

Battery Module

The battery module has been extensively tested to verify its behaviour both in charge and discharge mode. To be noted that both weight and physical size of the module prototype under testing are well within the expected targets (see Table 1):

- Weight: 27.5 kg
- Dimensions: 206 x 476 x 176 mm

Moreover the tests are intended to verify the coherence and accuracy of the voltage, current and temperature sensors located in the module and managed by the module BMS with respect to external test measurements.

To be noted that the module does not have any cooling except for its natural convection inside the climatic chamber.

		Element	Module	Pack
Nominal voltage	V	3,7	37	333
Upper limit voltage	V	4,15	41,5	373,5
Lower limit voltage	V	2,7	27	243
Nominal capacity	Ah	94	94	94
Specific capacity	Ah/kg	46	3	0
Nominal energy	kWh	0,35	3,48	31,30
Specific energy	Wh/kg	168,83	126,01	106,69
Continuous discharge current	A	188	188	188
Continuous discharge power	kW	0,70	6,96	62,60
Specific discharge power	W/kg	337,67	252,03	213,37
Max discharge current (5 s)	A	282	282	282
Max discharge power	kW	1,04	10,43	93,91
Continuous charge current	A	47	47	47
Continuous charge power	kW	0,17	1,74	15,65
Max charge current (5 s)	A	188	188	188
Max charge power	kW	0,70	6,96	62,60
Life cycle	#	4000		
Curb weight	kg	2,06	20,6	248,4
Structure weight	kg	0	7	45
Total weight	kg	2,06	27,6	293,4
Height	mm	125	175	205
Width	mm	173	201	
Thickness	mm	45	486	
Volume	l	0,97	17,10	
Series	---	90	10	9
Parallel	---	1	1	1

Note	---	All values @25 °C AND SoC 50%	
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Table 1: From single cell to module assembly to complete battery pack.

Testing Set-up

The module under testing has been located into a climatic chamber (Angelantoni 600 TL) that will also provide safety protection in case of cell failures (see Figure 12). The testing temperature for all test has been set at 25°C.



The module is electrically coupled to Arbin EVTS-X charge-discharge cycling equipment capable of bidirectional 200 A currents with 400 mA and 300 mV accuracy.

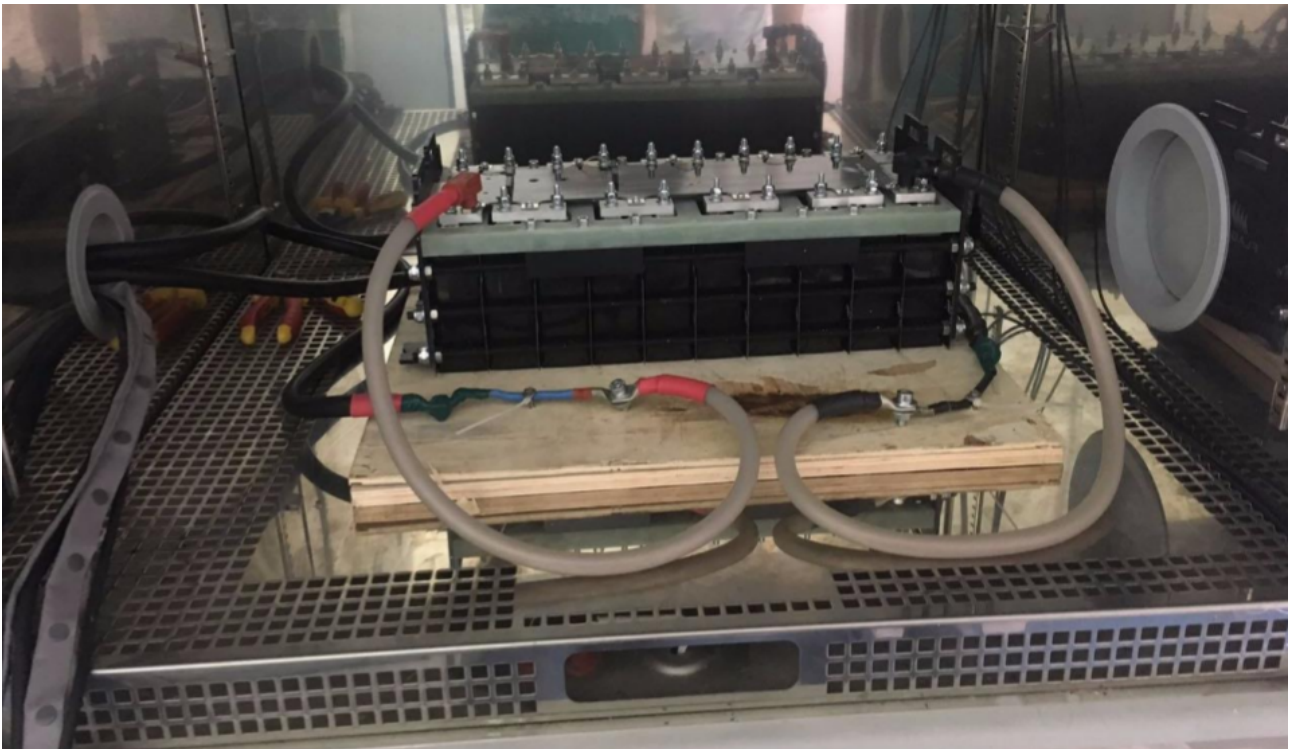


Figure 12: Battery module under test located into the climatic chamber set @25°C.

A temperature sensor has been located on the module side (directly on a cell wall) to be used as reference for the module self-heating under different charging and discharging conditions (see Figure 13) with respect to BMS integrated temperature and cell voltage sensors (see Figure 14).



Figure 13: Location of external reference temperature sensor.

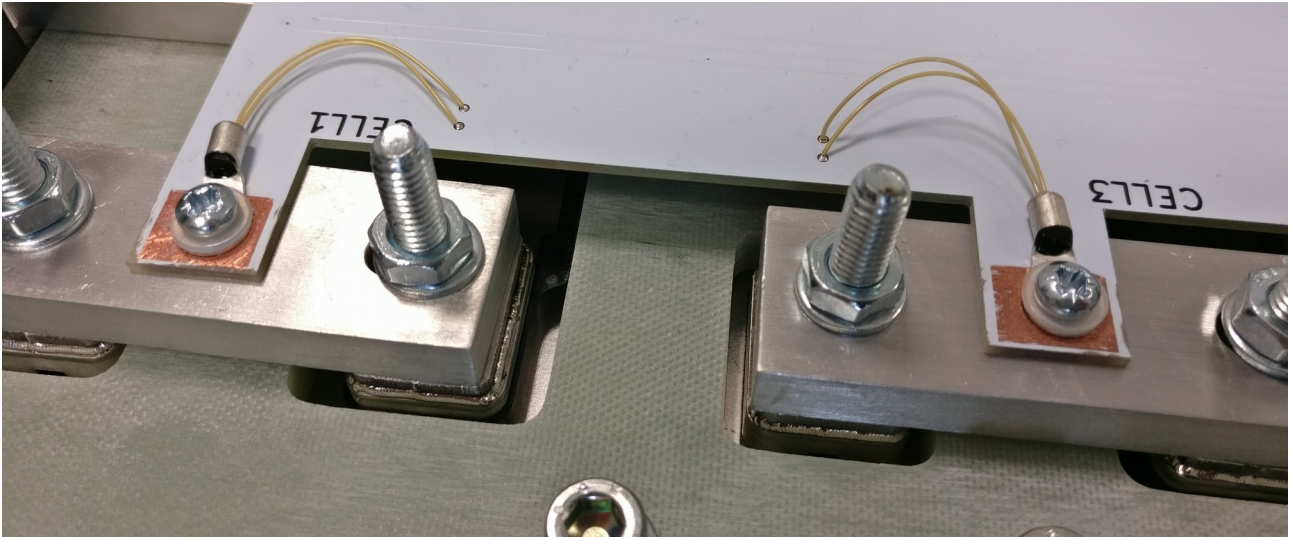


Figure 14: Detail of BMS integrated temperature sensors (one every two cells).

Testing Objective

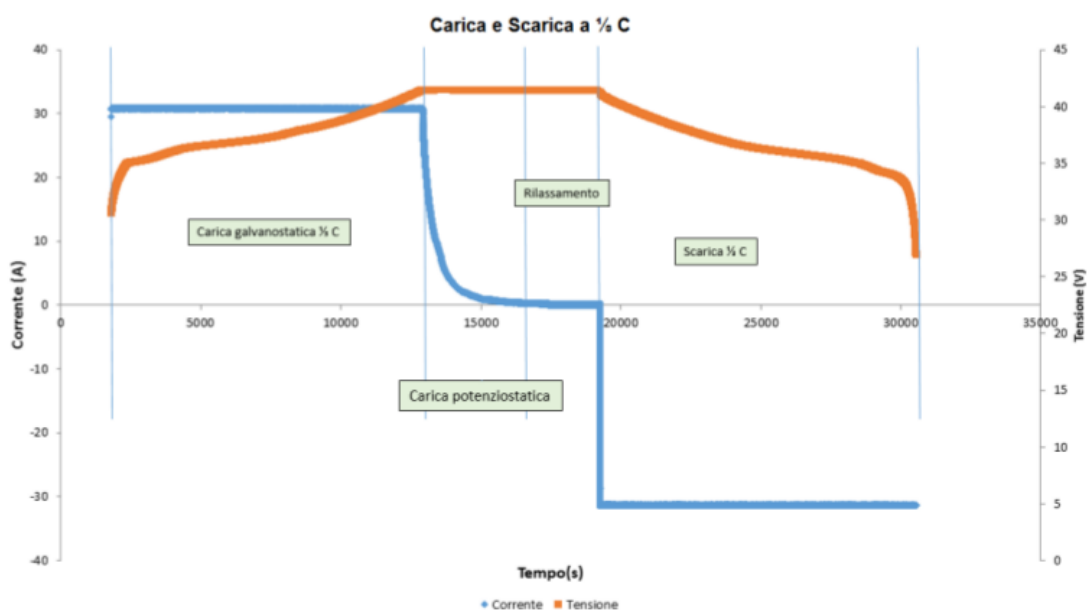
The main goal of the module testing activity is to check the behaviour of the module under different charging and discharging conditions within the cell specified “continuous operation conditions” @ 25 °C:

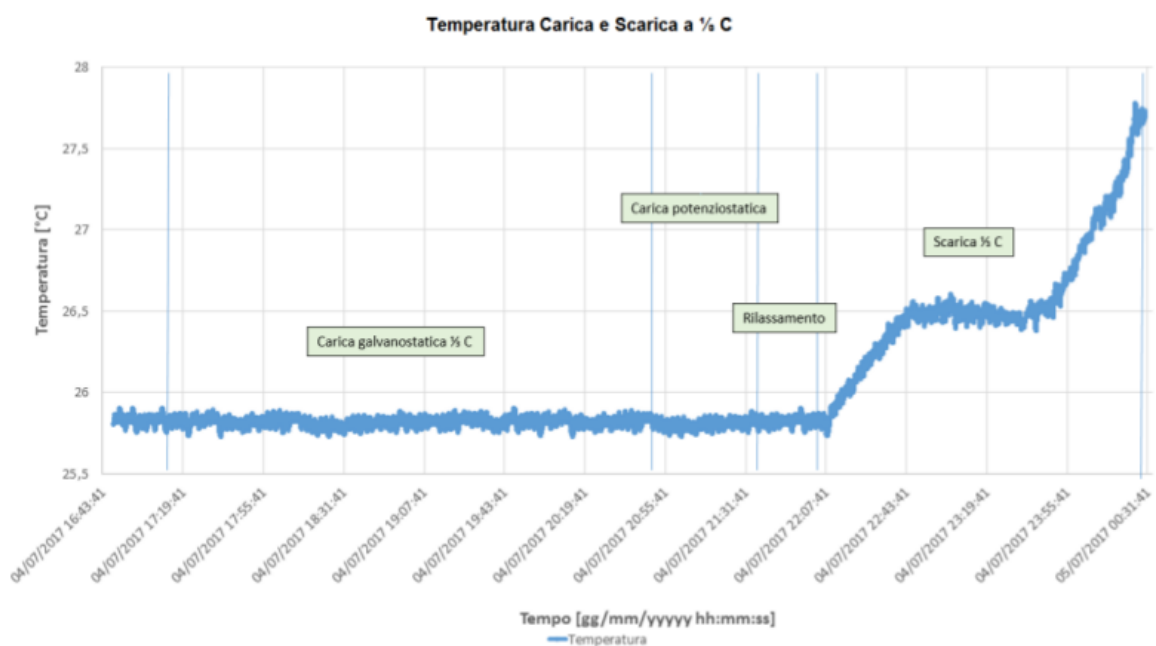
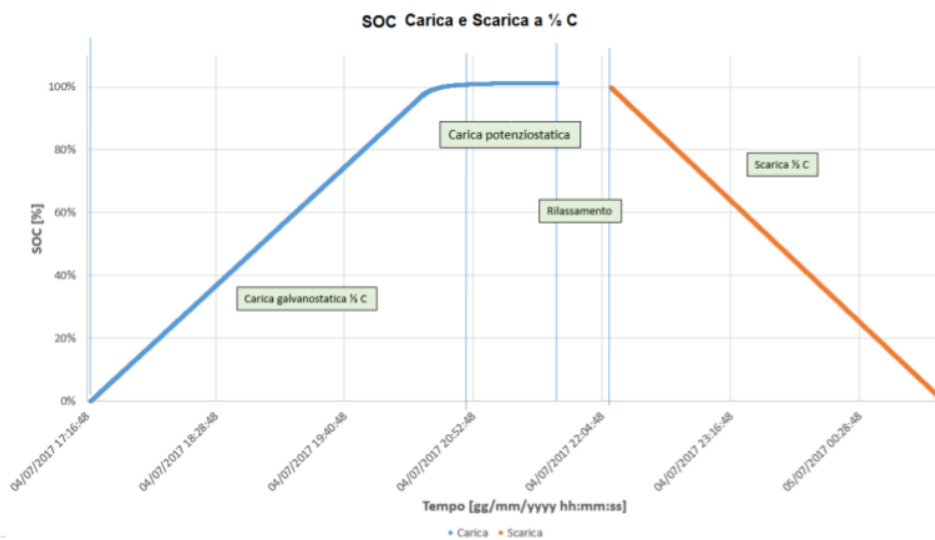
- 0.5 C charge (47 A),
- 2 C discharge (180 A).

To be noted that more demanding operating condition both at low temperature (down to -40 °C) and high temperature (up to 60 °C), and peak charging (270 A) and discharging (413 A) currents were out of the scope of the present testing.

Full “slow” 1/3 C Charge and 1/3 C Discharge

Carica e Scarica a $\frac{1}{3}$ C					
Step		Parametri		Criteri di Stop	
				Condizione	Tempo [s]
1	Climatizzazione di cella a 25 °C	Tambiente=25°C	C-Rate	$T_{\text{finale_celle}}=25\text{ °C}$	(*)
2	Fase di riposo	$I = 0\text{ A}$	-	$t > 30\text{ min}$	1800
3	Carica galvanostatica	$I=31\text{ A}$	$\frac{1}{3}\text{ C}$	$V > 41.5\text{ V}$ (4.15 V per cella)	11124
4	Carica Potenziostatica	$V= 41.5\text{ A}$	-	$I_{\text{carica}} < 0.1\text{ A}$ (4.15 V per cella)	4530
5	Fase di riposo	$I = 0\text{ A}$	-	$t > 30\text{ min}$	1800
6	Scarica	$I= - 31\text{ A}$	$-\frac{1}{3}\text{ C}$	$V_{\text{cut-off}} < 27\text{ V}$ (2.7 V per cella)	11284
7	Fase di riposo	$I = 0\text{ A}$	-	$t > 30\text{ min}$	1800

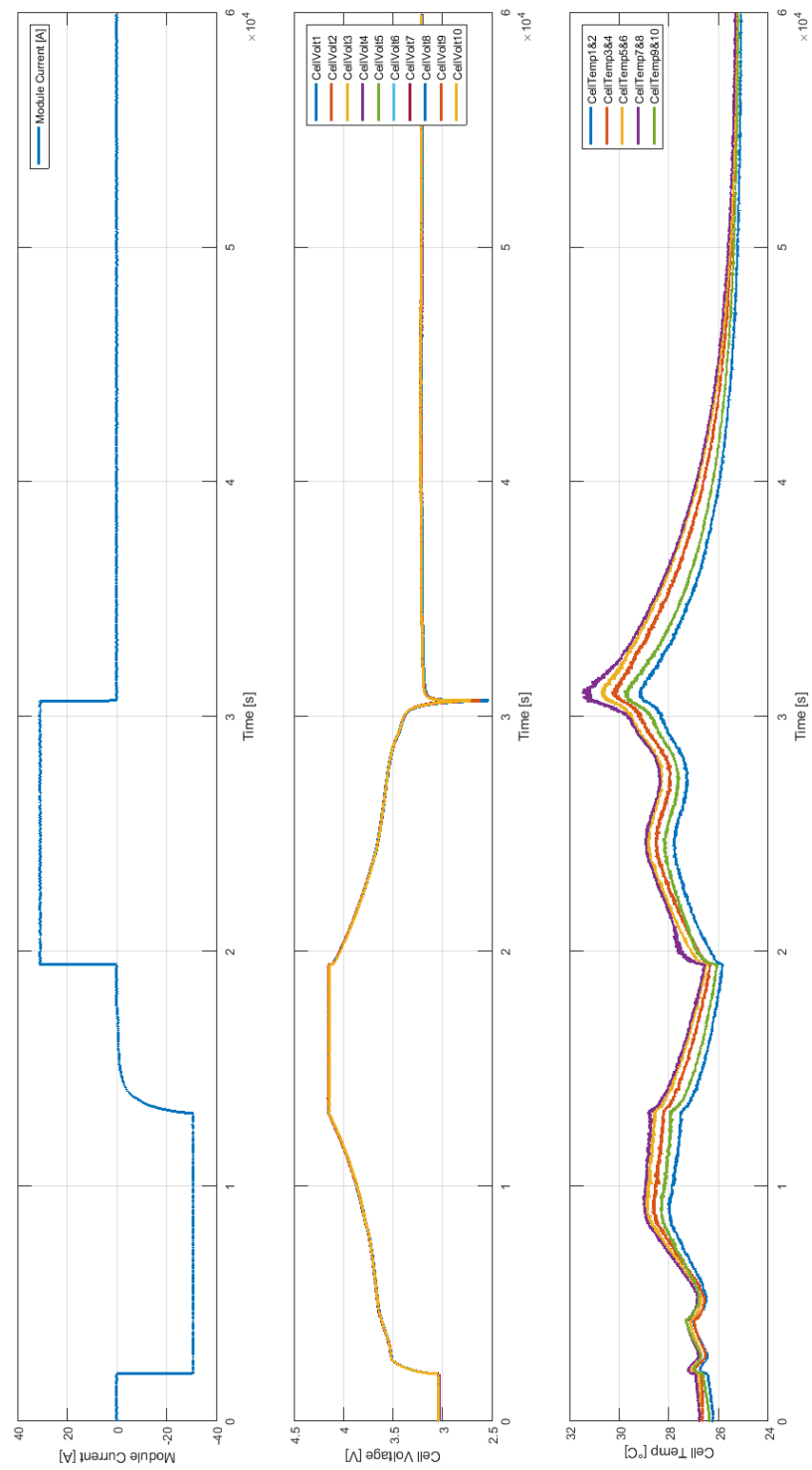




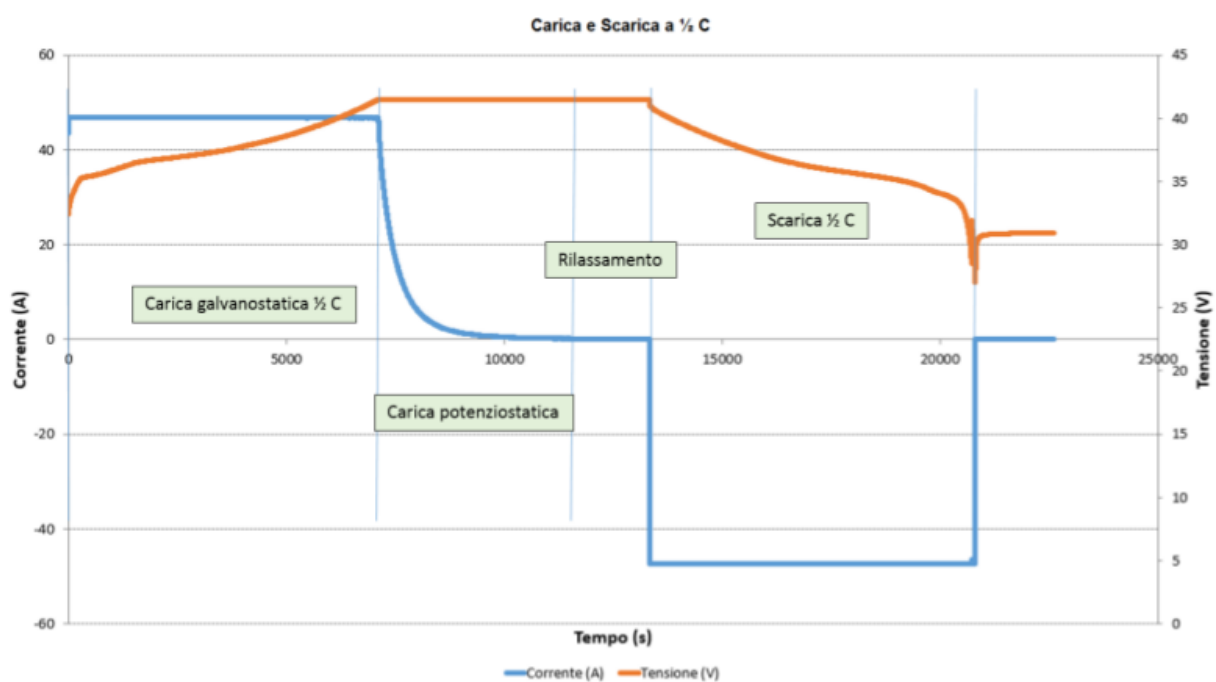
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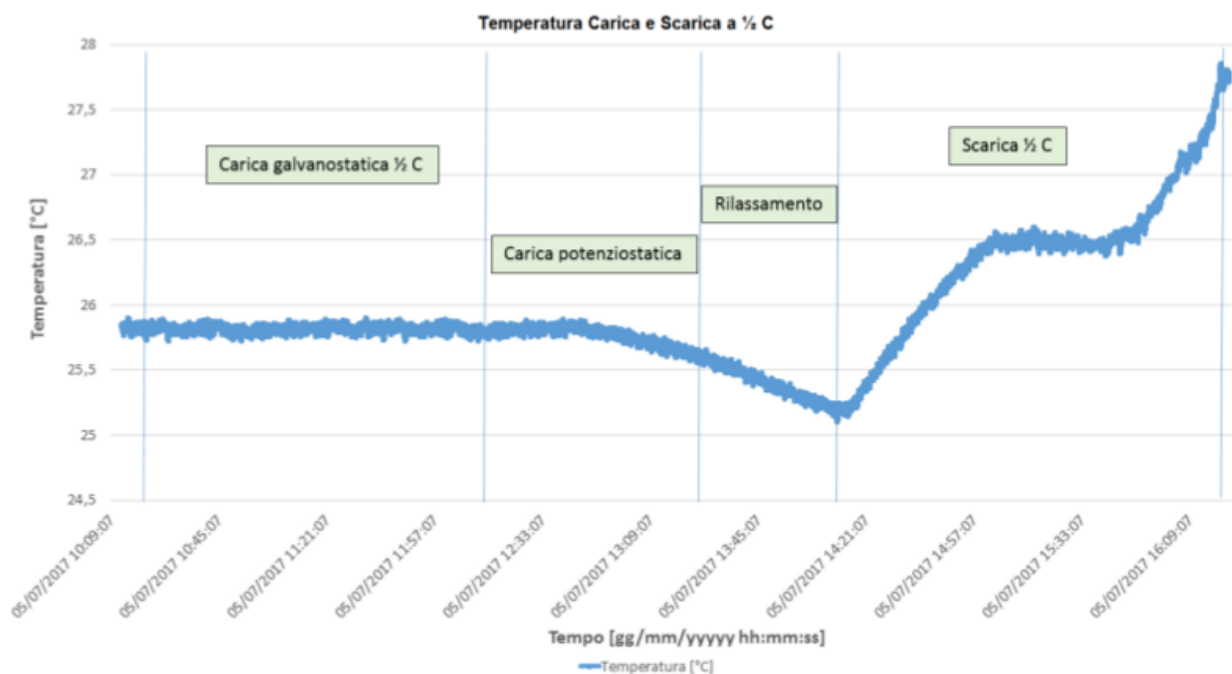
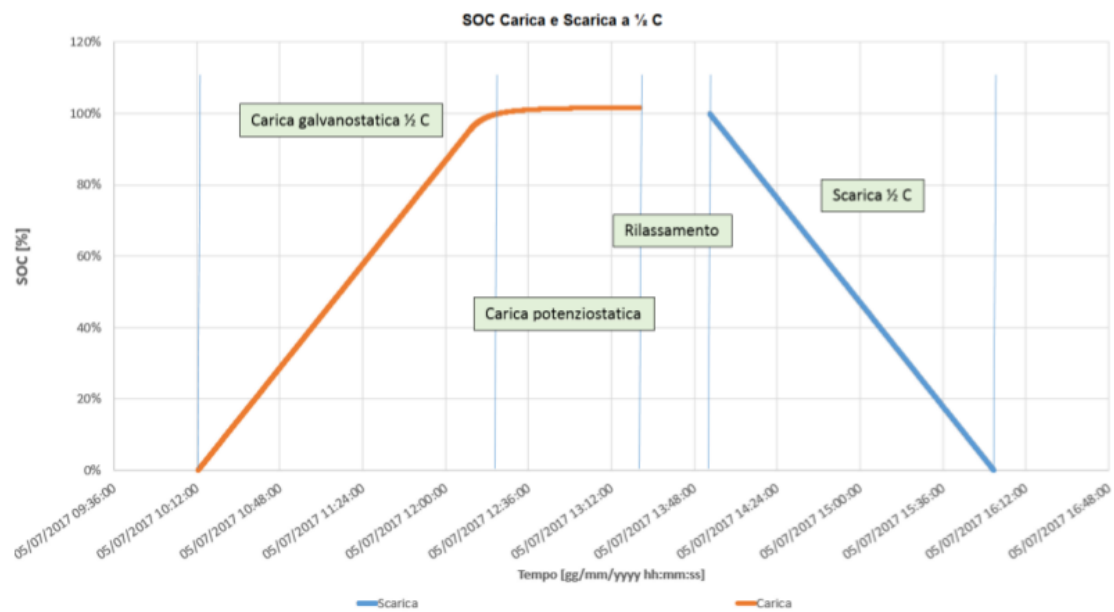
Author(s): Stefano Carabelli

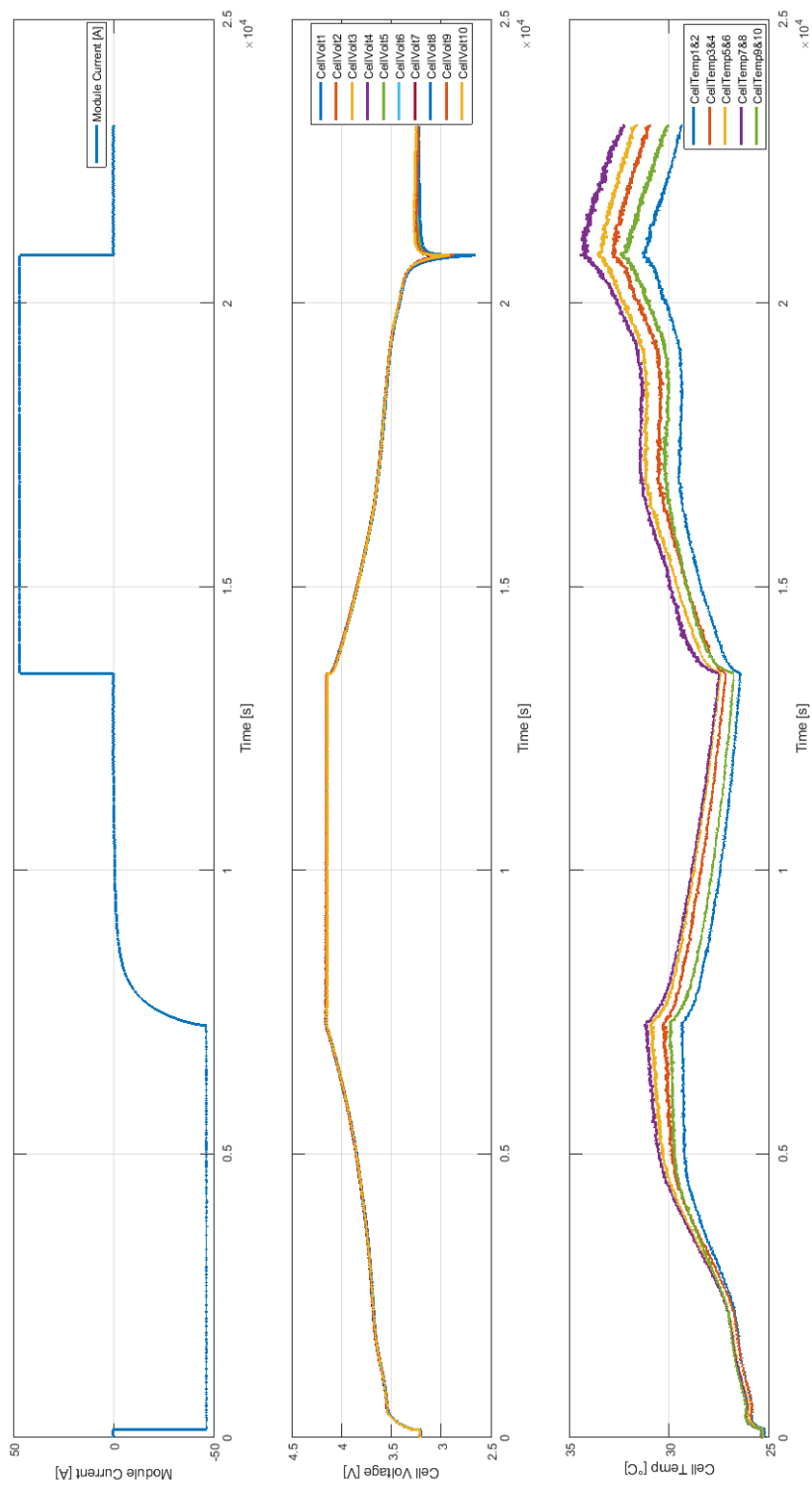
Full “rated” 1/2 C Charge and 1/2 C Discharge



Carica e Scarica a ½ C					
Step		Parametri		Criteri di Stop	
				Condizione	Tempo [s]
1	Climatizzazione di cella a 25 °C	T _{ambiente} =25 °C	C-Rate	T _{finale_cella} =25 °C	(*)
2	Fase di riposo	I = 0 A	-	t > 30 min	1800
3	Carica galvanostatica	I=47 A	½ C	V > 41.5 V (4.15 V per cella)	11124
4	Carica Potenziostatica	V= 41.5 A	-	I _{carica} < 0.1 A (4.15 V per cella)	4530
5	Fase di riposo	I = 0 A	-	t > 30 min	1800
6	Scarica	I= - 47 A	-½ C	V _{cut-off} < 27 V (2.7 V per cella)	11284
7	Fase di riposo	I = 0 A	-	t > 30 min	1800

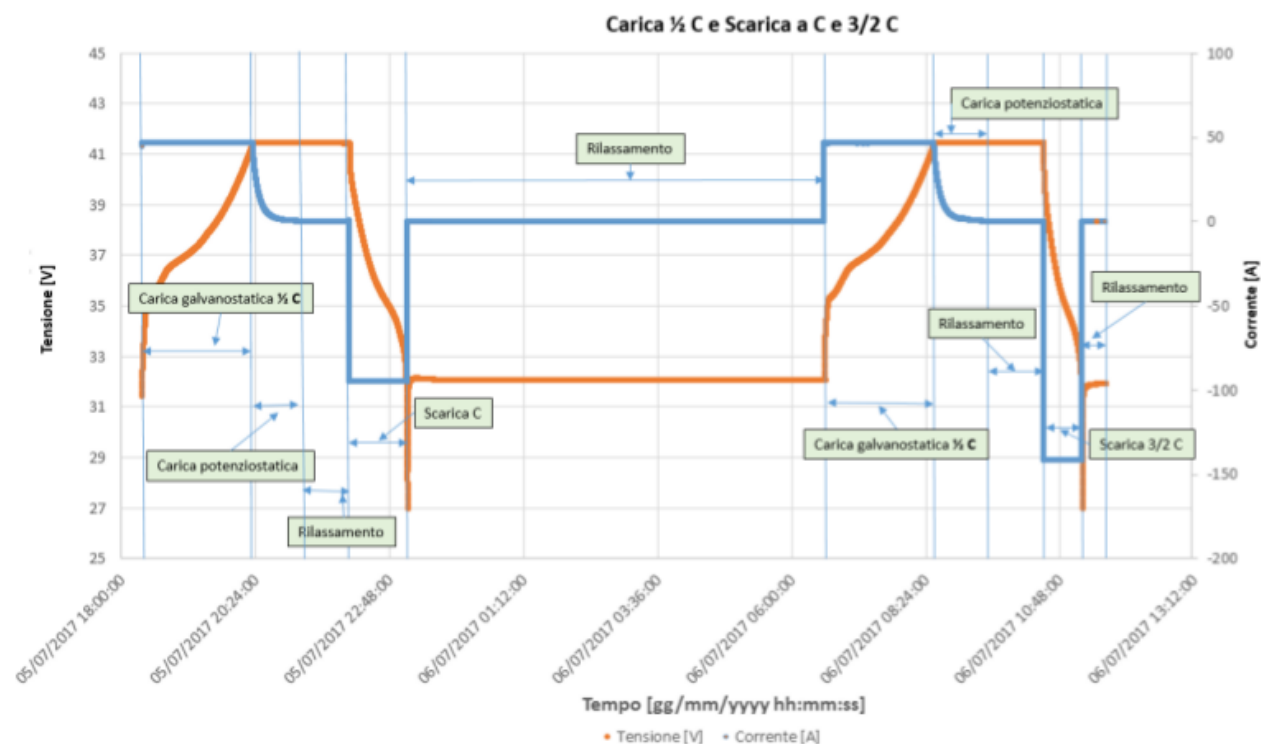


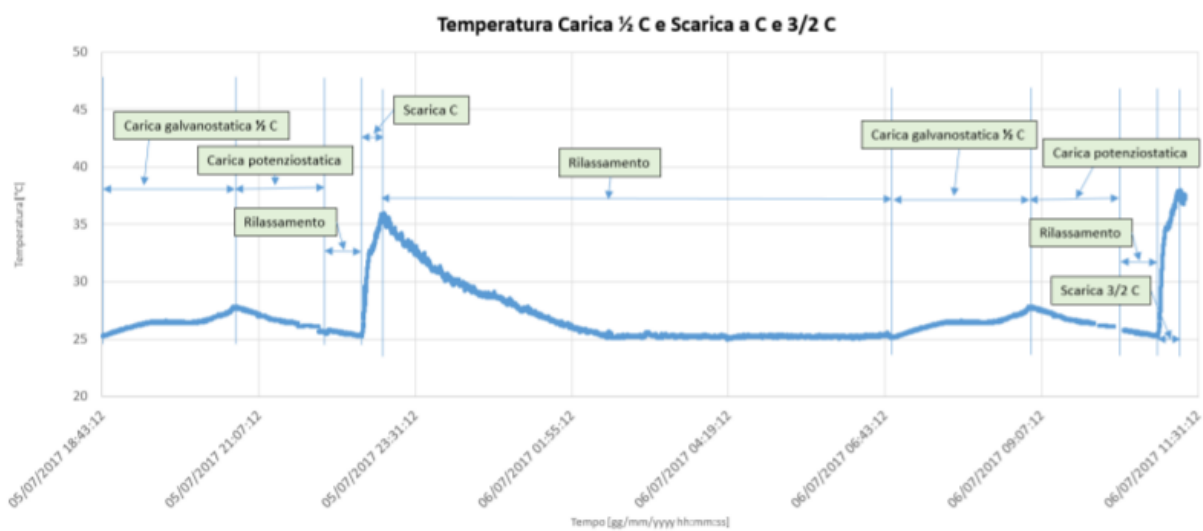
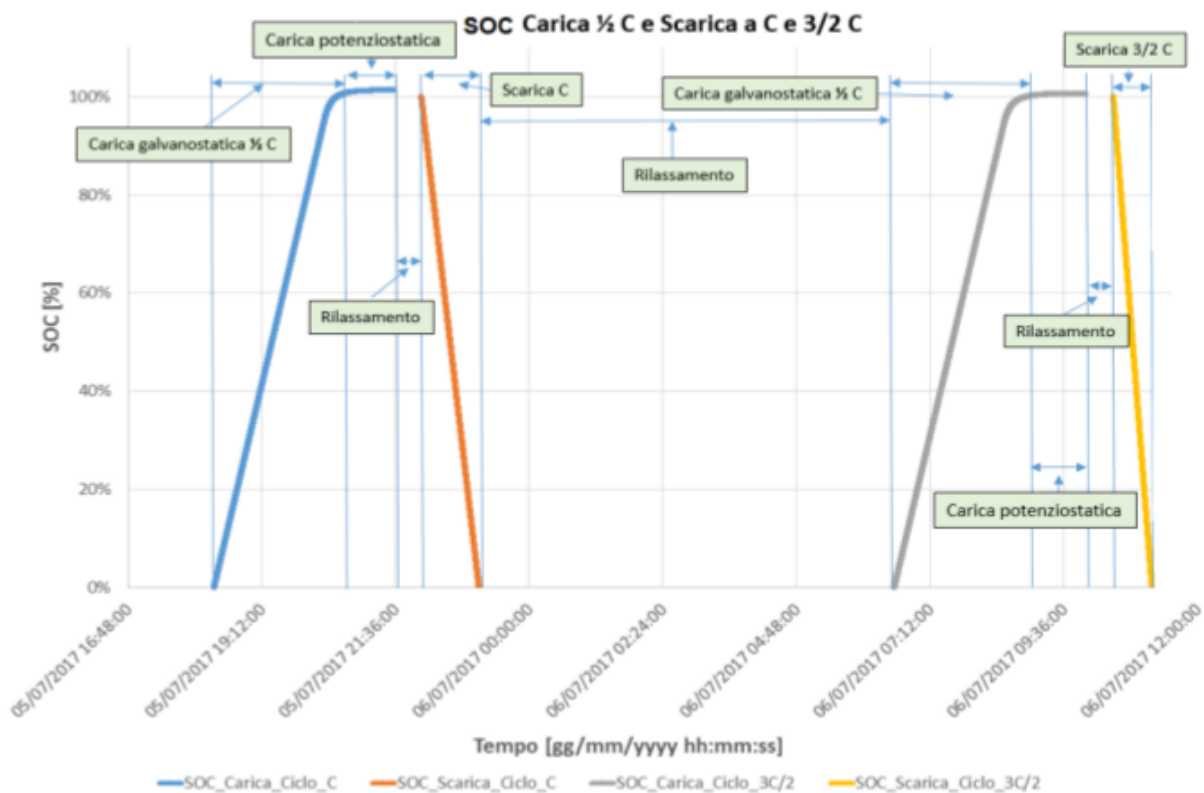


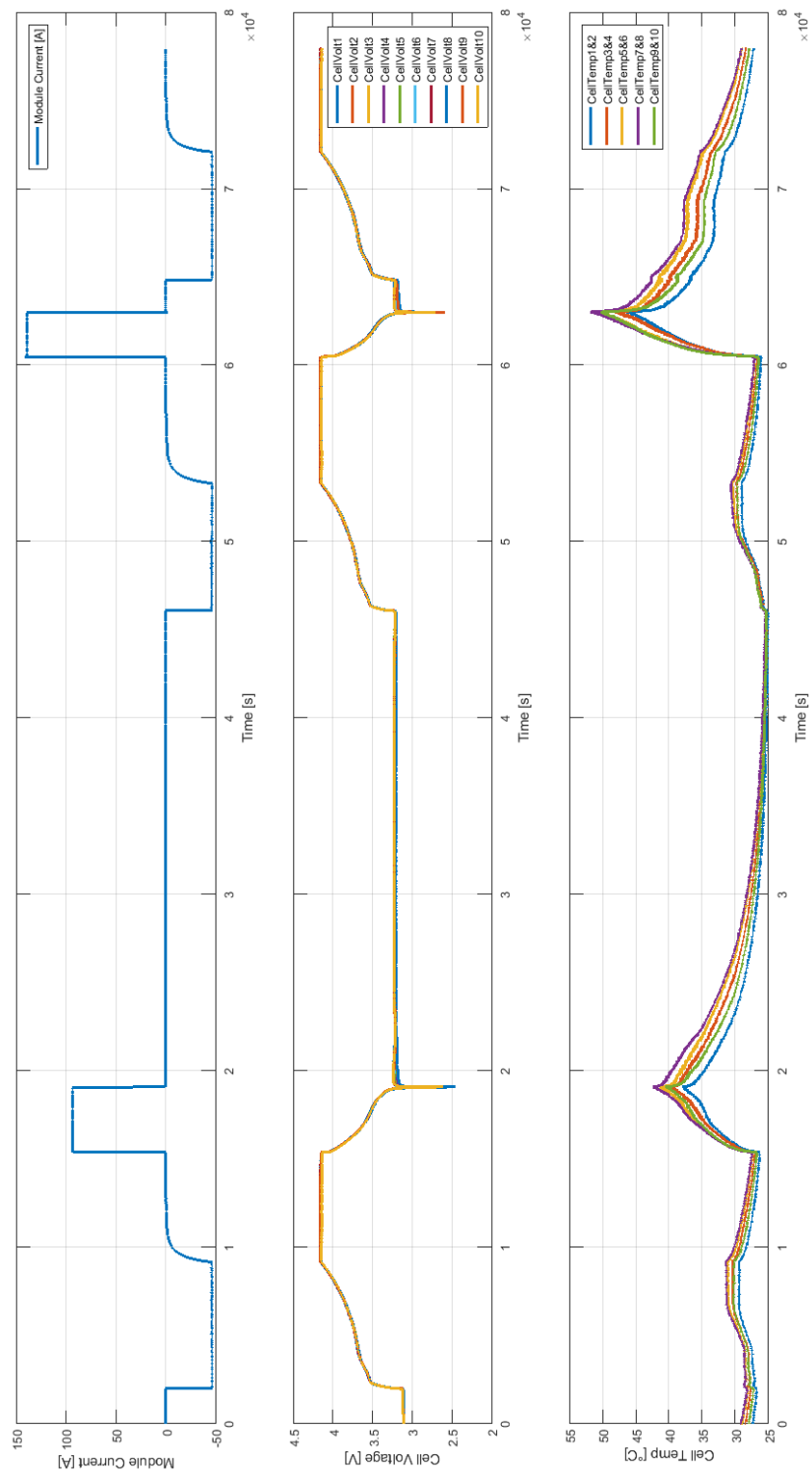


Full “rated” 1/2 C Charge and 1 C & 3/2 C Discharge

Carica ½ C e Scarica a C e 3/2 C					
Step		Parametri		Criteri di Stop	
				Condizione	Tempo [s]
1	Climatizzazione di cella a 25 °C	$T_{\text{ambiente}}=25$ °C	C-Rate	$T_{\text{finale_celle}}=25$ °C	(*)
2	Fase di riposo	$I = 0$ A	-	$t > 30$ min	1800
3	Carica galvanostatica	$I=47$ A	½ C	$V > 41.5$ V (4.15 V per cella)	7176
4	Carica Potenziostatica	$V= 41.5$ A	-	$I_{\text{carica}} < 0.1$ A (4.15 V per cella)	4429
5	Fase di riposo	$I = 0$ A	-	$t > 30$ min	1800
6	Scarica	$I= - 94$ A	C	$V_{\text{cut-off}} < 27$ V (2.7 V per cella)	3716
7	Fase di riposo	$I = 0$ A	-	$t > 30$ min	1800
8	Carica galvanostatica	$I=47$ A	½ C	$V > 41.5$ V (4.15 V per cella)	8856
9	Carica Potenziostatica	$V= 41.5$ A	-	$I_{\text{carica}} < 0.1$ A (4.15 V per cella)	5250
10	Fase di riposo	$I = 0$ A	-	$t > 30$ min	1800
11	Scarica	$I= - 141$ A	3/2 C	$V_{\text{cut-off}} < 27$ V (2.7 V per cella)	2487
12	Fase di riposo	$I = 0$ A	-	$t > 30$ min	1800

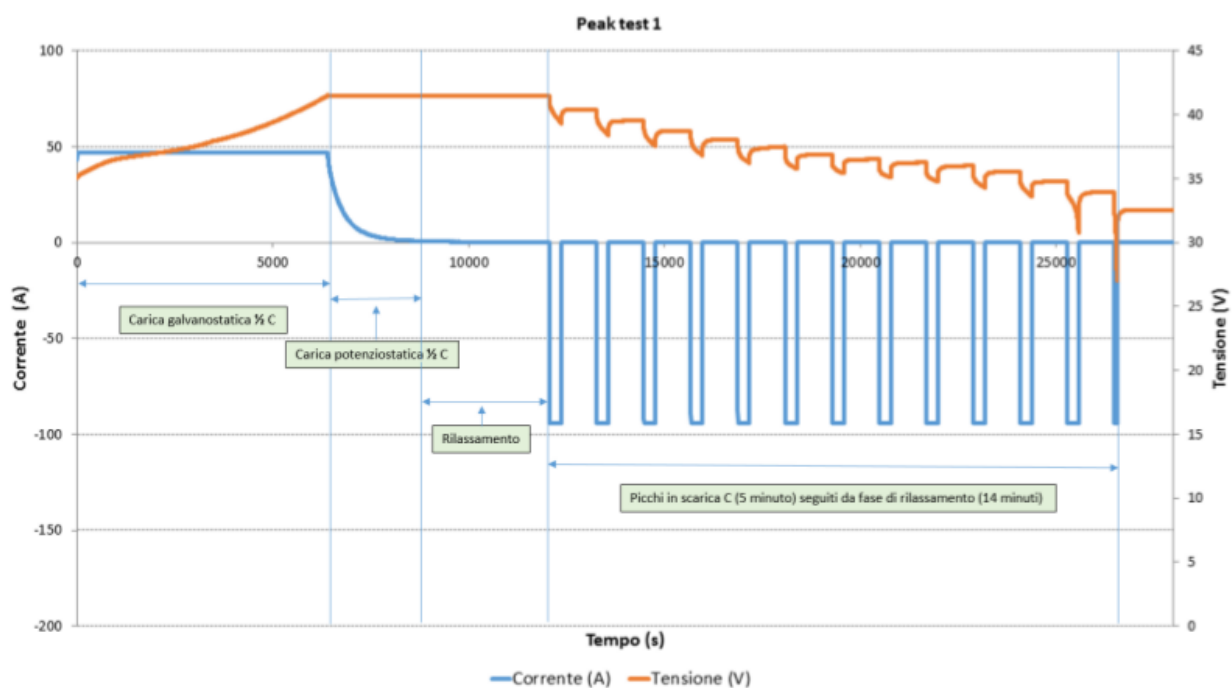


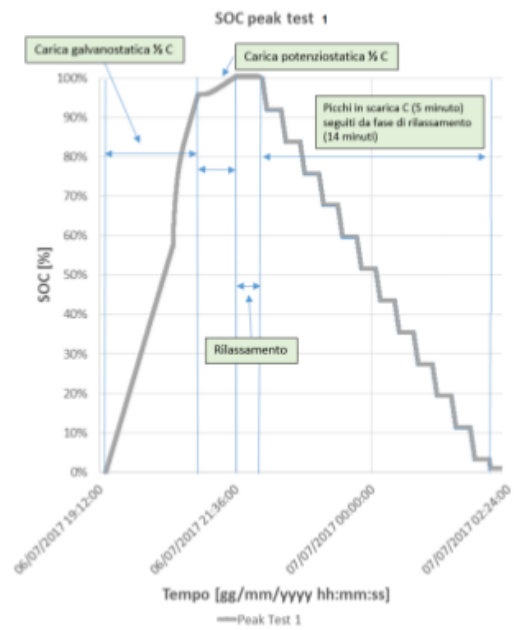
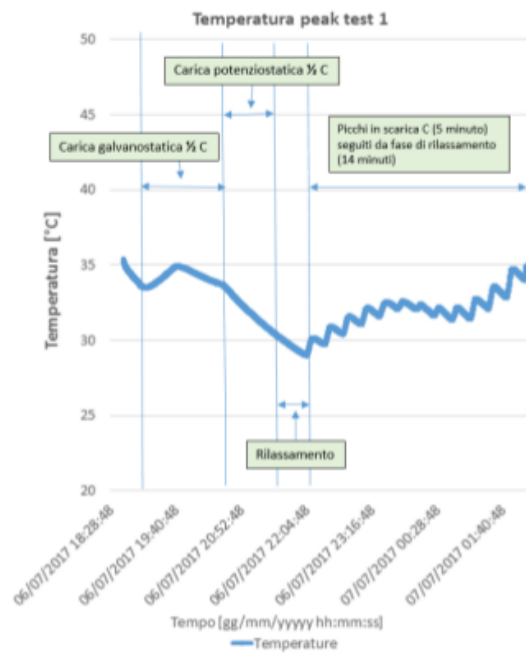




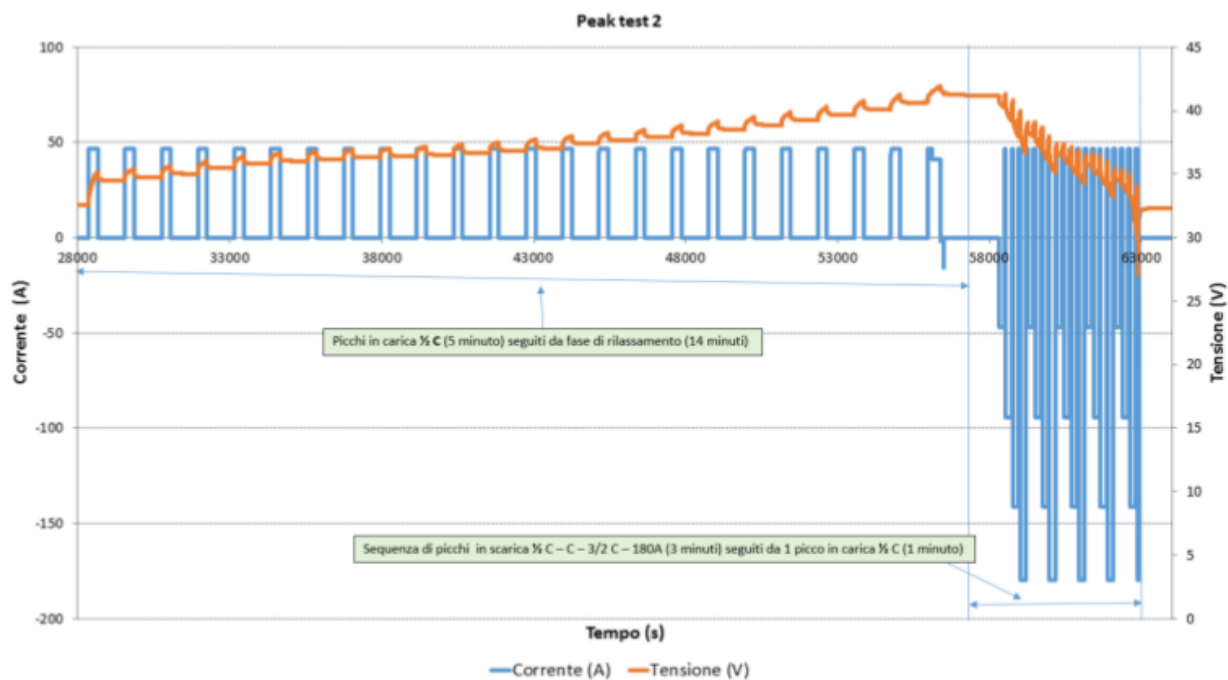
Full “rated” 1/2 C Charge and Impulse Train 1 C & 3/2 C Discharge

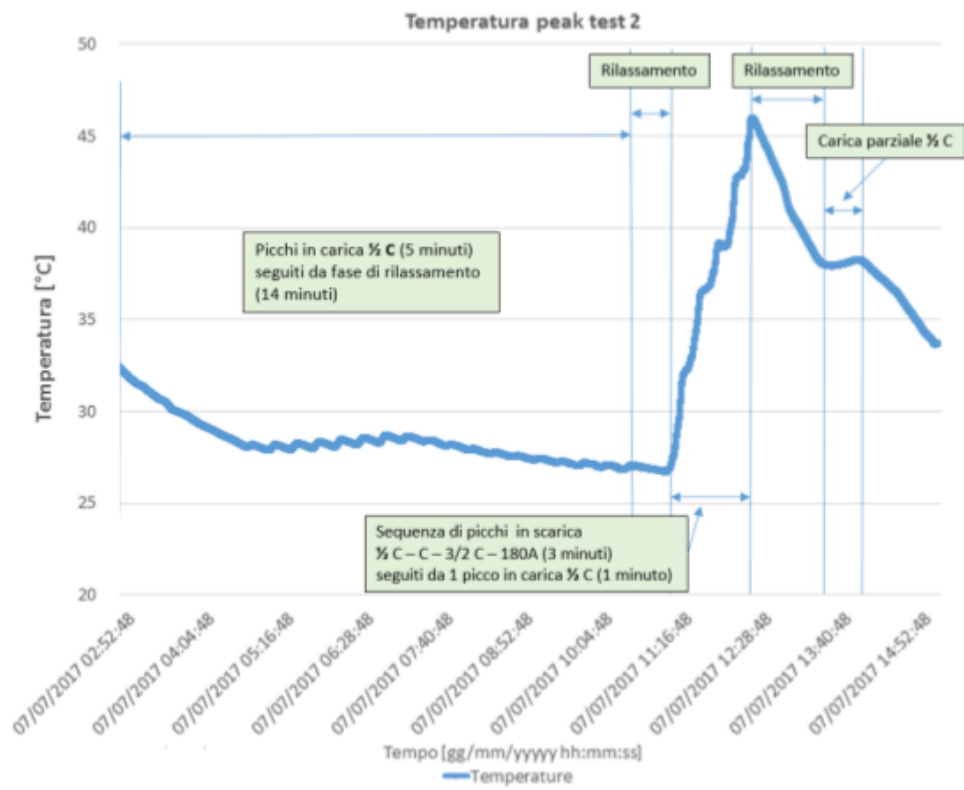
Peak Test 1					
Step		Parametri		Criteri di Stop	
				Condizione	Tempo [s]
1	Climatizzazione di cella a 25 °C	$T_{\text{ambiente}}=25$ °C	C-Rate	$T_{\text{finale_cella}}=25$ °C	(*)
2	Fase di riposo	$I = 0$ A	-	$t > 30$ min	1800
3	Carica galvanostatica	$I=47$ A	$\frac{1}{2}$ C	$V > 41.5$ V (4.15 V per cella)	7176
4	Carica Potenziostatica	$V= 41.5$ A	-	$I_{\text{carica}} < 0.1$ A (4.15 V per cella)	4429
5	Fase di riposo	$I = 0$ A	-	$t > 30$ min	1800
6	Picco in Scarica	$I= - 94$ A	C	$V_{\text{cut-off}} < 27$ V (2.7 V per cella)	300
7	Fase di riposo	$I = 0$ A	-	$t > 14$ min	840
8	Torna al punto 6	se		$V > 27$ V	
9	Fase di riposo	$I = 0$ A	--	$t > 30$ min	1800

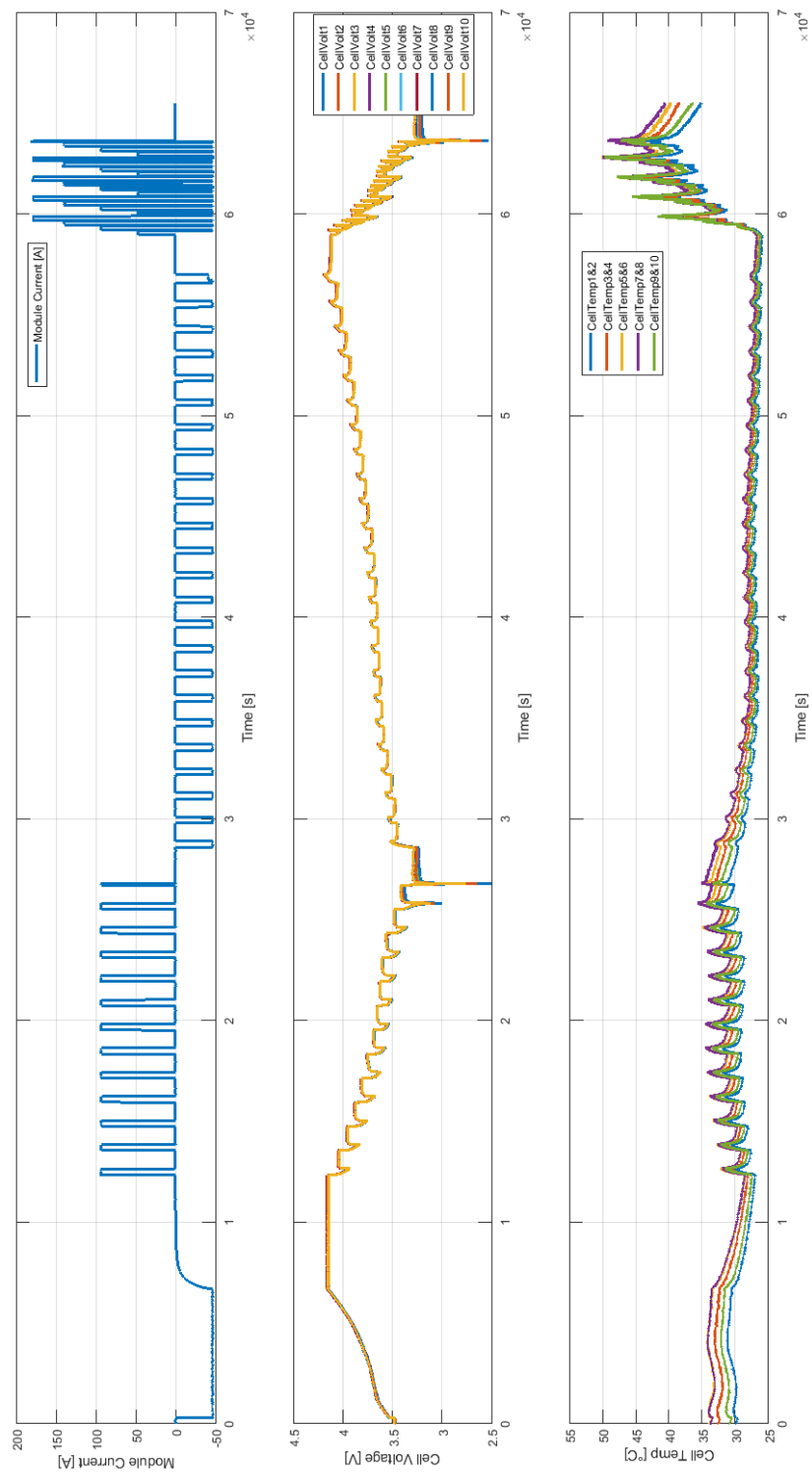




Peak Test 2					
Step		Parametri	C-Rate	Criteri di Stop	
				Condizione	Tempo [s]
1	Picco in Carica	$I=47\text{ A}$	$\frac{1}{2}\text{ C}$	$V > 41.5\text{ V}$ (4.15 V per cella)	300
2	Fase di riposo	$I = 0\text{ A}$	-	$t > 14\text{ min}$	840
3	Torna al punto 1	se		$V_{\text{cut-off}} < 41.5\text{ V}$	
4	Picco in Scarica	$I= - 47\text{ A}$	$\frac{1}{2}\text{ C}$	$V_{\text{cut-off}} < 27\text{ V}$ (2.7 V per cella)	180
5	Picco in Carica	$I=47\text{ A}$	$\frac{1}{2}\text{ C}$	$V > 41.5\text{ V}$ (4.15 V per cella)	60
6	Picco in Scarica	$I= - 94\text{ A}$	C	$V_{\text{cut-off}} < 27\text{ V}$ (2.7 V per cella)	180
7	Picco in Carica	$I=47\text{ A}$	$\frac{1}{2}\text{ C}$	$V > 41.5\text{ V}$ (4.15 V per cella)	60
8	Picco in Scarica	$I= - 141\text{ A}$	$\frac{3}{2}\text{ C}$	$V_{\text{cut-off}} < 27\text{ V}$ (2.7 V per cella)	180
9	Picco in Carica	$I=47\text{ A}$	$\frac{1}{2}\text{ C}$	$V > 41.5\text{ V}$ (4.15 V per cella)	60
10	Picco in Scarica	$I= - 180\text{ A}$	-	$V_{\text{cut-off}} < 27\text{ V}$ (2.7 V per cella)	180
11	Picco in Carica	$I=47\text{ A}$	$\frac{1}{2}\text{ C}$	$V > 41.5\text{ V}$ (4.15 V per cella)	60
12	Torna al punto 4	se		$V > 27\text{ V}$	
13	Fase di riposo	$I = 0\text{ A}$	-	$t > 30\text{ min}$	1800
14	Carica galvanostatica	$I=47\text{ A}$	$\frac{1}{2}\text{ C}$	$V > 41.5\text{ V}$ (4.15 V per cella)	7176

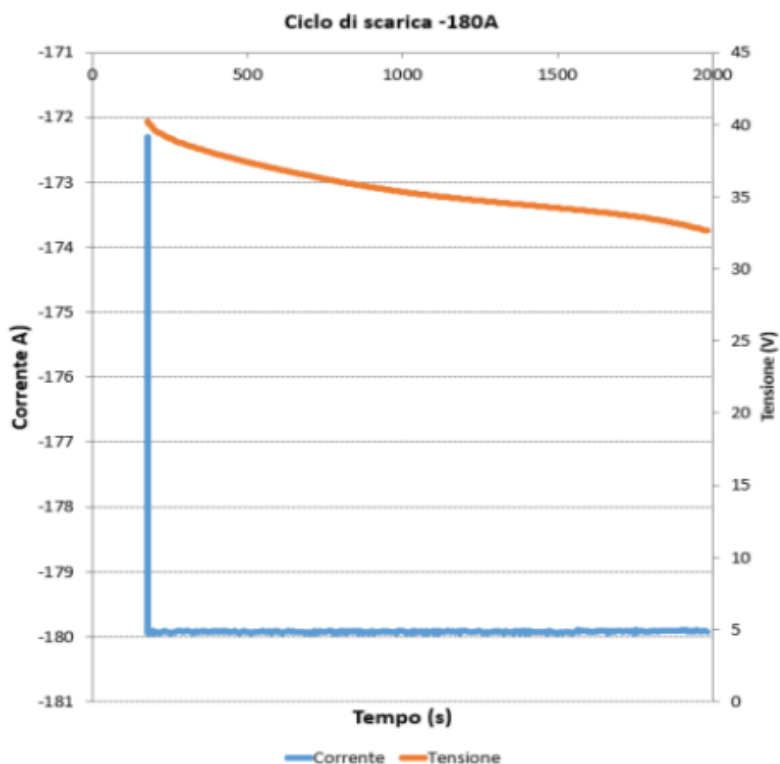
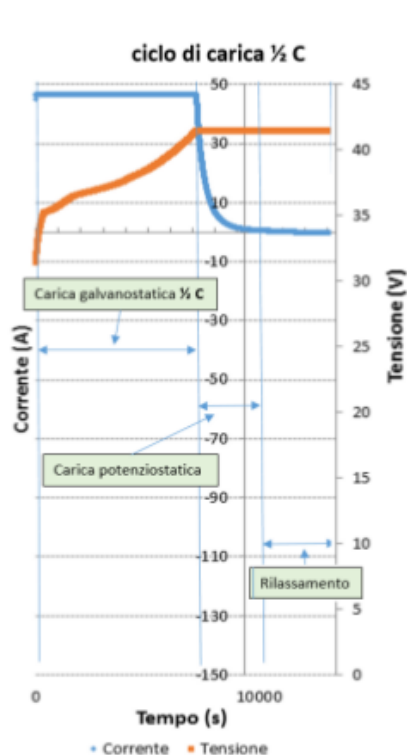


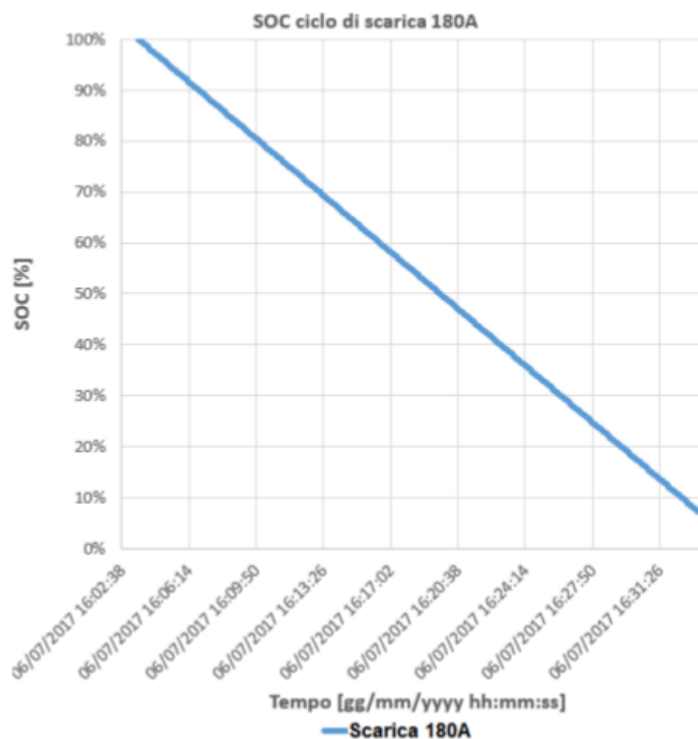
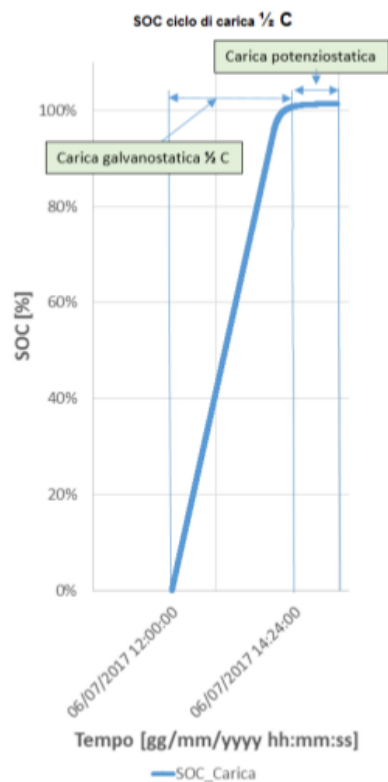
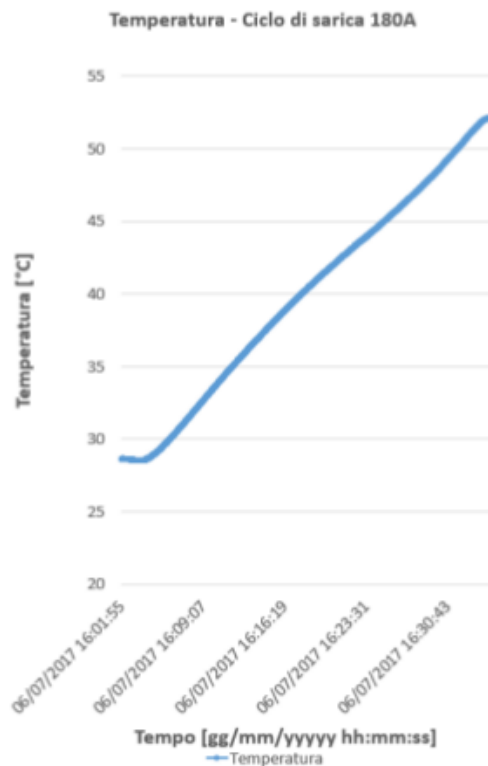
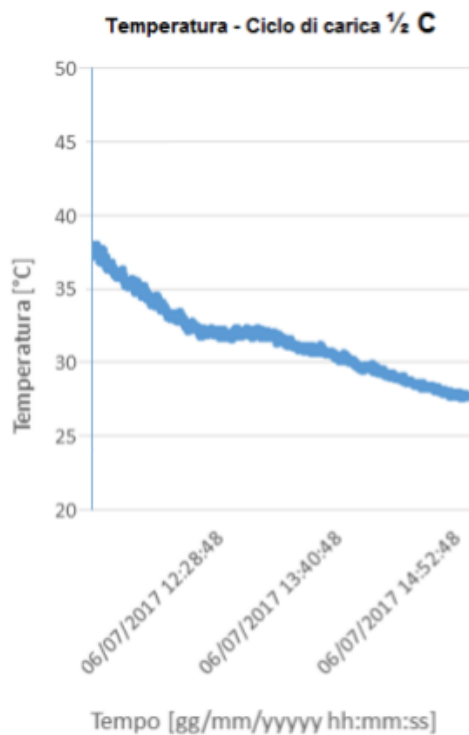




Full “rated” 1/2 C Charge and 2 C Discharge

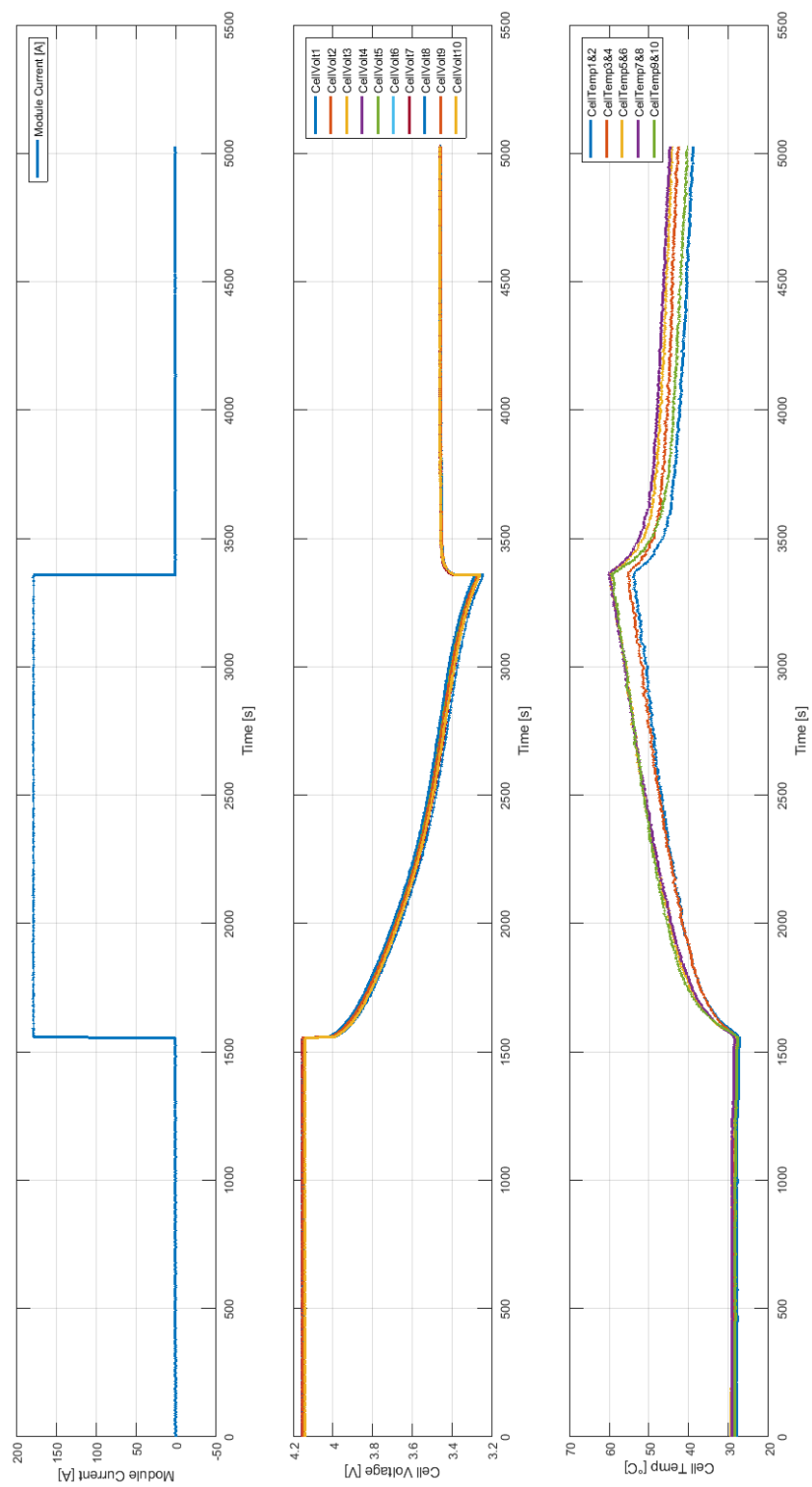
Carica ½ C e Scarica a 180A					
Step		Parametri		Criteri di Stop	
				Condizione	Tempo [s]
1	Climatizzazione di cella a 25 °C	$T_{\text{ambiente}}=25\text{ °C}$	C-Rate	$T_{\text{finale_celle}}=25\text{ °C}$	(*)
2	Carica galvanostatica	$I=47\text{ A}$	½ C	$V > 41.5\text{ V}$ (4.15 V per cella)	7143
3	Carica Potenziostatica	$V = 41.5\text{ A}$	-	$I_{\text{carica}} < 0.1\text{ A}$ (4.15 V per cella)	3748
4	Fase di riposo	$I = 0\text{ A}$	-	$t > 30\text{ min}$	1800
5	Scarica	$I = -180\text{ A}$	180A	$V_{\text{cut-off}} < 27\text{ V}$ (2.7 V per cella)	1801
6	Fase di riposo	$I = 0\text{ A}$	-	$t > 30\text{ min}$	1800





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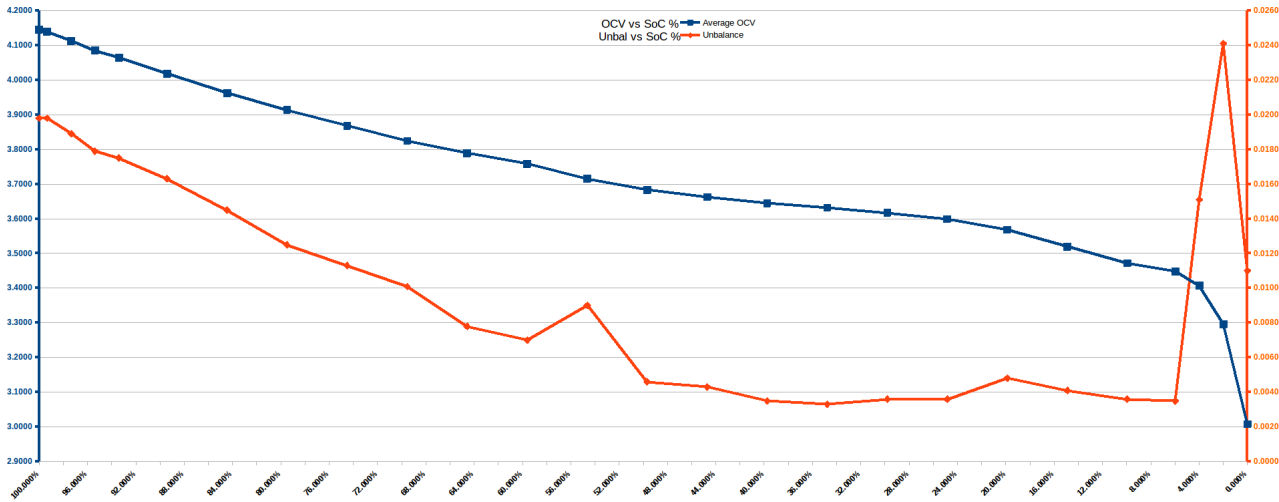
Author(s): Stefano Carabelli



Battery Pack

Slow Discharge

In order to assess the State-of-Charge (SoC) relation with the cell singular voltage value and distribution (average and standard deviation) a very slow discharge has been carried on using a pure resistive load.



Delta (Ah)		2.000151	2.000182	2.000045	4.000059	5.000088	5.000128	5.000138	5.000124	5.000176	5.000088	5.000087	5.000085	5.000131	5.000077	5.000128	5.000135	5.000156	5.000118	5.000077	4.000156	2.000053	2.000021	2.000061	0.688111	0.588689	
Cumulative (Ah)		0.00000	2.00015	4.00033	6.00538	10.00544	15.00552	20.00565	25.00584	30.00598	35.00610	40.00628	45.00637	50.00645	55.00653	60.00666	65.00674	70.00686	75.00700	80.00716	85.00727	90.00736	95.00750	100.00764	100.00768	100.30771	
SoC %		100.000	99.999	99.996	99.993	99.989	99.984	99.978	99.971	99.963	99.954	99.944	99.933	99.921	99.908	99.894	99.879	99.863	99.846	99.828	99.809	99.789	99.768	99.746	99.723	99.699	
Module Cell		Mod. Cell	Cell #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1	1	1	0.0016	0.2968	0.4085	0.4485	0.4731	0.5026	0.5692	0.5998	0.6174	0.6329	0.6482	0.6638	0.6845	0.7178	0.7601	0.7917	0.8269	0.8704	0.9174	0.9554	0.9822	0.9883	0.9886	0.9886	
	2	2	0.0089	0.2965	0.4081	0.4484	0.4717	0.5027	0.5690	0.5987	0.6162	0.6314	0.6464	0.6620	0.6825	0.7157	0.7582	0.7903	0.8262	0.8696	0.9158	0.9546	0.9814	0.9884	0.9886	0.9886	
	3	3	0.0111	0.2972	0.4071	0.4485	0.4719	0.5186	0.5676	0.5982	0.6165	0.6313	0.6464	0.6602	0.6811	0.7171	0.7507	0.7861	0.8199	0.8637	0.9087	0.9573	0.9806	0.9875	0.9874	0.9874	
	4	4	0.0070	0.2967	0.4077	0.4483	0.4723	0.5192	0.5678	0.5992	0.6162	0.6316	0.6461	0.6623	0.6831	0.7180	0.7588	0.7903	0.8256	0.8695	0.9162	0.9544	0.9807	0.9879	0.9882	0.9880	
	5	5	0.0072	0.2979	0.4092	0.4482	0.4718	0.5211	0.5693	0.5989	0.6167	0.6313	0.6469	0.6632	0.6825	0.7176	0.7584	0.7903	0.8256	0.8691	0.9158	0.9544	0.9808	0.9878	0.9871	0.9871	
	6	6	0.0139	0.2959	0.4063	0.4479	0.4712	0.5184	0.5670	0.5978	0.6159	0.6308	0.6457	0.6603	0.6806	0.7141	0.7542	0.7861	0.8219	0.8654	0.9125	0.9508	0.9768	0.9839	0.9840	0.9840	0.9840
	7	7	0.0086	0.2976	0.4079	0.4483	0.4726	0.5190	0.5678	0.5994	0.6165	0.6320	0.6462	0.6622	0.6831	0.7177	0.7586	0.7904	0.8243	0.8677	0.9142	0.9522	0.9789	0.9845	0.9843	0.9843	0.9843
	8	8	0.0055	0.2963	0.4076	0.4482	0.4715	0.5202	0.5679	0.5983	0.6159	0.6313	0.6468	0.6637	0.6830	0.7153	0.7568	0.7887	0.8230	0.8660	0.9125	0.9508	0.9768	0.9837	0.9837	0.9837	0.9837
	9	9	0.0072	0.2972	0.4077	0.4485	0.4723	0.5190	0.5678	0.5983	0.6167	0.6316	0.6462	0.6621	0.6824	0.7150	0.7549	0.7865	0.8204	0.8638	0.9101	0.9481	0.9741	0.9811	0.9811	0.9811	0.9811
	10	10	0.0096	0.2988	0.4088	0.4491	0.4723	0.5200	0.5680	0.6000	0.6174	0.6328	0.6468	0.6622	0.6834	0.7166	0.7580	0.7887	0.8225	0.8655	0.9122	0.9503	0.9762	0.9832	0.9832	0.9832	0.9832
2	1	11	0.0101	0.2947	0.4056	0.4463	0.4721	0.5192	0.5676	0.5990	0.6168	0.6320	0.6464	0.6624	0.6819	0.7125	0.7564	0.7871	0.8215	0.8642	0.9097	0.9572	0.9814	0.9881	0.9881	0.9881	0.9881
	2	12	0.0072	0.2928	0.4046	0.4469	0.4703	0.5187	0.5671	0.5978	0.6159	0.6309	0.6454	0.6616	0.6817	0.7147	0.7562	0.7872	0.8222	0.8653	0.9107	0.9589	0.9814	0.9889	0.9889	0.9889	0.9889
	3	13	0.0084	0.2925	0.4038	0.4472	0.4710	0.5175	0.5668	0.5972	0.6149	0.6300	0.6450	0.6604	0.6805	0.7130	0.7543	0.7851	0.8199	0.8614	0.9067	0.9544	0.9802	0.9879	0.9879	0.9879	0.9879
	4	14	0.0097	0.2936	0.4049	0.4475	0.4713	0.5181	0.5665	0.5978	0.6159	0.6307	0.6453	0.6611	0.6811	0.7111	0.7555	0.7864	0.8207	0.8631	0.9088	0.9567	0.9819	0.9877	0.9877	0.9877	0.9877
	5	15	0.0035	0.2930	0.4052	0.4479	0.4720	0.5190	0.5687	0.5992	0.6169	0.6317	0.6465	0.6627	0.6836	0.7167	0.7591	0.7905	0.8262	0.8697	0.9162	0.9550	0.9814	0.9881	0.9883	0.9883	0.9883
	6	16	0.0121	0.2952	0.4063	0.4471	0.4713	0.5189	0.5679	0.5978	0.6153	0.6302	0.6450	0.6606	0.6809	0.7150	0.7543	0.7847	0.8182	0.8608	0.9057	0.9530	0.9788	0.9845	0.9845	0.9845	0.9845
	7	17	0.0035	0.2924	0.4044	0.4479	0.4719	0.5190	0.5678	0.5986	0.6169	0.6316	0.6466	0.6626	0.6831	0.7168	0.7582	0.7902	0.8257	0.8693	0.9159	0.9546	0.9802	0.9874	0.9880	0.9880	0.9880
	8	18	0.0099	0.2937	0.4048	0.4485	0.4722	0.5191	0.5677	0.5988	0.6169	0.6315	0.6465	0.6624	0.6827	0.7137	0.7582	0.7898	0.8247	0.8681	0.9140	0.9525	0.9788	0.9848	0.9854	0.9854	0.9854
	9	19	0.0107	0.2933	0.4044	0.4480	0.4714	0.5183	0.5668	0.5978	0.6158	0.6305	0.6455	0.6611	0.6811	0.7109	0.7550	0.7865	0.8207	0.8635	0.9076	0.9552	0.9803	0.9868	0.9868	0.9868	0.9868
	10	20	0.0037	0.2931	0.4049	0.4484	0.4722	0.5197	0.5682	0.5994	0.6174	0.6325	0.6471	0.6632	0.6836	0.7169	0.7594	0.7910	0.8267	0.8702	0.9168	0.9553	0.9812	0.9887	0.9887	0.9887	0.9887
3	1	21	0.0115	0.2960	0.4073	0.4488	0.4725	0.5202	0.5685	0.5989	0.6172	0.6319	0.6460	0.6623	0.6824	0.7131	0.7558	0.7877	0.8219	0.8649	0.9104	0.9580	0.9827	0.9886	0.9886	0.9886	0.9886
	2	22	0.0057	0.2945	0.4063	0.4484	0.4723	0.5193	0.5686	0.5992	0.6172	0.6323	0.6463	0.6621	0.6828	0.7147	0.7592	0.7913	0.8264	0.8701	0.9169	0.9563	0.9818	0.9885	0.9885	0.9885	0.9885
	3	23	0.0071	0.2942	0.4058	0.4472	0.4710	0.5181	0.5672	0.5977	0.6157	0.6305	0.6457	0.6617	0.6824	0.7138	0.7575	0.7900	0.8243	0.8680	0.9145	0.9529	0.9788	0.9845	0.9845	0.9845	0.9845
	4	24	0.0056	0.2949	0.4066	0.4491	0.4725	0.5203	0.5686	0.5996	0.6175	0.6320	0.6462	0.6625	0.6829	0.7157	0.7597	0.7916	0.8267	0.8702	0.9168	0.9569	0.9822	0.9889	0.9889	0.9889	0.9889
	5	25	0.0075	0.2945	0.4059	0.4473	0.4714	0.5190	0.5675	0.5986	0.6163	0.6312	0.6462	0.6624	0.6824	0.7146	0.7581	0.7895	0.8248	0.8682	0.9145	0.9532	0.9791	0.9848	0.9848	0.9848	0.9848
	6	26	0.0090	0.2951	0.4065	0.4488	0.4728	0.5199	0.5684	0.5987	0.6173	0.6324	0.6464	0.6625	0.6830	0.7154	0.7596	0.7913	0.8266	0.8701	0.9169	0.9554	0.9820	0.9889	0.9889	0.9889	0.9889
	7	27	0.0073	0.2947	0.4063	0.4493	0.4718	0.5197	0.5682	0.5995	0.6175	0.6325	0.6465	0.6626	0.6831	0.7159	0.7594	0.7910	0.8267	0.8702	0.9168	0.9569	0.9822	0.9889	0.9889	0.9889	0.9889
	8	28	0.0076	0.2940	0.4062	0.4472	0.4710	0.5183	0.5674	0.5978	0.6158	0.6310	0.6463	0.6625	0.6828	0.7148	0.7583	0.7902	0.8247	0.8681	0.9140	0.9525	0.9788	0.9848	0.9854	0.9854	0.9854
	9	29	0.0046	0.2954	0.4068	0.4489	0.4720	0.5203	0.5687	0.5995	0.6175	0.6322	0.6468	0.6636	0.6840	0.7154	0.7595	0.7912	0.8269	0.8711	0.9172	0.9558	0.9822	0.9890	0.9890	0.9890	0.9890
	10	30	0.0098	0.2963	0.4076	0.4476	0.4720	0.5192	0.5682	0.5992	0.6173	0.6326	0.6471	0.6635	0.6831	0.7145	0.7593	0.7913	0.8270	0.8702	0.9168	0.9569	0.9822	0.9889	0.9889	0.9889	0.9889
4	1	31	0.0104	0.2968	0.4078	0.4491	0.4716	0.5191	0.5679	0.5985	0.6159	0.6311	0.6461	0.6616	0.6820	0.7135	0.7568	0.7887	0.8222	0.8649	0.9104	0.9580	0.9827	0.9886	0.9886	0.9886	0.9886
	2	32	0.0073	0.2966	0.4080	0.4482	0.4722	0.5197	0.5678	0.5986	0.6168	0.6318	0.6465	0.6628	0.6828	0.7143	0.7588	0.7903	0.8261	0.8695	0.9158	0.9548	0.9802	0.9879	0.9879	0.9879	0.9879
	3	33	0.0073	0.2963	0.4079	0.4487	0.4726	0.5204	0.5689	0.5996	0.6174	0.6323	0.6469	0.6631	0.6835	0.7150	0.7596	0.7910	0.8267	0.8702	0.9168	0.9569	0.9822	0.9889	0.9889	0.9889	0.9889
	4	34	0.0121	0.2965	0.4090	0.4479	0.4714	0.5182	0.5669	0.5982	0.6156	0.6308	0.6458	0.6612	0.6811	0.7118	0.7550	0.7862	0.8206	0.8632	0.9084	0.9566	0.9817	0.9872	0.9872	0.9872	0.9872
	5	35	0.0098	0.2963	0.4081	0.4479	0.4718	0.5199	0.5682	0.5995	0.6175	0.6325	0.6465	0.6626	0.6831	0.7159	0.7594	0.7910	0.8267	0.8702	0.9168	0.9569	0.9822	0.9889	0.9889	0.9889	0.9889
	6	36	0.0074	0.2957	0.4067	0.4485	0.4727	0.5203	0.5687	0.5993	0.6173	0.6324	0.6464	0.6625	0.6830	0.7151	0.7591	0.7905	0.8264	0.86							

Full Charge

The battery pack (see Figure 15) is charged by means of Brusa AC/DC charger (see Figure 16) at $\frac{1}{2}$ C according to the indication of the cell manufacturer to guarantee the number of specified charge/discharge cycles.



Figure 15: Battery pack fully connected at test bench.

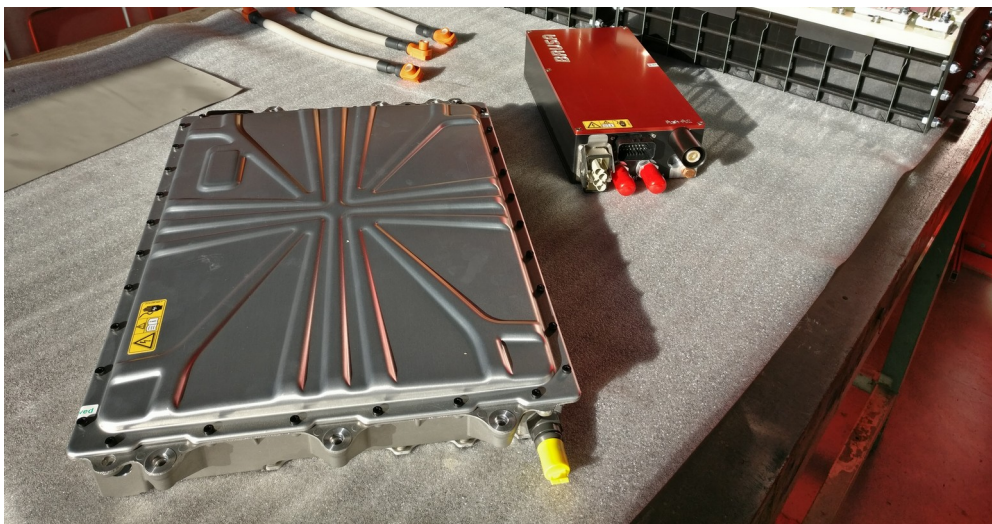
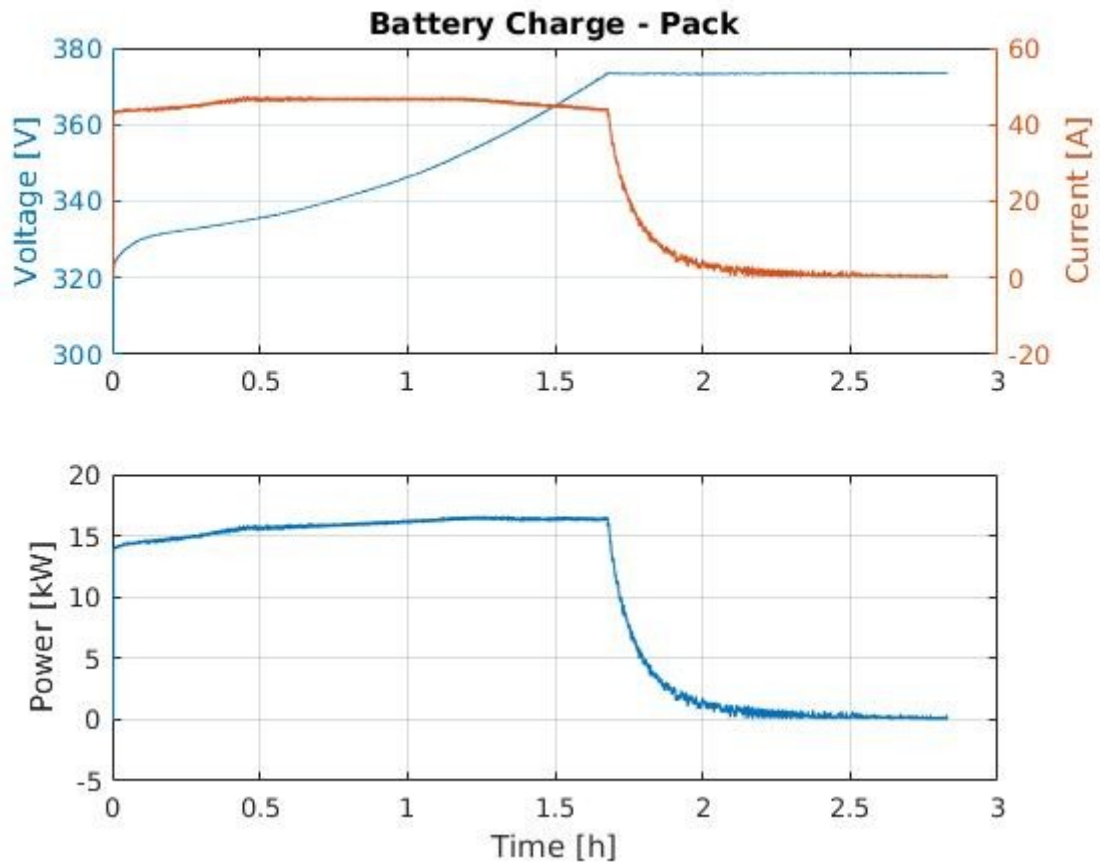


Figure 16: Brusa AC/DC and DC/DC chargers.

Battery Pack

The reported battery pack voltage and current are measured by the master BMS.



Modules

All module cells are voltage monitored while temperature is measured at couples (see Figure 14) by the slave BMS.

