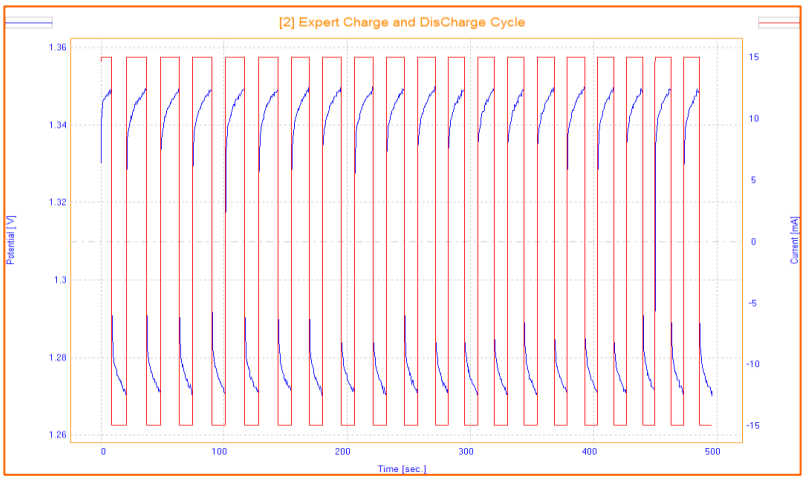
Application Note

Battery
AP-B01

Expert Charge and Discharge Cycle



This Application Note describes how the Expert Charge and Discharge Cycle method works by giving an example with a Ni-Cd 1.2V 600 mAh battery.

Origalys Electrochem

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Introduction

Nowadays batteries play a significant role in our life. Qualification tests on batteries are important to design and choose the right material for the battery, according to the use, and will cause saving money, time and energy. In this application note, one of the battery test methods of OrigaMaster software "Expert charge and discharge" and its parameters, is discussed.

Different kind of batteries found in the market can be tested by OrigaMaster software:

- Cylindrical Battery
- Coin Cell Battery
- Mobile Battery
- Laptop Battery
- Car Battery
- And so on

Figure 1: Different types of battery

⚠ Note that before testing the battery, the user must know the battery' specifications to put the correct parameters in the software. In case of putting wrong parameters, there is a risk of destruction or explosion of the battery.

Figure 2: Examples of problems with batteries

Parameters

Expert Charge and Discharge Cycle is an OrigaMaster's method available from the Chemistry items - Batteries (or Capacitors) group of the Sequence Ribbon. The method consists of 2 phases:

Properties

Display all | Details | Graph

Expert Charge and DisCharge Cycle	
Phase no. 1	
Cycle number	1
Galvanostatic Phase no. 1	
Set Current 1	10, mA
For Duration	30, sec.
Or exit if potential is	>, 1600
Record every dt	0.5, sec.
Or record every dE (mV)	10
Potentiostatic Phase no. 1	
Hold potential	30, sec.
Or exit if | current | <	0, µA
Record every dt	0.5, sec.
Or record every dQ	10, A.h
Open Circuit Potential Phase no. 1	
Exit conditions Phase no. 1	
If | Charge variation | >	600, A.h
If Phase no. 1 Duration >	10, hour
If Open Circuit Potential is	<, 1200
Phase no. 2	
Cycle number	2
Galvanostatic Phase no. 2	
Set Current 2	-10, mA
For Duration	15, sec.
Or exit if potential is	<, 1000
Record every dt	0.5, sec.
Or record every dE (mV)	10
Potentiostatic Phase no. 2	
Hold potential	0, min.
Or exit if | current | <	10, mA
Record every dt	1, sec.
Or record every dQ	10, mA.h
Open Circuit Potential Phase no. 2	
Exit conditions Phase no. 2	
If | Charge variation | >	600, A.h
If Phase no. 2 Duration >	10, hour
If Open Circuit Potential is	<, 800
Global parameters	

Figure 3: Parameters of the method

1- Phase No. 1: first phase where the battery is charged (or discharged depending on the polarity of the current applied).

2- Phase No. 2: followed by an optional second phase where the battery is discharged (or charged depending on the polarity of the current applied).

Each phase can be run several times before moving on to the next phase, by using: « Cycle number ». The sequence of these two phases can also be repeated several times.

Each phase is a sequence of three sub-phases where the potentiostat operates in three different modes:

1. First the galvanostatic mode where the current is imposed
2. followed by the potentiostatic mode where the potential is hold
3. and finally the mode where we measure the open circuit potential (free potential).

The 1st mode (galvanostatic) is always performed. Nevertheless it can be programmed for a very short duration (1ms). The 2nd and 3rd mode are optional.

NOTE:
Before testing a battery through charge-discharge method, it is very important that the user knows about the parameters of the battery. The most important parameters that must be known are as below:

- **Capacity:** A battery's capacity is the amount of electric charge it can deliver. The unit is mAh (mA per hour).
- **Nominal Voltage:** It describes the voltage of a battery in the middle of its discharge cycle. This is also where the voltage stays for the longest period during the discharge. For example, most lithium ion batteries have a nominal voltage of 3.6 volts. When fully charged, it's 4.2 volts.
- **Maximum current for discharge:** The maximum current that can be applied on the battery during discharge phase.
- **Maximum current for charge:** The maximum current that can be applied on the battery during charge phase.
- **Maximum voltage of charge:** The maximum limit of potential that the battery can have during the charge.
- **Minimum voltage of discharge:** The minimum amount of potential that the battery can have during the discharge.

- For industrial batteries all these parameters are **available** in the brochure or website of the manufacturer**.**
- For homemade batteries the user **must know** all these parameters to run the test correctly and safely.

1- Phase No. 1 or 2

This Phase consists in 4 subphases (figure 4):

Expert Charge and DisCharge Cycle	
Phase no. 1	
Cycle number	1
Galvanostatic Phase no. 1	
Set Current 1	10, mA
For Duration	30, sec.
Or exit if potential is	>, 1600
Record every dt	0.5, sec.
Or record every dE (mV)	10
Potentiostatic Phase no. 1	
Hold potential	30, sec.
Or exit if | current | <	0, µA
Record every dt	0.5, sec.
Or record every dQ	10, A.h
Open Circuit Potential Phase no. 1	
Duration	10, sec.
Record every dt	0.5, sec.
Or record every dE (mV)	0
Exit if drift threshold (mV/min) <	0
Exit conditions Phase no. 1	
If | Charge variation | >	600, A.h
If Phase no. 1 Duration >	10, hour
If Open Circuit Potential is	<, 1200

Figure 4: Parameters of the Phase 1

- **Galvanostatic Phase** where the current is imposed. The most important parameter in this subphase is to put correct "*exit potential*" according to "*maximum voltage of charge*" during charge of battery and "*minimum voltage of discharge*" during discharge of battery.

- **Potentiostatic Phase** where the potential is hold.

- **OCP Phase** where we measure the free potential (Open Circuit Potential).

- **Exit condition Phase**, where the condition in which the test stops. The most important parameter is to put the correct amount in "*charge variation*" which directly depend to the "*capacity of battery*".

2- Global Parameters

Global parameters	
Cycle number (Phase no. 1+2)	20
Max Total Duration	150, hour
Analog Filter	1 msec.
Digital Filter	0
Open circuit at end	No
Ordinate Y2	Temperature

Figure 5: Global parameters

Through the « cycle number » the phase 1+2 will be repeated as many time as it is defined in the box.

3- Examples

Potential (blue line) and current (red line) during real time plots.
In figure 6 it can be seen that due to the method, the charge and discharge currents are 15 mA and -15 mA respectively. In charge period when the potential reaches 1350 mV the imposed current changed to discharge mode till the potential reaches 1270 mV. The test is repeated 20 times.

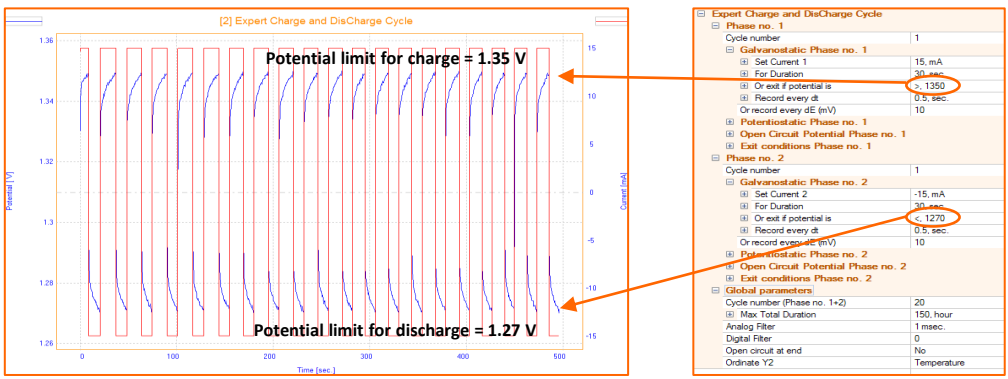


Figure 6: 20 cycles of charges and discharges

Figure 7 shows another charge/discharge curve which is done for 1000 time.

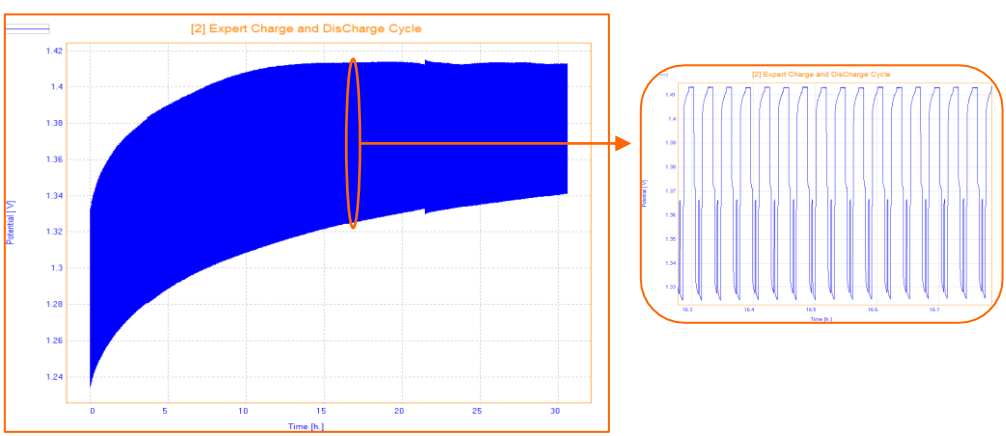
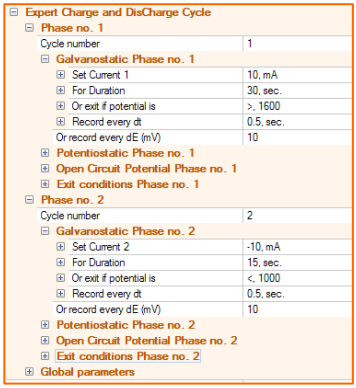


Figure 7: 1000 cycles of charges and discharges

The charge and discharge currents are set to 10 mA and -10 mA. The exit potentials are set according to battery parameters. It can be seen in the graph that the imposed current changed from charge mode to discharge mode after 30 seconds even if the potential limitation is not reached.
In fact, the Phase no. 1 finishes after the duration or if the potential limit is reached. The first parameter to be reached becomes the exit condition.



Instrument and Electrodes

Figure 8: OrigaFlex OGF500

Electrode setup	
Battery	Ni-Cd 1.2V, 600 mAh
Electrode system	2 electrodes
Instrument	OrigaFlex OGF500
Software	OrigaMaster

Connection: the battery was connected thanks to a dedicated cable to the WRK and T°C (to monitor the temperature) connectors.

Consult us to get more information on this cable.

Figure 9: Ni-Cd 1.2 V Battery

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