
Positron Universal Substation Insulator Tester

With Instant Graphical Capability

Model # 3782652U/50 & 3782652U/60

User Manual

Description and Operation Guide



Disclaimer Notice: Although Positron Inc. has made every effort to ensure the accuracy of the information contained herein, this document is subject to change.



CAUTION

IMPORTANT SAFETY NOTICE

This instrument is intended to be used in high voltage environments.

It should be used ONLY by personnel trained to work in those environments.

Although this instrument does not make electrical contact with the high voltages,

IT IS ESSENTIAL THAT THIS INSTRUMENT IS USED COUPLED WITH A SUITABLE

HIGH DIELECTRIC STRENGTH HOT STICK THAT HAS A VOLTAGE RATING

EQUIVALENT TO OR GREATER THAN THE VOLTAGE ON THE DEVICES OR LINES

BEING TESTED.

NOTE To be used on AC lines only

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Chapter 1

General Information

1.0 General Information

1.1 Publication Information

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Positron Universal Substation Insulator Tester

Description and Operation Guide

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The Insulator Testers are manufactured by Positron Inc. in Montreal, Canada. The Positron Insulator Testers is protected by US patents including “METHOD AND APPARATUS FOR THE VERIFICATION OF AN ELECTRICAL INSULATOR DEVICE BASED ON THE ANALYSIS OF THE ELECTRICAL FIELD ALONG THE INSULATOR”.

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- 2) shall use same for operating and maintenance purposes only.

1.2 About this Guide

This guide introduces and describes the operation of Positron’s Universal Substation Insulator Tester for Live Line AC high voltage testing of energized bushings at power stations. The Universal Substation Insulator Tester is used as a maintenance and safety tool to test and report conductive defects and their severity in Porcelain and Composite (Polymeric) bushings of apparatuses at power stations.

1.3 How to use this Guide

This guide is designed to describe the operational modes of the Universal Substation Insulator Testers.

The reader is invited to use the digital (PDF) version of this document to allow searching by keywords. Select **Edit**, then **Find** from the pull-down menu, or select **Ctrl+F** to access the **Find** menu.

1.4 List of Associated References

- [1] "Suspension Insulator Puncture Tester"; Report No. ELE 92-62; Bonneville Power Administration Division of Laboratories; December 7, 1992.
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- [6] G. H. Vaillancourt, P. Bilodeau, "Diagnostic Testing of Composite Insulators Used on Series Compensation Platforms in Hydro-Quebec," Conference Proceedings of 11th International Symposium on High Voltage Engineering, London, England, August 22-27, 1999.
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- [11] I. Gutman (SE), A. Pigni (IT) et al. "Assessment of Composite Insulators by means of Online Diagnosis", CIGRE WG B2.21 2013.
- [12] C. Jean, "High Voltage Insulator Testing based on Electric Field method" 2015 INMR World Congress Conference, Munich, Germany, September 2015.

Chapter 2

Overview

2.0 Overview: Universal Substation Insulator Tester with Ski-Guides

Model # 3782652U/50: Universal Substation Insulator Tester with Ski-Guides, 50Hz

Model # 3782652U/60: Universal Substation Insulator Tester with Ski-Guides, 60Hz

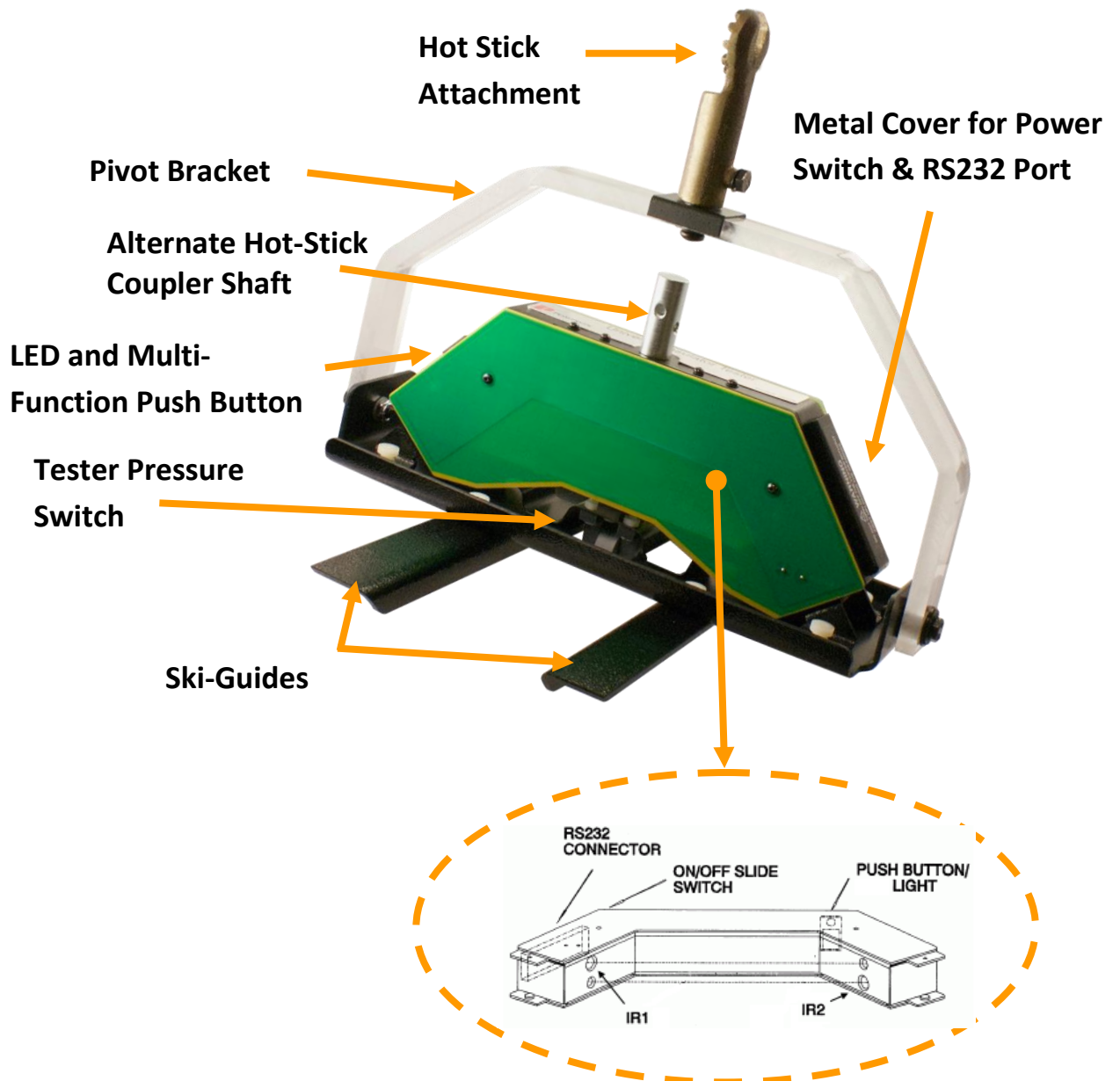


Figure 1: Universal Substation Insulator Tester (S-Tester) with Ski-Guides

2.1 General

The document describes Positron's Universal Substation Insulator Tester equipped with Ski-Guides.

With the Universal Substation Insulator Tester field Probe mounted on an adjustable Ski-Guide platform, the user attaches a non-conductive high dielectric strength hot-stick to the coupling of the Probe's pivot bracket. Readings are taken by sliding the Probe along the bushings of Power Station apparatus as the Ski-Guides maintain the correct orientation and position on the insulator.

2.2 General Methodology

In this document, the term "insulator" is used to also represent all types of insulators commonly used in substations, including insulating bushings, lightning arrestors, posts, suspension and dead-end insulators, etc.

When Power Station high-voltage apparatus insulating bushings fail, there can be substantial destruction at the Power Station. For example, replacement transformers are expensive and may need to be custom-built and may have a long lead time. This can keep the high-voltage line of service for a protracted period of time.

Voltage transformers, current transformers, circuit breakers, lightning arrestors, coupling capacitors, insulator posts, and cable terminations are examples of Power Station apparatus that require high-voltage insulating bushings that should be routinely tested for defects that can cause a failure. For suspension and dead-end insulators of voltages greater than 100kV, the Positron Porcelain Tester and the Positron Composite Tester are recommended.

Early diagnosis of a conductive defect of a high-voltage insulating bushing may be due to physical damage, internal defect, and moisture infiltration or due to surface contamination enables action to be taken to prevent catastrophic failure.

The Universal Substation Insulator Tester is a unique instrument that senses the strength of the Electric Field surrounding the insulating bushing, processes the data in its microprocessor, and plots a curve of the E-Field on a reference graph. Deviations in the electric field are caused by conductive defects in the bushings and are shown by deviations in the resulting curves of the Electric Field.

The methodology of using this instrument is:

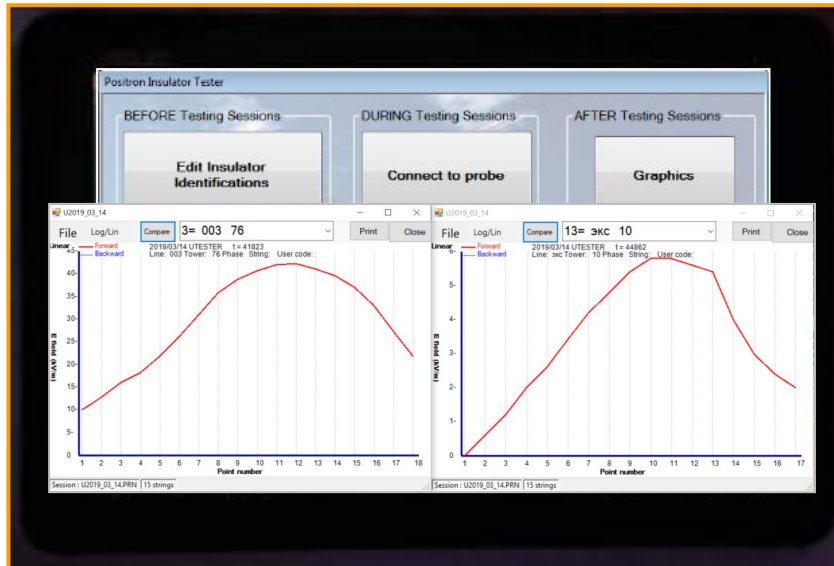
- Establish a baseline comparative reference for known good insulating bushings by sliding the Universal Substation Insulator Tester along the insulating bushings of each phase of a Power Station apparatus. Note: Each type and manufacturer of bushing has its own signature curve. Since there are many types of bushings found in a power station, it is necessary to record a typical signature curve for each type of bushing.
- The resulting graphs of each of the 3 phases of the E-field of the apparatus bushing would represent an E-Field signature that is typical of a good insulating bushing for that particular type and brand of Power Station apparatus. A typical signature curve is the same for each of the bushings of the three phases of a piece of equipment. If the signature of one phase is different than the other two phases, then that bushing has a conductive defect and should not be considered as “good”.
- Retain the E-Field graph of a known good Power Station apparatus insulating bushing in a Reference Folder created using the Windows-based Insulator Tester software.
- The Reference Folder should include graphs for each type and brand of Power Station insulating bushing.
- Using a Comparative Methodology, if one of the insulating bushings shows an E-Field signature different than the other two phases, that insulating bushing is deteriorating towards failure and planned action can be taken before a destructive failure occurs.
- All three graphs of the three phases associated with the Power Station apparatus can be compared simultaneously either side by side or superimposed on each other on the screen of the Tablet or PC for analysis.

A spring-loaded Insulator Roller Wheel (trigger switch) is located in the center of the Ski-Guide assembly. Readings are taken as the spring loaded Insulator Roller Wheel travels over the ridges (or discs) of porcelain or polymeric composite skirts of insulating bushings.

Each time the Probe’s Trigger Switch is activated, a reading is taken and the electric field surrounding the insulating bushing is recorded. Defective bushings are easily identified as the internal microprocessor processes the data and produces the resulting data graphs which can be compared against the stored baseline reference curves.

After an insulating bushing is scanned, the Probe’s data is downloaded via a Bluetooth communication link (range 100 meters) to the Tablet/Laptop for on-site analysis. Any conductive defect in an insulating bushing will cause a change in the electric field surrounding the apparatus which will be shown in the displayed signature curve,.

The Electric field is measured by the Probe. The data is processed and immediately downloaded to a database on the Tablet for analysis. The graph displaying the E-Field of the insulating bushing is clearly displayed on the Tablet/Laptop while in the field or, if the utility prefers to retain the data in the probe for later download to PC when back at the office.



Tablet with Windows-based Insulator Tester Software displaying two graphs for comparative analysis

2.3 Data Format

The data is stored in ASCII format which is compatible with any text editor, including Excel spreadsheet and Microsoft NOTEPAD. The ASCII data can be imported into existing customer databases.

NOTE



- Verify the Date and Time settings of the Tablet/Laptop before performing a testing session.
- It is important to disable the WIFI of the Tablet/Laptop to avoid long operating system updates and range reduction of the Bluetooth link while performing testing sessions.

2.4 Universal Substation Insulator Tester Model Numbers

For ordering information, contact Positron Customer Support:

North America: 1-888-577-5254, Option 9, Option 1.

International: 001-514-345-2220, Option 9, Option 1

Testers and Model Numbers

Item Description	Model Number
Universal Substation Insulator Tester with Ski-Guides, 60 Hz	3782652U/60
Universal Substation Insulator Tester with Ski-Guides, 50 Hz	3782652U/50
220Vac/120Vac charger replacement	378126
Rechargeable battery pack replacement for the Probe	378127
12Vdc auxiliary automotive power charger replacement	378128
Replacement Ski Guide Assembly	378129
RS232 Bluetooth adapter replacement	378325/3
Replacement cover plate for Probe power switch	378613
Replacement Screws Kit including Screw Driver	241W000177-401



Chapter 3

Universal Substation Insulator Tester Elements

3.0 Description of Universal Substation Insulator Tester Kit

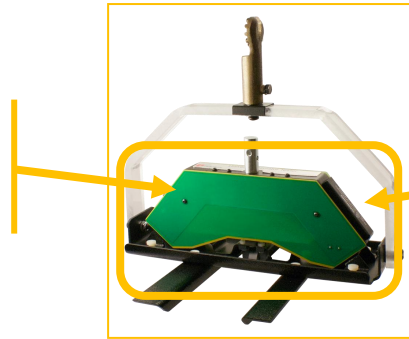
3.1 The Universal Substation Insulator Tester Kit

The Universal Substation Insulator Tester kit consists of:

- Spare switch cover
- A Quick Start Guide
- A rugged carrying case
- A Ski Guide Assembly
- A Pressure-Switch Actuator Assembly
- Two insulator bumpers (large and small)
- A 12Vdc auxiliary automotive power charger
- A USB key loaded with the Insulator Tester user manual and PC software installer
- A Universal Substation Insulator Tester Electric Field Probe
- User manual in print and stored electronically on the Tablet/Laptop
- A long-range (100m / 328 ft) Bluetooth (RS232) Serial Adapter, pre-paired with the Tablet/Laptop
- A Tablet/Laptop with Insulator Tester Data Processing Software installed
- Replacement screws and screw driver
- Plug-in wall transformer: 120Vac/220Vac input, 12Vdc output (includes international wall-plug adaptors)

The **Operator Interface** (see Figure 2) consists of:

- A push-button
- A Status LED
- An internal buzzer



- RS 232 Port for Bluetooth transmitter
- On / OFF Power Switch
- Cover for Power Switch

Figure 2

The E-field Probe uses two infrared detectors to detect the position of the each bell or shed of the bushing via the trigger or pressure switch. The Probe's microprocessor matches the electric field strength to the position along the bushing on the displayed graph.

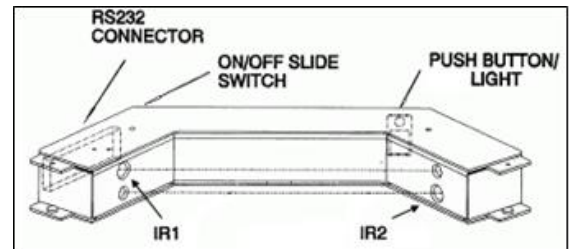


Figure 3

CAUTION



Please refer to Figure 3. The two infrared detectors are identified as IR1 and IR2.

The RS232 connector port is used to recharge the Probe's internal battery and to connect a Bluetooth adapter for data transfer.

The ON / OFF Power Switch is located near the RS232 connector and is used to switch the power ON or OFF. See Figure 4. Set the switch towards the RS232 connector to turn the unit on.

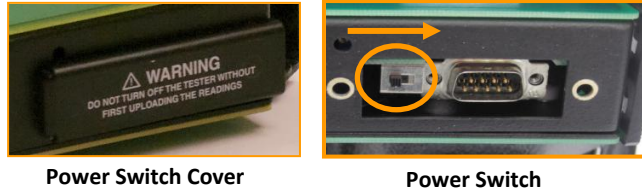


Figure 4



DO NOT SWITCH THE POWER SWITCH OFF BEFORE DOWNLOADING THE DATA.

When the power is switched off the accumulated data is lost. Once a testing session is completed and the data has been downloaded, slide the switch away (left) from the RS232 connector to switch the unit off.

3.2 Probe Charger

The Probe’s battery is recharged using a 120Vac/220Vac universal wall charger connected to a cable with a DB-9, RS232 female connector to connect to the Probe. A set of AC charger adaptors is provided to accommodate various country standards. For charging the Probe in the field, a 12Vdc auxiliary automotive charger cable terminated in a DB-9 connector is supplied to recharge the battery from a car or truck.

Both the AC power charger and the automotive DC charger are equipped with an LED status to report on when the battery is charged. When first plugged in to charge, the LED will glow red. After 9 hours on charge, the LED will glow green, indicating that the charging time is completed.

The battery should be recharged overnight the day before a testing session. The battery charge will last one day if the power switch is left in the ON position.

The battery can be recharged with the power switch in the ON or OFF position, however the Probe will charge faster when the power is switched off.

CAUTION



The data accumulated by the Probe must be transferred via Bluetooth to a Tablet/Laptop prior to switching the Probe off or the data will be lost.

3.3 Universal Substation Insulator Tester Hot Stick Attachments

The Universal Substation Insulator Tester Probe has an integrated hot-stick coupler on the connecting bracket of the Ski-Guide assembly. Additionally, in the field Probe kit there is a universal adaptor joint that enables total flexibility for positioning the field Probe's Ski-Guide against the insulator. See Figures 5.

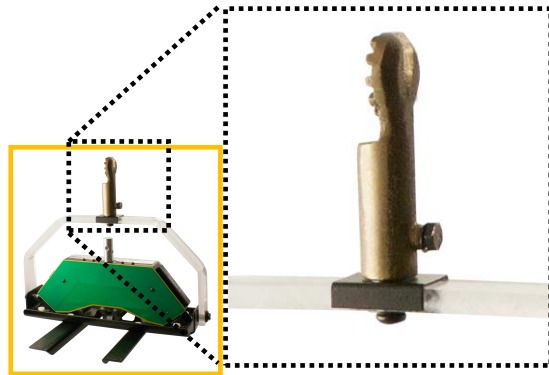


Figure 5

3.4 Universal Substation Insulator Tester Ski-Guides

The Universal Substation Insulator Tester is shipped complete with the Ski Guide assembly attached. See Figures 6.

The adjustable Ski-Guides enable the user to slide the Universal Substation Insulator Tester along polymeric or porcelain Power Station insulating bushings. There are mounting holes in the platform to attach the skis and to adjust the distance between the skis.

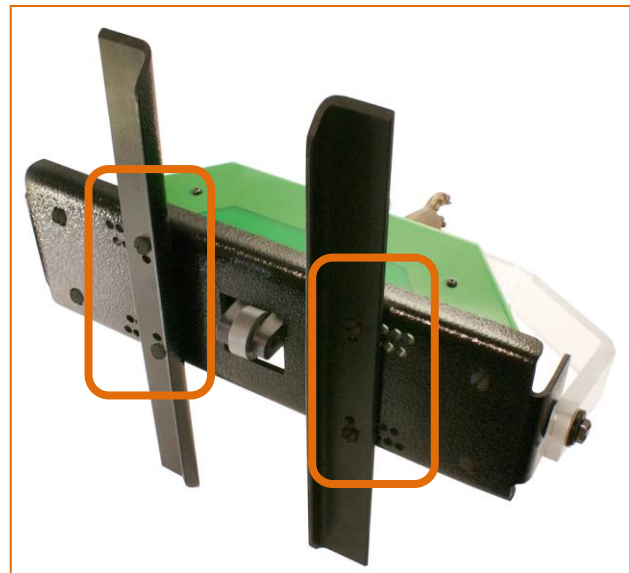
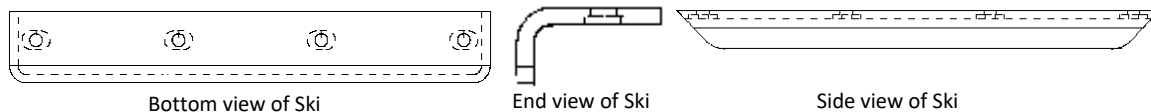


Figure 6

There are two sets of skis provided with the kit. See Figure 7.

- First set of adjustable skis is 22cm long
- Second set of adjustable skis is 34cm long



Ski for Universal Substation Insulator Tester

Figure 7

3.4.1 Pressure Switch Actuator Attachment



For small diameter insulators that are too small to be accommodated by the Ski Guides, a separate kit is provided. This typically occurs on low voltage insulators of 100 kV or lower.

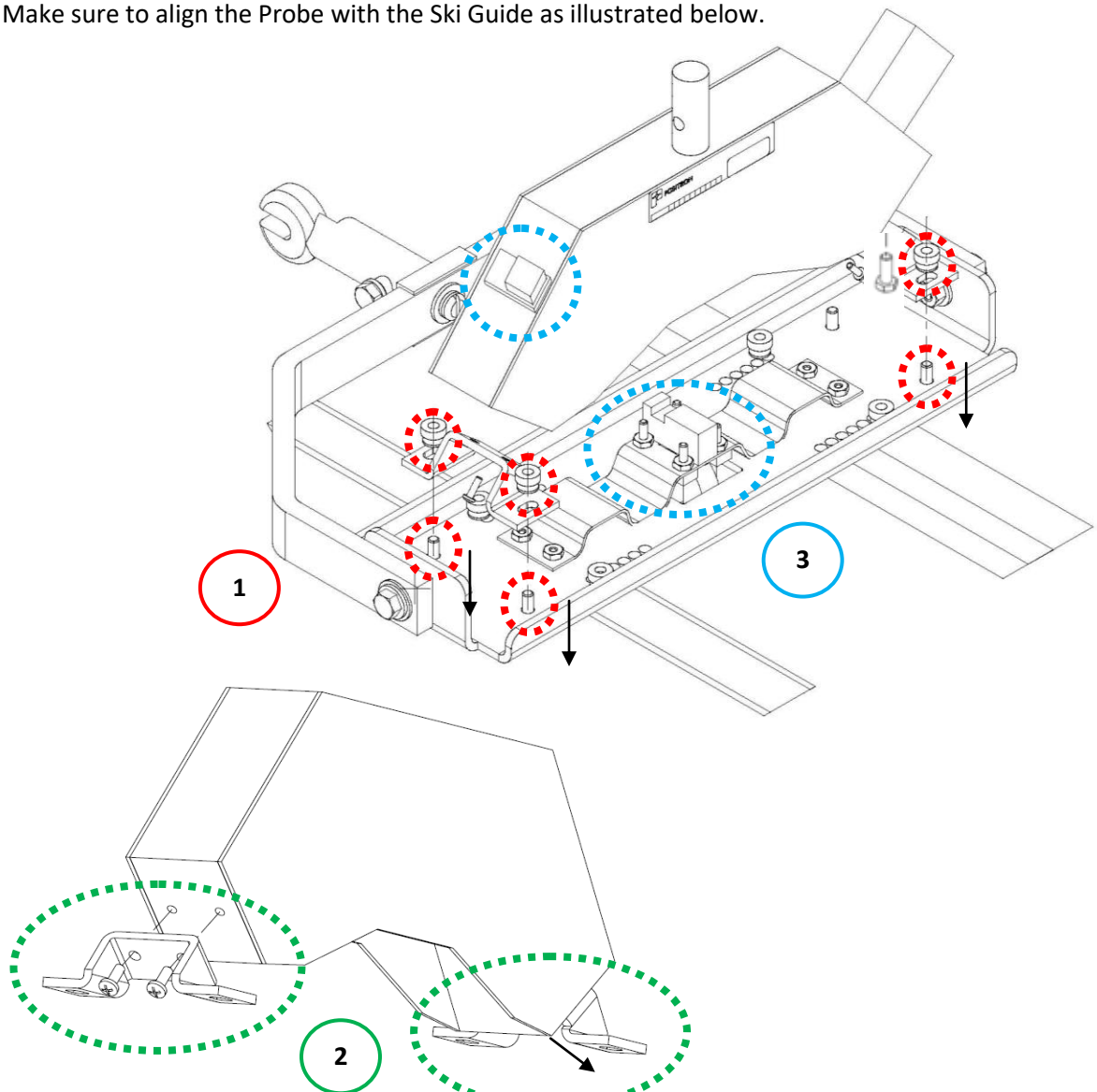
The Universal Substation Insulator Tester kit is equipped with an attachable Pressure Switch Actuator Assembly. The Ski Guide Assembly can quickly be changed for the Pressure Switch Actuator Assembly. A convertible Slotted and Philips-head screw driver is provided in the kit to make this change. See Figure 8

From Ski Guide Assembly to Pressure Switch Assembly mode:

1. Remove the four (4) thumb screws that hold the Ski Guide Assembly to the Probe
2. Remove the two mounting brackets from the Probe by removing the four (4) screws that attach the mounting brackets to the Probe. Ensure that the two (2) mounting brackets removed are kept with the Ski Guide Assembly for re-attachment when needed.

From Pressure Switch Assembly back to Ski Guide Assembly mode:

3. Make sure to align the Probe with the Ski Guide as illustrated below.



Pressure-Switch Assembly mode:

4. Attach the Pressure Switch Actuator using the same four (4) screws removed during Step #2.

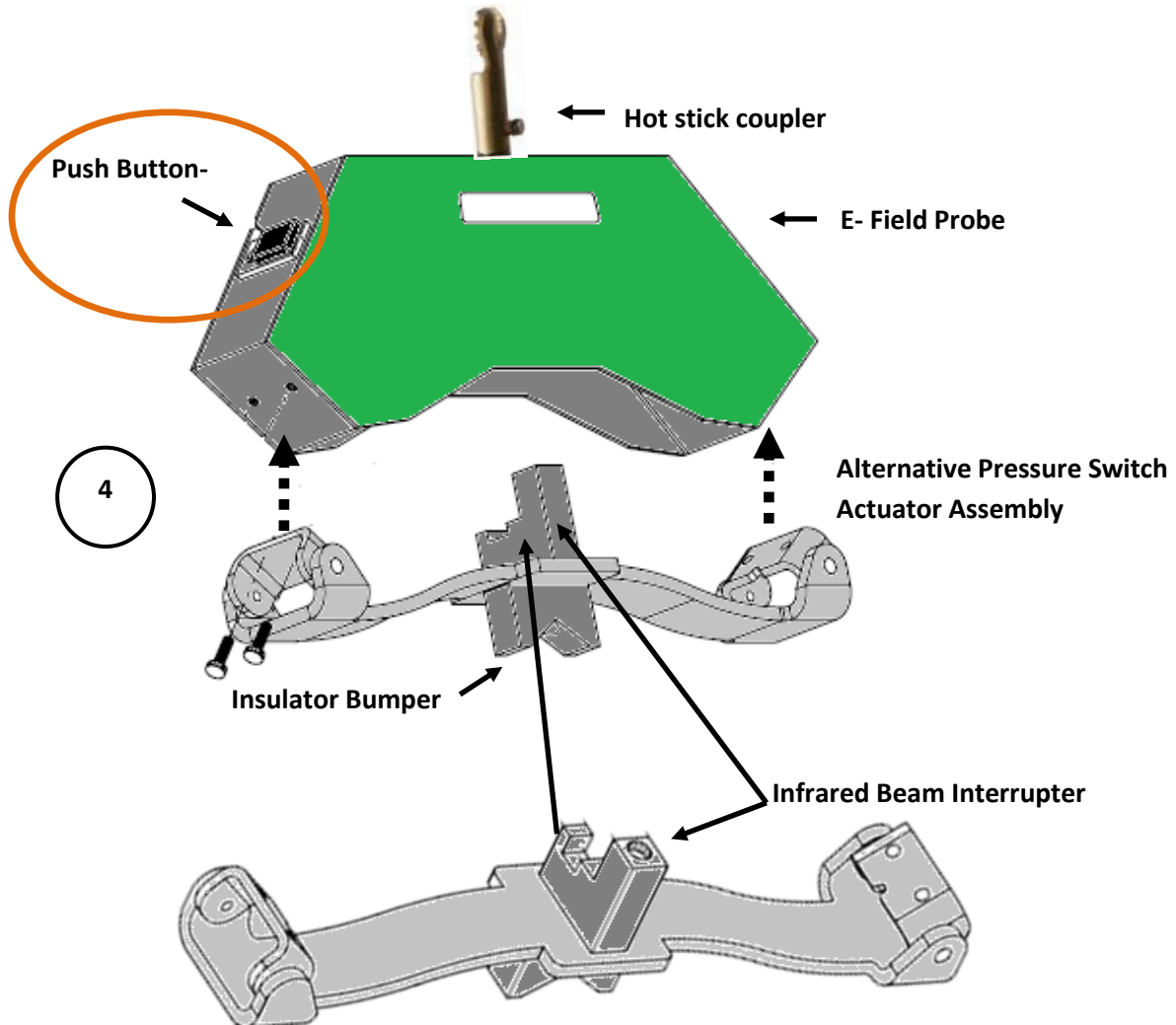


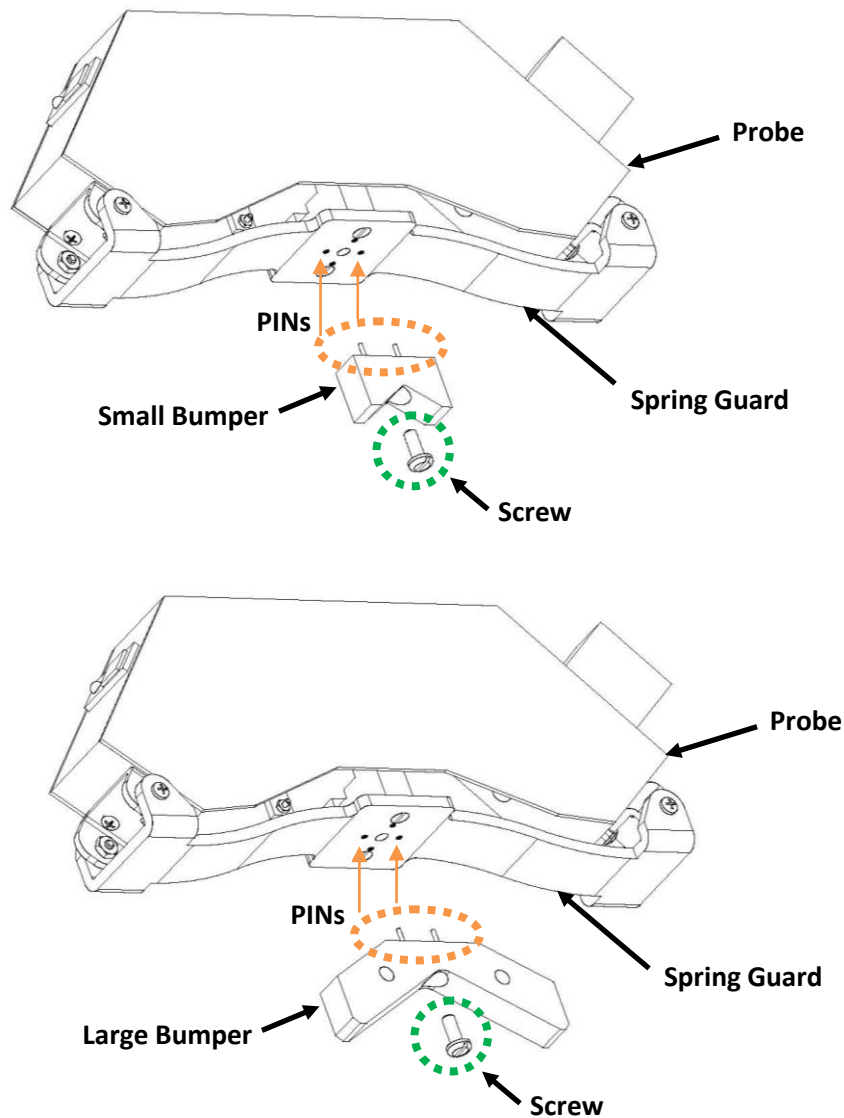
Figure 9

Alternative Pressure Switch Actuator Assembly

5. The Insulator Tester kit includes two insulator bumpers (large and small) fixed by a screw on the Pressure Switch Actuator. The large and small insulator bumpers can easily be interchanged, removed or rotated by 90°.
 - a. The **large bumper** is mainly used to test the lower voltage string of porcelain insulators. To test these strings containing 10 discs or less, apply a pressure under each discs on the pin (not the cap) to take a reading of the electrical field.
 - b. The **small bumper** is used for all other testing applications, including smaller bushing, arresters, cable termination, etc.

For larger apparatuses, the ski assembly should be used whenever possible.

To install or interchange the insulator bumper, remove the screw and separate the bumper from the spring guard by pulling on the bumper as shown below. Install the bumper parallel or at 90° to the probe aligning the PINs on the spring guard to ensure the best positioning and stability of the probe during the pressure on the insulator.



3.5 Tablet/Laptop

3.5.1 General

A Tablet/Laptop is provided with the Probe. The Tablet/Laptop is Bluetooth-enabled and is shipped paired with the Bluetooth transmitter of the Probe. Refer to Figure 10. The Insulator Tester Data Processing Software is factory pre-installed on the Tablet/Laptop.

The Tablet/Laptop is used on-site to receive the data from the Probe after each bushing is scanned to view the resulting graphs. The transfer of data to the Tablet enables the user to determine instantaneously the condition of the insulator and avoids the risk of data loss should the tester be inadvertently switched off before the data is downloaded.



Figure 10

3.5.2 Separating the Tablet While in the Field

When using the Tablet/Laptop in the field, it is best to separate the Tablet from its associated keyboard, as shown in Figure 11. The operating procedure in the field does not require the keyboard.

When attached, the keyboard is useful when creating insulator lists and preparing for the field visit.

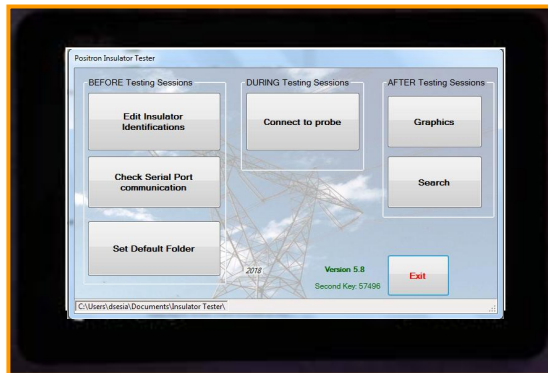


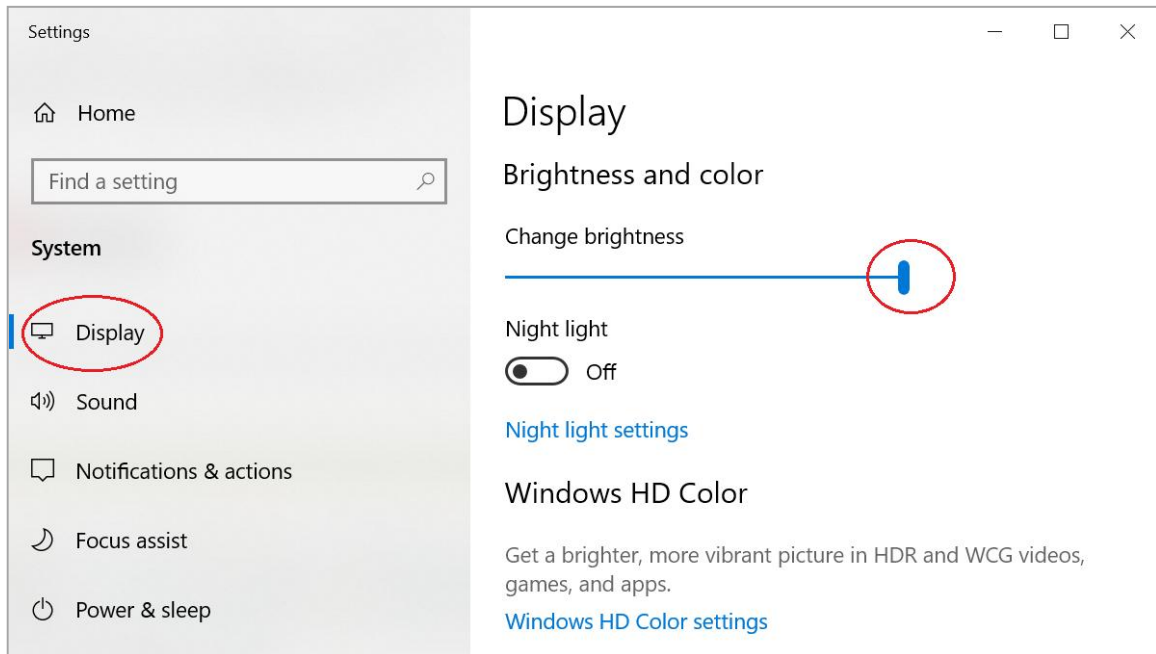
Figure 11

The Tablet has large *“Touch Screen Buttons”* which are used to operate the Windows-based Positron Insulator Tester Software in the field.

The person on the ground uses the Tablet while the Probe Operator scans the insulating bushing of an apparatus in the Power Station. When they have completed one or more tests of the bushing, they download the results immediately to the Tablet to identify/correlate the bushing and then see the profile of the E-field surrounding the bushing, thereby revealing its health, and determining immediately if a hazardous condition exists.

The intensity of the Tablet’s screen display is factory adjusted to its maximum setting. If this setting was changed by a user, it is important to adjust the intensity of the screen back to the maximum.

Access **Display** through the tablet/laptop's **Settings**. Slide the adjust bar to the far right for maximum brightness.



The use of polarized sunglasses may make it difficult to see the display on the Tablet screen in Landscape mode (long edge of the Tablet screen is horizontal).

In this situation, rotate the Tablet 90° to switch to Portrait mode (short edge of the Tablet screen is horizontal). Otherwise, avoid the use of polarized sunglasses during use of the Tablet.

Chapter 4

Windows Based Software

4.0 Windows-based Insulator Tester Software

The Positron Insulator Tester Software is factory-installed on the Tablet/Laptop shipped with the Universal Substation Insulator Tester. Similarly, the RS232 Bluetooth adapter has been factory-paired with the Tablet/Laptop shipped.

4.1 Insulator Tester Software Description

The Tablet/Laptop is Windows based and has the Positron Insulator Tester Software pre-installed. All data formats are backward compatible. The long range Bluetooth Class I device enables on-the-spot remote downloading.

The Windows-based Insulator Tester Software is used:

- A) **BEFORE** the testing session:
- To set a different working folder
 - To create and store one or more lists of Power Station apparatus' identifications used to identify in the field each Power Station apparatus prior to generating a graph of the insulating bushing's E-field
 - To test the Bluetooth communication between the Tablet and the Probe
- B) **DURING** the testing session
- To remotely download the data scanned by the insulator tester
 - To identify last scanned Power Station apparatus from the list
 - To display the graphic representation of the E-field along with the identification of the apparatus
 - To make on-site **GO/NOGO** decisions based on the severity of the defects detected
 - To retain or discard the immediate results of a downloaded insulator test
 - To signal the Tester Operator
 - To put the Probe in sleep mode or power OFF after the testing of all the phases of an apparatus.
- C) **AFTER** the testing session
- To use as a reference database to evaluate apparatus degradation over time
 - To display the relative health of bushings using graph of the E-field along an insulator during live-line conditions
 - To use as a tool in the asset management associated with all manner of HV insulators, station hollow posts, bushings, lightning arrestors, etc, of both Porcelain and Polymeric Composite varieties

The Insulator Tester Software has been pre-installed on the Tablet/Laptop supplied with the unit. The icon for the Insulator Tester Software appears on the main-touch screen.



4.2 The Bluetooth Serial Adaptor

The long-range (100m) Bluetooth serial adaptor is powered by the Probe Module and has been paired with the Tablet/Laptop supplied with the Universal Substation Insulator Tester.

4.3 Instant Graphical GO/NO-GO Reporting Capability

The Positron Universal Substation Insulator Tester allows an on-site **GO/NOGO** decision-making capability. A scan can be instantly downloaded to the Tablet/Laptop from the Probe and this data is used to get a graphic representation of the E-field distribution of a Power Station apparatus bushing which shows all conductive defects. A decision for replacement or establishing safety levels for live-line work can then be made.

During the scanning of an insulating bushing, the Tester Operator manipulates the Universal Substation Insulator Tester with a hot stick, while the Tablet Operator is stationed at ground level and uses the Tablet/Laptop. Once the scan is done, the Tablet Operator can immediately download the data to identify the bushing and the apparatus and to get the graphic representation of the distribution of the E-field of the bushing or insulator.

Once the Tablet Operator, located at ground level, has downloaded the data from the Probe and has viewed the graph of the E-field, the Tablet Operator can choose to **Accept** or **Reject** the scan using the Windows-based Insulator Tester software interface installed on the Tablet/Laptop. In either case, the data in the Probe recorded during the scan will be deleted after the data is successfully downloaded to the Tablet/Laptop.

The Universal Substation Insulator Tester provides a graphical signature of the E-field of a Power Station apparatus which can be compared with adjacent phases. Deviation from a reference signature is an indication of a defect.

Chapter 5

Using the Universal Substation Insulator Tester & Software Interactively

5.0 Using the Universal Substation Insulator Tester & Software Interactively

The Universal Substation Insulator Tester and Tablet/Laptop are used together in the field. The Tablet Operator is stationed at ground level and controls the Tablet and data acceptance. The Tablet Operator can determine the health of the bushing. The Tester Operator controls the Universal Substation Insulator Tester and performs the scans.

After a scan of a power station apparatus, the Tablet Operator can instantly download the resulting data obtained by the Tester Operator. Once downloaded, the Tablet Operator can view the E-field profile of the scanned apparatus bushing on the screen of the Tablet/Laptop and the relative health of the apparatus can instantly be assessed.

The Tablet Operator can choose to **Accept** or **Reject** the scan. In both cases, once a choice has been made by the Tablet Operator the data in the Probe is erased. If the choice is made to **Accept** the scan, the data is stored on the Tablet/Laptop.

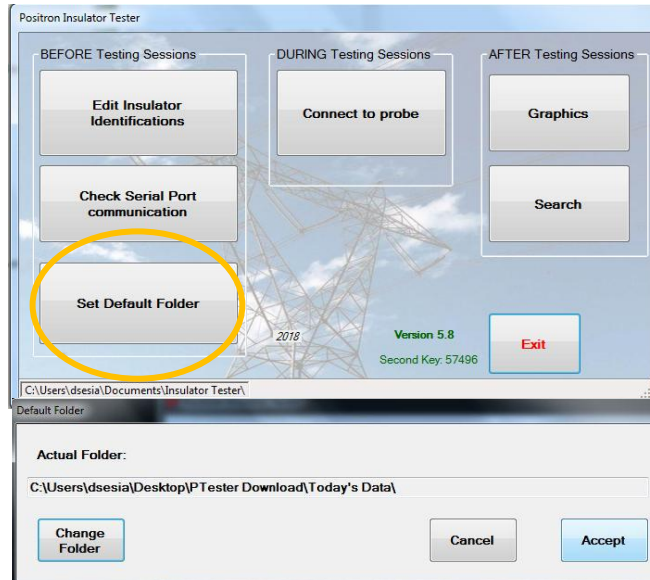
5.1 BEFORE Testing Sessions

If required, adjust the date and the time of the tablet and set the display intensity to maximum. Begin by double-clicking the Insulator Tester icon. Ensure that the Bluetooth feature is enabled on the Tablet/Laptop and the WIFI is turned OFF.



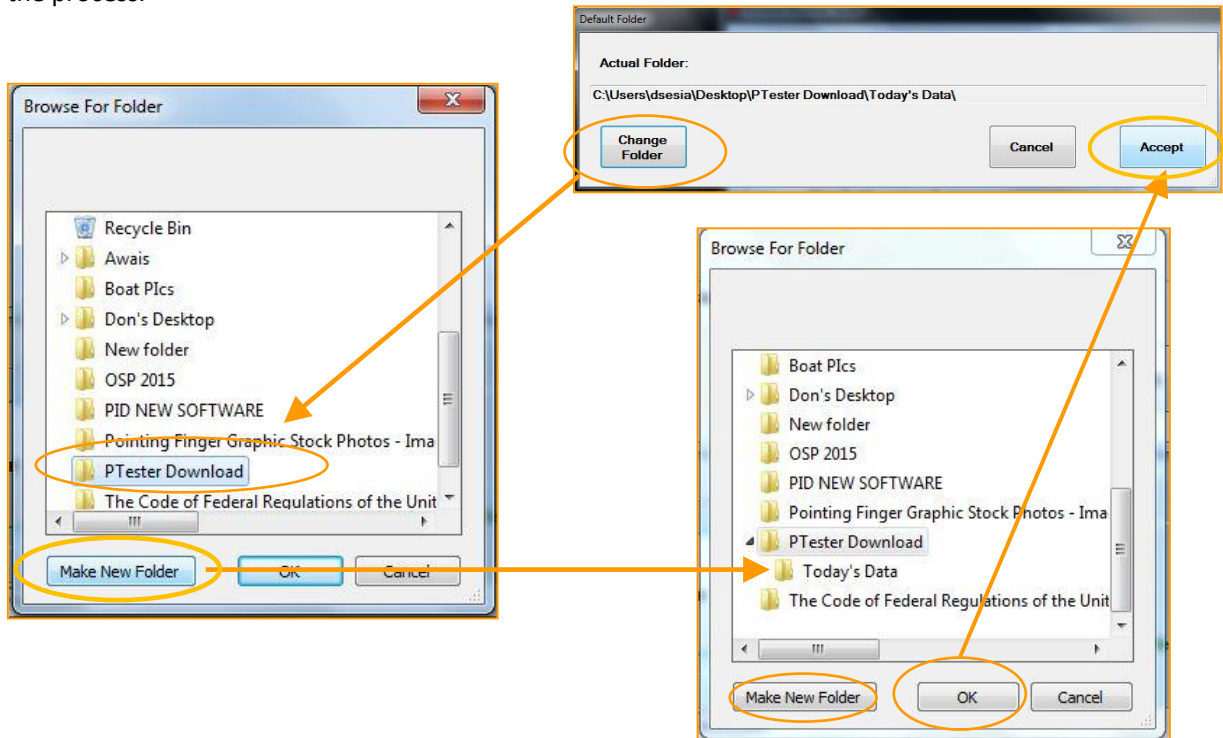
5.1.1 Select the Default Folder

First, set the Default folder where the data will be stored. From the screen, select **Set Default Folder**. A dialogue box will be returned showing you the default file location.



5.1.2 Changing the Folder

You can change the default location and folder name by selecting **Change Folder**. The **Change Folder** selection and Windows OS will guide you through the steps. Be sure to select **Accept** at the end of the process.



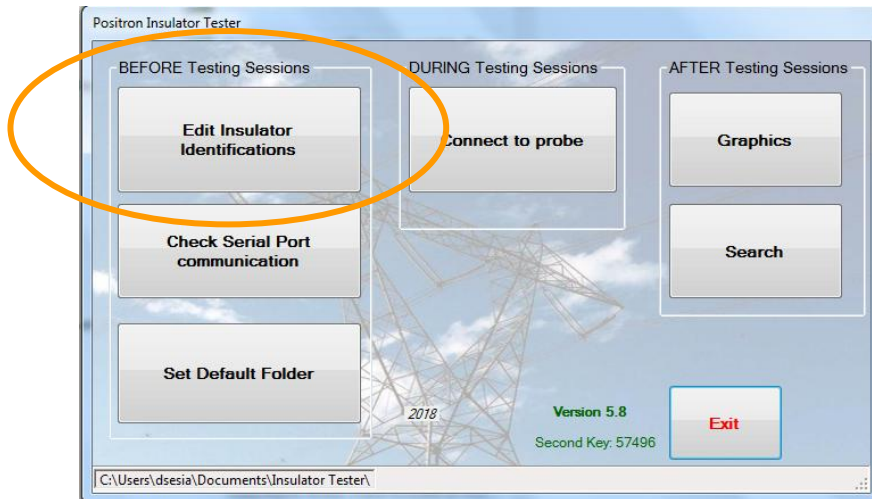
5.1.3 Create a List of Insulator Identifications

Create a listing of all insulators to be tested during an upcoming Testing session. This list will be used during a testing session to identify each insulator. This is best done with the Tablet engaged with the keyboard for ease of typing.

To create an Insulator Identification List, you have 3 choices:

- Select **Edit Insulator Identifications** and type in the list on the tablet PC
- Install the Positron Tester Software on any Windows based Desktop and type in the list. This part of the software is not copy protected; no Software Activation Key is required for this operation. The file created has the suffix “.ID”. This file can then be copied from the Desktop to the Tablet PC using the USB memory stick supplied with the equipment. Copy the file in the Folder selected in the previous section of the manual: “Changing the Folder”
- If the Power Utility has already a long list of Insulator Identifications in Excel or ASCII format, Positron can assist in the conversion to “.ID” format. Note: The “.ID” file can be edited using any ASCII editor such as Microsoft Notepad.

A dialogue window will open so you can open the **Default.id** file. This will be used to enter the information identifying the apparatus to be scanned.



The **Identification List Editor** will open. Edit a field by clicking into it and move to the next field using the **TAB** key on your keyboard. The **ENTER** key or the Duplicate button will bring you to the field immediately beneath.

With the list completed, select **Save and Close**.

Note that number shown in the upper-left corner of the **Identification List Editor** corresponds to the number of entries there are in the list.

Identification List Legend:

- the **Line** field refers to the transmission lines at the Power Station,

27	Line	Tower or Apparatus	Phase	Insulator	Code
	7010	0039	L	1	01
	7010	0039	L	2	01
	7010	0039	M	1	01
	7010	0039	M	2	01
	7010	0039	D	1	01
	7010	0039	D	2	01
	7010	0040	T	1	01
	7010	0040	M	2	01
	7010	0040	D	1	01
	7010	0041	A	1	01
	7010	0041	B	1	01
	7010	0041	C	1	01
	7010	0042	A	1	01
	7010	0042	A	2	01
	7010	0042	A	3	01
	7010	0042	A	4	01
	7010	0042	B	1	01

- The **Tower or Apparatus** field is used to identify the either a power transmission tower or an apparatus being tested at a substation using a user-generated four character alpha numeric code.

- The **Phase** field is used to identify the phase to which a particular bushing of the apparatus is connected to.

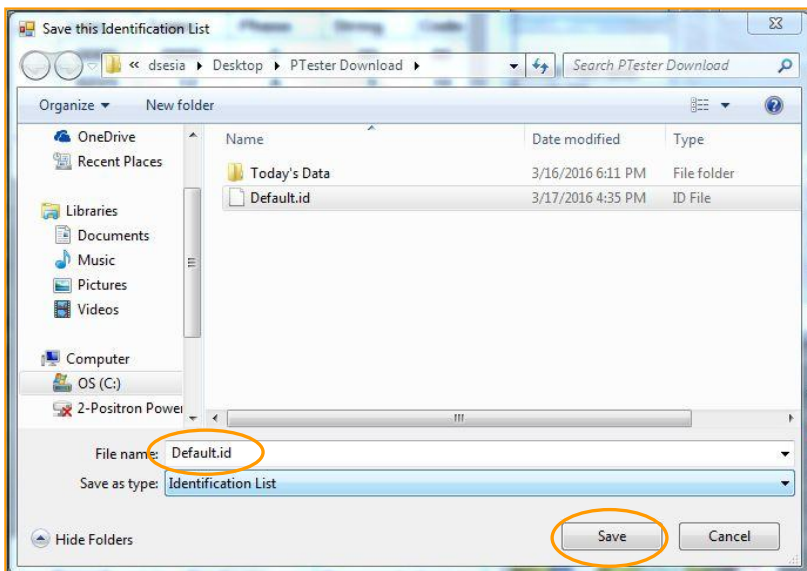
- The **Insulator** field is used to identify the bushing or other insulators being tested,

- The **Code** field can be used to insert any additional user defined code. This code is not used by the Search function.

27	Line	Tower or Apparatus	Phase	Insulator	Code
	7010	0039	L	1	01
	7010	0039	L	2	01
	7010	0039	M	1	01
	7010	0039	M	2	01
	7010	0039	D	1	01
	7010	0039	D	2	01
	7010	0040	T	1	01
	7010	0040	M	2	01
	7010	0040	D	1	01
	7010	0041	A	1	01
	7010	0041	B	1	01
	7010	0041	C	1	01
	7010	0042	A	1	01
	7010	0042	A	2	01
	7010	0042	A	3	01
	7010	0042	A	4	01
	7010	0042	B	1	01

This will open the **Save this Identification List** dialogue box.

Enter a name for your list, and click **Save**. The list is saved with a file suffix of **“.ID”**.



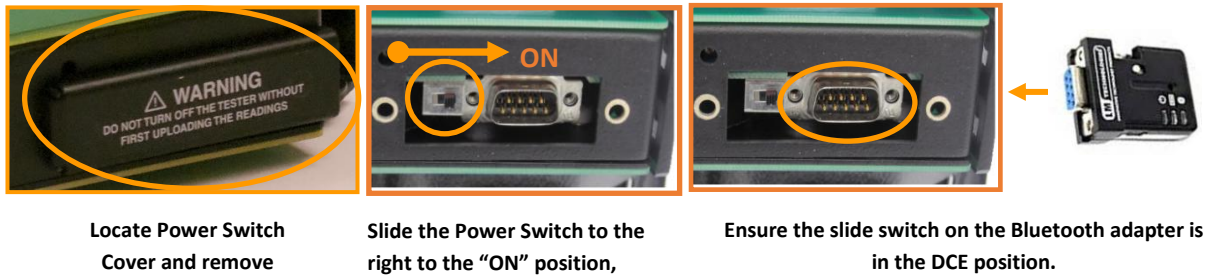
5.1.4 Verifying Communication Before a Testing Session

Before using the Universal Substation Insulator Tester, it is advised to test the Bluetooth communication between the Probe and the Tablet/Laptop. After communication has been established, the Probe and Bluetooth adaptor can be switched off until the test session.

5.1.5 Switching the Probe On

To switch on the Probe, remove the Power Switch Cover and move the power switch to the right, toward the DB-9 connector, as shown in Figure 12. The Probe will first enter the Power-On Self-Test (POST). See 5.1.5.1 for details.

Ensure the slide switch on the Bluetooth adapter is in the DCE position. Insert the long range Bluetooth Serial adapter into the DB-9 Serial port of the Insulator Tester Probe. The long range Bluetooth Serial adapter is powered by the battery of the Probe.



Locate Power Switch Cover and remove

Slide the Power Switch to the right to the "ON" position, toward the DB-9 connector

Ensure the slide switch on the Bluetooth adapter is in the DCE position.

Figure 12

5.1.5.1 Power-On Self-Test (POST) of the Probe

Upon switching the Probe on, the **POST** process commences and the infrared detectors are automatically verified.

The power-up sequence for the 3782652U/x Universal Substation Insulator Tester is described below:

1. Apply power by sliding the switch located on the side of the Probe, underneath the Switch Cover, toward the RS232 connector
2. The LED will flash **Amber** once
3. The LED will then flash **Green** four times
4. To fully check the 2 infrared beams (IR1, IR2), apply pressure on the Ski Assembly Roller-Wheel (See Figure 13) at the beginning of the long tone. This action will interrupt the IR beams.

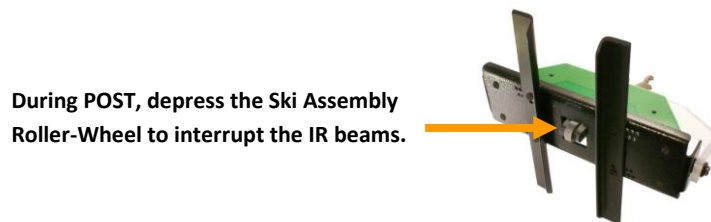


Figure 13

- If the **Red** LED begins flashing, then the Probe’s infrared sensors are being obstructed. Ensure that there are no obstructions and that the lenses are not dirty. The **Red** LED will stop flashing the moment the infrared beams are unobstructed.

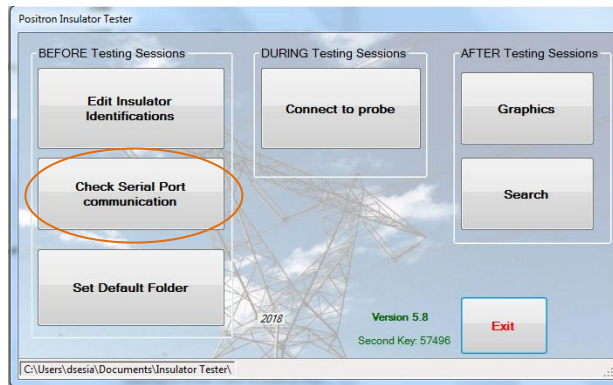
The LED will flash **Amber** 10 times and shut off during which the Infrared beams are partially tested.

Once the infrared (IR) beams have been temporarily blocked, or after flashing 10 times, the LED and the tone will shut off.

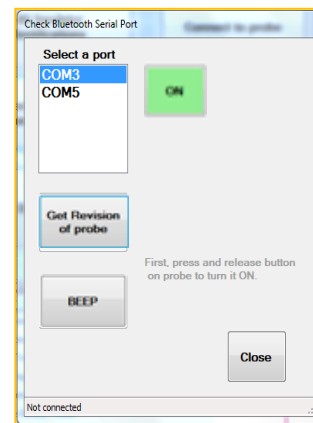
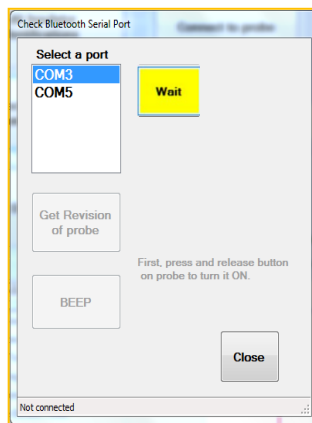
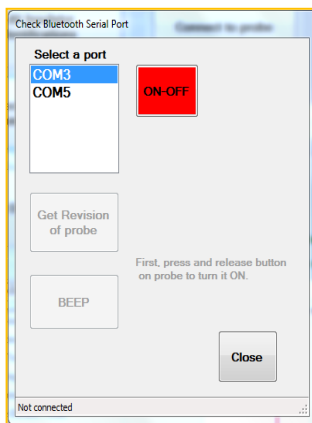
Once the Probe has been switched on and the **POST** procedure is finished, communications between the Probe and the Windows-based software on the Tablet/Laptop must be tested.

5.1.6 Check Bluetooth Serial Port Communication

Select the **Check Serial Port Communication** button to verify long range Bluetooth connectivity between the Tablet/Laptop and the Insulator Tester prior to going into the field.

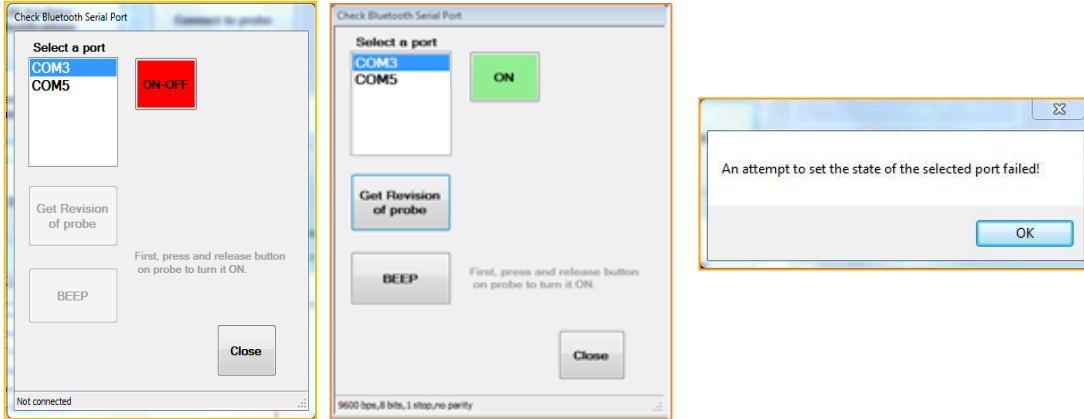


The **Check Bluetooth Serial Port** dialogue screen will appear. Select the COM Port used by the Tablet/Laptop to communicate with the Bluetooth adapter.



Select the RED **ON-OFF** button. The button will change to YELLOW and “Wait” will appear until Bluetooth communication is established, and then it will change to GREEN.

NOTE If the button does not change to **YELLOW** and read "Wait", but changes to **GREEN** immediately, try another port. If the button flashes **YELLOW** before **GREEN**, you have connected to the correct COM port. If the incorrect COM Port has been selected, an error message may be returned. If so, change the COM Port and retry.



These steps verify communication with the Tablet and the Probe's long range Bluetooth RS232 Adapter. Take note of the COM port associated with the long range Bluetooth Adapter. This COM port will need to be reconnected once the unit is taken to a Power Station for a scanning session.

It is important not to transport the Probe to the testing location with the long range Bluetooth Adapter inserted in the DB9 connector. This is to avoid possible physical damage during transport.

NOTE The buttons in the Insulator Tester Software change to **GREEN** once each software function receives an acknowledgment from the Probe. If a button in the Insulator Tester Software changes to **RED** after it has been **GREEN**, the Probe may be in sleep mode and the Push Button of the Probe must be pressed to bring the unit into Awake Mode.



5.1.7 Get (Software) Revision of the Probe

Select **Get Revision of the Probe** to receive the Probe's internal Firmware Revision level. Normally, this function is used by Positron Technical Support when troubleshooting the Probe. In this instance, the function is used as a confirmation that the Tablet/Laptop can communicate a command to the Probe and that the Probe will respond via the long range Bluetooth communication through the associated COM Port.

Once you have selected **Get Revision of the Probe**, communication between the Tablet and Probe is established. Ensure that the Probe is in **Awake Mode** by pressing the push button of the Insulator Tester Probe. If required, select **Get Revision of the Probe** after the Probe is awakened.

This step verifies that the Tablet/Laptop can communicate with the Probe. Once Bluetooth connectivity and functional communication are verified, first press the **Close** button to close the "Check Bluetooth Serial Port" dialog. Then the Power switch of the Probe can be switched OFF to save power. The Probe will be switched on again in the field when scanning is to begin. See Figure 14.

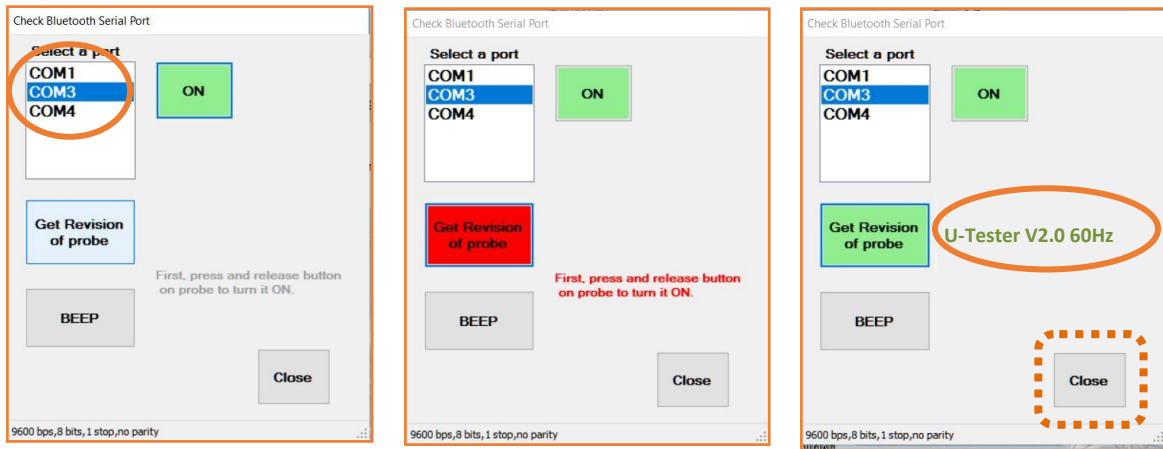


Figure 14



NOTE Before going out into the field for an insulator scanning session, ensure the Positron Insulator Tester and Tablet/Laptop are fully charged. The batteries of the Tablet/Laptop are best maintained for longer life by recharging before the battery charge depletes below 50%.

5.2 DURING Testing Sessions

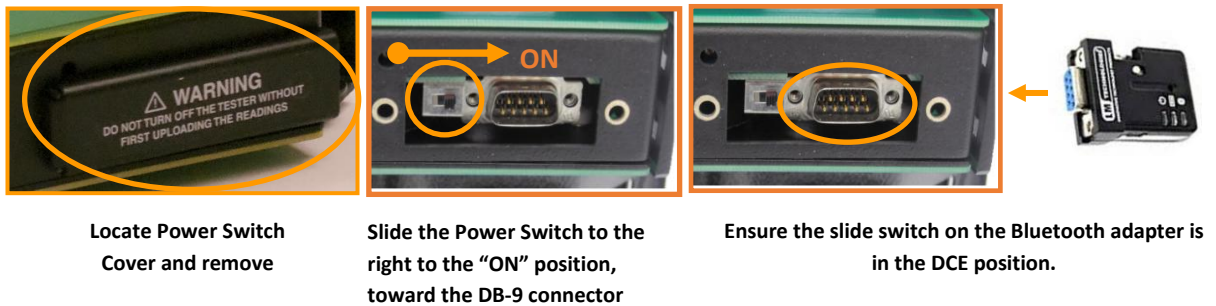
It is important to disable the WIFI of the Tablet/Laptop to avoid long operating system updates and range reduction of the Bluetooth communication link while performing a testing session.



Equipped with the Tablet separated from the keyboard, the Tablet Operator launches the Insulator Tester Software. Optionally, the camera of the Tablet/Laptop can be used take a picture of the tested Power Station apparatus.

To activate the Probe, remove the Power Switch Cover and move the power switch to the right, toward the DB-9 connector, as shown in Figure 15. The Probe will first enter the Power-On Self-Test (POST) as described in 5.1.5.1.

Ensure the slide switch on the Bluetooth adapter is in the DCE position. Insert the long range Bluetooth Serial adapter into the DB-9 Serial port of the Insulator Tester Probe. The long range Bluetooth Serial adapter is powered by the battery of the Probe.



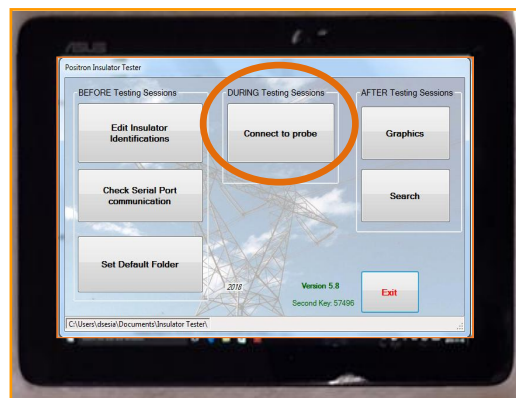
Locate Power Switch Cover and remove

Slide the Power Switch to the right to the "ON" position, toward the DB-9 connector

Ensure the slide switch on the Bluetooth adapter is in the DCE position.

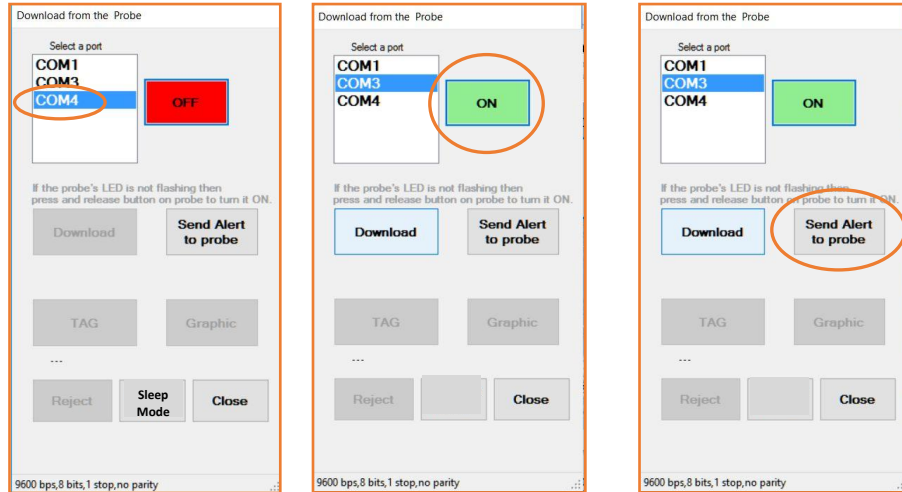
Figure 15

Before the probe is given to the Operator to test an apparatus, ensure that the Probe has been switched **ON**, select **Connect to Probe** and reconnect to the same COM port noted in the communications check performed prior to going out in the field for a scanning session.



Select the appropriate COM Port, and Select **ON**.

Use the **Send Alert to Probe** button in the field to check the communication link. The Probe will respond with an annunciating tone.



With communication confirmed, the Tester Operator can now prepare to make a test. Once in position, the Tester Operator should press the Probe's button to ensure it is in **Awake Mode**. If not, the Tablet Operator will be unable to signal the Probe. Ensure that the LED of the Probe is flashing GREEN.

After 4 minutes of no communication, the Insulator Tester will go into **Sleep** mode. The Tablet Operator can keep the Probe awake by sending a download request or by pressing the **Send Alert to Probe** button in the Windows based Insulator Tester Software interface.

5.2.1 Performing a Scan Using the Ski Guide Assembly

Once the Probe is securely fastened to the Ski Guide Assembly and hot stick, place the Universal Substation Insulator Tester with Ski-Guides onto one end of the insulating bushing of the apparatus to be tested.

Apply a slight pressure to maintain direct contact between the tester and the bushing as the tester glides along the bushing. This ensures that the Roller Wheel Pressure Switch triggers a reading of the E-field at each skirt (or shed) as the Probe travel along the bushing or insulator. Do not pause the Tester between skirts (sheds).

Only one pass from one end to the other end of the bushing is required to obtain an accurate graphic representation of the E-field surrounding the insulator.

NOTE



Although a scan can start from either end of a bushing to the other end, it is recommended to begin the scan from the uppermost (top) portion of the bushing and moving the Tester towards the lowermost (bottom) portion of the bushing. Working with gravity will make the manipulation of the hot stick easier.

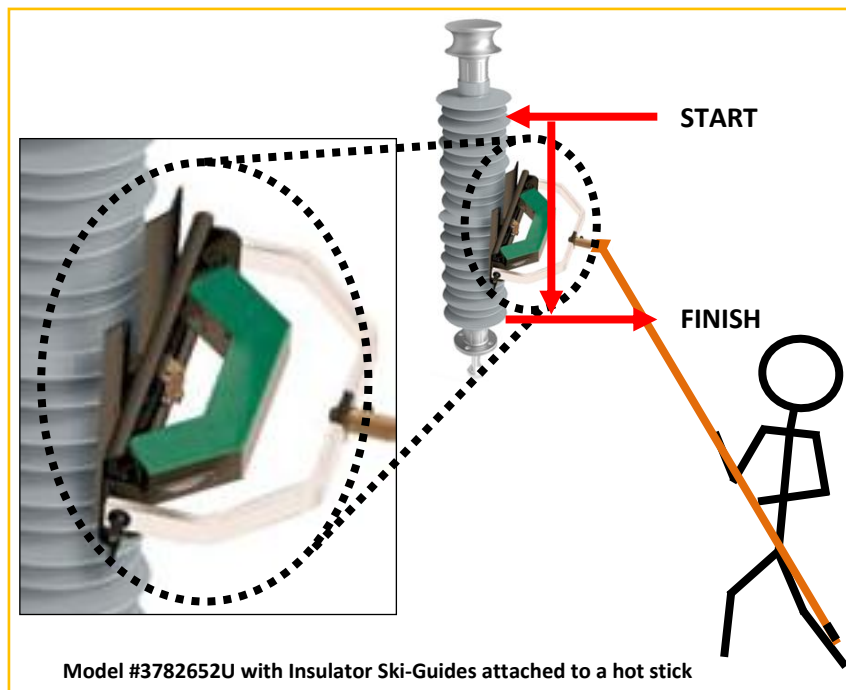
In the graphs generated by the Windows-based software, the solid red line is conventionally identified as *Forward*. A minimum of 5 points at which a measurement is made is recommended to generate a good graph.


Once a scan has been performed, the operator presses the “Download” button on the touch screen of the Tablet/PC and the E-Field profile of the insulator scan can instantly be viewed.

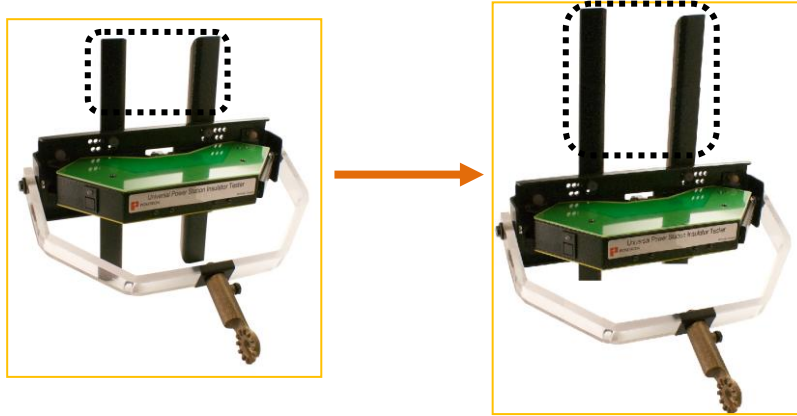
NOTE




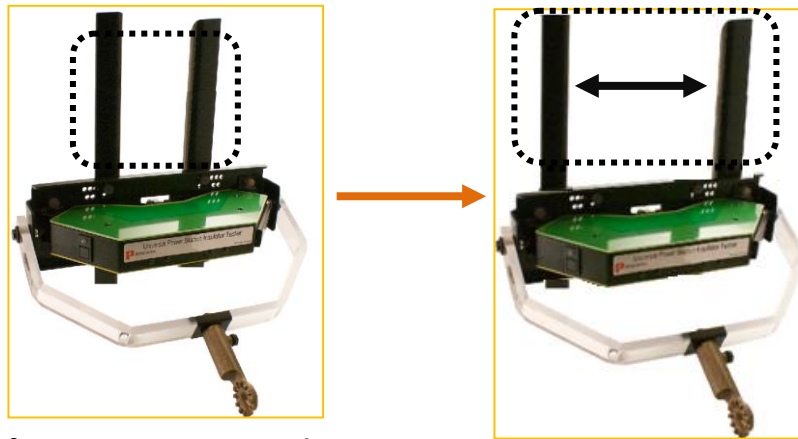
After each scan, make sure that the number of skirts (sheds) scanned is identical to the number of skirts of the tested bushing. If the number of skirts (sheds) scanned is not equal to the tested bushing, reject the scan and redo the scan to ensuring that each scan shows the same number of skirts (sheds). This is important for later comparison with earlier scans of the same or other identical bushings. See Section 6.2 for information on comparing graphs.



NOTE
 Depending on the Power Station apparatus to be tested, it may be necessary to **change the position of the skis of the ski assembly to an offset position** to remove any mechanical interference with the point where the apparatus meets with the bushing.



NOTE
 The skis of the assembly can also be adjusted to accommodate different diameters insulators or bushings.



5.2.2 Performing a Scan Using the Pressure Switch Actuator Assembly

For use on insulators and bushings where the size of the insulator or bushing is too small to be accommodated by the adjustable ski guides. It is also recommended to test a porcelain insulator string of less than 12 bells using this assembly. See figure 20.

With the Ski-Guide Assembly removed, remove the hot-stick coupler from the Pivot Bracket of the Ski-Guide assembly and install it on the mounting shaft that protrudes from the body of the Probe. See Figure 16. Secure the hot-stick coupler by tightening the set-screw. See Figure 17.



Figure 16



Figure 17

There is also a universal adaptor joint that enables total flexibility for positioning the Probe's Pressure-Switch Actuator against the bushing or insulator. See Figure 18.

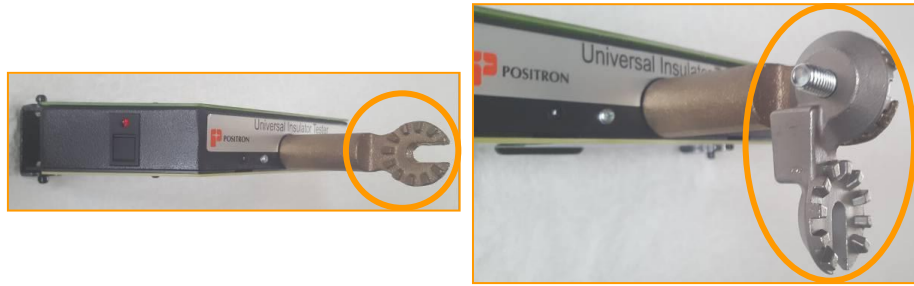


Figure 18

5.2.3 Performing a Scan Using the Pressure Switch Actuator

1. The scanning session consists of testing of minimum of 5 points. Per Figures 19, 20, and 21, the best practice in scanning is to take readings by pressing the Pressure Switch Actuator of the Probe against the bushing or insulator, starting at one end and progressing toward the other end. The scan can begin at either the low-voltage or high-voltage end of the bushing or insulator. See Figure 19. The Pressure Switch Actuator should be pressed against each pin under the porcelain insulator bell of a lower voltage insulator string. See Figure 20.
2. Ensure that the Probe is held approximately perpendicular to the bushing or insulator being scanned.
3. Once the first set of readings has been obtained, the Tester Operator waits for further instructions.
4. The Tablet Operator will **Download** the scanned data to the Tablet/Laptop PC to view the resulting graph and will **Accept** or **Reject** the scan. In either case, the data is wiped from the Probe leaving the Probe ready for the next scan.
5. The Tablet Operator selects **Send Alert to Probe** and an annunciating tone in the Probe attracts the attention of the Tester Operator so the Tablet Operator can communicate the next step to the Tester Operator.

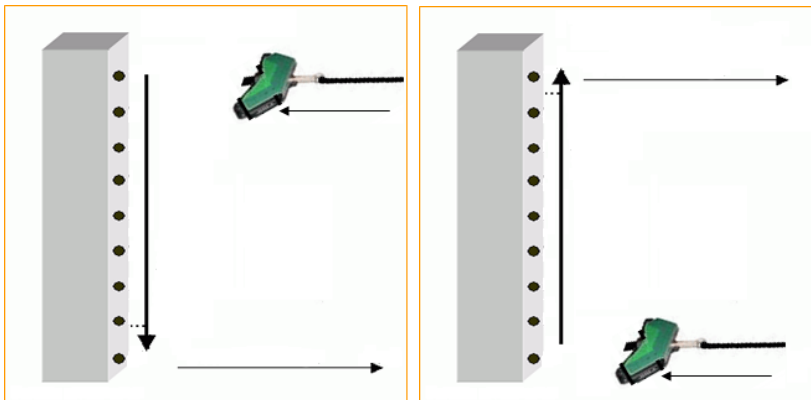


Figure 19: A Test of a bushing or insulator can be done from “top to bottom” or “bottom to top” although working with gravity will make the manipulation of the hot stick easier

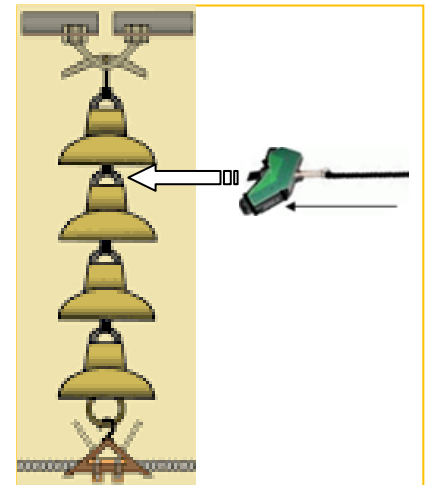


Figure 20

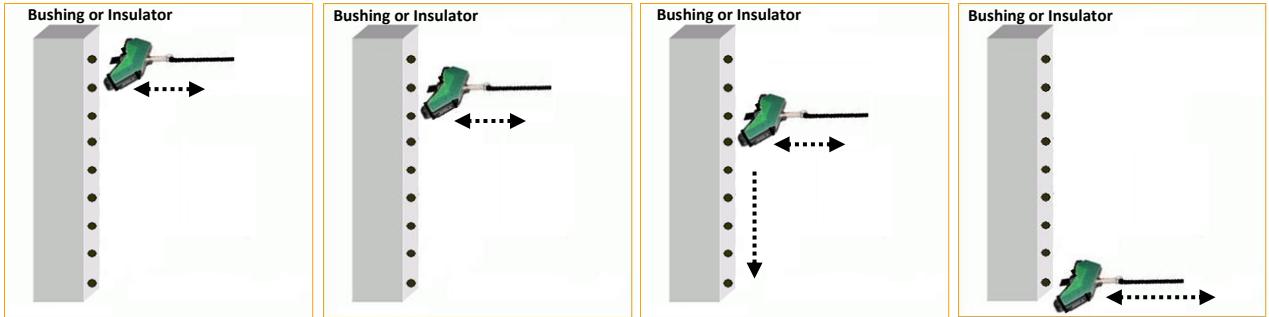


Figure 21: Press the Probe's Pressure Switch Actuator between the bells or skirts of the bushing or insulator

5.2.4 After an Insulator Scan

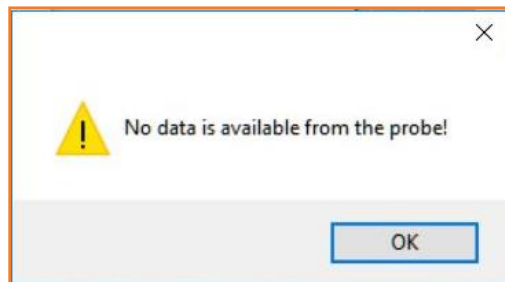
5.2.4.1 Downloading Data

The results of the scans are immediately downloaded and viewed on the Tablet/Laptop PC.

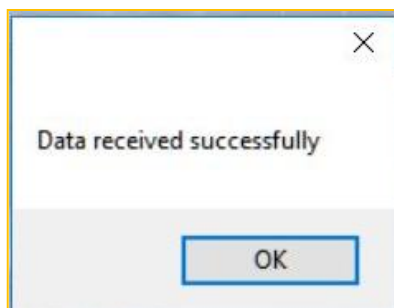
NOTE



During the Download process, if a system message is returned stating “**No data is available from the Probe**” this indicates that the Insulator Tester Software is in communication with the Probe, but that there is no data in the Probe to download. The **Download** button will still change to **GREEN**, indicating that the Windows-based Insulator Tester Software is able to communicate with the Probe, but that no data was present.



A successful **Download** will be confirmed by a system message from Positron's Windows-based software installed Tablet/Laptop stating “**Data received successfully**” and the **TAG** button will change to **GREEN**.

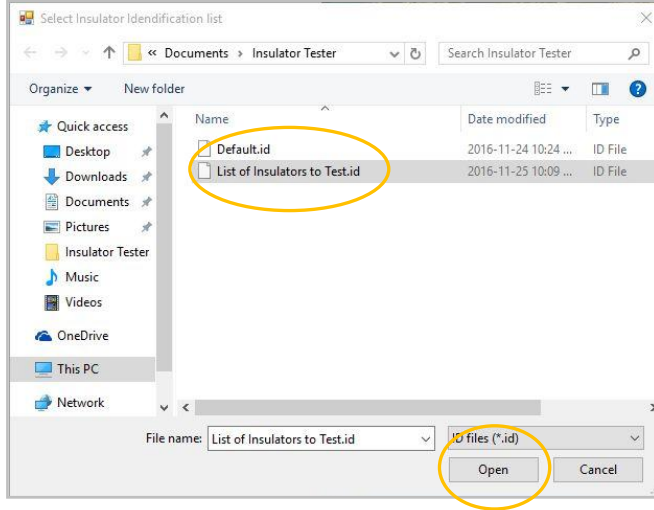
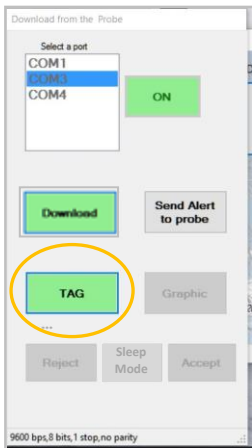


NOTE



Once the data has been transferred successfully to the Tablet/Laptop (or PC) and confirmed by a system message, the data in the Probe is erased.

Select **TAG** and the **Select Insulator Identification List** will open.



From the **Select Insulator Identification List** you can select and open the Insulator ID List created before the testing session.

Select the Insulator just scanned from the list created earlier, and select **TAG**.

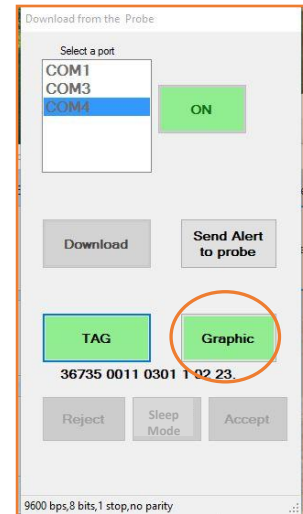
List of Insulators to test					
27	Line	Tower or Apparatus	Phase	Insulator	Code
	7010	0039	L	1	01
	7010	0039	L	2	01
	7010	0039	M	1	01
	7010	0039	M	2	01
	7010	0039	D	1	01
	7010	0039	D	2	01
	7010	0040	T	1	01
	7010	0040	M	2	01
	7010	0040	D	1	01
	7010	0041	A	1	01
	7010	0041	B	1	01
	7010	0041	C	1	01
	7010	0042	A	1	01
	7010	0042	A	2	01
	7010	0042	A	3	01
	7010	0042	A	4	01
	7010	0042	B	1	01

Press TAG to identify the insulator using the selected identification.

TAG

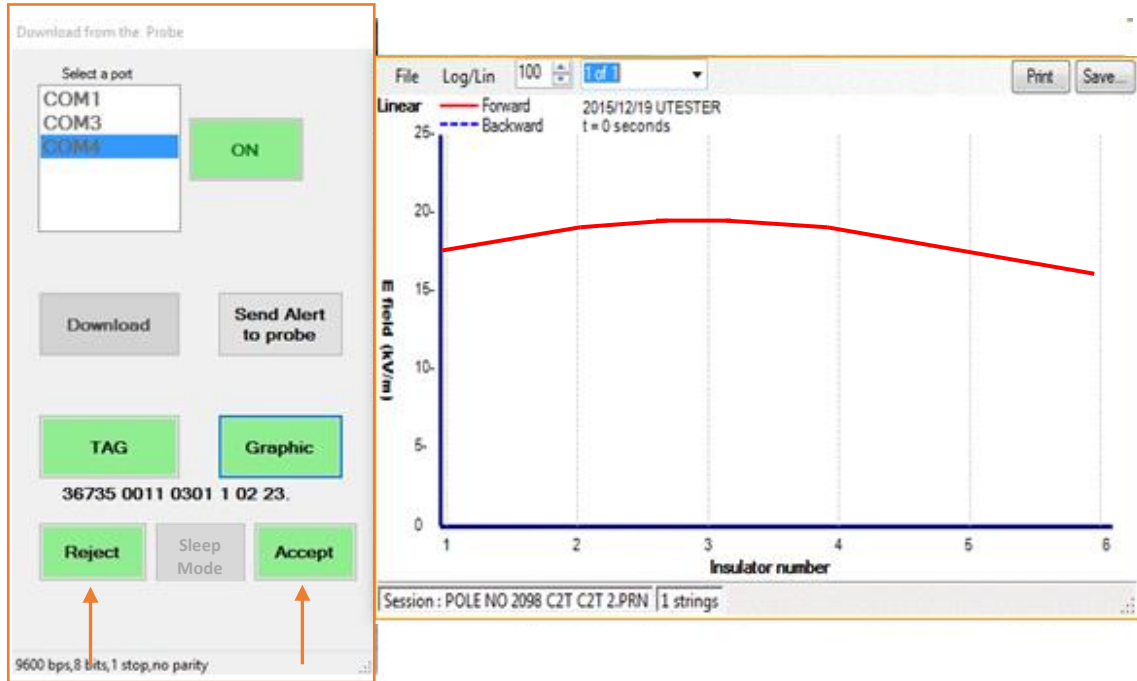
List of Insulators to Test.id

Select **Graphic** to see one or more graphs of the E-Field from scans of the last tested apparatus bushing. If more than one scan was done on the last tested bushing, click or touch the graphic to see the next related graphic.



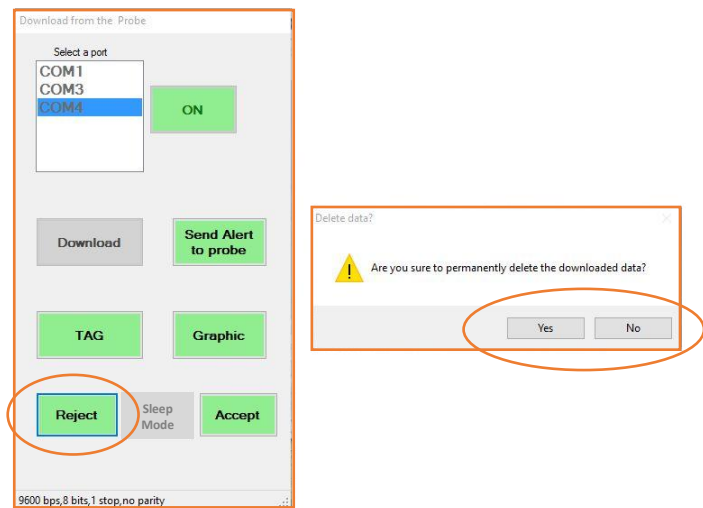
An instant determination can be made by the Tablet Operator whether to **Reject** or **Accept** the last insulator scan. Here are some examples of scans to be rejected:

- **Incomplete scan:** The Tester operator stopped for any reasons the scan before reaching the end of the scan
- **Disc or skirt missing:** The scan missed a disc or skirt because the operator didn't apply enough pressure on the hot-stick
- **Practice session:** The first time, it is recommended to perform some "dummy" scans to get used to the manipulation of the hot-stick

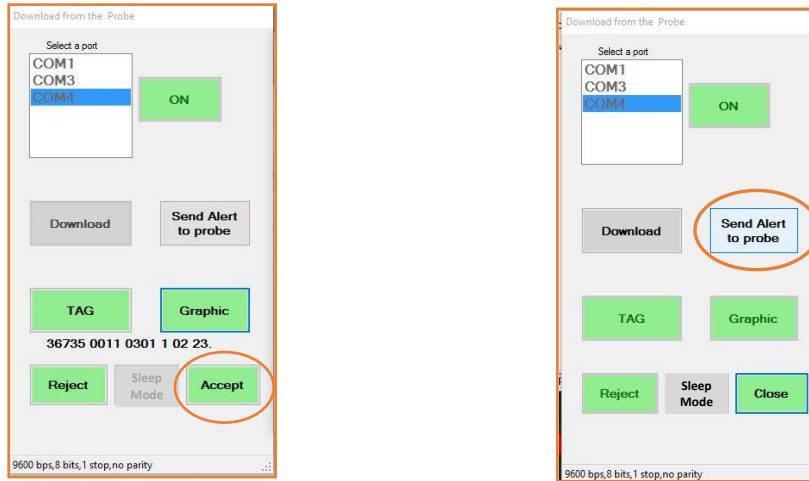


If the scan is rejected, a system message will be returned asking if you are sure you want to delete the downloaded data. If **rejected**, the data is erased from the Insulator Tester.

If **accepted**, the data from the scan, with all identifiers, is retained in the results database of the Insulator Tester Software.



In the example shown here, the data was **accepted** by the Tablet Operator.



Once accepted, the next insulator may be scanned. The Tablet Operator can attract the attention of the Tester Operator by selecting **Send Alert to Probe** and issue the instructions for another insulator scan.

If this was the last planned scan, the Tablet Operator may elect to:

A) Select the **Sleep Mode** button to place the Probe into Sleep Mode. (The Probe can be awakened by pressing the Push Button of the Probe.)

B) Optionally, select **Close** button to close the current window (The Bluetooth will disconnect to save power).

NOTE



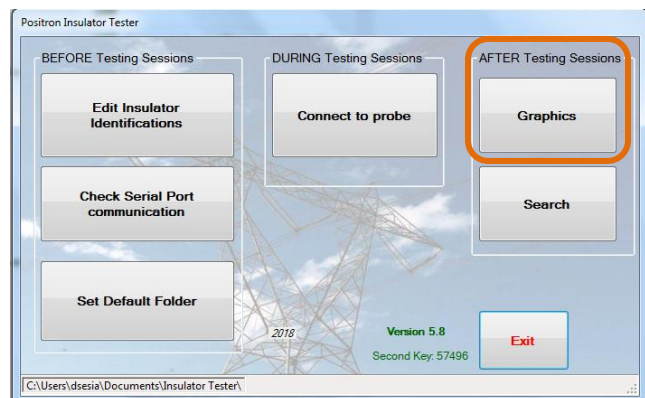
If during the process any of the software interface buttons changes to RED when selected, it may mean that the Probe has gone into **sleep mode**. The Tester Operator must be signaled to wake the Probe by pressing the Probe's Push Button.

The Probe will go to Sleep Mode after 4 minutes if no message (Alert or Download) has been received from the Tablet/Laptop.

5.3 AFTER Testing Sessions

5.3.1 Displaying Graphs

At any time before, during or after a testing session, press the "Graphics" button on the Tablet screen to display the data graphs stored in the Tablet/Laptop. Refer to Chapter 6 for interpretation of the graphs



5.3.2 Searching the Database

Search a database for a given apparatus in the database to evaluate its degradation over time. See Section 6.3 for a description of superimposed graph comparison.

To **search** for an insulator:

- In Section 1, **Browse** to select the folder that contains your Identification Lists. Select **Include sub-folders in the search**,
- In Section 2, create a search by making criteria selections
- In Section 3, select the “**Search**” button from the menu of the Insulator Tester Software
- Select the desired insulator testing session for that insulator
- Select **Graphic** to view the stored insulator graph.
- If more than one scan has been performed on the found insulator, select the next line in the list to display the graph of the same insulator tested at another time. Degradation over time can then be viewed. Using the **Compare** button, the opacity of one graph can be reduced so both graphs can be viewed superimposed on each other to see the degradation over time. See Section 6.3 for details. See Figure 22 for an example.

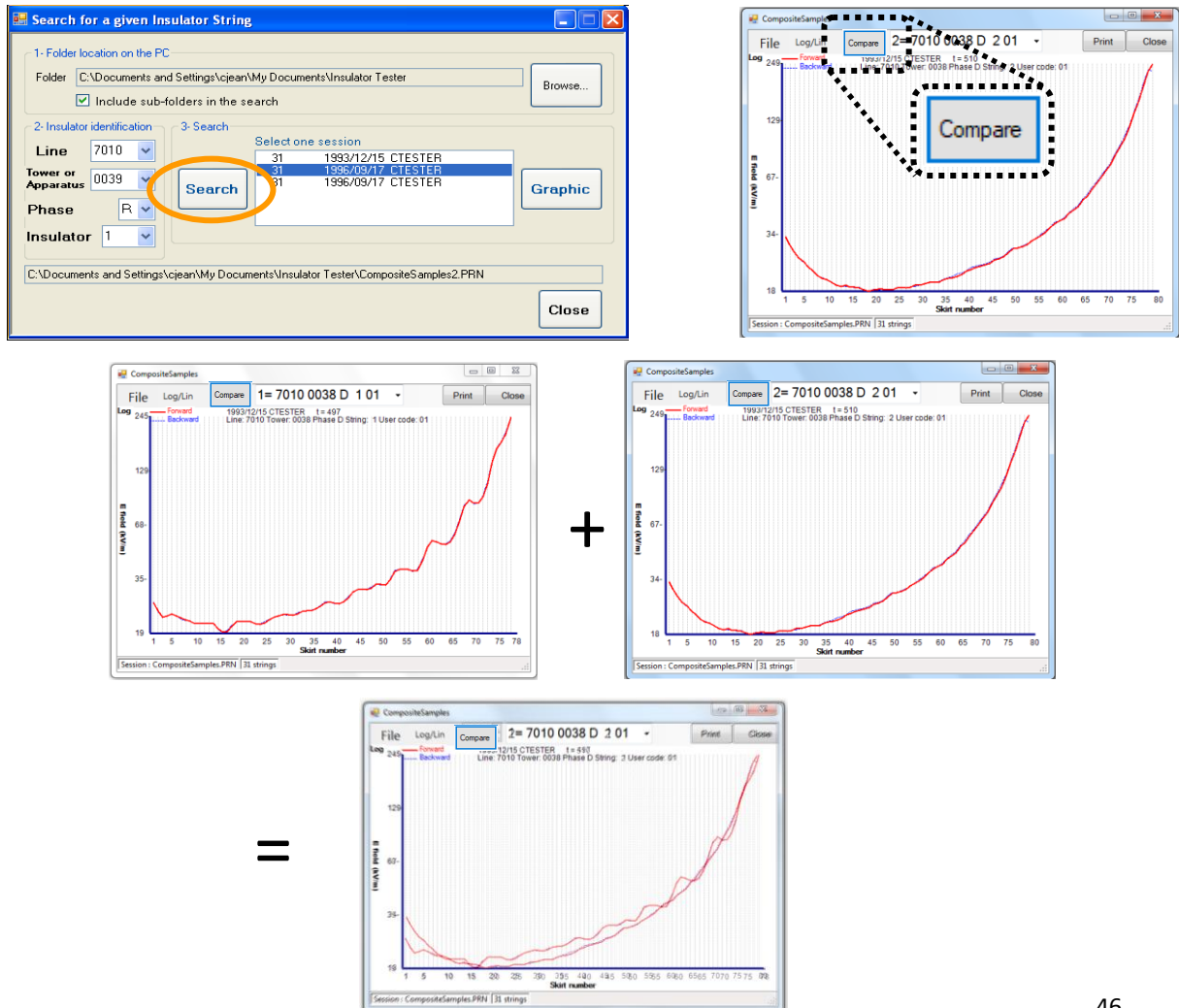


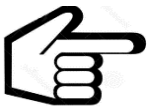
Figure 22: One graph superimposed on another using the **Compare** feature (The curves shown above are for illustrative purposes only)

5.4 Important General Notes

- ✓ Always use the same Bluetooth adapter with its paired Tablet/Laptop.
- ✓ If the Probe has not been used for more than six (6) months, recharge its battery before switching ON the power of the Probe.
- ✓ The Probe's battery should be recharged overnight (9 hours minimum) before each day of testing. If the power switch remains ON, the battery will discharge completely after approximately two days.
- ✓ Recharge the battery of the Probe and the Tablet/Laptop before a day of testing.
- ✓ Switch the power OFF when the Probe is left unused. To switch the Probe OFF, remove the cover and move the slide switch away from the RS232 connector.
- ✓ To verify that the power is ON, press the push-button; the LED should flash, then press the push-button again to switch the light OFF.
- ✓ Do not use the Probe and the Tablet/Laptop in rain or snow or during lightning.
- ✓ To recharge the battery, remove the RS232 cover (3" x 1"), plug the charger cable to the Probe and plug the universal wall transformer to a 120/220 Vac source, 50 or 60 Hz.
- ✓ If the battery is completely discharged (No light on power-up), switch the Probe OFF while the battery is recharging. Under normal circumstances, it is not necessary to switch the Probe OFF during a recharge, however, the battery will recharge faster if the Power switch of the Probe is switched OFF.

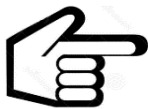
Switching the Probe OFF will erase all data in the Probe.

WARNING



The equipment covered in this manual should be used and serviced only by competent and trained personnel familiar with and following good work safety practices. This equipment is intended solely for the use by such trained personnel. This manual is not intended as a substitute for adequate training and experience. Appropriate safety procedures must be followed at all times in the use of this equipment.

NOTE



This equipment will detect any conductive defect irrespective of the cause of the conductive defect. Conductive defects can be manufacturing defects or internal defects due to deterioration or caused by mechanical failure or cracks or due to conductive pollution. The tester does not detect non-conductive defects including mechanical defects that have not resulted in a conductive defect.

5.5 Using the Tester without the Tablet and Bluetooth

It is possible to use the tester in a mode without downloading the data after each scan. This mode requires the Tester Operator to push the button on the probe after each scan in order to store the data in the probe. The data stored in the probe can be downloaded at a later time.

We do not recommend this method as it has the following disadvantages:

- The user does not get instantaneous feedback on the condition of the bushing tested.
- A dangerous condition will not be known until after the data is downloaded.
- If a scan is improperly done, this will only be known later and a return trip might be necessary.
- It requires the user to take notes and later correlate manually these notes with actual equipment and bushings identification.
- The database created would contain only the E-Field data. The equipment and bushing identifications associated with the E-field curves would therefore not be included within the database for future use.
- The graphic title will not contain the insulator identification.
- It will not be possible to perform a database search in absence of insulator identifications.

Advantage of using the Tablet/PC with Bluetooth:

- The use of the tablet enables the manager to download or type in a list the equipment and bushings to be tested so that the tablet operator has an assigned task list for the field work.
- The Tablet Operator and Tester Operator can work together without having to take notes to correlate the equipment and bushings tested data curves with the equipment identification and each bushing. The curves are instantly tagged by the Tablet Operator to the equipment and bushing including phase, etc. This saves a lot of time and also errors that can occur when using a manual identification method.

Bulk downloading stored data from the probe to a PC:

- This can be done via the Bluetooth provided with the Tester to a Bluetooth enabled PC.

The following procedure is applicable ONLY for bulk download from the probe if the tablet and Bluetooth are not used in the field. Disregard this procedure when using the Positron Tester in the recommended manner with the tablet/PC and Bluetooth while using the Tester in the field.

To download bulk E-field data stored in the probe:

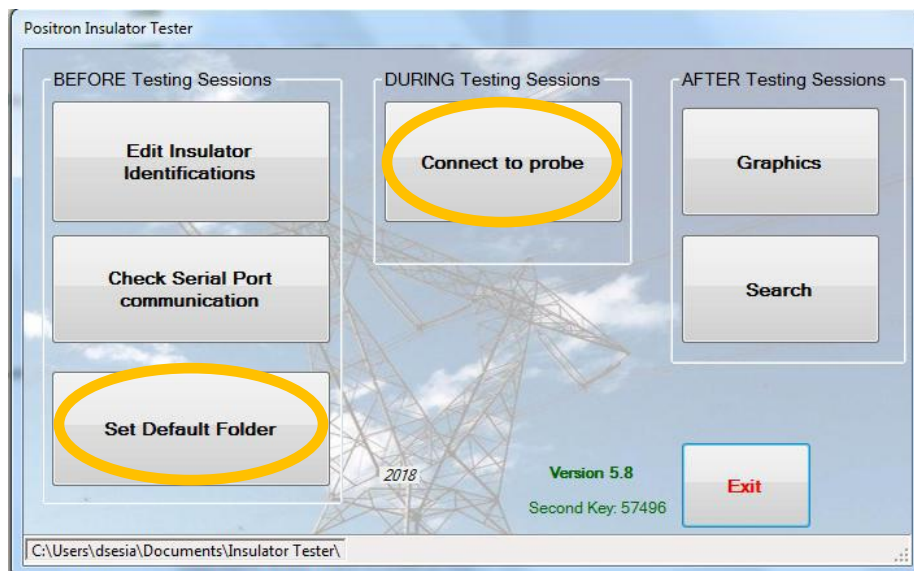
- 1- Connect the Bluetooth adapter to the probe (Ensure the slide switch on the adapter is in the DCE position)



- 2- Press the push button on the probe

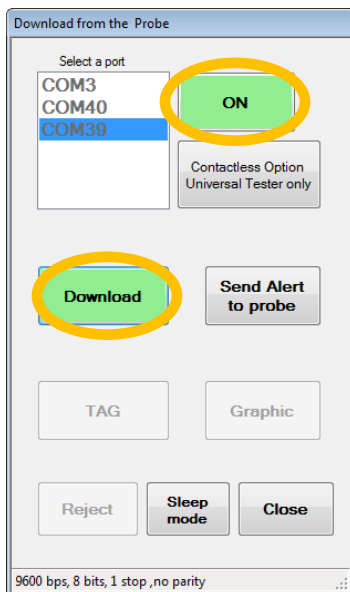


- 3- Start the Positron software on the Bluetooth enabled Tablet/Laptop PC, select the folder by pressing the "Set Default Folder" button then press "Connect to probe"

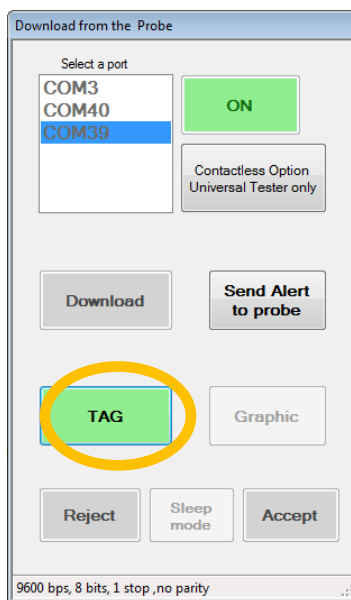
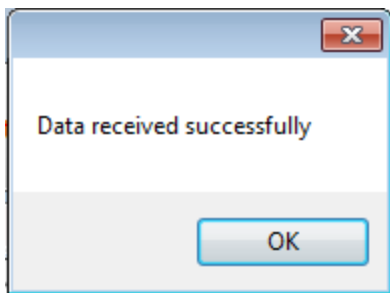


Main Menu

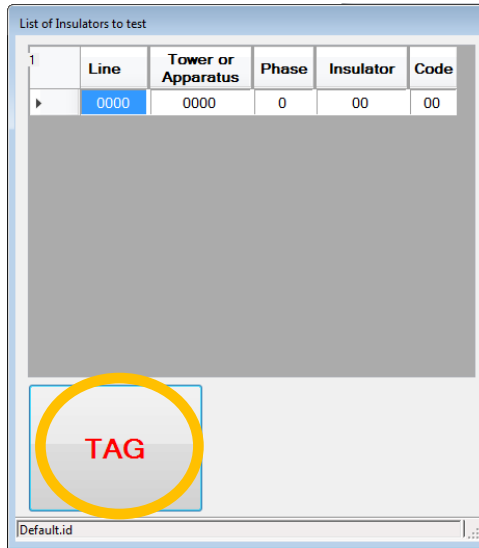
4- Select the COM port and press “Download”



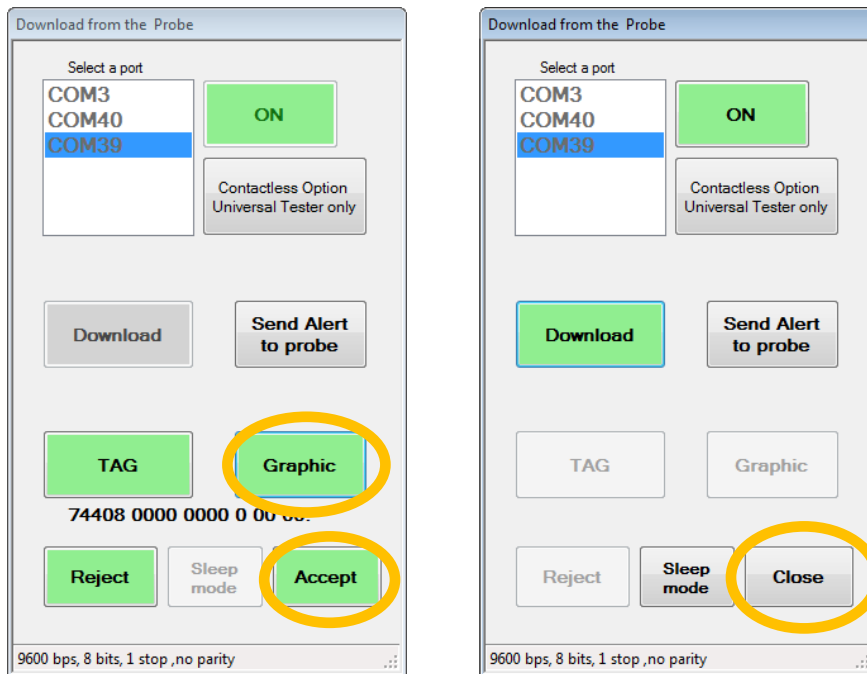
5- After receiving the message “Data received successfully”, press the “TAG” button



- 6- Select "Default.id" file, select the first line in the list then press on "TAG" button



- 7- Press "Graphic", close the graphic displayed, press "Accept" then press "Close"



- 8- The E-field data is stored in the database located into the previously selected folder. The database consists in two ASCII files: Date.PRN and Date.LOG.
- 9- Press on the "Graphics" button on the Main Menu to display the graphics. The Graphics will not have any insulator identification into their title.



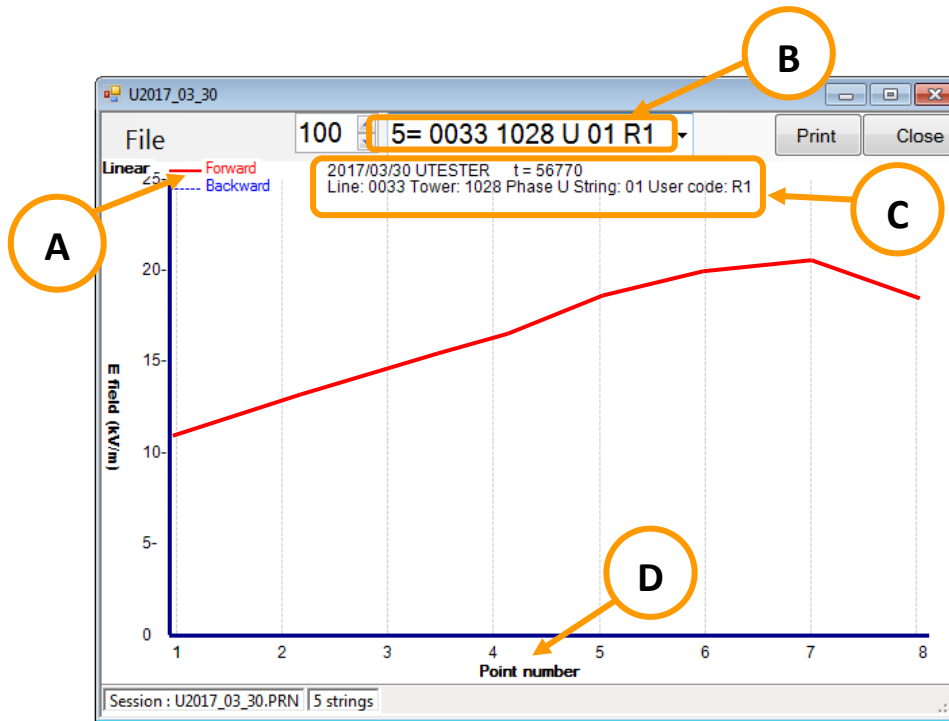
Chapter 6

Interpreting Graphic Results

6.0 Interpreting Graphic Results

6.1 Understanding the Graphs

The curve on the graph is generated using only one red line color because only one pass is required to acquire the readings.



Typical Reference Graph

Figure 23

- A) The solid **RED** line indicates the readings taken on a scan from the low-voltage end to the high-voltage end of the insulator
- B) This section of the graph provides a truncated identifier for the porcelain testers being scanned.
 - a. **0033** identifies the particular power transmission line being scanned
 - b. **1028** identifies a particular apparatus associated with the power transmission line being scanned
 - c. **U** indicates the power phase associated with the power transmission line being scanned
 - d. In this example, **01** indicates the 1st insulator or bushing of the actual phase, a breaker may have two bushings for a given phase
 - e. These last 2 characters are a user-defined code and are not used by the software Search function.

- C) Contains detailed information of the scan.
- “2017/03/30” indicates the date of the scan
 - “UTESTER” indicates that the a Universal Tester was used
 - “t = 56770” indicates the number of seconds since midnight,
 - “Line: 0033 Tower: 1028 Phase U String: 01” identifies the tested insulator or bushing.
 - “User code: R1” can be any code defined by the user,
- D) “Point number” indicates the tested point number along the insulator or bushing.

6.2 Linear / Log Graphic Options

The “Linear” display mode is used to display the electric field readings from the Probe on a linear scale. It is used for lower voltage applications (9 or less tested points). Linear display mode is normally used when testing bushings.

The “Log” display mode is used to amplify the small variations in the lower portion of the curve. It is normally used for higher voltage suspension insulator applications (10 or more tested points).

The Windows-based Insulator Tester software allows you to toggle the scale of the graphs being viewed between **Linear** and **Logarithmic** scale for 10 or more tested points.

6.3 Interpreting Results

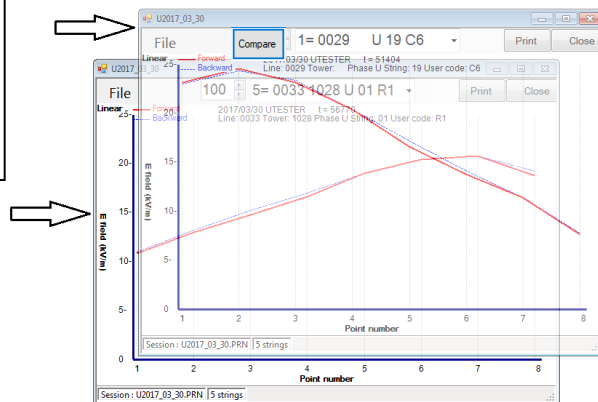
It is recommended to test several identical insulators to obtain a graphic “health signature” for each particular type and manufacturer of insulator. This signature serves as the baseline for evaluating like-insulators. As an example, on a 3-phase distribution line, the signature from each phase should be identical. A minimum of 5 tested points per insulator is recommended to obtain a valid reading.

The resulting graphs of the E-field of the insulators can be superimposed for comparison. By placing one graph over the other and reducing the opaqueness down from 100, one graph will become visible through the other.

This method can also be used to evaluate the degradation over time of a given insulator by using the Search button on the screen of the Tablet or on the PC or computer into which the data has been downloaded.

Using the **Compare** button, the graph of faulty insulator is adjusted to 50% opaqueness superimposed over established E-field Signature Reference for comparative analysis

Reference E-field Signature graph of “healthy” insulator derived from testing a number of known good insulators



NOTE



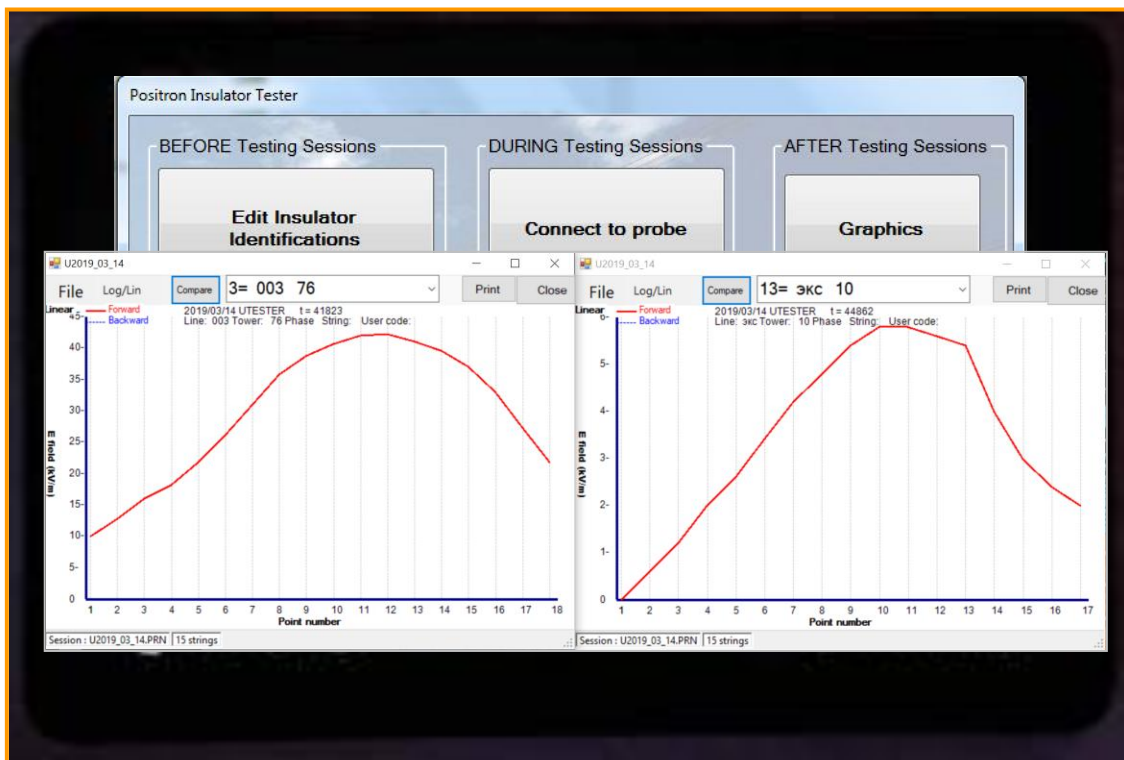
The graphs of phase A, B and C of an apparatus can be placed side-by-side on the Tablet or PC screen to compare their signatures.

A picture of the apparatus can be taken using the tablet/PC. Make sure the date and time of the Tablet/PC is correct to simplify the association between the apparatus and its graphics.

NOTE



Establishment of a reference signature of “healthy insulators” may differ depending on insulator types. As such, the reference signature indicated in this figure is illustrative only.

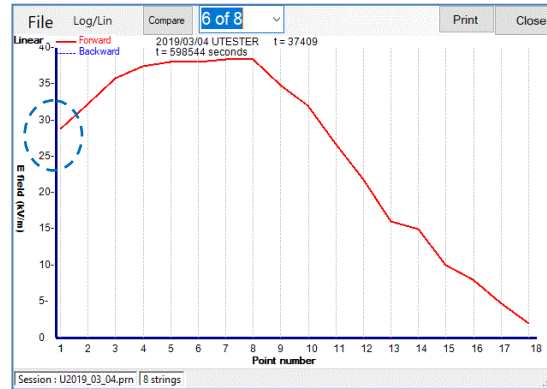
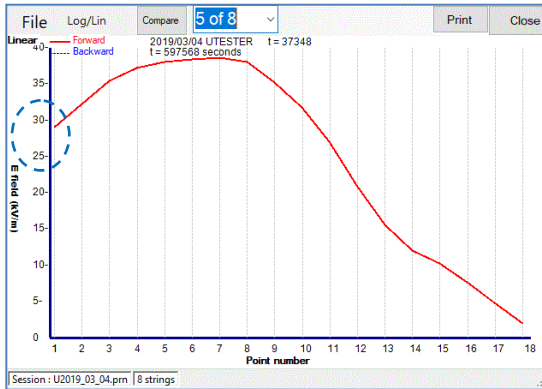


Tablet running Windows-based Insulator Tester Software showing two graphs for comparative analysis

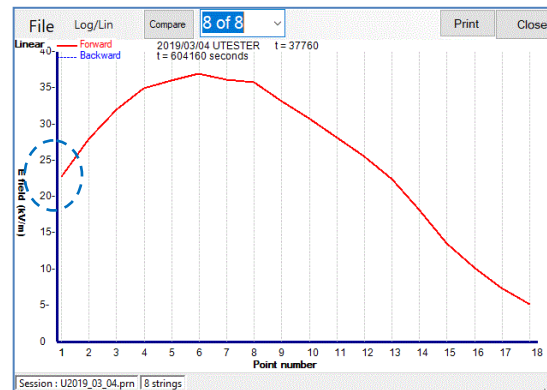
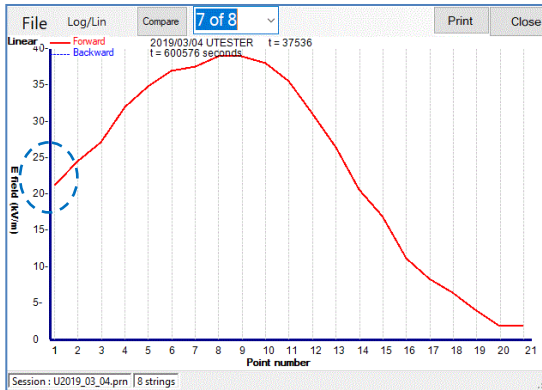
6.4 Illustrative Example of a “Known Good” Bushing versus a Bushing having Partial Discharge Caused by a Manufacturing Defect.

Graphs #5, #6, #7 and #8 below show the E-Field signatures of four high-voltage bushings. Note that the E-Field signatures are very similar. After scanning several bushings and obtaining similar results, a graph can be chosen to represent a “known good” bushing. This graph can be identified as such and used to compare graphs of other bushings. These bushings have been scanned from the ground end toward the High voltage end of the Line Termination.

Graphs #5, #6, #7 and #8 are of Normal Bushings with no Partial Discharges Used to Establish the E-Field Signature of a “Known Good” Bushing

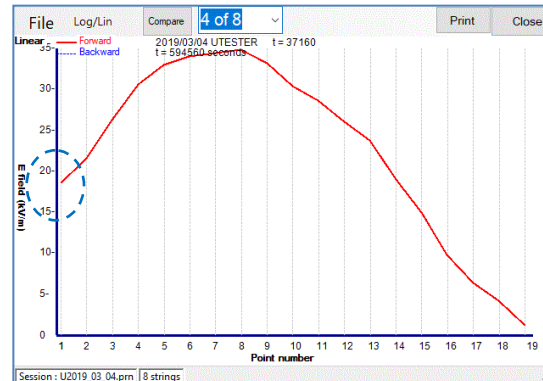
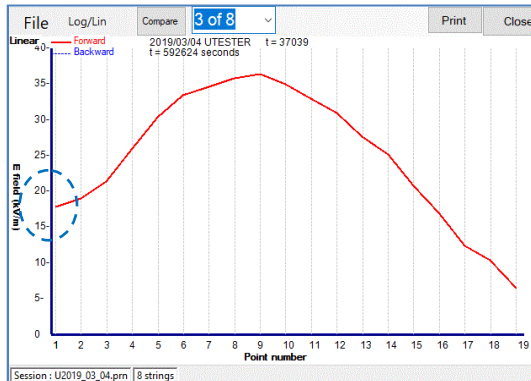


Graphs #5 and #6 show an E-field near the bottom of a bushing = 29 kV/m



Graphs #7 and #8 show an E-field near the bottom of a bushing = 23 kV/m

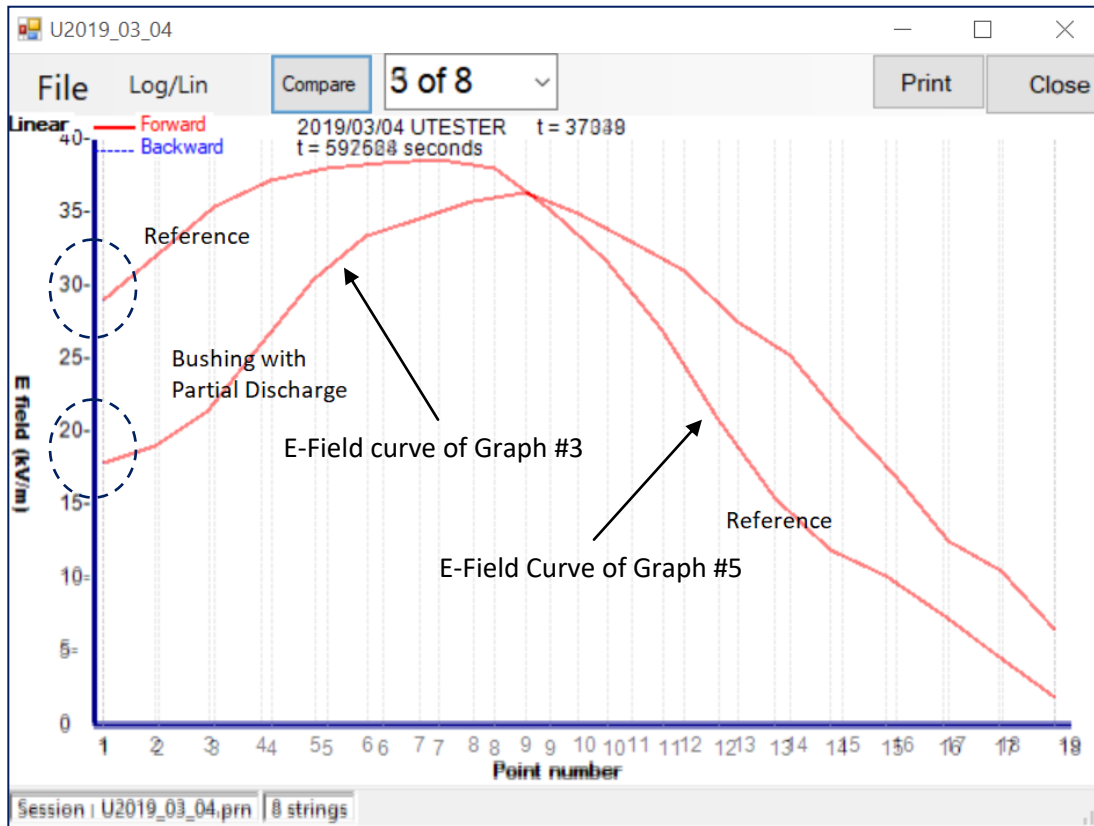
Bushings with Partial discharges



Graphs #3 and #4 show a lower E-field near the bottom of the bushing = 18 kV/m.

Graphs #3 and #5 of bushings with partial discharges due to manufacturing defect are superimposed below using the Compare function for comparison (See Sections 5.3.2 and 6.3). The E-field reduction caused by partial discharge of the bushing shown in Graph #3 is clearly visible.

The degree of difference between a “Known Good” bushing and a bushing with a partial discharge can be assessed and plans can be made to remedy the situation before a failure occurs that could cause costly damage.





Chapter 7

Specifications

7.0 Specifications

Parameter	Specifications
Maximum tested points per insulator (Universal)	200 bells or sheds
Minimum tested points per insulator (Universal)	5 tested points recommended
Maximum voltage	1,000 kV phase to ground
Minimum battery recharging time	10 hours (one night)
Cumulative use between charges	12 hours
Maximum period between battery charges	1 day
Operating temperature range: <ul style="list-style-type: none"> • Probe • Bluetooth Adapter 	-4°F to 140°F (-20°C to +60°C) 14°F to 158°F (-10°C to +70°C)
Dimensions of Universal Tester	10.6" x 4.7" x 2" (27 cm x 12 cm x 5 cm)
Weight	1.2 kg (2.65 lbs)
Humidity	95%
Factory calibration (User recalibration is not required)	500 raw units = 100 kV/m longitudinally

NOTE To be used on AC lines only



Chapter 8

Important Information

8.0 Important Information

8.1 Service and Support

Positron Contact Information

General information: Positron Inc. 5101 Buchan Street Suite 220 Montreal, Québec, Canada H4P 2R8 US and Canada: 1-888-577-5254 International: 1-514-345-2214 Fax: 1-514-345-2271 E-mail: info@positronpower.com Web site : www.positronpower.com	Receiving address: Positron Inc. 5180 Pare Street Montreal, Québec, Canada H4P 1P3
Repairs	US and Canada: 1-888-577-5254, Option 1 International: 001-514-345-2220, Option 1

We can communicate also by Skype if pre-advised by e-mail.

8.2 Technical Customer Support

Positron is committed to providing excellent ongoing technical support to its customers. A team of specialists is always available for telephone consultations, or for on-site visits to assist in maintenance and troubleshooting.

For more information, or assistance in the planning, configuration, use and interpretation of data produced by the equipment, contact Technical Customer Support (TCS) at 1-888-577-5254, Option 1, Option 3 (US and Canada) or +1-514-345-2220 Option 1, Option 3 (International). Or, email scarbonaro@positronpower.com. Skype calls can be arranged.

8.3 Customer Training

Full customer training courses on the operation and results interpretation of Positron Insulator Testers are available. For information, contact Positron.

8.4 Repair Service

All warranty repairs are performed at no cost. Positron reserves the right to repair or replace any equipment that has been found to be defective.

For information about out-of-warranty repairs, contact Positron's Repair department at 1-888-577-5254 (US and Canada) or +1-514-345-2220 (International).

Due to the varied nature of repairs, no specific turnaround can be guaranteed, but average turnaround time is two weeks from date of receipt. In emergency situations, special arrangements can be made. All repaired items are warranted for a period of 180 days, or balance or warranty, whichever is longer.

Before returning any items to Positron for repair, warranty repair or replacement, call or e-mail the Repair Department (info@positronpower.com) to obtain a Return Material Authorization (RMA) number. Parts returned without RMA numbers cannot be accepted. The RMA number must always be clearly marked on all boxes and crates and on all shipping documents.

To accelerate the repair process, whenever possible, include a report detailing the reason for return with the unit(s). Also, please include the name and phone number of a contact person should our Repair department need further information.

When packing items being returned for repair, please ensure they are properly packed and shipped in their carrying cases to avoid further damage.

8.5 Warranty

Subject to the provisions of this paragraph, Positron warrants that the equipment shall perform in accordance with Positron's specifications. The warranty on the electronic Probe and the Bluetooth device is three (3) years from the date of shipment. The warranty on the tablet/PC is one (1) year. The warranty fully covers workmanship, materials and labor. Positron shall, at its sole discretion, repair or replace the problem unit. A detailed warranty description is available on request.

During the warranty period, freight costs to ship defective equipment to Positron are borne by the Customer, while the return of replaced or repaired equipment is at Positron's expense. To obtain an RMA for warranty repair, e-mail customerservice@positronpower.com.

8.6 Limitation of Liability

Subject to anything to the contrary contained herein, Positron's sole obligation and liability and the customer's sole remedy for Positron's negligence, breach of warranty, breach of contract or for any other liability in any way connected with or arising out of, the equipment or any services performed by Positron shall be as follows:

- In all situations involving performance or non-performance of the equipment or any component thereof, the customer's sole remedy shall be, at Positron's option, the repair or replacement of the equipment or said component.
- For any other claim in any other way related to the subject matter of any order under, the customer shall be entitled to recover actual and direct damages; provided that Positron's liability for damages for any cause whatsoever, and regardless of the form of the action, whether in contract or in tort (including negligence), shall be limited to the value of the order.

Positron shall not be obligated to repair or replace any item of the equipment which has been repaired by others, abused or improperly handled, improperly stored, altered or used with third party material or equipment, which material, or equipment may be defective, of poor quality or incompatible with the equipment supplied by Positron, and Positron shall not be obligated to repair or replace any component of the equipment which has not been installed according to Positron specifications.

IN NO EVENT SHALL POSITRON BE LIABLE FOR ANY INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL, PUNITIVE, EXEMPLARY OR SIMILAR OR ADDITIONAL DAMAGES INCURRED OR

SUFFERED INCLUDING LOSS OF PROFITS, LOSS OF REVENUES, LOSS OF DATA, LOSS OF BUSINESS INFORMATION, LOSS OF GOODWILL, LOSS OF LIFE, STAFF INJURY, LOSS OF EXPECTED SAVINGS OR BUSINESS INTERRUPTION ARISING OUT OF OR IN CONNECTION WITH THE EQUIPMENT, A PURCHASE ORDER SUPPLIES, MAINTENANCE SERVICES OR OTHER SERVICES FURNISHED HEREUNDER, EVEN IF POSITRON HAS BEEN ADVISED OR IS AWARE OF THE POSSIBILITY OF SUCH DAMAGES.

EXCEPT AS EXPRESSLY SET FORTH IN THIS AGREEMENT, POSITRON DISCLAIMS ANY FURTHER CONDITIONS, REPRESENTATIONS OR WARRANTIES, WHETHER WRITTEN OR ORAL, EXPRESSED OR IMPLIED, INCLUDING THE CONDITIONS AND WARRANTIES OF MERCHANTABILITY, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE, PERFORMANCE AND THOSE ARISING FROM STATUE, TO THE EXTENT PERMITTED BY LAW. POSITRON DOES NOT WARRANT THAT THE SYSTEM WILL OPERATE WITHOUT INTERRUPTION OR THAT IT WILL BE ERROR FREE.

8.7 Disclaimer Notice

The equipment covered in this manual should be used and serviced only by competent and trained personnel familiar with and following good work safety practices. This equipment is intended solely for the use by such trained personnel and is not intended as a substitute for adequate training and experience. Appropriate safety procedures must be followed at all times in the use of this equipment.

The descriptive information contained in this manual is not intended to and does not cover all details, usages, or methods of use of this equipment, and such information is not intended to discuss all situations or contingencies which might be encountered with respect to the operation, maintenance or use of the equipment. This information is provided for purposes of description only and is not to be relied upon or utilized by any purchaser as instructions, warranties, specifications or use certifications. Although Positron Inc. has made every effort to ensure the accuracy of the information contained herein, this document is subject to change without notice due to ongoing product development. Any additional information which may be required by any purchaser regarding the use, maintenance, installation or operation of this equipment should be referred to Positron Inc.

8.8 Cancellation and Rescheduling Charges

Should the customer cancel, prior to shipment, any part of an order, the customer agrees to pay to Positron cancellation charges, not as a penalty, which shall total all expenses, including labor expenses, incurred by Positron prior to said cancellation. Modified equipment that has been specially developed for the customer's specific applications shall not be subject to cancellation. Cancellation or rescheduling is not permissible after shipment of the System.

Positron's Suite of Insulator Products

Simply slide the tester sled along the insulator (string).

Positron's Insulators Testers and software enhances worker safety with an Instant Graphical Download of the insulator's surrounding E-field for immediate on-site viewing, providing immediate warning for **DANGEROUS** conditions.

Porcelain Tester

The Porcelain Tester is used for Porcelain and Glass insulators.



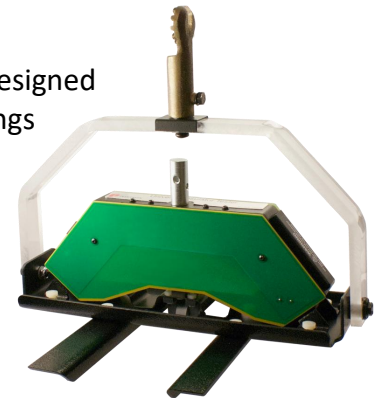
Composite Tester

The Composite Tester is used to detect floating or connected defects for Composite (or Polymeric) insulators



Universal Substation Insulator Tester

The Universal Substation Insulator Tester has been specifically designed for use in fully energized equipment in substations to test bushings and insulators of all shapes and sizes.



Positron's Mapping System displays at a glance the health and location of the insulators in the power network.

