Technical Report

Product Service

Technical Report No.: 64.105.19.30154.01

Dated: 2022-01-14

Client:	Report holder's name:	Huawei Technologies Co., Ltd.
	Report holder's Address:	Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, 518129 Shenzhen, PEOPLE'S REPUBLIC OF CHINA
	Contact person of report holder:	Chen Dongxiang
	Manufacturer's name:	Same as the applicant
	Manufacturer's address:	Same as the applicant
Factory:	Factory 1's name:	Huizhou Desay Battery Co., Ltd.
	Factory 1's address:	No.18, Jin Zhong Road, Huicheng District, 516000 Huizhou, Guangdong, PEOPLE'S REPUBLIC OF CHINA
	Factory 2's name:	Shenzhen BYD Electronic Co., Ltd
	Factory 2's address:	A7 Building of BYD, No.1 Yan'an Road, Kuichong Street, Dapeng New District, 518119 Shenzhen, Guangdong, PEOPLE'S REPUBLIC OF CHINA
Test object:	Product:	Rechargeable Lithium Ion Battery (Energy Storage Module)
	Model:	LUNA2000-5-E0
	Trade mark:	HUAWEI
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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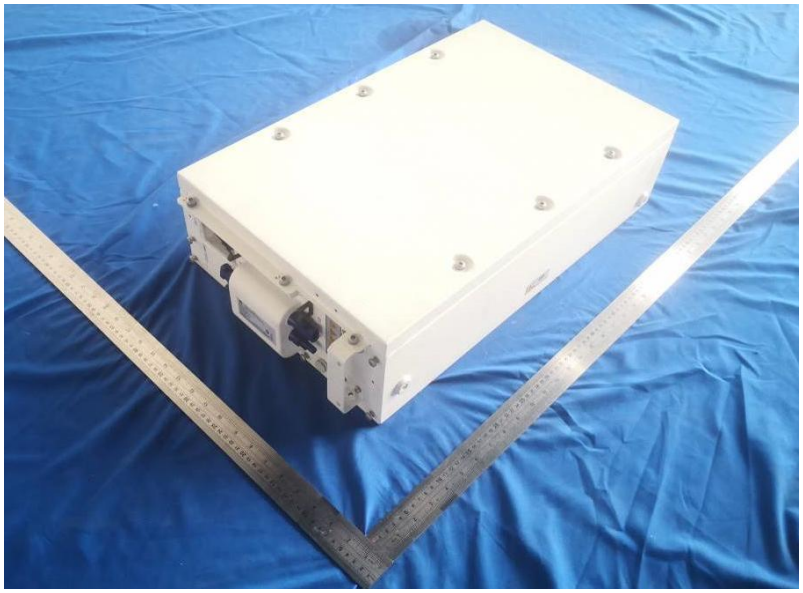
1. Description of the test subject

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

☐ 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 (Energy Storage Module), model: LUNA2000-5-E0 is integrated with DC-DC converter and is used in industrial application, which has three suppliers for cells. All of the three cells have been approved with IEC 62619:2017 (First Edition) certification.

Additionally, details information of the battery and its component cells are shown in following table:

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Product name	Rechargeable Lithium Ion Cell	Rechargeable Lithium Ion Cell	Rechargeable Li-ion Cell	Rechargeable Lithium Ion Battery (Energy Storage Module)
Type/model	001CB0Y0	C47FCSA	LF100L	LUNA2000-5-E0
Nominal voltage	3.2Vd.c.	3.2Vd.c.	3.2Vd.c.	51.2Vd.c
Rated capacity	100Ah	102Ah	102Ah	100Ah
Charging voltage declared by manufacturer	3.65V	3.65V	3.65V	56.4V
Upper limit charging voltage	3.65V	3.65V	3.65V *	58V
Standard Charging Current	50A	20.4A	50A	50A
Maximum continuous charging current	100A	102A	100A	50A
Discharging current declared by manufacturer	50A	20A	50A	50A
Maximum continuous discharging current	100A	250A	250A	50A
Discharge cut-off voltage	2.5V	2.5V	2.0V	47V
Standard temperature range for charging	5°C to 65°C	0°C to 65°C	0°C to 65°C	5°C to 55°C (T1~T2: -20°C~5°C, heater will work when the cell temperature is below 5°C)
Standard temperature range for discharging	-30°C to 65°C	-30°C to 65°C	-30°C to 65°C	-20°C to 55°C
Standard charging method by manufacturer	Charge at constant current 50A until the voltage reaches 3.65V, then charge at constant voltage 3.65V until charge current is 5A.	Charge at constant current 20A until the voltage reaches 3.65V, then charge at constant voltage 3.65V until charge current is 5A.	Charge at constant current 50A until the voltage reaches 3.65V, then charge at 3.65V till charge current is 0.05/t (5.1A).	Charge at constant current 50A until the voltage of battery reaches 56.4V then charge at constant voltage 56.4V until charge current is 5A
Charging procedure for internal short-circuit test	Stored at 0°C or 70°C for 1 h - 4 h, then charge at constant current 100A until the voltage reaches 3.65V, then	Charge at constant current 102A until the voltage reaches 3.65V, then charge at constant voltage 3.65V until	Charge at constant current 100A until the voltage reaches 3.9V, then charge at 3.9V till charge	-

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	charge at constant voltage 3.65V until charge current is 0.05I_tA (5A).	charge current is 0.05ItA (5.1A).	current is 0.05/t (5.1A).	
Dimension	TxWxH: (49.91±1.0) mm x (160±1.0) mm x (119±1.0) mm	TxWxH: (49.9±0.5) mm x (160±0.8) mm x (118.5±0.5) mm	T*W*H: (49.9±0.5)mm* (160.0±0.8)mm* (118.5±0.5)mm	W*H*D: (670±1.0)mm* (360±0.6)mm* (150±0.5)mm
Weight	(1950±150) g	(1.980±0.1) kg	(1.98±0.1) kg	Approx. 50kg
Configuration	-	-	-	16S
Remark: * The upper limit charging voltage in cell certificate is 3.9V, it is 3.65V for Rechargeable Lithium Ion Battery (Energy Storage Module), model: LUNA2000-5-E0.				

Battery model no.	Configuration	BMS model no.	HW version	SW version
LUNA2000-5-E0	16S	-	ENQ1CTLF (BMU) VER.A; ENQ1PWRB (LLC) VER.C	FusionSolarDG V100R002C00

2. Order

2.1 Date of Purchase Order, Customer's Reference

2020-05-12

2.2 Test Sample(s)

- Reception date(s): 2020-09-16
- Location(s) of reception:
  Huawei Technologies Co., Ltd.
  Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, 518129 Shenzhen, PEOPLE'S REPUBLIC OF CHINA
- Condition of test sample(s): Engineering samples

2.3 Date(s) of Testing

2020-09-16 to 2021-11-30

2.4 Location of Testing

Huawei Xi'an Research Center
No.127 Jinye Road, Yanta District, Xi'an City, Shaanxi, , PEOPLE'S REPUBLIC OF CHINA

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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: 3.9V/cell Under voltage protection value: 2.5V/cell
Current protection	Class B	Charge overcurrent protection value: 60A Discharge overcurrent protection value: 85A
Temperature protection	Class B	Charge mode: Over temperature protection value: 60°C, Under temperature protection value: 0°C, Discharge mode: Over temperature protection value: 65°C, Under temperature protection value: -25°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

HUAWEI 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.

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3.3.2 Architecture

BMS architecture is shown in Figure 1.

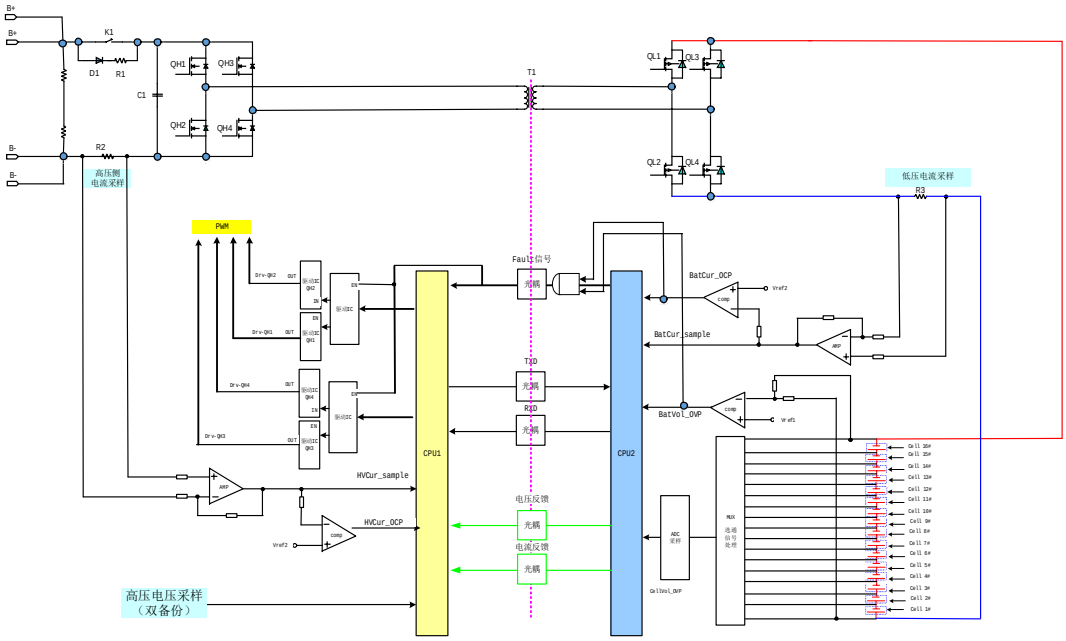

Figure 1 BMS architecture

1. Cell overvoltage and undervoltage protection:

The safety function is implemented by PWM shut down. The cell voltages are measured by BMS sampling circuit diagram → MUX → ADC → CPU2 and if CPU2 find it is overvoltage or undervoltage, it will shut down PWM by CPU2 → Fault signal → driver IC → MOS. See Figure 2 block diagram.

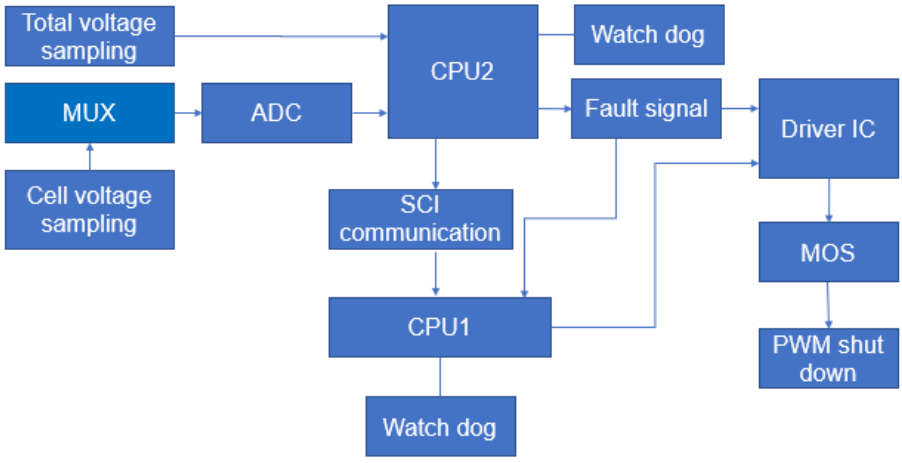

Figure 2 Cell overvoltage and undervoltage protection block diagram

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The safety function is realized by a single channel with periodic self-test structure. CPU2 will sampled total voltage of module. The diagnostic of overvoltage and undervoltage protection circuit is to compare the sum of cells' voltage and the total voltage of module. The CPU1 can shut down PWM in case the CPU2 cannot turn off the circuit.

2. Cell overcurrent protection:

The safety function is implemented by PWM shut down. The cells' current is measured by current sampling circuit on SELV side and if comparator find it is overcurrent, it will shut down PWM by Comparator → Fault signal → driver IC → MOS. See Figure 3 block diagram.

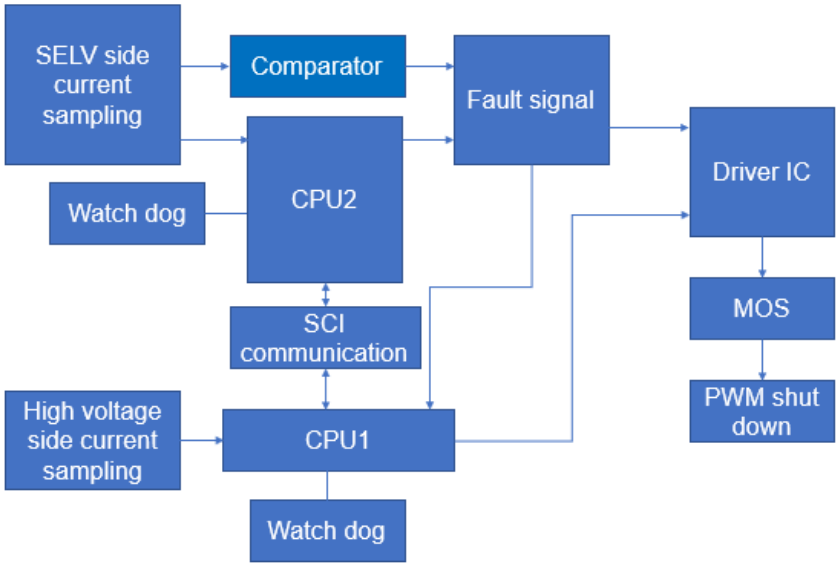

Figure 3 Cell overcurrent charge protection block diagram

The safety function is realized by a single channel with periodic self-test structure. CPU1 will sample the current of high voltage side and send it to CPU2 by SCI communication. The diagnostic of overcurrent protection circuit is to compare current of SELV side and High voltage side. The CPU1 can shut down PWM in case the CPU2 cannot turn off the circuit.

3. Cell over and under temperature protection:

The safety function is implemented by PWM shut down. The cells' temperature is measured by total 8 NTCs and if CPU2 find it is over temperature or under temperature, it will shut down PWM by CPU2 → Fault signal → driver IC → MOS. See Figure 4 block diagram.

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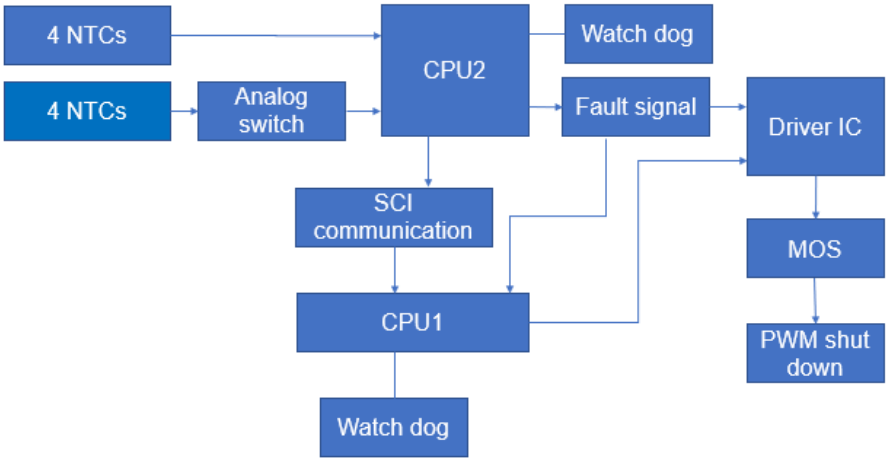

Figure 4 Cell over and under temperature protection block diagram

The safety function is realized by a single channel with periodic self-test structure. The diagnostic of over and under temperature protection circuit is to compare the temperature from all NTCs by CPU2. The CPU1 can shut down PWM in case the CPU2 cannot turn off the circuit.

4. Circuit over and under voltage protection

When the PWM has no output, the winding has no output voltage. The CPU1 and CPU2 are powered off and the system is in a safe state.The input of battery and safety related circuit is protected up to 60V d.c..

The 3.3V power supply of the CPU2 is from isolated winding of the transformer (Secondary circuit_12V). When the high voltage circuit on the primary side of the transformer is faulty, the voltage will not be poured into secondary circuit_12V directly. The 3.3V is created from the secondary circuit_12V by buck circuit, it has the function of overvoltage, undervoltage, overcurrent and overtemperature protection. The overvoltage protection point for the secondary circuit_12V circuit is 16V, the undervoltage protection point for the secondary circuit_12V circuit is 10V.

The 3.3V power supply of the CPU1 is from primary winding of the transformer (Primary circuit_ 12V). The 3.3V is created from the primary circuit_12V by buck circuit.

Result:

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

3.3.3 Fault Injection Test

HUAWEI performed a fault injection test which simulated the typical faults according to fault models defined by Annex H of IEC 60730-1. The fault injection test was witnessed by TÜV SÜD. The test also covered the diagnostic software to check the effectiveness of the implemented measures.

Result:

The fault injection test was performed without objections.

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3.3.4 Software

The software implemented is responsible for the execution of the safety function and support of diagnostics. The following measures are implemented and executed:

- ROM/Flash test, RAM test
- Register test, Flag test
- Program Flow monitor, stack supervision and watchdog function
- Program counter test
- Voltage, current and temperature signal comparison
- Communication detection

Result:

The reliability of the safety function and the effective of diagnostics above where tested during fault injection test. The tests were 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 the standard. BMS was also tested according to Annex H of IEC 60730-1 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 in accordance with Annex H of IEC 60730-1.

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

Project no.	Revision	Date	Author	Modification / Description
64.105.19.30154.01	00	2022-01-14	Ryan Jin	Initial

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5. Documentation

No.	Title	Document number / ID	Rev.	Date
[D1]	Hazard analysis & Risk Assessment	SUP_M_R110608	V01.00	2021-07-15
[D2]	FusionSolarDG V100R002C00 SRS	OFFE00082596_OTH150ZH	A	2020-10-10
[D3]	FusionSolarDG V100R002C00 Safety Plan	OFFE00082596_OTH151ZH	A	2020-09-22
[D4]	System FMEA	SUP_M_R110610	V01.00	2021-10-09
[D5]	Component FMEA	SUP_M_R110609	V01.00	2021-07-28
[D6]	FusionSolarDG V100R002C00 Verification & Validation Plan	OFFE00082596_OTH152ZH	A	2020-09-22
[D7]	User manual	LUNA2000-(5kW, 5kWh) User manual	01	2020-09-18

6 Summary

The safety functions of BMS in battery model no. LUNA2000-5-E0 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: Ryan Jin / Project Handler

printed name, function & signature

Approved by: Joyce Lian / Designated Reviewer

printed name, function & signature

--- End of Report ---

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