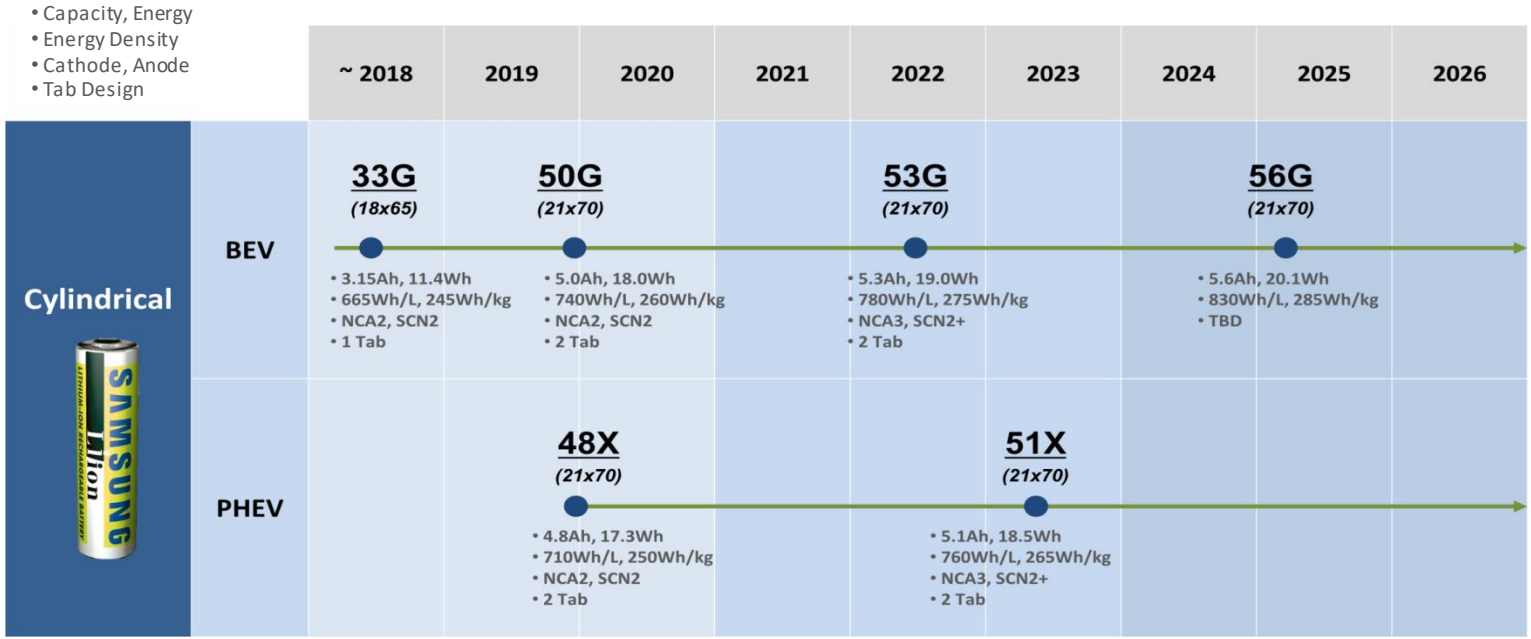
SAMSUNG 21700 50G Cylindrical battery for EV

Feb. 2019

SAMSUNG SDI

Samsung provides state-of-art xEV cell solutions with the most advanced materials



※ BEV/PHEV Capacity(Typical) : 0.2C

Target Specification

Specification	Product	21700
		50G
General	Typical Energy (4.2V, 0.2C discharge, Wh)	18.15
	Typical Capacity (4.2V, 0.2C discharge, mAh)	5,000
	1) GB/T Capacity (4.2V,0.33C/2.5V,1.0C discharge, mAh)	4,900
	Energy Density (Wh/L, Typical)	749
	Energy Density (Wh/kg, Typical)	267
	IR (AC 1KHz SOC30/ DC SOC50, 10sec, Typ., mΩ)	AC 14.5 / DC 24.5
	Weight (Typ, g)	68.0
	Nominal Voltage (V) (DCH 0.2C)	3.63
Charge	Charging Voltage (V)	4.2
	Standard Charging Current	0.33C
	Max. Charging Current (not for cycle)	1.0C
	Max. Charging Current (cycle)	-
Discharge	Discharging End Voltage (V)	2.5
	Standard Discharging Current	0.2C
	Max. Discharging Current (not for cycle)	3.0C
	Max. Discharging Current (cycle)	
Life	Cycle Life (0.33C charge / 1.0C discharge) – GB/T Condition	80%@ 1,000cycle

* Target specifications are subject to change with EV & cell requirements

Development Schedule

SDI will be ready to mass produce 50G with most advanced 21700 cell design in early 2019 and set up manufacturing line for 50G.

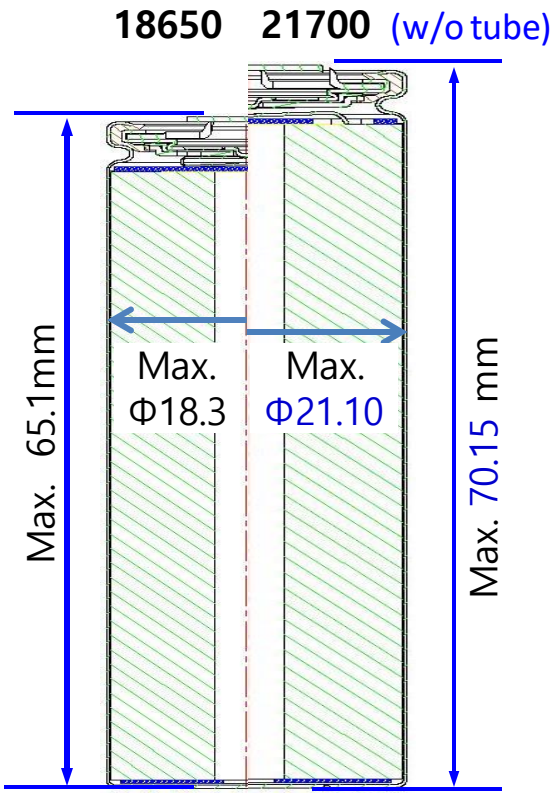
☐ **21700 50G Development Schedule**

Year	2018				2019			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
50G Project Timeline			*Ready to off-process sample*		*Cell Design Verification Completion*	SOP		
			Cell Design Verification		Production Validation			

☐ **Customer Sample Availability**

Phase	A SPL	B SPL	C SPL	SOP
Milestone	Available from Jul 2017	Available from Sep 2018	Available from Q2 2019	
Production Line	Slow speed mass production line (Off-tooling)	Mass production line (Off-process)		
Main Activities	• Mechanical & chemistry design • Design feasibility	• Cell design optimization and confirmation • Fulfill the OEM's functional requirements • Process design • Design verification	• Process optimization • Product validation • Ramp up	• Mass production

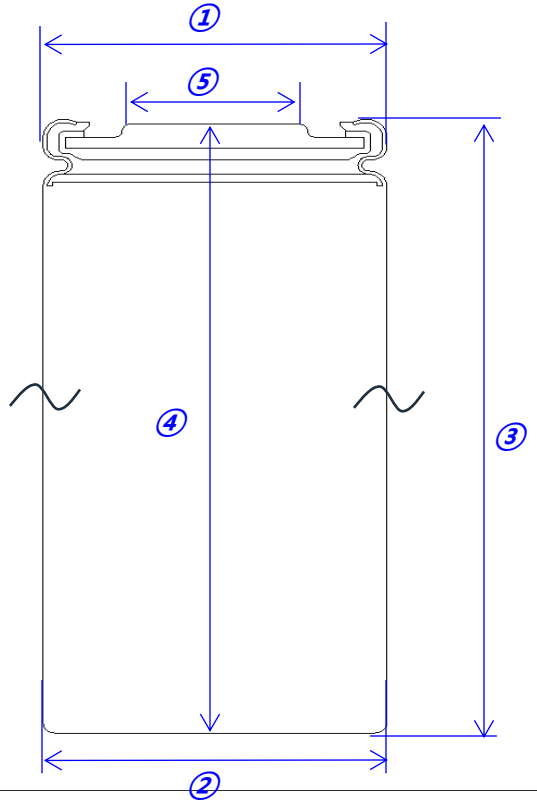
Design Concept



Design	21700-50G	Remarks
Typical Capacity (typ. mAh)	5,000	Charge: 0.33C 4.2V , 0.025C cut-off Discharge: 0.2C 2.5V
GB/T Capacity (min. mAh)	4,900	Charge: 0.33C 4.2V, 0.025C cut-off Discharge: 1C 2.5V
Cathode	NCA	High Ni NCA
Anode	Graphite + SCN	SCN: Silicon Carbon Nano composite
Separator	CCS	CCS: Ceramic Coated Separator
CAN	0.22t Steel	-
CID	Slim CID	CID: Current Interrupt Device

Dimensions

☐ 21700-50G Cell Dimensions



☐ Without Tubing

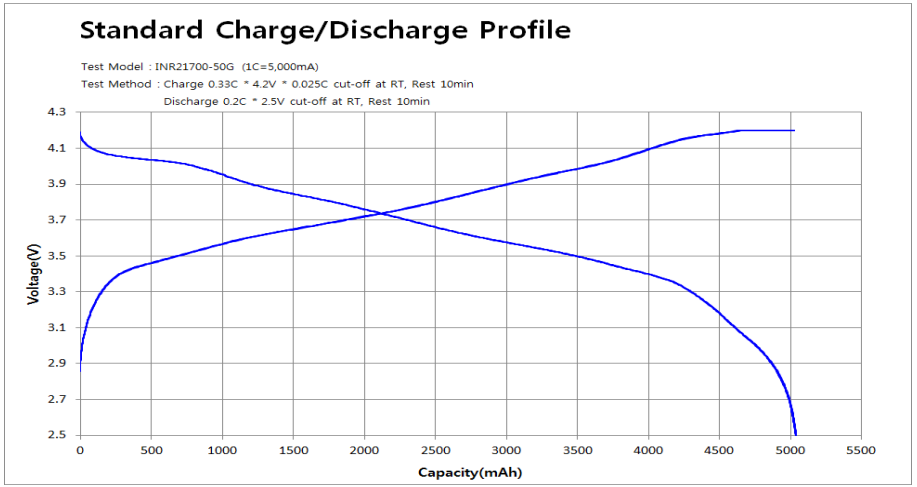
Dimension	Nominal (mm)	Remark
①	21.00	Cell diameter
②	21.00	Cell diameter
③	70.00	Shoulder height
④	69.90	Cell height
⑤	9.0	Welding area(+)

☐ With Tubing

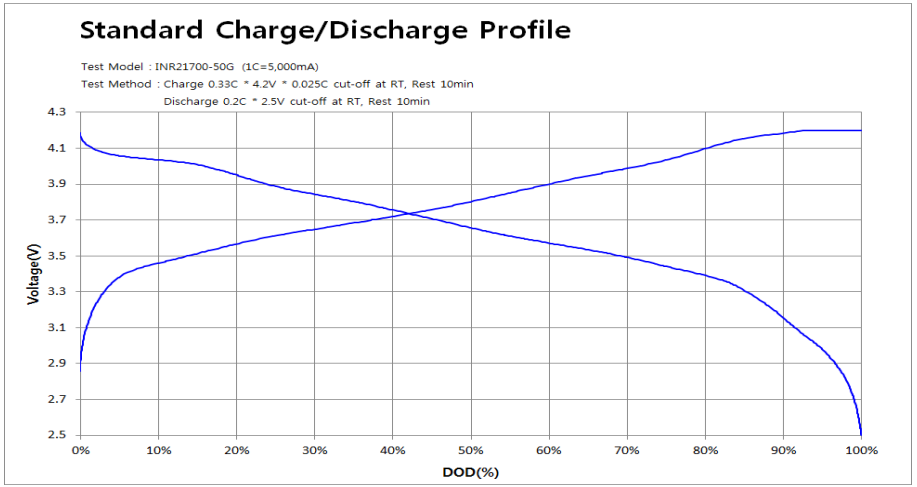
Dimension	Nominal (mm)	Remarks
①	21.15	Cell diameter
②	21.15	Cell diameter
③	70.58	Shoulder height
④	70.65	Cell height
⑤	9.0	Welding area(+)

Standard Capacity

☐ Standard Charge/Discharge Profile @ RT



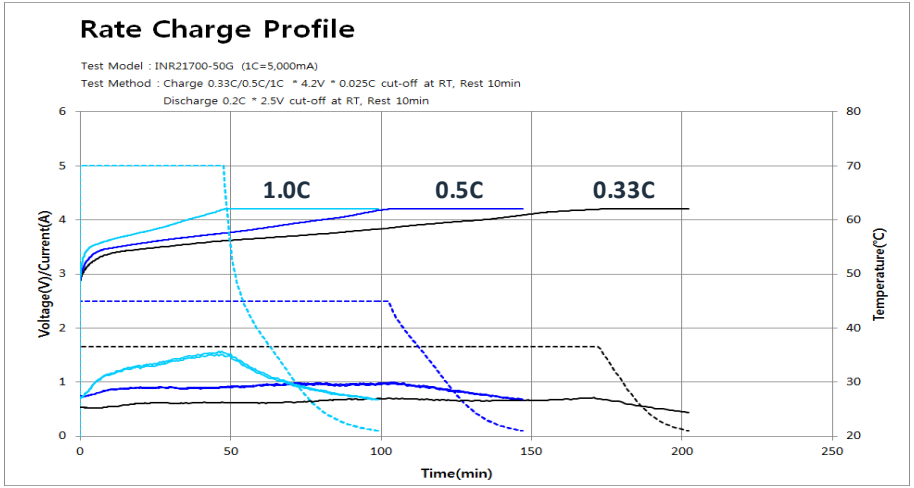
☐ DOD Profile @ RT



	Capacity	Energy	Average Voltage
Standard Capacity	5,000mAh	18.15Wh	3.63V

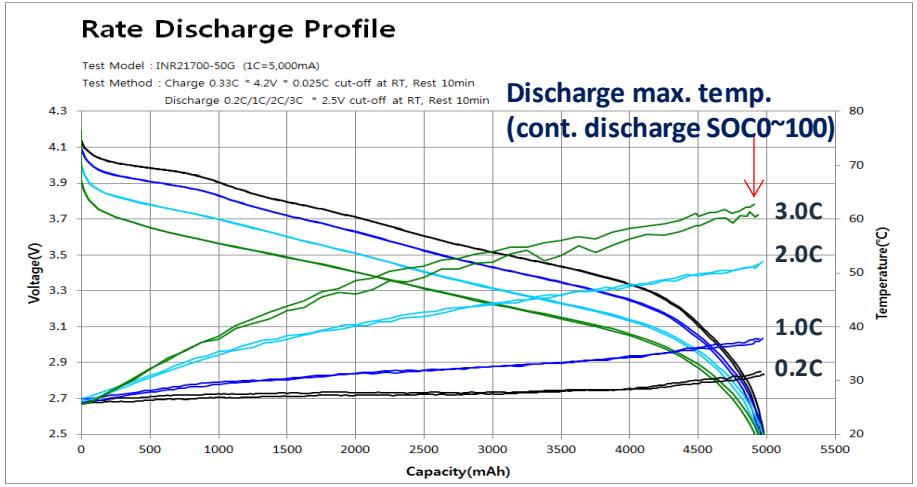
Charge / Discharge capability @ C-rate

☐ Charge capacity w/ charge rate @ RT



	0.33C	0.5C	1C
Capacity (vs. 033C)	100%	99.9%	100.2%
Charging Time	202min.	147min.	99min.
Max. Temp.	27.1℃	29.9℃	35.6℃

☐ Discharge capacity w/ discharge rate @ RT



	0.2C	1C	2C	3C
Capacity (vs. 0.2C)	100%	99.8%	99.7%	99.1%
Max. Temp.	30.7℃	37.7℃	51.8℃	62.1℃
△ Temp.	12.7℃	26.8℃	37.1℃	△ Temp.

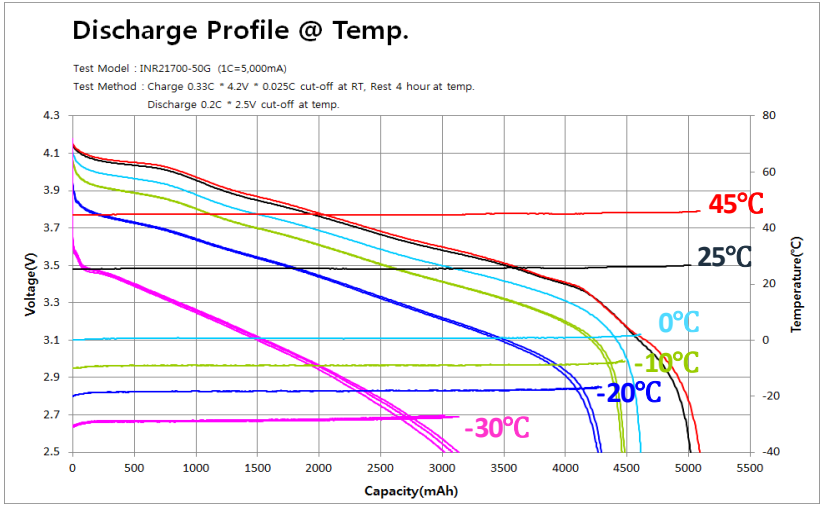
Charge / Discharge capability @ Temp.

☐ Charge/Discharge capacity @ Temp.

		Test Temp.					
Condition	C-rate	-30℃	-20℃	-10℃	0℃	25℃	45℃
Discharge	0.2C	61.3	85.3	89.1	92.0	100.0 *	101.5
	0.33C	-	84.0	88.2	90.3	98.2	100.5
	0.5C	-	82.8	87.5	90.0	97.8	100.3
	1.0C	-	73.0	85.3	88.6	96.6	100.0
	2.0C	-	40.7	66.6	89.1	97.3	99.0
	3.0C	-	31.7	92.4	93.0	97.7	98.5
Charge	0.33C	-	-	-	97.4	100.0 *	99.8
	0.5C	-	-	-	96.6	100.0	99.8
	1.0C	-	-	-	95.3	99.5	99.5

* Standard condition (Charge 0.33C / Discharge 0.2C) @25℃ = 100%

☐ 0.2C Discharge capacity @ Temp.

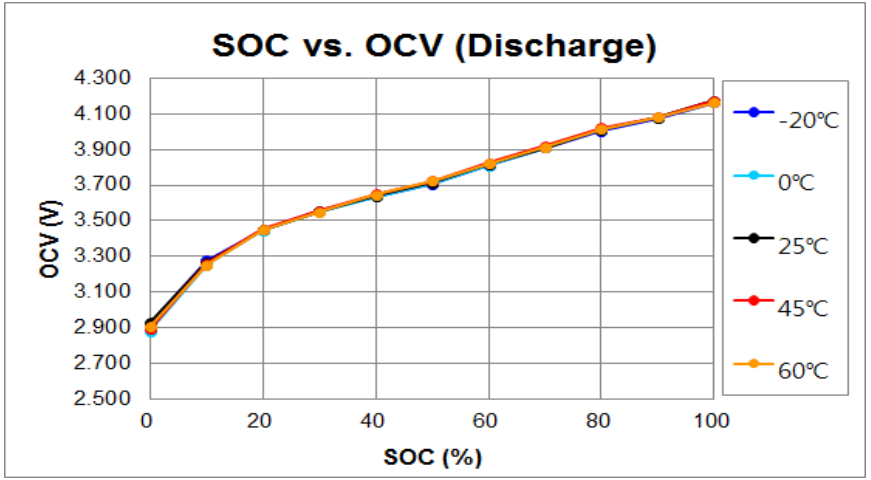


	-30℃	-20℃	-10℃	0℃	25℃	45℃
Max. Temp.	-27.4℃	-16.6℃	-7.4℃	2.1℃	26.9℃	46.1℃
△ Temp.	2.6℃	3.4℃	2.6℃	2.1℃	1.9℃	1.1℃

OCV vs. SOC (Discharge)

☐ OCV vs. SOC @ Temp.

SOC	-20℃	0℃	25℃	45℃	60℃
100.0	4.164	4.175	4.175	4.175	4.163
90.0	4.074	4.077	4.079	4.082	4.083
80.0	4.005	4.009	4.011	4.022	4.013
70.0	3.909	3.912	3.912	3.920	3.915
60.0	3.809	3.811	3.819	3.826	3.821
50.0	3.705	3.709	3.714	3.726	3.723
40.0	3.634	3.636	3.639	3.649	3.647
30.0	3.557	3.553	3.555	3.556	3.551
20.0	3.450	3.447	3.450	3.452	3.451
10.0	3.278	3.253	3.268	3.259	3.254
0.0	2.923	2.883	2.929	2.894	2.909



* Test condition :

- SOC setting : Charge 0.33C / Discharge 0.2C
- Rest : 1 hour

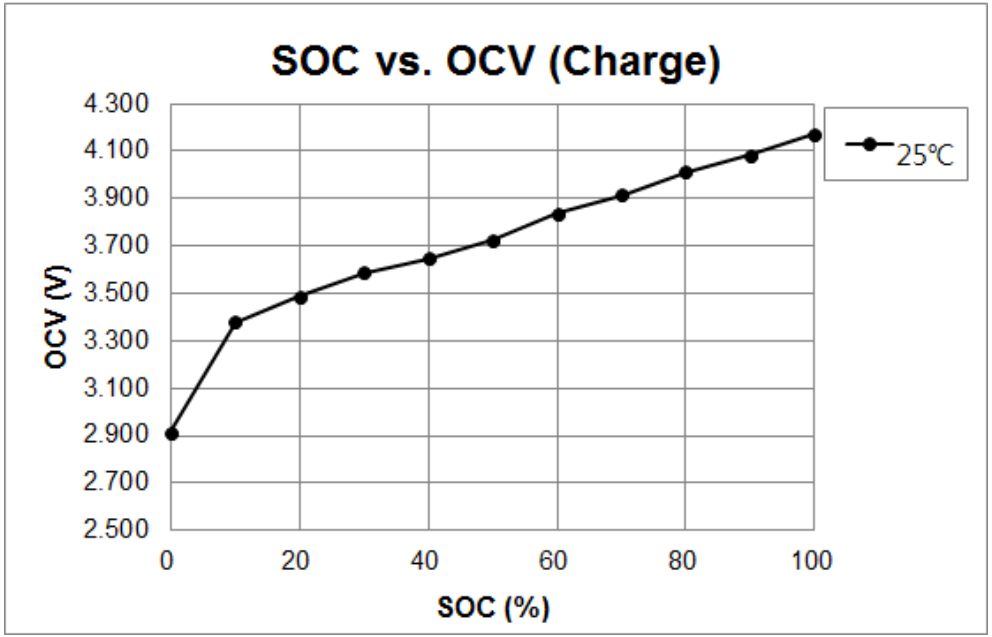
OCV vs. SOC (Charge)

☐ OCV vs. SOC @ Temp.

SOC	25℃
100.0	4.173
90.0	4.083
80.0	4.013
70.0	3.915
60.0	3.839
50.0	3.724
40.0	3.649
30.0	3.586
20.0	3.487
10.0	3.379
0.0	2.915

* Test condition :

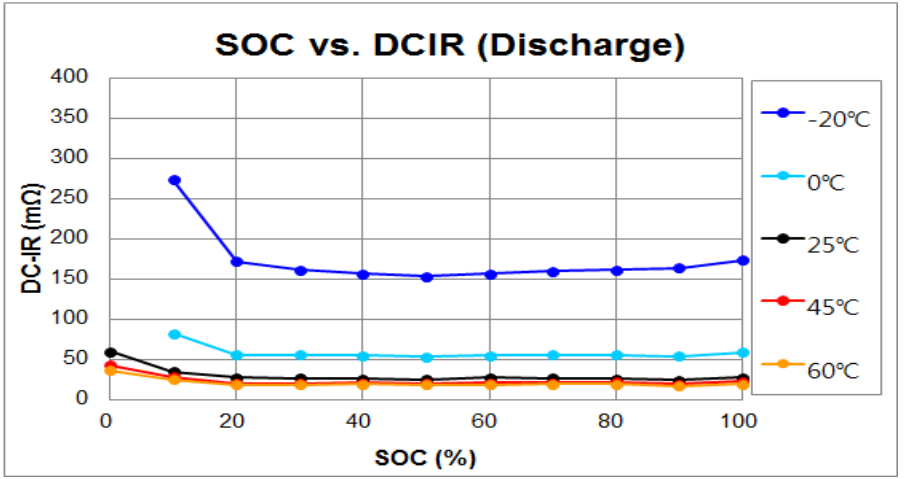
- SOC setting : Charge 0.33C / Discharge 0.2C
- Rest : 1 hour



DCIR vs. SOC

☐ DCIR (10sec) vs. SOC @ Temp.

SOC	-20℃	0℃	25℃	45℃	60℃
100.0	174.0	58.8	27.6	22.4	19.6
90.0	164.0	54.4	24.4	19.2	16.8
80.0	161.6	56.0	26.0	21.6	19.2
70.0	159.6	55.6	26.4	21.2	19.2
60.0	156.8	55.2	27.2	21.2	18.8
50.0	153.2	53.2	24.8	20.4	18.4
40.0	156.4	54.8	25.6	20.8	19.2
30.0	161.6	56.0	26.4	20.4	18.8
20.0	172.4	55.6	27.2	20.4	18.8
10.0	273.6	82.8	35.2	28.0	24.8
0.0	-	-	59.6	43.2	36.8



* Test condition :

- SOC setting : Charge 0.33C / Discharge 0.2C
- Rest : 1 hour
- DCIR : 0.5C

DCIR vs. SOC

☐ Discharge : 0.5C 2sec

SOC	-20℃	0℃	25℃	45℃	60℃
100.0	157.6	48.8	21.6	17.6	16.0
90.0	149.6	46.4	20.8	16.4	14.8
80.0	146.0	46.4	20.8	17.2	16.0
70.0	144.0	46.0	21.2	16.8	15.6
60.0	143.6	46.8	22.0	17.2	15.6
50.0	142.0	46.0	20.4	16.8	15.2
40.0	144.8	47.6	21.2	17.2	16.0
30.0	148.4	47.6	21.6	16.8	15.6
20.0	158.0	47.6	22.4	16.8	15.6
10.0	219.2	64.0	26.0	20.4	18.0
0.0	334.4	138.0	37.6	25.2	21.2

☐ Discharge : 0.5C 10sec

SOC	-20℃	0℃	25℃	45℃	60℃
100.0	174.0	58.8	27.6	22.4	19.6
90.0	164.0	54.4	24.4	19.2	16.8
80.0	161.6	56.0	26.0	21.6	19.2
70.0	159.6	55.6	26.4	21.2	19.2
60.0	156.8	55.2	27.2	21.2	18.8
50.0	153.2	53.2	24.8	20.4	18.4
40.0	156.4	54.8	25.6	20.8	19.2
30.0	161.6	56.0	26.4	20.4	18.8
20.0	172.4	55.6	27.2	20.4	18.8
10.0	273.6	82.8	35.2	28.0	24.8
0.0	-	-	59.6	43.2	36.8

☐ Discharge : 0.5C 30sec

SOC	-20℃	0℃	25℃	45℃	60℃
100.0	193.6	72.0	35.2	28.4	24.0
90.0	179.6	64.8	29.6	22.4	19.6
80.0	179.6	69.2	34.0	27.2	24.4
70.0	176.8	68.4	34.0	26.8	24.0
60.0	172.0	65.2	33.2	25.6	22.8
50.0	168.8	64.0	31.2	25.2	22.8
40.0	172.8	66.0	31.6	25.6	23.6
30.0	178.4	67.6	32.8	26.0	23.6
20.0	191.6	68.4	34.0	26.4	24.4
10.0	-	114.4	51.2	41.6	37.2
0.0	-	-	112.4	95.2	76.8

☐ Charge : 0.5C 2sec

SOC	-20℃	0℃	25℃	45℃	60℃
100.0	-	-	-	-	-
90.0	-	46.8	20.4	16.4	14.8
80.0	-	47.2	20.4	16.8	15.6
70.0	-	46.8	20.8	16.4	15.2
60.0	-	47.6	22.0	17.2	15.6
50.0	159.2	48.0	21.2	16.8	15.2
40.0	163.6	49.6	21.2	17.2	16.0
30.0	166.0	49.6	22.0	16.8	15.6
20.0	174.8	50.8	23.2	17.2	16.0
10.0	206.4	62.4	25.2	19.2	18.0
0.0	286.0	111.6	40.4	28.4	23.6

☐ Charge : 0.5C 10sec

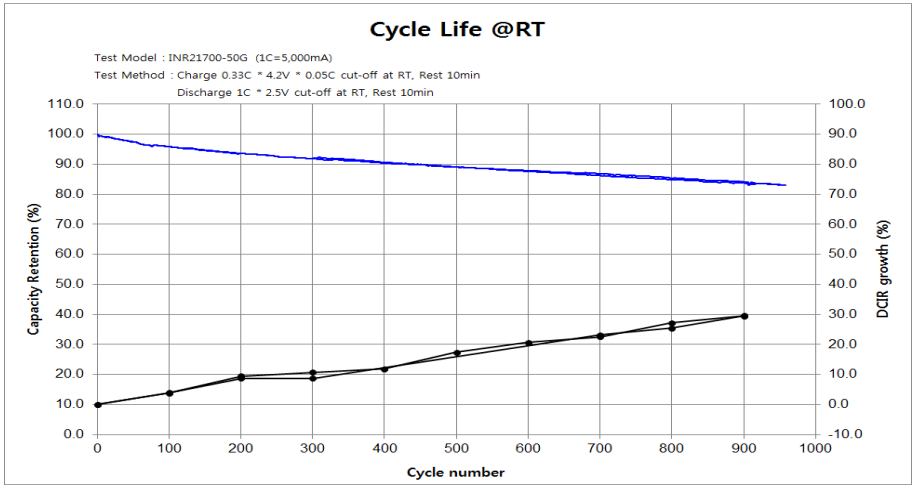
SOC	-20℃	0℃	25℃	45℃	60℃
100.0	-	-	-	-	-
90.0	-	-	24.0	19.2	17.2
80.0	-	54.8	24.4	20.0	18.4
70.0	-	54.4	24.8	19.6	18.0
60.0	-	55.6	26.8	21.6	19.2
50.0	174.8	56.0	26.4	20.4	18.4
40.0	178.0	56.4	25.6	20.8	18.8
30.0	180.4	56.4	26.0	20.4	18.8
20.0	190.0	58.8	28.0	20.8	19.6
10.0	222.0	72.4	32.0	25.2	23.2
0.0	314.8	135.6	62.4	50.8	42.8

☐ Charge : 0.5C 30sec

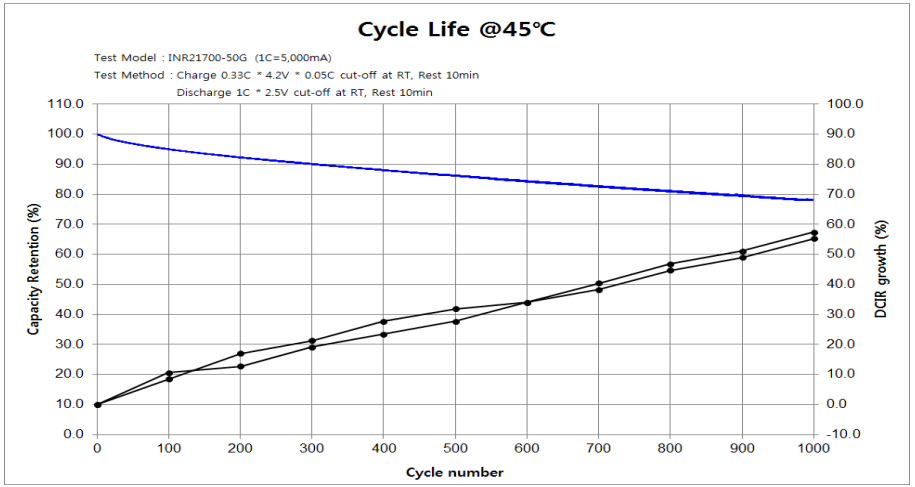
SOC	-20℃	0℃	25℃	45℃	60℃
100.0	-	-	-	-	-
90.0	-	-	28.8	22.4	19.6
80.0	-	66.0	30.8	24.4	22.0
70.0	-	64.4	30.4	23.6	21.2
60.0	-	65.6	32.8	27.2	24.0
50.0	179.6	68.0	33.6	26.0	22.8
40.0	182.8	67.2	32.0	24.8	22.4
30.0	186.8	65.6	31.2	25.2	23.2
20.0	202.4	70.0	34.8	26.4	24.4
10.0	236.0	84.8	41.2	34.8	32.0
0.0	343.2	168.4	96.4	84.8	73.6

Cycle Life (4.2V-2.5V)

☐ 0.33C/1C cycle life @ RT (4.2V-2.5V)



☐ 0.33C/1C cycle life @ 45℃ (4.2V-2.5V)

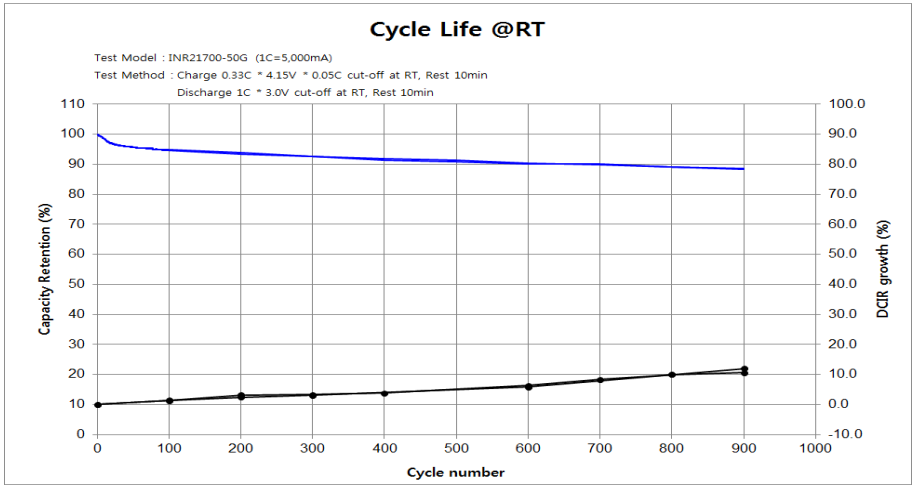


	Capacity Retention	DCIR growth
@ RT, 500cyc.	89.1%	17.4%
@ RT, 1000cyc.	On-going	On-going

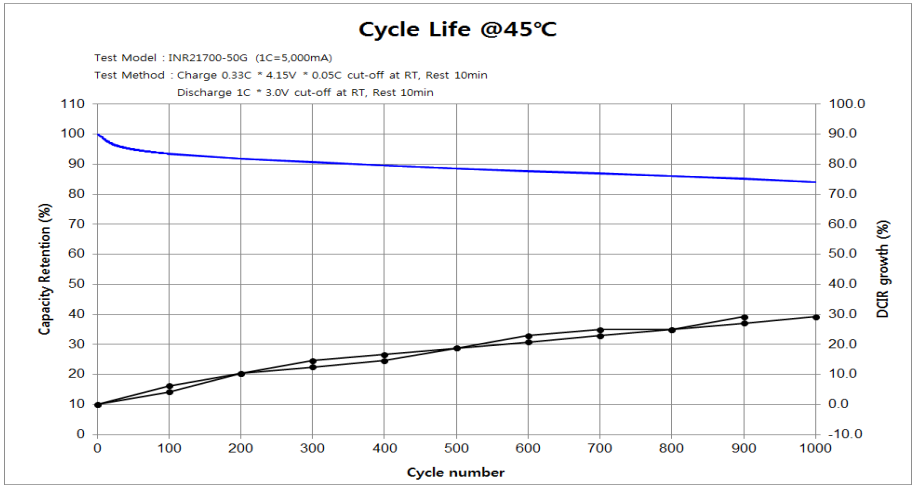
	Capacity Retention	DCIR growth
@ 45℃, 500cyc.	86.2%	29.8%
@ 45℃, 1000cyc.	78.0%	57.4%

Cycle Life (4.15V-3.0V)

☐ 0.33C/1C cycle life @ RT (4.15V-3.0V)



☐ 0.33C/1C cycle life @ 45℃ (4.15V-3.0V)

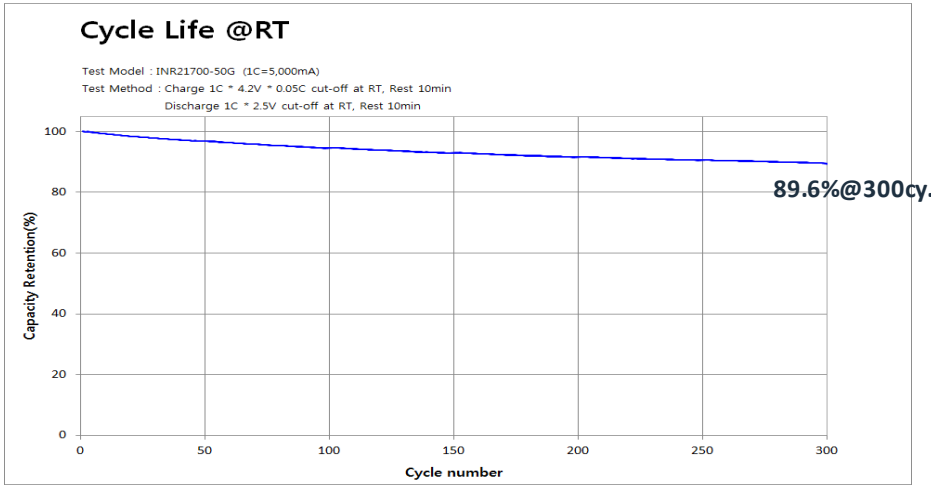


	Capacity Retention	DCIR growth
@ RT, 500cyc.	90.7%	5.3%
@ RT, 1000cyc.	On-going	On-going

	Capacity Retention	DCIR growth
@ 45℃, 500cyc.	88.6%	18.7%
@ 45℃, 1000cyc.	84.5%	29.2%

Fast Charge Cycle Life

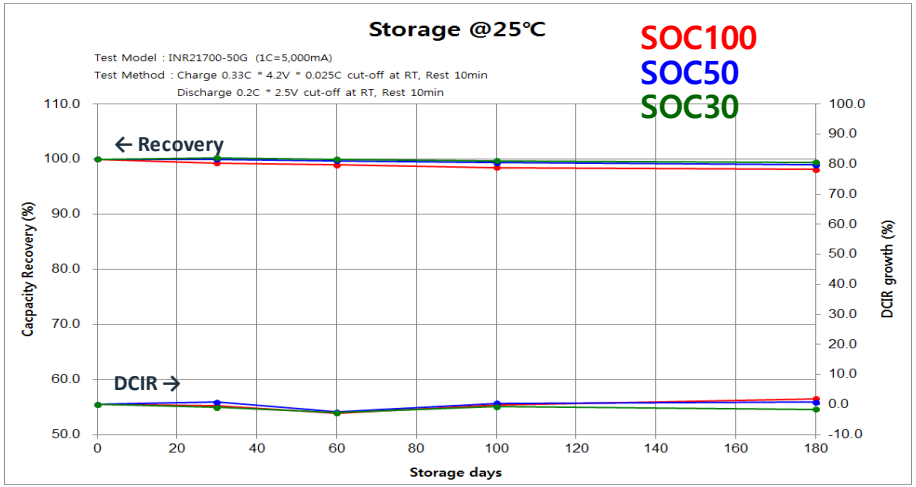
☐ 1C/1C cycle life @ RT



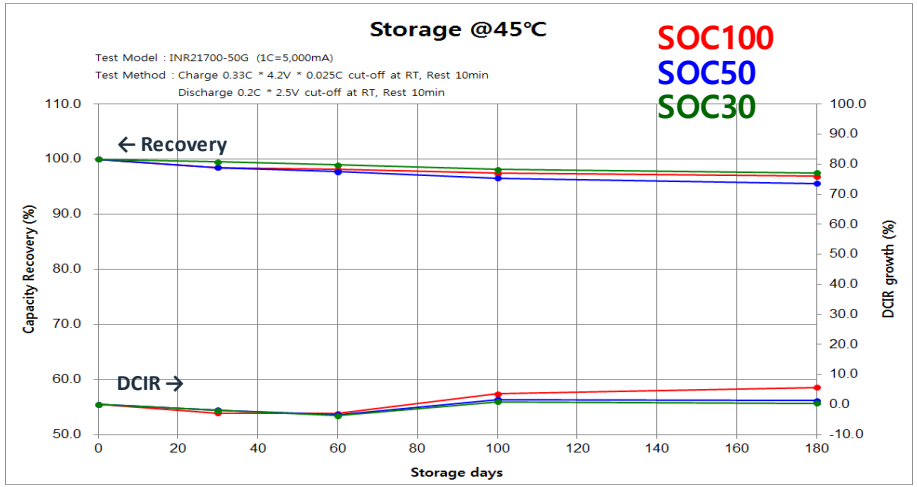
@ RT	Capacity Retention
300cycle	89.6%

Storage

☐ Storage w/ SOC @ 25℃



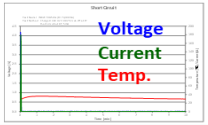
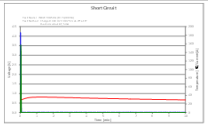
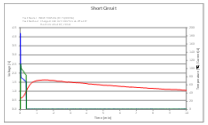
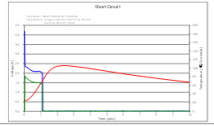
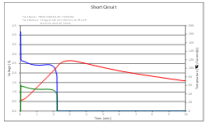
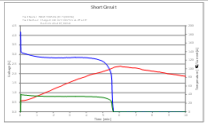
☐ Storage w/ SOC @ 45℃



@ 25℃, 180days	Capacity Recovery	DCIR growth
SOC100%	98.1%	1.9%
SOC50%	99.0%	0.8%
SOC30%	99.5%	-1.5%

@ 45℃, 180days	Capacity Recovery	DCIR growth
SOC100%	96.9%	5.7%
SOC50%	95.6%	1.3%
SOC30%	97.5%	0.4%

External Short Circuit

Test Condition	Profile	Max. temp.	Max. Current	Result
5mΩ		35.9℃	180A	OK (positive tab melting)
10mΩ		36.1℃	158A	OK (positive tab melting)
20mΩ		72.3℃	111A	OK (fully discharge, CID activation)
30mΩ		106.3℃	83A	OK (fully discharge, CID activation)
50mΩ		117.9℃	61A	OK (fully discharge, CID activation)
80mΩ		105.8℃	41A	OK (fully discharge, CID activation)

50G Performance usable guide （TBD）

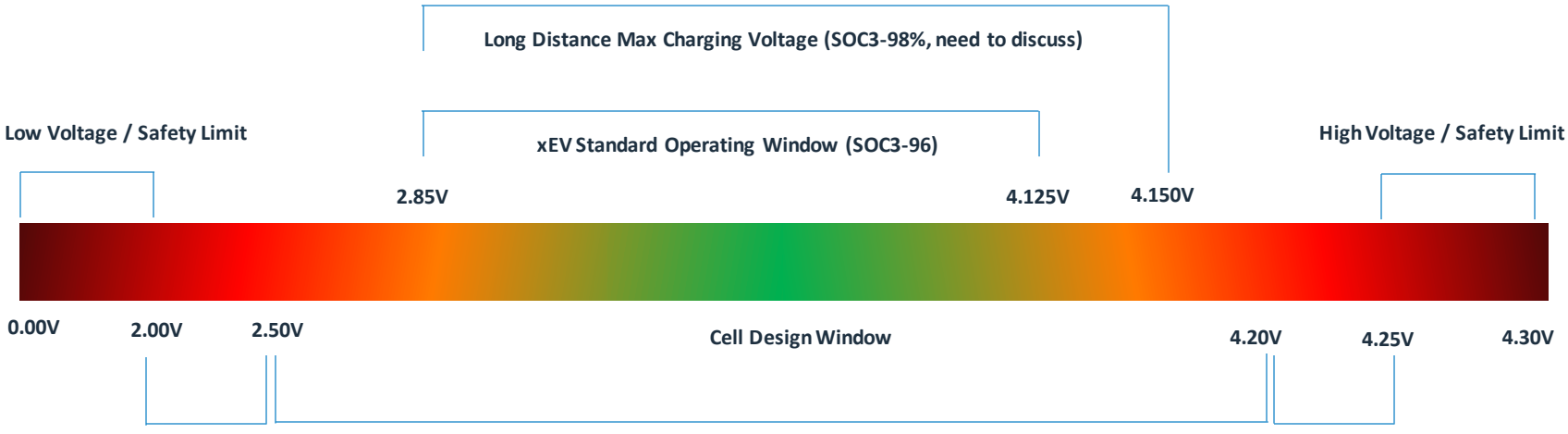
- **Usable Voltage Range**

Low Temp Charging Algorism Check

DC/AC Inverter Operating Voltage Check

Cell Surface	Charge Max Voltage (V)			Discharge Min Voltage (V)		
	Operating Limit	Pulse Limit	Safety Limit	Operating Limit	Pulse Limit	Safety Limit
-30℃~-20℃	Not permitted			2.850V	2.500V	2.000V
-20℃~-10℃				2.850V	2.500V	2.000V
-10℃~0℃				2.850V	2.500V	2.000V
0℃~10℃	4.125V	4.200V	4.250V	2.850V	2.850V	2.500V
10℃~25℃	4.125V	4.200V	4.250V	2.850V	2.850V	2.500V
25℃~32℃	4.125V	4.200V	4.250V	2.850V	2.850V	2.500V
32℃~40℃	4.125V	4.200V	4.250V	2.850V	2.850V	2.500V
40℃~50℃	4.125V	4.150V	4.200V	2.850V	2.850V	2.500V
50℃~60℃	Not permitted			2.850V	2.850V	2.500V

Operating window guide



Voltage	SOC
4.200V	100%
4.175V	99%
4.150V	98%
4.125V	96%
4.100V	92%

Voltage	DOD
2.50V	100%
2.85V	97%
3.00V	95%

50G Operating Charging Guide (TBD)

Temperature (℃)	< 0	0~5	5~10	10~20	20~30	30~40	40~50	> 50
Charging Condition	Not Permitted	0.15C 4.125V	0.20C 4.125V	0.25C 4.125V	0.33C 4.125V	0.33C 4.125V	0.20C 4.125V	Not Permitted
Heating		Need	X	X	X	X	X	
Cooling		X	X	X	X	Need	Need	
Quick Charging		X	X	X	X	Permitted (Cooling 32±2℃)	X	

※ Notice

✓ Heating Start Temperature : 0℃ / Heating End Temperature : 5℃

✓ Regeneration Charging < SOC95%, Less than 10sec

✓ Operating Temperature : 32±2℃, Storage Temperature : 25±2℃ (Cooling Guide)

- The above condition must be complied with when low temperature charging, heating, and regeneration charging of the cylindrical Li-ion battery for xEV.
- If the customer anticipates any problems in meeting the above conditions, customer must immediately notify Samsung SDI, and the parties will discuss. 11

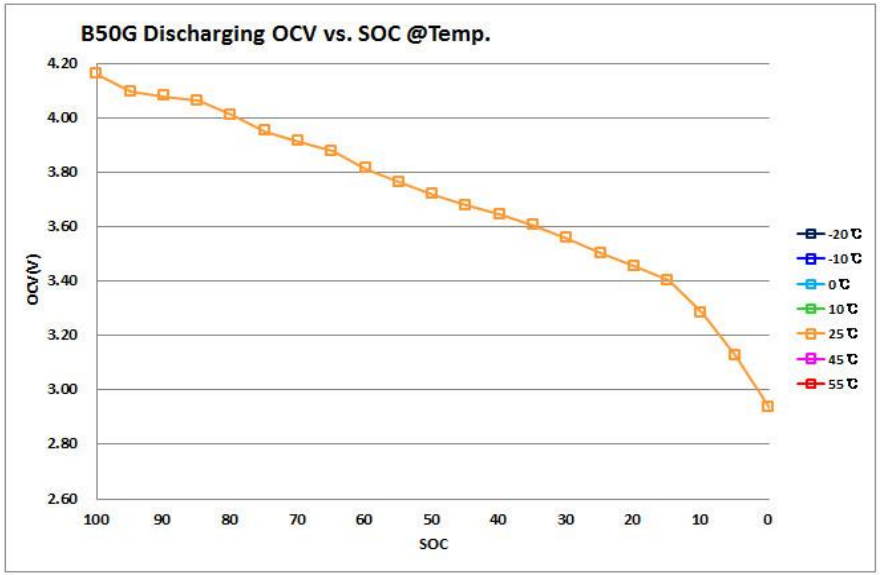
BOL SOC vs. OCV Table (Discharge)

1. Test Condition

Step1. Charge 0.20C 4.20V 0.05C Cut-off
Step2. Storage 4hr @RT -------> OCV Check @SOC100
Step3. Discharge 0.20C 5% of capacity Cut-off
Step4. Storage 4hr @RT--------> OCV Check @SOC95~0
Step5. Repeat Step 3-4 until 0%
Step6. Charge 0.2C 5% of capacity Cut-off
Step7. Storage 4hr @RT--------> OCV Check @SOC5~100
Step8. Repeat Step 8-9 until 100%

2. Test Result

SOC	-20℃	-10℃	0℃	10℃	25℃	45℃	55℃
100					4.159		
95					4.095		
90					4.079		
85					4.061		
80					4.009		
75					3.951		
70					3.911		
65					3.878		
60					3.814		
55					3.764		
50					3.719		
45					3.678		
40					3.644		
35					3.605		
30					3.556		
25					3.501		
20					3.453		
15					3.401		
10					3.284		
5					3.127		
0					2.935		



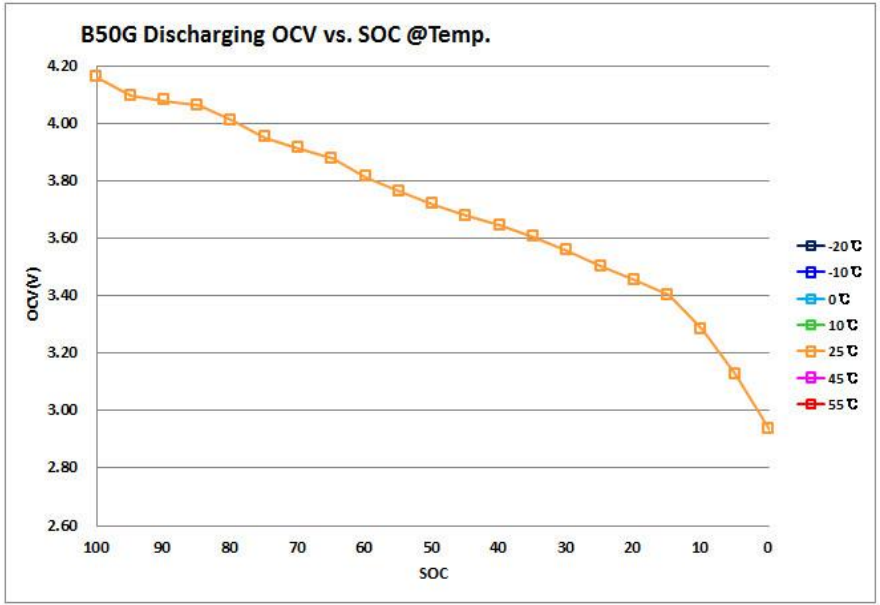
BOL SOC vs. OCV Table (Charge)

1. Test Condition

Step1. Charge 0.20C 4.20V 0.05C Cut-off
Step2. Storage 4hr @RT -------> OCV Check @SOC100
Step3. Discharge 0.20C 5% of capacity Cut-off
Step4. Storage 4hr @RT--------> OCV Check @SOC95~0
Step5. Repeat Step 3-4 until 0%
Step6. Charge 0.2C 5% of capacity Cut-off
Step7. Storage 4hr @RT--------> OCV Check @SOC5~100
Step8. Repeat Step 8-9 until 100%

2. Test Result

SOC	-20℃	-10℃	0℃	10℃	25℃	45℃	55℃
100					4.159		
95					4.095		
90					4.079		
85					4.061		
80					4.009		
75					3.951		
70					3.911		
65					3.878		
60					3.814		
55					3.764		
50					3.719		
45					3.678		
40					3.644		
35					3.605		
30					3.556		
25					3.501		
20					3.453		
15					3.401		
10					3.284		
5					3.127		
0					2.935		



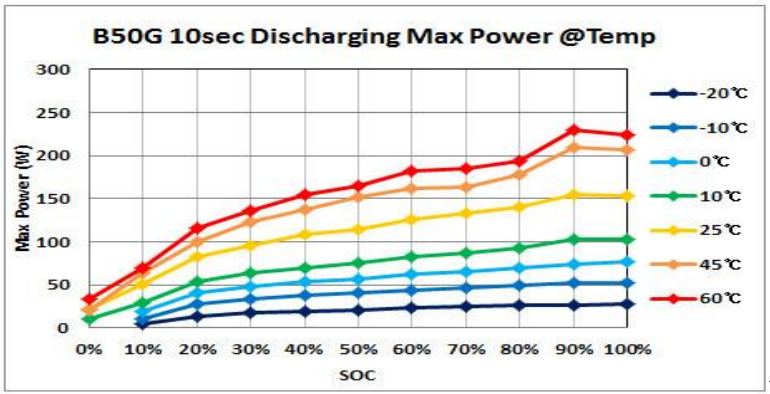
BOL Discharge Max Power

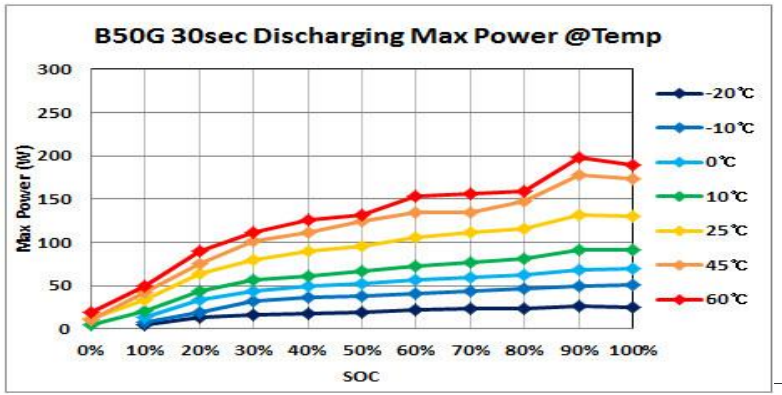
1. Test Condition

- Charge 0.33C, 4.20V, 0.05C Cut-off @25℃
- Discharge 0.20C Time Cut-off each SOC@25℃
- Temperature Storage Time : 4hr @ Each Temp.
- Discharge 0.5C/1.0C/2.0C 30sec Cut-off ※ -20℃,-30℃ 0.33C/0.5C/1.0C

2. Test Result (30sec)

Temp	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
-20℃	-	4.4	13.1	16.6	18.6	19.9	21.7	23.1	24.3	25.9	25.7
-10℃	-	8.1	20.0	31.9	36.0	38.2	41.5	44.5	46.6	49.9	50.7
0℃	-	13.5	33.8	43.9	49.0	51.9	56.7	60.2	62.5	68.3	70.3
10℃	4.5	21.2	44.4	57.0	61.4	66.7	72.7	77.4	81.2	91.4	91.6
25℃	12.6	34.0	63.9	80.5	90.4	95.1	106.2	112.1	115.9	132.4	130.6
45℃	10.3	42.6	75.5	101.2	112.0	124.6	135.1	134.2	148.1	178.4	173.3
60℃	19.6	49.7	89.9	112.0	126.5	132.5	153.4	156.6	158.5	197.6	189.8





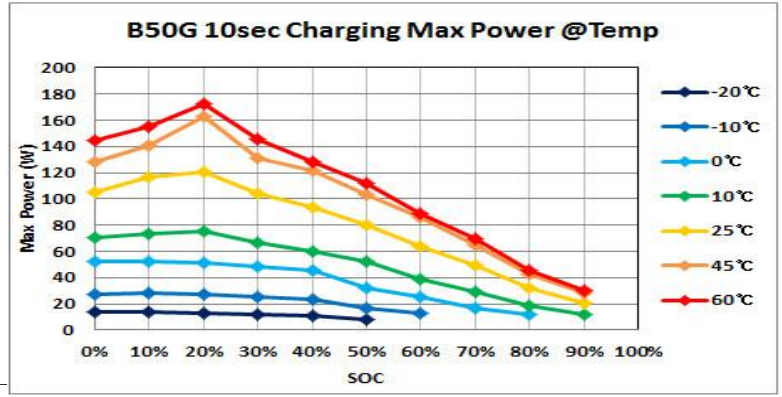
BOL Charge Max Power

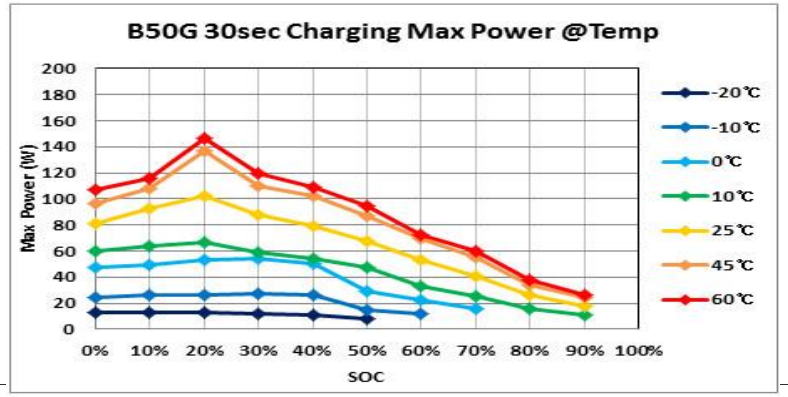
1. Test Condition

- Charge 0.33C, 4.20V, 0.05C Cut-off @25℃
- Discharge 0.20C Time Cut-off each SOC@25℃
- Temperature Storage Time : 4hr @ Each Temp.
- Charge 0.5C/1.0C/2.0C 30sec Cut-off ※ -20℃,-30℃ 0.33C/0.5C/1.0C

2. Test Result (30sec)

Temp	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
-20℃	12.5	12.6	12.5	11.9	11.4	7.7	-	-	-	-	-
-10℃	24.9	26.0	26.8	27.3	26.8	15.1	12.2	-	-	-	-
0℃	47.5	49.9	53.2	53.9	50.1	28.8	22.7	15.4	-	-	-
10℃	60.2	63.4	66.7	59.2	54.4	47.0	32.9	25.7	16.1	10.7	-
25℃	81.5	92.4	101.9	87.6	79.3	67.3	52.9	40.7	26.4	17.8	-
45℃	96.1	107.9	137.1	109.6	102.8	86.9	69.3	55.1	34.0	24.5	-
60℃	107.1	116.0	146.3	119.5	109.0	94.8	72.7	59.7	37.5	26.4	-





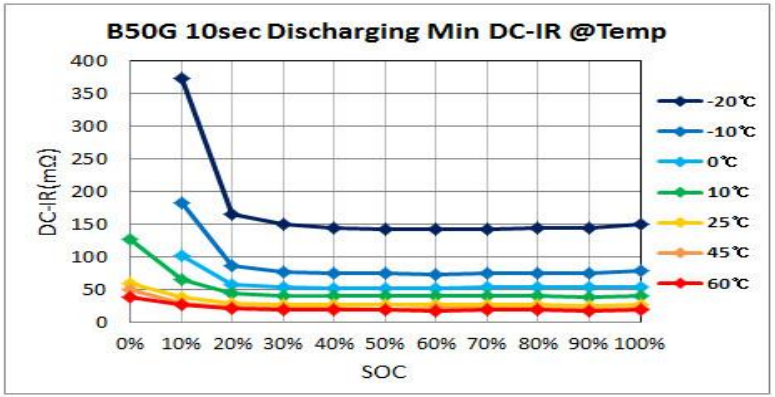
BOL Discharge Min DC-Impedance

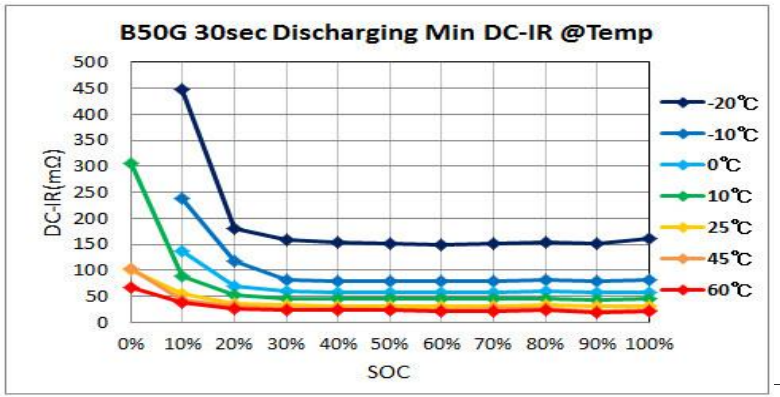
1. Test Condition

- Charge 0.33C, 4.20V, 0.05C Cut-off @25℃
- Discharge 0.20C Time Cut-off each SOC@25℃
- Temperature Storage Time : 4hr @ Each Temp.
- Discharge 0.5C/1.0C/2.0C 30sec Cut-off ※ -20℃,-30℃ 0.33C/0.5C/1.0C

2. Test Result (30sec)

Temp	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
-20℃	-	447.3	180.7	158.8	152.7	151.2	150.0	152.3	154.6	151.7	160.2
-10℃	-	237.2	118.3	82.3	78.8	78.7	78.3	79.0	80.4	78.9	81.2
0℃	-	138.0	69.8	59.7	57.9	58.0	57.3	58.4	60.2	57.7	58.4
10℃	304.8	89.8	53.3	46.0	46.2	45.3	44.9	45.5	46.3	43.1	45.0
25℃	102.0	55.6	37.0	32.6	31.5	31.8	30.8	31.4	32.5	29.8	31.7
45℃	103.4	43.5	31.2	25.8	25.4	24.4	24.2	26.3	25.5	22.2	23.9
60℃	66.0	38.5	26.4	23.4	22.6	23.0	21.4	22.5	23.8	20.0	21.8





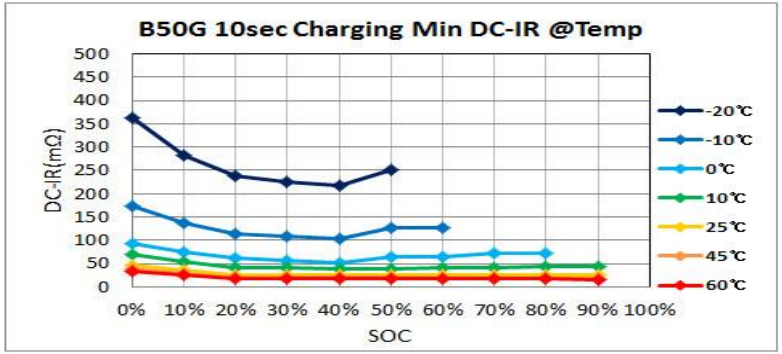
BOL Charge Min DC-Impedance

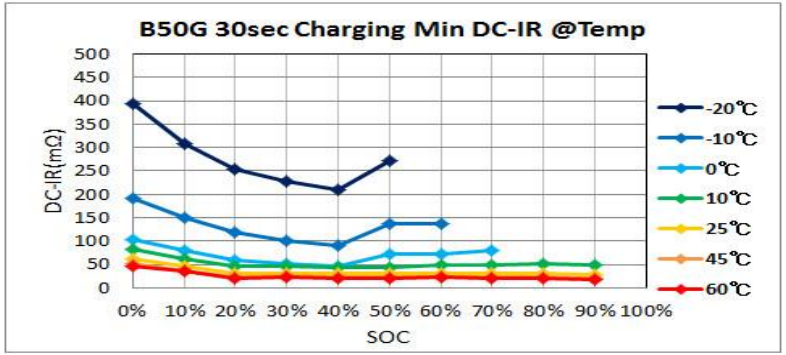
1. Test Condition

- Charge 0.33C, 4.20V, 0.05C Cut-off @25℃
- Discharge 0.20C Time Cut-off each SOC@25℃
- Temperature Storage Time : 4hr @ Each Temp.
- Charge 0.5C/1.0C/2.0C 30sec Cut-off ※ -20℃,-30℃ 0.33C/0.5C/1.0C

2. Test Result (30sec)

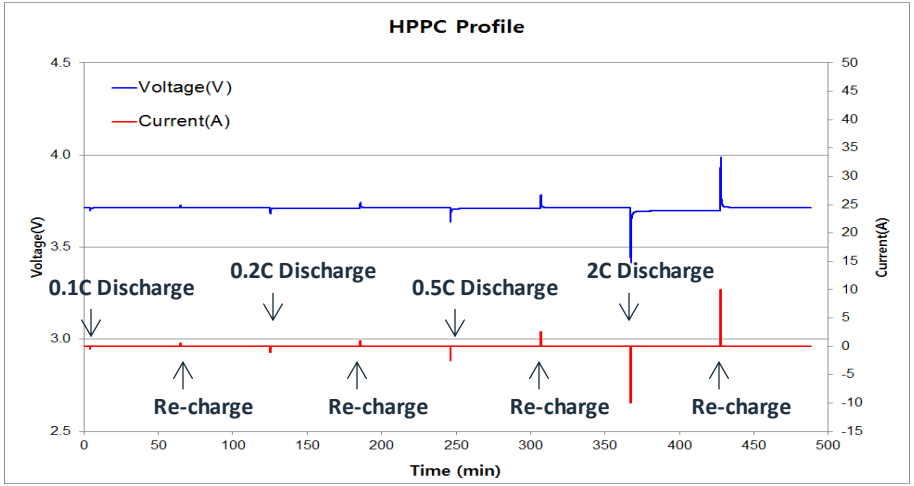
Temp	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
-20℃	394.2	307.0	254.0	227.6	209.0	271.8	-	-	-	-	-
-10℃	191.6	150.9	118.1	100.1	89.8	137.4	138.4	-	-	-	-
0℃	102.8	79.2	59.1	50.9	46.9	72.0	73.2	79.4	-	-	-
10℃	82.3	61.8	47.6	46.1	43.6	44.0	50.3	47.9	51.4	48.6	-
25℃	61.6	45.5	31.1	31.3	30.3	30.6	31.4	30.1	31.4	28.8	-
45℃	51.2	36.3	23.1	25.0	22.9	23.4	23.6	22.2	23.5	20.5	-
60℃	46.3	35.6	21.6	23.0	21.1	21.2	22.0	20.4	21.7	18.9	-



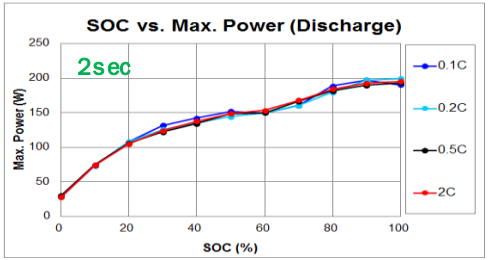


Appendix: HPPC

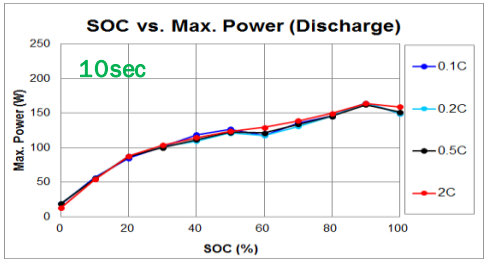
☐ HPPC Profile (ex. SOC50%, RT)



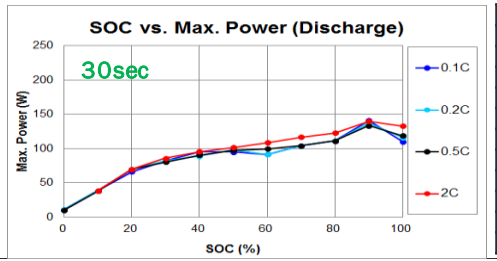
☐ HPPC Power vs. SOC @ RT



SOC	0.1C	0.2C	0.5C	2C
100.0	190.3	199.2	193.5	195.2
90.0	197.4	197.4	189.8	192.6
80.0	188.9	179.9	181.6	184.3
70.0	160.5	160.5	166.5	168.1
60.0	149.9	149.9	149.8	153.3
50.0	151.8	144.5	148.8	148.9
40.0	142.4	135.7	134.4	137.7
30.0	131.9	125.6	122.2	123.9
20.0	108.0	108.0	106.0	105.2
10.0	73.8	74.2	74.5	74.0
0.0	28.2	29.9	30.2	28.2



SOC	0.1C	0.2C	0.5C	2C
100.0	149.6	149.4	151.4	158.8
90.0	164.5	164.5	161.8	163.8
80.0	145.3	145.3	145.3	149.3
70.0	135.8	130.7	133.7	139.0
60.0	117.8	117.8	121.1	129.2
50.0	126.5	121.4	122.4	123.5
40.0	118.6	109.6	111.3	114.5
30.0	101.4	101.4	100.0	103.5
20.0	84.8	88.0	87.3	88.1
10.0	56.5	55.1	55.0	53.9
0.0	18.5	19.4	19.0	13.1

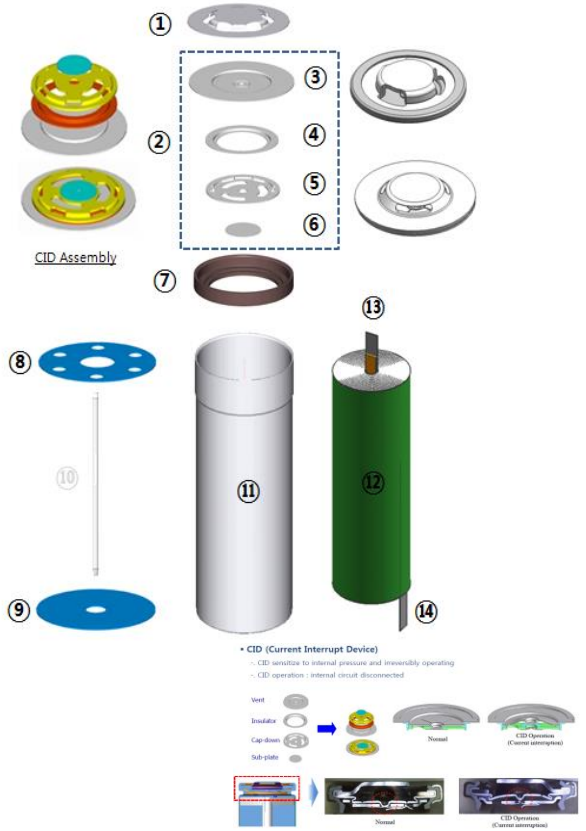


SOC	0.1C	0.2C	0.5C	2C
100.0	110.2	116.2	118.8	132.6
90.0	141.0	136.1	133.4	140.0
80.0	111.1	111.1	111.1	122.6
70.0	103.8	103.8	103.8	116.5
60.0	91.6	91.6	99.2	108.4
50.0	94.8	97.9	97.3	101.6
40.0	94.9	89.1	90.2	95.3
30.0	82.4	82.4	80.5	86.0
20.0	66.0	69.9	69.9	69.5
10.0	38.4	38.6	37.8	38.4
0.0	10.9	11.3	10.1	-

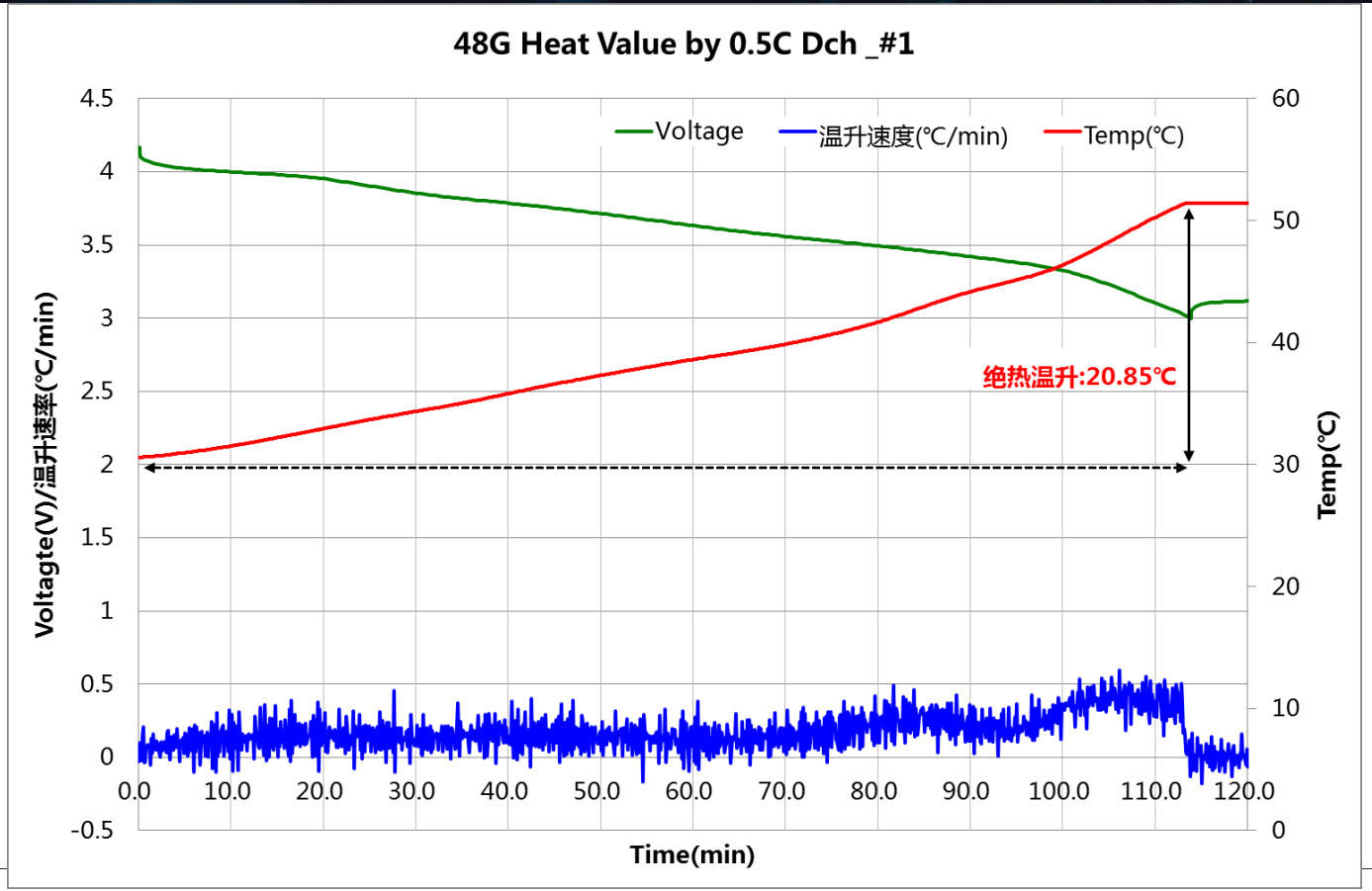
EOD

Appendix: Cylindrical cell design

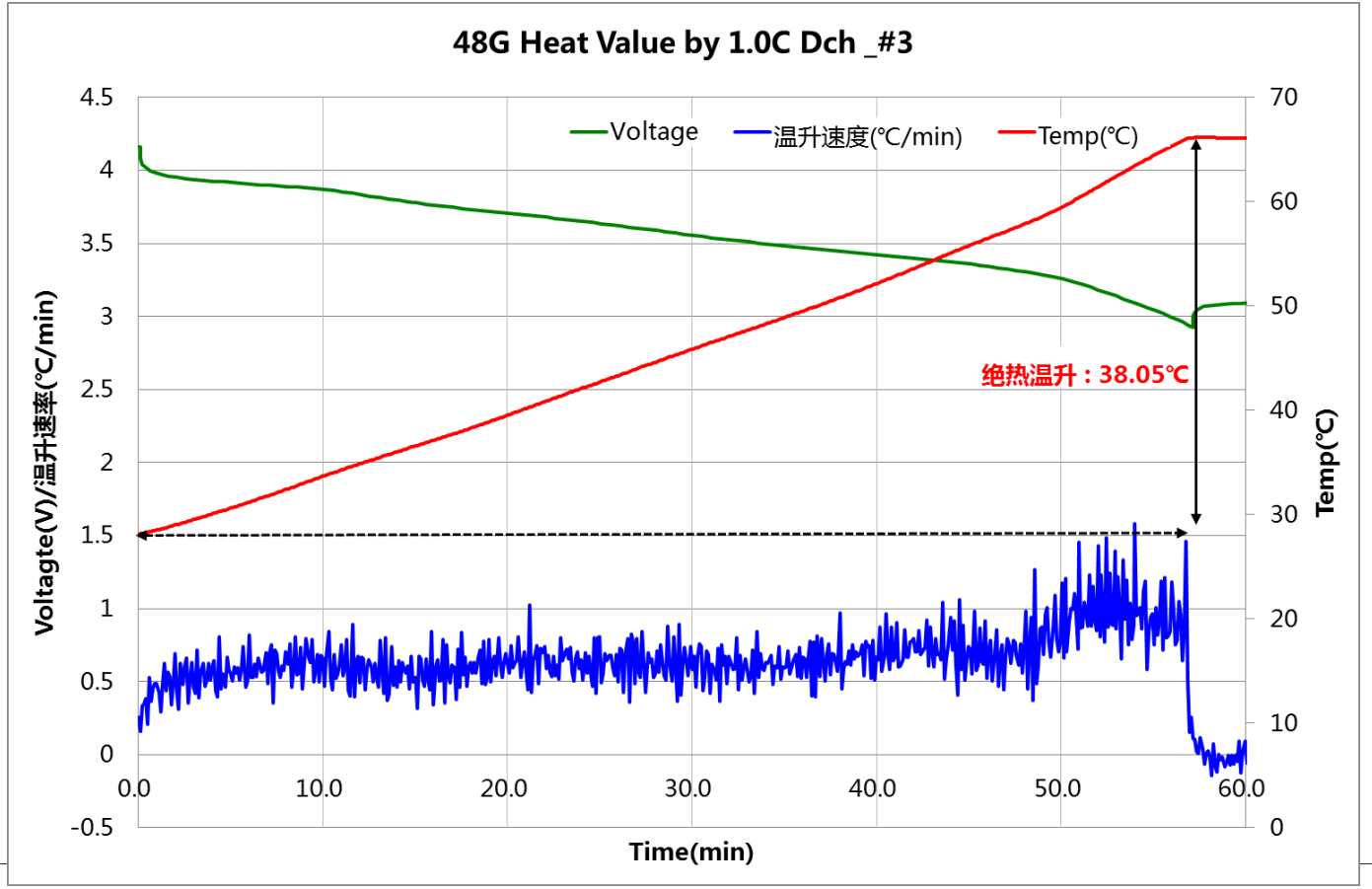
No.	Name	Function
1	Top Cap-up	Positive terminal, Evacuation of gas
2	CID	Current Interrupt Device
3	Vent	Release internal pressure
4	CID Insulator	Insulation between Vent and Cap down
5	Cap Down	Prevent mechanical damage of vent
6	Sub-plate	Cathode tab conduction path
7	Gasket	Prevent leakage, Insulation between + and -
8	Top Insulator	Insulation between (+)Tab and Jelly Roll
9	Bottom Insulator	Insulation between Jelly Roll and Can
10	Center-pin	Path for releasing internal gas
11	Can	Overall housing
12	Jelly-roll	Winded Positive/Negative/Separator
13	Cathode Tab	Conduction path
14	Anode Tab	Conduction path



Appendix: 48G 绝热温升 （0.5C放电）



Appendix: 48G 绝热温升 （1.0C放电）



Appendix: 48G 绝热温升 （1.2C充电）