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Megger electrical testing

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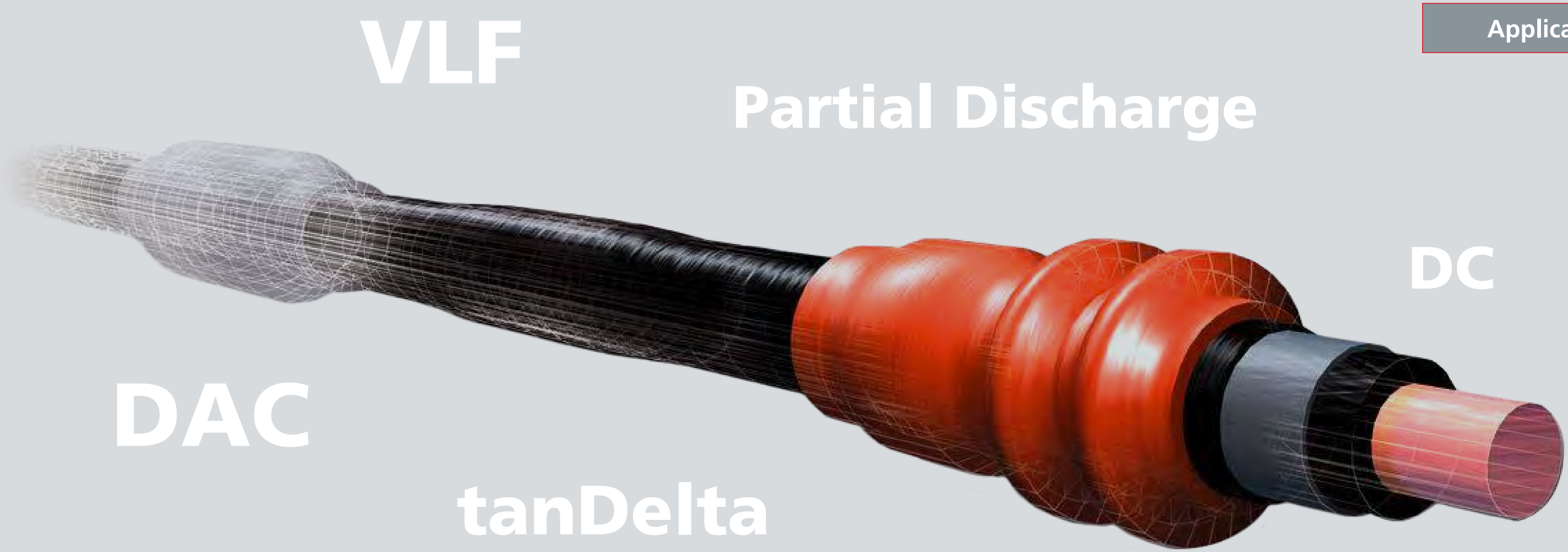
Cable Testing & Diagnostics –
Solutions for *Medium Voltage Networks (1 kV - 36 kV)*

Basics of Testing
Basics of Diagnostics
Application Notes



Cable Testing	
DC Products	VLF Products

Cable Diagnostics	
Integral / Dielectrical Diagnostics	Local / Partial Discharge Diagnostics

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Basics of Testing

Basics of Testing
Basics of Diagnostics
Application Notes

There are two main applications for cable testing:

- **Commissioning / after laying testing**
  checking the installation quality of joints and terminations of newly installed cable circuits.
- **Condition assessment / after repair testing**
  to test aged cables or to re-commission cable circuits to break down local weak spots in a controlled environment. Local weak spots can be e.g. soaked joints, water trees in the cable insulation, insulation damage caused by construction works.

Basics of Testing

VLF Sinus versus VLF CR

For withstand testing of medium voltage cables DC test sets and VLF test sets are the most commonly used technologies. Comparing DC test sets with VLF test sets, VLF test sets have the major advantage that it can also be used on polymer insulated cables and is therefore now the most commonly applied withstand test method.

The first VLF systems operated on the still existing and proven cosine-rectangular technology (CR).
In the early nineties the VLF sinusoidal technology was introduced. The main difference between these two technologies is that VLF Sinus test sets are low power units and can only test short cables, whereas VLF CR based units can test long cables or several phases in parallel and via that save valuable testing time.

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Basics of Testing

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System selection

The table below allows to perform a system selection based on cable length and test voltage for commissioning testing as per IEC 60502-2 standard.

VLF system versus maximum testable length with 3U0 test voltage (IEC 60502-2)

	VLF Sinus 34	VLF Sinus 45	VLF Sinus 62	TDM 45	VLF CR-28	VLF CR-40-B/ P	VLF CR-60-B/ P	VLF CR-60-HP	VLF CR-80-B/ P
10 kV XLPE cable with $\mathbf{U_{test} = 18\ kV_{rms}}$	4 km	3,4 km	12 km	50km	40 km	30 / 55 km	20 / 30 km	> 100 km	50 / 75 km
11 kV XLPE cable with $\mathbf{U_{test} = 19\ kV_{rms}}$	3,75 km	3,2 km	10 km	50km	35 km	25 / 50 km	15 / 25 km	> 100 km	45 / 70 km
15 kV XLPE cable with $\mathbf{U_{test} = 27\ kV_{rms}}$	x	3 km	7,5 km	35 km	25 km	20 / 40 km	11 / 20 km	75 km	35 / 55 km
20 kV XLPE cable with $\mathbf{U_{test} = 36\ kV_{rms}}$	x	x	5,5 km	28 km	x	15 / 30 km	8 / 13 km	55 km	25 / 40 km
36 kV XLPE cable with $\mathbf{U_{test} = 60\ kV_{rms}}$	x	x	x	x	x	x	5 / 10 km	32,5 km	15 / 22,5 km
45 kV XLPE cable with $\mathbf{U_{test} = 78\ kV_{rms}}$	x	x	x	x	x	x	x	x	11 / 13,5 km

Note: length is based on a single phase, not system length
Note: The VLF Sinus test systems will have a higher test power at lower freqeuncies, however this is not as per Cenelec or IEC standard!!

Basics of Diagnostics

Introduction

The importance of high reliability of distribution cables increases in times of higher competition between utilities and due to regulatory requirements. Customer minutes lost have to be monitored and the asset management departments are requesting clear indication about the condition of medium voltage (MV) cables and their accessories.

Failures in MV-cables can be divided into two categories:
failures in the insulation and failures in accessories.

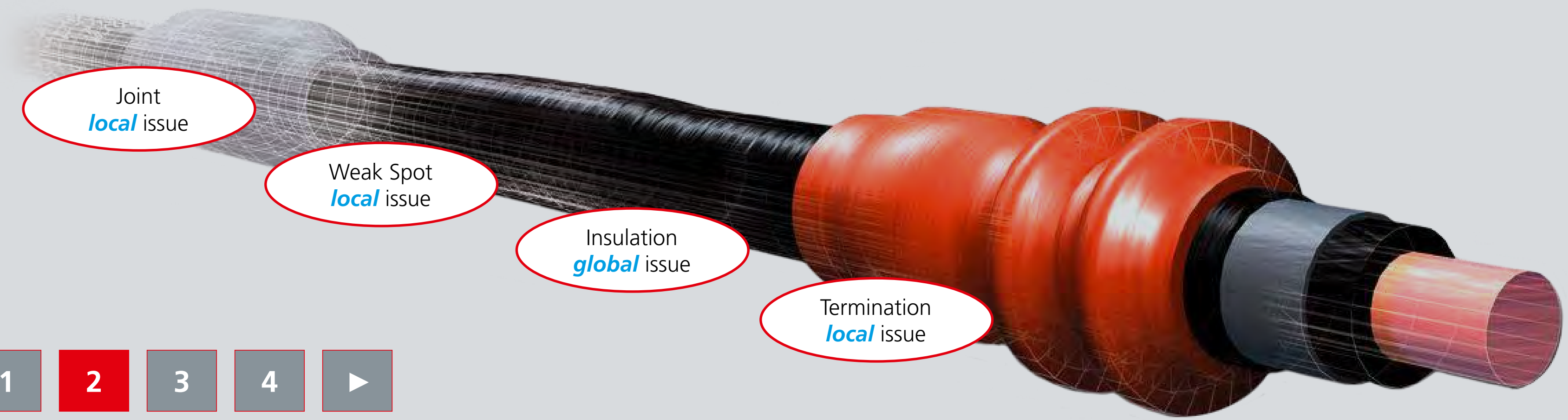
In most cases insulation failures are related to integral degradation of the insulation like water treeing in XLPE cables and degradation of cellulose for PILC cables e.g., whereas faults in accessories are local problems such as bad workmanship of a joint, accelerated ageing because of overload of the cable or a decreased oil-level in case of oil-filled joints.

To reduce the amount of failures by internal defects, on-site cable diagnostics can be applied.

Basics of Diagnostics

Overview of typical ageing phenomena

The picture below illustrates the typical type of faults in a cable which are either a local problem or a global problem. Global problems can only be identified by using integral/dielectrical diagnostic methods. For local problems a partial discharge diagnosis is needed.



Basics of Diagnostics

Dielectrical diagnostics

Most common used technologies for the assessment of the condition of the insulation are dielectric loss measurements (also known as tanDelta), polarization/depolarization current measurements and return voltage measurements.

Dielectric loss measurements mainly only detects water trees/ moisture content, this method is not really suited to measure the thermal ageing of the cable. As the water trees/ moisture content are the most important ageing phenomenon this is not really a problem, making the dielectric loss measurements still the most widely used method.

Polarization/depolarization current measurement and return voltage measurement can detect all types of ageing.

Basics of Diagnostics

Partial discharge diagnostics

Partial discharge diagnostics is nowadays a well proven and accepted method for both quality control of newly installed cables as well as condition assessment of aged cable circuits. There are a variety of systems available on the market which mainly differ in the type of excitation voltage. Most common onsite excitation voltages for the PD measurement are damped AC (DAC), VLF Sinusoidal and VLF Cosine Rectangular. The DAC and VLF CR excitation voltage have the main advantage of getting results which are directly comparable with normal operating conditions, this apart from the higher test power these power sources have.

Application Notes

More information about cable testing and the differences between DC, VLF sinus and VLF CR methods can be found in this paper:

The evolution of VLF Testing Technologies over the past two decades

H.T. Putter, D. Götz, F. Petzold, SebaKMT, and H. Oetjen, HDW Electronics

Abstract– **Due to the regulation of the electricity market, the reliability of distribution networks becomes more and more important. Network operators are forced to maintain the distribution cable system carefully. Withstand testing after installation or after repair of failures reduces significantly the failure rate during normal operation.**

This paper describes the evolution of the Very Low Frequency (VLF) testing technology over the past two decades. Since the introduction of the VLF technology not only the technology itself has changed. Because of the large number of systems in operation and the gathered field data/performed researches, also the application has received high attention from the asset management.

Index Terms— High-voltage techniques, Power distribution, Power distribution faults, Power system reliability, Reliability, Availability, Maintenance, Condition monitoring, Testing, Preventative maintenance.

I. Why VLF Testing

The VLF technology was introduced in 1986; the main driver of this technology was the need for a new testing method for polymer insulated cables and the enormous problems with water treeing effects in XLPE cables of the 1st generation. Several researches [1], [2] have showed that the traditional DC-testing method on polymer insulated cables

Fig. 1. Water trees of critical length can effectively be tested out by using VLF-Test methods [3].

VLF Testing also has got its advantages compared to testing at 50Hz or resonance frequencies:
- Less weight;
- Higher output capacity;
- Less destructive to the healthy insulation;

In figure 2 [11] the withstand voltage as function of the frequency is plotted for XLPE insulated model cables with and without mechanical damages. It can be clearly seen that the breakdown voltage of the cable without mechanical damage is the highest at 0.1Hz, meaning that if a VLF test is performed the healthy insulation is not affected/ aged, whereas at frequencies close to power frequency or higher have a much

More information about cable diagnostics including some practical examples can be found in this paper:

Innovative Solutions for On-site Diagnosis of Distribution Power Cables

H. T. Putter, D. Götz, F. Petzold, *SebaKMT*, and H. Oetjen, HDW Electronics

Abstract– **This paper describes the important aspects that diagnostics play in reducing "customer minutes lost" in medium-voltage networks. The strategic approach of different diagnostic methods e.g. local methods like PD measurements at Damped AC voltages, integral methods like RVM (Return Voltage Measurements), IRC (Isothermal Relaxation Current) and tan δ will be discussed. All of these diagnostic methods have the same goal; assessing the condition of cable insulation and cable accessories of aged and newly installed medium-voltage power cables. The main difficulty is to interpret the diagnostic data and transform them into knowledge rules to make reliable decisions. Based on field experiences from several countries a lot of practical data has been gained and transformed into knowledge rules which can support the asset manager's decision process.**

Index Terms– Power cables, partial discharges, return voltage, diagnostics, isothermal relaxation current, knowledge rules, asset management.

I. Introduction

Fig. 1. Different examples of power cables insulation degradation. The insulation defects may origin from poor installation from the beginning on or may be initiated during the service life of a cable system.

Local types of defects show a typical symptom called partial discharges. In XLPE these defects are mainly located in accessories.

*Please **contact us** for the application notes!*

Basics of Testing

Basics of Diagnostics

Application Notes

Cable Testing

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Cable Diagnostics

Integral / Dielectrical Diagnostics | Local / Partial Discharge Diagnostics

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DC Testing

HV Tester 25

Portable, battery-operated DC test set with up to 25 kV_{DC} output voltage.

datasheet

T99/1

Portable DC test set with up to 40 kV_{DC} output voltage.

datasheet

HV Test Set 50/80/110

Portable, two piece design, DC test set with up to 50, 80 or 110 kV_{DC} output voltage.

datasheet

HPG 70-K

Portable, two piece design, fully insulated DC test set with up to 70 kV_{DC} output voltage.

datasheet

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VLF Testing

Sinus

VLF Sinus 34

Portable and compact VLF test set with up to 34 kV_{peak} output voltage.

datasheet

Sinus

VLF Sinus 45

Portable VLF test set with internal tanDelta measurement with up to 45 kV_{peak} output voltage.

datasheet

Sinus

VLF Sinus 62

Portable VLF test set with internal tanDelta measurement with up to 62 kV_{peak} output voltage.

Sinus CR

TDM 45 series

All-in-one solution for testing and diagnostics of MV cables.

datasheet

CR next

Experience the world of
Megger electrical testing

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VLF Testing

back Sinus

CR

VLF CR 28...60

Portable, high power VLF test set with up to 28, 40 or 60 kV_{rms} output voltage.

datasheet

CR

VLF CR-60HP

Van or container mounted high power VLF test set up to 60 kV_{rms} suited to test long cables such as 36 kV submarine cables.

datasheet

CR

VLF CR-80

Van or container mounted high power VLF test set up to 80 kV_{rms} suited to test 66 kV rated cables up to 2 Uo.

datasheet

Dielectrical Diagnostics

tanDelta

Integral cable diagnostics system.

datasheet

CDS

Compact, absolutely non-destructive test system for condition assesment of polymer and paper isolated cables.

datasheet

VLF Sinus 45 TD

VLF Sinus 45 kV_{peak} power source with internal tanDelta for condition assesment of polymer and paper isolated cables.

datasheet

VLF Sinus 62

Portable VLF test set with internal tanDelta measurement with up to 62 kV_{peak} output voltage.

Partial Discharge Diagnostics

Sinus | CR | DAC

TDM 45 series

All-in-one solution for cable testing and diagnostics. PD measurement using either VLF sinusoidal, VLF cosine rectangular or damped AC voltage up to 40 kV_{rms}

datasheet

CR | DAC

TDS NT

Unique combination system for cable testing and PD diagnostics. PD measurement using either VLF cosine rectangular test or damped AC voltage up to 40 or 60 kV_{rms}

datasheet

DAC

MV DAC-30

Fully insulated damped AC based PD measurement system up to 30 kV_{peak}

datasheet

Sinus

PDS 62-SIN

Lightweight PD coupler for all Megger VLF sine test systems up to 62 kV_{peak}

next

Partial Discharge Diagnostics

PD LOC

Partial discharge pinpointing system to precisely locate PD faults.

datasheet

PD SCAN

Online handheld PD surveying system for MV systems.

UHF PDD

Online handheld UHF PD detector for PD detection in accessible terminations and joints in MV and HV systems

datasheet

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Looking for another solution?
Don´t hesitate to contact us!

en.megger.com/contact-us

More information:

- Cable fault location in a medium voltage network
- Powerful Tools