BATTERY CELL CHARGE & DISCHARGE TEST SYSTEM MODEL 17011

KEY FEATURES
- High precision output and measurement up to 0.02%F.S.
- High sampling rate up to 10ms
- Channel parallel output function with maximum 1200A output
- Operating modes: CC/CC-CV/CP/CR
- Dynamic working condition simulation (current/power)
- Built-in DCIR test
- Built-in HPPC test
- Built-in EDLC capacitance and DCIR test
- Built-in LIC capacitance and DCIR test
- Flexible sampling recording (t, V, I, Q, W)
- Low ripple current
- Real time external circuit resistance monitoring function
- Equipped with redundant DC power supply to avoid affecting the cycle life test due to power failure factor (linear circuit series)
- Energy recycling during discharge (AC/DC bi-directional regenerative series)
- Integrating ACIR test fixture, temperature/ data logger and humidity chamber

FUNCTIONS
- LIB charge/discharge test Capacity, ACIR and DCIR tests
- EDLC charge/discharge test Capacitance, ACIR, DCR and LC tests
- LIC charge/discharge test Capacitance, ACIR, DCR and LC tests

APPLICATIONS
- Characteristics analysis
- Product life test
- Material test
- Production test
- Voltage adjustment application
- Quality assurance for incoming/shipping inspection

The Chroma 17011 Battery Cell Charge and Discharge Test System is a high precision system designed specifically for testing lithium-ion batteries (LIB), electrical double layer capacitors (EDLC), and lithium-ion capacitors (LIC). It is suitable for product characteristics screening, cycle life testing, incoming and shipping inspection, material experiment, and balancing battery voltage.

Based on the test characteristics and size of battery current, the Chroma 17011 test system has AC/DC bi-directional regenerative series and linear circuit series with precision output and measurement traceability to guarantee product specifications. Small errors among channels and relatively reliable test data are suitable for analyzing the characteristics differences and detecting changes in detail. The system is equipped with energy-saving design and thermal management capable of running stably for long periods and providing reliable real-life testing data. The modular design allows the system to be configured based on test requirements, and each channel can run tests independently with parallel output supported. The test system has high product compatibility and testing flexibility.

In view of energy issues, the fabrication of green products should be in line with production methods that are environmentally friendly. The Chroma 17011 AC/DC bi-directional regenerative test system has an energy recycling function that can convert the discharged energy to the charging channel improving power efficiency when in use. The excess power will feed back to grid if the energy recovered is more than the system requires. In addition to decreasing electricity costs, the regenerative power function reduces system heat significantly by lowering air conditioning demands and operation costs. It not only improves system stability, extends service life, but also creates a low carbon emission environment for production.

For small current testing and material development, the Chroma 17011 linear circuit series features low noise and precision outputs, with redundant DC power supplies which are more stable and reliable when compared to general switching power supplies. When a power module fails, it will shut down automatically, and the rest of the modules can be paralleled in order to output sufficient power, maintaining a stable power supply. In addition, it supports a hot swap function that allows the malfunctioning module to be switched without shutting down the system to make sure no interruptions occur during testing.

Four current range models are available for material research and development. The standalone device can easily be placed on the lab desk. This device is suitable for precision and leakage current testing with an automatic current shift resolution up to 0.1uA. With data refresh rate up to 1ms in pulse mode, it can perform rapid pulse current charge/discharge tests on various material samples for characteristics verification.

The lithium ion battery cell tests include life and characteristics tests such as ACIR, DCIR and HPPC, etc. The Chroma 17011 includes built in test steps in line with regulations that can provide test results fast and accurately without requiring conversion afterwards. It provides easy operation with low chances of human error, and can draw battery characteristic curves via software for specification comparison or application parameter analysis.

For EDLC and lithium capacitors, capacitance, DCIR and leakage current tests are included. The test steps built into the Chroma 17011 comply with the standards which get the capacitance and DCIR test results with one step. It also measures the leakage current directly.


Ethernet CE

**Chroma**

BATTERY CAPACITY TESTING

The capacity of a battery cell is usually the integral of discharge current and time, therefore having highly accurate current test equipment is important for testing. Though every battery has manufacturer labeled specifications where the low charge and discharge rates are commonly used for testing capacity, the power battery capacity and actual capacity will be different if the specifications are used as the power battery is often charged and discharged under high charge and discharge rate. For practical use, the final battery charge and discharge rate should be used for battery cell tests in order to get a more accurate capacity.
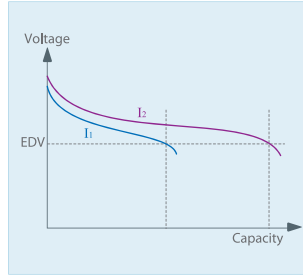

Capacity Measurement

BATTERY CYCLE LIFE TESTING

The battery cycle life is one of most important items for testing a battery. The test uses predefined charge/discharge conditions as a cycle to test the same cell repeatedly and evaluates the cycles executed for the battery before the end condition is met. More cycles indicate 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.
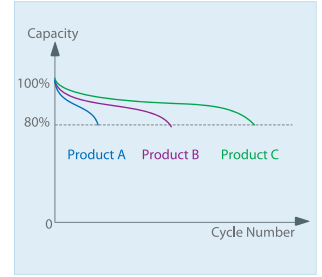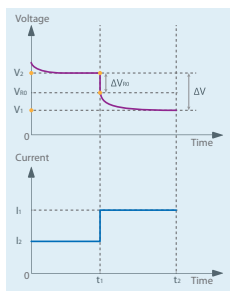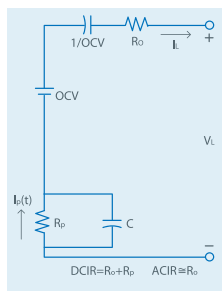

Cycle Life Teting
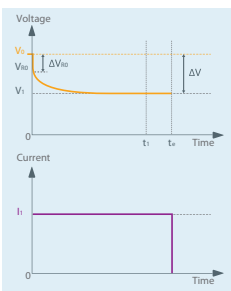
DCIR TESTING

DCIR Test (1)

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

DCIR Test (2)

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

Lumped Parameter Model Circuit Diagram

The internal resistance value is related to the charge/discharge current of a battery. The larger the internal resistance value, the lower the efficiency when temperature rises. The traditional LCR meter 1Khz measurement can only assess the battery sudden power output hinder caused by the resistive conductivity close to Ro (near ACIR), but unable to assess the polarization resistance (Rp) caused during electrochemistry transition. The DCIR assessment includes the resistance of ACIR that is closer to the actual resistance effect of continuous current power battery applications. The Chroma17011 has built in two DCIR test modes: DCIR test (1) to calculate the DCIR value using the voltage difference caused by the change of one loading current; DCIR test (2) to calculate the DCIR value using the voltage difference caused by the change of two loading currents. The users can select the test mode as desired to get the test results that comply with IEC 61960 standards automatically without any manual calculation.

HPPC TESTING

HPPC is a test solution created by the US Department of Energy that tests the battery power performance of hybrid and electric vehicles. The main purpose of the test is to establish the depth of discharge and power function within the batteries voltage range, with the secondary purpose of establishing the depth of discharge, conductive resistance and polarization resistance function via the voltage response curve from discharging, standing to charging within the battery voltage range. The measured resistance can be used to assess the power recession of 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.
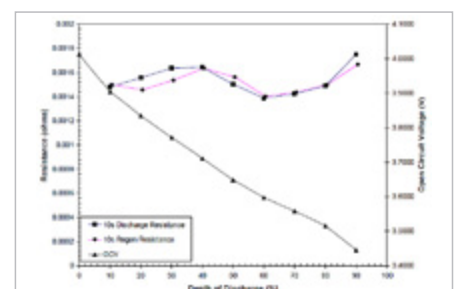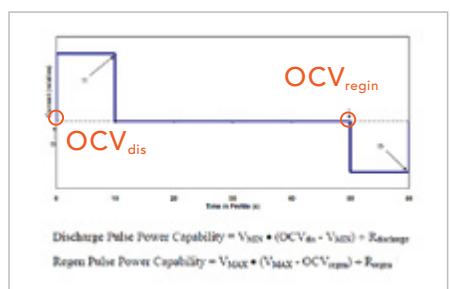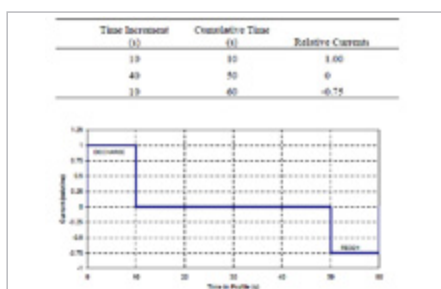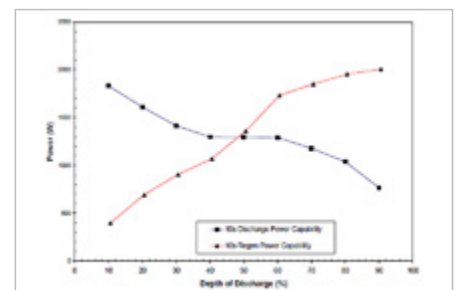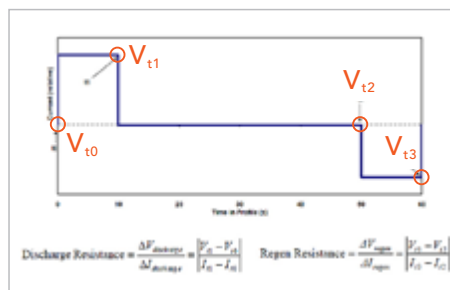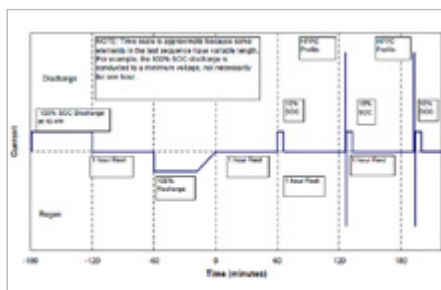
* The content and diagrams of the HPPC are referring to the U.S. Department of Energy Vehicle Technologies Program INL/EXT-07-12536

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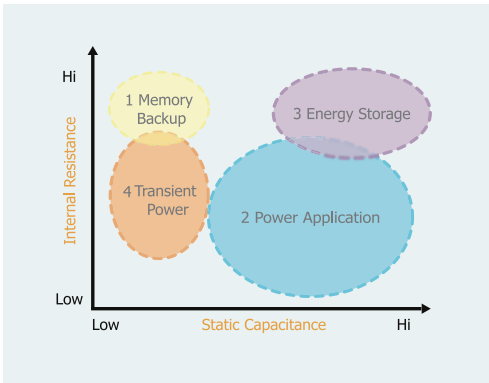
The EDLC test follows the actual product application to divide the test conditions. Based on the category of IEC 62391 standards, there are 4 basic EDLC product applications: 1. Memory Backup, 2. Power Application, 3. Energy Storage, 4. Transient Power. Different test applications indicate different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

Type	EDLC Types			
	1	2	3	4
	Memory Back Up	Power Application	Energy Storage	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 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 discharge energy and spacing time to calculate the EDLC capacity.

EDLC DC Internal Resistance (DCIR) 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. 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.
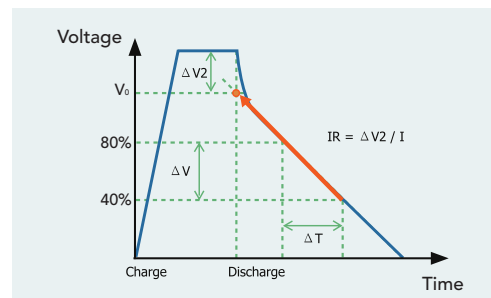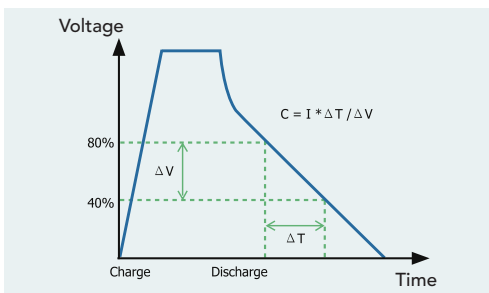

LIC TESTING

LIC Capacitance Testing Curve

According to the LIC test standard IEC 62813, before testing the capacity, the LIC has to make sure it is fully charged via CV charging process. The capacitance measurement uses the current in the calculation formula below to perform CC discharge. When the discharge is done, get time point T1 = CNRN and T2 = 2CNRN that maps to the discharge curve as line section and extend to the discharge starting time point. Use the estimated voltage and the voltage difference after discharge along with the spacing time and discharge current to calculate the LIC capacitance.

LIC DCIR Testing Curve

According to the LIC test standard IEC 62813, the LIC has to make sure it is fully charged via CV charging process. The DCIR measurement uses the current in the calculation formula below to perform CC discharge. When the discharge is done, get time point T1 = CNRN and T2 = 2CNRN that map to the discharge curve as line section and extend to the discharge starting time point. Use the estimated voltage and the voltage difference before discharge as well as the discharge current to calculate the DCIR value.
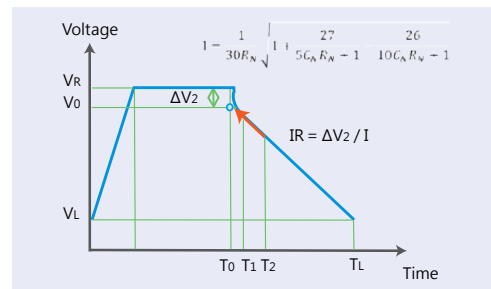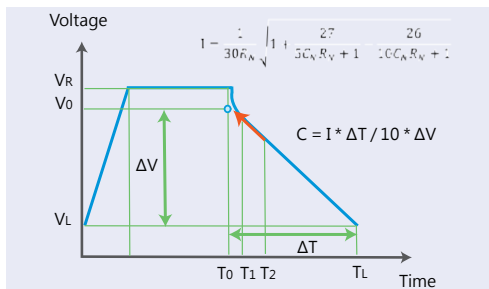
WORKING CONDITION SIMULATION

The usa of a power battery cell is often fast with irregular current status. Through the simulation of working conditions, the battery cell use status can actually be reflected on the battery.

- Simulating dynamic charge/discharge waveform of battery actual usage. In the dynamic current mode (Waveform), the fastest switching time of maximum discharge and charge current is 10ms
- Step can set the current waveform Excel file saved in PC for reading
- Each channel can save 720,000 points for long hour dynamic testing
- Setting time interval: 10ms~999s
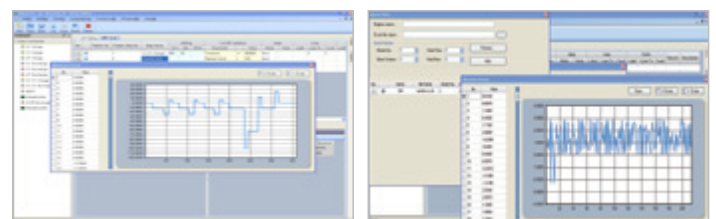
Loading DST waveform current

Loading FUDS waveform current

OPTIMAL UTILIZATION OF ENERGY RECYCLING

- Optimal utilization of energy recycling during discharge
 Direct recycling: It converts the discharging energy to the battery cell requires charging
  Grid recycling: It recycles the excess power to grid
- Regenerative design with low heat consumption
- Saving the expense of air conditioning by lowering down the ambient temperature
- Total harmonic distortion of current regenerate to grid is below 5%
- Power factor is larger than 0.9 under rated power
- When discharging under rated power full load, the direct regenerative rate is up to 80% and the grid regenerative rate is up to 65%. The regenerated power will be used first
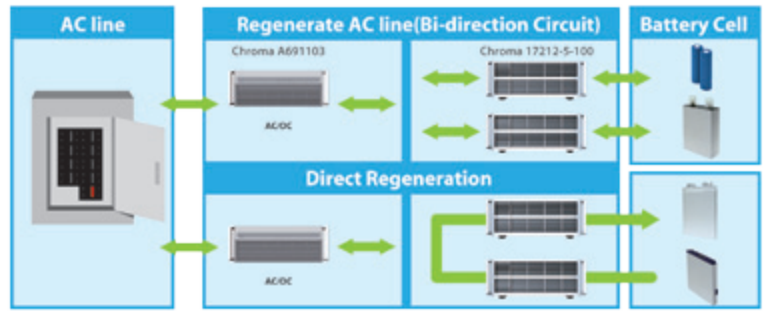
SYSTEM FEATURES

Programmable Charge/Discharge Test System Software

- Multilingual interface: Support Traditional Chinese, Simplified Chinese and English three languages interface
- Real time monitoring: Real time system status browsing without waiting. Both channel and system integration data can be viewed simultaneously
- Icon management: Different icons are used to manage the channel testing status for immediate understanding
- Setting user authority: Able to set user authority for management
- Failure record tracking: Independent channel to record abnormality
- Rich reports and charts: Channel reports and cut-off reports

ACR Test Switch Fixture   17011   Chamber   Data Logger
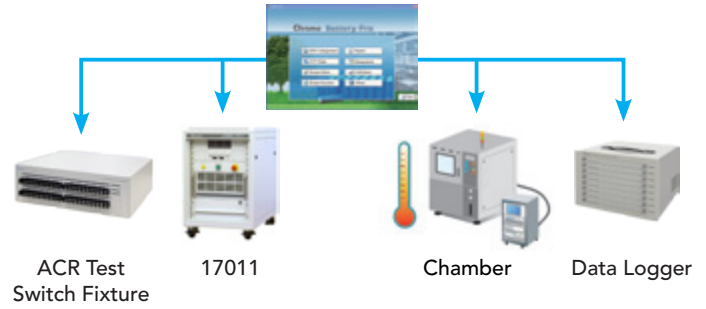
System Integration

- Integrating with humidity chamber through software can do sync settings conditions for charge/discharge testing
- Integrating with temperature/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 ACR Meter is in use. Programmable ACR steps can be edited in test recipe without changing the test fixture during testing, in addition the built-in precision leakage current measurement function is able to edit the leakage current step in test recipe to measure the DUT actual current

Report Wizard and Statistics Report

- Able to define report format to export PDF, CSV and XLS files
- Equipped with report graphical analysis function. The user can define the X and Y axis parameters to generate a test report as demanded without exporting from word processing software
- Able to generate channel report, cut-off report, Life-cycle report, capacitance – voltage comparison report (Q-V report) and charge/discharge test report (V/I/T-time report), etc

PC Exception Allowed

- Maintaining operation: When error occurs on PC or the connection is interrupted during testing, if the 17011 power is not outage, 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

17011 10V / 6A STANDALONE DEVICE FOR LABORATORY

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.

- Four current ranges (200uA, 6mA, 200mA, 6A) for measurement
- Dual voltage range design for high and low voltage testing (-5V~5V or 0V~10V)
- Up to 0.02%F.S high accuracy output and measurement
- Up to 1ms dynamic data refresh rate in pulse mode
- Desktop laboratory equipment with single phase power input and front wiring
- 10V/6A/16CH standard unit specification

1. Power switch	5. Reset button
2. Power indicator	6. Ethernet communication port
3. Working indicator	7. Chassis grounding hole
4. Drive & Sense socket	8. AC input connector

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

The system can be configured as needed since the channel numbers are expandable, and up to 100 channels can be controlled at the same time.

40 channels

1. DC Power Supply 62000B
2. CHG/DHG Tester 17200
3. ACR Test Switch Fixture A172010
4. Thermal/Multi-function data logger 51101-64

1. Power indicator	9. Communication bus socket
2. Mainframe working indicator	10. Reset button
3. Sense socket	11. Ethernet communication
4. Drive terminals	port
5. Module power input socket	12. Chassis grounding hole
6. 24V power socket	13. Parallel setting dip switch
7. Retention screw	14. EDLC model indicator
8. Mainframe power socket	15. Test mode switch
	16. Battery mode indicator

17011 5V / 100A REGENERATIVE STANDARD SYSTEM CONFIGURATION

The system can be configured as needed since the channel numbers are expandable, and up to 48 channels can be controlled at the same time.
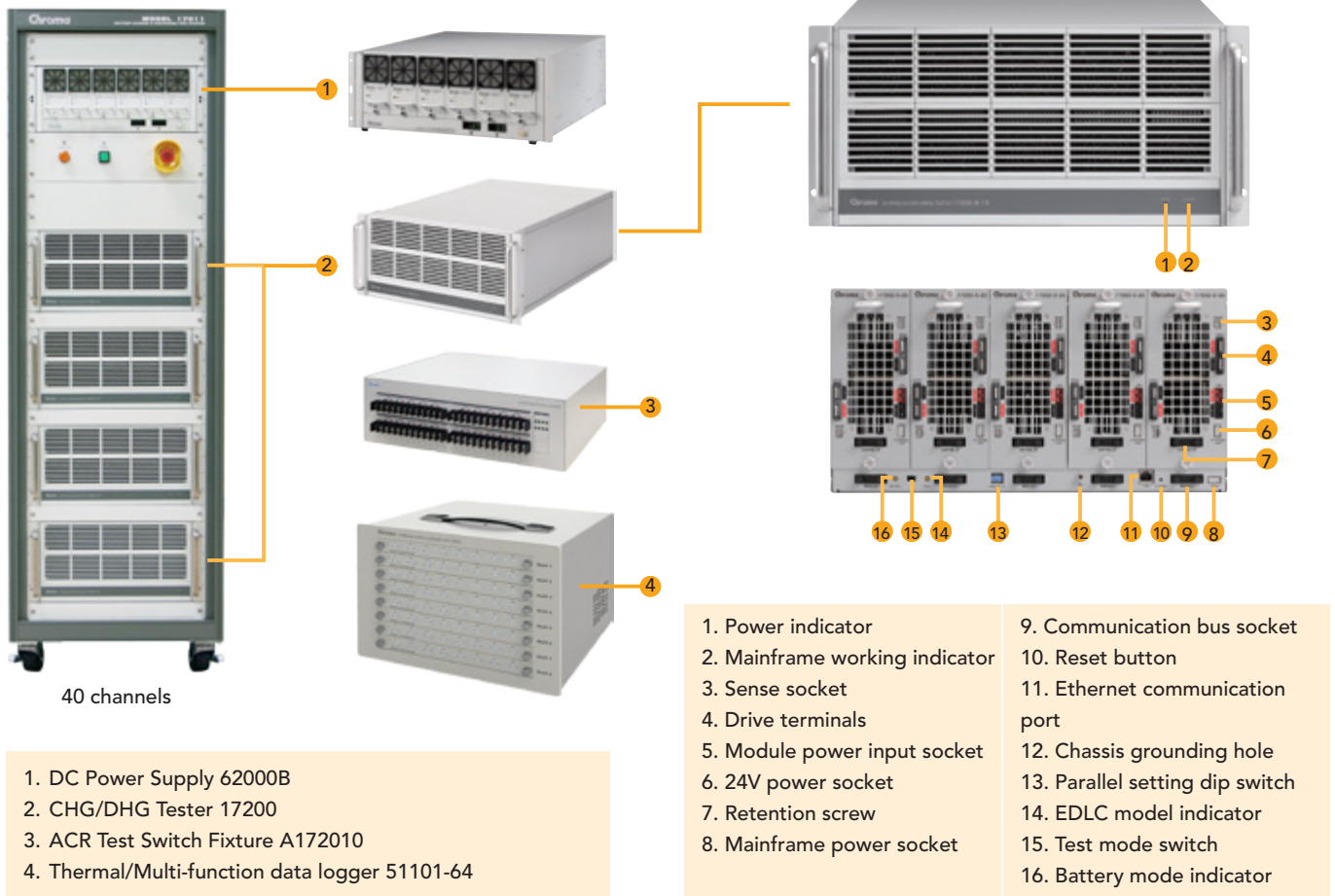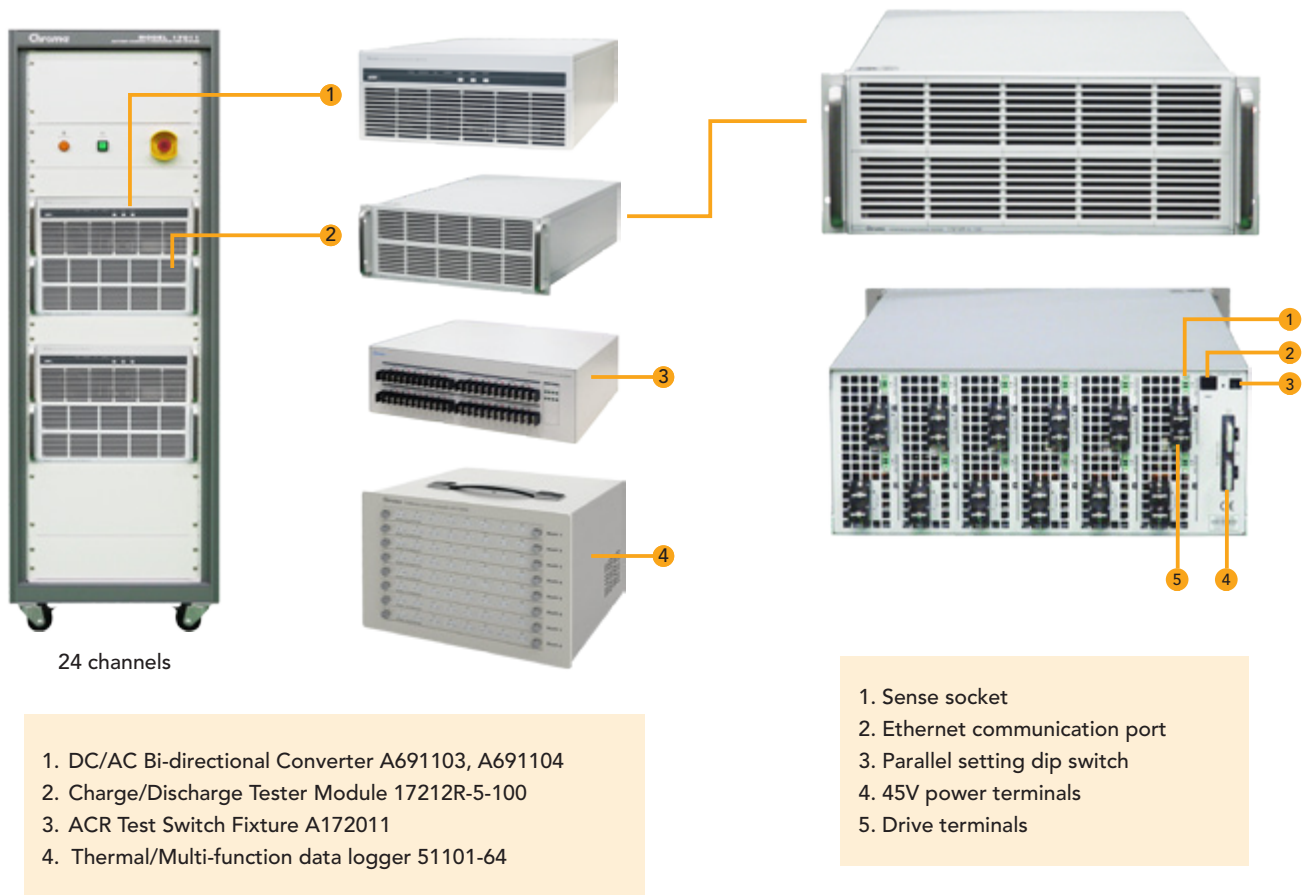
24 channels

1. DC/AC Bi-directional Converter A691103, A691104
2. Charge/Discharge Tester Module 17212R-5-100
3. ACR Test Switch Fixture A172011
4. Thermal/Multi-function data logger 51101-64

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

SPECIFICATIONS

Module	17202-5-20	17202-5-30	17212R-5-100	17216M-10-6
Maximum Voltage/Current	5V/20A	5V/30A	5V/100A	10V/6A
Maximum Channel	2 ch/module, 10 ch/frame	2 ch/module, 10 ch/frame	12 ch/set (fixed)	16 ch/set (fixed)
Parallelable Current	40A, 100A, 200A	60A, 150A, 300A	200A, 300A, 400A, 600A, 1200A	6A to 96A

Voltage

	17202-5-20	17202-5-30	17212R-5-100	17216M-10-6
Setting Range	0 mV ~ 5000 mV, resolution 1mV	0 mV ~ 5000 mV, resolution 1mV	0mV~5000mV *1, resolution 1mV	0V~10V or -5V~5V, 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	0V~10.4V or -5V~5.04V, resolution 0.2mV
Accuracy	± (0.02% rdg.+0.02% F.S.)	± (0.02% rdg.+0.02% F.S.)	± (0.02% rdg.+0.02% F.S.)	± (0.02% F.S.)

Current

	17202-5-20 Range	17202-5-20	17202-5-30 Range	17202-5-30	17212R-5-100 Range	17212R-5-100	17216M-10-6 Range	17216M-10-6
Setting Range	3A	1mA ~ 3,000mA , resolution 1mA	4A	1mA ~ 4,000mA , resolution 1mA	100A	0.01A ~ 100.00A, resolution 0.01A	200µA	0.1µA ~ 200µA , resolution 0.1µA
							6mA	1µA ~ 6mA, resolution 1uA
	20A	0.01A ~ 20.00A , resolution 0.01A	30A	0.01A ~ 30.00A , resolution 0.01A			200mA	0.1mA ~ 200mA, resolution 0.1mA
							6A	1mA ~ 6A, resolution 1mA
Reading Range	3A	0.0mA~ 3,150.0mA, resolution 0.1mA	4A	0.0mA ~ 4,200.0mA, resolution 0.1mA	100A	0.000A ~ 105.000A, resolution 0.001A	200µA	0A ~ 210µA, resolution 0.01µA
							6mA	0A ~ 6.3mA, resolution 0.2µA
	20A	0.000A ~ 21.000A , resolution 0.001A	30A	0.000A ~ 31.500A, resolution 0.001A			200mA	0A ~ 210mA, resolution 0.01mA
							6A	0A ~ 6.3A, resolution 0.2mA
Accuracy	3A	± (0.02% rdg.+ 0.02% rng.)	4A	± (0.05% rdg.+ 0.05% rng.)	100A	± (0.05% rdg.+ 0.05% F.S.)	200µA / 6mA / 200mA / 6A	± (0.02% rng.)
	20A	± (0.03% rdg.+ 0.03% rng.)	30A	± (0.05% rdg.+ 0.05% rng.)				

Power

	17202-5-20 Range	17202-5-20	17202-5-30 Range	17202-5-30	17212R-5-100 Range	17212R-5-100	17216M-10-6 Range	17216M-10-6
Setting Range	15W	10 mW ~ 15,000 mW, resolution 1 mW	20W	10 mW ~ 20,000 mW, resolution 1 mW	500W	0.05W~500.00W, resolution 0.01W	2mW	1µW~2mW, resolution 1µW
							60mW	10µW~60mW, resolution 10µW
	100W	0.05 W ~ 100.00 W, resolution 0.01 W	150W	0.05 W ~ 150.00 W, resolution 0.01 W			2W	1mW~2W, resolution 1mW
							60W	10mW~60mW, resolution 10mW
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	500W	0.000 W~520.000 W, resolution 0.001W	2mW	0W~2.1mW, resolution 0.1µW
							60mW	0W~63mW, resolution 2µW
	100W	0.000 W ~ 104.000 W, resolution 0.001 W	150W	0.000 W ~ 160.000 W, resolution 0.001 W			2W	0~2.1W, resolution 0.1mW
							60W	0~63W, resolution 2mW
Accuracy	15W	± (0.04% rdg.+ 0.04% rng.)	20W	± (0.07% rdg.+ 0.07% rng.)	500W	± (0.07% rdg.+ 0.07% F.S.)	2mW	± (0.04% rng.)
							60mW	
	100W	± (0.05% rdg.+ 0.05% rng.)	150W	± (0.07% rdg.+ 0.07% rng.)			2W	
							60W	

	17202-5-20	17202-5-30	17212R-5-100	17216M-10-6
Flow Edit Capability	Max. step number in one flow: 500 steps ; Max. cycle number in one step: 999999 steps			
Data Storage	10ms~60min *2			
Power Supply	Built in 62015B-24-62 DC Power Supply Module		A691103、A691104 DC/AC Bi-direction Converter	Built in
AC Input Voltage	1Φ, 220V 3Φ 4 wire, △connection, 220V / 380V		3Φ 4 wire, △connection, 220V / 380V	1Φ, 220V

Note *1: The maximum discharge current will derate at low voltage range between 1V to 0V.
Note *2 : The model 17202-5-20 and 17202-5-30 of 10ms sampling time, the current and power accuracy specification is a bit lower than 100ms.
* All specifications are subject to change without notice. Please visit our website for the most up to date specifications.

ORDERING INFORMATION

17011 : Battery Cell Charge & Discharge Test System
17200-5-10 : Programmable Charge/Discharge Tester Frame for 5 modules
17202-5-20 : Programmable Charge/Discharge Tester Module 5V/20A, 2 channels
17202-5-30 : Programmable Charge/Discharge Tester Module 5V/30A, 2 channels
17212R-5-100 : Programmable Charge/Discharge Tester Module 5V/100A, 12 channels
17216M-10-6 : Programmable Charge/Discharge Tester Module 10V/6A, 16 channels
51101-64 : Thermal Multi-function Data Logger 64 channels

62000B-3-1 : 62000B Series Mainframe for 3 Modules
62000B-6-1 : 62000B Series Mainframe for 6 Modules
62015B-24-62 : Modular DC Power Supply 24V/62.5A/1500W
A172010 : ACR test switch fixture, for 5V/20A/30A, 10 channels
A172011 : ACR test switch fixture, for 5V/100A, 12 channels
A691103 : DC/AC Bi-direction Converter, AC 220V to DC 45V
A691104 : DC/AC Bi-direction Converter, AC 380V to DC 45V