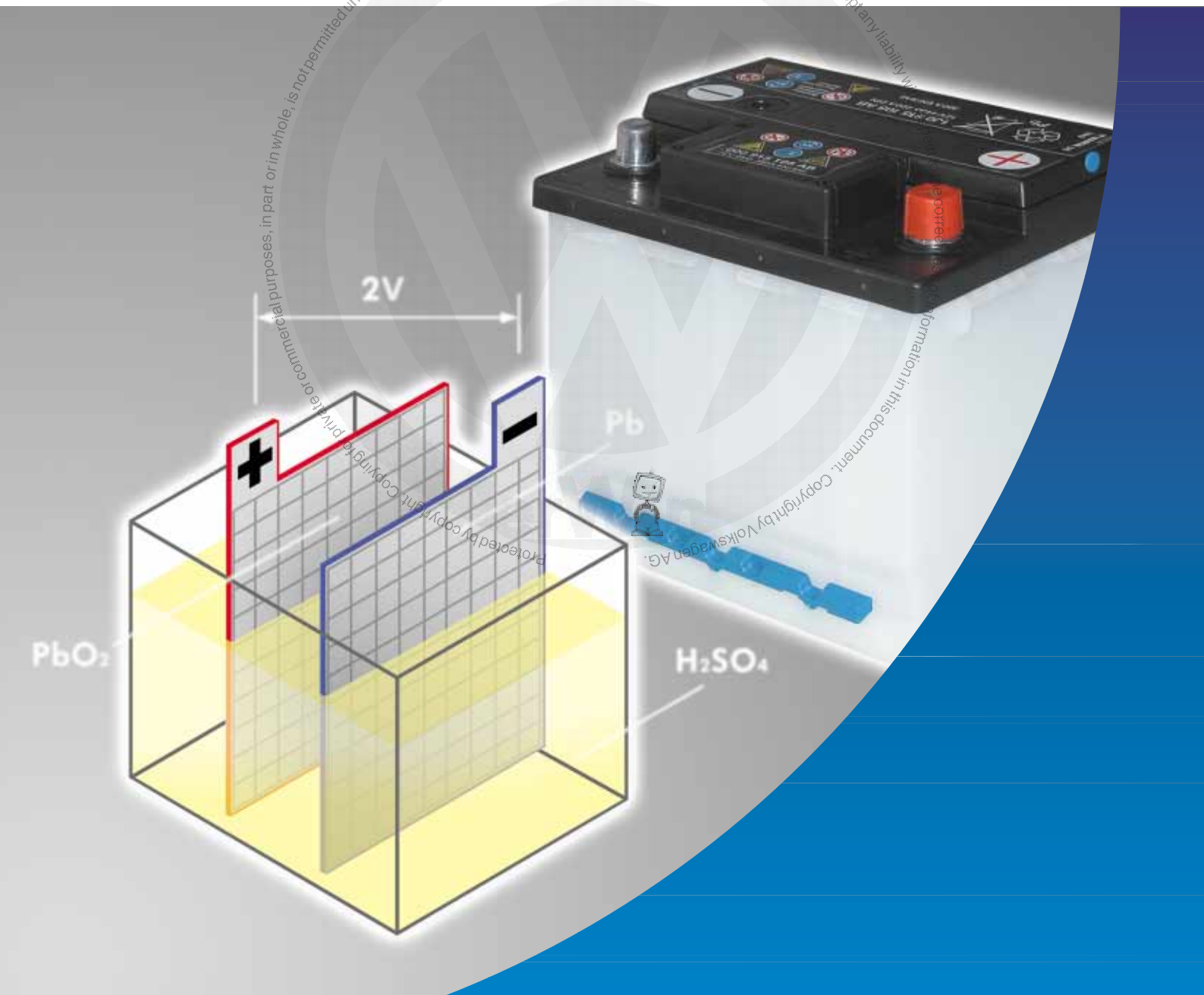
Service Training

Self-study programme 234

Vehicle batteries

Fundamentals and handling

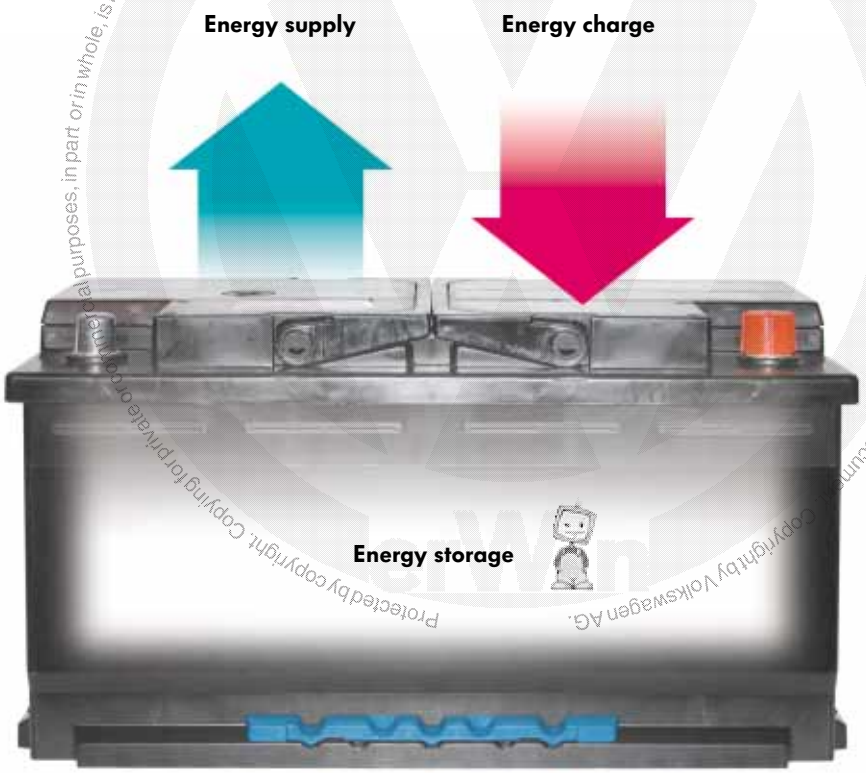


The battery is one of the most important electrical components in the vehicle.
A perfectly functioning battery contributes significantly towards customer satisfaction.

In addition to the engine starting function, the vehicle battery also has the task of storing electrical energy for the whole onboard electrical system in the vehicle.

The vehicle battery acts as an accumulator. This means it can accept electrical energy for purposes of storage and make it available for other uses at a later stage, depending on the demand.

To enable correct handling of batteries for service and maintenance, a degree of basic knowledge is necessary, which will be provided in this self-study programme.



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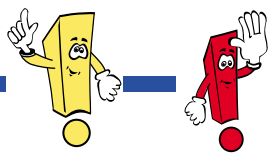


Important Note

The self-study programme shows the design and function of new developments!
The contents will not be updated.

For current testing, adjustment and repair instructions, refer to the relevant service literature.

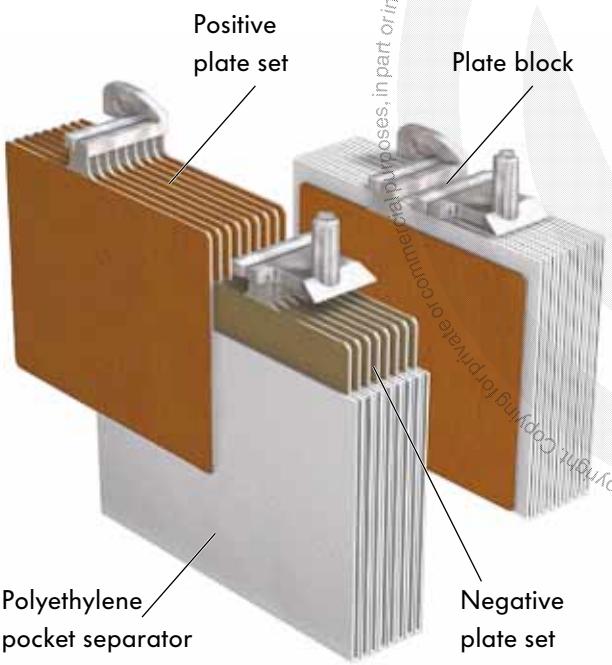
Contents

Battery construction

A 12 V battery features six cells, connected in series, which are separated by partitions in a polypropylene block structure.
One cell comprises of a plate block, which is made up of one positive and one negative plate set each.

The plate set comprises of lead plates (lead grid and active earth) and separators made from microporous insulating material between plates of different polarity.
The means of separation is provided by either a positive or negative plate set with polyethylene pocket separators.

The terminals and the cell and plate connectors are made of lead. The terminals differ by virtue of their different diameters.
The positive terminal is always thicker than the negative terminal. The different diameters serve as a means of reverse polarity protection.
The inter-cell links are fed through the cell partition.
The block body is made from acid-resistant insulating material (polypropylene) and forms the housing of the battery. It features protruding strips around the base to facilitate clamping. The block body is sealed at the top by means of a cover.



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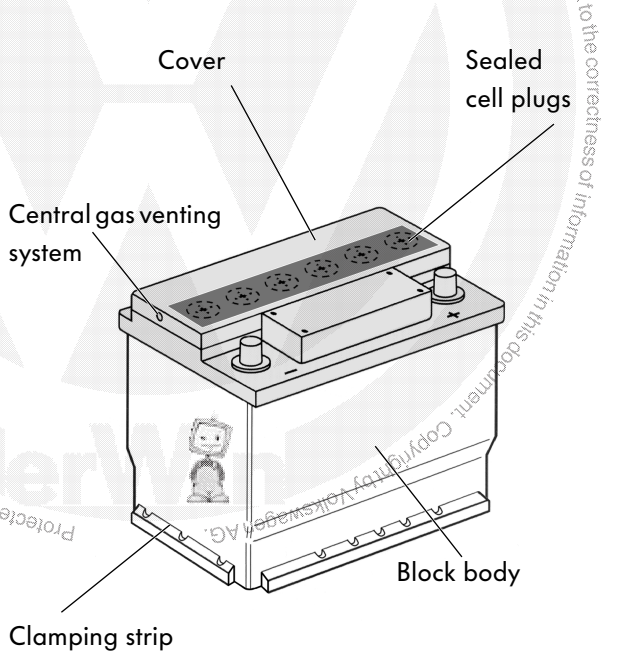


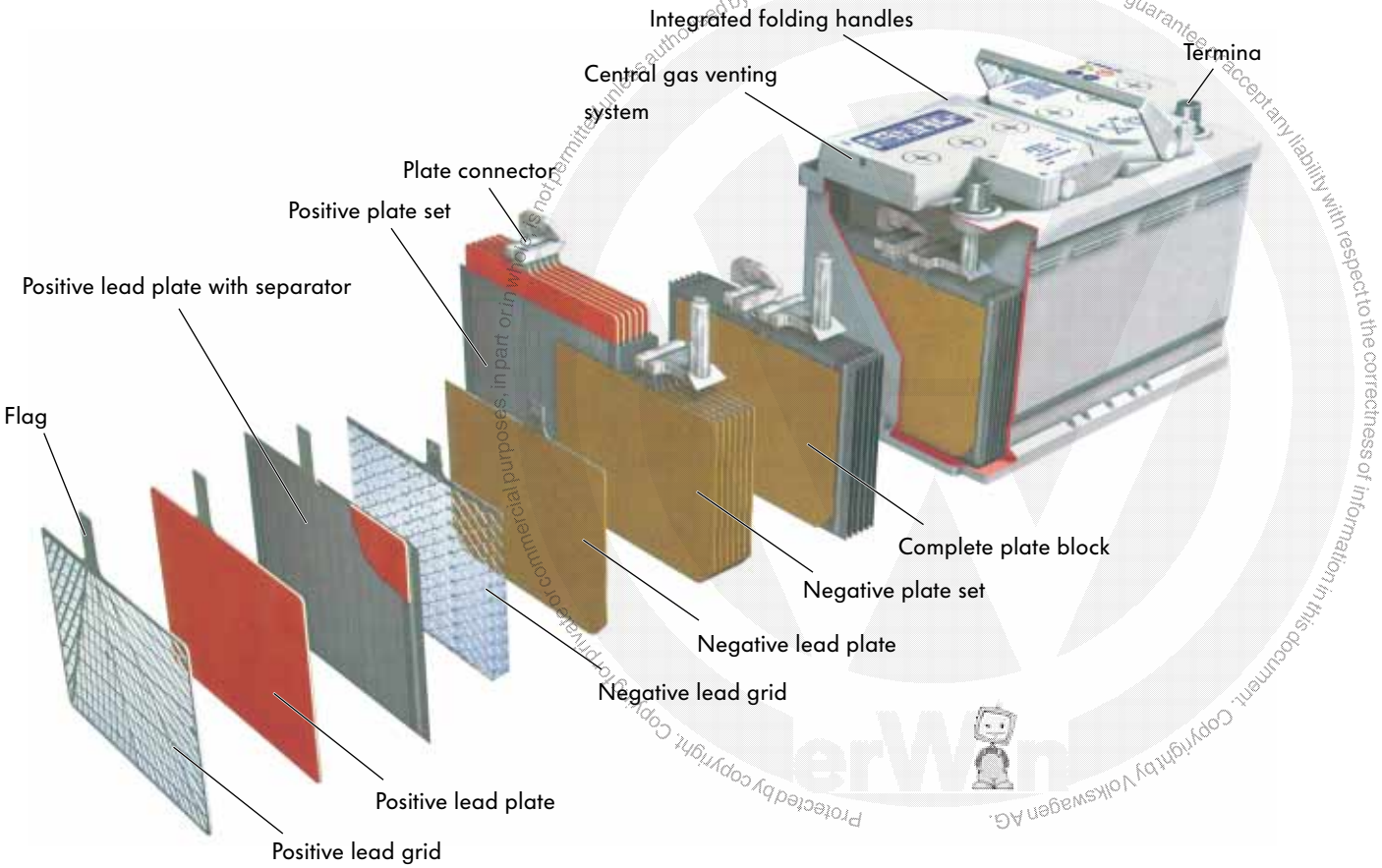
S234_003

Series connection of the cells is by means of inter-cell links. The desired battery voltage is achieved by connection of the cells via inter-cell links. As a rule, the negative terminal from one cell is always linked to the positive terminal of the next cell.

The battery fluid (electrolyte) is weak sulphuric acid, which fills up the space in the free cell area and the pores in the plates and separators.

n older type batteries, which are not maintenance-free, each cell has a removable cell plug. The cell plug serves as a means of initial filling, maintenance and venting the oxy-hydrogen that builds up inside.
Maintenance-free batteries are generally supplied in a completely sealed state.
Gas venting is by means of a central gas vent.

The illustrations in this SSP are just examples for purposes of representation.



S234_004

Electrolyte

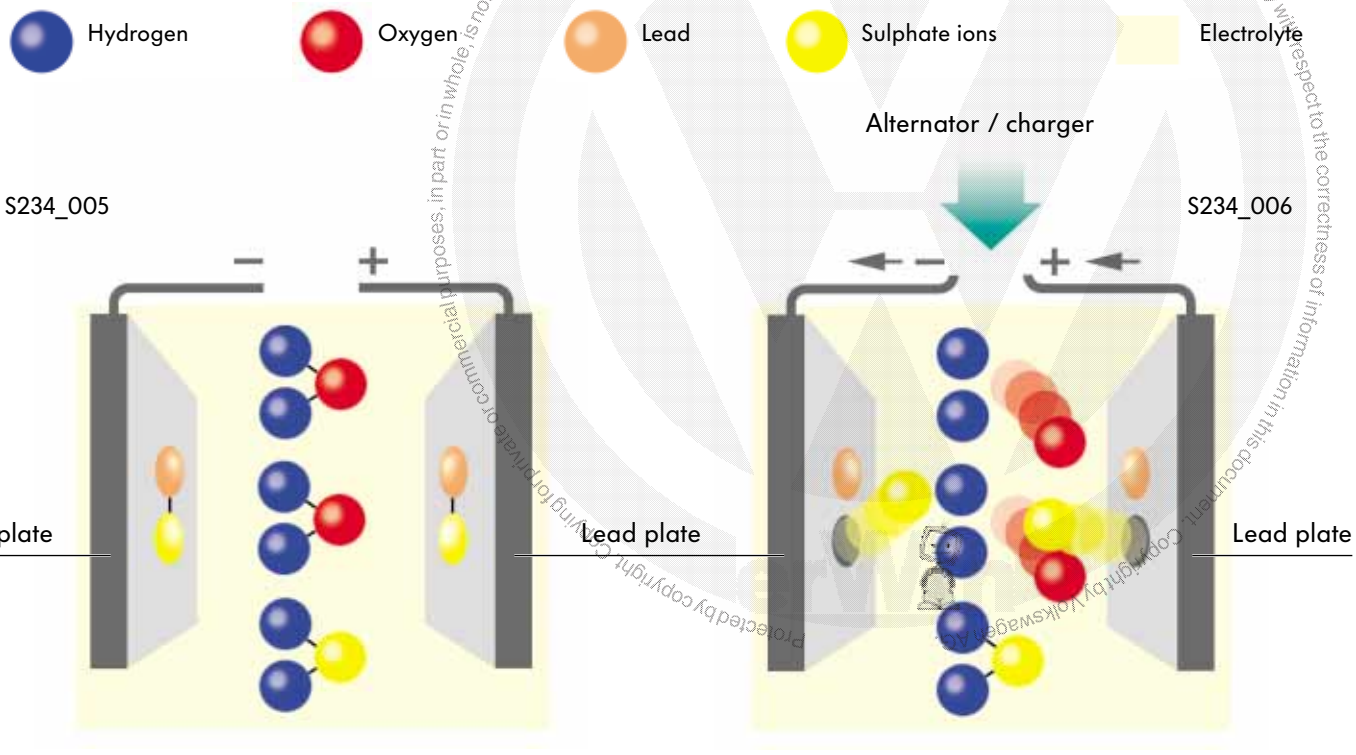
Fluid electrolyte
The battery fluid is generally referred to as electrolyte. In a lead-acid battery, watered-down sulphuric acid is used as the electrolyte.
In a completely charged state, the percentage of sulphuric acid is approx. 38 %. The rest is distilled water. Since electrolyte is ionised, it is capable of conducting an electrical current between the electrodes.

The nominal density of the electrolyte changes according to the charge state of the battery.

Solidified electrolyte
To prevent damage being caused by leaking battery acid, solidified electrolyte can be used.
The electrolyte can be solidified for this purpose using a gel agent. By adding silicic acid to the sulphuric acid, the electrolyte will solidify to a gel-like mass.
Another way to solidify electrolyte is to introduce absorbed glass mat (AGM), which acts as a separator. The AGM binds the electrolyte and prevents fluid from escaping in the event of housing damage.

Acid density	Charge state	Voltage
1,28 g/cm^3	100 %	12,7 V
1,21 g/cm^3	60 %	12,3 V
1,18 g/cm^3	40 %	12,1 V
1,10 g/cm^3	0 %	11,7 V

- Electrolyte is highly corrosive!
- Observe safety instructions!



Battery in discharged state

Battery under charge

Charge and discharge processes

- **Charging:**
  Charging means the reintroduction of electrical energy to a battery.
  During the charging process, electrical energy is converted into chemical energy.

As soon as the engine starts to run, the alternator sends a charge to the battery.
The result: Lead sulphate and water that build up in a battery during discharge are converted into lead, lead dioxide and sulphuric acid. This makes the chemical energy available again, necessary for the release of electrical power.
The acid density increases.

- **Discharging:**
  Discharging means the release of electrical energy from a battery.
  During the discharging process, chemical energy is converted into electrical energy.

As soon as a battery is connected to an activated electrical consumer, the discharging process beings. The sulphuric acid breaks down.
The percentage of electrolyte becomes less.
Water begins to form. The percentage of water in the electrolyte increases.
The acid density reduces.
Lead sulphate forms both on the positive plate and on the negative plate.

An optimal regulating voltage is important for the charging process.
If the regulating voltage is too high, the water content will be reduced as a result of electrolysis.
Over a period of time, the level of electrolyte will become less in the battery.
If the regulating voltage is too low, the battery will not be charged correctly.
The persistent charge fault will impair starting ability and reduce the life of the battery.
Oxy-hydrogens are generally formed when a battery is charged. Warning, danger of explosion !

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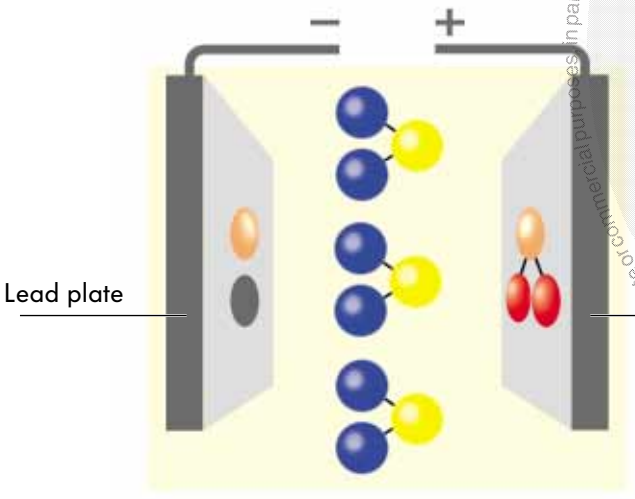

Battery in charged state

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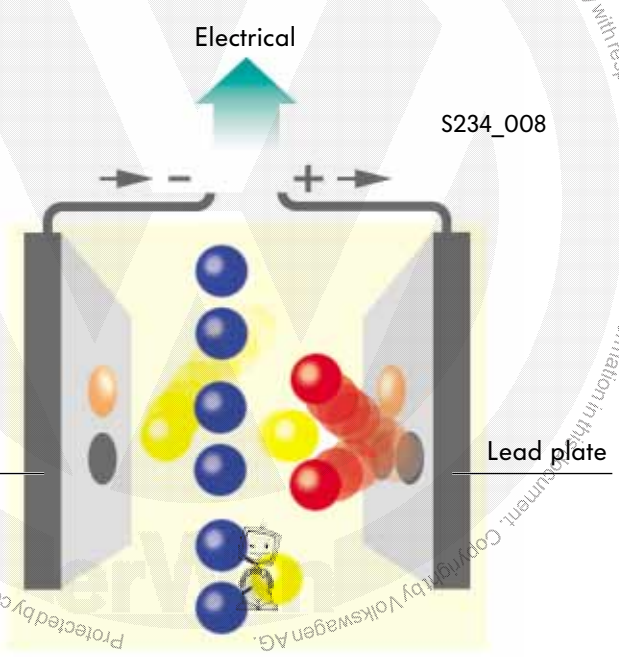
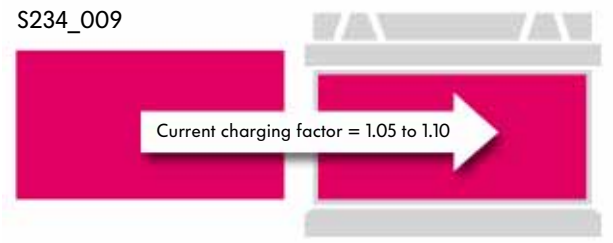


Battery discharging

Technical battery figures and terms

Current charging factor
The energy that is introduced in a battery during charging is always greater than the energy that can be taken from a battery.
This excess load serves as a means of compensating for the electro-chemical losses from charging.
In order to charge a battery to a maximum of 100 %, a quantity of between 105 % and 110 % of the energy taken must be reintroduced.
This figure (1.05 or 1.10) is the current charging factor.

S234_009



Percentage of current supplied = 105 to 110 %

Percentage of current released = 100 %

Capacity
The amount of electricity available in a battery or cell, measured in ampere hours (Ah).
The capacity is affected by the battery temperature and discharge current. The capacity available in a battery becomes considerably less as the discharge current figure rises and the ambient temperature drops (frost).

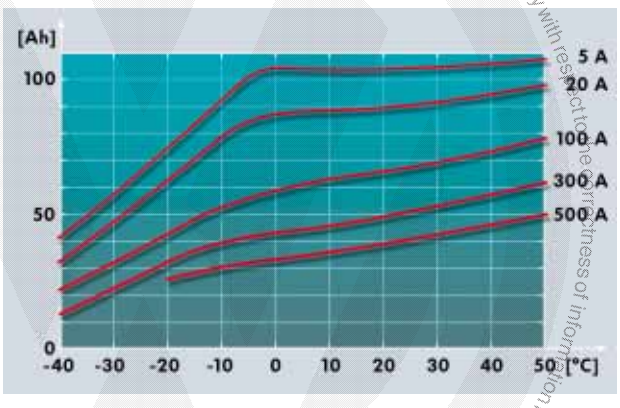
Nominal capacity K_{20}
Battery capacity specified by the manufacturer, measured in ampere hours.
A fully charged, new battery should give off a current of **K_{20} : 20 h** at room temperature for at least twenty hours.
The battery voltage should thereby not drop below 10.5 V. Example - 60 Ah battery:

60 Ah : 20 h = 3 A

A 60 Ah battery should give off a current of 3 A for at least twenty hours, without the battery voltage dropping below 10.5 V.

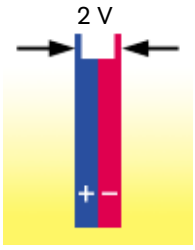
Cold test current
The start capability of a battery in cold weather is shown by the cold test current.
The cold test current is the discharge current specified by the manufacturer, which should be given off from a fully charged battery at -18 °C for a standard fixed period of time. During this time, the standard fixed voltage limit should be reached and maintained. The testing procedure is described in VW standard 750 73.
(See glossary)

S234_010



Available capacity of a battery (12 V 100 Ah) depending on temperature and discharge current, based on period of discharge 20 h and 100% charge state.

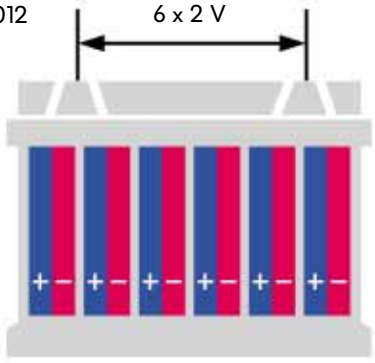
S234_011



Nominal voltage
of one cell

Cell voltage
The cell voltage is the difference in capacities arising between the positive and negative plates in the electrolyte.
The cell voltage is not a constant figure.
It depends largely on the charge state (acid density) of the battery.
The degree to which cell voltage relies on the temperature is negligible.
The nominal voltage of a cell, however, is constant. It amounts to 2 V.

S234_012



Nominal voltage

Nominal voltage
On vehicle batteries, the nominal voltage of a cell is determined by industrial standards.
The nominal voltage of a battery can be calculated by multiplying the nominal voltage of the individual cells by the number of cells.
For vehicle batteries, the standard nominal voltage is 12 V.

Terminal voltage
The terminal voltage is the voltage measured between the terminals of a battery.

Gas voltage
The gas voltage is the charge voltage, above which a battery begins to generate gas most noticeably. Gas starts to build up from 14.4 V terminal voltage (2.4 V cell voltage). The result of this is a high level of excess hydrogen (oxy-hydrogen). Warning, danger of explosion!

Rest voltage
The rest voltage, or idle voltage, is the voltage of a disconnected, load-free battery after a certain threshold has been reached.

- **Note :**

Further information on rest voltage can be found in ELSA.

- "Workshop manual", Electrical system, Repair group 27
- "Maintenance charts", Service on out-of-use and stored vehicles.

This function is available from version 3.1.

Latest technologies

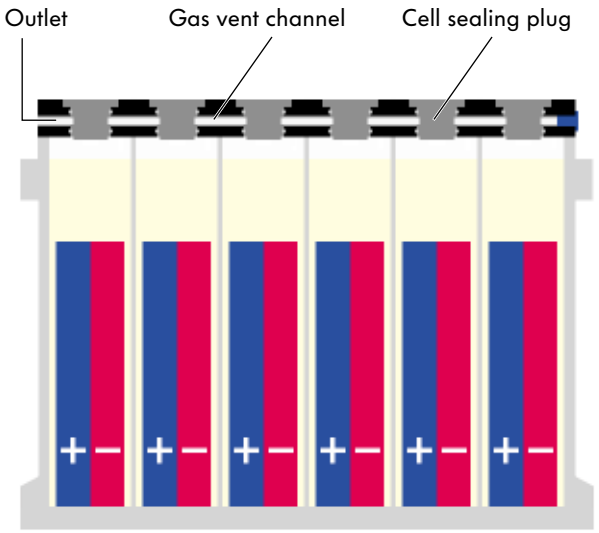
Different types of battery

Wet batteries

Batteries with fluid electrolyte are referred to as wet batteries.
Wet batteries are available with removable cell sealing plugs, for purposes of maintenance, and without cell sealing plugs.

Advantages:
- Good value for money.
- High commercial availability (diverse range).
- Suitable for installation in engine compartment.

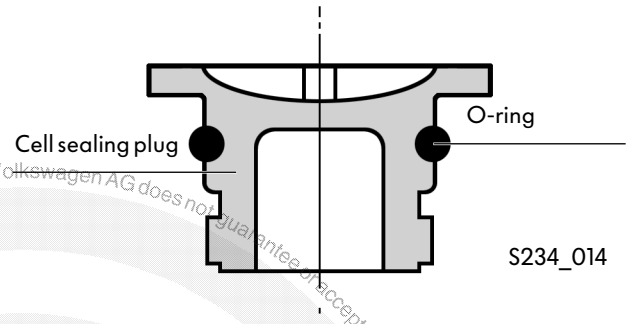
Disadvantages:
- Level of electrolyte must be checked during inspection work using magic eye (condition indicator).
- No protection against leaks



Wet battery

Cell sealing plugs

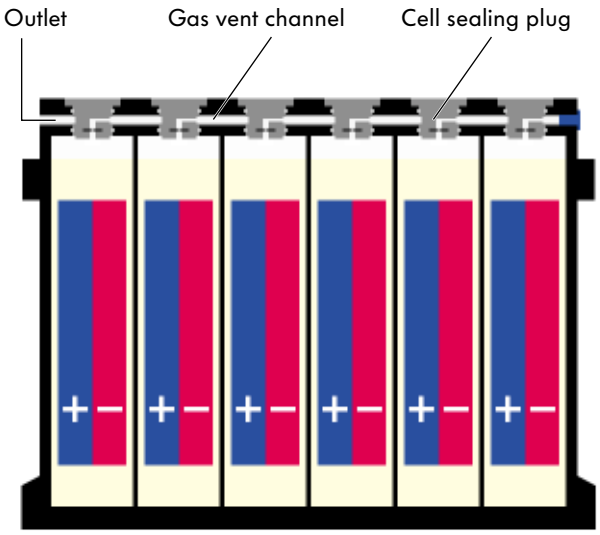
Gas ventilation of the cells in a wet battery occurs by way of the central gas vent channel. The gas vent channel feeds the gas to one or two side outlets in the battery cover.
If there are two outlets, one is always sealed!
On batteries with cell sealing plugs, an O-ring prevents gas escaping passed the plugs.



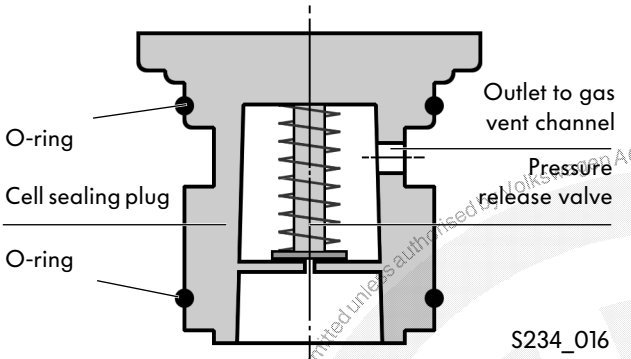
Cell sealing plug from wet battery

On all battery types, electrolyte can escape out of the battery housing from damage or improper handling. There will thus be a risk of acid corrosion!

When charging wet batteries that have cell sealing plugs, never unscrew the plugs!



VRLA-battery



Cell sealing plugs of VRLA battery

VRLA batteries

(Valve Regulated Lead Acid Battery)
VRLA batteries are of the solidified electrolyte type.
The cell sealing plugs cannot be unscrewed.
The gases that result from excess loading, i.e. hydrogen and oxygen, are converted back into water within each respective cell.

Advantages:

- Maintenance-free as there is no need to check or replenish the electrolyte.

Disadvantages:

- If the battery is charged excessively, the surplus gas is discharged via a gas ventilation valve, designed as a safety valve. Since the volume of fluid cannot be replaced, long-term damage to thebattery can ensue! For charging purposes, therefore, choose only a battery charger with a charge load limit of 14.4 V!

Cell sealing plugs

Located in the non-accessible sealing plugs are gas vents that allow excessive gas pressure to be released via the central gas vent channel.

Latest technologies

Gel batteries

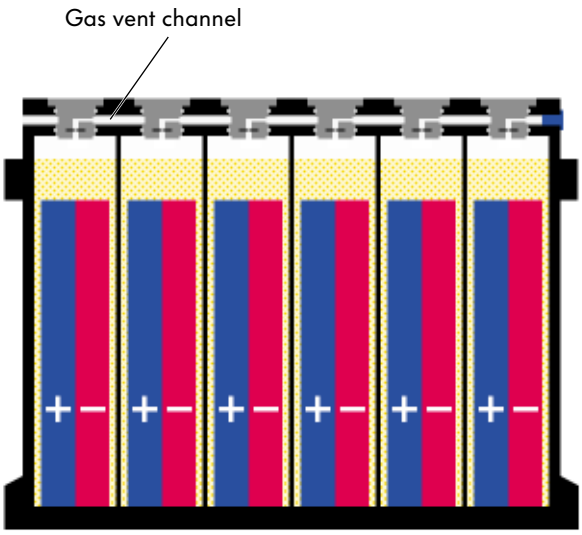
Electrolyte in gel batteries is solidified to a gel-like mass by the addition of silicic acid to form sulphuric acid.
Due to the gas venting properties, gel batteries belong to the VRLA type.

The phosphorous acid contained in the electrolyte increases the charge/discharge cycle capacity and thereby offers favourable conditions for recharging after deep discharge.
The battery is sealed by a battery cover.
The non-removable cell sealing plugs and gas vent channel are integrated in the cover.
Gel batteries are not equipped with a magic eye (condition indicator).

Advantages:
- Protection against leaks
- High charge/discharge cycle capacity
- Maintenance-free
- Low build up of gas

Disadvantages:
- Poor cold starting properties
- High price
- Low availability
- Not compatible with high temperatures, not suitable for engine bay

Note:
Gel batteries are not installed in VW vehicles.



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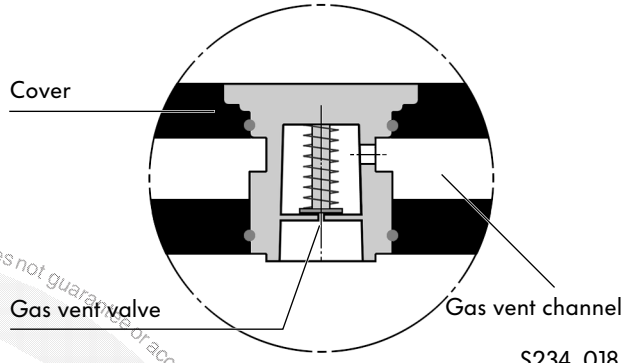
Gel battery with solidified electrolyte.



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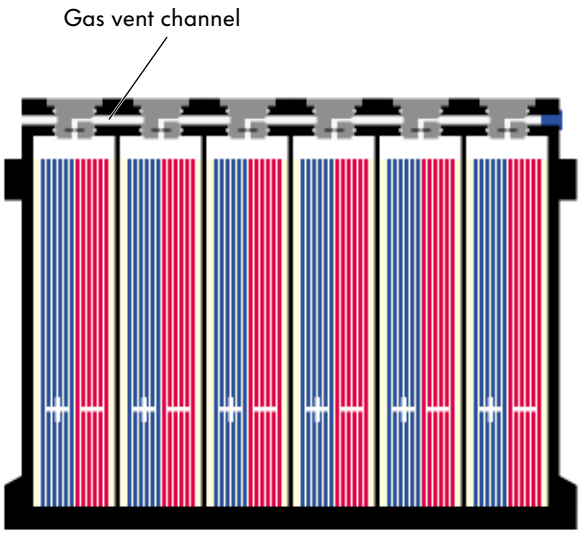
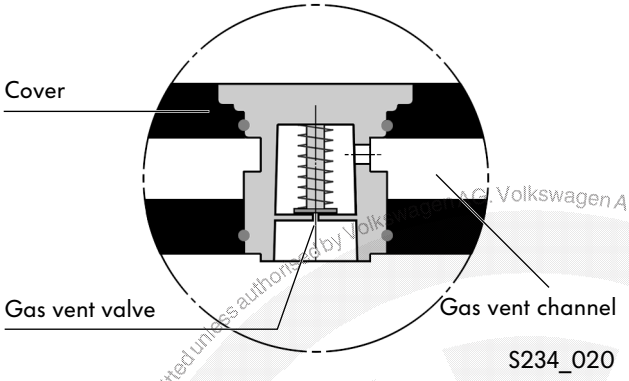
Section of battery cover
The cell sealing plugs and the gas vent channel of a gel battery are integrated in the battery cover.

On all battery types, electrolyte can escape out of the battery housing from damage or improper handling. Risk of acid corrosion!



AGM battery with completely enclosed housing.
The electrolyte is absorbed in this battery by the glass mat.



ASection of battery cover
The cell sealing plugs and the gas vent channel of an AGM battery are integrated in the battery cover.

AGM-batteries

(Absorbent Glass Mat Battery)
Batteries in which the electrolyte is solidified by absorbent glass mat are referred to as AGM batteries. The glass mat is like a fleece material, which is comprised of very fine interwoven glass fibres. The glass mat works very well with sulphuric acid and is highly absorbent. It fulfils the function of a separator.
The full volume of electrolyte is absorbed by the glass mat.
AGM batteries therefore offer protection against leaks.
In the event of housing damage, there is still a risk of electrolyte fluid escaping, though the quantity is negligible
(from zero to a few millilitres).
The battery is sealed by a battery cover.
The cell sealing plugs and the gas vent channel are integrated in the cover.
AGM batteries are not equipped with a magic eye (condition indicator).
Due to the gas venting properties, AGM batteries belong to the VRLA type.
AGM batteries are used at VW in areas where the charge/discharge cycle capacity, cold start and leak protection need to be higher.

Advantages:
- High charge/discharge cycle capacity
- Leak protection
- Maintenance-free
- Low build up of gases
- Good cold starting properties

Disadvantages:
- High price
- Low diversity of commercial products
- Not compatible with high temperatures, therefore not suitable for installation in engine bay

VOLKSWAGEN factory fitted batteries

Properties and special features

The central gas venting system
On a central gas venting system, the gas is discharged at a defined point from the battery. With the aid of a gas vent pipe, gas can be vented to a particular side of the battery where there is no danger of it causing harm, e.g. away from sources of
ignition. Depending on the installation position, the battery can vent gas to the positive or negative side.

The backfire inhibitor
The backfire inhibitor consists of a porous plastic washer, which acts like an anti-backfire valve. The plastic washer can be found in front of the central gas vent.
If gas discharged from the vent hole is ignited externally, the plastic washer is designed to prevent flames from entering the inside of the battery.

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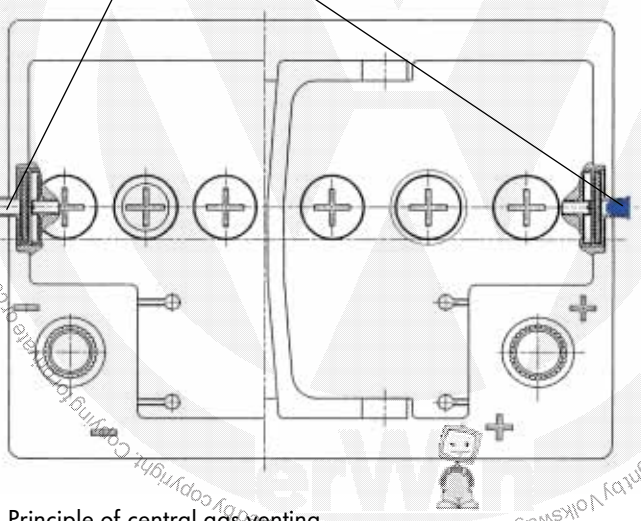
S234_022



Principle of central gas venting

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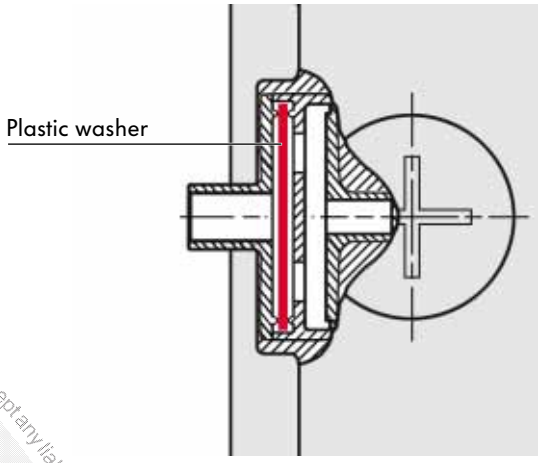
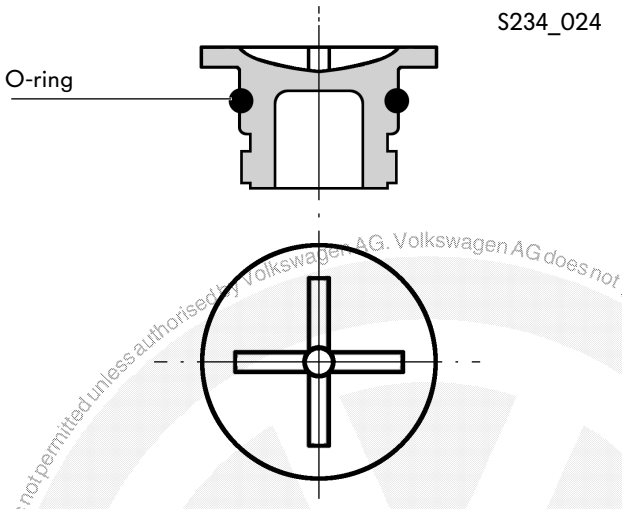


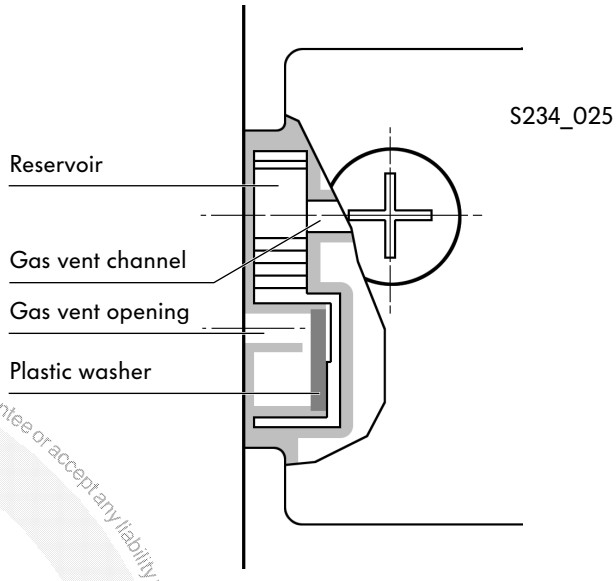
Backfire inhibitor

Generally, Volkswagen factory fitted batteries are equipped with one vent hole at each terminal side. Of these two vent holes, one must always be sealed. This ensures that gas ventilation is carried out only at the gas vent pipe which is connected.
In the event that both vent holes are sealed, the battery could explode under pressure. It is imperative that a plug is removed out of one of the vent holes in accordance with the table in the installation instructions for Volkswagen factory fitted batteries.

Cell sealing plug with O-ring
The cell sealing plugs are fitted around their circumference with an O-ring, by which an airtight seal is formed, irrespective of the tightening torque when the plug is screwed in.
The sealing plugs with O-rings also serve as a means of inhibiting backfire. Their function is only assured if the gases are discharged centrally via one vent installed explicitly for that purpose.

Acid trap feature
On Volkswagen factory fitted batteries there is a reservoir at the end of the central gas vent channel, which collects acid droplets that are drawn through by the gas stream.



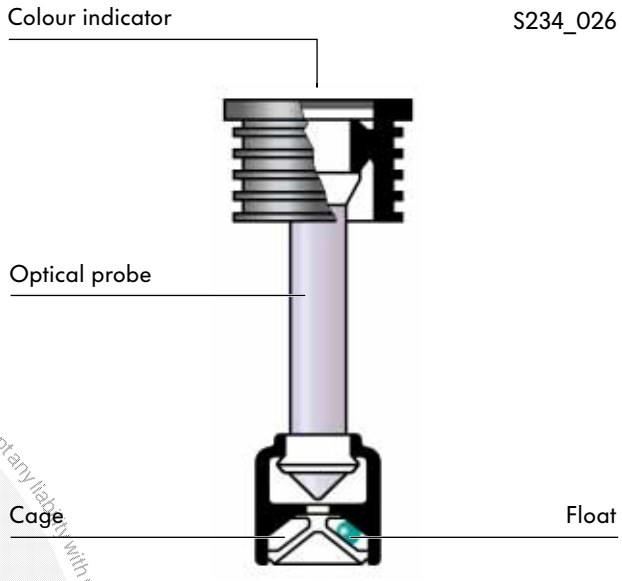


On batteries with cell plugs that do not have an O-ring, there is a risk that water could make its way into the inside of the battery via the unsealed cell plugs. If the plugs are not sealed, the fluid level in the battery could rise and cause electrolyte leaks. Damage to the bodywork could ensue.
On cell plugs with O-rings, gas could escape passed the cell plugs. In a worst case scenario, external sources of ignition could cause the battery to explode.

VOLKSWAGEN factory fitted batteries

The magic eye
Installed in all models of the VW Group, with the exception of the Audi A8, Audi A6 and Audi A4, are wet batteries equipped with a magic eye. The magic eye provides information about the charge state and acid level of the battery by means of a colour indicator.
Detection in just one cell is sufficient to determine the initial load state of the battery.
Before a visual inspection is carried out via the magic eye, carefully knock against the eye using the grip of a screwdriver. Any air bubbles that could impair the indicator's reading will be dispersed in this way. The accuracy of the colour indicator will therefore be greater.

Note:
During battery charging, the acid density increases only in the area of the plates. A rise in acid density above the plates occurs by means of diffusion. The magic eye detects the acid density, however, only above the plates.
In isolated cases, this can lead to the following incorrect reading:
Despite fully charged battery, the magic eye could indicate black. This is due to the fact that the electrolyte with high acid density has not yet mixed with the electrolyte with low acid density. This mixing process (diffusion) can take several days.
For a precise evaluation of the battery status, it is necessary to test the battery using battery tester VAS 5097 A.



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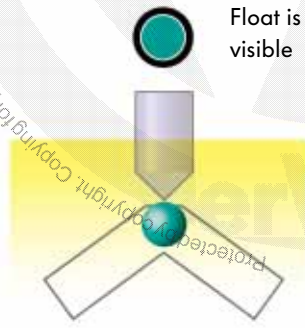
Three different colours are possible in the indicator of the magic eye:

Green:
Good state of charge >65%, battery OK



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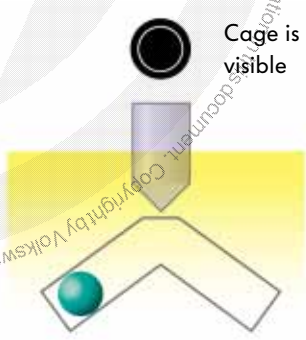
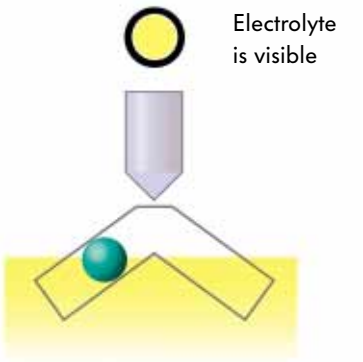
Black:
Poor charge status <65%, charge battery



S234_028

Yellow or neutral:
Electrolyte level too low, renew battery



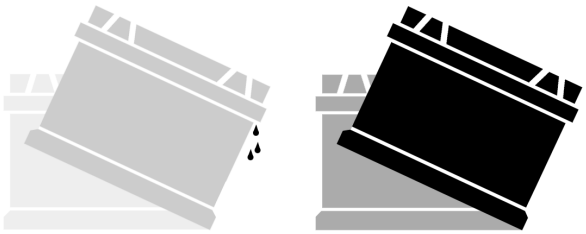
S234_029

Tilt angle optimisation

On some types of vehicle, the battery has to be tilted or moved about its axis for removal and installation.

Volkswagen factory fitted batteries are designed so that they can even be turned upside down for a brief period without electrolyte escaping.

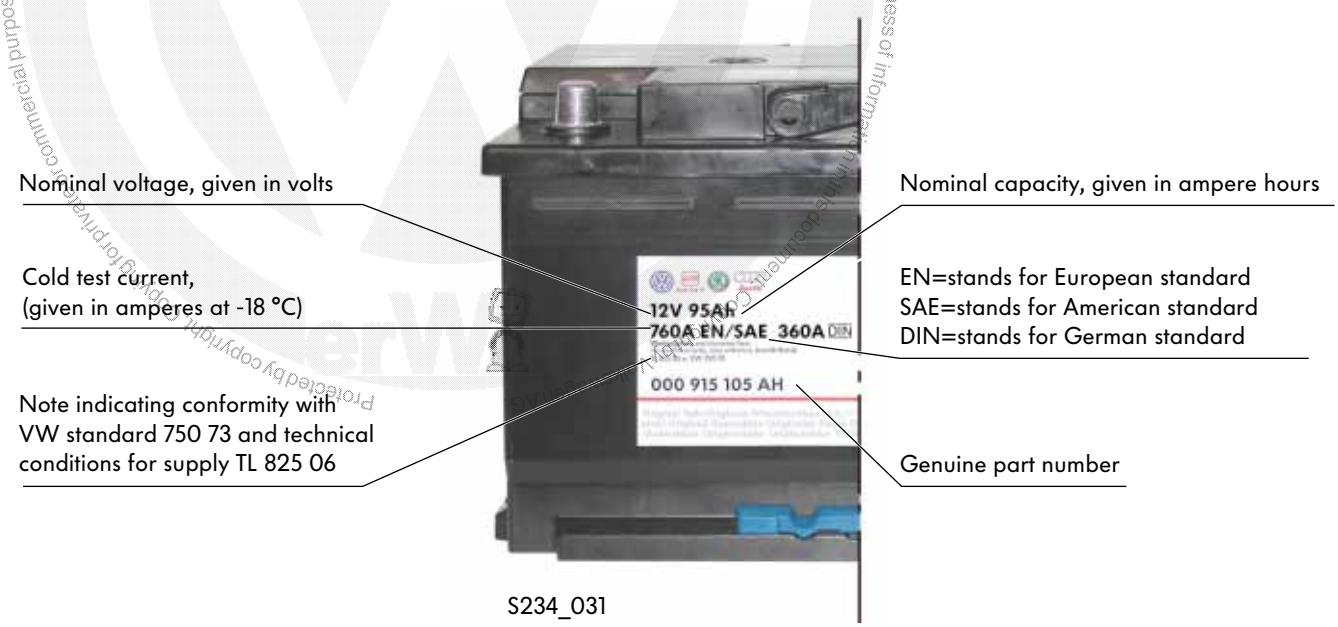
On other makes of battery there is a risk of acid leaking if the battery is tipped over.



S234_030

Battery markings

To describe the performance and allocation of batteries clearly and unequivocally, the following details are necessary:



S234_031

VOLKSWAGEN factory fitted batteries

Low maintenance and maintenance-free batteries

Low maintenance battery
A battery is called "low maintenance" if the calculated gross water consumption over 42 days is no greater than 16 g/Ah of the nominal capacity. Low maintenance batteries are only used at VW when requested as a replacement part for older vehicles.

Low maintenance battery	Maximum **16 g** per Ah nominal capacity
Maintenance-free warm installation position	Maximum **3 g** per Ah nominal capacity
Maintenance-free cold installation position	Maximum **8 g** per Ah nominal capacity

Maintenance-free battery
A battery is referred to as maintenance-free if, under normal operating conditions, it does not need to be replenished with distilled water. The housing of maintenance-free batteries is transparent. The cover is black.
(Introduced as of 2004)

Maintenance-free batteries are differentiated by their installation position.

Maintenance-free - cool location

- When gross water consumption after 42 days is a maximum of 8 g/Ah of the nominal capacity.

Example: Battery located in cold position

S234_032

Example: Battery located in hot position

S234_033

Maintenance-free - warm location

- When gross water consumption after 42 days is a maximum of 3 g/Ah of the nominal capacity.

Wet VOLKSWAGEN factory fitted batteries fulfil the demands associated with "maintenance-free - hot location".
For means of testing, see VW standard 75073

Maintenance-free batteries with cell sealing plugs
These batteries can be identified by the magic eye and sealed cell plugs.
To replenish the batteries, the foil seal over the cell plugs can be pulled off.

Maintenance-free batteries without cell plugs
These batteries feature a magic eye and no separate cell sealing plugs.
The cell sealing plugs are integrated in the cover.
The cover is used to seal the battery after initial filling during production.

S234_034

S234_035

Do not remove adhesive foils with warning notices!

The cover should not be removed as otherwise the battery could become damaged.
The battery will be rendered useless.

Transparent housing on wet batteries
Wet batteries installed from 2004 have a black cover and transparent housing.
The transparent housing makes it possible to check at a glance the level of electrolyte in all cells when the battery is supplied and prior to installation in the vehicle. This is not possible on black battery housings.

Black housing on AGM batteries
AGM batteries have a black cover and a black housing. The different housing colours allow identification between AGM batteries and wet batteries.

VOLKSWAGEN factory fitted batteries

Installation positions in vehicle

The installation position or place where the battery can be found in the vehicle has a strong influence on the battery's operability.

A favourable installation position for the vehicle battery has to fulfil different criteria:

- Good accessibility for service and repair work.
- Protected against hot spots or air cooling when the vehicle is in motion.
- Protection against damp, oil and fuels and also any form of mechanical influence.
- In the event of a crash, the vehicle occupants must be protected from escaping gases and leaking battery acid

Battery in engine compartment
If, for design reasons, the battery is installed in close vicinity to the engine or near ancillaries that radiate a lot of heat, the high temperatures to which the battery is subjected to could have a negative impact on the ageing process of the battery.

Corrosion in the positive grid, water consumption and self-discharge are increased.

To counteract this process, the batteries are often installed in battery boxes made from plastic. For particularly hot conditions, the battery is protected in addition by means of a heat insulating jacket. Contrary to popular belief, this is not designed to keep the battery warm in adverse weather conditions.

Battery box in Touran, model year 2004

S234_036

Heat insulating jacket in Golf, model year 2003

S234_037

Battery in vehicle interior / luggage compartment

If the battery is located on the inside of the vehicle, the battery used is always of the wet-type with optimised tilt angle properties, or an AGM battery with anti-leak protection. Likewise, batteries installed on the inside of the vehicle are always equipped with a gas vent pipe.
If the vehicle were to roll over in an accident and come to rest on its roof, battery acid could leak out. The occupants could be injured in this way.
By the use of tilt angle optimised or anti-leak batteries, the risk of acid burns is kept to an absolute minimum.

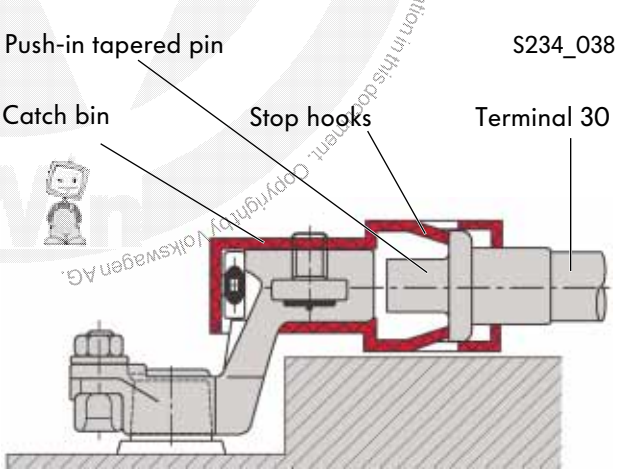
- It is therefore important, when renewing a battery, to choose one with these features. This is the standard on VW factory-fitted batteries
- Take special care to ensure that the gas vent pipe is inserted back in the central gas vent opening of the battery.

No repairs should be carried out on units comprising of a safety battery terminal and associated wiring connector.
If found to be damaged, the complete unit must be renewed.

Sicherheitsbatterieklemme

Die Sicherheitsbatterieklemme kommt zum Einsatz, wenn die Batterie im Fahrzeuginnenraum oder im Kofferraum eingebaut ist. Mit dem relativ langen Verlegungsweg des Batteriekabels zum Anlasser steigt die Brandgefahr bei Kabelbeschädigung im Falle eines Unfalls.
Im Crashfall wird bei Airbagauslösung die Plusverbindung von der Batterie zum Anlasser getrennt. Die Spannungsversorgung für das Bordnetz bleibt jedoch für wichtige Sicherheitsfunktionen wie z.B. Warnblinklicht und Beleuchtung erhalten.

Die Trennung der Plusverbindung geschieht durch Absprengung in einem Fangkorb.
Zwei Widerhaken im Fangkorb verhindern einen ungewollten erneuten Kontakt.
Diese Art der Sicherheitsbatterieklemme ist z.B. im Lupo 3L und Phaeton verbaut.



Safety battery terminal: In isolated state

Energy structure

Factors affecting energy structure

The energy structure evolves from the relationship between the battery capacity, the consumers of the onboard electrical system, the alternator output, the alternator ratio, the idling speed of the engine and the driving conditions.

The vehicle battery provides a power source from which the various consumers have to be supplied with sufficient energy.
It must therefore be continually charged by the alternator. If the amount of energy supplied is greater, the battery will become "flat". The charge becomes ineffective

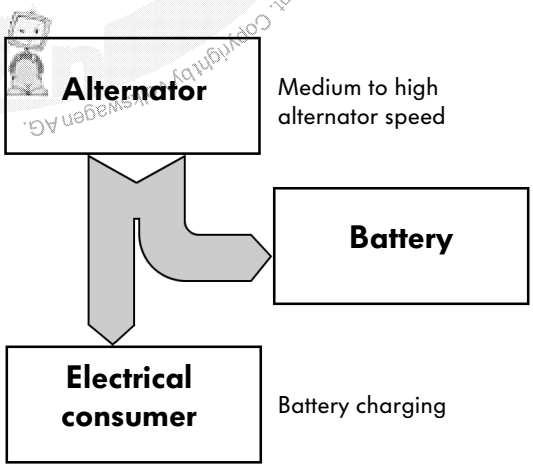
- A well balanced ratio between energy input (charge) and energy output (discharge) provides the ideal conditions for a healthy energy structure.
- Additional consumers installed in the vehicle or extreme driving conditions can affect the healthy balance of an energy structure.
- The sum of the consumption values and the individual driving conditions have a considerable influence on the energy structure.

Favourable situation:
Operation of main beam headlights

S234_039

Main beam headlights are normally used on open roads, where traffic is not so dense, and at high engine speeds.
In city traffic, at low engine speeds, frequent engine idling periods, in dense traffic and during short journeys, the main beam headlights are not required.
Consumers of this type do not represent a problem because they are normally used in a favourable alternator speed range.
All consumers are provided with a sufficient supply of energy and the battery is recharged.

⊕ All influencing factors, therefore, work well in this instance.



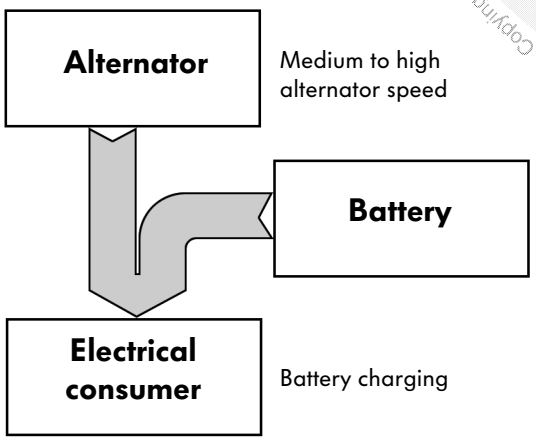
S234_040

Unfavourable situation:
Operation of fog lamps

S234_041

If a number of electrical consumers are switched on at the same time, such as fog lamps, lights and heated windscreen for example, the conditions are not so favourable.
All these electrical consumers are normally switched on in the lower engine speed range, in which the alternator cannot return the full amount of energy. Fog forces traffic to move slowly. Even when there is oncoming traffic the fog lights remain switched on. They remain on for a relatively long period of time.

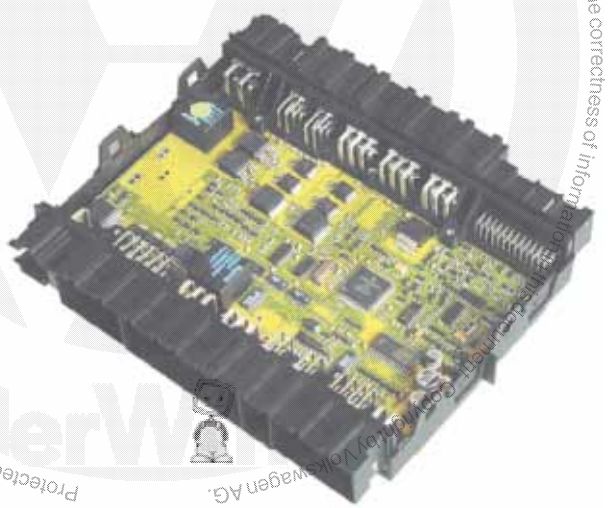
⊖ In this example, the influencing factors do not work as well together.



S234_042

Functions of onboard supply control unit J519
Functions that were previously carried out in control units and relays around the vehicle are now localised in the onboard supply control unit. The onboard supply control unit is responsible for the load management of different convenience consumers. To do this, it monitors the voltage status at the battery.
If certain thresholds are reached, it demands a higher engine idling speed.
The increase in alternator speed thereby provides more favourable conditions in the onboard electrical system.

If there is a risk of the engine starting ability being impaired or of electrical consumers with safety functions not operating correctly, convenience consumers, such as the heated rear window for example, can be switched off for a brief period of time.



Onboard supply control unit J519 in Touareg S234_043

Energy structure

Electrical system concepts

In conventional vehicles, a battery has the task of ensuring there is enough electrical energy to start the engine and to supply the electrical consumers.
All of the consumers are supplied by just one battery in all operating conditions.

Due to the wide number of vehicle equipment levels and particularly high cold starting requirements, it may be that one battery alone will no longer be adequate to supply sufficient quantities of power.

If this is the case, either an

- auxiliary battery

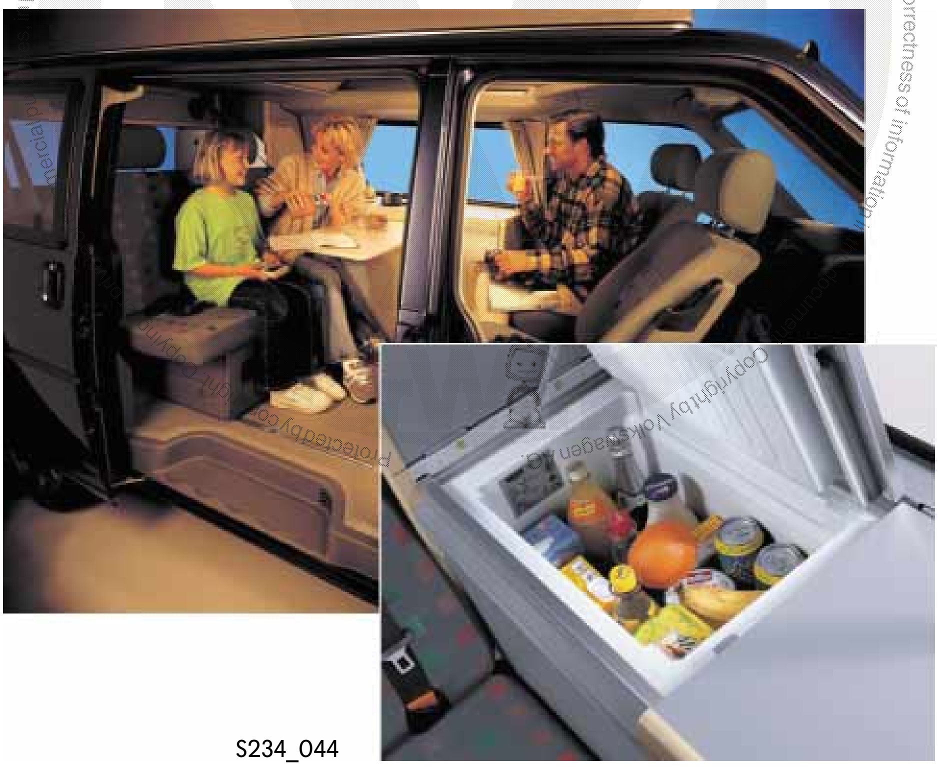
  or
- dual battery concept is used

The auxiliary battery
In recreational vehicles, the parking heater, cooling box, interior lights and much more are wired to a separate current circuit.
Power for this circuit is supplied by a separate 12 V battery, also referred to as an auxiliary battery.

This setup ensures that a sufficient quantity of energy is available to start the engine when the vehicle is parked for a period of time with activated consumers, e.g. camping.

- When the engine is running, the battery and auxiliary battery are connected in parallel and are charged by the alternator.
- When the engine is switched off, both batteries are separated by an isolator relay.

Auxiliary battery in recreational vehicles, for example



S234_044

Dual battery concept

On vehicles with dual battery concept, the electrical system is supplied by an onboard supply battery and a starter battery.

The dual battery concept in the Phaeton comprises of starter battery (A), onboard supply battery (A1), battery parallel circuit relay (J581) and battery monitor control unit (J367).

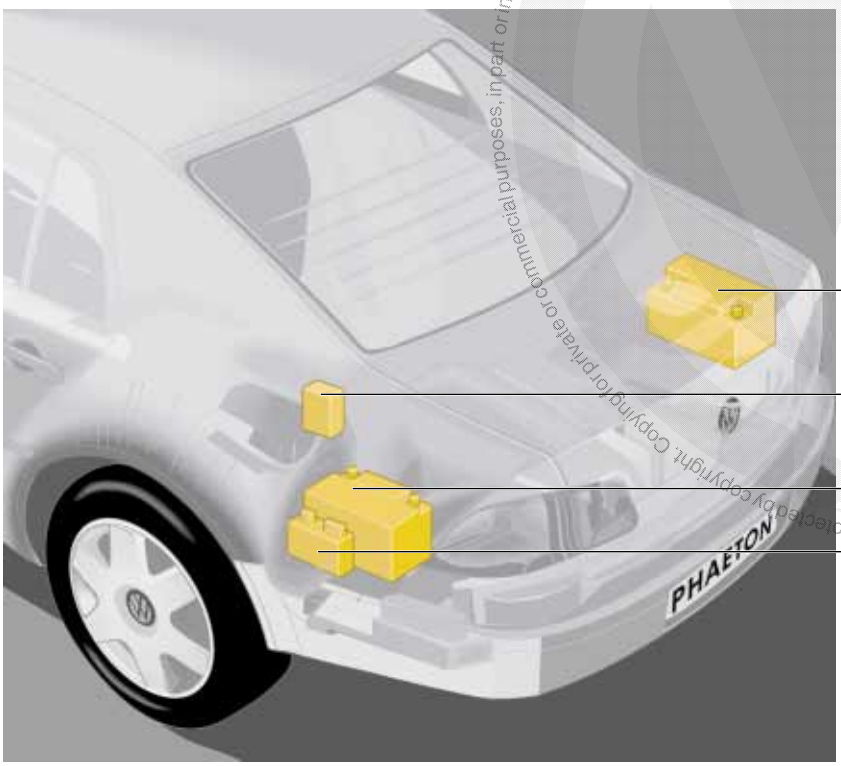
The starter battery supplies circuit to start the engine, the onboard supply battery provides 12 V for the vehicle electrical system.

The vehicle can still be started if the onboard supply battery is flat. This is controlled by the battery monitor control unit and battery parallel circuit relay.

During operation, the starter battery is recharged optimally by a DC/DC converter via the battery monitor control unit.

For the dual battery concept of the Touareg (V10 TDI), an onboard supply control unit (J519) takes over the function of the battery monitor control unit (J367).
Here, the vehicle can also still be started if the onboard supply battery is flat. Recharging of the starter battery, however, is only possible if there is an excess of energy in the onboard electrical system, i.e. without support from a DC/DC converter.

Dual battery concept, e.g. in the Phaeton



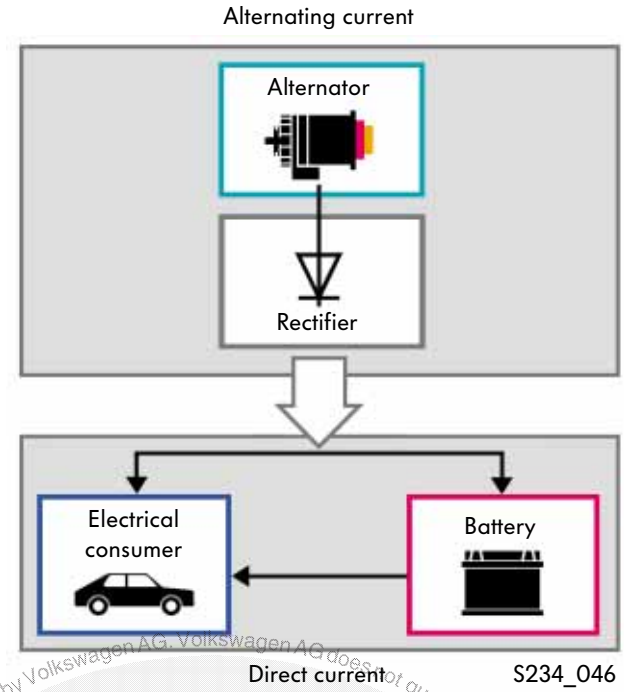
Energy structure

Harmonisation of battery and alternator

The alternator output, battery capacity and energy requirement of the electrical consumer network must be in harmony for the whole system to work safely and trouble-free.

The size, type and construction of a vehicle alternator is therefore determined in accordance with its role so that it can supply sufficient quantity of power to the electrical consumers and to recharge the battery.

Alternators generate an alternating current. The electronics system, however, requires a direct current.
Conversion of the alternating current to direct current is performed by a rectifier in the alternator.



The power consumption of a consumer is calculated using the following equation:

$$\text{Current I (A)} = \frac{\text{Output P (W)}}{\text{Voltage U (V)}}$$

$$\mathbf{I = \frac{P}{U}}$$

Example of calculation:
Rear fog lamp (55 W power consumption)

$$\text{Current (A)} = \frac{\mathbf{55\ W}}{\mathbf{12V}} = \mathbf{4{,}6\ A}$$

Energy requirement of consumers in motor vehicle

Basic consumers

Ignition 20 W	Fuel injection 50...70 W
Fuel pump 50...70 W	Engine management 10 W

In networked vehicles, the current could be as high as 240 W (=20 A) with the ignition switched ON !

Heavy usage consumers

Fog lamps 35...55 W each	Vehicle heater 20...60 W
Surround lighting 4 W each	Car radio 10...15 W
Instrument lighting 2 W each	Windscreen wipers 60...90 W
Number plate lights 5 W each	Radiator fan 80...600 W
Parking lights 3...5 W each	Fresh air blower 80 W
Dipped beam 55 W each	Heated windscreen 120 W
Main beam 55 W each	Tail lights 5 W each
Auxiliary headlights 55 W each	

Light usage consumers

Turn signals 21 W each	Starter 800 ... 3000 W
Brake lights 21 W each	Cigarette lighter 100 W
Reverse light 21...25 W each	Car horn 25...100 W
Additional brake lights 21 W each	Glow plugs 100 W each
Headlight washers 60 W	Engine aerial 60 W
Power windows 150 W	

Energy structure

Discharge and response to temperatures

Chemically induced self-discharge
Self-discharging is inherent of the design and function of a vehicle battery.
The degree to which a battery discharges itself depends heavily on the temperature.
It also depends on the battery technology.

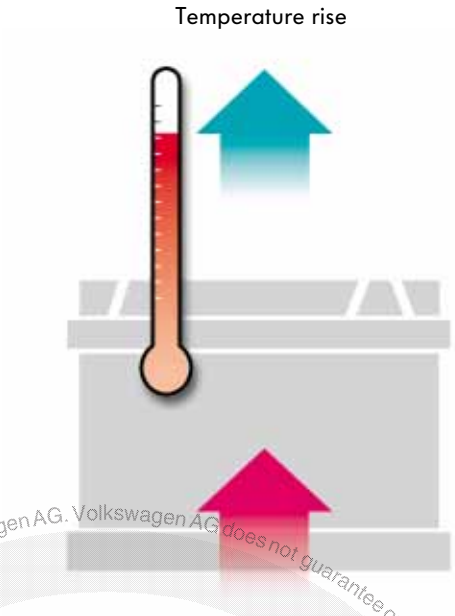
In the wet-type and AGM batteries used commonly today, a lead calcium alloy is used.

The advantages of this alloy are:
- Major reduction in self-discharge
- No increase in self-discharge as battery ages.

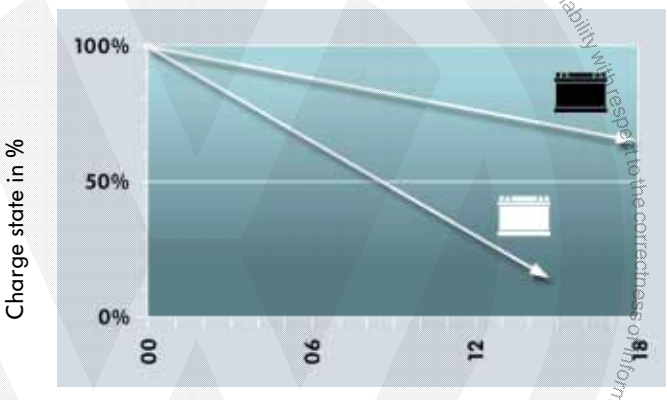
At a room temperature of 20 °C and after six months out-of-use, this means, for practical purposes, that new **conventional** vehicle batteries only have an acid density of 1.20 g/cm^3 in a filled state.
That equates to a charge status of approx. 50 %.
Under certain circumstances, damaged batteries can reach this level within just a few weeks.

On maintenance-free and AGM batteries, the acid density is 1.24 g/cm^3, after the same period of time. This equates to a charge status of 80 %.
These batteries reach the 1.20 g/cm^3 figure only after approx. 18 months.
Due to the pure alloy system of the lead calcium grid, this accelerated effect is stopped. The low self-discharge rate in the positive and negative plates remains constant over the entire period of use.

- The chemical self-discharge depends heavily on the temperature.
- An increment temperature rise of 10 °C doubles the self-discharge rate.



S234_047



S234_048

The self-discharge pattern on conventional and maintenance-free batteries.

Conventional battery
Maintenance-free battery

Vehicle clock

Alarm system

Car telephone

Car radio

S234_049

Discharge from rest current

A further reason for the discharge of vehicle batteries is the rest or idle current. A constant load is placed on the battery, depending on the vehicle equipment level, by electrical consumers that are always active.

Among the permanently active electrical consumers are the clock, alarm system, car phone (if fitted) and programmable radio or tyre pressure monitoring system.

- The strength of the rest current in a vehicle is dependent on the amount and size of the permanently active electrical consumers.
- Since the rest current influences the starting capability of a vehicle, the size of the vehicle battery is calculated on the strength of rest current.
- On vehicles with energy management system, this ensures that the battery is not discharged beyond a minimum charge state, e.g. in the event that an interior light, radio or similar is left on.

Transportation mode

To ensure a battery is not discharged unnecessarily when vehicles are being shipped, for example, there is the transportation mode. It is activated on completion of assembly work. With transportation mode activated, the functions that are not required during transportation, e.g. interior monitoring, radio, clock, etc. are switched off.

- By isolating these items, power consumption is reduced.

The aim is to protect the battery against possible damage from heavy power discharge after transportation and consequent storage periods.

Energy structure

High temperatures
High temperatures lead to an acceleration in the chemical reactions of a battery.

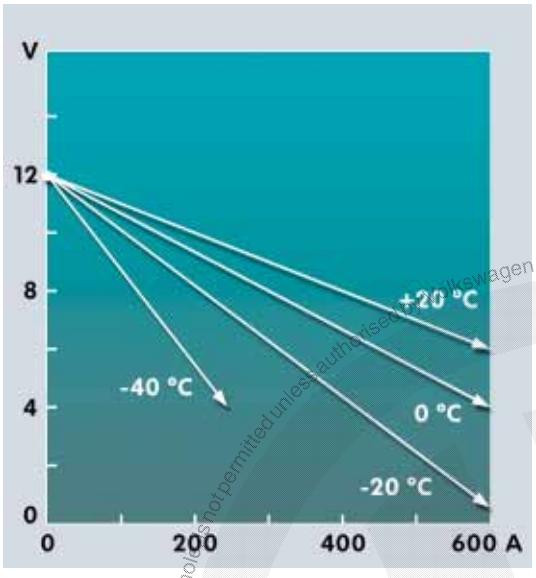
- The performance of a battery increases as a result of the low viscosity in the acid.
  The capacity becomes slightly higher.
- However, high temperatures also lead to greater corrosion in the plates and consequently in the grids too.
- At high temperatures, the level of chemical self-discharge rises.

Low temperatures
As temperatures fall, the battery capacity becomes less. The chemical processes are not as effective at low temperatures due to the increase in viscosity of the electrolyte.

The capacity of the battery should therefore not be too low for the intended purpose.
At extremely low temperatures there will otherwise be a risk that the engine will not start at the necessary turnover speed.

The greater the discharge, the more the acid solution is weakened. This also affects the hardening point (freezing temperature).
Deeply discharged batteries could begin to freeze at temperatures of 0 °C!

S234_050



Discharge voltage

Discharge current

Note:
The voltages, acid density figures and freezing points specified in the text are subject to a nominal tolerance. The figures should therefore only be used as guidelines.

Voltage	Charge state	Acid density	Freezing point
12,7 V	100 %	1,28 g/cm^3	< -50 °C
12,5 V	80 %	1,24 g/cm^3	-40 °C
12,3 V	60 %	1,21 g/cm^3	-30 °C
12,1 V	40 %	1,18 g/cm^3	-20 °C
11,9 V	20 %	1,14 g/cm^3	-14 °C
11,7 V	0 %	1,10 g/cm^3	-5 °C

Frozen electrolyte
A battery with frozen electrolyte is no longer suitable for starting purposes.

Warning!
- A frozen battery should never be charged because the viscous battery acid will begin to expand.
- VOLKSWAGEN advises its customers in the operating instructions to renew frozen batteries as a rule.
  Hairline cracks could occur in the plastic housing due to expansion in the volume of frozen electrolyte and this could lead to leaks. Damage to the bodywork could ensue!

Cold starting
The most unfavourable load on a battery is the cold starting procedure. During the cold starting procedure, three factors place additional load on the battery:

- The mechanical resistances in the engine are greater because the oil is thick at low temperatures.
  The starter therefore needs more energy.
- The output of the battery is considerably less due to the high internal friction caused by the cold conditions.
- The battery is not fully charged due to the low temperatures.

The battery must be in good order for it to return its maximum output during cold starting procedures.

S234_051

Check battery before winter sets in.
Always replace defective batteries.

Battery check

Visual check
Before measurements can be carried out on a battery, e.g. rest voltage, acid density or battery load test, the battery should be checked visually.

The check covers:

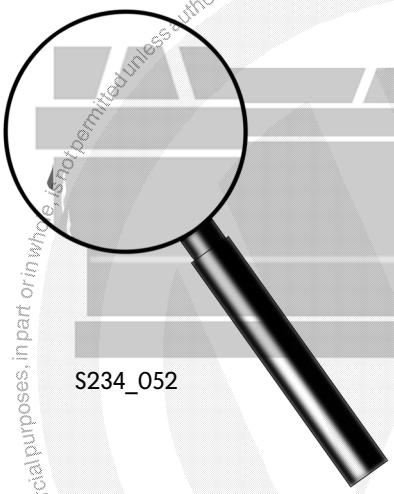
- **The battery housing**
  Acid leaks can be the cause of housing damage. Acid is corrosive and can lead to serious damage to the vehicle body or components.
  The vehicle parts affected by acid leaks should be treated immediately with a soap solution or renewed.

- **The battery terminals and terminal clamps**
  Correct contact at the battery terminals could be impaired if the battery terminals and terminal clamps are damaged in any way.
  If the terminal clamps are not fitted properly and tightened, a fire could be caused in the wiring.

- **Battery securing point**
  If the battery securing point is affected in a negative way, the life of the battery could be shortened considerably by vibrations. Damaged grid plates could be the result. The battery could explode.

  The battery clamping plate could cause damage to the battery housing.
  A poorly securely battery has a negative influence on crash safety.

  A check should be carried out to ensure the battery clamp plate is located correctly on the base strip. If necessary, an adapter should be used.
  The securing bolt should be tightened to the prescribed torque setting.


S234_052

Side fixing of the battery is assured by a groove in the base strip. Whether the battery is fixed on one side or two depends on the type of vehicle. Ensure the correct type of fixing is in place!

The fixing point of the battery is checked during the vehicle roadworthiness test.

Checking and replenishing the acid level
The correct level of acid in a battery is an important factor for longlife and effective use. If the acid level is too low, the cell plates could dry out and lead to a loss in capacity.

If the cell plates are not submerged in battery acid, corrosion occurs on components of the battery interior. Corrosion can lead to serious functional defects or even battery explosion.

- The battery must be replenished using distilled water.

If the acid level is too high, battery acid leaks can cause damage to functional elements in the engine compartment, for example.

- The excess battery acid must be pumped out.
- The acid level can only be rectified on wet-type batteries, which allow access for maintenance purposes.

Notes:
In AGM batteries there is no fluid electrolyte present. The electrolyte level can therefore not be altered in this case either.

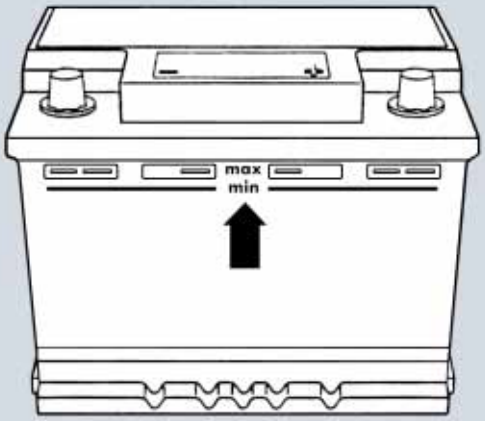
- **AGM batteries should never be opened!**

Check using the "magic eye":

- If the colour indicator is neutral or light yellow, the battery must be renewed!

- Observe safety instructions!
- Follow the instructions given in the **El**etronic **S**ervice and **A**dvise system ELSA

S234_053



S234_054

On batteries with transparent housing, without magic eye, the acid level must be checked from the exterior by means of the "min" and "max" markings.
If no markings are present on the battery housing, or if the acid level cannot be checked visibly due to a black coloured housing, the cell sealing plugs must be removed, where possible.

Battery check

Battery load test
The load capability is the amount of current that a fully charged battery can be subjected to over a set period of time, up to a defined temperature, without falling below a prescribed voltage limit.
The load capability is specified in amperes.

To carry out the battery load test, the following workshop equipment/special tools are required:

- Battery tester VAS 5097 A

- If carrying out the battery load test using battery tester VAS 5097 A, it is not necessary for the battery to be removed or disconnected.
- The test pressure reading may be required to help process warranty claims.

S234_055

Measuring range selected on equipment

Diagram, arrow shows battery status

Result of test

Battery voltage during test

Vehicle data, date, to be entered by tester

S234_056

- Read operating instructions of battery tester!
- Please follow the instructions given in ELSA
- The battery is only designed for single testing. Before the test is repeated, the battery should therefore be recharged!

Protocol print-out	Measure
Start output very good *	Battery OK
Start output good	Battery OK
Start output satisfactory	Charge battery
Start output poor	Charge battery
Start output very poor	Charge battery
Cannot be tested	Charge battery for 24 hours and repeat test

* Standard required for handover inspection

Battery charging

Charge
If the battery load test shows that the battery needs recharging, the following points must be observed.

Notes:
- Observe accident prevention measures.
- Ensure working space is well ventilated.
- The battery should be at a temperature of at least 10 °C.
- At acid temperatures greater than 55 °C, the battery test must be cancelled.
- Batteries should not be fast charged! Fast charging causes damage.

To charge the battery, the following workshop equipment/special tools can be used:
- Battery charger VAS 5095 A or
- Automated charger unit VAS 5900 or
- Battery charger (plug-in type) VAS 5901

- Read operating instructions of battery charger!
- Please follow the instructions given in ELSA

Charging deeply discharged batteries
If not used for a lengthy period of time, e.g. in storage vehicles, batteries will begin to discharge themselves or be discharged by the rest current in a vehicle if the battery is not disconnected.
A battery is deemed in a state of deep discharge if the acid density is below 1.14 g/cm^3.

Notes:
- Deeply discharged batteries could freeze in winter due to a high quantity of water in the electrolyte.
- Frozen batteries should be exchanged due to potential hairline cracks.
- Deeply discharged batteries begin to sulphate, that is the entire plate surface of the battery starts to harden.
  If deeply discharged batteries are recharged directly following deep discharge, sulphate could begin to reform.
  If these batteries are not charged, the plates will continue to harden. The ability to accept a charge will be impaired.
  A reduction in battery performance will be the result.
- The charge period must total at least 24 hours.
- If deeply discharged batteries are charged too quickly they will not accept the charge current, or they will show a "full" reading due to a "surface charge" too early. They only appear to be charged.
- Deeply discharged batteries often only accept a small charge current to start with.
- Deeply discharged batteries from storage vehicles should be renewed before customer delivery.

Battery recharging

Maintaining a charge
On vehicles that are out-of-use for a long period of time, the battery is subjected to a very low charge from the rest current and to temperature influences.
As a result, the charge state of the battery drops permanently on storage vehicles.

- To counteract this discharge process on storage vehicles, a system is introduced to help maintain the charge.
  It serves to counteract any discharge.

- The battery is kept in a fully charged state by a constant voltage charger unit, which operates using a low charge current.

To help maintain the battery's charge status, the following workshop equipment/special tools can be used:

- Solar panel VAS 6102 or
- Battery charger VAS 5095 A or
- Automated charger unit VAS 5900 A or
- Battery charger (plug-in type) VAS 5901

The solar panel VAS 6102
By using workshop equipment VAS 6102, the loss in battery capacity from self-discharge and rest current can be counteracted.
Solar panel VAS 6102 is positioned in the windscreen of the vehicle and connected to the battery supply via the cigarette lighter socket.

The charge provided by the sun's energy is sufficient to compensate for any energy loss from the battery. In unfavourable conditions, up to three solar panels can be connected in parallel.

Solar panel VAS 6102 S234_057

S234_058

Battery charger VAS 5095 A

S234_059

Automated charger unit VAS 5900

S234_060

Battery charger (plug-in type) VAS 5901

S234_061

Buffer and support mode

For service and repair work on networked vehicles (for example when interrogating control units) the battery is placed under load and must be supported by a battery charger.

- Support mode prevents the battery from being discharged excessively.
- In support mode, the battery, charger unit and electrical consumers are linked together. The charger unit supplies energy that is just sufficient to maintain the charge status of the battery at 100 %
- The battery supplies current peaks to the electrical consumers. It is kept fully charged by a constant voltage.

Warning:
On vehicles with auxiliary battery, ensure that the correct battery is being supported.

To carry out support mode, the following workshop equipment/special tools can be used:

- Battery charger VAS 5095 A or
- Automated charger unit VAS 5900 or
- Battery charger (plug-in type) VAS 5901

- Read the operating instructions of the relevant equipment before use!
- Please follow the instructions given in ELSA

Boost starting

Boost starting
If the engine does not start because the battery is flat, the vehicle can be boost started using an external power source.

To boost start a vehicle, use either battery starter VAS 5098 or the battery from another vehicle with the aid of jump leads.

Battery starter VAS 5098 provides energy to boost start a vehicle with flat or weak battery, regardless of network. Depending on the ambient temperature and battery capacity, between 15 and 30 boost start attempts can be made.
If the battery is replaced, the equipment offers a support mode to prevent any data from being lost.

Never boost start a frozen battery
– risk of explosion !
The battery MUST be renewed.

- Use only jump leads that are of the correct thickness and that are fitted with insulated clips. There should be no electrical contact between the vehicles, otherwise current could begin to flow when the positive clips are attached.
- The engine providing the power source should be allowed to run for at least 1 minute before an attempt is made to start the engine with flat battery.

S234_062

Battery starter VAS 5098

S234_063

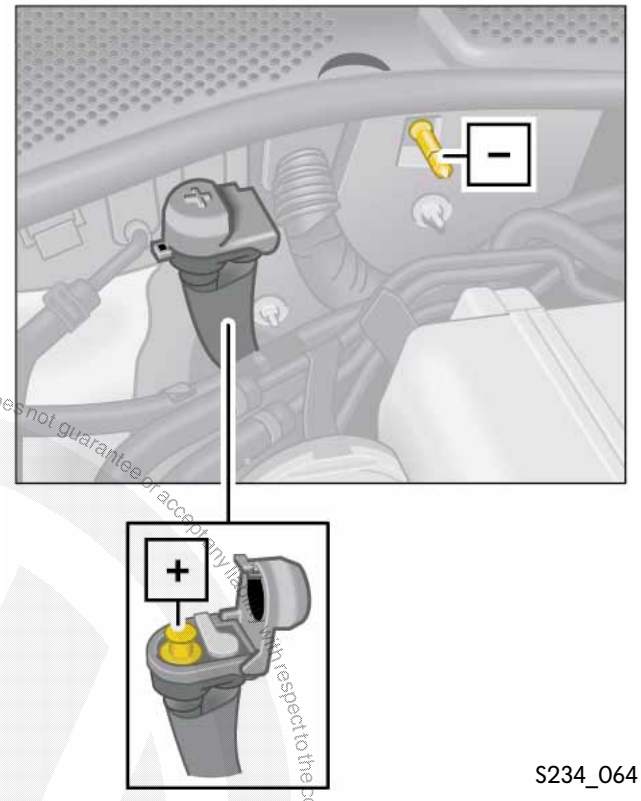
Jump leads

- Read the operating instructions for the battery starter VAS 5098 before use!

Note:
To avoid damage from other makes of car during boost starting, the following basic rules should be applied:

- It is essential that the correct polarity is observed.
- The discharged vehicle battery must be connected correctly to the onboard electrical system.
- Both batteries should have the same nominal voltage.
- The capacity of the battery providing the power source should not be below that of the discharged battery.
  An insufficient capacity of the battery providing the power source could lead to serious damage!
- Before disconnecting, the driving lights should be switched off.
  To reduce voltage peaks when disconnecting, the electrical consumers, such as heated rear window or interior ventilation system, should be switched on.

Boost starting points in engine compartment of Phaeton



S234_064

- Vehicles that have an internally fitted battery feature a boost starting point in the engine compartment.
  To boost start the vehicle, only this connection should be used.
- The precise location of the boost starting point and sequence of connection can be gleaned from the relevant operating instructions. (Booklet 3.2 "Tips and Maintenance“)

Handhabung

Battery renewal
The procedure for renewing a battery can differ depending on the type of vehicle. There are, however, a number of important basic rules that should be applied to all instances of battery renewal.

Removal:
- First check whether a coded radio is installed. If yes, the anti-theft code must first be obtained.
- To prevent an interruption in the supply of power to the onboard electrical system, the system should be supported, e.g. via the cigarette lighter socket. The positive cable should not be earthed in any way when doing this.
- Switch off ignition.
- Open heat insulating jacket (if fitted).
- First unscrew the negative clamp and then unscrew the positive clamp.

Never fit or remove the positive terminal clamp if the negative terminal clamp is still connected. There is a risk of short circuiting the system.

Note:
- Ensure that Volkswagen factory fitted batteries are of the same dimensions before they are exchanged.
- To ensure that the battery is secured in place correctly, the latest vehicles should only be fitted with batteries that feature a low base strip. On these vehicles, any adapters fitted to compensate for the difference in height should be removed.
- Battery terminals should no longer be coated with grease, otherwise the terminal clamps could work loose.

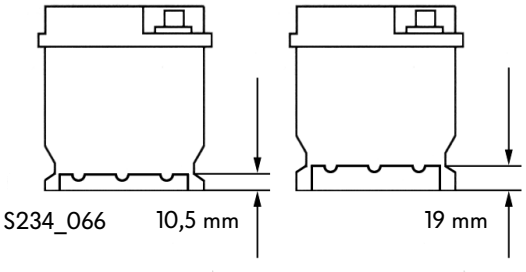
Installation instructions
for original equipment battery S234_065

- Observe the safety instructions shown on the battery!
  Volkswagen factory fitted batteries feature safety instructions in nine different languages.
- Observe the battery installation instructions before fitting!
- Please follow the instructions given in ELSA.

Installation:

- To avoid damage to the battery housing, the battery terminal clamps should be fitted by hand without using force.
- Tighten the battery positive terminal clamp to the prescribed torque setting as described in ELSA.
- Once the positive terminal clamp has been tightened, the negative terminal clamp (battery earth strap) can be fitted to the battery.
- On batteries that feature a hose for central gas venting, ensure that the hose is not crimped.
- On batteries without hose for central gas venting, ensure that the vent opening at the top of the battery cover is not blocked.
- Ensure that the installation position of the battery on the console is correct and observe, if necessary, the groove in the base strip at the front or rear.
- Tighten battery clamping plate to prescribed torque setting as described in ELSA. Any compensation adapter that may be fitted could be bent in the process.
- Auxiliary items, such as heat insulating jacket, terminal cover caps, gas vent reservoir or gas vent pipe should be placed back in their correct position.
- When the battery is reconnected, items of vehicle equipment, such as radio, clock, convenience consumers (e.g. power windows, etc.) should be checked and/or activated in accordance with the instructions given in ELSA.
- Interrogate fault memory and carry out repair measures as necessary.

Precise details for the use of compensation adapters can be found in the operating instructions for replacement batteries.



S234_066

Low base strip

High base strip

Compensation adapter for base strip

S234_067

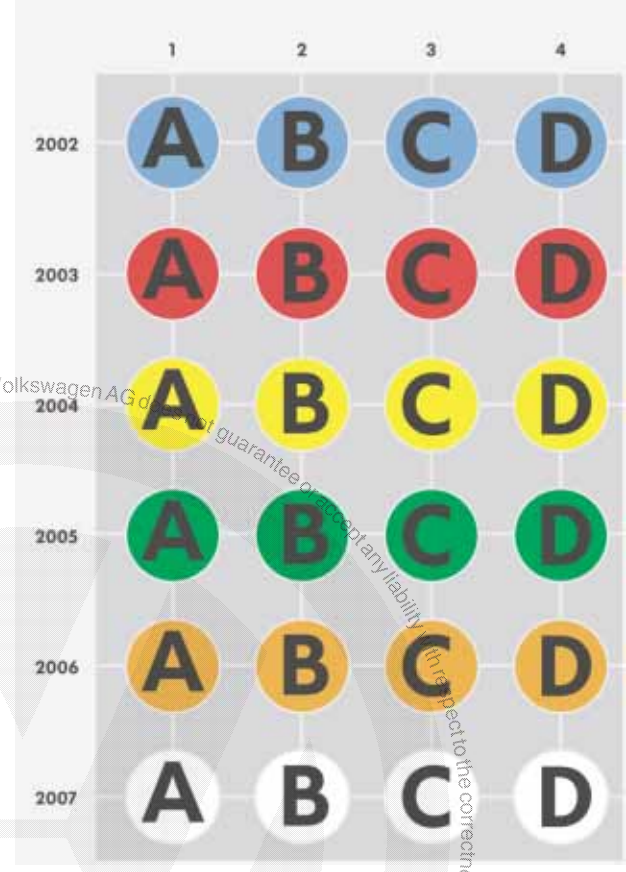
Storage and transportation

Storage
Batteries should be stored, installed and dispatched using the FIFO principle (**f**irst **i**n, **f**irst **o**ut) to prevent unnecessary build up of stock.
Based on the FIFO principle is a code that indicates the date of battery manufacture.
It is not visible to the customer.
The FIFO storage principle means that the oldest or longest stored batteries are selected first.

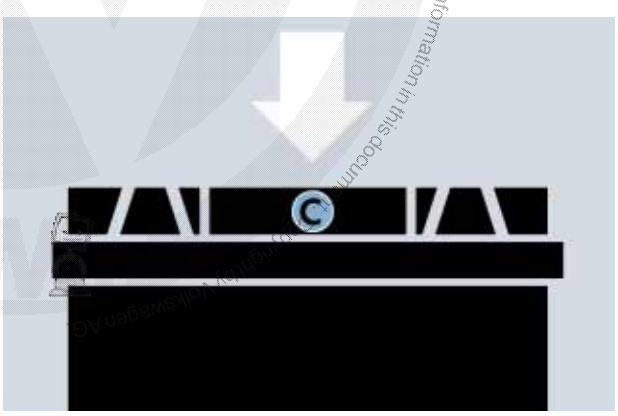
The maximum period of storage is 12 months.

A colour code was established for six consecutive years.
The basic colour of the round sticker documents the year of manufacture.
The year of manufacture is split into four quarters.
These are represented by a black capital letter.

For example, a black "C" on a blue background indicates that the date of manufacture was the 3rd quarter of 2002.



Coding system for batteries S234_068


Colour code on battery housing S234_069

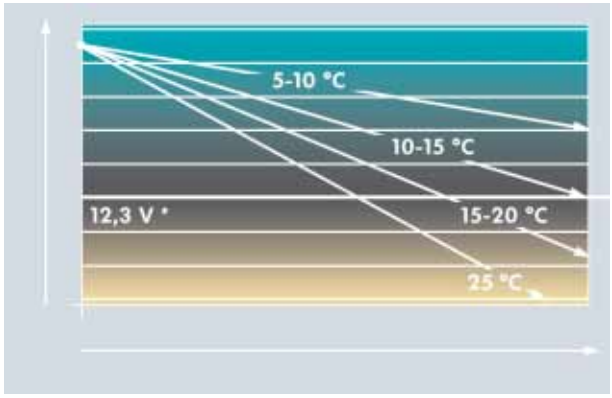
- **Note:**
  Also refer to the instructions in ELSA on the subject of storage.

- "Workshop manual", Electrical system, Repair group 27
- "Maintenance charts", Service on out-of-use and stored vehicles.

This function is available from version 3.1.

Note:

- Good ventilation
  Steps must be taken to ensure that the storage area is well ventilated.
- Store in cool area
  Batteries should be stored in a cool and dark area, if possible up to a max. 20 °C. Any drop in rest voltage is dependent on the storage temperature.
  The cooler the store, the lower the tendency to self-discharge.
- Prevent short circuits
  Batteries should be stored in such a way so as to avoid the risk of short circuits and spark generation. Remove cap from battery terminal only for installation.
- Recharge
  If stored batteries no longer have their full capacity due to self-discharge, it is essential that they are recharged prior to sale. The charge state can be measured from the rest voltage and from the "magic eye" indicator.
  - If the voltage of a battery drops below 12.3 V or if the magic eye changes from green to black, the battery must be recharged. It will reach its full capacity again in this way. The quality of the battery will not be impaired.
    Original equipment batteries that are older than 12 months should not be sold as new items.



Storage period S234_070

Transport

- Batteries should be secured in place so that they cannot slip, slide, tilt over or become damaged.
- Batteries should be protected against short circuit. If being transported on pallets, batteries should be protected against short circuit if the batteries on the top pallet are covered by cardboard or packaging material.
- To prevent any resulting damage, the batteries should not show any traces of acid on the outer surfaces.

S234_071

Multi-purpose carrier for transporting vehicle batteries
Order number: Z416305TE

Dangers when handling vehicle batteries

Recognising and avoiding dangers
Batteries are inherently dangerous.
If the warning notices on the battery, in the operating instructions and in ELSA are followed, however, the dangers can be avoided.

- Untrained personnel, such as apprentices or students on work placements, should only work on vehicle batteries whilst under the supervision of a mechanic or electrician, for example, who has attained the basic or advanced trade qualification.
- Acid is highly corrosive.
  If batteries are not handled correctly, there is a risk that personnel could come into contact with the harmful electrolyte.
  Therefore, suitable measures should be available to take action against acid burns.
  Such action could be the use of a soap solution, for example.
- If electrolyte leaks out of a battery, skin burns could result, acid could eat away materials and corrosion could occur on the vehicle. This could also affect safety relevant components in the vehicle in some circumstances.
- The oxy-hydrogen gas given off during charging, and also after charging in some cases, is highly explosive. In extreme cases, an explosion could be caused by escaping gases due to incorrect battery handling.
- Spark generation from grinding, welding, and cutting operations and open flames, e.g. smoking near batteries, are forbidden.
  Measures should also be taken to avoid sparks from electrostatic discharge.
  Measures could be, for example, touching the vehicle body before handling the battery.
- Only work on batteries in well ventilated rooms suitable for that purpose.

S234_072

Personal protective equipment
When working with acid, personal protective equipment (PPE) must be used.

The equipment consists of:
- Acid resistant goggles
- Acid resistant apron
- Acid resistant rubber gloves

To avoid damage to the eyes, it is recommended that goggles are also worn for other battery handling operations, e.g. transportation of batteries.

First aid
If, despite all protective measures, acid comes into contact with the skin or eyes, first aid must be administered immediately.

- To do this, the affected items of clothing and skin areas should be neutralised with a soap solution, for example, and then rinsed for several minutes with clear water.
- Acid splashes in the eye/s should be rinsed out immediately for at least 10 minutes with clear water.
- Therefore, there should be an eye bath connected to the drinking water supply at an easily accessible position in the workshop, ideally in the vicinity of the battery charging room.
- If this is not the case, an eye bath bottle should be kept for emergencies near the place of work.
  It should always be filled with clean, fresh water that is regularly changed for reasons of hygiene. This change should be carefully checked and recorded.
- After first aid has been administered effectively by intensive rinsing of the eyes or skin, advise should always be sought from a doctor in the event of injuries from acid burns.

Warning notices

Explanation of warning notices on battery

1) Adhere strictly to the notices on the battery, in the "Electrical system" section in ELSA and in the operating instructions.

2) Risk of acid burn: Battery acid is highly corrosive. Protective gloves and goggles should therefore be worn when working on the battery. The battery should never be tilted. Acid could leak out of the gas vent holes.

3) When working on or around batteries, fire, sparks, open lights and smoking are forbidden. Avoid spark generation from cables, electrical equipment and electrostatic discharge. Short circuits should be avoided. Therefore, tools should not be placed on top of the battery.

4) Wear eye protection when working on the battery.

5) Never allow children to come into contact with acid or batteries.

6) There is a risk of explosion when working on batteries. When batteries are charged, a highly explosive oxy-hydrogen mixture is formed.

7) End-of-life batteries should never be disposed of in the household waste.

8) Disposal: Old batteries require special disposal. They should only be disposed of at a suitable collection point and only in compliance with the legal framework of conditions for disposal of such items.

S234_074

Notes:

Glossar

Accumulator:
Accumulator means "collector". It saves energy and makes it available for supply at a later stage.

Ampere (A):
Unit of measurement for strength of current.

Ampere hour (Ah):
Product of current multiplied by time.

Battery:
Used here in the same way as accumulator.

Battery terminal clamps:
Die-cast or screw-type clamps for connection of wires to terminals of battery.

Lead-acid battery:
Battery, in which the electrodes (effective mass) consist of lead dioxide (positive electrodes) or of lead (negative electrodes) in a charged state.
The electrolyte is weakened sulphuric acid.

Block body:
Vessel for multiple cells in a battery.
The block body is separated by partitions.

Cover or lid:
Serves as a means of covering the cells in a block body. The cover is fixed permanently on the block body by means of a plastic weld.

Distilled water
Replenishment for water content of electrolyte that diminishes from gas generation and evaporation. Specific purity regulations must be adhered to (see VDE 0510).
Use only distilled water! Never use water from the tap!

Density:
Ratio of mass to volume, expressed for example in kg/ltr. or g/cm^3

Diffusion
Chemical, opposing penetration of fluids and gases.

EN
Abbreviation for "European standard".

Electrolyte:
Ionic conductor that binds electrodes together, e.g. sulphuric acid and water solution.

Electrolyte level
Level of electrolyte in wet-type batteries, same as acid level.

Battery terminals:
Serve as a means of drawing gross voltage from a battery and for accepting charge voltage.

Discharging:
Conversion of chemical energy in electrical energy (current flow set in opposite direction of that during charging).

End discharge voltage:
Fixed voltage below which a figure should not drop from allocated current draw.
Once end discharge voltage is reached, discharge is stopped.

Gas venting / gas discharge:
On starter batteries with gas discharge, the oxy-hydrogen gas formed from charging is fed along a plastic hose and vented to a non-hazardous position.

Gas generation:
Gas formed at the electrodes of a lead-acid battery.
Oxy-hydrogen gas is formed especially during the final stages of charging from water being broken down in the electrolyte into hydrogen and oxygen.

Gas formation voltage:
Charge voltage above which a battery begins to generate large quantities of gas.

Alternator:
Describes a unit powered by a motor vehicle engine, which is responsible for generating energy for the electrical consumers and to charge the battery in a vehicle (three-phase current generator with AC to DC rectifier).

Grid:
The grids are the carriers of the active mass in a battery. (Lead grid as mass carrier)

Rectifier:
The rectifier transfers alternating current into direct current (AC to DC).

Capacity:
Amount of current that can be drawn from a battery, measured in ampere hours (Ah).

Cold test current (A) in line with EN and DIN
A high discharge current linked to the battery type, with which the starting capability of the vehicle can be evaluated at cold temperatures.

The cold test currents, in line with EN and DIN standards, are two high discharge currents linked to the battery type, with which mainly the starting capability can be evaluated at cold temperatures and under prescribed discharge conditions. They are based on testing conditions specified in EN or the old DIN standard.
Two cold testing currents are shown on a battery.
For example on a 60 Ah battery: 480 A EN and 280 A DIN. Each of these currents should be able to be returned by the battery for different lengths of time at -18° C, without the prescribed battery voltage falling below a given value.
Example for 60 Ah battery:
At a load of 480 A at -18° C in line with the EN standard, the battery voltage should not drop below 7.5 V after 10 seconds.
After a subsequent break of 10 seconds, the battery is placed under a further load of 280 A at -18° C.
Once 133 seconds have elapsed under load with the DIN current, the battery voltage should not drop below 6 V.

Terminal voltage:
Voltage between the two terminals of a battery.

Oxy-hydrogen gas:
Explosive mixture of hydrogen and oxygen.

Charging:
Conversion of electrical energy in chemical energy by means of a current, which flows in a particular direction through the battery.

Charge voltage:
Voltage during charging.

Charge current:
Current with which the battery is charged.

Charge state:
Indicates the degree to which the battery is charged.

Useful lifespan:
Period of operation until the battery is no longer serviceable.

Mass, active:
Composition of plates (electrodes) that are subjected to chemical reactions from the current flow.

Negative plate:
Negative plate of which the effective mass (on charged battery) consists of metallic lead (Pb).

Top-up water:
Replenishment for water content of electrolyte that diminishes from gas generation and evaporation. Specific purity regulations must be adhered to (see VDE 0510).
Use only distilled water!
Never use water from the tap!

Glossar

Nominal figures:
Fixed voltage, capacity, density, temperature values, etc, as specified in DIN 40729 and DIN 72311 standards, e.g.

Nominal voltage of lead-acid battery:
Product of the number of cells connected in series (e.g. 6 cells in 12 V battery) and the nominal voltage of the lead-acid cell (2.0 V).

Nominal capacity:
Capacity at which the battery can return the associated nominal current at 20 hours of discharge (at nominal temperature, nominal density and nominal level of electrolyte), without falling below end discharge voltage.

Plate block:
Combination of positive and negative plate sets of one cell, including plate insulation (separators).

Plate connector:
Conductive connection between plates of the same polarity in one cell.

Positive plate:
Positive plate of which effective mass (on charged battery) consists of lead dioxide (PbO_2).

Connected in series:
Connected one after the other. Also known as series connection. If cells are connected in series (e.g. 6 lead-acid cells to form a 12 V battery), the opposite terminals of neighbouring cells are connected together.

Rest voltage:
Voltage at the terminals of a battery when charge and discharge currents stop after a certain threshold is reached.

SAE
US industrial standard (Society of Automotive Engineers)

Acid density:
See density.

Hydrometer:
Oversized pipette-type device, in which there is a float with acid levels to measure the acid density of the electrolyte.

Acid level:
Level of electrolyte in wet-type batteries, same as electrolyte level.

Acid level marking:
Marking for prescribed acid level.

Rapid charge:
Fast charging of the battery using a much greater charge current. Rapid charging only charges the battery in part.
Warning: Batteries should not be charged in this way. Rapid charging causes damaged.

Sulphuric acid (H_2SO_4):
Acid weakened with water and used in batteries as electrolyte.

Self-discharge:
Discharge from chemical reactions in the battery without a load being placed on the battery by electrical consumers.

Separator:
Ion penetrable separating material between the plates of different polarity.
Polyethylene for wet batteries, glass mat for AGM batteries

Starter battery:
Serves mainly as a means of starting and for engine ignition.

Start output:
Power required by engine for it to be turned over.

Current charge factor:
Ratio of volume of current required to fully charge a battery to volume of current drawn.

Sulphating:
Conversion of mass in lead battery to crude crystalline lead sulphate.

Deep discharge:
Current draw up to complete drain of energy in a battery. A battery is deemed to be deeply discharged if the acid density is below 1.14 g/cm^3 and the rest voltage is below 11.9 volts.

Sealing plug:
Sealing plug for the central gas venting system in the battery cover. The sealing plug must be placed on just one side of wet-type replacement batteries.
(Not to be confused with cell sealing plugs!)

Full charge:
Charge by which the chemical conversion is complete. Lead-acid batteries are fully charged when acid density and voltage come to rest at the end of the charge process.

Volt (V):
Unit of measurement for voltage.

Water:
Used in this SSP to refer to distilled water.

Cell sealing plug:
The cell sealing plug serves as a means of sealing the openings in the cover.

Test yourself

1. What does the word "electrolyte" mean?

a) ☐ Distilled water

b) ☐ Battery acid or battery fluid

c) ☐ Weakened sulphuric acid

2. What is meant by terminal clamp voltage?

a) ☐ Another way of describing cell voltage

b) ☐ It describes the voltage between the terminals of a battery

c) ☐ The designation on the battery housing

3. What is meant by nominal capacity?

a) ☐ A voltage of 12 V

b) ☐ A current of 175 ampere

c) ☐ The volume of current that can be stored by a battery

4. What can be found in a battery cell?

a) ☐ The base strips and the block body

b) ☐ The terminals

c) ☐ The plate block with positive and negative plate sets and the electrolyte

5. How can the difference between battery terminals be noticed?

a) ☐ In the colour

b) ☐ By the material

c) ☐ By the diameter

6. What is meant by "magic eye"?

a) ☐ A colour indicator for the charge state and level of electrolyte

b) ☐ A display element in the dash panel insert

c) ☐ A colour indicator for the battery temperature

7. Which colour indicates that the charge state is in order?

a) ☐ Green

b) ☐ Black

c) ☐ Yellow/neutral

8. What does the density of the acid show?

a) ☐ The fill level of the battery

b) ☐ The charge status of the battery

c) ☐ Discharge from rest current

Prüfen Sie Ihr Wissen

9. From what level of acid density and voltage is a battery deemed to be deeply discharged?

a) ☐ 1.28 g/cm^3 at 12.7 volts

b) ☐ 1.14 g/cm^3 at 11.9 volts

c) ☐ 1.10 g/cm^3 at 11.7 volts

10. How is the battery checked in the correct manner?

a) ☐ Rest current check using VAS 5901

b) ☐ Battery load test using VAS 5097 A

c) ☐ Rest voltage test using VAS 5900

11. How can a battery with housing damage be repaired?

a) ☐ By replacing the cover

b) ☐ With hot adhesive

c) ☐ It cannot be repaired and must be replaced

12. What is the purpose of the battery surround elements (box and jacket)?

a) ☐ Protects the battery against freezing temperatures

b) ☐ Protects the battery against excessive heat radiation

c) ☐ To shield other ancillaries from the battery temperature

13. What is the rest voltage?

a) ☐ The voltage of a battery, which is not placed under any load, after a threshold is reached

b) ☐ The voltage after charging

c) ☐ The voltage after a cold start

Answers:

1b und 1c / 2b / 3c / 4c / 5c / 6a / 7a / 8b / 9b / 10b / 11c / 12b / 13a

234

040.2810.53.20 Technical status 01.04

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