



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 helpful to characteristic research, cycle life testing, product screening, and quality assessment.

The Chroma 17011 has developed linear circuit and regenerative AC/DC bidirectional test systems for different applications. The linear circuit test system featured in extremely low output noise and high measurement accuracy is suitable for testing energy storage components in small and medium sizes. The regenerative bidirectional test system with high efficiency, power saving, low heat, and stable measurement capabilities is applicable for testing energy storage components in medium and large size or power type battery cells to meet the low carbon emission production for the green energy industry.

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 to comply with the international standards that made the

programs 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 function to securely store the data in a non-volatile memory in case of a power outage or disconnected communication to prevent potential data loss and resume the tests after reboot.

Since safety is very important for testing lithium-ion battery cells, the design of Chroma 17011 offers a variety of safety protections such as performing contact check and polarity check before the test starts to avoid testing under poor connection. Besides the intrinsic hardware circuit protection, the user can customize the firmware to detect overvoltage (OVP), over current (OCP), over capacity (OQP), voltage / current variation ($\Delta V / \Delta I$), loop resistance and other abnormal conditions to safeguard the lithium-ion battery cells.



MODEL 17011

KEY FEATURES

- High precision output and measurement up to 0.02% of F.S.
- Fast current response up to $<100 \mu\text{s}$
- High sampling rate up to 10 mS
- Flexible sampling recording (Δt , ΔV , ΔI , ΔQ , ΔW)
- Channel parallel output function with maximum 1200A output
- High efficiency charge and discharge with low heat
- Energy recycling during discharge (AC/DC bi-directional regenerative series)
- Waveform simulation function (current/power mode)
- Built-in DCIR test function
- Built-in HPPC 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
- Integrating data logger and chamber

APPLICATIONS

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



Chroma



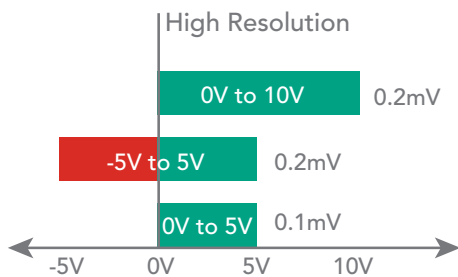
Model 17216M-10-6



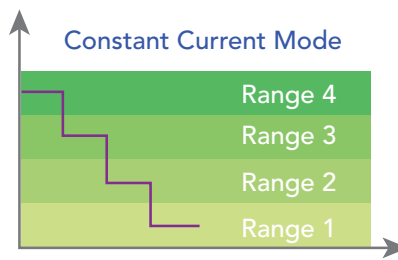
Model 17208M-6-30

High precision – improving product quality

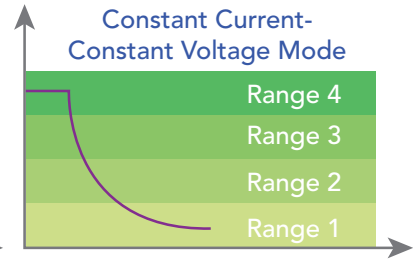
- Voltage / current measurement accuracy: $\pm 0.015\%$ of F.S. / $\pm 0.02\%$ of F.S.
- Multiple range measurement design: Provide multiple current or voltage ranges based the models to greatly improve the measurement accuracy and resolution. The current range switches automatically without any current output interruption at constant voltage mode.



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

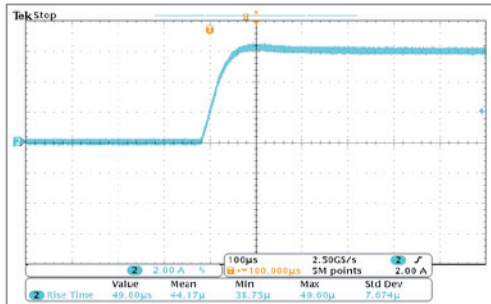


Multi-Current Range

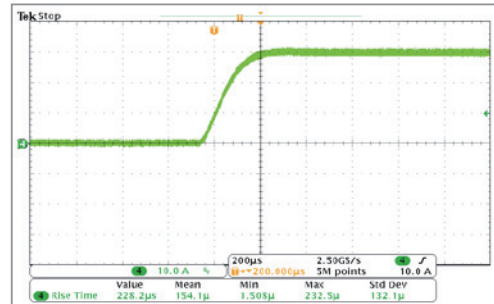


Fast current response – suitable for a variety of high-speed transient test applications

- Current response speed (10% to 90%) $< 100 \mu\text{s}^*$
- Support dynamic waveform to simulate the rapid changing current and power states



Rise Time $< 100 \mu\text{s}$ (17216M-10-6)

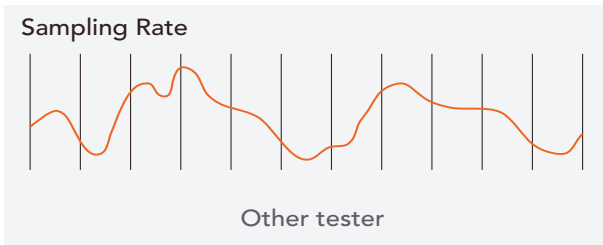


Rise Time $< 250 \mu\text{s}$ (17208M-6-30)

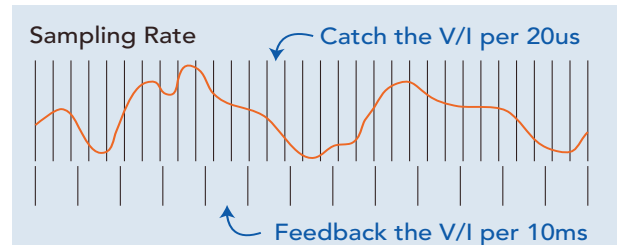
High frequency sampling measurement technology – improving measurement accuracy

- V / I sampling rate: 50 KHz ($\Delta t : 20 \mu\text{s}$)

Generally, battery tester 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 speed of model 17216M-10-6 is $< 100 \mu\text{s}$, also the impedance of UUT may different slightly.

REGENERATIVE BIDIRECTIONAL TEST SYSTEMS



5V
60A

AC/DC Bi-direction
Converter A691104

Charge & Discharge
Tester 17212R-5-60
12~48 CH per rack



5V
100A

AC/DC Bi-direction
Converter A691104

Charge & Discharge
Tester 17212R-5-100
12~36 CH per rack



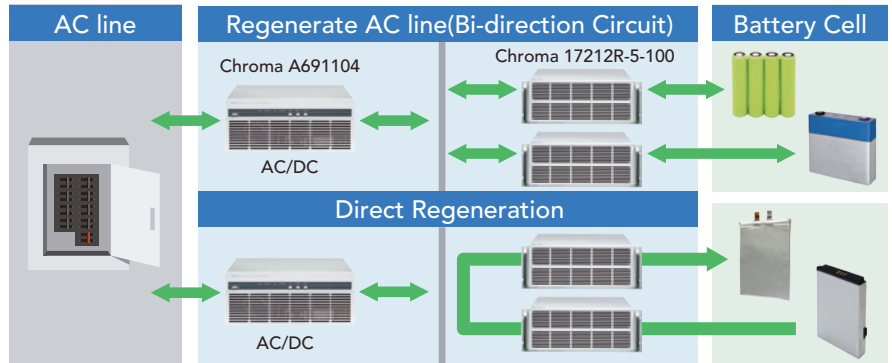
6V
100A

AC/DC Bi-direction
Converter A691104

Charge & Discharge
Tester 17212M-6-100
12~36 CH per rack

Energy recycling – optimal utilization of electricity

- Direct recycling: Automatically transfer the discharging energy to the battery cell to be charged with recycling efficiency >80%
- Grid recycling: Recycle the excessive energy to the grid with recycling efficiency >65%
- Implementation of low carbon emissions for green energy to prevent waste heat from generating during discharge
- Saving electricity costs with high efficiency power charge and discharge
- Saving air conditioning costs on cooling equipment
- Total harmonic distortion <5% for equipment feedback to grid current
- Power factor >0.9 at rated power

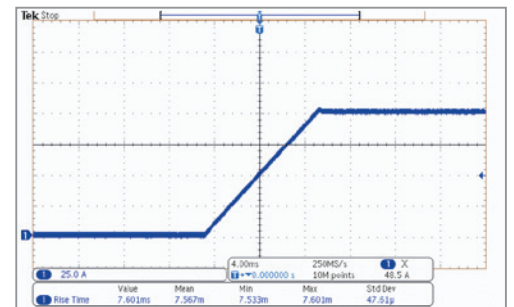


High precision – improving product quality

- Voltage accuracy: $\pm(0.02\% \text{ of Reading} + 0.02\% \text{ of F.S.})$
- Current accuracy: $\pm(0.05\% \text{ of Reading} + 0.05\% \text{ of F.S.})$

Fast current response – waveform mode

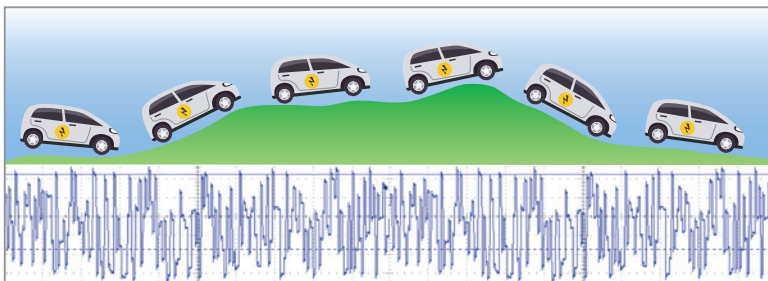
- Current response speed (10% to 90%) < 10 mS applicable for all kinds of tests
- Support dynamic waveform to simulate the current and power state of actual driving with NEDC, FUDS and DST test standards



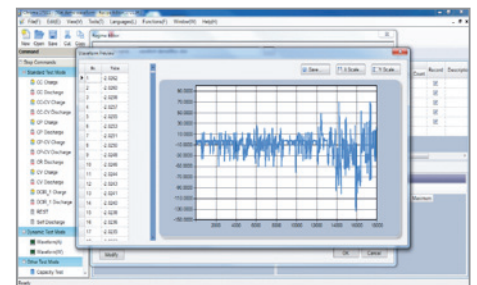
Rise time < 10mS

DYNAMIC WAVEFORM SIMULATION

- Simulate dynamic charge/discharge waveform of actual battery usage. In the dynamic current mode (waveform), the fastest switching time of maximum discharge and charge current is 10 mS
- Import the current and power waveforms from Excel file
- Save 720,000 points in each channel for long hour dynamic testing
- Minimalize time interval for data output: 10 mS



Dynamic waveform simulation

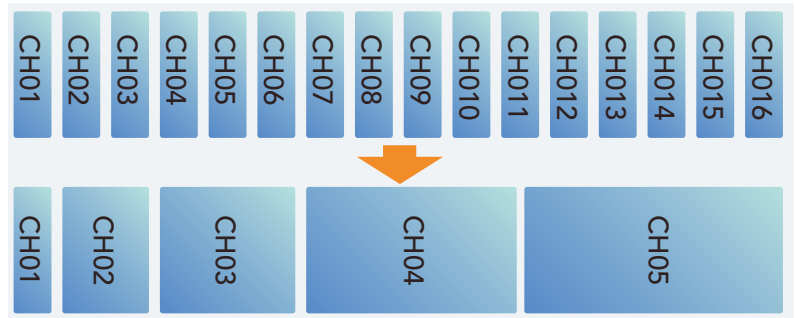


Loading waveform current

FLEXIBLE PARALLELING CHANNELS FOR OUTPUT

The test system allows flexible setting for paralleling channels to provide higher current application for multi-channels and broad testing ranges, which are suitable for numerous 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

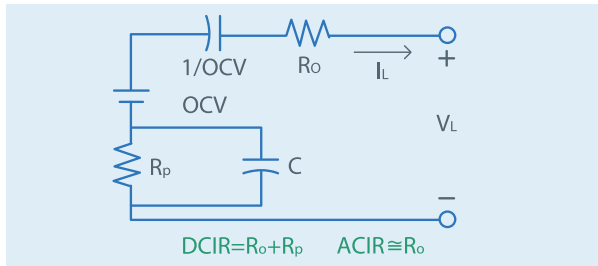


Flexible paralleling channels control

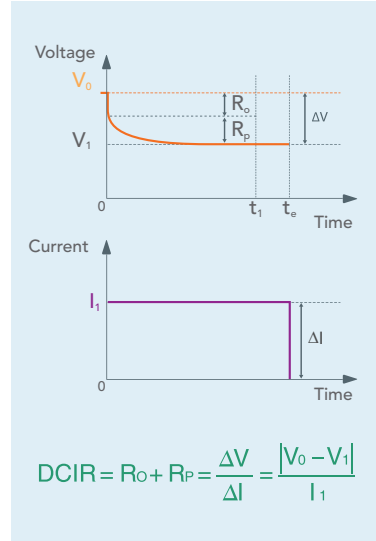
BATTERY DCIR TEST APPLICATION

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 meter can only evaluate the conductive resistance (R_o) of the battery that affects the instantaneous power output, but unable to evaluate the polarization resistance (R_p) caused during electrochemical reaction. The DCIR evaluation includes the ACIR that is closer to the actual polarization effect of battery under continuous power applications.

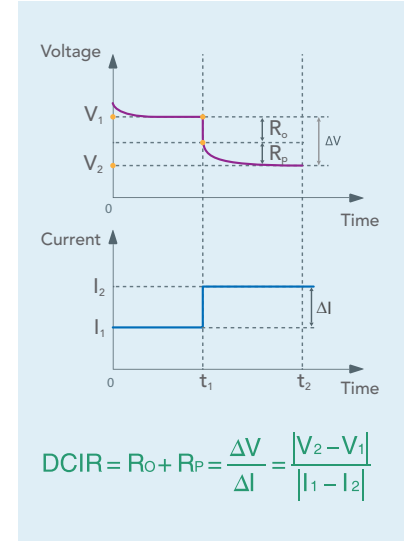
The Chroma17011 has built in two types of DCIR test modes: DCIR test (1) to calculate the DCIR value using the voltage difference caused by the change of one-step current, DCIR test (2) to calculate the DCIR value using the voltage difference caused by the change of two-step current. Users can select the test mode as desired to get the results that comply with IEC 61960 standards automatically without any manual calculation.



Lumped parameter model circuit diagram



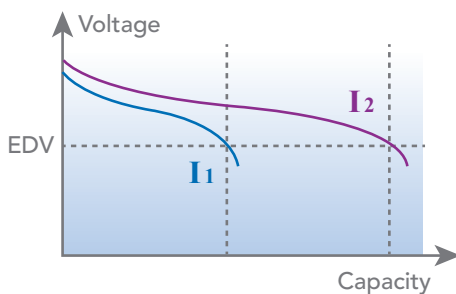
DCIR test (1)



DCIR test (2)

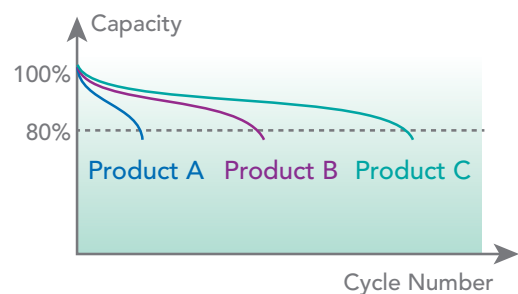
BATTERY CAPACITY TEST APPLICATION

The capacity can be obtained by integrating the current with respect to time from starting charging and discharging to the end of cut-off condition. The comparison results can be used to analyze the performance of a product, and the common test items include current ratio and temperature characteristics tests. The higher accuracy of current, voltage measurement and the faster of sampling can more accurately distinguish the difference of battery cell capacity.



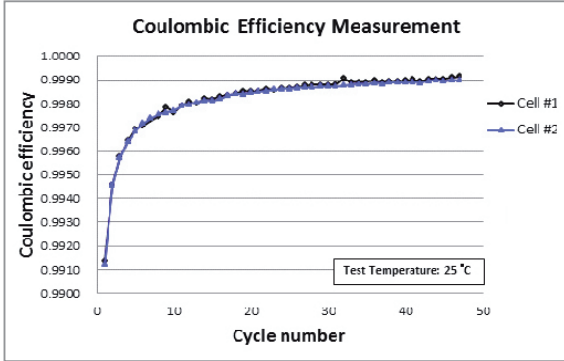
BATTERY CYCLE LIFE TEST APPLICATION

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.



COULOMBIC EFFICIENCY TEST APPLICATION

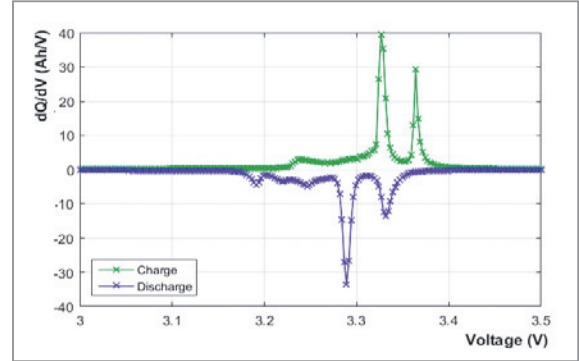
Coulombic efficiency is calculated by the ratio between charge and discharge capacity when the battery is fully charged and discharged. A good battery has higher coulombic efficiency, and needs high precision and stable equipment to distinguish the differences. An accurate coulombic efficiency test can estimate the battery lifespan with a few cycles.



Coulombic efficiency test

INCREMENTAL CAPACITY ANALYSIS APPLICATION

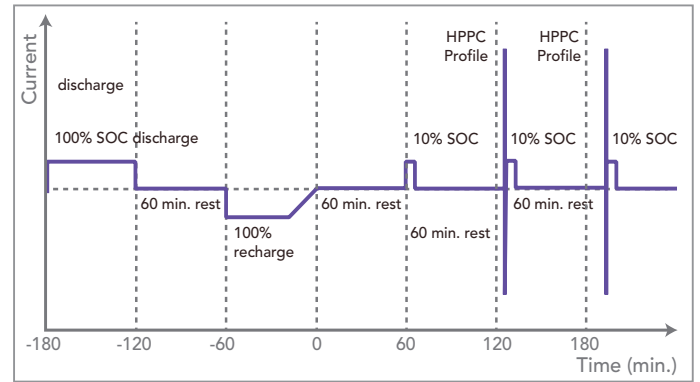
The high-precision voltage measurement and ΔV sampling function can draw dQ/dV vs voltage curve diagrams for battery cell characteristics and capacity degradation analysis.



dQ/dV vs voltage

HPPC TEST APPLICATION

HPPC is a test solution created by the USABC (U.S. Advanced Battery Consortium) that tests the battery power performance of hybrid and electric vehicles. The main purpose of the test is to establish the function of the relationship between the depth of discharge and power within the batteries operation voltage range, with the secondary purpose of establishing the depth of discharge, conductive resistance and polarization resistance function via the voltage and current response curve from discharging, standing to charging within the battery voltage range. The measured resistance can be used to assess the power recession of the following life test and the equivalent circuit model development of power battery. The user can automatically obtain the test results that comply with the HPPC standards without any manual calculation.

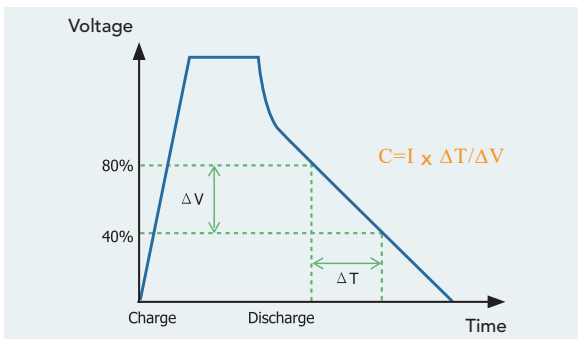


HPPC test

EDLC TEST APPLICATION

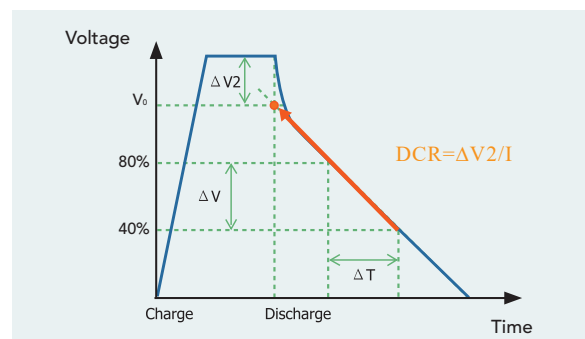
EDLC capacitance testing

According to the EDLC testing standard IEC 62391, the EDLC has to be CV charged before testing the capacity. The capacity test is to discharge CC via the above discharge current. Then, get the EDLC voltage difference, time interval and discharge current to calculate the EDLC capacity.



EDLC internal resistance (DCR) testing

According to the EDLC DCR test standard IEC 62391, the EDLC has to be CV charged before testing the capacity. The capacity test is to discharge CC via the above discharge current. When the discharge is done, 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.



GRAPHICAL SOFTWARE OPERATING INTERFACE

The Chroma 17011 test system is controlled by computer software with diverse functions for testing energy storage products. It has high safety, stability and friendly operation interface allowing users to perform setting and testing rapidly.

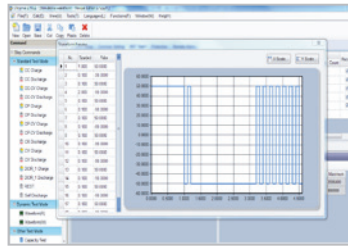
- Support Traditional Chinese, Simplified Chinese and English three languages interface
- Real time system status monitoring
- Security management: Able to set user authority for management
- Failure record tracking: Independent channel to record abnormality, charge and discharge protection will abort the test when an abnormal condition is detected



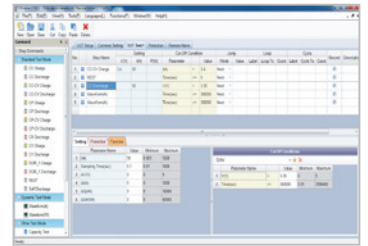
Battery Pro main panel



Real time monitoring



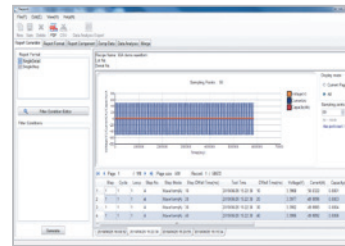
Waveform current editor



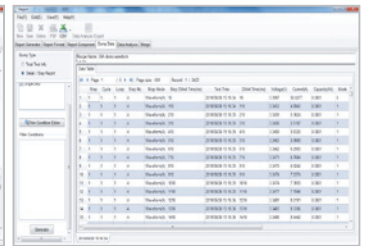
Charge/Discharge test program editor

Recipe editing

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



Test diagram



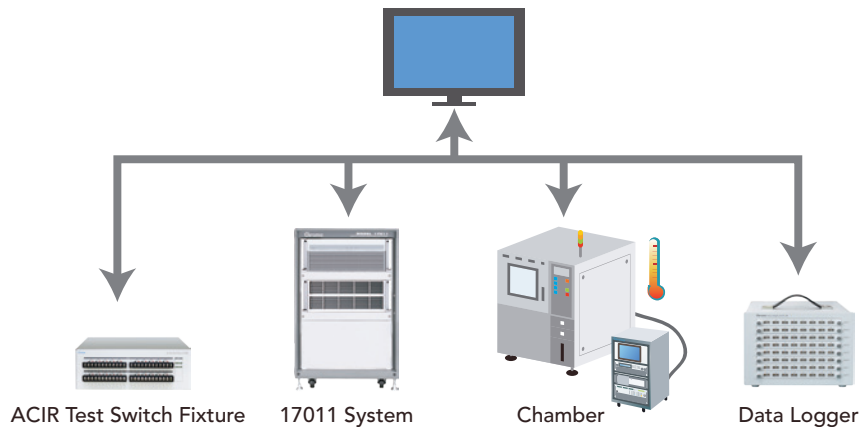
Test report

Statistics report

- Able to define report format to export PDF, CSV and XLS files
- Graphical report analysis function: Custom reports such as cycle life reports, Q-V reports, V / I / T time reports, etc. are allowed.

SYSTEM INTEGRATION

- Integrating with environmental chamber through software can do sync settings conditions for charge/discharge testing
- Integrating with multifunctional data logger through software can read multiple temperature records during charge/ discharge process, and the conditions can turn to protection or cut-off conditions
- Integrating with ACIR test fixture through software can measure the ACIR in rotation when the 1KHz ACIR test switch fixture is in use



PC EXCEPTION ALLOWED

- Maintaining operation: When error occurs on PC or the connection is interrupted during testing, if the 17011 power is not out, the test will continue and save the data in memory. Restore PC connection before the memory is depleted and the data can be retrieved to maintain operation.
- Test recovery: If the entire factory is having power outage, the 17011 will save the executed commands in memory and restart after the problem is solved. When the PC receives the commands, it can choose to resume the test step stopped at power outage or to start the testing again.

TEST SYSTEM CONFIGURATION

Linear circuit models

The tester can be used standalone in a small space, which is suitable for a handful of tests performed on the desktop. When the tester is configured with many 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 at the same time.



Model 17216M-10-6



Model 17208M-6-30

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



6A / 36U rack



30A / 36U rack



25U rack

Chassis Size	6A	30A	Dimensions (D x W x H) mm
25U	32 CH *	16 CH *	1100 x 600 x 1340
36U	64 CH *	32 CH *	1100 x 600 x 1830
41U	--	40 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 integrate into a standard 19 in. 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 a PC at the same time.



60A / 41U rack



100A / 41U rack

Chassis Size	60A	100A	Dimensions (D x W x H) mm
25U	12 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

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
6A	1 Φ 220V/3 Φ 380V	--	--	3 kVA	--	5 kVA	--	--	8 kVA	10 kVA
30A	1 Φ 220V/3 Φ 380V	4.5 kVA	--	9 kVA	13 kVA	17 kVA	--	22 kVA	--	--
60A	3 Φ 220V/3 Φ 380V	--	9 kVA	--	18 kVA	--	26 kVA	--	35 kVA	--
100A	3 Φ 220V/3 Φ 380V	--	15 kVA	--	29 kVA	--	43 kVA	--	--	--

ORDERING INFORMATION

17011 : Battery Cell Charge & Discharge Test System

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

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

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

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

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

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% of Reading + 0.02% of F.S.)		±(0.02% of Reading + 0.02% of F.S.)	
Resolution	Setting	1mV	1mV	
	Reading	0.1mV	0.1mV	
Current *1				
Range	50mA ~ 60A		50mA ~ 100A	
Accuracy	±(0.05% of Reading +0.05% of F.S.)		±(0.05% of Reading +0.05% of F.S.)	
Resolution	Setting	10mA	10mA	
	Reading	1mA	1mA	
Power				
Setting Range	0.05W ~ 300W		0.05W ~ 500W	
Accuracy	±(0.07% of Reading +0.07% of F.S.)		±(0.07% of Reading +0.07% of F.S.)	
Resolution	Setting	10mW	10mW	
	Reading	1mW	1mW	
Data Record			10ms	
Current Rise Time (+10% ~ +90%)	25mS		25mS	

Model	17216M-10-6		17208M-6-30	
Maximum Voltage/Current	10V/6A		6V/30A	
Maximum Channel	16 Ch. / set (fixed)		8 Ch. / set (fixed)	
Parallelable Current	6A to 96A		30A to 240A	
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	1mA	1µA ~ 1mA
	6mA	1µA ~ 6mA	100mA	0.1mA ~ 100mA
	200mA	0.1mA ~ 200mA	10A	10mA ~ 10A
	6A	1mA ~ 6A	30A	10mA ~ 30A
Accuracy	± 0.02% of Range		± 0.02% of Range	
Resolution	Setting	0.1µA/1µA/0.1mA/1mA	1µA/0.1mA/0.01A/0.01A	
	Reading	0.01µA/0.2µA/0.01mA/0.2mA	0.1µA/0.01mA/1mA/1mA	
Power				
Setting Range	2mW	1µW~2mW	6mW	6µW~6mW
	60mW	10µW~60mW	600mW	0.6mW~600mW
	2W	1mW~2W	60W	60mW~60W
	60W	10mW~60W	180W	0.18W~180W
Accuracy	± 0.035% of Range		± 0.035% of Range	
Resolution	Setting	1µW/10µW/1mW/10mW	1µW/0.1mW/0.01W/0.01W	
	Reading	0.1µW/2µW/0.1mW/2mW	0.1µW/0.01mW/1mW/1mW	
Data Record			10mS	
Current Rise Time (+10% ~ +90%)	100µS		250µS	

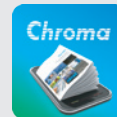
Note*1: The maximum discharge current will derate at low voltage range between 1V to 0V.

* All specifications are subject to change without notice.

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