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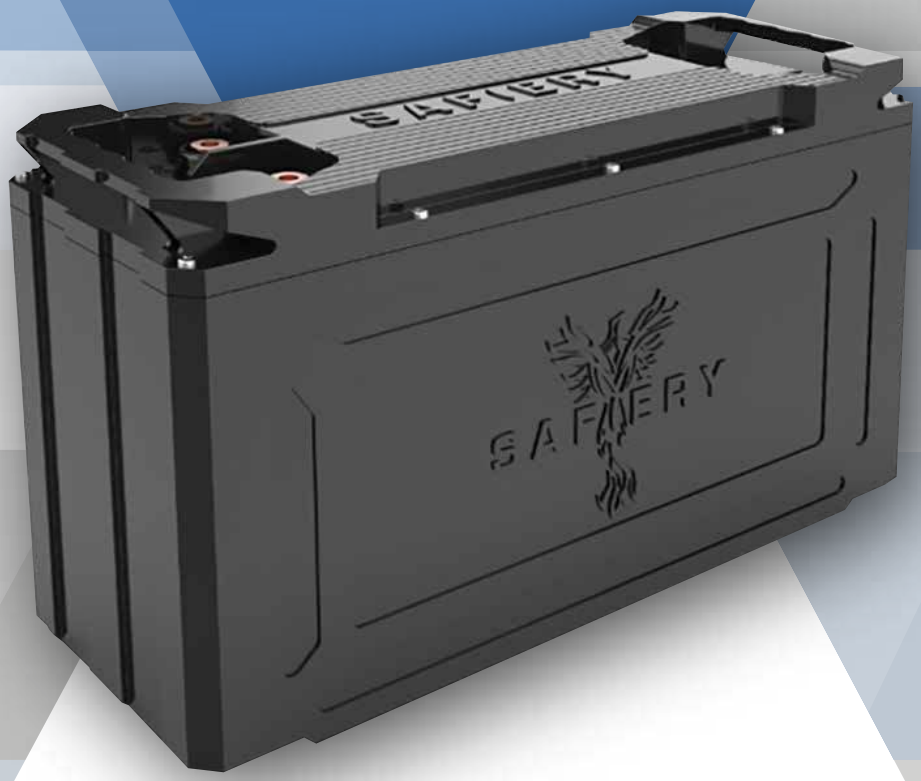
SOLID STATE LITHIUM BATTERY

OPERATING MANUAL



12V 24V 48V

Tomorrow's Technology, Today

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CONTENT

Product Overview 1

Specifications 2

Data Communication 3

Installation Guidelines 5

Safety and Operational Limits 6

CAN Bus Battery Management System (BMS) Protocol 7

Safety Highlights 11

Bluetooth Operation Guide 12

Safiery App 13

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Product Overview

Safiery solid-state lithium batteries are advanced energy storage solutions available in

12V 24V 48V

CONFIGURATIONS

THE 48V VARIANT INCLUDES TWO MODELS

1C MODEL

Maximum discharge current of 50A

3C MODEL

Maximum discharge current of 150A

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Specifications

SPECIFICATION	12V MODEL	24V MODEL	48V MODEL(1C)	48V MODEL(3C)
Nominal Voltage	12.8V	25.6V	51.2V	51.2V
Nominal Capacity	217Ah	107.9Ah	53.7Ah	53.7Ah
Energy Capacity	2788Wh	2788Wh	2788Wh	2788Wh
Maximum Parallel Units	40 units	40 units	40 units	40 units
Max Continuous Discharge	200A	100A	50A	150A
Peak Discharge (2s)	250A	125A	60A	180A
Cycle Life	10,000 cycles @80% DOD	10,000 cycles @80% DOD	10,000 cycles @80% DOD	10,000 cycles @80% DOD
Operating Temperature	-20°C to 55°C	-20°C to 55°C	-20°C to 55°C	-20°C to 55°C
Weight	20kg	20kg	20kg	20kg
Dimensions	420 x 252 x 150 mm	420 x 252 x 150 mm	420 x 252 x 150 mm	420 x 252 x 150 mm
IP Rating	IP 65	IP 65	IP 65	IP 67

Compliance and Certifications Available Upon Request

- **IEC 62619: TUV SUD Singapore** Certificate number 085-282360021-000
- **UL1973:** Certified for stationary and motive auxiliary power applications **Intertek** Control Number: 5014636

  MSDS and UN 38.3 Also available.

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Data Communication

CAN Communication

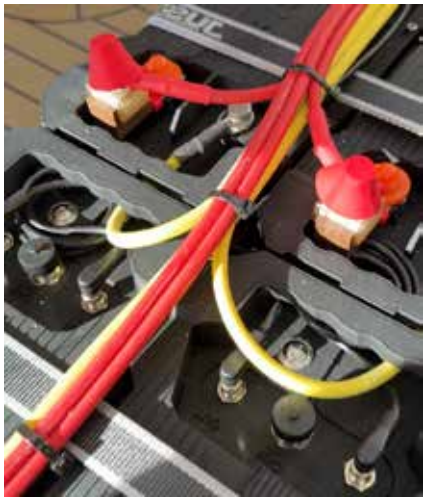
- Baud rate: 250 baud
- NMEA compliant standard isolated cabling without power
- There is an inbuilt 120 Ohm precision resistor inside the battery on the CAN interface
- Any battery can be used as a Master.
  Every battery as a CAN communication module installed which is only used when it is actively connected

RS485 Communication to Slave Batteries

- Master battery OUT to Slave battery IN
- Then Slave battery OUT to Slave battery IN
- The last battery will have only 1 485 data cable connected on the “in” port
- Keep the protection caps on all data sockets not used or warranty is void

			Solid State Lithium 48V 3C 2788Wh 7,500W	Solid State Lithium 48V 2788Wh 2,500W	Solid State Lithium 12V 2788Wh 2,500W
Cell over-voltage	Cell over-voltage alarm	V	3.7V	3.7V	3.7V
	Recovery voltage	V	3.5V	3.5V	3.5V
	Cell over-voltage protection	V	3.75V	3.75V	3.75V
	Recovery voltage	V	3.6V	3.6V	3.6V
Cell low-voltage	Cell low voltage alarm	V	2.9V	2.9V	2.9V
	Recovery voltage	V	3.0V	3.0V	3.0V
	Cell low voltage protection	V	2.5V	2.5V	2.5V
	Recovery voltage	V	2.7V	2.7V	2.7V
Auto Cell Active Balance	Balance on voltage	Note this Voltage is between 90-95% SOC	3.4V	3.4V	3.4V
	Voltage difference of Balance on mV	mV	30mv	30mv	30mv
	Voltage difference of Balance off mV	mV	10mv	10mv	10mv
	Low voltage charging prohibition for cell	THIS IS BMS LOCK OUT VOLTAGE	1.5V	1.5V	1.5V
Battery over-volt	Battery over-volt alarm		59.2V	59.2V	59.2V
	Recovery voltage		54V	54V	54V
	Battery over-volt protection	Bulk Charge = 58V, 62.8, 43.6, 28.6	62.8V	62.8V	62.8V
	Recovery voltage	Float Voltage = 54, 59.2, 40.8, 27	54V	54V	54V
Battery low-volt	Battery low-volt alarm	Cut Off Voltage Inverter = 45,11.5	46.4V	46.4V	11.6V
	Recovery voltage	Recovery Voltage Inverter = 46.5, 11.8	48V	48V	12V
	Battery low-volt protection		41.6V	41.6V	10.4V
	Recovery voltage		46V	46V	11.5V
harge over current	Charge over current alarm	Amps	55A	55A	200A
	Recovery	Amps	50A	50A	190A
	Nominal Power Max in Watts AT THE BATTERY	Watts			
	Charge over current protection	Amps	60A	60A	210A
	Delay time	Amps	10s	10s	10s
Discharg over current	Discharge over current alarm	Amps	160A	55A	200A
	Recovery	Amps	150A	50A	190A
	Discharge over current protection	Amps	180A	60A	220A
	Delay time	Amps	10s	10s	10s
Peak current	Peak current	Amps	200A	100A	300A
	Calculated Power in	Max 30mS	10000W	5000W	3700W

33.5kWh Solid State Lithium
30kW Electric Propulsion
in new Lagoon Catamaran 43
Using 48V 1C Discharge



Using Eaton Cube Fuses to comply with ABYC fusing per battery with Solid State

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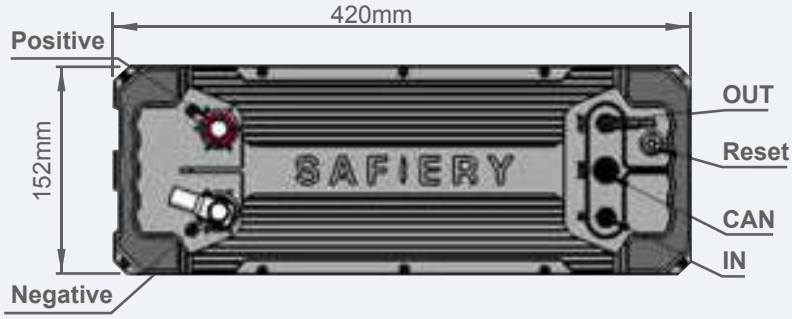
Data Communication

Data Wiring Pinouts

- CAN cabling Connection is standard NMEA compliant cable Isolated with no power to CAN
- 120 Ohm Precision resistor inside Solid State Lithium
- Any Battery can be a “master”
- CAN connection is to Victron Cerbo VE.CAN. Set baud rate at 250baud



- A “blue” Victron CAN plug may be required if this is the only CAN connection

IN (M8 aviation plug)	
PIN1	RS485B
PIN2	RS485A
PIN3	GND
PIN4	GND
PIN5	R
PIN6	N/A
PIN7	RESET+
PIN8	RESET-

CAN (M12 aviation plug)	
PIN1	N/A
PIN2	N/A
PIN3	GND
PIN4	CAN H
PIN5	CAN L

OUT (M8 aviation plug)	
PIN1	RS485B
PIN2	RS485A
PIN3	GND
PIN4	E
PIN5	T
PIN6	N/A
PIN7	N/A
PIN8	N/A

Connection of multiple batteries

- Take M8 aviation cable and connect to the “out” of the master battery with the other end connect to the “In” of the second battery
- Repeat this process till all connected
- Press the “Reset/On” button at the Master Battery. It will come on and then the string of connected batteries follows
- If there is a fault in the string or a connection is not screwed in properly, the Master will flash a red light

Remote On/Off/Reset

- Connect an M8 cable to the IN of the “Master” battery
- Pins 7 and 8 are the connections to close with free voltage contacts to remotely turn on
- DO NOT CONNECT ANYTHING TO PINS 1-5 ON THIS CABLE

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Installation Guidelines

- Ensure correct polarity when connecting batteries
- Batteries can be stacked and connected in parallel
- Don not connect in Series, parallel operation only
- Connect batteries sequentially from "Out" of the master to "In" of the subsequent units
- Press "Reset/On" button on the Master battery to initiate operation

Interconnecting Power Straps

These are made from high grade copper, tin coated flexible fused straps.

Their dimensions are 25mm wide and 2mm thick with a cross section of 50mm2

The MAX safe current rating of these straps is 250A

Match this table with maximum load

	12V	24V	48V(1C)	48V(3C)
MAXIMUM CURRENT THROUGH THE STRAPS	250A 3,000W	250A 6,250W	250A 12.5kW	250A 12.5kW

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Safety and Operational Limits

			Solid State Lithium 48V 3C 2788Wh - 7500W	Solid State Lithium 48V 2788Wh-2500W	Solid State Lithium 12V 2788Wh - 2500W
Cell over-voltage	Cell over-voltage alarm	V	3.7V	3.7V	3.7V
	Recovery voltage	V	3.5V	3.5V	3.5V
	Cell over-voltage protection	V	3.75V	3.75V	3.75V
	Recovery voltage	V	3.6V	3.6V	3.6V
Cell low-voltage	Cell low voltage alarm	V	2.9V	2.9V	2.9V
	Recovery voltage	V	3.0V	3.0V	3.0V
	Cell low voltage protection	V	2.5V	2.5V	2.5V
	Recovery voltage	V	2.7V	2.7V	2.7V
Auto Cell Active Balance	Balance on voltage	Note this Voltage is between 90-95% SOC	3.4V	3.4V	3.4V
	Voltage difference of Balance on mV	mV	30mv	30mv	30mv
	Voltage difference of Balance off mV	mV	10mv	10mv	10mv
	Low voltage charging prohibition for cell	THIS IS BMS LOCK OUT VOLTAGE	1.5V	1.5V	1.5V
Battery over-volt	Battery over-volt alarm		59.2V	59.2V	59.2V
	Recovery voltage		54V	54V	54V
	Battery over-volt protection	Bulk Charge = 58V, 62.8, 43.6, 28.6	62.8V	62.8V	62.8V
	Recovery voltage	Float Voltage = 54, 59.2, 40.8, 27	54V	54V	54V
Battery low-volt	Battery low-volt alarm	Cut Off Voltage Inverter = 45,11.5	46.4V	46.4V	11.6V
	Recovery voltage	Recovery Voltage Inverter = 46.5, 11.8	48V	48V	12V
	Battery low-volt protection		41.6V	41.6V	10.4V
	Recovery voltage		46V	46V	11.5V
Charge over current	Charge over current alarm	Amps	55A	55A	200A
	Recovery	Amps	50A	50A	190A
	Nominal Power Max in Watts AT THE BATTERY	Watts			
	Charge over current protection	Amps	60A	60A	210A
	Delay time	Amps	10s	10s	10s
Discharg over current	Discharge over current alarm	Amps	160A	55A	200A
	Recovery	Amps	150A	50A	190A
	Discharge over current protection	Amps	180A	60A	220A
	Delay time	Amps	10s	10s	10s
Peak current	Peak current	Amps	200A	100A	300A
	Calculated Power in Watts AT THE BATTERY	Max 30mS (in rush current)	10000W	5000W	3700W

Solid State Wafer Cell Performance Assessment by Chat GPT from Testing chart
These are 3.2V 53.4 Ah Nominal Wafer Cells

The column headings in the chart, translated from Chinese to English, are as follows:

1. 样品编号: Sample Number
2. 放电倍率 (C): Discharge Rate (C)
3. 放电容量 (Ah): Discharge Capacity (Ah)
4. 容量保持率 (%): Capacity Retention (%)
5. 放电能量 (Wh): Discharge Energy (Wh)
6. 平均电压 (V): Average Voltage (V)
7. 放电温升 (°C): Temperature Rise (°C)
   - 正: Positive (Temperature Rise)
   - 负: Negative (Temperature Rise)
   - 中: Middle (Temperature Rise)

样品编号	放电倍率/C	放电容量/Ah	容量保持率/%	放电能量/Wh	平均电压（V）	放电温升/℃ Temp. rising		
						正	负	中
5#	0.33	53.5100	100.00%	171.77	3.210	0.7	0.8	0.9
	0.5	53.1870	99.40%	169.48	3.186	1.3	1.3	1.6
	1	52.3212	97.78%	163.53	3.125	3.0	3.4	3.7
	2	51.4306	96.11%	156.12	3.034	7.0	7.8	7.8
	3	51.2289	95.74%	151.95	2.966	11.6	13.0	11.6
6#	0.33	53.8598	100.00%	172.91	3.210	0.8	0.7	0.8
	0.5	53.5455	99.42%	170.66	3.187	1.3	1.0	1.5
	1	52.6554	97.76%	164.60	3.125	3.0	2.6	3.5
	2	51.6721	95.94%	156.86	3.035	6.7	5.9	7.3
	3	51.3967	95.43%	152.48	2.966	11.0	9.6	11.0

Based on the data in the table, here's an analysis of the performance at different discharge rates (C):

1. Discharge Capacity (Ah):
   - The capacity remains relatively consistent across the discharge rates for both cells (Sample 5 and Sample 6). The difference in capacity across rates is minor, which indicates good efficiency even at higher discharge rates.

    - For example, at a 0.33C rate, the discharge capacity is about 53Ah for both cells, and at 3C, it's still about 51Ah. This suggests a small drop in capacity as the discharge rate increases, but the cells maintain most of their capacity under higher loads.
2. Capacity Retention (%):
    - The capacity retention is quite high across all discharge rates, generally ranging between 95.43% and 100%. This is a strong indicator of the cells' ability to retain their capacity during high-rate discharges, which is crucial for long-term performance, especially in high-power applications like electric vehicles or energy storage systems.
    - The retention starts to dip slightly at higher discharge rates, but it's still well within a range that suggests good overall performance.
3. Discharge Energy (Wh):
    - The discharge energy (Wh) is slightly lower for higher discharge rates (3C), which is expected due to the increased heat generation, but it remains fairly stable considering the rate. This means the cell is relatively efficient at higher rates and isn't losing excessive energy in the form of heat.
4. Average Voltage (V):
    - The voltage remains quite stable across the discharge rates. There's a slight decrease in voltage as the discharge rate increases, but again, this is typical in lithium-based cells under higher loads.
    - The voltage drop is minimal and doesn't significantly impact the overall performance of the cell.
5. Temperature Rise (°C):
    - The temperature rise is the most critical factor in determining the cell's thermal management capabilities.
    - At a 3C discharge rate, the temperature rise is relatively controlled, with Sample 5 reaching a peak of 11.6°C and Sample 6 reaching 11.0°C.
    - The cells' ability to maintain a relatively low temperature rise even under high discharge rates indicates good thermal management, which is essential for safety, longevity, and performance under demanding conditions.

Overall Impressions:

- High Discharge Rate Performance: The cells show robust performance at higher discharge rates (up to 3C), with only a minor drop in capacity and a reasonable temperature rise, making them suitable for applications requiring higher power output.
- Thermal Efficiency: The moderate temperature rise suggests that the cells are well-designed for power-hungry applications without significant risk of overheating or thermal runaway, which is crucial for safety.
- Retention and Efficiency: The high capacity retention and relatively stable energy output across discharge rates suggest that the cells have a long operational life and are efficient even under stress.

In conclusion, the performance looks strong, especially considering the minor drop in capacity and the good thermal behaviour. These cells should perform well in applications requiring high power output, such as electric vehicles, marine, or industrial power storage systems.

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CAN Bus Battery Management System (BMS) Protocol

1. General CAN Specifications

- **CAN Frame Format:** Standard 11-bit identifier (CAN 2.0A)
- **Bitrate:** 250 kbps
- **Termination:** At least one CAN bus termination is required; built-in termination in the solid state battery
- **Isolation:** Battery CAN ports are isolated; minimum required wiring is GND, CAN-H, and CAN-L

2. CAN IDs: Messages from BMS to Inverter/Controller

Alarm/Warning Encoding for 0x35A

- **Bit pairs:**
  - 00 - Not supported
  - 10 - Active
  - 01 - OK
  - 11 - Reserved

Note on CVL/CCL/DCL Strategy

- Do **not** send CCL = 0 to stop charging. Instead, **reduce CVL**.
- DCL = 0 disables discharge entirely.
- Use dynamic CVL adjustment to avoid overvoltage or unintentional discharging.

CAN Bus Battery Management System (BMS) Protocol

- **CAN Frame Format:** Standard 11-bit identifier (CAN 2.0A)

CAN ID	Description	Byte Offset	Data Type	Scaling	Unit
0x351	Charge & Discharge Limits	0	un16	0.1	V
	Charge Current Limit (CCL)	2	sn16	0.1	A
	Discharge Current Limit (DCL)	4	sn16	0.1	A
	Discharge Voltage	6	un16	0.1	V
0x355	State of Charge & Health	0	un16	1	%
	State of Health (SOH)	2	un16	1	%
	High-resolution SOC (optional)	4	un16	0.01	%
0x356	Voltage, Current, Temperature	0	sn16	0.01	V
		2	sn16	0.1	A
		4	sn16	0.1	°C
0x35A	Alarm & Warning Status	Byte bits define individual flags across 8 bytes			
0x35E	Manufacturer Name	0	string(8)	ASCII	
0x35F	Battery Type, Firmware Version	0	un16		
0x370	BMS Name (Part 1)	0	string(8)	ASCII	
0x371	BMS Name (Part 2)	0	string(8)	ASCII	
0x372	Module Status	0	un16×4		
0x373	Min/Max Cell Volt/Temp	0	un16×4	mV, K	
0x374–377	Cell Identifiers	0	string(8)	ASCII	
0x378	Energy In/Out	0	un32×2	100 Wh	
0x379	Installed Capacity	0	un16		Ah
0x380–381	Serial Number	0	string(8)	ASCII	
0x382	Battery Family Name	0	string(8)	ASCII	

3. Messages from Inverter/Controller to BMS

CAN ID	DESCRIPTION	FORMAT
0x305	Keepalive	8 bytes: all 0x00
0x307	Inverter Identification	Bytes 4–6: ASCII 'VIC' (legacy)

4. Timing & Communication Guidelines

- **Timeouts:**
  - BMS should tolerate loss of 0x305 for **10 minutes**.
  - Inverter stops operation if 0x351 is not received within **3 seconds**.

5. Implementation Advice

- Use **11-bit** identifiers only.
- Avoid 29-bit IDs even though mixed-mode is technically possible.
- All current values should be **positive** regardless of direction.
- SOC high-res field is optional.
- Use **ASCII encoding** (7-bit) for all name and string fields.

6. Testing Checklist

- Ensure CAN communication is visible (e.g., via candump)
- Confirm correct reception of 0x351, 0x355, 0x356, 0x35A
- Validate alarm flag encoding
- Validate proper reaction to CVL/CCL changes in DC-coupled solar systems
- Confirm safe shutdown and recovery from blackout events
- Check full set of extended fields if implemented (0x372–0x382)

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CAN Bus Battery Management System (BMS) Protocol

CAN-Bus BMS Protocol – Message ID Map

0x351	Charge Voltage Limit (CVL), Charge/Discharge Current Limit (CCL/DCL), Discharge Voltage
0x355	State of Charge (SOC), State of Health (SOH), High-res SOC (optional)
0x356	Battery Voltage, Battery Current, Battery Temperature
0x35A	Warnings & Alarms Status (Bit fields)
0x35E	Manufacturer Name (8-char ASCII)
0x35F	Battery Type, Firmware Version
0x370	BMS Name Part 1
0x371	BMS Name Part 2
0x372	Module Status (OK/Block/Offline)
0x373	Min/Max Cell Voltages & Temperatures
0x374-377	Cell Voltage/Temp Identifiers (ASCII)
0x378	Energy In/Out (Total Charge/Discharge)
0x379	Installed Capacity (Ah)
0x380-381	Serial Number Parts 1 & 2
0x382	Battery Family Name (ASCII)
0x305	Keepalive from Inverter (8 bytes of 0x00)
0x307	Inverter Identification (ASCII 'VIC' in bytes 4-6)

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Safety Highlights

- **Short-circuit resistant:** Up to 60 minutes
- **Thermal resilience:** Up to 130°C without combustion
- **Impact resistant:** Can withstand 200KN crush force
- **Penetration resistance:** Can be penetrated by an 8mm nail without thermal event

Maintenance and Storage

- Recommended storage humidity: <85% RH
- For storage exceeding 3 months, maintain SOC around 50%, checking every 6 months

Troubleshooting

- Red flashing LED indicates a fault in battery string or poor connection
- Reset the system by pressing the Reset/On button on the Master battery

Disposal

- Do not discard batteries in general waste
- Contact qualified recyclers for proper disposal

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Bluetooth Operation Guide

SOME Batteries have a Bluetooth Option.

1. APK APP Download
Android: Search Safiery Solid State in the Play Store after June 10th 2025.
iOS: Search Safiery Solid State in the App Store after June 10th 2025.

2. Logging Into the App
Open the App by double-clicking the icon.
Default credentials:
Username: admin
Password: 111111

3. Connecting to the Device
After logging in, your device(s) appear in the interface.
Single Operation: Displayed as BP00.
Parallel Operation: Display multiple BPXX entries.
Click on the device name (BP00 or BPXX) to connect.
If Bluetooth signal is unstable, click 'search for device again'.

4. Main Interface Features
Displays battery operation modes (single/parallel), SOC, voltage, current, and remaining capacity.
Shows alarm and protection statistics. Click these to view detailed specifications.
Status bar shows inverter connection type (CAN or RS485).

5. Viewing and Modifying Configuration
Click 'Edit' and enter the password (111111) to modify parameters.
Save changes; confirm the modification prompt to apply.

6. Switch Settings
Enable or disable battery pack via the 'Switch Setting' option.
Confirm changes through the prompt.

7. Additional Features
Access account settings, change password, or logout through the 'My Account' interface.

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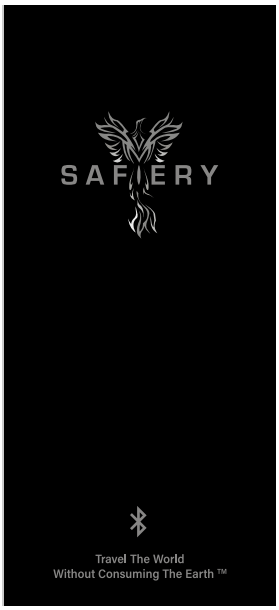
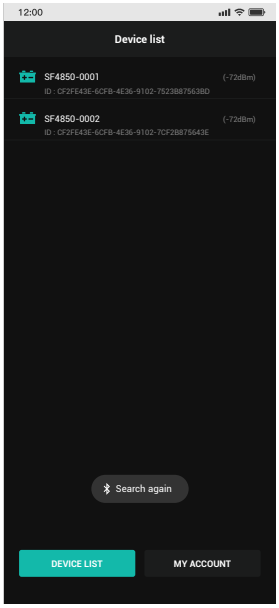
Safiery Solid State App

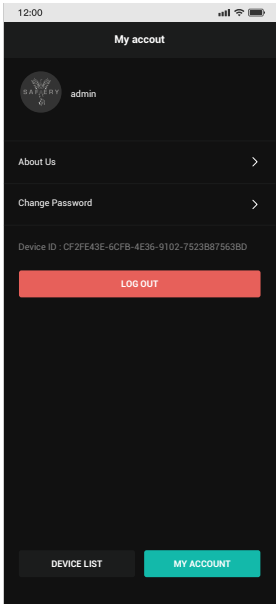
This App will connect with Master Battery and show aggregate data from all connected batteries. There is the choice to also access the slave batteries.
Available from Mid to late June 2025 on selected battery models.

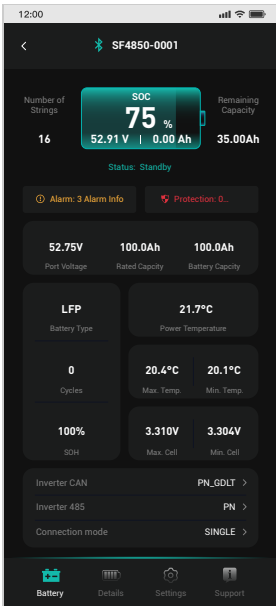
Available on the App Store

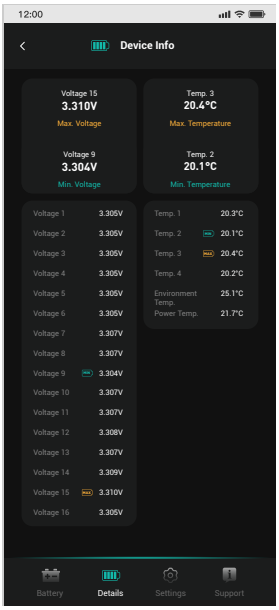
GET IT ON Google Play

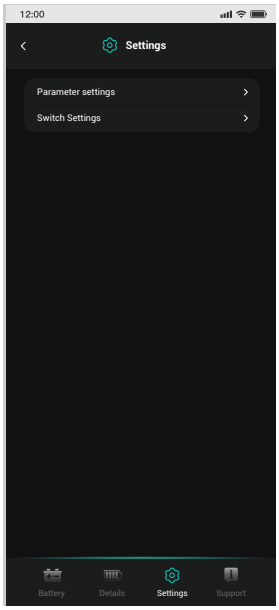


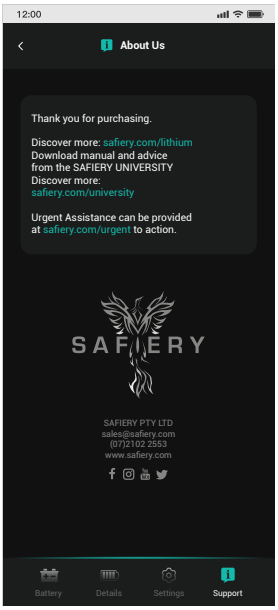












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Field Testing

Solid State Lithium 12V Battery 80% SOC has Nail Fired Into Battery March 3, 2025.

1. Mechanical Abuse

Solid State Lithium idividual wafer Cells are certified to withstand penetration by a nail. However, there are no publicised results of mecahnical abuse of an entire battery.
In the event these batteries are installed under a chassis in a vehicle, there is the possibility of direct puncture of the basttery case and into the battery short circuiting multiple wafer cells.
Decision was taken to fire a nail into a 12V Solid State Lithium Battery at high velocity with a percussion nail gun. This was done with battery upside down into the bottom 6 wafer cells through the metal case.

2. Electrical Abuse

The Solid State Lithium battery was pre-charged to 80% SOC.
The Nail penetration was accross the botton two arrays of 8 wafer cells totally 6.3V and 1,394 Wh of contained energy. There would be a direct short circuit and release of that energy upon impact.

3. Immediate Results

No explosion.
No Fire.
Small amount or gas.
Temperature rise of short circuited cells reached 107C then reduced to 45C in 1 hour.
ABS case was deformed in bottom half.

4. Following Day Results

The voltmeter shows the top two layers perfectly intact recording 6.3V.
The CAN BMS was still reponding when we increased the voltage to 12V on terminals.
There was NO persistent dead short accross the terminals.

5. Conclusion

Wafer cells have a certified temperature threashold of 130C.
Although the temperature went to 107C, the non penetrated wafer cells remained perfectly in tect and operating.
No explosion nor fire in the open area with plenty of oxygen arround gives the highest safety peace of mind.

SAFIERY

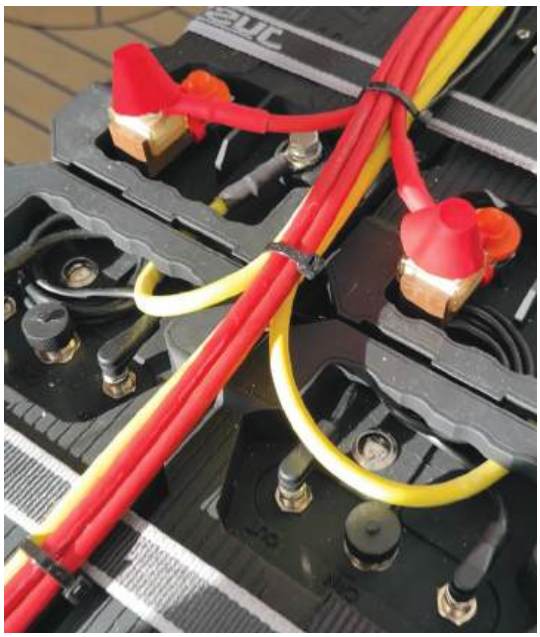
Marine Compliance

Marine Compliance to ABYC E-11 (Electrical Systems on Boats)

1. Individual Battery Fusing

See photo below using Blue Sea Systems MRBF with terminal block (#5191) for installation in Lagoon 43 for electric propulsion on Starboard side.

33.5kWh Solid State Lithium
30kW Electric Propulsion in new Lagoon Catamaran 43
Using 48V 1C Discharge



2. Blocking Charge and Blocking Discharge

The CAN messaging sends the warning commands before the BMS relay opens circuit
For systems without CAN, add an M8 connector to the “In terminal” on the last battery and Pins 6,7 and 8 are used for Charge and Discharge blocking outputs.

SAFIERY

Quality of Cell Grading

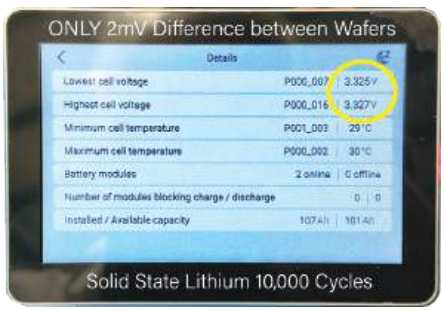
This is a 46kW installation in Engine Room of Martimo 51

1. After running 2 x BMG with 15kW Charging

See photo below on either side in engine room with no blower. We ran the charging for 1 hour from 2 x Bidirectional Motor Generators pushing 15kW into 45kWh Solid State Lithium. After 1 hour while sill charrging the cell differential accross the batteries was 30mV. The batteries in question were on opposite side of the engine room. They had a 4m parallel electrical connection.
See also the temperature differential across all 16 batteries.

2. Second Example of two Solid State Batteries in Close Promimity

The Cell Min/ Max is only 2mV afer 5 days of continuouse use.



SUPPORT

- Safiery Pty Ltd
- Contact: sales@safiery.com
- Phone: (07) 210 22 553

This manual ensures optimal performance and safety of your Safiery Solid State Lithium Battery system

de stille boot

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