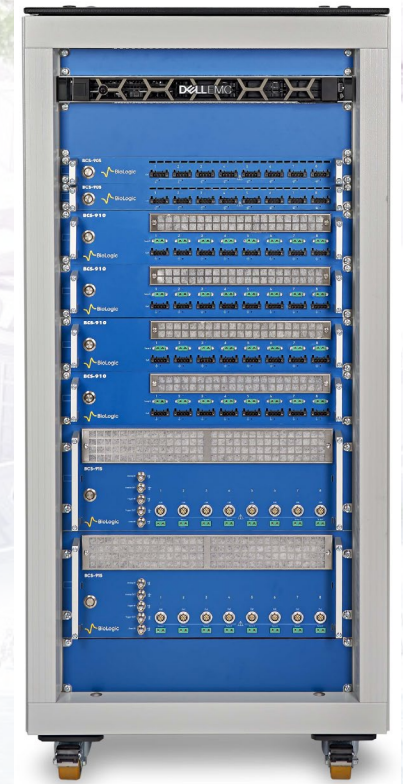


BioLogic多功能充放电测试系统 BCS系列 介绍



“はかる”技術で未来を創る

 東陽テクニカ

东扬精测系统(上海)有限公司

Biologic BCS产品华南地区独家代理

※ 授权区域: 广东, 福建, 浙江, 江西, 重庆, 四川, 云南, 贵州, 湖南, 广西, 海南, 香港

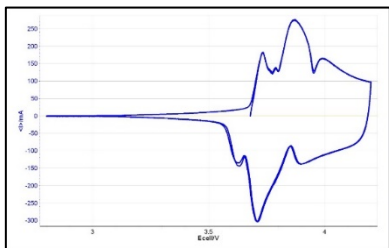
系统概要

- 传统充放电功能以外，配备了**循环伏安**，**电流扫描**等电化学测试功能
- **配备交流阻抗测试功能** [10mHz~10kHz]
- 1台控制器可自由组合三种不同充放电模块 ($\pm 0.15A/\pm 1.5A/\pm 15A$)
- 充放电通道(15A)可通过**自由并联**扩大电流范围 (**最大120A**)
- 内置**中央处理器和存储器**，并通过**服务器进行数据保存和远程控制**，大幅降低电脑依赖度。
- **高精度·高稳定性**：系统测试分辨率**18bit**，最小测样间隔：**1ms**
- 全通道完全独立，可在整机系统**不停机状态下**进行个别模块的维修和校正



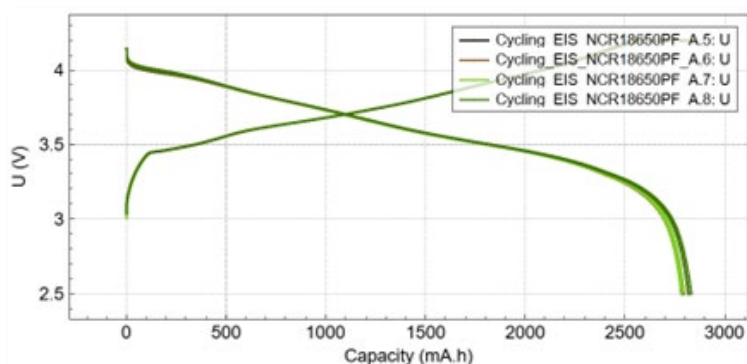
无需样品移动和设置变更
自动执行 充放电·阻抗·电化学测试

全型号·全通道对应

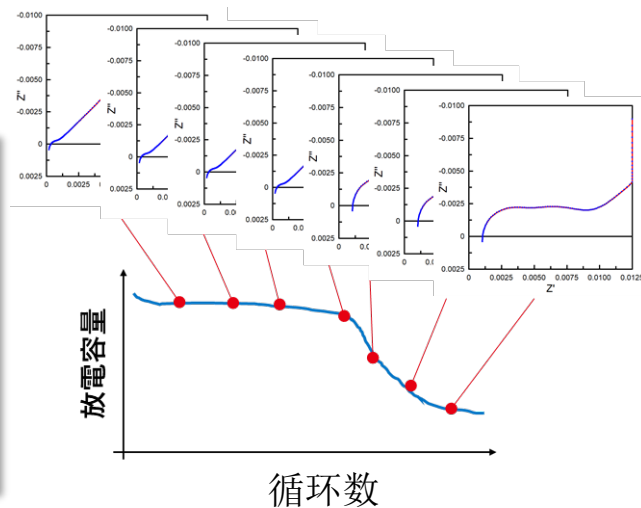


2.7Ah 18650电池的CV测试
[扫描速度：10 μ V/sec]

电化学分析



充放电循环



每个循环后的阻抗自动测试

“はかる”技術で未来を創る

产品规格



	BCS-905 (1U)	BCS-910 (2U)	BCS-915 (4U)
通道数	1模块=8通道(完全独立)		
输出电流	150 mA	1.5 A	15 A
电流量程	15uA~150 mA(5量程)	150uA~1.5A(5量程)	1.5mA~15A (5量程)
电压范围	0~10 V	0~10 V	0~9V
电流控制/测量 精度(准确度)	量程的0.015%±读值0.05% (15uA~150mA量程) 量程的0.015%±读值0.1% (1.5A量程) 量程的0.04%±读值0.3% (15A量程)		
电流分辨率	800pA (控制) 0.2nA (测试)	8nA (控制) 2nA (测试)	80nA (控制) 20nA (测试)
电压控制/测量 精度 (准确度)	设定值的0.01%±300 μV		
电压分辨率	150μV (控制) / 40μV (测试)		
阻抗测试范围	10 mHz~10 kHz		
ADC (模拟↔数字信号转换器)	18-bit		
最小测样间隔	1msec		
K热电偶	-	对应	对应
并列连接电流增幅	-	-	对应(最大120A)
高度/重量	1U/6.5kg	2U/11kg	4U/24.5kg

“はかる”技術で未来を創る

- 1 | 高精度控制**
 - ▶ 采用18bit分辨率的检测硬件，控制和测试精度超越电化学工作站设备
- 2 | 多功能**
 - ▶ 充放电测试以外，可进行交流阻抗，循环伏安等电化学测试
省去[充放电⇔电化学]试验间的切换时间和工序
可通过并联扩大测试电流至120A
- 3 | 操作便利安全**
 - ▶ 新一代9系列机型采用程序内置运行+远程服务器访问的控制形式，大幅降低对电脑主机的依赖度。
 - ▶ 支持热插拔，便于各模块的更换和维修。
- 4 | 多种夹具**
 - ▶ 可对应各种型号电池，最大耐热温度可达150℃

Importance of Coulombic Efficiency Measurements in R&D Efforts to Obtain Long-Lived Li-Ion Batteries

by J. R. Dahn, J. C. Burns, and D. A. Stevens

Researchers and companies around the world are now recognizing the importance of high-precision coulometry. For example, Yoshio Ukyo at Kyoto University has recently completed construction of an ultra high precision charger that should have better specifications than the Dalhousie unit. However, this was achieved at even greater cost. Two industrial firms, Novonix (www.novonix.ca – Canada) and Bio-logic (www.bio-logic.info – France) have now begun offering instruments suitable for ultra-high-precision coulometry with specifications very similar to the Dalhousie unit. These instruments are much more affordable than the Dalhousie system. Figure 6 shows a photo of a 96 channel Novonix

firms, Novonix (www.novonix.ca – Canada) and Bio-logic (www.bio-logic.info – France) have now begun offering instruments suitable for ultra-high-precision coulometry with specifications very similar to the Dalhousie unit. These instruments are much more affordable than the

and verify Li-ion cells with long lifetime. It is also worth noting that “beyond” lithium ion technologies such as non-aqueous Na-ion and Mg-ion will also need to attain extremely high coulombic efficiencies to attain decades-long lifetimes. High-precision coulometry will be essential in the development of those technologies as well. ■

<https://iopscience.iop.org/article/10.1149/2.F07163if/pdf>

高精度电流控制

电流量程

120 A

15 A

1,5 A

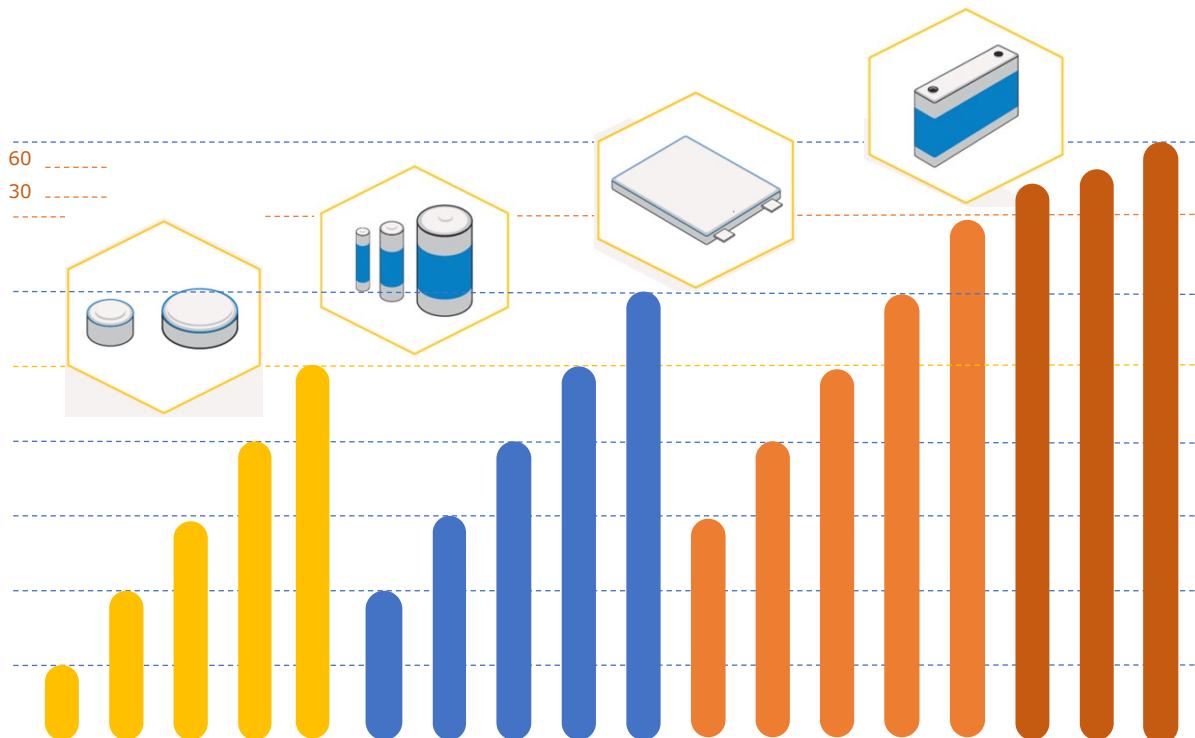
150 mA

15 mA

1,5mA

0,15mA

15 μ A



BCS 905

BCS 910

BCS 915



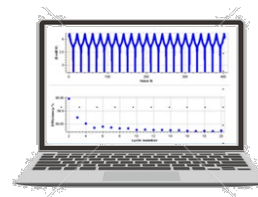
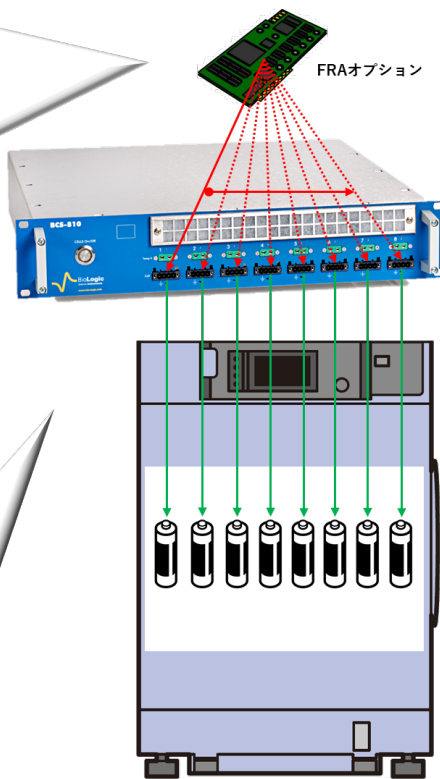
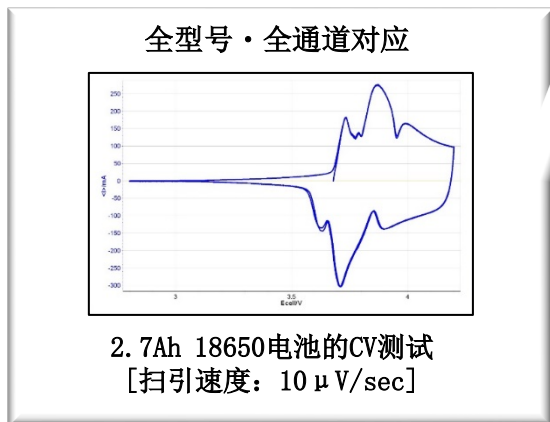
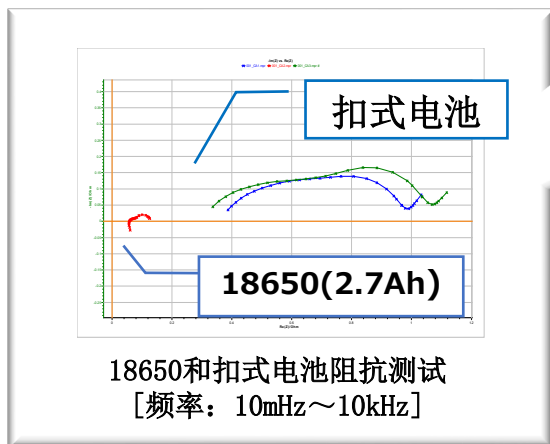
针对不同的
电池样品和
测试条件，
提供了丰富
的测试量程，
分辨率为
18Bit

“はかる”技術で未来を創る

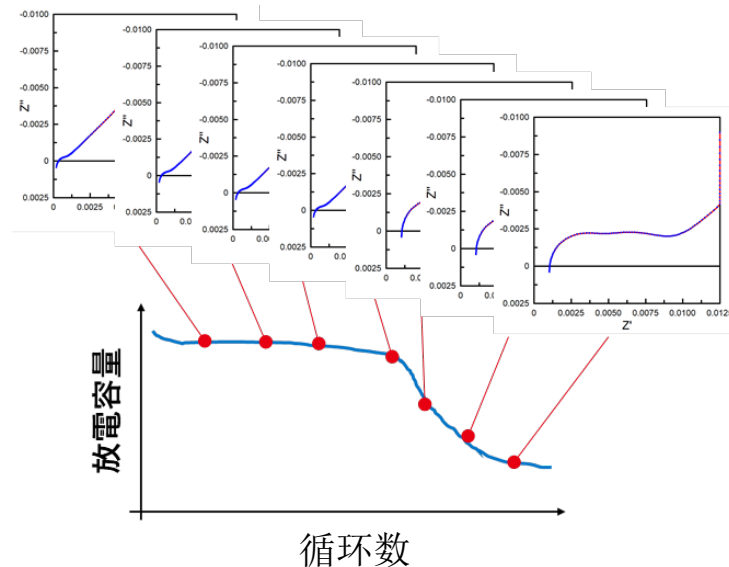


多功能（电压扫描·电流扫描·EIS功能）

配有VS（电压扫描）·CS（电流扫描）·阻抗测试(10mHz~10kHz)等电化学功能。



阻抗多循环测试



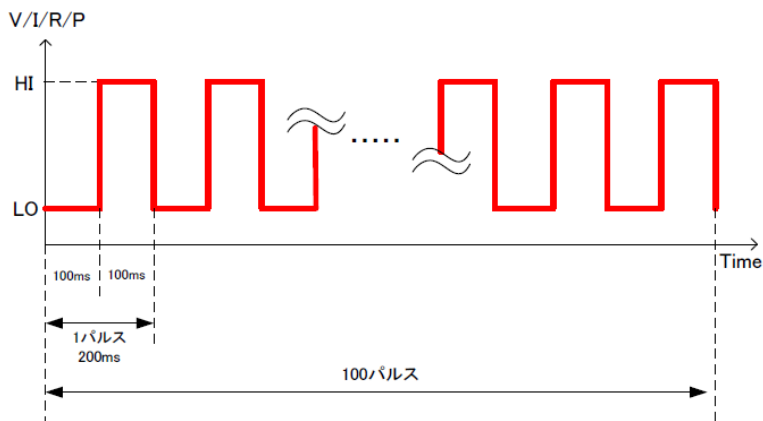
可省去充放电⇌电化学工作站设备间的切换时间

提供了多种常用且有效的测试方案

- CC (Constant Current)
- CV (Constant Voltage)
- REST
- AUP (Arbitrary User Profile)
- CALCULATE 函数计算
- CC_CV (Constant Current Constant Voltage)
- CLD (Constant Load)
- CPW (Constant Power)
- CS (Current Scan)
- DCIR (Direct Current Internal Resistance)
- G-ACIR (Galvano Alternating Current Internal Resistance)
- GEIS (Galvano Electrochemical Impedance Spectroscopy) 交流阻抗测试（电流控制法）
- LOOP
- PEIS (Potentio Electrochemical Impedance Spectroscopy) 交流阻抗测试（电压控制法）
- VS (Voltage Scan)

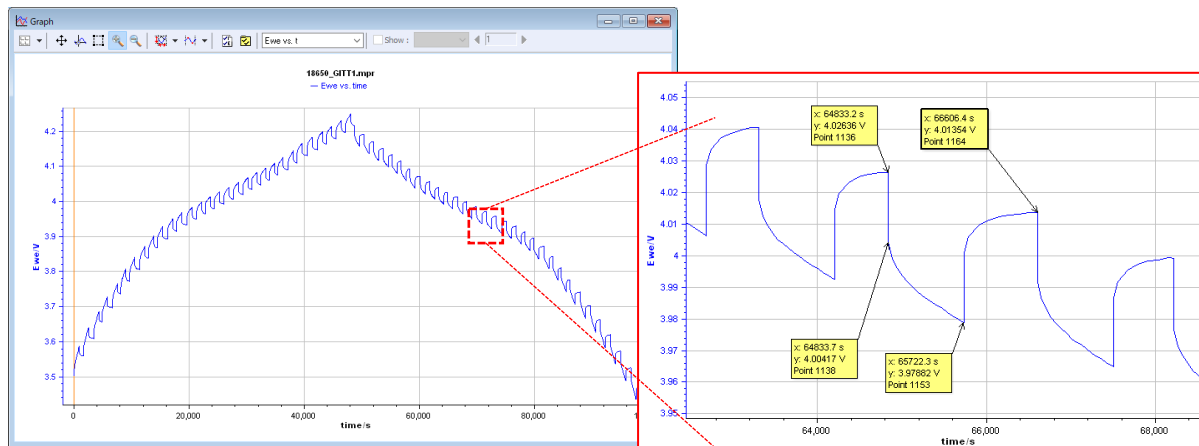
多种测试波形对应

脉冲放电和GITT电流波形

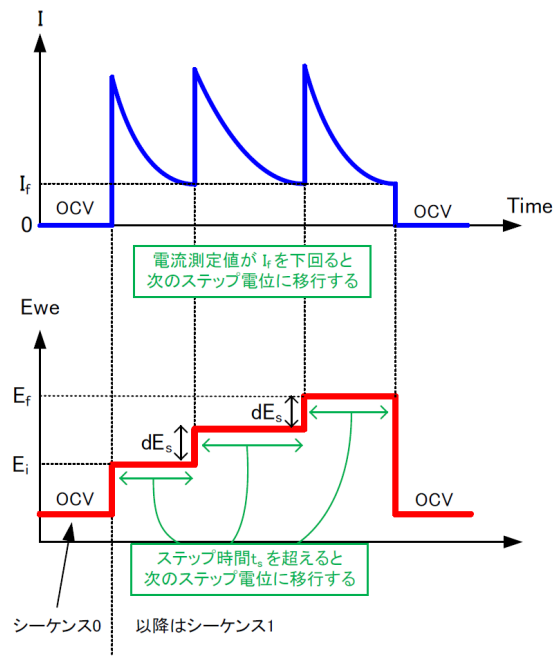


BCS设备可达到最快1m秒的测样速度，可对应GITT，PITT等测试模式。

GITT测试



PITT测试



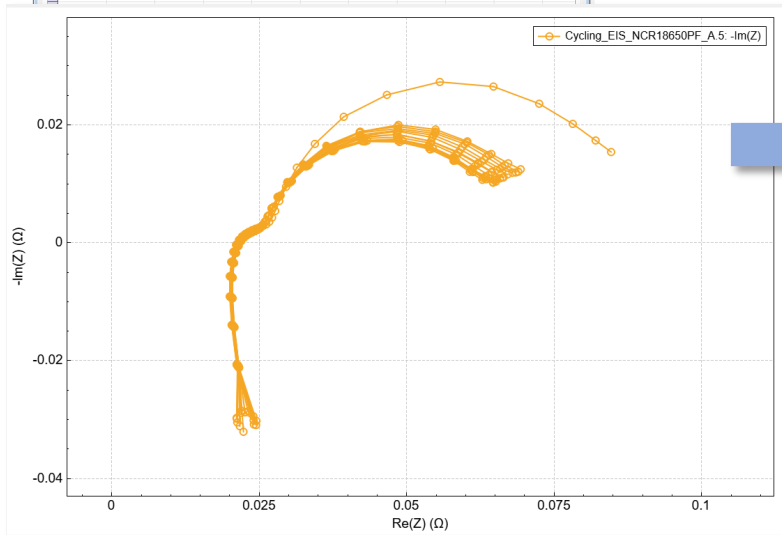
脉冲・GITT/PITT等测试

丰富的阻抗解析功能

充放电阻抗数据批量大，重复性高，为此东
 扬精测开发了专门的解析辅助软件，提供高
 效准确的阻抗数据自动拟合方案。

Sheet1 - Summary per cycle (auto) - Cycling_EIS_NCR18650PF

Cycle number	Duration (h)	Umean (V)	Q (mAh)	Q charge (mAh)	Q discharge (mAh)	Efficiency (%)	Energy (Wh)	Energy charge (Wh)	Energy discharge (Wh)	Rk (Ω)	Rk (Ω)
1	18339	3.6377	24.104	28162	27941	0.99143	0.67396	10.738	10.255	-	-
2	18330	3.6383	32.817	28209	27881	0.98837	0.89308	10.737	10.044	-	-
3	18356	3.6384	33.24	28222	2789	0.98832	0.89492	10.742	10.047	-	-
4	18376	3.6383	33.221	28227	27955	0.98833	0.89548	10.744	10.049	-	-
5	18427	3.637	31.599	28258	27992	0.98811	0.88311	10.736	10.047	-	-
6	18448	3.6385	32.479	28193	2797	0.98848	0.88375	10.732	10.038	-	-
7	18419	3.6387	32.443	2819	2795.6	0.98814	0.88901	10.73	10.031	-	-
8	18512	3.6388	33.63	2816.5	2784.8	0.98807	0.70141	10.739	10.027	-	-
9	18358	3.6381	32.189	28163	2794.1	0.98837	0.69673	10.72	10.024	-	-
10	18451	3.6389	34.999	28171	2782.1	0.98799	0.70896	10.725	10.015	-	-
11	18467	3.637	33.793	28164	2782.7	0.98802	0.70990	10.722	10.016	-	-
12	18480	3.6374	33.879	28154	2781.5	0.98797	0.70845	10.719	10.011	-	-
13	18487	3.6375	33.980	28143	2780.7	0.98806	0.70901	10.716	10.007	-	-
14	18473	3.6373	33.611	28153	2779.6	0.98805	0.71035	10.712	10.002	-	-



批量阻抗数据的自动拟合

Z-FIT-Analysis

File (F) Export (E) Setting (S) Help (H)

Data file

Single EIS(*.z,*.mpt) Multi EIS(*.mpt)

Data Folder: C:\SAN\ZData_3D File name filter: *

Model: C:\SAN\demo_Z-FIT.mdl Frequency range: All Range 1.000E-06 - 1.000E+09 [Hz]

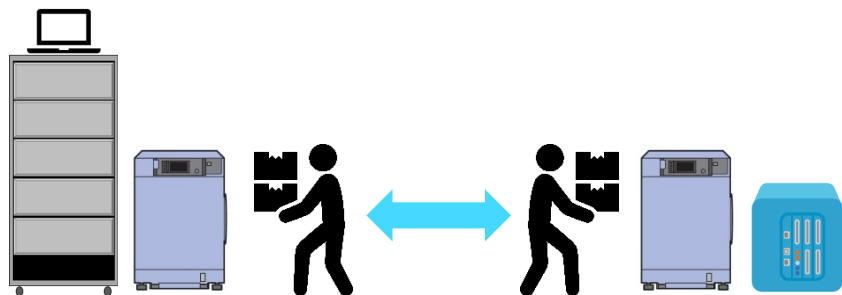
Correction file Auto fitting repeat condition

Auto Stopped Show frequency list 1 [%]

File name	SOC	TEMP	CYCLE	CAPACITY	L1/1:Value	R3/2:Value	R0/3:Value	R1/4:Value	CPE1-P/5:Value	/6:Value	R2/7:Value	CPE
16 LIB_17.z					4.5806E-07	0.17555	0.0632	0.0034013	0.44989	0.85144	0.013055	2.018
17 LIB_18.z					4.5834E-07	0.17493	0.063194	0.0034087	0.46016	0.84897	0.013405	2.095
18 LIB_19.z					4.5892E-07	0.17538	0.063164	0.0039986	0.61522	0.81079	0.012865	1.992
19 LIB_20.z					4.585E-07	0.17879	0.063202	0.0039063	0.56974	0.82965	0.012991	1.908
20 LIB_21.z					4.5902E-07	0.18052	0.063221	0.0045365	0.76791	0.79514	0.012386	1.778
21 LIB_22.z					5.0426E-07	0.11047	0.061838	0.011239	6.231	0.45484	0.0091094	2.18

切换工序・调温时间的削減

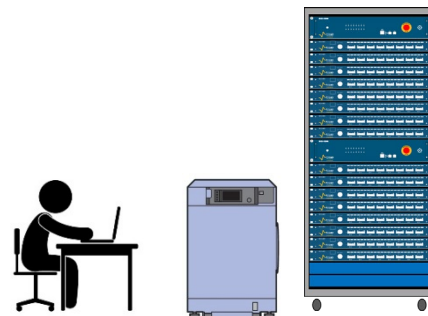
原来方法



充放電 配線変更 温調 EIS 配線変更 温調 充放電 ...

- 样品移动，连接工序繁琐
- 软件的设定切换耗费时间
- 控温测试时调温等待时间漫长

BCS 方案



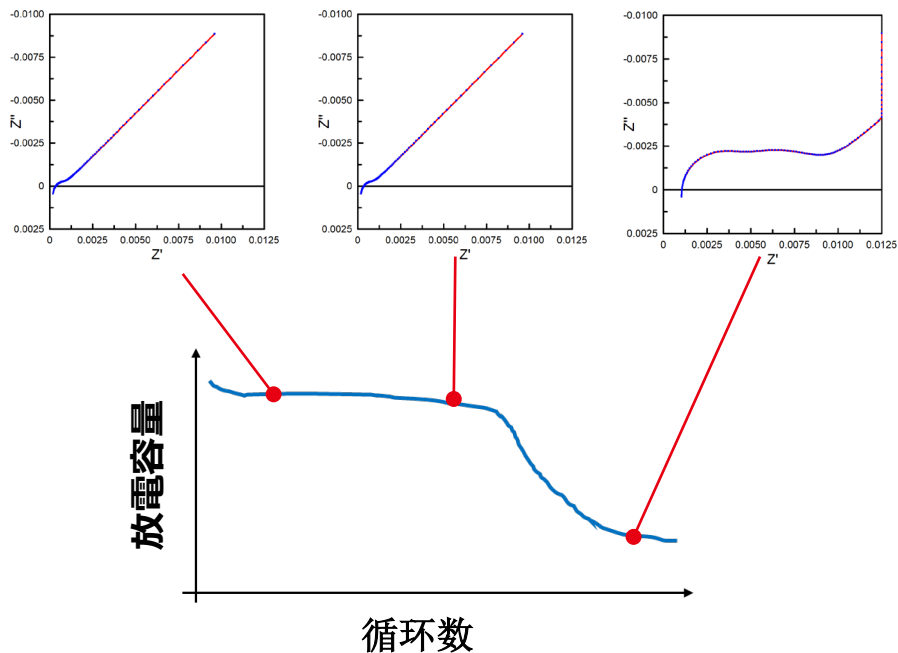
充放電 EIS 充放電 EIS 充放電 EIS ...

- 样品移动，连接的工序消滅
- 设定・等待时间消滅
- 调温・操作时间消滅

BCS方案的测试效率大幅提高

信息量的增加

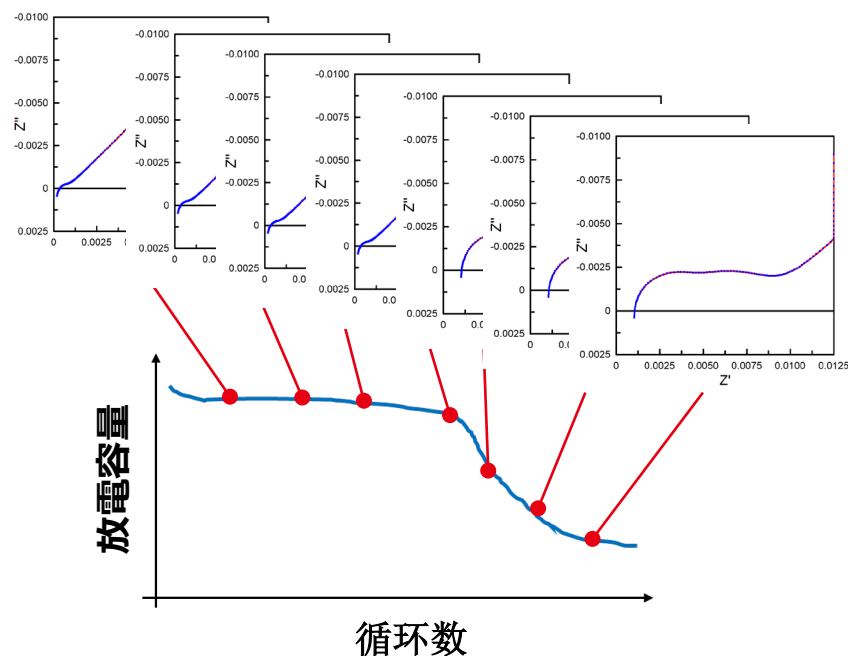
原来方法



- EIS测试费时 → 测试数据减少
- 劣化过程难以解析



BCS 方案



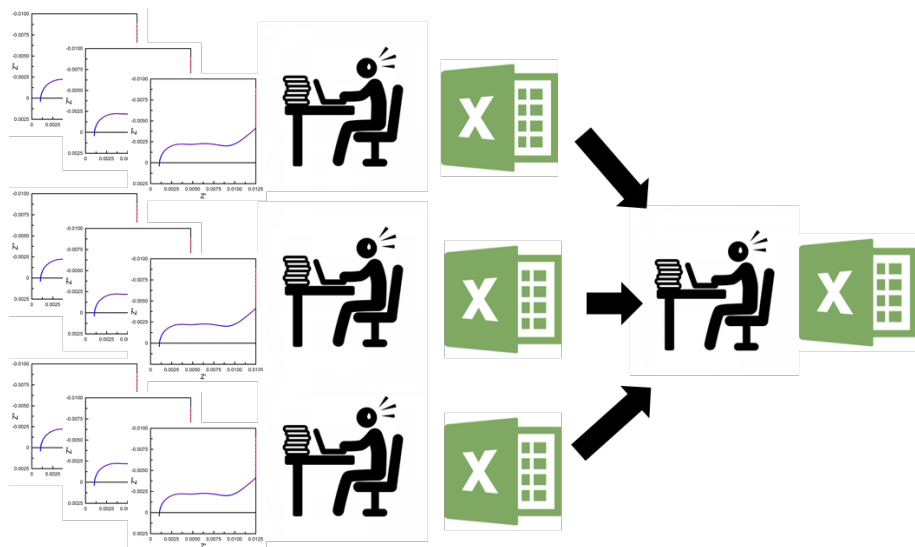
- EIS测试简便 → 测试数据增多
- 劣化过程的信息量增加



导入BCS后可以得到更丰富的样品测试信息

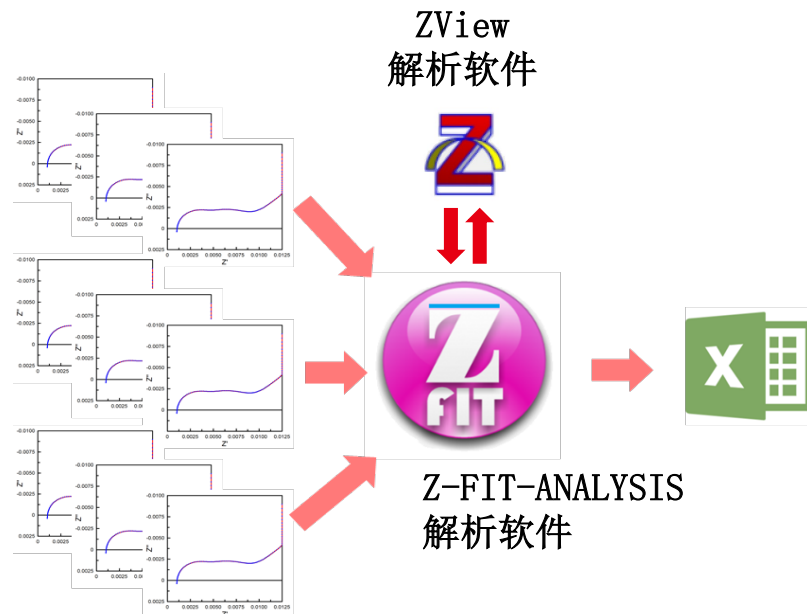
解析工序の消滅

原来方法



- 如果要对每一组数据进行解析，耗费人力和时间
- 解析相同等效电路时产生大量重复性操作

BCS 方案



- 使用解析软件进行自动批量解析
- 避免重复阻抗拟合操作，提高测试效率

大幅消滅相同等效电路的阻抗拟合时间，可获得批量阻抗拟合大数据

并列接续时的大电流测试

15A型号可进行**最大±120A**的并联扩展（电流）

使用例①

15A试验 x 8ch

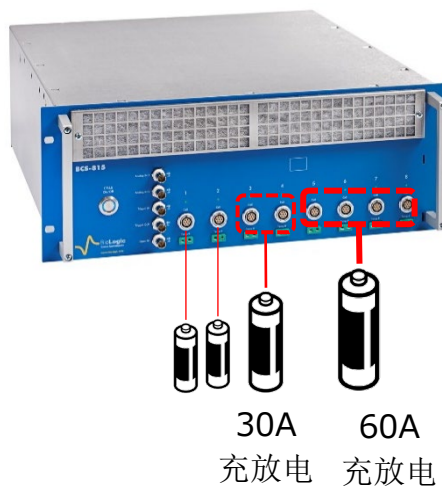


使用例②

15A试验 x 2ch

30A试验 x 1ch

60A试验 x 1ch



使用例③

120A试验 x 1ch



软件设定

All channels in parallel mode with :

Module	Max Current required	Channels in parallel
	30 A <input checked="" type="checkbox"/>	<input type="checkbox"/> 1,2 <input checked="" type="checkbox"/> 3,4 <input type="checkbox"/> 5,6 <input type="checkbox"/> 7,8
C	60 A <input checked="" type="checkbox"/>	<input type="checkbox"/> 1,2,3,4 <input checked="" type="checkbox"/> 5,6,7,8
	120 A <input type="checkbox"/>	<input type="checkbox"/> 1,2,3,4,5,6,7,8

※ 并列连接时无法进行EIS测试

可自由通过并联进行电流增幅

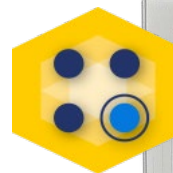
测试高稳定性

新一代BCS-Core控制器



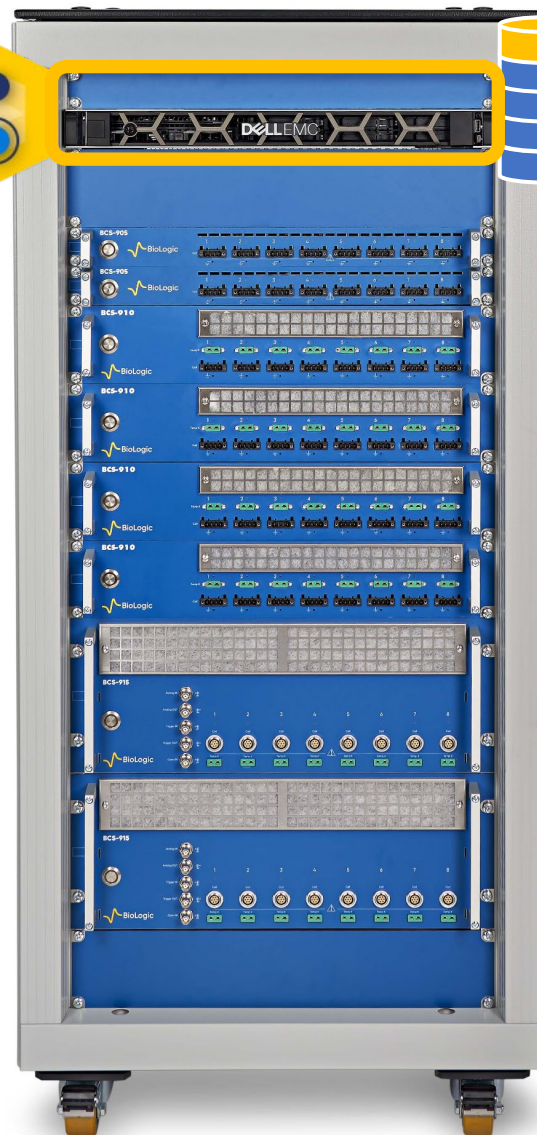
内置BT-Test™软件

程序运行



存储

- 9系列采用新一代控制器，内置测试程序 [BT-Test™] 以及存储器，大幅降低因电脑故障引起的测试中断风险。
- 测试数据也可以寄存于服务器中，或通过远程服务器控制设备操作和数据处理，大幅提高了测试效率和数据保存安全性。
- 电脑操控软件分为BT-Test™（用于测试编辑与控制）和BT-Analysis™（用于数据处理与显示）两款。细化了各项操作，并提供多种形式的友好操作界面。



BCS
900
测试
模块

で未来を創る

测试高效稳定性和数据安全性

A comprehensive solution for battery cycling

通过BT-Test™软件进行
程序设置和运行监控
(可通过服务器远程操作)

内置BT-Test™软件进行
设备自控, 可有效
防止电脑主机故障
(测试程序自动运行)

Analysis

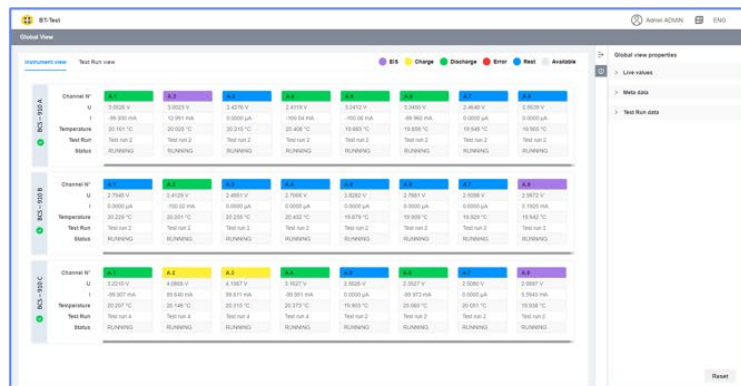
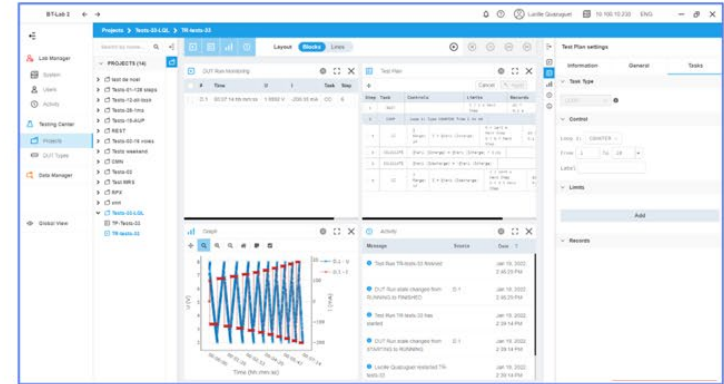
Monitoring

通过 BT-Analysis™ 软件进行
数据处理和显示
(可通过服务器远程操作)

BT-Test™ 用于测试程序的编辑，实验进程的监控

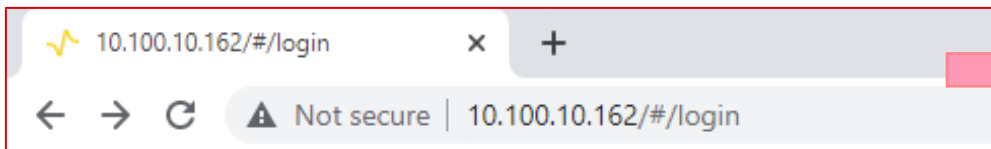


- Modern interface with **user-friendly grid**
- **Embedded software operation**
- **Global View to monitor all channels**
- **Remote access for easy data management**
- **Redundant storage for data safety**



- Displaying live data points
- Following your **channel status** on the DUT Run monitoring table
- Providing the **activity log**
- Modifying Test Plans **on-the-fly**
- Use of Variables to automate Test Plans

网页式多用户访问界面



可直接通过IP地址进入网页式操控界面

#	Time	U	I	Task	Step	Status
C.1	19:21:55 hh:mm:ss	3.5282 V	-30.279 mA	CC	18	RUNN

Graph showing Voltage (U) and Current (I) over time. The x-axis is Time (hh:mm:ss) and the y-axis is U (V) and I (mA). The graph shows a repeating pattern of voltage and current over time.

接受多用户远程访问，各用户可以分别创建属于自己的测试项目文件

Task configuration panel showing various settings like CC, I Range, Control, Limits, and Next Step. The 'Limits (1/6)' section has a dropdown menu open, with 'User Variables' highlighted in red.

参数赋值时，除普通数字外，还可以利用函数进行变量引用和多重计算

“はかる”技術で未来を創る

变量使用案例1：自定义充放电倍率测试

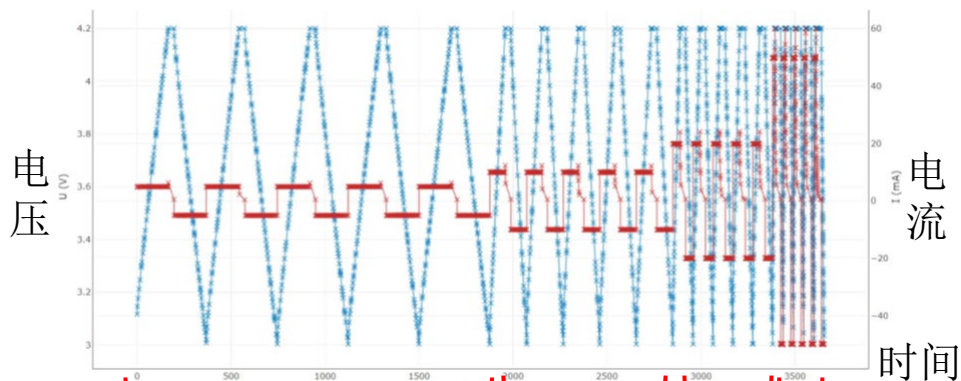
Step	Task	Controls
1	LOOP	Loop 1: Type LIST on 20;10;5;2;1 Label : C/N
2	CALCULATE	@Var1 (CperNCharge) = \$NOMINAL_CAPACITY / #1.VALUE / 3600
3	CALCULATE	@Var2 (CperNDischarge) = -@Var1 (CperNCharge)
4	LOOP	Loop 2: Type COUNTER from 1 to 5 Label : Cycling
5	CC	I Range: 1A I = @Var1 (CperNCharge)
6	CC	I Range: 1A I = @Var2 (CperNDischarge)

(1) 每个循环的变量设定：20，10，5，2，1

(2) Var1 (充电电流) = 理论容量 / (1) 变数, Var2 (放电电流) = -Var1

(3) 5循环

(4) Var1值充电，Var2值放电

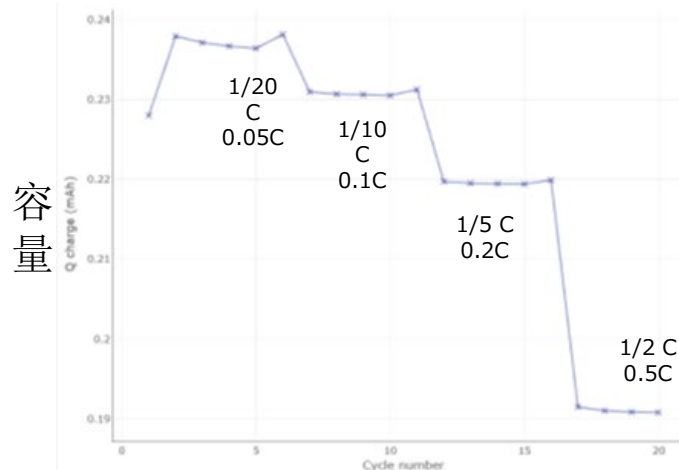


变量: 2
5次循环

变量: 20
5次循环

变量: 5
5次循环

变量: 10
5次循环

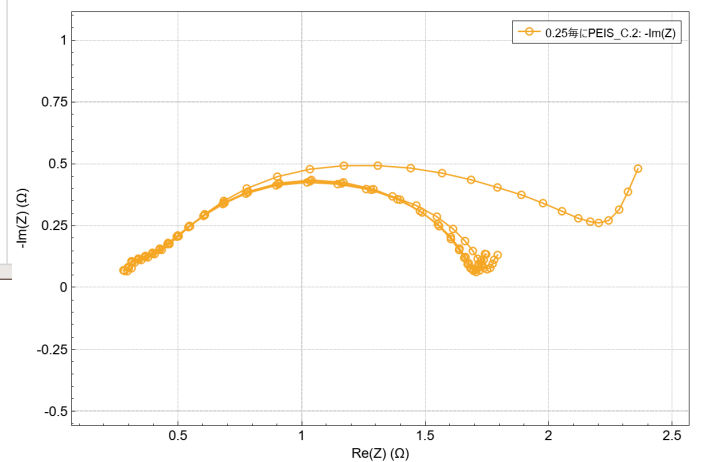
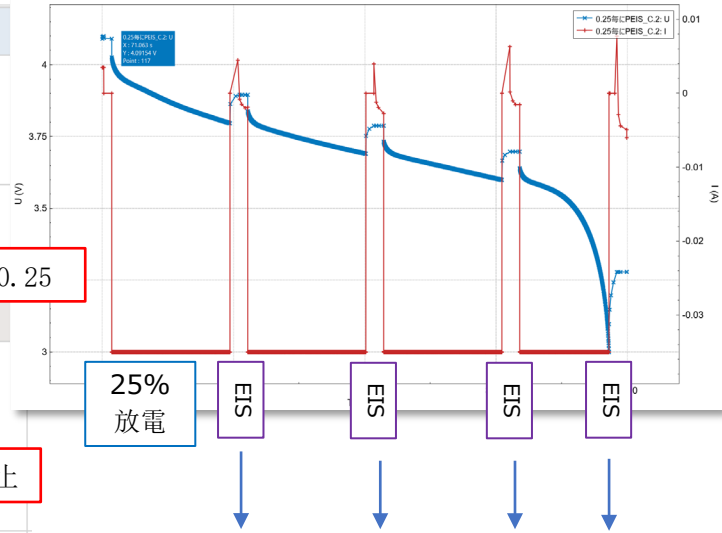


循环数

“はかる”技術で未来を創る

变量使用案例2: SOC调整+EIS

Step	Task	Controls	Limits
1	CC_CV	I Range: 10mA CC: C/N with N = 10 (3.5000 mA) in CHARGE until U reaches 4.1 V CV: U = 4.1 V until < 5 mA	(1) 充电
2	REST		t > 1 min Next Step
3	CALCULATE	@Var1 (CAPAlimit) = \$NOMINAL_CAPACITY * 0.25	(2) Var1 (放电中止值: 25%) = 理论容量 * 0.25
4	LOOP	Loop 1: Type COUNTER from 1 to 4	
5	CC	I Range: 100mA CxN with N = 1 (35.0000 mA) in DISCHARGE	t > 25 h Next Step Q discharge > @Var1 (CAPAlimit) Next Step U < 3 V Next Step
6	REST		(3) 放电: 在容量Var1中止
7	PEIS	I Range: Auto limited (min: 100µA; max: 1A; init: 1A) CV: U vs. Uoc = 0 mV t > 1 s Amplitude Ua = 10 mV Scan from fi = 10 kHz to ff = 0.1 Hz Nd = 6 Na = 1 pw = 0.1 Task estimated time: 0 h 1 min Drift correction disabled	(4) 阻抗测试 (EIS)



变量使用案例3：内部阻抗的循环测试

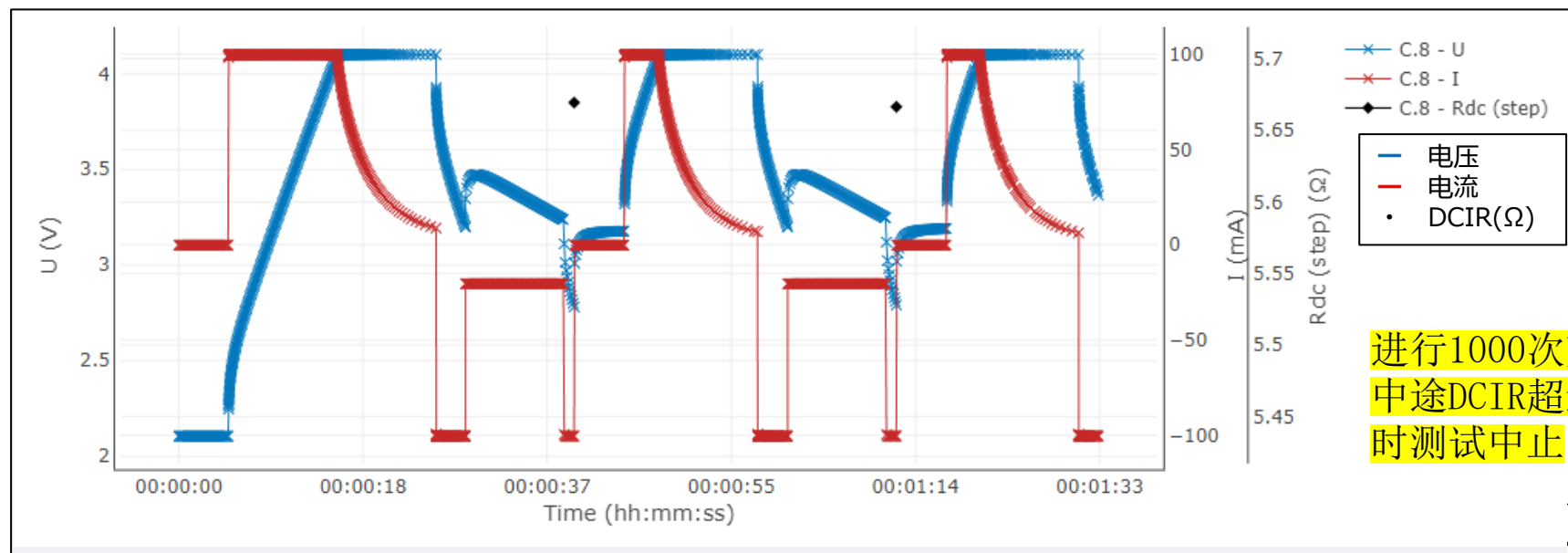
Step	Task	Controls	Limits
1	LOOP	Loop 1: Type COUNTER from 1 to 1000	@Var1 (Rdc) > 60 Next Step
2	REST		
3	CC_CV	I Range: 1A CC: C/N with N = 1 (100.00 mA) in CHARGE until U reaches 4.1 V CV: U = 4.1 V until < 1 mA or t > 10 s	
4	CC	I Range: 1A C/N with N = 1 (100.00 mA) in DISCHARGE	t > 100 s Next Step U < 3.2 V Next Step
5	DCIR	I Range: 1A C/N with N = 5 (20.000 mA) in DISCHARGE; t ₁ = 10 s C/N with N = 1 (100.00 mA) in DISCHARGE; t ₂ = 1 s	
6	CALCULATE	@Var1 (Rdc) = #5.SUMMARY_RDC	

(1) 1000循环, Var1>60时中止

(2) 充电

(3) 放电

(4) DCIR测试取值



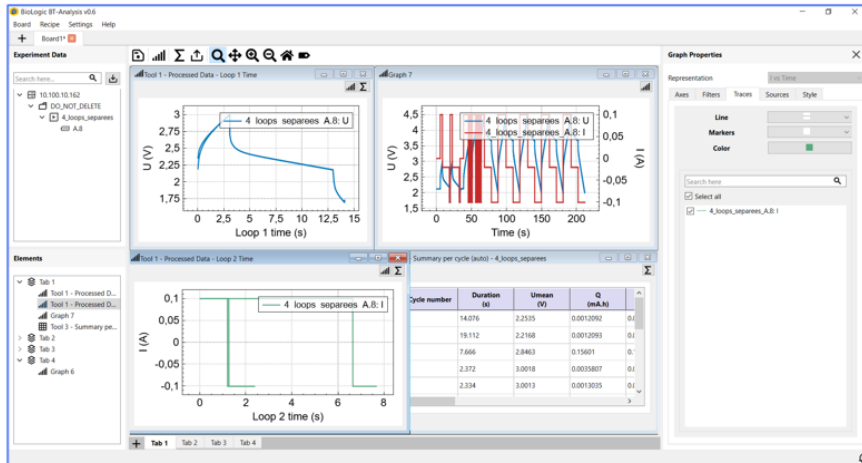
进行1000次充放电,
中途DCIR超过60 Ω
时测试中止

BT-Analysis™ 用于测试结果数据的汇总以及输出

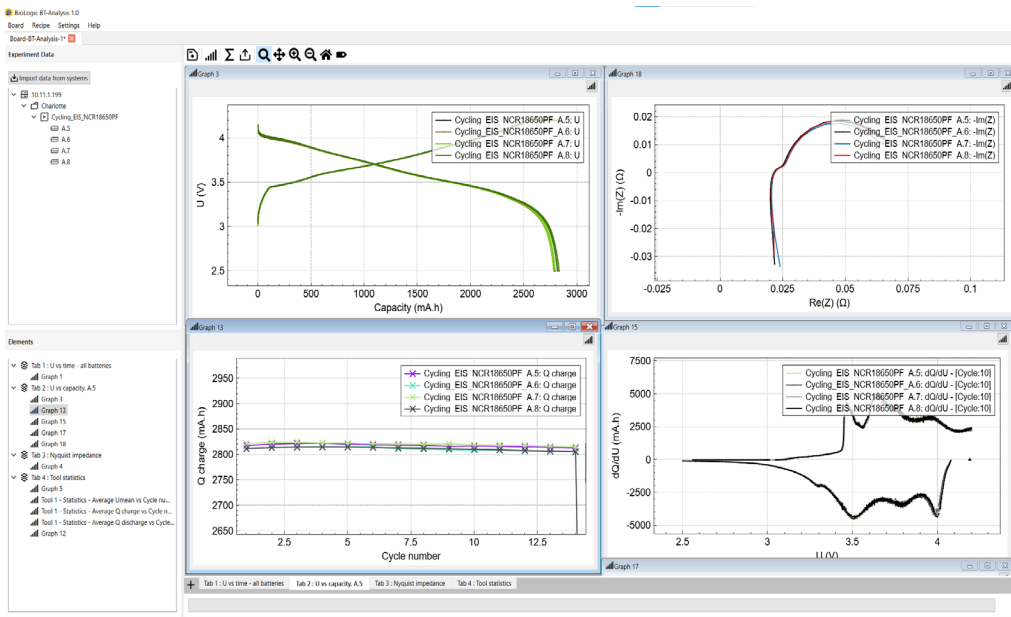


BT-Analysis is a new software to replace complementary products as Excel, Origin, Z-view, etc for data processing.

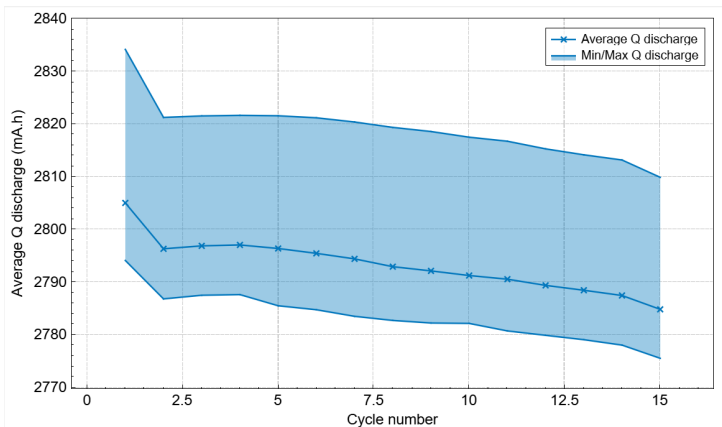
- Remote access to database for live data import
- Online and offline data access
- User-friendly and intuitive navigation
- Customizable graphical and tabular representation
- Multiple application-oriented data processing and statistic tools: Summary table, Statistics, Processed Data, Recipes for automated data processing
- Battery plot comparisons
- Data fit to a predefined circuit thanks to Z Fit analysis



多重显示功能



测试结果的多维度图表显示



批量结果数据的最小·最大·平均点显示

New Recipe*

1. Configure Recipe 2. Run Recipe

Recipe Information

Export results in Browse..

Content

Select Graph to plot

- Select All
- U+I vs Time
- U vs Capacity
- U vs Q
- dQ/dU vs U
- Power vs Time
- Q charge vs Cycle number
- Q discharge vs Cycle number

Select Tool to process

Graph Output

- Select All
- Average Umean vs Cycle number
- Average Q charge vs Cycle number
- Average Q discharge vs Cycle number
- Processed Data vs Cycle Time
- Processed Data vs Loop 1 Time
- Processed Data vs Loop 2 Time
- Processed Data vs Loop 3 Time
- Processed Data vs Loop 4 Time

Table Output

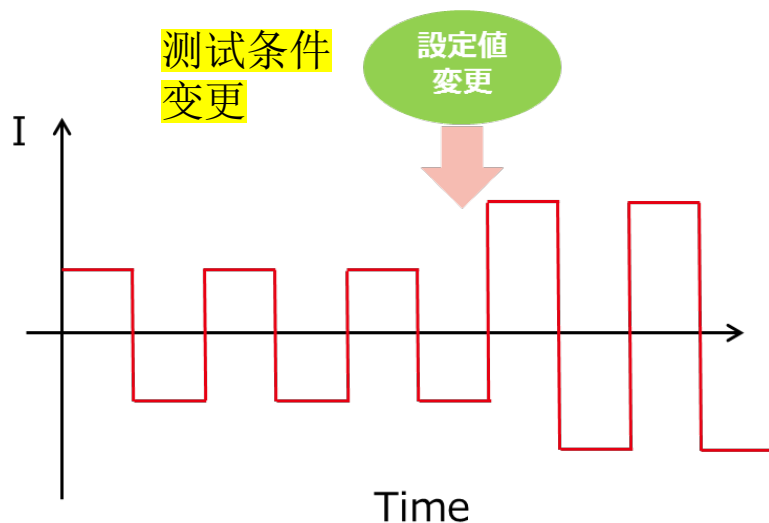
- Select All
- Summary Table per Cycle
- Summary Table per Step
- Summary Table per Loop 1
- Summary Table per Loop 2
- Summary Table per Loop 3
- Summary Table per Loop 4

Cancel
Save As
Save
Next

Recipe功能：图表，表格的显示项目选项

测试过程中的参数修改

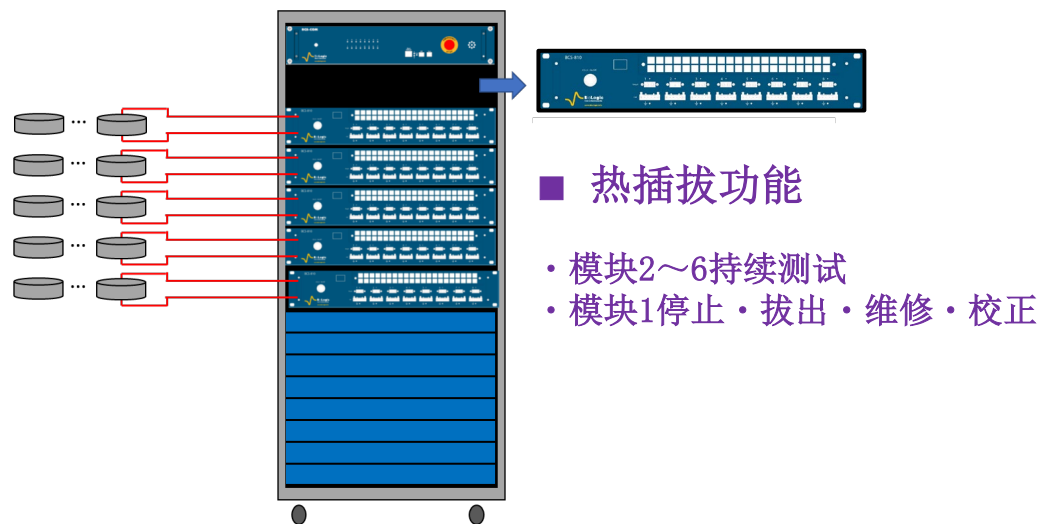
BT-LAB和EC-LAB一样，可以在测试开始后，在不中止测试的状态下修改测试参数。



热插拔功能/现场修正・维修

BCS设备具有热插拔功能，可以在**整体不停机的状态下进行充放电模块个体的维修和校正。**

ホットスワップのイメージ図



维修和校正不影响设备的整体运行

各种夹具

HOLDERS

- ❑ 4 points connection - accurate AC and DC tests
- ❑ Compatible with climatic chamber - up to 80°C

Coin cell holders



CCH-1



CCH-8

- ❑ Single or 8 position configuration
- ❑ Max cell diameter: 24 mm
- ❑ Max cell height: 3.2 mm

Pouch cell holders



PBH-4/PBH-8



PbH-125/PHB-150

- ❑ 4 or 8 position configuration
- ❑ Holder clamps for mono-channel pouch cell
- ❑ Currents up to 32A (up to 50A for PBH-150)

Current collectors



CC4-60A

Cylindrical cell holders



BH-1i



CBH-4/CBH-8

- ❑ 4 or 8 position configuration
- ❑ Currents up to 32A

Pouch/prismatic cell holders



PPBH-132



PPBH-1100

- ❑ Single-channel high power prismatic / pouch cells
- ❑ Currents up to 100A



CC8-120A

- ❑ Provided with 2 m output cables

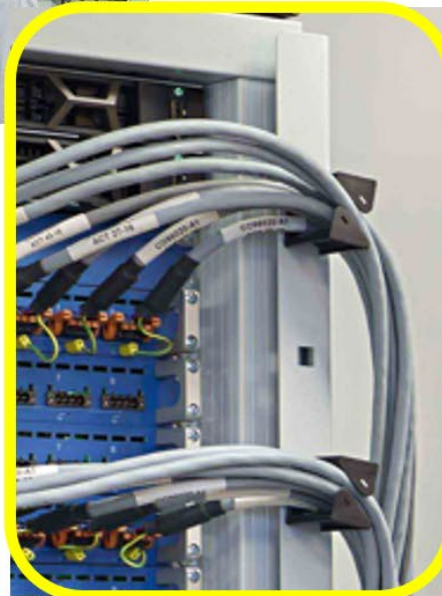
各种夹具

Features for users

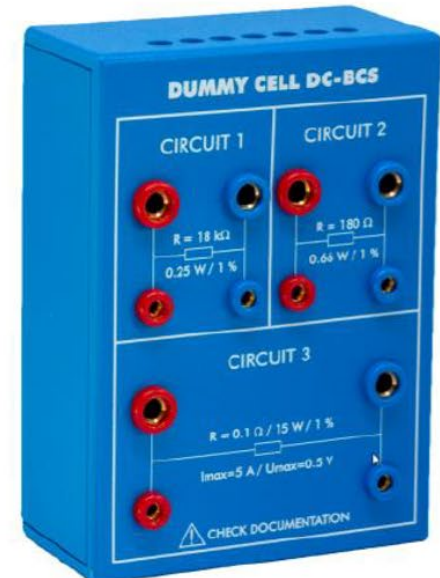
CABLE HOLDERS



OPTIONAL



DUMMY CELLS



DC BCS (integrated)
& DC DC BCS (integrated)