To: LFEVY42016 Team
From: Geoff Nudge
Date: 5/7/2016
Subject: Acceptance Test Report: Item 5

Abstract

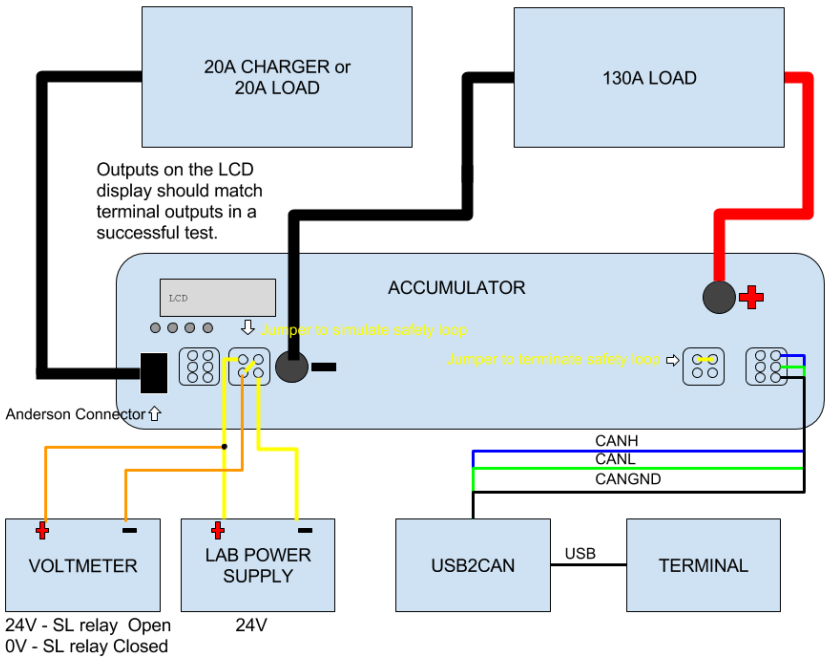
This item consisted of fully charging and discharging an accumulator through the 20A port, and discharging an accumulator though AIRs with varying current while connected to a safety loop. Jumpers on the safety loop connector and 24 V DC power supply stood in place of the GLV safety loop. Data was collected by VSCADA via CAN during all tests.

Requirements Analysis

The following chart details the requirements that are tested with this item:

R001: TSV Battery Pack Accumulator					
SOW Req. #	Descrption	Team Member	ATP Item	P/F	Grade
R001a	Charge Algorithm	Geoff	5	P	
R001c	Displays and Indicators	Jae	5	F	
R001d	Pack Controls	Jae	5	F	
R001e	Low Current Output	Geoff	5	P	
R001f	One Complete Accumulator	Geoff	5	P	
R002j	Plug and Forget Charging	Geoff	5	P	

Technical Findings



The above diagram details the test setup used. VSCADA software was used to collect data on the terminal.

The following procedure was followed:

1. All system menus are navigated to while pack is near 0%, and values noted.
2. A charger set to 20 A is connected to the accumulator with SOC near 0%
3. Charging commences automatically.
4. All system menus are navigated to while pack is charging, and values noted.
5. Charging ends automatically at 100% SOC.
6. All system menus are navigated to while pack charged, and values noted.
7. The charger is disconnected.
8. The charger is reconnected to ensure charging does not continue.
9. All system menus are navigated to, and values noted.
10. A 20 A load is connected to the 20 A port and the accumulator is discharged to about 50% to set up the second charge test.
11. All system menus are navigated to while discharging, and values noted.
12. A charger is connected to the accumulator with SOC near 50%
13. Charging commences automatically.
14. Charging ends automatically at 100% SOC.

15. A 20 A load is connected to the 20 A port and the accumulator completely discharged.
16. The charger is reconnected and the accumulator is charged to prepare for discharge through the AIRs.
17. Verify that SOC is near 100% on LCD screen and disconnect the charger. Check that the system is properly connected to all components, and a suitable load is attached to the accumulator.
18. Close the safety loop and put the system in demo mode.
19. Apply load to draw 20 A for 30 sec.
20. Apply load to draw 75 A for 30 sec.
21. Apply load to draw 130 A (this is a maximum for the load) for 30 sec.
22. Set load to 75 A and allow SOC to fall to 10%.
23. Apply load to draw 20 A for 30 sec.
24. Apply load to draw 75 A for 30 sec.
25. Apply load to draw 130 A for 30 sec.
26. Set load to 75 A and allow SOC to fall to 0%.
27. Verify that the safety loop has opened to prevent damage to cells.

The following data was collected during the test and determinations of pass/fail were made accordingly:

R001a: Charging Algorithm

- Pass/Fail: The pack charges successfully, and stops charging near 100% SOC on LCD screen. Discharge stops near 0% SOC on LCD.

Observations taken during the following steps	Observed Initial SOC%	Observed Load/Charge Current, Amps	Observed Control Panel Current, Amps	Observed Final SOC%	Time Required (Data Collection Only)
1, 4, 4, 5	0	19.98	-20.184	100	2:56:37
10,11,11,10	100	20.00	20.576	50	1:25:48
12,13,13,14	50	19.98	-20.338	100	1:27:46
15 all fields	100	20.0	20.571	0	3:10:22
16 all fields	0	19.98	-20.478	100	3:12:43
17 all fields	100	0	0.056	100	NA
19 all fields	100	20.2	20.336	100	0:00:48

20 all fields	98	75.1	75.267	97	0:00:49
21 all fields	96	130.3	130.669	94	0:00:48
22 all fields	94	75.0	75.012	10	0:39:58
23 all fields	10	20.1	19.785	10	0:00:39
24 all fields	10	75.0	74.971	8	0:00:41
25 all fields	8	130.0	130.306	5	0:00:39
26 all fields	5	75.0	74.864	0	0:04:15

Geoffery Nudge	5/5/16	Pass
Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: The accumulator does not require human intervention (plug and forget) to complete a charge cycle.

Human Interaction Required After Attaching Charger
None

Geoffery Nudge	5/5/16	Pass
Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: An accumulator Thevenin resistance and voltage are calculated from the results of a load test with the pack fully charged and is consistent with the design values.

Calculated Thevenin Resistance (Ohms)	Calculated Thevenin Voltage (V)
14 mOhm @ 100% SOC 26 mOhm @ 0% SOC	23.6 V @ 100% SOC 21.2 V @ 0% SOC

Geoffery Nudge	5/5/16	Pass
Witness/Examiner Signature	Date	Pass/Fail

R001c: Displays and Indicators

- Pass/Fail: The state of the accumulator (idle, charging, charge complete), and all pertinent data, are displayed.

SOC, overall pack voltage, pack current, cell voltage and temperature, and pack state, cell balancing state, safety loop state, charging history, discharge history, and calibration factors.

The following pictures show the menus:

Values Not Available Through the Menu System
Charge History, Discharge History, Cal Factors

Geoffery Nudge	5/5/16	Fail
Witness/Examiner Signature	Date	Pass/Fail

- Pass/Fail: A ‘pack-alive’ light is illuminated when the AIRs are closed

Geoffery Nudge	5/5/16	Pass
Witness/Examiner Signature	Date	Pass/Fail

R001d: Pack Controls

- Pass/Fail: The controls allow navigation to all menus.

Expected Menus that Are Not Available
Cal Factors, Charge/Discharge History

Geoffery Nudge	5/5/16	Fail
Witness/Examiner Signature	Date	Pass/Fail

Pass/Fail: A top level menu with SOC, overall voltage, and highest temperature reading

- Cycle up and down buttons select each cell and drill down button.
  - Will include picture of menu

Geoffery Nudge	5/5/16	Fail
Witness/Examiner Signature	Date	Pass/Fail

Pass/Fail: A menu for each cell available by drilling down from top level that contains voltage, temp, and calibration factors

- Drill down to select calibration factor.
  - Will include picture of menu

Geoffery Nudge	5/5/16	Fail
Witness/Examiner Signature	Date	Pass/Fail

R001e: Low Current Output

- The output is used to supply power to a load

Pass/Fail: This is satisfied if the accumulator can power the load without component or software failure in all SOC and from near 100% to near 0%.

Observed Failures
None

Geoffery Nudge	5/5/16	Pass
Witness/Examiner Signature	Date	Pass/Fail

R001f: Complete Accumulator

- Pass/Fail: All requirements related to completing an accumulator are tested successfully with this item.

Geoffery Nudge	5/5/16	Pass
Witness/Examiner Signature	Date	Pass/Fail

Software	Description	Version Used
PACMAN	Software that speaks over CAN and monitors the PAC	0.14
AMS	Responds to I2C messages from PACMAN to report measurands	3.0

Results

Data collected via CAN with VSCADA is available as csv and xlsx files on the course website at the following address:

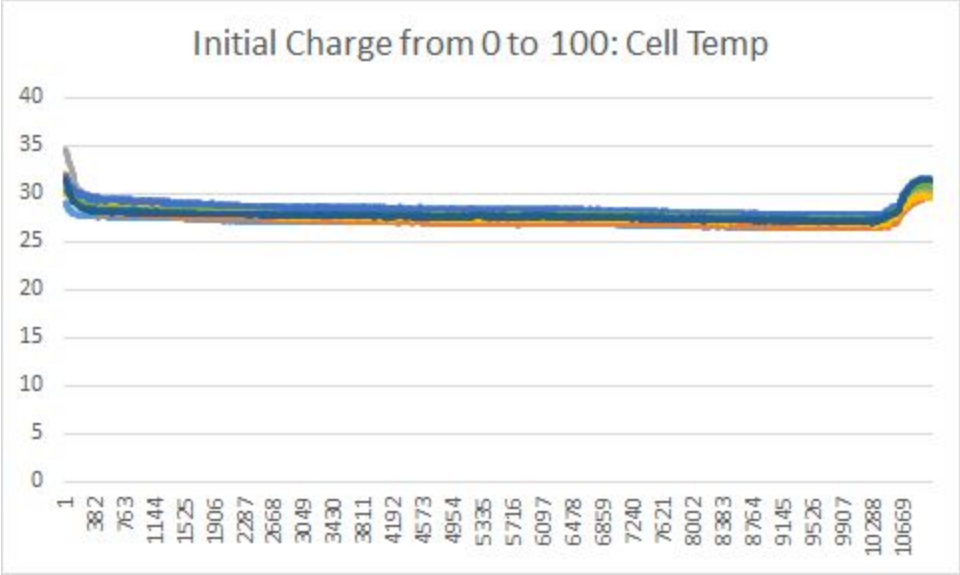
https://sites.lafayette.edu/ece492-sp16/files/2016/05/AcceptanceTestData_TSV.zip

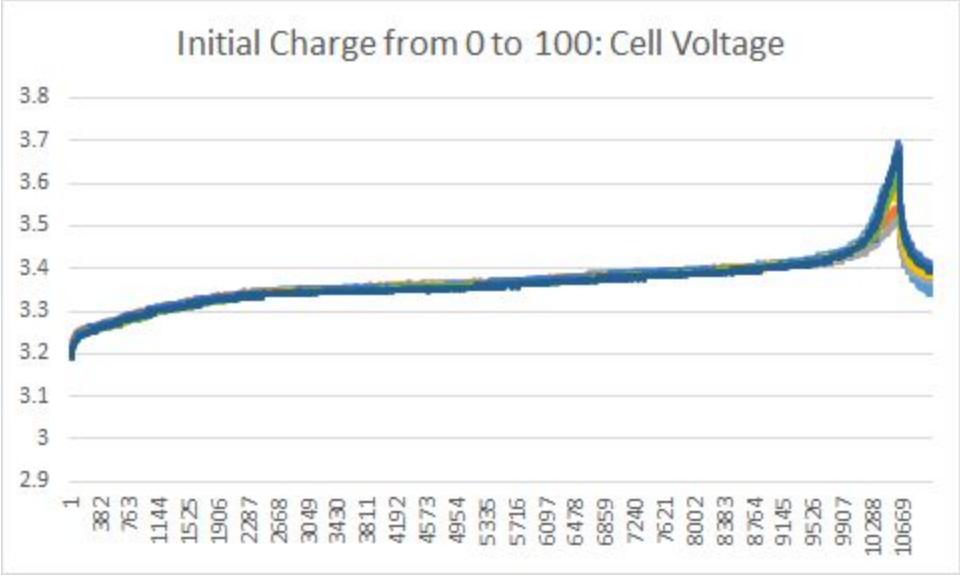
Graphs of the relevant data are attached.

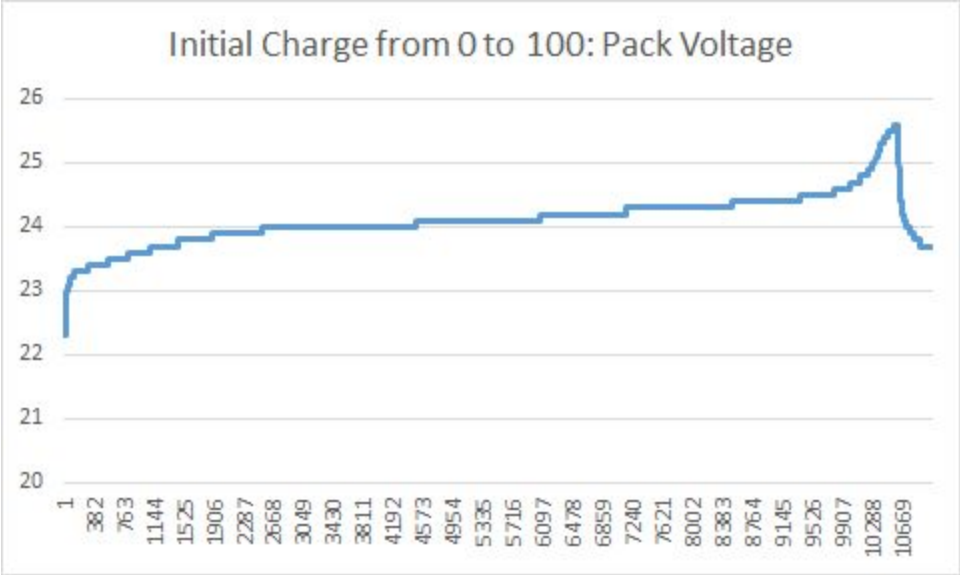
Failures were a result of particular menus not being implemented.

Additionally, it was observed that closing/opening the AIRs can result in the microcontroller restarting. It recovers automatically with the default 50% SOC. Upon reaching complete charge

or discharge this value is automatically corrected. This is shown in graph below for varied high current discharge SOC.






Initial Charge from 0 to 100: Pack Voltage
26
25
24
23
22
21
20
1
382
763
1144
1525
1906
2287
2668
3049
3430
3811
4192
4573
4954
5335
5716
6097
6478
6859
7240
7621
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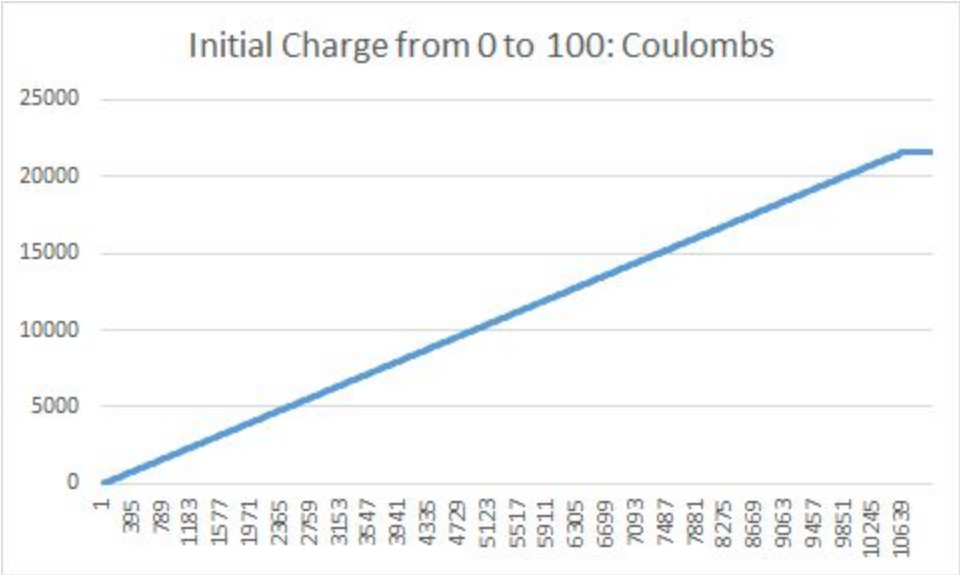
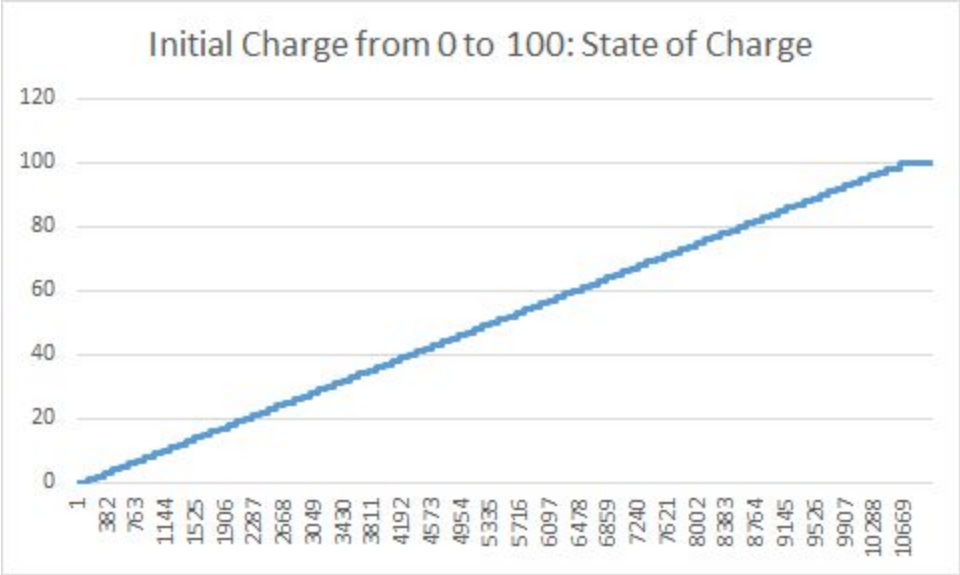
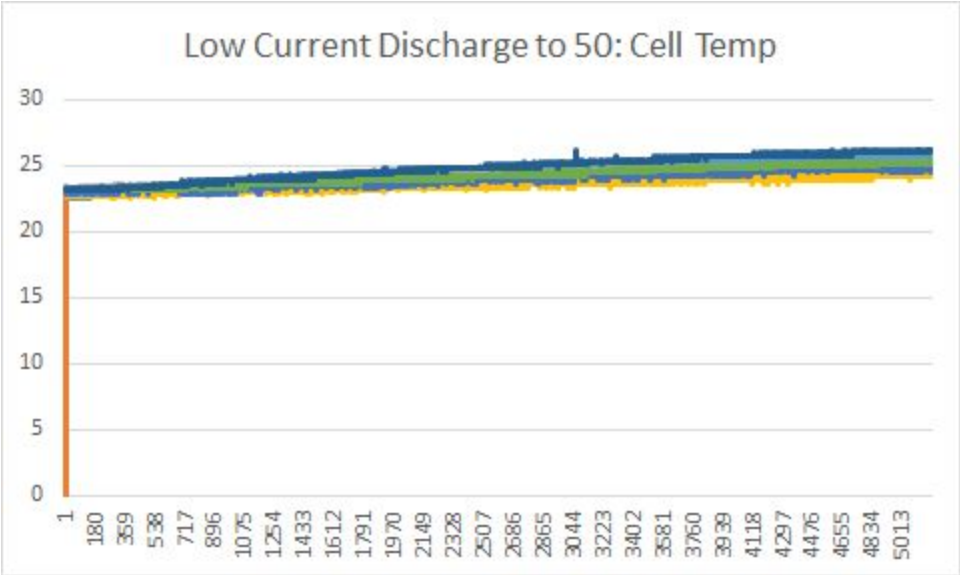
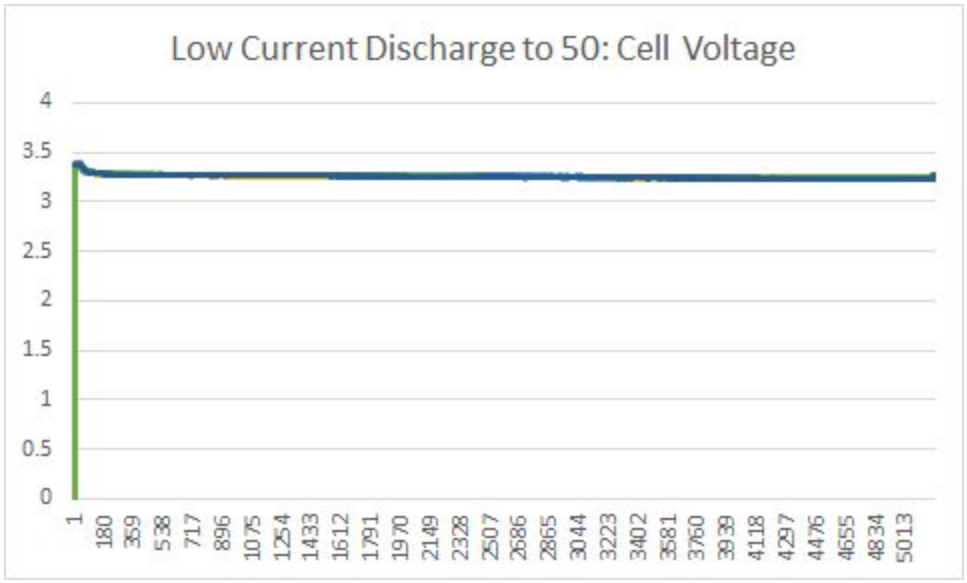
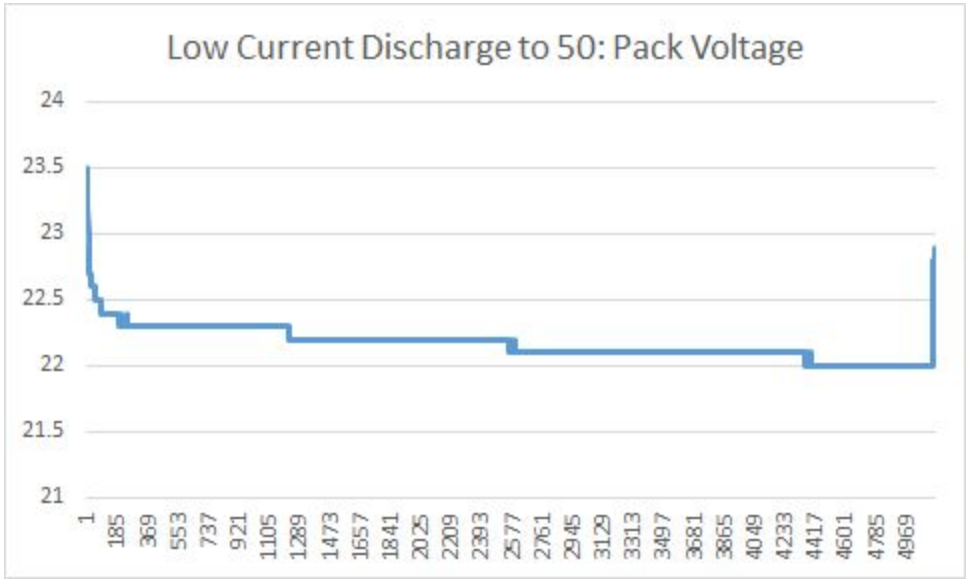
8383
8764
9145
9526
9907
10288
10669

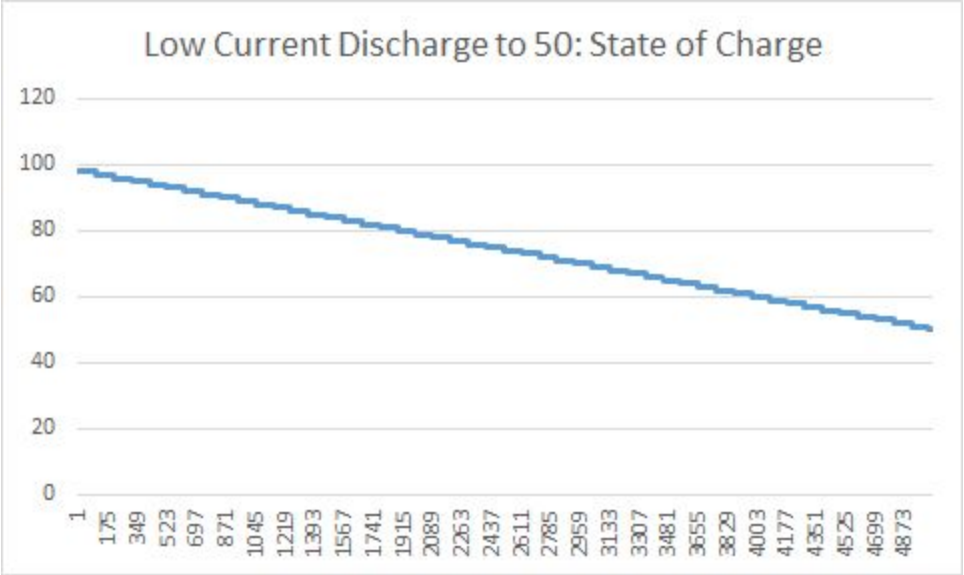

Initial Charge from 0 to 100: Coulombs
25000
20000
15000
10000
5000
0
1
395
789
1183
1577
1971
2365
2759
3153
3547
3941
4335
4729
5123
5517
5911
6305
6699
7093
7487
7881
8275
8669
9063
9457
9851
10245
10639

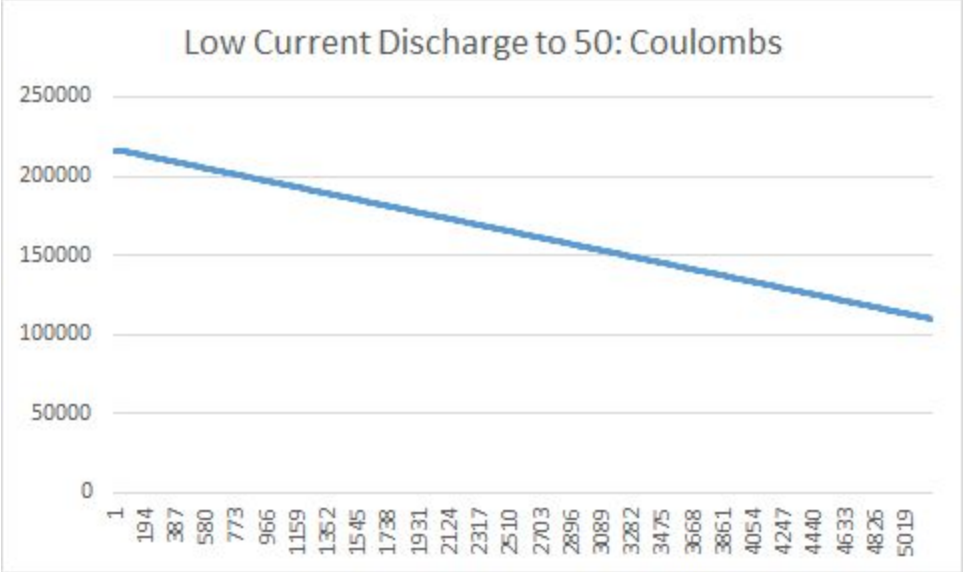

Initial Charge from 0 to 100: State of Charge
120
100
80
60
40
20
0
1
382
763
1144
1525
1906
2287
2668
3049
3430
3811
4192
4573
4954
5335
5716
6097
6478
6859
7240
7621
8002
8383
8764
9145
9526
9907
10288
10669

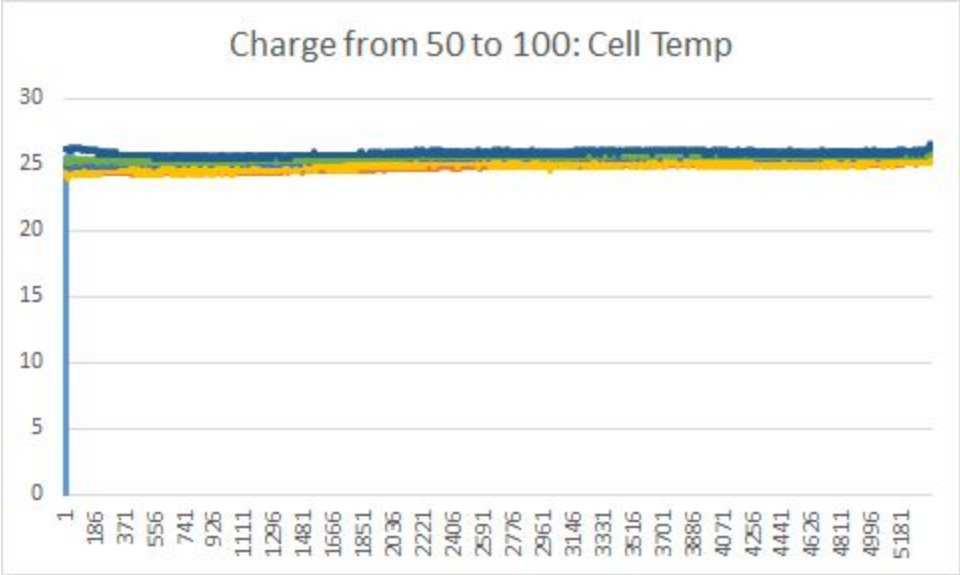

Low Current Discharge to 50: Cell Temp
30
25
20
15
10
5
0
1
180
359
538
717
896
1075
1254
1433
1612
1791
1970
2149
2328
2507
2686
2865
3044
3223
3402
3581
3760
3939
4118
4297
4476
4655
4834
5013

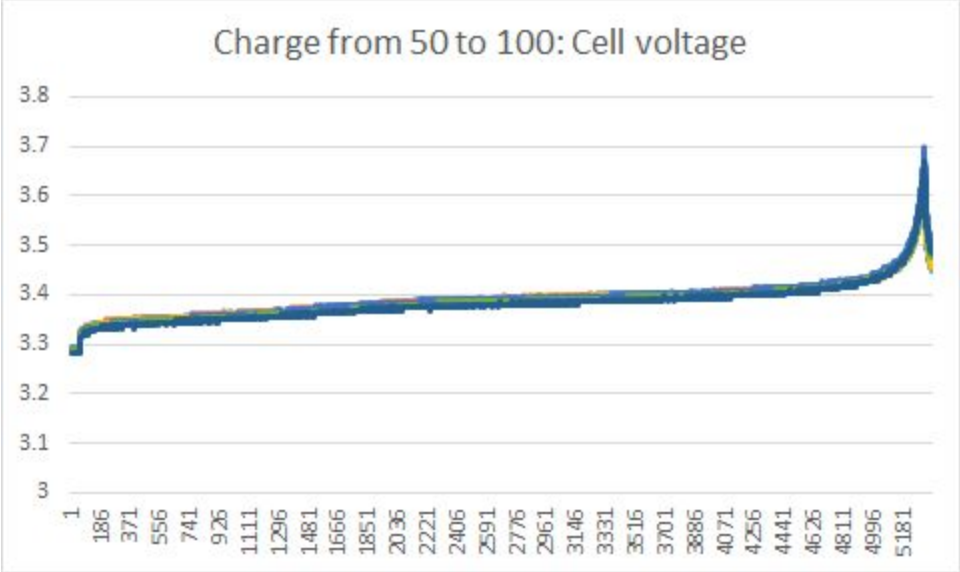

Low Current Discharge to 50: Cell Voltage
4
3.5
3
2.5
2
1.5
1
0.5
0
1
180
359
538
717
896
1075
1254
1433
1612
1791
1970
2149
2328
2507
2686
2865
3044
3223
3402
3581
3760
3939
4118
4297
4476
4655
4834
5013

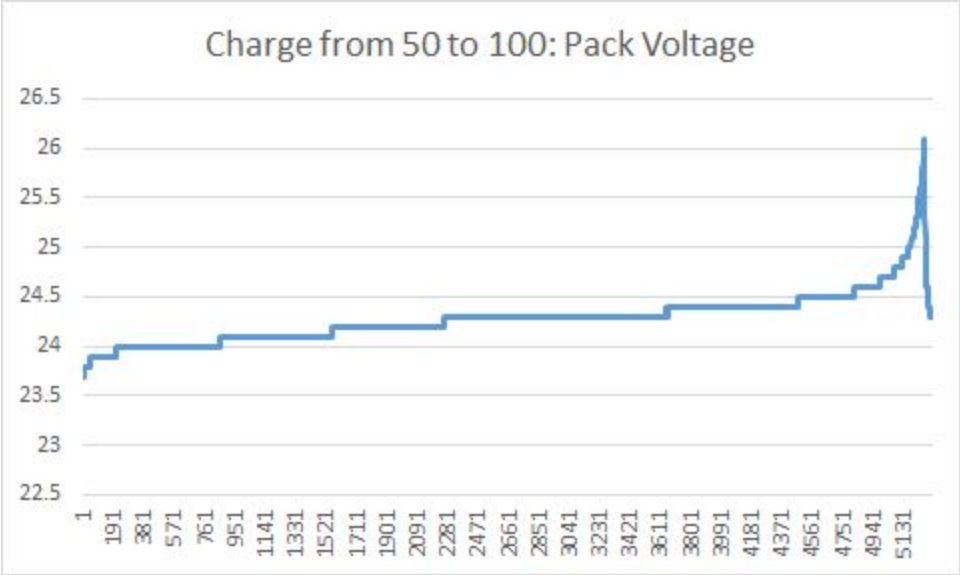

Low Current Discharge to 50: Pack Voltage
24
23.5
23
22.5
22
21.5
21
1
185
369
553
737
921
1105
1289
1473
1657
1841
2025
2209
2393
2577
2761
2945
3129
3313
3497
3681
3865
4049
4233
4417
4601
4785
4969

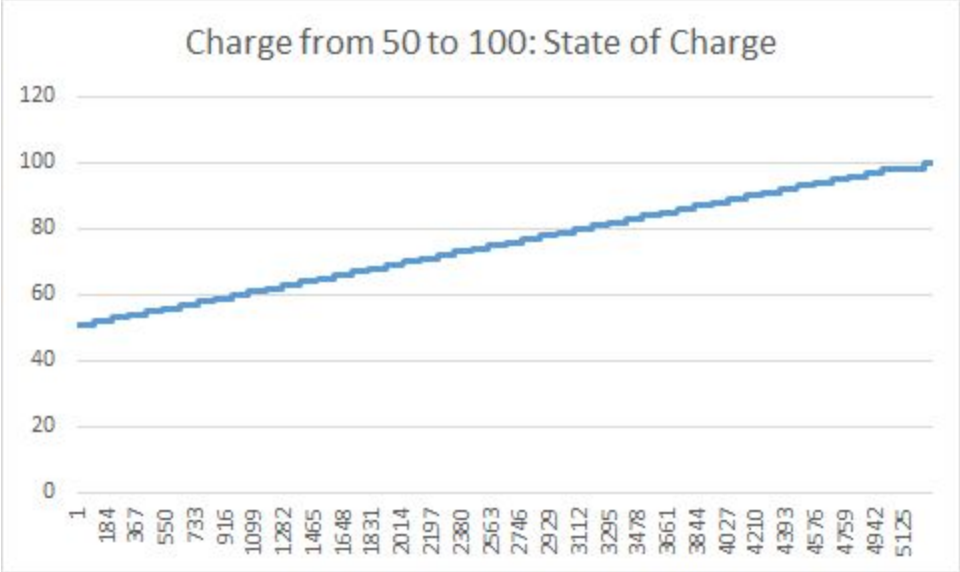

Low Current Discharge to 50: State of Charge
120
100
80
60
40
20
0
1
175
349
523
697
871
1045
1219
1393
1567
1741
1915
2089
2263
2437
2611
2785
2959
3133
3307
3481
3655
3829
4003
4177
4351
4525
4699
4873

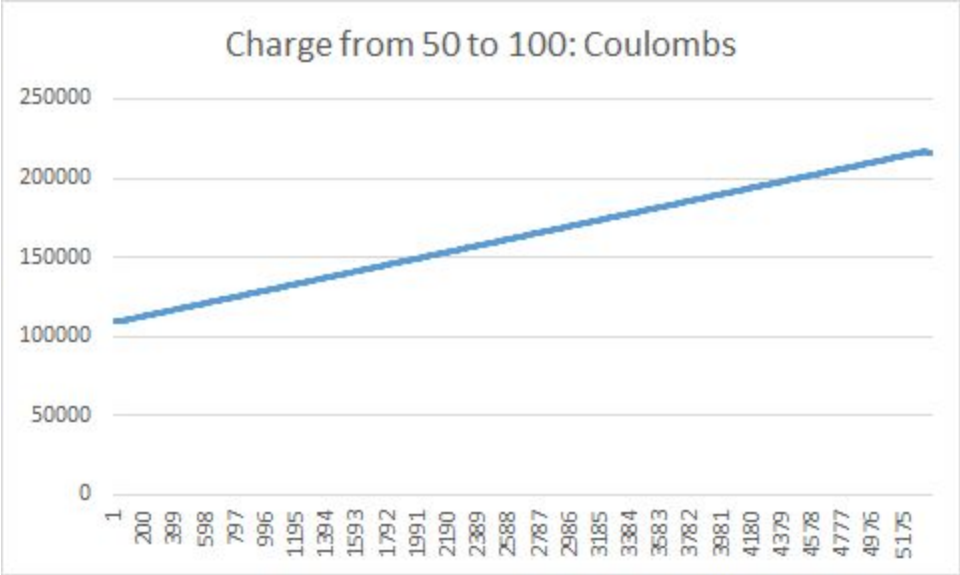

Low Current Discharge to 50: Coulombs
250000
200000
150000
100000
50000
0
1
194
387
580
773
966
1159
1352
1545
1738
1931
2124
2317
2510
2703
2896
3089
3282
3475
3668
3861
4054
4247
4440
4633
4826
5019

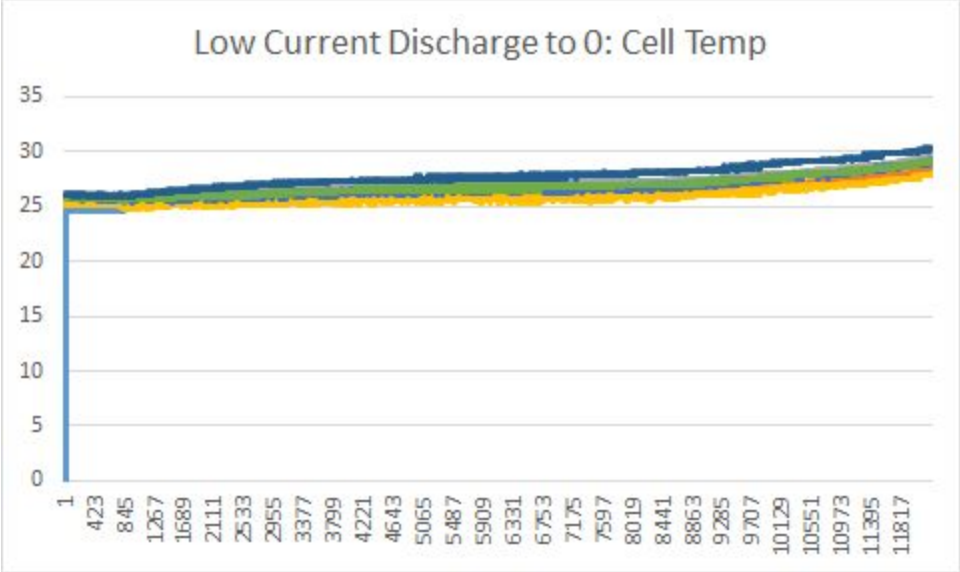

Charge from 50 to 100: Cell Temp
30
25
20
15
10
5
0
1
186
371
556
741
926
1111
1296
1481
1666
1851
2036
2221
2406
2591
2776
2961
3146
3331
3516
3701
3886
4071
4256
4441
4626
4811
4996
5181

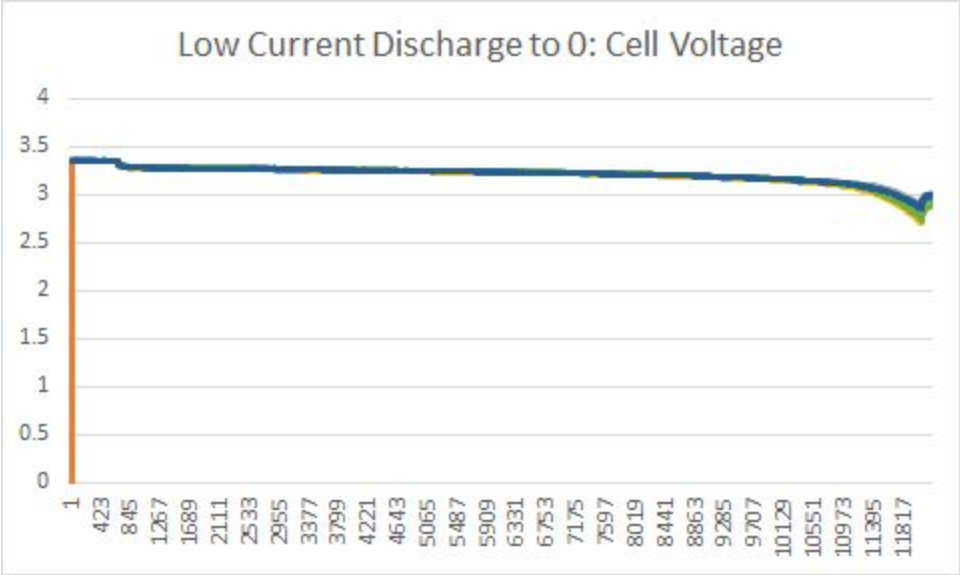

Charge from 50 to 100: Cell voltage
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
1
186
371
556
741
926
1111
1296
1481
1666
1851
2036
2221
2406
2591
2776
2961
3146
3331
3516
3701
3886
4071
4256
4441
4626
4811
4996
5181


Charge from 50 to 100: Pack Voltage
26.5
26
25.5
25
24.5
24
23.5
23
22.5
1
191
381
571
761
951
1141
1331
1521
1711
1901
2091
2281
2471
2661
2851
3041
3231
3421
3611
3801
3991
4181
4371
4561
4751
4941
5131


Charge from 50 to 100: State of Charge
120
100
80
60
40
20
0
1
184
367
550
733
916
1099
1282
1465
1648
1831
2014
2197
2380
2563
2746
2929
3112
3295
3478
3661
3844
4027
4210
4393
4576
4759
4942
5125


Charge from 50 to 100: Coulombs
250000
200000
150000
100000
50000
0
1
200
399
598
797
996
1195
1394
1593
1792
1991
2190
2389
2588
2787
2986
3185
3384
3583
3782
3981
4180
4379
4578
4777
4976
5175


Low Current Discharge to 0: Cell Temp
35
30
25
20
15
10
5
0
1
423
845
1267
1689
2111
2533
2955
3377
3799
4221
4643
5065
5487
5909
6331
6753
7175
7597
8019
8441
8863
9285
9707
10129
10551
10973
11395
11817


Low Current Discharge to 0: Cell Voltage
4
3.5
3
2.5
2
1.5
1
0.5
0
1
423
845
1267
1689
2111
2533
2955
3377
3799
4221
4643
5065
5487
5909
6331
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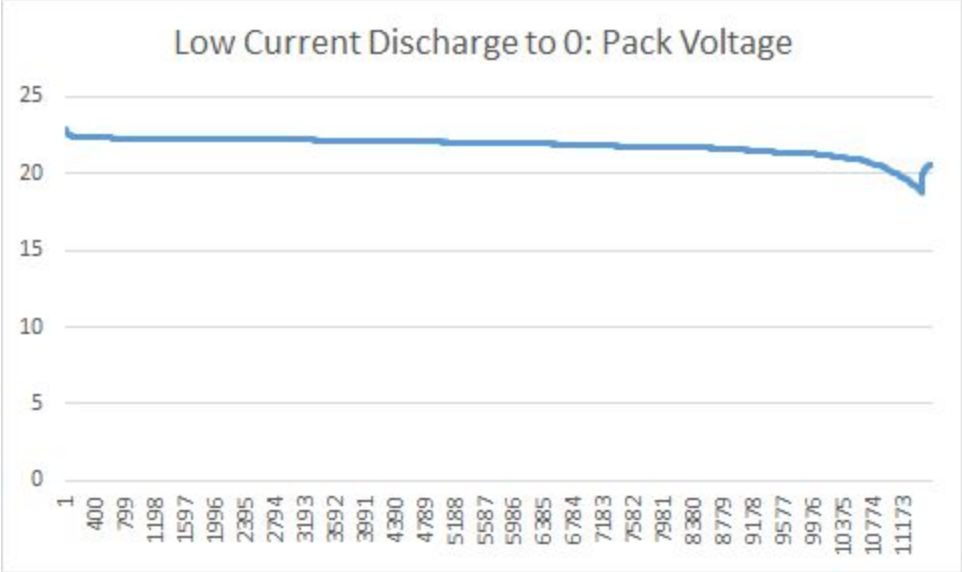
9285
9707
10129
10551
10973
11395
11817


Low Current Discharge to 0: Pack Voltage
25
20
15
10
5
0
1
400
799
1198
1597
1996
2395
2794
3193
3592
3991
4390
4789
5188
5587
5986
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6784
7183
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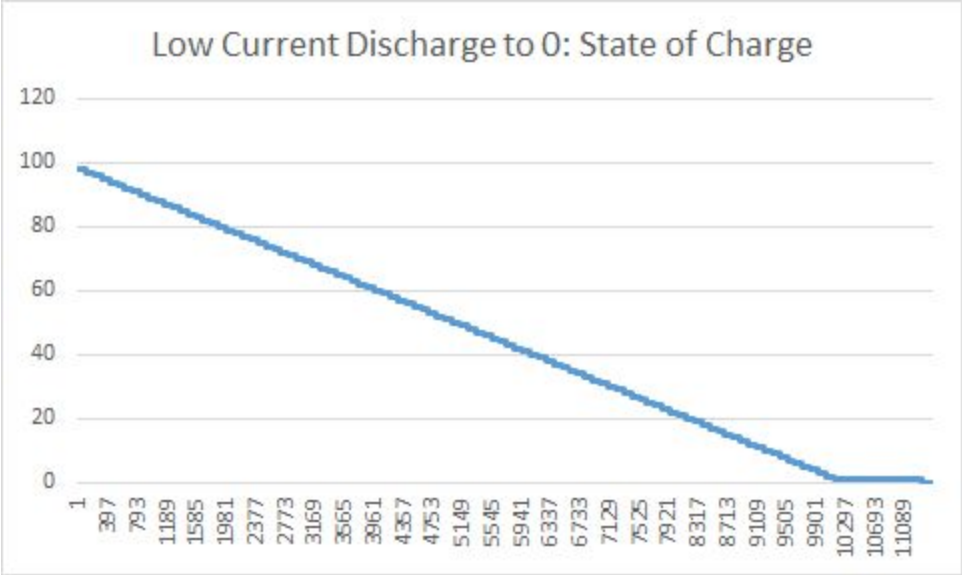
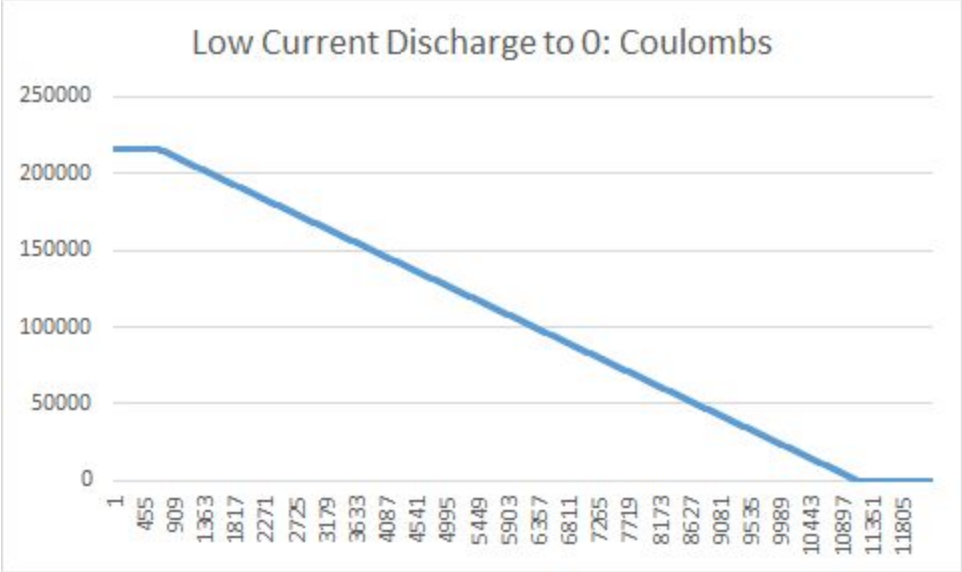
8380
8779
9178
9577
9976
10375
10774
11173


Low Current Discharge to 0: State of Charge
120
100
80
60
40
20
0
1
397
793
1189
1585
1981
2377
2773
3169
3565
3961
4357
4753
5149
5545
5941
6337
6733
7129
7525
7921
8317
8713
9109
9505
9901
10297
10693
11089


Low Current Discharge to 0: Coulombs
250000
200000
150000
100000
50000
0
1
455
909
1363
1817
2271
2725
3179
3633
4087
4541
4995
5449
5903
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6811
7265
7719
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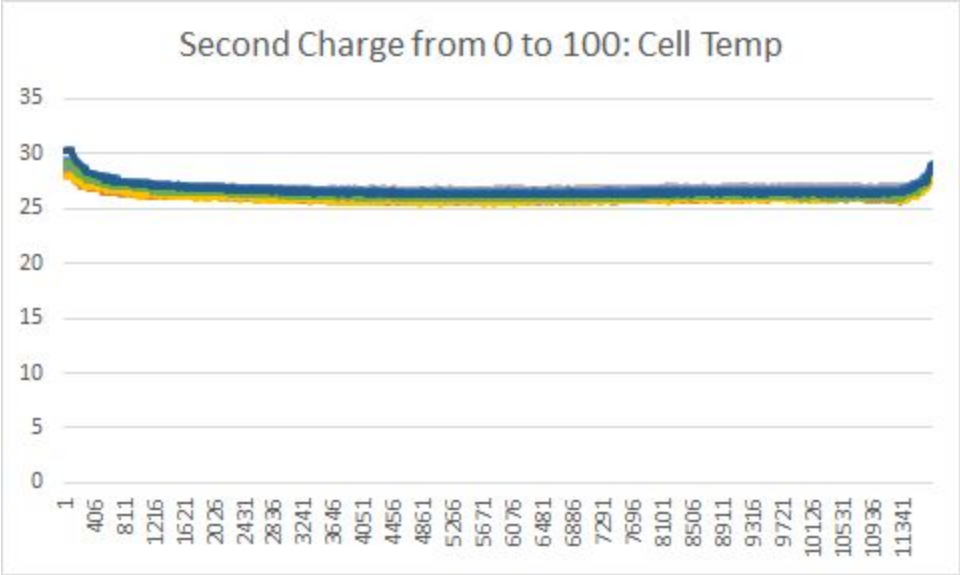
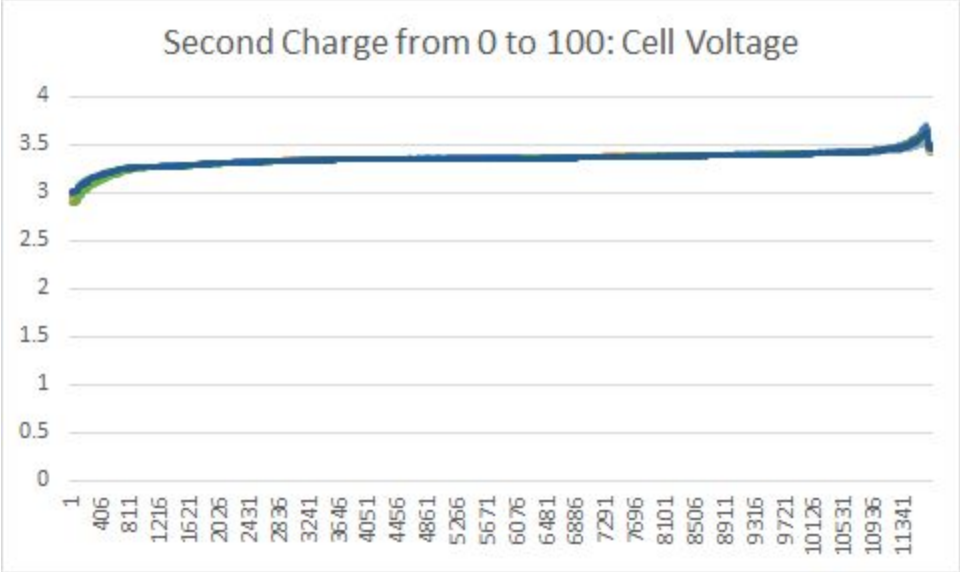
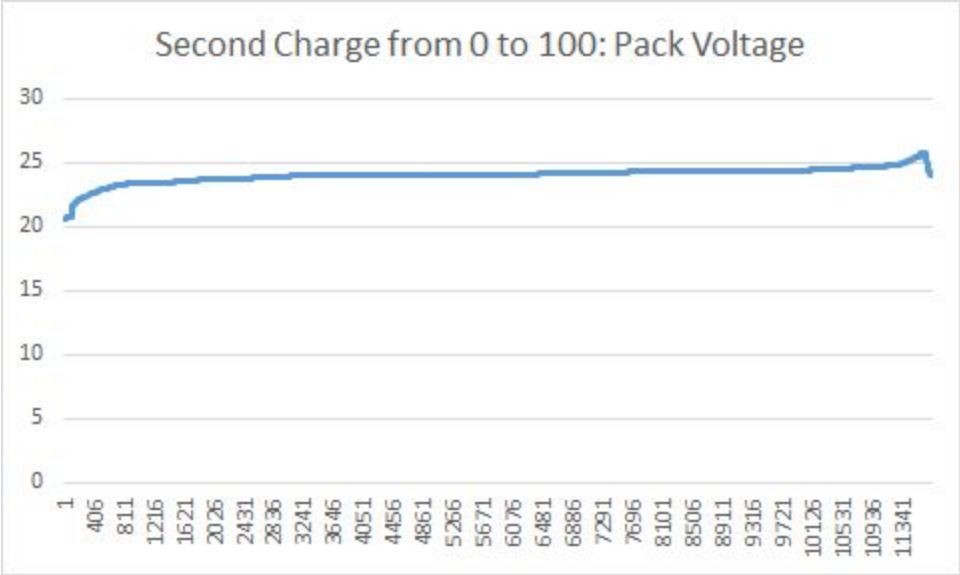
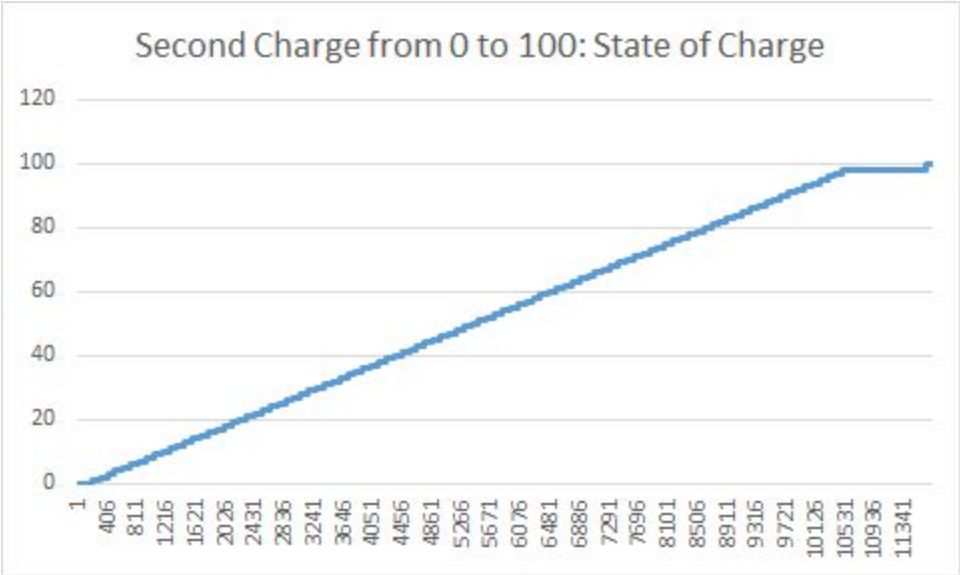
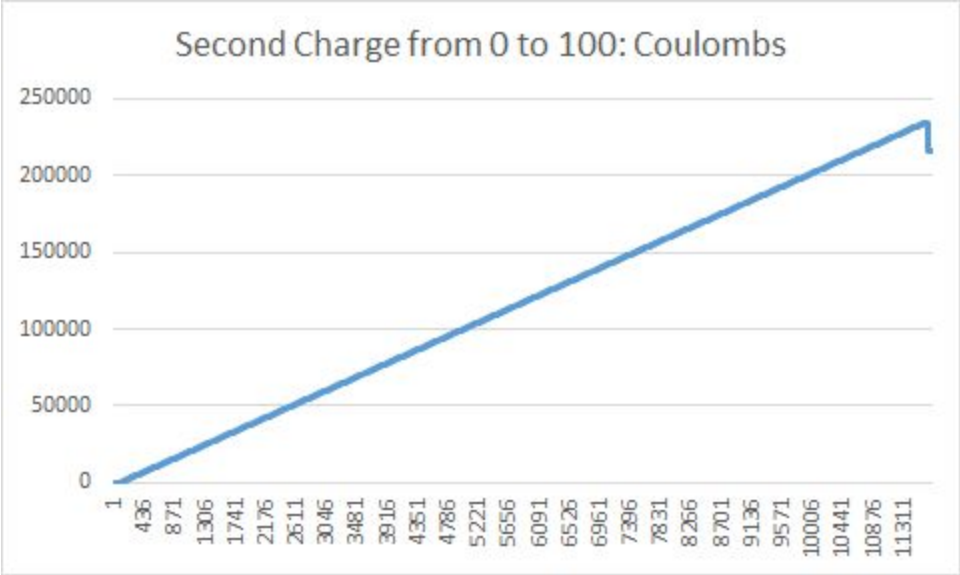
8627
9081
9535
9989
10443
10897
11351
11805

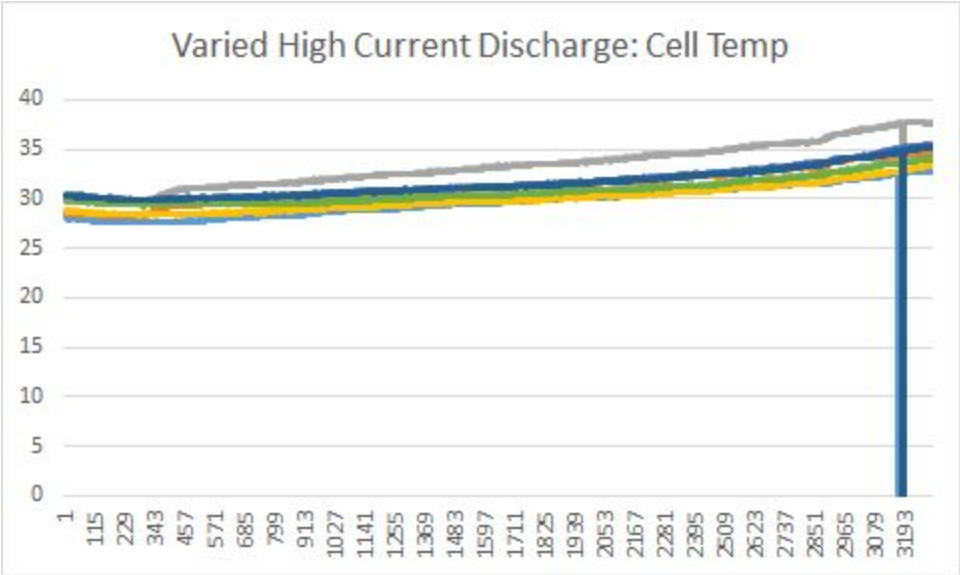

Second Charge from 0 to 100: Cell Temp
35
30
25
20
15
10
5
0
1
406
811
1216
1621
2026
2431
2836
3241
3646
4051
4456
4861
5266
5671
6076
6481
6886
7291
7696
8101
8506
8911
9316
9721
10126
10531
10936
11341

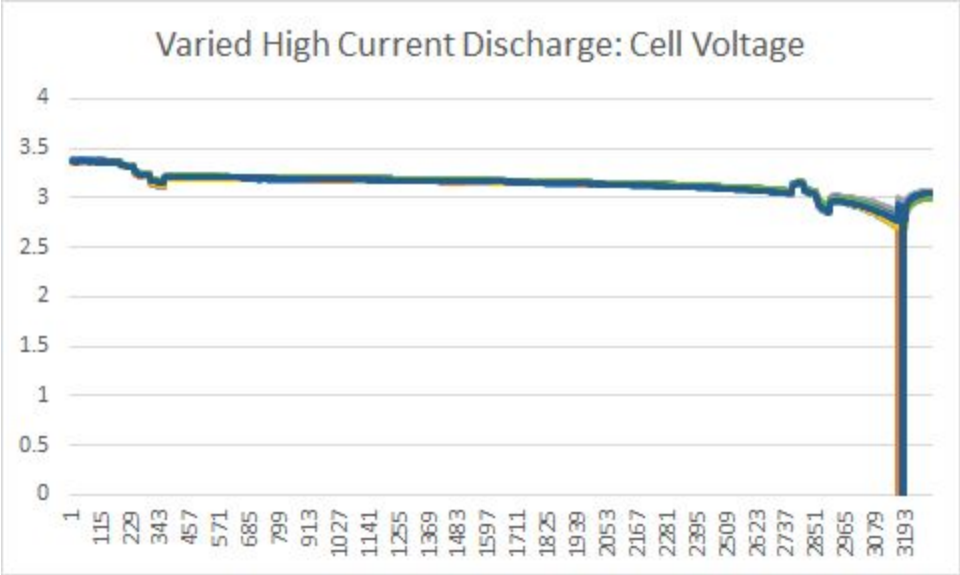

Second Charge from 0 to 100: Cell Voltage
4
3.5
3
2.5
2
1.5
1
0.5
0
1
406
811
1216
1621
2026
2431
2836
3241
3646
4051
4456
4861
5266
5671
6076
6481
6886
7291
7696
8101
8506
8911
9316
9721
10126
10531
10936
11341

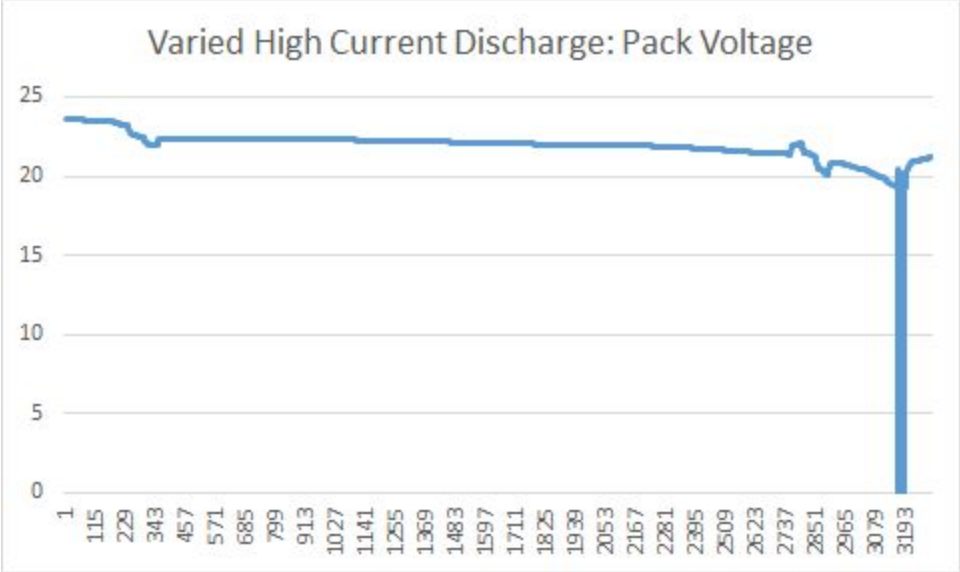

Second Charge from 0 to 100: Pack Voltage
30
25
20
15
10
5
0
1
406
811
1216
1621
2026
2431
2836
3241
3646
4051
4456
4861
5266
5671
6076
6481
6886
7291
7696
8101
8506
8911
9316
9721
10126
10531
10936
11341

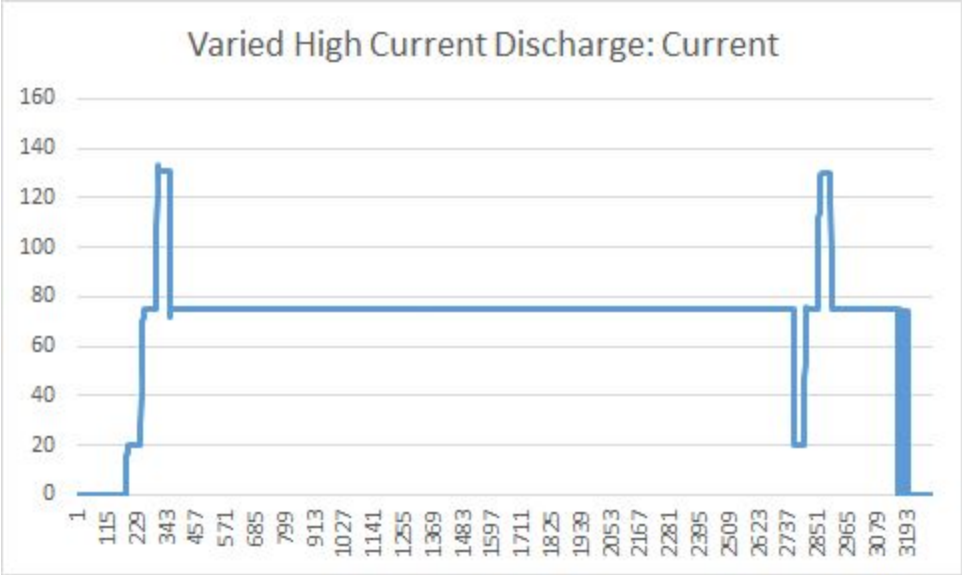

Second Charge from 0 to 100: State of Charge
120
100
80
60
40
20
0
1
406
811
1216
1621
2026
2431
2836
3241
3646
4051
4456
4861
5266
5671
6076
6481
6886
7291
7696
8101
8506
8911
9316
9721
10126
10531
10936
11341

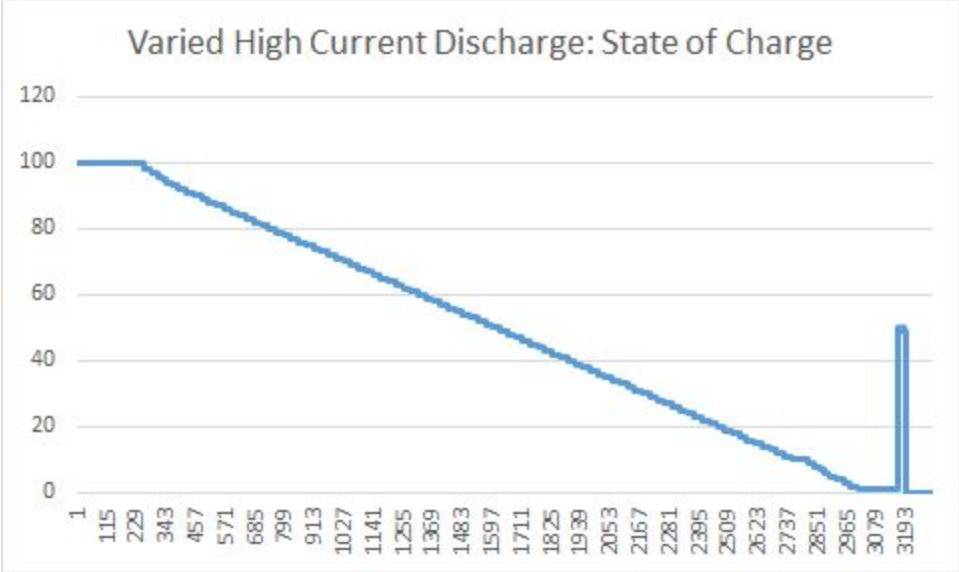

Second Charge from 0 to 100: Coulombs
250000
200000
150000
100000
50000
0
1
436
871
1306
1741
2176
2611
3046
3481
3916
4351
4786
5221
5656
6091
6526
6961
7396
7831
8266
8701
9136
9571
10006
10441
10876
11311

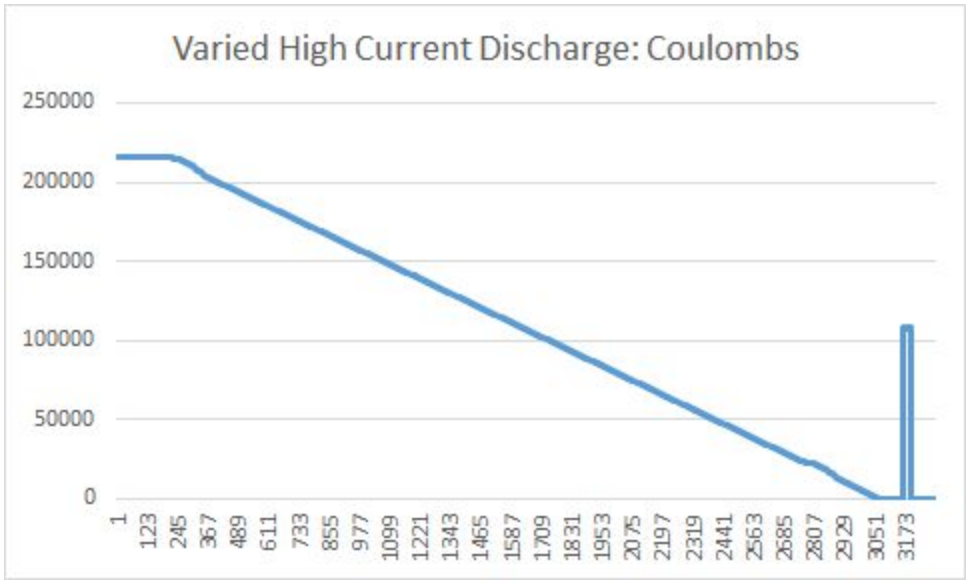

Varied High Current Discharge: Cell Temp
40
35
30
25
20
15
10
5
0
1
115
229
343
457
571
685
799
913
1027
1141
1255
1369
1483
1597
1711
1825
1939
2053
2167
2281
2395
2509
2623
2737
2851
2965
3079
3193


Varied High Current Discharge: Cell Voltage
4
3.5
3
2.5
2
1.5
1
0.5
0
1
115
229
343
457
571
685
799
913
1027
1141
1255
1369
1483
1597
1711
1825
1939
2053
2167
2281
2395
2509
2623
2737
2851
2965
3079
3193


Varied High Current Discharge: Pack Voltage
25
20
15
10
5
0
1
115
229
343
457
571
685
799
913
1027
1141
1255
1369
1483
1597
1711
1825
1939
2053
2167
2281
2395
2509
2623
2737
2851
2965
3079
3193


Varied High Current Discharge: Current
160
140
120
100
80
60
40
20
0
1
115
229
343
457
571
685
799
913
1027
1141
1255
1369
1483
1597
1711
1825
1939
2053
2167
2281
2395
2509
2623
2737
2851
2965
3079
3193


Varied High Current Discharge: State of Charge
120
100
80
60
40
20
0
1
115
229
343
457
571
685
799
913
1027
1141
1255
1369
1483
1597
1711
1825
1939
2053
2167
2281
2395
2509
2623
2737
2851
2965
3079
3193


Varied High Current Discharge: Coulombs
250000
200000
150000
100000
50000
0
1
123
245
367
489
611
733
855
977
1099
1221
1343
1465
1587
1709
1831
1953
2075
2197
2319
2441
2563
2685
2807
2929
3051
3173