


Technical Report No.: 5061925025708-00

Date: 2025-12-12

Client: Shanghai PYTES Energy Co., Ltd.
No. 3492, Jinqian Road, Fengxian District, 201406 Shanghai, PEOPLE'S
REPUBLIC OF CHINA

Manufacturer: Same as the applicant

Factory: Same as the applicant

Test object: Product: Rechargeable Li-ion Battery
Model: V16
Trade mark: 

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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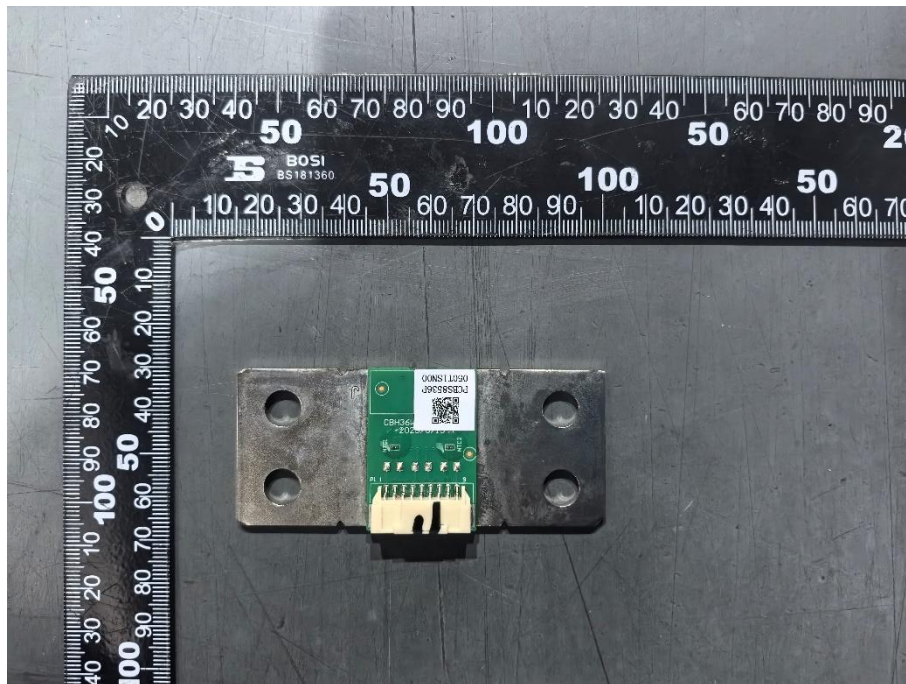
1. Description of the test object

MCU board for Rechargeable Li-ion Battery, model: V10-MCU-V5

PWR board for Rechargeable Li-ion Battery, model: V10-PWR-V7

LIMIT_CHG board for Rechargeable Li-ion Battery, model: V10- LIMIT_CHG_V04

SHUNT board for Rechargeable Li-ion Battery, model: PCBS8536P050T1SN00



1.1 Function

Manufacturer's specification for intended use:

- according to the user manual or installation instructions.

1.2 Consideration of the foreseeable use

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

1.3 Technical Data

1. The Rechargeable Li-ion Battery, model: V16, which consists of Rechargeable Li-ion Cell model no. , connected in 16S, is used in industrial applications.
2. The external communication mode for Rechargeable Li-ion Battery, model: V16 is CAN and RS485.
3. Additionally, detailed information of the cell is shown in following table:

Product name	Rechargeable Prismatic Lithium-ion Cell	Rechargeable Li ion Battery System
Type/model		V16
Nominal voltage	3.2Vd.c.	51.2Vd.c.

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Building A, No.15 Factory, Jintong International Industrial
Park, No.8, Xihu Road, Wujin National Hi-tech Industrial
Development Zone, Changzhou, Jiangsu, China

Rated capacity	314Ah	314Ah
Recommended charging voltage by manufacturer	3.65V	56.8V
Upper limit charging voltage	3.75V	-
Charging current declared by manufacturer	157A	125A
Maximum continuous charging current	314A	200A
Discharging current declared by manufacturer	157A	150A
Maximum continuous discharging current	314A	200A
Standard temperature range for charging	0°C to 60°C	-
Standard temperature range for discharging	-30°C to 60°C	-
Operating ambient temperature range	-	0 °C to 25 °C
Standard charging method by manufacturer	Charge at constant current 157A until the voltage reaches 3.65V, then switch to constant voltage 3.65V till charge current drops to 15.7A	Charge at constant current 125A until voltage reaches 56.8V, then charge at constant voltage 56.8V till charge current is 9.42A.
Charging method for internal short-circuit test	-	-
Discharging cut off voltage	2.5V(T>0°C); 2.0V(T≤0°C)	46.5V
Dimension	L*W*H: (71.7±2)mm x (174.0±2)mm x (206.8±2)mm	L*W*H: (700±2.0)mm x (671±2.0)mm x (260±2.0)mm
Weight	(5.78±0.3)kg	(130.0±1.0)kg
Configuration	-	16S

1.4 The information for BMS system

Battery model no.	BMS model no.	BMS manufacturer	HW version	SW version	MCU information
V16	V16 BMS V1	Shanghai PYTES Energy Co., Ltd.	MCU board: V10-MCU-V5	Software version: V16A16SV1.16.1 CRC: 0xE5898FD7	GD32F307ZGT6 (U304, GigaDevice)
			PWR board: V10-PWR-V7	-	-
			LIMIT_CHG board: V10-LIMIT_CHG-V03	-	-
			SHUNT board: PCBS8536P0 50T1SN00	-	-

2. Order

2.1 Date of Purchase Order, Customer's Reference

2025-09-16

2.2 Test Sample(s)

- Reception date(s): 2025-10-13
- Location(s) of reception: TÜV SÜD New Energy Vehicle Testing (Jiangsu) Co., Ltd.
- Condition of test sample(s): Engineering samples

2.3 Testing

- Testing date(s): 2025-10-23 to 2025-10-30
- Location(s) of testing: TÜV SÜD New Energy Vehicle Testing (Jiangsu) Co., Ltd.
Building A, No.15 Factory, Jintong International Industrial Park, No.8, Xihu Road, Wujin National Hi-tech Industrial Development Zone, Changzhou, Jiangsu, China

3. Test Results

- Decision rule according to ILAC-G8:09/2019 clause 4.2.1 Binary statement for simple acceptance rule or IEC Guide 115:2023, clause 4.3.3 Simple acceptance 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 and respond time
Voltage protection	Class B	Over voltage protection value: 3.65V±96mV, respond time: 2s±2s Under voltage protection value: 2.8V±96mV, respond time: 2s±2s
Current protection	Class B	Charge overcurrent protection value: 210A±5A, respond time: 18s±8s Discharge overcurrent protection value: 210A±5A, respond time: 18s±8s
Temperature protection	Class B	Charge mode: Over temperature protection value: 57°C±2°C, respond time: 6s±2s Under temperature protection value: 2°C±2°C, respond time: 4s±2s Discharge mode: Over temperature protection value: 57°C±2°C, respond time: 6s±2s Under temperature protection value: -20°C±2°C, respond time: 6s±2s

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

Shanghai PYTES Energy Co., Ltd. describes the project, the planned activities and responsibilities for managing functional safety by a safety plan. The safety plan covers 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 Class B control development according to Annex H of IEC 60730-1.

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 turning off the charge, discharge and current limit MOSFET and circuit breaker (with shunt release). The cell voltages are measured by BMS sampling circuit diagram → AFE(U392) → MCU(U304)(SPI communication). The BMS totally sampling 16S cell's voltage. If MCU(U304) on MCU board finds it is overvoltage, it will turn off the charge and current limit MOSFET. If MCU(U304) on MCU board finds it is undervoltage, it will turn off discharge MOSFET. In case of the charge, discharge or current limit MOSFET is in fault, MCU(U304) on MCU board will turn off the circuit breaker (with shunt release). See Figure 2 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. BMS also sample the total voltage of battery → IC(U327) → MCU(U304)(I2C communication). The diagnostic of voltage sampling fault protection circuit is to compare the sum of cells' voltage and the total voltage of battery. If MCU(U304) on MCU board finds that voltage difference between them is more than 3V, MCU(U304) on MCU board will find the voltage sampling in fault and turn off the charge, discharge MOSFET and circuit breaker.

2. Cell overcurrent protection:

The safety function is implemented by turning off the charge, discharge and current limit MOSFET. The cells' current is measured by current sampling resistance on BMS main board → IC(U327) → MCU(U304) (I2C communication). If MCU(U304) on MCU board finds it is charging or discharging overcurrent, it will turn off the charge and discharge MOSFET. In case of the charge or discharge MOSFET is in fault, MCU(U304) on MCU board will turn off the circuit breaker (with shunt release). See Figure 3 block diagram.

Figure 3 Cell overcurrent charge and discharge protection block diagram

The safety function is realized by a single channel with periodic self-test structure. BMS also sample the current of battery by shunt resistor on SHUNT board → IC(U21) → MCU(U304) (I2C communication). The diagnostic of current sampling fault protection circuit is to compare the current of current sampling resistance and shunt resistor. If the MCU(U304) on MCU board finds that difference between them is more than 2A, it will find current sampling is in fault and turn off the charge, discharge MOSFET and circuit breaker.

3. Cell over and under temperature protection:

The safety function is implemented by turning off the charge and discharge MOSFET. The cell temperature is measured by 8NTCs → AFE(U392) → MCU(U304)(SPI communication). If the MCU(U304) on MCU board finds it is over or under temperature, it will turn off the charge and discharge MOSFET. In case of the charge or discharge MOSFET is in fault, MCU(U304) on MCU board will turn off the circuit breaker (with shunt release). 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 to compare the temperature from all 8* NTCs modules series. If MCU(U304) on MCU board finds that the temperature difference between NTCs exceeds 20°C, MCU(U304) on MCU board will turn off the charge, discharge MOSFET and circuit breaker.

Result:

The architecture described above is suitable for realization of the safety functions overvoltage, undervoltage, overcurrent, overtemperature 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 effectiveness of diagnostics above were tested during fault injection test. The tests were performed without objections.

3.3.4 Fault Injection Test

Shanghai PYTES Energy 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:

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. Test History

Project no.	Revision	Date	Author	Modification / Description
5061925025708-00	00	2025-12-12	Dai Chencheng	Initial

5. Documentation

No.	Title	Document number / ID	Rev.	Date
[D1]	Hazard analysis and risk assessment	PYTES-V16-000	V1.0	2024-04-12
[D2]	Safety Requirement Specification	PYTES-V16-001	V1.0	2024-05-15
[D3]	Safety Plan	PYTES-V16-002	V1.0	2024-05-16
[D4]	Verification & Validation Plan	PYTES-V16-003	V1.0	2024-05-18
[D5]	System safety design	PYTES-V16-004	V1.0	2024-05-30
[D6]	Software safety design	PYTES-V16-Software security design	V1.0	2024-07-30
[D7]	Component FMEA	PYTES-V16-DFMEA	V1.0	2024-09-20
[D8]	User manual	Pytes V16 LFP Battery User Manual	1.0	2025-09-10

6. Summary

The safety functions of BMS in battery model no.: V16 are suitable for Class B control according to Annex H of IEC 60730-1:2013+AMD1:2015+AMD2:2020.

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Technical Report



Tested by:

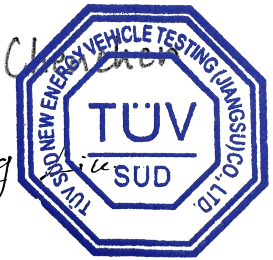
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