

BOS Balance of Storage Systems AG

TEST REPORT

SCOPE OF WORKS

IEC 62619:2017 / BOS LE300

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TEST REPORT FOR BOS BALANCE OF STORAGE SYSTEMS AG

Report No.: 2230686KAU-002

Date: 2017-10-27

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CONCLUSION

The requirements in dependence of the IEC 62619:2017; whole drop test, are pass.

The requirements in dependence of the IEC 62619:2017; overcharge control of voltage test, are pass.

The requirements in dependence of the IEC 62619:2017; overcharge control of current test, are pass.

The requirements in dependence of the IEC 62619:2017; overheating control test, are pass.

The requirements in dependence of the IEC 62619:2017 / IEC 62620:2014; marking and designation, are pass.

Customer:

BOS Balance of Storage Systems AG

Beim Mühlbach 3

89171 Illerkirchberg

Germany

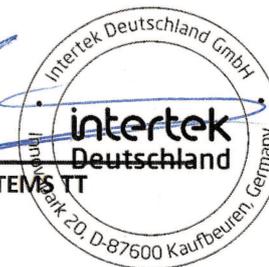
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TEST TECHNICIAN TT



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SECTION 1 MEASUREMENTS AND TEST SPECIFICATIONS

SECTION 1.1 USED STANDARDS

Lithium Ion battery Requirements according to the following standards.

STANDARD	DESCRIPTION OF STANDARD
IEC 62619: 2017	Secondary cells and batteries containing alkaline or non-acid electrolytes – Safety requirements for secondary lithium cells and batteries for use in industrial applications
IEC 62620:2014	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications

Table 1 Used standards

SECTION 1.2 TEST SEQUENCE

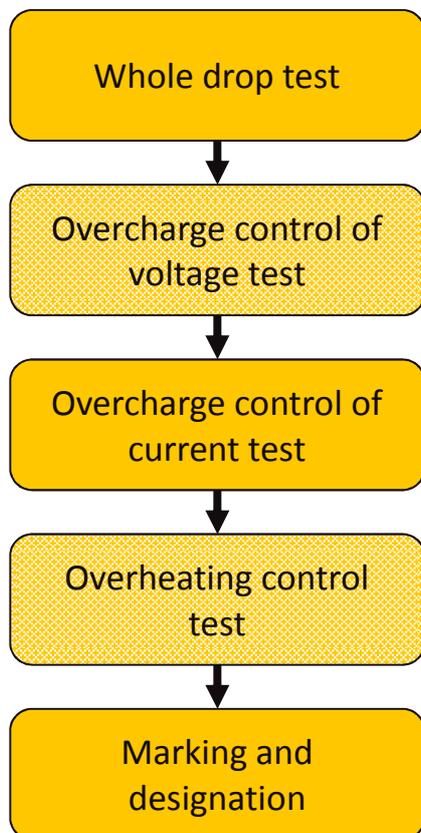


Table 2 Test sequence

SECTION 2 DESCRIPTION OF DUT

SECTION 2.1 SIZE AND TYPE OF THE DUT

Definition of a battery according to UN 38.3 Rev.6:

Battery means two or more cells which are electrically connected together fitted with devices necessary for use, for example, case, terminals, marking and protective devices.

SECTION 2.1.1 SIZE

Small battery with BMS

(Small battery means a lithium metal battery or lithium ion battery with a gross mass of less than 12 kg.)

Small battery without BMS

(Small battery means a lithium metal battery or lithium ion battery with a gross mass of less than 12 kg.)

Large battery with BMS

(Large battery means a lithium metal battery or lithium ion battery with a gross mass of more than 12 kg.)

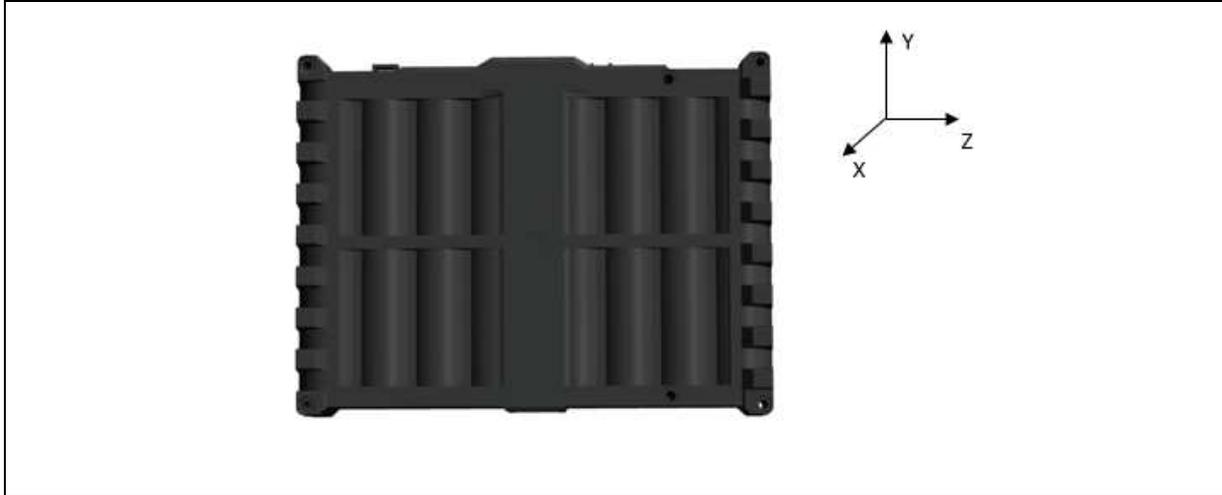
Large battery without BMS

(Large battery means a lithium metal battery or lithium ion battery with a gross mass of more than 12 kg.)

SECTION 2.1.2 TYPE / CHEMISTRY

- Lithium polymer cell
- Lithium cobalt dioxide cell (LiCoO₂)
- Lithium titanate cell
- Lithium air cell
- Lithium manganese cell
- Lithium iron phosphate cell (LiFePO₄)
- other type
- not given by the manufacturer

SECTION 2.2 TECHNICAL DATA OF THE BATTERY



Weight of the product in kg	3,35 kg
Dimensions of the product in mm (l × w × h)	175*235*65
BMS	available
Communication to BMS	Serial RS485 interface
Communication commands	BOS proprietary protocol
Maximum continuous charge current	12,50 ADC
Maximum continuous discharge current	12,50 ADC
Nominal charge current	12,50 ADC
Nominal discharge current	12,50 ADC
Maximum charge voltage	15,00 VDC
Nominal voltage	12,80 VDC
Minimum discharge voltage	11,00 VDC
Capacity	25,60 Ah
Charging /Discharging method	CCCV/CC

Table 3 Technical data of the battery

SECTION 2.3 OPERATING CONDITIONS

In order to operate the batteries it is necessary to connect the battery to a LV-voltage of approximately 14,4 VDC at the HV-cables.

It is necessary to check the voltage of the battery via CAN with the software of the manufacturer.

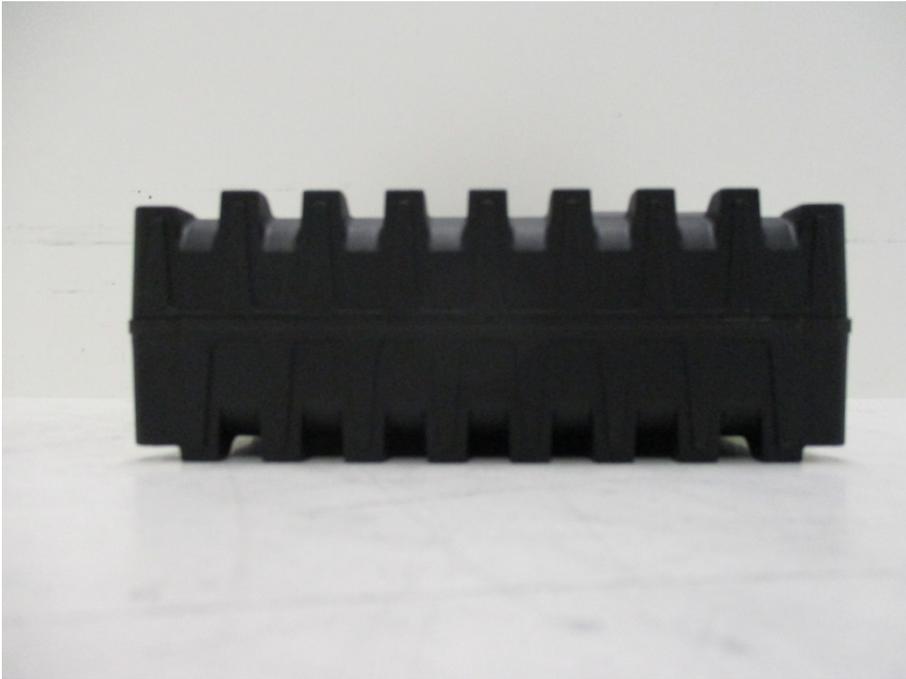
SECTION 2.4 GENERAL PICTURES



Picture 1 General picture of Li-ion battery



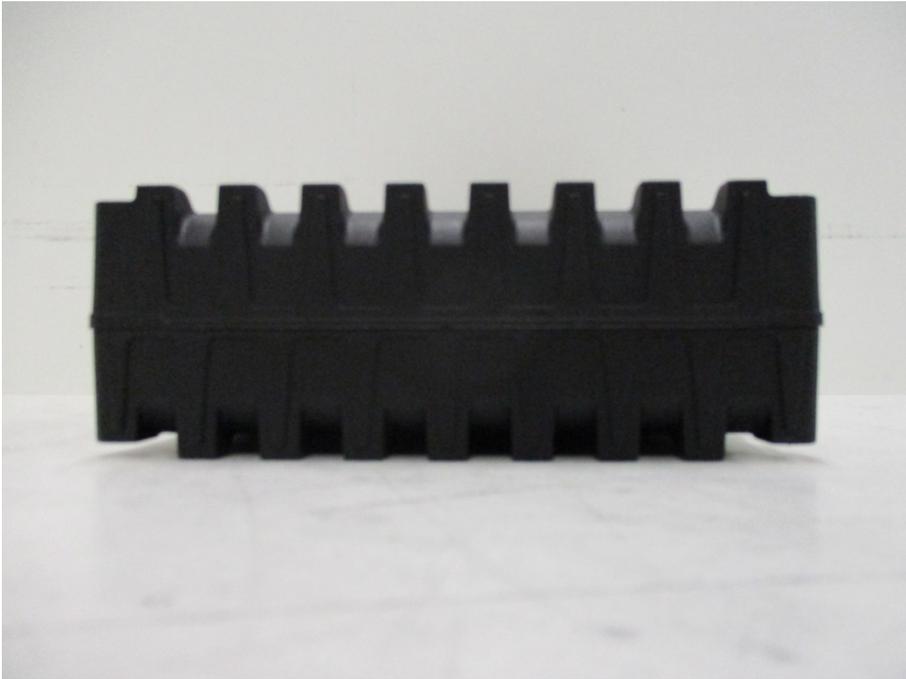
Picture 2 General picture of Li-ion battery



Picture 3 General picture of Li-ion battery



Picture 4 General picture of Li-ion battery



Picture 5 General picture of Li-ion battery



Picture 6 General picture of Li-ion battery

SECTION 2.5 SERIAL NUMBERS

CLIENT SERIAL NUMBER	INTERTEK - ID	DATE OF DELIVERY	COMMENT
000185	KAU1708091145-003	08.08.2017	000185
000187	KAU1708091145-004	08.08.2017	000187
000198	KAU1708091145-005	08.08.2017	000198
000202	KAU1708091145-006	08.08.2017	000202

Table 4 Serial no. of DUT

SECTION 3 TEST RESULT OVERVIEW

LITHIUM ION BATTERY	SAMPLES RECEIVED	DATE OF TEST	PASS	FAIL	APPLIED
Whole drop test	2017-08-08	2017-08-18	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overcharge control of voltage test	2017-08-08	2017-09-07	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overcharge control of current test	2017-08-08	2017-09-08	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overheating control test	2017-08-08	2017-09-11	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Marking and designation	2017-08-08	2017-09-20 – 2017-10-25	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Table 5 Test overview

SECTION 4 TEST OVERVIEW

SECTION 4.1 WHOLE DROP TEST

SECTION 4.1.1 NORMATIVE REFERENCES

TEST APPLIED ACCORDING TO THE FOLLOWING SPECIFICATIONS / STANDARDS without DEVIANCE	Whole drop test 7.2.3.2 IEC62619:2017
--	--

SAMPLES RECEIVED	1 KAU1708091145-003
DATE OF TEST	2017-08-18
PLACE OF TEST	Kaufbeuren

DESCRIPTION OF TEST SAMPLES

One (1) BOS LE300.

PURPOSE OF TEST

This test serves to verify that a dropping does not cause fire or explosion.

TEST PROCEDURE

The test unit is dropped three times from a height of 100 cm onto a flat concrete floor. The test unit is dropped so as to obtain impacts in random orientations.
After the test, the test unit shall be put on a rest for a minimum of 1 h and then a visual inspection shall be performed.

ACCEPTANCE CRITERIA

No fire, no explosion.

SECTION 4.1.2 TEST SETUP



Picture 5 Test setup of the whole drop test

SECTION 4.1.3 TEST RESULTS

TEST REQUIREMENTS

pass

fail

applied

COMMENT

The test was performed as described under section 4.1.1 and 4.1.2.
No fire and explosion could be detected during the test.
There were cracks in the enclosure like shown on the pictures below.



Picture 6 Crack in the enclosure after the test



Picture 7 Crack in the enclosure after the test



Picture 8 Crack in the enclosure after the test

SECTION 4.2 OVERCHARGE CONTROL OF VOLTAGE**SECTION 4.2.1 NORMATIVE REFERENCES**

TEST APPLIED ACCORDING TO THE FOLLOWING SPECIFICATIONS / STANDARDS without DEVIANCE	Overcharge control of voltage 8.2.2 IEC62619:2017
--	--

SAMPLES RECEIVED	1 KAU1708091145-004
DATE OF TEST	2017-09-07
PLACE OF TEST	Kaufbeuren

DESCRIPTION OF TEST SAMPLES

One (1) BOS LE300.

PURPOSE OF TEST

The BMS shall control the charging voltage below the upper limit charging voltage of the cells.

TEST PROCEDURE

The test shall be carried out in an ambient temperature of 25 °C±5°C and under normal operating conditions with the cooling system (if any) operating (main contactors are closed with the battery system controlled by the BMS). Each test battery system shall be discharged at a constant current of 0,2 C, to a final voltage specified by the manufacturer. Sample batteries shall then be charged at the maximum current of the recommended charger with set voltage exceeding the upper limit charging voltage by 10 % for each cell in the battery.

The exceeded voltage can be applied by an additional charger if it is difficult to do it by the original charger. Also the exceeded voltage can be applied to only a part of the system such as the cell(s) in the battery system, if it is difficult to do it in using the whole battery system.

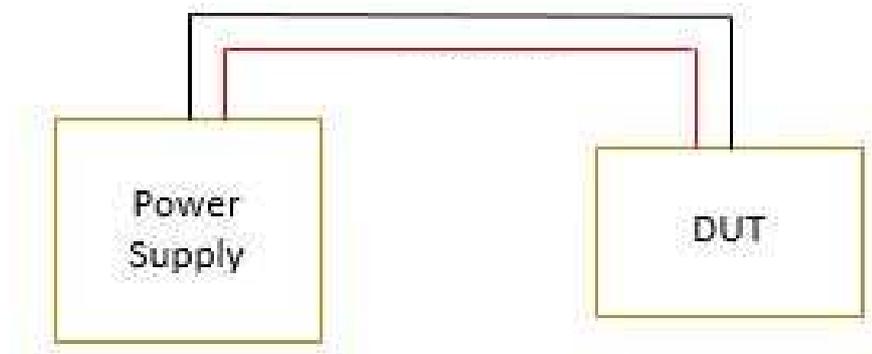
The test shall be carried out until the BMS terminates the charging, which should occur before reaching 110% of the upper limit charging voltage. Data acquisition/monitoring shall be continued for 1 h after charging is stopped. All functions of the battery system shall be fully operational as designed during the test.

ACCEPTANCE CRITERIA

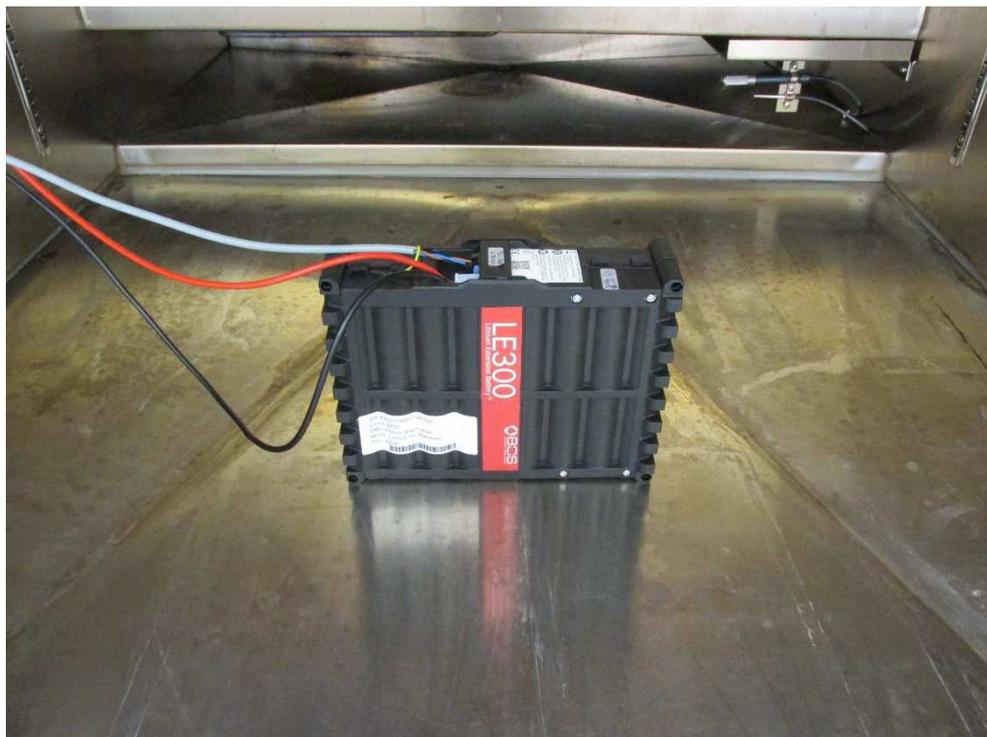
No fire, no explosion.

The BMS shall interrupt the overcharging current by an automatic disconnect of the main contactors in order to protect the battery system against further related severe effects.

SECTION 4.2.2 TEST SETUP



Picture 9 Sketch of the overcharge control of voltage test



Picture 10 Test setup of the overcharge control of voltage test

SECTION 4.2.3 TEST RESULTS

TEST REQUIREMENTS

pass

fail

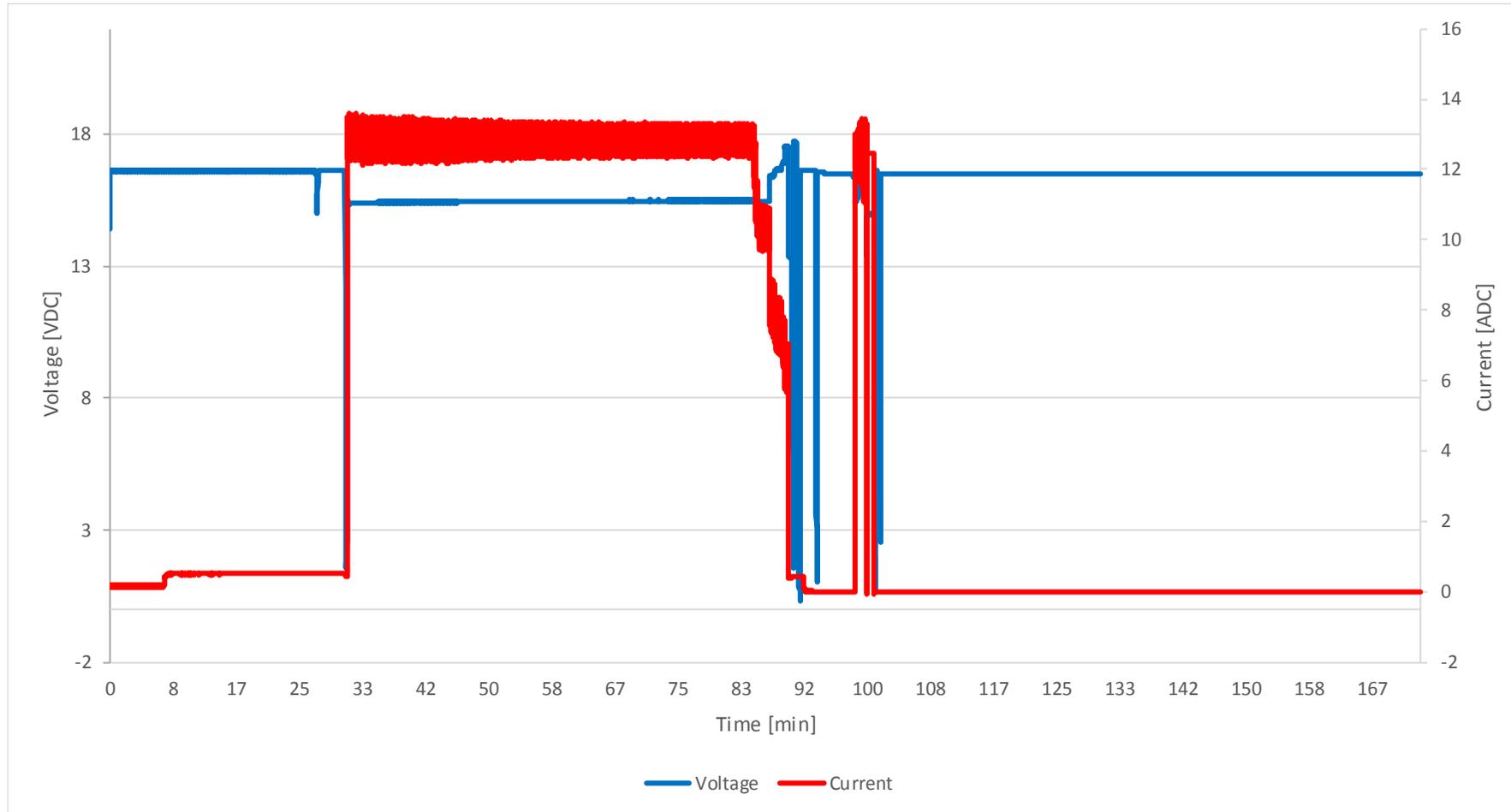
applied

COMMENT

The test was performed as described under section 4.2.1 and 4.2.2.
 After reaching 16,5 VDC the BMS opened the contactors and stopped charging.
 No fire and explosion could be detected during the test.

INTERTEK LABEL NO.	CLIENT SERIAL NO.	VOLTAGE PRE TEST [VDC]	VOLTAGE POST TEST [VDC]	COMMENTS
KAU1708091145-004	000187	14,40	16,50	

Table 11 Measured voltage before and after the overcharge control of voltage test



Graph 1 Measured voltage and current during the overcharge control of voltage test

SECTION 4.3 OVERCHARGE CONTROL OF CURRENT TEST**SECTION 4.3.1 NORMATIVE REFERENCES**

TEST APPLIED ACCORDING TO THE FOLLOWING SPECIFICATIONS / STANDARDS without DEVIANCE	Overcharge control of current 8.2.3 IEC62619:2017
--	--

SAMPLES RECEIVED	1 KAU1708091145-006
DATE OF TEST	2017-09-08
PLACE OF TEST	Kaufbeuren

DESCRIPTION OF TEST SAMPLES

One (1) BOS LE300.

PURPOSE OF TEST

In case the input current to the cells and batteries exceeds the maximum charging current of the cells, the BMS shall interrupt the charging to protect the battery system from hazards related to charging currents above the cells specified maximum charging current

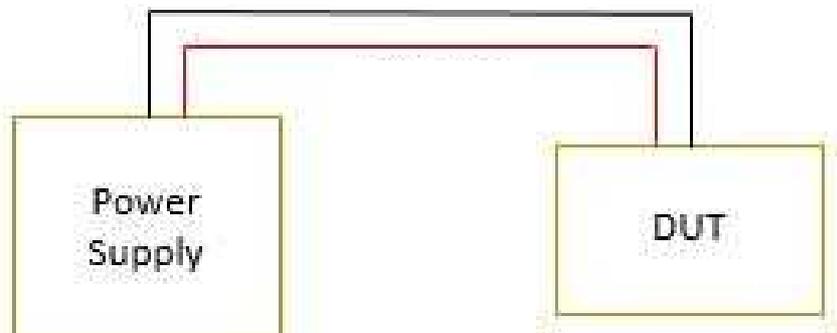
TEST PROCEDURE

The test shall be carried out in an ambient temperature of 25°C +-5°C and under normal operating conditions with the cooling system (if any) operating (main contactors closed with the battery system being controlled by the BMS). Each test battery system shall be discharged at a constant current of 0,2 It A, to a final voltage specified by the manufacturer. Sample batteries shall then be charged at a current exceeding the maximum charging current by 20%. Data acquisition/monitoring shall be continued for 1 h after charging is stopped. All functions of the battery system shall be fully operational as designed during the test.

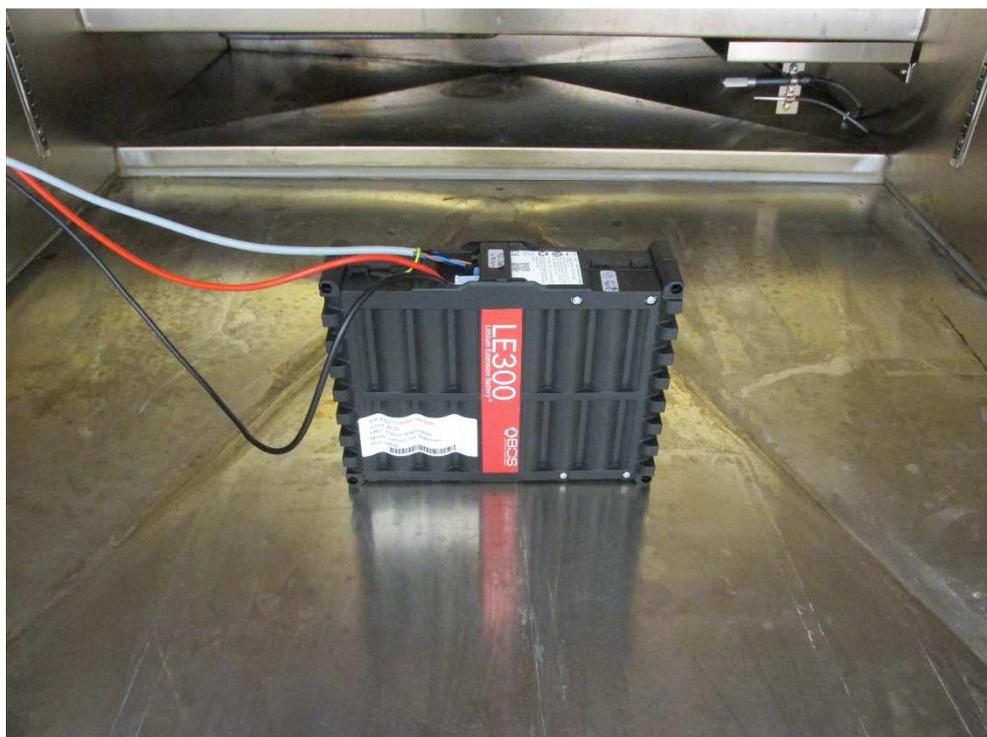
ACCEPTANCE CRITERIA

The BMS shall detect the overcharging current and shall control the charging below the maximum charging current in order to protect the battery system against further related severe effects. No fire, no explosion.

SECTION 4.3.2 TEST SETUP



Picture 12 Sketch of the overcharge control of current test



Picture 13 Test setup of the overcharge control of current test

SECTION 4.3.3 TEST RESULTS

TEST REQUIREMENTS

pass

fail

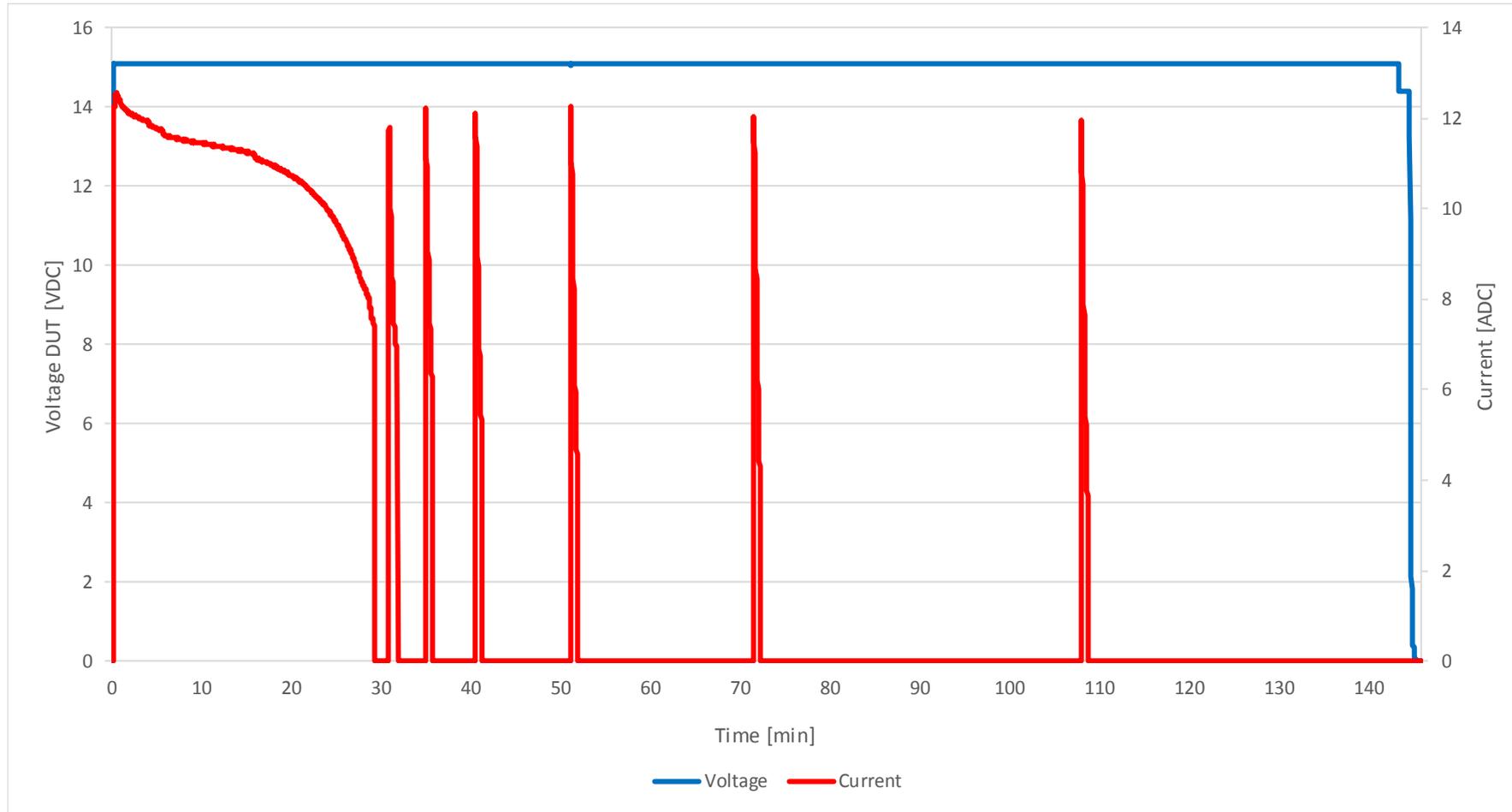
applied

COMMENT

The test was performed as described under section 4.3.1 and 4.3.2.
After reaching 12,55 ADC the BMS opened the contactors and stopped charging. The contactors were closed for several times during the test duration of 1 h.
No fire and explosion could be detected during the test.

INTERTEK LABEL NO.	CLIENT SERIAL NO.	VOLTAGE PRE TEST [VDC]	VOLTAGE POST TEST [VDC]	COMMENTS
KAU1708091145-006	000202	14,39	15,11	

Table 6 Measured voltage before and after the overcharge control of current test



Graph 2 Measured voltage and current during the overcharge control of current test

SECTION 4.4 OVERHEATING CONTROL TEST

SECTION 4.4.1 NORMATIVE REFERENCES

TEST APPLIED ACCORDING TO THE FOLLOWING SPECIFICATIONS / STANDARDS without DEVIANCE	Overheating control 8.2.4 IEC 62619:2017
--	---

SAMPLES RECEIVED	1 KAU1708091145-005
DATE OF TEST	2017-09-11
PLACE OF TEST	Kaufbeuren

DESCRIPTION OF TEST SAMPLES

One (1) BOS LE300.

PURPOSE OF TEST

The BMS shall terminate charging when the temperature of the cells and/or battery exceeds the upper limit that is specified by the cell manufacturer.

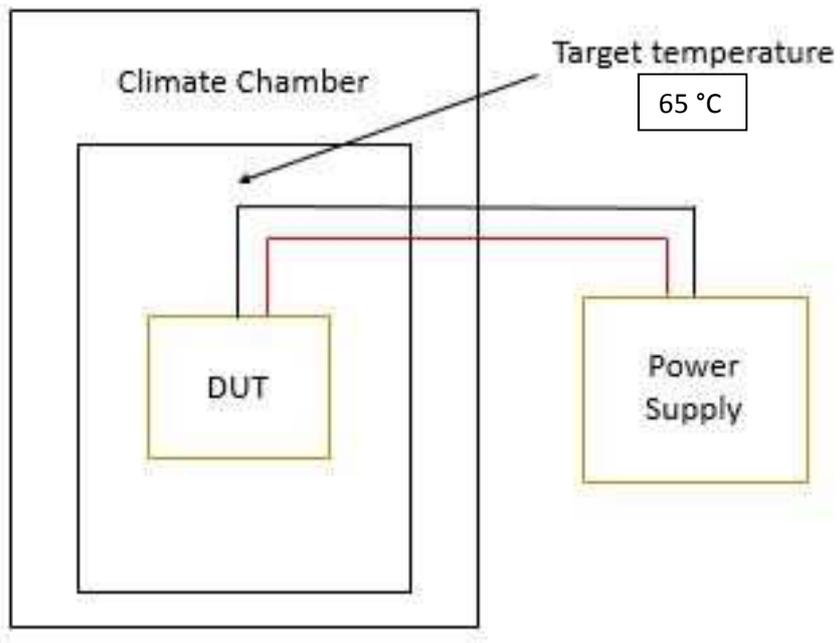
TEST PROCEDURE

The test shall be carried out in an initial ambient temperature of 25°C +-5°C and under normal operating conditions (main contactors are closed with battery system being controlled by the BMS) with the exception that the cooling system, if provided, shall be disconnected. Each test battery system shall be discharged at a constant current of 0,2It A, to a final voltage specified by the manufacturer. Sample batteries shall then be charged at the recommended current to a 50% state of charge. The temperature of the battery system shall be increased to 5°C above the maximum operating temperature. The charging is continued at the elevated temperature until the BMS terminates the charging. Data acquisition/monitoring shall be continued for one hour after the sequence is stopped (e.g. the BMS has terminated charging).

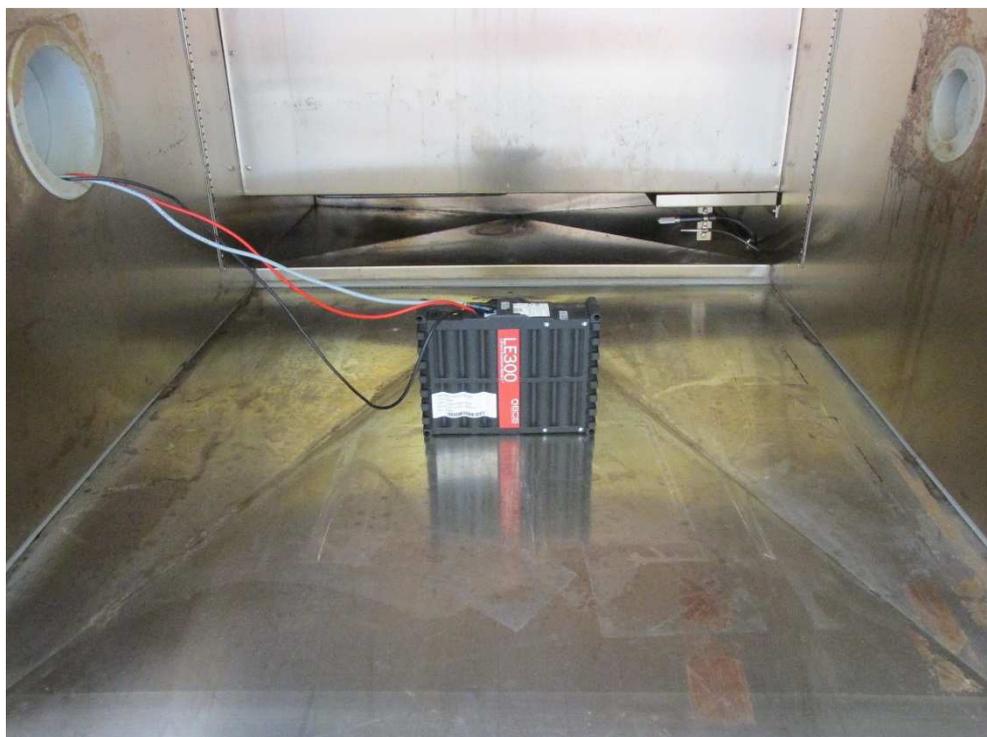
ACCEPTANCE CRITERIA

No fire, no explosion.

SECTION 4.4.2 TEST SETUP



Picture 14 Sketch of the overtemperature test



Picture 15 Test setup of the overheating control test

SECTION 4.4.3 TEST RESULTS

TEST REQUIREMENTS

pass

fail

applied

COMMENT

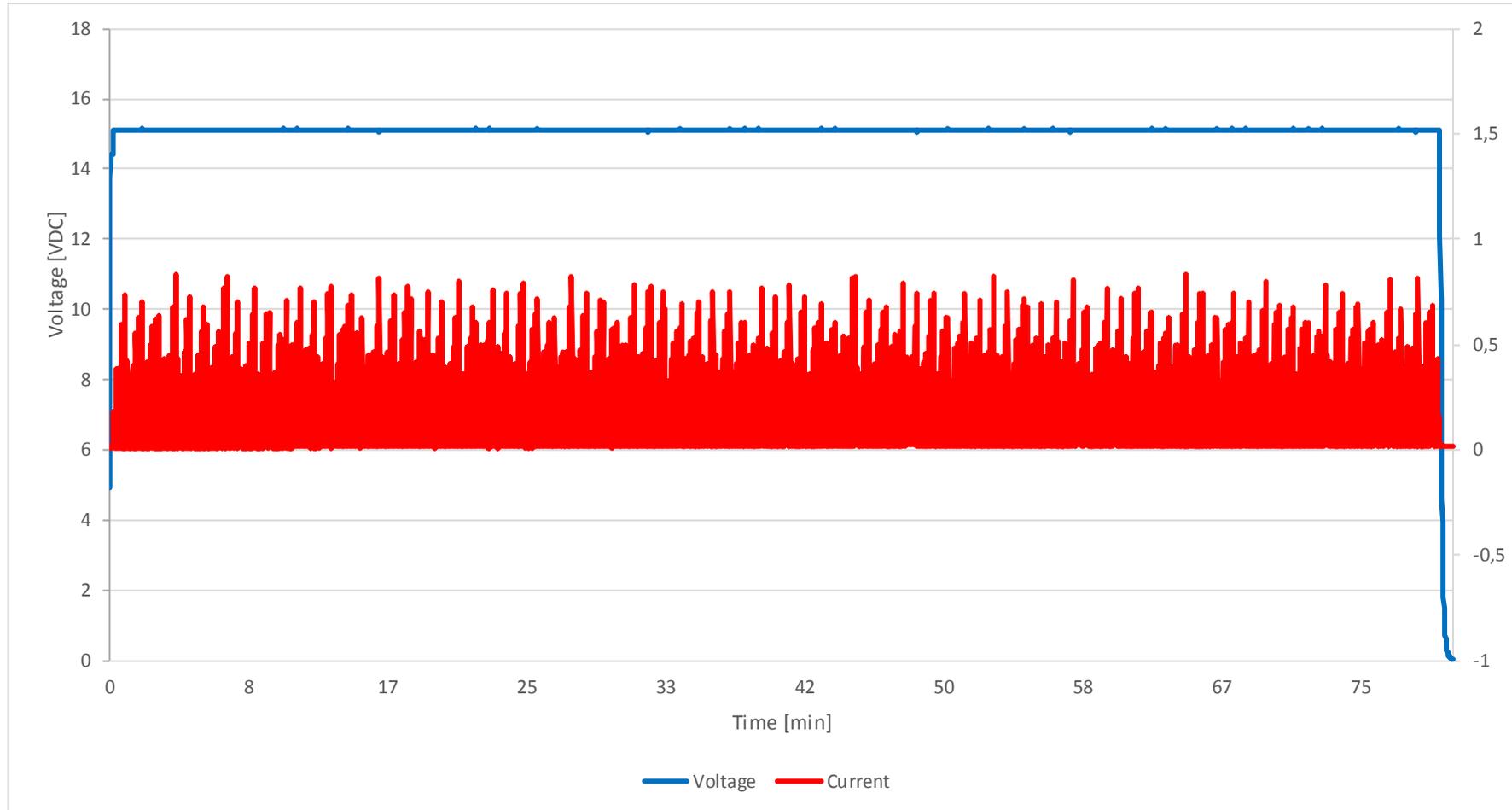
The test was performed as described under section 4.4.1 and 4.4.2.

The battery operating temperature is max. 60°C. The contactors were closed for several times during the test duration of 1 h.

No fire and explosion could be detected during the test.

INTERTEK LABEL NO.	CLIENT SERIAL NO.	VOLTAGE PRE TEST [VDC]	VOLTAGE POST TEST [VDC]	COMMENTS
KAU1708091145-005	000198	14,39	15,11	

Table 16 Measured voltage before and after the overheating control test



Graph 17 Measured voltage and current during the overheating control test

SECTION 4.5 MARKING AND DESIGNATION

SECTION 4.5.1 NORMATIVE REFERENCES

TEST APPLIED ACCORDING TO THE FOLLOWING SPECIFICATIONS / STANDARDS without DEVIANCE	Marking and designation 10; IEC 62619:2017
	Marking and designation 5; IEC 62620:2014

SAMPLES RECEIVED	1 KAU1708091145-005
DATE OF TEST	2017-10-25
PLACE OF TEST	Kaufbeuren

DESCRIPTION OF TEST SAMPLES

One (1) BOS LE300.

PURPOSE OF TEST

This test serves to verify the required markings and designations according to the standard.

TEST PROCEDURE

The markings and designations are checked according to the standard.

ACCEPTANCE CRITERIA

The battery system shall carry clear and durable markings giving the following information:

- Secondary (rechargeable) Li or Li-ion
- Polarity
- Date of manufacture
- Name or identification of manufacturer or supplier
- Rated capacity
- Calculated rated capacity
- Method for calculating rated capacity
- Nominal voltage
- Watt-hour
- Appropriate caution statement (Including disposal instructions)
- Cell designation
- Battery designation
- Recommended charge instructions

SECTION 4.5.2 TEST RESULTS

TEST REQUIREMENTS

pass

fail

applied

COMMENT

The test was performed as described under section 4.5.1 and 4.5.2.

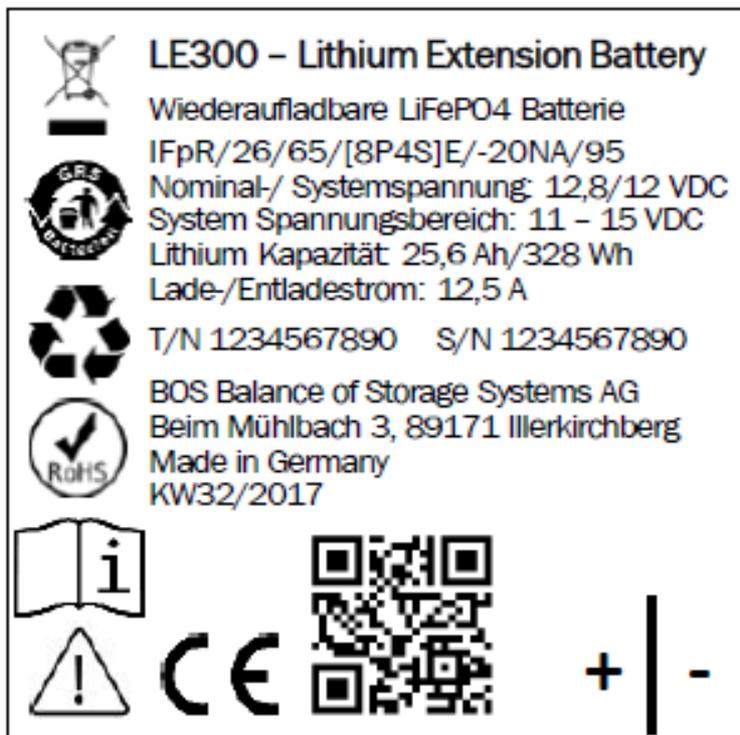
All markings and instructions are in German.

The latest version of the German manual during the test was "User manual LE300_draft_rev.11_Deutsche Übersetzung_rev12.pdf".

For the results see the table below.

MARKING INFORMATION	IEC 62620:2014 CLAUSE	BATTERY SYSTEM	COMMENTS
Secondary (rechargeable) Li or Li-ion	5.1 and table 1	PASS	
Polarity	5.1 and table 1	PASS	
Date of manufacture	5.1 and table 1	PASS	In calendar week and also in code
Name or identification of manufacturer or supplier	5.1 and table 1	PASS	Name and address of manufacturer
Rated capacity	5.1 and table 1	PASS	25,6 Ah
Calculated rated capacity	5.1 and table 1	Not evaluated	Not necessary if there is no evaluation of the split unit
Method for calculating rated capacity	5.1 and table 1	Not evaluated	Not necessary if there is no evaluation of the split unit
Nominal voltage	5.1 and table 1	PASS	12,8 VDC
Watt-hour	5.1 and table 1	PASS	
Appropriate caution statement (Including disposal instructions)	5.1 and table 1	PASS	Caution marking and the marking which refers to the manual. Caution and safety statements are in the manual (including disposal instructions)
Cell designation	5.2 and table 1	Not evaluated	Not necessary because the designation is on the battery system
Battery designation	5.3 and table 1	PASS	IFpR/26/65/[8P4S]E/-20NA/95
Recommended charging instructions	5.1 and table 1	PASS	There is the information on the label and in the manual

Table 7 Results marking and designation



Picture 18 Markings and designation

SECTION 4.6 LABORATORY CONDITIONS

Unless stated otherwise or in case of an abnormal, the samples were stored under controlled ambient conditions of **20 ± 5 °C**, **15 ... 85 % r. H.** and **975 ± 50 mbar**.

Unless stated otherwise all tests were conducted under the ambient condition stated out above.

After the completion of testing, all samples were stored until send back to the customer or disposal.

SECTION 5 ATTACHMENT

SECTION 5.1 USED TEST EQUIPMENT

SECTION 5.1.1 WHOLE DROP TEST

EQUIPMENT	TYPE	MANUFACTURER	INVENTORY-NO.
Data logger	MA25904S	Ahlborn	PM KF 2338
Temp./Humidity sensor	FHAD46-2L00	Ahlborn	PM KF 2340
Air pressure sensor	FDA612-SA	Ahlborn	PM WI 0793
Drop tester	HF-520AS	Haida	PM KF 2311
Ruler	1000 mm	Inox	PM KF 0984

SECTION 5.1.2 OVERCHARGE CONTROL OF VOLTAGE TEST

EQUIPMENT	TYPE	MANUFACTURER	INVENTORY-NO.
Data logger	MA85909	Ahlborn	PM KF 2342
Temp./Humidity sensor	FHAD46-2L05	Ahlborn	PM KF 2348
Air pressure sensor	FDA612-SA	Ahlborn	PM WI 0793
Multimeter	177	Fluke	PM KF 2289
Data logger	34972A	Agilent	PM KF 2692
Slot card	34901A	Agilent	PM KF 2570
Current clamp	i30s	Fluke	PM KF 2506
Power supply	EA PSI9080-100	EA	PM KF 2233

SECTION 5.1.3 OVERCHARGE CONTROL OF CURRENT TEST

EQUIPMENT	TYPE	MANUFACTURER	INVENTORY-NO.
Data logger	MA85909	Ahlborn	PM KF 2342
Temp./Humidity sensor	FHAD46-2L05	Ahlborn	PM KF 2348
Air pressure sensor	FDA612-SA	Ahlborn	PM WI 0793
Multimeter	177	Fluke	PM KF 2289
Data logger	34972A	Agilent	PM KF 2692
Slot card	34901A	Agilent	PM KF 2570
Current clamp	i30s	Fluke	PM KF 2506
Power supply	EA PSI9080-100	EA	PM KF 2233

SECTION 5.1.4 OVERHEATING CONTROL TEST

EQUIPMENT	TYPE	MANUFACTURER	INVENTORY-NO.
Data logger	MA85909	Ahlborn	PM KF 2342
Temp./Humidity sensor	FHAD46-2L05	Ahlborn	PM KF 2348
Air pressure sensor	FDA612-SA	Ahlborn	PM WI 0793
Multimeter	177	Fluke	PM KF 2289
Data logger	34972A	Agilent	PM KF 2692
Slot card	34901A	Agilent	PM KF 2570
Current clamp	i30s	Fluke	PM KF 2506
Power supply	EA PSI9080-100	EA	PM KF 2233
Climate chamber	TCV7120-5-ESS VH	Tira GmbH	PM KF 2802