Product Service

Technical Report No.: 64.280.22.60505.01

Dated: 2023-03-24

Client:	Report holder's name:	Shenzhen Ensmar Technology Co., Ltd
	Report holder's Address:	Fl.5, Block A, Wanhe Technology Building, Huitong Road, Fenghuang Community, Guangming District, 518107 Shenzhen City, Guangdong Province, PEOPLE'S REPUBLIC OF CHINA
	Contact person of report holder:	Devin Yeung
	Manufacturer's name:	Dongguan Ensmar New Energy Technology Co., Ltd
	Manufacturer's address:	Room 403, Block 6, No. 169, Xianjiang Road, Dalang Town, 523000 Dongguan City, Guangdong Province, PEOPLE'S REPUBLIC OF CHINA
Factory:	Factory's name:	Dongguan Ensmar New Energy Technology Co., Ltd
	Factory's address:	Room 403, Block 6, No. 169, Xianjiang Road, Dalang Town, 523000 Dongguan City, Guangdong Province, PEOPLE'S REPUBLIC OF CHINA
Test object:	Product:	Rechargeable Lithium Ion Battery System
	Model:	ES S-48100H
	Trade mark:	ENSMAR
Test specification:	Annex H of IEC 60730-1:2013+AMD1:2015+AMD2:2020 (Class B control)	
Purpose of examination:	Testing and evaluation according to the test specification	
Test result:	The test results show that the presented product is in compliance with the above listed test specifications.	

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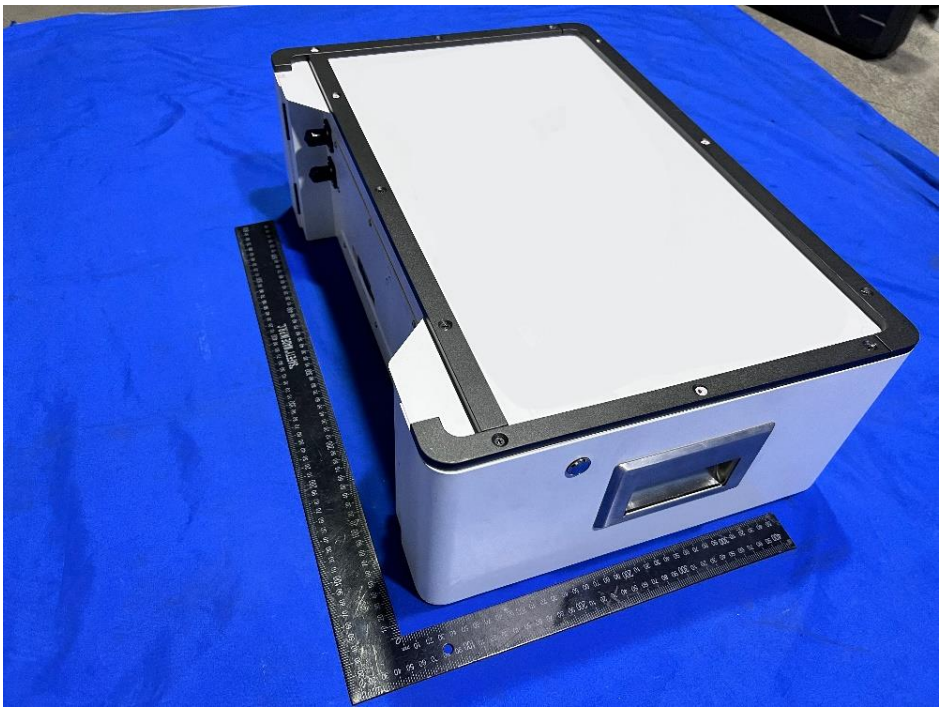
1. Description of the test subject

1.1 Picture(s)



1.2 Function

Manufacturer's specification for intended use:
(According to the user manual)

Manufacturer's specification for foreseeable use:
(According to the user manual)

1.3 Consideration of the foreseeable use

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☐ Not applicable
☒ Covered through the applied standard
☐ Covered by the following comment
☐ Covered by attached risk analysis

1.4 Technical Data

The Rechargeable Lithium Ion Battery System ES S-48100H is used in industrial appliances. It consists of 16pcs cells IFP48173115-100Ah connected in 16S.
Additionally, details of the battery system and the built-in cell are shown in following table:

Product name	Li-ion Prismatic Power Cell	Rechargeable Lithium Ion Battery System
Type/model	IFP48173115-100Ah	ES S-48100H
Nominal voltage	3.2Vd.c.	51.2Vd.c.
Rated capacity	100Ah	100Ah
Charging voltage declared by manufacturer	3.65V	56.8V
Upper limit charging voltage	3.65V	57.6V
Charging current declared by manufacturer	50A	20A
Maximum continuous charging current	100A	95A
Discharging current declared by manufacturer	50A	20A
Maximum continuous discharging current	100A	95A
End of discharge voltage	2.5V	44.8V or 2.8V/cell
Standard temperature range for charging	0°C to 60°C	0°C to 55°C
Standard temperature range for discharging	-20°C to 60°C	-15°C to 55°C
Standard charging method by manufacturer	At 25°C±2°C, constant current charge to 3.65V at 50A, constant voltage charge to stop until 5A.	Charge at constant current 20A until total voltage reaches 56.8V, then at constant voltage 56.8V till charge current reduces to 5A
Charging method for internal short-circuit test	At constant current 100A till cell voltage reaches 3.65V, then switch to constant voltage 3.65V till charge current drops to 5A (0.05 It)	-
Dimension	Thickness x Wide x Height: 49.3mm (max.) x 174.4mm (max.) x 121.6mm (max.)	H × D × W: Max.200mm ×Max.403mm ×Max.602mm
Weight	2.0±0.1kg	49.5kg
Configuration	-	16S

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1.5 The information for BMS

The battery is supplied with BMS built-in. For detailed information, please see below table.

Battery model no.	BMS model no.	BMS manufacturer	HW version	SW version	MCU information
ES S-48100H	EMU1101 PCBA-V16	Shanghai Energy Electronic Technology Co., Ltd.	EMU1101 PCBA-V16: Hardware version: V16	V16.04.06_PN01_221123_IEC62619_TUVTest: Software version: 16.04	Model: SWM181RCT6 (U5, Synwit Technology Co., Ltd.)

2. Order

2.1 Date of Purchase Order, Customer's Reference

2022-10-26

2.2 Test Sample(s)

- Reception date(s): 2022-12-08
- Location(s) of reception: PS: Battery department, Guangzhou
- Condition of test sample(s): Engineering samples

2.3 Date(s) of Testing

2022-12-12 to 2023-03-23

2.4 Location of Testing

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3. Test Results

- "Decision rule according to IEC Guide 115:2021, clause 4.4.3, 4.5.1 was applied."

3.1 Test Object

According to the hazard analysis and risk assessment and IEC 62619:2017, the battery management system (BMS) should comply with the functional safety requirements of Annex H of IEC 60730-1.

The safety functions in the BMS system including:

Safety function	Classes of control function	Parameters
Voltage protection	Class B	Over voltage protection value: 3.65V/cell; Under voltage protection value: 2.7V/cell

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Current protection	Class B	Charge mode: Current-limited protection mode: >95A --When charging current >95A, the battery will be limited to be charged at constant current 10A until the battery reaches over-voltage protection Charge overcurrent protection value: 100A; Discharge overcurrent protection value: 100A
Temperature protection	Class B	Charge mode: Over temperature protection value: 55°C; Under temperature protection value: 0°C; Discharge mode: Over temperature protection value: 55°C; Under temperature protection value: -15°C

3.2 Scope

Scope of this report is the evaluation of the safety functions listed in Test object. All of them fulfil the class B control requirements of Annex H of IEC 60730-1:2013+AMD1:2015+AMD2:2020.

3.3 Results

3.3.1 Functional Safety Management and Lifecycle Audit

Dongguan Ensmar New Energy Technology Co., Ltd describes the project, the planned activities and responsibilities for managing the functional safety by a safety plan. The safety plan covers the measures to avoid failures during hardware and software development.

Result:

The specified measures to avoid systematic failures were reviewed during the project. The measures to avoid systematic failures are suitable for a Class B control development according to Annex H of IEC 60730-1.

3.3.2 Architecture

BMS architecture is shown in Figure 1.

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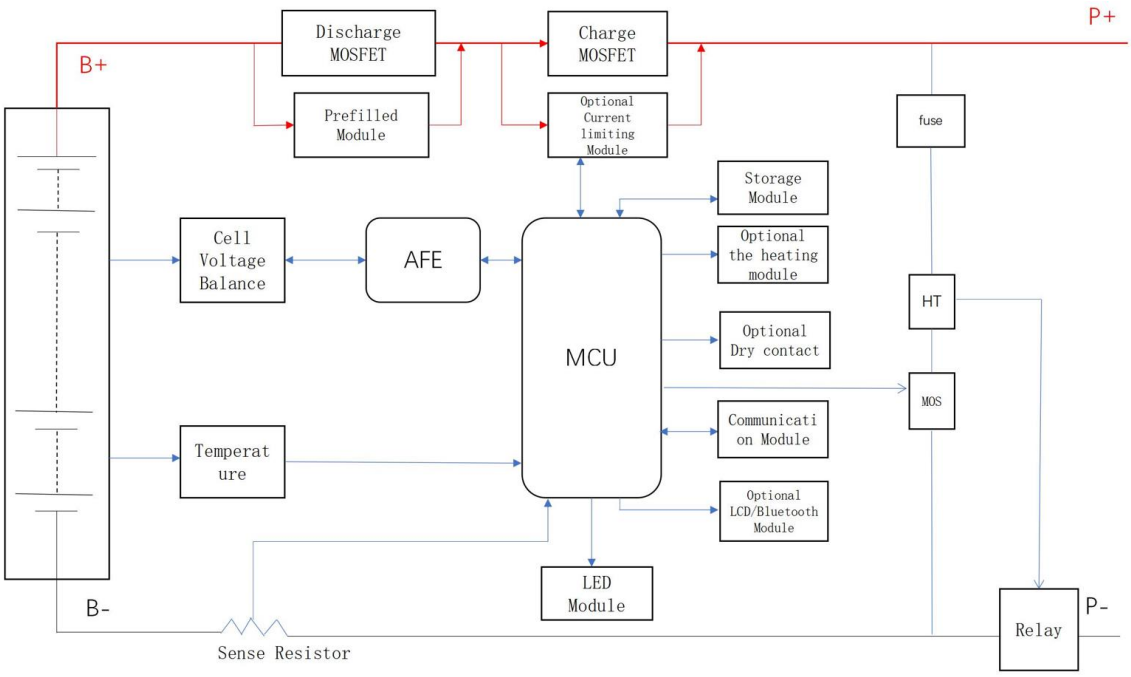

Figure 1 BMS architecture

1. Cell overvoltage and undervoltage protection:

The safety function is implemented by turning off charge & discharge MOSFET. The 16 cells voltages are measured by BMS sampling circuit diagram → AFE → MCU and if MCU find it is overvoltage or undervoltage, it will turn off charge/discharge MOSFET. In case of MOSFET in single fault, MCU will control to turn off the contactor. See Figure block diagram.

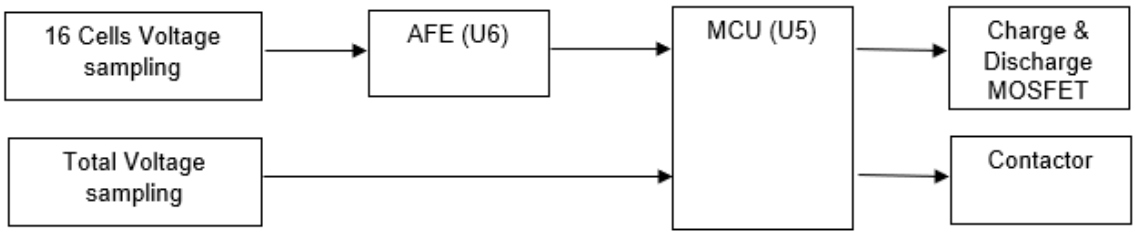

Figure 2 Cell overvoltage and undervoltage protection block diagram

The safety function is realized by a single channel with periodic self-test structure. MCU will also sample total voltage of battery. If MCU find it is overcharge or undervoltage, MCU will control to turn off charge/discharge MOSFET. MCU also compare the sum of cells' voltage and the total voltage of battery.

2. Cell overcurrent protection:

The default setting for the battery is supplied with Current-limited protection function.

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The safety function is implemented by turning off charge MOSFET in charge current-limited circuit or charge/discharge MOSFET. The cells' current is measured by current shunt → MCU and if the MCU find it is overcurrent, MCU will turn off charge MOSFET in charge current-limited circuit or charge/discharge MOSFET.

In case of any MOSFET in single fault, MCU will control to turn off the contactor. See Figure 3 block diagram.

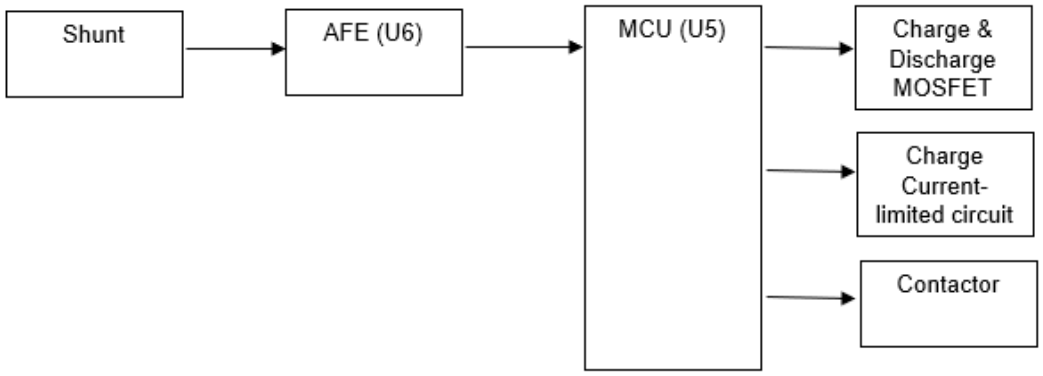

Figure 3 Cell overcurrent protection block diagram

The safety function is realized by a single channel with periodic self-test structure. The diagnostic of overcurrent protection circuit is realised by checking the temperature for NTC6 which is under MOSFET. If the temperature is higher than 90°C, MCU will control to turn off charge/discharge MOSFET.

3. Cell over and under temperature protection:

The safety function is implemented by turning off charge & discharge MOSFET. The cells' temperature is measured by NTCs (NTC1, NTC2, NTC3, NTC4) → MCU and if the MCU find it is over or under temperature, MCU will turn off charge/discharge MOSFET.

In case of any MOSFET in single fault, MCU will control to turn off the contactor. See Figure 4 block diagram.

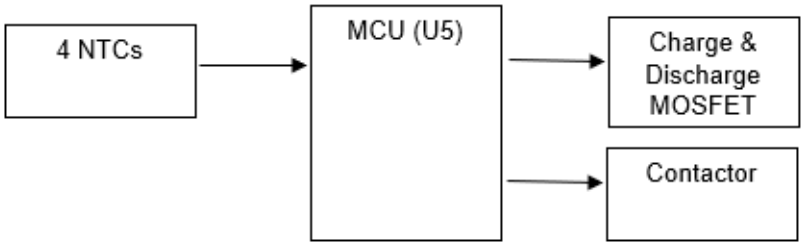

Figure 4 Cell over and under temperature protection block diagram

The safety function is realized by a single channel with periodic self-test structure. The diagnostic of over and under temperature protection circuit is realized by comparing the temperatures from 4 NTCs by MCU. MCU will control to turn off charge/discharge MOSFET.

Result:

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The architecture described above is suitable for realization of the safety functions overvoltage, undervoltage, overcurrent, overtemperature and undertemperature for Class B control of IEC 60730-1 Annex H.

3.3.3 Software

The software implemented is responsible for the execution of the safety function and support of diagnostics.

Result:

The reliability of the safety function and the effective of diagnostics were tested during fault injection test. The tests were performed without objections.

3.3.4 Fault Injection Test

The BMS manufacturer Dongguan Ensmar New Energy Technology Co., Ltd performed fault injection test which simulated the typical faults according to fault models defined by Annex H of IEC 60730-1. The test also covered the diagnostic software to check the effectiveness of the implemented measures.

Result:

The fault injection test was performed without objections.

3.3.5 Safety and environmental testing

The battery safety was tested in accordance with IEC 62619:2017 and the regulations related to these standards. The battery was also tested for environmental testing.

Result:

The tests have passed without objections and are documented by test reports.

3.3.6 EMC testing

The strength of the design versus electromagnetic immunity was tested.

Result:

The tests are passed without objections and are documented by test reports.

3.3.7 Manual

The product manual includes the necessary information for system integrators.

4. Remark

4.1 Revision history

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Project no.	Revision	Date	Author	Modification / Description
64.280.22.60505.01	00	2022-03-24	Zoey Liu	Initial

5. Documentation

No.	Title	Document number / ID	Rev.	Date
[D1]	Hazard analysis and risk assessment	ENS-YF-21	A.0	2022-02-20
[D2]	Safety Requirement Specification	ENS-YF-06	A.0	2022-04-08
[D3]	Safety Plan	ENS-YF-03	A.0	2022-02-21
[D4]	Verification & Validation Plan	ENS-YF-05	A.0	2022-04-03
[D5]	System safety design	EJ-QR-YF004	V1.0	2022-05-10
[D6]	System software design	EJ-QR-YF004	V1.0	2022-05-10
[D7]	Component FMEA	Component and IC FMEA	A	2022-07-24
[D8]	User manual	User manual for ES S-48100H	A0	2022-04-08

6 Summary

The safety functions of BMS in battery model ES S-48100H is suitable for Class B control according to Annex H of IEC 60730-1:2013+AMD1:2015+AMD2:2020.

TÜV SÜD New Energy Testing (Guangdong) Co., Ltd.

Tested by: Zoey Liu / Project Handler

printed name, function & signature

Approved by: Ryan Jin / Designated Reviewer

printed name, function & signature

--- End of Report ---

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