

TRANSMISSION POWER CABLES PD DETECTION AT DAMPED AC VOLTAGES up to 150 kV

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Why On-site PD Testing of HV Power Cables?

1. On-site PD testing is becoming the most important non-destructive test method for installed extruded HV power cables.
2. PD results from after-laying test and from inspections during service life are important for condition assessment of a power section.
3. Condition assessment is important issue for Asset Management decision process.



Voltage type: equivalence in PD inception processes among different voltage stresses for solid insulating materials

Non-destructiveness: non-destructiveness of voltage stress during the diagnosis

IEC 60270 conformity: in the case of measuring the PD quantity apparent charge of PD pulses in [pC] and [nC] the PD detection methods applied has to fulfil the recommendation of IEC 60270

Sensitivity: immunity for on-site interference's and the level of system background noise

Analysis: possibility to generate advanced diagnostic information to support diagnostic knowledge rules

Efficiency: investment costs, maintenance costs, transportability and operation of the method in different field circumstances

Continuous
energizing

AC voltages
50/60Hz, 20-200Hz

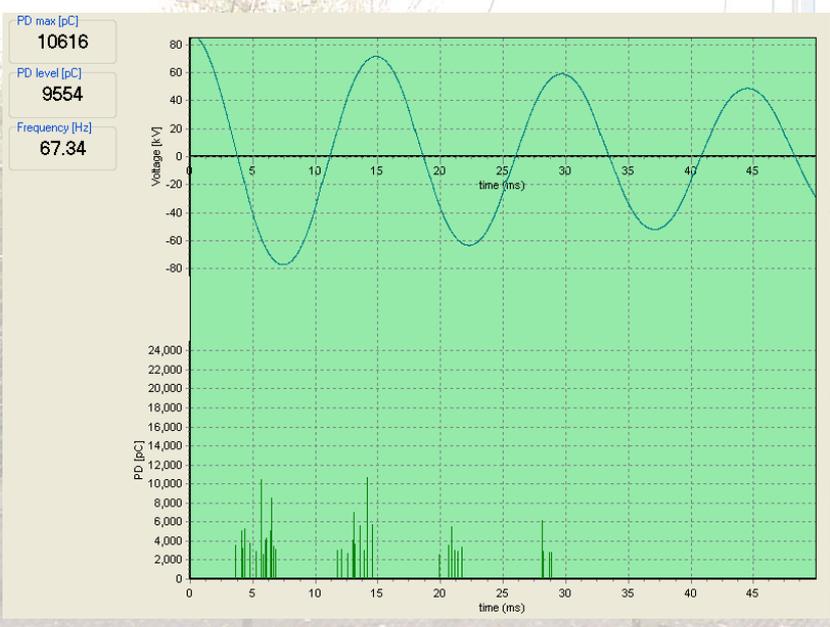
Temporarily
energizing

Damped AC (DAC) voltages
50-500Hz

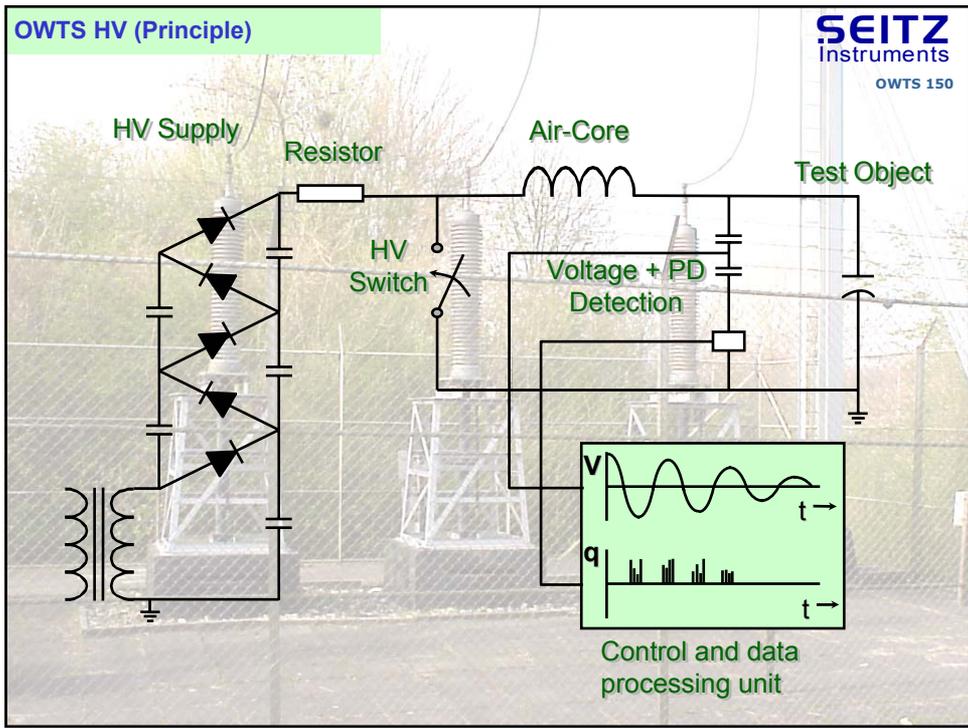
Mobile HV Systems characteristics; *Source: [CIGRE 2002, paper 33-304]*

- o Lightweights measured with kg/kVA specific weight, e.g. 25 kg/MVA
- o Compactness versus output voltage by Necessary power demand
- o System assembling and voltage erecting effort
- o Possibility of sensitive non-destructive PD detection

Partial discharge occurrence during DAC voltages



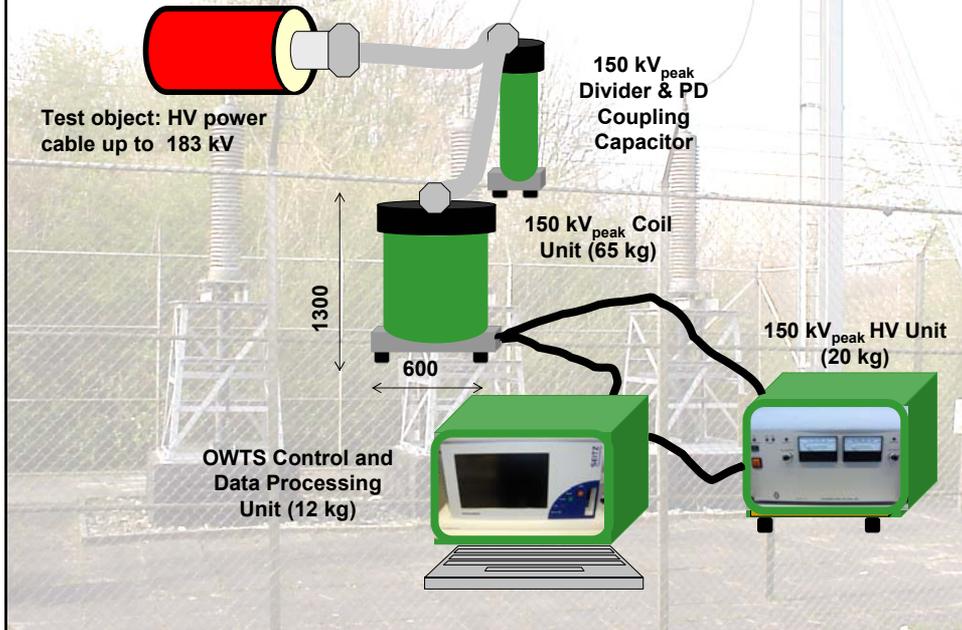
OWTS HV (Principle)



OWTS HV PD diagnosis system type 150kV_{peak}

(Concept test set-up)

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Technical parameters of the OWTS HV PD diagnosis system type 150kV_{peak}

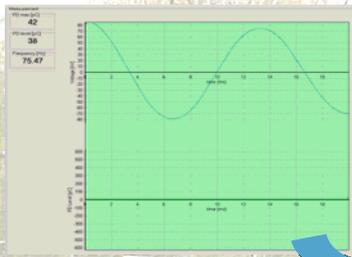
HV power supply	Primary power	1.8 kW
	Output power (e.g. load 0.8uF)	13 MVA
OWTS coil unit	Max. Voltage	150 kV
	Load current	10 mA
	Weight: 20kg	
Divider	Type HVDC multiplier	
	Max voltage 150 kV, Max. current 300 A	
Test Objects	Weight: 65kg	
	Type : solid-state switch, turn-on resistance < 1Ω	
Data processing unit	Switching time: 1μs	
	Inductance: 4.5H/ 30Ω; type air core, epoxy insulated, PD free	
Data processing unit	AC/DC divider C= 1nF, R= 200 MΩ; PD free	
	Resistor: 4kΩ to limit the switching discharge current of the power supply to max 16 A; Weight: 15kg	
Data processing unit	HV power cables up to 150kV voltage rating	
	Cable length: 100m -20km	
Data processing unit	Pentium 4, 2.0GHz	
	HV power supply control software	
Data processing unit	PD detector IEC 60270; Time Dominie Reflectometry;	
	PD mapping generator; Database interface;	
Data processing unit	Voltage Withstand Diagnosis package	
	Weight: 12kg	

$$150kV_{\text{peak}} \rightarrow 1.2 \times U_0 \text{ (150 kV power cable systems)}$$

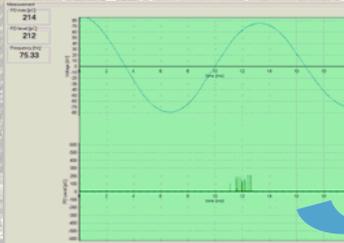
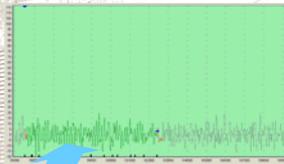
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HV Power Cable PD on-site diagnosis up to $2 \times U_0$

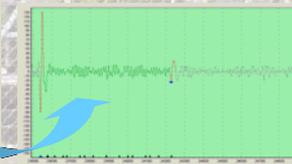
Example: 6km /50kV; XLPE



**L1, L2 up to $2 \times U_0$ PD-free
PD < 10 pC**

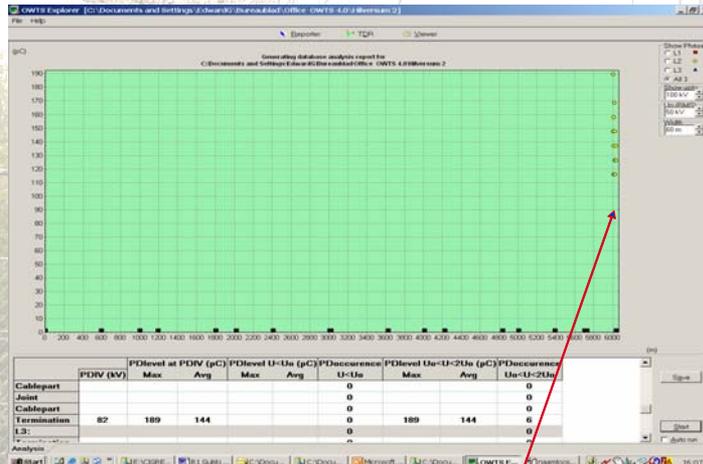


**L3: PDIV @ 82kV
PD ~180 pC**



HV Power Cable PD on-site diagnosis up to $2 \times U_0$

Example: 6km /50kV; XLPE

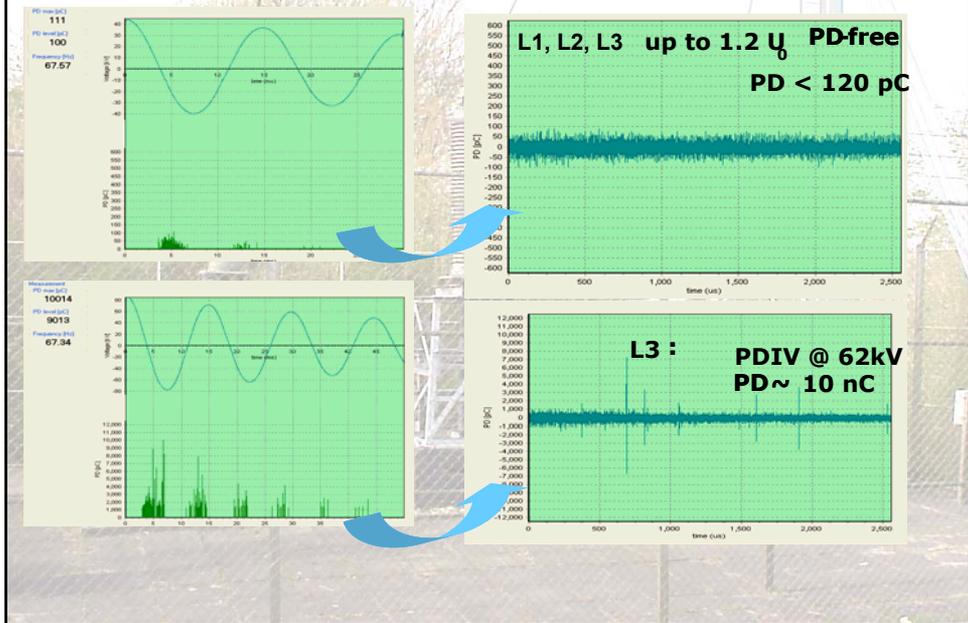


L1, L2: up to $2 \times U_0$ PD-free (PD < 10 pC)

L3: PDIV @ 82kV; PD level ~180 pC located in the termination

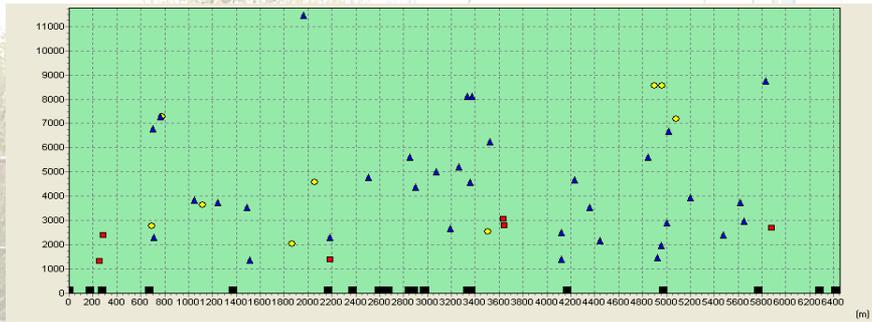
HV Power Cable PD on-site diagnosis up to $2 \times U_0$

Example: 6.4 km /50kV; Mass-impregnated



HV Power Cable PD on-site diagnosis up to $2 \times U_0$

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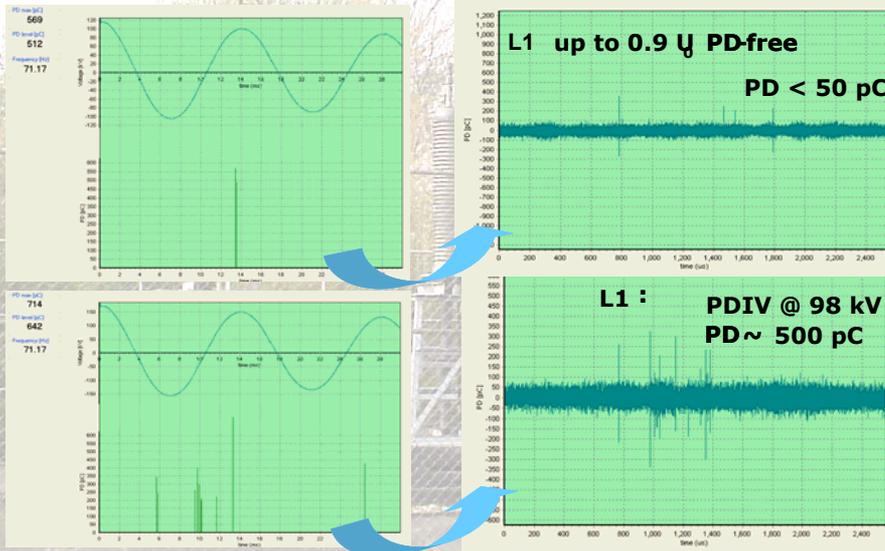


Cablepart	PDIV (kV)	PDlevel at PDIV (pC)		PDlevel $U < U_0$ (pC)		PDoccurrence	PDlevel $U_0 < U < 2U_0$ (pC)		PDoccurrence
		Max	Avg	Max	Avg	$U < U_0$	Max	Avg	$U_0 < 2U_0$
Joint	82	6771	4531			0			0
Cablepart	82	7292	4965			0			0
Joint						0			0
Cablepart	82	11458	5451			0			0
Joint	82	2292	2292			0			0
Cablepart						0			0

L1, L2, L3: PD-free up to $1.2 U_0$, PD < 120pC
L3 @ 62kV; PD level ~ 10 nC distributed location

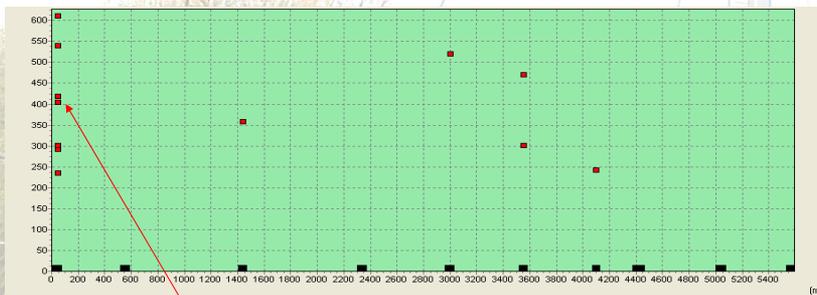
HV Power Cable PD on-site diagnosis up to $2 \times U_0$

Example: 5.5 km /150kV; XLPE



HV Power Cable PD on-site diagnosis up to $2 \times U_0$

Example 4: 5.5 km /150kV; XLPE



	PDIV (kV)	PDlevel at PDIV (pC)		PDlevel $U_0 < U_0$ (pC)		PDoccurrence $U_0 < U_0$	PDlevel $U_0 < U_0 < 2U_0$ (pC)		PDoccurrence $U_0 < U_0 < 2U_0$
		Max	Avg	Max	Avg		Max	Avg	
Whole Cable	111	419	388	521	425	1	611	373	1
L1:	111	419	388	521	425	1	611	373	1
Termination	111	419	419	419	412	1	611	395	1
Cablepart						0			0
Joint	111	419	419	419	412	1	611	395	1

L1: PD-free up to $0.9 \times U_0$, PD < 50pC

L1 @ 98kV; PD level ~ 500 pC located in the termination