TEST REPORT
IEC 62619

Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications

Report Number. ..... :	68.280.15.607.01
Date of issue..... :	2016-03-23
Total number of pages ..... :	23pages
Applicant's name..... :	BYD CO LTD.
Address..... :	Baolong industrial Town.1 Bao Ping Rd.518116 Longgang,Shenzhen,Guangdong,PEPOLE'S REPUBLIC OF CHINA
Test specification:	
Standard ..... :	IEC 21A/556/CD (draft IEC62619 Ed. 1.0)
Test procedure ..... :	TÜV Mark
Non-standard test method ..... :	N/A
Test Report Form No. ..... :	IEC62619A
Test Report Form(s) Originator.... :	TÜV SÜD Product Service Ltd.
Master TRF..... :	
Test item description..... :	Rechargeable Li-ion Battery
Trade Mark..... :	BYD
Manufacturer..... :	BYD CO LTD. Baolong industrial Town.1 Bao Ping Rd.518116 Longgang,Shenzhen,Guangdong,PEPOLE'S REPUBLIC OF CHINA
Model/Type reference..... :	U3A1-50P-A,B-BOX 2.5,B-BOX 5.0,B-BOX 7.5,B-BOX 10.0
Ratings..... :	51.2Vd.c., 50Ah(U3A1-50P-A,B-BOX 2.5)100Ah(B-BOX 5.0)150Ah(B-BOX 7.5)200Ah(B-BOX 10.0)

Telephone : +86 755 8828 6998
Telefax : +86 755 8828 5299

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TÜV SÜD Certification and Testing (China) Co., Ltd.
Shenzhen Branch,TÜV SÜD Group

Building 12&13, Zhiheng Wisdomland Business Park,
Nantou Checkpoint Road 2, Nanshan District
518052 Shenzhen, CHINA

Testing procedure and testing location:

Testing Laboratory:

Testing location/ address ..... :	TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch No.11, Jukeng Rd., Juling Village, Jutang District, Guanlan, Longhua New District, Shenzhen, 518110 P.R. China
Tested by (name + signature) .....:	Burook Wu .....
Approved by (name + signature) .:	Harry Zhang .....

List of Attachments:

Attachment No.1: 14 pages of Photo Documentation

Summary of testing:

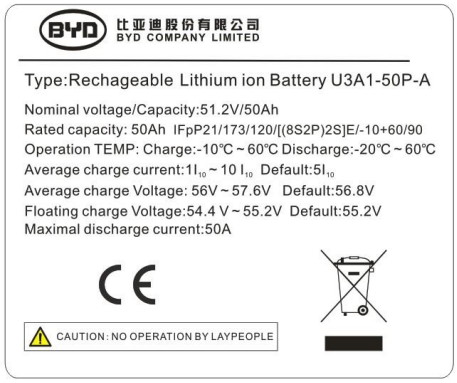
Tests performed (name of test and test clause):	**Testing location:**
In section 8, each test clause below is performed with three cells except for clause 8.2.2 with six cells, clause 8.2.3.2 with 3 batteries and clause 8.3.2 with five cells. - Clause 8.2.1 External short circuit test (cell) - Clause 8.2.2 Impact test (cell) - Clause 8.2.3.1 Whole drop test (cell) - Clause 8.2.3.2 Edge or corner drop test (battery system) - Clause 8.2.4 Thermal abuse test (cell) - Clause 8.2.5 Overcharging test (cell) - Clause 8.2.6 Forced discharge test (cell) - Clause 8.3.2 Internal short-circuit (cell) In section 9, each test clause below is performed with one battery. - Clause 9.2.2 Over charge control of voltage (battery system) - Clause 9.2.3 Over charge control of current (battery system) - Clause 9.2.4 Overheating control (battery system) The samples comply with the requirement of IEC 21A/556/CD (draft IEC62619 Ed. 1.0).	TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch No.11, Jukeng Rd., Juling Village, Jutang District, Guanlan, Longhua New District, Shenzhen, 518110 P.R. China

Summary of compliance with National Differences

N/A

Copy of marking plate

The following labels are attached on the surface of battery.
U3A1-50P-A



Polarity is marked on the terminal connector. Besides,date of production meeting below barcode way in nameplate.

For example,Serial No. is “BYD10033-AC141609-00001-01”.The”1416” mean that the manufacture date is 14th week in 2016.

B - BOX series

Polarity is marked on the terminal connector. Besides,date of production meeting below barcode way in nameplate.

For example,Serial No. is “PGM00001326-102141613-00001”.The”1416” mean that the manufacture date is 14th week in 2016.

The example of B-BOX 5.0

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Test item particulars .....:	
Classification of installation and use.....:	Use in energy storage applications
Supply connection.....:	Supply connection is by screw terminal
Recommend charging method declaired by the manufacturer .....:	See page 5
Discharge current (0,2 I_t A) .....:	See page 5
Specified final voltage.....:	See page 5
Upper limit charging voltage per cell.....:	See page 5
Maximum charging current.....:	See page 5
Charging temperature upper limit.....:	See page 5
Charging temperature lower limit .....:	See page 5
Polymer cell electrolyte type.....:	☐ gel polymer ..... ☐ solid polymer
Possible test case verdicts:	
- test case does not apply to the test object..... :	N/A
- test object does meet the requirement..... :	P (Pass)
- test object does not meet the requirement..... :	F (Fail)
Testing ..... :	
Date of receipt of test item..... :	2015-12-04
Date (s) of performance of tests ..... :	2015-12-04 to 2016-03-23

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Name and address of factory (ies)..... :	BYD CO LTD. Baolong industrial Town.1 Bao Ping Rd.518116 Longgang,Shenzhen,Guangdong,PEPOLE'S REPUBLIC OF CHINA

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General product information:

The battery(U3A1-50P-A) is comprised of 32 cells(C20), the connecting way of cells is 8S2P into a set, and then two groups in series; there is a separate battery management system(PMU) in the battery (U3A1-50P-A). The Battery system consists of a certain number of batteries and a rack with BMU management system, when the battery number is 1, battery system called B-BOX 2.5, battery number is 2, battery system known as B-BOX 5.0; And so on, B-BOX 7.5 battery system contains three batteries, B-BOX 10.0 battery system contains four batteries, battery system is mentioned above are only used to a BMU management system and a cabinet. There are two kinds of color of the cabinet, creamy white and black.

Product name	Rechargeable Li-ion Cell	Rechargeable Li-ion Battery	Rechargeable Li-ion Battery System			
Type/model	C20	U3A1-50P-A	B-BOX 2.5	B-BOX 5.0	B-BOX 7.5	B-BOX 10.0
Nominal voltage	3.2V	51.2V	51.2V			
Rated capacity	25Ah	50Ah	50Ah	100Ah	150Ah	200Ah
Recommended charging voltage by manufacturer	3.8V	56.5	56.5V			
Upper limit charging voltage	3.8V	-	-			
Recommended charging current by manufacturer	4A	10A	10A	20A	30A	40A
Maximum charging current	40A	50A	50A	90A	135A	180A
Charging temp. upper limit	60°C	60°C	60°C			
Charging temp. lower limit	-10°C	-10°C	-10°C			
Standard charging method by manufacturer	Charge at constant current 4A until voltage reaches 3.8V.	Charge at constant current 10A until voltage reaches 56.5V, then charge at constant voltage 56.5V till charge current is 0.05C (2.5A).	Charge at constant current 10A(B-BO X2.5),20A(B-BOX 5.0),30A(B-BOX 7.5),40A(B-BOX 10.0) until voltage reaches 56.5V, then charge at constant voltage 56.5V till charge current is 0.05C (2.5A~B-BOX 2.5,5A~B-BOX 5.0,7.5A-B-BOX 7.5,10A-B-BOX 10.0).			
Charging procedure for internal short-circuit test	Charge at constant current 50A until voltage reaches 3.8V, then charge at constant voltage 3.8V till charge current is 0.05C (1.25A).	-	-			
Maximum discharging current	80A	50A	50A	90A	135A	180A
Final discharge voltage	2.0V	40V	40V			
Dimension	(20~20.80)mm×(172.40~172.60)mm×(119.0~119.55)	482.6mm×130mm× 469.5mm	820±2mm×600±2 mm× 510±2mm			

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	mm					
Weight	(0.8±0.03)kg	36.8kg	78kg	116kg	154kg	192kg

The final evaluation of the battery must be conducted in the end product for which the battery will be used.

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IEC 21A/556/CD (draft IEC62619 Ed. 1.0)			
Clause	Requirement + Test	Result - Remark	Verdict
4	**Parameter measurement tolerances**		P
	Parameter measurement tolerances		P
5	**General safety considerations**		P
5.1	Insulation and wiring		P
	Internal wiring and insulation are sufficient to withstand maximum anticipated current, voltage and temperature requirements.		P
	Orientation of wiring maintains adequate clearances and creepage distances between conductors.		P
	Mechanical integrity of internal connections accommodates reasonably foreseeable misuse.		P
5.2	Venting		P
	The casing of a cell, module, battery pack, and battery system incorporates a pressure relief function that will preclude rupture or explosion.		P
	Encapsulation used to support cells within an outer casing does not cause the battery system to overheat during normal operation nor inhibit pressure relief.		P
5.3	Temperature/voltage/current management		P
	Batteries are designed such that abnormal temperature rise conditions are prevented.		P
	Batteries are designed to be within temperature, voltage and current limits specified by the cell manufacturer.		P
	Batteries are provided with specifications and charging instructions for equipment manufacturers so that associated chargers are designed to maintain charging within the temperature, voltage and current limits specified.		P
5.4	Terminal contacts of the battery pack and/or battery system		P
	Terminals have a clear polarity marking on the external surface of the battery pack or battery system.	"+,-" marking on the battery	P
	The size and shape of the terminal contacts ensure that they can carry the maximum anticipated current.		P
	External terminal contact surfaces are formed from conductive materials with good mechanical strength and corrosion resistance.		P
	Terminal contacts are arranged to minimize the risk of short circuits.		P

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IEC 21A/556/CD (draft IEC62619 Ed. 1.0)			
Clause	Requirement + Test	Result - Remark	Verdict
5.5	Assembly of cells , modules, or battery packs into battery systems		P
5.5.1	General		P
	Each battery system has an independent control and protection method(s).		P
	Manufacturers of cells make recommendations about current, voltage and temperature limits so that the battery system manufacturer/designer may ensure proper design and assembly.		P
	Batteries that are designed for the selective discharge of a portion of their series connected cells shall incorporate separate circuitry to prevent the cell reversal caused by uneven discharges.		N/A
	Protective circuit components should be added as appropriate and consideration given to the end-device application.		P
	When testing a battery, the manufacturer of the battery provides a test report confirming the compliance according to this standard.		N/A
5.5.2	Battery system design		P
	The voltage control function of the battery system design shall ensure that the voltage of each cell, or cell block shall not exceed the upper limit of the charging voltage specified by the manufacturer of the cell, except in the case where the stationary application devices or motive application devices provide an equivalent voltage control function.	The voltage control function of the battery system design can ensure that the voltage of cell block shall not exceed the upper limit of the charging voltage.	P
	For the battery system which has series-connected plural single cells, modules or battery packs, it is recommended that the voltages of any one of the single cells or cell blocks does not exceed the upper limit of the charging voltage, specified by the cell manufacturer, by monitoring the voltage of every single cell or single modules consisting of plural cell blocks.		P
5.6	Quality plan		P
	The manufacturer prepares and implements a quality plan that defines procedures for the inspection of materials, components, cells and batteries and which covers the whole process of producing each type of cell, module, battery pack, and battery system		P
6	**Test guide lines**		P
6.1	Operating region of lithium cells and battery systems for safe use		P
6.1.1	General		P

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IEC 21A/556/CD (draft IEC62619 Ed. 1.0)			
Clause	Requirement + Test	Result - Remark	Verdict
6.1.2	Safety of secondary lithium cells and battery systems		P
6.1.3	Considerations for charge voltage		P
6.1.3.1	General		P
6.1.3.2	Explanation of safety view point		P
6.1.3.3	Safety requirements, when the upper limit charge voltage is applied		P
6.1.4	Considerations for temperature and charge current		P
6.1.4.1	General		P
6.1.4.2	Recommended temperature range	Specified charge temperature: -10-60°C	P
6.1.4.3	High temperature range		P
6.1.4.4	Low temperature range		P
6.1.5	Considerations for discharge		P
6.1.5.1	General		P
7	**Type test conditions**		P
7.1	General		P
7.2	Test items		P
	Tests are made with the number of cells or batteries specified in Table 1, using cells or batteries that are not more than six months old.		P
	Unless otherwise specified, tests are carried out in an ambient temperature of 25 °C ± 5 °C.	Tests are carried out in an ambient temperature of 25 °C ± 5 °C.	P
8	**Specific requirements and tests**		P
8.1	Charging procedure for test purposes		P
	Prior to charging, the battery is discharged at 25 °C ± 5 °C at a constant current of 0,2 I_t A down to a specified final voltage.		P
	Unless otherwise stated in this standard, cells or batteries are charged in an ambient temperature of 25 °C ± 5 °C, using the method specified by the manufacturer.	Cells and batteries are charged in an ambient temperature of 25 °C ± 5 °C.	P
8.2	Reasonably foreseeable misuse		P
8.2.1	External short circuit (cell or cell block)		P
	Fully charged cells are short-circuited by connecting the positive and negative terminals with a total external resistance of 30 ± 10mΩ.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	The cells remain on test until one of the following occurred: - 6 hours elapsed; or		N/A
	- The case temperature declines by 20% of the maximum temperature rise.		P
	Results: No fire. No explosion	(See Table 8.2.1)	P
8.2.2	Impact test (cell or cell block)		P
	A test sample is to be placed on a flat surface. A 15.8mm diameter bar is to be placed across the centre of the sample. A 9.1kg mass is to be dropped from a height of 61 ± 2.5 mm onto the bar placed on the sample.		P
	A cylindrical or prismatic cell is to be impacted with its longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the 15.8 mm diameter curved surface lying across the centre of the test sample.		P
	A prismatic cell is also to be rotated 90 degrees around its longitudinal axis so that both the wide and narrow sides are subjected to the impact.		P
	Each sample is to be subjected to only a single impact with separate samples to be used for each impact.		P
	Results: No fire. No explosion	(See Table 8.2.2)	P
8.2.3	Drop test (cell or cell block, and battery system)		P
8.2.3.1	Whole drop test (cell or cell block, and battery system)	For the cell (Weight: approx. 0.5kg)	P
	Each fully charged test unit is dropped three times from a height shown in table 2 onto a concrete floor.		P
	In the case of the mass of test unit is less than 7kg, the test units are dropped so as to obtain impacts in random orientations.		P
	In the case of the mass of test unit is 7kg or more and less than 20 kg, the test is performed with the test unit dropped in the bottom down direction. The bottom surface of the test unit is specified by the manufacturer.		N/A
	After the test, the test units are put on rest for a minimum of one hour and then a visual inspection shall be performed.		P
	Results: No fire, No explosion	(See Table 8.2.3.1)	P
8.2.3.2	Edge and corner drop test (cell or cell block, and battery system)	For the battery (Weight: approx. 25kg)	P

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Clause	Requirement + Test	Result - Remark	Verdict
	Each fully charged test unit is dropped two times from a height shown in table 2 onto a concrete floor.		P
	The drop test conditions assure, with test arrangements as shown in Figure 3, Figure 4 and Figure 5, reproducible impact points for the shortest edge drop impact and the corner impacted.		P
	The two impacts, per impact type, shall be on the same corner and on the same shortest edge.		P
	For the corner and edge drops, the test unit is oriented in such a way that a straight line drawn through the struck corner/edge and the test unit geometric centre is approximately perpendicular to the impact surface.		P
	Results: No fire, No explosion	(See Table 8.2.3.2)	P
8.2.4	Thermal abuse (cell or cell block)		P
	Each fully charged cell, stabilized at room temperature, is placed in a gravity or circulating air-convection oven which is raised at a rate of 5°C / min ± 2 °C /min to a temperature of 85 °C ± 5 °C.		P
	The cell remains at this temperature for 3h before the test is discontinued.		P
	Results: No fire, No explosion	(See Table 8.2.4)	P
8.2.5	Overcharging (cell or cell block)		P
	Discharged cells are charged with a constant current equal to the maximum specified charge current of the battery system until the voltage reaches the maximum voltage value that is possible when any single failure on the charge control or charge protection function occurs, then the charge is terminated.	Maximum charge current:40A Maximum charge voltage:3.8V	P
	Test is continued until the temperature of the cell surface: - Reached steady state conditions (less than 10°C change in 30-minute period); or		P
	- Returned to ambient		N/A
	Results: No fire, No explosion		P
8.2.6	Forced discharge (cell or cell block)		P
	A discharged cell is subjected to a forced discharge at 1,0 I_t A for a test period of 90min.		P
	The voltage is kept at the target voltage by reducing the current for the remaining test period if the discharge voltage reaches the target voltage shown below within the test period.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	The target voltage is determined as follows: i. Battery system provided with redundant independent protection for discharge voltage control or the battery system has only single cell or cell block: Target voltage = - (upper limit charge voltage of the cell)		N/A
	ii. Battery system provided with only a single protection or less for discharge voltage control: Target voltage = - [upper limit charge voltage of the cell × (n-1)]. n: the number of cells connected in series in the battery system.		N/A
	If the maximum discharge current of the cell is less than 1.0 I_t A, perform a reverse charge at the current for the test period shown below: $t = \frac{1I_t}{I_m} \times 90$ t: test period (min.) I_m: maximum discharge current of the cell (A)	Maximum discharge current: $3I_t$ A	N/A
	Results: No fire, No explosion	(See Table 8.2.6)	P
8.3	Considerations for internal short-circuit – Design evaluation		P
8.3.1	General		P
8.3.2	Internal short-circuit test (cell or cell block)		P
	Refer to clause 8.3.9 of IEC 62133 Ed.2		P
	The sample preparation procedure may be changed from the procedure outlined in IEC 62133 prior to performing the final pressing process with the corresponding charging procedure according to clause 8.3.9 of IEC 62133 Ed.2. - The nickel particle may be inserted into a discharged element and then charged, or		N/A
	- The nickel particle may be inserted into the element before the electrolyte filling and then it may be assembled, filled with electrolyte and charged. In these assemblies, a polyethylene bag and/or an aluminium-laminated bag can be used instead of the metal case for the actual cell.		N/A
	In the case of a prismatic cell with a stacking type or folding type electrode element, the nickel particle should be inserted at the centre of the end positive and negative electrode pair, and the maximum pressing pressure is 400 N.		P
	Results: No fire, No explosion	(See Table 8.3.2)	P

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Clause	Requirement + Test	Result - Remark	Verdict
8.3.3	Propagation test (battery system)		N/A
	One cell in the fully charged battery system is heated until the cell enters thermal runaway……:		N/A
	After thermal runaway in the cell is initiated, the heater is turned off and battery system is observed for 1 hour.		N/A
	Results: No external fire from the battery system or no battery case rupture.		N/A
9	**Functional safety (system safety)**		P
9.1	General requirements		P
	Reliance on electric, electronic and software controls and systems for critical safety shall be subjected to analysis for functional safety: IEC 61508 series, IEC 60730-1 (Annex H) or other standards	Relevant documents provided by the client indicate analysis for functional safety has been done according to IEC 60730-1 (Annex H) by battery manufacturer	P
	A process hazard, risk assessment and mitigation of the battery system shall be done by the battery system manufacturers.		P
9.2	Battery management unit (or battery management system)		P
9.2.1	Requirements for the BMU		P
	The BMU evaluates the condition of cells and batteries and maintains cells and batteries within the specified cell operating region.	See clause 9.1	P
	The BMU is designed according to the safety integrity level (SIL) target defined in clause 9.1 c).		N/A
	Battery system manufacturers perform the tests mentioned in clauses 9.2.2 to 9.2.4 to evaluate the charge control that affects safety		P
9.2.2	Overcharge control of voltage (battery system)		P
	The test is carried out in an ambient temperature of 25 °C ± 5 °C and under normal operating conditions with the cooling system (if any) operating.	Battery without cooling system	P
	Each test battery is discharged at a constant current of 0.2 I_t A, to a final discharge voltage specified by the manufacturer.		P
	Discharged batteries are charged at the maximum current of the recommended charger with set voltage exceeding the upper limit charge voltage by 10% for each cell in the battery.		P
	The exceeded voltage is applied - To the whole battery system.		P

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	- To a part of cell in the battery.		N/A
	The test is carried out until the BMU terminates the charge, which should occur before reaching 110% of the upper limit charge voltage.		P
	Data acquisition/monitoring are continued for one hour after charge is stopped.		P
	All functions of the battery system are fully operational as designed during the test.		P
	Results: No fire, No explosion. The BMU shall interrupt the overcharge current by an automatic disconnect of the main contactors in order to protect the battery system against further related severe effects.	(See Table 9.2.2)	P
9.2.3	Overcharge control of current (battery system)		P
	The test is carried out in an ambient temperature of 25 °C ± 5 °C and under normal operating conditions with the cooling system (if any) operating.	Battery without cooling system	P
	Each test battery is discharged at a constant current of 0.2 I_t A, to a final discharge voltage specified by the manufacturer.		P
	Discharged batteries are charged at a current exceeding the maximum charge current by 20%.		P
	Data acquisition/monitoring are continued for one hour after charge is stopped.		P
	All functions of the battery system are fully operational as designed during the test.		P
	Results: No fire, No explosion. The BMU shall detect the overcharge current and shall control below to the maximum charge current in order to protect the battery system against further related severe effects.	(See Table 9.2.3)	P
9.2.4	Overheating control(battery system)		P
	The test is carried out in an initial ambient temperature of 25 °C ± 5 °C and under normal operating conditions with the exception that cooling system (if any) shall be disconnected.		P
	Each test battery is discharged at a constant current of 0.2 I_t A, to a final discharge voltage specified by the manufacturer.		P
	Discharged batteries are charged at the recommended current to a 50% state of charge.		P
	The charge is continued at the elevated temperature with 5 °C above the maximum operating temperature until the BMU terminates the charge.		P

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Telefax : +86 755 8828 5299

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TÜV SÜD Certification and Testing (China) Co., Ltd.
Shenzhen Branch, TÜV SÜD Group

Building 12&13, Zhiheng Wisdomland Business Park,
Nantou Checkpoint Road 2, Nanshan District
518052 Shenzhen, CHINA

IEC 21A/556/CD (draft IEC62619 Ed. 1.0)			
Clause	Requirement + Test	Result - Remark	Verdict
	Data acquisition/monitoring shall be continued for one hour after sequence is stopped.		P
	All functions of the battery system are fully operational as designed during the test.		P
	Results: No fire, No explosion The BMU shall detect the overheat temperature and shall terminate charge in order to protect the battery system against further related severe effects.	(See Table 9.2.4)	P
9.3	**Environmental consideration**		N/A
	A battery system should be designed with consideration for recycling.		N/A
10	**Information for safety**		P
	Manufacturers of cells shall ensure that information is provided about current, voltage and temperature limits of their products.		P
	Manufacturers of battery systems shall ensure that equipment manufacturers and, in the case of direct sales, end-users are provided with information to minimize and mitigate hazards.		P
	It is the equipment manufacturer's responsibility to inform end-users of the potential hazards arising from the use of equipment containing secondary lithium cells and batteries.		P
11	**Marking and designation**		P
	Refer to clause 5 of IEC 62620	Battery marked as specified in IEC 62620.	P
12	**Packaging**		P
	The packaging of secondary cells and batteries for transport prevents opportunities for short-circuit, mechanical damage and possible ingress of moisture.		P
	The materials and pack design are chosen so as to prevent the development of unintentional electrical conduction, corrosion of the terminals and ingress of environmental contaminants.		P

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5.1 – 5.6	TABLE: Critical components information				P
Object/part no.	**Manufacturer/ trademark**	**Type/model**	**Technical data**	**Standard**	**Mark(s) of conformity**
1.Cell	-	C20	3.2V,25Ah	UL 1642	MH27673-20150402
-Cathode	HuiZhou BYD	E60	$LiFePO_4$	-	-
-Anode	HuiZhou BYD		Graphite	-	-
-Electrolyte	HuiZhou BYD	LB-23	$LiPF_6$,EC,EMC,DMC	-	-
-Separator	ShenZhenXing Yuan material Technology Co., Ltd.	SD4	PP, 0.025mm(Thickness)× 222mm(Width)× 6000mm(Length)	-	-
-Positive electrode tab	-	-	Aluminum	-	-
-Negative electrode tab	-	-	Nickel	-	-
- Container	ShenzhenKeda li Industry Co., Ltd	-	3003Aluminum	-	-
2.BMU Board				-	-
- TRANSFORMER	DongGuan Dazhong	DK25E0796	Inductance value: 200uH ± 10% Insulation resistance : 100Mohm Min	-	-
-Mosfet	Fairchild semiconductor	FDB33N25	33A, 250V, R_{DS}(on) = 0.094Ω @V_{GS} = 10 V	-	-
-Optocouplers	Avago Technologies	HCNW137	High Speed: 10 MBd Typical Low Input Current Capability: 5 mA Guaranteed ac and dc Performance over Temper-ature: -40°C to +85°C	-	-
-Optocouplers	Toshiba electronic asia,ltd	TLP2301	Operating temperature: -40 to 125℃ Current transfer ratio: 900 % (min) @IF = 0.5 mA Maximum output current: 80 mA	-	-
-MCU	NXP	LPC1765FBD100	32-bit ARM Cortex-M3 microcontroller; up to 512 kB flash and 64 kB SRAM with Ethernet, USB 2.0 Host/Device/OTG, CAN	-	-

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-Current Mode Controllers	ON	UC3845BVD1R2	Current Mode Operation to 500 kHz Output Switching Frequency Output Deadtime Adjustable from 50% to 70%	-	-
-Connectors	SHENZHEN CONNECTION. ELECTRONIC CO.,LTD	PLTBH1.5	300V,8A;2500V	-	-
-Fuse	Littelfuse Inc.	0451015	Operating Temperature: –55°C to 125°C	UL 248	E10480
3.PMU Board				-	-
-PCB	Huizhou China Eagle Electronics Technology Corp	PCB-BYD10033-P-V6	FR-4, V-0, 2mm	UL796	E198681
-Fuse	Sart	S6125-F-15.0A	Interrupting Rating UL 50A 65V AC 65V DC Typical Cold DCR (mΩ):3.7	-	-
-Mosfet	Infineon	IPB600N25N3G	R_{DS}=60mΩ,V_{DS}=250V,I_D=25A	-	-
-Mosfet	Fairchild	FDB33N25	33A, 250V, R_{DS}(on) = 0.094Ω @V_{GS} = 10 V	-	-
-Mosfet	Infineon	IPB072N15N3G	R_{DS}=7.2mΩ,V_{GS}=150V,I_D=100A	-	-
-Mosfet	Fairchild semiconductor	FDB075N15A	R_{DS}=6.25mΩ,V_{GS}=10V,I_D=100A	-	-
-Mosfet	International Rectifier	IRFS3607PBF	R_{DS}=9mΩ,V_{GS}=10V,I_D=46A	-	-
-Capacitance	Murata Electronics Trading(Shenzhen)Co,Ltd	DE1E3KX222M	2nf±20% 250V	-	-
- TRANSFORMER	DongGuan Dazhong	DK25E0796	Inductance value: 200uH ± 10% Insulation resistance : 100Mohm Min	-	-
-Fuse	Littelfuse	142.5631.6102-100A	Rated at 58V	-	-
-IC	Texas Instruments	Bp76PL536-Q1	Temperature Range –40°C to 105°C ±1 mV Typical Accuracy 14-Bit Resolution, 6-µs Conversion Time	-	-
Supplementary information:					

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Telefax : +86 755 8828 5299

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8.2.1	External short circuit test (cell)	P

Model	Ambient (at 25°C ± 5°C)	OCV at start of test, (Vdc)	Resistance of circuit, (Ω)	Maximum case temperature rise ΔT, (K)	Results
C20	25.5	3.341	0.034	19.3	A, B
C20	24.9	3.343	0.034	19.7	A, B
C20	23.9	3.341	0.034	20.3	A, B

Supplementary information:

- A: No fire
- B: No explosion
- C: Leakage
- D: Venting
- E: Rupture
- F: Explosion
- G: Fire
- Other (Please Explain): Slight bulge

8.2.2	TABLE: Impact (cell)	P

Model	OCV at start of test, (Vdc)	Results
C20	3.342	A, B
C20	3.342	A, B
C20	3.400	A, B
C20	3.449	A, B
C20	3.442	A, B
C20	3.447	A, B

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Telefax : +86 755 8828 5299

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Supplementary information:

- A: No fire
- B: No explosion
- C: Leakage
- D: Venting
- E: Rupture
- F: Explosion
- G: Fire
- Other (Please Explain)

8.2.3.1	TABLE: Whole free drop (cell)	P

Model	OCV at start of test, (Vdc)	Results
C20	3.343	A, B
C20	3.345	A, B
C20	3.345	A, B

Supplementary information:

- A: No fire
- B: No explosion
- C: Leakage
- D: Venting
- E: Rupture
- F: Explosion
- G: Fire
- Other (Please Explain)

8.2.3.2	TABLE: Edge and corner drop test (battery)	P

Model	OCV at start of test, (Vdc)	Results
C20	53.40	A, B
C20	53.66	A, B
C20	53.34	A, B

Supplementary information:

- A: No fire
- B: No explosion
- C: Leakage
- D: Venting
- E: Rupture
- F: Explosion
- G: Fire
- Other (Please Explain)

8.2.4	TABLE: Thermal abuse (cell)	P

Model	OCV at start of test, (Vdc)	Results
C20	3.346	A, B
C20	3.346	A, B
C20	3.346	A, B

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Building 12&13, Zhiheng Wisdomland Business Park,
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Supplementary information:

- A: No fire
- B: No explosion
- C: Leakage
- D: Venting
- E: Rupture
- F: Explosion
- G: Fire
- Other (Please Explain)

8.2.5	TABLE: Overcharge (cell)				P
Model	**OCV prior to charging, (Vdc)**	**Maximum charge current, (A)**	**Maximum charged voltage, Vdc.**	**Maximum case temperature, (ºC)**	**Results**
C20	2.7140	40A	4.56	32.9	A, B
C20	2.6889	40A	4.56	37.1	A, B
C20	2.6730	40A	4.56	36.2	A, B

Supplementary information:

- A: No fire
- B: No explosion
- C: Leakage
- D: Venting
- E: Rupture
- F: Explosion
- G: Fire
- Other (Please Explain):

8.2.6	TABLE: Forced discharge (cell)				P
Model	**OCV before application of reverse charge, (Vdc)**	**Measured reverse charge I_t, (A)**	**Maximum discharge voltage, V**	**Time for reversed charge, (minutes)**	**Results**
C20	2.6765	25	1.874	90	A, B
C20	2.6417	25	1.482	90	A, B
C20	2.6717	25	1.525	90	A, B

Supplementary information:

- A: No fire
- B: No explosion
- C: Leakage
- D: Venting
- E: Rupture
- F: Explosion
- G: Fire
- Other (Please Explain): Bulge

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Telefax : +86 755 8828 5299

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518052 Shenzhen, CHINA

8.3.2	TABLE: Forced internal short circuit (cell)	P

Model	Chamber ambient, (°C)	OCV at start of test, (Vdc)	Particle location [1)]	Maximum applied pressure, (N)	Voltage drop, (mV)	Results
C20	25	3.348	1	400	0.3	A, B
C20	25	3.347	1	400	0.1	A, B
C20	25	3.346	1	400	0.6	A, B
C20	25	3.345	1	400	0.3	A, B
C20	25	3.346	1	400	0.3	A, B

Supplementary information:

[1)] Identify one of the following:
1: Nickel particle inserted between positive and negative (active material) coated area.
2: Nickel particle inserted between positive aluminium foil and negative active material coated area.

- A: No fire
- B: No explosion
- C: Explosion
- D: Fire
- Other (Please Explain)

8.3.3	TABLE: Propagation test (battery system)	N/A

Model	OCV at start of test, (Vdc)	Results

Supplementary information:

- A: No external fire from the battery system
- B: No battery case rupture
- C: External fire from the battery system
- D: Battery case rupture
- Other (Please Explain)

9.2.2	TABLE: Over charge control of voltage (battery system)	P

Model	OCV at start of test, (Vdc)	Maximum charge current, (A)	Maximum charge voltage, (Vdc)	110% of upper limit charge voltage, (Vdc)	Total time of charge, (s)	Results
U3A1-50P-A	47.440	50.0	58.906	66.88	56.4	A, B
B-BOX 2.5	46.486	50.0	59.067	66.88	57.6	A, B

Supplementary information:

- A: No fire
- B: No explosion
- C: No function
- D: Leakage
- E: Venting
- F: Rupture
- G: Explosion
- H: Fire
- Other (Please Explain): The BMU interrupts the overcharge current in order to protect the battery system against further related severe effects.

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Telefax : +86 755 8828 5299

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9.2.3	TABLE: Over charge control of current (battery system)			P
Model	**OCV at start of test, (Vdc)**	**120% of maximum charge current, (A)**	**Total time of charge, (s)**	**Results**
U3A1-50P-A	46.748	60.0	15.13	A, B
B-BOX 2.5	47.890	60.0	15.17	A, B
B-BOX 10.0	46.559	216.0	1.04	A, B

Supplementary information:

- A: No fire
- B: No explosion
- C: No function
- D: Leakage
- E: Venting
- F: Rupture
- G: Explosion
- H: Fire
- Other (Please Explain): The BMU detects the overcharge current and controls below to the maximum charge current in order to protect the battery system against further related severe effects.

9.2.4	TABLE: Overheating control (battery system)			P
Model	**OCV at start of test, (Vdc)**	**Recommend charging current I_t, A**	**Maximum temperature, ºC**	**Results**
U3A1-50P-A	52.829	10.0	65.0	A, B
B-BOX 2.5	52.776	10.0	65.0	A, B

Supplementary information:

- A: No fire
- B: No explosion
- C: No function
- D: Leakage
- E: Venting
- F: Rupture
- G: Explosion
- H: Fire
- Other (Please Explain): The BMU detects the overheat temperature and terminates charge in order to protect the battery system against further related severe effects.

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Telefax : +86 755 8828 5299

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List of test equipment used

Item	Reference No.	Testing / measuring equipment / material used	Range used	Calibration Due date
1	68-5-34-13-001	Multiple meter	0~1000V, 0~10A, 0~50MΩ	3/31/2016
2	68-5-34-13-002	Multiple meter	0~1000V, 0~10A, 0~50MΩ	4/19/2016
3	68-5-35-13-002	Micro-ohm meter	30mΩ~30KΩ	4/16/2016
4	68-5-40-13-006	Temperature data logger/34972A	-190°C~600°C, 10mV~100V, 1mA~1A	6/4/2016
5	68-5-40-13-007	Temperature data logger/34972A	-190°C~600°C, 10mV~100V, 1mA~1A	3/29/2016
6	68-5-47-13-002	Electric Balance	0~1000g/0.1g	4/14/2016
7	68-5-47-14-005	Electric balance	60kg/0.02kg	6/23/2016
8	68-5-47-14-004	Electric balance	150kg/0.05kg	6/23/2016
9	68-5-53-13-003	Temperature and humidity tester	15°C~35°C, 10%~95%RH	5/25/2016
10	68-5-53-13-005	Temperature and humidity tester	15°C~35°C, 10%~95%RH	4/19/2016
11	68-5-53-13-007	Temperature and humidity tester	15°C~35°C, 10%~95%RH	4/16/2016
12	68-5-53-13-008	Temperature and humidity tester	15°C~35°C, 10%~95%RH	4/19/2016
13	68-5-66-13-007	Cycler/5V/60A	0~5V, 0~60A	5/24/2016
14	68-5-66-13-011	Cycler/60V/60A	0~60V, 0~60A	5/24/2016
15	68-5-66-13-005	Cycler5V/6A	0~5V, 0~6A, 1W~5W, 10Ω~100Ω	4/13/2016
16	68-5-66-15-019	Chroma 17020	100V 50A	8/6/2016
17	68-5-90-13-005	High-low temperature chamber	-70°C~150°C	5/24/2016
18	68-5-90-13-012	Oven/SPH301	RT+20°C~200°C	4/13/2016
19	68-5-93-13-007	Drop tester/BF-DX-150S	0~1500mm	7/20/2016
20	68-5-93-13-009	Impact tester/HY-CJ-200	0~1000mm, 9.1kg	7/20/2016
21	68-5-93-13-012	Internal short tester/HY-DL-21	value0.1	6/25/2016
22	68-5-18-13-003	Measure tape	0~7500mm	3/31/2016

---End of Test Report---

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