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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.....:	TSZ22110505-P01-R01
Date of issue.....:	2023-1-5
Total number of pages.....:	19 Pages
Applicant's Name.....:	MUST ENERGY (GUANGDONG) TECHNOLOGY CO.,LTD
Address.....:	1-5F，7F，9F，10Fof No.8 building,No.115,Zhangcha Road 1,Chancheng district,Foshan city,Guangdong Province,P.R.China
Test specification:	
Standard.....:	IEC 62619:2022

General disclaimer:

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 laboratory.

Test item description.....:	LiFePo4 BATTERY PACK
Trade Mark(s).....:	MUST
Manufacturer.....:	Same as Applicant
Model/Type reference.....:	LP18-256120
Ratings.....:	25.6V ,120Ah , 3072Wh

Responsible Testing Laboratory:

Testing Laboratory:	Shenzhen Tiansu Calibration and Testing Co.,Ltd.	
Testing location/ address.....:	B/1,4, NO.2 Jinlong Road, Longgang District, Shenzhen, China	
Tested by (name, function, signature).....:	Zhang jiaquan	Jacky Zhang
Reviewed by (name, function, signature)... :	Zhou wencheng	
Approved by (name, function, signature)... :	Duan Jiangtao	Duan Jiangtao

SHENZHEN TIANSU CALIBRATION AND TESTING CO., LTD. Report Seal (01-01)

List of Attachments (including a total number of pages in each attachment): **See to ANNEX 1: PHOTOS**	
Summary of testing:	
Tests performed (name of test and test clause): 7.2.1 External short-circuit test (cell) 7.2.2 Impact test (cell) 7.2.3 Drop test (cell and battery system) 7.2.4 Thermal abuse test (cell) 7.2.5 Overcharge test (cell) 7.2.6 Forced discharge test (cell) 7.3.2 Internal short-circuit test (cell) 8.2.2 Overcharge control of voltage (battery system) 8.2.3 Overcharge control of current (battery system) 8.2.4 Overheating control (battery system)	**Testing location:** B/1,4, NO.2 Jinlong Road, Longgang District, Shenzhen, China
☒ **The product fulfils the requirements of _IEC 62619: 2022.**	

Copy of marking plate:

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.

MUST®

Product Name: LiFePO4 BATTERY PACK

Model: LP18-256120

Nominal Energy/Voltage: 3.07kwh/25.6V

Nominal Capacity: 120Ah

S/N.: LP1825.6120HFGXCLY22121700001

MADE IN CHINA

Test item particulars..... :	
Classification of installation and use.....:	To be defined in final product
Supply Connection.....:	DC connector
.....:	
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.....:	2022-12-28
Date (s) of performance of tests.....:	2022-12-28 to 2023-1-5

General remarks:

"(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).....: Same as applicant

General product information and other remarks:

The battery of model LP18-256120 is composed of 64 lithium-ion cells (8S8P), and equipped with overcharge, overdischarge, overcurrent, and short circuit protection circuits.

	Cell	Battery
Model	IFR32135-15Ah	LP18-256120
Rated capacity(Ah)	15	120
Nominal voltage(V)	3.2	25.6
Recommended Charge Current(A)	3	20
Maximum Charge Current(A)	15	100
Recommended Discharge Current(A)	3	50
Maximum Discharge Current(A)	15	100
Maximum Charge Voltage(V)	3.65	29.2
End-of-discharge Voltage(V)	2	20
Charge temperature Range(°C)	0-55	0-50
Discharge temperature Range(°C)	-30-60	-10-60
Nominal mass(kg)	0.268	26.4
External dimensions(mm)	33.4mm×139.8mm	540.6mm×440.5mm×130.4mm

4	**PARAMETER MEASUREMENT TOLERANCES**		P
	Parameter measurement tolerances		P

5	**GENERAL SAFETY CONSIDERATIONS**		P
5.1	**General**		P
	Cells and batteries are safe under conditions of both intended use and reasonably foreseeable misuse....:	Clause 6, Clause 7, 8.1, and 8.2. See also table 5.1 for Critical components information	P
	Reduce the risk of injuries from moving parts		P
5.2	**Insulation and wiring**		P
	Voltage, current, altitude, and humidity requirements		P
	Adequate clearances and creepage distances between connectors and live parts at different voltages or between live parts and non-current-carrying accessible parts		P
	Protect from hazardous live parts, including during installation		P
	The mechanical integrity of internal connections		P
5.3	**Venting**		P
	Pressure relief function		P
	Encapsulation used to support cells within an outer casing		P
5.4	**Temperature/voltage/current management**		P
	The design prevents abnormal temperature-rise		P
	Voltage, current, and temperature limits of the cells		P
	Specifications and charging instructions for equipment manufacturers		P
5.5	**Terminal contacts of the battery pack and/or battery system**		P
	Polarity marking(s)		
	Polarity marking not provided for keyed external connector		P
	Capability to carry the maximum anticipated current		P
	External terminal contact surfaces		P
	Terminal contacts are arranged to minimize the risk of short circuits		P
5.6	**Assembly of cells, modules, or battery packs into battery systems**		P
5.6.1	General		P
	Independent control and protection method(s)		P

	Recommendations of cell operating limits, mounting advice, storage conditions and other design recommendations by the cell manufacturer		N/A
	Batteries designed for the selective discharge of a portion of their series connected cells		N/A
	Protective circuit component(s) and consideration to the end-device application		N/A
5.6.2	Battery system design		P
	The voltage control function		P
	Maximum charging/discharging current of the cell are not exceeded		P
5.7	**Operating region of lithium cells and battery systems for safe use**		P
	The cell operating region.....:	Information mentioned in manufacturer's specifications.	P
	Designation of battery system to comply with the cell operating region		N/A
5.8	**System lock (or system lock function)**		N/A
	Non-resettable function to stop battery operation		N/A
	Manual with procedure for resetting of battery operation		N/A
	Emergency battery final discharge		N/A
5.9	**Quality plan**		P
	Manufacturing quality plan (for example: ISO9001, etc.) prepared and implemented.....:	Provide Quality plan	P
	The process capabilities and the process controls		P

6	**TYPE TEST CONDITIONS**		P
6.1	**General**		P
6.2	**Test items**		P
	Cells or batteries that are not more than six months old (See Table 1 of IEC 62619)		P
	Capacity confirmation of the cells or batteries		P
	Default ambient temperature of test, 25 °C ± 5 °C	Tests were carried out in an ambient temperature of 25+5°C	P

7	**SPECIFIC REQUIREMENTS AND TESTS**		P
7.1	**Charging procedure for test purposes**		P
	The battery discharged to a specified final voltage prior to charging		P

	The cells or batteries charged using the method specified by the manufacturer.....:	The method mentioned in manufacturer's specifications	P
7.2	**Reasonably foreseeable misuse**		P
7.2.1	External short-circuit test (cell or cell block)	Tested complied.	P
	Short circuit with total resistance of 30 m ± 10 m at 25 °C ± 5 °C		P
	Results: no fire, no explosion	(See appended table 7.2.1)	P
7.2.2	Impact test (cell or cell block)		P
	Cylindrical cell, longitudinal axis impact	Cylindrical cell	P
	Prismatic cell, longitudinal axis and lateral axis impact		N/A
	Results: no fire, no explosion.		P
7.2.3	Drop test (cell or cell block, and battery system)	Cell tested. Battery Pack tested.	P
7.2.3.1	General		P
7.2.3.2	Whole drop test (cell or cell block, and battery system)		P
	Description of the Test Unit.....:	Cell	—
	Mass of the test unit (g).....:	268g	—
	Height of drop (m).....:	1m	—
	Results: no fire, no explosion		P
7.2.3.3	Edge and corner drop test (cell or cell block, and battery system)	Battery system applied.	P
	Description of the Test Unit.....:	Battery system applied.	—
	Mass of the test unit (kg).....:	24.2Kg	—
	Height of drop (m).....:	0.1m	—
	Results: no fire, no explosion		P
7.2.4	Thermal abuse test (cell or cell block)	Tested complied.	P
	Results: no fire, no explosion		P
7.2.5	Overcharge test (cell or cell block)	Tested complied.	P
	For those battery systems that are provided with only a single protection for the charging voltage control		—
	Results: no fire, no explosion.....:	See Table 7.2.5.	P
7.2.6	Forced discharge test (cell or cell block)	Tested complied.	P
	Cells connected in series in the battery system..... :		N/A
	Redundant or single protection for discharge voltage control provided in battery system..... :		N/A
	Target Voltage.....:	-3.65V applied.	P
	Maximum discharge current of the cell, Im.....:	1It A=15A	P

	Discharge current for forced discharge, 1.0 It.....:	1It A=15A	P
	Discharging time, t = (1 It / Im) x 90 (min.).....:	90min, tested with 1 It A=15A.	P
	Results: no fire, no explosion.....:	(See appended table 7.2.6)	P
7.3	**Considerations for internal short-circuit – Design evaluation**		P
7.3.1	General		P
7.3.2	Internal short-circuit test (cell)	Tested complied.	P
	Samples preparation procedure: In accordance with Clause A.5 and A.6 of IEC 62133-2:2017		P
	Tested per 7.3.2 b) in an ambient temperature of 25 °C ± 5 °C.		P
	The appearance of the short-circuit location recorded by photograph or other means..... :		—
	The pressing was stopped - When a voltage drop of 50 mV was detected; or		N/A
	- The pressing force of 800 N (cylindrical cells) or 400 N (prismatic cells) was reached	800N for cylindrical cell	P
	Results: no fire.....:	(See appended table 7.3.2)	P
7.3.3	Propagation test (battery system)	7.3.2 was selected.	N/A
	Method to create a thermal runaway in one cell .... :		N/A
	Results: No external fire from the battery system, no battery case rupture.....:		N/A

8	**BATTERY SYSTEM SAFETY (CONSIDERING FUNCTIONAL SAFETY)**		P
8.1	**General requirements**		P
	Functional safety analysis for critical controls		N/A
	Conduct of a process hazard analysis for both the cell manufacturing process and the battery system manufacturing process		N/A
	Conduct of risk assessment and mitigation of the battery system		N/A
8.2	**Battery management system (or battery management unit)**		P
8.2.1	Requirements for the BMS		P
	The safety integrity level (SIL) target of the BMS		N/A
	The charge control evaluated by tests in clauses 8.2.2 to 8.2.4		P
8.2.2	Overcharge control of voltage (battery system)	Tested complied.	P
	The exceeded charging voltage applied to the whole battery system		P

	The exceeded charging voltage applied to only a part of the battery system, such as the cell(s)..... :		N/A
	Results: no fire, no explosion.....:	(See appended table 8.2.2)	P
	The BMS terminated the charging before exceeding the upper limit charging voltage		P
8.2.3	Overcharge control of current (battery system)	Tested complied.	P
	Results: no fire, no explosion.....:	(See appended table 8.2.3)	P
	The BMS detected the overcharging current and controlled the charging to a level below the maximum charging current		P
8.2.4	Overheating control (battery system)	Tested complied.	P
	The cooling system, if provided, was disconnected		N/A
	Elevated temperature for charging, 5 °C above maximum operating temperature..... :	Maximum operating temperature is 60°C.	P
	Results: no fire, no explosion.....:	(See appended table 8.2.4)	P
	The BMS detected the overheat temperature and terminated charging		P
	The battery system operated as designed during test		P

9	**EMC**		N/A
	Battery system fulfil EMC requirements of the end-device application.....:		N/A

10	**INFORMATION FOR SAFETY**		P
	The cell manufacturer provides information about current, voltage and temperature limits of their products		P
	The battery system manufacturer provides information regarding how to mitigate hazards to equipment manufacturers or end-users.		P

11	**MARKING AND DESIGNATION (REFER TO CLAUSE 5 OF IEC 62620)**		P
	The marking items shown in Table 1 in IEC 62620 indicated on the cell, battery system or instruction manual.		P
	Cell or battery system has clear and durable markings		P
	Cell designation		N/A
	Battery designation		N/A
	Battery structure formulation		N/A

12	**PACKAGING AND TRANSPORT**		N/A
	Refer to Annex D		P

ANNEX A	**OPERATING REGION OF CELLS FOR SAFE USE**		P
A.1	General		P
A.2	Charging conditions for safe use	Cell charge temperature range: 0~55°C,	P
A.3	Consideration on charging voltage	3.65V applied.	P
A.4	Consideration on temperature		P
A.5	High temperature range	Charging high temperature declared by client is: 55°C.	P
A.6	Low temperature range	Charging low temperature declared by client is: 0°C.	P
A.7	Discharging conditions for safe use	Discharging temperature declared by client is: -30 ~60°C	P
A.8	Example of operating region		P

ANNEX B	**PROCEDURE OF 7.3.3 PROPAGATION TEST BY LASER IRRADIATION**		N/A
B.1	**General**		N/A
B.2	**Test conditions**		N/A
B.2.1	Cell test (preliminary test)		N/A
	The cell fully charged according to the manufacturer recommended conditions.....:		—
	Laser irradiation point on the cell..... :		—
	Output power of laser irradiation..... :		—
	Tested in an ambient temperature of 25 °C ± 5 °C		N/A
	Repeat of cell test for 3 times		N/A
B.2.2	Battery system test (main test)		N/A
	The battery system fully charged according to the manufacturer recommended conditions.....:		—
	Target cell to be laser irradiated.....:		—
	The irradiation point on the target cell same or similar as that on the cell test		N/A
	Output power of laser irradiation..... :		—
	Tested in an ambient temperature of 25 °C ± 5 °C		N/A

ANNEX C	**PROCEDURE OF 7.3.3 PROPAGATION TEST BY METHODS OTHER THAN LASER**		N/A
C.1	General		N/A
C.2	Test conditions:		N/A
	– The battery fully charged according to the manufacturer recommended conditions.....:		—
	– Target cell forced into thermal runaway.....:		—
	– A specially prepared sample (e.g. a heater or a hole for nail penetration provided) used for ease of testing..... :		—
C.3	Method used for initiating the thermal runaway. 1) Heater (Heater, Burner, Laser, Inductive heating 2) Overcharge 3) nail penetration of the cell 4) Combination of above methods 5) Other methods..... :		—

ANNEX D	**PACKAGING AND TRANSPORT**		P
	The materials and pack design chosen in a way as to prevent the development of unintentional electrical conduction, corrosion of the terminals and ingress of environmental contaminants		P
	Regulations concerning international transport of secondary lithium batteries		P

5.1	TABLE: Critical components information				P
Object / part No.	**Manufacturer/ trademark**	**Type / model**	**Technical data**	**Standard**	**Mark(s) of conformity[1)]**
Cells	Hefei Gotion High-tech Power Energy Co., Ltd	IFR32135-15Ah	3.2V 15Ah 48Wh	IEC 62619:2022	Tested with apparatus
PCB	GLOBAL SUCCESS CIRCUITS CO LTD	SCS-M	temperature：130°C, Fire rating：V-0	UL 94 UL 796	UL E365866
- Fuse (R253)	Shenzhen liangsheng electronics Co., LTD	12h1400C	Vr: 63V, Ir: 4A, Interrupting Rating: 50 Amperes at 63V DC(1A~4A) 100 Amperes at 32V DC(5A)	UL 1434	Tested with apparatus
- NTC (RT2)	Shenzhen Sunlord Electronics Co., Ltd.	SDNT1608X103 F3435FTF	10KΩ±1%, B(25/85)=3435K±1% Operating temperature： -55℃~+125℃	UL 1434	Tested with apparatus
- Control IC (UM1)	HUADA SEMICONDUCTOR Co., Ltd	HC32F460PETB	VCU= (3.6±0.08) V; VDL= (1.65±0.02) V; Topr:-40°C ~85°C	IEC 62619:2022	Tested with apparatus
- MOSFET (QP1-24)	MAGNACHIP Co., Ltd	MDE10N026	VDS:100V VGS:±20V, ID:120A (TA=25°C), TJ:-55-175°C	IEC 62619:2022	Tested with apparatus
- PTC(R308)	JinRui	JK-nSMD005	60V50mA	UL 1434	Tested with apparatus
- Description:N/A					

7.2.1	TABLE: External short-circuit test (cell or cell block)				P
Sample No.	**Ambient (at 25°C ± 5°C)**	**OCV at start of test (V dc)**	**Resistance of Circuit (mΩ)**	**Maximum Case Temperature Rise ΔT (°C)**	**Results**
C01#	23.6	3.343	35.4	62.9	A, E
C02#	23.6	3.342	32.6	66.5	A, E
C03#	23.6	3.339	33.8	61.2	A, E

Supplementary information:

A – No fire or Explosion
B – Fire
C – Explosion
D – The test was completed after 6 h
E – The test was completed after the cell casing cooled to 20% of the maximum temperature rise

F – Other (Please explain):___

7.2.5	TABLE: Overcharge test (cell or cell block)					P
Sample No.	**OCV at start of test (V dc)**	**OCV at end of test (V dc)**	**Measured Maximum Charging Current (A)**	**Measured Maximum Charging Voltage (V dc)**	**Max. Cell Case Temperature, (°C)**	**Results**
C13#	2.945	3.442	15	4.015	40.2	A, E
C14#	2.952	3.445	15	4.015	38.6	A, E
C15#	2.944	3.448	15	4.015	37.5	A, E

Supplementary information:

Results:
A – No fire or Explosion
B – Fire
C – Explosion
D – Test concluded when temperature reached a steady state condition
E – Test concluded when temperature returned to ambient

F – Other (Please explain): _____

7.2.6	TABLE: Forced discharge test (cell or cell block)				P
Sample No.	**OCV before applying reverse charge, (V dc)**	**Target Voltage (V dc)**	**Measured Reverse Charge Current It, (A)**	**Total Time for Reversed Charge Application (min)**	**Results**
C16#	2.950	3.65	15	90	A
C17#	2.948	3.65	15	90	A
C18#	2.945	3.65	15	90	A

Supplementary information:

Results:
A – No fire or Explosion
B – Fire
C – Explosion
D – Other (Please explain): ___

7.3.2	TABLE: Internal short-circuit test (cell)			P
Sample No.	**OCV at start of test, (V dc)**	**Particle location [1)]**	**Maximum applied pressure, (N)**	**Results**
C19#	3.349	1	800	A, E
C20#	3.352	1	800	A, E
C21#	3.350	1	800	A, E
C22#	3.351	1	800	A, E
C23#	3.354	1	800	A, E

Supplementary information:

8)..... 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.

Results:

A – No fire or explosion
B – Fire
C – Explosion
D – Test concluded when 50 mV voltage drop occurred prior to reaching force limit
E – Test concluded when 800/400 N pressure was reached and 50 mV voltage drop was not achieved
F – Test was concluded when fire or explosion occurred

G – Other (Please explain): __

7.3.3	TABLE: Propagation test (battery system)				N/A
Sample No.	**OCV of Battery System Before Test, (V dc)**	**OCV of Target Cell Before Test, (V dc)**	**Maximum Cell Case Temperature, (°C)**	**Maximum DUT Enclosure Temperature, (°C)**	**Results**
-	-	-	-	-	-

Method of cell failure 1)	**Location of target cell**	**Area for fire protection (m^2)**
-	-	-

Supplementary information:

1) Cell can be failed through laser exposure, applied heat, overcharge, nail penetration or combinations of these failures or other acceptable methods. See supporting documentation for details on cell failure method

2) If the battery system has no outer covering, the manufacturer is required to specify the area for fire protection.

Results:
A – No fire external to DUT enclosure or area for fire protection or no battery case rupture
B – Fire external to DUT enclosure or area for fire protection
C – Explosion
D – Battery case rupture
E – Other (Please explain): __

8.2.2	TABLE: Overcharge control of voltage (battery system)				P
Sample No.	**OCV at start of test for Cell/Cell Blocks, (V dc)**	**Maximum Charging Current, (A)**	**Max. Charging Voltage, (V dc)**	**Max. Voltage of Cell/Cell Blocks, (V dc)**	**Results**
B3	2.944	100	29.12	3.644	A, D, F
B4	2.950	100	29.20	3.642	A, D, F

	Charge Voltage Applied Battery System: 1)	
	Whole	**Part**
	32.12	/

Supplementary information:

8. The exceeded voltage can be applied to only a part of the system such as the cell(s) in the battery system per Figure 6 of IEC 62619, if it is difficult to do it in using the whole battery system.

Results:
A – No Fire or Explosion
B – Fire
C – Explosion
D – The voltage of the measured cells or cell blocks did not exceed the upper limit charging voltage
E – The voltage of the measured cells or cell blocks did exceed the upper limit charging voltage
F – All function of battery system did operate as intended during the test.

G – All function of battery system did not operate as intended during the test.

H – Other (Please explain): ___

8.2.3	TABLE: Overcharge control of current (battery system)			P
Sample No.	**OCV at start of test, (V dc)**	**Max. Charging Current, (A)**	**Max. Charging Voltage, (V dc)**	**Results**
B5	22.64	120	29.2	A, D, F
B6	22.56	120	29.2	A, D, F

Supplementary information:

Results:
A – No fire or Explosion
B – Fire
C – Explosion
D – Overcurrent sensing function of BMU did operate and then charging stopped
E – Overcurrent sensing function of BMU did not operate and then charging stopped
F – All function of battery system did operate as intended during the test.
G – All function of battery system did not operate as intended during the test.
H – Other (Please explain): ____

8.2.4	TABLE: Overheating control (battery system)		P
Model No.	**OCV at start(SOC 50%) of test, V dc**	**Maximum Charging Current, A**	**Maximum Charging Voltage, V dc**
B7	26.42	120	29.2
B8	26.45	120	29.2
Maximum Specified Temperature of Battery System, °C		**Maximum Measured Cell Case Temperature, °C**	**Results**
50		60	A, D, F
50		60	A, D, F

Supplementary information:

Results:
A – No fire or Explosion
B – Fire
C – Explosion

D – Temperature sensing function of BMU did operate and then charging stopped

E – Temperature sensing function of BMU did not operate and then charging stopped

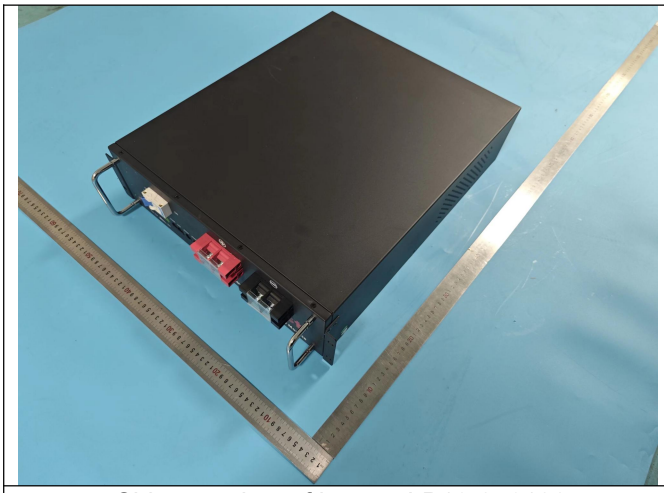
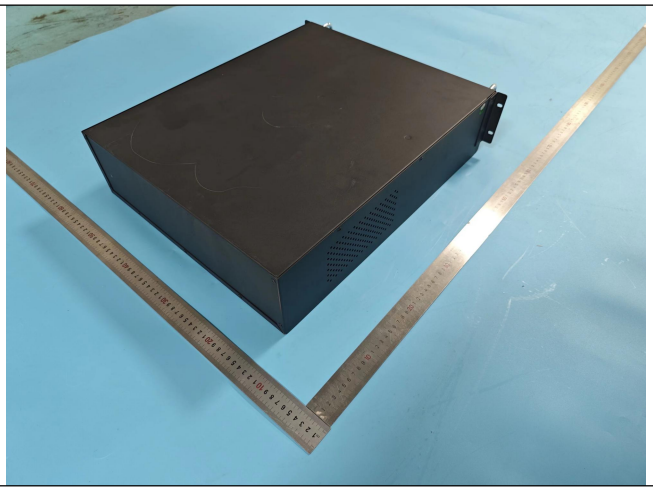
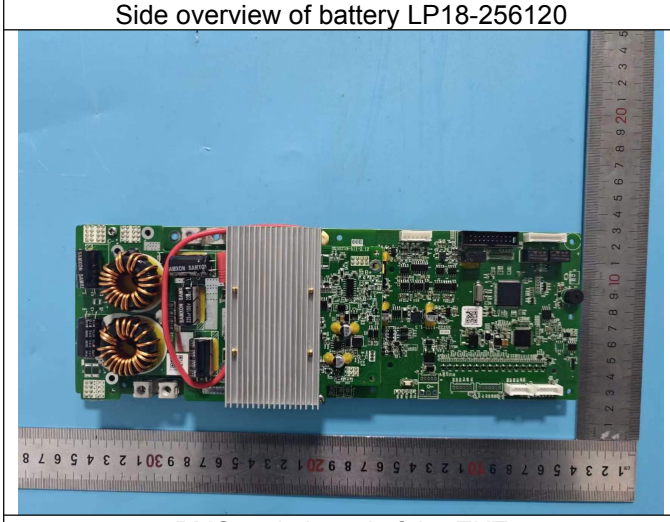
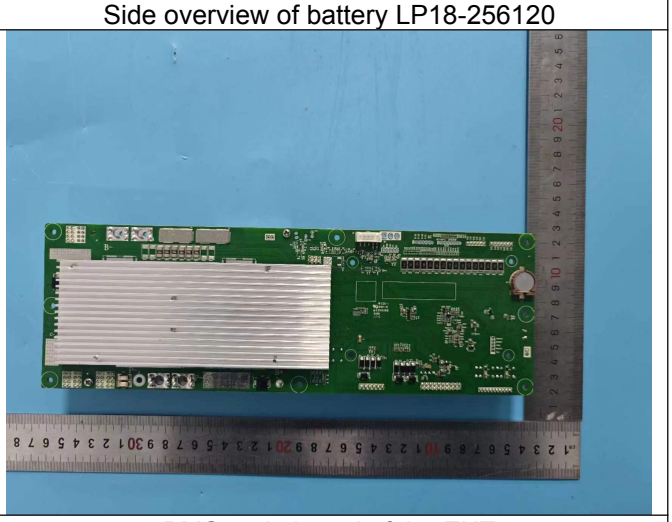
F – All function of battery system did operate as intended during the test.

G – All function of battery system did not operate as intended during the test.

H – Other (Please explain): ____

ANNEX 1: PHOTOS

Model type: LP18-256120

	
Side overview of battery LP18-256120	Side overview of battery LP18-256120
	
BMS main board of the EUT	BMS main board of the EUT