About the manual

This version of the manual

This version of the manual replaces all previous versions. ELEO has made every effort to ensure this document is complete and accurate. All data in this document is subject to change or correction without prior notice.

Copyright

Related documents

The following documents are available from ELEO upon request:

- The CAN protocol mapping document
- 3D STEP files
- Module configuration software and GUI.

Units

SI units are used throughout this manual.

Safety warnings and notes

fields throughout the document. Examples of the style and purpose of each are shown below:

A S1 safety warning indicates a hazard with a high level or risk which could result in death or serious injury

A S2 safety warning indicates a hazard with low level of risk which could result in a minor or moderate injury

A NOTE indicates a risk of (irreversible) damage to the product or its surroundings or important information for proper functioning and warranty of the product

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Warranty

Please refer to the terms and conditions of sale or contract under which the product was purchased for full details of the applicable warranty.

Product identification

Each product is supplied with a unique product number (PN). When discussing technical issues make sure to have your products PN available. The PN is located at the front and/or top of each battery module.

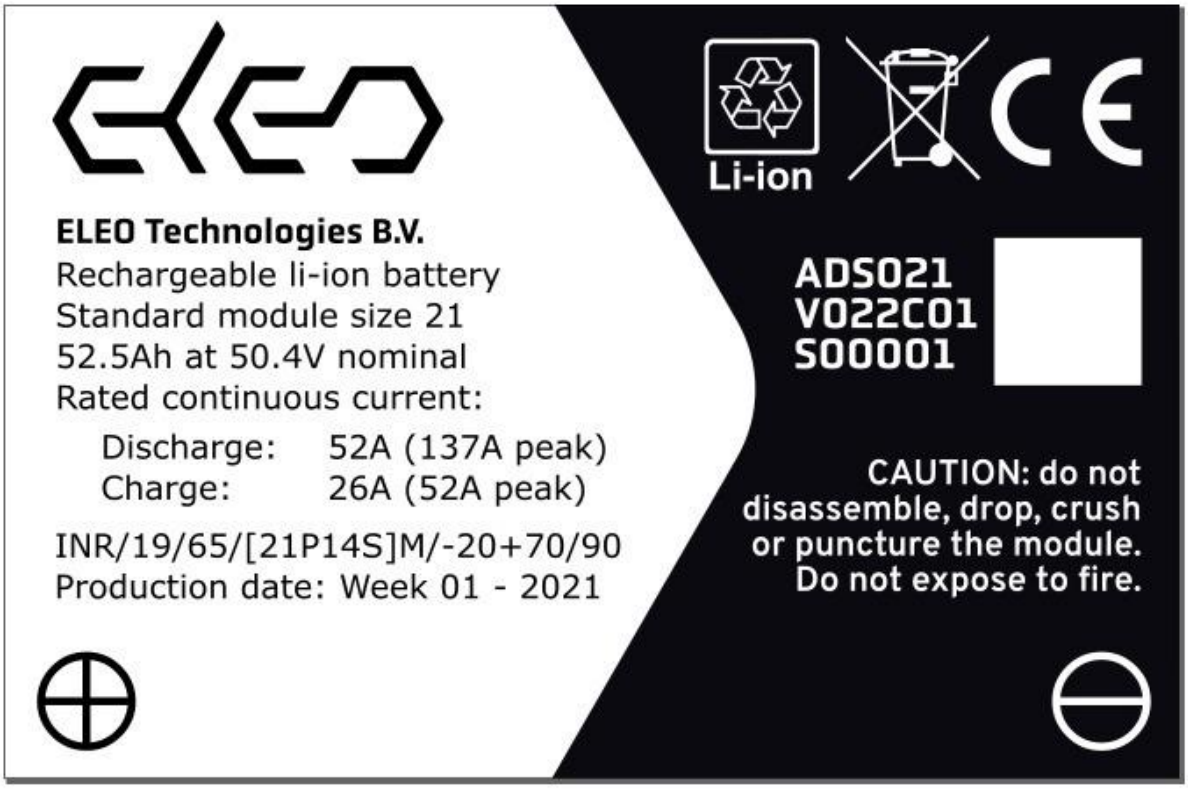

Figure 1: Example of product label. PN is marked with a red rectangle.

Software version control and updates

Our products are being optimized and improved throughout its lifetime. To allow for improvements and additional features ELEO reserves the right to implement small improvements and bug fixes without prior notice as long as the products remains functionally identical. To implement more significant improvements, that compromises the way our product functions and which may lead to changes on customers side, ELEO reserves the right to do so once every 6 months with at least a 3 month notice.

In case the customer is notified of a critical software update or fix, which is essential to the proper and safe functioning of the product over its lifetime, the customer is obliged to adopt this update.

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Safety Precautions

- Do not disassemble the module
- Do not drop, crush or puncture the module
- Do not use the module outside of its specified temperature range
- Do not heat, expose to fire and/or dispose of in fire
- Do not short circuit the module
- Do not overcharge the module
- Always add a battery fuse
- Always isolate the battery in case of a BMS error event
- Always isolate the battery when communication is lost with the BMS
- Take appropriate measures to prevent electrical shock

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Introduction

ELEO's 48V Li-ion battery modules are designed to offer a plug and play battery solution without compromising on safety and performance. These include both on and off-highway vehicles as well as maritime, railway and stationary applications. A range of models is available to suit a wide number of applications and cooling regimes.

The modules can be configured in any series and/or parallel configuration up to a 1000VDC ensuring any required capacity and voltage is possible.

Certified for industrial use. Designed for automotive.

- Tested safety: IEC62619, UN 38.3, EN61000-6 and inhouse abuse testing.
- Cell-level short circuit protection
- Designed for IP65
- Integrated BMS and microprocessor
- Voltage, temperature and current monitoring
- Advanced SOC analysis
- Extremely low temperature gradient amongst cells
- 12V and 24V externally powered BMS
- Robust CANbus communication
- Isolated logics
- Built-in data storage for monitoring (mis)usage
- Automatic controlled passive balancing

Flexible. Scalable. Customizable

- Simple GUI
- Automatic configuration of battery pack with profided config. software
- Freely scalable up to a 1000VDC
- Out-of-the-box compatible chargers
- Orientation independent mounting
- Superior thermal interface for cooling and heating
- Designed and produced in the Netherlands

Easily expandable

- Liquid cooling and convection heatsinks available
- SOH / SOF functionality

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Intended use and safety concept

The ELEO 48V Li-ion battery module is intended for use in both vehicles and stationary applications. This may be vehicles for road use, but also vehicles for industrial use and home use. The ELEO Advanced Module may also be used for marine, railway and (stationary) energy storage applications.

The ELEO Advanced Module is not a portable battery and should therefore always be assembled permanently inside the intended application.

NOTE: Always add an active system or ELEO battery controller that can disconnect the battery in case of an error event.

The ELEO 48V Li-ion battery module is a building block for constructing battery pack solutions. One or multiple modules can be built in an application and can be integrated together up to a 1000VDC. Measured data is transmitted from the battery modules to each other and to other vehicle systems via CAN. The battery modules have no integrated relay and are therefore not able to disconnect itself from the rest of the application. Additional Relays or the ELEO battery controller must always be integrated in the application outside of the battery module(s). In case there is no communication for at most 5 seconds the relays should be opened as well.

NOTE: An external fuse of the appropriate type and current rating must always be integrated as close to the battery as possible

An external fuse of the appropriate type and current rating must always be integrated in the application outside of the battery modules. If an ELEO battery module has an overcurrent event without an external fuse, the safety mechanisms inside the module would take over which will cause permanent failure of the module.

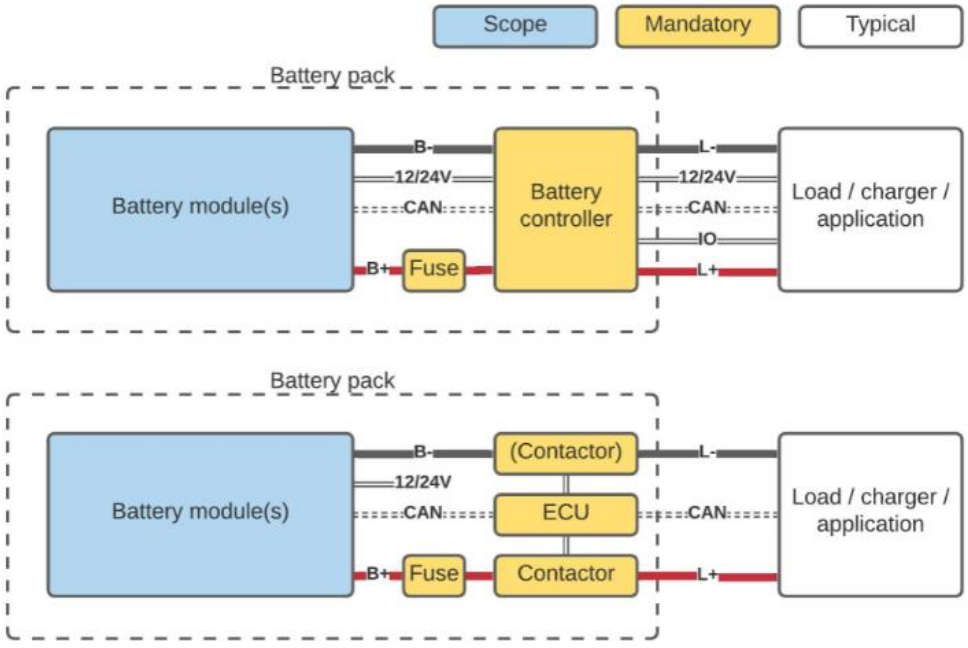

Figure 2: Overview of safety concept of ELEO 48V Li-ion battery module

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Electrical specifications

Each module is equipped with a BMS and communicates over a CAN-bus with configurable baud rate. The BMS in the modules needs to be powered externally when turning on the application or initiating charging. The CAN-bus and BMS are galvanically isolated from the (HV) battery positive and negative. The enclosure of the modules should be grounded to a defined voltage potential in the application.

ELECTRICAL DATA	**Standard module**		**Power module**	
Chemistry	Li-ion NCA/NMC		Li-ion NCA/NMC	
Nominal voltage	50.4 V		50.4 V	
Voltage (min.)	42.0 V		42.0 V	
Voltage (max.)	57.4 V		57.4 V	
Idle power consumption	0.8 W		0.8 W	
BMS supply voltage	8-28V		8-28V	
Cycle life[1]	1000 … 3000 cycles		500 … 1500 cycles	
Size	**21**	**35**	**21**	**35**
Standard capacity[2]	57.8 Ah	96.3 Ah	62.0 Ah	103.3 Ah
Rated capacity[3]	52.5 Ah	87.5 Ah	-	-
Standard Energy	2.9 kWh	4.9 kWh	3.1 kWh	5.2 kWh
Standard charge	26 A	43 A	31 A	51 A
Max. continues charge	52 A	87 A	84 A	140 A
Standard discharge	52 A	87 A	105 A	175 A
Max. continues discharge	104 A	174 A	210 A	350 A
Peak discharge	137 A	229 A	420 A	700 A
Charge temperature	0 - 45ºC	0 - 45ºC	0 - 50ºC	0 - 50ºC
Discharge temperature	-20 - 60ºC	-20 - 60ºC	-20 - 70ºC	-20 - 70ºC

[1]Depending on use, DoD and temperature; [2]Minimum full discharge capacity @0.2C with 2.5V cutoff; [3]According to IEC62619;

NOTE: Do not lift the module using any of the electrical interfaces and/or connectors.

The electrical interfaces are shown below. The main terminals are M6 internally threaded. Two identical connectors provide CAN interfacing and power supply to the BMS. A RGB LED for feedback and an explosion proof pressure relief valve are located in the middle. Do not lift the module using any of these interfaces and/or connectors.

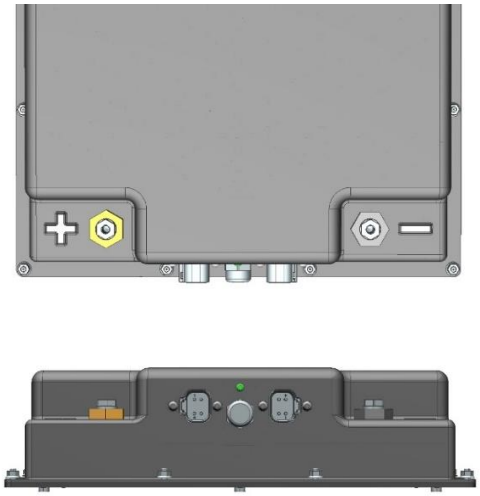

Figure 3: Electrical interfaces: B+ (left), 2x CAN + supply (middle) and B- (right).

Additional information can be found in the table below.

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Name	Type	PN	PN mating part	Pin layout / Comment
Battery positive	Screw terminal	-	-	M6x1.0 (18mm DEEP)
Battery negative	Screw terminal	-	-	M6x1.0 (18mm DEEP)
Data	Connector	Deutsch DT15-4P	Deutsch DT06-4S	Pin 1: BMS supply + Pin 2: CAN High Pin 3: BMS supply - / CAN GND Pin 4: CAN Low

LED indicator

Color	**Description**
Red	Reset from watchdog
Orange	Error
Green	OK
Blue	Configuration mode

Storage

It is recommended to store the battery at low temperature (recommended 20 degrees Celsius), low humidity (below 65%) in an area with no dust and a non-corrosive atmosphere at a SOC of around 30%.

Transport & Packaging

Transport classification: UN 3840

Packaging group: PI965 section IA

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Mechanical and thermal specifications

Note: The module(s) cannot be part of a load-bearing construction

The modules are equipped with female threaded inserts at the bottom. These can be used to fixate the modules and/or to attach a cooling or heating solution.

Function	Specification	Tightening torque [Nm]
Bottom plate inserts	M5x0.8 4.6mm deep	6.5
Battery terminals	M6x1 18mm deep	11.3

The modules can be fixated in any possible orientation. The module cannot be part of a load-bearing construction. Add brackets or other constructions to handle the mechanical loads. Protect the module against reasonable foreseeable mechanical misuse in the application.

S1: Do not drop, crush or puncture the module.

The position of modules and added cooling and/or heating systems may introduce a temperature gradient between separate modules. Make sure the temperature difference between the modules stays below 5 degrees Celsius.

MECHANICAL DATA	Energy module		Power module	
Protection class[1]	IP65		IP65	
Width Y	303 mm		303 mm	
Height Z	80 mm		80 mm	
Size	**21**	**35**	**21**	**35**
Length X	550 mm	864 mm	550 mm	864 mm
Weight	16.9 kg	27.7 kg	16.9 kg	27.7 kg

1 Designed not certified;

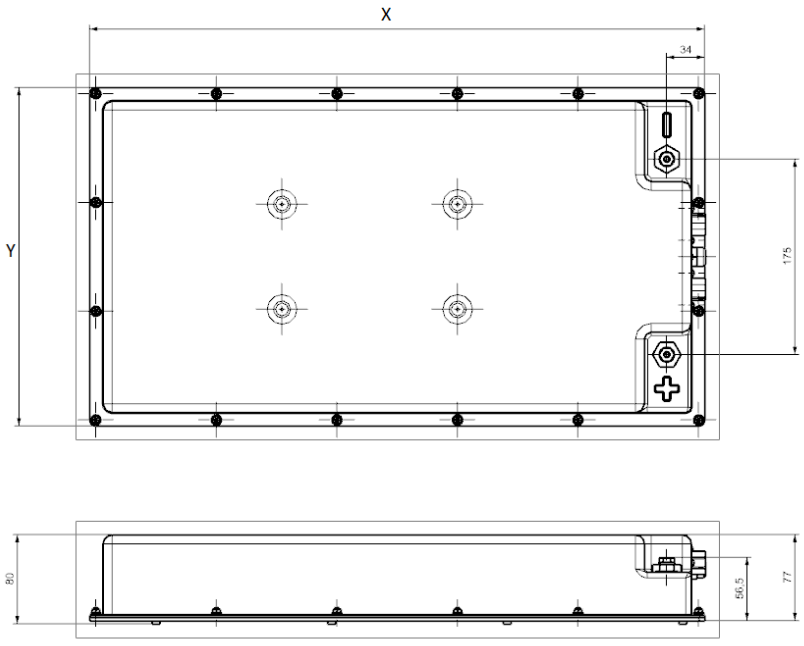

Figure 4: Dimensions of the battery module

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Battery functional interface

Communication interface

Depending on the application one or multiple battery modules communicate over the CAN bus. To provide a single interface to interact with the battery, the modules are organized in a master-slave configuration. Every module acts as a “slave” module and communicates with the module configured as master. A module is automatically chosen to be the master module when configuring using the provided configuration software. In addition to the summarized information the master module also acts as a slave providing detailed information of the module itself. The master module provides an interface for the rest of the applications and summarizes the data such as errors and minimum and maximum values from the other modules. The data of individual slaves provide more detailed information of the modules’ functioning.

Minimal safety requirements

For proper function and warranty, it is important to make sure the modules stay within their specified limits. The BMS gathers all necessary data and provides this over the CAN-bus. The BMS also interprets this data to allow for easy control and integration of the battery in any application. The battery however does not possess the functionality to act as it is a passive system. The application and the creators of the application are responsible for keeping the battery within its specification.

Required for minimum misuse and safety: disconnect/isolate the battery from the application in case of an error event or when communication with the BMS is lost for more than 5 seconds.

To prevent an error, it is recommended to configure the application to automatically act on warnings (downrating, adjusting cooling/heating, maintenance) dependent on the type of warning. In case of more extensive controlling strategies the raw sensor data from the modules can be used. The error and warning structure can be seen in Appendix A.

Charging

When charging, the BMS has to be set to charging mode which sets temperature safety limits and allows the BMS to engage balancing circuits. When using the out-of-the-box compatible charger this functionality is automatically provided. Details of setting the BMS to charging mode can be found in the CAN-mapping document. When not using the out-of-the-box charger the control of the charger will have to be done by the application. The “Charging allowed” and “Charging done” bit found in the CAN-mapping document can provide reference when implementing a charger.

Balancing

During charging mode the BMS will automatically decide if the voltage levels of the modules have drifted too far apart and it is necessary to balance them. During the charging cycle the modules can periodically balance signaled by the “In balancing mode” bit in the CAN-mapping document. At the end of the charge cycle the module either continues periodically balancing or sets the “Balancing done” bit. It is recommended to leave the modules in charge mode to finish balancing after charging is done.

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First use and installation

S1: When connecting more than 1 module in series adequate safety measures must be taken for working with High voltage (HV) systems.

Note: When (re-)connecting the main power terminals of the modules to the application or other modules in parallel always pre-charge first.

Note: When connecting the modules in series make sure that the battery voltages of the modules are within 0.2V of each other to minimize initial pack balancing time.

Note: Modules connected to the same CAN-bus should be powered by the one and the same power source.

When receiving the modules make sure they show no signs of damage due to transport. Do not assemble modules that show any physical signs of damage.

Mechanically secure the modules in the application and add cooling/heating systems when needed. Connect the data and power supply to all modules by connecting them in one chain. Add can termination at both ends of the CAN-bus chain by adding a 120Ohm resistor between the CAN High and CAN Low lines.

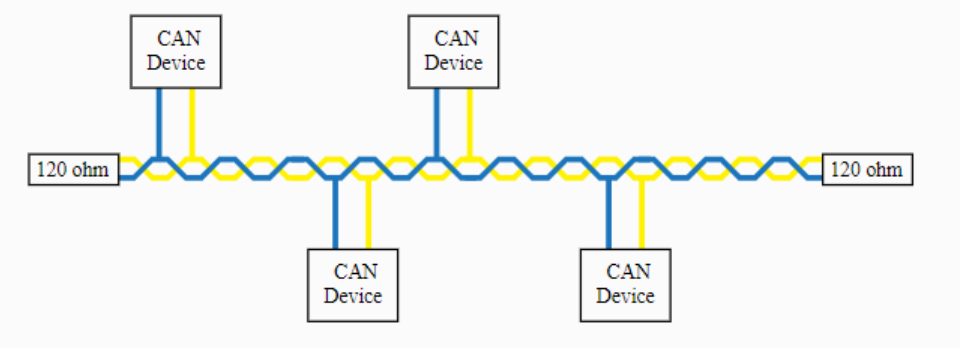

Figure 3: Example of CAN-bus wiring and termination

All modules connected with the same CAN-bus should be powered from the same power source. Additional CAN devices connected to the same CAN-bus must have a common (CAN) ground. The ground of the low voltage power supply to the modules acts as the CAN GND.

Supply power to the modules and make sure the CAN-bus is functioning properly. When powered the LED on each module should light up. The appropriate CAN-messages will be visible on the CAN-bus according to the CAN-mapping document.

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Software configuration

In case the modules came preconfigured for the particular application there is no need to configure the modules, the status LED will be green when connected properly. Otherwise configure the modules with the provided configuration software.

Power connections

When the modules are securely mounted in the application and are configured and integrated with the application the main battery power connection can be made. When connecting modules in parallel make sure to pre-charge them before connecting to prevent in-rush currents. When connecting the modules in series make sure the module voltages are within 0.2V from each-other to prevent long initial balancing times.

Each module is equipped with cell-level fusing. Additionally, it is mandatory to use a main fuse in the B+ power line outside of the modules preferably as close as possible to the modules. In case of high voltage (2 or more modules in series) make sure to work according to High voltage safety guidelines and regulations. Parallel modules should be connected to each other in such a manner that the current flow is equally divided amongst the parallel modules. In a series connection this is inherently the case.

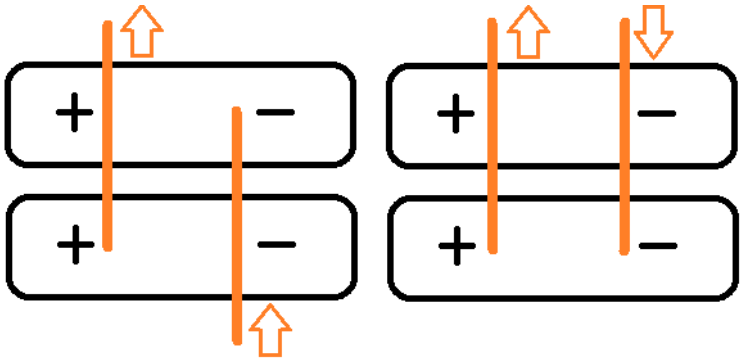

Figure 5: Good parallel connection (left), Bad parallel connection (Right)

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Appendix A: Add-ons

Name	Description

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