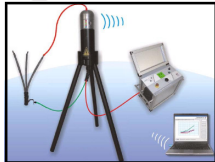


High Voltage Test and Diagnostic Systems for MV Cables

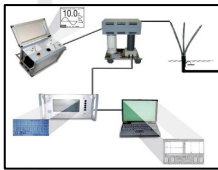
High Voltage VLF and Tan Delta Specialists



▶ **Hipot VLF test systems**



▶ **Tan Delta test systems**



▶ **Partial Discharge diagnostic systems**

STOP

T: 00: 11/ 30min

Manual Mode Sine 0.1Hz

10.0

kV

rms

4.8kV

1 μ A

<1nF

>20G Ω



HV Diagnostics

www.hvdsa.com

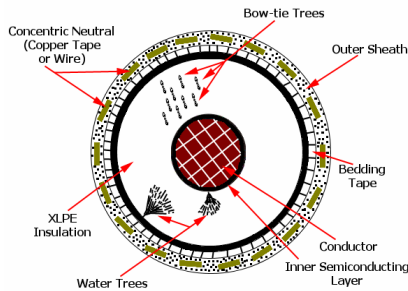
Introduction

Water trees in XLPE cables

Water trees are small tree shaped channels found within the insulation of a cable.

There are two ingredients for initiating and developing water trees.

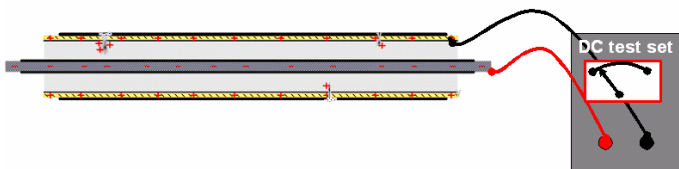
1. Water ingress into the cables (and under the Semi conductive tape).
2. The operating Voltage at (50Hz)



Water trees and DC test

Testing of these service aged cables at elevated DC "Hipot" voltage levels may cause the cable to fail prematurely after the cable has been returned to service.

Space charges that can occur under elevated DC voltages at the sites of these water trees can result



in localized stress enhancements.

With the reapplication of normal AC power to the cable, these localized stress enhanced areas at the water tree sites can ultimately lead to an electrical tree or trees.

Once an electrical tree has been initiated, complete cable failure is normally imminent and inevitable.

In addition, DC "proof" or hipot testing has been found to be ineffective in detecting even serious defects in cables. Since this is the main objective of any hipot test, and due to the negative side effects of DC, VLF AC waveform testing is now recommended by almost all cable testing standards/guides such as IEEE, CENELEC, VDE, SABS, etc.

Acceptance or maintenance hipot/proof testing using

VLF high voltage sinusoidal AC allows the operator to efficiently detect serious cable insulation defects, before they result in an in-service failure, without affecting those healthy sections of the cable that still have remaining service life.

0.1Hz Sinusoidal Wave Form Test Set.

With the new modern technology we build up the sinusoidal wave form using digital signal processing technology, IGBTs and High speed AD converters to produce perfect sine wave.

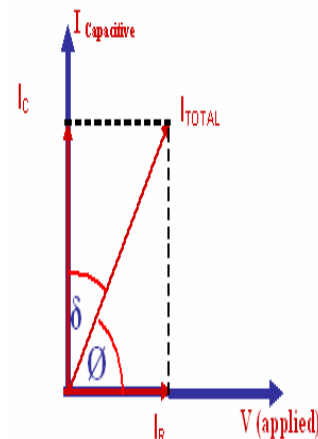
The advantages of having this symmetrical and sinusoidal wave form are:

- Both volume resistivity and permittivity of the insulation are now stressed
- R, L and C are brought into the equation
- Diagnostic testing is possible
- Partial Discharge (PD) – Testing is possible
- Tan Delta (TD) – Testing is possible
- Stress lines are similar to 50Hz
- Power consumption is 500 times less than at 50Hz ($P = V^2 \omega C$)
- All the electrical Parameters such as leakage current, RMS and Instantaneous current, Capacitance, Volume Resistivity are now available for the operator.
- Weight of the test instrument is similar to D.C.

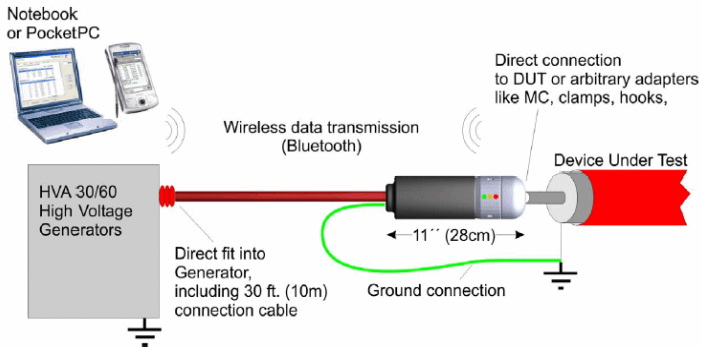
Tan Delta or Dielectric Loss Angle

As the cable ages so the dielectric loss increases and is therefore an important indication of the dielectric quality.

The Tan Delta or Dielectric loss angle is a measure of the dielectric's ability to withstand breakdown and a measure of the dielectric's losses.



Tan Delta is an AC Sinusoidal test to evaluate the quality of the dielectric. In theory the Tan Delta (at a fixed frequency) should remain constant as the voltage increases. Another important factor is that the Tan Delta is virtually independent of the length of the cable.



Note: These are very important factors when using T.D. diagnostics. Unlike in D.C. over voltage testing the leakage current is dependant of the cable length, and increase proportionally. TD is a ratio and is fixed and known whether XLPE or PILC

Partial Discharge Diagnostics

What is a Partial Discharge?

The IEC/IEEE defines PD as a “localized electrical breakdown that only partially bridged the insulation between conductors and which may or may not occur adjacent to a conductor.”

In effect they are very small “electrical sparks” or discharges that occur in or on the surface of the cable insulation system and do not as individual incidents cause a complete collapse of the applied voltage.

Partial Discharges occur as singular events of very short duration (few nano seconds) and they generate light, sound, heat and electromagnetic pulses. The PD levels during site measurements, depend on type of cable, type of joint/splice/termination.

A good PILC oil impregnated insulation may display a PD level of 100pC, on the other hand a XLPE dielectric could not continue operating at this level.

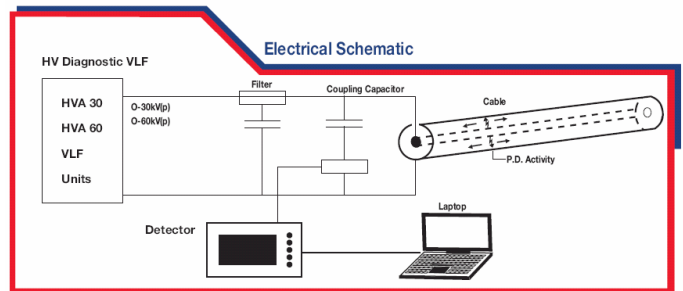
Sources of P.D. in XLPE / PILC cables include:

- Outer screen damage on an XLPE cable
- Splice/joint/termination defects

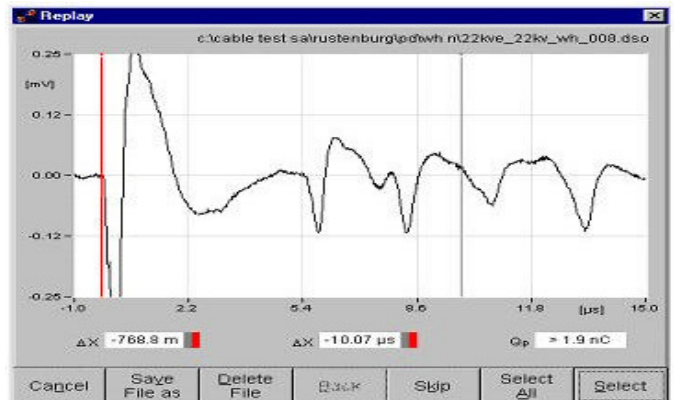
- Cable defects (Electrical Trees)
- Drying out of PILC cables (draining of the oil)
- Concentric neutral damage
- Poor installation & workmanship
- Voids and delaminating
- Moisture Ingress and Tracking

The PD Traveling waves are used to locate the point of discharge.

Partial discharge testing in the field is an effective and meaningful diagnostic tool.



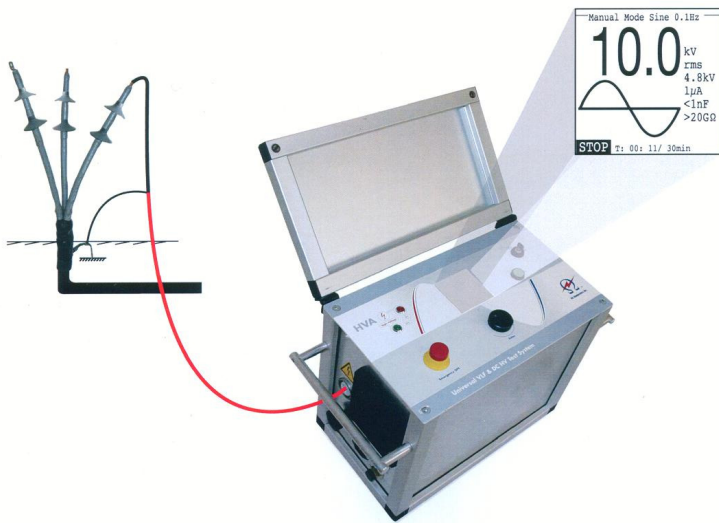
Today it is possible to energize the PILC or XLPE cable with a sinusoidal wave form to determine the location phase and magnitude of these partial discharges.



Find your cable faults before they occur

HVA series

(4 in 1 Universal High Voltage Test Systems)
Models: HVA30 / HVA30.5 / HVA60 / HVA90



▶ **VLF 0.1 Sine / Square**

▶ **DC (±)**

▶ **Jacket/Sheath testing**

▶ **Fault Conditioning**

▶ **Product Design**

The HVA's are not only the most advanced HV test system available, it is also the lightest, most compact instrument of its type on the market. The HVA's have the highest power to weight ratio of any comparable unit available.

There is no need to carry two pieces of equipment around and then interconnect them!

Apart from the variable frequency VLF output, the operator can also select dual polarity DC and cable jacket or sheath testing outputs modes.

The applied test voltage, current, capacitance, resistance and time are displayed and recorded.

The instrument is easily programmable allowing the operator to setup or select test sequences in either automatic or manual mode.

To assist the operator, the instrument will automatically calculate the optimum frequency to be selected for larger loads.

The load independent, symmetrical output waveform avoids the potentially destructive space charge effects caused by DC polarization that occurs in aged extruded cables such as XLPE / PE / EPR, causing

them to fail prematurely when exposed to conventional high voltage DC or to test instruments with large non-symmetrical output waveforms.

Should a breakdown occur during testing, the actual voltage at which it occurred is displayed and recorded.

If cable burning (fault conditioning) mode is activated, the fault resistance can be conditioned to allow easier and less stressful fault location techniques to be applied.

Test results are stored in the instrument's onboard memory allowing easy retrieval and download to a PC/Laptop for review and analysis.

▶ **Applications Include...**

- √ Cables: XLPE, PE, EPR, PILC etc.
- √ Capacitors
- √ Switchgear
- √ Transformers
- √ Rotating Machines (IEEE 433)
- √ Insulators
- √ Bushings



► Operational Features

- The smallest, lightest, most advanced universal high voltage test instrument available, ideally suited for a variety of applications.
- VLF (0.1Hz), DC (\pm), Cable Fault Conditioning (Burning), and Sheath/Jacket Testing modes all included.
- VLF: the proven and accepted replacement for the traditional DC Hipot or “proof” test for solid dielectric cables such as XLPE and EPR.
- Fully Automatic or manual cable test sequences complying with International Standards/Guides such as IEEE 400.2, VDE 0296, CENELEC, HD620 S1, NEN 3620, SANS 10198 and IEC 60060-3 (draft).
- Meets all your cable testing requirements.
- True Symmetrical Sinusoidal, load independent, output waveform across the full load range.
- Real-time Display of actual output waveform.
- Easy to use, ergonomic, menu guided, large backlit user interface.
- Rugged, one piece portability.
- Large output load capability.
- Automatic and integrated load capacitance measurement with optimum frequency selection.
- Storage of test results for later retrieval or download to a PC/Laptop.
- No oil or arcing contacts that require routine maintenance.
- Short circuited protected with active arc management regulation that avoids the usual nuisance tripping of conventional HV test equipment when a dielectric failure occurs.

► Safety Features

- Short circuit protected
- Status display of all important safety functions and messages.
- Safe, easy to use operation with emergency off and key switch lock-out.
- Fully integrated discharge circuit to safely ground the DUT (Device Under Test) after testing.
- Zero start interlock.
- Zero voltage switching



► HVA models

- **HVA 30**
O/P voltage: Sinusoidal: 0-33 kV peak, Square: 0-30 kV eff, DC \pm : 0-30 kV , Load capacity up to 5 μ F
- **HVA30.5**
O/P voltage: Sinusoidal: 0-33 kV peak, Square: 0-30 kV eff, DC \pm : 0-30 kV , Load capacity up to 15 μ F
- **HVA60**
O/P voltage: Sinusoidal: 0-63 kV peak, Square: 0-60 kV eff, DC \pm : 0-60 kV , Load capacity up to 10 μ F
- **HVA90**
O/P voltage: Sinusoidal: 0-90 kV peak, Square: 0-90 kV eff, DC \pm : 0-90 kV , Load capacity up to 11 μ F

Find your cable faults before they occur

Technical Specifications

Type	HVA30	HVA30-5	HVA60	HVA90
Input Voltage	100-240 V 50/60 Hz			
Output Voltage	Sinusoidal: 0-33 kV peak, Square: 0-30 kV peak DC ±: 0-30 kV Accuracy ±1%	Sinusoidal: 0-33 kV peak, Square: 0-30 kV peak DC ±: 0-33 kV Accuracy ±1%	Sinusoidal: 0-62 kV peak, Square: 0-60 kV peak DC ±: 0-62 kV Accuracy ±1%	Sinusoidal: 0-90 kV peak, Square: 0-90 kV peak DC ±: 0-90 kV Accuracy ±1%
Output Current	0-15 mA (Resolution 1µA) Accuracy ±1%	0-88mA (Resolution 10µA) Accuracy ±1%	0-44 mA (Resolution 1µA) Accuracy ±1%	0-40 mA (Resolution 1µA) Accuracy ±1%
Resistance Range	0.1 MΩ...20 GΩ			
Output Frequency	0.01 ...0.1 Hz in steps of 0.01Hz (default 0.1Hz)			
Output Load	0.5µF @ 0.1Hz @ 23kV RMS (Approx 1.5 km of cable)* 1.0µF @ 0.05Hz @ 23kV RMS (Approx 3.0 km of cable)* 2.5µF @ 0.02Hz @ 23kV RMS (Approx 8.0 km of cable)* 5.0µF @ Reduced Voltages and/ or Frequencies	3.4µF @ 0.1 Hz @ 23kV RMS (Approx 11km of cable)* 5µF @ 0.1 Hz @ 19kV RMS (Approx 17km of cable)* 6.25µF @ 0.08 Hz @ 19kV RMS (Approx 20km of cable)* 10µF @ 0.05 Hz @ 19kV RMS (Approx 33km of cable)* 15µF @ 0.02 Hz @ 19kV RMS (Approx 50km of cable)*	1.0 µF @ 0.1 Hz @ 44kV RMS (Approx 3.0 km of cable)* 2.0 µF @ 0.05 Hz @ 44kV RMS (Approx 6.0 km of cable)* 5.0 µF @ 0.02 Hz @ 44kV RMS (Approx 5.5 kmof cable)* 10.0 µF @ Reduced Voltages and/or Frequencies	1.1 µF @ 0.1 Hz @ 57kV RMS (Approx 5,000m of cable)** 2.0 µF @ 0.05 Hz @ 57kV RMS (Approx 10,000m of cable)** 11.0 µF @ 0.01 Hz @ 57kV RMS (Approx 50 kmof cable)** Max capacitance 11.0 µF
Output Modes	* Based on typical cable: 330pF/m			** Based on typical cable: 220µF/km
Output Modes	AC Hipot (VLF) Symmetrical and load independent across full range DC Hipot (plus or negative polarity) Burn / Fault Condition or Fault Trip Mode Jacket / Sheath Testing			
Memory	50 Test Records Stored in non-volatile built in memory			
Metering	Voltage and Current (True RMS and/or peak) Capacitance, Resistance, Time, Flashover Voltage			
Duty	Continuous			
HV Cable	15' (4.5m) with Alligator clamps on end (other options available on request)			24' (7.5m) with Alligator clamps on end (other options available on request)
Computer Interface	RS232 connection (Software Included)			
Temperature	Storage: -25 °C to +70 °C Operating: -5 °C to 45 °C			
Dimensions (LXWXH)	17" x 14" x 10" / (430x360x250mm)	18" x 13.5" x 20.5" / 450x340x520mm	18" x 13.5" x 20.5" / (450x340x520mm)	18" x 21" x 22" / (450x530x550mm)
Weight	44 lbs (20 kg)	100 lbs (45 kg)	132 lbs (60 kg)	230 lbs (105 kg)

▶ HVA30 options:

Part Number	Description
SH 0207	TD 30 Tan Delta Accessory
SH 0220	PD 30 Partial Discharge Accessory
GH 0202	Battery Charger with Integrated Charger
GH 0501	Special Lead 50kV / 4m / Dolphin MC Clamp
VKR 0002	Transport Case
GH 0505	Protective Gear
GH 0600	HVA Printer Serial upgrade (software)
GH 0001	Epson printer Serial (RS 232) + Cable
GH 0601	Vacuum Bottle upgrade (DC) 50Hz 10kV Feedback Protection

▶ HVA30.5 options:

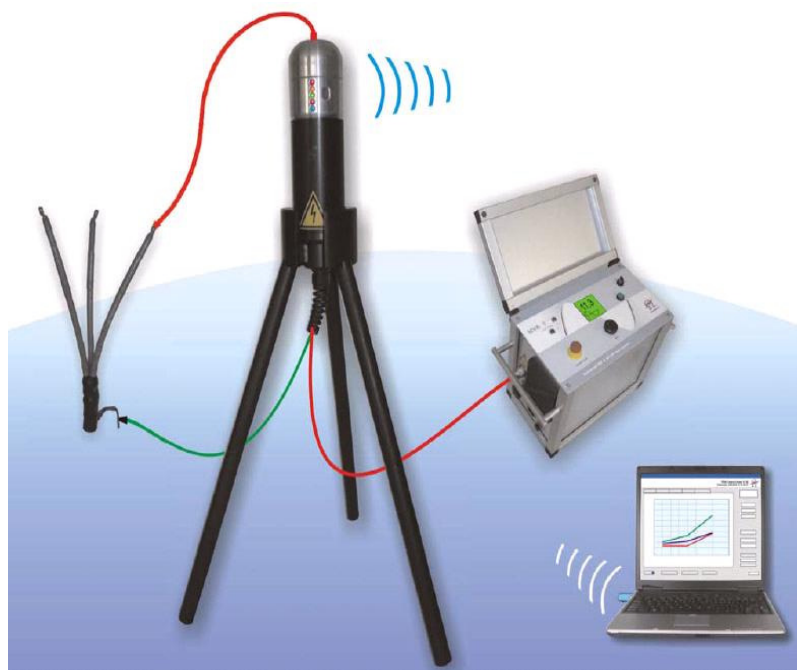
Part Number	Description
SH 0206	Standard High Power HVA 30/5
SH 0207	T30 Tan Delta Accessory
SH 0220	PD 30 Partial Discharge Accessory
GH 0202	Special Lead 50kV/4m/MC Dolphin Clamp
GH 0505	Protective Cover
GH 0600	HVA Printer Serial Upgrade Software
GH 0001	Epson Printer Serial (RS 232) + Cable
VKR 0003	Transport Case

▶ HVA60 options:

Part Number	Description
800 004	Heavy Duty HV Test Lead with Quick Coupling MC Connector (15'/4.5m)
800 005	Shipping / Transport Case for HVA60 including compartment for Test Leads.
800 010	Vacuum Bottle Tester Feature Upgrade
700 006	Vise Grip Quick Connector
800 008	External Manual Discharge Rod / Grounding Rod
700 009	Flashing Remote HV Indication Light with clamp and 4.5m / 15ft extension lead.

TD series

Tan Delta Test Systems



- ▶ **Tan Delta / Capacitance**
- ▶ **Automatic Report Writer**
- ▶ **Light Weight**
- ▶ **Wireless Connection**
- ▶ **Simple & Easy to Hookup**

▶ **Product Design**

H.V. Diagnostic SARL produce two models TD30 for the TD measurements up to max voltage of 23kVrms (33 KV peak), and the TD60 for TD measurements up to a max voltage of 44kVrms (or 62 KV peak).

The TD30/60 is a battery powered system that is directly connected to the HVA30 series of VLF test systems.

The TD30/TD60 uses standard C Type alkaline batteries which last for 10 hours thus providing the capacity for many tests. The TD30/60 is supplied with 10 meters of output cable which is terminated to suit the HVA30/60 test system.

The TD30/60 is supplied complete with operating software which gives a complete picture of the tan delta measurement together with a real time wave form of the output voltage and current. The data transmission to a laptop PC or PDA is via Bluetooth™ wireless communication thus eliminating hardwires or fiber optic cables to minimize the hookup time and operator errors.

▶ **Description**

Tan Delta testing enables the cable test engineer to detect insulation defects before the cable fails in service.

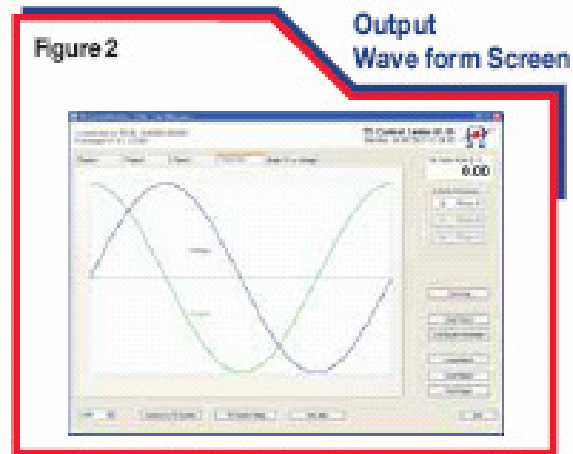
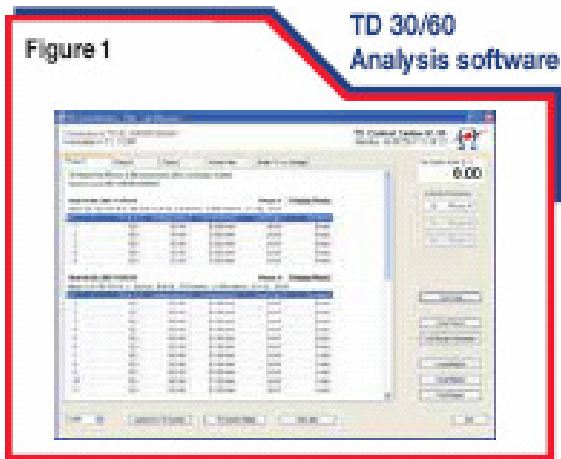
The TD30/60 is a versatile tan delta measuring system that is directly connected to the H.V. Diagnostics and HVA series of VLF test systems. The tan delta of the test object can be measured quickly and the results stored, thus providing a “signature” of the cable being tested. This enables the cable engineer to make tan delta a routine test and combine this diagnostic test with the normal over voltage pressure “testing” to provide a smart VLF test.

▶ **Applications**

Tan Delta (also referred to as “Power Factor”) is the ratio of the Resistive Power versus the Capacitor Power of the dielectric material. It is the measure of the quality of the insulation medium.

The TD30/60 provides the testing and commissioning engineer with a versatile high voltage tan delta measuring system suitable for testing cables: XLPE, PE, EPR, PILC and other electrical equipment: capacitors, switchgear, transformers and rotating machines.





TD 30/60 Analysis software

The test report screen gives all the details of the measurements taken during a test sequence. The results are based on individual measurements per cycle of voltage and current. From these results the Tan Delta is calculated and displayed.

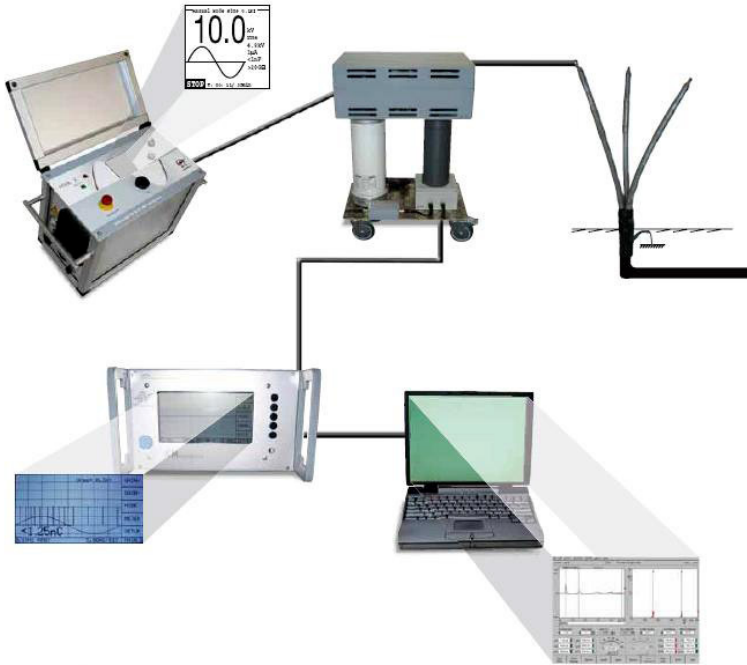
Output wave form screen

In the Wave form screen both the output voltage and output current are displayed simultaneously in real time. In addition to the status of the voltage and current wave forms, the Tan Delta value is also displayed.

Technical Data		
Type	TD30	TD60
Part number	SH0207	SH0206
Input voltage	2 type "C" alkaline cells	2 type "C" alkaline cells
Operating voltage	Sinusoidal: 1– 23 kV RMS Frequency: 0.1Hz	1 - 44 kV RMS 0.1 Hz
Voltage measurement	Resolution: 0.1 kV RMS Accuracy: 0.5% of reading	0.1 kV RMS 0.5% of reading
Current measurement	Resolution: 1 µA RMS Accuracy: 0.5% of reading	1 µA RMS 0.5% of reading
Frequency resolution	0.01 Hz	0.01 Hz
Tan delta measurement	Resolution: 0.1 x 10-3 Accuracy: ± 0.3 x 10-3 (load > 15nF) ± 0.5 x 10-3 (load < 15nF)	0.1x 10-3 ± 0.3 x 10-3 (load > 15nF) ± 0.5 x 10-3 (load < 15nF)
Weight	3kgs (7lbs)	5 kgs (11lbs)
Dimensions	240mm long x 80mm in diameter (9.5" long x 3.2" in diameter)	450mm long x 120mm in diameter (18" long x 5" in diameter)
Computer interface	Bluetooth™. Results download via software which is included	As for TD30
Accessories supplied	HV connection cable, transit case Bluetooth™ Dongle Earth cable, operating software Operating manual	As for TD30
Standards	Shock: IEC68-2-27 (15g/11ms half sinus) Vibration: IEC68-2-6 (10...150Hz : 2g) EMC: IEC6100-4-2, IEC6100-4-4, EN55011 Safety: EN60950, EN50191, EN61010-1	As for TD30
Temperature	Storage: -25 °C to +70 °C Operating: -5 °C to +45 °C	As for TD30
Humidity	Humidity Max 80% RH now condensing	As for TD30

PD30 / PD60

Partial Discharge Detection and Location for MV Cables



- ▶ **PD Detection**
- ▶ **PD Phase Angle**
- ▶ **PD Mapping**
- ▶ **PD Fault Location**

▶ **Product Design**

The PD30 and PD60 are designed to operate in conjunction with the HVA30 & HVA60 products of H.V. Diagnostics SARL.

The PD30 and PD60 consist of the following:

- ▶ High Voltage Filter (Fig 4)
- ▶ Coupling Capacitor (Fig 4)
- ▶ Partial Discharge Detector (Fig 3)
- ▶ Software for P.D. Diagnostics and P.D. Location (Fig 7)
- ▶ Cabling & Earthing
- ▶ HVA High Voltage lead
- ▶ Corona Rings

The P.D. Detector is a stand alone unit (Lap Top independent) capable of indicating with a backlit LCD the following:

- ▶ PD Discharge Meter (Fig 5)
- ▶ Phase position of Discharges (Fig 6)
- ▶ Scope display. Sine Wave superimposed PD Mapping – location of partial discharge sites using TDR principles (Fig 7)
- ▶ Voltage Measurement circuit (Fig 4)
- ▶ Location of these PD sites is normally done with a laptop due to the higher resolution

Figure 3



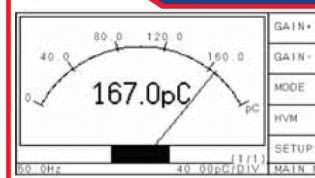
Detector

Figure 4



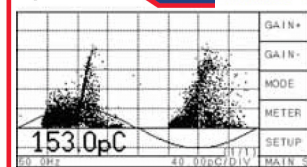
Filter and Coupling Unit

Figure 5



P.D. Discharge Meter

Figure 6



Phase Position of P.D. Pulse

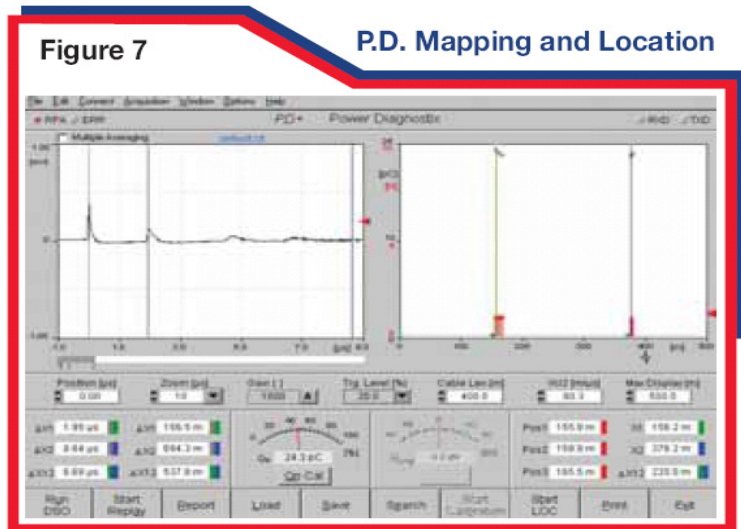


► PD Software

The enhanced diagnostics, archiving and reporting software is included in the standard package.

The PD Detector can be connected and controlled by a remote PC using the Serial RS232/USB port and operating under Microsoft Windows.

The software automatically scans, records, edits, replays and allows the printing of the Partial Discharge screens. Zoom and cursor functions provide for the precision P.D. mapping and P.D. location.



The software will record the:

- pC magnitude over time
- Plot the P.D. map (location)
- Plot the P.D. intensity

The following parameters are recorded:

- Calibration Pulse (in accordance IEC60270) and End Detection
- Background Noise
- PDIV Partial Discharge Inception Voltage
- Partial Discharge at $1.7U_0$
- PDEV partial Discharge extinction voltage

The above parameters will determine if any P.D. activity which is “ignited” by the overvoltage ($1.7U_0$), extinguishes before U_0 .

The software results can be archived or exported to Microsoft EXCEL (MS) or WORD (MS) programs.

Technical Data

Type	PD30	PD60
HV FILTER + Coupling Capacitor		
Rated Voltage kV (peak)	33	62
Rated Current (amps)	1	1
Filter Capacitance (nF)	20	10
Dimension LxHxB (mm)	550 x 680 x 250	550 x 800 x 360
Weight (kg)	30	45
Calibrator		
Display pC	100-> 10.000	100 -> 10.000
Weight (kg)	2	2
Partial Discharge Detector		
Display Resolution (Pixel)	Backlit LCD 128 x 240	Backlit LCD 128 x 240
Input Impedance	10k Ω / 50pF	10k Ω / 50pF
Lower Cut-off (kHz)	40, 80 or 100	40, 80 or 100
Upper Cut-off (kHz)	250, 600 or 800	250, 600 or 800
Synchronisation (Hz)	0.1, 0.05, 0.02	0.1, 0.05, 0.02
Auto Zero Crossing	Yes	Yes
Triggered Noise	Manual + Auto	Manual + Auto
Dimensions LxHxB (mm)	250 x 150 x 300	250x150x300
Weight (Kg)	3	3
Software		
Windows (Microsoft)	9X/NT/2000/XP	9X/NT/2000/XP
PD Mapping + Location	Yes	Yes

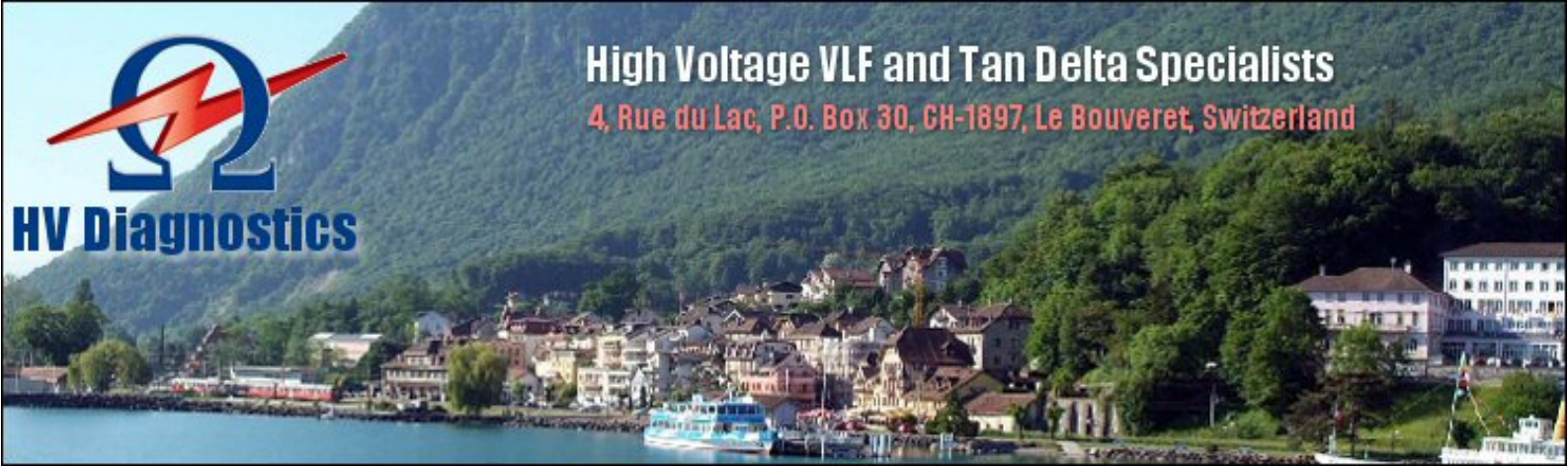
Find your cable faults before they occur



HV Diagnostics

High Voltage VLF and Tan Delta Specialists

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For more information please contact us at:

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