BATTERY CELL CHARGE & DISCHARGE TEST SYSTEM MODEL 17011

The Chroma 17011 Battery Cell Charge and Discharge Test System is a high precision system designed specifically for testing lithium-ion battery (LIB) cells, electrical double layer capacitors (EDLC), and lithium-ion capacitors (LIC). It is suitable for product development, quality control, and is helpful to characteristic research, cycle life testing, product screening, and quality assessment.

The Chroma 17011 has linear circuit and regenerative AC/DC bi-directional models for different applications. The linear circuit test systems feature extremely low output noise and high measurement accuracy and are applicable for testing small and medium sized energy storage components. The regenerative bi-directional test systems with high efficiency, power saving, low heating, and stable measurement capabilities suit testing medium and large size energy storage components or power type battery cells and fit green energy low carbon emission production.

In addition to the commonly used constant current (CC), constant power (CP), constant voltage (CV), constant resistance (CR), and rest test modes, Chroma 17011 is also equipped with waveform simulation functions and test items including DCIR, HPPC, EDLC capacitance, and EDLC DCR that comply with the international standards, so making program editing and test results analysis much easier.

The Chroma 17011 test system has flexible software editing functions embedded that can create basic charging/discharging or complex cycle tests for each channel to run independently. The program can edit logic decisions to jump or output variables, and pause or resume. It also has data protection functions to securely store the data in a non-volatile memory in case of a power outage or disconnected communication, as to prevent potential data loss and resume the tests after reboot.

Since safety is crucial for testing lithium-ion battery cells, the design of Chroma 17011 offers a variety of safety protections. Before starting, a contact check and polarity check avoid testing under poor connection. During testing, besides the preloaded hardware circuit protection, the user can customize the firmware to detect overvoltage (OVP), overcurrent (OCP), overcapacity (OQP), voltage / current variation (ΔV / ΔI), loop resistance and other anomalies to safeguard the lithium-ion battery cells.

Ethernet CE

MODEL 17011

KEY FEATURES

- High precision output and measurement up to 0.015% of full scale
- Fast current response up to <100 μS
- High sampling rate up to 10 mS
- Flexible sampling recording (Δt, ΔV, ΔI, ΔQ, ΔE)
- Channel parallel output function with maximum 1200A output
- High efficiency charge and discharge with low heating
- Energy recycling during discharge (AC/DC bi-directional regenerative series)
- Waveform simulation function (current/power mode)
- Built-in DCIR test function
- Built-in EDLC capacitance and DCR test function
- Operating modes: CC / CP / CV / CR / CC-CV / CP-CV / Rest / SD test
- Multi-level safety protection mechanism
- Integrable data logger and chamber

APPLICATIONS

- Electric vehicle
- Electric scooter/bike
- Energy storage system
- Power tools
- Quality inspection agency
- Academic research

Chroma

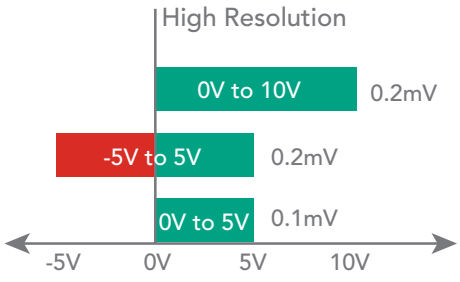
Model 17216M-10-6 | Model 17216M-6-12 | Model 17208M-6-30 | Model 17208M-6-60

Model	Voltage Ranges	Current Ranges	Channels
17216M-10-6 *1	±5V / 0~5V / 0~10V	200μA / 6mA / 200mA / 6A	16
17216M-6-12	0~6V	100mA / 1A / 3A / 12A	16
17208M-6-30	0~6V	1mA / 100mA / 10A / 30A	8
17208M-6-60 *2	0~6V	500mA / 5A / 15A / 60A	8

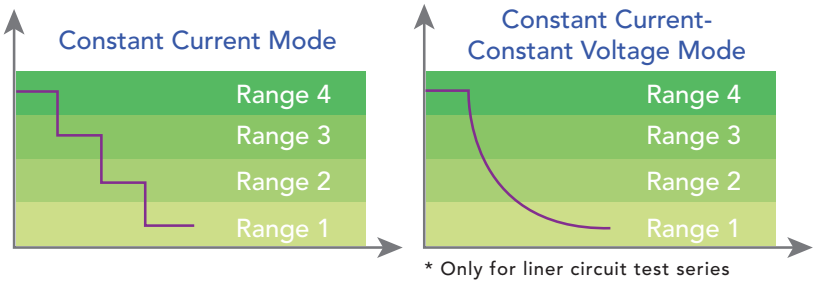
*1: 17216M-10-6 has three built-in voltage output modes that can be switched through the software settings.
*2: 17208M-6-60 has to be paired with an external power supply and placed into a rack; other models contain an integrated power module and can be used either stand-alone or in a rack.

High precision – improving product quality

- Voltage / current measurement accuracy: ±0.015% of F.S. / ±0.02% of F.S.
- Wide range of voltage output: Equipped with a 0V to 6V output range, and specific models allow to switch between three built-in voltage output modes. Voltage measurements distinguished up to 0.1mV.
- Multiple range measurement design: Providing various current or voltage ranges (depending on the model) to greatly improve measurement accuracy and resolution. The current range switches automatically and at the constant voltage mode there is no current output interruption.



Multi-Voltage Range (17216M-10-6)



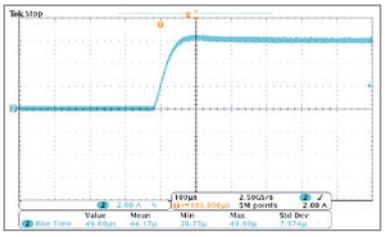
* Only for liner circuit test series

Multi-Current Range

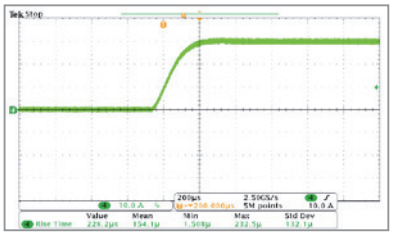
Fast current response – suitable for a variety of high-speed transient test applications

- Current response time (10% to 90%) < 100 μS *1
- Support dynamic waveform to simulate the rapid changing current and power states

*1: The current response time <100 μS applies to model 17216M-10-6, the impedance of other UUTs will slightly differ.



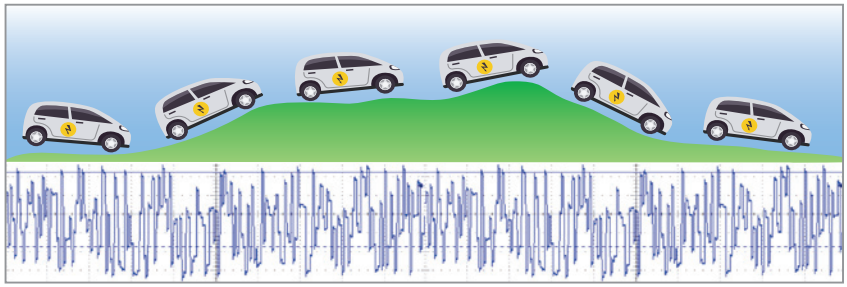
Rise Time<100 μS (17216M-10-6)



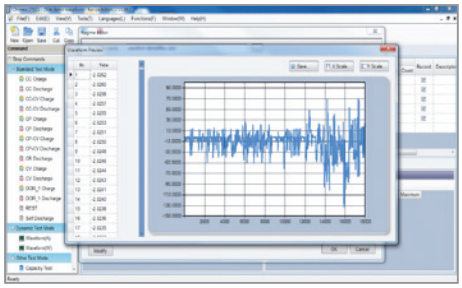
Rise Time<250 μS (17208M-6-30)

Dynamic waveform simulation

- Current and power dynamic charge/discharge waveform, simulate the actual battery usage of car driving or other real life applications
- Import the current and power waveforms from Excel file
- Save 1,440,000 points in each channel for long hour dynamic testing
- Minimalize time interval for data output: 10 mS



Dynamic waveform simulation



Loading waveform current

5V 60A

AC/DC Bi-direction Converter A691103/A691104

Charge & Discharge Tester 17212R-5-60

5V 100A

AC/DC Bi-direction Converter A691103/A691104

Charge & Discharge Tester 17212R-5-100

6V 100A

AC/DC Bi-direction Converter A691103/A691104

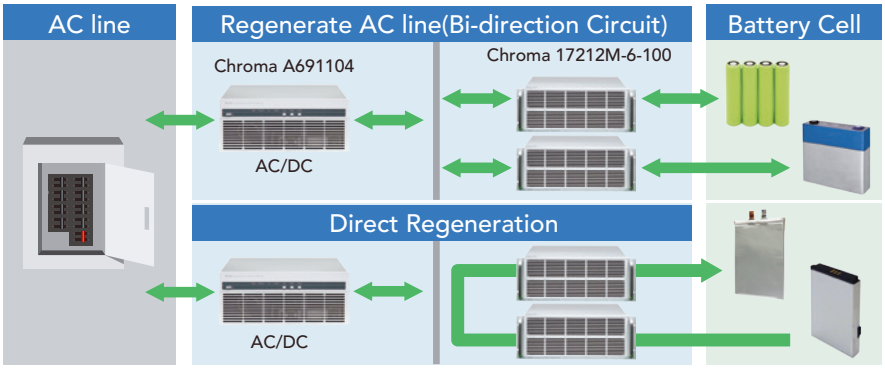
Charge & Discharge Tester 17212M-6-100

Model	Voltage Ranges	Current Ranges	Channels
17212R-5-60	Charge 0~5V ; Discharge 1.5V~5V	60A	12~48
17212R-5-100	Charge 0~5V ; Discharge 1.5V~5V	100A	12~36
17212M-6-100	Charge 0~6V ; Discharge 1.5V~6V	25A / 50A / 100A	12~36

* A fitting AC/DC bi-directional converter is chosen according to the power input and placed into a rack.

Energy recycling – optimal utilization of electricity

- Direct recycling: Automatically transfer the discharging energy to the battery cells to be charged with recycling efficiency >80%
- Grid recycling: Recycle the excessive energy to the grid with recycling efficiency >60%
- Low carbon emissions for green energy, preventing waste heat from generating during discharge
- Saving electricity costs with high efficiency power charge and discharge
- Saving air conditioning costs on cooling equipment
- Current harmonic distortion <5% for feedback to grid current
- Power factor >0.98 at rated power

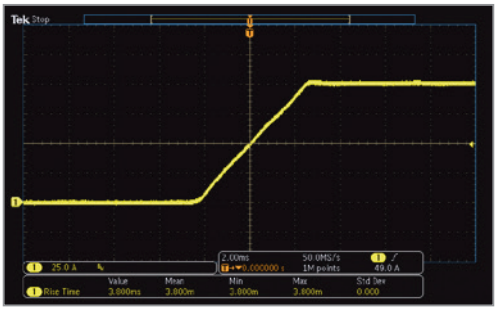


High precision – improving product quality

- Voltage accuracy: ±(0.02% of Reading + 0.02% of F.S.)
- Current accuracy: ±0.05% of F.S.

Fast current response – waveform mode

- Current response speed (10% to 90%) < 5 mS applicable for all kinds of tests
- Support dynamic waveform to simulate the current and power state of actual car driving with NEDC, FUDS and DST test standards



Rise time < 5 mS

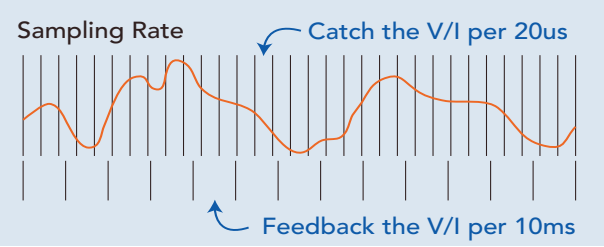
FUNCTIONS

High frequency sampling measurement technology – improving measurement accuracy

■ V / I sampling rate: 50 KHz (Δt：20 μS)

Generally, battery testers use software to read current values for calculating power; however, limited data sampling rates could result in large errors when calculating the dynamic current capacity. By increasing the sampling rate and using a double integration method, Chroma 17011 is able to provide a capacity calculation with much higher accuracy. When the current changes, the data is not lost and the transmission speed is not affected.

General charger/discharger sampling rate



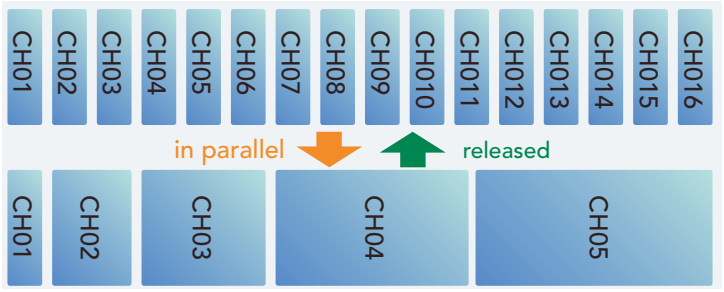
Chroma charge & discharge tester sampling rate

* Note: The current response time <100 μS applies to model 17216M-10-6, the impedance of other UUTs will slightly differ.

Flexible paralleling channels for output

The test systems allow flexible setting for paralleling channels in order to provide higher current application for multi-channels and broad testing ranges, making the Chroma17011 suitable for various UUTs.

■ Easy to parallel the tester channels via software which supports full range of products
■ Suitable for high ratio charge and discharge test or diversified battery test applications



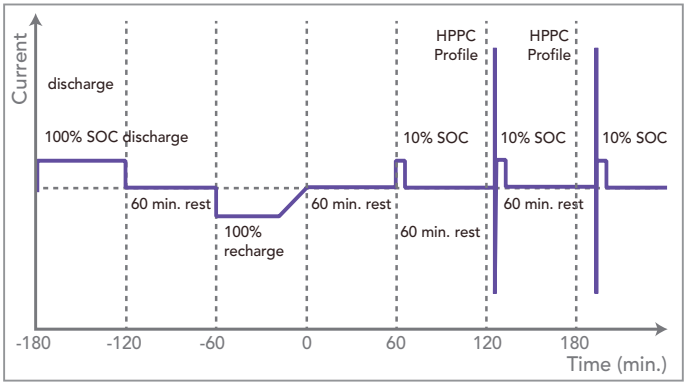
Flexible paralleling channels control

Data protection and recovery

■ Power loss data restoring mechanism: After a power loss, the PC will automatically recover the data status of the testing data that already was written into the database. The user can choose to resume or restart testing.

HPPC test application

HPPC is a test procedure developed by the USABC (U.S. Advanced Battery Consortium) for the battery power performance of hybrid and electric vehicles. Within the batteries operation voltage range, the procedure mainly establishes the function of the relationship between the depth of discharge and power and, secondarily, establishes the depth of discharge, conductive resistance and polarization resistance function via the voltage and current response curve from discharging, standing to charging. The measured resistance can be used to assess the battery's power recession during later life tests and its equivalent circuit model development. Chroma 17011 has a flexible editing program that allows HPPC testing.

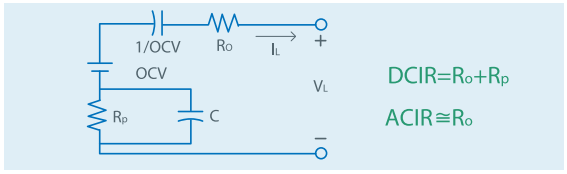


HPPC Test

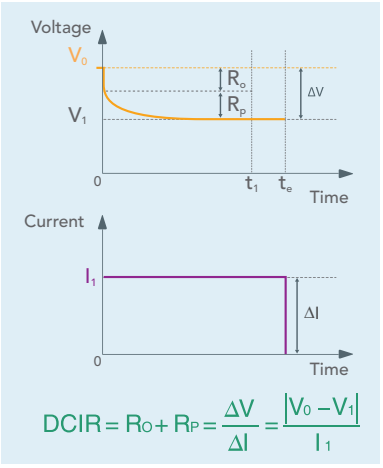
Battery DCIR test application

The internal resistance value is related to the charge/discharge ratio of a battery. The larger the internal resistance value, the lower the efficiency when temperature rises. According to the lithium-ion battery equivalent circuit model, the ACIR measurement of traditional 1KHz LCR meters can only evaluate the conductive resistance (Ro) of the battery that affects the instantaneous power output, but is unable to evaluate the polarization resistance (Rp) produced during electrochemical reaction. The DCIR evaluation includes the ACIR that is closer to the actual polarization effect of battery under continuous power applications.

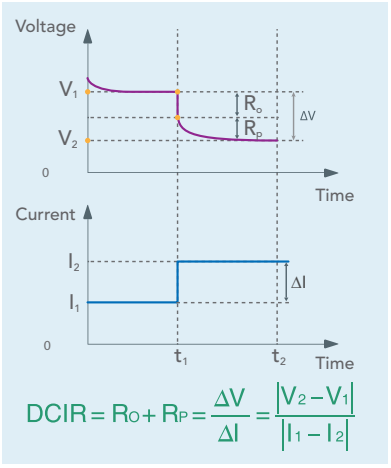
The Chroma 17011 includes two types of DCIR test modes: DCIR test (1) calculates the DCIR value using the voltage difference caused by the change of one-step current, DCIR test (2) calculates the DCIR value using the voltage difference caused by the change of two-step current. Users can select the desired test mode and automatically, without any manual calculation, get the results that comply with IEC 61960 standards.



Lumped parameter model circuit diagram



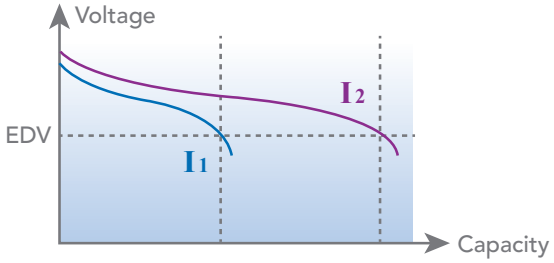
DCIR test (1)



DCIR test (2)

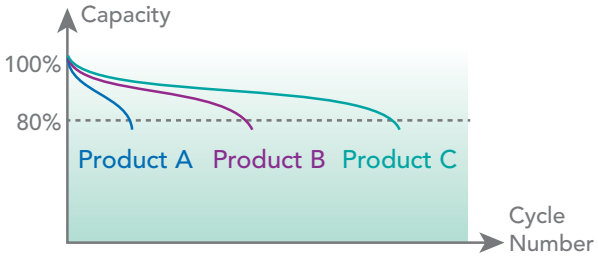
Battery capacity test application

The capacity can be obtained as the integral of the current integrating the current versus time from the start of charging/discharging until the cut-off condition is reached. The comparison results are useful to analyze performance differences between products, and the common test items include current ratio and temperature characteristics tests. Higher accuracy of current, voltage measurement and faster sampling enable to distinguish more accurately the differences in battery cell capacity.



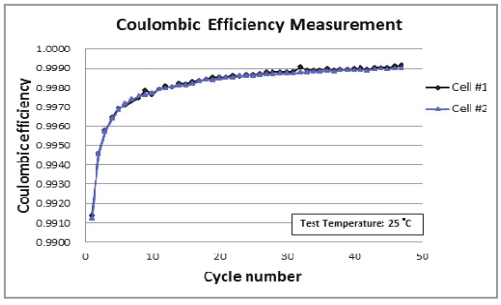
Battery cycle life test application

Cycle life is one of the most important test items for batteries. In accordance with the experimental purpose, it tests the same battery through repeated charge and discharge conditions until the capacity falls to 80%, and calculates the cycle numbers. The cycle life test can be used to evaluate the battery performance or define the applicable conditions of use.



Coulombic efficiency test application

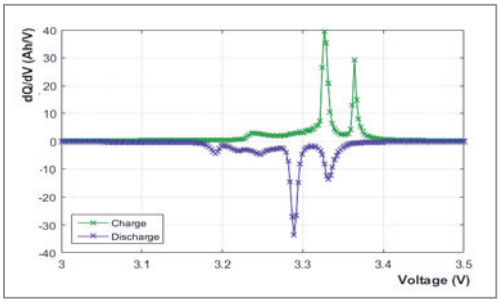
Coulombic efficiency (CE) is calculated by the charge/discharge capacity ratio when the battery is fully charged and then fully discharged. Good batteries have higher coulombic efficiency, and need high precision and stable equipment to distinguish differences. An accurate coulombic efficiency test can estimate the battery lifespan with only a few cycles.



Coulombic efficiency test

Incremental capacity analysis application

The high precision voltage measurement and ΔV sampling function can draw dQ/dV versus voltage curve diagrams to analyze battery cell characteristics and capacity degradation.

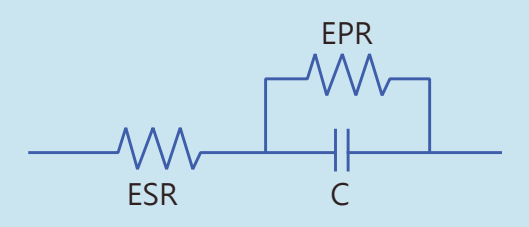


dQ/dV vs voltage

EDLC TEST APPLICATIONS

The equivalent circuit model development of the classical EDLC includes an equivalent series resistance (ESR), a capacitance (C), and an equivalent parallel resistance (EPR). The ESR is used to evaluate the internal loss and heat of the EDLC during charging/discharging; the EPR to evaluate the leakage effect in the EDLC's long-term storage; the C to evaluate the EDLC cycle life.

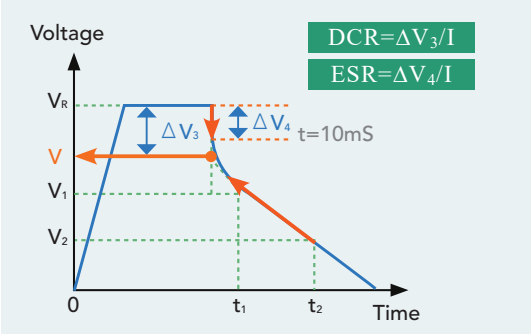
These parameters are not easily directly measured in a laboratory; researchers need data analysis and complex calculations to determine these important indicators. Chroma 17011 is equipped with the IEC 62391 testing standards and the user can use charge/discharge tests to obtain the EDLC parameters values, in order to evaluate the EDLC characteristics and cycle life.



EDLC equivalent circuit model development

EDLC direct current resistance (DCR) and equivalent series resistance (ESR) test application

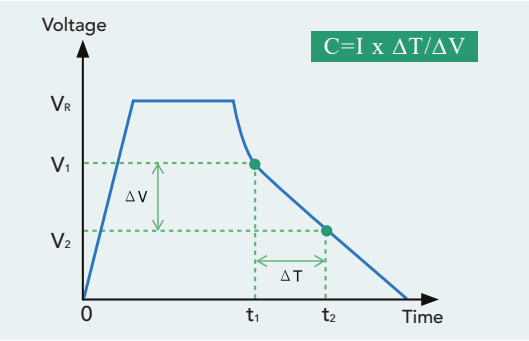
Chroma 17011 offers EDLC direct current resistance testing function compliant with test standard IEC 62391. Before testing, the EDLC has to be CV charged. The capacity test is to discharge CC via the above discharge current. When the discharge is completed, get the linear section on the discharge curve and extend it to discharge time and then get the voltage difference of rated voltage and discharge current to calculate the DCR value.



Voltage Characteristic Between EDLC Terminals

EDLC capacitance (C) test application

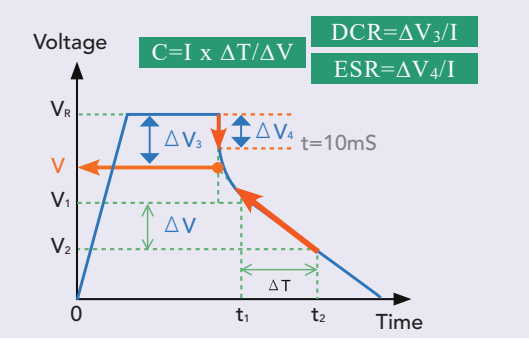
In accordance with the Straight Line Approximation Method of the IEC 62391 testing standard, before measuring the capacitance (C) value, the EDLC first needs to be fully charged through a CC-CV charging mode. The capacity test is to discharge CC via the above discharge current. Then, the electric potential difference (ΔV) of two reference points on the discharge curve are taken against the time difference (Δt) and the discharge current (I) to calculate the capacitance value of the EDLC.



Voltage Characteristic Between EDLC Terminals

EDLC combined DCR and C test application

Chroma 17011 also has a direct current resistance (DCR) and capacitance (C) combined test application. Under the same CC-CV charged and CC discharged conditions, the user can use the electric potential in the chosen reference points to simultaneously calculate the DCR and C values of the EDLC to save testing time.

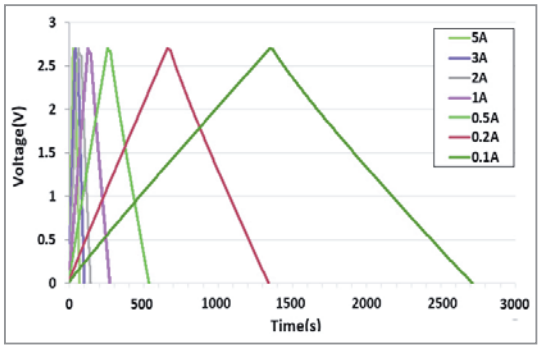


Voltage Characteristic Between EDLC Terminals

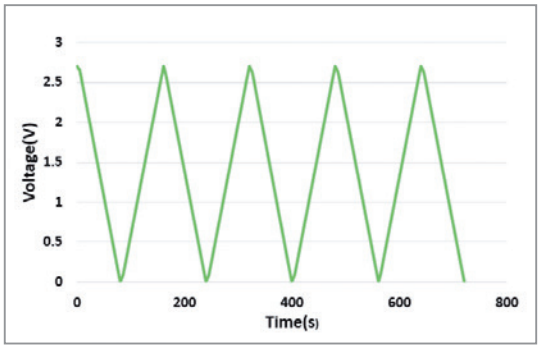
EDLC TEST APPLICATION

Charge/discharge performance and cycle life test application

The built-in direct current resistance (DCR) and capacitance (C) test modes can be combined with cycle function and variable set testing conditions to test the EDLC load endurance and reliability. After testing, the user can directly export DCR vs Cycle No. and Capacity vs Cycle No. reports to analyze the EDLC failure and deterioration mechanisms.



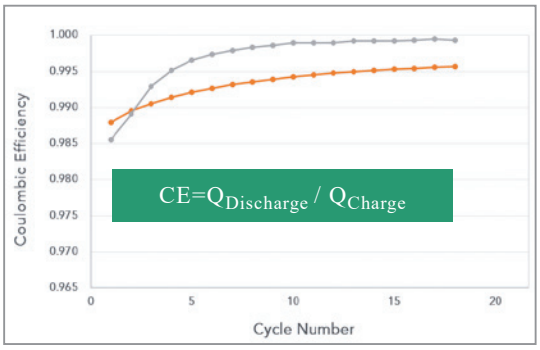
Charge-Discharge Rate Test



Charge-Discharge Cycle Testing

Coulombic efficiency test application

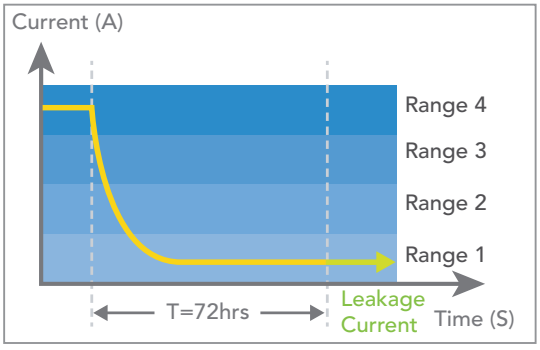
Chroma 17011 is equipped with low noise, automatically switching current range, and cut-off report as to quickly output accurate current charge/discharge. The coulombic efficiency (CE) is calculated by the charge/discharge capacity ratio, which indicates the EDLC internal capacity conversion as available capacity. A highly accurate CE is an important marker to distinguish differences between products.



Coulombic efficiency test

Leakage current test application

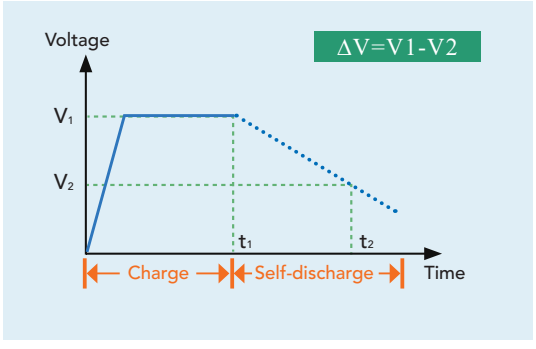
EDLC leakage current measurements generally need to CC-CV charging until a specific time and then it measures this tiny charging current, which is seen as leakage current. The Chroma 17011 CC-CV mode can automatically change current range without output interruption. Under stable voltage, the current range can be as small as 200μA.



Automatically change current range in CC-CV mode

Self-discharge test application

Chroma 17011 also has a built-in self-discharge test mode, when the EDLC is fully charged it can test the charge/discharge for a set time period. When this mode starts, the system will cut off the measuring circuit to provide the ideal open circuit and solely measure the starting potential (V1) and cut-off potential (V2). The software can automatically calculate the electric potential difference (ΔV).



Self-discharge test mode

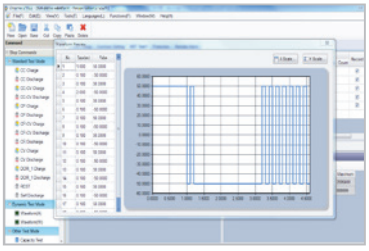
GRAPHICAL SOFTWARE OPERATING INTERFACE

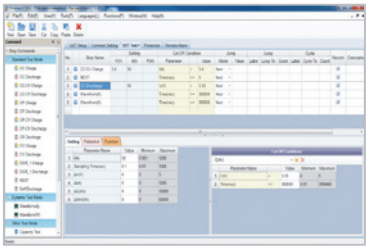
The Chroma 17011 test systems are controlled by computer software with diverse functions for testing energy storage products. The safe, stable and friendly operation interface allows users to perform setting and testing rapidly.

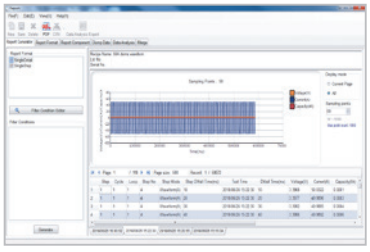
- Support English, Traditional Chinese, and Simplified Chinese languages interfaces
- Real time multi-channel DUT status monitoring
- Security management: set user authority for safe management
- Failure record tracking: independently record abnormalities for each channel, the charge and discharge protection will abort the test when an abnormal condition is detected

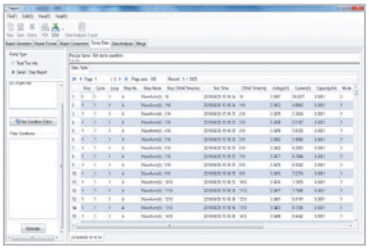
Battery Pro main panel


Real time monitoring


Waveform current editor


Charge/Discharge test program editor


Test diagram


Test report

Recipe editing

- 500 steps per recipe
- Double loop (Cycle & Loop) with 999,999 repeat counts per loop
- Sub-recipe function: Call existing recipes
- Test steps : CC / CV / CP / CC-CV / CP-CV / CR / Rest / Waveform / DCIR / C / DCR, etc.
- Cut-off conditions : Time / Current / Capacity / Power / Variable, etc.
- Logical operations : Next / End / Jump / If-Then

Recipe executing

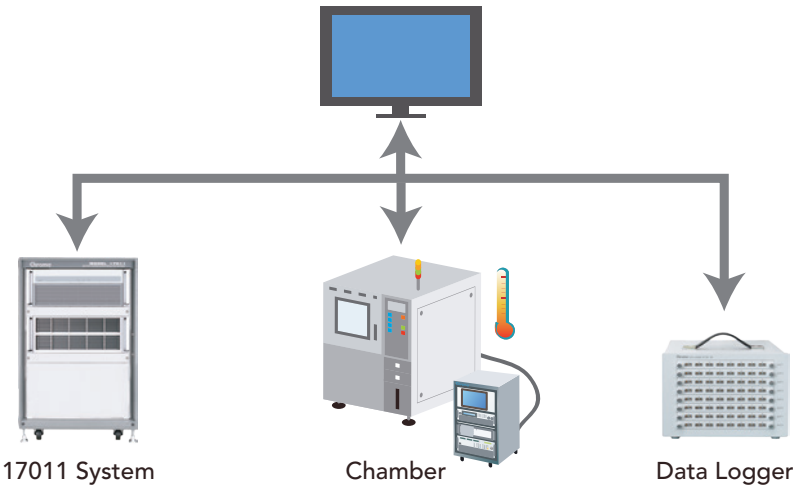
- Operating modes: Start / Stop / Pause / Resume / Jump / Reserve Pause / Modify during test
- Display interfaces: Graphic display / Table display
- Instant monitoring window

Statistics report

- Able to define report formats and export them as PDF, CSV, and XLS files
- Graphical report analysis functions allow custom reports such as cycle life reports, Q-V reports, V / I / T time reports, etc.

SYSTEM INTEGRATION

- Integrate with an environmental chamber through software to synchronize the settings conditions for charge/discharge testing
- Integrate with a multifunctional data logger through software to read and set multiple temperature records during the charge/discharge process. Change these conditions to protection or cut-off conditions



EXTERNAL STRUCTURE

Linear circuit models

The tester can be used stand-alone to take up little space, which fits a handful of tests performed on the desktop. When the tester is configured with more test channels, it can be integrated into a standard 19-inch rack for use. The system can be configured as demanded by the user as the channel numbers are expandable, and up to 64 channels can be controlled by one PC at the same time.

Model 17216M-10-6

Model 17208M-6-30

25U rack

6A/12A/30A
36U rack

60A
36U rack

Model	Dimensions (D x W x H) mm	High
17216M-10-6	697 x 428 x 221	5U
17216M-6-12	697 x 428 x 221	5U
17208M-6-30	733 x 428 x 221	5U

Chassis Size	6A/12A	30A	60A	Dimensions (D x W x H) mm
25U	32 CH *	16 CH *	16 CH	1100 x 600 x 1340
36U	64 CH *	32 CH *	32 CH	1100 x 600 x 1830
41U	--	--	32 CH *	1100 x 600 x 2060

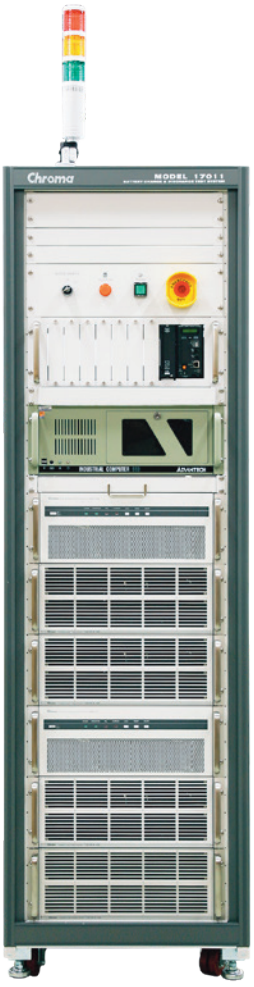
* Available space for data logger

Regenerative models

A charge/discharge tester and an AC/DC bi-direction converter can be integrated into a standard 19-inch rack for use. The system can be configured as demanded by the user as the channel numbers are expandable, and up to 48 channels can be controlled by one PC at the same time.

Chassis Size	60A	100A	Dimensions (D x W x H) mm
25U	24 CH *	12 CH *	1100 x 600 x 1340
36U	48 CH	36 CH	1100 x 600 x 1830
41U	48 CH *	36 CH *	1100 x 600 x 2060

* Available space for data logger



60A / 41U system

100A / 41U system

Chroma 17011 system power consumption

Type	Power	8 CH	12 CH	16 CH	24 CH	32 CH	36 CH	40 CH	48 CH	64 CH	Regenerative
6A	1Φ220V/3Φ380V	--	--	3 kVA	--	5 kVA	--	--	8 kVA	10 kVA	--
12A	1Φ220V/3Φ380V	--	--	3 kVA	--	6 kVA	--	--	9 kVA	12 kVA	--
30A	1Φ220V/3Φ380V	4.5 kVA	--	9 kVA	13 kVA	17 kVA	--	22 kVA	--	--	--
60A	1Φ220V/3Φ380V	9 kVA	--	18 kVA	26 kVA	34 kVA	--	43 kVA	--	--	--
	3Φ220V/3Φ380V	--	9 kVA	--	18 kVA	--	26 kVA	--	35 kVA	--	Yes
100A	3Φ220V/3Φ380V	--	15 kVA	--	29 kVA	--	43 kVA	--	--	--	Yes

ORDERING INFORMATION

17011 : Battery Cell Charge & Discharge Test System

17216M-10-6 : Programmable Charge/Discharge Tester, 10V / 6A, 16CH

17216M-6-12 : Programmable Charge/Discharge Tester, 6V / 12A, 16CH

17208M-6-30 : Programmable Charge/Discharge Tester, 6V / 30A, 8CH

17208M-6-60 : Programmable Charge/Discharge Tester, 6V / 60A, 8CH

17212R-5-60 : Programmable Charge/Discharge Tester, 5V / 60A, 12CH

17212R-5-100 : Programmable Charge/Discharge Tester, 5V / 100A, 12CH

17212M-6-100 : Programmable Charge/Discharge Tester, 6V / 100A, 12CH

A691103 : DC/AC Bi-direction Converter, AC 220V to DC 45V

A691104 : DC/AC Bi-direction Converter, AC 380V to DC 45V

SPECIFICATIONS-1

Model		17216M-10-6		17216M-6-12	
Maximum Voltage/Current		10V/6A		6V/12A	
Maximum Channel		16 Ch. / set (fixed)		16 Ch. / set (fixed)	
Parallelable Current		6A to 96A		12A to 192A	
Voltage					
Range		0V~10V, 0V~5V or -5V~5V		0mV~6000mV	
Accuracy		±0.015% of F.S.		±0.015% of F.S.	
Resolution	Setting	1mV		1mV	
	Reading	0.1mV		0.1mV	
Current					
Range		200μA	0.1μA ~ 200μA	100mA	0.1mA ~ 100mA
		6mA	1μA ~ 6mA	1A	1mA ~ 1A
		200mA	0.1mA ~ 200mA	3A	1mA ~ 3A
		6A	1mA ~ 6A	12A	10mA ~ 12A
Accuracy		± 0.02% of Range		± 0.02% of Range	
Resolution	Setting	0.1μA/1μA/0.1mA/1mA		0.1mA/1mA/1mA/10mA	
	Reading	0.01μA/0.2μA/0.01mA/0.2mA		0.01mA/0.1mA/0.1mA/1mA	
Power					
Setting Range		2mW	1μW~2mW	600mW	0.1mW~600mW
		60mW	10μW~60mW	6W	1mW~6W
		2W	1mW~2W	18W	10mW~18W
		60W	10mW~60W	72W	10mW~72W
Accuracy		± 0.035% of Range		± 0.035% of Range	
Resolution	Setting	1μW/10μW/1mW/10mW		0.1mW/1mW/10mW/10mW	
	Reading	0.1μW/2μW/0.1mW/2mW		10μW/0.1mW/1mW/1mW	
Data Record		10mS			
Current Rise Time (+10% ~ +90%)		100μS		250μS	

Model		17208M-6-30		17208M-6-60	
Maximum Voltage/Current		6V/30A		6V/60A	
Maximum Channel		8 Ch. / set (fixed)		8 Ch. / set (fixed)	
Parallelable Current		30A to 240A		60A to 480A	
Voltage					
Range		0mV~6000mV		0mV~6000mV	
Accuracy		±0.015% of F.S.		±0.015% of F.S.	
Resolution	Setting	1mV		1mV	
	Reading	0.1mV		0.1mV	
Current					
Range		1mA	1μA ~ 1mA	500mA	0.1mA ~ 500mA
		100mA	0.1mA ~ 100mA	5A	1mA ~ 5A
		10A	10mA ~ 10A	15A	10mA ~ 15A
		30A	10mA ~ 30A	60A	10mA ~ 60A
Accuracy		± 0.02% of Range		± 0.02% of Range	
Resolution	Setting	1μA/0.1mA/0.01A/0.01A		0.1mA/1mA/10mA/10mA	
	Reading	0.1μA/0.01mA/1mA/1mA		0.01mA/0.1mA/1mA/1mA	
Power					
Setting Range		6mW	6μW~6mW	3W	1mW~3W
		600mW	0.6mW~600mW	30W	10mW~30W
		60W	60mW~60W	90W	10mW~90W
		180W	0.18W~180W	360W	100mW~360W
Accuracy		± 0.035% of Range		± 0.035% of Range	
Resolution	Setting	1μW/0.1mW/0.01W/0.01W		1mW/10mW/10mW/100mW	
	Reading	0.1μW/0.01mW/1mW/1mW		0.1mW/1mW/1mW/10mW	
Data Record		10mS			
Current Rise Time (+10% ~ +90%)		250μS		250μS	

* All specifications are subject to change without notice.

* Continued on next page

SPECIFICATIONS-2

Model		17212R-5-60	17212R-5-100
Energy Recycling		Yes	Yes
Maximum Voltage/Current		5V/60A	5V/100A
Maximum Channel		12 Ch. / set (fixed)	12 Ch. / set (fixed)
Parallelable Current		60A to 720A	100A to 1200A
Voltage			
Range		0mV ~ 5000 mV	0mV ~ 5000 mV
Accuracy		± (0.02% rdg.+0.02% of FSR)	± (0.02% rdg.+0.02% of FSR)
Resolution	Setting	1mV	1mV
	Reading	0.1mV	0.1mV
Current *1			
Range		50mA ~ 60A	50mA ~ 100A
Accuracy		± (0.05% rdg.+0.05% of FSR)	± (0.05% rdg.+0.05% of FSR)
Resolution	Setting	10mA	10mA
	Reading	1mA	1mA
Power			
Setting Range		0.05W ~ 300W	0.05W ~ 500W
Accuracy		± (0.07% rdg.+0.07% of FSR)	± (0.07% rdg.+0.07% of FSR)
Resolution	Setting	0.1% of FSR	0.1% of FSR
	Reading	0.01% of FSR	0.01% of FSR
Data Record		10ms	
Current Rise Time (+10% ~ +90%)		25mS	25mS

Model		17212M-6-100	
Energy Recycling		Yes	
Maximum Voltage/Current		6V/100A	
Maximum Channel		12 Ch. / set (fixed)	
Parallelable Current		100A to 1200A	
Voltage			
Range		0mV ~ 6000 mV	
Accuracy		± (0.02% rdg.+0.02% of FSR)	
Resolution	Setting	1mV	
	Reading	0.1mV	
Current *1			
Range		25A	2mA ~ 25A
		50A	5mA ~ 50A
		100A	10mA ~ 100A
Accuracy		± 0.05% of F.S.	
Resolution	Setting	1mA/5mA/10mA	
	Reading	0.1mA/0.5mA/1mA	
Power			
Setting Range		150W	10mW~150W
		300W	30mW~300W
		600W	60mW~600W
Accuracy		± 0.09% of F.S.	
Resolution	Setting	10mW	
	Reading	1mW	
Data Record		10mS	
Current Rise Time (+10% ~ +90%)		10mS	

Note*1: The maximum discharge current will derate at low voltage range between 1V to 0V.
* All specifications are subject to change without notice.

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