



On-line Moisture in Oil Monitor

Excess water in the insulating oil of high voltage equipment, such as transformers and reactors, causes well known adverse effects. High moisture content will cause reduction in dielectric rigidity and migration of water into the insulating paper, with the risk of formation of bubbles and accelerated aging in the presence of high temperatures, thus jeopardizing the equipment life cycle and integrity.

The Moisture in Oil Monitor MO is comprised of a sensor module, installed in contact with the oil, and an Interface Module that allows on line measuring and monitoring of the moisture present in the oil, generating important information in determining the equipment's current state:

- Water in oil saturation percentage (RS%) and oil temperature;
- Calculation of water saturation percentage converted to a reference temperature selected by the user (RS% @ TREF), allowing users to know, for instance, what would be the value for moisture saturation for the oil at a reference temperature or at the transformer's lowest expected operating temperature;
- Calculation of water saturation percentage converted to a second value for temperature, measured by a Pt100W at 0°C input sensor (RS% @ T2), allowing users to know, for instance, the level of water saturation if the transformer is de-energized and allowed to cool to ambient temperature (measured with a Pt100 RTD);
- Water content in oil in parts per million (ppm), calculated based on the readings for moisture saturation percentage and oil temperature with user programmable water solubility constants, allowing users to adjust the constants in accordance with the type and age of the oil;
- Evolution trend (rise or drop) in the water content in the oil in ppm per day (ppm/24h).

Based on the above information, the MO's alarm activation limit values are programmed by the user for high or very high moisture saturation percentages (RS%, RS% @ TREF and RS% @ T2), high or very high water content (ppm) and high water content evolution trend.

Main Features:

- IED (Intelligent Electronic Device) designed specifically for substation yard conditions (interferences, extreme temperatures), suitable for integration into supervision or monitoring system through RS485 port (Modbus or DNP3.0);
- Easy visualization LED display;
- Programmable analog output for remote reading of RS%, RS% @ T2, RS% @ TREF or water content (ppm). User programmable output range: 0...1, 0...5, 0...10, 0...20 or 4...20mA;
- Six user programmable output relays for alarm indications;
- Internal clock with date and time and nonvolatile memory for saving readings;
- Self-diagnosis for internal fault detection. Total absence of mechanical parts in parameter definition and calibration.
- Optional mass memory for recording of measurements and alarms in non-volatile memory.

Optional Functions

OPTIONAL 1 – MASS MEMORY

Nonvolatile memory type FIFO (First In First Out) with capacity for storage of 1489 registers. Each register includes relative saturation, water content in oil, oil temperature, temperature of sensor 2 (if used), evolution trend of water content and alarm events, based on internal clock with day, month, year, hour, minute and second. A memory recording can be started by:

- User defined time interval between recordings (1 to 1000 minutes), or;
- Variation of water content or oil temperature higher than the dead band selected by users, or;
- Occurrence of any alarm.

OPTIONAL 2 – DNP 3.0 PROTOCOL

User selectable communication protocol: Modbus RTU or DNP 3.0 level 1. DNP3.0 protocol with support for 1ms resolution time-stamp.

Technical Specifications

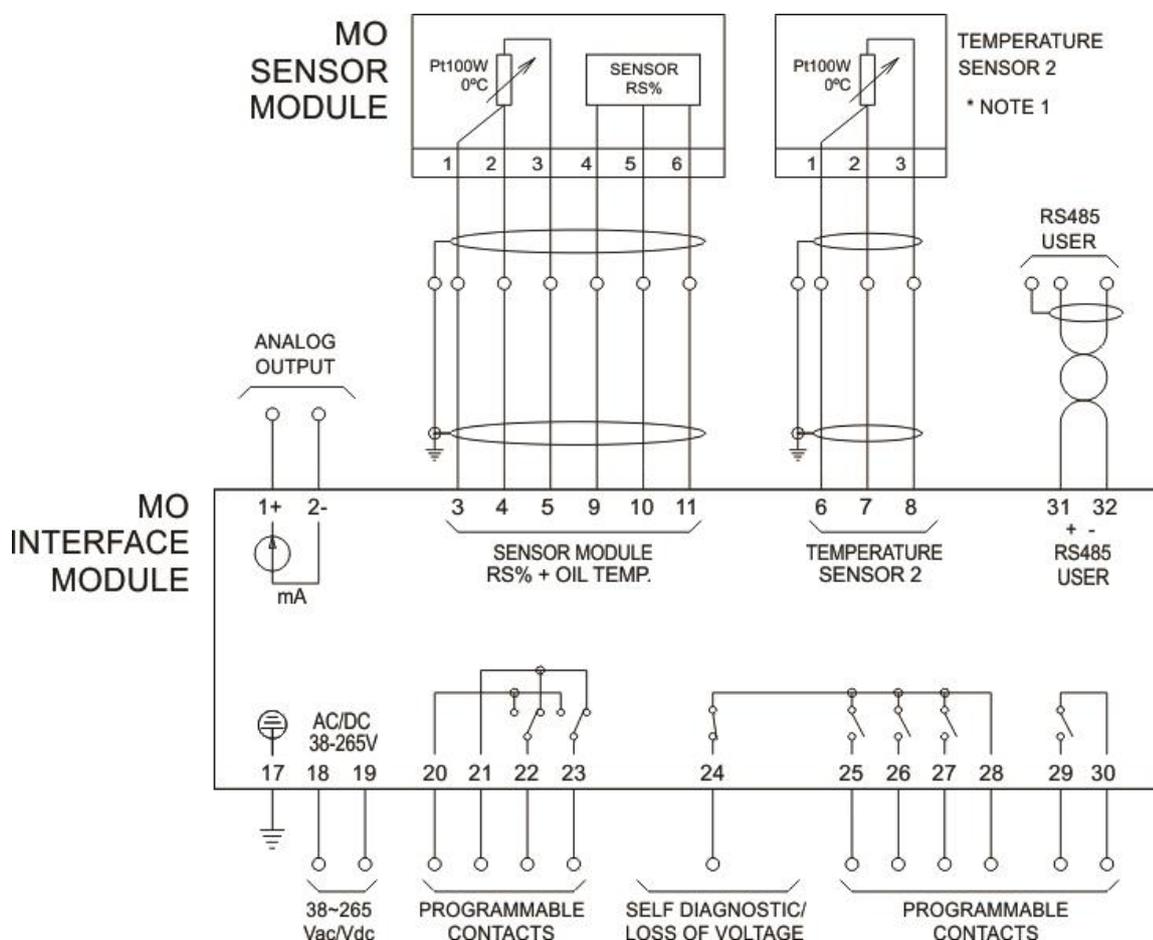
1) Interface Module

Condition	Interval/Description
Input Voltage:	38 to 265 Vac/Vdc 50/60Hz
Maximum Consumption:	< 5 W
Operating Temperature:	-40 to +85 °C
Degree of Protection:	IP 20
Wire size – removable connectors:	22 to 12 AWG, 0.3 to 2.5mm ²
Fixation:	Built in panel
Direct temperature measurements:	Two (oil + 2nd temperature selectable)
Sensor:	Pt100Ω at 0°C w/ continuous self-calibration
Measuring range	-55...200°C
Maximum error at 20°C:	0.5% of full scale
Deviation by temperature variation:	20ppm/°C
Type of connection:	3-wire sensor
Water saturation percentage measurement:	
Type of Input:	Treetech Moisture Sensor
Measuring range:	0 to 100% of water saturation
Maximum Error at 20°C:	±2% of water saturation
Connection:	Three wires
Analog output (optional):	One
Maximum error:	0,5 % of full scale
Options (selections) and maximum load:	0...1mA, 10kΩ 0...5mA, 2kΩ 0...10mA, 1kΩ 0...20mA, 500Ω 4...20 mA, 500Ω
Relay outputs:	Dry contacts
Maximum switching power:	70 W (dc) / 220 VA (ac)
Maximum switching voltage:	250 Vdc / 250 Vac
Maximum conduction current:	5 A
Serial Communication Ports (optional):	1 RS485 for supervision/monitoring systems
Communication protocols:	Modbus RTU or DNP3.0 level 1
Mass Memory (optional):	Non-volatile type FIFO (First In First Out)
Recording interval:	1 to 1000 minutes
Capacity:	1489 registers

2) Sensor Module

Condition	Interval/Description
Operating Temperature – Ambient:	-40 to +85 °C
Operating Temperature – Oil:	-40 to +85 °C
Storage temperature:	-51 to +125 °C
Typical response time:	10 minutes
Maximum pressure supported in the process:	0,1 MPa (1,0 bar) / full vacuum
Degree of Protection:	IP 66 (NEMA 4)
Wire size:	6 wires 0,3 to 1,5mm ² , 22 to 14 AWG
Installation:	Ball or Drawer valve 1/2" or larger
Connection to the valve:	Thread 1/2" BSP (standard) or 1/2" NPT (under request)

Connection Diagram

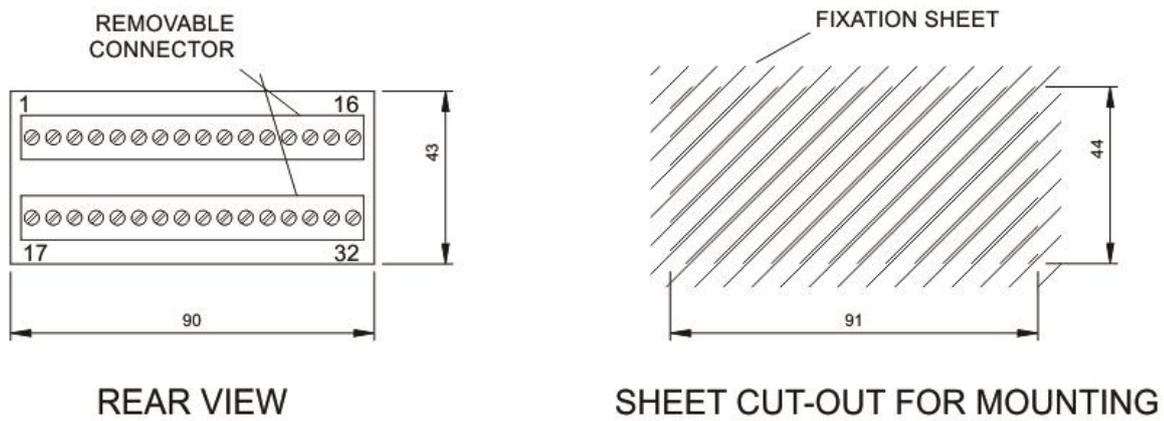
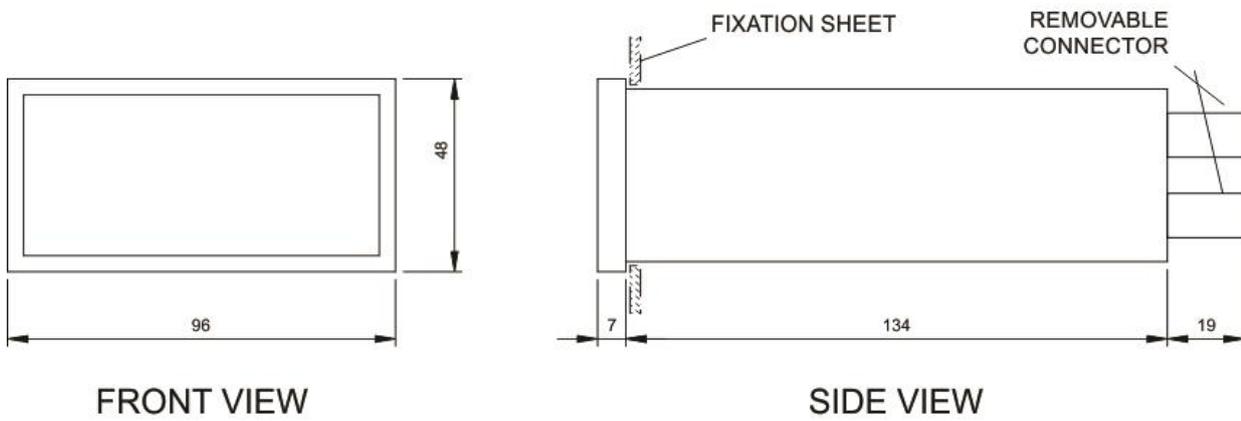


Notes:

1. The use of the second temperatures sensor is optional. Typical application is measuring ambient temperature.
2. All contacts shown with MO de-energized.

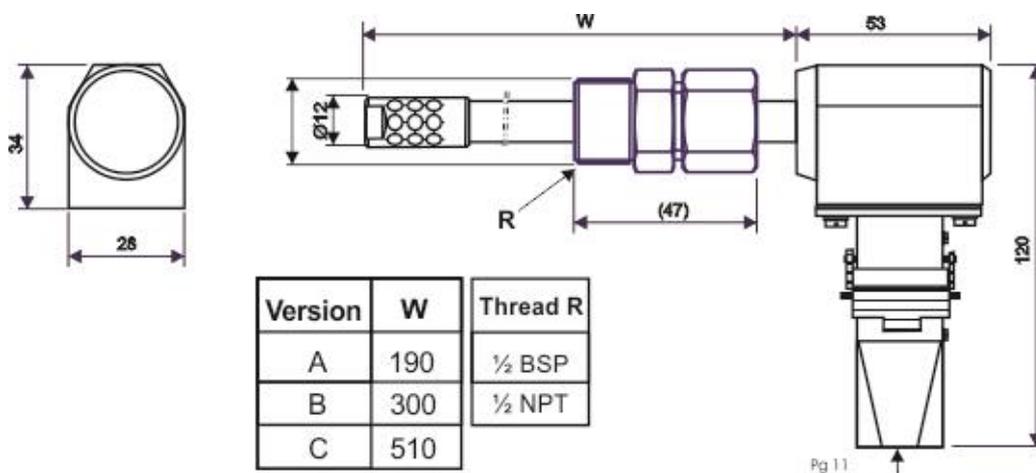
Dimensions

Interface Module

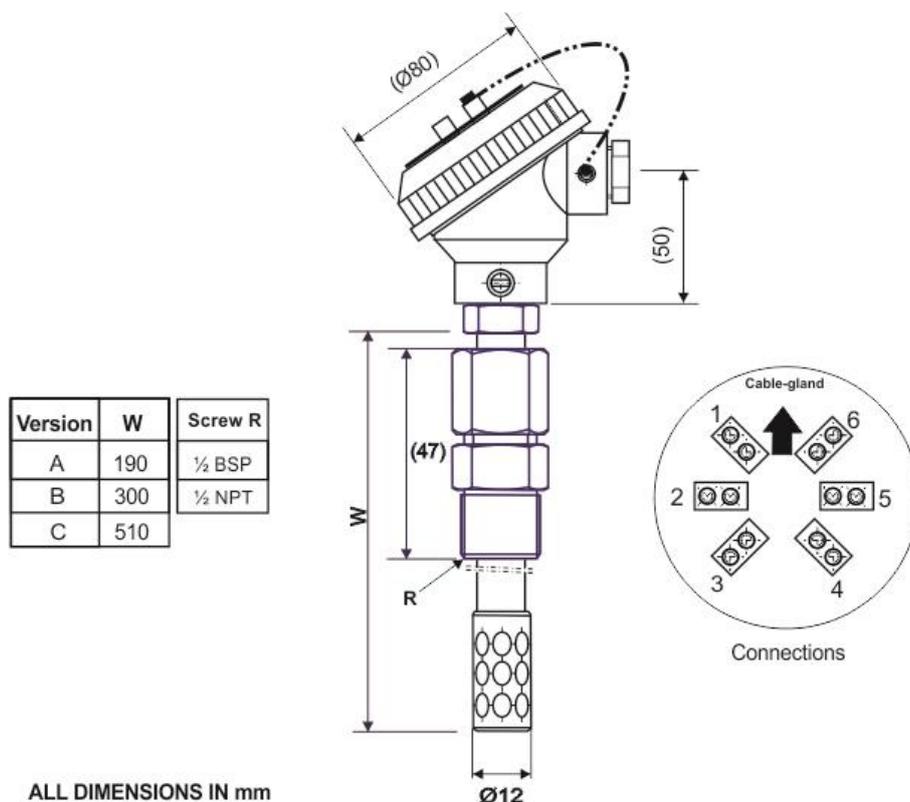


ALL DIMENSIONS IN mm

Removable Plug Sensor Module



Removable Plug Sensor Module



Order Specification

The Moisture in Oil Monitors MO are universal devices, its features are selected by using the programming menus. These adjustments can be made directly on the device's front panel or by way of the serial communication port RS485. The power feed input is universal (38 to 265 Vdc/Vac 50/60 Hz).

Therefore, in purchase orders for the equipment only the following need to be informed:

- Moisture in Oil Monitor MO Sensor Module:
 - Connection Type: Removable Plug or Head Type
 - Length version: A (190 mm), B (300 mm) or C (510 mm)
 - Type of thread for connection to the valve: Standard (½" BSP) or ½" NPT;
 - Quantity.
- Moisture in Oil Monitor MO Interface Module:
 - Quantity (one Interface Module for each Sensor Module)
 - Desired optional function:
 - Optional 1 - Mass Memory;
 - Optional 2 - DNP 3.0 Protocol.

Optional Accessories

- **Outdoor cabinets**

The MO Moisture in Oil Monitor must be always installed in a shelter against bad weather. The Moisture Oil Monitor must be installed in a weatherproof area, usually inside the control panel of the transformer. When this is inconvenient, such as, for example, when old transformers are refurbished, the MO can be supplied in a weatherproof cabinet, easy to be installed.

Characteristics:	
Mounting:	Bolted or with high load capacity magnets.
MO Anchoring	On a sliding rack
Wiring connection	Multi-polar removable plugs at the bottom of the cabinet.
Degree of Protection:	IP55
Insulation test:	2kV, 50/60 Hz, 1 min.



- **Weather instrument shelter to measure outside temperature**

The Moisture Monitor - MO has a second input for temperature sensor, whose reading can be used in calculating the percentage of moisture saturation in oil at this second temperature. Typically this input is used in measuring ambient temperature, which allows monitoring of moisture saturation in oil if the transformer is de-energized.

Ambient temperature is measured by way of Pt100W at 0°C type temperature sensor installed in thermal shelter, minimizing errors caused by sun, rain, wind, etc. on the readings. If required, TreeTech has available sensors and thermal shelters suited for this type of reading, supplied as optional accessories.



Type Testing

Surge Immunity (IEC 60255-22-5):	
Phase-neutral surges:	1 kV, 5 per polarity (+/-)
Phase-ground and neutral-ground surges:	2 kV, 5 per polarity (+/-)
Electrical transients Immunity (IEC 60255-22-1 and IEEE C37.90.1):	
1st cycle peak	2.5 kV
Frequency:	1.1 MHz
Time and repetition rate:	2 seconds, 400 surges/sec.
Decay to 50%:	5 cycles
Voltage Impulse (IEC 60255-5):	
Wave form:	1.2 / 50 μ s
Amplitude and energy:	5kV, 0.5J
Number of pulses:	3 negative and 3 positive, 5s interval
Insulation Voltage (IEC 60255-5):	
Industrial frequency insulation voltage	2 kV 60Hz 1 min. to ground
Irradiated electromagnetic field Immunity (IEC 61000-4-3 / IEC60255-22-3):	
Frequency:	26 to 1000 MHz
Field intensity:	10 V/m
Conduced electromagnetic perturbations immunity (IEC 61000-22-6):	
Frequency:	0.15 to 80 MHz
Field intensity:	10 V/m
Electrostatic Discharge (IEC 60255-22-2 and IEEE C37.90.3):	
Air mode:	
Contact mode:	8 kV, ten discharges per polarity 6 kV, ten discharges per polarity
Fast electrical transient immunity (IEC60255-22-4 e IEEE C37.90.1):	
Power supply, inputs and outputs:	
Serial communication port:	4 kV 2 kV
Climatic test: (IEC 60068-2-14):	
Temperature range:	-40 to +85°C
Total test time:	96 hours
Vibration response: (IEC 255-21-1):	
Application mode:	3 axis (X, Y and Z), sinusoidal
Amplitude:	0,075mm from 10 to 58 Hz 1G from 58 to 150 Hz
Duration:	8 min/axis
Vibration resistance: (IEC 255-21-1):	
Application mode:	3 axis (X, Y and Z), sinusoidal
Frequency	10 to 150 Hz
Amplitude:	2G
Duration:	160 min/axis



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