Chroma Advanced Electrical Safety Testing

Chroma ATE Inc.

T&M BU - Jack Chang

2025/09/09

- Basic Concept -

Essence of Standard

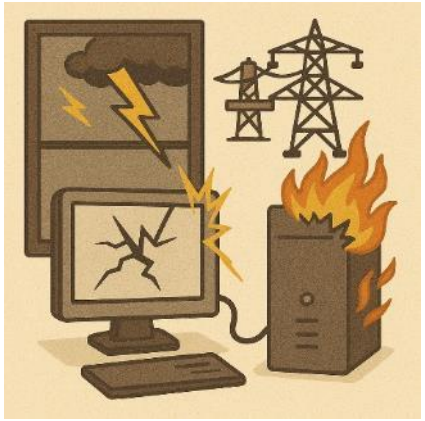
First Law: all electrical product need EST (Electrical Safety Test)

What is the spirit of laws?

- Prevent human body from being an electric shock .
- Prevent equipment ignites due to leakage current
- Avoid to design failure

Why does customer need Electrical Safety Test?

- Good for sales if complied with regulatory standards.
- Improve product quality and reliability
- Reduce potential electric hazard
- Cost Down by Risk control
- Improve corporate and product image
- Make profit and higher revenue



What is standard?

Global - **IEC** – International Electrotechnical Commission

US – **UL**

Canada – **CSA**

Germany – **TUV**

Japan – **JIS**

China – **GB**

Regulation introduction

Regulatory Classification Standards

Type	Standard No.	Description
Home appliance	**IEC 60950**	IT product
	IEC 60065	Video and Audio Appliance
	IEC 60335	House Appliance
Instrument and Equipment	**UL 61010-1**	Equipment used in Laboratory
	UL 60601-1	Medical Equipment
Power	**UL1310**	Class 2 Power Unit
	UL 1778	UPS
Transformer	**UL 1411**	Transformer and Motor used in Video and Audio appliance
	UL 1585	Class 2 and Class 3 Transformer used in appliance which have outlet leads.
	IEC 61558-1	Power Supply and Transformer Safety Requirement

Regulation introduction

Type	Standard No.	Description
Electric vehicle	ISO6469-1/GB18384-1	RESS safety requirement
	ISO6469-3/GB18384-3	Personnel Electric Shock Protection
	ECE R100	special safety requirements for electric vehicles
	ECE R12 /ECE R94	Traditional vehicle steering mechanism and regulations supplement the content of electric vehicles
	FMVSS305	American Electric Vehicles - Electrolyte Spill and Electric Shock Protection
Human Protection System	UL2231-1	General requirements
	UL2231-2	Special requirements for protective devices for charging systems
EV battery	IEC619821-3、UL2580、UL2271	
MCU & BMS	UL508、UL991、UL60730、GB18488-1、GB18488-2	
Electric vehicle charging facilities	IEC61851-1、UL2202、EN61851-1、GB18487.2、UL2594	

Remark: ECE-Regulation = Economic Commission of Europe, (ECE)

Regulation introduction

◆ Electric vehicle

Standard No.	Chapter		Description
GB18384-1	6.2.2	Insulation Resistance	Powertrain and Chassis; Powertrain and Auxiliary Circuits
	6.2.3	Withstanding voltage	Double insulation 2U+3250 ; Supplementary insulation 2U+2250 (V)

◆ Human Protection System

Standard No.	Chapter		Description
UL2231	19	Leakage current test	19.1 The leakage current of the DUT shall not exceed 0.5 mA
	24	Dielectric Voltage-Withstand Test	24.1 Input circuit and other component circuits; input circuit and accessible metal parts

Regulation introduction

◆ EV battery

Standard No.	Chapter		Description
UL2580	15	Dielectric Voltage Withstand Test	Test points are battery electrodes and uncharged metal parts
	16	Insulation Resistance Test	The test points are the same as the withstand voltage test point, requiring 500V DC, 60 seconds, not less than 50,000 ohms

◆ Motor Control Unit (MCU) & Battery Management System (BMS)

Standard No.	Chapter		Description
GB18488	5.8	Withstanding voltage	The dielectric strength between the live circuits of the controller to the ground (enclosure) and the circuits that are not electrically connected to each other, shall be able to withstand the test voltage specified in (Table 2) for a duration of 1 min. <60V → Hi-pot :500V > 500V → 2V+1000
	5.19	Touch current	The electrode and its controller should have good insulation performance, and the test should follow GB/T 12113-2003, and its thermal contact current should not be greater than 5mA during normal operation.

Regulation introduction

◆ Electric vehicle charging facilities

Standard No.	Chapter		Description
UL2594	44	Leakage Current Test	According to different test conditions, the upper limit of the current limit is also different
	49	Dielectric Voltage Withstand Test	The test points include 1. Primary to non-charged metal 2. Primary to secondary 3. Between winding components on the secondary
	54.1	Grounding Impedance Test	The open circuit voltage does not exceed 6V, the frequency is 60Hz, and the current of 25A is tested for 60 seconds, and the resistance of the measurement group is less than 0.1 ohm
UL2202	47	Leakage Current Test	The test point is the power input terminal and the secondary side terminal; under normal situation, it should not exceed 0.5mA
	51	Dielectric Voltage-Withstand Test	The output needs to be capable of 500VA with a 200V ramp per second The test points include 1. Primary to non-charged metal 2. Primary to secondary 3. Between winding components on the secondary
	57	Grounding Impedance Test	The open circuit voltage does not exceed 6V, the frequency is 60Hz, and the current of 25A is tested for 60 seconds, and the resistance of the measurement is less than 0.1 ohm

Withstanding voltage test (ACW) - Regulation

	Test Volt.	UL 1310	UL 1411	UL 1585	UL 1778	IEC 60950	UL 60601	IEC 61558	IEC 60335	IEC 60065
Rated Voltage 120V	P to S	1240	2900	2500	1240	2000	2000	2110	1880	4242
	P to Enclosure (metal)	1240	-	-	1240	2000	2000	2110	1880	4242
	P to Core	1240	2900	1240	1240	2000	2000	2110	1880	4242
	P to Earth	1240	-	-	1240	1000	600	1055	1000	1410
	S to Core	500	500	500		500	-	1055	1000	1410
Rated Voltage 230V	P to S	1480	2900	2500	1480	3000	2500	3547	3750	4242
	P to Enclosure (metal)	1480	-	-	1480	3000	2500	3547	3750	4242
	P to Core	1480	2900	1240	1480	3000	2500	3547	3750	4242
	P to Earth	1480	-	-	1480	1500	1150	1773	1770	2121
	S to Core	500	500	500		*	-	1773	1770	2121

UL60601: winding exceed 500V, 5 times of rated voltage and 5 times of frequency.
UL60950: Depends on working voltage.
Basically: 1000V + 2 x rated voltage = 1240~1480V

**for reference only, please follow the latest regulation requirement from their websites*

How to convert AC to DC?

Safety Standard		High-pot test (Withstanding voltage test)			Ground bond test			
Product type	Regulation No.	Test voltage (rated voltage 250Vac)	Max. Current	Test time (s)	Test Current	Volt.	Max. R (Ohm)	Test time (s)
IT product	UL 1950	1500VAC or 2121VDC	No Flashover or Breakdown				0.1	60
	CSA C22.2 No.950	1500VAC or 2121VDC	No Flashover or Breakdown				0.1	12
	EN 60950	1500VAC or 2121VDC	No Flashover or Breakdown				0.1	12
Medical equipment	UL 2601-1	1500VAC or 2121VDC	No Flashover or Breakdown				0.1	5
	CSA C22.2 No.601.1	1500VAC or 2121VDC	No Flashover or Breakdown				0.1	5
	EN 60601-1	1500VAC or 2121VDC	No Flashover or Breakdown				0.1	5
	UL 544	1000+2*VAC (V<240)	No Flashover or Breakdown	60	25A	6VAC	0.1	5
		1000+240VAC	No Flashover or Breakdown	1				

1VAC = 1.414VDC

- Common test item: ACW -

Required test items from the regulations

Withstanding voltage test (Hi-pot Test)

- AC Hi-pot (ACW)
- DC Hi-pot (DCW)

Insulation Resistance (IR)

Grounding Test

- GC - Ground Continuity
- GB - Ground Bond

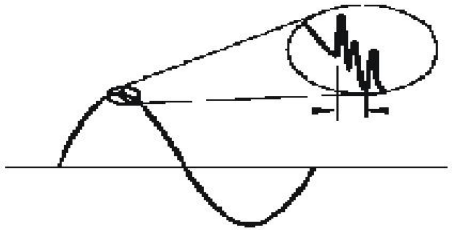
Leakage Current Test (LC)

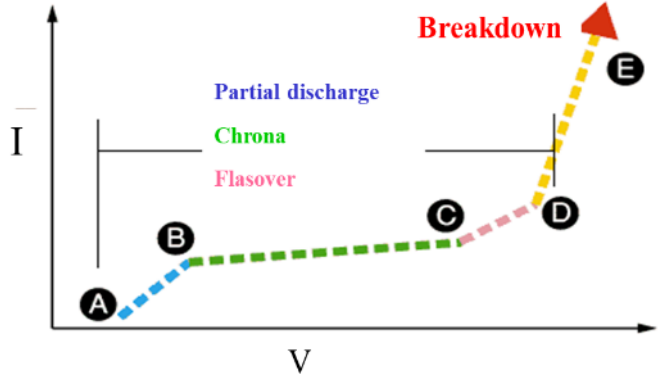
- ELC - Earth LC
- ECLC - Enclosure LC
- PLC - Patient LC
- PALC - Patient Auxiliary LC

Withstanding voltage test (Hi-pot Test)

What is hipot test:

- Hi-pot test = Dielectric Withstand Voltage test = Dielectric strength test
- Both AC or DC could be used.
- Test the insulation withstand ability of the DUT **under abnormally high voltage.**
- Apply a high voltage which higher than the application voltage to the input power terminal of the DUT for one minute, to test the insulation area, **no electrical flashover (Arcing) or insulation breakdown shall occur during the test.**



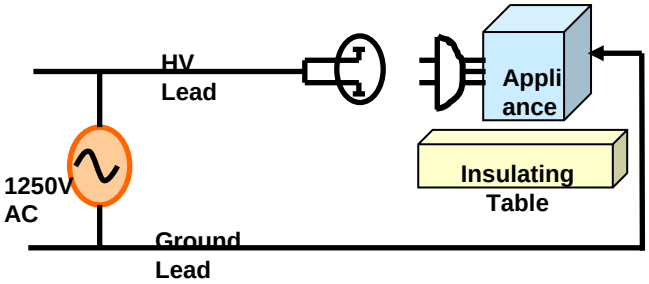


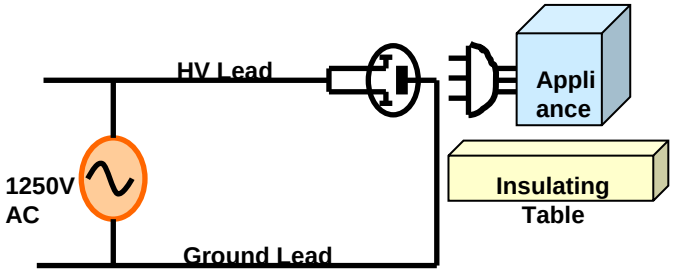
AC Hi-pot (ACW)

Where to test?

Generally will test the leakage current of P-E. *(Protective Earth, PE to Earth)*

During the test, the L&N of the primary side will be shorted, and the leakage current of the primary test to the enclosure will be measured. The reason why to test the enclosure is because the enclosure is the place where people are most easily to get electric shock





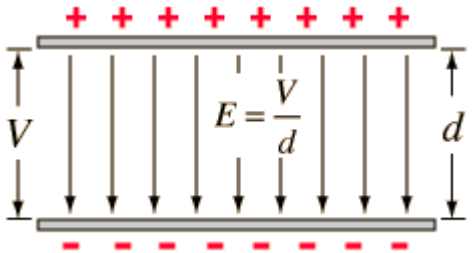
Withstanding voltage test (Hi-pot Test)

Can find the following situation:

- The dielectric strength of the insulating material is too weak
  (Ex. Between Protective Earth, and Earth, the insulation is too week)

- Insufficient distance between components
  (Ex. Between Protective Earth, and Earth, the distance for the insulation part is insufficient)

Electric field strength
E = voltage V/distance d



Withstanding voltage test (Hi-pot Test)

Test condition:

1. AC: 1000V + 2 * rated voltage
2. DC: (1000V + 2 * rated voltage) * 1.414
3. Test time could be shorten to 1 ~ 3 seconds on production line, but test voltage should * 1.2 times

Test result: (Customer defined)

FAIL → The current flowing through the insulation area greater than the upper limit

PASS → The current flowing through the insulation area less than the upper limit.

AC Hi-pot (ACW)

For AC input power DUTs, ACW tests are mostly selected, such as **home appliance**

Advantages:

- ACW can test positive and negative electric polarity
- There is no capacitor charging issue because AC can not fully charge the stray capacitors, therefore it is no need to discharge after the test.

Disadvantages:

- For the capacitive load DUTs, the generated current will be greater than the leakage current, cause the real leakage current cannot be truly measured.
- When there is a large-capacity EMI filter between the input end and the ground, it is difficult to judge by ACW. DCW is recommended for this application. (DC=AC*1.414)

AC Hi-pot (ACW)

*Stray Capacitance

Stray capacitance refers to the unintended capacitance that exists between conductors, components, or circuits due to their physical proximity.

Even when no capacitor is deliberately designed, electric fields can form between traces, wires, or device parts, creating parasitic capacitance.

ACW leakage current result displayed during the test is the sum of the two below:

1. Impedance between test points
2. Stray capacitance

AC Hi-pot (ACW)

Consider stray capacitance when setting the upper and lower limits. The way the wires are placed and the lengths, also humidity can cause the stray capacitance changing.
In addition, there will also have stray capacitances in the circuit.

** OSC OFFSET function:*

Cables and fixtures contain stray capacitance, once user change the test cable or fixtures, it's necessary to redo the OFFSET to deduct the value, to make sure the accuracy is correct.

- Common test item: DCW -

DC Hi-pot (DCW)

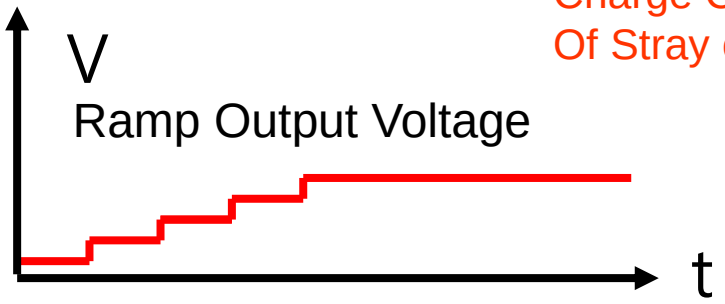
Ex. Electric vehicle battery pack, using DCW to test.

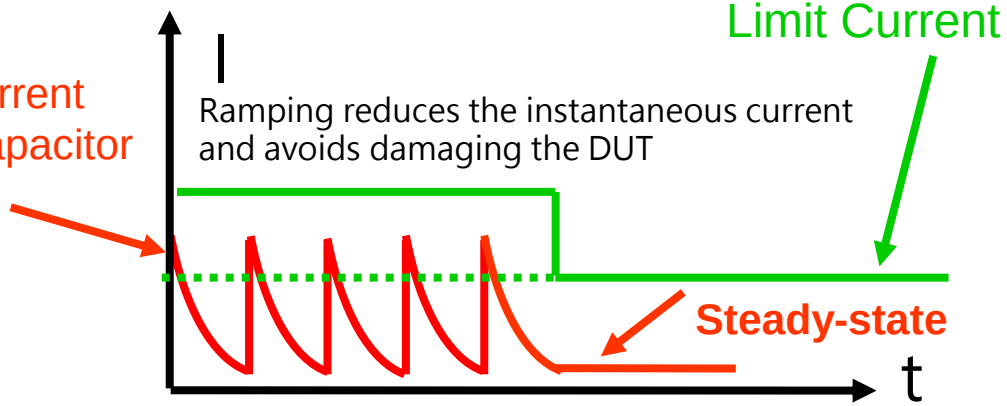
Advantages:

Because the stray capacitance and capacitance have been charged by the Ramp Time, the reading value is the actual leakage current.

Disadvantages:

- During the test, the test current needs to be slowly increased through the Ramp Time to avoid the instantaneous charging current being too large, which may cause it reaches the upper limit before entering to the Test Time*1.
- Discharge is required*2





DC Hi-pot (DCW)

*1. Because the use of DCW will charge the stray capacitance or the real capacitance, it takes a certain RAMP time to climb the voltage. Otherwise, if the RAMP is not set, the instantaneous supply of high voltage may cause the DUT internal damage.

*2. DC will charge the capacitor. After the capacitor is charged, if the test is stopped, the capacitor is still in charged status, so the hipot machine itself has a built-in function which can quickly discharge the DUT

- Common test item: IR -

Required test items from the regulations

Withstanding voltage test (Hi-pot Test)

- AC Hi-pot(ACW)
- DC Hi-pot(DCW)

Insulation Resistance (IR)

Grounding Test

- GC - Ground Continuity
- GB - Ground Bond

Leakage Current Test (LC)

- ELC - Earth LC
- ECLC - Enclosure LC
- PLC - Patient LC
- PALC - Patient Auxiliary LC

Insulation Resistance (IR) test

- Purpose: To verify that the measured insulation resistance meets or exceeds specification before shipment.
- Method: DC voltage only. Using DC ensures the true IR value is accurately measured.
- Significance: A higher insulation resistance value indicates better protection against electric shock and reduced risk of electrical fire.

- Application: Used to assess the electrical insulation condition of products.

Insulation Resistance (IR) test

- The key difference between IR and the DCW is that IR testing does not determine insulation status by **breakdown**, whereas DCW testing evaluates insulation strength by applying higher stress.

- The judgment of the DCW test is based on the leakage current, but the IR test is based on the resistance value. Usually, the test value must be above MΩ.

- Test conditions (IR): Input voltage is usually 500 Vdc or 1000 Vdc, with a test duration of 1 minute.

- Common acceptance limits: 10 MΩ or 2 MΩ, depending on product specifications.

- AC/DC/IR basic Hipot series -

Hipot Family 19050/19070 series

19052

19053

19054

19071

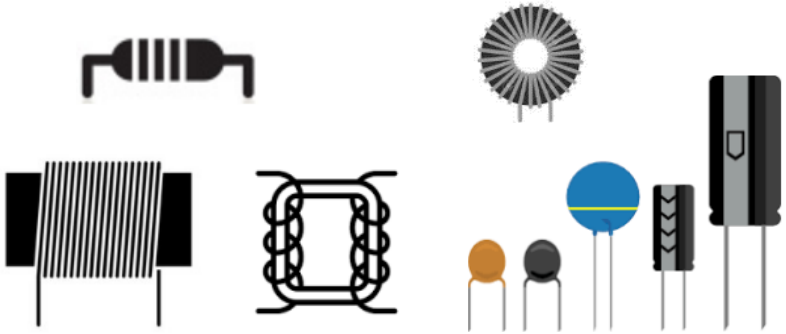
19073

	AC/DC Hipot			Insulation Resistance	
	AC/DC Output	Cutoff Current	Flashover Detection	DC Output	Range
19052 19053 19054	5kVac 6kVdc	AC:30mA DC:10mA	AC:15mA DC:10mA	1kV	50GΩ

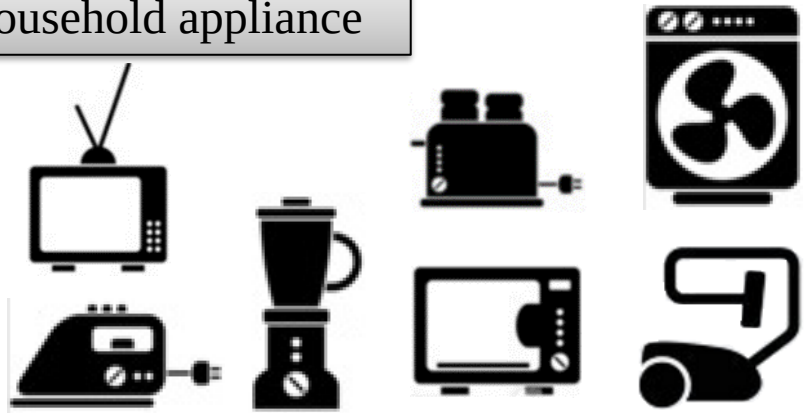
	AC/DC Hipot			Insulation Resistance	
	AC/DC Output	Cutoff Current	Flashover Detection	DC Output	Range
19071	5kVac	AC:20mA	AC:20mA	-	-
19073	5kVac 6kVdc	AC:20mA DC:5mA	AC:20mA DC:5mA	1kV	50GΩ

Application

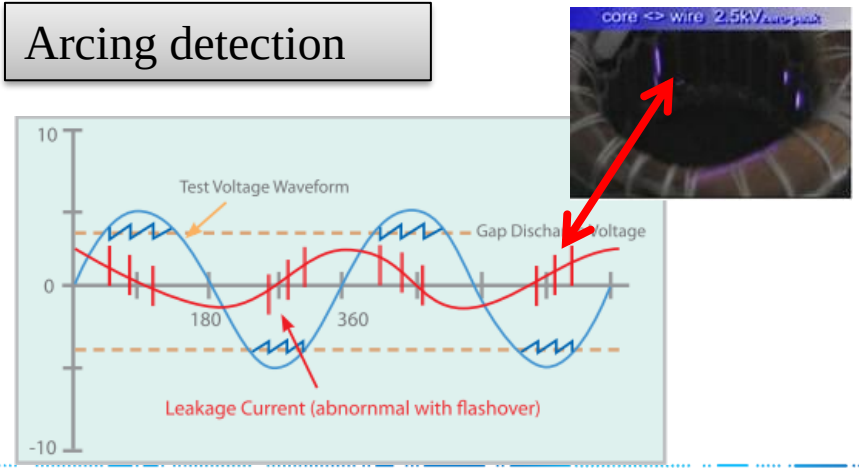
Passive Components



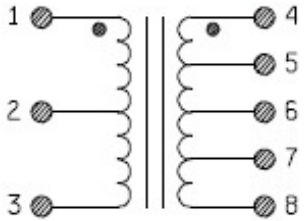
Household appliance



Arcing detection



Multi-Channels scan test capability (19053)



- Multi-channel test solution-

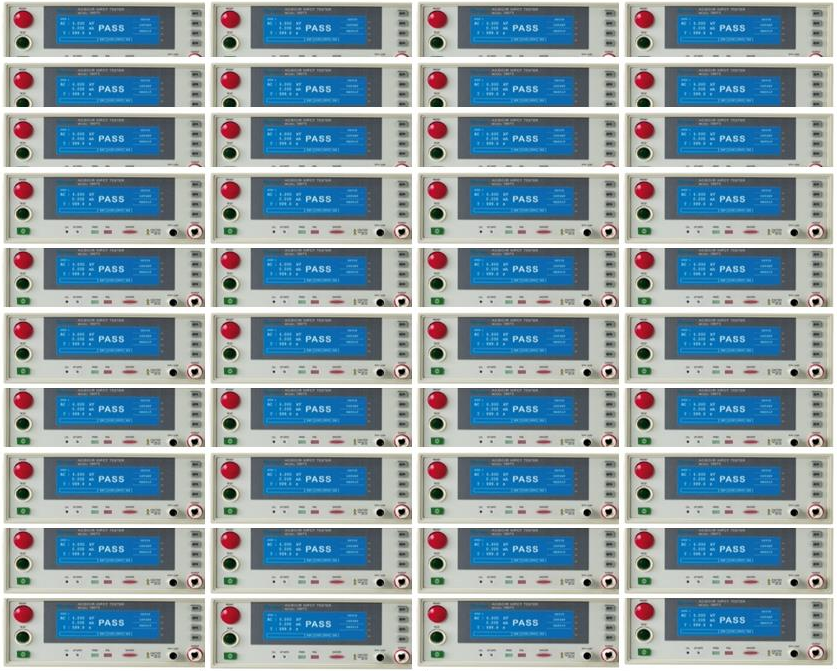
DUTs that may require multi-channel simultaneous testing

- Power cord
- Capacitor
- Resistance
- Switch/Relay
- Connector
- Charger
- Adapter

- Which need to test multiple identical products at the same time.
- For the same type of product, the test will be conducted on the same two points.

Traditional vs. 19020 in Production by Auto line (Example :X / Y cap Production Line)

Traditional 40 sets Hipot Tester get 40CH



6 meters

Less Space

Less Power

19020 x 4 sets get 40CH

1.5 meters

Advantage: 10 in 1,Save Space & Power

Traditional vs. 19020 in Production by Auto line (Example :X / Y cap Production Line)

Traditional 2 Separated Hi-Pot testers

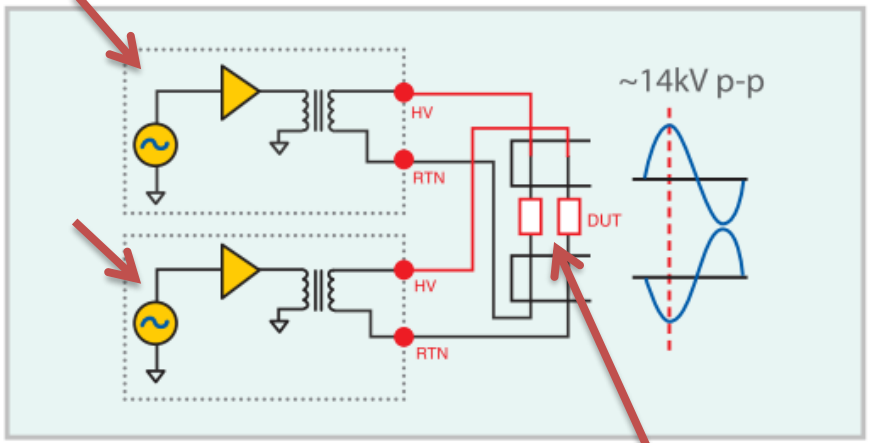


Figure 1 : Unsynchronized Output

Two DUTs may create a discharge of high voltage difference and cause the fixture to be damaged

19020 Synchronized Output phase

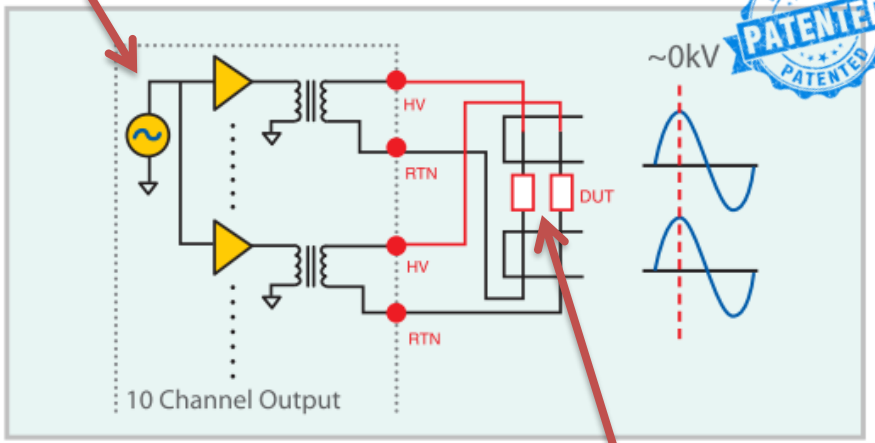


Figure 2 : Synchronized Output

There is no high voltage difference on the two ends that not only can extend the life of equipment

Advantage: To avoid damaging the UUT & equipment

Chroma 19020 series

Maximum/Model	19020	19020-4	19021	19021-4	19022	19022-4	19023-8-20
Output Channels	10CH	4CH	10CH	4CH	10CH	4CH	4CH
AC	5kV,10mA		6kV,8mA		-------		8kV,20mA
DC	6kV,5mA		-------		8kV,3.5mA		-------
IR	1kV		-------		1kV		-------
Load Regulation	± (1% of setting + 0.1% of F.S.)						
Voltage Resolution	2V						
Voltage Accuracy	± (1% of setting + 0.1% of F.S.)						
Cutoff Current	AC:10mA,DC:5mA		AC:0.01mA~8mA		DC:3.5mA		AC:0.01uA~20mA
Current Resolution	AC : 1μA, DC : 0.1μA						0.01 uA
Current Accuracy	± (1% of setting +0.5% of F.S.)						± (1% of setting +2% of F.S.) ± (1% of setting +0.5% of F.S.) for 3mA,20mA range.
Output Frequency	50Hz / 60Hz						
Flashover Detection	AC : 1mA ~ 20mA, DC : 1mA ~ 10mA , step 0.1mA						

- AC/DC/IR 500VA Hipot series -

Hipot 19055 (500VA model)

19055

	AC/DC Hipot			Insulation Resistance	
	AC/DC Output	Cutoff Current	Flashover Detection	DC Output	Range
19055	5kVac 6kVdc	AC:100mA (4kVac: 120mA) DC:25mA	AC:20mA DC:10mA	5kV	50GΩ

- Output Frequency: 50Hz~600Hz (400Hz for Aviation regulations)
- Floating output

- Advanced function: Corona discharge-

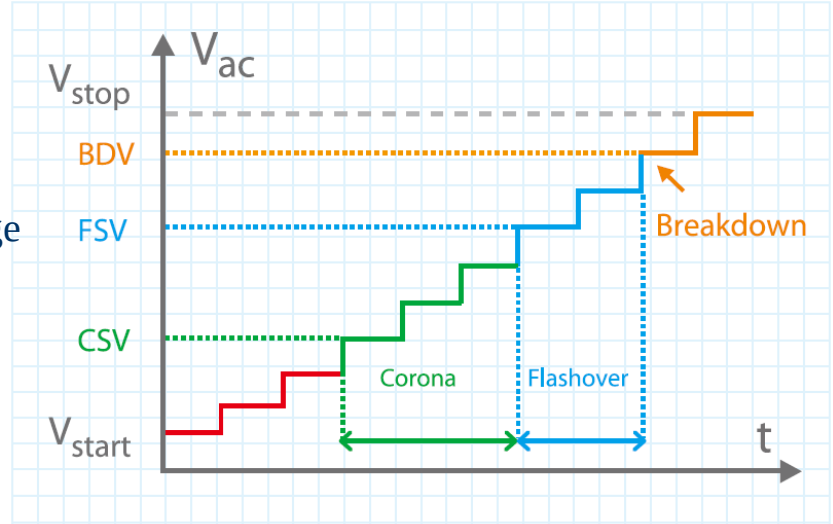
Discharge Level Analysis, DLA

- 19055/19055-C Hipot analyzer can do discharge level analysis by different level voltages and discharge judgments.
  - HIGH/LOW LIMIT ; ARC LIMIT ; CORONA LIMIT
  - start voltage/ end voltage / ramping steps / test time per step
- Before do the analysis, please do pretreatment (5min/V_{test})

CSV: Corona start voltage

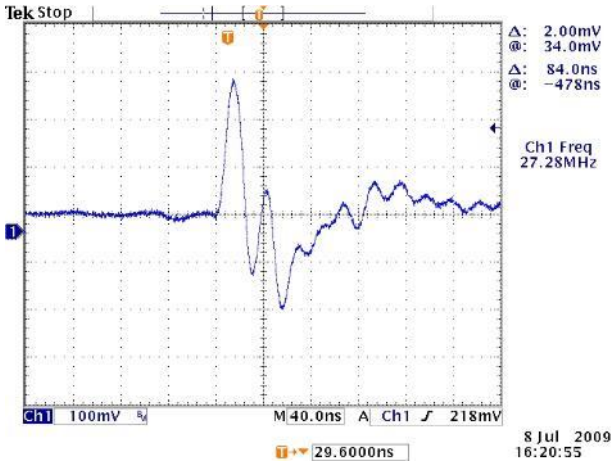
FSV: Flashover start voltage

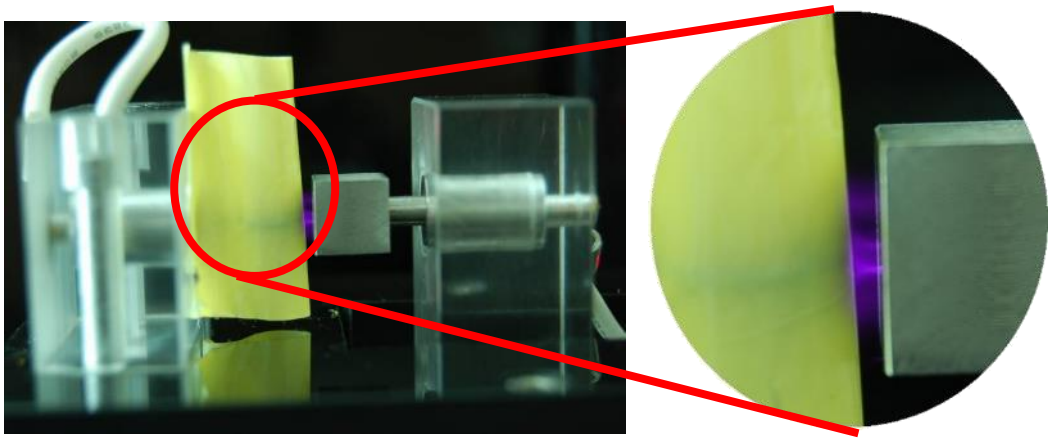
BDV: Breakdown start voltage



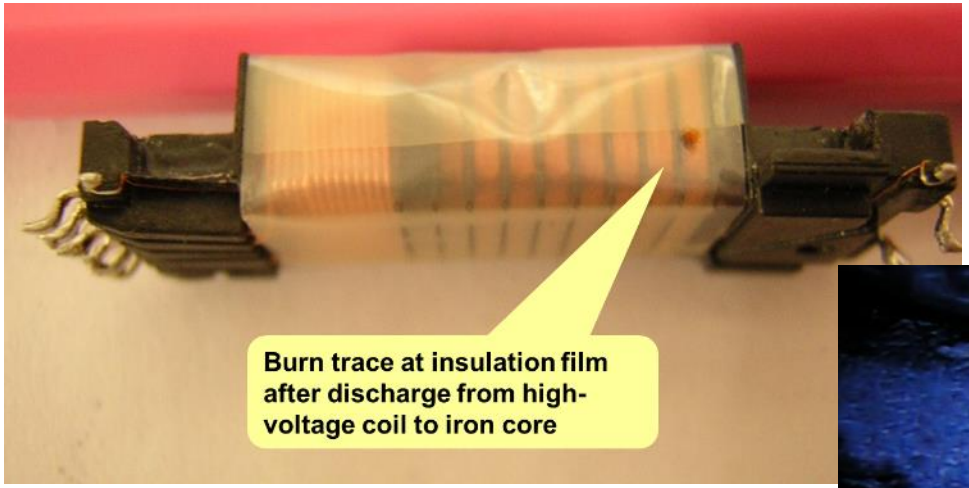
Corona Discharge

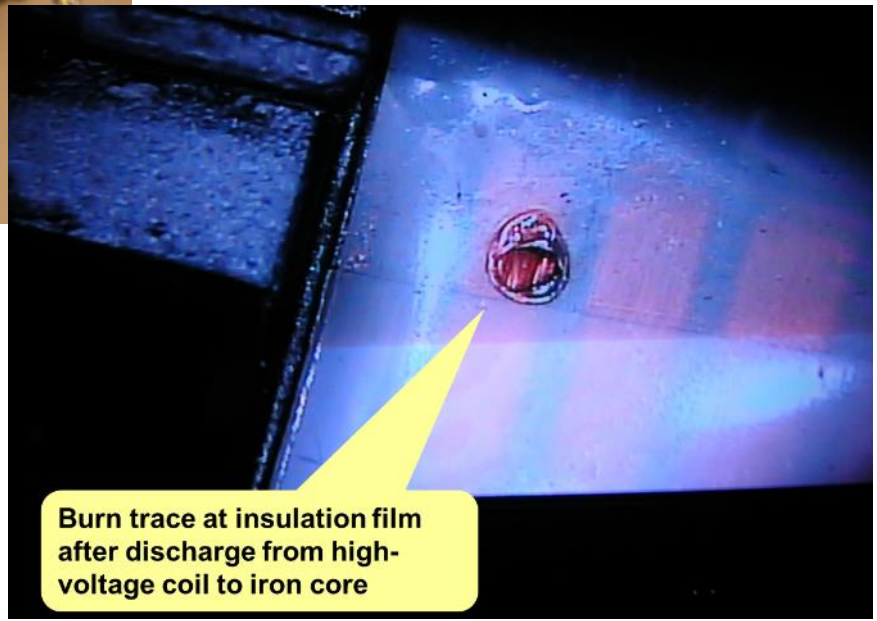
- Cause temperature rise over time
- Insulation deteriorate
- Insulation break down
- Product failure (quality issue)





Corona Discharge





Hipot 19055-C (500VA model with Corona discharge)

19055-C

	AC/DC Hipot			Insulation Resistance	
	AC/DC Output	Cutoff Current	Flashover Detection	DC Output	Range
19055	5kVac 6kVdc	AC:100mA (4kVac: 120mA) DC:25mA	AC:20mA DC:10mA	5kV	50GΩ

- Output Frequency: 50Hz~600Hz (400Hz for Aviation regulations)
- Floating output

Application

Product Type	Description
Motor & Generator	1. AC Hipot (higher current) 2. Corona detection
HV capacitor	1. AC Hipot (higher current) 2. Corona detection
PCB board	1. After cutting, the edge is not clear and caused insulation fail. We can use AC hipot or corona detection.
Solar cell, module	IR 5kV

- Advanced function: GB test -

Required test items from the regulations

Withstanding voltage test (Hi-pot Test)

- AC Hi-pot(ACW)
- DC Hi-pot(DCW)

Insulation Resistance (IR)

Grounding Test

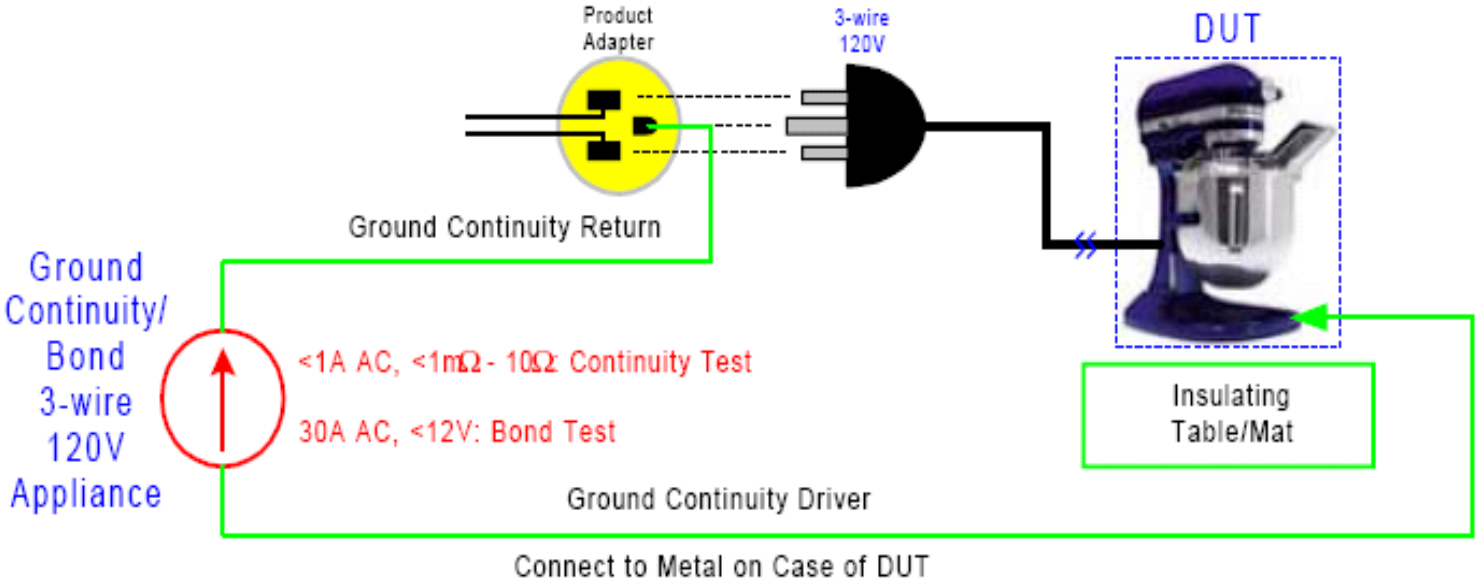
- GC – Ground Continuity
- GB – Ground Bond

Leakage Current Test (LC)

- ELC - Earth LC
- ECLC - Enclosure LC
- PLC - Patient LC
- PALC - Patient Auxiliary LC

Ground Continuity (GC) test

Confirm whether the grounding of the input terminal is connected to the DUT enclosure. A proper connection should exhibit low impedance.



Ground Bond (GB) test

Confirm whether the grounding of the input end and the DUT enclosure is properly connected. A good connection should exhibit low impedance.

Measure the impedance by applying 10–60 A *(25A for UL; 40A for CSA)* continuously for more than 60 seconds.

If the impedance is high, there is a risk of electric shock when touching the DUT enclosure.AC output voltage limit: below 6 V or 12 V (depending on standard).

Ground Bond (GB) test

Example: test requirements from IEC 61010-1

- Test current: 25A (or twice the rated current)
- Test time: 1min.

Ground Resistance Specifications:

- 0.1Ω (machines with power sockets)
- 0.2Ω (machines with fixed power cables)

Europe EN standard: EN 61010

Japan JIS standard: JIS C 1010

China GB standard : GB4793

It is requested that the screw to be used to fix with the metal enclosure, must:

- At least one “star washer” type of screw has been used
- The part on the enclosure with the fixed screws should have paint treatment
- Recommended to use the screws larger than M4.

Ground Bond (GB) test (IEC 60950-1 list)

The cross-sectional area of the grounding wire needs to meet the minimum size requirements. The figure below defines the wire diameter that needs to be met for the grounding wire under different rated currents of the DUT.

Current rating of the circuit under consideration A	Minimum conductor sizes	
	Cross-sectional area mm²	AWG or kcmil (cross-sectional area in mm²)
Up to and including 16	Size not specified	Size not specified
Over 16 up to and including 25	1,5	14 (2)
Over 25 up to and including 32	2,5	12 (3)
Over 32 up to and including 40	4,0	10 (5)
Over 40 up to and including 63	6,0	8 (8)
Over 63 up to and including 80	10	6 (13)
Over 80 up to and including 100	16	4 (21)
Over 100 up to and including 125	25	2 (33)
Over 125 up to and including 160	35	1 (42)
Over 160 up to and including 190	50	0 (53)
Over 190 up to and including 230	70	000 (85)
Over 230 up to and including 260	95	0000 (107)
Over 260 up to and including 300	120	250 kcmil (126)
Over 300 up to and including 340	150	300 kcmil (152)
Over 340 up to and including 400	185	400 kcmil (202)
Over 400 up to and including 460	240	500 kcmil (253)

NOTE – AWG and kcmil sizes are provided for information only. The associated cross-sectional areas have been rounded to show significant figures only. AWG refers to the American Wire Gage and the term "cmil" refers to circular mils where one circular mil is equal to the area of a circle having a diameter of one mil (one thousandth of an inch). These terms are commonly used to designate wire sizes in North America.

- Advanced function: LC test - (Dynamic Leakage Current Test)

Required test items from the regulations

Withstanding voltage test (Hi-pot Test)

- AC Hi-pot(ACW)
- DC Hi-pot(DCW)

Insulation Resistance (IR)

Grounding Test

- GC – Ground Continuity
- GB – Ground Bond

Leakage Current Test (LC)

- ELC - Earth LC
- ECLC - Enclosure LC
- PLC - Patient LC
- PALC - Patient Auxiliary LC

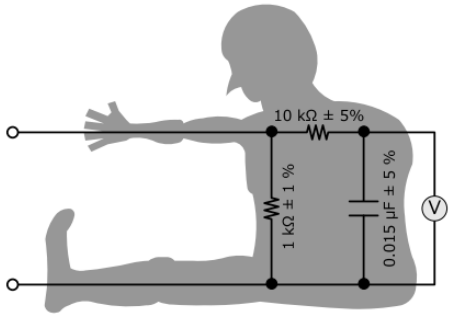
Dynamic leakage current test (LC test)

What is LC test:

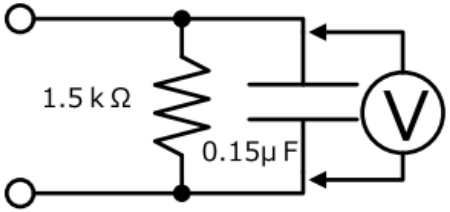
current outside the electronic circuit that has nothing related to the function

Leakage current test classification:

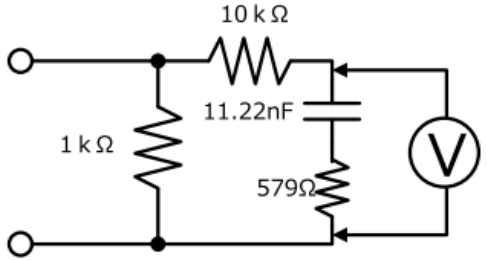
1. Earth leakage current: test the leakage current value of the machine itself after the machine itself is power on
2. Touch current: When simulating the human body touching the machine, measure whether the leakage current flowing into the machine exceeds the specification value



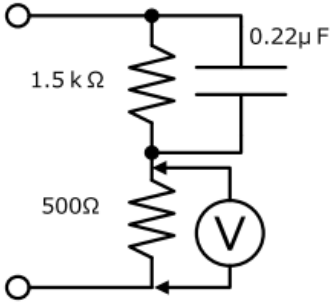
Simulate human resistance = Measurement network

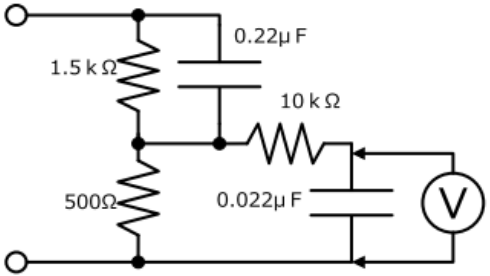


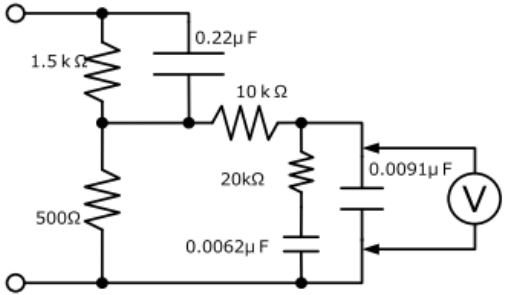
UL standard



Act on Product Safety of Electrical Appliances and Materials (PSE)







IEC 60990（IEC 60065-1,IEC 60950-1,IEC 61010-1 etc）

IEC 60990：Methods of measurement of touch current and protective conductor current

Leakage Current Test Conditions

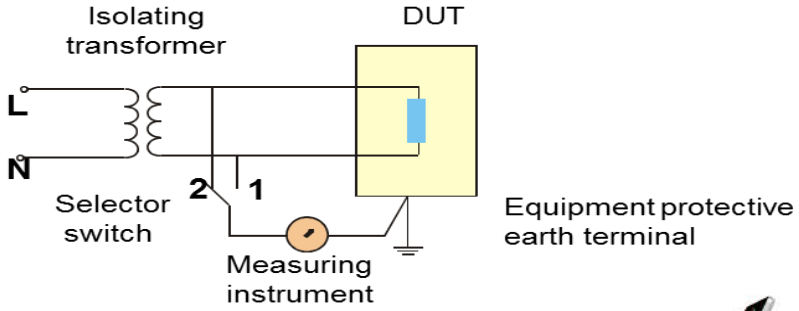
The specified value of ground leakage current, touch leakage current, patient leakage current or patient test current must meet the following conditions

- Test normal and single fault condition
- When the medical equipment is powered ON and fully loaded
- Test rated power frequency
- Test 110% of the rated voltage of the DUT

Dynamic leakage current test (LC test)

Leakage current classification

- Earth leakage current
- Shell contact leakage current
- Contact leakage current
- Patient Leakage Current (Medical Device Specification)
- Patient Auxiliary Leakage Current (Medical Device Specification)



Isolation transformer 500VA or 1000VA

The purpose is to isolate the leakage current from the non-DUT itself from the power terminal.

- AC/DC/IR/GB/LC Hipot series -

Chroma Solution – 19032 series

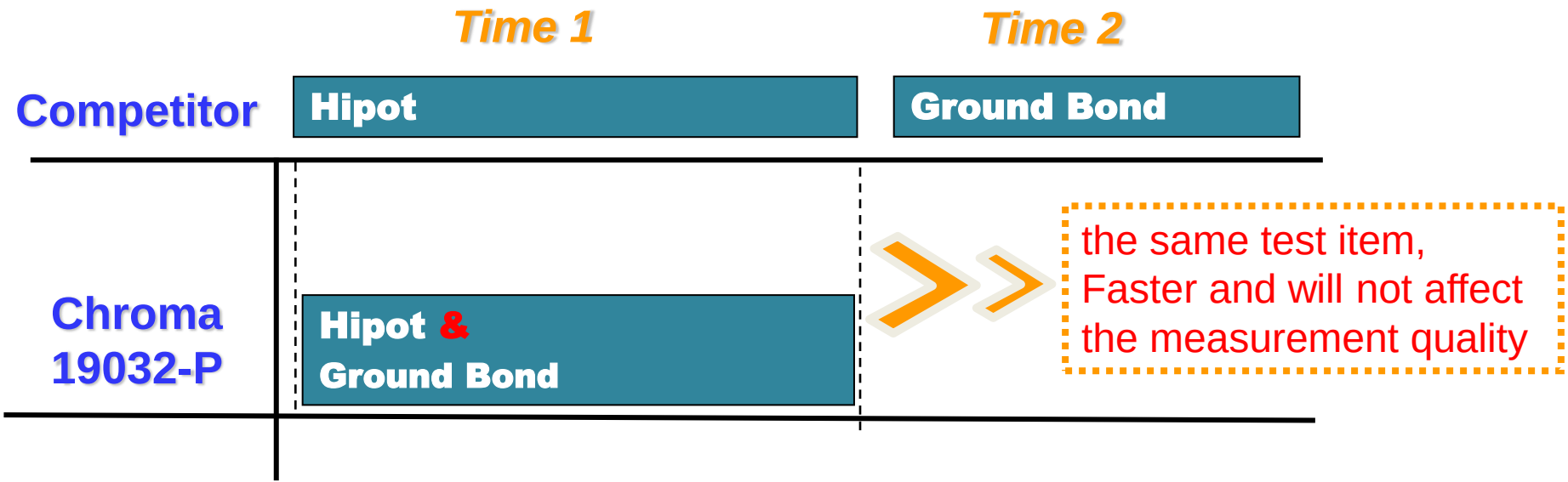
19032

19032-P

Model	19032	19032-P (500VA)
AC 5kV	40mA	100mA
DC 6kV	12mA	20mA
GB Range	30A	40A
IR 1kVdc	50GΩ	
LC	Ground, Touch, Patient, Patient Auxiliary LC measurement	
Human Protect	Fast Cutoff >0.4ms	Floating, GFI
Interface	GPIB,RS-232	GPIB,RS-232,USB

Twinport function *Patent

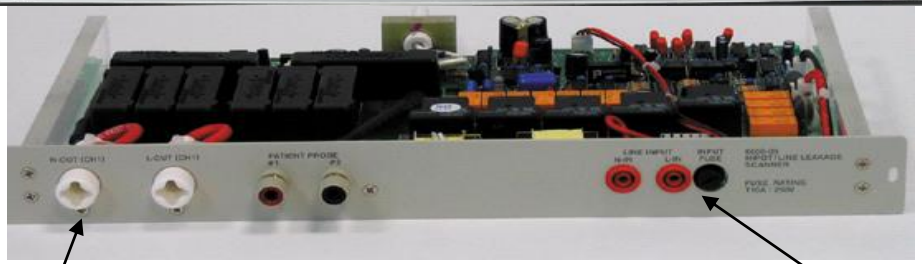
Twinport function: Hipot and GB could be executed simultaneously
➔ Reduce test time,
➔ Increase the throughput of production line



Leakage Current Test connection method

Rear panel of 19032 series

LC test Option cards



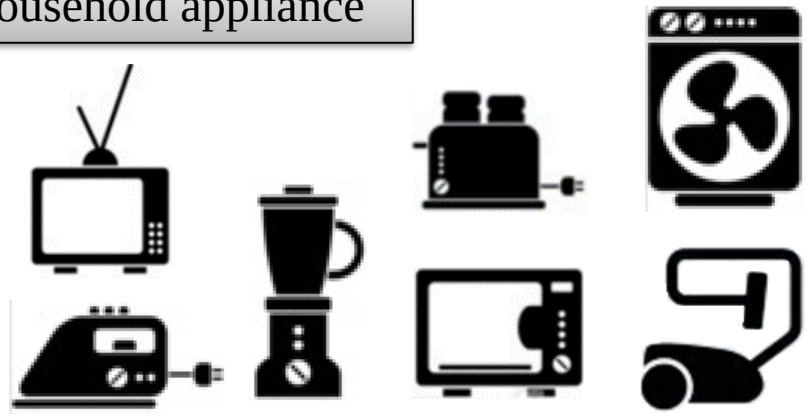
DUT power input \ LC to ground

Isolation transformer

Application

Medical Devices

Household appliance



Electrical Vehicles related

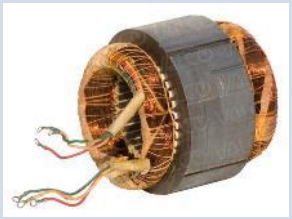
Others

- SMPS (Power Supply)
- Adapter
- Charger
- Information Technology products
- Lighting Industry & LED related

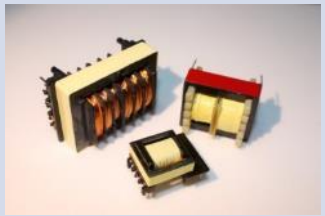
- Winding components test -

Winding components

Motor Stator


Transformer




Inductor (>10uH)



Industry Test Methods

– Testing of coils and cores

In motor stators, due to wiring defects or other causes, the insulation distance may be insufficient, resulting in dielectric withstand failures.

→ ACW/DCW and IR test

– Dielectric withstand test of the coil itself

When manufacturing motor stators, defects or damage in the enamel wire may cause dielectric withstand failures between coils.

→ Impulse Test

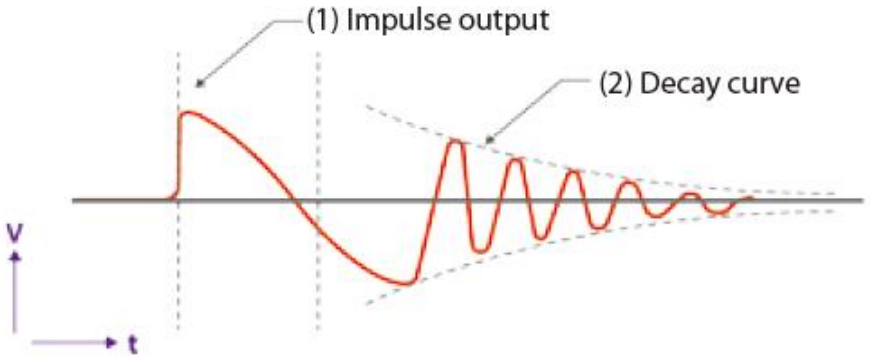
– Winding / Motor / Coil

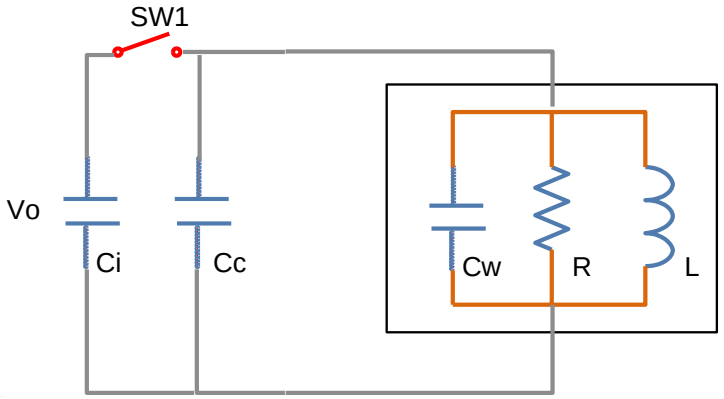
Measure resistance balance using a DCR test.

→ DCR Test

What is Impulse winding Test

The impulse winding test(IWT) is to impose a non-destructive impulse, which has short duration and low energy, on the DUT for analyzing/comparing the waveforms with golden sample and finding the defect products.



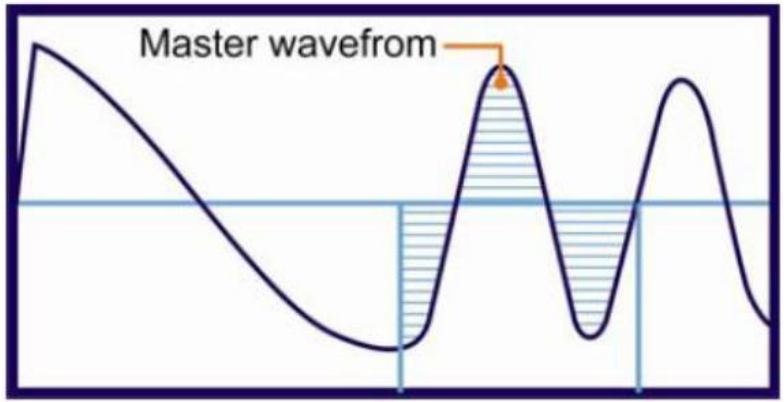


Ci: Internal Capacitor
Cc: Cabling capacitance
Cw: Parallel Capacitance of Winding
R : Equivalent parallel Resistance

What is Impulse winding Test

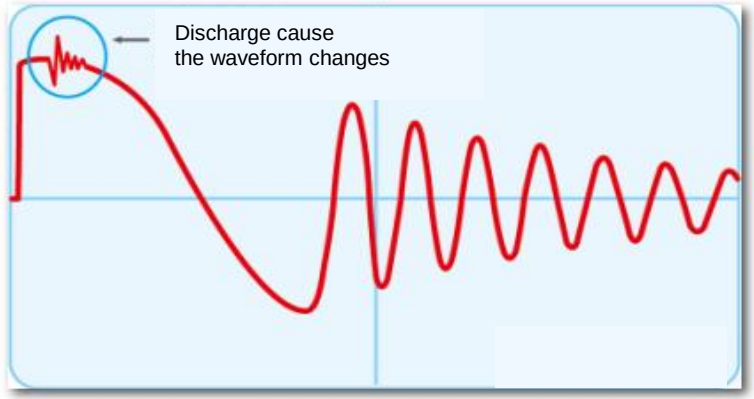
- Area size comparison

  When a test coil has layer short, the total area is smaller than the golden sample's. Because it has energy loss

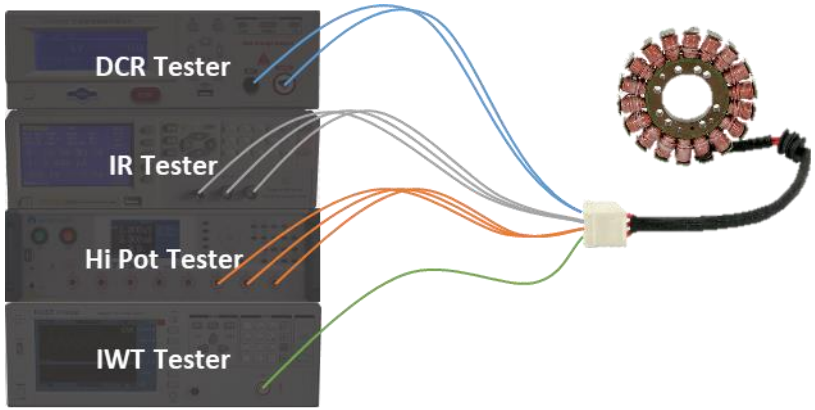


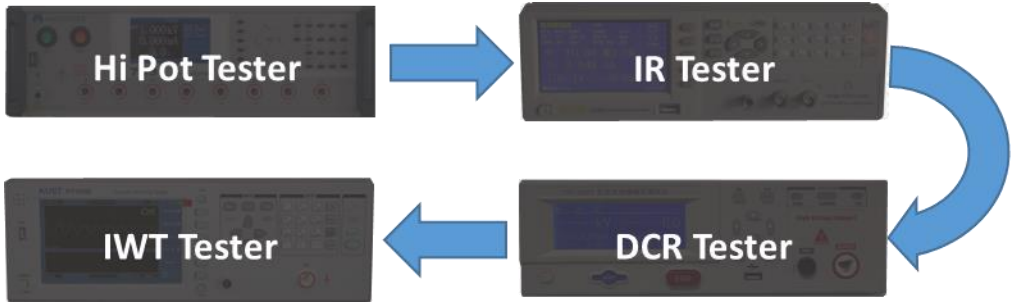
- Laplacian detection

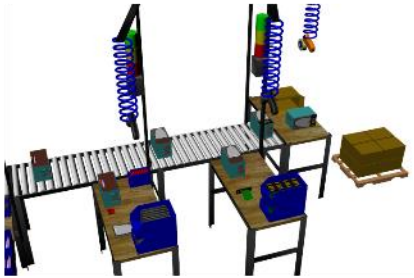
  Detect small discharge by calculating the second order derivative of the waveform (More sensitive)



Other Brands' Solution







- AC/DC/IR/DCR/IWT series -

Chroma 19036

Insulation resistance (IR)

Make sure the insulation is enough between coils and core

ALL IN ONE

AC hi-pot

Test between coils and core can withstand high voltage or not

DC hi-pot

Test between coils and core can withstand high voltage or not

DC Resistance (DCR)

Measure coils resistance, and check balance

Impulse Winding (IWT)

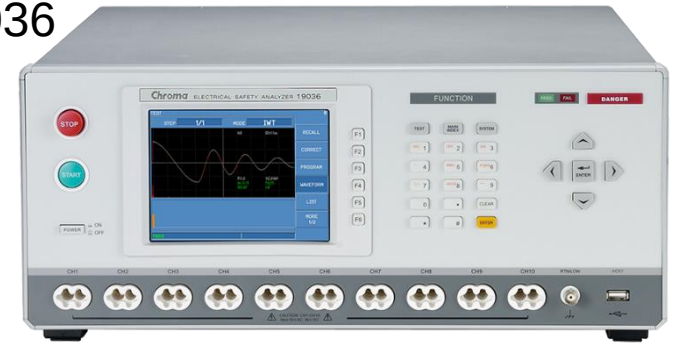
Test coils have layer-short or flashover

Combine all the necessary test items for winding components

Chroma Solution – 19035/19036

19035

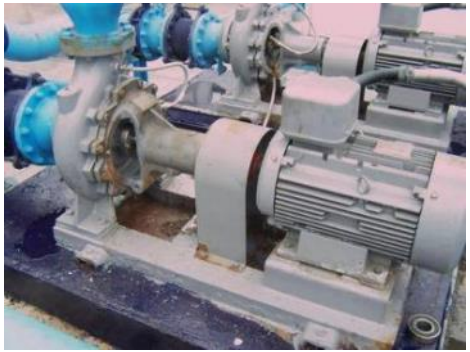
19036



Model	19035-8CH	19036-10CH
AC 5kV	30mA	100mA
DC 6kV	10mA	25mA
DCR Range	50Ω~500kΩ	0.1mΩ~500kΩ
IWT Test	Non	Yes
Interface	GPIB, RS-232, Handler	GPIB,RS-232, Handler, USB, LAN

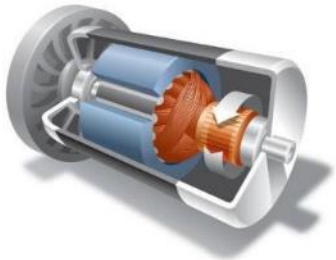
Application

AC motor/ fan



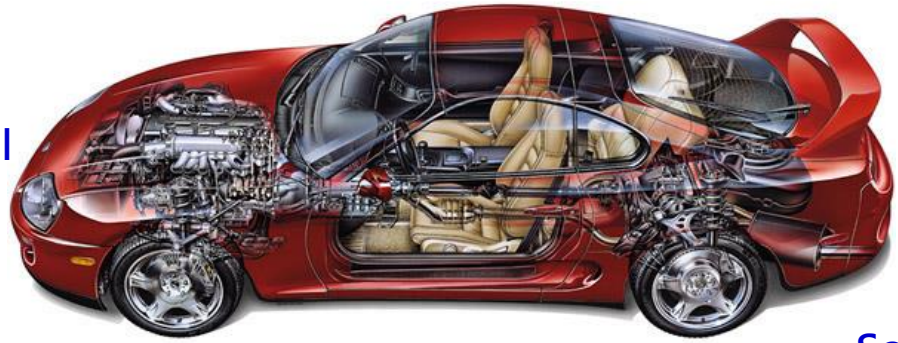
- Industrial Equipment
  - Server, Equipment , Rack etc.
  - Electrical tools, Compressor etc.

- Household use
  - Treadmill motor .
  - Slope adjustment rise motor.



- Medical equipment
  - Including medical bed, operating table and other lifting equipment rise motor

Car components



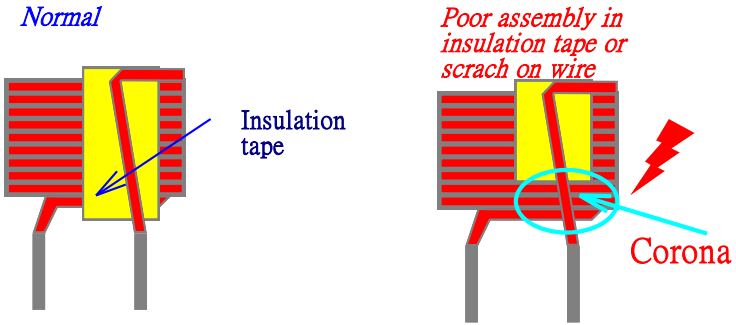
- Inductor Test solutions -

- General WV (Withstanding Voltage) problem for inductors

Power choke can be roughly sorted as general winding choke and metal molding choke.
The WV issue factors are different.

- Higher Lx general winding inductor

Non-molded power choke, even with pin-hole or broken on the enameled wire, most of them are exposed with air or between turns without high V difference, with less WV issue.
But, because of more winding or used in HV application, poor winding sequence, enameled wire broken in return wire path or poor insulation tape assembly in where with HV difference may cause WV issue.



Background

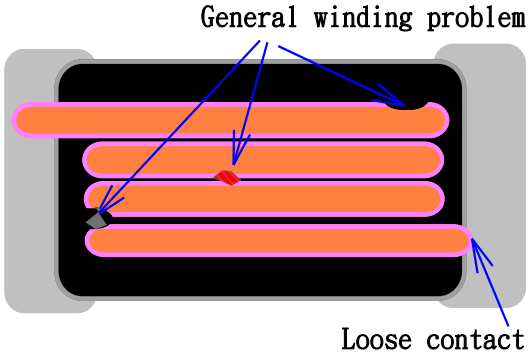
- Metal Molding Choke

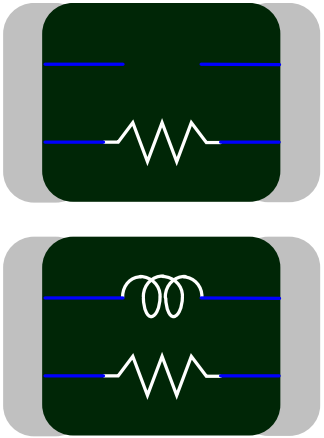
Molding powder on the winding, and high metal ratio, enameled wire problem may easily become WV problem. Therefore, WV testing on this kind of choke is more necessary.

Slim & Small MMP Series

General problems

1. The enameled wire breaks at the place that has a high voltage difference
2. The metal particle is pressed into the turns or the layers of winding
3. The magnetic core is abnormal causing more energy loss
4. There is Loose contact between the winding and the electrode





19301A Impulse Winding Tester

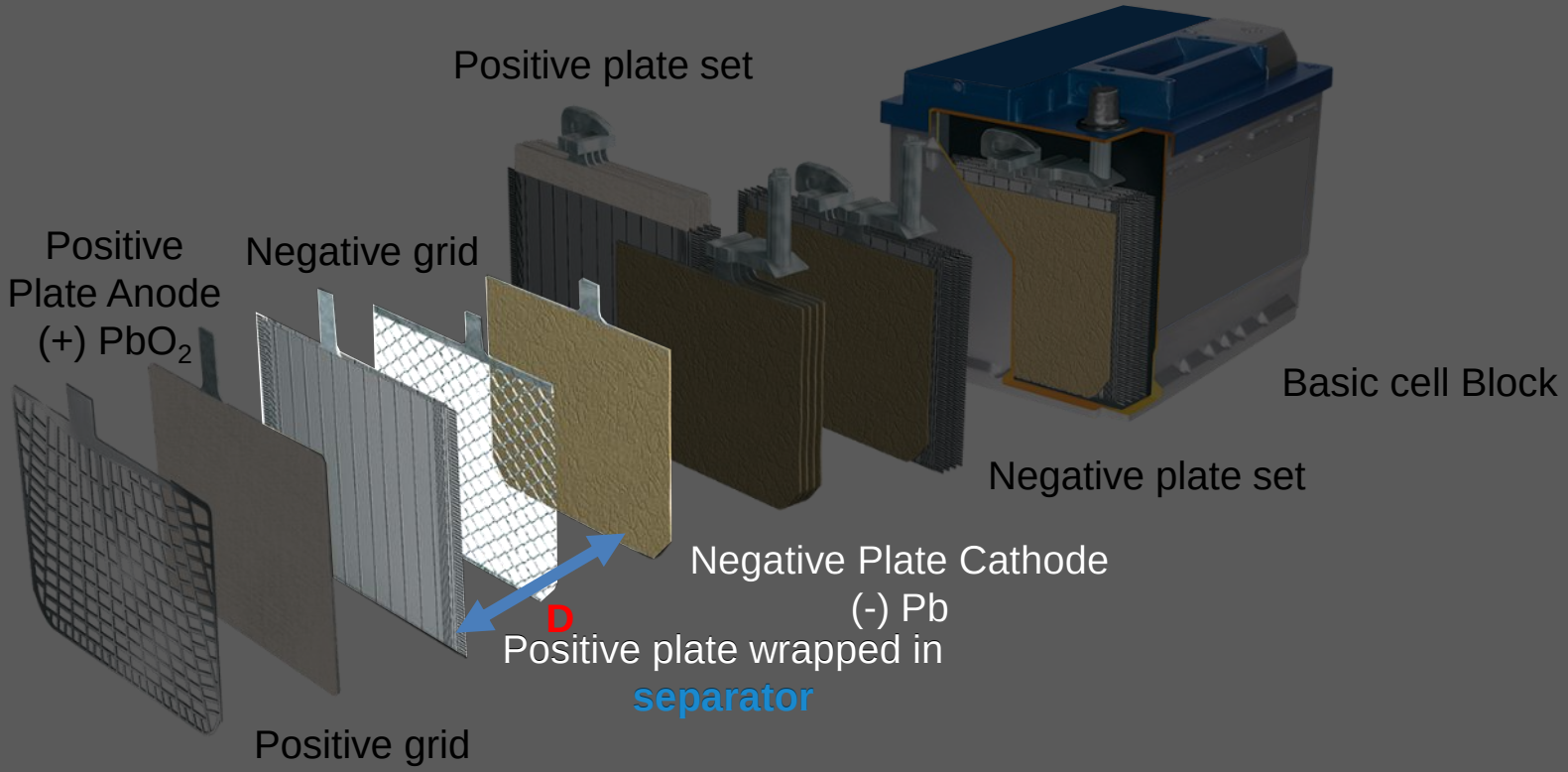
19301A Impulse Winding Tester

- Test inductance range : 0.1uH~***1mH) ;*** *(New model 19303: 10nH~)*
- Test voltage range : 10V~1000V, sampling resolution 0.06V
- High test speed: 20mS (Pulse 1.0 by ACQ, screen off)
- 200MHz , 10bits sampling rate
- 7 types of waveform analysis and judge
  - AREA SIZE (Breakdown)
  - LAPLACIAN DETECTION (Flashover)
  - [ΔPeak Ratio %] [*New* for low Q/ poor Rp detection]
  - [ΔPeak %] [*New* for low Q/ poor Rp detection]
  - Pretest [*New* for low Q/ poor Rp detection before high voltage test]
  - DIFFERENTIAL AREA
  - FLUTTER DETECTION
  - [ΔResonant Area %]
- USB for waveform record and settings backup
- Multi-language user interface
- Standard LAN,USB,RS232, Handler I/O interface

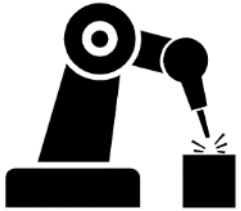
- Lead Acid Battery Test Solution-

Lead acid battery structure

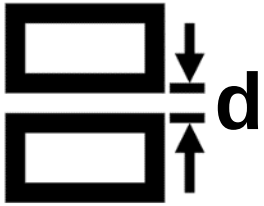
Test the isolation **before the electrolyte injection**



The purpose of testing the lead-acid battery cells



Find the bad cells **before** and **after** **Inter cell welding**



Check the **insulation** and the **distance** between two plates

Make sure the **separator** **exists**

Increase the **quality** of battery

Chroma 19311 Surge Tester

Provide very **short period (small) energy**

Able to provide **high voltage**
when cell contains **the moisture**,
also **without leakage current limit**

No matter batteries are **formed or unformed**
No charging issue (Ignore the battery capacity)

1-2 Specification

- **Output Voltage : 0.1 ~ 6kV**
- **Maximum testable capacitance : ≥3kV@50nF**
- **19311-10 has 10 channels scanning test (up to 9 cells)**
- **A190362 16CH scan Box, up to Max. 25 CH**
- **6 cells test < 1.5s**
- **Two Comparison types : Limits and Reference**
  - **Limits(limits comparison) :**
    V1(V), V3(V), Peak Ratio (%), Flutter & Laplacian
    - Doesn't require SAMPLE waveform for comparison
  - **Reference(Waveform Comparison):**
    AREA(%), Diff-Area(%) & ΔPeak Ratio(%)
    - Requires SAMPLE waveform for comparison

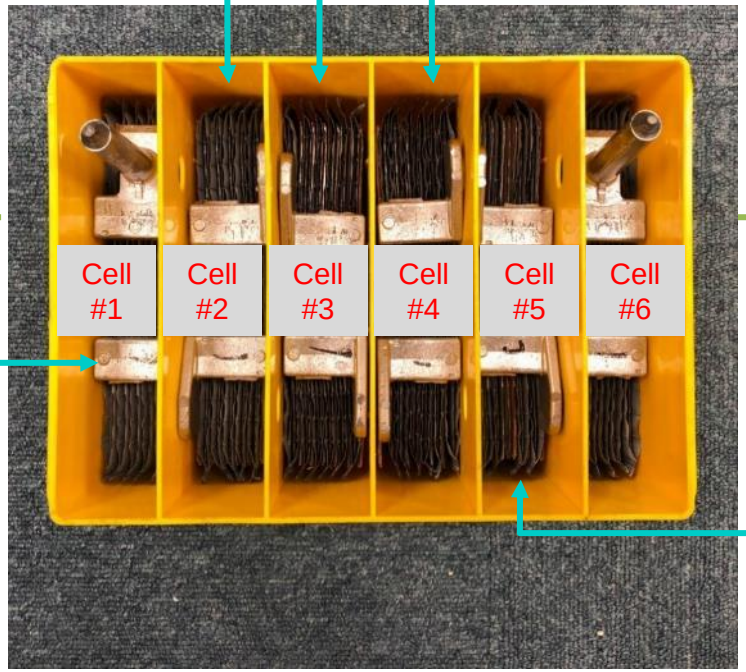
A190362

DUT Image

Cell #2

Cut off the separator

Cell #3 Cell contains moisture



Cell #4 Lost one plate

Cell #1

Cell #6

Golden Sample

PASS

Golden Sample

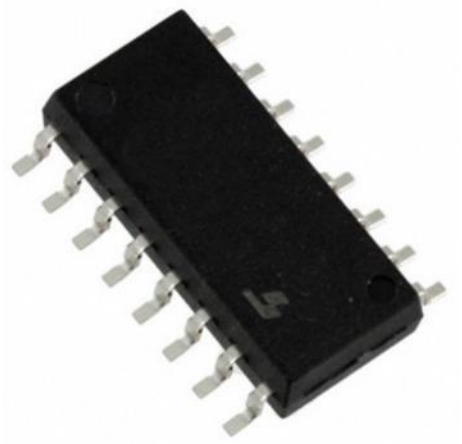
Cell #5

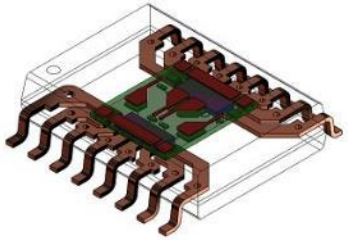
Pull down and fold the separator

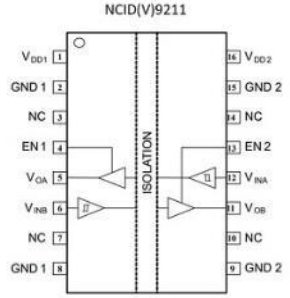
- Partial Discharge Test Solution-

Isolated Devices PD test requirements

Standards	Device	Test instrument	Chroma Test Solution
IEC 60747-5-5 (UL 1577)	Optoelectronic devices – **Photocouplers**	PD Tester	19501 + A195004 1950 (System)
IEC 60747-17 (VDE-0884-17)	Magnetic and capacitive coupler for basic and reinforced insulation **(Isolators)**	PD tester	19501 + A195004 1950 (System)

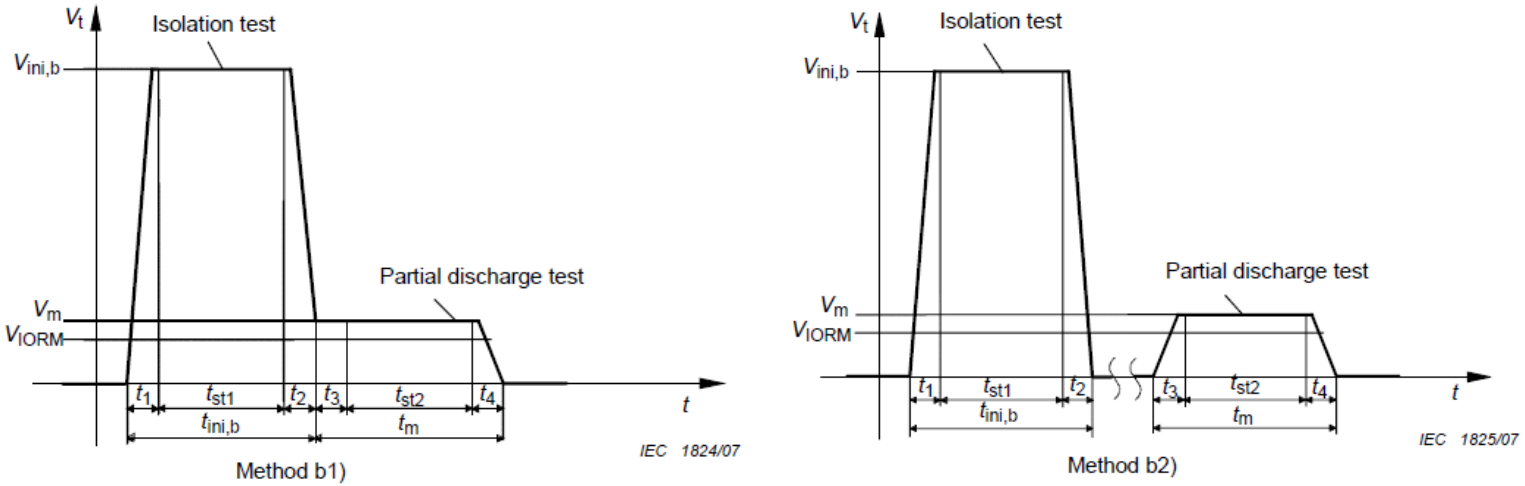






Semiconductor (Photocoupler) Safety Related regulations

- The requirement of IEC standard
  - During the Hi-Pot test , no **breakdown** or **flashover** shall occur. But the light Corona Discharge can be ignored. However, the corona discharge should be disappeared before back to working voltage.(means there is no continuous corona discharge at working voltage) **.**

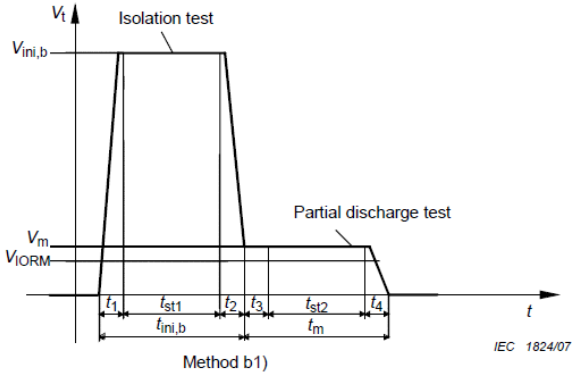


IEC 60747-5-5 Method b1, and b2

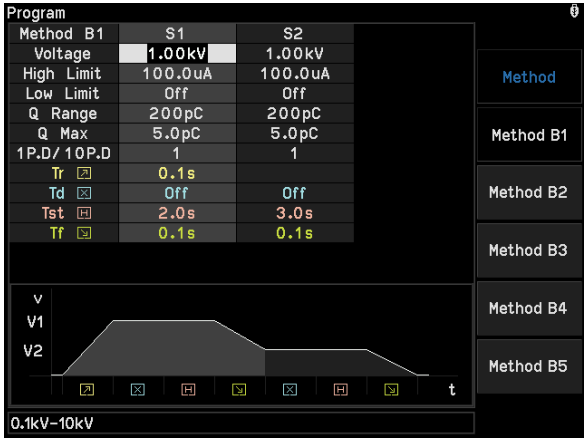
The features and application of Chroma 19501-K

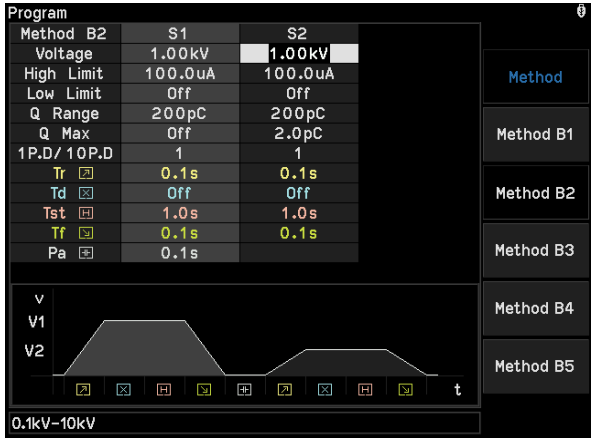
- Feature – Edit screen
  - According to the test methods required by regulation

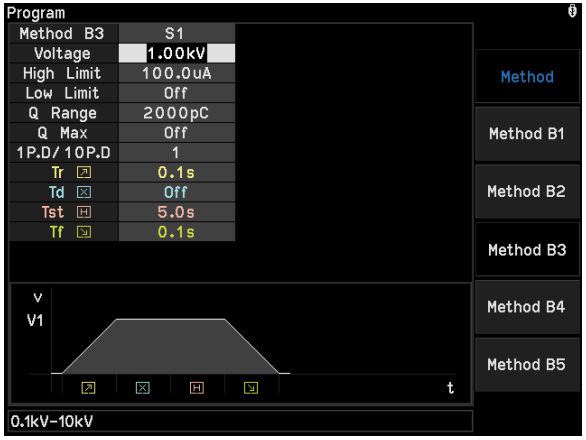
    Built-in IEC60747-5-5 Test b1, b2, and b3 test modes



IEC 60747-5-5 Method b1







Chroma PD test solution - Partial Discharge Tester

Chroma 19501 Partial Discharge Tester

Key Features

- Separated architecture design for AC high voltage output & PD measurement and mainframe
- Build in AC Hi Pot test and PD detection functions
- Slave model (19501S) available for multi-channels operation in lower cost.
- Compliant with IEC60747-5-5, VDE0884 and IEC 60270 standards requirements
- PDIV & PDEV test function (OK for production test)
- High voltage contact check (HVCC) function
- 3-voltage-stages test methods
- PD measurement result display (pC)
- PD failure count setting (1~10)
- USB flash drive for Screenshot storage
- USB, LAN, RS-232, and Handler remote control interface
- CE certification

Chroma 19501
Partial Discharge Tester

Chroma A195004
HV module

A195004 HV Module main spec.

- Programmable AC voltage: 0.1kVac ~ 10.0kVac
- Current meter
  - 0.1uA ~ 30mA max. (60Hz)
  - 0.1uA ~ 10mA max. (600Hz)
- PD measurement range: 1pC ~ 2000pC (N.B.)
- Max. load capacitance: 100pF(typ.)
- Flashover detection: 0.1mA ~ 20.0mA
- Built-in 5pC & 10pC verification circuit

Applications: photocoupler, digital Isolator, isolated IC, isolated D/D power, small transformer, etc.

Isolated Devices PD test requirements

Standards	Device	Test instrument	Chroma Test Solution
IEC 60747-15	Isolated power semiconductor devices **(MOS,IGBT)**	PD tester	19501+A195005
IEC 60270	High-voltage test techniques –Partial discharge measurements**(Referred for PD testing details)**		
IEC 60664-4	Insulation coordination for equipment within low-voltage systems - Part 4: Consideration of high-frequency (30kHz~10MHz) voltage stress **(SiC module verification for insulation design)**	HF HV Tester	11805 + A118034 (20kHz~200kHz, 2.5kV/400mArms)

Chroma PD test solution - Partial Discharge Tester

A195005 HV Module main spec.

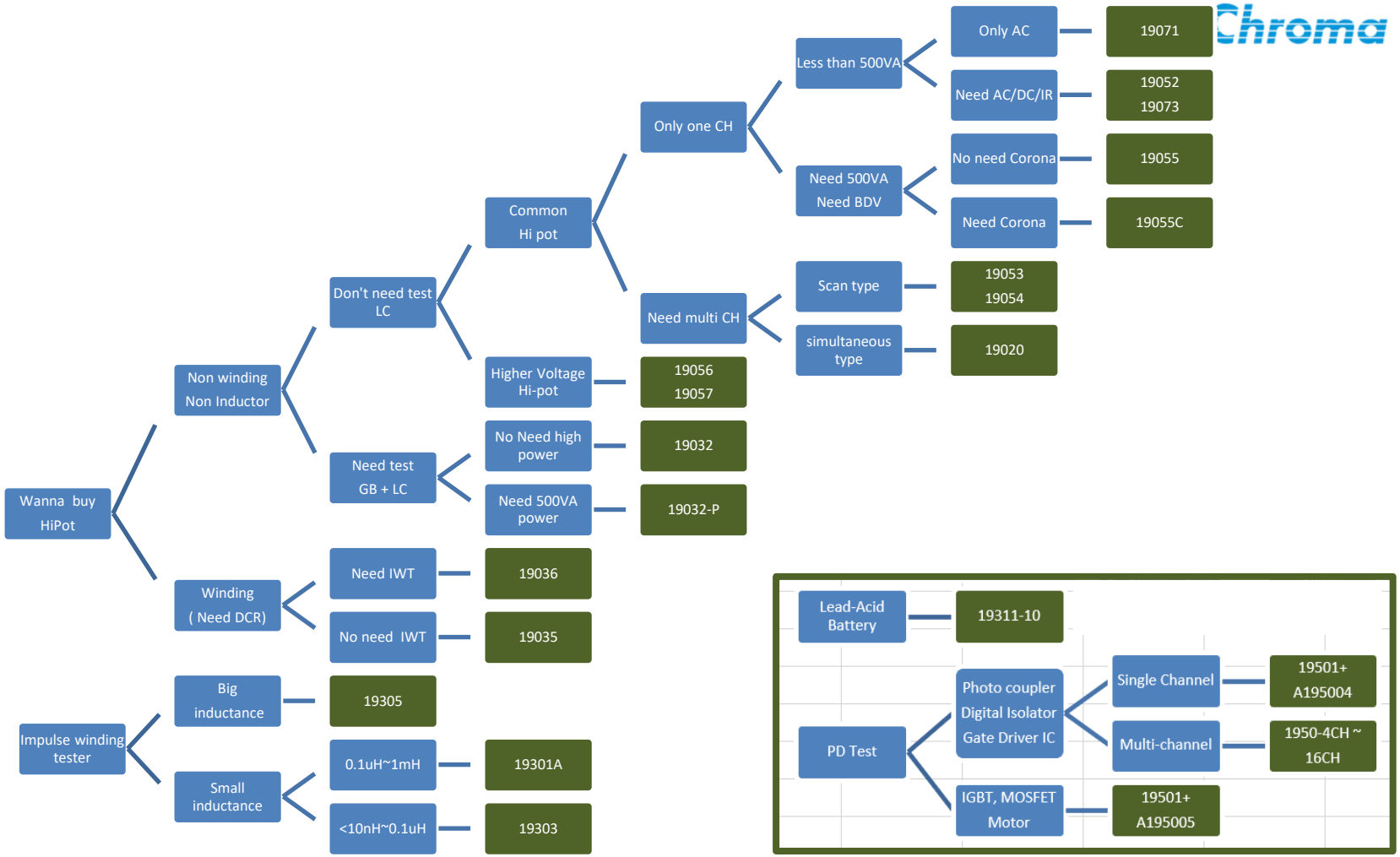
- Programmable AC voltage: 0.1kVac ~ 5.0kVac
- Current meter: 0.1μA ~ 3000μA
- Partial Discharge measurement range: 1pC ~ 6000pC (W.B.)
- Max. load capacitance: 3nF(typ.)

Applications: IGBT (Module), SiC-MOSFET (Module), large transformer, motor stator, etc.

Chroma 19501
Partial Discharge Tester

Chroma A195005
HV module

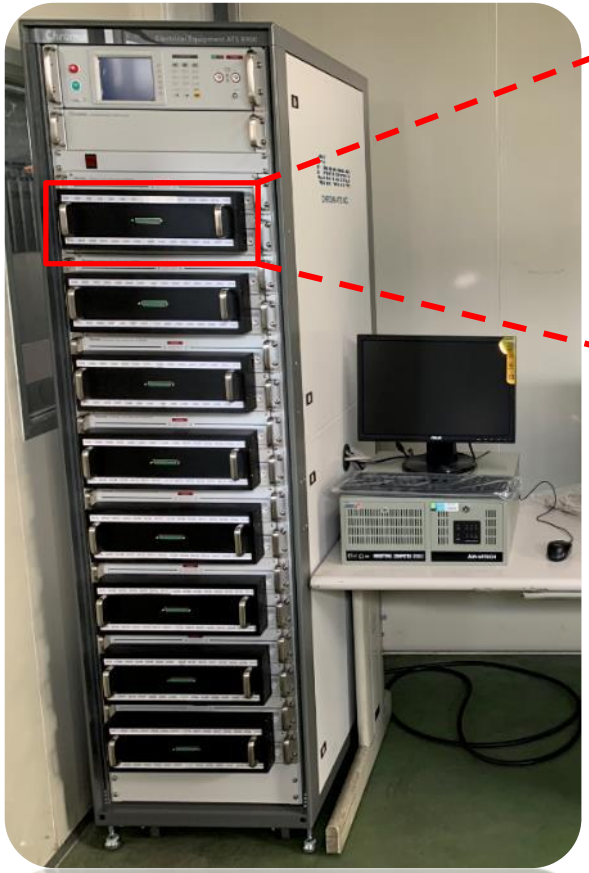
- Conclusion -


Wanna buy HiPot
Non winding Non Inductor
Don't need test LC
Common Hi pot
Only one CH
Less than 500VA
Only AC
19071
Need AC/DC/IR
19052
19073
Need 500VA Need BDV
No need Corona
19055
Need Corona
19055C
Need multi CH
Scan type
19053
19054
simultaneous type
19020
Higher Voltage Hi-pot
19056
19057
Need test GB + LC
No Need high power
19032
Need 500VA power
19032-P
Winding (Need DCR)
Need IWT
19036
No need IWT
19035
Impulse winding tester
Big inductance
19305
Small inductance
0.1uH~1mH
19301A
<10nH~0.1uH
19303
Lead-Acid Battery
19311-10
PD Test
Photo coupler Digital Isolator Gate Driver IC
Single Channel
19501+ A195004
Multi-channel
1950-4CH ~ 16CH
IGBT, MOSFET Motor
19501+ A195005

- Software and System -

Successful Case For High Voltage Harness

confidential



- 19055 + 256 CH (customize 16ch scan box *16)
  For AC+DC+IR multi-channel test requirement

- *19036 + 256 CH (customize 16ch scan box *16)*
  For AC+DC+IR + DCR multi-channel test requirement

Successful Case For High Voltage Harness

confidential

Customer supply:

D-SUB 37pin adapter cable

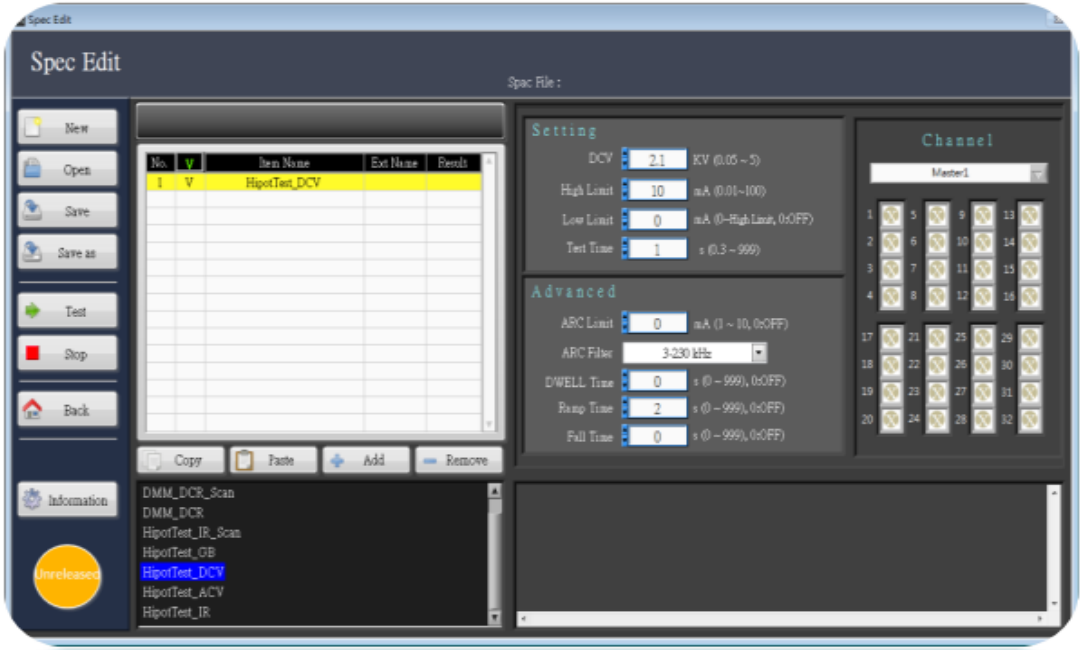
Customize output conversion box

Customize connector *customer specify*

Successful Case For High Voltage Harness

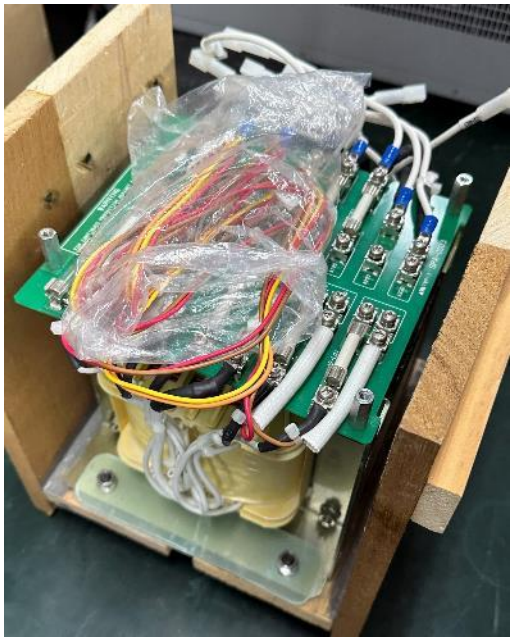
confidential

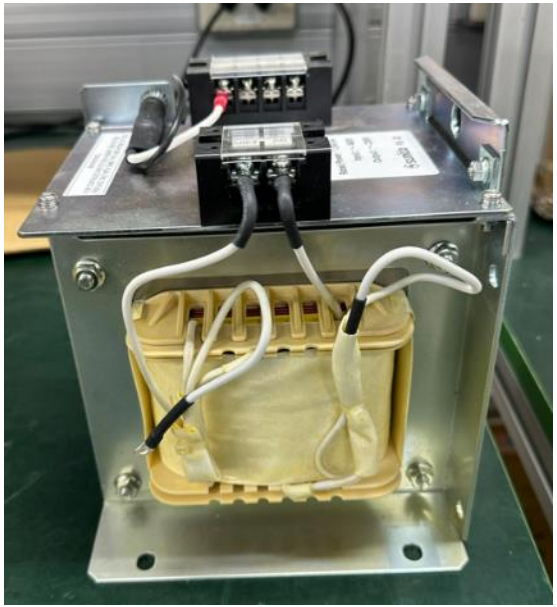
- Only required 64CH, so we proposed 19032-P + 19200 + DMM to have DCR test capability
- Customer supplies test fixture



Successful Case For Transformer multi-channel test

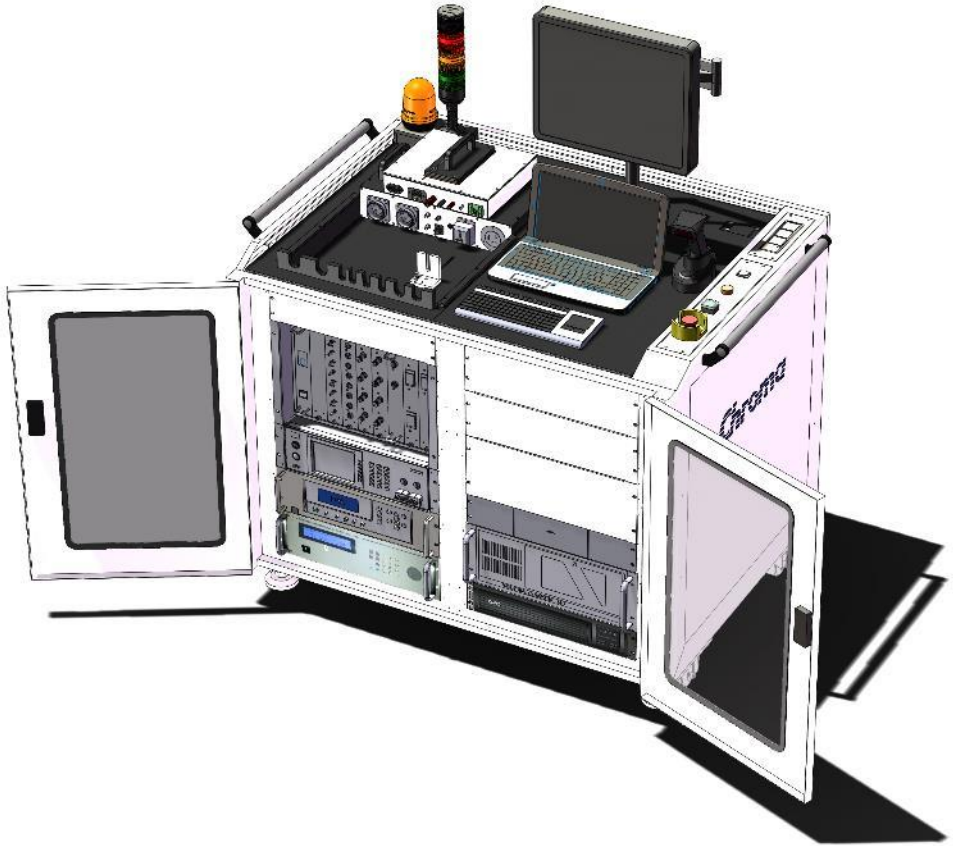
confidential





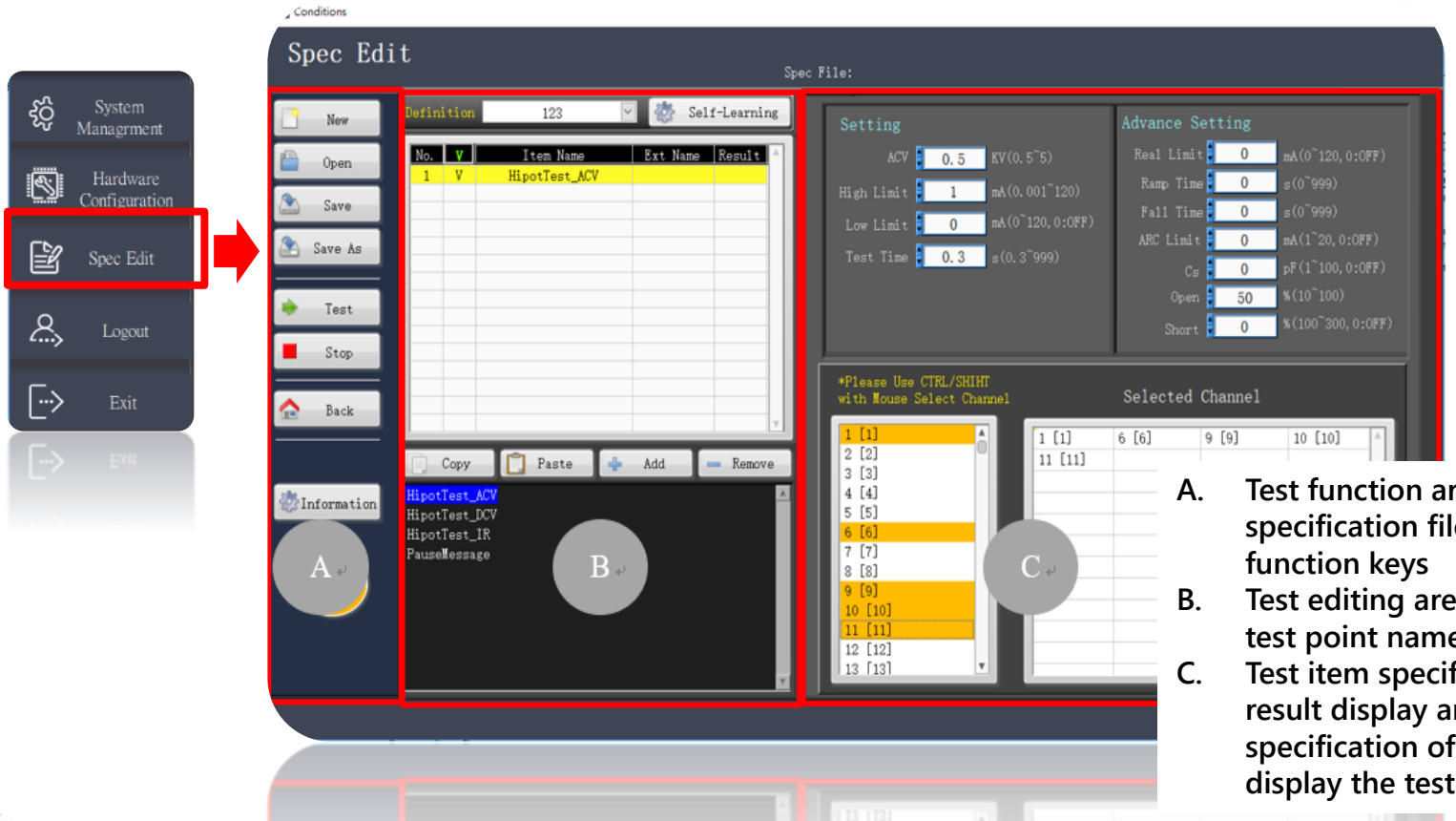
Successful Case For Medical Device Test

confidential



Software introduction

System Function Area Description – Spec Edit



A. Test function area: execute the specification files and related function keys
B. Test editing area: edit test items and test point name file selection
C. Test item specification editing and result display area: edit the specification of the test item and display the test result

Test Report Example

test sample_ - 記事本

檔案(F) 編輯(E) 格式(O) 檢視(V) 說明(H)

Test Report

Model :
Test Name :
Operator :root
Serial No.:
Date\Time :2022/12/20 11:55:40
Auditors :

Item No: 1 HipotTest_ACV [Pass]
Remark :

Test Point	Voltage	Low Limit	High Limit	Measure Value	Result
1 [1]	0.495 kV	0.000 mA	1.000 mA	0.005 mA	PASS
2 [2]	0.495 kV	0.000 mA	1.000 mA	0.005 mA	PASS
3 [3]	0.495 kV	0.000 mA	1.000 mA	0.005 mA	PASS
4 [4]	0.495 kV	0.000 mA	1.000 mA	0.005 mA	PASS

Item No: 2 HipotTest_DCV [Pass]
Remark :

Test Point	Voltage	Low Limit	High Limit	Measure Value	Result
1 [1]	0.497 kV	0.000 mA	1.000 mA	0.003 mA	PASS
2 [2]	0.497 kV	0.000 mA	1.000 mA	0.003 mA	PASS
3 [3]	0.497 kV	0.000 mA	1.000 mA	0.003 mA	PASS
4 [4]	0.497 kV	0.000 mA	1.000 mA	0.003 mA	PASS

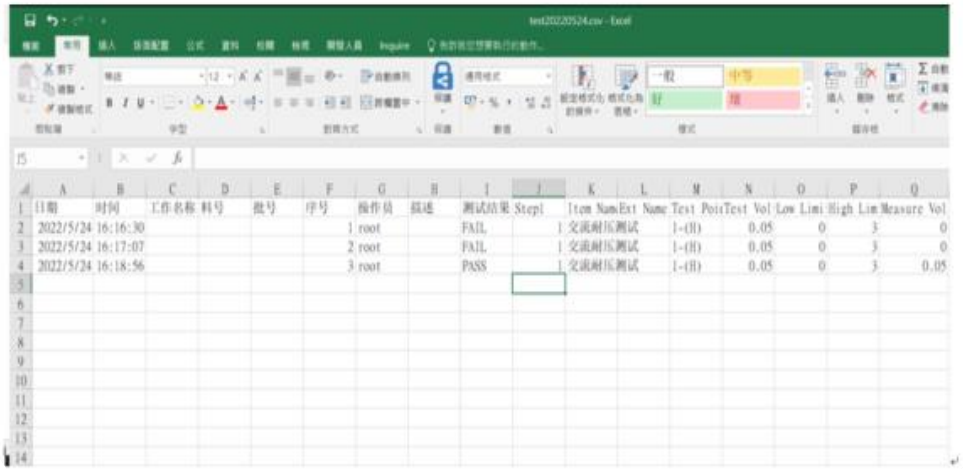
Item No: 3 PauseMessage [Pass]
Remark :
Change Cable test point!

Item No: 4 HipotTest_IR [Pass]
Remark :

Test Point	Voltage	Low Limit	High Limit	Measure Value	Result
5 [5]	0.050 kV	0.100 MOhm	OFF	> 9999MOhm	PASS
9 [9]	0.048 kV	0.100 MOhm	OFF	> 9999MOhm	PASS
10 [10]	0.050 kV	0.100 MOhm	OFF	> 9999MOhm	PASS
12 [12]	0.050 kV	0.100 MOhm	OFF	> 9999MOhm	PASS

Total Result : [Pass]

CSV文件格式范例如下：



日期	时间	工作名称	料号	批号	序号	操作员	描述	测试结果	Step	Item Nam	Ext Name	Test Poi	Test Vol	Low Limi	High Lim	Measure Vol
2022/5/24	16:16:30				1	root		FAIL	1	交流耐压测试		1-(1)	0.05	0	3	0
2022/5/24	16:17:07				2	root		FAIL	1	交流耐压测试		1-(1)	0.05	0	3	0
2022/5/24	16:18:56				3	root		PASS	1	交流耐压测试		1-(1)	0.05	0	3	0.05

Chroma

Advancing Excellence

Thank You

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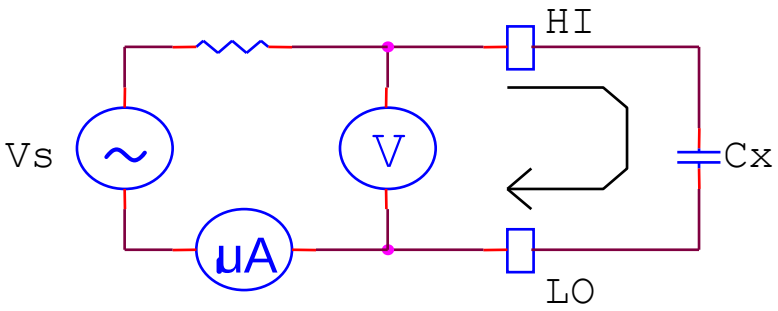
OSC function (contact check)

Use equivalent capacitance to judge the contact check

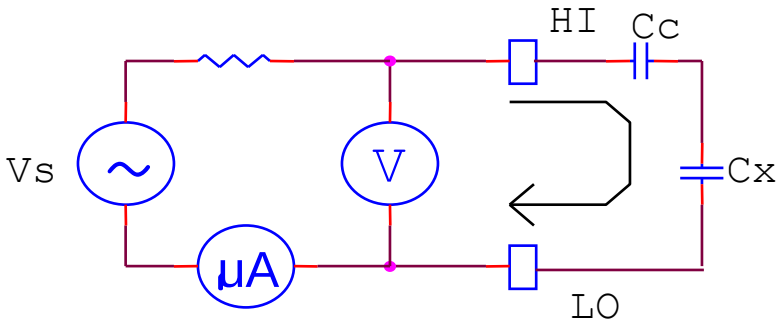
Normal connection: X0pF~uF

Open➔ Capacitance will be lower (50% lower)

Close➔ Capacitance will be higher (300% higher)



Normal condition



Open Condition

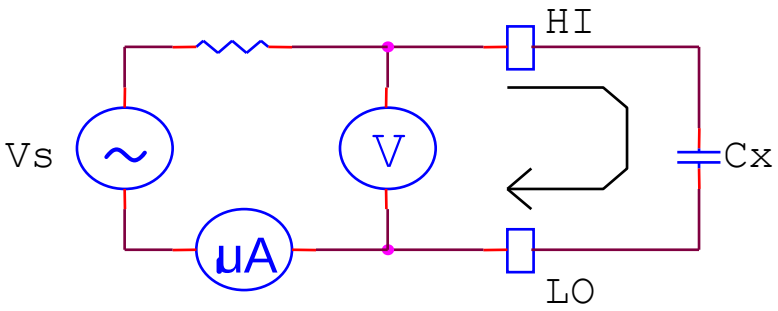
OSC function (contact check)

Use equivalent capacitance to judge the contact check

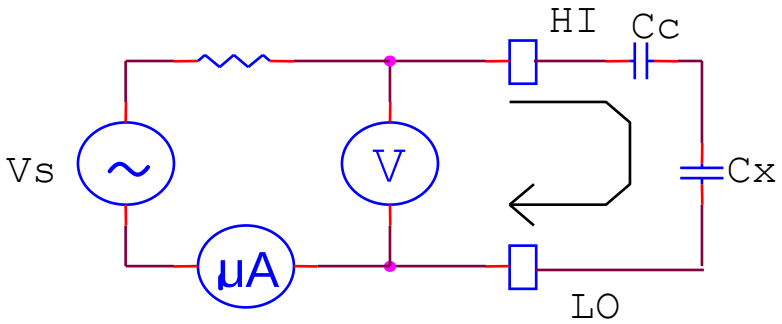
Normal connection: X0pF~uF

Open➔ Capacitance will be lower (50% lower)

Close➔ Capacitance will be higher (300% higher)



Normal condition



Open Condition

GFI function (Safety)

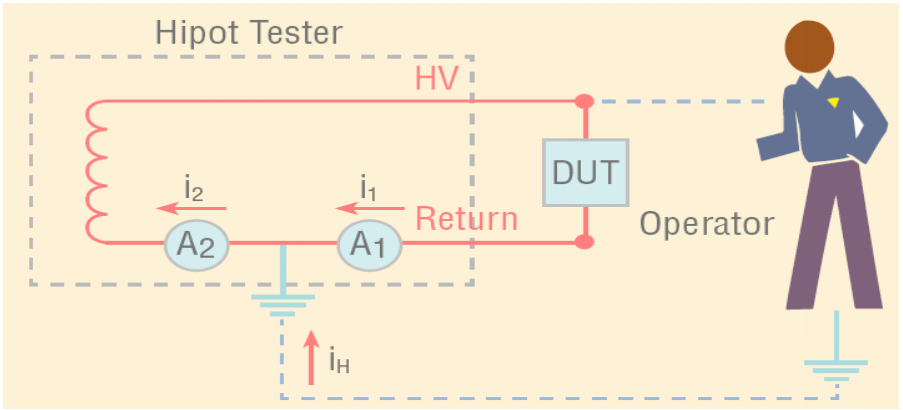
Improper grounding of the test fixture or operator touch may cause danger!

➔ To improve production safety and ensure the company's brand image

➔ GFI is important

- When a person touches the point where the high voltage test occurs, a leakage current of i_H will be generated to the ground ➔ i2 = i1+ i_H
- When i2≠i1, it is judged that there is excessive leakage current

  ➔ GFI will be proceeded, to avoid keeping afford the electric shock.



ARC detection (Flashover)

- Fast transients in voltage or current

Electrical discharges cause internal or surface changes to create transient conductive paths!

Cause the insulating material to lose its proper insulating ability,

ARC detection judges the instantaneous change rate of voltage or current

(3kHz~230kHz)

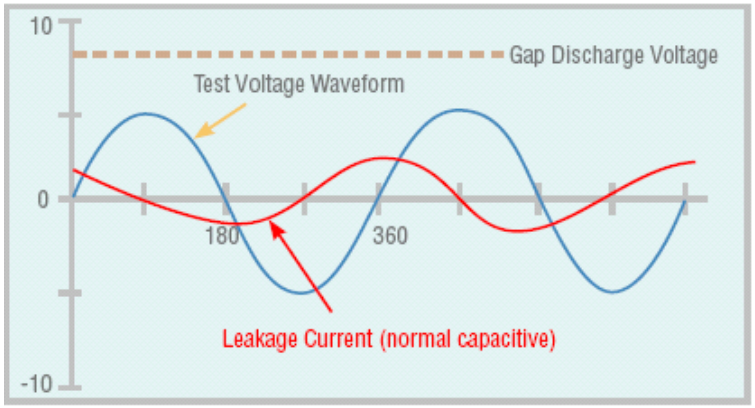


Figure 1 : Normal Leakage Current Waveform

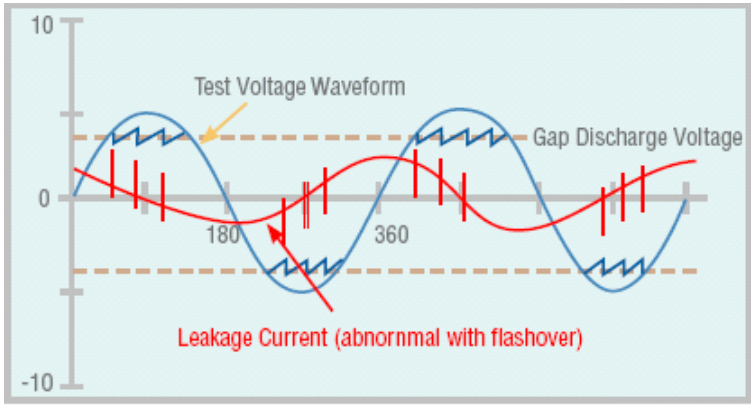


Figure 2 : Leakage Current Waveform when flahover occurred

Sub function

- GFI (19032P)
  - Human protection
- OSC
  - Open/Short Check
- PA Mode
  - Pause mode is designed for exchange DUT while testing.
- PRESET
  - Auto range: It sets withstand voltage auto-range function is open or not
  - Ramp Judg: When set Ramp. Judg. to ON, it will judge if the current value is over High Limit setting value as DC mode executes Ramp time. (ver 5.20)
- SYSTEM
  - Discharge V: Avoid over-current discharge. The high limit setting of DC discharge, the range is 0.05 ~ 5.1kV. The voltage below Discharge-V setting will be discharged quickly in 0.2sec.