OIL & WINDING
TEMPERATURE INDICATORS
for
POWER & DISTRIBUTION
TRANSFORMERS

TERMAN

Bollate (Mi) Italia

Electric Systems
transformeraccessories
Sydney

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Introduction.

The winding is the component with the highest temperature within the transformer and, above all, the one subject to the fastest temperature increases as the load increases. Thus, to have total control of the temperature parameter within the transformer, the temperature of the winding, as well as top oil, must be measured. An indirect system is used to measure winding temperature, since it is dangerous to place a sensor close to the winding due to the high voltage.
The indirect measurement is done by means of a *Thermal Image.*
This instrument is designed to measure the temperature of the winding by means of a special bulb surrounded by a heating resistance through which passes a current proportional to the current passing through the transformer winding, subject to a given load and immersed in insulating oil at temperature T_{oil}. It is possible to adjust the heating system by means of a potentiometer located on the winding temperature indicator's dial. In this way the value of the winding temperature indicated by the instrument will be equal to the one planned by the transformer manufacturer for a given transformer load.
The winding temperature indicators are fitted with four change-over microswitches suitable to control cooling equipment and protection circuits (alarm and trip) of the transformer.

This sector of our production is the result of considerable research and experiment commitment which has led to internationally patented new concept in instrument design and construction.
The component designs of our instruments are protected by : **ITALIAN PATENT No. 208603**
ITALIAN PATENT No. 89113
E.E.C. PATENT No. 0245212 U.S. PATENT No. 4,727,227.

Effectiveness of these instruments must be stressed, both as regards measuring/commutation precision and extreme simplicity of operation. Special attention has been paid to design of each single part resulting in extreme high reliability of our instruments and ensuring long-lasting accurate operating. We have designed the setting system, the mounting devices and the dimensions of the cable boxes to allow the operator to easily install the indicator and to save time in setting and making cable layout.

Besides the exact construction and severe quality control we adopt, the high performance of our instruments are further assured by the use of the best products supplied by European technology's more advanced names. In particular:

- the **INDICATING SHAFT** is mounted on 2 micro ball bearings to reduce friction and to grant right working under vibrations.
- the **AWG 22 CABLES** we use are silver plated and protected with Teflon according to MIL - W - 16878-4 Standard;
- the **TERMINAL BLOCKS** (**WEIDMULLER** - Germany) give very high performance and are certified in accordance with VDE standards;
- the **POWDER PAINT** grants total protection against corrosion and increases the insulation of the device;
- the **SENSING SPRING TUBE** is manufactured with a special bronze alloy that avoids any plastic deformation and hysteresis of the spring.

Description and general specifications.

TEMPERATURE SENSING SYSTEM: expansion type compensated for ambient temperature changes by means of a built-in compensating device.
To avoid checking after commissioning and periodical re-calibration, we adopt particular care in testing the components' working quality. In particular, the sensing system is subject to 3 different tests:

1. *vacuum test*: the sensing system is connected to a vacuum plant. The plant pressure is decreased to $2x10^{-3}$ mbar (hpa) to verify the quality of the weldings and the porosity of the material;
2. *pressure test*: the sensing system is put under pressure up to 280 bar to verify the weldings and that the spring is not subject to any deformation;
3. *overheating test*: after being completed, the sensing system bulbs are located in a heating plant controlled by a microprocessor based temperature monitoring system. The temperature is increased up to a value that is 20% more than the maximum range value of the sensing systems (i.e. for an indicator 0/150°C the overheating test temperature is 180°C). The temperature remains at that value for 6 hours in this way simulating 1 year life under normal working conditions (i.e. for an indicator range = 0/150°C ---> 110°C). In this way we train the spring and verify that the precision remains the same.

CAPILLARY TUBE PROTECTION: Rilsan® tubing to DIN 74324

BULB: bronze with stainless steel connecting nut, BSP ¾" male

CASING: aluminium alloy powder painted (RAL 7035) suitable to withstand any climate, heavy polluted atmosphere as well as tropical or arctic climates (-40/+70°C). All components are made of corrosion resistant or surface treated materials.
The case is provided with a breather device to avoid dew on the lens.
To make cable layout quick and easy, the case is equipped with a large junction box that is completely separate from the instrument's sensing system. Cable glands are threaded M 20x1,5.

MECHANICAL PROTECTION DEGREE: IP 65.

LENS: polycarbonate

LOCKING RING: Nickel plated brass.

STANDARD MEASURING RANGE: 0/+150°C;

MEASURING TOLERANCE: 1,5% of full scale value.

COMMUTATION TOLERANCE: 2% of full scale value.

COMMUTATION DIFFERENTIAL: 4% of full scale value.
On customer's request the differential can be increased.

INSULATION: 2000V 50Hz between terminals and earth, 1 minute

MICROSWITCHES MAKING AND BREAKING CAPACITY:

	MICROSWITCHES			
VOLTAGE	**RESISTIVE LOAD**	**INDUCTIVE LOAD**		
125 VAC	5 A	5 A		
250 VAC	5 A	5 A		
30 VDC	5 A	3 A		
50 VDC	1 A	1 A		
75 VDC	0,75 A	0,25 A		
125 VDC	0,5 A	0,1 A		
250 VDC	0,25 A	0,1 A		

Options.

ELASTIC SUSPENSION (Drwg. No.1231): is a vibration damping system able to minimize the effects of a machine vibrations on the instrument.

EARTHQUAKE PROOF VERSION: equipping the instrument with the elastic suspension and suitable internal components.

PT 100 SENSOR : the temperature indicator can be equipped with one or two PT 100 sensors that convert the temperature values (degrees Centigrade) to resistance values (ohms) and transmits them to a receiver with digital display or to a SCADA monitoring system.

RECEIVER (Drwg. No.1479): we can supply a digital receiver (220VAC 50/60Hz) to display the temperature signal received from the sensor.

TRANSDUCER 4…20mA (Drwg. No.1689): we can supply a transducer 4…20mA that converts the resistance values (ohms) to current values (milliamps). This transducer is DIN rail mounted in a control cubicle apart from the transformer and draws power from the SCADA system.

Operating instructions .

MOUNTING: mount the instrument on its machine or transformer using the

- rigid locking screw M14 (Drwg. No.1242/B) located on the top of the thermometer; OR
- elastic suspension (Drwg. 1231) mounted on the top of the thermometer with a screw M14 that fixes the instrument to the transformer, OR the
- rear flange clearance holes (Drwg. No.1242/B-F) for wall mounting to the oil tank.

REMOVE THE TERMINAL BOX COVER: by unscrewing the 4 stainless steel screws.

CABLE LAYOUT: the numbers 1-2-3-4 indicate the number of microswitches and their progression (red, blue, green, yellow pointer). Close to the terminals you will find the following abbreviations: • C = common • NO = normally open • NC = normally closed which allow the operator to choose the desired cable layout. Connect the microswitch terminals and the earth terminal. If the thermometer is equipped with the PT 100 probe you find also the PT 100 terminals with a clear label that indicates how you can connect the probe to the display or to a transducer. After having done all the connecting operations re-position the terminal box cover taking care to put the flat gasket in the right position and screwing the 4 stainless steel screw.

REGULATION OF THE VALUE OF ΔT (winding temperature) : within the instrument's terminal board there are, as well as earth and microswitches connection terminals, the terminals T-T and the terminals A-A (see Drwg. No.1529). Procedure for regulating the instruments:

1. insert the ammeter probes in terminals **A-A**
2. remove jumper **A-A**
3. connect terminals **T-T** to the current transformer. **AFTER** having checked that the value of the power supply current printed on the dial (above the knob for regulating overheating) is, in fact, the same as that of **TA**
4. regulate the current on the basis of curve **I - ΔT** attached
5. replace jumper **A-A**
6. remove the ammeter probes
7. wait a few minutes to allow **Tw** to stabilize
8. check the exactitude of **Tw**

N.B.: the bulb of the thermometer for the thermal image must be filled with oil to accelerate the heat interchange occurrences. The bulb must be inserted in a well filled with transformer oil: the oil will rise through a suitable hole located in the bottom of the bulb itself until it covers the resistance.

It's very important to stress that the I - ΔT curves are only valid if the bulb is immersed in oil.

SETTING: to set microswitches please follow exactly the instructions:

- remove the locking ring;
- remove the polycarbonate locking clear window (take care of the O-ring);
- stop the microswitches setting dial (small black dial) with two fingers and slide the frictioned microswitches setting pointers until they are located at the desired temperature. *Note that to reduce errors you have to slide the pointers towards higher temperature value.*
- Replace the polycarbonate locking clear window taking care that the max. temperature indicating pointer is located on the right side of the temperature indicating pointer and that the lens is correctly positioned over the sealing O-ring.

Lock the lens screwing the locking ring.

TERMAN Factory Finished Product Quality Control Tests.

INSTRUMENT CALIBRATION: carried out through thermostatic baths controlled by a computer system. The procedure varies according to instruments scale.
Example of procedure for a thermal image scale 0/150°C: the calibration is made using 5 different baths set at the following temperatures:
bath 1 = 0°C, bath 2 = 20°C, bath 3 = 50°C, bath 4 = 100°C, bath 5 = 125°C

CALIBRATION PROCEDURE:

Step 1: a check is carried out to see wheter the temperature taken by the instrument under test differs from that taken through the sample sensor by more than the 70% of the maximum allowed instrument reading tolerance value.
This test is performed by sequentially plunging the Winding Temperature bulb into successive temperature increasing thermostatic baths: 0°C/+20°C/+50°C/+100°C/+125°C

Step 2: the instrument is heated until the instrument pointer exceeds by 20% the angular full scale value.

Step 3: step 1 is repeated, but inversely.

MICROSWITCHES ACTUATION TEST: performed through a computer controlled testing unit. The bulb is immersed in a thermostatic bath. The computer changes the temperature inside the bath and by means of suitable sensors verifies the commutation tolerance, the commutation differential, the electrical circuits of each microswitch.
At the end of the test a test report is directly printed by the computer.

CHECK OF INSTRUMENT MECHANICAL PROTECTION DEGREE: IP 65.
This test is carried out by means of a lance-sprinkled water jet on all sides of the thermometer

ISOLATION TEST: carried out by means of a microprocessor controlled testing unit.

RECORDS: all the collected data is immediately transferred, by means of the computer net, to the quality control and design departments to be supervised and evaluated.
In our files, we keep all the above test data and, for each instrument, we can supply to the customer a detailed report showing the test performance of the instrument delivered.

Rilsan® capillary protection

CAPILLARY PROTECTION: 11 tube according to DIN 74324

TUBE INTERNAL DIAMETER: 6,5mm, EXTERNAL 10 mm

MINIMUM RADIUS OF CURVATURE: 60mm.

NOMINAL OPERATING PRESSURE: >20bar at 20°C

RESISTANCE TO SHOCK: acc. to ASTM D256 STANDARD→8,6Kgs./cm per cm^2

TENSILE STRENGHT: acc. to ASTM D638 STANDARD→550Kgs./cm^2

ELASTIC MODULUS: 12.000Kgs./cm^2 with H_R=0%, 10.500Kgs./cm^2 with H_R=65%

Rilsan® is a polyamide derived from the 'green' raw material castor beans exhibiting high performance characteristics in resisting :

- abrasion, pressure, corrosive chemicals and climate extremes
- stress liable to cause cracking and impact at sub-zero temperatures

In the unlikely event of capillary fracture, the expansion fluid is contained within the Rilsan® tube. Rilsan® tube will not rust or scratch transformer or thermometer paintwork. TERMAN considers Rilsan® is a more effective and practial capillary protector than corrugated stainless steel tubing.

Preferred stock types &
Part numbers for identification and ordering

*** Two switch oil or four switch winding**
Basic part numbers :
oil (342)
winding (354)

*** Metres of capillary :**
2, 5 or 9 m (all stocked)
(or any special length from 1 to 16 m)
add the number of metres to basic part number
eg 3429 = 2 switch oil + 9 m capillary

*** Remote indication output in ohms acc to Pt100**
add the letter 'P' to part number
(for 2 x Pt100 sensors add "PX")
eg 3429P = 2 switch oil + 9 m capillary + Pt100
3545PX = 4 switch winding + 5 m capillary + (2 x Pt100)

*** Remote indication output in millliamps (4 – 20 mA)**
order as a separate item :
Transducer R88000 (drwg 1707) (no power supply required)
Transducer with galvanic isolation….
Separate power supply…
Digital temperature display ……

Accessories :
Pocket BSP ¾" F……..
Elastic mount …….