MTE Meter Test Equipment

HYDROCAL 1009

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

The HYDROCAL 1009 is a permanently installed multi-gas-in-oil analysis system with transformer monitoring functions. It individually measures, Moisture in Oil (H_2O) and the key gases Hydrogen (H_2), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Methane (CH_4), Acetylene (C_2H_2), Ethylene (C_2H_4), Ethane (C_2H_6) and Oxygen (O_2) dissolved in transformer oil.

As Hydrogen (H_2) is involved in nearly every fault of the insulation system of power transformers and Carbon Monoxide (CO) is a sign of an involvement of the cellulosic / paper insulation 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. Oxygen (O_2) can be a sign of excessive ageing or leakages within the sealing of hermetic transformers.

The device can serve as a compact transformer monitoring system by the integration / connection of other sensors present on a transformer via its optional analog inputs:

- 4 Analog inputs 0/4 ... 20mADC
- 6 Analog inputs 0/4 ... 20mAAC +20% or 0 ... 80 VAC +20% (configurable by jumpers)

Key Advantages

- Individual measurement of Hydrogen (H_2), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Methane (CH_4), Acetylene (C_2H_2), Ethylene (C_2H_4), Ethane (C_2H_6) and Oxygen (O_2)
- Moisture in Oil (H_2O) measurement
- Easy to mount on a transformer valve (G 1½" DIN ISO 228-1 or 1½" NPT ANSI B 1.20.1)
- Installation on the operational transformer without any operational interruption
- Advanced software (on the unit and via PC)
- Maintenance free system
- Communication interfaces ETHERNET 10/100 Mbit/s (copper-wired / RJ 45 or fibre-optical / SC Duplex) and RS 485 to support MODBUS®RTU/ASCII, MODBUS®TCP, DNP3 proprietary communication and IEC 61850 protocols
- Optional 2G/3G modem with external adhesive antenna
- Optional DNP3 serial modem for SCADA connection
- Optional IEC 61850 modem for SCADA connection
- Optional HV and LV bushing sensors for HV and LV bushing monitoring applications via communication interface

Transformer monitoring functions

Voltages and Currents
(via voltage and current transformers / transducer)

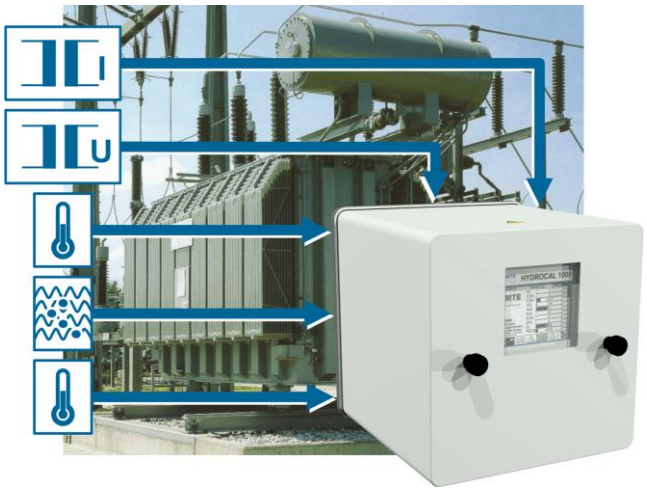
Temperature Monitoring
Bottom and top oil temperature, ambient temperature
(via additional temperature sensors)

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

Free configuration
Analog inputs can be free allocated to any additional sensor

Further Calculations:

Hot-Spot (acc. IEC 60076) } joint development
Loss-of-Life } with PAUWELS
Ageing Rate } Belgium



HV and LV Bushing monitoring functions (option)

The Bushing Monitoring System simultaneously monitors the bushing leakage current of 2, three phase groups of bushings. The Bushing Monitoring system incorporates three different measurement modes on each tested component to provide accurate Power Factor and Capacitance values to evaluate the condition of bushing insulation. The measurement modes are:

Phase comparison
Compares the power factor of tested component with another tested component energized with the same phase voltage

Sum of three current test
Measures the imbalance current from the summation of A, B and C phase currents from three tested components such as the three HV or LV bushings on the transformer

Adjacent phase reference test
compares the power factor of the tested components with other phase components on the same equipment

The bushing sensors / adapters are connected to the capacitor taps designed for all types of bushings to allow measurement of the leakage current up to 140 mA. The adapters are designed for bushings with grounded and undergrounded capacitor taps. The adapter is designed to prevent a voltage developing on the equipment should the sensor become disconnected from Bushing Monitoring System.

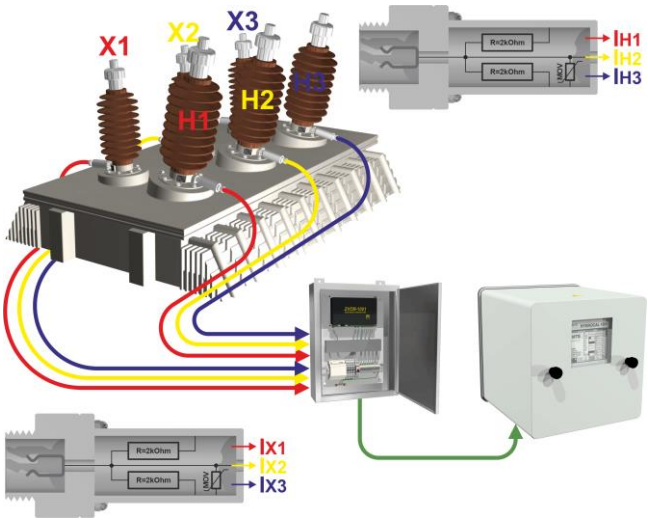
Different bushing sensor configurations possible:

- Monitoring of high voltage side
- Monitoring of high- and low voltage side
- Reference HV bushing from other transformers
- Reference CCVT / CCPT

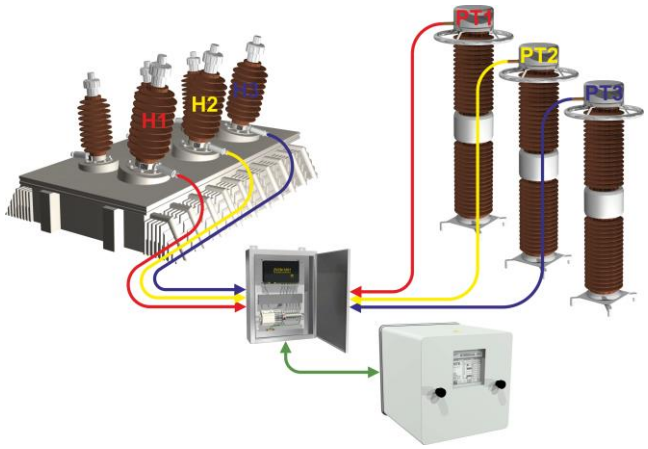
Configuration with 3, 6, 9[1)] or 12[1)] bushing sensors possible.

Notes

[1)] Two Bushing Monitoring units necessary



Monitoring of high- and low voltage side



Reference CCVT / CCPT

Joint development with ZTZ Services

HYDROCAL firmware main menu

1 **Extraction status**

- Shows the actual operating status of the unit

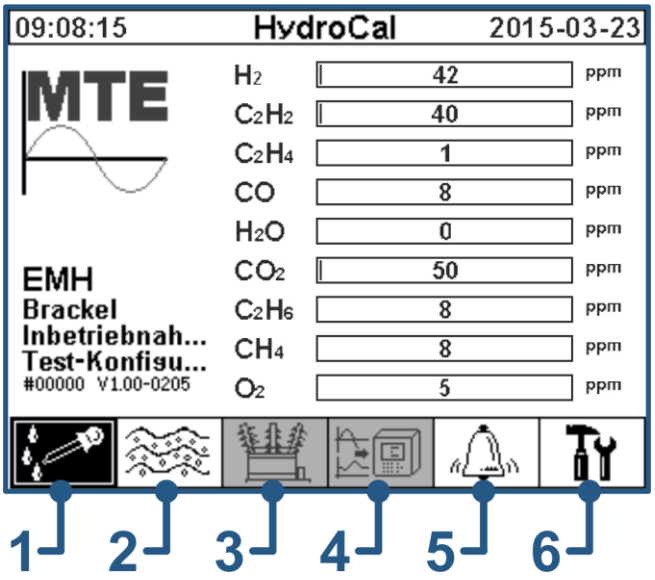
2 **Gas-in-oil overview**

- Column chart
- Trend graph
- Data table

3 **Transformer specific measurements**

- Trend graph
- Data table

(to be included)



4 **Additional sensor measurements**

- Trend graph
- Data table

(to be included)

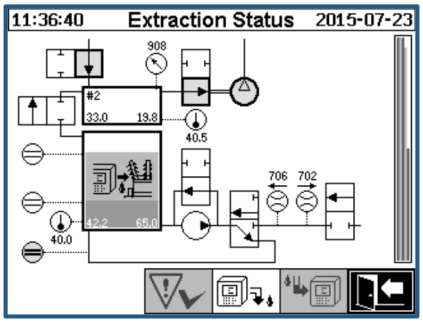
5 **Alert overview**

- Alert acknowledgement
- Alert table

6 **Device setup**

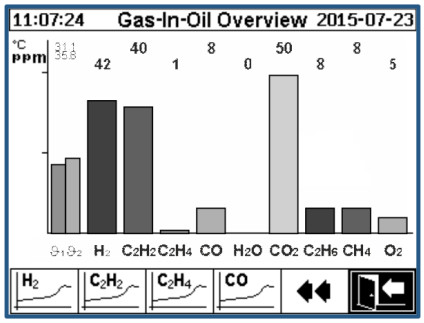
- Alert level setting
- Communication setting
- Transformer setting
- In- and output setting

Extraction status



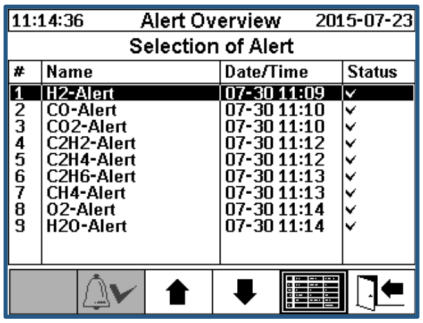
Shows the status of the actual process step and information of safety functions.

Gas-in-oil overview



Individual chart diagram for Hydrogen (H_2), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Methane (CH_4), Acetylene (C_2H_2), Ethylene (C_2H_4), Ethane (C_2H_6), Oxygen (O_2) and Moisture in Oil (H_2O) and temperatures.

Alert overview

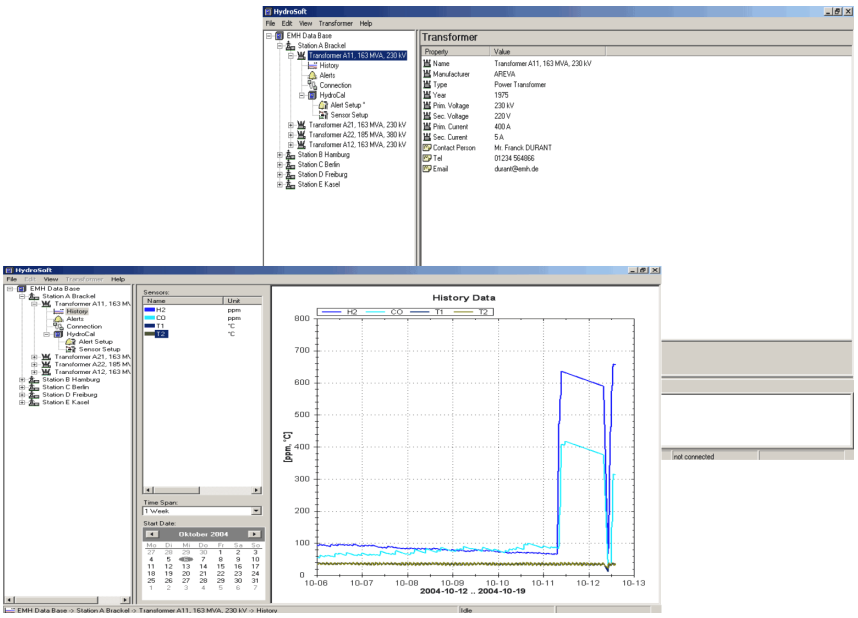


Display of alarm list. Details of each alarm and individual settings are shown.

HydroSoft PC-Software

Program key features

- Configuration and administration of each individual HYDROCAL unit
- Data and configuration read out of HYDROCAL units
- Processing and presentation of data read out (trend or table)
- Online functions (online sensors, extraction status and process flow)
- Diagnostic functions (Duval triangle and Rogers 3D graphic)
- Further processing of the processed data (Excel, CSV, clipboard and printing)
- Storage of the processed data and unit configuration
- Automatic data read out and alerting by e-mail



Technical data HYDROCAL 1009

General

Optional nominal voltages of auxiliary supply:	120 V -20% +15% AC 50/60 Hz [1] or 230 V -20% +15% AC 50/60 Hz [1] or 120 V -20% +15% DC [1] or 230 V -20% +15% DC [1] Other nominal voltages on request!
Power consumption:	max. 600 VA
Housing:	Aluminum
Dimensions:	W 263 x H 274 x D 331 mm
Weight:	approx. 15 kg
Operation temperature: (ambient)	-55°C ... +55°C (below -10°C display function locked)
Oil temperature: (in the transformer)	-20°C ... +90°C
Storage temperature: (ambient)	-20°C ... +65°C
Oil Pressure:	0 - 800 kpa (negative pressure allowed)
Connection to valve:	G 1½" DIN ISO 228-1 or 1½" NPT ANSI B 1.20.1

Safety

	CE certified
Insulation protection:	IEC 61009-1:2002
Degree of protection:	IP-55

Measurements

Gas/Moisture in oil Measurement		Accuracy [2] [3]
Measuring quantity	Range	
Hydrogen H_2	0 ... 10.000 ppm	± 15 % ± 25 ppm
Carbon Monoxide CO	0 ... 10.000 ppm	± 20 % ± 25 ppm
Carbon Dioxide CO_2	0 ... 20.000 ppm	± 20 % ± 25 ppm
Methane CH_4	0 ... 5.000 ppm	± 20 % ± 25 ppm
Acetylene C_2H_2	0 ... 10.000 ppm	± 20 % ± 5 ppm
Ethylene C_2H_4	0 ... 10.000 ppm	± 20 % ± 10 ppm
Ethane C_2H_6	0 ... 10.000 ppm	± 20 % ± 15 ppm
Oxygen O_2	0 ... 50.000 ppm	± 10 % ± 1000 ppm
Moisture H_2O (aw)	0 ... 100 %	± 3 %
Moisture in Mineral Oil	0 ... 100 ppm	± 3 % ± 3 ppm
Moisture in synt. Ester[5]	0 ... 2.000 ppm	± 3 % of MSC[6]

[5]Option [6]Moisture Saturation Content

Operation principle

- Miniaturized gas sample production based on headspace principle (no membrane, negative pressure proofed)
- Patent-pending oil sampling system (EP 1 950 560 A1)
- Near-infrared gas sensor unit for CO, C_2H_2 and C_2H_4
- Near-infrared gas sensor unit for CO_2, CH_4 and C_2H_6
- Micro-electronic gas sensor for H_2 and O_2
- Thin-film capacitive moisture sensor H_2O
- Temperature sensors (for oil and gas temperature)

Analog and digital outputs

10 x Analog DC outputs		Default concentration (Free assignment)
Type	Range	
1 x Current DC	0/4 ... 20 mADC	Hydrogen H_2
1 x Current DC	0/4 ... 20 mADC	Carbon Monoxide CO
1 x Current DC	0/4 ... 20 mADC	Carbon Dioxide CO_2
1 x Current DC	0/4 ... 20 mADC	Methane CH_4
1 x Current DC	0/4 ... 20 mADC	Acetylene C_2H_2
1 x Current DC	0/4 ... 20 mADC	Ethylene C_2H_4
1 x Current DC	0/4 ... 20 mADC	Ethane C_2H_6
1 x Current DC	0/4 ... 20 mADC	Oxygen O_2
1 x Current DC	0/4 ... 20 mADC	Moisture in Oil H_2O
1 x Current DC	0/4 ... 20 mADC	Free programmable

10 x Digital outputs		Max. Switching capacity (Free assignment)
Type	Control voltage	
10 x Relay	12 VDC	220 VDC/VAC / 2 A / 60 W

Analog inputs and digital outputs (option)

6 x Analog AC inputs		Accuracy	Remarks
Type	Range	of the measuring value	
6 x Current AC **or** **6 x Voltage AC**	0/4 … 20 mA +20% or 0 ... 80 V +20%	≤ 1.0 %	Configurable by jumpers [4]

4 x Analog DC inputs		Accuracy	Remarks
Type	Range	of the measuring value	
4 x Current DC	0/4 ... 20 mADC	≤ 0.5 %	

5 x Digital outputs		Max. Switching capacity (Free assignment)
Type	Control Voltage	
5 x Optocoupler	5 VDC	U_{CE}: 24 V rated / 35 V max. U_{EC}: 7 V max. I_{CE}: 40 mA max.

Communication

- RS 485 (proprietary or MODBUS® RTU/ASCII protocol)
- ETHERNET 10/100 Mbit/s copper-wired / RJ 45 or fibre-optical / SC Duplex (proprietary or MODBUS® TCP protocol)
- 2G/3G modem with external adhesive antenna (optional) (proprietary protocol
- DNP3 serial modem (Option)
- IEC 61850 modem (Option)

Notes

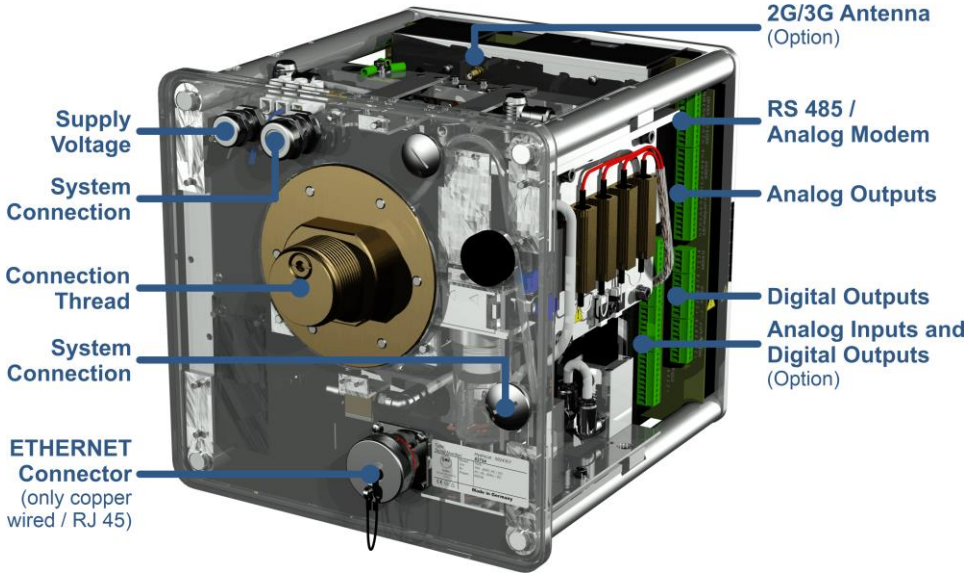
[1] **120 V** ⇨ 120 V -20% = **96 V_{min}** 120 V +15% = **138 V_{max}**
230 V ⇨ 230 V -20% = **184 V_{min}** 230 V +15% = **264 V_{max}**

[2] Related to temperatures ambient +20°C and oil +55°C

[3] Accuracy for moisture in oil for mineral oil types

[4] Default jumper configuration: Current

Connections



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