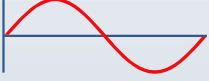
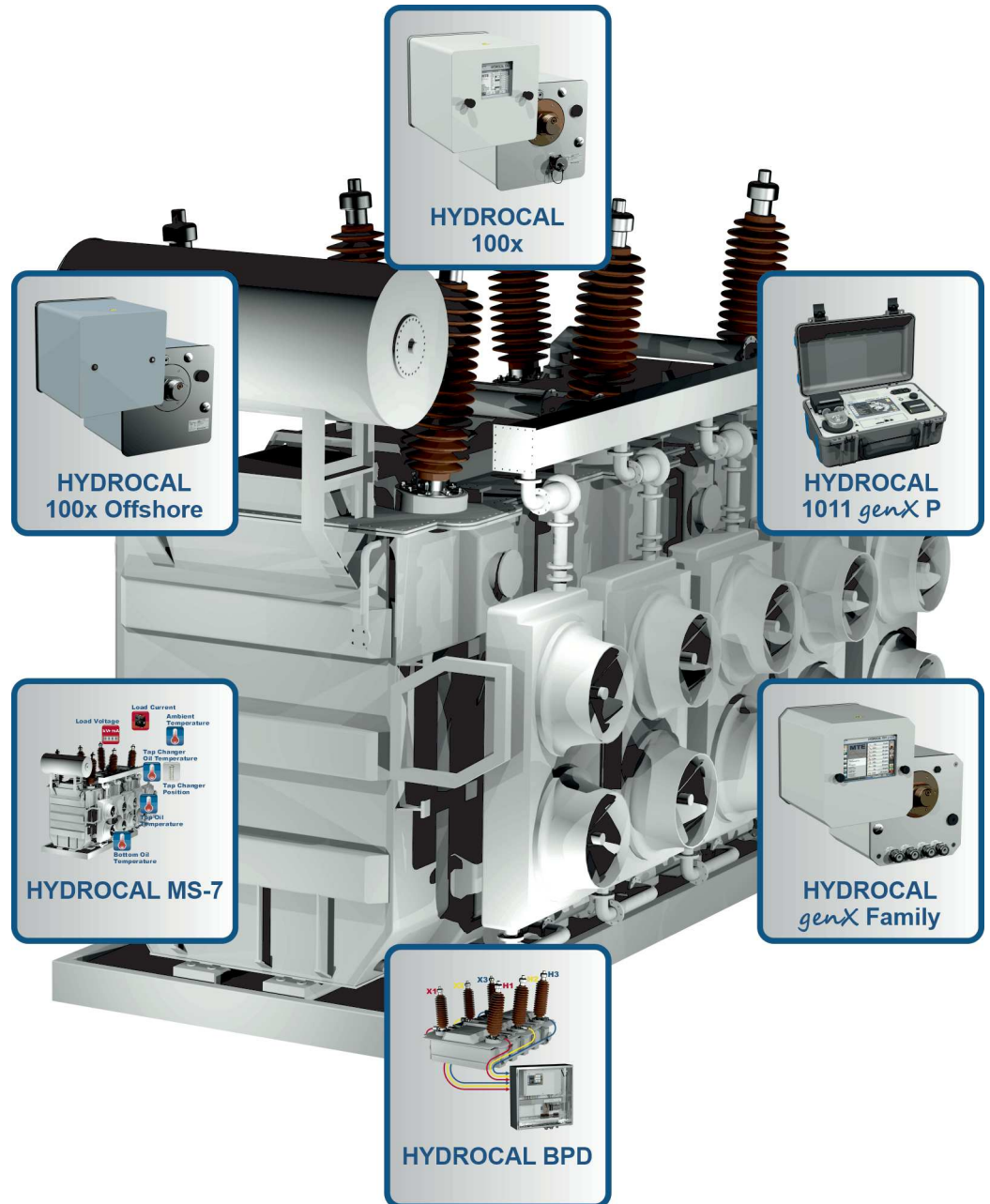


MTE



Meter Test Equipment



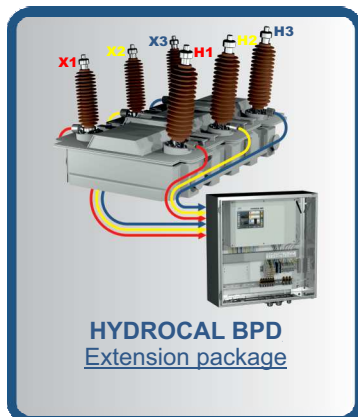
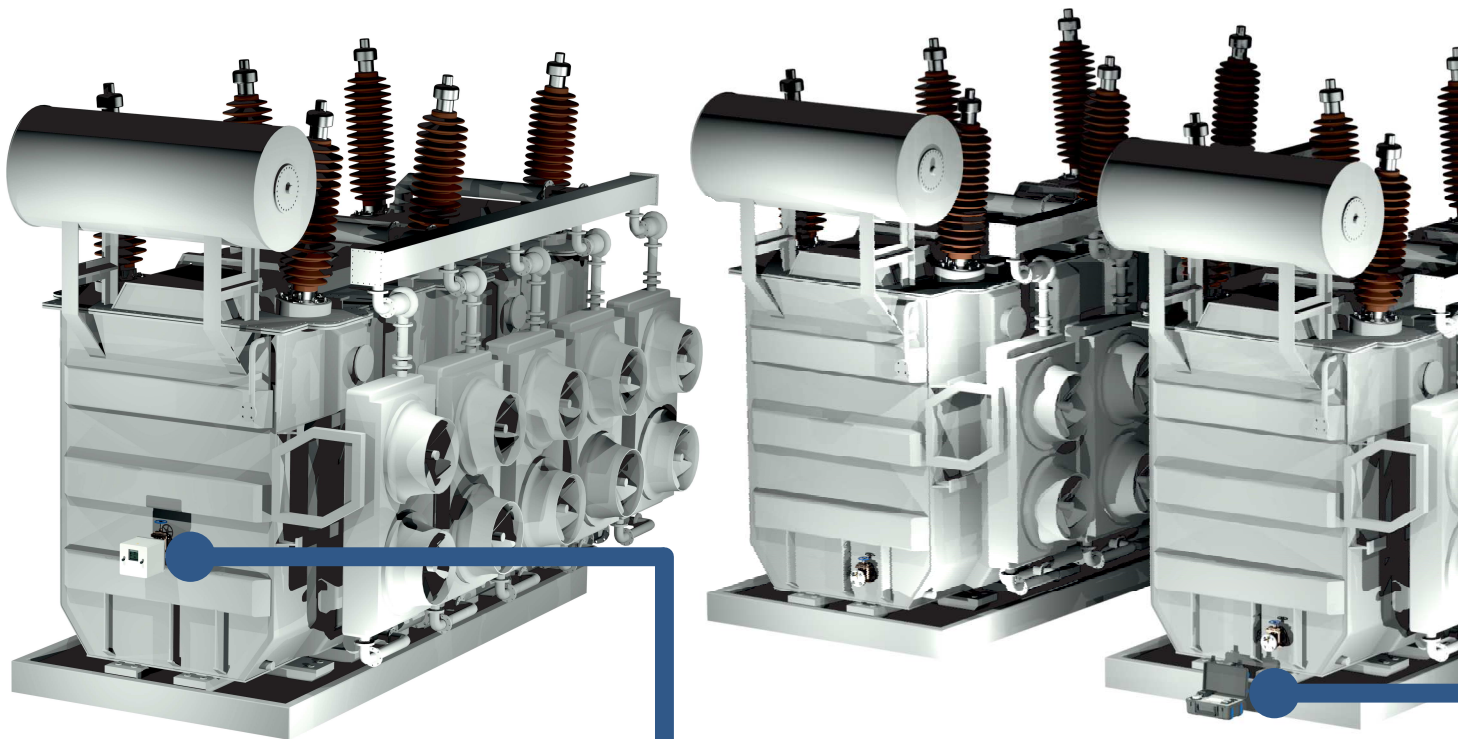
Transformer Monitoring

Overview and MTE's approach

Transformers are crucial for failure-free and stabilized operation of high-voltage power transmission. Transformer failures or disruptions can result in costly power outages or even in the total loss of expensive plant assets. Moreover transformers are the most cost intensive single component assets in high-voltage power transmission and should therefore be supervised with special care.

Analysis of the gases dissolved in power transformer oil is recognized as the most useful tool for early detection and diagnosis of incipient faults in transformers. The cost effectiveness of online dissolved gas analysis (DGA) and control systems are gaining importance worldwide.

With its comprehensive product range for the online monitoring of transformers, MTE offers both the extension of the transformer lifetime and the contribution to a more secure high-voltage power transmission.

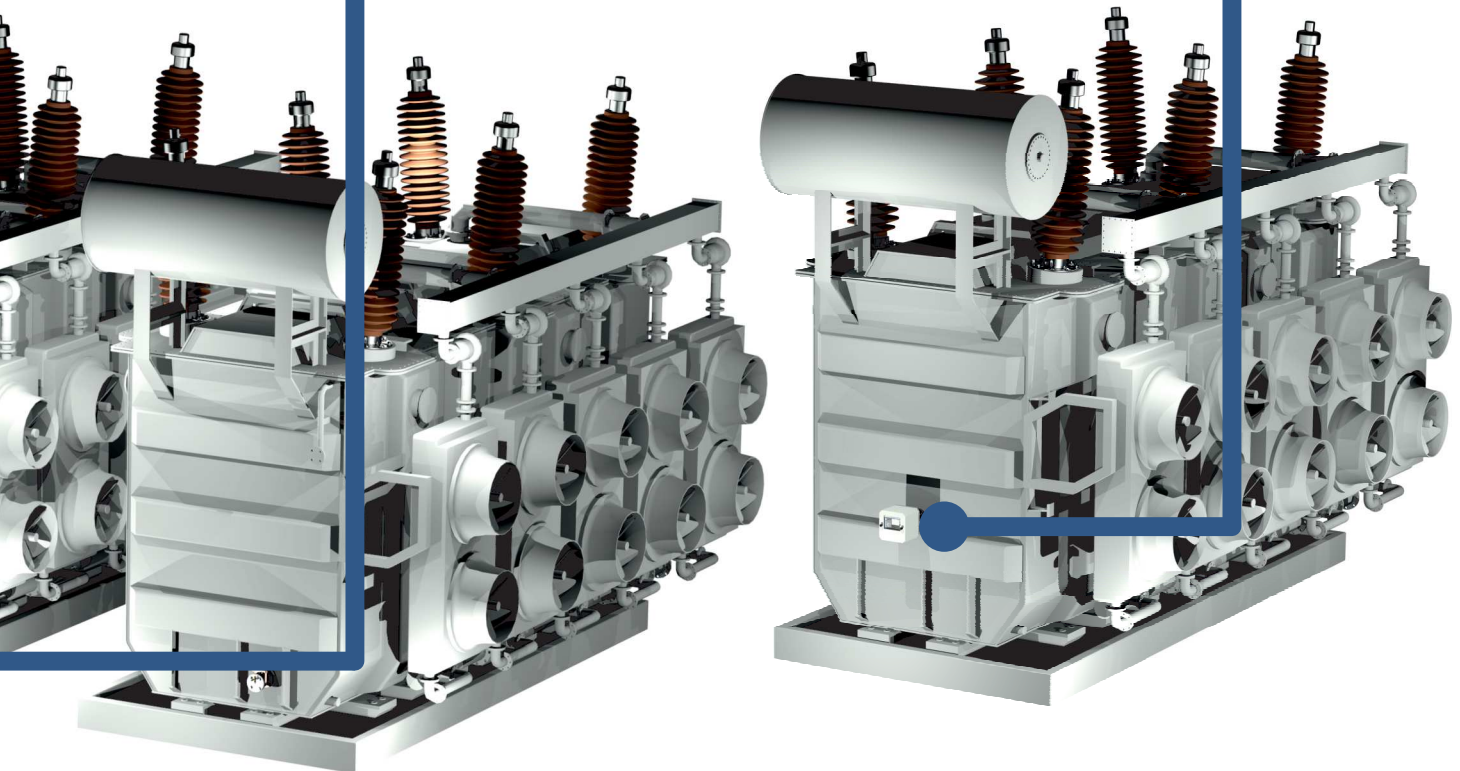




HYDROCAL 1011 genX P
Portable Dissolved
Gas Analysis







HYDROCAL genX
Truly maintenance-
free online DGA



Advantages of MTE's solutions for Transformer Monitoring






- Permanent online monitoring of transformer condition
- Early warning
- Less risk of expensive power outages
- Reduced on-site inspections
- Maintenance free system
- Extending transformer life time due to improved preventative maintenance and faster reaction time in case of failures
- Modular system components and extension packages for the specific customer requirements
- Easy and fast mounting on the operating transformer (HYDROCAL 100x, genX and Offshore versions)
- Approved solution with more than 9'300 supplied units

Product portfolio

	HYDROCAL 1001+ 	HYDROCAL 1003 	HYDROCAL 1004 genX 	HYDROCAL 1005 
Gas-in-oil analysis	H ₂ CO CH ₄ C ₂ H ₂ C ₂ H ₄ C ₂ H ₆ (composite)	H ₂ CO (individual)	H ₂ CO C ₂ H ₂ (individual)	H ₂ CO C ₂ H ₂ C ₂ H ₄ (individual)
Moisture in oil analysis (H₂O)	✓	✓	✓	✓
Transformer monitoring inputs / outputs	N/A	✓	✓	✓
Offshore suitable ¹⁾	N/A	✓	N/A	✓
HYDROCAL MS-7 ²⁾	N/A	✓	N/A	✓
Bushing and PD Monitor HYDROCAL BPD ²⁾	N/A	N/A	✓	✓
Communication	TCP/IP, RS 485, MODBUS	RS 232, RS 485, MODBUS	TCP/IP, RS 485, MODBUS	TCP/IP, RS 485, MODBUS
(Options)		TCP/IP, IEC 61850 DNP 3.0, 3G Modem	IEC 61850 DNP 3.0, 3G Modem	IEC 61850 DNP 3.0, 3G Modem

1) Special version with corrosive protection for the installation on offshore platforms

2) Extension packages (options)

HYDROCAL 1006 genX 	HYDROCAL 1008 	HYDROCAL 1009 	HYDROCAL 1011 genX 	HYDROCAL 1011 genX P 
H ₂ CO CH ₄ C ₂ H ₂ C ₂ H ₄ (individual)	H ₂ CO CO ₂ CH ₄ C ₂ H ₂ C ₂ H ₄ C ₂ H ₆ (individual)	H ₂ CO CO ₂ CH ₄ C ₂ H ₂ C ₂ H ₄ C ₂ H ₆ O ₂ (individual)	H ₂ CO CO ₂ CH ₄ C ₂ H ₂ C ₂ H ₄ C ₂ H ₆ C ₃ H ₈ O ₂ N ₂ (individual)	H ₂ CO CO ₂ CH ₄ C ₂ H ₂ C ₂ H ₄ C ₂ H ₆ C ₃ H ₈ O ₂ N ₂ (individual)
✓	✓	✓	✓	✓
✓	✓	✓	✓	N/A
N/A	N/A	✓	N/A	N/A
N/A	✓	✓	N/A	N/A
✓	✓	✓	✓	N/A
TCP/IP, RS 485, MODBUS IEC 61850 DNP 3.0, 3G Modem	TCP/IP, RS 485, MODBUS IEC 61850 DNP 3.0, 3G Modem	TCP/IP, RS 485, MODBUS IEC 61850 DNP 3.0, 3G Modem	TCP/IP, RS 485, MODBUS IEC 61850 DNP 3.0, 3G Modem	ETHERNET, WLAN / WiFi, USB Type B

Early warning



HYDROCAL 1001+

The HYDROCAL 1001+ is a permanently installed composite gas in oil sensor for the Total Dissolved Combustible Gases (TDCG) analysis of the key fault gases Hydrogen (H₂), Carbon Monoxide (CO), Methane (CH₄), Acetylene (C₂H₂), Ethylene (C₂H₄) and Ethane (C₂H₆).

To detect an even wider range of potential transformer faults, the HYDROCAL 1001+ analyses additionally the content of Moisture (H₂O) in the transformer oil.

The HYDROCAL 1001+ is a fully integrated (6 key fault gases and Moisture in oil) compact and cost effective

device used in particular for early transformer fault detection and preventative maintenance.

Key advantages:

- Cost effective and comprehensive monitoring of 6 fault gases
- Measurement of Moisture (H₂O) in the transformer oil
- Easy and fast installation while the transformer is operating
- Compact and resistant design for long lasting usage
- ETHERNET and RS 485 interfaces to support MODBUS[®]TCP proprietary communication



HYDROCAL 1003

The HYDROCAL 1003 is an online transformer monitoring device for the dissolved gas analysis (DGA) of the key fault gases Hydrogen (H₂) and Carbon Monoxide (CO).

In addition, water contamination deteriorates the performance of the oil as high moisture content increases the risk of corrosion and overheating.

The HYDROCAL 1003 reacts on this issue and provides its users the analysis of Moisture

(H₂O) in the transformer oil to achieve an even higher safety standard.

Key advantages:

- Easy to mount on the operating transformer without any operational interruption
- ETHERNET (Option), RS 232 and RS 485 interfaces to support MODBUS[®]RTU/ASCII, DNP3 proprietary communication and IEC 61850 protocols
- Option: Offshore version



HYDROCAL 1004 genX

The HYDROCAL 1004 genX is the first truly maintenance free multi-gas online DGA solution combining proven near infrared (NIR) measuring technology with vacuum protected membrane extraction.

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) further classifies the nature of a fault as overheating, partial discharge or high energy arcing.

Key advantages:

- Maintenance free system
- Easy to mount on the operating transformer without any operational interruption
- Advanced software (on the unit and via PC) with intuitive operation by 7" color TFT capacitive touchscreen, WLAN and Webserver operation from any smart phone, tablet or notebook PC
- ETHERNET and RS 485 interfaces to support MODBUS[®] RTU/ASCII, MODBUS[®] TCP, DNP3 proprietary communication and IEC 61850 protocols



HYDROCAL 1005

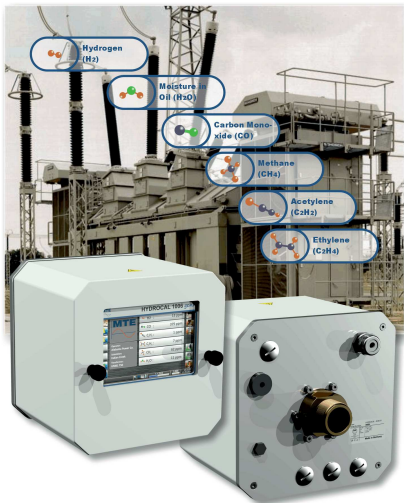
The HYDROCAL 1005 is a permanently installed multi-gas-in-oil analysis system with transformer monitoring functions. It individually measures Moisture in oil (H_2O) and the key gases Hydrogen (H_2), Carbon Monoxide (CO), Acetylene (C_2H_2) and Ethylene (C_2H_4) dissolved in the transformer oil.

Especially 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 HYDROCAL 1005 acts as a compact transformer monitoring system by the integration of other sensors present on a transformer (HYDROCAL MS-7 and / or HYDROCAL BPD extension packages).

Key advantages:

- Easy to mount on the operating transformer without any operational interruption
- ETHERNET and RS 485 interfaces to support MODBUS[®] RTU/ASCII, MODBUS[®] TCP, DNP3 proprietary communication and IEC 61850 protocols
- Option: Offshore version



HYDROCAL 1006 genX

The HYDROCAL 1006 genX is the first truly maintenance free multi-gas online DGA solution combining proven near infrared (NIR) measuring technology with vacuum protected membrane extraction.

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) further classifies the nature of a fault as overheating, partial discharge or high energy arcing.

The additional measurement of Methane (CH_4) serves for

further analysis, e.g. Duval triangle acc. IEC 60599

Key advantages:

- Maintenance free system
- Easy to mount on the operating transformer without any operational interruption
- Advanced software (on the unit and via PC) with intuitive operation by 7" color TFT capacitive touchscreen, WLAN and Webserver operation from any smart phone, tablet or notebook PC
- ETHERNET and RS 485 interfaces to support MODBUS[®]RTU/ASCII, MODBUS[®]TCP, DNP3 proprietary communication and IEC 61850 protocols



HYDROCAL 1008

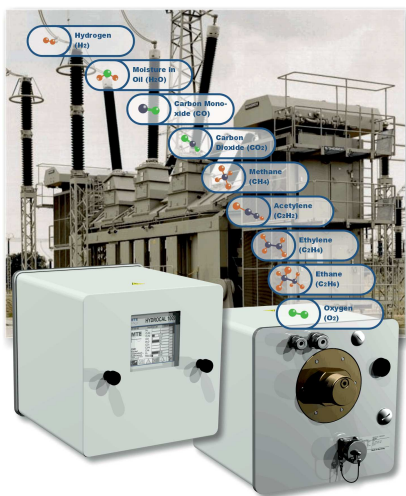
The HYDROCAL 1008 is a permanently installed multi-gas-in-oil analysis system with transformer monitoring functions. It individually measures Moisture in oil (H_2O) and the key gases Hydrogen (H_2), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Methane (CH_4), Acetylene (C_2H_2), Ethylene (C_2H_4) and Ethane (C_2H_6) dissolved in the transformer oil.

The HYDROCAL 1008 acts as a compact transformer monitoring system by the integration of other sensors

present on a transformer (HYDROCAL MS-7 and / or HYDROCAL BPD extension packages).

Key advantages:

- Easy to mount on the operating transformer without any operational interruption
- ETHERNET and RS 485 interfaces to support MODBUS[®]RTU/ASCII, MODBUS[®]TCP, DNP3 proprietary communication and IEC 61850 protocols



HYDROCAL 1009

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.

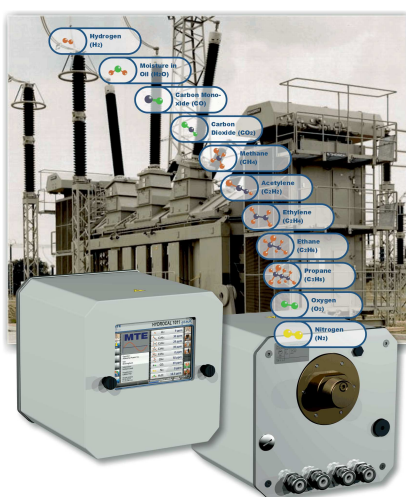
Oxygen (O_2) can be a sign of excessive ageing or leakages within the sealing of hermetic transformers.

The HYDROCAL 1009 is MTE's most comprehensive

transformer monitoring system, which can be even expanded with different extension packages (HYDROCAL MS-7 and / or HYDROCAL BPD extension packages).

Key advantages:

- Easy to mount on the operating transformer without any operational interruption
- ETHERNET and RS 485 interfaces to support MODBUS[®]RTU/ASCII, MODBUS[®]TCP, DNP3 proprietary communication and IEC 61850 protocols
- Option: Offshore version



HYDROCAL 1011 genX

The new HYDROCAL 1011 genX is a full-range / maintenance-free multi-gas online DGA solution combining proven near infrared (NIR) measuring technology with miniaturized gas sample production based on headspace principle (no membrane, negative pressure-proofed).

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), Oxygen (O_2), Nitrogen (N_2) and Propane (C_3H_8) dissolved in transformer oil.

Key advantages:

- Moisture in Oil (H_2O) measurement
- Easy to mount on the operating transformer without any operational interruption
- Advanced software (on the unit and via PC) with intuitive operation by 7" color TFT capacitive touchscreen, WLAN and Webserver operation from any smart phone, tablet or notebook PC
- ETHERNET and RS 485 interfaces to support MODBUS[®]RTU/ASCII, MODBUS[®]TCP, DNP3 proprietary communication and IEC 61850 protocols

Portable DGA and Software



HYDROCAL 1011 genX P

The HYDROCAL 1011 genX P is a portable device for the analysis of dissolved and free gases from the insulation fluid of oil-filled power transformers and other electrical equipment. 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), Oxygen (O_2), Nitrogen (N_2) and Propane (C_3H_8) dissolved in transformer oil.

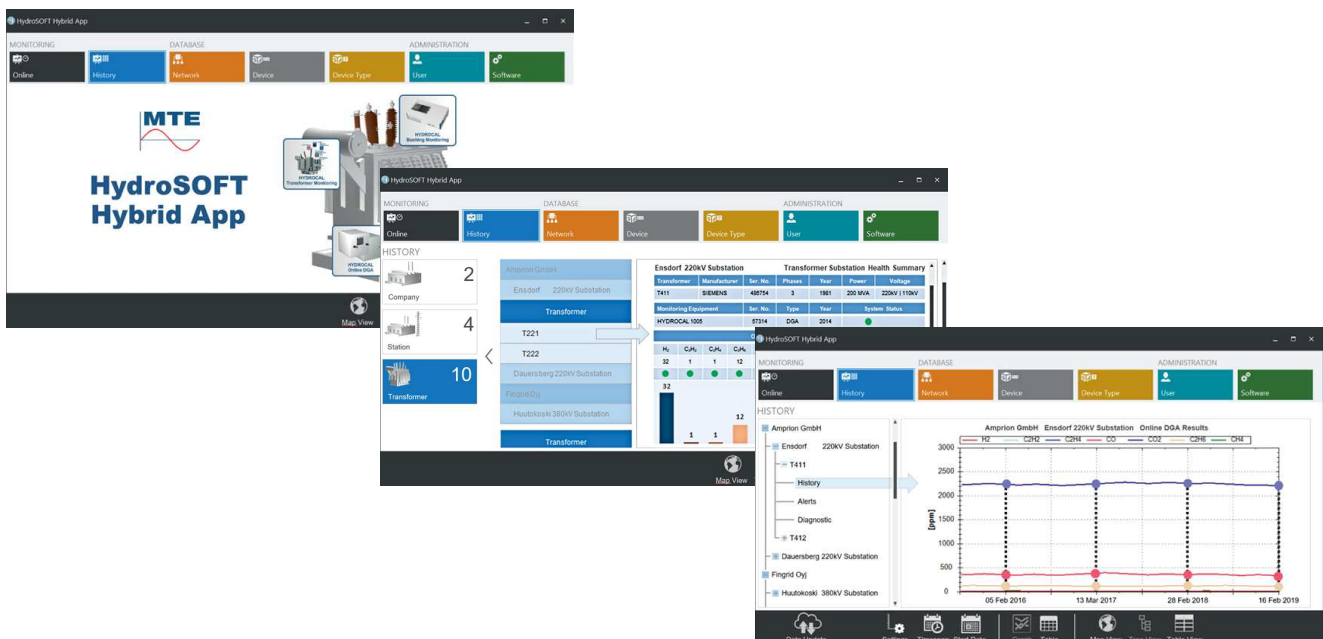
Key advantages:

- Maintenance-free near infrared measurement system with head-space gas extraction acc. IEC 60567
- Operation by integrated 7" color TFT (800x480 pixel) touch-screen or via genX webserver from any smart phone, notepad or PC
- Communication interfaces WiFi, USB or ETHERNET 10/100 Mbit/s
- SD memory of test results, history and diagnostic data of power transformers and oil-filled electrical equipment
- Integrated thermal report printer

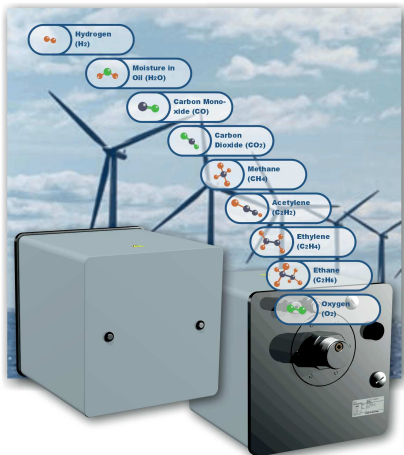
Software Tool HydroSOFT Hybrid App

HydroSOFT Hybrid App is the new central software tool to collect, display and report DGA results from HYDROCAL 1011 genX P as well as all other HYDROCAL online DGA devices (upon request). The software is designed for touchscreen operation as well as for classical operation by keyboard / mouse.

It is supported by a powerful SQL Server Express database allowing multi-user access as well as the configuration of HYDROCAL devices.



Offshore versions and extension packages

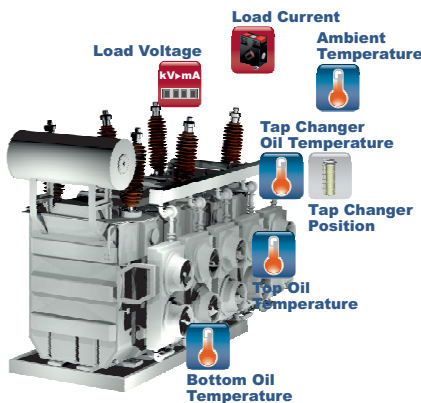


HYDROCAL Offshore
1003 / 1005 / 1008 / 1009

The HYDROCAL Offshore (1003, 1005 and 1009) transformer monitoring systems are specially designed for the harsh conditions (salt water, corrosion) on offshore platforms (e.g. wind mill parks). Special painted housing with no window and the application of chrome nickel and stainless steel ensures the reliability and the persistence of the device.

Key advantages:

- Special design for offshore applications:
 - Housing without window painted in C5M
 - Back plate with 2 cable glands M20 (chrome-nickel steel, IP 68, corrosion-free and acid-resistant)
 - Back plate, oil entrance and housing screws made of stainless steel V4A



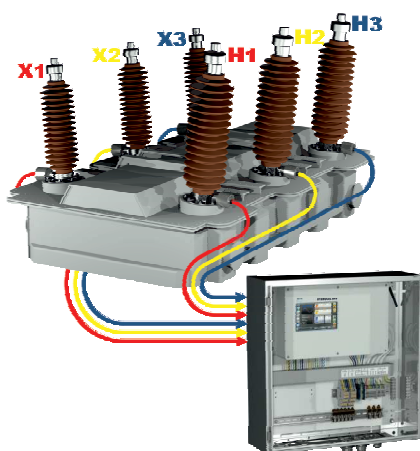
HYDROCAL MS-7
extension package

The HYDROCAL MS-7 is an extension package to the HYDROCAL 1003, 1005, 1008 and 1009 that measures 3 oil temperatures (top oil, bottom oil & tap changer oil), ambient temperature, load current, load voltage and the tap changer position of a transformer.

With this solution MTE addresses the issue that thermal conditioning is one of the most important means to detect transformer problems and to avoid transformer outages.

Key advantages:

- Complete on-line transformer monitoring extension package with direct integration into hardware, firmware and into HydroSoft
- Individual measurement of top oil temperature, bottom oil temperature, ambient temperature, tap changer oil temperature, tap changer position, load current and load voltage



HYDROCAL BPD
extension package

HYDROCAL BPD is a modular online monitoring system for high voltage bushings. It supports the measurement of voltage and phase angle on the test tap to derive $\tan\delta$ /PF of the bushing capacitance.

HYDROCAL BPD combined with online DGA performed by the HYDROCAL product family provides the ideal overall transformer monitoring solution.

The measurement of voltage and phase angle on the test tap of high voltage bushings allows to compare $\tan\delta$ /PF with factory test results for analysing deterioration of the bushings.

Key advantages:

- Monitoring of capacitance, \tan /PF of up to six high voltage bushings (3 or 6 bushings)
- Advanced software (on the unit and via PC) with intuitive operation by 7" color TFT capacitive touchscreen, WLAN and Webserver operation from any smart phone, tablet or notebook PC
- Communication interfaces WiFi, USB or ETHERNET 10/100 Mbit/s
- SD memory of test results, history and diagnostic data of power transformers

The following MTE leaflets are available:

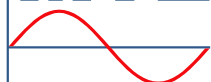
HYDROCAL 1001+ / 1003 / 1004 *genX* / 1005 / 1006 *genX* / 1008 / 1009 / 1011 *genX* / 1011 *genX* P

HYDROCAL 1003 Offshore / 1005 Offshore/ 1009 Offshore

HYDROCAL MS-7

HYDROCAL BPD

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06.2020_R05
Subject to alterations