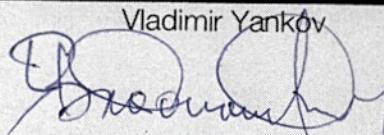
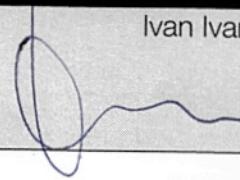






Test report

Flight Acceptance Test Requirements for Lithium-ion Cells and Battery Packs

Prepared	Revised	Approved
Vladimir Yankov 	Ivan Ivanon 	Giuseppe Sisinni 
18/06/2018	19/06/2018	21/06/2018

3	Required Test Procedures - Physical And Electrochemical Characteristics Text.....	2
3.1	Test Documentation	2
3.2	Visual Inspection.....	2
3.3	Measurement Of The Physical Properties	2
3.4	Electrochemical Characteristic.....	3
4	Charge Cycling Data Procedures.....	4
5	Cell Over-Charge Procedures	9
6	Cell Over-Discharge Procedure.....	9
7	External Protection	9
8	Circuit Schematic Analysis	9
9	Vibration Test	10
10	Vacuum Test	10

BATTERY TEST REPORT

Four "VARTA 1/LPP 503759 8HH" Lithium Ion Polymer cells are used in two battery packs (1S2P) connected in parallel (1S4P). The total energy level is 20.8Wh.

All tests according "NR-SRD-139 Revision C" are performed and described in this document. Numbering of the paragraphs is aligned with the above-mentioned document.

3 REQUIRED TEST PROCEDURES - PHYSICAL AND ELECTROCHEMICAL CHARACTERISTICS TEXT

3.1 Test documentation

Manufacturer	Storage GMBH
Cell model number	1/LPP 503759 8HH (VKB56427 201 018)
Date of manufacture	4 th week of April 2017 (047C)
Manufacturer cell / Battery specifications	VARTA/1400mAh 3.7V 5.2W
Cell chemistry	Lithium-Ion Polymer
Electrolyte type	Polymer Electrolyte
Date of battery cell testing	May-June 2018

3.2 Visual inspection

No scrapes, budges and dents were found on the battery cells after a visual inspection

3.3 Measurement of the physical properties

The following measurements are performed with 0.1mm precision

	Cell 1	Cell 2	Cell 3	Cell 4	Datasheet [Max]
Length [mm]	58.7	58.9	58.9	58.9	60.5
Width [mm]	36.3	36.5	36.5	36.6	37.5
Height [mm]	4.9	4.9	4.9	4.9	5.4

The following measurements are performed with 0.1g precision accuracy

	Cell 1	Cell 2	Cell 3	Cell 4	Datasheet [Max]
Weight [g]	24.1	24.2	24.2	24.2	Approx. 25

3.4 Electrochemical Characteristic

The test is performed on flight cells. All cells are charged with “Graupner Ultra Duo Plus 60 No.6478” to the manufacture’s recommended voltage level (4.2V). Measurements are performed with more than 0.1V precision.

3.4 A Measurement of Open Circuit Voltage

Cell	Open Circuit Voltage [V]
1	4.2
2	4.2
3	4.2
4	4.2

3.4 B Measurement of Closed Circuit Voltage

Cell	Closed Loop Circuit Voltage (C/2, 30sec)
1	4.013
2	4.002
3	4.007
4	4.011

3.4 C Open Circuit Voltage (OCV) 14-day test

All cells are discharged to the minimal specified voltage by the manufacture (3V) and terminated when the current tapers below C/100 (14mA). Batteries were discharged in several steps with decreasing current. “Graupner Ultra Duo Plus 60 No.6478” was used to perform this test.

For last step, the discharging current was set with 100 Ohm resistor (C/100 – 14mA) connected to the batteries and monitored with multimeter (C/100 – 14mA). The cell open circuit voltage was monitored for 14 days.

	Day1	Day3	Day7	Day10	Day14
Cell1 [V]	3.016	3.214	3.237	3.248	3.255
Cell2 [V]	3.010	3.366	3.380	3.385	3.387
Cell3 [V]	3.011	3.365	3.380	3.386	3.388
Cell4 [V]	3.008	3.366	3.380	3.386	3.389

No declining voltage was monitored. All cells are accepted

4 CHARGE CYCLING DATA PROCEDURES

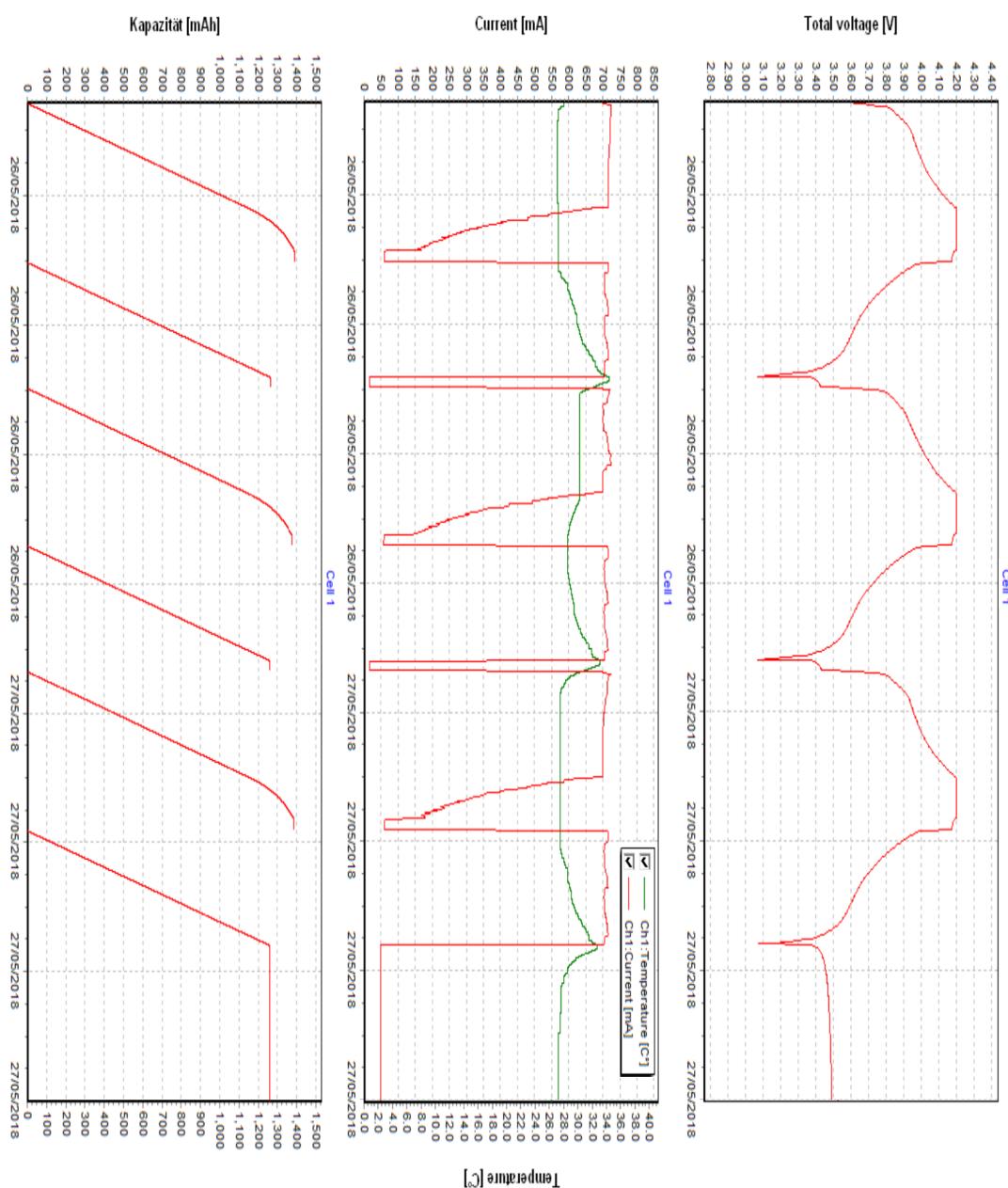
For this test, “Graupner Ultra Duo Plus 60 No.6478” cycle option was used. Batteries were charged and discharged to the recommended manufacture’s voltage level - respectively 4.2V for charge and 3V for discharge. According to the test specification. Ten minutes rest to the batteries is provided between every cycle (charge and discharge). Temperature of the battery cells was monitored for the all duration of the test.

The Charge Cycling Data Procedures include the following cycle order:

- Charge
- Discharge
- Charge
- Discharge
- Charge

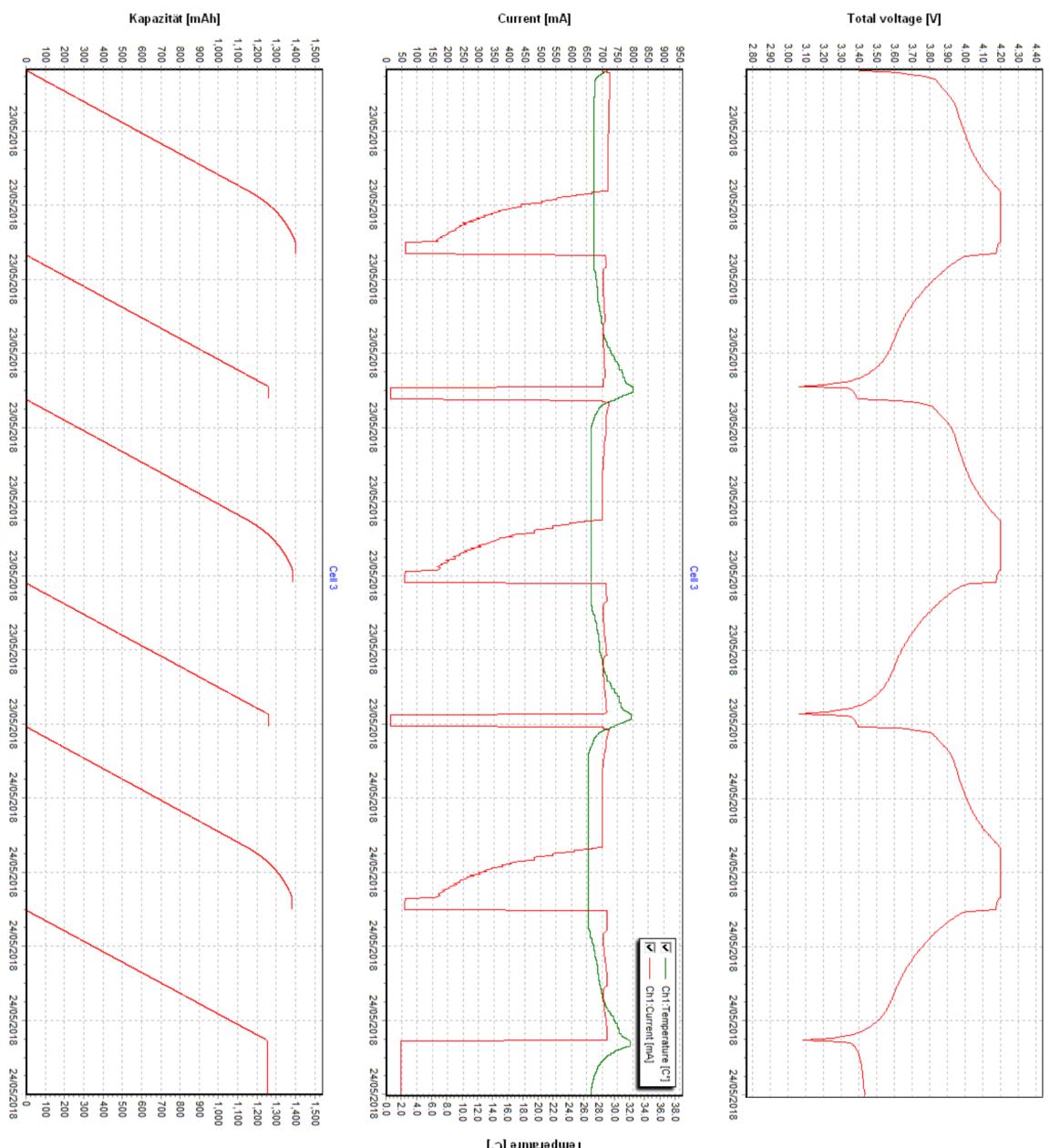
TEST REPORT

Cell 1		
Cycle Order	Voltage [V]	Capacity [mAh]
1.Charge	3.39 -> 4.2	1390
2.Delay	4.2-> 4.17	
3.Discharge	4.15 -> 3.01	1264
4.Delay	3.00 -> 3.43	
5.Charge	3.43 -> 4.2	1374
6.Delay	4.2 -> 4.17	
7.Discharge	4.15 -> 3.01	1262
8.Delay	3.00 -> 3.43	
9.Charge	3.43 -> 4.2	1387



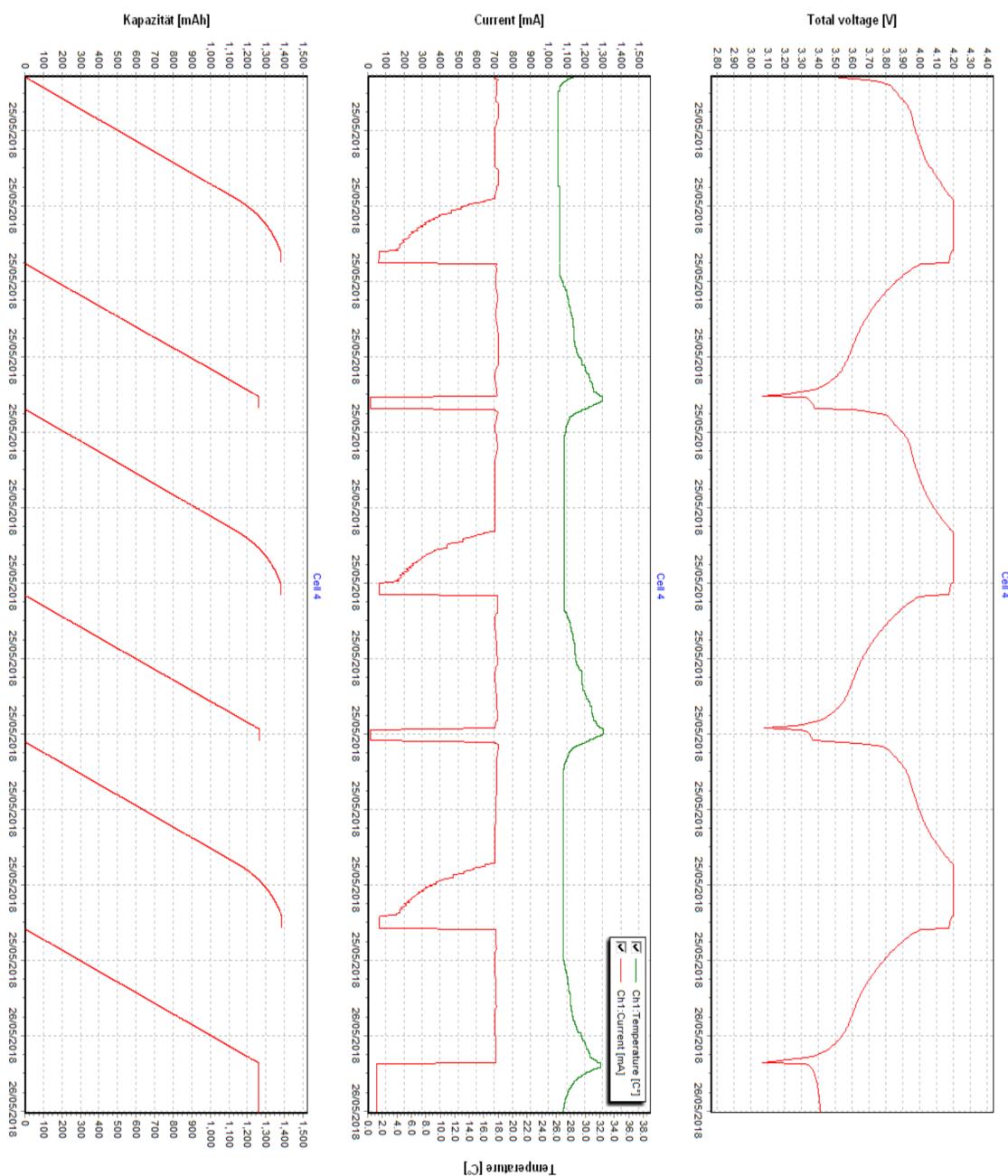
TEST REPORT

Cell 2		
Cycle Order	Voltage [V]	Capacity [mAh]
1.Charge	3.20 -> 4.2	1400
2.Delay	4.2 -> 4.17	
3.Discharge	4.15 ->3.01	1261
4.Delay	3.00 -> 3.39	
5.Charge	3.39 -> 4.2	1386
6.Delay	4.2 -> 4.17	
7.Discharge	4.16 -> 3.01	1258
8.Delay	3.00 -> 3.40	
9.Charge	3.40 -> 4.2	1382



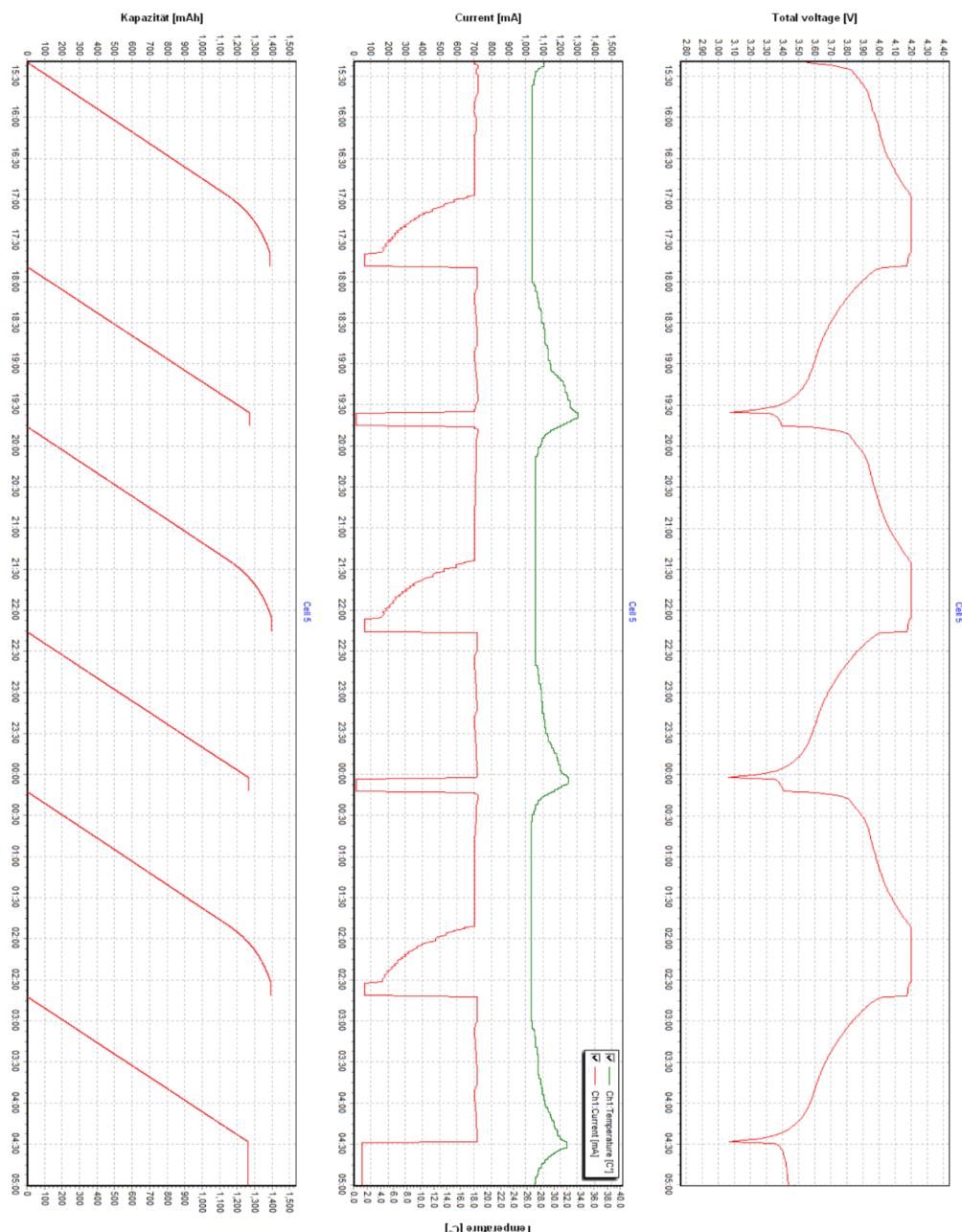
TEST REPORT

Cell 3		
Cycle Order	Voltage [V]	Capacity [mAh]
1.Charge	3.33 -> 4.2	1378
2.Delay	4.2-> 4.17	
3.Discharge	4.16 -> 3.01	1259
4.Delay	3.00 -> 3.38	
5.Charge	3.38 -> 4.2	1379
6.Delay	4.2 -> 4.17	
7.Discharge	4.16 -> 3.01	1263
8.Delay	3.00 -> 3.37	
9.Charge	3.37 -> 4.2	1385



TEST REPORT

Cell 4		
Cycle Order	Voltage [V]	Capacity [mAh]
1.Charge	3.38 -> 4.2	1387
2.Delay	4.2-> 4.17	
3.Discharge	4.16 -> 3.01	1270
4.Delay	3.00 -> 3.40	
5.Charge	3.40 -> 4.2	1379
6.Delay	4.2 -> 4.17	
7.Discharge	4.16 -> 3.01	1266
8.Delay	3.00 -> 3.41	
9.Charge	3.41 -> 4.2	1393



5 CELL OVER-CHARGE PROCEDURES

Battery cells will not be charged while on or at ISS. The specified Over-charge detection is: $4.275V \pm 0.025V$ (0.7 to 1.3sec. delay, resume min. $4.275V \pm 0.025V$) by manufacturer.

6 CELL OVER-DISCHARGE PROCEDURE

Over-discharge tests was performed on non-flight cell. All cells have integrated protection circuit module. Over-discharge characteristic given by the manufacture is $2.30V \pm 0.058V$ (14 to 26 msec. delay, resume $2.30V \pm 0.058V$).

6A

For this test battery cell from the same lot of the flight batteries was used. The cell was discharged to 2.2V with 1C (1400mA) with "Rigol DL3021 Programmable DC Electronic Load". The protection circuit module integrated in the battery interrupt the discharge at 2.27V.

6B

To determine the voltage at which the protection circuit module feature is reset the same battery cell from 6A was used and charge with C/5 (300mA). The battery cell immediately reset the over-discharge protection. Hysteresis was not found or it is negligible and cannot be measured. The specified voltage and time for release this protection is $2.30V \pm 0.058V$ / 14 to 26 msec. delay by manufacture specifications.

7 EXTERNAL PROTECTION

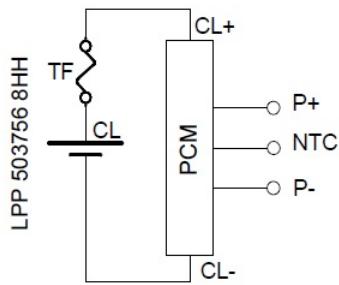
For the short circuit protection, we used the same non-flight battery cell of section 6. All cells have integrated protection circuit module. The specified over-current detection by the manufacture is 2.0A to 4.0A (8 to 16 msec. delay). Experimentally, it was found that overcurrent protection is between 2.2-2.4A (using Rigol DL3021 Programmable DC Electronic Load). We verified that when short-circuit occurs, the dedicated protection circuit module disconnects the cell until it is removed.

8 CIRCUIT SCHEMATIC ANALYSIS

The battery cells have integrated protection circuit module.

EnduroSat verified that the parameters by manufacturer's specifications respond to the tested:

- Overcharge Detection: $4.275V \pm 0.025V$ (0.7 to 1.3sec. delay, resume min. $4.275V \pm 0.025V$)
- Overdischarge Detection: $2.30V \pm 0.058V$ (14 to 26 msec. delay, resume $2.30V \pm 0.058V$)
- Overcurrent Detection: 2.0A to 4.0A (8 to 16 msec. delay)

CIRCUIT DIAGRAM**9 VIBRATION TEST**

The vibration test has been performed on flight cells installed in the power module following the spectrum as specified in paragraph 9 of the NR-SDR-139 Rev. C. Test report is attached in Annex I.

The difference of the Open Circuit Voltage before and after the vibration test is lower than 0.1%..

10 VACUUM TEST

The vacuum test has been performed on flight cells installed in the power module following the spectrum as specified in paragraph 10 of the NR-SDR-139 Rev. C.

10A / 10B

Physical properties before the vacuum test are specified in paragraph 3.3.

10C

The battery cells were charged with maximum voltage of 4.1V.

10D

Test has been performed as specified in point D of paragraph 10. Test report is attached to this document (Annex II).

10E

No leaks, deformations or bulges were found after a visual inspection of the cells.

10F

Physical properties of the cells after the vacuum are as follow:

TEST REPORT

The following measurements are performed with 0.1mm precision

	Cell 1	Cell 2	Cell 3	Cell 4	Datasheet [Max]
Length [mm]	58.7	58.8	58.6	58.8	60.5
Width [mm]	36.4	36.5	36.5	36.5	37.5
Height [mm]	5	5	5	5	5.4

10G

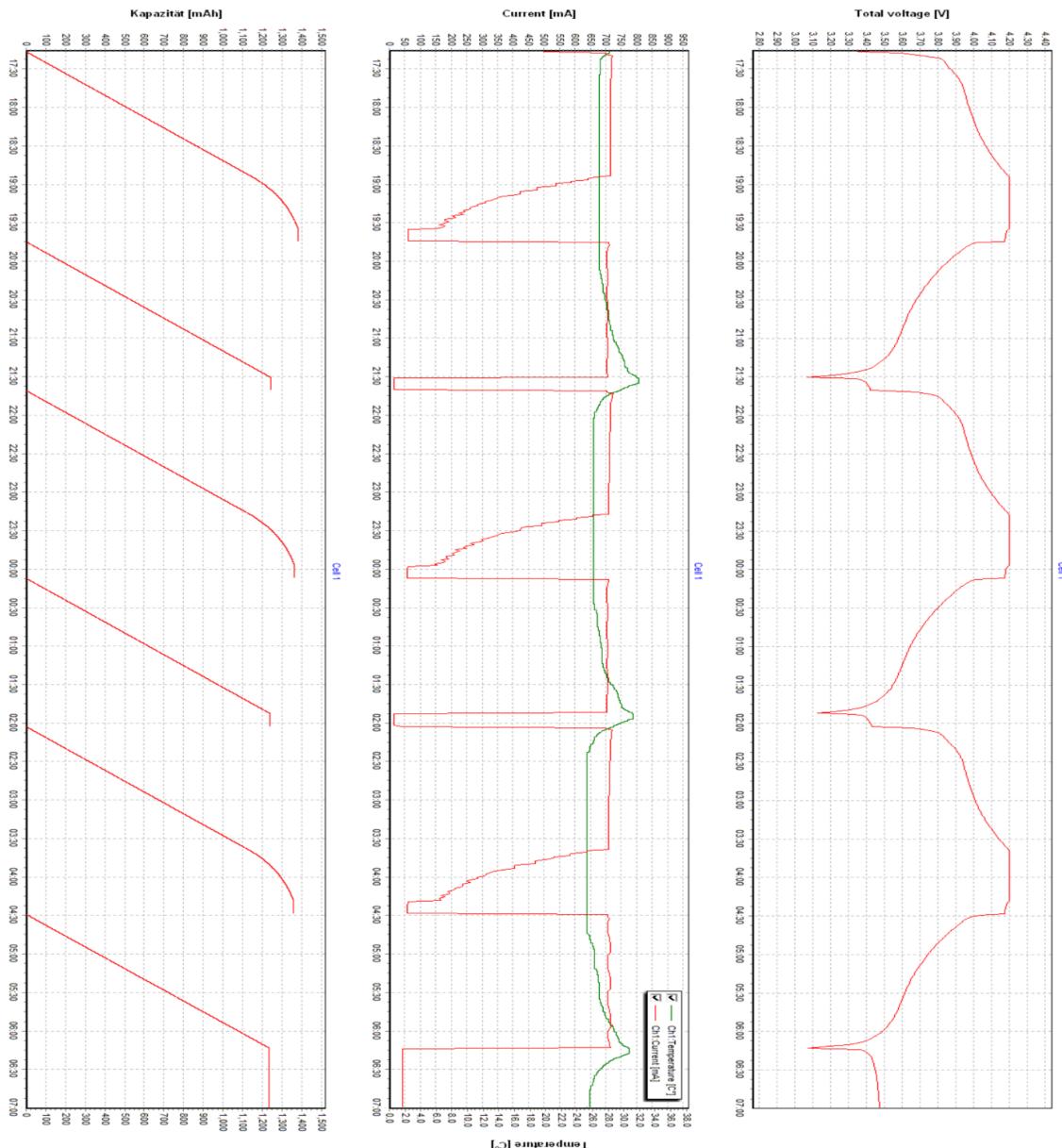
The following measurements are performed with 0.1g precision accuracy

	Cell 1	Cell 2	Cell 3	Cell 4	Datasheet [Max]
Weight [g]	24.1	24.2	24.2	24.2	Approx. 25

TEST REPORT

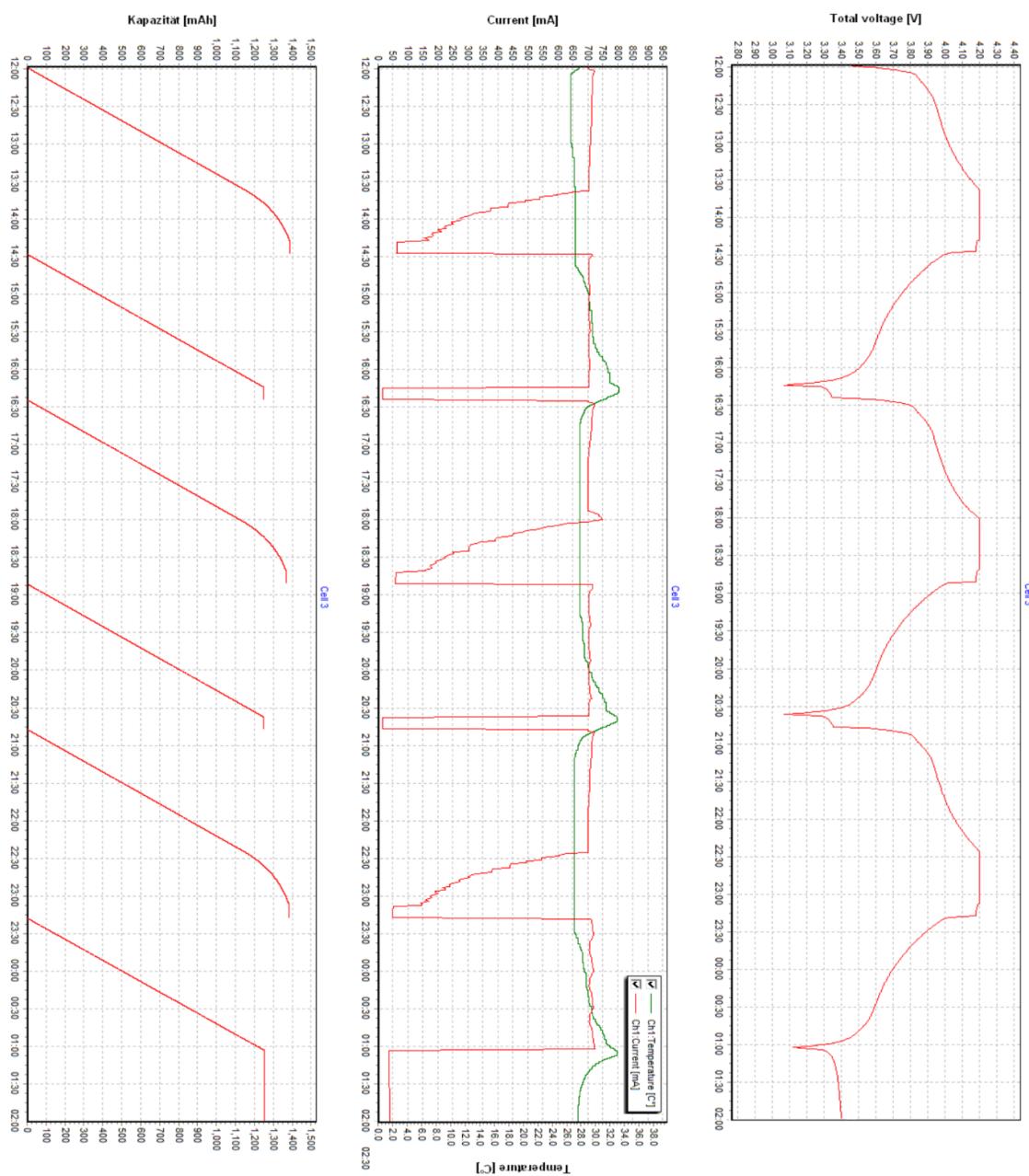
10H Charge/discharge cycle after Vacuum test as specified in Section 4:

Cell 1		
Cycle Order	Voltage [V]	Capacity [mAh]
1.Charge	3.34 -> 4.2	1383
2.Delay	4.2-> 4.17	
3.Discharge	4.15 -> 3.01	1244
4.Delay	3.00 -> 3.42	
5.Charge	3.42 -> 4.2	1364
6.Delay	4.2 -> 4.17	
7.Discharge	4.16 -> 3.01	1240
8.Delay	3.00 -> 3.43	
9.Charge	3.43 -> 4.2	1361



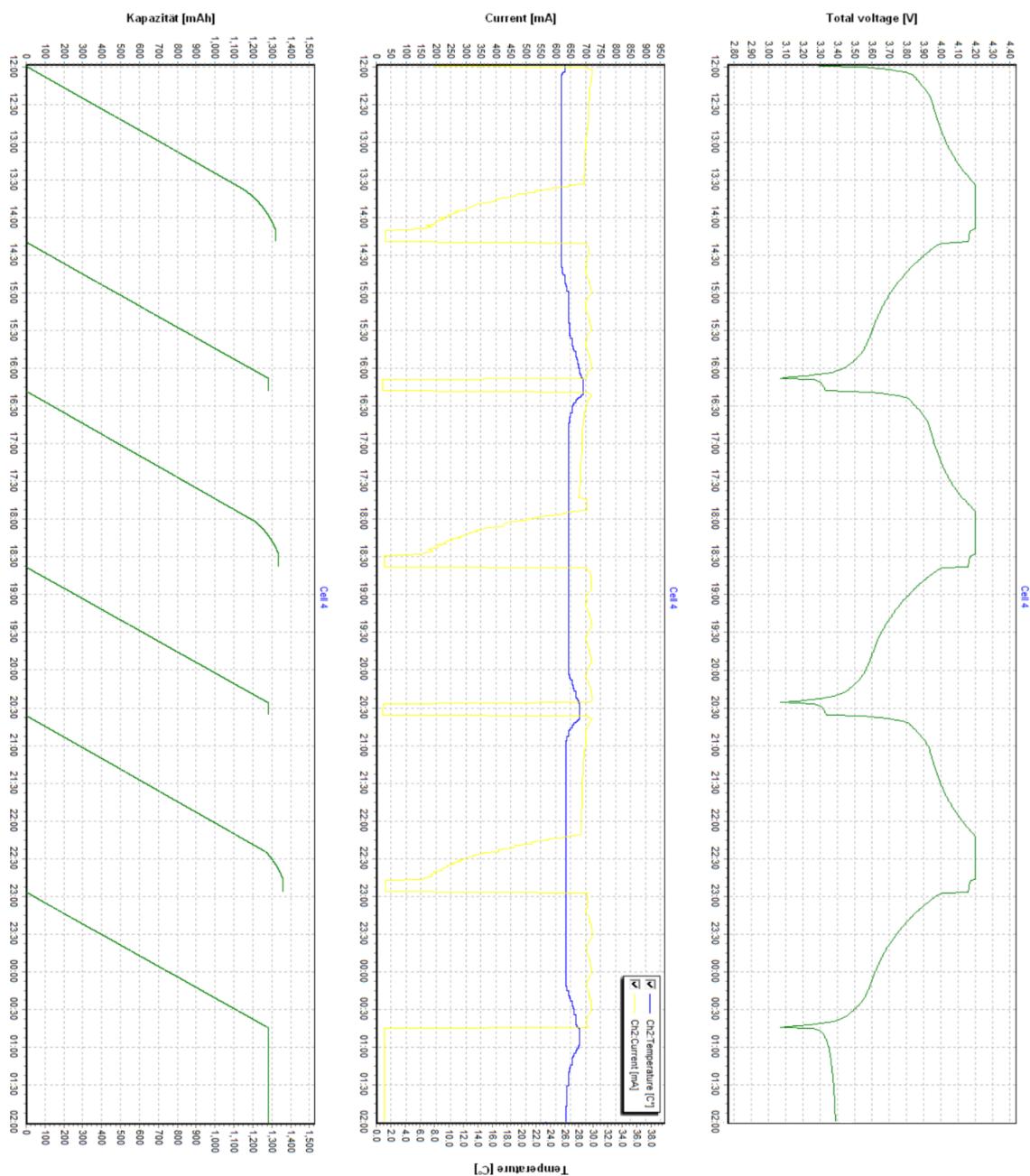
TEST REPORT

Cell 2		
Cycle Order	Voltage [V]	Capacity [mAh]
1.Charge	3.30 -> 4.2	1388
2.Delay	4.2 -> 4.18	
3.Discharge	4.16 ->3.01	1248
4.Delay	3.00 -> 3.35	
5.Charge	3.35 -> 4.2	1369
6.Delay	4.2 -> 4.18	
7.Discharge	4.16 -> 3.01	1246
8.Delay	3.00 -> 3.36	
9.Charge	3.36 -> 4.2	1385



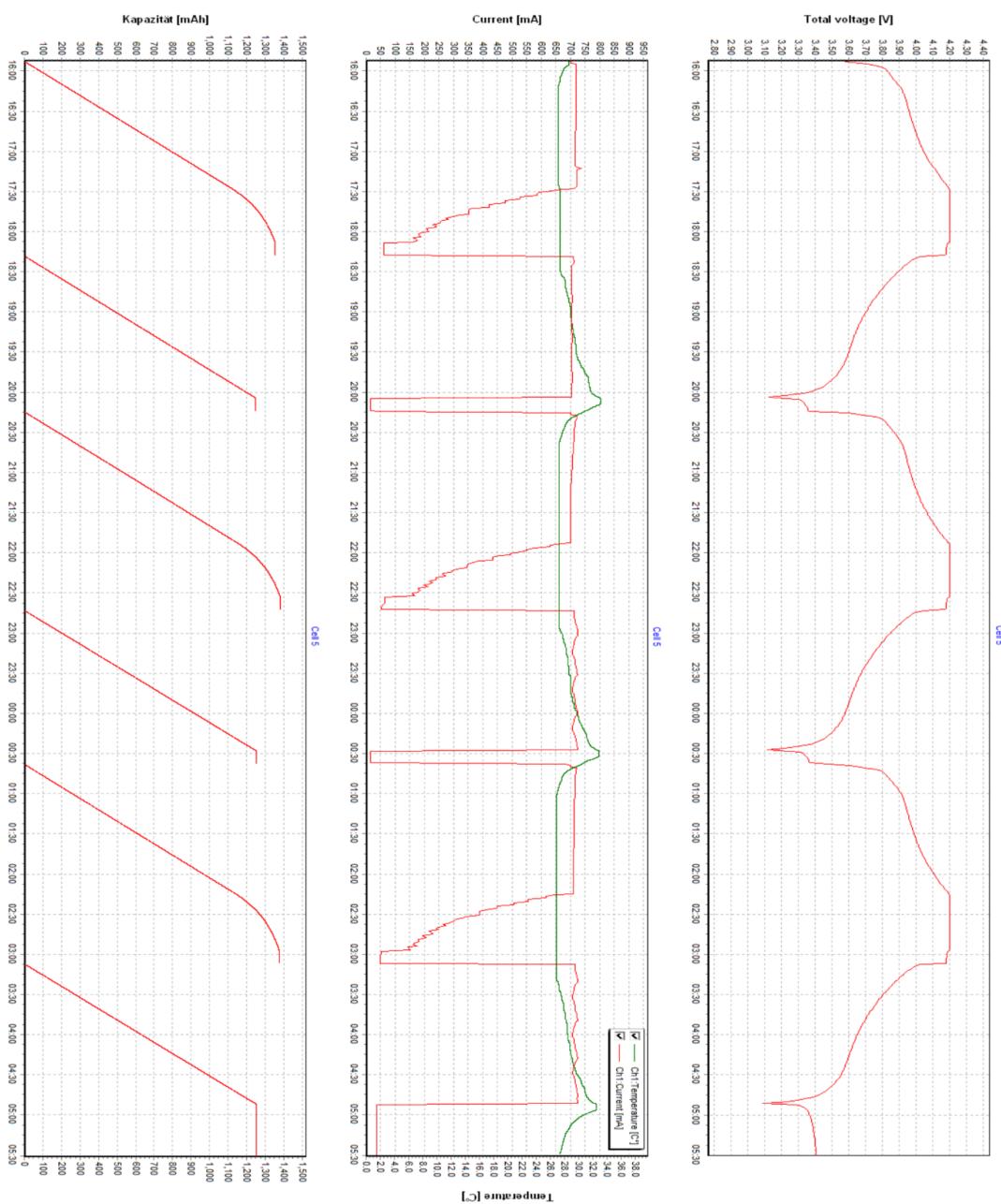
TEST REPORT

Cell 3		
Cycle Order	Voltage [V]	Capacity [mAh]
1.Charge	3.29 -> 4.2	1318
2.Delay	4.2-> 4.16	
3.Discharge	4.15 -> 3.01	1283
4.Delay	3.01 -> 3.33	
5.Charge	3.35 -> 4.2	1336
6.Delay	4.2 -> 4.16	
7.Discharge	4.15 -> 3.01	1282
8.Delay	3.01 -> 3.34	
9.Charge	3.35 -> 4.2	1360



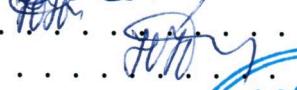
TEST REPORT

Cell 4		
Cycle Order	Voltage [V]	Capacity [mAh]
1.Charge	3.43 -> 4.2	1354
2.Delay	4.2-> 4.18	
3.Discharge	4.16 -> 3.01	1250
4.Delay	3.00 -> 3.36	
5.Charge	3.36 -> 4.2	1382
6.Delay	4.2 -> 4.17	
7.Discharge	4.16 -> 3.01	1251
8.Delay	3.00 -> 3.37	
9.Charge	3.37 -> 4.2	1375



ANNEX I

Vibration Test Report

TEST REPORT**Test Program NANORACKS, BDS EN 60068-1 and BDS EN 60068-2-64****Report**Reference № : **18.0179/03. 0313 -TR -EN**Tested by (+signature) : B. Tenchev Checked by (+signature) : N. Tencheva Head of laboratory (+signature) : N. Tencheva 

Date of issue : 19.06.2018

Contents : 11 pages

**Testing laboratory**Name : TESTING OF ELECTRICAL PRODUCTS
Laboratory to ALL TEST Ltd.

Address : Mladost IV, bl.411, Sofia 1715, Bulgaria

Testing location : as above

Client

Name : ENDUROSAT Ltd.

Address : Tundga str. No. 16, Sofia 1606, Bulgaria

Test specificationStandard : **Test Program ENDUROSAT**
BDS EN 60068-1:2014 (EN 60068-1:2014)
(IEC 60068-1:2013))
BDS EN 60068-2-64:2008 (EN 60068-2-64:2008)
(IEC 60068-2-64:2008))

Non-standard test method : N.A.

Test item

Description : EPS Type I Plus (2 battery packs) - sample 1

Trademark : EnduroSat

Model and/or type reference : EPS Type I Plus

Manufacturer : ENDUROSAT Ltd.

Ratings (Min./Nominal/Max.) : -

Dimensions (WxDxH) : 250mm x 250mm x 70mm (height - axis Z)

Weight : 2339g

Test result : The a.m. product passed/failed

Test case verdicts

Test case does not apply to the test object : **N(A.)**

Test item does meet the requirement : **P(ass)**

Test item does not meet the requirement : **F(ail)**

Repetition sign : _____

Testing

Date of receipt of test item : June 01.2018

Date(s) of performance of test : June 05.2018 ÷ June.07.2018

General remarks

This test shall not be reproduced except in full without the written approval of the testing laboratory.
The test results presented in this report relate only to the item tested.

"(see remark #)" refers to a remark appended to the report

"(see additional appended table)" refers to a table appended to the report

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

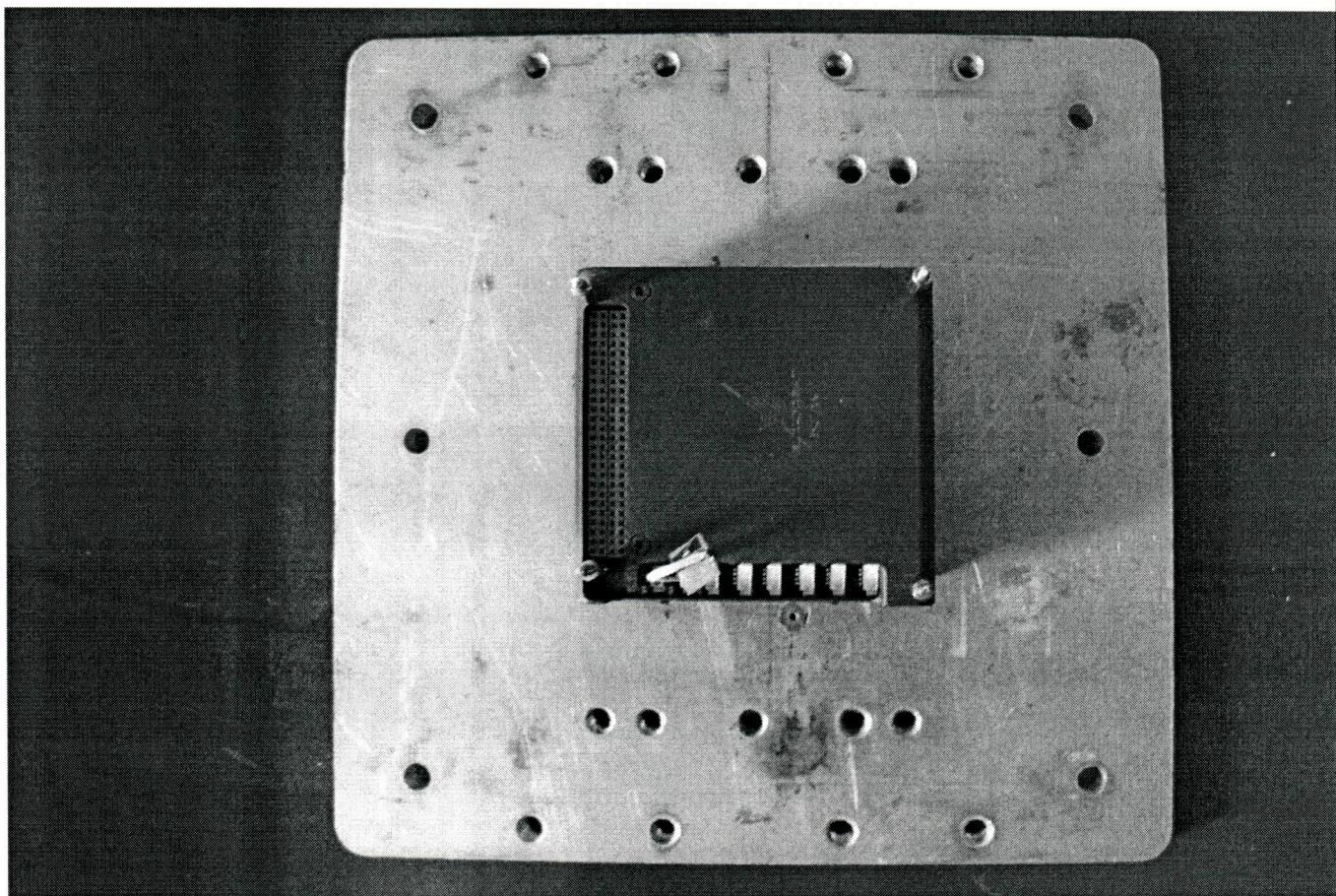
Copy of marking plate: N/A

Nature of supply:

Degree of protection against moisture:

Type of mounting: for building-i

Intendet:

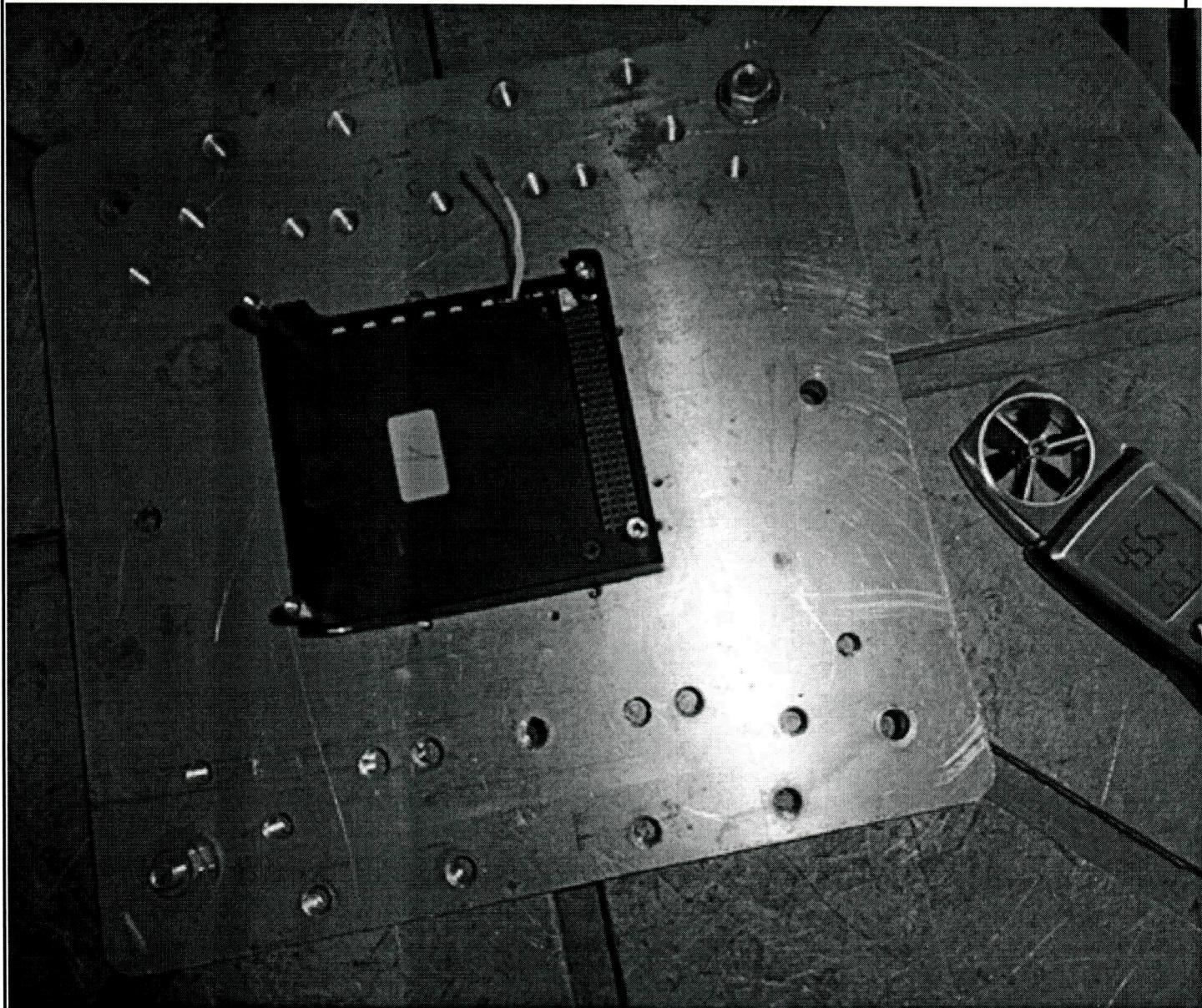


EPS Type I Plus (2 battery packs)

Applied measuring instruments and testing apparatus

Measurement/test	Identification No=	Last calibration
Digital thermometer TESTO-410-2, Germany	-	2018-10-05
Digital hygrometer TESTO-410-2, Germany	-	2018-10-05
Digital anemometer TESTO-410-2, Germany	-	2018-10-05
Barometer Brüel & Kjær, UZ 0001, Denmark	-	2018-06-24
<i>Complete vibration system VEB Robotron Germany:</i>		
-“- vibrator ST 5000/300-1, N 43/82, Germany	290	2016-10-19
- VM4S Vibrationsmessgerät - VEB metra-mess U, FREQUENZTECHNIK - RFT SCHWEBUNGSGENERATOR SQ401	-	-
-“-accelerometer KD 35a	20416	2016-10-19
-“-accelerometer M 1302	91142	2016-10-19
<i>Portable Vibration meter Brüel & Kjær, Denmark</i>		
-accelerometer “Brüel & Kjær”, Denmark	4370	2016-10-17
<i>Complete pulse system VEB Robotron German:</i>		
-“-vibrator ST 5000/3001	08035	2017-02-10
-“- piezotronics accelerometer 357B03	1844-3	2017-02-10
-“-piezotronics charge amplifier 422E12	1844-4	2017-02-10
-“-piezotronics accelerometer 357B03	1844-5	2017-02-10
-“-piezotronics charge amplifier 422E12	1844-6	2017-02-10
Tape-measure ORIENT, Bulgaria	03083	2018-02-23
Digital caliper MANERSMAN, Germany	N 1021	2018-02-23
Balance VEDIA, Bulgaria	-	2018-02-22

VIBRATION TEST



A program NANORACKS, EN 60068-1 and EN 60068-2-64

Clause	Requirement - Tests	Result - Remark	Verdict
	GENERAL CONDITIONS FOR TESTS according to Test Program ENDUROSAT and BDS EN 60068-1:2014 (EN 60068-1:2014 (IEC 60068-1:2013))		
Test Progr.	Tests performed according to Test Program ENDUROSAT of manufacturer e.g.	see Annex 1- page 1, clause 9.Vibration Test Procedure (performed on flight cells/battery)	P
	-“-correct initial review and measurements	without visual defects	P
	-“- correct sequence of testing – Table 9-1	comply	P
	Composite test including:		
	1. test Fh : Random vibration	fulfilled	P
	-“-mounting, etc.	comply	P
4.1	Tests performed according to the IEC 60068-1:		
	-“- complete series of operations	comply	P
	-“- preliminary preparation of the samples	comply	P
	-“- initial review and measurements: visual views with the naked eye	without any visible defects	P
	-“- initial conditioning	in the environment of the laboratory	P
	-“-conditioning duration: at least 4 hours	12h	P
	-“- post-test recovery	in the environment of the laboratory	P
	-“- duration of the recovery: at least 6 hours	12h	P
	-“- the correct ambient temperature range for the tests	see clause 5.3	P
	-“- the worst test position	along each axis	P
	-“- final inspection and sample measurements	implemented	P
	1.mass	2339g (with the mounting plate)	P

A program NANORACKS, EN 60068-1 and EN 60068-2-64

Clause	Requirement - Tests	Result - Remark	Verdict
	2.visual views with the naked eye	without any visible defects	P
4.2	Test specimen:	clean new, delivered	P
5.3	Standard atmospheric conditions for measurement and testing:		
	-“- temperature 15 ÷ 35°C	25,6°C	P
	-“- relative humidity 25 ÷ 75 %	50,9%	P
	-“- atmospheric pressure 86 ÷ 106 kPa	96kPa	P
5.4	Terms of recovery: the ambient temperature for measurement and testing	in the environment of the laboratory	P
5.5	Mounting		
	Do not amplify resonance in any of the frequency ranges	comply	P
	During the vibration test the DUT were secured with overhead clamps and vertical threaded bars	comply	P
	Test procedure:		
	The vibration and shock test were conducted in the following order:		
	1.random vibration test first vertical axis Z	comply	P
	2.random vibration test second horizontal axis X	comply	P
	3.random vibration test horizontal axis Y	comply	P
	Visual checks:		
	After each direction the specimens were subjected to a visual check	without visual defects	P
	TEST Fh: RANDOM VIBRATION according to Test Program ENDUROSAT and BDS EN 60068-2-64:2008 (EN 60068-2-64:2008 (IEC 60068-2-64:2008))		P
	A visual inspection was performed before and after the non-operational random vibration profiles	see Annex 1- page1, clause 9.Vibration Test Procedure (performed on flight cells/battery)	P

A program NANORACKS, EN 60068-1 and EN 60068-2-64

Clause	Requirement - Tests	Result - Remark	Verdict
	The functional test is carried out by the manufacturer	does not report peculiarities	P
	The DUT was not powered throughout the testing	comply	P
Test Progr.	Tests performed according to Test Program ENDUROSAT of manufacturer e.g.	see Annex 1 – page 1, clause9, table 9-1Vibration Testing Spectrum	P
	Apply the consecutive series of random vibration profiles with spectrum profiles of Annex 1	applied	P
4.3.1	Fixing points		
3.2.1	Check points	fixing points	P
3.3.2	Control points	multipoint control	P
4.4	Mounting		
	During the random vibration test the DUT were secured with overhead clamps and vertical threaded bars	2xM8	P
5	Test sample conditioning	switched-off, ready for use state	P
5.2, 8.4	Test frequency range	20Hz ÷ 2000Hz	P
	-“-frequency resolution: 10Hz	10Hz	P
	-“-r.m.s value of acceleration: ± 10% of the r.m.s.	± 10%	P
	-“-the initial and finale slope: ≥ + 6dB/octave and ≤ - 24dB/octave	+ 4,93dB/octave and -3,86dB/octave	P
	Direction of application of impact	on each 3 orthogonal axes	P
5.3, 8.4	Acceleration spectral density level (ASD level): $0,05(m/s^2)^2/Hz \div 100,0(m/s^2)^2/Hz$	$0 \div 9,65Grms$	P
5.4, 8.4	Shape of acceleration spectral density curve	+6dB/octave, -3,86dB/octave	P

A program NANORACKS, EN 60068-1 and EN 60068-2-64

Clause	Requirement - Tests	Result - Remark	Verdict
5.5, 8.4	Duration of exposure: 1min ÷ 300min in each axis -“-duration of testing with a tolerance of +5%	1min per each 3 orthogonal axes +5%	P
6	Pre-conditioning	12 h	P
7.	Initial measurements:	2339g, without any visible defects	P
8.1	Testing axes and order of testing	comply	P
8.4	Multiple measurements of acceleration spectral density	comply	P
	Accuracy of applied vibrations: -“- spectral density of acceleration	±3 dB	P
	-“- r.m.s acceleration values	± 10%	P
	Statistical accuracy: -“- statistical degrees of freedom Nd ≥ 120 dB	120 dB	P
8.5	Intermediate measurements	not necessary	P
9	Recovery	12 h	P
10	Final measurements and acceptance or rejection criteria: -“-visual and dimensional check shows	without cracks, crushing, deformation, abrasion or other mechanical damage	P
	-“-acceptance or rejection criteria	no defect and no-damage	P
	-“-measurement of sample mass	2339g	P
	-“-functional test	carried out by the manufacturer after the completion of the entire	

A program NANORACKS, EN 60068-1 and EN 60068-2-64

Clause	Requirement - Tests	Result - Remark	Verdict
		test program	P
	The DUT were returned to the customer following completion of the vibration and shock testing for functional measurement and further evaluation	fulfilled	P

Next: ANNEX 1. Test Program ENDUROSAT – page 1, clause 9

Types of representatives: no representative representatives

END

Page 11 of 11	18.0179/03.0313-TR-EN		
A program NANORACKS, EN 60068-1 and EN 60068-2-64			
Clause	Requirement - Tests	Result - Remark	Verdict

ANNEX 1

9 Vibration Test Procedure (performed on flight cells/battery)

Note: This test may be performed separately or with the battery installed in the satellite during satellite structural vibration testing as long as these test levels are enveloped and the battery can be inspected and/or performance health checked after the test.

Record the OCV for each flight cell/battery before vibration testing and between each axis of vibration. Vibration testing should follow the spectrum as specified in Table 9-1 for one minute on each axis.

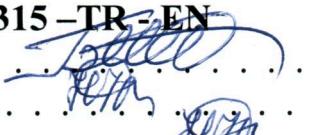
Table 9-1: Vibration Testing Spectrum

Frequency, Hz	ASD, G ² /Hz	dB/OCT	Grms
20.00	0.028800	*	*
40.00	0.028800	0.00	0.76
70.00	0.072000	4.93	1.43
700.00	0.072000	0.00	6.89
2000.00	0.018720	-3.86	9.65

Conduct the Discharge/charge cycle order as in Section 4 for each flight cell/battery after the vibration tests and record the capacity. The pass/fail criteria requires that there shall be less than 0.1% change in the OCV and less than 5% change in capacity before and after vibration tests and throughout the remainder of the test procedures.

ANNEX II

Vacuum Test Report

TEST REPORT**Test Program ENDUROSAT, BDS EN 60068-1 and BDS EN 60068-2-13****Report**Reference № : **18.0181/03. 0315 –TR - EN**Tested by (+signature)..... : B. Tenchev Checked by (+signature)..... : N. Tencheva Head of laboratory (+signature) : N. Tencheva 

Date of issue : 19.06.2018

Contents : 11 pages

**Testing laboratory**Name : TESTING OF ELECTRICAL PRODUCTS
Laboratory to ALL TEST Ltd.

Address : Mladost IV, bl.411, Sofia 1715, Bulgaria

Testing location : as above

Client

Name : ENDUROSAT Ltd.

Address : Tundga str. No. 16, Sofia 1606, Bulgaria

Test specificationStandard : **Test Program ENDUROSAT**
BDS EN 60068-1:2014 (EN 60068-1:2014)
(IEC 60068-1:2013))
BDS EN 60068-2-13:2003 (EN 60068-2-13:1999)
(IEC 60068-2-13:1983))

Non-standard test method : N.A.

Test item

Description : EPS Type I Plus (2 battery packs) – Space 1

Trademark : EnduroSat

Model and/or type reference : EPS Type I Plus

Manufacturer : ENDUROSAT Ltd.

Ratings (Min./Nominal/Max.) : -

Dimensions (WxDxH) : 90mm x 98mm x 33mm (height)

Weight : 278g

Test result : The a.m. product passed/failed

Test case verdicts

Test case does not apply to the test object : **N(A.)**

Test item does meet the requirement : **P(ass)**

Test item does not meet the requirement : **F(ail)**

Repetition sign : _____

Testing

Date of receipt of test item : June 01.2018

Date(s) of performance of test : June 12.2018 ÷ June 14.2018

General remarks

This test shall not be reproduced except in full without the written approval of the testing laboratory.
The test results presented in this report relate only to the item tested.

"(see remark #)" refers to a remark appended to the report

"(see additional appended table)" refers to a table appended to the report

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

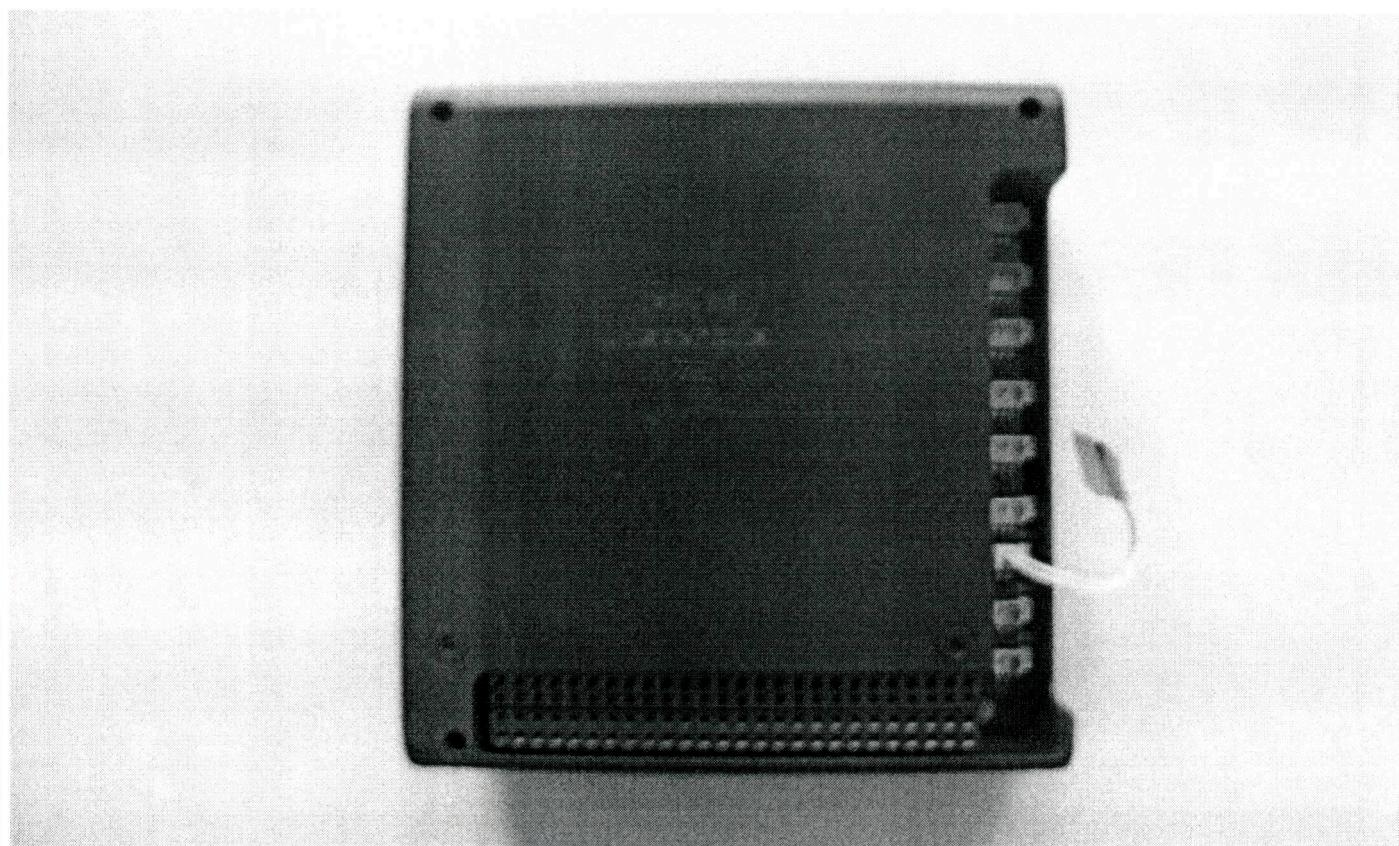
Copy of marking plate: N/A

Nature of supply: -

Degree of protection against moisture: -

Type of mounting: for building-i

Intendet: -



EPS Type I Plus (2 battery packs)

Applied measuring instruments and testing apparatus

Tests M: LOW AIR PRESSURE

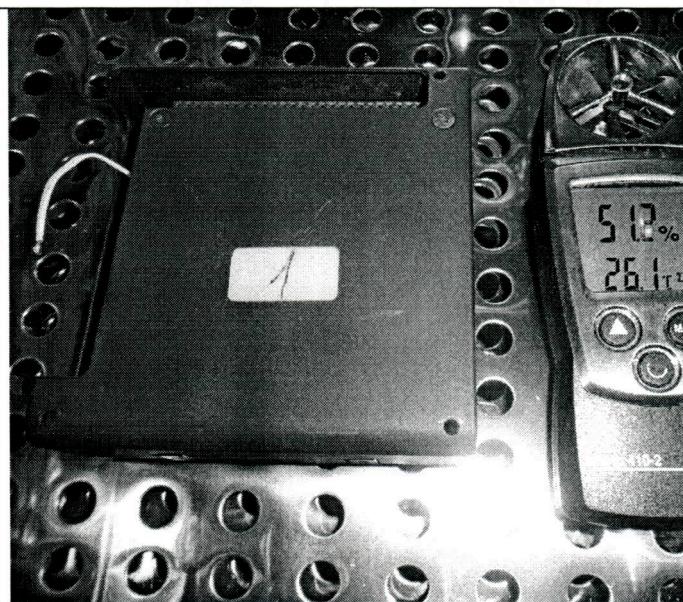


fig1 – position of the sample in the chamber

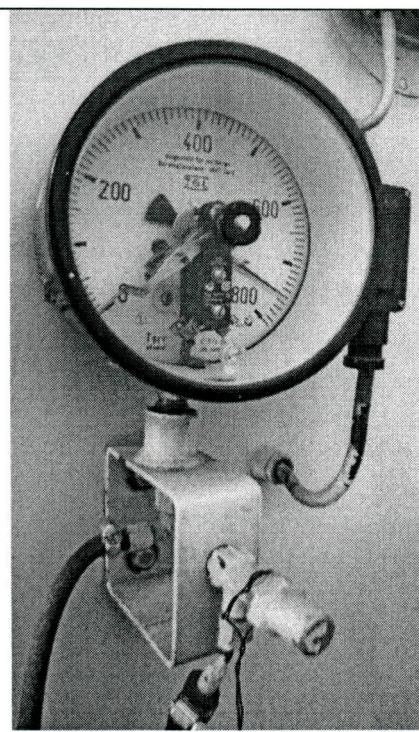


fig2 – moment of the vacuuming process

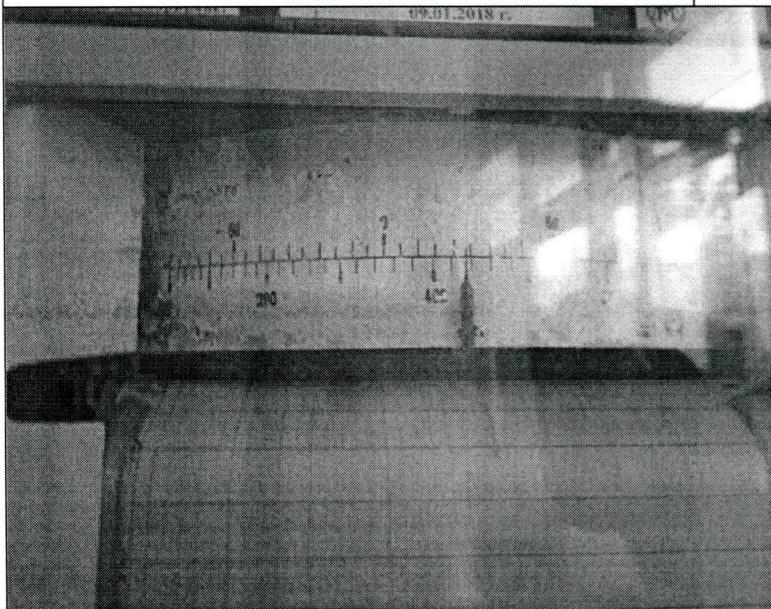


Fig 3 – temperature and humidity

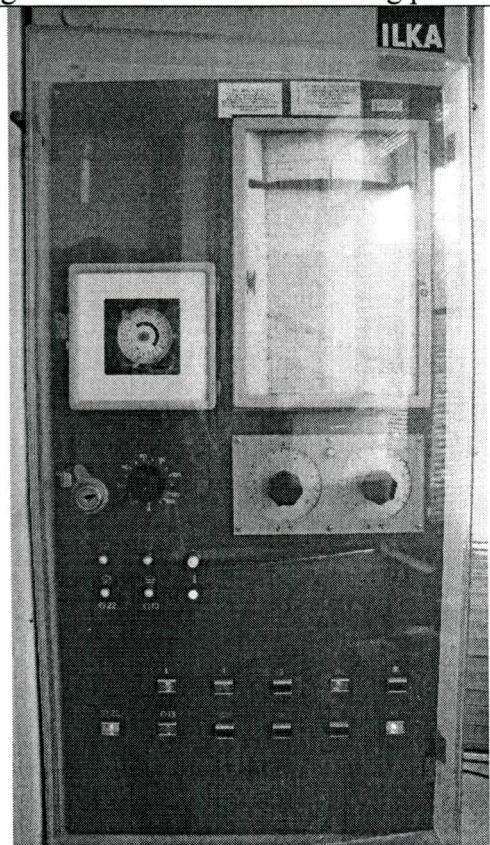


Fig 4 - Low Atmospheric Pressure Test

A program Vacuum Test Procedure – clause D, EN 60068-1 and EN 60068-2-13

Clause	Requirement - Tests	Result - Remark	Verdict
	GENERAL CONDITIONS FOR TESTS according to Test Program ENDUROSAT and BDS EN 60068-1:2014 (EN 60068-1:2014 (IEC 60068-1:2013))		
Test Progr.	Tests performed according to Test Program of manufacturer e.g.	see Annex 1 Vacuum Test Procedure - clause D	P
	-“-correct initial review and measurements	mass: 278g	P
	-“- correct sequence of testing	comply	P
	Composite test including:		
	1. Test M: Low air pressure	fulfilled	P
4.1	Tests performed according to the IEC 60068-1:		
	-“- complete series of operations	comply	P
	-“- preliminary preparation of the samples	comply	P
	-“- initial review and measurements: visual views with the naked eye	without any visible defects	P
	-“- initial conditioning	in the environment of the laboratory	P
	-“-conditioning duration: at least 4 hours	12h	P
	-“- post-test recovery	in the environment of the laboratory	P
	-“- duration of the recovery: at least 1 hours	1h	P
	-“- the correct ambient temperature range for the tests	see clause 5.3	P
	-“- the worst test position	see page 5 - fig.1	P
	-“- final inspection and sample measurements	implemented	P
	1.mass	278g	P
	2.visual views with the naked eye	without any visible defects	P

A program Vacuum Test Procedure – clause D, EN 60068-1 and EN 60068-2-13

Clause	Requirement - Tests	Result - Remark	Verdict
4.2	Test specimen:	clean new, delivered	P
5.3	Standard atmospheric conditions for measurement and testing: -“- temperature 15 ÷ 35°C -“- relative humidity 25 ÷ 75 % -“- atmospheric pressure 86 ÷ 106 kPa	25,0°C 50,0% 95,12kPa	P P P
5.4	Terms of recovery: the ambient temperature for measurement and testing	in the environment of the laboratory	P
5.5	Mounting	the specimen is placed in the test chamber	P
TEST M: LOW AIR PRESSURE according to Test Program ENDUROSAT and BDS EN 60068-2-13:2003 (EN 60068-2-13:1999 (IEC 60068-2-13:1983))			P
	A visual inspection was performed before and after the non-operational LOW AIR PRESSURE TEST	see Annex 1 Vacuum Test Procedure - clause D	P
	The functional test is carried out by the manufacturer	does not report peculiarities	P
	The DUT was not powered throughout the testing	comply	P
Test Progr.	Tests performed according to Test Program ENDUROSAT of manufacturer e.g.	see Annex 1 Vacuum Test Procedure - clause D	P
2.	General description		
	-“-place the sample in the test chamber	see fig.1 of page 5	P
	-“-reduce the air pressure to the values specified in the relevant specification	1kPa = 7600 Torr	P
	-“-conditions are maintained for the appropriate duration of exposure	6h	P
3.	Description of test apparatus	see page 4 and 5	P
	-“-the test chamber to provide the required atmospheric pressure according to item 4	comply	P

A program Vacuum Test Procedure – clause D, EN 60068-1 and EN 60068-2-13

Clause	Requirement - Tests	Result - Remark	Verdict
	-“-not to pollute the environment from the auxiliary equipment and the purity of the saturation entering the chamber when the pressure is increased to normal	comply	P
	-“- when tested with heat dissipated samples the requirements of the test specification should be the same: Test Z / BM	no such samples	P
4.	Severitie:		P
	-“- of air pressure requirements	see clause 4.1	P
	-“- the duration of the test	see clause 4.2	P
4.1	The air pressure		P
	The chamber shall be capable of maintaining the pressure values specified in the table with an accuracy of $\pm 5\%$ or $\pm 0,1 \text{ kPa}$ - which is greater	$\pm 5\%$	P
	The degree of pressure requirement of 84 kPa is not more than $\pm 2 \text{ kPa}$	comply	P
4.2	Duration of exposure for testing		P
	The corresponding specification may choose one of the following exposure periods: 5min, 30min, 2h, 4h, 16h	6h – see Annex 1	P
5.	Pre-conditioning	12h	P
6.	Initial measurements		P
	The sample to be subjected to an:		
	-“- external inspection	without any visible defects	P
	-“- checking the electrical parameters	test is carried out by the manufacturer	N
	-“- checking the mechanical characteristics in accordance with the specification	90mm x 98mm x 33mm (height), 278g	P
7.	Conditioning	switched-off, ready for use state	P
7.1	The camera shall be in the temperature mode specified for		

A program Vacuum Test Procedure – clause D, EN 60068-1 and EN 60068-2-13

Clause	Requirement - Tests	Result - Remark	Verdict
	normal ambient test conditions	25°C, 50%	P
	The sample is tested in the non-working state by being placed in the chamber unpackaged, off, in a "ready-to-use"	comply	P
7.2	The pressure in the chamber is reduced to the required value	1kPa	P
	There may be a limit in the rate of change of pressure in the specification, but not more than 10 kPa / min	55,12 kPa/min	P
7.3	Test of sample in working order	tested in the non-working state only	N
7.4	Set the air pressure to the specified accuracy for the duration specified in the specification	1kPa/6h/5%	P
7.5	Reset the air pressure to normal	95,12kPa	P
	If the specification specifies a rate of change in pressure, it shall not exceed 10kPa/min	62,01kPa/min	P
8.	Recovery		P
	Unless otherwise specified in the relevant specification, the specimen shall be left in normal atmospheric conditions for the test for not less than 1h and not more than 2h	1h	P
9.	Final measurements		P
	Submit the specimen to:		
	-“-a careful external view	without cracks, crushing, deformation, abrasion or other mechanical damage	P
	-“-to measure its electrical parameters	carried out by the manufacturer after the completion of the entire test program	N
	-“-check the mechanical properties	90mm x 98mm x 33mm (height), 278g	P
	The DUT were returned to the customer following completion of the vibration and shock testing for functional measurement and further evaluation	fulfilled	P

Page 10 of 11	18.0181/03.0315-TR-EN		
A program Vacuum Test Procedure – clause D, EN 60068-1 and EN 60068-2-13			
Clause	Requirement - Tests	Result - Remark	Verdict

Next: ANNEX 1. Test Program ENDUROSAT – page 1, Clause 10 Vacuum Test Procedure (performed on flight cells/battery), point D).

Types of representatives: no representative representatives

END

A program Vacuum Test Procedure – clause D, EN 60068-1 and EN 60068-2-13

Clause	Requirement - Tests	Result - Remark	Verdict
---------------	----------------------------	------------------------	----------------

ANNEX 1**Vacuum Test Procedure**

- A. The length, width, and height need to be measured before beginning this test. Length, width, and height are specified in Section 3.2-a. Measurements should be recorded with 0.1mm precision.
- B. Obtain and record the mass of each cell/battery. Measurements should be recorded with 0.1g precision.
- C. Measure the voltage of all cells/ batteries and record the values. If any batteries are not fully charged, charge before continuing.
- D. Place fully charged batteries into the vacuum chamber at atmospheric pressure and pull vacuum at approximately 8 psi/minute. Maintain vacuum (approximately 0.1 psia) for 6 hours. Re-pressurize the chamber to ambient at a rate of 9 psi/minute.

Note: The lithium-ion polymer cells should be tested in an environment of 8 to 10 psi pressure for the flight acceptance leak test rather than the vacuum (~0.1 psi) or deep vacuum (below ~10–4 Torr). In addition, the pouch cell designs should be leak tested with the pressure restraints on the wide faces of the cells to prevent damage due to pouch expansion.

- E. Visually inspect the batteries for leaks, deformations, or bulges. Record any findings.
- F. Obtain measurements of the length, width, and height of the post-vacuum tested batteries.
- G. Obtain and record the mass of each cell/ battery. The pass/fail criteria requires that there is less than 0.1% change in mass.
- H. Complete a charge/discharge cycle order as specified in Section 4 and record the capacity. The pass/fail criteria requires that there shall be less than 0.1% change in the OCV and less than 5% change in the capacity before and after vacuum testing.