

HYDROCAL 1005

Multi-Gas-in-Oil Analysis System with Transformer Monitoring Functions



The HYDROCAL 1005 is a permanently-installed multi-gas-in-oil analysis system with transformer monitoring functions. It allows for the individual measurement of moisture and the key gases hydrogen (H_2), carbon monoxide (CO), acetylene (C_2H_2) and ethylene (C_2H_4) dissolved in transformer oil.

As hydrogen (H_2) is involved in nearly every fault of the isolation system of power transformers and carbon monoxide (CO) is a sign of an involvement of the cellulosic / paper isolation the presence and increase of acetylene (C_2H_2) and ethylene (C_2H_4) further classifies the nature of a fault as overheating, partial discharge or high energy arcing. The device can serve as a compact transformer monitoring system by the integration / connection of other sensors present on a transformer via its analog inputs:

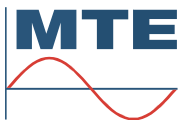
- 4 analog inputs 0/4-20 mADC
- 6 analog inputs 0/4-20 mADC +20% / 0-80 VAC +20% configurable by jumpers

It is further equipped with digital outputs for the transmission of alarms or the execution of control functions (e. g. control of a cooling system of a transformer):

- 5 digital relay outputs
- 5 digital opto-coupler outputs

Key Advantages

- Hydrogen (H_2), Carbon monoxide (CO), acetylene (C_2H_2) and ethylene (C_2H_4) measurement
- Moisture-in-oil measurement
- Communication interfaces ETHERNET 10/100 Mbit/s (copper-wired or fibre-optical) and RS 485 to support proprietary communication protocols and to be open / prepared for substation communication protocols IEC 61850, MODBUS, DNP 3 etc.
- Optional on-board Ethernet, GSM and analog modems for remote communication
- 6 analog AC current inputs for the connection of capacitive HV bushing sensors for HV bushing monitoring applications



Transformer monitoring functions

Voltages and Currents

(via voltage and current transformers / transducer)

Temperature Monitoring

Bottom and oil temperature
(via additional temperatures sensors)

Free configuration

Analogue inputs can be free allocated to any additional sensor

Further Calculations:

Hot-Spot (acc. IEC 60076)

Loss-of-Life

Ageing Rate

Cooling Stage / Tap Changer Position (e.g. via current transducer)

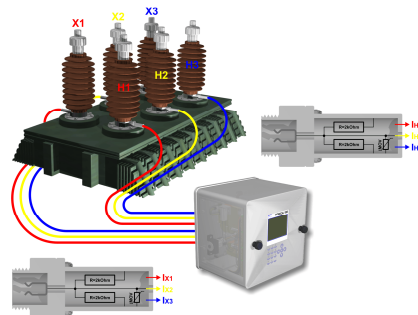
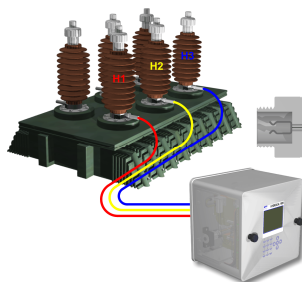
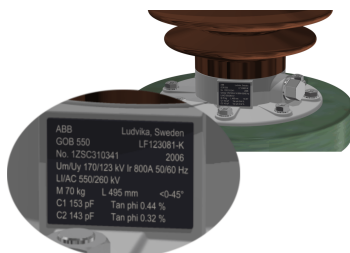
joint R&D design together with
power transformer manufacturer
PAUWELS



HV Bushing Monitoring

HV Bushing / Test tap / Name plate

Test methods: Leakage current
Sum of currents



Capacity C1 and $\tan\delta$ / PF under factory testing are documented on name plate of bushing

Configuration 1:
Monitoring of high voltage side

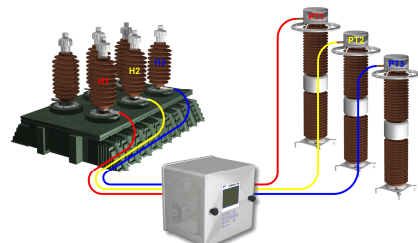
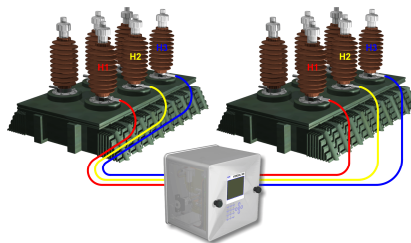
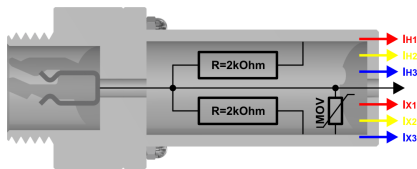
Configuration 2:
Monitoring of high voltage and low voltage side

Bushing sensor

(joint development with
ZTZ Services International,
USA)



Test method: $\tan\delta$ (dissipation factor)
PF (power factor)



Operation principle

Voltage range

Resistive Bridge

69 kV – 765 kV AC
(Bushing / Primary)

Max. 2.5 kV AC
(Sensor / Secondary)

Current range

0 – 140 mA AC

Thread

0.75" / 1.25" / 2.25"

(other configurations available upon request)

Configuration 1:
Reference HV bushing
(from other transformer)

Configuration 2:
Reference CCVT/CCPT

Sensor firmware main menu

User menu

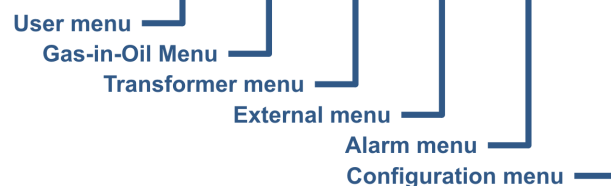
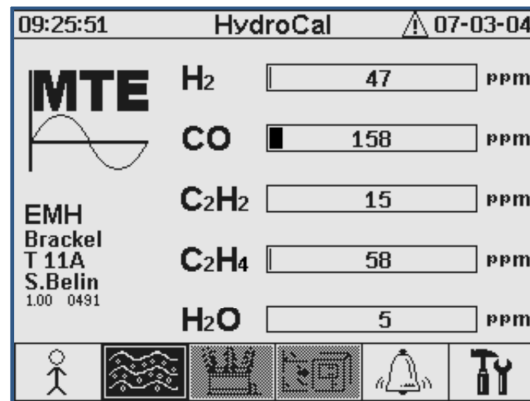
- Transformer administrator data
- Customer / Site administrator data

Gas-in-Oil menu

- Chart diagram
- Result table

Transformer menu

- Aging rate
- Hot spot temperature
- Loss-of-Live



External menu

- Voltage and current measurement
- Bottom and top oil measurement
- Oil humidity measurement

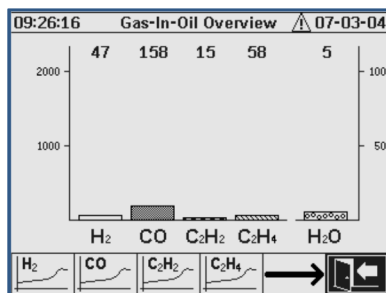
Alarm menu

- Report table
- Alarm acknowledgement

Configuration menu

- Alarm level setting
- Communication setting
- Transformer setting
- Installation

Gas-in-Oil overview menu



Individual chart diagram for hydrogen (H₂), carbon monoxide (CO), acetylene (C₂H₂), ethylene (C₂H₄) and moisture.

Alarm setup / edit menu

| # | Name | Date/Time | Status |
|---|----------------|-------------|--------|
| 1 | H2-Alert(#1) | 04-07 13:12 | [Icon] |
| 2 | CO-Alert(#2) | 04-06 12:15 | [Icon] |
| 3 | C2H2-Alert(#3) | 04-06 12:15 | [Icon] |
| 4 | C2H4-Alert(#4) | 04-06 12:15 | [Icon] |
| 5 | H2O-Alert(#5) | 04-06 12:15 | [Icon] |

Display of alarm list. Details of each alarm and individual settings.

Bushing monitoring setup menu

Bushing Monitoring Setup

Frequency [Hz]: 50

HV Bushing Voltage [kV]: 380

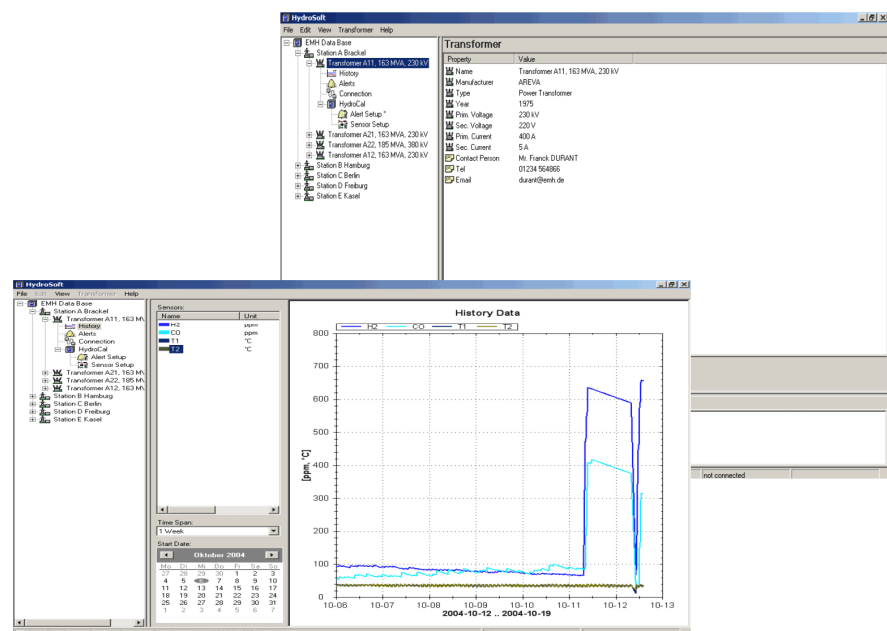
LV Bushing Voltage [kV]: 110

The bushing monitoring setup menu allows the input of all basic parameters required for the bushing monitoring.

PC-Software

Transformer administration data

- All administration data of a transformer can be entered
- Network of different power plants and transformer banks can be configured
- Selective contact to each transformer in the network
- Obtaining information of total transformer situation



Technical data HYDROCAL 1005

General

| | |
|--|--|
| Auxiliary supply: | 88 VAC _{min} ... 276 VAC _{max} Optional: 88 VDC _{min} ... 390 VDC _{max} |
| Power consumption: | max. 350 VA |
| Housing: | Aluminium |
| Dimensions: | W 263 x H 263 x D 257 mm |
| Weight: | Approx. 13.5 kg |
| Operation temperature: (ambient) | -55°C ... +55°C |
| Oil temperature: (inside transformer) | -20°C ... +90°C |
| Oil Pressure: | up to 800 kpa (negative pressure permitted) |
| Connection to valve: | DIN ISO 228: G 1½ Optional: NPT 1½ |

Safety

| | |
|-----------------------|---------------------------|
| Isolation protection: | CE certified |
| Degree of protection: | IEC 61010-1:2002 IP-55 |

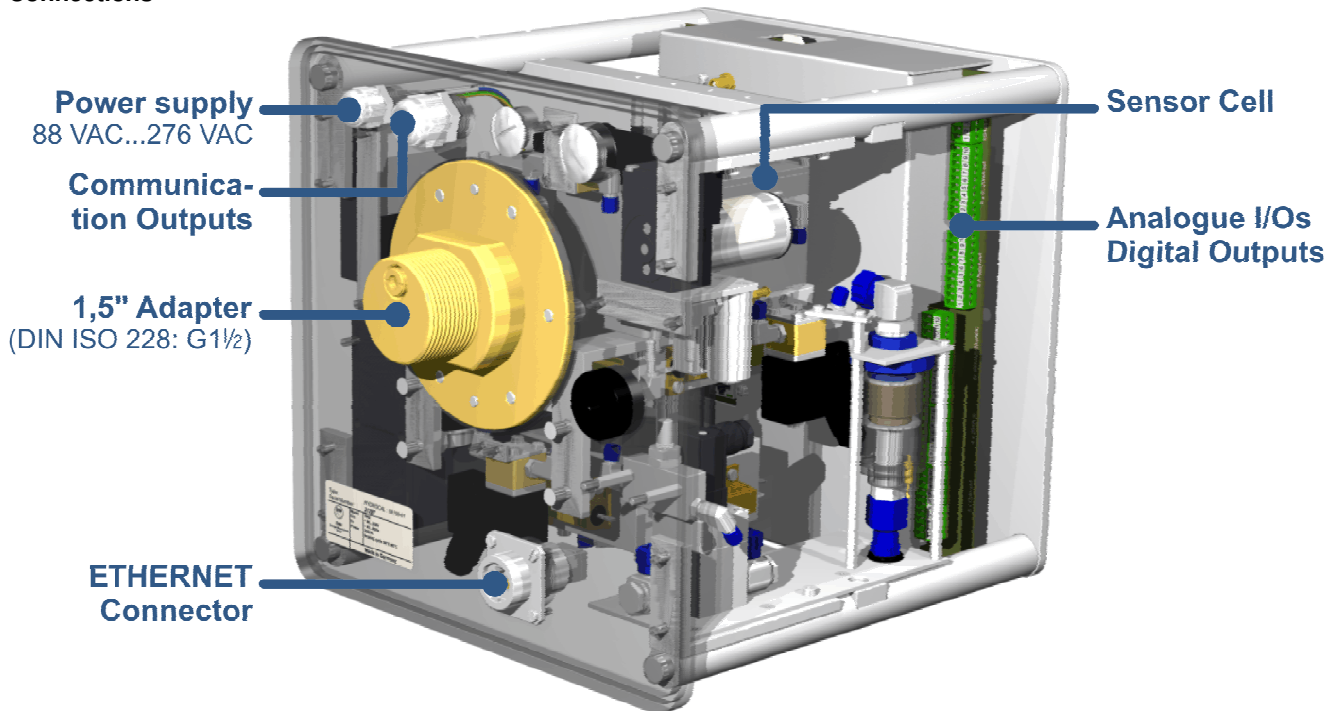
Measurements

| Gas/Humidity-in-Oil Measurement | | |
|---|-----------------|-----------------|
| Measuring Quantity | Range | Accuracy |
| Hydrogen H ₂ | 0 ... 2.000 ppm | ± 15 % ± 25 ppm |
| Carb. Monoxide CO | 0 ... 5.000 ppm | ± 20 % ± 25 ppm |
| Acetylene C ₂ H ₂ | 0 ... 2.000 ppm | ± 20 % ± 5 ppm |
| Ethylene C ₂ H ₄ | 0 ... 2.000 ppm | ± 20 % ± 10 ppm |
| Moisture | 0 ... 100 ppm | ± 3 % ± 3 ppm |

Operation Principle

- Miniaturized gas sample production based on headspace principle (no membrane, negative pressure-proof)
- Patent-pending oil sampling system (EP 1 950 560 A1)
- Infrared NIR gas sensor unit for CO, C₂H₂ and C₂H₄
- Micro-electronic gas sensor for H₂
- Thin-film capacitive moisture sensor

Connections



Analogue and Digital Outputs (standard)

| Analogue DC Outputs | | Default functions | Alternative functions |
|---------------------|-----------------|------------------------------------|-----------------------|
| Type | Range | | |
| Current DC | 0/4 ... 20 mADC | H ₂ Con. | Free config. |
| Current DC | 0/4 ... 20 mADC | CO Con. | Free config. |
| Current DC | 0/4 ... 20 mADC | C ₂ H ₂ Con. | Free config. |
| Current DC | 0/4 ... 20 mADC | C ₂ H ₄ Con. | Free config. |
| Current DC | 0/4 ... 20 mADC | Moisture Con. | Free config. |

| Digital Outputs | | |
|-----------------|-----------------|--------------------------|
| Type | Control Voltage | Max. Switching Capacity |
| Relay | 5 x 12 VDC | 220 VDC/VAC / 2 A / 60 W |

Analogue Inputs and Digital Outputs (optional)

| Analogue DC Inputs (External sensors) | | Accuracy | Remarks |
|---------------------------------------|---------------------|------------------------|---------|
| Type | Range | of the measuring value | |
| Current | 4 x 0/4 ... 20 mADC | ≤ 0.5 % | |

| Analogue AC Inputs (Cap. HV Bushing) | | Accuracy | Remarks |
|--------------------------------------|---|------------------------|-------------------------|
| Type | Range | of the measuring value | |
| Voltage or Current | 6 x 0 ... 80 V +20% 6 x 0/4 ... 20 mA +20% | ≤ 1.0 % | Configurable via jumper |

| Digital Outputs | | |
|-----------------|-----------------|---|
| Type | Control Voltage | Max. Switching Capacity |
| Opto-coupler | 5 x 5 VDC | U _{CE} : 4 V (rated) / 35 V (max.) U _{EC} : 7 V (max.) U _{CE} : 40 mA (max.) |

Analogue Outputs

Communication

- ETHERNET 10/100 Mbit/s (copper-wired or fibre-optical)
- RS 485 (proprietary or MODBUS protocol)
- On-board GSM or analog modem (optional)