Positron Composite Insulator Tester

Model # 3782101C/50 & 3782101C/60

Composite (Polymeric) Insulator Tester
For 25kV Electric Railway Systems

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**

Contents

Chapter 1

General Information

1.0 General Information

1.1 Publication Information

Positron Composite Insulator Tester

Description and Operation Guide

User Manual Part #: **925W378210-02E**
(Based on Part # 925W378209-09E)

Publication date: December 2018

Published By
Positron Inc.
5101 Buchan Street, suite 220
Montréal, Québec
H4P 2R9 Canada

Trademarks
Positron Insulator Tester is a trademark of Positron Inc.

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”.

Product names, other than Positron’s, mentioned herein may be trademarks and/or registered trademarks of their respective companies.

Confidentiality Notice

The information contained in this document is the property of Positron Inc. Except as specifically authorized in writing by Positron Inc., the holder of this document:

1) shall keep all information contained herein confidential and shall protect same in whole or in part from the disclosure and dissemination to all third parties, and

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

1.2 About this Guide

This guide introduces you to and describes the operation of Positron’s Live Line High Voltage Tester used as a maintenance tool to test and report defects in Composite Insulators and for use as a safety tool to determine the condition of high-voltage insulators prior to beginning Live-Power Line work.

1.3 How to use this Guide

This guide was designed to describe the operational modes of the Composite 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 Insulator Tester"; Report No. ELE 92-62; Bonneville Power Administration Division of Laboratories; December 7, 1992.

[2] G.H. Vaillancourt, J.P. Bellerive, M. St-Jean, C. Jean, "New Live Line Insulator Tester for Porcelain Insulators on High-Voltage Power Line," IEEE Transactions on Power Delivery, Vol. 9, January 1994, pp. 208-219.

[3] "J.C. Pohlman, C.R. Davis, "Cracked Insulators Create Hazardous Working Conditions During Restoration after Extreme Ice Storms," Proceedings of ESMO-95, Columbus, Ohio, USA, October 29 - November 3, 1995, IEEE Paper 95CH35755.

[4] A.S. Jagtiani, J.R. Booker, "Aging of Porcelain Insulators Under Mechanical and Electrical Stress on EHV AC Lines," Proceedings of ESMO-95, Columbus, Ohio, USA, October 29 - November 3, 1995, IEEE Paper ESMO 95-CP-08.

[5] G. H. Vaillancourt, M. Hamel, J. Frate, "Experience with Two Faulty Composite Insulators Detection Methods in Hydro-Quebec," Conference Proceedings of 10th International Symposium on High Voltage Engineering, Montreal, Canada, August 25-29, 1997.

[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.

[7] G. H. Vaillancourt, S. Carignan, C. Jean, "Experience with the detection of faulty composite insulators on High-Voltage power lines by the E-field measurement method," IEEE Transactions on Power Delivery, Val. 13, No. 2, April 1998, pp 661-666.

[8] Y.C. Chen, C. R. Li, X. Liang, S. Wang, "The Influence of Water and Pollution on Diagnosing Defective Composite Insulators by E-field Mapping," Conference Proceedings of 11th International Symposium on High Voltage Engineering, London, England, August 22-27, 1999.

[9] D. H. Shaffner, D. L. Ruff, G. H. Vaillancourt, "Experience with a Composite Insulator Testing Instrument based on the Electric Field method" ESMO 2000, Montreal, Canada, October 8-12, 2000.

[**10**] L. J. Fernandez, J. M. Munoz, A. Andrés, "Electric field measurement on composite insulators using live working techniques", 5th International Conference on Live Maintenance, ICOLIM 2000, Madrid, Spain, May 17-19, 2000.

[**11**] I. Gutman (SE), A. Pigini (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 Introduction to the Composite Insulator Testers

2.1 Personnel Terminology Used in this Guide

The Composite Insulator Tester is used by field technicians and are referred to in this document as the "**Tester Operator**".

The Foreman or other members of the supporting Crew operate the Tablet/Laptop used in the field together with the Insulator Tester. In this guide they are referred to as the "**Tablet Operator"**.

2.2 General

The document describes the operation of Positron's Composite Insulator Tester.

Model # 3782101C/50: Composite Insulator Tester, 50Hz
Model # 3782101C/60: Composite Insulator Tester, 60Hz

Refer to Figure 1 for a detailed drawing of the unit.

With the Composite Insulator Tester Probe mounted onto a user-supplied hot-stick, the Tester Operator passes the Probe along the length of the composite Insulator. Any conductive defect in an insulator will cause a change in the E-Field surrounding the insulator. This perturbation of the E-Field indicates a faulty insulator. The fault is detected and identified by the Probe, and the data is downloaded to a database installed on the Tablet/PC for analysis. The graph displaying the E-Field of the insulator is clearly displayed on the Tablet/Laptop while in the field enabling **GO/NOGO** decision-making on-the-spot.

The skirts, or sheds, of Polymeric or Composite insulators are counted by the field Probe's two integrated infrared detectors, referred to as IR1 and IR2 (see Figure 1), and the E-Field of each insulator is recorded. Defective insulators are easily identified using the resulting data graphs that present the contour of the E-Field along the length of the composite insulator. The field Probe contains a microprocessor-based recording system. A minimum of 5 skirts is required for a scan.

After a Composite insulator is scanned by the Tester Operator, the Tablet Operator downloads the Probe's data via a long range Bluetooth communication link to the Tablet/Laptop for immediate GO/NOGO analysis.

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

NOTE

- Verify the Date and Time settings of the Tablet/Laptop
- It is important to disable the WIFI of the Tablet/Laptop to avoid long operating system updates and interference with the long range Bluetooth communication link while preparing for or performing a testing session.

2.2.1 Recommended Testing Methodology:

Testing insulators when dry using the Positron testers will only detect conductive defects in the insulators. Testing the insulators when moist, the Positron testers will detect defects in the insulators as well as conductive defects due to pollution.

When a flashover occurs in a region, it is prudent to test not only the flashed over insulator, but also other insulators in that area. The likelihood is that if one insulator flashed over, other adjacent or nearby insulators will be similarly covered by a pollutant film and should be tested as they are also likely to flash over in the near future when moistened by rain or early morning dew.

If the railway operator gets readings on many insulators in a region that show high conductive pollution on insulators, the railway operator will know which groups of insulators should be changed or cleaned at one time as a preventative maintenance measure. This minimizes interruptions or downtime of rail traffic as well as minimizing danger to any maintenance crew whether working underneath the high-voltage lines per their routine schedule. The Tester will act as a Health detector of the insulators tested in advance of any failure.

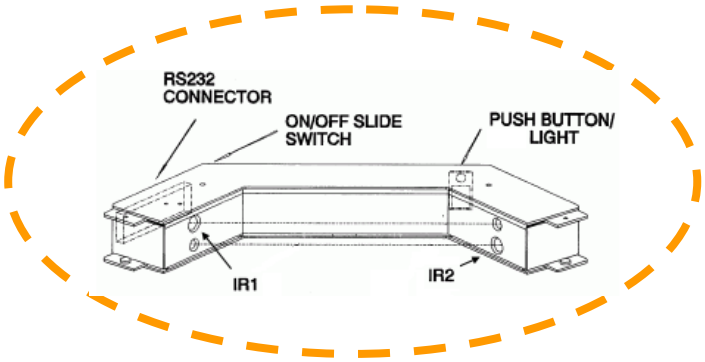
Whether or not the insulators are cleaned, the Positron Tester will detect conductive defects whether due to an internal defect in the insulator or due to surface pollution conductive defects under moist conditions. It is possible to test segments of the electrified insulators along a line to determine if they are defective, or if they will flashover due to pollution accumulation.

2.2.2 Advantages of Using Positron Testers (PID)

- Health detection of overhead insulators in advance of any failures;
- Enables the use of a defined maintenance schedule;
- Safety of maintenance crews and other personnel doing proximity works;
- Detects all internal insulator conductive defects;
- Detects defects due to surface contamination (moist conditions may be required to detect certain defects);
- Prevents outages and railway traffic delays;
- Reduces time to find defects and to perform appropriate maintenance;
- Reduces costs (for maintenance and operation of the railway traffic).

2.3 Overview

Model #3782101C/xx



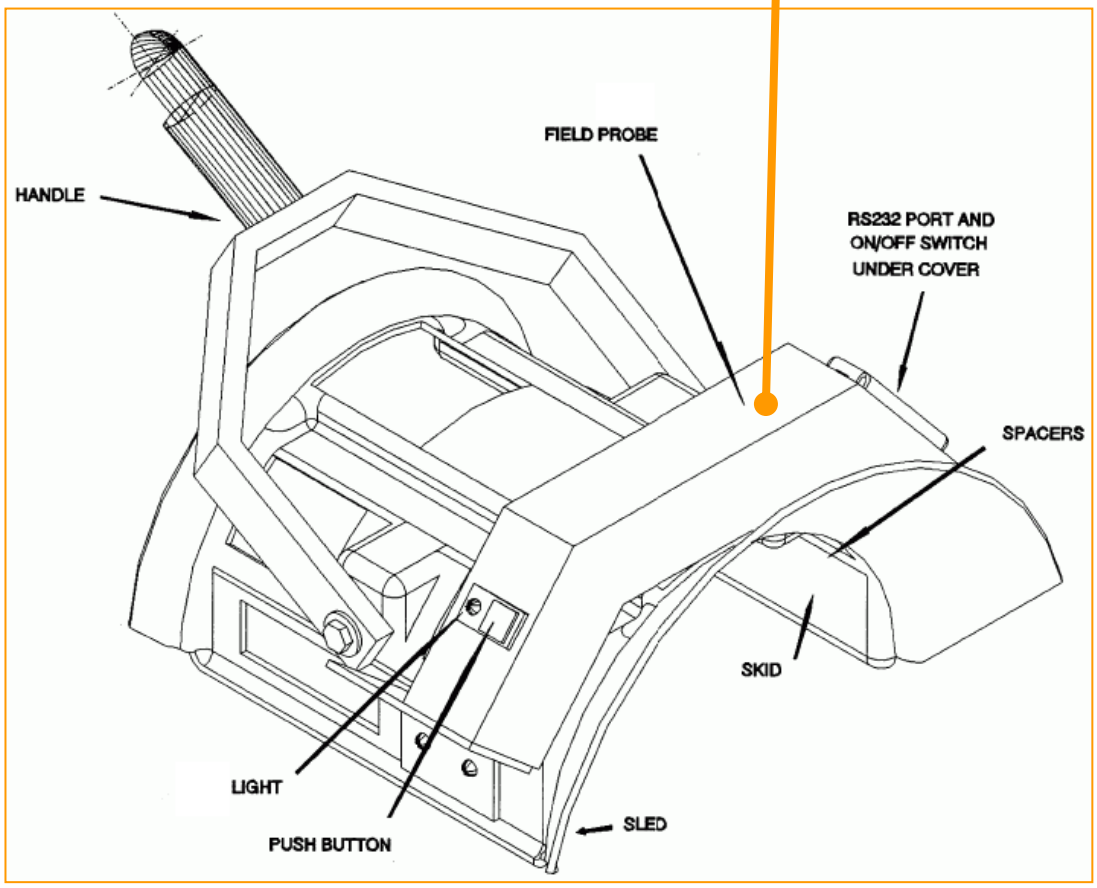


Figure 1: Composite Insulator Tester (C-Tester) Model #s 3782101C/50 (50Hz) & 3782101C/60 (60Hz)

2.4 Composite 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
Composite Railway Insulator tester, 60 Hz, standard 10" sled	3782101C/60
Composite Railway Insulator tester, 50 Hz, standard 10" sled	3782101C/50
220Vac/120Vac cable charger replacement	378126
Rechargeable battery pack replacement for the Probe	378127
12Vdc auxiliary automotive power cable charger replacement	378128
RS232 Long-range Bluetooth adapter replacement	378325/3
Replacement standard sled kit for 378210/xx	378610
50 Hz GO/NO-GO E-field Probe for Composite Insulators (no sled)	378608
60 Hz GO/NO-GO E-field Probe for Composite Insulators (no sled)	378612
Replacement cover plate for Probe power switch (Min Order 25 pcs)	378613

Chapter 3

Composite Insulator Tester Elements

3.0 Description of Composite (Polymeric) Insulator Tester Kit

3.1 The Composite Tester Kit

The Composite Tester kit consists of:

- User manual
- A Quick Start Guide
- A rugged carrying case
- An adjustable Composite (Polymeric) Insulator Tester Sled
- USB key loaded with Insulator Tester user manual and PC software installer
- A 12Vdc auxiliary automotive power cable charger
- Sled spacer set to accommodate various insulator sizes
- A long-range RS232 Bluetooth Serial Adaptor, pre-paired with the Tablet/Laptop
- A Tablet/Laptop with Insulator Tester Data Processing Software installed
- Plug-in wall transformer: 120Vac/220Vac input, 12Vdc output (includes international wall-plug adaptors)
- Spare switch cover

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

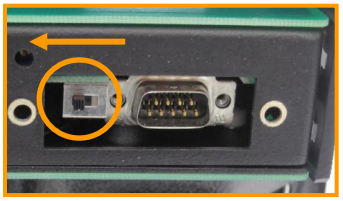
- a push-button
- a Status LED

Figure 2

An ON/OFF switch is located to the left of the RS-232 connector underneath the Power Switch Cover. Remove the Power Switch Cover and slide the switch to the right to switch the Insulator Tester on. Slide the switch toward the left to switch the Insulator Tester off. See Figure 3.

Location of Power Switch Cover

Power Switch Cover



Power Switch (OFF position)

Figure 3

CAUTION

DO NOT TURN THE POWER SWITCH OFF BEFORE DOWNLOADING THE DATA.
When the power is turned off the accumulated data in the Probe is lost.

The Insulator Tester uses two infrared detectors to find the location of each E-Field reading. Please refer to Figure 4. The two infrared detectors are identified as IR1 and IR2.

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

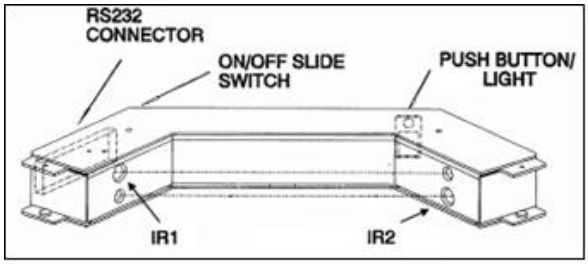


Figure 4

3.2 Tester Charger

The Insulator Tester'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 Insulator Tester. A set of AC charger adaptors is provided to accommodate various country standards. For charging the Insulator Tester 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 the charging status. 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.

NOTE

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

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

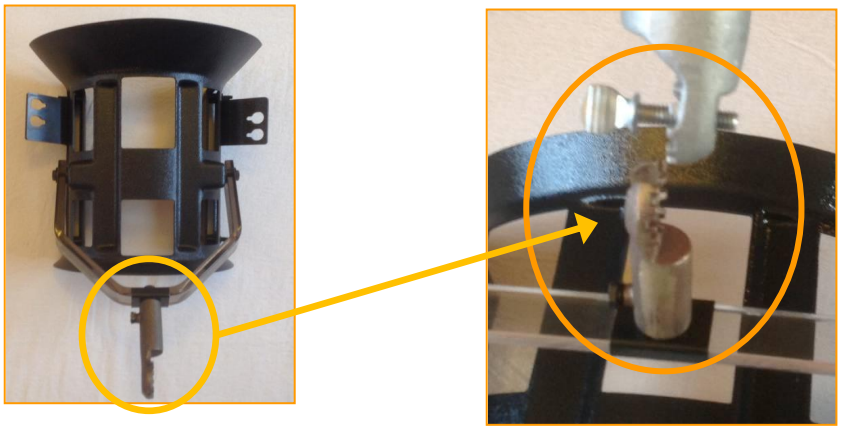
CAUTION

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

3.3 Insulator Tester Sled

The Insulator Tester mounts on a non-metallic sled. The sled permits the Insulator Tester to slide along an insulator string.

Together, the sled and Insulator Tester attach to a hot stick via the coupler mounted on the sled's bracket. See Figure 5.



Insulator Sled for #3782101C/x

Insulator Tester Sled Hot stick Coupler

Figure 5

3.4 Sled Adjustments

The sled is equipped with adjustable skids to accommodate the different insulator sizes. A spacer kit is provided if the sled skids require adjustment. See Figure 6.

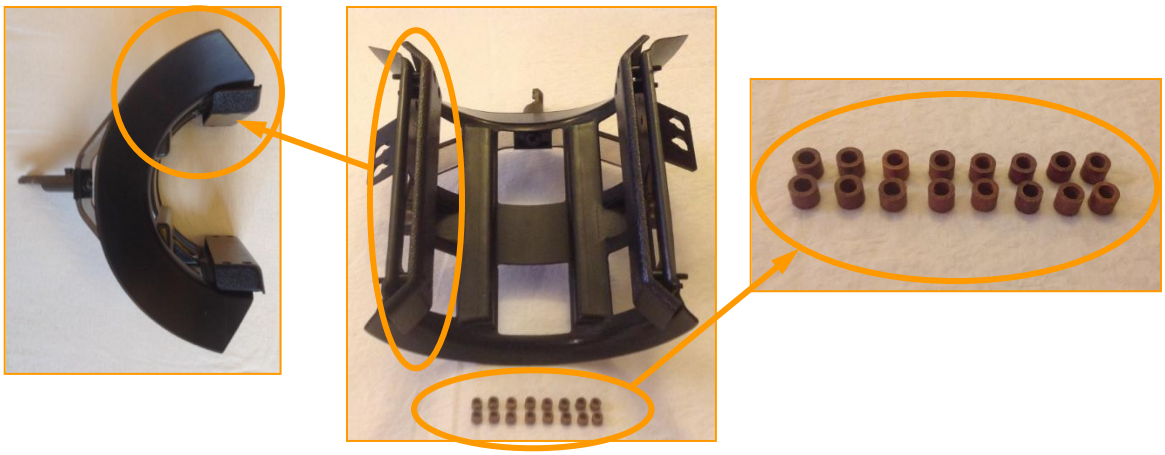


Figure 6

3.5 Placement of Probe on the Insulator Sled

The Composite Insulator Probe attaches to the companion sled via four key-hole openings on the insulator sled. Note that the Probe is skewed when attached to the sled to make the skirt thickness larger as seen by the IR detectors. See Figure 7.

GO/NOGO Insulator Tester
#3782101C/x

Figure 7

3.6 Tablet/Laptop

3.6.1 General

A Tablet/Laptop is provided with the Insulator Tester. The Tablet/Laptop is Bluetooth-enabled and is shipped paired with the long range Bluetooth adapter of the Probe. Refer to Figure 8.

The Insulator Tester Data Processing Software is pre-installed on the Tablet/Laptop.

Figure 8

The Tablet/Laptop is used on-site for transfer of the data from the Insulator Tester after one or more scans of one insulator to immediately view the resulting graphs (interactive mode). The resulting graph can immediately be viewed enabling **GO/NOGO** decision making for immediate insulator replacement or establishing relative safety for live-line work. The transfer of data to the Tablet on-site also avoids the risk of data loss should the tester be switched off after testing.

CAUTION

The Tablet/Laptop should <u>not</u> be used by the same technician performing the tests on the insulators for safety reasons. The Tablet/Laptop is to be operated by a member of the Ground Team (Tablet Operator).

3.6.2 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 9. 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.

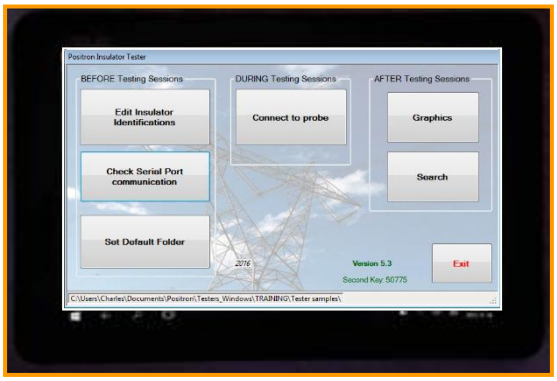
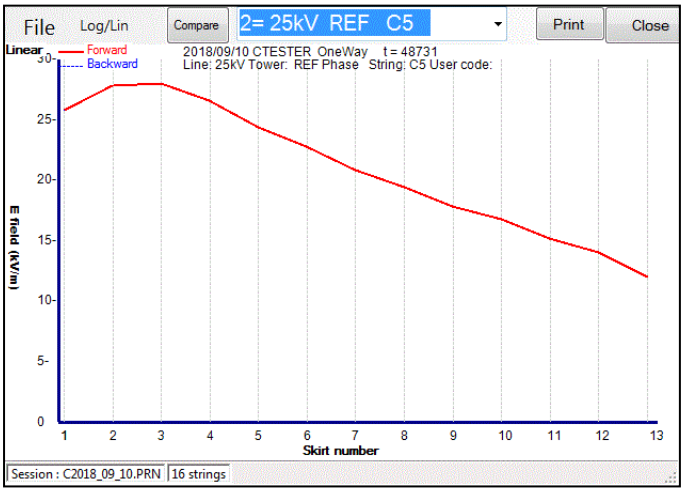


Figure 9

Large *"Touch Buttons"* are used to operate the Windows-based Positron Insulator Tester Software in the field.

The person on the ground uses the Tablet while the Tester Operator scans the Composite Insulators. When they have completed one or more tests, they download the results immediately to the Tablet to see the profile of the E-field surrounding the tested insulator, thereby revealing its health, and determining immediately if a hazardous condition exists.



Example Only

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 (Select 100% after selecting the small battery icon).

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^{o} 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 was factory-installed on the Tablet/Laptop shipped with the Insulator Tester. Similarly, the long-range 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 create and store one or more lists of insulators to identify the insulator to test and the condition of each insulator prior to generating a graph of the insulator E-field
- To test the Bluetooth communication between the Tablet and the Insulator Tester
- To set up a working folder

B) **DURING** the testing session

- To remotely download the data scanned by the insulator tester
- To identify last scanned insulator from the list
- To display the graphic representation of the E-field along with the identification of the insulator
- 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 after the testing of all insulators in the structure

C) **AFTER** the testing session

- To use as a reference database to evaluate insulator degradation over time
- To display the relative health of insulators using graph of the E-field along an insulator during live-line conditions
- To use this information to determine where and when preventative action needs to be taken to prevent failures
- To use as a tool in the asset management associated with all manner of HV Composite (Polymeric) insulator 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 and has been paired with the Tablet/Laptop supplied with the Composite Insulator Tester.

4.3 Instant Graphical GO/NO-GO Reporting Capability

The Positron Composite Insulator Tester enables on-site a **GO/NOGO** decision making capability. A scan instantly downloaded to the Tablet/Laptop from the Probe is used to get a graphic representation of the E-field distribution of a composite (polymeric) insulator showing any floating or connected defects. A decision emergency replacement or establishing safety levels for live-line work can then be made.

During the scanning of a railway insulator, the Insulator Tester Operator manipulates the Insulator Tester with a hot stick, while the Tablet Operator uses the Tablet/Laptop. Once the scan is done, the Tablet Operator can immediately download the data to get the graphic representation of the distribution of the E-field along the composite (polymeric) insulator.

Once the Tablet Operator has downloaded the data from the Insulator Tester and has viewed the graph of the insulator's 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 Insulator Tester gathered during the scan will be deleted after download to the Tablet/Laptop.

Chapter 5

Using the Composite Insulator Tester & Software

5.0 Using the Composite Insulator Tester & Software

The Composite Insulator Tester and Tablet/Laptop are used together in the field. The Tablet Operator controls the Tablet/Laptop running the Windows-based Insulator Tester Software while the Insulator Tester Operator controls the Composite Insulator Tester and scans the insulator.

After a scan of a composite (polymeric) insulator, the Tablet Operator can instantly download the resulting data obtained by the Insulator Tester Operator. Once downloaded, the Tablet Operator can view the E-field profile of the scanned insulator on the screen of the Tablet/Laptop and the relative health of the insulator can be assessed while in the field.

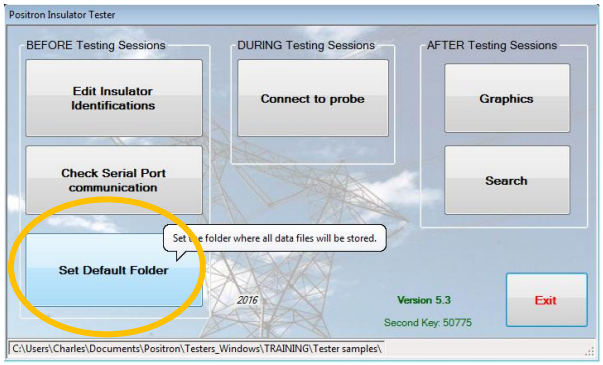
Using the Tablet/Laptop, the Tablet Operator can choose to **Accept** or **Reject** the scan. In both cases, once a choice has been made by the Tablet Operator the data in the Insulator Tester is erased. If the choice is made to **Accept** the scan, the data is stored on the Tablet/Laptop.

5.1 BEFORE Testing Sessions

If required, adjust the date and the time of the tablet. Begin by double-clicking the Insulator Tester icon. Ensure that the Bluetooth feature is enabled on the Tablet/Laptop.

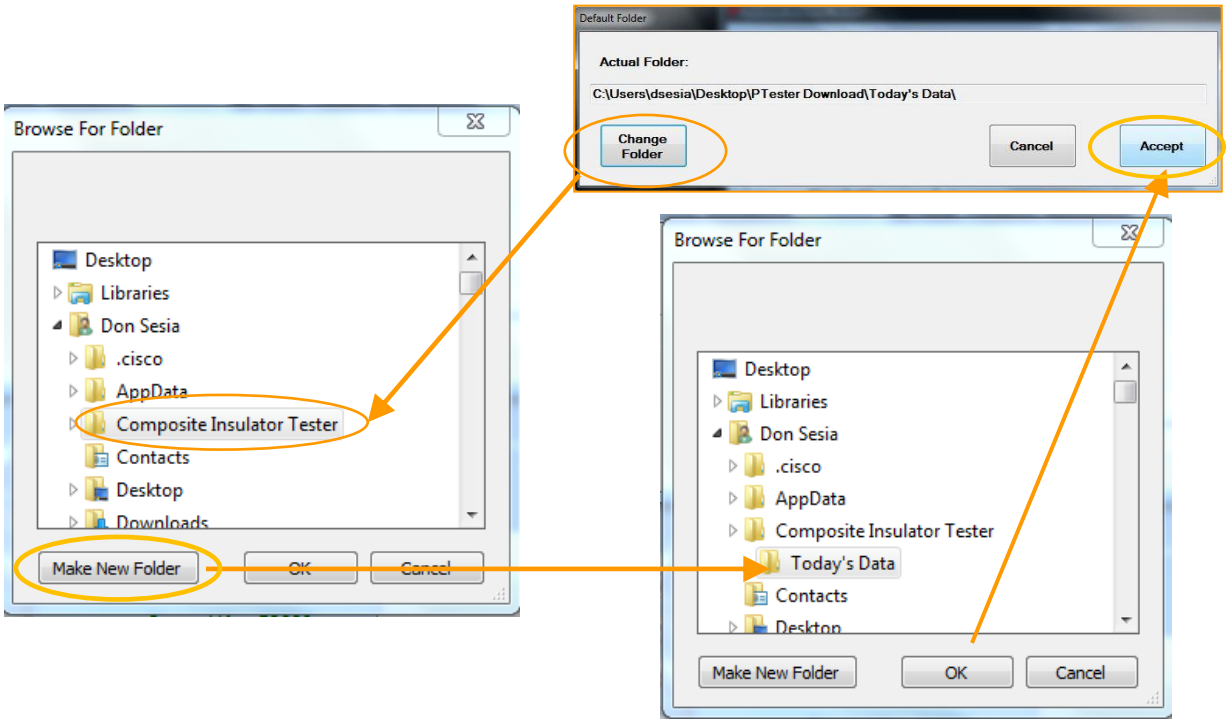
5.1.1 Select the Default Folder

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

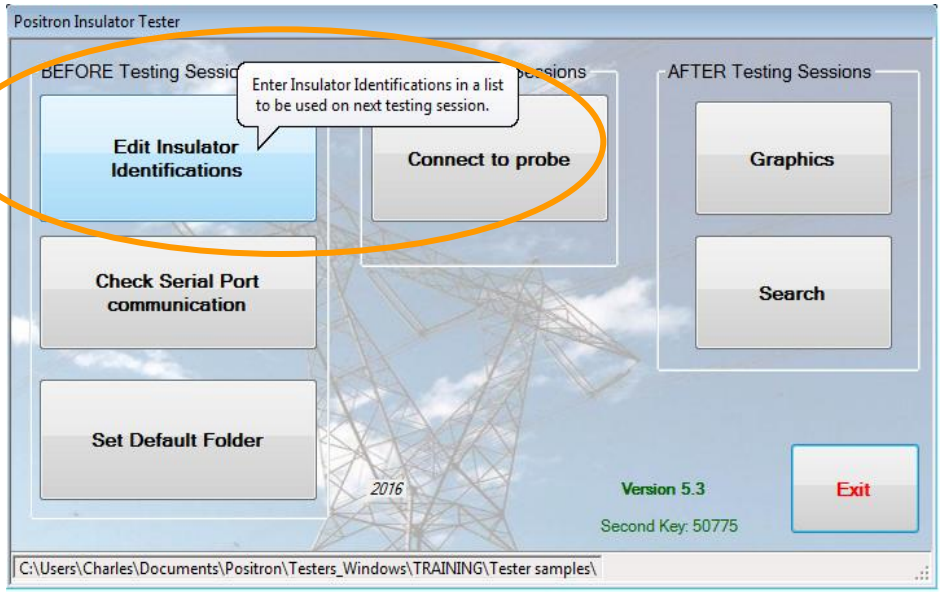
Create a listing of all Insulators to be tested during an upcoming Testing session. This list will be used during a testing session to identify each insulator. This is best done with the Tablet engaged with the keyboard for ease of typing.

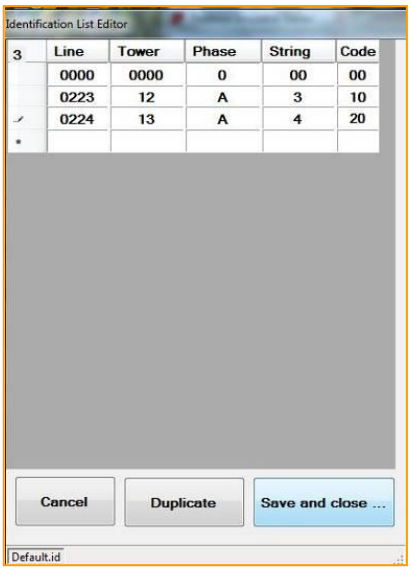
To create an Insulator Identification List, you have 3 choices:

- 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 Railway entity 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.

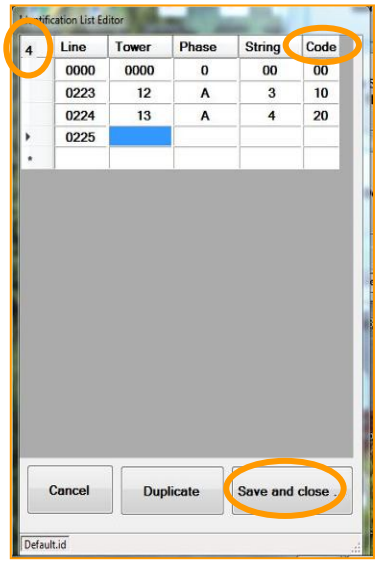
A dialogue window will open so you can open the **Default.id** file. This will be used to enter the information identifying the insulators to be scanned.





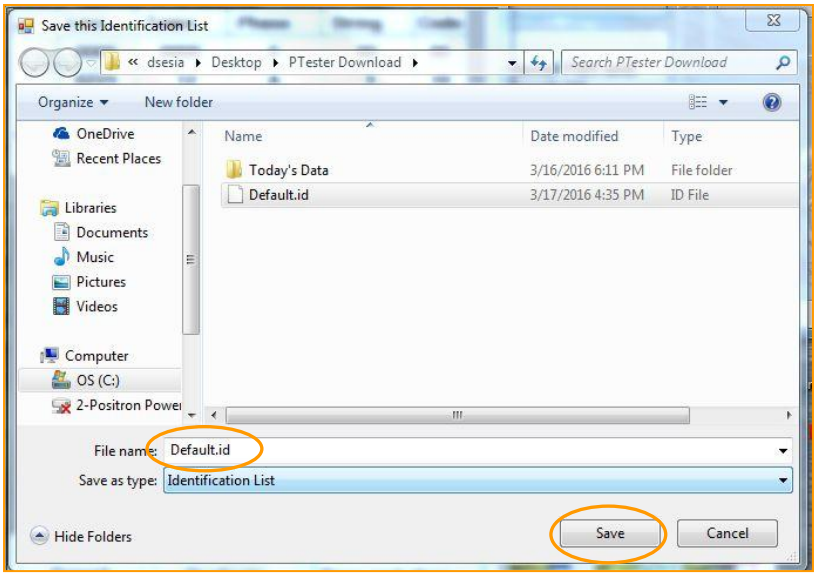
The **Identification List Editor** will open. Edit a field by clicking into it and move to the next field using the **TAB** key on your keyboard. The **ENTER** key will bring you to the field immediately beneath.

With the list completed, select **Save and Close**. This will open the **Save this Identification List** dialogue box.



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.

Enter any user defined code in the **Code** field. 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

Prior to going out in the field to use the Composite Insulator Tester, testing the Bluetooth communication between the Insulator Tester and the Tablet/Laptop is advised. This can only be done with the PC Insulator Tester software activated. After communication has been established, the Insulator Tester and Bluetooth adaptor can be switched off again before going out into the field.

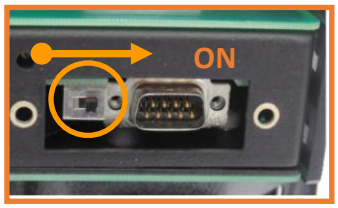
5.1.5 Switching the Probe On

To switch on the Insulator Tester, remove the Power Switch Cover and move the power switch to the right, toward the DB-9 connector, as shown in Figure 10. The Insulator Tester will first enter the Power-On Self-Test (**POST**). See 5.1.5.1 for details.

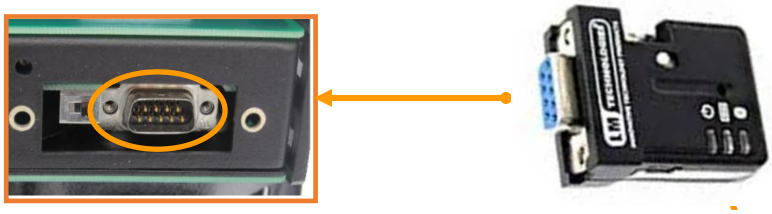
Ensure the slide switch on the Bluetooth adapter is in the DCE position. Insert the Bluetooth Serial adapter into the DB-9 Serial port of the Insulator Tester Probe. The Bluetooth Serial adapter is powered by the battery of the Insulator Tester.

Location of Power Switch Cover

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 10

5.1.5.1 Power-On Self-Test (POST) of the Insulator Tester

During the Power-ON Self-Test, the Infrared transmit/receive interfaces are tested to insure that the two IR receivers can detect the following 2 states:

- Presence of infrared on the two IR receivers,
- Absence of infrared on the two IR receivers.

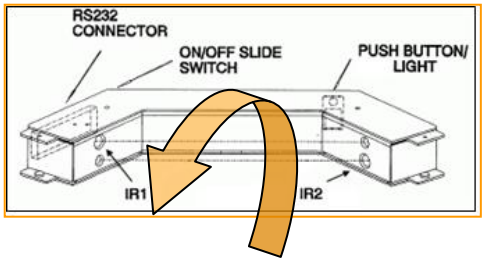
This is implemented the following way in this order:

1. After the memory test (Green LED flashes 4 times), the 2 IR receivers must detect the **presence** of infrared,
2. Then the sound beeps and the LED will flash Amber up to 10 seconds till the 2 IR receivers detect the **absence** of infrared.

The operator should manually interrupt the Infrared beams immediately after the start of the sound to make sure the 2 states of the Infrared are verified. Otherwise, only the "presence of infrared" state will be verified.

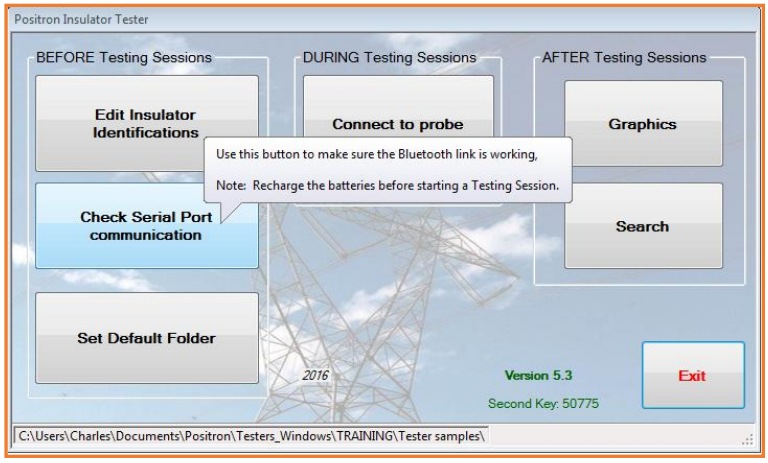
Once the infrared beams have been broken, or after flashing 10 times, the LED and the tone will turn off.

Once the Insulator Tester 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.

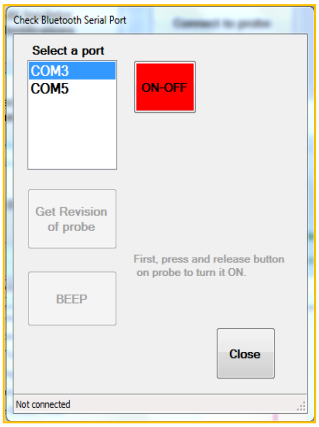


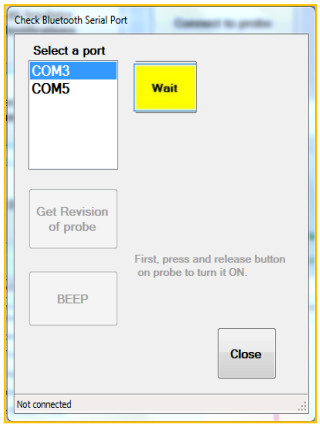
5.1.6 Check Long-Range Bluetooth Serial Port Communication

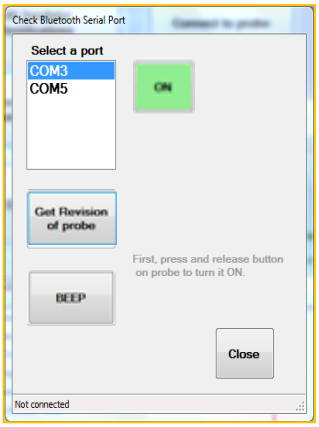
Select the **Check Serial Port Communication** button to verify long range Bluetooth connectivity between the Tablet/Laptop and the Insulator Tester prior to going into the field.



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



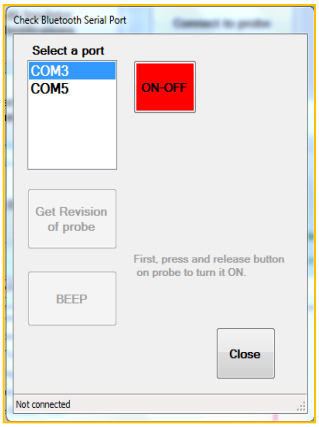


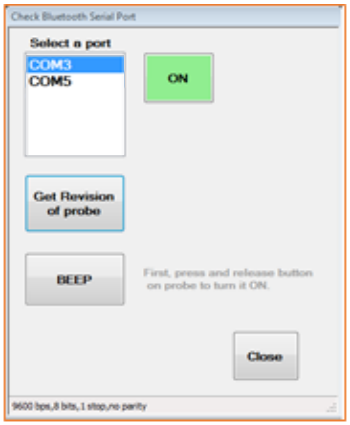


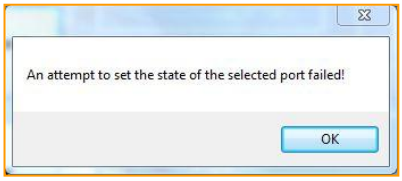
Select the RED **ON-OFF** button. The button will turn YELLOW and "Wait" will appear until Bluetooth communication is established, and then it will turn GREEN.

NOTE

If the button does not turn **YELLOW** and read "Wait", but turns **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 Insulator Tester's Bluetooth RS232 Adapter. Take note of the COM port associated with the Bluetooth Adapter. This COM port will need to be reconnected once the unit is taken to the field for a scanning session.

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

NOTE

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

5.1.7 Get (Firmware) Revision of the Probe

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

Once you have selected **Get Revision of Probe,** communication between the Tablet and Insulator Tester is established. Ensure that the Probe is in **Awake Mode** by pressing the push button of the Insulator Tester Probe. See Figure 11. If required, select **BEEP** after the Probe is awakened. The Probe will respond with a BEEP tone.

This step verifies that the Tablet/Laptop can communicate with the Probe. Once Bluetooth connectivity and functional communication are verified, the Probe can be switched off after pressing the Close button. The Probe will be switched on again in the field when scanning is to begin.

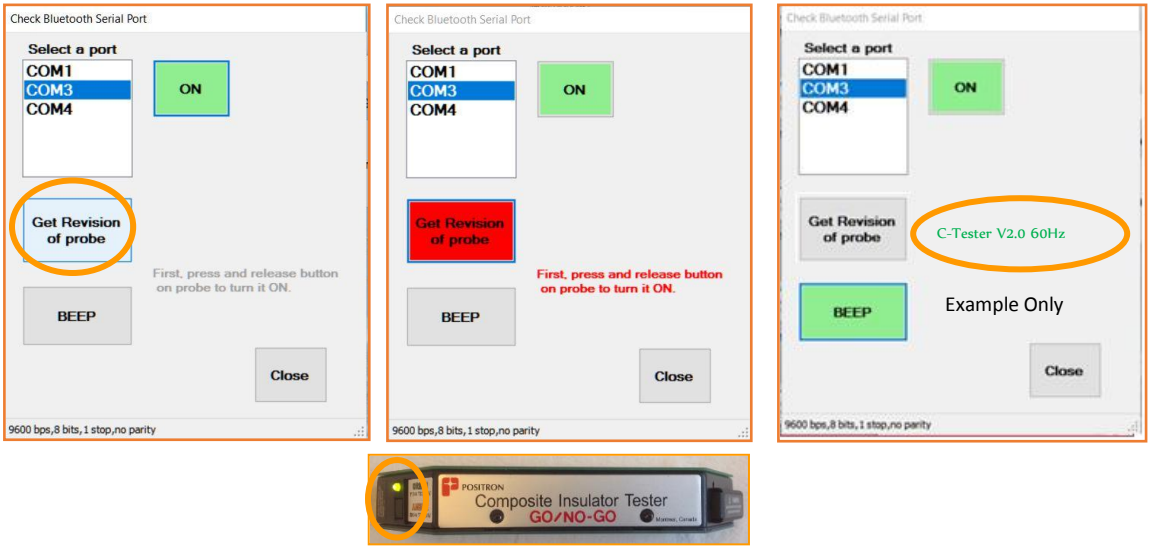


Figure 11

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 interference with the long range Bluetooth link while performing a testing session.

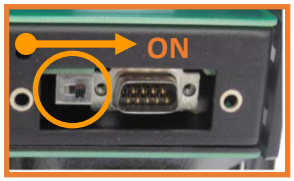
Equipped with the Tablet separated from the keyboard, the Tablet Operator launches the Insulator Tester Software. Optionally, the camera of the Tablet/Laptop can be used take a picture of the tested structure.

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 12. The Probe will first enter the Power-On Self-Test (**POST**) as described in 5.1.5.1.

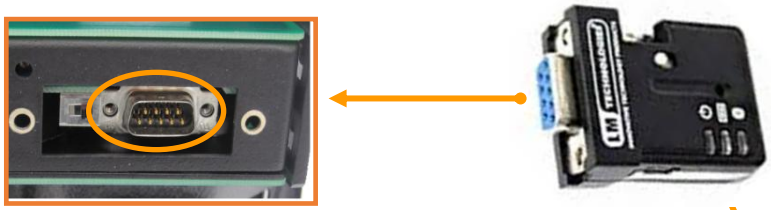
Ensure the slide switch on the Bluetooth adapter is in the DCE position. Insert the Bluetooth Serial adapter into the DB-9 Serial port of the Insulator Tester Probe. The Bluetooth Serial adapter is powered by the battery of the Insulator Tester.

Location of Power Switch Cover

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

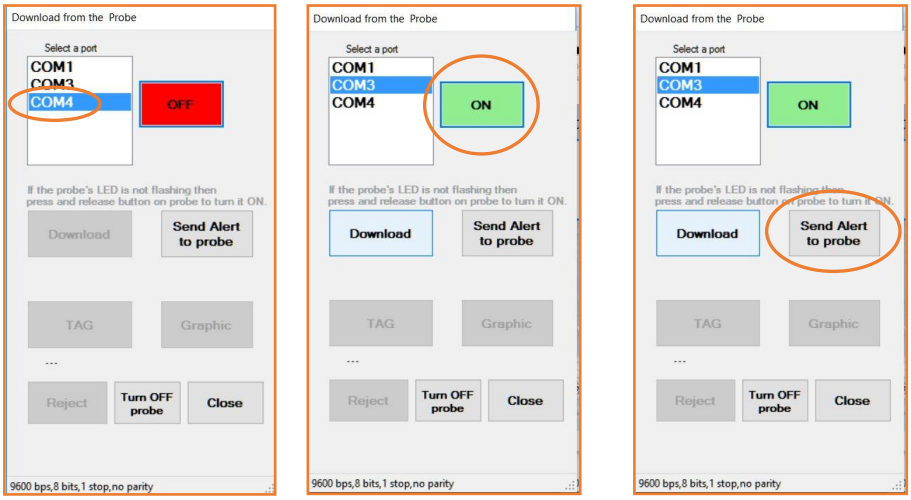
NOTE

It is important to avoid moving the Insulator Tester backward at any time during the execution of a scan of the Composite (polymeric) insulators.

Ensuring that the Insulator Tester 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 Insulator Tester Operator can now proceed. Once in position, the Insulator Tester Operator should press the Insulator Tester's button to ensure it is in **Awake Mode**. If not, the Tablet Operator will be unable to signal the Insulator Tester. Ensure that the LED of the Probe is flashing GREEN.

After 8 minutes of no communication, the Insulator Tester will go into Sleep mode. The Tablet Operator can keep the Insulator Tester 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 Scanning a 25kV Composite (Polymeric) Railway-Insulator

5.2.1.1 Performing a Horizontal Scan of a Insulator

Once the Composite Insulator Tester is securely fastened to the sled and the hot stick is attached, follow this procedure, per Figure 14:

1. Following the instructions of the Tablet Operator, if the LED is not flashing, press the Push-button on the Insulator Tester (See Figure 13) and place the Insulator Tester as close as possible to the high-voltage end of the composite (polymeric) insulator.

Figure 13

NOTE

It is best if two operators are working together with a compound hot stick as shown in Figure 14. **Operator B** maintains the upward pressure required to maintain the tester's contact with the composite insulator, while **Operator A** also exerts a tangential upward pressure to move the tester along the skirts of the Composite

2. Slide the tester along the Railway Composite Insulator from the high-voltage end toward the low-voltage end of the insulator. A tone will sound each time a reading is taken at each insulator skirt (shed).
3. Remove the Insulator Tester from the insulator and wait for the download initiated by the Tablet Operator.
   - 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 Insulator Tester leaving the Insulator Tester ready for the next scan.
   - The Tablet Operator selects **Send Alert to Probe** and the annunciating tone attracts the attention of the Insulator Tester Operator so the Tablet Operator communicates the next step to the Insulator Tester Operator.
   - This process is repeated for each insulator.

Performing a Horizontal Scan

- Operator **A** and **B** place the Tester on the **high-voltage** end of the insulator
- Operator **A** applies a moderate upward pressure and moves the Tester toward the **low-voltage** end
- Operator **B** follows the motion of Operator **A**, also moving the hot-stick slightly downward as the sweep progresses to the **low**-voltage end.

NOTE

- It is important to position the Operators as shown coordinated with the direction the tester is to be moved.

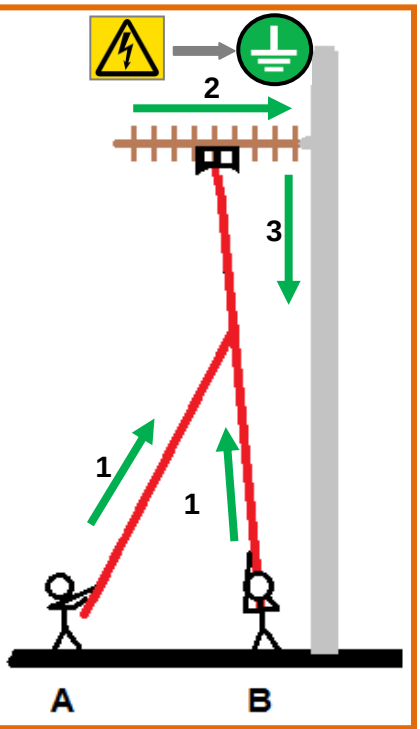


Figure 14

5.2.1.2 Performing an Angular Scan

Once the Composite Insulator Tester is securely fastened to the sled and the hot stick is attached, follow this procedure, per Figure 16:

1. Following the instructions of the Tablet Operator, if the LED is not flashing, press the Push-button on the Insulator Tester (See Figure 15) and place the Insulator Tester as close as possible to the high-voltage end of the composite (polymeric) insulator.

Figure 15

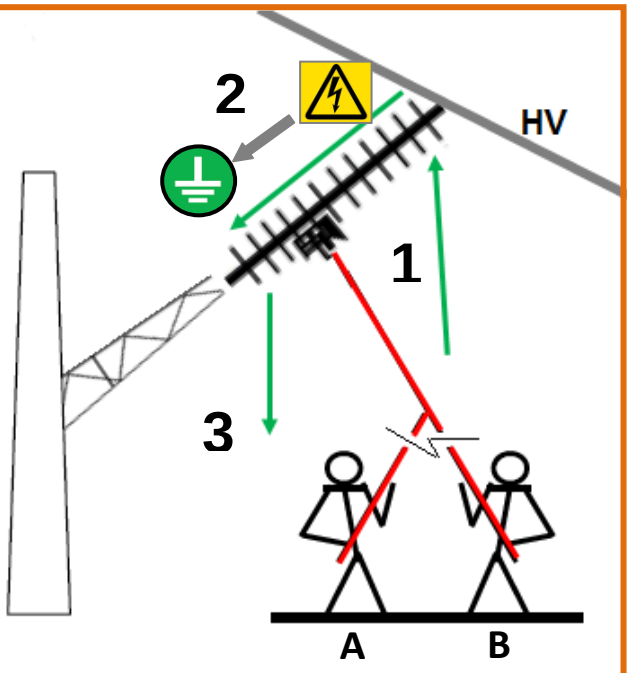
NOTE

It is best if two operators are working together with a compound hot stick as shown in Figure 16. **Operator B** maintains the upward pressure required to maintain the tester's contact with the composite insulator, while **Operator A** also exerts a tangential upward pressure to move the tester up along the skirts of the Composite

2. Slide the tester along the Railway Composite Insulator from the high-voltage end toward the low-voltage end of the insulator. A tone will sound each time a reading is taken at each insulator skirt (shed).
3. Remove the Insulator Tester from the insulator and wait for the download by the Tablet Operator.
   - 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 Insulator Tester leaving the Insulator Tester ready for the next scan.
   - The Tablet Operator selects **Send Alert to Probe** and the annunciator tone attracts the attention of the Insulator Tester Operator so the Tablet Operator communicates the next step to the Insulator Tester Operator.
   - This process is repeated for each insulator.

Performing an Angular Scan

- Operator **A** and **B** place the Tester on the **high-voltage** end of the insulator
- Operator **B** applies a moderate upward pressure.
- Operator **A** draws the Tester toward the low voltage end of the insulator while Operator **B** maintains a steady upward pressure until the scan is complete**.**



NOTE

- It is important to position the Operators as shown coordinated with which the direction the tester is to be moved.

Figure 16

5.2.1.3 Performing a Vertical Scan

Once the Composite Insulator Tester is securely fastened to the sled and the hot stick is attached, follow this procedure, per Figure 18:

1. Following the instructions of the Tablet Operator, if the LED is not flashing, press the Push-button on the Insulator Tester (See Figure 17) and place the Insulator Tester as close as possible to the low voltage end of the composite (polymeric) insulator.

Figure 17

2. See Figure 18. **Operator A** maintains a slight pressure required to maintain the tester's contact with the low-voltage end of the composite insulator. Operator A draws the tester down along the skirts of the insulator towards the high-voltage end of the composite insulator. A tone will sound each time a reading is taken at each insulator skirt (shed).
3. Remove the Insulator Tester from the insulator and wait for download by the Tablet Operator.
   - 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 Insulator Tester leaving the Insulator Tester ready for the next scan.
   - The Tablet Operator selects **Send Alert to Probe** and the annunciating tone attracts the attention of the Insulator Tester Operator so the Tablet Operator communicates the next step to the Insulator Tester Operator. This process is repeated for each insulator.

Performing a Vertical Scan

- Operator **A** places the Tester on the **low-voltage** end of the insulator
- Operator **A** applies a moderate pressure against the insulator.
- Operator **A** moves the Tester down towards the **high-voltage** end of the insulator while maintaining a steady pressure until the scan is complete**.**
- **It is important to note that the resulting graphs will be rendered horizontally flipped compared to scans performed from the high-voltage end to the low-voltage end of the insulator**

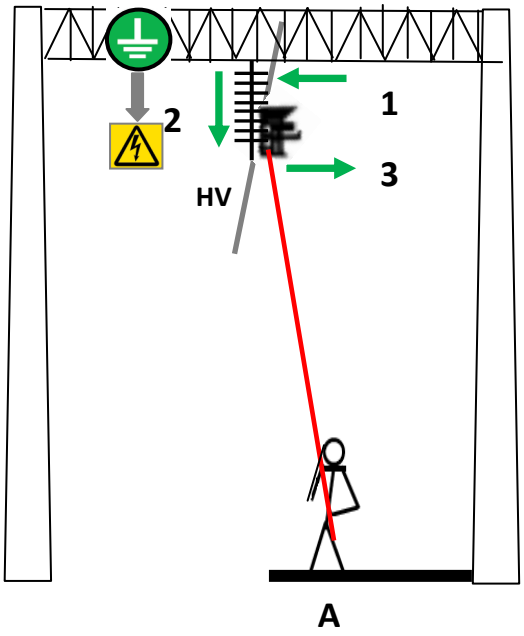


Figure 18

NOTE

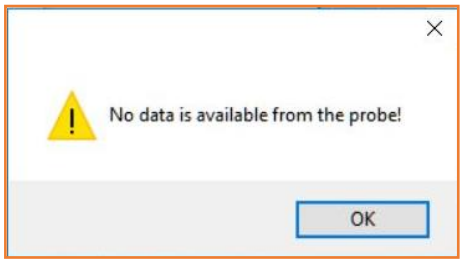
It may also be required to move the tester near the High Voltage end, without making contact with it, to trigger the E-Field detector before starting a scan. A beep with sound once the E-Field has been detected by the tester, then at each skirt thereafter.

5.2.2 Downloading Data

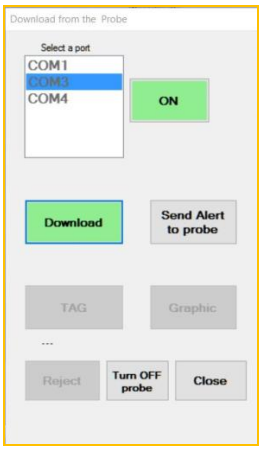
The result of the scan is immediately downloaded and viewed on the Tablet/Laptop PC.

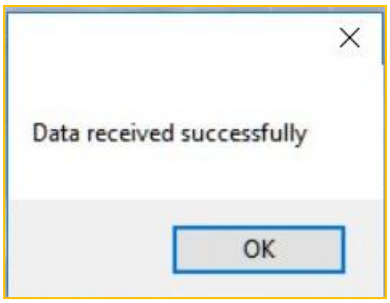
NOTE

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 Insulator Tester, but that there is **no** data in the Insulator Tester to download. The **Download** button will still turn **GREEN**, indicating that the Windows-based Insulator Tester Software is able to communicate with the Insulator Tester, but that no data was resident.



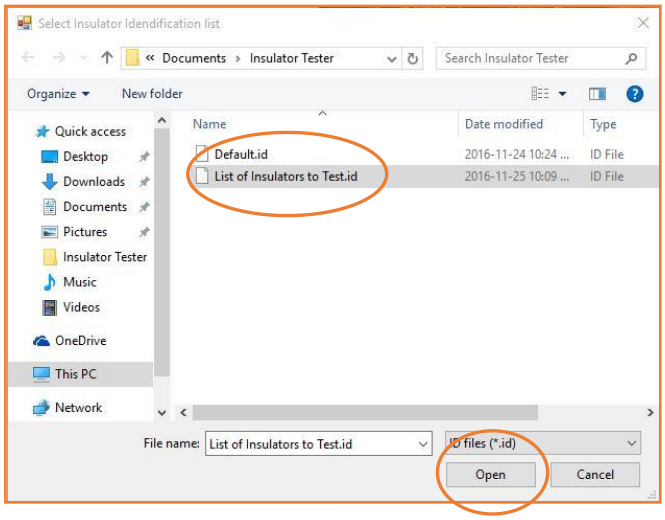
A successful **Download** will be confirmed by a system message stating **Data received successfully** and the **TAG** button will turn **GREEN.**

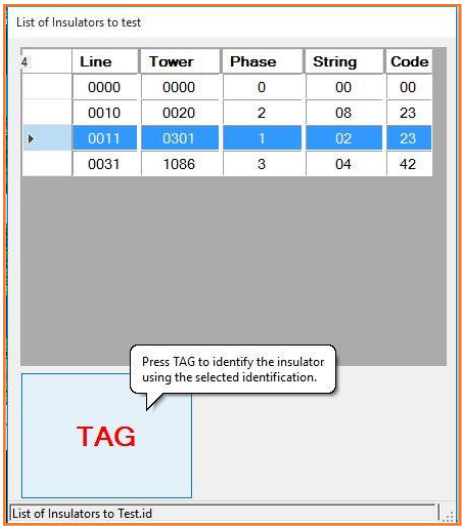




The **Download from the Probe** dialog box will open, showing the graph of the E-Field of the scanned insulator. From this screen, you can associate the insulator scan with an ID created earlier in the Insulator Identification List.

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





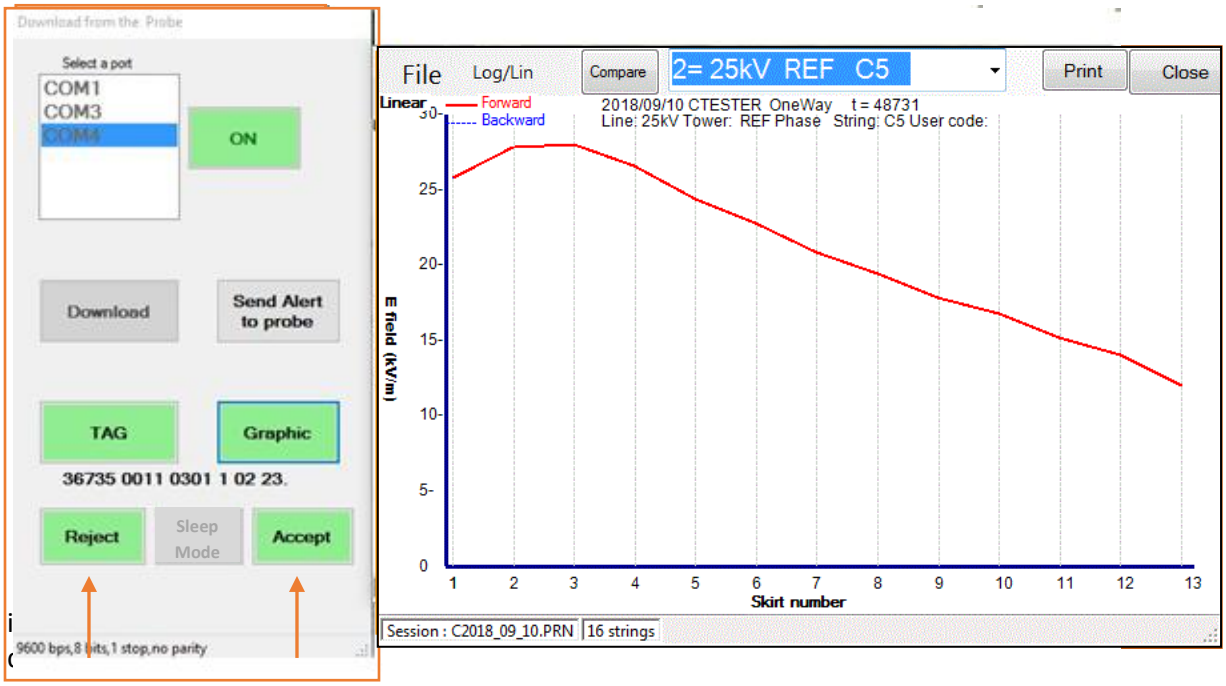
From the **Select Insulator Identification List** you can select and open the Insulator ID List created before the testing session.

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

Select **Graphic** to see one or more graphs of the E-Field from scans of the last tested insulator. If more than one scan was done on the last tested insulator, click or touch the displayed graphic to see the next 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
- **Shed missing:** The sled jumped over a shed or skirt because the operator didn't apply enough pressure on the hot-stick
- **Curves don't match:** If two scans have been performed, the two curves should be almost identical
- **Practice session:** The first time, it is recommended to perform some "dummy" scans to get used to the manipulation of the hot-stick



If **accepted**, the data from one or more scans, with the unique identifiers, is retained in the results database of the Insulator Tester Software database.

In the example shown below, 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 Insulator Tester Operator by selecting **Send Alert to Probe** and issue the verbal instructions for another insulator scan.

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

A) Select **Sleep Mode to** put the Insulator Tester into **sleep mode** (The Insulator Tester can be awakened by pressing the Push Button of the Insulator Tester).

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

If during the process any of the software interface buttons turns 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.

5.3 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 insulator 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 structures and insulators identification.
- The database created would contain only the E-Field data. The insulator and structures identifications associated with the E-field curves would therefore not be included within the database for future use.

Advantage of using the Tablet/PC with Bluetooth:

- The use of the tablet enables the manager to download or type in a list of the structures and railway insulators 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 structures and railway insulators tested data curves with the structure identification and each railway insulator. The curves are instantly tagged by the Tablet Operator to the structure and railway insulator 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.

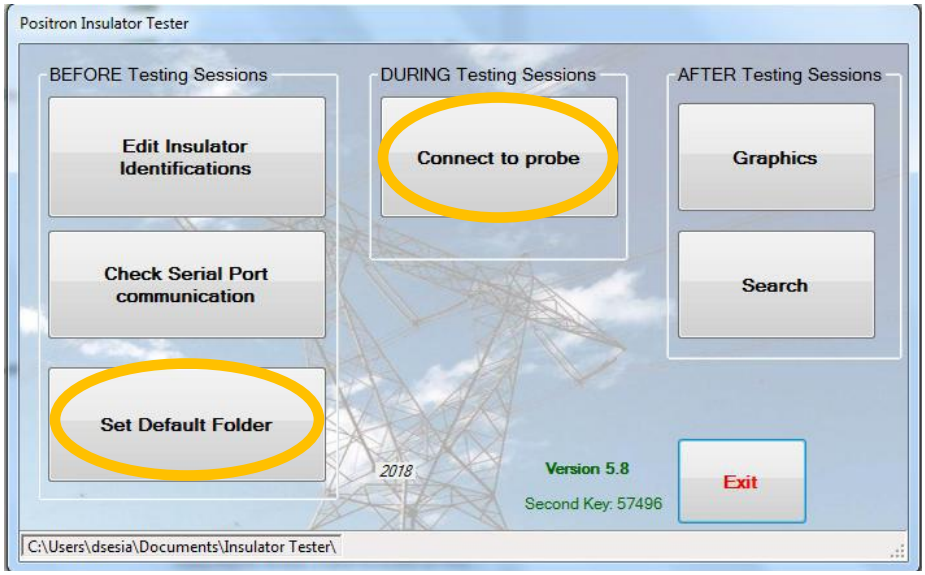
The following procedure is applicable ONLY for bulk download from the probe if the tablet and Bluetooth are not used in the field. Disregard this procedure when using the Positron Tester in the recommended manner with the tablet/PC and Bluetooth while using the Tester in the field.

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)

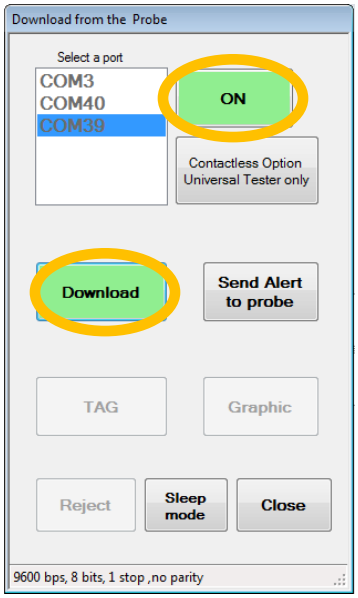
2- Press the push button on the probe

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**"

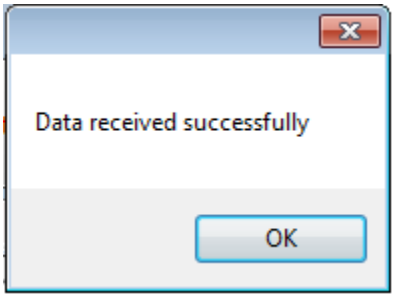


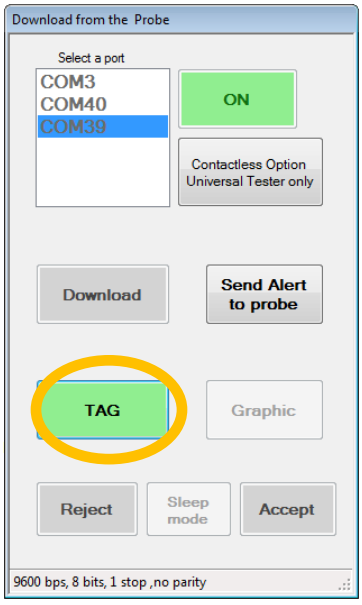
Main Menu

4- Select the COM port and press "**Download**"

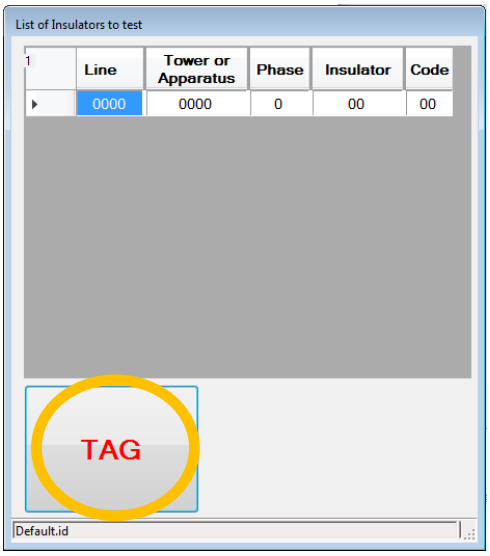


5- After receiving the message "**Data received successfully**", press the "**TAG**" button

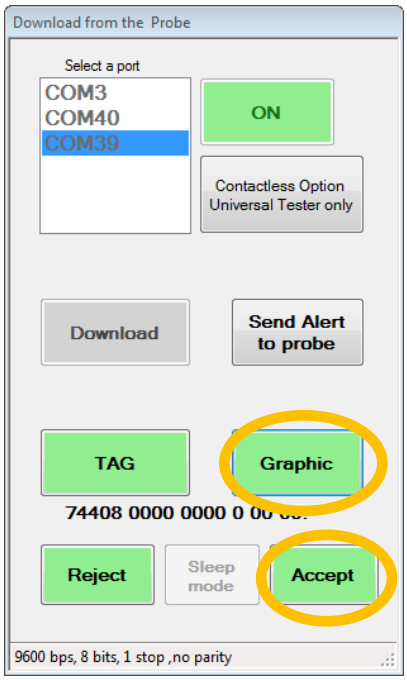


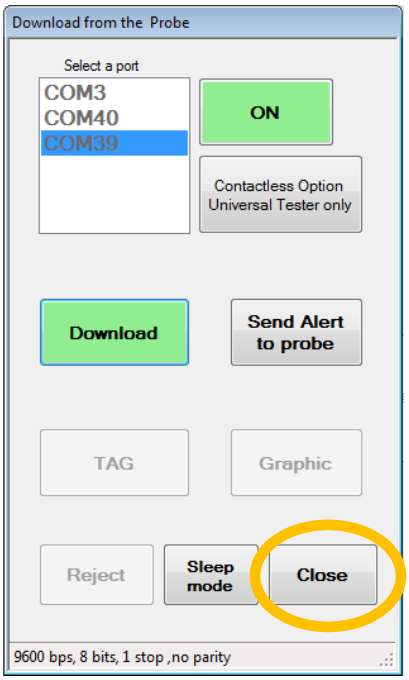


6- Select “Default.id” file, select the first line in the list then press on “TAG” button



7- Press “**Graphic**”, close the graphic displayed, press “**Accept**” then press “**Close**”





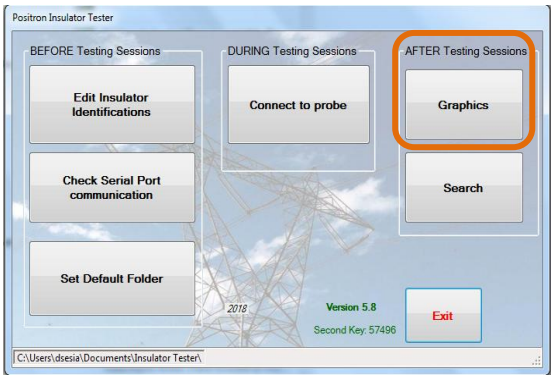
8- The E-field data is stored in the database located into the previously selected folder. The database consists in two ASCII files: Date.PRN and Date.LOG.

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.

5.4 AFTER Testing Sessions

5.4.1 Displaying Graphs

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

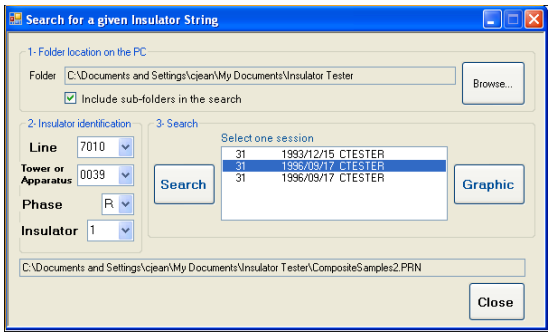


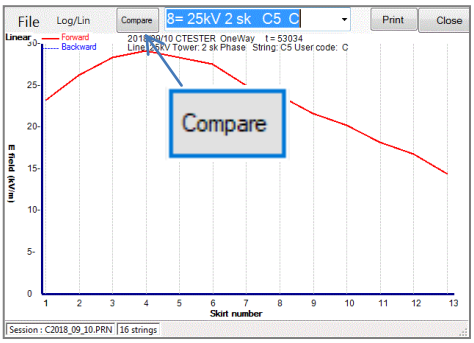
5.4.2 Searching the Database

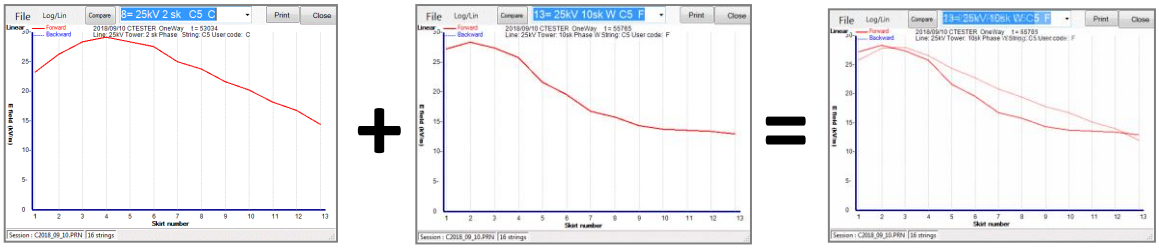
Search a database for a given insulator in the database to evaluate its degradation over time. See Section 6.6 for a description of superimposed graph comparison.

To **search** for an insulator:

- Browse and select the “**Search**” button from the menu of the Insulator Tester Software,
- Select the folder (and optionally all its subfolders)
- then choose an insulator
- display the chosen insulator
- select the next insulator
- display its graphic and reduce its opacity to superimpose many graphics
- the degradation over time becomes evident







One graph superimposed on another using the **Compare** feature

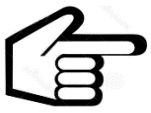
5.5 Important General Notes

- ✓ Always use the same Bluetooth adapter with its paired Tablet/Laptop.
- ✓ If the Insulator Tester has not been used for more than six (6) months, recharge its Ni-Cad battery before turning ON the power of the Insulator Tester.
- ✓ The Insulator Tester'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 two days.
- ✓ Recharge the battery of the Insulator Tester and the Tablet/Laptop before a day of testing.
- ✓ Switch the power OFF when the Insulator Tester 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 turn the light OFF.
- ✓ Do not use the Insulator Tester 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 Insulator Tester 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 Insulator Tester OFF while the battery is recharging. Under normal circumstances, it is not necessary to turn the Insulator Tester OFF during a recharge.

Switching the Insulator Tester OFF will erase all data in the Insulator Tester.

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.

WARNING



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.

Chapter 6

Interpreting Graphic Results

Electric Railway Application

6.0 Interpreting Graphed Results

6.1 Understanding the Graphs

The data transfer software on the Tablet/Laptop creates ASCII files. MS-Excel or any text editor, such as Microsoft NOTEPAD, can import these files. The tagging of an insulator creates, an ASCII file ".LOG", which contains time tag and insulator identification pairs. The associated data file ".PRN" contains the same time tag which is used to identify the data. See Figure 17 for a description of the fields shown on the graphs.

A) **Log/Lin** indicates the scaling of the graphic results of the scans, and is selectable. This graph is shown using LINEAR scaling.

B) Shows the date and type of scan and the type of insulator tester (CTester = Composite Tester)

C) Detailed information of the scanned insulator taken from the user's insulator list.

D) "t = 48731" indicates the number of seconds since midnight. In this case, this represents approximately 14:32H, local time.

E) This pull-down menu allows the selection of an insulator identification, dependant on how the data is entered when creating the Insulator Identification List. (See Section: 5.1.3)

   i. **"25kV"** identifies the particular power distribution line being scanned

   ii. **REF** means that this is a reference graph of a known-good C5 polymeric insulator

   iii. **C5** indicates the type of polymeric insulator being tested

   iv. The last two characters, if used, can be any alphanumeric characters chosen by the user. These last 2 characters are not used by the software Search function. The other alphanumeric characters are used for the "Search for a given insulator" function.

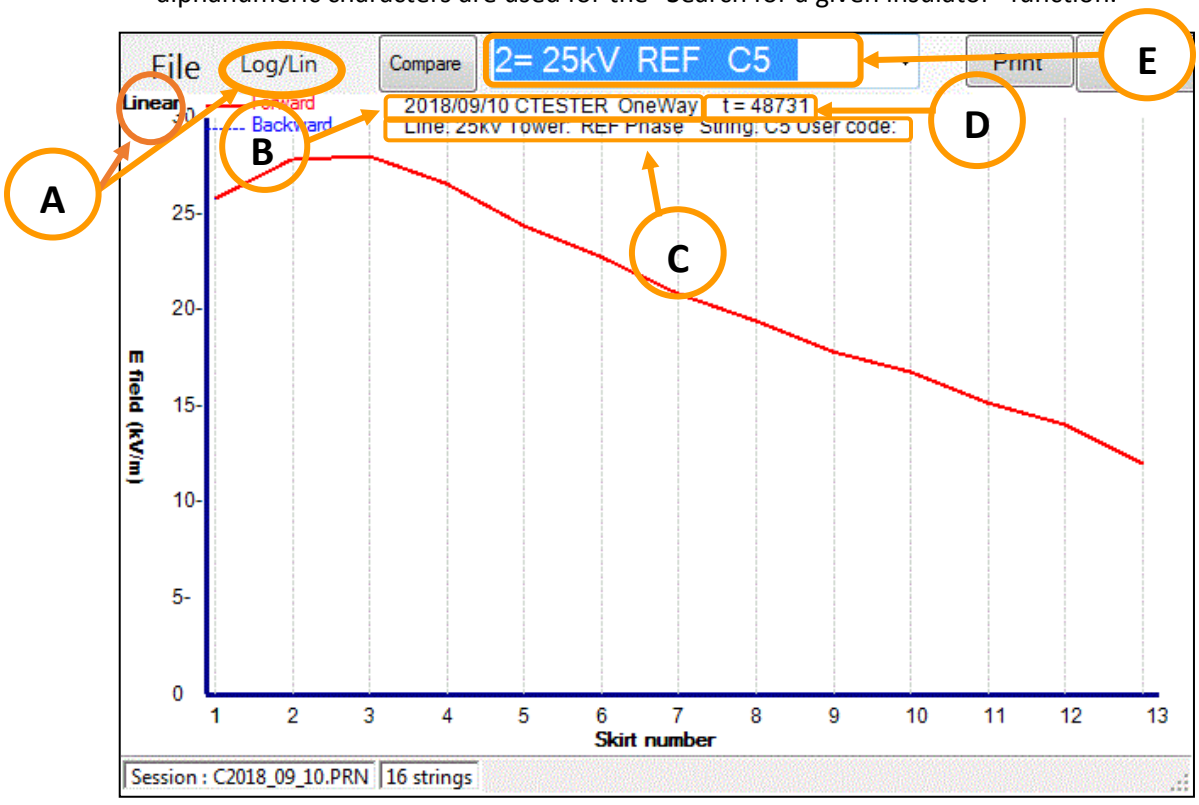


Figure 17: Example of a Graph of a Composite (polymeric) Insulator Scan shown using LINEAR Scaling

6.2 Linear and Log Graph Options

The "**Linear**" display mode is used to display the E-field readings from the Probe on a linear scale. The "**Log**" display mode is used to amplify the small variations in the lower-voltage portion of the curve for greater detail to be shown. This is particularly useful when the insulator has floating defects. Floating defects have a lesser impact on the surrounding E-Field so viewing the results in the Logarithmic scale will show greater detail than the Linear scaling.

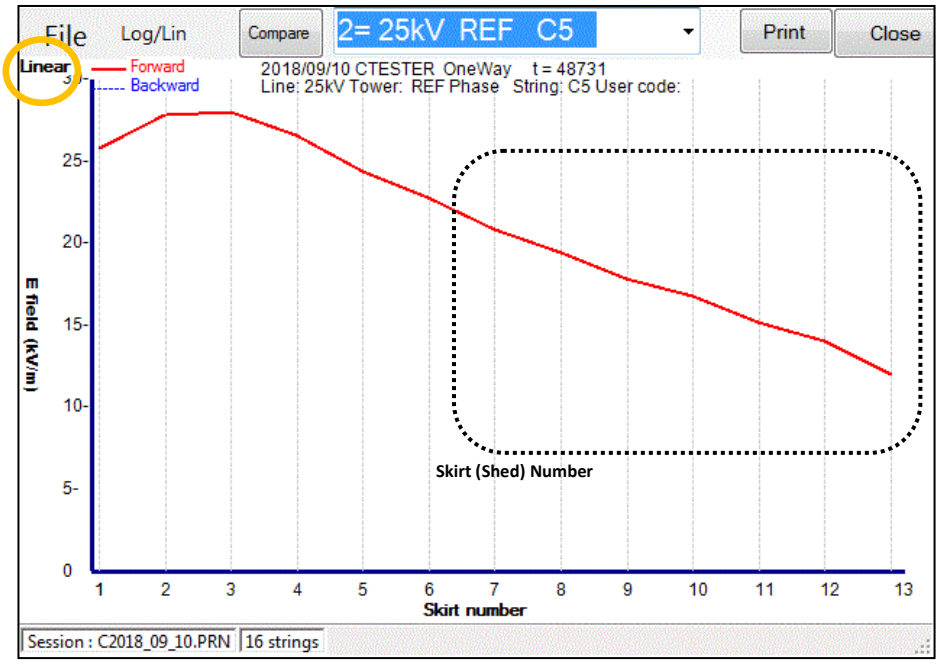


Figure 18: Example of scan of a C5 polymeric insulator shown on Linear Scaling

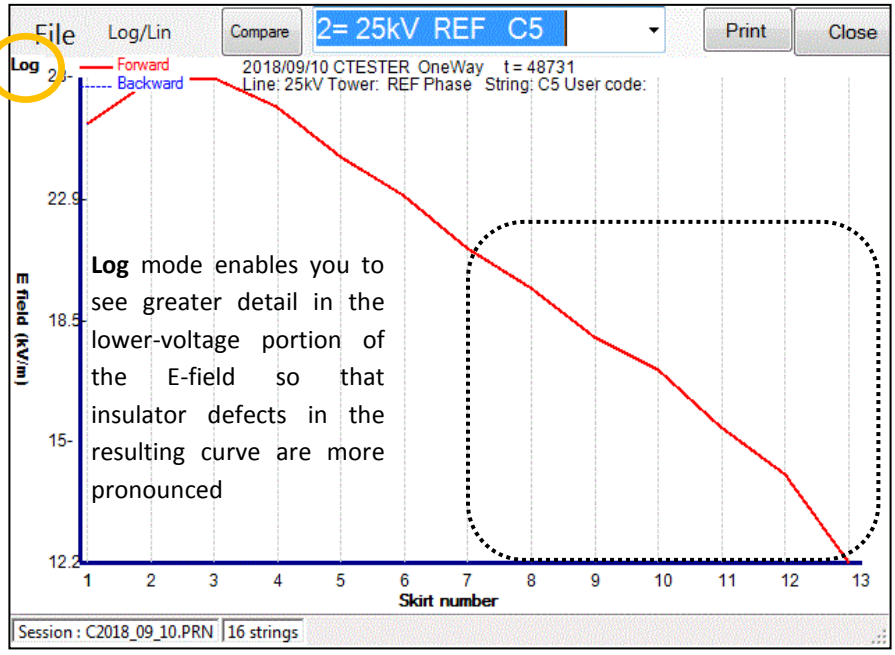


Figure 19: Example of scan of the same insulator shown on Log (Logarithmic) Scaling, focusing on the magnified variations on the lower portion of the curve.

6.3 Using the COMPARE function to Compare Historical Graphs

Graphs can be superimposed for comparison using the **Compare** function. Refer to Figure 20, which is used as a reference graph.

Place one graph over the other, and reduce the opaqueness down from 100 until one graph is visible through the other.

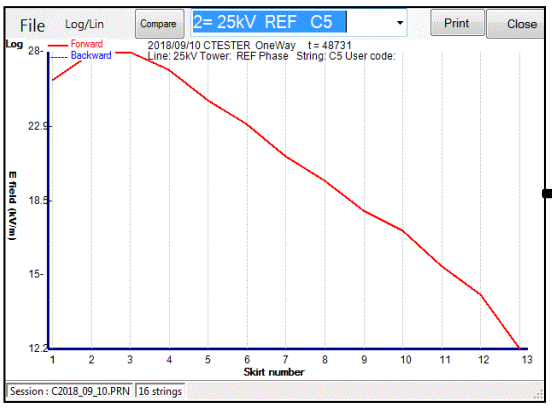


Figure 20: Example of a Reference Graph of a Known-Good, Energized C5 Insulator shown in **Log** scaling.

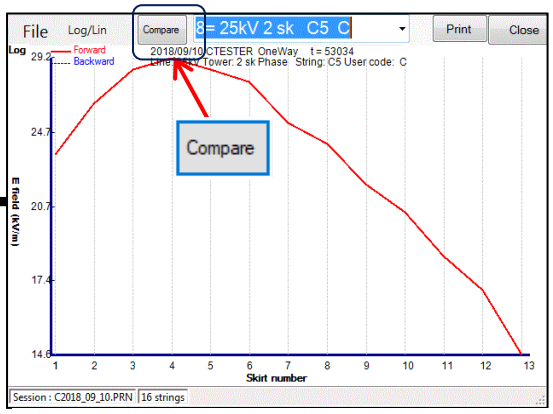


Figure 21: Example of an Energized C5 insulator with a connected, 2-skirt conducive defect

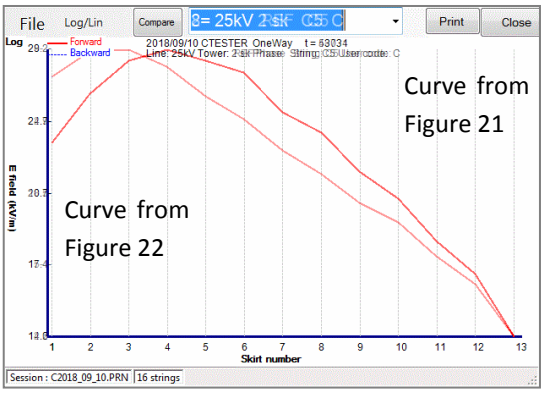


Figure 22: One Composite insulator graph superimposed on another using the **Compare** feature

6.4 Composite Insulator Tester Results: Healthy Insulators

6.4.1 Creating a Reference Graph of a Known-Good, Clean Insulator

First, it is necessary to create an E-Field signature reference graph of an energized, known-good, clean insulator. This will produce a graphic signature of an energized, known-good, clean insulator to be used as a comparator for other scanned insulators of same type and configuration: Number of skirts, orientation, scan direction, etc.

A reference graph of an energized, known-good, clean insulator is required for each type and model of composite (polymeric) insulator. The reference graphs should be preserved to be used as a future reference when performing insulator testing.

On the reference graph, if the test was performed from the high-voltage end toward the ground-end or from the ground-end to the high-voltage end, the maxima of the curve on the resulting graph will shift as a result. See Figures 24 and 25 below for an example:

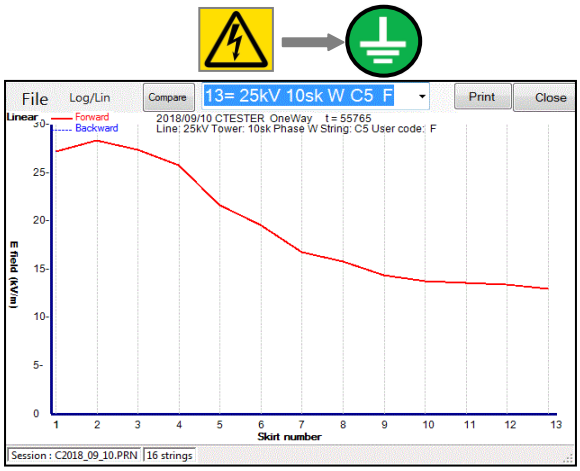


Figure 23: Resulting curve of a known-good, energized insulator tested from the high-voltage end to the ground-end.

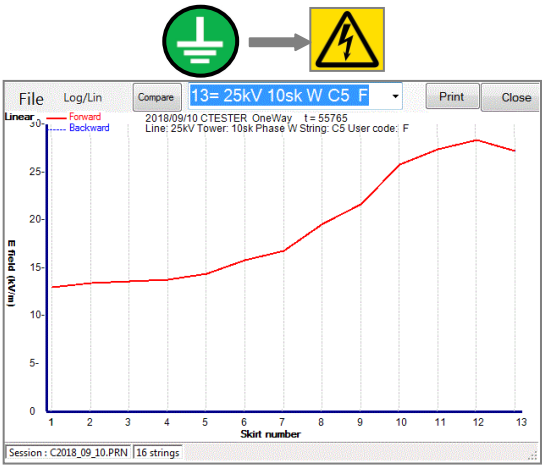


Figure 24: Resulting curve of the same known-good, energized insulator tested from the ground-end to the high-voltage end.

The comparison of the shapes of the curves, and not the absolute values, is the parameter that determines if there are any defects.

The E-field signatures in Examples 23 and 24 both show a healthy insulator, regardless of the direction of the scan.

6.4.2 Defects

When testing from the high-voltage end to the ground-end, the maxima of the curves moves to the right when there are connected defects. The more severe the connected defect, the more the maxima of the curve shifts to the right. Below are two examples:

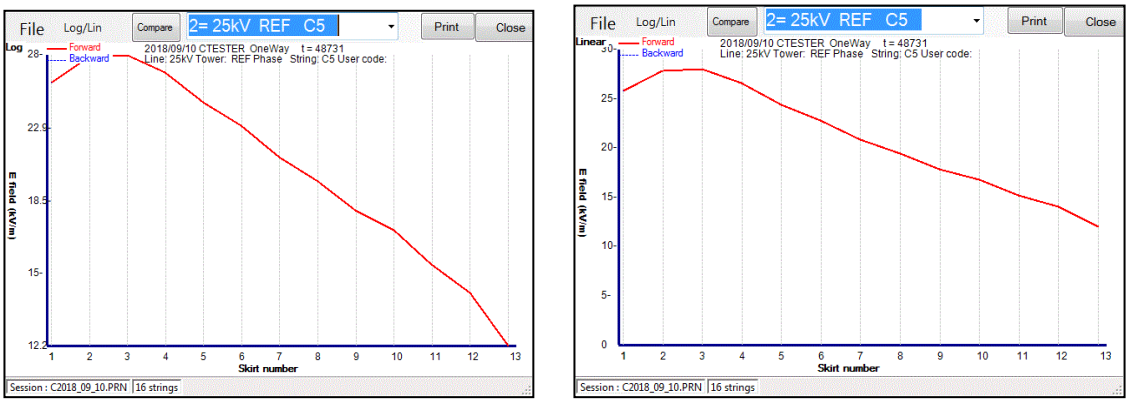


Figure 25: Example of a Reference Graph of a Known-Good, Energized C5 Insulator shown in both **Log** and **Linear** scaling.

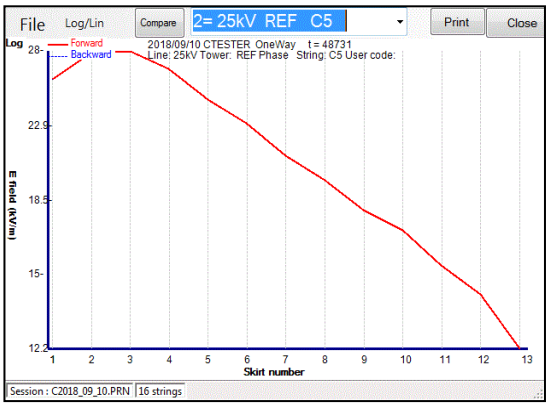


Figure 26: Example of a Reference Graph of a Known-Good, Energized C5 Insulator shown in **Log** scaling.

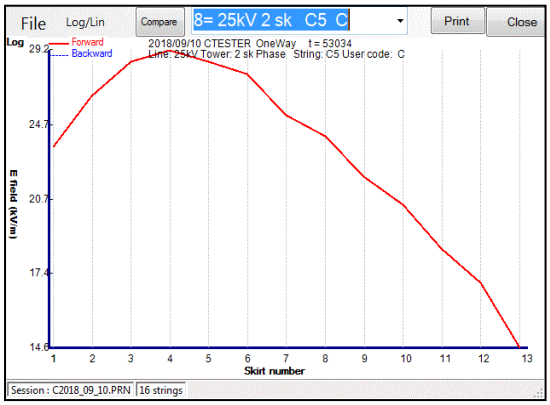


Figure 27: Example of a C5 Insulator with a 2-skirt connected defect shown in **Log** scaling.

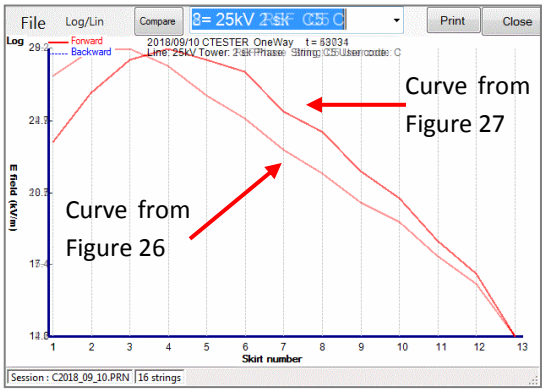


Figure 28: Overlay of C5 Insulator Reference Graph and a C5 Insulator with a 2-skirt connected defect using the **Compare** function (See Section 5.4.2). The maxima of the curve shifts to the **right** due to the connected defect.

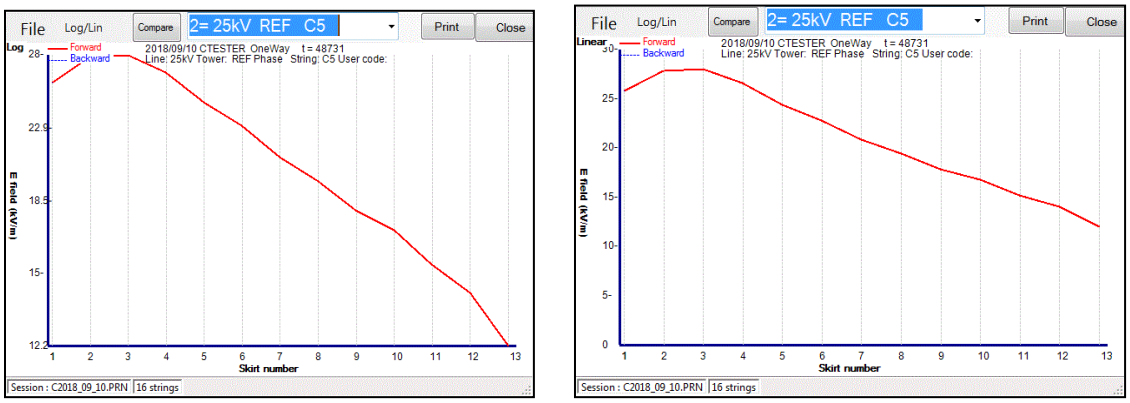


Figure 29: Second Example of a Reference Graph of a Known-Good, Energized C5 Insulator shown in both **Log** and **Linear** scaling.

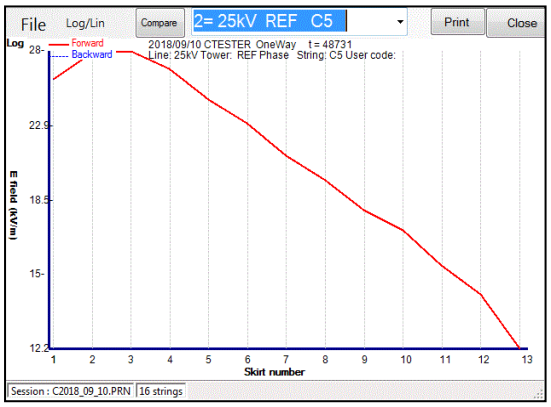


Figure 30: Second Example of a Reference Graph of a Known-Good, Energized C5 Insulator shown in **Log** scaling.

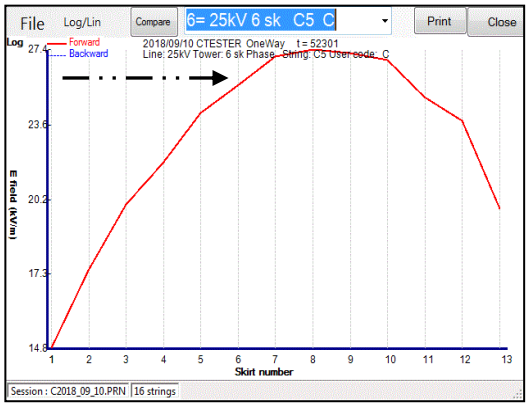


Figure 31: Second Example of a C5 Insulator with a **6-skirt connected defect** shown in **Log** scaling.

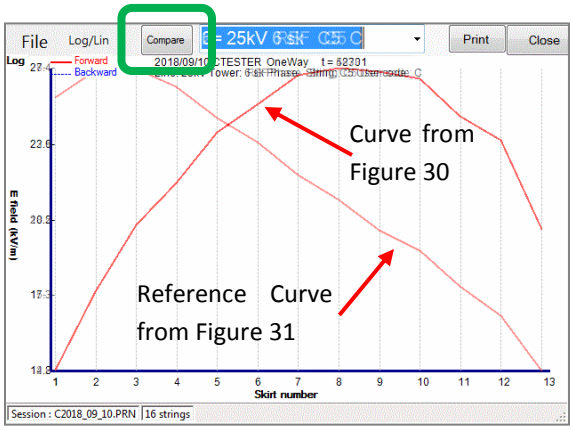


Figure 32: Second Example of a Reference Graph of a Known-Good, Energized C5 Insulator shown in **Log** scaling superimposed, using the **Compare** feature, over a graph of an insulator with a serious connected defect close to the high-voltage end.

6.4.3 Floating Defects

Floating defects on an insulator have a lesser effect on the surrounding E-Field. Therefore, when evaluating graphic results of an insulator with floating defects, the **Logarithmic Scaling** will expose floating defects more so than the **Linear Scaling.**

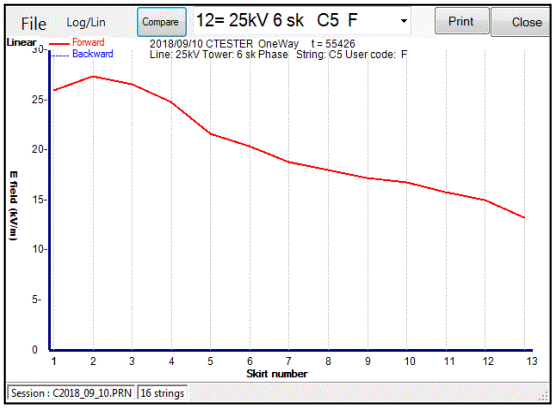


Figure 33

This an example of a C5 insulator with floating defects shown in **Linear Scaling**

Figure 34 is the same C5 insulator scan as shown in **Figure 33**, but shown using the **Logarithmic Scaling**. Logarithmic Scaling exposes more detail than the **Linear Scaling**. The impact of the floating defects can be much more clearly seen using the **Logarithmic Scaling**.

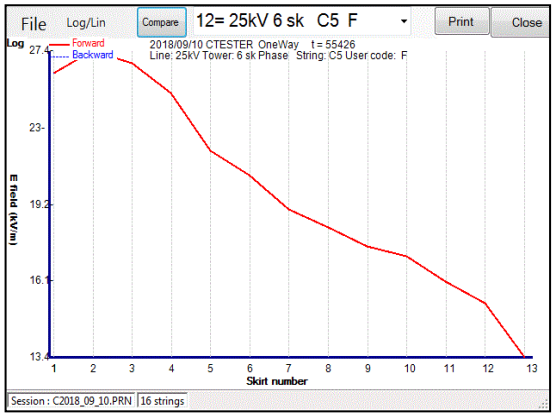


Figure 34

The reference curve for a known-good, clean C5 composite (polymeric) insulator should be used to evaluate the curves displaying floating defects.

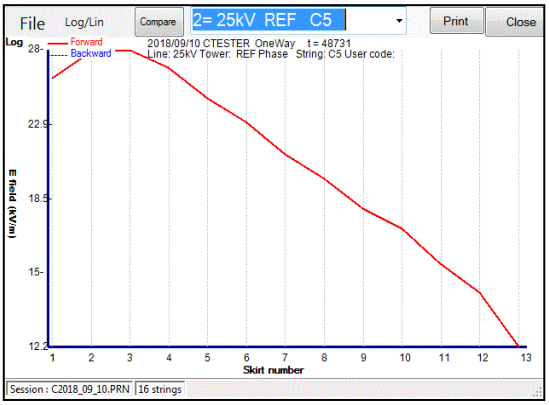


Figure 35: Reference curve for a known-good, clean C5 insulator

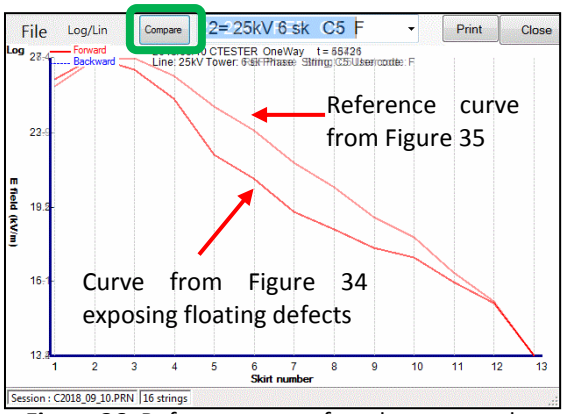


Figure 36: Reference curve for a known-good, clean C5 insulator shown in **Log** scaling superimposed over a graph of an insulator with a floating defect in the middle of the insulator.

Chapter 7

Specifications

7.0 Specifications

Parameter	Specifications
Maximum skirts per insulator	150 skirts
Minimum skirts per insulator	5 skirts (sheds)
Scanning speed	From 1 to 10 skirts/sec
Maximum voltage	1,500 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: • Probe • Bluetooth Adapter	 -40°F to 167°F (-40°C to 75°C) -4°F to 167°F (-20°C to 75°C)
Composite Tester Dimensions Skirt (shed) diameter	12" x 11" x 6" (30.5 cm x 28 cm x 15 cm) 4.3” to 6.7” (10.9 cm to 17 cm)
Weight (Composite Tester)	2.4 lbs (1 kg)
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:	**Receiving address:**
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	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, MERCHANTABLE QUALITY, 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

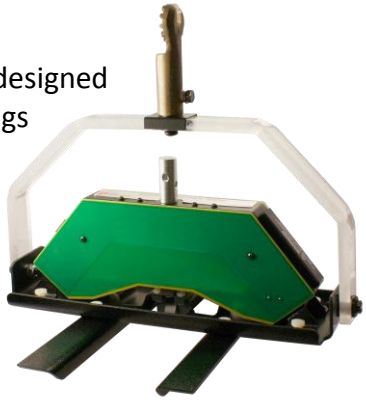
The Porcelain Tester is used for Porcelain and Glass insulators.

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.