High Voltage Asset Monitoring for Today’s Smart Grid

Improve reliability while lowering O&M costs
Smart-Enable Your High Voltage Equipment

With the addition of sensors and devices, our equipment monitoring packages will turn your high voltage switchgear into a smart enabled asset.

Smart-enabled assets employ continuous monitoring services to send proactive event notifications of key performance indicators (KPIs).

With continual asset monitoring there is no need to regularly open a circuit breaker or GIS for exploratory maintenance, information is streamlined throughout the company, and work procedures become predictive rather than reactive. The overall result being lower costs from a smarter, more reliable power grid.

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Root cause analysis is the new maintenance strategy

The primary goal of Asset Monitoring is to provide a system for continuously monitoring asset health. When a problem is detected, a diagnosis of the root cause is reported to a user so that the problem is minimized and the user can turn their efforts to immediately resolving the issue. Event driven reporting means that the assets inform the user that attention is required. By utilizing a consistent monitoring and reporting solution for all assets, a standardized approach to managing information is provided by the asset management system.

**Asset Monitoring Benefits**

**Innovative technologies**
- Our equipment monitoring packages provide a compliant “Smart Grid” solution that continually monitors the health of a circuit breaker.
- Our software seamlessly integrates power grid assets, monitoring equipment, communications devices, and user settings – creating a cohesive and easy-to-use system.

**Productivity**
- Allows users to move from the typical “time-based maintenance” to a “conditioned-based maintenance” approach.
- Defers/extends maintenance intervals
- Reduces unnecessary downtime
- Extends equipment life

**Cost-reduction**
- Reduces maintenance intervals
- Reduces / eliminates emergency repairs
- Prevents loss of revenue due to failed equipment
- Minimizes SF\(_6\) gas usage

**Efficiency**
- Useful tool for maintenance personnel to effectively maintain assets
- Prioritizes higher maintenance (preventive/corrective) actions
- Allows adequate time to schedule outages
- Enables ability to predetermine any parts or equipment required for maintenance or repair

**Environmental Impact**
- Compliant with EPA regulations to reduce the usage of SF\(_6\) gas
- Provides early leak detection
- Facilitates proper outage planning
“Smart” maintenance = lower cost & higher reliability

Equipment that is smart-enabled with an asset monitoring device becomes an active participant in maintenance planning by notifying the user when maintenance is needed with the data to identify the type of problem(s) the equipment is experiencing, i.e., electrical, mechanical, or how often it is happening.

<table>
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<tr>
<th>Time</th>
<th>Use</th>
<th>Condition</th>
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<tbody>
<tr>
<td>Reactive maintenance</td>
<td>Reactive maintenance</td>
<td>Proactive maintenance</td>
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<td>Maintenance performed based on number of years in operation:</td>
<td>Maintenance intervals which consider the following factors:</td>
<td>Smart-enabled maintenance with an asset monitoring package:</td>
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<td>• Exposes internal components to environmental contaminants</td>
<td>• Environment</td>
<td>• Synergize data from number of operations and interrupter wear for real-time determination of breaker condition</td>
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<tr>
<td>• Requires an outage, training, gas cart, crane, etc.</td>
<td>• Low/high ambient temperature</td>
<td>• Automatic alerts when the equipment is not adjusting properly to environmental conditions (i.e. heater problems)</td>
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<tr>
<td>• Expensive and not always needed at ten years if breaker has experienced minimal switching, few faults, and the environment is relatively mild</td>
<td>• Pollution/salt/humidity</td>
<td>• Sensors provide temperature-compensated pressure data for early detection of SF₆ leaks</td>
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<td></td>
<td>• Application significantly affects switching operations (i.e. capacitor bank vs. busbar)</td>
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<td></td>
<td>• Electrical load</td>
<td></td>
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<tr>
<td></td>
<td>• Exposure to short circuit currents</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Number of motor starts</td>
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- Smart-enabled maintenance focuses maintenance resources (personnel, time, and budgets) on the high voltage equipment that needs attention
- Equipment monitoring packages provide the data service technicians need before a service call
- Asset monitoring’s continual flow of information results in more reliable equipment with less emergency outages/repairs
How it works

A standard circuit breaker can provide basic alarm contacts for SCADA, but it lacks the necessary smart-intelligence equipment to maintain a reliable grid through proactive condition-based assessment. ABB has specifically designed “Equipment Monitoring Packages” that add the required sensors and device (e.g. CBS Lite) to collect information at a circuit breaker’s main cabinet. The device acts as a collection point or gateway to convert all the required signals and conditions into a protocol (e.g. DNP3.0). This protocol can then be communicated through fiber, Ethernet, or wireless (e.g. cellular) applications via the customers network. The bundled smart grid packages are key to proactive maintenance strategies and lowering O&M costs through condition-based maintenance.

A series of external sensors provide the monitoring device with information on key parameters necessary to access the condition of the switchgear. Each diagnostic feature requires information on several parameters.
Smart Features

- SF$_6$ gas monitoring
- Breaker timing through simulated travel
- Mechanical Charging System
- Close and trip coils
- Heaters
- Moisture
- Interrupter Wear
- Coil Signature Analysis

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Smart Features explained

**SF₆ gas monitoring**
Sulfur-hexafluoride (SF₆) is essential for maintaining insulation to ground and for abetting current interruption. Any significant loss of the gas can lead to breaker failure, while even small emissions contribute to the greenhouse impact on the environment. Through on-line monitoring, ABB provides advance warning of performance affecting leakages as well helps utilities document their SF₆ usage in support of the EPA’s drive to reduce greenhouse gas emissions.

**Moisture**
Online dew point measurement combined with SF₆ gas monitoring provides an excellent assessment of the condition of the SF₆ insulation. Online dew point measurement alerts the user to moisture issues, which can weaken the insulation properties of SF₆ and cause rapid deterioration.

**Heaters**
All high voltage circuit breakers require anti-condensation heaters in the control cabinet. Additionally, the interrupting tanks and/or mechanism may also require auxiliary heating to assure proper breaker operation at low temperatures. ABB monitors both thermostatically controlled as well as continuously energized heaters.

**Coil Signature Analysis**
Coil currents can be collected during an operation via either shunts or powered CT’s. The coil signature, independently per coil, is then evaluated to determine the health of both the coil and the breaker’s mechanical system. Such monitoring of a circuit-breaker’s parameters is necessary to assess the breaker’s switching function capabilities.
Smart Features explained

Mechanism charging system
Critical to successful fault current interruption is the breaker’s mechanism, which relies on a charging motor to maintain readiness to operate. ABB monitors the number of motor starts per day as well as motor run time. It differentiates between motor starts that follow breaker operation from those without operation. Conditions such as worn motor brushes, inefficient pumps or hydraulic leaks can be detected before they result in loss of stored energy.

Close and trip coils
ABB can monitors the breaker’s close and trip coils, whose failure may not otherwise become evident until called upon to operate. Open as well as shorted coil conditions are monitored, as failure in either mode can result in unplanned outages. Affording such early detection of control coil problems enables scheduling of repairs during off-peak times.

Interrupter wear
Online monitoring of accumulated interrupter wear enables service to be performed on a proactive basis, eliminating costly unplanned interrupter overhauls. This also this feature eliminates any invasive measures to remove and inspect the interrupter.

Breaker timing through simulated travel
Breaker timing parameters can be extracted from any breaker manufacture or type by using auxiliary switch timing. Auxiliary switch timing can serve to calculate contact speed, reaction time and mechanism time. A travel curve is built applying our patent pending simulated travel functionality.
Complete List of Features

- Coil Continuity
- Total Travel*
- Contact Velocity
- Reaction Time**
- Coil Energization Time
- Contact Wear
- Auxiliary Nozzle Wear
- Main Nozzle Wear***
- Trip Count
- RMS Current
- Tank/Gas Temperature
- Mech./Cab. Temperature
- Leak Rate (5 time spans)
- Heater off a low temperature
- Heater on at high temperature
- Heater off (heater w/o thermostat)
- Pump starts w/o operation
- Pump starts w/ operation
- Coil Signature Analysis

CBS Lite Simulated Travel
* Not a true measurement when using simulated travel
** Not a true measurement but indicative of changes when using simulated travel
*** Same as auxiliary nozzle wear unless interrupter geometry is known
Sensor Package: Travel Sensors

- CBS travel sensors are for ABB Breakers ONLY!
- Rotary encoders for newer mechanisms (HMB / BLG / BLK)
- Optical sensors for legacy mechanisms (FSA / AHMA)

Example: HMB 1.0 mechanism w/ encoders
Sensor Package: Phase Current Transformers

- Ring Core / Split Core CT’s
- Ratio = 5000:1
- Nominal Values:
  - 2.0 A
  - 5.0 A
- Range: up to 50 times nominal value without clipping
- Split Core current transformers available for retrofit applications
Sensor Package: Temperature Sensors

- Resistive temperature devices (RTD)
- Resistance change: 38.5 Ω/ 100 °C
- Mounting locations: tank, mechanism, cabinet
Sensor Package: Heater Current Transformers

- Measure Heater Current
- Determine on/off condition
- Assemblies of 3 and 4 CT’s
- Ratio = 1000:1
- Shown with terminal block
Sensor Package: Pressure Sensor

- 4-20 mA sensor
- Rugged industrial design
- Mounted opposite of pressure gauge
- 0 – 150 PSIG, 0.5 PSI accuracy
Sensor Package: Coil Signature Current Transformers

- Powered Bidirectional CT
- Operating Temperature Range: -40° to +85°C
- Input Range: ±50A
- Accuracy Across Temperature Range: ±1% Full Scale
Sensor Package: Coil Signature Shunt Assembly

- Multi-Tap Shunt Resistor Assembly
- Taps for 5A, 10A, and 20A Nominal Current
- Wired In Series With Coil
Sensor Package: Other Connection Points

- Control Coils
- Motor
- Auxiliary Switches
Devices for Equipment Monitoring Packages

ABB provides asset monitoring packages within High Voltage Substations rated 69 kV and above.

- Universal applications regardless of breaker manufacture
- Factory and / or retrofit projects
- Monitors that support SF₆ gas system, Interrupter wear, Mechanical System, Electrical Controls & Aux.

Dead Tank
- GIS
- GCB

Live Tank
- CBS
- CBS-Lite
- CBS-F₆
- CBS Lite CSA
- GMS600

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Complete Solution
ABB is the ONLY company with the resources in place to provide a complete end-to-end solution. Whether you just need a smart device or have a turnkey project, ABB has the depth and breadth of experience to design a system that works best for you.

- Engineering Research and Design
- Project Management
- Network & communication architectures
- IT Security / Data Validation
- Device & System integration
- Factory installed devices
- Factory cabinet assemble
- Site installation & commissioning
- Training

- Turnkey Projects
- Phone Support
- Availability Contracts
- Retrofits
- Remote Services
- Upgrades
- Combined w/ SF\textsubscript{6} gas management services
- Supports Asset Health Center Solution

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**Frequently Asked Questions**

**Q:** Why was the family of CBS monitoring devices developed?  
**A:** The family of devices were developed to provide an economical choice to address a customer’s entire fleet of breakers regardless of manufacture. Our new simulated travel curve algorithm eliminates costly travel sensors, engineering and design elements, while still offering repeatable travel measurements.

**Q:** What type of high voltage switchgear is supported?  
**A:** Dead Tank Breakers (DTB), Gas Insulated Switchgear (GIS), Live tank Breakers (LTB), & Generator Circuit Breakers (GCB).

**Q:** What is unique to ABB monitoring devices?  
**A:** ABB’s devices are a universal solution that can be integrated into virtually any SF₆ filled product regardless of manufacture such as GIS, live tank breakers, and hybrid switching modules. The CBS-Lite offers a NEW simulated travel curve algorithm. The CBS-Lite supports communications (ModBus / DNP3.0) that allow integration into enterprise systems such as ABB’s Asset Optimization Package, SCADA or enterprise level systems. The CBS-Lite includes travel features that accurately monitor Mechanism Time, Reaction Time, Contact Velocity and Total Travel.

**Q:** Where can I get additional literature on this product?  
**A:** Please contact you ABB Mt. Pleasant representatives for information on this and other ABB high voltage products or support services.

**Q:** How long does it typically take to install this device?  
**A:** If integrated with your new ABB breaker, it typically would add another 4 hours to 2 days in the production and testing cycle. For retrofit, this product requires 1-4 days depending on the type of device and type of breaker.

**Q:** What are the local annunciation features of the monitoring devices?  
**A:** The devices have long lasting LED’s that show power and alarm status on the front of the unit.

**Q:** What is required to retrofit this device?  
**A:** The device is typically mounted inside the control cabinet unless there is a limited amount of space, in which an external cabinet is required.

**Q:** What communications options are available?  
**A:** The devices come equipped with a serial port and optional Ethernet convertor which allows for a fiber connection. The devices communicate using your choice of its proprietary protocol, Modbus, or DNP3.0.
Success Story: Improved Reliability for Mission Critical Assets

Background

- **Reliability of critical assets**: Customer needed to receive status and performance parameters of each breaker monitored at central office via wireless communication

Solution

- Outfitted fleet of RG&E 121-kV and 362-kV type PMI dead tank circuit breakers with CBS device & ABB’s Asset Optimization system
- CBS (Circuit Breaker Sentinel) used to monitor the fleet of HV circuit breakers
- ABB utilized cross-BU expertise to design and develop network and communications architectures, including device and system integration, IT security, and data validation for a complete solution

Customer Benefits

- Complete asset management program based on remote condition monitoring
- Maintenance activities are prioritized based on condition vs. time in use
- Customer awarded PUC-approved rate increase through improved reliability on critical assets
- Accumulated data is processed by ABB’s Asset Optimization system, which alerts of any impending need for service before a failure can occur
- Asset Optimization system provides root cause analysis of pending or historical maintenance events and other KPIs (key performance indicators)

Customer: Rochester Gas & Electric

Year of Commissioning: 2011
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