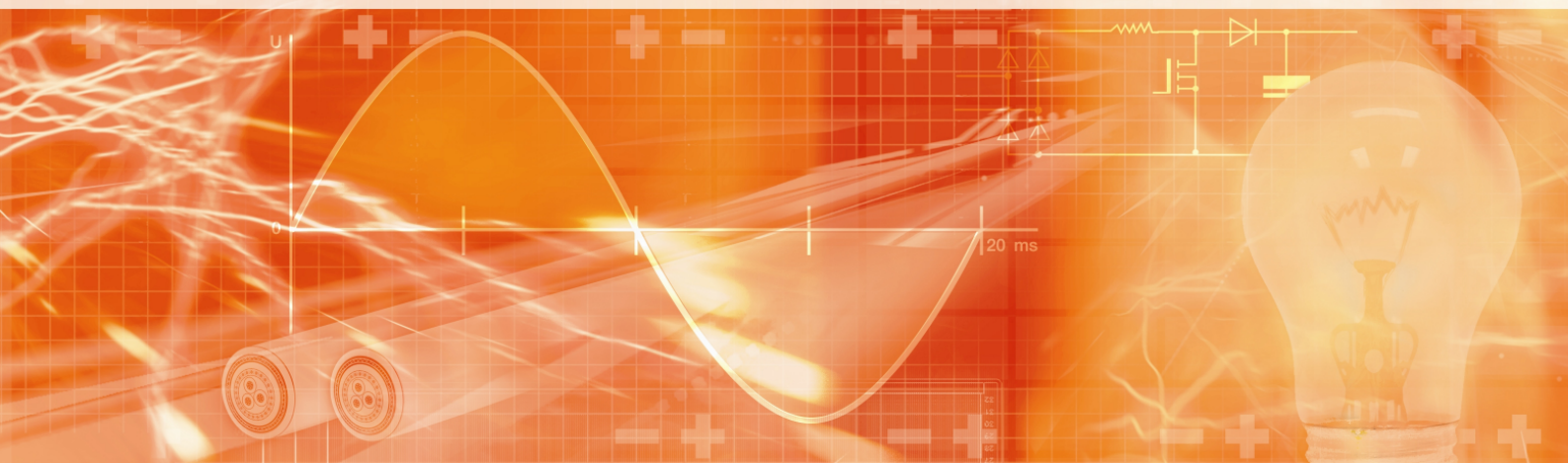


Argumentation support +

General system information



OWTS M-series



sebaKMT



OWTS-M series

General Description

The OWTS-M (Oscillating Wave Test System) is a diagnostic tool which makes it possible to identify, evaluate and locate weak spots in cable insulation and accessories in all types of medium voltage cables. These weak spots could be a result of e.g. faulty installation of joints, cable damages caused by construction work or corrosion of the lead-sheath of a PILC-cable. Simultaneously with the PD-measurement the $\tan \delta$ is recorded, which is providing the user apart from information about local weak spots also information about the global insulation status.

In general the OWTS can be applied for two issues, namely:

- Quality / integrity issue

As a part of commissioning equipment on-site: to check on-site if transportation from manufacturer to site and erection on-site has not caused any new and dangerous defects in the insulation + checking the quality of the installed joints and terminations.

- Availability / reliability issue

For diagnostic purposes: to estimate the actual condition of the service aged cable system by checking the insulation degradation after a period of service operation e.g. 20 years + providing reference values of diagnostic tools (partial discharges, dielectric losses) for later tests.

System Description

The system consists of a notebook as control unit and an HV unit. The HV unit contains of an HV source, a resonance inductor and an integrated electronic thyristor-switch to generate the attenuated AC test voltage. HV divider and embedded controller for digital data acquisition and PD signal processing are also integrated in the HV unit. Storage, analysis and evaluation of the PD signals takes place in the notebook and can be done either on- or off-site. PD fault location is based on the TDR (Time Domain Reflectometry) principle.

Functionality of the OWTS is accordingly; test object is charged to a preselected peak value by the HV source within a couple of seconds, afterwards the test object will be shorted with an inductor via the thyristor-switch, resulting in a resonance network. Thus a sinusoidal oscillating AC voltage with low damping is created (DAC). The frequency of the DAC voltage is fixed in a range from 20 Hz up to a few hundreds of Hz, depending on the capacitance of the test object.

Frequency of the DAC voltage is comparable with the power frequency, which is an utmost since one want to compare the obtained results with normal operating conditions. It's known that PD characteristics are changing when frequencies are far from power frequency.

Parameters like PD extinction voltage and $\tan \delta$ -value can be easily determined due to the decaying amplitude of the test voltage. The DAC voltage energizes the test object only for a few 100 ms and therefore causes no long-term influences.

**Technical Specifications:****OWTS-M28**

Max. DAC output-voltage	28 kV _{peak} / 20 kV _{rms}
DAC frequency range	50 Hz ... 600 Hz
Capacitance range	0,05 µF ... 2 µF
HV charging current	10 mA
PD measuring range	1 pC ... 100 nC
PD level detection	acc. to IEC 60270
Bandwidth for PD-localisation	150 kHz ... 45 MHz
Dissipation factor tan δ	0,1 % ... 10 %
Power supply	115 / 230 V 50 / 60 Hz
Operating temperature	-10 °C ... + 40 °C
Weight	app. 55 kg

Dimensions

Unit 1	Ø: 600 mm, H: 650 mm
Unit 2	Notebook app. 2 kg

OWTS-M60

Max. DAC output-voltage	60 kV _{peak} / 42 kV _{rms}
DAC frequency range	50 Hz ... 600 Hz
Capacitance range	0,025 µF ... 2 µF
HV charging current	7 mA
PD measuring range	1 pC ... 100 nC
PD level detection	acc. to IEC 60270
Bandwidth for PD-localisation	150 kHz ... 45 MHz
Dissipation factor tan δ	0,1 % ... 10 %
Power supply	115 / 230 V 50 / 60 Hz
Operating temperature	-10 °C ... + 40 °C
Weight	app. 80 kg

Dimensions

Unit 1	Ø: 600 mm, H: 970 mm
Unit 2	Notebook app. 2 kg

Added to both units:

- ▶ Additional capacitance, 60kV/ 0.15µF, for measurements on short cables (<300m XLPE), switchgear, motors and generators.

Optional to both units:

- ▶ Adapter set for PD-Free connection on terminations.
- ▶ PD-Loc for pin-pointing of the weak spot.
- ▶ TE-PDS for PD-measuremenst on accesable joints terminations.



Advantages of the OWTS M-series:

- ▶ **System is lightweight and portable;** since the principle is based on DAC using a resonance-circuit with the test-object as capacitance, weight, input power and dimensions are reduced. The reduction has led to a small, light and portable system with low input power, like no other competitor is able to.
- ▶ **Applicable on all cable types;** the OWTS can perform PD measurements on all type of cables such as; PE, XLPE, EPR or PILC, but also combinations of these types (mixed cables). PD measurements are performed according to the international standards, IEC 60060-3, IEC 60502-3, IEEE 400.3, IEC 60270 and IEC 885-3.
- ▶ **Short voltage application;** because of the DAC principle the insulation will only be subjected to higher voltages for a short period of time of less then 1 second. Thus not unnecessarily stressing the cable as with continuous voltage application and certainly non-destructive.
- ▶ **Off-line data processing;** with off-line data processing the entire PD-spectrum will be saved and analysed afterwards, making it possible to localize all weak spots. Whereas with on-line data processing the software triggers on the highest discharge resulting in a lower accuracy since not all discharges are captured.
- ▶ **User friendly;** the software is available in 7 different languages and has an easy to use step by step protocol approach.
- ▶ **DAC frequency comparable with 50/60Hz;** the frequencyspectrum of the damped AC voltage is between 50 and 500Hz resulting in comparable PD-characteristics as with the power frequency situation. When the difference between power frequency and test frequency is large, it is known that the PD characteristics will change, leading to unreliable results.
- ▶ **Simultaneous PD and Tan δ recording;** during the damped AC period both PD and tan δ values are recorded, the result being saving time since not two measurements have to be performed and also unnecessary stressing of the insulation is prevented.
- ▶ **PD-Pattern recognition;** with the OWTS it is possible to display the discharges as function of the phase (PD-pattern). This could either be per AC cycle or per several AC cycles. PD patterns can give the user valuable information about the type of fault, e.g. discharges in oil-filled joints, discharges in between paper-layers or corona (discharges in gas/ air).
- ▶ **Compensate attenuation;** because of the physical properties of the cable, pulses which travel through the insulation will attenuate, also PD-pulses will attenuate leading to incorrect read outs of the discharge height. The OWTS-Explorer analysis software has a function to compensate this attenuation effect and via that obtain representative PD-values again.
- ▶ **Manual and automatic evaluation;** the data can be either analysed manually or automatically via the OWTS-Explorer analysis software.
- ▶ **Automatic calibration mode;** the OWTS consists of an automatic calibration mode with joint locating feature. With the joint locating feature it is possible to find and locate joints in the cable under test.



- ▶ **Automatic bandwidth adaption;** OWTS software is also equipped with an automatic bandwidth adaption for optimised signal detection. With this tool the OWTS has got the highest accuracy for long and short cables.
- ▶ **Mixed cable correction;** it is known that the propagation velocity of PILC and XLPE cables differ. When measuring on mixed cables this will lead to a false indication of the fault location, since the propagation velocity is an average. With the mixed cable correction option, the propagation velocity can be adapted per cable section, leading to a correct fault location again.
- ▶ **Independent of cable length;** although in the technical specifications $2\mu\text{F}$ is stated, the OWTS can measure on larger capacities, read “longer cables”, as well. The $2\mu\text{F}$ is purely an indicative parameter which is related to the PD-locating feasibility. The big advantage of the OWTS compared with the competition is that it is able to detect PD on long cables, whereas the competition have to splice the cable or have to use extreme low frequencies (0,01Hz) to be able to load the cable.



Disadvantages of using 0,1Hz for PD diagnosis:

- ▶ **Frequency not comparable with 50/60Hz;** as a result of a frequency difference of 500 to 600 times compared with the power frequency the PD-characteristics cannot be compared anymore. Research has concluded that especially the PDIV (Partial Discharge Inception Voltage) at 0,1Hz could be much higher as compared with the PDIV at 50Hz, thus weak spots are not found, or qualified as non-essential were in reality they are threatening. In general the PDIV is one of the most important parameters in the decision making process and a high weighting factor should be attached to this parameter.
- ▶ **Continuous voltage application;** using 0,1Hz means continuous voltage application. At 0,1Hz a PD-measurement will take 10min > per phase, voltage stresses are up to 2-2,5U₀. Concluding from these facts we can regard the PD measurement at 0,1Hz as testing and testing is destructive!!! For newly installed cables the elevated voltages will most probably not result in a breakdown, but for service aged cables with water trees the risk of a breakdown because of the elevated voltage level is high. It is widely known that with VLF voltages the water tree growth is at its highest, making the risk of a breakdown even higher.
- ▶ **On-line data processing;** PD-data is processed on-line having the disadvantage that the software will trigger on the highest discharge; smaller discharges of other weak spots could be discarded by the software leading into a lower accuracy.
- ▶ **No PD-pattern recognition;** PD-pattern recognition over one or more AC-cycles is not possible. With PD-pattern recognition one can identify the type of fault on forehand, e.g. making a distinction between discharges in joints or discharges in the insulation. When repairing the fault, one knows where to focus on, a joint or a part of a cable, which is in this case not possible.
- ▶ **No simultaneous PD and TD;** PD-measurement and Tan δ measurement have to be performed separately from each other, resulting in a longer measurement time and longer voltage stressing of the cable insulation.
- ▶ **Heavy equipment;** since a VLF sine source is used the weight of the equipment becomes that high that integration in a test van is a necessity making it not portable anymore.
- ▶ **Length limited;** since the VLF sine source is load limited, the maximum cable length is limited. With 0,1Hz it's not possible to measure on long cables without splicing the cable, or decreasing the frequency to 0,01Hz. The latter will result in PD-characteristics (PDIV, PDEV and PD-level) which are of no meaning, since it differs 5000 to 6000 times with the power frequency.



Disadvantages of using resonance test sets for PD diagnosis:

- ▣ **Filtering of discharges;** to keep the circuit into resonance, the cable must be re-energized each couple of AC-cycles. This re-energizing of the cable is accompanied by a lot of noise, thus filtering is required resulting that also PD-signals will be filtered away. Consequently a lower accuracy is obtained.
- ▣ **High power demand;** resonance test sets are known to have a high power demand in the order of 50kVA.
- ▣ **No continuous measurements possible;** due to the high power consumption of the system the number of test cycles is limited (3 cycles per day) because of cooling purposes. For warmer countries the number of test cycles will even be lower.
- ▣ **Heavy weight;** weight of the equipment is 1500kg, making it a heavy weight solution which can only be integrated in a test van.
- ▣ **Length limited;** because of the high weight of resonance test sets, integration in test vans leads to capacity limitations, consequently the length is limited to only 1,5 to 4,5km of cable. Measurements on longer cables can only be performed when the cable is spliced.
- ▣ **Difficult to control;** highly skilled staff is required to control the resonance test set because of its complexity.

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