APPROVAL SHEET

MESSRS	
BRAND	
PRODUCT	3V RECHARGEABLE LITHIUM MANGANESE BUTTON BATTERY
MODEL	ML1220
PREPARED	
CHECKED	
DATE	JAN. 08, 2021

CUSTOMER APPROVAL RECORD			
COMPANY NAME	DEPART-MENT	APPROVED BY	DATE

1. Scope

The purpose of this product specification is to provide technical information for the rechargeable lithium manganese button battery ML1220, manufactured and supplied by TAC.

2. Description and Model

Description	3V rechargeable lithium manganese button battery
Model	ML1220

3. Specification

No.	Item		Specification	Remark
01	Model		ML1220	
02	Nominal Capacity		16 mAh	discharge continuously to 2.0V with resistor load of 30kΩ; tailored between 12～18mAh to fulfil client demand.
03	Nominal Voltage		3.0 V	
04	Mean Voltage		2.8 V	End voltage after 8mAh discharge with resistor load of 30kΩ
05	Cut-off Voltage		2.0 V	
06	Standard Charge/Discharge Current		0.1 mA	
07	Max. Continuous Discharge Current		4 mA	This is determined so that 50% of the nominal capacity is obtained with an end voltage of 2.0V at 23℃
08	Max. Pulse Discharge Current		8 mA	Current value for obtaining 2.0V cell voltage when 15sec. pulse is applied at 50% discharge depth at 23℃
09	Internal Resistance		20～50Ω	Four-probe method
10	Operating Temperature		-20～60℃	
11	Charge	Constant Current /Constant Voltage	0.01～0.5mA /3.2～3.3V	1)Charge to 3.25V by standard constant 0.1mA current or rapid 0.5mA constant current 2)then charge at 3.25V with an end current below 0.05mA
		Constant Voltage with Limiting R_{Load}	3.1～3.3V	
12	Life Expectancy		1000cycles	10%DOD，charge/discharge at 0.1mA
			600cycles	10%DOD，charge/discharge at 0.5mA
			300cycles	10%DOD，charge/discharge at 1.0mA
			180cycles	10%DOD，charge/discharge at 2mA
			150cycles	10%DOD，charge at 2mA/discharge at 4mA
			50cycles	10%DOD，charge at 2mA/discharge at 15mA
			500cycles	20%DOD，charge/discharge at 0.1mA
			200cycles	20%DOD，charge/discharge at 1.0mA
13	Dimension	Diameter	12.5 mm	

		Height	2.0 mm	
14	Weight		0.7 g	approx.
15	Stored Energy		45 mWh	

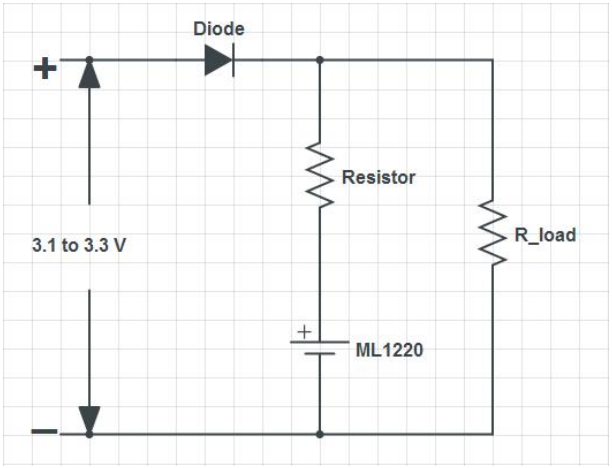


Figure 1 Recommended circuit of constant voltage charge with protective resistor

Table 3 Example value for protective resistor

Model	Charge voltage	
ML1220	3.1V	3.25V
	510Ω	1kΩ

4. Technical Requirements

4.1 Testing Conditions

4.1.1 Standard charge methods

4.1.1.1 Constant current/constant voltage charge method

At (25±5)℃, the cell should be charged to an upper voltage limit within (3.1～3.3)V with constant current I_{Charge}, then the cell be charged at that constant voltage until the charge current falls to below $0.5I_{Charge}$. The said upper voltage limit is recommended to be 3.25V and no more than 3.3V.

4.1.1.2 Constant voltage charge method with protective resistor

At (25±5)℃, the charge circuit refers to the one in figure 1 and relevant parameters are demonstrated in Table 3. Charging continues until the charging current falls to less than 0.05mA.

4.1.2 Standard discharge procedures

4.1.2.1 Standard discharge at constant current

At (25±5)℃, the fresh cell should be discharged at constant current I_{const} selected between 0.03 to 0.1mA for the duration of (%DOD x Nominal capacity/I_{const}) hours , the cutoff voltage is 2.0V.

4.1.2.2 Standard discharge with constant resistance load

At (25±5)℃, the fresh cell be discharged continuously to the cutoff voltage of 2.0V with a loading equivalent resistor of 30kΩ in series.

4.1.3 Standard testing environment

Temperature: 20～30℃

Relative humidity: 25%～85%RH

Atmosphere pressure: 86～106kPa

Measuring and testing instruments as reference: program controlled Neware BTS standard coin battery

testing equipment (voltage/current precision of ±0.1%), four-probe resistor meter (precision of 8%), loading resistor (precision of ±0.5%)

4.2 Electrical Performance

No	Item	Testing procedures	Requirement
01	Nominal capacity	Under standard testing environment (4.1.3), the fresh cell should be discharged following standard discharge procedures (4.1.2), then the cell be charged to less than 3.3V following standard charge method (4.1.1). Finally, the cell should be discharged to 2.0V according to standard discharge procedures (4.1.2), so that the discharged electric quantity is recorded as nominal capacity.	
02	Internal resistance	Under standard testing environment (4.1.3), fresh cells should be tested by four-probe resistor meter.	Among the tested samples, the percentage of those with resistance between 20 ～ 55Ω should be greater than 99%.
03	Life expectation	Under standard testing environment (4.1.3), for fresh cell samples, follow the steps: ①expectant electric quantity be discharged according to standard (4.1.2.1) with cutoff voltage as 2.0V, ②stand-by status for 10min., ③charge the cell to 3.25V according to (4.1.1.1), ④stand by for 10min., ⑤loop from step ① until the discharged electric quantity falls to 50% of the required value.	When the charge/discharge current is set as standard 0.1mA, the percentage of those samples whose 10% DOD life-span exceeds to 1000cycles should be greater than 90%, those of above 800cycles be greater 95%. When the accelerated life tests are planned to perform with the charge/discharge current set as 2mA, the duration of constant voltage charge at 3.25V at each loop can be limited to as short as 1hour. The percentage of those whose 10% DOD life-span exceeds to 150cycles should be greater than 95%.
04	Self-discharge	Under standard testing environment (4.1.3), after one year of storage of fresh cells with open electrodes disconnected , do the discharge according to (4.1.2.2.)	The discharge duration should be no less than 155 hours using draining current of 0.1mA or equivalent load condition.
05	Over-charge	Charge fresh cells with a level of constant 3.25V voltage at 23±5℃ for a duration of 20 days.	No indication of electrolyte leakage. Discharge capacity and voltage platform should not deteriorate to below nominal values.

5. Warning for circuit design

5.1 Never set the charge voltage above 3.3V

The recommended upper limit for the charging voltage between the two electrodes of cell is 3.25V. Charging at higher voltage more than 3.3V could cause the generation of gas, internal short-circuiting, or other malfunctions.

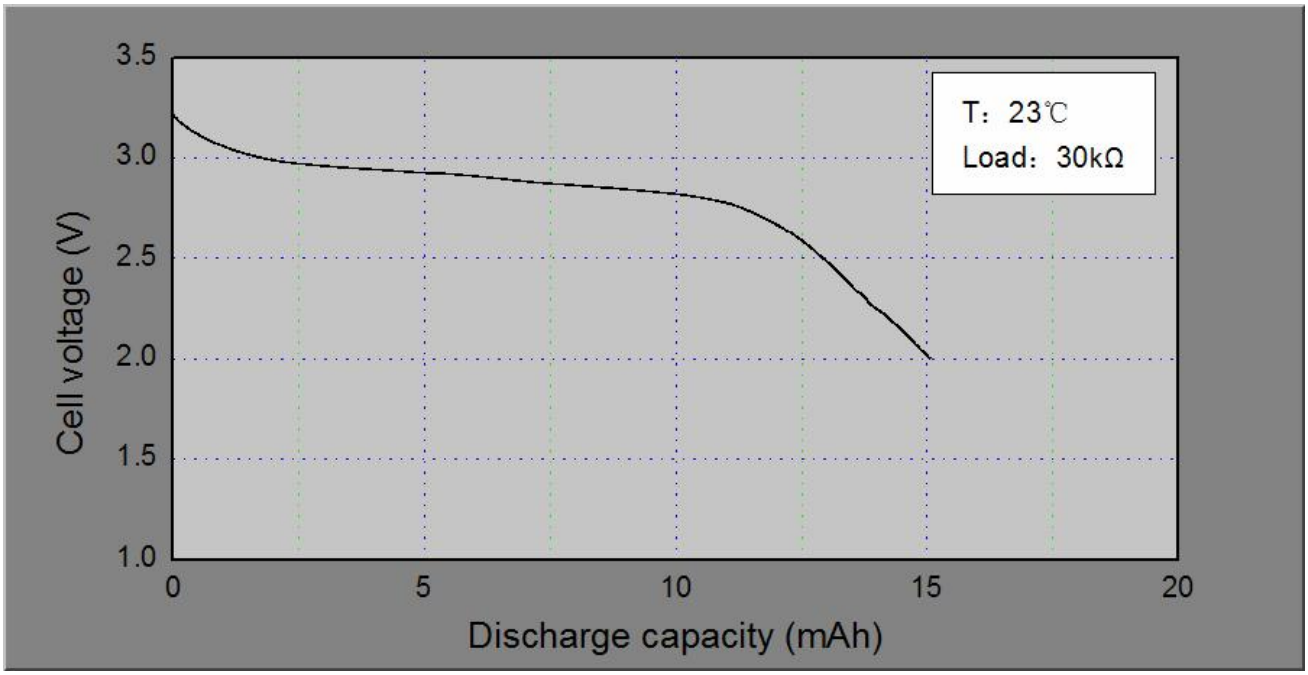
5.2 Different life-expectancy for different charge/discharge current routines

The larger current employed during the whole life of charge/discharge loops would lead to less cycles of life-span. Though JERAMIC®ML1220 could discharge at 15mA for each 10%DOD loop surviving some extreme and harsh application circumstances, the life-span would decrease to 50 cycles of loop. Appropriate selection of charge/discharge current should be taken into consideration.

6. Typical Characteristic Curves

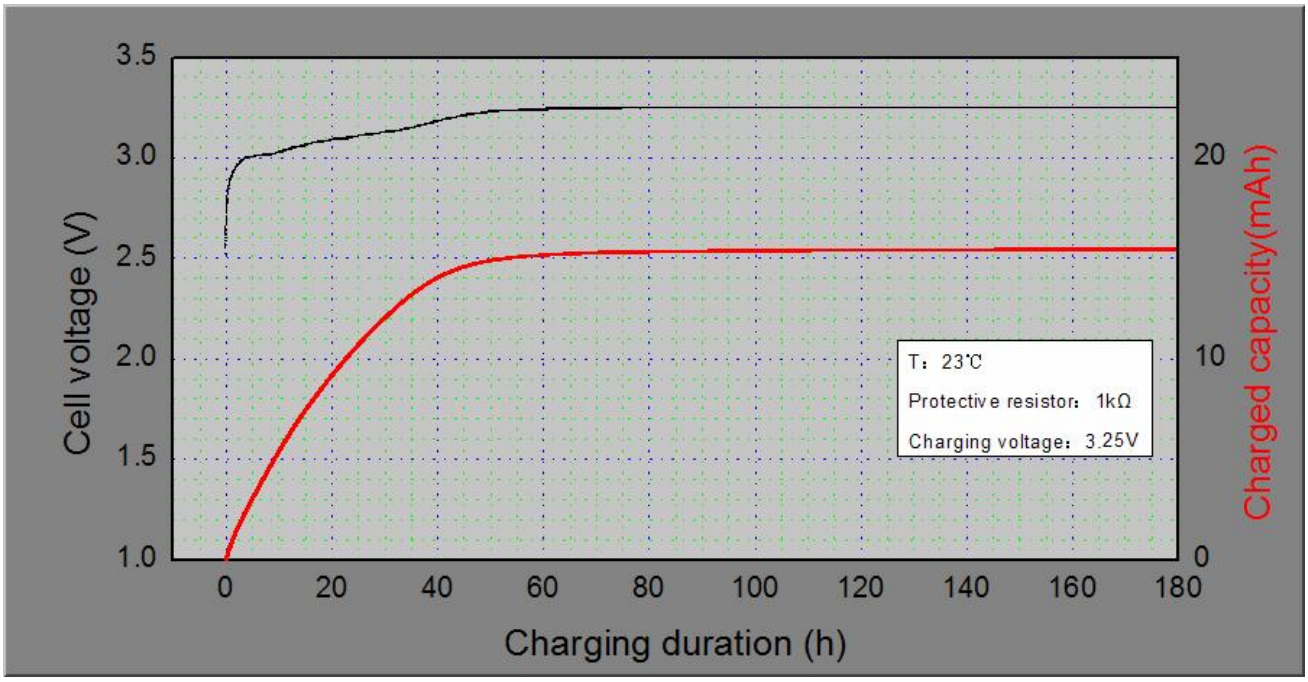
6.1 ML1220 discharge characteristic

Figure 1 Discharge curve measuring nominal capacity (section4.2)



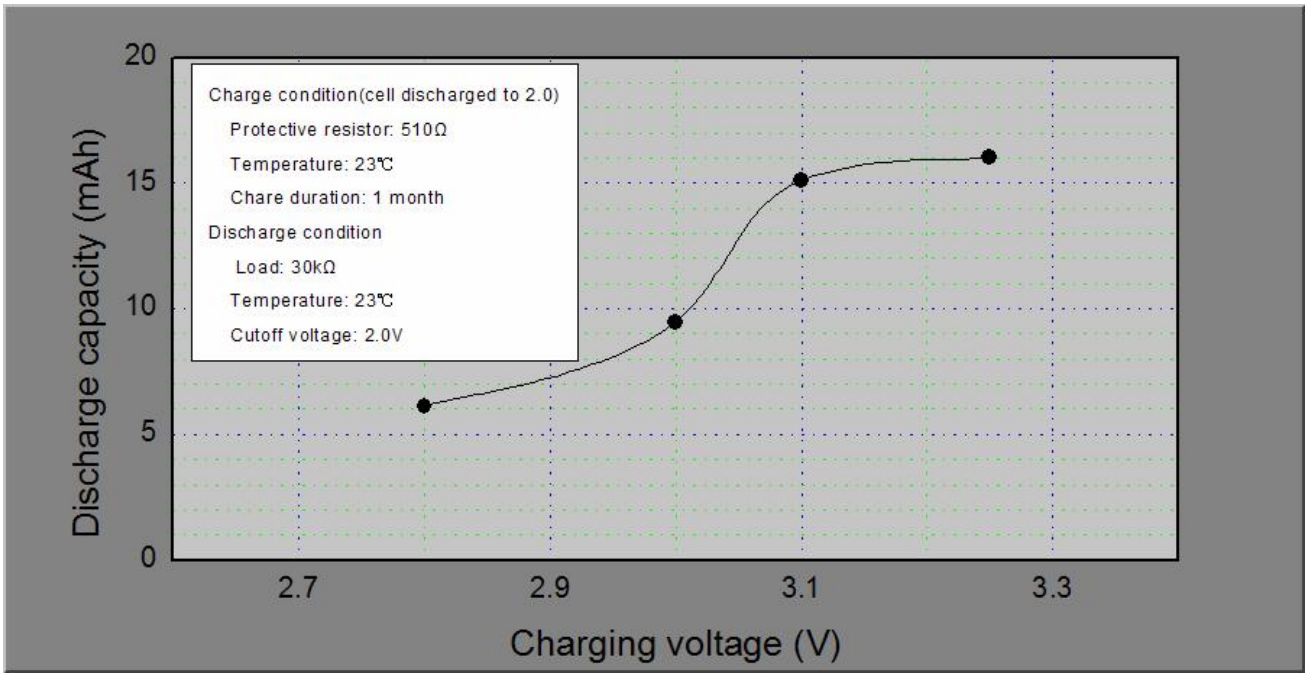
6.2 Constant voltage charge with protective resistor

Figure 2 Constant voltage charging with protective resistor (section 4.1.1.2)



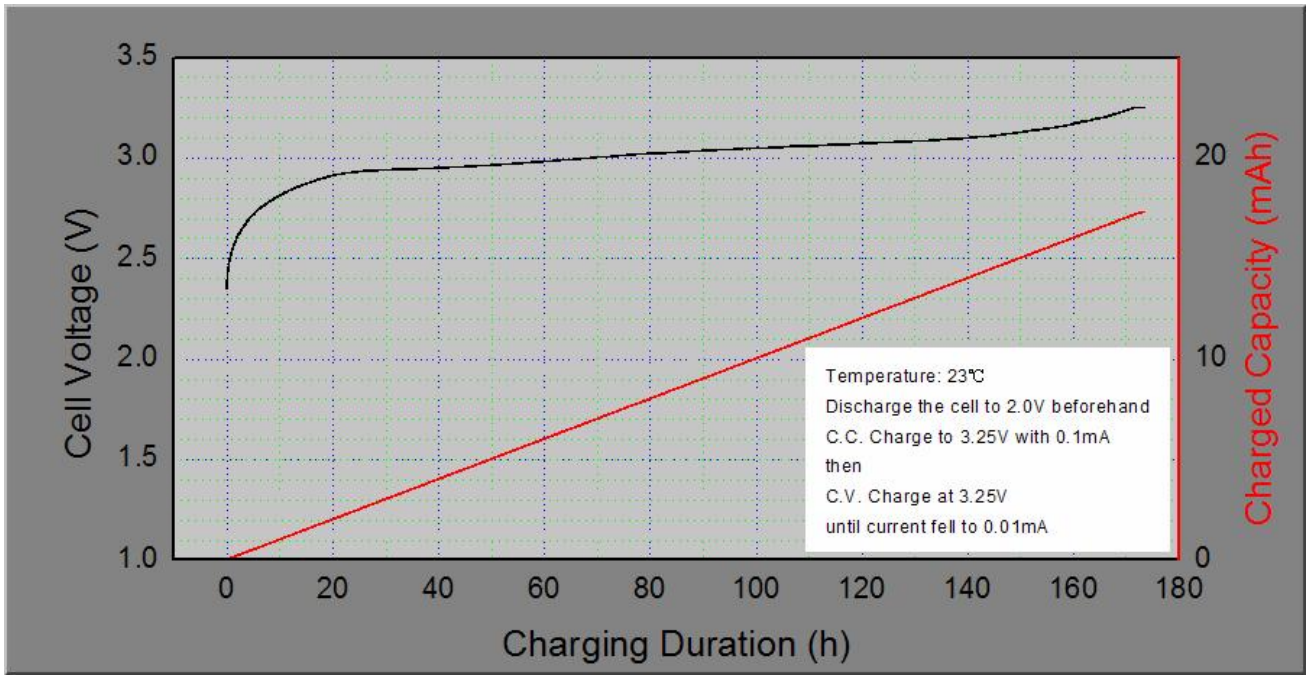
6.3 Constant charge voltage vs. capacity

Figure 3 Constant charge voltage vs. capacity



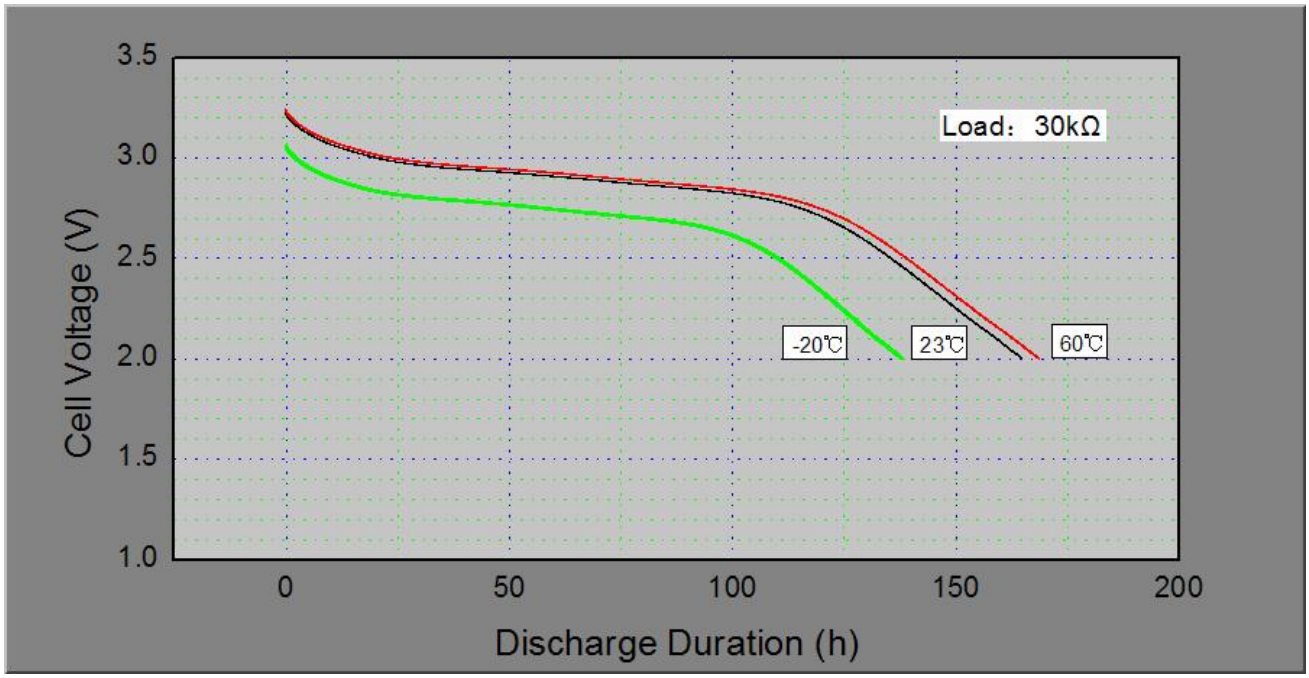
6.4 Charge with constant current/constant voltage

Figure 4 Cell voltage and charged capacity vs. charge duration



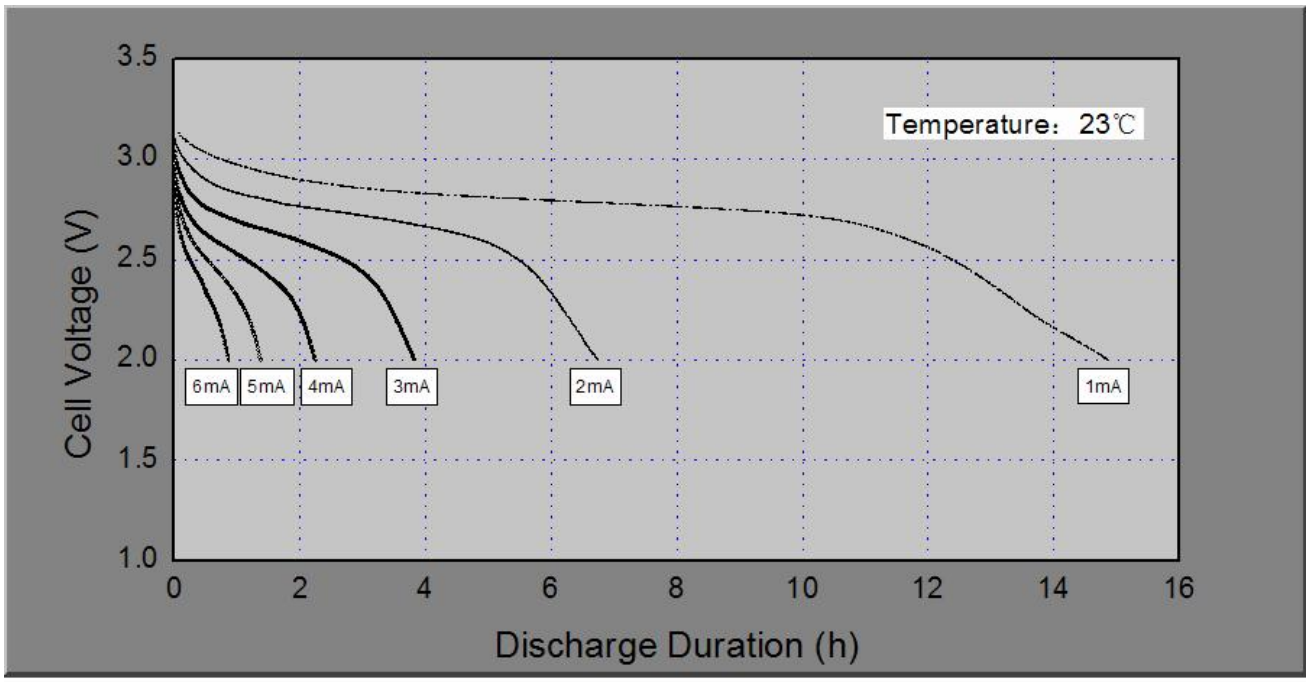
6.5 Temperature characteristics

Figure 5 Discharge curve at different temperatures



6.6 High rate discharge characteristics

Figure 6 Discharge curve at different discharge current



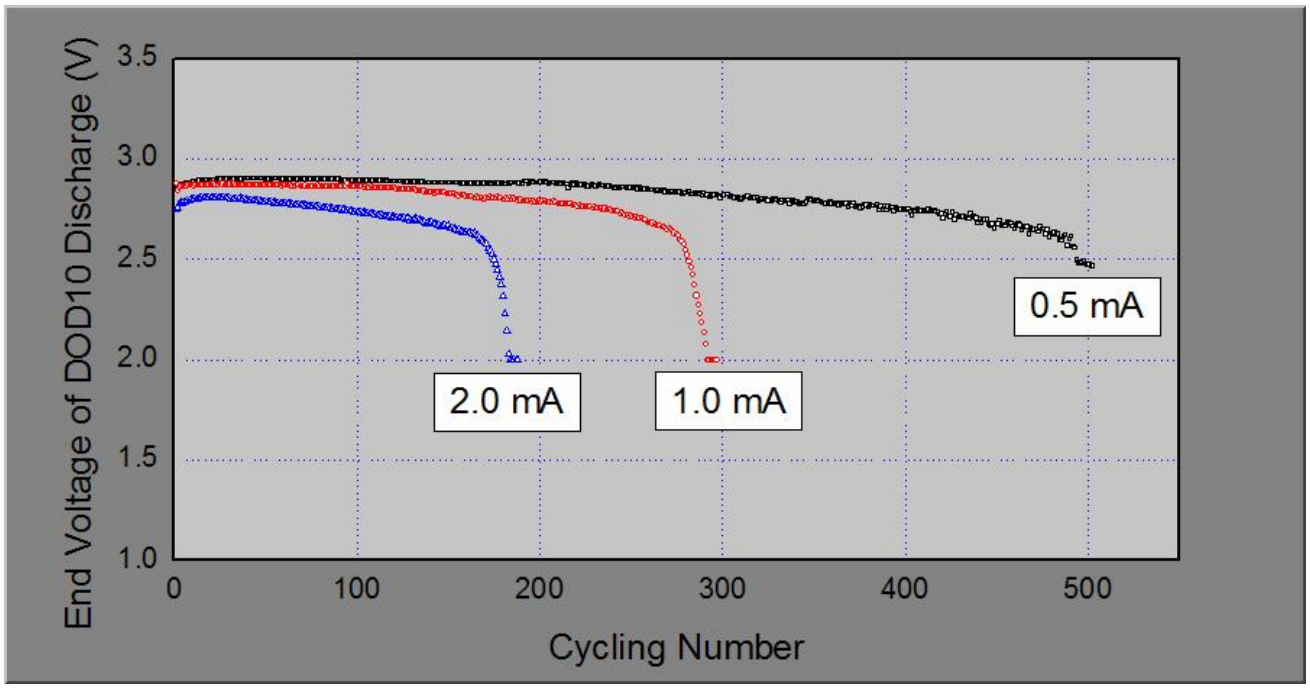
6.7 Accelerated test of life expectancy

Figure 7 End voltage of each DOD10 discharge vs. cycling number

(Charge step at each loop: C.C. charge to 3.25V using 0.5mA, 1.0mA and 2.0mA respectively, then C.V.charge for 1h)

(Discharge step at each loop: C.C. discharge 10% of nominal capacity, 1.5mAh,using 0.5mA, 1.0mA and 2.0mA respectively)

(Criteria for life end: the end voltage of DOD10% discharge fell to 2.0V and the discharged capacity of DOD10% attenuated to 0.75mAh)



7. Drawing