Prüfbericht-Nr.: *Test Report No.*:	**60237007-001**	**Auftrags-Nr.:** *Order No.*:	3285435	Seite 1 von 8 *Page 1 of 8*
Kunden-Referenz-Nr.: *Client Reference No.*:	0010/249/4500845282	**Auftragsdatum:** *Order date*:	07.03.2019	
Auftraggeber: *Client*:	Hoppecke Batterien GmbH & Co. KG Postfach 11 40, D-59914 Brilon			
Prüfgegenstand: *Test item*:	Fire protection rack			
Bezeichnung / Typ-Nr.: *Identification / Type No.*:	sun | systemizer scalebloc			
Auftrags-Inhalt: *Order content*:	Propagation test on Battery Energy Storage System			
Prüfgrundlage: *Test specification*:	VDE-AR-E 2510-50:2017, clause 6.2.6 Stationary battery energy storage systems with lithium batteries – Safety requirements			

Wareneingangsdatum: *Date of receipt*:	N/A, on-site Testing
Prüfmuster-Nr.: *Test sample No.*:	N/A, on-site Testing
Prüfzeitraum: *Testing period*:	2019-03-28 - 2019-03-28
Ort der Prüfung: *Place of testing*:	Fraunhofer HHI Am Stollen 19, 38640 Goslar
Prüflaboratorium: *Testing laboratory*:	TÜV Rheinland LGA Products GmbH
Prüfergebnis*: *Test result**:	Pass

geprüft von / *tested by*:			**kontrolliert von /** *reviewed by*:		
10.04.2019	Martin Hessenmüller/SV ; Matthias Kahrs/SV		10.04.2019	Stephan Scheuer / LL	
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

Sonstiges / *Other*: This report consists of 8 pages. The documented measurement results are only valid in conjunction with the entire test report.
The test represents an one-time test on one test sample of the above mentioned product, only according to clause 6.2.6 of the VDE-AR-E 2510-50:2017.
For further information see "Remarks" on page 3.

Zustand des Prüfgegenstandes bei Anlieferung: Prüfmuster vollständig und unbeschädigt
Condition of the test item at delivery: *Test item complete and undamaged*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

V04

Prüfbericht-Nr.: 60237007-001
Test Report No.:

Liste der verwendeten Prüfmittel
List of used test equipment

Prüfmittel *Test equipment*	**Prüfmittel-Nr. / ID-Nr.** *Equipment No. / ID-No.*	**Nächste Kalibrierung** *Next calibration*
High precision current transducer LEM IT 200-S	2731836	09/2020
Voltage measurement MCTS 200	2884332	09/2020
Data logger CL-2108	2731885	09/2020
Temperature recorder	2730071	10/2020
Voltage measurement Fluke 87 V	2729183	08/2019

Produktbeschreibung
Product description

1	**Produktdetails** *Product details*	Cell Technology : Lithium-ion (NMC) Form / Type of cel : prismatic Interconnection : 22S1P (Battery module level) End-of-charge-voltage cell : 4.15 V Nominal capacity : 94 Ah Energy : 7.61 kWh Voltage range : 70.4 V - 91.3 V Maximum discharge current: - Maximum charge current: - Operating temperature : max. 45 °C
2	**Maße / Gewicht** *Dimensions / Weight*	Height : 160 mm Width : 370 mm Depth : 650 mm Weight: 54 kg
3	**Bedienelemente** *Operating elements*	N/A
4	**Ausstattung / Zubehör** *Equipment / Accessories*	N/A
5	**Verwendete Materialien** *Used materials*	N/A
6	**Bemerkungen** *Remarks*	

The performed test represents the worst case condition of an Energy Storage System (ESS) which is additional protected by a final system enclosure.

So, the documented test results in this report are only valid when the installation of these battery module racks are realized in a position/location inside of a final system enclosure which are free of potential fire or ignition sources.

Absatz	**VDE-AR-E 2510-50:2017, clause 6.2.6**	Messergebnisse - Bemerkungen	Bewertung
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Evaluation*
6.2.6	**Propagation test: stackable BESS**		
6.2.6.1	**Purpose**		
	For stackable solutions, hazards as described in 6.2.4 shall be limited to a permissible area. Cell defects shall propagate neither from module to module nor from module to system level.	Overcharge procedure was applied on one cell inside of the battery module. Internal CID (current interrupting device) was disabled. Battery modules were fully charged. Charge cut-off voltage of the cell: 4,150 V_{dc} Battery module voltage at the end of charging process: 4,105 V_{dc} Battery modules were climatically preconditioned to 45 °C. The test setup was metrologically recorded (cell and module voltage incl. thermo couples inside of the system). See picture 4 and 5.	P ☒ F ☐ N/A ☐ N/T ☐
6.2.6.2	**Test procedure**		
	Testing shall be conducted according to 6.2.4 (see also Figure 3).	See picture 1 below. The middle rack module (Section B2) was defined as worst case condition for the test. The module inside of this rack was prepared for the propagation test (See picture 2). Additional a fully charged Battery module was installed (Section A2 over the propagation module). See also picture 3 for a schematically description of the test setup.	P ☒ F ☐ N/A ☐ N/T ☐

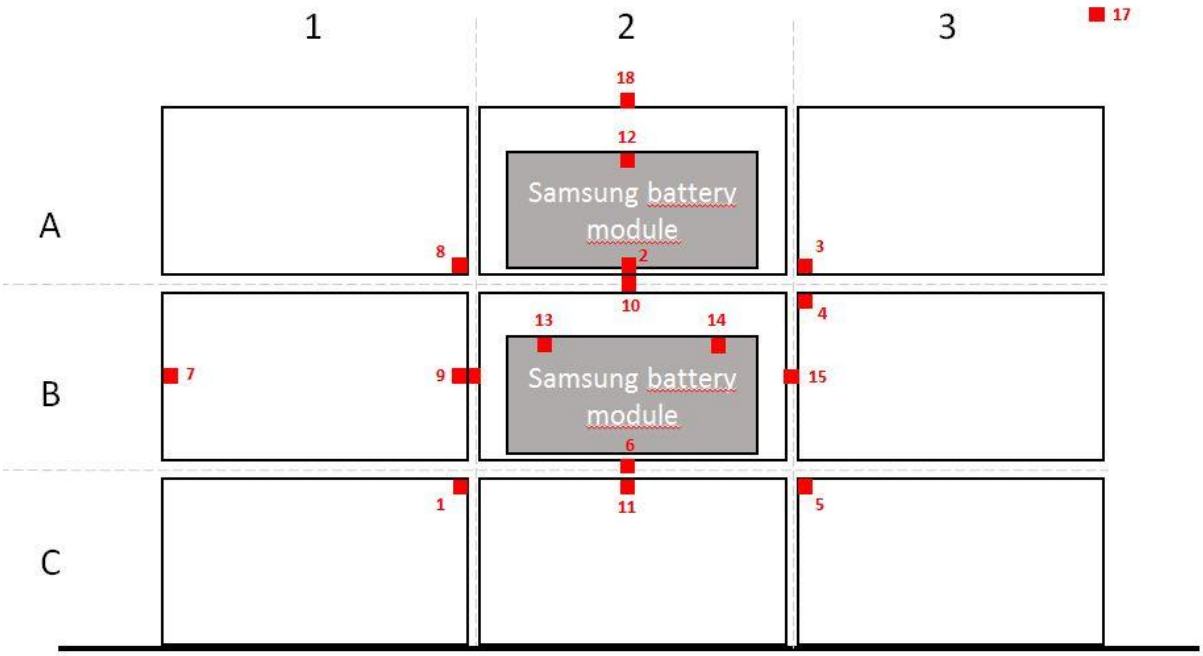
Absatz	**VDE-AR-E 2510-50:2017, clause 6.2.6**	Messergebnisse - Bemerkungen	Bewertung
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Evaluation*
6.2.6.3	**Requirements**		
	Component verification: For the purpose of fire protection, each single module shall be equipped with a fire protection enclosure in accordance with DIN EN 62368-1 (VDE 0868-1), M 4.3, 6.4.8. The fire protection enclosure may be the one of the secondary lithium battery itself or that of the device in which it is contained.	The rack module for the battery module consists of solid metal. Additionally this rack module consists of constructive fire protection measure inclusive an external installed fire protection matting.	P ☒ F ☐ N/A ☐ N/T ☐
	The presence of this fire protection enclosure shall be demonstrated by means of the test report or visual inspection of the relevant materials or by submitting the data sheet of the secondary lithium battery.	See picture 1.	P ☒ F ☐ N/A ☐ N/T ☐
	Test verification: - Cell defects shall only propagate within the module in which the thermal instability of the cell was intentionally caused. - A propagation from this module to an adjacent module shall be precluded by testing (see above). - Hazards (liquid electrolyte, fire, explosion or ejected parts) shall not propagate beyond the system boundaries (except vented gases which are considered separately in 7.10.3).	Propagation has occurred internally of the rack module. Propagation of the affected battery module has no effect to the above installed battery module in sector A2 (See picture 3). No liquid electrolyte leaking, no fire, no explosion and no ejected parts occurred. Additional see remark on page 3, concerning the requirement in the end use of a final system enclosure.	P ☒ F ☐ N/A ☐ N/T ☐

Prüfbericht-Nr.: 60237007-001 *Test Report No.*:			Seite 6 von 8 *Page 6 of 8*
Absatz	**VDE-AR-E 2510-50:2017, clause 6.2.6**	Messergebnisse - Bemerkungen	Bewertung
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Evaluation*

Photo documentation

Picture 1 - Test sample inside of the chamber

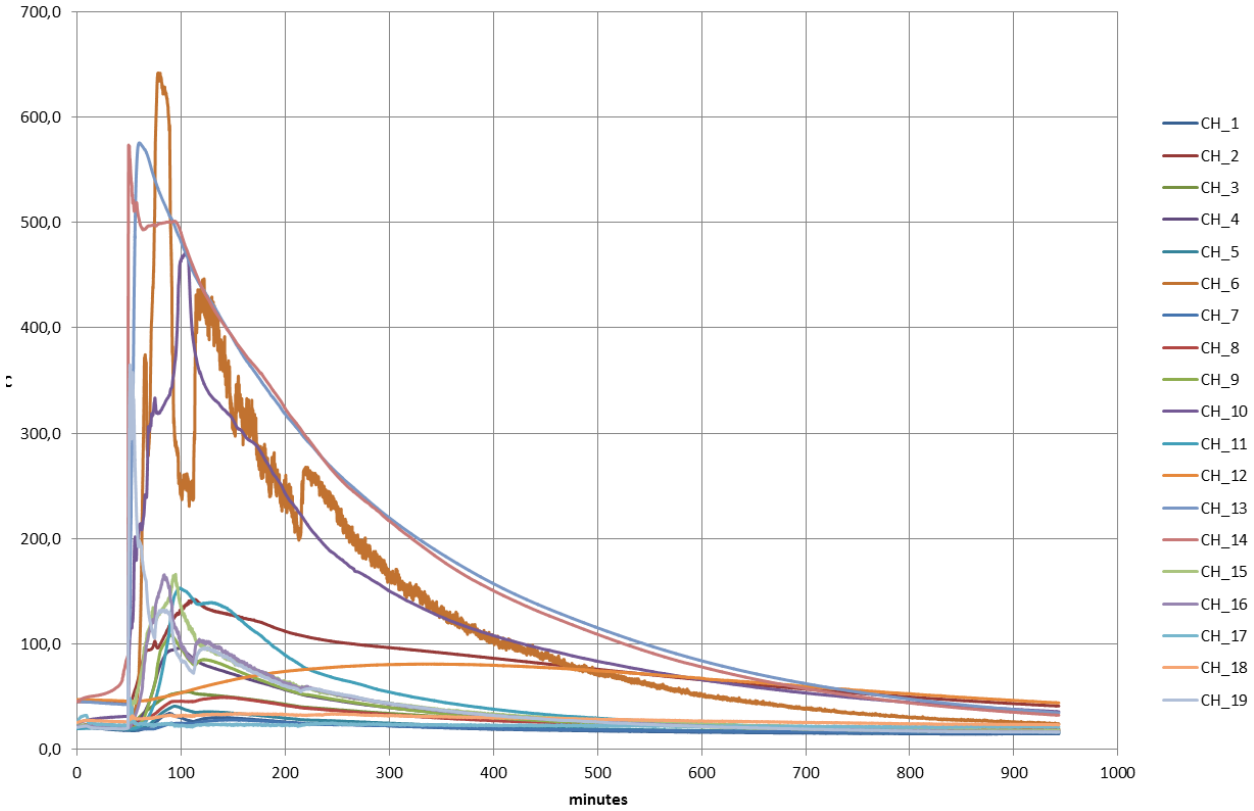
Picture 2 - Preparted battery module



Picture 3 - Schematic of the test setup incl. indicated system locations and thermo couples

Absatz	**VDE-AR-E 2510-50:2017, clause 6.2.6**	Messergebnisse - Bemerkungen	Bewertung
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Evaluation*

Temperature measurment:

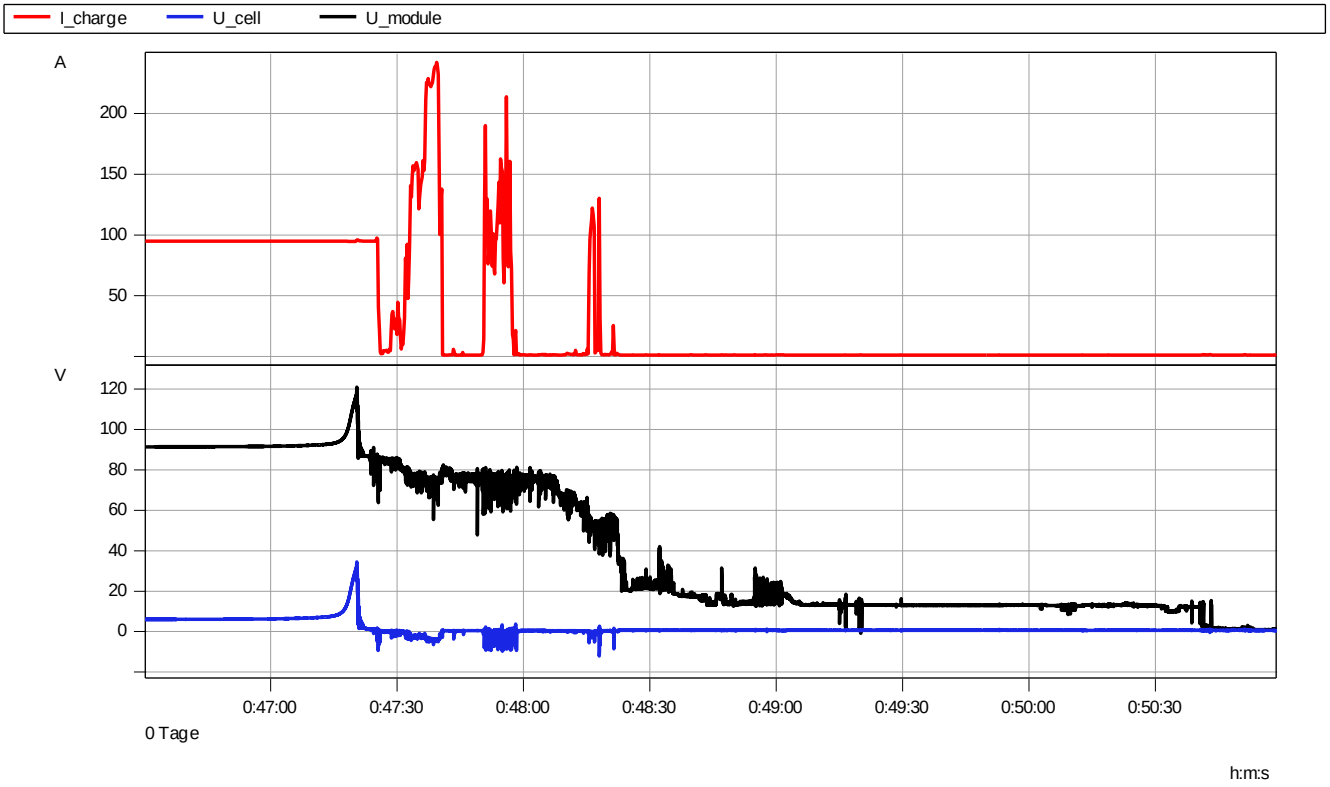


Picture 4 – Temperature diagram

Channel	Position description
1	Location C1 – Side panel right, top corner, inside
2	Location A2 – Bottom Center, Inside (under Samsung battery module)
3	Location A3 – Side panel left, bottom corner, inside
4	Location B3 – Side panel left, top corner, inside
5	Location C3 – Side panel left, top corner, inside
6	Between location B2 and C2
7	Location B1 – Side panel left, center, inside
8	Location A1 – Side panel right, bottom corner, inside
9	Location B1 – Side panel right, center, inside
10	Between location A2 and B2
11	Location C2 – Top center, inside
12	Samsung module in location A2 – Inside temperature
13	Samsung module in location B2 „Propagation“ – minus pole cell left outside
14	Samsung module in location B2 „Propagation“ – minus pole Propagation cell
15	Between location B2 and B3
16	Between location B1 and B2
17	Ambient temperature test bench chamber
18	A2 Top outside
19	B2 Front side center outside (Hoppecke aperture)

Prüfbericht-Nr.: 60237007-001 *Test Report No.*:			Seite 8 von 8 *Page 8 of 8*
Absatz	**VDE-AR-E 2510-50:2017, clause 6.2.6**	Messergebnisse - Bemerkungen	Bewertung
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	*Evaluation*

Voltage and Current measurment:



Picture 5 – Voltage and Current diagram