

USER MANUAL

Transformer Temperature Monitor – MasterTemp



SUMMARY

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INTRODUCTION

The Temperature Monitor **MASTERTEMP®** was designed to monitor up to 3 windings oil temperature, to command the cooling system, and to protect distribution and power transformers (ANSI 49I and ANSI 49);

The **MASTERTEMP®** was built obeying to rigorous quality patterns and it uses last generations electronic components (SMD type), its hardware was designed to stand against severe working conditions, all of this protected by a aluminum cabinet in conformation with DIN IEC 61554 norm, this features allows to do its installation directly on Power Transformer and Reactor panels, on substation halls, maritime platforms and Chemical Plants.

As input signal, the **MASTERTEMP®** allows up to 2 (two) Temperature Sensors PT-100 that can be set to: Environment temperature measurement and to the transformer main tank oil top measurement, TAP Changer oil Temperature and Oil Top with configurable alarm or two measurement points for redundancy and backup in case of measure loss from one of ths PT-100 Sensors.

It also has 3 (three) electrical current measurement input from the Thermal Image CT to calculate the winding temperature using a precision transductor CT Split Core Type.

For remote transmission of these quantities, the **MASTERTEMP®** has 5 (five) analog outputs totally configurable being able to transmit any quantity measured or calculated, such as; Oil Temperatures, Winding Temperatures, Primary windings electrical current, Secondary windings electrical current, windings percentual loading, Temperature differential between sensors 1 and 2 with selectable pattern as 0 to 1 mA, 0 to 5 mA, 0 to 10 mA, 0 to 20 mA and 4 to 20 mA.

To the SCADA or Specialist Software all the measured quantities, calculated and Setting parameters, beyond the engineering patterns that are available on **MASTERTEMP®** that can be accessed through a RS-485 digital output with 2 standards communication protocols, Modbus RTU and DNP 3.0 (Level 2) chosen by the use on **Configuration Set** equipment parameter, including real-time electric drives remote commands.

For Alarm indication and thermal protection, the **MASTERTEMP®** has 13 isolated and potential free driving relays with configurable setpoints to alarms and shutdowns by oil and winding temperature levels, temperature differential alarms and sensors failure and 1st 2nd and 3rd ventilation groups activation that can also be driven through the power transformer percentual loading and 1 auxiliary relay that is configurable by the user for actuation by any measured value.



Fig. 1 – Entrada para cartão de memória Micro SD Card



Fig. 2 – Entrada USB para Parametrização via Software UseEasy

The **MASTERTEMP®** display presentation mode is totally configurable, being possible to introduce the measured quantities in 5 lines and on the 1st one is possible to configurate the SCAN mode all the selected quantities by the user.

The display shows measured and calculated indications, written messages of the events and its activated relays, as well as a watcher with hours/minutes/seconds indication used in a datalogger timestamp that stores its information in a Micro SD Card all **MASTERTEMP®** events and measurement by a uninterrupted 10 years with a 5 minutes recording interval.

MAIN FEATURES

HUMAN MACHINE INTERFACE (HMI)

- **OLED** display with 128 x 64 pixels graphic capacity, with contrast adjustment and background color and letters inversion, legible under any illumination condition, including directly sun exposure;
- Main Screen with simultaneous indication of 5 selected quantities in SCAN mode;
- HMS watcher indication, in case of energy breaks it doesn't lose its configuration until 240 hours, it uses a super-capacitor as an energy backup for high operation temperatures and it will never require replacement;
- 5 Silicon navigation keys with smooth touch;
- 14 LED's on frontal that allows the identification, even over long distances, of driven outputs relays;
- Failure and Events written indication on the OLED display (Announcer) and driven relays describing;
- Intuitive Configuration Sets, indication, actuation, maintenance and transformer parameters, protected by an access password and in 2 languages (Portuguese and English);
- Consult menu for maximum temperature indication reached by the sensors;
- Consult menu for working time indication of each cooling group;
- Consult menu of final gradient indication of each power transformer winding;
- Consult menu for percentual loading of each power transformer winding;

- Consult menu of measured currents by the external CT (Split Core / Clamp);
- Consult menu of winding currents indication of the power transformer (Calculated Value);
- Consult menu of life loss of each winding and the remaining life of each winding;

ENGINEERING ALGORITHMS FOR MONITORING

- Thermal image calculation (Hot Spot) based on IEC 60076-7, IEEE C57.91 and NRB 5356-7:2017 normative;
- Power Transformer loading percentage calculation;
- Temperature Final Gradient Calculation for the current load (Oil-winding);
- Life loss calculation of the selectable insulation for Kraft (55°C), stabilized term (65°C) and Nomex (95°C) based on Arrhenius Theory and insulation remaining working life in hours and days;
- Temperature differential calculation between two PT-100 Sensors in order to monitor TAP Changer defects or Cooling efficiency monitoring;
- Time Monitoring of the ventilators actuation (Hourmeter) with programmable Alarm for Maintenance Warning;

COMMUNICATION PROTOCOLS AND DIGITAL COMMUNICATION PORTS

- USB 2.0 Frontal communication port with type A connector for configuration upload or download through **USEEASY** software;
- 2 wires RS-485 digital output (ANSI/TIA/EIA-485-A) with 2 available protocols, **Modbus RTU** and **DNP3** (Level 2) for remote monitoring through SCADA software and access to all measured parameters and digital outputs activations
- Auto Baud Rate of 2.400 to 57.600 bps (It automatically detects the communication network speed);

DATA STORAGE AND DATA LOGGER

- Frontal 8GB Micro SD card input that stores up to 10 years of the MasterTemp of the calculated and measured data;
- Stores by time and measuring variations, the recording interval can be configurable between 5 to 180 minutes, and the variation value can be disposable between 1°C to 10°C and 100mA to 1 A;
- The non-volatile internal memory that stores the higher temperatures from the PT-100 sensor reading and from the transformer windings;

SENSORS AND MEASUREMENT INPUTS

- 3 digital inputs of electrical current measurement up to 0 to 10 Amperes for the thermal image calculation, it uses an external CT (Split Core / Clamp) and an electrical current transducer that makes available an amplified 4 to 20 mA pattern analog output that allows it to be installed over 500 meter distance between from the monitor without precision loss (1%) and signal quality;
- 2 inputs for temperature Reading through 3 wires PT-100 sensors (EM 60751 – DIN 73760) with -50°C to 250°C measurement range with 0,25% (FS) and with 1 decimal place indication,

one of the inputs is mandatorily used for oil top temperature measurement of the transformer and the other sensor can be configured as:

1. TAP Changer oil temperature measurement with configurable differential alarm for Operation defects detection;
2. Main Tank inferior level temperature measurement or the radiator output with temperature differential indication between the top oil temperature, used to measure the transformer cooling system efficacy;
3. A second top oil temperature measuring point of the transformer with average temperature indication between two PT-100 and automatic backup in sensor for failure cases;
4. Environment Temperature measurement to use it on the transformer admissible loading calculation;

RELAY DIGITAL OUTPUTS

- 1 NO (Normally Open) Relay with 6 amperes conduction capacity to trigger the High Oil Temperature Alarm (NC Relay only by requesting);
- 3 NO's (Normally Open) relays with 6 Amperes conduction capacity to trigger the winding high temperature alarm (Normally Closed Relay only by request);
- 1 NO (Normally Open) Relay with 6 amperes conduction capacity to trigger the transformer TRIP with 0 to 20 minutes programmable delay;
- 1 NO (Normally Open) Relay with 6 amperes conduction capacity to Fail signalization of the Watchdog monitor;
- 1 NO (Normally Open) auxiliary Relay with 6 amperes conduction capacity that can be programmed to work like the alarms, TRIP and as a temperature differential;
- 3 NO's (Normally Open) relays with 6 Amperes conduction capacity to trigger the transformer cooling system or NC Pump – Normally Open or Normally Closed – with programmable hysteresis with timing lock of 15 seconds;

TECHNICAL DATA

MasterTemp	
Operation Voltage	48 to 265 Vdc/Vac 50/60 Hz (-20 % / +10%)
Operation Temperature	-40°C to 85°C
Storage Temperature	-50°C to 50°C
Consumption	< 15 W
Temperature measurement input	2– PT-100 Ohm to 0°C to 3 wires (EN 60751 - DIN 43760)
Measurement Range	-50 to 250°C
Electrical Current Measurement input	3 – CT's Split Core of 0 to 10A (True RMS)
Maximum load and analog outputs options	0 ... 1mA - 8000 Ohms
	0 ... 5mA - 1600 Ohms
	0 ... 10mA - 800 Ohms
	0 ... 20mA - 400 Ohms
	4 ... 20mA - 400 Ohms
Measurement inputs maximum errors	0,25% end of scale
Analog Output maximum error	0,25% end of scale
Output Contacts	13– Potential Free
Maximum Power Switching	70 W / 250 VA
Maximum Voltage Switching	250 Vac/Vdc
Electrical current maximum Conduction	6,0 A
Serial Communication Port	RS 485 – 2 fios - (ANSI/TIA/EIA-485-A)
Communication Protocol	Modbus RTU and DNP 3 Level 2 (Slave)
Network Speed – Auto Baud Rate	2.400 to 57.600 bps
USB Frontal port (configuration)	USB Serial 2.0 – Tipo A
Box DIN IEC 61554 (cabinet)	98 x 98 x 98 mm – Aluminum
Fixation – W/ Steel Clip	Embbded on the panel
Electrical Current Transformer - CT Split-Core	
Analog Output	4 to 20mA
Measurement Range	0 to 10 A
Measurement input maximum error	1% end of scale
Linearity	1% end of scale
Operation Temperature	-40 to +85°C

TYPE TESTS ATTENDED

- Applied Voltage (IEC 60255-5): 2kV / 60 Hz / 1 min. (Against earth);
- Voltage Impulse (IEC 60225-5): 1,2/50 µseg. / 5kV / 3 neg. and 3 pos. / 5 sec; interval;
- Electrostatic Discharge (IEC 60255-22-2): Air Mode = 8 kV / Counted Mode = 6 kV;
- Irradiated Electromagnetic Disturbance immunity (IEC 61000-4-3): 80 to 1000 MHZ / 10V/m;
- Fast Electrical transients' immunity (IEC 60255-22-4): Pow.Supply/input/output = 4KV/common 2kV;
- Surges immunity (IEC 60255-22-5): phase/neutral 1kV, 5 per polar. (±) – phase-earth/neutral-earth 2kV, 5 per polar. (±)
- Conducted electromagnetic disturbances immunity (IEC61000-4-6): 0,15 to 80 MHz / 10V/m;
- Climatic test (IEC 60068-21-14): -40°C +85°C / 72 hours;

- Vibration Resistance (IEC 60255-21-1): 3 axis / 10 to 150Hz / 2G / 160 minutes/axis;
- Vibration response (IEC 60255-21-1): 3 axis / 0,075 mm-10 to 58 Hz / 1G of 58 to 150 Hz / 8 min/axis;

APPLICATION EXAMPLE

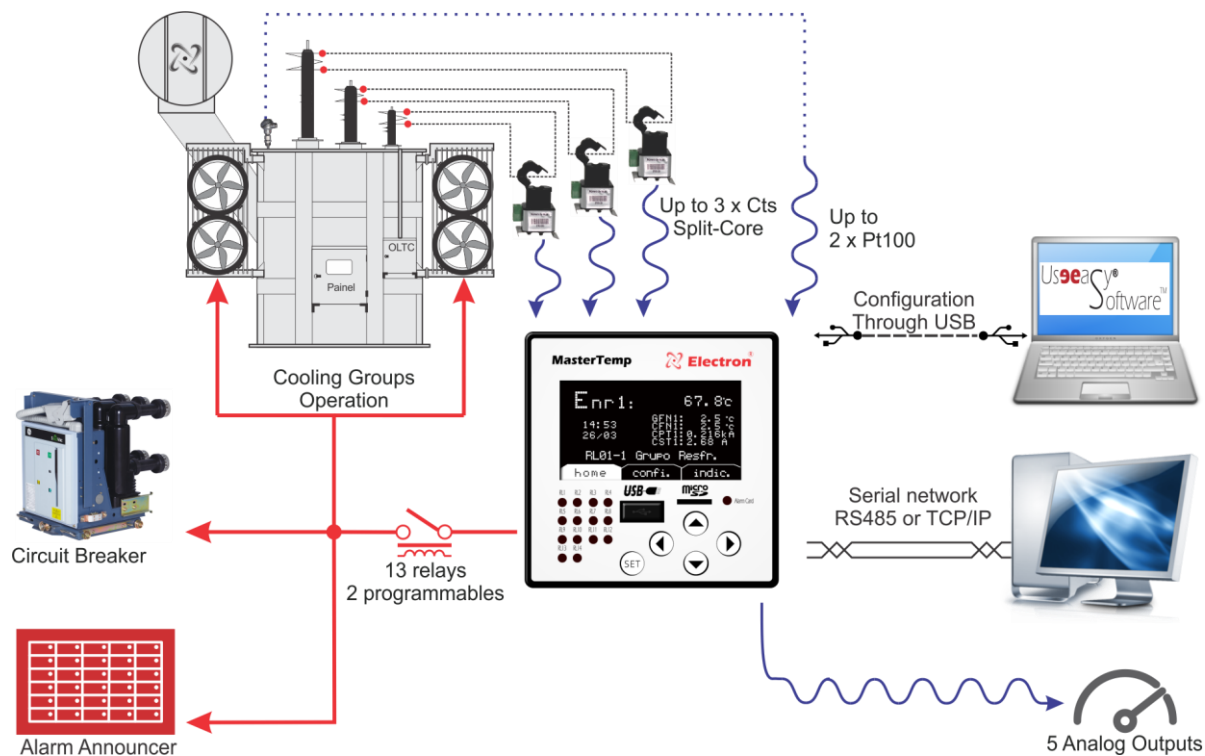


Fig. 3 – MasterTemp Application Example

DIMENSIONS

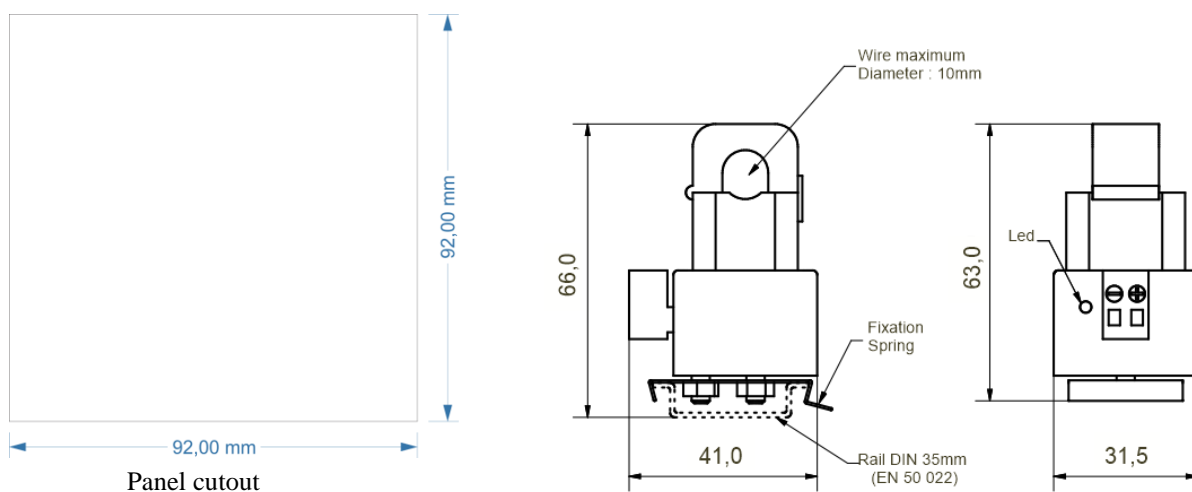




Fig. 6 – MASTERTEMP DIMENSIONS

DIMENSIONS

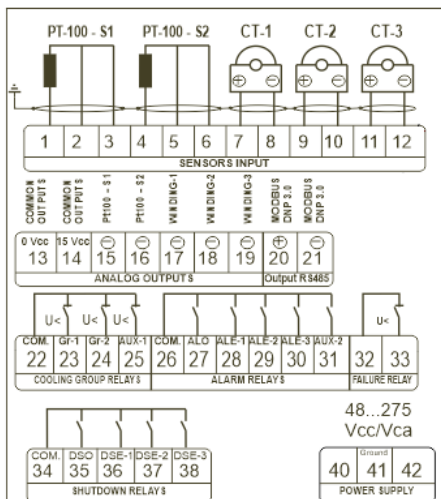


Fig. 7 – MasterTemp Connections Diagram

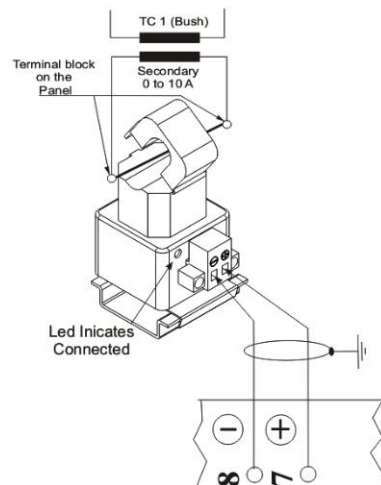
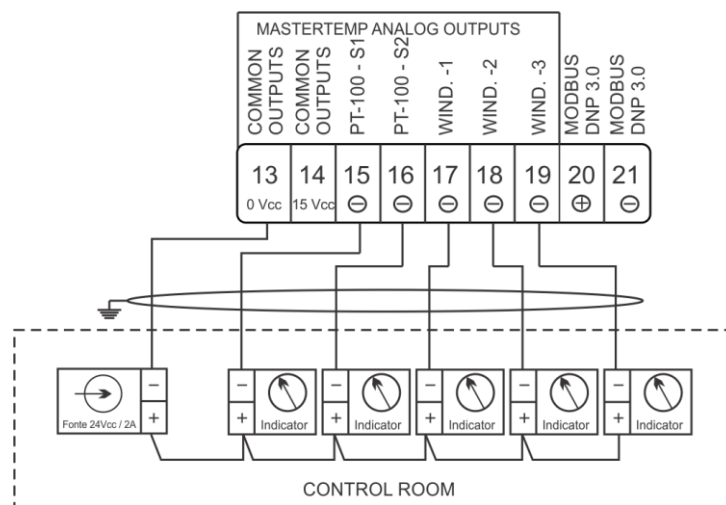



Fig. 8 – Connections Diagram CT 1



Connection Diagram for analog indicators with external power supply.

ORDER SPECIFICATION

MTTP- 

Electrical Current Measurement

1	1 - CT Split Core
2	2 - CT Split Core
3	3 - CT Split Core

KNOWING THE MASTERTEMP

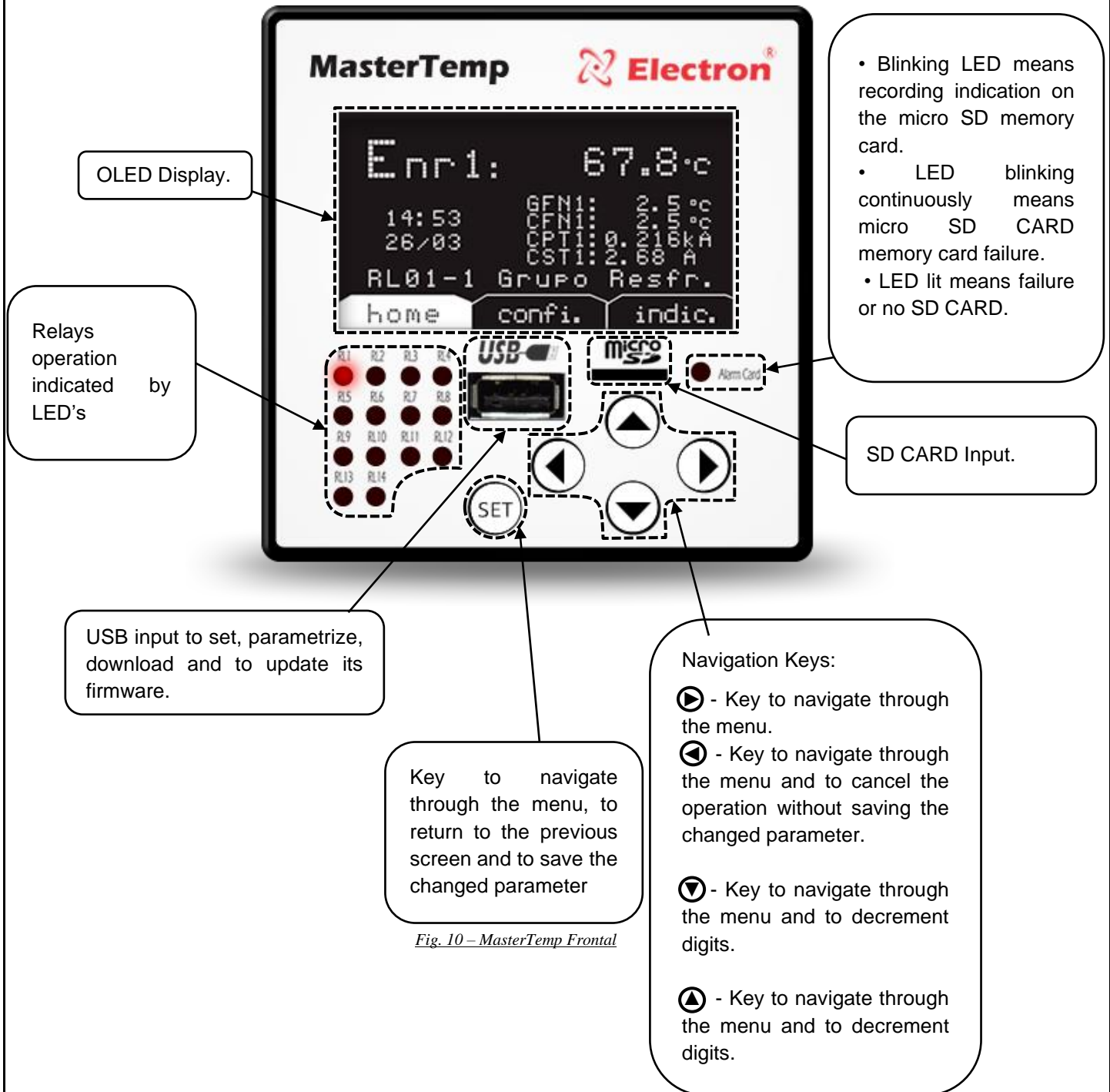


Fig. 10 – MasterTemp Frontal

DISPLAY VISUALIZATION SETTINGS

To access the Display Set the display should be on the quantity readings presentation mode. Press the ▼ key to select one of the 5 lines, ◀ with ▶ and select the variable that will be displayed on the OLED screen and confirm it pressing **SET**. To exit the “Display Set” screen use the navigation keys to select the back option and then press the **SET** key.

The OLED display has 5 lines for Reading indication, that can be set to show the following variables:

Variables that can be indicated in the OLED display	Display presentation form
Environment temperature	Ambient: 0.0 C
Top oil temperature	Oil Top: 0.0 C
Bottom oil temperature	Bot. Oil: 0.0 C
OLTC temperature	OLTC: 0.0 C
<u>Winding 1 Temperature</u>	Wnd1: 0.0 C
<u>Winding 2 Temperature</u>	Wnd2: 0.0 C
Winding 3 Temperature	Wnd3: 0.0 C
Winding 1 Final Gradient Temperature	FtG1: 0.0 C
Winding 2 Final Gradient Temperature	FTG2: 0.0 C
Winding 3 Final Gradient Temperature	FTG3: 0.0 C
Winding 1 Loading percentage	LPE1: 0.0 %
Winding 2 Loading percentage	LPE2: 0.0 %
Winding 3 Loading percentage	LPE3: 0.0 %
Current in the Secondary of the Thermal Imaging CT1	STC1: 0.0 A
Current in the Secondary of the Thermal Imaging CT2	STC2: 0.0 A
Current in the Secondary of the Thermal Imaging CT3	STC3: 0.0 A
Current in the Primary of the Thermal Imaging CT1	PTC1: 0.0 kA
Current in the Primary of the Thermal Imaging CT2	PTC2: 0.0 kA
Current in the Primary of the Thermal Imaging CT3	PTC3: 0.0 kA

PS.: To show the variable on the display indication the MasterTemp should be configured to do the selected variable reading.

CONFIGURATION SET

The CONFIGURATION SET or “**confi**” is used to set the following parameters:

- Sensor Reading;
- OLED Display;
- RS-485 Output;
- Output Current;
- SD Card Log;
- Date and Hour;
- Password Change;
- Idioma/language;

To access the **confi**. Menu with the display on reading presentation mode, press **SET** key. The display will show on the inferior part the menus and with the ▶ go to the option **confi**. And press **SET** key.

The **confi.** menu has an access password, “Password Reminder” will appear at the OLED top oil and **0000** below it.

Use **▲** or **▼** Keys to set to confirm the chosen number and press **►** to set the next number **◄**. Confirm the four digits pressing the **SET** key and you shall access the CONFIGURATION SET and its submenus. But if the you input the wrong password a “incorrect password” message on the OLED screen and will go back **0000**.

After input the MasterTemp password, and it will request again only if you return to the main menu, if you keep doing the configuration through the menus the MasterTemp will not ask the password anymore.

The MasterTemp password is **0000**. In case of loss or forgotten password, get in touch with Electron do Brasil and inform the ‘Password Reminder’.

Navigate through the MasterTemp Menus, and submenus **▲▼◄►** with keys and select the desired parameter and press **SET**. To change a variable condition use **▲▼** keys and press the **SET** key to confirm the changes, otherwise the variable will return to its previous value.

Menu	Parameter	Variable	Description
Sensor Readout	Type readout	Backup	<p>The Sensor 1 or the Sensor 2 will read the top oil temperature and it indicates the two Sensors average.</p> <ul style="list-style-type: none"> • If a PT-100 failure occurs in one of them, the thermal image calculation will be made by the other active sensor. • Disables 1st and 2nd auxiliary relays differential temperature function; • On Backup mode, the Sensor 1 should automatically read the environment temperature and the Sensor 2 will read the oil top temperature;
		Indep.	<p>The Sensor 1 or the Sensor 2 does the oil top temperature reading, according with the user selection. Then, the other sensor can be Set to do the environment temperature reading, or the bottom oil level temperature reading, or the TAP Changer Temperature reading.</p> <ul style="list-style-type: none"> • If a PT-100 failure occurs in one of them, the thermal image calculation shall be interrupted, indicated by a “OFF” message on the OLED display and then, the Failure and System Cooling relays will be activated; • Enables the Temperature Differential between 1 and 2 auxiliary relays; • On Independent mode the sensor 1 should automatically read environment temperature and the Sensor 2 the top oil temperature;
	<p>Sensor 1 Submenu to configure the PT-100 readout: PS.: By Pattern, the Sensor 1 or The Sensor 2 should be settled to reading the Oil Top Temperature. If don't, the MasterTemp will set it automatically;</p>		
			OFF Sensor 1 OFF;
			Ambient Sensor 1 reading the Environment Temperature;
			Top Oil Sensor 1 reading the Maintank Top Oil Temperature;

	Sensor 1 Readout	Bot. Oil	Sensor 1 reading the Maintank lower temperature oil level;	
		OLTC	Sensor 1 reading the TAP Changer temperature;	
	Sensor 2 Submenu to configure the PT-100 readout: PS.: By Pattern, the Sensor 1 or The Sensor 2 should be settled to reading the Oil Top Temperature. If don't, the MasterTemp will set it automatically;			
	Sensor 2 readout	OFF	Sensor 2 OFF;	
		Ambient	Sensor 2 reading the Environment Temperature;	
		Top Oil	Sensor 2 reading the Main tank Top Oil Temperature;	
Bot. Oil		Sensor 2 reading the Main tank lower temperature oil level;		
OLTC		Sensor 2 reading the TAP Changer temperature;		
Sensor readout	winding 1 winding 2 winding 3	Submenu to enable or disable the input sensors on 1, 2 and 3 windings;		
		ON/OFF	ON Enables the selected winding Reading; OFF Disables the selected winding Reading;	
	Correction Deviation	Submenu to use the temperature deviation correction from the Sensors 1 and 2. Also, to correct the electrical current deviation from the winding's ampere reading;		
Confi. Display OLED	Menu To configure the presentation mode of the OLED display and to test the frontal LED's			
	Contrast	Submenu to configure the OLED display contrast level;		
		0 to 255	Choose the contrast required level between this range;	
	Display Mode	Submenu para configurar o modo de visualização da tela do Display OLED;		
		Black White	Black – Black background and White letters; White – White background and Black letters;	
	Appearance	Fixed Scan	Fixed –The Display will show just one quantity at the first line, according to the user selection;	
			Scan –This function shows all the quantities selected by the user simultaneously (to do the group of these quantities use the UseEasy Software);	
	LED and Display Test	Display OLED and LED's Testing Submenu;		
---		Press SET to check if all of the LED's are lit and if the letters colors have changed.		
	Menu to set the Serial Communication Network Parameters (SCADA);			
	Protocol	Submenu to set the Communication Protocol Type;		
		MBUS DNP	MBUS – Selects the MODBUS RTU Communication Protocol; DNP – Selects the DNP3 Level 2 Communication Protocol;	
	Address	Submenu to the Communication Protocol:		
		1 to 254	Submenu to set the equipment serial network address. Each equipment connected to the RS485 (20 and 21 connections) must have a unique address number, different from the other network devices.	
	Submenu to configure the Serial Communication Speed;			

RS485 output	Baudrate KBps	Auto	AUTO – It detects automatically the Network Communication Speed;
		2.4	2.4 – Communication Speed fixed in 2.400 bps;
	Parity	4.8	4.8 – Communication Speed fixed in 4.800 bps;
		9.6	9.6 – Communication Speed fixed in 9.600 bps;
		19.2	19.2 – Communication Speed fixed in 19.200 bps;
	Protection	38.4	38.4 – Communication Speed fixed in 38.400 bps;
		57.6	57.6 – Communication Speed fixed in 57.600 bps;
	Parity	Submenu to set the communication parity, that means, the last message bit will check the data integrity.	
		NONE	NONE – No Parity;
		ODD	ODD – The last message bit will be 1;
	Protection	EVEN	EVEN – The last message bit will be 0;
		Submenu to configure the Serial Network Protection;	
	Protection	On	ON – Protection System Against Parameter Changes ON;
		Off	OFF – Protection System Against Parameter Changes OFF. Under this condition the MasterTemp allows parameters changes to be made by the user;

Menu	Parameter	Variable	Description
Current output	Menu to configure the type and the range of electrical current outputs.		
	Scale	Submenu for configure the electrical current outputs (Analog Outputs).	
		0-1 mA	Sets the electrical current output range to 0-1 mA;
		0-5 mA	Sets the electrical current output range to 0-5 mA;
		0-10 mA	Sets the electrical current output range to 0-10 mA;
		0-20 mA	Sets the electrical current output range to 0-20 mA;
		4-20 mA	Sets the electrical current output range to 4-20 mA;
	Output 1	Submenu to configure which quantity will be reflected on the analog outputs 1.	
		OFF	OFF – Analog Output 1 OFF;
		Sen 1	Sen.1 – Reflects the Sensor 1 Temperature on the analog output 1;
		Sen 2	Sen.2 – Reflects the Sensor 2 Temperature on the analog output 1;
		Wnd. 1	Wnd.1 – Reflects the temperature of the winding 1 on the analog outputs 1;
		Wnd. 2	Wnd.2 – Reflects the temperature of the winding 2 on the analog outputs 1;
		Wnd. 3	Wnd.3 – Reflects the temperature of the winding 3 on the analog outputs 1;
		1°CT1	1°CT1 – Reflects the primary electrical current of the winding 1 on the analog output 1;
		1°CT2	1°CT2 – Reflects the primary electrical current of the winding 2 on the analog output 1;
		1°CT3	1°CT3 – Reflects the primary electrical current of the winding 3 on the analog output 1;
		2°CT1	2°CT1 – Reflects the secondary electrical current of the winding 1 on the analog output 1;
		2°CT2	2°CT2 – Reflects the secondary electrical current of the winding 2 on the analog output 1;
		2°CT3	2°CT3 – Reflects the secondary electrical current of the winding 3 on the analog output 1;
		Load.1	Load.1 – Reflects the winding 1 loading percentage on the analog output 1;
		Load.2	Load.2 – Reflects the winding 2 loading percentage on the analog output 1;
		Load.3	Load.3 – Reflects the winding 3 loading percentage on the analog output 1;
		Delta	Delta – Reflects the temperature differential on the analog output 1;
	Cur 1 outputrange	Submenu to configure the maximum and minimum range of the analog output 1;	
		Min out	Min out 1 – Minimum Value to the analog output 1;
		Max out	Max out 1 – Maximum Value to the analog output 1;

Menu	Parameter	Variable	Description
Analog Outputs	Output 2	Submenu to configure which quantity will be reflected on the analog output 2.	
		OFF	OFF – Analog Output 2 OFF;
		Sen. 1	Sen.1 – It reflects the Sensor 1 Temperature on Analog output 2;
		Sen. 2	Sen.2 – It reflects the Sensor 2 Temperature on Analog output 2;
		Wnd. 1	Wnd.1 – It reflects the winding 1 temperature on the analog output 2;
		Wnd. 2	Wnd.2 – It reflects the winding 1 temperature on the analog output 2;
		Wnd. 3	Wnd.3 – It reflects the winding 1 temperature on the analog output 2;
		1°CT1	1°CT1 – It Reflects the primary electrical current of the winding 1 on the analog output 2;
		1°CT2	1°CT2 – It Reflects the primary electrical current of the winding 2 on the analog output 2;
		1°CT3	1°CT3 – It Reflects the primary electrical current of the winding 3 on the analog output 2;
		2°CT1	2°CT1 – It Reflects the primary electrical current of the winding 1 on the analog output 2;
		2°CT2	2°CT2 – It Reflects the primary electrical current of the winding 2 on the analog output 2;
		2°CT3	2°CT3 – It Reflects the primary electrical current of the winding 3 on the analog output 2;
		Load.1	Load.1 – It Reflects the winding 1 loading percentage of the analog output 2;
		Load.2	Load 2 – It Reflects the winding 2 loading percentage of the analog output 2;
		Load.3	Load 3 – It Reflects the winding 3 loading percentage of the analog output 2;
		Delta	Delta – It reflects the differential temperature on the analog output 2;
	Cur 2 outputrange	Submenu to configure the maximum and minimum range of the analog output 2;	
		Min out	Min out 2 – Minimum Value to the analog output 2;
		Max out	Max out 2 – Maximum Value to the analog output 2;

Menu	Parameter	Variable	Descriptions
Current Outputs	Outputs 3	Submenu to configure which quantity will be reflected on the analog output 3;	
		OFF	OFF – Analog Output 3 OFF;
		Sen 1	Sen.1 – It reflects the Sensor 1 temperature on the analog output 3;
		Sen 2	Sen.2 – It reflects the Sensor 1 temperature on the analog output 3;
		Wnd. 1	Wnd.1 – It Reflects the winding 1 temperature on the analog output 3;
		Wnd. 2	Wnd.2 – It Reflects the winding 2 temperature on the analog output 3;
		Wnd. 3	Wnd.3 – It Reflects the winding 3 temperature on the analog output 3;
		1°CT1	1°CT1 – It Reflects the electrical current of the winding 1 on the analog output 3;
		1°CT2	1°CT2 – It Reflects the electrical current of the winding 2 on the analog output 3;
		1°CT3	1°CT3 – It Reflects the primary electrical current of the winding 3 on the analog output 3;
		2°CT1	2°CT1 – It Reflects the primary electrical current of the winding 1 on the analog output 3;
		2°CT2	2°CT2 – It Reflects the primary electrical current of the winding 2 on the analog output 3;
		2°CT3	2°CT3 – It Reflects the secondary electrical current of the winding 3 on the analog output 3;
		Load 1	Load.1 – It Reflects the winding 1 loading percentage of the analog output 3;
		Load 2	Load 2 – It Reflects the winding 2 loading percentage of the analog output 3;
		Load 3	Load 3 – It Reflects the winding 3 loading percentage of the analog output 3;
		Delta	Delta – It reflects the differential temperature on the analog output 3;
	Cur 3 outputrange	Submenu to configure the maximum and minimum range of the analog output 3;	
		Min out	Min out 3 – Minimum Value to the analog output 3;
		Max out	Max out 3 – Maximum Value to the analog output 3;

Menu	Parameter	Variable	Description
Current Outputs	Output 4	Submenu to configure which quantity will be reflected on the analog output 4;	
		OFF	OFF – Analog Output 4 OFF;
		Sen 1	Sen.1 – It reflects the Sensor 1 temperature on the analog output 4;
		Sen 2	Sen.2 – It reflects the Sensor 2 temperature on the analog output 4;
		Wnd. 1	Wnd.1 – It Reflects the winding 1 temperature on the analog output 4;
		Wnd. 2	Wnd.2 – It Reflects the winding 2 temperature on the analog output 4;
		Wnd. 3	Wnd.3 – It Reflects the winding 3 temperature on the analog output 4;
		1°CT1	1°CT1 – It Reflects the electrical current of the winding 1 on the analog output 4;
		1°CT2	1°CT2 – It Reflects the primary electrical current of the winding on the analog output 4;
		1°CT3	1°CT3 – It Reflects the primary electrical current of the winding 3 on the analog output 4;
		2°CT1	2°CT1 – It Reflects the secondary electrical current of the winding 1 on the analog output 4;
		2°CT2	2°CT2 – It Reflects the secondary electrical current of the winding 2 on the analog output 4;
		2°CT3	2°CT3 – It Reflects the secondary electrical current of the winding 3 on the analog output 4;
		Load 1	Load 1 – It Reflects the winding 1 loading percentage on the analog output 4;
		Load 2	Load 2 – It Reflects the winding 2 loading percentage on the analog output 4;
		Load 3	Load 3 – It Reflects the winding 3 loading percentage on the analog output 4;
		Delta	Delta – It reflects the differential temperature on the analog output 4;
	Cur 4 outputrange	Submenu to configure the maximum and minimum range of the analog output 4;	
		Min out	Min out 4 – Minimum Value to the analog output 4;
		Max out	Max out 4 – Maximum Value to the analog output 4;

Menu	Parameter	Variable	Description
Output Currents	output 5	Submenu to configure the maximum and minimum range of the analog output 5;	
		OFF Sen 1 Sen 2 Wnd. 1 Wnd. 2 Wnd. 3 1°CT2 1°CT2 1°CT3 2°CT1 2°CT2 2°CT3 Load 1 Load 2 Load 3 Delta	OFF – Analog Output 5 OFF; Sen.1 – It reflects the Sensor 1 temperature on the analog output 5; Sen.2 – It reflects the Sensor 2 temperature on the analog output 5; Wnd.1 – It Reflects the winding 1 temperature on the analog output 5; Wnd.2 – It Reflects the winding 2 temperature on the analog output 5; Wnd.3 – It Reflects the winding 3 temperature on the analog output 5; 1°CT1 – It Reflects the electrical current of the winding 1 on the analog output 5; 1°CT2 – It Reflects the primary electrical current measurement of the winding 2 on the analog output 5; 1°CT3 – It Reflects the primary electrical current measurement of the winding 3 on the analog output 5; 2°CT1 – It Reflects the secondary electrical current measurement of the winding 3 on the analog output 5; 2°CT2 – It Reflects the secondary electrical current measurement of the winding 2 on the analog output 5; 2°CT3 – It Reflects the secondary electrical current measurement of the winding 3 on the analog output 5; Load 1 – It Reflects the winding 1 loading percentage of the analog output 5; Load 2 – It Reflects the winding 2 loading percentage on the analog output 5; Load 3 – It Reflects the winding 3 loading percentage on the analog output 5; Delta – It reflects the differential temperature on the analog output 5;
	Cur 5 outputrange	Submenu to configure the maximum and minimum range of the analog output 5;	
		Min out Max out	Min out 5 – Minimum Value to the analog output 5; Max out 5 – Maximum Value to the analog output 5;
	Deviation Correction	Submenu para realizar a correção de desvio na saída de Corrente;	
		Output 1 Output 2 Output 3 Output 4 Output 5	-1,00 mA to 1,00 mA Range. S. Analog. 1: Select an addition or Subtraction Analog Output Value; S. Analog. 2: Select an addition or Subtraction Analog Output Value; S. Analog. 3: Select an addition or Subtraction Analog Output Value; S. Analog. 4: Select an addition or Subtraction Analog Output Value; S. Analog. 5: Select an addition or Subtraction Analog Output Value; PS.: To correct the deviation in the current output, it must be linear.

Menu	Parameter	Variable	Description
SD Card Log Setup	Menu to Set the parameter used for SD card data recording.		
	Data Logging	Submenu to enable and/or disable recording of data on the SD Card.	
		YES	Yes – Enable Data Log;
		NO	No – Disable Data Log;
	Aquisi. Time	Submenu to Set the time log of the equipment integrity on the SD Card.	
		Off	Off - Log by time off.
		5 to 180	5 min – Record the SD Card log once every 5 minutes. Increment the Log recording time through multiples of 5.
Date/Hour	Var. Temp.	Submenu to configure the temperature variation to record it on the SD Card.	
		1,0 to 10,0	Temperature Variation Value (°C)
	Var. Corrent.	Submenu to configure the electrical current variation to record it on the SD Card;	
		0,1 to 1,0	Electrical Current Variation Value (A).
Date/Hour	Menu to configure date and time on the equipment internal watch		
	Date	Day/Month /Year	Submenu to configure the watch date;
	Hour	Hour: Minutes	Submenu to configure the watch hour;
	Week	---	Submenu to present the watch day of the week; PS.: This submenu sets itself according with the day, month and year parameter;
Password Setup	Menu to Set the Configuration password.		
	---	0000 to 9999	The MasterTemp Factory password is 0000 . In case of loss or forgotten password please, get in touch with Electron do Brasil and give us the “Password Reminder” number.
Idioma/ Language	Menu para configurar o idioma de apresentação no display do MasterTemp		
	---	Portuguese English	Portuguese – Sets Portuguese as the equipment main language; English – Sets English as the equipment main language;

INDICATORS SET

The **indic.** Menu has the following menus that presents its respective consult parameters:

- Date / Hour;
- Current Temperature;
- Maximum Temperature;
- Hour meter;
- Final Gradient;
- Load Percentage;
- Secondary Current;
- Primary Current;
- Actuation Reset;
- Transformer Aging;
- Equipment Version;

Press **SET** key and the menus tabs will appear below. Press the ► to navigate through them and press **SET** on the **indic** menu.

Menu	Parameter	Variable	Description
Date / Hour	---	---	Indicates, Date, Hour and weekday of the equipment internal watch. To adjust this watch, use the menu “ conf. – Date/Hour “.
Current Temperature	Sensor 1 and 2 Wind. 1, 2 and 3	-50 to 250	Indicates the Sensors and Windings current temperature.
Temperature Maximum	Sensor 1 and 2 Wind. 1, 2 and 3	- 50 to 250	Indicates the Sensors highest registered temperature. To Reset the maximum temperature value, select the Reset option and through the navigation keys choose the Sensor and press SET .
Horimeter	Hourmeter 1° Group 2° Group 3° Group	Day Hour Minutes	Indicate how many days, hours and minutes that the cooling system have been working. To change this time, select the respective variable and navigate through the ▲▼ keys, change the values and press SET to confirm the operation.
Gradient Final	Wind. 1, 2 and 3	- 50 to 250	Indicates the winding temperature after the thermal stabilization considering the loading and temperature conditions at the checking exactly time.
Percentual Loading	Wind. 1, 2 and 3	0 to 300%	Indicates the transformer percentual loading. According with electrical current relation between the thermal image CT reading and the transformer rated current.
Secondary Current	Wind. 1, 2 and 3	0 to 9,999 A	Indicates the electrical current on the secondary of the Thermal Image CT to the 3 windings.
Primary Current	Wind. 1, 2 and 3	0 to 9,99 KA	Indicates the electrical current on the primary of the Thermal Image CT to the 3 windings.

Menu	Parameter	Variable	Description
Actuation Reset	Oil Alarm Shutdown by oil Winding 1 Alarm Shutdown by W1 Winding 2 Alarm Shutdown by W2 Winding 3 Alarm Shutdown by W3 Fail Alarm Gr1.Cool.Maint Gr2.Cool.Maint Gr3.Cool.Maint	---	<p>Submenu to reset the actives Alarms.</p> <p>To reset an alarm activation, just select it and confirm it pressing SET.</p> <p>The Alarm will only be Reset if the alarm condition is already reestablished</p> <p>PS.: An alarm reset will be only necessary only if the alarm is settled as “manual return” on the menu Actuation Return.</p>
Transformer Aging	PV Wnd.1 PV Wnd.2 PV Wnd.3	0 to 300%	Submenu to consult the transformer windings 1, 2 and 3 elapsed life percentage.
	Life Extrapolation	Days or Hours	<p>Submenu to present the transformer windings lifetime estimative;</p> <p>Wnd1 Days – Winding 1 number of days left to reach 100% loading;</p> <p>Wnd1 Hours – Wnd1 Days – Winding 1 number of hours left to reach 100% loading;</p> <p>Wnd2 Days – Winding 1 number of days left to reach 100% loading;</p> <p>Wnd2 Hours – Wnd1 Days – Winding 1 number of hours left to reach 100% loading;</p> <p>Wnd3 Days – Winding 3 number of days left to reach 100% loading;</p> <p>Wnd3 Hours – Winding 3 number of hours left to reach 100% loading;</p>
Equipment Version	Version Serial Number Calibration	---	<p>Screen to consult about equipment information</p> <p>Version: Equipment Firmware Version;</p> <p>Serial Number: Equipment Serial Number;</p> <p>Calibration: Calibration Date/Equipment Calibration.</p>

ACTUATION SET

O “**Actua.**” Is used to configure the MasterTemp Actuators and it has the following parameters:

- High Temperature Alarm;
- TRIP;
- Cooling System;
- Auxiliary Relay;
- Actuation Return;
- Actuation Logic;
- Actuation Test;
- Cooling Actuation;

To access the **confi.** Menu with the display on reading presentation mode, press **SET** key. The display will show on the inferior part the menus and with the **►** go to the option **confi.** And press the **SET** key.

The **confi.** menu has an access password, “Password Reminder” will appear at the OLED top oil and **0000** below it. Use **▲** or **▼** Keys to set to confirm the chosen number and press **►** to set the next number **◀**. Confirm the four digits pressing the **SET** key and you shall access the CONFIGURATION SET and its submenus. But if the you input the wrong password a “incorrect password” message on the OLED screen and will go back **0000**.

After input the MasterTemp password, and it will request again only if you return to the main menu, if you keep doing the configuration through the menus the MasterTemp will not ask the password anymore.

Navigate through the menus, sub-menus and parameter using **▲▼◀▶** Keys. Select the submenus or the wished parameter and press **SET**, and change the chosen variable pressing **▲** or **▼** key and to confirm the parameter update press **SET**, but if you don’t confirm the parameter change, but its last value will remain the same.

Menu	Parameter	Variable	Description
Cooling Exerci.	Menu to disable and/or configure the Cooling System Exercise		
	Exercise	Submenu to disable and/or configure the Cooling System Exercise	
		ON OFF	On Cooling Exercise Enabled; Off Cooling Exercise Disabled;
	Frequency	Submenu to define the cooling system exercise operating frequency;	
		Daily Mon.Tue. Wed. Thu. Fri. Sat. Sun.	Daily: Executes the Cooling System Exercise every day. Weekly: Selects a day of the week to run the Exercise. (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday)

Menu	Parameter	Variable	Description
Cooling Exercise	I. Time	Submenu to configure the Cooling system exercise starting hour;	
		Hours/minutes	Cooling system exercise starting hour;
	F. Time	Submenu to configure the Cooling system exercise ending hour;	
		Hours/minutes	Cooling system exercise ending hour;
Cooling Maintenance	Menu to configure the Cooling System Groups Maintenance;		
	Maintenance	Submenu to enable and/or disable the Fans maintenance;	
		Desa. Enab.	Disa.: Cooling System Maintenance Function Disabled; Enab.: Cooling System Maintenance Function Enabled; PS.: If the Cooling system maintenance has been enabled, the MasterTemp will automatically enable the auxiliary relay too.
	1° Gr Hours	Submenu to configure how many hours left to the maintenance of the 1° Cooling Group	
		0 to 50.000	How many hours left to the Maintenance of the 1° Cooling Group
	2° Gr Hours	Submenu to configure how many hours left to the maintenance of the 2° Cooling Group	
		0 to 50.000	How many hours left to the Maintenance of the 2° Cooling Group;
	3° Gr Hours	Submenu to configure how many hours left to the maintenance of the 2° Cooling Group	
		0 to 50.000	How many hours left to the Maintenance of the 3° Cooling Group;

MAINTENANCE SET

Menu	Parameter	Variable	Description
Transformer Aging	Menu to configure the Transformer Aging Alarm.		
	PV Wnd.1 PV Wnd.2 PV Wnd.3	Submenu to configure the windings insulation percentage life Alarm and to Enable the actuation of the Auxiliary Relay;	
		0 to 100%	windings insulation percentage life to Alarm actuation;
		On Off	On – Enables the auxiliary relay alarm; Off – Disables the auxiliary relay alarm;

POWER TRANSFORMER SET

The Power Transformer Menu is to configure the following parameters:

- Temperature Gradient;
- Time Constant;
- Hotspot Factor;
- Cooling type;
- Rated Current;
- Current Ratio;
- Transf. Aging.

To access the **Transf.** Menu with the display on reading presentation mode, press **SET** key. The display will show on the inferior part the menus and with the ► go to the option **confi.** And press the **SET** key.

The **transf.** menu has an access password, “Password Reminder” will appear at the OLED top oil and **0000** below it. Use ▲ or ▼ Keys to set to confirm the chosen number and press ► to set the next number ◀. Confirm the four digits pressing the **SET** key and you shall access the CONFIGURATION SET and its submenus. But if the you input the wrong password a “incorrect password” message on the OLED screen and will go back **0000**.

After input the MasterTemp password, and it will request again only if you return to the main menu, if you keep doing the configuration through the menus the MasterTemp will not ask the password anymore.

Navigate through the menus, sub-menus and parameter using ▲▼◀▶ Keys. Select the submenus or the wished parameter and press **SET**, and change the chosen variable pressing ▲ or ▼ key and to confirm the parameter update press **SET**, but if you don’t confirm the parameter change, it last value will remain the same.

Menu	Parameter	Variable	Description
Temperature Gradient	Menu to configure the windings temperature gradient;		
	OWG 1	Submenu to configure the winding 1 temperature gradient;	
		0,1°C to 100,0°C	Temperature differential between the oil top and the winding 1 average temperature, after the thermal stabilization on rated load conditions.
	OWG 2	Submenu to configure the winding 2 temperature gradient;	
		0,1°C to 100,0°C	Temperature differential between the oil top and the winding 2 average temperature, after the thermal stabilization on rated load conditions.
	OWG 3	Submenu to configure the winding 3 temperature gradient;	
		0,1°C to 100,0°C	Temperature differential between the oil top and the winding 3 average temperature, after the thermal stabilization on rated load conditions.
Time Constant	Menu to configure the windings time constant (by seconds): PS.: If this information's is missing, please, input 300 seconds (Used for cobber winding)		
	WTC1	Submenu to configure the winding 1 time constant;	
		0 to 500 sec.	Winding 1 Thermal Inertia time, this value is obtained on the Transformer heating test;
	WTC2	Submenu to configure the winding 2 time constant;	
		0 to 500 sec.	Winding 2 Thermal Inertia time, this value is obtained on the Transformer heating test;
	WTC3	Submenu to configure the winding 3 time constant;	
		0 to 500 sec.	Winding 3 Thermal Inertia time, this value is obtained on the Transformer heating test;

Menu	Parameter	Variable	Description
Hot Spot Factor	Menu to configure the Transformer HotSpot Factor:		
	Hot Spot ABNT	Submenu to sum the hotspot factor to the gradient:	
		0.00°C to 20,0°C	Adding to the Temperature Gradient according with the NBR 5416 norm and IEEE std C57.91-1995, lies the winding highest temperature hotpoint. In case of IEC norm utilization for hotpoint calculation, this parameter must be adjusted to zero .
	Hot Spot IEC	Submenu to multiply the hotspot factor to the gradient:	
		1,0 to 15,0	Multiplied by the temperature gradient according with IEC 543 norm lies the winding highest temperature hotpoint calculation. In case of ABNT norm utilization for hotpoint calculation, this parameter must be adjusted 1.0 (1.0 to 1.5 Range)
Cooling type	Menu to configure the Transformer cooling type.		
	2M	1,0 to 2,0	1.6 (Natural Oil and Forced oil); 2.0 (Driven oil);
Rated Current	Menu to configurate the Transformer Rated Current:		
	Wind. 1	Winding 1 Rated Current;	
		0.000 to 0.900 kA	Winding 1 rated electrical current configuration value, on kA
	Wind. 2	Winding 2 Rated Current;	
		0.000 to 0.900 kA	Winding 2 rated electrical current configuration value, on kA
	Wind. 3	Winding 3 Rated Current;	
		0.000 to 0.900 kA	Winding 3 rated electrical current configuration value, on kA
Current Ratio	Menu to configure the power transformer ratio of the windings thermal image CT: Example: Thermal Image CT 950/5amp – CT Ratio = 190.		
	Wind. 1	Winding 1 electrical current ratio;	
		0.000 to 0.900 kA	Value to configurate the winding 1 rated current, on KA.
	Wind. 2	Winding 2 electrical current ratio;	
		0.000 to 0.900 kA	Value to configurate the winding 2 rated current, on KA.
	Wind. 3	Winding 3 electrical current ratio;	
		0.000 to 0.900 kA	Value to configurate the winding 3 rated current, on KA.

Menu	Parameter	Variable	Description
HotSpot Factor	Menu to configure the Transformer Aging parameters:		
	Classe	Submenu to configure the Transformer Thermal Class insulation:	
		Kraft Termost. Nomex	Kraft – Kraft Paper – Class 55; Termost. – Thermal Stabilized Term – Class 65; Nomex – Aramid Paper – Class 95;
	PV Wnd. 1	Submenu to configure the winding 1 insulation life loss.	
Cooling Type	PV Wnd. 2	0 to 100%	Winding 1 running life loading;
		Submenu to configure the winding 2 insulation life loss.	
Rated Current	PV Wnd. 3	0 to 100%	Winding 2 running life loading;
		Submenu to configure the winding 3 insulation life loss.	
		0.000 to 0.900 kA	Winding 3 running life loading;

RECOMMENDED ADJUSTMENTS

	ABNT		IEC		ANSI	
	55,0°C	65,0°C	55,0°C	65,0°C	55,0°C	65,0°C
HotSpot - HS+ (ABNT)	10	15	0			
HotSpot - HS * (IEC)	1		1,3			
2M Expoent	1,6 (NO* E OF**)/2,0(DO***)					
Winding time constant, WTC	300 Seconds					
Ventilation Temperature Actuation	65°C 1st group and 75°C group					
Oil Temperature Alarm - HTA-SEN2	85°C (NO*) / 75°C(FO**)					
Windings Temperature Alarm - HTA-SEN3	105°C					
Oil Temperature TRIP - SHT - SEN2	110°C					
Winding Temperature TRIP - SHT-SEN3	120°C					
TRIP Time delay	2 minutes					
Refrigeration TRIP Hysteresis	5°C					

*NO = Natural Oil, ** NO = Forced Oil, *** NO = Driven Oil

DEFECTS SOLUTIONS

Message	Symptom	Solution
<u>SOFF</u>	There is no reliable signal coming from Sensor to MasterTemp	Check and replace the sensor cabling in case of no wiring shielding.
		Check the sensor cable grounding
		Seek and eliminate any bad connection possible
		Replacement of the Temperature Sensor if it is damaged.

When normalized the temperature sensor automatically returns to the reading operation mode. To Reset the MasterTemp, press ► key until the OLED display turns off. After that, release the ► key and the monitor will reinitialize, but it will not lose its previous parameters.

IMPORTANT RECOMMENDATIONS

Before operating this equipment, consider the following recommendations:

1. All sensors and the equipment as well must be grounded;
2. The sensors and the power supply should be correctly grounded in order to avoid bad working and damages in cases of electrical disturbances, electrical induction and electrical surge;
3. Use it on RS485 communication network;
4. Use 120 ohms resistors on both transmission line extremities (at the End and at the Beginning);
5. Only use with MASTERTEMP the original accessories that come with the equipment (TC Split Core), because they were tested together to ensure a maximum efficiency and high performance;
6. Do not use this equipment under direct sun exposure. It's important to use tinted glass, to ensure that filtering of the ultraviolet rays that damage the frontal polycarbonate. In this way, a longer lifetime is ensured;

WARRANTY TERM

The **MASTERTEMP** has a 2 years of warranty time counted from the sale consigned date on the invoice, to cover manufacturing defects that turns it inappropriate for its applications.

WARRANTY EXCLUSION

The warranty does not cover transportation costs to the technical assistance, Freight and insurance for shipment of product with indication of defect or malfunction. The following event are also not covered by this warranty:

Pieces natural wear inflicted by continuous and frequent work, External damages inflicted by falls or improper packaging; Fixing attempt / Sealing violation with damages made by unauthorized people by Electron and with disagree with its instruction that are part of the technical description.

WARRANTY TERM

This product will automatically lose its guarantee when:

- If the instruction is not observed and the procedure and assemblies of this user manual;
- Submit to the conditions out of the limits specified on the respective technical description;
- Violated or fixed by someone who doesn't belong to Electron Technical Staff;

- Damage inflicted by crash or impact;
- If occurs water or any other liquid infiltration;
- If occurs an overload that cause component degradation and product parts;

WARRANTY UTILIZATION

To use this warranty the customer should send this product to Electron with an invoice buying copy properly packed with the equipment to avoid any transportation damage. To a quick treatment is recommended to report a high information volume possible related to the defect or problem. The reported problem will be analyzed and submitted to full operational tests.

The product analysis and its respective maintenance should be made only by the Electron do Brasil technical Staff in its Corporate Headquarters.

Available to download at the following link: <https://electron.com.br/pt-br/produtos/ep4/>