



Transformer Monitoring System

Comprehensive on-line diagnostics solution



- on-line diagnostics
- helps optimize machine utilization
- early warning of impending faults

Transformer Monitoring System is intended for on-line diagnostics of transformers and chokes. Constant monitoring permits optimization of machine maintenance and utilization. Early warning of impending faults helps prevent costly equipment repairs and power outages. The functionality of the monitoring system, including integrated mathematical models, has been proven through long-term operation on 400 and 220 kV transformers. Quality, reliability and minimum maintenance are a significant benefit for the customer. The solution incorporates our extensive experience with the implementation of monitoring and control systems for the power industry.

→ Basic Characteristics

The system monitors important transformer operating parameters and equipment status, and regularly performs expert calculations. The system can be adapted to the nature of the monitored machine and the customer's preferences, and in a number of cases the solution can be simplified significantly.

Equipment Status Measurement and Monitoring, Outputs	
Temperatures	Oil temperature in the upper and lower part of the tank
	Tap changer oil temperature
	Outdoor temperature
Electrical parameters	Cooler input and output oil temperature
	Hot-spot temperatures of individual windings if sensors are installed on the transformer
	Transformer winding currents
Equipment status and position	Capacitive bushing voltage
	Cooling system pump operation
	Cooling system fan operation
Dissolved gases in tank oil (as per analyzer)	Transformer tap changer position
	Hydrogen/composite value
	Oil CO content
	Oil moisture content
Contact outputs	Comprehensive on-line DGA analysis, if applicable
Other parameters	Alarm and control outputs
	Optional addition of measurement and signalling



TECHSYS cubicle on the tank of a 350 MVA 400/110 kV transformer

Mathematical Models	
Transformer load and losses	Transformer load
	Immediate transformer losses
	Transformer operating time
	Permitted transformer overloading
IEC 600076-7:2005 ageing calculation	Hot-spot temperatures of individual windings (calculation)
	Transformer ageing rate
	Elapsed transformer life
Insulation moisture Bubble formation	Moisture in winding paper
	Temperature of bubble formation on windings
	Difference between bubble formation temperature and oil temperature
Bushings	Indication of dielectric changes in bushings
	Temperature gradient on coolers, cooling efficiency
Cooling system	Pump operating time
	Fan operating time
Tap changer	Changer position
	Wear due to number of changes and load magnitude
	Difference between changer and transformer oil temperature
Trends	Calculations based on parameter changes
Alarms	Crossing of limit values, trends, operating times

→ Typical Use

On-line diagnostics of power transformers and chokes in transmission and distribution, power station block transformers, forge transformers and important supply transformers.





Detail of measurement connection used for bushing diagnostics on the 400 kV side

→ System Solutions

- central monitoring system unit processes monitored values, performs expert calculations and archives and aggregates data in an SQL database
- values from the central unit are displayed on workstations on the user's intranet
- immediate parameters and mathematical model outputs are presented through convenient graphical screens with live data
- dangerous situations are indicated using configurable alarms and warnings; changes to status parameters and crossing of user-configured parameter limits are signalled in a similar manner
- histories and trends are displayed in graphs and tables. A graph can display multiple parameters with various scales, a magnifying glass can be used and limits can be displayed. Tables can be exported into different formats
- reports can be printed and exported into various formats
- remote diagnostics of the monitoring system cabinet and its contents down to the component level simplifies maintenance

→ Design and Build

- central monitoring system unit, including measuring and signalling inputs, is located in a cabinet mounted on the transformer tank. Sensor, instrument and LAN cables terminate within the cabinet
- design and build of equipment corresponds to its use in an outdoor environment with a high level of interference
- gascontent analyzers for transformer oil can be chosen according to application and customer preferences. Both simple and comprehensive DGA analyzers from GE Energy, Kelman, Morgan Schaffer and a large number of other manufacturers are available
- detectors, sensors, instruments and cabling are suitable for mounting on a transformer

Monitoring System Cabinet Interface	
Temperatures	PT100, PT1000, 20 mA sensors
Winding currents	1/5 A AC inputs Clamp probes for installation without interrupting current 20 mA inputs for AC/DC converters
Voltage in general	100/230 V AC inputs 20 mA inputs for AC/DC converters
Bushing voltage	Measurement using an adaptor connected to the bushing's measuring connector
Equipment status and position signalling	Signalling voltage: 24, 110, 220 V DC 230 V AC
Contact outputs	6 A AC / DC
Power supply	110 to 230 V AC / DC
Serial communication	RS-232, RS-485 with galvanic separation
LAN	Ethernet, fibre optic, metallic

→ Communication, Data Exchange

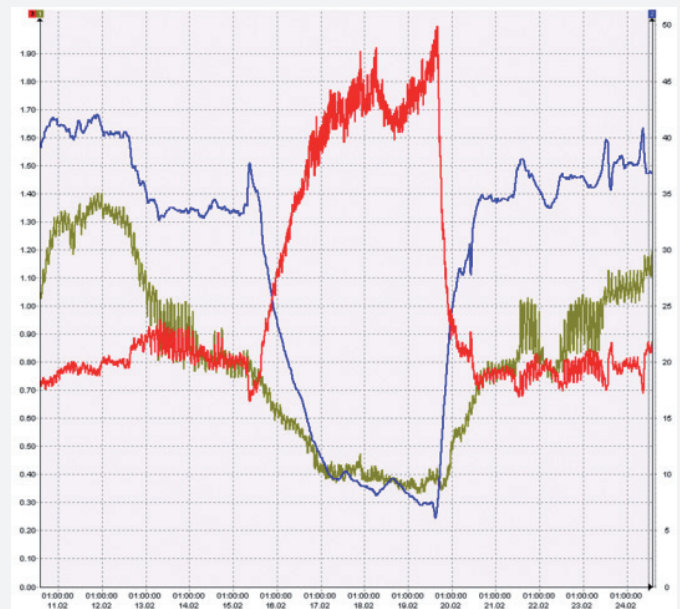
- IEC 60870-5-104, DNP 3.0 TCP, Modbus TCP, IEC 61850-8-1 network protocols
- GPRS communication support, IEC 60870-5-104 protocol
- RS-232/RS-485 IEC 60870-5-101, Modbus RTU serial lines
- ODBC interface for data exchange with information systems

● Přehled		● Přepínač		● Teploty		● Modely		● Ostatní		● Chlazení		● Servis	
HV						LV						TV	
U [kV]	mez	I [A]	mez	U [kV]	mez	I [A]	mez	L1	I [A]	mez	L1	I [A]	mez
L1	415,0	440	180,8	600	L1	119,2	130	622,4	2 000	L1	5,1	6 000	
L2	415,4	440	180,5	600	L2	119,3	130	616,0	2 000	L2	4,4	6 000	
L3	415,6	440	177,6	600	L3	119,3	130	608,8	2 000	L3	5,1	6 000	
Chlazení						Zatížení						MST výstraha	
1	Čerpadlo	■ vstup	57,7 °C		zatížení	130,0 MVA	350			Celková	■		
	Ventilátory	■ výstup	57,1 °C		% zatížení	35,81 %	100						
2	Čerpadlo	□ vstup	57,3 °C		Přepínač								
	Ventilátory	□ výstup	40,0 °C		poloha odbočky	13							
3	Čerpadlo	□ vstup	47,4 °C		Buchhořz relé								
	Ventilátory	□ výstup	39,0 °C		Množství plynu	0 %	0						
4	Čerpadlo	□ vstup	57,3 °C		Calisto								
	Ventilátory	□ výstup	39,7 °C		obsah vodíku	63,0 ppm	100						
5	Čerpadlo	□ vstup	52,4 °C		vlhkost v nádobě	13,0 ppm	30						
	Ventilátory	□ výstup	40,0 °C		Teploty								
6	Čerpadlo	□ vstup	53,4 °C		teplota okolí	23,4 °C	40	50					
	Ventilátory	□ výstup	39,4 °C		teplota horní vrstvy oleje	56,1 °C	80	80					
					teplota dolní vrstvy oleje	45,4 °C	80	80					

Screen with live values of main monitored parameters

→ Monitoring System Delivery

- delivery of a comprehensive system including sensors, dissolved gas content analyzer, installation on the transformer and commissioning. The customer can perform his own installation according to design documentation
- standard solution for distribution transformers with output in the tens of MVA for a favourable price
- specialized solution for monitoring bushings and processing data from dissolved gas content analyzers
- separate module with mathematical modules with inputs from the customer's system



Paper insulation moisture calculation model - red line

Measured values: oil temperature - blue line, oil moisture - green line

