INSTRUCTION MANUAL

Battery Pack, ReOx 1

THIS INSTRUCTION MANUAL IS AN ORIGINAL
Document ID: 73-H028 / Version: 1.0

INSTRUCTION MANUAL

Thank you for purchasing a Nilar product.

It is required to read and understand these instructions carefully for a safer installation and operation, as well as optimum performance and longer service life.

Keep this manual in a safe place for future reference.

This manual may be modified and updated without prior notice. Contact Nilar for validation.

Colours used in illustrations, e.g., for cables, are only illustrative and might deviate from the actual colour.

Without written permission from Nilar, this manual is not to be copied or transferred for other purposes, neither in its entirety nor parts of it.

The product described in this manual is manufactured in compliance with the Low Voltage Directive (LVD) 2014/35/EU, the Electromagnetic Compatibility Directive (EMCD) 2014/30/EU, and Restrictions of Hazardous Substances (RoHS) Directive 2011/65/EU.

The product contains metal hydride battery packs that follow the EU-directive 2006/66/EC ('Battery Directive'). The battery packs do not contain the heavy metals lead, mercury, or cadmium.

The product adheres to the Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU. This means that the manufacturer/importer is responsible for the manufactured products being collected, taken care of, and recycled after they have reached the end of their lifespan.

Nilar products are in compliance with EU regulation (EC) No. 1907/2006 concerning the Registration, Evaluation, Authorization, and restriction of Chemicals (REACH). We check that our suppliers comply with REACH requirements for all the materials and components they deliver to us.

Document identification: *73-H028*

Version	Status	Date
1.0	Released for ReOx 1	2022-12-07

INSTRUCTION MANUAL

This manual will give you, as a reader, all the necessary instructions for more professional and safer handling of the product. Read the manual carefully to avoid mistakes and risks. The manual is divided into the following chapters:

Chapter	Content
1. Safety Information	General safety information
2. Technical Support and Warranty	References
3. Environment	Content, recycling
4. Function description	General description of the product
5. Transportation, lifting, and storage	Instructions, conditions
6. Installation	Instructions for installation
7. Operation	Operational conditions
8. Maintenance	Advises, schedules
9. Decommissioning	Instructions, references
10. Troubleshooting	Self-help

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1. SAFETY INFORMATION

1. Safety Information

This chapter contains safety information that applies to the Nilar battery pack.

To avoid personal injury, do not perform any service unless you are qualified. Refer to all safety summaries before installing, operating, maintaining, and decommissioning. For a more detailed specification regarding safety, contact Nilar.

1.1 Safety markings in this instruction

WARNING!

The exclamation mark within an equilateral triangle is intended to alert the user that negligence of this information can be life threatening.

CAUTION!

The exclamation mark within a circle is intended to alert the user that negligence of this information can be associated with bodily injury and/or damage to the product.

1.2 General warnings and cautions

WARNING! Wear electrically insulated gloves when handling a battery pack. Battery pack surfaces may carry hazardous voltage due to lowered insulation resistance. Do not place battery packs on conductive surfaces.

WARNING! Risk for electric shock and arcing if the product is misused or electrically installed incorrectly.

WARNING! The battery packs cannot be switched off. Please note:

- Work only with one battery pack terminal at a time.
- The printed circuit board (PCB); Integrated Monitoring Unit (IMU) at the front of the battery pack may have hazardous voltage.
- The rupture disc may release electrolyte during abnormal use. We, therefore, recommend wearing safety glasses.

WARNING! Risk for electrical hazards if the product is exposed to rain or moisture.

WARNING! Never install a damaged battery pack or a damaged insulation tray.

WARNING! If a battery fire occurs, it can be extinguished by using CO_2. Ensure that fire extinguishers are available.

WARNING! Do not operate the product with suspected failures. If you suspect the product is damaged, have it inspected by qualified service personnel.

WARNING! Do not block or cover the rupture disc outlet at the back of the battery pack.

CAUTION! To avoid potential hazards, use this product only as specified.

CAUTION! Do not install other battery chemistry types or batteries together with Nilar's battery packs.

CAUTION! If the battery pack(s) is damaged mechanically, the following may occur:

- High heat generation on battery pack surface.
- Electrolyte may escape.
- The smoke from burning battery packs can irritate the skin, eyes and respiratory system.

Therefore, follow these guidelines:

- Do not open the battery pack.
- Do not modify or mechanically damage the battery pack or its cables
- Operate the battery pack only within the allowed operating range.
- Do not short-circuit the battery pack(s).
- Do not continue to use the battery pack after identified as faulty.

CAUTION! Do not install or place the products in direct sunlight for a longer time to avoid potential damage to plastics on the battery pack and insulation tray.

CAUTION! Do not expose the battery pack or insulation tray to heat or fire.

1. SAFETY INFORMATION

CAUTION! Do not operate the product with the covers removed. If covers are removed during, e.g., repair, do not touch any exposed connections.

CAUTION! The product shall not be exposed to liquids (not even dripping or splashing), and objects filled with liquids shall not be placed on or close to the product.

CAUTION! The product shall be installed inside an enclosure with panels and doors that only a key or screws can open.

CAUTION! Remove personal metal items from hands, wrists and neck, such as rings, bracelets, necklaces, and watches, when physically handling the product since it can result in a short-circuit current, causing a severe burn. Please note:

- We recommend using tools rated to 1000 VAC according to EN 60900.
- We recommend using flame-resistant protective clothing according to EN 61482-1-1 and rated as minimum class 1 according to EN 61482-1-2.

CAUTION! Keep product surfaces clean and dry.

2. Technical support and warranty

CAUTION!

Please make sure to always have your serial number of your product(s) available for warranty and technical support matters.

The battery pack's serial number can be found on the side of the battery pack at the top ①.

Figure 1: Indication of the serial number on the battery pack

Please see the separate document for the detailed warranty and conditions.

3. Environment

This chapter will inform about how the Nilar battery pack is recycled.

When the Nilar battery pack has reached its end of life (EOL), Nilar takes full responsibility for the recycling process by accepting the complete battery packs back. Contact your local Nilar representative for more information. The recycling process ensures that most materials are reused or recycled appropriately.

3.1 Compliance

Nilar products are compliant with the following environmental directives and regulations:

- EU-Directive 2006/66/EC ('Battery Directive'). The battery pack(s) do not contain the heavy metals lead, mercury or cadmium.
- Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU.
- Restrictions of Hazardous Substances according to RoHS Directive 2011/65/EU.
- Nilar products comply with EU regulation (EC) No. 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

4. Function description

This chapter will describe the functions of the various parts of the battery pack.

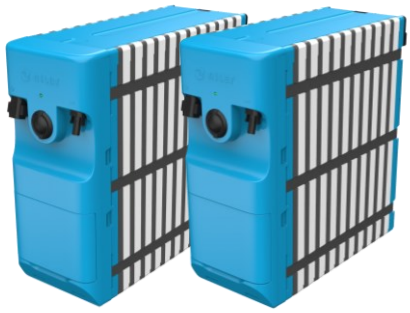


Figure 2: Overview of 144 V and 120 V battery packs incl. IMU (from left to right)

Figure 3: Build-up of a 144 V battery pack with IMU

4.1 Datasheet

Table 1: Technical specification of ReOx 1 battery pack in various sizes @ +20°C

Properties	96V	108V	120V	144V	Unit
Rated energy	0.96	1.08	1.20	1.44	*kWh*
Nominal voltage	96	108	120	144	*VDC*
Max. continuous charging power	0.96	1.08	1.20	1.44	*kW*
Max. continuous discharging power	0.96	1.08	1.20	1.44	*kW*
Dimensions (LxHxW)	246 x 306 x 127	269 x 306 x 127	291 x 306 x 127	335 x 306 x 127	*mm*
Weight	24	26	29	34	*kg*
Ingress protection (Battery pack)	20	20	20	20	*IP*
Battery pack voltage range	80-132	90-144	100-160	120-192	*V*
Min - Max. allowed ambient humidity (without condensation)[1]	5 – 55	5 – 55	5 – 55	5 – 55	*% RH*
Ambient operating temperature	0 to +30	0 to +30	0 to +30	0 to +30	*°C*
Battery pack operating temperature	0 to +55	0 to +55	0 to +55	0 to +55	*°C*
Allowed ambient temperature for handling	-20 to +40	-20 to +40	-20 to +40	-20 to +40	*°C*
Overvoltage category	III	III	III	III	*Category*
EMC	EN 61000-6-2:2005 (Immunity) EN 61000-6-3:2007 (Emission)				*IEC*
Maximum installation altitude	2000	2000	2000	2000	*m (a.s.l.)*

[1] For more information, see section 6.1.2 Humidity and ventilation

4. FUNCTION DESCRIPTION

4.2 Battery pack specification and build-up

A battery pack can contain between 8 and 12 modules (12 VDC per module), and each module always contains 10 battery cells.

Battery packs are designed to be used in systems with a maximum system voltage of up to 800 VDC. The maximum voltage is obtained during charging, namely when fully charged.

Note! The following measurements do not include the additional space that is required for an insulation tray, which is mandatory for all installations (see section 6.3 Orientation and placement of battery pack*).*

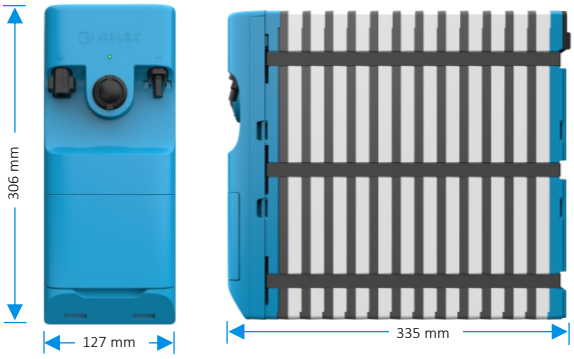


Figure 4: Measurement illustration of 144 V battery pack with length incl. IMU

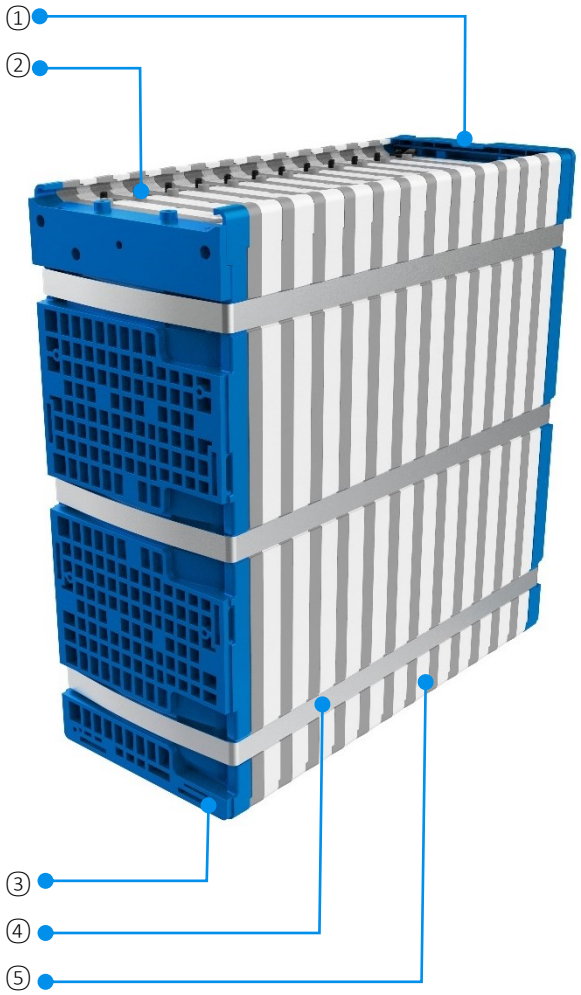


Figure 5: Parts of 144 V Battery pack excl. IMU

4.2.1 Rupture disc (① not displayed)

The Nilar battery pack is fitted with a 'rupture disc' that is activated when the pressure is too high. The rupture disc is located on the rear side of the battery pack. The rupture disc is only activated under abusive conditions.

4.2.2 Module voltage terminals (②)

Each module provides the IMU (see section 4.5.1 Module voltages) with voltage through the module voltage terminals. From each module's pole terminal (first to last), there is a cable to the IMU.

4.2.3 End pieces (③, blue ●)

There is one end piece on each side of the battery pack to ensure the required compression.

4.2.4 Steel strapping bands (④, black ●)

The battery pack is bound together by three (3) isolated steel strapping bands, and their function is both to hold the modules together and to ensure the correct compression for the battery pack.

4.2.5 Module (⑤, black and white cream ●●)

The 12 V module is the building block for all Nilar battery packs. Ten (10) cells are connected in series to create modules with a rated capacity of 10 Ah and nominal voltages of 12 VDC.

4.3 Front of the battery pack

The Integrated Monitoring Unit (IMU) is attached to the front of the battery pack behind the cover lid, with one IMU per battery pack.

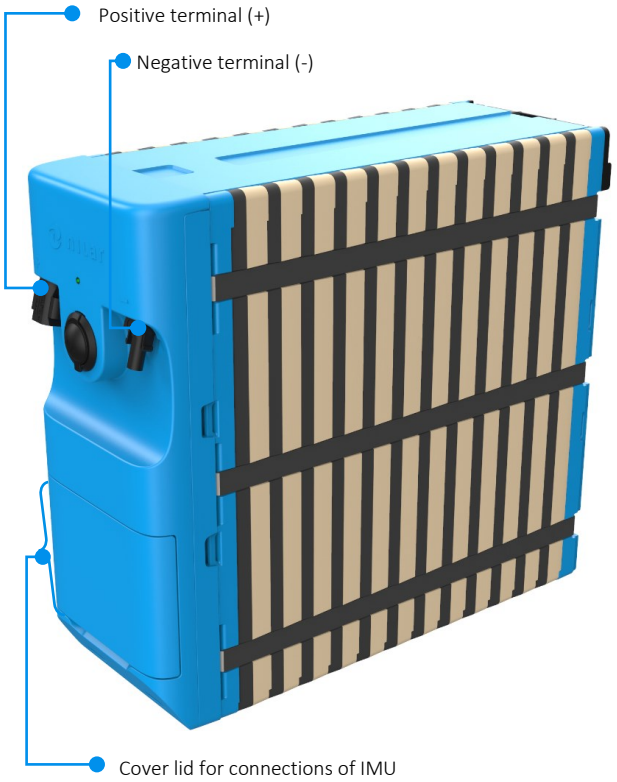


Figure 6: 144 V Battery pack

4. FUNCTION DESCRIPTION

4.3.1 Negative (-) and positive (+) terminals

WARNING!

Never detach the assembled male and female connection during load.

This is related to electrical arcs or sparks hazards.

The terminal posts are located on the upper side of the IMU. The connections are 'Phoenix Sunclix PV, chassis connector' type. The cables to connect the battery packs need to have the connection type 'Phoenix Sunclix PV, cable connector'. A flat screwdriver is required to detach the assembled male and female connection. The chassis-mounted terminals come as standard equipment with the battery pack.

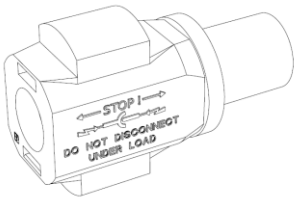


Figure 7: Design, positive (+) chassis connector, type Phoenix 1805180

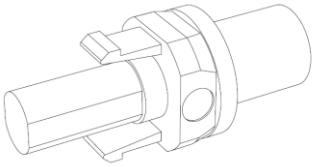


Figure 8: Design, negative (-) chassis connector, type Phoenix 1805177

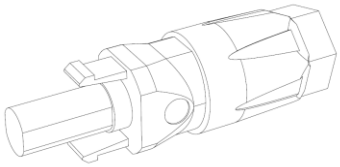


Figure 9: Design, positive (+) cable connector, type Phoenix 1774674

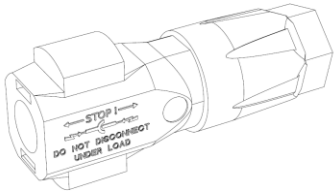


Figure 10: Design, negative (-) cable connector, type Phoenix 1774687

In order to detach the assembled male and female connection, a flat screwdriver is needed.

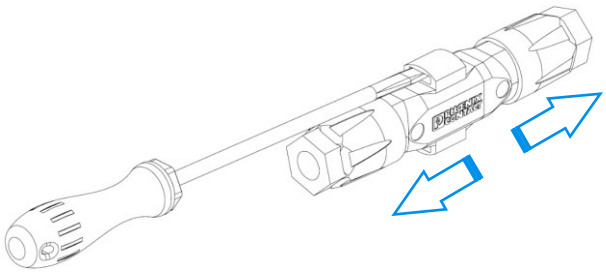


Figure 11: Disconnection of cable connectors

4. FUNCTION DESCRIPTION

4.4 Connections IMU

All connections for the IMU are to be found under the cover lid.

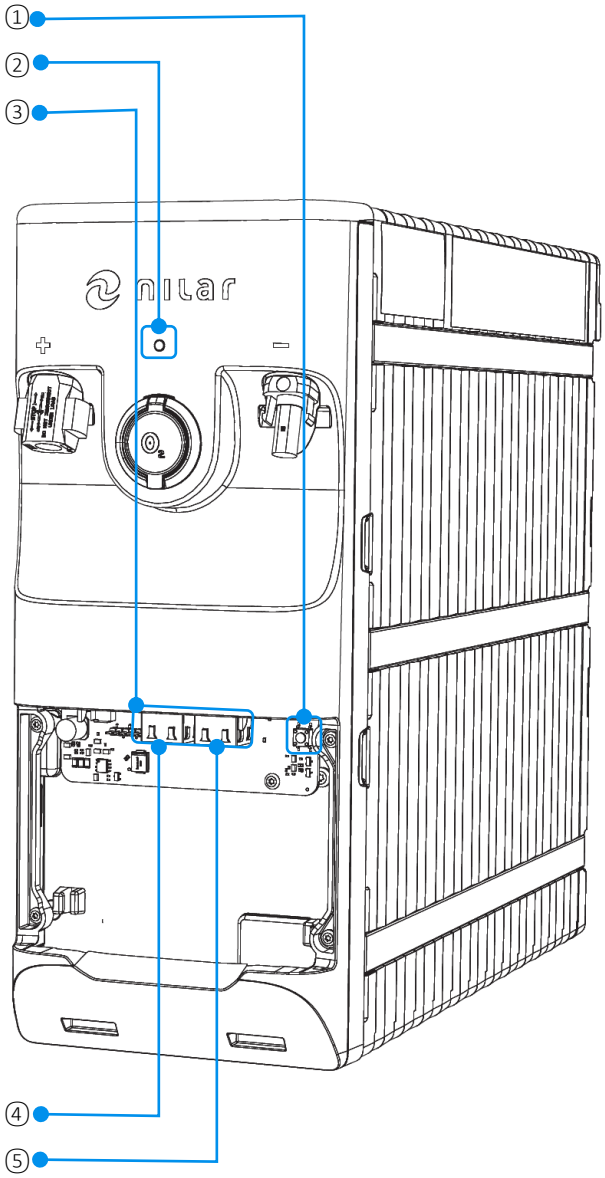


Figure 12: Overview of IMU with the cover lid removed

4.4.1 Reset button (①)

By pushing the Reset button, the IMU will be manually restarted.

4.4.2 Operation LED (②)

The operation LED indicates the status of the IMU, as displayed in the following table.

Table 2: Description of visual signals

Visual signal	State
● *Green*	*Normal mode (system measuring is active)*
● *Red*	*Active alarm*
● *Yellow*	*Start-up sequence (IMU requests settings input from superior control system)*
● *White*	*Automatic addressing on IMU*

An IMU that is running in normal mode will flash:

Green → *off* → Green → *off* etc.

An IMU that does not have the correct safety pulse IN will have static light:

Yellow

An IMU that is in addressing mode will flash:

White → *off* → White → *off* etc.

An IMU that is in addressing mode with no safety pulse IN will have a static light:

White

An IMU with an active safety alarm will replace the green signal and hence flash:

Red → *off* → Red → *off* etc.

4.4.3 Communication connections, (③)

Connections that are available on the IMU are as follows:

④ CAN + safety IN (From SCU or IMU)

⑤ CAN + safety OUT (to SCU or IMU)

The CAN connections (type: RJ45/8P8C shielded) are used as input and output per battery pack in order to series connect the battery string for communicating with the IMU as described in section 4.5 Signals IMU.

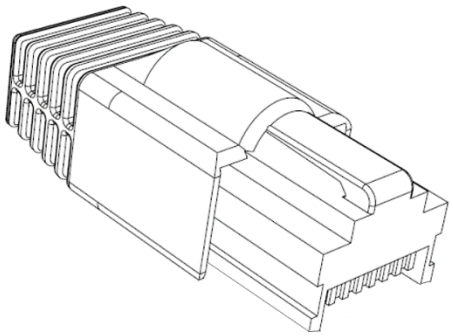


Figure 13: CAN connector, Shielded RJ45

4.5 Signals IMU

The IMU monitors the following signals and communicates them to the Battery Management System (BMS), which is briefly explained in subsequent sections.

For more detailed descriptions, please see the Integrations Manual for BMS 3.0, 73-H027.

4.5.1 Module voltages

The voltage monitors measure the voltage of each module. An alarm will be triggered if the actual voltage is out of the defined range.

In addition to the module voltages, the combined voltage of the battery pack is also measured and presented as a total battery pack voltage value.

4.5.2 Pressure sensor

An internal battery pressure sensor measures the relative pressure in each battery pack. Due to the common gas channel in the Nilar bipolar pack design, all the cells in the battery pack have the same pressure. If the pressure is out of the defined range, an alarm will be triggered and communicated to the BMS to prevent damage due to high pressure.

4.5.3 Battery temperature

There is a temperature sensor in each battery pack that measures the temperature. If the temperature exceeds the defined range, an alarm will be triggered and communicated to the BMS to prevent the battery from overheating.

4.5.4 Safety

A safety circuit is built into the IMU and monitors the battery packs' pressure and temperature.

4.6 Reoxygenating (ReOx)

WARNING!

Do not modify or mechanically damage the pneumatic ReOx connection. Hydrogen and oxygen might escape from the inside of the battery pack.

WARNING!

Do not connect anything to the pneumatic ReOx connection without permission and instructions from Nilar. Hydrogen and oxygen might escape from the inside of the battery pack.

Nilar's battery pack is fitted with a connector for the Reoxygenating service. The connector is only for the Reoxygenating service and should not be used in normal operation.

Nilar performs the Reoxygenating service of the battery pack(s). Please contact Nilar for more information about when your battery pack(s) needs a reoxygenating service.

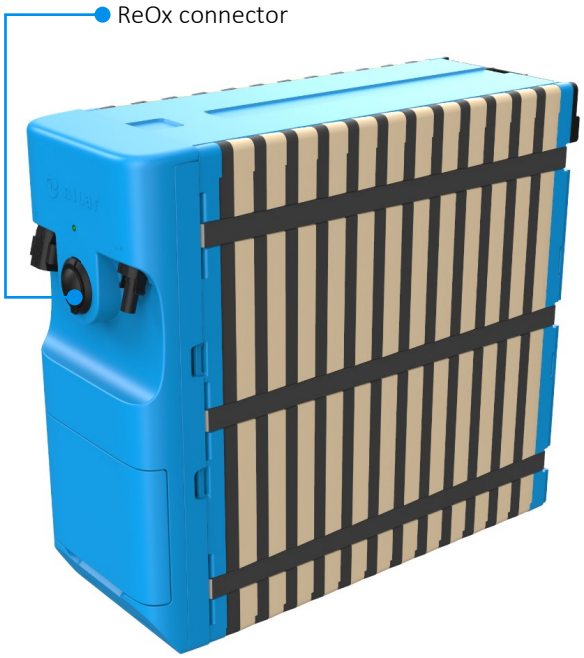


Figure 14: 144 V Battery pack with IMU on front and location of ReOx connector

5. Transportation, lifting, and storage

This chapter deals with Nilar products' required conditions when transported, moved, lifted, and stored.

WARNING!

Battery pack surfaces may carry hazardous voltage due to lowered insulation resistance. Always transport and/or store the battery packs on insulating (non-conductive) surfaces.

CAUTION!

Please make sure that the battery packs are positioned in the correct way during transportation and storage. If the battery pack tips over turn it up as soon as possible.

CAUTION!

Always wear Personal Protective Equipment (PPE) when handling battery packs. At minimum this includes:

Safety glasses, safety shoes with steel toe and electrically insulated gloves.

The battery packs must always be placed in an upright position (with the terminals in the upper position) during transportation and storage:

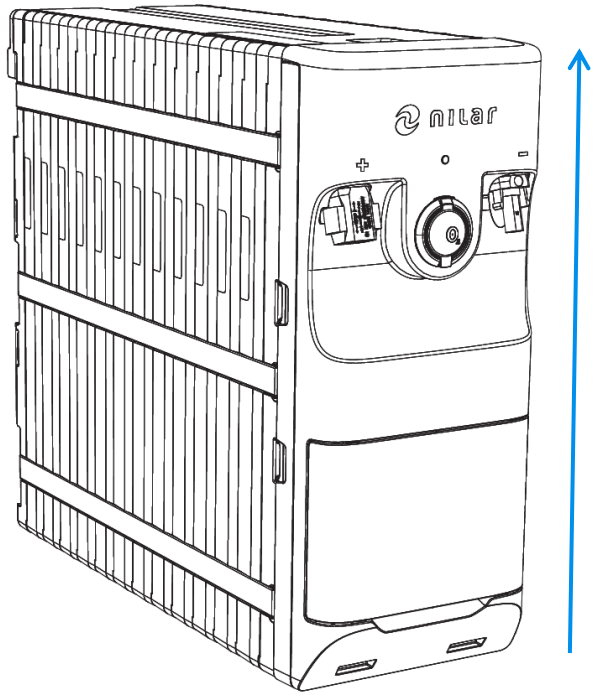


Figure 15: Orientation of battery pack

5. TRANSPORTATION, LIFTING, AND STORAGE

5.1 Transportation

When transporting Nilar products, some preparations and precautions must be taken, which will be described in this part of the chapter.

5.1.1 Packaging, duration and outside conditions

CAUTION!

When performing the visual inspection, it is important not to remove the battery packs from their original Nilar sealed plastic packaging.

CAUTION!

It is important to always pack the battery packs in their original Nilar sealed plastic packaging with moisture-absorbent bags if being transported.

CAUTION!

The Nilar product package shall under no circumstances be exposed to rain.

Nilar battery packs are delivered well-protected in their original packaging. Nevertheless, transport damages can occur. If any transport damage is discovered:

- Document the damage
- Report the damage to the responsible logistics company
- Contact your local Nilar representative

If undamaged, we advise keeping the original packaging for future transportation. If this is not possible, please get in touch with your local Nilar representative.

Transport duration, incl. storage, shall be made at an ambient temperature of −20°C to +40°C.

5.1.2 Transportation regulations of Battery packs

Nilar battery packs do not require UN-approved packaging or marking when transported by sea, road, rail, or air.

No dangerous goods documentation is required when transporting Nilar battery packs by road or rail.

A dangerous goods declaration is required if battery packs are transported by sea in quantities of over 100 kg in one transport unit. Nilar battery packs are then defined as dangerous goods, class 9. UN number and Proper Shipping Name (PSN) are UN 3496, and Batteries, Nickel Metal Hydride, respectively.

An Air Waybill or similar is required if battery packs are transported by air. Nilar battery packs are not classified as dangerous goods and belong to the entry *Batteries, dry* in the list of dangerous goods in IATA (no UN number). If an Air Waybill is used, the words 'Not Restricted' and the Special Provision number (A123) must be included in the description of the substance on the Air Waybill, according to IATA-DGR.

The battery packs must be separated from each other to prevent short circuits and be securely packed to prevent movement that could lead to short circuits; Nilar's original packaging ensures that this cannot occur.

Please observe that special regulations apply for defective or damaged battery packs that can potentially lead to a hazardous event during transportation. Please contact your local Nilar representative for advice regarding transporting damaged or defective battery packs.

5. TRANSPORTATION, LIFTING, AND STORAGE

5.2 Moving and lifting

CAUTION!

Be careful when lifting the battery pack. Depending on the configurations, it weighs more than 25 kg. We therefore recommend using lifting aids and safety shoes with steel toe.

CAUTION!

Always use both straps when lifting and/or carrying the battery pack.

The battery packs are equipped with two detachable and durable straps on each side of the battery pack. It is always advised to carry the battery packs using these lifting straps if short manual lifting is needed. It is strongly recommended to use lifting aid equipment.

Figure 16: Battery pack incl. lifting straps

5.3 Storage

CAUTION!

Moist conditions can create irreversible damage on Nilar battery pack including but not limited to electrical failure and corrosion.

CAUTION!

The Nilar product package shall under no circumstances be exposed to rain and outdoor weather conditions.

The battery pack must be recharged before the energy content is depleted 'deep discharged' due to self-discharge and to avoid damage to the battery pack. Battery pack shall be recharged to 75 % SOC after storage within:

- 84 days when stored up to 20°C
- 42 days when stored up to 30°C
- 13 days when stored up to 40°C
- 4 days when stored above 40°C

The specified time for when a recharge is required is from the date of shipment from Nilar.

It is highly recommended that battery packs are stored indoors in their original transport packing.

Note! The battery packs might require a few charge/discharge cycles before full capacity can be obtained after storage.

6. Installation

This chapter does, amongst others, explain under which circumstances a safe installation can take place and provides guidance through the installation of the battery pack(s) step-by-step.

For installation of Nilar BMS components, please see the Integrations Manual for BMS 3.0, 73-H027.

WARNING!

The electrical installation must fulfil national/local legislations, regulations, suitable standards, and applicable demands from recognized organizations, etc.

WARNING!

Always check for any visible damage and signs of electrolyte leakage prior to installation of the battery packs.

CAUTION!

Do not install other battery types or batteries with other chemistry together with Nilar's battery packs.

CAUTION!

Always wear Personal Protective Equipment (PPE) when handling battery packs. At minimum this includes:

Safety glasses, safety shoes with steel toe and electrically insulated gloves.

CAUTION!

Do not work alone with electrical work and heavy lifting - in the event of an emergency, another person's presence may be essential!

CAUTION!

Always remove both lifting straps in connection with the installation of the battery packs.

CAUTION!

Do not fasten the battery pack or insulations tray with e.g., scotch tape, cable ties, etc.

6. INSTALLATION

6.1 General conditions on-site

WARNING!

No installation close to sources of electromagnetic disturbances and always make sure that the ground is intact to prevent electrical shock and to help reduce electrical electromagnetic disturbances.

WARNING!

Do not install Nilar battery packs in areas that are subject to contamination, such as high levels of airborne dust, metal particles, flammable, or corrosive materials/gases in the environment. Do not install where liquids, or any other foreign objects or substances may enter the installation place of the battery packs.

WARNING!

It is required that a smoke alarm, preferably with connected surveillance and forced ventilation function, is installed.

Furthermore, the installation of a hydrogen gas alarm is recommended, preferably with connected surveillance and forced ventilation function.

CAUTION!

When choosing the location for the product, a stable, fairly flat and vibration free surface must be considered.

6.1.1 Temperature and altitude

CAUTION!

Do not allow direct sunlight on the battery packs and insulation trays.

CAUTION!

The installation altitude shall not exceed 2000 meters above sea level.

Nilar recommends installing and operating the battery packs in a location where the ambient temperature corresponds to a span between 0 to +40°C.

6.1.2 Humidity and ventilation

CAUTION!

The humidity must under all conditions be kept 5 – 55 % relative humidity (RH) and without condensation at any time.

The inflow of moisture via air or building construction should be limited; dehumidifiers may be needed to maintain relative humidity below the maximum allowed humidity.

Condensation is harmful to the Nilar battery pack(s); therefore, a stable temperature is important, as sudden temperature changes can potentially lead to condensation. For the same reason, the airflow from air-conditioning equipment shall never be directed toward the product. If air-conditioning equipment is used, ensure that water formed is removed from the battery room.

6. INSTALLATION

6.2 Preparation of connections before installation

WARNING!

The positive (+) and negative (-) terminal of the battery pack shall **NOT** be connected to each other. This would result in a short-circuit, damage battery pack(s) and potentially injuries for present person(s).

Inspect each terminal post. If the terminal posts show any signs of damage, do not use the product.

WARNING!

The negative and positive cables between the battery pack and the external system must be protected against overload and short-circuit currents.

6.3 Orientation and placement of battery pack

WARNING!

Never install battery packs without insulation trays.

CAUTION!

It is essential to observe the location and direction of the outlet for the rupture disc when installing the battery pack. The position of the outlet and the direction of the exhaustion of flammable gases, such as hydrogen, is indicated in the illustrations in this section.

Proper hazard prevention and mitigation to handle flammable gases in the environment are needed due to the risk of pressure-building faults that can occur with the battery pack.

The battery packs must always be placed in an upright position (with the terminals in the upper position) during installation:

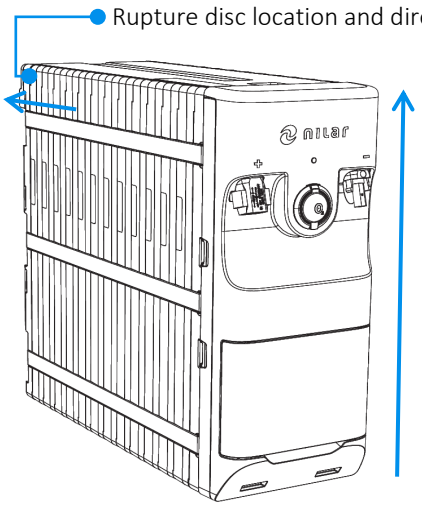


Figure 17: Orientation of battery pack

6. INSTALLATION

WARNING!

Never install a damaged battery pack or a damaged insulation tray.

The insulation tray can be reused four (4) times. Before using a reused insulation tray, make sure by visual inspection that the insulation tray is undamaged.

CAUTION!

Make sure the battery pack is placed at the centre and back against the supporting heels at the back of the insulation tray.

Place the battery packs on their designated insulation trays, as displayed in the following illustration.

The battery pack 'ReOx 1' is delivered with the insulation tray '57-H035'. The version of the insulation tray might be changed in future, which Nilar will inform you about when that happens.

Note! The insulation trays are not displayed in the illustrations of sections 6.4 Installation of a single battery pack *and* 6.5 Series connection of battery packs to form a battery string.

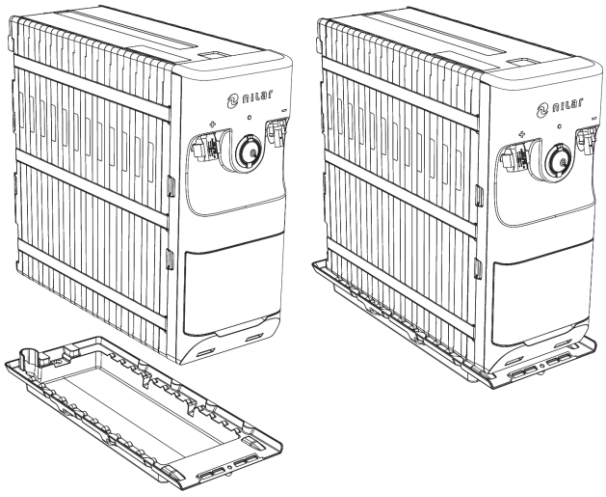


Figure 18: Before and after placement of battery pack on insulation tray

Note! The insulation tray in the illustration above may deviate in design from the delivered insulation tray.

6.4 Installation of a single battery pack

The battery pack installation must follow the order described in this chapter.

WARNING!

Before any connections are made to the battery pack, it needs to be checked that the battery pack is **NOT** connected to any external power source. Any switches must be turned off, fuses must be taken out/switched off and cables must be disconnected before any connection can commence.

6.4.1 Removal of IMU cover lid

Remove the cover lid of the IMU by tilting it upwards by the cable entry, lifting it outwards by hand, and then pulling it off.

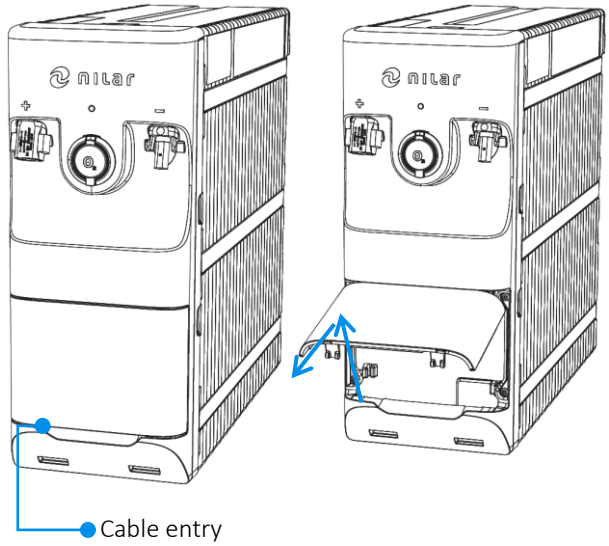


Figure 19: Before and after cover lid removal

6. INSTALLATION

6.4.2 Installation of CAN communication cable

CAN is a serial bus, and it is important to connect the CAN communication cables with its RJ45 plug into the correct CAN sockets, CAN1 or CAN2.

This is indicated in green (●) in the following figure.

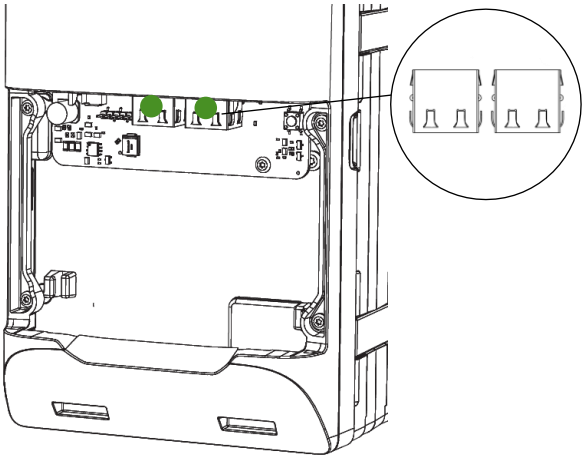


Figure 190: Installation of CAN connection into CAN port on IMU

For more detailed instructions on connecting CAN communication cables, please see the Integration Manual for BMS 3.0, 73-H027.

6.4.3 Automatic address setting

The addresses are set automatically by the BMS of each battery pack IMU.

No action is required during installation. However, if a battery string needs to be replaced, the new battery packs inherit the older battery pack addresses. This is the case since the address is not unique to the pack but specific to the physical position in the system.

6.4.4 Reassemble IMU cover lids

Reassemble the IMU cover lid back while checking that all cables are routed through the cable entry (see section 6.4.1 Removal of IMU cover lid and performed in reverse order).

6.4.5 Installation of negative terminal cable

Plug in the negative (-) cable connector, type Phoenix 1774687, into the negative (-) chassis connector, type Phoenix 1805177 (see section 4.3.1 Negative (-) and positive (+) terminals)

This is indicated in black (●) in the following figure.

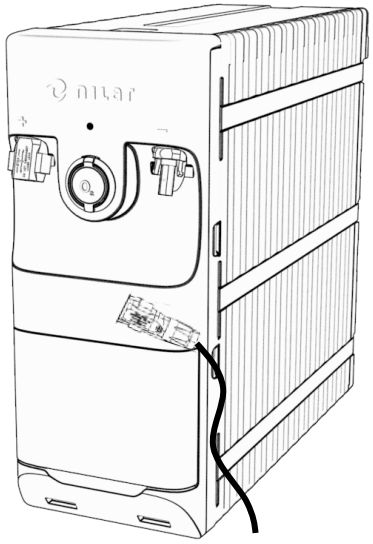


Figure 20: Installation of negative (-) cable before connection (IMU connections not displayed)

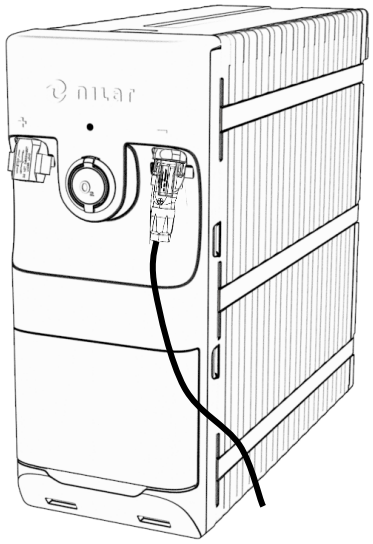


Figure 21: Installation of negative (-) cable after connection (IMU connections not displayed)

6. INSTALLATION

6.4.6 Installation of positive terminal cable

Plug in the positive (+) cable connector, type Phoenix 1774674, into the positive (+) chassis connector, type Phoenix 1805180 (see section 4.3.1 Negative (-) and positive (+) terminals)

This is indicated in red (●) in the following figure.

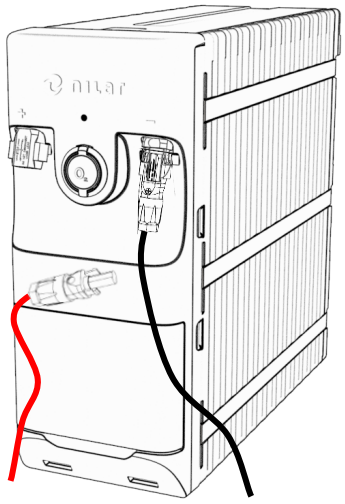


Figure 22: Installation of positive (+) cable before connection (IMU connections not displayed)

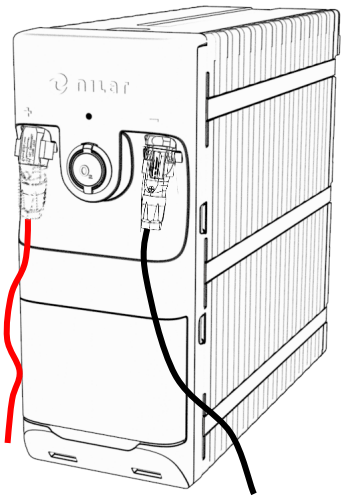


Figure 23: Installation of positive (+) cable after connection (IMU connections not displayed)

6.5 Series connection of battery packs to form a battery string

WARNING!

Before any connections are made to the battery packs it needs to be checked that the battery packs are **NOT** connected to any external power source. Any switches must be turned off, fuses must be taken out/switched off and cables must be disconnected before any connection can commence.

WARNING!

The outer surfaces of the battery packs must, due to lowered insulation resistance, be treated as hazardous voltage. Therefore, consider suitable protection measures (See 11. Appendix 1: Information bulletin, IT-grounding).

WARNING!

The interpack power cables in-between the battery packs of a battery string, must be protected against overload and short-circuit currents.

CAUTION!

Battery packs are designed to be used in systems with a maximum battery voltage of up to 800 VDC.

6. INSTALLATION

CAUTION!

Installation altitude of a battery pack string configuration shall not exceed 2000 meters above sea level for an 800 VDC system.

The battery string installation must follow the order described in this chapter.

6.5.1 Order of Battery packs

During manufacturing, the battery packs are matched, sorted and labelled with string serial-number to achieve the best performance of the battery string. Installing matched battery packs with the same string serial number in a string is essential.

For more detailed instructions on the correct order of battery packs, please see the Integration Manual for BMS 3.0, 73-H027.

6.5.2 Series connection of CAN communication cable

For detailed instructions on connecting the CAN communication correctly, please see the Integrations Manual for BMS 3.0, 73-H027.

6.5.3 Installation of power cables

This section shows an example of connecting four battery packs to form a battery string.

WARNING!

Please be careful when connecting the interpack cables. Do **NOT** connect the positive (+) and the negative (-) terminal of one (1) battery pack with each other.

This would result in a short-circuit, damage battery pack(s) and potentially injuries for present person(s).

Inspect each terminal post. If the terminal posts show any signs of damage, do not use the product.

6. INSTALLATION

Plug in the negative (-) cable connector of the interpack cable (●) into the negative (-) chassis connector of the ‘first’ battery pack. Connect the positive (+) cable connector of the interpack cable to the positive (+) chassis connector of the ‘second’ battery pack.

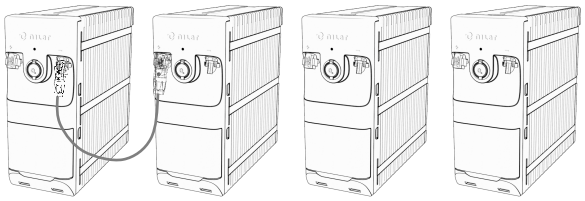


Figure 24: Finished installation of interpack cable between the ‘first’ and ‘secondary’ battery pack (IMU connections are not displayed)

Repeat the procedure of installing interpack cables between the ‘second → ‘third’ → ‘fourth’ battery packs.

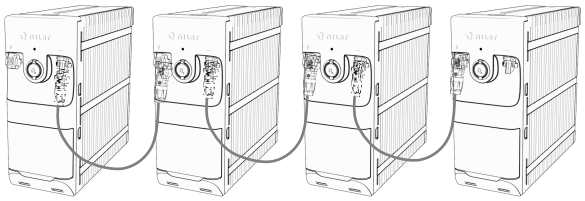


Figure 25: Finished installation of interpack cable between the ‘first’, ‘second’, third, and ‘fourth’ battery packs (IMU connections are not displayed)

Plug in the negative (-) cable connector on negative cable (●) from the BMS into the negative (-) chassis connector of the ‘fourth’ battery pack.

This is indicated in black (●) in the following illustration.

Connect the positive (+) cable connector on positive cable (●) from the BMS into the positive (+) chassis connector of the ‘first’ battery pack.

This is indicated in red (●) in the following illustration.

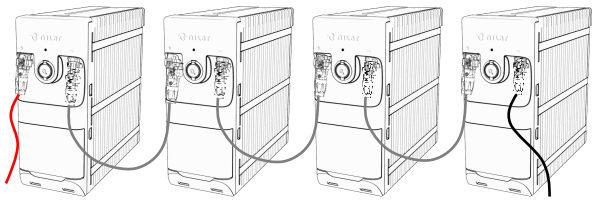


Figure 26: Finished installation of interpack cable between the ‘first’, ‘second’, third, and ‘fourth’ battery packs and cables from the BMS (IMU connections are not displayed)

7. OPERATION

7. Operation

This section will explain how to operate the Nilar battery packs concerning maximum service life and safety. Nilar BMS maintains the battery pack within their optimal operating window. A cyclic use, where the battery pack is charged and discharged, results in heat dissipation.

Please consult Nilar AB to define the operating window for your specific application.

7.1 Charging

An inherent feature of the Nilar Hydride® (NiMH) electrochemical system at charging is the build-up of pressure and temperature at the end of the full charge. The unique battery pack pressure sensor, integrated into Nilar battery packs and measured battery pack temperature, are efficient means to secure charge termination over the whole temperature and power range. The charge rate can be limited at low temperatures by an increased voltage needed to charge the battery pack. At elevated temperatures, the maximum charge rate is limited by the rise in temperature and pressure at the end of the charge.

The recommended charge procedure is a constant current charge with charge termination based on the rate of temperature increase (dT/dt). As a standard, the recommended charge rate is 0.3C to a rise in temperature, dT/dt, corresponding to 1.5 °C in 5 minutes. The charging procedure can be used for charging battery packs with battery pack temperatures in the range of specified operating ambient temperatures (see section 4.1 Datasheet

Table 1: Technical specification of ReOx 1 battery pack in various sizes @ +20oC

Properties	96V	108V	120V	144V	Unit
Rated energy	0.96	1.08	1.20	1.44	*kWh*
Nominal voltage	96	108	120	144	*VDC*
Max. continuous charging power	0.96	1.08	1.20	1.44	*kW*
Max. continuous discharging power	0.96	1.08	1.20	1.44	*kW*
Dimensions (LxHxW)	246 x 306 x 127	269 x 306 x 127	291 x 306 x 127	335 x 306 x 127	*mm*
Weight	24	26	29	34	*kg*
Ingress protection (Battery pack)	20	20	20	20	*IP*
Battery pack voltage range	80-132	90-144	100-160	120-192	*V*
Min - Max. allowed ambient humidity (without condensation)	5 – 55	5 – 55	5 – 55	5 – 55	*% RH*
Ambient operating temperature	0 to +30	0 to +30	0 to +30	0 to +30	*oC*
Battery pack operating temperature	0 to +55	0 to +55	0 to +55	0 to +55	*oC*
Allowed ambient temperature for handling	-20 to +40	-20 to +40	-20 to +40	-20 to +40	*oC*
Overvoltage category	III	III	III	III	*Category*
EMC	EN 61000-6-2:2005 (Immunity) EN 61000-6-3:2007 (Emission)				*IEC*
Maximum installation altitude	2000	2000	2000	2000	*m (a.s.l.)*

7. OPERATION

4.2 Battery pack specification and build-up). Within this temperature range, a fully discharged battery is recharged in less than 3.5 h.

When the specified maximum battery pack temperature and battery pack pressure are exceeded, all charging (and discharging) must be terminated to avoid overpressure and potential opening of the rupture disc.

At normal charge, full charge is possible from a battery pack temperature being the same as the specified maximum ambient operating temperature.

dT/dt limits for charge termination depend on charge rate and temperature. Please get in touch with your local Nilar representative or Nilar directly for further consultation on this matter.

7.2 Discharging

After a moderate initial voltage drop, the discharge voltage is stable over more than 80 % of the discharge and ends with a distinct 'knee' at the end of the useful capacity. Discharge voltage depends on discharge rate, temperature and the state of charge (SoC).

Terminating discharge on a pre-set minimum allowed voltage is recommended to optimise the performance and life expectation of the battery pack. With proper settings of the end of discharge voltage (EODV), utilisation of capacity is optimised, and the risk of detrimental deep discharge of individual cells or modules is minimised.

EODV is a function of discharge rate, battery pack size and environmental conditions. Lower cut-off voltage can be used at low temperatures and high discharge rates for better capacity utilisation. Deep discharge, especially reversed polarity, will have a detrimental effect on the performance.

7.3 Resistance

Battery resistance varies with temperature and SoC. Optimum resistance is achieved at 100 to 30 % SoC. Below 20% SoC, the resistance increases significantly. The resistance also increases with decreasing temperature.

7.4 Self-discharge

Nilar battery pack will lose capacity on storage due to internal chemical reactions consuming capacity. This self-discharge is pronounced at elevated temperatures; below 0°C, the self-discharge is close to zero. Parasitic loads on the battery from charger, load and electronic systems will increase the rate of capacity loss during storage.

7.5 Cycle life

Cycle life is the number of charges and discharges a battery pack can achieve before the discharge capacity drops to a predetermined capacity. Several circumstances have to be considered when estimating cycle life. Among the most important are temperature, charge method, charge and discharge rates, depth of discharge and environmental aspects. The depth of discharge (DOD), battery pack temperature, and charge procedure significantly impact the cycle life. If a battery pack is cycled in a shallower manner, the number of cycles that can be achieved will be greater until the battery pack is unable to sustain service.

Typically, impedance increases and capacity decreases when a battery pack is cycled. As a user, this is experienced as reduced run time, and finally, depending on how the End-of-Life (EOL) is defined, the battery pack is not able to perform as required.

8. Maintenance

This chapter details how to maintain the battery pack.

WARNING!

The battery pack including its IMU may contain hazardous voltage and energy, including residual or stored energy, even when it is switched off or may appear switched off.

WARNING!

Battery packs shall neither be connected nor disconnected when current is flowing.

8.1 Protective measures during maintenance

CAUTION!

Always wear Personal Protective Equipment (PPE) when handling battery packs. At minimum this includes:

Safety glasses, safety shoes with steel toe and electrically insulated gloves.

CAUTION!

Do not clean any surface of the battery pack or insulation tray with detergents, solvents, or otherwise wet cloths.

Personnel involved in the work on a battery pack or in close vicinity must be competent to carry out such tasks and must be trained in all necessary special procedures.

8.2 Inspection and monitoring

For functional and safety reasons, the customer is responsible for regular inspections of the battery packs and their operating environment are carried out.

8.2.1 Maintenance Schedule

The following needs to be inspected on an annual basis:

- Visually check for external signs of damage. Consult your local Nilar representative if any damage is detected.
- Visually check for signs of electrolyte leakage. Consult your local Nilar representative if any leakage is detected.
- Check cable connectors and battery attachments.

9. Decommissioning

This chapter gives brief instructions on how to proceed when decommissioning the Nilar battery pack.

WARNING!

The battery pack including its IMU may contain hazardous voltage and energy, including residual or stored energy, even when it is switched off or may appear switched off.

CAUTION!

Always wear Personal Protective Equipment (PPE) when handling battery packs. At minimum this includes:

Safety glasses, safety shoes with steel toe and electrically insulated gloves.

CAUTION!

Do not discard Nilar's products into regular or household recycling bins.

9.1 Temporarily decommissioning

When decommissioning the Nilar product temporarily for a period of time, the conditions as stated in sections "5.3 Storage" and "6.1 General conditions on-site" must be followed. It is recommended that battery packs are charged to 75 % SoC before decommissioning. If the downtime can be kept to a maximum of 72 h, the battery packs do not need to be re-packed in their original Nilar package.

Please refer to chapter "6. Installation". for information about dismantlement by following the installation steps backwards.

9.2 Permanent decommissioning

It is recommended to discharge the battery packs to 0 % SoC before permanent decommissioning.

9.2.1 End-of-life (EOL) / no usage

When the product has reached its EOL or is no longer needed, it must be treated like an operational battery pack during decommissioning.

In 2002 the European Union introduced the Directive on Waste Electrical and Electronic Equipment (WEEE). The directive requires you, as an end-user, to dispose of any WEEE separately. Electrical and Electronic Equipment is labelled with the following 'crossed out wheeled bin' symbol.

Figure 27: WEEE symbol for separate disposal

Always return any obsolete battery packs to Nilar AB or any authorised local Nilar representative; see chapter 5.1 Transportation for how to prepare the transportation. From there on, Nilar covers all costs arising from collecting, treating and recycling all waste industrial batteries and accumulators collected per the Battery Directive 2006/66/EC.

9.3 Damage

When the product has been damaged, constitutes a hazard, or is malfunctioning, it must be decommissioned.

The damaged product must be treated with carefulness.

Always use your Personal Protective Equipment (PPE) and refer to the MSDS (Material Safety Data Sheet) for the correct handling of the product.

For instructions regarding decommissioning, handling, and transportation of a damaged product, contact your local Nilar representative.

10. Troubleshooting

This chapter contains techniques to address issues that may occur after installation or during operation. The measures must follow the same logical order as described (A.1 → A.2, etc.).

WARNING!

The battery pack including its IMU may contain hazardous voltage and energy, including residual or stored energy, even when it is switched off or may appear switched off.

CAUTION!

Always wear Personal Protective Equipment (PPE) when handling battery packs. At minimum this includes:

Safety glasses, safety shoes with steel toe and electrically insulated gloves.

Q.1) No power supply to the IMU (LED is off)?

A.1) Check that the external CAN communication cables are connected correctly in the designated socket on the IMU (see sections 4.4 Connections IMU & Integrations Manual for BMS 3.0).

A.2) Check that an eventual MCB/fuse has not tripped.

A.3) Reset the IMU using the manual Reset button (see section 4.4.1 Reset button (①)).

A.4) Contact your authorised local Nilar representative.

Q.2) Is there no voltage value (or is a wrong value displayed)?

A.1) Check that the CAN communication is established.

A.2) Contact your authorised local Nilar representative.

Q.3) No communication established with the IMU?

A.1) Check that the external CAN communication cables are connected correctly in the designated socket on the IMU (see sections 4.4 Connections IMU & Integrations Manual for BMS 3.0).

A.2) Reset the IMU using the manual Reset button (see section 4.4.1 Reset button (①)).

A.3) Check that the LED in front of the battery pack is flashing correctly according to section 4.4.2 Operation LED (②).

A.4) Contact your authorised local Nilar representative.

Q.4) Is there no pressure value (or is a wrong value displayed)?

A.1) Check that the CAN communication is established.

A.2) Contact your authorised local Nilar representative.

Q.5) Is there no temperature value (or is a wrong value displayed)?

A.1) Check that the CAN communication is established.

A.2) Contact your authorised local Nilar representative.

Q.6) The battery pack does not charge/discharge?

A.1) Check that the terminal cables are correctly connected to the terminal posts (see sections 6.4.5 Installation of negative terminal cable & 6.4.6 Installation of positive terminal cable)

A.2) Contact your authorised local Nilar representative.

11. Appendix 1: Information bulletin, IT-grounding

IMPORTANT INFORMATION

The Nilar battery packs can be installed in both IT-grounding[2] and non-IT-grounding systems.

If installed in an IT-grounding system, an insulation monitoring device (IMD) is required (IEC 60364).

If not installed in an IT-grounding system Residual Current Device (RCD) of type B or Residual Current Monitor (RCM) of type B (IEC 60755) is highly recommended to be installed.

WARNING!

Only authorised electricians are allowed to carry out the installation.

Having an RCD, RCM or other devices with equal functionality installed is highly recommended, which should have suitable means to reduce the risk of getting injured from alternating current (AC) or direct current (DC).

Perform a function test of the installed RCD, RCM or the other equal functioning device, in direct connection with the completed installation by pressing the function test pushbutton. Validation of the function is successful if the residual current device disconnects the electric power as intended.

For more information regarding the RCD and RCM installation and types, please get in touch with Nilar directly.

IMPLICATIONS

WARNING!

The outer surfaces of the battery packs must, due to lowered insulation resistance, be treated as hazardous voltage.

Due to lowered insulation resistance, the battery pack(s) must always (independent of the type of grounding system) be managed in, e.g. one (1) of the three (3) following ways (IEC 61010-1, 2010):

#1 CLOSED CASING WITHOUT DOOR

Battery pack(s) must be placed inside a closed casing so that the packs cannot be touched. Eventual openings in the casing, e.g. for air exchange, shall not be larger than 8 mm. The minimum allowed shortest straight distance from these openings over to the two largest side surfaces of the battery packs is 104 mm. The casing must be locked by screws[3] and equipped with an external warning sign(s) that alerts for hazardous voltage, including a warning text for live working, e.g.:

HAZARDOUS VOLTAGE!

Obey local regulations for live working when casing is open

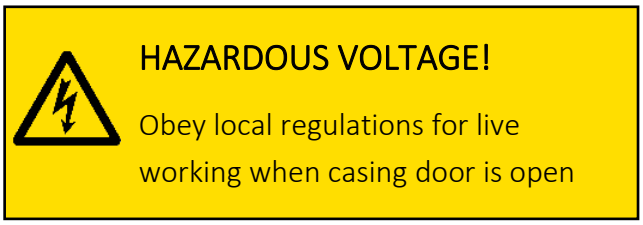
[2] The battery packs are considered to be installed in an IT-grounding system if the inverter (converter) has galvanic isolation.

[3] The screws must require a tool, such as a screwdriver, to be opened. Hand-operated screws (e.g. wing screws) are not allowed!

11. Appendix 1: Information bulletin, IT-grounding

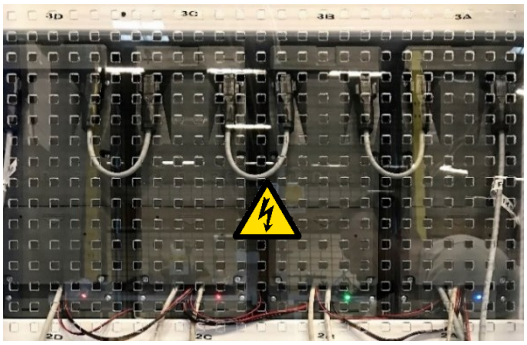
#2 CLOSED CASING, DOOR WITH SPECIFIC KEY

Battery pack(s) must be placed inside a closed casing that is designed so that the battery packs cannot be touched. Eventual openings in the casing, e.g. for air exchange, shall not be larger than 8 mm. The minimum allowed shortest straight distance from these openings over to the two largest side surfaces of the battery packs is 104 mm. The door[4] of the casing must be locked with a specific key[5] and equipped with an external warning sign(s) that alerts for hazardous voltage, including a warning text for live working, e.g.:



#3 CLOSED CASING WITH DOOR

Battery pack(s) must be placed inside a closed casing that is designed so that the battery packs cannot be touched. Eventual openings in the casing, e.g. for air exchange, shall not be larger than 8 mm. The minimum allowed shortest straight distance from these openings over to the two largest side surfaces of the battery packs is 104 mm. The casing door does not need to be locked by any specific key if the battery pack(s) are placed touch-proof. Touch-proof placement can be obtained, e.g., behind a fixed and rigid non-conductive surface, which must require a tool, such as a screwdriver, to be removed. The fixed and rigid non-conductive surface must be equipped with a warning sign(s) that alerts for hazardous voltage. The fixed and rigid non-conductive surface can be perforated for air exchange purposes as long as the perforations are no larger than 8 mm. The minimum allowed the shortest distance from these perforations over to the two largest side surfaces of the battery packs is 104 mm. The example below shows the battery packs behind a screwed[3] plexiglass protection cover.



[4] Preferably of a self-closing and self-locking type.

[5] A specific key is defined as a key that only fits the specific enclosure or the same group of the enclosure. A specific key is not a general controller cabinet key, such as a square or triangle key.

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