BATTERY CELL INSULATION TESTER MODEL 11210

Chroma 11210 Battery Cell Insulation Tester is specially designed for measuring leakage current (LC) and insulation resistance (IR) of Lithium-ion batteries (dry cell/jelly roll). This model also measures solid capacitors, multilayer ceramic capacitors (MLCC), high voltage electrolytic capacitors and insulation materials. In addition to standard LC/IR measurement, the 11210's PD detection function is designed to detect and analyze strong partial discharge (PD) and electrical flashover (Flashover) in the insulator during high-voltage measurement. This function helps to detect whether the effective insulation distance of the lithium-ion battery (dry cell/jelly roll) under test is sufficient before electrolyte filling, so as to prevent potentially defective products from entering the next production stage or end market. Compared with traditional insulation test solutions, Chroma 11210 takes safety and insulation material quality testing of lithium-ion battery-driven products and electric vehicles to a new level.

The 11210 uses special circuit design to carry out and monitor the entire process of testing for flashover due to abnormal PD in the battery cell, and quantifies the data in numbers and recordable waveforms. Moreover, after reaching the test voltage, the LC or IR will be measured and judged as abnormal during the test time, similar to using WV/IR testers.

The +Flash function provides two-stage intermittent high and low voltage, detects the DUT's withstand voltage (WV) under high voltage and LC under low voltage, and independently judges the LC and PD, making for an effective testing application for various energy storage components.

Chroma 11210 's high-level charging current and fast measurement circuit greatly improve the overall test speed. The regular insulation test sequence provided for capacitive DUTs is "Charge -> Dwell -> Test -> Discharge", and can automatically execute a comprehensive test within a 20ms sequence, significantly improving the efficiency of the production line. The 11210 measures the LC from 1pA to 20mA with 7 ranges of current measurement to enhance precision. In addition, the auto-range function can automatically switch to the most suitable measurement range, saving the user's time while ensuring accuracy.

The quality of the contact check has a decisive influence on the reliability of the insulation test. If the test instrument detects "no contact" during the entire measurement process, the DUT is likely to be judged as a good product. This misjudgment leads to a defective product entering the market. As the misjudgment will be more obvious when the insulation resistance of the DUT is very high, a contact check must be executed during the insulation test. Chroma 11210 uses high-level circuit architecture to execute a complete contact check within 5ms, and provides the option to do a thorough contact check before and/or after the measurement.

Chroma

MODEL 11210

KEY FEATURES

- Test voltage: up to 1KV (DC)
- Charge current : 50mA max.
- Wide range of Leakage Current (LC) measurement (1pA ~ 20mA)
- Partial discharge/flashover detection for inspection on potential internal short circuits (option of A112100):
  - PD level and number of occurrence display
  - PD events and V/I waveform monitor
  - Programmable PD level limit setting
  - PD and V/I waveform logging (option of A112101)
- Built-in +Flash Test function
- Built-in reliable contact check
- Automatic test with sequence: charge→dwell→test→discharge
- High speed testing (20ms/min.)
- Full-color display and touch panel
- Standard Handler, USB, RS-232, Ethernet interfaces

APPLICATIONS

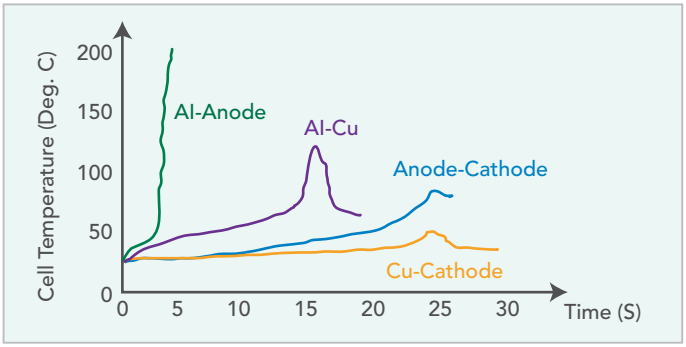
- Lithium-ion battery (LIB) dry cell
- Solid Capacitor
- Multilayer Ceramic Capacitors (MLCC)
- High Voltage Electrolytic Capacitors (HV-ELCAP)
- Plastic Film Capacitor (Film Cap)
- Special insulating material

LITHIUM-ION BATTERY SAFETY ISSUES

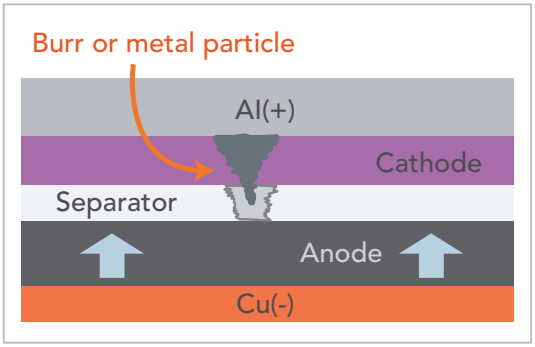
The most dangerous aspect of internal short circuits is the HEAT generated in localized areas inside the cell, which is caused by a short circuit between the aluminum positive electrode and the material coated on the negative electrode. This kind of battery explosion is the main culprit behind several car fire accidents in the past decade. [Figure 1]

[Figure 1] Car fire accident due to battery explosion (descriptive drawing)

Consequences from fire or explosion of lithium ion batteries (LIB) is an increasing concern. As technology advances, the increased energy density of the LIB poses a growing risk to consumers. In order to eliminate the risk of fire or explosion, the root cause must be identified and defective units must be filtered out before they reach the consumer market. Research indicates that internal short circuits between the positive electrode (aluminum) and the material coated on the negative electrode (anode) inside the cell is the root cause of these fires and explosions [Figure 2]. Burrs on the metal electrodes or contaminated particles inside the separator are known to cause this kind of internal short circuit [Figure 3].

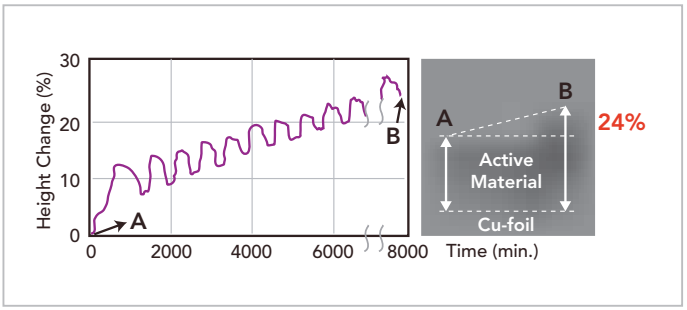


[Figure 2] Temperature rising in different internal short circuit scenarios

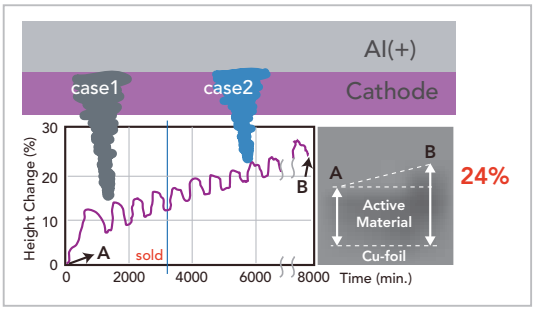


[Figure 3] A burr extruding from the positive electrode may touch the material coated on the negative electrode and eventually cause a fire accident.

Research also shows that the material coated on the negative electrode (typically graphite) inflates during the charging phase, inflating up to 24% or more as the charge/discharge cycle repeats. It may continue to inflate until the burrs on the aluminum plate finally touch the graphite coating and result in a fire accident [Figure 4]. There are usually several charge/discharge cycles carried out on the battery cells in the factory before shipping. Take as an example, two cases of defective cells which are present in the production line, and each has a single burr of a different height on its aluminum plate [case 1 & case 2 in Figure 5]. Case 1 will be detected during the second charging cycle in the factory, since the burr will make contact with the anode during the production process. However, in case 2, the second defect will not be detected until after many more charging cycles, which is very likely to happen only after the product reaches the consumer.



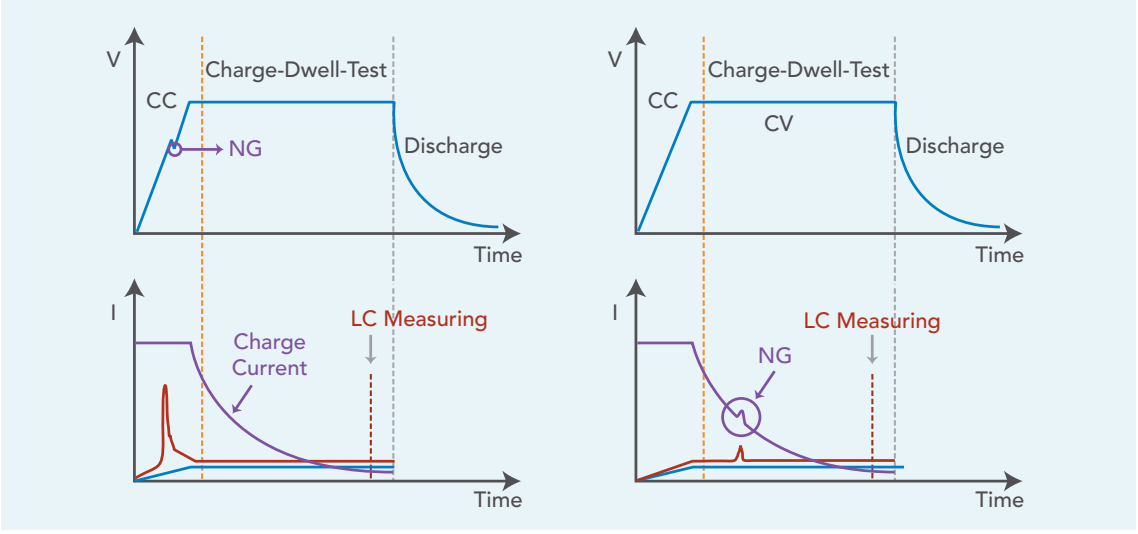
[Figure 4] Real lab experiments show that 24% expansion of the graphite material (coating on the negative electrode) may happen after only 10 cycles of charging/discharging.



[Figure 5] Two burrs (case 1 & case 2) of different height extruding out from the aluminum positive electrode may cause internal short circuits at different times.

STRONG P.D. / FLASHOVER DETECTION AND MEASUREMENT FUNCTION

Chroma 11210 Battery Cell Insulation Tester features a strong partial discharge and electrical flashover detection function, which detects electrical flashover inside the lithium-ion battery dry cell (LIB) caused by insufficient distance between electrodes during high voltage testing. Chroma 11210 is designed to charge at a constant current, and the insulating layer of the LIB dry cell is made of perforated plastic, so the charging voltage should rise in a straight line. The Chroma 11210 PD Option Card analyzes whether the curve has a positive transition (V">0) by simulating a second-order differential equation, and quantifies its degree (V_PD). In addition, the voltage is basically fixed at the set test voltage during the dwell and test time, and the leakage current is generally either fixed or decreases exponentially. However, if an electrical flashover occurs, although there may not be an observable decrease in voltage, the leakage current will show an abnormal increase (CV supplementary charge) and then decrease, or the decrease speed will noticeably slow down and accelerate [Figure 6]. The Chroma 11210 PD Option Card also analyzes whether the curve has a negative transition (I" <0) by simulating a second-order differential equation, and quantifies its degree (C_PD) so that the user can inspect the state of the discharge.

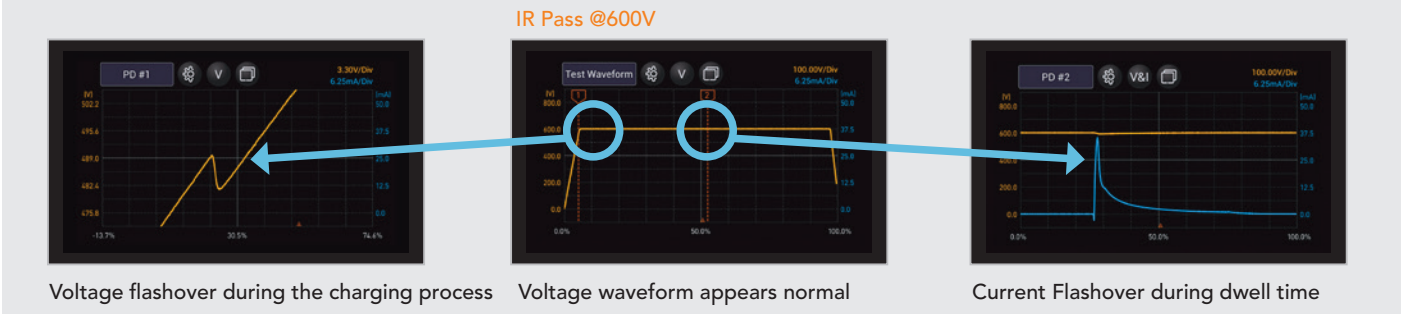


[Figure 6] Completed lithium-ion battery insulation anomaly detection

Whether in charge mode or during testing, the Chroma 11210 is able to detect up to 99 occurrences of the PD events described above [Figure 7]. Either the magnitude or the number of occurrences or both can be set as a threshold level for pass/fail criteria, which is very helpful when testing various devices with different characteristics in the production line.

[Figure 7]] Chroma 11210 reports detected abnormal electrical discharge

General IR meters or WV testers can only measure the average leakage current within a specific time interval, and cannot monitor abnormal changes in voltage and current waveforms. In addition to its excellent abnormal discharge detection function, Chroma 11210 also allows recording of the voltage waveforms of PD occurrences in every defective product [Figure 8]. With the included zoom-function enabling easy viewing of the PD waveform details, this function is of great help to any QA and R&D department.



[Figure 8] Chroma 11210 can record the voltage waveform of PD for every defective product

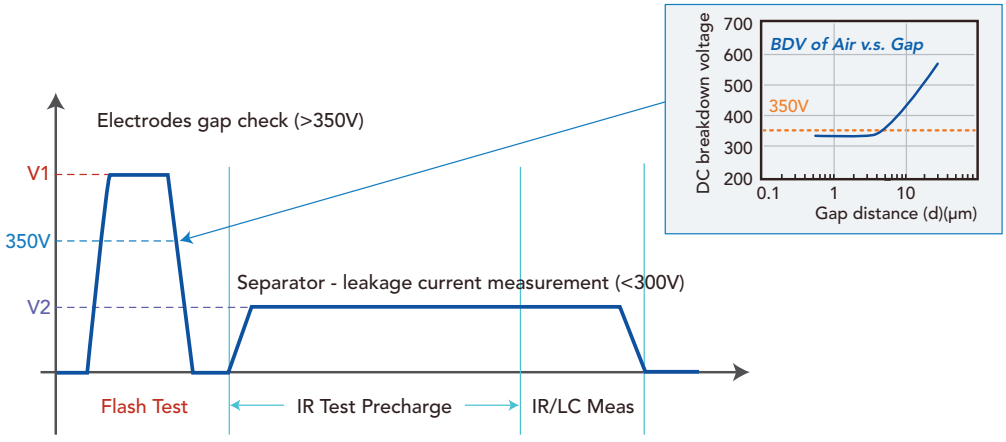
+FLASH TEST FUNCTION

Chroma 11210’ s brand new +Flash test function provides a variety of test conditions (test voltage, charging current, measurement range, sampling integration time) and judgment conditions (LC measurement level or PD limit value) to meet the requirements of actual insulation withstand voltage testing of various components.

Adequate insulation testing of lithium-ion batteries requires two test items: (1) Effective distance between positive and negative electrodes (refer to the battery safety topic) (2) Electronic conductive impurities (leakage current) in the separator. The test and judgment conditions for both items differ significantly.

For MLCCs, in consideration of MLCC dielectric material, the nominal voltage is in a linear condition, which is quite different from the withstand voltage of actual dielectric material (often about 3 to 10 times as high). Therefore, the traditional production insulation test comprises an instantaneous overvoltage (exceeding the rated voltage) test (Flash Test) and measurement of the insulation resistance value under the nominal voltage. To accomplish a comprehensive insulation material quality inspection, it ensures there is no abnormal leakage current at the nominal voltage while at the same time ensuring a normal withstand voltage margin. In terms of the withstand voltage margin testing requirements, other capacitive components have similar requirements. Chroma 11210’ s +Flash test function is perfectly designed to inspect the insulation quality of such energy storage components.

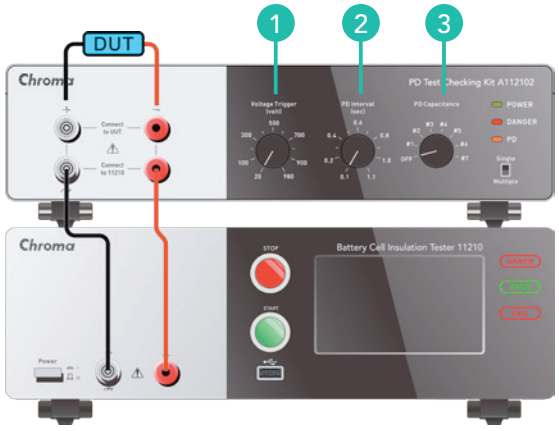
Taking the lithium-ion battery test as an example [Figure 9], the first Flash Test voltage is for electrode gap detection. The reference air breakdown voltage (>350V) is set higher than the effective electrode distance to be detected in order to test high-risk products that have not short-circuited. The point is to detect whether insulation breakdown or electrical flashover occurs due to abnormal electrode distance under this short-duration, high-voltage test. The subsequent IR Test serves to detect abnormal electronic leakage current. It uses about 5~10 times the working voltage of a lithium-ion battery (about 2.5V~4.3V) to detect the stable leakage current, in order to prevent excessive self-discharge when the battery reaches the end of the production process. Generally, a longer dwell time is required.



[Figure 9] Application of Chroma 11210 + Flash Test function during inspection of Li-ion Battery insulation quality

PD TEST CHECKING KIT

When using the Chroma 11210 Battery Cell Insulation Tester with the Partial Discharge Detection Card (A112100) or the Partial Discharge Analysis Card (A112101), the relevant settings of the Chroma A112102 PD Test Checking Kit can be adjusted to simulate abnormal discharges of different levels. It can also be used with other standard DUTs to perform routine checks with the Partial Discharge detect function of the purchased 11210.



Chroma A112102 connected to Chroma 11210 schematic

1. Voltage Trigger:
   PD ignition voltage level setting in CC charge
2. PD Interval Time:
   Active when Single/Multi SW is switched to "Multi"
3. PD Capacitance:
   Select PD "Energy" or "Charge Capacity"

SPECIFICATIONS

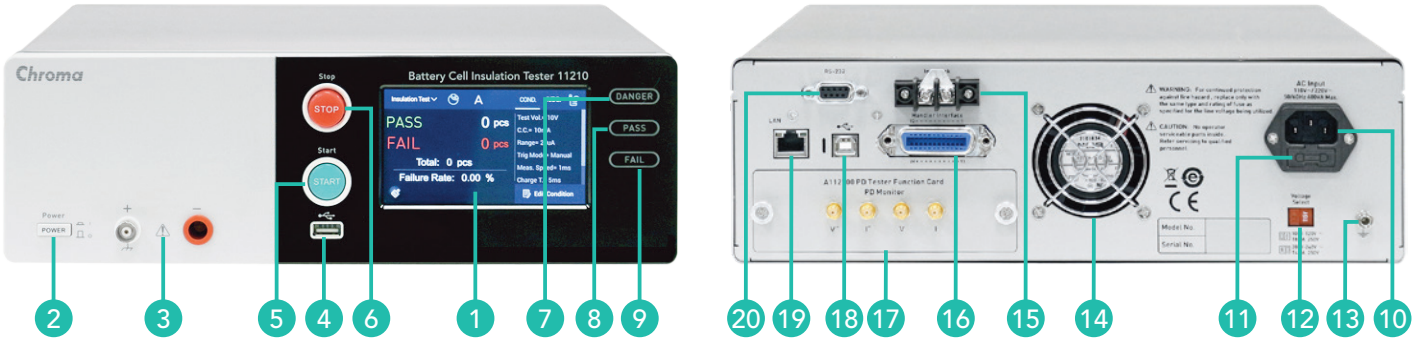
Model		11210
Main Functions		Insulation Resistance (IR) Leakage Current (LC) measurement Partial Discharge(PD) detection (option)
Output Specifications		
Output Voltage		1.0V ~ 100V, steps of 0.1V Accuracy: ±(0.5% Setting + 1% Range) 101V ~ 1000V, step 1V Accuracy: ±(0.5% Setting + 0.5% Range)
Charging Current		0.5mA ~ 50mA, steps of 0.5mA Accuracy: ±(1.5 % Setting + 1.5% Range)
Measurement Display Range		
IR (Insulation Resistance)		0.01kΩ ~ 10 TΩ [kΩ, MΩ, GΩ]
LC (Leakage Current)		00.001nA ~ 20.000mA [nA, uA, mA]
Basic Measurement Accuracy		
LC	20.00nA	±(5.0% Reading + 5.0% Range) [Note 1]
	200.0nA	±(1.0% Reading + 1.0% Range) [Note 1]
	2.000uA	±(0.3% Reading + 0.3% Range) [Note 1]
	20.00uA	±(0.3% Reading + 0.3% Range) [Note 1]
	200.0uA	±(0.3% Reading + 0.3% Range) [Note 1]
	2.000mA	±(0.3% Reading + 0.3% Range) [Note 1]
	20.00mA	±(0.3% Reading + 0.3% Range) [Note 1]
Vmea	100V	±(0.3% Reading + 0.3% Range) [Note 1]
	1000V	±(0.3% Reading + 0.3% Range) [Note 1]
IR		Defined by LC and Vmea measurement accuracy
LC Range		20nA, 200nA, 2uA, 20uA, 200uA, 2mA, 20mA; Auto-Range (automatic range selection)
Test Time Setting		
Charge		0.005s ~ 99.999s, steps of 0.001s
Dwell		0.003s ~ 99.999s, steps of 0.001s
Test		0.001s ~ 99.999s, steps of 0.001s
L.C. Measurement Integration Time Setting		
Integration Time		1ms
		4ms
		1PLC (50Hz: 20ms ; 60Hz: 16.6ms)
		100ms
		500ms
		User defined (5ms ~ 99.999s)
PD Detection (with option A112100)		
Magnitude Detected		Level 0.1 ~ 99
Number of Occurrence		0 ~ 99
Type of PD Occurrence		VPD (PD occurred in CC mode) CPD (PD occurred in CV mode)
Judgement Criteria		Magnitude or the number of occurrence or both
PD Analyzer (with option of A112101)		
Waveform Display		Both voltage and current waveform
Quick Shot (image) of PD Occurrence		Up to 10 shots (images) per test can be recorded
Max. Sampling Rate		5MHz
Sub Functions		
Correction		Null cancellation function (open circuit)
Comparator		Upper limit, lower limit for LC/IR measurement
Contact Check		≦5ms, pre-test, post-test or both.
Interface		Ethernet, Handler, RS-232, USB-Host (front panel), USB-Device (rear panel)
Mechanical and General Specifications		
Operation Environment		Temperature：0℃ ~ 40℃ ; Humidity：10% ~ 90% RH
Input Power Requirement		90Vac ~ 132Vac or 180Vac ~264Vac ; 47Hz ~ 63Hz
Power Consumption		300 VA
Outline Dimension (H x W x D)		100 x 320 x 400 mm
Weight		10 Kg

Note 1: Conditions of basic measurement accuracy

- Within 1 year after factory calibration
- Temperature: 23°C±5°C; Relative humidity: 75% maximum
- Warm up: 30 minutes minimum
- Test condition for all accuracy: measurement speed with integration time of 500ms
- Guarantee only for the tests on pure resistive DUT

All specifications are subject to change without notice.

PANEL DESCRIPTION



1. Touch panel display
2. Power button
3. High voltage output terminals
4. USB (host) interface (A-type)
5. Start button (starts the test)
6. Stop button (stops the test)
7. DANGER indicator
8. PASS indicator
9. FAIL indicator
10. AC power input
11. AC input Fuse
12. Input voltage range selector
13. Grounding terminal
14. Ventilation fan
15. Interlock protection terminals
16. Handler interface (Amphenol 57-30240 type)
17. PD tester/PD analyzer card slot (option)
18. USB (device) interface (B-type)
19. Ethernet interface (RJ-45)
20. RS-232 interface (D-sub 9-pin)

ORDERING INFORMATION

11210: Battery Cell Insulation Tester
A112100: Partial Discharge Detection Card
A112101: Partial Discharge Analyzer Card
A112102: PD Test Checking Kit
A112103: Handler interface
B112100: BNC*4+SMA*4
B112102: 11210 3M cable
B112103: 19" Rack Mountain Kit for 11210

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EUROPE
CHROMA ATE EUROPE B.V.
Morsestraat 32,
6716 AH Ede,
The Netherlands
T +31-318-648282
F +31-318-648288
www.chromaeu.com
salesnl@chromaeu.com

CHROMA GERMANY GMBH
Südtiroler Str. 9, 86165,
Augsburg, Germany
T +49-821-790967-0
F +49-821-790967-600
www.chromaeu.com
salesde@chromaeu.com