Freen-BSL Energy Storage Unit

Installation and User Manual

FREEN OÜ
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For the latest documentation, technical updates and warranty information, visit:

www.freen.com

Product Scope

This manual applies to the following products:

Energy Storage Unit Freen-BSL

All specifications and descriptions in this manual are verified to be accurate at the time of publication.
Due to continuous product improvement, Freen OÜ reserves the right to make changes to the product, documentation, or specifications without prior notice.

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1. Product overview

The Freen-BSL series offers scalable, low-voltage rechargeable sodium-ion battery modules ideal for residential and small commercial energy storage systems. With excellent cycle life, high round-trip efficiency, and robust operating temperature range, these floor-mounted units are designed for performance and reliability.

With a nominal voltage of 48 V and modular configurations, Freen-BSL systems are compatible with tested and widely used inverters available on the market, providing high power output, extended cycle life, and dependable operation

For the current list of compatible inverters, please refer to *www.freen.com/documentation*

High Efficiency

Over 97% round-trip energy efficiency ensures minimal energy loss during storage and retrieval.

Long Lifetime

Delivers over 10000 full charge-discharge cycles with >60% of end capacity for long-term performance and reliability.

Sodium-ion Technology

A fire-safe, and sustainable alternative with stable performance across various conditions.

Modular Design

Scalable architecture allows flexible system sizing to meet different energy storage needs.

Broad Temperature Tolerance

Consistent performance even in the harshest temperature conditions. Capable of discharging between -30°C and +60°C.

Low Upkeep Requirements

Natural convection cooling, robust safety engineering, and smart CAN/RS485 communication.

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2. Safety information

(Compliant with EU Regulation 2023/1542 - general user-level requirements)

2.1. General Safety

- Do not open, disassemble, or modify the battery enclosure.
- Keep the product away from water, moisture, and chemically aggressive environments.
- Do not expose the system to direct sunlight, open flames, sparks, or heat sources.
- Do not stack heavy objects on top of the unit or apply mechanical shock (impact, dropping, crushing).
- Ensure that the unit is positioned on a level, stable surface before operation.
- Do not allow children or unauthorized people to operate or interact with the system.
- The system must be used only with compatible inverters and electrical equipment (see actual list on freen.com).

2.2. Electrical Safety

- Always **turn off** the inverter and isolate the DC circuit before connecting or disconnecting the battery.
- Ensure correct polarity:
  Red/Orange = Positive (+), **Black = Negative (–)**.
- Never short-circuit the DC terminals.
- Use only approved cables with appropriate current ratings and insulation.

Required minimum DC cable cross-section: 25 mm^2 copper

- Avoid loose connections - improperly tightened terminals can cause overheating or arcing.
- Do not touch exposed conductors with wet hands or conductive tools.
- Ensure that the system is properly grounded according to local electrical regulations.
- Avoid placing metal objects near the terminals.

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2.3. Temperature and Environmental Requirements

Operating Temperature

- **Charging:** 0°C to +55°C
- **Discharging:** -30°C to +60°C

Storage Temperature

- Recommended: **-10°C to +25°C**
- Long-term storage should be at **25–75% state of charge (SoC)**.

Environmental Conditions

- Indoor installation only
- Keep the system away from humidity, dust, and corrosive agents.
- Maintain at least **5 cm** clearance around the enclosure for airflow.
- Prevent condensation - allow the battery to acclimate to room temperature before powering on if previously stored in a cold environment for not less than 24 hours.

2.4. Emergency Procedures

Overheat, Smoke, Abnormal Noise or Smell

- If one mentioned above observed:
- Immediately turn off the inverter and disconnect the DC power circuit.
- Move away from the product and ensure ventilation of the room.
- Do not attempt to open the enclosure.
- Contact technical support.

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Liquid Exposure

If exposed to water or other liquids:

- Disconnect the unit from all power sources
- Do not turn it back on
- Allow professional inspection before reuse

Physical Damage

If the unit has been dropped, severely shaken, or damaged:

- Do not operate the system
- Contact the manufacturer for inspection

Fire Safety

- Evacuate personnel if smoke becomes dense or the unit becomes abnormally hot.
- In case of fire, immediately contact local emergency services and inform them about the nature of the fire.
- Use only appropriate extinguishers for battery-related incidents.
- Do NOT use water.

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3. System Description

The Energy Storage Unit Freen-BSL uses Sodium-Ion (Na-ion) battery cells. Sodium-ion chemistry provides high cycle life, enhances thermal stability and does not rely on lithium-based components.

The resulting system voltage is compatible with most 48 V-class inverters and energy storage applications.

Scope of Supply –

1. Energy storage unit.
2. A set of connection plugs.
3. BMS RS485-USB cable.
4. Installation and User manual.

3.1. Mechanical Features

The Energy Storage Unit is built using reinforced metal housing designed for indoor stationary installations. The enclosure provides structural rigidity, thermal stability and mechanical protection for the internal sodium-ion battery modules and the integrated **Battery Management System (BMS)**.

Key housing features:

- Powder-coated metal enclosure, corrosion-resistant
- Protection degree: **IP20** (indoor use only – no exposure to water, dust ingress limited)
- Side ventilation openings for natural air cooling
- Dedicated internal compartment for the BMS
- Front control panel with indicators, communication ports and main power terminals
- Lower structural frame for stable floor mounting

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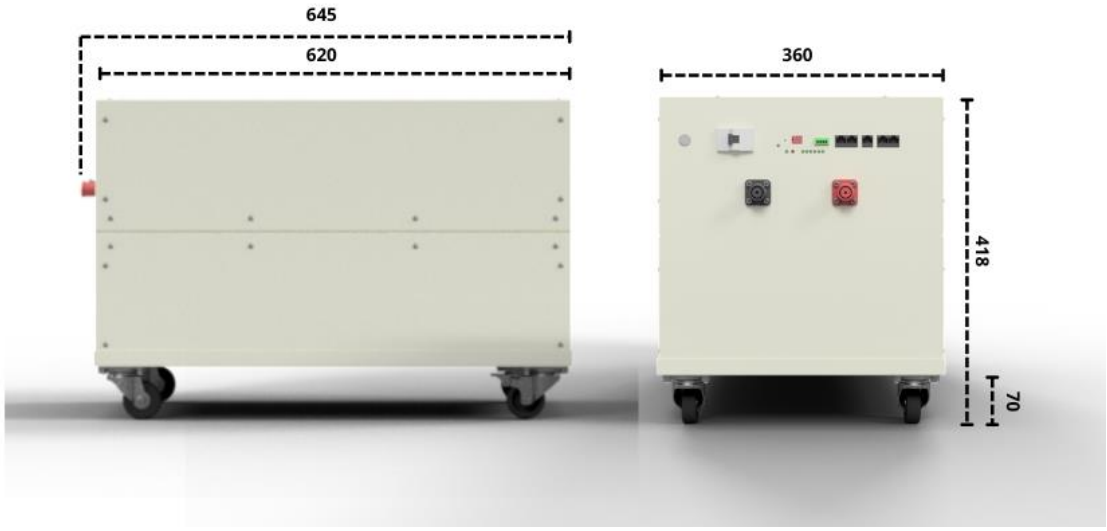

(Picture 1. Dimensions of Energy Storage Unit)

(The actual design of the unit may be different and changed by manufacturer.)

3.2. Integrated BMS Functions

The system uses **Battery Management System** optimized for sodium-ion modules.

The BMS continuously monitors the battery state and ensures protection under all operating conditions.

Main BMS functions:

Monitoring

- Cell voltage monitoring (individual series cells)
- Pack voltage and current measurement
- Dual temperature sensing
- State of Charge (SoC) calculation
- Full charge-discharge cycle quantity monitoring

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Protection Features

- Overcharge protection
- Over-discharge protection
- Over-current protection (charge and discharge)
- Short-circuit protection
- Over-temperature protection for charge/discharge
- Low-temperature charge restriction
- Automatic shutdown under critical conditions

Balancing

- Active balancing between cells for optimal lifetime and improved cycle stability
- Balancing during charge and float modes

Communication

- CAN bus (for inverter/EMS connection)
- RS485 (Modbus-type communication for monitoring)

Compatibility of this function must be verified for the specific inverter model.

Automatic Modes

- Auto wake-up after power connection
- Sleep mode during long inactivity
- Fault memory storage for service diagnostics

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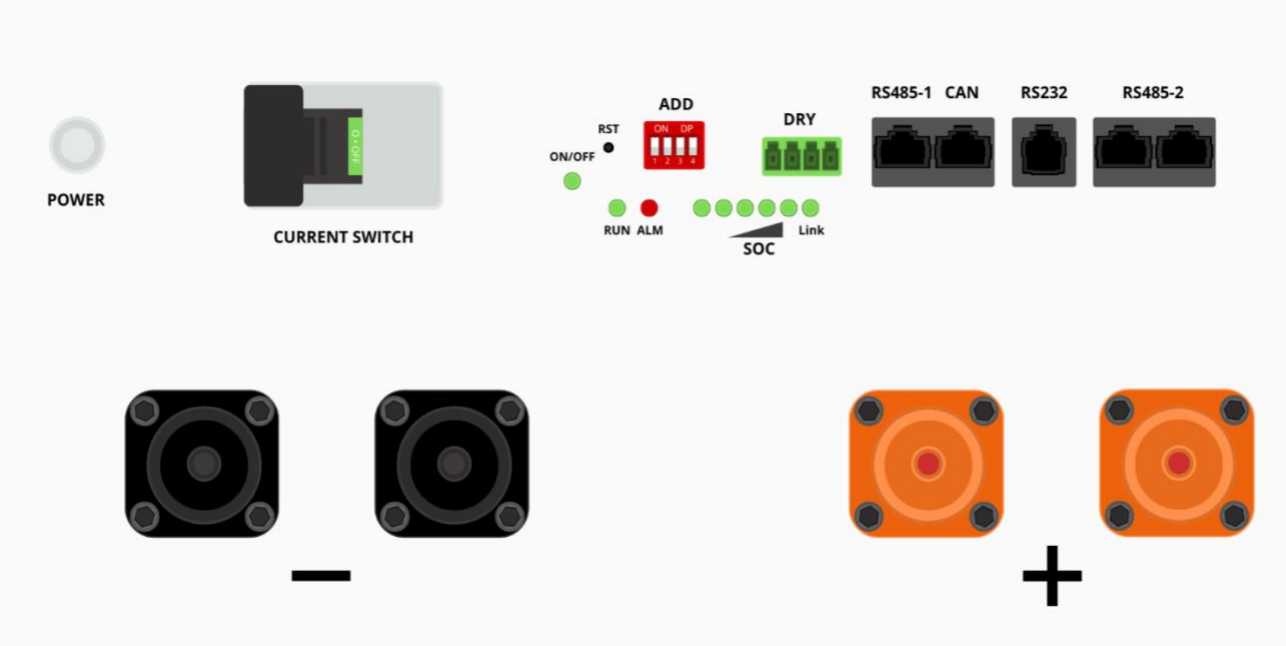
3.3. Ports, Interfaces and Terminals/ Indicators and Controls

The front panel (see picture 2) includes all user-accessible elements.

(Picture 2. Energy Storage Unit Front Panel)



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Interface	Function / Purpose
Power Button	Turns the BMS system ON or OFF. Used to power-up after connection or shut down safely.
Current Switch (ON/OFF breaker)	Main current isolation switch. Cuts battery output/input current. Must be ON for the BMS to operate.
RST Button (Reset)	Resets the BMS controller. Used after wiring changes, errors, or configuration updates.
ADD – Address DIP Switches (1-4)	Sets the CAN/RS485 communication address when multiple BMS units are used in parallel.
RUN LED	Blinks when BMS is running normally.
ALM LED	Lights when an alarm is active (overvoltage, undervoltage, overcurrent, temp error, etc.).
SOC LEDs	Battery State of Charge indicator (more LEDs = higher charge level).
Link LED	Indicates active communication link (RS485/CAN).
DRY Contact (Dry Relay)	Relay output used for controlling external devices (contactors, alarms, chargers). No internal voltage.
RS485-1 / CAN	Communication port for CAN Bus or RS485 to inverter, computer, or another BMS.
RS232	Serial port for configuration or monitoring.
RS485-2	Additional RS485 port for daisy-chain communication.
Negative terminals (-)	Energy storage negative connection points.
Positive terminals (+)	Energy storage positive connection points.

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4. System installation

This section describes the required steps to install and commission the Energy Storage Unit Freen-BSL. All installation work must be performed by qualified personnel.

4.1. Electrical Connection Procedure

Before you start

- Ensure the inverter is powered OFF.
- Lock the unit's caster brakes.
- Verify correct cable size for DC current **(Minimum DC cable cross-section: 25 mm^2 copper. Ensure the same cable cross-section is used on both sides of the DC connection)**
- Confirm correct polarity on DC terminals.

Connection Steps (see picture 3)

1. **Connect the Ground**
   Attach the grounding cable to the designated grounding point of the battery enclosure.
2. **Connect the Negative (–) Terminal**
   Connect the black DC cable to the negative terminal. Tighten using an insulated tool. Ensure correct torque and firm contact
3. **Connect the Positive (+) Terminal**
   Connect the red DC cable to the positive terminal. Tighten using an insulated tool Ensure correct torque and firm contact.
4. **Secure all connections**
   Check for proper crimping, tightening, and insulation.
5. **Connect communication cables (if used)**
   Install CAN or RS485 cables between the battery and the inverter/energy controller.
6. **Recheck all wiring**
   Verify that no cables are under tension or touching sharp edges.

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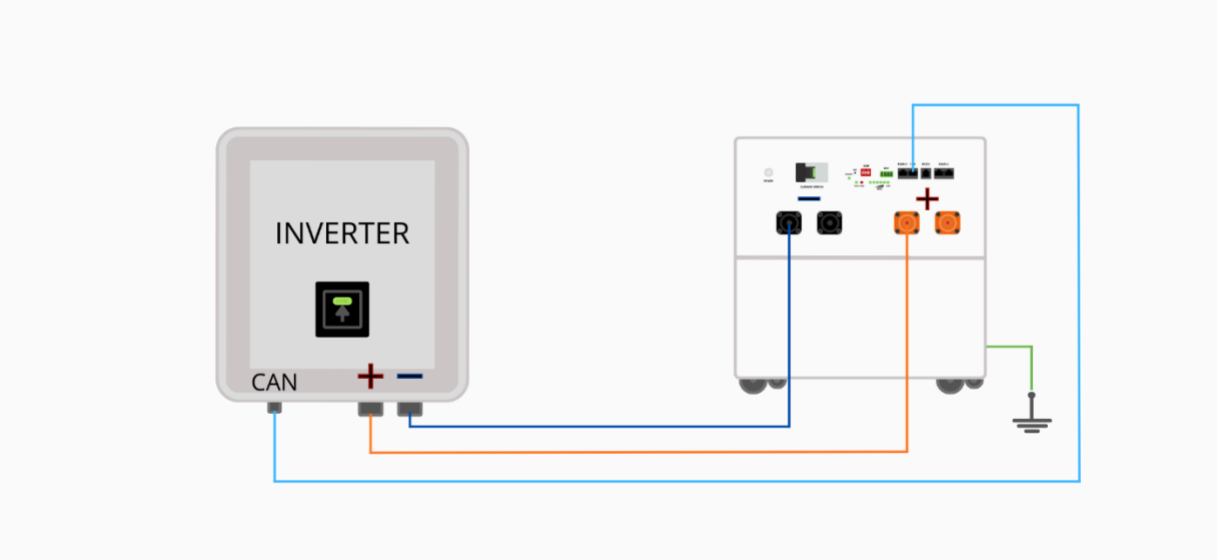

(Picture 3. Simple connection diagram)

4.2. Communication Wiring (CAN / RS485)

The Energy Storage Unit supports optional communication protocols for closed-loop control.

General Guidelines

- Use shielded twisted-pair cables (max. recommended cable length: 20-25m indoors)
- Avoid routing communication cables next to high-current DC lines.
- Follow the inverter manufacturer's wiring diagram for pin assignments.
- Only connect **one** communication protocol at a time (CAN *or* RS485).

- **For CAN**: follow device-specific CAN mapping (termination resistor if needed).
- **For RS485**: verify Modbus device ID and baud rate if applicable.
  - Ensure connectors are fully seated and secured.

Typical Functions

- SoC reporting
- Charge/discharge control
- Error signaling
- Voltage/current telemetry

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4.3. Initial Power-On Procedure

1. Verify that the housing is not damaged.
2. Ensure the unit is placed on a level floor surface.
3. Check ambient temperature: **+10 °C to +35 °C recommended**.
4. Connect protective earth (PE).
5. Connect DC cables to the inverter observing polarity.
6. Connect CAN or RS485 communication cable if required.
7. Turn on Battery current switch
8. **Turn on** the inverter or system controller.
9. The BMS will automatically wake up; Power LED should illuminate.
10. Check that no Fault indication is active.

4.4. System Scalability and Parallel Expansion

To increase the total system energy capacity as well as the maximum charge/discharge current, multiple identical Freen-BSL battery modules may be connected in parallel. Up to 16 individual energy storage units can be combined to create a larger battery system tailored to your requirements. The system configuration allows scalable energy storage systems from 7.6 kWh to 121.6 kWh.

Before starting any parallel connection work, the following mandatory technical conditions must be met:

1. Module Identity

Only battery modules of the same model and the same nominal voltage are permitted to be connected in parallel.

2. State of Charge (SOC)

Before connection, all modules must have the same voltage.

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The allowable voltage deviation between individual modules must not exceed 2%.

This requirement is necessary to prevent BMS protection shutdown due to excessive equalization currents flowing through the power cables between adjacent storage units.
For safety reasons, it is recommended to perform parallel connection when the state of charge does not exceed 30%.

3. Cables

Copper cables of identical length and cross-section must be used for all parallel interconnections.
This requirement ensures equal resistance of the interconnection cables. Without compliance with this condition, proper system operation cannot be guaranteed.

4. Terminals

Cables must be tightly secured with the front panel terminals.

Power cables connection Procedure

To ensure safety, follow the steps below:
1. Switch Off All Units
Make sure that all circuit breakers on the batteries and the inverter are in the “OFF” position.

2. Positive Connection (+)
Connect the positive connector (+) of one battery to the positive connector (+) of the next battery.
Continue connecting all batteries positive-to-positive (+ to +) to form a parallel connection.

3. Negative Connection (-)
Connect the negative connector (-) of one battery to the negative connector (-) of the next battery.
Continue connecting all batteries negative-to-negative (- to -) to complete the parallel connection.

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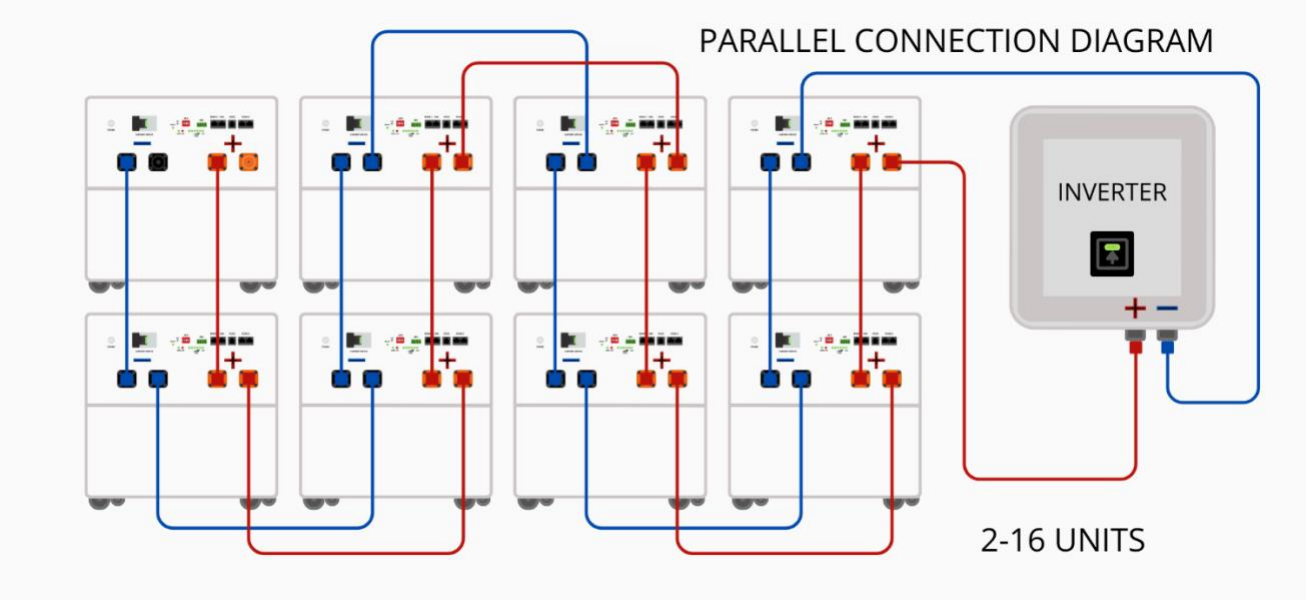
4. Connection to the Inverter

Connect the positive cable from the inverter to a positive connector (+) of the energy storage.
Connect the negative cable from the inverter to a negative connector (-) of the energy storage.

Note: Always verify polarity before switching the system ON.



(Picture 4. – ESS parallel connection diagram 2-16 units)

5. Grounding Connection:
Connect the protective earth (PE) grounding points located at the designated grounding positions on the battery enclosures to the system grounding.

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Communication between Battery Storage Units in parallel connection

When battery modules are connected in parallel, monitoring of the entire system as a single unit (total SOC, voltage, and current readings) is achieved via Master-Slave communication over the CAN bus (Picture 5).

1. Master Assignment

The Master module is defined as:
The unit first connected to the inverter, or the unit that configured as master via DIP switch settings according to DIP switch address table:

Address	DIP Switch Positions			
	1	2	3	4
0	OFF	OFF	OFF	OFF
1	ON	OFF	OFF	OFF
2	OFF	ON	OFF	OFF
3	ON	ON	OFF	OFF
4	OFF	OFF	ON	OFF
5	ON	OFF	ON	OFF
6	OFF	ON	ON	OFF
7	ON	ON	ON	OFF
8	OFF	OFF	OFF	ON
9	ON	OFF	OFF	ON
10	OFF	ON	OFF	ON
11	ON	ON	OFF	ON
12	OFF	OFF	ON	ON
13	ON	OFF	ON	ON
14	OFF	ON	ON	ON
15	ON	ON	ON	ON

(DIP switch address table)

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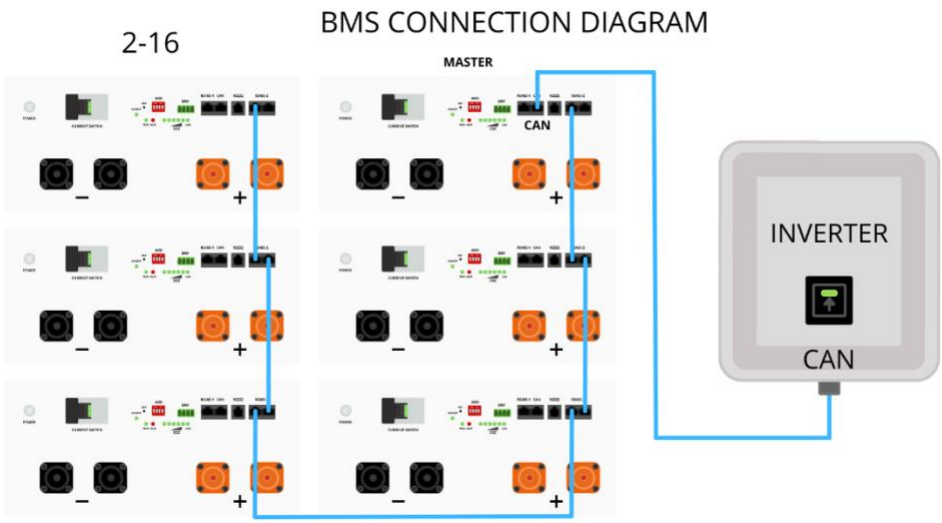
2. Interconnection

Connect the modules sequentially via the RS-485 interface using a shielded RS-485 compatible cable.
The RS-485 port of the first module connects to the RS-485 port of the second module, and so on



(Picture 5. – BMS interconnection diagram 2-16 units)

3. Connection to Inverter

The Master module is connected to the inverter via the CAN communication port using the same type of cable for data transmission.

System Start-Up Procedure:

1. Turn ON the circuit breakers on all battery modules.
2. Turn ON the inverter.

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5. System Operation

The Unit operates automatically under normal conditions. The BMS and inverter coordinate charging and discharging.

5.1. Normal Power Modes

- **Standby:** BMS active, inverter idle, no current flow.
- **Charge Mode:** Pack voltage rising, active thermal monitoring.
- **Discharge Mode:** Inverter supplies connected loads.
- **Protection Mode:** System isolates battery until safe recovery conditions are met.

5.2. Charge/Discharge Behavior

- Operating voltage: 40-60 V
- Max charge/discharge current: 100 A
- Max power: 4.8 kW

Temperature limits:

- Charge: 0 °C to +55 °C
- Discharge: -30 °C to +60 °C

Recommended Storage temperature range: -10 °C to +25 °C

The BMS automatically reduces or stops charging if:

- Temperature is below 0 °C or above +55 °C
- Current exceeds permitted limits
- Voltage reaches maximum

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5.3. LED Indicators and Status Codes

Indicator	State	Meaning
Power LED	Solid green	System ON / normal operation
	No light	Unit in sleep mode or no power
SOC LEDs	1-4 green dots	Battery state of charge (25–100%)
Fault LED	Red blinking	Protection active (over-voltage, over-temp, etc.)
	Solid red	Critical fault - system locked, service required

Notes:

- Fault LED behavior is controlled by BMS event priority.
- Detailed diagnostics available via CAN/RS485 reading.

5.4. Standby and Sleep Modes

The unit enters Sleep Mode after long inactivity without communication or current flow.

Wake-up occurs automatically when:

- Inverter requests current
- Communication becomes active
- DC voltage applied

Sleep mode minimizes internal consumption and protects the battery during long idle periods.

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5.5. Full Charge–Discharge Cycle Monitoring (via PC)

The integrated JK (Jikong) Battery Management System records the total number of completed full charge-discharge cycles **(Full Equivalent Cycles).**

The JK BMS MONITOR software is available only for Windows PC, if you have MacOS computer, please install Windows App at the App Store to proceed.

To check the cycle count using PC and BMS Software:

1. Install the official JK BMS monitoring software

   JK BMS MONITOR Software Download link - https://www.jkbms.com/wp-content/uploads/2025/12/jkbms.com-monitor-3.4.0-setup.zip

2. Open the installed JK BMS MONITOR program.

3. Connect the supplied RS485-USB communication cable.

4. Verify communication readiness:
   - Confirm that the computer recognizes the USB device.
   - Make sure the CH340 driver is installed correctly.

5. In the software, press “Connect”,
   - Ensure that the correct COM port is selected.
   - Verify that the DIP switch address settings correspond to the system configuration.

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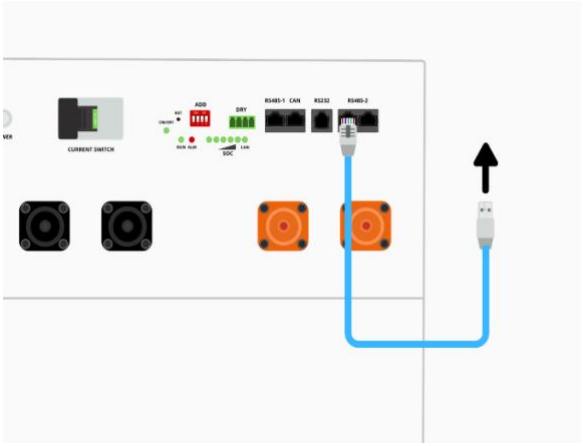
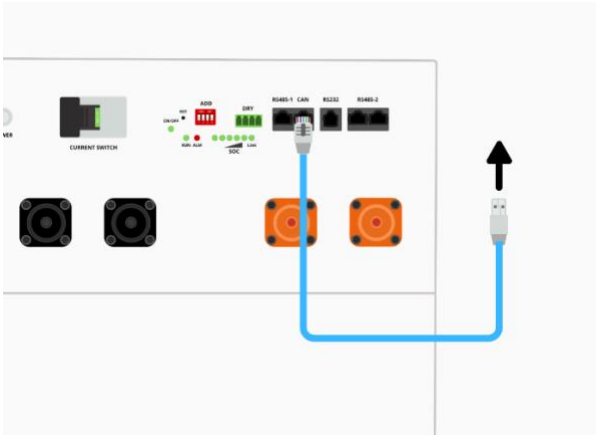
After successful connection, the software interface will display the full list of battery parameters, including the total Cycle Count value.

The displayed Cycle Count represents the total number of full equivalent charge-discharge cycles recorded by the BMS.



(Picture 6.)

Slave module PC Connection



(Picture 7.)

Master module PC Connection

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6. Maintenance

6.1. Visual Inspection (Every Month)

- Check for damage to housing or connectors
- Ensure ventilation slots are not blocked
- Confirm no signs of overheating or smell
- Verify LEDs for normal operation
- Check cabling for wear, corrosion or loose connections

6.2. Recommended Service Intervals

Every 2-3 months:

- Check and restore tightening terminal connections
- Clean ventilation zone surface

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7. Storage and Transport

Storage Requirements

- Store at **25–75% State of Charge (SoC)** for long-term storage.
- Storage temperature: -**10°C to +25°C** recommended.
- Avoid direct sunlight and high humidity.
- Recharge the battery every **3 months** if stored idle.

Transport

- Transport upright and secure in the original packaging.
- Do not expose to excessive shock, vibration, or dropping.
- Ensure power is turned off before transport.
- Follow regional battery transport regulations.
- For safety reasons, the storage units are shipped with a SoC of approximately 30%

FREEN OÜ
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VAT number EE102096378
Arenduse tn 6, Kohtla-Järve, 30328 Ida-Viru maakond, Estonia
freenindustries.com | freenwind.com | freensolar.com | freen.com
contact@freen.com
+372 5374 17 54

8. Datasheet

Technical specifications	
Cell type:	Sodium-ion
Rated capacity:	158 Ah
Nominal/Usable Energy:	7.6 kWh
Nominal voltage:	48 V
Operating voltage:	40-60 V
Max. charging/discharging current:	100 A
Max. charging/discharging power:	4.8 kW
Dimensions, mm (W / L / H):	360 × 680 x 418
Weight:	120 kg
Mounting method:	Floor Mounted
Installation location:	Indoor
Storage temperature range:	-10 ºC to +25 ºC
Operating temperature range:	Charge 0 ºC to +55 ºC Discharge -30 ºC to +60 ºC
Degree of protection:	IP20
Cooling concept:	Natural Cooling
Communication:	CAN, RS485
Relative humidity:	< 70%
Round-trip efficiency:	> 97%
Life cycle:	> 10000 times (SOH 60%)

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9. Warranty and Service Information

For any technical support and warranty-related inquiries, please contact us via:

Phone: +372 58 7878 25
E-mail: support@freen.com

For the warranty terms and conditions, please refer to the attached warranty documentation.

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