

THERMOREGULATION DIGITAL SYSTEM TYPE 960 AND ACCESSORIES TYPE 961

BRAHMA

MICROPROCESSOR MANAGEMENT BOARD FOR AUTOMATIC IGNITION ATMOSPHERIC BOILERS.



DESCRIPTION

This device is designed specially to control the safety cycle and the temperature of open and closed chamber atmospheric gas boilers.

GENERAL FEATURES

The main features are the following:

- In accordance with EN 298-2003 (European standard for flame programming and detection automatic systems of gas burners);
- Ignition and ionization flame control, single or double electrode, with remote or on-board igniter (type TR2) otherwise with a completely solid state and high efficiency igniter (type TD or TSM),
- Possibility of accomplishing multiple ignition attempts,
- Electrical or manual reset,
- Boiler components checking process (system circulator, fan, diverter valve, gas valve, flow switch/flow meter, air pressure switch, room thermostat, safety thermostat, etc.);
- Possibility to control a traditional gas valve or the Brahma gas valve VCM01,
- Possibility to control a brushless fan phase cut in order to minimize the NoX emissions;
- Commands, regulations and signals on a personalized module connected to the mother board through flat cable or potentiometers and luminous LEDs located on board .
- The use of (maximum 3) contact and/or immersion probes NTC for temperature reading;
- Thermoregulation function checking by microcontroller;
- 4 kV and 8 mm SELV (Safety Extra Low Voltage) isolation on the PCB surface between components connected to mains supply and low voltage controls ;
- flame modulation by proportional, integral and derivative electronic system (PID) through a PWM signal;
- outgoing temperature thermoregulation program by means of external probe;
- possibility to be used in (low temperature) floor heating installations,
- varistor which provides protection from voltage transient on the mains supply;
- The system is EMC compatible;
- Connection possibility through interface RS232 or RS485 (cascade connection) and remote control with Opentherm compatible protocol (by adding an optional control panel).

TECHNICAL DATA

Power supply:	230V - 50/60Hz
Operating temperature:	-20°C / +60°C
Humidity:	Max. 95% at 40°C
Protection degree:	IP 00
Dimensions:	140x115x40mm

CONSTRUCTION

The system is composed of:

Generic thermoregulation device (960), on which the power supply and the microprocessor for the thermoregulation are located;

Flame detection board for modulation boards (SRM) which accomplishes flame ignition and control with a microcontroller; this module is mounted directly on the board "960" through welding, which reduces in this way the number of switchboard wires.

Control panel (SC), on which the regulation commands (push buttons) and the diagnostic signals through display are mounted;

Interface board (SI), on which there are the circuits appointed to control the optional functions, such as for example the Opentherm distance communication protocol, the RS485 protocol for cascade boilers management or The RS232 protocol;

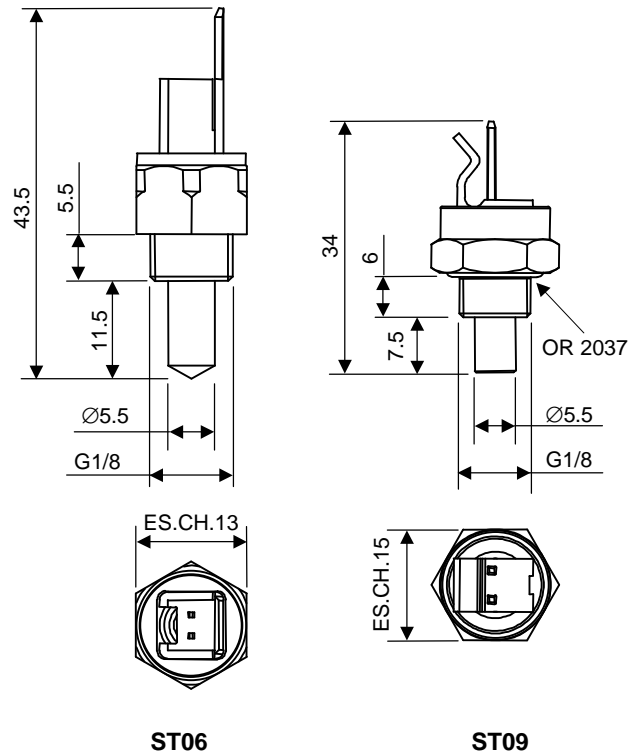
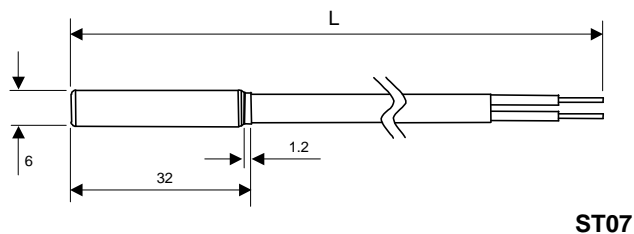
It's possible to fit to this system (upon client's request) indifferently a **remote igniter (AR)** type TR2 or an **external igniter (AE)** type TSM or TD, to be chosen in base on the specific requirements of every application.

ACCESSORIES

The system is able to control maximum 3 temperature probes, all of them (*) are characterized by a NTC sensor type $10k\Omega \pm 1\%$ a 25°C con $\beta=3435^\circ\text{K} \pm 1\%$; these probes can be indifferently contact type (ST07), or immersion type (ST06 and ST09): Any way do not connect terminals with female connectors of different marks.

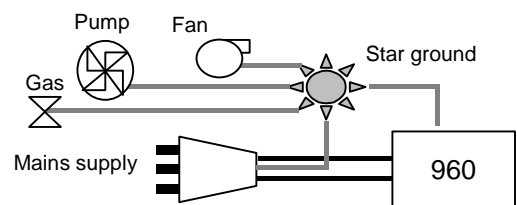
The type of termination used to interface the accessories with the board is MSF Lumberg series.

(*) Upon specific request of the client, it's possible to manage also probes which have electrical characteristics, coefficient β and different mechanical characteristics comparing with the up-mentioned ones (for example type ST03, ST04 and ST11).



DIRECTIONS FOR INSTALLATION

- The applicable national and European standards (ex. EN60335-1 / EN50165) related to the electrical safety must be respected.
- Phase-neutral polarity must be respected (in case the device is polarized). Not respecting polarity can cause dangerous conditions.
- Before starting the system check the wiring carefully. Wrong connections can damage the controllers and compromise the plant safety.
- Cut off power supply before connecting and disconnecting the control system.
- The system can be mounted in any position.
- Avoid exposure to dripping water.
- The device in which the thermoregulation system is installed must provide a commensurate protection against risks of electrical shocks (at least IP20).
- Avoid putting signals control cables close to power cables.
- Check the correct connection to the grounding system.
- The earth of the board is only functional (for flame detection), it is not a safety ground, so it must connect from the ground node of the boiler (star ground centre). The mains ground must be connected directly to the star ground of the boiler, as illustrated in the following figure .



INTEGRATED THERMOREGULATION SYSTEM

The Integrated thermoregulation systems, in general, are customized (according to the client's requirements) The customization concerns whether the operation or the boiler components control; in order to expand on their description anyway we will refer to the "960" system in the "standard" configuration in order to expand on the description of the above systems.

The main technical specifications are as follows:

Times:

- pre-purge time (TW): 1,5 ... 60 s
- safety time (TS): 3 ... 120 s
- discharge time (TSP): (TS - 1) s
- response time in case of flame failure: < 1 s
- post-purge time: 0 ... 60 s

The times given correspond to the values guaranteed. The actual values can diverge slightly from the declared ones, meaning that pre-purge time can be longer and safety time shorter than their nominal values.

- Recycle attempts** 1...10
- Power consumption :** 15VA
- Maximum load rating:**

- EVG: 0.3 A $\cos \varphi \geq 0.4$
- Fan: 0.4 A $\cos \varphi \geq 0.4$
- Diverter valve: 0.1 A $\cos \varphi \geq 0.4$
- Circulator: 0.5 A $\cos \varphi \geq 0.4$
- External ignition device: 0.15 A $\cos \varphi \geq 0.2$
- Auxiliary control 0.1 A $\cos \varphi \geq 0.4$

the power of the board is filtered; the total sum of the current allowed by the board for the loads is 1.2 A: so the sum of loads must be less or equivalent to this value.

Maximum length of external components cable:

1 m

internal fuse:

3.15 A fast

Flame control:

The flame detection device uses the rectification property of the flame; this device is supplied with protection impedances and so the detection electrode is protected against electrical shock (in the dualelectrode configuration).

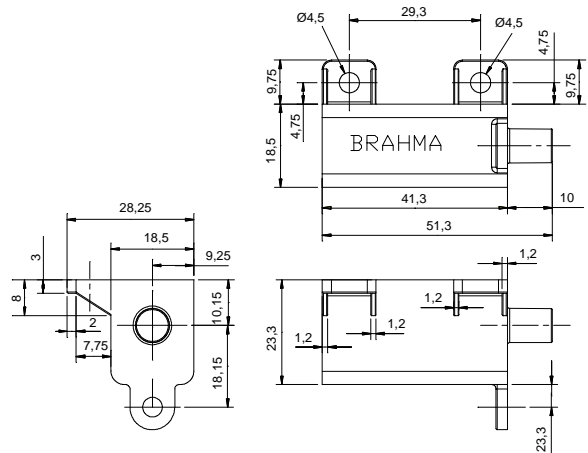
- Minimum ionization current: 0.5 μ A
- Recommended ionization current :
3 ÷ 5 times the minimum ionization current
- Maximum cable length: 1 m
- Min. insulation resistance of detection electrode and cable to earth: ≥ 50 M Ω
- Max. parasitic capacitance of electrode: ≤ 1 nF
- Max short circuit current: < 200 μ A AC

On board / remote ignition device:

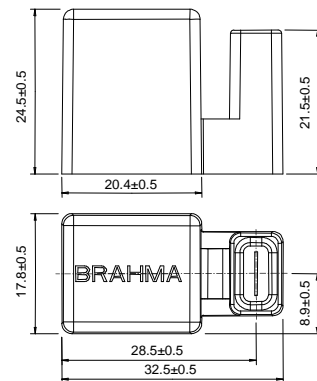
- Model : TR2
- Peak voltage with 30pF load: 15 - 18 kV
- Peak current: 800 mA
- Spark repetition rate: 25 Hz
- High-voltage cable standard length: 0.6 m
- High-voltage silicon cable with diameter: 4 mm
- Other lengths are available upon request .
- recommended discharge distance: 2 ÷ 4 mm
- Consumption: 2.5 VA
- Spark energy: 20 mJ
- Maximum usage temperature: 150°C

For the remote model:

- Standard length of power supply cable 0.6 m
- Maximum length of power supply cable 1.5 m



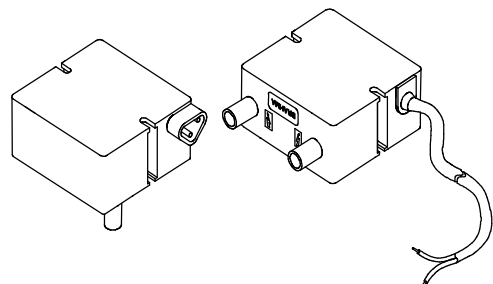
Remote ignition device : BRAHMA Mod. TR2



On-board ignition device: BRAHMA

External ignition device (AE) :

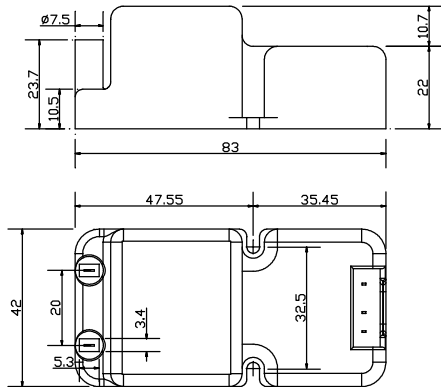
- Model : TD1xxxAF / TD2xxxAF
- Duty cycle: 50% over 2 minutes
- Output peak voltage: 15 kV with 30 pF load (TD1)
2x10 kV with 30 pF load (TD2)
- Output peak current: 45 mA under short circuit (TD1)
55 mA under short circuit (TD2)
- Output voltage frequency: 6 kHz with 30pF load
10 kHz under short circuit
- Max. ignition cables length: 1.5 m
- Recommended distance between electrodes: 3 ÷ 5 mm
- Consumption: 45 VA discharge distance 10 mm (TD1)
55 VA discharge distance 10 mm (TD2)



External ignition device: BRAHMA Mod. TDxxxxAF

External ignition device (AE) :

- Model : TSM
- Output peak voltage: 15 kV with 30 pF load
- Output peak current: 200 mA under short circuit
- Output voltage frequency: 200 Hz
- Max. ignition cables length: 1.5 m
- Recommended distance between electrodes: 3 ± 5 mm
- Consumption: 10 VA



External ignition device: BRAHMA Mod. TSM

Outputs:

High voltage outputs

Ignition device
Fan (power supply)
Circulator
Gas valve (traditional type)
Diverter valve
Safety thermostat
Anti-freeze
Generic (Ex. Loading valve)
High voltage outputs and board interface with each other through terminations type STELVIO and MOLEX (only for ignition device)

Low voltage outputs

Gas valve Brahma VCM01
Gas pressure sensors
Gas valve modulator
Safety thermostat
Air pressure switch/ Combustion products device
Brushless fan driver
Water pressure switch
Pressure transducer
Room thermostat
Flow switch / Flow meter
3 temperature probes
Control panel
Serial communication (RS232)
Serial communication (RS485)
Remote communication (Opentherm)
The low voltage outputs and the board interface with each other through screw terminal blocks (room thermostat, remote communication) or terminations type LUMBERG MSF series.

Temperature detection probe

The system can manage up to 3 temperature probes: the outgoing probe of the primary circuit must be always present, the probe of the sanitary plant can be either present or absent, according to the comfort quality required, and the remaining probe (the third one) can be either present or absent according to the settings (software) chosen by the client.

The **outgoing probe of the primary** circuit is located on the outgoing pipeline of the boiler heat exchanger and the **sanitary probe** (if exists) is located on the output pipeline of the sanitary circuit; the board is completed then by the possibility to connect an **external probe** in order to manage the room thermoregulation in systems which can gain advantage from this probe.

It should be noted that the outgoing probe of the primary circuit acts as a limit thermostat, therefore it allows the inhibition of every demand if the water temperature exceeds the prefixed temperature limit value. In this sense, if this probe is interrupted or short-circuits, the thermoregulation system cancels every demand and prevents the boiler functioning.

In case of interruption or short circuit of any of the other two probes the system keeps working by using (for thermoregulation) the outgoing probe of the primary circuit and signalling anyway the correspondent anomaly.

For all the probes (*):

Recognizing threshold when probe is interrupted $> 50 \text{ k}\Omega$

Recognizing threshold when probe is short-circuited $< 500 \Omega$

(*) For the only external probe:

Recognizing threshold when probe is interrupted $> 130 \text{ k}\Omega$

Recognizing threshold when probe is short-circuited $< 5.5 \text{ k}\Omega$

Safety thermostat

Normally the system is totally secured against eventual overtemperature in the primary circuit by a safety thermostat which is monitored by the microcontroller of the 960 board. The thermostat intervention leads immediately to volatile loc-out. Before proceeding to a recycle attempt, it's necessary to reset the system manually or electrically (according to versions).

Automatic loading valve

The system is able to control an automatic hydraulic loading valve of the heating plant.

Circulator

It's possible to connect a 230 Vac Circulator to the board. An antiblocking function is applied. In order to avoid pump blocking due to scale, the function consists in making the pump work for few seconds at least once a day.

Diverter valve

The system is able to control indifferently boilers supplied with 3 way electric diverter valve (230 Vac), to be connected to the board, and boilers supplied with hydraulic diverter valve. An antiblocking function is applied. In order to avoid valve blocking due to scale, the function consists in making the valve commutate every time a sanitary water demand is fulfilled.

Fan (power supply) / Fan driver

The following fan types can be employed :

a standard fan (*)

a brushless fan driven with a 24V PWM signal .

(*) for modulating speed, the 230 V driving can occur also during phase cut.

Gas valve / Pressure sensor

The following gas valves can be employed :

230 Vac standard gas valve;

24 V Brahma Gas valve type VCM01 fitted with its pressure sensor;

Brahma gas valve type VCM01 without sensor

If the VCM01 Brahma gas valve is used with sensor, accurate diagnostics of the pressure sensor correct functioning are made by monitoring also its fatigue.

If the VCM01 Brahma valve is employed without sensor then a diaphragm must be used to limit the gas maximum range. The diaphragm can change according to the used burner and to the boiler capacity.

Air pressure switch / Combustion products device

It checks the correct air circulation in the combustion chamber and permitting the boiler ignition only if the fan is working and the draft is regular, besides it guarantees the boiler safety lockout if one of these conditions is not fulfilled during operation. Upon request, for the open chamber boilers, the pressure switch can be replaced by a combustion products device, by using the same connector and changing the connection configuration. The 3 contact intelligent air pressure switch (Vcc-Gnd-Signal) produced by Brahma can also be connected to the board.

Water pressure switch/ Pressure transducer

It checks if the primary circuit pressure is in the requested operation field. In case the pressure is too low, the thermoregulation system inhibits every demand and signals the fault on the control panel.

Water flow switch / Flowmeter

the board can read the device which indicates the service water extraction. This signal can be obtained by a flow sensor (water flow switch or flowmeter): therefore it is possible to control a 3 way electric valve or alternatively a pump for the sanitary circuit.

Room thermostat

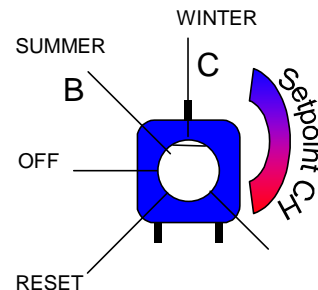
The room thermostat is connected to the board, low voltage type (24 V), via two wires; it must work with a contact isolated from the mains.

Regulation potentiometers

The DGT board has 4 potentiometers to set the operation mode and different parameters. in this way the board doesn't need any control panel.

Particularly:

- Heating mode/set-point: this potentiometer acts as a selector and allows to specify the board operation mode (Reset, Off, Summer, Winter) and the eventual value of the outgoing probe set-point. See the following figure in order to better understand its operation.



- Sanitary set-point: this potentiometer sets the sanitary temperature.
- Ignition power: this potentiometer sets the ignition power during the cycle safety time TS.
- Maximum heating power: this potentiometer sets the maximum power in heating mode.

Onboard signal LED

The 960 board has 4 bicolour LEDs (red, green and so red+.green=orange) to give luminous signals related to the operation status and the boiler diagnostics. Their interpretation are highly personalizable and so it is specified in the user's manual (or technical sheet).

RS232 serial communication

The interface board (SI) has a connector for the RS232 serial communication: This feature is useful to visualize the system data on an external computer.

RS-485 serial communication

The interface board (SI) has a connector for the RS485 serial communication: with this feature the board can be connected to a communication network with proprietary B-bus protocol so as to realize plants of ganged atmospheric boilers. It should be noted that every boiler can be singularly addressed by means of a 16 position selector located on the interface board too.

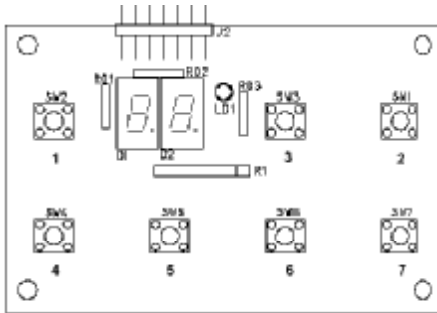
Opentherm[®] Remote communication

The interface board (SI) has a connection for the communication through Opentherm[®] protocol: with this feature the board can be controlled by a remote control panel (eventually integrated in a chronothermostat).

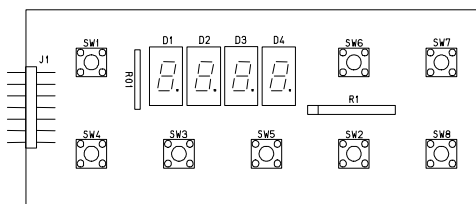
Control panel

The 960 board is able to pilot control panels supplied with push buttons (up to max. 8) and a 7 segment display (type 361, 366, 368) or LCD display (Type 390, 398, intelligent keyboard).

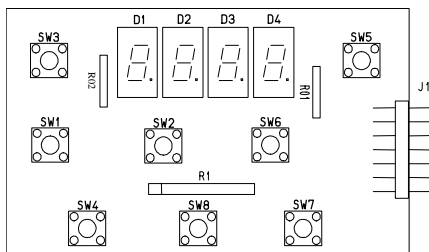
Type 361



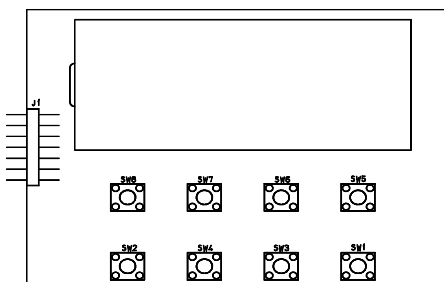
Type 368



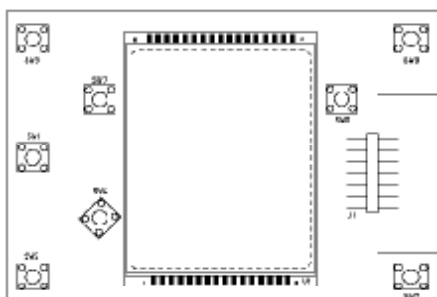
Typo 366



Type 390



Type 398/intelligent keyboard



PS: All the functions of every button and the various displayed data are accurately indicated in the user's manual (or technical sheet)

OPERATION:

Starting cycle

The starting cycle begins against a heating demand (coming out from the room thermostat) or a sanitary hot water demand (coming out from the water flow switch, the flowmeter or the tank probe) if the sanitary circuit is present.

The water pump is power supplied and an ignition request of the burner is given by a particular command supplied to the SRM board if the water temperature is less than the one already set.

In case of a closed chamber boiler, the control device SRM energizes the fan only if the air pressure switch is in the "non-air circulation" condition; when the pressure switch commutates to the "air circulation" position the pre-purge time TP starts, at the end of which starts the safety time TS, the gas valve is power supplied and the ignition device is energized. In this phase, the burner power is kept at a controlled value according to the application requirements (ignition power).

If flame is detected at the end of TS, thermoregulation process starts with burner flame modulation in order to obtain a water temperature equal to the set temperature; if the flame is not detected within TS, the gas valve closes at the end of TS. If the attempts reach the set maximum number then a lock-out occurs, otherwise a new ignition cycle begins. The boiler lock-out is signalled on the control panel or through the LEDs located on the 960 board, the system can be reactivated by pressing the appropriate push button of the control panel or by turning the function selection knob of the boiler. If the hot water demand remains, the boiler will start a new ignition cycle: in case the conditions which caused the lockout continue to remain, the boiler will proceed to this state. The boiler will stay in running position till the demand stops, otherwise one of the safety devices will intervene, or the flame will shut off.

Operation cycle variations

The possible operation cycle variations based on the chosen options are as follows:

- Lockout due to flame simulation

The system proceeds to lockout if flame is detected at the beginning or during pre-purge time TW,

- Flame failure in running state

The system goes immediately to lockout if no flame is detected in running state.

- Post-purge time

The controller continues to power supply fan and pump for a time interval after it has shut off the burner (time is fixed upon request): this behaviour is useful in case of a boiler equipped with bithermal heat exchanger in order to help cooling the exchanger and avoid scale formation caused by hot stagnant water.

- Ignition attempts

The controller proceeds to more than one ignition attempts on flame failure (the attempts number is set upon request).

- Inter-purge time

The controller starts a purge time after a failed ignition attempt and before proceeding to a new ignition attempt (TW/TS cycle).

Sanitary mode

The ignition request in *sanitary mode* takes priority over the ignition request in *heating mode* in order to guarantee more comfort to the user who requires sanitary hot water; in this phase the system behaviour changes according to the sanitary type.

- Boiler with instantaneous sanitary system

The sanitary mode starts when a hot sanitary water is extracted: the boiler will try to supply the user with sanitary hot water at the set temperature. If the required power is less than the minimum modulation power, the boiler will go to short switch-on/ switch-off cycles. If the required power is higher than the maximum set power, the water temperature will be proportional to the extraction made, but it will be less than the set temperature.

- Boiler with external thermostated tank

The sanitary mode starts when the tank thermostat closes (connected to the flow switch connection): in this case the boiler heats up the tank water (sanitary water) by means of the heating circuit and by switching the deflection valve located in the sanitary circuit. The system will continue to fulfil the sanitary water demand (coming from the tank) till the thermostat closes .

- Boiler with tank and tank probe

The sanitary mode starts when the probe (tank) indicates that the temperature of the water in the tank is lower than the set point which has been already set: in this case the boiler heats up the tank water (sanitary water) by means of the heating circuit and by switching the diverter valve located in the sanitary circuit. The system will continue to fulfil the sanitary water demand till the temperature detected by the tank probe reaches the set-point which has been already set.

The system keeps always the primary heating circuit temperature under control by shutting off the burner if the outgoing probe reads a higher temperature comparing with the allowed one. The burner is switched on again if the outgoing temperature becomes lower than the one allowed.

Heating mode

Eventual ignition requests in *heating mode* can be fulfilled by the system only if it is set in the winter mode: in this case, when the room thermostat is closed, if the related outgoing temperature (of the primary or secondary circuit) is lower than the Set-point which has been already set, the boiler accomplish a start cycle and starts the flame modulation till reaching the running state. If the outgoing temperature (of the primary or secondary circuit) exceeds by 5°C the Set-point which the user has set, the boiler goes off; the reignition occurs when the water temperature becomes 5°C lower than the set value.

Circulator post-circulation

Every time the boiler goes off, the circulator keeps working for a short settable period so as to reduce the water temperature in the exchanger.

“Sliding temperature” mode

When the external probe is installed and the Ke dispersion parameter is set, the regulation system works in “*sliding temperature*” mode: this means that the outgoing temperature of the heating plant is regulated according to the external climatic conditions so as to guarantee a high comfort and energetic saving all year long.

In particular, once the external temperature raises the outgoing temperature of the plant is reduced according to a certain “compensation curve” which can be set by working on:

The desired room temperature;

hc (heating curve) dispersion coefficient for external temperature compensation.

The predetermined range is 5 ÷ 35, the calculation of the outgoing probe is done according to the following formula:

$$T_i = (T_{ap} - T_e) \cdot hc/10 + T_{ap}$$

where

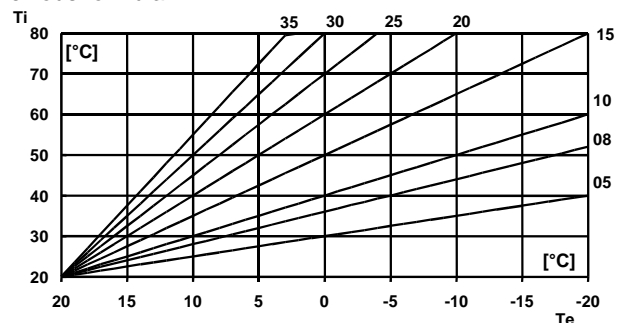
T_{ch} is the calculated heating set-point,

T_{room} is the desired room temperature,

T_{ext} is the external temperature and

hc is the dispersion coefficient which has been just described.

In the following diagram the curves correspond to the previous formula



The diagram is related to the external temperature compensation for various values of HC, with $T_{ap}=20^{\circ}\text{C}$

Anti-freeze mode

If the outgoing temperature of the primary system goes under 5°C the boiler is energized at its minimum power with a 30°C set-point. Anyway this function can be customized .

Other features

The following features concern the plant protection:

Circulator anti-blocking → to avoid the circulator's blocking due to a long outage, the circulator is energized for about 30 seconds if no ignition cycle has been made by the boiler in a fixed period of time (generally 24 hours). This function is active also during the lock-out state of the boiler.

Diverter valve anti-blocking → every time the circulator is off the diverter valve switches for a second and then returns to the original position.

Anti-legionella function → the water of the eventual tank reaches 65° C with a weekly frequency in order to eliminate the legionella bacteria.

DENOMINATION OF BOARD TYPE 960

960 . H W . S . R

- H ->** Letter/s attributed to the client and it's within the internal competence of BRAHMA
- W ->** progressive number for client:
Indicates a particular hardware whose composition is specified in a customized technical document to the board
- S ->** Software and hardware revision index of BOARD 960:
00, 01, 02....: progressive order
- R ->** SRM Software and hardware revision index:
00, 01, 02....: progressive order

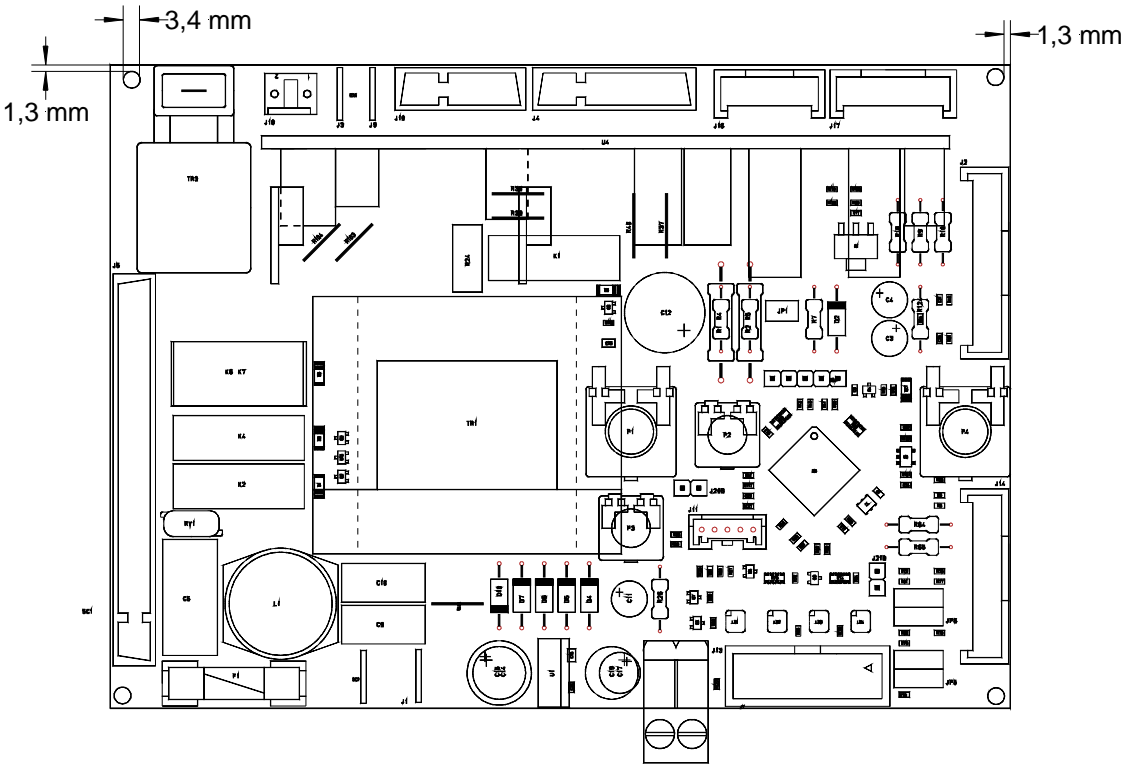
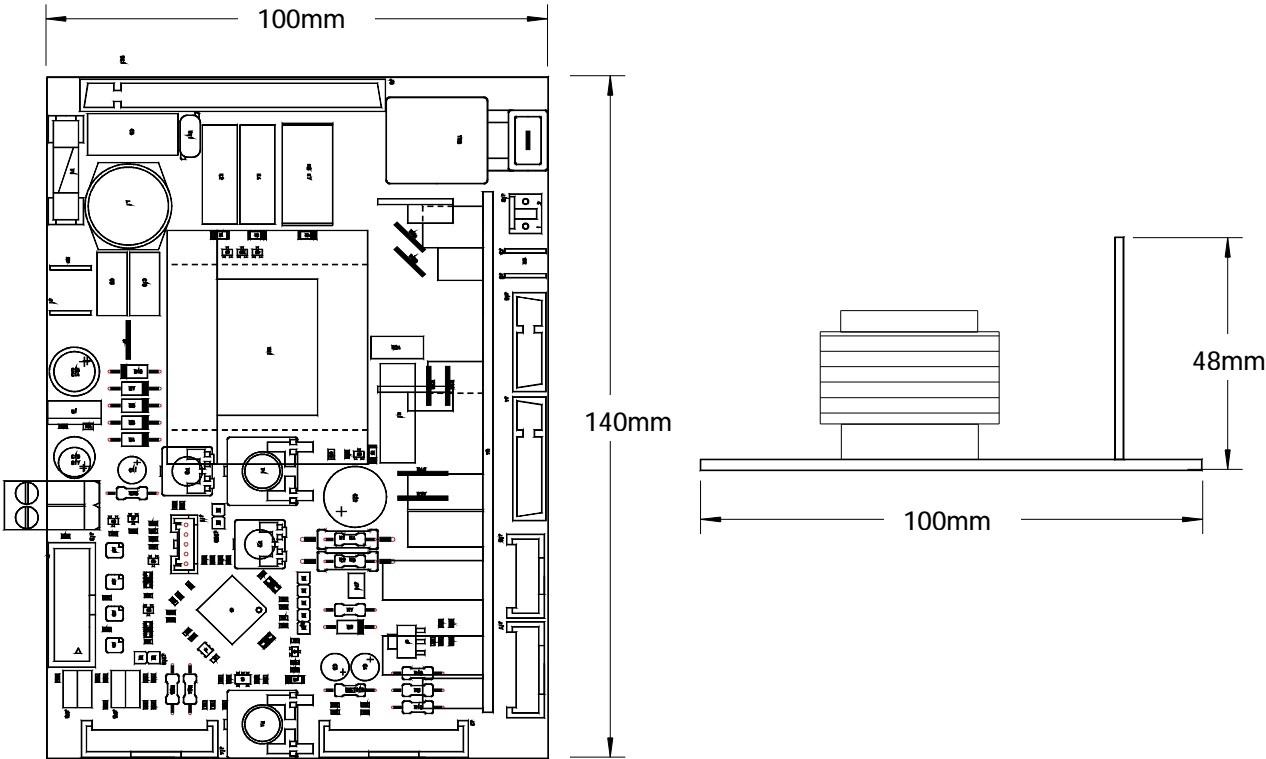
Note: concerning SRM module, see related technical sheet

DENOMINATION OF INTERFACE BOARD TYPE 961

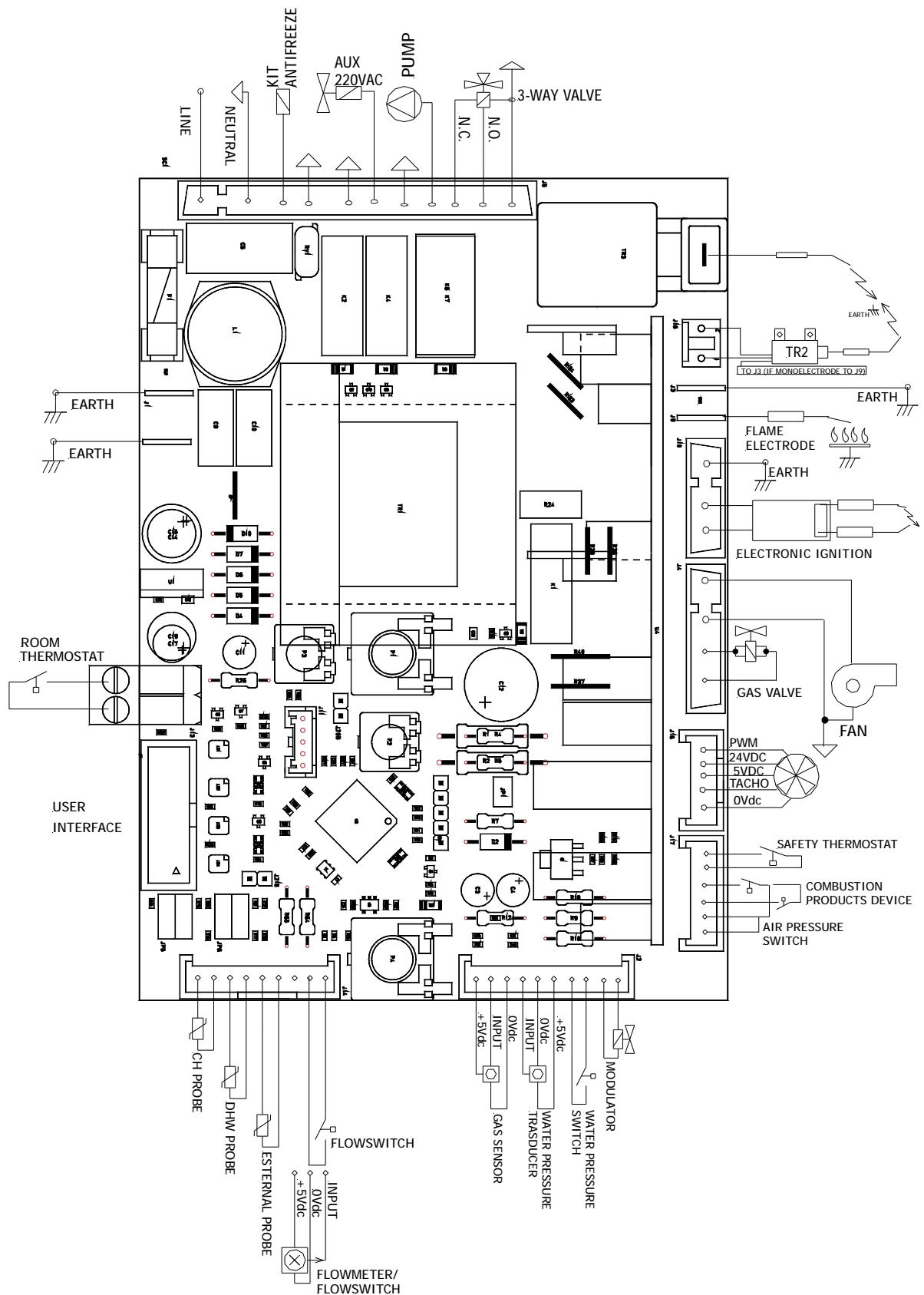
961 . X Y Z

- X ->** Opentherm® protocol connection
No letter: not available. Standard.
O: available.
- Y ->** Jumper address selection
No letter: not available. Standard.
J: available.
- Z ->** Serial protocol connection
No letter: not available. Standard.
2: protocol RS232
4: protocol RS485

OVERALL DIMENSIONS



960 CONNECTION DIAGRAM



961 INTERFACE CONNECTION DIAGRAM

