BPM

High-voltage circuit breaker monitoring

Turns every operation into a full breaker diagnostic: waveform capture, trip-coil and insulating-gas monitoring, all continuous

BPM

Breaker Performance Monitor

amperis

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Continuous asset management

BPM control unit, with the main processor module, the universal power supply module and the input/output cards per chassis.

Full diagnostics on every operation

Every breaker open and close is put through a full diagnostic of its mechanical and electrical systems. Smart Capture technology graphically compares the waveform of each operation against the first-trip reference, with detailed analysis of open and close timing, latch and bearing behaviour, lubrication problems, auxiliary contact condition and fault current values.

Condition-based maintenance

Multi-parameter sensors continuously track the density, temperature and humidity of the insulating gas, and raise alarms for leak rate, trend to lockout and mass gas loss, alongside trip-circuit resistance, contact wear and charging-motor behaviour.

Improved system reliability

The unit provides data on the state of the breaker's stored-energy system, allowing a fault to be detected before the breaker is called on to operate — information that cannot be obtained from reactive recording devices such as microprocessor-based protection relays.

Why monitor the breaker

High-voltage circuit breakers are essential to the safety and effective operation of the power system: they must interrupt fault current quickly to isolate it from the rest of the network. A slow breaker, or one that fails to open on command, exposes the system to excessive fault current, leading to premature ageing and costly failures in transformers and other equipment. Breaker operating failures are, in fact, one of the leading causes of substation incidents; without electronic monitoring, utilities have to rely on time-based maintenance and offline testing, both increasingly less effective as infrastructure ages and specialist staff become scarcer.

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Operating times and Smart Capture technology

Waveform-capture analytics: per-phase load currents, trip-coil current and auxiliary A/B contact status for each operation.

High-speed waveform capture

The BPM combines the most effective offline and online test methods in a single monitoring package, capable of detecting operating deficiencies well before they become a breaker problem. The waveform-overlay function graphically shows the performance variations of each operation against the first-trip reference, making early diagnosis easier.

Coil currents and trip-coil 1/2 identification

On every operation, the unit records whether the trip was initiated through trip coil 1 or trip coil 2, together with the peak and maximum amperes drawn by that coil and by the close coil where applicable. This identification, with the operation's interruption time, is available in printable graphs and tables that serve as verifiable evidence of each operation.

Auxiliary contacts and operation counter

Auxiliary A and B contact signals are logged alongside per-phase load currents and open, close and arcing times, with a counter of total operations and of faulted operations that gives an immediate historical view of how hard the breaker has actually worked.

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Trip coil, contacts and cumulative I^2T

In-service high-voltage circuit breaker, showing the bushings and the operating mechanism where the BPM takes its measurements.

Trip-circuit resistance

Trip-coil integrity monitoring detects changes in trip-circuit resistance, an early indicator of the coil's condition and that of related components, well before that deterioration could prevent a successful interruption.

Breaker condition and cumulative I^2T

Accurate, cumulative I^2T calculations per operation make it possible to schedule internal inspections only when actually needed, rather than on a fixed calendar, cutting both the cost and the labour associated with time-based cyclical maintenance.

Contact wear

Cumulative I^2T and fault-operation tracking, together with the auxiliary contact status logged on every operation, give a continuous estimate of main contact wear, with graphical and tabulated evidence for each event.

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Charging motor and spring, cold-weather behaviour

Operating mechanism and high-voltage circuit breaker, with the stored-energy system monitored by the BPM.

Charging-motor starts, current and run time

The unit logs the starts of the motor that recharges the breaker's spring or stored-energy system, together with its current and run time, providing data on the state of that system that cannot be obtained from reactive recording devices such as microprocessor-based protection relays.

Cold-weather adaptation

Stored-energy systems can be adversely affected in cold-weather environments. The BPM adapts its motor run-time analysis in real time to temperature-driven changes in hydraulic fluid viscosity, and monitors excess moisture and pressure in pneumatic systems, symptomatic of frozen air lines — regardless of the type of stored-energy system used in the breaker.

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SF6 gas and dry air, cabinet heaters

SF6 and dry-air gas monitoring

Multi-parameter sensors track the density, temperature and humidity of the insulating gas (SF6 or dry air), with alarms for leak rate, trend to lockout and mass gas loss.

Cabinet heaters and ambient conditions

Monitoring heater current and voltage detects faults that often go unnoticed between maintenance cycles and which, left uncorrected, lead to condensation in control cabinets, control-wiring corrosion, short circuits and premature ageing of electrical components. The unit also provides ambient, control-cabinet and insulating-gas temperature.

Why monitor the insulating gas

- Safety: SF6 is a potent greenhouse gas; catching leaks early reduces risk to people and minimises emissions.
- Equipment performance: insufficient gas pressure compromises insulation and the breaker's interrupting capability.
- Planned maintenance: logging gas trends over time makes it possible to anticipate failures and optimise maintenance activities.
- Regulatory compliance: many countries regulate and limit SF6 emissions; continuous monitoring supports accurate-data reporting.

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Architecture, modules and non-intrusive sensing

Modular construction

The BPM is configured with only the modules each installation needs: processor, universal power supply (110-240 VAC or 110-250 VDC) and the input/output cards covering the trip coil, gas, heaters, charging motor and auxiliary contacts, housed in a 4-slot or 9-slot chassis depending on how many cards are required.

Non-intrusive sensing

Every variable is derived from electrical and environmental signals that already exist on the breaker — the trip circuit, the charging-motor circuit, the heaters and the insulating-gas instrumentation — without touching or modifying the breaker's mechanism. This allows the unit to be installed on new breakers as well as on units already in service.

Multiple communication options

The unit offers several communication options — DNP3, Modbus or IEC 61850 — over Ethernet, in both copper and fibre, making it easy to integrate into the substation's SCADA system alongside the rest of the monitoring equipment.

Why continuous monitoring beats periodic testing

Breakers spend long periods idle between operations, which favours lubrication degradation and contact corrosion; periodic cyclical tests do not always reproduce these conditions, so an incipient fault — even something as simple as a heater thermostat — can go unnoticed until the next inspection. Continuous monitoring, by contrast, easily detects even the slightest changes in the breaker's physical, mechanical or electrical properties.

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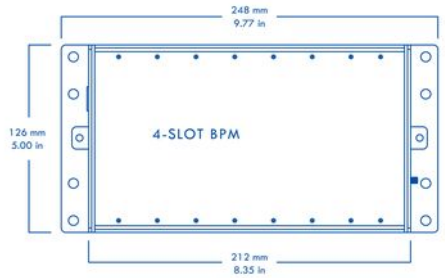
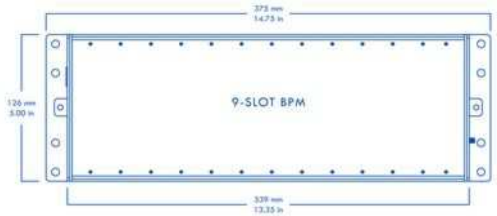
Installation and mounting



4-slot BPM chassis: 248 × 126 mm front panel (9.77 × 5.00 in), 212 mm on the lower dimension line (8.35 in) and 143 mm depth (5.62 in).



9-slot BPM chassis: 375 × 126 mm front panel (14.75 × 5.00 in) and 339 mm on the lower dimension line (13.35 in), with the same 143 mm depth (5.62 in).

Two chassis sizes

The BPM is available in a 4-slot or a 9-slot chassis depending on how many expansion cards the configuration needs: the 4-slot version is more compact for installations with few optional functions, while the 9-slot version leaves room to expand gas, heater, charging-motor and trip-coil monitoring within a single enclosure.

Mounting

Both chassis share the same height (126 mm / 5.00 in) and depth (143 mm / 5.62 in), with fixing holes at all four corners for panel or substation-cabinet mounting.

Environmental conditions

The unit is rated for a temperature range of -40°C to +70°C (-40°F to 158°F), allowing outdoor installation in the substation's own cabinet, next to the breaker.

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Management software, alarms and communications

Engineering access to the monitor from a desktop application, for viewing data and running diagnostics.

Insulating-gas pressure and temperature trend, with the configured alarm levels.

Desktop application and fleet management

The BPM includes a desktop application that gives engineering access to the unit for viewing data and running diagnostics. It can be extended with a fleet-management version that gathers data from every monitor on site — breaker, transformer or third-party — to analyse trends and support informed maintenance and risk-management decisions across the whole asset base.

Condition-based alarms

Every monitored variable — gas, trip coil, heaters, charging motor — generates threshold- and trend-based configurable alarms, so maintenance staff can act before a problem turns into a costly repair or unplanned breaker downtime.

Communications

The unit integrates into the substation's SCADA system via DNP3, Modbus or IEC 61850 over copper or fibre-optic Ethernet, consolidating its alarms and variables alongside the rest of the monitored assets.

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BPM — TECHNICAL SPECIFICATIONS

Smart Capture	Full diagnostics per operation; waveform analysis against the first-trip reference; open/close timing, latch and bearing behaviour, lubrication, auxiliary contacts and fault current
Trip coil	Trip-circuit resistance; trip coil 1/2 identification; peak and maximum current per operation
Breaker condition	Cumulative I^2T per operation; total and faulted operation counters; interruption time
Insulating gas (SF6/dry air)	Density, temperature and humidity; leak-rate, trend-to-lockout and mass-loss alarms
Heaters and environment	Cabinet heater current and voltage; ambient, cabinet and gas temperature
Charging motor	Starts, current and run time; adapts to hydraulic-fluid viscosity and to pneumatic moisture/pressure in cold weather
Construction	Modular, by input/output card; 4-slot or 9-slot chassis depending on configuration
Communications	DNP3, Modbus, IEC 61850 over Ethernet (copper and fibre)
Power supply	110-240 VAC (50-60 Hz) or 110-250 VDC
Temperature range	-40°C to +70°C (-40°F to 158°F)

Chassis, by number of expansion slots

Parameter	4 slots	9 slots
Expansion slots	Up to 4	Up to 9
Width (outer dimension)	248 mm (9.77 in)	375 mm (14.75 in)
Width (second dimension)	212 mm (8.35 in)	339 mm (13.35 in)
Height	126 mm (5.00 in)	126 mm (5.00 in)
Depth	143 mm (5.62 in)	143 mm (5.62 in)

Status, alarm, trend and event-date values shown in the software screenshots are illustrative examples and do not constitute a unit specification.

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