SLG Prüf- und Zertifizierungs GmbH

Test Protocol

UN Transportation Test

UN Manual of Tests and Criteria, PART III, Sub-Section 38.3, Rev. 6 A1

Protocol

Protocol No	1129-17-MM-18-PP002
Tested by (+ signature)	Harmel
Approved by (+ signature)	Kékedi
Date of issue	14.09.2018
Contents	11 pages

Testing laboratory

Name	SLG Prüf- und Zertifizierungs GmbH
Address	Burgstädter Straße 20, 09232 Hartmannsdorf, Germany
Email	service@slg.de.com
Phone	+49 (0)3722 7323-0
Testing location	as above

Applicant

Name	Akku Power GmbH
Address	Paul-Strähle-Straße 26
	73614 Schorndorf, Deutschland

Test specification

Standard	UN Manual of Tests and Criteria PART III, Sub-Section 38.3, Rev. 6 A1
Test procedure	Test of battery pack, see above

Protocol update: 2018-01

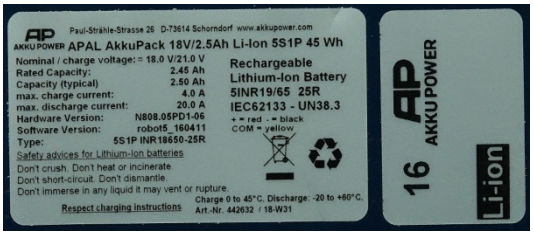
Test item

Description	Rechargeable Li-Ion-battery
Brand / Type	104299 APAL 18V / 2,5Ah / 5S1P
Manufacturer	Akku Power GmbH Paul-Strähle-Straße 26 73614 Schorndorf, Deutschland

Testing

Date of receipt of test item	2018-08-06 and 2018-09-07
Date(s) of performance of test	Aug-2018…Sep-2018

Copy of marking plate



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)

General remarks

The test results presented in this report relate only to the object tested.

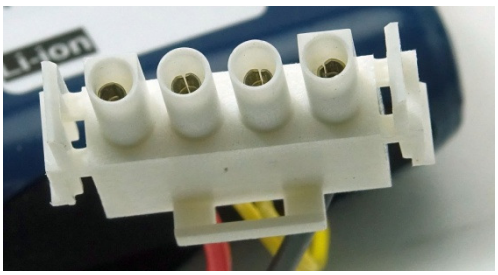
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.

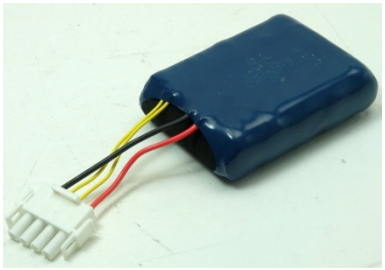
Throughout this report a point is used as the decimal separator.

General product information

Battery Name..... : 104299 APAL 18V / 2,5Ah / 5S1P

SLG Reference Number..... : 1129-17-M/011…018 and 1129-17-M/053…060





Composition Description:
Battery assembled for use in mobile applications with a rated voltage of 18 V and a capacity of 2.5 Ah, with 5 single cells a 2.5 Ah, Samsung SDI INR18650-25R (successful UN-Test, Document No. MT0080405)

Summary of test results

Test number	Test description	Result
38.3.4.1	Altitude Simulation (Unterdrucktest)	P
38.3.4.2	Thermal Cycle Test (Thermischer Zyklentest)	P
38.3.4.3	Vibration (Vibrationstest)	P
38.3.4.4	Shock (Mechanischer Stoß)	P
38.3.4.5	External Short Circuit (Äußerer Kurzschlusstest)	P
38.3.4.6	Impact (Schlagprüfung)	N/A
38.3.4.7	Overcharge (Überlasttest)	P
38.3.4.8	Forced Discharge (Erzwungene Entladung)	N/A

CYCLE CONDITIONING
The preparation of the battery pack/single cells in accordance with the provisions in the UN Manual of Test and Criteria Part III, Sub-Section 38.3, Paragraph 38.3.3 was carried out by the contracting authority.

TEST DESCRIPTION		
TABLE 1: Important Battery Data before start of test		
Battery	Voltage [V]	Weight [g]
1129-17-M/011	20.7	266
1129-17-M/012	20.5	268
1129-17-M/013	20.7	267
1129-17-M/014	20.7	267
1129-17-M/015	20.5	267
1129-17-M/016	20.7	267
1129-17-M/017	20.6	267
1129-17-M/018	20.7	266
1129-17-M/053	20.7	267
1129-17-M/054	20.7	268
1129-17-M/055	20.7	267
1129-17-M/056	20.7	266
1129-17-M/057	20.5	266
1129-17-M/058	20.6	267
1129-17-M/059	20.6	268
1129-17-M/060	20.6	266
Samples 11 - 14 and 53 – 56 are in the first charging/discharging cycle. Samples 15 - 18 and 57 – 60 have completed 50 charging/discharging cycles.		

TEST 1: LOW PRESSURE TEST (38.3.4.1)

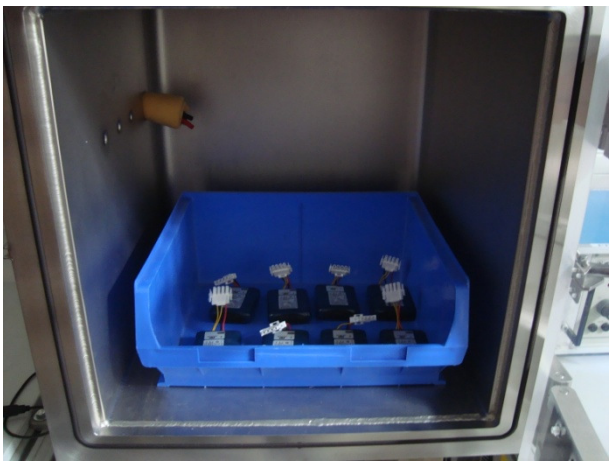



Figure 1: Pressure level in test chamber with the batteries inside

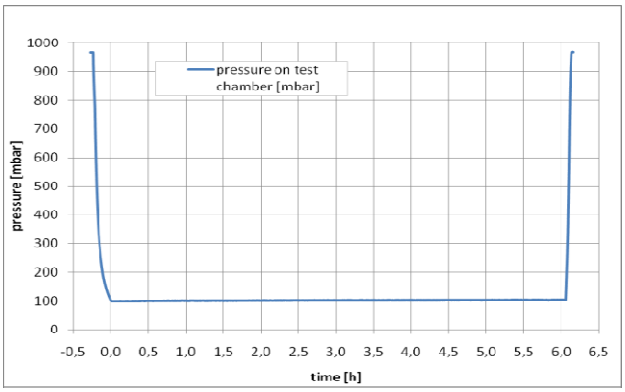



Figure 2: Diagram of pressure level in test chamber with the batteries inside

TABLE 2	Test results low pressure test				
Battery	Voltage [V] before test	Weight [g] before test	Voltage [V] after test	Weight [g] after test	Result
1129-17-M/011	20.7	266	20.5	267	P
1129-17-M/012	20.5	268	20.4	268	P
1129-17-M/013	20.7	267	20.5	266	P
1129-17-M/014	20.7	267	20.5	267	P
1129-17-M/015	20.5	267	20.4	267	P
1129-17-M/016	20.7	267	20.5	267	P
1129-17-M/017	20.6	267	20.5	267	P
1129-17-M/018	20.7	266	20.5	267	P

TEST 2: THERMAL TEST (38.3.4.2)

Figure 3: Thermal test in climate cabinet with the batteries inside

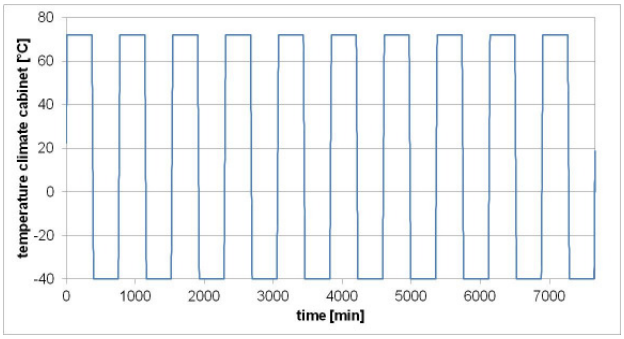


Figure 4: Temperature profile in climate cabinet with the batteries inside

TABLE 3 Test results thermal test

Battery	Voltage [V] before test	Weight [g] before test	Voltage [V] after test	Weight [g] after test	Result
1129-17-M/011	20.5	267	20.5	266	P
1129-17-M/012	20.4	268	20.4	268	P
1129-17-M/013	20.5	266	20.4	266	P
1129-17-M/014	20.5	267	20.4	266	P
1129-17-M/015	20.4	267	20.4	266	P
1129-17-M/016	20.5	267	20.5	267	P
1129-17-M/017	20.5	267	20.4	267	P
1129-17-M/018	20.5	267	20.4	266	P

TEST 3: VIBRATION TEST (38.3.4.3)

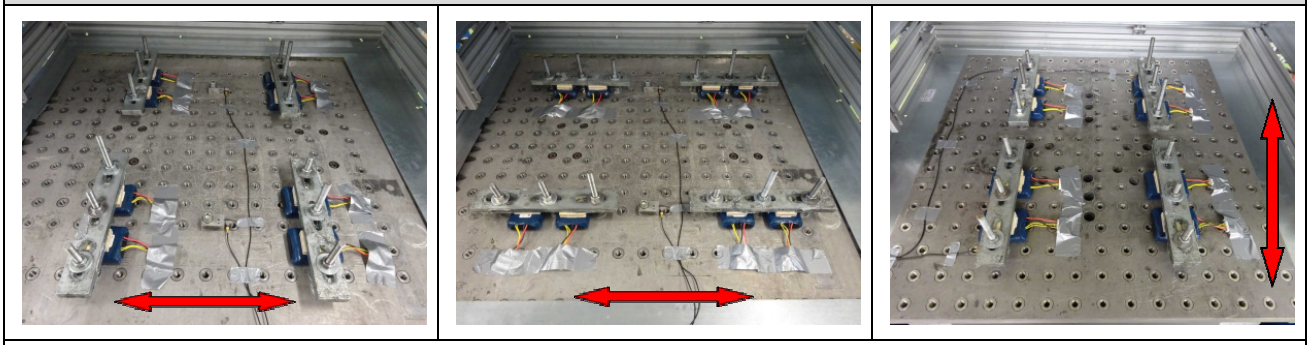


Figure 5: Vibration test on shaker table with the batteries

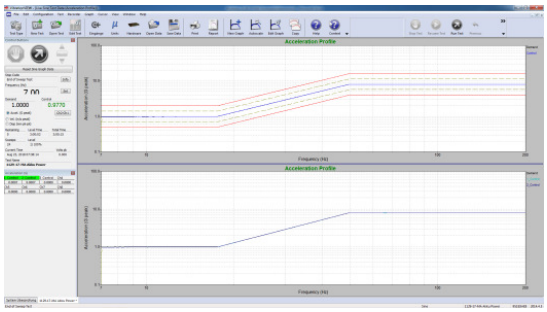


Figure 6: Vibration profile on shaker table with the batteries

TABLE 4 Test results vibration test

Battery	Voltage [V] before test	Weight [g] before test	Voltage [V] after test	Weight [g] after test	Result
1129-17-M/011	20.5	266	20.5	266	P
1129-17-M/012	20.4	268	20.4	268	P
1129-17-M/013	20.4	266	20.4	266	P
1129-17-M/014	20.4	266	20.4	266	P
1129-17-M/015	20.4	266	20.4	266	P
1129-17-M/016	20.5	267	20.5	267	P
1129-17-M/017	20.4	267	20.4	267	P
1129-17-M/018	20.4	266	20.4	266	P

TEST 4: SHOCK TEST (38.3.4.4)

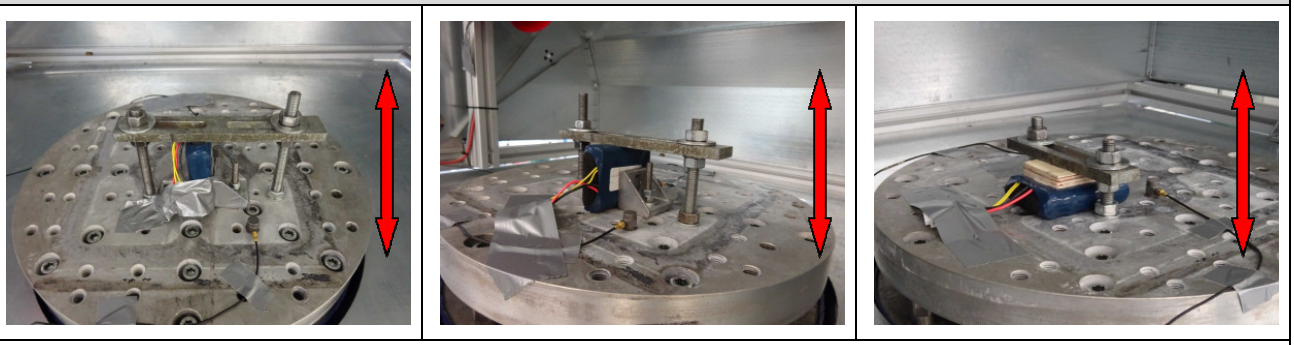


Figure 7: Shock test on shaker table with the batteries

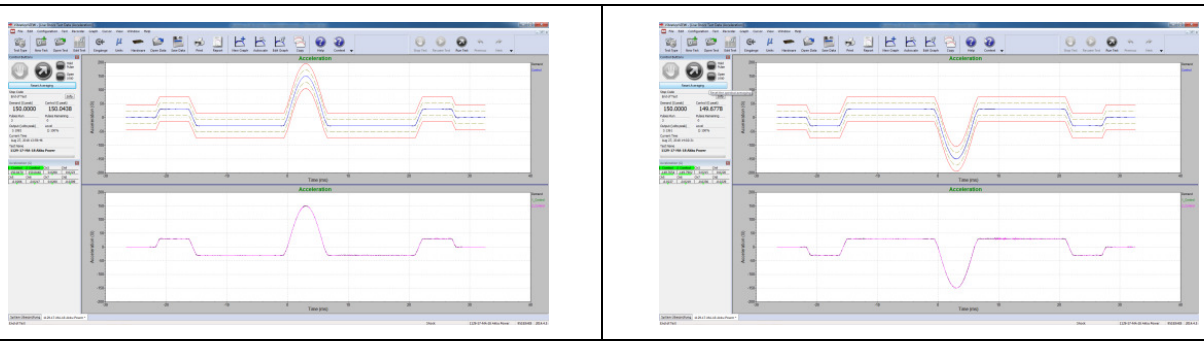


Figure 8: Vibration profile on shaker table with the batteries

TABLE 5 Test results shock test

Battery	Voltage [V] before test	Weight [g] before test	Voltage [V] after test	Weight [g] after test	Result
1129-17-M/011	20.5	266	20.4	266	P
1129-17-M/012	20.4	268	20.4	268	P
1129-17-M/013	20.4	266	20.4	266	P
1129-17-M/014	20.4	266	20.4	266	P
1129-17-M/015	20.4	266	20.4	266	P
1129-17-M/016	20.5	267	20.4	267	P
1129-17-M/017	20.4	267	20.4	267	P
1129-17-M/018	20.4	266	20.4	266	P

TEST 5: SHORT-CIRCUIT TEST (38.3.4.5)

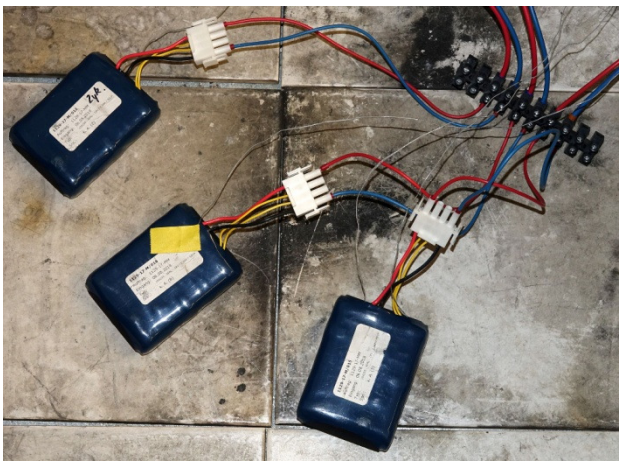


Figure 9: Short-circuit test in heat cabinet at 55 °C with the batteries

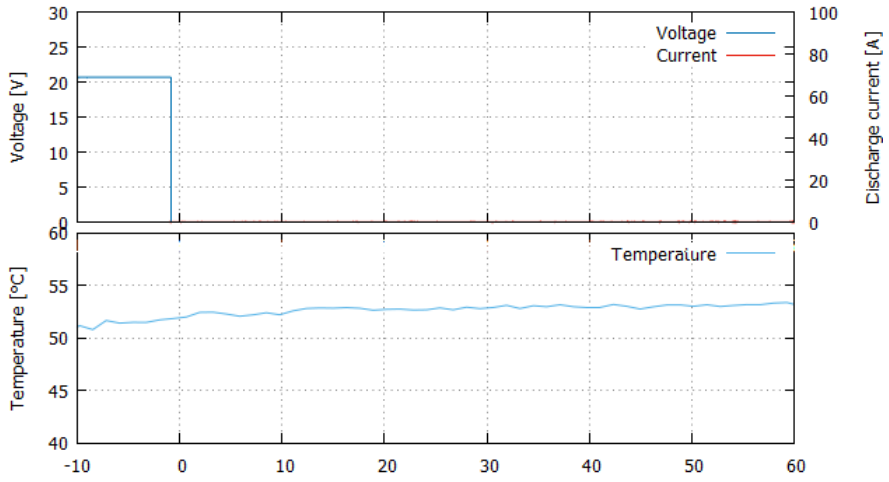


Figure 10: Short-circuit test diagram in heat cabinet at 55 °C with the batteries (at time 0 [min] discharge current was switched on)

TABLE 6 Test results short-circuit test

Battery	Voltage [V] before test	Weight [g] before test	Maximum temperature [°C]	Voltage [V] after test	Weight [g] after test	Result
1129-17-M/011	20.4	266	< 60	0.0	266	P
1129-17-M/012	20.4	268	< 60	0.0	268	P
1129-17-M/013	20.4	266	< 60	0.0	266	P
1129-17-M/014	20.4	266	< 60	0.0	266	P
1129-17-M/015	20.4	266	< 60	0.0	266	P
1129-17-M/016	20.4	267	< 60	0.0	266	P
1129-17-M/017	20.4	267	< 60	0.0	266	P
1129-17-M/018	20.4	266	< 60	0.0	266	P

TEST 7: OVERCHARGE TEST (38.3.4.7)

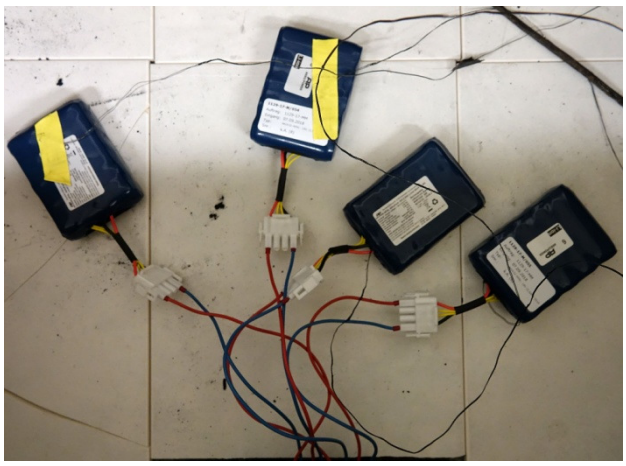


Figure 11: Overcharge test in safety cabinet with charge equipment (overcharge current 8 A, overcharge voltage 25.2 V)

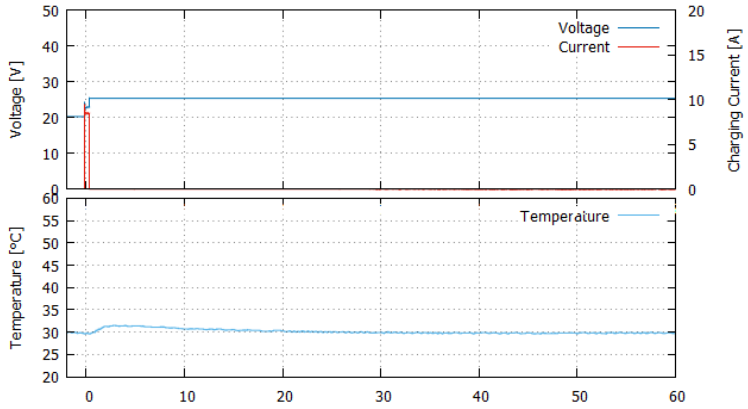


Figure 12: Overcharge test diagram (overcharge current 8 A, overcharge voltage 25.2 V, at time 0 [min] overcharge current was switched on)

TABLE 7 Test results overcharge test

Battery	Voltage [V] before test	Weight [g] before test	Damage	Fire	Voltage [V] after test	Weight [g] after test	Result
1129-17-M/053	20.7	267	No	No	0.0	267	P
1129-17-M/054	20.7	268	No	No	0.0	268	P
1129-17-M/055	20.7	267	No	No	0.0	267	P
1129-17-M/056	20.7	266	No	No	0.0	266	P
1129-17-M/057	20.5	266	No	No	0.0	266	P
1129-17-M/058	20.6	267	No	No	0.0	267	P
1129-17-M/059	20.6	268	No	No	0.0	268	P
1129-17-M/060	20.6	266	No	No	0.0	266	P

TABLE 8:	List of Critical Components				
Object/Part No.	Manufacturer/ Trademark	Type/Model	Technical Data	Standard	Mark(s) of Conformity[1])
Battery Pack:					
Enclosure material (all models)	Not stated	Not stated	Not stated	-	-
Cell holder	Not stated	Not stated	Not stated	-	-
PCB material	Not stated	Not stated	Not stated	-	-
Single cell	Samsung	INR18650-25R	3.6 V 2500 mAh	-	CB-Certificate IEC62133 DK-34607-UL
NTC	Not stated	Not stated	Not stated	-	-
Charger	Not stated	Not stated	21 V 4 A	-	-

End of test protocol

ANNEX Test Equipment				
Clause	Test	Equipment		Range used
38.3.4.1	Low pressure	Temperature controlled room (IEC17025) Low pressure chamber	20℃ ± 5 K Low pressure chamber Inv. no. 1499	20℃ ± 5 K Low pressure ≤ 11.6 kPa
38.3.4.2	Cycling temperature change	Conditioning cabinet	Vötsch VC4034 Inv. no. 1400	-20 ℃ ± 2 K…75 ℃ ± 2 K
38.3.4.3	Vibration	Vibration test system	Vibration test system TIRA TV 59335/AIT-440 with slip table. Inv. no. 1544 Rated peak force 35 kN Fluke 179 Inv. no. 5005	Sinusoidal vibration test Frequency range: 10 Hz to 55 Hz; Displacement amplitude: 0.76 mm; Acceleration amplitude: 3 to 91 m/s^2
38.3.4.4	Mechanical shock (crash hazard)	Vibration test system	Vibration test system TIRA TV 59335/AIT-440 Inv. no. 1544	20 ℃ ± 5 K Shock test (halfsine) Max. shock amplitude from 125 g to 175 g (remark: test can only be realized for small test samples)
38.3.4.5	Outer short circuit	Conditioning cabinet contactor; test sample in steel box	Memmert ULE500 Inv. no. 0469 Contactor Steel box	-20℃ ± 5 K…55℃ ± 5 K ≤ 100 mΩ
38.3.4.6	Impact	Test equipment impact		
38.3.4.7	Overcharge	Charging power station	Elektro-Automatik GmbH EA-532-100. Inv. no. 2731 Hioki LR8400-20 inv.no.: 2429	I_{charge} = 2 $I_{nominal}$ Max. DC voltage 54 V, current 40 A Max. DC voltage 54 V, current 20 A
38.3.4.8	Forced discharge	Discharge power station	Höcherl&Hackerl ZS1406	Max. DC voltage 60 V, current 150 A Max. DC voltage 44 V, current 40 A Max. DC voltage 44 V, current 20 A
38.3.4.1 – 38.3.4.8	All tests	Voltage measurement Current measurement	Data Logger Hioki LR8431-20 inv.no.: 2856, 2422, 2423 Current probe Z202A, inv.-no. 2425	Max. DC voltage 60 V