# MONITRA - I M T 02SE

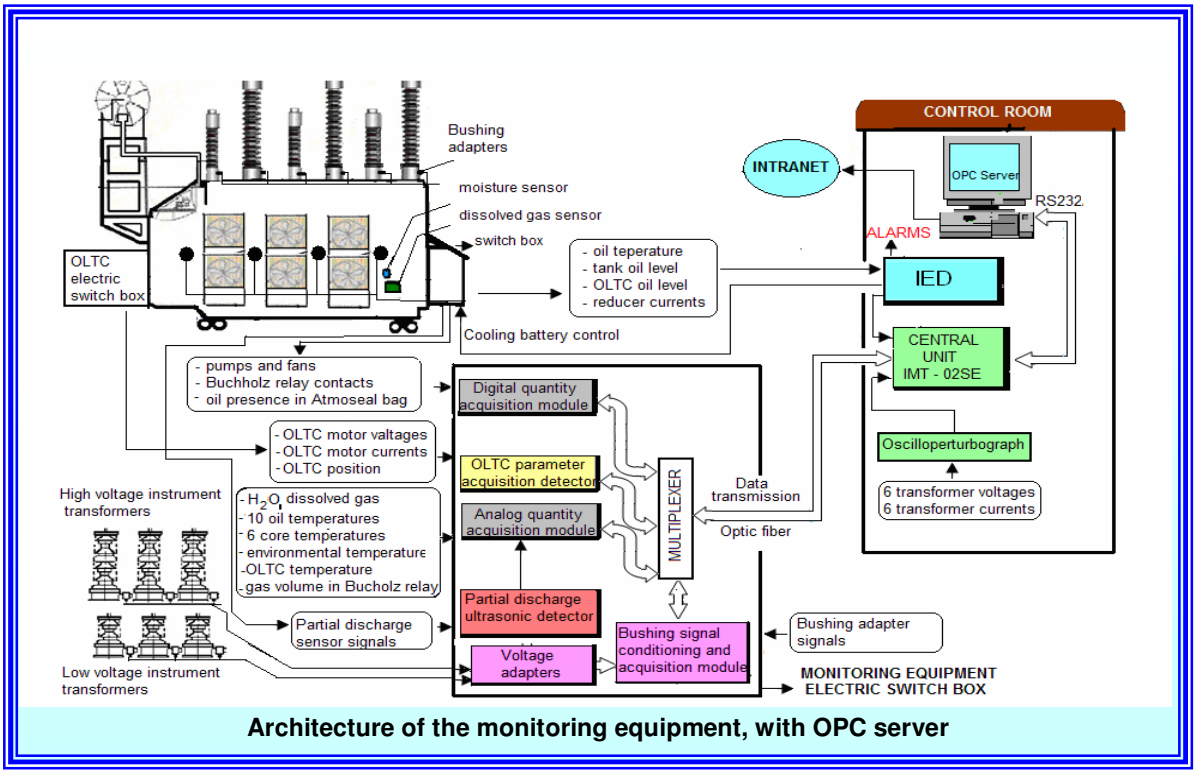
## MICROPROCESSOR-BASED EQUIPMENT FOR POWER TRANSFORMER PROTECTION AND OPERATION MONITORING

*Taking into account that power transformer is the major item of equipment in power systems, its correct operation is vital to system operation. It is well known that transformer failures are sometimes catastrophic and almost always include irreversible internal damage.*

*The monitoring of power transformers makes possible to obtain the maximum practicable operating efficiency and optimum life of power transformers, minimizing the risk of premature failures and providing potential for changing the maintenance strategies.*

*Research, Development and Testing National Institute for Electrical Engineering – ICMET Craiova has developed and designed* ***Microprocessor-based equipment for power transformer protection and operation monitoring, type MONITRA - IMT 02SE.***

**MONITRA - IMT 02SE** *equipment is intended to protect and monitor the power transformer operation; it monitors oil temperature, level of oil in tank and OLTC, temperature of HV and LV windings, condition of OLTC, temperature of magnetic core, oil temperature at the input and output from cooling batteries, environment temperature, tan δ, capacitive currents of the bushings, partial discharge level, dissolved gases ($H_2$, CO) concentration, oil moisture level, on/off states of the pumps and fans, gas volume in Buchholz relay.*




**Architecture of the monitoring equipment, with OPC server**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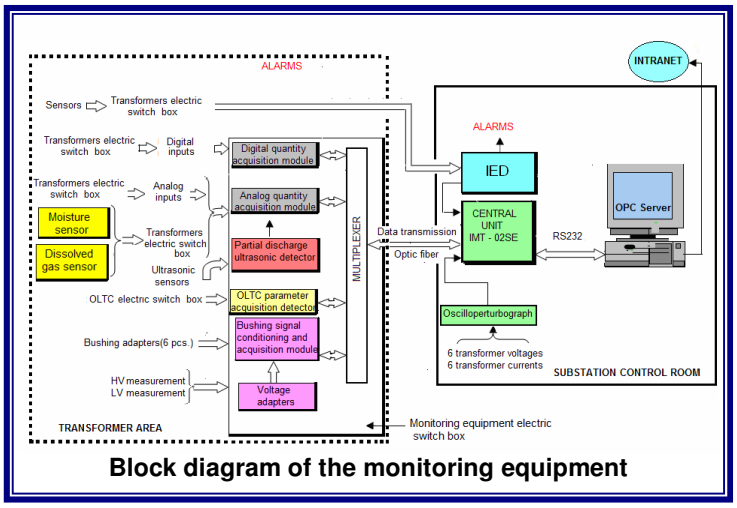
## Advantages of continuous monitoring:

- Prevention of transformer failures and downtimes
- Transformer life extension leading to the delay of investment for a new transformer
- Optimization of transformer use by means of condition – based maintenance instead of time – based maintenance

**Because of its modularity, the equipment can easily be focused on the customers needs and on the requirements of the monitored transformer, any configuration being available when requested.**

## TECHNICAL CHARACTERISTICS

Configuration:




**Block diagram of the monitoring equipment**

**Analogic inputs**

- Input for windings current (3 inputs)
- Input for magnetic core temperature (max. 6 inputs)
- Input for environment temperature (1 input)
- Input for OLTC oil temperature (1 input)
- Input for temperature at the input and output from the cooling batteries (10 inputs)
- Input for monitoring the quantities characteristics for the bushings (tan δ, capacitive current) (max. 6 inputs)
- Input for monitoring the content of $H_2$ in oil (1 input)
- Input for monitoring the content of CO in oil (1 input)
- Input for monitoring the content of $H_2O$ in oil (1 input)
- Input for monitoring the gas volume in Buchholz relay (1 input)
- Input for monitoring oil temperature (1 input)
- Input for oil level (2 inputs)
- Input for high voltages and low voltages and currents (6 inputs for voltages + 6 inputs for currents)
- Input for voltages of drive motor OLTC (3 inputs)
- Input for partial discharge level from DUDP-2N (PD Acoustic Emission Detector) (4 inputs)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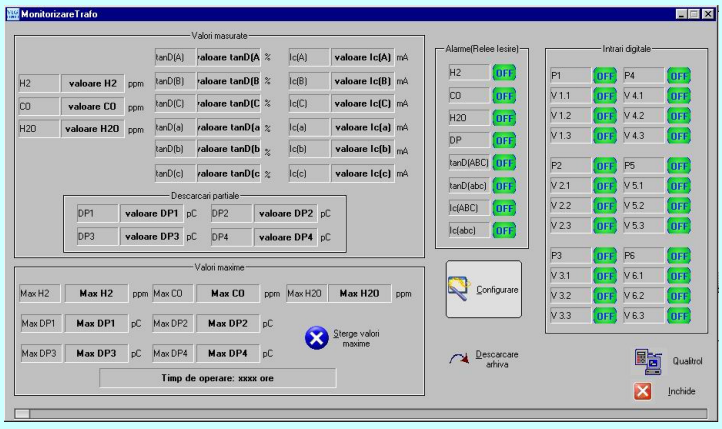
| | |
|---|---|
| **Digital inputs** | • Inputs for pumps and fans monitoring (18 inputs)<br>• Inputs for OLTC position monitoring (5 inputs)<br>• Input for presence of oil in the ATMOSEAL bag (1 input) |

| | |
|---|---|
| **Outputs** | Control relays ( 10 A; 250 V AC ):<br>• One contact for the cooling step I<br>• One contact for the cooling step II<br>• One contact for alarm oil temperature<br>• One contact for trip oil temperature<br>• One contact for alarm temperature of winding<br>• One contact for trip temperature of winding<br>• One contact for minimum level of oil<br>• One contact for maximum level of oil<br>• One contact for signaling the increase of $H_2$ concentration over a preset value<br>• One contact for signaling the increase of CO concentration over a preset value<br>• One contact for signaling the increase of $H_2O$ concentration over a preset value<br>• One contact for exceeding the tan δ alarm level for HV bushings<br>• One contact for exceeding the tan δ alarm level for LV bushings<br>• One contact for exceeding the capacitive current alarm level for HV bushings<br>• One contact for exceeding the capacitive current alarm level for LV bushings<br>• One contacts for the partial discharge level exceeding<br><br>**Note:** Alarm level values can be easily set and changed from the keyboard |

**Software:** IMT 02SE Equipment is delivered with the software necessary to send the stored data through the serial interface RS 232 or RS 485.

Analysis software allows the rapid interpretation of the stored data , and their arrangement as tables




Window for computer communication with IMT 02S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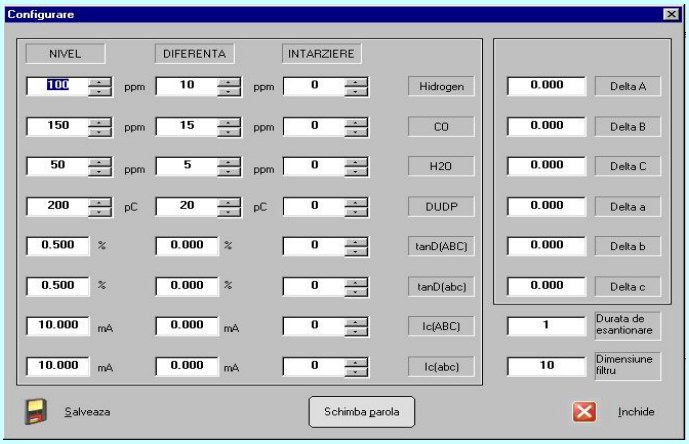
# MONITRA - I M T 02SE




Window for alarm parameter

The device is provided with a keyboard and a local display, allowing the programming (prescribing the alarm thresholds, delays at relay connection and disconnection, constants specific to transformer) and local or remote display of the quantities monitored. Additionally, the relay condition is locally signaled, by LEDs,

**Note:** All the values introduced from the equipment keyboard can be introduced and coded also from the computer keyboard.

The main menu is accessible by pressing any key and gives the possibility to visualize the monitored quantities **(SUPERVISE),** to set the transformer parameters and the quantities required for operation **(CONFIG),** to calibrate the input quantities **(CALIBRATE)** and to simulate the operation **(SIMULATE).**

MONITRA - IMT 02SE equipment is provided with a real - time clock and a battery allowing autonomous operation for 10 years.

It is possible to store the value of monitored quantities, at programmable time intervals, for a period of about 2 months. The stored data can be transmitted by the RS 232 interface to IBM-PC compatible equipment. When the buffer is 90% filled, it is necessary to save the stored data.

Window with display of monitored quantities

aaa.arh - WordPad

File Edit View Insert Format Help

ARCHIVE

| Index | Time | Date | Oil Temp | I1 | WT1 | I2 | WT2 | I3 | WT3 | DUDP |
|---|---|---|---|---|---|---|---|---|---|---|
| 01984. | 14:00:31 | 15-01-2002 | 021 | 000 | 021 | 000 | 021 | 000 | 021 | 00000 |
| 01985. | 14:10:31 | 15-01-2002 | 020 | 000 | 021 | 000 | 021 | 000 | 021 | 00000 |
| 01986. | 14:20:31 | 15-01-2002 | 021 | 000 | 021 | 000 | 021 | 000 | 021 | 00000 |
| 01987. | 14:30:31 | 15-01-2002 | 021 | 000 | 021 | 000 | 021 | 000 | 021 | 00000 |
| 01988. | 14:40:31 | 15-01-2002 | 020 | 000 | 020 | 000 | 020 | 000 | 020 | 00000 |
| 01989. | 14:50:31 | 15-01-2002 | 021 | 000 | 021 | 000 | 020 | 000 | 020 | 00000 |
| 01990. | 15:00:31 | 15-01-2002 | 020 | 000 | 021 | 000 | 021 | 000 | 021 | 00000 |
| 01991. | 15:10:31 | 15-01-2002 | 020 | 000 | 021 | 000 | 021 | 000 | 021 | 00000 |
| 01992. | 15:20:31 | 15-01-2002 | 021 | 000 | 021 | 000 | 020 | 000 | 020 | 00000 |
| 01993. | 15:30:31 | 15-01-2002 | 021 | 000 | 021 | 000 | 021 | 000 | 021 | 00000 |
| 01994. | 15:40:31 | 15-01-2002 | 021 | 000 | 020 | 000 | 020 | 000 | 020 | 00000 |
| 01995. | 10:10:43 | 30-01-2002 | 019 | 000 | 019 | 000 | 019 | 000 | 019 | 00000 |
| 01996. | 10:20:43 | 30-01-2002 | 020 | 000 | 020 | 000 | 020 | 000 | 020 | 00000 |
| 01997. | 10:41:09 | 30-01-2002 | 022 | 000 | 021 | 000 | 021 | 000 | 021 | 00000 |
| 01998. | 09:33:54 | 05-02-2002 | 016 | 000 | 016 | 000 | 016 | 000 | 016 | 00000 |
| 01999. | 11:18:30 | 13-02-2002 | 020 | 000 | 020 | 000 | 020 | 000 | 020 | 00000 |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| Monitored and Displayed quantities | Domain |
|---|---|
| Oil temperature | 0 to $120^0$C |
| Winding temperature | 0 to $150^0$ C |
| Oil level in tank and OLTC | 0 to $100^0$C |
| Dissolved hydrogen concentration | 0 to 2000 ppm |
| Dissolved carbon oxide concentration | 0 to 2000 ppm |
| Oil moisture | 0 to 100 ppm |
| Partial discharge level | 0 to 10000pC |
| Tan δ for the bushings | 0,1 to 4 % |
| Capacitive current for the bushings | 0 to 100 mA |
| Working time | hours |
| Spent life time | hours |
| Oil pumps condition | on/off |
| Fans condition | on/off |
| Gas in Buchholz relay | 0 to 400 $cm^3$ |
| OLTC condition | |

- phase current/voltage of the tap changer driving motor
- active power absorbed when switching
- tap changer position
- total number of switching operation

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# MONITRA - I M T 02SE

## Programming range for the protection levels

- Oil temperature:
  - range: 0 to 120$^0$C
  - difference: 0 to 10$^0$C
  - alarm delay: 0 to 40 minutes
- Winding temperature:
  - range: 0 to 150$^0$C
  - difference: 0 to 10$^0$C
  - alarm delay: 0 to 40 minutes
- Oil level in the tank and OLTC:
  - range: 0 to 100%
  - difference: 0 to 10%
  - alarm delay: 0 to 40 minutes
- Dissolved hydrogen concentration:
  - range 0 to 2000 ppm
  - difference 0 to 100 ppm
  - alarm delay 0 to 40 minutes
- Dissolved carbon oxide:
  - range 0 to 2000 ppm
  - difference 0 to 100 ppm
  - alarm delay 0 to 40 minutes
- Oil moisture level:
  - range 0 to 100 ppm
  - difference 0 to 5 ppm
  - alarm delay 0 to 40 minutes
- Partial discharge level
  - range 0 to 10000 pC
  - difference 0 to 500 pC
  - alarm delay 0 to 40 minutes
- Tan $\delta$ for the bushings:
  - range 0,1 to 4%
  - difference 0 to 0,1 %
  - alarm delay 0 to 40 minutes
- Capacitive current for the bushings:
  - range 0 to 100 mA
  - difference 0 to 1 mA
  - alarm delay 0 to 40 minutes
- Gas in Buchholz relay:
  - range 10 to 400 cm$^3$
  - difference 0 to 10 cm$^3$
  - alarm delay 0 to 40 minutes

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# MONITRA - I M T 02SE

## Mains supply:

- 90 to 264 V AC, 50 Hz ; 120 to 370 V DC

## Measurement accuracy:

| | |
|---|---|
| Oil temperature | ± $1^0$ C |
| Winding temperature | ± $2^0$ C |
| Oil level | ± 1% |
| $H_2$ concentration | ± 15 ppm |
| CO concentration | ±15 ppm |
| $H_2O$ concentration | ± 5 ppm |
| Partial Discharge level | ± 100 pC |
| Tan δ | ± 0,1 |
| Capacitive current | ± 1.5% |
| Gas in Buchholz relay | ± 5 $cm^3$ |

**Note:** At the measuring accuracy for $H_2$, CO and $H_2O$ it is added the measuring accuracy of measuring equipment

## Environmental conditions:

| | |
|---|---|
| Range of operating temperatures | $-5^0$ C … + $50^0$ C |
| Protection degree | IP 50 |
| Maximum altitude | 1000 m |

## Overall dimensions:

| | |
|---|---|
| IMT 02SE | W x H x D = 305 x 225 x 123 mm |
| DUDP – 2N: | W x H x D = 295 x 205 x 180 mm |

## Accessories:

- Communication adapter
- Multiplexer
- Electric switch box

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# MONITRA - I M T 02SE

## Tests

| | | |
|---|---|---|
| Immunity | - power frequency electromagnetic field | IEC 61000-4-8 |
| | - voltage interruptions or supply voltage variations | IEC 61000-4-11 |
| | - surge | IEC 61000-4-5 |
| | - electrostatic discharge | SR EN 61000-4-2 |
| Measurement | - conducted disturbances | CISPR 22 |

**Optionally, data transmission could be carried out by optical fiber or cable, between the electric switch box INTERMON and the central unit within the control room.**

**Other facilities:**

## MONITORING OF GAS VOLUME IN BUCHHOLZ RELAY

For monitoring the gas volume within Buchholz relay, the output signal of the relay measuring unit is used (standard signal 4 … 20 mA)

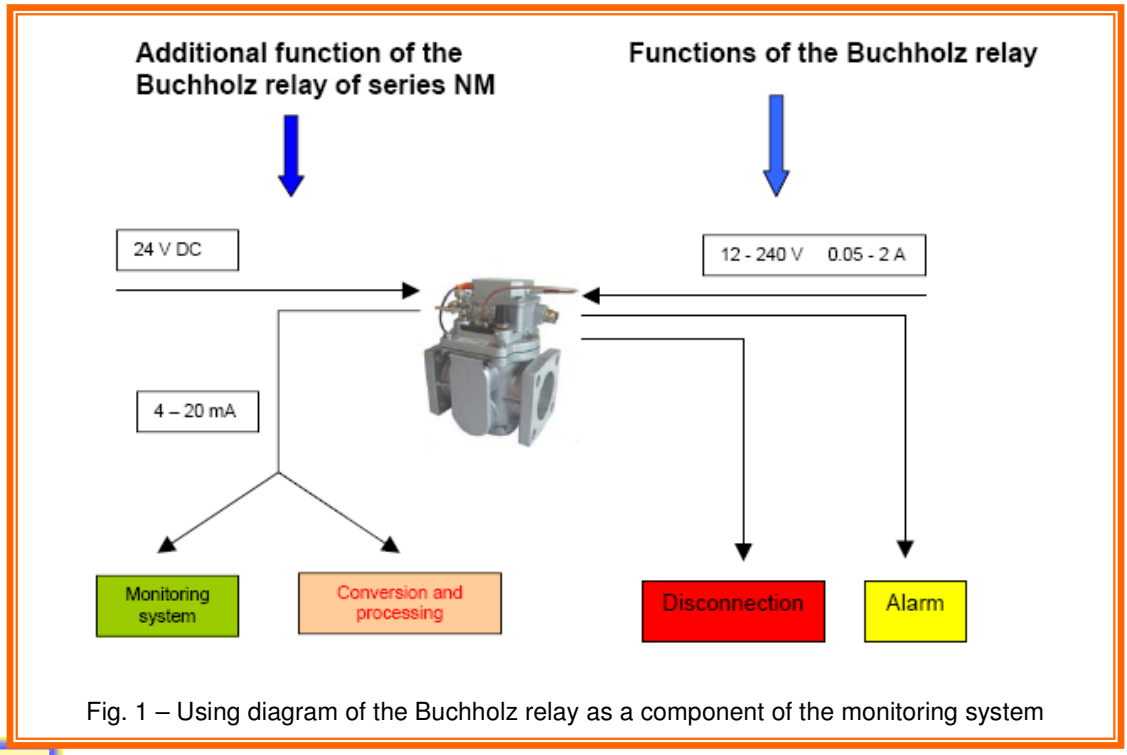


Fig. 1 – Using diagram of the Buchholz relay as a component of the monitoring system


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# MONITRA - I M T O2SE

The output signal of the capacitive sensor amplifier is a current signal depending on the insulating liquid level. This dependence is presented in Figure 2.

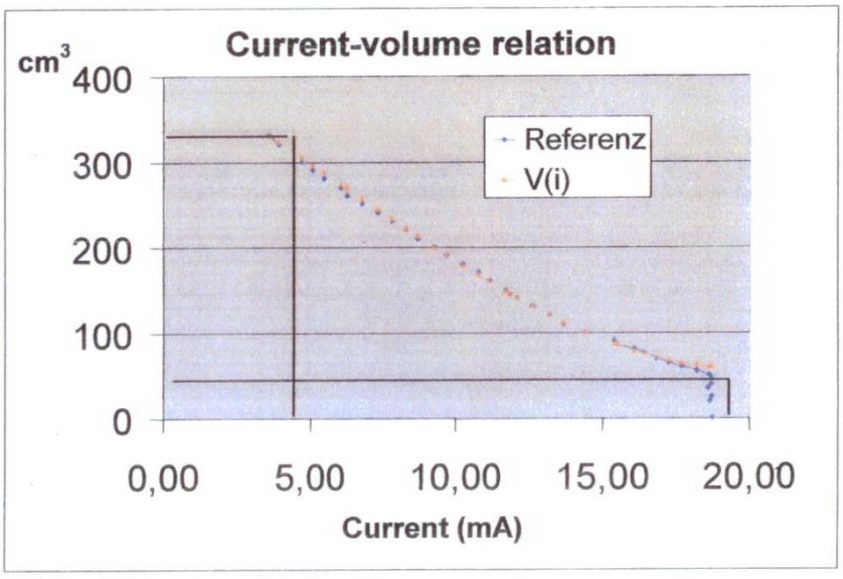
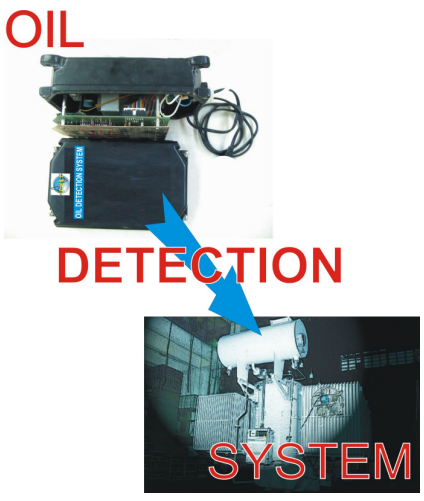



Fig.2 – Current –gas volume variation

## MONITORING OF OIL PRESENCE IN THE ATMOSEAL- TYPE BAG INSIDE THE CONSERVATOR




The oil detection system is used for signaling the decrease of the maximum oil level from the ATMOSEAL type conservators from power transformers, due to the cracking of the bag-type membrane from inside the conservators or to the accidental appearance of major oil losses.

The oil detection system is composed of:

I. Detector for presence of oil – placed inside, at the upper side of the conservator;

II. Control Module for Signaling the Presence of Oil – placed in the electric switch box of the transformer.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# MONITRA - I M T 02SE

## Technical characteristics

| | |
|---|---|
| Working medium | transformer oil |
| Pressure of the working medium | 0 - 5 bar |
| Working temperature | -20$^0$C to + 85$^0$C; -40$^0$C to + 105$^0$C |
| Supply voltage of the Control Module for Signaling the Presence of Oil | 110 – 220 V AC |
| Detector supply voltage | 12 V DC |
| Rated current of relay contact | 8 A / 24 V DC or 4 A/250 V AC |

## MONITORING OF POWER TRANSFORMER ON LOAD TAP CHANGER (TAP POSITIONS AND DRIVING MOTOR CURRENT)

The microcontroller-based system for monitoring the on load tap changer performs this function by acquiring the parameters influencing the tap changer condition:

- phase current/voltage of the tap changer driving motor
- active power absorbed when switching
- tap changer position
- total number of switching operations

The data package acquired during a switching operation is sent (using a serial output RS232) to a personal computer where the data can be stored and analyzed with a view to determining the condition of the on load tap changer.

## Technical characteristics

- Supply: 220 V, 50 Hz
- Inputs:
  - 4 analog inputs: supplying of the on load tap changer driving motor 3 x 380 V, 50 Hz (L1, L2, L3, N)
  - 8 digital inputs (6 for the position BCS of the tap changer + contact RAISE – switching in increasing direction, contact LOWER – switching in decreasing direction)
- Outputs
  - 3 analog outputs: (L1, L2, L3) for supplying the on load tap changer driving motor 3 x 380 V, 50 Hz
  - one digital output (open collector) for synchronization (active during a switching operation)
  - one serial output RS232 for data transmission

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