TYPE TEST REPORT

OPzS CELLS AND BLOCK BATTERIES

According to IEC 60896-11

U-POWER BATTERIES, 66 Tzar Asen Srt, Sofia, Republic of Bulgaria

Report Type	Type Test acc. to IEC 60896-11, DIN 40736 & DIN 40737
Product Type	OPzS cells and block batteries

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OPzS Type Test Report

This test report applies to all Upower's OPzS cells and monobloc batteries of the vented type for float charge applications, (i.e. permanently connected to a load and to a d.c. power supply), in a static location (i.e. not generally intended to be moved from place to place) and incorporated into stationary equipment or installed in battery rooms for use in telecom, uninterruptible power supply (UPS), utility switching, emergency power or similar applications and also solar applications.

Table 1 shows the relation between the test type and the number of cells acc. to IEC60896-11. The selection of the cell type Vs the test type was made in order to be able to extrapolate the results to the whole OPzS range. In most cases, the selection was made by the possible worst case scenario.

Test Clause According to IEC60896-11	Samples per Test
14. Capacity (240 h, 120h , 48h, 10 h, 8 h, 3 h, 1 h, 0,5 h)	6
15. Suitability for floating battery operation	6
16. Endurance in cycles	6
17. Endurance in overcharge	6
18. Charge retention	3
19. Short-circuit current and internal resistance	3

Table 1 – Test type Vs Cell Type acc. to IEC 60896-11

Some extra tests have been added by UPOWER and are presented below:

Extra Tests	Samples per Test
Impact of stress temperature of 55°C or 60°C (as per IEC 60896-21, clause 6.16)	3

Table 2 – Supplementary type tests

1 Discharge Capacity.

The purpose of this test is to confirm the capacity of the cells/batteries to a specific end-voltage at the selected discharge rate. One cell type per 50Ah, 70Ah, 100Ah and 125Ah plate has been selected. Regarding the 50Ah plate, the tests have been separated into two categories:

- 2V cells
- Monoblock batteries

The reason for this categorization is the difference of the separator for these two types (the plate remains the same but the monoblock batteries are using thinner separator comparing to the 2V cells).

Each cell type was tested at the following rates:

Rate	C0,25	C1	C3	C8	C10	C20	C48	C120
Temperature (°C)	20	20	20	20	20	20	20	20
Final Voltage (V/cell)	1,6	1,6	1,7	1,75	1,8	1,8	1,8	1,85

Table 3 – Discharge rates and end voltages

The most common applications for the U-POWER OPzS batteries are:

UPOWER OPzS Batteries Applications	Low Discharge Rate	Medium Discharge Rate	High Discharge Rate
Telecommunications	☐	☑	☑
Control and monitoring systems in power plants and distribution stations	☐	☑	☑
Railway, airport and seaport signalling	☑	☑	☐
Emergency lighting	☐	☑	☑
Data processing systems	☐	☑	☐
Automation	☑	☑	☐
UPS	☐	☑	☑
Renewabl e energy systems (solar, wind, hydro)	☑	☑	☐

Table 4 – UPOWER OPzS batteries applications

Deviation according to IEC: cells have been submitted initially to two C10 discharges (IEC mentions that the cells shall not have been previously submitted to any discharges). In any case, the results from the two initial discharges were successful with the actual capacity to be ≥95% of the rated capacity.

1.1 2V - OPzS 50Ah Plate

Instruction: IEC 60896-11, clause 14

Test items: 6pcs, 2V - 5 OPzS 250

Specification: Actual Capacity Vs Rated Capacity Ca ≥ 95 % Crt at 1st cycle and Ca ≥ 100 % Crt at 5th cycle

Test Result: **Successful**

5 OPzS 250								
Rate	C0,25	C1	C3	C8	C10	C20	C48	C120
Current (A)	330,2	148,6	68,8	32,9	27	15,6	7,47	3,15
Final Voltage (V)	1,6	1,6	1,7	1,75	1,8	1,8	1,8	1,85
Test Temperature (°C)	20	20	20	20	20	20	20	20
Nominal Capacity (Ah)	82,6	148,6	206,4	263,2	270,0	312,0	358,6	378,0
Measured Capacity (Ah)	97,29	168,46	229,52	282,14	288,80	333,86	379,47	396,74
Nominal Capacity (50 Ah Plate)	16,5	29,7	41,3	52,6	54,0	62,4	71,7	75,6
Measured Capacity (50 Ah Plate)	19,46	33,69	45,90	56,43	57,76	66,77	75,89	79,35
Result (%)	**117,9%**	**113,4%**	**111,2%**	**107,2%**	**107,0%**	**107,0%**	**105,8%**	**105,0%**

Table 5 – Summary of test results for the 2V – 5 OPzS 250

Summary of test results: Tests were successful. In all the rates the following was applied Ca ≥ 100 % Crt

The measurement curves are shown below:

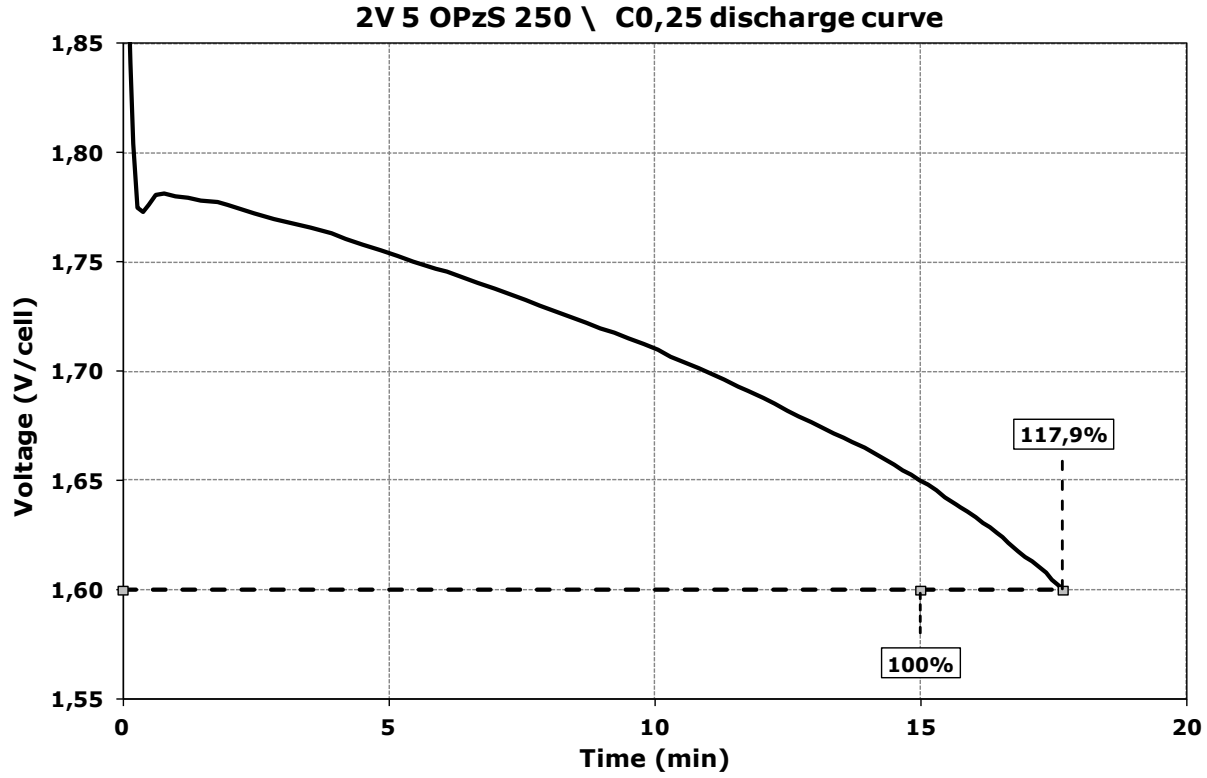

Figure 1. C0.25 Capacity Test

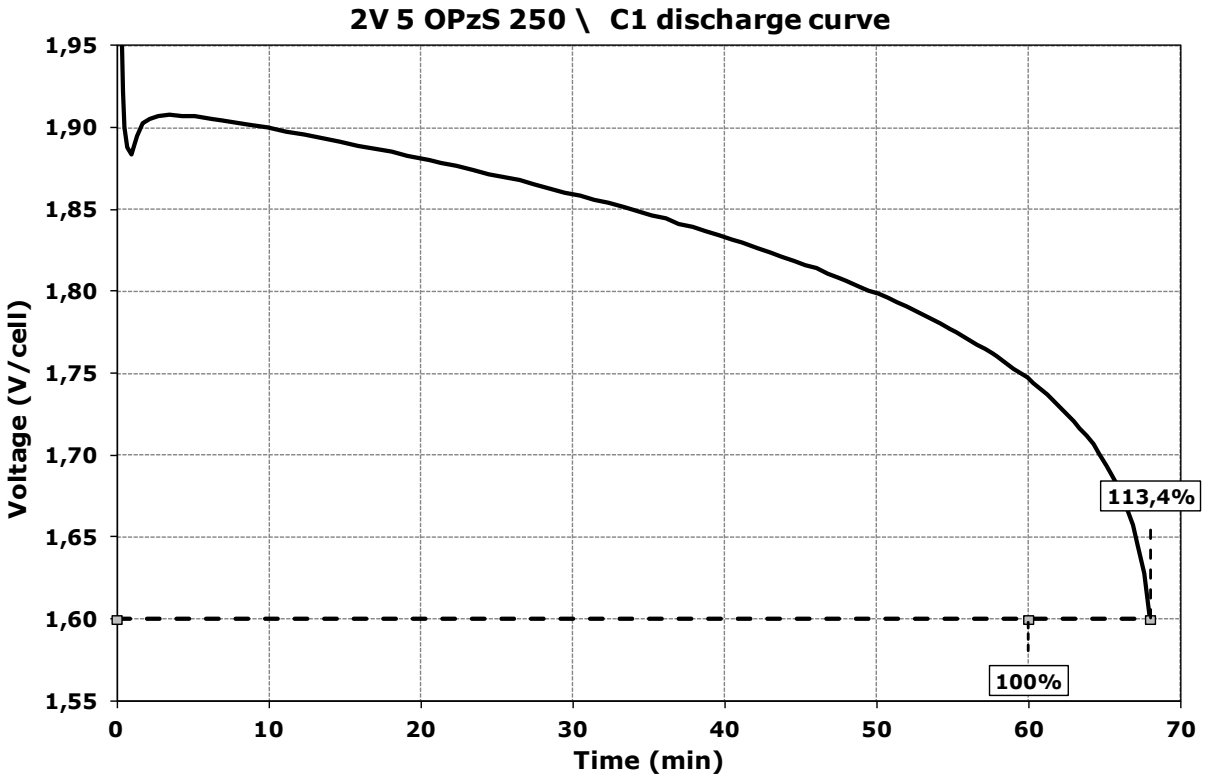

Figure 2. C1 Capacity Test

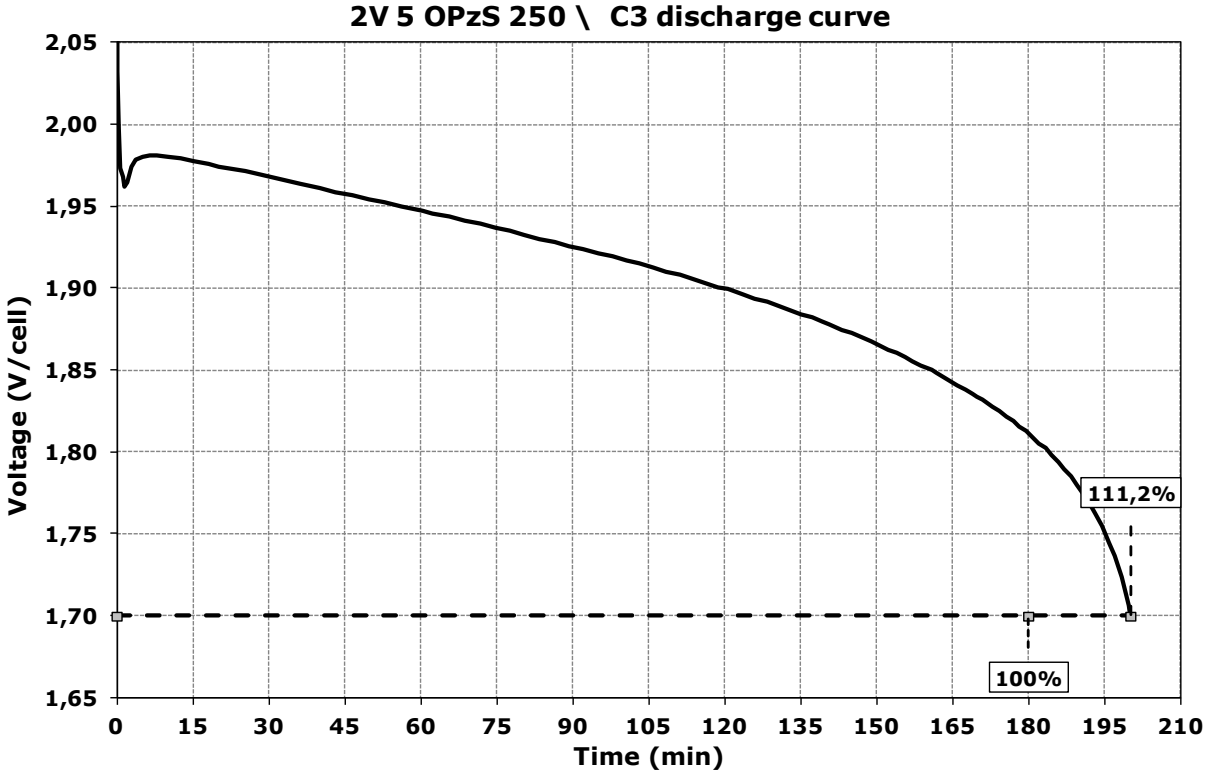

Figure 3. C3 Capacity Test

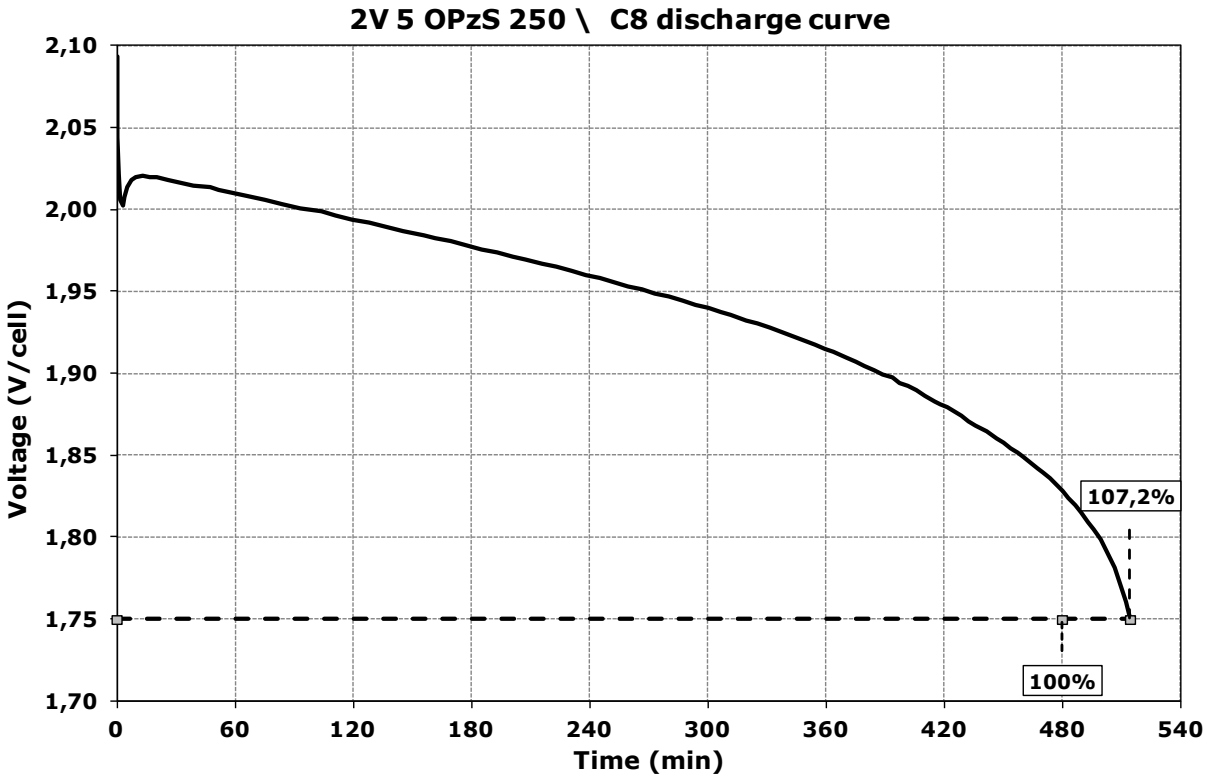

Figure 4. C8 Capacity Test

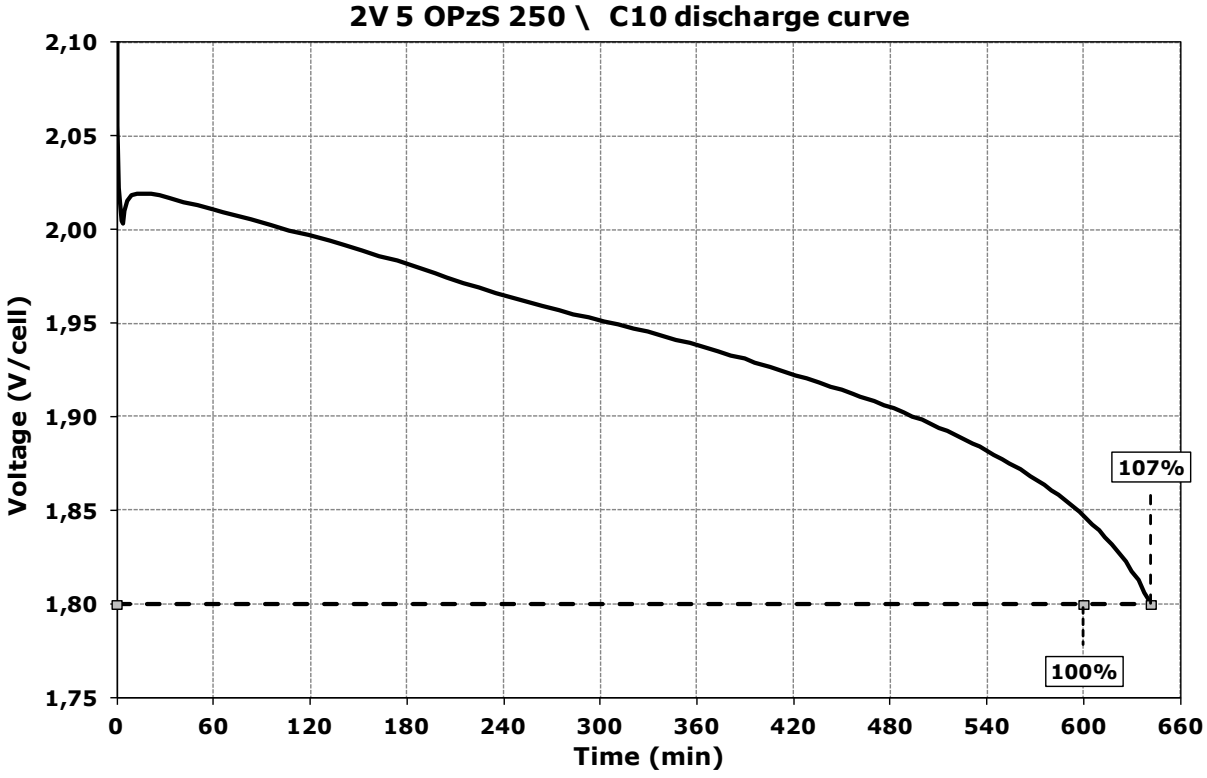

Figure 5. C10 Capacity Test

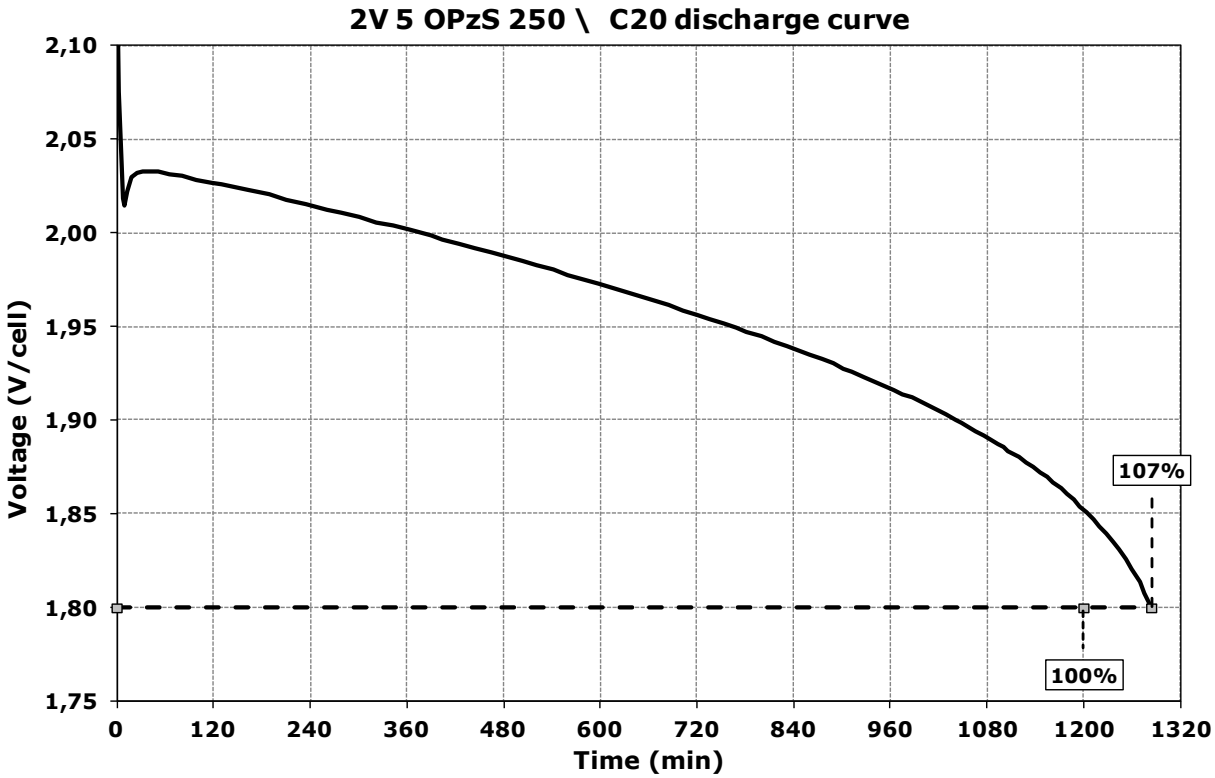

Figure 6. C20 Capacity Test

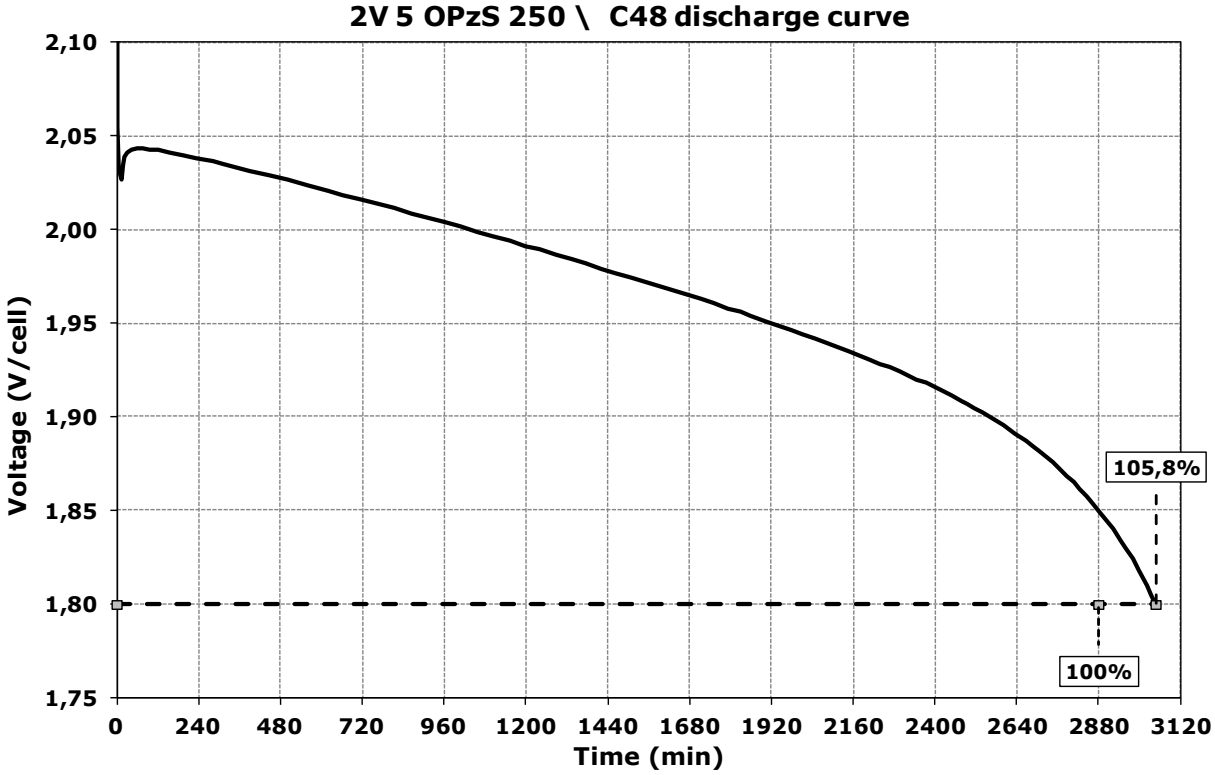

Figure 7. C48 Capacity Test

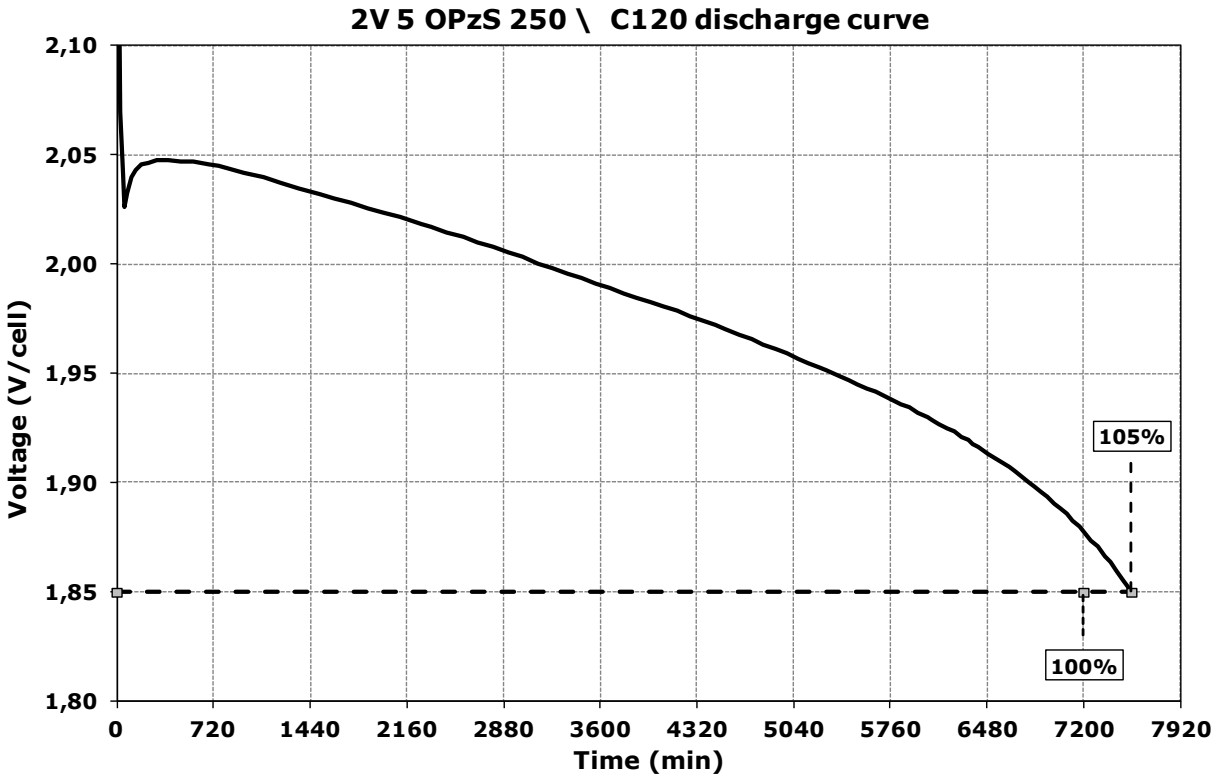

Figure 8. C120 Capacity Test

1.2 6V - OPzS 50Ah Plate

Instruction: IEC 60896-11, clause 14

Test items: 6pcs, 6V - 6 OPzS 300

Specification: Actual Capacity Vs Rated Capacity Ca ≥ 95 % Crt at 1st cycle and Ca ≥ 100 % Crt at 5th cycle

Test Result: **Successful**

6V - 6 OPzS 300								
Rate	C0,25	C1	C3	C8	C10	C20	C48	C120
Current (A)	373,7	181,6	82,6	38,5	31,2	17,69	8,28	3,40
Final Voltage (V)	4,8	4,8	5,1	5,25	5,4	5,4	5,4	5,55
Test Temperature (°C)	20	20	20	20	20	20	20	20
Nominal Capacity (Ah)	93,4	181,6	247,8	308,0	312,0	353,8	397,4	408,0
Measured Capacity (Ah)	108,03	190,78	262,57	320,11	318,82	363,69	408,97	419,89
Nominal Capacity (50 Ah Plate)	15,6	30,3	41,3	51,3	52,0	59,0	66,2	68,0
Measured Capacity (50 Ah Plate)	18,00	31,80	43,76	53,35	53,14	60,61	68,16	69,98
Result (%)	**115,6%**	**105,1%**	**106,0%**	**103,9%**	**102,2%**	**102,8%**	**102,9%**	**102,9%**

Table 6 – Summary of test results for the 6V – 6 OPzS 300

Summary of test results: Tests were successful. In all the rates the following was applied Ca ≥ 100 % Crt

The measurement curves are shown below:

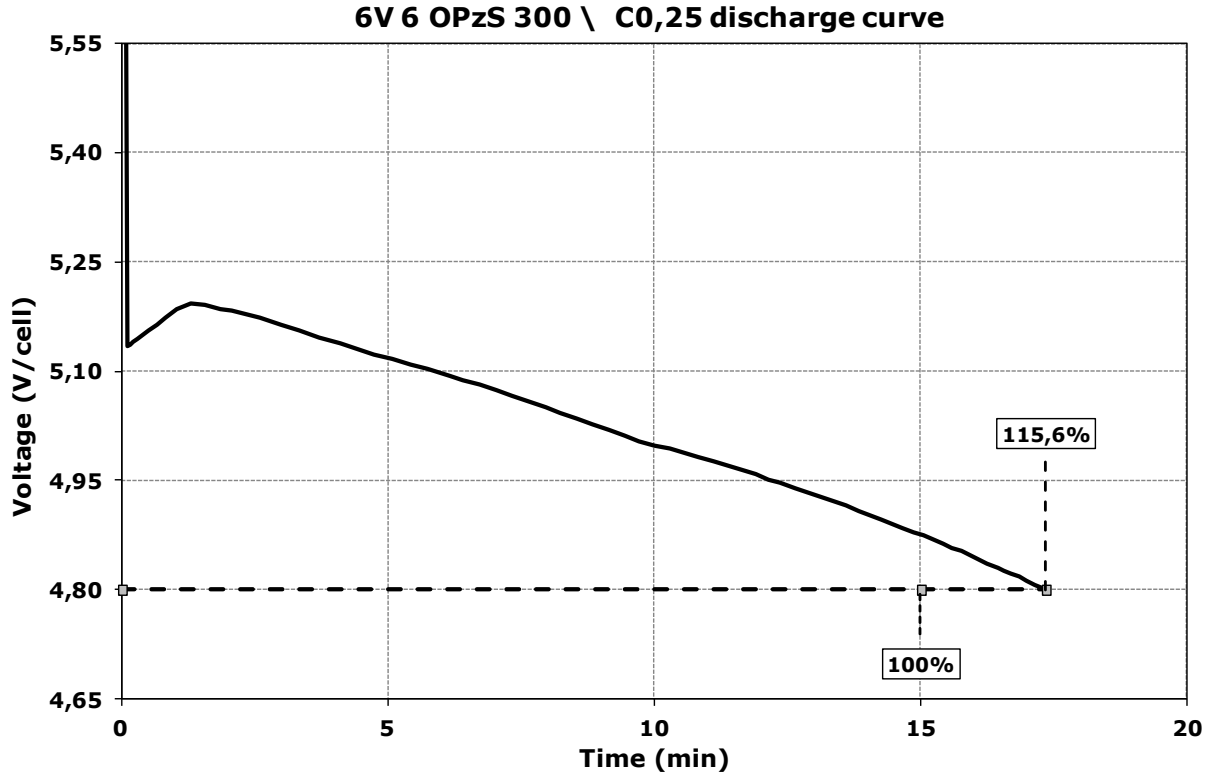

Figure 9. C0.25 Capacity Test

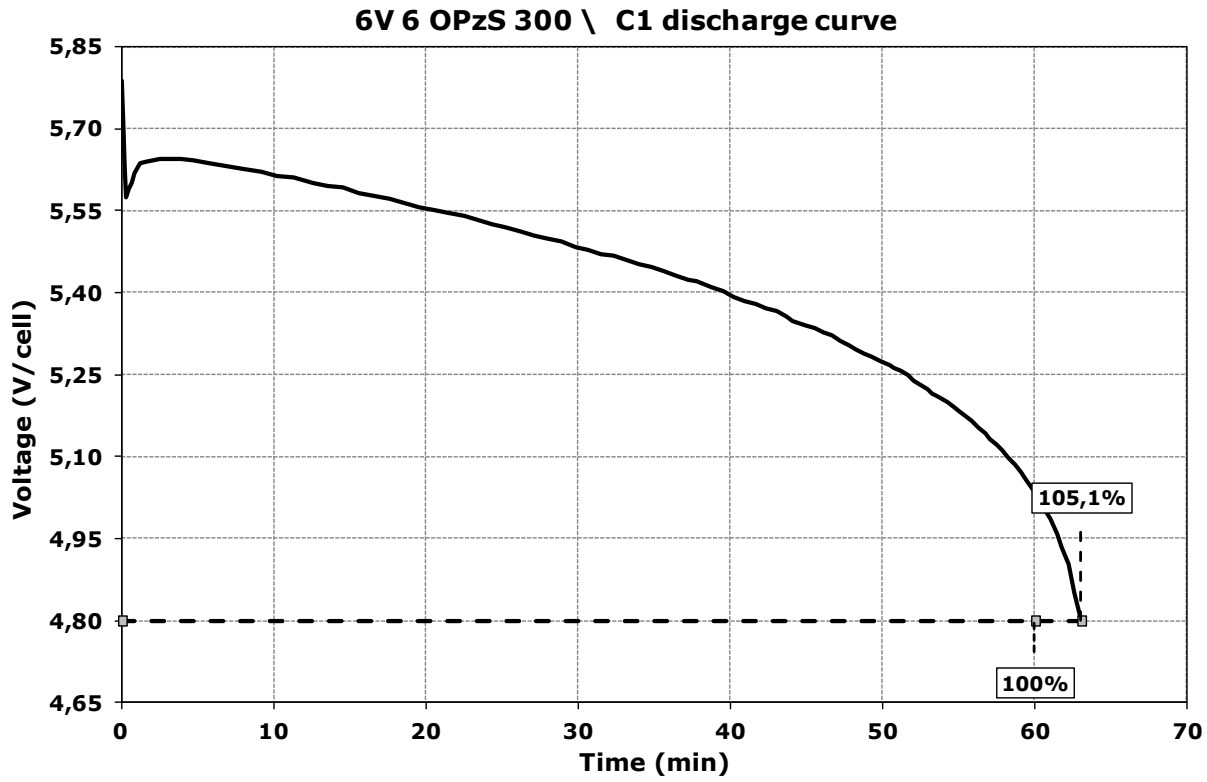

Figure 10. C1 Capacity Test

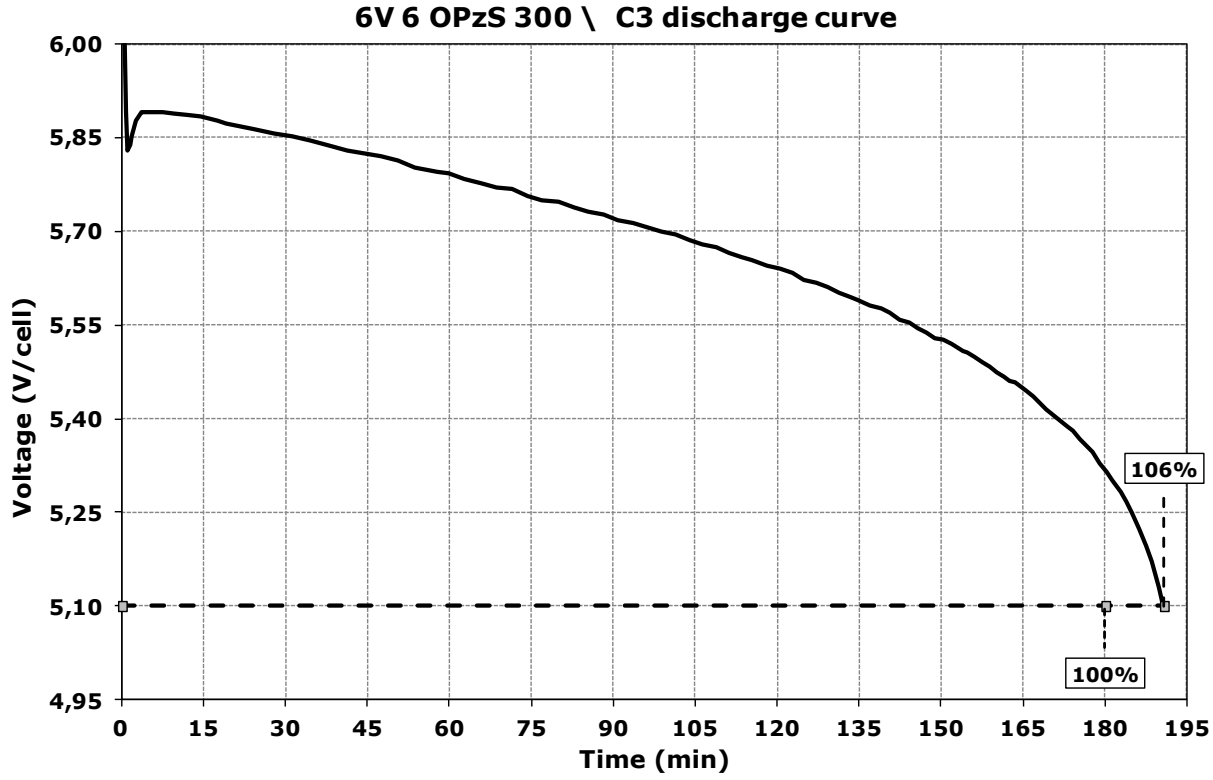

Figure 11. C3 Capacity Test

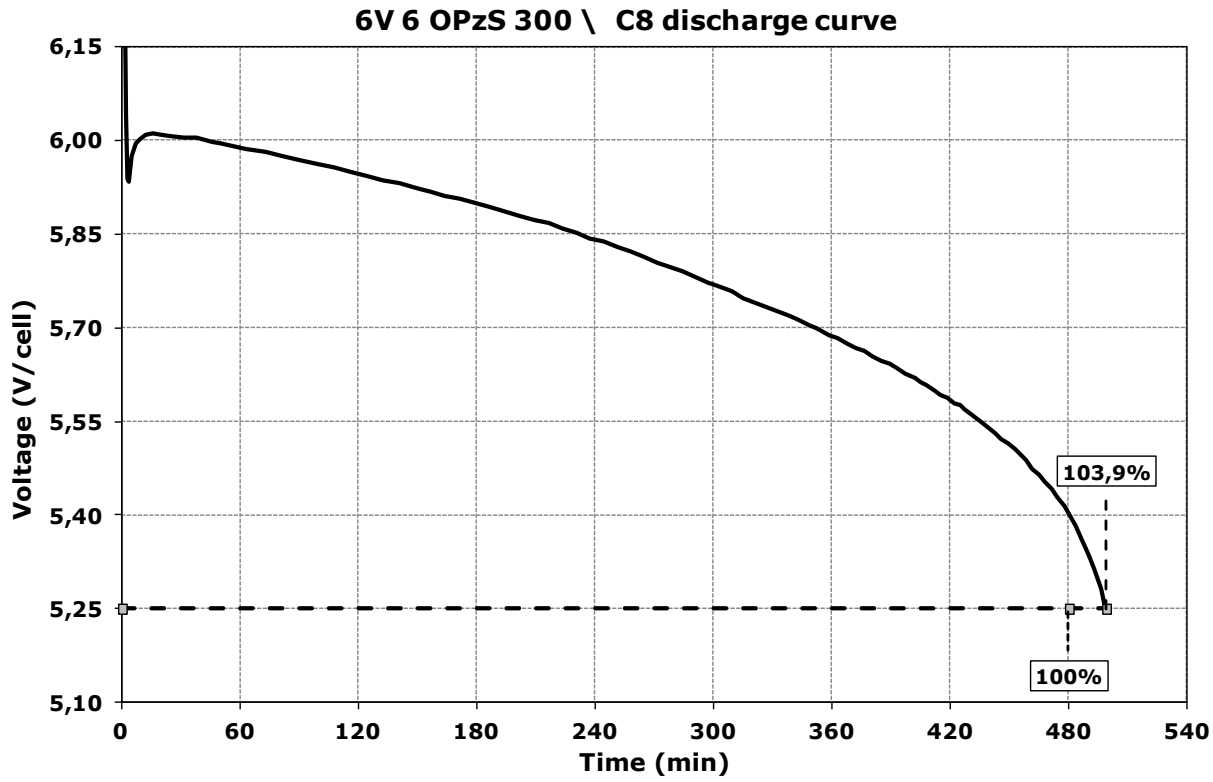

Figure 12. C8 Capacity Test

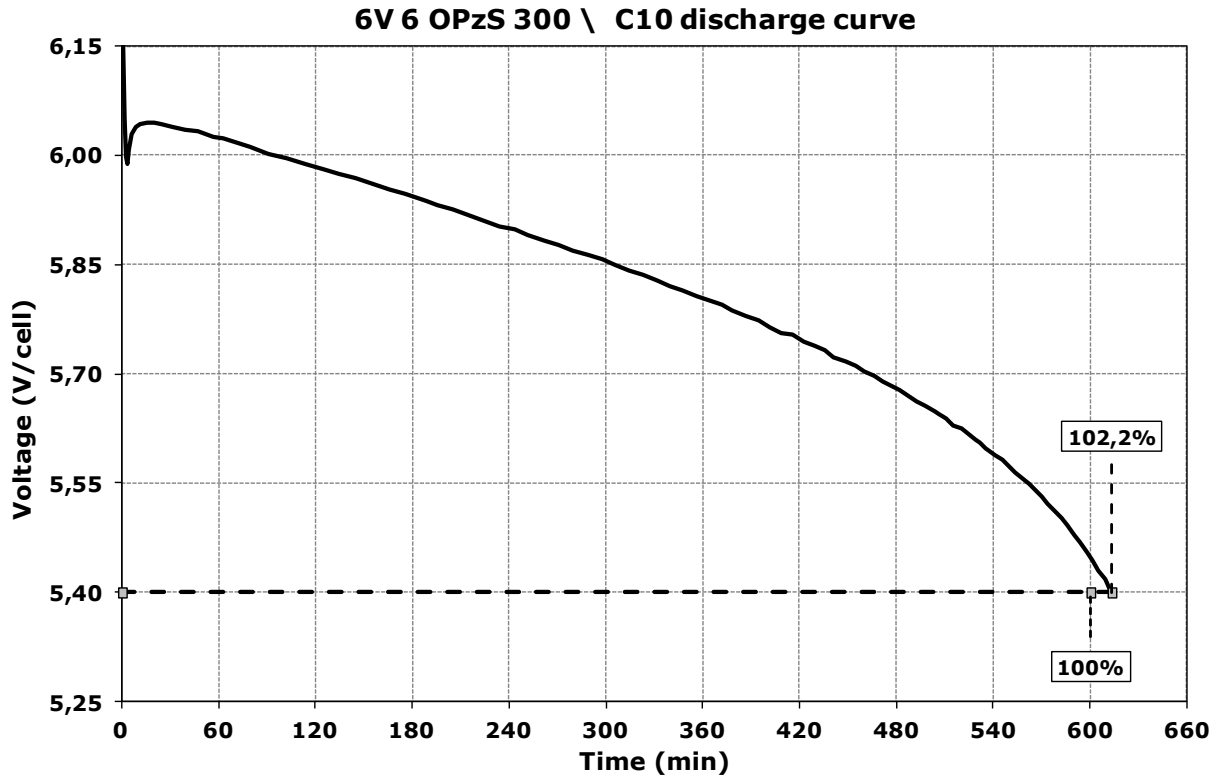

Figure 13. C10 Capacity Test

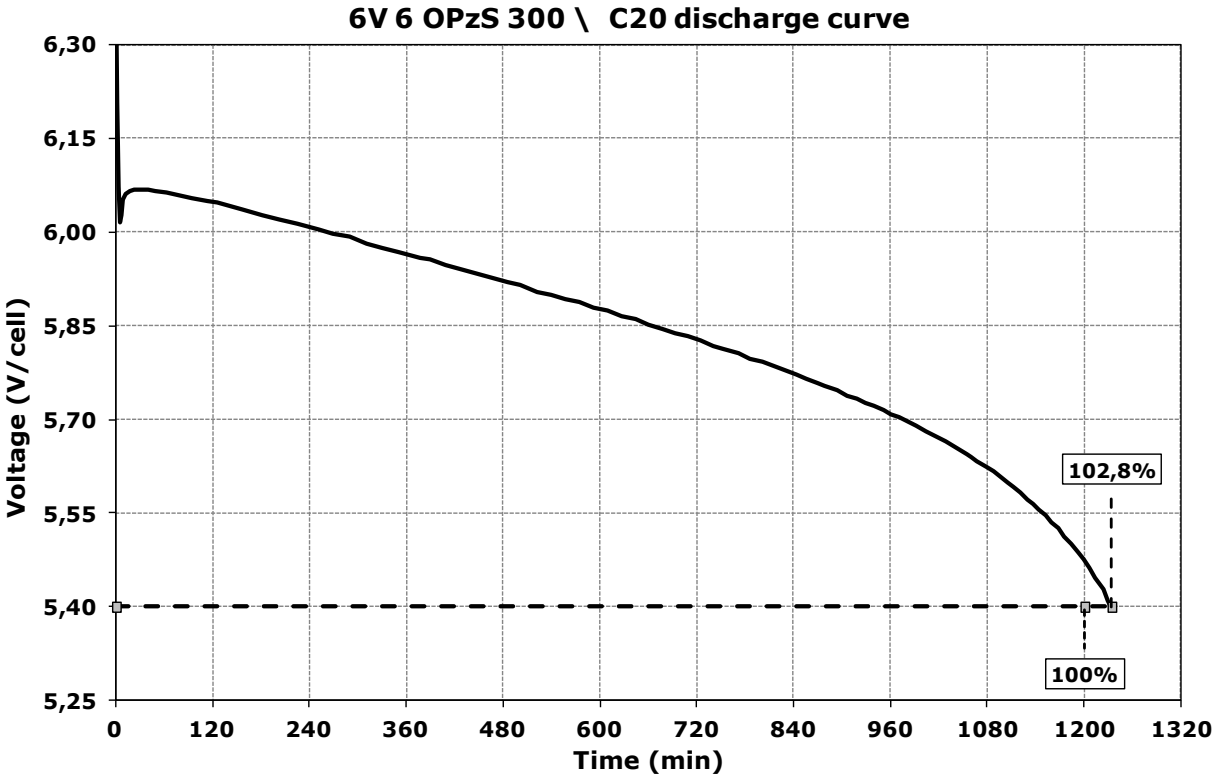

Figure 14. C20 Capacity Test

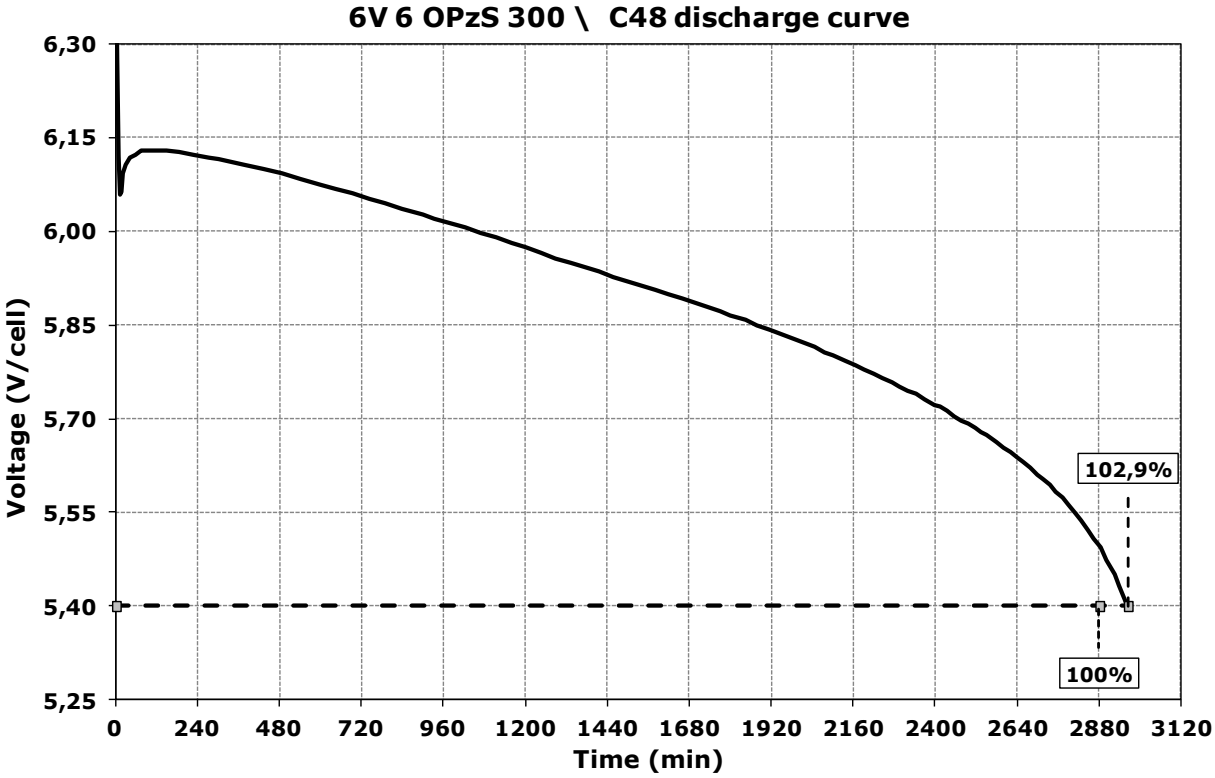

Figure 15. C48 Capacity Test

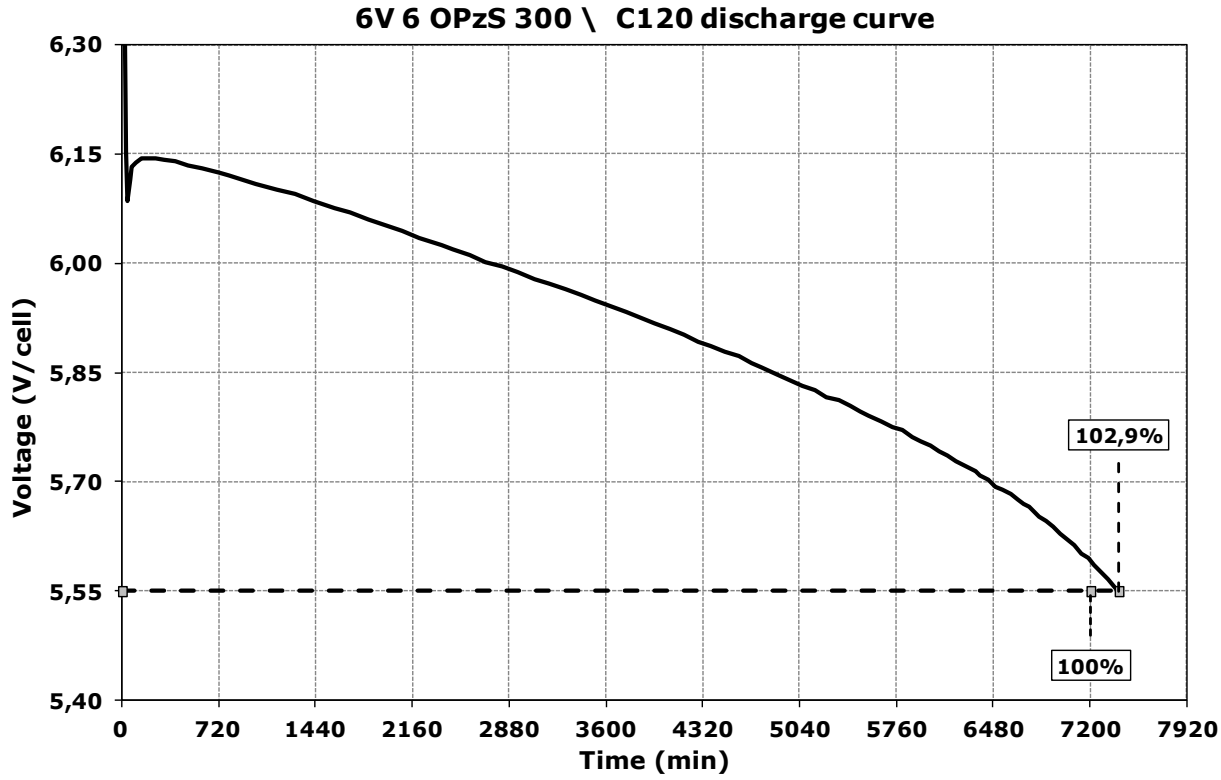

Figure 16. C120 Capacity Test

1.3 12V - OPzS 50Ah Plate

Instruction: IEC 60896-11, clause 14
Test items: 6pcs, 12V - 2 OPzS 100
Specification: Actual Capacity Vs Rated Capacity Ca ≥ 95 % Crt at 1st cycle and Ca ≥ 100 % Crt at 5th cycle
Test Result: **Successful**

12V - 2 OPzS 100								
Rate	C0,25	C1	C3	C8	C10	C20	C48	C120
Current (A)	139,3	64,2	28,3	12,75	10,3	5,74	2,66	1,10
Final Voltage (V)	9,6	9,6	10,2	10,5	10,8	10,8	10,8	11,1
Test Temperature (°C)	20	20	20	20	20	20	20	20
Nominal Capacity (Ah)	34,8	64,2	84,9	102,0	103,0	114,8	127,7	132,0
Measured Capacity (Ah)	36,29	65,71	85,53	103,19	104,82	119,17	133,75	133,61
Nominal Capacity (50 Ah Plate)	17,4	32,1	42,5	51,0	51,5	57,4	63,8	66,0
Measured Capacity (50 Ah Plate)	18,15	32,85	42,77	51,60	52,41	59,59	66,87	66,81
Result (%)	**104,2%**	**102,3%**	**100,7%**	**101,2%**	**101,8%**	**103,8%**	**104,8%**	**101,2%**

Table 7 – Summary of test results for the 12V – 2 OPzS 100

Summary of test results: Tests were successful. In all the rates the following was applied Ca ≥ 100 % Crt

The measurement curves are shown below:

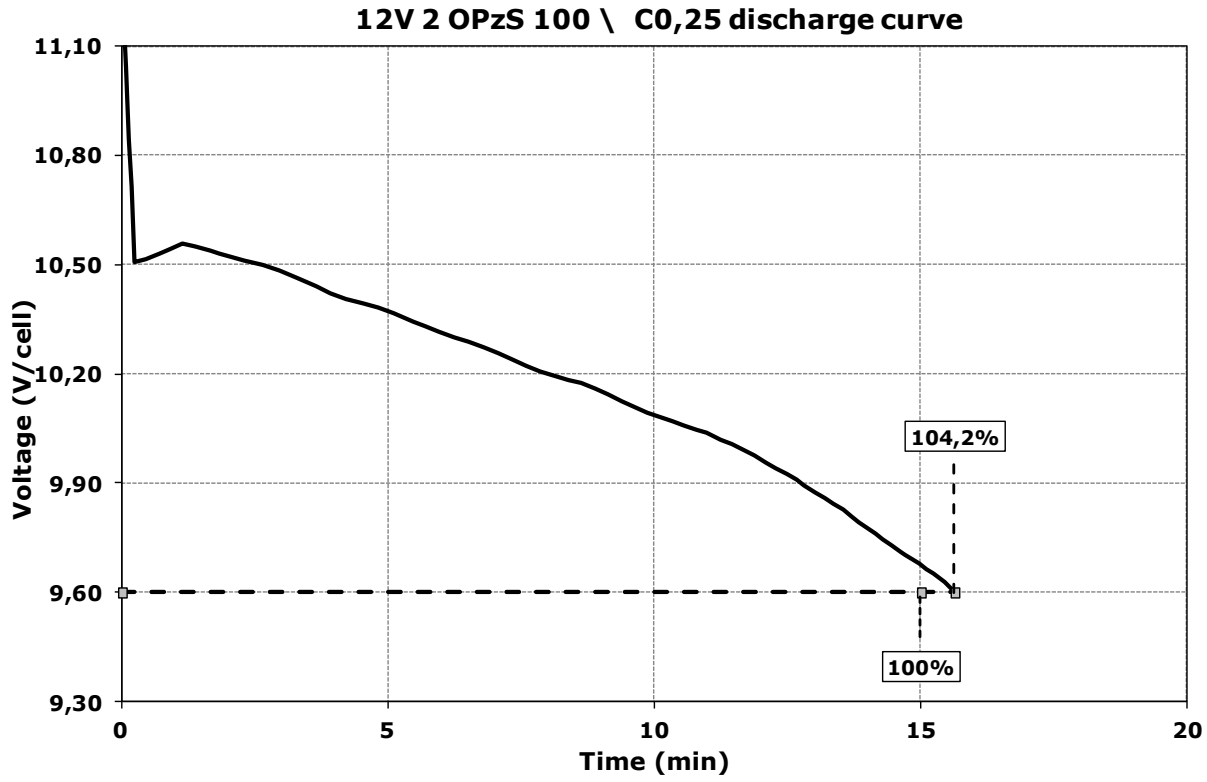

Figure 17. C0.25 Capacity Test

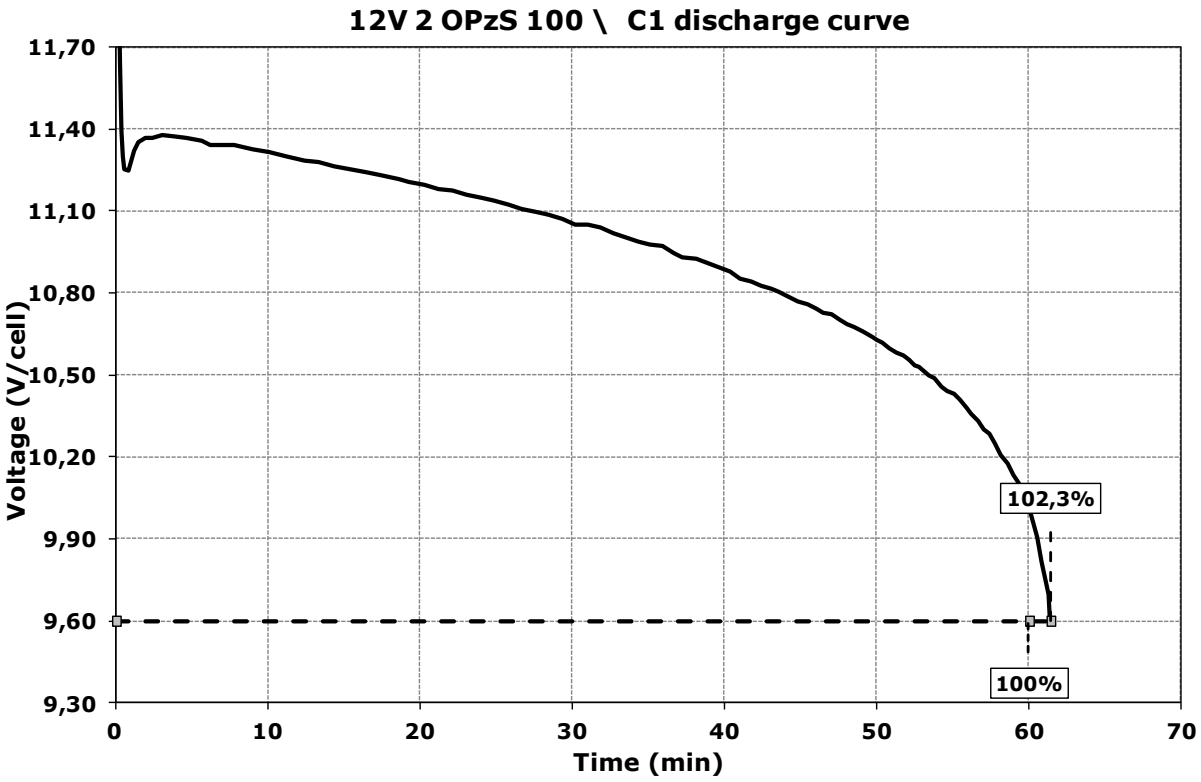

Figure 18. C1 Capacity Test

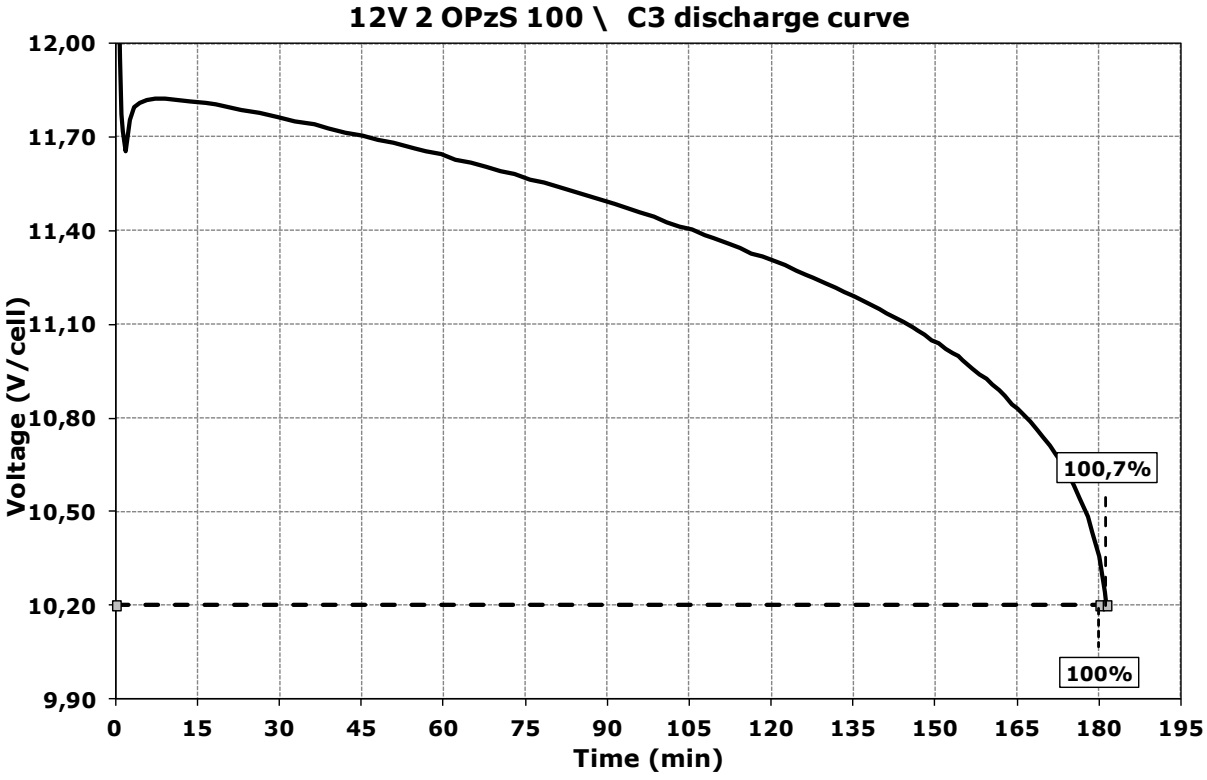

Figure 19. C3 Capacity Test

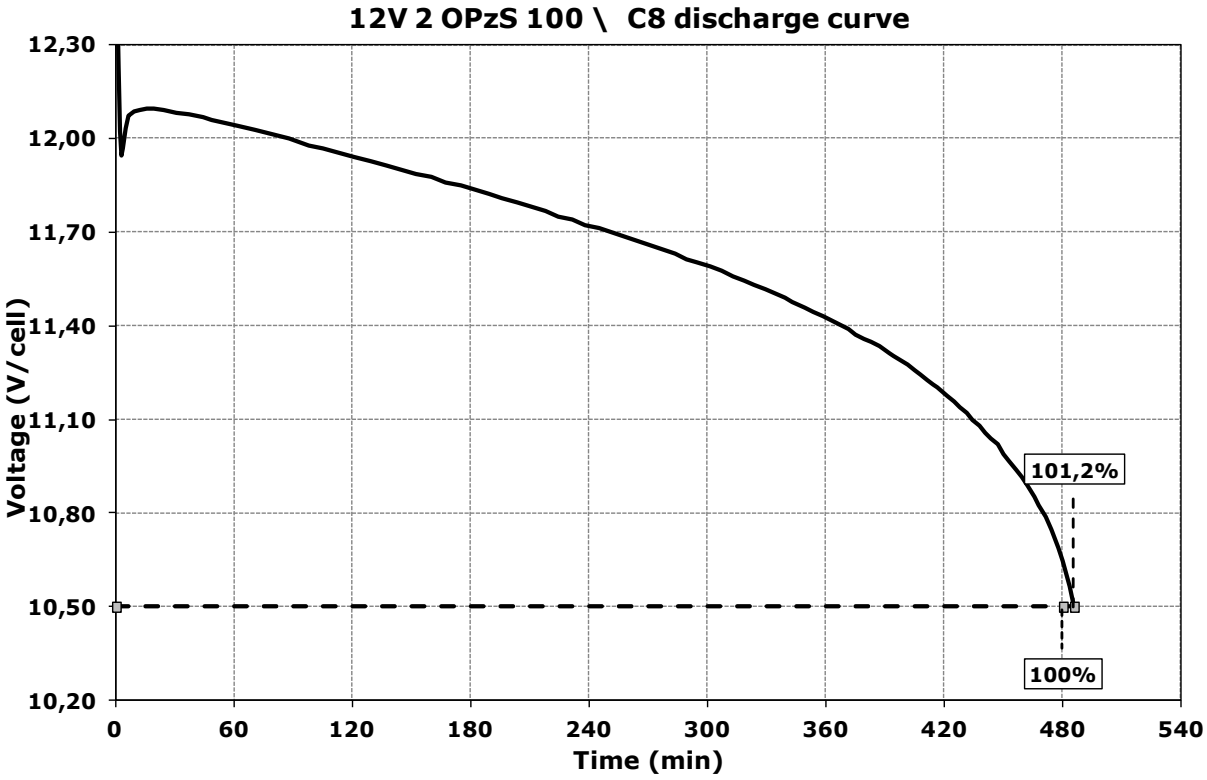

Figure 20. C8 Capacity Test

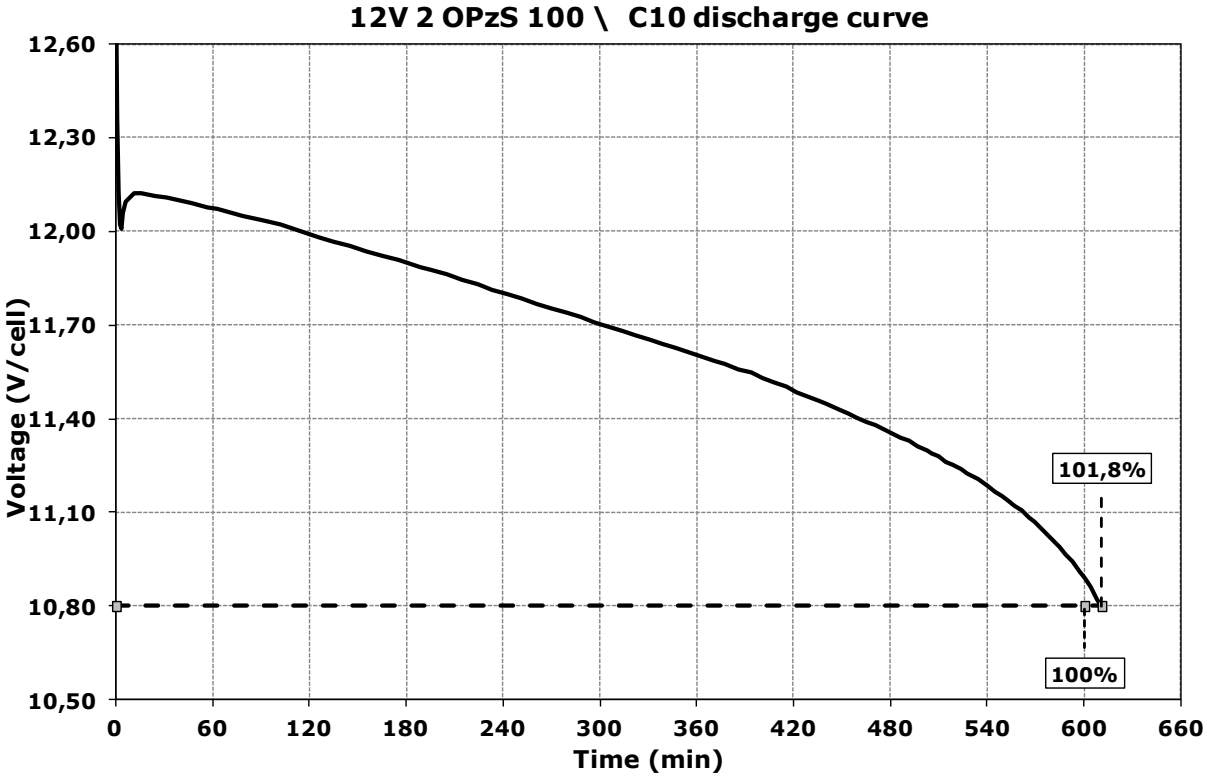

Figure 21. C10 Capacity Test

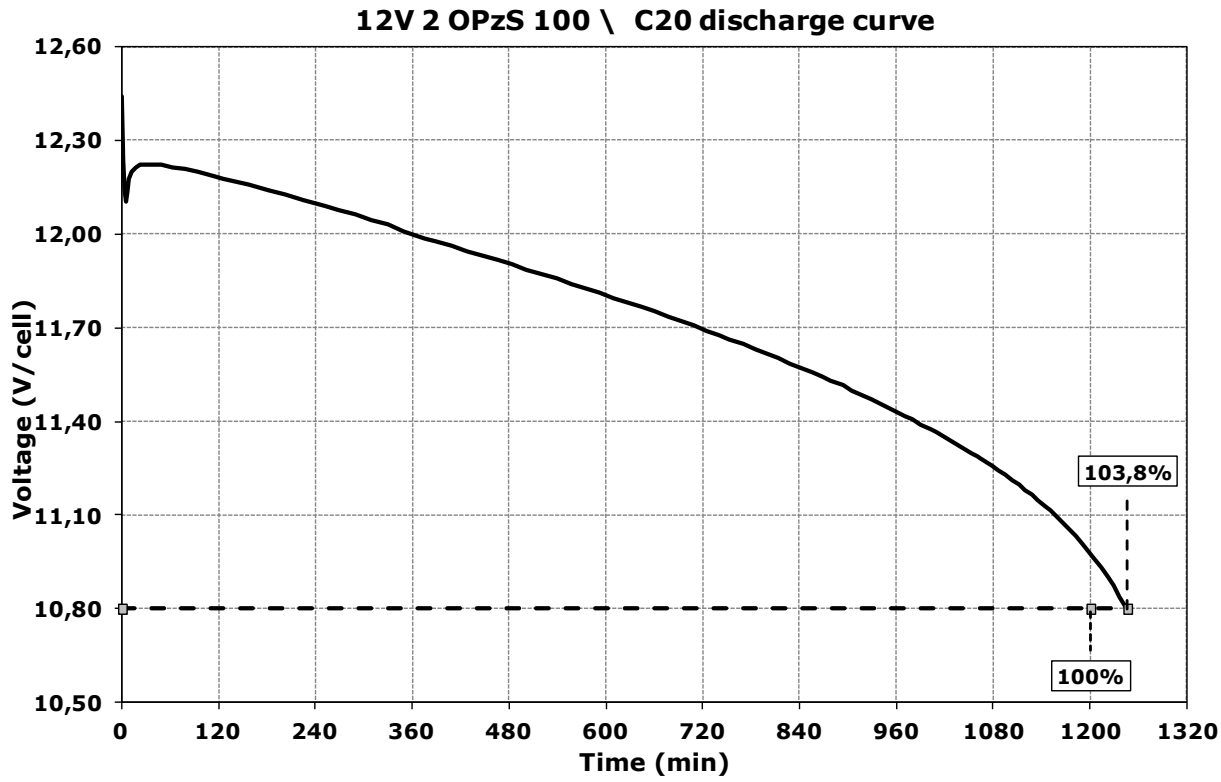

Figure 22. C20 Capacity Test

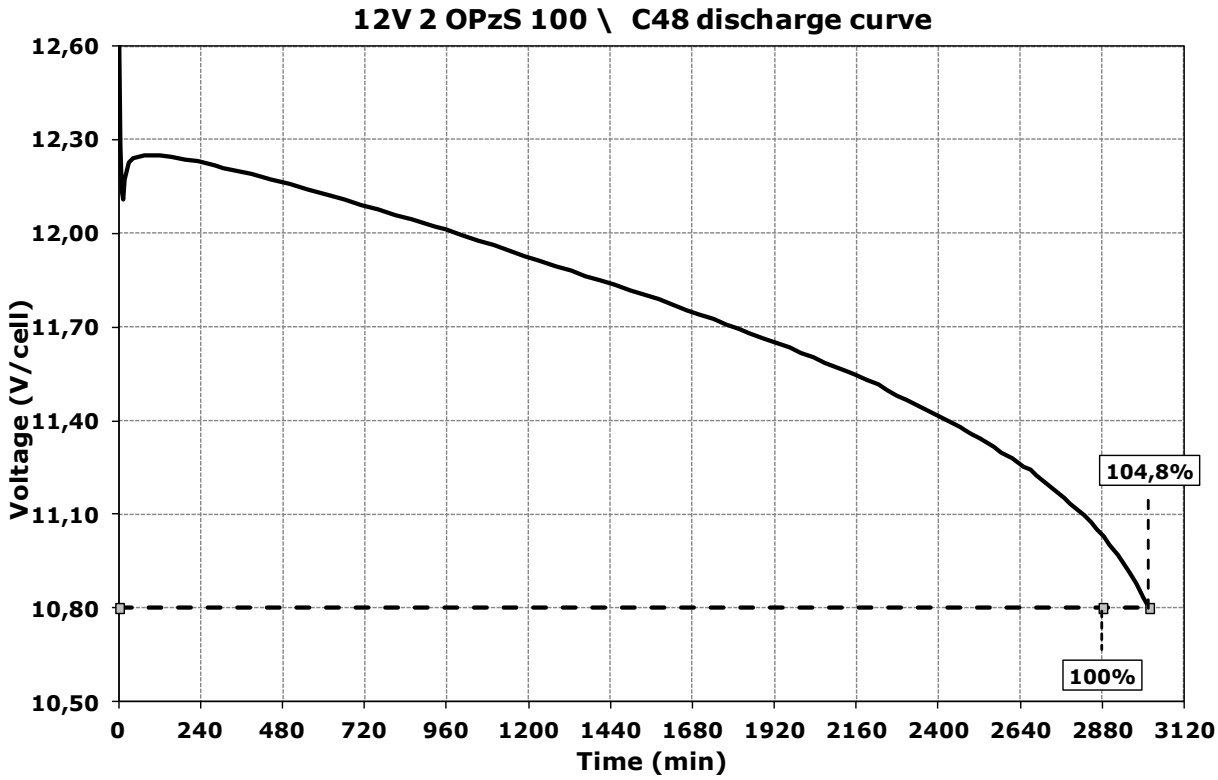

Figure 23. C48 Capacity Test

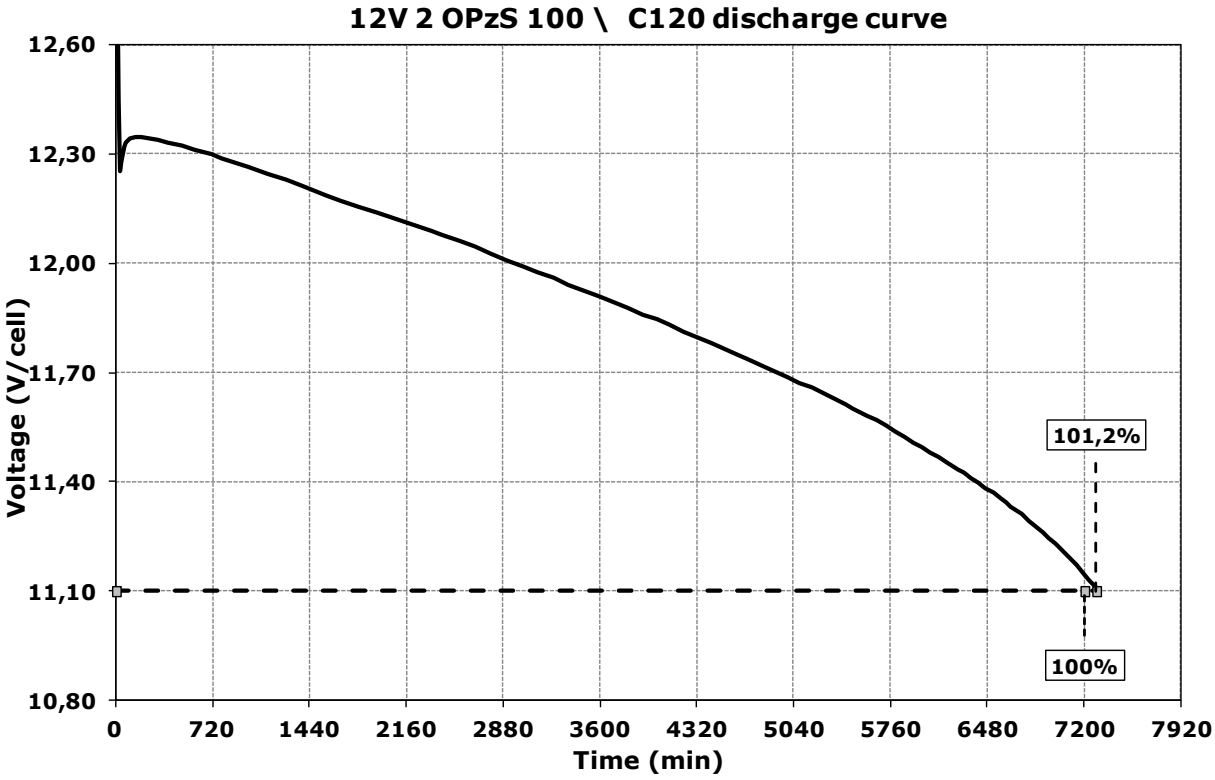

Figure 24. C120 Capacity Test

1.4 70Ah Plate

Instruction: IEC 60896-11, clause 14

Test items: 6pcs 2V - 6 OPzS 420

Specification: Actual Capacity Vs Rated Capacity Ca ≥ 95 % Crt at 1st cycle and Ca ≥ 100 % Crt at 5th cycle

Test Result: **Successful**

2V - 6 OPzS 420								
Rate	C0,25	C1	C3	C8	C10	C20	C48	C120
Current (A)	516,5	265,9	122,8	58,5	47,4	27,4	13,13	5,51
Final Voltage (V)	1,6	1,6	1,7	1,75	1,8	1,8	1,8	1,85
Test Temperature (°C)	20	20	20	20	20	20	20	20
Nominal Capacity (Ah)	129,1	265,9	368,4	468,0	474,0	548,0	630,2	661,2
Measured Capacity (Ah)	153,47	292,09	383,65	481,01	502,29	573,52	649,37	675,07
Nominal Capacity (70 Ah Plate)	21,5	44,3	61,4	78,0	79,0	91,3	105,0	110,2
Measured Capacity (70 Ah Plate)	25,58	48,68	63,94	80,17	83,72	95,59	108,23	112,51
Result (%)	**118,9%**	**109,9%**	**104,1%**	**102,8%**	**106,0%**	**104,7%**	**103,0%**	**102,1%**

Table 8 – Summary of test results for the 2V – 6 OPzS 420

Summary of test results: Tests were successful. In all the rates the following was applied Ca ≥ 100 % Crt

The measurement curves are shown below:

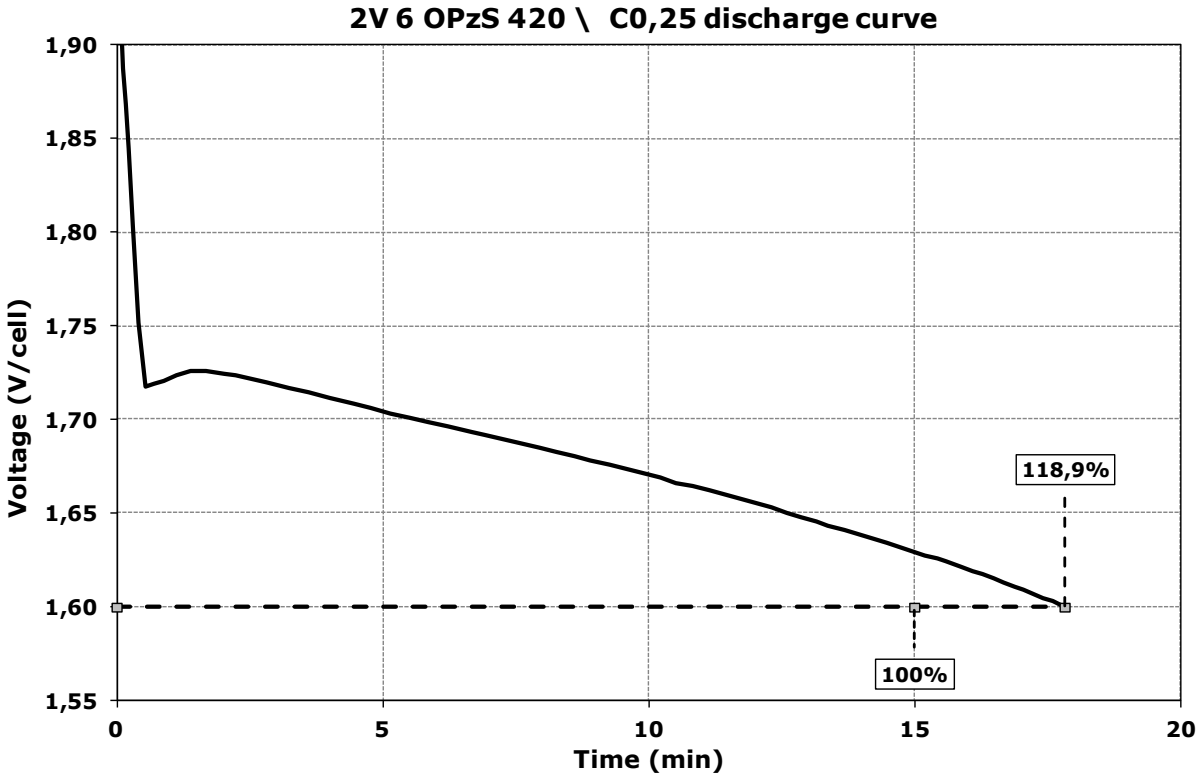

Figure 25. C0.25 Capacity Test

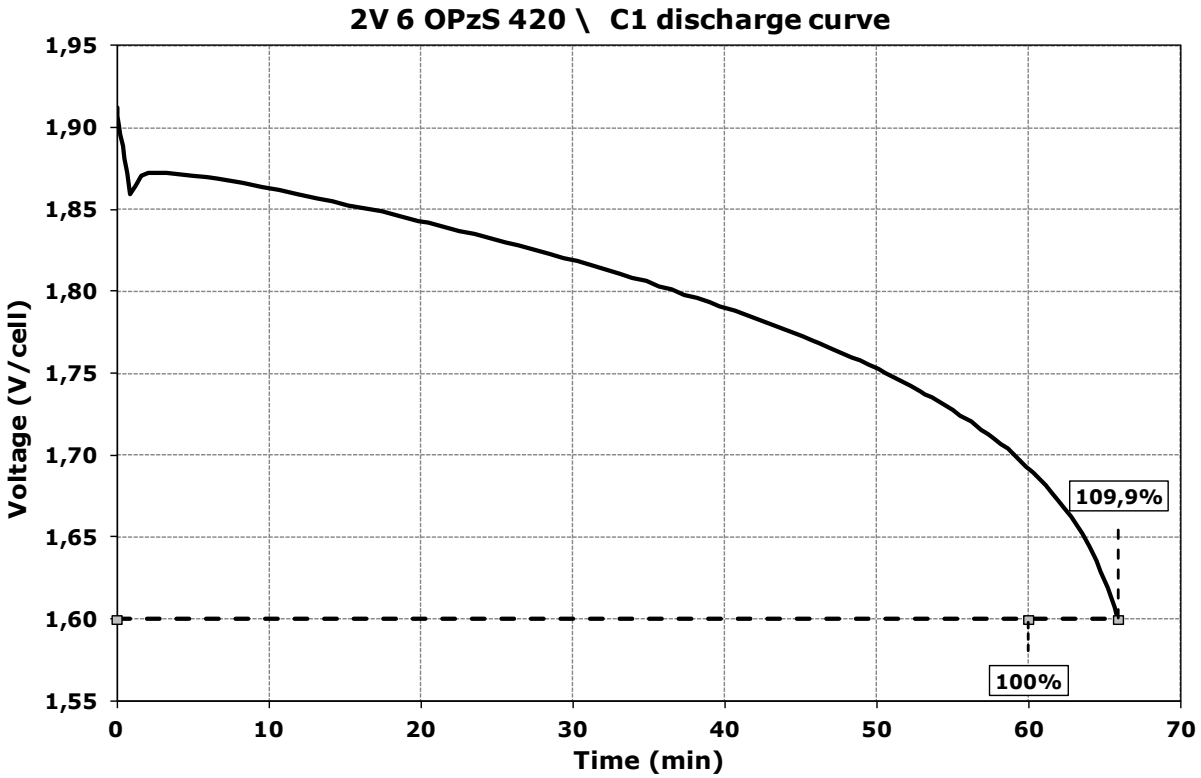

Figure 26. C1 Capacity Test

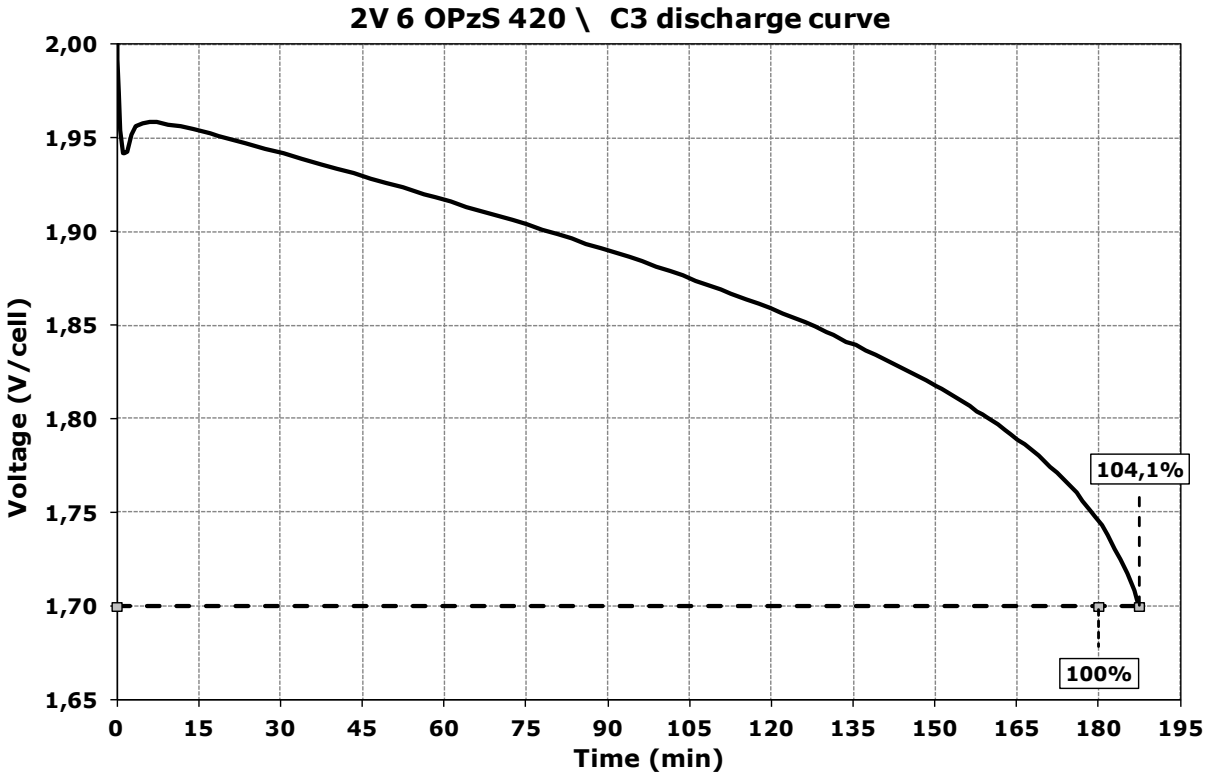

Figure 27. C3 Capacity Test

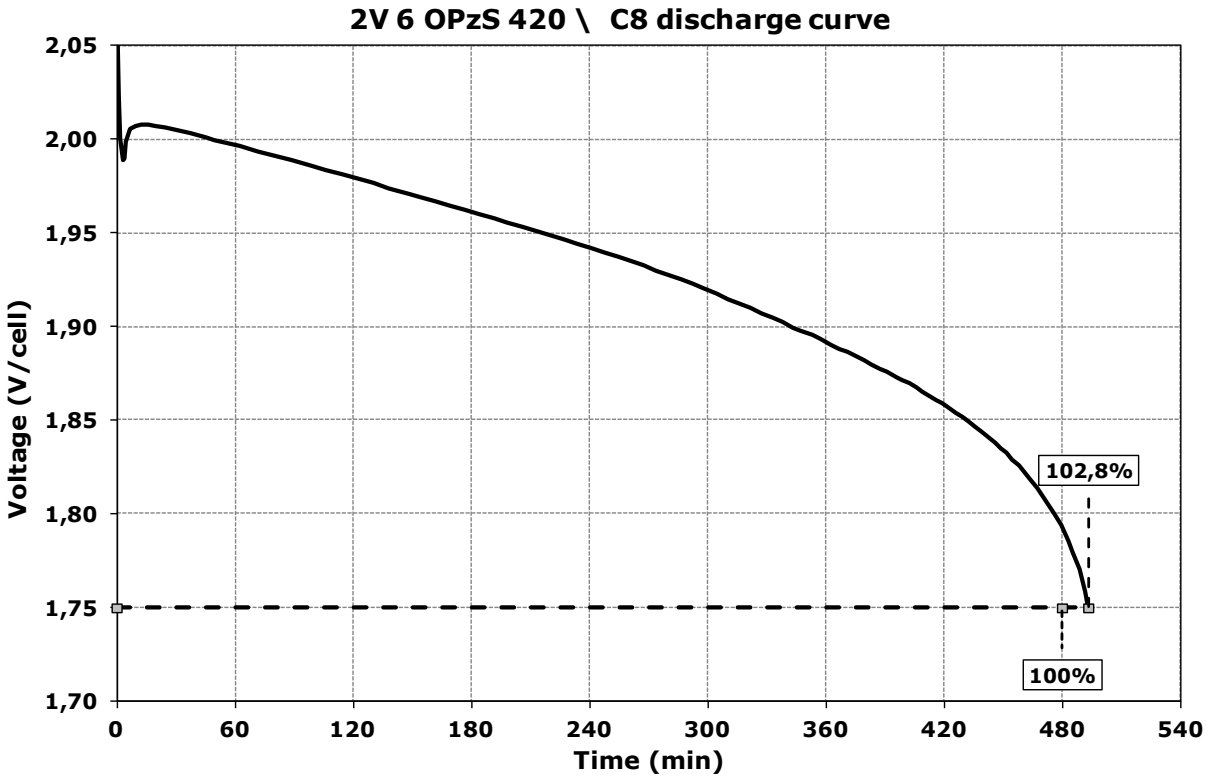

Figure 28. C8 Capacity Test

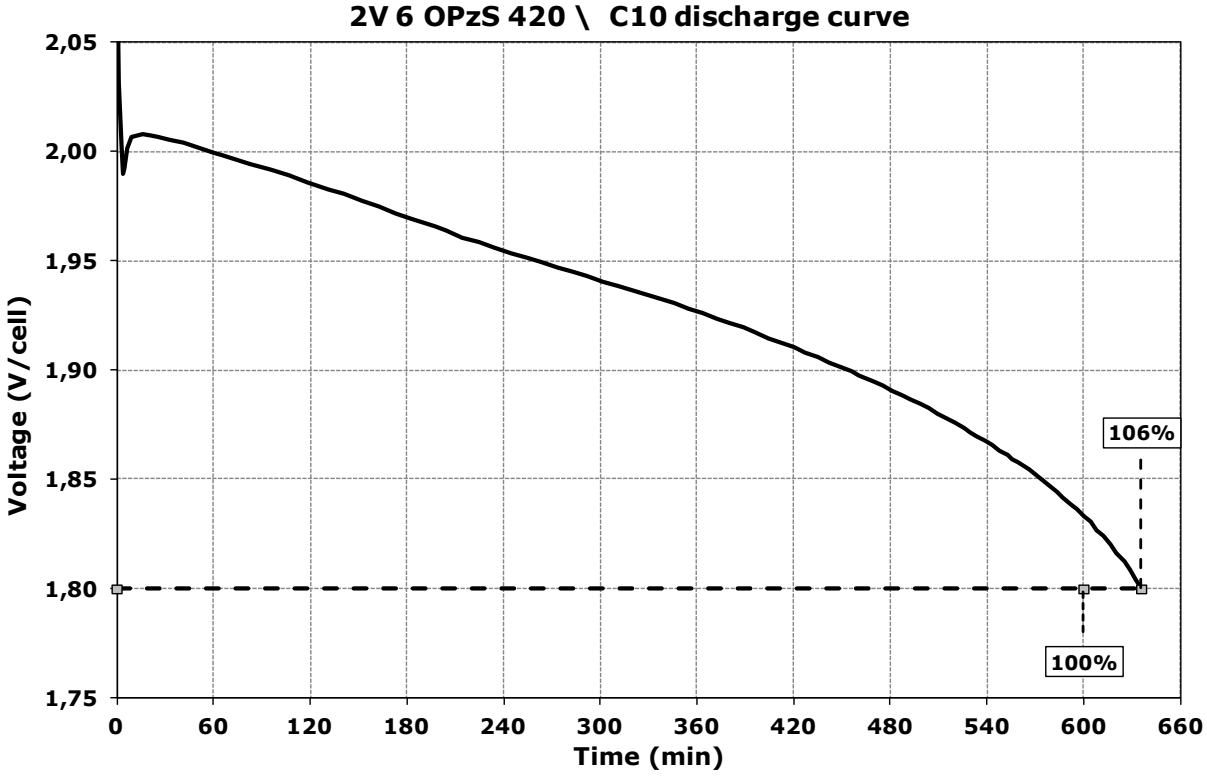

Figure 29. C10 Capacity Test

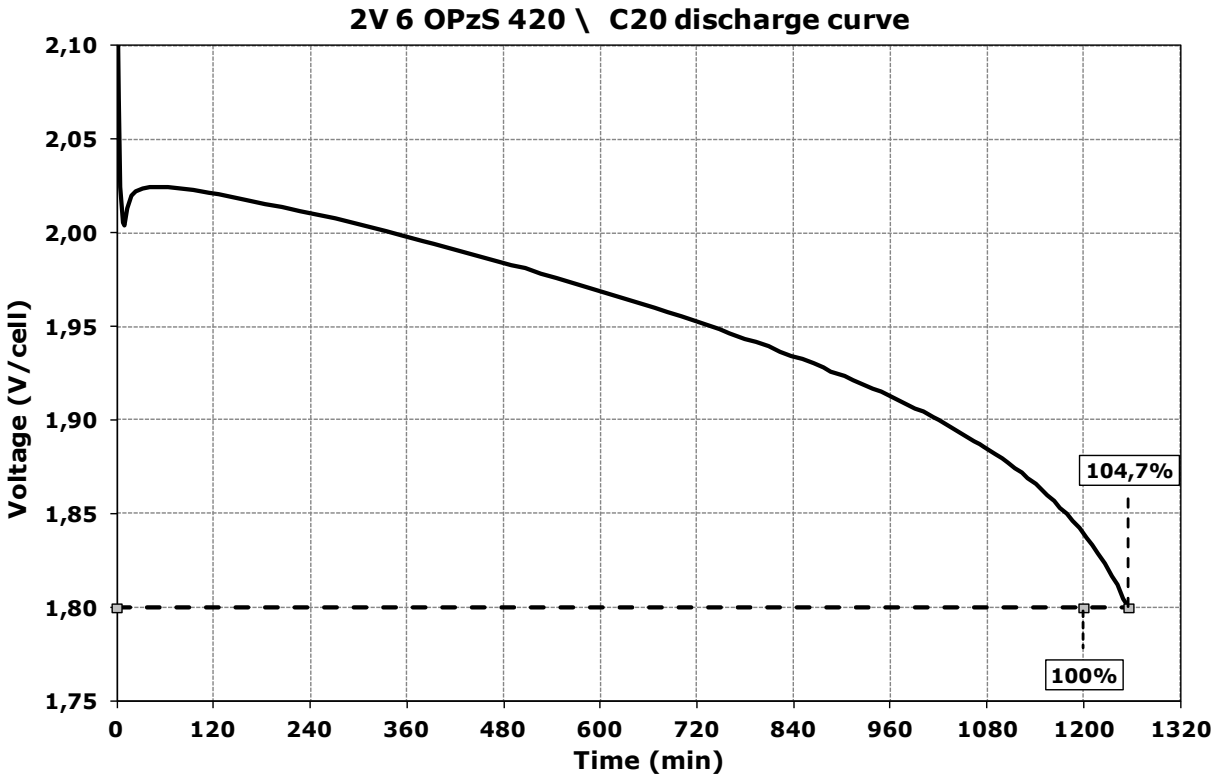

Figure 30. C20 Capacity Test

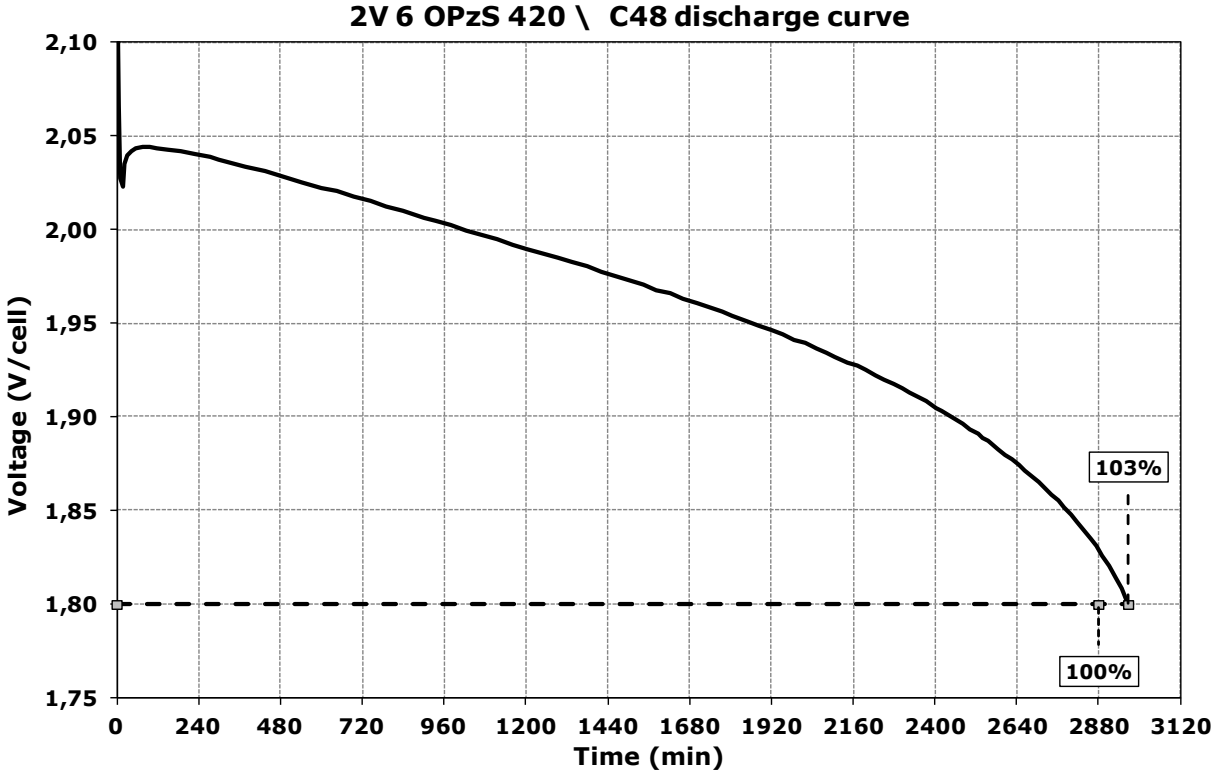

Figure 31. C48 Capacity Test

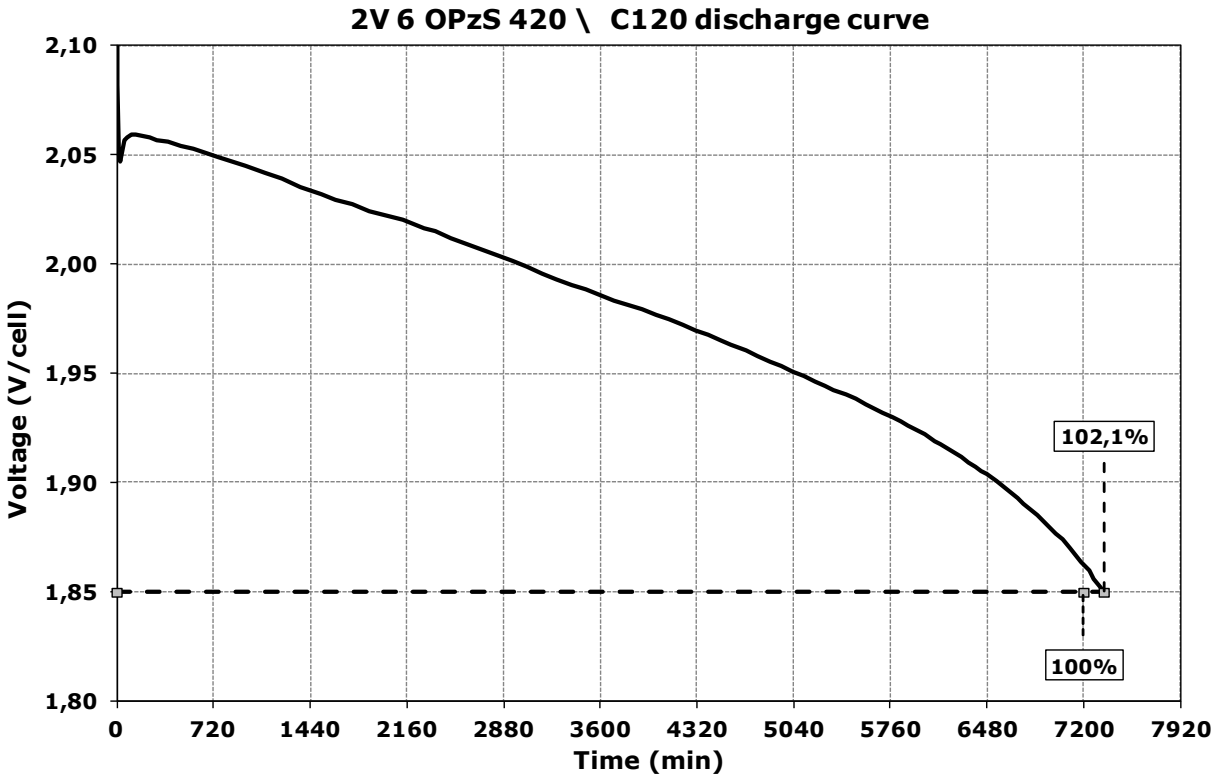

Figure 32. C120 Capacity Test

1.5 100Ah Plate

Instruction: IEC 60896-11, clause 14

Test items: 6pcs 2V - 6OPzS600

Specification: Actual Capacity Vs Rated Capacity Ca ≥ 95 % Crt at 1st cycle and Ca ≥ 100 % Crt at 5th cycle

Test Result: **Successful**

2V - 6 OPzS 600								
Rate	C0,25	C1	C3	C8	C10	C20	C48	C120
Current (A)	656,6	378,1	175	83,6	67,2	39,4	19,07	8,05
Final Voltage (V)	1,6	1,6	1,7	1,75	1,8	1,8	1,8	1,85
Test Temperature (°C)	20	20	20	20	20	20	20	20
Nominal Capacity (Ah)	164,2	378,1	525,0	668,8	672,0	788,0	915,4	966,0
Measured Capacity (Ah)	231,9	400,5	563,8	688,6	700,0	814,9	925,0	979,8
Nominal Capacity (100 Ah Plate)	27,4	63,0	87,5	111,5	112,0	131,3	152,6	161,0
Measured Capacity (100 Ah Plate	38,66	66,75	93,97	114,76	116,67	135,81	154,17	163,30
Result (%)	**141,3%**	**105,9%**	**107,4%**	**103,0%**	**104,2%**	**103,4%**	**101,1%**	**101,4%**

Table 9 – Summary of test results for the 2V – 6OPzS600

Summary of test results: Tests were successful. In all the rates the following was applied Ca ≥ 100 % Crt

The measurement curves are shown below:

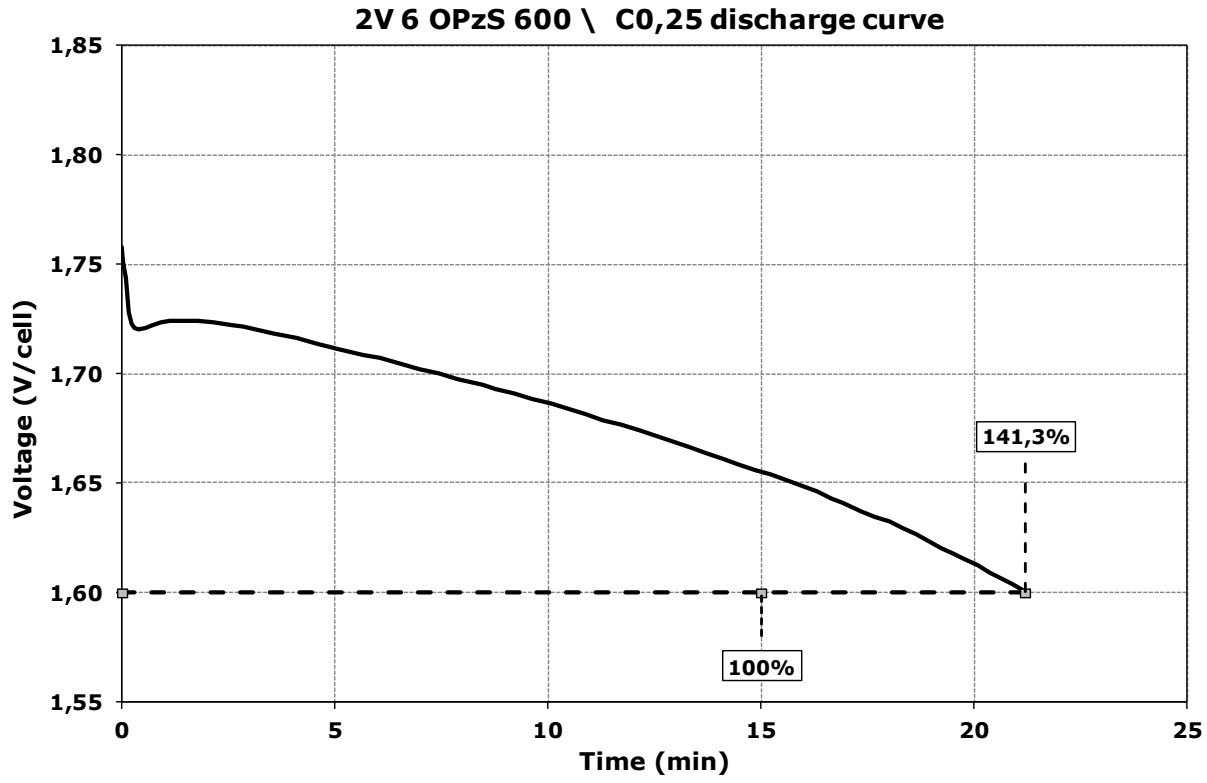

Figure 33. C0.25 Capacity Test

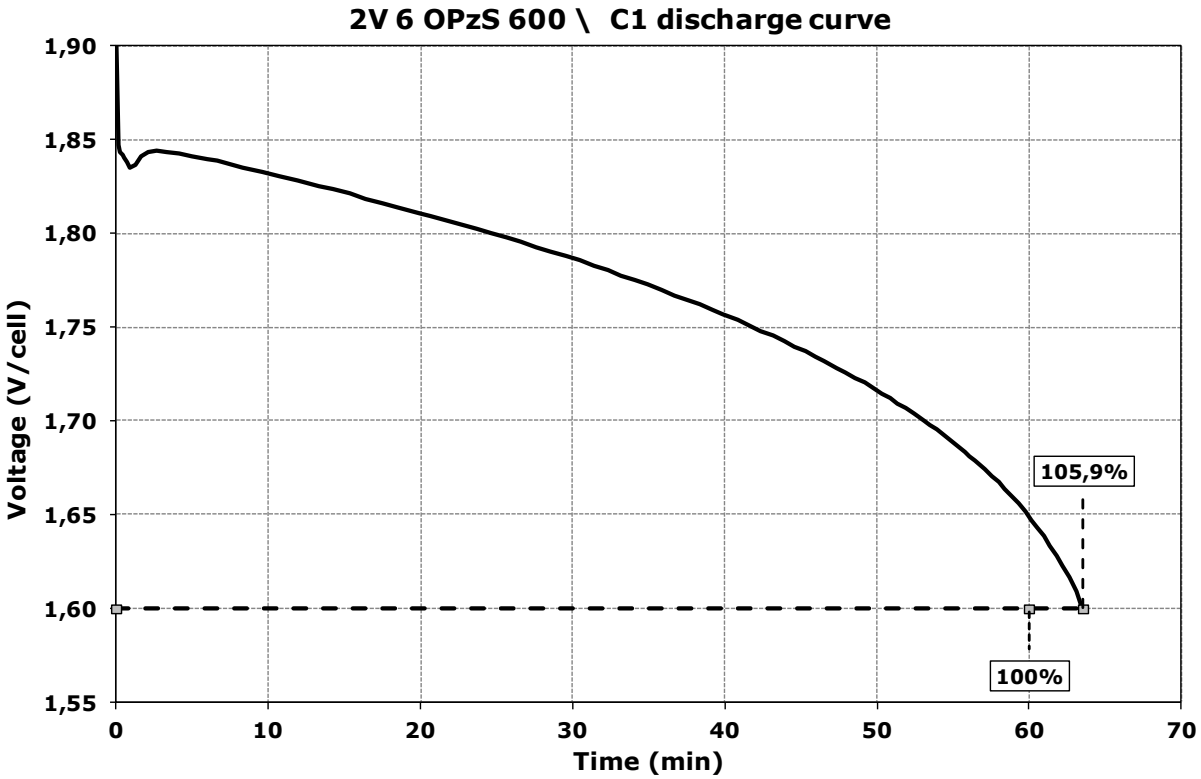

Figure 34. C1 Capacity Test

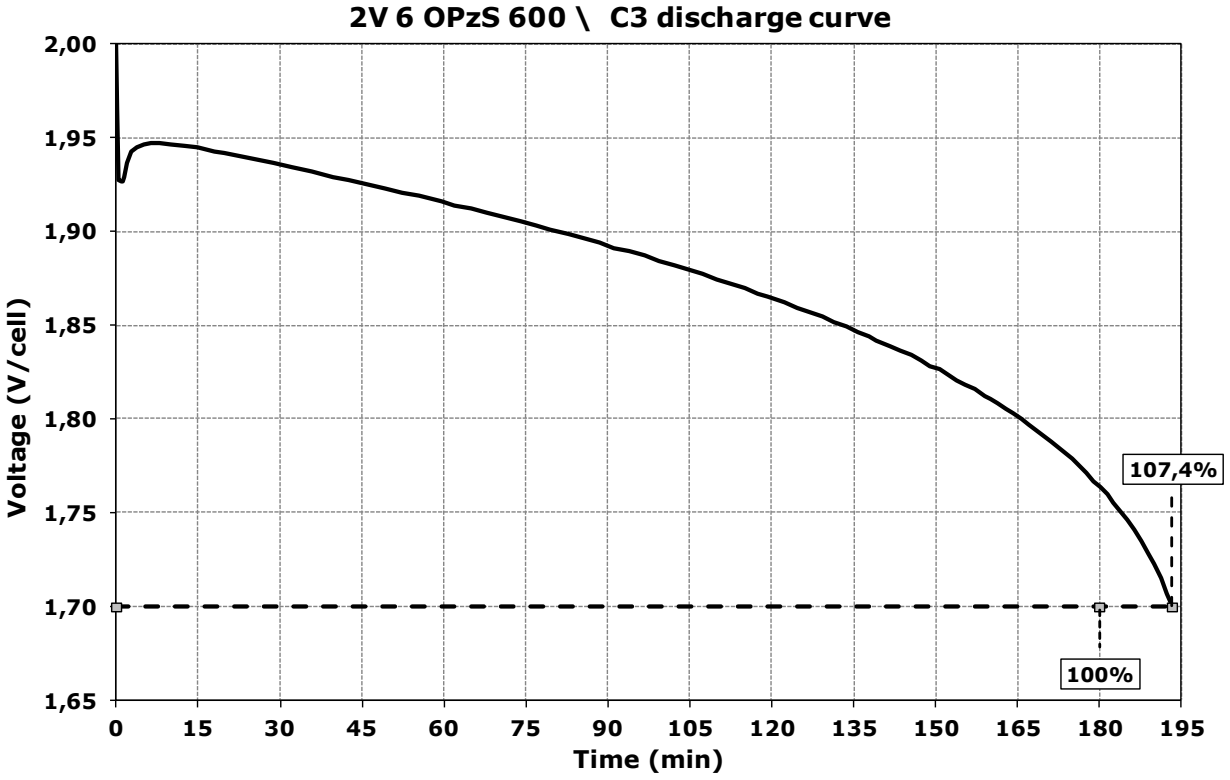

Figure 35. C3 Capacity Test

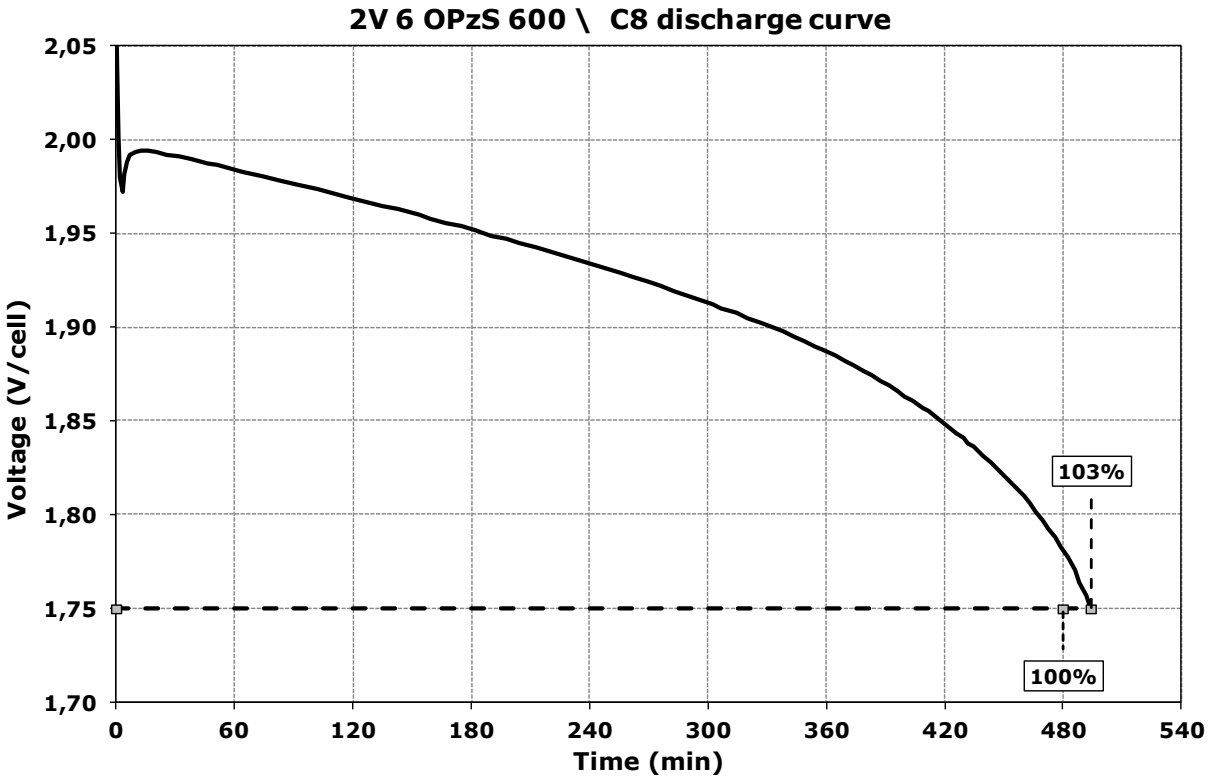

Figure 36. C8 Capacity Test

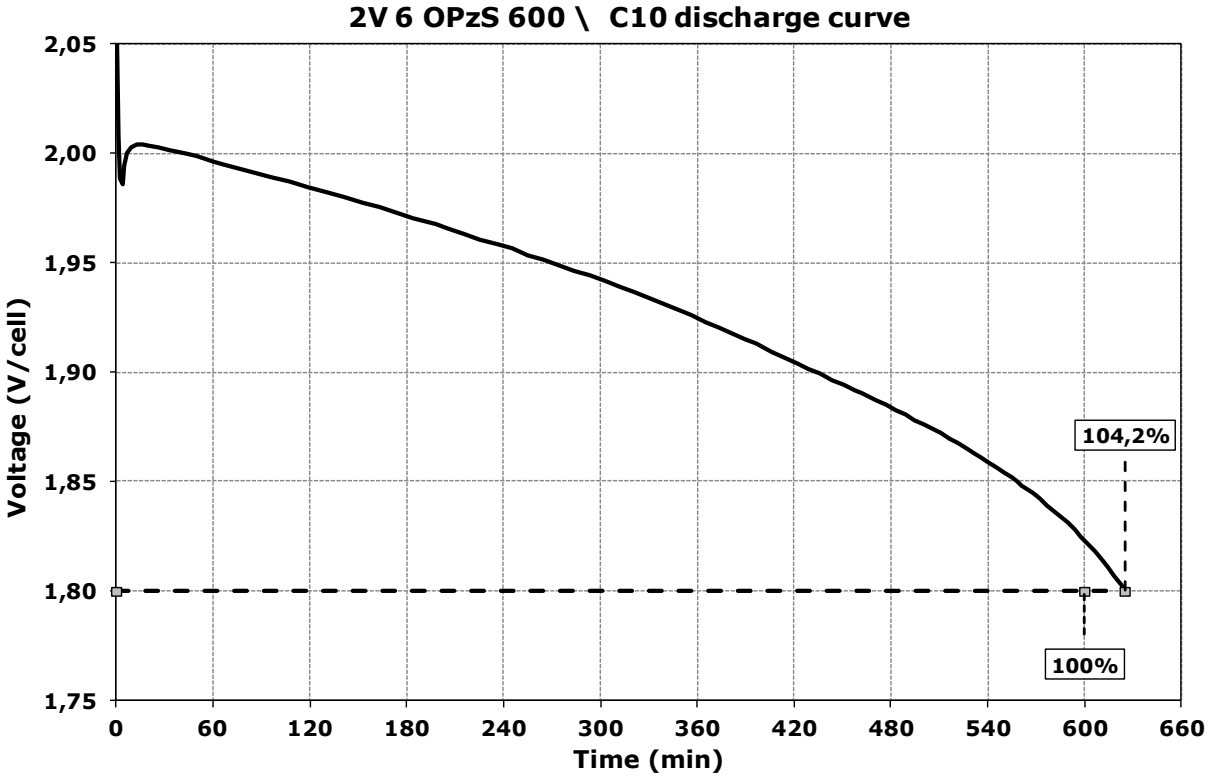

Figure 37. C10 Capacity Test

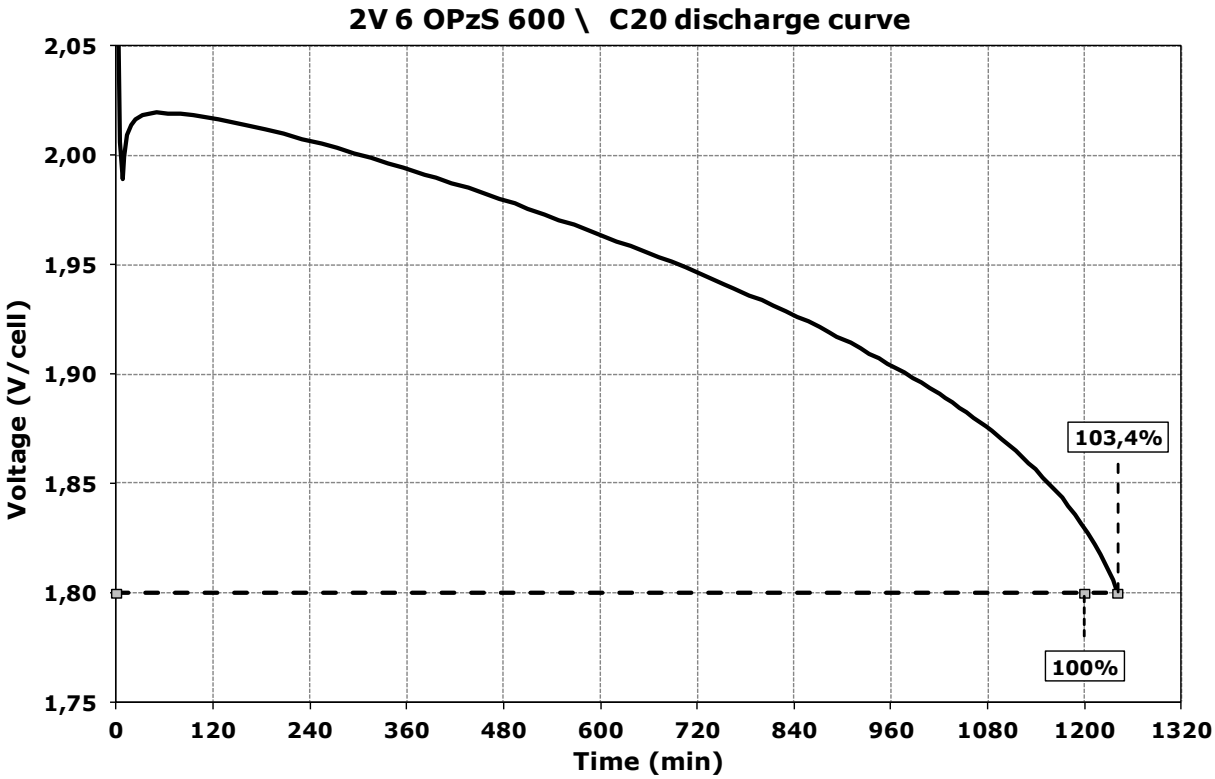

Figure 38. C20 Capacity Test

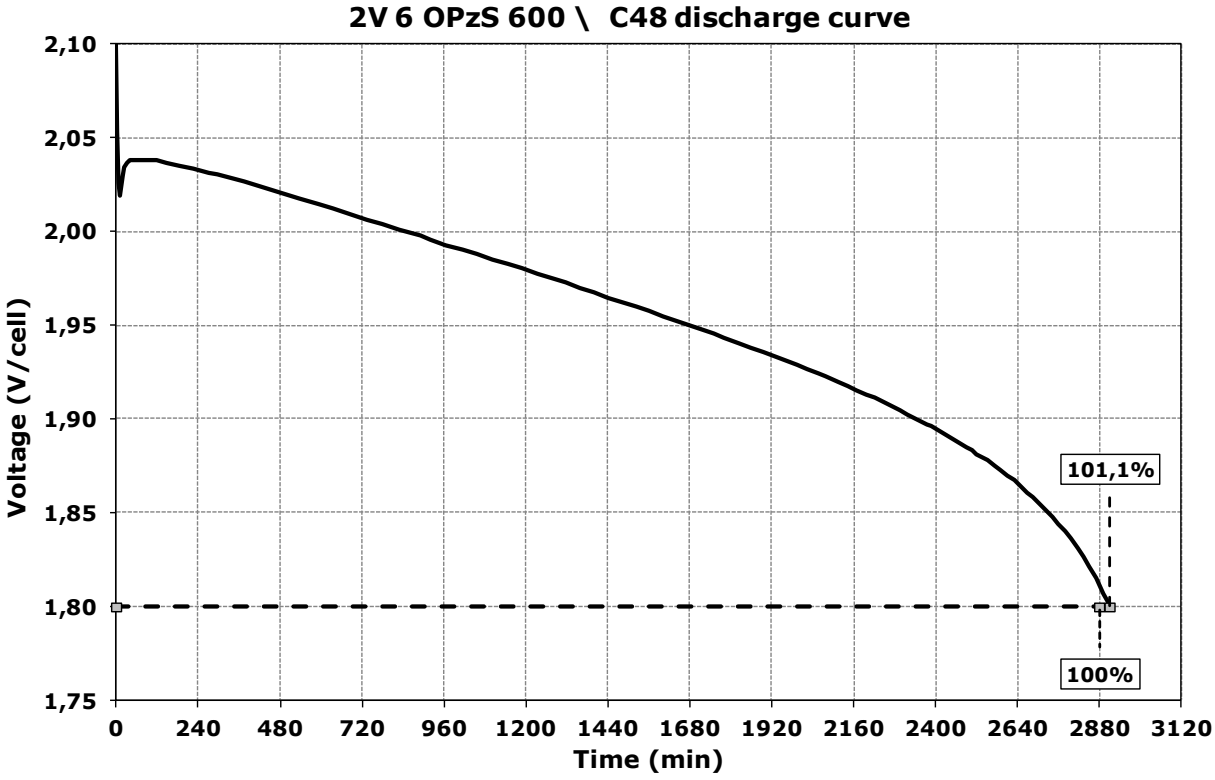

Figure 39. C48 Capacity Test

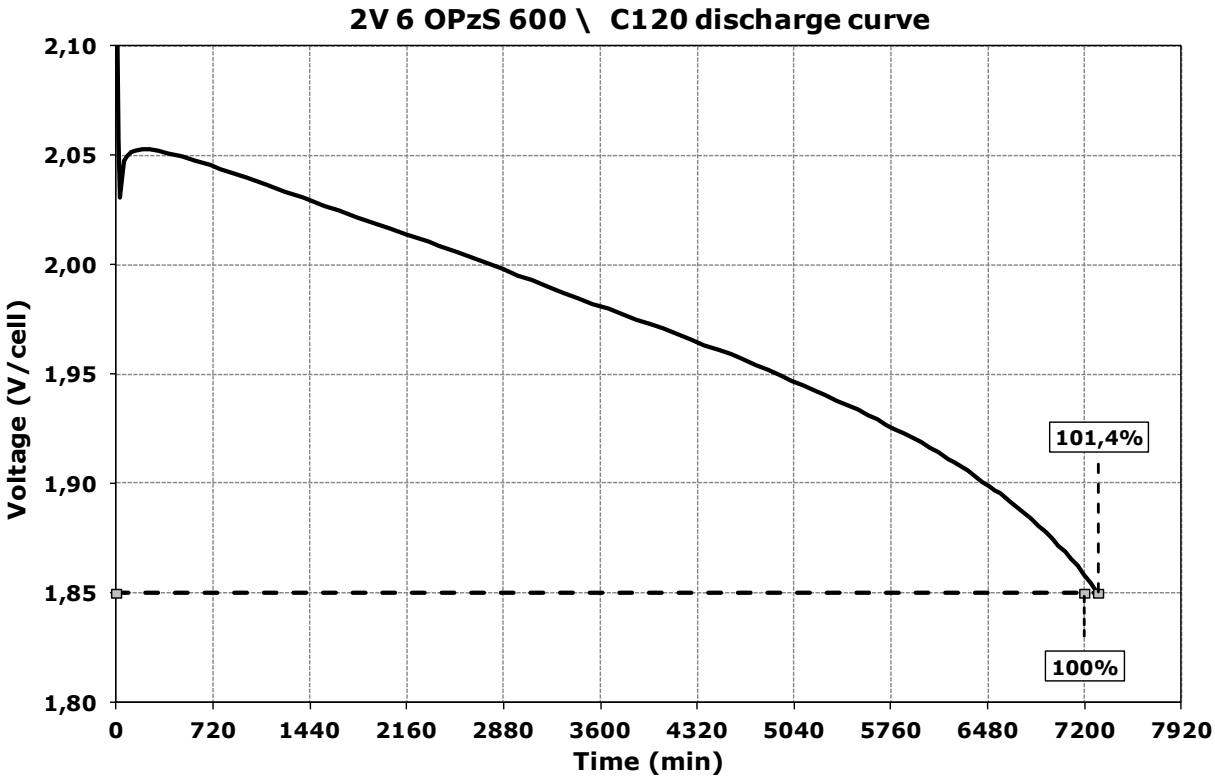

Figure 40. C120 Capacity Test

1.6 125Ah Plate.

Instruction: IEC 60896-11, clause 14

Test items: 6pcs 2V - 24 OPzS 3000

Specification: Actual Capacity Vs Rated Capacity Ca ≥ 95 % Crt at 1st cycle and Ca ≥ 100 % Crt at 5th cycle

Test Result: **Successful**

2V - 24 OPzS 3000								
Rate	C0,25	C1	C3	C8	C10	C20	C48	C120
Current (A)	2966	1861	877,7	418	336,1	194,5	92,3	38,50
Final Voltage (V)	1,6	1,6	1,7	1,75	1,8	1,8	1,8	1,85
Test Temperature (°C)	20	20	20	20	20	20	20	20
Nominal Capacity (Ah)	741,5	1861,0	2633,1	3344,0	3361,0	3890,0	4430,4	4620,0
Measured Capacity (Ah)	849,1	1928,6	2786,0	3453,9	3480,7	3979,5	4544,9	4789,2
Nominal Capacity (125 Ah Plate)	30,9	77,5	109,7	139,3	140,0	162,1	184,6	192,5
Measured Capacity (125 Ah Plate	35,38	80,36	116,08	143,91	145,03	165,81	189,37	199,55
Result (%)	**114,5%**	**103,6%**	**105,8%**	**103,3%**	**103,6%**	**102,3%**	**102,6%**	**103,7%**

Table 10 – Summary of test results for the 2V – 6 OPzS 420

Summary of test results: Tests were successful. In all the rates the following was applied Ca ≥ 95 % Crt

The measurement curves are shown below:

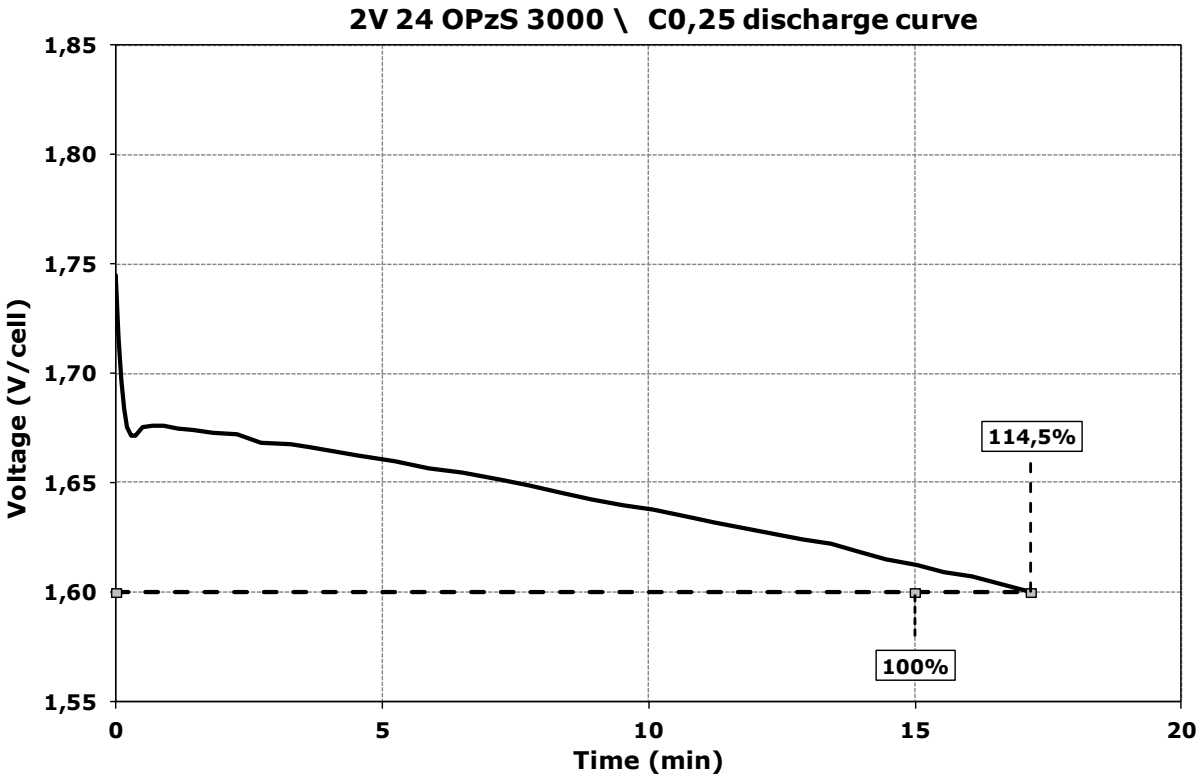

Figure 41. C0.25 Capacity Test

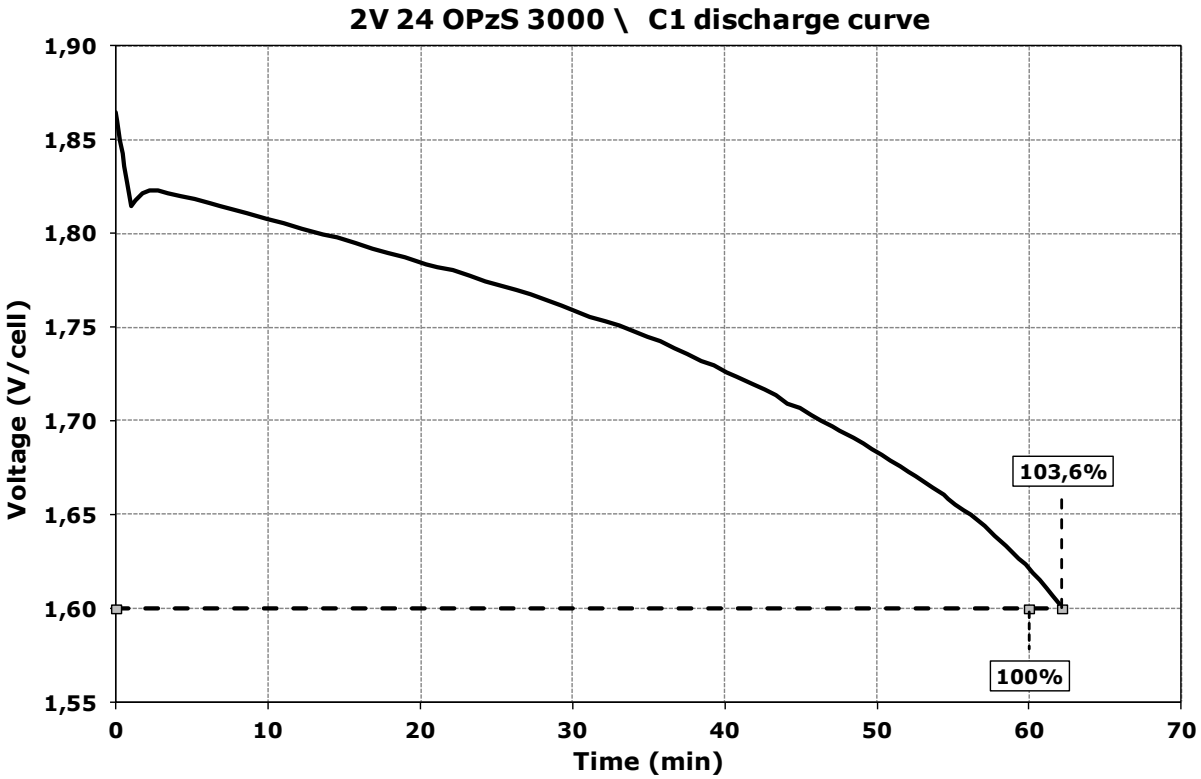

Figure 42. C1 Capacity Test

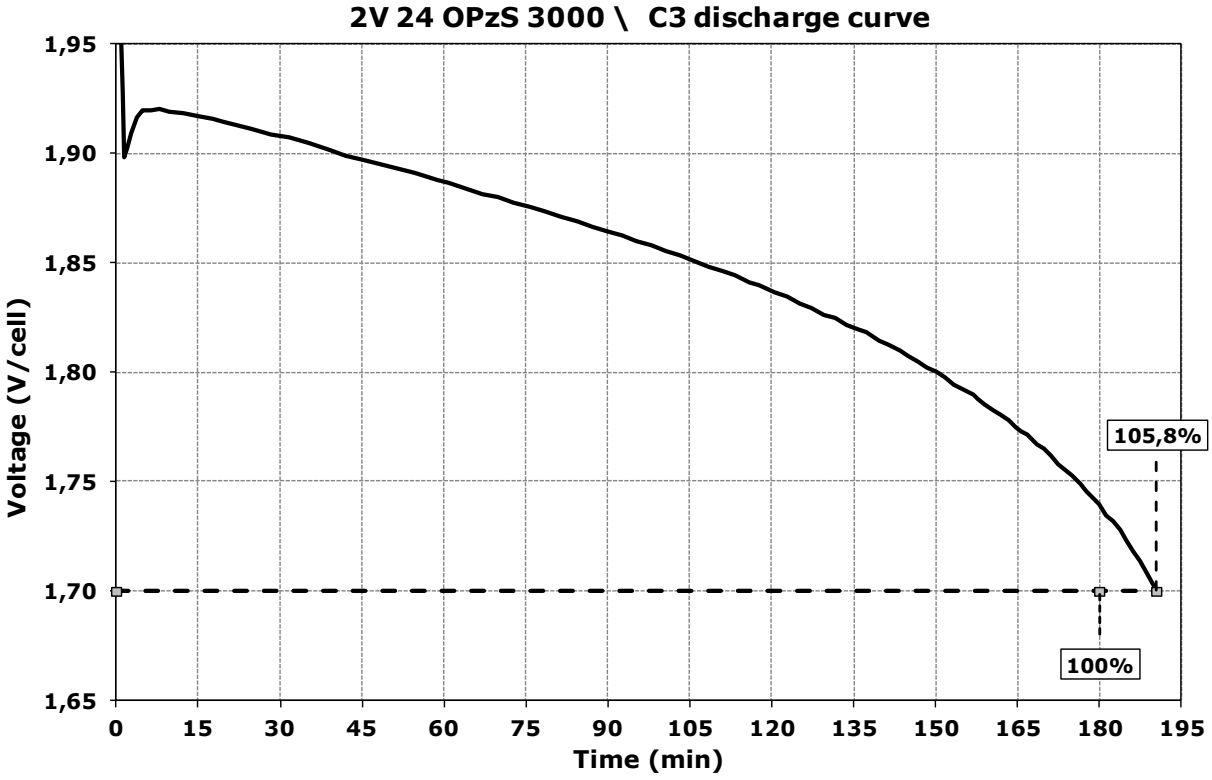

Figure 43. C3 Capacity Test

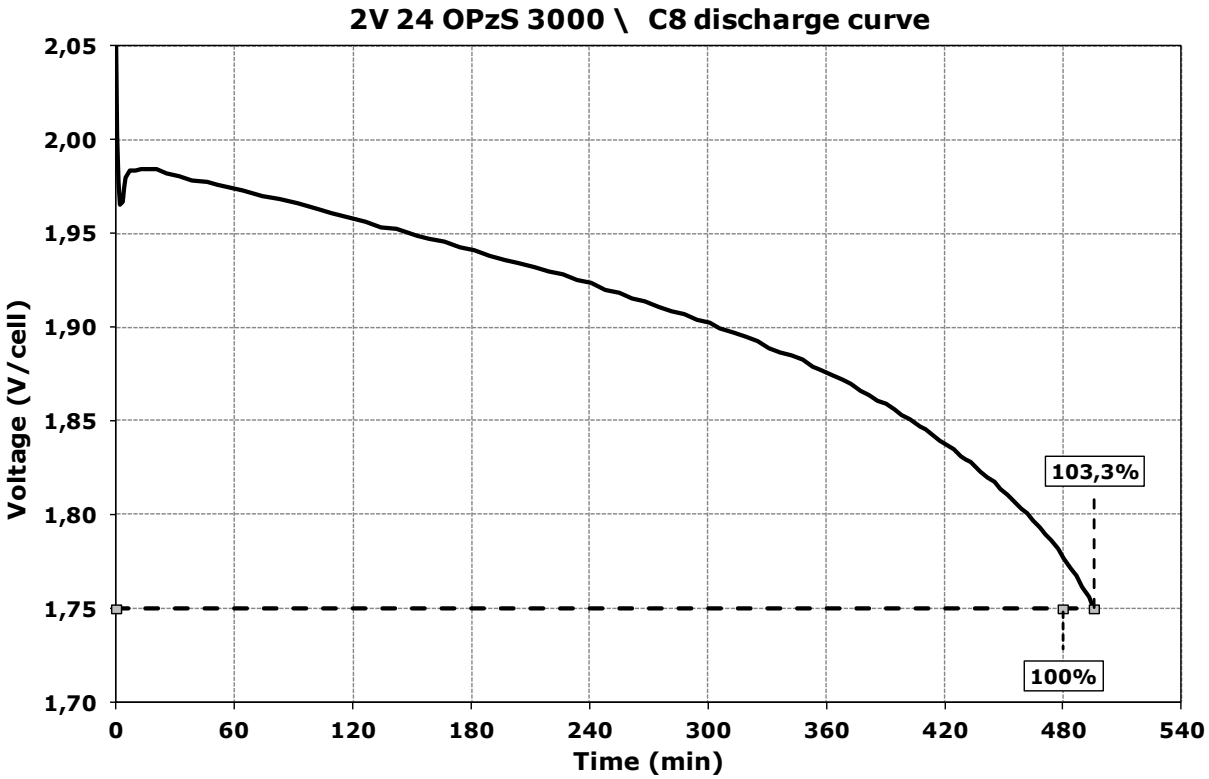

Figure 44. C8 Capacity Test

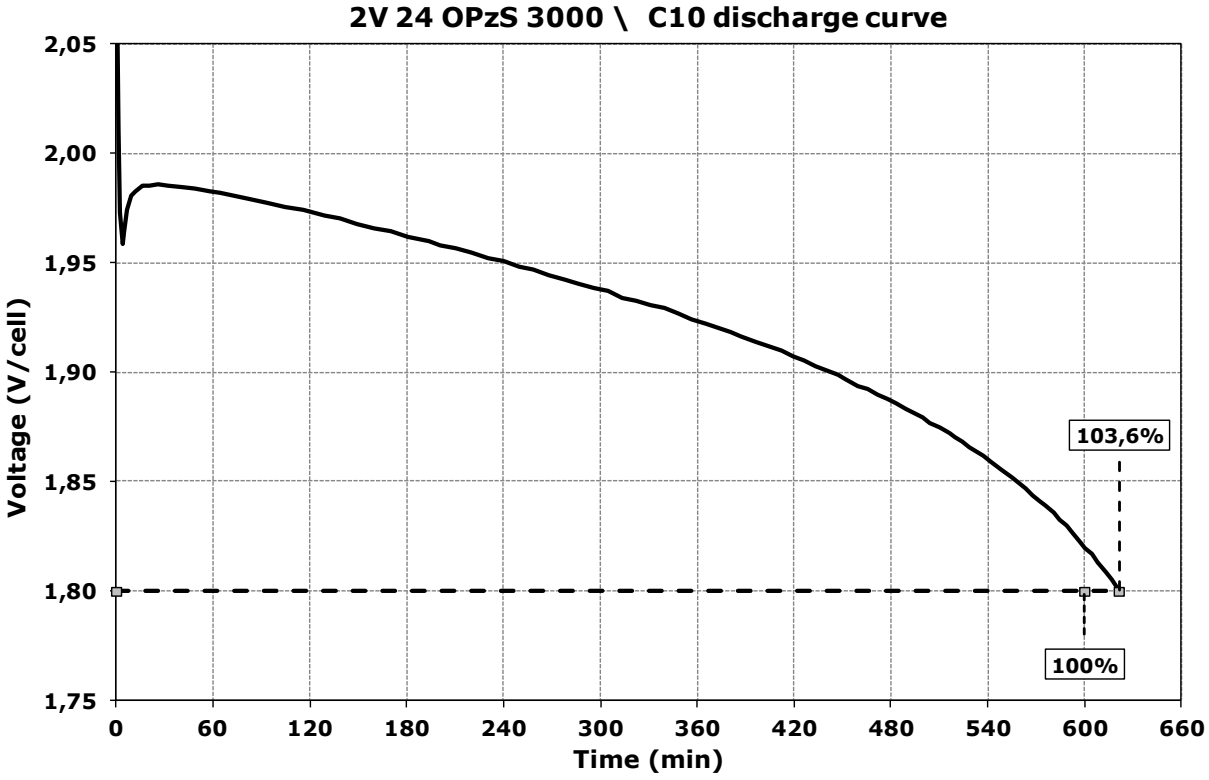

Figure 45. C10 Capacity Test

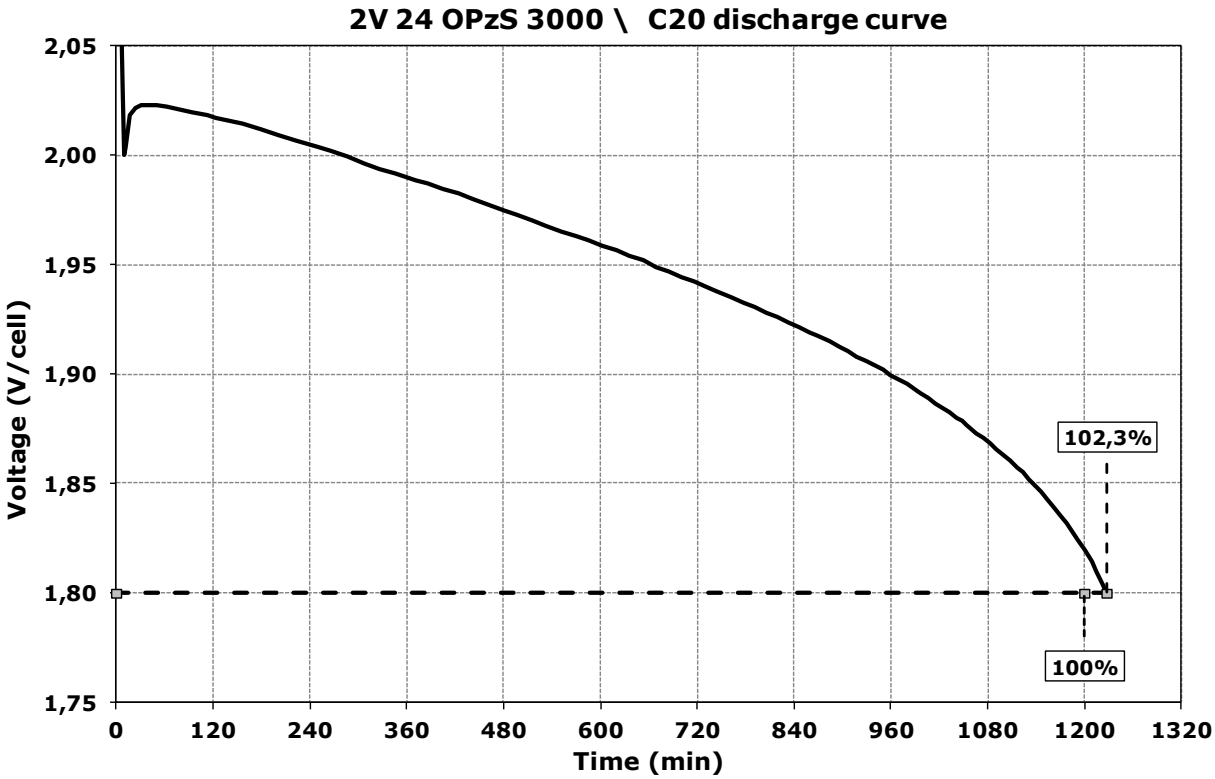

Figure 46. C20 Capacity Test

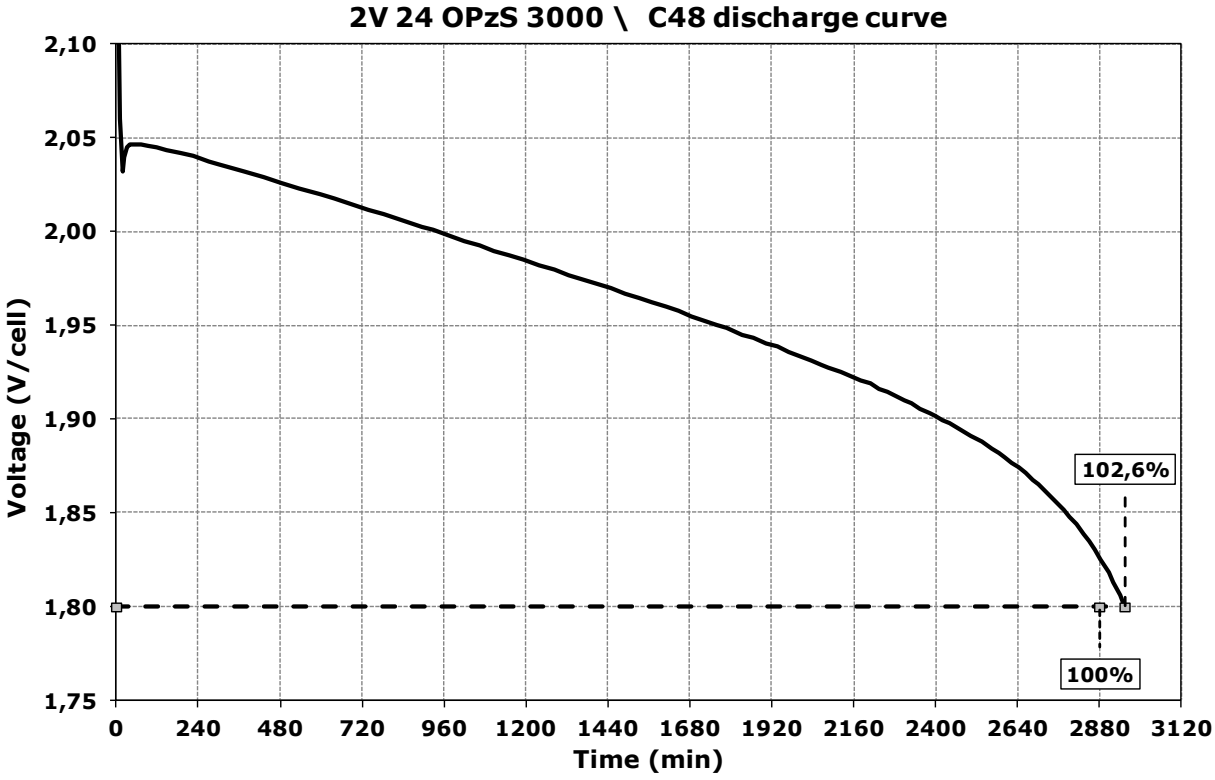

Figure 47. C48 Capacity Test

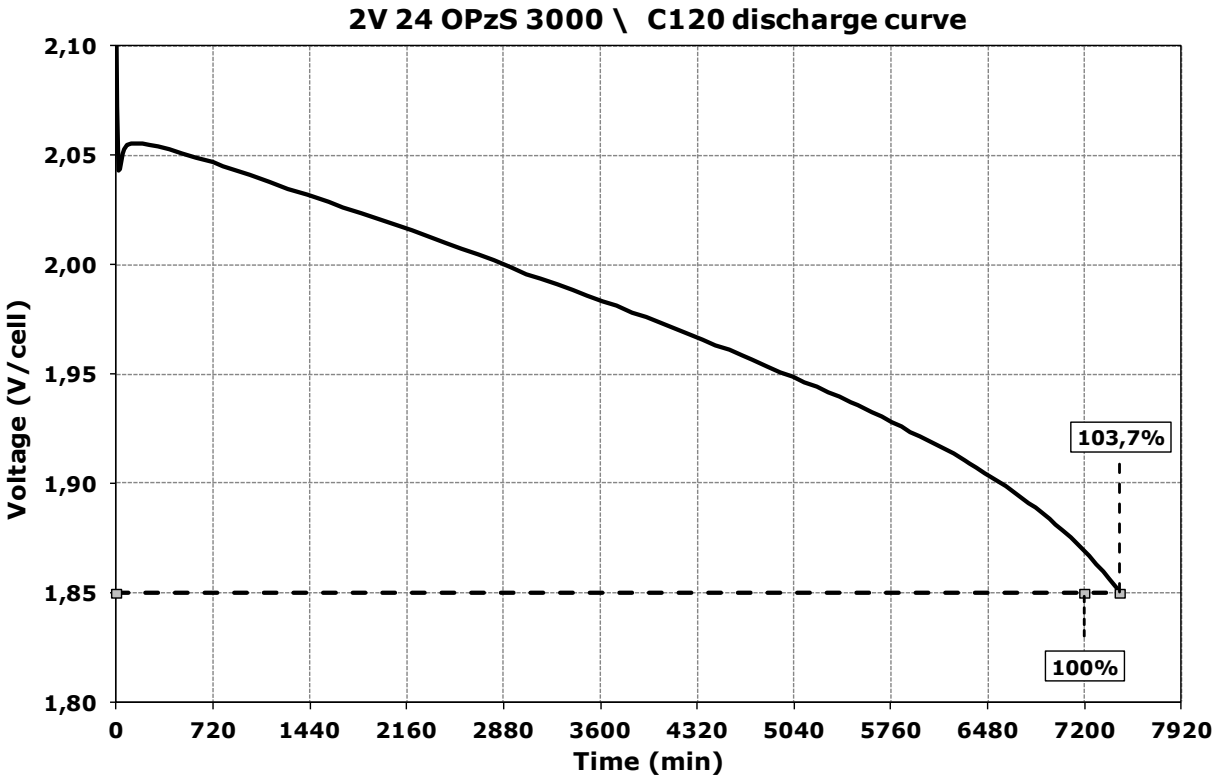

Figure 48. C120 Capacity Test

2 Short Circuit Current & DC Internal Resistance

The purpose of this test is to define prospective short-circuit value Isc and internal resistance Ri of the specific OPzS units. The short circuit current is defined by determining two data pairs in the following way:

a. First data pair (Ua, Ia)

After 20 s of discharge at the current Ia = 4 x I10, the voltage and current shall be recorded to give the first data pair. The current shall be interrupted after 25 s maximum and, without recharge and after an open circuit stand of 5 min, the second data pair shall be determined.

b. Second data pairs (Ub, Ib)

After 5 s of discharge at the current Ib = 20 × I10, the voltage and current shall be recorded to give the second data pair.

Instruction: IEC 60896-11, clause 6.3

Test items: 3pcs 2V - 5 OPzS 250, 3pcs 12V - 2 OPzS 100, 3pcs 6V - 6 OPzS 300, 3pcs 2V - 6 OPzS 420, 3pcs 2V - 6OPzS600 & 3pcs 2V - 24 OPzS 3000

Specification: values must be ±10 % of the specification values

Temperature: 20°C

Test Result: **Successful**

The results are shown on the table below:

Cell type	Cnom (Ah) DIN values	I1 (A)	I2 (A)	U1 at 20sec (V)	U2 at 5sec (V)	Ri-test (mΩ)	Isc-test (A)	Ri-spec ±10% (mΩ)	Isc-spec ±10% (A)	Ri-test Vs. spec	Isc-test Vs. spec
2V 5 OPzS 250	250	100	500	1,957	1,710	0,618	3269	0,671	3000	92,0%	109,0%
2V 6 OPzS 420	420	168	840	1,943	1,620	0,481	4210	0,518	3900	92,9%	108,0%
2V 6 OPzS 600	600	240	1200	1,911	1,501	0,427	4715	0,447	4500	95,7%	104,8%
2V 24 OPzS 3000	3000	1200	6000	1,882	1,385	0,104	19376	0,108	18800	96,3%	103,1%
12V 2 OPzS 100	100	40	200	11,67	10,23	9,03	1332	9,679	1260	93,3%	105,7%
6V 6 OPzS 300	300	120	600	5,775	4,865	1,90	3166	2,000	3040	94,8%	104,1%

Table 11 – Rint & Isc Results

3 Charge Retention during Storage

The purpose of this requirement is to show the residual dischargeable capacity Cr after storage on open circuit under defined conditions of temperature and time.

Instruction: IEC 60896-11, clause 18

Test items: 6pcs 2V - 6 OPzS 420

Result: **Successful. Capacity reduction is less than 2,5% per month**

Test procedure: After having undergone the initial capacity test (Ca1), the battery is fully recharged, thoroughly cleaned and then is being stored on open circuit at an average cell temperature of 20 °C ± 2 °C for a period of 90 days. During that time, the maximum cell temperature does not exceed +25 °C and the minimum temperature is not less than +15 °C. At the end of the open circuit storage the residual capacity is determined.

Results:

Cell type	2V 6 OPzS 420
Test samples	6 cells
Discharge rate	C10
Rated capacity (Cr)	420 Ah
Rated current (Ir)	42 A
Cut off voltage (Uf)	1,80 Vpc

	initial	residual
Test initial temper. (To)	19 oC	20 oC
Average test current (I)	42 A	42 A
Discharge time (t)	705 min	665 min
Test capacity (C)	494 Ah	466 Ah
Capacity at 20°C	496 Ah	466 Ah
Capacity at 20°C %	**118,2%**	**110,8%**
Capacity reduction in 3 months %	**7,38%**	
Capacity reduction per month %	**2,46%**	

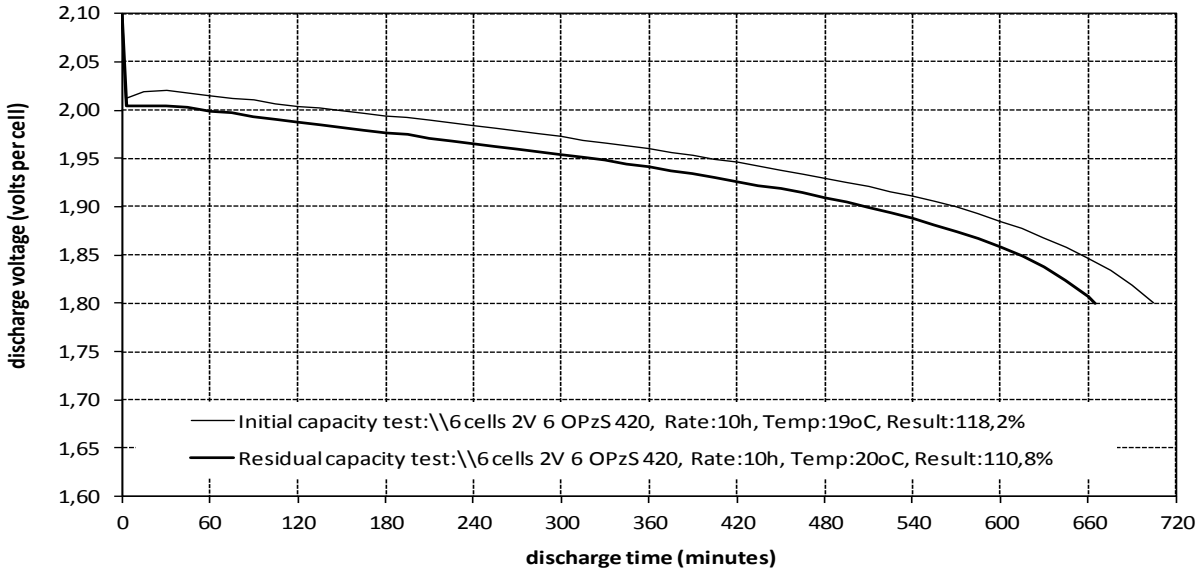

Figure 49. Capacity test before and after the storage period

4 Cycle life test (Endurance in Discharge – Charge Cycles)

The purpose of the test is to measure the endurance in discharge-charge cycles for applications where frequent discharges of the battery are to be encountered due either to a deliberate choice of operational or to frequent power-line outages.

Instruction: IEC 60896-11, clause 16

Test items: 6pcs, 2V – 6 OPzS 420

Test Result: **1520 cycles to reach 80% C10**

Test procedure: The test was performed under the following profile:

a. Capacity test settings: 10h rate at 1.80V/c according DIN capacity and current values (C10=420Ah, I10=42A). Capacity is implemented after an equalizing charge
b. Discharge cycling settings: Discharge with 2.0 x I10 for 3 hours. This current corresponds to ~4h discharge DIN rate. The 3h discharge out of 4h nominal yields 75% DoD for each cycle.
c. Recharge the battery for 21h at 2.40 ± 0.01 V/cell
d. Nominal electrolyte density is 1.240 ± 0.010 gr/ml at 20°C
e. Nominal single cell voltage deviation is -50 to +100mV from the average battery voltage
f. During test, the electrolyte temperature is 25± 5 °C

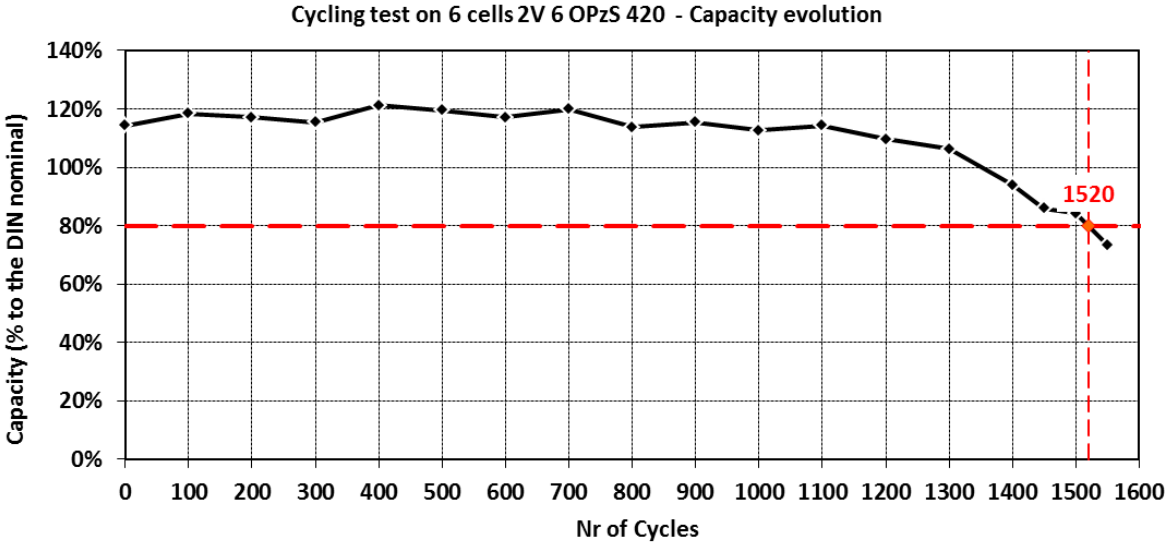

Figure 50. Capacity Vs Cycles

5 Suitability for Floating Operations

The purpose of the test is to check the suitability of the cells or batteries in this operation.
A battery in floating operation has a constant voltage, permanently applied to its terminal which is sufficient to maintain it in a state close to full charge and is intended to supply a circuit whose normal power supply may fail.

Test items: 6pcs, 2V – 6 OPzS 420

Test Result: **Successful. The cells retained their capacity, voltage and density values within nominal range without water loss**

Test procedure: The cells are kept at an ambient temperature close to 20 °C. The upper surface of the cells (lids) was kept clean and dry throughout the test. The cells were submitted to a permanent floating charge at a voltage 2.23Vpc. After intervals of three months, the voltage and the electrolyte density of each cell and the level of the electrolyte were measured and noted. After six months of battery floating operation, the cells were subjected to a capacity test at 10h DIN rate. The following rules and settings have been observed:

- Nominal floating voltage for the battery is 2.23 ± 1% V/cell
- Nominal electrolyte density is 1.240 ± 0.010 gr/ml at 20°C
- Nominal single cell voltage deviation is -50 to +100 mV from the average battery voltage
- During test, the electrolyte temperature is 20± 5 °C

Results:

Densities (gr/ml at 20°C)										Variation from average	
cell	1	2	3	4	5	6	Average	Minimum	Maximum	to Minimum	to Maximum
initial	1,240	1,239	1,240	1,240	1,239	1,239	1,240	1,239	1,24	0,000	0,000
at 3 months	1,242	1,24	1,242	1,243	1,241	1,241	1,242	1,24	1,243	-0,002	0,002
at 6 months	1,243	1,241	1,242	1,244	1,242	1,244	1,242	1,241	1,244	-0,001	0,002
Conclusion: Densities remain within nominal values											

Float voltage (Volts)										Variation from average	
cell	1	2	3	4	5	6	Average	Minimum	Maximum	to Minimum	to Maximum
initial	2,205	2,251	2,265	2,258	2,21	2,201	2,232	2,201	2,265	-0,031	0,033
at 3 months	2,212	2,236	2,262	2,251	2,212	2,205	2,230	2,205	2,262	-0,025	0,032
at 6 months	2,221	2,235	2,254	2,246	2,222	2,221	2,233	2,221	2,254	-0,012	0,021
Conclusion: Float voltages remain within nominal values											

Water consumption (mm from MAX level)										Variation from average	
cell	1	2	3	4	5	6	Average	Minimum	Maximum	to Minimum	to Maximum
initial	MAX	MAX	MAX	MAX	MAX	MAX	MAX	MAX	MAX	not detected	not detected
at 3 months	MAX	MAX	MAX	MAX	MAX	MAX	MAX	MAX	MAX	not detected	not detected
at 6 months	MAX	MAX	MAX	MAX	MAX	MAX	MAX	MAX	MAX	not detected	not detected
Conclusion: No water loss was detected within 6 months											

Cell type	2V 2 OPzS 250
Test samples	6 cells
Discharge rate	C10
Rated capacity (Cr)	250 Ah
Rated current (Ir)	25 A
Cut off voltage (Uf)	1,80 Vpc

	initial	after 6 months
Test initial temper. (T)	21 oC	19 oC
Average test current (I)	42 A	42 A
Discharge time (t)	658 min	667 min
Test capacity (C)	274 Ah	278 Ah
Capacity at 20°C	273 Ah	280 Ah
Capacity at 20°C %	**109,0%**	**111,8%**
Capacity difference %	**2,8%**	

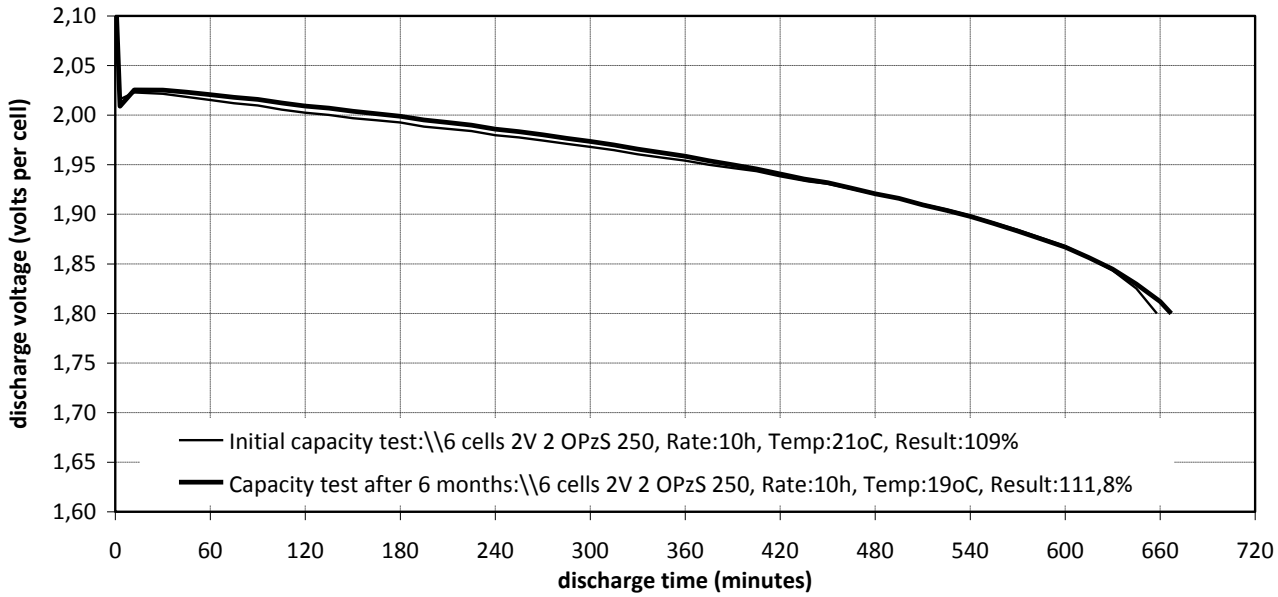

Figure 51. Capacity test before and after the floating period

6 Service Life Test (at 60 °C)

The purpose of the test is to define the expected lifetime of the battery under normal service conditions (floating voltage of 2.23 V/c and temperature 20 °C).

The parameter that is used to accelerate the test is the temperature. The batteries are subjected to the normal floating voltage but at a much higher temperature (60 °C).

The acceleration factor to extrapolate the service life at 20°C from the achieved duration at 60°C is the value that corresponds to the halving of the lifetime for every 9°K temperature rise.

$F_{(60vs20)} = 2^{[(60-20)/9]} = 21.77$ times

LifeTime at 20°C = LifeTime at 60°C x 21.77

Test items: 6pcs, 2V – 6 OPzS 420

Test Result: **Days at 60°C: 472.8**

Equivalent Service Life at 20°C: 28.2 years

Test procedure: The batteries are subjected to the test conditions for periods of 30 days each. After the end of each period a discharge test was applied in order to measure the available capacity under the following conditions:

a. 10h capacity test at 1.80V/cell at 20°C (DIN values)
b. Full charge before and after a capacity test
c. The end-of-test criteria is the capacity drop below 80% of the DIN nominal value

Results - 6 cells 6 OPzS 420

Days at 60°C achieved: 472.8 days

Equivalent service life at 20°C: 28.2 years

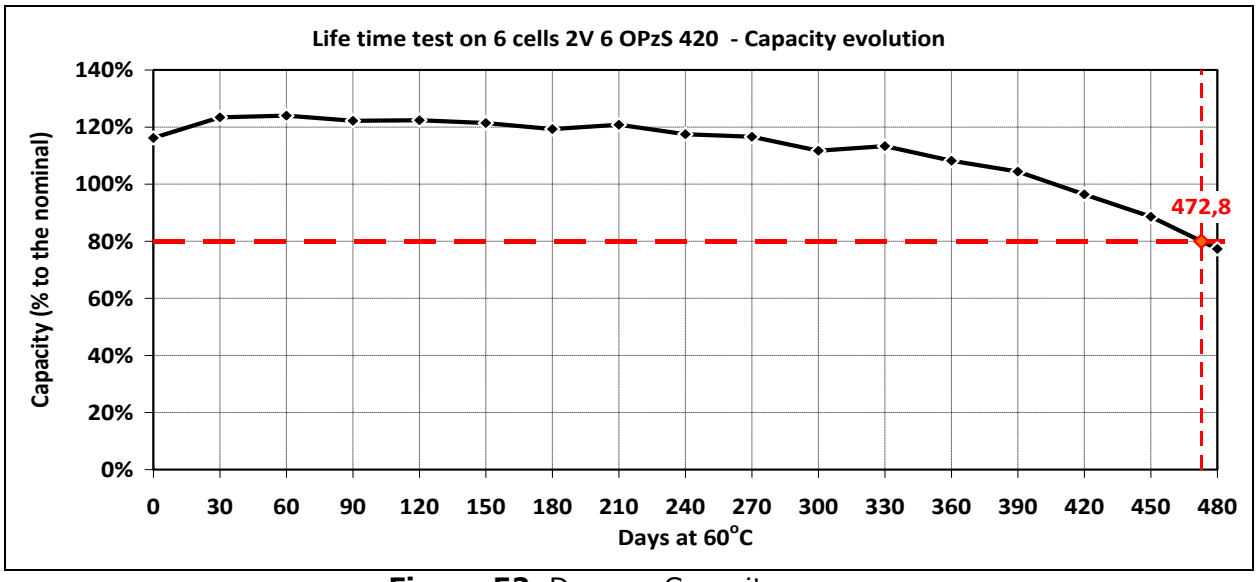

Figure 52. Days vs Capacity