THERMTRONIC®

MONITORAMENTO | CONTROLE | VENTILAÇÃO

Manual de Uso

Rev. 0

TH104BUS

THERMTRONIC

S1 S2 S3 Tamb

026 °F °C

FAULT

HOT SCAN MAN Tmax

ALARM

M/E

TRIP

NETWORK
RX
TX

1 FAN 2

P

Protection Relays

TH104BUS V5.2

THERMAL PROTECTION RELAY

www.thermtronic.net

INDEX

HARDWARE AND SOFTWARE TECHNICAL DESCRIPTION

TH104BUS V5.2
Thermal protection relay

SUPPLIED PARTS

- One TH104BUS V5.2;
- 2 side fixing clips, with metallic screws;
- User manual.

INTRODUCTION

The TH104BUS is an electronic device (an electronic controller/relay) designed for thermal supervision and protection of devices such as dry transformers, motors, generators, and so forth. It has four inputs for PT100 type temperature sensors. It also has several relays for triggering alarms, circuit breakers and fans. A display, on the front panel, allows viewing of temperatures, checking status of the output relays and program the device (the device can be programmed by the user).

It has a communication port for connecting to a RS485 Modbus® RTU interface, which allows you to view and store temperature data on a computer or PLC. With a RS485-to-Ethernet adapter (please contact us for details), it is possible to connect the device to the internet for remote communication.

At version 5.2 is now possible to enable/disable each temperature channel individually (S1, S2, S3, Tamb).

THERMTRONIC
MONITORAMENTO | CONTROLE | VENTILAÇÃO

TECHNICAL FEATURES

General features
- Measure of temperature in Celsius (°C) or Fahrenheit (°F) degrees *NEW*
- Allows enable/disable any of the PT100 channels individually *NEW*
- Keypad with beep.
- Plug-in connectors for easy installation, checking and replacement.
- Allows viewing and changing the parameters.
- Protection against accidental parameter change.
- Keeps operative while in programming mode.
- Output relays testing through the panel keyboard.
- Detects and warns problems on Pt100 sensors.
- The Tamb PT100 input allows ambient temperature (room temperature) measurement. It´s use is optional.
- RS485 port for connection to MODBUS® RTU networks, with frontal status leds.

Power supply
- Supply voltage: 24 to 240 Vac / Vdc.
- Supply voltage limits: 20 to 242 Vac / Vdc.
- Line frequency (Vac): 48 to 62Hz.
- Power consumption: 3VA.

Inputs
- 4 inputs for RTD PT100 3 wire thermal sensors, according to DIN43760/IEC751 standard.
- Reading range: from 0 to 250ºC.
- Accuracy: ±1% full scale ± 1 digit.
- Recommended gauge for PT100 wires: 0.5mm².
- Minimum gauge for PT100 cables longer than 500m: 1.0mm².
- Protection against electromagnetic noise and internal power supply overload.

Outputs
- 2 warning relays (ALARM and TRIP). Contacts NO (Normally Open) and NC (Normally Closed).
- 2 relays for the fans (FAN1 and FAN2). Contact NO.
- 1 sensor fault indicating relay (FAULT). Contact NC.
- Relay contacts capacity (resistive load): 5A at 250Vac.
- Has a feature for testing the output relays.

Front panel
- 3-digit, 18mm height displays.
- 3mm leds for input and output status indication.

Communication port (only for TH104BUS)
- Now the communication port comes by default on all equipments *NEW*
- RS485 serial data port. Works with Modbus® RTU protocol.
- Data rate: 1200 to 115200bps (1.2 to 115.2kbps).
- Selectable address range: from 1 a 247.

Dimensions
- Weight: 430g.
- Front device dimensions: 96x96mm (according DIN 4370 standard).
- Device length: 100mm, with connectors.

- Panel cutting (necessary to fix the device): 92x92mm.
- Fixing: by side clamps.

Environmental operation conditions

- Working temperature: -10 a 45⁰C.
- Storage temperature: up to 50⁰C.

OPERATION

When the power is turned-on, all LEDs light up and a message corresponding to the controller model and firmware version appears on the display. Then it measures the temperature of all channels (PT100 probes), it performs comparisons to the setup values and acts as explained below:

− It reads the sensors on the channels S1, S2, S3 and Tamb. If some of them arrives above the programmed value of ALARM for 5s, the ALARM led will light up. If it persists for more than 15s, ALARM relay will be activated, contacts closed between pins 5 and 7 (Figure 3). If the key ⌨ is pressed for more than 5s, the ALARM relay will open the contacts 5 and 7 (this feature is useful in the case of ALARM relay is connected to a siren and the user want to stop the sound), although led ALARM will remain lit up till the measured temperature of all sensors goes down the programmed value of ALARM. In the case of turned-off by the user, the ALARM relay will activates again only when a new alarm condition occurs.

− If the temperature continues to increase and one or more sensors exceeds the value programmed in TRIP by 1°C for 5 s, the TRIP led will light up. If the situation persists for more than 15 seconds, the TRIP relay will be activated, contacts closed between pins 8 and 10 (Figure 3). When the TRIP is activated, ALARM is activated, since ALARM is a precondition for TRIP.

− When the temperature decreases by 1°C to the value programmed in TRIP, the TRIP led will turn-off and the relay will return to the previous condition, contacts opened between pins 8 and 10 (Figure 3).

− When the temperature decreases by 1°C to the value programmed in ALARM, the ALARM led will turn-off and the relay will return to the previous condition, contacts opened between pins 5 and 7 (Figure 3).

− PT100 sensors tests: The possible failures to detect are PT100 sensor open or short circuit. If a fail is detected, the message *FLt* followed by the name of the sensors in fault condition (*S1*, *S2*, *S3* or *tAb*) will appear on the display. The FAULT LED, together with the respective faulty sensor LEDs, will flash. The FAULT relay will close the contacts, contact is closed between pins 11 and 12 (Figure 3). If the faulty condition is solved, the FAULT led will turn off and the FAULT relay will open the contacts again, contacts opened between pins 11 and 12 (Figure 3).

− In the case of a fault condition, when the user press any key the device will show the temperature of the sensors that are working. The relay programing function will be allowed, even in the case of a fault condition. However, if the fault condition is not fixed, after 5s of inactivity of the panel keyboard the relay will warn again about the fault condition. Important: despite of a fault condition occurs, the relay remain working with the sensors that are good.

− If any sensor exceeds the temperature of the parameter Fon for more than 15 seconds, the FAN1 relay will activate (Figure 3, contacts 3 and 4 closed). The relay will turn-off when the temperature of all sensors are lower than the programmed value of parameter Fof (Fan off). The same applies to the parameters of FAN2 and the relay FAN2 (Figure 3, contacts 1 and 2).

TEMPERATURE DISPLAY FUNCTION ⌨

Pressing the key ⌨ (Menu/Escape), you can choose the following viewing options:

− HOT: This function shows the channel which the temperature is higher (it light up the corresponding channel led and shows the value on the display). HOT is the default operation mode for the TH104BUS. When is selected MAN or Tmax function, after 50s of keyboard inactivity, it automatically returns to the HOT function.

− SCAN: It shows the temperature of each channel for 4s, and lights up the corresponding led of the actual reading channel, alternating between all the channels (sweeping them). After 3 complete cycles, the HOT led lights up for 10s, which shows the sensor with the highest current temperature and its value. After this period, it clears the HOT led and back sweeping all channels again. If the Scan mode is disabled, the HOT mode stays active by defaut. In this mode the controller lights up the sensor LED with the highest temperature and shows its value on the display.

− MAN: Select and shows the temperature on the selected channel. Press the keys ▼ and ▲ to select the channel (will be turned-on the selected sensor channel led).

− Tmax: This function shows the maximum temperature already registered by the device on the selected channel. Press the keys ▼ and ▲ to select the channel (will be turned-on the selected sensor channel led). Tmax will keep a historical record of the maximum temperatures reached. These values can be cleared through the programming menu.

− [NEW] The PT100 sensor inputs that are enabled, are shown at the display as 51 oFF, 52 oFF, 53 oFF and tAb oFF, when manually selected through MAN or Tmax option. Disabled inputs not are considered when monitoring.

The following figure shows the front panel and its functions:

Front panel, display and keys meanings
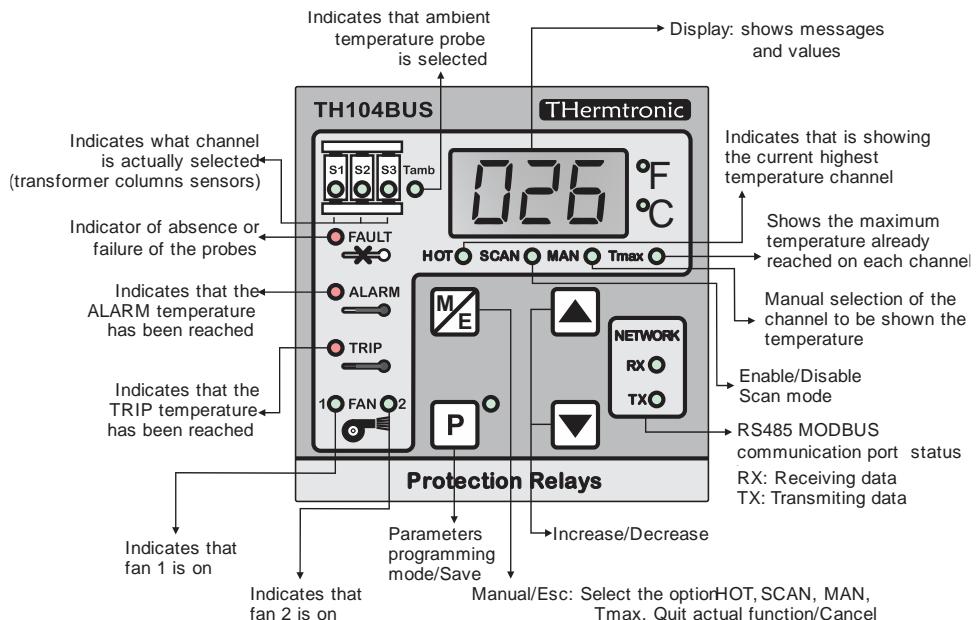
Figure 1 – Front Panel

PARAMETERS PROGRAMMING FUNCTION [P]

Keeping the key [P] pressed by at least 5s allows entering the parameters programming mode. The device remains working actively (maintain the control of the temperature) while in the programming mode.

The following table presents the description of each parameter in the programming mode:

	Press	Display	Leds	Press		Description
1	[P]	5 I/on	S1	[▲]On	[▼]Off	NEW S1 temperature channel enable/disable: On/Off.
2	[P]	52/on	S2	[▲]On	[▼]Off	NEW S2 temperature channel enable/disable: On/Off.
3	[P]	53/on	S3	[▲]On	[▼]Off	NEW S3 temperature channel enable/disable: On/Off.
4	[P]	ALr	S1, S2, S3	[▲]Inc	[▼]Dec	Alarm activation temperature (for the channels S1, S2 and S3).
5	[P]	trP	S1, S2, S3	[▲]Inc	[▼]Dec	Trip activation temperature (for the channels S1, S2 and S3).
6	[P]	tAb/on	Tamb	[▲]On	[▼]Off	Ambient temperature channel enable/disable (S4): On/Off.
7	[P]	ALr	Tamb	[▲]Inc	[▼]Dec	Alarm activation for ambient temperature(channel Tamb).*(1)
8	[P]	trP	Tamb	[▲]Inc	[▼]Dec	Trip activation for ambient temperature(channel Tamb).*(1)
9	[P]	Fon	FAN1	[▲]Inc	[▼]Dec	FAN1 turn-on temperature.
10	[P]	FoF	FAN1	[▲]Inc	[▼]Dec	FAN1 turn-off temperature.
11	[P]	Fon	FAN2	[▲]Inc	[▼]Dec	FAN2 turn-on temperature.
12	[P]	FoF	FAN2	[▲]Inc	[▼]Dec	FAN2 turn-off temperature.
13	[P]	rSt	Tmax	[▲]Yes	[▼]No	Reset temperature history (reset Tmax): Yes/No.
14	[P]	tSt	---	[▲][▼] Simultaneously		Enters output relays test mode. *(2)
15	[P]	Adr/00 I	---	[▲]Inc	[▼]Dec	MODBUS network address.
16	[P]	SPd/9.6	---	[▲]Inc	[▼]Dec	MODBUS communication port data rate (kbps).
17	[P]	SCA/°C	°C / °F	[▲]°F	[▼]°C	NEW Changes the temperature scale to Celsius (°C) or Fahrenheit (°F)

Notes:

*(1): If any of channels S1 to S3 are enabled, menu items 4 and 5 are not shown. Case Tamb channel is not enabled, menu items 7 and 8 are not shown.

*(2): Caution accessing this option, as it allows you to trigger the output relays, including Trip, which turns off the transformer. This option should only be used by specialized operators for checking the operation of the circuit

While in programming mode, the led next to the key $\boxed{P}$ will remain on.

After any parameter changing, it is mandatory pressing the key $\boxed{P}$ for saving. <u>If not pressed the key $\boxed{\text{M/E}}$, the actual changed parameter will not be saved</u> and the device will quit from the programming mode.

The device will quit from the programming mode when pressing the key $\boxed{\text{M/E}}$ or, automatically, if not pressed any key after 20s. The changed and saved (with the key $\boxed{P}$) values will remain saved.

Case Tamb is not enabled, the options 4 and 5, of the presented table, will not appear.

Programming limit-values:

While in programming mode, the temperature values are modified, however the TH104BUS controller does not allow the values to exceed certain limits, in order to guarantee a logical operation. These values are:

- The maximum accepted temperature is 254ºC (482°F) and the minimum is 15ºC (59°F);

- The Alarm temperature cannot exceed the TRIP temperature value;

- The TRIP temperature value cannot be lower than the Alarm temperature value;

- Fan turn-on temperature (*Fon* - Fan On). Cannot be lower than the turn-off (*FoF*) temperature.

- Fan turn-off temperature (*FoF* - Fan Off). Cannot be higher than the turn-on (*Fon*) temperature.

TESTS FUNCTION tSt

The tests function allows turn-on/turn-off the output relays. To access this function, it is necessary entering the parameters programming mode and select option tSt. At this point, press the keys ▲ and ▼ simultaneously. The following message appears: $CAUt~ion - rELAY~tESt$. Press the key P to enter or the key 🖉 to quit.

When entering the tests function, the temperature control is disabled. The key P selects the relay and the keys ▲ and ▼ turn-on/turn-off the respective selected relay and led. The key 🖉 exits the test function, coming back to the parameters programming menu. If no key is pressed for more than 20s, the device returns to the parameters programming menu and the controller activates the temperature control again.

IMPORTANT: Be careful when accessing this function as it allows to trigger the output relays, including Trip, which turns-off the transformer. This option must only be used by specialized operators for checking the circuit operation.

The following table shows a typical tests sequence:

Press	Display	Press		Actuates the relay/led:
P	ALr	▲On	▼Off	ALARM
P	trP	▲On	▼Off	TRIP
P	FLt	▲On	▼Off	FAULT
P	$FA1$	▲On	▼Off	FAN1
P	$FA2$	▲On	▼Off	FAN2
P	ALr	Restart the tests		ALARM

When entering the test function, all the relays are turned off. So the fault circuit will be activated, since the normal state of the FAULT relay is switched on (when all is ok).

ELECTRICAL CONNECTIONS
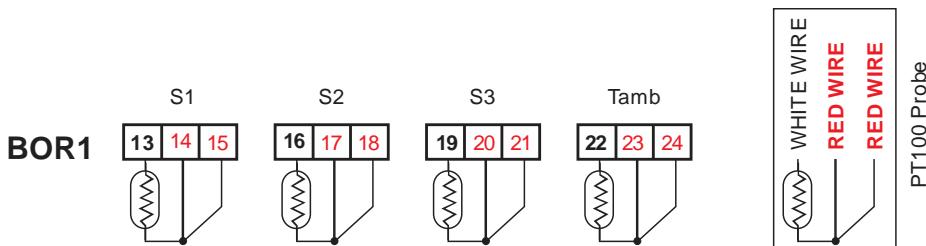
Figure 2 - PT100 probe connections
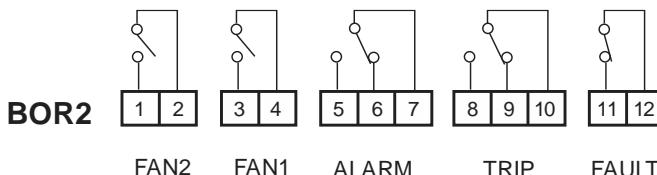
Figure 3 - Alarm, trip and fan relay connections
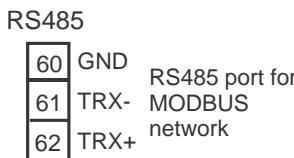
Figure 4 – RS485 serial communication port for MODBUS
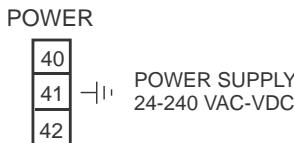
Figure 5 – Power supply connections.

IMPORTANT: **The TH104BUS controller operates on a very wide power range (24 ~ 240Vac / Vcc). Values over 50V are dangerous for the human been. Inform properly the installation and maintenance personnel on this point and protect the BOR3 power terminal and the unused BOR2 contacts.**

SETUP

For mounting the device on an electric panel, a square hole of 92x92mm and 100mm depth space is required for the installation (including the backplane connectors). Take into account the additional space for the electrical cables. It is desirable that the internal temperature of the panel does not exceed 45ºC.

The thermal sensors (PT100 probes) must be connected to BOR1, according to Figure 2. The backplane of the controller has the probes and relay contacts symbols printed on.

The power cord must be connected to pins 40 and 42 of BOR3 (Figure 5). Pin 41 should be connected to the earth ground.

Figure 3 shows the pinout of the controller output relays. According to the diagram of Figure 6, the FAULT relay operates normally closed, which means that the controller will indicate a failure condition in the case of a power fault (no power supply on BOR3).
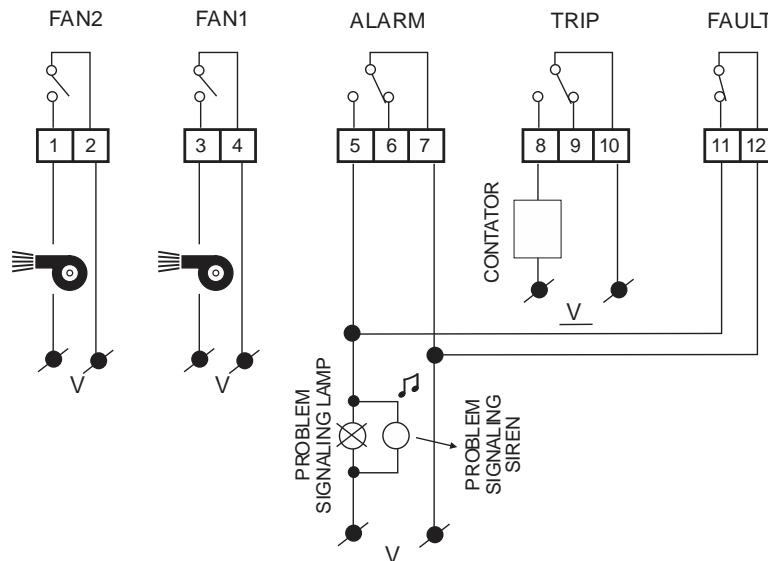

Figure 6 – Wiring diagram

INTRODUCTION TO THE MODBUS NETWORK

The TH104BUS controllers have a built-in communication port, allowing the data exchange with a PC, PLC or other RS485 communication device. With an RS485-to-Ethernet adapter (contact us for details) it is also possible to connect the device to the internet, for remote communication.

The protocol used is the Modbus® RTU. Through this communication system it is possible to remotely acquire the following information:

- The measured temperatures on the channels S1, S2, S3 and TAmb.
- Maximum historical temperature values of all channels.
- The current state of the relays: ALARM, TRIP, FAULT, FAN1 and FAN2.
- The configuration parameters.
- Do a reset of the maximum historical temperature values.
- The time that the controller is on since its last power-up.

At the front panel (Figure 7), on the "NETWORK" box there is a RX led that indicates when the serial port is receiving data, and a TX led that indicates transmitting data. These leds blink alternatively when a normal MODBUS communications is stablished.

Figure 7 – RS485 port communication status at the front panel

For further information, refer to the "Modbus Manual for TH104BUS".

INSTALATION OF THE RS485 MODBUS COMMUNICATION PORT

For the communication network, a twisted-pair cable (minimum 24AWG), with 120Ω resistive terminators at its ends, must be used. On the Figure 8 the terminators are represented as "RT". The connection of the cable mesh to the GND terminal is optional. It is indicated for cables with more than 3m in length.

The RS485 communication interface of the TH104BUS supports a maximum of 500m of cable, with a maximum of 32 devices connected to the same line/cable. Do not place the communication cable near power cables to avoid interference and communication errors.

In addition to the electrical connection, it is necessary to configure the address and speed of the RS485 serial port. The address can be selected from the panel of the TH104BUS: In the parameters programming function (see parameters programming function chapter), go to "*Adr*" (Address). The selection procedure is the same as the rest of the parameters. The choice range is from 1 to 247.

The communication speed can be selected from the panel of the TH104BUS: In the parameters programming function (see parameters programming function chapter), go to "*SPd*" (Speed). The selection procedure is the same as the rest of the parameters. The choice ranges from 1.2kbps to 115.2kbps.

The address and speed options, wiring diagram and other technical characteristics of the RS485 port are available on the TH104BUS controller are as follows:

- Communication speed (data rate): Selectable 1.2kbps, 2.4kbps, 4.8kbps, 9.6kbps, 14.4kbps, 19.2kbps, 28.8kbps, 38.4kbps or 115.2kbps (9600bps is the default).
- Serial port parity: No parity.
- Serial port stop-bit: One stop bit.
- Communication address: Selectable from 1 to 247 (1 is the default).
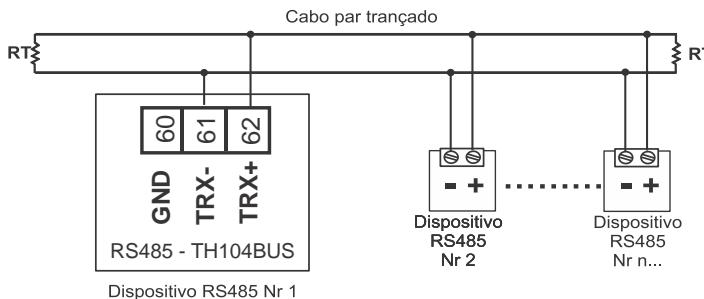
Figure 8 - RS485 Modbus® network connection schematic.

MODBUS® PROTOCOL MEMORY REGISTERS

The Modbus protocol has a list of commands and addresses for read-only (most addresses return a 16-bit word). Commands and error codes are standardized according to the Modbus protocol specification. For details and the use of the Modbus RTU protocol, go to http://www.modbus.org/

Below the description and addresses of memory registers that can be read by the RS485 port through Modbus® protocol. The following registers are read-only. They are accessible though the command **Modbus 03**, "Read Holding Registers":

Decimal Address	Hexadecimal Address	Return values
000	0000	S1, Alarm temperature.
001	0001	S1, Trip temperature.
002	0002	S2, Alarm temperature.
003	0003	S2, Trip temperature.
004	0004	S3, Alarm temperature.
005	0005	S3, Trip temperature.
006	0006	Tab, Alarm temperature.
007	0007	Tab, Trip temperature.
008	0008	NEW Measure scale: 0=Celsius, 1=Fahrenheit
009	0009	FAN1-ON, fan1 activation temperature
010	000A	FAN1-ON, fan1 deactivation temperature
011	000B	Reserved.
012	000C	Ambient temperature channel status: 0=disabled, 1=enabled.
013	000D	FAN2-ON, fan2 activation temperature
014	000E	FAN2-ON, fan2 deactivation temperature
015	000F	Reserved.
016	0010	Time, in minutes, since the controller was turned-on.*(1)
017	0011	NEW S1 temperature channel status: 0=disabled, 1=enabled.
018	0012	NEW S2 temperature channel status: 0=disabled, 1=enabled.
019	0013	NEW S3 temperature channel status: 0=disabled, 1=enabled.

128	0080	Historical maximum temperature measured in S1.
129	0081	Historical maximum temperature measured in S2.
130	0082	Historical maximum temperature measured in S3.
131	0083	Historical maximum temperature measured in TAmb.
132	0084	Current temperature measured on S1. *(2)
133	0085	Current temperature measured on S2. *(2)
134	0086	Current temperature measured on S3. *(2)
135	0087	Current temperature measured on TAmb. *(2)

Notes:

*(1): Displays, in minutes, the time elapsed since the last time the controller was restarted. The maximum value is 65535 minutes (45 days). After this period, the value remains fixed at 65535.

*(2): The temperature values are limited from 0 to 254°C (489°F). The returned temperature values are 16-bit integers and correspond directly to the temperature in °C (or °F). **If the value 999 is returned**, it indicates that the respective sensor or channel is faulty.

The following example shows a read request to Sensor 1 (channel S1 sensor):

Address	Command	Start Address	Register No.	CRC
01 H	**03 H**	**0084 H**	**0001 H**	**C423 H**

Returned value:

Address	Command	Byte No.	Temperate channel S1	CRC
01 H	**03 H**	**02 H**	**0059 H**	**787E H**

The number of records requested can range from 1 to 8. The Start Address plus the Register No. cannot exceed the highest address (008B H), otherwise the controller will report an error.

CHECKING THE RELAY STATUS (COILS)

Here is the description of the memory registers that will be read by the RS485 port. All are read-only. The status of the relays is accessed through the command **Modbus 01**, "Read Coil Status".

Decimal Address	Hexadecimal Address	Return values
032	0020	FAN2 relay: 1=activated, 0=deactivated.
033	0021	FAN1 relay: 1=activated, 0=deactivated.
034	0022	FAULT relay: 1=activated, 0=deactivated.
035	0023	TRIP relay: 1=activated, 0=deactivated.
036	0024	ALARM relay: 1=activated, 0=deactivated.

The following example shows the FAN1 relay status request:

Address	Command	Start Address	Relay No.	CRC
01 H	01 H	0021 H	0001 H	ADC0 H

The answer indicates that the relay is activated:

Address	Command	Byte No.	Relay Status	CRC
01 H	01 H	01 H	01 H	9048 H

The relay number, "Relay No." cannot exceed five, as this is the amount of relays available on the TH104BUS controller. The "Start Address" plus "Relay No." cannot exceed the highest address (0025H), otherwise the controller will report an error.

THERMTRONIC
MONITORAMENTO | CONTROLE | VENTILAÇÃO

RESETING THE MAXIMUM TEMPERATURES HISTORY

Corresponds to the command **Modbus 05**, "Modify Register Status", which allows a reset of the maximum temperatures history. To do so, send FF00H to address 0030H. Once the action is done, a copy of the sent message is returned.

Decimal Address	Hexadecimal Address	Return value
048	0030	Reset the maximum temperatures history

Example of the function 05:

Address	Command	Register	Data	CRC
01 H	05 H	0030 H	FF00 H	8C35 H

Answer:

Address	Command	Register	Data	CRC
01 H	05 H	0030 H	FF00 H	8C35 H

UPDATE HISTORY, ADDENDUMS AND CORRECTIONS

The version 5.2 of TH104 relay has the following main changes:

− Added individual enable/disable function on channels S1, S2, S3 and Tamb.

− Programming menu sequence changed. Added enable/disable options (S1, S2, S3 and Tamb).

The version 5.0 of TH104 relay has the following main changes:

− Added Fahrenheit measurement scale.

− Modbus interface cames by default on the device. Standard model TH104BUS.

− Added Modbus address 0008H that indicates Celcius or Fahrenheit degrees measurement

− If modbus returns a measurement of 999 degrees, it indicates that the sensor or channel is faulty.

− Changes on equipment case design.

− The "S" front key was supressed. SCAN function is available now through the "E/M" key.

− Improved internal power supply and temperature measurement electronic circuit.

− The MODBUS communication status LEDs RX and TX changed to the front panel.

− Metal screws on the side fixing clamp.

− Fault indication relay NO contact has been removed.

− The weight of the equipment changed from 430g to 370g.

WARRANTY

THermtronic warrants the equipment for a period of 12 months from the date of receipt, being limited to the exchange or repair of parts of the equipment that is recognized as defective. The replacement of the parts/equipment during the warranty period does not imply on the extension of the warranty.

The guarantee shall not cover expenses or risks arising from freight or packaging, insurance, loading/unloading, disassembly/assembly or other expenses necessary to transport the parts or equipment to be repaired from the place where they are installed to the place where it will be repaired and vice versa.

The warranty will not cover the replacement or repair for damage, deterioration or accident due to negligence, improper use, inadequate protection or failure caused by elements not foreseen by the seller or damages that may result during transportation by the buyer or third parties.

Damages caused by materials or designs specified by the buyer will be excluded from warranty. Any work or intervention performed on the equipment during the warranty period, by the purchaser or by third parties without the express authorization of THermtronic, will result in the expiration of the warranty clause.

The work inherent of warranty repairs shall be performed by the seller (by him or by third party company), in his establishment, in an isolated place or in any other place that has the necessary means. On this case, the buyer must provide, without charge, maximum cooperation and assistance.

All materials, elements or parts replaced during the warranty period will remain on property of the seller.

In the event of any damages during the warranty period, the buyer cannot claim compensation respective of loss of profit (direct or indirect), material damage or injury to persons.

The prompt assistance during the warranty period will be according to the work possibilities of our company.

TH104 - Thermal protection relay.

TESTING/QUALITY CONTROL

Test	Type	Description of the test
1	A	Front panel keys working checking.
2	A	Leds checking.
3	A	Automated relay test (each relay is activated and tested it´s contacts 5 times).
4	A	Mechanic general test.
5	A	Automated calibration.
6	A	Automated test of measurement and accuracy, at 50°C.
7	A	Automated power supply test at 24 and 220Vac.
8	A	72 hours of work test and 24 hour Burn-in 60°C test.

Type of test:
- A: all units.
- B: one each 100 units.
- C: Certification only on request. Check prices.

Manufacturing and Sales:

THermtronic Global LTDA.

Sales: comercial@thermtronic.net
Technical support: tecnico@thermtronic.net
Web: www.thermtronic.net

NOTES:

TH104 - Thermal protection relay.

TH104

| S1 | S2 | S3 |
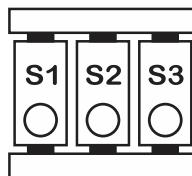
THermtronic

Brazilian Industry