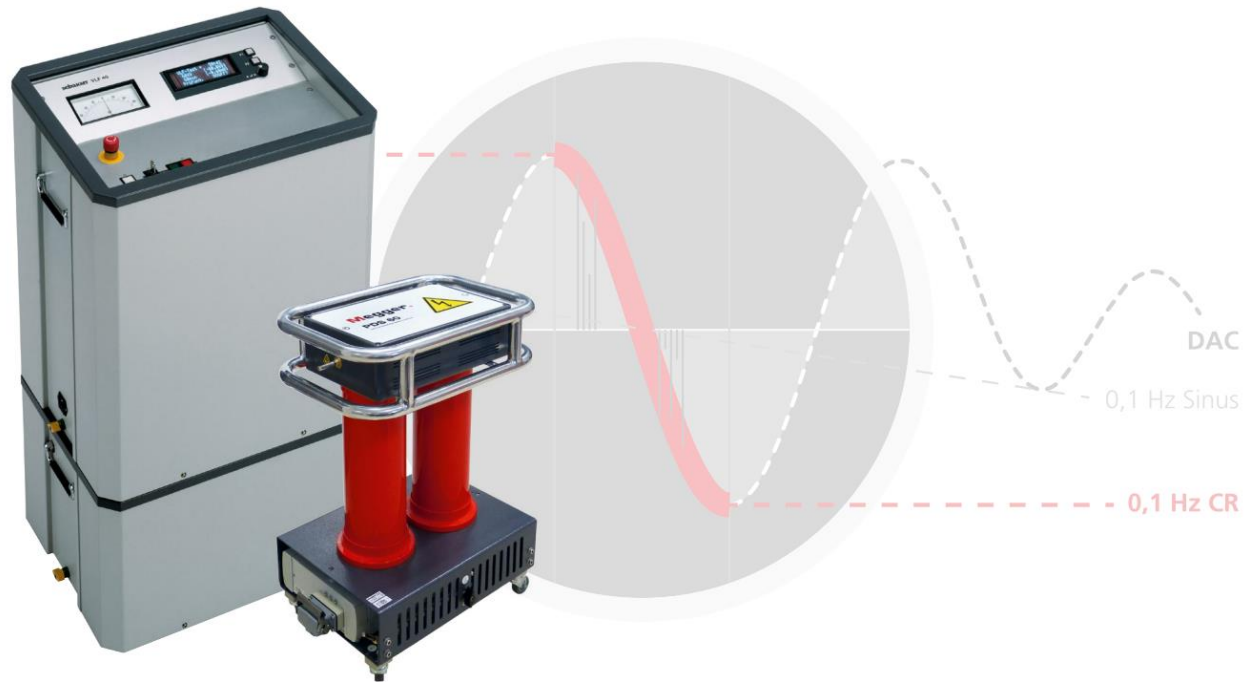


# ***The Next Generation of Partial Discharge Diagnostic Systems***



Philipp Legler

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**Megger**<sup>®</sup>

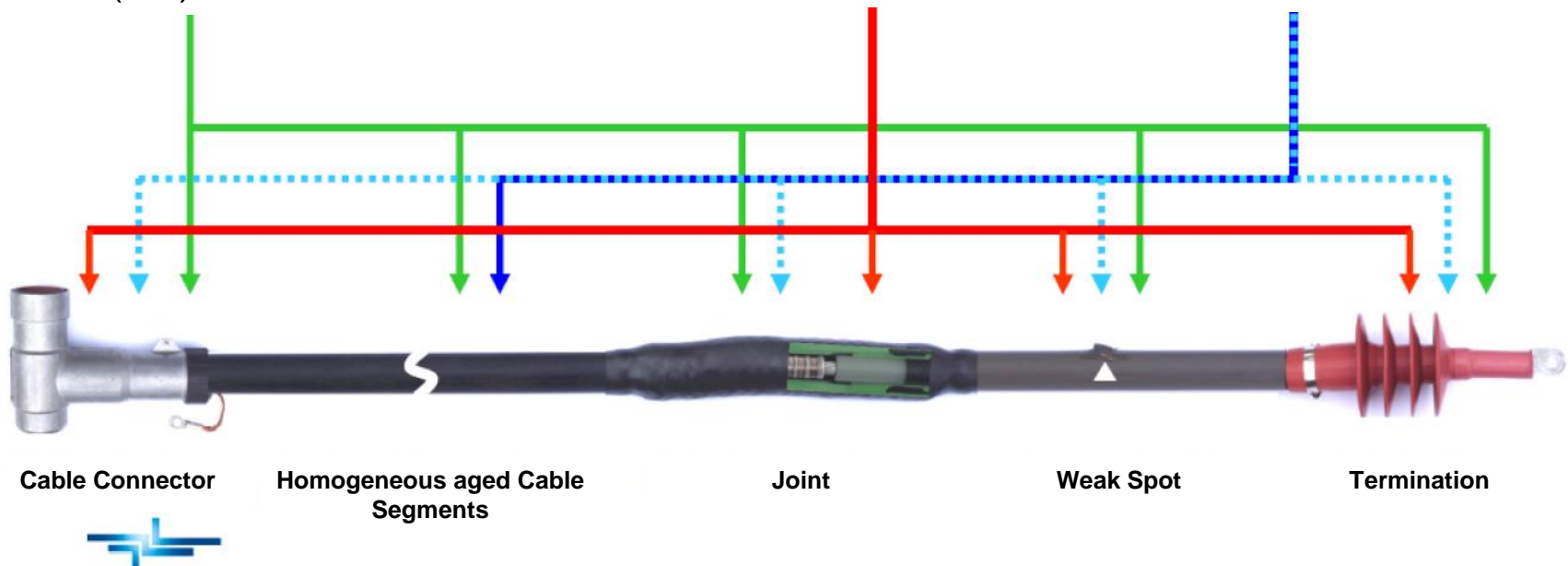
# Testing & Diagnostic Opportunities

## Testing Methods

- Voltage Withstand Test
  - AC 50 Hz
  - Resonant Test
  - VLF 0.1 Hz
  - (DC)

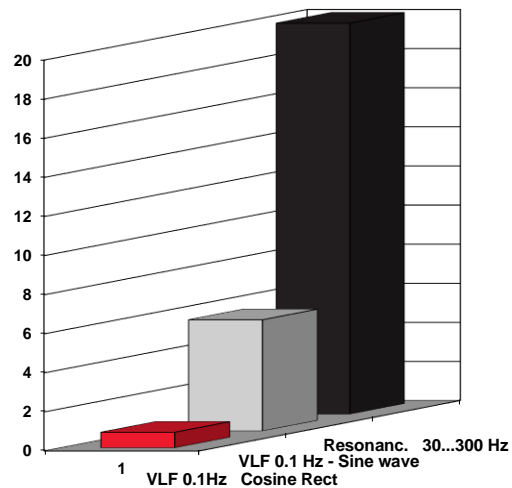
## Diagnostic Methods

- Local
  - Partial Discharge (Measurement & Location)
- Global
  - RVM
  - IRC
  - TanDelta

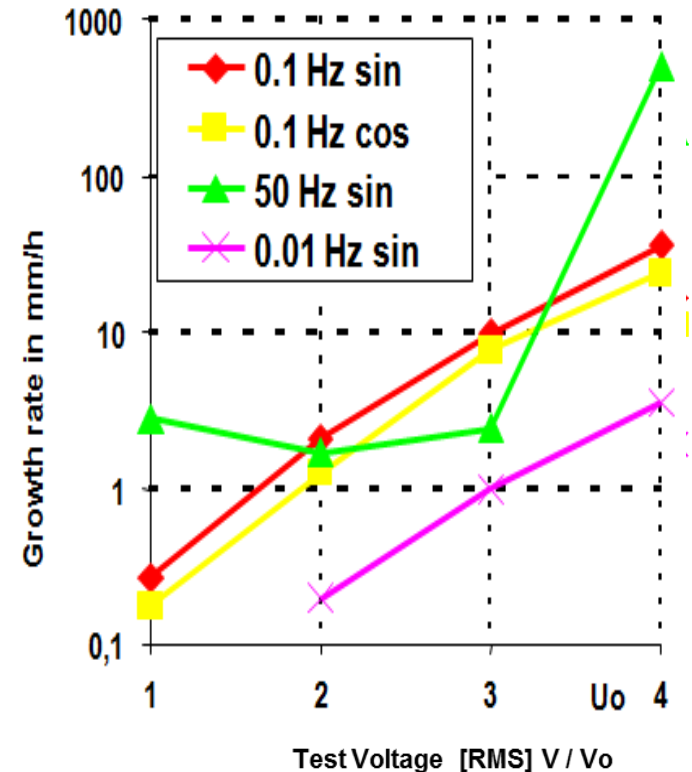


# Commissioning Testing using VLF 0.1 Hz

Relative power requirements for different cable test methods



Relative Power Ratings required for different test methods for the same test load



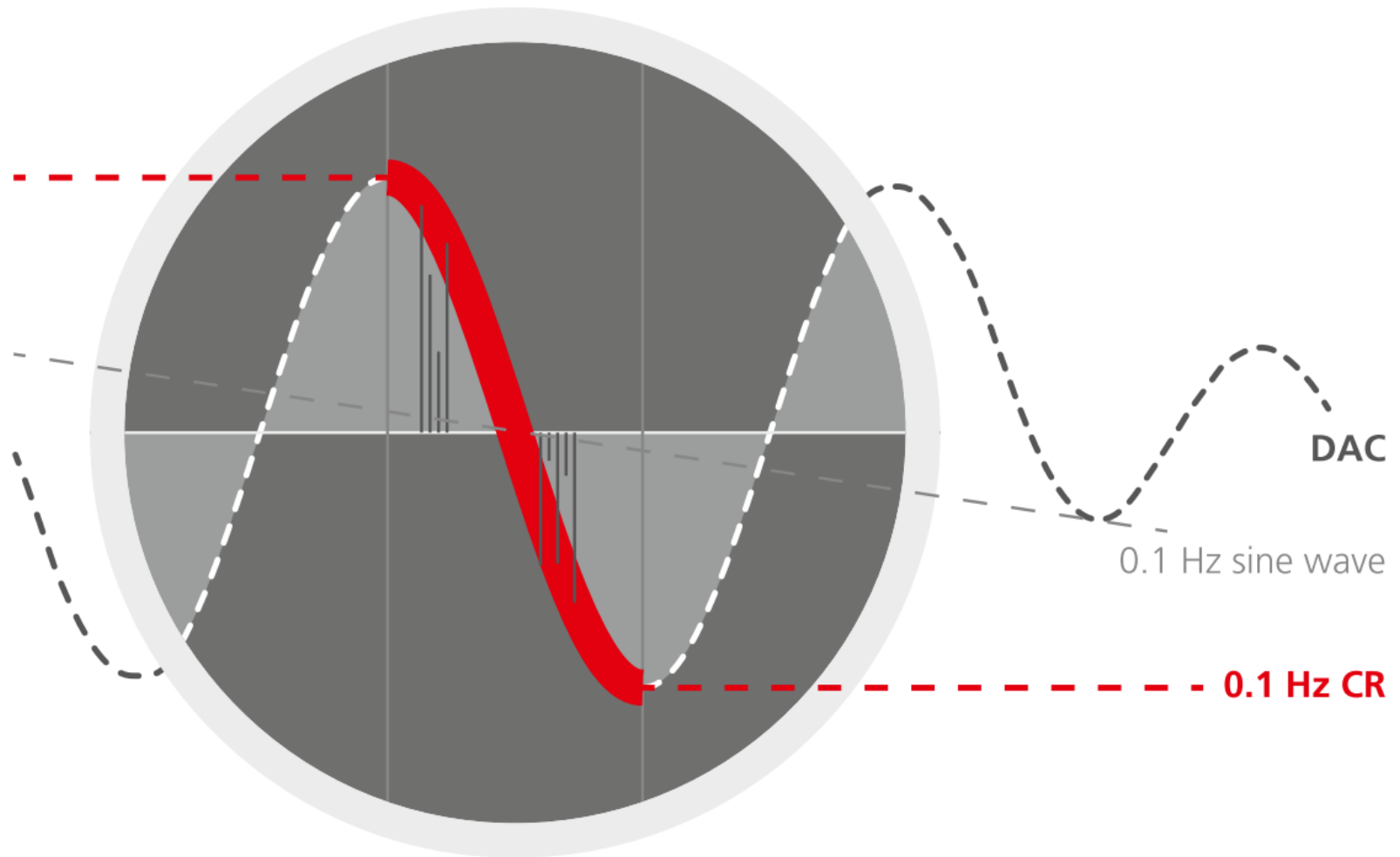
Electrical tree growth rate for different voltage wave shapes as a function of the applied test voltage (RMS)

# Influence of Frequency

- Test at lower Frequencies (e.g.: 0.01 Hz instead of 0.1 Hz) result in lower Growth Rate of Electrical Trees
  - ➡ Growth Rate: 10 times lower (roughly)
  - ➡ Testing Time: 10 times higher (should be !!!)
- For Example: Commissioning Test at  $3 U_0$ 
  - ➡ 0.1 Hz      1 h
  - ➡ 0.01 Hz    10 h
- Tree Growth Rate at 0.1 Hz comparable for Sinusoidal & CR
- Tree Growth Rate at 50 Hz lower then at 0.1Hz, especially when looking to Test Standard ( $50\text{Hz} \geq 2 U_0$  &  $0.1\text{Hz} \geq 3 U_0$ )
  - ➡ Testing with 0.1 Hz more effective



# New TDS-NT - 50 Hz Slope Technology



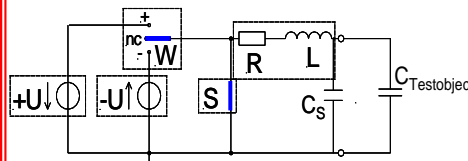
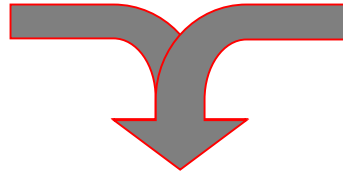
# Withstand - & Diagnostic Testing

## PD Diagnosis

*Non destructive; Short Excitation Time; Characteristics comparable to Power Frequency; Localization*

## Withstand Testing

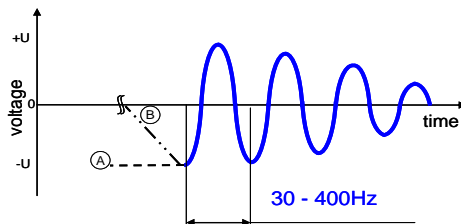
*Pass / fail Test; Provide sufficient Testing Stress; Additional PD Monitoring*



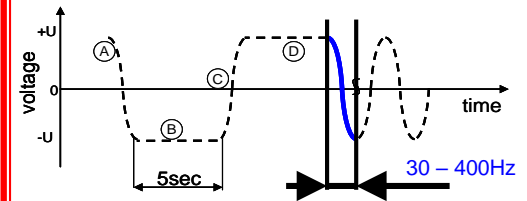
**Schematic / Test Set**



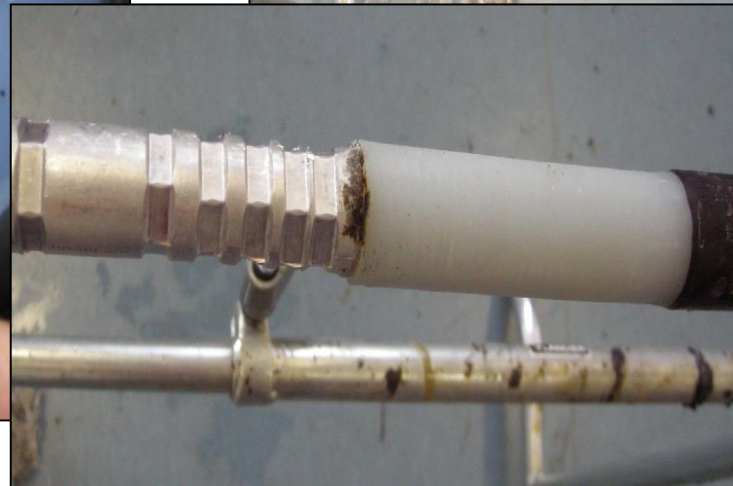
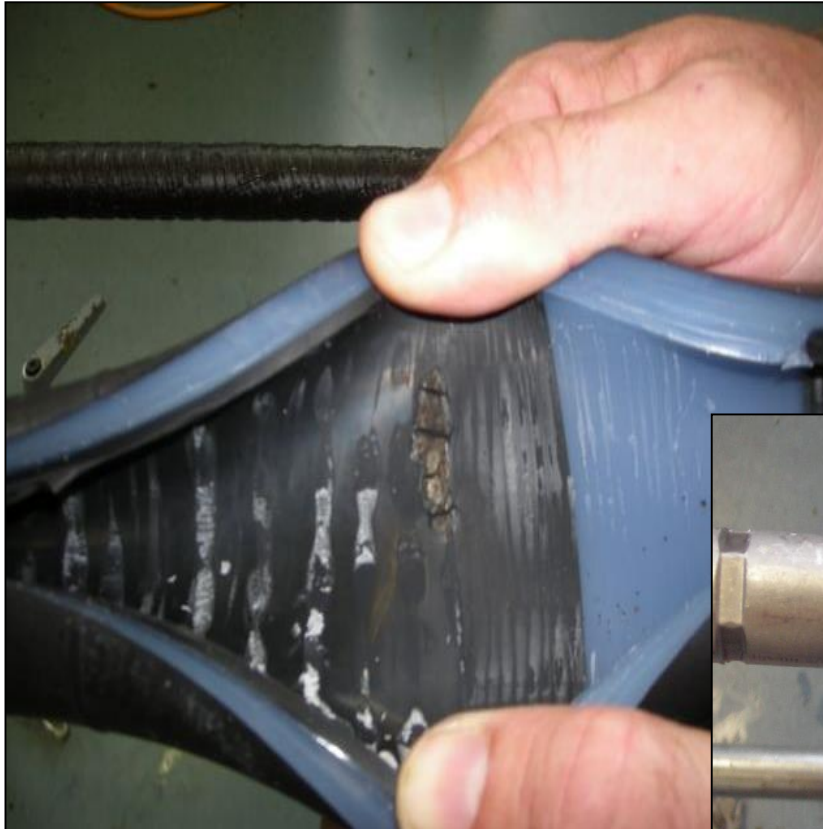
## **Damped AC (DAC)**



## **Very low Frequency Cosine Rectangular (VLF CR)**



# Assembly Fault detected by PD Testing



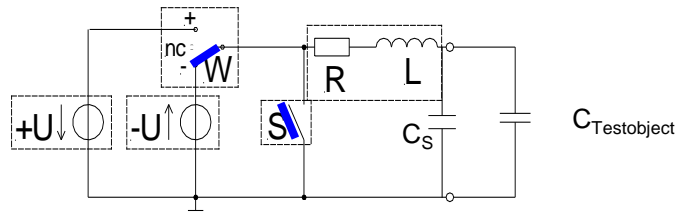


# Assembly Fault detected by PD Testing

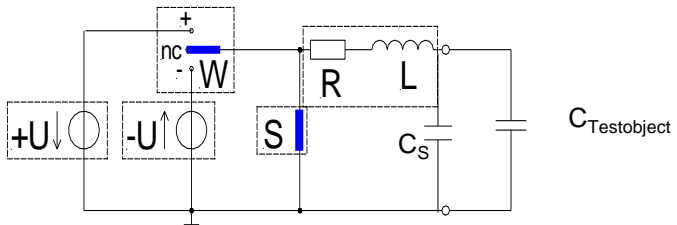
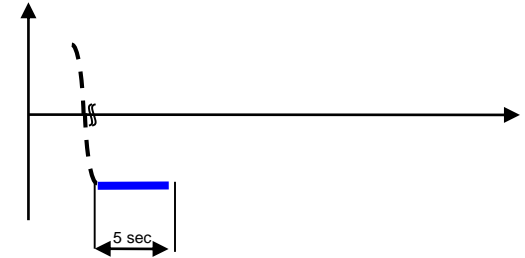




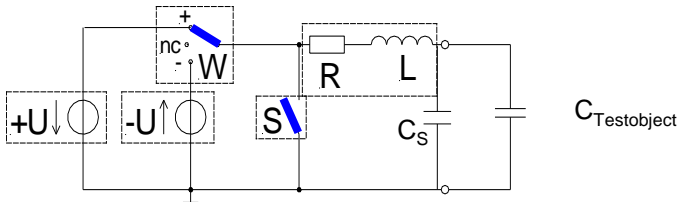
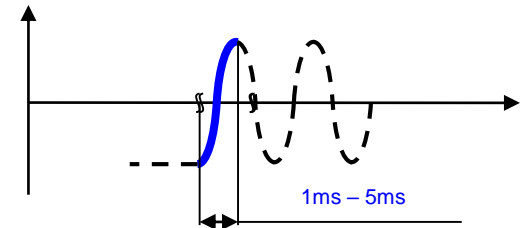
# Cosine Rectangular Voltage Generation



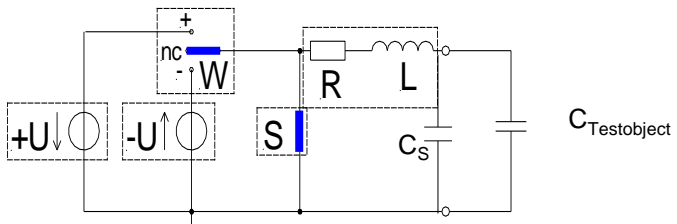
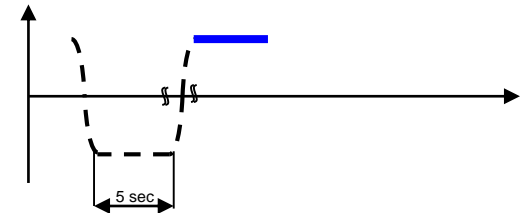
$C_{\text{Testobject}}$



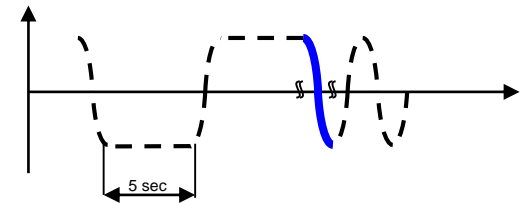
$C_{\text{Testobject}}$



$C_{\text{Testobject}}$



$C_{\text{Testobject}}$



# Comparability of relevant PD Parameters

## ■ Comparison to 50 Hz Power Frequency

	DAC	VLF CR Slope
PD Inception Voltage (PDIV)	✓	✓
PD Extinction Voltage (PDEV)	✓	✓
Voltage Gradient / Frequency	20-300Hz	20-300Hz
PD Level	✓	✓

# New TDS Series

## ■ 50 Hz Slope Technology

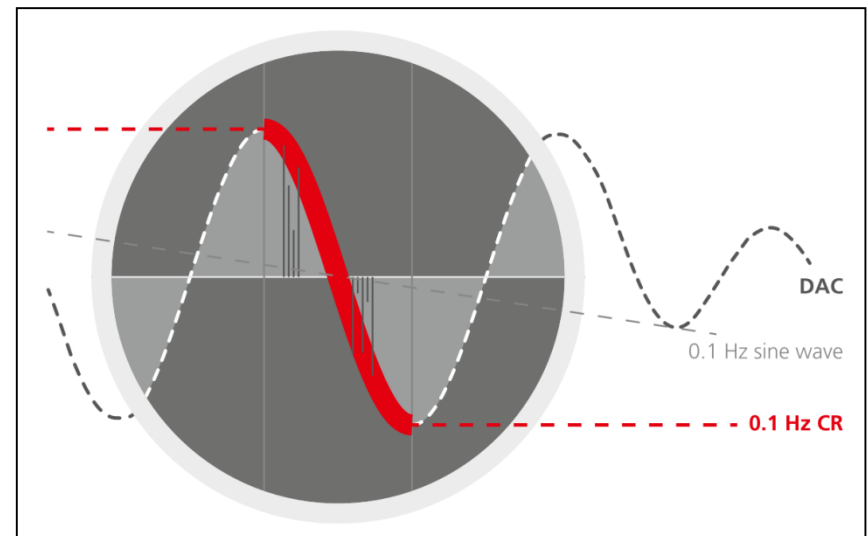
- Both *VLF CR* & *DAC* Voltage Wave Shapes are having a Frequency *comparable* to the *50/60 Hz* Power Frequency
  - ➡ Therefore Wave Shapes are *ideal for a PD Diagnosis*
  - ➡ In Dontrast to VLF 0.1 Hz Sinusoidal Voltages with a difference in Frequency of 500/600 Times

## ■ VLF CR

- ➡ PD measured only during Voltage Transition

## ■ DAC

- ➡ PD measured during oscillating Phase



# New TDS Series

## ■ Functionalities of TDS Power Source

- Up to User to decide
- TDS together with PDS 60 for PD Diagnostics
- TDS (“only”) for:
  - High power VLF Withstand Testing  
(with Leakage Current Indication\*)
  - DC Testing
  - Sheath Testing
  - As Power Source for Sheath Fault  
Pin-pointing with optional ESG NT  
Step Voltage Probe



\* The Leakage Current Indication gives User a first Indication about the Quality of Insulation

# Functionalities of TDS Power Sources

## ■ Technical Data

Variant		TDS 40	TDS 60
Output voltage	VLF	3 ... 40 kV <sub>RMS</sub>	3 ... 60 kV <sub>RMS</sub>
	DAC	3 ... 40 kV <sub>peak</sub>	3 ... 60 kV <sub>peak</sub>
	DC	3 ... ±40 kV	3 ... ±60 kV
Output current		7 mA	5 mA
Leakage current measurement		0 ... 7 mA, resolution 10 µA	0 ... 5 mA, resolution 10 µA
Frequency	VLF	0.1 Hz	
	DAC	50 to 500 Hz	
Testable cable capacitance VLF			
Basic version		2.4 µF / 40 kV <sub>RMS</sub> @ 0.1 Hz	1 µF / 60 kV <sub>RMS</sub> @ 0.1 Hz
Plus version		4.8 µF / 40 kV <sub>RMS</sub> @ 0.1 Hz	2 µF / 60 kV <sub>RMS</sub> @ 0.1 Hz
Testable cable capacitance DAC		5 µF / 40 kV <sub>peak</sub> 10 µF max.	2 µF / 60 kV <sub>peak</sub> 10 µF max.
Sheath test / fault pinpointing		Testing: 3 ... 10 kV Pinpointing: 3 ... 10 kV, pulse 1:3 / 1:5 / 1:9	
Safety devices		Breakdown detection, integrated discharge unit, earth loop monitoring	
Power supply		230 V, 50/60 Hz, 500 VA 120 V, 60 Hz, 500 VA	
Logging		Yes	
Temperature	Operation	-25 °C ... +55 °C	
	Storage	-40 °C ... +70 °C	
Relative humidity		93% / 30 °C (non-condensing)	93% / 30 °C to 50 kV (non-condensing) 70% / 30 °C from 50 kV to 60 kV (non-condensing)
Protection class		IP 20	
Weight (depends on options fitted)		Approx. 55 kg + 48 kg	Approx. 85 kg + 48 kg
Dimensions W x H x D, divided in two devices		550 x 1100 x 420 mm	550 x 1100 x 420 mm

- Basic & plus Version are available
- Plus Version with higher testable Capacity

# New TDS Series

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- Two Voltage Levels are available

## **TDS NT-40 Basic or Plus**

- For powerful VLF Testing with accompanying PD Measurement up to **23..25 kV** rated Cables with Test Voltage  **$3 U_0$  ( $4.8 \mu F$ )**
- For PD Diagnosis up to **36 kV** rated Cables with  **$2 U_0$**  Test Voltage (**DAC**)

## **TDS NT-60 Basic or Plus**

- For powerful VLF Testing with accompanying PD Measurement up to **36 kV** rated Cables with Test Voltage  **$3 U_0$  ( $2 \mu F$ )**
- For PD Diagnosis up to **45 kV** rated Cables with  **$2 U_0$**  Test Voltage (**DAC**)

# New TDS Series

- Functionalities of PDS PD Detector
- With Help from *PDS 60* the TDS Power Source gets upgraded to *multifunctional Diagnostic Test Set* capable of:
  - PD Diagnosis up to  $60 \text{ kV}_{\text{peak}}$  using *DAC*
  - PD Diagnosis up to  $60 \text{ kV}_{\text{RMS}}$  using *VLF CR*
  - *VLF monitored Withstand Testing*  
up to  $60 \text{ kV}_{\text{RMS}}$





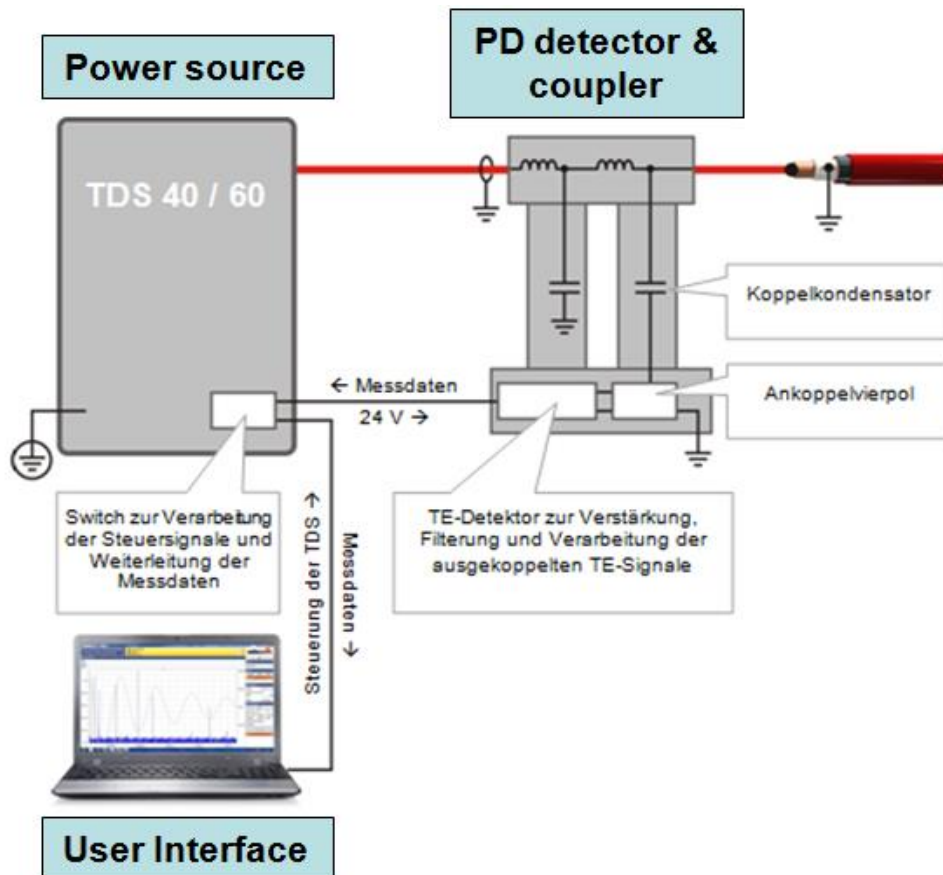
# Functionalities of PDS PD Detector

## ■ Technical Data PDS 60

PD detector PDS 60		
Voltage	Operation Type	max. 60 kV <sub>RMS</sub> VLF CR or DAC
Capacity of HV coupling capacitor		25 nF
Sensitivity range		2 pC ... 100 nC
Resolution		± 0.1 pC
PD self-noise level		< 2 pC
PD impulse repetition rate		100 kHz
PD localization	Measuring range Propagation velocity v/2 Sampling rate Bandwidth Precision Resolution	0 ... 16.000 m / v/2= 80 m/μs 5 ... 120 m/μs 125 MHz (8 ns) 3 / 25 MHz (switchable) 1% of the cable length ±0.1 pC / ±0.1 m
Filter		Analog and digital
Power supply		24 V via TDS test system
Temperature	Operation Storage	-20 °C ... +55 °C -40 °C ... +70 °C
Relative humidity		93 % / 30 °C (non-condensing)
Weight	HV filter/ coupler PD detector	25 kg 6 kg
Dimensions (W x D x H)		40 x 78 x 54 cm
PD calibrator (IEC 60270-compliant)	Measuring range Power supply	200 pC ... 20 nC 9 V block battery
Software		EasyGo principle, integrated cable database, fully automatic evaluation

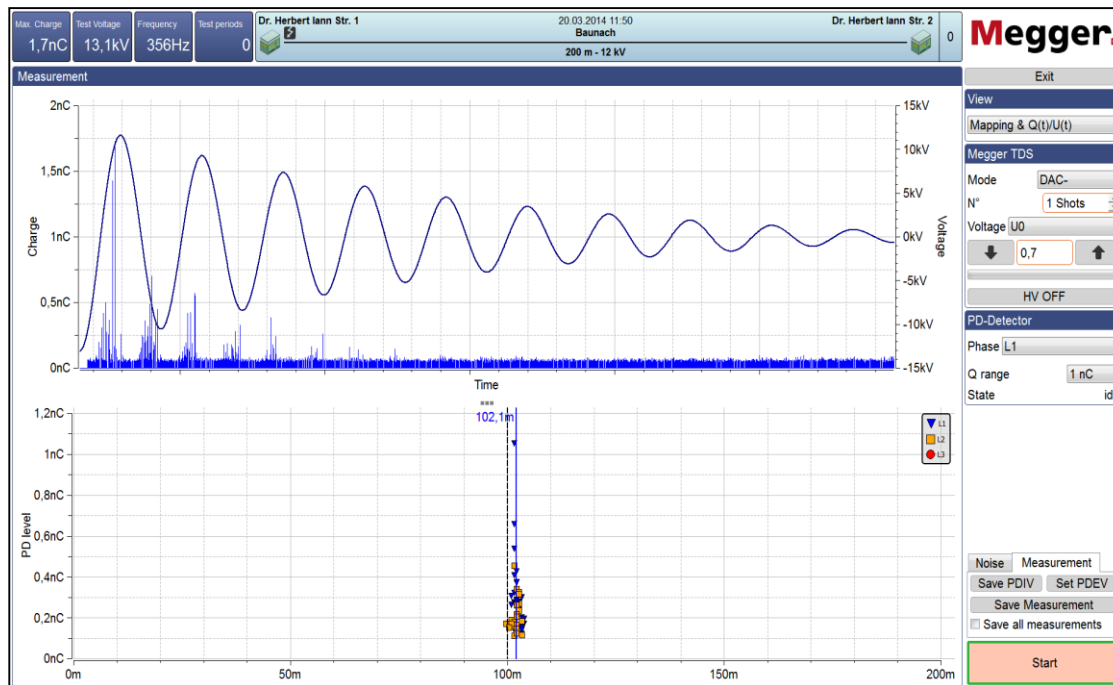
# TDS NT Unit

## ■ Connection Diagram



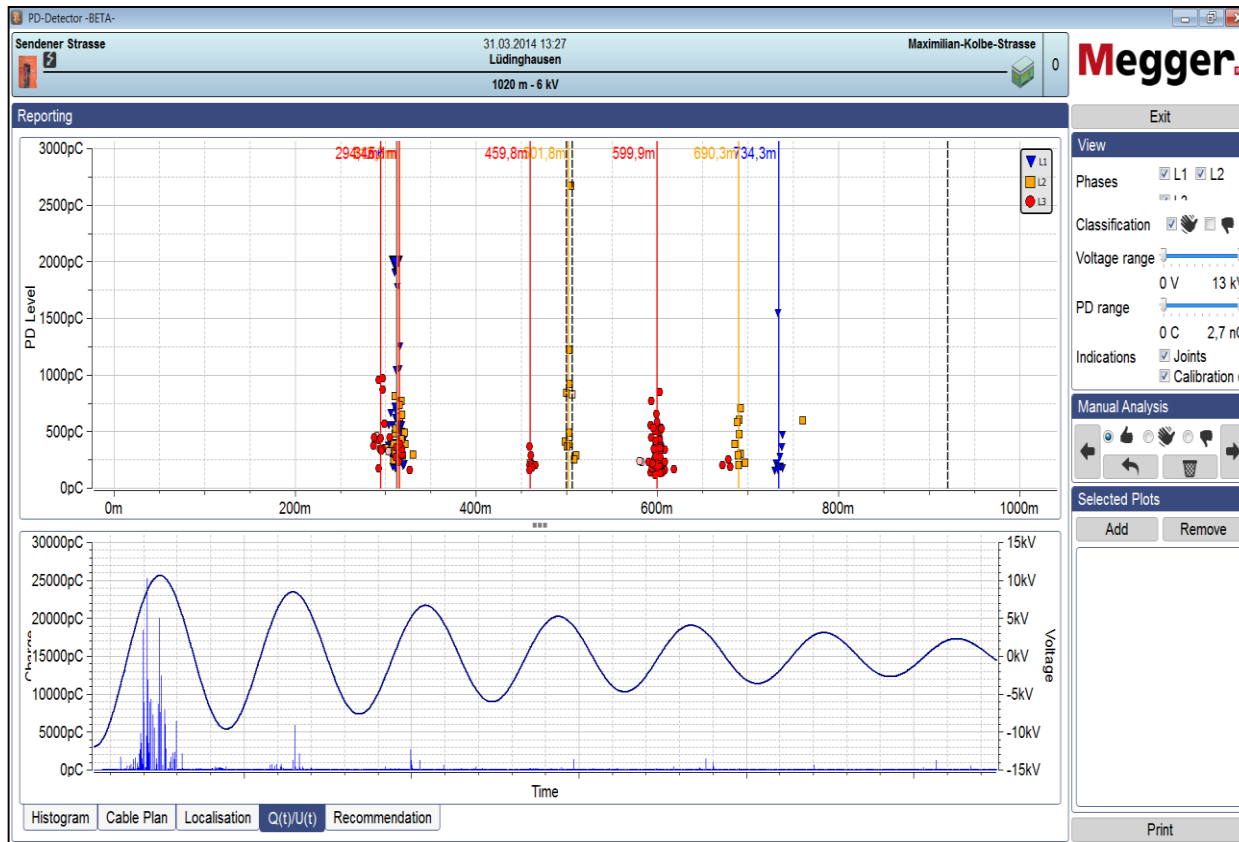
# The Operating Software

- **„Live“ PD Mapping**
- PD Evaluation Algorithm enables a *reliable automatic Detection* & *precise Location* of Partial Discharges (PD Mapping) *whilst Measurement is taking place*



# The Operating Software

## ■ Evaluation & Reporting



**Settings for display  
of Results**

**Settings for manual  
Analysis**

# Conclusion & Discussion

- *Combined Voltage Generation* System (DAC & VLF CR) allows Diagnosis & Withstand Testing in one System
- VLF CR Voltage Wave Shape is demonstrated as *excellent Excitation Voltage for PD Testing*
- VLF CR allows PD Monitored Withstand Testing on *longer Cables* or *3 Phases in parallel* respectively by still using the most effective *0.1 Hz* Test Frequency
- PD Parameter *comparable to Power Frequency*
- Localisation Map of PD Defects directly while Measurement
- Data Management due to *innovative Database* Concept
- *Smart Reporting* Functionality
- *PD Pattern* to be comparable at tested PD Defects
  - ➡ Next Presentation



# Question Time



# Contact

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**Thank you for your attention!**



Let's have a break ?

Let's have  
a



BREAK ?!

