GE
Grid Solutions

CB Watch 3

HV Circuit Breaker Monitoring Solution

Utility Asset Managers all know how critical their power transformers are and understand the risks and consequences of any failure. They are now focusing on the fact that high voltage circuit breakers are often just as critical. When a transformer problem is detected, protection relays and circuit breakers are relied upon to isolate it from the grid and a breaker's "failure to operate" is not a palatable option.

With circuit breaker fleets worldwide averaging more than 25 years of age and operating budgets shrinking yearly, many Asset Managers are exploring ways to move from time-based to condition-based maintenance on their circuit breakers while also providing increased availability and reliability.

Capitalizing on 15 years of field experience and domain expertise, the CB Watch 3 is a compact, modular, online monitoring solutions, suitable for most high voltage circuit breakers. It records information using non-invasive sensors and monitors key diagnostic parameters during the breaker operation. It looks for significant changes in performance and assesses the breaker against the most common causes of failure.

The CB Watch 3 highlights the timely need for mechanical maintenance or arcing contact replacement, reducing the need for fixed interval inspections and overhauls. It enables instead a more cost effective and less reactive "as needed" maintenance approach.

With worldwide scrutiny on SF_6 gas usage, increased environmental reporting requirements and even possible penalties, precise early detection of small gas leaks is essential. The latest generation of EMC resistant digital gas sensors is used to provide leak detection down to 0.1% per year and to forecast refilling needs prior to reaching threshold levels and affecting operation.

Key Benefits

- Modern modular solution that fills diverse needs with the same platform
- Retrofittable on site to most HV circuit breaker types/brands
- Delivers reduced and optimized operating maintenance costs
- Enables health/condition based asset replacement strategy
- Helps reduce costly SF_6 gas losses into the environment
- Seamless communication with digital systems and through web server HMI

Applications

The CB Watch 3 is suitable for most HV circuit breakers: live tank or dead tank, ganged or independent pole operation. Small configurations can be mounted inside the control cabinet or in an additional enclosure.

Thanks to its modular approach, the same platform with different options is now suitable for your entire fleet of breakers: large and small, most critical to your grid, with a prior history of issues or just simply ageing.

imagination at work

Operational Timing

- Verifies that mechanism is opening/closing and indicates deviation in speed of operation
- Detects performance degradation possibly linked to friction, corrosion or linkage failure
- Timing compensation for cold temperature to avoid spurious alarms

SF_6 Gas Monitoring

- Measures pressure and temperature of SF_6 gas (or gas mixture) and calculates density
- Detects gas leaks and gives advance warning before reaching critical threshold levels
- Exposes gas liquefaction risk at low temperature

Arcing Contact Wear

- Records number of interrupting operations and for each, measures the current during interruption as well as the arcing time
- Calculates the arc energy (I^2T) and resulting cumulative electrical contact wear/erosion

Control Circuits

- Monitors current flow through open/close coils
- Can check coil continuity and DC supply level
- Uses temperature sensors to check for proper operation of the cabinet heating systems

Stored Energy System

- Looks at the frequency and time taken to rearm the stored energy system
- Monitors the current used by the motor(s) for any change in profile

Operational Timing

To ensure that the circuit breaker (CB) will operate when asked to and in a timely fashion as per its specification.

Status and Logs

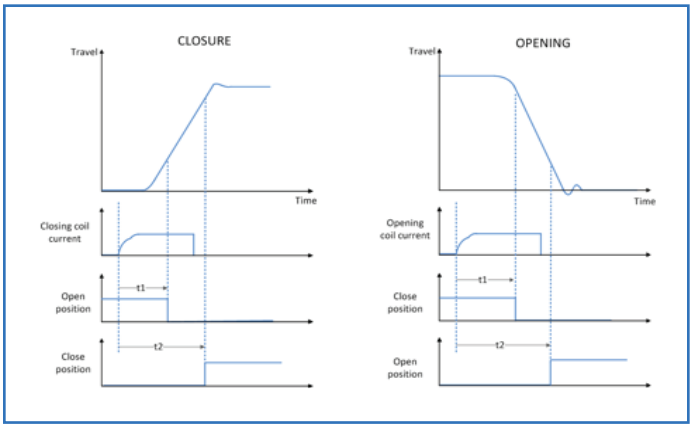
The status of the CB (open or closed), the position of all the 52A and 52B auxiliary contacts, the ambient temperature and the date, time and type of the last operation are always available. In addition, for each pole, the cumulated number of opening/closing operations is stored, with possible notification when each of two levels is reached.

Timings

For each opening operation and for each pole, a recording is made of:

- The date and time of the appearance of the command to open
- The reaction time (t1) between the appearance of the command on the coil circuit and when the CB starts moving
- The operation time (t2) between the appearance of the command on the coil circuit and when the CB arrives in the fully "open" position
- The contact travel time (t2-t1) is also calculated as well as the contact separation speed

A similar recording is made for each closing operation and for each of the poles. The above values are then compared to nominal values (from Factory Acceptance Test) and an alarm raised for any significant deviation.



Refinements

Data for the last 50 operations is kept in memory to enable comparison.

As the CB operating time varies (due to increased friction at low temperature), these timing variations can be compensated for in order to avoid false alarms.

When all poles are opened simultaneously, there will always be small differences between poles, but if one pole experiences a delay compared to the others which is greater than a set threshold, than an alarm is raised so that the cause can be investigated.

Gas Leakage

Most new HV CB today use SF_6 gas (or a mixture) to extinguish the arc and their performance can be severely affected by insufficient gas pressure.

Our proprietary fully digital EMC-resistant gas sensors can detect leaks in either one gas tank per pole or one common gas tank for all 3 poles. It has a male BSP G½" straight parallel thread to connect to existing tank valves, (adapters may be required).

Gas Density

Because gas pressure varies with temperature, comparisons are either made using "density" or the "pressure normalised at 20°C", calculated from the measured pressure at the measured temperature for the gas mixture used. Alarms can be set for or in advance of the threshold levels:

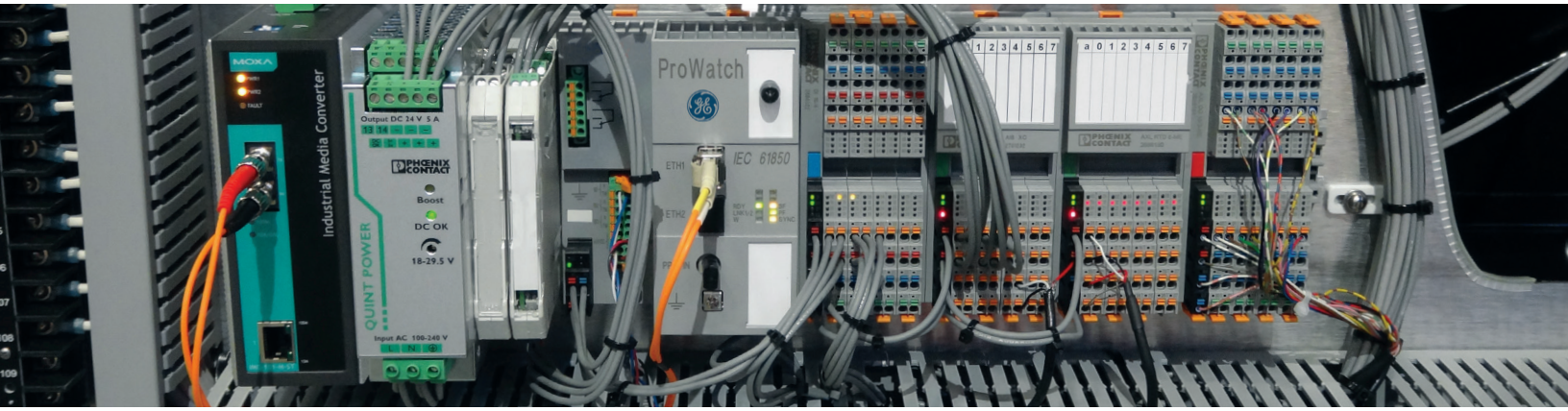
- L1 "Additional filling required": The CB is still capable of fulfilling its function but a gas refill action is required to prevent reaching level L2
- L2 "Interlocking": The CB is no longer capable of fulfilling its function and is either locked closed or automatically opened and then locked
- L3 "Overfilling": When the amount of gas after refill is too high, there is a risk of overpressure at elevated temperature

SF_6 Gas Sensor with digital output

Leakage Rate Detection

Any sustained drop in density/pressure is measured and indicated as a gas leak rate.

Comparing precise daily gas pressure readings taken every night (to avoid external influences) enables to detect the smallest leaks in the system. Extrapolating the leak rate, an estimate can be made of the future value after a selectable time horizon in days. An alarm can be raised if threshold level L1 is going to be reached within this long term time horizon, providing an advance warning that a refill is needed. Similarly, a shorter term alarm can also be set for warning that threshold level L2 is going to be reached.



Arcing Contact Wear

Circuit breakers use special arcing contacts specifically designed to withstand the high arcing energy that occurs during opening. These contacts have a finite life and need to be replaced regularly. Because this requires removing the SF_6 gas, breaking the gas seals and opening the breaker, this should only be done when absolutely needed and not before.

Arcing time

The arcing time is monitored for any degradation in current interruption performance.

Contact Wear

By measuring the RMS current interrupted, squared and multiplied by the arcing time, we get the "I^2T" measure of the energy that the contact has been subjected to. This is often much larger than nominal during fault conditions and this is what wears out the contacts more quickly. Keeping a cumulative total of this energy, we can compare it to the manufacturer's stated life for the contacts and trigger a maintenance alarm when required.

Control Circuit

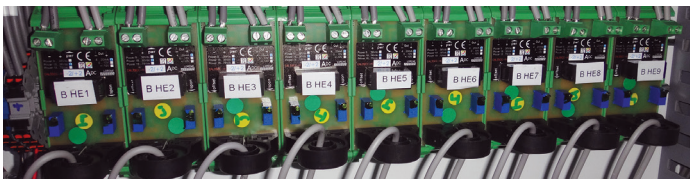
To ensure open or close command from the protection relay can be executed.

DC Power Source

The DC supply (backed-up by sub-station batteries) used by the control circuit can be monitored. Low voltage means longer time to generate the actuation charge in the coil, leading to slower operating times. If voltage drops too low, then the coil will be unable to trip the CB latch.

Coil Current

By measuring the DC current flowing through the coil during operation we can detect change/damage to the coil that will prevent it from having enough charge to actuate the latch next time. The curve is displayed and stored. Alarms can be set on the current value and the coil charge (current x time).



Coil Continuity

Using an additional sensor which injects a small current (below the level needed to actuate the coil), the continuity of the coil can be continuously monitored to detect if a coil has gone open circuit and raise an alarm.

Stored Energy Motor

A spring is often used as the source of energy to drive open the CB. It is normally rewound by a motor. In other types of breakers, a pump is used for building up hydraulic or pneumatic stored pressure.

Number/hours of operations

This is recorded as pumps or motors often require maintenance after so many hours of operation, while an hydraulic pump operating when no operation has been performed indicates a possible leak in the circuit.

Motor current

The current drawn by each motor is measured. An alarm can be set on the inrush current in order to detect any additional friction requiring more torque or a problem with the motor itself.

Spring rewinding times

With connections to the motor on/off contacts, the time taken by the motor can be acquired. Alarms can be set and any shortening of the time may indicate a partially broken spring while lengthening may indicate additional friction or a problem with the motor itself.

Cabinet Temperature

When operating circuit breakers in harsh winter conditions or when trying to avoid condensation forming, making sure that the heaters in the various drive and control cabinets are operating correctly and maintaining the proper temperature becomes key.

While some systems rely on monitoring the heater current when it should be on and the switching of heaters on and off, the logic can be tricky to implement correctly and the analysis can lead to inaccurate conclusions.

The CB Watch 3 instead monitors the end result, the actual temperature in the various cabinets, ensuring that the correct temperature is being achieved or triggering an alarm if it is starting to drift both low or high.

Spare Analogue Channels

Depending on the overall system configuration, there may be up to 4 spare analogue channels that can be assigned to measure and monitor other values as per customer requirements.

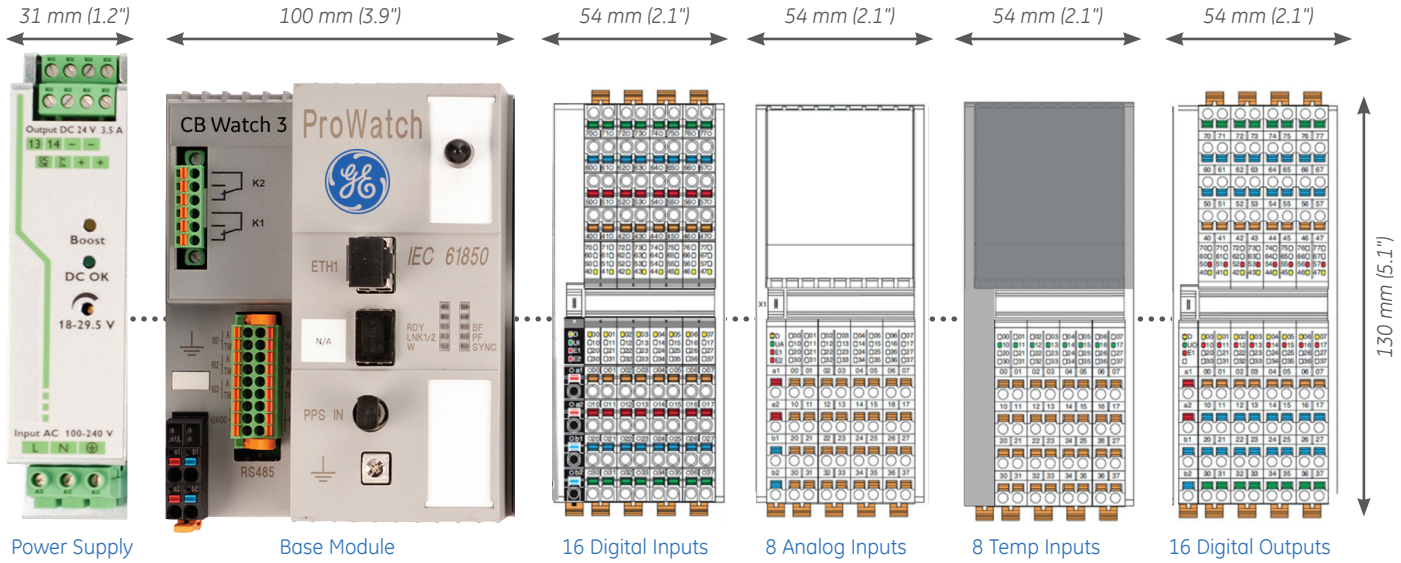
Numerous sensor signals can be accommodated (either V or mA). The name and the units of the measured value can be specified and alarms can be set.

Modern Interface

Interacting with the systems can be done easily, without additional software, using a Web server interface that display all monitoring information. Data can be further regularly downloaded to historians using Modbus, DNP3 or IEC 61850 Ed2 protocols.

SNTP, 1PPS or PTP (IEC 1588) time synchronisation is available and all graphs are stored in COMTRADE format for easy SFTP download and analysis

The System can use either AC or DC power (85-264Vac/90-330Vdc) and still supports dry contact relay alarm connections to SCADA systems.



Modularity to match your needs

All circuit breakers do not operate as often or are not as critical, so Asset Managers often want different levels of monitoring within their CB fleet. The CB Watch 3's modular design coupled with the small size of the modules and the bus architecture of the product allows customers to have different specifications for different types of breakers while keeping the same equipment supplier, the same hardware platform and the same software interface.

A CB Watch 3 system needs to be configured for a specific circuit breaker and for the functionalities required. Here are the most common options:

CB Watch 3	-	Sxx	Tx	Gx	Wx	Cx	Mxxx	Hx	Rx	Nx	Px	Exx	Selection Description
System		S11											Ganged CB, 1x open, 1x close circuits
		S12											Ganged CB, 2x open, 1x close circuits
		S31											Independent Pole Operation CB, 3x open, 3x close circuits
		S32											Independent Pole Operation CB, 6x open, 3x close circuits
Timing			T0										No CB timing
			T1										CB Timing
			T2										CB timing with DC voltage monitoring
SF6 Gas				GO									No SF6 gas monitoring
				G1									1x SF6 tank monitoring
				G3									3x SF6 tank monitoring
Contact Wear					W0								No arcing contact wear monitoring
					W1								Arcing contact wear monitoring
Coils						C0							No coil integrity monitoring
						C1							Coil current monitoring (all open & close coils)
						C2							Coil current and continuity monitoring
Motors							M000						No motor monitoring
							MSD1						Spring rearming, DC motor, x1
							MSD3						Spring rearming, DC motor, x3
							MPD1						Pump, DC motor, x1
							MPD3						Pump, DC motor, x3
							MPA1						Pump, AC motor, x1
							MPA3						Pump, AC motor, x3
Temperature								H0					No temperature monitoring
								H1					Cabinet heater temperature monitoring
Relays									R0				No extra dry contact alarm relays (2x)
									R1				16x extra dry contact alarm relays (18x)
Ethernet										N1			TCP/IP over MM Fibre Optic (LC connector)
										N2			TCP/IP over copper wire (RJ45 connector)
Protocol											P1		Modbus
											P2		DNP3
											P3		IEC 61850 Ed2
Enclosure												E00	Loose produt for customer integration
												E1A	System in large enclosure with stand, AC powered
												E1D	System in large enclosure with stand, DC powered
												E2A	Reduced system in small wall-mount enclosure, AC powered
												E2D	Reduced system in small wall-mount enclosure, DC powered

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