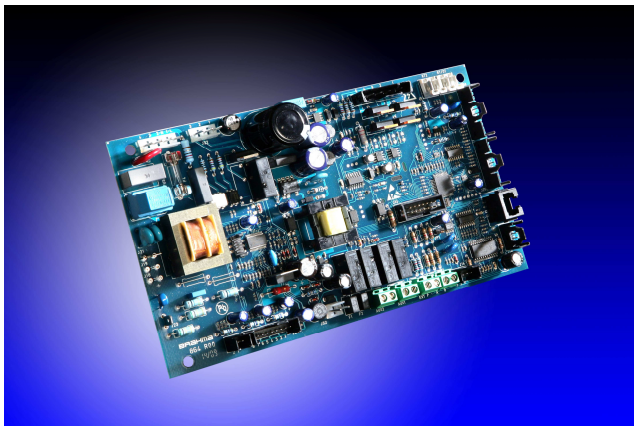
TEMPERATURE AND SAFETY DIGITAL CONTROL SYSTEM SERIES 864

BRAHMA

MICROCONTROLLER-BASED ELECTRONIC BOARD FOR BURNER IGNITION, CONTROL AND THERMOREGULATION IN CONDENSING PREMIX BOILERS



DESCRIPTION

This unit has been specifically designed for safety cycle and temperature control in condensing premix gas boilers.

GENERAL FEATURES

This control board is provided with the following features:

- Compliance with UL 372, UL 1998 (120 VAC / 60 Hz power supply).
- EMC – compatible system.
- Varistor protecting the system from voltage transients which may be generated in the mains supply.
- 4kV and 5mm PELV (Protective Extra Low Voltage) insulation on the printed circuit board surface between components connected to the mains supply and low voltage controls.
- Double electrode ignition and flame detection (ionization)
- External high-efficiency ignition device (main power supply).
- Possibility of multiple ignition attempts.
- Electrical reset or manual reset from non-volatile lockout.
- Control of the boiler thermo-regulation and safety parts (modulating circulator, gas valve, stepper motor / 3 way DHW valve, flow switch/flow-meter, air pressure switch, safety thermostat, etc.).
- Settings and visualizations on a LCD control board connected to the board by means of a multi-polar flat cable.
- Use of (up to) 6 NTC contact and/or immersion probes for temperature measurement.
- Control of water temperature by means of microcontroller-based adjustment functions.
- Flame modulation by means of a proportional, integral and derivative (PID) electronic system.
- Outgoing water temperature adjustment program by means of an outside probe.
- Differentiated setting of the required water temperature for heating and domestic hot water operation mode.
- Burner power modulation by means of a PWM-controlled brushless fan.
- Circulator speed modulation according to the system characteristics.
- Heating (CH) request managed by room thermostat contact or remote OpenTherm-compatible chrono-thermostat (Brahma “Encrono OT”).
- Sanitary (DHW) system with instantaneous exchanger (managed by flow switch / flow-meter

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and NTC temperature probe) or external storage tank (managed by tank thermostat or NTC temperature probe).
- Prearranged for use in floor heating systems.
- Prearranged for use in systems with two separate zones, at the same temperature or with different temperatures; possibility to connect and manage two areas pump (valves) or a PID-controlled mixing valve.
- Cascade system application (via RS485 communication) both in autonomous configuration (only 864 boards) or managed by an external Brahma CBS device.
- Connection with a remote PC by means of a RS232 cable or via GSM (wireless modem) for remote boiler analysis, diagnostics and settings.
- Prearranged for the management of a solar thermal system through an optional external board reading up to 5 solar probes and driving up to 2 phase-cut solar circulators and an auxiliary general-purpose contact.

TECHNICAL DATA

Supply voltage :	110-120VAC 50/60Hz
Operating temperature range:	-20°C / +60°C
Humidity:	95% max at 40°C
Protection degree:	IP 00
Dimensions:	210x120x50 mm

CONSTRUCTION:

The system consists of three electronic boards:

Mother Board 864, which houses the electronics controlling the boiler parts (temperature adjustment) and burner safety functions.

Control Board LCD, on which adjustment controls (push-buttons) and diagnostic signals (on a display) are mounted. On customer's demand, this system can be fitted with different control board: for information see control board description and the relevant datasheet.

Solar Optional Board, including the electronics managing a solar thermal system.

DIRECTIONS FOR INSTALLATION

- Respect the applicable national standards regarding electrical safety.
- Before starting the system check the cables carefully: a wrong wiring can damage the devices and compromise the safety of the installation.
- Connect and disconnect the control system only after switching off power supply.
- The system can be mounted in any position.
- Avoid exposing the system to dropping water.
- The appliance in which this temperature adjustment system is mounted must provide adequate protection against the risk of electric shock.
- Avoid placing control signal cables close to power cables.
- Make sure the device is correctly connected to the grounding system.

Timings:

- Pre-purge time **(TW):**	1,5 … 60 s
- Safety time **(TS):**	3 … 120 s
- Spark ignition time **(TSP):**	(TS - 1) s
- Drop-out time on flame failure:	< 1 s
- Post-purge time:	0 … 60 s
- Inter-purge time **(TIP):**	1…240 s

The above times correspond to guaranteed values. Actual values may differ from declared ones, as waiting (TW) or post-purge may be longer and safety time (TS) shorter.

Ignition attemps: 1…10

Consumption (without loads): 5.8VA / 3.15W

Load ratings:

- Fan:	1A	cos φ ≥ 0.4
- Electrical pump:	1A	cos φ ≥ 0.4
- Deflection valve:	1A	cos φ ≥ 0.4
- External ignition device:	0.5 A	cos φ ≥ 0.2
- Gas valve:	450 mA	@ 24VDC
- Stepper motor:	250 mA	@ 24VDC

Max. cable length of external components: 1 m

Fuse current: 4A fast acting

Flame control:

The flame detection device makes use of the rectification property of the flame.

- Min. ionization current:	0.5μA
- Recommended ionisation current:	3 ÷ 5 times the min.
- Max. cable length:	1 m
- Min. insulation resistance of detection electrode and cable to earth:	≥ 50 MΩ
- Max. electrode stray capacitance:	≤ 1 nF
- Max. short circuit current:	< 200μA AC

Contacts:

High voltage contacts on Mother Board 864
- Supply voltage
- Ignition device
- Fan (power supply)
- Pump system

Isolated contacts on Mother Board 864
- 2 auxiliary isolated contact

Low voltage contacts on Mother Board 864
- Safety thermostat
- Auxiliary safety thermostat
- Air pressure switch
- Combustion products thermostat
- Water pressure switch/ Water pressure transducer
- Room thermostat - Opentherm® chrono-thermostat
- Room thermostat secondary system
- Flow switch / Flowmeter
- Stepper motor
- Gas valve
- Valve gas pressure sensor

- 6 temperature probes
- Control panel
- Serial communication (RS232)
- Serial communication (RS485)

High voltage contacts on Solar Optional Board
- 2 pumps

Isolated contacts on Solar Optional Board
- Auxiliary isolated contact

Low voltage contacts on Solar Optional Board
- 5 temperature probes

Temperature measuring probes
The system can control up to 6 temperature probes, one of which (the primary system outgoing water) must necessarily be always available: the remaining ones (domestic hot water probe, outside probe, return probe, secondary system outgoing water probe, combustion products detection probe) can be available or not, depending on the settings (software) selected by the user and the comfort desired.
Please note that the primary system outgoing water probe also operate as limit thermostats, enabling any heat demand to be inhibited if the water or the combustion products temperature exceeds the preset limit temperature. In this sense, if this probe is cut-off or in short circuit, the temperature adjustment system will cancel any heat demand, preventing the boiler from operating. On specific customer's request, any other probe can operate this way.
Instead, by default, in case of short circuit or cut-off of the domestic hot water probe the system continues operating using the primary system outgoing water probe (for temperature adjustment), but anyway signalling the relevant failure.

Central heating probe (CH probe):
NTC immersion sensor
10 kΩ @ 25 ℃, β coefficient = 3435
Measuring the temperature of the primary system outgoing water.
The following formula enables to calculate the resistance value of the NTC sensor at a T temperature expressed in Kelvin degrees:

$$R_T = R_{25} \exp[\beta(\tfrac{1}{T} - \tfrac{1}{T_{25}})]$$

Demand hot water probe (DHW probe):
NTC immersion sensor
10 kΩ @ 25 ℃, β coefficient = 3435
Measuring the temperature of the sanitary exchanger outgoing water (instantaneous DHW) or the storage tank water (external tank DHW).
The following formula enables to calculate the resistance value of the NTC sensor at a T temperature expressed in Kelvin degrees:

$$R_T = R_{25} \exp[\beta(\tfrac{1}{T} - \tfrac{1}{T_{25}})]$$

Return probe (RT probe):
NTC immersion sensor
10 kΩ @ 25 ℃, β coefficient = 3435
Measuring the temperature of the CH circuit return water.
The following formula enables to calculate the resistance value of the NTC sensor at a T temperature expressed in Kelvin degrees:

$$R_T = R_{25} \exp[\beta(\tfrac{1}{T} - \tfrac{1}{T_{25}})]$$

Chimney probe (CP probe):
NTC contact sensor
20 kΩ @ 25 ℃
Measuring the temperature of the primary exchanger combustion products

Heating probe secondary system (CH2 probe):
NTC immersion sensor
10 kΩ @ 25 ℃, β coefficient = 3435
Measuring the temperature of the secondary system outgoing water.
The following formula enables to calculate the resistance value of the NTC sensor at a T temperature expressed in Kelvin degrees:

$$R_T = R_{25} \exp[\beta(\tfrac{1}{T} - \tfrac{1}{T_{25}})]$$

Outside probe (EXT probe):
NTC contact sensor
10 kΩ @ 25 ℃, β coefficient = 3435
Measuring the outside temperature.
The following formula enables to calculate the resistance value of the NTC sensor at a T temperature expressed in Kelvin degrees:

$$R_T = R_{25} \exp[\beta(\tfrac{1}{T} - \tfrac{1}{T_{25}})]$$

On customer demand, the system can also control probes with electrical and mechanical characteristics differing from the above-mentioned ones.
N.B. For electrical and mechanical characteristics, please refer to the relevant Data Sheets.

Safety thermostat (TS)
The system is perfectly safe against possible overheating in the primary system by means of a safety thermostat realized by a traditional bi-metal on/off thermostat (either with manual or automatic reset). The thermostat switching can immediately lead the system to non-volatile lockout (signalled by a suitable error code).

Air pressure switch (APS)
864 checks the evacuation of combustion products and allows boiler ignition only if the fan is operating and the draft is regular; it also ensures the boiler safety shutdown if one of these conditions fails during operation. It is important to note that the board type 864 can also work without air pressure switch, as the boiler manufacturer may decide to disable its control via software. In this case, however, the fan speed is always kept under control (by the microcontrollers placed on the board), so that during the working cycle it can never drop below convenient safety thresholds.

Combustion products thermostat (TC)
The 864 can fit a combustion products thermostat for check combustion. It is important to note that the board

type 864 can also work without combustion product thermostat, as the boiler manufacturer may decide to disable its control via software.

Auxiliary safety thermostat (TAUX)
The board is provided with an auxiliary contact (switch on-off) that can be read and managed as safety input.

Water pressure switch (PH_2O)/ Water pressure transducer (WPT)
It ensures that the primary circuit pressure is within the required operation range. In case the pressure is too low, the temperature adjustment system cancels any heat demand.

Water differential pressure switch (FL)
The system is provided with an input which can be used both as differential pressure switch: it guarantees safety against possible circulator failures.
The switching of the device will only occur with the circulator in running state.

Demand hot water flow switch (FL DHW)/ Demand hot water flowmeter (FLUX)/ Tank thermostat (TT)
The 864 is prearranged for an input connection signalling domestic water drawing: this signal can be generated by a flow sensor (flow switch or flowmeter). Also, a thermostat for managing DHW demand from an external hot water tank can be connected instead. In all these cases the stepper motor o 3 way valve are electrically controlled by the system.

Room thermostat (RT)
The room thermostat (or chrono-thermostat) is connected to the 864 by two wires (24V); it is designed to operate with a contact isolated from the power supply line. The room thermostat can be a traditional on/off thermostat or a Opentherm® compatible thermostat such as, for example, the Brahma Encrono OT1 and OT2.

Room thermostat secondary system (TR2)
The room thermostat (or chrono-thermostat) for the secondary system (available in double-temperature mixed systems or in systems with 2 separate areas) is connected to the Mother Board, at low voltage, by means of two wires; it is prearranged for operation with a contact isolated from the mains supply.

Pump system (PUMP)
The Mother Board can be fitted to any type of circulator with 120Vac power supply, which can be controlled in a classical way (constant speed) or through "phase-shift control" (variable speed): in case the latter characteristic is selected, the system will be able to optimize the circulator control so as to make the difference (ΔT) between outgoing water temperature and return water temperature as great as possible, to the advantage of the boiler performance.

Stepper motor (STEP)
The system can also control boilers provided with a stepper motor for manage the boiler in CH mode or DWH mode. The different operation modes (stepper motor or 3 way valve) will be determined by suitable software settings. 3 way valve or stepper motor are available according to customer's requirements.

Motorized deflecting 3-ways valve (VDM)
The system can also control boilers provided with a hydraulic 3 way valve to be connected to auxiliary outputs (AUX1, AUX2), The different operation modes (stepper motor or 3 way valve) will be determined by suitable software settings. 3 way valve or stepper motor are available according to customer's requirements.

Fan (power supply and regulation) (FAN)
The system is prearranged for the use of a standard 120Vac modulating fan, supplied and controlled by means of PWM signal.
Both power supply and regulation circuits are integrated on the board. Fan is only equipped with an Hall speed sensor.
On customer demand it is possible also to use a fan with regulation electronics on board. In this case 864 system only supplies the fan with 120Vac.

Mixing valve (MIX)
The system can control an electric mixing valve connected to auxiliary outputs (AUX1, AUX2); this characteristic is useful in case of a mixed system for two areas with differentiated temperatures, i.e. a low-temperature area and a high-temperature area.

Zone pumps (ZP)/ Zone valves (ZV)
In case of a system with two separate areas at the same temperature (without mixing valve but with area pumps and/or valves), the auxiliary contacts AUX1, AUX2 can be configured to drive the related zone circulators/ valves.

Gas valve (EGV)
The system is prearranged for driving a pneumatic gas valve with air-gas ratio control at 24Vdc, Several types of valve are compatible with the board, but it is advisable to know their characteristics for a final check.

External ignition Device (IGN)
The board can drive any kind of external ignition device 120Vac-supplied. A Brahma “TSM” high-efficiency igniter can be connected.
N.B. For electrical and mechanical characteristics, please refer to the relevant Data Sheets.
N.B. On customer's request, this system can be fitted with different type of ignition device.

Serial communication RS232
The board 864 is fitted with a 8-pole connector for RS232 serial communication (type Lumberg MICS): this

characteristic is useful both to update the board software directly on the field (without necessarily disassembling the board from the boiler or disconnecting it from the power supply), or for the boiler analysis, diagnostics and settings on a remote computer connected via GSM modem or through a RS232 cable.

Serial communication RS485

The Mother Board is provided with a connector for RS485 serial communication: this characteristic is useful to connect the board in a boiler-cascade (battery) system, both in autonomous configuration (application with only 864 boards) or managed by an external Brahma CBS device.

Control board LCD

Back-lighted LCD control board fitted with 8 push-buttons to carry out any adjustment and setting, displaying information about temperatures and other digital inputs and signaling any situation of anomaly.

DEVICE ON SOLAR OPTIONAL BOARD

The Solar Optional Board is able to manage the following devices:

Solar probes (SOL probe)

The Solar Board is able to manage up to 5 PTC contact sensor whit following characteristics:
1 kΩ @ 0 ℃, α coefficient = 0.00385 $ºK^{-1}$
Measuring solar thermal system temperatures.
Operating temperature: -40℃ ÷ +250℃

Solar pumps (PUMP SOL)

The Solar Board is able to manage up to 2 circulators with 230Vac power supply, which can be controlled in a through "phase-shift control" (variable speed).

Auxiliary isolated contact (SAUX)

The Solar Board is able to manage a auxiliary isolated contacts.

OPERATING CYCLE

Starting cycle

The operating cycle starts if at least one of the following conditions is fitted and all the conditions for burner ignition are satisfied (see the description of the specific working states):

- System heating demand (by room thermostat or OpenTherm chrono-thermostat);
- Domestic hot water demand (by flow-meter signal or water flow switch or external tank probe contacts closed);
- Chimney-sweep function at the minimum or maximum working (CH) power;
- Antifreeze operation activated;
- Ignition request coming from the cascade or solar thermal application.

Ignition cycle is performed as follows:

- Fan is energized;
- When fan speed reaches the ignition speed ± 500rpm the pre-purge time TW starts to be counted;
- At the end of the pre-purge time TW, the gas valve is supplied, the ignition device is started and the safety time TS begins, during which the fan speed (and the burner capacity) is kept at the ignition value;
- If no flame signal is detected within the safety time TS, the gas valve is closed and the ignition device inhibited. If the total number of available ignition attempts has not run out yet, the system performs an inter-purge time TIW at the inter-purge fan speed, then a new TW/TS cycle starts again, turning back fan speed at ignition value;
- Otherwise, if the total number of available ignition attempts has run out, a safety shutdown occurs and the board lock-out condition is generated;
- To restore normal system operation, the corresponding push-button (RESET) must be pressed: if hot water demand still occurs, the boiler starts a new ignition cycle (with one or more ignition attempts); if the conditions leading to lock-out still occur, after using all available ignition attempts the boiler will go back to lockout;
- If a flame signal is detected during TS, the system inhibits the ignition device at the end of TS and the burner flame modulates in order to reach the same water temperature as the preset value (running stage);
- The running stage continues until either heat demand stops, or one of the safety devices switches on, or the flame extinguishes;
- On accidental flame extinguishing during operation, the device carries out one or more re-ignition attempts (depending on the options selected); if these attempts do not succeed, lock-out occurs;
- After performing a safety shutdown or after heat demand stops, the device continues supplying the fan at the post-purge speed for a post-purge time: this behavior is useful to help the evacuation of humid vapors and prevent moisture from invading or damaging the fan driving circuit.

WORKING STATES

- The board, depending on the actual system conditions, can perform the following working states (ordered by priority, highest to lowest):
- OFF state (OFF operating mode);
- Anti-Legionella state (WINTER or SUMMER operating modes);
- Domestic hot water state DHW (WINTER or SUMMER operating modes);
- Chimney-sweep state (WINTER or SUMMER operating modes);
- Central heating state CH (only WINTER operating mode);
- Antifreeze state (OFF or WINTER operating modes);

DHW STATE

Ignition demand in DHW state has priority over ignition demand in heating state, in order to ensure a higher comfort to the user needing domestic hot water. In order to serve a DHW request, system must be set into SUMMER or WINTER operating mode.

Boiler with instantaneous DHW system – flow switch

- Access to DHW state occurs when domestic hot water is drawn: in this case the flow switch contact is CLOSED.
- Access to DHW state terminates when domestic hot water flow is stopped: in this case the flow switch contact is OPEN.
- System circulator: ON, always at the maximum speed (regardless of any setting about pump modulation). When DHW mode terminates, pump is immediately stopped.
- Stepper motor o 3 way valve: turns deflecting valve into DHW position.
- When DHW mode terminates, stepper motor holds the deflecting valve into DHW position.
- Fan: when running stage is reached, as described in the “Operating cycle” section, the thermo-regulation process begins: the PID algorithm modulates fan speed between its minimum and maximum values.
- Conditions for the ignition cycle to start: DHW probe temperature ≤ DHW set-point + switch-on offset.
- Conditions for the ignition cycle to stop: DHW probe temperature ≥ DHW set-point + switch-off offset.
- System modulates burner power (fan speed) for DHW probe to reach and maintain the set-point value.

Notes:

The system monitors the primary heating circuit temperature constantly, and will turn the burner off if the temperature detected by the outgoing water (CH) probe is higher than the maximum temperature allowed. The burner is turned on again in case the outgoing water temperature drops below the maximum temperature allowed and the ignition condition described below is still satisfied.

Boiler with instantaneous DHW system – flow-meter

- Access to DHW state occurs when domestic hot water is drawn and flow-meter detects a domestic water flow higher than the minimum allowed (1.5 l / min).
- Access to DHW state terminates when domestic hot water flow is stopped and flow-meter detects a domestic water flow lower than the minimum allowed (1.3 l / min).
- System circulator: ON, always at the maximum speed (regardless of any setting about pump modulation). When DHW mode terminates, pump is immediately stopped.
- Stepper motor or 3 way valve: turns deflecting valve into DHW position. When DHW mode terminates, stepper motor holds the deflecting valve into DHW position.
- Fan: when running stage is reached, as described in the “Operating cycle” section, the thermo-regulation process begins: the PID algorithm modulates fan speed between its minimum and maximum values.
- Conditions for the ignition cycle to start: DHW probe temperature ≤ DHW set-point + switch-on offset.
- Conditions for the ignition cycle to stop: DHW probe temperature ≥ DHW set-point + switch-off offset.
- System modulates burner power (fan speed) for DHW probe to reach and maintain the setpoint value.

Notes:

The system monitors the primary heating circuit temperature constantly, and will turn the burner off if the temperature detected by the outgoing water (CH) probe is higher than the maximum temperature allowed The burner is turned on again in case the outgoing water temperature drops below the maximum temperature allowed and the ignition condition described below is still satisfied.

Boiler with external DHW tank and tank thermostat

- Access to DHW state occurs when tank thermostat contact is CLOSED.
- Access to DHW state terminates when tank thermostat contact is OPEN.
- System circulator: ON, always at the maximum speed (regardless of any setting about pump modulation). When DHW mode terminates, pump is immediately stopped.
- Stepper motor: turns deflecting valve into DHW position. When DHW mode terminates, stepper motor holds the deflecting valve into DHW position.
- Fan: when running stage is reached, as described in the “Operating cycle” section, the thermo-regulation process begins: the PID algorithm modulates fan speed between its minimum and maximum values.
- Conditions for the ignition cycle to start: CH probe temperature ≤ 75℃.
- Conditions for the ignition cycle to stop: CH probe temperature ≥ 85℃.
- System modulates burner power (fan speed) for CH probe to reach and maintain the 80℃ value.

Boiler with external DHW tank and DHW probe

- Access to DHW state occurs when DHW probe temperature ≤ DHW set-point – switch-on offset.
- Access to DHW state terminates when DHW probe temperature ≥ DHW set-point + switch-off offset.
- System circulator: ON, always at the maximum speed (regardless of any setting about pump modulation). When DHW mode terminates, pump is immediately stopped.

- Stepper motor: turns deflecting valve into DHW position. When DHW mode terminates, stepper motor holds the deflecting valve into DHW position.
- Fan: when running stage is reached, as described in the “Operating cycle” section, the thermo-regulation process begins: the PID algorithm modulates fan speed between its minimum and maximum values.
- Conditions for the ignition cycle to start: CH probe temperature ≤ 75℃.
- Conditions for the ignition cycle to stop: CH probe temperature ≥ 85℃.
- System modulates burner power (fan speed) for CH probe to reach and maintain the 80℃ value.

HEATING SATE (primary system)

This boiler operation mode is only possible if the installer has set the primary system at "fixed set-point" and if the user decides to set the system in WINTER mode, in this case, on switching-on of the room thermostat, if the outgoing water temperature is lower than the preset set-point, the boiler will carry out an ignition cycle, and flame modulation will begin until the boiler reaches the running condition. If the outgoing water temperature of the primary system is 5℃ (3℃ for low-temperature system) higher than the set-point preset by the user, the boiler will switch off; re-ignition occurs as soon as the water temperature drops of 5°C (3℃ for low-temperature system) below the preset value.

If the user sets the boiler in SUMMER mode, any heat demand by the room thermostat will be disregarded (the DHW system only will be controlled).

Instead, if the installer sets the primary system so as to exploit "temperature compensation", the above-described mode will not be followed, and the system will operate as described in the below paragraph **"Shifting temperature" mode (primary system).** In case of a board controlling a variable speed circulator (i.e. phase-shift controlled), when the boiler reaches the running condition and modulates the flame, at the same time the circulator speed is suitably modified so as to reach the temperature of 55° C on the return water probe, in order to help the production of condensation.

Circulator overrun (primary system)

Every time the boiler switches off, the circulator keeps on running for a short time, which can be set upon request, in order to lower the water temperature in the heat exchanger.

"Shifting temperature” mode (primary system)

When the external probe is installed and the primary system is set so as to exploit "climatic compensation" the temperature adjustment system works in "shifting temperature" mode, i.e. the primary heating system outgoing water temperature is adjusted according to the outside climatic conditions, in order to ensure a high comfort and energy saving during the whole year.

In particular, on outside temperature increase, the system outgoing water temperature is decreased according to a "**compensation curve**", which can be set by adjusting the corresponding parameters. With reference to the diagram compensation curve, CH set-point is calculated by the system using the following formula:

CH setpoint =
(T_{ROOM1}– External probe temperature) * K_1 + T_{ROOM1}.

Where:
CH setpoint is the calculated setpoint for CH probe
K_1 is the dispersion coefficient.
T_{ROOM1} is the desired room temperature.

HEATING STATE (secondary system)

In order for this operation mode to be available, it is necessary first to set a "fixed set-point" secondary system as available, and then to decide if this is a "mixed" system (fitted with mixing valve) or a system for "separate areas": in fact, according to these indications, the boiler behaviour will change considerably.

System for separate areas → if the user decides that the system must be in WINTER state, heat demands can come from both systems indifferently (and independently), but the heat demand of the system having priority (higher temperature) will be fulfilled first. Consequently, if both heating demands are active, the setpoint followed by CH probe will be the highest between the two setpoint. For the rest, heat demand coming from one of the systems can be fulfilled as already described in the previous paragraph “Heating mode primary system”.

If the user sets the boiler in SUMMER mode, any heat demand by the room thermostat will be disregarded (the DHW system only will be controlled).

System with mixing valve → if the user decides that the system must be in WINTER state, heat demands can come from both systems indifferently (and independently), but the heat demand of the system having priority (higher temperature) will be fulfilled first. Consequently, if both heating demands are active, the setpoint followed by CH probe will be the highest between the two setpoint. For the rest, heat demand coming from one of the systems can be fulfilled as already described in the previous paragraph “Heating mode primary system”.

At the same time, when low-temperature room thermostat is closed, the boiler will start modulating the mixing valve opening or closing in order to obtain the desired temperature on the low-temperature zone. If the secondary system outgoing water temperature exceed of more than 2℃ the set-point preset by the user, the greater the difference between required temperature and measured temperature, the quicker the system will shut off the valve; the valve opens again as soon as the water temperature drops of more than 2℃ below the preset value.

"Shifting temperature” mode (secondary system)

When the external probe is installed and the secondary system is set so as to exploit "climatic compensation" the temperature adjustment system works in "shifting temperature" mode, i.e. the secondary heating system

outgoing water temperature is adjusted according to the outside climatic conditions, in order to ensure a high comfort and energy saving during the whole year.
In particular, on outside temperature increase, the system outgoing water temperature is decreased according to a "**compensation curve**", which can be set by adjusting the corresponding parameters. With reference to the diagram compensation curve. CH set-point is calculated by the system using the following formula:

CH setpoint =
(T_{ROOM2}– External probe temperature) * K_2 + T_{ROOM2}.

Where:
CH setpoint is the calculated setpoint for secondary system (CH probe)
K_2 is the dispersion coefficient for secondary system.
T_{ROOM2} is the desired room temperature for the secondary system.

ANTIFREEZE STATE
When the primary system outgoing water temperature drops below 8℃, the circulator is started; if the outgoing water temperature decreases down 5℃, the boiler will start at minimum CH power. The burner and the pump (after a post-circulation interval) stop only when CH probe temperature increases over 20℃.
The antifreeze operates in even if the boiler is in OFF position.

CHIMNEY-SWEEP STATE
When the user switches on the "chimney-sweep" function at maximum heat capacity, the boiler works at the maximum CH heating power. Instead, when user switches on the "chimney-sweep" function at minimum heat capacity, the boiler works at the minimum (CH and DHW) power.
The chimney-sweep function stops if:
- Key EXIT is pressed;
- DHW request occurs;
- CH probe temperature ≥ Maximum CH set-point;

In order to serve a chimney-sweep request, system must be set into WINTER or SUMMER operating modes.

OTHER CHARACTERISTICS
Other functions are related to the system safeguard:
- Circulator lockout prevention → if the boiler has not carried out any ignition cycle within a given period of time (usually 24 hours), the circulator will switch on for 30 seconds approximatively to avoid lockout due to protracted non-operation.

PARAMETERS SETTING MODE
Through the setting of parameters on 864 board users, installers or manufacturers can configure the system.
The parameters menu is divided into specific submenu.

01 - Boiler menu (“Boil”)
This menu allows to set all the boiler parameters (climatic compensation configuration, pump configuration, fan speed configuration, burner operating cycle timings, temperatures ranges and offsets).

02 - OEM menu (“OEM”)
This menu (available only for manufacturer) allows to set some advanced parameters in the boiler, like the PID algorithm constants for the fan or the CH / DHW operations.

03 - Configuration menu (“Conf”)
This menu allows setting the system typology, i.e. CH configuration (CH mode available / not available, low or high temperature operation), DHW configuration (DHW mode available / not available, instantaneous DHW or external tank DHW, request by flow switch with on-off information or by Hall impulses flow-meter), cascade system configuration and solar system configuration.

04 - Secondary system menu (“Sec”)
This menu allows setting the parameters related to the secondary system configuration.

05 - Cascade menu (“Casc”)
This menu allows setting the parameters related to the cascade system configuration.

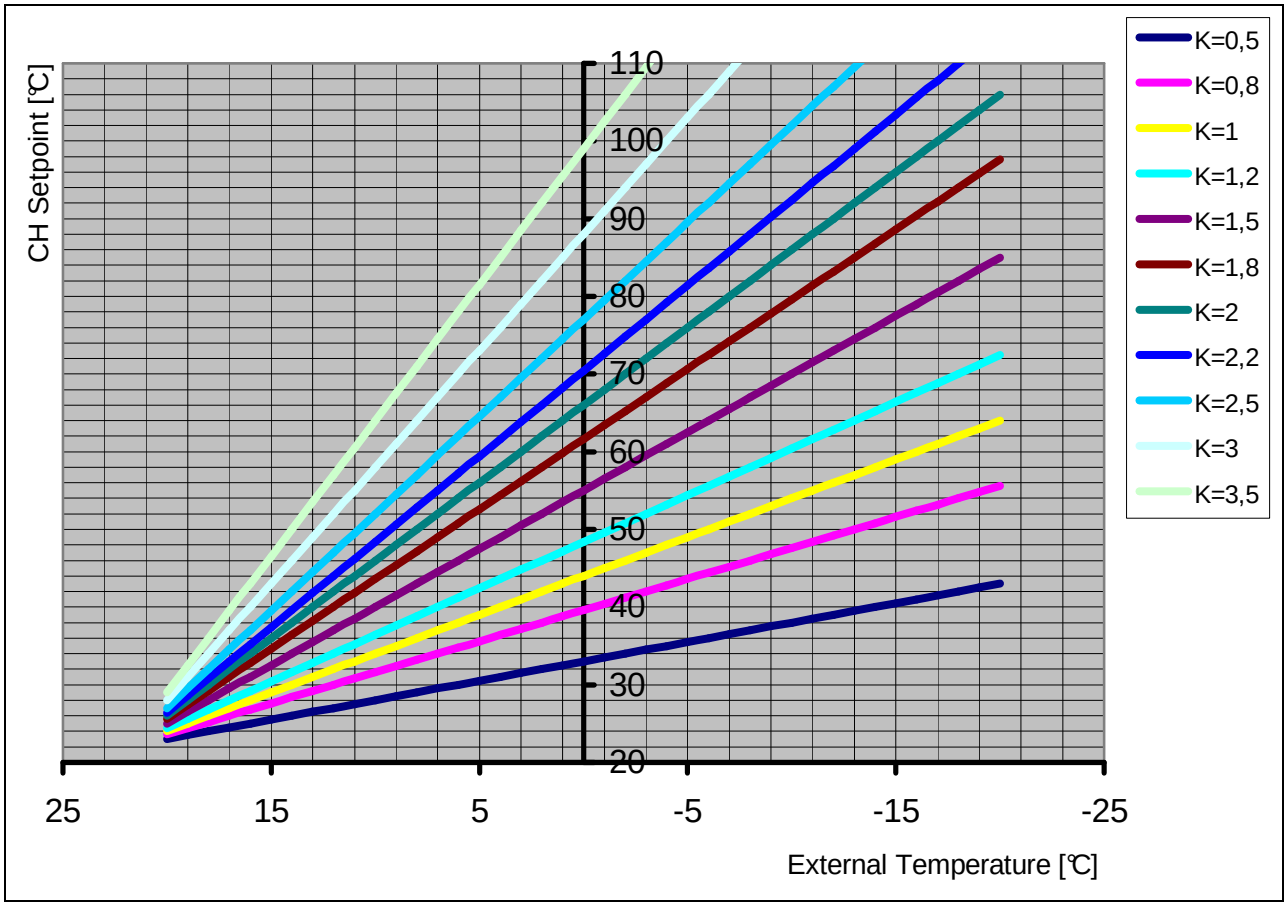
06 - Solar operations menu (“Sun”)
This menu allows setting the parameters related to the solar thermal system configuration.

07 - Connections menu (“Conn”)
This menu (available only for manufacturer) allows to select / deselect all the boiler devices. These parameters are automatically configured by setting parameters in other menus (for example, setting CH mode available in menu 01 will automatically set parameter 01 = 1); anyway, through these parameters each single device in the boiler can be forced to be considered or not by the system.

The parameters setting modes can be customized on customer's request. For more information on parameters setting mode you can see, the relevant 864 technical datasheet.

ANOMALIES
The board can detect and display all the anomalies affecting the system. Anomalies are displayed with the notation “Err. xx.yy”, where “xx” is the general error code (a family of anomalies inherent to a specific device or part of the system) and “yy” is the detailed error code.

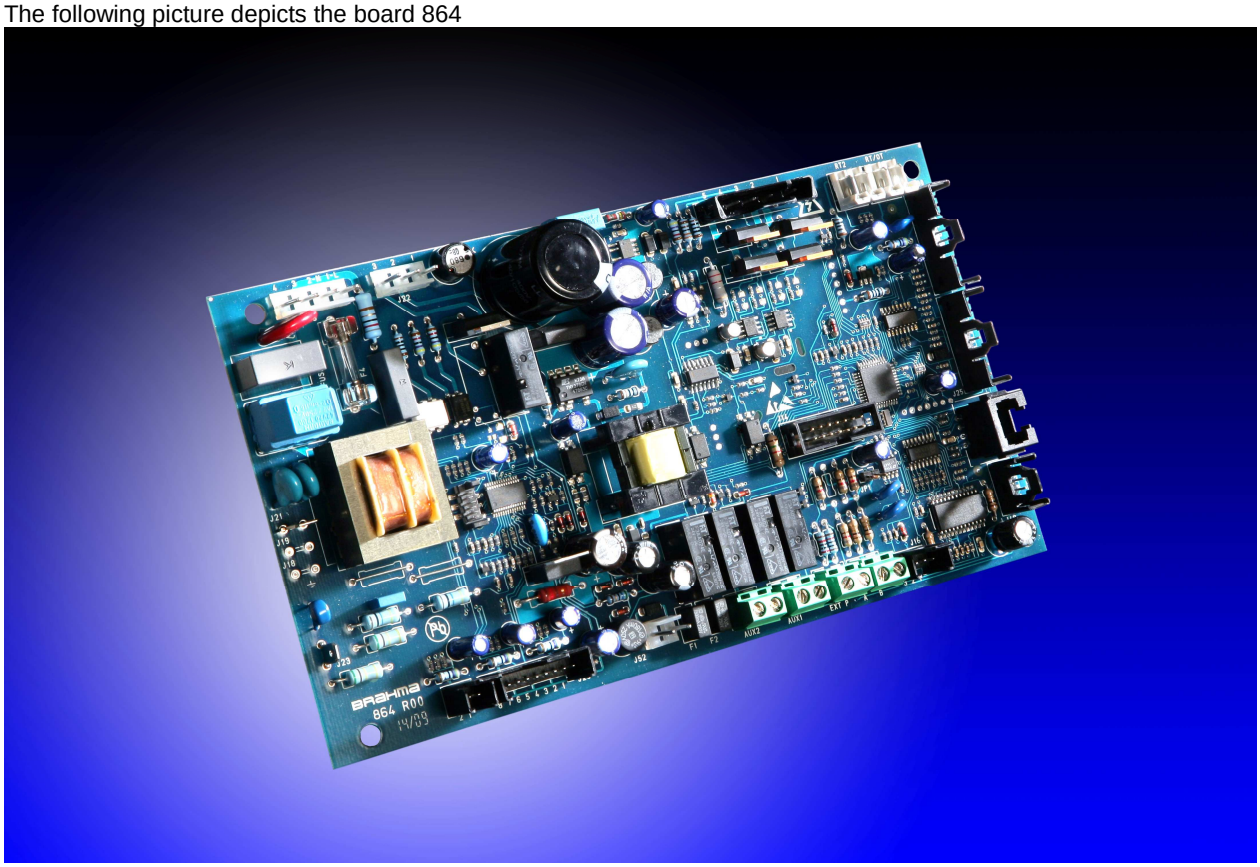
COMPENSATION CURVE



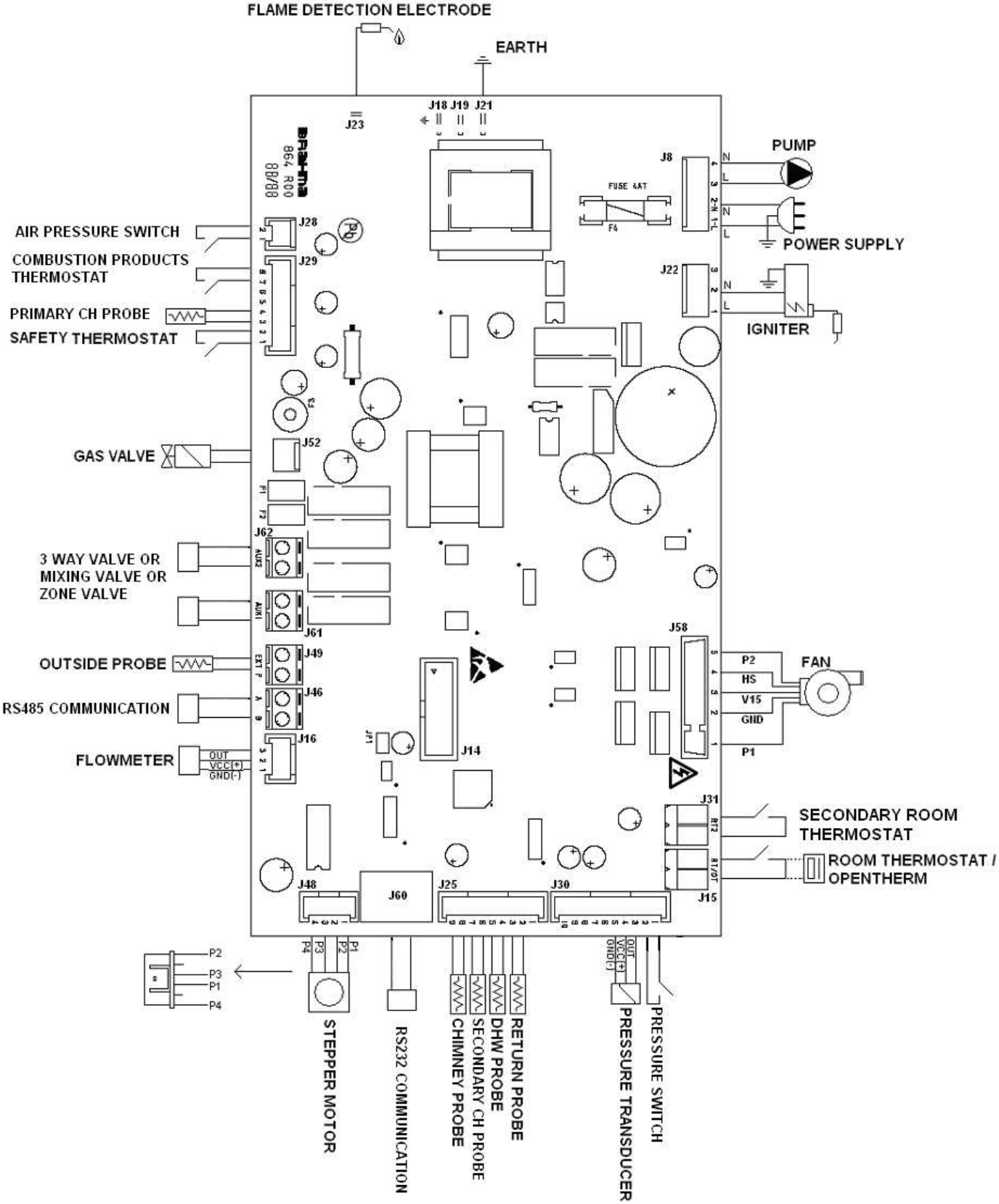
CH setpoint = (T_{ROOM} – External probe temperature) * K + T_{ROOM}

PRODUCT PICTURE

The following picture depicts the board 864



WIRING & CONTACTS
Diagram



Legend

Power supply

Description:	Electric board main power supply.	
Contacts:	Connector:	**J8**
	Type:	Molex 4 poles
	Pin:	1. L: Live
		2. N: Neutral
Voltage:	High (120 VAC)	

Pump (PUMP)

Description:	Boiler internal pump, whole (120 VAC) or phase-cut power supply.	
Contacts:	Connector:	**J8**
	Type:	Molex 4 poles
	Pin:	3. L: Live
		4. N: Neutral
Voltage:	High (120 VAC)	

Control board LCD

Description:	Back-lighted LCD control board fitted with 8 push-buttons to carry out any adjustment and setting, displaying information about temperatures and other digital inputs and signaling any situation of anomaly.	
Contacts:	Connector:	**J14**
Voltage:	Low (5 VDC)	

Room thermostat (RT)/ OpenTherm (TA)

Description:	Room thermostat signaling primary system heating demand. It is prearranged for operation with a contact isolated from the mains supply. Also, connection for an OpenTherm-compatible remote chronothermostat (e.g. BRAHMA ENCRONO OT1/OT2).	
Contacts:	Coonector:	**J15**
	Type:	Stelvio CUM 2 poles
	Pin:	1. Room thermostat contact (24 VDC) / OpenTherm connection
		2. Room thermostat contact (GND) / OpenTherm connection
Voltage:	Low (5 VDC)	

Demad hot water flowmeter (FLUX)

Description:	Connection signaling domestic hot water drawing (flow rate information by means of a Hall sensor turbine).	
Contacts:	Connector:	**J16**
	Type:	Lumberg 2,5 MSF 3 poles
	Pin:	1. GND
		2. 5 VDC
		3. Input signal
Voltage:	Low (5 VDC)	

Demand hot water flow switch (FL DHW)

Description:	Contact signaling domestic hot water drawing.	
Contacts:	Connector:	**J16**
	Type:	Lumberg 2,5 MSF 3 poles
	Pin:	1. GND
		3. Input signal
Voltage:	Low (5 VDC)	

Tank thermostat (TT)

Description:	Thermostat for managing DHW heating demand from an external hot water tank.	
Contacts:	Connector:	**J16**
	Type:	Lumberg 2,5 MSF 3 poles
	Pin:	1. GND
		3. Input signal
Voltage:	Low (5 VDC)	

Earth

Description: Board Earth connection.

Contacts: Connector: **J18, J19, J21**

Type: Faston 6,3x0,8

Ignitor device (IGN)

Description: High efficiency electronic ignition transformer.

Contacts: Connector: **J22**

Type: Molex 3 poles

Pin: 1. L: Live

2. N: Neutral

Voltage: High (120 VAC)

Flame detection electrode (FLAME)

Description: Flame detection electrode connection.

Contacts: Connector: **J23**

Type: Faston 4,8x0,8

Voltage: High (150 VAC)

Return probe (RT probe)

Description: NTC immersion sensor (10 KΩ @ 25 ℃, β coefficient = 3435) measuring the temperature of the CH circuit return water.

Contacts: Connector: **J25**

Type: Lumberg 2,5 MSF 9 poles

Pin: 2. Input signal

3. GND

Voltage: Low (5 VDC)

Demand hot water probe (DHW probe)

Description: NTC immersion sensor (10 KΩ @ 25 ℃, β coefficient = 3435) measuring the temperature of the sanitary exchanger outgoing water (instantaneous DHW) or the storage tank water (external tank DHW).

Contacts: Connector: **J25**

Type: Lumberg 2,5 MSF 9 poles

Pin: 4. Input signal

5. GND

Voltage: Low (5 VDC)

Heating probe secondary system (CH2 probe)

Description: NTC immersion sensor (10 KΩ @ 25 ℃, β coefficient = 3435) measuring the temperature of the secondary low-temperature CH system.

Contacts: Connector: **J25**

Type: Lumberg 2,5 MSF 9 poles

Pin: 6. Input signal

7. GND

Voltage: Low (5 VDC)

Chimney probe (CP probe)

Description: NTC contact sensor (20 KΩ @ 25 ℃) measuring the temperature of the primary exchanger combustion products.

Contacts: Connector: **J25**

Type: Lumberg 2,5 MSF 9 poles

Pin: 8. Input signal

9. GND

Voltage: Low (5 VDC)

Air pressure switch (APS)

Description: Air pressure switch contact to check the correct evacuation of combustion products

Contacts: Connector: **J28**

Type: Lumberg 2,5 MSF 8 poles
Pin: 1. 5 VDC
2. Input signal
Voltage: Low (5 VDC)

Safety thermostat (TS)
Description: Safety thermostat to make the system perfectly safe against possible overheating in the primary circuit.
Contacts: Connector: **J29**
Type: Lumberg 2,5 MSF 8 poles
Pin: 1. Input signal
2. 5 VDC
Voltage: Low (5 VDC)

Central heating probe (CH probe)
Description: NTC immersion sensor (10 KΩ @ 25 ℃, β coefficient = 3435) measuring the temperature of the primary system outgoing water.
Contacts: Connector: **J29**
Type: Lumberg 2,5 MSF 8 poles
Pin: 3. Input signal
4. 5 VDC
Voltage: Low (5 VDC)

Auxiliary safety contact (TAUX)
Description: Auxiliary contact that can be read and managed as safety input.
Contacts: Connector: **J29**
Type: Lumberg 2,5 MSF 8 poles
Pin: 5. Input signal
6. 5 VDC
Voltage: Low (5 VDC)

Combustion products discharge thermostat (TC)
Description: Thermostat to make the system perfectly safe against possible overheating of the combustion products.
Contacts: Connector: **J29**
Type: Lumberg 2,5 MSF 8 poles
Pin: 7. Input signal
8. 5 VDC
Voltage: Low (5 VDC)

Water pressure switch (PH_2O)
Description: By means of this device, the board constantly ensures a correct pressure in the system itself.
Contacts: Connector: **J30**
Type: Lumberg 2,5 MSF 10 poles
Pin: 1. 5 VDC
2. Input signal
Voltage: Low (5 VDC)

Water pressure transducer (WPT)
Description: By means of this device, the board calculates, displays and controls the water pressure in the primary water circuit, thus ensuring a constantly correct pressure in the system itself.
Contacts: Connector: **J30**
Type: Lumberg 2,5 MSF 10 poles
Pin: 3. Input signal
4. 5 VDC
5. GND
Voltage: Low (5 VDC)

Water differential pressure switch (FL)
Description: By means of this device, the board constantly ensures the correct water circulation on the system against any pump failure.
Contacts: Connector: **J30**
Type: Lumberg 2,5 MSF 10 poles

Pin: 3. Input signal
4. 5 VDC
Voltage: Low (5 VDC)

Room thermostat secondary system (RT2)

Description: Room thermostat signaling secondary system heating demand. It is prearranged for operation with a contact isolated from the mains supply.
Contacts: Connector: **J31**
Type: Stelvio CUM 2 poles
Pin: 1. 24 VDC
2. GND
Voltage: Low (5 VDC)

Serial communication RS485

Description: Connection with an external cascade system (Brahma CBS device or 864 boards) via RS485 communication
Contacts: Connector: **J46**
Type: Screw 2 poles
Pin: 1. RS485 communication - “B” signal
2. RS485 communication - “A” signal
Voltage: Low (5 VDC)

Stepper motor (STEP)

Description: Linear step actuator for controlling DHW operations.
Contacts: Connector: **J48**
Type: Lumberg 2,5 MSF 4 poles
Pin: 1. P1: Phase coil 1, terminal A
2. P2: Phase coil 2, terminal A
3. P3: Phase coil 2, terminal B
4. P4: Phase coil 1, terminal B
Voltage: Low (24 VDC)

Outside probe (EXT probe)

Description: NTC contact sensor (10 KΩ @ 25 ℃, β coefficient = 3435) measuring outside temperature.
Contacts: Connector: **J49**
Type: Screw 2 poles
Pin: 1. GND
2. Input signal
Voltage: Low (5 VDC)

Gas valve (EGV)

Description: Gas valve with air-gas ratio control.
Contacts: Connector: **J52**
Type: Molex 2 poles
Pin: 1. V26: EVG voltage supply 24 VDC
2. GND: Board low voltage reference
Voltage: Low (24 VDC)

Fan power supply and driver (FAN)

Description: Modulating fan supplied and controlled by means of PWM signal.
Contacts: Connector: **J58**
Type: Stocko 5 poles
Pin: 1. P1: Phase coil 1 (end winding)
2. GND: Board low voltage reference (–)
3. V15: Hall sensor voltage supply 15VDC (+)
4. HS: Hall sensor output signal (Out)
5. P2: Phase coil 2 (beginning winding)
Voltage: High (150 VDC) - Coils
Low (15 VDC) - Hall sensor

Serial communication RS232

Description: GSM modem or RS232 cable for the connection with a remote PC for the analysis, diagnostic and parameters setting of the boiler.

Contacts: Connector: **J60**
Type: SOCKET 8 poles
Pin: 2. 5 VDC
3. GND
6. TX signal
7. RX signal

Voltage: Low (5 VDC)

Zone pump 1 (ZP1)

Description: Contact for supplying the primary external pump in a separate zones system.

Contacts: Connector: **J61**
Type: Screw 2 poles
Pin: 1. L: Live (Input)
2. L: Live (Output)

Voltage: High (120 VAC)

Zone pump 2 (ZP2)

Description: Contact for supplying the secondary external pump in a separate zones system.

Contacts: Connector: **J62**
Type: Screw 2 poles
Pin: 1. L: Live (Input)
2. L: Live (Output)

Voltage: High (120 VAC)

Mixing valve (MIX)

Description: Contact for supplying the open/close ways of a mixing valve in a separate zones system with different temperatures.

Contacts: Connector: **J61**
Type: Screw 2 poles
Pin: 1. L: Live (Input)
2. Open: Live for the open way of the mixing valve (Output)
Connector: **J62**
Type: Screw 2 poles
Pin: 1. L: Live (Input)
2. Close: Live for the open way of the mixing valve (Output)

Voltage: High (120 VAC)

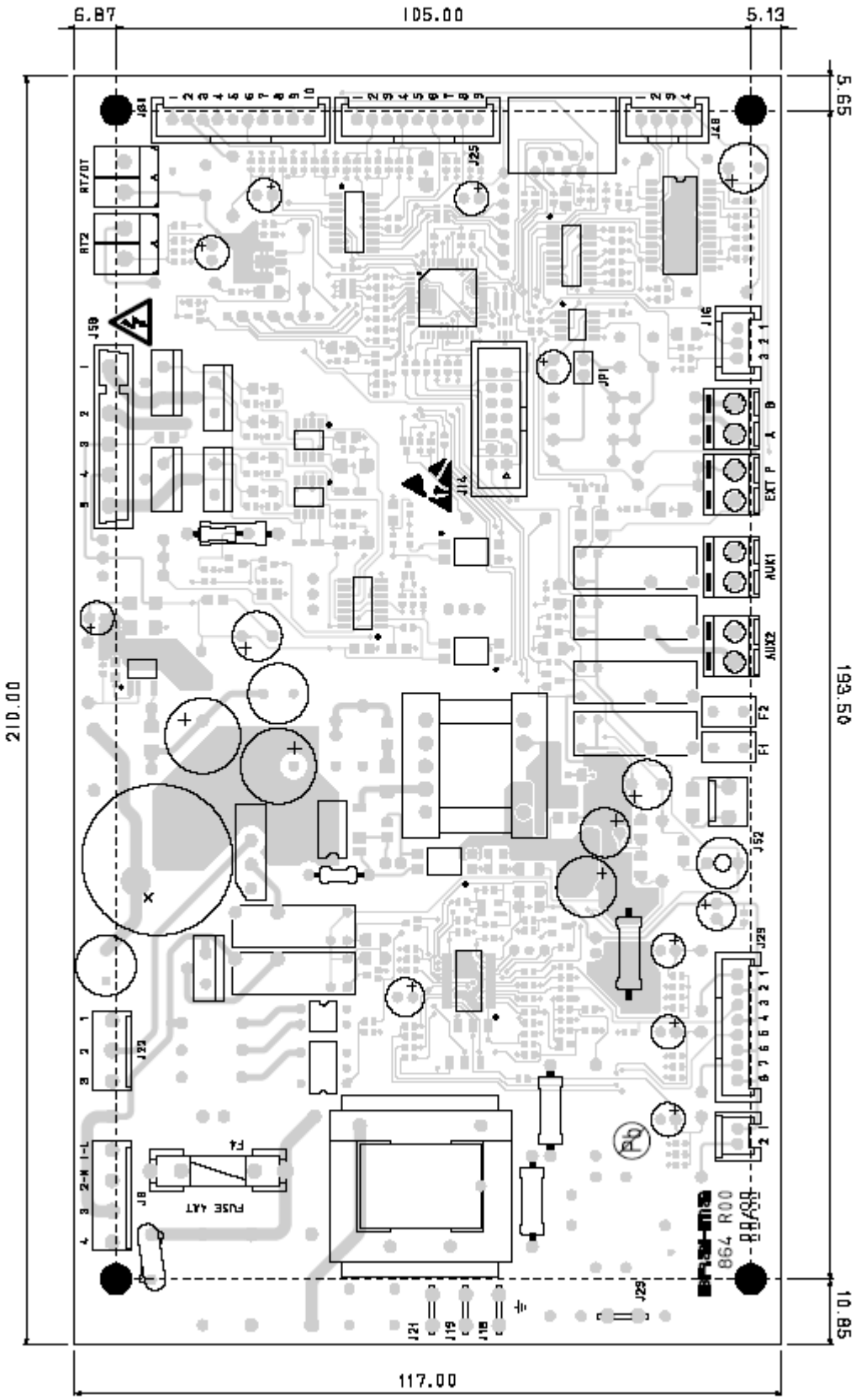
Motorized deflecting 3-ways valve (VDM)

Description: Contact for supplying the open/close ways of an electrical 3-ways valve in DHW operations.

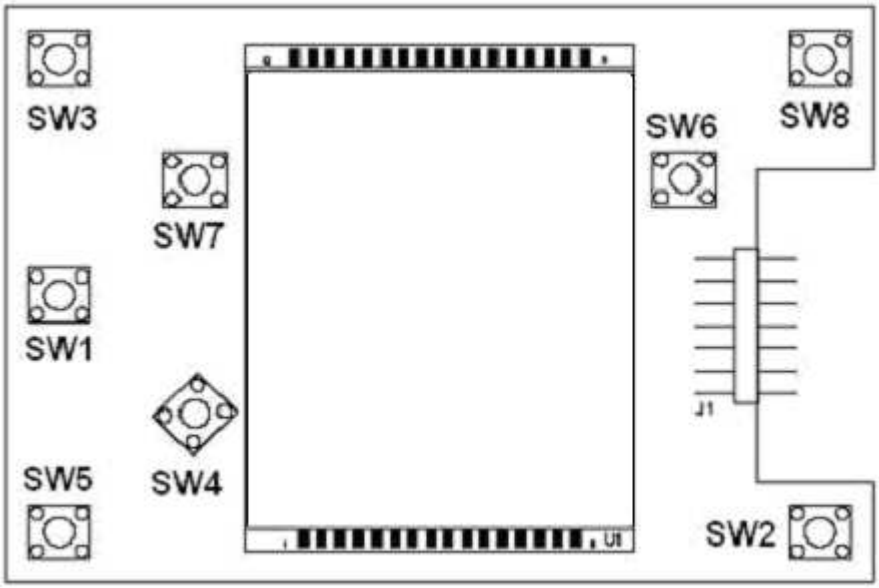
Contacts: Connector: **J61**
Type: Screw 2 poles
Pin: 1. L: Live (Input)
2. CH: Live for the CH way of the 3-ways valve (Output)
Connector: **J62**
Type: Screw 2 poles
Pin: 1. L: Live (Input)
2. DHW: Live for the DHW way of the 3-ways valve (Output)

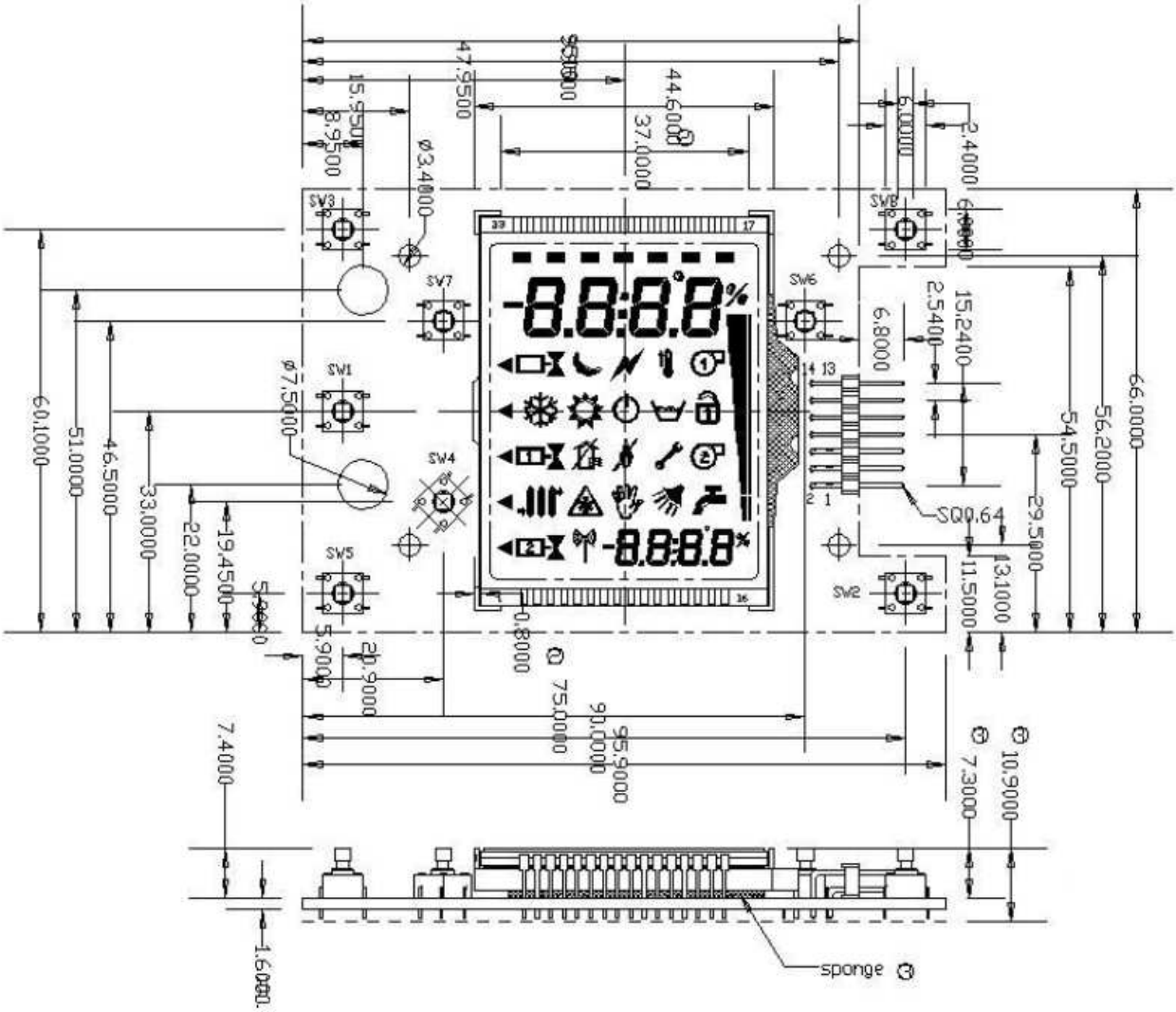
Voltage: High (120 VAC)

Dimensions

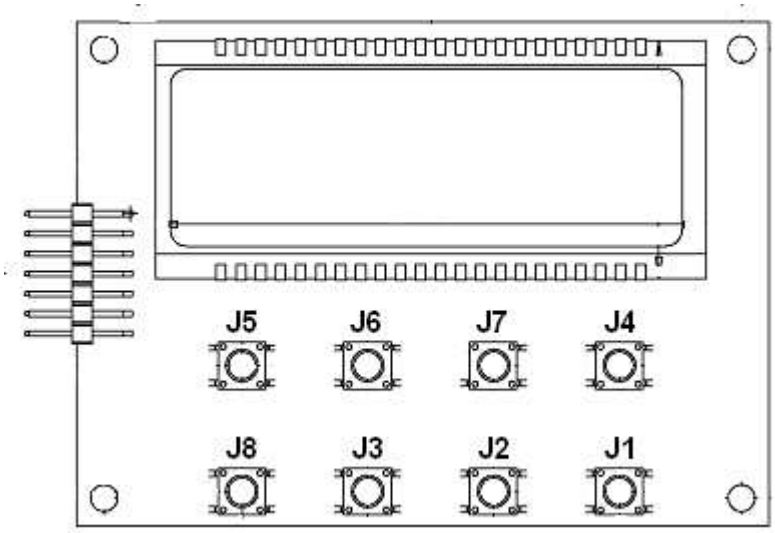

6.87
105.00
5.13
5.65
210.00
193.50
10.85
117.00
J31
J25
J48
RT/DT
RT2
J59
J16
JP1
J14
EXT P
AUX1
AUX2
F2
F1
J52
J29
J22
J8
F4
FUSE 4AT
J21
J19
J18
J29
864 R00

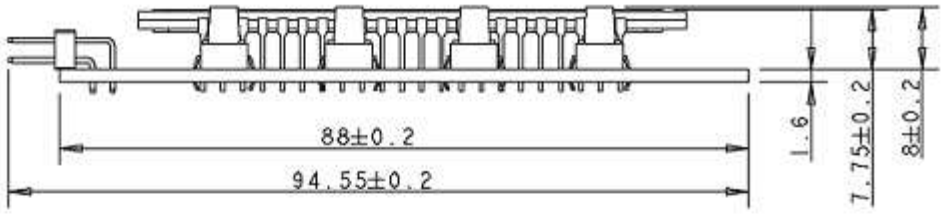
CONTROL BOARDS
Control board LCD1

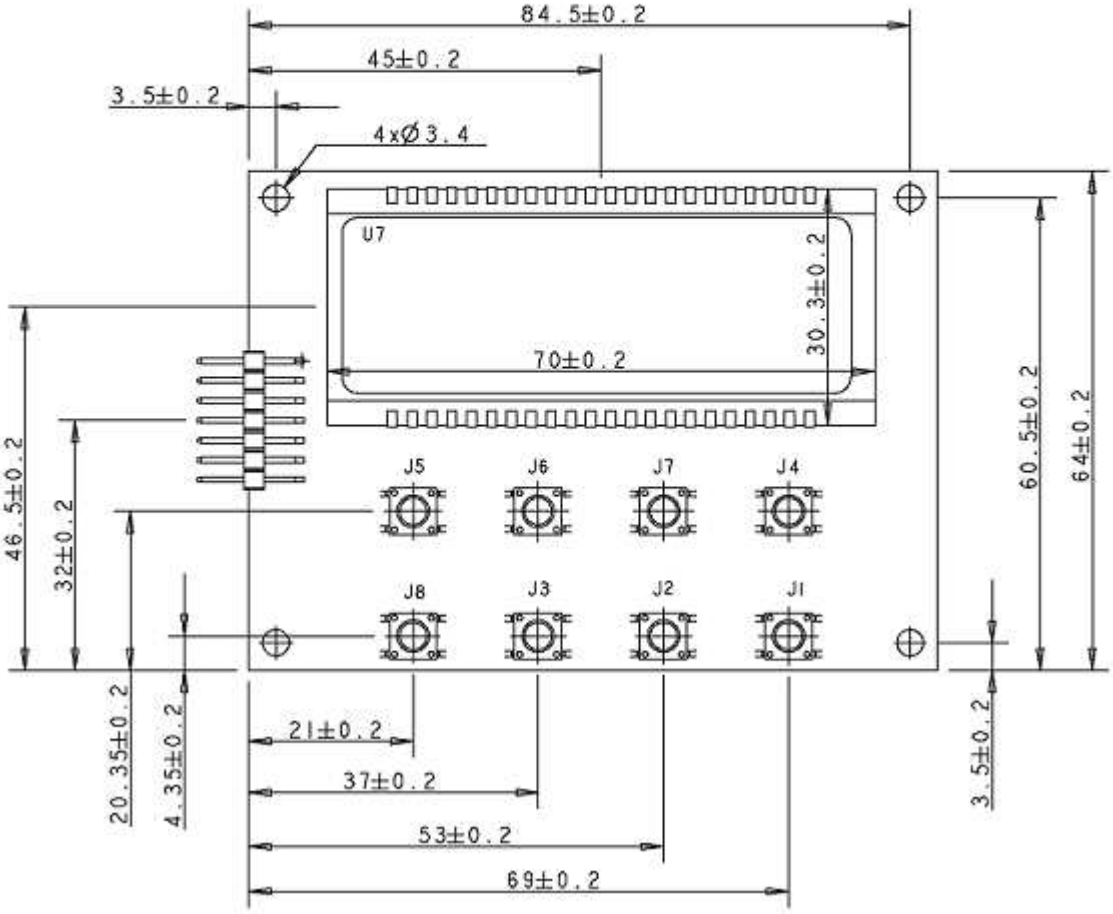




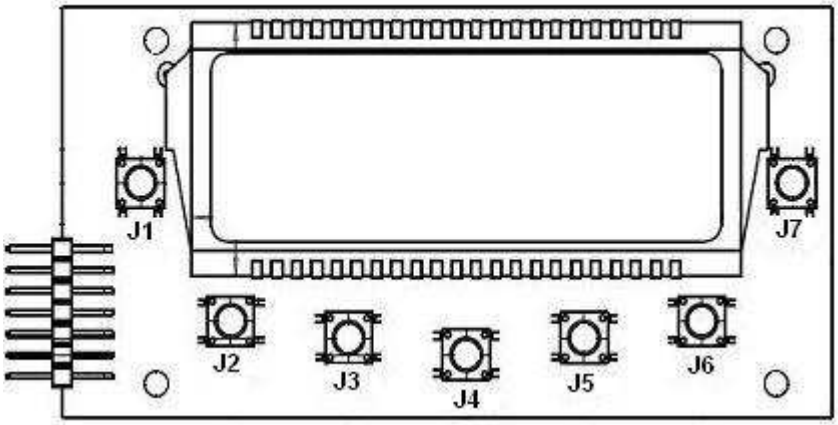
Control board LCD2

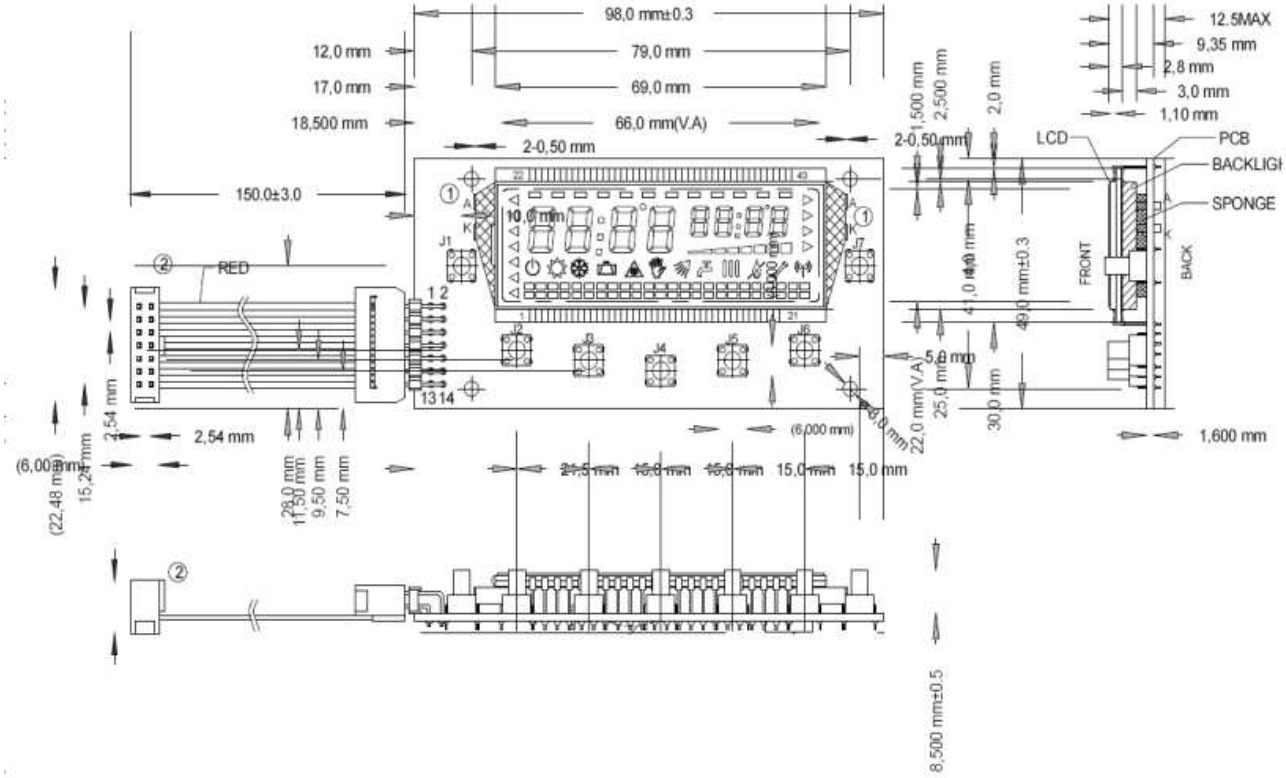




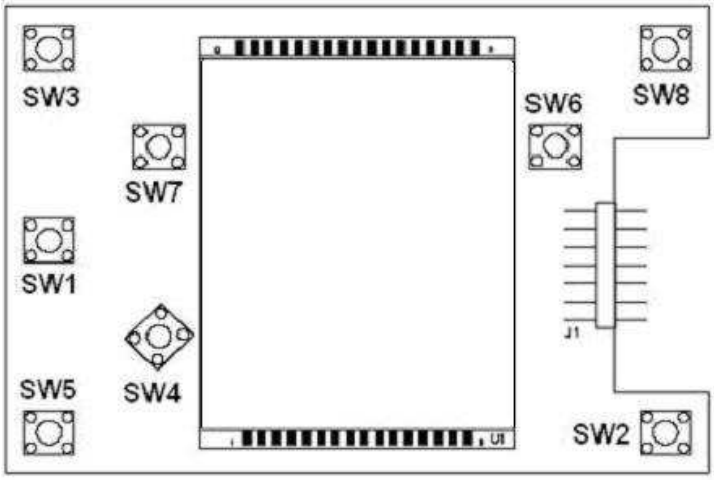


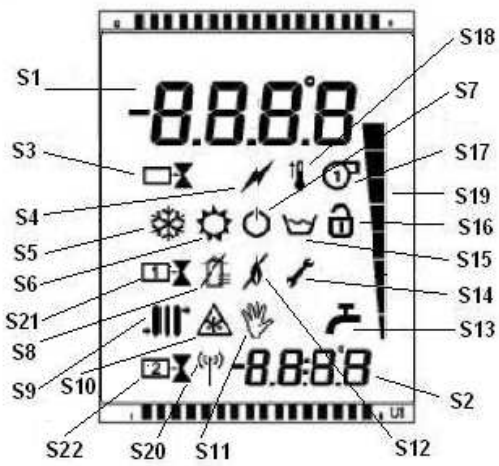
Control board LCD4





Settings and visualizations





BUTTONS
SW1: Show / Increase CH setpoint / Increase parameter index
SW2: Reset from non-volatile lockout
SW3: Show / Increase DHW setpoint / Increase parameter value
SW4: Show / Decrease DHW setpoint / Decrease parameter index
SW5: LCD Backlight / Exit
SW6: Menu access / Show device info
SW7: Show / Decrease CH setpoint / Decrease parameter index
SW8: Menu access / Show device info

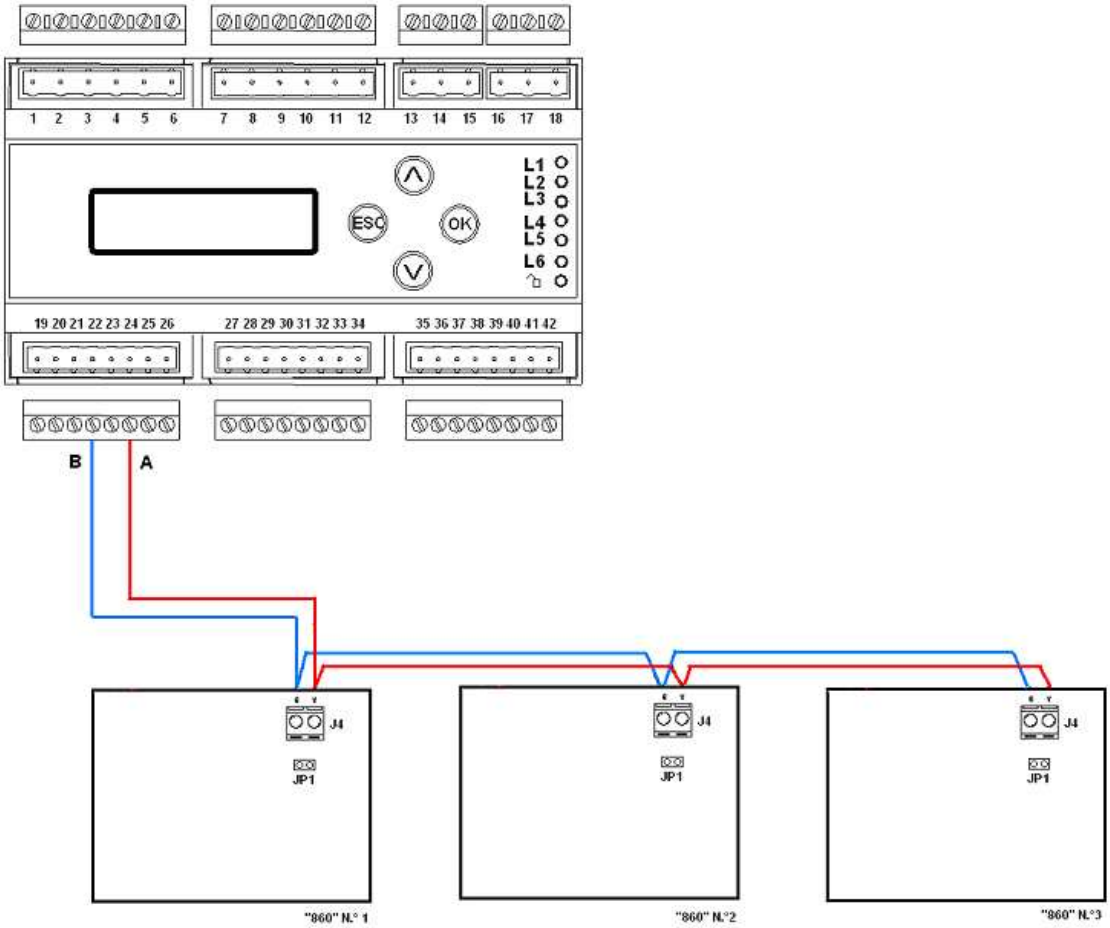
VISUALIZATIONS
S1: Probes temperature value
S2: Water pressure value
S3: Gas valve
S4: Igniter
S5: Winter operative mode
S6: Summer operative mode
S7: OFF operative mode
S8: Chimney-sweep state
S9: Central Heating request state
S10: Antifreeze state
S11: Parameters setting menu
S12: Flame detected or flame lack
S13: Domestic hot water state
S14: Boiler anomaly
S15: Water pressure switch / transducer
S16: Password for parameters menu
S17: Fan
S18: Probes temperature
S19: Modulation bar
S20: Opentherm communication
S21: Stepper motor CH position / Zone pump / Mixing valve
S22: Stepper motor DHW position/Zone pump/Mixing valve

N.B: On customer's request, the push-buttons operations and visualizations can be modified.

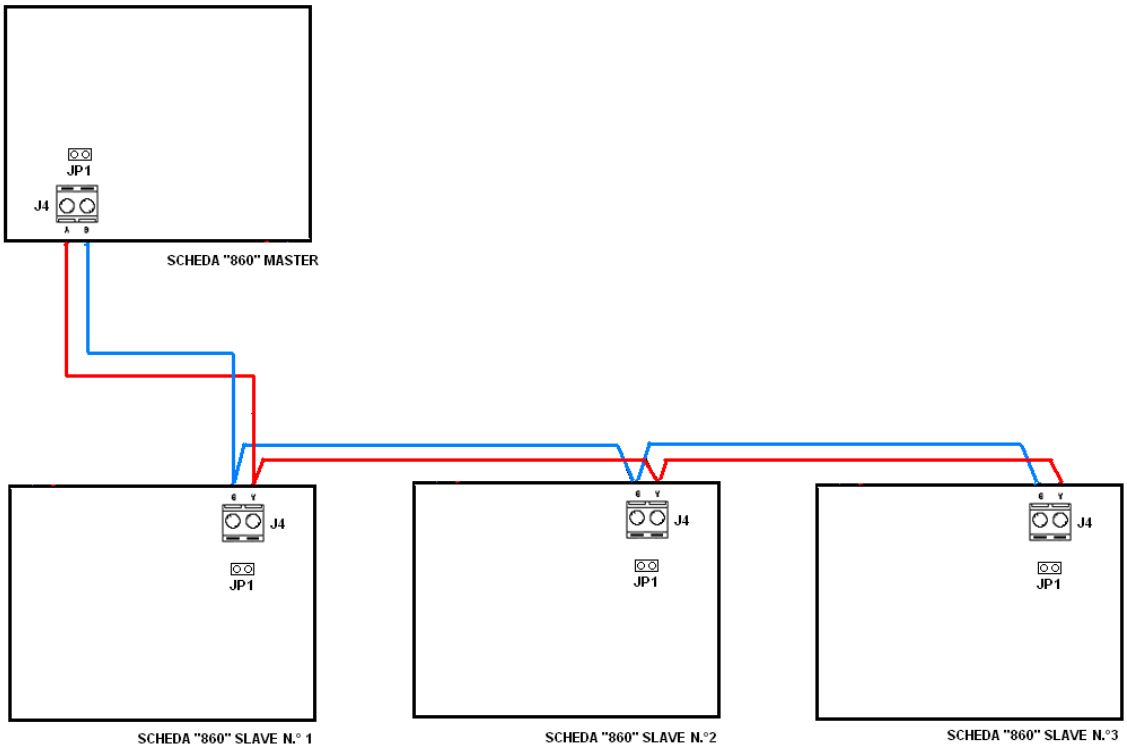
N.B: On customer's request, this system can be fitted with different control board; for further information see the relevant datasheets.

CASCADE SYSTEMS – TYPES OF CONNECTION

Cascade with Brahma "CBS06"

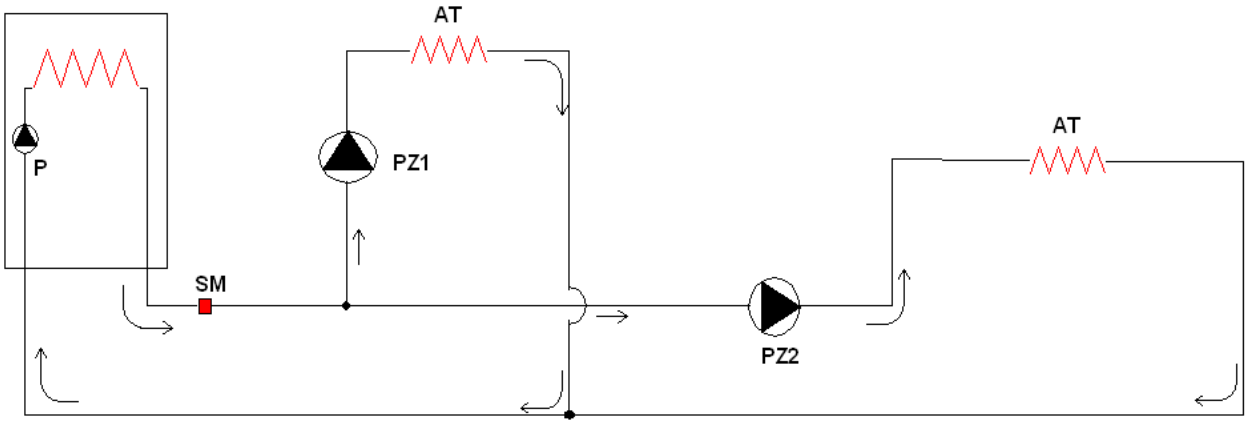


Cascade with "MI860" boards - "Master / Slave"

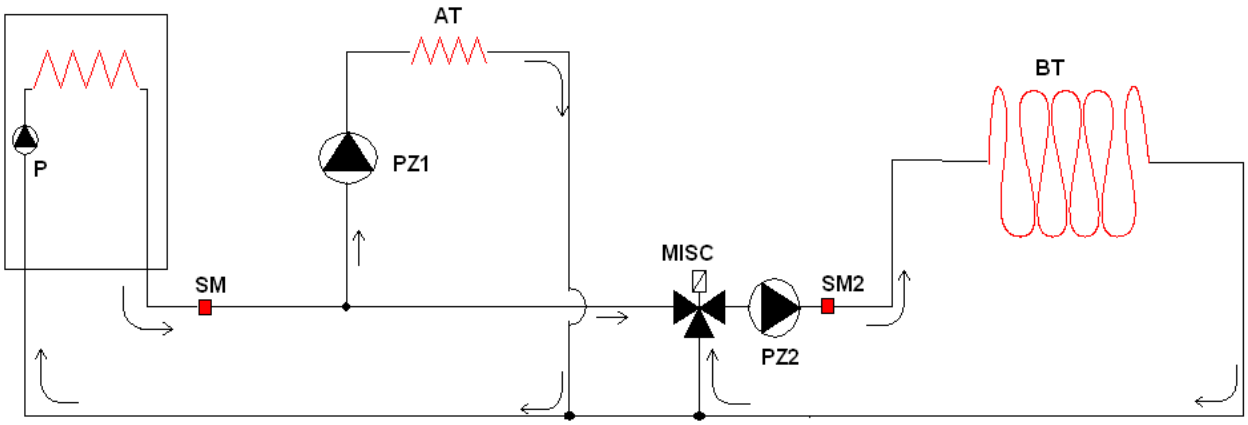


SYSTEMS WITH TWO ZONES – TYPES OF HYDRAULIC CIRCUITS

Two zones at the same temperature (both high or low temperature)



Two zones at different temperature (one high and one low temperature)

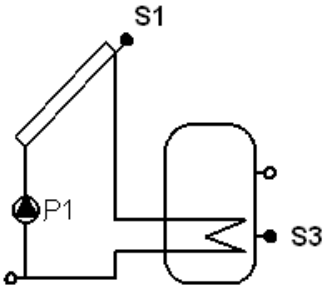


Where:

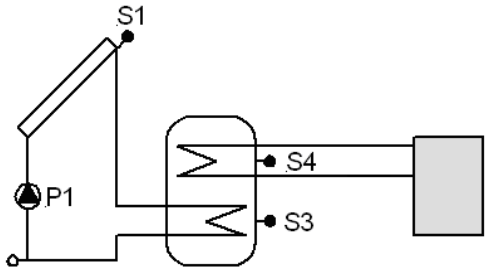
P = Boiler pump
SM = CH primary outgoing water probe
SM2 = CH2 secondary (low temperature) outgoing water probe
PZ1 = Zone pump n. 1
PZ2 = Zone pump n. 1
MISC = Mixing valve
AT = High temperature zone
BT = Low temperature zone

SOLAR SYSTEM – TYPES OF HYDRAULIC CIRCUITS

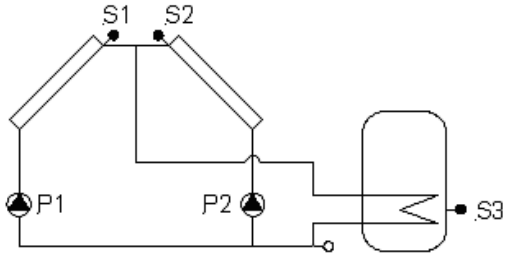
Solar system with storage



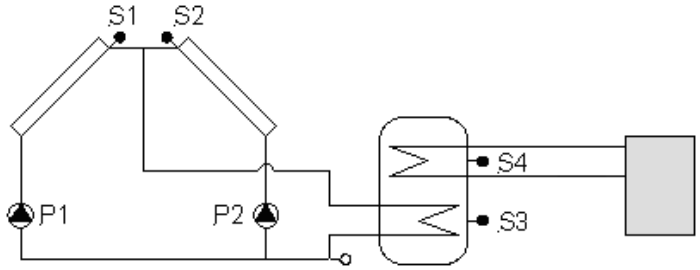
Solar system with storage and boiler integration



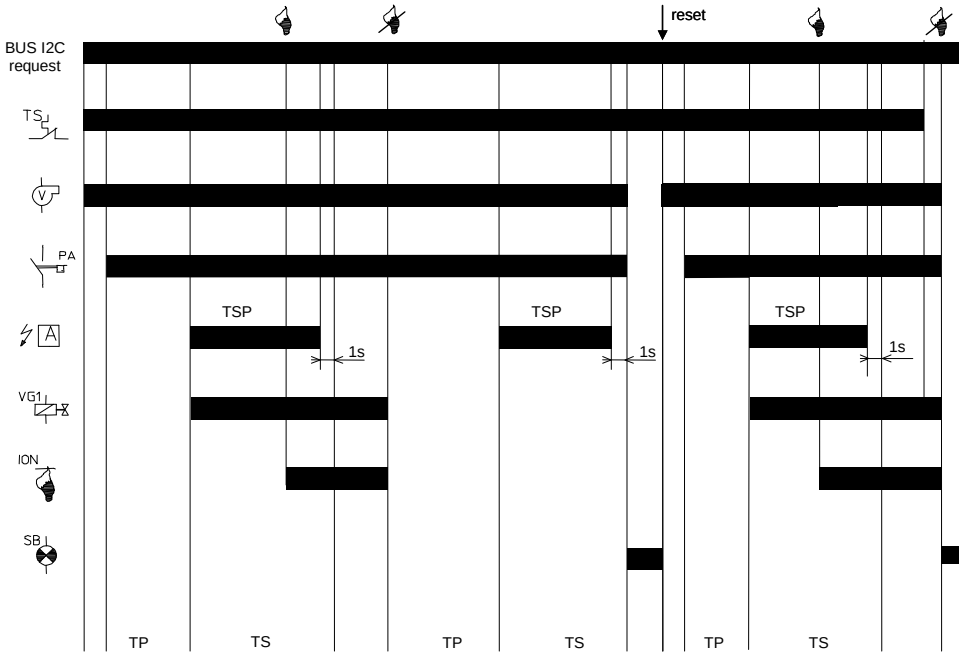
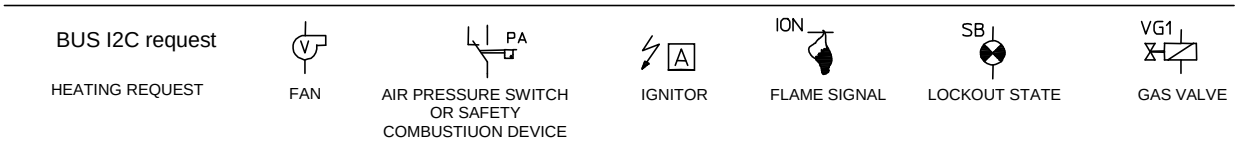
Solar "East – West" system



Solar "East – West" system with boiler integration



Where:

S1: Solar probe S1 (PT1000)
S2: Solar probe S2 (PT1000)
S3: Solar probe S3 (NTC)
S4: Solar probe S4 (NTC)
P1: Solar pump n. 1
P2: Solar pump n. 2

OPERATING CYCLE DIAGRAM STANDARD VERSION