the battery, what is the expected voltage for a fully charged battery?
- What is the expected voltage for a fully charged battery for a Stop & Start vehicle with AGM or EFB battery installed?
- What is the minimum OCV for a battery to be installed, and its importance?
- What could happen if you install a regular flooded battery in a Stop & Start vehicle?
- What battery problems could you encounter at the roadside?
- What does it mean, your Battery is completely worn out?

ROADSIDE ASSISTANCE BREAKDOWN STATISTICS 2022.



TEST EVERY BATTERY!

BATTERY CHARGING STATUS



BATTERY TESTER DIFFERENTIATE BETWEEN:

1. STATE OF CHARGE (SOC)

Voltage



While in conventional cars, the battery needs CRANKING (CCA).

2. STATE OF HEALTH (SOH)

State of health is made up of three factors

COLD CRANKING (CCA)

CHARGE ACCEPTANCE (CA)

RESERVE CAPACITY (Ah)



The battery for start-stop and highly equipped vehicles needs even more CCA and on top reserve capacity (Ah) and charge acceptance (CA).

Minimum Voltage when installing a Battery



SOC = State Of Charge			
	Ca/Ca	AGM	
Charge Rate	SOC	SOC	Acid Density*
100%	12.70 V	12.90 V	1.28 kg/l
90%	12.60 V	12,75 V	1.25 kg/l
80%	12.50 V	12.65 V	1.24 kg/l
70%	12.40 V	12.50 V	1.22 kg/l
60%	12.30 V	12.40 V	1.20 kg/l
50%	12.20 V	12.25 V	1.18 kg/l
20%	11.80 V	11.80 V	1.10 kg/l
0-10%	11.50 V	11.50 V	1.05 kg/l

BATTERY TYPES

- Pb/Sb, Conventional until 1985, 13,5V - 14,0V
- Pb/Ca, Hybrid 1985 to 2002, 13,8V - 14,4V
- Ca/Ca, Common non-Start/Stop, from 2000, 14,2V - 14,8V
- AGM, Start/Stop, Brake energy recuperation, 14,0V - 14,4V (75% to 80% SOC)
- EFB, Start/Stop, 14,0V - 14,7V (75% to 100% SOC)
- LiFePO4, Start/Stop 14,2V – 14,8V
- Li-ion, Start/Stop 14,25V – 14,8V



Traditional Battery



Conventional Battery



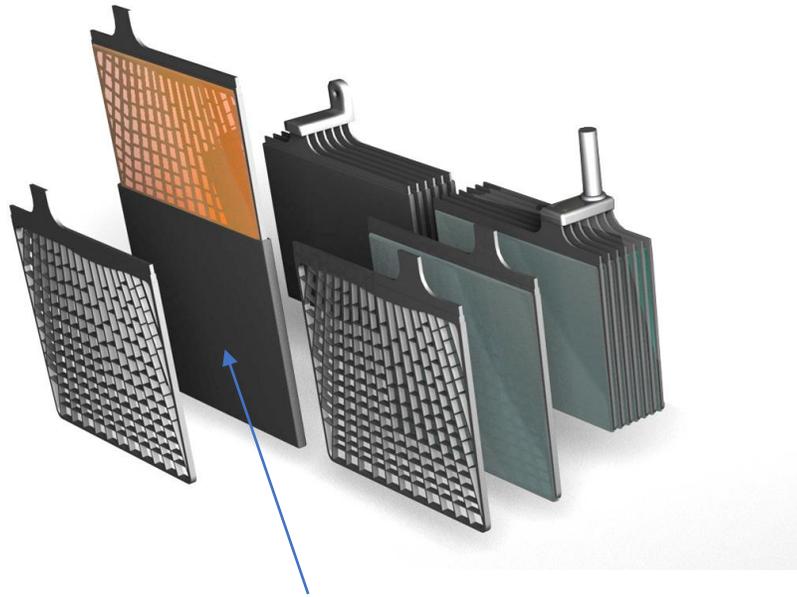
EFB Battery



AGM Battery

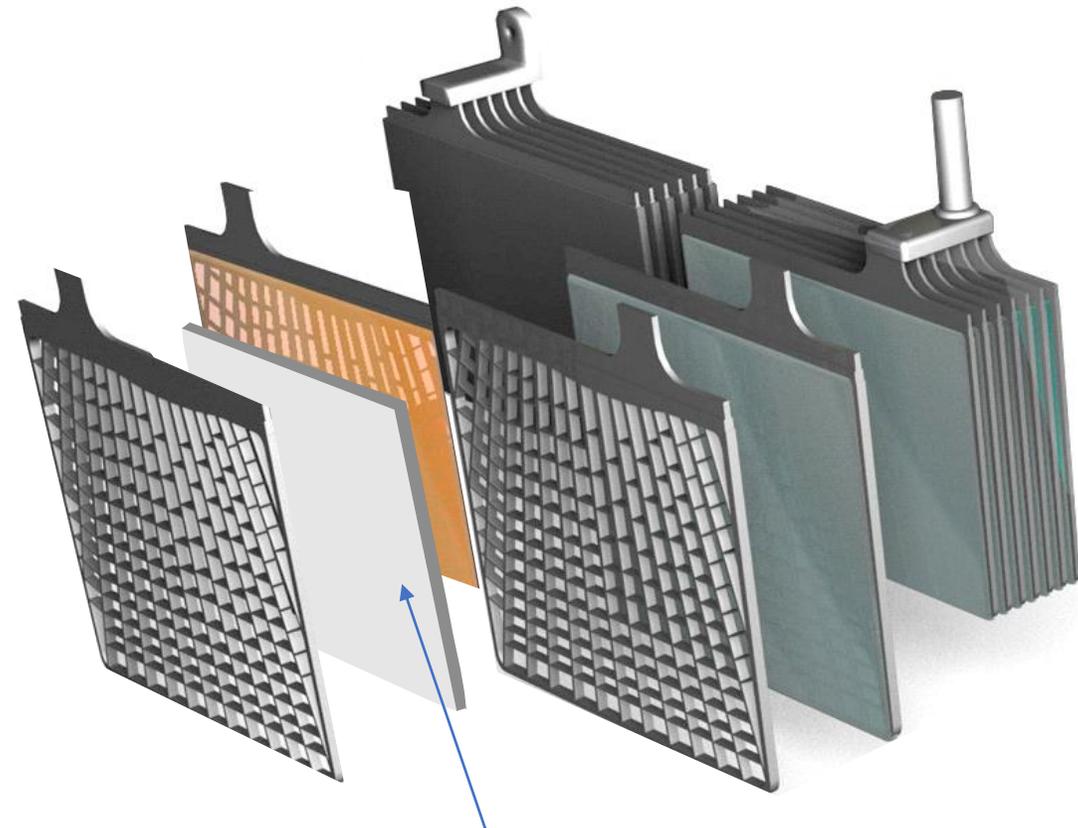
Start/Stop systems AGM and EFB batteries

A conventional battery is surrounded by acid



Convencional envelope separator

AGM batteries acid is absorbed in a glass mat separator



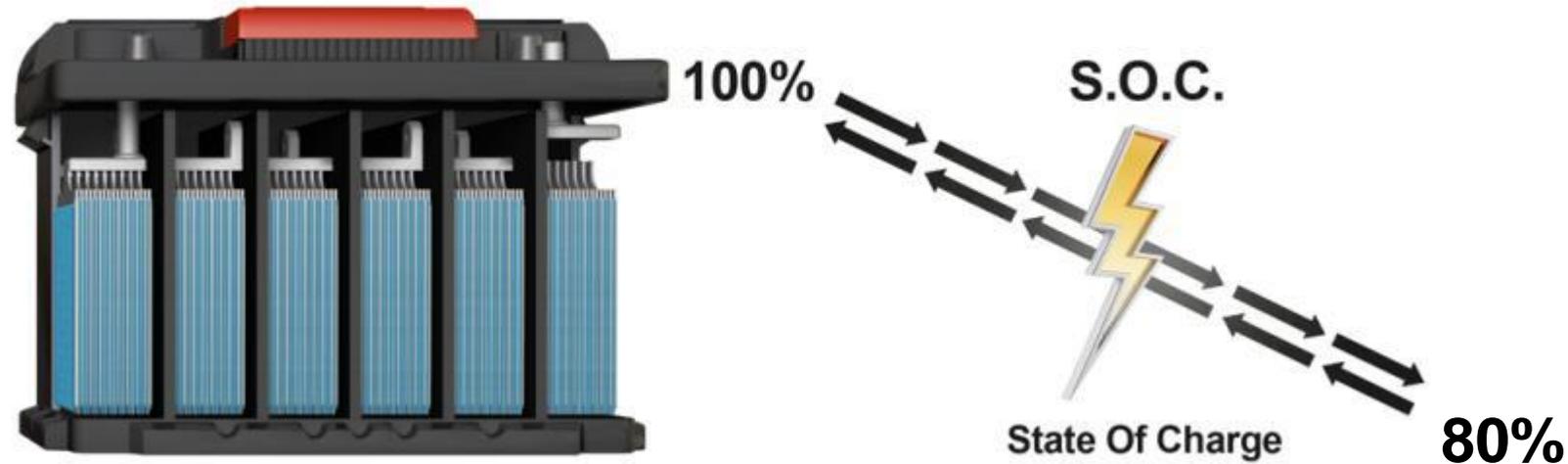
Absorbent glass mat separator

Start/Stop systems AGM and EFB batteries

EFB



AGM



12V Lithium Iron Phosphate LiFePO4 and Li Lithium-ion

High Energy Density: Lithium batteries offer a higher energy density compared to traditional lead-acid batteries, providing more power in a smaller and lighter package.

Longer Lifespan: Lithium batteries typically have a longer lifespan, lasting up to 10 years or more, reducing replacement frequency.

Fast Charging: They can be charged quickly, saving time and providing convenience.

Low Self-Discharge: Lithium batteries have a lower self-discharge rate, making them ideal for vehicles that may sit idle for extended periods.



12V Lithium Iron Phosphate LiFePO4 and Li Lithium-ion

Higher Cost: Lithium batteries are more expensive upfront compared to lead-acid batteries, which can be a barrier for some consumers.

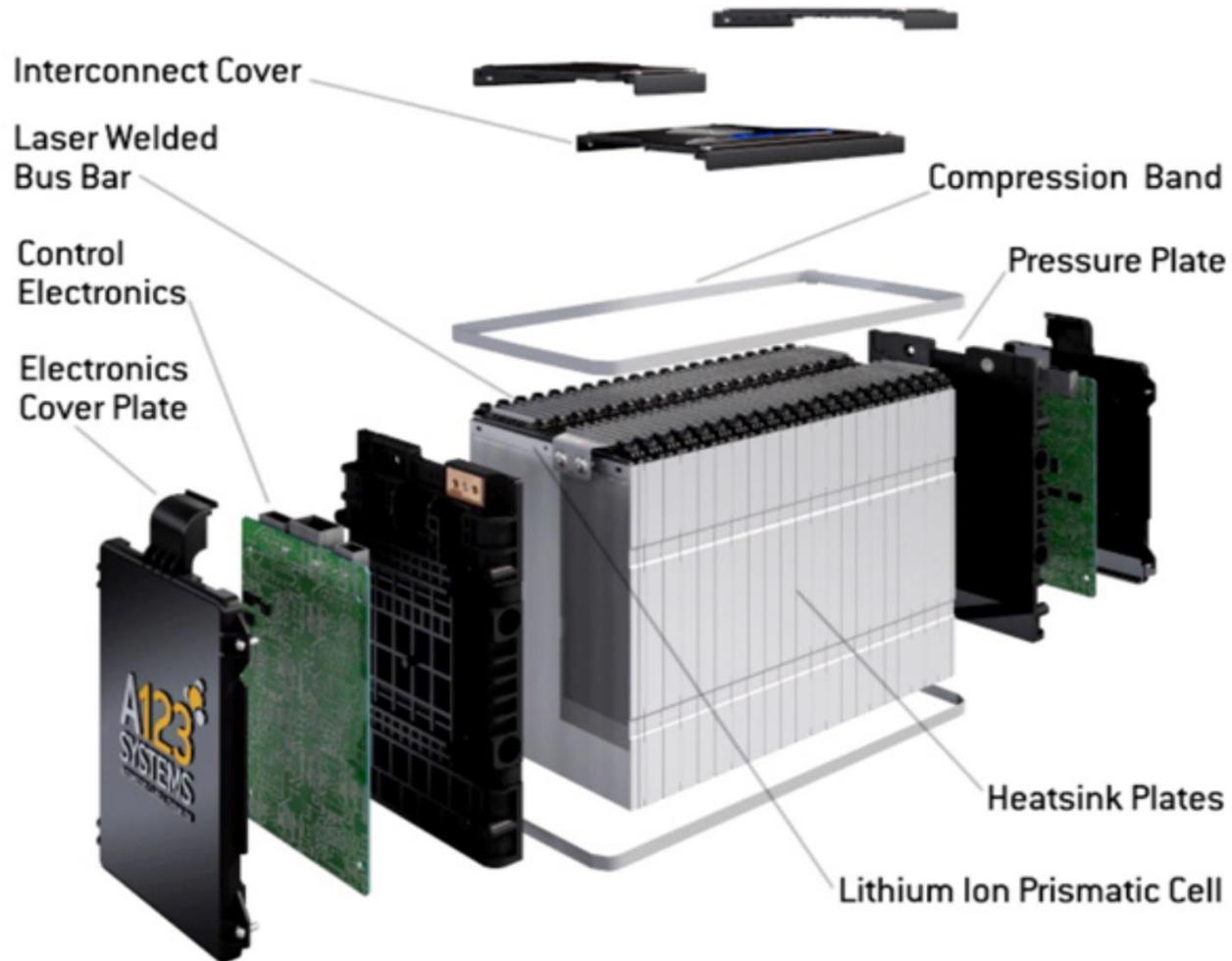
Limited Cold Weather Performance: They may have reduced performance in extremely cold temperatures, affecting cold-weather reliability.

Complex Charging Management: Lithium batteries require sophisticated charging management systems to prevent overcharging and overheating.

Safety Concerns: While generally safe, lithium batteries can pose fire and safety risks if damaged or mishandled.



LiFePO₄ and Li Lithium-ion internals



12V Lithium batteries offer numerous advantages such as high energy density, long lifespan, fast charging, and low self-discharge.

However, they come with challenges like higher cost, limited cold weather performance, complex charging management, and safety concerns.

The choice of the type of a battery depends on specific automotive applications and priorities.

Battery types and Start/Stop systems

	MICRO	ADVANCED MICRO			MILD
	 AGM baseline	 Li-ion	 PbA + small Li-ion	 PbA + ultracaps	 PbA + 48V Li-ion
Battery 1	Lead-acid	Lithium-ion	Lead-acid	Lead-acid	Lead-acid
Battery 2	x	x	Lithium-ion	Ultracaps	Lithium-ion
Weight	26kg	10kg	17kg + 4kg	20kg + 5kg	17kg + 12kg
System component upgrades:	x	Stronger alternator	Stronger alternator	Stronger alternator	Starter-generator with inverter
Additional components	DC/DC (200W) Battery sensor	x	Battery sensor Cranking switch	DC/DC Battery sensor	DC/DC (12V/48V) Battery sensor
Total cost OEM	\$290	\$600	\$460	\$615	\$1,325
Total cost over life	\$540	\$600	\$520	\$690	\$1,385
Fuel economy improvement*	2 - 5%	5 - 10%			15%

Battery Faults

Sulfation and Stratification

1. What is it?
2. Caused by?
3. How to recognize?
4. Actions, what is possible?

- Age
- Sulfation
- Over or under charging
- Deep discharge
- Temperature variation
- Vibration
- Poor Fitment

Sulfation

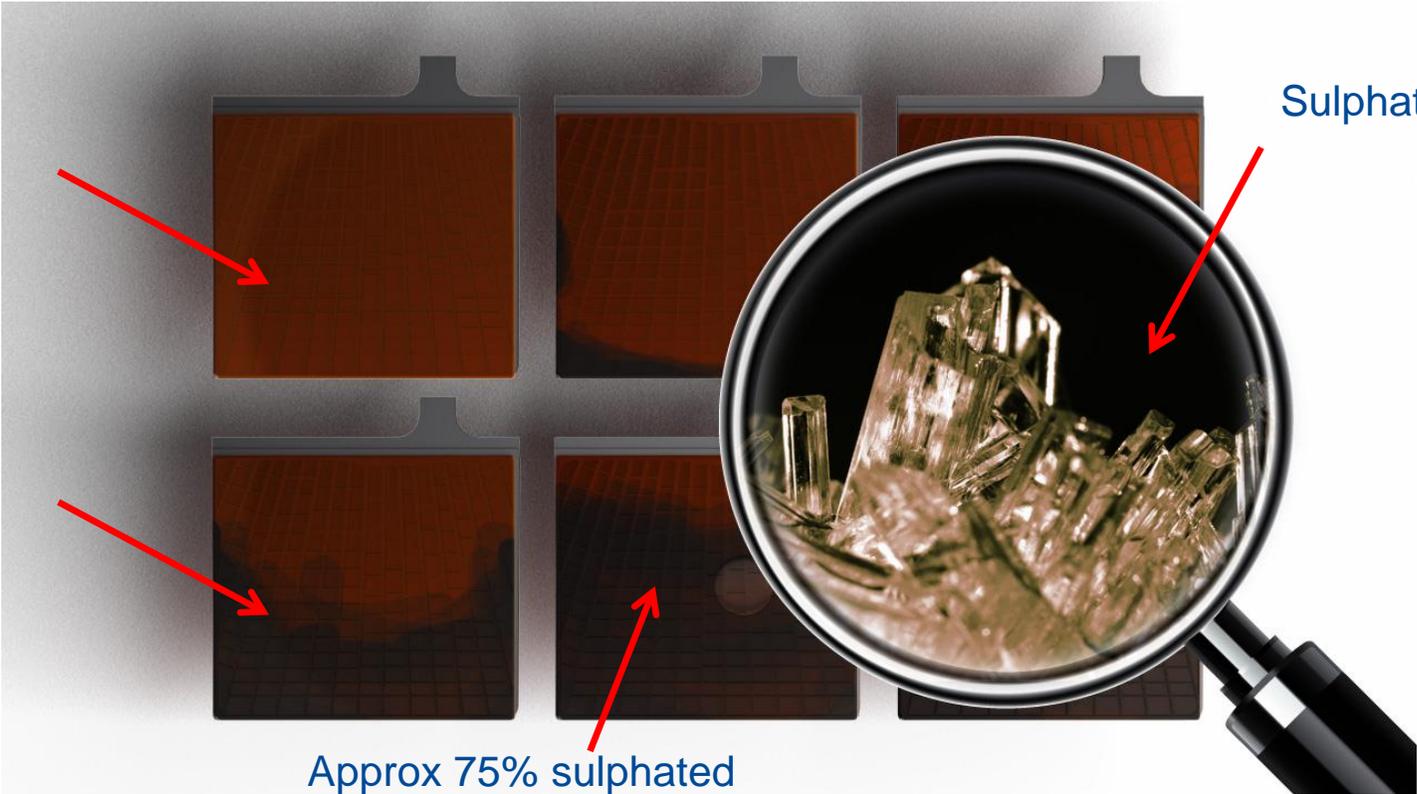
- Due to a low state of charge a chemical reaction occurs, This leads to the development of large crystals that reduce the battery's active material, which is responsible for the performance of the battery.
Not a battery defect or issue but application or usage issue.

Good Plate

Approx 45%

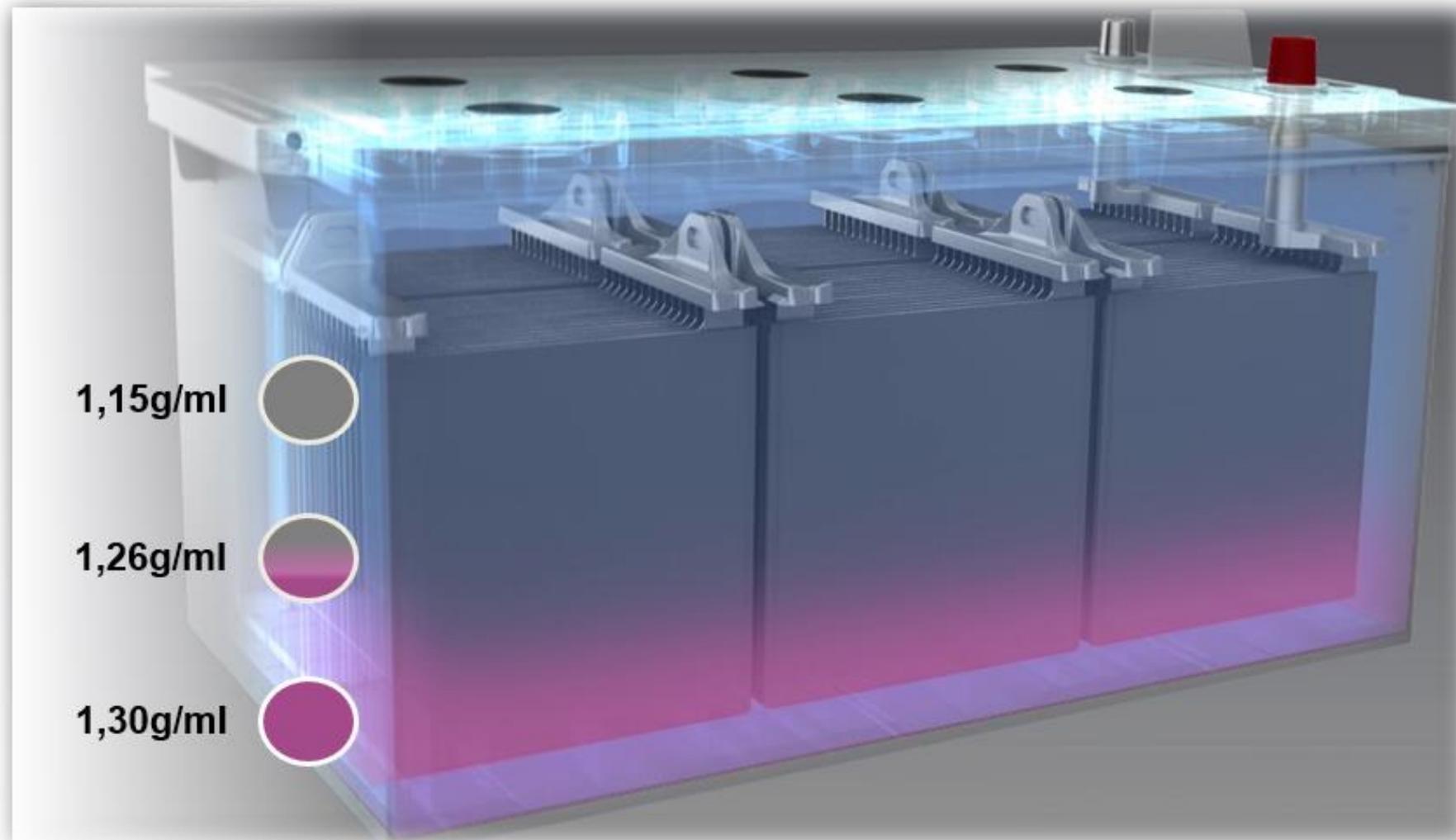
Approx 75% sulphated

Sulphation Crystals



- If a battery is charged with a voltage which is too low, or if it always operates with a voltage which is too low (below 80%) acid layering, also referred to as stratification, occurs. The acid in the electrolyte stratifies due to poor mixing. Various densities cause layering of the sulfuric acid on the bottom and water in the top area of the battery. Because of this, only the middle section of the electrolyte, i.e. only a third, can be used for the discharging and charging process.
- A result of acid layering is sulfation. If this occurs in the battery, or if it is not constantly charged to an adequate level, the lead sulfate (PbSO_4) crystallizes on the electrodes, to form larger crystal structures over the course of time. This process is known as “sulfation”. The crystallization prevents the re-conversion of lead sulfate into the original components lead or lead oxide, which results in the prevention of charge acceptance and reduction in the cold start power.
- Sharp crystals may also damage the separators or cause short circuits in the cells.
- A possible cause of acid layering is mainly short journeys with the simultaneous use of a large number of electrical consumers. In this case, the alternator does not have enough time to recharge the battery.

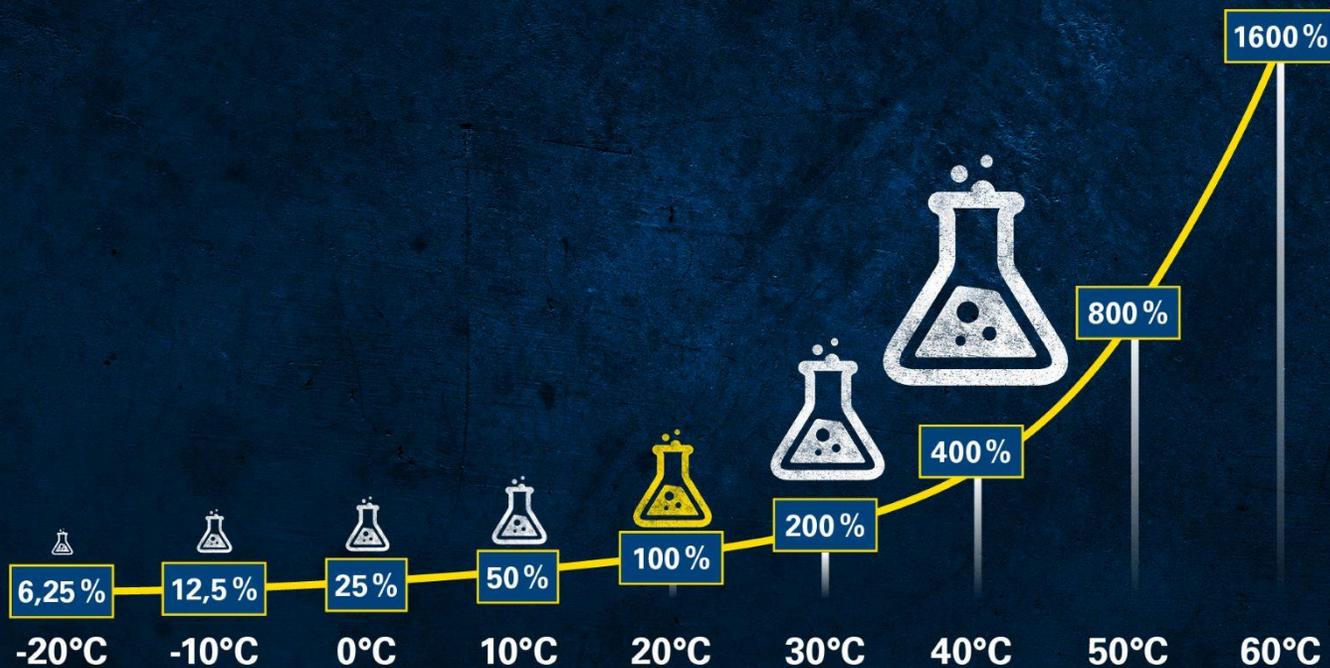
Sulfation and acid layering



Effect of Temperature on batteries

LEVEL OF CHEMICAL REACTION AS A FUNCTION OF TEMPERATURE

(20°C set as baseline)

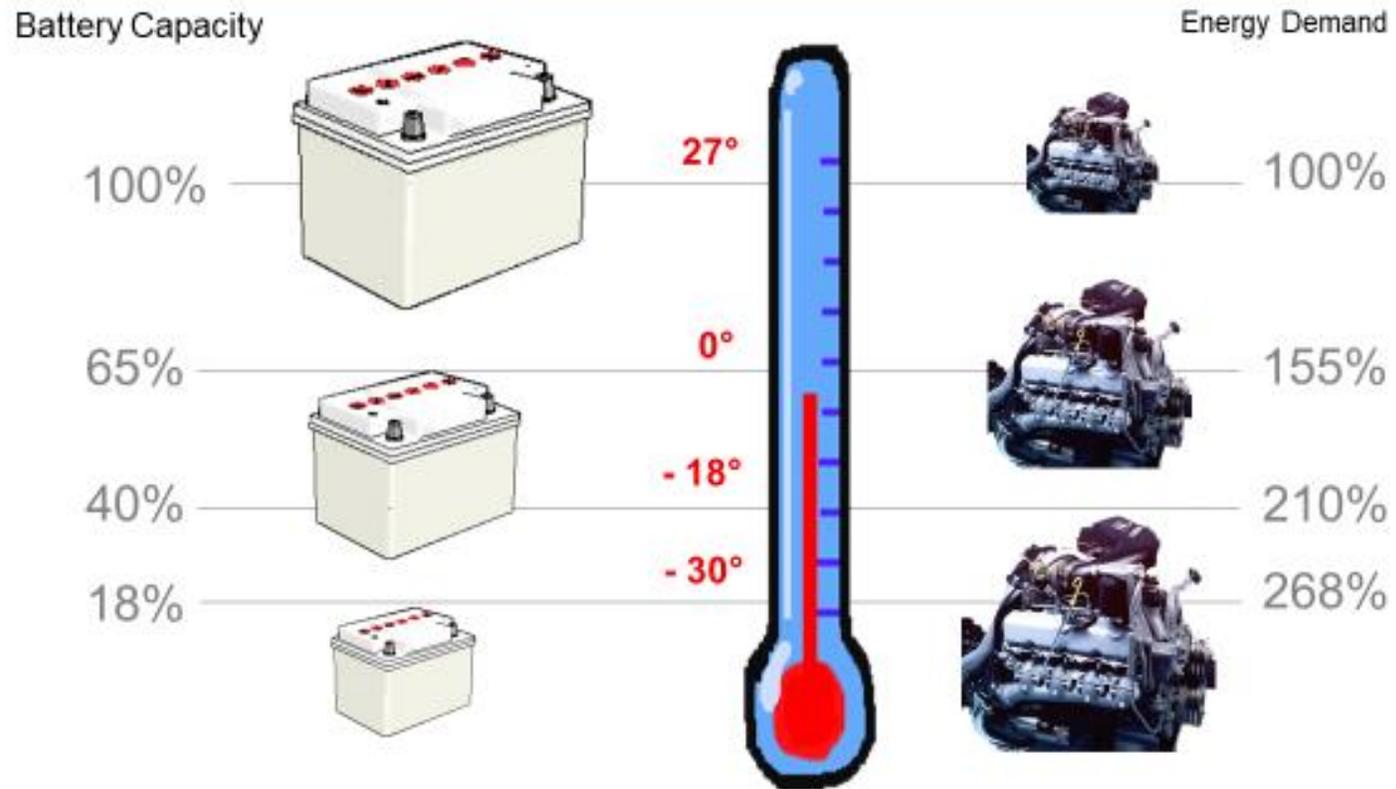


VARTA

The batteries are damaged in summer, but we notice in winter

- Higher ambient temperature speeds up chemical corrosion
- At the same time, it accelerates the natural self-discharge

Influence of Temperature



- Cold temperature causes a serious, temporary, drop in cranking capacity (CCA)

WORN OUT BATTERY



BATTERY BREAKDOWN DIAGNOSIS, STEP-BY-STEP

On arrival, always introduce yourself

Communication, get extra information from customer,

Investigate situation

Check Battery for open/closed circuit

Battery testing, including startermotor, charging system and current drain

Explain your findings and diagnosis, advise the customer, guard his/her safety, risk of driving,

Replace battery Y/N, (keep the 12V alive!)

If necessary, proceed with battery registration in the vehicle



First test then the rest

Connect the battery tester to the battery terminals to determine the state of charge and the internal resistance.



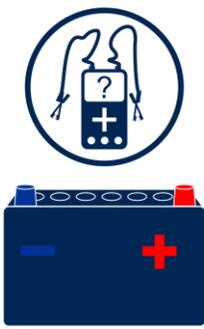
To connect the testing device to a battery which is located in the trunk or the passenger compartment, the battery terminals there and not the starting aid contacts in the engine compartment must be used, as the resistance of the cable which is installed in the vehicle would affect the measurement.



To connect the testing device to a battery which is located in the trunk or the passenger compartment. Connect to the battery terminals on the battery and not the starting aid contacts in the engine compartment, as the resistance of the cable which is installed in the vehicle will affect the measurement.



Set the battery tester to the correct battery type: MF, Gel, EFB or AGM battery. The device uses a different test algorithm for each battery type, so that an incorrect setting would produce an incorrect measurement value. In addition, for some test devices it is important to know whether the test is being made on a battery installed in the vehicle, or whether it is outside of the vehicle.



ALWAYS TEST FIRST, THEN JUMPSTART OR RECHARGE THE BATTERY

Which technology?

- Regular flooded, SLI
- EFB
- AGM
- Lithium

- ✓ What is the charge acceptance of the battery?
- ✓ What is the battery type and technology?
- ✓ How is the charging system performing?
- ✓ Is it safe for your customer to drive?

Remember, 12V Lithium batteries are becoming more common!

Jumpstart Safety

Technical Information



No use of mobile 12V jump-start devices with built-in Lithium-Ion battery

Do not use mobile 12V jump-start devices with built-in Lithium-Ion battery for jump-starting vehicles with built in 12V lithium batteries - Risk of fire!

In case of a discharged 12V vehicle battery do not use mobile 12V jump-start devices ("booster") with a built-in Lithium-Ion battery for jump-starting the vehicle, since this can lead to an overload of the Lithium-Ion battery of the mobile jump-starting device and as a result the device may catch fire. For jump-starting the vehicle either use a donor vehicle in combination with a jump-lead as described in the workshop manual or an external lead-acid or AGM battery.

Technical background:

The 12V jump-start device ("booster") has an internal contactor which isolates the booster's internal battery from the vehicle's system after a jump-start if the system voltage exceeds a certain value. The voltage of the vehicle's 12V system may be lower than the cut-off threshold of the booster which then may lead to an overcharge of the booster.

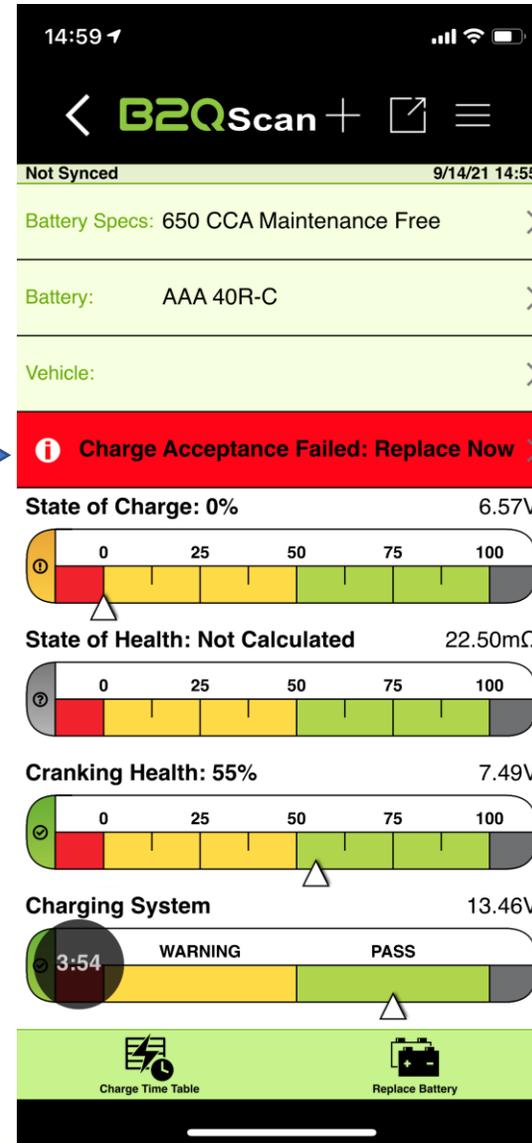
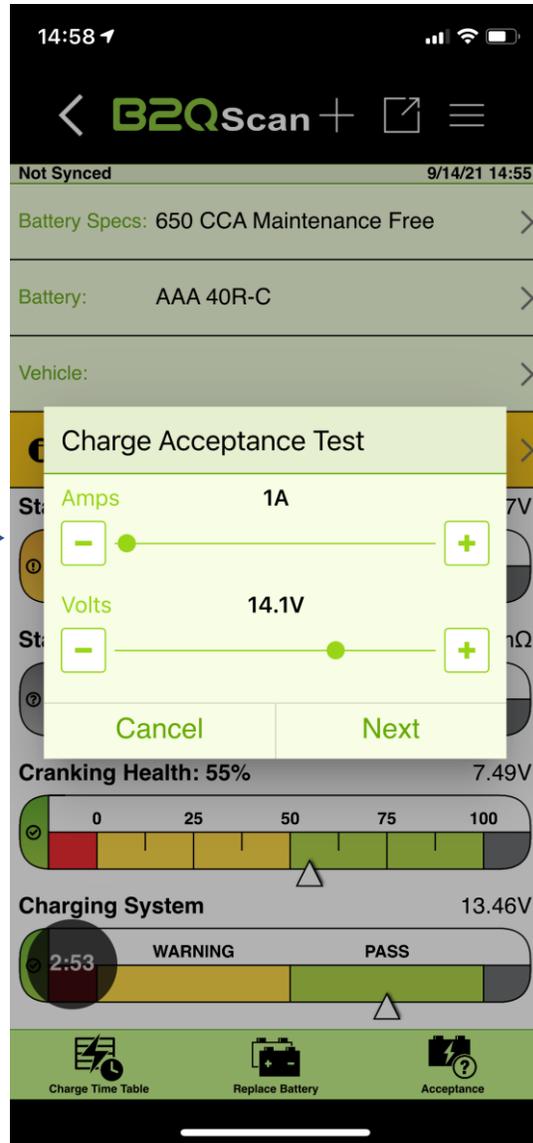
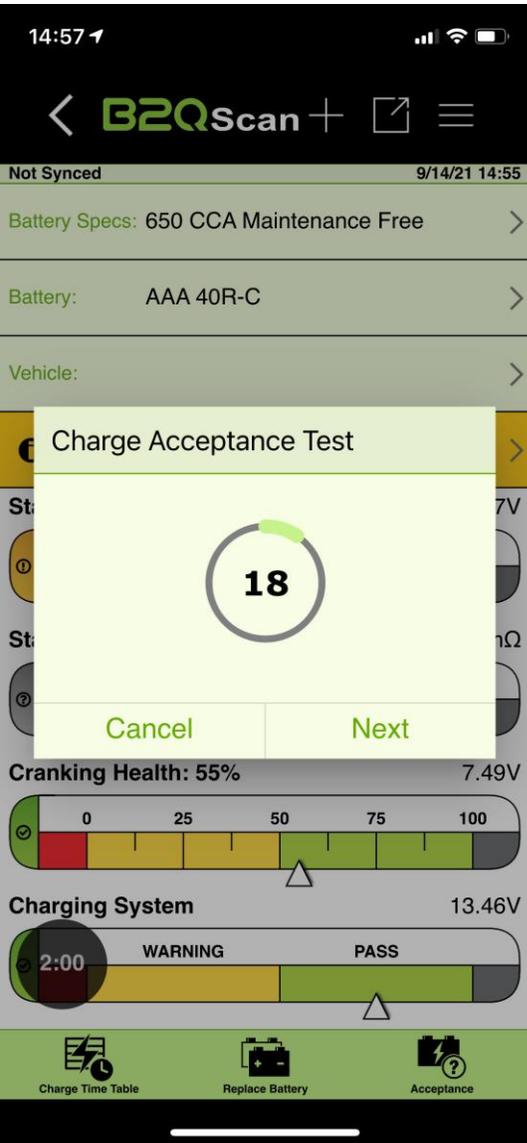
Please pass this information also to your local roadside-assistance providers.



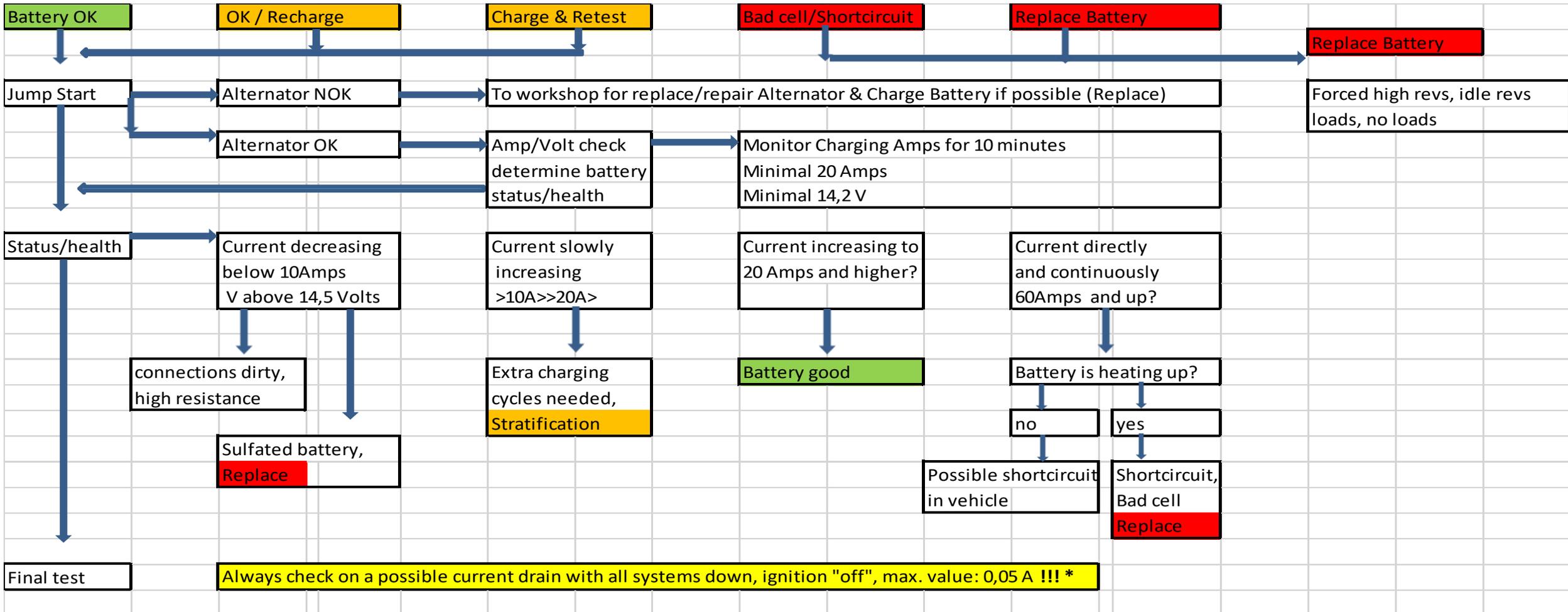
Importance of Charge Acceptance Testing

Why are the residual capacity and charge acceptance so important for a reliable test result?

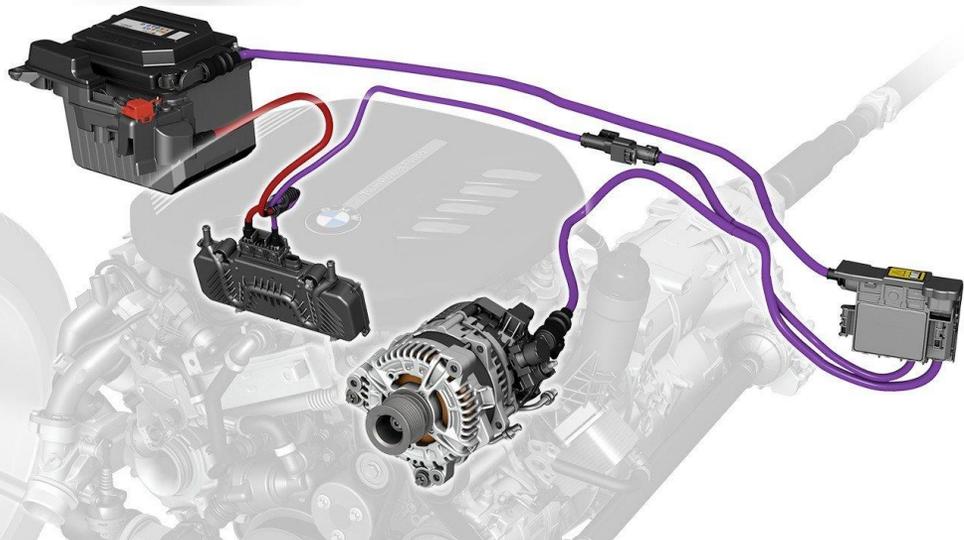
- Good charge acceptance is very important specially in start/stop systems because the battery needs to supply sufficient current during a journey with a large number of stops and starts
- Consumers remain in operation during the standstill and the large number of engine starts also have to be ensured. During driving and braking (in the case of a start-stop system with recuperation, which feeds regenerative energy into the battery) the battery must therefore charge sufficiently in order to reliably handle the next stop.
- Residual capacity must be sufficient to also supply the consumers during the standstill.
- The residual capacity is the energy which is available to supply the electrical consumers during certain situations:
 - During all stop phases, either at traffic lights, in traffic jams or when parking.
 - To compensate for inadequate charging by the generator, or to maintain a stable voltage while driving.



Importance of a charging current acceptance test



48V Batteries & Systems



Enhanced Start-Stop System:

Smoother engine restarts reduce emissions and fuel consumption, making 48V systems eco-friendly.

Power Boost for Performance:

Provides extra power for acceleration and improved driving performance, especially in hybrid vehicles.

Quick Charging:

Lithium batteries offer fast charging capabilities, reducing downtime for recharging.

Lighter Weight:

Lithium batteries are lightweight compared to traditional 12V lead-acid batteries, improving overall vehicle weight distribution.

48V Batteries & Systems

THE 48-VOLT MACHINES

- 1 **Electric motor/generator** starts engine, then helps the car to get going. Later charges the battery during braking
- 8 **Electrical supercharger** starts providing boost before engine starts, eliminating turbo lag

THE 48-VOLT SYSTEM ...

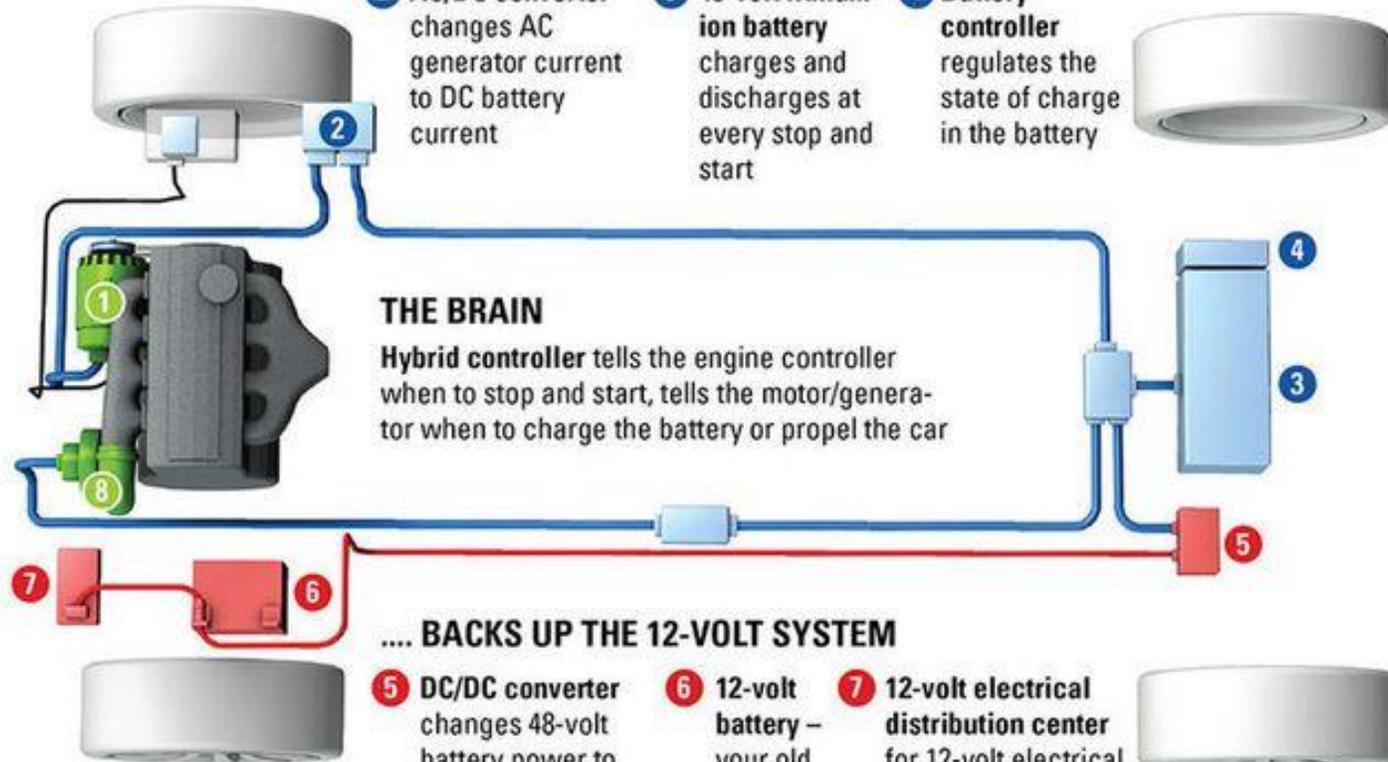
- 2 **AC/DC converter** changes AC generator current to DC battery current
- 3 **48-volt lithium ion battery** charges and discharges at every stop and start
- 4 **Battery controller** regulates the state of charge in the battery

THE BRAIN

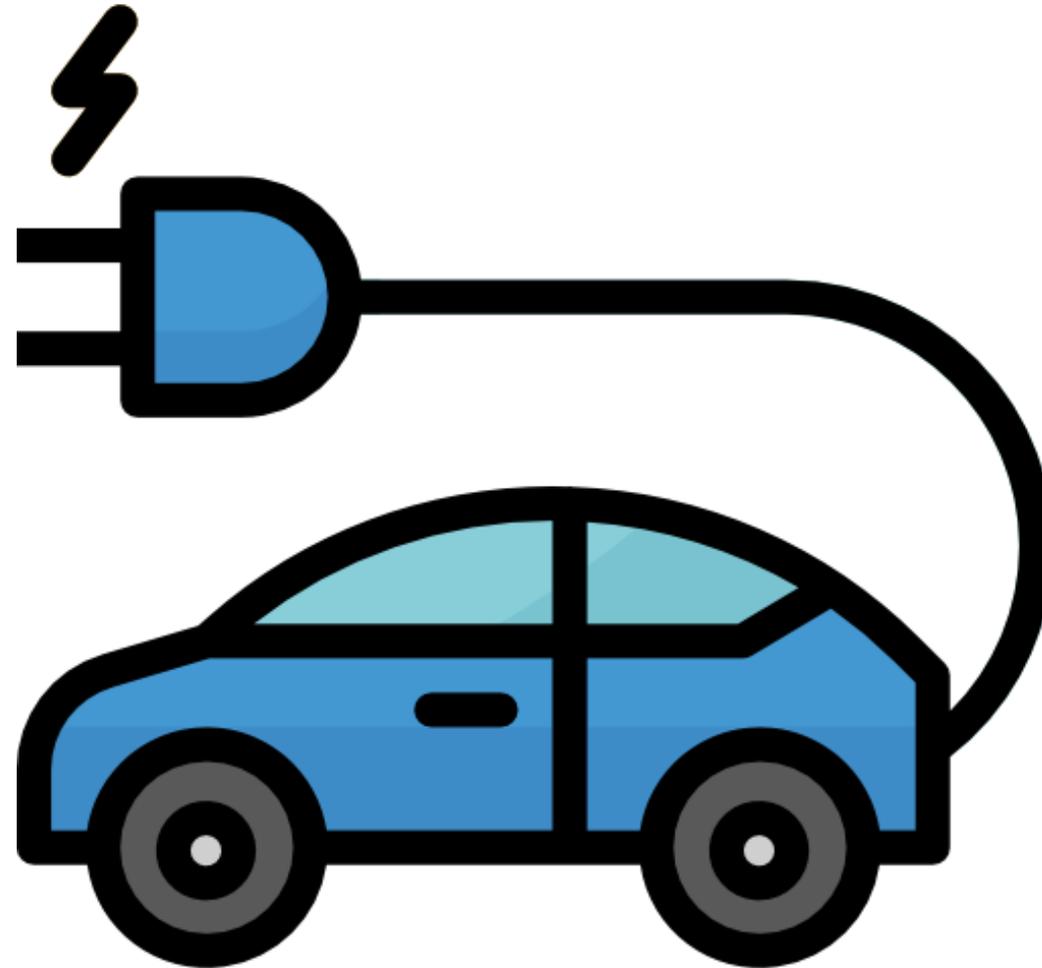
Hybrid controller tells the engine controller when to stop and start, tells the motor/generator when to charge the battery or propel the car

... BACKS UP THE 12-VOLT SYSTEM

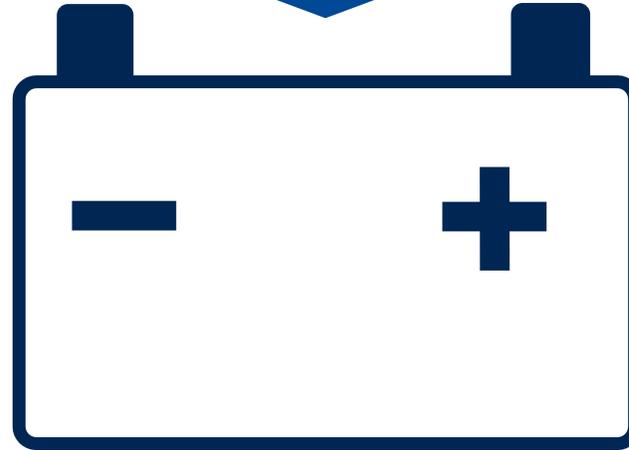
- 5 **DC/DC converter** changes 48-volt battery power to back up the 12-volt accessories
- 6 **12-volt battery** – your old friend
- 7 **12-volt electrical distribution center** for 12-volt electrical devices like the center console, power seats and windows sensors, etc.



Battery Electric Vehicles BEV



Still, a 12V
battery is
installed



How can
we test
this
battery?

How to replace?

What is the function of
the 12 Volt battery?

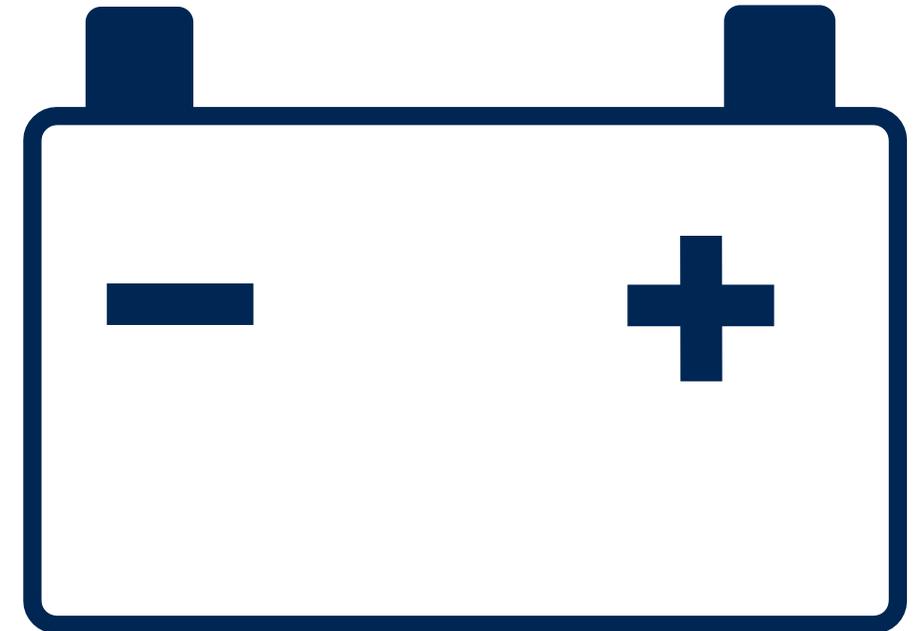
Which technology?

How does the car charge the
battery?

12V batteries from ICE, HEV to BEV

Which technology?

- Regular flooded, SLI
- EFB
- AGM
- Lithium



What is the function of the 12V battery in an E.V.?



Vehicle Startup: The 12-volt battery is responsible for providing the initial power needed to start the vehicle's computer systems, sensors, and other electrical components. It powers the vehicle's onboard computers and control modules that manage various systems, including the main high-voltage battery and powertrain.



Accessory Power: The 12-volt battery supplies power to various accessories in the vehicle, such as lights, infotainment systems, HVAC (heating, ventilation, and air conditioning), power windows, and other electrical components that are not part of the main propulsion system.



Emergency Systems: The 12-volt battery also supports critical safety and emergency systems, such as airbags, anti-lock braking systems (ABS), and other safety electronics. These systems require a separate power source to ensure they remain operational even if there's an issue with the main high-voltage battery.

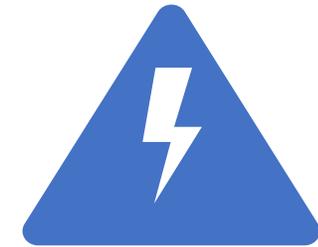
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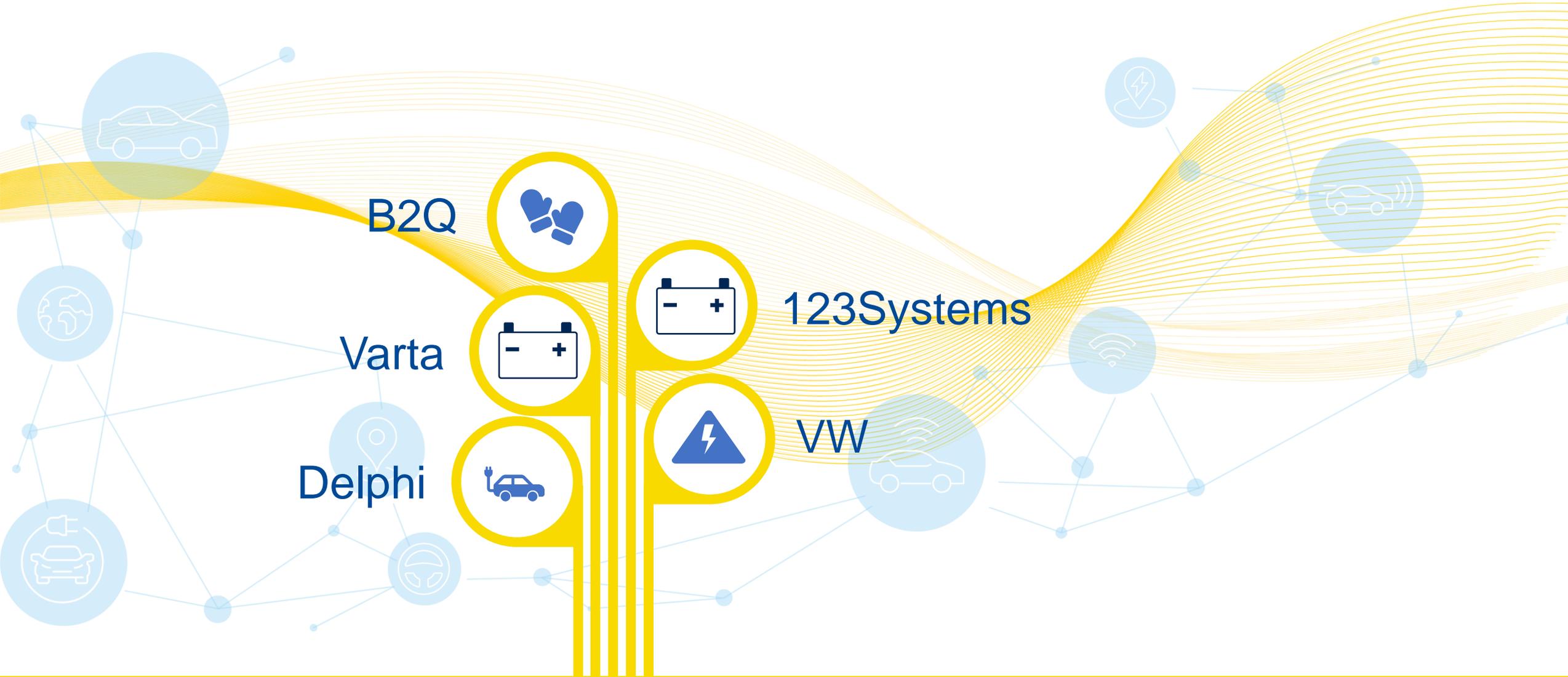
Backup Power: In case the main high-voltage battery becomes depleted or malfunctions, the 12-volt battery can still provide enough power to keep essential functions operational, allowing the driver to pull over safely and contact assistance if needed.



Vehicle Diagnostics and Monitoring: The 12-volt battery is used to power diagnostic and monitoring systems that check the health of various components in the vehicle. These systems help detect and report any issues or malfunctions to the driver.



Power Management: The 12-volt battery plays a role in power management and helps distribute power to various components efficiently. It acts as a buffer between the main high-voltage system and the 12-volt components, ensuring stable and reliable power delivery.





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THANK YOU

