HV Diagnostics

HV Suite

PD30-E/PD60-2/PD90-2

User Manual

ENGLISH

DHV0055 Rev00

Firmware: 1.6.0.24

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Africa, Asia, Australasia,
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1. Forward

Purpose

This operating manual serves to ensure the proper and safe use of the test instrument.

1.1. Regarding this Document

Target User

This operating manual is designed to inform various user groups. The scope and depth of the information provided may not be appropriate for all users. However, it is important that all users familiarize themselves with this document in full. The following is a guideline indicating the most significant information as a function of the user's responsibilities.

User	Responsibilities	Focus
HVA Operator	• To connect the equipment • To carry out manual or pre-programmed test sequence • To verify validity of application • To adjust instrument settings • To program automatic test sequences in accordance with particular testing standards	**All** Sections Particular focus on all **safety** messages
PD Operator	•	
Procurement, Management	• To assure that the workplace is safe and has all required equipment • To assure that operators are qualified technicians • To assure that operators fulfil their responsibilities	Particular focus on **safety** messages and information regarding **general** product description.

Safekeeping

NOTICE

This manual should always be on hand when using one of the PD test instrument with the HV Suite.

1.2. Documentation Conventions

The following explain the symbols, and safety messages found in this document. The employment of safety symbols and signal words are according to the American National Standards Institute standard ANSI Z535.6 "Product Safety Signs and Labels".

Safety Messages

Danger

DANGER

Indicates a hazardous situation which if not avoided will result in death or serious injury

Warning

WARNING

Indicates a hazardous situation which if not avoided could result in death or serious injury.

Caution

CAUTION

Indicates a hazardous situation which if not avoided could result in minor or moderate injury.

Notice

NOTICE

Indicates suggested practices to protect equipment and property.

Symbols

Yellow triangle, framed in black: Used to indicate a potential hazard.
Only used in conjunction with description of the possible hazard!
Detailed symbol may correspond to this specific hazard.

Red outlined circle with red diagonal line: Used to indicate forbidden practices.
The described handling practice must not be carried out!

Blue circle with white exclamation mark: Used to indicate recommended precautionary measures or a situation that can lead to property damage.

1.3. Legal Considerations

Warranty

HVDSA provides a one-year warranty from the original purchase date of instrument for all necessary parts and labor. This warranty is void in the event of abuse, incorrect operation or use, unauthorized modification or repairs, or failure to perform the specified maintenance as indicated in this operation manual. This warranty does not include normal consumable items such as lamps, paper rolls, printer ribbons, batteries or other auxiliary items.

This warranty and our liability are limited to replacing or repairing defective equipment, at our discretion. Equipment that is returned to HVDSA must be packed in original packaging. All shipped items must be prepaid and insured. No other warranties are expressed or implied.

Contact Information

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Copyright

NOTICE

The information presented in this instruction manual is believed to be accurate and correct for the intended use of this product. Should this instrument be used for other applications and purposes not covered herein, please contact HVDSA to validate its suitability.
This manual, all of its contents and the instruments specifications are subject to change without notice.

YOUR OPINION MATTERS!

Your comments and suggestions are of value. We are dedicated to supporting your needs. Offering you optimal documentation is part of our promise of quality. Improvement suggestions regarding this manual may be sent to:

sales@hvdiagnostics.com

Thank you for your feedback!

2. Safety

Safety is **priority**! Respect all **safety information**; only use the PD with the HV Suite for **appropriate applications** and ensure that operators possess the required **operator qualifications.**

2.1. General Safety

NOTICE

Operation Manual

Before carrying out any high voltage test with this instrument, read this Operating Manual in its entirety.

2.2. Work Safety

DANGER

Electric Shock Hazard

Never assume that equipment is safe to handle without using the necessary safety equipment and earthing procedures.

- All procedures must comply with local safety regulations
- Always treat exposed connectors and conductors as potential electric shock hazards.
- DUT must be earthed, de-energized and isolated from all power sources.
- All auxiliary electrical apparatus such as switchgear, surge arresters etc. must be isolated from the test power source and the DUT.
- All cables and connectors must be inspected for damage before use. Damaged equipment must not be used.
- Earth connections must be made first and removed last!
- DUT must be discharged and earthed before disconnecting the test lead.
- Avoid testing alone. In the event of an emergency another person's presence may be essential.
- Don't touch the PD during the test and before you didn't have grounded the DUT and the filter.

The metal frame is under High Voltage during High Voltage Test!

DANGER

Authorized Personnel Only

The test area must be secured to keep non-qualified personnel off the premises!

- Signs must warn all persons of the high voltage test area.
- Only qualified electrical technicians should have access to the test area.
- Other persons must be accompanied by qualified electrical technicians and must be informed of the risks involved.

WARNING

Radiation Hazard

Testing vacuum bottles, above their voltage rating, with DC can produce dangerous X-rays.

NOTICE

Equipment Handling

DUT must have clean connections.

Test instruments must only be repaired or modified by authorized HVDSA personnel.

NOTICE

If required according to local safety regulations

Wear high voltage gloves when handling high voltage cables and equipment.

2.3. Appropriate Applications

The HVDSA PD test instrument is designed to perform high voltage insulation testing of various types of highly capacitive loads.

Appropriate DUTs

DUT Type	Examples
Cables	• Extruded cables (e.g. XLPE) • Laminated cables (e.g. PILC) • Insulated cables
Other highly capacitive loads	• Generators • Switchgear • Transformers • Rotating machines • Insulators • Bushings

Appropriate Measurements

Measurement	Examples
Test	• Phase position of discharges indicated • Scope display sine wave superimposed • PD mapping actual locations of partial discharges • Locates sites using TDR principles • Voltage measurement circuit

NOTICE

Other Applications

Before proceeding, contact HVDSA to validate appropriate use!

2.4. Operator Qualifications

HVA/PD operators must be **qualified electrical technicians!** Proof of necessary qualifications for working in high voltage domain is mandatory. It is highly recommended that operators have completed an emergency rescue training program.

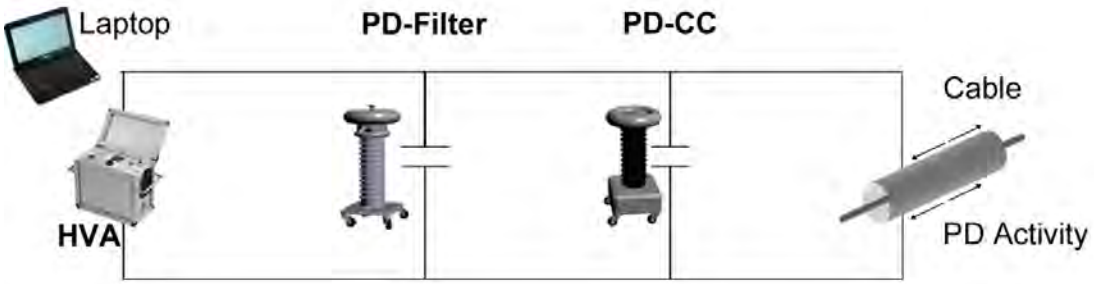
3. Introduction

3.1. Principles of PD Time of flight or Traveling Wave (TDR)

A long high voltage cable behaves as a wave guide. The cable has a conductor, a dielectric and a coaxial neutral (Screen copper tape or lead) which forms an ideal wave guide. The dielectric creates a large capacitor. The longer the cable, the more of these capacitors are in parallel. These PD waves travel down the wave guide – one PD wave to the one end of the cable and the other PD pulse to the opposite end. If we now place a capturing device – a coupling capacitor and a Digital Storage Oscilloscope at the one end, it is possible to view the "time of flight" of these PD pulses.

The following two diagrams Fig 1 + 2 clearly demonstrate these two PD pulses:

Electrical Shematic



4. PD Hardware

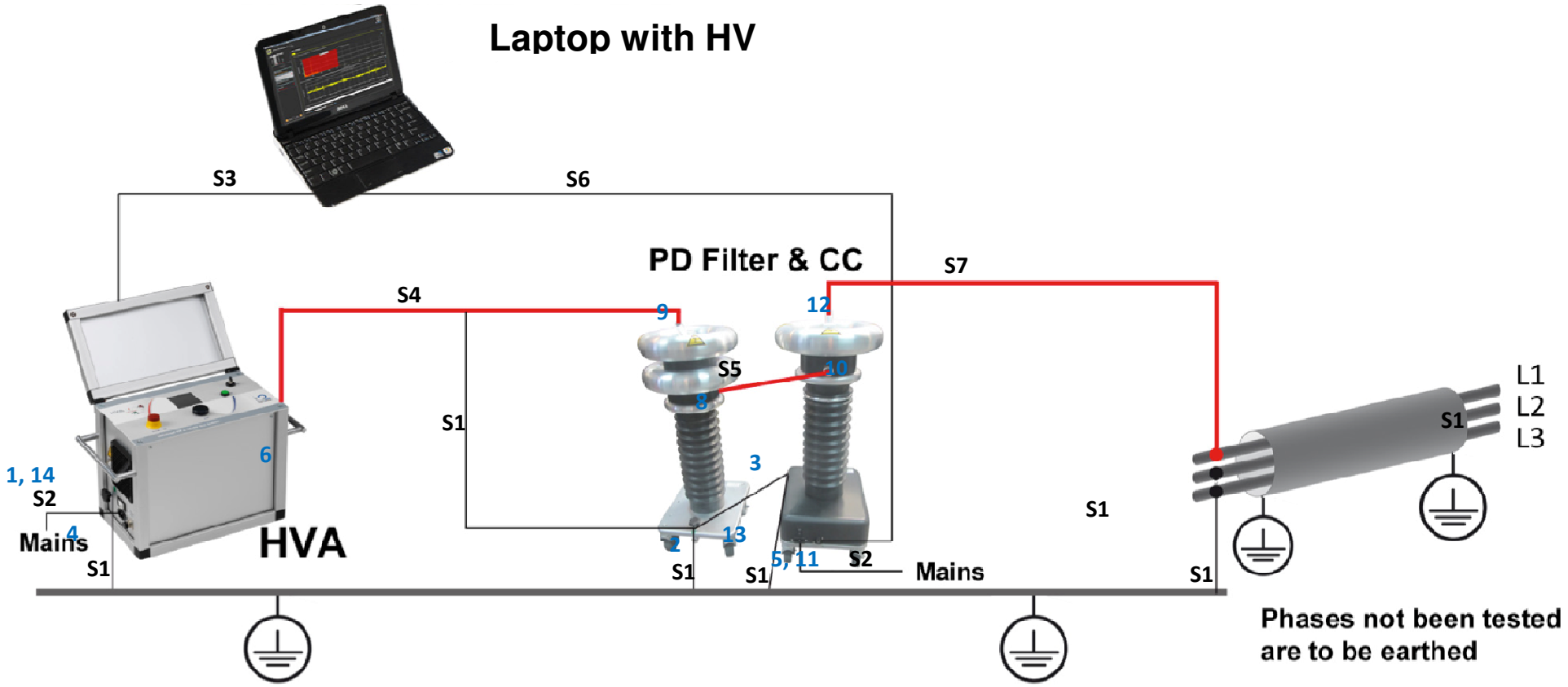
PD60CC/TD-2

HVA60

Right Side

Left Side

4.1. Layout and Cable Connections



Nr.	Description	Art. Nr.
S1	Connect Earthing Cable • Connect earthing cable to the HVA earthing connector (1) • Connect earthing cable between the PD Filter (2) and the PD-CC (3) **Remark: as short as possible!** • Connect earthing cable to the PD CC connector (3) • Connect earthing cable to the DUT ground	 GH0522 GH0577/ GH0578 GH0522 GH0522
S2	Connect Power Supply Cable • Connect the power supply cable to the HVA power supply plug (4) • Connect the power supply cable to the PD-CC power supply plug (5)	KEK0019
S3	Connect the HVA with the Laptop	KEK0017 KEK0049
S4	Connect the HVA with the PD Filter (7)	GH0601
S5	Connect the PD Filter (9) with the PD-CC (10)	GH0567 GH0550
S6	Connect the Laptop with the PD-CC (11)	GH0579/ GH0582/
S7	Connect HV Test Lead	GH0550/ GH0551
S8	Verify Connections • Check that all cables are attached securely.	

Nr.	Picture	Name	Description
1		Earthing connector	Serves as connection point from HVA earth
2		Earthing connector	Serves as connection point from PD Filter earth
3		Earthing connector	Serves as connection point from PD-CC earth
4		Power supply plug	Serves as connection point from the HVA to the powers source.
5		Power supply plug	Serves as connection point from the PD-CC to the powers source
6		Communication port	Serves as connection point from the HVA to Laptop via RS232
7		HV output connector	Serves as connection point from the HVA to the HV test lead.
8		HV input connector	Serves as connection point from HVA
9		Connection point Filter - CC	
10		Connection point CC - Filter	
11		Communication port	Serves as connection point from the PD-CC to Laptop via USB
12		Connection point CC - DUT	
13		PD-CC Main switch [on/off]	I Battery is on! 0 Current is coming from Power Source (5).If the PD-CC is connect with the Power Source the Battery is charging!
14		HVA Main switch	Activates the HVA. This switch is a

		[on/off]	fuse with integrated magnetic auto-reset 16A To reset -> Turn the main switch OFF and then ON again

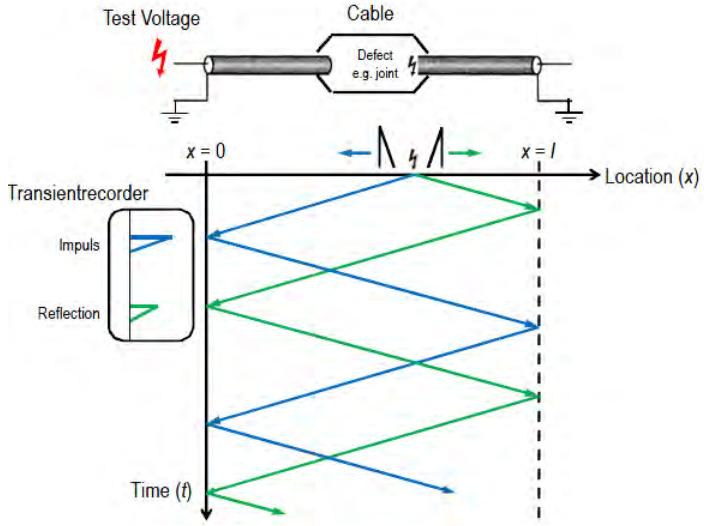
5. PD Basics

A long high voltage cable behaves as a wave guide. The cable has a conductor, a dielectric and a coaxial neutral (Screen copper tape or lead) which forms an ideal wave guide. The dielectric creates a large capacitor. The longer the cable, the more of these capacitors are in parallel. These PD waves travel down the wave guide – one PD wave to the one end of the cable and the other PD pulse to the opposite end. If we now place a capturing device – a coupling capacitor and a Digital Storage Oscilloscope at the one end, it is possible to view the "time of flight" of these PD pulses.

The above echogram is displayed by the Digital Storage Oscilloscope.(DSO) The 1st PD pulse (emanating from the PD source) arrives first at the coupling unit (see pulse marked 1st whilst the 2nd pulse travels to the far end, travels the full length of the cable and arrives at the coupling unit (see pulse marked 2nd). The time Δt, is therefore the distance from the far end seeing the above lettuce diagram? The 1st pulse reflects out of the coupling unit and travels to the far end and reflects back hence 3rd pulse. Δt2 is therefore the time differences between these two incoming pulses and the time to the PD source from the near end. If we now know the velocity of propagation of the PD pulse in the cable we can calculate the distance to the PD source (Dist = Velocity x time)

Unfortunately on very long cables the subsequent reflections may be attenuated to such an extent that they are not visible.
Joint / splices also attenuate these pulses.
PILC cables have a greater attenuation on these traveling PD waves than that of a similar XLPE cable. If the returning pulse (2nd) is not visible it is not possible to do a location. The 1st pulse only indicates that there is a discharge on the cable.

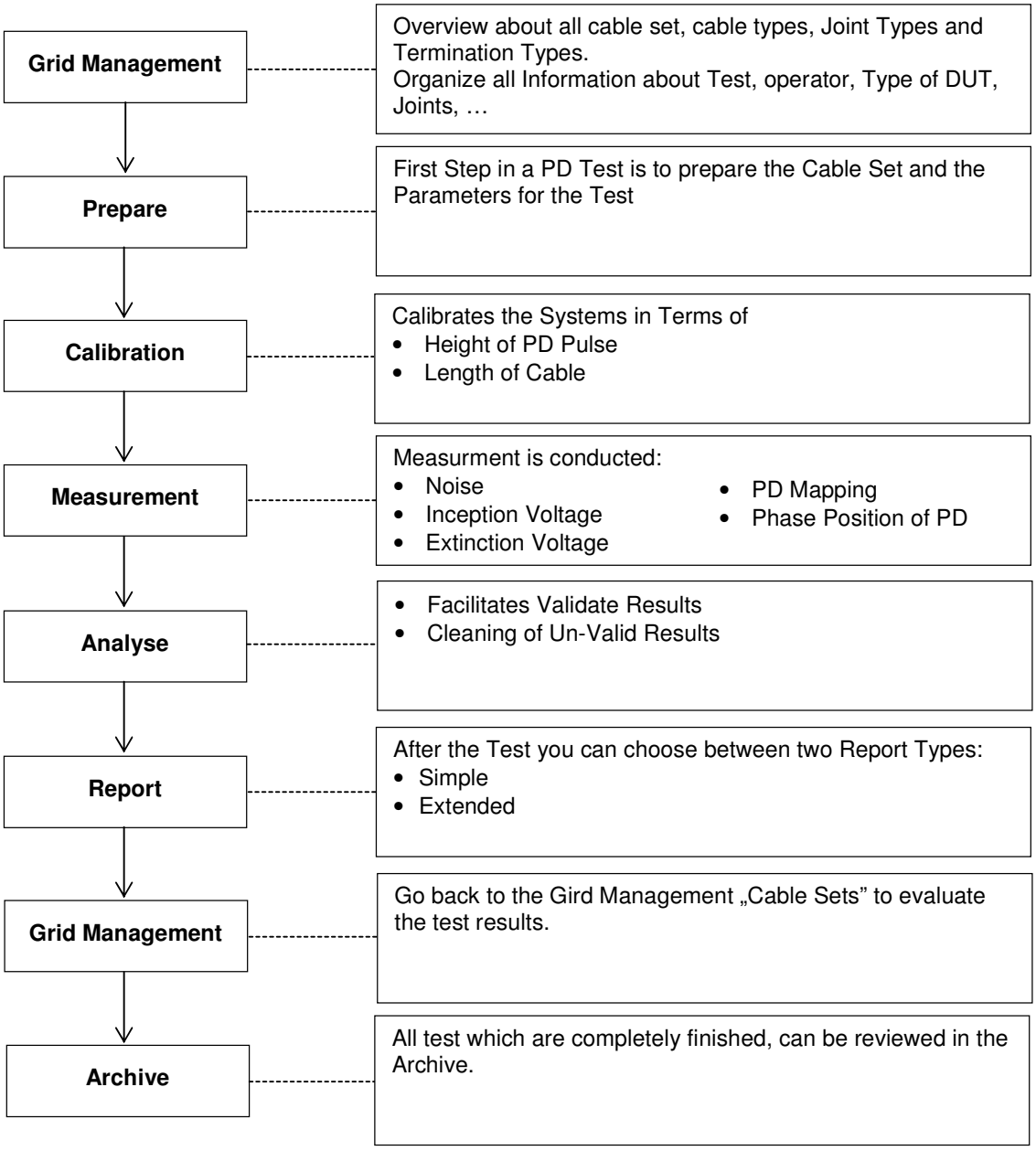
By examining the rise times of the calibration pulse and this PD pulse it is possible to determine if it is from the near end termination or not.



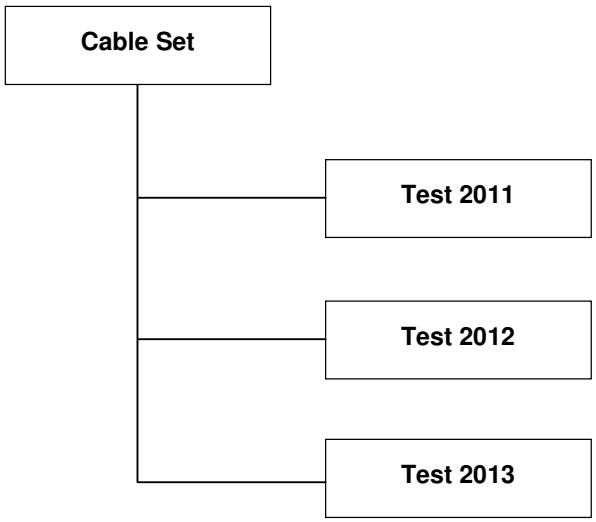
6. HV Suite

The PD Suite is a “All in One” Software. You can test Tan Delta, Partial Discharge, VLF Testing and Sheath Testing with only one Software.

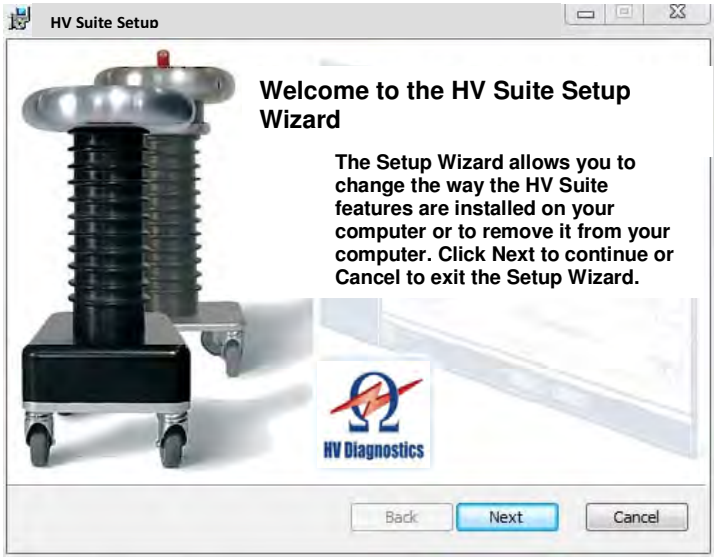
Main Idea of the HV Suite



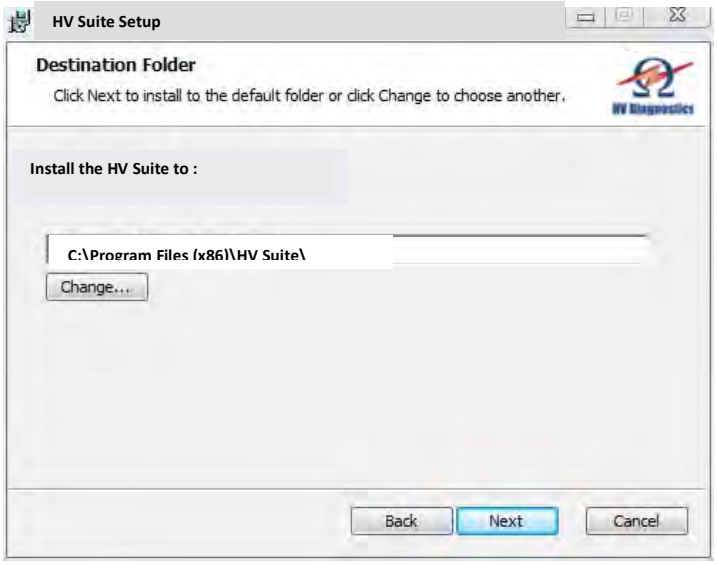
Normally one cable set will be tested more than once. With the HV Suite the cable settings will be set once and be reviewed or re-used for future measurements.

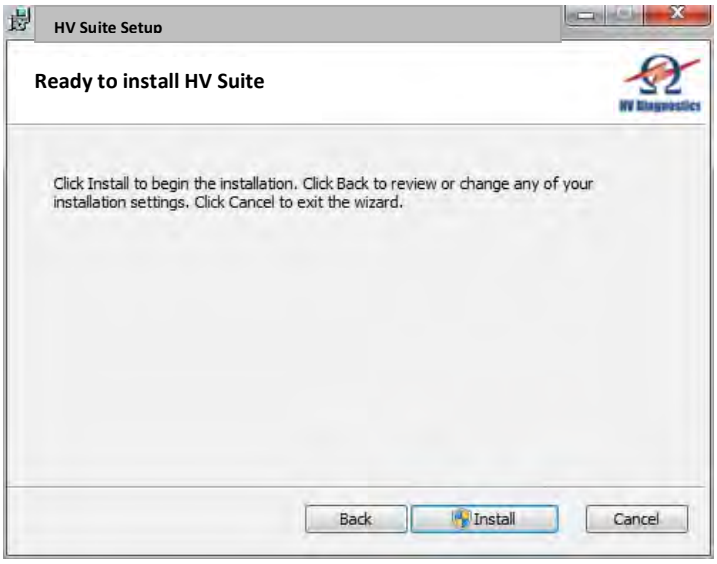
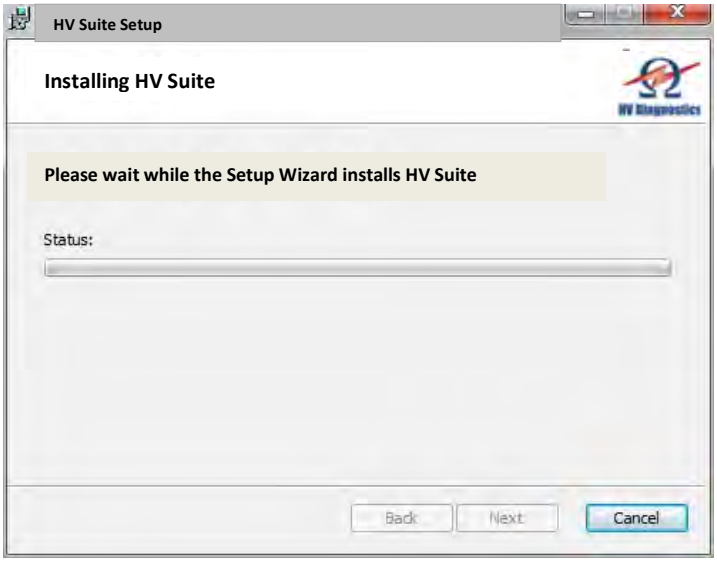


6.1. Installation

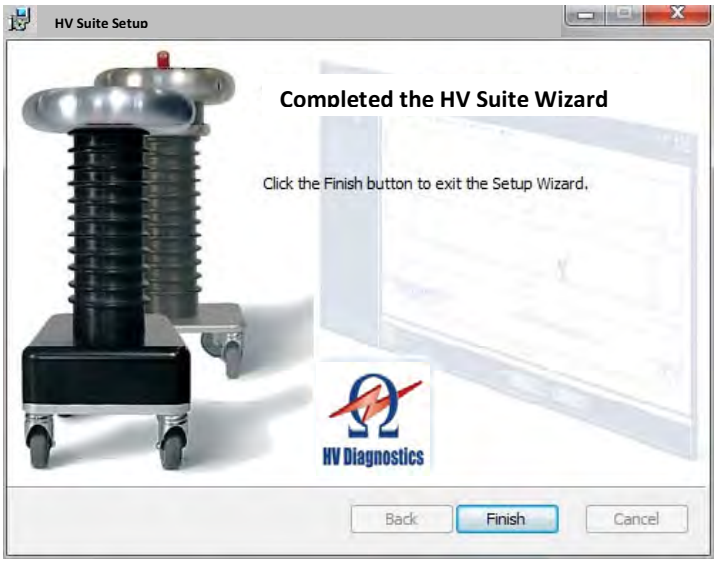
Nr	Example	Options
IN01:		For installation, insert the HV Suite CD included in your standard accessories and follow the instructions displayed on the screen. To manually start the installation go to the CD/USB Folder and run the program called "HV Suite Setup.exe".
IN02:		HV Suite Setup Start Screen appears.

IN03:


HV Suite Setup
Destination Folder
Click Next to install to the default folder or click Change to choose another.
Install the HV Suite to :
C:\Program Files (x86)\HV Suite\
Change...
Back
Next
Cancel

Nr	Example	Options
IN04:		
IN05:		•

Nr	Example	Options
IN05:		
		
IN06:		
		

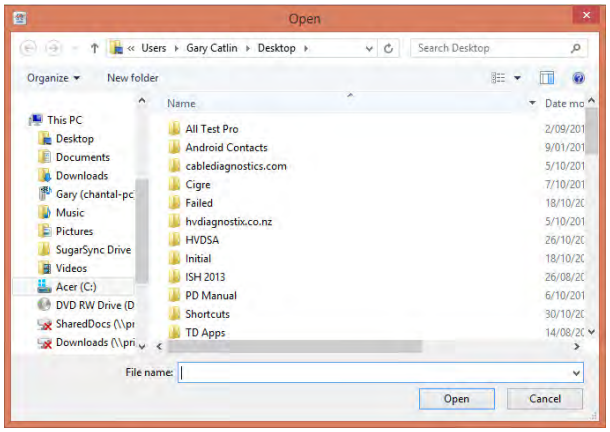
Nr	Example	Options
IN06:		
		

6.2. Symbols & Functions

SYMBOLS

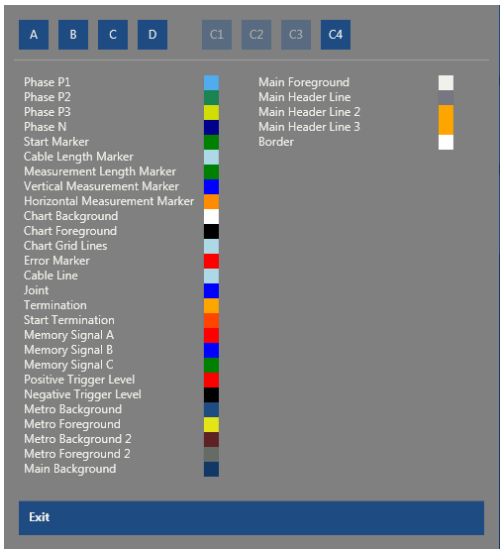
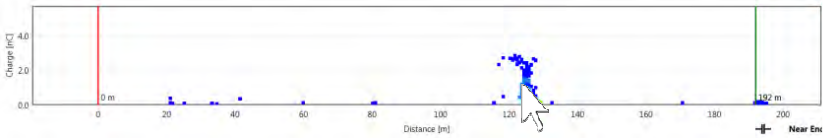
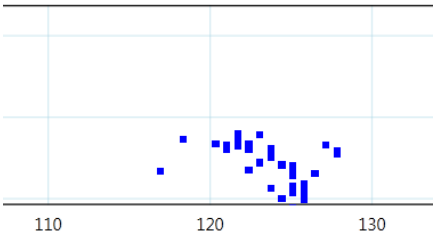
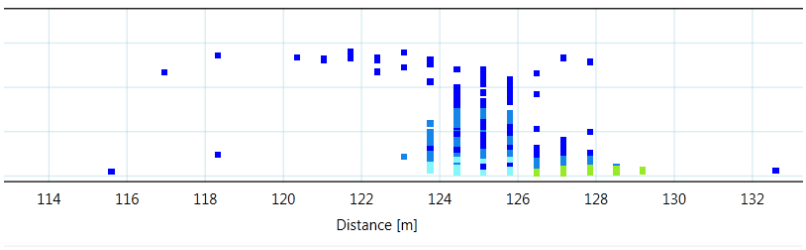
BUTTON	NAME	DESCRIPTION
	Home	Go back to the Main Menu
	Grid Management	Go to the Grid Management, and set cable parameters
	Back	Go back to the last page
	Add	Add a new function, for example a new Cable Set in the Grid Management.
	Clear	Delete a function
	Add Link	Add a link to a Homepage
	Next	Go to next position
	Previous	Back to previous position
	Start	Start a function
	Stop	Stop a function
	Record	Record a Measurement
	Find defects automatically	Automatic function to mark the position
	Reports	Create Report from measurement
	Notes	Fill in your personal comment
	Save	Save Datas, Signals, …
	Clear all Signals	Clear all Signals
	Check Box active	The Box is active and will be considered in a test.
	Check Box inactive	The box is inactive

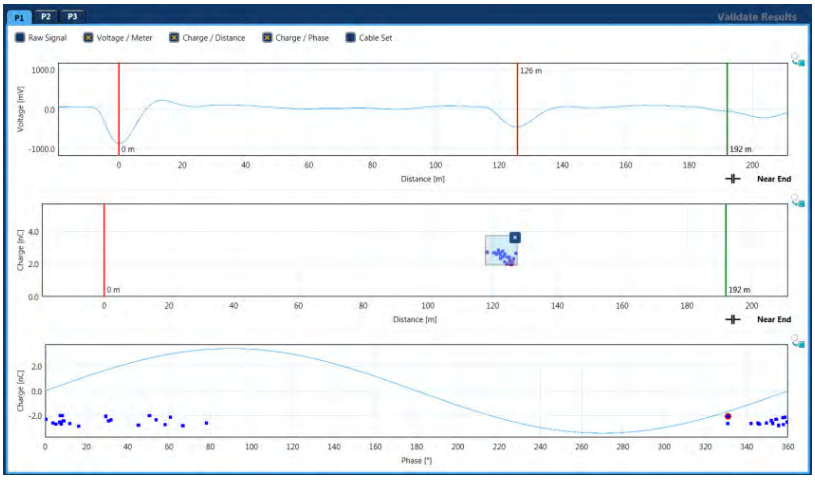
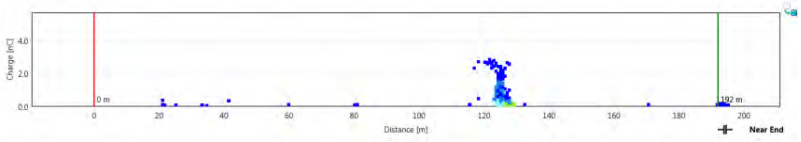
	Previous	Go back to the previous step
BUTTON	**NAME**	**DESCRIPTION**
	Automatic Mode	Automatic Mode
	Next	Go to the next step
	Connection Status	Red: is no connection! Green: Connected!
	Drag and Drop	Choose given selections
	Calendar	You will find this button by date and time. There will come a drop down calendar.
	Sep is finished	Step in a test is finished!
	Step not completed	Step in a test is not completed!
	Drop Down List	Choose given selections
	Drop Down List inactive	There are no given selections
	Phases of Cable	Selection Phase of cable tested
	unlock	Measurement isn't locked. Changes possible, f. ex. continue the active Measurement
	lock	Measurement is locked. No changes possible.

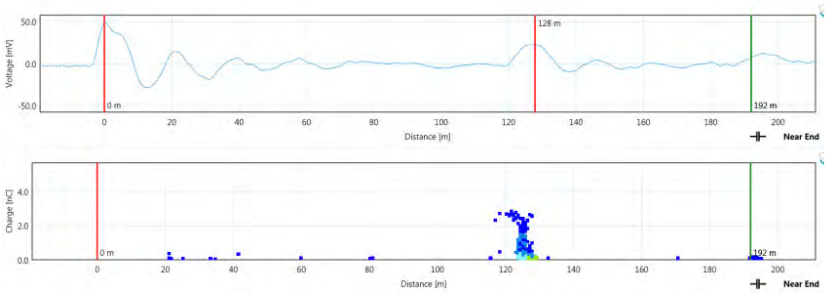
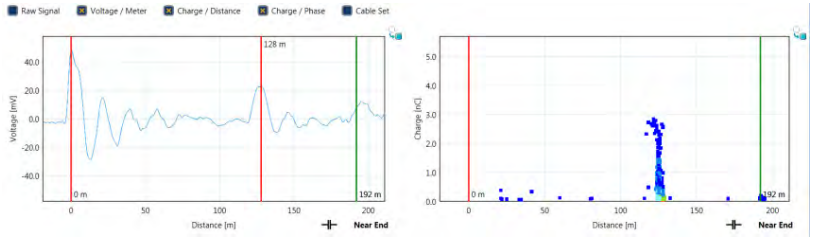
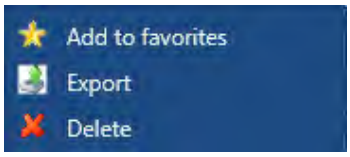
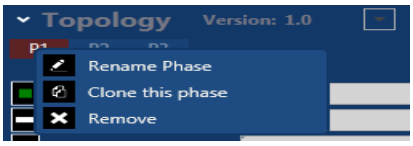
	Import Cable Set	Choose a document 

BUTTON	NAME	DESCRIPTION
	Refresh Clusters	Renew data
	Recalculate Shot	Return back the last shot
	Recalculate all Shots	Return back all shots
	Save Shot	Save the last shot
	Save all	Save all Shots
	Compute average Signal	Compute average Signal
	Export raw signals	Export raw signals
	Change Algorithm	You can change Algorithm (Peak, Slope, Hinkley)
	Delete Shot	Delete the last Shot
	Delete All	Delete all Shots
	Add Document	Add a document

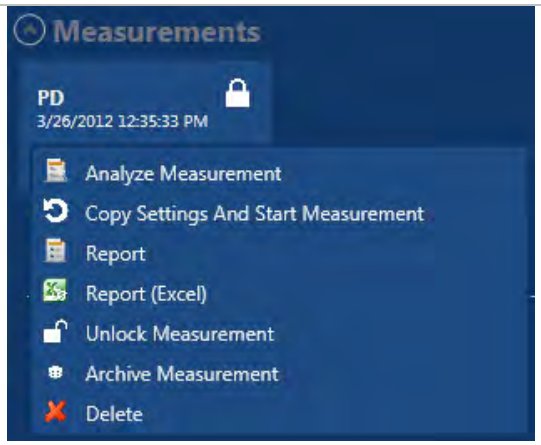
FUNCTIONS

BUTTON	NAME	DESCRIPTION	
F9	Change Color	Change color of background and various settings	
Alt + scroll	Zoom In	Normal:  Zoom In 	
Strg + right mouse click	mark		

BUTTON	NAME	DESCRIPTION
Alt+right mouse taste drag	Rubber Band	 All Charts and PD Shots are reduced to the marked range.
double click	Back to view original	Double Click on the left mouse click, turn back to the starting position 

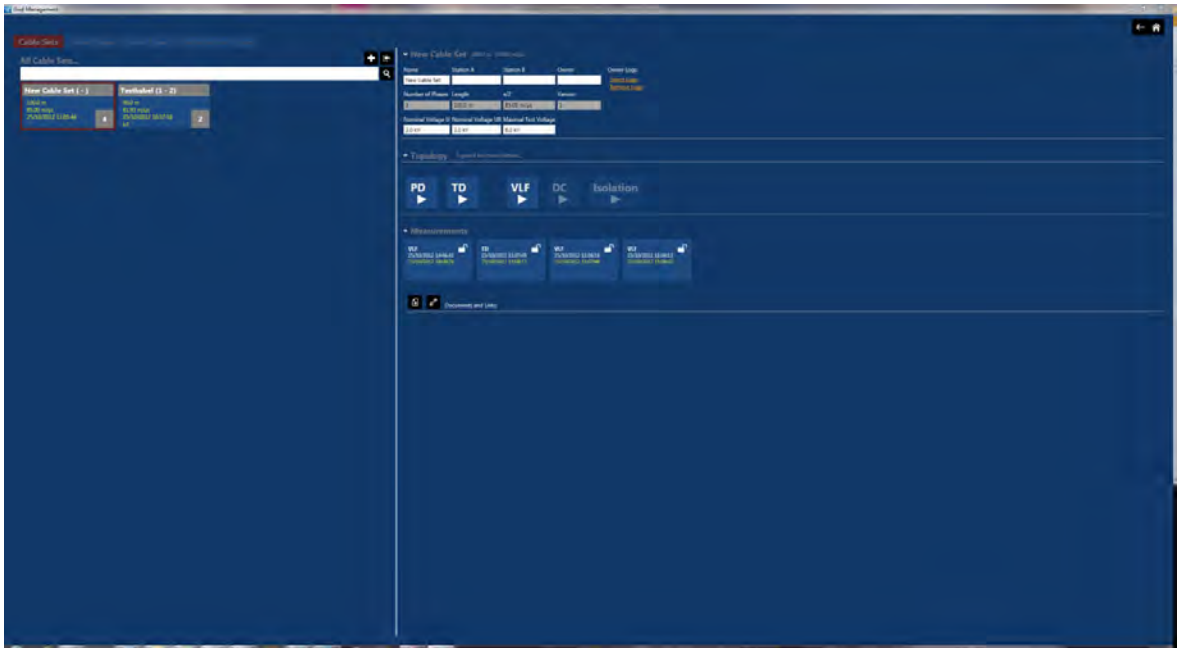
BUTTON	NAME	DESCRIPTION
+ Right mouse click	Chart View	To split the screen in Analyses Press right mouse click on the Drag and Drop Button… • to Split Horizontal • to Split Vertical • Reset • to Split Horizontal  • to Split Vertical  • Reset Display goes back to the main screen
Right mouse click on a cable set	Cable Set Features	• Add the chosen cable set to Favorites • Export the cable set • Delete the Cable set 
Right mouse click on on a Phase	Phase Features	• Rename a Phase • Clone a Phase • Remove a Phase 

BUTTON	NAME	DESCRIPTION
Right mouse click on unlocked Measure ments	Features for unlocked Measurements	• Continue the Measurement • Copy the Settings of the Measurement and Start a new Measurement with the Settings • Show the Report • Export the Report in an Excel File • Lock the Measurement • Archive the Measurement • Delete the Measurement 
Right mouse click on locked Measure ments	Features for locked Measurements	• Analyze the Measurement • Copy the Settings of the Measurement and Start a new Measurement with the Settings • Show the Report • Export the Report in an Excel File • Unlock the Measurement • Archive the Measurement • Delete the Measurement

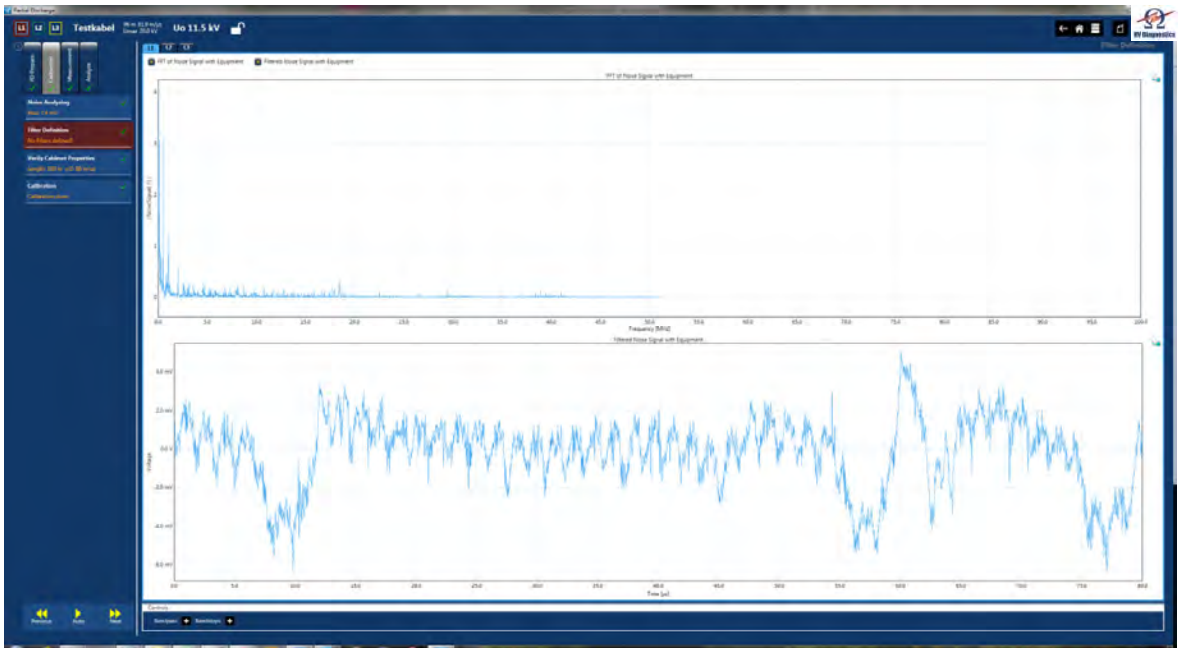
BUTTON	NAME	DESCRIPTION
		

6.3. Display Instruction

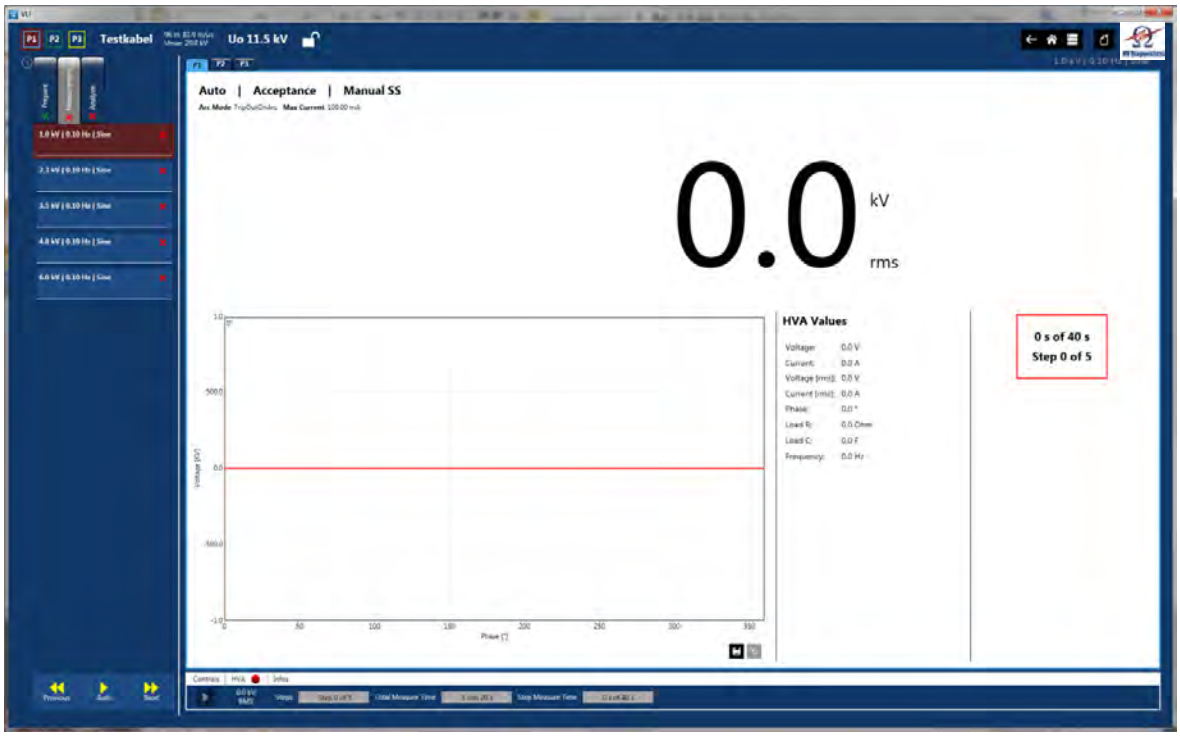
GRID MANAGEMENT



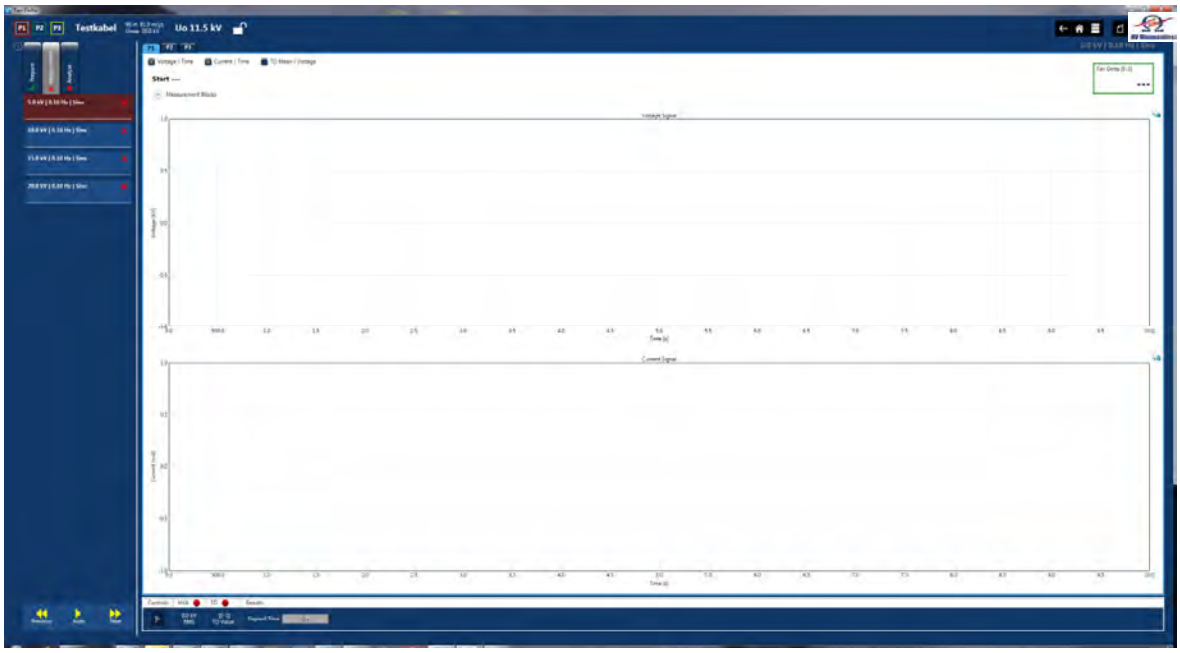
PD TEST



VLF TEST

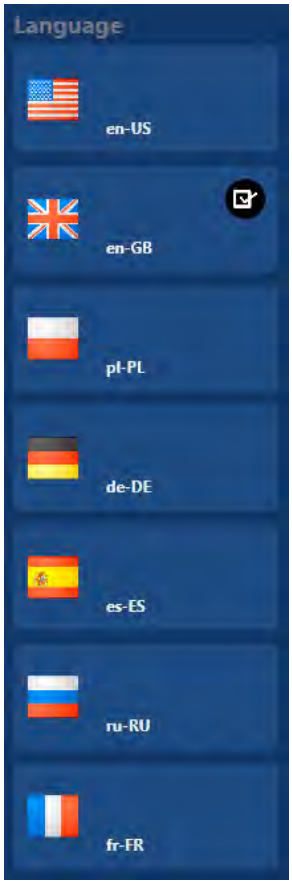


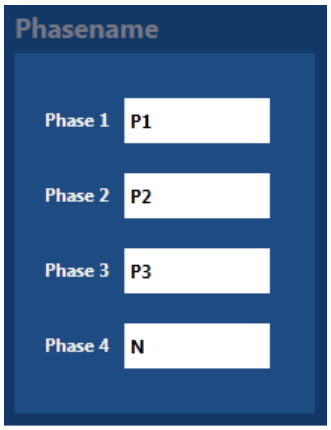
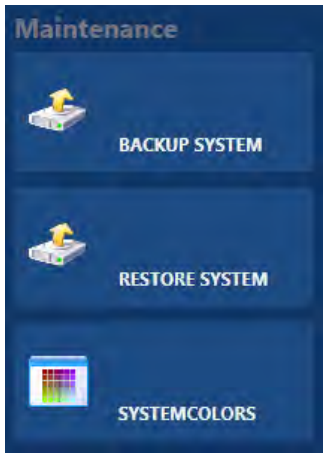
TD TEST

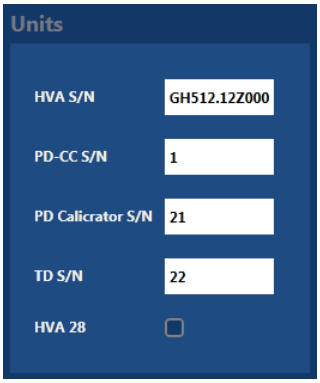
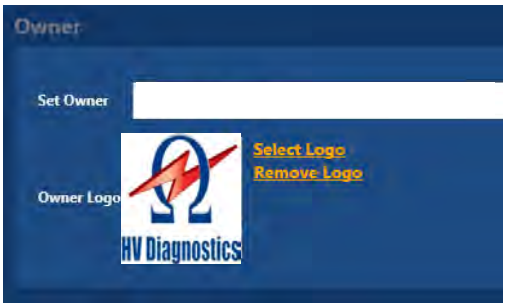


6.4. Settings

Language, Phasename, and General Settings can be changed in the “Settings” menu.

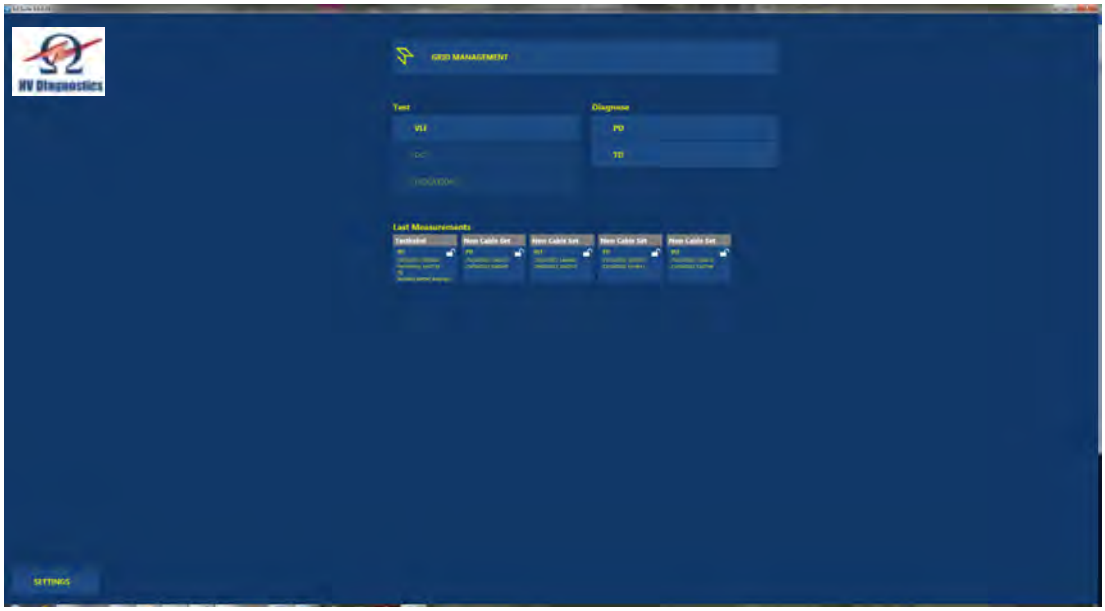
	EXAMPLE	OPTIONS
Settings		Select “Settings”
Language		Select you Language: • English US • English GB • Polish • German • Spanish • Russian • French

Rename Phases		Fill in the name of each Phase.
	EXAMPLE	**OPTIONS**
Maintenance		Make **Backup** from each database. Or restore the Database. ***Notice*** This can last between 5 or 30 minutes, depending on your computer. Make a Backup once a month or after some Measurements. At the moment it is no Auto Backup available. ***Recommendation:*** Store the large amounts of data on an External Hard Disk Drive or on Server. You can also change the colors of the HV Suite in the menu "**Systemcolors**".

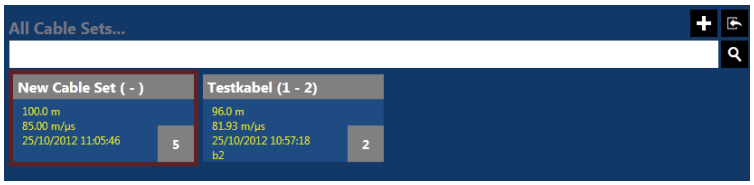
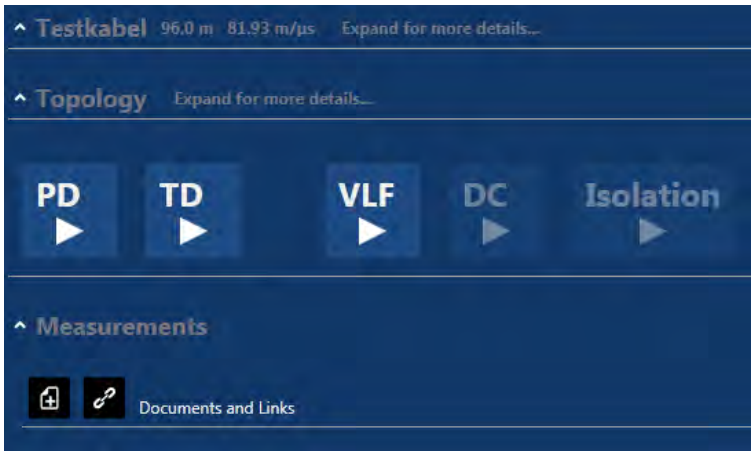
Units		You have to fill in the Serial numbers of • the HVA • PD-CC • PD Locator • HVA28 or not
System Owner		

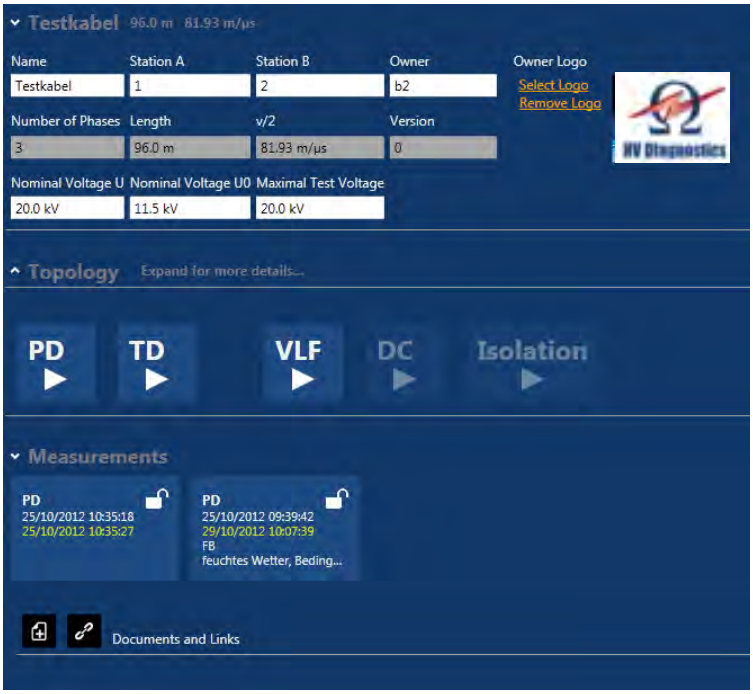
6.5. Grid Management

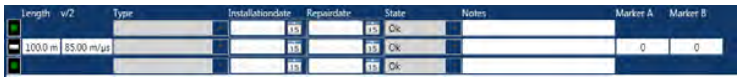
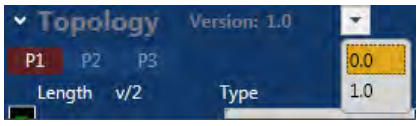
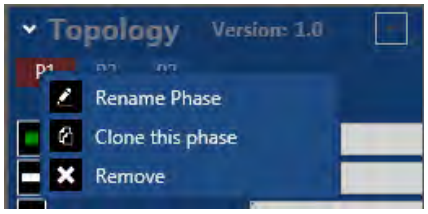
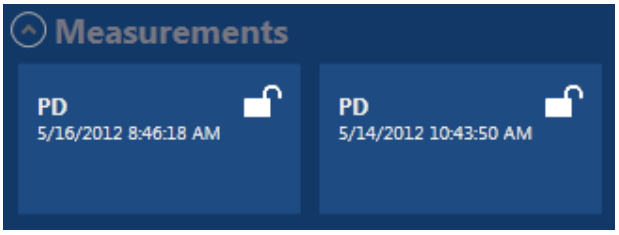
START MENU



6.5.1. Manage Cable Sets

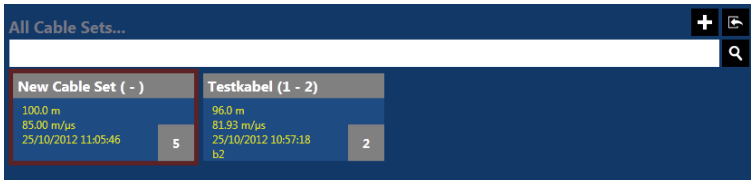
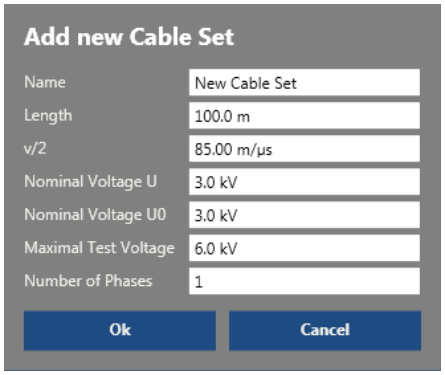
Nr	Example	Options
MC01: Open the Grid Management		Select “Grid Management”
MC02: Cable Sets		The “Cable Set” will open automatically
MC03: Choose Cable Set	 	“Add new Cable Set” . (See GM03) Import a cable Set Search a cable: fill in a keyword and press all Cable Sets which are found with the keywords will be listed. 2 shows how much measurements are still open
MC04: Choose Function		By selection of a previous cable measurement is overview of necessary information is given • HVDSA Test Cable: Start Test • Open Measurements: • Topology • Measurements • Documents and Links

Nr	Example	Options
MC05: Information about the Cable Set		Information about the cable set are listed. -> See GM04 how to create a new Cable Set.
MC06: Start a new Test		Start a new Test directly from the Grid Management • PD • TD • VLF • DC • Isolation
MC07: Open Measurements		All Measurements are shown. Open them with a double click.

Nr Example	Options
MC08: Topology     	Exact Details of the Cable. • Length • v/2 • Type • Installation Date • Repair Date • State (OK, Bad, Critical) • Notes • Marker A • Marker B • Connection Cable Joint Defined Markers: Each Phase has its own topology. Phases can be cloned or deleted. -> right mouse click one the Phase You can also choose between the
MC09: Last Measurements  	All Measurements are listed. Following information are listed: 1) Date and Time at the Test Begin 2) Date and Time of the last Change 3) Operator who works on the Measurement 4) Notes to the Measurement
MC10: Archive  	All Measurements in the Archive are listed

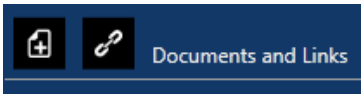
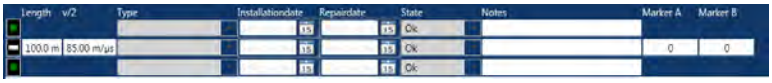
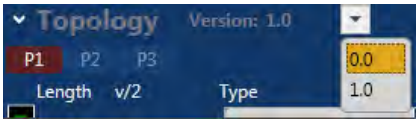
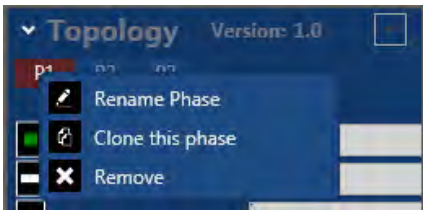
6.5.2. New Cable Set

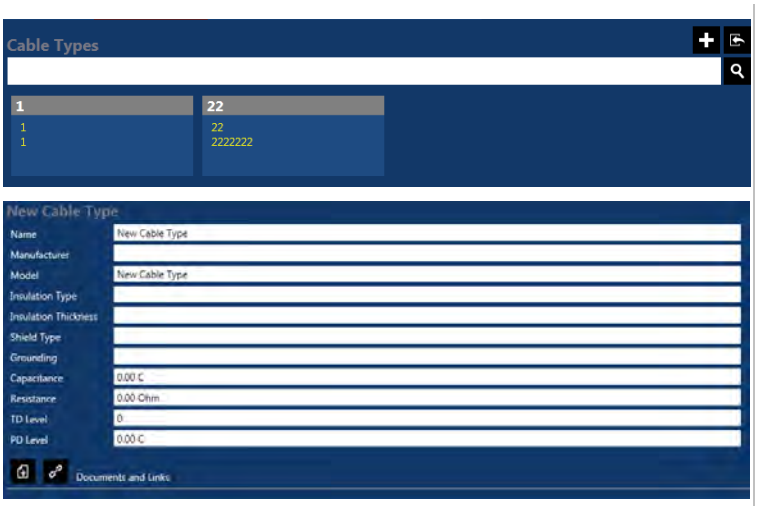
Follow the Steps GM01 – GM16 to set up a new Cable.

Nr	Example	Options
GM01: Open the Grid Management		Select “Grid Management”
GM02: Cable Sets		Set your cable parameters such as **cable name**, **cable types**, **Joint types** and **termination types**.
GM03: Make a new Cable Set		Pess  to add a new Cable Set.
GM04: Fill in Data		Add a new cable set with  . A new window will open. Fill in: • Name of the cable set • Length of the cable set • v/2 • Nominal Voltage U • Nominal Voltage U_0 • Maximal Test Voltage • Number of Phases
GM05: Start a new Test		

Start a new Test directly from the Grid Management.

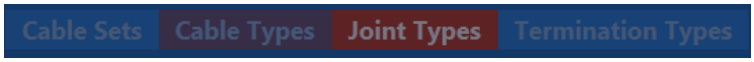
- PD
- TD
- VLF
- DC
- Isolation

NR	EXAMPLE	OPTIONS
GM06: Add a Document or/and a Link		Add a Document or/and a Link for the new Cable Set.
GM07: Topology	   	Fill in the missing data If you change the length of the cable set or the length changes after calibrate the cable, the software will change the Cable Set Version. ***Notice*** Changes at the cable set (for example the cable length) should be done in each phase. Right mouse click on a Phase (P1) • Rename a Phase • Clone a Phase • Remove a Phase
GM08: Cable Types		Choose “Cable Types” in the Task List.
GM09: Make a new Cable Type		



Pess + to add a new Cable Type and fill in the desired Data:

- Name of the cable set
- Manufacturer of the cable set
- Model of the cable
- Type of Insulation
- Thickness of Insulation
- Shield Type
- Grounding Type
- Capacitance
- Resistance
- TD Level
- PD Level

NR	EXAMPLE	OPTIONS
GM10: Joint Types		Proceed with “Joint Types” in the Task List.
GM11: New Joint Types		Pess  to add a new Cable Type and fill in the desired Data: • Name of the Joint Type • Name of the Manufacturer • Name of the Model
GM12: Termination Types		Proceed with “Termination Types” in the Task List.
GM13: New Termination Types		Press  to add a new Termination Type and fill in the desired Data: • Name of the Termination Type • Name of the Manufacturer • Name of the Model

6.6. PD (Partial Discharge)

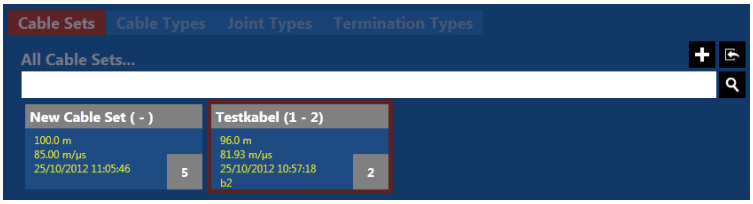
6.6.1. Prepare, Calibration, Measuring and Analyse

The HV suite will lead you thru a complete cycle of Partial Discharge diagnostics (PCMA).

Prepare	Cable Set, Parameter, Notes
Calibration	Noise, Filter, Cable Length, Charge
Measuring	Noise, Inception Voltage, PD Measuring
Analyse.	Validation, Cleaning, Analyse, Report

6.6.2. Running a PD Test

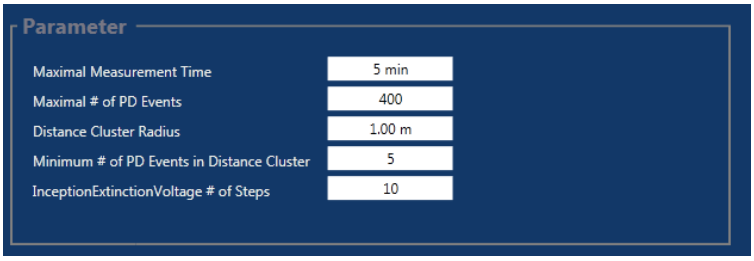
Steps PD01 –PD19 describes how to run a Partial Discharge Test

NR.	EXAMPLE	OPTIONS
PD01: Open the PD Mode		Select in the Main Menu “PD”.
PD02: Choose DUT	 	Choose the Cable which should be tested or create a new Cable Set (GM03). Open the chosen cable with double click or press “OK”. Now you can open the a new PD Measurement with a double click on  or you can open an older measurement.

P Prepare

First Step in a PD Test is to prepare the Cable Set, the Parameters for the Test

PD03: Parameter

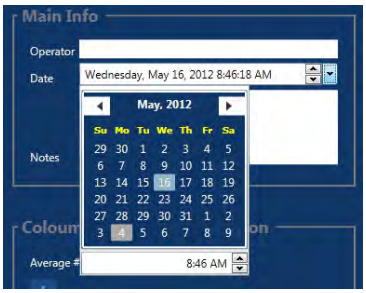


Fill in the missing data in the white boxes.

Notice

Change the data in the grey box in the “Grid Management” if it is necessary.

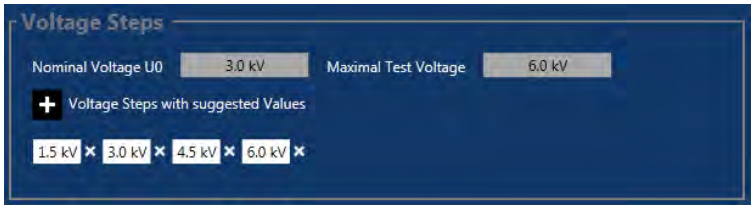
PD04: Main Info



Fill in

- the name of the Operator,
- Date and Time
- and maybe some notes

PD05: Voltage Step



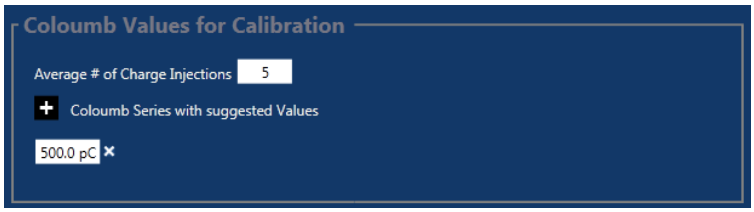
Voltage levels of later PD measurement and number of voltage steps for device under Test (DUT). These are the voltage steps later driven by the HVA generator.

Fill in the individually voltage steps.

Notice

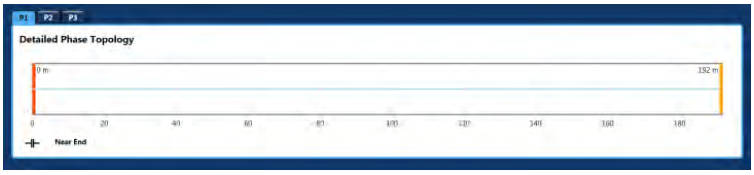
Change the data in the grey box in the “Grid Management” if it is necessary.

PD06: Coulomb Values for Calibration



Choose number of calibration and values. This should be done according to the expected PD level and ambient noise.

PD07: Detailed Phase Topology



You can see the detailed Phase Topology.

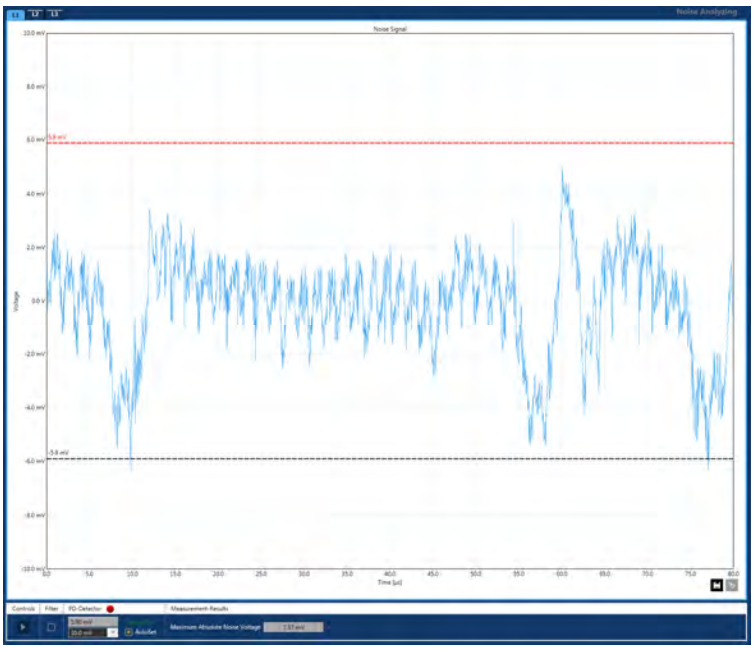
C Calibration

Before PD detection and location is initiated, the PD System and the cable system has to be calibrated. Each phase has to be calibrated before any PD test can be conducted. Every Cable will have a different length and characteristic impedance and it is very important to calibrate each phase separately. **The PD levels are meaningless unless the calibration is done.** In order to do the calibration the safety earths should be removed from the near and. far end terminations.

Place the calibrator across the termination keeping the calibrator wires as close to the termination as possible to reduce the reflections. Do not connect the calibrator across coupling capacitor.

Do not forget to remove calibrator after the calibration is completed.

PD08: Noise Analyzing



Start with Noise Analyzing!

Do not perform this test with high voltage!

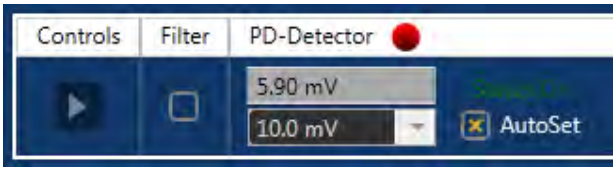
Controls: Start Noise Analyzing

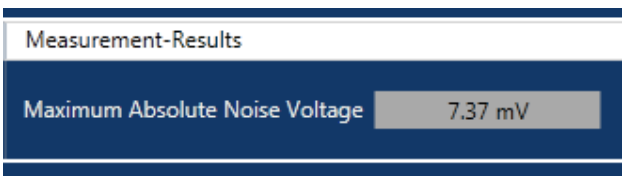
Filter: On or not?

PD-Detector:

If PD Detector is not connected, the light appears in red color. To reconnect to the detector, press right hand mouse click and re-connect.

Settings for trigger level and gain can be set to automatic or manual settings.

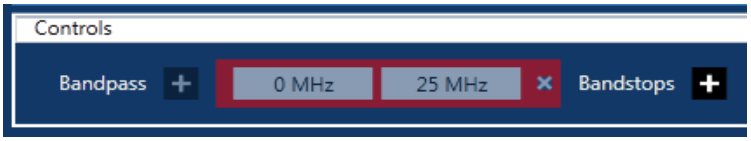




Lower Part in window indicates PD Noise Level

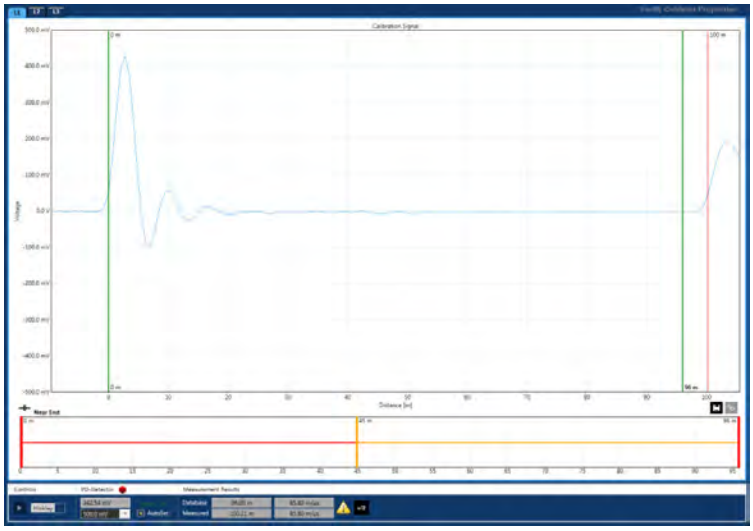
PD09: Filter Definition

With a click (left mouse button) in the bandpass/bandstop selection, you can move the selection to the desired position. To widen or narrow bandwith, click on the edge of the bandpass (rubber band)

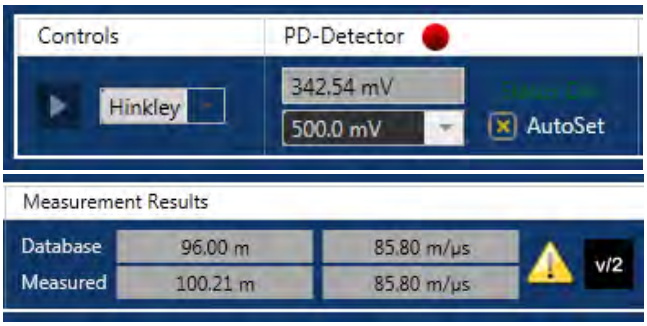


Indicates on set Bandwidth (Nandpass and Bandstops)

PD10: Verify Cable Set Properties



The cable “near end” and the far end” can be seen. Please note, that cable velocity has to be set properly in order to achieve accurate measurement. Cursers will be set automatically to “peak” (also to slope and hinkley). Curser can be also set manually at all time.



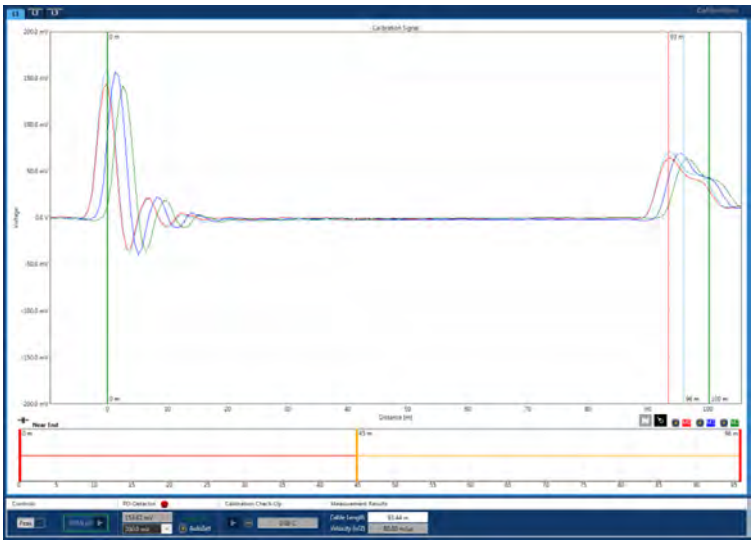
Measurement Results:

Database: Data from the Database

Measured: Data from the Measurement

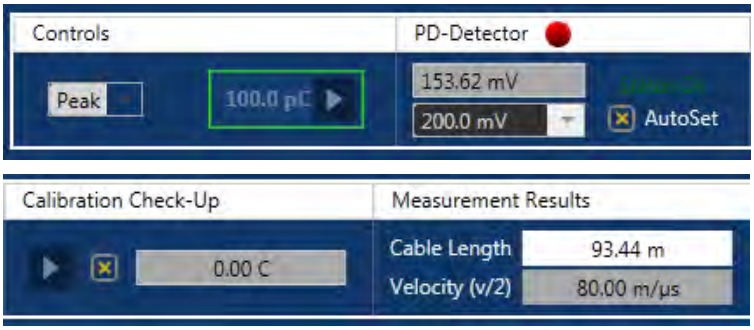
v/2 calculate v/2 according to the curser and put it into the database

PD11: Calibration



PD Amplitdude will be calibrated.

Choose desired PD Level on the Calibrator (100pC, 200 pC, 500 pC 1 nC, 5 nC or 10 nC)



Notice

The curser, which is set in the Calibration Controls f.ex. “Hinkley” is active for the whole measurement.

M Measurement

Before you continue with high voltage measuring, please make sure that you have disconnected calibration unit

Make sure that both Termination Ends are safe and ready for testing. Comply fully with the local utilities/Responsible Authority switching, earthing and safety regulations. Have the safety earths removed from both end terminations by the responsible operations.

The maximum test voltages which should be applied for PD Testing is normally between 1.7Uo.

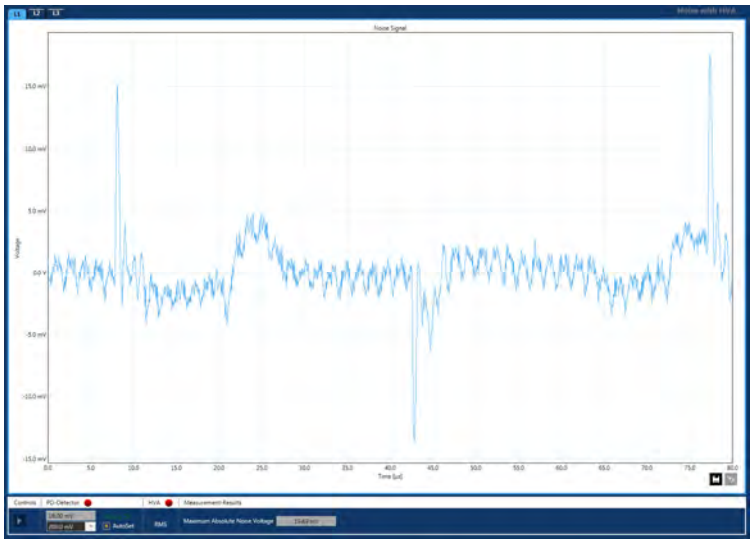
For a partial discharge to occur, the localized field stress at the site of a defect must be sufficient to exceed the inception stress, also known as the PDIV or partial discharge inception voltage. Once this inception voltage has been met, repetitive partial discharge activity will normally continue until the applied voltage is decreased to a level known as the PDEV or partial discharge extinction voltage. This PDEV level is typically 1.3 to 1.5 times less than PDIV. Therefore defects that have Partial Discharge Inception Voltages close to the operating voltage of the cable system are more likely to be initiated by an over voltage transient like those generated by switching or lightning for example. Even after the transient has subsided, the normal system voltage can be sufficient to sustain these partial Discharges, resulting in a possible cable failure.

PD12 Attention High Voltage!

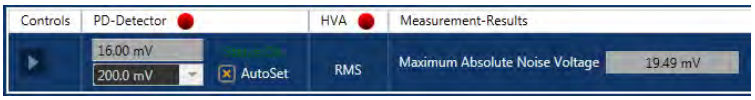
A notification will appear on the screen.

Press the green Button on the HVA to start High Voltage!

PD13: Noise with HVA

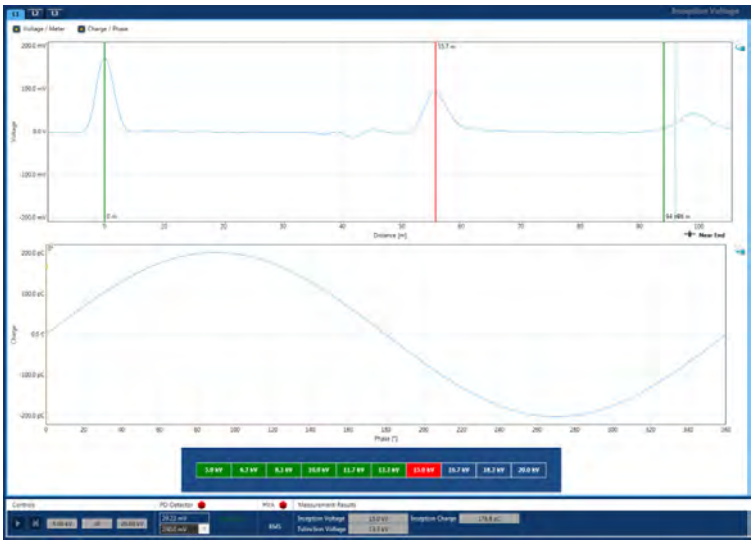


Noise signal will be measured without High Voltage on but with the HVA Device switched on.



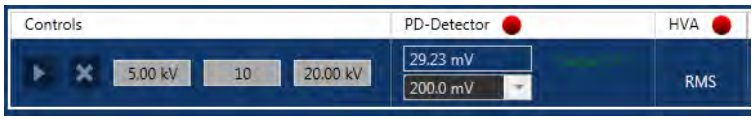
Maximum absolute noise voltage will be indicated in lower part of the screen.

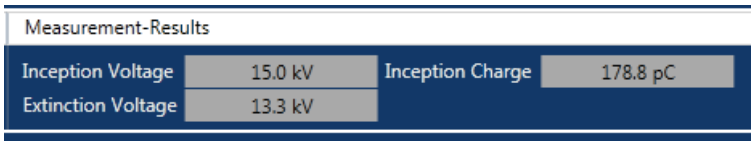
PD14: Inception Voltage



The next step is to analyze the inception and extinction voltage.

After activating the HVA series the voltage steps are applied to the DUT according to the settings in PD Preparation (see voltage series and inception extinction voltage # of steps).

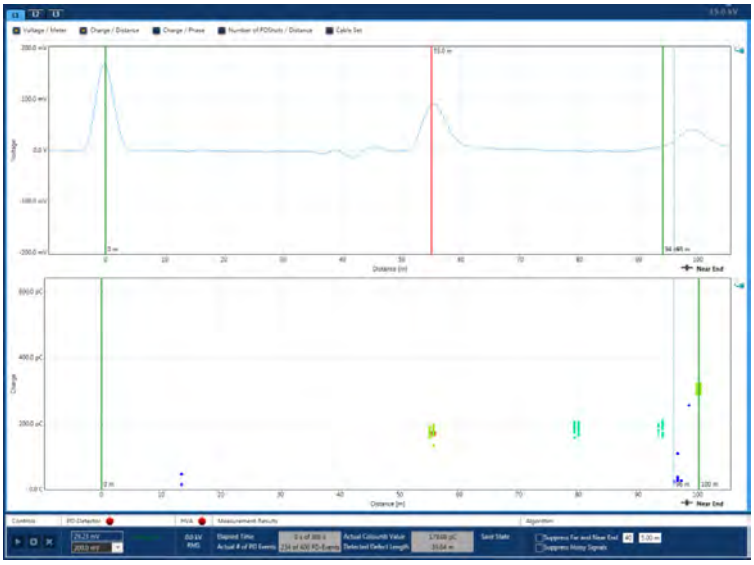




Indicates

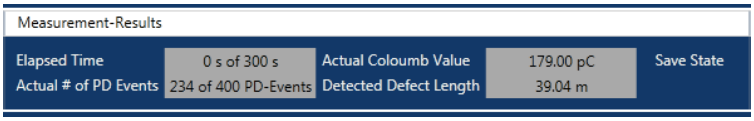
- Initial Voltage rms
- No of Steps
- Max Voltage

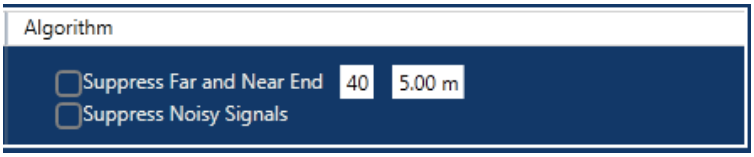
PD15: Measurement with ..kV



Now it'll test the selected voltage steps.

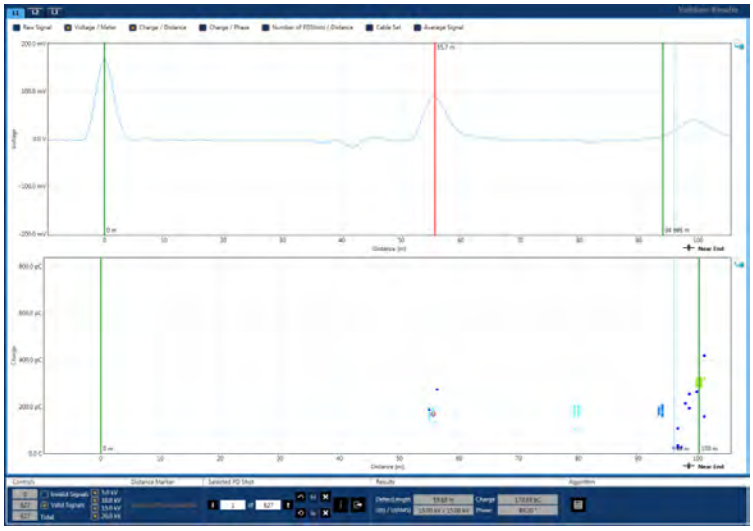
The PD measurement will be performed subsequently according to the pre-set high voltage levels and steps





A Analyze

PD16: Validate Results



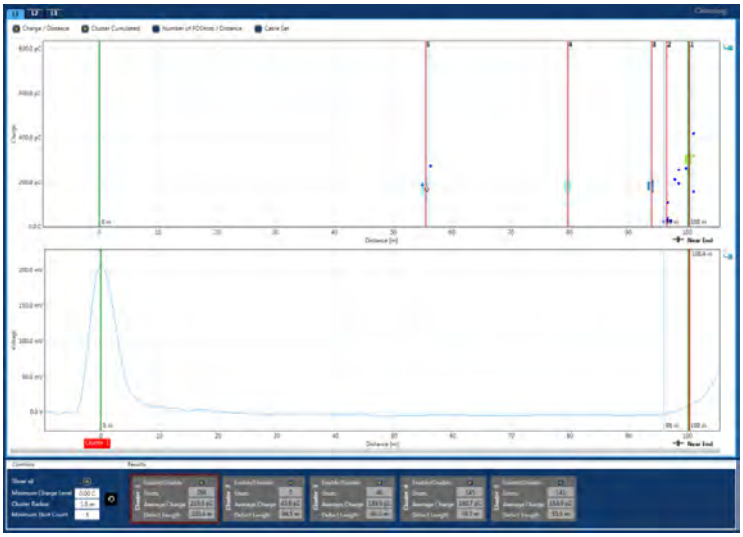
It shows you an overview about the measured results. This procedure is to eliminate valid from invalid measurements and to display an average value of valid measurements

Selected PD Shot:

You can recalculate the PD Shots and make calculate the average signal with ∫.

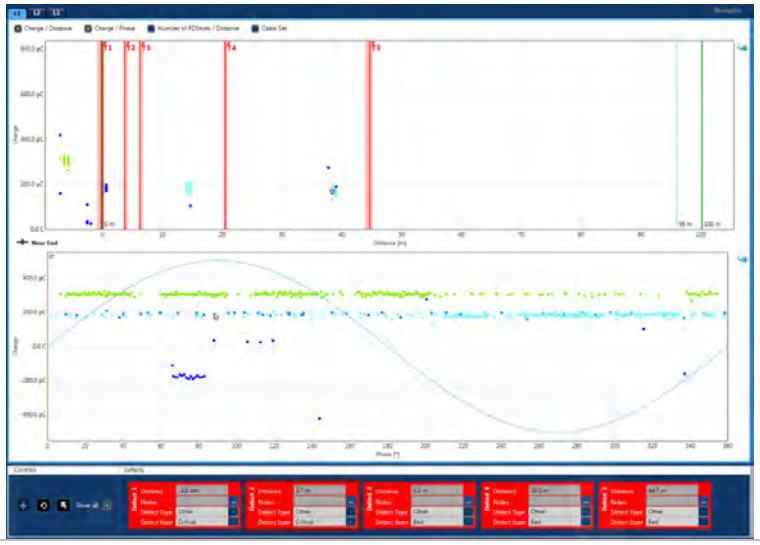
To export the raw signal press

PD17: Cleaning

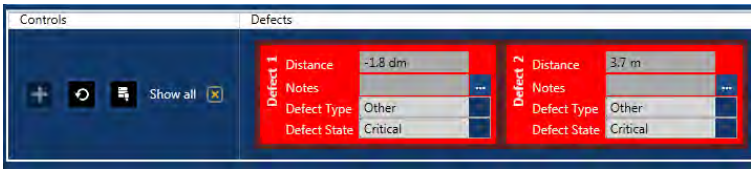


To constrain the results, a cluster function is embedded in the PD suite. Cluster Radius, numbers of shots and minimum charge level helps to qualify PD events and distinguish errors.

PD18: Results



After the validation of the result and the cleaning final results (PD Events) are indicated and displayed, giving distance to the relevant findings.

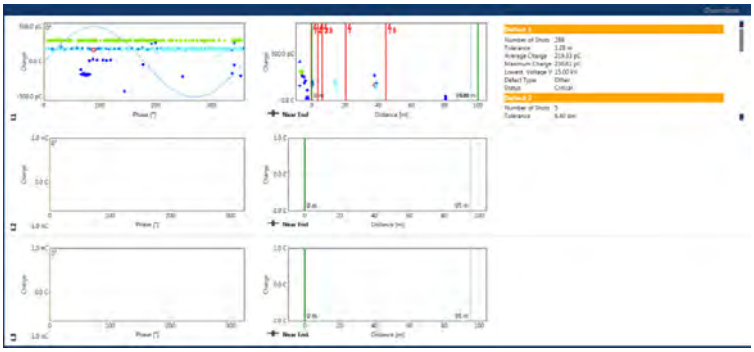


You can edit each defect.

- Cable Defect Description
- Defect Type
- Defect Slate

You can also make a Report – press 

PD19: Overview



On the left side you can see all defects of each phase. On the right side you'll find a detailed description of each defect.

6.7. VLF Testings

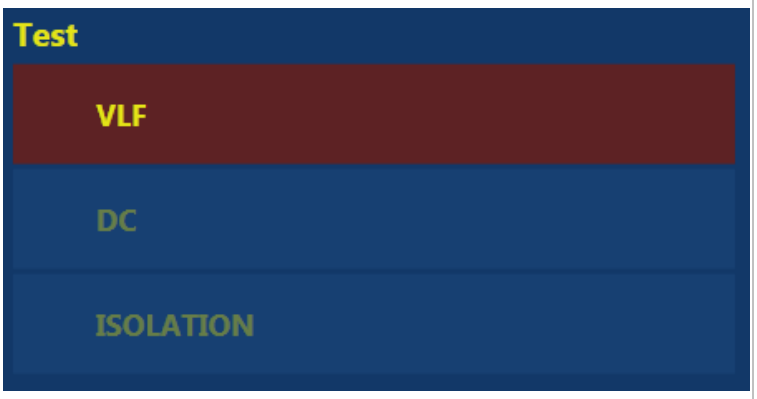
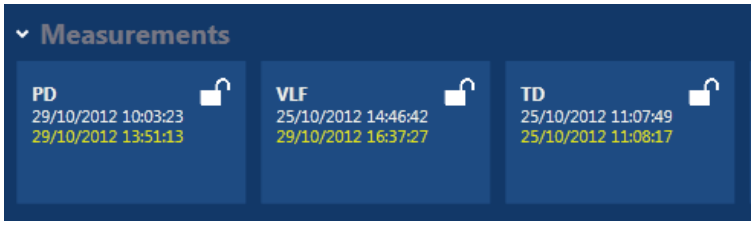
6.7.1. Prepare, Measuring and Analyze

The PD suit will lead you thru a complete cycle of VLF Testing (PMA).

Prepare	Cable Set, Parameter, Main Info, Sequences
Measuring	HVA Measurement
Analyse.	Results, Report

6.7.2. Running a VLF Test

Steps VLF01 –VLF15. describes how to run a VLF Test

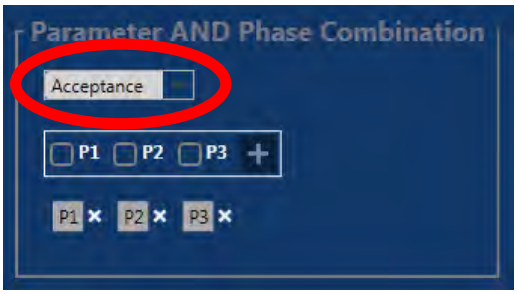
NR.	EXAMPLE	OPTIONS
VLF01: Open the VLF Mode		Select in the Main Menu “VLF”.
VLF02: Choose DUT	 	Choose the Cable which should be tested or create a new Cable Set (GM03). Open the chosen cable with double click or press “OK”. Now you can open a new PD Measurement with a double click on VLF ▶ or you can open an older measurement.

Prepare

P

First Step in a VLF Test is to prepare the Parameter, the Phase Combination, Sequences, and the Cable Set for the Test.

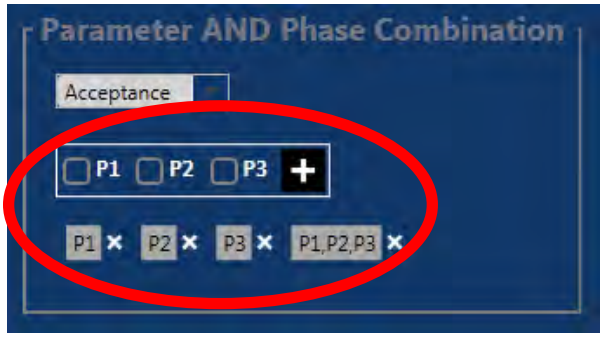
VLF03: Test Prupose



Select aim of the test from one of the following:

- Acceptance
- Maintenance
- Diagnostic

VLF04: Phase Combination



Choose which Phases should be tested:

- P1, P2 and P3 each Phase separately or
- All 3 Phases together

Activate the Control Box with the Phase which is needful and add it to your list with +.

All Phases which at the list will be tested:

VLF05: Main Info

Fill in the general information:

- Name of the Operator
- Date and Time
- Notes

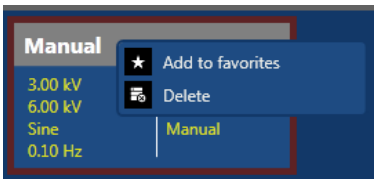
VLF06: Sequences

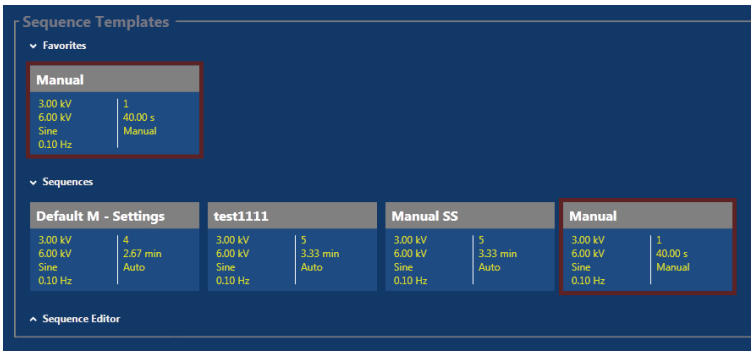
You can see all Sequences which are generated.

The data to each Sequence can be open with

The red marked Sequence will be taken for the test.

VLF07: Favorites

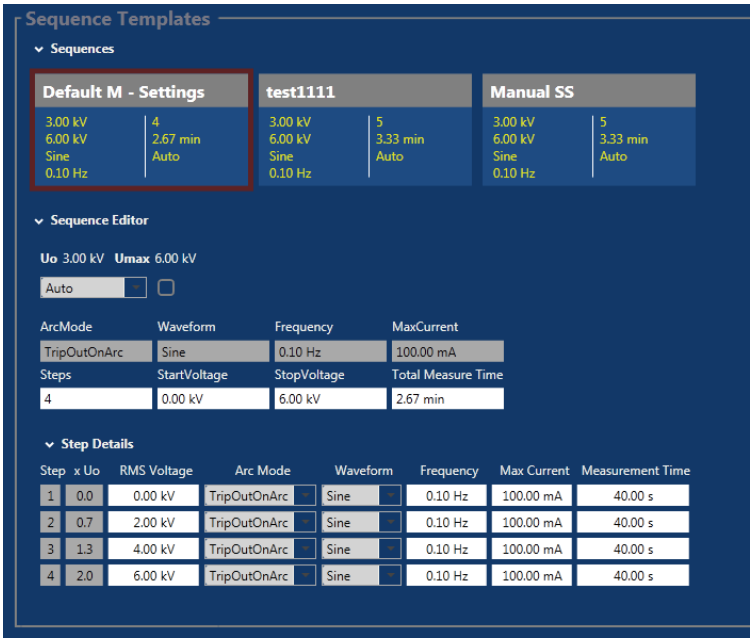




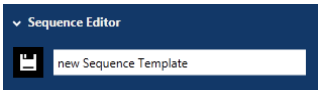
With a right mouse click on a Sequence you can add it to the Favorites list.

➔ See left

VLF08: New Sequences



Save a sequence



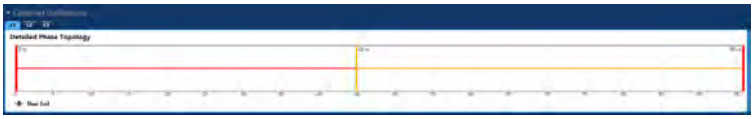
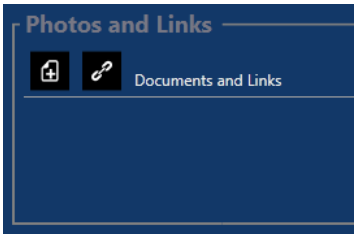
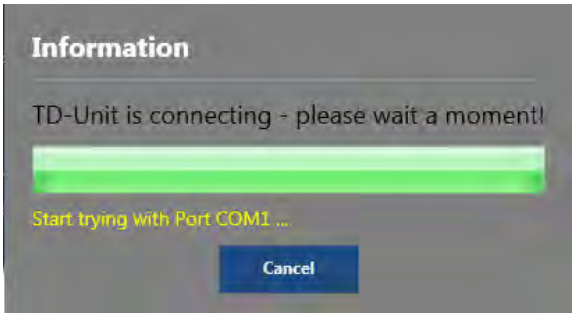
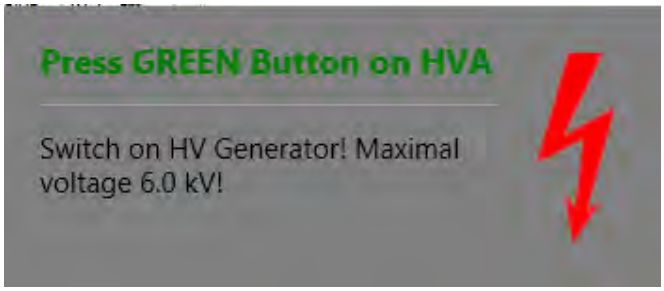
To generate a new Sequence, open an existing Sequence. Change the necessary parameters. Just as one Position will be changed you can store it as a new Sequence:

The following data can be changed:

- **Mode:**
  Manual -> further operation at the HVA unit
  or Auto
- **Arc Management Mode:**
  Trip out on Arc or Burn on Arc
- **Waveform:**
  Sine wave
  Square wave
  DC+
  DC-
- **Frequency**
  depends on with which HVA will be tested
- **Voltage Steps:**
  Specify the number of voltage steps to be applied to the DUT.
- **Start Voltage**
- **Stop Voltage**
- **Total Measure Time:**
  Min. test duration / step = 1 min
  Max. test duration/step = 120 min

After the Data are defined you can fill in the Step Details:

- **RMS Voltage**
- **Frequency**
- **Max Current**
- **Measurement Time**

VLF09: Cable Set Definitions 	You can see the data of the Cable Set
VLF10: Add Photos and Links 	Add Photos and Links
VLF11: HVA Connection 	The computer set up a connection with the HVA unit via Bluetooth or via FTDI USB Adapter.
VLF12: HV Activation 	Once the activation screen appears, press the HV switch (on the HVA unit) within 10 seconds.

Measurement

M The next step is “Measurement”. Attend that all procedures must comply with local safety regulations. Before, turning on the power supply and before activating the HVA, verify that all system elements are properly grounded!

VLF13: Auto Mode – Measurement

Press Auto to start the test. All defined steps will be tested automatically.

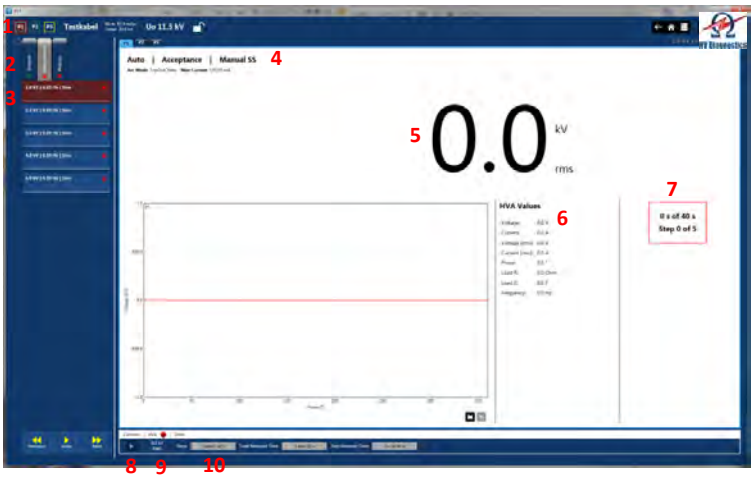
Press Next to start the test. Each phase has to be started separately.

You can see all Data on the screen.

VLF14: Manual Mode – Measurement

You have to define the Sequence and start the test at the HVA unit.

Screen Description

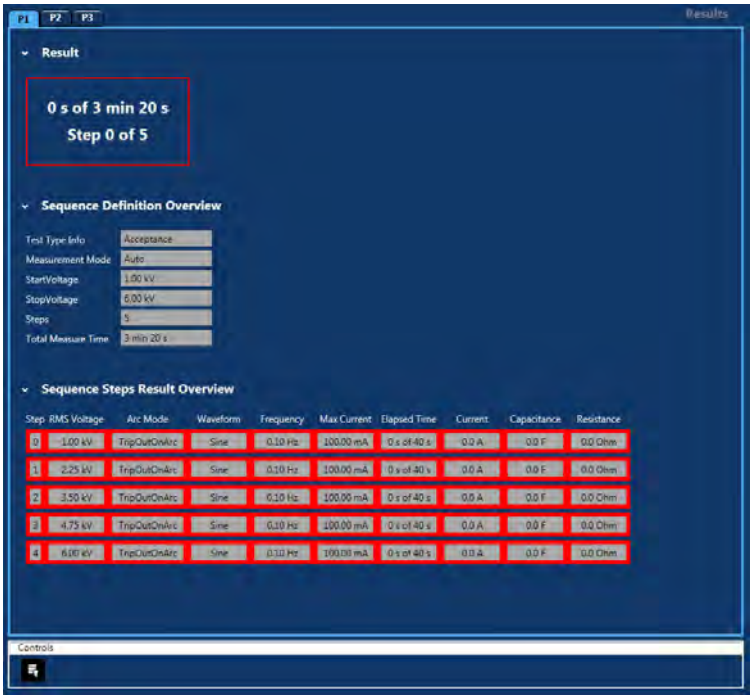


1) Shows which Phase will be tested
2) Measurement
3) Details of each Step. The red marked step is tested
4) General Sequence Information
5) Test Voltage
6) HVA Values
   Shows the following test data:
   Voltage
   Current
   Voltage [rms]
   Current [rms]
   Phase
   Load R
   Load C
   Frequency
7) Timer of each step
8) HVA Controls
9) HVA Voltage [rms]
10) Infos about:
    the steps
    Total Measure Time
    Step Measure Time

A Analyze

The Test is finished. You'll find a detailed Analyze of the test which could be generating to a report.

VLF15: Analyze



The Result of the Measurement is shown. Press  to generate a Report.

6.8. TD Testing

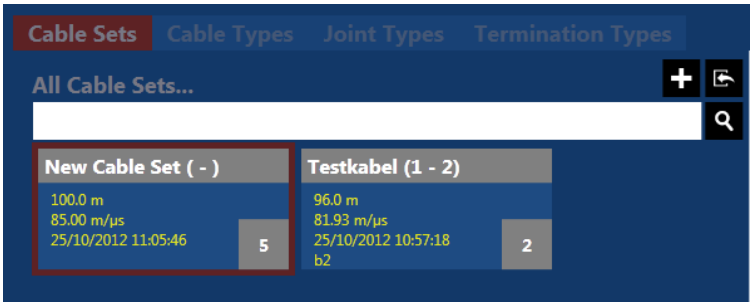
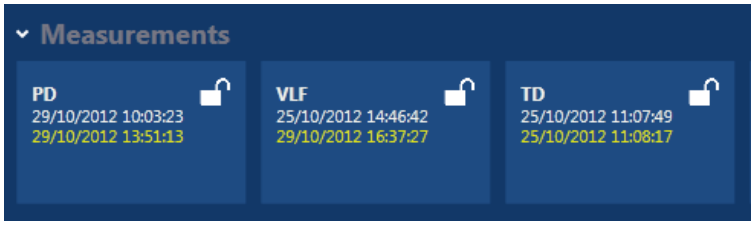
6.8.1. Prepare, Measuring and Analyze

The HV suite will lead you thru a complete cycle of TD Testing (PMA).

Prepare	Cable Set, Parameter, Main Info, Sequences
Measuring	TD Measurement
Analyse.	Results, Report

6.8.2. Running a TD Test

Steps TD01 – TD…. describes how to run a TD Test

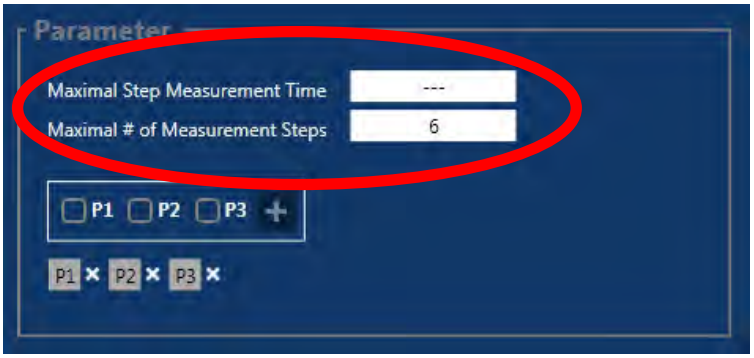
NR.	EXAMPLE	OPTIONS
TD01: Open the TD Mode		Select in the Main Menu “PD”.
PD02: Choose DUT	 	Choose the Cable which should be tested or create a new Cable Set (GM03). Open the chosen cable with double click or press “OK”. Now you can open a new PD Measurement with a double click on  or you can open an older measurement.

Prepare

P

First Step in a TD Test is to prepare the Parameter, the Voltage Step, TD Limits, and the Cable Set for the Test.

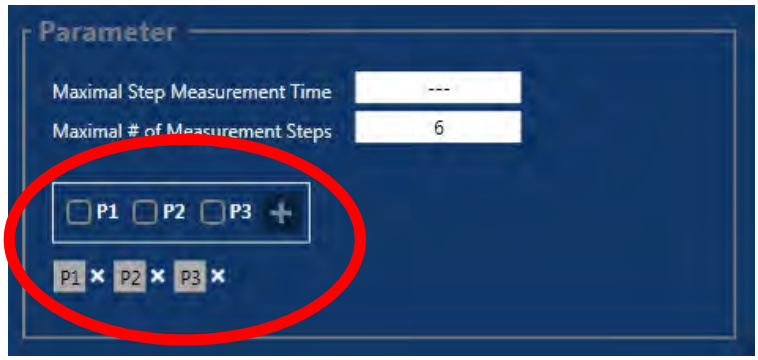
TD03: Steps



The following Data should be defined:

- Maximal Step Measurement Time
- Maximal # of Measurement Steps

TD04: Phase Combination



Choose which Phases should be tested:

- P1, P2 and P3 each Phase separately or
- All 3 Phases together

Activate the Control Box with the Phase which is needful and add it to your list with +.

All Phases which at the list will be tested:

TD05: Main Info

Fill in the general information:

- Name of the Operator
- Date and Time
- Notes

TD06: Voltage Steps

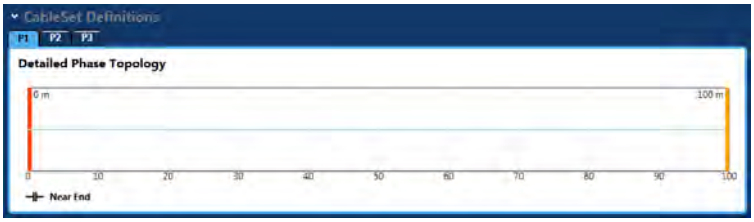
Manage the Voltage Steps with their Values.

TD07: TD Limits

Fix the TD Limits.
There are three steps:

- None
  Nothing happens
- Warning
  There will be a warning
- Stop
  Test Stops

TD08: Cable Set Definitions

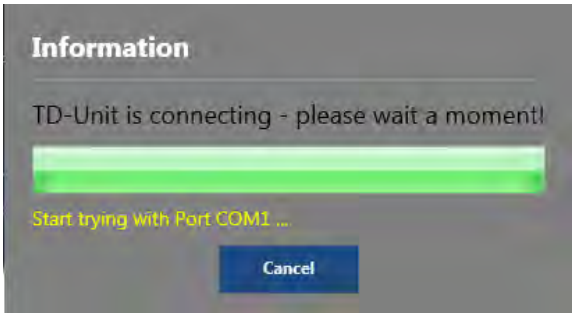


You can see the data of the Cable Set

TD09: Photos and Links

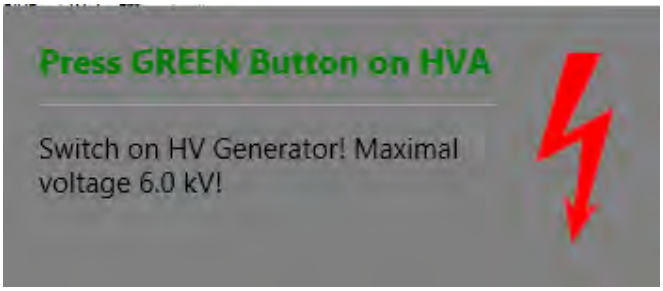
Add Photos and Links.

TD10: TD Connection



The computer set up a connection with the TD unit via Bluetooth.

TD11: HV Activation

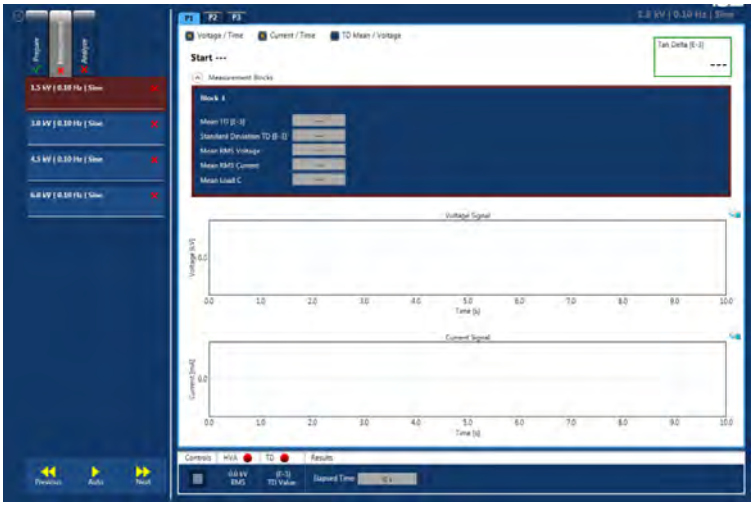


Once the activation screen appears, press the HV switch (on the HVA unit) within 10 seconds.

Measurement

M The next step is “Measurement”. Attend that all procedures must comply with local safety regulations. Before, turning on the power supply and before activating the TD, verify that all system elements are properly grounded!

12: TD Measurement



Press Auto to start the test. All defined steps will be tested automatically.

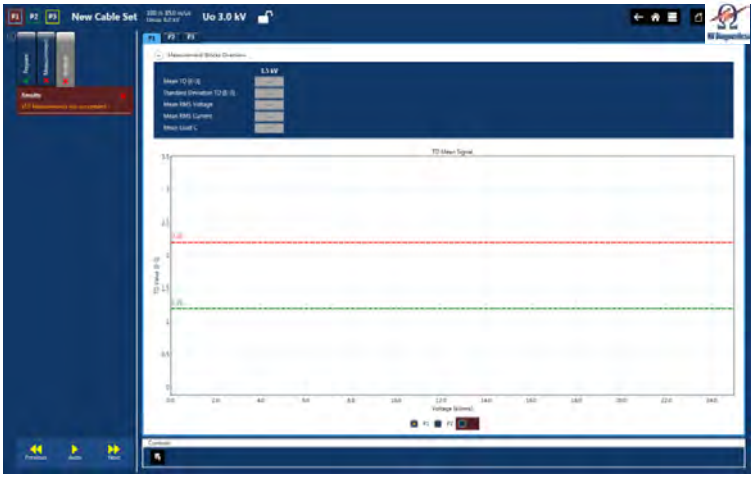
Press Next to start the test. Each phase has to be started separately.

You can see all Data on the screen.

A Analyze

The Test is finished. You'll find a detailed Analyze of the test which could be generating to a report.

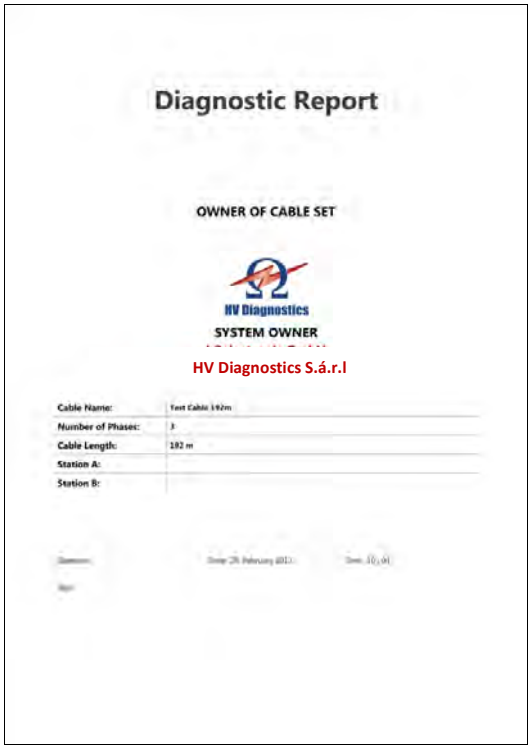
VLF15: Analyze



The Result of the Measurement is shown. Press  to generate a Report.

6.9. Reporting

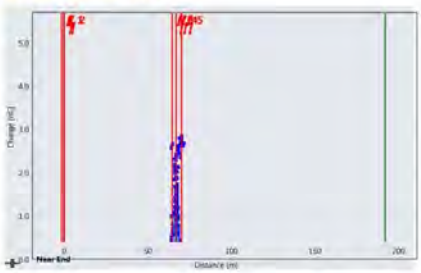
6.9.1. Simple Version



[PD REPORT]

SUMMARY P1

CHARGE / DISTANCE PLOTS



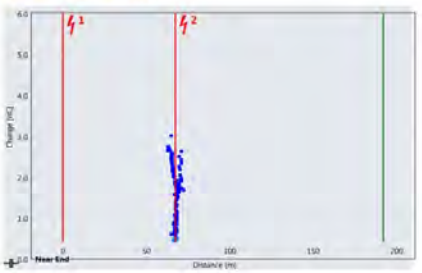
DEFECTS

Defect 1	Distance	-1.56 m	Number of Shots	26	DefectType
	Average Charge	0.10 nC	Maximum Charge	0.14 nC	Lowest Voltage Value 12.00 kV
Defect 2	Distance	-0.27 m	Number of Shots	16	DefectType
	Average Charge	0.12 nC	Maximum Charge	0.19 nC	Lowest Voltage Value 14.00 kV
Defect 3	Distance	64.62 m	Number of Shots	814	DefectType
	Average Charge	0.18 nC	Maximum Charge	2.86 nC	Lowest Voltage Value 6.00 kV
Defect 4	Distance	86.55 m	Number of Shots	864	DefectType
	Average Charge	0.52 nC	Maximum Charge	2.74 nC	Lowest Voltage Value 6.00 kV
Defect 5	Distance	70.16 m	Number of Shots	15	DefectType
	Average Charge	2.67 nC	Maximum Charge	2.85 nC	Lowest Voltage Value 12.00 kV

[PD REPORT]

SUMMARY P2

CHARGE / DISTANCE PLOTS



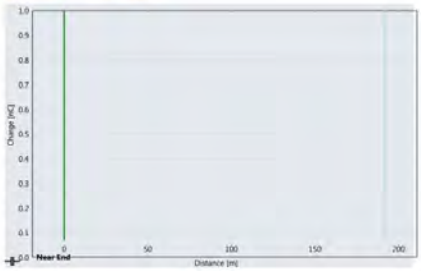
DEFECTS

Defect 1	Distance	-0.11 m	Number of Shots	72	DefectType
	Average Charge	0.11 nC	Maximum Charge	0.31 nC	Lowest Voltage Value 6.00 kV
Defect 2	Distance	67.34 m	Number of Shots	733	DefectType
	Average Charge	0.43 nC	Maximum Charge	2.63 nC	Lowest Voltage Value 3.00 kV

[PD REPORT]

SUMMARY P3

CHARGE / DISTANCE PLOTS



DEFECTS

[PD REPORT]

STATUS

Phase	Status
P1	Ok
P2	Ok
P3	Ok

NOTES

6.9.2. Extended Version


Diagnostic Report

OWNER OF CABLE SET

HV Diagnostics

SYSTEM OWNER

HV Diagnostics S.á.r.l

Cable Name:	Test Cable 192m
Number of Phases:	3
Cable Length:	192 m
Station A:	
Station B:	


[PD REPORT]

EQUIPMENT

Unit	S/N
HVA80	HVA80 GHS204.10C007
PD-CC	08 + TD
PD-Calibrator	Cal 18 1737
tz Suite	1.3.0.0

PD DIAGNOSTIC SETUP

PARAMETER

Maximal Measurement Time	2.00 s
Maximal # of PD Events	400
Measurement Interval	2.00 mi
Minimum # of PD Event between Interval	10
InceptionExtinctionVoltage # of Steps	20
InceptionExtinctionVoltage # of Valid Signals	3

VOLTAGE SERIE

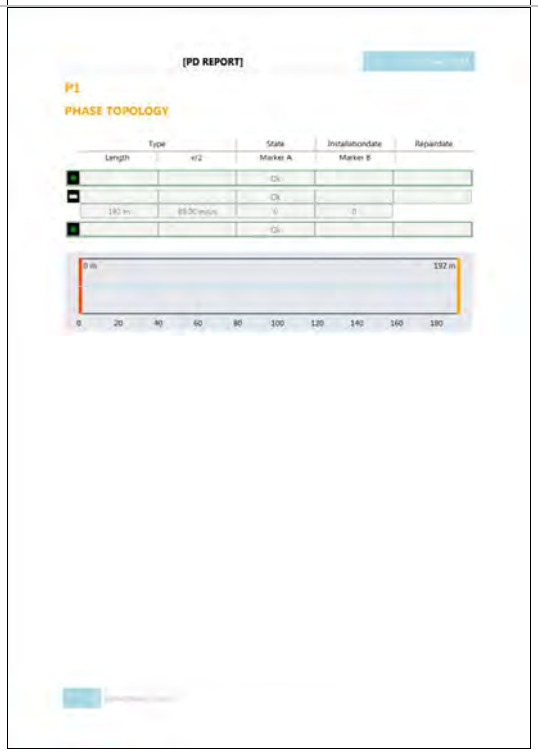
3.00 kV	6.00 kV	12.00 kV	14.00 kV

CALIBRATION LEVELS

0.20 nC	0.28 nC

PHASE 1/2/3

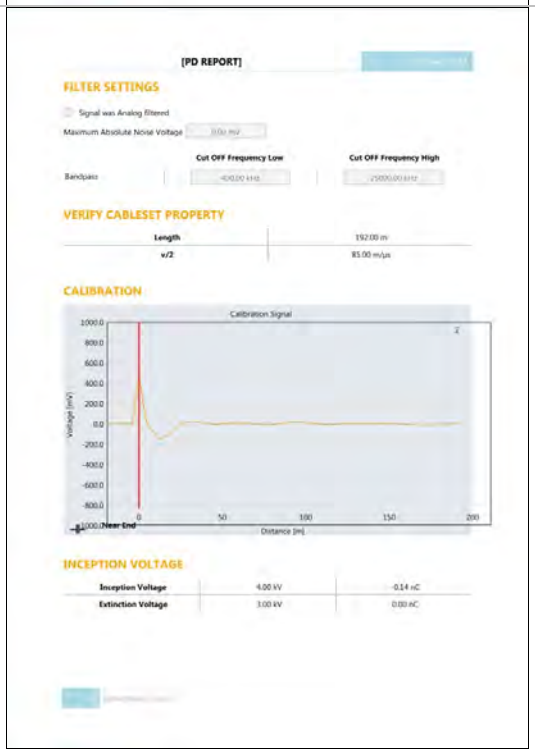
P1	Capacity	0.00 nF	Load	0.00 MOhm	Frequency	0.00 Hz
P2	Capacity	0.00 nF	Load	0.00 MOhm	Frequency	0.00 Hz
P3	Capacity	0.00 nF	Load	0.00 MOhm	Frequency	0.00 Hz


[PD REPORT]

P1

PHASE TOPOLOGY

Type		State	Installationdate	Repairdate
Length	v/2	Marker A	Marker B	
		Ok		
		Ok		
192 m	85.00 m/µs	0	0	
		Ok		


[PD REPORT]

FILTER SETTINGS

Signal was Analog filtered

Maximum Absolute Noise Voltage 0.00 mV

	Cut OFF Frequency Low	Cut OFF Frequency High
Bandpass	400.00 kHz	25000.00 kHz

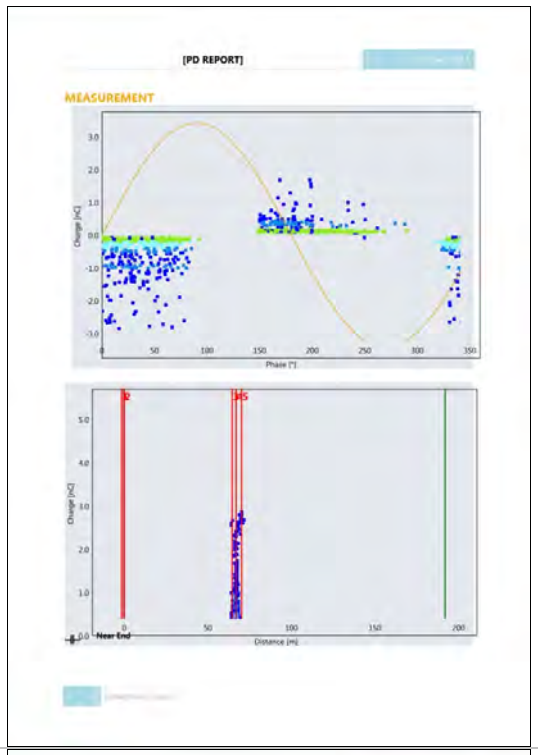
VERIFY CABLESET PROPERTY

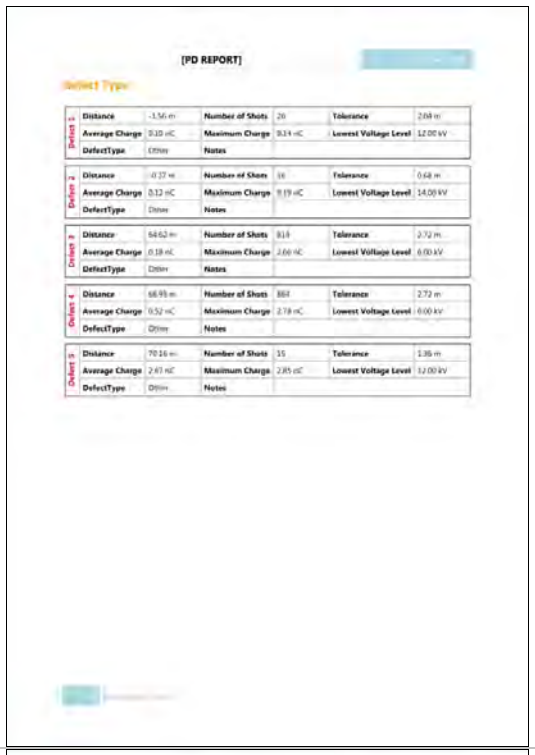
Length	192.00 m
v/2	85.00 m/µs

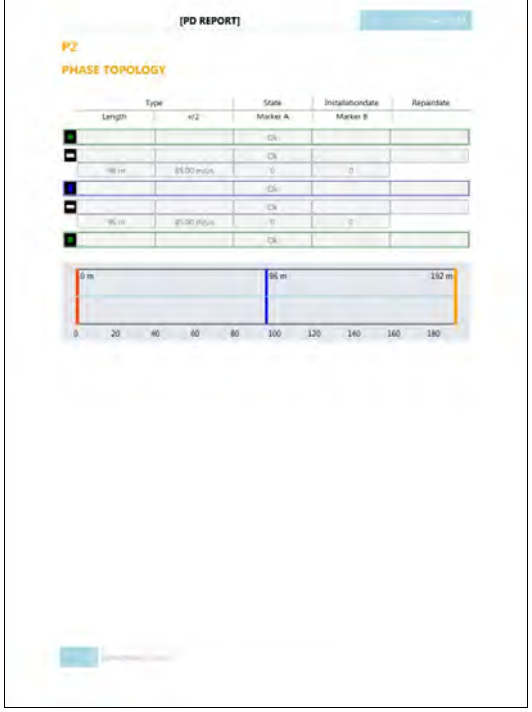
CALIBRATION

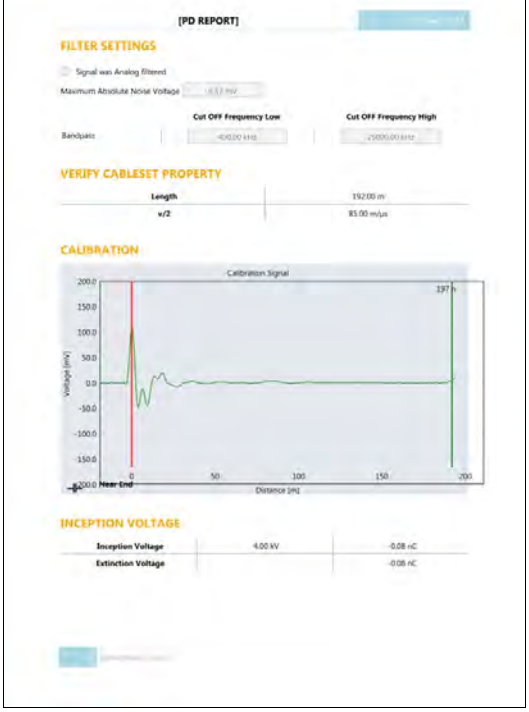
INCEPTION VOLTAGE

Inception Voltage	4.00 kV	0.14 nC
Extinction Voltage	3.00 kV	0.00 nC


[PD REPORT]
MEASUREMENT
Charge [nC]
Phase [°]
Charge [nC]
Distance [m]
Near End

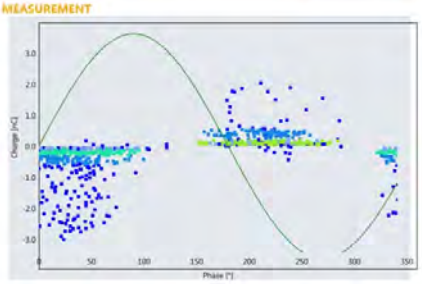

[PD REPORT]
Distance
Number of Shots
Tolerance
Average Charge
Maximum Charge
Lowest Voltage Level
DefectType
Notes

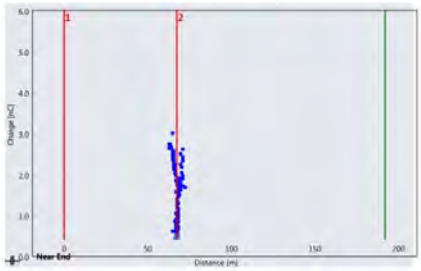

[PD REPORT]
P2
PHASE TOPOLOGY
Type
State
Initialisationdate
Repairdate
Length
v/2
Marker A
Marker B
0 m
96 m
192 m


[PD REPORT]
FILTER SETTINGS
Signal was Analog filtered
Maximum Absolute Noise Voltage
Cut OFF Frequency Low
Cut OFF Frequency High
Bandpass
VERIFY CABLESET PROPERTY
Length
192.00 m
v/2
85.00 m/µs
CALIBRATION
Calibration Signal
Voltage [mV]
Distance [m]
Near End
INCEPTION VOLTAGE
Inception Voltage
4.00 kV
Extinction Voltage

[PD REPORT]

MEASUREMENT





[PD REPORT]

Defect Type

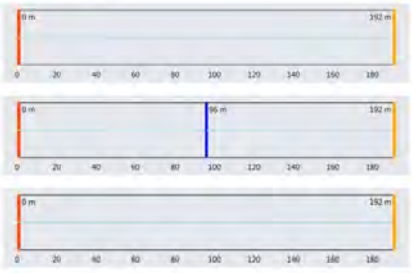
Defect 1	Distance	-0.11 m	Number of Shots	72	Tolerance	4.08 m
	Average Charge	0.11 nC	Maximum Charge	0.31 nC	Lowest Voltage Level	6.00 kV
	DefectType	Other	Notes			
Defect 2	Distance	67.34 m	Number of Shots	755	Tolerance	5.44 m
	Average Charge	0.43 nC	Maximum Charge	2.63 nC	Lowest Voltage Level	3.00 kV
	DefectType	Other	Notes			

[PD REPORT]

PHASE SUMMARY

Cable Name:	Test Cable 192m
Cable Length:	192.00 m
v/2:	85.00 m/µs
Number of Phase:	3
Maximum Voltage:	14.00 kV
Frequency:	0.1 Hz

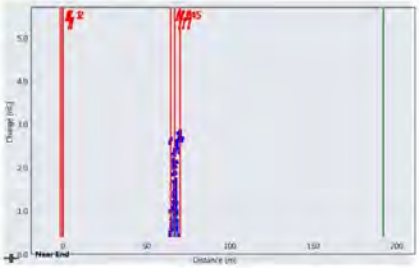
PHASE TOPOLOGIES



[PD REPORT]

SUMMARY P1

CHARGE / DISTANCE PLOTS



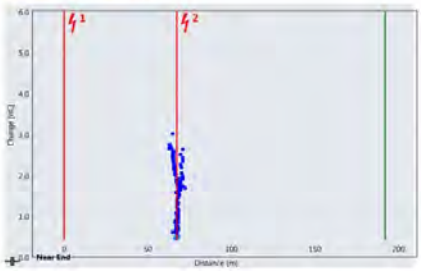
DEFECTS

Defect 1	Distance	-1.56 m	Number of Shots	25	DefectType	
	Average Charge	0.10 nC	Maximum Charge	0.14 nC	Lowest Voltage Value	12.00 kV
Defect 2	Distance	-0.27 m	Number of Shots	16	DefectType	
	Average Charge	0.12 nC	Maximum Charge	0.19 nC	Lowest Voltage Value	14.00 kV
Defect 3	Distance	64.62 m	Number of Shots	814	DefectType	
	Average Charge	0.18 nC	Maximum Charge	2.86 nC	Lowest Voltage Value	6.00 kV
Defect 4	Distance	86.55 m	Number of Shots	864	DefectType	
	Average Charge	0.52 nC	Maximum Charge	2.78 nC	Lowest Voltage Value	6.00 kV
Defect 5	Distance	70.16 m	Number of Shots	15	DefectType	
	Average Charge	2.67 nC	Maximum Charge	2.85 nC	Lowest Voltage Value	12.00 kV

[PD REPORT]

SUMMARY P2

CHARGE / DISTANCE PLOTS



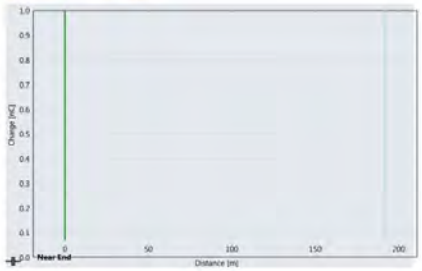
DEFECTS

Defect 1	Distance	-0.11 m	Number of Shots	72	DefectType
	Average Charge	0.11 nC	Maximum Charge	0.31 nC	Lowest Voltage Value 6.00 kV
Defect 2	Distance	67.34 m	Number of Shots	753	DefectType
	Average Charge	0.43 nC	Maximum Charge	2.63 nC	Lowest Voltage Value 3.00 kV

[PD REPORT]

SUMMARY P3

CHARGE / DISTANCE PLOTS



DEFECTS

[PD REPORT]

STATUS

Phase	Status
P1	Ok
P2	Ok
P3	Ok

NOTES

7. Glossary and Abbreviations

The following explains abbreviations and selected terms used in this document in alphabetical order.

Term	Explanation
DUT	Device under Test
Duty (continuous)	Load state in which the relay remains energized for a period long enough to reach thermal equilibrium
Hipot	High potential (voltage)
HV	High Voltage (tension) • Extremely high voltage: typically 220kV or 380kV • High voltage: typically 110kV
IEC	International Electrotechnical Commission
Peak value	Maximum Voltage = Vmax
RMS value	Root Mean Square voltage • Vrms = Vpeak / √2
Uo	Phase to earth or concentric neutral
VLF	Very Low Frequency • Typically between 0.01 -0.1 Hz
v/2