MODEL 19501

KEY FEATURES

- Separate design for AC high voltage output with PD measurement and mainframe
- Built-in AC Hi Pot test and PD detection functions
- Compliant with IEC60747-5-5, VDE0884 and IEC 60270 requirements
- Built-in regulation test methods
- 3-stage voltage testing method
- PD measured results display (pC)
- PD failure count setting (1-10)
- USB storage for screen capture
- Graphic aids design
- Standard LAN, USB, and RS232 remote control interface
- English/Chinese User interface

A195005 KEY SPECIFICATION

- Programmable test voltage
  0.1kVac-5.0kVac
- Leakage current meter
  0.01μA-3000μA
- PD measurement range
  1pC-6000pC
- Max. load capacitance
  3nF (typ.)
- Application
  IGBT (module), SiC-MOSFET (module), large transformer, motor, etc.

A195004 KEY SPECIFICATION

- Programmable test voltage
  0.1kVac - 10.0kVac (50/60Hz)
  0.1kVac - 5.0kVac (600Hz)
- Leakage current meter
  0.1μA - 10mA max.
- PD measurement range
  1pC-2000pC
- Max. load capacitance
  100pF (typ.)
- Flashover detection
  0.1mA - 20.0mA
- Integrated 5pC & 10pC PD Calibrator
- High voltage contact check (HVCC)
- Applications
  Photocoupler, digital isolator, isolated control IC, isolated D/D power, small transformer, etc.

PARTIAL DISCHARGE TESTER MODEL 19501

Chroma 19501 Partial Discharge Tester provides AC Hi-Pot test to measure leakage current and flashover, and partial discharge (PD) test to measure the charge (pC) of PD on the device under test (DUT). Performing AC Hi-Pot test and PD test on high withstand voltage components and insulation materials can ensure the product's insulation quality and improve its reliability.

The design of 19501 complies with the requirement of the IEC 60270 standard for PD measurement. The result of the PD measurement is intuitively displayed in charge (pC) on the screen of the mainframe. The test methods specified in the IEC60747-5-5 and VDE0884 standards have been designed into the instrument, which enables the user to operate and set up the unit more conveniently.

When there is a void inside the insulation material or when there is an air gap between the insulation materials, the void or the air gap has higher electric intensity under the normal operating (working) voltage, which might cause PD. When PD continuously occurs on the components used in a power system (e.g., optocoupler, digital isolator, IGBT, transformer, motor, etc.), the long-term damage from PD causes the insulation of these components to fail, leading to potential hazards. Therefore, the regulations recommend or require to perform PD test on these components, ensuring that PD does not occur under the normal operating voltage. For example, the IEC60747-5-5 standard requires the PD test to be 100% performed on the optocoupler in the production process (routine test), and PD should not exceed more than 5pC under the maximum insulation voltage.

HANDLER LAN USB RS-232 CE RoHS2 Compliant

Chroma
Advancing Excellence

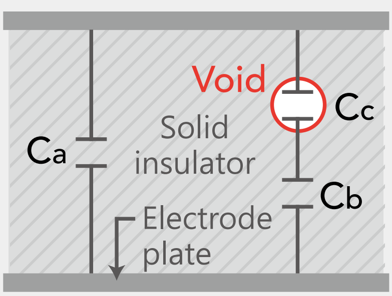
ELECTRICAL DISCHARGE THEORY

Partial Discharge

When there is a void inside the insulation material or when there is an air gap between the insulation materials, the void or the air gap is prone to partial discharge (PD) under the normal operating (working) voltage, which can lead to insulation degradation and cause the insulation quality to be abnormal.

Why does PD often appear at the voids inside the epoxy or the air gap between enameled wires? Because the relative permittivity of air is a lower than that of the insulation material, the capacitance of the void or air gap is lower than that of the insulating material, and therefore, the void or air gap will have a relatively high proportion of voltage. Additionally, under the same distance condition, the breakdown voltage of the void or air gap is lower than that of the insulation material. This electrical discharge, which occurs in the void or air gap (partial defects) while other insulation materials in series are remaining normal, is called partial discharge (PD).

When a sufficient test voltage is applied on the device under test (DUT), the charge quantity of PD is measured (in pC) by using PD measurement for checking whether the insulation material of the DUT has any potential risk of abnormal insulation quality.Therefore, applying the test voltage, which is slightly higher than the maximum rated working voltage of the component, for the PD test ensures the component's quality and reliability (no continuous PD) for long-term operation under normal operating voltage.



A void in the insulation material

Ca: Equivalent capacitance of the insulation material (path without any void between the electrodes)

Cc: Equivalent capacitance of the void

Cb: Equivalent capacitance of the insulation material (path with void between the electrodes)

APPLICATIONS

IGBT and SiC-MOSFET, both power semiconductor devices, are used in various fields such as electronic products, industrial equipment, aerospace, military equipment, railway systems, energy applications, smart grids, electric vehicles, etc. They are frequently used in high-power conversion, large-current power conversion and power control circuits, which may have an operating voltage with several kilo-volts. Because they will be switched ON and OFF very frequently, there is a PWM (Pulse-Width Modulation) high voltage difference across between the gate and collector or between the gate and drain of the module, and as well as between the module and heatsink. When the high voltage is across the insulation materials that contain voids, air gaps, or cracks, there is a higher likelihood of PD occurring. After long-term operation, the insulation material will be gradually degraded, which will eventually lead to insulation failure of the material and cause product damage.

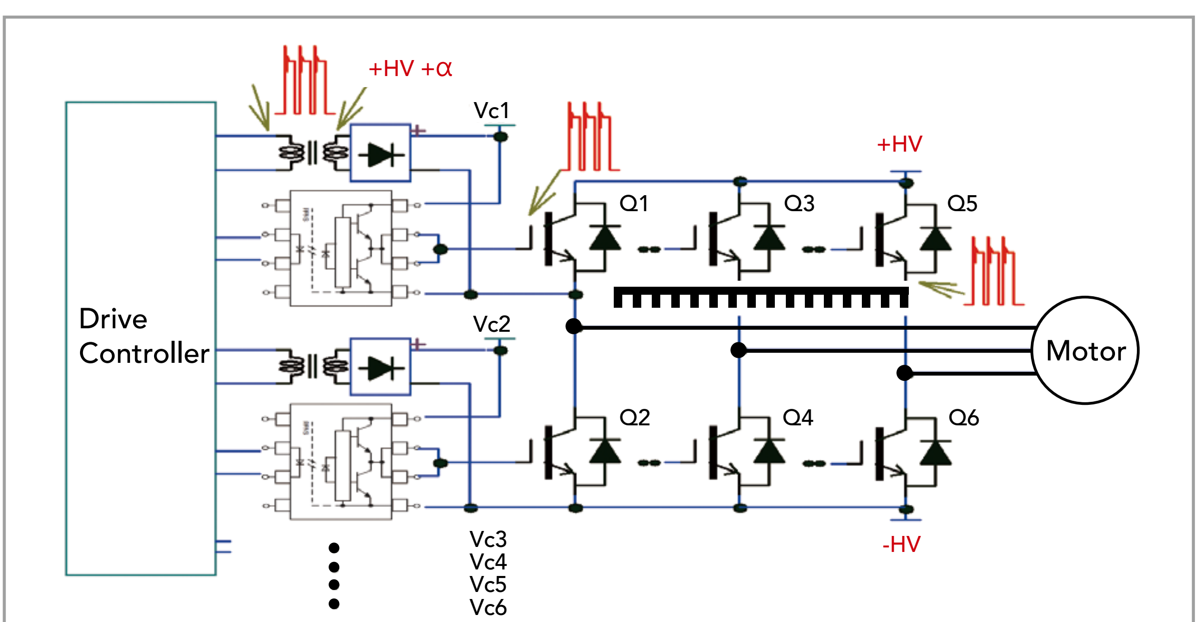


Figure 1. Circuit diagram of a motor driver

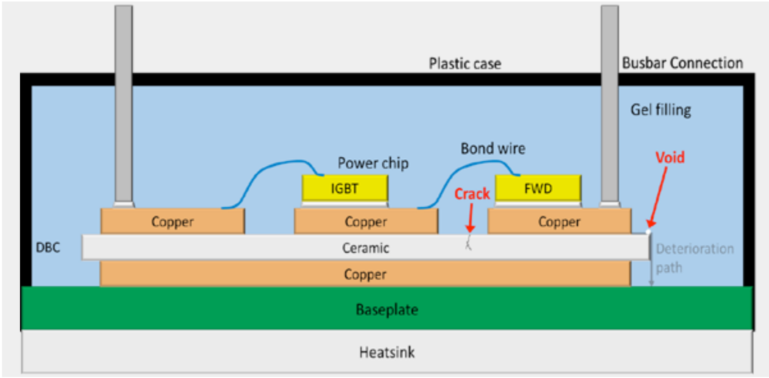


Figure 2. Air gap and crack inside IGBT

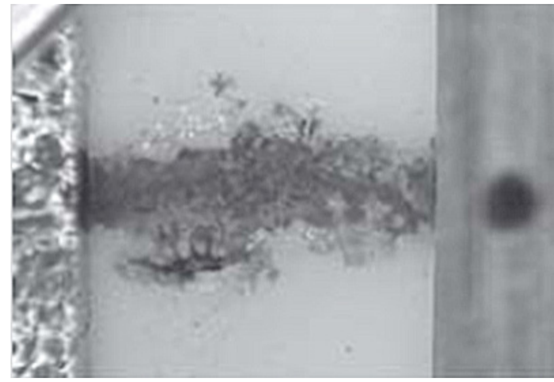


Figure 3. Deterioration path (real photo)

Additionally, the operating bias voltage (threshold voltage) between the Gate and Emitter or between the Gate and Source of each module may be provided by individual transformers. These transformers may have a high voltage difference with high frequency between their primary and secondary sides. When the insulation capability between the primary and secondary sides of a transformer is insufficient, the surges of continuous abnormal discharge may interfere with the digital control operations and result in transistor failure. Although the wires used in the transformers may have sufficient withstand voltage capabilities (e.g., 3000V) by themselves, when the coils/wires on the primary and secondary sides are very close to each other, it may appear that the wires can withstand a relatively high voltage (e.g., 6000V). However, in fact, after operating a period under the typical voltage (e.g., 1000V), insulation failure may occur. Because the permittivity of the general wire's insulation layer is much greater than that of air, the voltage division ratio across the air gaps between the wires is relatively high. When the voltage across the air gap between the wires is >350V (the discharge inception voltage for the shortest air distance at 1 atm), PD begins to occur on the partial surface between the wires. Because the insulation layer of the wires does not deteriorate or get damaged immediately, the insulation layer gradually carbonizes after continuous use over a period of time, ultimately leading to a short circuit on the primary and secondary sides of the transformer (Figure 4).

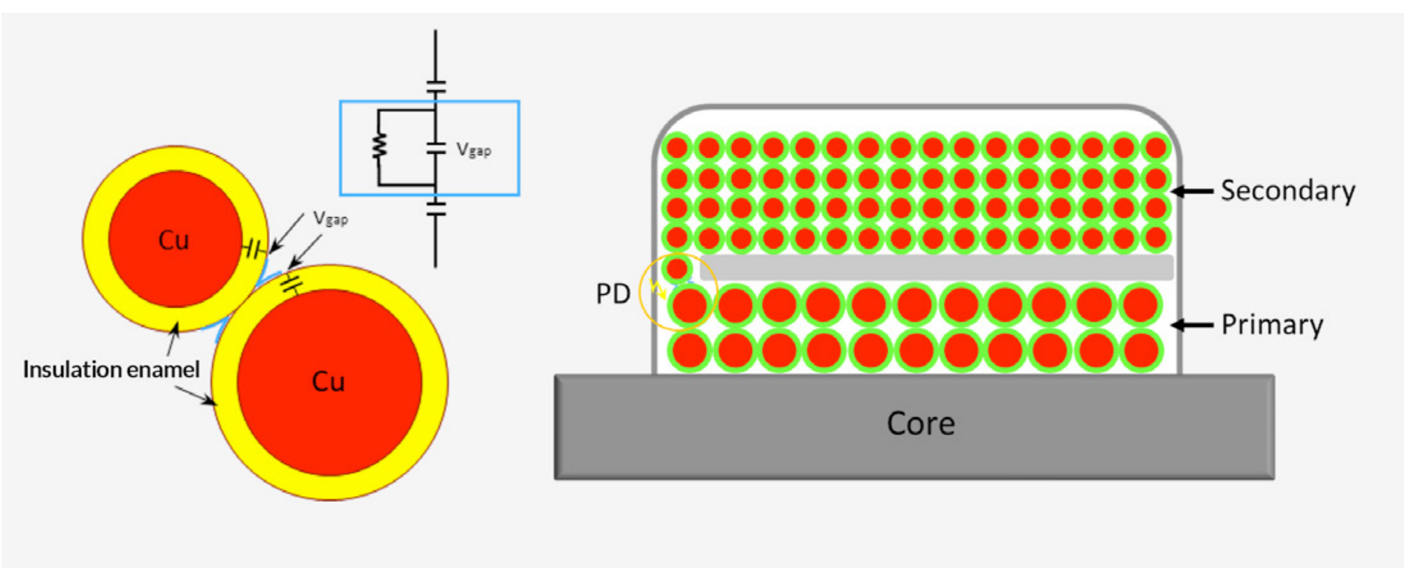


Figure 4. PD occurs between the wires of primary and secondary coils of a transformer

Photocouplers and digital isolators are used in various environments that require isolation. When the isolation voltage is applied across insulation materials that contain voids or cracks, the voltage across the voids or cracks may be sufficiently high to cause PD. After long-term degradation, the voltage isolation fails due to the insulation failure of the insulation material (Figure 5).

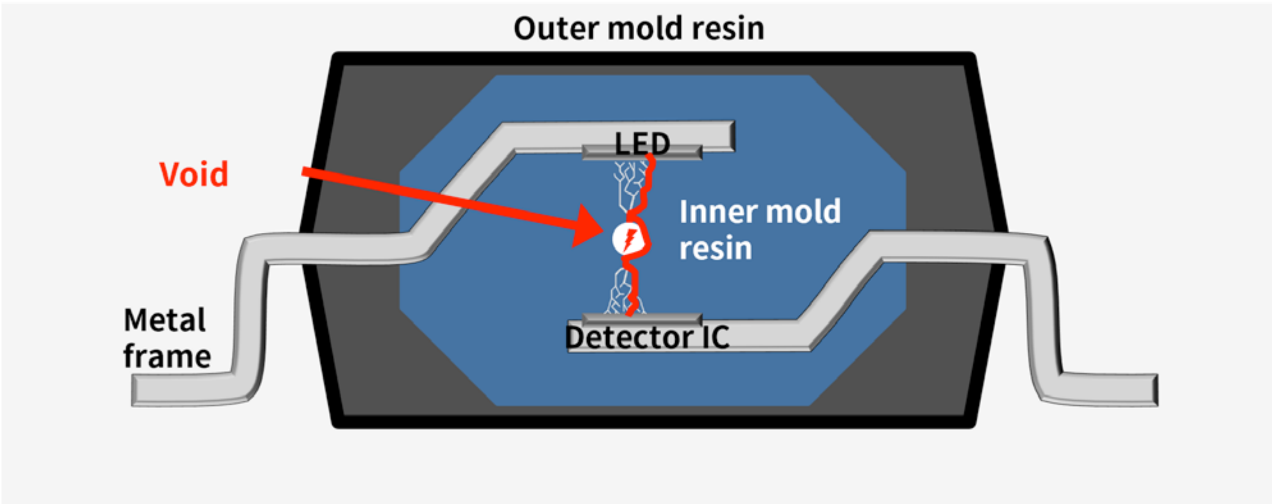
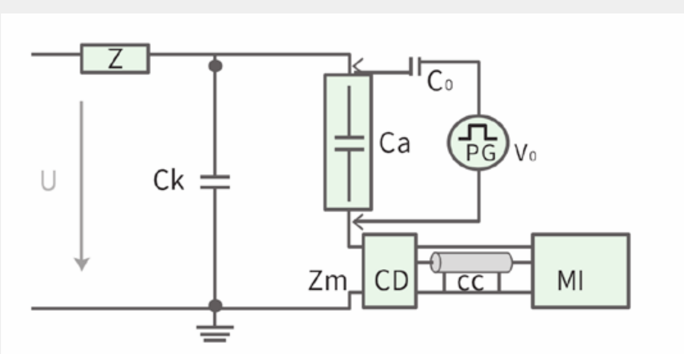


Figure 5. PD occurs when void is present inside a photocoupler

MEASUREMENT TECHNOLOGY

Partial Discharge Calibration

The PD tester is used for measuring and determining a tiny discharge quantity (in pC). Because this discharge signal is very small and rapid, the PD tester has to be precisely calibrated for ensuring the high frequency discharge signal can be accurately measured when the PD occurs.

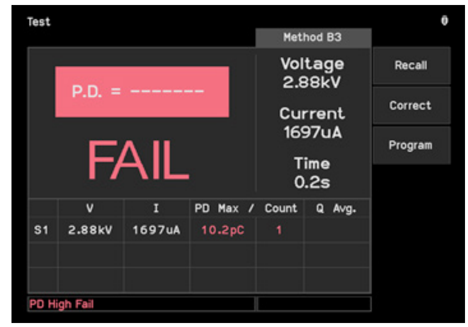


U: High voltage supply
Z: Blocking impedance
Ca: Capacitance of DUT
Ck: Coupling capacitor
Zm: Input impedance of measuring system
CD: Coupling device
CC: Connecting cable
MI: Measuring instrument
PG: Step voltage generator
V0: Step voltage

HV Module (A195005 & A195004)

The HV modules offer precise and wide-range PD measurement. Different high-voltage modules can be selected based on the capacitance of the DUT and the requirements of PD measurement. The A195005 has four PD measurement Ranges (1 - 4), with a total PD measurement range from 1pC to 6000pC. The A195004 has two PD measurement levels, with a PD measurement range from 1pC to 2000pC. After the test is completed, the mainframe will intuitively display the data and measurement results on the screen, aiding in the judgement and analysis of the discharge quantity.

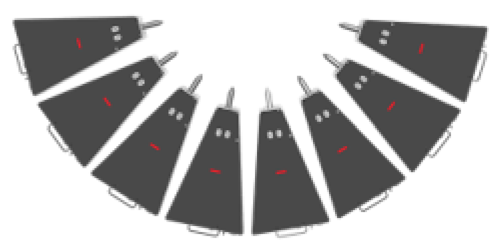
19501 + A195005



PD test Fail screen

The shape of the A195004 HV module has been designed as an isosceles trapezoid for the purpose of automation integration. This design allows multiple HV modules to be arranged in a fan-shaped configuration on the automated test system, which optimizes space usage. Additionally, the plug-in connection design brings the A195004 closer to the test socket, reducing test cable length (minimizing the impact of the cable on the test result). Moreover, the plug-in design makes insertion and removal of the HV module easier, and improves the convenience of maintenance and repair.

19501 + A195004

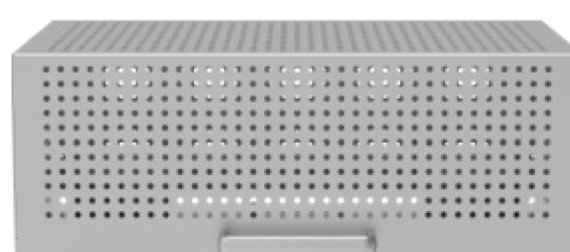


A195004 x 8 arranged in a circle

Anti-interference design

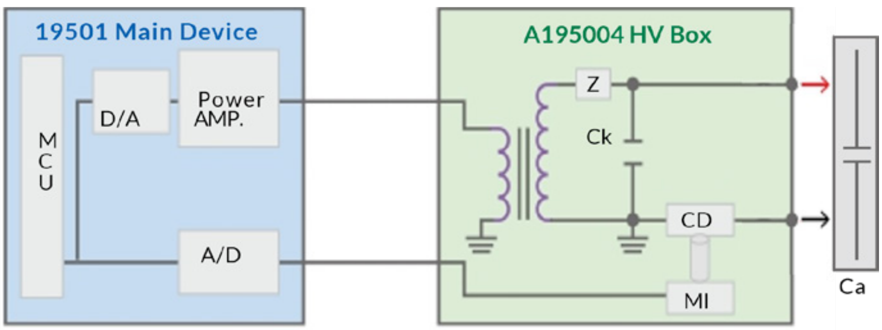
The HV modules (A195004 & A195005) measure the tiny discharge occurring on the DUT during the test. Because the duration of PD is very short and fast (in nS), the frequency of PD is very high, and the signal of PD is very small, high-frequency noise (e.g., electromagnetic waves) from the surrounding environment (e.g., mechanical operations, motor operations, etc.) can easily interfere with the measurement of tiny discharge, which causes measurement error, and affects the PD measurement and judgement. Reducing and preventing environmental interference with the PD measurement circuit is a significant challenge for product manufacturers and automation equipment makers. It is also a major technological challenge for the design of PD test instruments.

Anti-interference design (A195005)



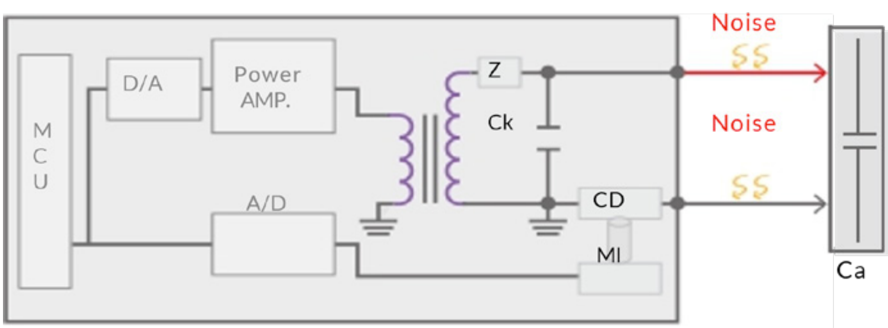
EMI Shielding Cover (A195005)

Because there may be unavoidable high-frequency noise in the test environment, "test & measurement" and "operation & display" need to be separated. The HV modules are designed for the purpose of test & measurement, and the mainframe is designed for operation & display. This design allows the HV module to perform the measurement as close as possible to the DUT, which minimizes interference on the test cable by high-frequency noise from the surrounding environment. The measurement circuit is designed to isolate the noise signal, and makes the measurement circuit as short as possible. Additionally, the low-voltage connection uses a coaxial cable to isolate the interference of environmental noise, and prevent the noise interference with the measurement circuit. Furthermore, a grounded metal shielding can be used to isolate the DUT from environmental noise and thereby ensure measurement accuracy.



CHROMA 19501 + A195004

- Separate design can reduce interference from high-frequency noise.



OTHER BRAND PD TESTER

- Non-separate design necessitates using a longer test cable to contact the DUT, which more easily gets interference from high-frequency noise in the surrounding environment

APPLICATIONS

Regulations require/suggest PD test for specific products and provide a reference formula for test voltage (Vpd) for the PD test. The PD test usually requires the maximum working isolation voltage or the maximum repetitive peak isolation voltage (whichever is higher) multiplied by 1.875 for the test voltage.

The test voltage formula of PD test (Vpd):

$$V_{pd} = F \times V_{IOWM} \text{ if } V_{IOWM} > V_{IORM}$$

Multiplying factor: F

* At routine test stage: F= 1.875

* At sample test stage & life tests: F = 1.6

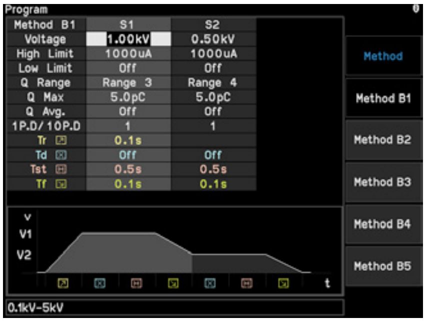
* After endurance tests: F = 1.2

V_{IOWM}: Maximum working isolation voltage

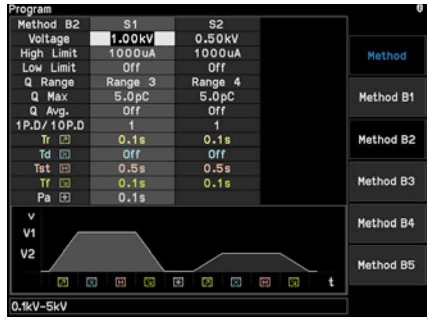
V_{IORM}: Maximum repetitive peak isolation voltage

3 Regulation-Compliant Test Methods

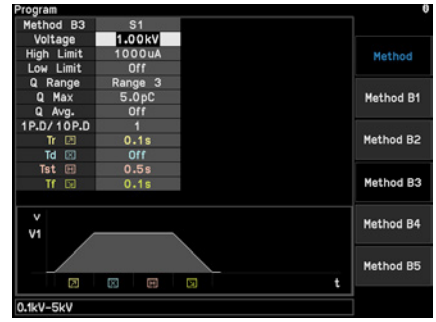
Chroma 19501 features three built-in regulatory test methods. The bottom of the program page displays the diagram of the selected test method to assist users editing the parameters and selecting the test method, which allows them to get started easily and quickly.



Method (1)



Method (2)

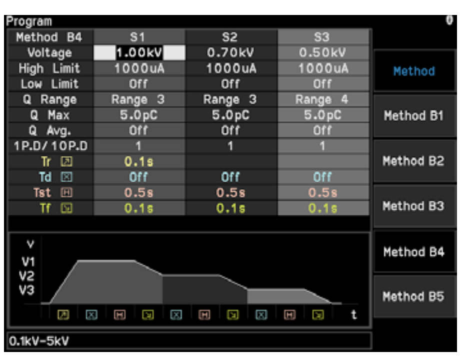


Method (3)

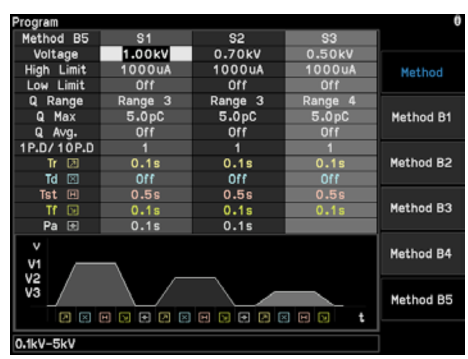
19501 / Regulation	Method (1)	Method (2)	Method (3)
IEC 60747-5-5	a, b1	b2	b3
IEC 60747-17	a, b1	-	b2

3-Stages Test Methods

Chroma 19501 has built-in 3-stage voltage test methods. This enables manufacturers to not only meet the regulation's PD test requirements, but also the requirements of quality improvement by using a test voltage that is higher than the regulation's PD test requirements. This test method starts with a withstand voltage test (1st test stage), then uses the test voltage that is higher than the regulation's PD test requirements for a PD test (2nd test stage), and finally uses the test voltage (Vpd) which meets the regulation's PD test requirements for a PD test (3rd test stage). This test method not only meets the regulation's requirements but also improves product quality.



Method (4)



Method (5)

Application of High Frequency Voltage (A195004 Only)

High-frequency voltage has three main advantages: (1) Increasing the frequency of output voltage increases the occurrence frequency of peak voltage, which can shorten the PD test time and improve productivity. (2) Because the original insulation condition of the DUT may contain unstable factors (Ex. moisture, dust, burrs, etc.), which may lead to unstable PDIV results, the high frequency and high voltage can be used to pre-process the unstable factors of the DUT (pretreatment) in order to obtain more stable PDIV results. Higher voltage can be used to eliminate the unstable factors, and the higher frequency can be used for shortening the time cost of eliminating the unstable factors. (3) When the weakness of the insulation quality needs to be analyzed or the location of the weaknesses needs to be identified, high frequency and high voltage can be used to deteriorate the insulation of the DUT. The higher voltage (> PDIV) can gradually degrade the insulation of the DUT, and the higher frequency can shorten the degradation time.

PD Count Judgement

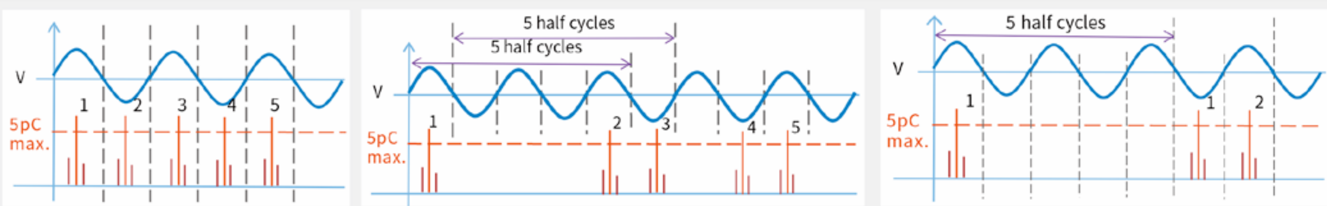
When PD occurs, its signal is very small, and its measurement is easily interfered with by high-frequency noise from the surrounding environment. This is why the purpose of PD count judgement is to reduce misjudgments of test results caused by interference from external noise, and to confirm that the PD indeed happens on the DUT instead of merely being a one-time interference event from the environment. The PD occurring on/in the DUT is usually periodically due to the cyclical variation of voltage. Therefore, compared to high-frequency noise from the environment, the PD is relatively stable.

The Chroma 19501 is designed to count the occurrences of PD that persist over the Q Max limit for every half-cycle of the test voltage. There must be more than two occurrences of PD over the Q Max limit within every 5 consecutive half-cycles in order to accumulate the PD count. After the first PD exceeds the Q Max limit, there must be at least one additional PD over the Q Max limit within the subsequent 4 half-cycles (2 cycles) in order to accumulate the PD count. If not, the count will reset to zero and start over. When the PD count reaches/exceeds the set limit, it will judge the DUT as PD fail.

Example: PD count judgement is set to 5 P.D.

(1) Condition met: PD Count ≥ 5

(2) Condition not met: PD Count < 5



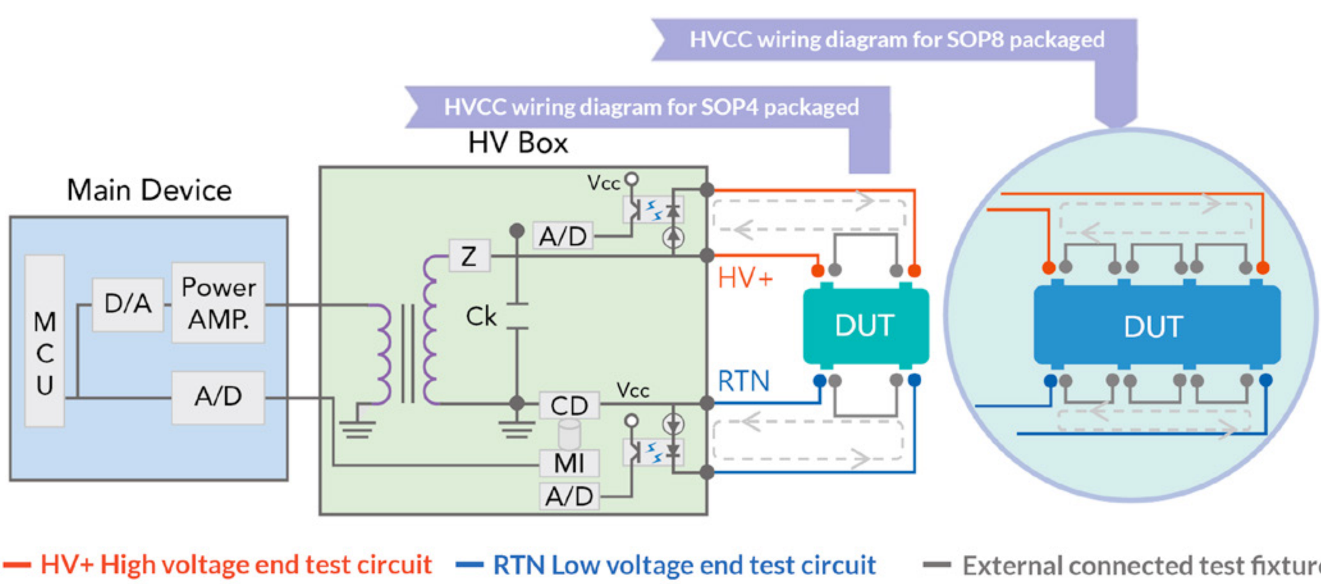
PD > Q Max (ex. 5pC) occurs every half cycle. PD count = 5.

PD > Q Max (ex. 5pC) occurs more than once within every 5 half cycles. PD count = 5. Count adds up when PD > Q Max occurs within every 4 half cycles.

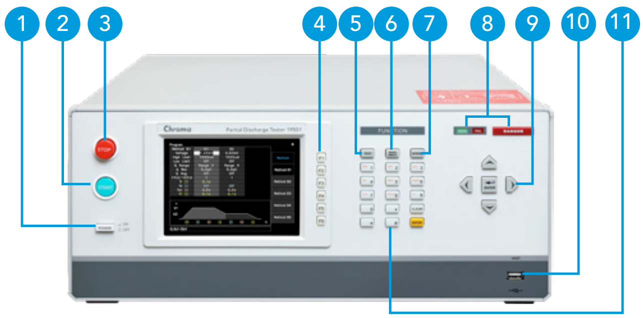
PD > Q Max (ex. 5pC) doesn't occur more than once within every 5 half cycles. If PD > Q Max (ex. 5pC) doesn't occur within every 4 half cycles, PD count resets to 0.

HVCC (High Voltage Contact Check)

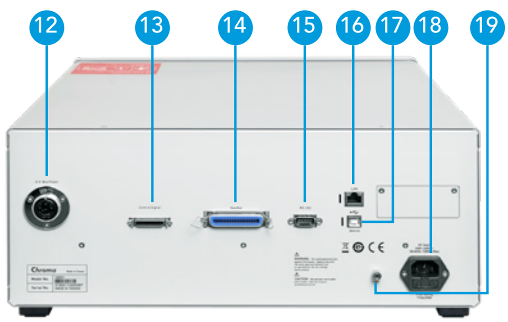
It is very important to perform a contact check on high insulation components before the high voltage output. Chroma's unique HVCC (High Voltage Contact Check) function uses Kelvin measurement to perform a contact check on the high insulation components before the high voltage output, which enhances the test reliability and productivity. The wiring circuit diagram is shown below.



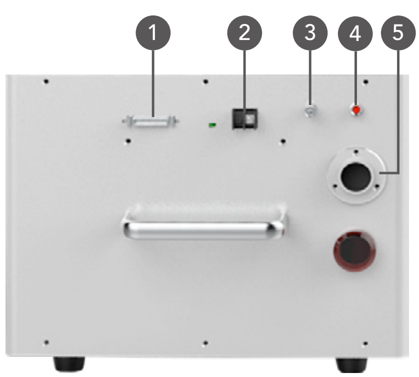
PANEL DESCRIPTION



1. Power Switch
2. Start button
3. Stop button
4. Function keys
5. Test Mode
6. Main Index
7. System
8. Test indicator
9. Directional Keypad
10. USB Flash Drive interface
11. Keypad

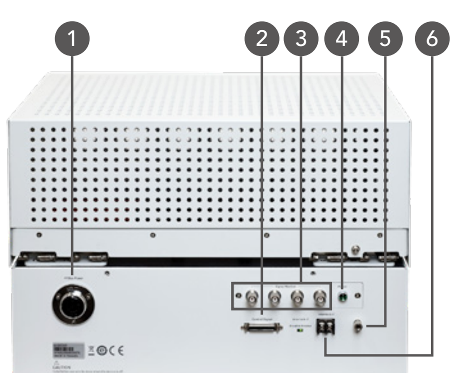


12. Power connector (HV Module)
13. Signal control (HV Module)
14. HANDLER Interface: PLC/Automation Control
15. RS-232 Interface: PC Control
16. LAN interface: PC Control
17. USB interface: PC Control
18. Power connector (Host)
19. Ground terminal



A195004

1. Signal control (HV Module)
2. Interlock (Safety)
3. Ground terminal
4. Power indicator
5. Power connector (HV Module)



A195005

1. Power connector (HV Module)
2. Signal control (HV Module)
3. Signal Monitor terminals
4. Power indicator
5. Ground terminal
6. Interlock (Safety)

SPECIFICATION

Model	19501
Test Timer (Note 1.)	
Test Time	0.3 to 99.9 sec., steps 0.1 sec.
	Accuracy: ± (0.2% of setting + 10ms)
Ramp/Fall time	0.1 to 9.9 sec., steps 0.1 sec.
PD detection delay time:	0 to 9.9 sec., steps 0.1 sec.
Handler Interface	
36 pins Handler Connector	All input/output are negative true logic and optically isolated open collector signals. (General-speed photo-coupler are used)
	• All outputs must be pulled-up with 10kohm resistor to +VEXT (external power supply). • All input optic-diode must be series with current limit (10mA±4mA for +3V to +26V) circuit.
Remote Interface	
RS-232	Programming language: SCPI
USB (B-type)	Meets USB TMC
LAN	Supports 10M/100M Ethernet
Memory Storage	
Internal Memory	200 instrument setups
USB Flash Drive (A-type)	Test parameters, result and waveform (BMP) storage (EXP. function)
	One memory of test procedure and parameter can be storage/recall
	Backup/restore all memory data to USB flash
	Supports USB Flash up to 32GB in size
General	
Specifications Range	18°C to 28°C (64°F to 82°F), ≤ 70% RH
Operable Range	0°C to 45°C, 15% to 95% RH@ ≤40°C (non-condensing)
Storage Range	-10°C to 50°C, ≤ 80% RH
Power Requirement	100Vac to 240Vac, 50/60 Hz
Power Consumption	Standby: <150W, Rated Load: <1000W
Dimensions (WxHxD)	Host: 428x176x500mm/16.9x6.9x19.7 inches
Weight	20.5 kg/45.2 lbs.

Note 1 .The timer setting is only used by a single host.

SPECIFICATION

HV Module	A195005	A195004
AC Output Voltage		
Voltage Range	0.10 kV to 5.00 kV, steps 0.01 kV	0.10 kV to 10.00 kV, steps 0.01 kV (Note 2.)
Voltage Accuracy	± (1% of setting + 0.5% full Scale)	
Load Regulation	± (1% of setting + 0.5% full scale)	
Frequency	50Hz, 60Hz ± 0.1%, sine wave	50Hz, 60Hz, 600Hz ± 0.1%, sine wave
Measurement		
V-display Accuracy	± (1% of reading + 0.5% full scale), 10V resolution	
Cutoff Current	0.1μA to 3000μA	0.1μA to 10mA max
Leakage Current Meter	300.0μA: 0.1μA to 300.0μA	300μA: 0.1uA to 300.0μA
	3000μA: 1μA to 3000μA	3mA: 0.001mA to 3.000mA
	-	10mA: 0.01mA to 10.00mA
	Accuracy ± (1% of reading + 2% full scale)	
Flashover Detection	-	0.1mA – 20.0mA, resolution 0.1mA
Partial Discharge Detector		
Ranges (Note 3.)	Range 1: 10pC to 6000pC, 1pC resolution	Range 1: 10pC to 2000pC, 1pC resolution
	Range 2: 5pC to 3000pC, 1pC resolution	
	Range 3: 2pC to 600pC, 0.1pC resolution	Range 2: 1pC to 200pC, 0.1pC resolution
	Range 4: 1pC to 300pC, 0.1pC resolution	
Accuracy (Note 4.)	± (1.5% of reading + 1.5% full scale)	± (1% of reading + 0.5% full scale)
Maximum Capacitance of Load	3nF (typical)	100pF (typical)
Filter Type	Wide-band	Narrow-band
General		
Specifications Range	18°C to 28°C (64°F to 82°F), ≤ 70% RH	
Operable Range	0°C to 45°C, 15% to 95% RH@ ≤40°C (non-condensing)	
Storage Range	-10˚C to 50˚C, ≤ 80% RH	
Dimensions (WxHxD)	388x281.1x272mm/15.3x11.1x10.7 inches	NA
Weight	Approx. 15kg	Approx. 20kg

Note 2. 0.1kVac - 5.0kVac (600Hz)
Note 3. The PD measurement ranges are defined by maximum capacitance of load. The available PD measurement range will be changed by the capacitance.
Note 4. The PD measurement uses correction pulse generator compliant to IEC60270 for verification. The specification measurement accuracy is defined as the relative error of correction generator.
* All specifications are subject to change without notice. Please visit our official website for the latest specifications.

SPECIFICATION

Model		A195001
Range	100pC	1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0 pC, Injection Capacitance: 1pF, typical
	2000pC	20, 50, 100, 200, 500, 1000, 2000 pC, Injection Capacitance: 20pF, typical
Polarity		Positive, Negative
Accuracy		± (3% of reading + 0.5pC)
Rise Time		<50nS
Pulse Repetition		100Hz
Operable Range		0˚C to 45˚C, 15% to 95% RH@ ≦40˚C and no condensation
Storage Range		-10°C to 50˚C, ≦ 80% RH
Power Supply		9V battery
Current Consumption		50mA max.
Dimensions (WxHxD)		65 x 150 x 36.5 mm/2.56 x 5.91 x 1.44 inch
Weight		Approx. 500g

ORDERING INFORMATION

19501: Partial Discharge Tester
19501S: Partial Discharge Tester (2024/Q4)
A195001: PD Calibrator
A195005: HV Module
A195004: HV Module (2024/Q4)


A195001


A195005


A195004

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