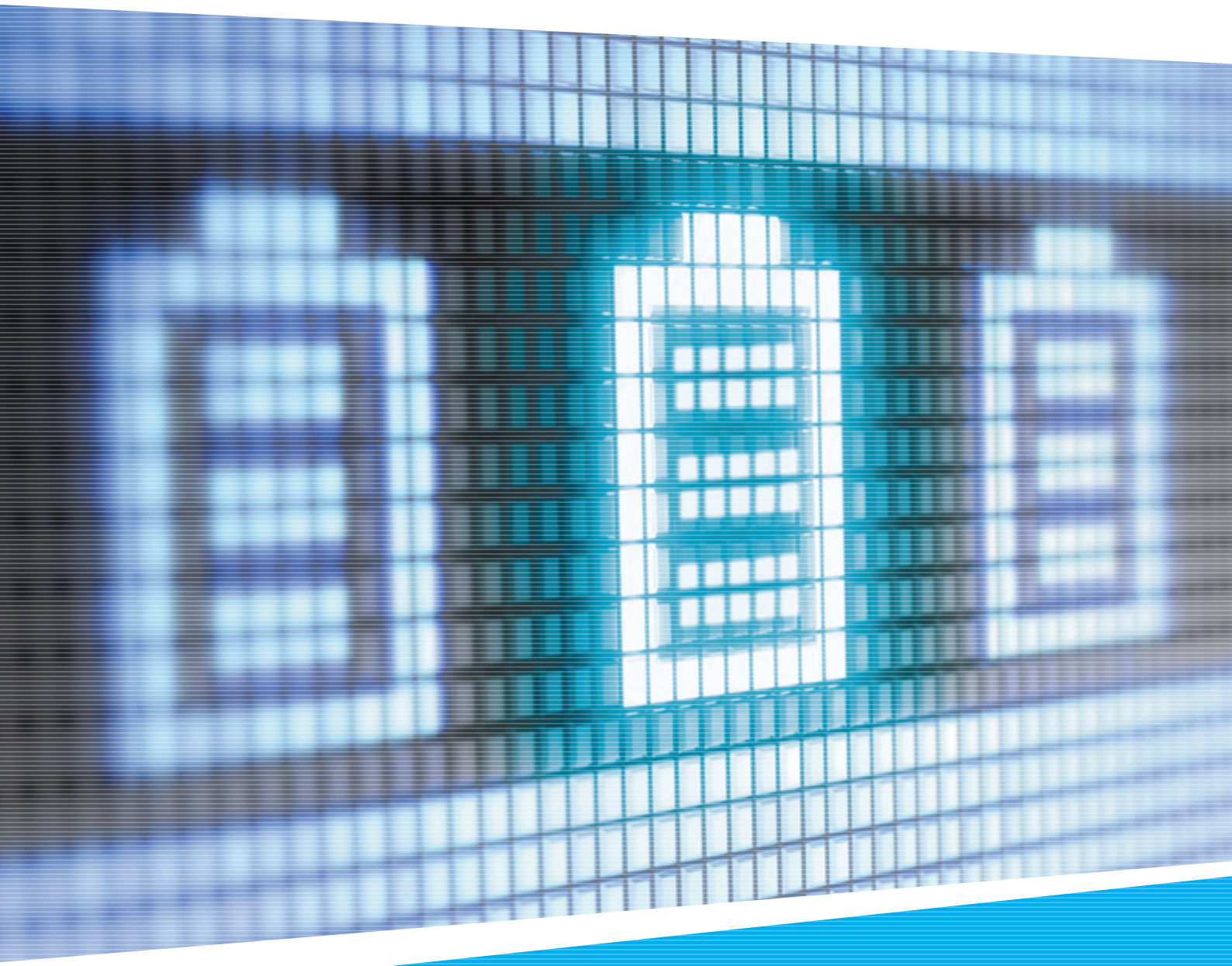


instrumentos  
de medida

# Battery Test Solutions

Cell/Module/Pack



**Chroma**

Turnkey Test & Automation Solution Provider



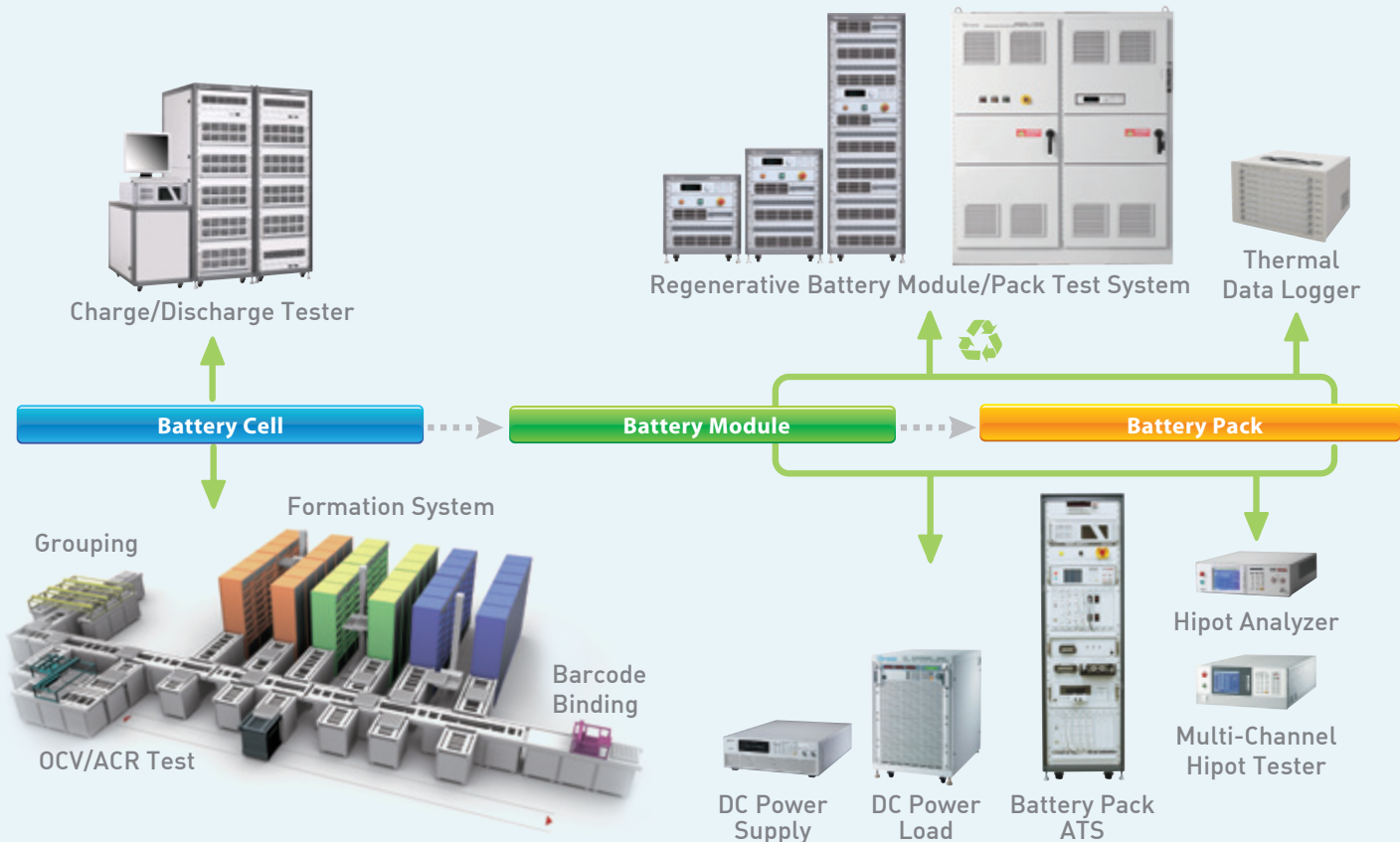
Founded in 1984, Chroma ATE Inc. is a world leading supplier of precision Test and Measurement Instrumentation, Automated Test Systems, Manufacturing Execution Systems and Turnkey Test and Automation Solutions marketed globally under the brand name "Chroma".

Significant markets Chroma serves include LED, photovoltaic, Li-battery, electric vehicle (EV/EVSE), semiconductor/IC, laser diode, flat panel display, video and color, power electronics, passive component, electrical safety, and thermoelectric test, as well as automated optical inspection and manufacturing execution systems.

Chroma has worldwide operation sites in the United States, Europe, Japan and mainland China chartered to deliver innovative technologies with high value-added product and service to satisfy our global customers' demands.



## Battery Test and Automation Solutions



# Battery Cell Test Solutions

## Battery Cell Charge/Discharge Test System

### Model 17011

Chroma's 17011 Charge/Discharge Test System is high precision automated test system designed specifically for testing Lithium-ion secondary batteries, Electrical Double Layer Capacitor (EDLC), and Lithium Ion Capacitors (LIC). It's suitable for cycle life test, incoming and out-going inspection, production, and reliability test. Test channels support parallel operation for maximum flexibility between high channel count and large currents. This system supports charge and discharge tests in CC-CV, CV and CP modes as well as battery capacity and DCIR tests, capacitance and DCIR tests for EDLC, and also ACR, LC tests.

#### Key Features

- ✓ High precision output and measurement, up to  $\pm (0.02\% \text{ of F.S.})$   
Voltage Range : 0~5V ; Current Range : 0~20A / 0~30A / 0~100A
- ✓ Independent test channel control and execution
- ✓ Channels parallel output function (17202-5-30 maximum parallel current 300A, 17212R-5-100 maximum parallel current 1,200A)
- ✓ High sampling rate up to 10mS
- ✓ Flexible data acquisition ( $\Delta t$ ,  $\Delta V$ ,  $\Delta I$ ,  $\Delta Q$ ,  $\Delta W$ )
- ✓ Real-time data acquisition (Q, Vt, It, time ) and step termination status (Q, V\_end, I\_end, time)
- ✓ Build-in two battery DCIR test modes for rapid and accurate results
- ✓ Build-in EDLC capacitance (F) and DCIR test functions to provide prompt and accurate test results (17202-5-20 and 17202-5-30 only)
- ✓ Waveform simulated conditions
- ✓ Real-time outer-loop resistance check
- ✓ Discharge energy recycle function (A691103 only)
- ✓ Option : Integrate ACR fixture to measure ACR, testing process without replace fixture



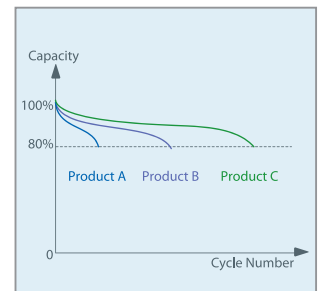
Hot Swappable & Redundant DC Power Supply



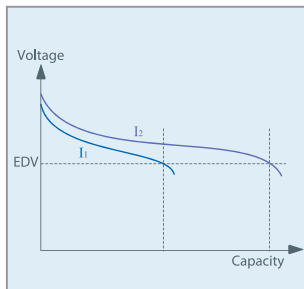
AC/DC Bi-Directional Converter



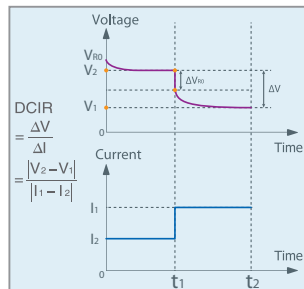
17011 Charge/Discharge Test System



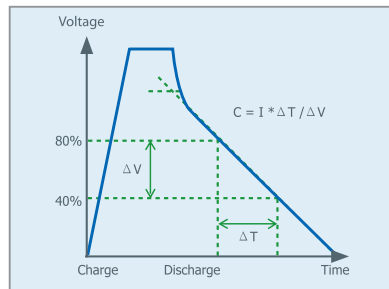
Cycle Life Testing



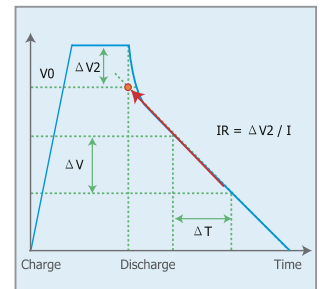
Capacity Measurement



DCIR Test



EDLC Capacitance Testing Curve



EDLC DCIR Testing Curve

## Recycling Li-ion Cell Formation System

### Model 17000

Chroma's 17000 series is specifically designed for the formation of Lithium-ion secondary batteries. This is a complete turn-key system, including carrier trays, robust battery probe contacts, high quality/charge/discharge modules and intuitive software all under computer control. The included MES software allows users to create a Formation Management System which is specifically designed for the battery formation processes. In many cases the 17000 MES software can control the entire formation process including FMS features.

#### Key Features

- ✓ BVT (Battery Voltage Tracking) reduces power consumption while battery charging
- ✓ ERM (Energy Recycling Module) recycles discharged energy
- ✓ Energy recycle to AC grid function improves the energy recycle efficiency of high discharge power
- ✓ Energy savings monitor : tracks kW, kWh, reduced CO2 or plated-tree display
- ✓ Real-time outer-loop resistance check
- ✓ System safety/test reliability through PLC/IPC monitoring of all sensors (temperature, smoke, device type and battery tray position)
- ✓ System are linked as a LAN offering remote monitoring and control with FMS (Formation Management System)
- ✓ Automated handling and sorting are available







# Battery Module/Pack Test Solutions

## Regenerative Battery Pack Test System

### Model 17020 Series

Chroma's 17020 Regenerative Battery Test System provides multiple independent channels to support dedicated charge/ discharge testing on multiple battery modules or packs. Channels can easily be connected in parallel to support higher current requirements. This feature provides flexibility between high channel count (max 60 channels) and high current testing.

#### Key Features

- ✓ Charge/discharge mode : CC/CV/CP/Waveform
  - Voltage Range: 20V/60V/100V/200V per channel
  - Current Range: 13A/30A/50A/62.5A/65A per channel
  - Power Range: 600W/1250W/2500W per channel
  - (Max of 60 channels (50kW) may be connected in parallel)
- ✓ High precision measurement accuracy
  - Voltage: 0.02% rdg.+0.02% F.S.
  - Current: 0.1% rdg+0.05% rng
- ✓ Voltage/Current sampling rate :
  - 50kHz for calculating dynamic charge/discharge capacity
- ✓ DCIR function (IEC 61960-2003)

#### Regenerative Energy

- ✓ Regenerative battery energy discharge
  - Direct recycling back to the grid or to charging pack
- ✓ Regenerative battery energy discharge efficiency :
  - About 85% at >20% of rated power
- ✓ Low heat output to reduce HVAC use and power consumption
- ✓ AC line current THD < 5% at rated power
- ✓ AC line PF is > 0.9 at rated power

#### Driving Cycle Simulation (Power/ Current Waveform Mode)

- Simulate real automotive working conditions by defining quick and irregular charge and discharge profiles
- ✓ Import dynamic charge/discharge waveforms designed to simulate DRIVE CYCLES or other actual charge/discharge profiles via .xls file formats
- ✓ Supports 720,000 points within driving profile memory
- ✓ Data point resolution ( $\Delta t$ ): 10ms~999s

#### Low Cost Temperature Measurement

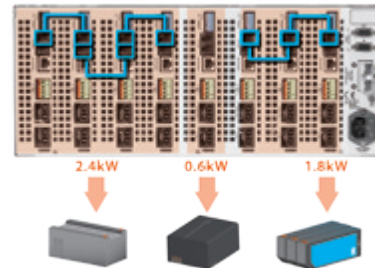
- ✓ Battery surface temperature measurement within the range of  $0\sim90^{\circ}\text{C} \pm 2^{\circ}\text{C}$
- ✓ 4 measurement sensors supported for each channel

#### Independent Battery Connections

For batteries with separate charge and discharge connections, user may set 17020's channels to independent charge/ discharge via software.

#### Support

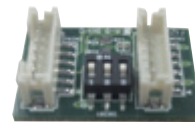
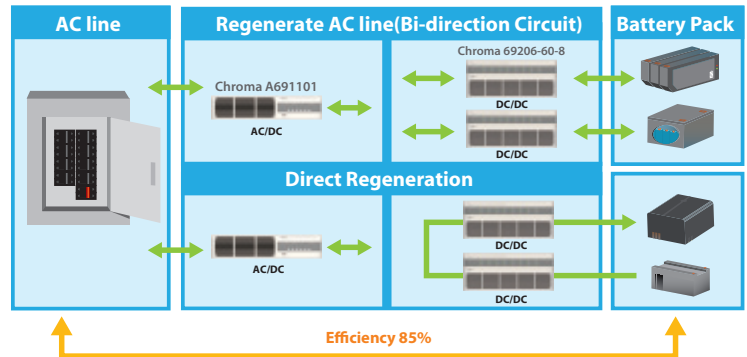
- ✓ Software integration supports BMS Communication Integration (CANbus)
- ✓ Thermal data loggers (Chroma 51101-64 for measuring the voltage and temperature) and thermal chamber control (optional)
- ✓ Flexible system configuration
- ✓ Channels parallelable for higher current
- ✓ Temperature Sensor



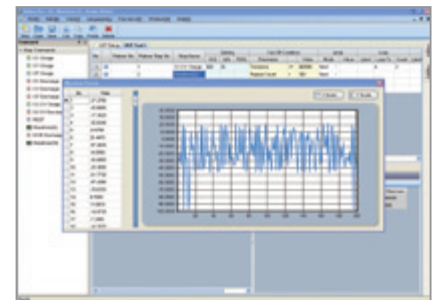
Channels parallelable for higher current



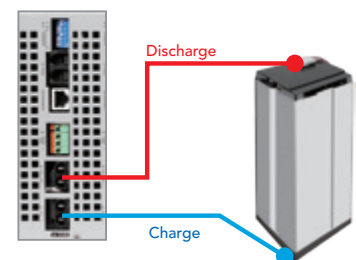
Flexible system configuration



Temperature Sensor



Loading Dynamic Power/current profile



# Regenerative Battery Pack Test System

## Model 17030 Series



### Regenerative Function

The 17030 Regenerative Battery Test System is a, single or dual output, high precision, integrated solution specifically designed for high power battery pack testing. Highly accurate power sources and measurement systems ensure quality results suitable for battery pack incoming or outgoing inspections, as well as capacity, performance, production and qualification testing.

### Key Features

- ✓ Charge/discharge mode : CC/CV/CP/Waveform
- ✓ Measurement accuracy
  - Voltage: 0.05% rdg.+0.05% F.S.
  - Current:  $\pm 0.1\%$  F.S.
- ✓ Regenerative battery energy discharge
- ✓ Customized power levels
  - Voltage range: 10~1200V
  - Current range: 0~1000A
  - Power range: 90~500kW (Up to 2 units can be used in parallel)
  - Like channels can be easily paralleled for higher power/current requirements. This feature provides ultimate flexibility between high channel count and high current testing
  - Dual output in one system, independent control

### Driving Cycle Simulation (Power/ Current Waveform Mode)

Simulate real automotive working conditions by defining quick and irregular charging and discharging profiles

- ✓ Import dynamic charge/discharge waveforms to simulate DRIVE CYCLES or other actual charge/discharge profiles via .xls file formats
- ✓ Supports up to 720,000 points within driving profile memory
- ✓ Data point resolution ( $\Delta t$ ): 10ms~999s

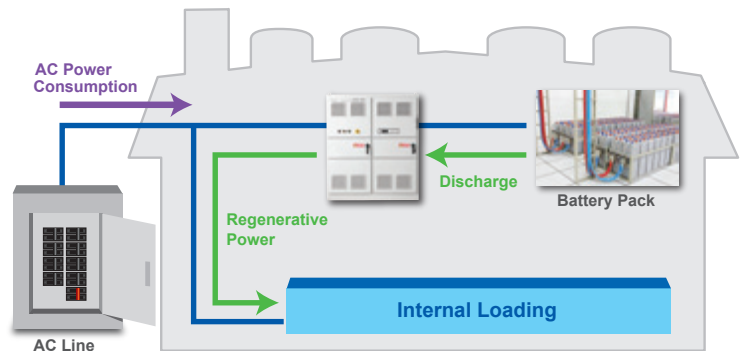
### Capacity Calculation

High frequency sampling rate used for calculating dynamic charge/discharge capacity ratings in waveform mode

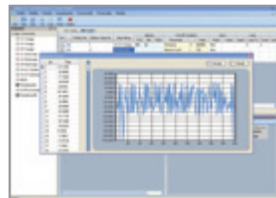
- ✓ Voltage/current sampling rate: 50KHz
- ✓ Minimum data acquisition: 10ms
- ✓ Supported integration methods calculation
  - I: Capacity
  - V x I: Energy

Software integration supports BMS communication integration (CANbus), thermal data loggers (Chroma 51101-64 for measuring the voltage, current, and temperature), and thermal chamber control (Optional)

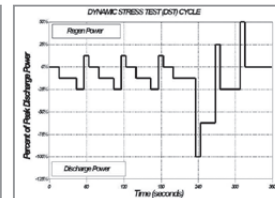
- ✓ User defines in the CANbus message
- ✓ Convert DBC to Battery Cycler using provided software tools
- ✓ Collect BMS data, such as voltage, current, temperature, battery states, etc.
- ✓ Data test steps for cut-off or protection testing and limits



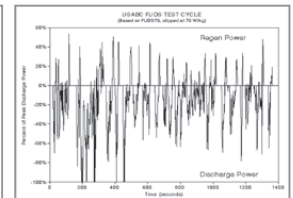
Regenerative Function



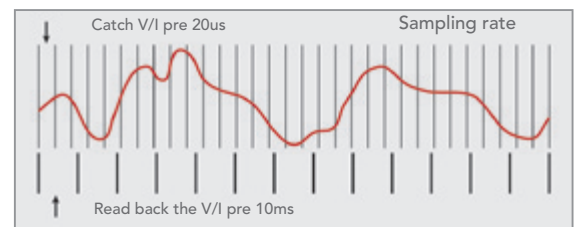
Loading Dynamic Power/Current Profile



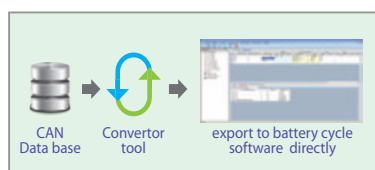
DST Power Profile



Support FUDS Test



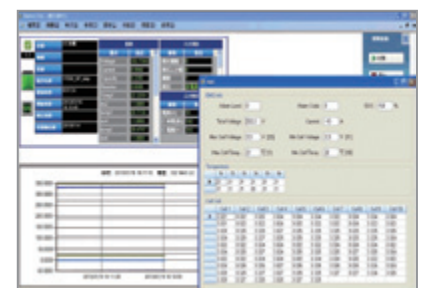
Capacity Calculation with Double Integrating Method



Convert DB Tools



CANbus Messaging Dialog Box



BMS Status Browse





## Software Platform

### Battery Pro (for Model 17030/17020/17011)

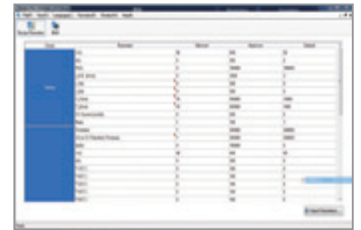
Chroma's Battery Pro test environment supports 17030, 17020 and 17011 systems using a common software platform. Battery Pro is specifically designed to meet the varied requirements of testing secondary battery packs with high safety and stability. Charge and discharge protection aborts tests when abnormal conditions are detected. Data loss, storage and recovery are protected against power failure.

#### Key Features

- ✓ Real-time multi channel battery pack status browse
- ✓ Icon Manager: Test status of each channel is managed through different icons, easy to read and understand
- ✓ Authority management: Sets the user's authority for operation
- ✓ Fault record tracking: Records the abnormal state of each channel independently
- ✓ 3000 charge/discharge conditions
- ✓ Sets dual layer loops (cycle & loop) with 9999 loops per layer
- ✓ Cut-off conditions
  - Time/Capacity/Voltage/Current/Temperature
  - Data Acquisition from data logger (optional)
  - Data Acquisition from BMS (optional)
- ✓ Protection
  - OVP/UVP/OC/OTP/OQP
  - Data Acquisition from data logger (optional)
  - Data Acquisition from BMS (optional)
  - Turns the main loop off for safety issues of AC line
  - $\Delta V$  protection /  $\Delta I$  protection for internal short of battery pack
  - $\Delta V$  period protection /  $\Delta I$  period protection
  - CC-CV transition time



Battery Pro Main Page (English)



UUT Specifications



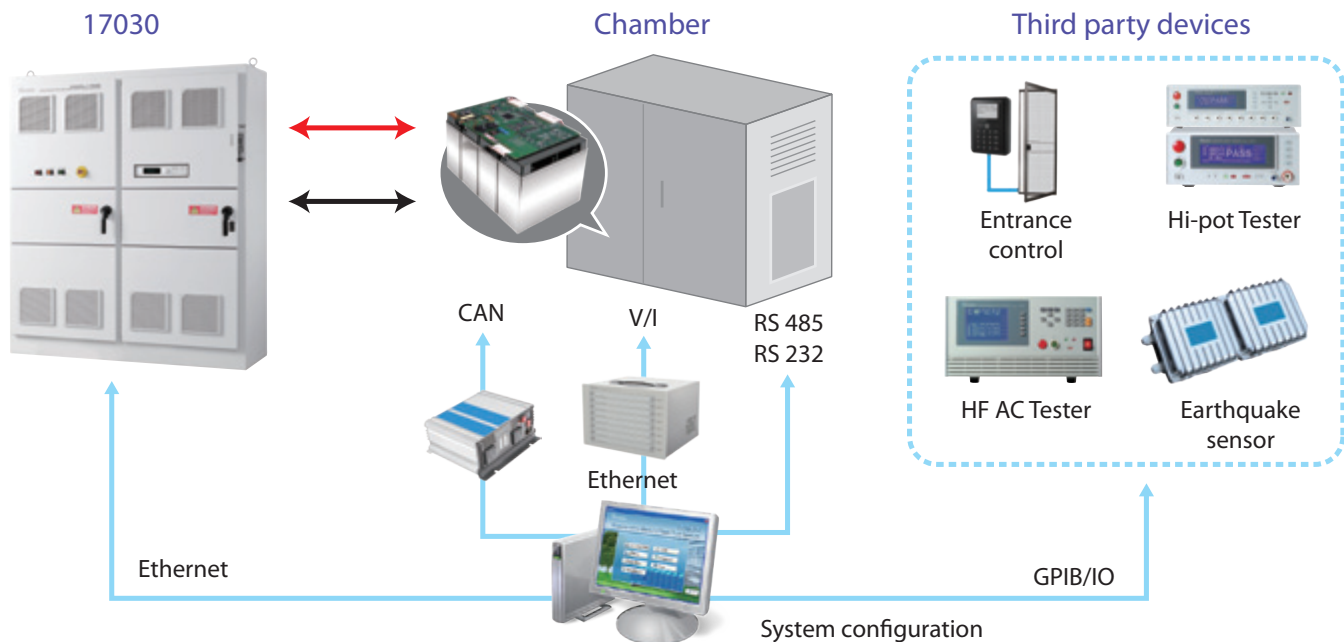
Status browser (1)



Status browser (2)

#### Software Integration Options

- ✓ Data logger integration allows for detailed collection of voltage, current and temperature data during charge/discharge profiling
- ✓ Battery Pro can communicate to most thermal chambers for life cycle and temperature testing
- ✓ Third party devices can be integrated into the 17030 via standard interface protocols (discrete I/O interface, GPIB, etc.)



## Electrical Safety Test Solutions

### Hipot Analyzer

#### Model 19055-C

- ✓ ACW/DCW/IR/HFCC/OSC
- ✓ Corona Discharge Detection/Discharge Level Analysis (DLA)



### Hipot Scanner Series

#### Model 19035

- ✓ ACW/DCW/IR/OSC
- ✓ 8 ports scanner
- ✓ Flashover detection



#### Jelly Roll

The distance between positive & negative electrodes is one of the key performance indicators of battery cells since the electric field intensity is related to distance ( $E=V/d$ ). The distance is usually defined by a separator. During jelly roll production processes, the distance may be shorter than specified due to the deckle edge of material cutting and due to metal particles introduced during rolling. Charging and discharging the cell under these conditions could result in dendritic crystals being produced on both sides of the separator which affects the quality of battery cell. Hi-pot test implementation can inspect the distance between positive & negative electrodes. Beyond general hipot inspection, Chroma 19055-C can detect the corona discharge within a minute distance. This function helps to improve the battery cell reliability and quality which cannot be detected by most IR meters.

#### Battery Cell

Electrical safety testing is extremely important for battery cell production. If battery cells are connected within a module with inadequate insulation, the battery cell or module might be damaged due to insulation casing failure. Chroma's 19055-C hipot can support high voltage testing to ensure the quality and safety of battery cell products prior to module level testing.

#### Battery Pack

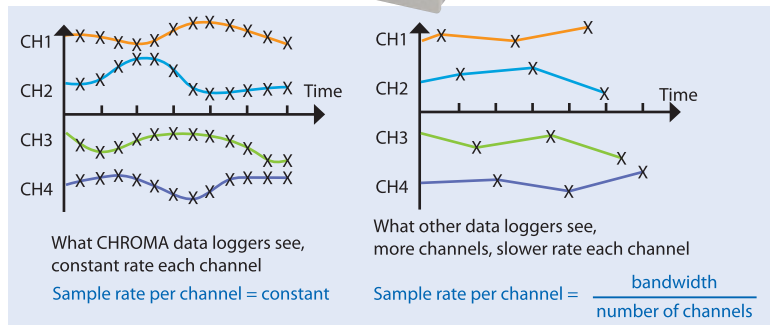
Electrical safety testing is extremely important for preventing battery packing error of cells, as insufficient insulation clearances can lead to insulation failure. (Related standard IEC 62133)

## Cell Voltage and Temperature Measurement

### Thermal/Multi-Function Data Logger

#### Model 51101 Series

- ✓ Support B, E, J, K, N, R, S, and T type thermal couples with ITS-90 defined temperature range
- ✓ Temperature resolution: 0.01°C  
Accuracy: (0.01% of reading+0.3°C)
- ✓ Cell Voltage measurement
  - Range:  $\pm 10\text{VDC}$
  - Resolution: 10uV
  - Accuracy: 0.015% of reading+100uV
- ✓ Synchronized and constant sampling rate for all channels, min sampling rate: 200ms
- ✓ 1000VDC channel to channel isolation



### Multi-Channel Hipot Tester

#### Model 19020

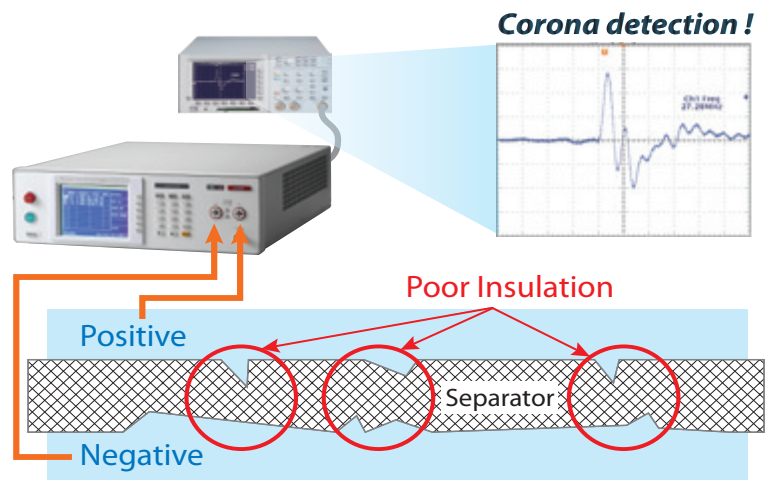
- ✓ ACW/DCW/IR/OSC
- ✓ 10 sets of sync. output and measurement
- ✓ Flashover detection



### One Channel Hipot Tester

#### Model 19073

- ✓ ACW/DCW/IR/OSC
- ✓ Flashover detection







## Power Electronics Test Solutions

### DC Power Supplies

#### Model 62000H Series

- ✓ Power range: 5kW / 10kW / 15kW
  - Current range: 0~375A
  - Voltage range: 0~1000V
  - High power density (15kW in 3U)
- ✓ Easy master/slave parallel & series operation up to 150kW



62000H Series

#### Model 62000P Series

- ✓ Wide range of Voltage & Current Combinations with Constant Power
  - Voltage range: 0~600V
  - Current range: 0~120A
  - Power Range: 600W, 1200W, 2400W, 5000W
- ✓ Power Factor Correction (0.95)



62000P Series

### DC Electronic Loads

#### Model 63200 Series

- ✓ Power Rating: 2600W, 5200W, 6500W, 10000W, 10400W, 14500W, 15600W
- ✓ Voltage range: 0 ~ 80V/0 ~ 600V/0 ~ 1000V
- ✓ Current range: Up to 1000A
- ✓ CC, CR, CV, CP load modes
- ✓ Master/Slave paralleling control mode, allow synchronous load control under static and dynamic loading mode (Up to 93.6kW)
- ✓ Dynamic loading : Up to 20kHz
- ✓ Only need 1V to draw rated current Programmable slew rate, up to 41A/μs
- ✓ Short circuit simulation and short circuit current measurement
- ✓ Battery discharge timer



63200 Series

### Battery Charge/Discharge Test Software

This software integrates a DC power supply and an electronic load for battery pack testing.

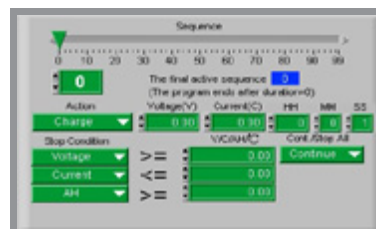
- ✓ Capacity Test
- ✓ Charge/discharge performance, C-V curve
- ✓ Endurance in cycles
- ✓ Users can use battery charge/discharge test software to set the charge/discharge test sequences
- ✓ Set the stop conditions and repeat cycles
- ✓ Dynamic current waveform simulation software records to an Excel compatible file
- ✓ Display the I-V curve and view/export test report when finished



Battery Charge/discharge Test



Main Operation Menu



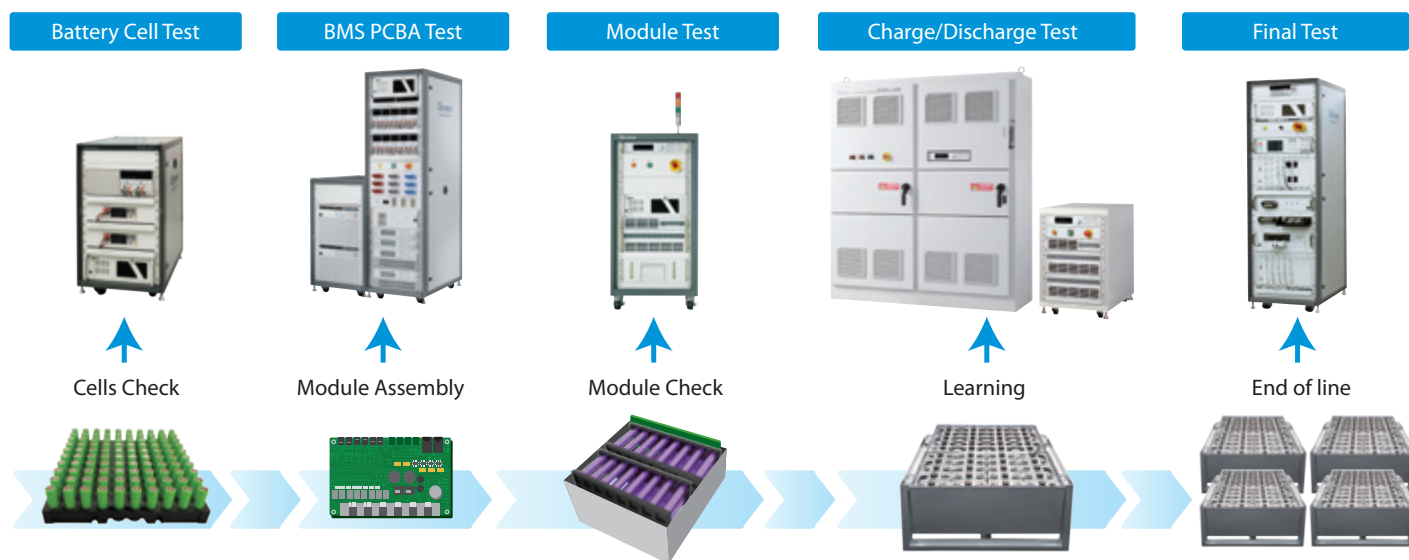
Charge/discharge Sequence Setting



Charge/discharge Test Report



# Battery Pack Manufacture Test Solutions



## Battery Cell Automated Test System

### Model 8000

This system applies to a wide range of battery cells such as cylindrical, prismatic, pouch, etc. It performs automated testing for the synthesized measurements that generate PASS/FAIL test results. It helps to check that the parameters of battery cells meet the consistency requirements before assembly.

#### Key Features

- ✓ Pass/fail validation for battery cell production
- ✓ OCV, ACIR and DCIR measurement for multi-channels
- ✓ Charge/discharge power range: 100W~400W
- ✓ Charge/discharge voltage/current range: 0V~80V/0A~80A



## BMS PCBA Automated Test System

### Model 8000

#### Functional Test for Battery Management System (BMS)

Chroma 8000 ATS is a flexible hardware architecture that can integrate a variety of hardware devices, such as DC Power Supplies, Electronic Loads, LCR and 6 1/2 digits Meters, etc. to comply with different automatic testing requirements for various applications.

In addition, new hardware and test items can be added to meet the demands for inspecting highly customized battery products with diversified tests. Many supported capabilities are listed below:

#### Key Features

- ✓ 2~32 series cell voltage simulation
- ✓ Support active and passive balance test
- ✓ Flexible hardware architecture that can select a variety of hardware devices
- ✓ The test items can be expanded to meet the demands for inspecting tests.
- ✓ Support dual-output of battery module
- ✓ Resistor measurement (ID pin/NTC)
- ✓ BMS IC Firmware program & Parameter download
- ✓ BMS data compare
- ✓ Support BMS interface: CANBus/RS485/RS232
- ✓ Support BMS power consumption measurement
- ✓ BMS IC V/I/T calibration
- ✓ Over voltage protection test
- ✓ Under voltage protection test
- ✓ Over charge current protection test
- ✓ Over discharge current protection test
- ✓ Over temperature protection test





## Battery Module Test Solutions

### Battery Module Automated Test System

#### Model 8000

This system applies to semi-finished battery modules, and performs automated tests for the synthesized measurements that generate PASS/FAIL test results. The application range includes battery modules for electric vehicles and energy storage systems.

#### Key Features

- ✓ Pass/Fail validation for battery module production
- ✓ Inspection of BMS functions for voltage/temperature measurement accuracy as well as the distribution consistency of voltage/DC resistance/temperature for each serial cell of battery pack
- ✓ Charge/discharge power range: 2.5kW~50kW
- ✓ Charge/discharge voltage/current range: 0V~200V/0A~2600A



### Battery Module/Pack Functional Automated Test System

#### Model 8000

#### Functional Test for Low Voltage Battery Pack/Modules

The 8000 ATS is for semi-finished and finished products like E-bikes and E-scooters. The system includes standard tests for low voltage battery packs. Chroma provides customized services to create test items and add hardware to test system.

#### Key Features

- ✓ Charge & discharge test
  - Charge: 10kW/100V/100A
  - Discharge: 13kW/80V/360A
- ✓ OCV status test
- ✓ Support ACIR test
- ✓ Support DC Resistor test
- ✓ Support OCP/ Short test
- ✓ BMS communication read/ write: CANBus/ RS485/ RS232



### Battery Module/Pack Maintenance Automated Test System

#### Model 8000

#### Balance control system for maintenance of E-bikes and E-scooters

A flaw in a single cell can affect the entire battery pack, creating a loss in efficiency and specified capacity, even reducing the lifespan of the product. In general, battery packs need a level of maintenance before being produced, to ensure the performance and quality. Used battery packs need regular maintenance as well, in order to extend the lifespan and ability of the battery.

#### Key Features

- ✓ DCIR Test
  - Measures the impedance (Ohm) of each cell. Impedance determines the capacity and difficulty of the balance test. Generally this is the first inspection for a battery pack.
- ✓ Capacity Test
  - Measures the capacity (Ah) of each cell. Discharges all cells by a constant current, and calculates capacity via discharge time. The capacities of all cells should be similar.
- ✓ Balance Test
  - Due to the impedance discrepancy between cells, the cell voltage in the pack will become imbalanced due to over time, and high temperatures. Regularly balance test are able to extend the lifespan of battery packs.



# Battery Pack Test Solutions

## Battery Pack Automated Test System

### Model 8000

In order to increase testing coverage and the efficiency of the power storage battery industry, Chroma ATE has developed an automated inspection system that can be applied to the EOL (End Of Line) of battery pack production for testing assembly defects, Battery Management System (BMS) communication, internal power switches, battery balancing circuits/consistency, and temperature distribution, etc. before battery packs are shipped out of the factory.

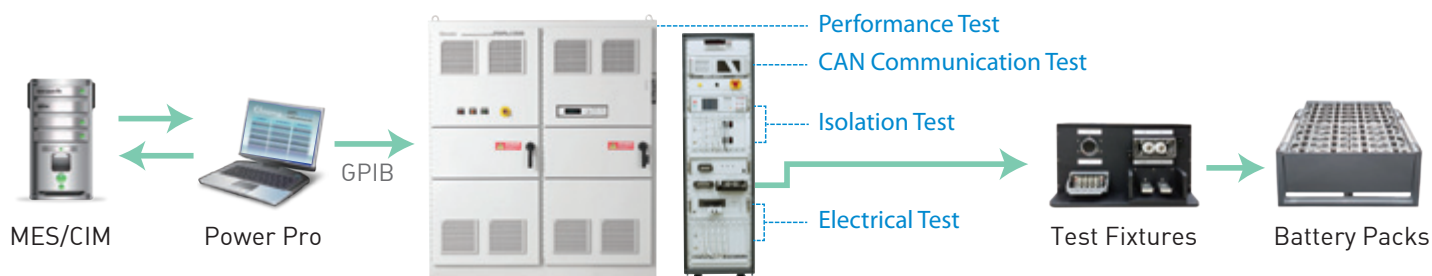
The comprehensive PASS/FAIL tests can be used in production lines, in a development phase nearing completion and used during battery pack acceptance inspection for EV or energy storage station.



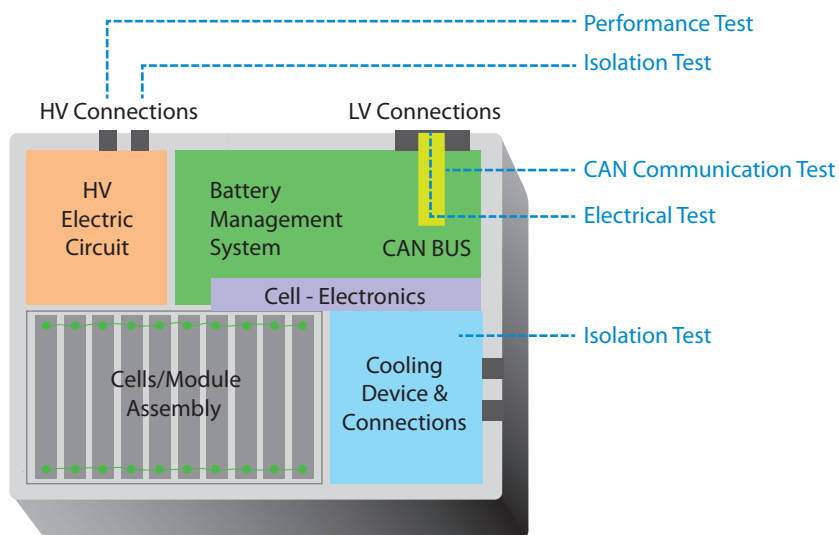
### Key Features

- ✓ Specifically designed for battery production line, or battery development testing
- ✓ The application range of this system includes battery modules for electric vehicles, motor vehicles, and power storage systems.
- ✓ Increases QA efficiency by up to 80%
- ✓ Inspection of BMS functions, connector withstand voltage, consistency, and performance of battery module
- ✓ Charge/discharge power range: 5kW~500kW; Charge/discharge voltage range: 0V~1200V; Charge/discharge current range: 0A~2600A
- ✓ Standard test items include insulation resistance, electrical tests, software/communication, and battery performance testing
- ✓ Able to create test fixture to connect the customized battery module with the automated switch control
- ✓ The control system is an easy to use open software platform that supports shop floor control integration with Manufacturing Execution System (MES)

### System Architecture



### Standard Function Test Items



- ✓ **Performance Test**
  - Standard charge/discharge capacity test
  - Drive profile cycle test
  - DCIR / OCV test
- ✓ **Isolation Test**
  - Terminal(HV+, HV-) insulation resistance
  - Ground isolation
  - Shield impedance
  - Hi-Pot test
- ✓ **Electrical Test**
  - HV interlock function test
  - Max. and Min Voltage/Temperature range test
- ✓ **CAN Communication Test**
  - Cell and Pack voltage/Temperature
  - Contactor characterization
  - Diagnostic trouble and fault mode test







Septiembre 31. 28022 Madrid  
Tel. 91 300 0191 Fax. 31 388 5433  
idm@idm-instrumentos.es



HEADQUARTERS  
CHROMA ATE INC.

66 Huaya 1st Road, Guishan,  
Taoyuan 33383, Taiwan  
T +886-3-327-9999  
F +886-3-327-8898  
info@chromaate.com  
www.chromaate.com

CHINA  
CHROMA ELECTRONICS (SHENZHEN) CO., LTD.

8F, No.4, Nanyou Tian An Industrial Estate,  
Shenzhen, China PC: 518052  
T +86-755-2664-4598  
F +86-755-2641-9620  
www.chroma.com.cn

JAPAN  
CHROMA JAPAN CORP.

472 Nippa-cho, Kouhoku-ku, Yokohama-shi,  
Kanagawa, 223-0057 Japan  
T +81-45-542-1118  
F +81-45-542-1080  
www.chroma.co.jp

U.S.A.  
CHROMA ATE INC. (U.S.A.)

7 Chrysler Irvine, CA 92618  
T +1-949-421-0355  
F +1-949-421-0353  
Toll Free +1-800-478-2026  
info@chromaus.com  
www.chromaus.com

CHROMA SYSTEMS SOLUTIONS, INC.

19772 Pauling, Foothill Ranch, CA 92610  
T +1-949-600-6400  
F +1-949-600-6401  
sales@chromausa.com  
www.chromausa.com

EUROPE  
CHROMA ATE EUROPE B.V.

Morsestraat 32, 6716 AH Ede, The Netherlands  
T +31-318-648282  
F +31-318-648288  
sales@chromaeu.com  
www.chromaeu.com