BATTERY TESTING SYSTEM
USER MANUAL

Version: 1.0, Using BTS 7.5.X

Acronyms

AC	Alternative Current
ACR	Alternative Current Resistance
BMS	Battery Management System
BTS	Battery Testing System
CAN	Controller Area Network
CC	Constant Current
CCV	Closed Circuit Voltage
CP	Constant Power
CR	Constant Resistance
CV	Constant Voltage
DC	Directive Current
DCR	Directive Current Resistance
DOD	Depth of Discharge
DST	Dynamic Stress Test
ESS	Energy Storage System
EV	Electric Vehicle
EVTS	Electric Vehicle Battery Testing System
FS	Full Scale
HEV	Hybrid Electric Vehicle
I2C	Inter-IC bus
IGBT	Insulated Gate Bipolar Transistor
NTFS	New Technology File System
OCV	Open Circuit Voltage
PF	Power Factor
SMB	Smart Battery
SOC	State of Charge
THD	Total Harmonic Distortion
UPS	Uninterruptible Power System

Glossary

Glossary

Only selected terms specific to this manual or those frequently misunderstood in the context of this manual are defined here.

Glossary	Definition
AUX	Auxiliary or auxiliary channel. An Aux. can only acquire voltage and /or temperature data.
Bottom Machine	A machine can response the steps you specified and acquire data from the testing battery.
BTS Client	A computer with BTSClient software installed. It provides user interface to manage equipment and testing activities.
BTS Server	A computer with BTSServer software installed. It transfers commands and manages all the raw the data in database.
BTSDA	BTS Data Analyzer. A software to cope with NDA files. It provides brilliant data and curves rendering, and also some other functions like curve comparing, data filtering.
CHANNEL	Each location on the tester that tests a single device is called a channel.
Channel Number	The number of the channel. Generally it ranges from 1 to 8 in real, and from 1 to 32 in virtual.
Coulombic Efficiency	Also called faradic efficiency, faradic yield, coulombic efficiency or current efficiency. A ratio between output (discharging) and input (charging) capacity of the battery.
Device Number	The number of the middle machine.
Host Computer	A computer can host and manage testing equipment, manage testing activities and data. Generally consists of BTS Server and BTS Client.
HPPC	Hybrid Pulse Power Characterization. A test whose results are used to calculate pulse power and energy capability under FreedomCAR operating conditions
Local IP	IP address of the middle machine.
Lower Machine	Another name for Bottom Machine.
Main Channel	A main channel can output controlled parameters like current, power and etc.
MAP	Establish a relationship between real and virtual channels.
Middle Machine	A machine can buffer channel control commands and recorded data, and also perform some data calculation and organization.
NDA	Neware Data Analysis. A file format which contains testing data and all other related information.
Negative Power Supply	A power supply installed in discharge circuit, can increase the discharge potential which enables to drain battery's energy.
Nominal Voltage	Rate voltage or named voltage of the battery. Generally this value is the same as discharge plateau.
Plateau	This is a specified voltage value or voltage range. Battery's voltage will change less than other voltage ranges as it charges or discharges. This value could be obtained from the differential capacity curve - the peaks of the curve represent the charge and discharge plateau. Discharge plateau could be called nominal voltage of the battery.

Secondary Machine	Another name for Middle Machine.
Server IP	An IP address which specifies the computer can host the equipment.
Step	A Step is an individual command in a procedure.
TC	Test Control. This is a lite BTS control software using RS232.
U	Height unit, 1U=44.5mm, usually has a 19inch or 482.6mm width.
Unit Number	The number of the lower machine. 1 lower machine can hold maximum 8 channels. You can also make the channels from different lower machines have the same virtual unit number. 1 virtual unit can hold maximum 32 channels.

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1. Introduction

1.1 About Neware

Neware, since 1998, is a "High-Tech Company" certificated by SHENZHEN government. We are committed to providing world-class battery testing equipment with large power output and high accuracy. We adopt SAP as our ERP system and comply with ISO9000 standard (ISO9001:2008, Reg. No.:0409035). We supply reliable and flexible testing equipment with reasonable price for more than 15,000 customers ranging from battery factories to R&D institutes all around the world.

- **Vision**
  Sustainable Future

- **Core Value**
  Safety & Health, Environment protection, Esteem and Self-respect

- **Mission**
  To achieve sustainable development through technology integration and lean production

- **Plan and Development**
  To be the world-class supplier for battery testing and power management equipment

1.2 Products

Below series are our major products. They are just brief introduced here. To know more, visit our official web site at http://www.newarebattery.com or contact our sales representative.

- BTS 3000
  BTS 3000 is the largest output series up to now. It is reliable and time-tested for battery capacity grading and performance testing solutions.

- BTS 4000
  This series is an updated version of BTS 3000. It provides higher data acquisition frequency up to 100Hz to enable you get reliable DCR (Direct Current Resistance) tests. And also it has a faster system output response and more accurate when compared with BTS 3000.

- BTS 8000
  BTS 8000 is designed for EV (Electric Vehicle) drive cycle simulation, providing faster system response than BTS 4000 and multi current ranges enabled to ensure high current or power accuracy.

- BTS 9000
  This series is our sophisticated series for battery or material research solutions. It characterized with a data acquisition frequency up to 1000Hz, an accuracy of 0.02% FS and a minimum pulse width of 400us (microsecond) which can be utilized for GSM or some other rapid pulse tests.

- BTS ES
  In most cases, discharged power from batteries is released as heat spread in air in vain. Our ES (Energy Saving) system enables feedback this fraction of power into electric circuit or electricity grid.

■ EVT 6000

This series is a testing solution for those energy devices with high voltages and high power such as battery module or pack. CAN (Controller Area Network) is supported to get data from BMS (Battery Management System).

■ EVT 7000

While EVT 6000 uses thyristor, EVT 7000 uses IGBT (Insulated Gate Bipolar Transistor), providing more reliability and efficiency and in smaller space.

■ BFGS

This series provides formation and capacity grading functions for 3C (Computer, Communication, Consumer Electronics) using battery. This is an economy solution for battery formation and capacity grading.

■ BVIR

BVIR provides portable ACR (alternative current resistance) and voltage testing solution for batteries. It complies with IEC 61436:1998, using 1 kHz alternative current stimulus signal for ACR measurement.

We provide not only above presented major products, but also calibration system, system integration solutions, testing services and software development such as BIS (Battery Information System) to manage battery production information and LIMS (Laboratory Information Management System) to manage testing activities in a laboratory.

	Features	Application
BTS 3000	Accuracy: 0.1% of FS for BTS 3000 / 0.05% of FS for BTS 4000 ; Data acquisition frequency :1 Hz for BTS 3000 / up to 100Hz for BTS 4000	Capacity / Cycle Life
BTS 4000		Pulse / DCR / HPPC+ BTS 3000 applications
BTS 8000	Auto current ranges, 0.05% of FS; Data acquisition frequency: up to 100 Hz	Drive cycle simulation + BTS 4000 applications
BTS 9000	Accuracy: 0.02% of FS; Data acquisition frequency: up to 1000 Hz Minimum pulse width: 400us;	GSM Pulse / Cyclic voltammetry
BVIR	ACR according to IEC 61436:1998	Portable ACR / Voltage meter
BTS ES	Energy saving rate >55%[1];PF (Power Factor)≥0.98; THD (Total Harmonic Distortion)≤5%	Capacity / Cycle Life
EVT 6000	Accuracy: 1% of FS for EVT 6000 / 0.2% of FS for EVT 7000; Data acquisition frequency: 1 Hz; CAN supported; Electricity feedback	Capacity / Cycle life for battery module or pack
EVT 7000		
BFGS	Accuracy: 0.2% of FS	Formation / Capacity grading

1. *When compared with BTS3000 or BTS 4000, this value increases when the voltage of your batteries goes higher.*

Table 1 : Features and Applications of Neware Products

1.3 System Architecture

All Neware testing equipment could be deployed via TCP/IP, providing flexibility, data security and integrity. For some agile testing solutions and calibration, RS232 or RS485 protocol is also used. Our setting in this manual is for the equipment deployed via TCP/IP.
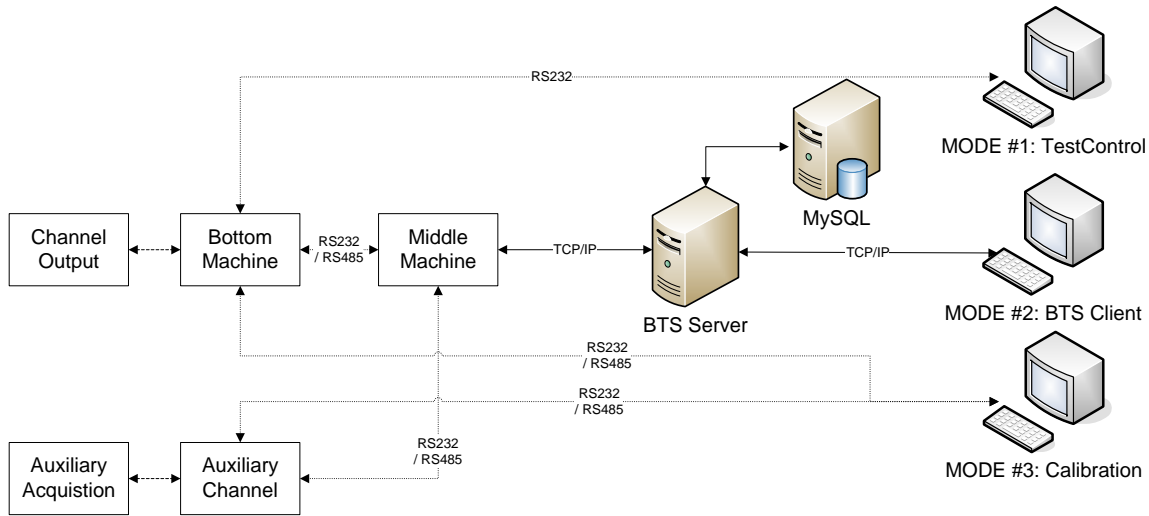
Picture 1 : System Connection Mode
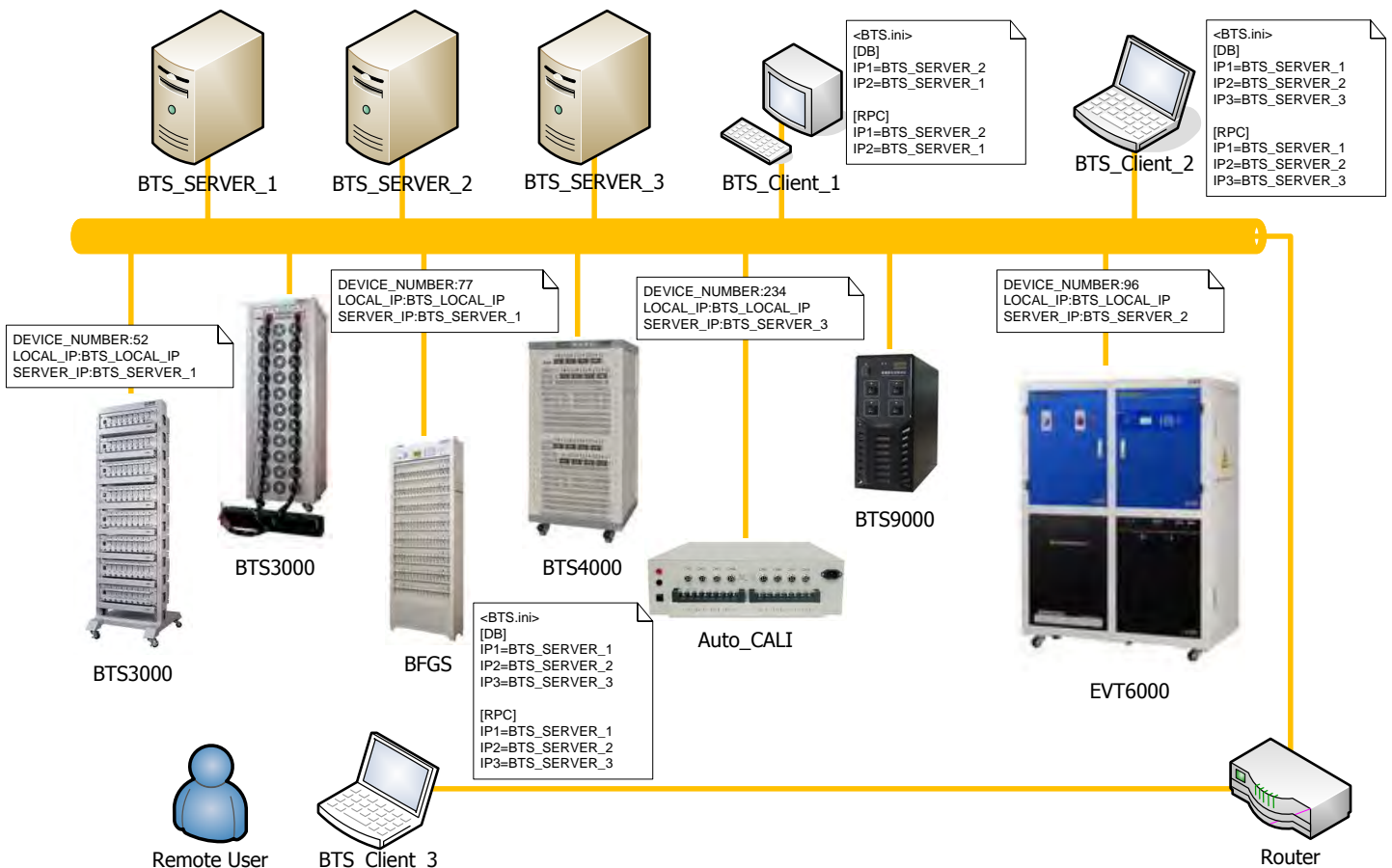
Picture 2 : System Architecture

Introduction

1.4 Notations Used in This Manual

	WARNING The WARNING is to alert you to the possibility of a dangerous safety condition that could result in damage to the NEWARE equipment, damage to the battery under test, or injury or death to you and/or surrounding people. All Warning messages have been collected together in Appendix E.
	CAUTION The Caution message is to alert you to potential conditions less severe than the Warning, but where damage could still occur.
	NOTE A Note shows key information, an easier way to do something, or provides a better understanding of what is being presented.
	TIP A Tip is to inform you of an alternate method or a good idea.

Table 2 : Notations Used in This Manual

2. Hardware

2.1 BTS Overview

Generally, Neware BTS consists of below components:

o   Neware tester, including embedded or external middle machine, auxiliary channel cabinet.
o   Power plugs.
o   Battery clamps.
o   Communication cables. Switches may be included if multi testers purchased.
o   CDROM. Including software, tools, patches and user manual.
o   Computer, Monitor or UPS (if purchased).

Equipment Diagram

Below diagram represents the basic inner architecture of our BTS series. BFGS, ES and EVT series differ from below diagram.
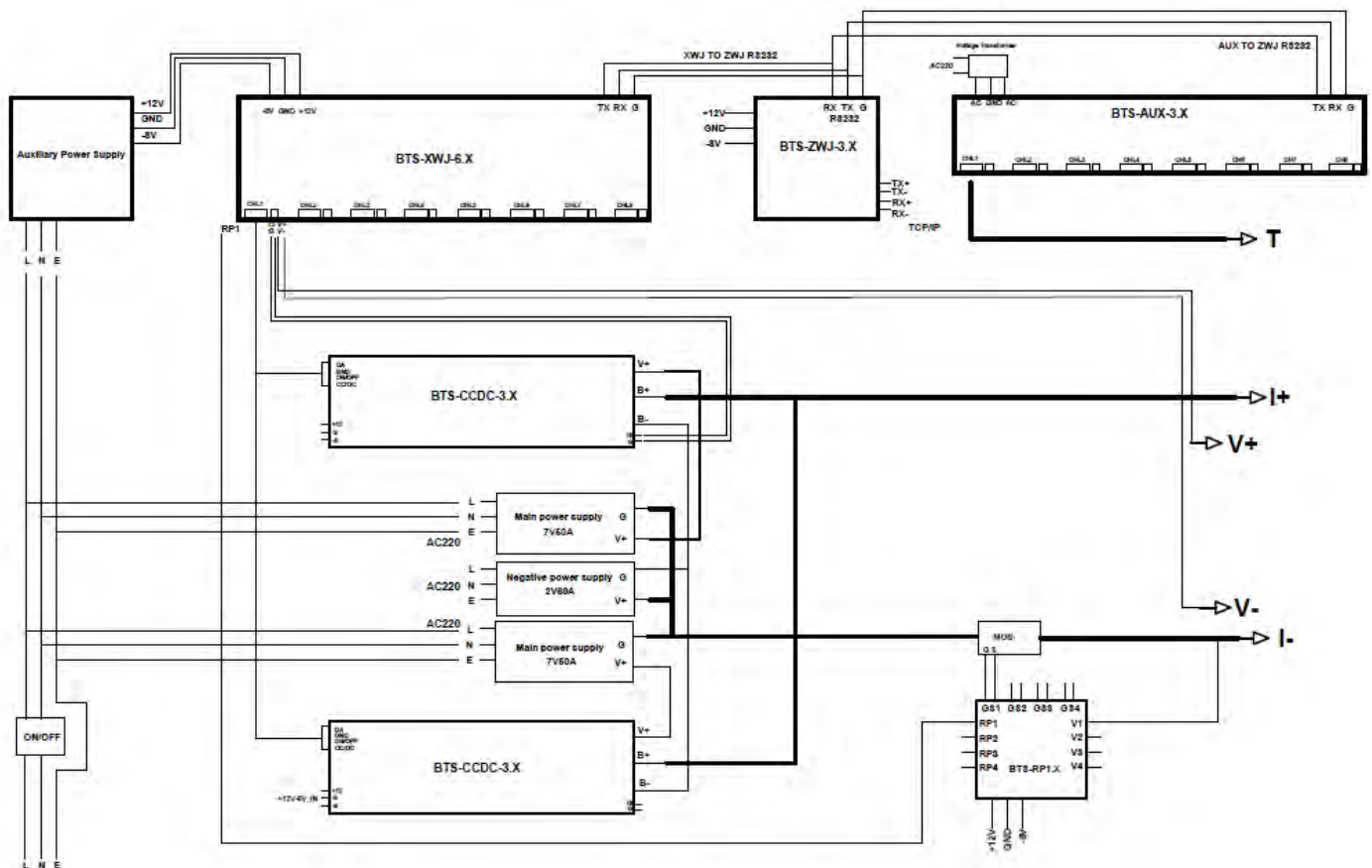
Picture 3 : BTS Module Diagram

Hardware

Front Panel

Below front panel goes the classic layout, including universal holder and a 164 air socket for some other types of clamp.
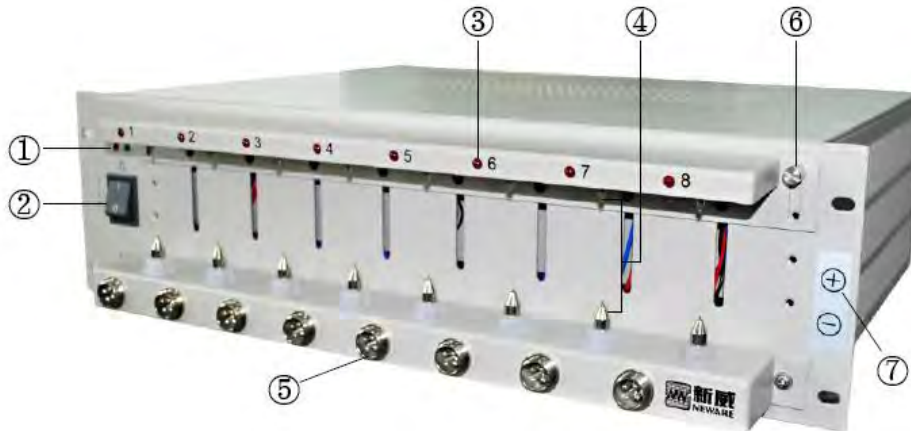
Picture 4 : Front Panel

① Power and Signal LED
② Power On/Off
③ Channel Working LED
④ Universal Holder

⑤ 164 Air Socket
⑥ Holder Height Adjustment Screw
⑦ Channel Polarity Label

Rear Panel

Picture 5 : Rear Panel

① Communication Port
② Power Socket

③ Equipment Information Label

Communication Port
1) You will see RJ45 port in yellow, this is for RS232; blue for RS485 and black for TCP/IP. There is also 9-pin RS232 male port on some older versions.

Equipment Information Label

Model: CT-3008-5V2mA-S4

Serial No.:T1307-157361-01

XWJ Version:BTS-XWJ-6.7.2S

Date of Production: 2013.07.21

AC Input: AC220V±10%, 50~60Hz

Power:30W

After-sales service hotline
83128100
83128600
83128900
(0086-755)

Picture 6 : Equipment Information Label

Serial No.
1) Serial No. is registered in our SAP system. You should provide this serial No. for calling after sales services.
2) If this number is separated in to 3 parts by hyphen, the last part is the unit number of the cabinet. There will be only 2 parts if a middle machine is embedded.

CT–3008W–5V2mA–S4
① ② ③ ④ ⑤

Picture 7 : Part Number Explanation

① Series. T-3 means BTS 3000; E-6 means EVT 6000 and etc.
② Channel quantity
③ Cabinet color. W means White and as the default, B means Black
④ Voltage and current output range
⑤ Fixture Type and other function

o N: Network, means there are embedded Middle Machine(s) enable system operation over TCP/IP.
o A: Anti-reverse, means system will protect battery being operated while reverse connected, i.e. system permits ONLY positive voltage (voltage sensing is on current cable) input.
o F: Negative power supply. Means system will have a power supply to increase the discharge power to drain the battery energy, enabling you discharge battery to 0V, or even lower.
o T: Temperature. Means system have embedded auxiliary temperature units.
o V: Voltage. Means system have embedded auxiliary voltage units.
o A1: Universal holder with Sharp voltage sense probes for battery with Aluminum case (Negative up and positive bottom).
o A4: Universal holder with Round voltage sense probes for battery with Aluminum case (Negative up and positive bottom).
o S1: Universal holder with Sharp voltage sense probes for battery with Steel case (Positive up and negative bottom).
o S4: Universal holder with Round voltage sense probes for battery with Steel case (Positive up and negative bottom).

Battery Clamp

Neware provides various kinds of battery clamps, such as: universal holders, alligator clips, polymer clamp, ring terminal connector and other types specified by customers. Here, only the common 4 types listed below for your reference.

	Universal holder. For any batteries with their polar on the other sides, and the battery case is hard enough for the clamp. Basically, there are 2 types of voltage sensing probe –sharp and round, and 2 types of polarity layout-positive up and positive bottom. This provides you 4 options for your choice. Sharp voltage sensing probes may leave visible but harmless scratches on the battery, but provides you better contact with the battery.
	Alligator clamp. 2 couples of wire provided for 4-wire connection – Voltage and current couple. Normally, the bolder wires present current cables, red stands for positive, black for negative.
	Polymer clamp. This is specially designed for polymer battery, providing good operation and contact with battery tabs, and also causing no distortion for battery tabs.
	Ring connector. We provide standard and non-standard ring connectors.

Table 3 : Battery Clamps

2.2 Electricity Connection

Before you power the equipment, you must pay enough attention to the electricity requirements – power voltage, maximum power requirement and also the wires' polarities, L means this wire is a Live wire, N Neutral wire, E Earth wire.

Electricity Connection
1) You can only plug the equipment to a power supply within the voltage range which indicated on the equipment information label.
2) Pay also attention the wire polarity and the maximum power requirement. Improperly electricity connection may result in equipment power damage or electric shock to the people.
3) The equipment must be grounded. There will be voltage difference between 2 sets of non-grounded equipment; touching them at the same time will result in electric shock to the people.

Short Period of Peak Power Requirement
1) If the equipment is stand by for a long time, there may be need some extra electric power to charge the capacitor of the inner power supply in the equipment, producing a transient large power requirement. This power may let the air-break switch to cut off the circuit, just re-turn on, maybe need some more times.

2.3 Communication Connection

There is a black RJ45 port on the rear panel of the equipment, using an RJ45 cable to connect the equipment to the host computer. You can connect them straight together, or through some other LAN devices like router, switch or hub. If you are using MODE #1 from below diagram and your equipment is of BTS 3000 or BFGS, this RJ45 cable should be crossover cable. Straight through or crossover cable will always function by using MODE #2, or by using MODE #1 but your equipment is of some other product series.
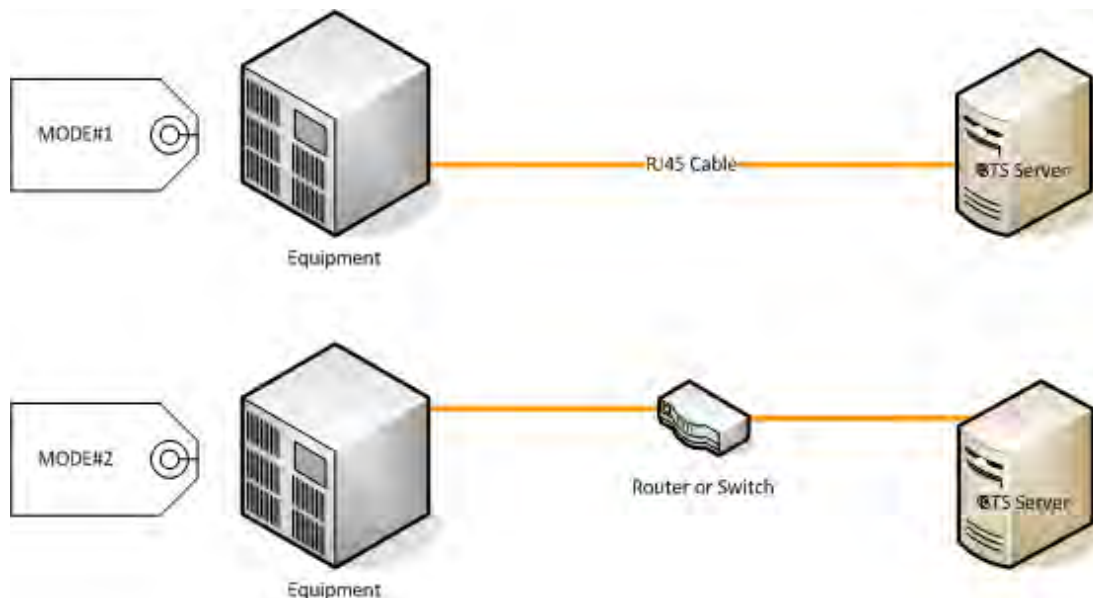
Picture 8 : Communication Connection

Ethernet Operation
1) Duplicated IP addresses of the equipment or the host computer will result in data loss or some other unexpected errors.
2) Deploying the testing equipment and host computer in an isolated LAN is highly recommended for data security.

Hardware

Straight through and crossover RJ45 cable wiring is illustrated as below.
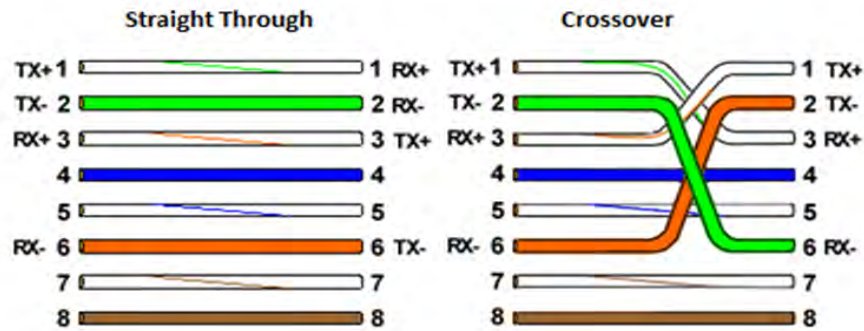
Picture 9 : RJ45 Cable Wiring

2.4 Battery Connection

If you are connecting the channel wire to the battery, you should take good care of below 2 factors.

o Current: Your connection to the fixture should be good contacted. Current carrying capacity should also be well considered while you are conducting any extension to the current wire, pay special attention to the joint points.
o Voltage: Every channel we have 2 couples of wire for the battery connection. Your voltage sensing point should be better when located at the very polar points of the battery.
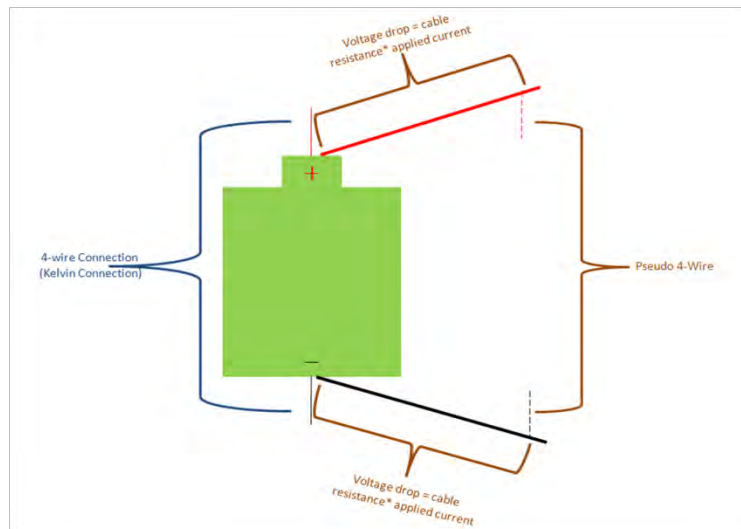
Picture 10 : 4-wire Connection and Pseudo 4-wire

Battery Connection
1) Battery should be correctly connected to the channel output clamps with good contact. Improper connection will result in battery damage or some other loss.
2) A battery with its voltage higher than the voltage range of the equipment you are connecting to is not permitted. This will damage the equipment.
3) If the equipment has a voltage output range or your battery voltage is larger than 36V (minimum safety voltage to human, different from standards), you should take great caution to operate both equipment channel and the battery you are going to test.

3. Software Installation

3.1 Preparation

Basic requirements for Neware software
1) Windows platform, enough computer hardware resources to run MySQL database.
2) 2 partitions and a non-system drive recommended for data security.
3) NTFS is suggested for the drive to enable larger file size and data security.
4) Write-caching disabled for data security.

1) To run NEWARE software on your computer, recommended system request will be as below:

Item	Technical Specifications
CPU Frequency	2.4GHz or above
Memory	2G DDR2 800 or above
Hard Disk	500GB SATA or above, RAID5 is preferred.
Operating System	Windows 2000 or above
Ports & Aux.	RJ-45, UPS

Table 4 : Host computer requirements

2) Making 2 partitions of your computer's disk is highly recommended. And a non-system drive is selected as the directory for NEWARE software.
3) File system of NTFS and disabled write-caching are preferred to ensure data security. (Why NTFS: The NTFS file system provides better performance and security for data on hard disks and partitions or volumes than the FAT file system used in some earlier versions of Windows; Why disabling writing-caching: Disabling write-caching is mainly to protect data from loss or corruption. This functions for the whole disk.)
   a) How to convert a partition from FAT / FAT32 to NTFS file system. Just type "*cmd*" in run, and type "*CONVERT volume /FS: NTFS*".

```
Microsoft Windows [Version 6.1.7600]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\David Chen>convert D: /fs:ntfs
Drive D: is already NTFS.
```

Picture 11 : Convert drive to NTFS

NTFS and write-caching disabled
1) NTFS enables file size larger than 4GB, preventing a writing error or data loss when database file larger than 4GB.
2) Disabled writing-caching will write data to file in real time, preventing unexpected data loss or corruption.

   b) How to disable write-caching. Just right click on target disk, choose "*Properties*". Then find your disk under "*Hardware*" tab view, click "*Properties*", Navigate to "Policies" tab view at the prompt. Uncheck "*Enable write-caching on the device*".
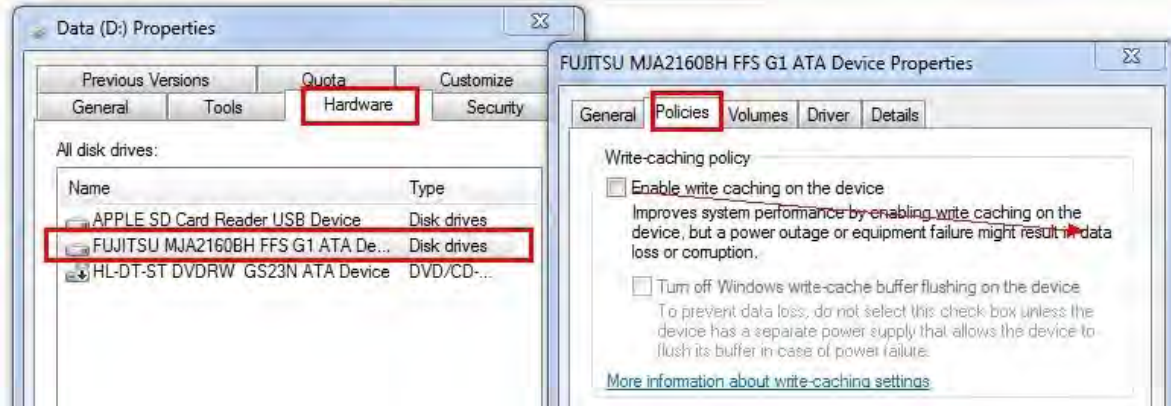
Picture 12 : Disable writing-caching

4) Virtual memory setting. To ensure a faster program running on a computer with fixed RAM, a proper setting of size of virtual memory is needed.
    a) Right click on "*Computer*" icon on desktop, find "*Properties*", click it, there will be a prompt dialog (if you use Windows Vista/7, you need to click "*Advanced system settings*" on left column of the prompt to provoke this prompt). See below screen shoot for your guidance. Just choose "*System managed size*" or take the circled recommended value for your custom size (Initial size).
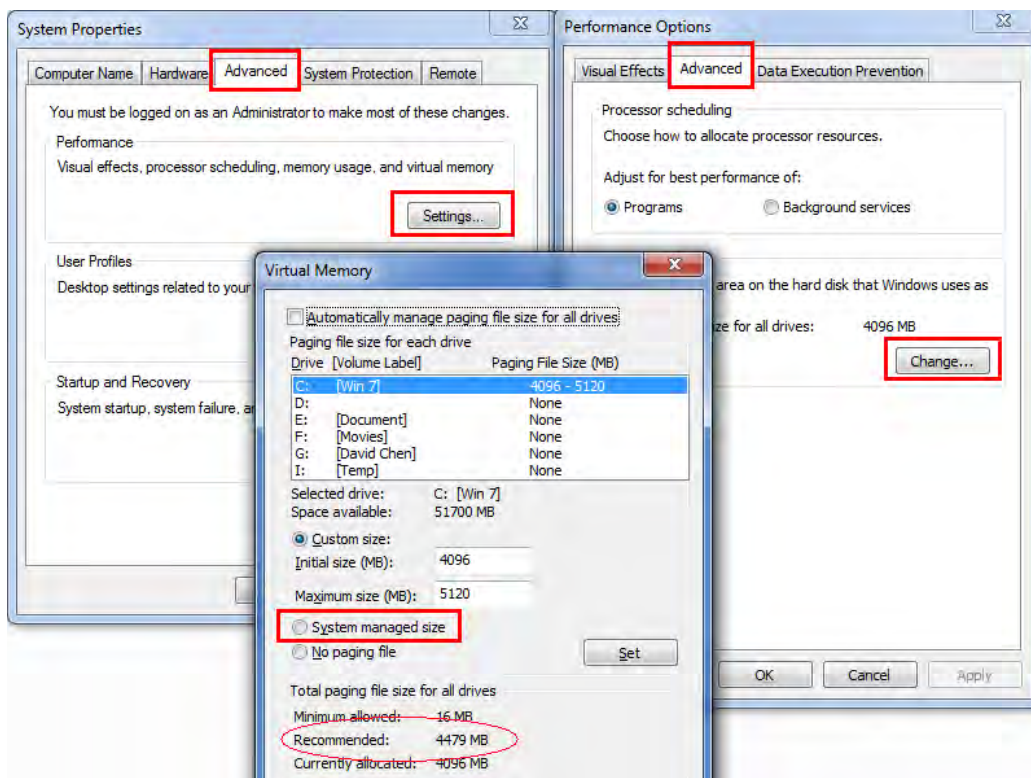
Picture 13 : Virtual memory settings

3.2 Installation

1) You may find Neware BTS software on our CDs or download from our official web site. Under each directory, there may be three items listed, one is *vcredist_86 folder* which is the C++ runtime, another one *BTSServer.msi* or *BTSClient.msi* which is the core software package, the third one is *setup.exe* which is an installation

sequence - installing C++ runtime firstly and *BTSServer.msi* or *BTSClient.msi* followed.

Installation Procedures
1) Microsoft Visual C++ 2010 runtime is a must framework to run Neware BTS software.
2) BTS Server will register two services - *btsserver* and *mysql* - onto the host computer.
3) One computer can function as both BTS server and BTS client.
4) You can deploy as many BTS clients in your LAN as you want.

Microsoft Visual C++ Runtime Libraries
1) Runtime provided here is X86 based, it is compatible with X64 based system. There is still no need to reinstall an X86 version if your C++ runtime is X64 one.

1) After C++ runtime installed, you can go installing BTS server or client. For both BTSServer and BTSClient, we suggest a non-system drive selected for the installation folders.
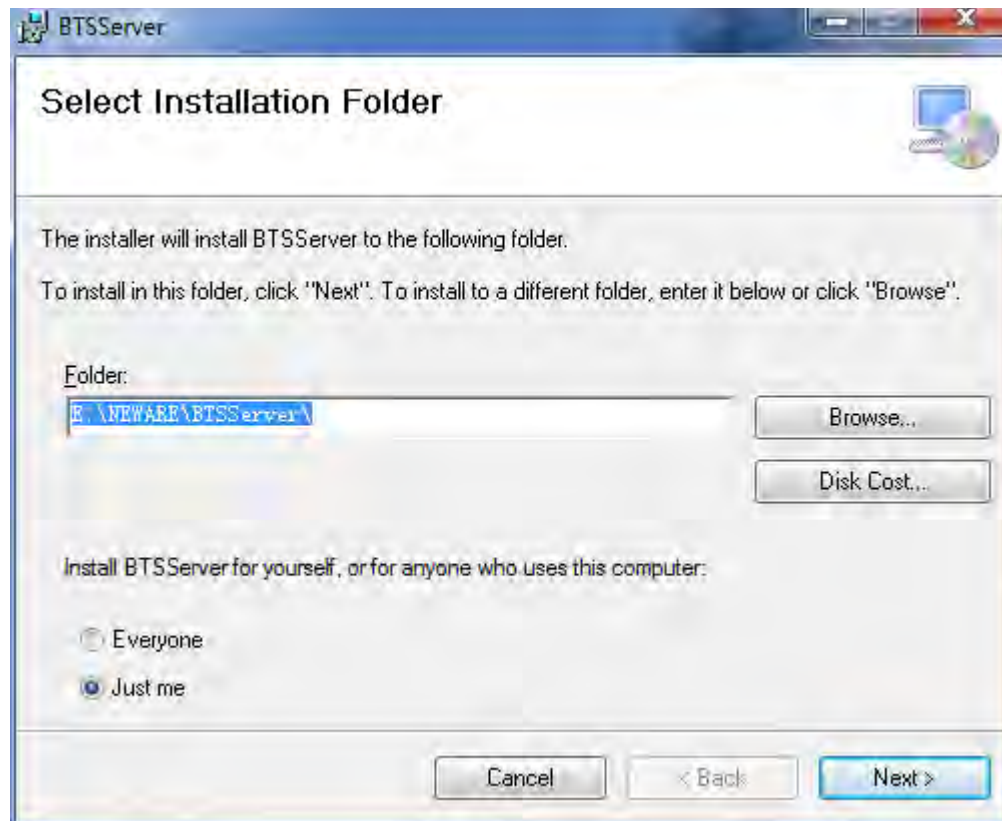
Picture 14 : Non-system drive selected for the BTS Server Folder

2) And after BTSServer installation complete, two services – *btsserver* and *mysql* – will be registered and under a status of Started.
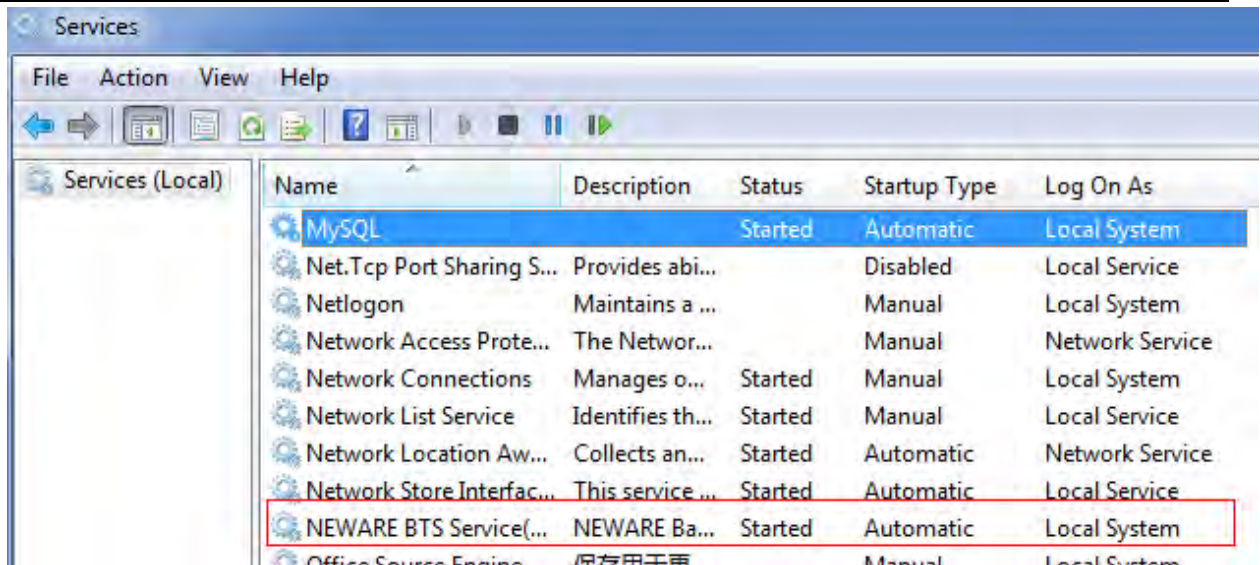
Picture 15 : BTS Server services registered and started

3) After BTSClient installation completed, three application shortcuts will be generated on the desktop.
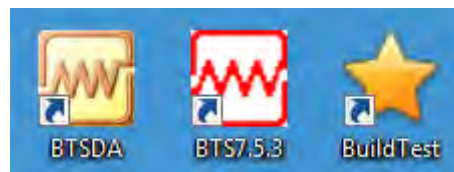
Picture 16 : BTS Client shortcuts

3.3 Uninstall

1) To have NEWARE BTS software uninstalled, you can use standard program management of Windows system or the MSI uninstall.
   a) Use *Control Panel*, navigate to *Programs and Features*, find the item you want to uninstall, then right click and select "*Uninstall*" or just click "*Uninstall*" on the title row to have this uninstalled.
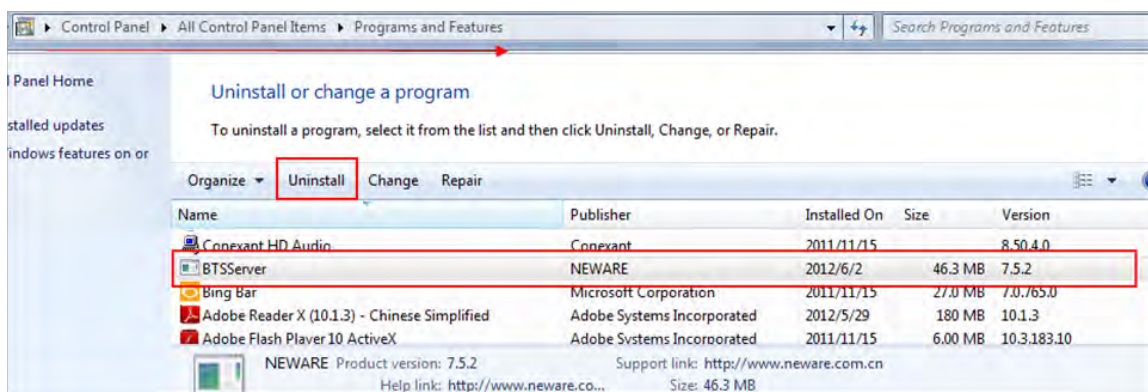
Picture 17 : Neware BTS software uninstall in Control Panel

   b) MSI uninstall. Navigate to the program you once installed. As an example. To have TC53 uninstalled, just simply navigate to TC53 directory, find "TC53_Se*tup.msi*", and then click "*Uninstall*'' on the right-click menu.
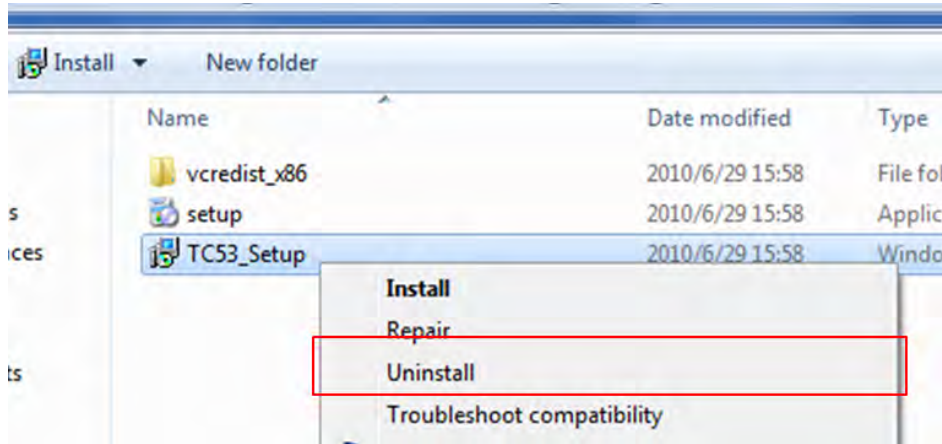
Picture 18 : Neware BTS software uninstall by MSI uninstall command

Delete Registered Services
1) If you still find *"btsserver"* and *"Mysql"* in host computer services list. Just use *"sc"* command to have them deleted. Command example: *"sc –delete btsserver"*

4. Software Operation

4.1 Software Relationship

Benefited from distributed architecture, BTS provides your most flexibility and data utility. BTS Client is a free software package on application tier, while some other custom solutions are provided on charge basis.

Application Tier	User Interface	BTSClient	Reporter	BIS	LIMS
Data Tier	BTSServer/MySQL	Commands Interpreter Data Organization & Management			Database
Hardware Tier	Middle Machine	Flash Buffer / Commands / Uploaded Data / Capacity Calculation			
	Bottom Machine	Commands Output Basic Data Acquisition			

Table 5 : Software Relationship

4.2 Key Files and Folders Description

1) Folders generated after BTS software installation completed are listed as below. If your computer functions only as BTS Client or BTS Server, there will only one such folder under NEWARE directory.

Picture 19 : Folder Hierarchy and Description

2) Meanwhile, you should still pay attention to below files:

o *BTS.ini* in *BTSClient* folder. This file specifies the configuration parameters of the client, like BTS servers connected to, step color, status color and etc.
o *my.ini* in *BTSServer* folder. This file is generated by MySQL, if you are not familiar with MySQL, maintain it unchanged.
o *BtsServer.ini* in *\Neware\BTSServer\bin* folder. This file specifies the configuration parameters of the server.
o *ibdata1* in *\NEWARE\BTSServer\data* folder. This is the data file which MySQL manages, storing all the test data.

Files and Folder Operation
1) Above presentation is only for better understanding of our software. We highly suggest that these files or folders are maintained unchanged except you are guided to do so.

4.3 Find and Connect with Equipment

Connection Procedures
1) Our equipment functions a LAN device, so firstly there should be LAN connected between BTS Server and the equipment. Equipment has a unique MAC and IP.
2) Set BTS Server's IP address as the value of Server IP (*Server_IP*) of the equipment. And *192.168.1.250* is the default value for this.
3) Configure your *BTS.ini* to make BTS client connected to target BTS servers.

Using DHCP Server to Allocate IP for Equipment

DHCP Server Warning
1) Improper use of this tool will result in your network malfunction and some other unexpected network errors.
2) Under most conditions, DHCP server won't be brought out since our equipment has a fixed IP for its application. And an isolated network is suggested to use this tool.

1) DHCP server is located in *tools* folder on our CDROM. You can also download it from our website or some other trusted channels.
2) Unpack this one, you will find the application item *dhcpsrv.exe* and a configuration settings file *dhcpsrv.ini*. There is also guide file for you to appreciate this application.
3) Now open *dhcpsrv.ini*, change this line *IPPOOL_1=192.168.1.10-200*. Make your own IP ranges you want to set. Then close and save this file.
4) Click *dhcpsrv.exe*, this will ask you to install this server as a system service. Choose "No". If you clicked "Yes", you may also click "Remove" after having IP fixed for the equipment.
5) Now reopen *dhcpsrv.ini,*, you will see below sections posted to the end of this file. This means your equipment has allocated with below IP address. You may go Configure Equipment section to fix the IP address of the equipment.

    [00-24-1D-D4-7A-71]
    IPADDR=192.168.1.10
    AutoConfig=07/06/2013 17:51:16

6) Now, you can exit this application. Make sure you removed this application from system service if you once clicked to install as a system service.

Using Network Scanner to Search Equipment

> **Network Scan**
> 1) If you already knew equipment's IP address, you can just ignore this step and move next for the equipment configuration.

- Our *Lansee.exe* on CDROM doesn't support English platform good. You download *NetScan* for use instead. (You can get it from its official website: http://www.softperfect.com/products/networkscanner/ or Neware Software Compact Online: http://sdrv.ms/JRQsfY). Launch this tool. Type the IP range and click *search*. Default IP range for our equipment is about *192.168.1.x* (x may range from 2 to 255). You can see those host names with "BTS_" initials are NEWARE testing equipment. "*ZWJ*" is the BTS 3000 type, and "*ZWJ4*" is BTS 4000 type. The following digits are their *Device Number*. Now you find corresponding IP address thereof.
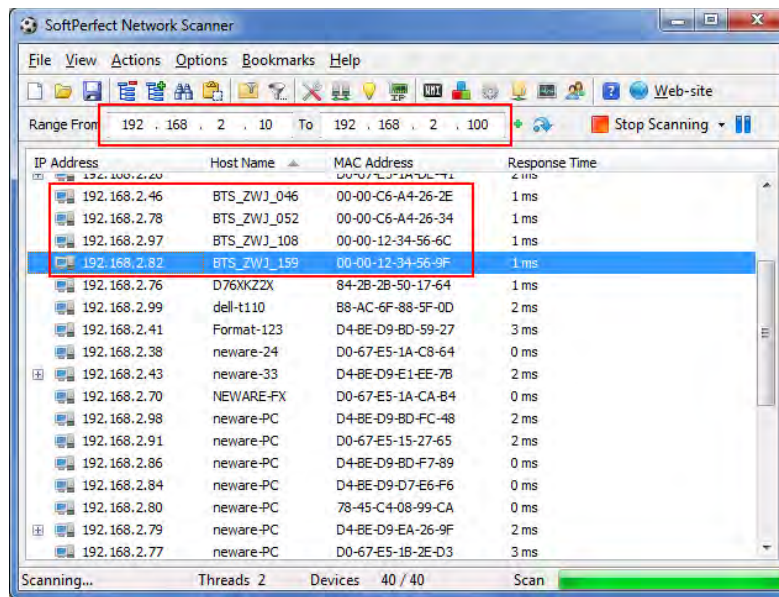
Picture 20 : Network Scan

Configure Equipment

- **FOR BTS 3000**
1) You need to use *TCP/UDP* to do below operations. Find this tool on CDROM or Neware Software Compact Online: http://sdrv.ms/JRQsfY). This tool doesn't have an English UI, but it works. Fill the corresponding IP address (LP or Local IP from the LCD) of the testing equipment, and click "*Connect*". This will establish connection between computer and testing equipment you specified. The status bar will show the connection result. Type digital number "*3*" and click "*Send ASCII*", this will show all the information of the testing equipment connected. It has a SERVER_IP of 192.168.2.26, this means only BTSSERVER on 192.168.2.26 can operate this equipment and acquire data from it. "*COM1 Connect 2 -- 2 6*" means 2 units (Unit number 2 and 6) are now hosted and accessible by this equipment. You can type digital number "*4*" for automatically searching. You can navigate to *Appendix A: Middle Machine Commands* for more commands and examples.

> **TCP/UDP Operation**
> 1) If you need commands other than "*3*" which is just getting information from the equipment, there should be no tests running.
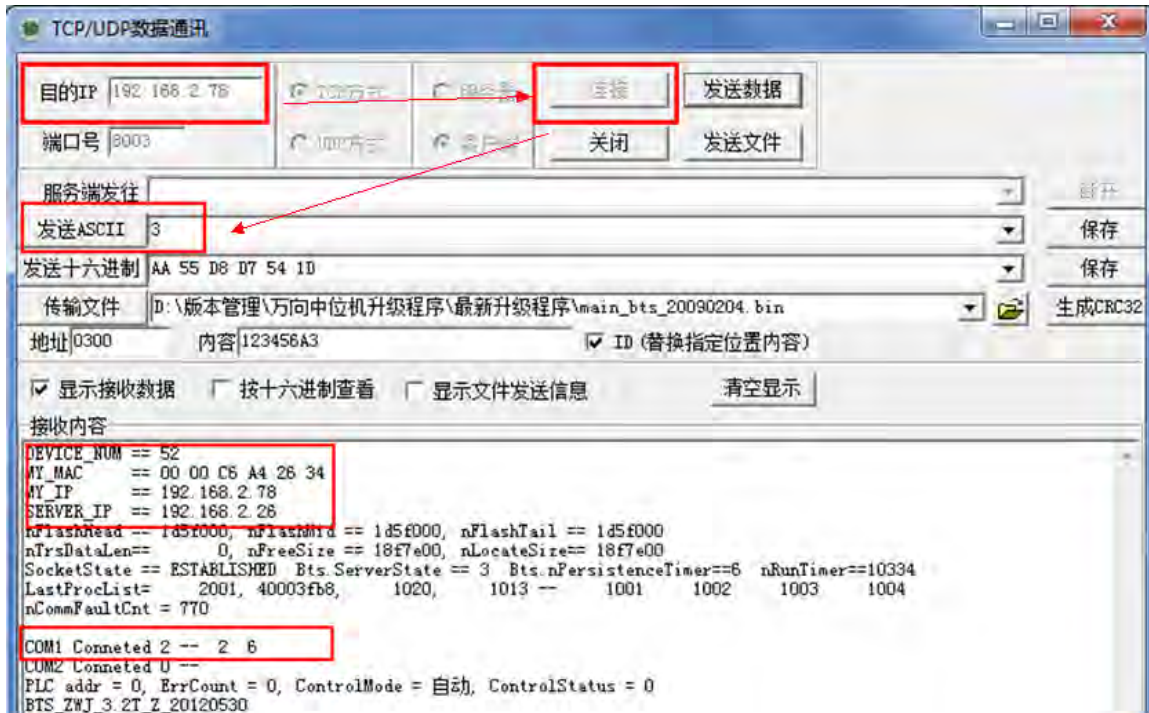
Picture 21 : TCP/UDP Operation

2) You can change the IP address of the computer where BTSServer is installed to the *SERVER_IP* value which you can see from above command result. This change should not generate duplicate IP in your LAN. If yes, you can use command "*ixxx.xxx.xxx.xxxp*" to change the *SERVER_IP* value to the IP address of the computer where BTSServer is installed.
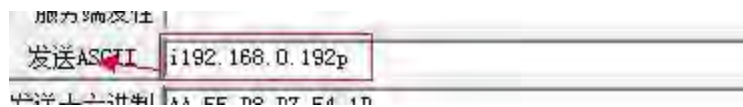
Picture 22 : Set Server_IP for BTS 3000

■ **FOR BTS 4000**
1) You can just use "*telnet xxx.xxx.xxx.xxx*" to launch setting commands for BTS 4000 series. *xxx.xxx.xxx.xxx* is the IP address of the equipment you want to configure.

Picture 23 : Information Inquiry Operation for BTS 4000

Software Operation

Telnet Command

1) If you are using windows Vista/7 operating system, or you are experiencing an "*Invalid command*" after enter *telnet*. You need to turn on *Telnet Client* in *Windows Features*.
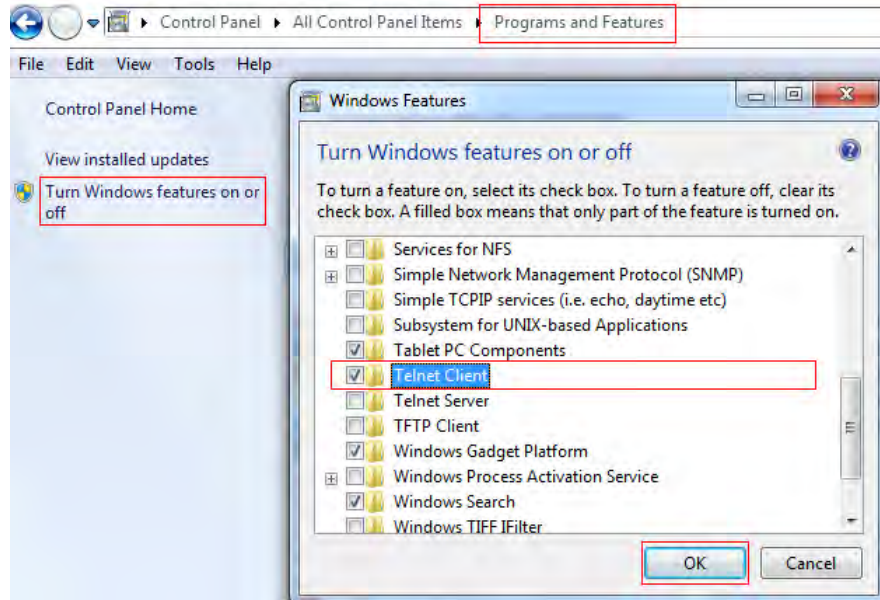
Picture 24 : Turn on Telnet Client Feature

2) Password for the entry is "*neware*", you can type "*ipconfig*" for all the information. The *SERVER_IP* value has a hexadecimal code, you can use calculator to convert into decimal. You can type"*help*" for help. You can also navigate to *Appendix A: Middle Machine Commands* for more commands and examples.

Use Keypad to Set IP and Configure Equipment

■ **For All Function Keypad**

1) If your keypad is similar as what below picture presents, Press "F" to change the LCD view to a screen indicating IP address. Switch "Auto" to "Manual". Digital keys enable you input digits directly, you can also use up/down arrow to increase or decrease digital numbers.

Picture 25 : All Function Keypad

2) Set locIP and svrIP to non-duplicated IPs in the LAN, locIP means the IP address of the middle machine, svrIP means the Server_IP of the middle machine.

3) You can also specify Device Number by the keypad.

■ **For Concise Keypad**

1) If your keypad is similar as what below picture presents. There are only 4 keys provided - up/down arrow to select basic function, return key and an Enter key. Navigate to *Configuration* to set IP address and other configurations.

Picture 26 : Concise Keypad

2) Change Get IP Addr from *MANUAL* to *AUTO*. You can set *Device ID* (Device Number), *MAC*, *LP* (Local IP address), *SM* (Sub Mask) and *SP* (Server IP). Use up/down arrow to increase or decrease number.

Configure BTSClient

1) Now, we suggest that you already finished searching and configuring your equipment and BTSServer has been installed. If your computer functions both BTS server and client, you can now just launch your *BTSClient.exe* created on your desktop. And if you are to connect BTS client to BTS server distributed in your LAN, you may edit *BTS.ini* in *\NEWARE\BTSClient7.5.3* folder. This file could be open by any notepad applications. You need to restart BTSClient to see the effect.

[DB]
IP1=127.0.0.1
IP2=192.168.2.26
IP3=192.168.1.250
; more servers added here
[RPC]
IP1=127.0.0.1
IP2=192.168.2.26
IP3=192.168.1.250
; more servers added here
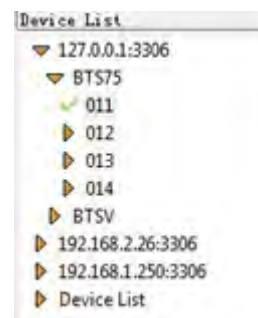
Picture 27 : BTS Client Configuration

BTSClient Configuration
1) You are allowed to add total 10 servers here. Some other lines will be neglected when your inputs is larger than 10 or IP* index larger than 10.

4.4 BTSClient Operation

BTSClient Overview

1) *BTS Client* is a traditional Windows program, has below 6 main content blocks.

ID	Name	Description
(1)	Device List	Devices and their connection status. Device management – Information inquiry, embedded software update, device configuration.
(2)	Current / History Tab	Search any history data on BTS server(s) under Search tab, and list all history data and manage them under History tab.
(3)	Brief View Settings	Set background color highlight different channel states and adjust what information to be viewed.
(4)	Auxiliary Information	List all the barcodes input, press machine monitor and control.
(5)	Main Content	Mapped channels and their real time data.
(6)	View Picker and other functions	Three views provided and two other functions – Capacity grading and Battery Match.

Table 6 : BTS Client Content Blocks

Picture 28 : BTS Client Overview

Exit BTSClient
1) Exit *BTSClient.exe* will NOT cause any running tests to cease. All your testing commands are transferred to, and all the record data is stored by BTS Server.

Log for Problem Shooting

Under some unexpected occasions, you may experience a problem which is requiring further information for shooting. Log files are such kind of information and you may be required to submit these files. Navigate to *Package Log* under *Help* on menu bar. This will compact all the files in *BTS Client\logData* folder.

User Management

1) BTSClient provides you multi roles to operate this client. You may specify users in different User Groups to allocate different accessing rights to the BTSClient. To access User Management, you should log as an administrator user. For non-administrator users, you can only modify your password.

2) Now, after you logged as administrator, you can access User Management by clicking *User Management* under *User* on the Menu Bar.
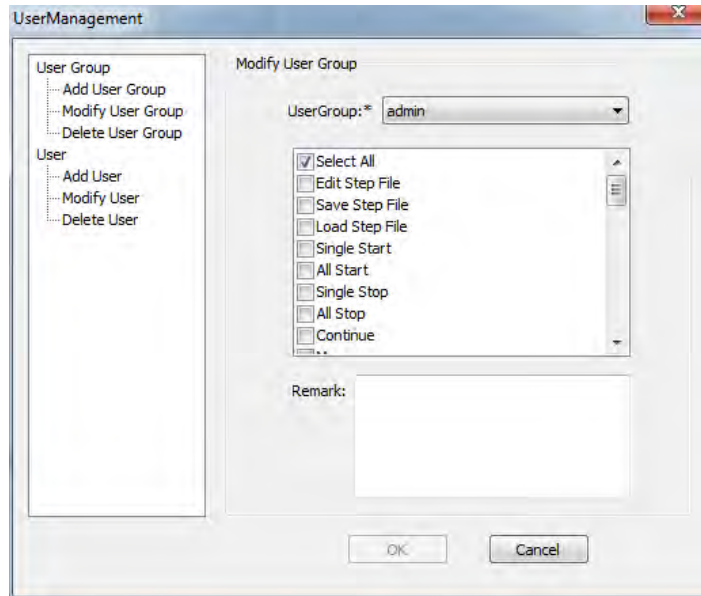
Picture 29 : User Management

3) You can add and delete a user group, and also allocate accessing rights to a selected group. And in User section, you can add users to a selected group.

Disable User Management Module
1) If there is nobody else to use this software or you do not need user management module and you are tired of entering user name and password. You can edit the *BTS.ini* by changing *[CLIENTMODE] MODE=2* to *[CLIENTMODE] MODE=1*.

View Settings

1) Basically, 3 views are provided for your selection. But Brief View is the most one we use because List View and Step View just provide testing data without permitting you starting a test and performing other settings.
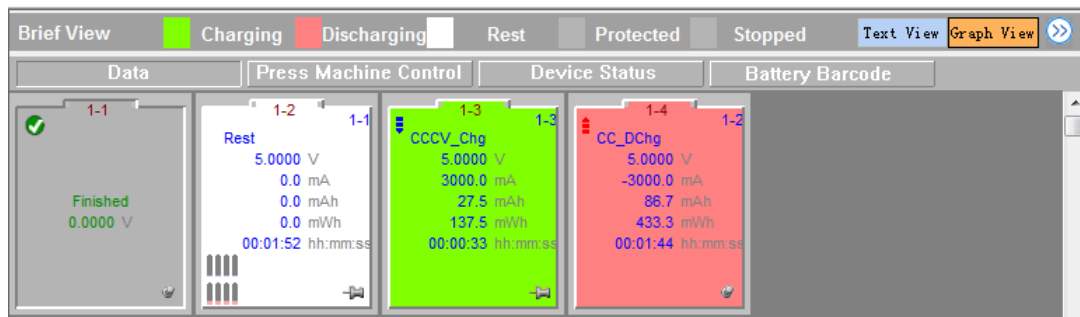
Picture 30 : Channel Brief View

2) You can set different highlight colors for different channel states. Click the color block before the state label will prompt a color picker for you to choose. Click the color block before Default will reset all the highlight colors to default.

3) In general, below channel information and real time data shown for you.

Mapped channel number
Charging or Discharging
Voltage value
Step capacity
Step time
Graphed Aux. value

Cycle number – Step number
Current value
Energy value
Pin tool
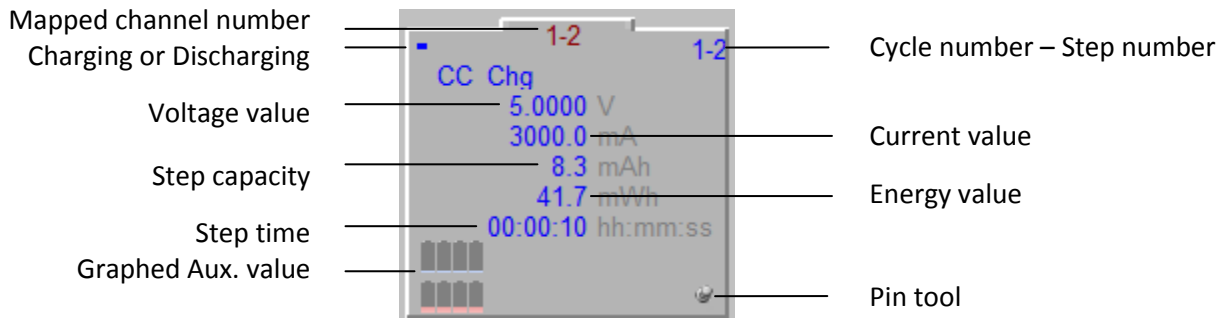
Picture 31 : Channel Information

4) Click ⧉ will guide you to some other data views.

5) You can also set colors to indicated different step type. Navigate to *Set Step Color* under *Setting* menu on the menu bar. Clicking the button with step name will prompt color picker for your selection.

Picture 32 : Step Color Setting

You will see the result when you launch *Step Editor* for a new test or *Channel Information* to view the test schedule.

Picture 33 : Step Color View

6) Right click in the main content area. There will be *Unit Setting* command enables you set the units of the testing data to be presented.
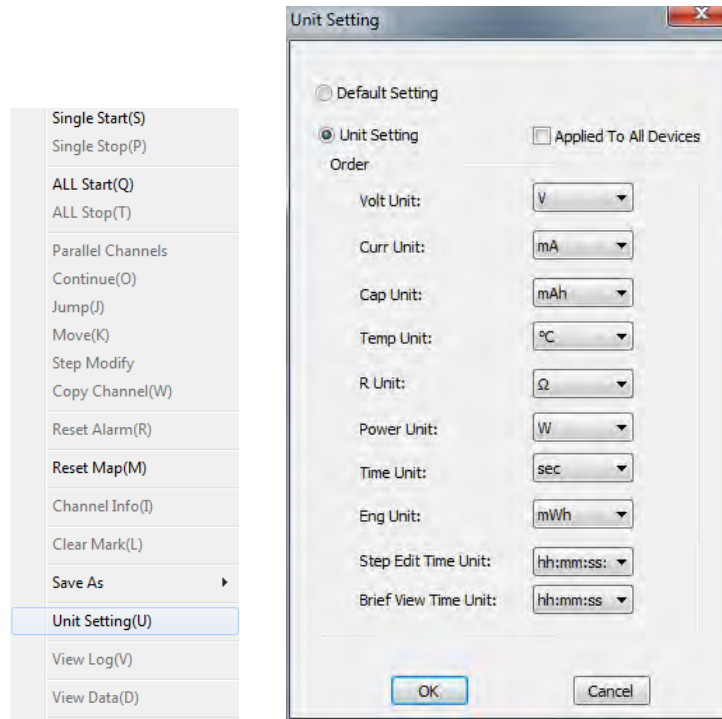
Picture 34 : Unit Setting

Device Operation

1) By right click on the device number on device list, you will have below operation commands enable you inquiry, update, modify and operate devices.
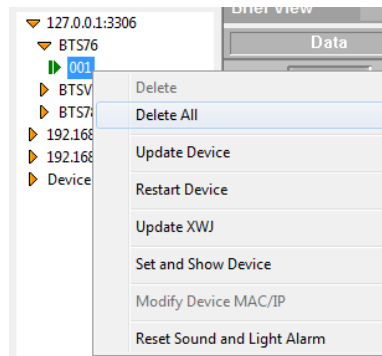
Picture 35 : Device Operation Menu

2) Our embedded software has strict tests before mass production, but there are still occasions that some new features brought in or some bugs need to be fixed. To update this sort of software, you should first acquire a binary update package and its password.
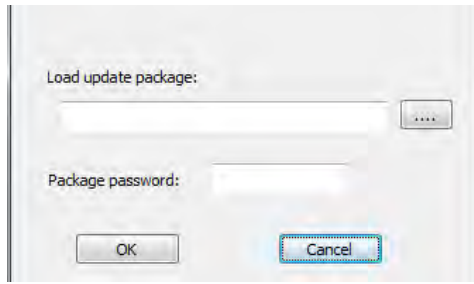
Picture 36 : Device Update
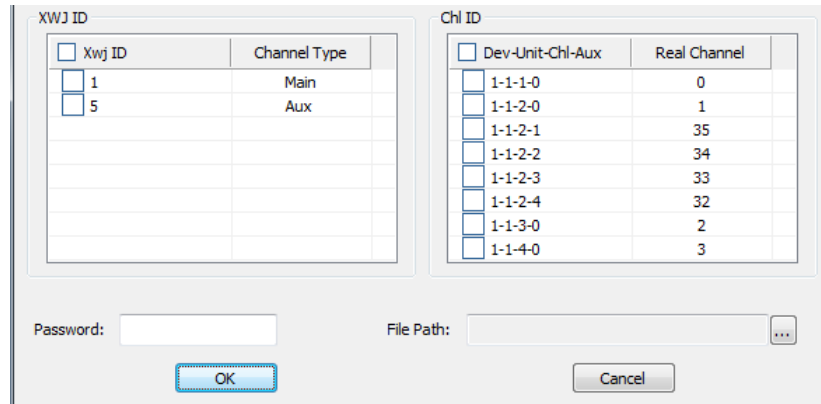
Picture 37 : Bottom Machine (XWJ) Update

Embedded Software Update
1) ONLY administrator has the authority to conduct this action.
2) ONLY mapped channels listed here ready for XWJ update.

MAP Operation

1) Below picture presents you the relationship of real channels on board and mapping channels in software.
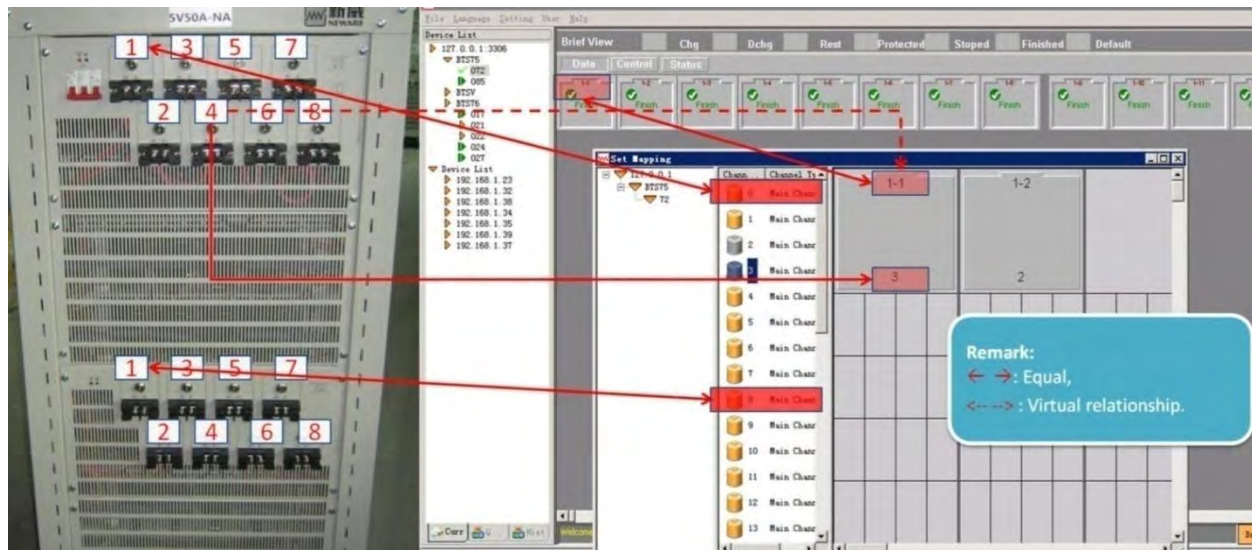
Picture 38 : Device Update

2) Right click in the main content area, Navigate to *Reset Map*. This will prompt a dialogue guiding you set the map. You can see Device 11 has total 32 main channels (index from 0) and 224 auxiliary channels. You can map them.
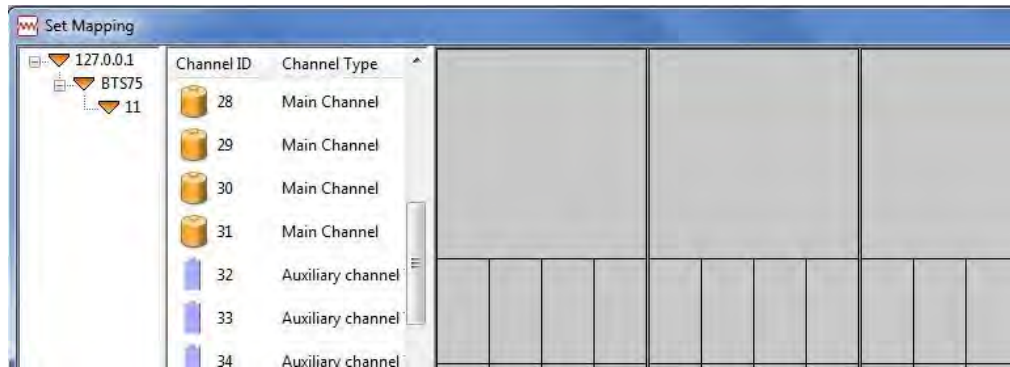
Picture 39 : Channel Mapping

3) You can drag the channels from left list to the right blank column. The bigger rectangle is for main channel, and smaller for auxiliary channel. You can arrange how many main channels in one row. Program provides 8 channels, 16 channels or 32 channels.
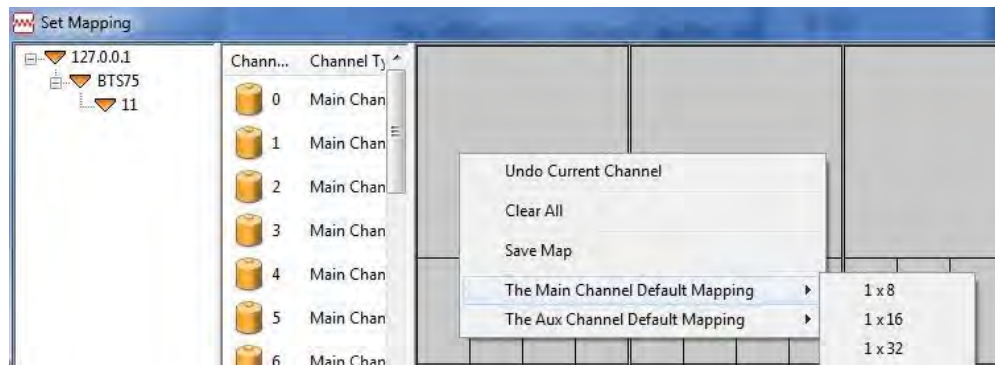
Picture 40 : Set Main Channel Mapping

4) For auxiliary channels, we provide 2 options. You can assign equal channel quantity for all the main channels. (Each get 7 auxiliary channels if you assign 224 auxiliary channels to 32 main channels,)
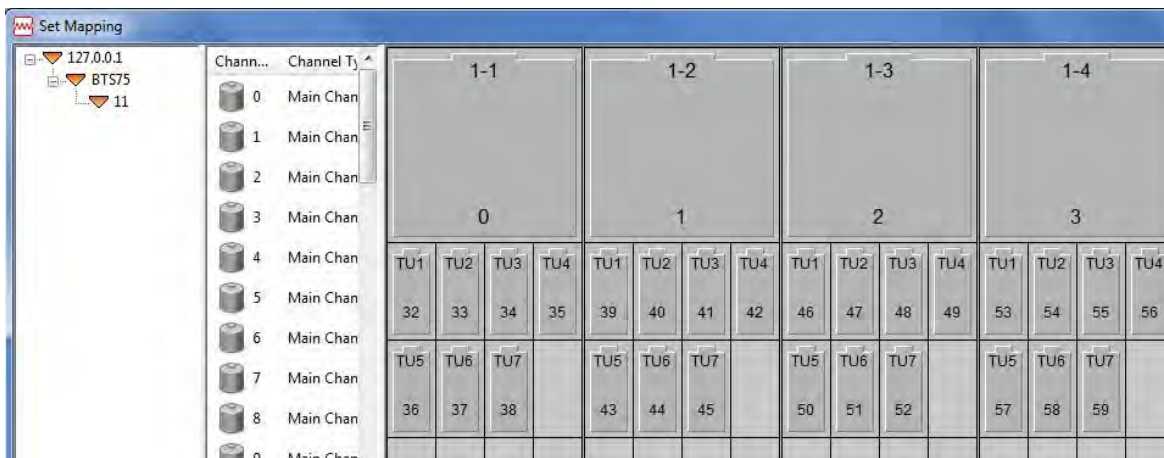
Picture 41 : Set Aux. Channel Mapping – Average

Or you can make the channels have smaller unit number prior to hold auxiliary channels. (1 main channel can max hold 248 auxiliary channels, but default setting is max 16 auxiliary channels.224 auxiliary channels for 32 main channels, Only the first 14 main channels will host auxiliary channels, and each has 16 auxiliary channels.)
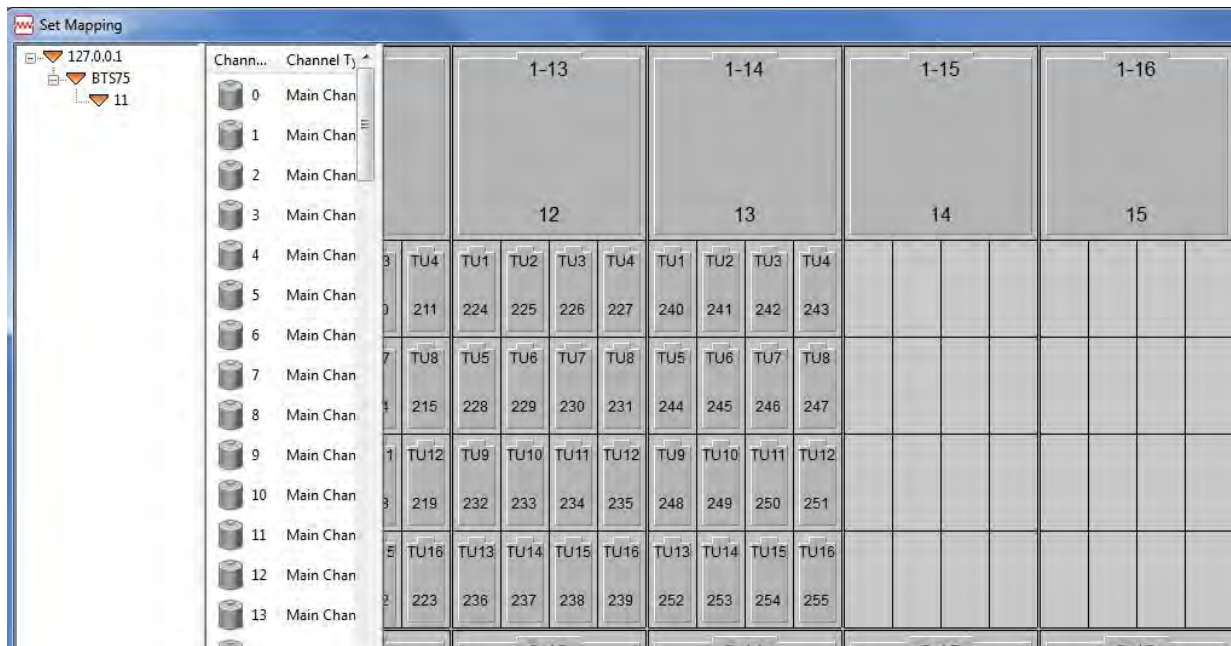
Picture 42 : Set Aux. Channel Mapping – Priority

If you want to have all the 224 auxiliary channels assigned to the single one main channel, you should double click on the mapped main channel to prompt dialogue. Use" *default map*" to assign all the auxiliary channels to the main channel you selected.
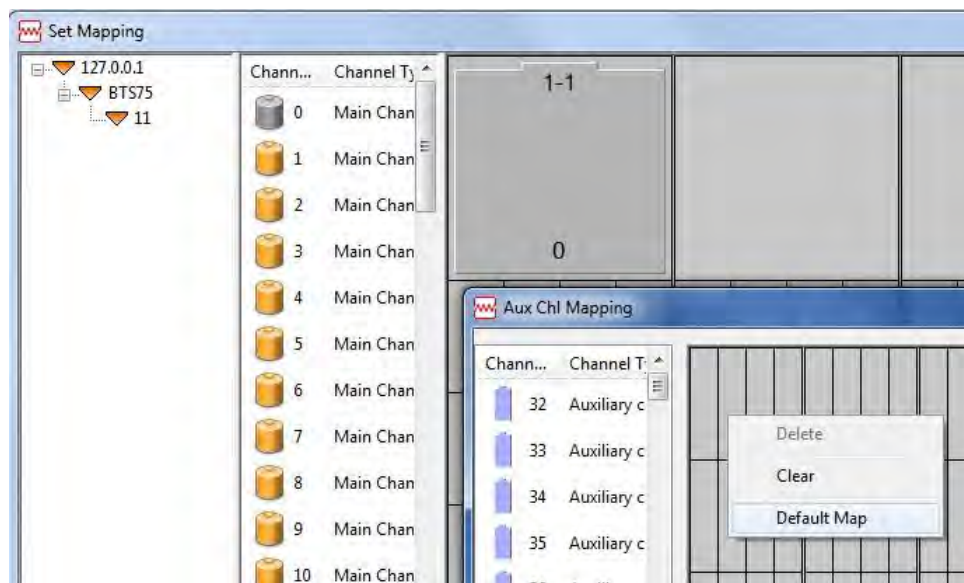
Picture 43 : Set Aux. Channel Mapping – Map All

Mapping Operation
1) Too many auxiliary channels mapped will expand data. Removing unnecessary auxiliary channels before testing is highly recommended.
2) When you get a cross mapping for the channels, you should clearly know how they are mapped.
3) A maximum number of 248 for the auxiliary channels could be assigned for one main channel.

Parallel Channels

1) Our Equipment support paralleled channels to increase current range. If you want to parallel channels, firstly select channels you want to parallel and right click, choose *Parallel Channels*. This will combine you channels you selected as one paralleled channel.
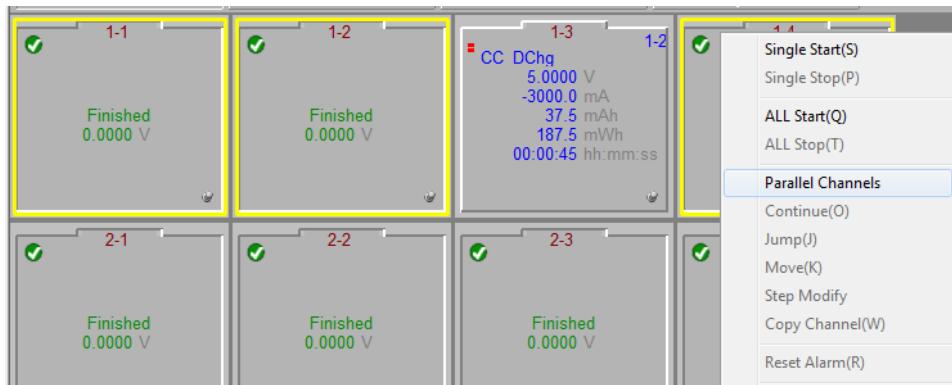
Picture 44 : Parallel Channels
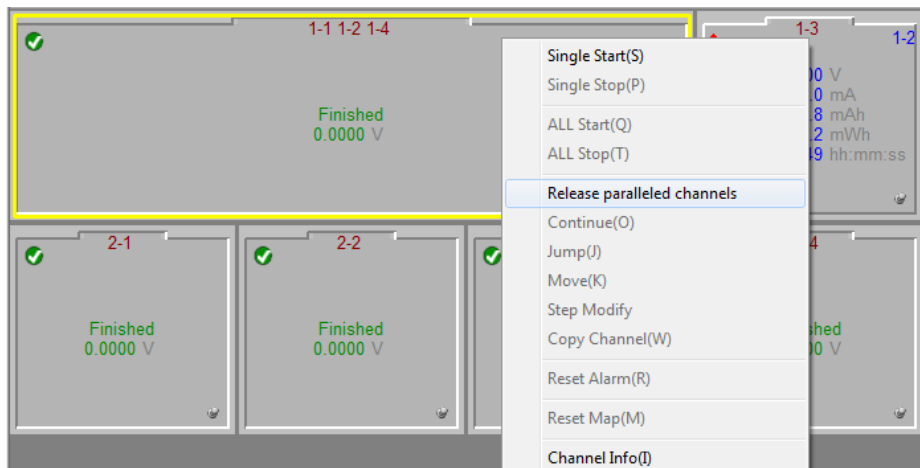
Picture 45 : Release Paralleled Channels

Parallel Channels
1) ONLY inactive channels within the same unit and maximum 4 channels can be selected for paralleling operation.
2) The first mapped channel of the combined channel provides the voltage sensing source.

Start a Test

1) Now, after connection, configuration and mapping, you are able to perform you test. You can right click on the

selected channels which are with yellow line borders to start Step Editor to edit or load your test schedule. If you want to select multi channels, drag your mouse in the shape of a rectangle around the channels with which you want to perform tests or, use CTRL key and left click of mouse on the channel, to choose multi channels. If there is some channels you want to remove, CTRL key and left click of mouse will remove the channel you clicked. You can also choose *All Start* on one channel to start the same test for all the channels under the same device number.
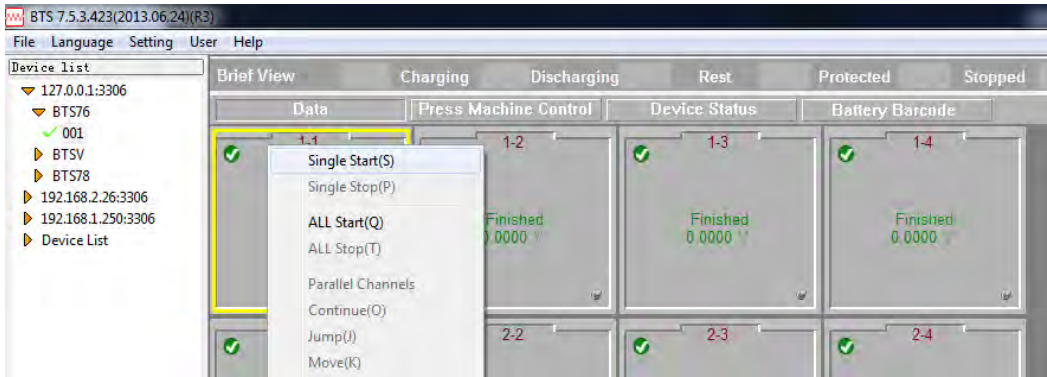
Picture 46 : Start a Test

2) When you click *Single Start* or *All Start*, this will prompt *Step Editor* for you. You can use Load on the left bottom to load a test schedule or use the form grid to schedule your test.
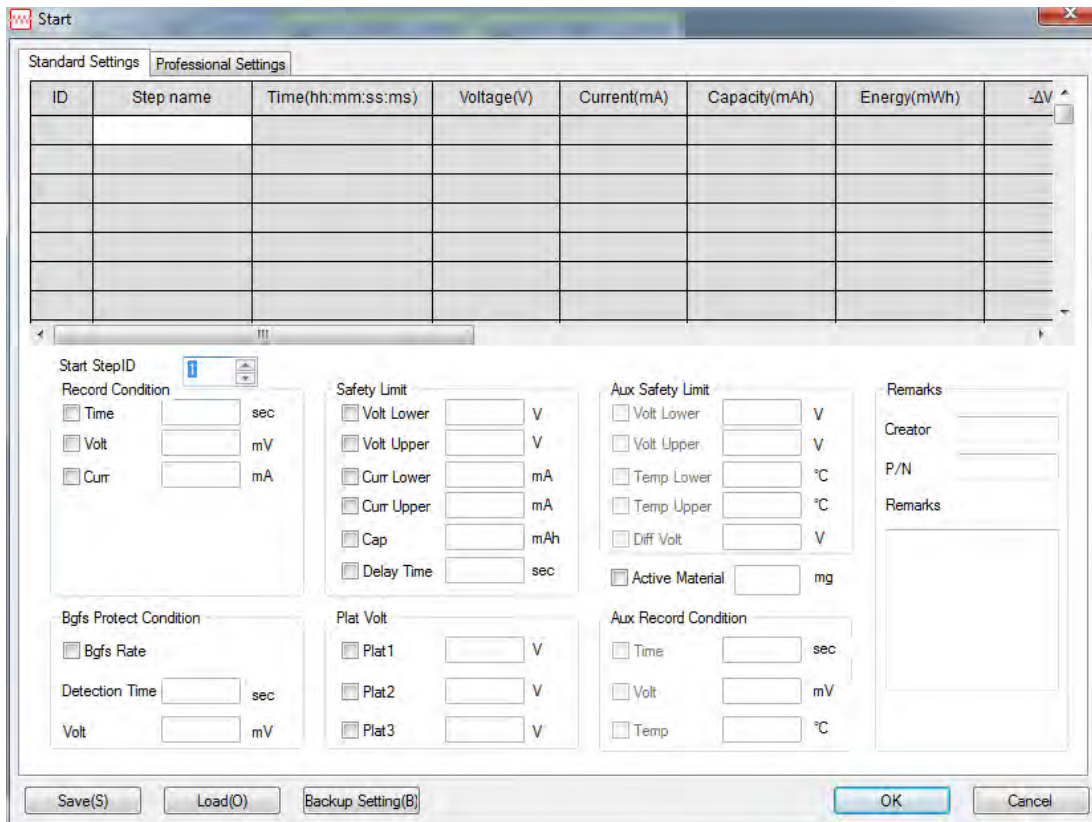
Picture 47 : Step Editor

3) Right click on the form grid, there is some other commands provided for your quick operation.
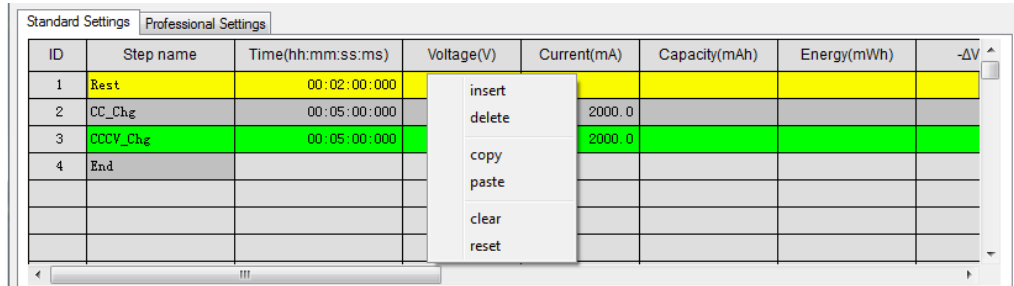
Picture 48 : Right Click Menu on Step Editor

o Insert: This will insert a same row after with the row you selected.
o Delete: This will delete the row you selected.
o Copy: This will copy the row you selected.
o Paste: This will paste a row after the row you selected with the content once you copied.
o Clear: This will clear all the contents in the form grid.
o Reset: This will reset all the contents to the original of this dialogue when it prompted.

4) BTSClient provides data backup for your data security. Click *Backup Setting* on the left bottom of the Step Editor, the prompt dialogue enables you set backup conditions as below.
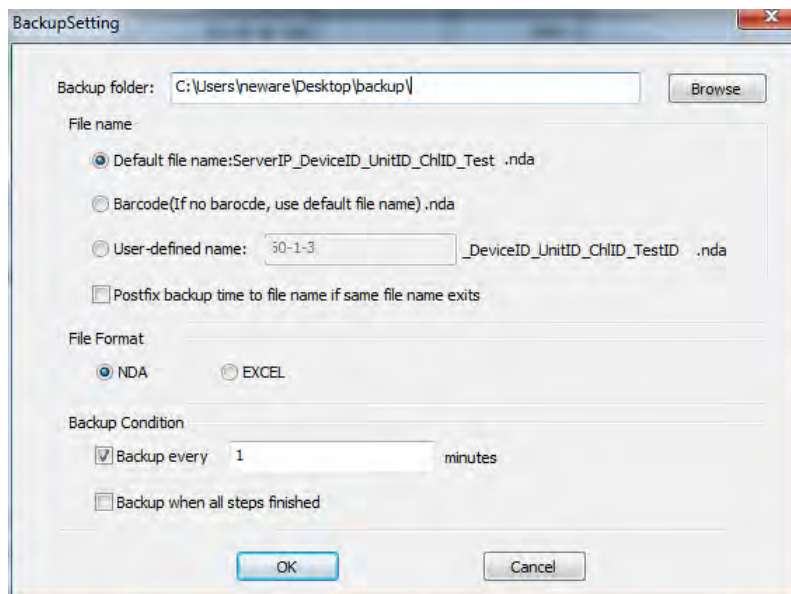
Picture 49 : Backup Settings

5) If you want to have the data more traceable, you can input some information in *Remarks* field of the *Step Editor*, and also can use Barcode function as below:

Picture 50 : Battery Barcode Management

6) To know more about step type and the precise meanings thereof, you can refer to *Appendix C: Step Type*.

7) You can also right click on the selected channel(s), click *Jump* to set the active channel(s) to a target step, or click *View Log* to view the history operation log, click *View Data* will download data from BTS Server and launch BTSDA to view this file. Navigate to know more about BTSDA operation.

4.5 BTSDA Operation

1) Now when you click any NDA format file or click *View Data* by right click on the channel, this will launch BTSDA to view this data file. The basic view of BTSDA is as below:
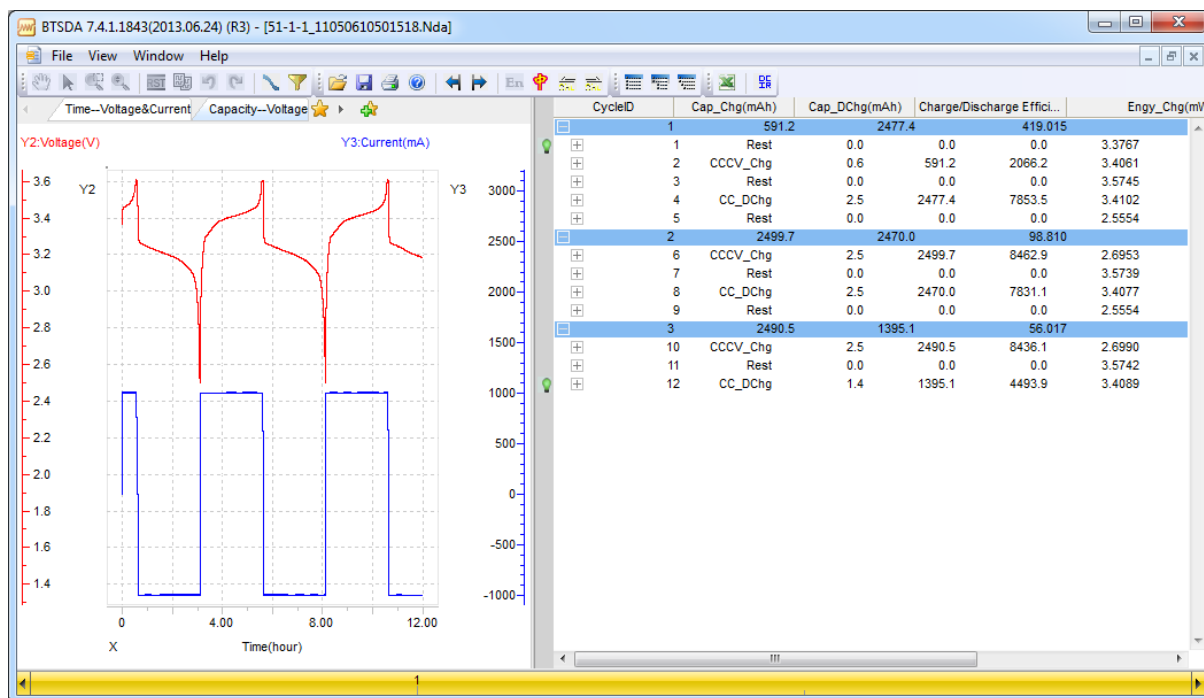
Picture 51 : BTSDA Overview

BTSDA Operation

1) NDA file is a kind of structured data file. This kind of file stores testing data and other information including steps once you scheduled and log during testing.

2) BTSDA is designed to organize NDA file format, providing structured data and flexible curve view, and also enabling multi curves comparison, filtering data to segments based on your criteria, DCIR calculation and exporting.

2) Normally, BTSDA loads data only the last 20 cycles, you can set to load more by double click the bottom cycle axis, or use the arrows at the both sides of the axis to view other cycles.

Picture 52 : Cycle Axis

Or even you can set the default loading behavior of BTSDA by the *Cycle Layer* setting from the *Parameter Setting* on right click menu in the data area.
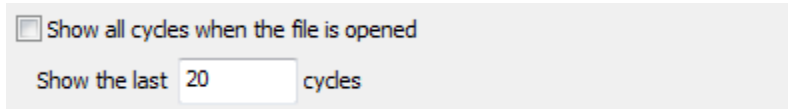
Picture 53 : Default BTSDA Loading Behavior

Tool Bar

1) Under title bar, there is a tool bar providing you tools or some other quick access to the BTSDA functions.
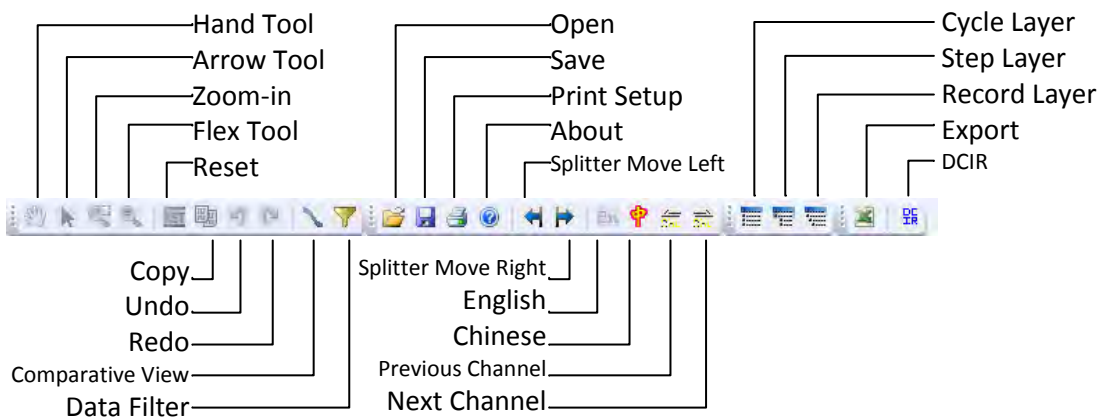
Picture 54 : BTSDA Tool Bar

Data View

1) The right part shows the structured data. Basically, there are three layers provided for organized view and quick summarized data. And some event bulbs are placed before the record ID, showing the very event. You can click to expand or collapse these layers.

CycleID	Cap_Chg(mAh)	Cap_DChg(mAh)	Charge/Discharge Effici...	Engy_Chg(mWh)	Engy_DChg(mWh)
1	591.2	2477.4	419.015	2066.2	7853.5
2	2499.7	2470.0	98.810	8462.9	7831.1
3	2490.5	1395.1	56.017	8436.1	4493.9

Picture 55 : Cycle Layer

You can select what data to be displayed by right click on the title of the data grid.
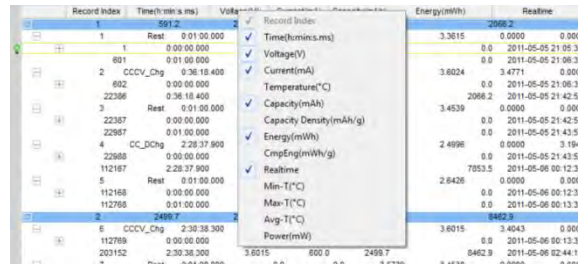
Picture 56 : Select Data to Be Displayed

The title will only change when you have selected a data row. And you can also select a title name to highlight selected column. If you want to select or unselect columns, click on their titles directly.

2) Right click in the data area, there are several commands provided.

o Expand/ Collapse: Same function as the Expand/Collapse tool on tool bar.
o Collapse: Collapse current data layer.
o Time Format: Choose time unit and how the account. If Single Step is selected, initial time will be zero for every step. No selected will accumulate time from the start of this test.
o Parameter Setting: Set data unit and select what information display for different layers, and there is some other functions provided for data summary for the cycle layer.
o Copy: Copy selected data into clipboard.
o Channel Information: View channel information.
o Log: View log.
o Marking DCIR: Select rows for DCIR calculation.
o DCIR: Guide you perform DCIR calculation.
o DCIR-P: Guide you perform DCIR calculation based on pulse data.
o Step Picture: View step infrared picture.
o Export: Export data.
o Print
o Print Preview
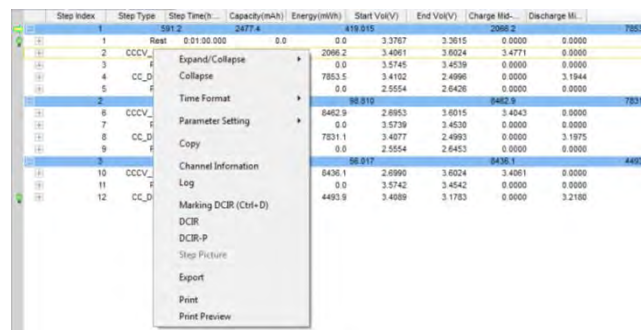
Picture 57 : Right Click Menu of the Data Area

3) Except data picker for cycle layer, below functions, as well as the default BTSDA data loading behavior setting mentioned before, are provided.
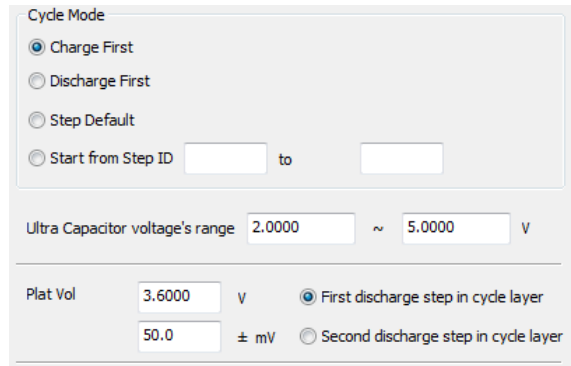
Picture 58 : Cycle Layer Settings

Curve View

1) The left part shows the curves. Data could be easily graphed. At the top of the curve area, there are several tabs with their names corresponding curves' parameters. You can click on the tabs directly or use the arrows at the both ends to navigate. There are some other collapsed tabs which will display by clicking on the star symbol. You can also add and define other tabs by clicking on the plus symbol. You can drag tabs to rearrange their sequence or right click on the tab then select *delete* to delete.
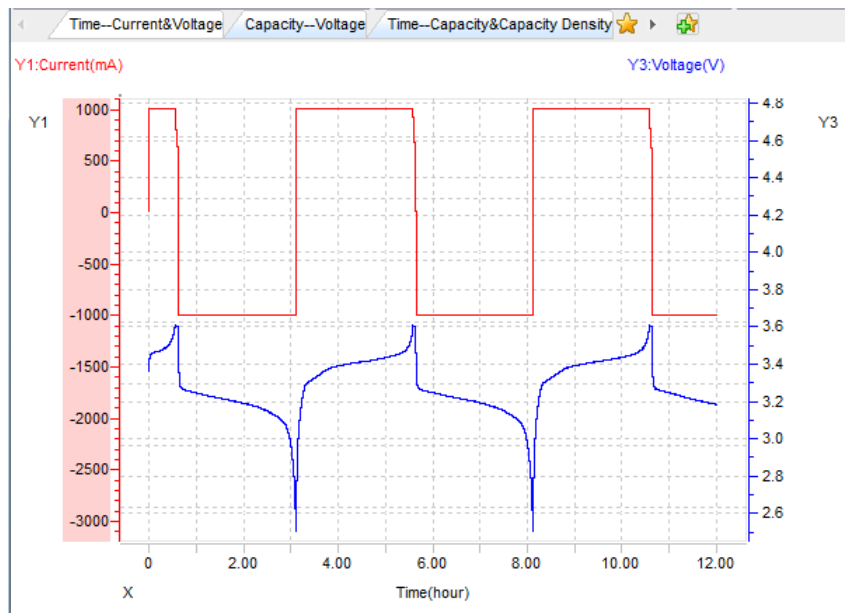
Picture 59 : Curve View

Generally, when you move your mouse on to the axis, the column close to the axis will enable you scroll the axis, the other column will enable you scale the axis.

These tools on the Tool bar will enable you:

- o Hand Tool: Drag the curves to decide which segment into the view.
- o Arrow Tool: Double click on the curves, will show you the corresponding original data in data area when the curve has a Time or Cycle ID X-axis.
- o Zoom-in: Drag your mouse in the shape of rectangle to zoom in the curves.
- o Flex Tool: This is similar as you scroll the mouse wheel. Drag up to zoom in, down to zoom out.
- o Reset: Reset the curves to their original states. This function is provided also on the right menu of the

curve area.

- o Copy: Copy graph to clipboard. This function is provided also on the right menu of the curve area.
- o Undo: Undo previous action.
- o Redo: Redo previous action.

2) When you right click on the axis, there are below commands provided to adjust the graph. You can set the grid lines by *Setting Scale*, change data unit by *Setting Unit*, show or hide the corresponding curves. Unit setting functions on whole data file.
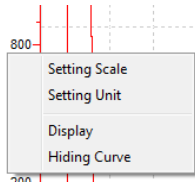
Picture 60 : Axis Settings

3) When you right click on the curve area, there is Curve Settings allowing you set curve parameters. You are allowed to assign maximum 4 Y-axis for a single graph. Y1 and Y2 are on the left. Set curve color or background color by clicking on the color block associated. Unselect the label from the *Label List* will delete it. Right click on the label will enable you rename the label or delete it.
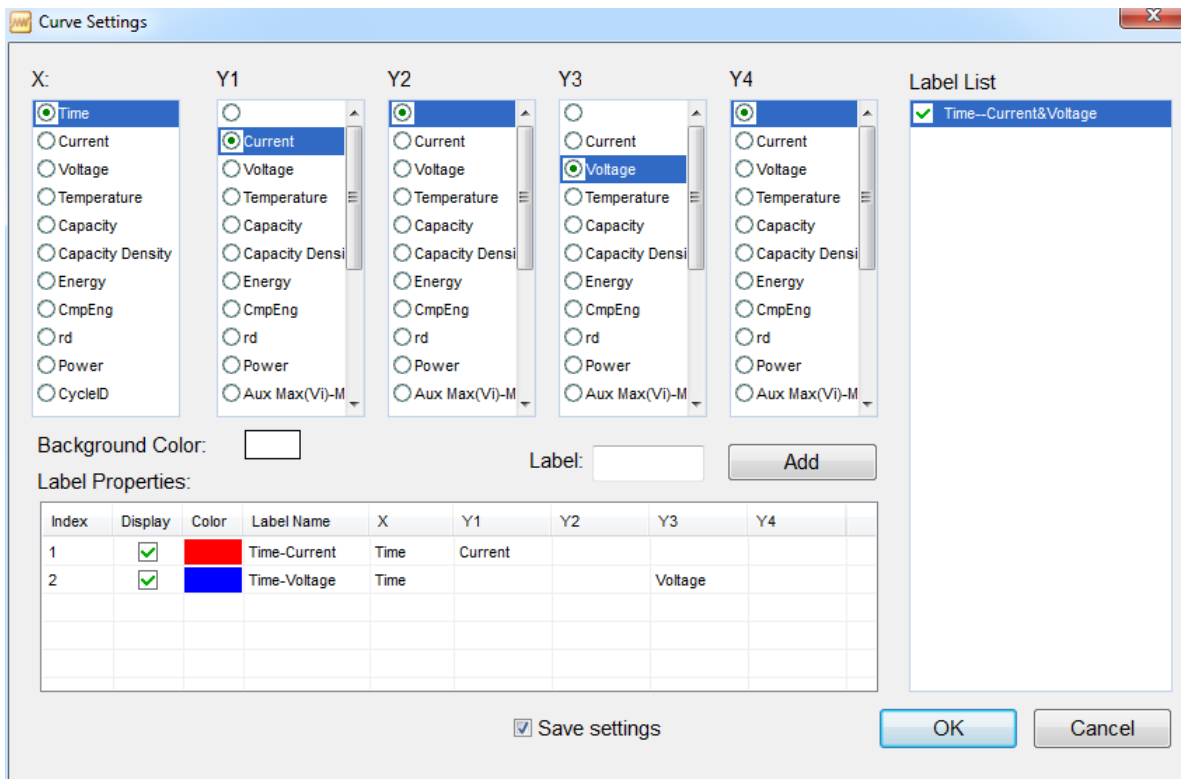
Picture 61 : Curve Settings

Comparative View

1) BTSDA provides also a quick compare for mass data. By clicking the *Comparative View* tool on Tool Bar or *Comparative View* command under View on Menu Bar, you will see below similar layout. Left part will enable you load more data files and select comparing mode. Right top part will show you the compared curves and

the bottom show you the summarized data.
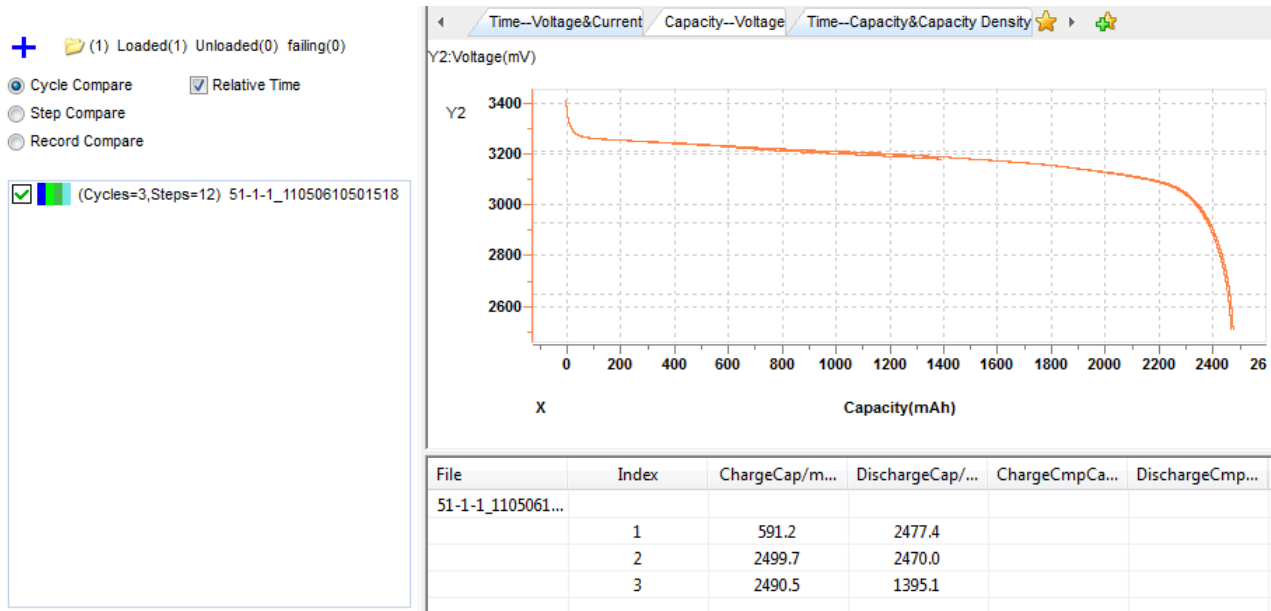
Picture 62 : Comparative View

2) Operations to the curve area are similar with what you can see from the curve view. There are some other right click commands provided like choosing steps or cycles range by *Cycles* and *Steps Setting*, exporting data and curves by *Export*.

3) This demo file has 3 charge-discharge cycles, if you want to compare the discharge curves to see the battery performance degrading, just choose the tab with the name of Capacity-Voltage, then choose the only discharge step by Cycles and Steps Setting. Some other curve tools like zoom-in or zoom out are also available for curve operations here.

DCIR

1) DCIR is a key parameter to the battery performance. To calculate DCIR, there should be 2 voltage values and 2 current values.

2) You can select record rows from the data area directly to calculate DCIR, or launch DCIR calculator by clicking the DCIR tool on the tool bar or the command on the right click menu of the data area.

> **DCIR Marking**
> 1) The rows selected for DCIR marking should be applied in couple to mark DCIR records.
> 2) You cannot mark more DCIR records between DCIR marking.

3) If you already marked DCIR records, you will see the result in the data grid by clicking *Refresh* button on the prompt dialogue.
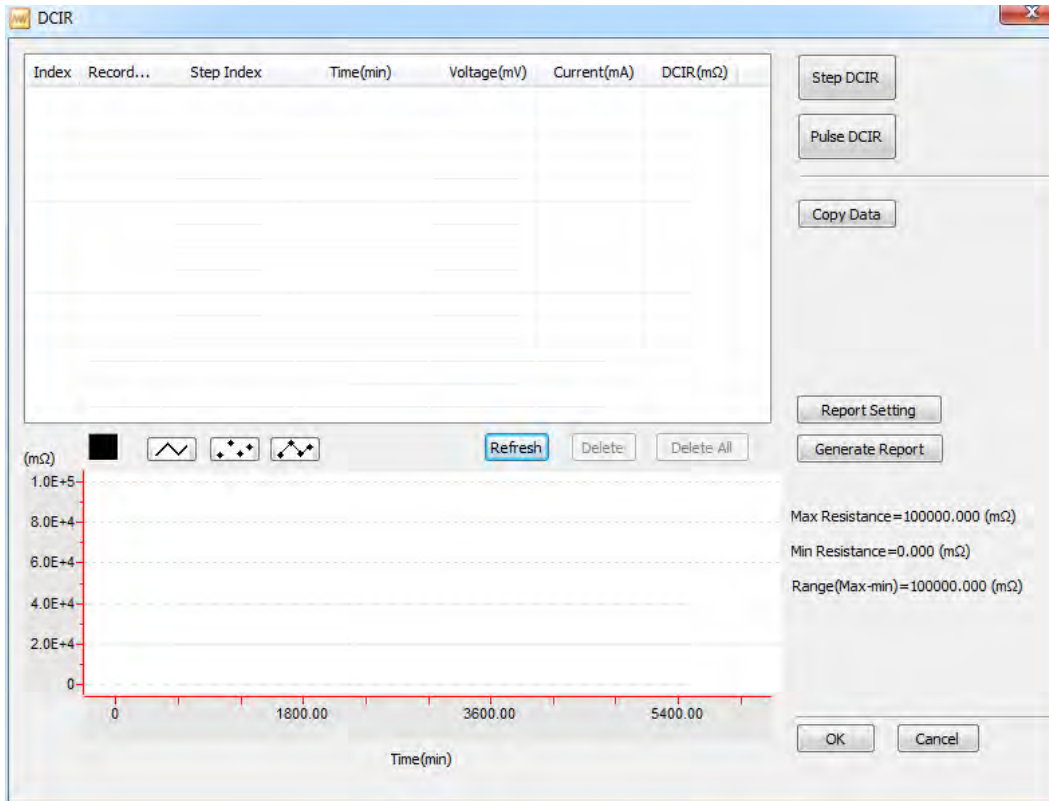
Picture 63 : DCIR Calculator

4) You can choose Step DCIR or Pulse DCIR to load the targeted data to calculate DCIR. If you click Step DCIR, there will be options provided to enable you manage what step groups and the exact records be accounted as DCIR raw data. HPPC test from FreedomCAR manual has a DCIR algorithm which draws data from the last point of rest and the data from the last point of the 10 seconds pulse – discharge or regen. Now we set the step groups and data select methods. Click OK will show the calculation result in the data grid. You can copy or export them.
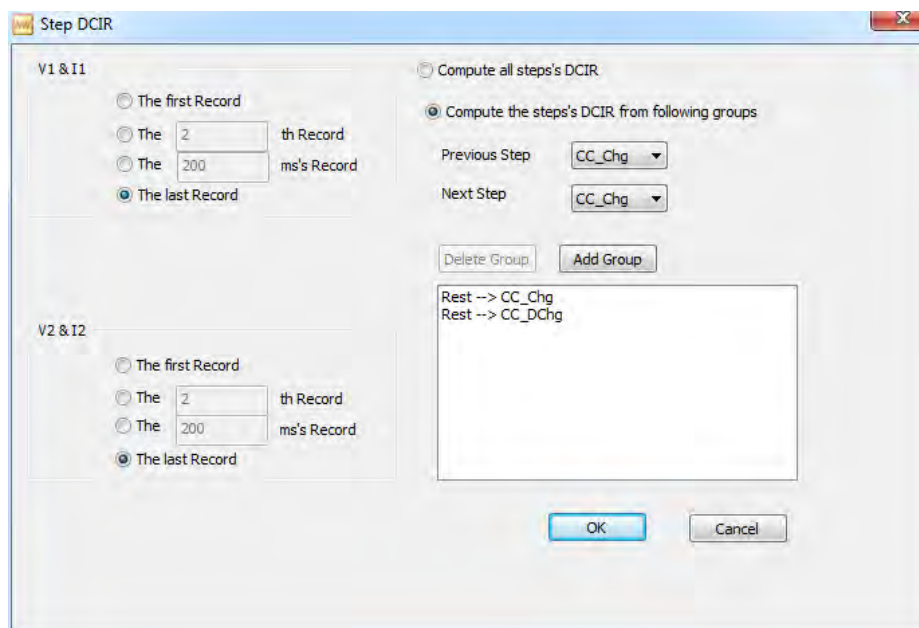
Picture 64 : Step DCIR Settings
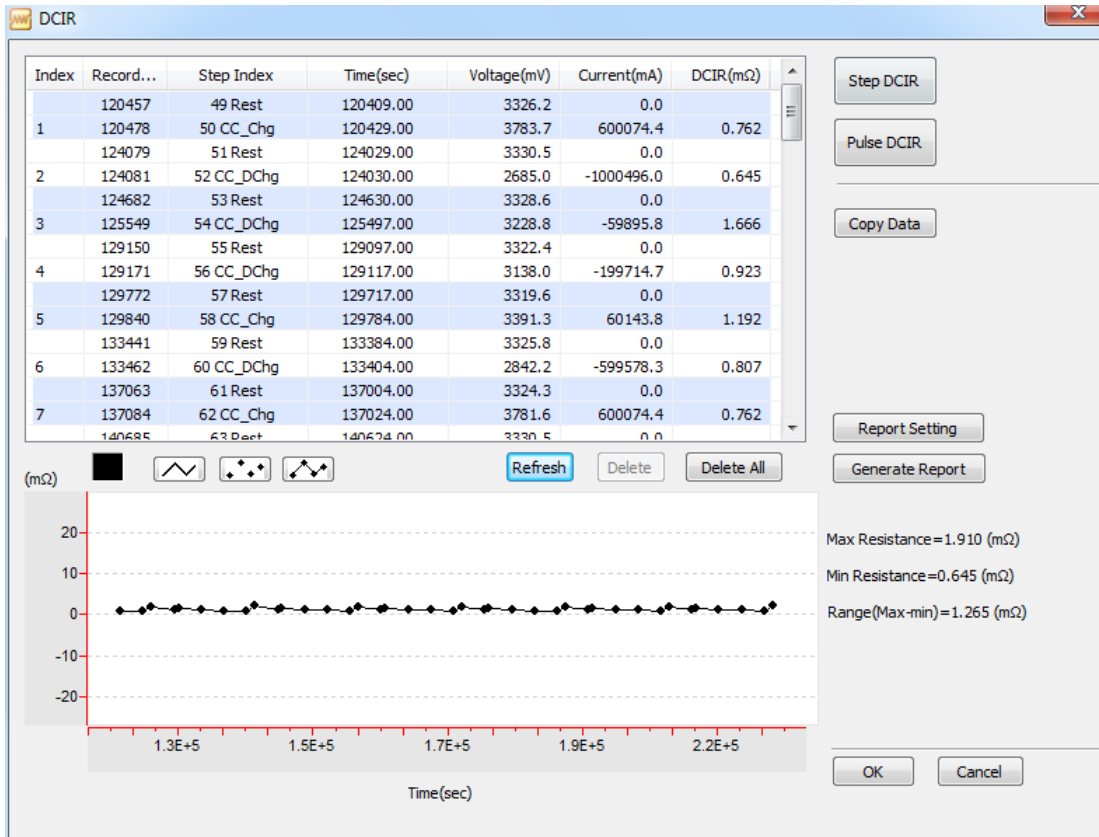
Picture 65 : Step DCIR Result

Export

1) Right click in the data area or use the Office Excel icon on tool bar, this will prompt Data Export dialogue.
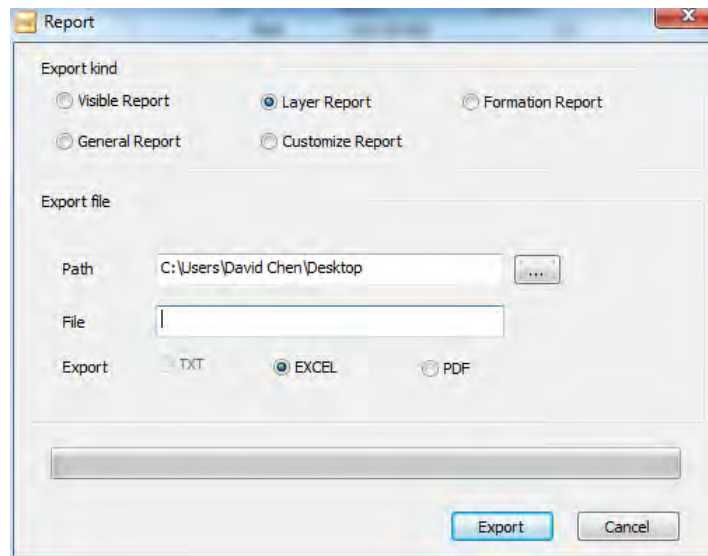
Picture 66 : Data Export

2) As you can see from the dialogue, Basically 2 file formats supported for your export: Excel and PDF and 5 custom exporting types.

o **Visible Report**: This will export all the data you have seen (WYSWYG: what you see is what you get) in BTSDA.

Picture 67 : NDA View for Visible Report

Picture 68 : Excel View for Visible Report

o **Layer Report**: This will present you 4 spreadsheets in your exported file.
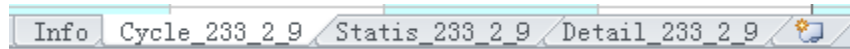
Picture 69 : Excel View for Layer Report

a) Info: Includes equipment information and basic test information.

b) Cycle: Includes Cycle information. How many cycles performed in your test, how many lines will get generated in this sheet.

Picture 70 : Cycle Data for Layer Report

c) Statis: This will show you the step information

Picture 71 : Step Data for Layer Report

d) Detail: This will show you all the record.

o **Formation Report**: This is a semi-function report. Can generate some formation information based on the first charge-discharge cycle.

o **General Report**: This will export data like what BTSDA presents – Cycle, step and record layer in a single sheet.

Load More Data
1) You can right click on the header to load more data for the export.
2) For more BTSDA operations, see BTSDA Operation.

o   Customize Report: This provides you capability to choose what information to get exported.
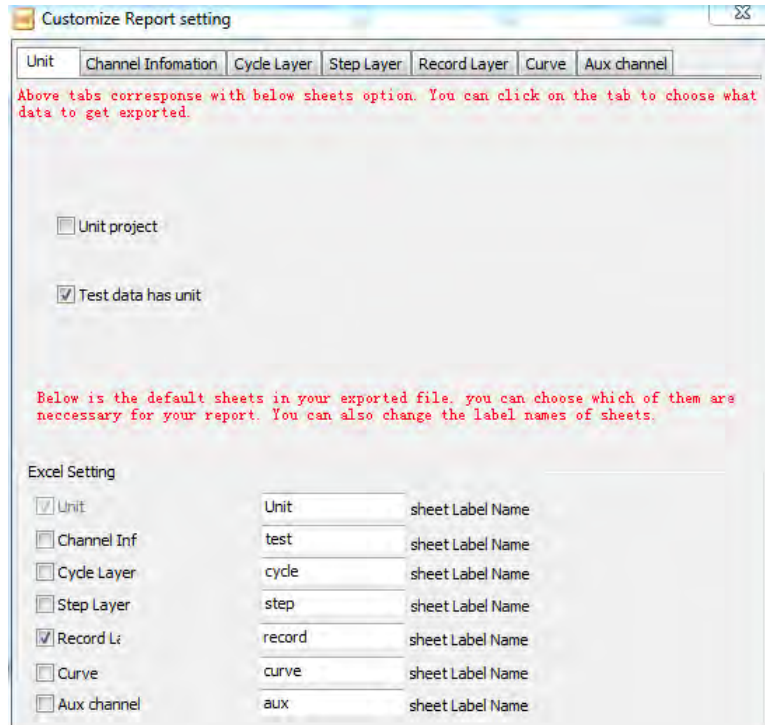
Picture 72 : Customize Report Settings

3)   2 examples posted below for reference.

o   Example 1: The discharge capacities of all cycles performed are exported to an Excel file.
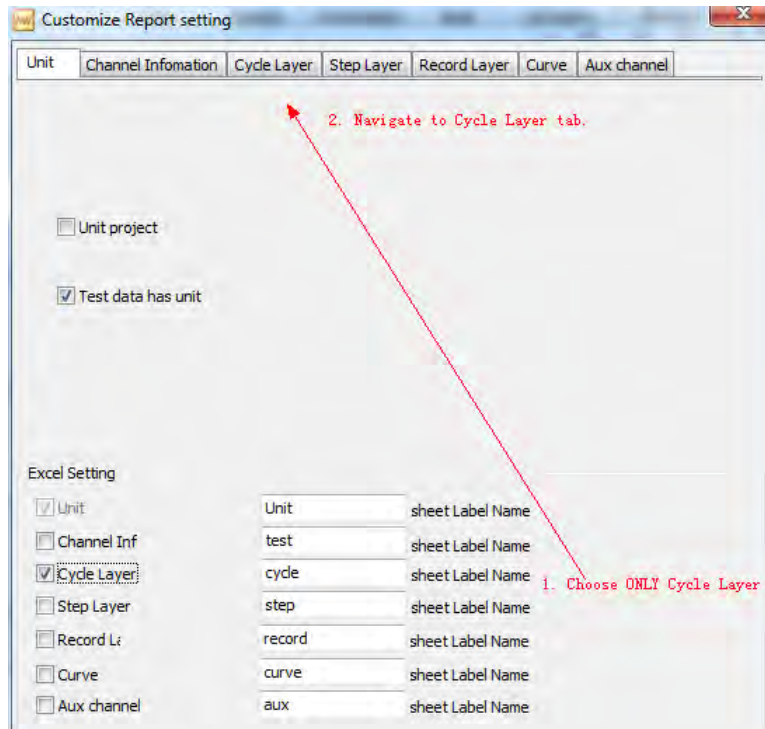
Picture 73 : Capacity Fading Export – Step 1
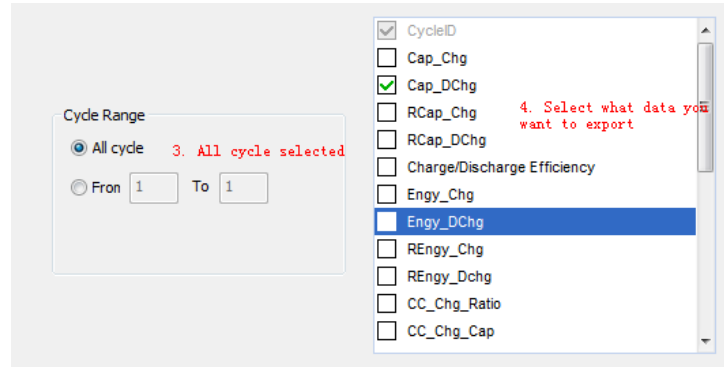
Picture 74 : Capacity Fading Export – Step 2

Picture 75 : Capacity Fading Export – Result

Capacity Fading Data
1) You can also collapse data to cycle layer in BTSDA then select the discharge capacity column, use copy and paste to export such data. It has the same function.
2) For more BTSDA operations, see BTSDA Operation.
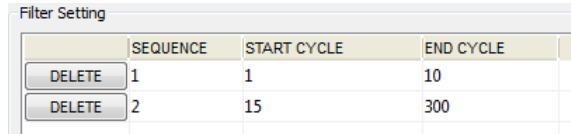
o Example 2: All the test records of the discharge step in cycle 392 are exported to an Excel file.
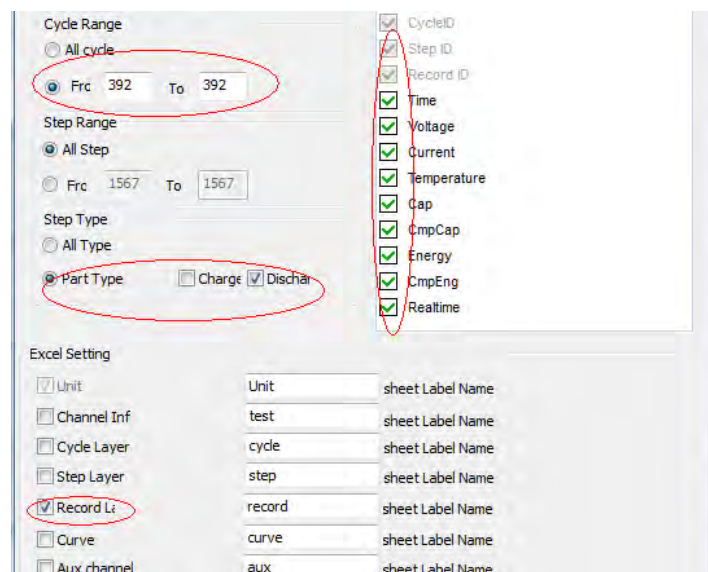
Picture 76 : Export Settings for Specified Data Range

Data Filter

1) If you want to create a subset data of the current NDA file, data filter provides you such function. Click the filter symbol on the tool bar will guide you to set extraction criteria. You are able to choose different ranges by choosing filtering pattern, and also you can set to extract all data record or partial record from main channel or auxiliary channel only.

Filter Setting			
	SEQUENCE	START CYCLE	END CYCLE
DELETE	1	1	10
DELETE	2	15	300

Picture 77 : Data Filter Settings

2) Set subset data file information like path and file name then click OK will create a subset with the criteria you set above.

Data Filter
1) The subset data contains also the same channel information as its mother file.

5. Maintenance and Calibration

5.1 Maintenance

Below maintenance suggestions are listed for your better using of the equipment.

o To achieve the best performance and testing accuracy, your equipment is suggested to be calibrated annually.
o The surrounding space must be clean, with proper temperature and humidity to avoid influence on the equipment accuracy, damage to the inner circuit or even safety issues.
o Also do not storage equipment in a space with large temperature difference, this will cause inner circuit corroded by vapor coagulation.
o Do not use any chemical detergent to clean the inside of the equipment. Some unknown chemical may corrode inner components.
o Use equipment and accessories from Neware but not from other channels.
o Always backup your important data to avoid unexpected errors or failures.

Proper use and maintenance of the equipment will help you get the most performance. Our data from many years of investigation and after sales services indicates that equipment failures most came from improper use or lack of maintenance. If you are experiencing any issues of our equipment, please do not hesitate to contact us.

5.2 Calibration

Calibration may be called for:

o After equipment has been repaired or modified.
o When a specified time period has elapsed.
o When a specified usage (operating hours) has elapse.
o Before and/or after a critical measurement.
o After an event, for example:
  a) After the equipment has had a shock, vibration, or has been exposed to an adverse condition which potentially may have put it out of calibration or damage it.
  b) Sudden changes in weather.
  c) Improper use of software to cause the loss of the calibration data.
o Whenever observations appear questionable or equipment indications do not match the output of surrogate instruments.
o As specified by a requirement, e.g., customer specification.

Methodology

Calibration, in general use, is often regarded as including the process of adjusting or aligning the output of or indication on the equipment to agree with value of the applied standard, within a specified accuracy.

Our BTS generally outputs and measures current and voltage. And it has different circuits for charge and discharge. So we need to calibrate a). Charge Current; b). Discharge Current; c). Charge Voltage; d). Discharge Voltage.

o Charge Current / Discharge Current (If negative power supply installed)
  Since the standard current meter generally cannot support large current, a DC shunt should be introduced for some large current calibration. You set a current value for the equipment to output, there will be a value indicated by our BTS. By below connection, there will be another value indicated by standard meter.
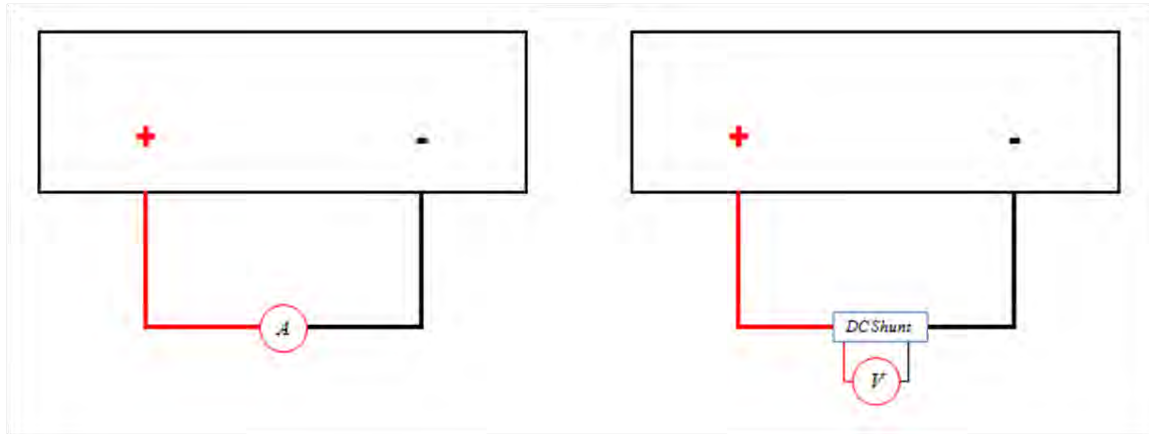
Picture 78 : Current Calibration Connection Diagram

o   Discharge Current (No negative power supply installed)
     If there is no negative power supply installed, the equipment cannot discharge except you connect a battery to function as a power supply. You can calibrate discharge current at this situation just string a battery in the circuit as above diagram. You need to consider the discharge capability of the battery connected.

o   Charge Voltage
     Now string a resistor in the circuit as below diagram, set constant voltage charge, this will create a voltage at the ends of the resistor. BTS will read a voltage value, and also the standard meter. These values will be taken into calculation for the calibration.
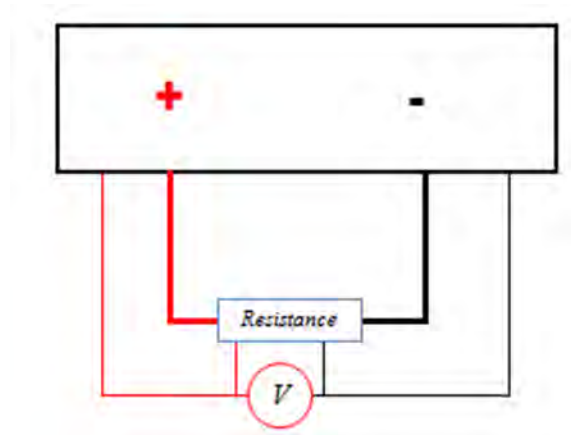
Picture 79 : Voltage Calibration Connection Diagram

o   Discharge Voltage
     For the equipment with negative power supply and empowered with Constant Voltage Discharge, you can use the same logical as above calibration for charge voltage. If no such conditions, a digital voltage signal source will be introduced for the calibration.

Linearity is an important item of MSA (Measurement System Analysis). To have better linearity in whole scale, you need to calibrate more segments.

Multiply 4 items you need calibrate with the segments' points, you get the calibration procedure matrix you need to take. This is a laborious job to complete the calibration manually. Our newly designed automated calibration system will facilitate this task.

Manual Calibration

1) This calibration tool is an old version. Our latest BTS Client now has integrated calibration function. They have similar usage. Since NwCal.exe is largely used before. Below steps are based on this.

2) NwCal uses RS232 or RS485 to communicate. So before you conduct the calibration work, you need to release the connection from bottom machine to middle machine, connect an RS232 cable directly from the middle machine to the host computer. If the RS232/RS485 port on the equipment is 9-pin male port, use a 9-pin RS232/RS485 wire to connect computer to the computer's COM port. If the RS232 / RS485 on the equipment is RJ45 jack, use an adapter wire – one end is RJ45 and the other is COM port, or use an RJ45 straight through cable to black Port Adapter(if purchased) which uses USB or COM to be connected with the computer.

3) Since models of different current ranges have different default segments for the calibration, you need to set the segments to the very correct one with the equipment you are going to calibrate. If your model has a current lower than or equal to 6A, use 1 segment, and 3 segments larger than 6A. Voltage and current will have the same segments count.
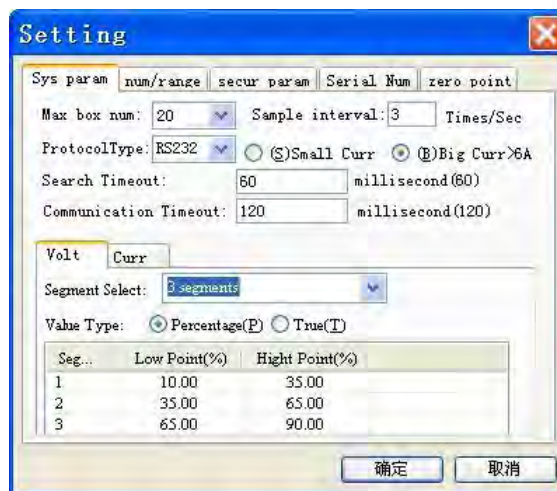
Picture 80 : Calibration Segments Settings

4) Then you click OK and exit the program. After you connect the bottom machine to the host computer with RS232 cable, you can re-launch this program. Program will search units automatically and click *Yes* to load the calibration data of the connected unit.
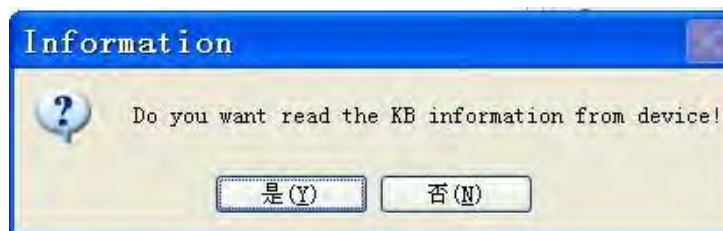
Picture 81 : Load Calibration Data

5) In the right area, there are channels listed, type of accuracy test and calibration mode for your choice, and also, if this unit is of main channel type, there will be 4 items you need to calibrate – CC (Charge Current), CV (Charge Voltage), DV (Discharge Voltage) and DC (Discharge Current). If you are calibrating current and the circuit is with shunt, you need to select *Shunt* choice from the *Digital Multi-Meter* field, and input the accurate resistance
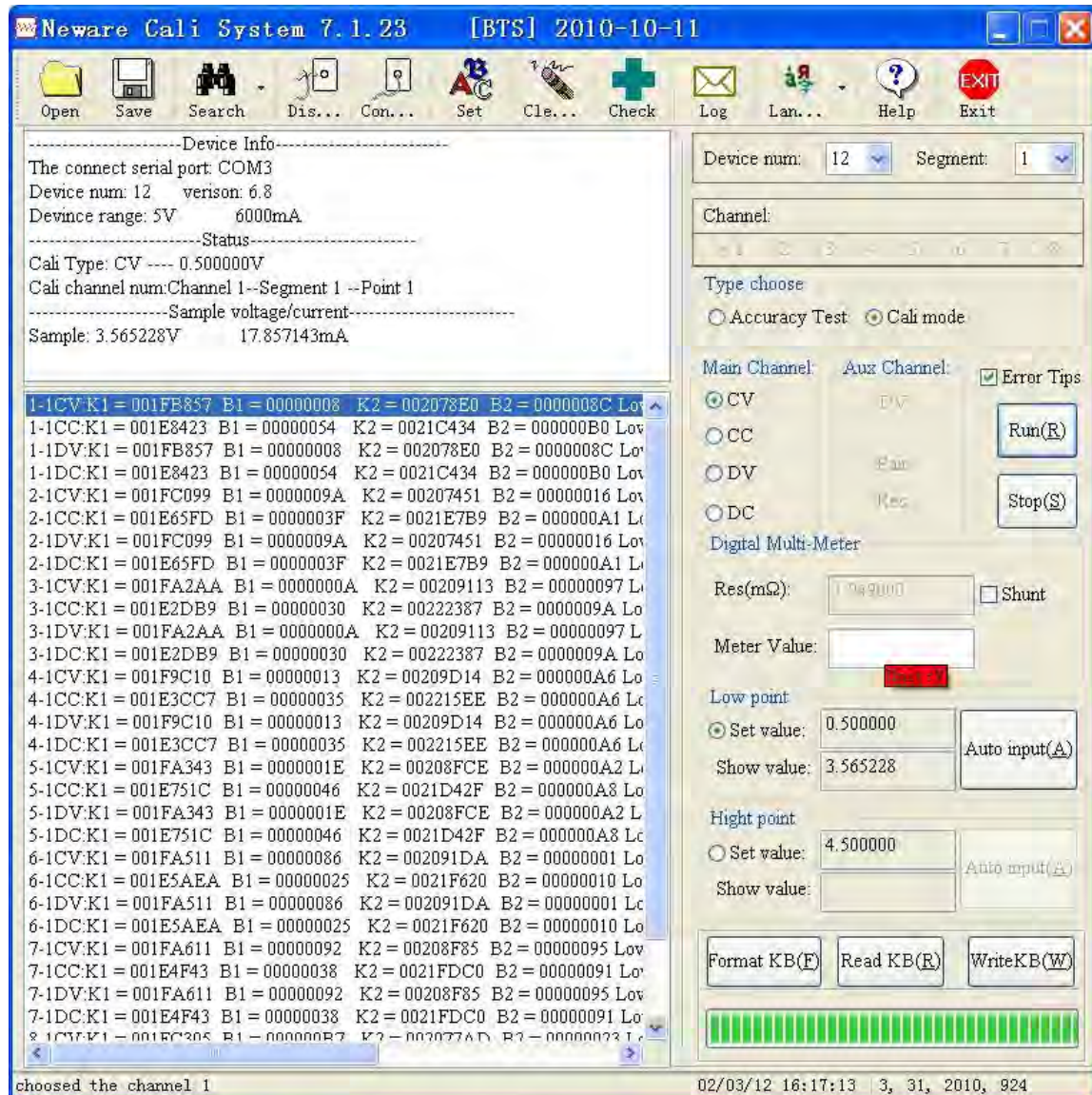
Picture 82 : Calibration Overview

6) Now, click Run will call the equipment to response the very value you set. There will be a value reading from the meter you connected – current or voltage based on the item you selected and the circuit you connected. If you choose current calibration and your circuit has a shunt stringed, you can only input the voltage readings into the *Meter Value* blank – program will calculate the equivalent current based on the voltage and the resistance.

7) Now Click Run again, program will call the equipment to response another point of the segment. Input the value same as the above procedure. If all points for this item of the channel have been finished, program will jump to next channel for calibration. Now you can move onto next item like CC (Charge Current).

8) If you do not have equipment powered with negative power supply and no available battery function as an external power source, you may choose Copy KB Value on the right click menu after you have finished CC (Charge Current) calibration. As the same, when you do not have a digital voltage signal source, you may choose Copy KB Value after you have finished CV (Charge Voltage) calibration.
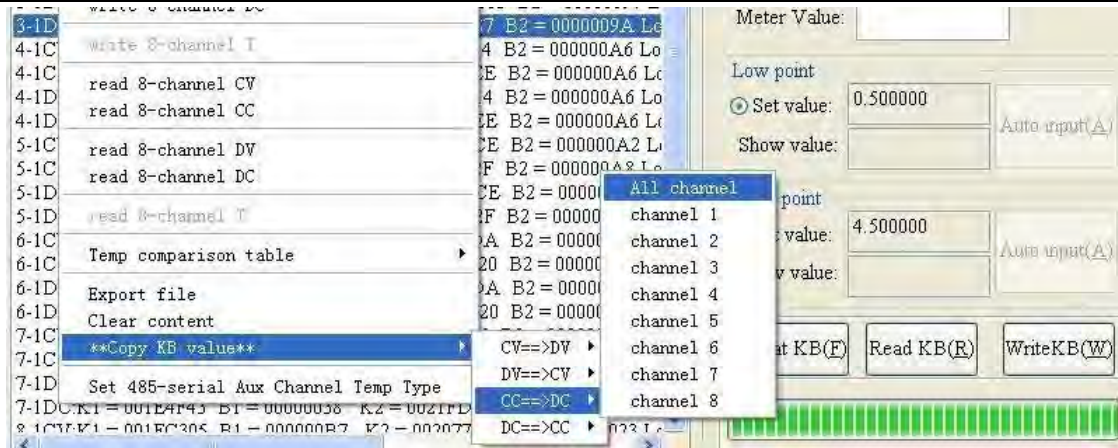
Picture 83 : Copy KB Value

9) When all items of all channels have been calibrated, you now click *Write KB(W)* to save all the calibration data. And a restart of the equipment is necessary to make the calibration take effect.

Calibration Operation
1) *Format KB(F)* will format the flash, all the calibration data will go back to its original status which has poor accuracy.
2) If the value of the meter (or equivalent value) is largely different from the value readings of the equipment (*Show value*), you may check your circuit connection.

Auto Calibration

Our automated calibration system brings you an auxiliary hardware integrated with all necessary parts mentioned above and also software with all calibration related functions.
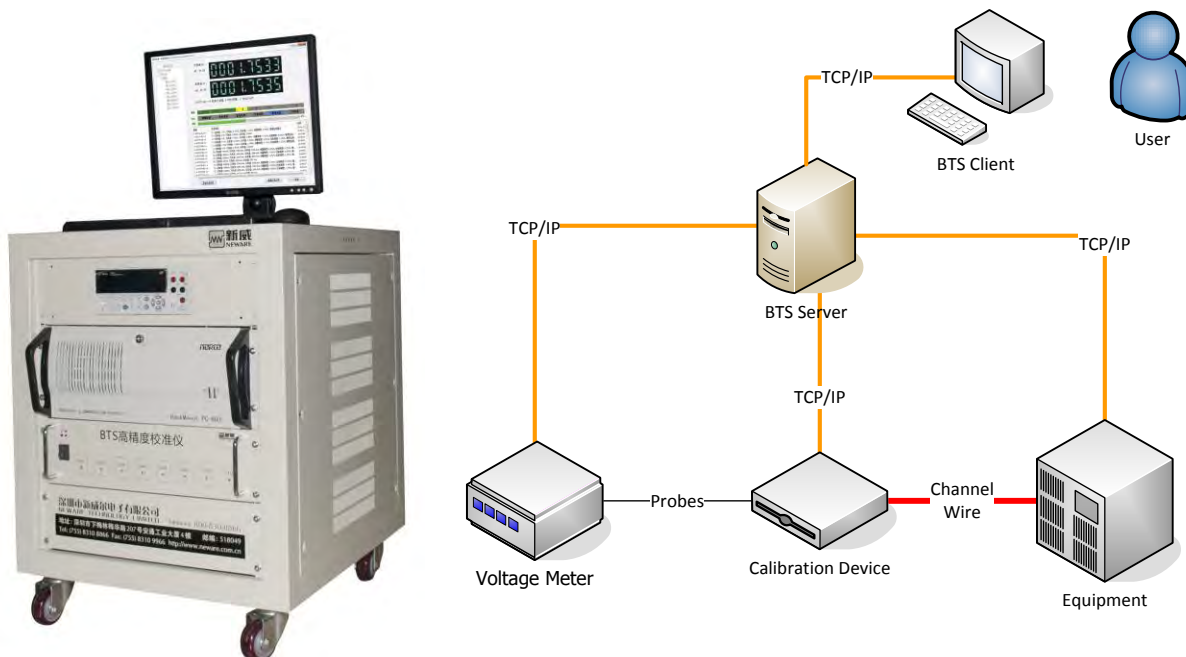
Picture 84 : Auto Calibration System Diagram

Picture 85 : Auto Calibration Processing

You can choose to generate calibration reports after the completion of the calibration.

NEWARE CO., LTD
Verification Data Report for BTS

Certificate No.:
Name of Customer:
Name of Instrument:
Type / Specification:
Serial No.:
Calibration Date:
Due Date:
Calibration Enviroment:

Main Standards of Measurement Used

Equipment Name / Characteristics   Equipment No.   Certificate No.   Due Date

Agilent 34401A

DC Shunt

Calibration Data Sheet

CHN	Item	Percentage	Control Value	Sample Value	Real Value	Control Variation	Sample Variation	Standard	Control Accuracy	Sample Accuracy	Result
108-1-1-0	CC	10.00	0.6000	0.6004	0.6003	0.0003	0.0001	10.0	0.1	0.1	Pass
		35.00	2.1000	2.0997	2.0999	0.0001	0.0002	10.0	0.2	0.3	Pass
		65.00	3.9000	3.8996	3.8999	0.0001	0.0003	10.0	0.2	0.6	Pass
		90.00	5.4000	5.3999	5.3999	0.0001	0.0000	10.0	0.2	0.0	Pass
108-1-1-0	DC	10.00	0.6000	0.5993	0.5993	0.0007	0.0000	10.0	0.7	0.0	Pass
		35.00	2.1000	2.0990	2.0990	0.0010	0.0000	10.0	1.6	0.1	Pass
		65.00	3.9000	3.9003	3.9007	0.0007	0.0004	10.0	1.2	0.7	Pass
		90.00	5.4000	5.4010	5.4007	0.0007	0.0003	10.0	1.2	0.5	Pass
108-1-1-0	CV	10.00	0.5000	0.4994	0.50	0.0003	0.0003	10.1	0.3	0.3	Pass
		35.00	1.7500	1.7504	1.7504	0.0004	0.0000	10.0	0.8	0.1	Pass
		65.00	3.2500	3.2502	3.2503	0.0003	0.0001	10.0	0.6	0.1	Pass
		90.00	4.5000	4.4993	4.4995	0.0005	0.0002	10.0	1.1	0.3	Pass
108-1-1-0	DV	10.00	0.5000	0.4991	0.4992	0.0008	0.0001	10.1	0.8	0.1	Pass
		35.00	1.7500	1.7479	1.7481	0.0019	0.0002	10.0	0.9	0.4	Pass
		65.00	3.2500	3.2481	3.2475	0.0025	0.0006	10.0	2.5	1.1	Pass
		90.00	4.5000	4.4981	4.4979	0.0021	0.0002	10.0	2.1	0.3	Pass

Result:
    PASS

Tested by: Approved by :

Page 1 of 1   Form No. : QR-QC-11-A0

Picture 86 : Calibration Report

6. Testing Examples

6.1 Cycle Life

Cycle life test is a traditional way to get the battery service life time. BTS 3000 can perform such tests. If you want to have some advanced features, such as jumping to other schedules based on the situation of the battery, or want to test battery at various conditions (like temperature or humidity) based on a remote controllable environment chamber.

1) Set or load below similar steps, click OK, system will cycle from step 2 to step 5 for 1000 times.

ID	Step name	Time(hh:mm:ss:ms)	Voltage(V)	Current(A)	Capacity(Ah)	Energy(Wh)	-ΔV
1	Rest	00:00:30:000					
2	CC_DChg	03:00:00:000	2.8000	50.0000			
3	Rest	00:30:00:000					
4	CCCV_Chg		3.8000	50.0000			
5	Rest	00:30:00:000					
6	Cycle	Begin Ste 2	Times: 1000				
7	End						

Picture 87 : Steps for Cycle Life Test

ID	Step name	Time(hh:mm:ss:ms)	Voltage(V)	Current(A)	Capacity(Ah)	Energy(Wh)	-ΔV
1	Rest	00:00:30:000					
2	CC_DChg	03:00:00:000	2.8000	50.0000			
	IF	Capacity	<	80.0000Ah	Goto:Finish		
	IF	Capacity	⇐	90.0000Ah	Goto:7		
3	Rest	00:30:00:000					
4	CCCV_Chg		3.8000	50.0000			
5	Rest	00:30:00:000					

Picture 88 : Advanced Steps for Cycle Life Test

2) Since this test will take a relative long time to complete. Backup data in the process is highly suggested to avoid some unexpected errors or failures. Here I would like to backup data every 5 hours.

Picture 89 : Backup Settings

3) You can open the backup data or use *View Data* by right click on the running channel to view the updated data to see the result.

4) BTSDA provides you curve and summarized data for your quick access.
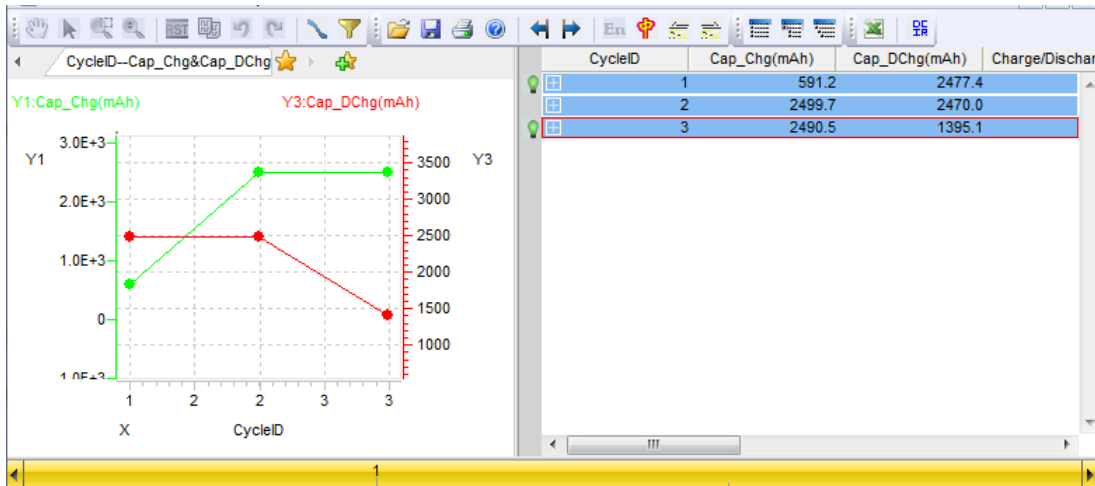
Picture 90 : Cycle Life Test Result

6.2 DCR Test

There are many standards specify how DCR should be measured or calculated. Basically, it needs 2 periods of charge or discharge with different current values. The calculation formula is like that: $R_{dc}=(U_2- U_1) / (I_2 – I_1)$, U_2 and U_1 are the usually the very end of the corresponding period.

1) Using our BTS 4000 or those equipment can support 10Hz or above record frequency for such test. Below schedule goes a testing method specified a standard manual.

ID	Step name	Time(hh:mm:ss:ms)	Voltage(V)	Current(A)	Capacity(Ah)	Energy(Wh)	-ΔV
1	Rest	00:01:00:000					
2	CC_DChg	00:00:10:000		0.4000			
3	CC_DChg	00:00:02:000		2.0000			
4	End						

Picture 91 : Cycle Life Test Result

2) Now use DCR (or DCIR) function in BTSDA to load the testing data. Set below computing group for calculation.
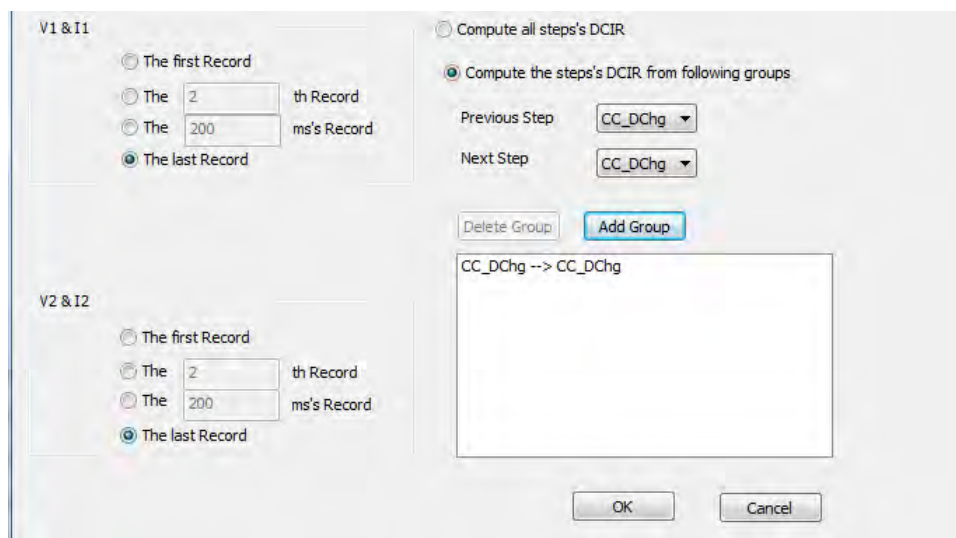
Picture 92 : DCR Calculation

Why BTS 4000 for DCR Test

DCR test is usually brought out in short time. So the equipment's capability is critical to the testing result. The equipment needs to response fast and has an accurate time control. And as specified in many testing standard manuals, it needs the voltage value at the very end of each period, so the closer value to the very end will contribute the DCR result accuracy. The current output accuracy and voltage measurement accuracy are the basic requirements.

o   Response Time. BTS 4000 responses set current in less than 10 ms (millisecond).
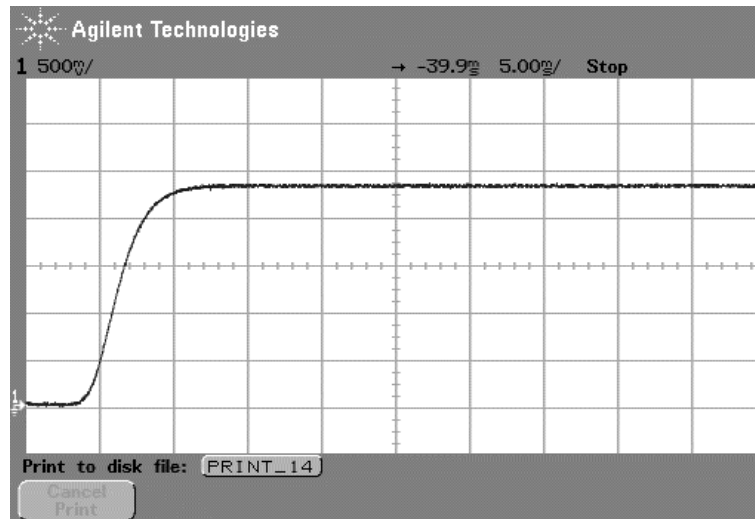
Picture 93 : Response Time of BTS 4000

o   Timing Control. BTS 4000 has a time accuracy of 1ms (millisecond).
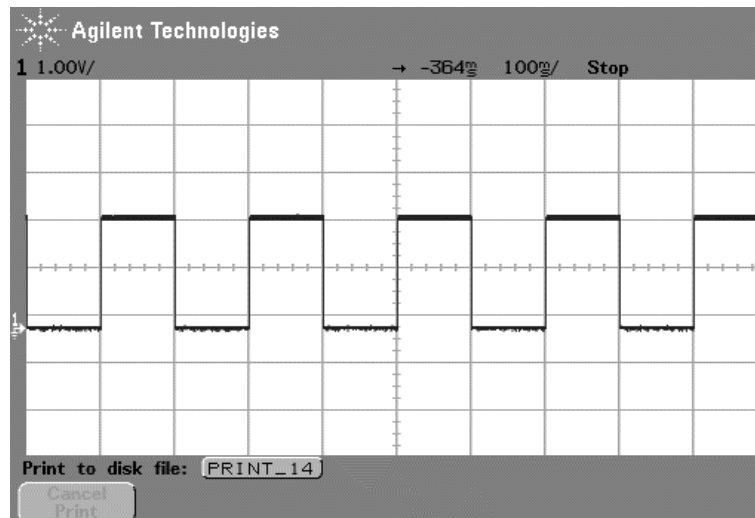
Picture 94 : Timing Control of BTS 4000

o   Data Acquisition Frequency. BTS 4000 has a conventional 10Hz data acquisition frequency, and 100Hz optional.

Below goes a comparison between BTS 4000 and BTS 3000. There are 2 data record frequencies adopted for the comparison – 1 second (1 Hz) and 0.1 second (10Hz). Battery was restored to its original SOC (State of Charge) after every DCR test to avoid the influence.

P.S.: 4S or 4 Series means BTS 4000, and 3S means BTS 3000

Discharge DCR(4S_0.1Sec, 4S_1Sec, 3S_1Sec)
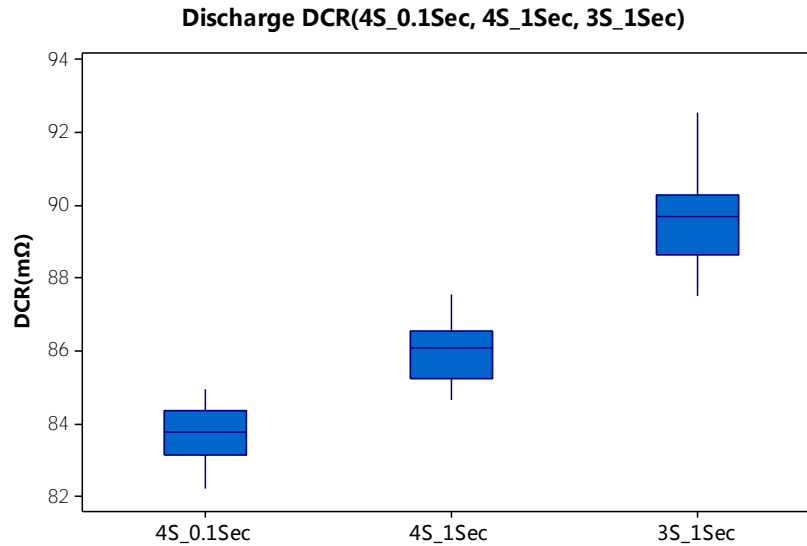
Picture 95 : Box Plot of DCR Values by Different BTS Series

Single Value Chart (4Series vs. 3Series)
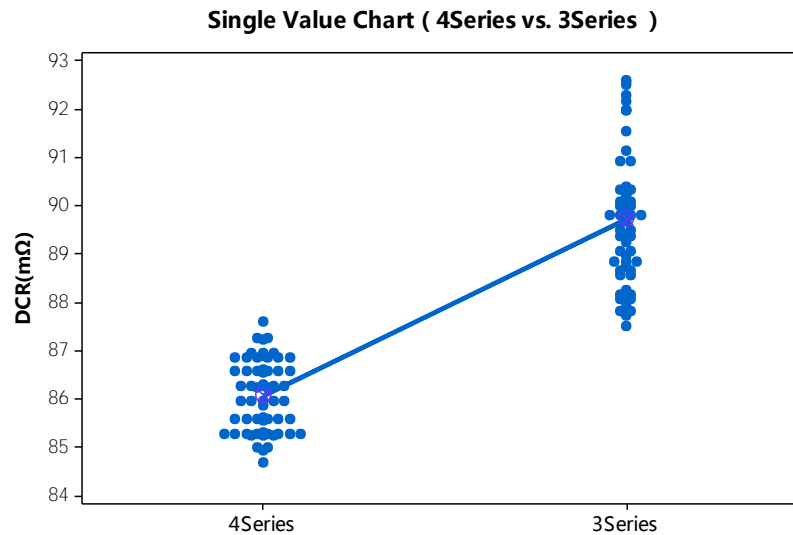
Picture 96 : Single Value Chart of DCR Values by Different BTS Series

6.3 HPPC Test

HPPC (Hybrid Pulse Power Characterization) test is intended to determine dynamic power capability over the device's useable voltage range using a test profile that incorporates both discharge and regen pulses. For more information, you can visit below file: *http://avt.inl.gov/battery/pdf/PLUG_IN_HYBRID_Manual%20Rev%200.pdf* which has elaborate explanation and how data gets summarized.

1) Since HPPC has pulse and DCR calculation, suggest you have our BTS 4000 or newer technology to bring out such test. And there is relative long time stand by, so conditional record will help you record necessary data but not expand the testing result data. Below steps settings assumes you already have fully charged the battery.

Picture 97 : Step Settings for HPPC Test

2) Below file goes the testing result. This result has no relationship with the steps set above. It comes from another similar test.
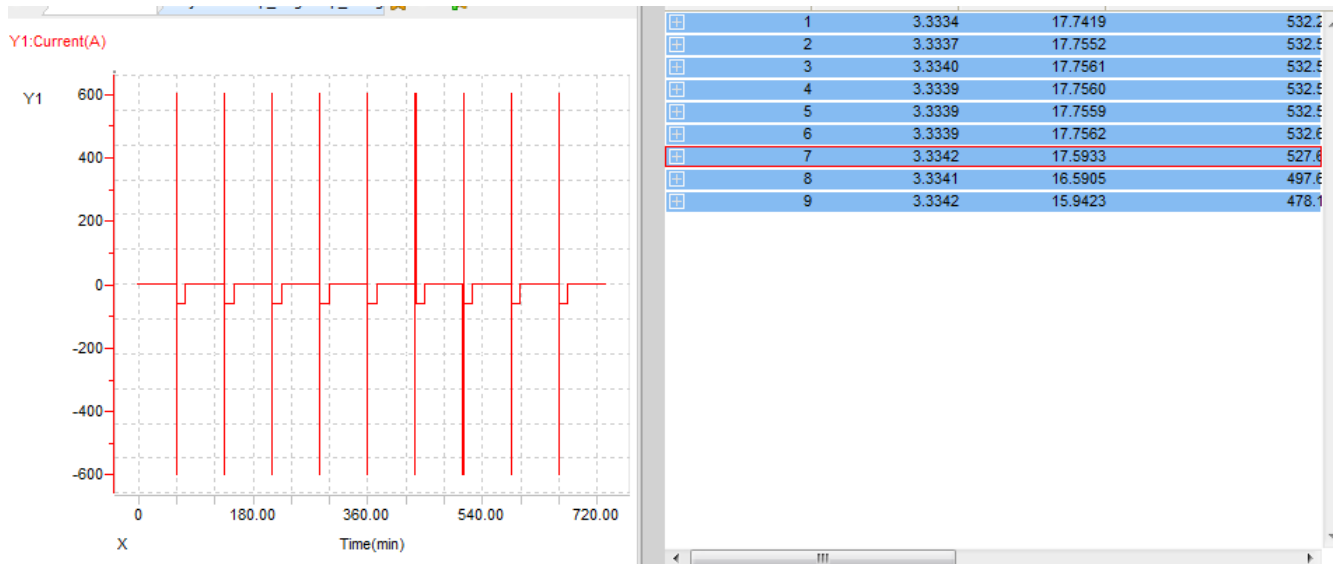
Picture 98 : HPPC Test Result

6.4 Driving Cycle Simulation

Driving cycle is most used for dynamometer test on fuel economy at different conditions. There are many driving schedules or driving cycles issued by various agencies or institutes. They are basically a speed table as a function of time, and there may be road slope taken into account. You can check the EPA (U.S. Environment Protection Agency) website for more: *http://www.epa.gov/nvfel/testing/dynamometer.htm*. For those simulations for EV, you need to convert these speed output into the power consumption or regeneration of the energy storage installed on the vehicle.

1) Your driving cycle table should consist of a row of time, and another row of power or current. As conventional, positive stands for charge or regen, negative discharge. Your driving cycle file should also comply with this convention.

2) Now, choose a BTS 8000 type for this simulation test (BTS 8000 responses fast, and benefited from the multi

current ranges, it has a better current or power accuracy over the whole scale). Click to choose a SIM step type. Click *File path* will launch a dialogue as below. You can choose sections of the file to be performed. And assign units to the 2 columns of the value, choose power mode or current. And also, you can use an integer as a multiplicator, this will multiply the column selected for power or current with the number you input.
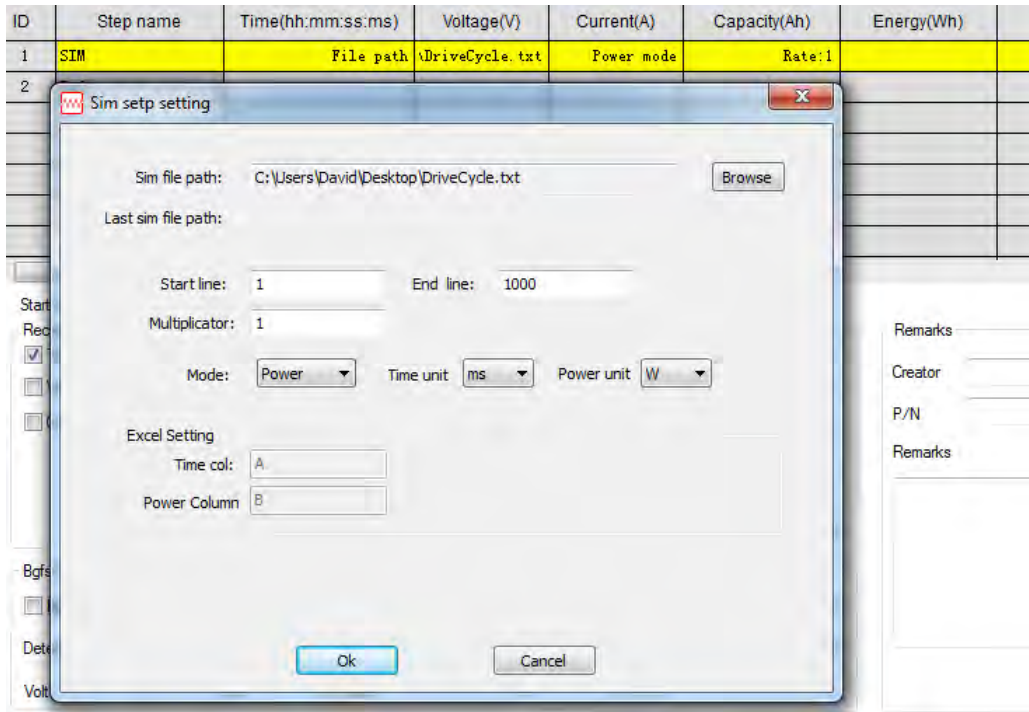
Picture 99 : Simulation Test

3) Below graph goes the output performed by our BTS 8000
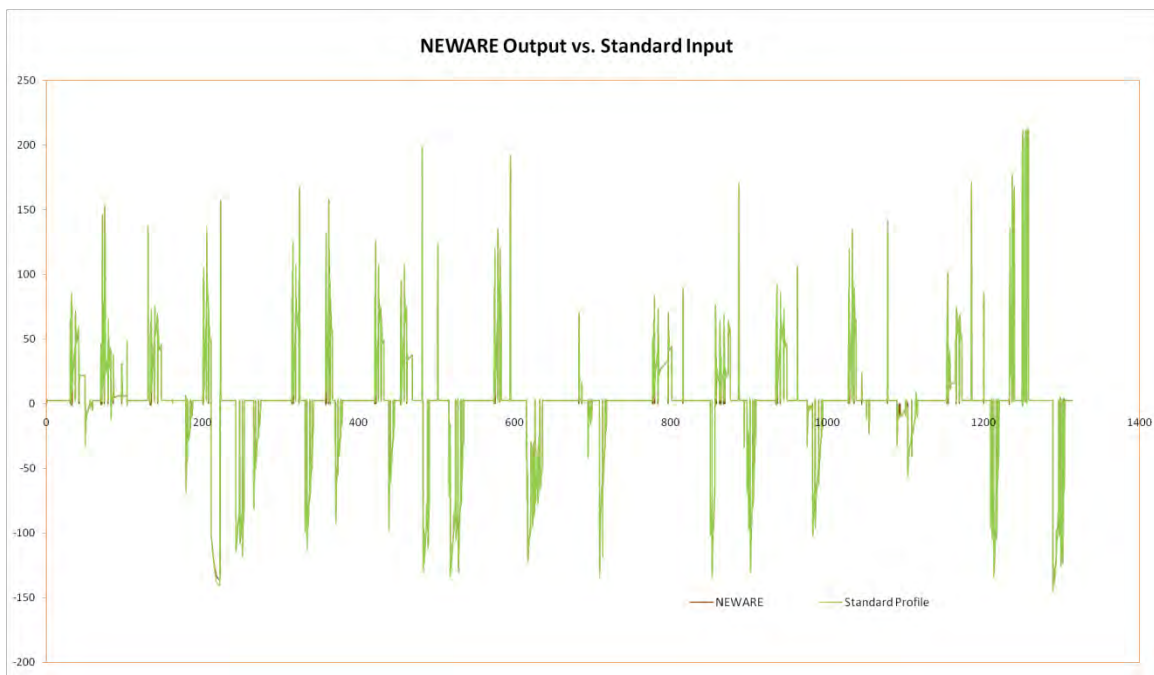
Picture 100 : Simulation Test Result

7. Algorithm and Summarized Data

7.1 Capacity Calculation

Capacity is an important parameter of the battery. How it is being accurately calculated is of great importance. You may also wonder if the data record frequency influences the measurement result. $Capacity = \int_0^t I dt$, if the current I is constant, you can also simplify this function into $Capacity=I\Delta t$. In real, there is no absolute constant, so there are 2 factors influence the capacity calculation – current control and measurement accuracy of the equipment, and the time interval of the integration. BTS calculates the capacity by the function $Capacity=\sum_1^n I\Delta t_i$. And it is calculated in real time, your record frequency affects no capacity measurement result. Below table shows the result:

Step Type	BTS Type	Expected Capacity (mAh)	Record Frequency (Second)	BTS Capacity (mAh)
CC 50A Discharge for 2 minutes	BTS 4000	1666.7 {=50A*(2/60)hour}	5	1667.8
			1	1667.8
			0.5	1667.8
			0.1	1667.8
CC 50A Discharge for 1 minutes	BTS 3000	833.3 {=50A*(1/60)hour}	5	834.5
			2	834.5
			1	834.5

Table 7 : Record Frequency Doesn't Influences Capacity Calculation

7.2 Summarized Data

Our BTSDA provides various kinds of summarized data for your quick access. You can choose which data to be displayed and exported.

Cycle Layer

Data for this layer is major on cycle level. You can right click on the cycle data header to load more summarized data or use cycle layer settings by right click on the data area. You can navigate to Data View section in BTS Operation o learn more about these operations. Below table shows all available summarized data for your choice.

No.	Data Title	Description
1	CycleID	Cycle Index
2	Cap_Chg	Total capacity from all the charge steps (CC charge, CV charge, CCCV charge, CP charge or any other charges).

3	Cap_DChg	Total capacity from all the charge steps (CC discharge, CP discharge or any other charges).
4	Capacity Density_Chg	Charge capacity density. Dividing Cap_Chg above by the weight of active material you set in *Unit Settings* will directly get this value.
5	Capacity Density_DChg	Discharge capacity density. Dividing Cap_DChg above by the weight of active material you set in *Unit Settings* will directly get this value.
6	Charge/Discharge Efficiency	Also called faraday (faradaic) efficiency, faradaic yield, coulombic efficiency or current efficiency. Dividing Cap_DChg above by the Cap_Chg will get this value.
7	Engy_Chg	Total energy from all the charge steps (CC charge, CV charge, CCCV charge, CP charge or any other charges).
8	Engy_DChg	Total energy from all the charge steps (CC discharge, CP discharge or any other charges).
9	REngy_Chg	Charge energy density. Dividing Engy_Chg above by the weight of active material you set in *Unit Settings* will directly get this value.
10	REngy_DChg	Discharge energy density. Dividing Engy_DChg above by the weight of active material you set in *Unit Settings* will directly get this value.
11	CC_Chg_Ratio	The ratio of capacity from CC charge to Cap_Chg.
12	CC_Chg_Cap	This will summary all the capacity produced by CC charge.
13	Plat_Cap	This is the capacity in the voltage intervals specified in the cycle layer of parameter settings. You can only define the first or the second discharge step to abstract this value.
14	Plat_Capacity Density	Dividing Plat_Cap above by the weight of active material you set in *Unit Settings* will directly get this value.
15	Plat_Efficency	The ratio of capacity from Plat_Cap to the whole capacity of the discharge step.
16	Plat_Time	This is the total time for battery discharged with its voltage
17	Capacitance_Chg	Capacitance could be calculated by the function. $C=\Delta Q/\Delta U$, you can define the voltage range in the cycle layer of parameter settings. This capacitance value is from charge steps. If there are multi charge steps, this value of cycle layer will add them up.
18	Capacitance_DChg	Capacitance could be calculated by the function. $C=\Delta Q/\Delta U$, you can define the voltage range in the cycle layer of parameter settings. This capacitance value is from discharge steps. If there are multi discharge steps, this value of cycle layer will add them up.

19	Mid_value Voltage	This is the voltage of the battery when discharged to its 1/2 of the whole step capacity. The first discharge step in the cycle will be applied for this calculation.
20	Discharge Fading Ratio	This value is the ratio of the current discharge capacity to the very first cycle's discharge capacity.
21	Charge Time	This is the total time of charge.
22	Discharge Time	This is the total time of discharge.

Table 8 : Data of Cycle Layer

Step Layer

Data for this layer focuses on the steps. Some of them are designed for special step types.

No.	Data Title	Description
1	Step Index	Step Index. This is different from step ID in Step Editor when there is at least one cycle step.
2	Step Type	This is the step type performed for the battery.
3	Step Time	This is the total time of the step.
4	Capacity	This is the capacity of the step.
5	Capacity Density	Dividing Capacity above by the weight of active material you set in *Unit Settings* will directly get this value.
6	Energy	This is the energy of the step.
7	CmpEnergy	Dividing Energy above by the weight of active material you set in *Unit Settings* will directly get this value.
8	Capacitance	Capacitance could be calculated by the function. $C=\Delta Q/\Delta U$, you can define the voltage range in the cycle layer of parameter settings.
9	Start Vol	This is the voltage value of the very first point of the step.
10	End Vol	This is the voltage value of the very last point of the step.
11	Start Temperature	This is the temperature value of the very first point of the step.
12	End Temperature	This is the temperature value of the very last point of the step.
13	Charge Mid-vol	This is the voltage of the battery when charged to its 1/2 of the whole step capacity.
14	Discharge Mid-vol	This is the voltage of the battery when discharged to its 1/2 of the whole step capacity.

15	DCIR	This will apply the first point of current step and the last point of previous step for DCIR calculation.
16	ChargeCap	If current step is of a charge type, the capacity of this step will be marked as ChargeCap.
17	DischargeCap	If current step is of a discharge type, the capacity of this step will be marked as DischargeCap.
18	AUX CHL START VOL	This is the voltage value of the very first point of the step from auxiliary voltage channels.
19	AUX CHL END VOL	This is the voltage value of the very last point of the step from auxiliary voltage channels.
20	AUX CHL START TEMP	This is the temperature value of the very first point of the step from auxiliary temperature channels.
21	AUX CHL END TEMP	This is the temperature value of the very last point of the step from auxiliary temperature channels.

Table 9 : Data of Step Layer

Record Layer

Data for this layer is the detailed data.

No.	Data Title	Description
1	Record Index	Record Index
2	Time	This is the relative time of the current record. If you have selected Single Channel under Time Format by right click on the data are, this time will index from this step. The time will be accumulated from the time when you initiated this test.
3	Voltage	Voltage value.
4	Current	Current value.
5	Temperature	Temperature value.
6	Capacity	Capacity value.
7	Capacity Density	Dividing Capacity above by the weight of active material you set in *Unit Settings* will directly get this value.
8	Energy	Energy value.
9	CmpEng	Dividing Energy above by the weight of active material you set in *Unit Settings* will directly get this value.
10	Realtime	This is real time from the computer clock.
11	Power	Power value, calculated directly from the equation $P=UI$, U and I are voltage value and current value of this record.

12	Min-T	The minimum temperature of all the temperature units you selected for calculation.
13	Max-T	The maximum temperature of all the temperature units you selected for calculation.
14	Avg-T	The average temperature of all the temperature units you selected for calculation.
15	Aux Min U	The minimum voltage of all the auxiliary voltage units you selected for calculation.
16	Aux Max U	The maximum voltage of all the auxiliary voltage units you selected for calculation.
17	Aux Min T	The maximum temperature of all the auxiliary temperature units you selected for calculation.
18	Aux Max T	The maximum temperature of all the auxiliary temperature units you selected for calculation.
19	Aux Avg T	The average temperature of all the auxiliary temperature units you selected for calculation.
20	Aux Max(Vi)-Min(Vi)	The voltage range (maximum value – minimum value) of all the auxiliary voltage units you selected for calculation.
21	Aux Max(Ti)-Min(Ti)	The temperature range (maximum value – minimum value) of all the auxiliary temperature units you selected for calculation.

Table 10 : Data of Record Layer

8. Warranty and Customer Service

Neware warrants its equipment for 1 year from shipment, to be free from defects in workmanship and material. For some other consumptive materials, like battery clamps, we provide a 3-month warranty. This warranty, including customer service support and software licenses, is not transferable. Meanwhile, we provide lifetime software update service to help your equipment optimized in its best status.

We provide below customer services:

o   Free Technical Training. Our technical service engineering team is always available for service call. We provide sufficient presales and after sales services. And you are sincerely welcomed to audit our company and factory.
o   Free Service Call Service. If you are experiencing a problem resulted from Neware BTS, you can contact our hotline 800-830-8866 for problem shooting.
o   Testing Service. If you are interested in one or some of our products, you can request a free demo testing and steps of which could be defined by you. If you have a large quantity or long time testing plan, you can ask Neware for quotation.
o   Calibration Service. As a basic requirement of the testing equipment, you should the equipment regularly. Neware provides professional calibration service at reasonable price.

Extended term warranties and other on-site customer services are available at additional cost, contact Neware for details.

You will be asked to provide the serial number and the company name when you request for after sales service. Our service staff will match this company name you provided and the company name queried from our SAP by the serial number. If they are missed, Neware has the rights to reject this call. You should request this service form the supplier.

Parts or subassemblies will be repaired or replaced at Neware's discretion. If the part or subassembly is replaced, Neware retains the original part or subassembly.

Appendix

9. Appendix

Appendix A: Middle Machine Command

o   For BTS 3000 (if the P/N initializes CT-3)

0	Flash format. This will erase all data. After command received, system need about 20 seconds to execute. After formation completed, system will reboot and retain default settings.
1	Disconnect / Connect to server.
2	Query usage of TCP sockets.
3	Query equipment information. Including device number, MAC, local IP, Server IP, Flash pointer, Connected units, Cache usage and etc.
4	Research connected units, create a valid list.
8	Save current status. System will reboot to the last saved settings if a power failure occurs.
9	Load the last setting.
I	Specify/Modify server IP. Send "I192.168.0.58P" will set 192.168.0.58 as the server IP.
N	Specify/Modify device number. Send "N168O" will set device number to 168.
H	Provides help information

o   For BTS 4000(if the P/N initializes CT-4)

flash –ca	Clear flash
flash –f	Format flash.
flash –cdf	Clear DF data in flash
dev –szn xxx	Set device number to xxx
version	View embedded software version of middle machine
ipconfig –ss 192.168.1.250 8001	Set the server IP of the middle machine to 192.168.1.250 and with 8001 port. (This is an updated command, not supported on some old versions.)
ipconfig –ss 0xaabbccdd 8001	Set the server IP of the middle machine to aabbccdd (hex decimal of IP address) and with 8001 port. (This is an obsolete command, only functions on some old versions.)
ipconfig –smac aabbccddeeff	Set the MAC of the middle machine to aabbccddff
ipconfig –i 192.168.1.10	Set the IP of the middle machine to 192.168.1.10
saveall	Save all the changes
restartsys	Restart middle machine

Appendix B: Thermal Resistor Resistance/Temperature Table

o   For 2k thermal resistor

T(℃)	R(Ω)	T(℃)	R(Ω)	T(℃)	R(Ω)	T(℃)	R(Ω)	T(℃)	R(Ω)	T(℃)	R(Ω)	T(℃)	R(Ω)
-40	37680	-17	11740	6	4234	29	1724.5	52	779.5	75	385.1	98	205
-39	35700	-16	11199	7	4062.1	30	1662.6	53	754.6	76	374.1	99	199.8
-38	33834	-15	10686	8	3898	31	1603.2	54	730.7	77	363.5	100	194.7
-37	32076	-14	10200	9	3741.5	32	1546.3	55	707.6	78	353.3	101	189.8
-36	30417	-13	9738.5	10	3592	33	1491.6	56	685.4	79	343.4	102	185
-35	28853	-12	9300.5	11	3449.3	34	1439.2	57	663.9	80	333.8	103	180.4
-34	27378	-11	8884.8	12	3312.9	35	1388.8	58	643.3	81	324.5	104	175.9
-33	25986	-10	8490	13	3182.7	36	1340.5	59	623.4	82	316.5	105	171.5
-32	24672	-9	8113.6	14	3058.2	37	1294.1	60	604.2	83	308.5	106	167.3
-31	23431	-8	7755.6	15	2939.3	38	1249.5	61	585.7	84	300.5	107	163.2
-30	22260	-7	7415.5	16	2825.5	39	1206.7	62	567.8	85	292.5	108	159.2
-29	21153	-6	7092.1	17	2716.8	40	1165.6	63	550.6	86	282.3	109	155.3
-28	20108	-5	6784.6	18	2612.7	41	1126.1	64	534	87	274.7	110	151.6
-27	19119	-4	6492	19	2513.2	42	1088.1	65	518	88	267.3	111	147.9
-26	18185	-3	6213.6	20	2418	43	1051.6	66	502.5	89	260.1	112	144.4
-25	17302	-2	5948.6	21	2327	44	1016.5	67	487.6	90	253.2	113	140.9
-24	16466	-1	5696.3	22	2239.9	45	982.7	68	473.2	91	246.5	114	137.5
-23	15675	0	5456	23	2156.5	46	950.3	69	459.2	92	240	115	134.3
-22	14927	1	5227.1	24	2076.6	47	919	70	445.8	93	233.7	116	131.1
-21	14219	2	5009	25	2000	48	889	71	432.8	94	227.6	117	128
-20	13548	3	4801.2	26	1926.7	49	860	72	420.3	95	221.7	118	125.1
-19	12913	4	4603.1	27	1856.4	50	832.2	73	408.1	96	215.9	119	122.1
-18	12311	5	4414.2	28	1789.1	51	805.4	74	396.4	97	210.4	120	119.3

o   For 10k thermal resistor

T(℃)	R(Ω)	T(℃)	R(Ω)	T(℃)	R(Ω)	T(℃)	R(Ω)	T(℃)	R(Ω)	T(℃)	R(Ω)	T(℃)	R(Ω)
-50	329.5	-27	95.52	-4	32.44	19	12.56	42	5.438	65	2.588	88	1.336
-49	310.9	-26	90.84	-3	31.05	20	12.09	43	5.255	66	2.511	89	1.301
-48	293.5	-25	86.43	-2	29.73	21	11.63	44	5.08	67	2.436	90	1.266
-47	277.2	-24	82.26	-1	28.48	22	11.2	45	4.911	68	2.364	91	1.232
-46	262	-23	78.33	0	27.28	23	10.78	46	4.749	69	2.295	92	1.2
-45	247.7	-22	74.61	1	26.13	24	10.38	47	4.593	70	2.228	93	1.168
-44	234.3	-21	71.1	2	25.03	25	10	48	4.443	71	2.163	94	1.137
-43	221.7	-20	67.77	3	23.99	26	9.632	49	4.299	72	2.1	95	1.108
-42	209.9	-19	64.57	4	23	27	9.281	50	4.16	73	2.039	96	1.079
-41	198.9	-18	61.54	5	22.05	28	8.944	51	4.026	74	1.98	97	1.051
-40	188.5	-17	58.68	6	21.15	29	8.622	52	3.896	75	1.924	98	1.024
-39	178.5	-16	55.97	7	20.3	30	8.313	53	3.771	76	1.869	99	0.9984
-38	169	-15	53.41	8	19.48	31	8.014	54	3.651	77	1.816	100	0.9731
-37	162.2	-14	50.98	9	18.7	32	7.728	55	3.536	78	1.765	101	0.9484
-36	151.9	-13	48.68	10	17.96	33	7.454	56	3.425	79	1.716	102	0.9246
-35	144.1	-12	46.5	11	17.24	34	7.192	57	3.318	80	1.688	103	0.9014
-34	136.7	-11	44.43	12	16.56	35	6.94	58	3.215	81	1.622	104	0.8789
-33	129.8	-10	42.47	13	15.9	36	6.699	59	3.116	82	1.577	105	0.8572

-32	123.3	-9	40.57	14	15.28	37	6.467	60	3.02	83	1.533	106	0.836
-31	117.1	-8	38.77	15	14.69	38	6.245	61	2.927	84	1.492	107	0.8155
-30	111.3	-7	37.06	16	14.12	39	6.032	62	2.838	85	1.451	108	0.7956
-29	105.7	-6	35.44	17	13.58	40	5.827	63	2.751	86	1.412	109	0.7763
-28	100.5	-5	33.9	18	13.06	41	5.629	64	2.668	87	1.373	110	0.7576

Appendix C: Step Type

Step Type	Description	Controlled Parameters	Jump Condition
CC_DChg	Constant Current Discharge	Discharging current	Time / Voltage / Capacity / Energy
CC_Chg	Constant Current Charge	Charging current	Time / Voltage / Capacity / Energy / -ΔV
CV_Chg	Constant Voltage Charge	Charging voltage	Time / Capacity / Energy / Cut-off current
Rest	Rest	-	Time
Cycle	Cycle from step x to the step above for n times	Cycle starting step ID, cycle number	Cycle number
CCCV_Chg	Constant current charge is followed by a constant voltage charge when the voltage meets the setting	Charging current, charging voltage	Time / Capacity / Energy / Cut-off current
Power_DChg	Constant power discharge	Discharging power	Time / Voltage /Current/ Capacity / Energy
RI_DChg	Constant resistance load discharge	Discharging resistance	Time / Voltage /Current/ Capacity / Energy
Power_Chg	Constant power charge	Charging power	Time / Voltage /Current/ Capacity / Energy
CV_DChg	Constant voltage discharge	Discharging voltage	Time / Capacity / Energy / Cut-off current
CCCV_DChg	Constant current charge is followed by a constant voltage discharge when the voltage meets the setting	discharging current, discharging voltage	Time / Capacity / Energy / Cut-off current
SIM	Load a drive schedule to perform simulation test	Drive schedule file	End of file or the specified end line
IF	If…goto…		Voltage/Current/Time/Capacity/Energy/Temperature Operators like $\geq, >, \leq, <$ $and =$ are enabled.

Record	3 kinds of section: Time, Voltage, Current for custom record frequency	-	-

Appendix D: FAQ

Q: Why I experience a "Database connection failed" or "Server connection failed" error when I launch BTS Client to perform a test.

A: If the MySQL or BTSServer is not at a status of started, you will experience such error prompt when you launch BTS client connected with it. Go System Services by *services.msc* in the *run* or *manage* on the right click menu of the computer, find "MySQL" and "BTSServer" then start them. If system cannot start one or all of them, you may need to reinstall the BTSServer.

Q: How many channels could one BTSServer hosts? And what is the guidance?

A: Based on the data executing and transferring efficiency, 2000 records per second can be securely and effectively handled by BTSServer. That is to say 2000 channels could be hosted when you record data every second (or 1Hz) and 200 channels at every 0.1second (or 10Hz). Since auxiliary channels have less information, 4 such channels could be counted as one.

Q: Why there is no available devices listed for operation.

A: If you can see the IP address of the equipment from the Device List on the left column of the BTSClient, you may consider: a). The BTS connected has a different *Server_IP* from the IP address of the host computer. Change one of them will fix this problem. b), the BTSClient is not compatible with the BTS type connected. Update the BTSClient to a newer one.
If you cannot see any IP addresses, you should consider the hardware connection.

Q: I have many channels of the same model under different devices. I have to do the same job for the devices but to launch a same test. Is there any way to simplify this action?

Appendix

A	You can map at most 256 (8 rows* 32 columns) channel for one virtual channel. Right click on the BTSV to set virtual device. You can map channels under different devices to one virtual device.
Q	If my settings for the safety protection and jump condition are the same, which one has the priority?
A	The safety protection functions prior to jump conditions. If you set a lower voltage limit of 2.7V, and discharge to 2.7V to jump to next step, the channel will get protected when the battery's voltage reaches 2.7V.
Q	Why I can only see the last period of the data.
A	BTSDA has a default data loading behavior – loading the last 20 cycles of the data. You can drag the yellow bar below to other cycle ranges, or right click on it to select the loading range, or right click on the data area to set default loading behavior under cycle layer settings.
Q	What does the -ΔV stand for and its application?
A	For NiMH battery, there will be a voltage drop when battery gets fully charged. This drop rates you can specify as a cut-off condition for the charge step. -ΔV is enabled only for CC charge step.

Appendix E: Warnings

Electricity Connection
1) You can only plug the equipment to a power supply within the voltage range which indicated on the equipment information label.
2) Pay also attention the wire polarity and the maximum power requirement. Improperly electricity connection may result in equipment power damage or electric shock to the people.
3) The equipment must be grounded. There will be voltage difference between 2 sets of non-grounded equipment; touching them at the same time will result in electric shock to the people.

Battery Connection
1) Battery should be correctly connected to the channel output clamps with good contact. Improper connection will result in battery damage or some other loss.
2) A battery with its voltage higher than the voltage range of the equipment you are connecting to is not permitted. This will damage the equipment.
3) If the equipment has a voltage output range or your battery voltage is larger than 36V (minimum safety voltage to human, different from standards), you should take great caution to operate both equipment channel and battery you are going to test.