Report No.: SZES180400148401
Date:2018-05-08

Applicant…… .....:	Tridonic UK Ltd.
Address .....:	House of Light, Butchers Race, Green Lane Industrial Estate, Spennymoor, County Durham.DL16 6JE
Manufacturer ……:	BST Power (Shenzhen) Limited
Address……:	No. 37 Xinlong Road, Dakang, Henggang Street, Longgang District, Shenzhen, Guangdong, China
Factory……:	Same as manufacturer
Address……..……:	
Test object / Model……:	Lithium Iron Phosphate Battery / 28002320
Test specifications / Test standard……:	ST/SG/AC.10/11/Rev.6/Section 38.3
Test procedure.....:	SGS-CSTC
Test Report Form No.....:	UN_BATT_201407
Test Report Form(s) Originator.....:	SGS-CSTC
Master TRF.....:	Dated 2014-07
Purpose of examination……:	Commission Test
Summary of testing……:	The sample(s) tested complies with the requirements of UNITED NATIONS “Recommendations on the transport of dangerous goods” Manual of test and Criteria ST/SG/AC.10/11/Rev.6 Section 38.3
Remark:	None

Wilson Zhu
Project Reviewer
Safety Laboratory

SGS-CSTC STANDARDS TECHNICAL SERVICES CO., LTD. SHENZHEN BRANCH E&E LAB 电子电气实验室 01

Mino Wu
Project Engineer

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1. Function / Description:

Lithium Iron Phosphate Battery

2. Ratings:

Items	Pack	Cell
Model	28002320	IFR18650E1500
Rated Voltage	3,2 V	3,2 V
Rated Capacity	4,5 Ah	1,5 Ah
Standard charge current	0,45 A	0,3 A
Maximum charge current	3,0 A	1,5 A
Standard discharge current	0,9 A	0,3 A
Maximum discharge current	3,0 A	4,5 A
Discharge cut-off Voltage	2,5 V	2,0 V
Maximum charge Voltage	3,65 V	3,65 V

Test information:

Possible test case verdicts:
- test case does not apply to the test object: N/A (Not Applicable)
- test object does meet the requirement: P (Pass)
- test object does not meet the requirement: F (Fail)

The tests were done in the Electrical Safety Laboratory of SGS-CSTC in Shenzhen.
Test project was received on 2018-04-16.
Tests were performed from 2018-04-16 to 2018-05-07.
Ambient temp.: 20 ºC ± 5 ºC
When determining the test conclusion, the Measurement Uncertainty of test has been considered.

3. Test result:

ST/SG/AC.10/11/Rev.6/Section 38.3			
Clause	**Requirement + Test**	**Result - Remark**	**Verdict**
38.3.4	Procedure		P
38.3.4.1	Test T.1: Altitude simulation		P
	Test procedure: Test cells and batteries shall be stored at a pressure of 11,6 kPa or less for at least six hours at ambient temperature (20 ± 5 ºC).		P
	Requirement: Cells and batteries Mass loss limit: ≤0,1%;		P
	Open circuit voltage not less than 90% of its voltage immediately prior to this procedure, the requirement relating to voltage is not applicable to test cells and batteries at full discharged states.		P
	No leakage, no venting, no disassembly, no rupture and no fire.		P

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38.3.4.2	Test T.2: Thermal test		P
	Test procedure: Test cells and batteries are to be stored for at least six hours at a test temperature equal to 72 ± 2 ºC, followed by storage for at least six hours at a test temperature equal to -40 ± 2 ºC. The maximum time interval between test temperature extremes is 30 minutes. This procedure is to be repeated 10 times, after which all test cells and batteries are to be stored for 24 hours at ambient temperature (20 ± 5 ºC). For large cells and batteries the duration of exposure to the test temperature extremes should be at least 12 hours.		P
	Requirement: Cells and batteries Mass loss limit: ≤0,1%		P
	Open circuit voltage not less than 90% of its voltage immediately prior to this procedure, the requirement relating to voltage is not applicable to test cells and batteries at full discharged states.		P
	No leakage, no venting, no disassembly, no rupture and no fire.		P
38.3.4.3	Test T.3: Vibration		P
	Test procedure: Cells and batteries are firmly secured to the platform of the vibration machine without distorting the cells in such a manner as to faithfully transmit the vibration. The vibration shall be a sinusoidal waveform with a logarithmic sweep between 7 Hz and 200 Hz and back to 7 Hz traversed in 15 minutes. This cycle shall be repeated 12 times for a total of 3 hours for each of three mutually perpendicular mounting position of the cell. One of the directions of vibration must be perpendicular to the terminal face. The logarithmic frequency sweep is as follows: from 7 Hz a peak acceleration of 1 g_n is maintained until 18 Hz is reached. The amplitude is then maintained at 0,8 mm (1,6 mm total excursion) and the frequency increased until a peak acceleration of 8 g_n occurs (approximately 50 Hz). A peak acceleration of 8 g_n is then maintained until the frequency is increased to 200 Hz		P
	Requirement: Cells and batteries Mass loss limit: ≤0,1%	.	P
	Open circuit voltage not less than 90% of its voltage immediately prior to this procedure, the requirement relating to voltage is not applicable to test cells and batteries at full discharged states.		P
	No leakage, no venting, no disassembly, no rupture and no fire.		P
38.3.4	Test T.4: Shock		P

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	Test procedure: Test cells and batteries shall be secured to the testing machine by means of a rigid mount which will support all mounting surfaces of each test battery. Each cell or battery shall be subjected to a half-sine shock of peak acceleration of 150 g_n and pulse duration of 6 milliseconds. Each cell or battery shall be subjected to three shocks in the positive direction followed by three shocks in the negative direction of three mutually perpendicular mounting positions of the cell or battery for a total of 18 shocks. However, large cells and large batteries shall be subjected to a half-sine or peak acceleration of 50 g_n and pulse duration of 11 milliseconds. Each cell or battery is subjected to three shocks in the positive direction followed by three shocks in the positive direction followed by the negative direction of each of three mutually perpendicular mounting positions of the cell for a total of 18 shocks.		P
	Requirement: Cells and batteries Mass loss limit: ≤0,1%		P
	Open circuit voltage not less than 90% of its voltage immediately prior to this procedure, the requirement relating to voltage is not applicable to test cells and batteries at full discharged states.		P
	No leakage, no venting, no disassembly, no rupture and no fire.		P
38.3.4.5	Test T.5: External short circuit		P
	Test procedure: The cell or battery to be tested shall be temperature stabilized so that its external case temperature reaches 57 ± 2ºC and then the cell or battery shall be subjected to a short circuit condition with a total external resistance of less than 0,1 ohm at 57 ± 4ºC. If this assessment is not Feasible, the exposure time shall be at least 6hours for small cells and small batteries, and 12 hours for large cells and large batteries. This short circuit condition is continued for at least one hour after the cell or battery external case temperature has returned to 57 ± 4ºC. The cell or battery must be observed for a further six hour for the test to be concluded, or in the large batteries, has decreased by half of the maximum temperature increase observed during the test and remains below the value.		P
	Requirement: Cell's or batteries' external temperature not exceed 170ºC.		P
	No disassembly, no rupture and no fire within six hours.		P
38.3.4.6	Test T.6: Impact / Crush		P

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	Test procedure 1: Impact The sample cell or component cell is to be placed on a flat smooth surface.		P
	A 15.8 mm ± 0.1mm diameter, at least 6 cm long, or the longest dimension of the cell, whichever is greater, Type 316 stainless steel bar is to be placed across the centre of the sample.		P
	A 9,1 kg ± 0,1 kg mass is to be dropped from a height of 61 ± 2,5 cm at the intersection of the bar and sample in a controlled manner using a near frictionless, vertical sliding track or channel with minimal drag on the falling mass. The vertical track or channel used to guide the falling mass shall be oriented 90 degrees from the horizontal supporting surface.		P
	The test sample is to be impacted with its longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the 15,8 mm ± 0,1mm diameter curved surface lying across the centre of the test sample. Each sample is to be subjected to only a single impact.		P
	Test procedure 2: Crush A cell or component cell is to be crushed between two flat surfaces. The crushing is to be gradual with a speed of approximately 1,5 cm/s at the first point of contact. The crushing is to be continued until the first of the three options below is reached.		N/A
	(a) The applied force reaches 13 kN ± 0,78 kN; or		N/A
	(b) The voltage of the cell drops by at least 100 mV; or		N/A
	(c) The cell is deformed by 50% or more of its original thickness.		N/A
	Requirement: Cell's or batteries' external temperature not exceed 170ºC.		P
	No disassembly, no rupture and no fire within six hours.		P
38.3.4.7	Test T.7: Overcharge		P
	Test procedure: The charge current shall be twice the manufacturer's recommended maximum continuous charge current. The minimum voltage of the test shall be as follows:		P
	(a) When the manufacturer's recommended charge voltage is not more than 18 V, the minimum voltage of the test shall be the lesser of two times the maximum charge voltage of the battery or 22 V.		P
	(b) When the manufacturer's recommended charge voltage is more than 18 V, the minimum voltage of the test shall be 1,2 times the maximum charge voltage.		N/A

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	Requirement: No disassembly, no rupture and no fire within seven days.		P
38.3.4.8	Test T.8: Force discharge		P
	Test procedure: Each cell shall be forced discharged at ambient temperature by connecting it in series with a 12 V D.C. power supply at an initial current equal to the maximum discharge current specified by the manufacturer.		P
	The specified discharge current is to be obtained by connecting a resistive load of the appropriate size and rating in series with the test cell. Each cell shall be forced discharged for a time interval (in hours) equal to its rated capacity divided by the initial test current (in ampere).		P
	Requirement: No disassembly, no rupture and no fire within seven days.		P

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T.1 to T.5 test data

Table: Test T.1 to T.5											P
Sample No.	Parameters prior to test		After Test T.1 Altitude simulation		After Test T.2 Thermal test		After Test T.3 Vibration		After Test T.4 Shock/		T.5 External short circuit /
	Mass (g)	OCV (V)	Mass loss (g)	Charge ratio (%)	Mass loss (g)	Charge ratio (%)	Mass loss (g)	Charge ratio (%)	Mass loss (g)	Charge ratio (%)	Max. Temp. (ºC)
b1#	141,349	3,345	0,001	100,00	0,006	99,79	0,000	100,00	0,000	100,00	58,0
b2#	140,985	3,349	0,001	99,94	0,006	99,76	0,000	100,00	0,000	100,00	58,7
b3#	141,314	3,346	0,000	99,97	0,014	99,79	0,000	100,00	0,000	100,00	58,3
b4#	141,611	3,345	0,000	100,00	0,007	99,79	0,000	100,00	0,000	100,00	58,5
b5#	141,573	3,345	0,001	99,97	0,004	99,82	0,000	100,00	0,000	100,00	58,0
b6#	140,866	3,349	0,001	99,88	0,005	99,82	0,000	100,00	0,000	100,00	58,3
b7#	141,487	3,345	0,000	99,94	0,005	99,85	0,000	100,00	0,000	100,00	58,7
b8#	141,360	3,346	0,000	99,97	0,005	99,79	0,000	100,00	0,000	100,00	58,4
Remark: Samples No. b#1 to b#4 are in fully charged states at first cycle; Samples No. b#5 to b#8 are in fully charged states after 50 cycles.											

T6 test data

Table: Test T.6		P
Sample No.	OCV Before test (V)	Max. surface Temperature (ºC)
c#1	3,278	62,0
c#2	3,277	103,8
c#3	3,278	28,9
c#4	3,276	30,5
c#5	3,276	101,7
Remark: Samples c#1 to c#5 are at first cycle at 50% of the design rated capacity.		

T7 test data

Table: Test T.7	P
Sample No.	OCV/ V (Before test)
b#1	3,345
b#2	3,349
b#3	3,349
b#4	3,345
b#5	3,349
b#6	3,349
b#7	3,345
b#8	3,348
Remark: Samples No. b#1 to b#8 are the undamaged samples previously used in test T.1 to T.5.	

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T8 test data

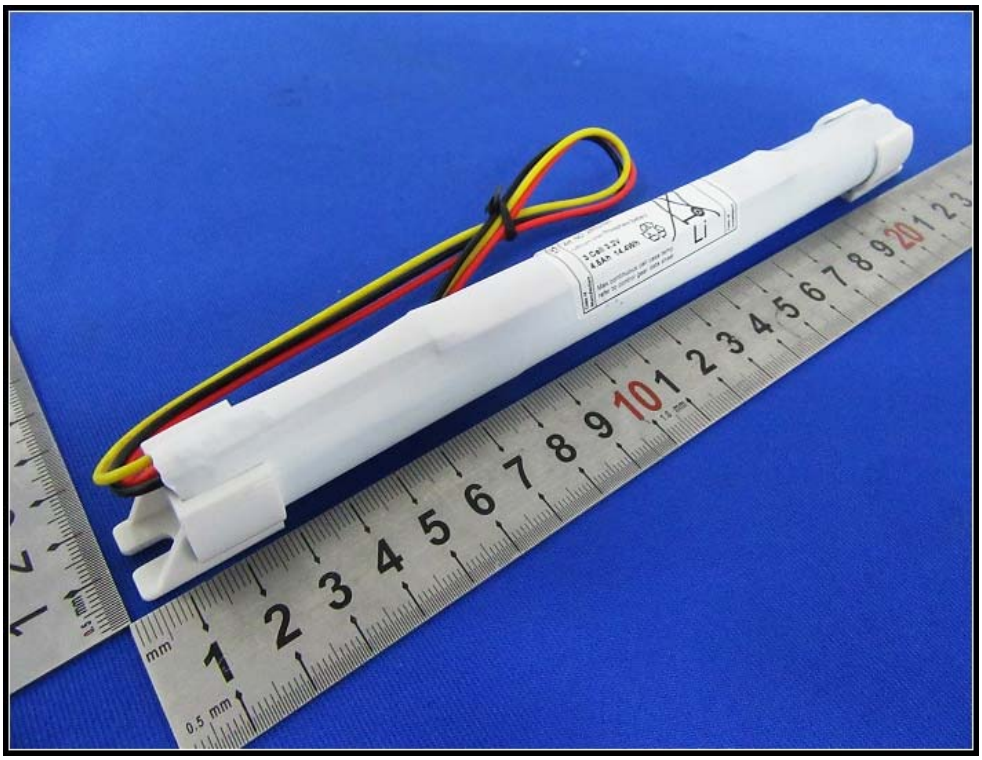
Table: Test T.8		P
Sample No.	OCV Before test (V)	Initial test current (mA)
c#6	2,929	4500
c#7	2,909	4500
c#8	2,917	4500
c#9	2,909	4500
c#10	2,928	4500
c#11	2,920	4500
c#12	2,914	4500
c#13	2,917	4500
c#14	2,903	4500
c#15	2,911	4500
c#16	2,927	4500
c#17	2,914	4500
c#18	2,920	4500
c#19	2,908	4500
c#20	2,908	4500
c#21	2,911	4500
c#22	2,909	4500
c#23	2,917	4500
c#24	2,920	4500
c#25	2,929	4500
Remark: Samples No. c#6 to c#15 are in fully discharged states at first cycle; Samples No. #16 to #25 are in fully discharged states after 50 cycles.		

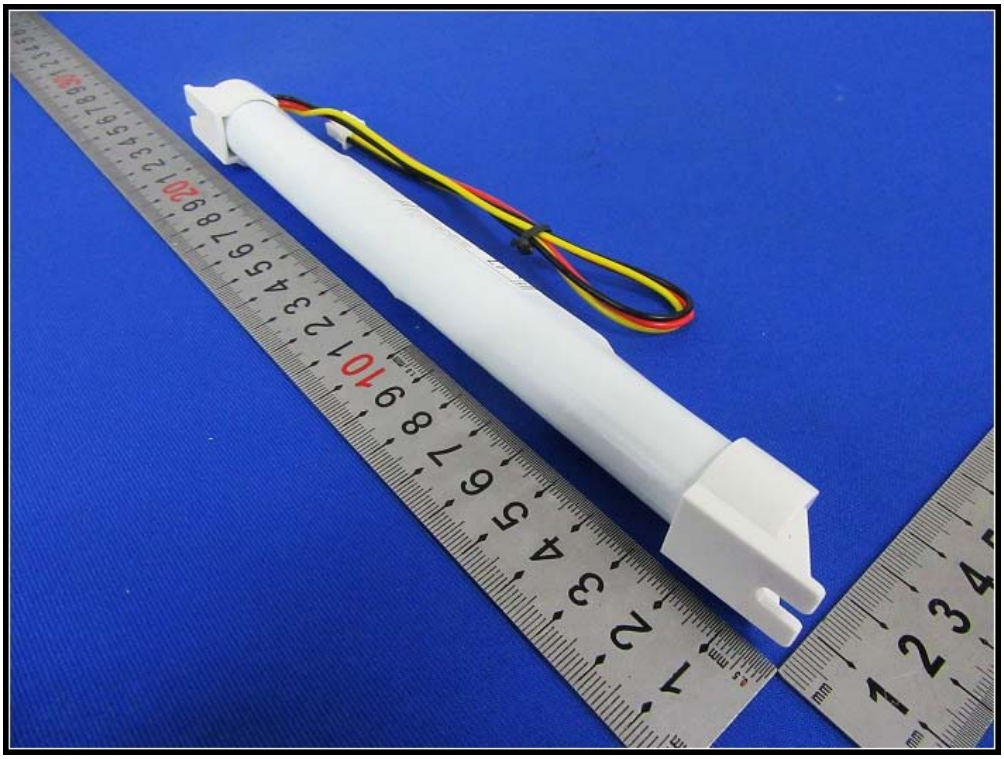
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Attachment: Sample photos

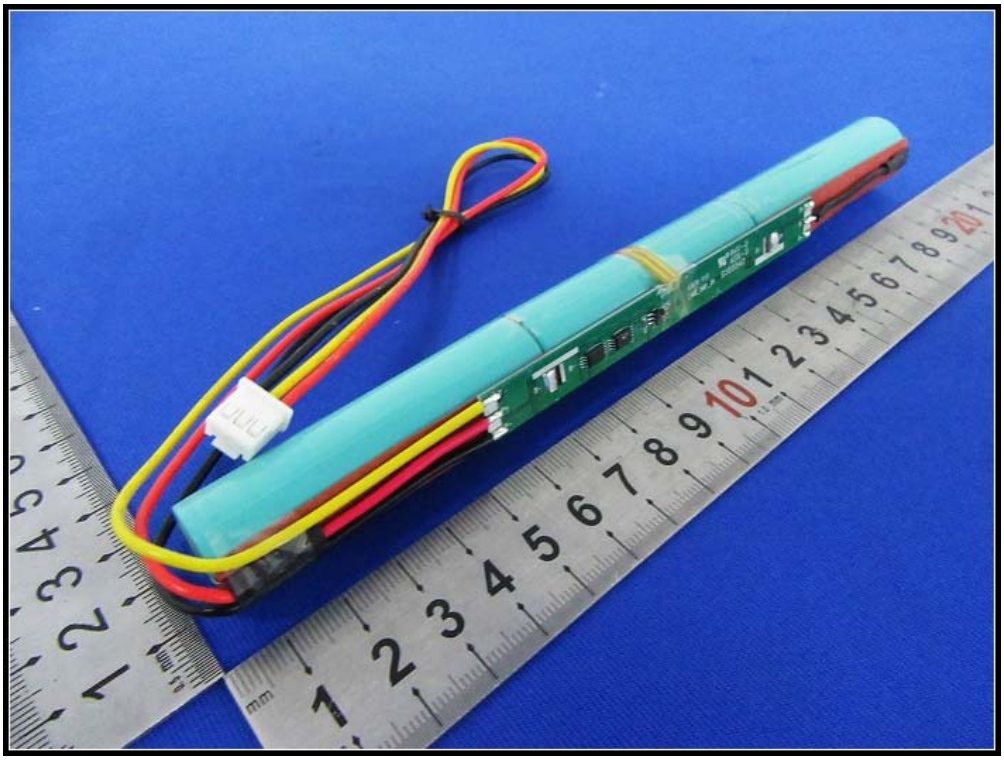
Whole unit

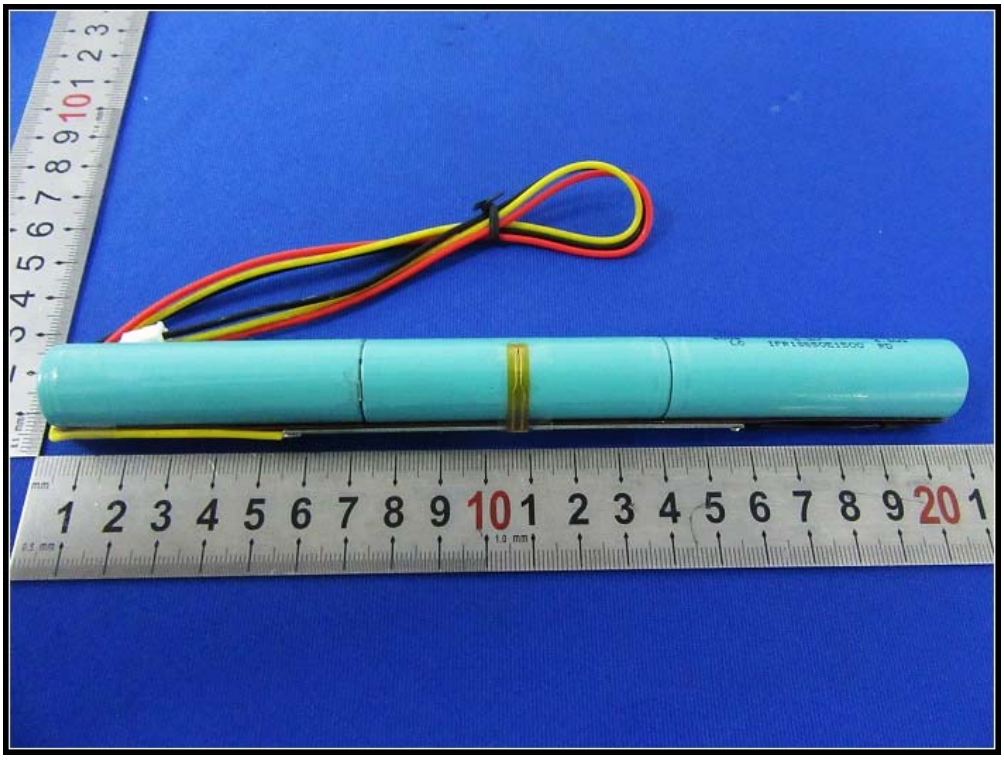




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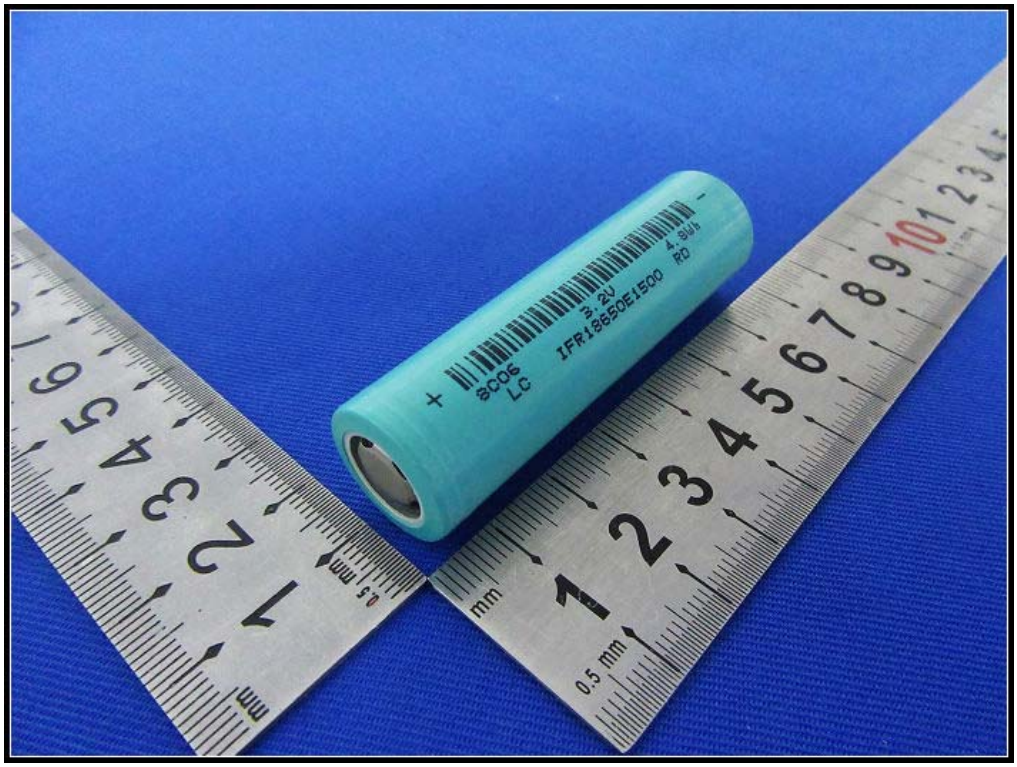


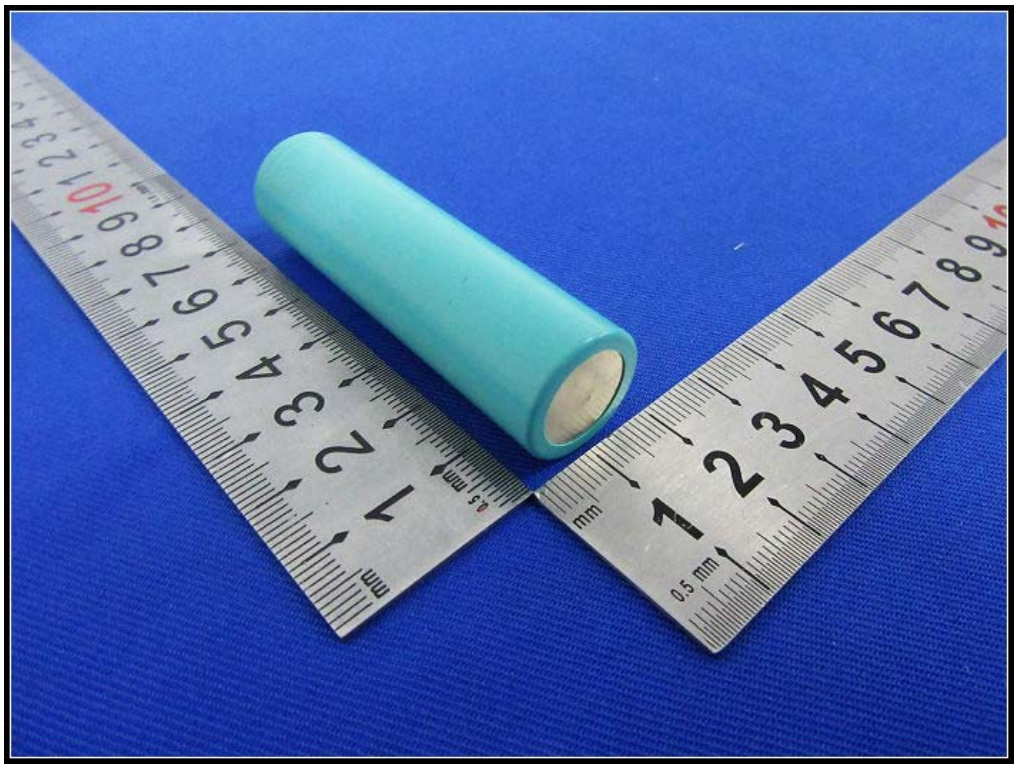


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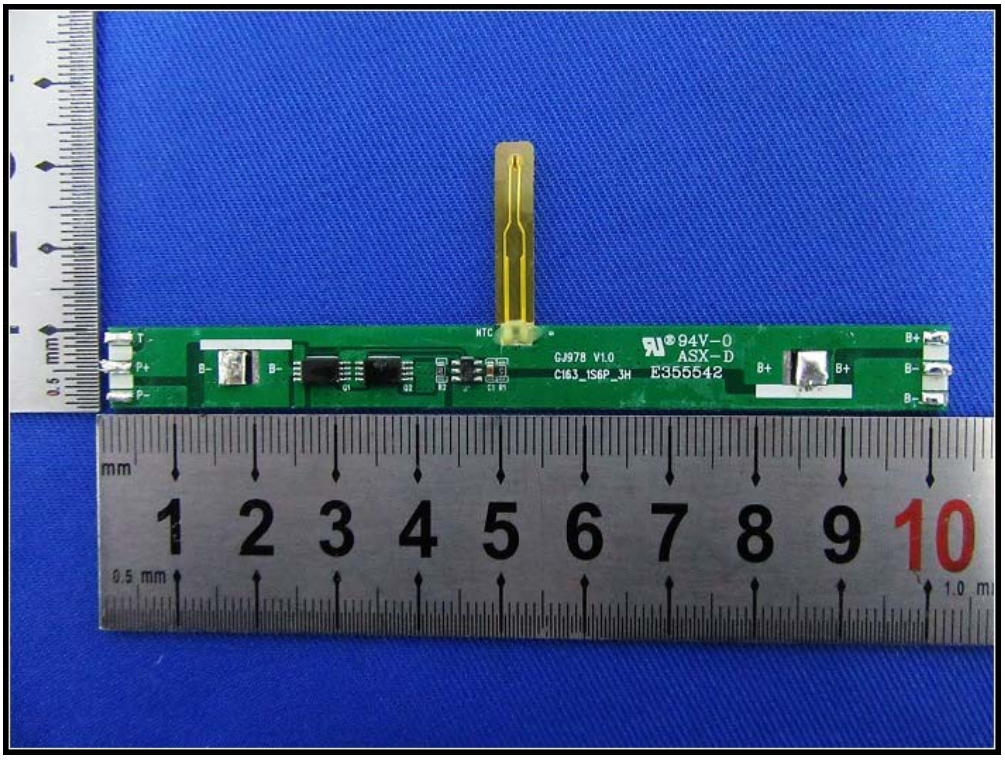


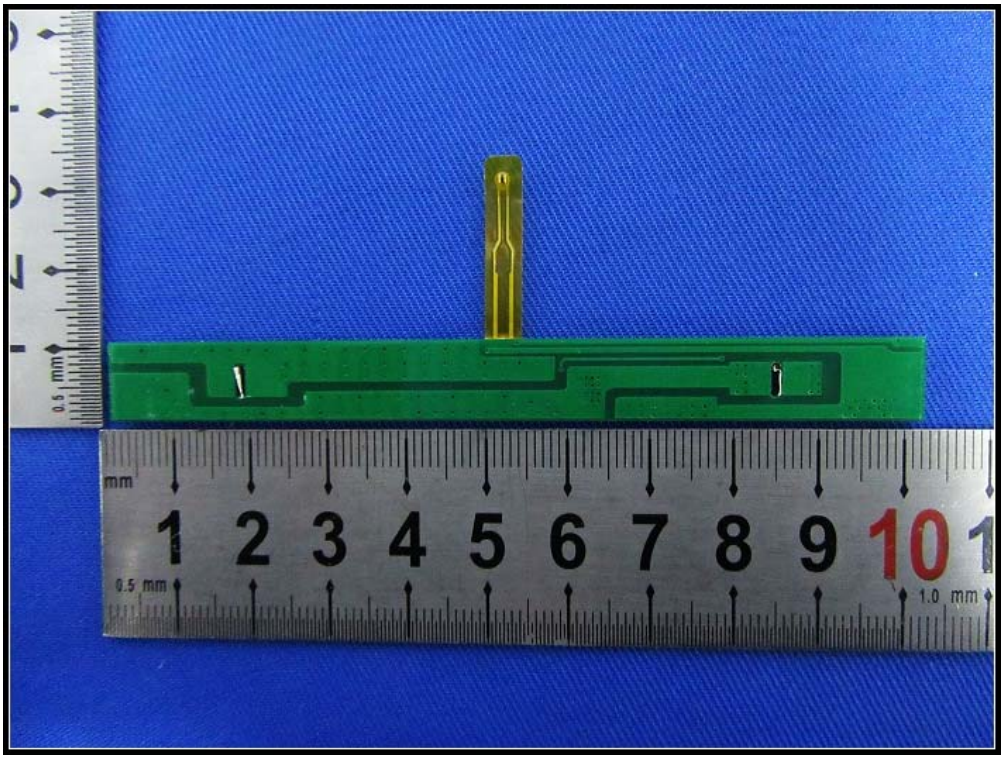


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