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Fuel gauge battery ZCV table test sop





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ACD_PT

Agenda

- Battery ZCV table test system equipment list
- ZCV table test method
- BAT760 Testing System User Manual
- Row data process

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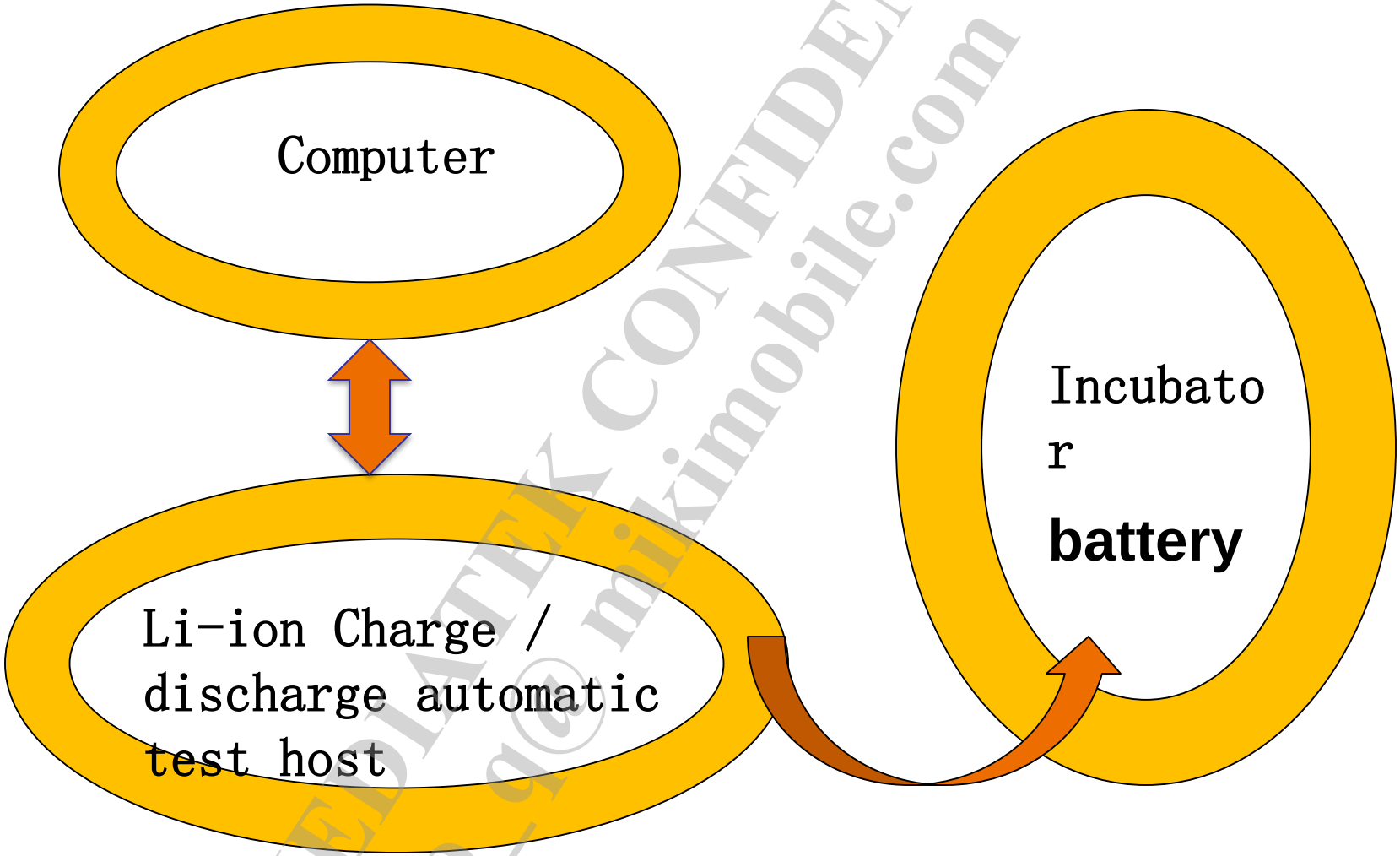
Battery test system equipment list





Test system（ Equipment List）



Test system（Equipment List）

- ✓ 1 Computer : Control the charging and discharging equipment, records test data
- ✓ 2 Incubator : Battery ambient temperature control, the temperature of the fuel can gauge test under the ZCV of table data (minus 10 degrees, 0 degrees, 25 degrees, 50 degrees), the incubator must be able to set the temperature of the above four
- ✓ 3 Li-ion Charge / discharge automatic test host : This equipment can control and record the battery capacity , charge / discharge time, and the battery voltage.
- ---- The MTK equipment used for BAT-760

Li-ion Charge / discharge automatic test host 【BAT-760B】

➢. 8 Channel Independent testing

➢. Constant current, constant voltage of charge

➢. Constant current, constant power of discharge

➢. CC：0.1 mA ~1999 mA；1 mA ~ 5999 mA

➢. CV：0.1 ~ 4.5 Vdc

Li-ion Charge / discharge automatic test host 【BAT-760B】 Vendor Information

- BAT-760B equipment price is 160000 NTD
- MSZ Purchase price：BAT-760B-6A 8channel price is 4820 USD
- BAT-760B
- AcuTech Headquarters
- AcuTech Systems Co., Ltd.
  Addr.:9F., No.179, Jian 1st Rd., Zhonghe Dist., New Taipei City 235, Taiwan , R.O.C
- Tel：886-2-2228-7016 张常松
- Fax：886-2-2228-7036
- E-Mail:sales@acutechsys.com

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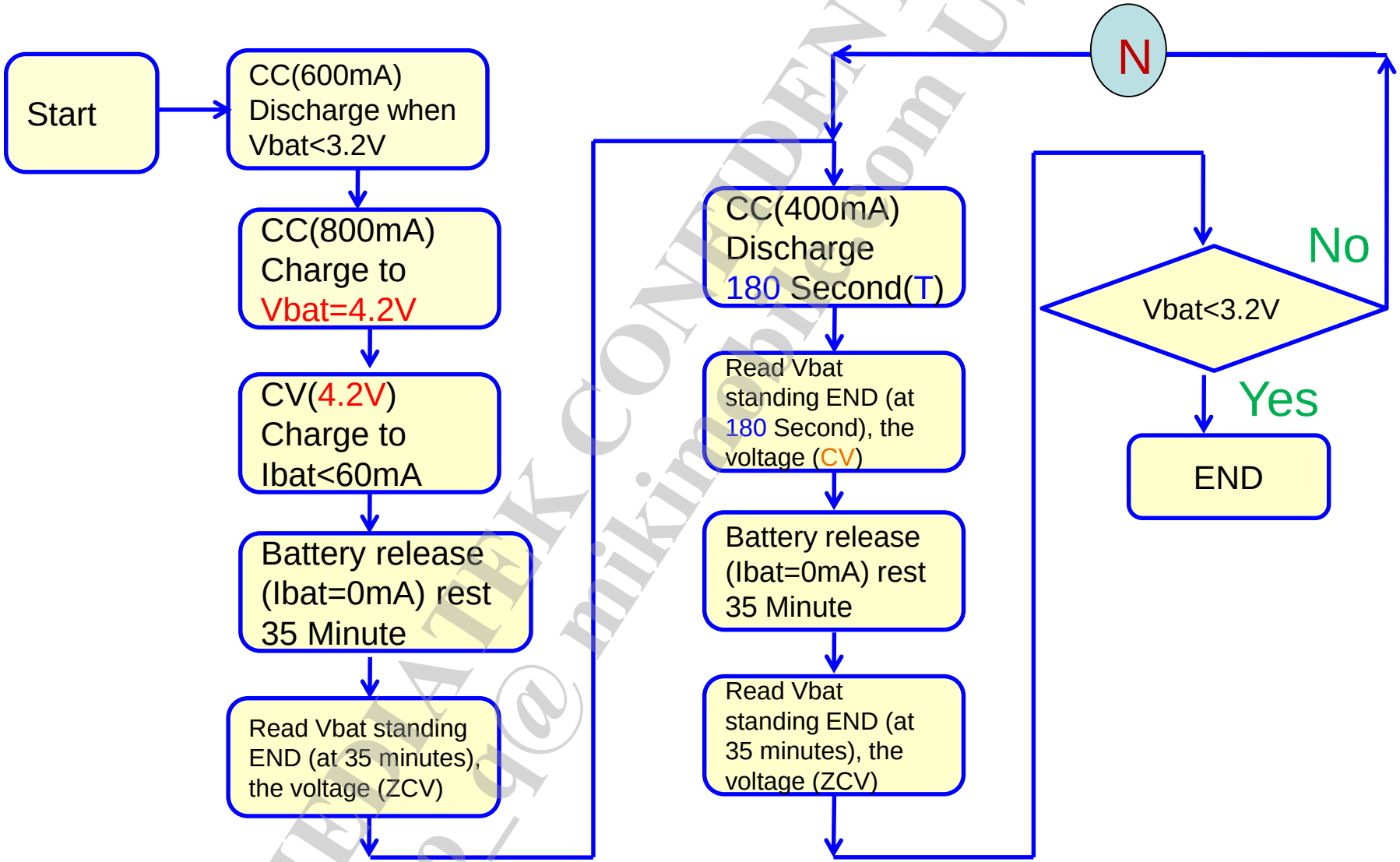
ZCV table test method





ZCV curve measured SOP



ZCV curve measured SOP

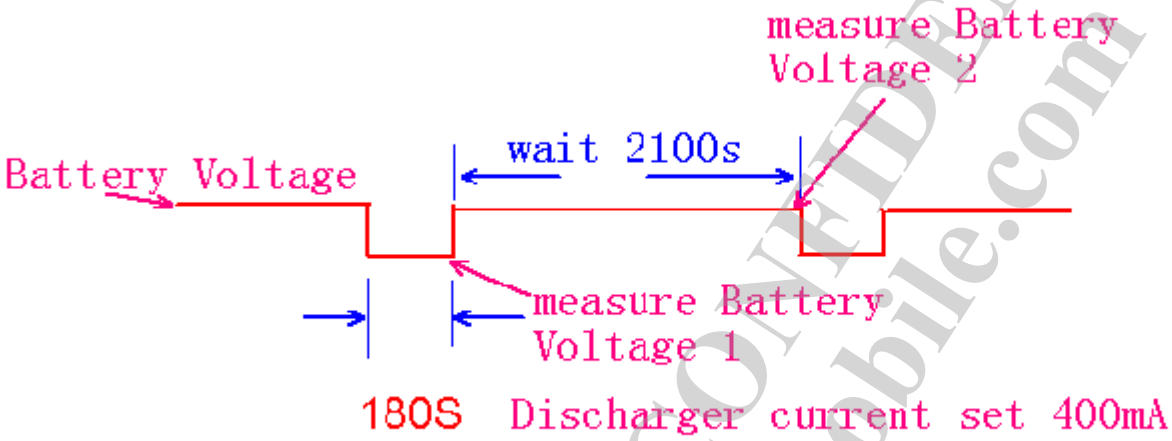
- Battery Full charge state
  - V_{bat}=4.2V I_{bat}<60mA （4.2V battery）
  - V_{bat}=4.3V (4.35V) I_{bat}<60mA
    - （4.3/4.35V HV battery）
- Battery Low charge state
  - Vbat<3.2V
- The setting of the discharge time (T)
  - Each discharge power capacity Δ = 400mA *T = 20mAH
  - T=20/400h=180S

放电 Δ mah Step select

Battery capacity(mah)	step (mah)
< 1500	20
1500 ~ 2200	30
> 2500	50

Note： Number of cycles N > battery capacity/ Δ mah.
To ensure that after N times of discharge Vbat <3.2V

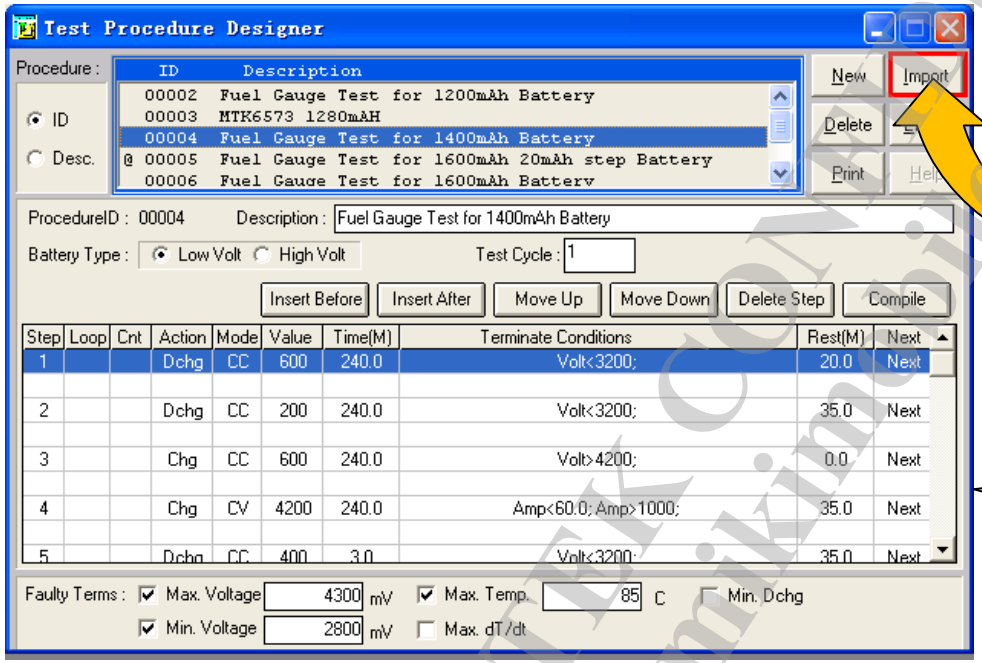
Battery Voltage Measure



- Record Voltage :
- ZCV is Open-circuit voltage (V2)
- CV is Closed-circuit voltage(V1)
- R_battery= (V2-V1)/400mA

Battery test method

- 1 .The use BAT_760 can be obtained from MTK test profile files to import the test procedures



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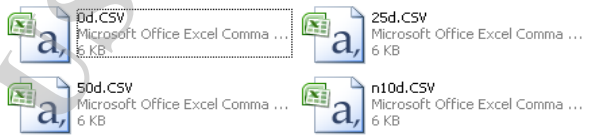
Note：
Select the test battery capacity program
Such as: 1500mah battery select 1600mah program

- 2. Other Li-ion charge and discharge test equipment customers need to own more of these tests to guide the preparation of the test program

Battery test method



Cell	StepID	Cycle	Loop	Step	Action	Mode	Set Value	Status	Data	Init mV 1	Max mV 1	Final mV	Final mA	Step mAH	Acc mAH	Time (M)
1	1			1	Discharge	CC	600	Pass		3795	3795	3198	600	622	622	62.2
1	2	1	0	2	Discharge	CC	300	Pass		3410	3410	3200	301	11	633	2.3
1	3	1	0	3	Charge	CC	600	Pass		3318	4200	4200	601	1217	1217	121.6
1	4	1	0	4	Charge	CV	4200	Pass		4200	4203	4200	60	223	1440	60.5
1	5	1	0	5	Discharge	CC	400	Pass		4177	4177	4078	400	30	30	4.5
1	6	1	0	6	Discharge	CC	400	Pass		4153	4153	4055	400	30	60	4.5
1	48	1	0	48	Discharge	CC	400	Pass		3680	3680	3589	400	30	1313	4.5
1	49	1	0	49	Discharge	CC	400	Pass		3677	3677	3572	400	30	1343	4.5
1	50	1	0	50	Discharge	CC	400	Pass		3671	3671	3531	400	30	1373	4.5
1	51	1	0	51	Discharge	CC	400	Pass		3630	3630	3404	400	30	1403	4.5
1	52	1	0	52	Discharge	CC	400	Pass		3512	3512	3199	400	24	1427	3.6
1	53	1	0	53	Discharge	CC	400	Pass		3345	3345	3199	400	4	1431	0.7
1	54	1	0	54	Discharge	CC	400	Pass		3319	3319	3199	400	3	1434	0.4
1	55	1	0	55	Discharge	CC	400	Pass		3304	3304	3196	400	2	1435	0.3
1	56	1	0	56	Discharge	CC	400	Pass		3288	3288	3198	400	1	1436	0.2
1	57	1	0	57	Discharge	CC	400	Pass		3280	3280	3200	400	1	1437	0.1
1	58	1	0	58	Discharge	CC	400	Pass		3274	3274	3196	400	1	1438	0.1
1	59	1	0	59	Discharge	CC	400	Pass		3269	3269	3196	400	0	1438	0.1

start

end

Record measurement data to determine test results:

1.Testing under 25 degrees, the end of the the VBAT open circuit voltage <3.4V, or the need to increase the number of discharge cycles N

Low temperatures, the battery internal resistance VBAT open circuit voltage may not be reduced to 3.4V, the number of test cycles N is use to 25 degrees.

2.CV charge final current need 60mA, otherwise increase the charging time.

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BAT760 Testing System User Manual



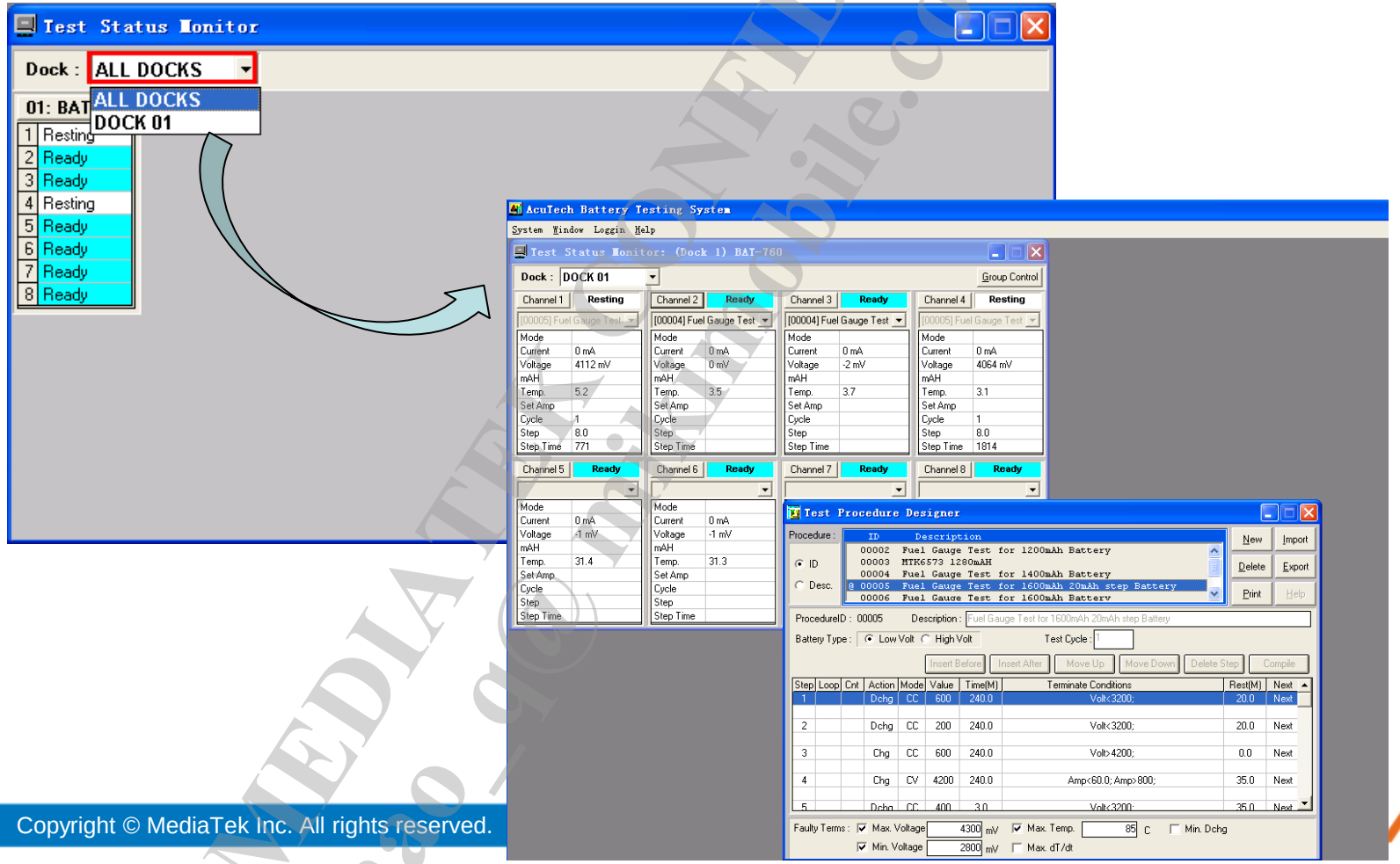


Outline

- Fuel Gauge Data testing methods
- Fuel Gauge Test data processing and fill

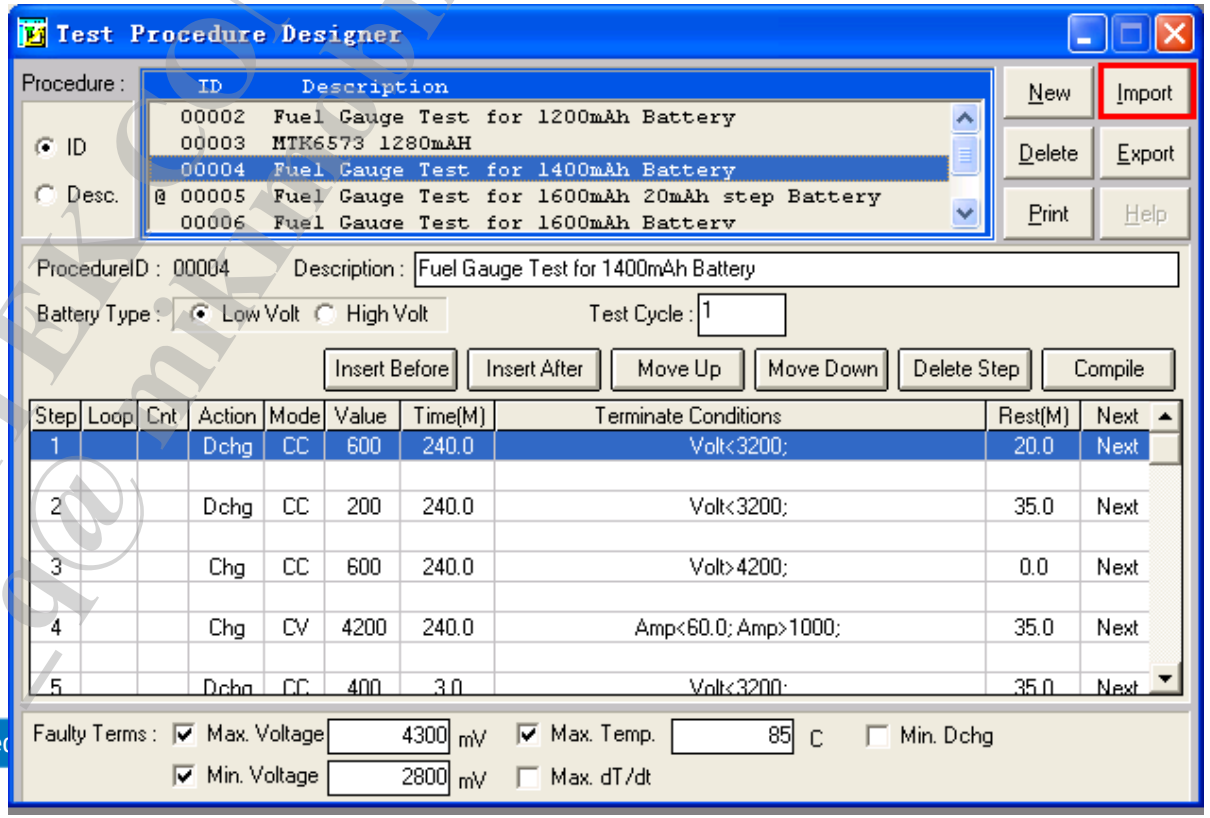
Testing process

- 1： Click on the Dock icon and select DOCK 01, entered the channel list



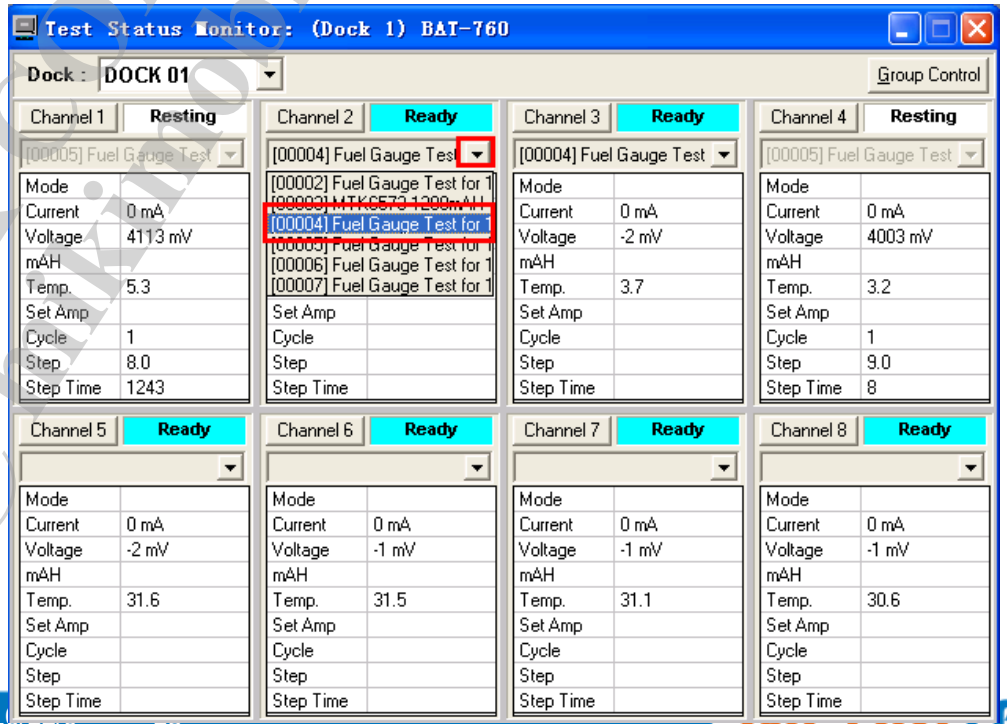
Testing process

- 2：Open the “Test Procedure Designer”, as shown below. Test Procedure Designer is mainly used for the preparation of the test program, and then automate the process of testing.
- 3： Can also Import test profile files to automate the process of testing.



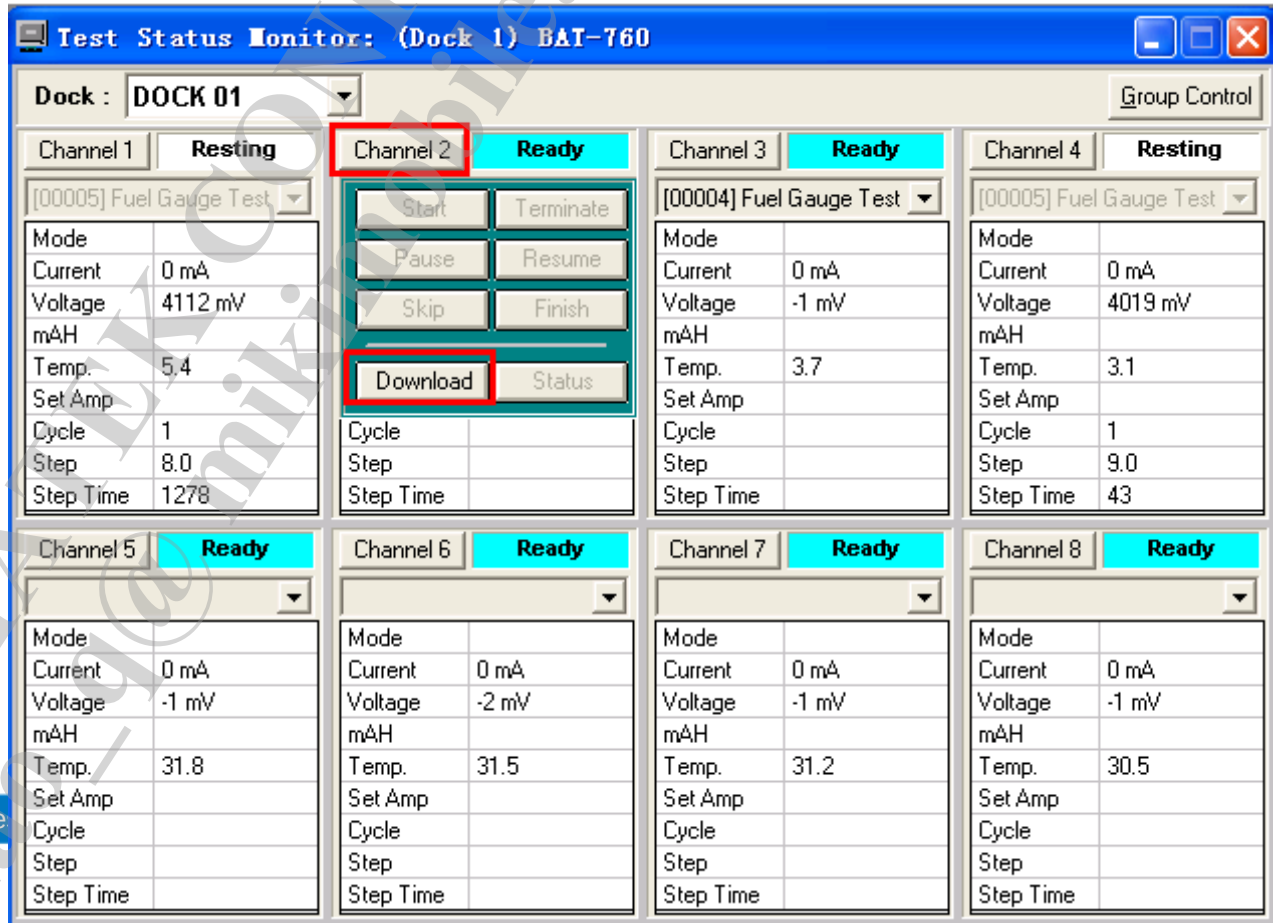
Testing process

- 4: For the procedure of the test channel selection. Click the drop-down icon for the channel, the channel can be selected test program will pop up, you need to test the capacity of the corresponding program.



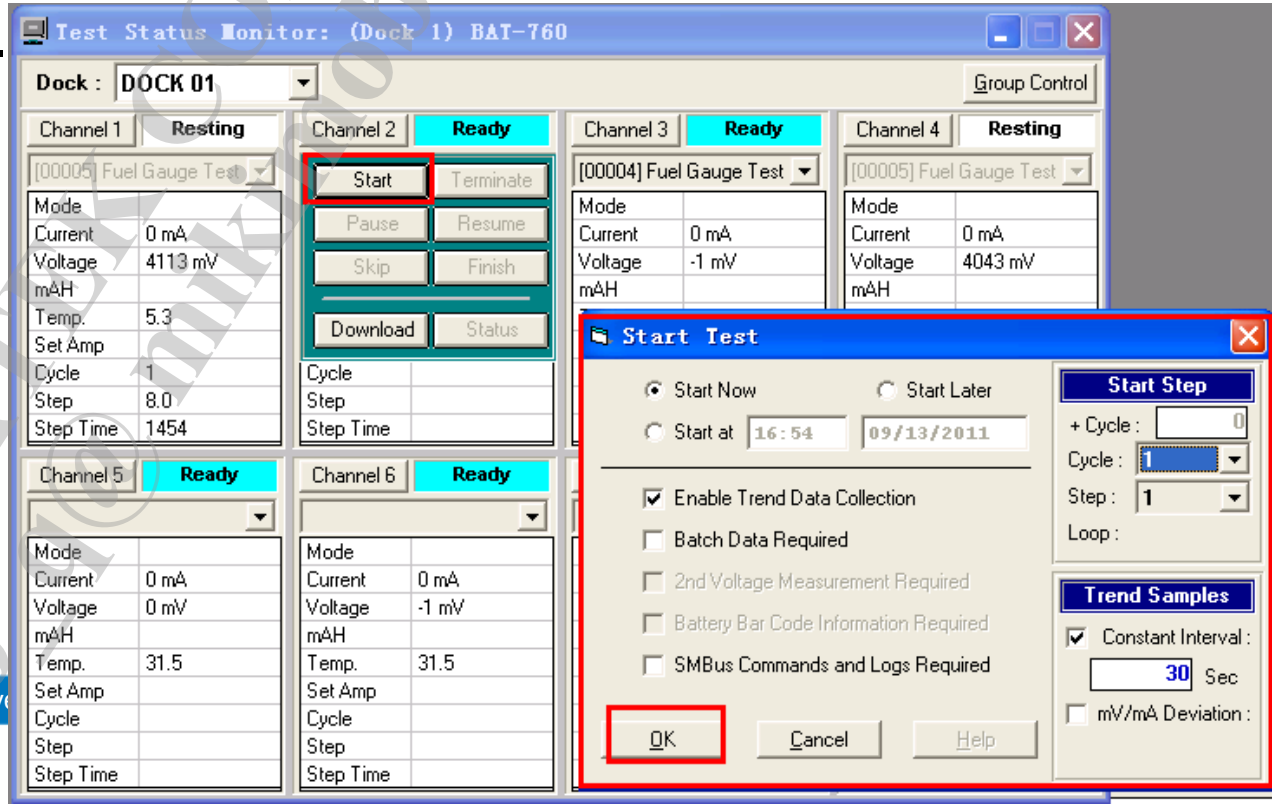
Testing process

- 5： Click on the channel icon will pop up instruction execution box, and click the "Download" icon, the corresponding test program has been downloaded to the instrument.



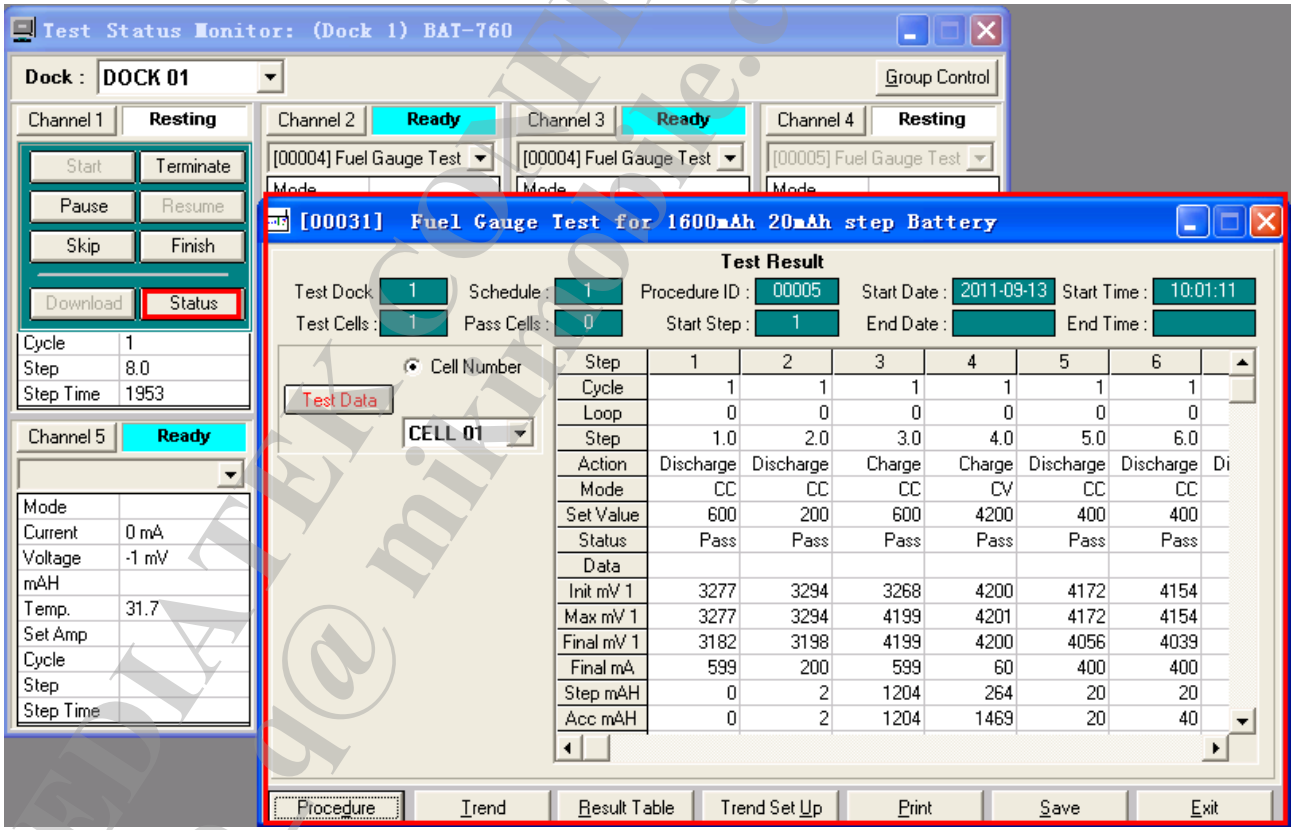
Testing process

- 6： Program after the download is complete, click on the "Channel" icon, the pop-up to execute instructions, this time click "Start" icon, then the "Start Test Options dialog box will pop up the settings in the dialog box without modification, just click" OK"button to start the test. After the program will automatically test.



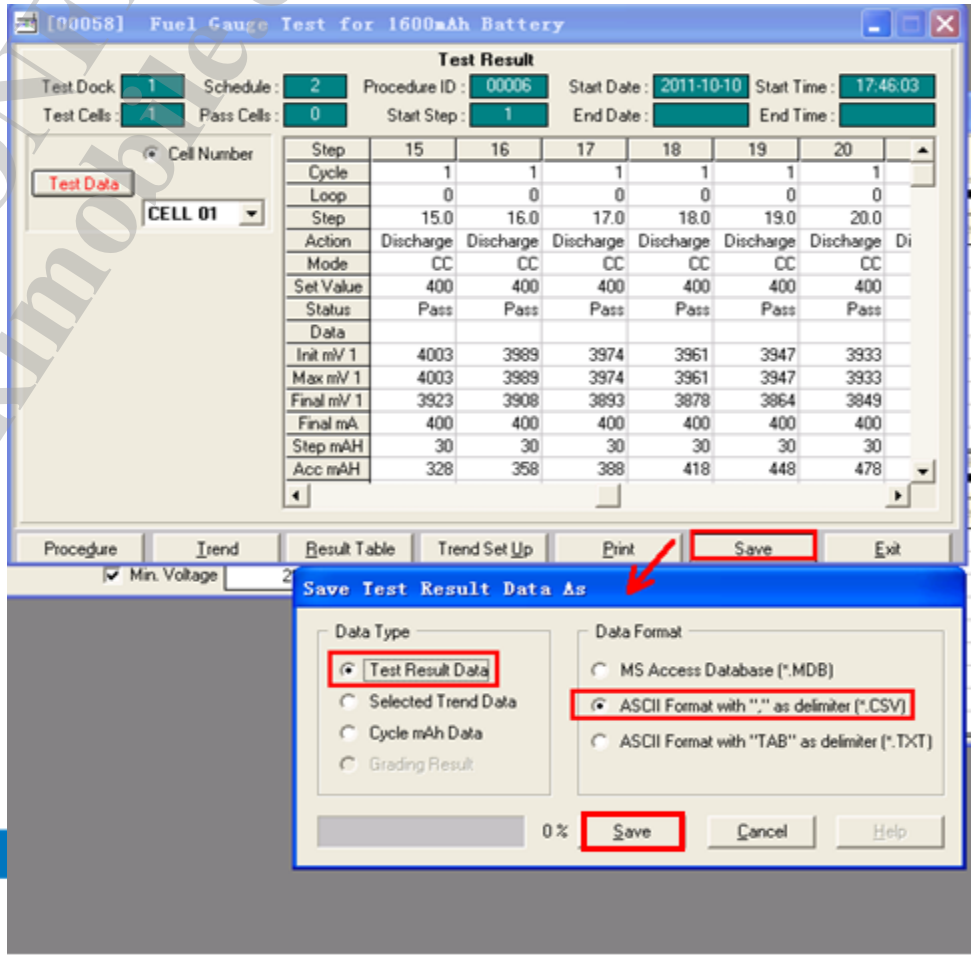
Testing process

- 7: In the Status window, we can see the status of each test step and test progress.



Testing process

- 8： Click "Save" icon in the corresponding channel "Status" window below will pop up the Save dialog box, check the icon option, then click the "Save" button to save.



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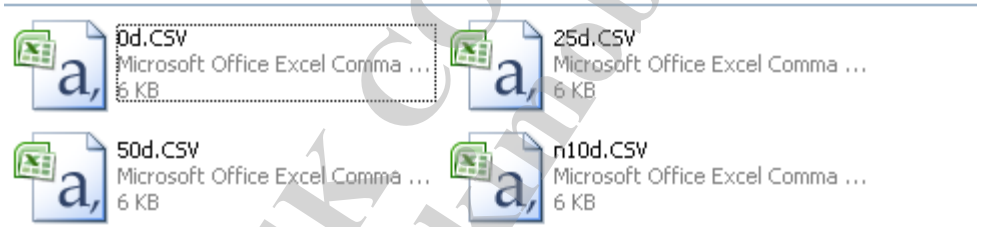
Raw data process





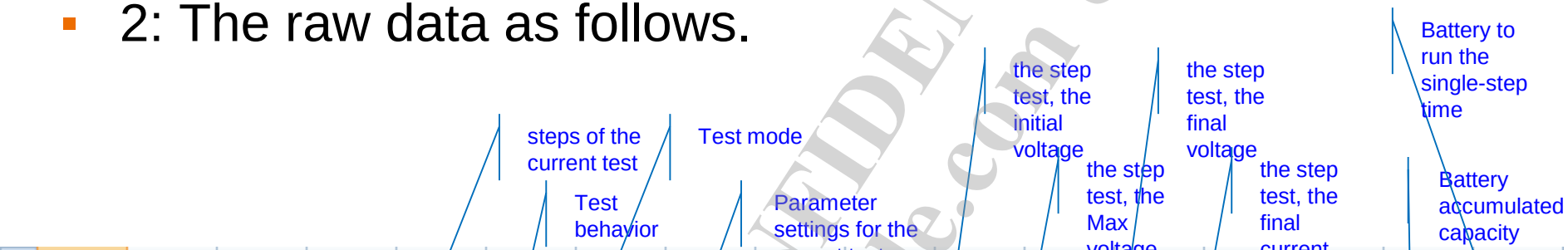
Test data processing

- 1： The raw data exported from the instrument as follows, the file format is CSV, you can open with Excel. The test data consists of four temperature -10 degrees, 0 degrees, 25 degrees, 50 degrees, so a four-test data.



Test data processing

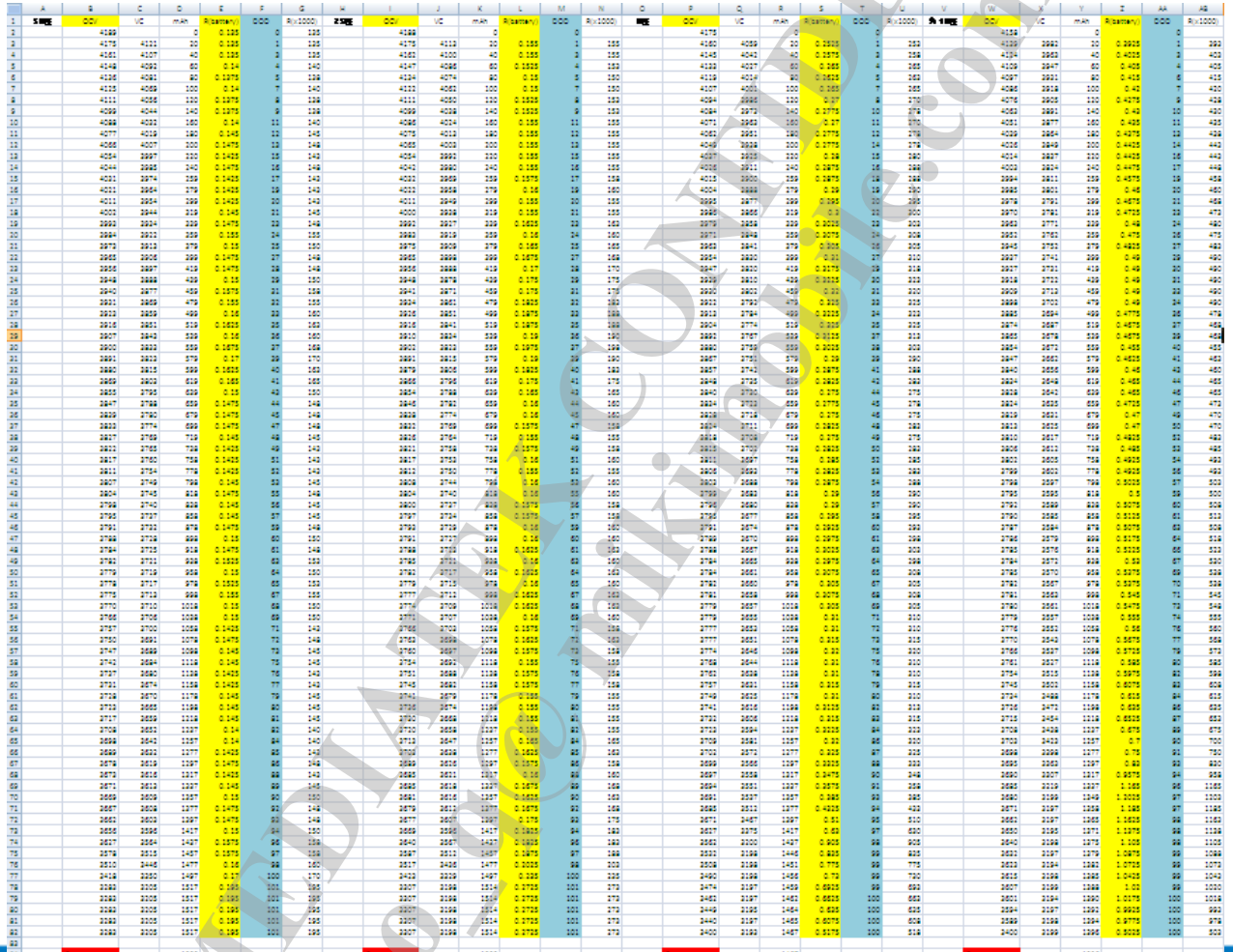
- 2: The raw data as follows.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Cell	StepID	Cycle	Loop	Step	Action	Mode	Set Value	Status	Data	Init mV 1	Max mV 1	Final mV	Final mA	Step mAH	Acc mAH	Time (M)
2	1	1	1	0	1	Discharge	CC	600	Pass		3300	3300	3177	600	0	0	0
3	1	2	1	0	2	Discharge	CC	200	Pass		3285	3285	3199	201	3	3	0.9
4	1	3	1	0	3	Charge	CC	600	Pass		3254	4199	4199	599	1321	1321	132.3
5	1	4	1	0	4	Charge	CV	4200	Pass		4199	4200	4200	60	150	1471	39.2
6	1	5	1	0	5	Discharge	CC	400	Pass		4181	4181	4096	400	20	20	3
7	1	6	1	0	6	Discharge	CC	400	Pass		4163	4163	4080	400	20	40	3
8	1	7	1	0	7	Discharge	CC	400	Pass		4147	4147	4065	400	20	60	3
9	1	8	1	0	8	Discharge	CC	400	Pass		4132	4132	4051	400	20	80	3
10	1	9	1	0	9	Discharge	CC	400	Pass		4117	4117	4037	400	20	100	3
11	1	10	1	0	10	Discharge	CC	400	Pass		4104	4104	4023	400	20	120	3
12	1	11	1	0	11	Discharge	CC	400	Pass		4091	4091	4010	400	20	140	3
13	1	12	1	0	12	Discharge	CC	400	Pass		4079	4079	3998	400	20	160	3
14	1	13	1	0	13	Discharge	CC	400	Pass		4066	4066	3986	400	20	180	3
15	1	14	1	0	14	Discharge	CC	400	Pass		4055	4055	3974	400	20	200	3
16	1	15	1	0	15	Discharge	CC	400	Pass		4043	4043	3962	400	20	220	3
17	1	16	1	0	16	Discharge	CC	400	Pass		4032	4032	3950	400	20	240	3
18	1	17	1	0	17	Discharge	CC	400	Pass		4020	4020	3939	400	20	259	3
19	1	18	1	0	18	Discharge	CC	400	Pass		4010	4010	3928	400	20	279	3
20	1	19	1	0	19	Discharge	CC	400	Pass		3999	3999	3918	400	20	299	3
21	1	20	1	0	20	Discharge	CC	400	Pass		3989	3989	3907	400	20	319	3
22	1	21	1	0	21	Discharge	CC	400	Pass		3979	3979	3897	400	20	339	3
23	1	22	1	0	22	Discharge	CC	400	Pass		3969	3969	3887	400	20	359	3
24	1	23	1	0	23	Discharge	CC	400	Pass		3961	3961	3877	400	20	379	3
25	1	24	1	0	24	Discharge	CC	400	Pass		3952	3952	3868	400	20	399	3

Test data processing

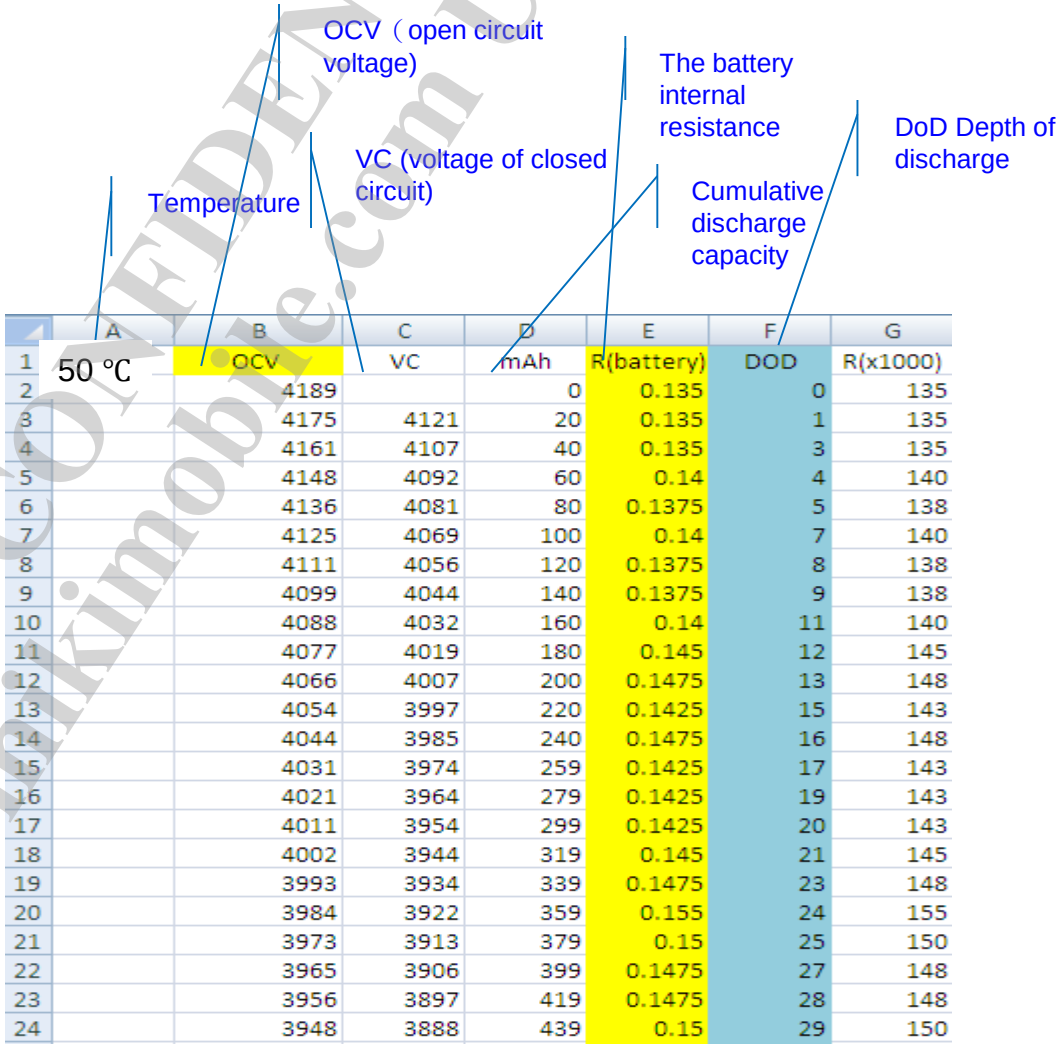
- 3： Open a data template that is used for data collection



ZCV

Test data processing

- 4： Template data corresponding to the column meaning, usually we fill in the OCV, the VC, mAh, the data of the Qmax. R (battery), DOD, the R (x1000) data will automatically generated.



	A	B	C	D	E	F	G
1	50 ℃	OCV	VC	mAh	R(battery)	DOD	R(x1000)
2		4189		0	0.135	0	135
3		4175	4121	20	0.135	1	135
4		4161	4107	40	0.135	3	135
5		4148	4092	60	0.14	4	140
6		4136	4081	80	0.1375	5	138
7		4125	4069	100	0.14	7	140
8		4111	4056	120	0.1375	8	138
9		4099	4044	140	0.1375	9	138
10		4088	4032	160	0.14	11	140
11		4077	4019	180	0.145	12	145
12		4066	4007	200	0.1475	13	148
13		4054	3997	220	0.1425	15	143
14		4044	3985	240	0.1475	16	148
15		4031	3974	259	0.1425	17	143
16		4021	3964	279	0.1425	19	143
17		4011	3954	299	0.1425	20	143
18		4002	3944	319	0.145	21	145
19		3993	3934	339	0.1475	23	148
20		3984	3922	359	0.155	24	155
21		3973	3913	379	0.15	25	150
22		3965	3906	399	0.1475	27	148
23		3956	3897	419	0.1475	28	148
24		3948	3888	439	0.15	29	150

Test data processing

- 5： Empty template original OCV of VC, mAh column corresponds to the data, as for example 50 degrees of data.

	A	B	C	D	E	F	G
1	50 ℃	OCV	VC	mAh	R(battery)	DOD	R(x1000)
2						0	
3					0	0	0
4					0	0	0
5					0	0	0
6					0	0	0
7					0	0	0
8					0	0	0
9					0	0	0
10					0	0	0
11					0	0	0
12					0	0	0
13					0	0	0
14					0	0	0
15					0	0	0

Test data processing

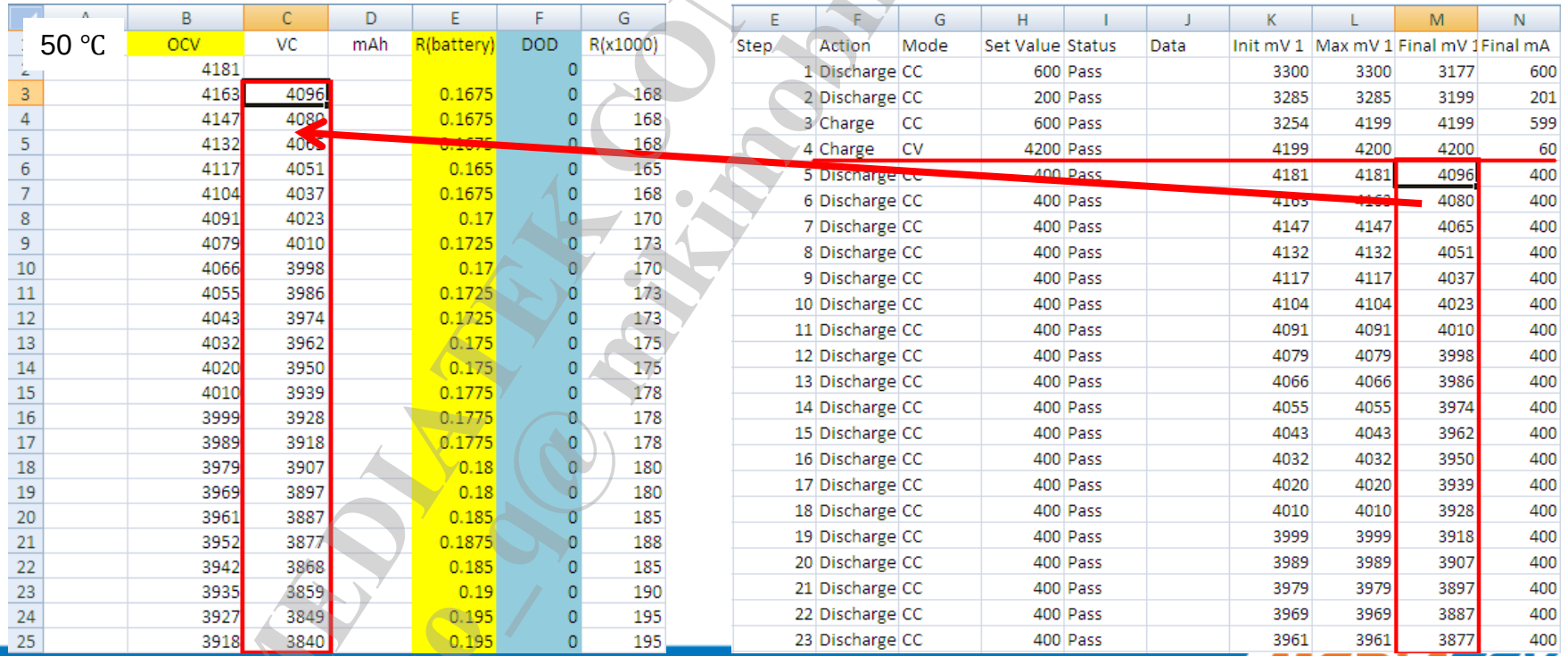
- 6： Raw data Init mV, a copy the data to the OCV column of the template, pay attention to fill in on line 2, the voltage data is copied to line 5 Discharge corresponding voltage from the original data.

	B	C	D	E	F	G
1	50 ℃ OCV	VC	mAh	R(battery)	DOD	R(x1000)
2	4181				0	
3	4163			10.4075	0	10408
4	4147			10.3675	0	10368
5	4132			10.33	0	10330
6	4117			10.2925	0	10293
7	4104			10.26	0	10260
8	4091			10.2275	0	10228
9	4079			10.1975	0	10198
10	4066			10.165	0	10165
11	4055			10.1375	0	10138
12	4043			10.1075	0	10108
13	4032			10.08	0	10080
14	4020			10.05	0	10050
15	4010			10.025	0	10025
16	3999			9.9975	0	9998
17	3989			9.9725	0	9973
18	3979			9.9475	0	9948
19	3969			9.9225	0	9923
20	3961			9.9025	0	9903
21	3952			9.88	0	9880
22	3942			9.855	0	9855
23	3935			9.8375	0	9838
24	3927			9.8175	0	9818

E	F	G	H	I	J	K	L	M
Step	Action	Mode	Set Value	Status	Data	Init mV 1	Max mV 1	Final mV 1
1	Discharge	CC	600	Pass		3300	3300	3177
2	Discharge	CC	200	Pass		3285	3285	3199
3	Charge	CC	600	Pass		3254	4199	4199
4	Charge	CV	4200	Pass		4199	4200	4200
5	Discharge	CC	400	Pass		4181	4181	4096
6	Discharge	CC	400	Pass		4163	4163	4080
7	Discharge	CC	400	Pass		4147	4147	4065
8	Discharge	CC	400	Pass		4132	4132	4051
9	Discharge	CC	400	Pass		4117	4117	4037
10	Discharge	CC	400	Pass		4104	4104	4023
11	Discharge	CC	400	Pass		4091	4091	4010
12	Discharge	CC	400	Pass		4079	4079	3998
13	Discharge	CC	400	Pass		4066	4066	3986
14	Discharge	CC	400	Pass		4055	4055	3974
15	Discharge	CC	400	Pass		4043	4043	3962
16	Discharge	CC	400	Pass		4032	4032	3950
17	Discharge	CC	400	Pass		4020	4020	3939
18	Discharge	CC	400	Pass		4010	4010	3928
19	Discharge	CC	400	Pass		3999	3999	3918
20	Discharge	CC	400	Pass		3989	3989	3907
21	Discharge	CC	400	Pass		3979	3979	3897
22	Discharge	CC	400	Pass		3969	3969	3887
23	Discharge	CC	400	Pass		3961	3961	3877
24	Discharge	CC	400	Pass		3952	3952	3868
25	Discharge	CC	400	Pass		3942	3942	3859
26	Discharge	CC	400	Pass		3935	3935	3849
27	Discharge	CC	400	Pass		3927	3927	3840

Test data processing

- 7：Raw data Init mV, a copy the data to the VC column of the template, pay attention to fill in on line 3, the voltage data is copied to line 5 Discharge corresponding voltage from the original data.



50 ℃

	B	C	D	E	F	G
	OCV	VC	mAh	R(battery)	DOD	R(x1000)
2	4181				0	
3	4163	4096		0.1675	0	168
4	4147	4080		0.1675	0	168
5	4132	4065		0.1675	0	168
6	4117	4051		0.165	0	165
7	4104	4037		0.1675	0	168
8	4091	4023		0.17	0	170
9	4079	4010		0.1725	0	173
10	4066	3998		0.17	0	170
11	4055	3986		0.1725	0	173
12	4043	3974		0.1725	0	173
13	4032	3962		0.175	0	175
14	4020	3950		0.175	0	175
15	4010	3939		0.1775	0	178
16	3999	3928		0.1775	0	178
17	3989	3918		0.1775	0	178
18	3979	3907		0.18	0	180
19	3969	3897		0.18	0	180
20	3961	3887		0.185	0	185
21	3952	3877		0.1875	0	188
22	3942	3868		0.185	0	185
23	3935	3859		0.19	0	190
24	3927	3849		0.195	0	195
25	3918	3840		0.195	0	195

	E	F	G	H	I	J	K	L	M	N
	Step	Action	Mode	Set Value	Status	Data	Init mV 1	Max mV 1	Final mV 1	Final mA
1	1	Discharge	CC	600	Pass		3300	3300	3177	600
2	2	Discharge	CC	200	Pass		3285	3285	3199	201
3	3	Charge	CC	600	Pass		3254	4199	4199	599
4	4	Charge	CV	4200	Pass		4199	4200	4200	60
5	5	Discharge	CC	400	Pass		4181	4181	4096	400
6	6	Discharge	CC	400	Pass		4165	4165	4080	400
7	7	Discharge	CC	400	Pass		4147	4147	4065	400
8	8	Discharge	CC	400	Pass		4132	4132	4051	400
9	9	Discharge	CC	400	Pass		4117	4117	4037	400
10	10	Discharge	CC	400	Pass		4104	4104	4023	400
11	11	Discharge	CC	400	Pass		4091	4091	4010	400
12	12	Discharge	CC	400	Pass		4079	4079	3998	400
13	13	Discharge	CC	400	Pass		4066	4066	3986	400
14	14	Discharge	CC	400	Pass		4055	4055	3974	400
15	15	Discharge	CC	400	Pass		4043	4043	3962	400
16	16	Discharge	CC	400	Pass		4032	4032	3950	400
17	17	Discharge	CC	400	Pass		4020	4020	3939	400
18	18	Discharge	CC	400	Pass		4010	4010	3928	400
19	19	Discharge	CC	400	Pass		3999	3999	3918	400
20	20	Discharge	CC	400	Pass		3989	3989	3907	400
21	21	Discharge	CC	400	Pass		3979	3979	3897	400
22	22	Discharge	CC	400	Pass		3969	3969	3887	400
23	23	Discharge	CC	400	Pass		3961	3961	3877	400

Test data processing

- 8：Copy the data to raw data Acc mAH column mAh column of the template, pay attention to fill in line 3, the voltage data is copied from the original data line 5 Discharge corresponding to the cumulative power. Power value of the line 2 of the template, fill in 0.

	A	B	C	D	E
1	50 ℃	OCV	VC	mAh	R(battery)
2		4181		0	
3		4163	4096	20	0.1675
4		4147	4080	40	0.1675
5		4132	4065	60	0.1675
6		4117	4051	80	0.165
7		4104	4037	100	0.1675
8		4091	4023	120	0.17
9		4079	4010	140	0.1725
10		4066	3998	160	0.17
11		4055	3986	180	0.1725
12		4043	3974	200	0.1725
13		4032	3962	220	0.175
14		4020	3950	240	0.175
15		4010	3939	259	0.1775
16		3999	3928	279	0.1775
17		3989	3918	299	0.1775
18		3979	3907	319	0.18
19		3969	3897	339	0.18
20		3961	3887	359	0.185
21		3952	3877	379	0.1875

K	L	M	N	O	P	Q
Init mV 1	Max mV 1	Final mV 1	Final mA	Step mAH	Acc mAH	Time (M)
3300	3300	3177	600	0	0	0
3285	3285	3199	201	3	3	0.9
3254	4199	4199	599	1321	1321	132.3
4199	4200	4200	60	150	1471	39.2
4181	4181	4096	400	20	20	3
4163	4163	4080	400	20	40	3
4147	4147	4065	400	20	60	3
4132	4132	4051	400	20	80	3
4117	4117	4037	400	20	100	3
4104	4104	4023	400	20	120	3
4091	4091	4010	400	20	140	3
4079	4079	3998	400	20	160	3
4066	4066	3986	400	20	180	3
4055	4055	3974	400	20	200	3
4043	4043	3962	400	20	220	3
4032	4032	3950	400	20	240	3
4020	4020	3939	400	20	259	3
4010	4010	3928	400	20	279	3
3999	3999	3918	400	20	299	3
3989	3989	3907	400	20	319	3
3979	3979	3897	400	20	339	3
3969	3969	3887	400	20	359	3
3961	3961	3877	400	20	379	3

Test data processing

- 9： Fill in the data are misplaced, so the the OCV column at the end of data one, so the top row of data is copied to the line can be.

71		3652	3572	1377	0.2	92	200
72		3616	3536	1397	0.2	93	200
73		3547	3464	1417	0.2075	94	208
74		3446	3355	1437	0.2275	96	228
75		3309	3199	1454	0.275	97	275
76		3288	3198	1457	0.225	97	225
77			3198	1458	-7.995	97	-7995
78					0	0	0
79					0	0	0
80					0	0	0
81					0	0	0
82					0	0	0
83							
84		Cmax		1500			
85		Cmax_400mA		1487			

70	3661	3585	1357	0.19	90	190
71	3652	3572	1377	0.2	92	200
72	3616	3536	1397	0.2	93	200
73	3547	3464	1417	0.2075	94	208
74	3446	3355	1437	0.2275	96	228
75	3309	3199	1454	0.275	97	275
76	3288	3198	1457	0.225	97	225
77	3288	3198	1458	0.225	97	225
78				0	0	0
79				0	0	0
80				0	0	0
81				0	0	0
82				0	0	0
83						
84	Cmax		1500			
85	Cmax_400mA		1487			

Test data processing

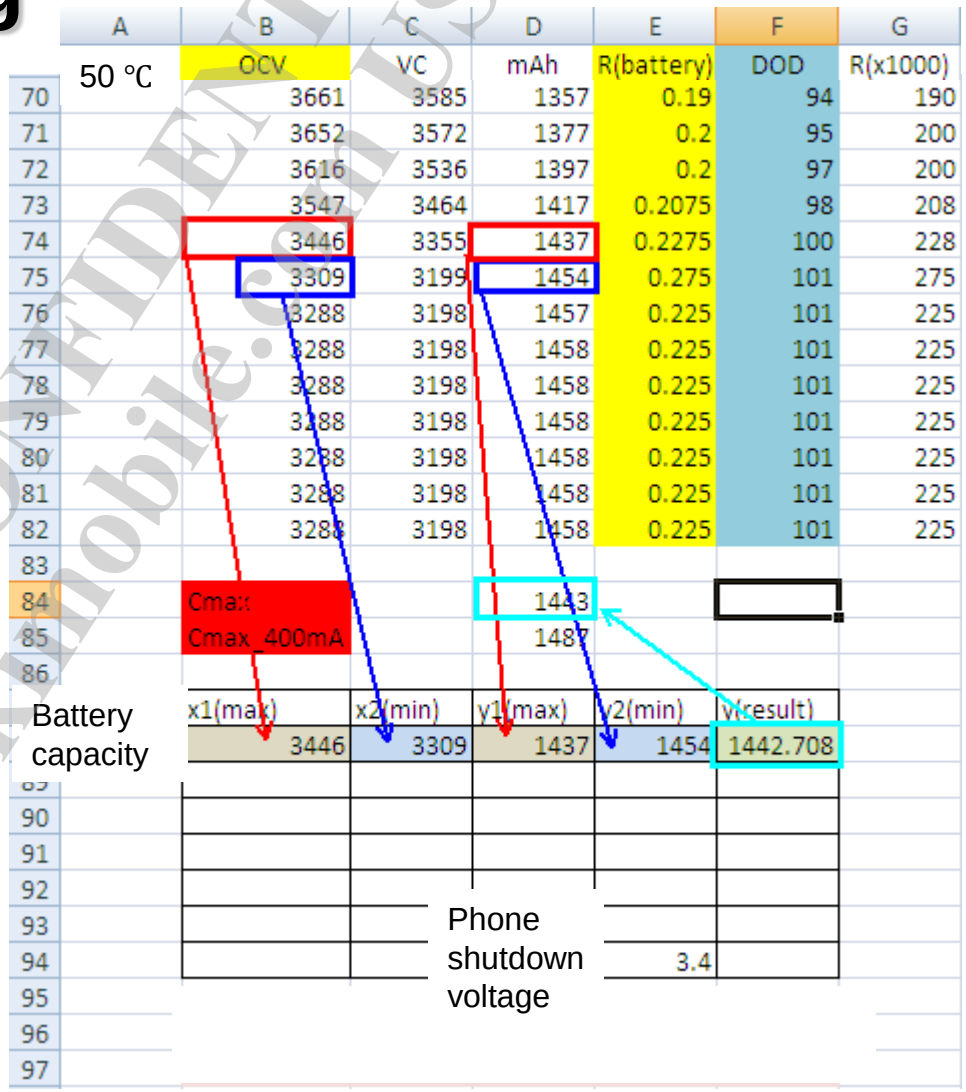
- 10： Filled the length of the data, the last row of data is populated, so the data length is the same length.

70	3661	3585	1357	0.19	90	190
71	3652	3572	1377	0.2	92	200
72	3616	3536	1397	0.2	93	200
73	3547	3464	1417	0.2075	94	208
74	3446	3355	1437	0.2275	96	228
75	3309	3199	1454	0.275	97	275
76	3288	3198	1457	0.225	97	225
77	3288	3198	1458	0.225	97	225
78	3288	3198	1458	0.225	97	225
79	3288	3198	1458	0.225	97	225
80	3288	3198	1458	0.225	97	225
81	3288	3198	1458	0.225	97	225
82	3288	3198	1458	0.225	97	225
83						
84	Cmax		1500			
85	Cmax_400mA		1487			

70	3661	3585	1357	0.19	90	190
71	3652	3572	1377	0.2	92	200
72	3616	3536	1397	0.2	93	200
73	3547	3464	1417	0.2075	94	208
74	3446	3355	1437	0.2275	96	228
75	3309	3199	1454	0.275	97	275
76	3288	3198	1457	0.225	97	225
77	3288	3198	1458	0.225	97	225
78				0	0	0
79				0	0	0
80				0	0	0
81				0	0	0
82				0	0	0
83						
84	Cmax		1500			
85	Cmax_400mA		1487			

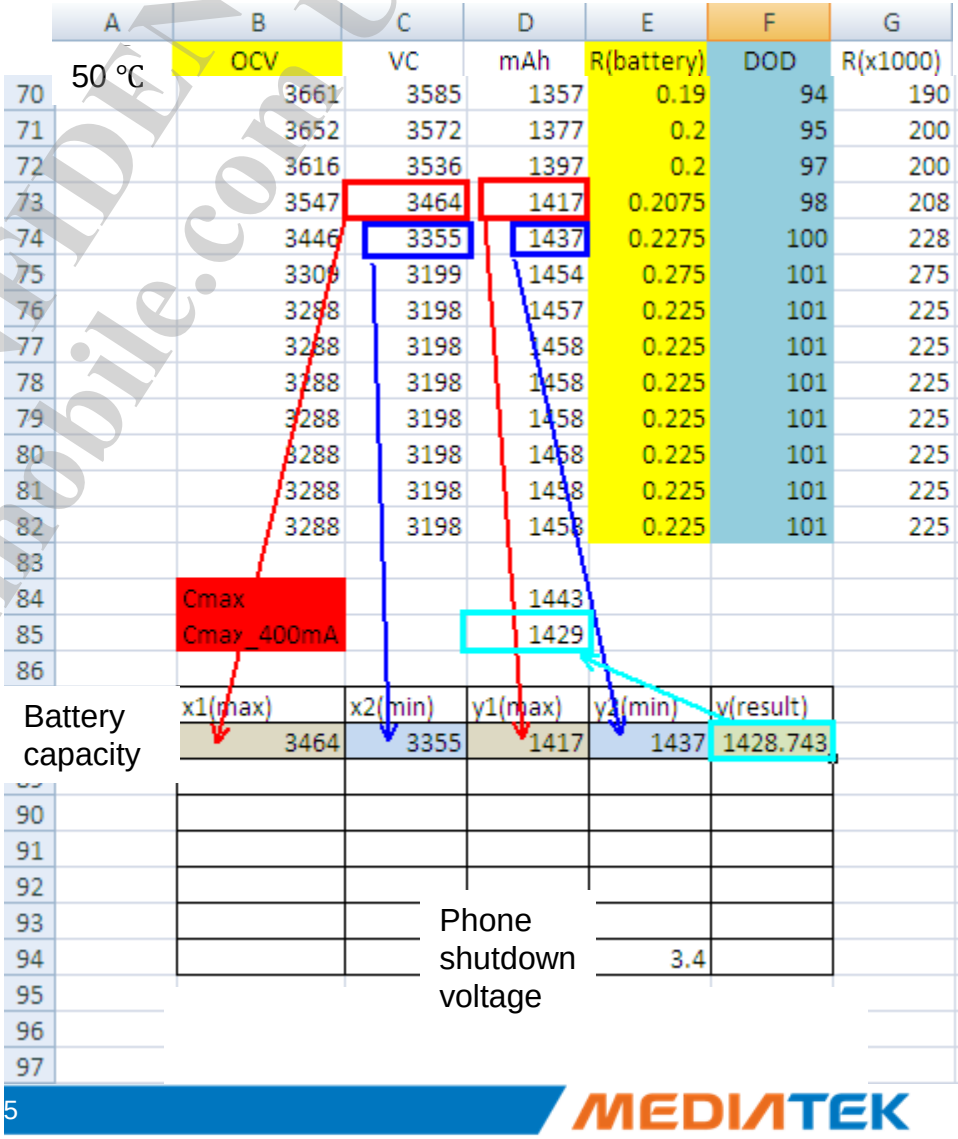
Test data processing

- 11： Qmax calculation. We need to calculate the 3.4V shutdown voltage corresponding to the battery capacity. Our measured data may not be exactly the voltage of 3.4V, so 3.4V corresponds to the power calculations. Right, fill in the data to the following power calculation tables, you can automatically calculate the battery capacity corresponding to 3.4V, then the power calculated values to fill out to Qmax data location, where the rounded fill 1442.708 should be counted as 1443.



Test data processing

- 12. Calculation of Qmax_400mA. We need to calculate the 3.4V shutdown voltage corresponding to the battery load capacity. Our measured data may not be exactly the voltage of 3.4V, so 3.4V corresponds to the power calculations. Right, fill in the data to the following power calculation tables, you can automatically calculate the battery capacity corresponding to 3.4V, and then power the calculated values to fill in to Qmax_400mA data location, where the rounded fill 1428.743 should be counted as 1429. Note that the voltage VC corresponding to the column.



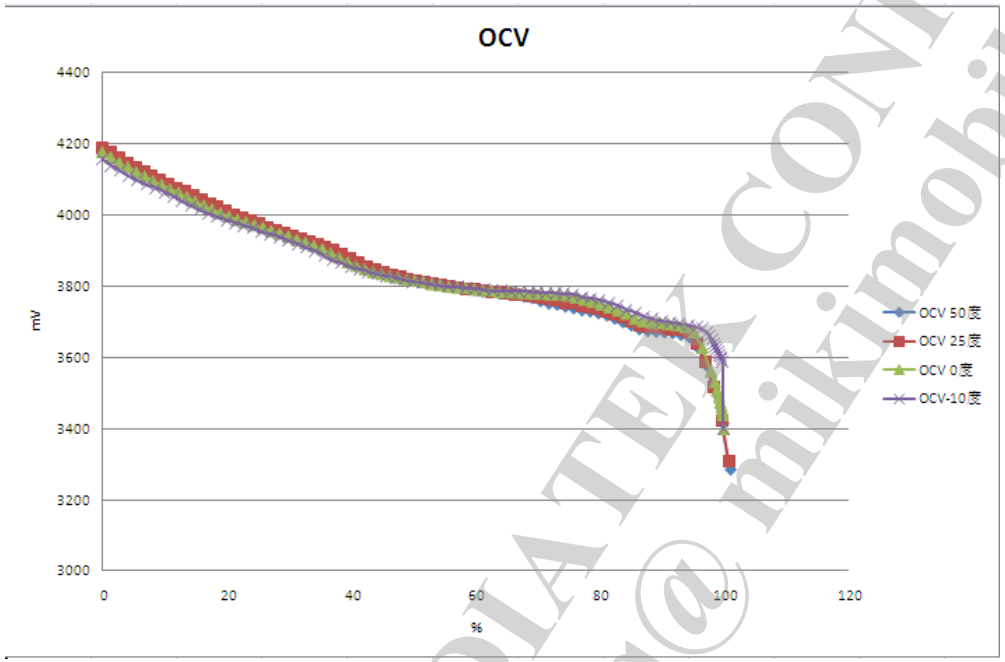
Test data processing

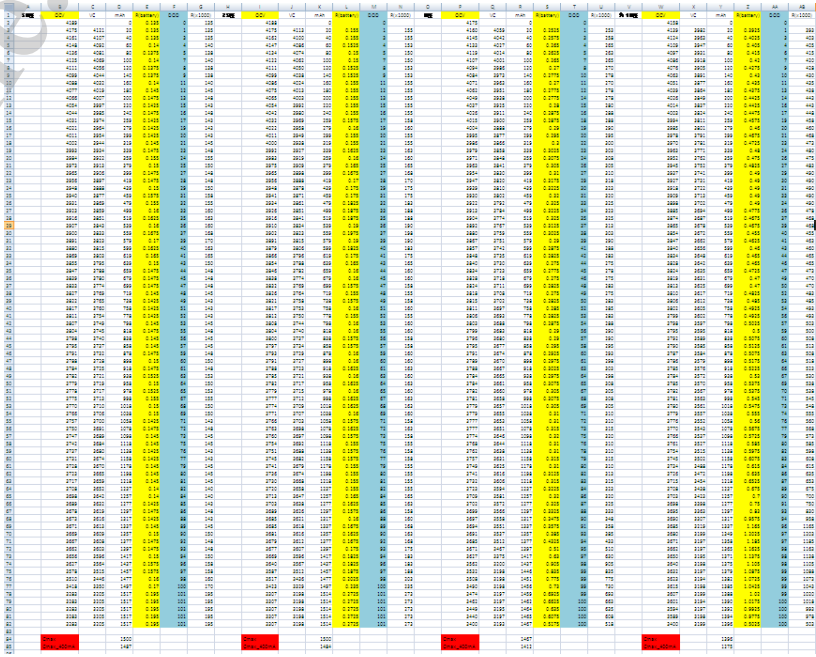
- 13： Because the second line hasn't VC voltage, so the system can not directly calculate the battery's internal resistance, so we will line resistance value directly copied to the line 2 can be, so that an OCV voltage corresponding resistance values.

	A	B	C	D	E	F	G
1	50 ℃	OCV	VC	mAh	R(battery)	DOD	R(x1000)
2		4189		0	0.135	0	135
3		4175	4121	20	0.135	1	135
4		4161	4107	40	0.135	3	135
5		4148	4092	60	0.14	4	140
6		4136	4081	80	0.1375	5	138
7		4125	4069	100	0.14	7	140
8		4111	4056	120	0.1375	8	138
9		4099	4044	140	0.1375	9	138
10		4088	4032	160	0.14	11	140
11		4077	4019	180	0.145	12	145

Test data processing

- 14：After completion of the four temperature data fill curve of ZCV will automatically born generation, the curve is as follows.





MEDIATEK

Thanks!