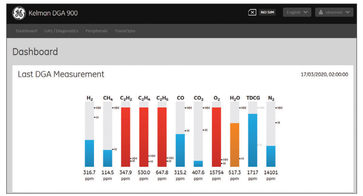
1 DGA 900 base:

Online DGA and moisture measurement

Dissolved Gas Analysis (DGA) and moisture measurements of insulating fluids are recognized as the most important tests for condition assessment of transformers. In previous years, multi-gas DGA was traditionally confined to a laboratory environment, with infrequent yearly off-line manual sampling aiding time-based maintenance strategies.

However, as the global average age of transformers continued to rise, the possibility of rapid aging and even catastrophic failure between off-line tests also increased, leading many asset owners to adopt on-line DGA monitoring to provides remote alert and multi-gas diagnostic of deteriorating transformer condition.

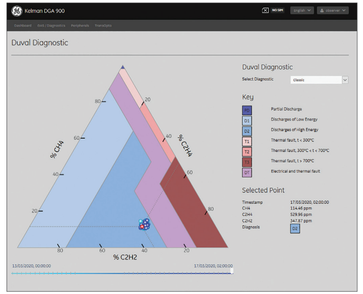


This facilitated operational decisions without needing to go to site for manual oil sampling. It avoided unplanned outages, increased network reliability and enabled the move to condition-based maintenance.

In the early 2000's, GE's original Kelman™ range of on-line multi-gas DGA analyzers brought Photo-Acoustic Spectroscopy (PAS) measurement technology to the market. GE is now proud to introduce the Kelman DGA 900, its next-generation multi-gas on-line DGA and moisture analyzer.

At its heart lies an evolved implementation of GE's proven PAS technology, providing laboratory challenging levels of precision and repeatability with no consumables (carrier or calibration gases) and no need for frequent re-calibration. It also has enhanced computing power and scalable I/Os for future proofing and adding functionalities to grow each analyzer into a flexible transformer monitoring solution.

Transformer issues can now be detected in their infancy, making sure that they are fixed early so that the nominal expected life of the transformer can be achieved. Maintenance interventions can now be planned, reducing their length and their cost and causing less disruption to the network and customers. In addition, aging asset replacement strategies can be anchored on hard health condition data and not purely based on the age of the transformer.



Benefiting from over 15 years of multigas DGA vendor experience and over 15,000 devices in the field, the DGA 900 encapsulates learnings and improvements derived from its predecessors to bring improved performance, innovative new features, enhanced user experience and increased field reliability and robustness.

2 Add-on:

Bushing Monitoring

Bushing failures account for a large proportion of substation events that result in severe and costly damages and unfortunately even sometimes fatalities. Preventive maintenance, early bushing replacement and regular off-line testing have been employed to address this issue in the past.

Monitoring transformer bushings is critical because bushings are constantly under high stress due to the line voltage and heat effect of the current flow. These stresses can be further aggravated by the presence of micro cracks from manufacturing, loss of mechanical strength due to aging, repeated thermal cycling (load + sun), pollution and external flashover eroding the porcelain, sludge and moisture in the insulating oil, and by the fact that new bushings have been made closer to design limits in order to reduce cost, size and weight.

The Kelman DGA 900 PLUS with bushing monitoring is an integrated on-line system that continuously monitors the condition of up to 6 bushings (3x HV and 3x LV). It uses custom bushing adapters (specifically designed for each bushing type).

- The system continuously measures the bushings leakage current, the change in the leakage current is proportional to the change in capacitance of C1, the system calculates the total percent change in capacitance of C1 for each of the bushing compared to it's nominal value when the bushing was installed, to gauge its dielectric capability and layer integrity.
- The system measures the timing differences between the 3 bushing current phases, which translate to phase angle differences relative to each other. Since a change of phase delay equates to a change in power factor, we can determine for each bushing the relative (compared to the others) change of power factor as a percentage of the nameplate value. This is used to gauge small deterioration of the bushing insulation.

"~30 Minute DGA"

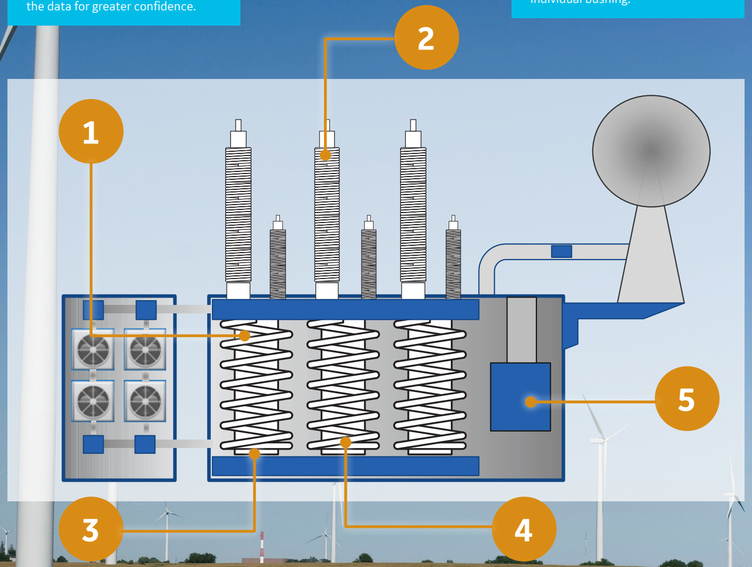
When acetylene gas levels are rising and a risk of explosion exists, decisions need to be made quickly as a transformer shut-down can cause system wide disruption. The DGA 900 has a unique "~30-minute" mode that provides acetylene gas readings in half the time of a full cycle. Instead of waiting 3 hours to have 3 points on a graph, you get 3 points in 1.5 hours. Decisions can be made in half the time or with double the data for greater confidence.

"No gas consumables"

Some DGA technologies require both carrier and calibration gases. When the gas runs out, the system stops working. The more units, the more gas bottles, costs, logistics and supply chain to manage. Reducing measurement intervals to save gas increases the risk of missing fault. The DGA 900 never runs out of gases and is always available to monitor the asset.

"Custom made bushing adapters"

The design of the tapping point bushing adapters is crucial, not only must it make electrical connection but always ensure a reliable earthing connection. The design must prevent moisture ingress and bushing oil seal leaks. The connection must also not be affected by transformer vibrations. This is why we custom design each adapter to suit the individual bushing.



"Cooling efficiency monitoring"

It is usually during the worst conditions (load and/or temperature) when problems associated with the cooling fans are noticed, leading to an overheating transformer. Regularly monitoring cooling capacity and efficiency helps identify these problems early.

"Ester oil compatibility"

With Ester based insulating fluids sometimes being used instead of mineral oil for their better flashpoint properties or better environmental credentials, the DGA 900 is ready and compatible with both natural and synthetic ester fluids with a change of settings.

"OLTC motor torque"

By monitoring the power consumed by the OLTC motor drive when changing position, we can analyze the consumption fingerprint and detect abnormal operating conditions.

Much more accurate than relying on the number of changes to that position to detect potential coking of the contacts.

3 Add-on:

Electrical Partial Discharge Detection

Using the same bushing adapters used for bushing monitoring, the DGA 900 PLUS can also detect developing electrical Partial Discharge (PD) activity in the transformer's main tank. The systems records the total number of PD events per cycle, calculates the total apparent charge (in pC) and total PD energy (in mW)

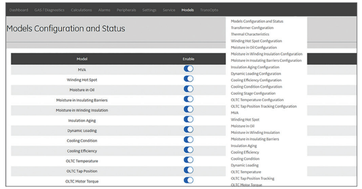
A HFCT is used to aid the system in discriminating external vs internal PD events. The system utilizes Polar Plots to determine in which phase of the main tank the PD activity is being generated from, as well as PRPD (Phase Resolve Partial Discharge) which is further used to identify and show the evolution (pattern) of the PD.

All these measurements will alert personnel of fault conditions at an early stage and provide vital health information on the bushings and the transformer, allowing transformer asset owners to detect impending failures and reduce their maintenance costs.

4 Add-on:

Transformer Insulating System Models

The integrated Kelman DGA 900 PLUS comes with optional Input/Output (I/O) cards so that additional sensors can be attached to increase its measurement scope.



With this add-on, the DGA 900 can continuously measures other critical parameters such as oil temperatures, load current, water content in oil, and cooling status which are complementary to the DGA information.

It further incorporates on-board calculations based on the very latest IEC®/IEEE® thermal and moisture models standards and computed from the specific transformer characteristics obtained from the name-plate and test reports of the transformer.

These models convert raw data into additional intelligent information to monitor the state of the transformer's insulating system every 10 minutes and determine its long term aging profile.

This information can also assist system operators in making critical operational decisions, particularly when it comes to safely overloading aging transformers by calculating the dynamic loading capacity.

The aim of all the models is to aid in optimizing the transformer's life (which is dictated by the state of its insulating system) and in deriving the optimum operating profile to maximize operational effectiveness.

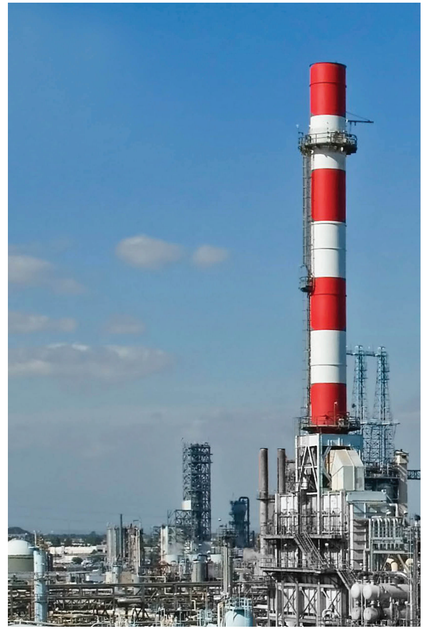
5 Add-on:

On Load Tap Changer (OLTC) Monitoring

On Load Tap Changers (OLTCs) are complex mechanical devices with moving parts that wear over time due to the current they switch (contact wear) and the number of switches they perform (mechanical wear). An OLTC can operate many times a day, switching thousands of amps on each switch and sometimes over-using a limited set of contacts. This repeated use means that OLTCs require careful attention through inspection, replacement and refurbishment.

By continuously monitoring current tap position, the frequency and number of switching operations, it is possible to estimate the level of wear on the OLTC, enabling maintenance and service intervals to be scheduled accordingly. In addition, the consumption of the OLTC drive motor can be used to detect an increased difficulty in switching positions. Finally, coking of the contacts will lead to increased arcing, to an elevated oil temperature in the OLTC compartment and thus can be detected by an oil temperature delta to the main tank.

By monitoring these additional parameters, Condition Based Maintenance can be used on this key electro-mechanical component and an OLTC failure can be avoided, along with its usually not insignificant ensuing disruptions.



6 Add-on:

Perception Fleet Software

Easy to install and configure, GE's Perception™ Fleet Asset Management Software is the ideal companion to your GE on-line monitors for both transformers and circuit breakers.

Perception Fleet moves customers from a manual, one-on-one asset assessment process to an automated and continuous fleet management solution.

Primarily, Perception Fleet automatically downloads data from each GE online monitor and populates its database. It provides asset experts with comprehensive transformer diagnostic tools and data trending capabilities in order for them to dissect data and decide on the best course of action.

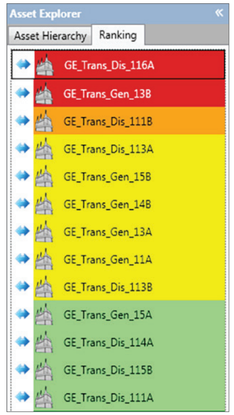
Perception also automatically analyses the data received, evaluates the condition of the asset and establishes the risk of failure of that asset (the Risk Index). Transformer risk evaluation algorythms are based on globally recognized standards (IEC, IEEE, ASTM, ISO & DIN) as well as CIGRÉ and EPRI best practices.

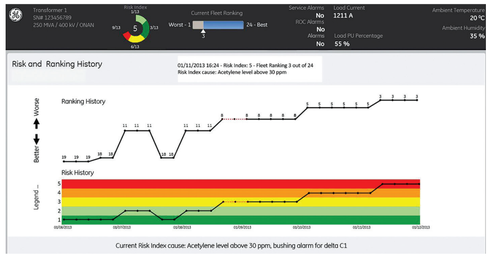
Perception features customizable overview reports and comprehensive alarm notification via email to ensure that the right person receives critical information should an asset condition change.

It also offers a highly customizable data import and export facility to enhance interoperability with data historians and other Asset Life-cycle Management (ALM) packages.

"Asset comparison and ranking"

By comparing the various asset Risk Indexes, Perception Fleet is able to rank assets within a fleet and focus attention on the higher-risk assets as well as those that have just changed risk index. This not only reduces the data analysis burden on experts (expertise that is rapidly being lost) but also provides a clear strategic view of the fleet and a data-driven, easily defendable, asset replacement strategy. It also tracks the "overall fleet risk index" over time to show if the asset replacement and maintenance strategy is having the desired network reliability effect .





Why GE as your partner of choice?

Experience

- Stable, large multinational, here for the long term
- Significant R&D capability to continually innovate and solve any issue
- One-stop shop with largest portfolio of M&D products, software and services
- Focused on product reliability, offering some of the industry's longest warranty periods
- Dedicated regional sales, installation and service teams around the globe
- Largest DGA monitoring installed base: over 50,000 units sold world wide
- Well integrated with GE's Protection & Control and Industrial Communication products

Delivering Outcomes

Support Services

- Installation and commissioning
- Technical support and product training
- Long term maintenance and service agreement
- Product rental solutions

Expert Services

- Cloud based remote monitoring
- Data diagnostics and interpretation
- Alarm setting and result analysis training

Technical Specifications

MEASUREMENTS

Technology

Automated head-space gas extraction.
Photo-acoustic spectroscopy (PAS) gas measurement.
Thin film capacitive moisture sensor.
Immersed fiber optic oxygen sensor.

Frequency

Configurable from once per hour to once every 4 weeks.
Faster sampling automatically triggered upon alert level reached.
"Rapid Mode" provides a rapid indication of the evolution of the gasses indicated below in ~30 minutes.

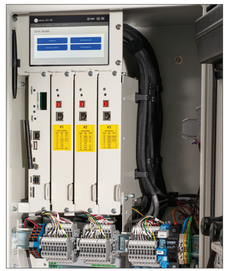
Range

	LDL	UDL	Accuracy*	Repeatability	Response Time***	Rapid Mode
Hydrogen (H_2)	5	5,000 ppm	± LDL or ±5 %	< 3 %	> 90 %	•
Carb. Monox. (CO)	1	50,000 ppm	± LDL or ±3 %	< 2 %	> 95 %	•
Methane (CH_4)	2	50,000 ppm	± LDL or ±3 %	< 2 %	> 95 %	
Acetylene (C_2H_2)	0.5	50,000 ppm	± LDL or ±3 %	< 2 %	> 95 %	•
Ethylene (C_2H_4)	1	50,000 ppm	± LDL or ±3 %	< 2 %	> 95 %	
Carb. Diox. (CO_2)	20	50,000 ppm	± LDL or ±3 %	< 3 %	> 95 %	•
Ethane (C_2H_6)	1	50,000 ppm	± LDL or ±3 %	< 2 %	> 95 %	
Oxygen (O_2)	100	50,000 ppm	± LDL or ±5 %	< 2 %		
Nitrogen (N_2) **	10,000	100,000 ppm	± LDL or ±15 %			
Moisture (H_2O)	0	100 % RS (in ppm)	± 3 % ppm	< 3 %		•

*whichever is greater. Accuracy quoted is the accuracy of the detectors during calibration. Gas-in-oil measurement may be affected by oil type and condition. Repeatability as measured from final production test data.

** N_2 value is calculated and available on free-breathing transformers only.

*** Time Response (typical): % of value after 1 measurement cycle.



Location of maximum 3 x add-on cards

FEATURES

Display

4 x Sunlight visible LED arrays
Backlit 7" inch color resistive touch screen (800 x 480)
Embedded secure webserver (https)

Analogue Input

1 x Standard for split core load CT sensor

Digital Output

6 x Standard customer programmable dry contact relays (type C, SPDT), NO/NC, 10A @250Vac resistive load, 8A @30Vdc resistive load
1 x Standard service alarm relay
1 x Standard watchdog relay

Digital Communications / Protocols

1 x Modbus® over RS485 / TCP/IP as standard
1 x DNP3.0 TCP/IP as standard
1 x Standard 1Gb Ethernet (RJ45)
Option: DNP3.0 over RS485 or TCP/IP
Option: IEC 61850 Edition 2
Option: ST/SC Multi-mode fiber converters
Option: GPRS/UMTS/HSPA+ modem

MECHANICAL

	Analysis Unit	Hub Unit
Dimensions	600 x 484 x 330 mm 23.6 x 19.1 x 13.0 in	600 x 380 x 330 mm 23.6 x 15.0 x 13.0 in
Weight	33.4 kg / 73.6 lb	18.5 kg / 40.8 lb

POWER REQUIREMENTS

AC	Nominal 100-240 Vac (Range 85-264), 4A
DC	Nominal 100-250 Vdc (Range 90-300)

OPTIONS

Mounting stand and Sun canopy
Longer umbilical cable between units

ADD-ONS †

Pack 1 – Thermal Models

Standard: 3 x 5A split core load CT sensors
Standard: 2 x Magnetic mounted temperature sensor

Pack 2 – Cooling Monitoring

Standard: 4 x 30A split core CT sensors
All sensors supplied as standard, no customization.
Note: Interdependency: Pack 2 requires Pack 1

Pack 3 – OLTC Monitoring

Standard: Active power consumption sensor
Standard: 2 x Magnetic mounted temperature sensor
Standard: 4 – 20mA or Resistive OLTC position input (sensor not supplied)

Pack 4 – Bushing Monitoring 3 Phase Transformers

Up to 6 x Bushing adaptors ordered separately
Standard: Bushing HV (3 Bushings)
Option: Bushings HV & LV (6 Bushings) ††
All sensors supplied unless noted

ENVIRONMENT

Operating Conditions

Ambient temperature	-40 °C to +55 °C (-40 °F to +131 °F)
Ambient humidity	0-95 % RH, non-condensing
Oil temp at valve†††	-20 °C to +120 °C (-4 °F to +248 °F)

Enclosure

IP56 certified
Standard: Powder coated marine grade 2 mm aluminium (RAL9002)
Option: Unpainted 316 Stainless Steel

DGA 900 PLUS POSSIBLE CONFIGURATIONS

Slot 1	Slot 2	Slot 3
-	-	-
Thermal Models	-	-
Thermal Models	Cooling Status	-
-	-	Bushing Monitor
Thermal Models	-	Bushing Monitor
Thermal Models	Cooling Status	Bushing Monitor
-	OLTC Monitor	Bushing Monitor
-	OLTC Monitor	-
Thermal Models	OLTC Monitor	-
Thermal Models	OLTC Monitor	Bushing Monitor
Thermal Models	Cooling Status	OLTC or Bushing Monitor

*Select maximum 3 out of 4 add-on packs

††Option for monitoring up to 9 x Bushings available soon

†††Based on testing carried out using Voltesso™ 35 mineral oil, over a ¼" pipe run of 10 metres or less from oil supply or return valve to monitor connection point and on transformer oil supply valve volumes of 200 ml or less. For oil temperatures colder than -20 °C GE recommends the use of heat trace cabling on piping

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Tel: +44 (0) 2892 622915

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For further information scan here

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English
230403

GE
Grid Solutions

Kelman DGA 900 PLUS

9 gas on-line DGA expandable with add-ons to a Transformer Monitoring System (TMS)

Knowledge of the condition of transformers is essential for all electrical networks and on-line monitoring of transformers is an increasingly vital component of successful asset management programs. The comprehensive information provided by the Kelman™ DGA 900 PLUS not only allows expensive failures to be avoided but enables asset capabilities to be maximized.

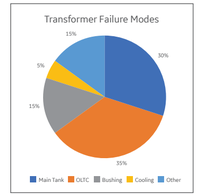
The Kelman DGA 900 PLUS builds on the standard 9 gas DGA and moisture capabilities of the DGA 900 by enabling the addition of extra sensors, electronic cards and firmware algorithms to expand its monitoring capabilities. Bushing monitoring, partial discharge detection, OLTC monitoring, cooling monitoring and transformer thermal models are amongst the options available to offer an integrated system which delivers a more in-depth picture of the transformer's overall condition and will monitor the root causes of most transformer failures.

Key Benefits

- Modular and retrofittable architecture using selectable standard add-on cards
- Provides extensive remote insight into transformer condition and safe operation
- Enables correlation of data for validation and in-depth fault analysis
- Graphical presentation using built-in web-page based HMI and local color screen
- Full integration with GE's acclaimed Perception™ Fleet asset management software
- From the only vendor with 15 years PAS experience and installed base of >15,000 units

Applications

While on-line DGA is now widely accepted as the most effective method of assessing the condition of a transformer, it does not cover all the possible sources of issues. Sub-systems like the tap changer, the cooling system or the bushings can generate their own problems if they are left unmonitored.



The DGA 900 PLUS monitoring system integrates DGA measurement, additional sensors, analysis models and data handling features to address the majority of prevalent failure modes. This cost-effective package provides the condition assessment tools essential for the effective management and optimal utilization of this critical sub-station asset.

It is most suited for monitoring large, mission critical transformers or compromised transformers with a view to extending their life and preventing any unexpected failure:

- GSU (Generation)
- Process critical Industrial transformer
- HVDC station transformers
- Transmission transformers

Cutting Edge DGA

- Laboratory challenging field measurement of nine gases plus moisture
- 4th generation of GE's PAS technology delivering improved measurement accuracy with lower detection limits
- No carrier or calibration gas consumables
- Complete analysis up to once per hour and new "Rapid Mode" for critical gases in ~30 min

Bushing Monitoring

- Measures the relative change in capacitance of C1 and Power Factor (tan delta) caused by the deterioration of the bushing
- Avoid widespread collateral damage and even total loss of transformer

Partial Discharge

- Detects electrical PD events inside the transformer using the same bushing adaptors
- Discrimination between external and internal PD using an HFCT and PRPD analysis

OLTC Monitoring

- Supervision of a key mechanical component of the transformer
- OLTC tap position recorder
- Temperature difference between tanks
- Torque used by tap changing motor

Transformer Models

- Winding hot spot and insulation aging
- Moisture in solid and liquid insulation
- Bubbling temperature and dynamic loading
- Cooling status and efficiency