

Battery Cell Charge & Discharge Test System



Battery Cell Charge & Discharge Test System Model 17011 Series

Chroma 17011 Programmable Charge/Discharge Test System is a high precision equipment designed specifically for testing Lithium-ion secondary batteries and Electrical Double Layer Capacitors(EDLC). It is suitable for cycle life testing, incoming and shipping inspection, product characteristics screening, material experiment and small batch trial run. The system is composed of Chroma 17200 Series Charge/Discharge Tester with Chroma 62000B Series Modular DC Power Supply or Chroma A691103 DC/AC Bi-directional Converter.

Chroma 17011 has fast output and measurement recording capability with highly accurate specification to assure the test quality. Its stable performance is applicable for various tests requiring reliable data. The flexible programming function is capable of sending recipe to each channel for independent test. Moreover, the design of multi-channel architecture can be configured based on the test requirement. The test channel supports parallel output that can be setup flexibly for large current tests. The application range covers various types of single lithium-ion battery testing in different capacities.

62000B Series is the power input of charge/discharge tester. Its redundancy DC power supply structure can assure the stability and reliability of lift test when conducted for a long period without interruption due to power failure. If any power module is failure during the process, the redundancy power module will increase the output to support stable power supply.

When 17011 system configure 17212R-5-100 for high current charge/discharge testing application, Chroma A691103 DC/AC Bi-direction converter will be the DC power source. This power source will transfer the battery discharged energy to charging channels to lower system power requirement. On the other hand, once discharging energy is higher than battery charging and system requirement, this converter will transfer the power back to facility grid. This feature will not only recycling energy and decreasing AC power requirement, but also reduce heat effect. It helps to reduce air condition costs and extend system life.

Chroma 17011 uses Ethernet interface to connect an external computer to control and program each channel independently with multiple test modes built in. It is able to implement the charge and discharge tests of CC-CV, CC, CP, battery DCIR tests, capacitance tests for EDLC and DCR tests. The step conversion is performed based on the time, voltage, current or power set in each test mode; while the data collected contains the returned test step, status, voltage, current and capacity. In addition, sampling via the conditions of time, voltage, current or capacity can be set for selection flexibly.

In battery test, besides life cycle experiment and capacity test, the battery internal resistance test is a very important part to power battery. DCIR is the initial of DC internal resistance which is the output hinder caused by the internal characteristic when a battery is loading the current. The value comes from physics conduction resistance plus the sum of chemical energy and electrical energy derived from equivalent resistance form the DCIR. 1701X system has built in two types of DCIR modes that can get the DCIR values rapidly and accurately through various settings of load current and measurements of precision voltage change with $R = \Delta V / \Delta I$ calculation formula to lower down the human calculation error.

The built-in IEC 62391 (same as EIAJ-2377) for capacitance and DCR measurement solution are supplied for EDLC tests, which allows the user to utilize the standard to calculate the capacitance and internal resistance value without programming and data calculation.

Multiple safety designs are made for Chroma 17011 for testing such as contact check and polarity check to confirm the circuit status before the test starts, also to ensure the safety of charge and discharge. It has over voltage, over current and loop resistance detecting functions to make sure the safety of test process. It also has data archive mechanism to store the data in memory without loss.

MODEL 17011 Series

Key Features:

- High precision output and measurement up to 0.02%
- Independent operation and test
- Channel parallel output function maximum 600A
- High Sampling Rate up to 10ms
- CC/CC-CV/CP Charge/Discharge modes
- Flexible (Δt , ΔV , ΔI , ΔQ), data acquisition
- Real-time data acquisition and log (Q, Vt, It, time) and step termination status(Q, V_end, I_end, time)
- Linear circuit design, low ripple current (17202-5-20 & 17202-5-30)
- Build-in two battery DCIR test mode to get DCIR values rapidly and accurately($DCIR = R_o + R_p$, $ACIR = R_o$)
- Build-in EDLC capacitance (F) and DCIR test functions to provide prompt and accurate test results. (17202-5-20 & 17202-5-30 only)
- Real-time outer loop resistance monitoring
- Modular design for easy installation and maintenance (17202-5-20 & 17202-5-30 only)
- Composed with redundancy DC power supply, avoid the effect for long term test during power down(62000B only)
- Discharging energy recycle function (A691103 only)

Functions:

- Battery charge & discharge test
- Battery capacity and DCIR test
- EDLC charge & discharge test (17202-5-20 & 17202-5-30 only)
- EDLC capacitance and DCR (17202-5-20 & 17202-5-30 only)

Applications:

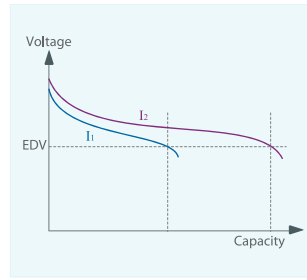
- Charge & discharge life cycle test
- OQC test
- IQC test
- Battery characteristic analysis
- Material test
- Production trial run
- Battery cell voltage balance



Chroma

BATTERY CAPACITY TESTING

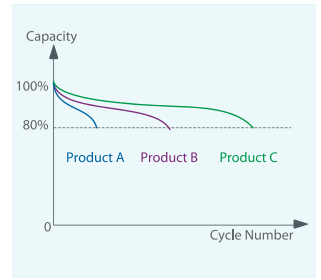
The capacity of battery cell is usually the integral of discharge current and time. Thus, the discharge current during capacity test may affect the test for last capacity. Though every battery has labeled the manufacture specification, and uses 0.2C or 0.3C for capacity test commonly, the dynamic battery often performs charge and discharge higher than 0.2C or 0.3C. If only spec is referred for setting the power battery capacity, it may differ from the actual capacity. For practical use, the final battery charge and discharge rate should be referred for battery cell test to get a more accurate capacity.



Capacity Measurement

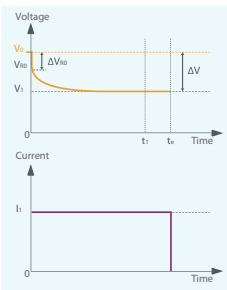
BATTERY CYCLE LIFE TESTING

The battery charge and discharge cycle life testing is not only required by power battery but all battery cells under the same test conditions. The test uses predefined charge/discharge conditions as a cycle to test the same cell repeatedly and evaluates the cycles executed for battery before the end condition is met. The more cycles indicate the longer battery cell life. The same test conditions can be used to test various battery cells for performance appraisal or to assess the most suitable charge/discharge and usage conditions.

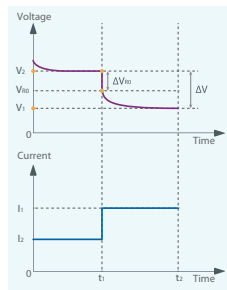


Cycle Life Testing

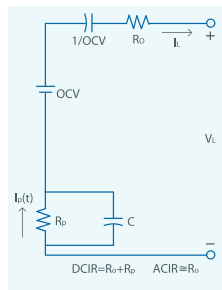
DCIR TESTING



DCIR Test (1)



DCIR Test (2)



Lumped Parameter Model Circuit Diagram

$$DCIR = R_0 + R_p = \frac{\Delta V}{\Delta I} = \frac{|V_0 - V_1|}{I_1}$$

$$ACIR \cong R_0 = \frac{\Delta V_{RO}}{\Delta I} = \frac{|V_0 - V_{RO}|}{I_1}$$

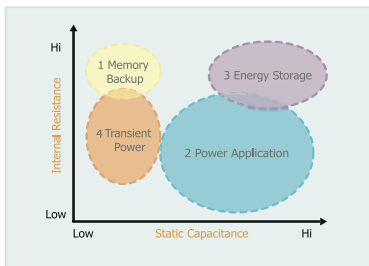
$$DCIR = R_0 + R_p = \frac{\Delta V}{\Delta I} = \frac{|V_2 - V_1|}{|I_1 - I_2|}$$

$$ACIR \cong R_0 = \frac{\Delta V_{RO}}{\Delta I} = \frac{|V_2 - V_{RO}|}{|I_1 - I_2|}$$

The value of internal resistance value is related to the charge/discharge current of power battery. The larger internal resistance the worse efficiency with temperature rising. The traditional LCR meter 1KHz measurement can only assess the battery sudden power output hinder caused by the resistive conductivity close to R_0 (near ACIR), but unable to assess the delay caused during electrochemistry transition. According to the equivalent circuit diagram in Figure 3, the DCIR assessment includes the resistance of ACIR. Thus, all cells used by power batteries should be assessed by DCIR. The assessment of DCIR complies to BS EN 61960 that can apply this test waveform to calculate the DCIR value using the current and voltage difference through two different loading currents.

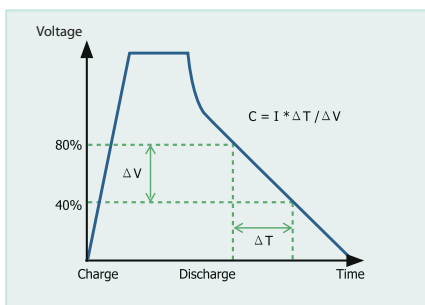
EDLC CAPACITANCE & DCIR TEST APPLICATION

The EDLC test follows the actual product application to divide the test conditions. Based on the category of IEC 62391 standard, there are 4 the basic EDLC product application: 1. Memory Backup, 2. Power Application, 3. Energy Storage, 4. Transient Power. Different test applications indicate different test condition and the tester should select suitable test equipment and current with accurate test device.



EDLC Capacitance Testing Curve

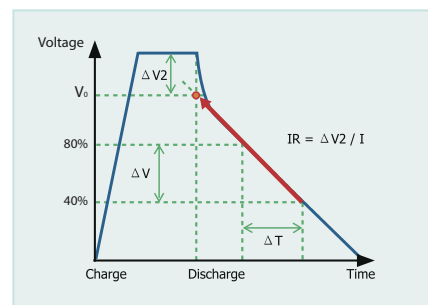
According to the EDLC test standard IEC 62391, the EDLC has to be CV charged before testing the capacity. The capacity test is to discharge CC via the above discharge current. Then, get 80% and 40% voltage points of EDLC rated voltage on the discharge curve when done and use the actual voltage drop and spacing time with discharge current to calculate the EDLC capacity.



Type	EDLC Types			
	1 Memory Back Up	2 Power Application	3 Energy Storage	4 Transient Power
I for C (mA)	1*C	4*CV	0.4*CV	400*CV
I for IR (mA)	10*C	40*CV	4*CV	400*CV

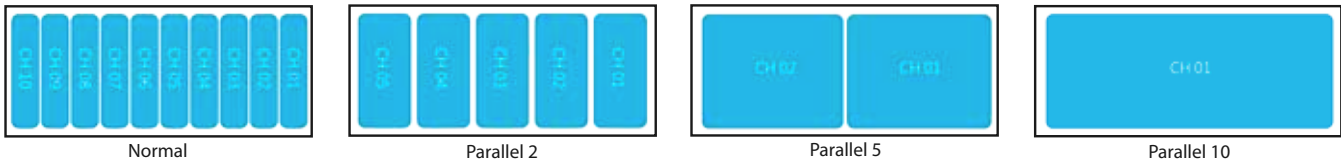
EDLC Internal Resistance (DCIR) Testing Curve

According to the EDLC test standard IEC 62391, same as the steps for testing DCIR, the EDLC has to be CV charged before testing the DCIR. 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 DCIR value.

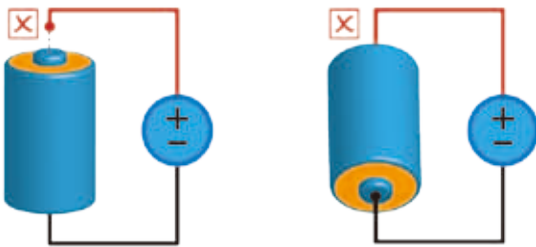


CHANNEL PARALLEL FUNCTION

The 17011 system supports channel parallel function. The test channel can use the common factor of maximum test channel number as the parallel condition for the user to set different channel for current testing. The maximum output current is up to 600A and the paralleled channel still remains as independent control characteristics that make the testing channel more exible.

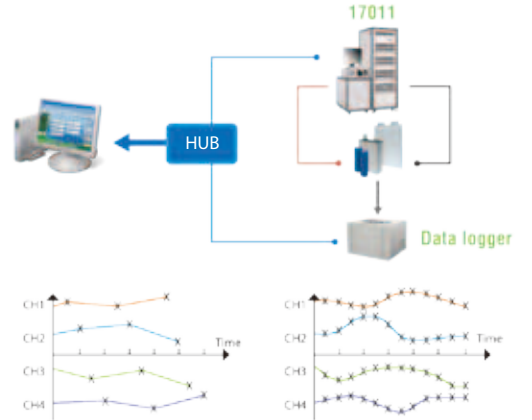


POLARITY & CONTACT



Poor contact will cause battery cell test failure and wrong polarity contact will cause safety concern of test operator & environment. In order to solve these issues, Chroma 17011 test system provides polarity check before test started. During test system will happen alarm when the loop resistance of poor contact reaches to pre-definded value to protect test operator and environment.

TEMPERATURE MEASUREMENT INTEGRATION



What other data loggers see, more channels, slower rate each channel

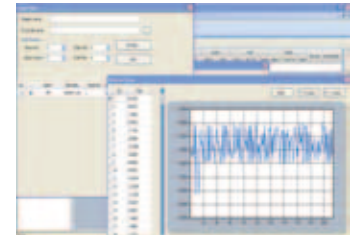
What CHROMA data loggers see, constant rate each channel

Chroma 17011 system integrated Chroma 51101 data logger and set maximum 8 temperature measurement point per test channel. Chroma 51101 has parallel data time logging function can support measurement with constant data logging. As the figure above without parallel data logging, the reading might be error because the time difference.

DRIVING CYCLE SIMULATION

The power battery cell is always is used at quick and un-regular current condition. The system simulates the real condition on battery cell by working condition simulator.

- Import dynamic charge/discharge power or current waveforms to simulate the DRIVE CYCLE or the actual application.
- Support Excel (xls) format
- There are 720,000 points of driving profile memory to save the waveform profile in each channel.
- Interval time Δt : 10ms~999s



CHARGE/DISCHARGE TESTING SYSTEM SOFTWARE

17011 Test system is specially designed to meet the various requirements for testing secondary battery cells and EDLC 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.

Independent Channel Control

- Real-time multi channel battery cell status browse

Report and Curve

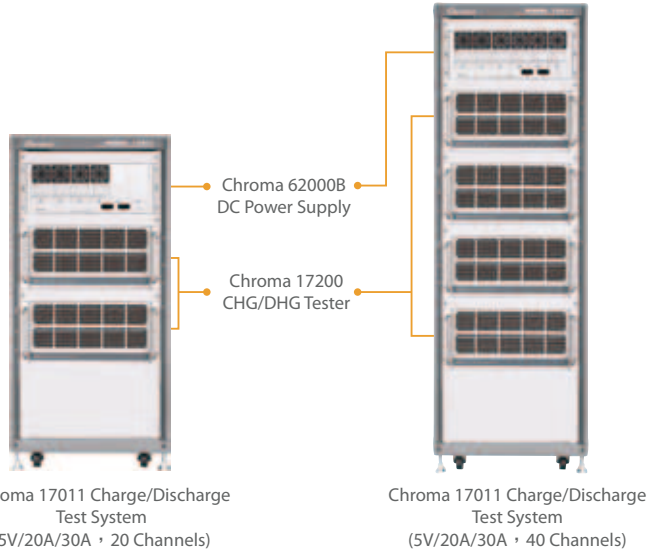
- Diversified report & charts : Real-time report, Cut-off report, X-Y scatter chart report
- Test report analysis function



CHROMA 17011 5V/20A/30A STANDARD SYSTEM



62000B Modular DC Power Supply



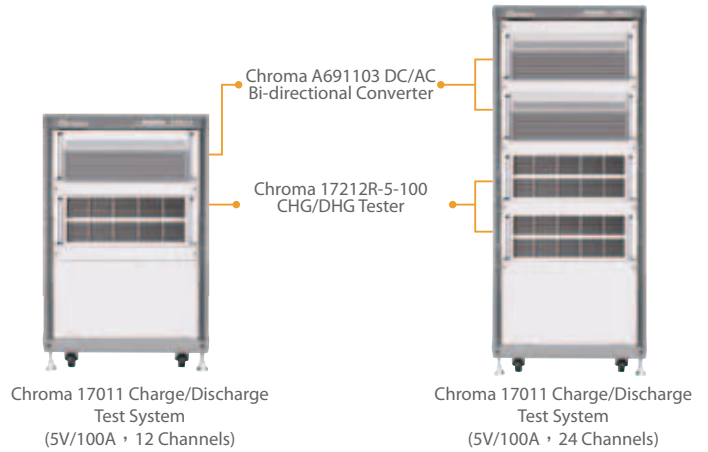
Chroma 17011 Charge/Discharge Test System (5V/20A/30A · 20 Channels)

Chroma 17011 Charge/Discharge Test System (5V/20A/30A · 40 Channels)

CHROMA 17011 5V/100A STANDARD SYSTEM



DC/AC Bi-directional Converter



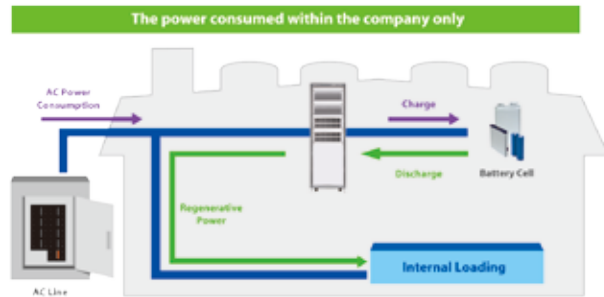
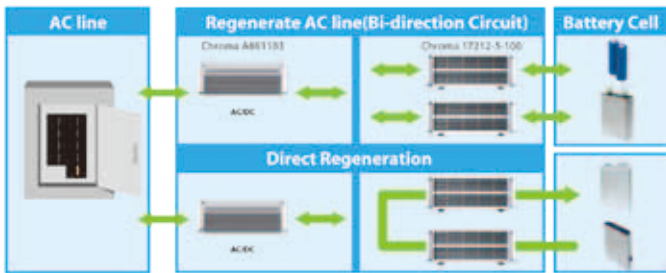
Chroma 17011 Charge/Discharge Test System (5V/100A · 12 Channels)

Chroma 17011 Charge/Discharge Test System (5V/100A · 24 Channels)

A691103 ENERGY RECYCLE

- Ideal usage of battery recycle energy
 - Direct recycle back to the battery under charging
 - Regenerate to grid
- Regenerative design with low heat generation

- Reduce air conditioner power requirement
- The THD is under 5% at rated power
- The PF is over 0.9 at rated power
- Direct return to factory AC internal loading



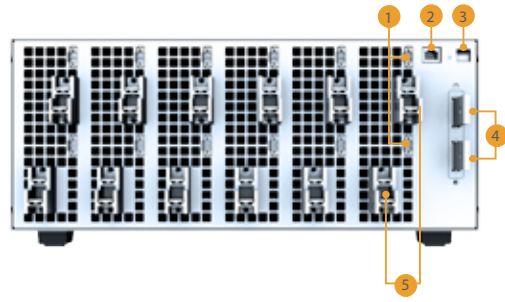
62000B HOT-SWAPPABLE OPERATION



Chroma 62000B series modular DC power supply provides multiple features for charge discharge equipment power application.

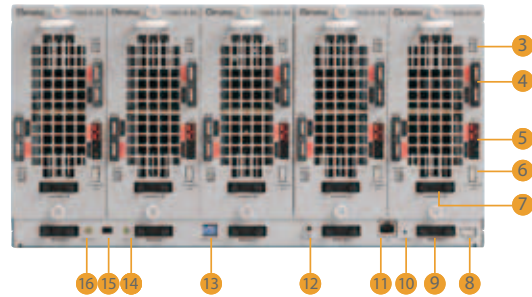
- Power output range : 1.5KW per module
- N+1 redundant function
- High power density (464mW/cm³ = 7.13W/In³)
- Hot-swappable maintenance function

CHROMA 17212R PROGRAMMABLE CHARGE/DISCHARGE TESTER



1. Sense socket
2. Ethernet communication port
3. Parallel setting dip switch
4. 45V power terminals
5. Drive terminals

CHROMA 17200 PROGRAMMABLE CHARGE/DISCHARGE TESTER



1. Power indicator
2. Mainframe working indicator
3. Sense socket
4. Drive terminals
5. Module power input socket
6. 24V power socket
7. Retention screw
8. Mainframe power socket

9. Communication bus socket
10. Reset button
11. Ethernet communication port
12. Chassis grounding hole
13. Parallel setting dip switch
14. EDLC mode indicator
15. Test mode switch
16. Battery mode indicator

CHROMA 17011 SYSTEM FUNCTION TABLE

Model\Function	EDLC Mode	Energy Regeneration	DC Power Source
17202-5-20	✓	×	62015B-24-62
17202-5-30	✓	×	62015B-24-62
17212R-5-100	×	✓	A691103

62015B-24-62 DC Power Supply Module

AC Input Voltage	3 ψ 4 wire, Δ connection, 187V~250V
Output Power	DC 1500W
Output Voltage	DC 1~24
Output Current	DC 62.5A
Load Regulation	1% of F.S.
Input Efficiency	> 87% @ full load
Frame Dimension (H x W x D)	176 mm x 444 mm x 466mm (model 62000B-6-1)
Others	Protection : OVP, OPP, OTP, OCP, FAN Error

A691103 DC/AC Bi-direction Converter

Input Power	3 ψ 4 wire, Δ connection, 180V~242V
Regenerative Bi-Direction Power	Output Power : DC11,000 W
	Output Voltage : DC 45V
	Output Current : DC 240A (Maximum)
Load Regulation	1% of F.S.
Regenerative Efficiency	> 85% (Typical)
Frame Dimension (H x W x D)	178 mm x 444 mm x 630 mm
Others	Protection : OVP, OPP, OTP, OCP, FAN Error

SPECIFICATIONS

Item	Specifications					
Frame	17200-5-10		17200-5-10		(None)	
Module	17202-5-20		17202-5-30		17212R-5-100	
Maximum Voltage/Current	5V/20A		5V/30A		5V/100A	
Maximum Channel	2 ch/module, 10 ch/frame (maximum)		2 ch/module, 10 ch/frame (maximum)		12 channels / set (fixed)	
Parallelable Current	40A, 100A, 200A		60A, 150A, 300A		200A, 300A, 400A, 600A	
Control Method	CC/CV/CP/DCIR charge, discharge models		CC/CV/CP/DCIR charge, discharge models		CC/CV/CP/DCIR charge, discharge models	
Voltage						
Setting Range	0 mV ~ 5000 mV, resolution 1mV		0 mV ~ 5000 mV, resolution 1mV		1800 mV ~ 5000 mV, resolution 1mV	
Reading Range	0.0 mV ~ +5199.9 mV, resolution 0.1mV		0.0 mV ~ +5199.9 mV, resolution 0.1mV		0.0 mV ~ +5199.9 mV, resolution 0.1mV	
Accuracy	± (0.02% stg.+0.02% F.S.)		± (0.02% stg.+0.03% F.S.)		± (0.02% stg.+0.02% F.S.)	
Current						
Setting Range	3A	1mA ~ 3,000mA , resolution 1mA		4A	1mA ~ 4,000mA , resolution 1mA	
	20A	0.01A ~ 20.00A , resolution 0.01A		30A	0.01A ~ 30.00A , resolution 0.01A	
Reading Range	3A	0.0mA~ 3,150.0mA, resolution 0.1mA		4A	0.0mA ~ 4,200.0mA, resolution 0.1mA	
	20A	0.000A ~ 21.000A ,resolution 0.001A		30A	0.000A ~ 31.500A, resolution 0.001A	
Accuracy	3A	± (0.02% stg.+0.02% rng.)		4A	± (0.05% stg.+0.05% rng.)	
	20A	± (0.03% stg.+0.03% rng.)		30A	± (0.05% stg.+0.05% rng.)	
Power						
Setting Range	15W	10 mW ~ 15,000 mW, resolution 1 mW		20W	10 mW ~ 20,000 mW, resolution 1 mW	
	100W	0.05 W ~ 100.00 W, resolution 0.01 W		150W	0.05 W ~ 150.00 W, resolution 0.01 W	
Reading Range	15W	0.0 mW ~ 15,600.0 mW, resolution 0.1 mW		20W	0.0 mW ~ 21,000.0 mW, resolution 0.1 mW	
	100W	0.000 W ~ 104.000 W, resolution 0.001 W		150W	0.000 W ~ 160.000 W, resolution 0.001 W	
Accuracy	15W	± (0.04% stg.+0.04% rng.)		20W	± (0.07% stg.+0.08% rng.)	
	100W	± (0.05% stg.+0.05% rng.)		150W	± (0.07% stg.+0.08% rng.)	
Flow Edit Capability	Max. step number in one flow: 500 steps Max. cycle number in one step: 999999 steps					
Data Storage	Battery mode : 100ms~60min EDLC mode : 10ms~60min *				10ms~60min	
Power Requirement	DC 23.8~24.5V, 2kW (Chroma 62000B with 2 modules)				DC 42.75~47.25V, 11kW (Chroma A691103)	
Frame Dimension (H x W x D)	222 mm x 428 mm x 630 mm				179 mm x 428 mm x 688 mm	
Weight (Full Module)	Approx. 63 Kg				Approx. 40 Kg	

* EDLC mode has higher sampling rate, thus the current and power accuracy specification of EDLC mode is a bit lower than battery mode.

* All specifications are subject to change without notice.

ORDERING INFORMATION

Model 17011 : Battery Cell Charge & Discharge Test System

Model 17200-5-10 : 17200 Charge/Discharge Tester Frame for 5 Modules

Model 17202-5-20 : Charge/Discharge Tester Module 5V/20A, 2 channels

Model 17202-5-30 : Charge/Discharge Tester Module 5V/20A, 2 channels

Model 17212R-5-100 : Charge/Discharge Tester Module 5V/100A, 22 channels

Model A691103 : DC/AC Bi-directional Converter

Model 62015B-24-62 : Modular DC Power Supply 24V/62.5A/1500W

62000B-3-1 : Three Position 62000B Mainframe

62000B-6-1 : Six Position 62000B Mainframe

Model 51101-64 : Thermal/Multi-function data logger

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