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Batteries rail | power AGM

Operating and Maintenance Manual

Version overview

Revision	Date	State	Name	Chapter	Reason for changes
00	2019-03-25	Created	W.Pickart	-	Initial version
	2019-04-01	Checked	T.Schreckenberg		
	2019-04-03	Approved	Dr. K.Gutzeit		
01	2020-02-05	Created	W.Pickart		Revision according to Documentation-Check
	2020-02-12	Checked	T. Schreckenberg		
	2020-03-18	Approved	Dr. D.Mahl		
02	2020-06-09	Created	W.Pickart	7.3	Chapter 7.3 "Storage with built-in battery" added
	2020-10-06	Checked	F. Mengeringhausen		
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03	2021-03-12	Created	W.Pickart	8.1	Chapter 8.1 "Checking the delivery" added
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	2022-01-24	Approved	Dr. D.Mahl	5.4.3	Changed charging characteristic
				5.4.3.1	Note "Operating temperature" added
				5.4.3.2	Note "Operating temperature" added
				9.2.3	Chapter extended by new version of the temperature sensor
				11	Details added
05	2022-02-11	Created	W. Pickart	5.4.3	Added table "Charging voltages of the blocks/cells"
	2022-02-14	Checked	T. Schreckenberg		
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06	2022-03-04	Created	W. Pickart	8.2.	Torque of L-connectors adjusted to 15 Nm
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				11.	
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08	2023-10-25	Created	W. Pickart	5.4.3	Chapter "Environmental conditions" added
	2023-10-25	Checked	Dr. K. Gutzeit		
	2023-10-25	Approved	Dr. D. Mahl	5.4.4	Chapter added
				9.1.1	Chapter revised

Foreword

Dear Customer,

Thank you very much for having decided in favour of a product bearing our brand name.

Please read this documentation carefully before working on the batteries or their components. It contains important information on safe and proper unpacking, storage, installation, commissioning and on operation and maintenance of rail | power AGM batteries.

Amendments to this documentation are subject to change without prior notice. Our products undergo continuous advanced development. As a result, there may be deviations between the illustrations given in this documentation and the purchased product. This installation manual is not covered by any change service.

Keep this documentation in such a manner that it is available immediately to all those who need to carry out work in connection with the battery system or its components.

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Table of Contents

1. Using this manual

This operating and installation manual is intended to assist with the optimal operation of the HOPPECKE rail | power AGM blocks/cells used, as well as their installation and maintenance. This is the only way in which a maximum service life can be achieved.

Please contact your local authorised dealer if:

- You have any queries on this documentation
- There are local regulations or provisions that are not covered by this documentation or are contrary to its contents.

1.1. Target group of this document

All work on the battery system and the rail | power AGM blocks/cells must only be carried out by authorised personnel (ideally skilled electricians):

- Personnel authorised by the safety officer of the train manufacturer
- Personnel authorised by the safety officer of the train operator
- Personnel authorised by HOPPECKE Batterie Systeme GmbH
- HOPPECKE experts

Untrained personnel must not carry out any work on rail.power blocks/cells.

1.2. Means of representation

1.2.1. Icons and signal Words

The following icons and signal words are used in this operating and maintenance manual:

DANGER!

Denotes an immediate hazard with a high level of risk that could lead to death or severe physical injury if it is not prevented.

WARNING!

Denotes a potential hazard with a medium level of risk that could lead to death or severe physical injury if it is not prevented.

CAUTION!

Denotes a hazard with a low level of risk that could lead to minor or medium degree of physical injury if it is not prevented.

Note

Denotes important instructions to make best use of the product.

1.2.2. Graphic symbols / pictograms on the battery system

Following graphic symbols are used in this operating and installation manual:

EN ISO 7010 - W012
Warning of electrical voltage

EN ISO 7010 - W026
Warning about danger from batteries

EN ISO 7010 - W023
Warning of corrosive substances

EN ISO 7010 - W002
Warning against explosive substances

EN ISO 7010 - P003
Fire, open light and smoking prohibited

EN ISO 7010 - M002
Follow instructions for use

EN ISO 7010 - M004
Use eye protection

EN ISO 7010 - M009
Use hand protection

EN ISO 7010 - M010
Use protective clothing

1.3. Notation of nominal data

Nominal battery data is used in accordance with the following notation in this operation and maintenance manual:

Notation	Description	Declaration
U_n	Nominal voltage	Defined for each cell-Chemistry; corresponding to the average voltage during discharge
U_E	Final discharge voltage	Voltage at which the battery is defined as discharged. This also depends on the discharge current.
U_0	Open circuit Voltage	Voltage at the battery terminals in idle state (no charge or discharge)
C_n	Nominal capacity	Electrical charge of the battery in Ah during discharge at rated current down to the final discharge voltage at rated temperature.
$I_n=I_5$	Nominal Current $I_n=I_5$	Fixed charge/discharge current (serves as reference value)
C-Rate	C-Rate	Battery discharge current based on the rated capacity Example: Discharge with 0.2 C means a discharge with 20 A for a 100 Ah battery
I_{XX}	Discharge Current	Named as I_{xx} based on rated capacity Example: I_5 for a 100 Ah battery = 100 Ah/5 h =20 A
T_n	Nominal Temperature T_n	Reference temperature for capacity

1.4. Abbreviations and glossary of terms

The following table describes abbreviations and terms that are used in this operating and installation manual:

Abbreviation/term	Explanation
Float charge	Denotes the charging of the battery to compensate for its self-discharge with the aim to keep the battery in a fully charged condition.
Boost charge	Denotes the charging of the battery with elevated voltage and a defined current to get the full state of charge in the best possible charging time.
CAS number	The CAS number (also called CAS registration number and CAS registry number, CAS = Chemical Abstracts Service) is an international identification standard for chemical substances.
Electrolyte	HOPPECKE rail | power AGM blocks are valve-regulated lead-acid batteries. When handled correctly, rail | power AGM batteries are safe and contact with the electrolyte is not possible.

2. Safety instructions

Observe the following safety instructions when handling the batteries and their components.

2.1. Potential hazards

2.1.1. Explosive gas mixture

Each time the batteries are charged, water is decomposed. This can form a hydrogen-oxygen gas mixture (oxyhydrogen gas), which ignites even at low energy levels.

There is danger through:
- Explosions
- Fires
- Blast waves
- Hot or molten substances flying around

These hazards may be caused by the following ignition sources:
- Short circuits
- Electrostatic charges and discharges
- Smoking
- Open flames / fire, embers and sparks near batteries
- Electrical sparks through switches or fuses
- Hot surfaces with temperatures above 300 °C

There is an immediate, high risk situation which, if not avoided, will result in death or serious injury.

Measures to avert the danger:
- Work with insulated, non-sparking tools.
- Ensure sufficient ventilation of the battery room in accordance with DIN EN IEC 62485-2 so that the potentially explosive gas mixture is removed.
- Avoid electrostatic charging:
  - Do not rub batteries with plastic housings with a dry cloth or a cloth made of synthetic material!
  - Only clean batteries with a cotton cloth moistened with water. Wiping with a cotton cloth moistened with water does not generate any electrical charge.
  - Wipe batteries damp (with water) before removing or tearing off a label.
  - Wear shoes and clothing which, due to their special surface resistance, prevent the formation of electrostatic charges. (see 2.2 Personal protective equipment on page 13)
- Use hand lamps with mains cable without switch (protection class II) or hand lamps with battery (protection class IP54).

2.1.2. Electrical voltage

Metal parts of the batteries are always live. High currents flow in the event of a short circuit.

There is danger from:
- Voltages
- Electric shocks

There is an immediate, high risk situation which, if not avoided, will result in death or serious injury.

Measures to avert the danger:
- Be very careful when working on the batteries.
- Never place tools or other metal objects on a battery.
- Take off watches and jewellery before working on the batteries.
- Do not touch bare battery parts, connectors and terminals.

2.1.3. Electrolyte

Rail. power blocks / cells contain sulphuric acid as electrolyte. The individual cells consist of grid structure electrodes. Each positive electrode is wrapped in a fleece. The electrolyte is fixed in this fleece.

- Electrolyte may leak if the housing of a block/cell is damaged.
- Reversed polarity of the battery or of individual cells can cause overheating and thus leakage of electrolyte.
- Electrolyte is very corrosive.
- During normal operation contact with the electrolyte is excluded.
- If the housing is destroyed, the released bound electrolyte is just as corrosive as liquid electrolyte.
- The electrolyte can cause severe skin burns and serious eye damage.

There is a potentially hazardous medium-risk situation which, if not avoided, could result in death or serious injury.

Measures to avert danger:
- Always wear protective goggles and gloves when working on batteries.
- Clothes contaminated with electrolyte should be washed with water.
- Check correct polarity before making connections.

Take the following first aid measures if contact with electrolyte has occurred:

Acid on the skin or hair

- Dab the acid with a cotton or paper towel, do not rub off.
- Remove contaminated clothing, avoiding contact with unaffected body parts.
- Rinse affected areas under running water for longer periods of time.

Acid in the eye

- Rinse eye gently with eye wash for a few minutes or rinse under running water. Avoid excessive water pressure. If possible, remove any contact lenses and rinse further.
- Seek medical advice immediately.

Acid in the body

- Rinse mouth. DO NOT induce vomiting.
- Seek medical attention or hospitalization immediately.

2.1.4. Toxic substances

Rail | power AGM blocks / cells contain lead.

- Symbol: Pb
- CAS-Number 7439-92-1

There is a low-risk hazard which, if not avoided, could result in minor or moderate injury.

Measures to avert the danger:

- Avoid contact with toxic substances.
- Wear personal protective equipment (see 2.2 Personal protective equipment on page 13).

Note

REACH

(**R**egistration, **E**valuation, **A**uthorisation and Restriction of **Ch**emicals)

In accordance with the REACH regulation, we point out that HOPPECKE rail | power AGM blocks/cells contain the SVHC substance lead metal (CAS.No. 7436-92-1) with more than 0.1 % by weight (SVHC = **S**ubstance of **V**ery **H**igh **C**oncern).

A material safety data sheet (MSDS) is available on request from your account manager.

For further information on REACH, refer to https://echa.europa.eu.

2.1.5. Fire

In the event of fire there is danger from:

- Hot or molten substances
- Short circuits
- Open flames / fire, embers and sparks
- Hot surfaces with temperatures above 300 °C

There is an immediate, high risk situation which, if not avoided, will result in death or serious injury.

Measures to avert the danger:

- Wear personal protective equipment against caustic solution (see 2.2 Personal protective equipment on page 13), also use breathing protection with self-sufficient breathing air supply for large battery systems. In the event of contact with water, there is a risk of reactions with the electrolyte (acid) and consequently of violent spraying.
- Disconnect the battery electrically.
- Extinguish incipient fires with CO2.
- When extinguishing electric fires with water in low-voltage systems (up to 1 kV), maintain a spray jet distance of 1 m and a full jet distance of 5 m.
- Extinguish at short intervals. Otherwise there is danger of explosion due to possible static charging on the battery housing.

2.1.6. Improper transport

The batteries may be damaged during improper transport. Falling batteries can cause personal injury.

If the batteries are transported improperly, there is a risk of damage:

- Suspended loads
- Dropping batteries or parts of batteries
- Leaking electrolyte

There is an immediate, high risk situation which, if not avoided, will result in death or serious injury.

Measures to avert the danger:

- Use safety shoes and goggles.
- Do not tilt batteries.
- Always lift the batteries by the handles or lifting points provided for lifting devices and never carry them by the terminals of the battery or cells.
- Only use approved lifting and transport equipment, e.g. lifting gear. Lifting hooks must not cause damage to cells, connectors or connecting cables.
- Always carefully remove batteries to avoid damage.
- Use suitable transport equipment.
- Carefully secure the load during transport to prevent damage to the battery housing.

2.1.7. Notes on disassembly

If the connecting cables have not been disconnected before replacing the batteries, there is a risk of electric shock.

There is an immediate, high risk situation which, if not avoided, will result in death or serious injury.

Measures to avert the danger:
- Before starting to dismantle the batteries to be replaced, disconnect the supply lines (fuses).

Due to the content of lead and acid, rail | power AGM batteries must not be disposed of with garbage or deposited in a landfill at the end of their service life. (see 12 Disposal on page 56)

2.2. Personal protective equipment

Always when working on the batteries and their components:
- Wear safety goggles
- Wear protective gloves
- Wear protective clothing, preferably made of cotton, to avoid electrostatic charging of clothing and body
- Wear safety shoes

In the event of an accident, injuries can thus be prevented or at least the consequences of injury mitigated.

The conductivity of textiles and shoes must have the following properties in order to avoid electrostatic charging:
- an insulation resistance ≥ 10^5 Ω
- a surface resistance < 10^8 Ω

2.3. Markings on the product

The type plate of a battery is attached to the container for the battery cells (container, tray, carrier). On the type plate you will find the type, nominal voltage, number of battery cells and nominal capacity (C5 = Cn) of the battery.

When battery kits (individual cells with accessories) are supplied, the type plate of the battery must be attached by the customer.

3. Use of the product

3.1. Intended use

The rail | power AGM blocks / cells of the battery are used to store and release electrical energy in rail vehicles.

Use only in rail vehicles for:

- Buffering and supply of the low-voltage vehicle electrical system
- Provision of energy in emergencies
- Provision of energy for the maintenance and start-up of vehicles
- Start of the vehicle drive motors

Intended use includes the following requirements:

- Operation of the batteries only in perfect condition
- No deactivation or dismantling of safety devices
- Compliance with all instructions in this operating and maintenance manual

3.2. Unintended use

DANGER!

The improper use of the batteries can lead to personal injury and damage to property.

HOPPECKE Batterie Systeme GmbH assumes no responsibility and no liability for personal injury or damage to property resulting directly or indirectly from handling the batteries if they are not used as intended. The risks associated with improper use are borne solely by the operator.

Any other use than described under "Intended use" is not intended and therefore not permitted.

The improper use of the product includes in particular:

- Operation in potentially explosive atmospheres
- Operation in safety-relevant applications, unless these applications are expressly specified or permitted in the product documentation.
- Operation without permanent/insufficient fastening
- Operation outside the technical data
- Operation or storage outside the specified environmental conditions
- The electrical connection does not correspond to the documentation supplied with the battery.
- Operation with unauthorized changes or modifications to the product

4. Directives, legislation and standards

Please observe the latest edition of the following rules and regulations:

- Accident prevention regulations
- ISO 20345:2011 ("Personal safety gear – Safety boots")
- DIN VDE 0105-103 (2014-10) ("Operation of electrical equipment"), in particular, governs the requirements for quality and qualification for working on electrical equipment (0105-100) and on electrical equipment for railways (0105-103).
- NEC/IEC 60364 ("Erection of low-voltage installations")
- IEC 60571 ("Railway applications - Electronic equipment used on rolling stock")
- IEC 62485-2:2019-04 ("Safety requirements for secondary batteries and battery installations")
- IEC 60077 ("Railway Applications - Electric equipment for rolling stock")
- IEC 60896-21: Stationary lead-acid batteries – Part 21: Valve regulated types – Methods of test (IEC 60896-21:2004); German version EN 60896-21:2004
- 0119-206-4: State of railway vehicles - Electric and traction systems, train electric equipment - Part 206-4: Batteries
- ADR/RID: European Treaty on the international transport of hazardous goods by road / Ordinance on the international transport of hazardous goods by rail
- IATA-DGR: Dangerous goods regulations - international air transport association. German: Gefahrgut-Bestimmungen - Internationale Flug-Transport-Vereinigung
- IMDG Code: International Maritime Code for Dangerous Goods, German: Gefahrgutkennzeichnung für gefährliche Güter im Seeschiffsverkehr
- Ordinance on the supervision of waste and residual materials (German Federal Law Gazette, 1996)
- AAR RP-590: Lead Acid Batteries and Compartments Recommended Practices RP-590
- APTA-RP-E-007-98: Recommended Practices for Storage Batteries and Battery Compartments
- APTA-RP-E-009-98: Recommended Practices for Wire Used on Passenger Equipment
- IEEE Std 16-2004: IEEE Standard for Electrical and Electronic Control Apparatus on Rail Vehicles
- IEEE Std 100-2000: The Authoritative Dictionary of IEEE Standard Terms, Seventh Addition
- IEEE Std 1188-2005: IEEE Recommended Practices for Maintenance, Testing and Replacement of Valve Regulated Lead Acid (VRLA) Batteries for Stationary Applications

In addition, observe and follow all applicable territorial, corporate and project-specific regulations.

5. Function and structure

5.1. Battery

Batteries are interconnected from rail | power AGM blocks/cells and used in rail vehicles.

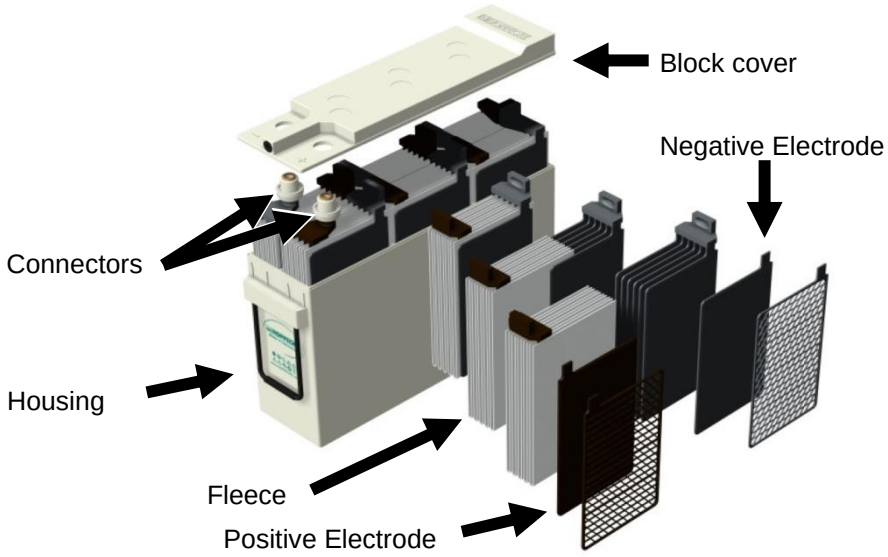
Here they perform one or more of the following functions:

- Buffering and supply of the low-voltage vehicle electrical system
- Provision of energy in emergencies
- Provision of energy for the maintenance and upgrading of vehicles
- Start of the vehicle drive motors

5.2. rail | power AGM blocks/cells

HOPPECKE rail | power AGM batteries are valve-regulated lead-acid batteries (VRLA) and are specially designed for use in rail vehicles. rail | power AGM batteries are available as single cells (2V) as well as block batteries (6 V, 12 V).

The following figure shows an example of the structure of a HOPPECKE rail | power AGM block:



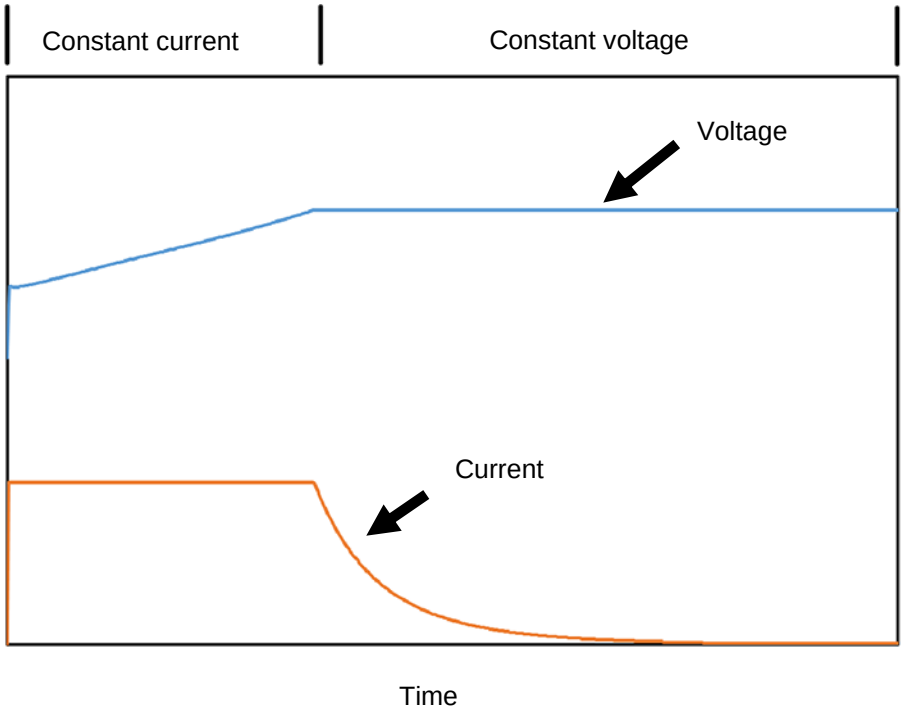
A block consists of 3 (6 V block) or 6 (12 V block) cells. They are installed in a single housing. The individual cells consist of grid structure electrodes. Each positive electrode is wrapped in a fleece. The electrolyte is fixed in this fleece.

Each cell has valves. These open at a certain pressure and allow any gases that may occur to escape in the event of overcharging.

5.3. Charging methods for rail | power AGM blocks/cells

5.3.1. Single-stage charging with constant current, constant voltage (IU)

This charging method limits both the current (I) and the voltage (U). At the beginning of charging, the charging current is limited and the charging voltage rises slowly. When a defined voltage is reached, it is kept constant by the charger. The current then drops automatically to a low value.

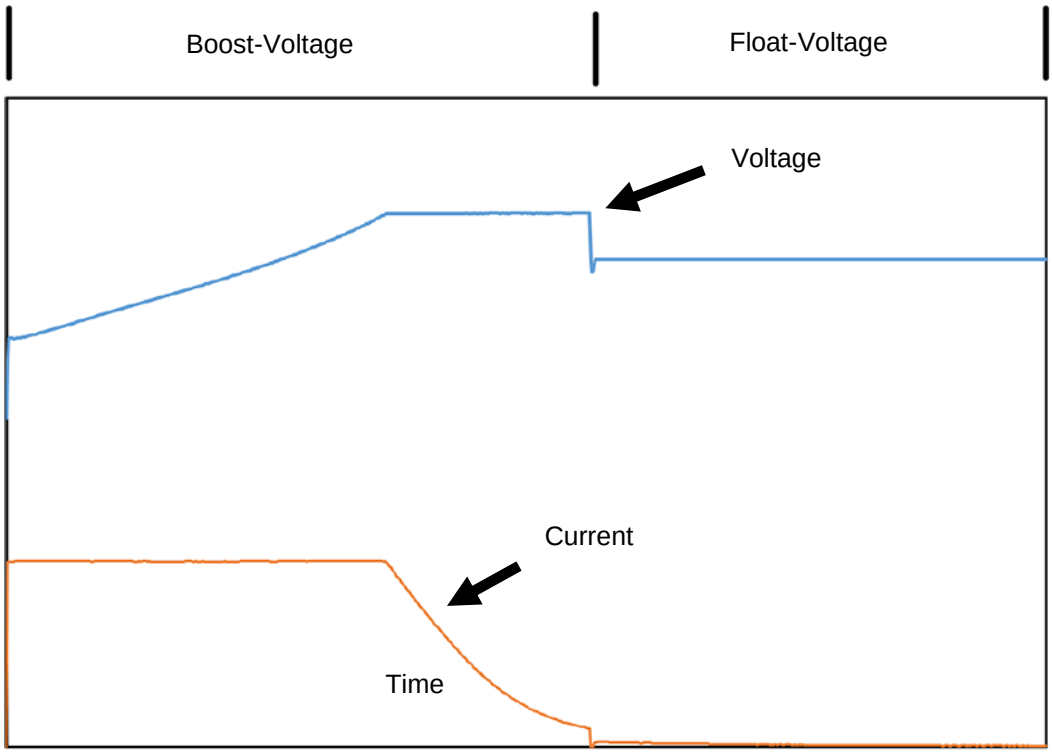


The setting of the charging voltage always represents a compromise between charging time and aging. As the current decays when the voltage limit is reached due to the natural behaviour of the battery, the charging process is slowed down. Although higher voltage extends the constant current phase and shortens the charging time, ageing is also accelerated by irreversible water loss (dehydration).

In accordance with the limited charging time in practice, HOPPECKE recommends a reduced state of charge of approx. 90% of the nominal capacity. For extreme applications (very high or very low temperatures, cyclical use) this value may be lower.

5.3.2. Two-stage charging with constant current, constant voltage (IU0U)

The two-stage charging process (IU0U) initially works according to the same principle as the single-stage charging process. First the current is limited, then the voltage is kept constant when a certain value is reached. This first voltage threshold is called the "boost voltage". When the boost voltage is reached, the charge current decays. When a certain charge current is reached (usually $I_{50} = C_n/50h$), the voltage is reduced to a lower value. This voltage value is referred to as the "float voltage".



The advantage is that the boost voltage can be selected higher than with a single-stage charge. This extends the constant current phase, resulting in a better state of charge in a shorter time.

After reaching the current threshold (I_{50}), which indicates that the battery has been sufficiently charged, the voltage is switched to the float voltage. This voltage is significantly lower than the voltage at single-stage charging. This keeps water consumption to a minimum while maintaining the state of charge.

If there has been a discharge of the battery, the charging current will increase again. When the switch-over point (I_{50}) is reached, the charging voltage is reset to the boost value to quickly recharge the battery. Then the charging current drops again and the charger switches back to float voltage.

As a result, this charging process eliminates the compromise between water consumption and state of charge of the single-stage charge.

In the case of two-stage charging, a reduction in the state of charge must also be taken into account when the battery is designed. The value is usually in the same range as for single-stage charging.

5.4. Technical data

5.4.1. Overview rail | power AGM blocks/cells

The following table shows an overview of the available rail | power AGM blocks/cells:

Designation	Type	Voltage [V]	Capacity [Ah]	Length [mm]	Width [mm]	Height [mm]	Weigth [kg]	Housing material
rail | power AGM 12 V 58 Ah	VRLA	12	58	267	177	190	23.0	PP
rail | power AGM 12 V 78 Ah	VRLA	12	78	342	177	190	31.0	PP
rail | power AGM 12 V 115 Ah	VRLA	12	115	344	170	275	46.0	PP
rail | power AGM 12 V 100 Ah	VRLA	12	100	541	125	217	38.5	ABS *)
rail | power AGM 12 V 130 Ah	VRLA	12	130	541	125	302	58.4	ABS *)
rail | power AGM 12 V 150 Ah	VRLA	12	150	541	125	302	59.7	ABS *)
rail | power AGM 12 V 170 Ah	VRLA	12	170	541	125	302	61.1	ABS *)
rail | power AGM 6 V 170 Ah	VRLA	6	170	242	170	275	32.0	PP
rail | power AGM 6 V 220 Ah	VRLA	6	220	308	170	275	41.0	PP
rail | power AGM 2 V 220 Ah	VRLA	2	220	183	90	310	14.4	ABS *)
rail | power AGM 2 V 308 Ah	VRLA	2	308	183	129	310	21.7	ABS *)
rail | power AGM 2 V 375 Ah	VRLA	2	375	183	155	310	25.0	ABS *)

*) Block/cell also in ABS-FR (Flame Retardent) available, fulfilling the UL94-V0 standard

5.4.2. Technical details

Construction / Design	• Cells according to EN 60896 - 21/22 • VRLA-Battery with electrolyte fixed in a glass fibre fleece (Absorbent Glass Mat AGM) • Battery meets the requirements of EN61373 (shock and vibration)
Battery designation	rail | power AGM <nominal Voltage> V <nominal Capacity> Ah
Nominal Temperature	20°C
Nominal Capacity	C_5 at 20°C available capacity for discharge with I_5 (see nameplate) down to 1.6 V per cell at nominal temperature
Nominal Current	$I_5 = C_5 / 5$ h (see name plate)
Nominal Voltage Cell	2.0 V / cell
Nominal Voltage Block	6.0 V or 12.0 V
Self Discharge	Ca. 2 to 3% per month at 20 °C
Electrolyte	Diluted sulphuric acid bound in fleece
Valve	Opening pressure 120 mBar integrated degassing

5.4.3. Environmental conditions for rail | power AGM cells / blocks

Environmental conditions according to EN 50125-1	Description
Temperature class T3	• ambient temperatures -25°C … +45°C, • inside temperatures -25°C … +55°C • Complied for the functionality and only for short term operation at high temperatures above +45°C up to maximum +60°C. • Not complied for class T3 as performance temperature range for the battery with the emergency case loads (see temperatures in respective sizing files for the battery)
Altitude class AX	More than 1400 m

5.4.4. Battery charging characteristics

Like all chemical reactions, the charge / discharge processes in the cell are subject to a temperature effect. In general, chemical reactions run faster with rising temperature and slower with falling temperature. For this reason, temperature compensation is used for the charging voltage.

This compensation is applied equally to the one-stage (IU) and two-stage (IU0U) charging method.

Note

Depending on the special operating mode of a vehicle and the resulting special requirements for the charging, individual values may differ from those listed below.

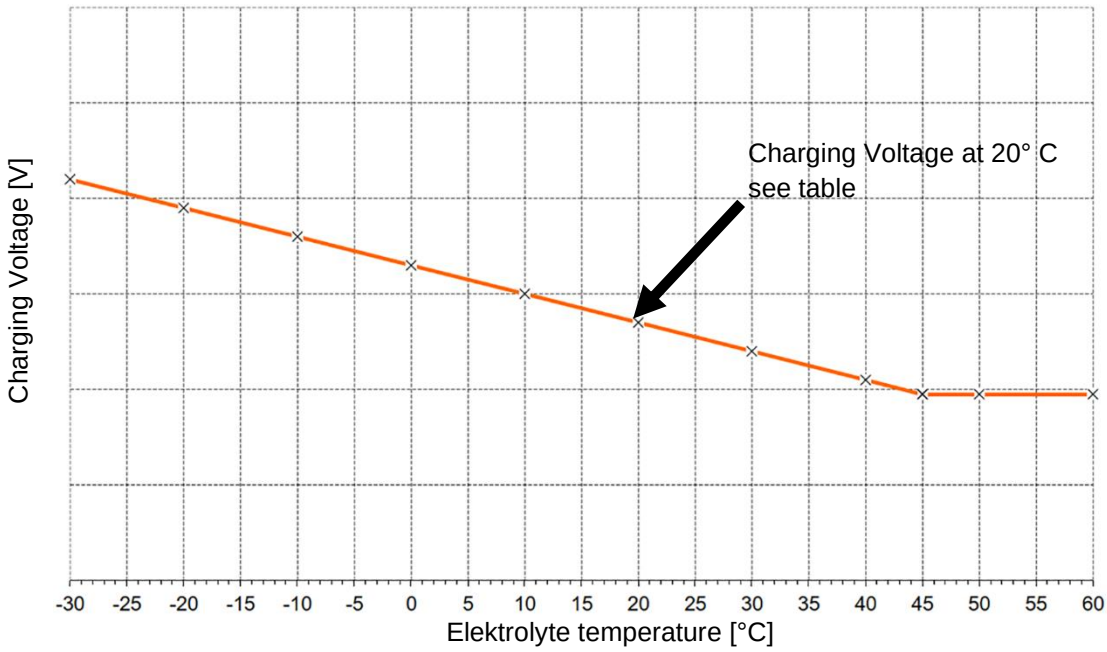
	Charging Voltage at 20 °C in V per cell connected in series			
rail | power AGM block / cell	Single Stage Charging (IU)	Two Stage Charging (IU0U), Float-Charge	Two Stage Charging (IU0U), Boost-Charge	Temperature kompensation in V/°C/Cell; starting from 20 °C
rail | power AGM 12 V 58 Ah	2,27 *)	2,25	2,40	-0,003
rail | power AGM 12 V 78 Ah	2,27 *)	2,25	2,40	
rail | power AGM 12 V 115 Ah	2,27 *)	2,25	2,40	
rail | power AGM 12 V 100 Ah	2,27 *)	2,25	2,40	
rail | power AGM 12 V 130 Ah	2,27 *)	2,25	2,40	
rail | power AGM 12 V 150 Ah	2,27 *)	2,25	2,40	
rail | power AGM 12 V 170 Ah	2,29 *)	2,27	2,40	
rail | power AGM 6 V 170 Ah	2,27 *)	2,25	2,40	
rail | power AGM 6 V 220 Ah	2,27 *)	2,25	2,40	
rail | power AGM 2 V 220 Ah	2,27 *)	2,25	2,40	
rail | power AGM 2 V 308 Ah	2,27 *)	2,25	2,40	
rail | power AGM 2 V 375 Ah	2,27 *)	2,25	2,40	

*): Guide values; may vary depending on the project

5.4.4.1. One stage, temperature compensated charging (IU-charging)

For rail. power batteries, a temperature-compensated charging characteristic is required to avoid excessive currents at high ambient temperatures and to fully charge the batteries at low temperatures. Starting from the charging parameters at design temperature, the charging voltage is increased or decreased depending on the measured battery temperature.

The figure below shows the charge voltage per cell as a function of the battery temperature monitored by the charger. It shows the temperature-compensated charge with -3 mV/°C per cell based on 20 °C for rail. power batteries referred to a single-stage constant voltage charge with current limitation.



The recommended maximum charge current is 1.0 x I_5.

Note

The charging curve describes a wide temperature range (based on EN50547) to ensure a safe power supply of the vehicle by the charger at any time. The specified temperature range is permissible for a few days, but should not be understood as the permanent operating temperature of the battery. At elevated battery temperatures, accelerated aging occurs which can significantly shorten the service life. The service life and maintenance intervals specified in this manual only apply at an average temperature of no more than 20°C (or another average temperature specific to the project).

Note

If the battery temperature ≥ is 60 °C, the charging process must be interrupted to prevent damage to the cells. Select a control that does not resume charging until the battery temperature has dropped to ≤ 55 °C

Note

You can assume that the temperature sensor is defective if the battery charger is measuring temperatures above +80 °C or below -50 °C. The battery charger will not be able to operate the battery if the temperature sensor is not in the correct range.

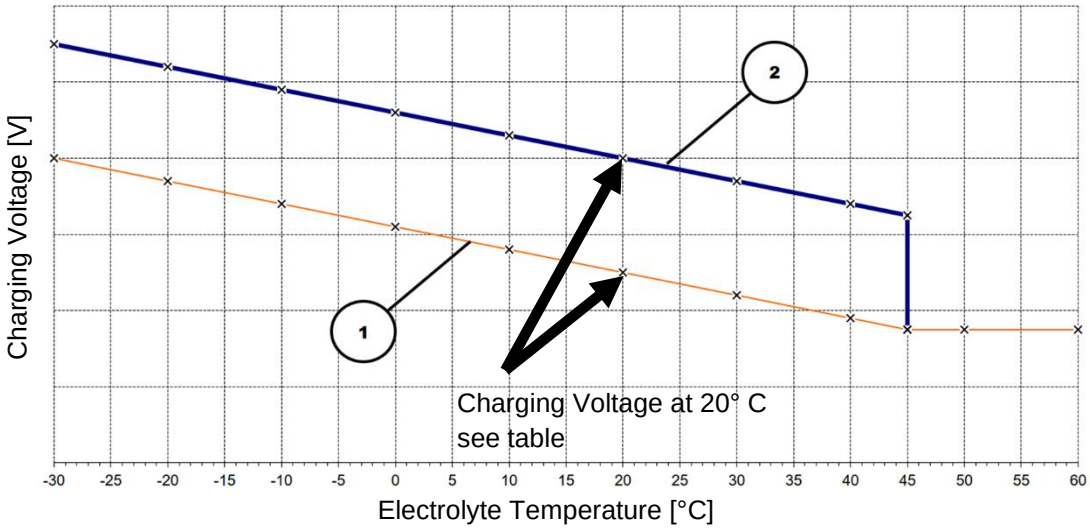
In this case, set the battery charger so that the charging voltage is limited to the value of the float charge at 30 °C.

The battery charger should generate a SERVICE message and the defective temperature sensor should be replaced within a few days.

5.4.4.2. Two stage, temperature compensated charging (IU0U-charging)

A two-stage charge (constant current / constant voltage) is recommended for rail | power AGM batteries. In addition, a temperature-compensated charging characteristic is required in order to avoid excessive currents at high ambient temperatures and to fully charge the batteries at low temperatures. Based on the charging parameters at design temperature, the charging voltage is increased or decreased depending on the measured battery temperature.

The following figure shows the charging voltage per cell depending on the battery temperature monitored by the charger. It shows the temperature compensated charge with - 3 mV/°C per cell based on 20 °C for rail | power AGM batteries related to a two-stage constant voltage charge with current limitation.



1 = Float charge 2 = Boost charge

The switchover from the low voltage level (float charge) to the higher voltage level (boost charge) takes place when the charge current I_{50} is exceeded.

The switchover from the higher voltage level (boost charge) to the lower voltage (float charge) takes place when the charge current falls below the same I_{50}.

To avoid battery damage, it is necessary to switch from boost charging to float charging at battery temperatures ≥ 45 °C. The hysteresis must be selected in such a way that the switch-back to boost charging does not occur until a temperature of ≤ 40 °C is reached.

The recommended maximum charge current is 1.0 x I_5.

Note

The charging curve describes a wide temperature range (based on EN50547) to ensure a safe power supply of the vehicle by the charger at any time. The specified temperature range is permissible for a few days, but should not be understood as the permanent operating temperature of the battery. At elevated battery temperatures, accelerated aging occurs which can significantly shorten the service life. The service life and maintenance intervals specified in this manual only apply at an average temperature of no more than 20°C (or another average temperature specific to the project).

Note

If the battery temperature ≥ is 60 °C, the charging process must be interrupted to prevent damage to the cells. Select a control that does not resume charging until the battery temperature has dropped to ≤ 55 °C

Note

You can assume that the temperature sensor is defective if the battery charger is measuring temperatures above +80 °C or below -50 °C. The battery charger will not be able to operate the battery if the temperature sensor is not in the correct range.

In this case, set the battery charger so that the charging voltage is limited to the value of the float charge at 30 °C.

The battery charger should generate a SERVICE message and the defective temperature sensor should be replaced within a few days.

6. Notes for transport

Observe the regulations for the transport of batteries, which are specified in the following sections.

Note

Follow the safety instructions, see 2 Safety instructions on page 9.

6.1. Transportation of undamaged batteries

Filled batteries are not defined as dangerous goods if all following points apply:

- Undamaged
- Tight
- Secured against toppling down and slipping on a palette
- No short circuit
- Surface of the battery and the package with no traces of acid

The sender, packer, and shipping agent have to care for following packaging:

- For transportation of the battery a solid palette has to be used.
- The battery has to be covered on top with a paperboard of the size of the battery to protect it against short circuits.
- Afterwards the battery has to be tightened with non-metallic straps (plastics) in horizontal and vertical direction to fix it on the palette.
- An additional clean cover (preferably water-proof) to protect the package is recommended.
- Every package must have the marking:
  - "Attention Filled Batteries"
  - "Transportation Upright"
- The transport document needs the comment:
  - Transportation according to RN 2801 a Section 4a (new battery)
  - Transportation according to RN 2801 a Section 4 b (used battery)

6.2. Transportation of damaged batteries

Filled batteries are treated as dangerous goods if one of the following applies:
- Damaged
- Leak
- Contaminated by acid

The battery must be packed and transported in a stainless steel or solid plastic container. For containers < 1 m^3 no type test is required.

The container must be labelled with hazard label No. 8 and UN NR 2794.

For transport, an accident leaflet for batteries (HO3) must be provided with the vehicle and the driver must be informed of the dangerous goods.

The following information must be entered in the accompanying document:
- Gross weight without pallet
- Batteries, wet, filled with acid, dangerous goods ADR KL. 8 2801 number 81 c UN 2794. Dangerous goods packed according to ADR, marked and approved for transport.

7. Notes on storage

The service life of the batteries begins with delivery ex works HOPPECKE. The storage periods are to be fully counted towards the service life.

Note

Follow the safety instructions, see 2 Safety instructions on page 9.

Unpack, install and commission batteries as soon as possible after delivery, see 8 Assembly / commissioning on page 30

In case this is not possible:
- Store the batteries in a clean, dry and frost-free room.
- Protect the batteries against mechanical damage and contamination.
- Do not expose the batteries to direct sunlight.
- Do not stack the batteries on one another. Observe and follow project-specific regulations applicable, if any.

During storage, you must charge lead-acid battery systems whether with permanent float charge or you have to charge it regularly, see:
- 7.1 Storage with permanent float charge on page 28
- 7.2 Storage with regularly recharge on page 28

If you follow the instructions of charging during storage, the battery system is always ready to use.

Note

A too high storage temperature leads to faster self-discharge and a premature ageing of the battery system.

The storage temperature must be in the range 0 °C … +40 °C.

The optimum storage temperature is in the range +10 °C … +20 °C.

7.1. Storage with permanent float charge

Float charge means: Charge permanent with current limitation of the nominal charge current $I_5=C_n/5h$ with following constant voltages:

- 2.25 V per cell in case of 2 V single cells
- 6.75 V per block in case of 6 V blocks
- 13.5 V per block in case of 12 V blocks

7.2. Storage with regularly recharge

Regularly recharge means: Charge the battery system for 24 hours with current limitation of the nominal charging current $I_5=C_n/5h$ with following constant voltages:

- 2.40 V per cell in case of 2 V single cells
- 7.20 V per block in case of 6 V blocks
- 14.40 V per block in case of 12 V blocks

Following intervals must be observed:

- Every 6 months, if the average storage temperature is ≤ +20 °C
- Every 3 months, if the average storage temperature is in the range of +20 °C … +30 °C
- Every 6 weeks, if the average storage temperature is in the range of > +30 °C

Note the respective loading processes in a log.

7.3. Storage with built-in battery

Note

Ideally, the battery should be stored separately from the vehicle in a clean, dry and frost-free room.

If it is not possible to separate the battery from the vehicle and the vehicle is parked, make sure the battery will not deep discharge.

Disconnect the battery electrically from the electrical system of the vehicle to prevent permanent consumers discharge the battery.

Parking has to be considered as normal operation for maintenance purposes. Carry out the regular maintenance intervals and works, see 9 Maintenance on page 35.

Note

Perform regular recharging during the parking period, see 7.2 Storage with regularly recharge on page 28.

8. Assembly / commissioning

Target: The battery is connected for use in the vehicle.

Note

Follow the safety instructions, see 2 Safety instructions on page 9.

DANGER!

Danger due to a short circuit between the positive and negative terminal of a battery.

If the positive and negative terminals of a battery are short-circuited, there is a risk of overheating and explosion.

There is an imminent danger with a high risk that will result in death or serious injury if not avoided.

Never short-circuit the positive and negative terminals of a battery.

DANGER!

Danger when connecting a battery to the load.

Reversed battery polarity can cause overheating and acid leakage.

There is an imminent danger with a high risk that will result in death or serious injury if not avoided.

Always check the correct polarity before making connections.

Make sure that all consumers in the vehicle and the charger are switched off.

Note

If the terminals of a battery are damaged, the battery can no longer be used.

Do not damage the terminals of the batteries.

Note

- Ensure stable, safe standing areas for carriers/trays/battery cells.
- Ensure that all consumers in the vehicle and the charger are switched off.

8.1. Checking the delivery

HOPPECKE Batterie Systeme GmbH packages your delivery with the greatest possible care so that it arrives undamaged.
Check the delivery immediately:

- Completeness (comparison with the delivery note)
- Transport damages
- Make a note of:
- - Damage to the outer packaging
- - Visible stains or moisture that would indicate leaking electrolyte.

If the delivery is incomplete or there is damage in transit:

- Write a short defect report on the delivery note before you sign it.
- Ask the carrier for an inspection and note the name of the inspector.
- Write a defect report and send it within 14 days to HOPPECKE Batterie Systeme GmbH and the forwarding agent.

Check the goods for defects:

- Observe the instructions in 2 Safety instructions.
- After delivery, unpack the batteries and check them for defects by performing a visual and functional inspection.
- Document any existing defects and send them in text form to Hoppecke Batterie Systeme GmbH within 14 days.

Note

If you notify the freight forwarder too late of defects or incompleteness, this may result in the loss of your claims.

8.2. Installation and connection

Target: The battery is connected for use in the vehicle.

DANGER!

Danger of a short circuit between the positive and negative terminals of a battery.

If the positive and negative terminals of a battery are short-circuited, there is a risk of overheating and explosion.

There is an immediate, high-risk hazard which, if not avoided, will result in death or serious injury.

Never short-circuit the positive and negative terminals of a battery.

DANGER!

Danger when connecting a battery to the consumer.

Polarity reversal of batteries may cause overheating and caustic leakage.

There is an immediate, high-risk hazard which, if not avoided, will result in death or serious injury.

Always check the correct polarity before making connections.

Ensure that all loads in the vehicle and the charger are disconnected or switched off.

Note

If the terminals of a battery are damaged, the battery can no longer be used.

Do not damage the terminals of the batteries.

Note

- Ensure stable, safe standing areas for carriers/trays/battery cells.
- Ensure that all consumers in the vehicle and the charger are switched off.

Note

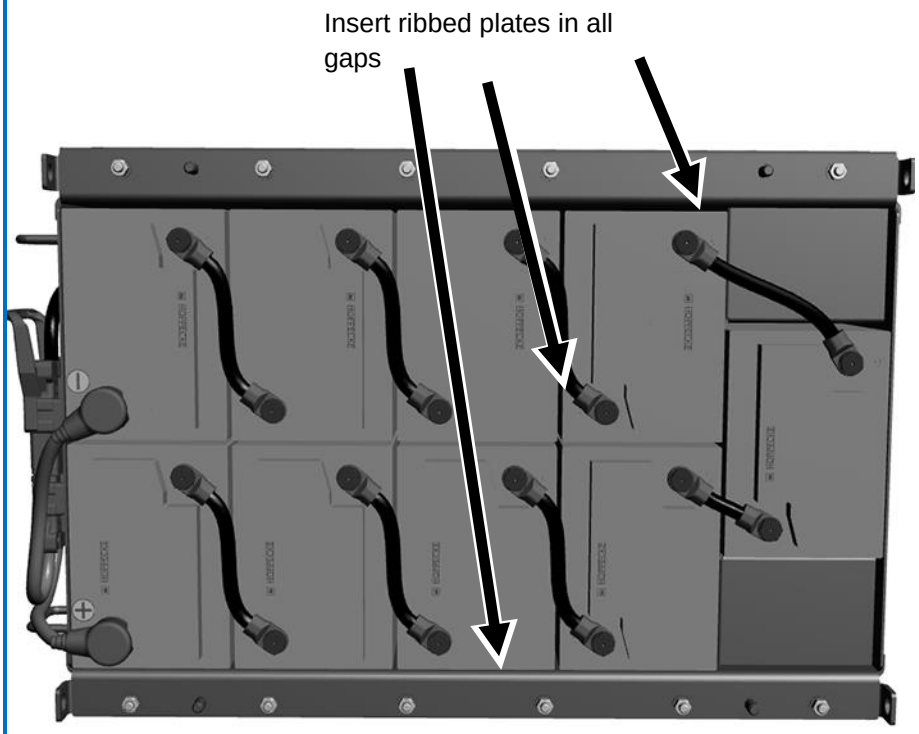
Observe the project-specific electrical circuit diagram.

In case of delivery of so-called battery kits (blocks/cells, connectors, terminal screws):

- Install the blocks/cells into the battery compartment of the vehicle according to your customer's installation drawing
- Install the connectors.
- Connect the end terminals.

Note

The installation of cells and ribbed panels is always carried out from the outside to the inside (and as specified in the construction drawing). Any gap dimension corrections and unevenness on the outer walls are compensated with ribbed plates depending on the gap. This ensures a form-fit installation of the cells/blocks in the battery trays.



Note

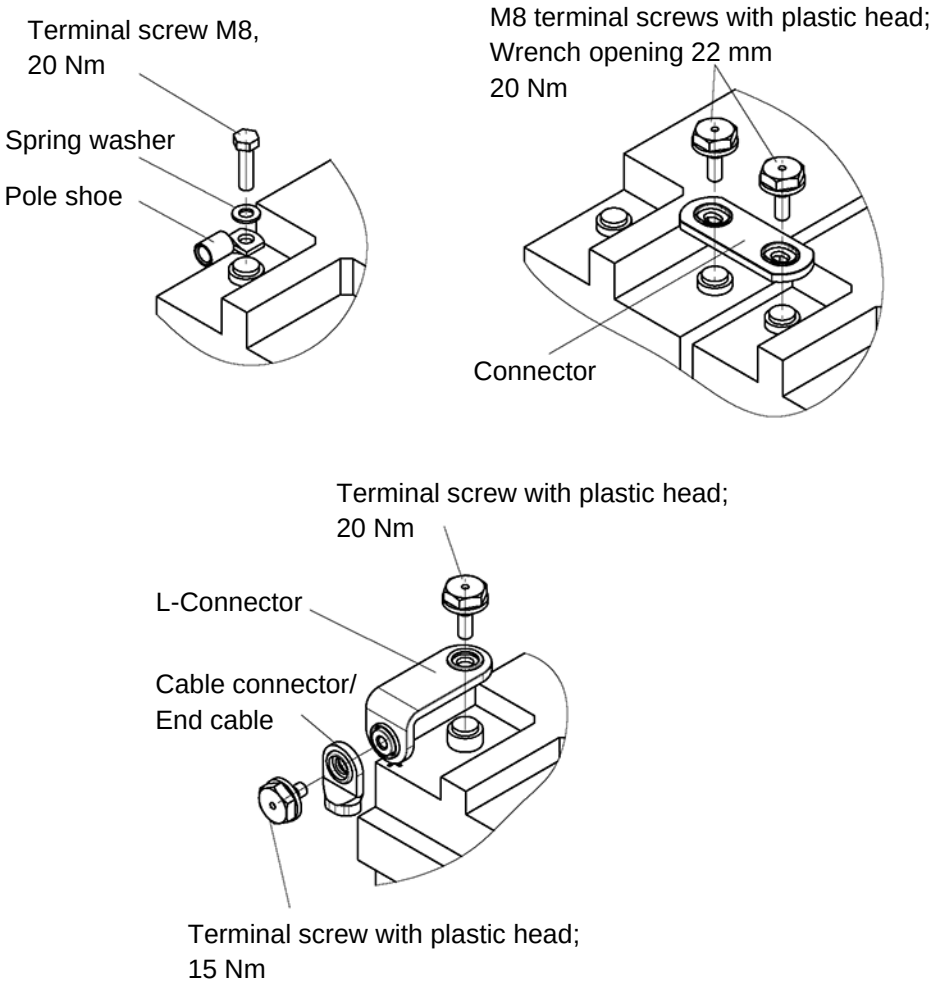
The cells/blocks must be mounted on a flat surface (tray bottom). The maximum flatness tolerance is 3 mm in relation to the total area of the tray.

Note

When mounting cells in containers or carriers, the cells/blocks must not be "driven in". They must be inserted without applying any great force, otherwise the box/lid weld seam will be overloaded and leaks will occur.

Note

When making the screw connections, observe the tightening torque of 20 resp. 15 Nm.



1. Connect the positive terminal of the battery to the positive terminal of the on-board power supply or charger.
2. Connect the negative terminal of the battery to the negative terminal of the on-board power supply or charger.
3. If applicable, connect existing control lines (e. g. temperature sensors, medium voltage taps etc.).
4. Check the battery connection, for example by checking the charging voltage and the control signals.

Result: The battery is connected for use in the vehicle.

9. Maintenance

9.1. Preventive maintenance

Note

Follow the safety instructions, see 2 Safety instructions on page 9.

Have the batteries serviced regularly and properly by HOPPECKE qualified personnel or personnel authorised by HOPPECKE Batterie Systeme GmbH.

To ensure the optimal state of the battery system, follow the maintenance plan:

Activity	Interval	Description
Visual inspection of the entire battery system	6 months	9.1.1 Visual inspection of the battery on page 36
Measurement of the voltage of the entire battery	1 year	9.1.2 Measurement of the charging voltage on page 37
Cleaning the battery		9.1.3 Cleaning the battery on page 38
Measurement of the insulation resistance		9.1.4 Measuring the insulation resistance on page 39
Measurement of single block/cell voltages	4 years	9.1.5 Measuring the open-circuit voltage on each battery block/cell on page 41
Replacement of the rail | power AGM blocks/cells and the attachments	6 years *)	11 Disassembly on page 51

*) Interval may vary depending on the project and/or ambient temperature.

Note

For proof in case of warranty, enter the activities and the measured values in a maintenance protocol, see 13.2 Maintenance protocol 59.

9.1.1. Visual inspection of the battery

Target: The visual inspection of the battery is done.

1. Check the battery against following criteria:

Test object	Test criterion	Remedy
Battery / cells, screws, connectors and cable lugs	Check battery/cells for contamination, especially in the area of the connections	Thoroughly remove dirt from battery cells, screws, connectors and cable lugs with a clean, damp cloth.
Ventilation openings	Check ventilation openings for free passage	Clear the ventilation openings.
Battery and container	Check battery and container for mechanical damage.	In case of mechanical damage: Contact the depot manager or HOPPECKE Service.
Connectors, screws, cables	Connectors, screws, cables must not be loose.	Tighten screws on cables or connectors.
Temperature sensor	Check temperature sensor, if present, for proper attachment.	Attach the temperature sensor.
Cells / batteries Valve plugs Impurities	Check for contamination by electrolyte.Plugs must be tight (no stains of electrolyte on the plugs or on the cells).	Check plug for tight fit, correct if necessary.
Seals	The container's seals, if any, must not show any mechanical damage.	Replace damaged seals.

2. Enter your activities in a maintenance protocol, see 13.2 Maintenance protocol on page 59.

Result: The visual inspection of the battery was done.

9.1.2. Measurement of the charging voltage

Target: The charging voltage of the battery is measured and checked.

The measurement of the voltages is used for error detection. Logging the measured voltages helps here.

DANGER!

When establishing access to the battery system, contact with sharp edges and/or live components may occur due to the design.

There is an immediate, high-risk hazard which, if not avoided, will result in death or serious injury.

Measures to avert the danger:

- Be very careful when carrying out any work on the batteries.
- Wear personal protective equipment, see 2 Safety instructions on page 9.

Precondition

The battery system is connected to the vehicle's onboard charger and is being charged.

Required tools:

- Digital Multimeter
- current clamp
- contact thermometer

1. Measure the charging voltage directly at the battery with a suitable multimeter.
2. Measure the charging current directly at the battery with a suitable current clamp.
3. Measure the temperature of the battery with a contact thermometer.
4. Check the measured value against the charging characteristic, see 5.4.4 Battery charging characteristics on page 21.

It applies:

	Measured Current (I)	Measured Voltage (U)
Batterie	< I50	Float Charge
	Higher than I_{50} but lower than I_5	Boost Charge
	≥ I_5	I-Phase; No statement possible. Wait until U=const , i.e. until Float- or Boost-Charging is available.

Example for a rail | power AGM Cell:

For Boost Charge a cell voltage of 2.40 V at 20 °C has to be measured.

5. Enter your activities in a maintenance protocol, see 13.2 Maintenance protocol on page 59.

Result: The charging voltage of the battery was measured and checked.

9.1.3. Cleaning the battery

Target: The battery is cleaned.

A clean battery is absolutely necessary, in order to avoid reduced service life and to ensure the availability of the battery.

Cleaning of the rail | power AGM blocks/cells and the container/tray is necessary in order to maintain the required insulation of the cells from each other, from the earth, and from other extraneous conductive parts. In addition, damage caused by corrosion and leakage can be avoided.

Cleaning of batteries is not only necessary to ensure high availability required, but is also an essential part of accident prevention regulations.

Note

Improper cleaning may damage the batteries.

Avoid damaging the battery:

- Do not use solvents or wire brushes for cleaning.
- Prevent penetration of cleaning water and dirt particles into the cells. The vent plugs must be closed.

1. Clean the battery with a clean cloth and with water without adding any detergents or cleaning agents.
2. Let the surfaces dry or use compressed air.

Note

Any liquids which entered the battery tray must be extracted and disposed of in accordance with waste monitoring guidelines.

3. Enter your activities in a maintenance protocol, see 13.2 Maintenance protocol on page 59.

Result: The battery was cleaned.

9.1.4. Measuring the insulation resistance

Target: The insulation resistance of the battery is measured.

The insulation resistance of a battery in a rail vehicle is a measure of the conductivity resulting from moisture and contamination of the battery between the battery terminals and the vehicle chassis. Ideally, there is no electrical conductivity here if the insulation resistance of the battery is infinitely high.

When commissioning a new battery, the insulation resistance must be > 1 MΩ. It decreases with the operating time (due to aerosols from the batteries, condensation, dust) and may not fall below the following values depending on the nominal battery voltage:

Battery Nominal Voltage	Norm	Insulation Resistance
below 100V	DIN VDE 0119-206-4	10 kΩ
between 100 and 120V	DIN EN 50272 Teil 2	100 Ω per Volt Nominal voltage
above 120V	DIN EN 62485-3 09/2015	No. of cells x 2.0 V Nominal voltage Cell x 500 Ω /V

If this minimum value is not reached, a possibly existing insulation monitor, an undesired increased discharge and loss of battery performance may occur.

Note

For rail | power AGM batteries, an insulation measuring instrument with a test voltage of 500 V must be used.

Use a suitable measuring device, e.g. Fluke 1507 (HOPPECKE Mat.nr.: 4141201237), with the settings 500 V/DC.

CAUTION!

Risk of damage to the on-board network of the vehicle.

An insulation test voltage of 500 V may damage other components connected to the battery.

Disconnect the battery from the on-board network, positive and negative terminal.

WARNING!

When carrying out measurements with an insulation measuring instrument, there is a risk of electric shock.

There is a potential medium risk which, if not avoided, could result in death or serious injury.

Observe the safety precautions described in the documentation of the insulation measuring instrument.

Required tools:

- Insulation measuring instrument (e.g. Fluke 1507)

1. Check the function of the insulation measuring device by measuring any metal part of the battery tray / battery container against any metal part of the vehicle chassis. The measured resistance must be 0 Ω.
2. Measure the insulation resistance between positive terminal of the battery and one metallic part of the rolling stock vehicle chassis (battery compartment or central earthing point).
3. Measure the insulation resistance between the negative terminal and a metallic part of the rolling stock vehicle chassis.
4. Check the function of the insulation measuring device by measuring any metal part of the battery tray / battery container against any metal part of the vehicle chassis. The measured resistance must be 0 Ω.
5. Clean the battery if the measurements fall below the minimum value (see 9.1.3 Cleaning the battery on page 38).
6. Measure insulation resistances again according to steps 2 and 3.

Note

If the isolation test fails again, contact HOPPECKE service.

7. Enter your activities in a maintenance protocol, see 13.2 Maintenance protocol on page 59.

Result: The insulation resistance of the battery is now measured.

9.1.5. Measuring the open-circuit voltage on each battery block/cell

Target: The open circuit voltages at each block/cell are measured.

1. Use a suitable measuring instrument (e.g. multimeter) to measure the open-circuit voltage per block/cell and record the values in a maintenance report. For charged rail | power AGM blocks/cells the voltage must be above:
   • 12.48 V for 12V-blocks
   • 6.24 V for 6V-blocks
   • 2.08 V for 2V-cells

Note

Before measuring the open-circuit voltage, let the cells / blocks rest for at least 4 hours (no charge, no loads).

The above-mentioned voltage values are valid for a temperature of 20°C

2. Calculate the mean value from the measured values.

Note

If a rail | power AGM block/Cell is more than

- 120 mV (12 V-block)
- 60 mV (6 V-block)
- 20 mV (2 V Cell)

below the calculated mean value, you must charge the entire battery, see following charging condition.

Charge the battery for 24 hours with current limited to $I_5 = C_n/5h$ with following voltages:

- 14.40 V per block (12 V blocks)
- 7.20 V per block (6 V blocks)
- 2.40 V per cell (2 V cells)

Repeat the measurement 4 hours after charging is complete.

If the block/cell is then noticeable again, the entire battery must be replaced or you can contact HOPPECKE Service

3. Enter your activities in a maintenance protocol, see 13.2 Maintenance protocol on page 59.

Result: The open circuit voltages at each block/cell were measured.

9.2. Corrective maintenance

Note

Follow the safety instructions, see 2 Safety instructions on page 9.

9.2.1. Exchange of rail | power AGM blocks/cells

Target: rail | power AGM blocks/cells are exchanged.

DANGER!

When establishing access to the battery system, contact with sharp edges and/or live components may occur due to the design.

There is an immediate, high-risk hazard which, if not avoided, will result in death or serious injury.

Measures to avert the danger:

- Be very careful when carrying out any work on the batteries.
- Wear personal protective equipment, see 2 Safety instructions on page 9.

DANGER!

Loose connections at the terminal screws can heat up strongly and cause inflammations or explosions.

Use each screw and washer only once.

- First tighten the terminal screws only by hand.
- Align batteries and connectors if necessary once again.
- Then tighten the terminal screws to the prescribed torque

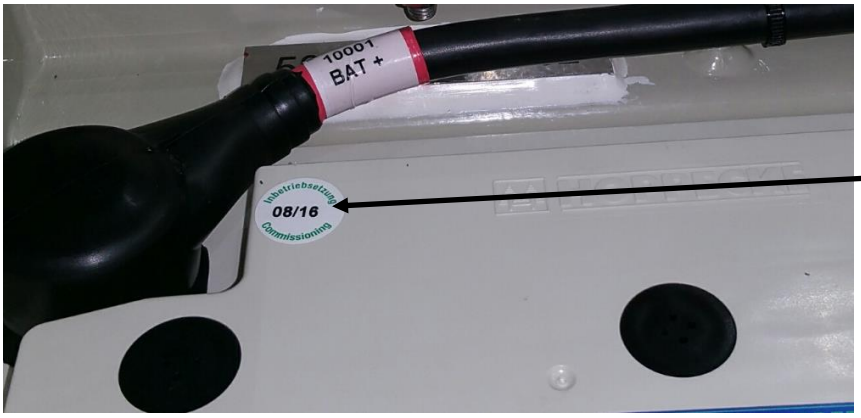
Note

- Switch off all loads and chargers from the battery system before starting any maintenance work.
- A battery always has a voltage at the terminals.
- A battery must not be earthed or short-circuited.
- Batteries/trays are very heavy. Carry the battery carriers with a sufficient number of persons or use suitable lifting equipment and means of transport.

Note

Each rail | power AGM block/cell has a sticker on it that identifies the commissioning.

- rail | power AGM blocks/cells up to 2 years old can be replaced by new rail | power AGM blocks/cells
- If the rail | power AGM block/cell to be replaced is 2 years old or older, please contact the HOPPECKE service department.
- If rail | power AGM blocks/cells are defective, you can replace a maximum of 12% of the blocks/cells of the entire battery. If more blocks/cells are defective, all blocks/cells must be replaced.



Required Tools:

- Torque wrench with suitable widths for M8 screws

1. Remove the connectors to the adjacent blocks/cells.
2. Lift the rail | power AGM block/cell to be replaced out of the tray/container.

Note

It is recommended to use a suitable suction lifting device for the removal and installation of the blocks/cells.

3. Lift the new rail | power AGM block/cell into the tray.
4. Make the electrical connections to the neighbouring blocks/cells.

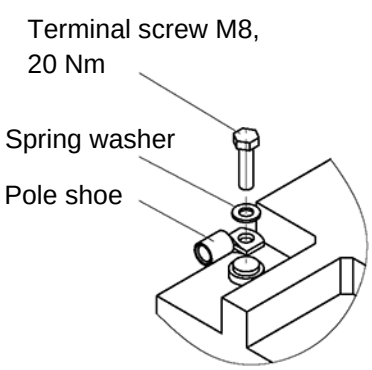
Note

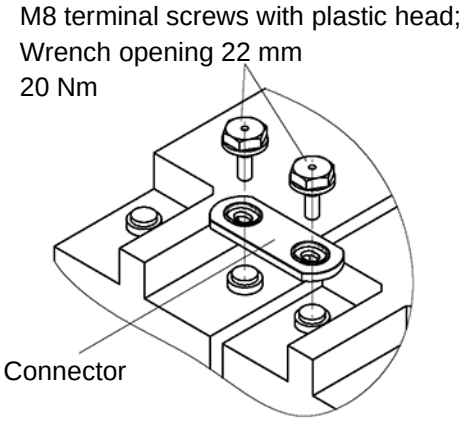
The exchange blocks/cells must be charged. Stored blocks/cells must be recharged according to 7 Notes on storage on page 27.

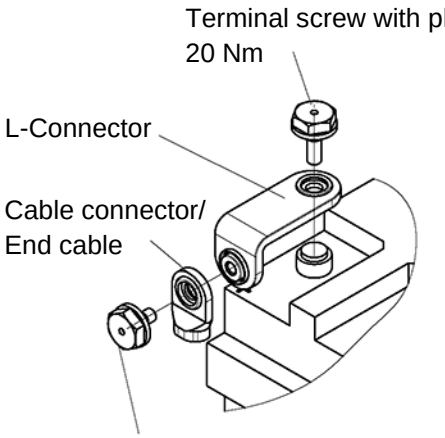
Note

The pole screws M8 with plastic head must be replaced by new ones because the screw connection is secured with a micro-encapsulated adhesive.

For connections with M8 pole screws without plastic head, you can reuse the screws, but must use new spring washers.







Result: The rail | power AGM blocks / cells are exchanged.

9.2.2. Exchanging a cell connector

Target: A defect connector is exchanged.

Required tools:

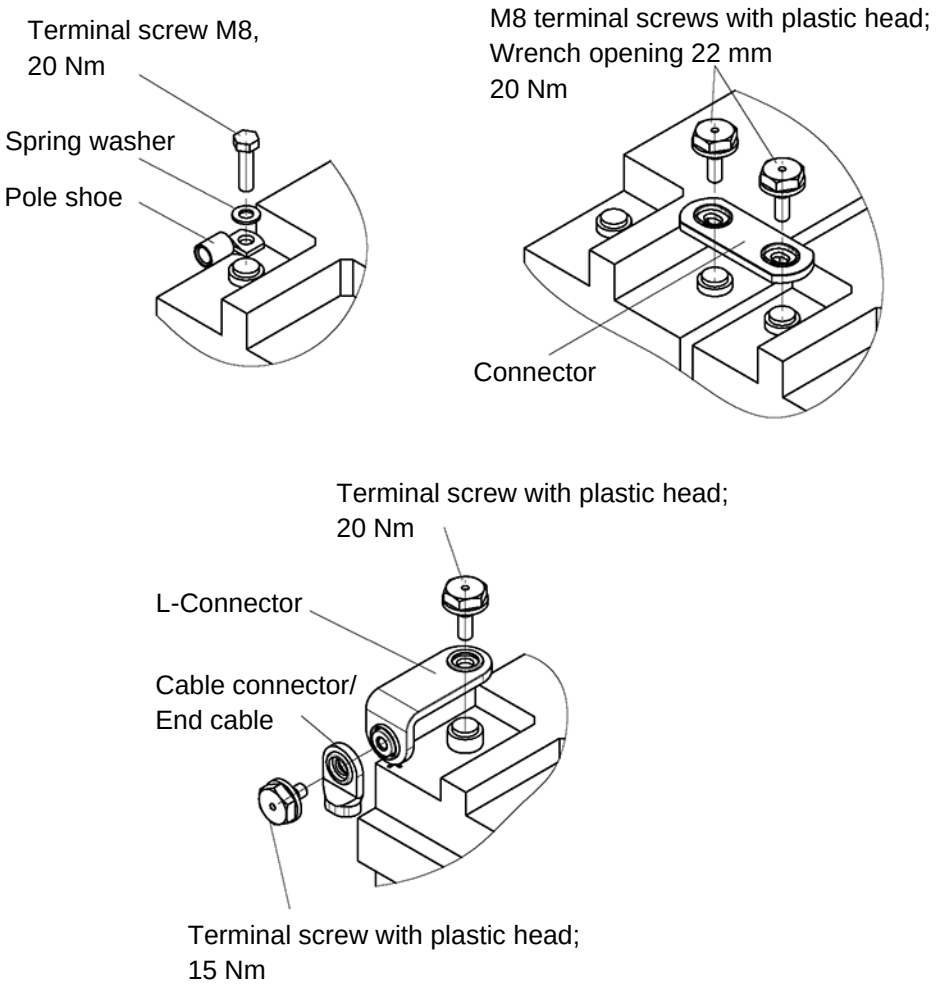
- Torque wrench with suitable widths for M8 screws

1. Loosen the terminal screws of the connector to be replaced.
2. Remove the defective connector.
3. Install the new connector and mount the terminal screws.

Note

The pole screws M8 with plastic head must be replaced by new ones because the screw connection is secured with a micro-encapsulated adhesive.

For connections with M8 pole screws without plastic head, you can reuse the screws, but must use new spring washers.



Result: The defect connector was exchanged.

9.2.3. Exchange of the temperature sensor

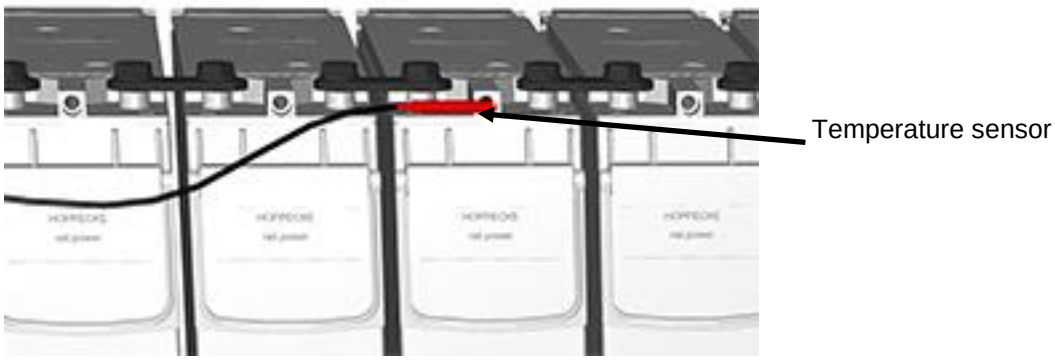
The temperature sensor can be designed as a T-piece or L-piece. Accordingly, there are 2 different possible mounting positions:

Version	
T-piece	9.2.3.1 Temperature sensor as T-piece in the central degassing duct of a block on page 46
L-piece	9.2.3.2 Temperature sensor as L-piece in special terminal screw on page 47

9.2.3.1. Temperature sensor as T-piece in the central degassing duct of a block

Target: The defect temperature sensor is exchanged.

1. Disconnect the Cannon plug.
2. Remove the defective temperature sensor.



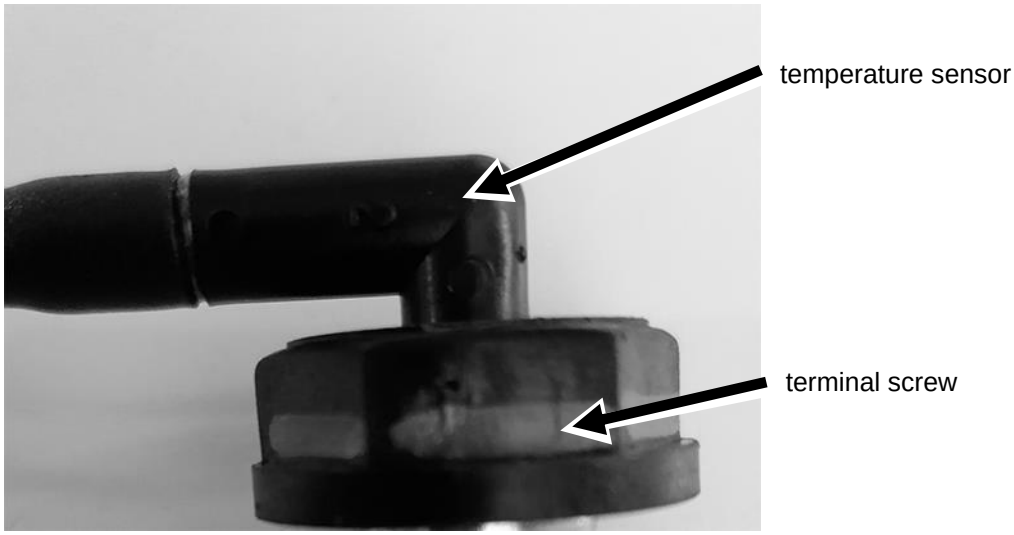
3. Install the new temperature sensor.
4. Reconnect the Cannon plug.
5. Check the charging voltage, see 9.1.2 Measurement of the charging voltage on page 37.

Result: The defect temperature sensor was exchanged.

9.2.3.2. Temperature sensor as L-piece in special terminal screw

Target: The defect temperature sensor is exchanged.

1. Disconnect the Cannon plug.
2. Remove the defective temperature sensor by pulling it out of the special terminal screw.

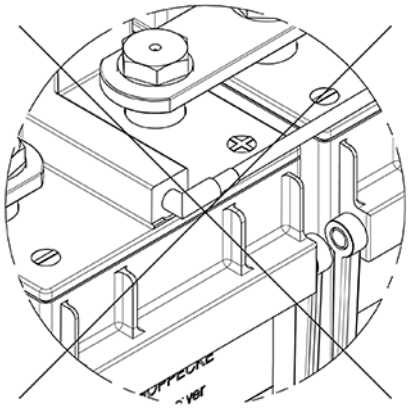


3. Install the new temperature sensor by inserting it into the special terminal screw provided for this purpose.
4. Reconnect the Cannon plug.
5. Check the charging voltage, see 9.1.2 Measurement of the charging voltage on page 37.

Result: The defect temperature sensor was exchanged.

Hinweis

Temperature sensors in L-design must not be mounted in the central degassing channel of a block, as this would close the central degassing.



10. Troubleshooting

Note

Follow the safety instructions, see 2 Safety instructions on page 9.

10.1. Insufficient capacity

If the capacity of the battery system is too low, proceed as follows:

Cause	Remedy
Loose or oxidised terminal(s)	Check all connector(s), replace the connector(s) if required (use new spring washer(s))
Temperature sensor has a defect. That causes incorrect charge parameters.	Check the temperature sensor if available

10.2. Insufficient insulation resistance

When commissioning a new battery, the insulation resistance must be > 1 MΩ. It decreases with the operating time (due to aerosols from the batteries, condensation, dust) and may not fall below the following values depending on the nominal battery voltage:

Battery nominal voltage	Norm	Insulation Resistance (minimum value)
below 100 V	DIN VDE 0119-206-4	10 kΩ
between 100 V and 120 V	DIN EN IEC 62485-2	100 Ω per Volt nominal voltage
Above 120 V, i.e. from 100 cells	DIN EN 62485-3 09/2015	Number of cells x 1.2 V nominal voltage x 500 Ω /V

If these minimum values are not reached, a possibly existing insulation monitor of the vehicle may response, an undesired increased discharge and loss of battery performance may occur.

If the insulation resistance is too low, leakage currents can reduce the available capacity. This can also cause differences in voltage between the cells. Regular cleaning prevents these leakage currents.

Cause	Remedy
Contamination	Cleaning
Cells / Blocks is/are leaking	Remedy the problem or replace the cell if necessary

10.3. No battery voltage can be measured

If no battery voltage can be measured, proceed as follows:

Cause	Remedy
Main plug of the battery system is not inserted	Connect the main plug
Main plug of the battery system is defect	Replace the main plug
Cable breakage	Replace the cable
Cell connector(s) is/are defect	Replace the connector(s) (use new spring washer(s))

10.4. Malfunction of the temperature sensor

If the temperature sensor does not provide plausible temperature values in the range lower -50 °C or higher 80 °C, proceed as follows:

Possible Cause	Remedy
Temperature sensor defect	Replace the temperature sensor
Plug defective	Replace plug
Plug not inserted	Insert plug
Cable breakage in the extension cable	Replace cable

11. Disassembly / Assembly of rail | power AGM blocks / cells and accessories

Target: The rail | power AGM blocks / cells are replaced.

DANGER!

When establishing access to the battery system, contact with sharp edges and/or live components may occur due to the design.

There is an immediate, high-risk hazard which, if not avoided, will result in death or serious injury.

Measures to avert the danger:

- Be very careful when carrying out any work on the batteries.
- Wear personal protective equipment, see 2 Safety instructions on page 9.

DANGER!

Loose connections at the terminal screws can heat up strongly and cause inflammations or explosions.

Use each screw and washer only once.

- First tighten the terminal screws only by hand.
- Align batteries and connectors if necessary once again.
- Then tighten the terminal screws to the prescribed torque

Note

Observe the notes on disassembly, see 2.1.7 Notes on disassembly on page 13.

Note

- Switch off all loads and chargers from the battery system before starting any maintenance work.
- A battery always has a voltage at the terminals.
- A battery must not be earthed or short-circuited.
- Batteries/trays are very heavy. Carry the battery carriers with a sufficient number of persons or use suitable lifting equipment and means of transport.

Precondition

You have established access to the battery system.

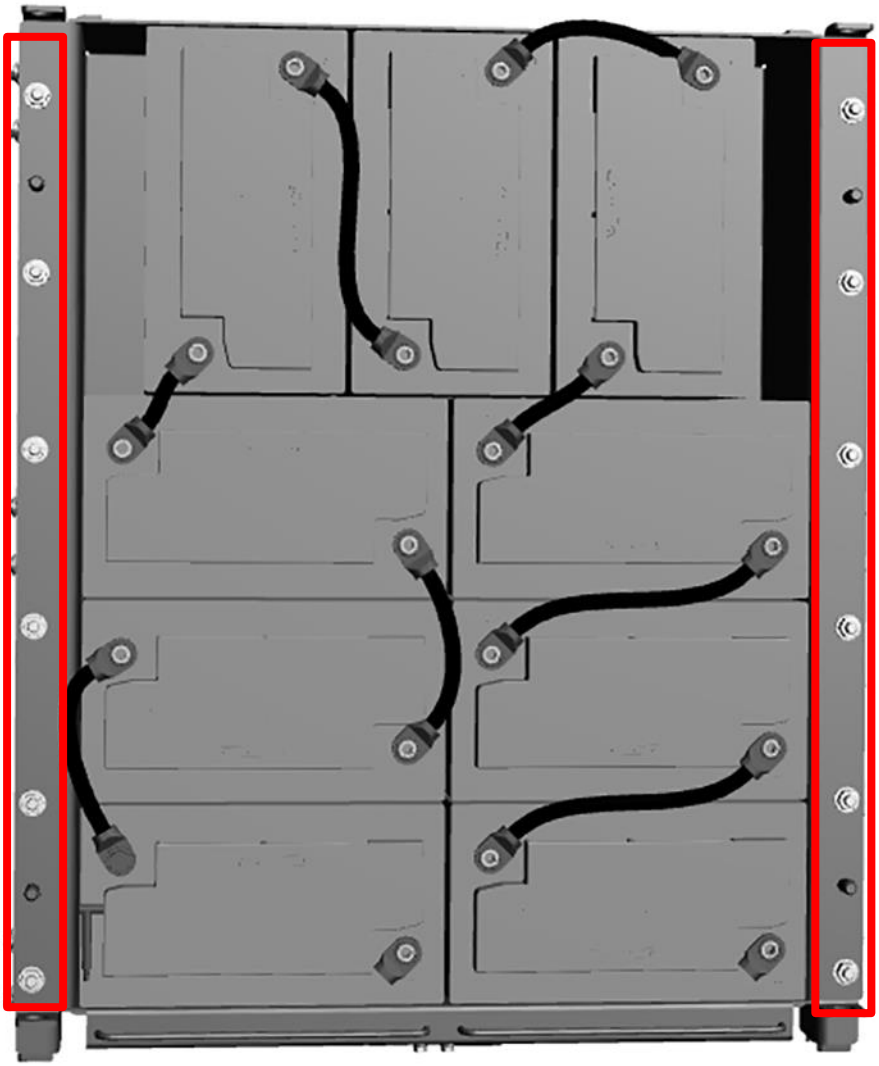
Note

In the following description of actions, the disassembly / assembly of rail | power AGM blocks / cells is explained by way of example using a special battery tray. In practice, the valid, project-specific design drawings must be used.

Required tools:

- Torque wrench with suitable wrench sizes

1. Switch off all chargers and consumers on the vehicle. If present, disconnect the battery from the vehicle electrical system and the charger using the corresponding disconnect switch.
2. Loosen the screws connecting the tray to the container.



3. Lift the tray out of the vehicle and place it on a safe ground.
4. Loosen and remove the cell connector/cable.
5. If present, dismount the temperature sensor.
6. Pull out cells / blocks.
7. Dispose of the individual parts separately.
8. Clean the tray or container.

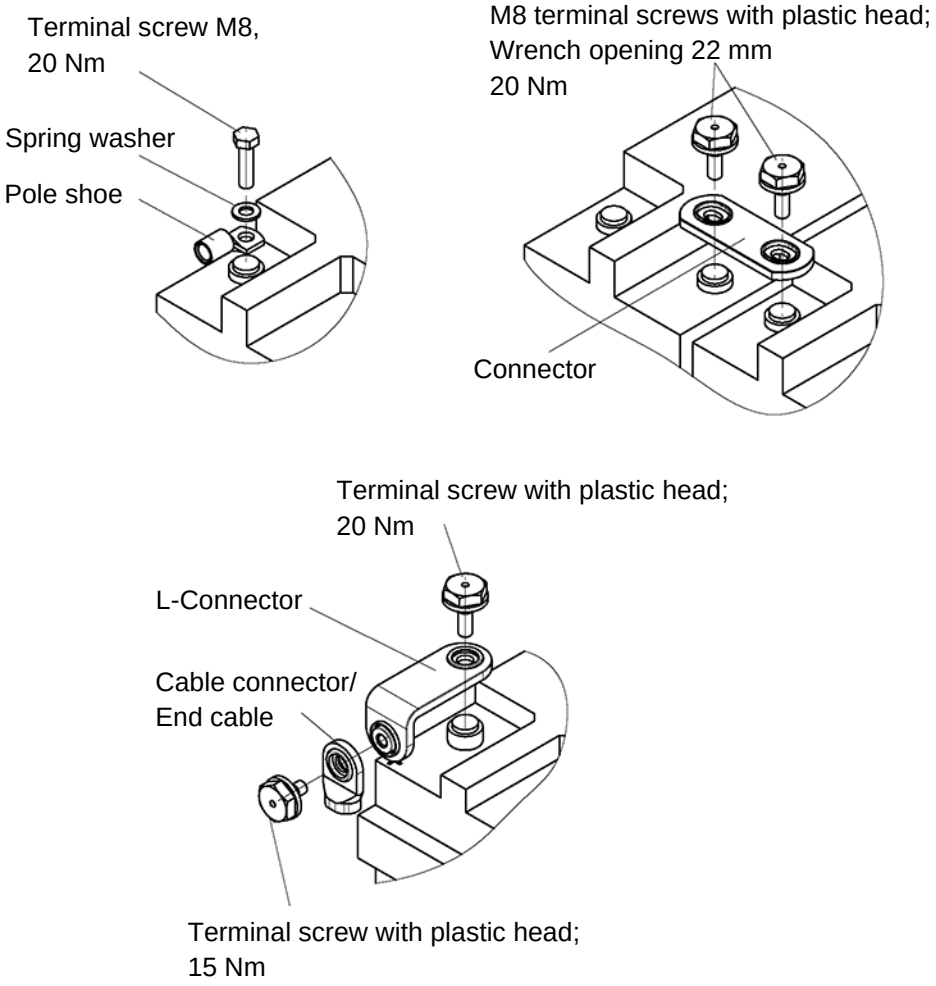
9. Mount new blocks / cells in the tray / container using the appropriate replacement kit.

10. Reassemble the cell connector / cable.

Note

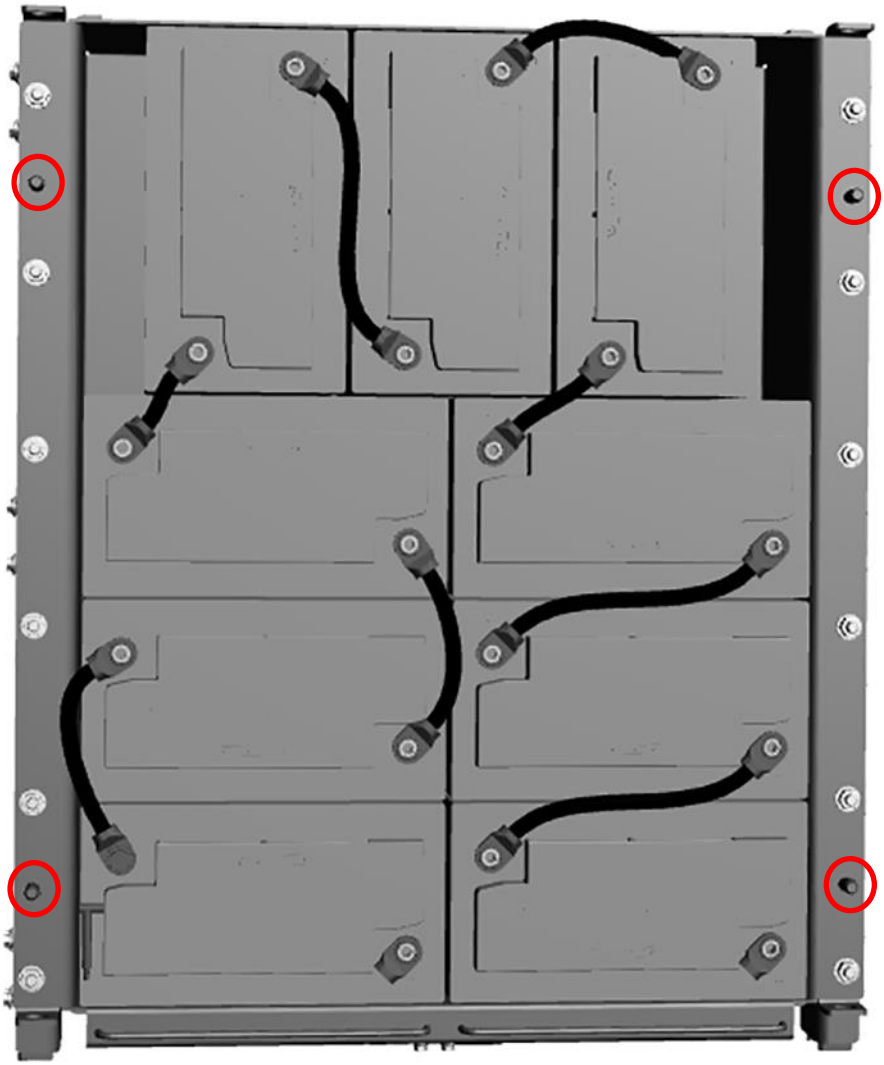
The pole screws M8 with plastic head must be replaced by new ones because the screw connection is secured with a micro-encapsulated adhesive.

For connections with M8 pole screws without plastic head, you can reuse the screws, but must use new spring washers.

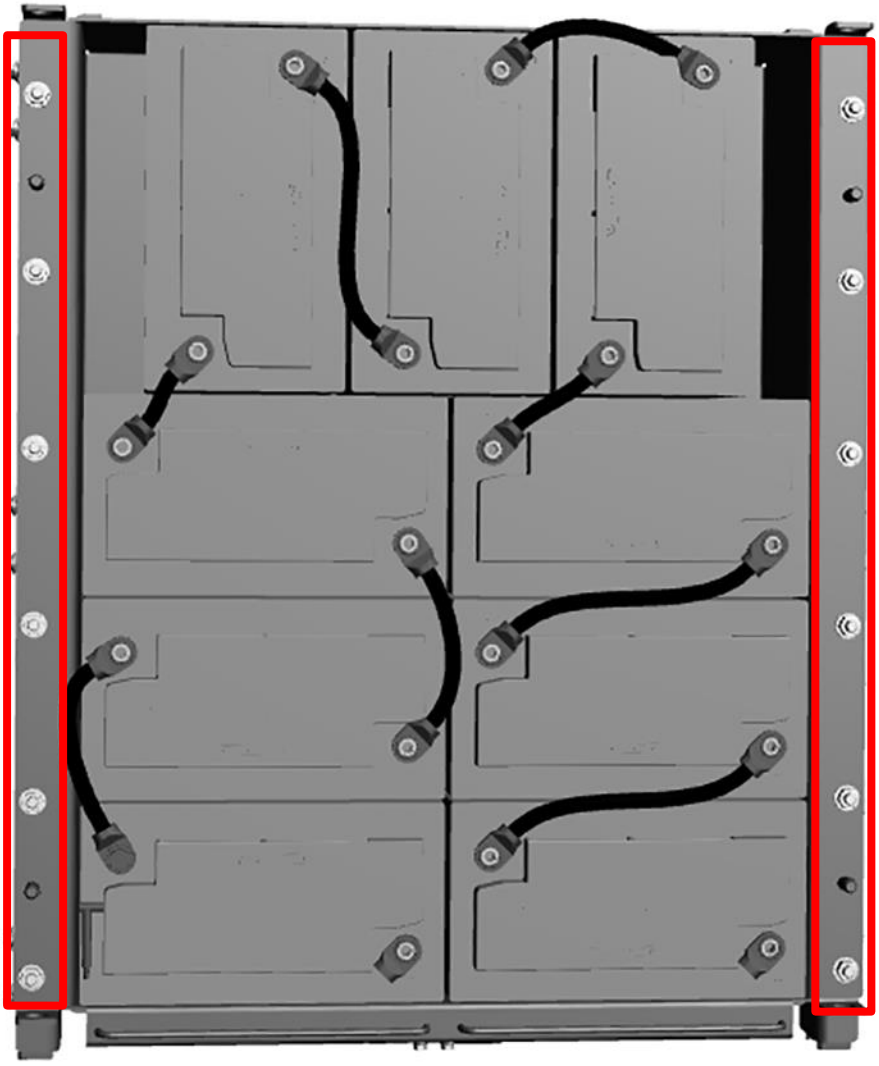


11. If present, mount the temperature sensor again.

12. Lift the tray back into the vehicle, paying attention to the guide pins.



13. Tighten the screws of the tray again.



14. Check the function of the battery according to the test specification in the separate document: PVE 10-20-General-00_Battery_Tray_rev<Versionsnummer>.pdf

15. Reassemble the battery system.

16. Switch on the chargers and consumers again. If present, switch the isolating switch back on.

Result: The rail | power AGM blocks / cells were replaced.

12. Disposal

Note

Follow the safety instructions, see 2 Safety instructions on page 9.

Note

Old batteries bearing this sign are recyclable economic goods and must be returned via the recycling process.

You can use the HOPPECKE recycling system. The old batteries are picked up and returned to the recycling system. Contact HOPPECKE Service for further information.

Note

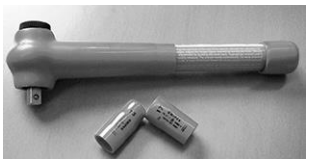
Arrange for the disposal of lead-acid batteries that are not returned to the recycling process as special waste, observing all regulations.

13. Appendix

13.1. Additional tools

The following lists additional tools for maintenance and service:

Tool	Description
	Voltmeter/Multimeter (Picture shows an example)
	Insulation tester: Fluke 1507 (HOPPECKE Mat.nr.: 4141201237)
	Current clamp DC (illustration shows an example)
	Charging / Discharging device (Picture shows an example)
	Contact-Thermometer (Picture shows an example)

	Fully insulated torque wrench (HOPPECKE Mat. No.: 4142500121)

13.2. Maintenance protocol

Hinweis

For proof in case of warranty, enter the activities and the measured values in the maintenance log.

Serial number of battery system: _____

Number of train: _____

Date of commissioning: _____

13.2.1. Half yearly maintenance interval

13.2.1.1. Maintenance - visual Inspection of the battery

Interval (Years)	Visual Inspection - Done (mark with cross)	Date	Inspector (Name)
0,5			
1			
1,5			
2			
2,5			
3			
3,5			
4			
4,5			
5			
5,5			

13.2.2. Yearly maintenance interval

13.2.2.1. Maintenance - measurement of the charging voltage

Interval (Years)	Voltage [V]	Current [A]	Temperature [°C]	Date	Inspector (Name)
1					
2					
3					
4					
5					

13.2.2.2. Maintenance - cleaning the battery

Interval (Years)	Cleaning - Done (mark with cross)	Date	Inspector (Name)
1			
2			
3			
4			
5			

13.2.2.3. Maintenance - measuring the insulation resistance

Interval (Years)	Insulation-Resistance [Ω]	Date	Inspector (Name)
1			
2			
3			
4			
5			

13.2.3. Maintenance interval 4 years

13.2.3.1. Maintenance - measuring the open-circuit voltage on each battery block / cell

Cell / Block No.	Open-Circuit voltage [V]
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
*	

*if more than 20 cells / blocks are installed, enlarge the table accordingly

Date: _____ Inspector: _____