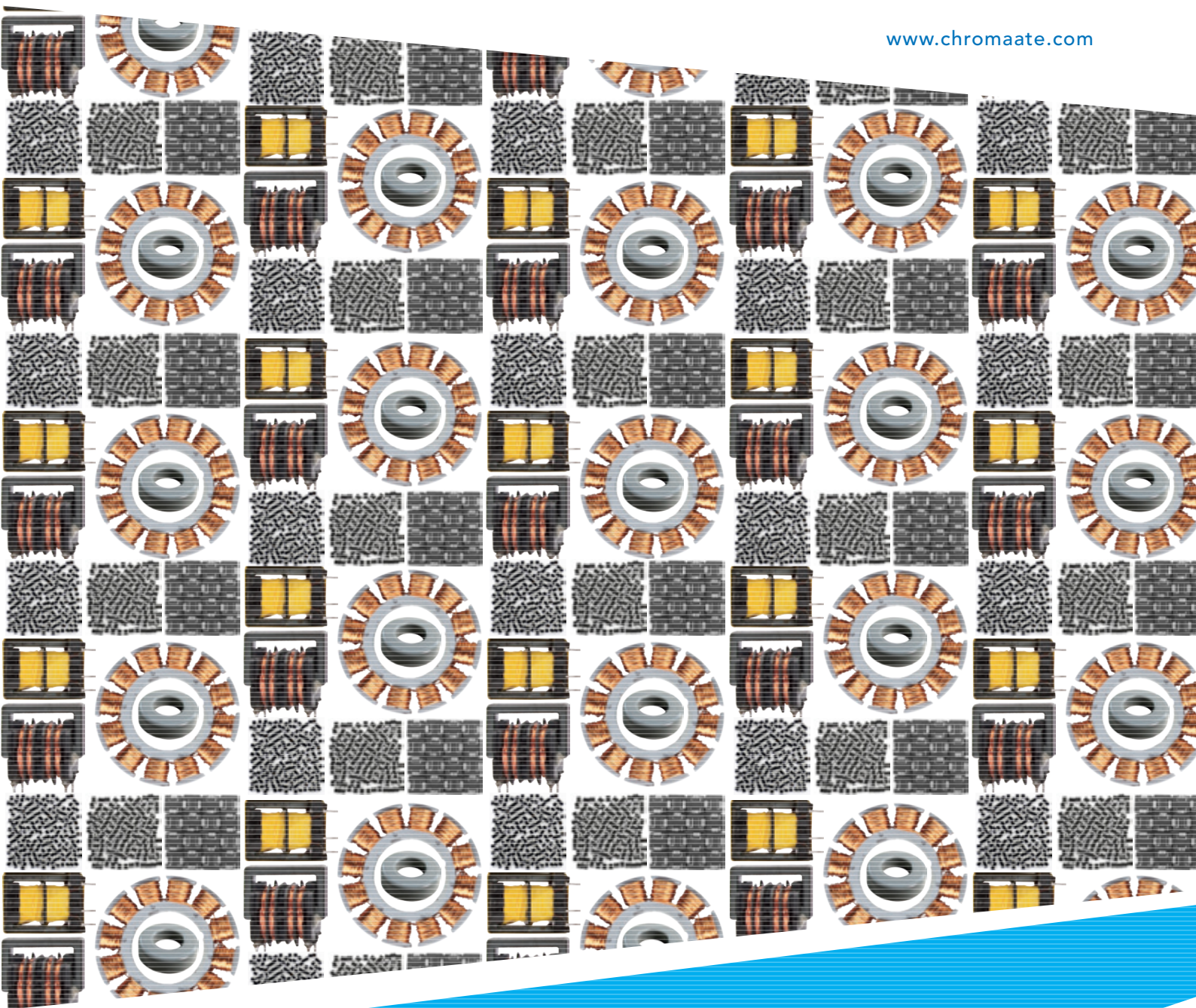


# Passive Components and Electrical Safety Testing

## Magnetic Components Test Solution

[www.chromaate.com](http://www.chromaate.com)

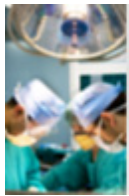


# Chroma

Turnkey Test & Automation Solution Provider



Magnetic components are widely used in electronic products as they are equipped with diversified functions for energy storage, filtering, and energy conversion. They appear in a variety of electronic products in the form of inductors, transformers and motors. Coping with changes over time and increasingly sophisticated electronic technologies, electronic products have also changed - from CRT TVs to thin LED LCD TVs, desktop PC to laptop to tablet, and now single-purpose communication devices to smart mobile devices. In addition, solar energy, electric vehicle, and other clean energy-related industries continue to be vigorously developed. To match with the cross-generational change of electronic products, the design of magnetic components has changed as well - from large size to compact, and from low to high working frequencies, for instance. As many quality issues may occur with design changes, Chroma provides overall testing solutions for solving common magnetic problems.



Medical Equipment



Mobile Devices



3C Products



Electric Vehicle



Solar Energy

### The corresponding instruments for inspecting common magnetic component issues

Using static characteristics to determine product quality	HF LCR Meter	Model 11050 Series
	Milliohm Meter	Model 16502
Hysteresis and magnetic saturation caused by reduced efficiency or failure	DC Bias Current Source	Model 11300
Power loss and temperature rise of magnetic components	Magnetic Component Test System	Model 1810
Small discharge causing short life	Hipot Analyzer	Model 19055-C
Insufficient withstand voltage causing coil turns failure	Impulse Winding Tester	Model 19301A
	Impulse Winding Tester	Model 19305
	Programmable HF AC Tester	Model 11802

### Magnetic components production test solutions

Power inductor production ATS solution	Inductor Test & Packing Machine	Model 1870D/1870D-12
	Inductor Layer Short ATS	Model 1871
Transformer production test application	Automatic Transformer Tester	Model 13350
	Multi-Channel Hipot Tester	Model 19020
	Impulse Winding Tester	Model 19305-10
Motor coil test application	Wound Component EST Analyzer	Model 19036
	Motor Stator Test System	Model 1920

## Overall solution for common magnetic component problems

## Using static characteristics to determine quality

The magnetic components are composed of coils and magnetic materials. When a magnetic component does not meet the specification, it could be a raw material issue, or an error caused in production. It is possible to use static characteristics to perform basic good or no good judgments based on the following parameters, and determine the issue source :

- Inductance (Ls): Check if the core material, coil turns, and production are normal
- Quality factor (Q/ACR): Check if the core material, coil, or electrode resistance is normal
- DC resistance (DCR): Check if the copper material or electrode resistance is normal

## HF LCR Meter

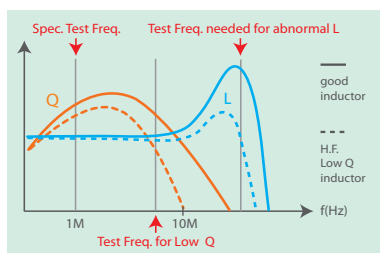
## Model 11050 Series



Since the internal DC circuit design of intelligent handheld devices can be up to 4~6MHz, the Chroma 11050 series HF LCR meters are equipped with testing frequencies from 1KHz to 10 MHz, and are able to provide high-speed, precision inductance and Q value for dual inductance measurements. They are able to detect quality problems caused by slight coil short circuits when 4-terminal measurement is not applicable for automatic equipments, and high/low frequency inductance is used for judgment. They provide complete automation-connecting interfaces for automatic high speed testing.

## Features

- ✓ Test parameter: L/C/R/Z/Y/DCR/Q/D/  $\theta$
- ✓ Test frequency: 1kHz ~ 10MHz
- ✓ Test voltage: 10mV ~ 5V
- ✓ Basic accuracy: 0.1%
- ✓ 7ms fast measurement
- ✓ 3 kinds of output impedance modes
- ✓ Dual frequency measurement and judgment
- ✓ Open/short and load compensation
- ✓ Detached design for measurement and display units
- ✓ Inductance dual-frequency testing function



### Relationship between Inductance (L), Quality Factor (Q) and Frequency (f)



## Parameter Sweep Mode

## Milliohm Meter

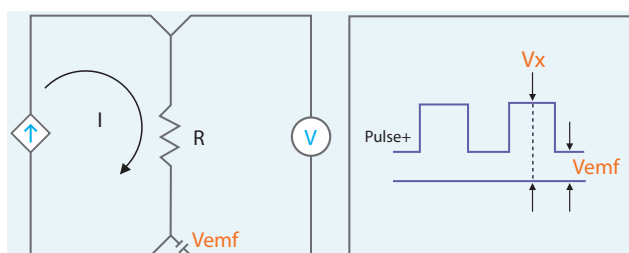
Model 16502



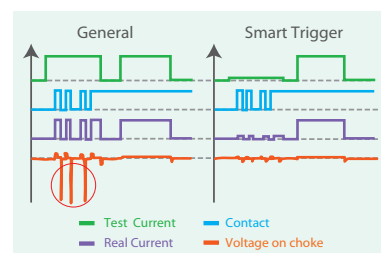
The Chroma 16502 is a milliohm meter specifically designed for measuring small resistance values. It has Pulse measurement modes for test signal selection that can eliminate the thermoelectric effect caused by test fixture contact. It also has a Smart Trigger function that can output current for measurement after contact with the device under test to avoid inductance generating counter-electromotive force due to mechanical contact bounce preventing damage to the product. In addition, complete automation-connecting interfaces are provided for automatic high-speed testing.

## Features

- ✓ Range: 0.001mΩ ~ 1.9999MΩ
- ✓ Basic Accuracy: 0.05%
- ✓ Provide Pulse measurement signal to eliminate measurement errors caused by thermoelectric effects
- ✓ Smart Trigger function
- ✓ Temperature Compensation (TC) function



### Pulse Measurement Signal for Eliminating Thermoelectric Effect

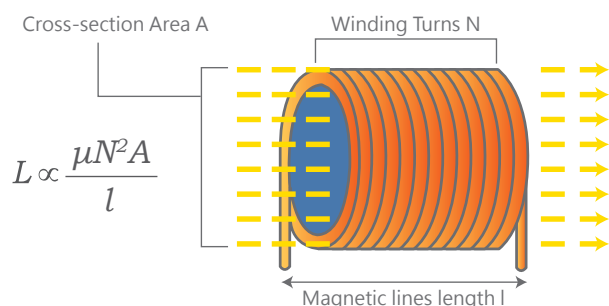


### Difference between Smart Trigger and General

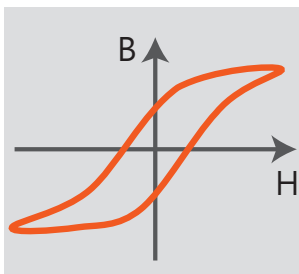


## Magnetic saturation causes efficiency decrease or failure in magnetic components

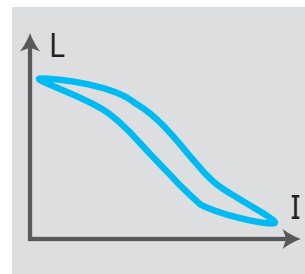
All magnetic components have a BH curve and will often be magnetized in electronic circuits. When the working current (I) is increased, the magnetic field intensity (H) and magnetic flux density (B) will increase as well. When the current continues to increase, the increment of magnetic flux density (B) will slow down due to magnetic saturation. The permeability coefficient ( $\mu = B/H$ ) will drop rapidly, and cause the inductance to quickly decline. Eventually the magnetic component will completely lose its functions in electronic circuits. The magnetic components may load DC current to get a LI curve and view the inductance drop via bias current test. In this way the feasible current range of inductors can be defined to ensure that the magnetic components characteristics will not fail when in use due to magnetic saturation.



Inductance (L) Equation of Wound Components



BH curve



LI curve

## Bias Current Test System

### Model 11300

The Chroma 11300 is a system designed for large DC current testing up to 300A, with a 4-terminal measurement fixture and LI test software. It is very convenient for R&D and QA personnel to use for testing. Customization is available on request for specifications over 300A.

### Features

- ✓ Frequency response: 20Hz to 1MHz
- ✓ Expandable up to 300Adc
- ✓ Multi-function 4-terminal test fixture
- ✓ Windows based software



LI curve software



A113008 DIP 100A 4-terminal test fixture



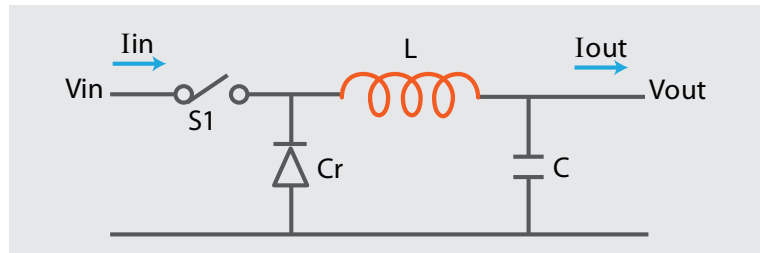
A113009 SMD 60A 4-terminal test fixture (working with A113008)



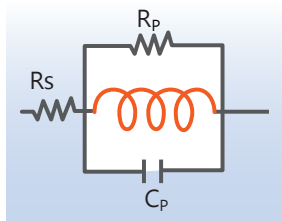
Model 11300 (300A)

## Power loss and temperature rise of magnetic components

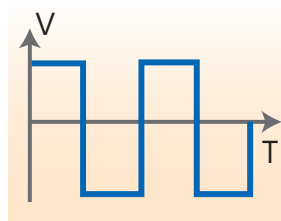
Today's products require low-power-loss and high-performance - reflected directly by internal parts - and there is no exception for magnetic components. The magnetic components are composed of a core and copper wire coils. Besides inductance, there are parallel resistance( $R_p$ ), parallel capacitance( $C_p$ ) and series resistance( $R_s$ ) for an equivalent circuit. Power loss includes iron loss caused by the core, and copper loss caused by the copper wire. The iron loss comprises eddy current loss and hysteresis loss that are mainly related to voltage ( $V^2/R_p$ ), while the copper loss is associated with copper wire and current ( $I^2R_s$ ). Magnetic components in electronic circuits are impacted by different working environments; therefore the loss generated and temperature rise conditions are also different. For instance, besides DC current flowing through, there is an AC voltage signal across the choke applied to a DC-DC converter internal circuit due to IC PWM controlling in working condition. Therefore, the actual power loss generated during use is the sum of iron loss produced by AC voltage and copper loss produced by AC/DC current that reflects the actual situation of temperature rise.



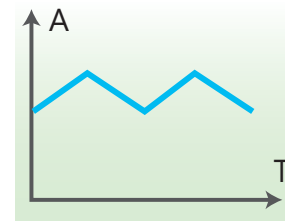
### DC-DC buck converter circuit



### Inductor Equivalent Circuit



### Voltage Waveform on DC-DC converter Choke



### Current Waveform on DC-DC Converter Choke

## Magnetic Component Test System

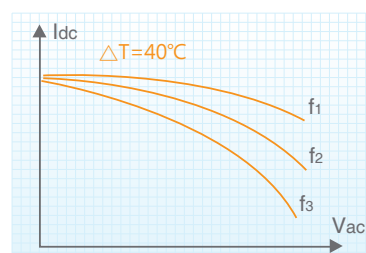
Model 1810



The Chroma 1810 is a magnetic component test system specifically designed for superposition of AC and DC signals. It simulates the actual working environment for power loss and temperature rise measurement. The equipped testing software can monitor and record real-time data, and also measure the relationship between voltage and current by fixed temperature rise in order to help customers analyze magnetic component specifications that are applicable.

## Features

- ✓ AC output CV/CC 20kHz~500kHz/1MHz  
sine wave~1kVA, above can be customized
- ✓ DC bias current (maximum 60A, customizable)
- ✓ AC output ~1kVA, customizable
- ✓ Magnetic component power loss detection  
(option)
- ✓ Magnetic component temperature detection  
(option)
- ✓ Software control support
- ✓ Able to provide the module as per customer's  
demands



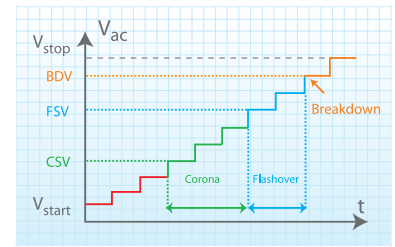
### Load Current ( $I_{dc}$ ) and AC Voltage ( $V_{ac}$ ) Curve



1810 Test Software

## Corona discharge causing short life

All magnetic components are subject to withstand voltage tests. However, even if the components pass the withstand voltage tests, abnormalities may occur and eventual failure sometimes happen after they have been in regular use. A short circuit is usually formed by either a corona discharge produced inside the magnetic component or when the insulation is insufficient, causing the temperature rise. Insulation failure can be divided into three stages: corona discharge, flashover, and breakdown. If the insulating materials have only been used for leakage current tests or for the insulation breakdown test, which ignores corona discharge and flashover, the insulating materials will be carbonized during use - which causes a short circuit and leads to breakdown. This causes the magnetic components to fail in regular use.



Discharge level analysis mode



Corona discharge causes insulation layer carbonization

## Hipot Analyzer

Model 19055-C



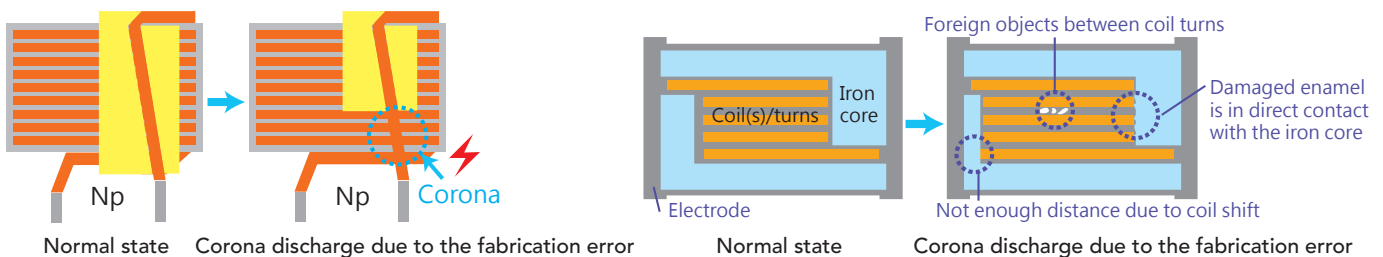
The Chroma19055-C Hipot Analyzer has 500VA output capability with the corona detection and the breakdown voltage analysis function. It can analyze the withstand voltage test on the DUT (device under test) in detail and identify the voltage that produces corona discharge, flashover, and breakdown, to ensure the product quality and increase the product life.

### Features

- ☒ Hipot test
  - AC 5kV/100mA (4kV/120mA)
  - DC 6kV/25mA
- ☒ Insulation resistance test
  - 5kV max
  - 0.1MΩ ~ 50GΩ
- ☒ 500VA output
- ☒ Corona discharge detection
- ☒ Flashover detection
- ☒ Breakdown Voltage Analysis (BDV)

## Insufficient withstand voltage causing coil failure

The magnetic component is composed of the coils and an iron core. There should be a sufficient withstand voltage from coil to coil, and from coil to iron core. A coil is wound with copper wire layer by layer. It has a high voltage terminal and a low voltage terminal when in use. If the withstand voltage of the copper wire is insufficient or the voltage difference between the high and low voltage terminals of the copper wire is too great due to the fabrication error, it will cause the coil to self-discharge. Self-discharge over a long period of time causes the insulating layer to be carbonized which then results in the insulation breakdown, and causes the magnetic component to fail. This is why it is necessary to test the insulation layers of the coil to make sure the withstand voltage is sufficient.



## Programmable HF AC Tester

Model 11802



The Chroma 11802 is a high frequency AC tester that can be equipped with different modules for high frequency, high voltage, or large current testing. When it works with the high voltage module for high frequency hipot testing, it can be used to inspect the insulation quality of magnetic components such as motors and transformers with high inductance.

### Features

- ☒ High frequency and high voltage endurance test
- ☒ High frequency hipot test
- ☒ High frequency breakdown voltage test
- ☒ Test frequency: 20kHz ~ 200kHz
- ☒ Able to work with different modules with wide range of output voltage and current (customized modules)
- ☒ Output voltage and current monitoring
- ☒ Programmable output voltage control

## Impulse Winding Tester

Model 19301A



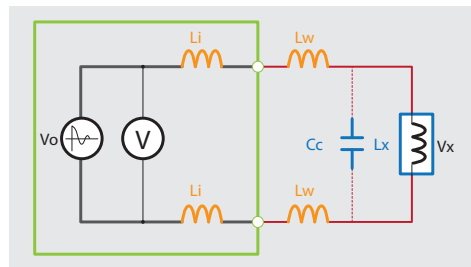
The Chroma 19301A is a layer withstand voltage test instrument specifically designed for testing the low inductance power inductors. It provides the 4-wire detection for testing the low inductance, and the contact check function (patent) to avoid the damage to the fixture due to the high voltage and the flashover caused by loose contact, poor contact or open circuit. It also has the voltage compensation function for differential inductance (patent) to reduce the testing voltage difference caused by the differential inductance. The high speed test can be applied with automatic test systems in production line environments.

## Features

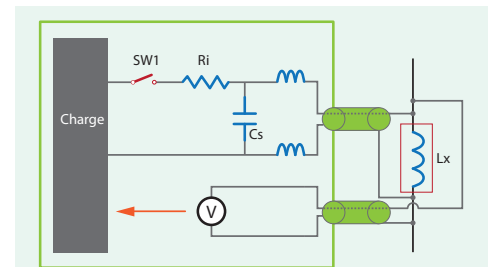
- ✓ Test application  $0.1 \mu\text{H} \sim 100 \mu\text{H}$
- ✓ Impulse voltage  $10\text{V} \sim 1000\text{V}$
- ✓  $< 18\text{ms}$  high speed test
- ✓ Impulse testing sampling rate (200MHz), 10 bits
- ✓ Inductance contact check function
- ✓ Voltage compensation function for differential inductance
- ✓ Breakdown Voltage Analysis (BDV)
- ✓ USB waveform storage and screen capture function

## 4-terminal Measurement

The common 2-wire layer short test equipment, which is located inside the current loop for the voltage measurement, has a big difference between the measured voltage and the actual voltage on the DUT. The Chroma 19301A uses the dual coaxial 4-wire detection to significantly improve the voltage accuracy for correct test results.

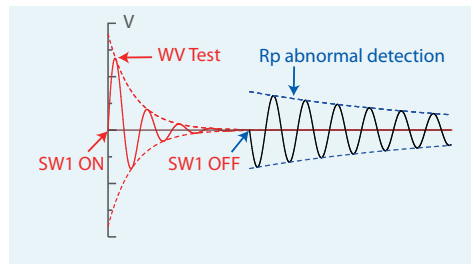


### Equivalent Circuit Diagram

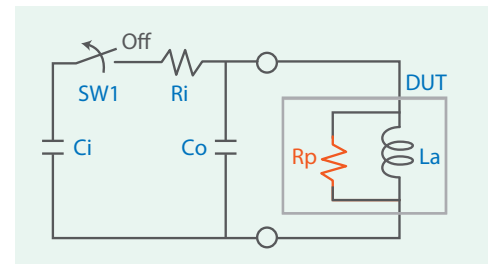


### 19301A 4-terminal measurement Diagram

The  $\Delta$  Peak Ratio judgment function, which can detect the abnormalities or the deterioration of the resistance(Rp) to improve the overall product quality, is a characteristic testing technology from Chroma.



### IWT Waveform & Peak Ratio Waveform



### Peak Ratio Test Circuit Diagram

## Impulse Winding Tester

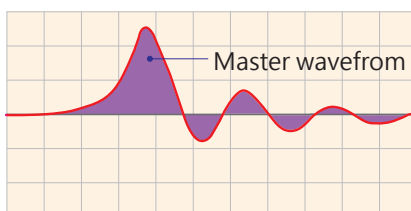
Model 19305



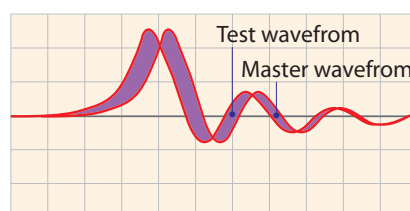
The Chroma 19305 is an impulse winding tester that is designed for testing the general winding components which are transformers, motor coils and the coils with large inductance. The Chroma 19305-10, which is suitable for fast measurement on the production lines, has a maximum of 10 channels scan test. The Laplacian function is able to detect a small self-discharge within the coil(s) to ensure the product quality.

## Features

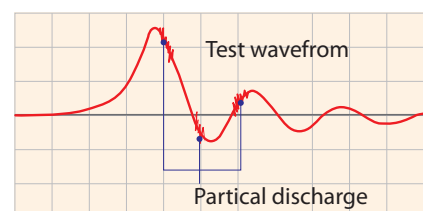
- ✓ Test application  $>10 \mu\text{H}$
- ✓ Impulse testing sampling rate (200MHz), 10 bits
- ✓ 6kV impulse test
- ✓ Breakdown Voltage Analysis (BDV)
- ✓ High speed test
- ✓ Maximum 10 channels scan test in a single device (19305-10)



### Waveform area comparison



### Waveform area difference comparison



Laplacian



## Production test application for magnetic components

### Automated production testing for power inductors

Power inductors are one of the most common magnetic components. Their requirements are the greatest in electrical products and the production demands are also the highest. For these reasons, the test equipment needs to meet high speed measurement requirements. The basic static electrical characteristics tests of power inductors on the production line include Ls, Q/ACR, DCR, polarity, hipot insulation, layer short, and BIAS current. Chroma provides a complete automated production test solution for testing power inductors.

### Automated Inductor Test & Packing Machine

1870D/1870D-12

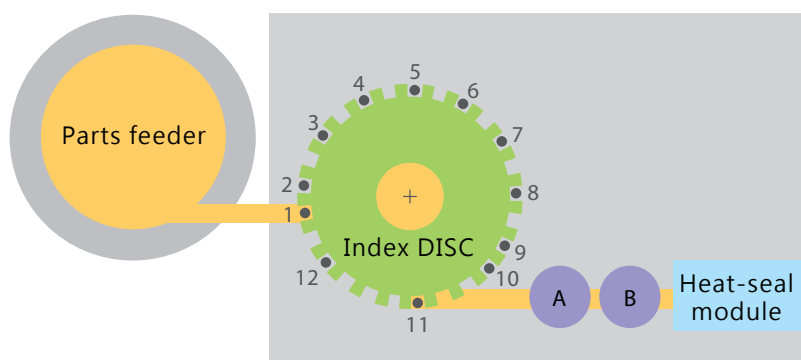
The Chroma 1870D Series high-speed test and packaging machines are designed specifically for wafer-type power inductors with testing speeds up to 1,800ppm. These combine the power inductor “must test” parameters of each test station with exclusive data collection software for analyzing production data in order to improve productivity and quality control.

#### Features

- ✓ Test and packing speeds from 200ppm to 1,800ppm
- ✓ Provides 4 test stations based on test requirements for users to select desired test items
- ✓ Complete list of test items: Polarity, Layer Short Circuit, IR, DCR, Ls & Rs (Q value)
- ✓ Patented high-speed polarity reversing design ensures that products on the conveyor all have the same polarity
- ✓ Each test station has an independent NG (No Good) product collection box for later quality analysis
- ✓ Circular load plate design eliminates dropped inductors.
- ✓ Equipment is fast, stable and safe
- ✓ Exclusive data collection software designed for test and packing machines for monitoring product quality in real time

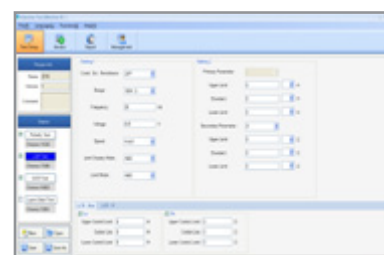


1870D / 1870D-12 Configuration Diagram and Stations Depiction



#### Stations

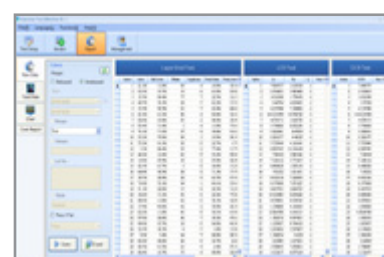
- |  |  |
|--|--|
| 1. Feed detection  | 9. NG inductor discharge for station 8               |
| 2. Polarity test   | 10. Good inductor receipt                            |
| 3. Polarity reverse  | 11. Move to packing tape                             |
| * 4. Layer short test (works with 19301A)<br>Insulation resistance test (works with 11300)<br>Bias current test (works with 11300) | 12. Clean remaining inductors                        |
| 5. NG inductor discharge for station 4   | A. Reserved for number spraying station              |
| 6. Winding resistance test (works with 16502)  | B. Reserved for automatic optical inspection station |
| 7. NG inductor discharge for station 6   |  |
| 8. Inductor/quality factor test (works with 11050 Series /3302)  |  |
- \* Choose one from three alternatives to work with installation testing for the 4th station



1870D Software testing parameters settings



1870D Software report



1870D Software production monitoring



## Inductor Layer Short Automatic Test System 1871

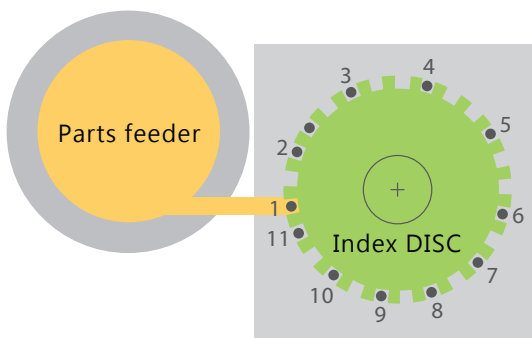


The Chroma 1871 is an inductor layer short automatic test system with production capacity of up to 1,500ppm for mass production applications. The 1871 ATS provides multiple test items for users to select from. It won't be idled even if it was installed during the initial development stage with lower production capacity.

### Features

- ☑ Test and packing speeds from 200ppm to 1,500ppm.
- ☑ Provides from 2 to 5 test stations for ATS selections based on testing requirements
- ☑ Equipped with inductance measurement contact check and voltage difference compensation functions
- ☑ Patented testing probe with "Four wire system" design to test voltage's authenticity and stability
- ☑ Tested NG inductors are collected to a separate box by failed item for bad process model and cause analysis
- ☑ Circular load plate design to eliminate dropped inductors
- ☑ Exclusive data collection software designed for layer short automatic test system for monitoring product quality in real time

### 1871 Configuration Diagram and Station Depiction



### Stations

1. Feeding detect
2. Layer short test station 1 (works with 19301A)
3. Layer short test station 2 (works with 19301A)
4. Layer short test station 3 (works with 19301A)
5. Layer short test station 4 (works with 19301A)
6. Layer short test station 5 (works with 19301A)
7. Good inductor receipt
8. Area NG inductor discharge
9. Laplacian NG inductor discharge
10. Contact check NG inductor discharge
11. Clean remaining inductors

\* Layer short test stations 3 to 5 are reserved when 2 stations are selected



1871 Software testing parameters settings



1871 Software production monitoring

1870D Application Size Maximum Productivity									Unit : pcs/min	
WxD (mm)	3.2 x 2.5		2.5 x 2.0		2.0 x 1.6 / 2.0 x 1.2			1.6 x 0.8		
H (mm)	1.2	1.0	1.2	1.0	1.2	1.0	0.8	1.0	0.8	0.6
Single-sided electrode	600	600	800	800	800	800	1,000	800	800	1,200
Five-sided electrodes	900	900	1,200	1,200	1,500	1,500	1,500	1,500	1,500	1,800

\* The maximum productivity listed above does not include layer short testing, insulation resistance testing, or bias current testing.

\* Production efficiency >1,200 pcs/min with paper tape used for packing. Do not use plastic tape.

1870D-12 Application Size Maximum Productivity					Unit : pcs/min	
WxD (mm)	4.0x4.0		6.0x6.0		8.0x8.0	
Single-sided electrode	250	200	150	100	80	

1871 Application Size Maximum Productivity									Unit : pcs/min	
WxD(mm)	3.2 x 2.5		2.5 x 2.0		2.0 x 1.6 / 2.0 x 1.2			1.6 x 0.8		
H(mm)	1.2	1.0	1.2	1.0	1.2	1.0	0.8	1.0	0.8	0.6
Single-sided electrode	600	600	800	800	800	800	800	800	800	800
Five-sided electrodes	900	900	1,200	1,200	1,500	1,500	1,500	1,500	1,500	1,500

\* The test condition for the above is pulse 1.0 with 5 stations of layer short testing.



## Transformer production testing

The transformer required by electrical products converts the power voltage and current for power. Generally, it has a multi-winding coil with multiple pins. Therefore, the test equipment needs multi-point or multi-channel scanning output capability. The test parameters for common transformers are Ls, L.K., DCR, Turn Ratio, Pin Short, Cp, Hi-pot and Layer Short, etc. For these tests, Chroma provides a complete transformer test solution.

### Automatic Transformer Tester

Model 13350



The Chroma 13350 is an automatic tester specifically designed for transformer production lines for testing all of the basic electrical characteristics. The 13350, along with an 80-channel scan box, provides an efficient measurement mode that can test the product over 20 pins. It can also perform scan tests on 4 transformers or LAN RJ-45 Jacks at the same time to shorten the measurement time and save manpower.

#### Features

- ✓ Test frequency 20Hz ~ 200KHz
- ✓ Support 80 channels scan box
- ✓ USB storage interface
- ✓ Individual Test frequency, voltage and speed setting
- ✓ Fail lock function
- ✓ Auto test function
- ✓ Any short circuit pin can be selected in all test items

### Multi-Channel Hipot Tester

Model 19020



The Chroma 19020 is a hipot tester that can test 10 channels simultaneously. The synchronous output design can avoid flashover generated by voltage difference due to unsynchronized output on adjacent electrodes. It can work with the A190201 3-channel scanner to perform simple transformer hipot scanning tests for independent judgment in order to increase production line efficiency.

#### Features

- ✓ 10 channels in one tester (19020-4 is 4 channels)
- ✓ 10 channels for sync output and measurement (19020-4 is 4 channels)
- ✓ Able to do 3 points scan when working with A190201
- ✓ ACW / DCW / IR 3 in 1 EST test
- ✓ Programmable voltage output and limit
- ✓ OSC detection (Open/Short Check)
- ✓ Flashover detection
- ✓ 5kVac & 6kVdc hipot test
- ✓ 1M $\Omega$  ~ 50G $\Omega$  insulation resistance test

### Impulse Winding Tester

Model 19305-10



The Chroma 19305-10 is a multi-channel impulse winding tester designed for testing common winding components that have large inductance applied on the coil turns such as transformers and motor coils. With a maximum of 10 channels scan test in a single device, it is suitable for fast measurement on the production line. The Laplacian detection function is able to detect small self-discharge on the coil turns to ensure product quality.

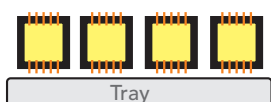
#### Features

- ✓ Test application >10  $\mu$  H
- ✓ Impulse testing high sampling rate (200MHz)
- ✓ 6kV programmable impulse test
- ✓ Breakdown Voltage Analysis (B.D.V)
- ✓ Maximum 10 channels scan test in a single device
- ✓ Support max. 40 channels scanning test

## Application example of transformer production line testing

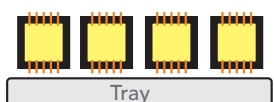
The parameters required for testing transformers are generally Ls, L.K., DCR, Turn Ratio, Pin Short, Cp, Hi-pot and Layer Short. These parameters can be divided into three types of test stations: hipot testing station, layer short testing station, and static parameters comprehensive testing station. Using trays to carry multiple UUTs for testing can minimize human touch or placement problems in order to speed up production. It can also work with automated equipment for automatic production testing.

19020 with A190201



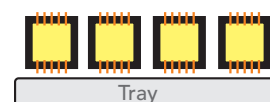
Hipot testing station

19305-10



Layer short testing station

13350 with A133505



Static parameters comprehensive testing station

## Application example for the motor coil production test

A motor coil, which can convert electrical energy into mechanical energy, has a stator coil and a rotor coil. The motor coil production test, which are Hi-pot, Layer Short, DCR, Ls and phase, can ensure the quality of the copper wire, the winding turns and the fabrication. Chroma has a complete test solution for the motor coils.

# Wound Component EST Analyzer

## Model 19036



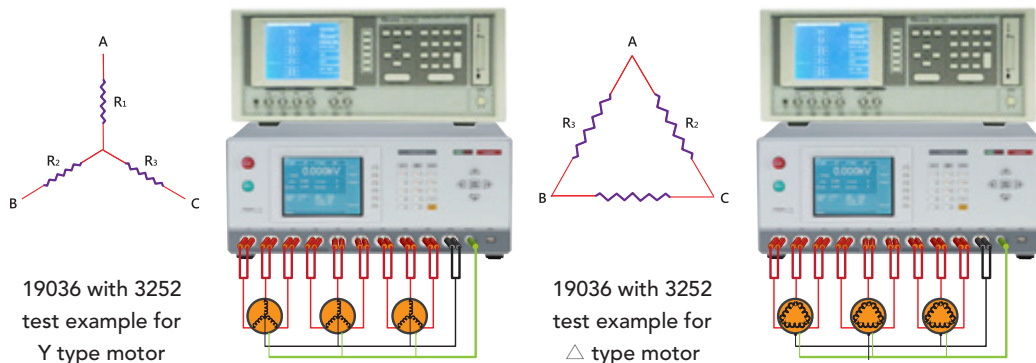
The Chroma 19036; Wound Component EST Analyzer, integrates hipot test, insulation resistance test, impulse test, and DC resistance test into one device. It has 5kVac/6kVdc high voltage output for hipot test, 5kV output for insulation resistance test, 6kV output for impulse test and DC resistance test, and 4-wire DC resistance measurement. It can work with the transformer tester (Option: Chroma 3252 or 3302) to measure the inductance and the quality factor (Q). It has 10 channels to perform the scan test on different motor coils, and can be extended to a maximum of 40 channels with two 16-channel high voltage fixtures (A190359 or A190362).

## Features

- ✓ Hi-pot test: 5kVac / 6kVdc
- ✓ High Speed Contact Check (HSCC) function
- ✓ Maximum 5kV IR test
- ✓ Impulse Winding Test (IWT) with high sampling rate (200MHz)
- ✓  $\Delta$  type/Y type motor winding resistance calculation
- ✓ Supports a maximum of 40 channels scan test
- ✓ Able to test inductance/quality factor (working with 3252/3302) (option)

## Application example for the motor coil production test

The Chroma 19036 with the Chroma 3252 is able to test the inductance and motor coils at one station. The Chroma19036 has a motor winding resistance calculation function to calculate the values R1, R2 and R3 of for  $\Delta$  type and Y type (without center-tapped) motor.



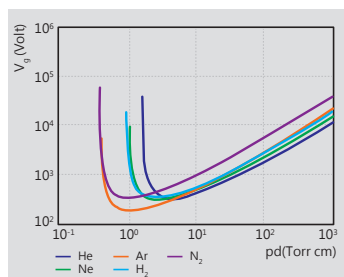
Motor Stator Test System  
Model 1920



The Chroma 1920 is a test system specifically designed for motor stator coils. Other than testing the electrical characteristics required by motor stator coils, it also has a low pressure test environment that can find product problems under lower test voltage condition. The Chroma 1920 has data collection software to gather and analyze the production data for efficiency and quality control.

## Features

- ✓ 7 in 1 test function  
(ACW/DCW/IR/IWT/DCR/L/Q/Phase)
- ✓ Programmable test item editor
- ✓ Layer short (IWT) and Hi-pot test in vacuum environment
- ✓ Left/right dual switch test
- ✓ Test data storage and report generation
- ✓ Software functions
  - Program editing
  - Data collection
  - Report output
  - Statistics of defects
  - User management



Paschen curve : The pneumatic gap of electrode that disrupts the voltage is related to the pressure and electrode distance.

$$V = f(P \times D)$$

P: Pneumatic pressure

D: Electrode distance







**HEADQUARTERS  
CHROMA ATE INC.**

66 Huaya 1st Road, Guishan, Taoyuan 33383, Taiwan  
T +886-3-327-9999  
F +886-3-327-8898  
info@chromaate.com  
www.chromaate.com

**ASIA  
CHROMA JAPAN CORP.**

888 Nippa-cho, Kouhoku-ku, Yokohama-shi,  
Kanagawa, 223-0057 Japan  
T +81-45-542-1118  
F +81-45-542-1080  
www.chroma.co.jp

**CHROMA ELECTRONICS (SHENZHEN) CO., LTD.**

8F, No.4, Nanyou Tian An Industrial Estate, Shenzhen,  
China PC: 518052  
T +86-755-2664-4598  
F +86-755-2641-9620  
www.chroma.com.cn

**QUANTEL PTE LTD.**

(A company of Chroma Group)  
46 Lorong 17 Geylang # 05-02 Enterprise  
Industrial Building, Singapore 388568  
T +65-6745-3200  
F +65-6745-9764  
sales@sg.quantel-global.com  
www.quantel-global.com

**USA  
CHROMA SYSTEMS SOLUTIONS, INC.**

19772 Pauling, Foothill Ranch, CA 92610  
T +1-949-600-6400  
F +1-949-600-6401  
sales@chromausa.com  
www.chromausa.com

**EUROPE  
CHROMA ATE EUROPE B.V.**

Morsestraat 32, 6716 AH Ede, The Netherlands  
T +31-318-648282  
F +31-318-648288  
sales@chromaeu.com  
www.chromaeu.com