

KELMAN BMT 430



An Essential Bushing and Partial Discharge Monitoring Solution for Transformers

Asset Managers know how critical their power transformers are, they also understand the risks and consequences of any failure. Bushings account for a large proportion of High Voltage (HV) substation failures often causing severe and costly damages within a substations and surrounding areas. Preventive maintenance, early replacement and regular off-line testing have been employed to address this issue in the past. Today on-line systems exist that give asset owners real time data on impending failures to make quick decisions to avoid catastrophic failures and help reduce overall maintenance costs.

The Kelman BMT 430 is GE Vernova's next generation on-line system that continuously monitors the condition of the bushings and developing partial discharge (PD) activity in the transformer. It will immediately alert personnel of evolving fault conditions with the bushings and provide vital health information on the bushings and the transformer.

The Kelman BMT 430 is a standalone system with field expandable capabilities, it can be integrated with GE Vernova's multi-gas DGA unit, transformer models and more. This level of flexibility and integration enables greater asset condition monitoring coverage based on current and future needs.

Key Benefits

- One product monitoring bushing Capacitance, Power Factor (tan delta) and Partial Discharge using a single sensor and connection point
- Capable of monitoring up to 9 bushings for a 3-phase transformer or a bank of single-phase transformers
- Built-in remote HMI and local color screen
- Field upgradeable to integrate GE Vernova's DGA multi-gas and transformer models, allowing for enhanced condition based monitoring on a single product platform
- Full integration with GE Vernova's Perception and Energy APM asset management software platforms

Applications

- Designed for Utility Generation, Transmission & Distribution and Industrial applications for various 3-phase and bank of single phase transformers
- Primary management of small, medium, and larger power and distribution transformers, auto transformers, and reactors
- Enables and enhances condition-based maintenance of transformers by expanding beyond bushings

Expandable Solution

- Monitors bushing condition and detects PD activity using a single sensor and connection point
- Field upgradeable to a Kelman DGA 900 Plus transformer monitoring solution via integrated add-on modules
- Can monitor up to 9 condenser type bushings

Bushing Adaptor

- Innovative 2-piece bushing tap connection to facilitate easy off-line testing
- Available in marine grade aluminum or stainless steel - rated IP66
- Safety - built in suppression circuit to always limit voltage within adaptors in case of transients and a fail safe to ensure tapping point always remains grounded through the bushing adaptor

Intuitive Software

- GE Vernova's Perception Desktop software included for diagnostics, visualization and download of data
- Upgradeable to GE Vernova's powerful Energy APM software suite
- Remote HMI for visualization and configuration of system parameters
- Intuitive local HMI display



Importance of Monitoring Transformer Bushings

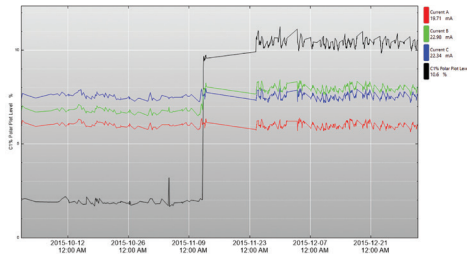
Transformer bushings are constantly under high stress which can cause the bushing insulation to deteriorate. Statistics show that transformer bushings contribute to roughly 15-20% of transformer failures. Bushing failures can lead to catastrophic failure, with violent explosions, large oil fires and broken shards of porcelain flying about. This can result in the total loss of the transformer, collateral damage to nearby equipment, environmental claims, and human injuries.

Periodically taking a transformer off-line to verify the bushing integrity makes this impractical and allows to miss fast changing conditions. Today with modern and advanced electronics, remote access to the data, continuous on-line monitoring of transformer bushings can now improve transformer service reliability and availability. The real benefit of an on-line system is the ability to detect anomalies under real operating conditions that otherwise could not be detected.

The Kelman BMT 430 Measurement Principle

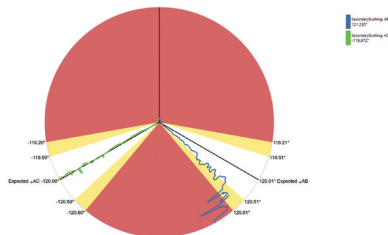
The Kelman BMT 430 is on-line system that continuously monitors the condition of bushings and provides end users with the changes in capacitance of C1 and power factor (tan delta), to assess the bushing dielectric efficiency and insulation integrity. Using state of the art custom made adaptors connected at the bushing voltage tapping point, the system provides:

- The change in bushing leakage current compared with the original values calculated from the bushing nameplate information and transformer operational voltage. As the change in current is proportional to the change in capacitance, the Kelman BMT 430 calculates the change in capacitance C1 of the bushing compared with when the bushing was installed, to gauge its dielectric capability and layer integrity.



Capacitive Layer breakdown - Trend of change of C1

- 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.



Phase Angle measurements

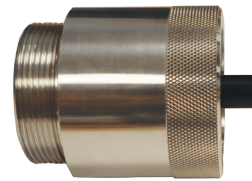
Partial Discharge Detection

PD is a localized breakdown of a small portion of a solid or fluid electrical insulation system that is under high voltage stress, which does not completely bridge the space between two conductors. PD on solid dielectrics results in localized gradual erosion of the insulation system that eventually leads to failure of critical insulation.

Using the same bushing sensor connected to the bushing test taps, the BMT 430 also measures high frequency transients associated to PD events which may occur in the bushing or close by (corona, top of the winding), adding a layer of protection to bushing monitoring. Several algorithms are used to separate noise from PD events and to remove reflections from PD originating on neighboring phases. The system assesses the PD polarity against the power voltage. Polarity is used to discriminate internal (to the bushing) PD events from those that are external. PD activity is then monitored, as is the Partial Discharge Phase Resolve (PRPD) pattern.

Off-line Bushing Testing Simplified

GE Vernova's latest bushing sensor (adaptor) design, makes off-line testing of bushings simple. It's unique and robust design, allows the user to disconnect the sensor's main electronic from the sensor test tap adaptor without having to remove the electrical connections. The sensor's test tap adaptor connected to the bushing tapping point can remain in place to perform off-line testing of the bushings.



Sensor Test Tap Adaptor



Sensor Electronic



The Complete Solution

Perception and Energy APM Software

GE Vernova’s Perception Desktop software allows an operator to easily download and visualize the data available from a critical transformer and use it to make better, more informed decisions. It offers ease of use, an intuitive interface, and familiar options that are common across all of GE Vernova’s Monitoring and Diagnostic products. The software is also upgradeable to GE Vernova’s powerful Energy APM software suite, which combines real-time data with industry expertise, analytics and connectivity, helping operators to develop an intelligent performance strategy for managing electrical substations.

Add-On – Upgrading to a full TMS

The BMT 430 can easily be turned into a Kelman DGA 900 Plus system, making it a more comprehensive transformer monitoring solution. This can easily be achieved by adding extra HW/FW

functionality within the BMT 430 product and/or by attaching the analysis module of the DGA 900 multigas product, all of which share the same underlying product platform. 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.

One-Vendor Solution Provider

Having a one-vendor providing the complete transformer monitoring solution can effectively lower installation costs, as well as reduce the administrative burden of coordinating various maintenance crews. All products work together and communicate seamlessly with no interface or responsibility issues.

GE Vernova has extensive experience and worldwide resources available to deliver integrated monitoring solutions and assist customers with transformer challenges, including installations, commissioning, training and on-going technical support.

Application Examples of GE Vernova’s Kelman BMT 430 Solution

Diagram 1, the Kelman BMT 430 is being used on a 3-phase transformer, where it can monitor either one set of three bushings; example: high voltage bushings, or up to three sets of three bushings; example: high, low, and tertiary voltage bushings. In Diagram 2, the Kelman BMT 430 is being used on a bank of single-phase transformers along with a spare transformer. A spare transformer can be brought into service replacing one of the bank transformers without interrupting the grid.

- Through the same bushing tapping points, the Kelman BMT 430 monitors bushing insulation health and checks for presence of PD activity
- Monitors sets of 3, 6 or 9 bushings
- Monitors ambient temperature and humidity, load current

Diagram 1

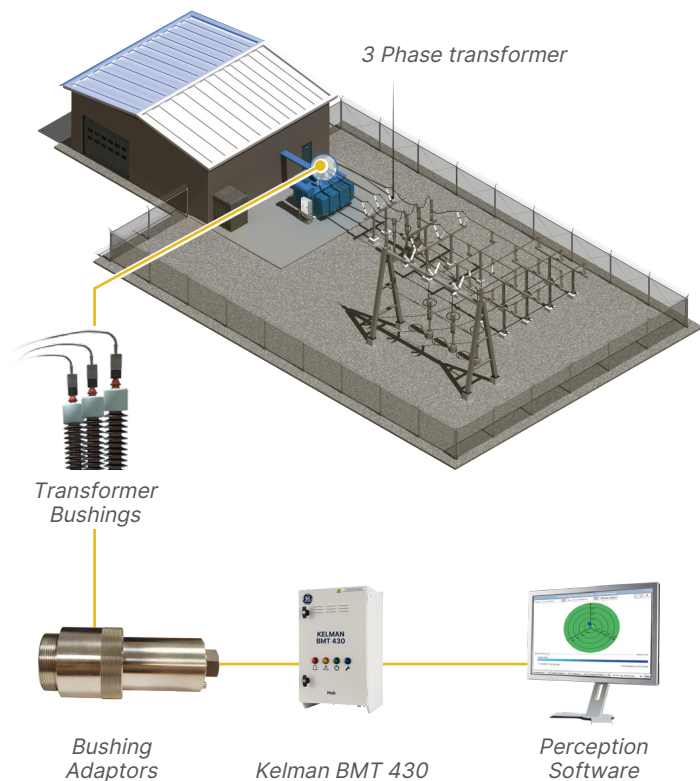
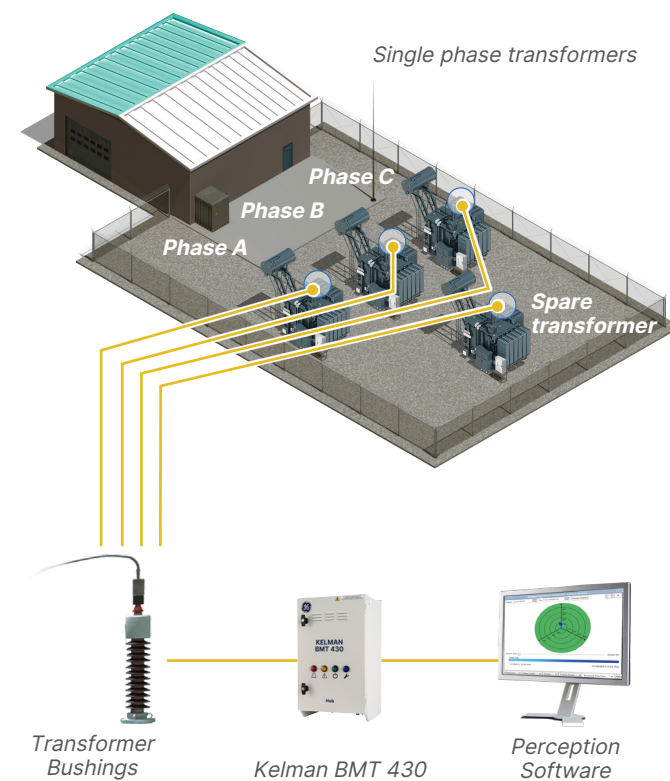


Diagram 2



Technical Specifications

MEASUREMENTS	ANALOGUE INPUT	ENVIRONMENT
BUSHINGS	1 x Standard set for load measurement - split core CT	OPERATING CONDITIONS
Leakage current: 2 to 200mA – resolution: 0.01mA	5 x optional analogue inputs slots (Add up to 5 additional load CT's or PT100 inputs or 4–20mA sensor cards)	Ambient Temperature -40 °C to +55 °C (-40 °F to +131 °F)
Relative Phase Angle - resolution: 0.01°		Operating Humidity 0 - 95 % RH (Non-condensing)
% Change in Capacitance	DIGITAL OUTPUT	ENCLOSURE
% Change in Relative Power Factor	6 x Standard customer programmable dry contact relays (type C, SPDT), NO/NC, 10A @250Vac resistive load, 8A @30Vdc resistive load	Rating IP56 certified
Sampling rate – 100kHz	1 x Standard service alarm relay	Standard: Powder coated marine grade 2mm aluminum (RAL9002)
PARTIAL DISCHARGE	1 x Standard service alarm relay	Option: Unpainted 316 Stainless Steel
Amplitude of the PD pulses (pC)	DIGITAL INPUTS	POWER REQUIREMENTS
Count of the PD Pulses (Units)	3 x status transition	AC Nominal 100-240 Vac (Range 85-264), 4A
Partial Discharge Index (mW)	ADDITIONAL SENSORS	DC Nominal 100-250 Vdc (Range 90-300)
Partial Discharge Index (mW)	Standard 1 x Top Oil temperature sensor	MECHANICAL
Sampling rate – 100MHz	Standard 1 x Split Core High Frequency CT	Dimensions 600 mm x 380 mm x 330 mm 23.6 in x 15.0 in x 13.0 in
FEATURES	Standard 1 x CT for load measurement	Weight 18.5 kg / 40.8 lb
BUSHING AND PD MONITORING FOR 3-PHASE TRANSFORMERS	COMMUNICATION	BUSHING ADAPTORS
Standard: 1 set of 3 bushings typically HV bushings or 2 sets of 3 bushings typically HV & LV bushings	DIGITAL COMMUNICATIONS / PROTOCOLS	Operating Temperature: -40 °C to +90 °C (-40 °F to +194 °F) at bushing tapping point
Optional: 3 sets of 3 bushings typically HV, LV and TV (tertiary) bushings	Standard:	Standard marine grade aluminum material
Optional: Monitoring a bank of single-phase transformers	1 x Modbus® over RS485 / TCP/IP as standard	Option: Stainless Steel material
Optional: Monitoring a bank of single-phase transformers and a spare transformer	1 x DNP3.0 TCP/IP as standard	
DISPLAY	1 x Standard 1Gb Ethernet (RJ45)	
4 x Sunlight visible LED arrays: Power; Caution; Alarm; Service	Options:	
Back-lit 7" inch color resistive touch screen (800 x 480)	DNP3.0 over RS485 or TCP/IP	
Embedded secure web-server (https)	IEC 61850 Edition 2	
	ST/SC Multi-mode fiber converters	
	Option: GPRS/UMTS/HSPA+ modem	

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