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A DIVISION OF IKONIX USA

Hipot Testing 102

- AC vs. DC Testing
- Leakage Current Limits
- 500 VA Hipot Testing
- Fault Detection Systems
- Hipot Tester Features

Meet Our Team

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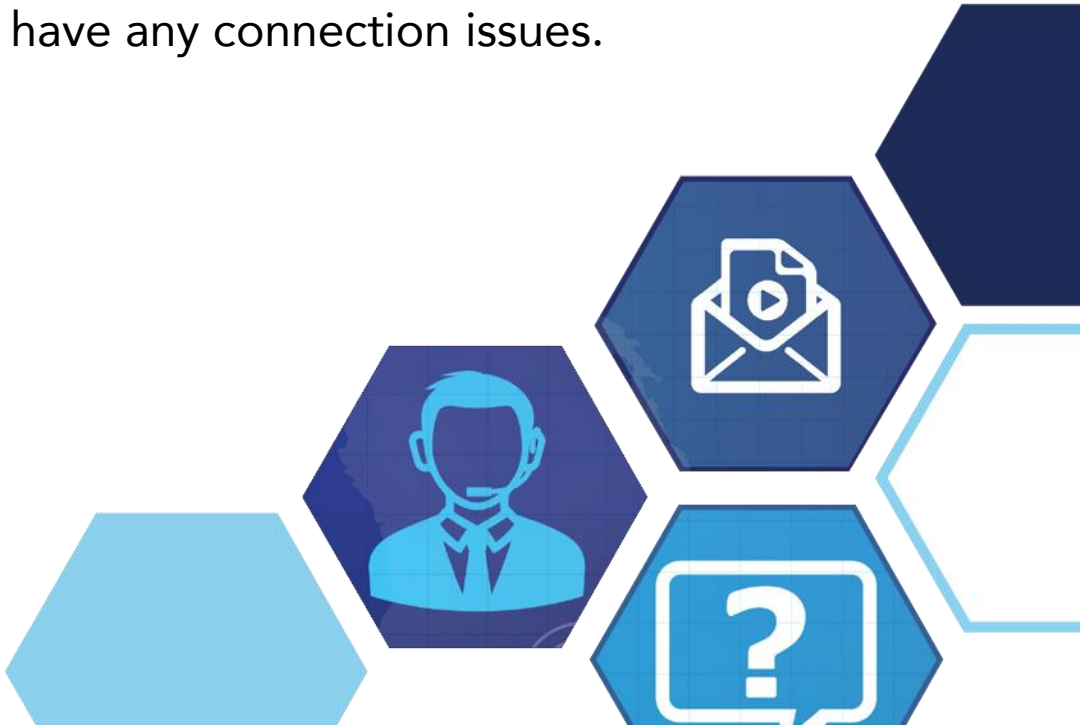
Communications Leader

Webinar Notes

Please use the Q & A utility to ask us any questions concerning the material being presented.

You can find a recording of this webinar and presentation on our Webinar Archive page, www.arisafety.com/webinars/archived-webinars/

Please contact Brittany Socha – on the chat line or email Brittany.socha@ikonixusa.com if you have any connection issues.



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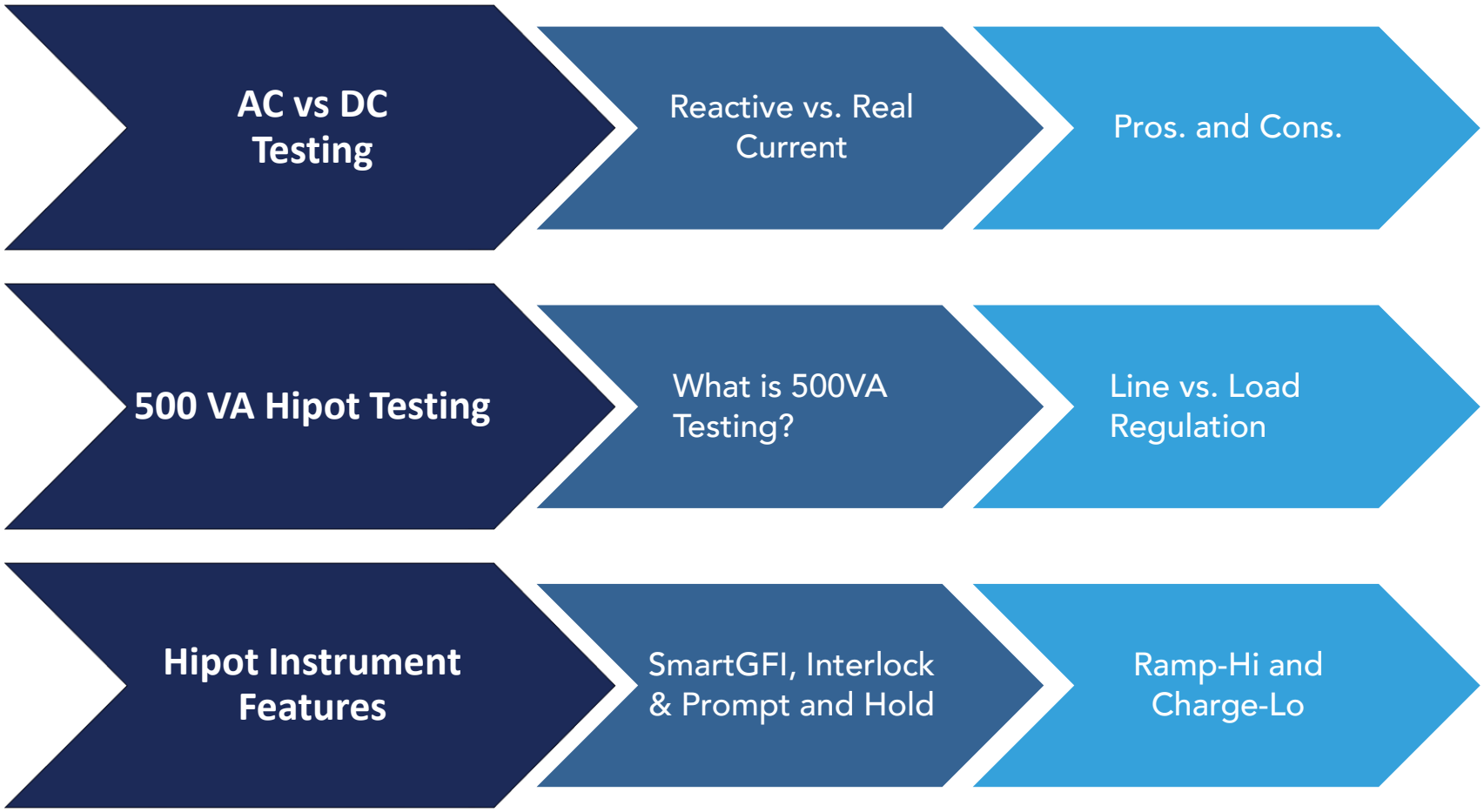
Hipot Testing 102: Learning Objectives



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Dielectric Withstand or Hipot Test

The Dielectric Voltage-Withstand Test, or Hipot (High Potential) Test, is designed to stress the insulation of your product far beyond what it will encounter during normal use.

The Assumption is that if the insulation can withstand the significantly higher voltage for a given time it will be able to function adequately at its normal level. Thus, the term “Voltage Withstand Test”.

AC vs. DC Hipot Testing

AC or DC

- Depending on the product being tested and the test standard, the hipot test can either be performed using AC or DC potential.

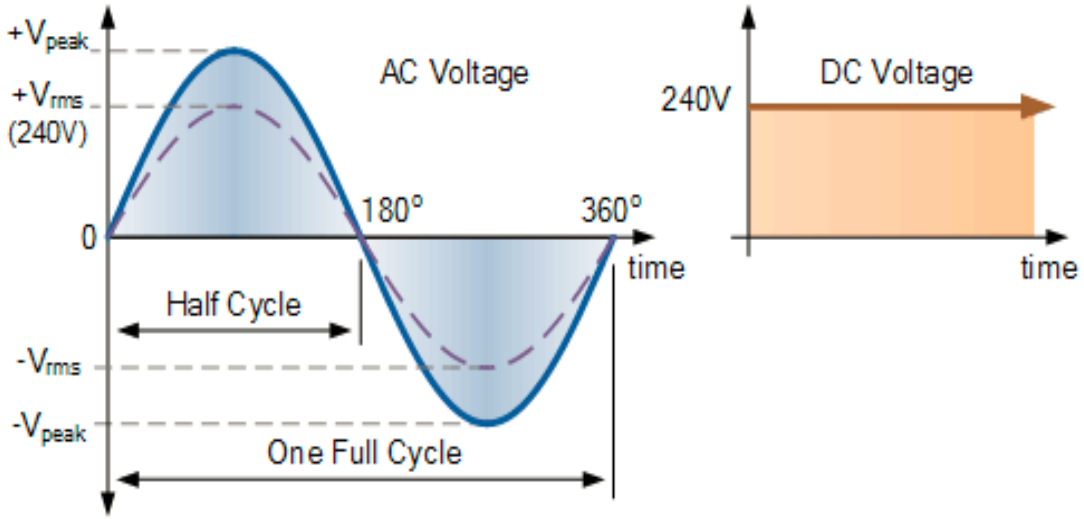
Differences

- Both AC and DC hipot tests have inherent advantages and disadvantages which are evident depending on the product being tested.

Which to use?

- It is important to understand the difference between the nature of AC and DC voltage/current.

AC vs. DC Hipot Testing



Due to the characteristics of your product it may be beneficial to test in either AC or DC voltages. Most standards will allow for either but with a variation in Voltage.

Voltage line-to-neutral a.c. r.m.s. or d.c.	1 min a.c. test voltage		1 min d.c. test voltage	
	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION
V	V	V	V	V
≤ 150	1 350	2 700	1 900	3 800
> 150 ≤ 300	1 500	3 000	2 100	4 200

H.17.1.2 Voltage-limiting-clamping devices (MOV) or line-to-ground filter (capacitors) are may be removed prior to test, or the test may be conducted using a dc potential at 1.414 times the AC potential

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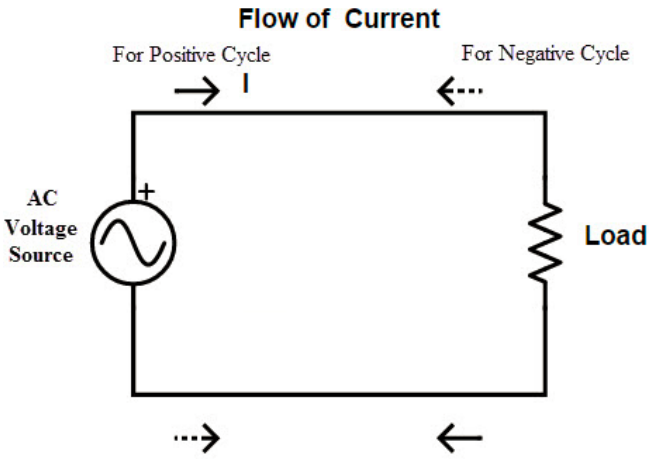
Ohm's Law

The behavior of AC and DC current varies in a resistive and capacitive circuit.

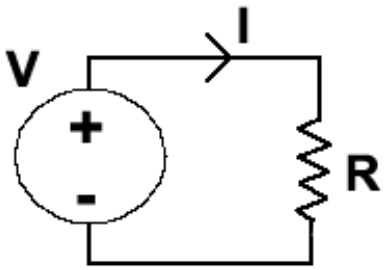
AC current is bi-directional in nature whereas DC current flows in one direction.

The relationship between current, voltage and resistance is defined by the famous OHM's LAW



$$V = I \times R$$

$$I = \frac{V}{R} \quad \text{or} \quad R = \frac{V}{I}$$



OHM's Law governs the relationship between current, voltage and resistance

Poll Question 1

We know a Hipot test can cause breakdown to your products insulation but can performing a Hipot test on your product cause damage to the actual Hipot tester?

The DC Hipot Test – Charging Current

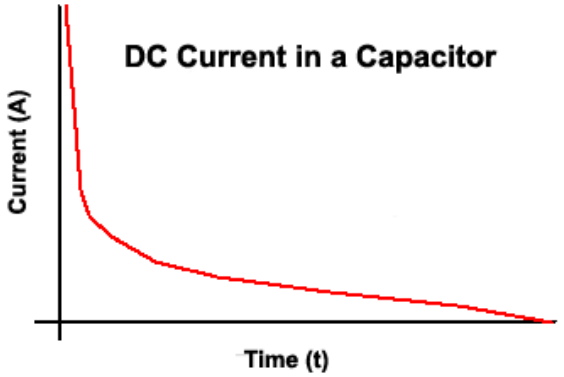
In a capacitive circuit, the AC and DC currents behave differently.

When a DC potential is applied across a capacitor, large amount of current is required to charge the capacitor.

As the capacitor charges up with time, the current decreases and point comes where the capacitor is fully charged and no current flows.

Maximum Capacitive Load DC Mode	1µF < 1KV	0.08µF < 4KV
	0.75µF < 2KV	0.04µF < 5KV
	0.5µF < 3KV	0.015uF < 6KV

Current in a capacitor goes to zero when fully charged.



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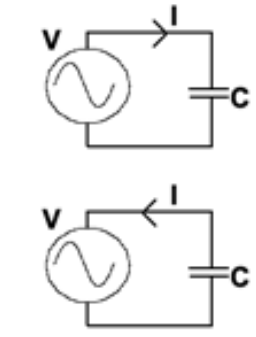
The AC Hipot Test – Reactive Current

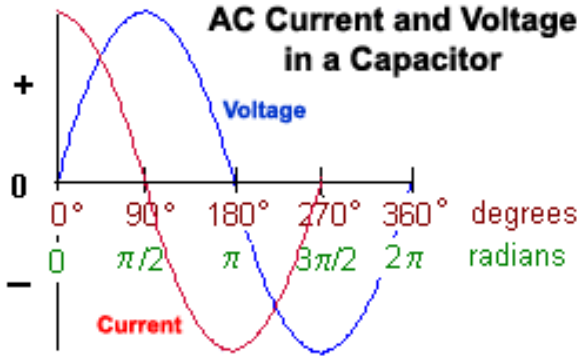
When an AC potential is applied across a resistor, the resulting leakage current is in phase with the applied voltage.

When an AC potential is applied across a capacitor, the resulting leakage current that flows is 90° out of phase with the applied voltage.

This is the reactive current due to the capacitor.



Current is bidirectional



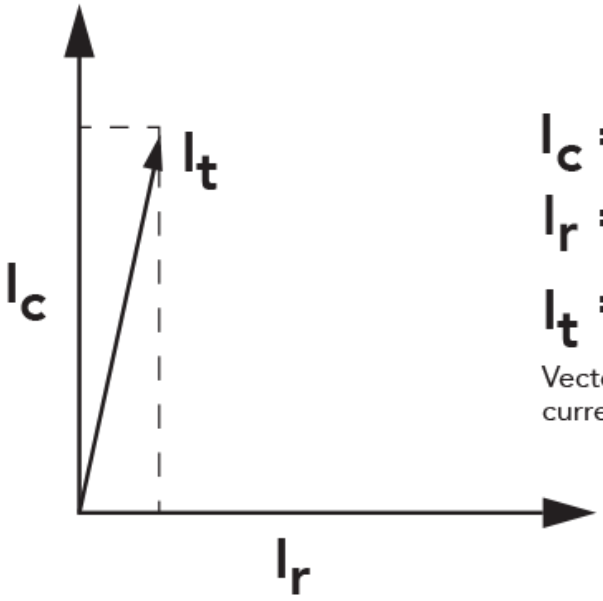
AC current through a resistor is bi-directional.

Total Leakage Current

The leakage current that is measured by most AC hipot testers is the vector sum of the resistive leakage current and the reactive leakage current.

Some Associated Research hipot testers are capable of displaying real and total leakage current for manufacturers who require extra information.

Vector Sum Relationship



I_c = Capacitive Current

I_r = Resistive Current

I_t = Total Current

Vector sum relationship of capacitive current and resistive current.

The hipot is more than just a go/no-go test. It can be used to find various insulation problems.

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AC vs. DC

AC HIPOT ADVANTAGES	DC HIPOT ADVANTAGES
No ramping of voltage required due to the changing polarity of the AC voltage	Can be performed at a much lower current level with less risk to the operator
Discharging the DUT is not necessary	Often easier to perform on capacitive DUT's
Insulation is stressed in both polarities	Leakage current measurement is purely real
Measures both real and reactive current	Cost effective
Commonly accepted by safety agencies	Not always accepted by safety agencies

500 VA Hipot Testing

VA Rating - Certain standards require the use of a 500VA hipot transformer

Energy and Breakdown - Originally this was required to ensure hipot voltage output remained constant under varying line and load conditions

High Leakage Applications - Higher mA output may also be required for high leakage currents. For example, a 2000m length of cable may have 60mA of leakage.

Most Associated Research instruments have a 5000V output. Thus, the instruments have a 100mA trip current rating and 200mA short circuit current rating.

500 VA Hipot Testing – By the Standards

IEC 61010-1	Equipment for Measurement, Control and Laboratory Use	*The generator shall be able to supply a power of at least 500 VA. The test voltage is raised uniformly from 0 V to the specified value within 5 s and held at that value for at least the specified time.*
IEC 60598-1	Luminaires	*A voltage of substantially sine-wave form, with a frequency of 50 Hz or 60 Hz and the value specified in Table 10.2, shall be applied for 1 min across the insulation shown in that table. Short circuit current shall be at least 200 mA. The overcurrent relay shall not trip when the output current is less than 100 mA.*
IEC 60335-1	Household Appliances	*The insulation is subjected to a voltage of substantially sinusoidal waveform having a frequency of 50 Hz or 60 Hz for 1 min…No breakdown shall occur.* *Tests run at 4000V or less require 100mA trip limit and 200mA short circuit current.*

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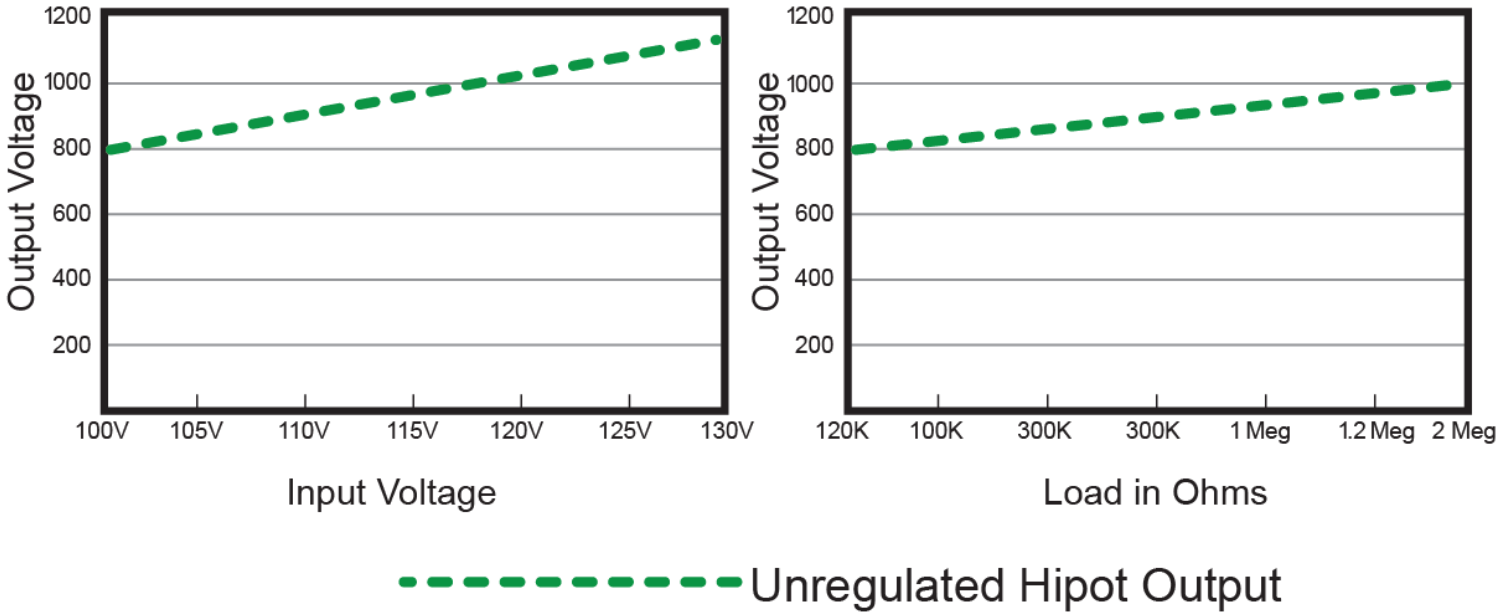
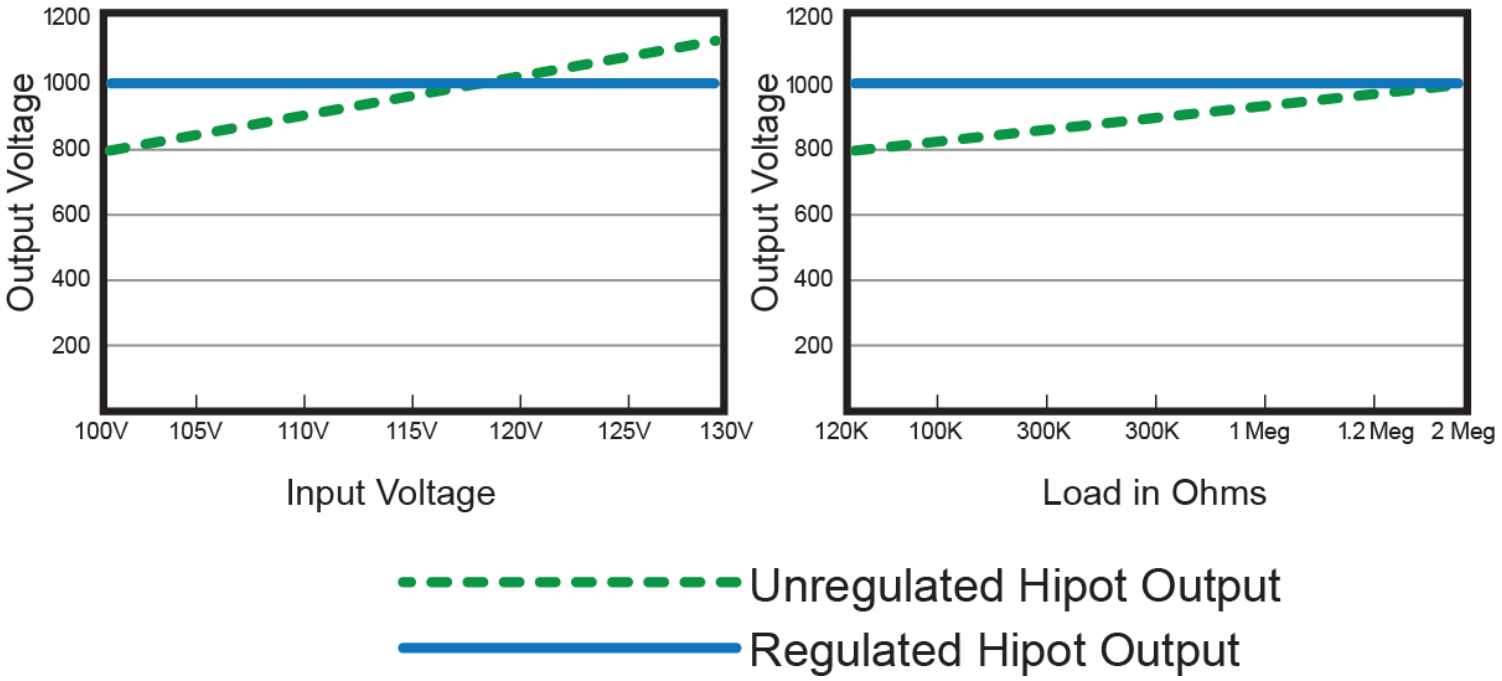
Line Vs. Load Regulation



If the hipot circuit is too heavily loaded or the input voltage drops, the hipot test voltage can dip causing an improper hipot test.

Line Vs. Load Regulation



If the hipot circuit is too heavily loaded or the input voltage drops, the hipot test voltage can dip causing an improper hipot test.

500 VA Hipot Testing

Some standards include exceptions to a 500VA hipot requirement

UL 1598 – Luminaires – Clause 19.20 :

"If the output of the test equipment is less than 500VA, the equipment shall include a voltmeter in the output circuit to directly indicate test potential."

Adoption of Exceptions

Keep your eyes open for new versions of standards – many of adding this exception to the 500VA requirement

In the end, you must follow what the standard states. However, your standard may contain an exception to the 500VA rule. Make sure you read the standard carefully.

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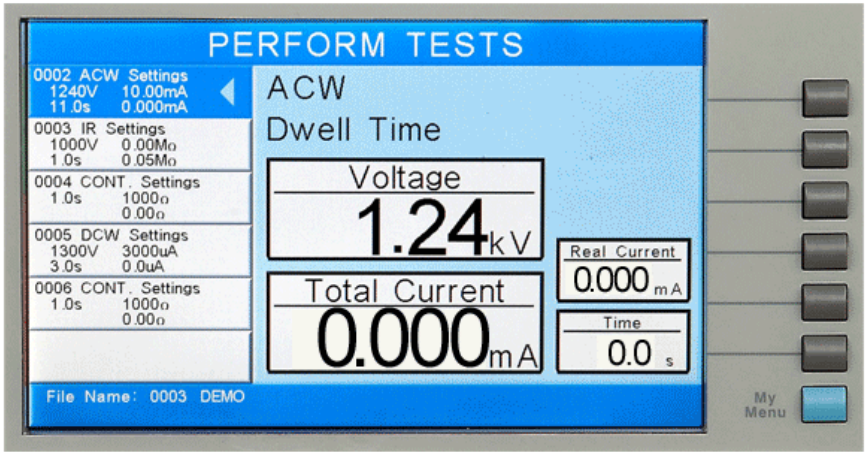
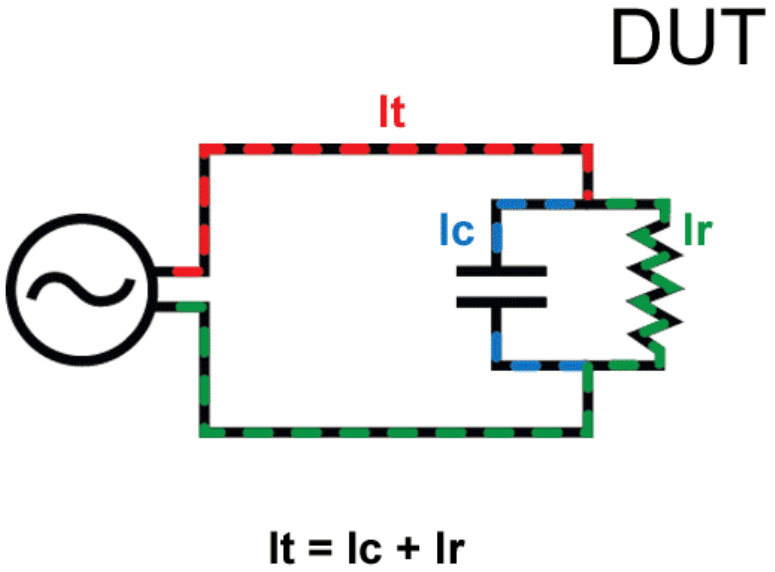
Leakage Current



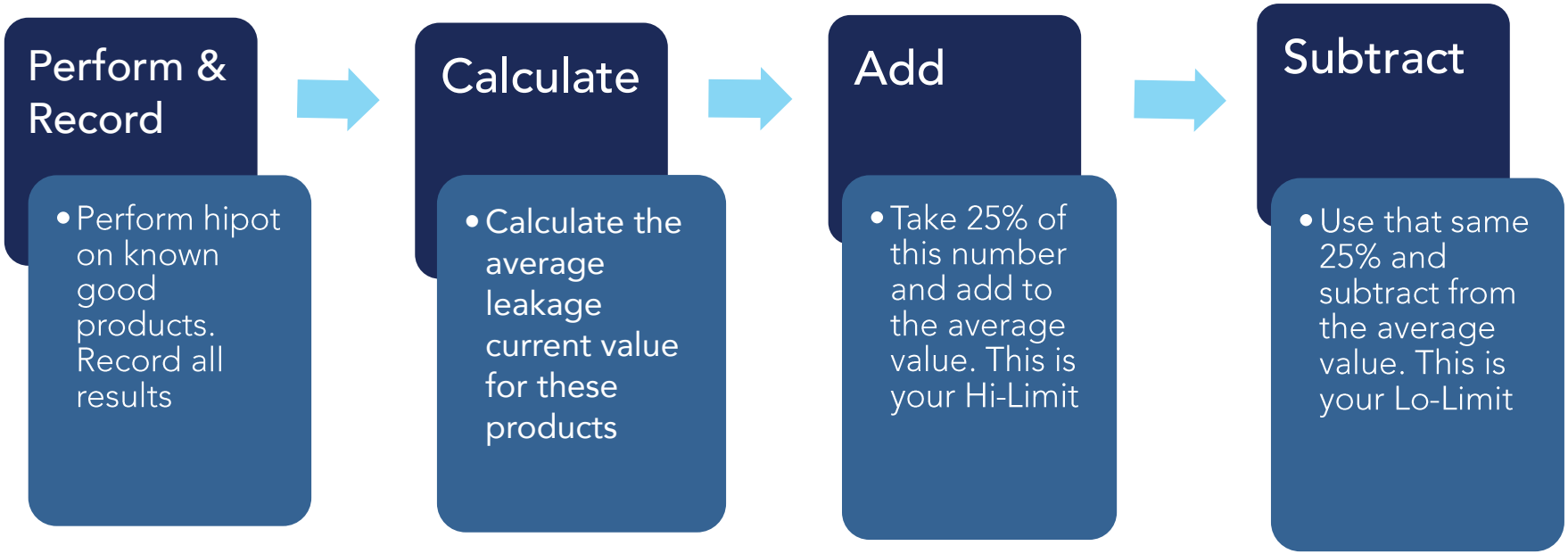


Leakage current is the stray current that actually flows through the insulation. It is undesired current that we want to quantify to better understand the quality of an insulation barrier.

Poll Question 2

When Hipot testing do you utilize your Hi and Lo limit parameters?

How to Set Leakage Current Limits?



Say I test 10 DUTs and calculate an average leakage current of 5.5mA. My limits would be:

Hi-Limit → (5.5mA)*0.25 = 1.375mA → 5.5mA + 1.375mA = **6.88mA**
Lo-Limit → 5.5mA – 1.375mA = **4.13mA**

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Hipot Instrument Features

Smart GFI®

Prompt & Hold

Charge-LO®

Ramp-HI®

Remote Safety Interlock

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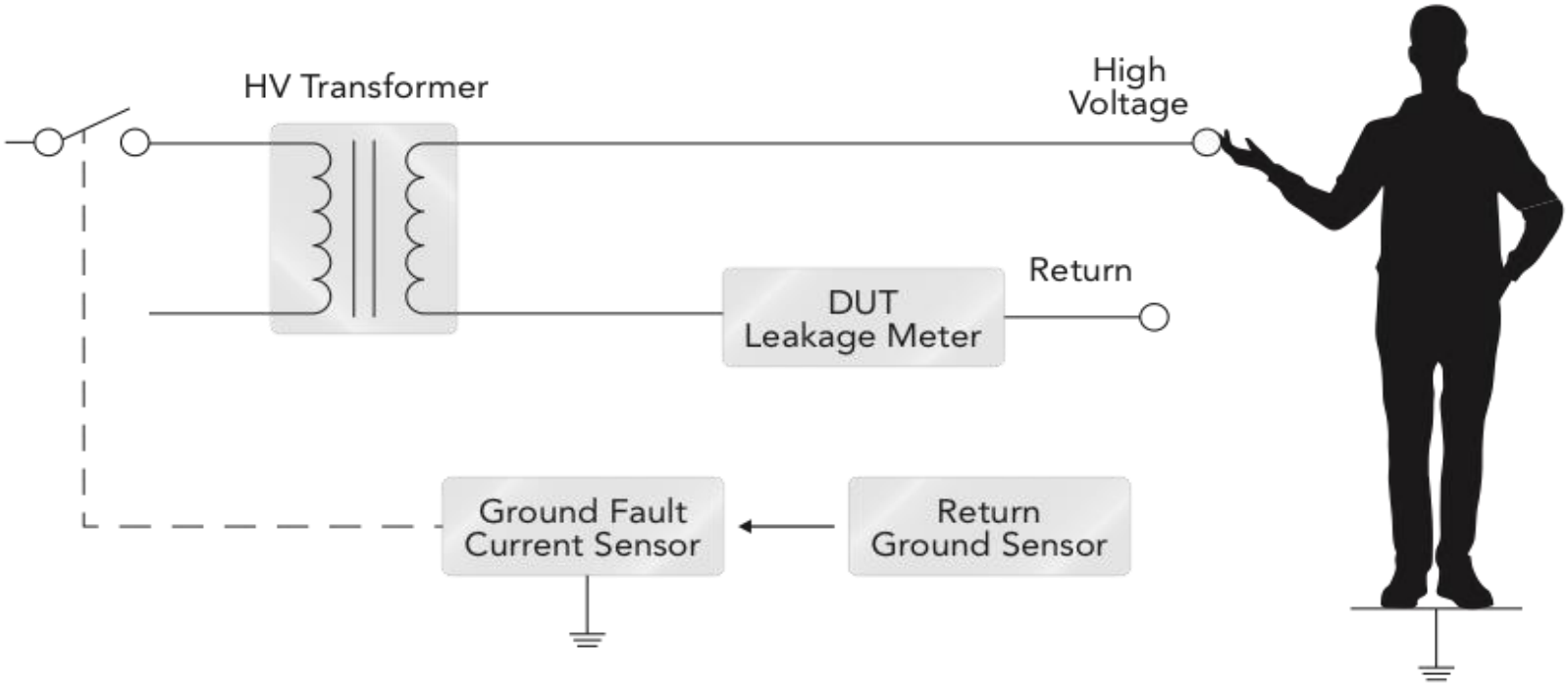
SmartGFI®



Associated Research's SmartGFI® can detect when an operator is touching the DUT by monitoring returning leakage current. Standard units set to 450µA trip. OMNIA ® II series and the new HYPOTULTRA can be set from 400µA – 5mA.

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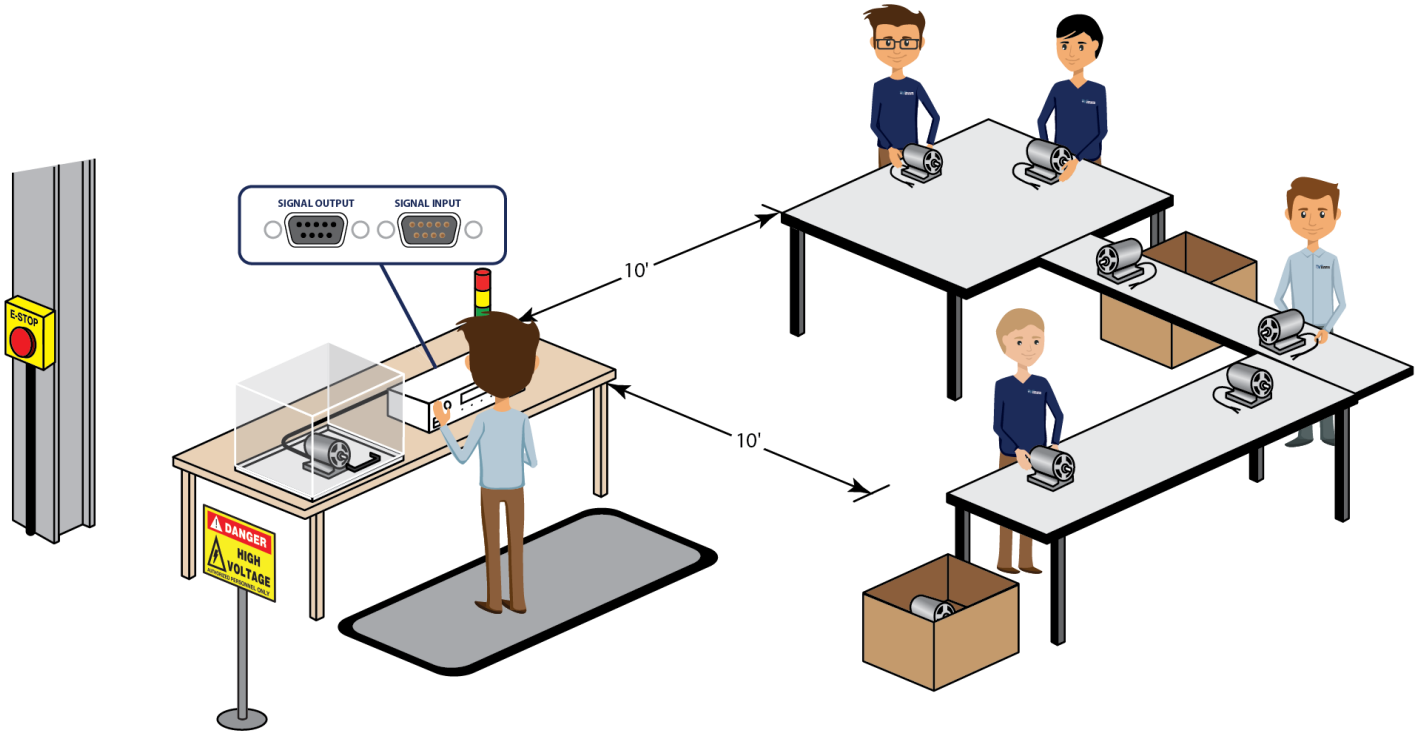
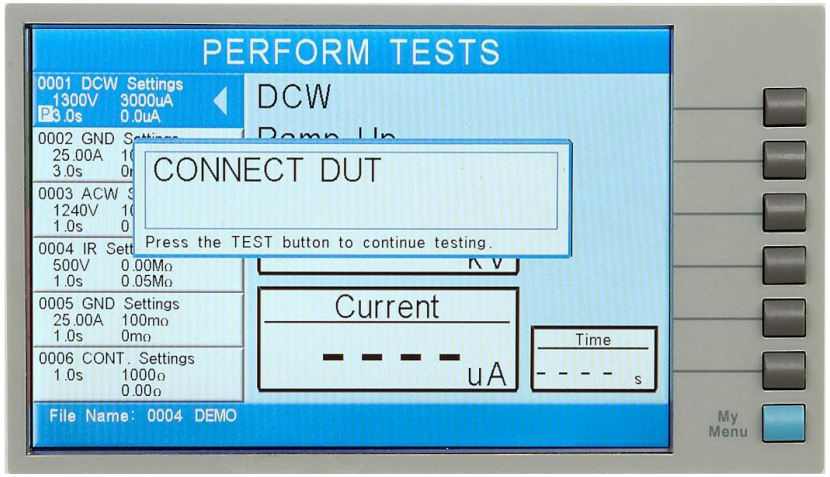
Interlock



Interlock located across pins 4 & 5 of Signal or Remote Input. Can be wired to DUT enclosure for an extra means of operator safety.

Prompt and Hold



User set prompt will hold the sequence until the operator presses TEST

The prompt allows the user to set instructions during the sequence. This could be used to convey a work instruction or for safety purposes.

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Ramp HI and Charge-Lo

DC Hipot Test – At test start, there will be inrush current. Once the insulation is charged (full test potential), the leakage current drops off to near zero mA.

Ramp-HI®

Ramp-Hi will ignore inrush current values so that the DC hipot does not falsely fail

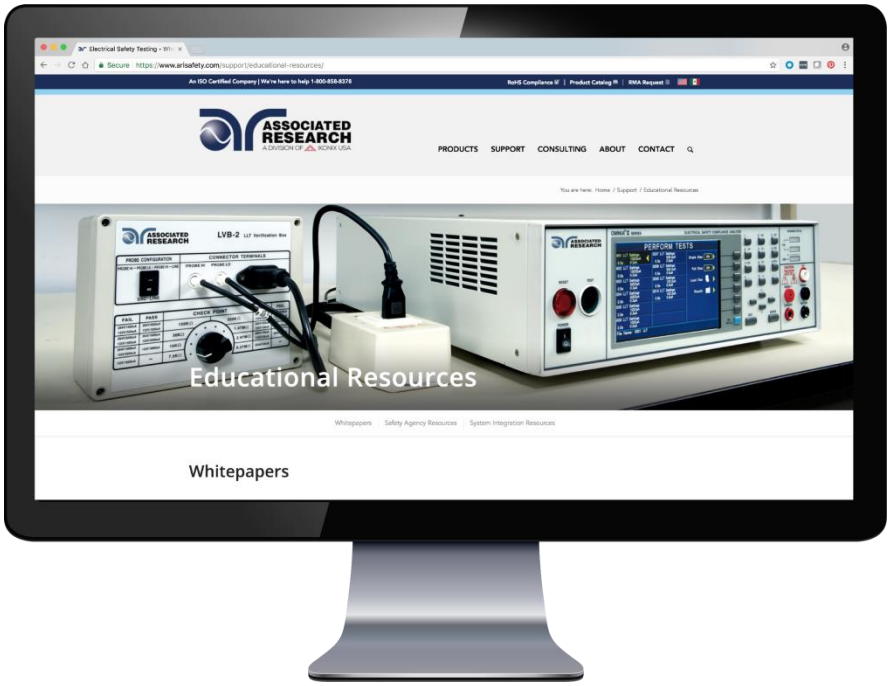
Charge-LO®

Charge-Lo monitors hipot circuit with DUT attached. The Charge-Lo circuit takes half the inrush current value and substitutes as a low limit check.

These features are used with a DC hipot or IR test. Due to the nature of a DC withstand test, setting high and low leakage limits can prove difficult. These features compensate for this difficulty and allow the user to properly monitor the limits.

Educational Resources

Visit us online to view all of our Educational Resources
arisafety.com/support/educational-resources/



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Our Next Webinar is

Testing the Ground Circuit

Wednesday, July 11 at 10 A.M. CT

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