IDAX 300/350

Insulation Diagnostic Analyzers

- **Automated measurement and analysis of moisture content, tan delta/power factor and oil conductivity**
- **Individual temperature correction (ITC) of tan delta/power factor and oil conductivity**
- **40% faster measurements with the new IDAX 5.0 SW**
- **Reliable measurements in high-interference environments**
- **Multi-function test set for transformer measurements**

DESCRIPTION

IDAX 300 is a very compact instrument and is used together with an external computer. The IDAX 350 has a built-in computer but can also be used with an external computer.

IDAX 300/350 provides an accurate and reliable condition assessment of insulation in transformers, bushings, generators and cables. The IDAX system maximizes the outcome of maintenance activities allowing for load and service life optimization.

IDAX 300/350 are smaller, lighter and faster than their predecessor IDA200 and IDAX 206. It maintains better accuracy and ability to provide reliable data using true AC DFR (Dielectric Frequency Response), also known as FDS (Frequency Domain Spectroscopy), for reliable test results in high interference environments. The state-of-the-art software makes testing both easier and faster, allowing transformer moisture and oil assessment in about 22 minutes (20°C).

IDAX measures the capacitance and tan delta/power factor of the insulation between power transformer windings at multiple frequencies. Analyzing the results using modeling technique makes it possible to assess the moisture level in the solid insulation, oil conductivity/tan delta at reference temperature (25°C) and power frequency tan delta at reference temperature (20°C). The test can be performed at any temperature as the temperature dependence of the dissipation factor is included in the modeling.

APPLICATION

With an aging power transformer population, today's electrical utility industry faces a tough challenge as transformer failures and consequent repair and revenue loss costs millions of dollars. Transformers have become one of the most mission critical components in the electrical grid. The need for reliable monitoring and diagnostic methods drives the world's leading experts to evaluate new technologies that improve reliability and optimize the use of every grid component [1].

IDAX is a revolutionary insulation diagnostic instrument based on DFR (Dielectric Frequency Response), also known as FDS (Frequency Domain Spectroscopy). This analysis technique has been used in laboratories for decades and IDA/IDAX was the first instrument designed for field use (1996). The IDA/IDAX instrument and measurement principle has been used and verified around the world over the last 15+ years.

MOISTURE IN TRANSFORMERS

One of the most important applications for IDAX is to determine the moisture content in transformer insulation. Moisture in the insulation significantly accelerates the aging process. The insulation system of power transformers consists of oil and cellulose. Among factors contributing mostly to the degradation of transformer insulation, moisture plays an important role. Presence of water in solid part of the insulation, even in small concentrations

- increases its aging rate
- lowers the admissible hot spot temperature
- increases the risk of bubble formation
- reduces the dielectric strength of transformer oil
- reduces the inception level of partial discharge activity

IDAX provides reliable moisture assessments in one test. The test can be made at any temperature and takes about 22 minutes at 20-30 C insulation temperature.

Decisions on maintenance and/or replacement should be based on knowing the condition of the insulation and the expected loading of the unit. Adding just a few operational years to the expected end-of-life for a transformer, generator or cable by optimizing the working condition based on reliable diagnostic data means substantial cost savings for the equipment owner.

The DFR technology can also be used to assess the condition and aging of the insulation in bushings, CTs, VTs and other components. Numerous ongoing research projects at institutes and universities around the world is adding experience and value to users of IDAX.

Water in oil vs. paper

Assessing reliable moisture content in transformer insulation based on oil sample tests is unreliable as the water migrates between the solid insulation and oil as temperature changes. An oil sample has to be taken at relatively high temperature and when the transformer is in equilibrium. Unfortunately, this is a rare state for transformers thus resulting in unreliable assessments. Experience has shown that this method tends to overestimate the amount of water in the insulation.

Figure 1 shows how the significant and potentially critical difference of 0.5% respectively 3.0% moisture in paper, correlates to the insignificant difference of 1 respectively 4 Parts Per Million (PPM) in an oil sample obtained at 20°C (68°F) [2].

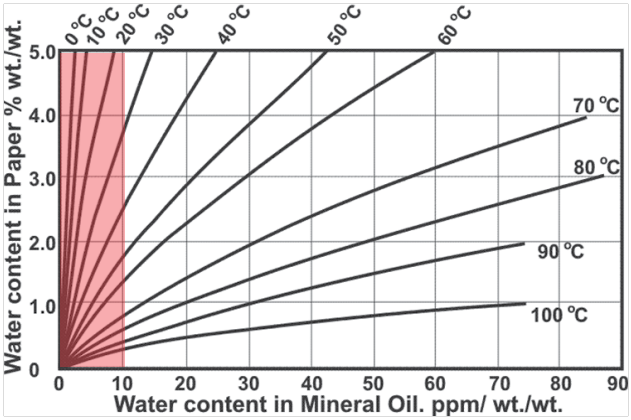

Fig. 1: Water in oil vs. paper correlation is unreliable at low temperature

The test

Dielectric loss or power factor is frequency and temperature dependent, so by injecting test signals at discrete frequency steps typically between 1 kHz and 1 mHz while recording results at each point, a frequency response at a specific temperature is obtained (Fig 2).

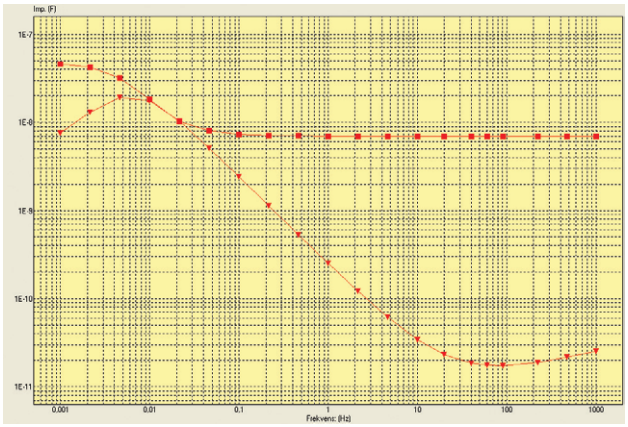

Fig. 2: Insulation measurements presented as capacitance and loss

This frequency response represent the properties of the insulation material in the transformer and will be used in further analysis as described below. The insulation temperature (oil or winding temperature) is recorded to be used in the model analysis described below.

The model

The insulation between the windings in a transformer consists of a solid and a liquid part. The solid part consists of barriers and spacers to create an oil duct for cooling purposes (Fig 3). In the analysis, a SW algorithm varies all insulation and geometry parameters to simulate every possible design. The model also applies Arrhenius equation to calculate and compensate for temperature dependence in the material [3].

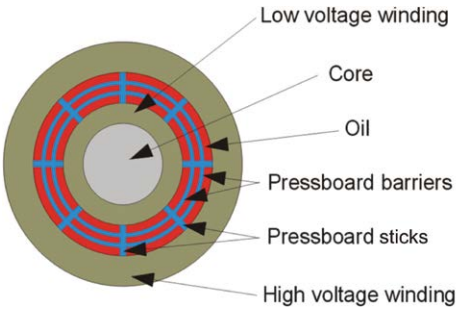

Fig. 3: Typical insulation design

The IDAX software creates new model curves and compares them to the measured curve until the best possible match is reached. The final results are presented as percent of moisture in paper and individually corrected power frequency tan delta and oil conductivity at reference temperature (Fig 4).

Fig. 4: Insulation assessment; Moisture, tan delta and oil conductivity

What controls the response

The general rule is that moisture is visible in the highest and lowest frequencies. Oil conductivity is dominant in the medium frequency and the temperature shifts the curve to the right and to the left respectively (Fig 5).

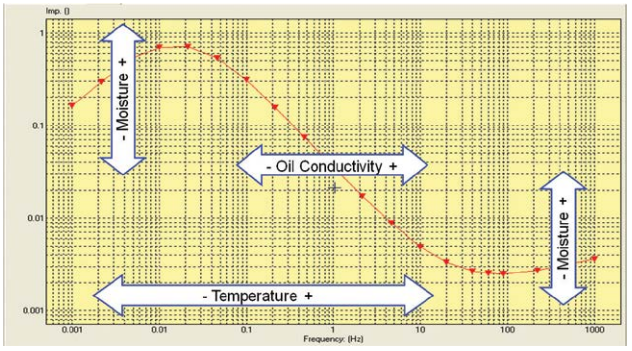

Fig. 5: Oil conductivity and moisture influence

One point is not enough

Traditional tan delta/power factor testing provides one value at mains frequency 50/60 Hz. This is where the IDAX method makes the difference. Figure 6 show that a single tan delta/power factor value cannot provide conclusive information about the potential problem. At best it can provide information that a problem exists. In this example, two transformers have the same power factor value at 60 Hz. However, one of them is wet (3.6%) and should be considered for a dry-out while the oil in the other unit should be replaced or regenerated. The IDAX method provides accurate and conclusive information in one test.

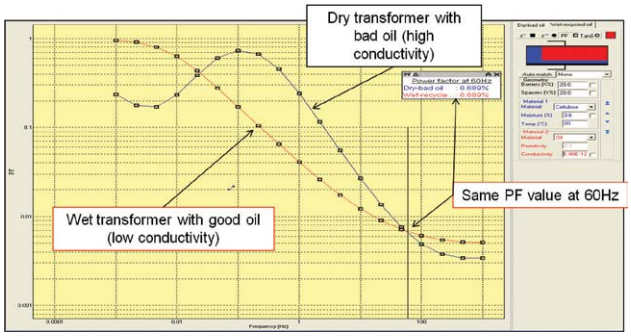

Fig. 6: Blue — dry with bad oil. Red — wet with good oil

Test procedure

The test preparation and procedure is similar to a standard tan delta/power factor test, which means that the transformer has to be off-line and preferably disconnected.

The IDAX software operates on Windows XP, Vista, 7 and 8 and utilizes standard USB or Ethernet communication. The software guides the user through a test template where all connections are illustrated as in Figure 7. Color markings on clamps makes it easy to connect according to the built in instructions. The test can be started as soon as the test cables are connected and unlike DC-methods there is no need for discharging the test object.

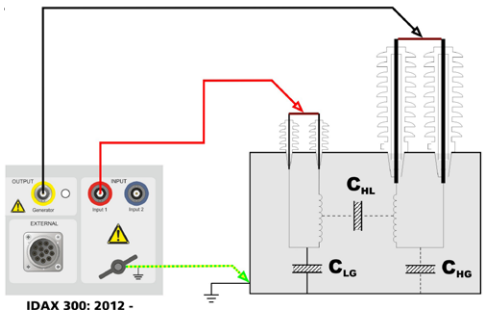

Fig. 7: Example of connections to a two-winding transformer

All IDAX have 3 measurement terminals (red, blue and ground) that allows measuring multiple tests in an automatic sequence without having to change cable connections on the transformer.

The extended versions IDAX 300S and IDAX 350 have dual separate current measurement channel, that allows for two completely independent measurements at the same time, thus minimizing test time.

Multi-function test set

Besides performing moisture assessment on oil-immersed transformers, IDAX is a multi-function test set for testing transformers, bushings and other power components. With IDAX you can do:

- Power frequency tan delta/power factor measurements
- Power frequency capacitance measurements
- Hot collar testing
- Tip-up/step voltage testing
- DC insulation testing (Insulation Resistance, Polarization Index and Dielectric Absorption Ratio)
- Excitation current measurements

Maximum test voltage for IDAX is 200 V (DC/peak AC). With the optional VAX020 amplifier, test voltage is maximum 2 kV (DC/peak AC)

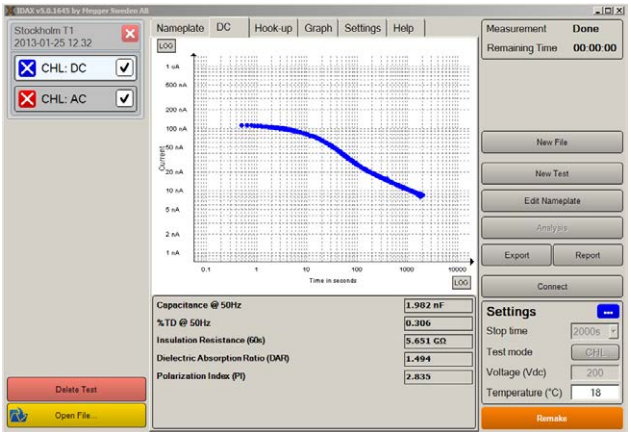

Fig. 8: DC insulation measurement

Calibration

The calibration set enables simple and reliable calibration of the IDAX system. It also reduces instrument downtime and transport cost as the calibration box is the only part that needs to be sent in for calibration. The new design allows calibration in any local certified calibration facility to avoid long shipment turn-around times and transport costs.

Monitoring

IDAX Monitoring is an additional feature of IDAX 5.0 software to use IDAX 300 for monitoring of different processes using DFR (Dielectric Frequency Response). Examples of processes to be monitored are:

- Dry-outs, reduction of moisture content, of unimpregnated as well as impregnated cellulose in e.g. power transformers.
- Impregnation, e.g. impregnation of dry cellulose with insulation liquids or resins
- Curing of resins or epoxy, e.g. stator insulation of electrical motors.

DFR sweeps are measured along with temperature and can be analysed in different ways. The monitoring feature is enabled with separate license code.

Conclusion

IDAX is a well-proven insulation diagnostic analyzer. The instrument and method including the insulation modeling algorithms for moisture assessment has been tested and verified with numerous customers over the years. In its latest 5th generation version it is faster, easier to use and more complete than ever before. With the wide frequency range from DC to 10 kHz, the capability to handle substation interference, the fast measurement method and the range of test voltages from 200 V to 30 kV (with optional high-voltage amplifiers), IDAX fulfills the requirements from the most demanding customer looking for a complete insulation diagnostic test set.

SPECIFICATIONS IDAX 300/350

Environmental

Application field	The instrument is intended for use in medium and high-voltage substations and industrial environments.
Ambient temperature	
Operating	IDAX300: -20°C to +55°C (-4°F to +131°F) IDAX350: -10°C to +55°C (14°F to +131°F)
Storage	-40°C to 70°C (-40°F to +158°F)
Humidity	< 95%RH, non-condensing

CE-marking

EMC	2004/108/EC
LVD	2006/95/EC

General

Mains voltage	100 – 240V ±10%, 50/60 Hz
Power consumption	250 VA (max)
Dimensions	
IDAX 300	335 x 300 x 99 mm (17.7" x 6.3" x 16.1")
IDAX 300 Flight case	520 x 430 x 220 mm (20.5" x 17" x 8.7")
IDAX 350	520 x 430 x 220 mm (20.5" x 17" x 8.7")
Weight	
IDAX 300	4.9 kg (11 lbs), 9.9 kg (22 lbs) incl. flight case
IDAX 350	13.5 kg (29.8 lbs)
Accessories	8.5 kg (18 lbs) soft bag

Measurement section

Inputs	Channel 1, channel 2, ground
Capacitance range	10 pF – 100 µF
Inaccuracy	0.5% + 1 pF
Dissipation factor range	0 - 10 (with retained accuracy of capacitance; otherwise higher)
Inaccuracy	< 0.5% + 0.0001, 45-70 Hz, C > 100 pF (with VAX020) < 0.5% + 0.0002, 45-70 Hz, C > 300 pF < 1% + 0.0003, 1 mHz-100 Hz, C > 1000pF < 2% + 0.0005, 100 Hz-1 kHz, C > 1000 pF
Max AC interference	1 mA, 1:10 SNR (IDAX) 10 mA, 1:10 SNR (VAX020)
Max DC interference	2 µA (IDAX) 20 µA (VAX020)
*Test modes**	UST: ungrounded Specimen Testing UST-R: UST: Measure Red, Ground Blue UST-B: UST: Measure Blue, Ground Red UST-RB: UST: Measure Red and Blue GST: Grounded Specimen Testing GST-GND: GST: Ground Red and Blue GSTg-R: GST: Guard Red, Ground Blue GSTg-B: GST: Guard Blue, Ground Red GSTg-RB GST: Guard Red and Blue *IDAX300 can measure mutiple test modes in an automatic sequence. IDAX 300S/350 can measure two test modes simultaneously.
Calibration	Calibration set allows field calibration

Time Domain Current Measurement (PDC)

Range	±50 mA
Resolution	0.1 pA
Inaccuracy	0.5% ±1 pA
Input resistance (DC mode)	≤10 kΩ

Outputs

GENERATOR

Voltage/current ranges, 10 V	0 – 10 Vpeak 0 – 50 mA peak
Voltage/current ranges, 200 V	0 – 200 Vpeak 0 – 50 mA peak
Frequency range	DC – 10 kHz

EXTERNAL

For external amplifier	E.g. VAX020

PC Requirements

Operating system	Windows 2000/ XP / Vista / 7 / 8
Processor	Pentium 500 MHz
Memory	512 Mb RAM or more
Interface	USB 2.0 and LAN

INCLUDED ACCESSORIES

Picture shows some of the included accessories. Generator cable, USB cable, Ground cable and Measurement cables.

Rugged carrying case with wheels and space for cables and accessories.

OPTIONAL ACCESSORIES

Accessory kit, AG-90100

ORDERING INFORMATION

Item	Art. No.
IDAX 300[1]	AG-19090
IDAX 300[2]	AG-19091
IDAX 300S[1]	
IDAX 300 with two ammeters	AG-19092
IDAX 350[1]	
IDAX 300S with internal computer	AG-19192

Included accessories

Mains cable
Ground cable 5 m (16 ft), GC-30060
[1] Generator cable 18 m (60 ft), GC-30312
[1] Measurement cable, red 18 m (60 ft), GC-30322
[1] Measurement cable, blue 18 m (60 ft), GC-30332
[2] Generator cable 9 m (30 ft), GC-30310
[2] Measurement cable, red 9 m (30 ft), GC-30324
[2] Measurement cable, blue 9 m (30 ft), GC-30334
USB cable, Windows software, Transport case

Optional software

Process monitoring	
IDAX Monitoring software license	AG-8200X
Commissioning , 2 days	AG-90300
Cabling, connectors, etc	on request

Optional accessories

IDAX calibration box CAL 300	AG-90010
IDAX demo box IDB 300	AG-90020
Additional ammeter (factory upgrade to IDAX 300S)	AG-90200
Generator cable, 9 m (30 ft)	GC-30310
Measurement cable, 9 m (30 ft), red	GC-30320
Measurement cable, 9 m (30 ft), blue	GC-30330

Accessory kit

Bushing tap adapters:
- 4 mm female / 4 mm female (3 pcs)
- 0.75" thread adapter
- 1" thread adapter
- "J" probe adapter
- Two special adapters

Hot collar straps, three of different lenghts
Temperature and humidity meter
Non-insulated shorting leads:
- 1 m (3 ft) (3 pcs)
- 2 m (6 ft) (3 pcs) — AG-90100

REFERENCES

[1] S.M. Gubanski, J. Blennow, L. Karlsson, K. Feser, S. Tenbohlen, C. Neumann, H. Moscicka-Grzesiak, A. Filipowski, L. Tatarski "Reliable Diagnostics of HV Transformer Insulation for Safety Assurance of Power Transmission System" Cigre Paris Aug 2006

[2] From. P. J. Griffin, C. M. Bruce and J. D. Christie: "Comparison of Water Equilibrium in Silicone and Mineral Oil Transformers", Minutes of the Fifty-Fifty Annual Conference of Doble Clients, Sec. 10-9.1, 1988

[3] U. Gäfvert, L. Adeen, M. Tapper, P. Ghasemi, B. Jönsson, "Dielectric Spectroscopy in Time and Frequency Domain Applied to Diagnostics of Power Transformers", Proc. Of the 6th ICPADM, Xi'an, China, 2000

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