Manual

Low voltage battery management system

1 Terms and conditions

Note that all values and functions in this document are for a default battery setup. Values and functionality are subject to change in integration projects. For custom installations, please see the modification document or contact your supplier.

V1.4

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3 Electrical interfaces

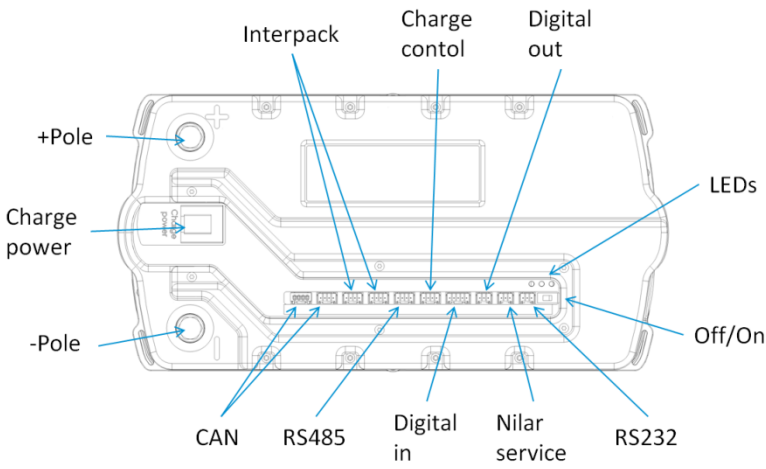

Figure 1: Electrical interfaces

Off/On switch

The switch is used to turn the electronics on and off. The poles are disconnected from the battery power when this switch is off, making the battery safe to handle. Note that the charge control cable has to be disconnected when restarting the battery pack.

Discharge terminals

The discharge terminals are threaded aluminum connectors for M8x14 stainless steel screws together with 8,4x16x1,6 stainless steel washer. Required mounting torque is 15Nm.

Charge power connector

This 2 pole connector is used to connect the charger. Please see chapter 4 for more information about connecting the battery. Note that a 30A fuse is needed on this cable in multipack configuration.

Interpack connectors

The interpack connectors are used when connecting multiple battery packs to one charger. It consists of one output and one input connector. Please see chapter 4 for more information about connecting the battery.

Charge control

The charge control connector is used to control the charger. The charging process will not start without this cable connected. Please see chapter 4 for more information about connecting the battery packs.

RS485

This connector is the Modbus interface which can be used to monitor the battery. For more information, see chapter 9.

Digital input and Digital output

The digital input can be used to put the electronics in sleep mode. See chapter 7 for more information.

Nilar Services

Nilar service connector, used for software updates.

RS232 and CAN

These interfaces can be customized to customer applications.

3.1 LEDs

The status LEDs are used to show current battery status. The LEDs are placed on top of the battery, see Figure 1. Table 1 explains what all LED combinations indicate.

Flashing green light	Normal
Solid green light	Fully charged
Flashing green and solid yellow	Charging
Solid green and solid yellow	Maintenance charging
Flashing yellow	Low voltage, requires charging
Flashing red	Error
Flashing red, green and yellow	Battery fault, contact support
No LED	Shut off or power saving mode
No LED on Slave	Slave not connected to master

Table 1: LED description

4 Connecting the system

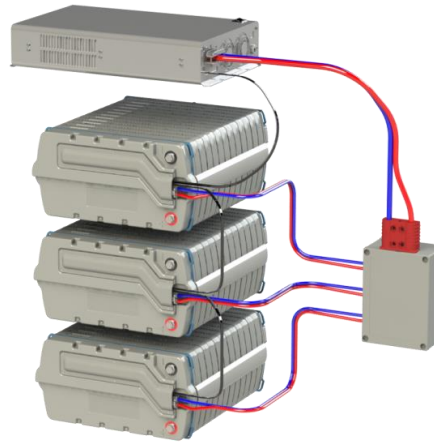

Figure 2: Multipack with charger

4.1 First power on

Before installation, verify that all battery packs are turned off, see chapter 3. The battery poles are disconnected when the battery is off, which enables safe installation. It's possible to verify the installation by measuring the resistance between the battery poles before power on.

The battery is delivered with around 75% charge and need to be charged before use. Power on each battery pack with the off/on switch (see chapter 3) and fully charge the batteries. Verify that every pack shows a solid green light after the first charge.

4.2 Single battery

Two cables connect the battery and the charger, the power cable and the control cable. The power cable is connected to the *charge power connector* and the control cable is connected to the *charge control connector* on the battery. Connect the load on the *discharge terminals*. See chapter 3 for an overview of the connectors.

It's also possible to charge the battery through the discharge terminals.

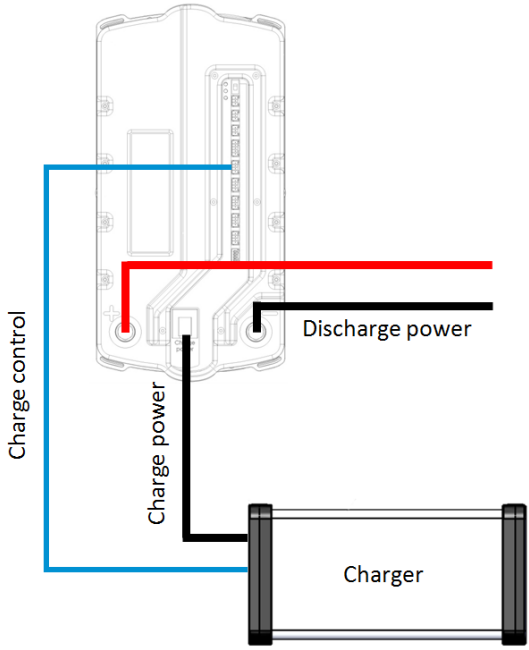

Figure 3: Schematic connection of single pack

4.3 Multipack

In the multipack configuration there's one battery pack that's master and 1 to 7 slave packs. See the label on each pack to identify them, label placement can be seen in Figure 5. Figure 4 gives an overview of how to connect the batteries. The signal goes from battery to battery via the *interpack connector*. The slave packs can be connected in any order, although it's recommended to connect them in order for easier maintenance. The charge control cable must connect the master pack with the charger. See chapter 3 to locate the connectors.

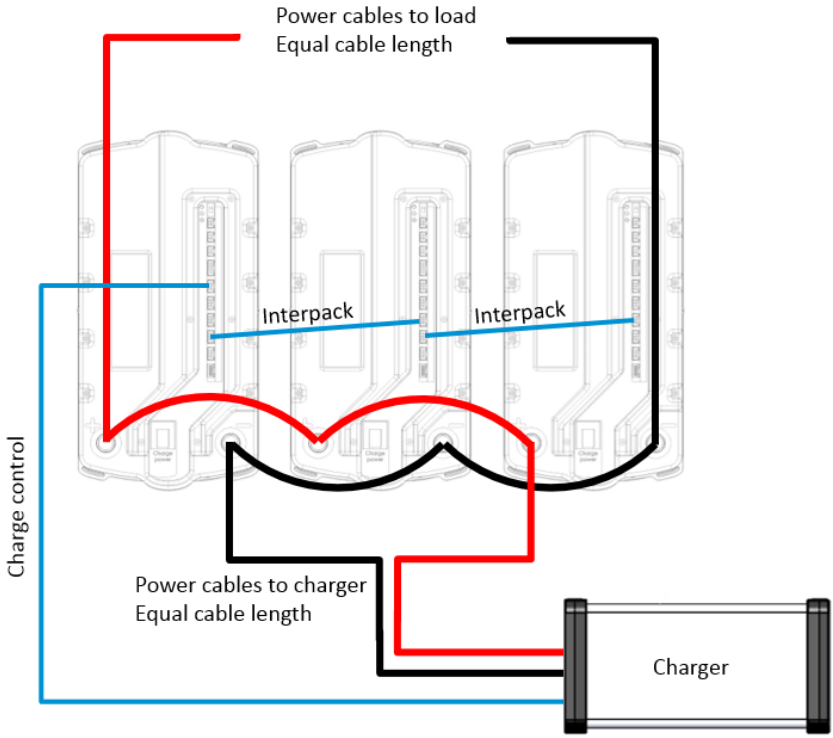

Figure 4: Schematic connection of multipack

When connecting the charge power to the battery bank, it's recommended to replace the connector with cable shoes and connect it as shown in Figure 4.

To get the maximum performance when connecting multiple battery packs in parallel, it's important to have minimum variance between them. A small change, for example different cable lengths, can give uneven charging or discharging of the battery packs. It's therefore advised to use cables of the same length and type to all battery packs. In Figure 4 there's three different power cable sets: The cables connecting the load to the bank, cables connecting the battery poles to each other and lastly the cables connecting the charger to the battery bank. All cables in each set shall be of equal length.

5 System information

See label on the battery for nominal voltage, capacity and maximum discharge rate.

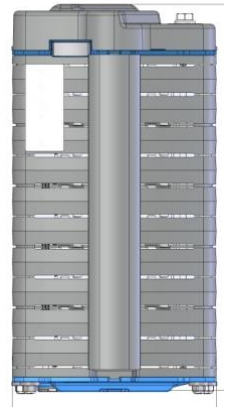

Figure 5: Label placement

As the battery is not voltage regulated, the maximum and minimum voltages are only approximations.

Maximum voltage is 133% of nominal. For maximum open voltage from charger, see charger datasheet.

Minimum voltage is around 90% of nominal.

5.1 Charging

Charging of the battery is done with a constant current of 0.3C, a full charge cycle from empty to full takes around 3 hours and 20 minutes. If the charger is still connected after this, it will enter maintenance charge. Charging is indicated by a solid light from the yellow LED. The green LED will go from blinking to solid light when the battery is full.

Charging can only start if the internal temperature of the battery is between –20°C and +40°C. The charge process will be automatically stopped if the temperature goes above 58°C.

In some cases, the charging process might be stopped because of high internal pressure. The pressure lowers itself during rest and charging can then be restarted.

5.1.1 Maintenance charging

Pulse maintenance charging that keeps the battery in healthy condition and always above 90% state of charge.

5.2 Discharging

See the label on the battery for maximum discharge rate. To prevent harmful over discharge, the battery management system will automatically disconnect the battery from the load when the battery is empty. A blinking yellow LED indicates that the battery is empty and needs to be recharged.

5.2.1 Fuses

Do not exceed the maximum discharge rate stated on the battery label.

There's an electronic fuse that disconnects the battery string if more than 6C is drawn for more than 1ms. The fuse will reset when the battery is restarted.

Each battery string is also equipped with a backup mechanical fuse in case the electronic fuse fails. The mechanical fuse requires service at a Nilar approved service location to be replaced. Other components might be damaged and need to be inspected by a trained operator.

5.3 Charging with load connected

The battery system can be charged with the load still connected. The charger shall be dimensioned to provide current to both the battery packs and the load simultaneously. Failing to provide enough current to charge the battery will result in an error in the battery management system and the battery will be disconnected.

6 Mounting instructions

6.1 System dimensions

System type	XX dimension
LV 24V 30Ah	213,8
LV 24V 40Ah	262,7
LV 24V 50Ah	311,6
LV 24V 60Ah	360,5
LV 48V 20Ah	261
LV 48V 30Ah	358

Table 2: System height

6.2 Mounting requirements

An air gap of minimum 16mm is needed around the battery.

When laying the battery down it's important to place the battery so that the internal gas chamber is in the top half of the battery. The gas chamber can be identified by the gray safety valve on the bottom of the battery, seen in Figure 6.

Figure 6: Safety valve

6.3 Environmental requirements

Forced ventilation might be needed in high current applications. Make sure to install the battery in a dry place as it has limited moisture protection built in.

- Storage temperature: -25°C to +40°C
- Transport temperature: -25°C to +50°C
- Discharge temperature: -20°C to +50°C
- Charge start temperature: -20°C to +40°C
- Charge max temperature: +58°C

7 Maintenance and storage

During storage it's recommended to keep the charger connected so that the BMS can maintain the battery.

If the battery pack needs to be stored without charger, make sure to switch each pack off with the off/on switch (see chapter 3). This prevents the small current to the electronics from draining the battery.

Another option is to use the sleep functionality to reduce the current drawn by the battery management system.

8 Accessories

8.1 Display

The display gives the user real time information about the battery. The following rows are shown in the standard configuration:

- State if charge (battery capacity left in %)
- Current
- Voltage
- Status message

The display is connected to the RS485 interface and cannot be combined with the Modbus interface described in chapter 9.

The status message is a multi-purpose row for charging information and potential error codes. See chapter 9.3 and 9.4 for error codes.

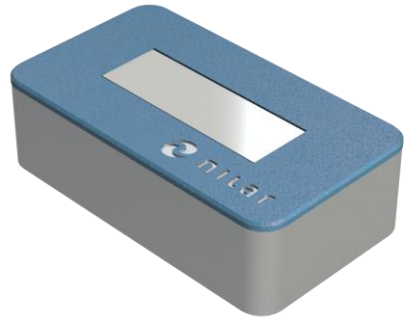

Figure 7: Display

8.2 Mounting options

Two different mounts are available from Nilar; side and top mounting. Both are made from durable PA plastic and can be screwed to a surface. Please contact your Nilar supplier for more information.

Figure 8: Side mounted

Figure 9: Top mounted

9 Modbus Interface specification

The Modbus interface can be used to receive data such as battery capacity, current, voltage and error codes. It's a read only interface that can be used by any customer system. The Modbus interface cannot be combined with the display accessory in chapter 8.1.

9.1 Communication parameters

Baudrate	19200
Databits	8
Parity	None
Stopbits	1
Protocol	Modbus RTU

9.2 Modbus Holding Register Address Map

Read only - function code 3

Address	Register Name	DATATYPE	Registers	Unit	Range	Description
0000	SOC	UINT16	1	% x 10	0-1000	Battery system state of charge
0001	I_TOT_SYS	INT16	1	A x 10	-x-x	Total system current
0002	VOUT	UINT16	1	V x 10	0-x	System terminal voltage
0003	FAULT_CODE	UINT16	1		See 9.3	System fault code (with highest priority)
0004	CHARGE_INHIBIT	UINT16	1		See 9.4	Charge inhibit status code (with highest priority)
0005	UNDERVOLTAGE	UINT16	1	bool	0,1	0: Battery voltage ok. 1: Battery under voltage
0006	CHARGER_ CURRENT_SP	UINT16	1	A x 10	0-x	Charger set point for current

9.3 Fault codes

Lowest fault code number has highest priority. In case of several faults, the fault code register will contain the fault code with highest priority

Fault code	Fault name	Fault type	Fault description
0			No fault
10	IDIFF	Battery fault	Battery string current difference too high. Internal battery fault.
20	SWITCH_SHORT	Battery fault	Power switch failure
30	CHARGER_HIGH_CURRENT	System fault	Charger current too high
40	CHARGER_LOW_CURRENT	System fault	Charger current too low
50	CHARGER_NO_CURRENT	System fault	No charger current
60	CHG_IERR	System fault	String current error during charge
70	OVERCURRENT	System fault	Battery string overcurrent
80	V_MIN	System fault	Battery string voltage too low
90	V_MAX	System fault	Battery string voltage too high
100	I_MIN	System fault	Battery string current too low
110	I_MAX	System fault	Battery string current too high
120	T_MIN	System fault	Battery string temperature too low
130	T_MAX	System fault	Battery string temperature too high
140	P_MIN	System fault	Battery pressure too low
150	P_MAX	System fault	Battery pressure too high

160	NDV_MAX	System fault	Battery string delta voltage too high
170	DVDT_MAX	System fault	Battery sting voltage rate of change too high
180	DTDT_MAX	System fault	Battery sting temperature rate of change too high
190	DPDT_MAX	System fault	Battery pressure rate of change too high
200	VDIFF_MAX	System fault	Battery string voltage difference too high
210	IDIFF_MAX	System fault	Battery string current difference too high
230	V_MIN	Charging fault	Battery string voltage too low
240	V_MAX	Charging fault	Battery string voltage too high
250	I_MIN	Charging fault	Battery string current too low
260	I_MAX	Charging fault	Battery string current too high
270	T_MIN	Charging fault	Battery string temperature too low
280	T_MAX	Charging fault	Battery string temperature too high
290	P_MIN	Charging fault	Battery pressure too low
300	P_MAX	Charging fault	Battery pressure too high
310	NDV_MAX	Charging fault	Battery string delta voltage too high
320	DVDT_MAX	Charging fault	Battery sting voltage rate of change too high
330	DTDT_MAX	Charging fault	Battery sting temperature rate of change too high
340	DPDT_MAX	Charging fault	Battery pressure rate of change too high
350	VDIFF_MAX	Charging fault	Battery string voltage difference too high
360	IDIFF_MAX	Charging fault	Battery string current difference too high
370	STATE_TIME_MAX	Charging fault	Charging state timeout

9.4 Charge inhibit status codes

Lowest charge inhibit number has highest priority. In case of several active charge inhibit codes, the charge inhibit code register will contain the code with highest priority

Code	Name	Description
0		Charging is allowed. No fault.
10	CHARGE_START_INHIBIT_LOW_TEMP	Charging is inhibited because of too low battery temperature
20	CHARGE_START_INHIBIT_HIGH_TEMP	Charging is inhibited because of too high battery temperature
30	CHARGE_START_INHIBIT_HIGH_PRESSURE	Charging is inhibited because of too high battery pressure
40	CHARGESTART_INHIBIT_HIGH_SOC	Charging is inhibited because of too high battery state of charge

10 Troubleshooting

Please check all possible errors from top to bottom when fault searching. Note that the charge control cable has to be disconnected when performing a restart.

Issue	Possible error	Action
Red LED flashing	Battery over temperature	Make sure the ambient temperature is OK
		Let the battery cool down for 1 hour and then restart it
	Battery over pressure	Make sure the ambient temperature is OK
		Let the battery rest for 1 hour and then restart it
	Internal error in battery	Contact Nilar support
Not charging	Battery not connected correctly to charger.	Connect charge control cable and charge power cable.
	Charger not connected to a working power source.	Connect charger to power source.
	Too high temperature or pressure in battery	Ensure ample ventilation, let battery cool down for 1 hour.
	Internal error in battery	Contact Nilar support.
No voltage on discharge terminals	Too high temperature or pressure in battery	Ensure good ventilation, let battery cool down for 1 hour.
	Battery is in fault mode	Follow steps for Red LED flashing

No LED when on	Slave pack is not connected to master	Connect the slave pack to master with interpack connection
	Pack is over discharged	Contact Nilar support
All LEDs blinking	System error	Contact Nilar support