Technical Report No.: 64.280.23.60319.01

Dated: 2024-06-03

Client:	Jiangmen Jeeseng Energy Co., Ltd. 3rd and 4th floors of Building 2, No. 93, Jiangwan Road, Huicheng, Xinhui District, 529100 Jiangmen City, Guangdong Province, PEOPLE'S REPUBLIC OF CHINA	
Manufacturer:	Same as the applicant	
Factory:	Same as the applicant	
Test object:	Product:	Rechargeable Li-ion Battery System
	Model:	JEEDD-102100, JEEDD-153100, JEEDD-204100, JEEDD-256100, JEEDD-307100, JEEDD-358100
	Trade mark:	JEESENG
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)

Rechargeable Li ion Battery System

JEEDD-102100:

JEEDD-153100:

JEEDD-204100:

JEEDD-256100:

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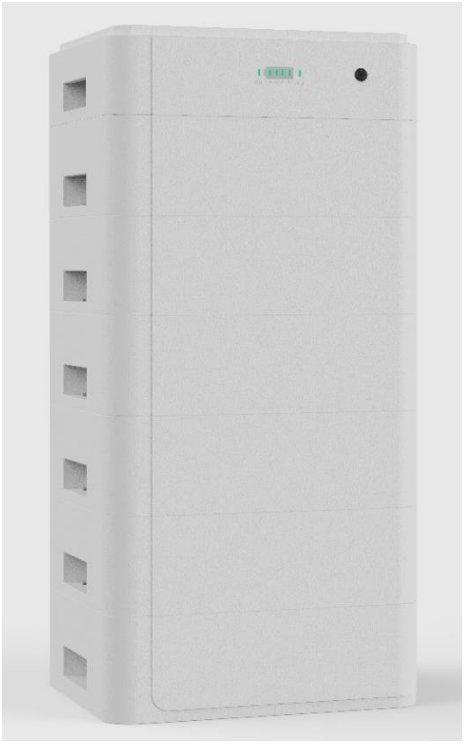
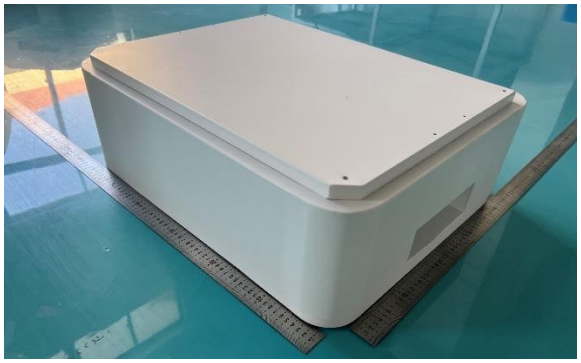
JEEDD-307100:

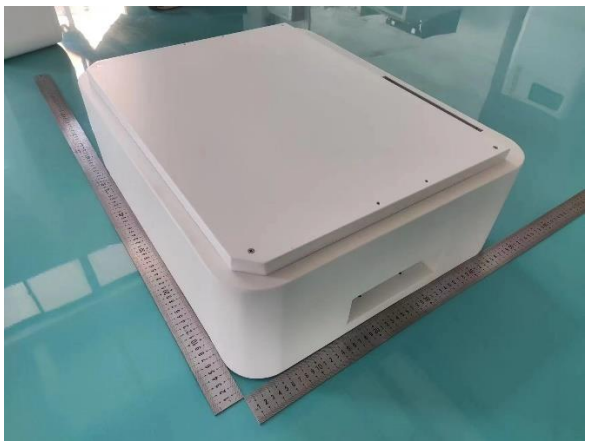


JEEDD-358100:

Rechargeable Li-ion Battery Module, model: JEEDDMK512100-1:



Rechargeable Li-ion Battery Module, model: JEEDDMK512100-2



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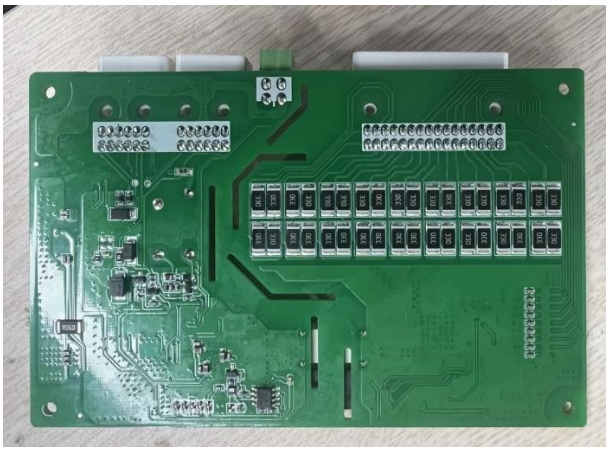
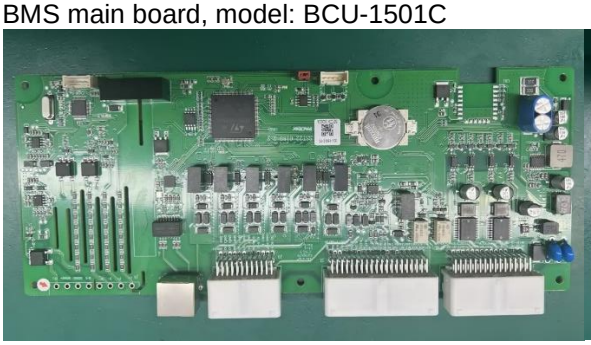
High voltage control unit, model: JSDD-100A

BMU board, model: BMU-18081C



BMS main board, model: BCU-1501C



1.2 Function

Manufacturer's specification for intended use:

- *according to the user manual or installation instructions.*

1.3 Consideration of the foreseeable use

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

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☐ Covered by attached risk analysis

1.4 Technical Data

1. Rechargeable Li ion Battery System model no. JEEDD-102100, JEEDD-153100, JEEDD-204100, JEEDD-256100, JEEDD-307100, JEEDD-358100 are used in industrial applications.

2. Rechargeable Li ion Battery System model no. JEEDD-102100, JEEDD-153100, JEEDD-204100, JEEDD-256100, JEEDD-307100, JEEDD-358100 respectively consist of a Rechargeable Li-ion Module model no. JEEDDMK512100-1, a high voltage control unit model no. JSDD-100A and 1, 2, 3, 4, 5, 6 pcs Rechargeable Li-ion Module model no. JEEDDMK512100-2 connected in series connection. In addition, Rechargeable Li-ion Module model no. JEEDDMK512100-1 is still located at the bottom.

3. Rechargeable Li-ion Module model no. JEEDDMK512100-1 and JEEDDMK512100-2 are same except for case height, which consists of Rechargeable Li-ion Cell with model no. LF100LA connected in 16S.

Additionally, details information of the battery is shown in following table:

Item	Specification		
Product name	Rechargeable Li-ion Cell	Rechargeable Li ion Battery Module	Rechargeable Li ion Battery System
Type /model	LF100LA	JEEDDMK512100-1, JEEDDMK512100-2	JEEDD-102100, JEEDD-153100, JEEDD-204100, JEEDD-256100, JEEDD-307100, JEEDD-358100
Nominal voltage	3.2Vd.c.	51.2Vd.c.	JEEDD-102100:102.4vd.c. JEEDD-153100:153.6Vd.c. JEEDD-204100: 204.8 Vd.c. JEEDD-256100: 256 Vd.c. JEEDD-307100:307.2Vd.c. JEEDD-358100: 358.4 Vd.c.
Rated capacity	102Ah	100Ah	100Ah
Charging voltage declared by manufacturer	3.65V	56V(3.50V/cell)	JEEDD-102100:112V or any cell reaches 3.50V, JEEDD-153100:168V or any cell reaches 3.50V, JEEDD-204100: 224V or any cell reaches 3.50V, JEEDD-256100: 280V or any cell reaches 3.50V, JEEDD-307100: 336V or any cell reaches 3.50V, JEEDD-358100: 392V or any cell reaches 3.50V
Upper limit charging voltage	3.9V	56.32V（3.52V/cell）	JEEDD-102100:112.64V or any cell reaches 3.52V, JEEDD-153100:168.96V or any cell reaches 3.52V, JEEDD-204100: 225.28V or any cell reaches 3.52V, JEEDD-256100: 281.6V or any cell reaches 3.52V,

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			JEEDD-307100: 337.92V or any cell reaches 3.52V, JEEDD-358100: 394.24V or any cell reaches 3.52V
Charging current declared by manufacturer	50A	70A	70A
Maximum continuous charging current	100A	75A	75A
Discharging current declared by manufacturer	50A	70A	70A
Maximum continuous discharging current	250A	75A	75A
Discharging cut off voltage	2.0V	45.6V or any cell reaches 2.85V	JEEDD-102100:91.2V or any cell reaches 2.85V, JEEDD-153100:136.8V or any cell reaches 2.85V, JEEDD-204100: 182.4V or any cell reaches 2.85V, JEEDD-256100: 228V or any cell reaches 2.85V, JEEDD-307100: 273.6V or any cell reaches 2.85V, JEEDD-358100: 319.2V or any cell reaches 2.85V,
Lower limit discharging voltage	1.9V	-	-
Standard temperature range for charging	0°C to 65°C	5°C to 45°C	5°C to 45°C
Standard temperature range for discharging	-30°C to 65°C	5°C to 45°C	5°C to 45°C
Standard charging method by manufacturer	Charge at constant current 50A until the voltage reaches 3.65V, then charge at 3.65V till charge current is 0.05I_tA (5.1A)	Charge at constant current 20A until the voltage reaches 46.4V or any cell reaches 2.9V, afterwards charge at constant current 50A until the voltage reaches 48V or any cell reaches 3.0V, after that charge at constant current 70A until the voltage reaches 55.2V or any cell reaches 3.45V, then charge at constant current 50A until the voltage reaches	JEEDD-102100: Charge at constant current 20A until the voltage reaches 92.8V or any cell reaches 2.9V, afterwards charge at constant current 50A until the voltage reaches 96V or any cell reaches 3.0V, after that charge at constant current 70A until the voltage reaches 110.4V or any cell reaches 3.45V, then charge at constant current 50A until the voltage reaches 111.36V or any cell reaches 3.48V,

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		55.68V or any cell reaches 3.48V, and then charge at constant current 10A until the voltage reaches 56V or any cell reaches 3.5V	and then charge at constant current 10A until the voltage reaches112V or any cell reaches 3.5V. JEEDD-153100: Charge at constant current 20A until the voltage reaches 139.2V or any cell reaches 2.9V, afterwards charge at constant current 50A until the voltage reaches144V or any cell reaches 3.0V, after that charge at constant current 70A until the voltage reaches 165.6V or any cell reaches 3.45V, then charge at constant current 50A until the voltage reaches167.04V or any cell reaches 3.48V, and then charge at constant current 10A until the voltage reaches 168V or any cell reaches 3.5V. JEEDD-204100: Charge at constant current 20A until the voltage reaches 185.6V or any cell reaches 2.9V, afterwards charge at constant current 50A until the voltage reaches 192V or any cell reaches 3.0V, after that charge at constant current 70A until the voltage reaches 220.8V or any cell reaches 3.45V, then charge at constant current 50A until the voltage reaches 222.72V or any cell reaches 3.48V, and then charge at constant current 10A until the voltage reaches 224V or any cell reaches 3.5V. JEEDD-256100: Charge at constant current 20A until the voltage reaches 232V or any cell reaches 2.9V, afterwards charge at constant current 50A until the voltage reaches 240V or any cell reaches 3.0V, after that charge at constant current 70A until the voltage reaches 276V or any cell reaches 3.45V, then charge at constant current

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			50A until the voltage reaches 278.4V or any cell reaches 3.48V, and then charge at constant current 10A until the voltage reaches 280V or any cell reaches 3.5V. JEEDD-307100: Charge at constant current 20A until the voltage reaches 278.4V or any cell reaches 2.9V, afterwards charge at constant current 50A until the voltage reaches 288V or any cell reaches 3.0V, after that charge at constant current 70A until the voltage reaches 331.2V or any cell reaches 3.45V, then charge at constant current 50A until the voltage reaches 334.08V or any cell reaches 3.48V, and then charge at constant current 10A until the voltage reaches 336V or any cell reaches 3.5V. JEEDD-358100: Charge at constant current 20A until the voltage reaches 324.8V or any cell reaches 2.9V, afterwards charge at constant current 50A until the voltage reaches 336V or any cell reaches 3.0V, after that charge at constant current 70A until the voltage reaches 386.4V or any cell reaches 3.45V, then charge at constant current 50A until the voltage reaches 389.76V or any cell reaches 3.48V, and then charge at constant current 10A until the voltage reaches 392V or any cell reaches 3.5V.
Dimension	T*W*H: (49.9±1.0)mm*(160.0±1.0)mm*(118.5±1.0)mm	JEEDDMK512100-1: L×W×H: (600.1±5)mm× (491.5±5)mm× (208.9±5)mm JEEDDMK512100-2: L×W×H: (600.1±5)mm× (491.5±5)mm×	L×W×H: 600.1mm×491.5mm×526mm for JEEDD-102100, L×W×H: 600.1mm×491.5mm×703mm for JEEDD-153100, L×W×H: 600.1mmx491.5mmx880mm for JEEDD-204100, L×W×H:

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		(194.5±5)mm	600.1mmx491.5mmx1057mm for JEEDD-256100, L×W×H: 600.1mmx491.5mmx1234mm for JEEDD-307100, L×W×H: 600.1mmx491.5mmx1411mm for JEEDD-358100
Weight	(1.98±0.1)kg	JEEDDMK512100-2: Approx.51.5kg JEEDDMK512100-1: Approx.54kg	JEEDD-102100:132.35kg, JEEDD-153100:186.65kg, JEEDD-204100: 240.95kg, JEEDD-256100: 295.25kg, JEEDD-307100: 349.55kg, JEEDD-358100: 403.85kg
Configuration	-	16S	JEEDD-102100: (16S)2S, JEEDD-153100: (16S)3S, JEEDD-204100: (16S)4S, JEEDD-256100: (16S)5S, JEEDD-307100: (16S)6S, JEEDD-358100: (16S)7S

1.5 The information for BMS system

Battery model no.	BMS model no.	BMS Manufacturer	HW version	SW version	MCU information
JEEDD-102100, JEEDD-153100, JEEDD-204100, JEEDD-256100, JEEDD-307100, JEEDD-358100	BMS main board, model: BCU-1501C	SHENZHEN PACE ELEC-TRONICS CO., LTD	SST22-0189-2.2	BCU-1501-JS30245-1.0	STM32H723ZGT6 (U3, ST)
	BMU board, model: BMU-18081C		SCH-SST22-0553-1.5	BMU-20553-1.5	STM32F072CBT6 (UM1, ST)

2. Order

2.1 Date of Purchase Order, Customer's Reference

2023-06-01

2.1 Test Sample(s)

- Reception date(s): 2023-09-11
- Location(s) of reception: PS: Battery department, Guangzhou
- Condition of test sample(s): Engineering samples

2.2 Testing

- Testing date(s): 2023-09-11 to 2024-06-02

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- Location(s) of testing: TÜV SÜD New Energy Testing (Guangdong) Co., Ltd. North-1/F, 2/F & Unit 301-3/F, TÜV SÜD Testing Center, D1, No. 63 Chuangqi Road, Shilou Town, Panyu District, Guangzhou 511447, China

3. Test Results

- "Decision rule according to IEC Guide 115:2023, clause 4.3.3 was applied."

3.1 Test Object

According to the hazard analysis and risk assessment and IEC 62619:2022, 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	Class of control function	Parameters
Voltage protection	Class B	Over voltage protection value: 3.52V/cell, respond time: 3s Under voltage protection value: 2.85V/cell, respond time: 3s
Current protection	Class B	Charge overcurrent protection value: 80A, respond time: 3s Discharge overcurrent protection value: 80A, respond time: 3s
Temperature protection	Class B	Charge mode: Over temperature protection value: 52°C, respond time: 3s Under temperature protection value: 4°C, respond time: 3s Discharge mode: Over temperature protection value: 52°C, respond time: 3s Under temperature protection value: -15°C, respond time: 3s

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.

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3.3 Results

3.3.1 Functional Safety Management and Lifecycle Audit

The battery manufacturer “Jiangmen Jeeseng Energy Co., Ltd.” and the BMS manufacturer “SHENZHEN PACE ELECTRONICS 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, 2 and 3.

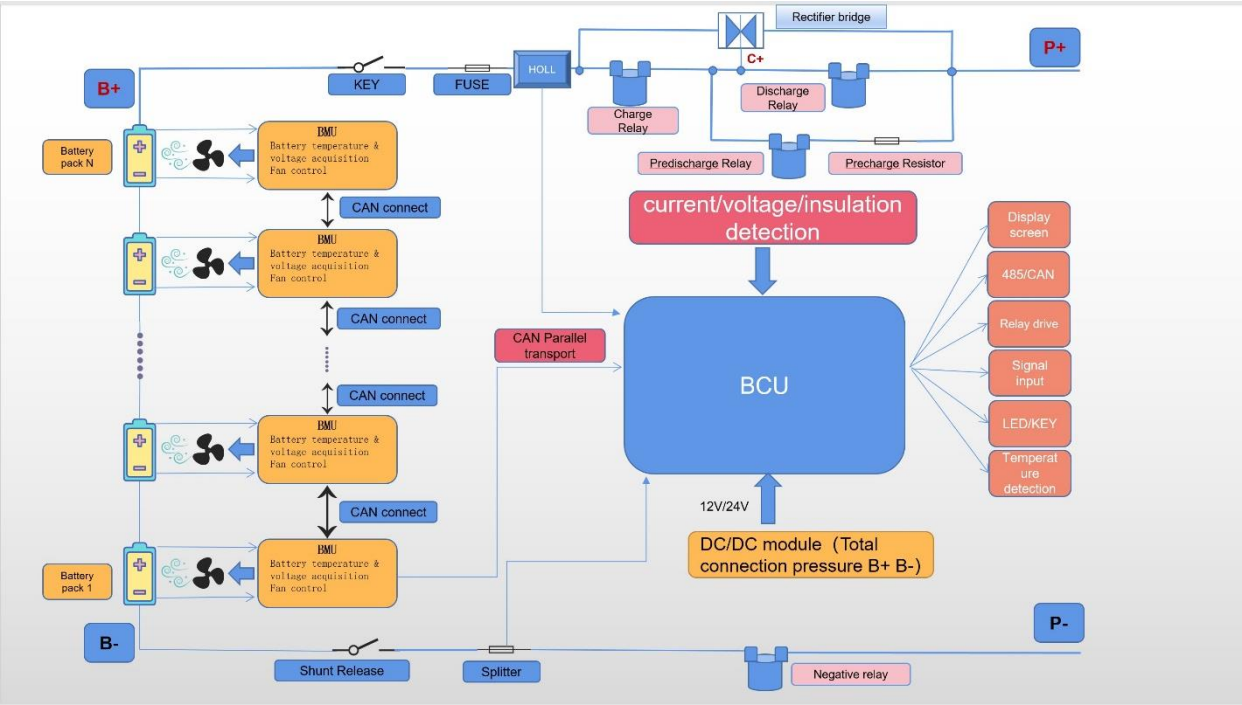

Figure 1 BMS architecture

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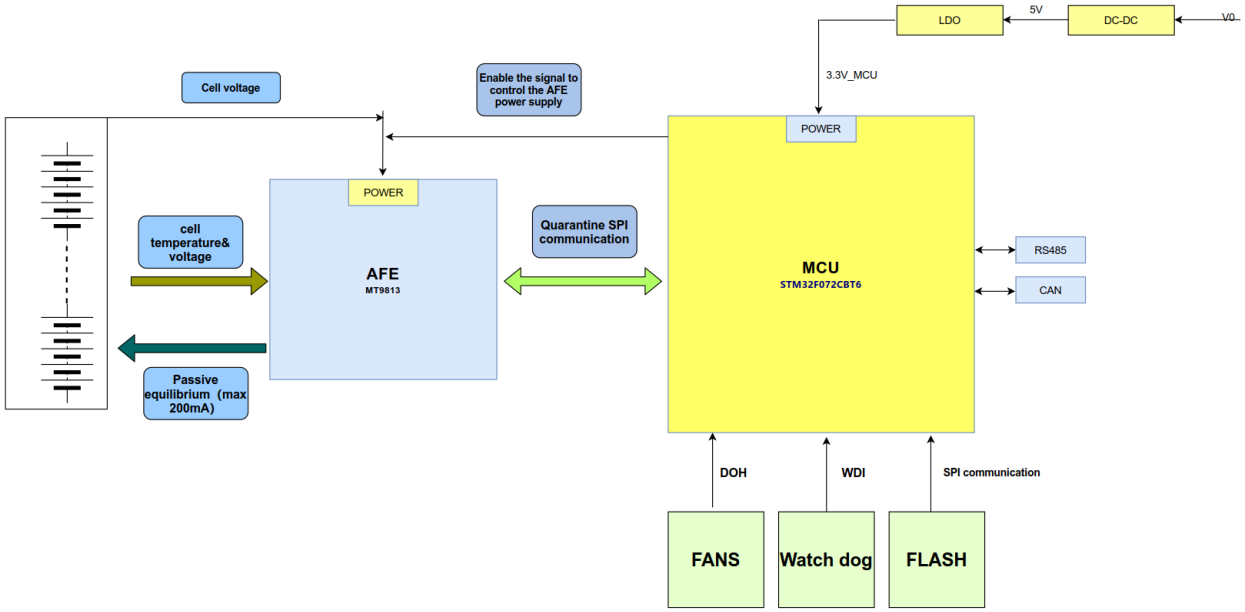

Figure 2 BMU architecture

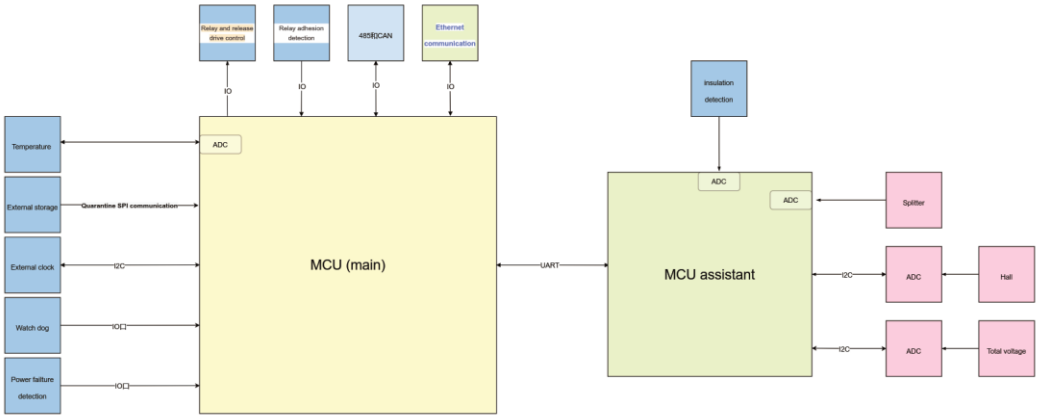

Figure 3 BCU architecture

1. Cell overvoltage and undervoltage protection:

   The safety function is implemented by turning off charge and discharge contactor and negative contactor.

   The cell voltages are measured by BMS sampling circuit diagram → AFE(U1) on BMU → MCU(UM1) on BMU → MCU(U3) on BCU and if MCU(U3) on BCU find it is overvoltage or undervoltage, it will turn off charge or discharge contactor. In case of charge or discharge contactor in single fault, MCU(U3) on BCU will control to turn off the negative contactor. See Figure 4 block diagram.

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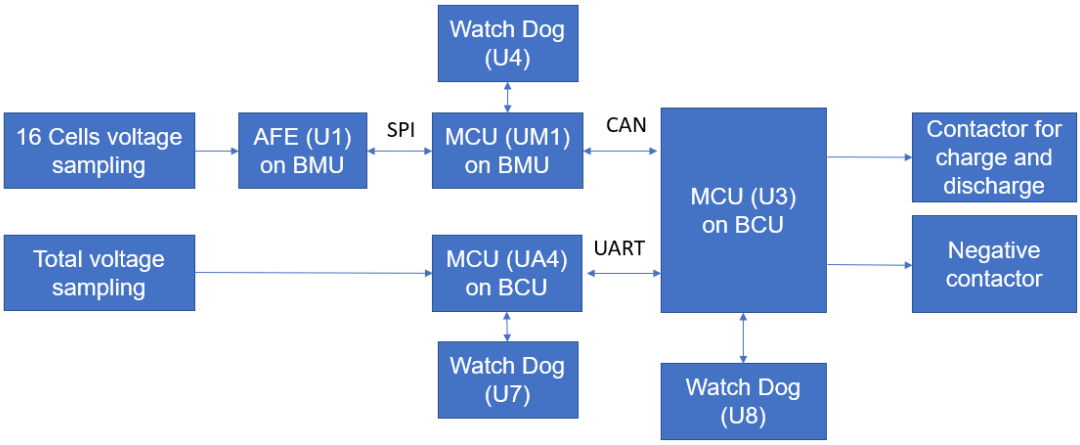

Figure 4 Cell overvoltage and undervoltage protection block diagram

The safety function is realized by a single channel with periodic self-test structure. The total voltage of battery is measured by MCU(UA4) on BCU → MCU(U3) on BCU. If MCU(U3) on BCU finds that voltage difference between the sum of cells' voltage and the total voltage is more than 20V, it will turn off the charge and discharge contactor.

2. Cell overcurrent protection:

   The safety function is implemented by turning off charge and discharge contactor and negative contactor.

   The cells' current is measured by shunt → MCU(UA4) on BCU → MCU(U3) on BCU. If MCU(U3) on BCU find it is overcurrent, it will turn off charge or discharge contactor. In case of charge or discharge contactor in single fault, MCU(U3) on BCU will control to turn off the negative contactor. See Figure 5 block diagram.

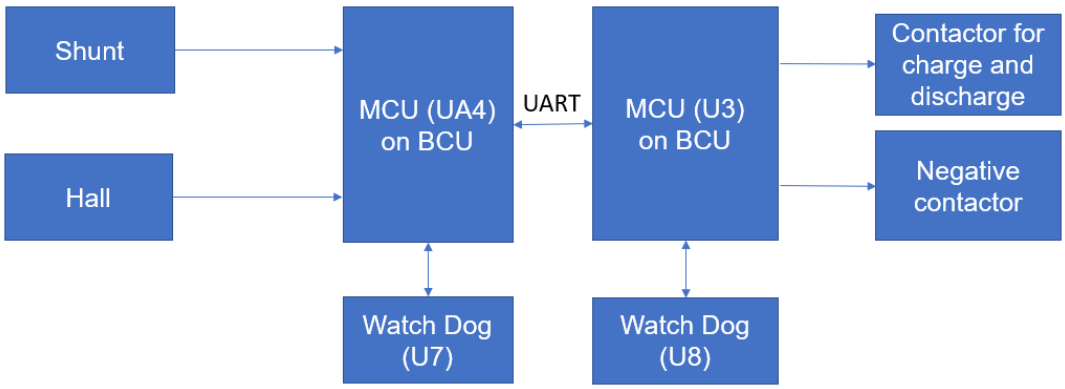

Figure 5 Cell overcurrent charge and discharge protection block diagram

The safety function is realized by a single channel with periodic self-test structure. The cells' current is also measured by Hall → MCU(UA4) on BCU → MCU(U3) on BCU. If MCU(U3) on BCU finds that current difference between the Shunt and Hall acquisition values is more than 5A, it will control to turn off charge and discharge contactor.

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3. Cell over and under temperature protection:

   The safety function is implemented by turning off charge and discharge contactor and negative contactor.

   The cells' temperature is measured by total 4 NTCs → AFE(U1) on BMU → MCU(UM1) on BMU → MCU(U3) on BCU, and if MCU(U3) on BCU find it is over temperature or under temperature, it will turn off charge or discharge contactor. In case of charge and discharge contactor in single fault, MCU will control to turn off the negative contactor. See Figure 6 block diagram.

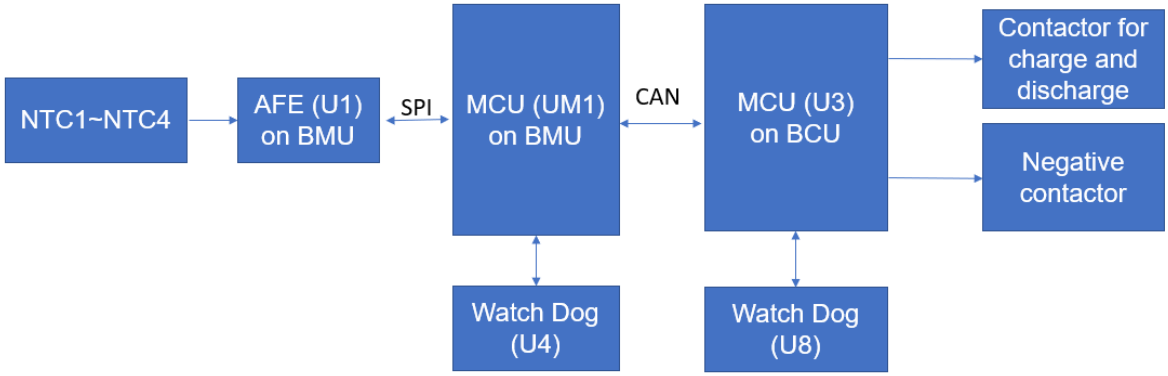

Figure 6 Cell over and under temperature protection block diagram

The safety function is realized by a single channel with periodic self-test structure. The diagnostic of over and under temperature protection circuit is to compare the temperature from all 4 NTCs/module by MCU(U3). If the max. and min. temperature difference of the cells exceeds 10°C, it will control to turn off charge and discharge contactor.

Result:

The architecture described above is suitable for realization of the safety functions overvoltage, undervoltage, overcurrent, over temperature and under temperature 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 above were tested during fault injection test. The tests were performed without objections.

3.3.4 Fault Injection Test

The battery manufacturer "Jiangmen Jeeseng Energy Co., Ltd." and the BMS manufacturer "SHENZHEN PACE ELECTRONICS CO., LTD" performed a fault injection test which simulated the typical faults according to fault modes 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 62619:2022 and the regulations related to the standard. The battery was also tested for environmental testing.

Result:

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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 Test history

Project no.	Revision	Date	Author	Modification / Description
64.280.23.60319.01	00	2024-06-03	Cara Yang	Initial

5. Documentation

No.	Title	Document number / ID	Rev.	Date
[D1]	Hazard analysis and risk assessment	JS001	V.1.0.01	2023-10-28
[D2]	Safety Requirement Specification	JS-c001	V.1.0.01	2023-11-01
[D3]	Safety Plan	JS-c002	V.1.0.01	2023-11-03
[D4]	Verification & Validation Plan	JS-FILE20231102	A	2023-11-08
[D5]	System safety design	Circuit diagram & PCB layout: 1. BMS main board, model: BCU-1501C; 2. BMU board, model: BMU-18081C	-	-
		JS-c004	V.1.0.01	2023-11-10
[D6]	System software design	PC-BCU30245-04	V1.0	2023-12-09
[D7]	Component FMEA	PC-BCU30245-FMEA-01	V1.0	2023-12-09
[D8]	User manual	Operation and maintenance instruction for high pressure stack installation	-	-

Telephone: +86 20 3817 0580
Telefax: +86 20 3832 0478

http://www.tuv-sud.cn

TÜV SÜD New Energy Testing (Guangdong) Co., Ltd.
North-1/F, 2/F & Unit 301-3/F, TÜV SÜD Testing Center, D1, No. 63 Chuangqi Road, Shilou Town, Panyu District, Guangzhou 511447, China

6 Summary

The safety functions of BMS in battery system model no. JEEDD-102100, JEEDD-153100, JEEDD-204100, JEEDD-256100, JEEDD-307100, JEEDD-358100 are 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:	Cara Yang / Project Handler *printed name, function & signature*	
Approved by:	Zoe Zhu / Designated Reviewer *printed name, function & signature*	

--- End of Report ---

Telephone: +86 20 3817 0580
Telefax: +86 20 3832 0478

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TÜV SÜD New Energy Testing (Guangdong) Co., Ltd.
North-1/F, 2/F & Unit 301-3/F, TÜV SÜD Testing Center, D1, No. 63 Chuangqi Road, Shilou Town, Panyu District, Guangzhou 511447, China