



Test Protocol UN Transportation Test

UN Manual of Tests and Criteria, PART III, Sub-Section 38.3, Rev. 5 A2

Protocol

Protocol No: 1093-16-MM-16-PP002

Tested by (+ signature).....: Harmel/ Lehmann

Approved by (+ signature): Kékedi

Date of issue.....: 12.10.2016

Contents: 11 pages

J. Harmel
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Testing laboratory

Name: SLG Prüf- und Zertifizierungs GmbH

Address.....: Burgstädter Straße 20, 09232 Hartmannsdorf, Germany

Testing location.....: as above

Applicant

Name: Lindhaus srl

Address.....: Via Belgio. 22

.....: 35127 Padova, Italy

Test specification

Standard: UN Manual of Tests and Criteria
PART III, Sub-Section 38.3, Rev. 5 A2

Test procedure.....: Test of battery pack, see above

Protocol update: 2015-07

Test item

Description.....: Rechargeable Li-Ion-Battery

Brand / Type: Lindhaus/ Mod. Li. 36/6

Manufacturer.....: Akku Power GmbH Batterien
Paul-Strähle-Straße 26
73614 Schorndorf, Deutschland

Factory.....: Akku Power GmbH Batterien
Paul-Strähle-Straße 26
73614 Schorndorf, Germany

Testing

Date of receipt of test item.....: 22.08.2016

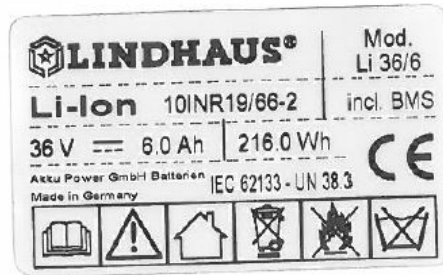
Date(s) of performance of test.....: August...October 2016

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This test report is based on the test report 1093-16-MM-16-PP001 and a declaration of identity issued by Akku Power GmbH and Lindhaus srl.



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..... : Mod. Li. 36/6 - 36V / 6.0Ah / 10S2P
 SLG Reference Number : 1093-16-M/001...008



Composition Description:

Battery assembled for use in mobile devices with a rated voltage of 36 V and a capacity of 6.0 Ah, with 20 single cells a 3 Ah, LG INR18650HG2 (successful UN-Test, Document No. QAE-EF02-150325-CY18650HG2 and IEC62133 Certificate Document No. 150331-[IEC62133] INR18650HG2)

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 Kurzschlussstest)	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]
1093-16-M/001	41.0	1286
1093-16-M/002	41.2	1289
1093-16-M/003	40.6	1292
1093-16-M/004	40.9	1286
1093-16-M/005	40.8	1279
1093-16-M/006	40.6	1291
1093-16-M/007	40.6	1283
1093-16-M/008	40.6	1287

Samples 1 - 4 are in the first charging/discharging cycle.

Samples 5 - 8 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

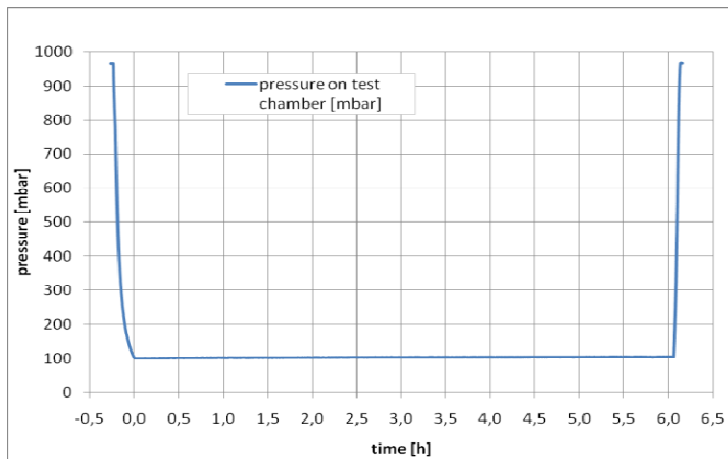


Figure 2: Diagram of pressure level

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
1093-16-M/001	41.0	1286	41.1	1286	P
1093-16-M/002	41.2	1289	41.1	1289	P
1093-16-M/003	40.6	1292	40.5	1293	P
1093-16-M/004	40.9	1286	40.8	1286	P
1093-16-M/005	40.8	1279	40.7	1280	P
1093-16-M/006	40.6	1291	40.6	1292	P
1093-16-M/007	40.6	1283	40.6	1284	P
1093-16-M/008	40.6	1287	40.6	1287	P

TEST 2: THERMAL TEST (38.3.4.2)



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

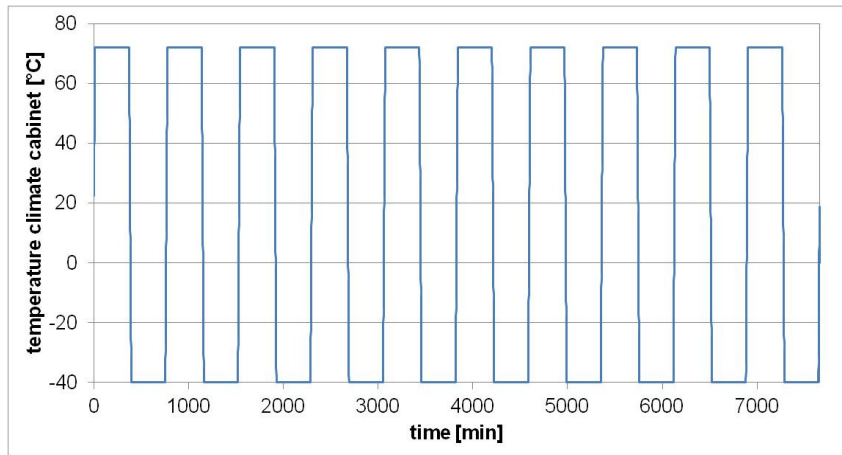


Figure 4: Temperature profile in climate cabinet with the batteries inside

TABLE 3 Test results thermal test					
Battery	Voltage [V] before test	Weight [g] before test	Voltage [V] after test	Weight [g] after test	Result
1093-16-M/001	41.1	1286	41.0	1285	P
1093-16-M/002	41.1	1289	40.8	1288	P
1093-16-M/003	40.5	1293	40.7	1292	P
1093-16-M/004	40.8	1286	40.7	1286	P
1093-16-M/005	40.7	1280	40.6	1278	P
1093-16-M/006	40.6	1292	40.7	1290	P
1093-16-M/007	40.6	1284	40.7	1282	P
1093-16-M/008	40.6	1287	40.6	1287	P

TEST 3: VIBRATION TEST (38.3.4.3)

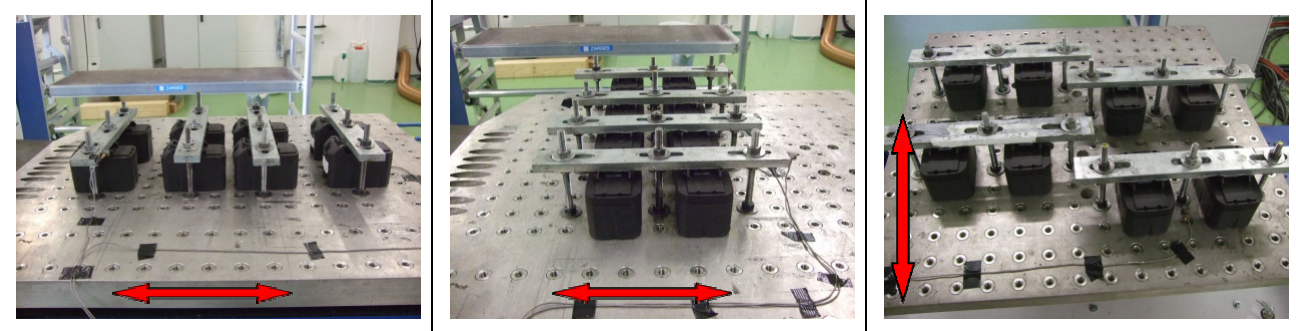


Figure 5: Vibration test on shaker table with the batteries

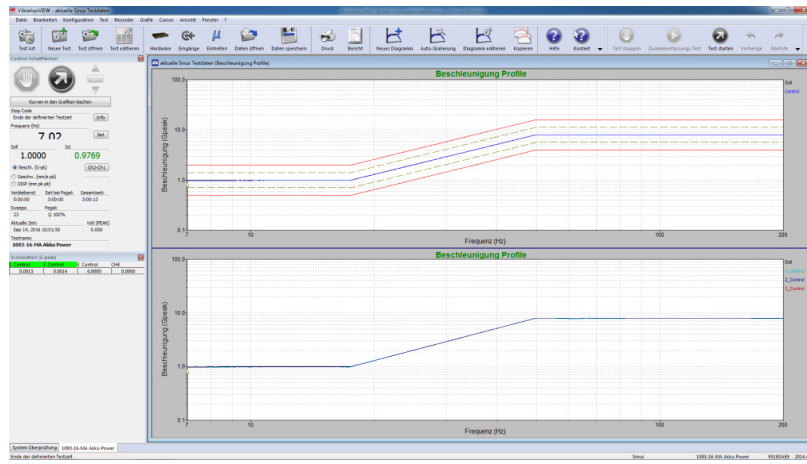


Figure 6: Vibration profile on shaker table with the batteries

TABLE 4 Test results vibration test					
Battery	Voltage [V] before test	Weight [g] before test	Voltage [V] after test	Weight [g] after test	Result
1093-16-M/001	41.0	1285	40.9	1285	P
1093-16-M/002	40.8	1288	40.8	1288	P
1093-16-M/003	40.7	1292	40.7	1292	P
1093-16-M/004	40.7	1286	40.7	1286	P
1093-16-M/005	40.6	1278	40.6	1278	P
1093-16-M/006	40.7	1290	40.7	1290	P
1093-16-M/007	40.7	1282	40.7	1282	P
1093-16-M/008	40.6	1287	40.6	1287	P

TEST 4: SHOCK TEST (38.3.4.4)

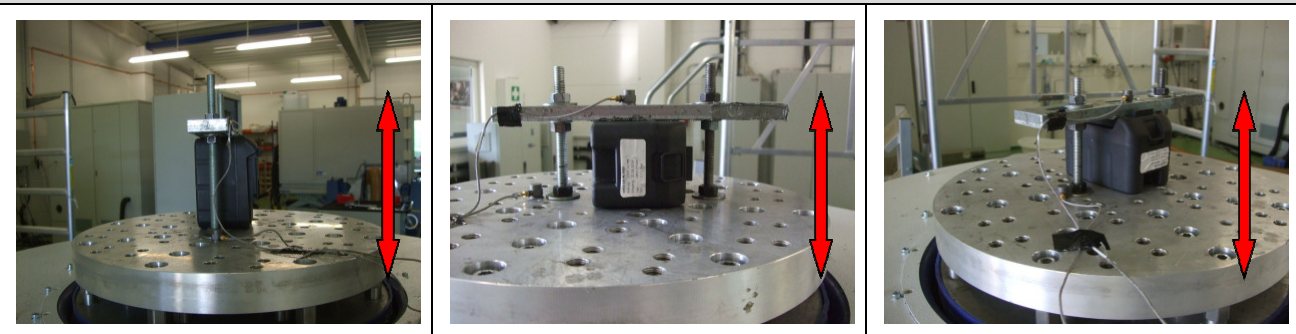


Figure 7: Shock test on shaker table with the batteries

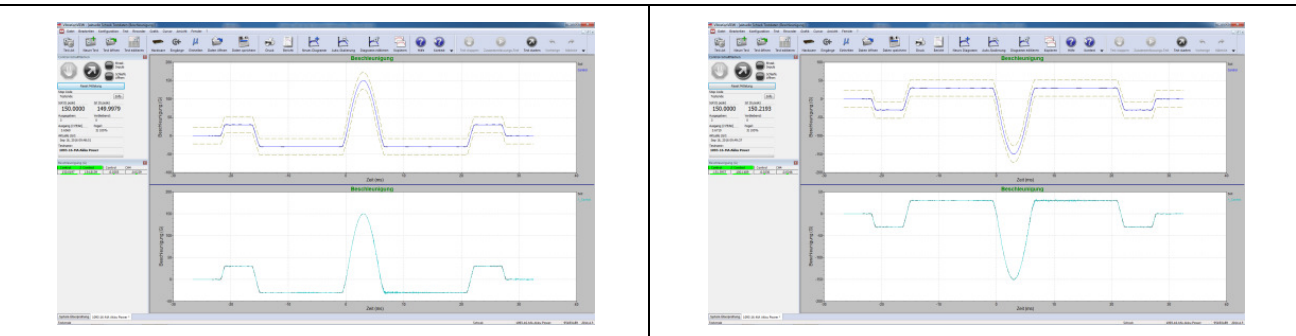


Figure 8: Vibration profile on shaker table with the batteries

TABLE 5		Test results shock test			
Battery	Voltage [V] before test	Weight [g] before test	Voltage [V] after test	Weight [g] after test	Result
1093-16-M/001	40.9	1285	40.9	1285	P
1093-16-M/002	40.8	1288	40.8	1289	P
1093-16-M/003	40.7	1292	40.7	1292	P
1093-16-M/004	40.7	1286	40.7	1286	P
1093-16-M/005	40.6	1278	40.6	1278	P
1093-16-M/006	40.7	1290	40.7	1290	P
1093-16-M/007	40.7	1282	40.7	1283	P
1093-16-M/008	40.6	1287	40.6	1286	P

TEST 5: SHORT-CIRCUIT TEST (38.3.4.5)



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

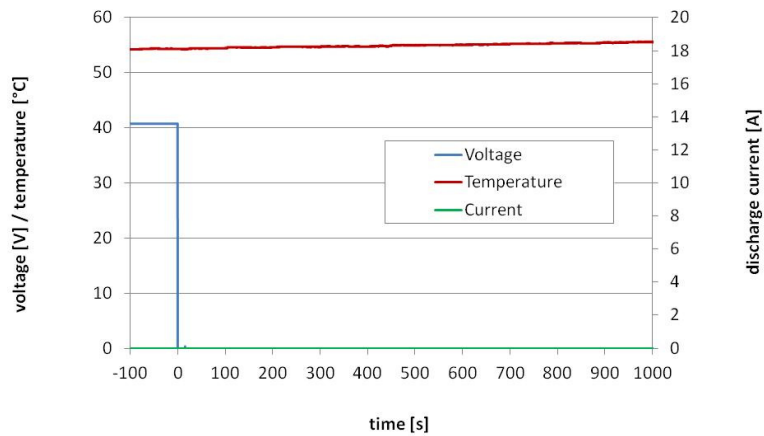


Figure 10: Short-circuit test diagram in heat cabinet at 55 °C with the batteries (at time 0 discharge current was switched on)

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
1093-16-M/001	40.9	1285	< 60	40.8	1284	P
1093-16-M/002	40.8	1289	< 60	40.8	1289	P
1093-16-M/003	40.7	1292	< 60	40.6	1292	P
1093-16-M/004	40.7	1286	< 60	40.7	1286	P
1093-16-M/005	40.6	1278	< 60	40.6	1279	P
1093-16-M/006	40.7	1290	< 60	40.6	1291	P
1093-16-M/007	40.7	1283	< 60	40.6	1284	P
1093-16-M/008	40.6	1286	< 60	40.5	1286	P

TEST 7: OVERCHARGE TEST (38.3.4.7)

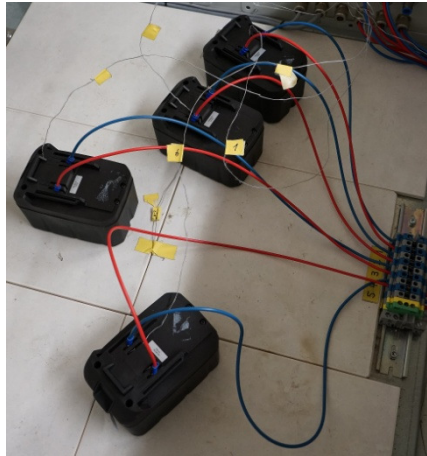


Figure 10: Overcharge test in safety cabinet with charge equipment (overcharge current 16 A, overcharge voltage 50.4 V)

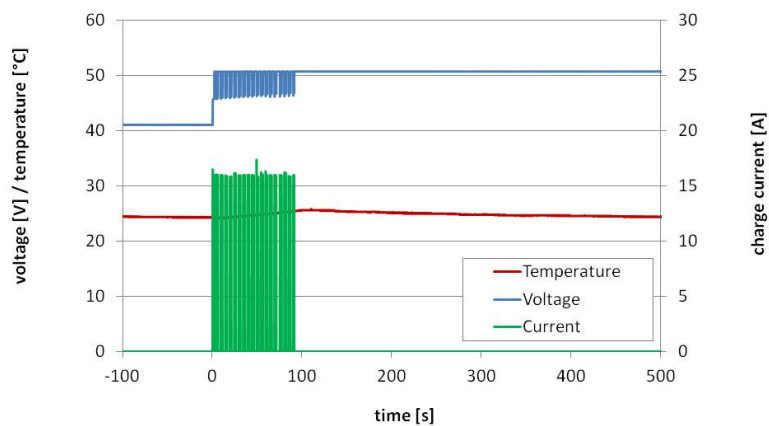


Figure 11: Overcharge test diagram (overcharge current 16 A, overcharge voltage 50.4 V, at time 0 overcharge current was switched on)

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
1093-16-M/001	40.8	1284	No	No	40.9	1284	P
1093-16-M/002	40.8	1289	No	No	40.8	1289	P
1093-16-M/003	40.6	1292	No	No	40.8	1292	P
1093-16-M/004	40.7	1286	No	No	40.7	1286	P
1093-16-M/005	40.6	1279	No	No	40.7	1279	P
1093-16-M/006	40.6	1291	No	No	40.6	1291	P
1093-16-M/007	40.6	1284	No	No	40.7	1284	P
1093-16-M/008	40.5	1286	No	No	40.7	1286	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	LG	INR18650HG2	3.6 V 3000 mAh	-	IEC62133 150331-[IEC62133] INR18650HG2
NTC	Not stated	Not stated	Not stated	-	-

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 °C ± 5 K Low pressure chamber Inv. no. 1499	20 °C ± 5 K Low pressure ≤ 11.6 kPa
38.3.4.2	Cycling temperature change	Conditioning cabinet	Vötsch VC4034 Inv. no. 1400	-20 °C ± 2 K...75 °C ± 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 °C ± 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 °C ± 5 K...55 °C ± 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	$I_{\text{charge}} = 2 I_{\text{nominal}}$ 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