

# Intellix™ BMT 300

## Bushing Monitoring and Partial Discharge Detection for Transformers

Bushings today are omnipresent in high voltage (HV) substation transformers, CTs and switchgear. They account for a large proportion of HV substation failures and half of the incidents are catastrophic with severe and dangerous consequences. Preventive maintenance, early replacement and regular off-line testing have been employed to address this issue in the past. Now, technology exists that enables asset owners to detect impending failures and reduce their maintenance costs.

GE's Intellix BMT 300 is an on-line system that continuously monitors not only the condition of the bushings (capacitance and power factor), but also the presence of partial discharge (PD) activity in the transformer main tank. It will alert personnel of fault conditions at an early stage and provide vital health information on the bushings and the transformer.

The Intellix BMT 300 can be utilized as a stand-alone device, or it can be used in conjunction with GE's Kelman TRANSFIX™ family of dissolved gas analysis (DGA) multi-gas analyzers. The combination of the Intellix BMT 300 and the TRANSFIX offers customers an integrated, one-source solution that provides a more in-depth view of the transformer's condition and monitors the root causes of most transformer failures.

### Key Benefits

- One product combining on-line continuous bushing monitoring and main tank partial discharge activity detection through the same bushing adaptor
- One diagnostic software, GE's Perception™, used for bushing information, PD activity and DGA data analysis, resulting in familiar easy-to-use information
- One supplier installing, servicing, ensuring proper communication and minimizing administrative burden in order to lower the total cost of ownership of your transformer

### Applications



#### Power Utilities

- Enables condition-based maintenance of transformer bushings
- Detects PD activity in the transformer main tank for DGA correlation



#### Metals

- Monitors bushing conditions to avoid unplanned production stoppage
- Monitors PD in over-stressed assets in aluminum or steel mills



#### Petrochemical

- Detects developing arcing faults with transformers
- Monitors bushing health to avoid catastrophic failures of transformers



### Integrated Solution

- Monitors bushing conditions and detects PD activity in the main tank
- Can monitor 3 (HV) or 6 bushings (HV + LV)
- One-source provider that installs and services the entire solution
- Can be stand-alone or easily integrated with GE's Kelman TRANSFIX family of DGA multi-gas units
- Provides a more comprehensive view of the transformer's condition

### Bushing Adaptor Protection

- Bushing analysis and PD detection data obtained using a single sensor
- Marine-grade aluminum to withstand extreme environmental conditions
- Redundant resistors ensure the bushing tapping points remain grounded
- Voltage and surge suppression circuit to always limit voltage from adaptors

### Minimal False Alarms

- Compensation for actual bushing temperature using oil and ambient temperature sensors
- Discrimination against factors affecting and causing the same effect on all bushings
- PD to humidity correlation factor using included humidity sensor

### Intuitive Software

- Familiar Perception software included for download and visualization of data
- Easy-to-use individual transformer software that can be upgraded to simultaneously monitor multiple transformers
- Flexible database/server options to accommodate user requirements

## Monitoring Transformer Bushings

Monitoring transformer bushings is critical, because bushings are constantly under high stress due to the line voltage and heat effect of current flow. These stresses can be further aggravated by the presence of micro cracks from manufacturing, loss of mechanical strength due to ageing, repeated thermal cycling (load + sun), pollution and external flashover melting 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.

These stresses can cause the insulation of the bushing to deteriorate. If left undetected, this can lead to catastrophic failure in more than half the cases, 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, human injuries, environmental claims and fines or contractual penalties.

For years, testing bushings meant taking a transformer off-line on a regular basis and closely inspecting the bushings for cracks or imperfections, monitoring the internal oil levels, measuring capacitance within the bushing itself (C1) or measuring the power factor (or tan-delta). Taking a transformer off-line makes this approach impractical, thus minimizing the frequency of testing to once every few years. A critical problem can easily develop in between checks.

With modern fast electronics, continuous monitoring of transformer bushings can now be technically achieved. Remote access to the data allows for continuous on-line monitoring of bushings and is now regarded as a "best practice" to better guard against catastrophic bushing failure.

## The Intellix BMT 300 Bushing Solution

The Intellix BMT 300 continuously monitors the condition of bushings in real-time and provides end users with the information they are used to receiving from off-line tests, namely changes in capacitance and power factor (tan delta), to assess the bushing dielectric efficiency and insulation integrity.

Using custom made adaptors connected at the bushing tapping points, the Intellix BMT 300 measures:

- The change in bushing leakage current compared with the original values calculated from the bushing nameplate information. As the change in current is proportional to the change in capacitance, the Intellix BMT 300 calculates the change in capacitance C1 of the bushing compared with when the bushing was installed, to gauge dielectric efficiency.
- 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) power factor change as a percentage of the nameplate value. This is used to gauge the health of the bushing insulation.

The Intellix BMT 300 measures both oil and ambient temperature. It correlates capacitance changes linked to thermal expansion of the bushing and compensates for the measurements being made at actual bushing operating temperature compared with nameplate values obtained off-line.

## Partial Discharge (PD) Detection

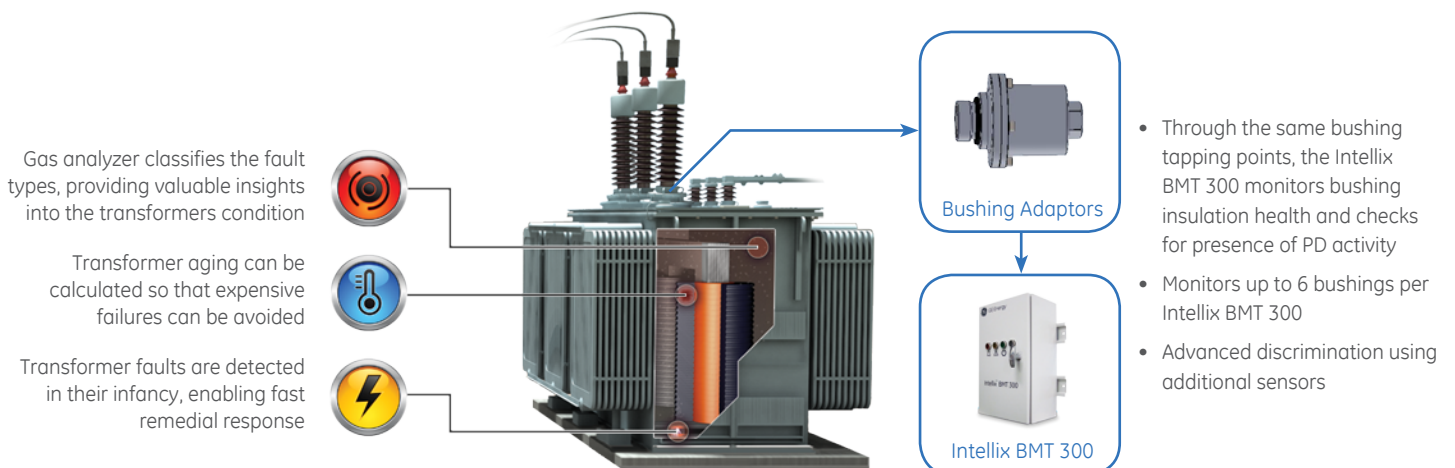
PD is a localized breakdown of a small portion of a solid or fluid electrical insulation system that is under high voltage stress, which does not completely bridge the space between two conductors. PD results in localized gradual erosion of the insulation system that eventually leads to failure of the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

Using the same bushing adaptors, the Intellix BMT 300 offers the added advantage of measuring high frequency signals in order to monitor PD activity, giving an added level of protection for the main tank of the transformer.

The amplitude of the PD pulses, as well as the number of pulses, are recorded and used to calculate an overall measure of PD activity.

Several methods are used to discriminate between internal PD and external noise (corona discharge).

## Example of GE's Intellix BMT 300 Solution Installed on a Three-Phase Transformer



## GE's Integrated Solution

### Intellix BMT 300 with Kelman TRANSFIX DGA

The Intellix BMT 300 can easily be integrated with GE's Kelman TRANSFIX DGA analyzer, giving the end user a unique all-in-one solution that provides a more comprehensive view of the transformer's overall condition, from bushing diagnostics and PD, to complete main tank monitoring.

The Kelman TRANSFIX is an 8-gas on-line transformer monitoring unit. Using specially developed advanced photo-acoustic detection technology, the TRANSFIX measures all significant fault gases.

### Increased Asset Reliability

Having an all-in-one integrated solution from GE will significantly increase the ability to detect potential transformer problems at an early stage. The system will provide status on:

- Developing key fault gases H<sub>2</sub>, CO, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H<sub>4</sub>, C<sub>2</sub>H<sub>6</sub>, CO<sub>2</sub> and CH<sub>4</sub>
- Moisture content in oil
- Partial discharge activity
- Deterioration of the bushing insulation

This helps to decrease the risk of unplanned downtime and improve network reliability.

### Perception Software

GE's Perception 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's Monitoring and Diagnostic products. The software is an upgradeable tool, allowing users to view all relevant transformer data from one centralized point.

With the Intellix BMT 300, Perception often uses a vector sum on a polar plot to easily highlight what is happening and eliminate common changes affecting all bushings (load, temperature) that are not a source of concern.

### One-Source Solution Provider

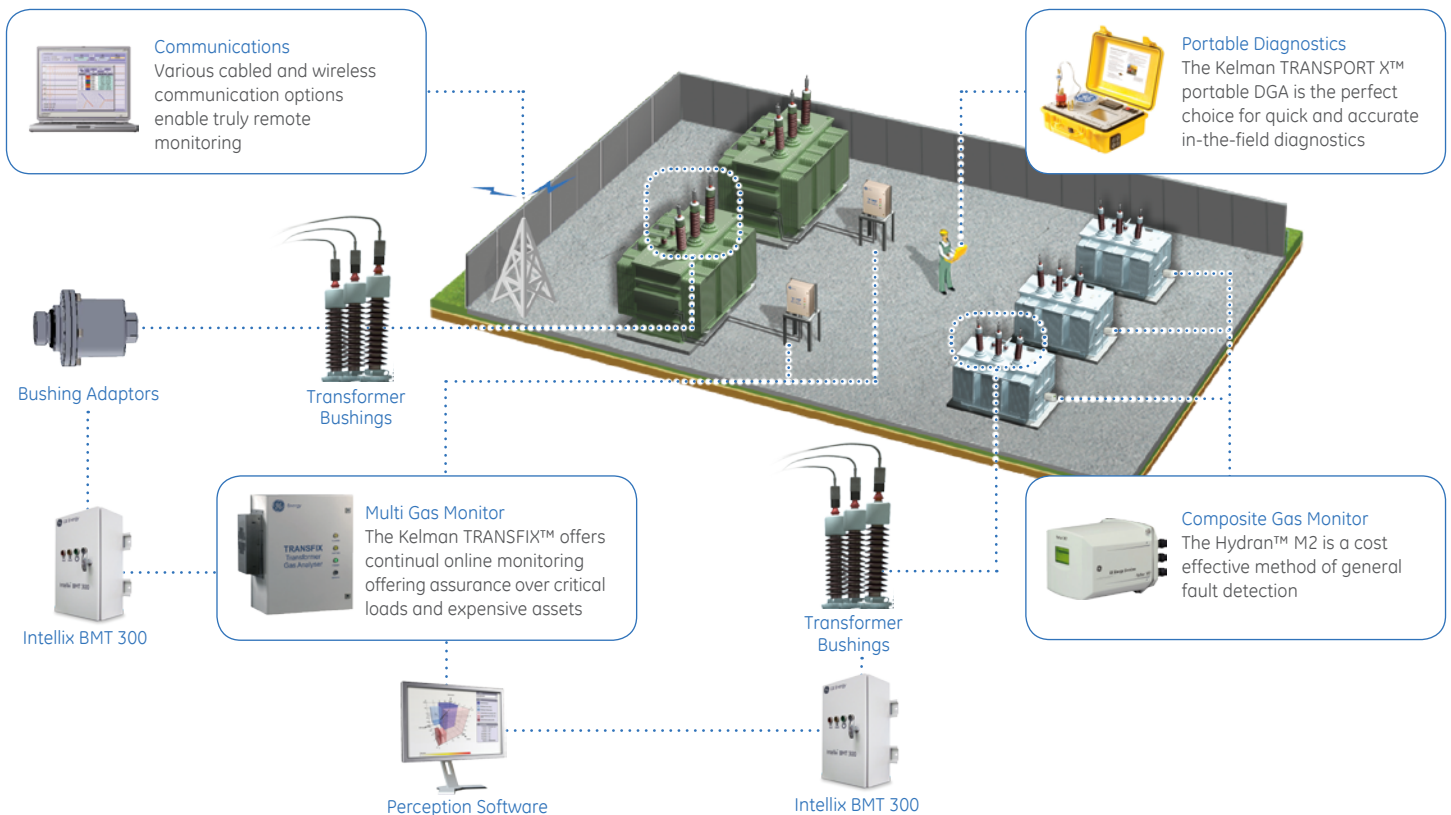
Having a one-source provider for complete transformer monitoring activities can effectively lower installation costs, as well as reduce the administrative burden of coordinating various maintenance crews.

All products work together and communicate seamlessly with no interface or responsibility issues.

GE 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.

## Substation Application Example

The application below showcases an integrated solution for bushing and transformer main tank monitoring utilizing the Intellix BMT 300, the Kelman TRANSFIX DGA analyzer and the Perception software for data analysis.



## Technical Specifications

### ELECTRICAL INPUTS

Input	Measurement on 3-phase bushings (HV)
Optional	Additional 3 phases (LV)
Sampling Rate	LF for bushing: 100kHz HF for PD: 100MHz
Resolution	Current: 0.01mA Phase angle: 0.01 degree

### ELECTRICAL OUTPUT (ENCLOSURE UNIT)

#### BUSHING DATA

- % Change in Capacitance
- % Change in Relative Power Factor

#### PARTIAL DISCHARGE DATA

- Amplitude of the PD pulses (pC)
- Count of the PD Pulses (Units)
- Partial Discharge Index (mW)

#### SUNLIGHT-VISIBLE LIGHT INDICATORS

- Red – Alarm
- Amber – Caution
- Green – Power
- Blue – Service

#### RELAYS FOR USER-ADJUSTABLE ALARMS

- Two SPDT alarm relays (Type C) for caution and alarm levels
- One SPDT alarm relay (Type C) dedicated to system faults
- Relay Contact Ratings: 2A @ 240 Vac resistive load or 2A @ 30 Vdc

### COMMUNICATIONS

#### Standard

Modbus RTU/ASCII over isolated RS-485

#### OPTIONAL

- Modbus RTU over serial multimode fiber optic with ST connector

The standard single-master communications interface can be replaced by a multi-master option over Ethernet (up to 3 masters) offering:

- Modbus TCP over Ethernet RJ-45
- Modbus TCP over 10 Mbps serial multimode fiber optic with ST connector

#### ENCLOSURE

##### Operating Temperature

Ambient -30°C to +55°C  
(-22°F to +131°F)

when equipped with multi-master comms option:

-20°C to +55°C  
(-4°F to +131°F)

Operating Humidity 5 - 95% RH (non-condensing)

Enclosure Rating IP 55

Power Supply 100-240 Vac ±10%, 50-60Hz, 1.24-0.41A

#### BUSHING ADAPTORS

Operating Temperature: -40°C to +90°C  
(-40°F to +194°F)  
at bushing tapping point

#### OIL TEMPERATURE SENSOR

Operating Temperature: -40°C to +150°C  
(-40°F to +302°F)

### STANDARDS

#### EMC TYPE TESTS

##### Standards

IEC/EN 61326-1, CISPR 11, 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 61000-3-2, IEC 61000-3-3, IEC 60255-5

#### ENVIRONMENTAL TESTS

##### Standards

IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-30, EN 60529

#### CE APPROVAL

##### Directives

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

#### SAFETY APPROVALS

##### Standards

IEC 61010-1  
CSA C22.2 No. 61010-1  
UL 61010-1  
EN 61010-1

## Order Codes

BMT 300	xx	xx	xx	Description
Number of Bushings to Monitor	B3			3 HV bushing measurements (standard)
	B6			3 HV plus an additional 3 LV bushing measurements (6 in total)
Communications		C0		Modbus RTU/ASCII over isolated RS-485
		C1		Modbus RTU over serial multimode fiber optic with ST connector
		C2		Multi-master: Modbus TCP over Ethernet RJ-45 and/or multimode 10 Mbps fiber optic (ST connector)
Mounting Stand			M0	No mounting stand required
			M1	Mounting stand

Bushing adaptors, tailor made for your specific transformer bushings, and special cables for connecting them, to be ordered separately.

Digital Energy  
Lissie Industrial Estate East  
Lissie Road  
Lisburn BT28 2RE  
United Kingdom  
Tel: +44 (0) 2892 622915  
gedigitalenergy@ge.com

[GEDigitalEnergy.com](http://GEDigitalEnergy.com)

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