POSITRON

Insulator Testers Frequently Asked Questions

September 2017

Version: 1.1

FAQ Contents Page

Q1: When is it not safe to work on power lines?

<u>ANSWER</u>: It is dangerous to work on or near power lines during rain, snow or when there is danger of lightning strikes. Never work near power lines if there is any visible lightning or if thunder is heard. Note that rain typically carries pollutants which can be conductive. Even the use of a suitable hot stick with nothing attached to it can be dangerous. That means that the Positron insulator tester should not be used under those circumstances.

Q2: What is the tolerance of the Positron Insulator Tester to moisture and humidity?

<u>ANSWER</u>: The electronics in the Positron Insulator are covered in a conformal coating. The Positron Insulator Testers can be used safely in very high humidity.

Provided the hot stick has been treated with hydrophobic coating, the unit can be safely used in condensing humidity.

Q3: What is the tolerance of the Positron Insulator Tester to mechanical impact?

<u>ANSWER</u>: Positron's Insulator Testers have no moving internal parts. The internal electronics is ruggedized and uses Surface Mount Technology (MDT) components. The sled of the Insulator Testers is made from a flexible durable ABS material that is designed to absorb impacts resulting from being dropped. The assembled Positron Insulator Testers are designed to withstand an impact from a drop of 3 meters.

Q4: What is the tolerance of the Positron Insulator Tester to dust?

<u>ANSWER</u>: The Positron Insulator Testers are impervious to dust infiltration and scans will not be negatively affected. Prolonged exposure to dust may result is a layer accumulating on the small clear plastic windows used for the infrared beams in the electronic module. Even so, the unit will still function. If the infrared windows become covered in dirt, they can easily be cleaned with a cotton swab.

Model #3781301P50 Porcelain Insulator Tester
Shown with Cotton Swab to clean IR windows

Q5: When viewing E-Field graphs after testing an insulator, what is the difference between the LINEAR, LOG, and FILTER graph settings?

ANSWER: The 3 different settings allow for different views of the graph of the scan of an insulator string's E-field. During analysis, the **LOG** and **FILTER** settings permit a more detailed view of the resulting scan.

Linear/Log/Filter Graph Setting Comparison

Linear Graph Setting

The **Linear** graph setting is used to show the resulting curve of the scan the Electric field (E-Field) of an insulator string.

In the **Linear** graph setting, a graph is produced showing the linear values of the strength of the E-Field at each porcelain insulator in a string or at each skirt of a polymeric composite insulator, expressed in kV/m (kilovolts / metre).

The Y-Axis scaling of the strength of the E-field auto adjusts depending on the highest E-field strength detected during a scan of an insulator.

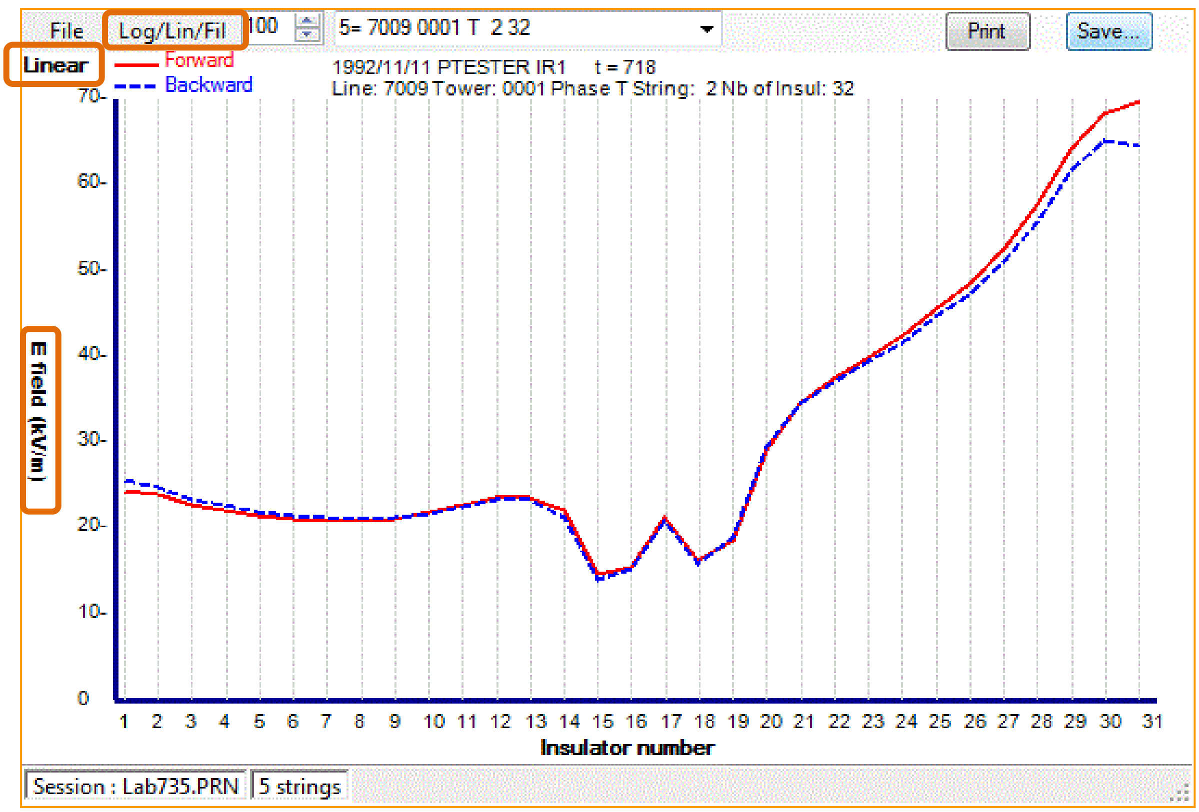


Figure 1: Graph of Porcelain Insulator String displaying compromised porcelain insulator bells shown using ***LINEAR*** *scale*. Compromised bells are shown as #'s 15, 16, 18 & 19

Log Graph Setting of the Same Insulator

The **LOG** scale increases the small variations in the lower portion of the curves shown using the **LINEAR** graph setting. See the comparison between **LINEAR** and **LOG** view settings in Figures 2 & 3 and 4 & 5**.** The **LOG** setting allows <u>greater detail</u> to be seen as a result of a magnification of the small variations in the lower portion of the resulting curve to aid in insulator health results assessment.

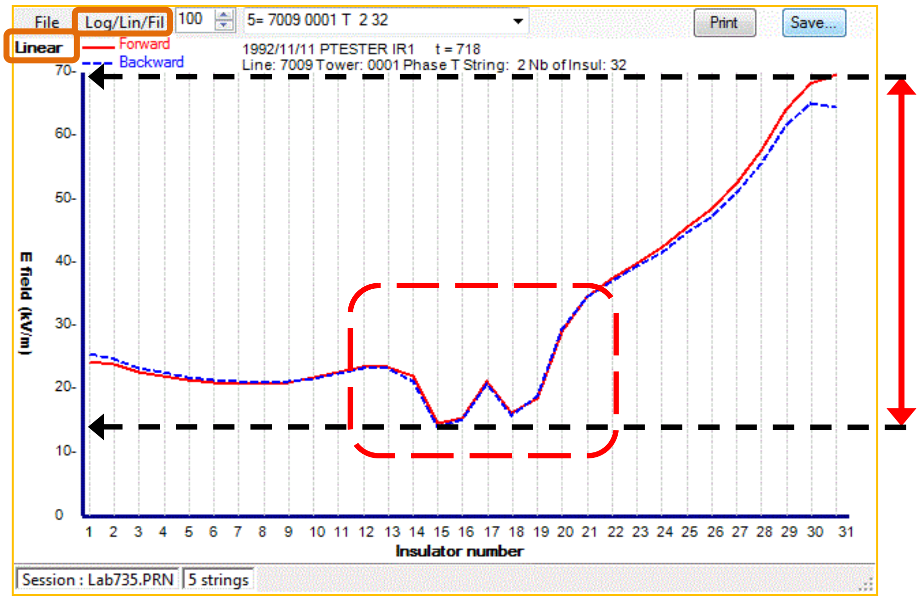


Figure 2: Example 1: Results of scan of Porcelain Insulator String.
Compromised bells shown in ***LINEAR*** graph setting as #'s 15, 16, 18 & 19

Figure 3: Example 1: Graph of Unhealthy Porcelain Insulator String
Compromised bells shown in ***LOG* scale** as #'s 15, 16, 18 & 19

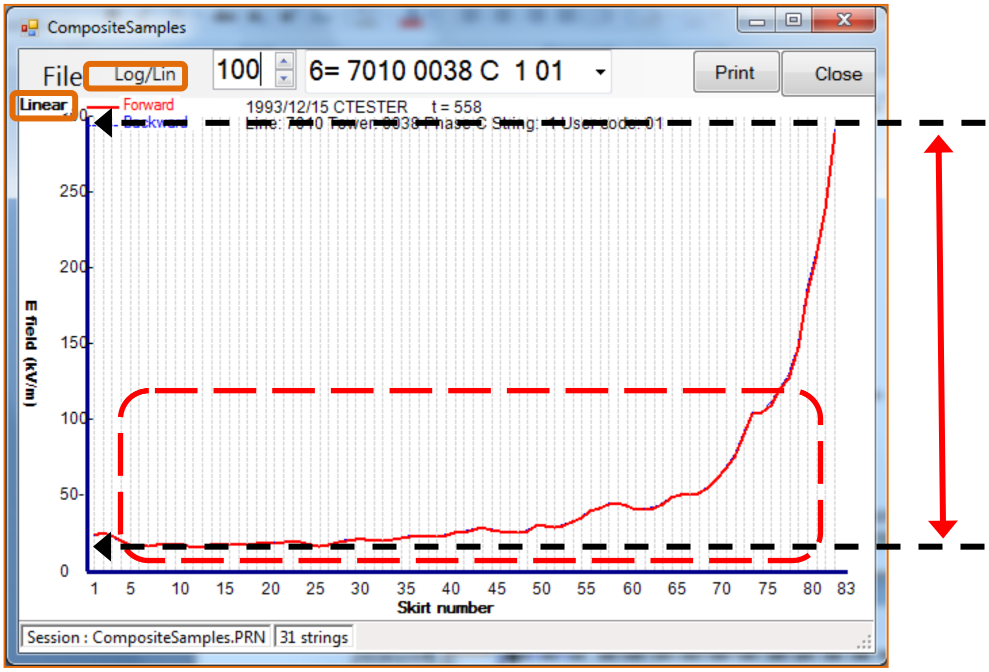


Figure 4: Example 2: Graph of Composite Insulator displaying an insulator with manufacturing defects. Shown using ***LINEAR*** graph setting.

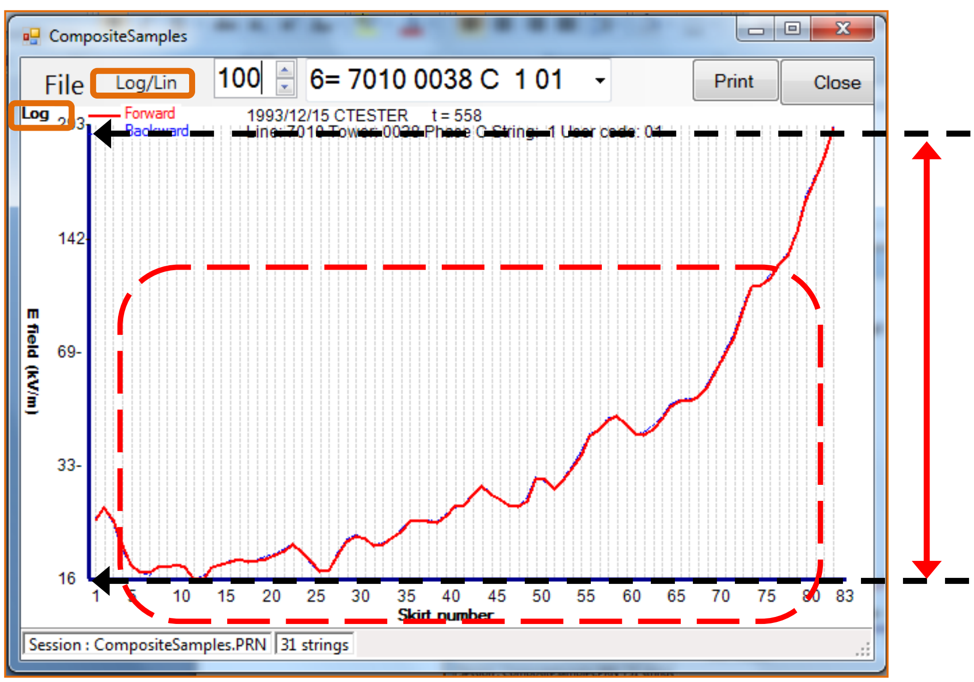


Figure 5: Example 3: Graph of Composite Insulator displaying an insulator with manufacturing defects. Shown using ***LOG*** graph setting.

Filter Setting

The **FILTER Setting** is used only for porcelain insulators. When **FILTER** is selected, the graph of the scan passes through a Digitial Signal Processing Algorithm which results is the addition of a blue baseline to the graph. All porcelain insulators with graphs that go below the blue line are shorted and should be replaced. All porcelain insulators where all parts of the graph are above the blue line are good.

Note that there is no unit assigned to the Y-Axis in **FILTER** setting. This is because the values of the Y-Axis of the graph are the result of a calculation from a filter algorithm. See Figures 6 & 7 and 8 for comparisons.

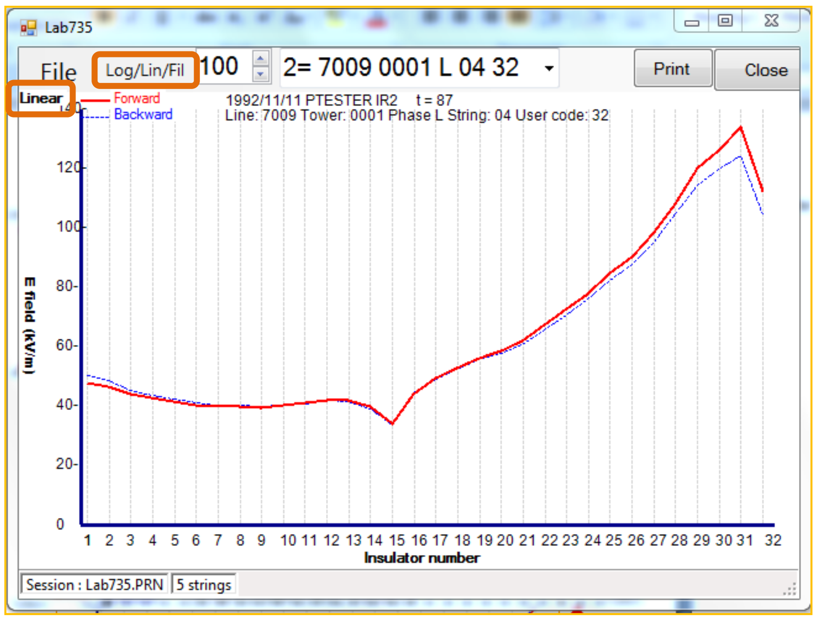


Figure 6: Graph of Porcelain Insulator String Shown in **Linear** scaling

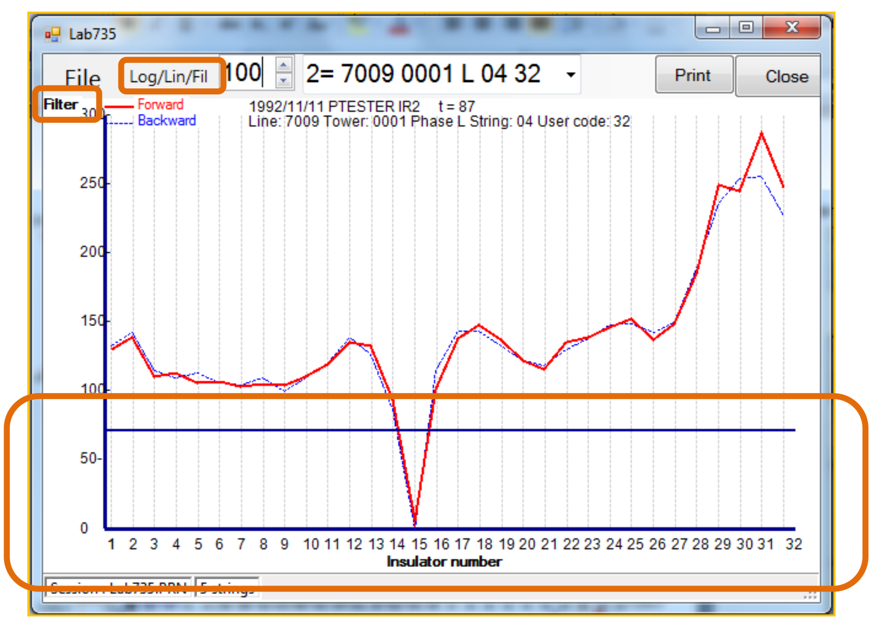
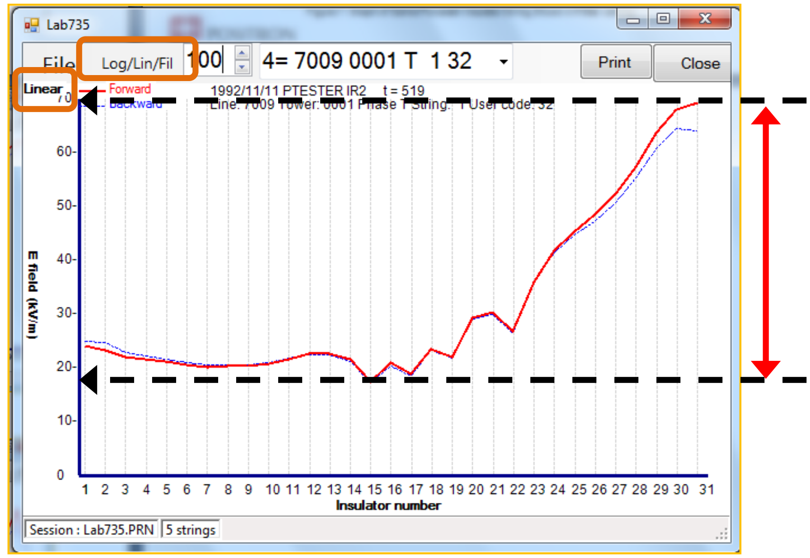


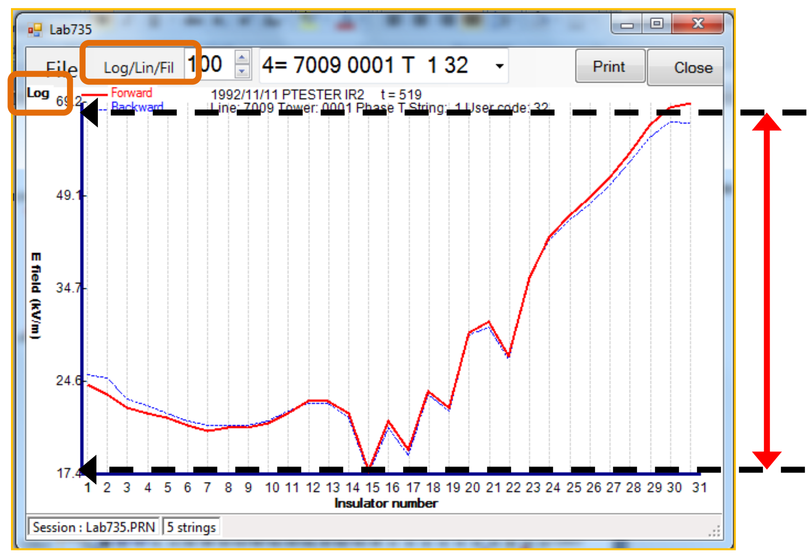
Figure 7: Graph of Same Porcelain Insulator String Shown in **Filter** setting

Summary of Graph Settings

LINEAR Mode shows the results of a scan with Y-Axis origin set to 0kV/m.



LOG mode increases the small variations in the lower portion of the curve in addition to the auto-scaling of the Y-Axis.



FILTER Mode presents the information of the scan using a Digital Signal Processing Algorithm resulting in a baseline reference. Porcelain insulators below the baseline are defective.

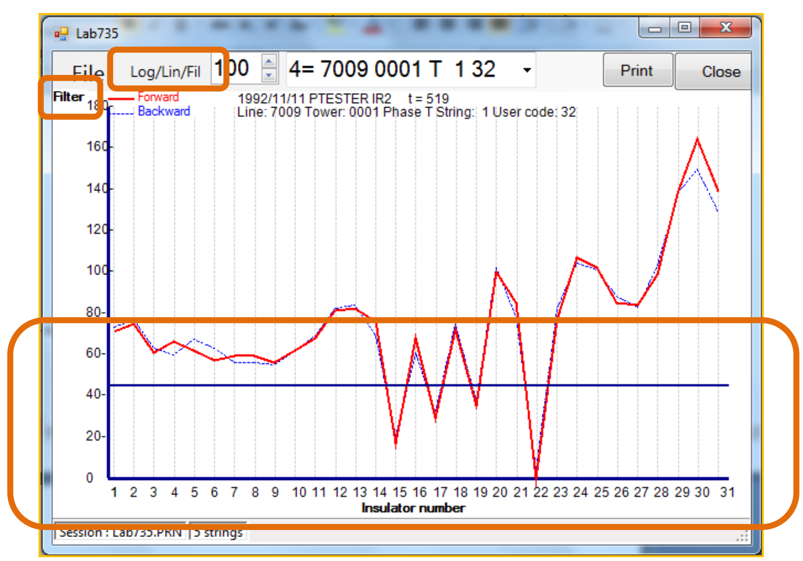


Figure 8: All three graphic representations of the same insulator scan shown in **Linear**, **Log**, and **Filter** modes

Q6: When working outdoors with the Tablet/Laptop in the sunlight, why is it at times difficult to see the Tablet/Laptop screen when wearing polarized sunglasses?

ANSWER: If you have difficulty seeing the screen of the Tablet/Laptop in sunlight while wearing polarized sunglasses, rotate the Tablet/Laptop by 90°.

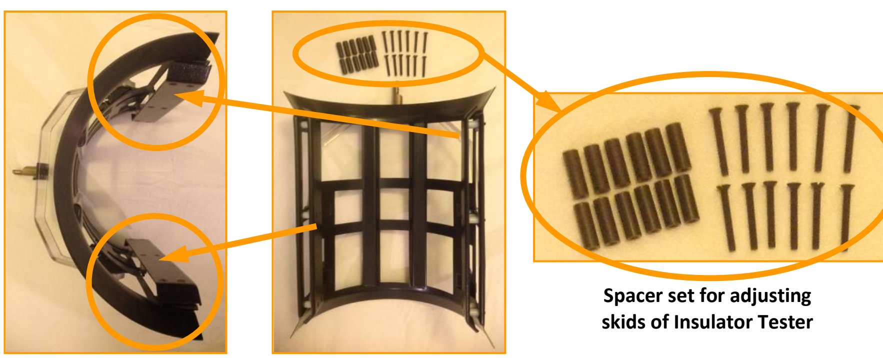
When viewing the screen of the Tablet/Laptop while wearing polarized sunglasses, the screen may appear black. This is due to the polarization of the sunglasses.

By rotating the Tablet/Laptop by ninety degrees relative to the sunglasses, the blanking effect caused by the polarization of the sunglasses is negated. Also, it is advisable to leave the screen settings of the Tablet/Laptop on the maximum intensity setting for best viewing.

Q7: Why do the red and blue lines of the Forward and Backward scans not match very closely when I look at the graph of a two-way scan?

ANSWER: Graphs that are produced where the red and blue lines do not reasonably match indicate an issue with the manipulation of the tester on the insulator tested.

The operator of the tester should ensure that the tester moves along the insulator with a slight pressure on the insulator. During the performing of a two-way scan, the orientation of the testers should not be changed. To remove the possibility of lateral skewing during a scan, the skids of the sleds of the insulator testers should be adjusted to fit the insulator so that the space between the insulator and the sled skids is minimized, but is still able to slide along the insulator during a scan. This ensures a proper orientation. See Figure 9.



Spacer set for adjusting skids of Insulator Tester

Adjustable skids of Insulator Tester Sled

Figure 9

Q8: When using the Porcelain Insulator Tester, how do I overcome the mechanical inference with arcing horns and end-fittings hardware associated with an insulator?

ANSWER: To avoid mechanical interference issues when testing a porcelain insulator string, use the Alternative Insulator Tester Sled, Model # 378603.

Regular Adjustable Sled Model # 378602

Modified Adjustable Sled Model # 378603

Figure 10

Q9: Is there any orientation methodology that needs to be followed when using the Positron Insulator tester?

<u>ANSWER</u>: The Porcelain and the Composite testers come with a sled that automatically maintains the correct orientation relative to the insulator being tested. The Universal Insulator tester for Power Station bushings is available with a special ski mechanism option that ensures correct orientation of the electronic module relative to the bushing or insulator being tested. The electronic module is automatically held perpendicular to insulator.

When using the standalone Universal Insulator Tester, it is important to orient the tester in a 90° perpendicular manner relative to the insulator or bushing. The detector circuit in the electronic module is sensitive to the angle of the tester relative to the insulator. The curve is impacted as the angle of insertion into the insulator's E-Field deviates from 90° perpendicular. Manually using a standalone tester without making sure that the tester is perpendicular to the insulator *will result in a false positive alert*. See Figure 11.

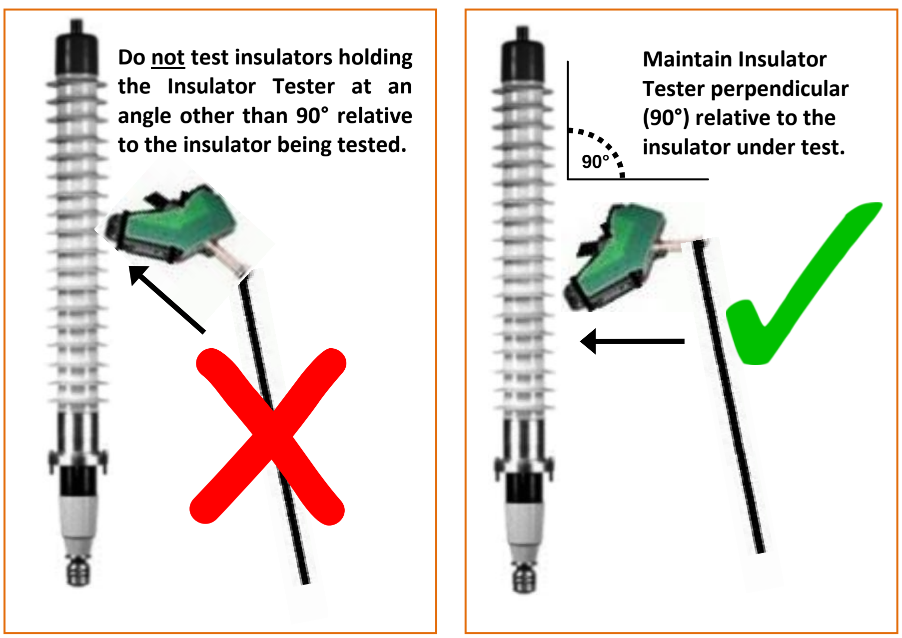


Figure 11

Q10: Does Positron supply database software with the Insulator Testers?

__ANSWER:__ The Windows-based Positron Insulator Tester software includes a simple ASCII-based database.

The Insulator Identification database table is created when making a list of insulators to be tested by selecting **Edit Insulator Identifications** from the Windows-based software interface. See Figure 12.

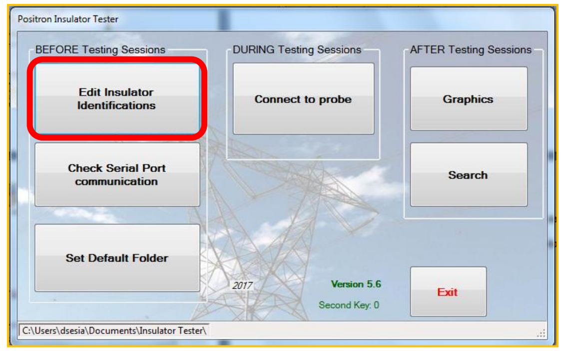


Figure 12

When the **Insulator Identification List** editor opens, you can create a list of all the insulators that are to be tested. The list is stored in ASCII format in a file with the extension "**.ID**". See Figure 13.

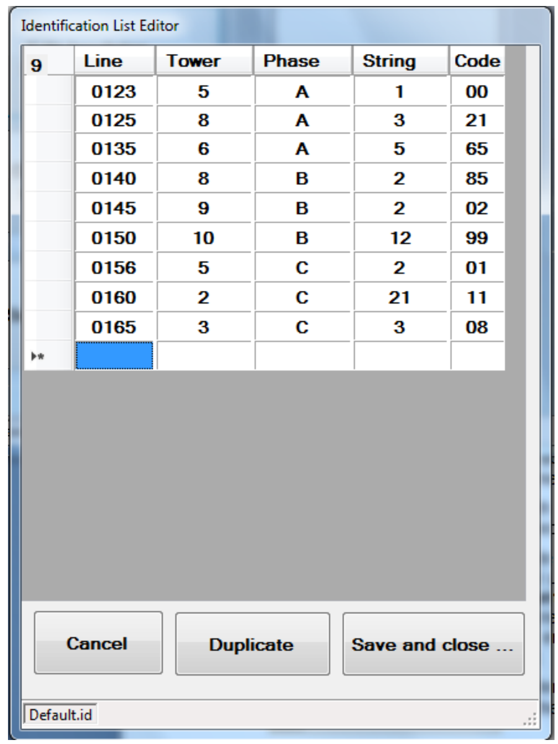


Figure 13

During a testing session, the data in this list is matched to the results obtained by the Insulator Tester during the testing process. The results form two ASCII-format tables that are stored in separate ASCII files with two different file extensions: "**.PRN**" and "**.LOG**".

The database created can be queried after a testing session by selecting "**GRAPHICS**" in the software interface. See Figure 14.

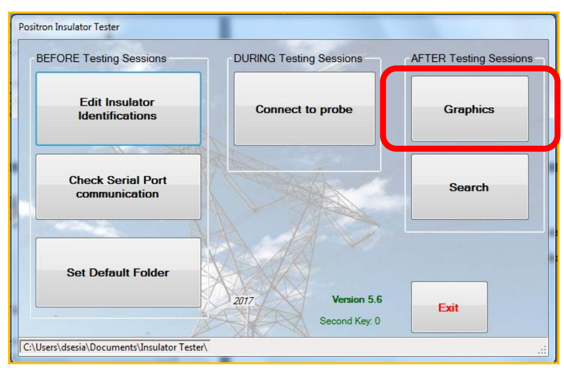


Figure 14

Using the pull-down menu, the results of every scan can easily be viewed. See Figure 15.
If the power utility has an existing database, Positron can provide a JSON-formatted file to simplify the export to the existing customer's database.

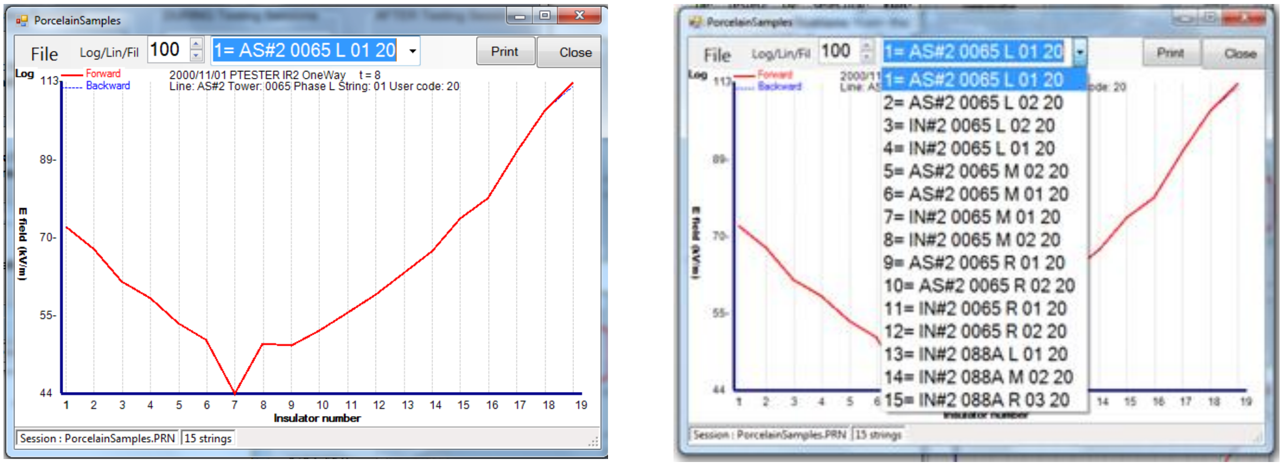


Figure 15

Q11: Why do we sometimes get different results while testing polymeric composite insulators contaminated with pollution?

ANSWER: Ambient humidity levels vary at different times of the day. Pollution-caused flashovers will occur in humid weather, but will not necessarily occur in dry weather. Pollution deposits on an insulator do not necessarily result in a conductive defect and may only do so in the presence of water condensation, such as early morning dew. The water may also contain some pollutants. When water is coupled with the pollutants on the insulator, it will act as an electrolyte resulting in a conductive defect. The Positron testers will detect any conductive defect in the insulator, but will only detect pollution that is conductive.

If the insulators are covered in a coat of pollution, the pollution is typically visible and is seen as discoloration on the insulator.

To detect if the pollution accumulation on the insulators is such that it would be conductive when moist, it is best to test such insulators in moist conditions such in the early morning when there is moisture or condensation.

If several insulators test as defective in a specific region under these conditions, it can be reasonably surmised that all of the insulators that are coated with a similar visible pollution in the same proximal region can be considered as defective due to the pollution covering.

This is why in regions subject to heavy pollution, insulators may not test as defective in dry conditions but may test as defective when they are wet. It doesn't matter whether the conductive defect is due to a defect in the insulator or due to pollution. Either way, the insulator needs to be changed.

Q12: If an insulator flashed over and tests as good when the insulator is dry, what procedure should be followed?

ANSWER: When a flashover occurs in a region and the insulator tests as good in dry conditions, look for visible pollution on the insulator and retest it when the insulator is moist, such as in the early morning. The likelihood is that if one insulator flashed over, other adjacent or nearby insulators will be similarly covered by a visible pollutant film and are also likely to flash over in the near future.

Q13: Will the insulator tester detect the physical damage of an insulator?

ANSWER: The Positron Insulator Tester tests the dielectric integrity of insulators. Physical damage to an insulator will not necessarily reduce its dielectric integrity. If the physical damage becomes conductive over time due to moisture ingress, the Insulator Testers will detect this.

There exists other equipment specifically for testing the structural strength of bushings and the contact impedance and other operational characteristics of breakers. That type of equipment serves a different function and does not detect conductive defects.

Q14: The hot sticks used in our country have a different coupling mechanism. How can I attach the hot stick to the Insulator Testers?

ANSWER: Positron Insulator Testers can be outfitted with a hot stick coupler that is compatible with the hot sticks used in many countries. Positron can provide a coupler fitting suitable for hot sticks with different couplings when needed if the mechanical design of the coupling mechanism is provided to Positron.

Q15: Is there any electrical contact with an insulator or a high-voltage line possible when using the Positron Insulator Testers?

ANSWER: The Positron Insulator Testers make no electrical contact with the insulators. Only the non-conductive materials of the Insulator Testers come into contact with an insulator during a test when used with a dielectric hot stick. In addition, the hot stick insulates and keeps the user at a safe distance from the high voltage. It is completely safe for technicians to use the tester with a hot stick on live high voltage lines.

Q16: What length of hot stick should be used with the Positron Insulator Tester?

ANSWER: The length of the hot stick used with the Positron Insulator Testers is dependent on the voltage level being tested per Table 1*.

Live-Line Work Minimum Approach Distances				
Nominal Voltage in Kilovolts Phase-to-Phase	Distance			
	Phase-to-ground exposure		Phase-to-phase exposure	
	(ft.-in.)	(m)	(ft.-in.)	(m)
0.05 to 1.0	*	*	*	*
1.1 to 15.0	2-1	0.64	2-2	.66
15.1 to 36.0	2-4	0.72	2-7	0.77
36.1 to 46.0	2-7	0.77	2-10	0.85
46.1 to 72.5	3-0	0.90	3-6	1.05
72.6 to 121	3-2	0.95	4-3	1.29
138 to 145	3-7	1.09	4-11	1.50
161 to 169	4-0	1.22	5-8	1.71
230 to 242	5-3	1.59	7-6	2.27
345 to 362	8-6	2.59	12-6	3.80
500 to 550	11-3	3.42	18-1	5.50
765 to 800	14-11	4.53	26-0	7.91

Table 1

*Reference: OSHA guidelines in Table R-6 of the Federal Register published 1/31/1994.

These distances take into consideration the highest switching surge an employee will be exposed to on any system with air as the insulating medium and the maximum voltages shown.

Note: The clear live-line tool distance shall equal or exceed the values for the indicated voltage ranges.

Q17: What are the advantages of the Positron Insulator Testers to other methodologies?

ANSWER: The Positron Insulator Testers use an Electric Field detection technology that can detect any conductive defect in an energized insulator. A defect in a porcelain or polymeric composite insulator changes the electric field around the insulator. This is a basic law of physics. It is impossible to miss such a defect using a sensitive electric field detector such as a Positron Insulator Tester, including defects that are not visible to the eye.

Acoustic detection methods are based on the acoustic reception of ultra sound generated by corona discharges. However, leaking or perforated Porcelain Insulators do not generate coronas when defective so this method is unusable. Polymeric Composite Insulators generate a corona discharge only when seriously defective. Acoustic methods are unreliable at detecting all conductive defects and are seriously impeded by surrounding noise and wind.

Positron Insulator Testers will detect all conductive defects and are unaffected by noise in the environment.

The UV detection method is based on seeing the Ultra-Violet radiation produced by corona discharges. This cannot be reliably used on either Porcelain or Polymeric Composite Insulators since corona discharges only occur with very severe dangerous defects. This detection happens too late. The UV method can only detect a fault once the fault is too severe to wait for a planned maintenance replacement.

The technology of Positron’s Insulator Testers acts like an “early warning system” since it also senses defects before they become catastrophic.

Furthermore, the UV detection method cannot locate any severe defects that are not in the viewing angle of the camera. Defects on the non-facing side of the insulator may not be detected, regardless of the severity. This means that an insulator that is dangerous could be judged incorrectly as safe. Additionally, UV cameras are very costly devices.

Positron Insulator Testers sense defects even if they are on the unseen side of an insulator.

The Infrared detection method is based on the temperature of the insulator. Similar to the issues associated with UV detectors, Porcelain Insulators do not generate heat when they are leaking or punctured so these defects cannot be seen using IR technology. Polymeric Composite Insulators generate inadequate heat for the IR method to detect anything other than the most severe and dangerous defects. This means that many conductive defects go undetected. Furthermore, bright sunlight will interfere with IR testing technology. This could cause a seriously defective insulator to go undetected.

The E-field sensing technology used Positron Insulator Testers succeeds when all these other technologies fail. Positron’s electric field detection device ensures 100% reliability in detecting all conductive faults. Since the electric field is always affected around a conductive defect, visible or not, these defects would always be detected. All faults, including early stage faults, are detected and recorded. Failures can be predicted and maintenance can be scheduled without unexpected disruptive power outages or dangerous conditions.

Summary of Comparisons between UV, IR, ACOUSTIC & Electric Field Detection Methods

UV detection is based on the Ultra-Violet radiation produced by **corona discharges**. It is a fast method but can only detect very severe dangerous defects, often too late. These are costly devices.

Disadvantages of UV Testers

On all types of Insulators:

- There are many types of defects in insulators. Many severe defects do not generate a corona.
- In absence of corona activity, no corona discharge will be generated and the fault will not be detected by UV.
- UV detection cannot detect small defects in insulators and so failures cannot be predicted.
- Even in the presence of some corona, defects not located in the viewing angle of the UV camera are not always visible and may not be detected.

Porcelain Insulators:

- UV cannot be used for the detection of punctured or leaking porcelain insulators in a string. A leaking or punctured porcelain insulator doesn't generate corona activity and so such faults will not be detected.
- A leaking current inside a porcelain disc will reduce its voltage and consequently will not produce any corona discharge. In absence of corona activity, no UV will be generated and the fault will not be detected.
- UV cannot be used as a method to detect faults in porcelain insulator strings except in very extreme and dangerous circumstances (example, all insulators failed in a string of 12 insulators except 2). There is often no warning of a major failure and power outage.

Composite Insulators:

- As per CIGRE*, UV & IR camera technologies are not useful or capable of detecting floating conductive defects less than 20 to 30% of the insulator length. This is not an "early fault detection" device.
- A defect greater that 25% of a composite insulator's length is extremely dangerous. Fallen lines and power outages may occur at any time.

  ***CIGRE** is an International Council on Large Electric Systems and is a global organization in the field of high voltage electricity. **CIGRE** and its members communicate the state of the art and the technical knowledge among those involved in the production, transmission and distribution of electrical energy by means of publications and conferences.

IR DETECTION METHOD

IR Detection: This method is based on temperature detection.

Disadvantages

- This method has similar disadvantages as the UV method.
- Porcelain insulators do not generate heat when they are leaking or punctured so the IR method is not recommended..
- Composite insulators do not generate enough heat for small and floating defects and so such defects cannot be found by IR. Only severe and dangerous defects can be detected.
- Detection can be compromised in bright sunlight.

ACOUSTIC DETECTION METHOD

ACOUSTIC Detection: This method is based on the acoustic reception of ultra sound generated by corona discharges.

Disadvantages

- Porcelain insulators do not generate coronas when defective so this method cannot be used.
- Composite insulators only generate a corona for the large dangerous defects.
- Surrounding noise and wind make this method very unreliable.
- This method also lacks location accuracy.

ELECTRIC FIELD DETECTION METHOD

Electric Field detection: Any conductive defect in an energized insulator changes the electric field around the insulator in the vicinity of the defect. This is a basic law of physics. It is impossible to miss this defect using a sensitive electric field detector.

Positron Insulator Testers:

- Positron's electric field detection device ensures 100% reliability in detecting all conductive faults.
- Since the electric field is always affected around a conductive defect, visible or not, these defects would always be detected.
- All faults including early stage faults are detected and recorded.
- Failures can be predicted and maintenance can be scheduled without unexpected disruptive power outages or dangerous conditions.