EQUIPMENT CATALOG

TMV

TEMPERATURE MONITOR AND VOLTAGE REGULATOR

Treetech

Temperature Monitor and Voltage Regulator – TMV

The quality of the voltage of electrical equipment, such as transformers, is essential for their safe operation, allowing us to obtain from these assets the maximum use of the investment without endangering its life cycle.

Treetech **Temperature Monitor and Voltage Regulator – TMV** is an equipment that combines thermal protection and control to the main functionalities of a voltage regulator relay.

Based on the readings of the temperature of the insulating oil and one or more transformer load currents, **TMV** performs temperature calculations (thermal image) of one or more windings and acts on the temperature management of the asset (functions 26 and 49).

Besides, during its operation, **TMV** aims to maintain the quality of the voltage in the load, that is, within a certain range of values, user programmable. For this, in addition to performing the function of relays 90, **TMV** presents a series of applications to meet the most demanding regulations in the electrical sector.

Finally, Treetech **TMV** has been specially designed to integrate in a harmonic and complete way with any product that supports the Modbus® (standard) or DNP3 (optional) protocols.

TMV AND MULTIGRADIENT FEATURE

Once the thermal behavior of a transformer varies according to the activation of its cooling stages, TMV presents the multigradient function.

This feature allows the equipment to vary thermal parameters according to the active cooling stage. The winding temperature calculation is more accurate according to the operation of the transformer, ensuring greater reliability when the equipment works on overload.

Features

MULTIMETER FUNCTION

Indications of voltage in the transformer and in the load, voltage deviation, current, active, reactive and apparent power, load percentage, power factor and frequency.

OLTC LOCK (INTRINSIC PROTECTION)

The OLTC is blocked in case of overcurrent and undervoltage. In case of overvoltage, the actuation is selectable: OLTC lock or rapid voltage decrease.

ADJUSTABLE PT/CT LAG

Settings between 0 and 330 °, allowing any type of TP / TC connection.

DROP COMPENSATION ON THE LINE

TMV performs this function in two ways: Resistance and Reattachment adjustments (Rx) or by the simplified voltage drop percentage method (Z compensation).

RUGGED HARDWARE

TMV design exceeds EMC (Electromagnetic Compatibility) standards to withstand severe electromagnetic substation conditions and operating temperature -40 to 85 °C.

VFD (VACUUM FLUORESCENT DISPLAY)

High brightness, legible under any lighting and temperature conditions.

INTERNATIONAL STANDARDS MET

IEEE C57.91 (2011) and IEC 60076-7 (2005) (international); ABNT NBR 5416 (1997) and ABNT NBR 5356-7 (2017) (Brazilian).

SMALL SIZE

Extremely compact size, 96x96x125 mm.

10 REGULATION SETS

Ten independent sets of voltage regulation parameters, activated through hourly programming (internal clock) or by communication.

OLTC COMMAND

TMV allows the user to choose the OLTC command mode between Local / Remote, and Manual / Automatic.

MEASUREMENT OF TWO TEMPERATURES

TMV allows the measurement of two temperatures between ambient, transformer oil and OLTC oil.

FINAL GRADIENT FORECAST

TMV calculates the final gradient prediction of oil-winding temperature for the current load.

REDUNDANT OIL TEMPERATURE MEASUREMENT

This function prevents the unavailability of the measurement in case of failure of a Pt100Ω sensor.

LOCAL COOLING CONTROL

TMV has two options to perform this function: Automatic or Manual - via frontal keyboard, and Remote - via communication port.

SELF-DIAGNOSIS

TMV has self-diagnostic relays for detecting internal faults or sensors and wirings.

INTERNAL CLOCK

Adjustment maintained for 48 hours in case of power failure, without the use of batteries - maintenance-free equipment.

UNIFORM USE OF FANS AND PUMPS

Automatic alternation of forced cooling groups.

Optional Functions

According to the request, TMV can be supplied with one or more of the optional functions listed below:

MMEM – Mass memory

Non-volatile memory for storage of measurements and alarms events, shutdowns and others, with capacity greater than 10 months recording every 15 minutes. The intervals between recordings and temperature range for recording are user programmable.

DNP3 – DNP3 protocol

Level 1 DNP3 slave communication protocol, RTU, with support for timestamp with 1 ms accuracy. Through the DNP3 protocol, the user can access parameter query and programming, checking of analog and digital measurements, and alarm events.

PCOL – Pre-cooling

Extends the life of the insulation by activating the cooling groups when load levels previously selected by the user are reached. Taking advantage of the large thermal inertia of the oil, forced cooling is triggered before the temperature rises excessively, reducing windings exposure to high temperatures and limiting the loss of life of the insulation. Programmed by the user:

- ✓ Percentage of load for individual drive of each forced cooling stage;
- ✓ Hysteresis to shut down the forced cooling stages when load decreases.

FEXC – Fan exercise

The **fan exercise** function prevents fans and / or pumps from being inactive for long periods on transformers with low load or during periods of low ambient temperature. This prevents axle locking by dirt accumulation or grease drying. Cooling equipment is activated daily, according to the equipment internal clock, as user selections made:

- ✓ Fan start time (hour and minute);
- ✓ Total daily fan operation time, from 0 to 999 minutes.

The fan exercise function can also be used for pre-cooling, in transformers subject to cyclic loading; the starting of the cooling is scheduled for a time prior to the daily peak of load, with the desired advance.

INAG – Insulation aging monitoring

This function performs the online monitoring of the winding insulation life loss, providing important information for the diagnosis and prognosis of the condition of the equipment:

- ✓ Current Percentage of life remaining, 100% (new insulation) to 0% (end of life of insulation);
- ✓ The average insulation loss rate, in % per day, calculated over a user-selectable time period;
- ✓ Extrapolation of the remaining lifetime for the insulation, calculated as a function of the variables above (percentage of remaining life and average rate of loss of life).

OLTD – OLTC temperature differential

This function allows you to compare the transformer oil with the OLTC temperature, to detect abnormal temperature differentials and alert maintenance personnel to the OLTC failure.

As the temperature differential is subject to the influence of external variables, the monitoring occurs in two different ways, in order to increase the efficiency of the diagnosis and to avoid false alarms:

- ✓ Instantaneous Differential Monitoring - Provides quick-response alarms for high-intensity, even short-term defects;
- ✓ Filtered Differential Monitoring - By subjecting the Instantaneous Differential to a low pass filter, it is possible to detect trends in the differential that indicate permanent defects of low intensity, albeit with a longer detection time.

DIGI – Digital inputs

Two digital inputs for control switching from OLTC command mode between manual / automatic and local / remote. They can also be used to raise tap / download tap if the optional TAPP is enabled.

TAPP – OLTC tap position*

Input for reading OLTC position by potentiometric sensor, with compensation for resistance of cables and detection of errors. Associated functions:

- ✓ Current output programming for remote tap reading;
- ✓ Manual command of OLTC, local (front panel) and by serial communication;

- ✓ Limitation of OLTC excursion range (minimum and maximum tap positions allowed) and memorizing maximum and minimum positions reached since last reset;
- ✓ Protection against undue tap operations: blockage of OLTC in case of operations not initiated by TMV.

OLMT – OLTC maintenance*

It allows the position measurement in the molds of the optional TAPP presented in the item above and adds:

- ✓ OLTC operation counter, with notice for high number of operations;
- ✓ Integration of current switched squared, with notice for high I^2 sum;
- ✓ Time remaining for maintenance;
- ✓ Maintenance alarms are issued with programmable advance.

OLCK – OLTC switching success check

Enabled, this feature allows the SDV to check the success of switching through the voltage changes after the control command (increase / decrease of voltage). It works by algorithms that identify voltage levels corresponding to the sensitivity of the circuit, identifying activity or not of the switching, signaling the fault (Alarm). It does not require potentiometric transmitter information.

MSPR – Master-Slave Parallelism*

In Master-Slave method, one of the transformers should be chosen as the master, while the remaining as slave or as individual. In this way, all the switching carried out by the master transformer is also started simultaneously on the slaves, keeping the same position in all transformers and avoiding current flow between the parallel windings.

CCPR – Circulating current parallelism*

Parallelism control for up to 6 transformers using the Minimum Circulating Current Method, with block for excess circulating current.

CONC – Parallelism concentrator*

Enables the communication function with the parallelism system via SPS.

*Under request.

Technical Data

Hardware	Interval / Description
Supply voltage	38 to 265 Vac/Vdc – 50/60 Hz
Consumption	≤ 13 W
Operating temperature	- 40 to + 85°C
Protection degree	IP20
Connections	0,3 to 2,5 mm², 22 to 12 AWG
Mounting	Panel mounted

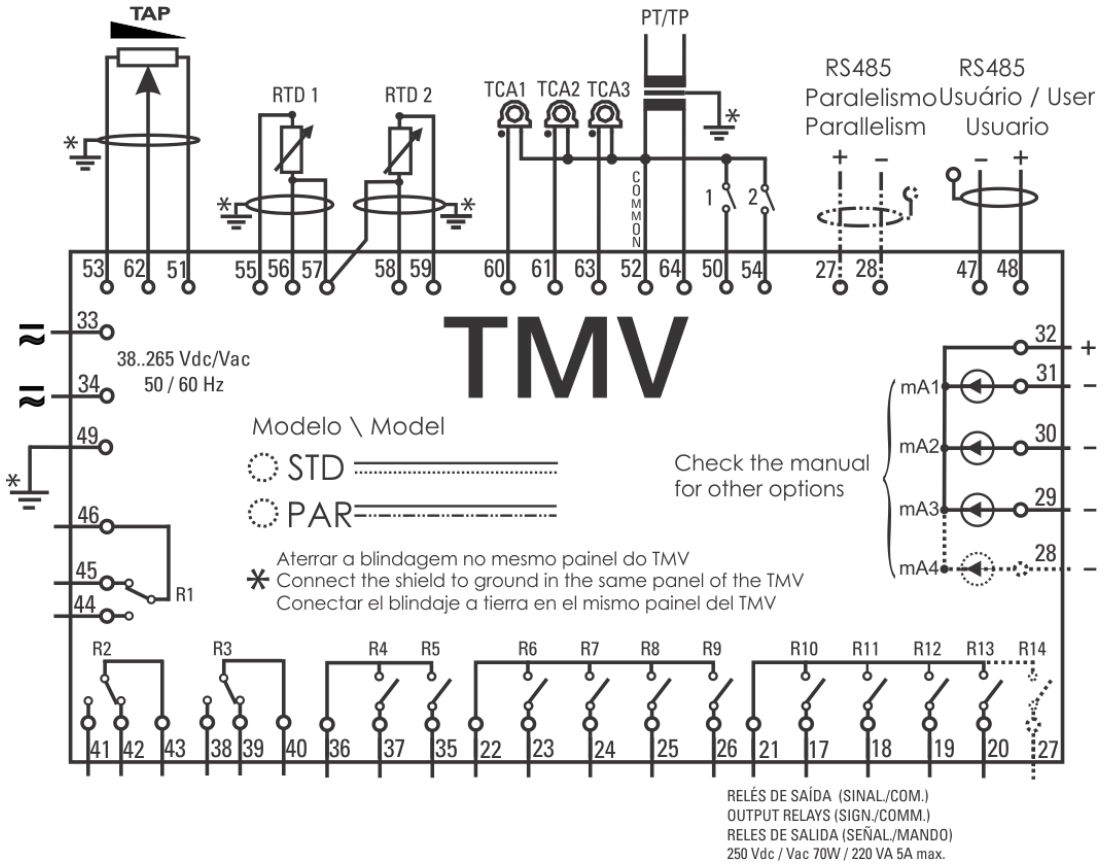
Measuring inputs	Interval / Description
Currents (for regulation only)	1 external CT 0...10 Aac rms
Currents (for thermal image)	Up to 3 clip-on external CTs 0…10 Aac rms
Rated frequency	50/60 ±2 Hz
Voltage	1 external PT 0…185 Vac rms
Temperatures	Two 3-wire Pt100 sensors at 0 ° C, range: -55...200°C
Dry contacts	Two potential free
Tap	Potentiometric transmitter, range: 4,7...20 Ω

Maximum errors	Interval / Description
Currents	0,5 % of range measurement 0,5...10 Aac
Voltages	1 % of range measurement 80...265 Vac / 100...300 Vdc
Temperatures	0,5 % of full scale + sensor error

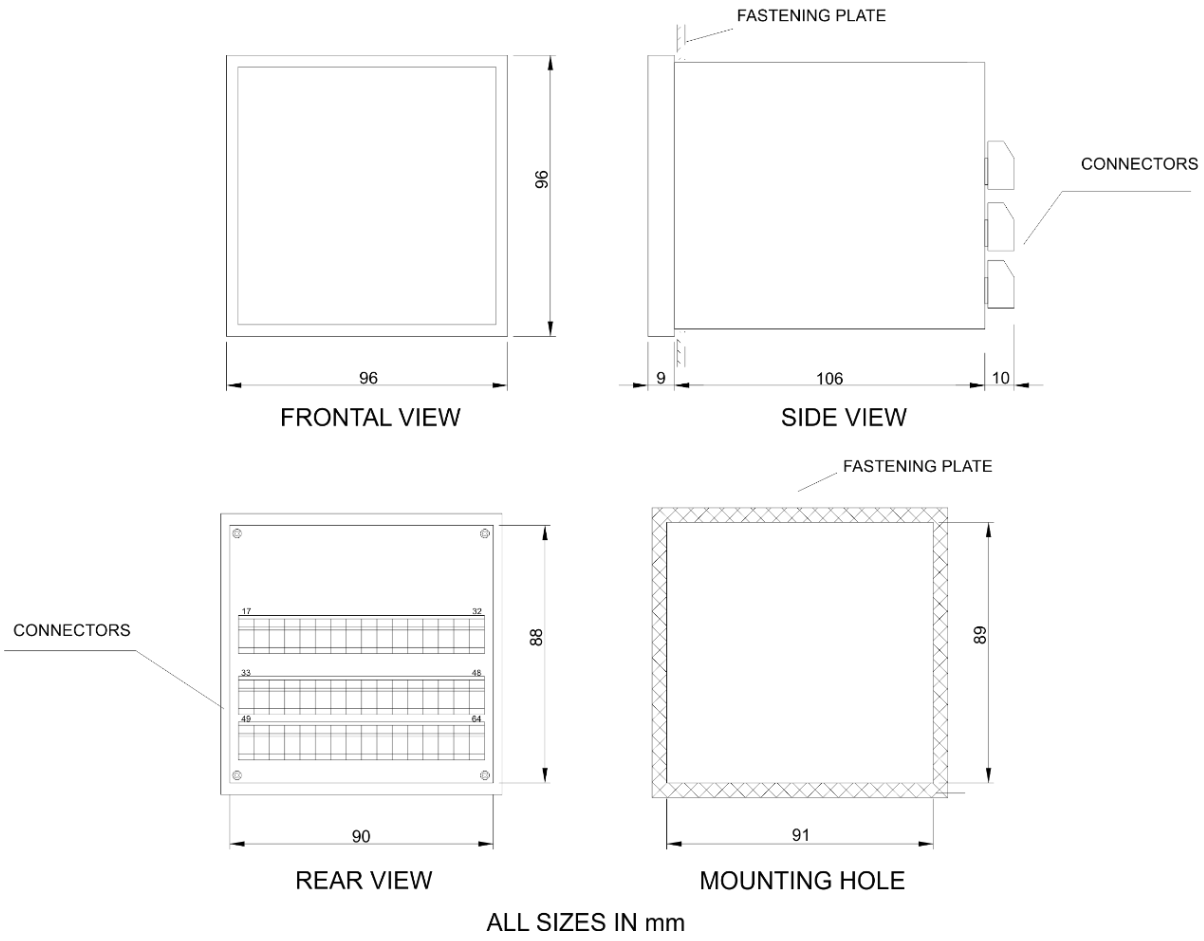
Outputs	Interval / Description
Relay outputs	Up to 3 reversible + 11 NO
Maximum switching power	70 W(dc) / 220 VA(ac)
Maximum switching voltage	250 Vdc / 250 Vac
Maximum conduction current	5 A
Current loop analog outputs	Up to 4 unipolar or 2 bipolar, with positive common
Maximum error	0,5 % of full scale
Selectable options and maximum load	0...1 mA, 10 kΩ 0...5 mA, 2 kΩ 0...10 mA, 1 kΩ 0...20 mA, 500 Ω 4...20 mA, 500 Ω
Bipolar and maximum load options	-1...1 mA, 10 kΩ -5...5 mA, 2 kΩ -10...10 mA, 1 kΩ -20...20 mA, 500 Ω

Network interface	Description
Serial communication ports	1x RS485 (user); 1x RS485 (Parallelism model)
Communication Protocols	Modbus® RTU; DNP3 RTU

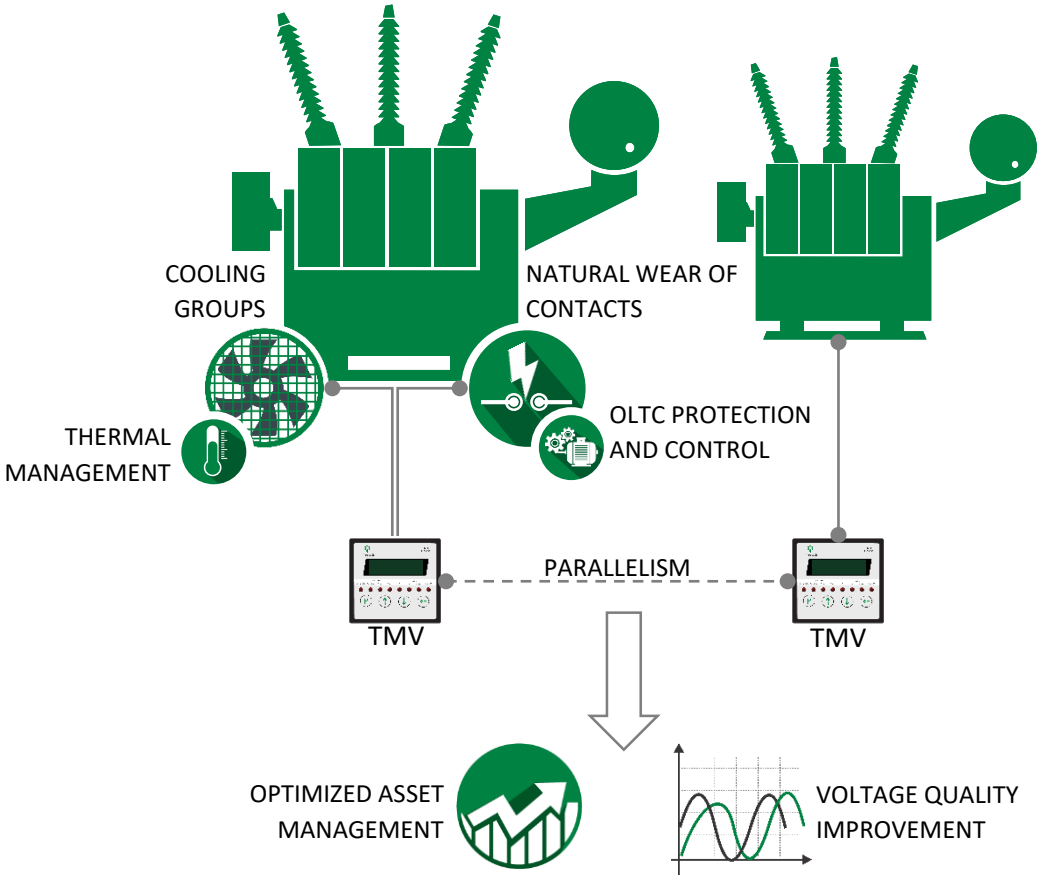
Connection Diagram



Dimensions


FASTENING PLATE
CONNECTORS
96
96
9
106
10
FRONTAL VIEW
SIDE VIEW
FASTENING PLATE
CONNECTORS
17
32
33
48
49
64
88
89
90
91
REAR VIEW
MOUNTING HOLE
ALL SIZES IN mm

Typical applications



Temperature Monitor and Voltage Regulator – TMV typical application.

Order Specification

In the TMV purchase order it is necessary to specify the following items:

1 – PRODUCT NAME

Temperature Monitor and Voltage Regulator – TMV.

2 – QUANTITY

Units number.

3 – MODEL

Choose one of the following options:

- ✓ **Standard** (14 output relays and 4 analog outputs).
- ✓ **Parallelism*** (13 output relays, 3 analog outputs and additional RS-485 port for parallelism).

*For TMV to perform parallelism, the user must enable at least one of the three options below:

- **CCPR –** Circulating current parallelism
- **CONC –** Parallelism concentrator
- **MSPR –** Master-slave Parallelism

4 – FUNCTIONALITY

Choose one of the following options:

- ✓ **Temperature measurement of one winding –** From the readings of the temperature of the insulating oil and a transformer load current, TMV performs the temperature calculation (thermal image) of one winding.
- ✓ **Temperature measurement up to three windings –** From the readings of the temperature of the insulating oil and one or more transformer load currents, TMV performs the temperature calculation (thermal image) of up to three windings.
- ✓ **Voltage regulation –** TMV maintains the quality of the voltage in the load, keeping it within a certain range of values, user programmable.
- ✓ **Voltage regulation + Temperature measurement of one winding –** This TMV feature allows the maintenance of the quality of the voltage in the load. In addition, based on readings of the temperature of the insulating oil and a transformer load current, TMV performs the temperature calculation (thermal image) of one winding.
- ✓ **Voltage regulation + Temperature measurement up to three windings –** This TMV feature allows the maintenance of the quality of the voltage in the load. In addition, based on readings of the temperature of the insulating oil and one or more transformer load currents, TMV performs the temperature calculation (thermal image) of up to three windings.

5 – OPTIONS

Depending on the model and functionality chosen, there are different combinations of options available, as shown in the table below.

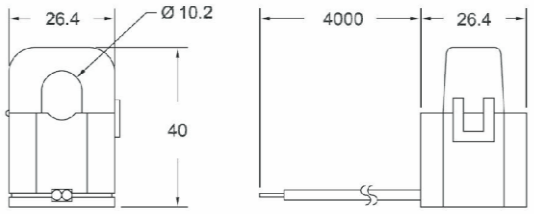
1 WIND	3 WIND	REG	REG + 1 WIND	REG + 3 WIND	
					DNP3
					MMEM
					PCOL
					FEXC
					INAG
△ⓘ	△ⓘ		△ⓘ	△ⓘ	OLTD
					DIGI
		△	△	△	TAPP
		△	△	△	OLMT
		△	△	△	OLCK
					CCPR
					CONC
					MSPR

SUBTITLE:	
	Available
ⓘ	Restricts oil temperature redundancy as it requires a Pt100 for OLTC temperature
△	Available with restrictions (one output relay and one analog output) in the version with Parallelism
	Available in Parallelism version only
	Not available

Required accessories

External split-core CTs (clip-on) for temperature measurement

The use of external split-core CTs is required for reading the transformer load currents. This item is supplied in the quantity required for the desired application type and must be requested in the purchase order.

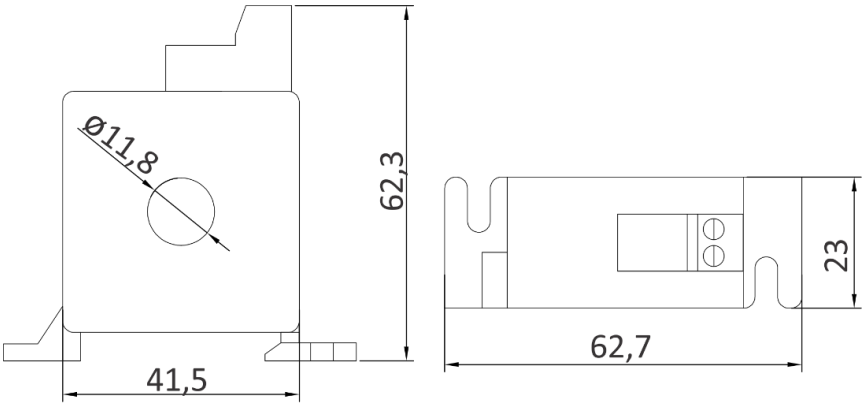


Operating temperature: -40...+85°C.

All sizes in mm.

External CT for regulation

The use of an auxiliary external CT is required for TMV use in the voltage regulation of the transformers. This item is supplied in the quantity required for the desired application type and must be requested in the purchase order.

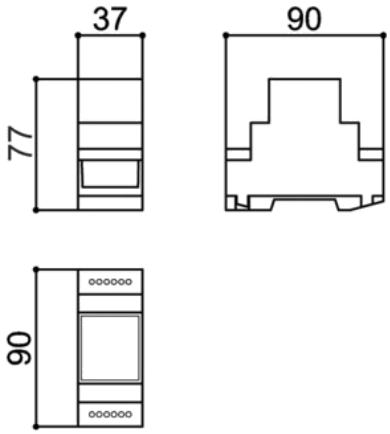


All sizes in mm

Features	Description
Encapsulation	DIN rail mounting box
Maximum primary measuring current	10 Arms; 50/60 Hz
Number of secondary winding turns	3000
Maximum secondary resistance	200 Ω
Power	≥0,5 VA (measurement only)
Linearity	Maximum error of ± 1 % with 300 Ω load
Maximum phase error	≤1° with 300 Ω load
Protection	Secondary with protection to load disconnection and external electrical transients

Auxiliary PT

The use of TMV in the regulation of voltage in transformers requires the installation of an auxiliary PT. This item is provided in the required amount to the desired type of application and must be requested in the purchase order, with the features listed in the following table.



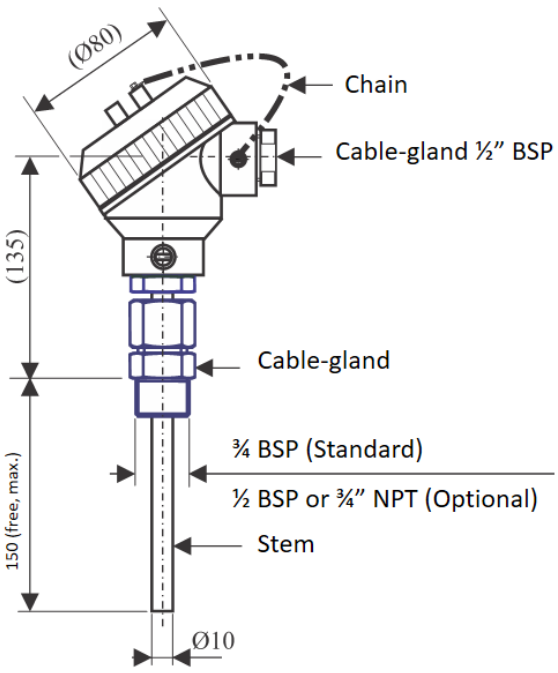
All sizes in mm

Features	Description
Encapsulation	DIN rail mounting box
Maximum primary measuring voltage	185 Vrms; 50/60 Hz
Maximum secondary measuring voltage	1,03 Vrms (rated NP/NS = 180)
Power	≥1 VA (measurement only)
Linearity	Maximum error of ± 1 % with 1 kΩ load
Operating temperature	-40...+85 °C
Protection	Capacitive between primary and secondary and available in external terminal for grounding (objective: capacitive decoupling to avoid interference on other measurements)
Dielectric strength	2500 Vrms; 60 Hz/1 min and 5 kV (1,2/50 µs) boost between: - primary and secondary; - primary and shielding; - secondary and shielding.
Maximum capacitance between primary and secondary (with shielding disconnected)	50 pF

Temperature sensor Pt100Ω at 0 °C

The temperature measurement of the oil top in power transformers is usually performed through a temperature sensor installed in a thermowell on the transformer cover. The sensors used must be of the Pt100Ω type at 0 ° C. If necessary, Treetech has a suitable sensor for thermowell installation, as shown below (special dimensions on request), supplied as an accessory.

FEATURES	INTERVAL
Standard	ASTM E1137, class B
Alpha coefficient	0,3850 / °C
Measurement range	-100 to +300°C
Head	Cast aluminum, painted
Bulb (stem)	Stainless steel
Cable gland	Nickel plated brass
Chain	Nickel plated brass
Screws	Nickel plated brass or stainless steel
Adapter	Stainless steel
Insulation	2kV, 50/60 Hz, 1min.



Optional accessories

Rapid Installation Panel - PIR

TMV must always be installed sheltered from the weather, and for this it is usually installed inside a control panel or inside a building. In cases where this is not convenient, for example, in retrofits of old transformers, the TMV can be supplied in easy installation weatherproof cabinets.

FEATURES	
Models	PIR-1 for one monitor (TMV); PIR-2 or PIR-3 for other Treetech monitors.
Fastening to transformer	Screwed or with high load capacity magnets.
TMV fastening	In withdrawable rack
Wiring connection	Removable multipolar plugs on bottom of cabinet
Protection degree	IP55
Insulation test	2kV, 50/60 Hz, 1 min

TMV installed with the cabinet

Weather shelter

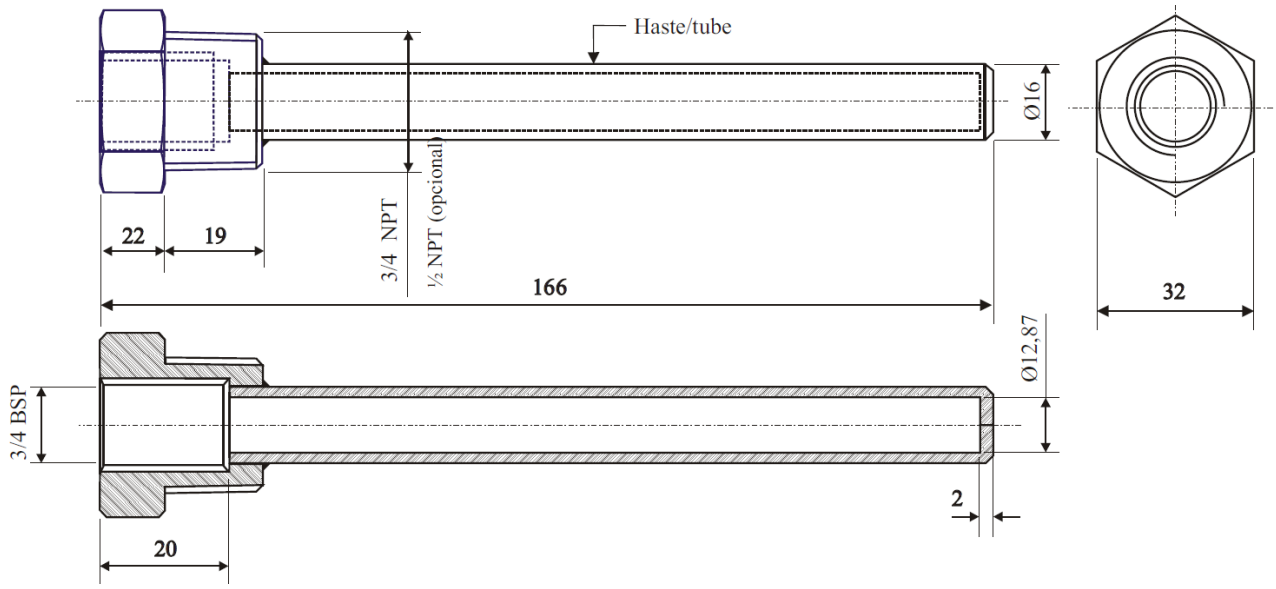
If ambient temperature measurement is desired in unguarded locations, a weather shelter should be used to protect the Pt100Ω sensor at 0 ° C, minimizing errors that sun, rain, wind, etc. could cause in the measurement. Treetech has a suitable weather shelter.

Thermometric wells for temperature sensor Pt100Ω at 0 °C

Thermometric wells are used to give total protection to the sensors where they are installed. They are also intended to completely seal the process against pressure losses, leaks or possible contaminations.

Mounting the sensors with thermowells is necessary where safety and installation conditions are highly critical.

Added to this is the ease of removal of the sensor for maintenance or exchange, without the inconvenience of a process shutdown.



The wells are made of 304 stainless steel, a material very resistant to corrosion and very used as protection in temperatures up to 900 °C. The dimensions of the figure above are in mm.

FEATURES	SPECIFICATION
Inner thread (Pt100Ω at 0 °C)	¾ BSP
External thread (process)	¾ NPT or ½ NPT

Monitoring software Sigma ECM®

The variables related to the condition and operation of the assets are captured by Treetech IEDs, such as **TMV**, and sent to Sigma ECM®, which treats them through algorithms and mathematical models constructed in accordance with Brazilian (NBR) and international (IEC and IEEE) standards.

This treatment originates the diagnosis of the current state of the equipment and the prognosis of its future state, in order to detect defects still in the incipient phase.

The computer with the software can be located in the substation control room or at a remote location, allowing access to all information via an intranet network.

Type tests

TMV is an equipment developed on the *SmartSensor 3* platform; therefore, the tests performed and corresponding results follow the table below:

Surge Immunity (IEC 60255-22-5)	
Differential Mode	1 kV (+/-)
Common mode	2 kV (+/-)
Electrical transient immunity (IEC 60255-22-1)	
1st cycle peak value, frequency, repetition rate	2,5 kV common mode 1 kV dif. mode 1 MHz 200 surges/s
Voltage applied (IEC 60255-5)	
Dielectric strength	2 kV in 60 Hz for 1 min
Voltage boost	5 kV (+/-)
Immunity to irradiated electromagnetic fields (IEC 60255-22-3)	
Frequency, modulation index, field strength, power supply	80 to 2500 Mhz 80% and 1 kHz sinusoidal 10 V/m 220 V / 60 Hz
Immunity to conducted electromagnetic disturbances (IEC 60255-22-6)	
Field strength, frequency, modulation index, scanning frequency, fixed frequencies, duration, power supply	10 Vrms 0,15 to 80 MHz 80% and 1 kHz sinusoidal 150 kHz to 80 MHz 27 to 68 MHz 20 s 220 V / 60Hz
Immunity to magnetic fields of industrial frequency (IEC 61000-4-8)	
Magnetic field strength and direction	30 A/m 3 orthogonal axes
Electrostatic discharges (IEC 60255-22-2)	
Strength and voltage	Air mode 15 kV 220 V / 60 Hz
Immunity to rapid electrical transients (IEC 60255-22-4)	
Power supply, inputs and outputs	4 kV (+/-) to 5 Hz
Current outputs	2 kV (+/-) to 5 Hz
Power supply failure (IEC 61000-4-11)	
Voltage drops	0-80% of U 1/2 to 300 cycles 85 V and 265 V 50/60 Hz
Short interruptions	5 seconds 85 V and 265 V 50/60 Hz
Resistance to cold weather (IEC 60068-2-1)	
Temperature, test duration	-40°C 16 hours
Resistance to dry heat (IEC 60068-2-2)	

Temperature, test duration	+85°C 16 hours
Resistance to damp heat (IEC 60068-2-78)	
Temperature and humidity, test duration	+40°C to 85% RH 24 hours
Thermal cycle (IEC 60068-2-14)	
Temperature range, total test duration	-40°C to 85°C 120 hours
Vibration response (IEC 60255-21-1)	
Application mode	Sinusoidal
Amplitude	0,075 mm (10 to 59 Hz); 1G (59 to 150 Hz);
Time	8 min/axis
Vibration durability (IEC 60255-21-1)	
Application mode	Sinusoidal
Amplitude	2G (10 to 150 Hz);
Time	160 min/axis

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