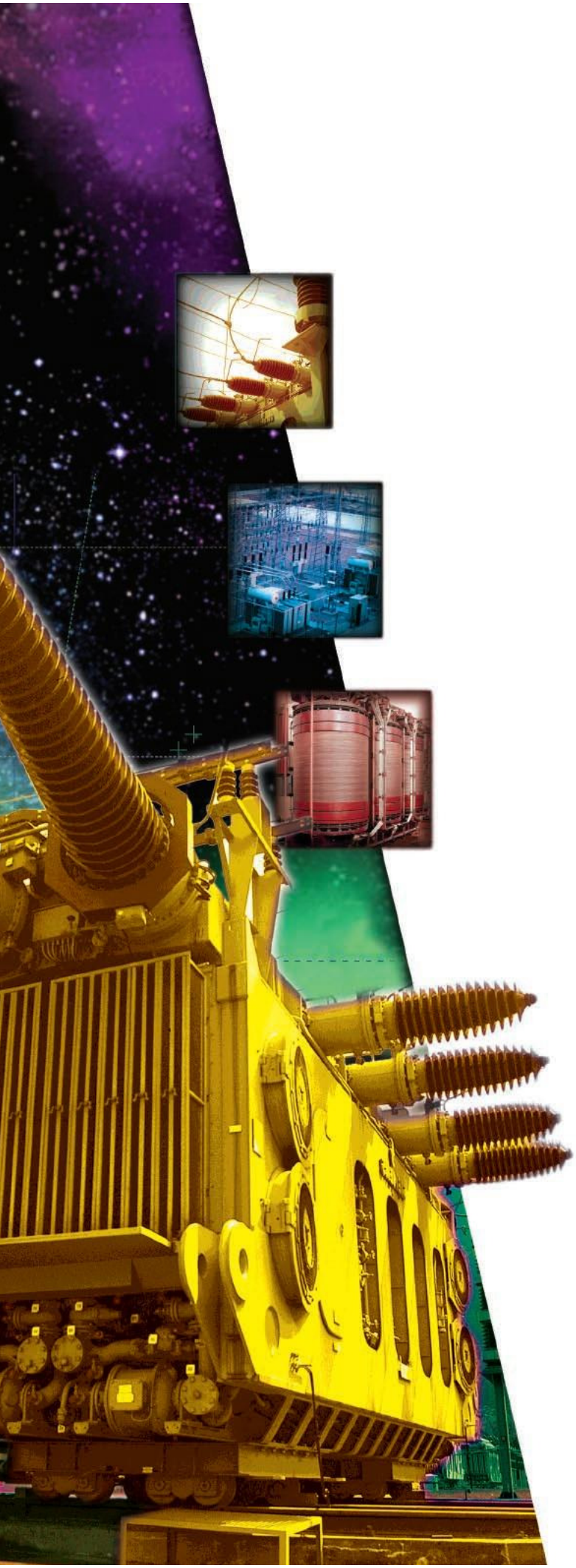
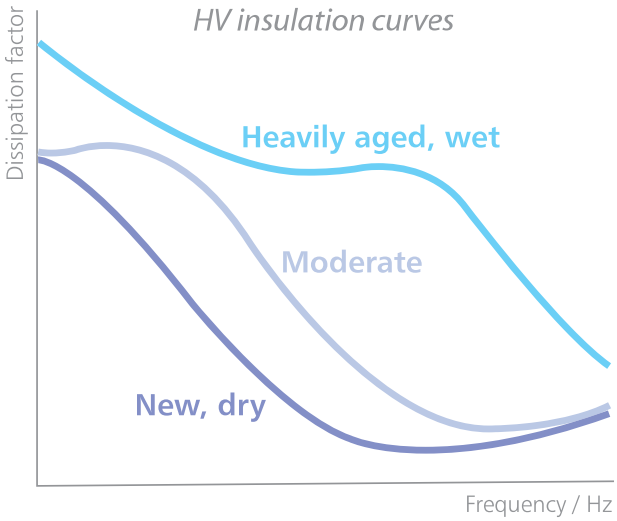


OMICRON

DIRANA

DIELECTRIC RESPONSE ANALYZER

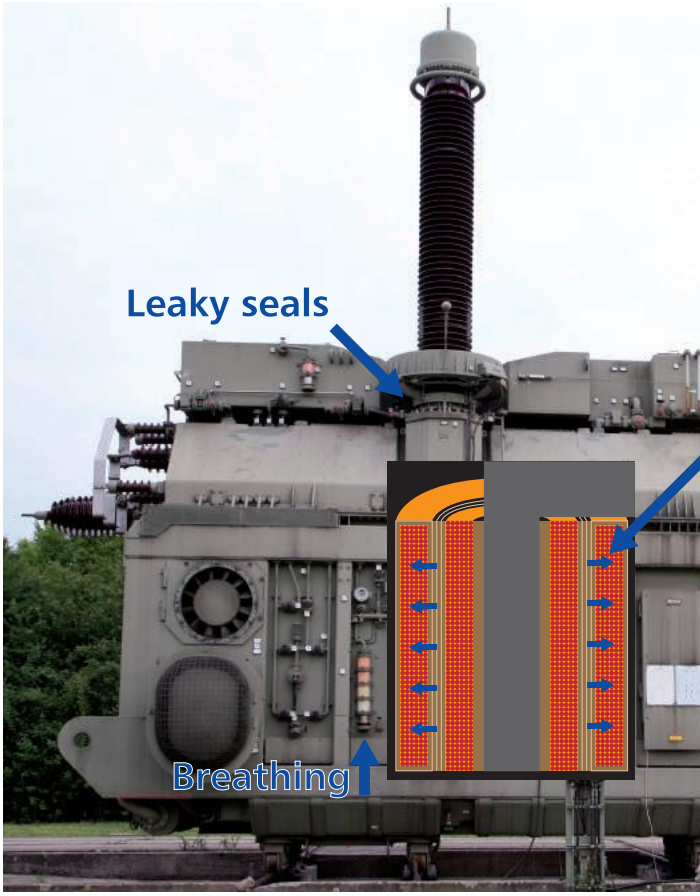
Fast Dual-Channel Measurement of Oil-Paper HV Insulations in Power Transformers, Bushings, Cables and Generators with subsequent Moisture Assessment



Water in Power Transformers

Cost-effective maintenance

Power transformers represent the most expensive links between generation and utilization side of energy. Due to the cost pressure of a de-regulated energy market the utilities shift maintenance from time based to condition based approaches. This development requires reliable diagnostic tools. DIRANA helps you prioritize the maintenance of your transformer fleet.



Why moisture determination?

Water entering in oil-paper insulations can cause three dangerous effects: it decreases the dielectric withstand strength, accelerates cellulose aging (de-polymerization) and causes the emission of gas bubbles at high temperatures.

Therefore an accurate knowledge about the actual moisture concentration is required in order to decide if further corrective action, such as on-site drying, is necessary.

Moisture contamination

Moisture enters transformers from the atmosphere (breathing, leaky seals) and during installation and repair. Aging of the oil-paper-insulation also increases the moisture level. Therefore, even in the case of a non-breathing transformer, the moisture can reach a dangerous level.

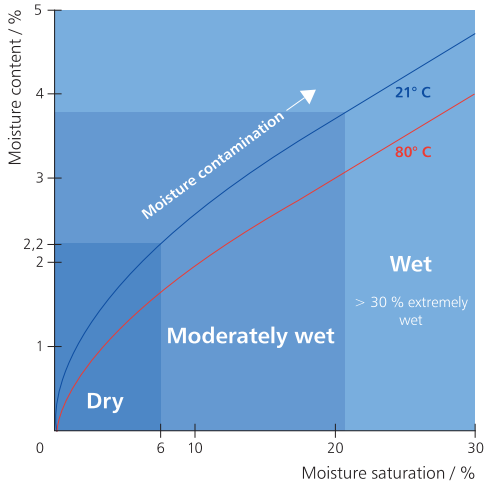
Where is the water?

DIRANA analyzes the moisture content of the paper/ pressboard insulation. The test result is an independent quantity that can be compared to other moisture analysis techniques. Typically the solid part of the insulation structures e.g. pressboard, paper and wood holds most part of the water, i.e. 200 times more than the oil. Thus the moisture concentration in the solid insulation is much more important than that in the oil.



How to assess the moisture results?

IEC 60422 categorizes moisture saturations of more than 6 % as "moderately wet", which is equivalent to a moisture content of approximately 2.2 %. At this level the water molecules start to become more active, which results in a dangerous moisture condition for the equipment being tested. Based upon this, corrective action should be taken as e.g., a drying process.
The graph below shows the temperature dependent relationship between moisture content and moisture saturation to allow conversion from one measure to the other. Moisture content relates water mass to the material mass, whereas moisture saturation relates water mass to the maximum water mass a material can adsorb.





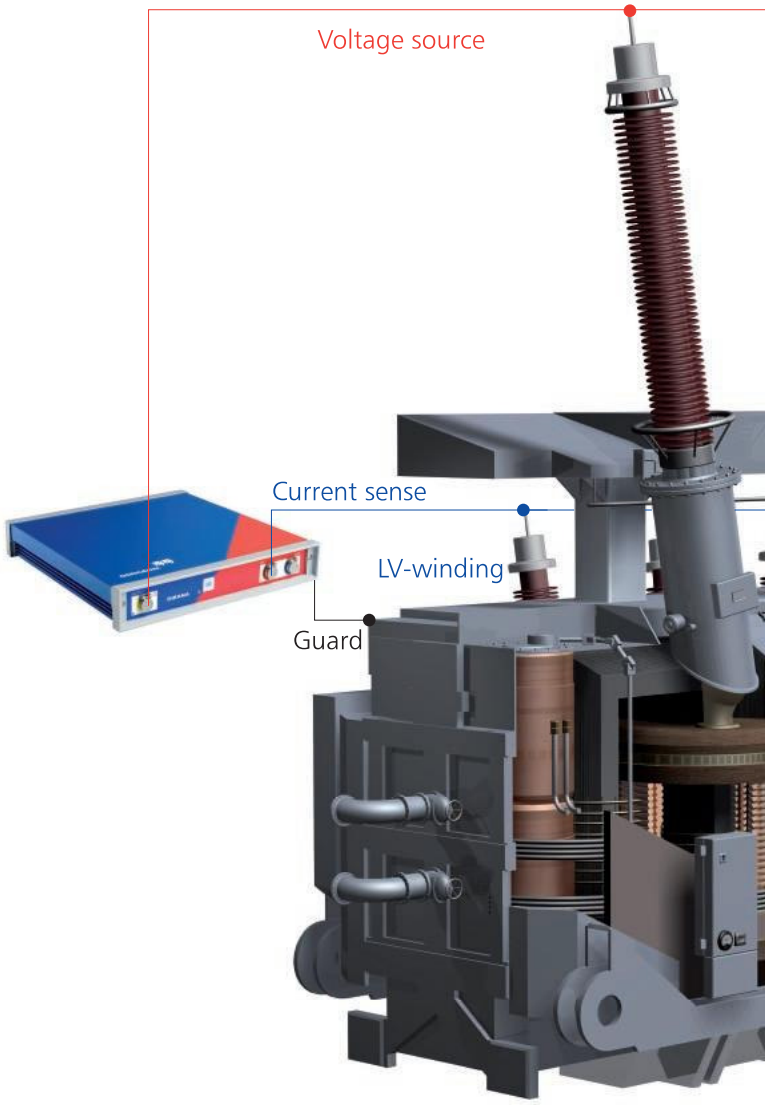
Benefits to you:

- A precise knowledge of the water content which is of vital importance for assessing the insulation condition of power transformers
- Reliable quantitative data from which a more accurate condition-based program can be developed
- Moisture assessment is based upon international standards

Dielectric Measurements

Why dielectric response measurements?

Valuable information about the condition of a high voltage insulation may be obtained by measuring its dielectric response. This can be an especially useful tool for the measurement of the concentration of moisture in oil/paper insulation systems. While a typical power-frequency measurement may provide limited results, exposing this same insulation to a wide band of frequencies and measuring how it reacts at those various frequencies results in a clearer understanding as to its condition. A deterioration of its ability as an insulation medium becomes very apparent.



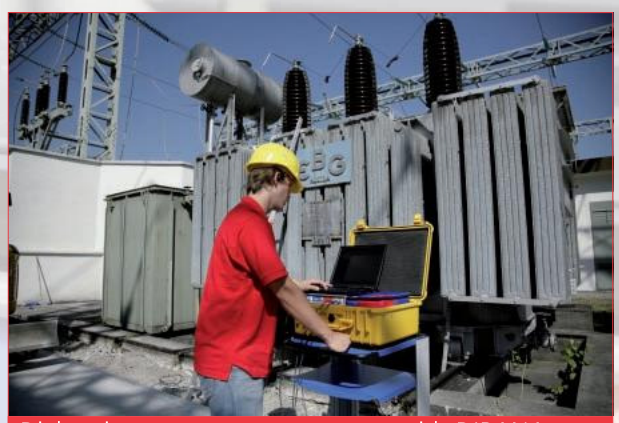
Physical properties revealed by dielectric response

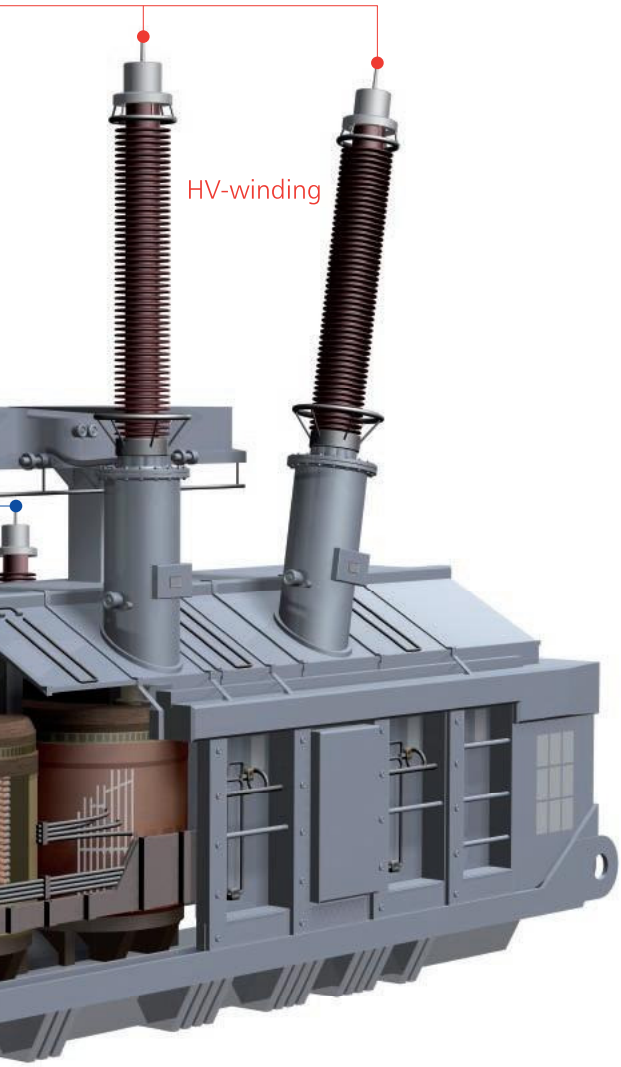
The polarization effects and dielectric losses are affected by various properties of the dielectric material at different frequencies. Among those properties are:

- Moisture content
- Contamination
- Byproducts of aging
- Temperature effects

Applications

- Moisture analysis in oil-paper insulations
- Capacitance and dissipation factor of power transformers
- Dissipation factor measurements and aging detection for bushings even at ambient temperature
- Paper-mass insulated cables
- Generators and motors


Dielectric response measurement with DIRANA



Measurement steps

A dielectric response measurement is a three terminal measurement that includes:

- output voltage, sensed current and guard.

DIRANA's guarding technique guarantees interference-free measurements even with on-site conditions of dirty insulations or bushings.

For a two-winding transformer which has been disconnected from the network:

- connect the voltage output to the HV winding.
- connect the sensed current input to the LV winding.
- connect the guard to the tank.

Unlike the conventional equilibrium method, the measurement can be taken right away. There is no requirement to allow the transformer to cool, or wait until moisture equilibrium between paper and oil has been reached.

Two channels = 50 % time savings

OMICRON's DIRANA is the first dielectric response analyzer which comes equipped with two input channels. By utilizing two channels, significant time savings can be achieved. For example, in the case of a three-winding transformer, the output voltage can be applied to the MV winding while the input channels are connected to the HV and the LV windings. This results in a time savings of 50%.



Connecting DIRANA to a bushing

Benefits to you:

- Wide frequency range provides a high degree of accuracy never possible in the past
- Precise measurements can be taken at all temperature levels and without waiting for moisture equilibrium of the insulation systems to be reached
- Various insulation systems can be evaluated
- DIRANA's special guarding technique provides measurement interference protection
- Two input channels significantly reduce testing time

Moisture Assessment

Why dielectric measurements for moisture determination?

The traditional oil sampling method requiring the use of an equilibrium diagram for evaluating moisture in transformers is an inexact approach. Besides the uncertainties due to sampling and water-in-oil measurement the degradation of oil and paper makes the application of conventional equilibrium charts very inaccurate. This, together with very long time constants for equilibrium processes, leads to a very poor accuracy. The dielectric response method, in contrast, is a very reliable method that provides a high degree of accuracy in assessing the moisture content in the solid insulation.

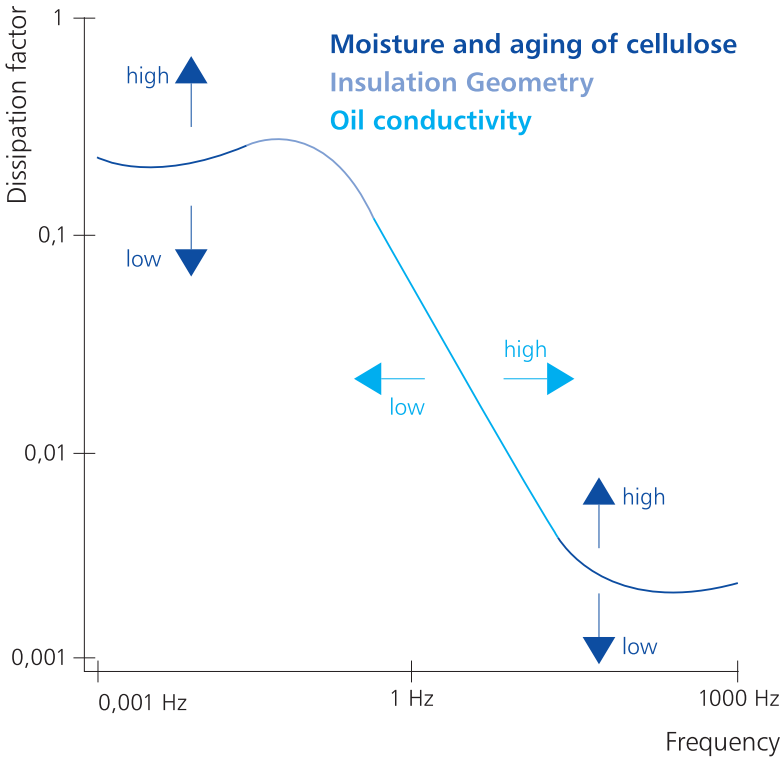
How does it work?

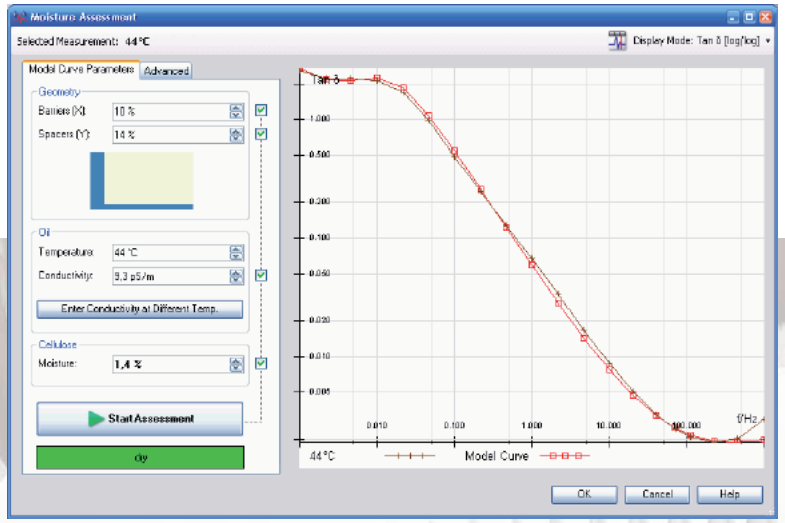
DIRANA derives the amount of moisture in paper or pressboard from properties as polarization current, complex capacitance, and dissipation factor. Each of these is strongly affected by moisture.

Interpretation method

The dissipation factor plotted against frequency shows a typical S-shaped curve. With increasing moisture content, temperature or aging the curve shifts towards higher frequencies. Moisture influences the low and the high frequency areas. The middle section of the curve with the steep gradient reflects oil conductivity. Insulation geometry conditions determine the "hump" to the left side of the steep gradient.

DIRANA's moisture determination is based on a comparison of the transformers dielectric response to a modelled dielectric response. A fitting algorithm rearranges the modelled dielectric response and delivers the moisture content along with the oil conductivity. Only the oil temperature needs to be entered.



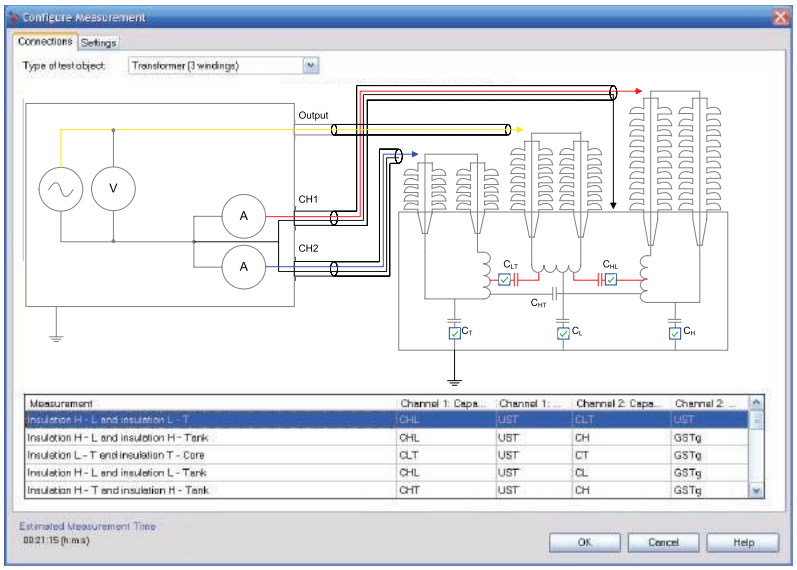


Easy-to-use and efficient software

The software features built-in expert knowledge with an intuitive user interface. Predefined tests for all transformer types make the operation easy and guide you through the measurements.

Reliable results even with aged transformers

DIRANA compensates for the disturbing influences of conductive aging byproducts such as acids. These substances increase the dielectric losses in the same way as water and may therefore lead to an overestimated water content. DIRANA's software uses a compensation algorithm that provides reliable results even with aged transformers.





Benefits to you:

- Scientifically proven interpretation scheme
- Automated analysis of moisture content and oil conductivity
- Compensation for temperature, insulation geometry and oil conductivity
- Aging byproducts are considered for dependable results on aged transformers

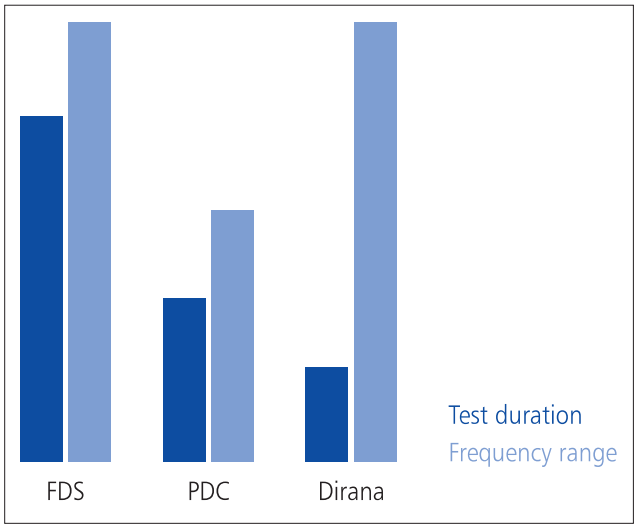
Our Innovative Instrument

OMICRON's DIRANA determines the dielectric properties of insulation materials within a wide frequency band. Based upon dissipation factor and capacitance, the system analyzes moisture content particularly in oil-paper-insulated power transformers. DIRANA also lends itself well to other high voltage insulations.



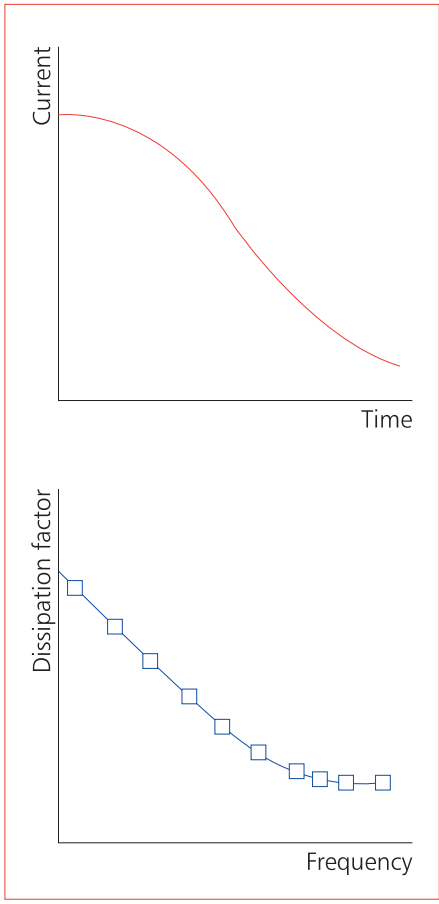
Time and frequency domain method combined

DIRANA combines the polarization current measurement (PDC) method in time domain with the frequency domain spectroscopy (FDS) and thus significantly reduces the testing time compared to existing techniques. Essentially, time domain measurements can be accomplished in a short time but are limited to low frequencies. In contrast, frequency domain measurements are feasible for high frequencies but take very long time at low frequencies.

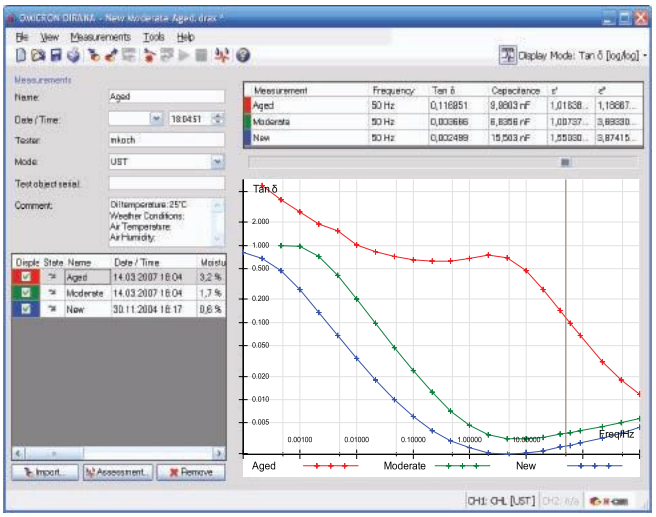


DIRANA's patented technique combines the advantages of both principles. It acquires data in the frequency domain from 5 kHz to 0.1 Hz and in the time domain from 0.1 Hz to 100 μHz. This reduces the measuring duration by 75 % compared to exclusive frequency domain measurements.

For instance, data acquisition for a frequency domain measurement from 1 kHz down to 0.1 mHz will typically take 11 hours, DIRANA will acquire this data in under 3 hours. DIRANA transforms the time domain currents into the frequency domain for subsequent evaluation.

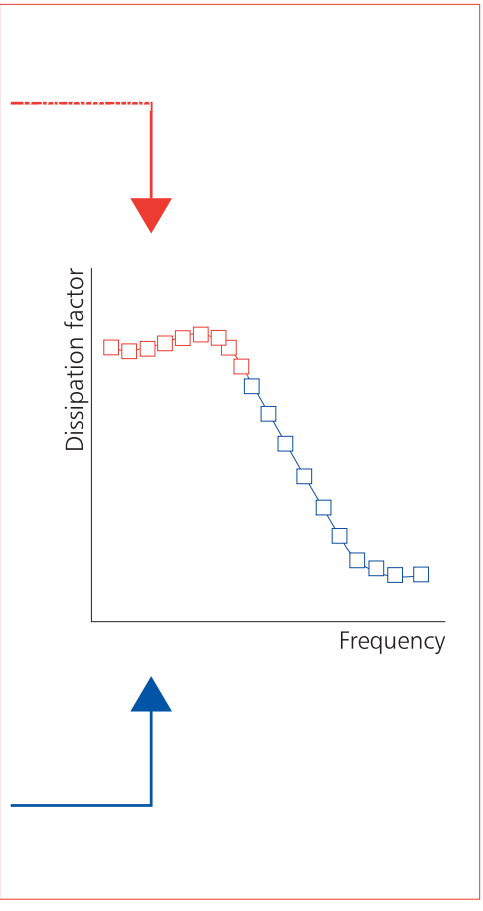






Built-in expert knowledge determines moisture

The easy-to-use software determines moisture content in the solid insulation. Moisture decreases the dielectric withstand strength, accelerates paper aging and causes bubbling at high temperatures. Thus knowledge about the moisture concentration is of utmost importance for the transformer operator.
DIRANA analyzes the dielectric response and determines the humidity in the solid insulation. The automated algorithm compensates for disturbing influences such as temperature, insulation geometry, oil conductivity and aging byproducts. Conductive aging byproducts appear as water and cause an overestimation of the moisture content leading to unnecessary drying. DIRANA compensates for this influence and thus reliably detects moisture even in aged transformers.



Benefits to you:

- Wide frequency range
- Non-intrusive test of HV insulations: transformers, bushings, cables and generators
- Fast measurement by combined time and frequency domain method
- Determination of moisture in power transformers without opening
- Reliable moisture evaluation also for aged transformers

The "one box" solution

Technical Data

Voltage Source	
Measuring voltage	± 200 V_{peak}
Max. continuous output current	50 mA_{peak}
Time Domain Current Measurement (PDC)	
Range, resolution	± 20 mA, 0.1 pA
Input resistance	10 kΩ
Accuracy	0.5 % ± 1 pA
Frequency Domain Spectroscopy (FDS)	
Measuring voltage	± 200 V_{peak}
Measuring current	± 50 mA_{peak}
Dissipation Factor, Capacitance	
Dissipation factor range, resolution	0…10, 10^{-5}
Accuracy for 1 mHz < f < 100 Hz	1 % + 3 × 10^{-4}
f < 1 mHz and f > 100 Hz	2 % + 5 × 10^{-4}
Capacitance	10 pF … 10 µF
Accuracy	0.5 % + 1 pF
Ranges for Combined FDS and PDC Measurement	
Frequency	0.1 mHz … 5 kHz
Test Modes	
UST, GST, GSTg	
Mechanical Data	
Dimensions (w × h × d)	26 × 5 ×26.5 cm 10.25 × 2 × 10.5 inch
Weight	< 2.3 kg / 5 lb (instrument) 16 kg / 34 lb complete case
PC Requirements	
Operating system	Windows XP, Windows Vista
CPU / RAM	Pentium 1 GHz / 512 MB
Interface / Drives	USB 2.0 / CD-ROM drive
Environmental	
Operating ambient temperature	-10…+55°C / -31…131°F
Storage ambient temperature	-10…+65°C / -31…+149°F
Relative humidity	20…95%, non-condensing
air-pressure (storage/operating)	70…106 kPa
Calibration	
Optional calibration every two years	





DIRANA comes in a rugged case which contains all necessary accessories like connection cables with clamps, drums etc.

Ordering Information

ID	Detailed description
VE000670:	Complete DIRANA set
VEHZ0607:	DIRANA accessories
VEHP0072:	Transport case for DIRANA

OMICRON is an international company providing innovative power system testing solutions. With sales in more than 120 countries, offices in Europe, North America, and Asia, and a worldwide network of sales partners, OMICRON has established a reputation as a supplier of leading edge technology.

OMICRON's automated primary and secondary testing capabilities are important benefits in light of the changing market conditions resulting in restructured organizations required to "do more with less". Services in the area of consulting, commissioning, testing, and training make the product range complete.

Specialization and visionary leadership allows OMICRON to continue with revolutionizing developments for its solutions to meet the customer needs of the 21st century.



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