Transformer Monitoring

Predictive maintenance

www.powerview-energy.com

PowerView
Testing & Monitoring Equipment

Pioneering the future of power testing and monitoring

Transformer online DGA Hydrogen Sensor

Fast response to fault

Fast response time for quick developing faults

Proven Hydrogen monitoring sensor and technology

ABB , SIEMENS, use the identical sensors and measurement technology

Description

The Immersed Tank Sensor is a DGA monitoring unit. It is capable of monitoring hydrogen, temperature , moisture and oil degradation directly from the transformer tank by permanently mounting on a flange . It has no moving parts (like pumps membranes gears etc. and uses solid state nickel palladium sensor for H2 measurement . No spare parts maintenance or recalibration are required in the min 15-year lifetime.

No spare parts consumables or recalibration

Absolutely no consumables or spare parts are needed for Immersed tank sensor and diagnostic (all fault gas) DGA

Different sensors and technologies

Solid-state Nickel palladium sensor is most widely used today for hydrogen monitoring as it has no requirements for recalibration, no maintenance and spare parts and minimum lifetime of 15 years and no cross sensitivity to other gases and drifting results.

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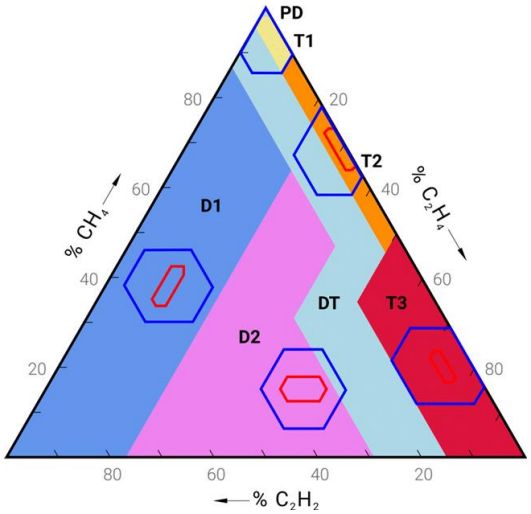
Transformer online DGA

DGA background

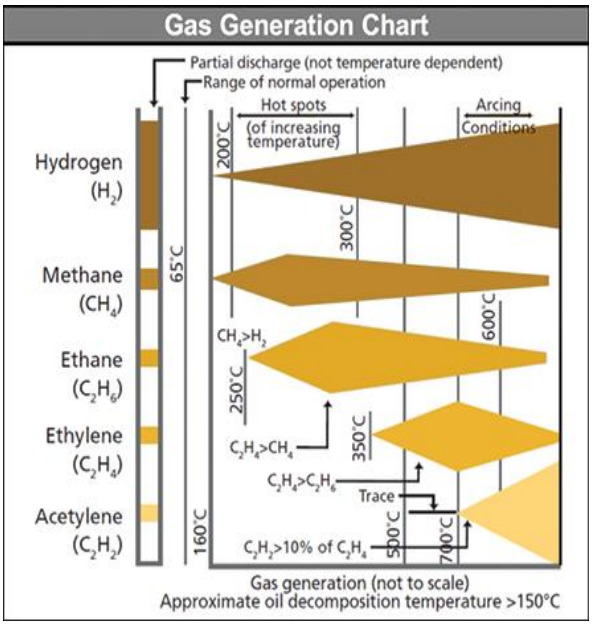
Dissolved gas analysis for transformer has been used for decades as a reliable tool for indication and prevention serious damage caused by transformer faults. According to international standards for maintenance of transformers– this analysis is mandatory.
Dissolved gas analysis (DGA) monitoring is the most powerful tool for transformer early phase fault detection and trending. Proven diagnostic tools (such as Douval triangle and Roger's ration) help determine nature of the fault by analyzing different gas presence.



Douval triangle

Gasses formation

Gases in oil are created by breaking the molecular bonds of oil molecules caused by electrical stress, partial discharges, hot spots, oxidation, decomposition of insulation, etc.). Molecules of insulating oil in high voltage equipment break down under the influence of the thermal and electrical stresses to produce hydro-carbon gases, hydrogen and carbon oxides. According all diagnostic tools and standards there are 7 known fault gasses Hydrogen, Carbon monoxide, Carbon dioxide, Methane, Acetylene ,Ethane Ethylene + nitrogen and oxygen (which are formed due to pour sealing)



Water formation and importance

Water can be present in transformers due to pour dehydration in production, inappropriate handling, por sealing (water ingress) , chemical water (which comes as a by product from various chemical reactions of materials.

Oil degradation

Transformer Oils are prone to degradation from electrical stress and various chemical reactions between coper , oxygen , water and particles released from insulation decomposition and different molecular re-bonding .
Transformer oil quality is generally assessed by oil laboratory testing .Breakdown voltage which is critically connected to water content tan delta, particles and acidity gives most valuable information in this regard to oil contamination and degradation .
Oil degradation is a catalytic process which speeds up snowball effect which leads to sludge formation


Gases formation different temperature

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Transformer online DGA Hydrogen Sensor

Technical specification

Measurement range (in oil)	**0 ... 5000 ppm_v**
Accuracy (in oil temperature range -20 ... +60 °C (-4 ... +140 °F))	±15 % of reading or ±25 ppm_v (whichever is greater)
Repeatability	±10 % of reading or ±15 ppm_v (whichever is greater)
Minimum detection limit	25 ppm_v
Typical long-term stability	3 % of reading / year
Cross sensitivity to other gases	< 2 % (CO2, C2H2, C2H4, CO)
Response time	63 % of full response: 2.5 h (when sensor is not in reference cycle) 90 % of full response: 17 h
Warm-up time	2 h, 12 h for full specification
Sensor	Catalytic palladium-nickel alloy film solid-state sensor

Oil type	**Mineral oil / Natural ester oil /Synthetic, ester oil**
Operating temperature (electronics)	-40 ... +60 °C (-40 ... +140 °F)
Storage temperature	-40 ... +60 °C (-40 ... +140 °F)
Operating humidity	0 ... 100 %RH, condensing
Pressure tolerance (probe, short-term)	Max. 10 bara
Pressure tolerance (probe, continuous)	Max. 4 bara
Temperature tolerance, sensor head	-40 ... +120 °C (-40 ... +248 °F)
Integrated protection for short power outages	> 3 s
EMC standard EN61326-1, Industrial environment;	Fulfills the requirements of IEC
CISPR22 class B emission limits when DC powered	61000-6-5 in the following tests:
	IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC 61000-4-8, IEC 61000-4-11, IEC 61000-4-12, IEC 61000-4-16, IEC 61000-4-17.

Transformer oil complete DGA monitoring

Why transformers fail

Transformers, like any other equipment, are susceptible to faults caused by the factor of imperfection and premature aging of materials, imperfection in making human errors in maintenance and manipulation. Depending on the value of the transformer, these faults, if not detected on time, develop into more expensive faults (more expensive repair and lost production if the fault is not repaired in early stage).

Yearly maintenance lab DGA addresses slowly developing faults .
When is has been indicated (by Lab testing or fault monitor) that a fault is developing inside a transformer a fully diagnostic all fault gasses DGA is the best solution which helps faulty transformer stay in service (until repaired) . With the FDM the fault development is monitored 27/7 and any significant change in the fault can be noted in an early stage.

This monitoring solution saves money , helps better understand fault and helps preventing expensive faults , and helps planning and optimizing service intervals.

An additional limitation of laboratory analysis is the time required to sample, analyze and obtain results (for example if a decision needs to be made to re-enable a transformer after an outage.

This monitoring system has no consumable, moving parts, spare parts, parts with a limited-service life (less than 15 years), no need for recalibration or any maintenance.

No spare parts consumables or recalibration

Absolutely no consumables or spare parts for diagnostic complete fault gas DGA

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Transformer DGA and Oil Quality Monitoring

Technology

This monitoring system uses the Vaisala NDIR Sensor and Tunable filters technology for detection of 6 fault gases while hydrogen is measured directly at the oil tank(for best response) .

It connects with external hoses to 2 flanges and uses Vacum extraction (which is proven as the most effective extraction technology for getting the dissolved gasses outies the oil.

The gasses are than exposed to NDIR sensor with tunable filters which require absolutely no need for recalibration or spare parts replacement in full lifecycle. .

Measured parameters

Online DGA on diagnostic fault gases
This system provides online measurement of all 7–transformer fault diagnostic gases:

- Hydrogen (H2);
- Carbon monoxide (CO);
- Carbon dioxide (CO 2);
- Methane (CH 4);
- Acetylene (C 2 H 2);
- Ethane (C 2 H 6);
- Ethylene (C 2 H 4);

Additionally, the system detects tank sealing problems (air leaking problems) (N2 , O2 gasses) by measuring total tank pressure.

Technical Specification

Measurement specification

Parameter	Range	Accuracy	Repeatability
Methane (CH4)	0 ... 10 000 ppm_v	±4 ppm or ±5 % of reading	10 ppm or 5 % of reading
Ethane (C2H6)	0 ... 10 000 ppm_v	±10 ppm or ±5 % of reading	10 ppm or 5 % of reading
Ethylene (C2H4)	0 ... 10 000 ppm_v	±4 ppm or ±5 % of reading	10 ppm or 5 % of reading
Acetylene (C2H2)	0 ... 5000 ppm_v	±0.5 ppm or ±5 % of reading	1 ppm or 5 % of reading
Carbon monoxide (CO)	0 ... 10 000 ppm_v	±4 ppm or ±5 % of reading	10 ppm or 5 % of reading
Carbon dioxide (CO2)	0 ... 10 000 ppm_v	±4 ppm or ±5 % of reading	10 ppm or 5 % of reading
Moisture (H2O)	0 ... 100 ppm_w	±2 ppm or ±10 % of reading	Included in accuracy

Transformer oil type	**Mineral oil**
Required minimum fire point of transformer oil	+125 °C (+257 °F)
Transformer oil pressure at oil inlet	Max. 2 bar_{abs} continuous Burst pressure 20 bar_{abs}
Transformer oil temperature at oil inlet	Max. +100 °C (+212 °F)
Ambient humidity range	0 ... 100 %RH, condensing
Ambient temperature range in operation	-40 ... +55 °C (-40 ... +131 °F)
Storage temperature range	-40 ... +60 °C (-40 ... +140 °F)

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Transformer DGA and Oil Quality Monitoring

Power supply

Operating voltage	100 ... 240 VAC, 50 ... 60 Hz, ±10 %
Overvoltage category	III
Maximum current consumption	10 A
Maximum power consumption	500 W
Typical power consumption at +25 °C (+77 °F)	100 W

Mechanical specifications

Total dissolved combustible gases (TDCG)	Combined total of H2 , CO, CH4, C2H6, C2H4, and C2H2
24 h average	Available for single gases, moisture, TDCG, and total gas pressure
Rate of change (ROC)	Available for single gases and TDCG for 24 h, 7 d, and 30 d periods
Gas ratios	Available ratios: CH4/H2 , C2H2/C2H4, C2H2/CH4,C2H6/C2H2, C2H4/C2H6 , CO2/CO

Outputs

RS-485 Interface

Supported protocols	Modbus RTU, DNP3 (optional feature)
Galvanic isolation	2 kV RMS, 1 min
Ethernet Interface	
Supported protocols	Modbus TCP, HTTP, HTTPS, DNP3 (optional feature), IEC 61850 (optional feature)
Galvanic isolation 4 kV AC (50 Hz, 1 min)	4 kV AC (50 Hz, 1 min)
Relay outputs	
Number of relays	3 pcs, normally open (NO) or normally closed (NC), user selectable
Trigger type	Gas alert with user selectable limits
Galvanic isolation	2 kV RMS, 1 min
Max. switching current	6 A (at 250 VAC) 2 A (at 24 VDC) 0.2 A (at 250 VDC)
User interface	
Interface type	Web based user interface, can be operated with standard web browsers

Measurement operation

Measurement cycle duration	1 ... 1.5 h (typical)
Response time (T63)	One measurement cycle
Warm-up time until first measurement data available	Two measurement cycles
Initialization time to full accuracy	Two days
Data storage	At least 10 years
Expected operating life	> 15 years

Mechanical specifications

Oil fitting	Stainless steel Swagelokâ fitting for 10 mm (0.39 in) outer diameter tubing. See list of accessories for adapters available from Vaisala.
Max. length of oil pipe to transformer	Max. 10 m (33 ft) with 7 mm (0.28 in) inner diameter tubing Max. 5 m (16 ft) with 4 mm (0.15 in) inner diameter tubing
Material	Marine aluminum (EN AW-5754), stainless steel AISI 316

Transformer oil Degradation Monitoring

Advanced reporting and communication

Most advanced reporting and communication protocols

Description

The oil quality is monitored by our state of art Transformer OIL QUALITY MONITORING The DGA monitoring system as described above covers all the major electrical faults in the transformer it gives no information about the transformer oil quality. While the DGA gives valuable information on the fault severity– it gives very limited information on the oil quality aging etc. . Ever since the beginning of transformers use the transformer oil breakdown voltage testing has been used as proven method for evaluating the dielectric properties of the transformer oil

Our revolutionary sensor measures and monitors breakdown voltage directly mounted on transformer tank. With this chemical properties and oil contamination can be identified in very early stage before sludge formation takes place. This reduces significant service costs as sludge. The TRO Degradation monitor was specially developed for permanent use in the field at the transformer and is used exclusively for continuous real–time measurement of breakdown voltage, water content and temperature of a mineral oil–based transformer oil.

This robust and compact online sensor is permanently installed on power transformers. The core is an aluminum–coated piezoelectric resonator, expanded to include a humidity and temperature sensor, is housed in a compact aluminum housing.

Only materials that can be permanently exposed to transformer oils have been used. The test and calibration routines were developed based on the evaluation of over 3800 oil samples from over 900 different transformers.

Measurement

The calculation, which considers the strong correlation between oil moisture (WC), acid number (TAN), temperature (T) and breakdown voltage, is carried out in the sensor by a 32–bit embedded system using a floating–point process (FPU) using a look–up table (Look– up–table). The representation of the limit behavior of the oil samples has already been considered in the look–up table

The Breakdown voltage and moisture sensor is equipped with a Parker RI1EDX3 / 471 connector which allows the device to be screwed on at the target location. The sensor can be mounted in any orientation, but a

free oil flow through the measuring chamber must be guaranteed. The connection for

the cable is located at the top of the sensor. The connection between the TRO degradation

monitor and the control unit is established with the connection cable supplied.

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Transformer oil Degradation Monitoring

Technical specification
oil quality and Breakdown Voltage Monitoring

Measured parameters

Breakdown Voltage	**10kV to 120kV (± 2.5%)**
Water content (WC)	2 ppm to 80 ppm (± 2%)
Temperature	-40 to 120 ± 0,2°C
Measurement interval	max. 0.1s

Operating environment

Ambient temperature	**-20°C to 70°C**
Oil temperature range	-20°C to 85°C
Operating pressure	Up to 3bar
Output	4.5V to 7.5V (5.0V recommended)

Interface	**Digital Protocol MODBUS TCP/IP**
Internal data logging capacity	dynamic latch buffer

Mechanical connection	**Parker RI1EDX3**
Housing classification when assembled	IP68

Control software	**Windows 7 or better**

Operating temperature	**-40°C to 100°C**
Operating pressure	5bar
Storage temperature	-65°C to 150°C

Breakdown voltage measurement range accuracy v. temperature

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Online Bushing Monitoring

Proven BMC technology

Proven Bushings monitoring sensors and technology
SIEMENS uses the same technology

Description

Bushing are relatively cheap (comparing to transformer value) . Unfortunately, bushings breakdown failure often leads to catastrophic transformer failure like windings deformations . Due to materials imperfection weather conditions and stress bushings are prone to failure. Unfortunately ,sometimes that failure escalates very quickly . Historically bushings were tested off-line to measure the capacitance and the dissipation / power factor.
The Bushing BMC Monitor is a permanently installed on-line bushing monitoring system. It continuously measures up to six leakage currents, tests the power factor and capacitance values and monitors the condition of bushings, CCVT`s 1) and free-standing CT`s.
The bushing monitoring system incorporates three measurement modes for standard and two for optional configurations.
Standard configuration with 6 current inputs:

•Sum of three current test
•Adjacent phase reference test
•Phase comparison

Optional configuration with 3 voltage and 3 current inputs:
•Reference test (3 bushings and 3 CCVT`s 1))

Optional configuration with 6 voltage inputs:
•CCVT 1) Reference test (6 CCVT`s 1))

The bushing sensors / adapters are connected to the capacitor taps designed for all types of bushings to allow measurement of the leakage current up to 140 mA AC.

Advanced reporting

Most advanced reporting and communication protocols

Bushing monitoring setup

The Bushing Monitoring system POWER VIEW BLC Monitor can be ordered in different versions with 3, 6, 9 2), 12 2) or 16 2) bushing sensors according to the specification.
The system contains following parts:
•Bushing sensors with connection cable
•Bushing Monitor Power View BLC including mounting plate, power supply, circuit breaker, terminals and wiring
•Communication cable
•Cabinet (Option)
The adapters are designed for bushings with grounded and un- grounded capacitor taps. The adapter is designed to prevent a voltage developing on the equipment, in case that the sensor becomes disconnected from the bushing monitoring system.

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Online Bushing Monitoring

Key advantages

•Simultaneous measurement of up to six bushing leakage cur- rents, providing following data:

- Relative capacitance in percentage to the start-up value
- Relative power factor (%PF) for each bushing
- Magnitude of imbalance currents for two three phase sets of bushings
- Phase angles of the imbalance currents
- Alarm in case the measured values exceed the threshold

• Complete on-line transformer monitoring and bushing monitoring system in conjunction with other POWER VIEW products

Technical Specification

Supply voltage	**85 ... 264 V AC / 47 ... 63 Hz or 120 ... 370 V DC**
Power consumption:	Max. 24 VA
Dimensions:	
Cabinet:	Stainless steel 304
3 and 6 channels	W 420 x H 595 x D 153 mm
9 and 12 channels	W 610 x H 686 x D 229 mm
Weight:	
3 and 6 channels	approx. 15 kg
9 and 12 channels	approx. 23 kg
Operation temperature:	-40 °C ... +65 °C
Storage temperature:	-40 °C ... +85 °C
AD converter	16 Bit
Sampling rate	10 kHz
Safety	
Electrostatic discharge:	IEC 801-2

Voltage range: (Bushing primary)	**69 ... 765 kV AC**
60 Hz voltage: (on the tap at monitoring)	max. 2.5 kV AC
60 Hz voltage: (on the tap at opened or mistakenly cut coax cable)	max. .5 kV AC
Dimensions:	Size is different depending on the voltage
Weight:	approx. no more than 1 kg
Operating temperature:	-55°C ... +90°C, 95 % relative humidity (non condensing)
Storage temperature:	-50 °C ... +55 °C
Installation environment:	Outdoor, no corrosive agents in the air
Type of capacitor tap:	Any manufacturer
Connector to test tap:	¾" / 1 ¼" / 2 ¼" others on request

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Transformer Bushing Monitoring

Technical Specification

Measurements		Accuracy
Measuring quantity	Range	
Leakage current	0 ... 140 mA AC	± 1.5 % of reading
Power factor / Dissipation factor	0 ... 100 %	± 0.045 % absolute
Capacitance	100 ... 5000 pF	± 1.0 % of reading
Phase angle of imbalance current	0 ... 360	± 1.0 % of reading

Digital outputs

- Bushing sensor - Resistive bridge / capacitive bridge

Communication

- RS 232 – Screw terminals and RJ45 (Proprietary protocol) Communication interface
- DNP3 serial or MODBUS® RTU Controller (Option)

Operation principle

- Bushing sensor - Resistive bridge / capacitive bridge

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Ordering information

Ordering code	Description
101-1342	Single gas monitoring with accessories and communication module
101-1343	Multi gas monitoring in cabinet with accessories
101-1421	Oil quality monitoring unit
101-1623	Bushing monitoring for 3 channels (complete with sensors , main module and cabinet)
101-1626	Bushing monitoring for 6 channels(complete with sensors , main module and cabinet)
101-1629	Bushing monitoring for 9 channels(complete with sensors , main module and cabinet)
101-1612	Bushing monitoring for 12 channels(complete with sensors , main module and cabinet)

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