C50

Bushing and transformer monitoring

Anticipates bushing and tap-changer failure, with dissolved gas, cooling and voltage control built in

C50

Bushing and Problem-Detection Monitor for Transformers

amperis

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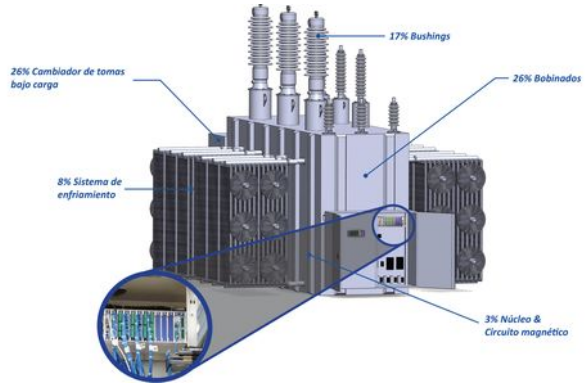
Advantages of online monitoring



Main failure locations in substation transformers: tap changer and windings (26% each), bushings (17%), cooling system (8%), and core and magnetic circuit (3%).

Risk mitigation

Based on online condition data, the system raises an alarm as soon as a problem appears, allowing early detection and action before it worsens. A transformer failure can be catastrophic: knowing the real condition of each asset reduces failure rates and unplanned outages.

Reduced maintenance costs

Built-in analytics filter condition data and automatically flag which problems need maintenance or attention, so operations teams spend their time solving issues instead of manually gathering data for an offline assessment.

Increased safety

Condition monitoring increases worker safety: it improves situational awareness before crews step in, reduces site visits, provides alerts and instructions, and helps meet industry safety standards.

Extended lifespan

Real-time measurement of operating parameters gives constant visibility of asset condition and the confidence to load it accordingly. Using this data for strategic decisions helps maximise the transformer's service life and plan its replacement.

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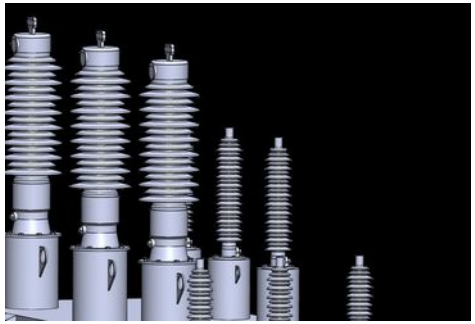
Bushing monitoring: measurement principle

Bushing sensor (BAU) installed on the capacitance tap of a power transformer.



Bushings on an in-service transformer, showing the capacitance tap where the system's sensors are installed.

Continuous online monitoring

Up to 50% of bushing failures end in fire, posing a serious risk to the transformer and to people. Unlike offline tests, carried out every few years, online monitoring is continuous, at normal service voltage and temperature, and gives the real-time capacitance and power factor of each bushing.

Sum of currents and voltage reference

Sum of currents connects up to six sensors to monitor two bushing sets: under balanced conditions, the vector sum of the leakage currents is zero if the power factor and capacitance of each bushing match, so any deviation reveals deterioration. Voltage reference connects up to three sensors and three voltage reference signals, calculating the power factor of each bushing independently.

Capacitance and power factor

Both methods continuously track each bushing's capacitance and power factor, the parameters that give early warning of a dielectric fault: a drop in capacitance can point to an oil leak, and a rise in power factor to moisture ingress. Logging their trend over time makes it possible to plan maintenance well ahead of an offline test.

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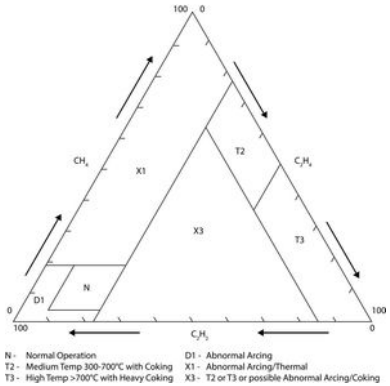
Partial discharge, dissolved gas and moisture



Dissolved-gas fault classification triangle: places the fault between arcing, overheating and carbonisation based on the proportion of combustible gases.

Partial discharge

The partial-discharge module directly measures the electrical discharge signals in the transformer and in the connected switchgear, responding much faster than online dissolved-gas analysis. Connected to the bushings' capacitance taps, it reaches points inside the transformer that acoustic monitoring barely detects, and its noise cancellation tells internal sources apart from external ones.

Dissolved gas analysis (DGA)

Hydrogen is the earliest indicator of most internal faults, particularly insulation problems. Thanks to its open architecture, the unit integrates over a serial link with third-party multi-gas and moisture analysers, preserving measurement accuracy and consolidating the data on the same web pages as the transformer's other variables.

Moisture and insulation health

Active moisture modelling and insulation health are part of the platform's advanced analytics, which reduce the resources needed to gather and analyse condition data and let the maintenance team spend its time solving the problems that are detected.

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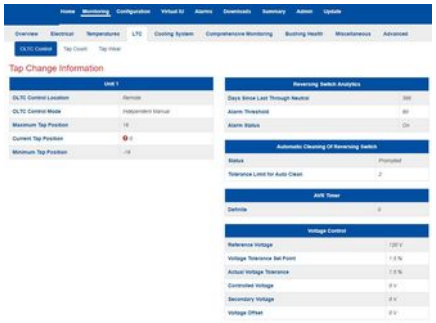
OLTC and cooling system



Tap changer: position, operation counter and days since the last pass through neutral.

Cooling radiator, with the fans and pumps monitored by the unit.

OLTC: early detection of problems

Of all the transformer's components, the on-load tap changer has the highest failure rate; when it fails, the transformer can no longer regulate voltage. The unit monitors the tap-changer motor's current and voltage and raises an alarm on any unexpected deviation.

Tap counter and contact wear

An individual operation counter is kept for each tap position, giving a summary of the changer's historical operation and making it possible to detect excessive operation. Other functions cover contact wear per tap, contact overheating (Delta T), a slow tap-change alarm, and monitoring of the OLTC breather.

Cooling system health and control

A cooling failure can trip the transformer. The unit monitors fan and pump current, contactor status and oil flow, giving early fault indication and supporting condition-based maintenance.

Cooling control functions

- Discrete control of more than two cooling stages.
- Dual-speed fan control for low-noise applications.
- Automatic duty-cycle management of parallel pumps, to even out their wear.
- Variable-speed output for coolers driven by a variable-frequency drive.

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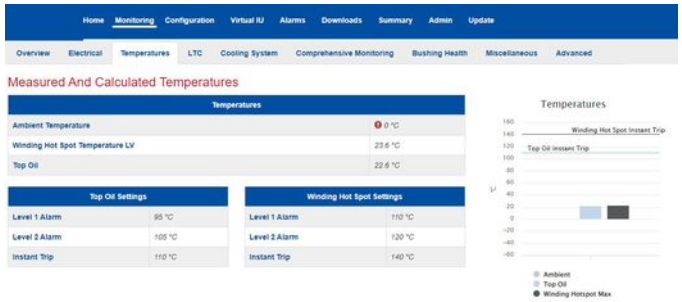
Thermal model, voltage control and fibre optics



Real-time comparison of measured and calculated temperatures: ambient, top oil and winding hot spot, with their alarm levels.

Advanced thermal modelling and hot spot

The thermal model follows the latest industry standards and adjusts the calculated winding hot-spot temperature according to the transformer's design, the cooling system's status, the losses specific to each tap position, and the cooling system's actual efficiency. Winding temperature can also be measured directly with a fibre-optic probe, as an alternative or a complement to the calculation.

Voltage control

The unit can take primary voltage control of a transformer or back up an existing control system, reducing the number of devices on the asset and, with it, the possible points of failure. Line-drop compensation is set using the R and X parameters, with a definite or inverse time delay.

Parallel operation

For transformers operating in parallel, it supports circulating-current, reverse-reactance or master-follower sharing; in the latter case, communication between transformers runs over a fibre-optic connection.

Fibre-optic communications

The main processor module offers a 10/100 Base-T copper network connection and a fibre-optic one, with a built-in switch that lets a maintenance PC connect without interrupting the second network connection.

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A modular, open architecture for monitoring bushings, the OLTC, cooling and dissolved gas on a single platform.

Architecture and modules

C50 control unit, with the main processor module, the power supply module and the input/output cards.

Processor, power supply and communications

The main processor module, the universal power supply module (110-240 VDC or 110-250 VAC; 48 VDC and other voltages on request) and the communications module are mandatory in every configuration. It supports several SCADA connections — critical alarms to operations, diagnostic data to maintenance — plus two RS-485 ports and an optional third one in RS-485, RS-232 or serial fibre, with master or slave operation.

Cooling control and monitoring

Form-C relay cooling control gives a fail-safe design. Each card adds three three-wire Pt100 RTD inputs for temperature, four AC current inputs for load or fan/pump current, and two DC analogue inputs — configurable for 0-1 mA, 4-20 mA or 0-10 VDC.

Annunciator and additional contacts

The annunciator module consolidates the status of alarm contacts, switch positions and contactors, with automatic-reset overcurrent and overvoltage protection. Additional contact cards extend the alarm functions, relay alarms to SCADA or drive local indicators, and are also used to monitor the oil conservator — level, bladder, nitrogen pressure — and load variables such as profile, power factor and voltage level.

Bushing cards and control unit

The sum-of-currents card supports up to six bushing sensors, expandable to twelve inputs; the voltage-reference card supports up to three sensors and three reference signals, with the same expansion capacity. Each control unit combines the processor, communications and power supply modules with one or more expansion cards, housed in a C54 or C59 chassis depending on the number of cards required.

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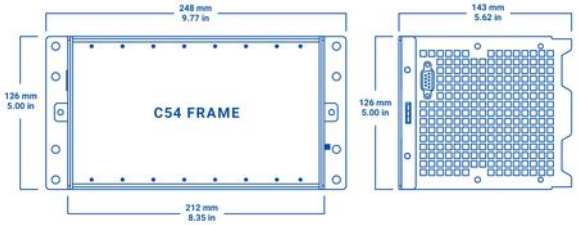
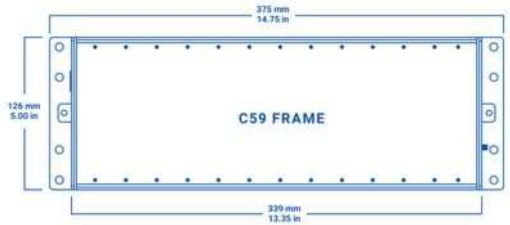
Installation and mounting



C54 chassis: up to four expansion cards, 248 × 212 mm (9.77 × 8.35 in) panel and 126 mm (5.00 in) depth.



C59 chassis: up to nine expansion cards, 375 × 339 mm (14.75 × 13.35 in) panel and 126 mm (5.00 in) depth.

Mounting options

The control unit mounts on a DIN rail or on a panel. The user-interface unit also supports 19″ rack mounting, making it easier to integrate into existing substation cabinets.

C54 and C59 chassis

The C54 chassis houses up to four expansion cards and the C59 up to nine, sharing the same 126 mm (5.00 in) depth; the front panel grows from 248 × 212 mm on the C54 to 375 × 339 mm on the C59 to fit the additional input/output cards.

Choosing a chassis

The chassis is chosen according to how many cards the configuration needs: the C54 is more compact for installations with few optional functions, while the C59 leaves room to expand bushing, OLTC, cooling and voltage-control monitoring within a single enclosure.

Environmental conditions

Both the control unit and the user-interface unit are rated from -40ºC to +70ºC, allowing outdoor installation in the substation's own cabinet.

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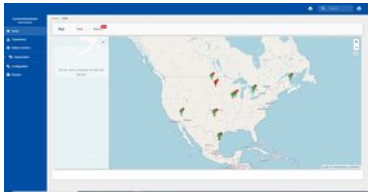
Software: web dashboard and communications

Overview: voltage, current and temperature alarm status.

Voltage control: trend against the defined setpoints.



Multi-site fleet grouped by location.

Built-in web dashboard

Each unit has its own web dashboard, organised into tabs — overview, electrical, temperatures, OLTC, cooling, comprehensive monitoring, bushing health and advanced variables — to analyse and communicate the collected data in a clear format, accessible at any time from any browser on the customer's network and with no software licences.

Voltage control from the dashboard

The voltage-control tab shows the trend of the measured value against the defined setpoints, with their tolerance bands, to optimise power quality and catch a deviation before it affects the load.

Fleet visualisation and management

A companion visualisation platform aggregates data from several units to ease asset-prioritisation decisions across a large transformer fleet: it gives an immediate read of current and historical status and supports more flexible maintenance planning.

Alarms and logging

Condition-based alarms let users act before a problem turns into a costly repair. Each alarm can be routed, via several SCADA connections and email notifications, to the right stakeholders, and grouped into common, major and minor alarms to simplify management.

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C50 — TECHNICAL SPECIFICATIONS

Thermal monitoring	Top oil, ambient and load; calculated hot spot or fibre-optic winding measurement; thermal ageing
Bushings	Sum of currents (6 sensors) or voltage reference (3 sensors + 3 references); expandable to 12 inputs; power factor and capacitance
Partial discharge	Up to 15 electrical channels; tap sensors, RFCTs and Rogowski coils; 2 alarm levels; up to 2 years of history
Dissolved gas and moisture	Serial integration of third-party multi-gas DGA and moisture analysers
OLTC	Tap position, motor current and voltage, Delta T; counter and wear per position; slow tap-change alarm
Cooling	Staged control (Form-C relay); dual-speed fan, parallel pumps, VSD output; 3 RTDs, 4 AC inputs, 2 DC inputs
Voltage control	Primary or backup tap-changer control; R/X compensation; circulating-current, reverse-reactance or master-follower parallel operation (via fibre optics)
Communications	Multi-protocol SCADA; 10/100 copper/fibre-optic Ethernet (FX) with switch; 2×RS-485 + 1 optional RS-485/RS-232/serial fibre; USB; web dashboard
Power supply and environment	110-240 VDC or 110-250 VAC (50-60 Hz), 48 VDC on request; -40°C to +70°C (-40°F to 158°F)
Mounting	DIN rail or panel (control unit); DIN rail, panel or 19″ rack (interface unit)

Control-unit chassis, by number of expansion cards

Parameter	C54	C59
Expansion cards	Up to 4	Up to 9
Front panel	248 × 212 mm (9.77 × 8.35 in)	375 × 339 mm (14.75 × 13.35 in)
Depth	126 mm (5.00 in)	126 mm (5.00 in)

For bushings without a capacitance tap, an 8, 16 or 28 kV coupling capacitor allows the same capacitance and power-factor measurement.
Nameplate values, alarms and voltages shown in the web-dashboard screenshots are illustrative examples and do not constitute a unit specification.

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