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# Siemens Bushing Monitoring System

Increased transformer reliability through transparent performance of bushings

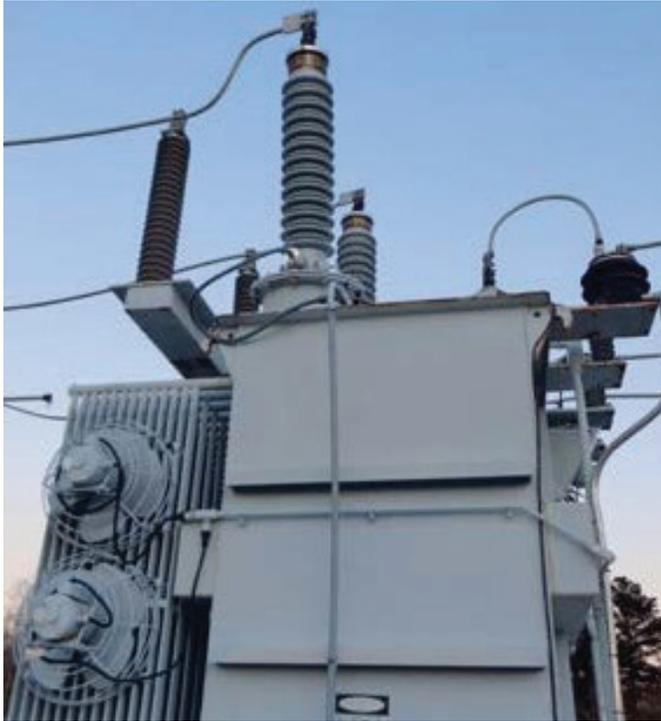
## Why Bushing Monitoring?

Among the reasons for transformer outages, bushing failures are often the cause. It is common to find a bushing testing poorly, and there have been many noted total transformer failures due to bushing failures. One reason may be because bushings are often tested offline to measure capacitance, dissipation factor and power factor.

With its new online Bushing Monitoring System, Siemens enables asset managers to check the condition of critical equipment such as power transformers and reactors while online. The asset condition data allows a thorough electrical analysis and can reveal developing equipment issues before they become a problem allowing for maintenance work and repairs to be scheduled accordingly with adequate personnel, minimizing maintenance costs and downtime.

## The solution: Siemens Bushing Monitoring

The new Siemens Bushing Monitoring System can be used as a standalone system, or in combination with Siemens' trusted Transformer Monitoring and Diagnostic System, integrating multiple measurement results into an overall picture. For ease of operation, the Siemens Bushing Monitoring System software provides alarm set-points, graphical displays and algorithm-based alarms that maximize response without triggering false alarms. The software can be individually adapted by our engineers to suit any type of installation.



## The Siemens Bushing Monitoring System

### Your advantages

- Early detection of a degradation of bushing insulation and internal layer breakdown
- Monitoring power factor/dissipation factor and capacitance at nominal voltage
- Universal applicability for each condenser bushing type and other OEMs
- High accuracy measurement by using parallel measurement of up to six bushing leakage currents
- Optimized and purposive maintenance strategy reduces outage costs
- Comprehensive online condition monitoring system for transformer and bushings, in combination with Siemens Transformer Monitoring and Diagnostic System.

### System description

#### Functional principle

The Siemens Bushing Monitoring System is designed to be permanently installed, monitoring the condition of condenser bushings, capacitor voltage transformers (CVTs) and freestanding current transformers (CTs), as well as potential transformers. The entire system is monitored online; up to six leakage currents are measured and the power factor and capacitance values are tested.

The Siemens Bushing Monitoring System incorporates three measurement models for standard and two for optional configurations:

- *Standard configuration with six current inputs:*
  - Sum-of-three current test
  - Adjacent phase reference test
  - Phase comparison
- *Optional configuration with inputs of three voltages and three currents:*
  - Reference test (three bushings and three CVTs)
- *Optional configuration with six voltage inputs:*
  - CVT reference test (six CVTs)

The sensors and adapters are designed for bushings with grounded and ungrounded capacitor taps to allow measurement of leakage currents of up to 140 mA AC.

Should the sensor become disconnected from the bushing monitoring system, the adapter design prevents a harmful overvoltage developing on the bushing. By establishing communications between the Siemens Bushing Monitoring

System and Transformer Monitoring System, a comprehensive transformer and bushing monitoring system is available as a package solution.

The Siemens Bushing Monitoring System has two programmable output relays with alarm changeover contacts. With its built-in programmable scheme logic, it allows operators to

- Measure AC leakage currents of fundamental harmonic ( $\Delta C$ )
- Measure phase angle ( $\Delta\%PF$ ) between two currents
- Measure phase angle ( $\Delta\%PF$ ) between currents of adjacent phases (three-phase mode)
- Measure magnitude and phase angle of imbalance current of three Y-connected bushings
- Generate alarm in case the measured values exceed the threshold.

The system's RS-232/RS-485 communications interface can be used for settings and status reports. For implementation in SCADA systems, a DNP3/MODBUS controller is available.

#### Most accurate condition analysis

For best results, the Siemens Bushing Monitoring System offers a combination of analysis methods to provide fast and reliable determination of the actual bushing condition. For identifying changes in the bushing's condition, bushing power factor and capacitance values are commonly calculated by using the sum-of-three currents and adjacent-phase analysis methods.

These analysis methods provide stable imbalance current and capacitance values, but in some cases the power factor data can be affected by temperature and power system voltage fluctuation, particularly on lower voltage bushings. If these conditions exist, the Siemens Bushing Monitor can be supplied with smoothing algorithms to eliminate any cyclical variation in the data, or the unsmoothed data can simply be evaluated for trends rather than instantaneous data points. Changes in bushing condition can be easily detected with either approach.

The Siemens bushing Monitor can also be configured for comparison or reference mode analysis in addition to the full leakage current magnitude and phase angle data. These analysis modes provide the highest available power factor and capacitance accuracy without the need for data smoothing algorithms.

Using proprietary algorithms, the Siemens Bushing Monitoring system software evaluates all available analysis modes to eliminate false alarms to ensure that bushing deterioration is detected early on.



### Technical data

| Measurements                      |                 |                    |
|-----------------------------------|-----------------|--------------------|
| Measuring quantity                | Range           | Accuracy           |
| 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  |

| General data Siemens Bushing Monitoring System |   |
|--|---|
| Supply voltage                                 | 85 ... 264 V AC/47 ... 63 Hz or 120 ... 370 V DC  |
| Power consumption                              | max. 24 VA  |
| Dimensions:                                    |   |
| 3 and 6 channels                               | W 420 x H 595 x D 153mm   |
| 9 and 12 channels                              | W 610 x H 686 x D 229 mm  |
| Operation temperature                          | -40 °C ... +65 °C   |
| Output relays                                  | potential-free changeover contacts  |
| Communication                                  | <ul style="list-style-type: none"> <li>• RS 232 – screw terminals and RJ45 (proprietary protocol)</li> <li>• Optional DNP 3 serial or MODBUS® RTU Controller</li> </ul> |

Customized bushing sensors, including redundant overvoltage protection, for each kind of bushing-tap available.

## Scope of supply and services

### Bushing Monitoring set-up

The Siemens Bushing Monitoring System is available in different versions with 3, 6, 9 or 12 bushing sensors, depending on individual requirements.

#### Each system comprises:

- Bushing sensors with connection cable
- Siemens Bushing Monitor System including mounting plate, power supply, circuit breaker, terminals and wiring
- Optional cabinet IP 55 (higher specifications available)

#### Turnkey installation and communications services:

- Highly skilled, experienced service team for installation and commissioning
- Expert analysis of monitoring data and customer support
- On-site training courses for operation and maintenance of our systems
- Design, installation and commissioning of all necessary communications equipment connect the Siemens Bushing Monitoring System to your network:
  - Via MODBUS, DNP3, Ethernet, RS485, or any other communications protocols
  - or across hard-wire, fiber optic, wireless, cellular modem or any other connections



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