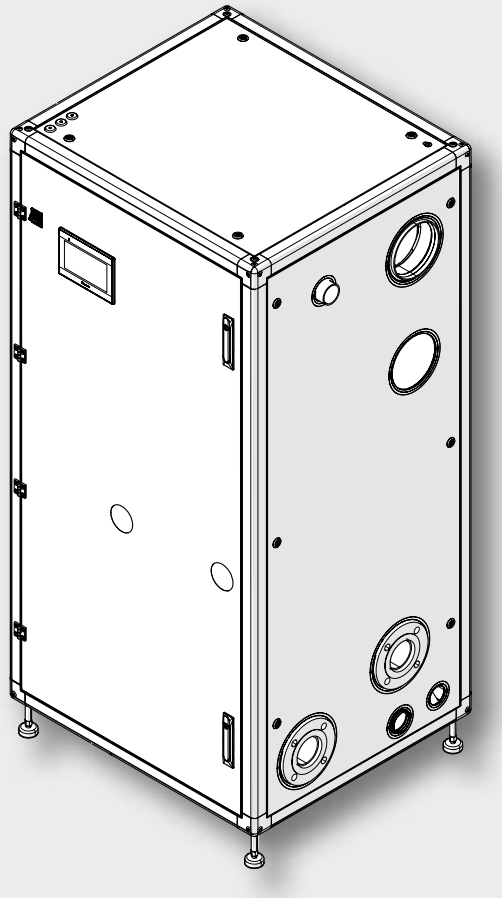


WARNING:
Improper installation, set-up, modification, operation or maintenance of the heating system can cause personal injury and property damage.
Follow these instructions precisely.
If you require assistance or further information, contact a trained and certified installer.

WARNING:
The operating instructions are part of the technical documents that must be handed over to the owner or operator of the heating system.
Explain to the owner or operator how to use the heating system using the operating instructions. Make sure that they are familiar with all required information for the safe and proper operation of the heating system.

These instructions are available in English,

Please keep these instructions for future reference.

BUDERUS SSB BOILER

CONTROL SYSTEM MANUAL

SSB800 SA | SSB1000 SA | SSB1000 TL

BOSCH

Installation and Service Instructions for Contractors

6720892984 (2024/05) US

Contents

1 Key to symbols and safety instructions

1.1 Key to symbols

Warnings

Warnings in this document are identified by a warning triangle printed against a grey background.

Keywords at the start of a warning indicate the type and seriousness of the ensuing risk if measures to prevent the risk are not taken.

The following keywords are defined and can be used in this document:

- **DANGER** indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION** indicates a hazardous situation which, if not avoided, could result in minor to moderate injury.
- **NOTICE** is used to address practices not related to personal injury.

Important information

This symbol indicates important information where there is no risk to people or property.

1.2 Safety instructions

Observe these instructions for your safety.

The burner and control must be correctly installed and adjusted to ensure safe and economical operation of the gas boiler.

Read this installation and maintenance manual carefully and note the details on the boiler nameplate before placing the boiler in operation.

Risk of fatal injury from explosion of flammable gases

If you smell gas there is a danger of explosion.

- ► Never work on gas lines unless you are licensed contractor / gas fitter.
- ► Make sure that a licensed contractor / gas fitter installs the boiler, connects gas and vent, places the boiler in operation, connects the electrical power, and maintains and repairs the boiler.
- ► No open flame! No smoking! Do not use lighters.
- ► Prevent spark formation. Do not operate electrical switches, including telephones, plugs or door bells.
- ► Close main gas valve.
- ► Open doors and windows.
- ► Warn other occupants of the building, but do not use door bells.
- ► Call gas company from outside the building.
- ► If gas can be heard escaping, leave the building immediately, prevent other people from entering, notify police and fire departments from outside the building

Risk to life from electrical shock.

- ► Disconnect the power supply to the boiler heating system before conducting any work on it, e.g. turn off the heating system emergency switch outside the boiler room.
- ► It is not sufficient just to turn off the control.
- ► Do not carry out electrical work unless you are qualified for this type of work.
- ► Before servicing disconnect electrical power and lock out to prevent accidental reconnection.
- ► Observe and follow the local, state and federal installation regulations.

Risk of fatal injury from flue gas poisoning

Insufficient ventilation or combustion air availability may cause dangerous flue gas leaks or formation.

- ► Make sure that inlets and outlets are not reduced in size or closed.
- ► If faults are not corrected immediately, the boiler must not be operated until all faults have been corrected.
- ► Inform the system operator and/or owner of the fault and the danger in writing.

When working on the flue gas venting equipment or vent damper leakage of flue gases may endanger the lives of people.

- ► Carefully observe proper operation of the vent damper. Do not start up the boiler unless the vent damper is operating properly.
- ► Use only original parts when replacing parts.
- ► When replacing the vent damper, install the new one in the specified position.

Risk to life by poisoning by spillage of flue gases

- ► If the blocked vent switch trips frequently the fault must be corrected and proper operation of the blocked vent switch test must be conducted.

Risk to life by poisoning by leakage of flue gases

- ► Make sure that the boiler is not equipped with a thermally controlled flue gas vent damper after the open draft hood.

Risk of fatal injury from neglecting your own safety in case of emergency, such as with a fire

- ► Never put yourself at risk. Your own safety must always take priority.

Fire danger due to flammable materials or liquids

- ► Make sure that there are no flammable materials or liquids in the immediate vicinity of the boiler.
- ► Maintain a minimum distance of 15 inches from the boiler.

Installation and maintenance

- ► Observe all current standards and guidelines applicable to the installation and operation of the boiler heating system as applicable in your state or local jurisdiction.
- ► Clean and service the boiler system once a year. Check that the complete heating system operates correctly.
- ► Immediately correct all faults to prevent system damage.
- ► Only use original Bosch spare parts. Losses caused by the use of parts not supplied by Bosch are excluded from the Bosch warranty.

1.3 General warning

The installation must conform to the requirements of the authority having jurisdiction or, in the absence of such requirements, to the latest edition of the National Fuel Gas Code, ANSI Z223.1./ NFPA 54. In Canada, installation must be in accordance with the requirements of CAN/CSA B149.1, Natural Gas and Propane Installation Code.

Where required by local, state and federal regulations, the system must comply with the American Society of Mechanical Engineers Safety Code for Controls and Safety Devices for Automatically Fired Boilers (ASME CSD-1).

The hot water distribution system must comply with all applicable codes and regulations. When replacing an existing boiler, it is important to check the condition of the entire hot water distribution system to ensure safe operation.

Valves external to the boiler must be fitted with T-handles and condensate piping must be installed in accordance with the State Plumbing Code.

NOTICE:

- ► This boiler must be installed by a licensed contractor/ gas fitter. Failure to do so shall void the product warranty.
- ► The boiler is intended only for the use for which it was specifically designed and built. Bosch is hereby excluded from any liability for damages caused to persons, animals or property resulting from installation errors, improper adjustment, maintenance or use.
- ► In order to ensure safety and correct operation, the installation shall always take place in full compliance with the applicable codes and following with the instructions provided by the manufacturer, and must always be carried out by a licensed contractor / gas fitter only.
- ► The equipment must be installed in appropriate place and in combination with appropriate systems as specified by code.
- ► The unit may be exposed to temperatures between 5 deg F (-15°C) and 150 deg F (65°C) in its original packaging. Do not expose the unit to weather without the protection of the original packaging until the boiler has been properly installed. Until then there is no frost protection for the boiler.
- ► After removing the packaging check the integrity and completeness of delivery and in case of non-compliance, contact your dealer.
- ► If there is a water loss, disconnect the boiler from the main power supply, close the water supply and immediately call technical assistance or installer/local contractor.
- ► Periodically check that the condensate drain is free from obstruction.
- ► Periodically check the system pressure. System pressure should be checked when the system is in standby mode and no call for heat is present.
- ► Maintenance is mandatory and shall be carried out at least once a year.
- ► This manual shall be read carefully, in order to install and operate the boiler appropriately, and safely.
- ► Boiler installations, settings and service should only be performed by experienced licensed contractor / gas fitter. End Users should only make adjustments with the assistance of a licensed contractor / gas fitter.
- ► Any maintenance operation or service before disconnecting the boiler from the main power supply is forbidden.
- ► Do not remove or modify safety equipment.
- ► Do not pull or twist the electrical wires, from the boiler, even if the device is disconnected from the main power supply.
- ► Do not obstruct or reduce the ventilation openings.
- ► Do not install the unit outdoors.
- ► Do not leave any combustibles or containers of flammable substances in the room where the boiler is installed.
- ► Keep packing material out of reach of children as it can be potentially dangerous. It must be disposed of as required by law.
- ► The opening of metal casing of the device and removing of the cover are prohibited to the end user. Any service on the boiler must be carried out by authorized personal.
- ► It's prohibited to dispose the product as domestic waste. The separate disposal of a household appliance avoids possible negative consequences for the environment and human health deriving from inappropriate disposal and allows to recover the materials it is made of in order to achieve significant savings in energy and resources.

2 STAND-ALONE BOILER (Burners Cascade) - SYSTEM ARCHITECTURE

2.1 General

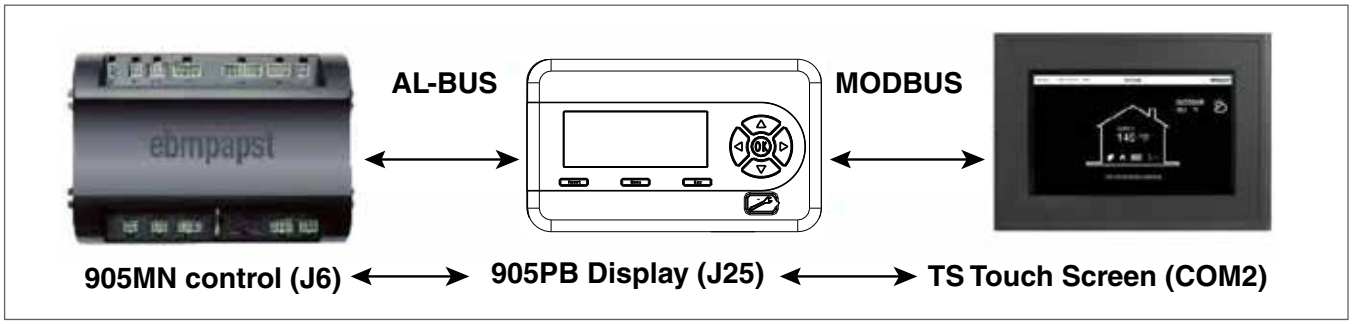
The 900 series burner controls are designed to function as a standalone control unit for intermittent operation on heating appliances with a premix (modulating) burner and a pneumatic air-gas system.

This specification is suitable for the following version:

PN: 900MN 900MN type for Commercial units

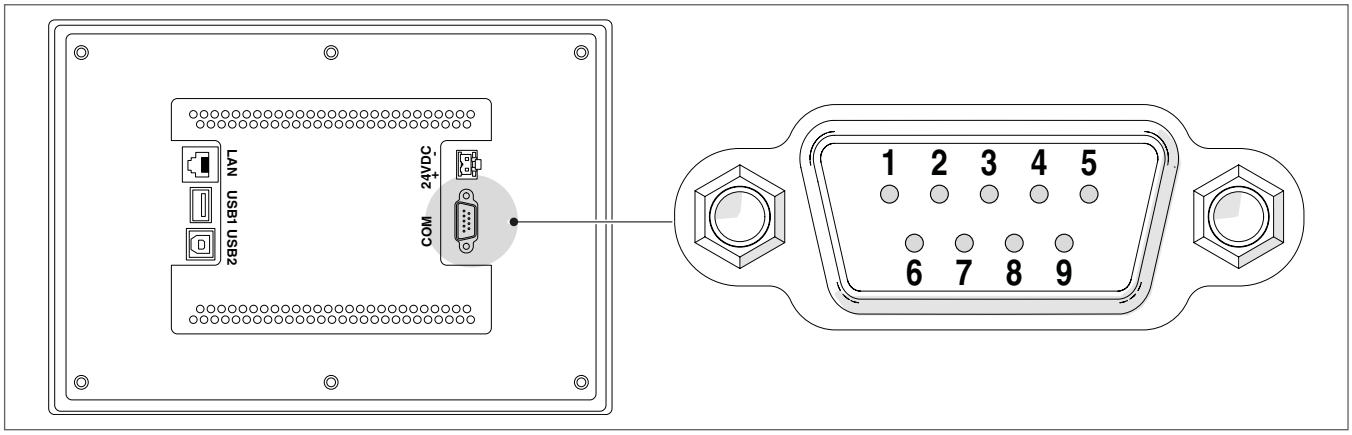
2.2 TS Control Systemn

The following scheme shows the communication protocols the 905 Modules use to communicate with each other:



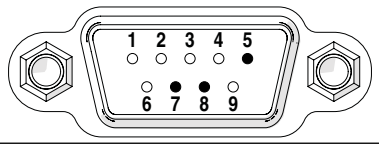
2.2.1 Modbus connection 905PB and TS

The TS has a port on the backside called ‘COM’, which is used to communicate with the 905PB display by MODBUS. The following illustration shows the location of the COM port (backside TS) and pin-numbering:



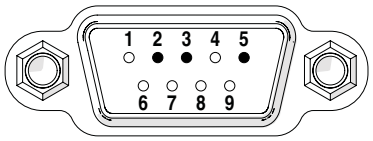
Primary connection to 905PB:

Communication	Pin	Function	Connect to
COM2 (Master)	5	GND	905 PB (J25-1)
	7	RS 485 +	905 PB (J25-3)
	8	RS 485 -	905 PB (J25-2)



Optional secondary interface:

Communication	Pin	Function	Connect to	
COM1 (Slave)	2	RS 232 RXD	External Adapter	RS 485
	3	RS 232 TXD	External Adapter	RS 485
	5	GND		



2.2.2 Setpoints on touch screen

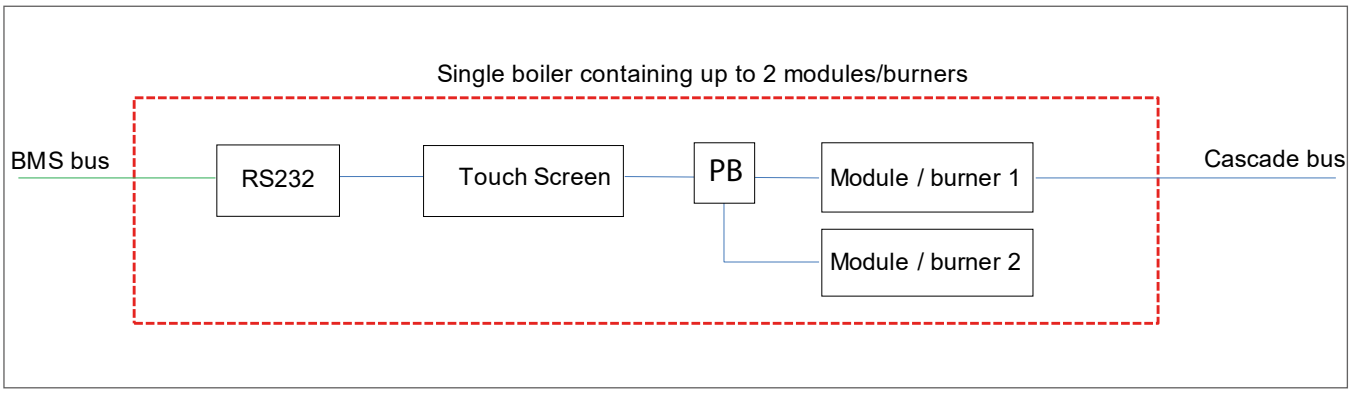
The following table describes the setpoints that are shown on ver 2.d or higher:

CH mode	Cascade screen – System setpoint Cascade system supply setpoint	Boiler screen – Boiler Setpoint Cascade boiler supply setpoint	Module screen – Module Setpoint Burner supply setpoint
No demand	CH Mode X setpoint	Frost Protection Setpoint	Frost Protection setpoint
Frost	CH Mode X setpoint	Frost Protection Setpoint	Frost Protection setpoint
0	Parameter CH setpoint	Cascade system supply setpoint + increase calculated by the boiler cascade controller	Cascade boiler supply setpoint + increase calculated by the burner/ module cascade controller
1	Calculated outdoor setpoint		
2	Calculated outdoor setpoint		
3	Calculated outdoor setpoint		
4	0-10V input setpoint		
Emergency Cascade	See above	Cascade System Emergency Setpoint	Cascade boiler supply setpoint + increase calculated by the burner/ module cascade controller
Emergency Boiler	See above	Boiler Emergency Setpoint	Boiler Emergency Setpoint

The following table describes how the setpoint is limited in a cascade system:

E2_Ch_Max_Setpoint	90°C / 194°F	= Absolute maximum setpoint
Controller maximum setpoint =	90°C / 194°F	E2_CH_Reset_Curve_Boiler_Maximum
	CH Control range	
Controller minimum setpoint =	30°C / 86°F	E2_CH_Reset_Curve_Boiler_Minimum
E2_Ch_Min_Setpoint	20°C / 68°F	= Absolute minimum setpoint

2.3 2 Burners Cascade with Touchscreen and Building Management System (BMS)



2.4 Dipswitch setting for 2 Burners Cascade

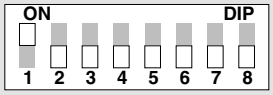
Power switch S1 should only be activated on the managing boiler. Activating more than one switch on the cascade bus may damage the controller!

For a single burner the address is:

Stand-Alone: All dip-switches OFF.

2 burner cascade addressing:

Group 1 (1-2): All dip-switches OFF, the selected burner number ON.

Dip-switch setting	Burner Operation	LabVision Device Address
	Standalone burner	100
	1st burner (managing)	100
	2nd burner (depending)	101

2.5 Additional device specifications

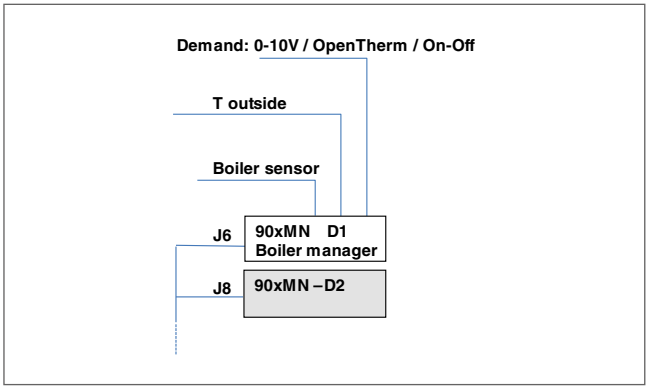
No.	Type	Brand	Configure	Article description
1	Flow Sensor	Huba Control		Huba DN25. Flow sensor for liquid media type 200. Flow range 0,5 … 150 l/min
2	Water Pressure switch	Huba Control		Relative pressure switch type 620/625
3	Gas Pressure switches (min.–max)	Krom Schroder		Gas and air, ¼" NPT, DG 50NT and DG 50HT
5	Sensor	Taco	Customer	Only LWCO probe, no controller, 3/8" P8S-1
6	Burner		Customer	150 kW ~ 511BTU/hr
7	Fan	ebm-papst		NRG137 (120VAC PWM) NRG137/2400-3633-010304-115
8	Unit Return Temp. Sensor	Tasseron	Inside	NTC sensor - TSD00AE (10k@25°C / 77°F, 3%)
9	Unit Flow Temp. Sensor	Tasseron		NTC sensor - TSD00AE (10k@25°C / 77°F, 3%)
10	Unit Flue Temp. Sensor	Tasseron	Inside	NTC sensor - TSD20D1 (10k@25°C / 77°F, 3%)
11	System Temp. Sensor	Tasseron	Inside	NTC sensor - TSK10D2 (10k@25°C / 77°F, 3%)
12	Outdoor Temp. Sensor	Tasseron	Inside	NTC sensor - TSRD110-R (10k@25°C / 77°F, 3%)
13	Safety Temp. Sensor	Term-o-disc		TS18-12491, 100°C / 212°F
14	Unit Flue Pressure Switch	Krom Schroder		DL4ET-1 330 - 350Pa
15	Unit Condensate Pressure Switch	Krom Schroder		DL4ET-1 330 - 350Pa
16	Gas valve	Honeywell		VK4405V

3 BURNERS cascade

3.1 Burner cascade communication setup

In order for the system to work for cascade the communication busses must be parallel linked together. The managing burner uses the AL-bus connection on J6 1-8 for burner cascade. The depending burner must be connected to the managing burner on the J8 AL-bus connection.

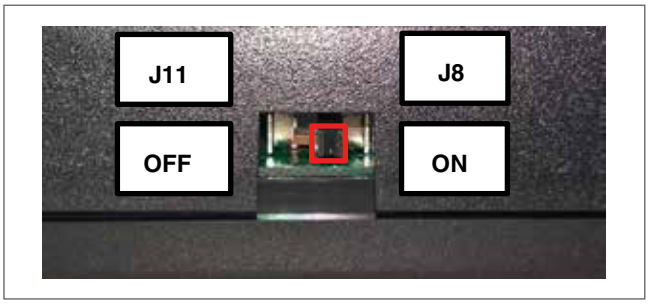
It is important that the power on the J8 AL-bus connection on all depending burners is switched to the OFF position. Also all burners in the cascade system must have a unique address selected.



3.2 Setting the burner address (Rev. 4.0.905.15250)

The managing burner of the cascade system is connected to the AL-bus connection on J6 1-8. This connection also provides the power for the communication bus. The depending burners are all parallel connected to the managing burner communication bus.

Since the bus power is provided by the managing burner on J6 1-8, switch S1 must be set in the OFF position on all controls.



The burner address can be set through an e2prom setting or the Dip-Switch input available on the control. Which option is used can be set with the Dip-switch configuration parameter on the Labvision PC software. Each burner must be configured with its own unique address.

3.2.1 E2prom address selection through e2prom setting

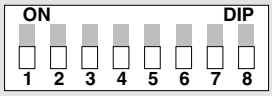
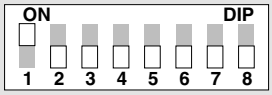
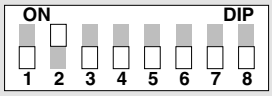
When the Dip-switch configuration is set to disabled the burner address is selected with an e2prom parameter. This setting can be changed using a computer with LabVision PC software.

Burner address	Burner Operation	Function of sensor input J5 (7-15)	LabVision Device Address
0 (default)	Standalone burner	No function	100
1	1st boiler (Managing)	System sensor	100
2	2nd boiler (dependent)	No function	101
3	3rd boiler (dependent)	No function	102
4	4th boiler (dependent)	No function	103
↓	↓		↓
8	8th boiler (dependent)	No function	107

3.2.2 E2prom address selection through dip-switch input

When the Dip-switch configuration is set to Cascade burner address the burner address is selected with the dip-switch input. The switches are numbered 1 to 8. When an invalid dip-switch setting is selected the burner address will be set to a standalone burner. When the Dip-switch configuration is set to Cascade burner address the E2prom parameter is not used.

Make sure that the register n° 194 (DIP SWITHC CONFIG) are set to ENABLE

Dip-switch setting	Burner Operation	LabVision Device Address
	Standalone burner	100
	1st burner (managing)	100
	2nd burner (depending)	101

3.2.3 Communication with LabVision PC software

There are two options for communication with the LabVision PC software. The 850US Device (Argus-to-USB) can either be parallel connected to the cascade communication bus or separately to the J8 connection on the leading burner.

When the 850US Device (Argus-to-USB) is connected to the J8 connection, switch S1 has to be set in the ON position. This powers the communication bus to allow communication with the Labvision PC software.

NOTE: there is less information available when connected to the J8 connection on the leading burner. Only the information known by the leading burner can be shown in the Labvision PC software.

3.3 Cascade – Heating only (Rev. 4.0.905.15250)

Managing burner

When a burner is set as Managing (Address = 1), the controller of this burner will drive the cascade. The CH mode of this managing burner applies to all other burners. It is only required to set the CH mode on the managing burner.

- The outdoor temperature sensor connected to the managing burner will be the outdoor sensor for the cascade operation
- The system sensor (*T_System*) connected to the managing burner will be the control sensor for the cascade supply temperature.
- The (modulating) thermostat connected to the managing burner will be the CH heat demand input for the cascade system.

Based on the system temperature *(T_System)* and the requested *Cascade_Setpoint* the managing burner calculates a required burner setpoint, to achieve the requested *Cascade_Setpoint*.

The managing burner provides the calculated setpoint to all dependent burners. The modulating power of the dependent burners is PID controlled based on the calculated setpoint and dependent burner supply temperature.

Cascade CH setpoint adaption

When the system temperature is not high enough the setpoint for all burners will be adjusted.

The boiler setpoint will be increased when the system temperature drops below *Cascade_Setpoint* and decreased when it rises above *Cascade_Setpoint temperature*.

This is determined as following:

A PID-control loop over the system temperature *(Cascade_Setpoint / T_System)* calculates the adjustment of the boiler setpoint. The range of the PID controller is between *(Cascade_Setpoint + Max_Range_Up_Limit)* and *(Cascade_Setpoint – Min_Range_Down_Limit)*. This offset is added to the *Cascade_Setpoint* and then this calculated boiler setpoint will be limited at *CH_Max_Setpoint* (by default 80°C (176°F)).

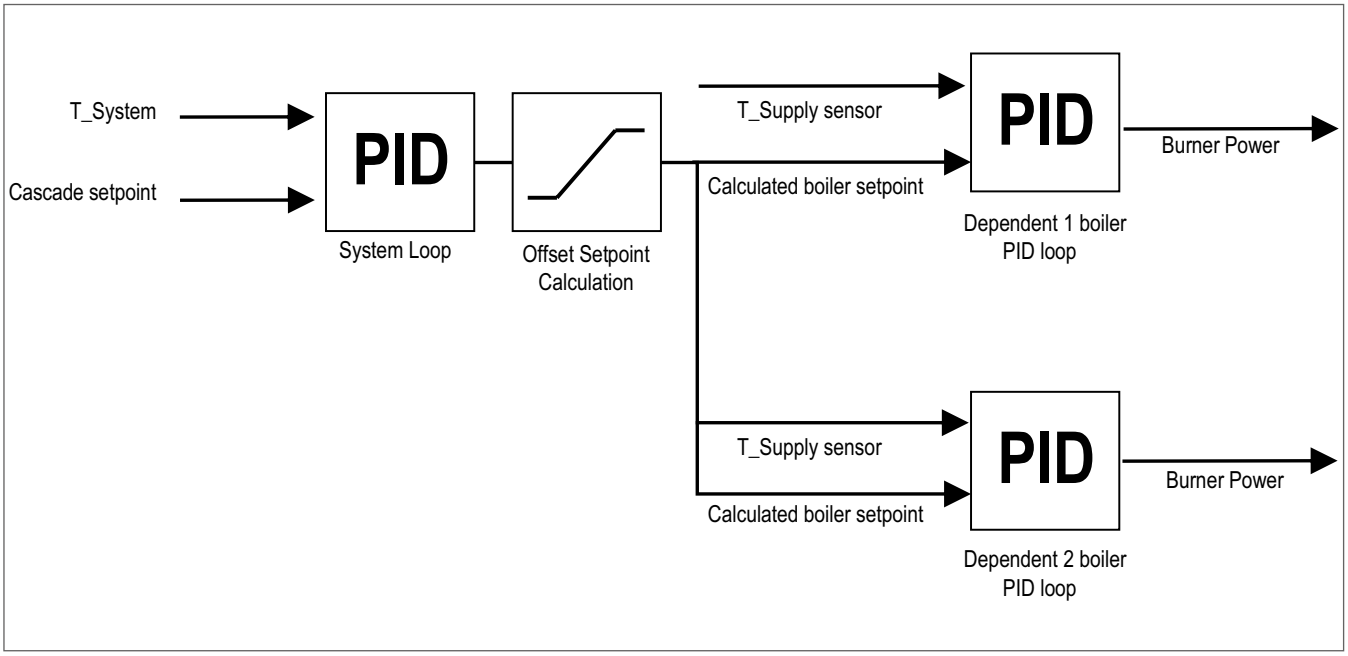
When the system temperature is above cascade setpoint, the calculated boiler setpoint will be decreased with a step defined by parameter *PID_Slew_Rate_Step_Down* (default 1°C (1,8°F)).

In case the system temperature is below cascade setpoint the calculated boiler setpoint will be increased with a step defined by parameter *PID_Slew_Rate_Step_Up* (default 1°C (1,8°F)).

The PID calculation does not start immediately but after a certain delay period to stabilize the system first.

The delay period is *Start_PID_Modulation_Delay_Factor* (settable), for example 60 minutes.

The following diagram shows how the setpoint to the dependents is determined:



PID slew rate

The changes of the PID output can be limited with the *PID_Slew_Rate_Step_Up and PID_Slew_Rate_Step_Down* (factory settable) setting to avoid big setpoint changes to the burners. The slew rate is set in °C/100ms.

For example when the *PID_Max_Slew_Rate_Up* and *PID_Max_Slew_Rate_Down* are set to 1,0°C/100ms it means the calculated setpoint can change a maximum of 1,0°C every 100ms.

The slew rate can be set in steps of 0,1°C/100ms. When set to 0,0°C/100ms the limitation is disabled.

Dependent Burner

The CH mode for the cascade is defined by the setting of the managing burner. CH mode settings on dependents are ignored.

In case a burner is set as dependent (Address = 2-8/16) the setpoint is always provided by the managing burner.

The modulating power of the ALL burners is PID controlled by the burner itself by comparing the calculated setpoint from the managing burner and *T_Supply*.

The burner of the managing burner itself will be controlled in the cascade system as it would as it was a dependent burner.

Only the pumps and sensor inputs are used.

Burner power

Cascade operation with power modes is designed to work best in cascade systems with equal burners/burners having the same power output.

3.3.1 Cascade – domestic hot water

Settings

In the installer DHW menu of the managing burner control the *DHW_Mode* should be set.

Available DHW modes in cascade are mode 1 or 2.

Dependent Burner

In case a burner is set as dependent (Address = 2-8/16) the DHW setpoint is always provided by the managing burner, the internal control of the setpoint functions are disabled.

3.3.2 Cascade – DHW priority (Rev. 3.0.0.12377)

Three possible level of DHW and CH heating priority are configurable:

- **DHW Priority - BOTH [0]:** When both CH and DHW demand have to be served the priority it is given to the DHW demand for a given interval (indicated with parameter *DHW_Max_Priority_Timer*).As soon as the interval has expired the priority switches to CH demand. The interval time will be reloaded and priority will switch again after the interval is over.
- **DHW Priority - CH [1]:** The priority is permanently given to CH Demand.
- **DHW Priority - DHW [2]:** The priority is permanently given to DHW Demand.
- **DHW/CH Parallel[3]:** The priority us permanently given to DHW Demand. But Under the following condition the CH pump can started: *Setpoint_CH* < SystemTemp.

Relevant variables

Specific Parameters	Level	(Default) Value	Range
DHW Priority Both, CH or DHW priority, Parallel	2: Installer	2	0..3
DHW Max Priority Timer [min] Interval time for switching the priority	2: Installer	60	1..60

3.3.3 Limitation of the MAX power for DHW (Rev. 4.0.905.16570)

When demand change from CH to DHW all burners in the boiler stop and start DHW demand with a limit amount of burner. The parameter *N_Max_Active_Dep_DHW* indicates the number of burners available for DHW. This number will be always be limited in the control to the amount of burners that is available in the cascade.

Relevant variables

Specific Parameters	Level	(Default) Value	Range
N_Max_Active_ Dep_DHW Max amount of active burners per boiler for serve DHW demand	2: Installer	1	0..16

The DHW on the system level can be set by settings parameter (193) DHW for all.

When the DHW is set to system level, the DHW of the burner level will become irrelevant.

The parameter (184) that was used for setting number of burners for DHW, is now used for setting the number of boilers for DHW.

This parameter shows the number of boilers used for the DHW, the boilers will use all available burners in the boiler for DHW when burning for DHW.

When, for example, the system consists of 4 boilers with each boiler having 2 burners in it, and the parameter 184 = 3 .

With DWH FOR ALL (193) = YES

3 boilers will use all of their burners for DHW, and the other 1 boiler will do nothing during the DHW, since DHW cannot be done in parallel with central heating (CH).

With DWH FOR ALL (193) = NO

The first boiler will use all of its 2 burners for DHW, and the other 3 boilers will do nothing during the DHW, since DHW cannot be done in parallel with CH.

In case of standalone boiler (no cascade) the parameter (193) DHW for all has to be disabled (NO).

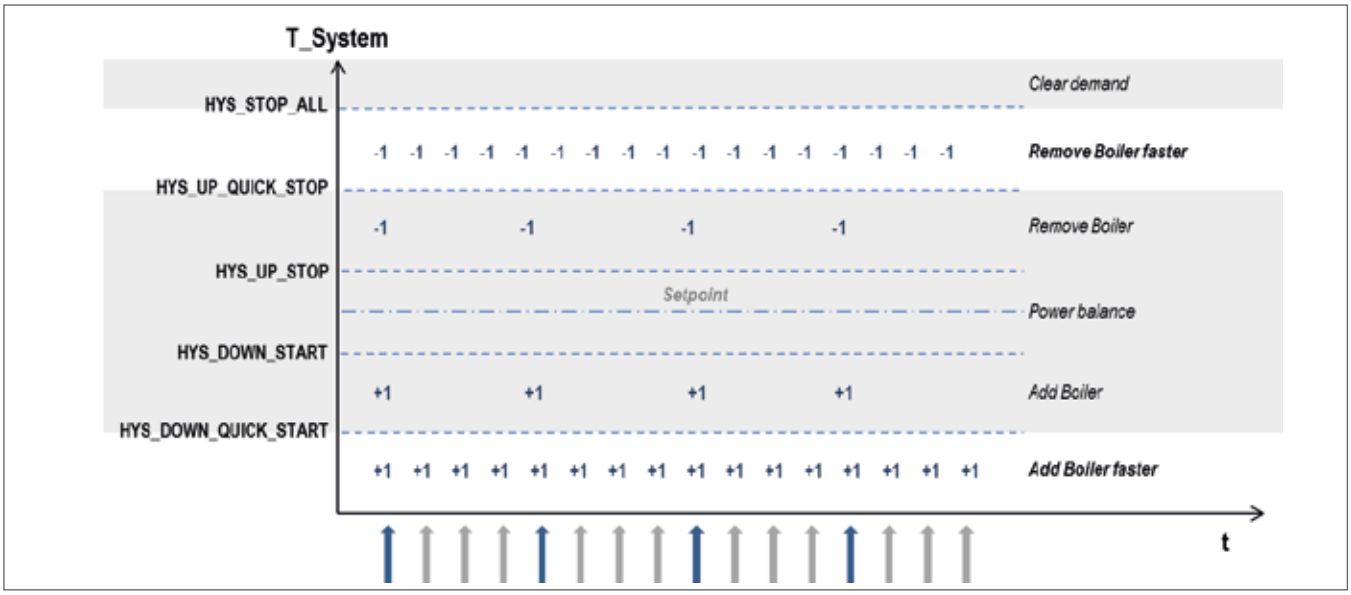
3.3.4 Cascade – start/stop sequence (Rev. 3.0.0.12315)

The managing burner sends the calculated *Cascade_Setpoint* to the dependent burners. The power of the burners is PID controlled based on the *Calculated_Setpoint* and *T_Supply*. Depending on the temperature difference between *T_Header and Header_Setpoint* (CH or DHW) the dependent burners will start or stop using different algorithms.

If a CH or DHW demand request is present, the next dependent burner is always called to ensure that the general (on board) pump of at least one dependent is always running especially in the case where *T_System* is much higher than the setpoint.
In the latter case the Frost protection setpoint is sent to the dependent burner.

Quick Starting and Stopping Burners

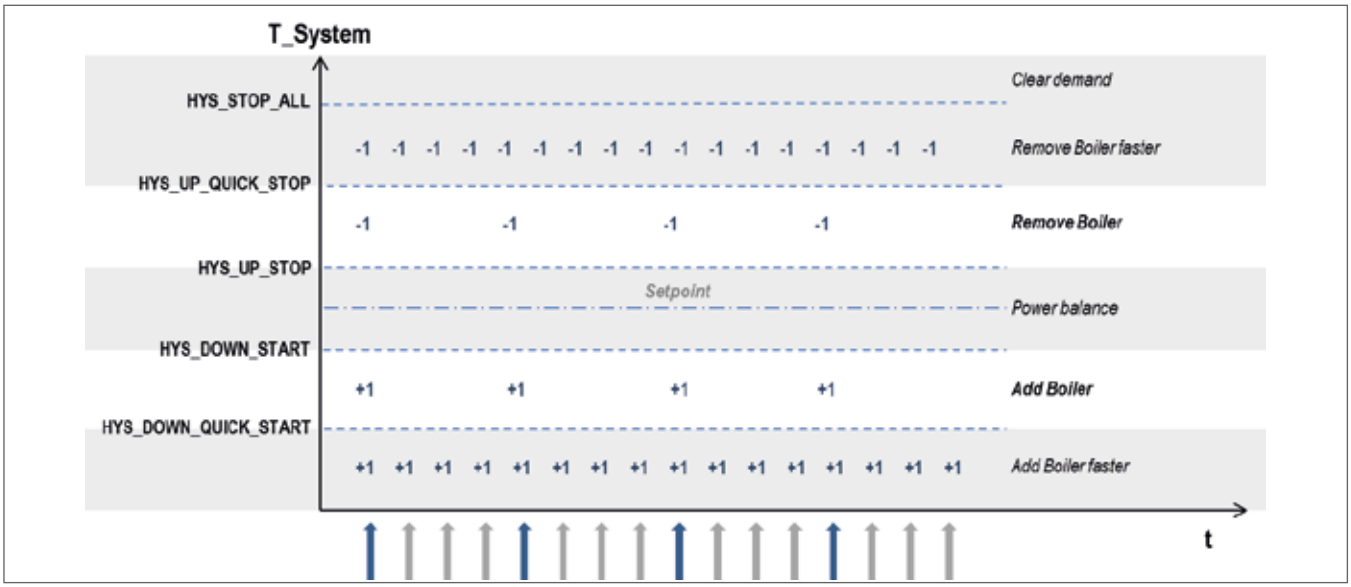
When there is a big difference between the *T_System* and the *Cascade_Setpoint* the call for a start or stop of the next or last depending is done quicker.



- **Quick Starting Burners**: If the *T_Syste*m is *Hyst_Down_Quick_Start* degrees below the *Cascade_Setpoint* the burners are started at intervals of *Quick_Start_Interval*, for example 30 sec.
- **Quick Stopping Burners**: If the *T_System* is *Hyst_Up_Quick_Stop* degrees above the *Cascade_Setpoint*, the burners are stopped at intervals of *Quick_Stop_Interval*, for example 30 sec.

Starting and Stopping Burners

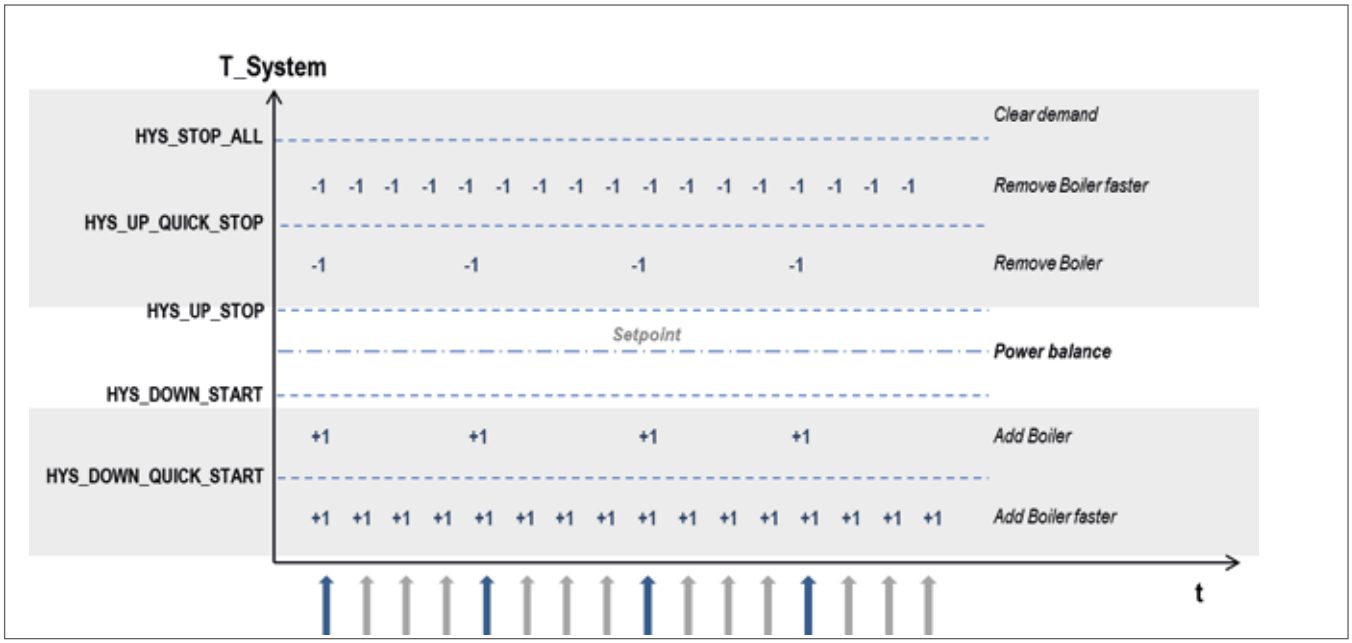
With a small difference between *T_System* and the *Cascade_Setpoint* the call for a start or stop of the next or last Dependant burner is executed.



- **Starting Burners**: If the *T_System* is *Hyst_Down_Start* degrees below the *Cascade_Setpoint* the burners are started at intervals of Start_Interval, for example 3 min.
- **Stopping Burners**: If the *T_System is Hyst_Up _Sto*p degrees above the *Cascade_Setpoint*, the burners are stopped at intervals of *Stop_Interval*, for example 3 min.

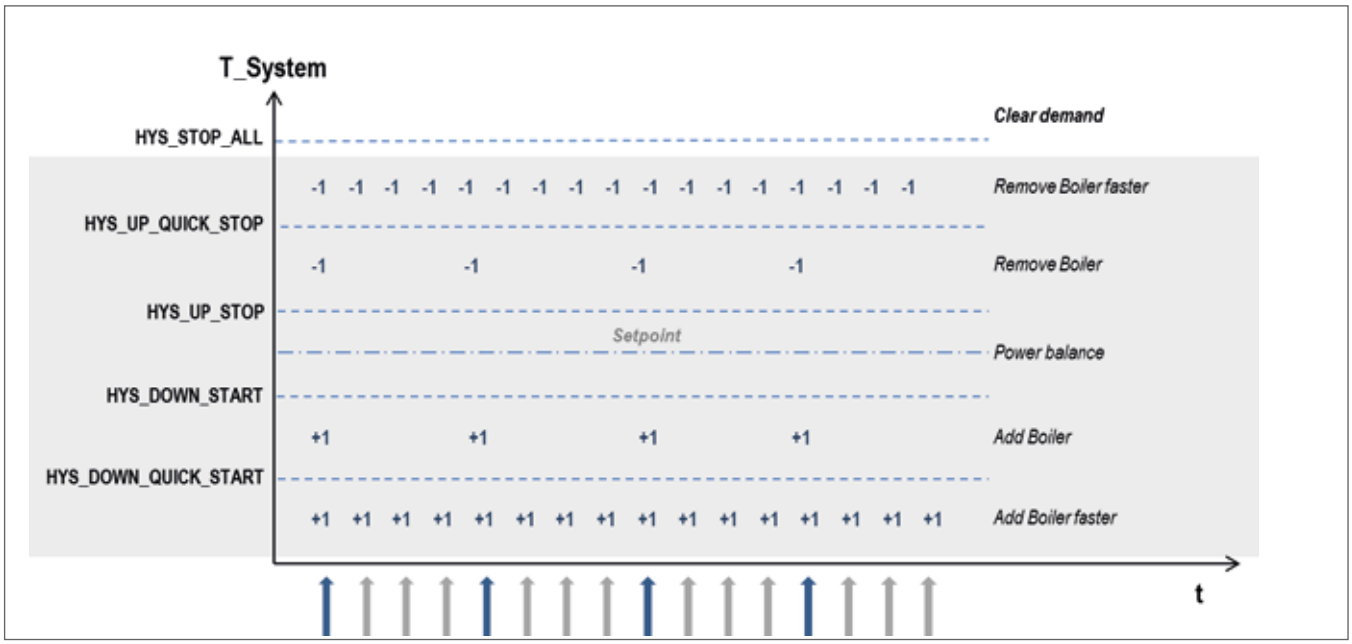
Power balance

When the *T_System* is between *Hyst_Down_Start* and *Hyst_Up_Stop* a power balance algorithm can be activated.
See “3.3.5 Cascade – power balance mode (Rev. 4.0.905.15906)” pag. 15.



Stop all dependent

All the dependents are stopped as soon as the *T_System* is far greater than *Cascade_Setpoint*.
The following graph shows when all the burners are stopped:



Relevant variables

Specific Parameters	Level	(Default) Value		Settable	
		°C	°F	°C	°F
Delay_ Period_Start_ Next_Burner [min] Start Delay Time	2: Installer	3 (min)		1..15	
Delay_ Period_Stop_ Last_Burner [min] Stop Delay Time	2: Installer	3 (min)		1..15	
Quick_Delay_ Period_ Start_Next_Burner [sec] Quick Start Interval	2: Installer	30 (sec)		5..300	
Quick_Delay_ Period_ Stop_Last_Burner [sec] Quick Stop Interval	2: Installer	30 (sec)		5..300	
Hyst_Down_Start_ Burner [°C/°F] Start Burner Diff	2: Installer	5	9	0..20	0..36
Hyst_Up_Stop_Burner [°C/°F] Stop Burner Diff	2: Installer	5	9	0..20	0..36
Hyst_Up_Stop_All [°C/°F] Stop Burner Diff	2: Installer	30	54	30	54
Hyst_Down_Quick_ Start [°C/°F] Start Burner Diff in short time	2: Installer	10	18	0..20	0..36
Hyst_Up_Quick_Stop [°C/°F] Stop Burner Diff in short time	2: Installer	10	18	0..20	0..36

3.3.5 Cascade – power balance mode (Rev. 4.0.905.15906)

Two different power control modes can be selected to operate the cascade system.

- **Power mode 0:**
  Power control disabled, each burner modulates based on the system setpoint.
- **Power mode 1:**
  Power control algorithm to have a minimum amount of boilers/burners active.
- **Power mode 2:**
  Power control algorithm to have a maximum amount of boilers/burners active.
- **Power mode 3:**
  Power control algorithm to have a balanced amount of boilers/burners active.

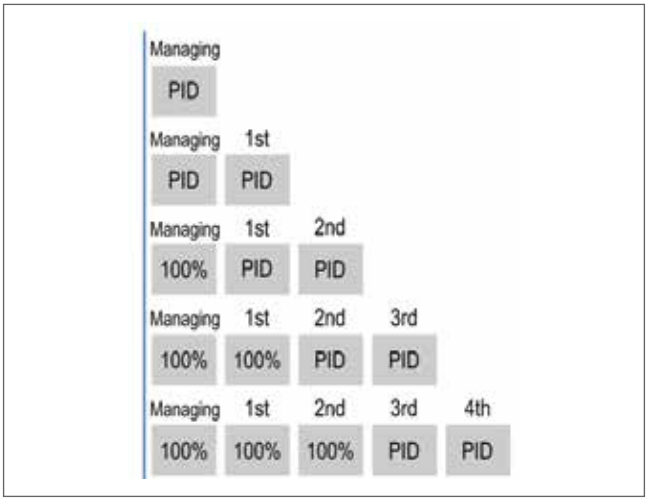
3.3.5.1 Power mode 1 - Minimum burners on (Rev. 4.0.905.15906)

Power Mode 1 guarantees to have as minimum as possible dependent ON in order to reach the *T_System*.

The modulation of most boilers/burners is forced to 100%, and the last 2 boilers/burners are PID controlled by the setpoint (*Cascade_Setpoint*) from the managing burner in relation to the system temperature (*T_System*).

The last 2 boilers/burners are modulating to make sure that the power can be adapted to the system temperature without continuous cycling of the last burner(s).

Below is a picture that shows an example with 4 boilers/ burners.



Burner Startup

The next burner is started under the following conditions:

- At least one PID controlled depending is operating at a power [%] > *Start_Rate_Next_Burner* [%].
  The managing burner forces another burner to 100% power and waits for 3 min. (*Delay_Period_Start_Next_ Dependent*, settable) before another burner can be started.

Burner shut down

The last started burner will be stopped under the following conditions:

- All PID controlled depending in burn state Power [%] < *Stop_Rate_Last_Burner* [%]. The managing burner releases another burner for PID control and waits for 3 min.(*Delay_Period_Stop_Next_Dependent*, settable) before another burner can be stopped.

Relevant variables

Specific Parameters	Level	(Default) Value		Range	
		°C	°F	°C	°F
Power_Mode	2: Installer	3		0..3	
Start_Rate_Next_ Burner [%] Threshold rate before start the next Burner. Condition: at least 1 depending in burn state power [%] > Start_Rate_ Next_Burner [%]	2: Installer	80		1..100	
Stop_Rate_Last_ Burner [%] Threshold rate before start the next Burner. Condition: all depending in burn state Power [%] < Stop_Rate_Next_Burner [%]	2: Installer	25		1..100	
Delay_ Period_Start_ Next_Burner [min] When the timeout is over the last dependent can be started	2: Installer	3		1..15	
Delay_ Period_Stop_ Last_Burner [min] When the timeout is over the last Burner can be stopped	2: Installer	3		1..15	

Specific Parameters	Level	(Default) Value °C	(Default) Value °F	Range °C	Range °F
Hyst_Up_Stop_Burner Hysterese to stop Burner. Condition: T_System above Header_Setpoint plus Hyst_ Up_Stop_ Burner	2: Installer	5	9	0..20	0..36
Hyst_ Down_Start_ Burner [sec] Hysterese to stop Burner. Condition: T_System below Header_Setpoint plus Hyst_ Up_Stop_Burner	2: Installer	5	9	0..20	0..36

3.3.5.2 Power mode 2 – Maximum burners on (Rev. 4.0.905.15906)

Power mode 2 is designed to have as many depending burners on as possible. When the average burner power of the active depending burners is above a set minimum power, another burner is started.

Burner startup

The next burner is started under the following conditions:

- When the average burner power of all depending burners is over the set minimum burner power + hysteresis.
  - Sum of burner power of all depending [%] > *minimum_power* [%] * (depending in burn + 1) + *minimum_power_hysteresis*.

Burner shut down

The last started burner will be stopped under the following conditions:

- When the average burner power of all depending burners is under the set minimum burner power.
  - Sum of burner power of all depending [%] < *minimum_power* [%] * depending in burn.

Relevant variables

Specific Parameters	Level	(Default) Value	Range
Power_Mode	2: Installer	3	0..3
Minimum_Power [%] Minimum average burner power setting	2: Installer	20	1..100
Minimum_Power_ Hysteresis [%] Hysteresis for the minimum average burner power setting	2: Installer	40	1..100

3.3.5.3 Power mode 3 – Balanced burners on (Rev. 4.0.905.15906)

Power mode 3 is designed to have a balanced water flow in systems with a header/manifold.

Burner startup

The next burner is started under the following conditions:

- When the average burner power of all depending burners is over the set start rate for the next burner.
  - Sum of burner power of all depending [%] > *Start_ Rate_Next_Burner* [%] * depending in burn.

Burner shut down

The last started burner will be stopped under the following conditions:

- When the average burner power of all depending burners is under the set stop rate for the next burner.
  - Sum of burner power of all depending [%] < *Stop_ Rate_Next_Burner* [%] * depending in burn.

Relevant variables

Specific Parameters	Level	(Default) Value °C	(Default) Value °F	Range °C	Range °F
Power_Mode	2: Installer	3		0..3	
Start_Rate_Next_ Burner [%] Threshold rate before start the next Burner. Condition: at least 1 depending in burn state power [%] > Start_Rate_ Next_Burner [%]	2: Installer	80		1..100	
Stop_Rate_Last_ Burner [%] Threshold rate before start the next Burner. Condition: all depending in burn state Power [%] < Stop_Rate_Next_Burner [%]	2: Installer	25		1..100	
Delay_ Period_Start_ Next_Burner [min] When the timeout is over the last dependent can be started	2: Installer	3		1..15	
Delay_ Period_Stop_ Last_Burner [min] When the timeout is over the last Burner can be stopped	2: Installer	3		1..15	
Hyst_Up_Stop_Burner Hysterese to stop Burner. Condition: T_System above Header_Setpoint plus Hyst_ Up_Stop_ Burner	2: Installer	5	9	0..20	0..36
Hyst_ Down_Start_ Burner [sec] Hysterese to stop Burner. Condition: T_System below Header_Setpoint plus Hyst_ Up_Stop_Burner	2: Installer	5	9	0..20	0..36

3.3.6 Cascade – burner rotation (Rev. 4.0.905.x)

The burner rotation function can change the start/stop sequence for the cascade burners.

The parameter *Burner_Rotation_Interval* sets the number of days after which the sequence is updated.

When *Burner_Rotation_Interval* is set to 0 burner rotation is disabled.

When the parameter *Burner_Rotation_Interval* is updated the burner rotation days left will be initialized to the new *Burner_Rotation_Interval* setting.

When for example *Burner_Rotation_Interval* = 5 the start sequence is as following (x is the last burner):

Days	Start/Stop sequence
Day 0-5	1-2-3-4-5..x
Day 5-10	2-3-4-5..x-1
Day 10-15	3-4-5..x-1-2
Day 15-20	4-5..x-1-2-3
Day 20-25	5..x-1-2-3-4

With parameter *First_Depending_To_Start* the current depending that is first to start in the sequence is selected.

When the burners are rotated the parameter *First_Depending_To_Start* is automatically updated to the next depending.

When burner rotation is disabled the parameter *First_Depending_To_Start* is reset to 0.

When the *First_Depending_To_Start* is manually changed the control will clear all demand of the cascade control. After this it will start cascade demand generation with the new selection for *First_Depending_To_Start*.

Relevant variables

Specific Parameters	Level	(Default) Value	Range
Burner_Rotation_ Interval	2: Installer	5	0..30 0 = Disable
First_Depending_To_ Start	2: Installer	1	1..8/16

3.3.7 Cascade – error handling

3.3.7.1 Emergency mode

Open / Shorted boiler or system sensor

When the setting "*Permit_Burner_Emergency_Mode*" is enabled the control can go into emergency mode when the system sensor status is not ok. When the system sensor is open or shorted the control goes into the emergency mode.

The managing burner display may show that the system is in emergency mode.

In emergency mode the system setpoint is set to the *Cascade_Emergency_Setpoint* (settable via installer menu).

When an emergency heat demand is generated all burners are allowed to start burning on this setpoint.

Loss of cascade communication (Rev. 3.0.0.14038)

The leading board is aware of how many dependents should be present in the system. This value is stored in the e2prom. When powering on the system the leading burner has to detect all depending burners within 60 seconds.

When not all dependent burners are detected the control will show the *CC_LOSS_COMMUNICATION* warning.

When the communication with any of the depending burners is lost during operation the control will show the *CC_LOSS_COMMUNICATION* warning after 60 seconds.

The *CC_LOSS_COMMUNICATION* warning is purely informative and will not block the control.

3.3.7.2 Managing burner error (Rev. 3.0.0.11748)

When the managing burner is in error mode this burner is not used anymore for the cascade system.

However depending on the error code, the pumps connected by the managing burner still can be active for the cascade system. When the managing unit is reset from lockout state, the cascade controllers are re-initialized.

4 Service display

4.1 General

4.1.1 Introduction

The 900PB Display is an advanced graphical user interface for applications such as HMI for heating appliances.

It can be used in combination with other epHS controls and communicates with these controls via the AL-BUS connection.

This manual is applicable for layout versions:

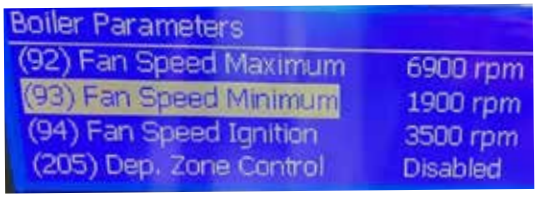
- 905PB05_3R

4.1.2 General information

Dimensions PCB	L × W × H	900PB0X_3R: 178x85x13mm (7,01”x3,35”x0,51”)
Operating temperature		0°C to +50°C (32°F to 122°F)
Connections		See “Appendix A - Connection diagram
LCD mode		255 x 80 Dot graphic
Module dimensions	W × H × T	121,4x47,6x5,0mm (4,78”x1,87”x0,2”)
Viewing area	W × H	106,4 x 39,0mm (4,19”x1,54”)
Active area	W × H	95,0 x 32,0mm (3,74”x1,26”)
Dot size	W × H	0.34 x 0.37
Dot pitch	W × H	0.37 x 0.40
LCD display mode		TN/Blue/Negative/ Transflective
Viewing direction		12 O’clock

4.1.3 Display functions

Button	Function
RESET	Reset Lockout error
MENU	Enter the main menu
ESC	Return to the Status overview
LEFT	Return to previous menu item or Status overview
RIGHT	Enter a menu item or confirm selection in Status overview (when directly setting Actual setpoint or DHW setpoint)
ENTER	Confirm a setting or enter a menu item
UP	Directly select Actual setpoint of DHW setpoint in the Status overview, push RIGHT to confirm and use UP or DOWN to adjust value
DOWN	Directly select Actual setpoint of DHW setpoint in the Status overview, push RIGHT to confirm and use UP or DOWN to adjust value



4.1.4 Display icons

The following table gives a short description of the icons that can be visible on the main screen during operating:

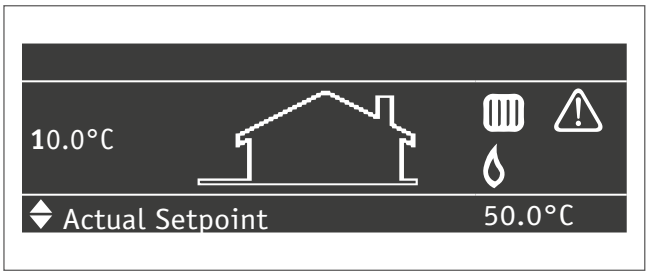
Icon	Description
	Central Heating demand
	Domestic Hot Water demand
	Indicates that the appliance burner is ON
	Cascade Emergency Mode active
	Error notification

4.2 Screens

4.2.1 Splash screen (Rev 1.1.0.13425)

This screen is active during power up and will remain active until communication with the Main Control (the AL-BUS) has been established. Standard no default start-up screen is installed, only the text “initializing” will appear (for certain projects a ‘Settings parameter is available to select a customized splash screen).

After communication has been established the following Status overview appears:



Set Actual setpoint/DHW setpoint directly via the Status overview

When CH is active, you can adjust the Actual setpoint directly on the bottom of the Status overview.

When DHW is active, you can adjust the DHW setpoint directly on the bottom of the Status overview.

Press UP/DOWN to select the mode, then press ENTER/RIGHT to confirm the mode and the Actual/DHW setpoint becomes directly settable. Use UP/DOWN to increase/decrease the setpoint.

Press ENTER/RIGHT to confirm your alteration or press BACK/LEFT to cancel.

A setpoint is only visible on the main screen when no error or alert is active. In case of an active error or alert, the bottom right part of the PB screen is used to display the error or alert text.

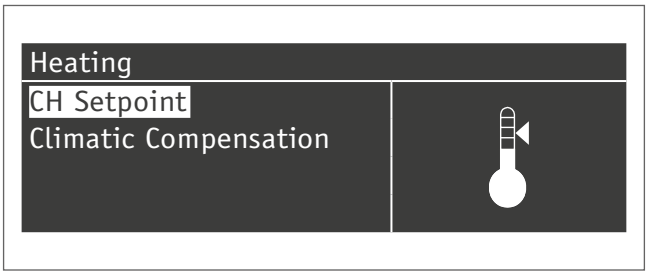
4.2.2 Entering the menu

Enter the menu by pressing the MENU button once. The header in the screen shows you are inside the main menu.

While scrolling through the menu you will see that the selected menu item is shown in a white rectangle.

Enter a menu item by pressing ENTER or RIGHT.

The header shows your location inside the menu, as seen in the following image on the next page:



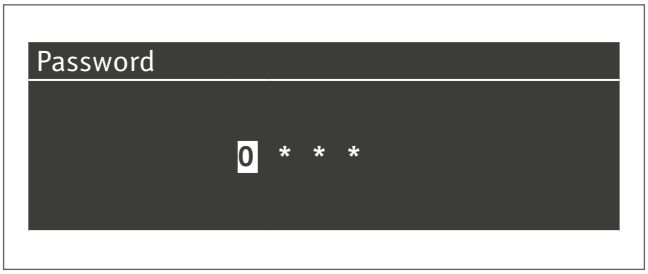
If you are inside the menu (or a menu item) and want to return directly to the Status overview press MENU/ESC.

If you want to go back one step in the menu press BACK/LEFT.

4.2.3 Protected menu items

Some menu items are protected and only accessible via a password*.

The following password screen will then appear:



Enter the password with the following steps:

1 Use the UP/DOWN button to adjust the first number
2 Press ENTER or RIGHT to confirm and to go to the following number.
3 Enter 0300.

Repeat this action for all numbers to enter the password.

During this action, if you want to return to the previous screen, just press MENU or ESC to cancel.

After the password is entered in correctly, the menu item will become available.

The following menu items require a password*:

(Sub) Menu item	Location inside menu
Climatic Compensation	via 'Heating > Climatic compensation'
Boiler	via 'Settings > Boiler'

* Passwords for different user levels are always customer specific and will be provided by epHS to the appliance manufacturer only (due to safety reasons).

4.2.4 DAir Sequence

The "De-Air" sequence is a safety function that starts at every power ON and is used to remove the air from the heater-exchanger.

The DAir sequence does not start after a general reset (like the locking error reset or 24 hours reset)

The display will show the following string during DAir sequence:

- Dair Running
- MN: Low Water Pressure

The DAir sequence can be canceled by the user by pressing the OK button for over 5 seconds.

4.2.5 Language settings

The 900PB display has a number of different language options, such as English, French, Spanish, Chinese and Italian.... (there are 18 languages)

Paragraph 4.2.5.1 describes how to set the display language (and characters) to Chinese.

Paragraph 4.2.5.2 describes how to set the language back from Chinese to English (or any other language).

4.2.5.1 Set the display language to Chinese

Please follow the next steps, which describe how to set the display language to Chinese:

[1] From the Status Overview, press the MENU button once
[2] Select "Settings" and press the ENTER button
[3] Select "General Settings" and press the ENTER button
[4] Select "Language" and press the ENTER button
[5] Select the Chinese language (中文) and press ENTER

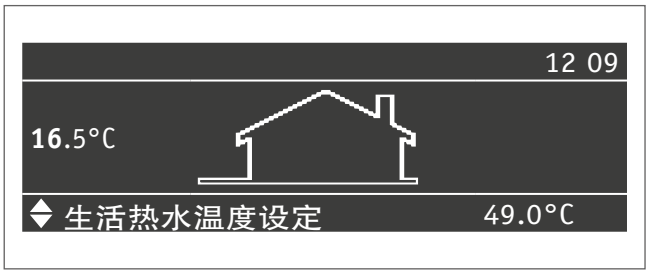
After the Step 5 the text and menu items will automatically be displayed in Chinese:

Press ESC to go back in the menu and return to the Status Indication screen.

No matter what language you set, the menu icons will always remain universal.

4.2.5.2 Set the display language from Chinese back to English

First, make sure you the Status Indication screen is displayed, which looks as following:



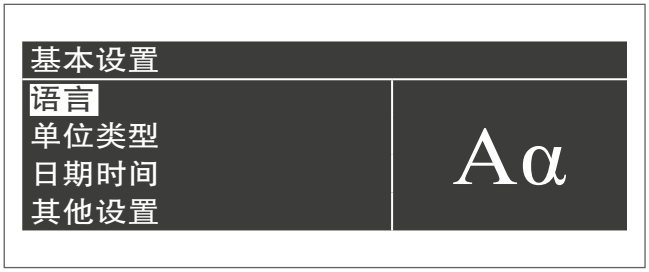
If this is not the case, press the ESC button a couple of times until you return to this screen.

The following steps describe how to set the display from Chinese back to English:

[1] Press the MENU button once to enter the main Menu (菜单)
[2] Select "Settings" (设置) and press the ENTER button to access this menu:

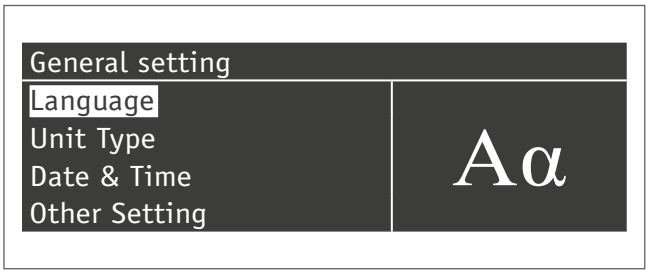
[3] Select "General Settings" (基本设置) and press the ENTER button:

[4] Select "Language" (语言) and press the ENTER button:



[5] Select the desired language (“English“) and press ENTER to confirm: (For setting the display to French: select “Français”, for Italian select “Italiano”)

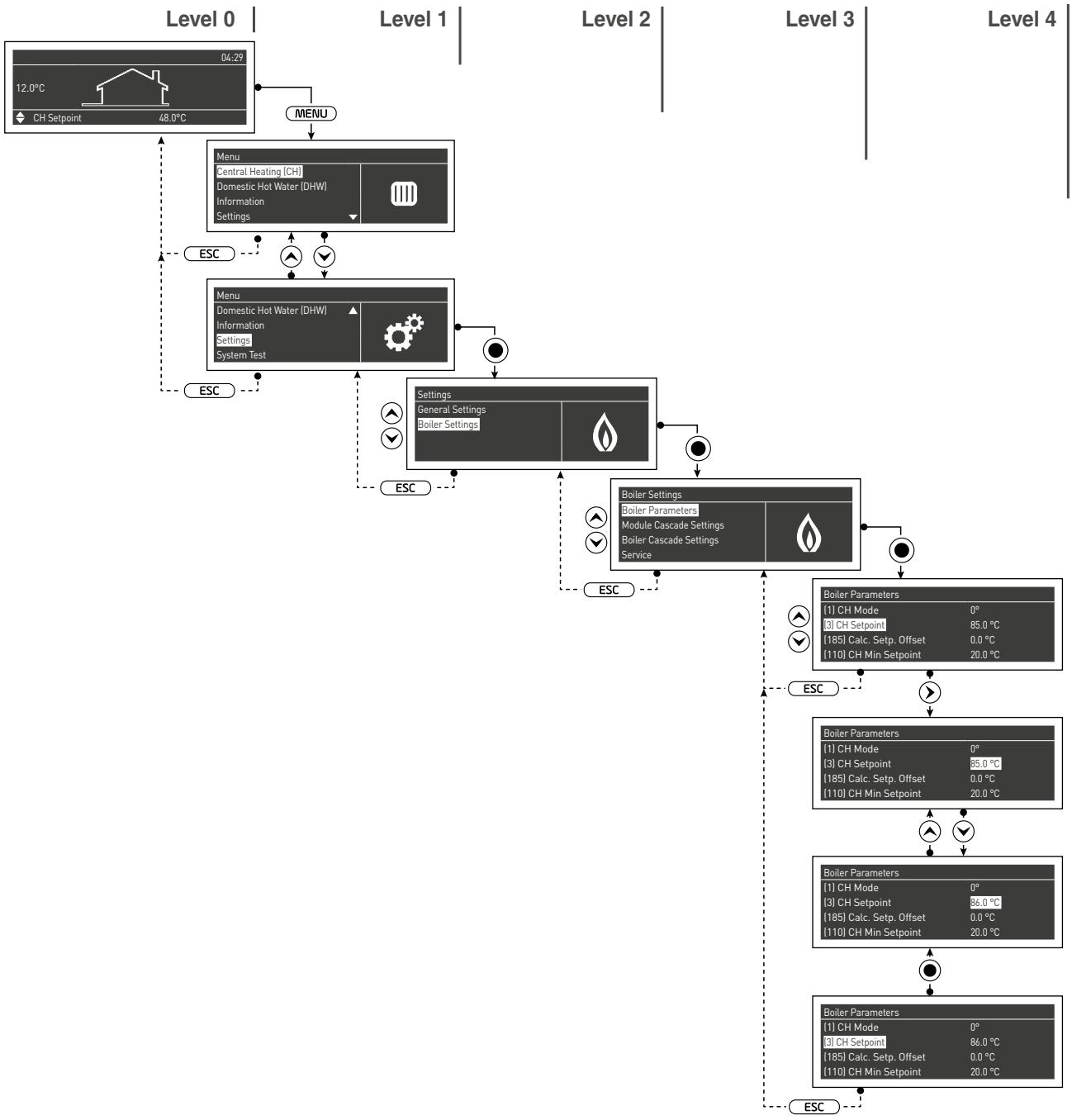
Once you have set the English language, the screen will display its information in English again:

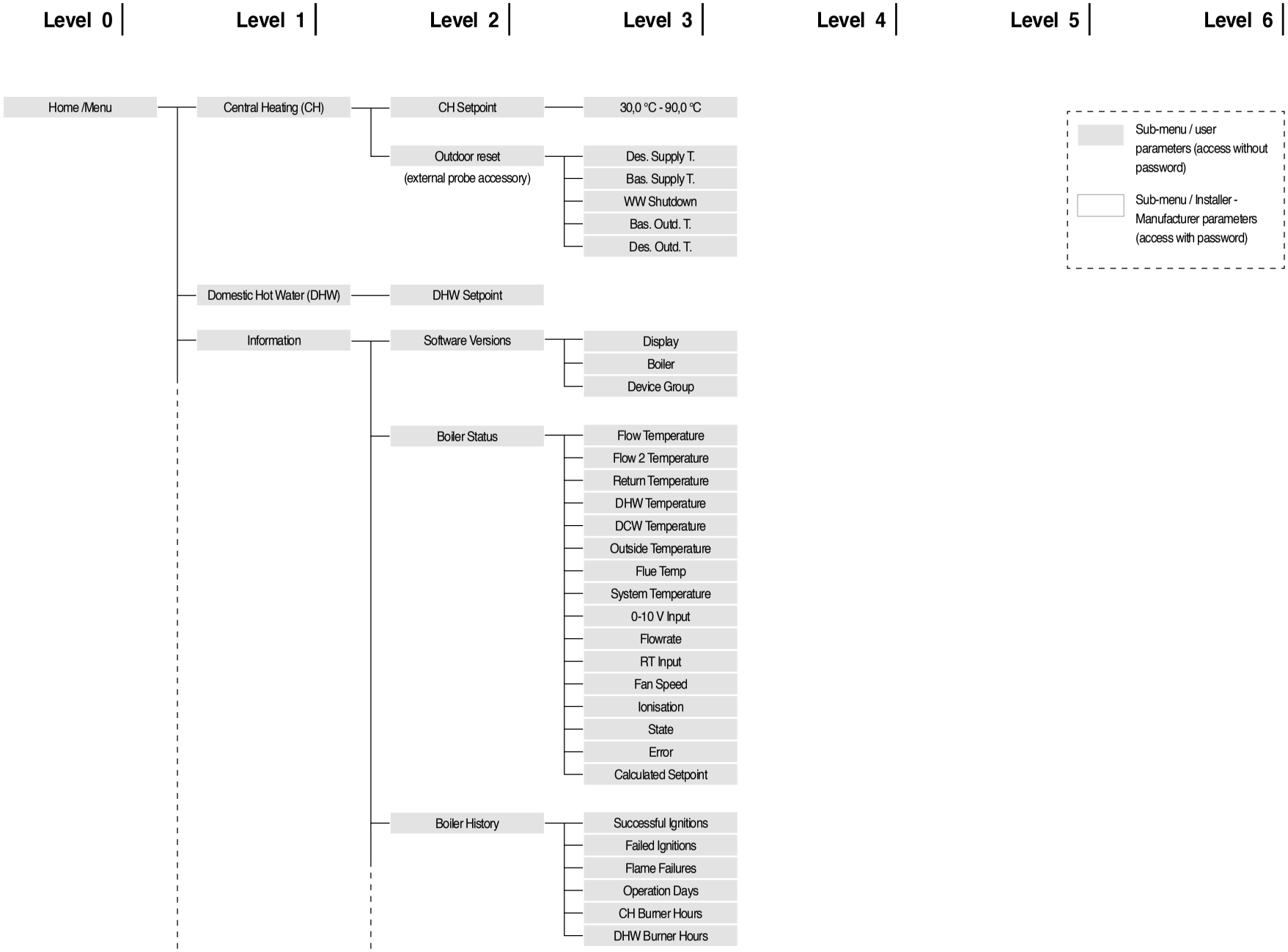


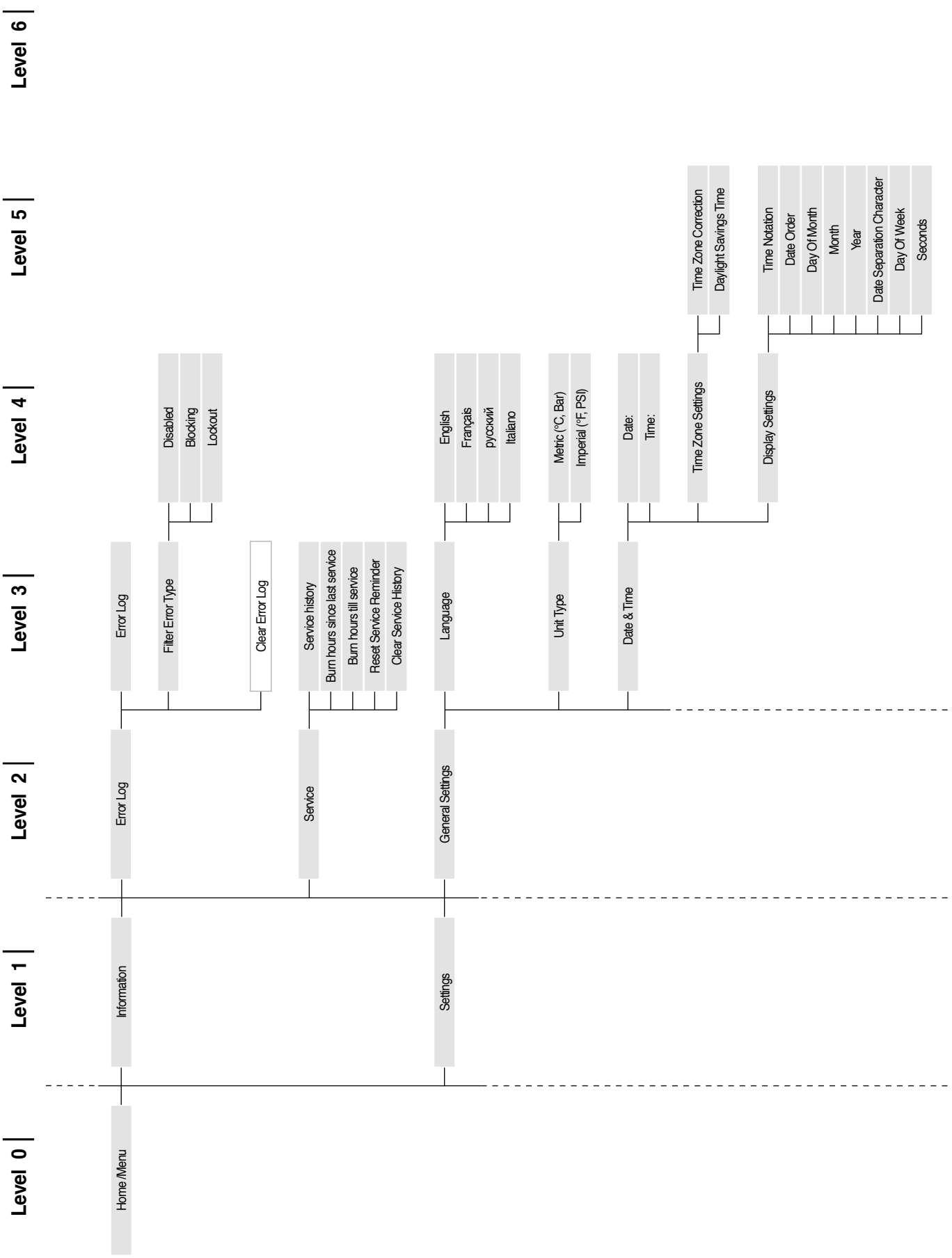
Press ESC to go back in the menu and return to the Status Indication screen.

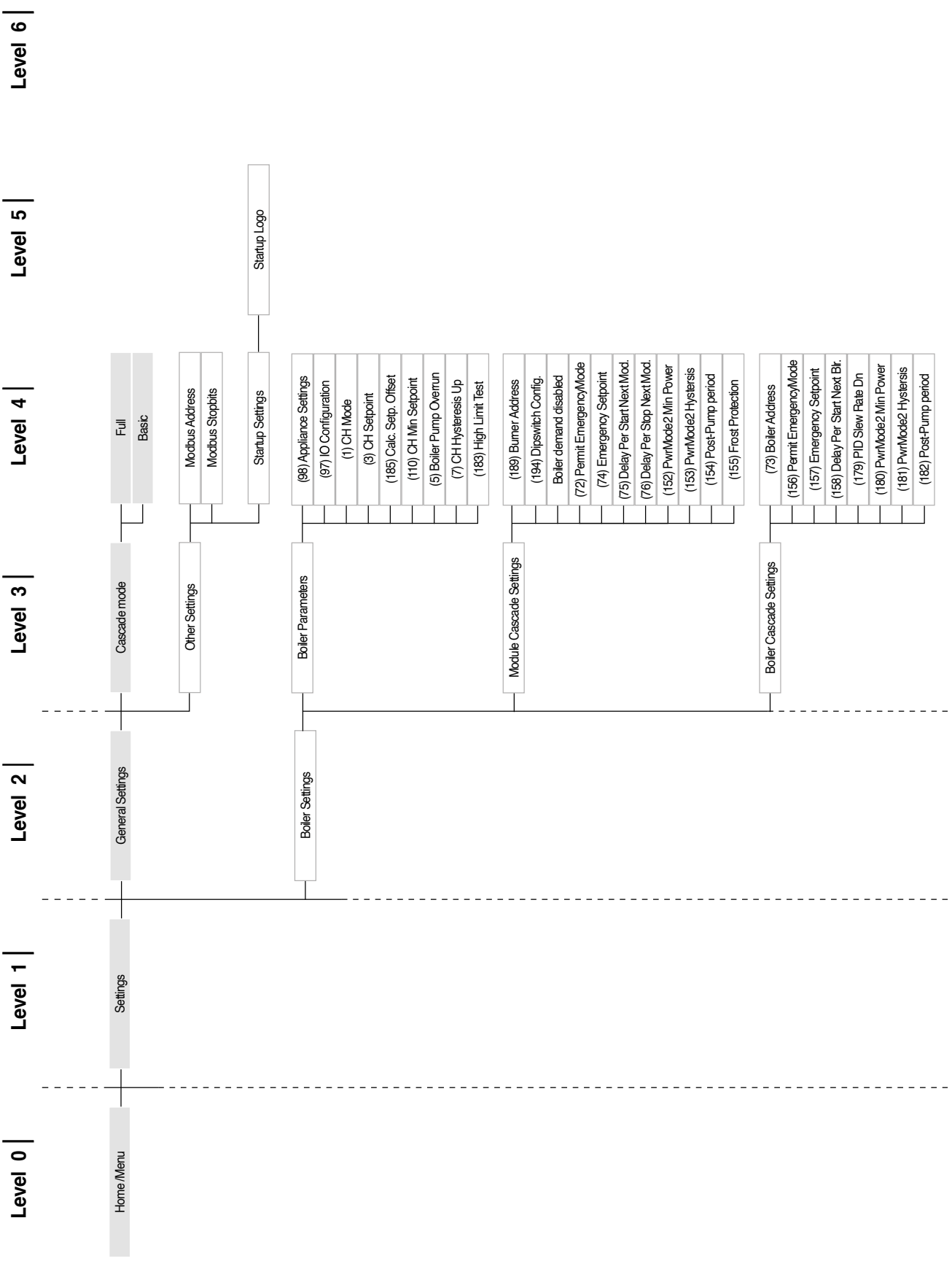
4.3 Menu Structure

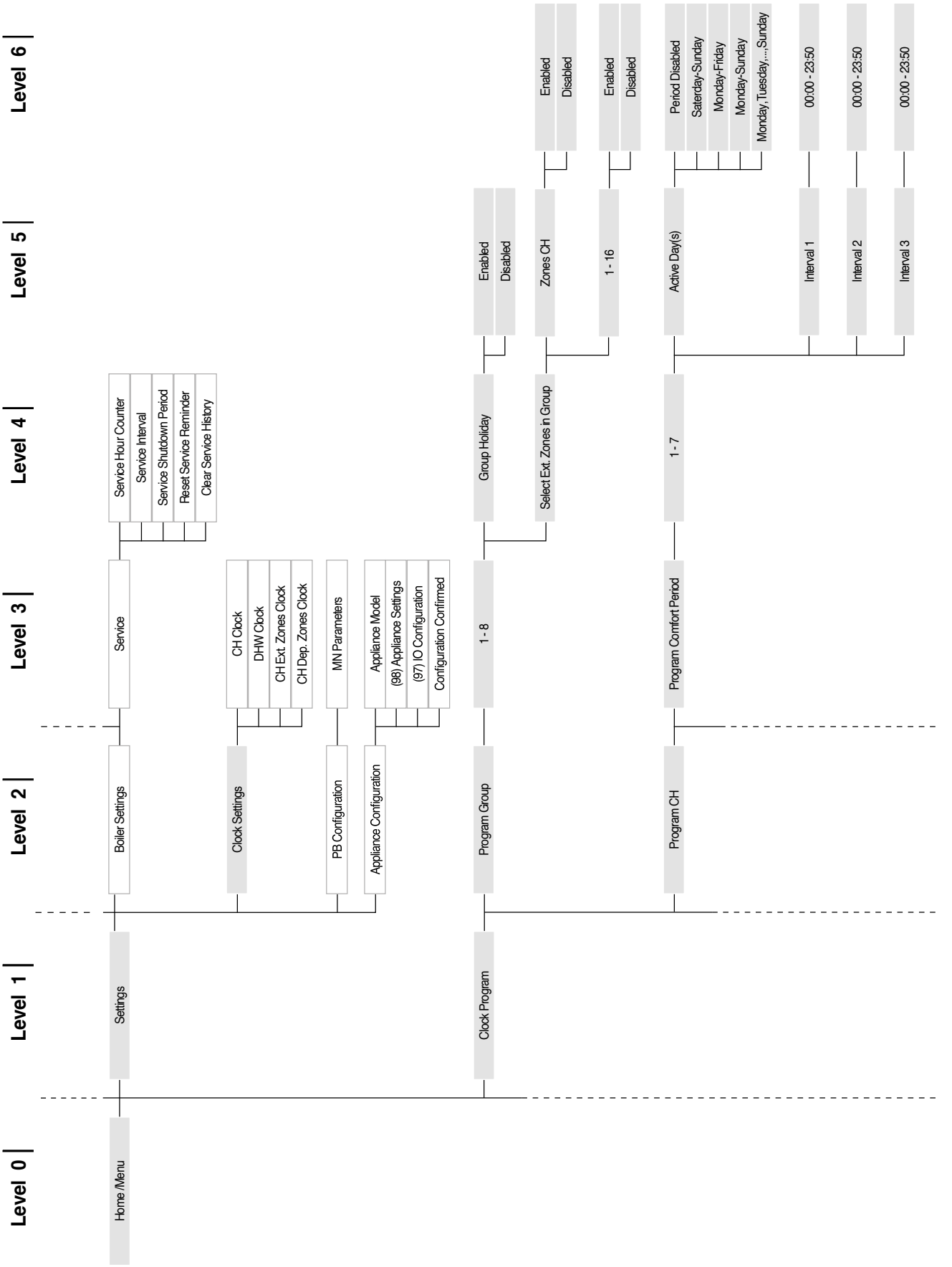
Below is a schematic overview of the menu structure of 900MN control.

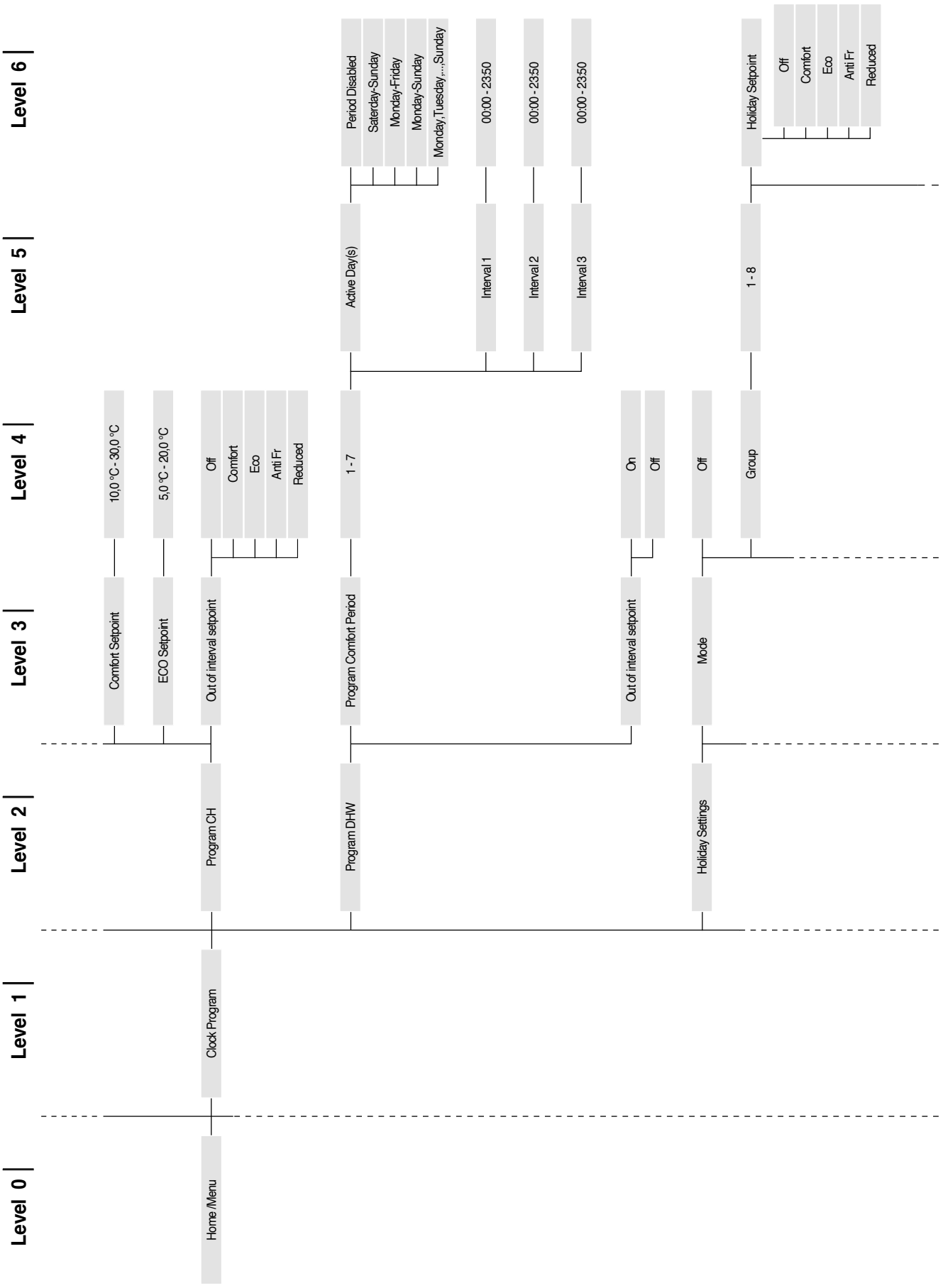


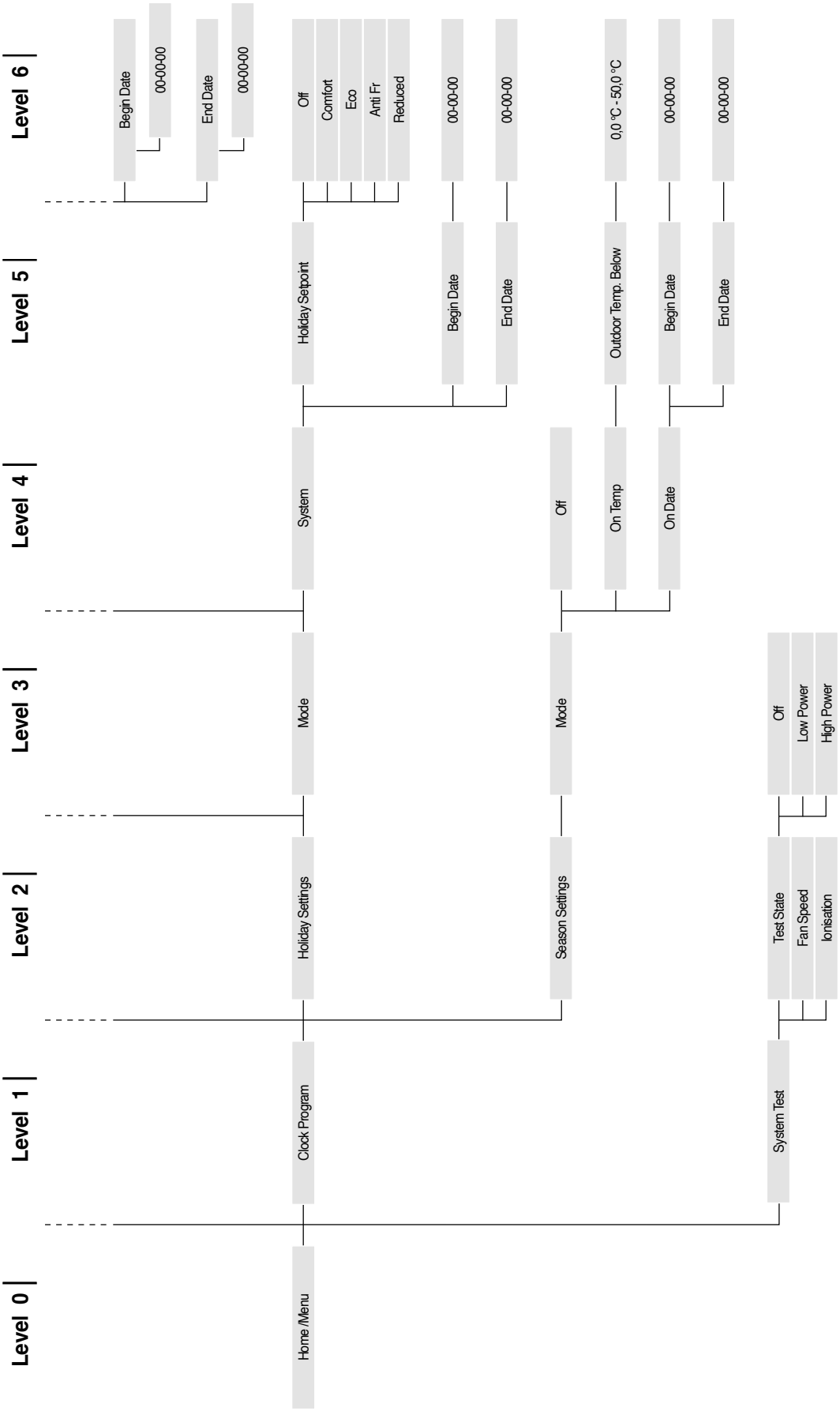

Level 0
Level 1
Level 2
Level 3
Level 4
Level 5
Level 6
Home /Menu
Central Heating (CH)
CH Setpoint
30,0 °C - 90,0 °C
Outdoor reset
(external probe accessory)
Des. Supply T.
Bas. Supply T.
WW Shutdown
Bas. Outd. T.
Des. Outd. T.
Domestic Hot Water (DHW)
DHW Setpoint
Information
Software Versions
Display
Boiler
Device Group
Boiler Status
Flow Temperature
Flow 2 Temperature
Return Temperature
DHW Temperature
DCW Temperature
Outside Temperature
Flue Temp
System Temperature
0-10 V Input
Flowrate
RT Input
Fan Speed
Ionisation
State
Error
Calculated Setpoint
Boiler History
Successful Ignitions
Failed Ignitions
Flame Failures
Operation Days
CH Burner Hours
DHW Burner Hours
Sub-menu / user parameters (access without password)
Sub-menu / Installer - Manufacturer parameters (access with password)


Level 0
Level 1
Level 2
Level 3
Level 4
Level 5
Level 6
Home /Menu
Information
Settings
Error Log
Service
General Settings
Error Log
Filter Error Type
Clear Error Log
Service history
Burn hours since last service
Burn hours till service
Reset Service Reminder
Clear Service History
Language
Unit Type
Date & Time
Disabled
Blocking
Lockout
English
Français
русский
Italiano
Metric (°C, Bar)
Imperial (°F, PSI)
Date:
Time:
Time Zone Settings
Display Settings
Time Zone Correction
Daylight Savings Time
Time Notation
Date Order
Day Of Month
Month
Year
Date Separation Character
Day Of Week
Seconds


Level 0
Level 1
Level 2
Level 3
Level 4
Level 5
Level 6
Home /Menu
Settings
General Settings
Cascade mode
Full
Basic
Other Settings
Modbus Address
Modbus Stopbits
Startup Settings
Startup Logo
Boiler Settings
Boiler Parameters
(98) Appliance Settings
(97) IO Configuration
(1) CH Mode
(3) CH Setpoint
(185) Calc. Setp. Offset
(110) CH Min Setpoint
(5) Boiler Pump Overrun
(7) CH Hysteresis Up
(183) High Limit Test
Module Cascade Settings
(189) Burner Address
(194) Dipswitch Config.
Boiler demand disabled
(72) Permit EmergencyMode
(74) Emergency Setpoint
(75) Delay Per Start Next Mod.
(76) Delay Per Stop Next Mod.
(152) PwrMode2 Min Power
(153) PwrMode2 Hystersis
(154) Post-Pump period
(155) Frost Protection
Boiler Cascade Settings
(73) Boiler Address
(156) Permit EmergencyMode
(157) Emergency Setpoint
(158) Delay Per Start Next Blr.
(179) PID Slew Rate Dn
(180) PwrMode2 Min Power
(181) PwrMode2 Hystersis
(182) Post-Pump period


Level 0
Level 1
Level 2
Level 3
Level 4
Level 5
Level 6
Home /Menu
Settings
Boiler Settings
Service
Service Hour Counter
Service Interval
Service Shutdown Period
Reset Service Reminder
Clear Service History
Clock Settings
CH Clock
DHW Clock
CH Ext. Zones Clock
CH Dep. Zones Clock
PB Configuration
MN Parameters
Appliance Configuration
Appliance Model
(98) Appliance Settings
(97) IO Configuration
Configuration Confirmed
Clock Program
Program Group
1 - 8
Group Holiday
Enabled
Disabled
Select Ext. Zones in Group
Zones CH
Enabled
Disabled
1 - 16
Enabled
Disabled
Program CH
Program Comfort Period
1 - 7
Active Day(s)
Period Disabled
Saterday-Sunday
Monday-Friday
Monday-Sunday
Monday, Tuesday,...,Sunday
Interval 1
00:00 - 23:50
Interval 2
00:00 - 23:50
Interval 3
00:00 - 23:50


Level 0
Level 1
Level 2
Level 3
Level 4
Level 5
Level 6
Home /Menu
Clock Program
Program CH
Comfort Setpoint
10,0 °C - 30,0 °C
ECO Setpoint
5,0 °C - 20,0 °C
Out of interval setpoint
Off
Comfort
Eco
Anti Fr
Reduced
Program DHW
Program Comfort Period
1 - 7
Active Day(s)
Period Disabled
Saterday-Sunday
Monday-Friday
Monday-Sunday
Monday,Tuesday,...,Sunday
Interval 1
00:00 - 23:50
Interval 2
00:00 - 23:50
Interval 3
00:00 - 23:50
Out of interval setpoint
On
Off
Holiday Settings
Mode
Off
Group
1 - 8
Holiday Setpoint
Off
Comfort
Eco
Anti Fr
Reduced


Level 0
Level 1
Level 2
Level 3
Level 4
Level 5
Level 6
Home /Menu
Clock Program
Holiday Settings
Mode
System
Holiday Setpoint
Begin Date
00-00-00
End Date
00-00-00
Off
Comfort
Eco
Anti Fr
Reduced
Begin Date
00-00-00
End Date
00-00-00
Season Settings
Mode
Off
On Temp
Outdoor Temp. Below
0,0 °C - 50,0 °C
On Date
Begin Date
00-00-00
End Date
00-00-00
System Test
Test State
Off
Low Power
High Power
Fan Speed
Ionisation

5 Main control

5.1 Ignition cycle (Rev 3.0.0.0)

The table below shows the states of the burner ignition cycle.

Control state	Actions
Pre purge 0	Fan is not running Initialize pre-purge 1.
Pre purge 1	Fan starts at ignition speed
Pre ignit	Fan stays at ignition speed Igniter is started
Safety period	Ignit state+ Safe proving
Ignit	Fan stays at ignition speed The gas valve is opened Igniter stays on
Flame proving	Fan stays at ignition speed The gas valve stays opened The igniter is stopped
Burn	The fan is modulating The gas valve stays opened
Post burn	The fan is set at ignition speed The gas valve is closed Initialize post purge 0
Post purge 0	The fan is set at ignition speed The gas valve is closed
Post purge 1	Fan stays at ignition speed
Stand-by	Fan is not running The gas valve is closed Pump post running may be active

During the ignition cycle there are multiple safety checks active.

False flame detection	If flame is detected at the end of the pre-spark period (*Pre ignit*) a lockout error occurs
Re-ignition	If at the end of the safety period no flame is detected the control will go to post-purge to remove the unburned gas. After this a re-ignition attempt is started following the same cycle. The number of re-ignition attempts is limited to *Max_Ignit_Trials* after which a lockout occurs.
Flame establishing time	Sparking stops in the *Flame proving* state to allow for ionization detection. The Flame proving state takes *SAFETY_PERIOD − IGNIT_PERIOD.*
Flame out too late	If at the end of the Post purge 0 state the flame is still detected a lockout follows.
Flame loss	When a flame is lost during a burn cycle the control will restart the burner. The number of restarts is limited by the *max_flame_trials* setting.
Fan supervision	The fan speed is continuously monitored. The following conditions for the fan speed are checked. • The actual fan speed must be within 300rpm of the target fan speed • When in the burn state both the actual and target fan speeds are above 4200rpm, the check on the 300rpm range is not performed.

5.2 Control functions

Dependent on the required functions of the appliance and connected sensors and components, several operation modes for Central Heating (CH) and Domestic Hot Water (DHW) can be selected.

5.2.1 Demand for central heating (Rev 3.0.0.0)

5.2.1.1 CH Mode 0 - Central Heating demand

For this mode the CH mode should be set to 0 and no outdoor sensor is needed.

If the room thermostat closes, the pump is switched ON. When the supply temperature drops *CH_Hysterese_Down below the CH_Setpoint* (settable via the menu) the burner is switched ON. The power for the burner is PID regulated between *T_Supply* and the *CH_Setpoint* using the PID parameters for Central Heating (Also see chapter “Appendix F - PID: Proportional-Integral-Derivative controller” pag. 75).

If the supply temperature reaches a temperature *CH_Hysterese_Up* above the *CH_Setpoint* the burner is switched OFF.

However, if *CH_Setpoint + CH_Hysterese_Up* is greater than maximum setpoint the burner switches OFF at the maximum setpoint.

If the room thermostat opens the burner is switched OFF (if this was not already happening) and the CH and general pumps run ON for *CH_Post_Pump_Time*.

Anti-cycling time

(This function is also applicable to all other CH modes)

When the burner is switched OFF because the supply temperature reaches *CH_Setpoint + CH_Hysterese_Up*, the control will wait a period of time (*Anti_Cycle_Period* → 180 sec. settable) before it is allowed to be switched ON again.

This function is to prevent fast switching ON and OFF of the burner. However, when during the anti-cycle wait time the differential between setpoint and supply temperature gets greater than *Anti_Cycle_T_Diff, anti-cycle* will be aborted and the burner is allowed to start.

Maximum CH power

(This function is also applicable to all other CH modes)

The maximum burner power during CH operation can be limited with parameter *P_CH_Max*.

Minimum CH power

(This function is also applicable to all other CH and DHW modes)

- The minimum burner power during operation can be limited with parameter *P_CH_Min*.

Relevant variables

Specific Parameters		Level	(Default) Value		Range	
			°C	°F	°C	°F
CH_Mode		2: Installer	0		0, 1, 2, 3, 4	
CH_Setpoint Sets the required supply temperature.	[°C/°F]	1: User	60	140	20..90	68..194
Post_Pump_Period	[sec]	1: User	120 sec.		10..900 sec.	
Max_Flue_Gas_Temp Sets the max flue gas temperature.	[°C/°F]	3: Factory	95	203	10..120	50..248
CH_Hysterese_Up	[°C/°F]	3: Factory	5	9	0..20	0..36
CH_Hysterese_Down	[°C/°F]	3: Factory	5	9	0..20	0..36
Anti_Cycle_Period	[sec]	2: Installer	180 sec.		10..900 sec.	
Anti_Cycle_T_Diff Aborts anti-cycle time when setpoint – actual supply temp > Anti_Cycle_T_Diff.	[°C/°F]	2: Installer	16	29	0..20	0..36
Hx_Diff_Delta_T_Min Minimum differential over heat exchanger (T_Supply - T_Return) at which burner load is decreased.	[°C/°F]	3: Factory	40	72	10..80	18..144
Hx_Diff_Max_Wait_Time Wait time after upper limit primary heat exchanger differential has been exceeded.	[sec]	3: Factory	0 sec.		1..255	
P_CH_Max Maximum burner power for CH operation	[%]	2: Installer	100		1..100	
P_CH_Min Minimum burner power for CH operation	[-]	2: Installer	1		1..50	
PID_P		3: Factory	100		0..1275	
PID_I		3: Factory	500		0..1275	
PID_D		3: Factory	0		0..1275	

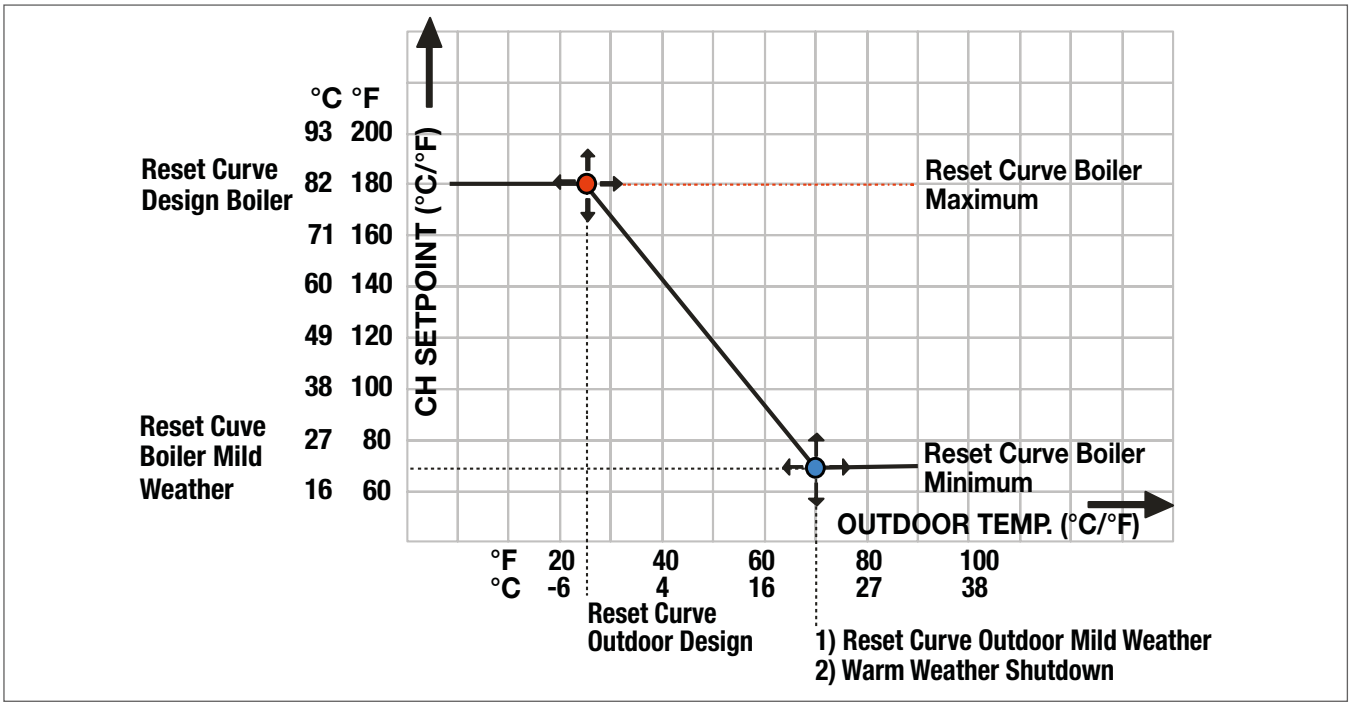
Status variables	Level		Value/Range	
			°C	°F
CH control state Central heating controller state			0 → Idle 1 → Request 2 → Demand 3 → Post circulation 4 → Off	
RT_Input Room thermostat open or closed			0 → Open 1 → Closed	

5.2.1.2 CH mode 1 - CH with an outdoor temperature reset and thermostat control

If the parameter *CH_Mode* is set to 1 the “Outdoor temperature reset with room thermostat” mode is selected.

This mode will only function when an outdoor temperature sensor is connected. If the outdoor sensor is connected, the boiler automatically uses *Reset_Curve_Boiler_Maximum*.

The setpoint is calculated depending on the outdoor temperature as indicated in the following graph and the burner will react on the room thermostat (as described in paragraph “5.2.1.2 CH mode 1 - CH with an outdoor temperature reset and thermostat control” pag. 31).



The outdoor reset curve can be changed by adjusting the design and mild weather reference temperatures.

The calculated CH-setpoint is always limited between parameters *Reset_Curve_Boiler_Minimum* and *Reset_Curve_Boiler_Maximum*.

The outdoor temperature used for the *CH_Setpoint* calculation is measured once a minute and averaged with the previous measurement. This is to avoid commuting when the outside temperature changes rapidly.

If an “open” outdoor sensor is detected the *CH_Setpoint* will be equal to the *Reset_Curve_Design_Boiler*.

Shutdown temperature

When the outdoor temperature rises above *Warm_Weather_Shutdown*, the call for heat is blocked and the pumps are stopped.

There is a fixed hysteresis of 1°C (1.8°F) around the *Warm_Weather_Shutdown* setting.

This means that the demand is stopped when the outdoor temperature has risen above *Warm_Weather_Shutdown* + 1°C.

When the outdoor temperature drops below *Warm_Weather_Shutdown* – 1°C again, the demand will also start again.

Boost function

The outdoor reset boost function increases the *CH_Setpoint* by a prescribed increment (**Boost_Temperature_Incr**) if a call for heat continues beyond the pre-set time limit (*Boost_time_Delay*).

CH_setpoint increases again if the call for heat still is not satisfied in another time increment.

Setpoint adjustment

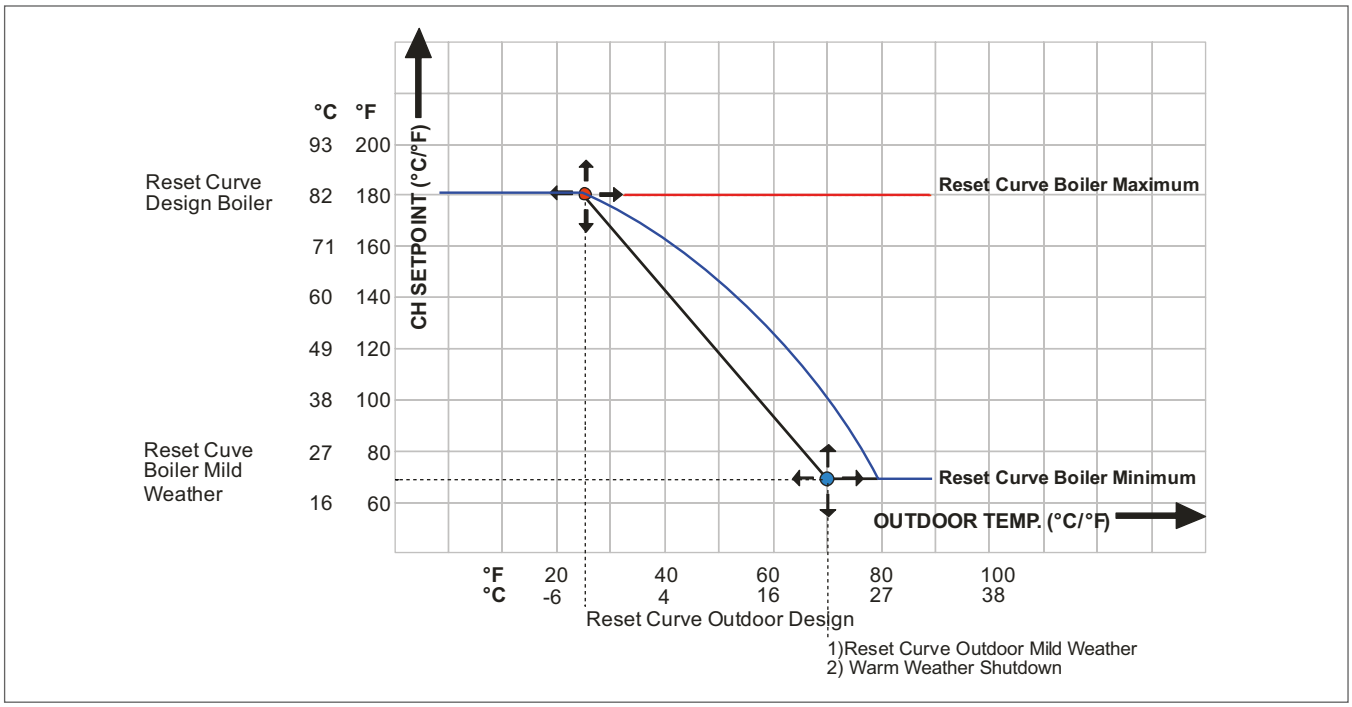
It is possible to adjust the calculated setpoint with parameter *CH_Setpoint_Diff*. The calculated setpoint can be increased or decreased with a maximum of 10°C. The CH setpoint limits (*Reset_Curve_Boiler_Minimum* and *Reset_Curve_Boiler_Maximum*) are respected while adjusting the setpoint.

Apart from the calculated setpoint the functionality is the same as described in paragraph “5.2.1.2 CH mode 1 - CH with an outdoor temperature reset and thermostat control” pag. 31)

CH Setpoint calculated with an extra correction

The calculated setpoint based on the outdoor temperature can also be adjusted with another correction. The generation of this extra correction is a result of a not linear computation.

The new setpoint is calculated as follow:
New CH calculated setpoint (@Outdoor_temp)= CH calculated setpoint (@Outdoor_temp) – extra correction (@Outdoor_temp)
The parameter used for the extra compensation is E2_CH_Reset_Curve_Comp**.**



CH outdoor reset curve in red color and CH outdoor reset Curve with extra compensation in blue

Relevant variables

Specific Parameters		Level	(Default) Value		Settable	
			°C	°F	°C	°F
CH_Mode		2: Installer	0		0, 1, 2, 3, 4	
CH_Hysterese_Up	[°C/°F]	3. Factory	5	9	0..20	0..36
CH_Hysterese_Down	[°C/°F]	3. Factory	5	9	0..20	0..36
Reset_Curve_Boiler_Minimum Sets the lower limit for the CH setpoint (minimum).	[°C/°F]	2: Installer	30	86	4..82	39..180
Reset_Curve_Boiler_Maximum Sets the upper limit for the CH setpoint (maximum).	[°C/°F]	2: Installer	80	176	27..90	81..194
Reset_Curve_Design_Boiler Sets high boiler CH setpoint when outdoor temp. is equal to Reset_Curve_Outdoor_Design. The range for this parameter is limited by the Reset_Curve_Boiler_Minimum and Reset_Curve_Boiler_Maximum parameters!	[°C/°F]	2: Installer	80	176		
Reset_Curve_Outdoor_Design Sets the outdoor temp at which the boiler setpoint must be high as set by Reset_Curve_Design_Boiler.	[°C/°F]	2: Installer	-5	23	-20..25	-13..77
Reset_Curve_Boiler_Mild_Weather Sets low boiler CH setpoint when outdoor temp. is equal to Reset_Curve_Outdoor_Mild_Weather. The range for this parameter is limited by the Reset_Curve_Boiler_Minimum and Reset_Curve_Boiler_Maximum parameters!	[°C/°F]	2: Installer	40	104		

Specific Parameters		Level	(Default) Value		Settable	
			°C	°F	°C	°F
Reset_Curve_Outdoor_Mild_Weather Sets the outdoor temp at which the boiler setpoint must be low as set by Reset_Curve_Mild_Weather.	[°C/°F]	2: Installer	20	68	0..30	32..86
Warm_Weather_Shutdown Set max. outdoor temp. Above this temperature heat demand is blocked.	[°C/°F]	2: Installer	22	72	0..35	32..95
Boost_Temperature_Incr CH setpoint increment when heat demand remains beyond Boost_Time_Delay.	[°C/°F]	2: Installer	0	0	0..20	0..36
Boost_Time_Daily	[min]	2: Installer	20 min.			1..120
CH_Setpoint_Diff Adjusts the calculated CH setpoint.	[°C/°F]	1: User	0	0	-10..10	-18..18
CH_Reset_Curve_Comp Extra compensation	[°C/°F]	1: User	0	0	-10..10	-18..18

Status variables	Level		Value/Range	
			°C	°F
Actual_CH_Setpoint Calculated CH setpoint based on outdoor reset curve.			20..90	68..194

5.2.1.3 CH mode 2 – Central Heating with full outdoor temperature reset

When *CH_Mode* is set to 2, full weather compensator is chosen. For this mode an outdoor sensor has to be connected.

The *CH_Setpoint* is calculated on the same way as described in paragraph”5.2.1.2 CH mode 1 - CH with an outdoor temperature reset and thermostat control” pag. 31.

The *CH_Setpoint* can be calculated with an extra correction described in paragraph “5.2.1.2 CH mode 1 - CH with an outdoor temperature reset and thermostat control” pag. 31

However, the demand does not depend on the RT input but on the outdoor temperature and the outdoor reset setpoint.

When the outdoor temperature is below *Warm_Weather_Shutdown* (settable) CH demand is created.

During the night an input signal from an external clock can lower the *CH_Setpoint*.

When the RT input opens *CH_Setpoint* will be decreased with *Night_Setback_Temp*.

The RT input does not influence the CH demand directly!

Relevant variables

Parameters		Level	(Default) Value		Settable	
			°C	°F	°C	°F
CH_Mode		2: Installer	0		0, 1, 2, 3, 4	
Night_Setback_Temp Sets the desired CH setpoint decrease, when the clock (RT) input is closed.	[°C/°F]	2: Factory	10	18	0..50	0..90
Warm_Weather_Shutdown Set max. outdoor temp. Above this temperature heat demand is blocked.	[°C/°F]	2: Installer	22	72	0..35	32..95
CH_Setpoint_Diff Adjusts the calculated CH setpoint	[°C/°F]	2: User	0	0	-10..10	-18..18

5.2.1.4 CH mode 3 - CH with permanent heat demand

For this mode the *CH_Mode* should be set to 3, no outdoor sensor is needed.

The supply temperature is kept constantly at the setpoint temperature. The burner is controlled in a similar way as described in paragraph “5.2.1.1 CH Mode 0 - Central Heating demand” pag. 29.

When the room thermostat contact opens *CH_Setpoint* will be decreased with *Night_Setback_Temp*.

In this condition the pump is always ON.

NOTE: the pump start every 24 hours function is not performed during this mode. The pump in this mode is continuously running.

Relevant variables

Parameters	Level	(Default) Value		Settable	
		°C	°F	°C	°F
CH_Mode	2: Installer	0		0, 1, 2, 3, 4	
CH_Setpoint	1: User	60	140	20..80	68..176
CH_Hysterese_Up	3: Factory	5	9	0..20	0..36
CH_Hysterese_ Down	3: Factory	5	9	0..20	0..36

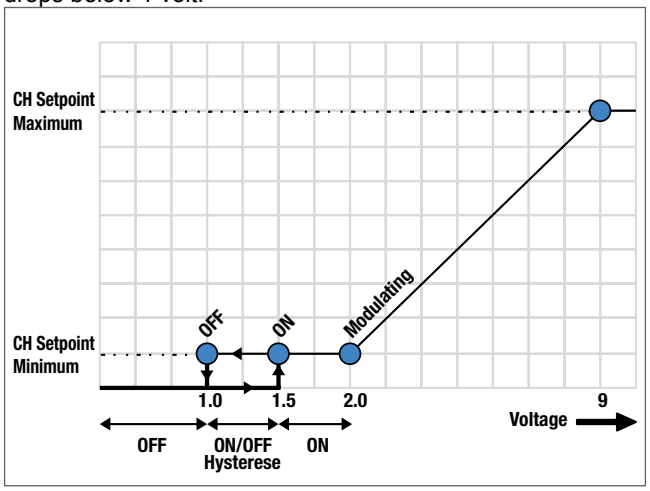
5.2.1.5 CH mode 4 - CH with Analog Input Control of setpoint

CH mode is set to 4. In this mode of operation, the boiler CH setpoint is controlled by an analog input signal provided by a remote means such as a building management system or a system controller. The analog input 0-10 Vdc, is used to adjust the boiler

setpoint between the *CH_Setpoint_Min* and the *CH_Setpoint_Max* settings.

The minimum analog input signal will correspond to the CH setpoint minimum parameter and the maximum analog input signal will correspond to the CH setpoint maximum parameter. All other safety and control functions associated with the boiler will react normally to adverse condition and override control of the analog signal to prevent an upset condition.

The CH setpoint Min. and CH setpoint Max. parameters can be adjusted to provide the desired temperature adjustment band. A heat request will be generated by an input of 1.5 volts or higher. The setpoint modulation will occur between 2 and 9 volts. The request for heat will be removed when the voltage drops below 1 volt.



Relevant variables

Parameters	Level	(Default) Value		Settable	
		°C	°F	°C	°F
CH_Mode	2: Installer	0		0, 1, 2, 3, 4	
CH setpoint Minimum [°C/°F]	2: Installer	20	68	20..80	68..176
CH setpoint Maximum [°C/°F]	2: Installer	80	176	20..80	68..176

5.2.2 Demand for Domestic Hot Water (Rev 3.0.0.0)

5.2.2.1 DHW mode 0 – No Domestic Hot Water

No domestic hot water is available. The *T_DHW_Out* sensor does not need to be connected.

5.2.2.2 DHW mode 1 – Storage with sensor

In DHW Mode 1 DHW is prepared by warming up a indirect tank. Either a DHW pump or 3-way valve can used to switch to DHW mode.

The DHW temperature in the tank is measured with sensor *T_Store* and set with parameter *DHW_Store_Setpoint*.

When this sensor drops below *DHW_Store_Setpoint – DHW_Store_Hyst_Down* the control detects a demand for the store and starts the general and DHW pump .

If the supply temperature *T_Supply* is below *DHW_Store_Setpoint + DHW_Store_Supply_Extra – DHW_Supp_Hyst_Down* the burner is started as well.

When the burner is ON the power is PID-modulated so *T_Supply* is regulated towards

DHW_Setpoint + DHW_Store_Supply_Extra.

The burner is stopped when the supply temperature rises above

DHW_Store_Setpoint + DHW_Store_Supply_Extra + DHW_Supp_Hyst_Up.

The demand for the tank is ended when the tank-sensor rises above *DHW_Store_Setpoint + DHW_Store_Hyst_Up*.

The pump continues *DHW_Post_Pump_Period*.

DHW Priority

Standard DHW demand has priority over CH demand but the priority period is limited up to *CH_DHW_Switching_Time*.

The priority timer starts when both CH and DHW demand are present. After the *CH_DHW_Switching_Time* is achieved, the control will switch from DHW to CH operation. CH has priority now for a maximum period of *CH_DHW_Switching_Time*.

Different DHW Priority types can be chosen:

DHW priority	Description
0 → Time	DHW has priority to CH during *CH_DHW_Switching_Time*
1 → Off	CH always has priority to DHW
2 → On	DHW always has priority to CH
3 → Parallel	DHW always has priority to CH. CH Pump can be started if CH has a request and *CH_Setpoint* > Supply for DHW

Default DHW_Priority is set to 2.

Store warm hold function

Because of the presence of the store sensor (T_Store) the control can detect demand for holding the store warm.

If *T_Store* drops below *DHW_Store_Setpoint - DHW_Store_Hold_Warm* the burner starts at minimum power.

The burner stops if T_Store is higher than *DHW_Store_Setpoint + DHW_Store_Hyst_Up*.

Relevant variables

Specific Parameters		Level	(Default) Value °C	(Default) Value °F	Settable °C	Settable °F
DHW_Mode		2: Installer	0		0, 1, 2, 3, 5, 6, 7, 8	
DHW_Store_Setpoint Sets the desired DHW temperature.	[°C/°F]	1: User	57	135	40..71	104..160
DHW_Store_Hyst_Down Hysterese to detect store demand. Condition: T_Store below DHW_Store_Setpoint less DHW_Store_Hyst_Down.	[°C/°F]	3. Factory	5	9	0..20	0..36
DHW_Store_Hyst_Up Hysterese to end store demand. Condition: T_Store above DHW_Store_Setpoint + DHW_Store_Hyst_Up.	[°C/°F]	3. Factory	5	9	0..20	0..36
DHW_Store_Supply_Extra Increases the supply temperature to the store until DHW_Store_Setpoint + DHW_Store_Supply_Extra.	[°C/°F]	2: Installer	15	27	0..30	0..54
DHW_Priority	[-]		2		0 → Time 1 → Off 2 → On 3 → Parallel	
DHW_Supp_Hyst_Down Hysterese to start burner for DHW. Condition: T_Supply below DHW_Supply_Setpoint less DHW_Supp_Hyst_Down.	[°C/°F]	3. Factory	5	9	0..20	0..36
DHW_Supp_Hyst_Up Hysterese to stop burner for DHW. Condition: T_Supply above DHW_Supply_Setpoint plus DHW_Supp_Hyst_Up.	[°C/°F]	3. Factory	5	9	0..20	0..36
DHW_Store_Hold_Warm If T_Store drops below DHW_Store_Setpoint the store warm hold function becomes active.	[°C/°F]	3. Factory	5	9	0..10	0..18

Status variables	Level	Value/Range °C	Value/Range °F
DHW control state Central heating controller state		0 → Idle 1 → Request 2 → Demand 3 → Post circulation 4 → Off	

5.2.2.3 DHW mode 2 – Storage with thermostat

In this Mode DHW is prepared by warming up a indirect tank. Either a DHW pump or 3-way valve can used to switch to DHW mode. The temperature of the DHW in the indirect tank is regulated by a thermostat (instead of a sensor), which should provide only an open/closed signal to the control.

When the thermostat closes the control detects a demand for the tank and starts the DHW pump.

If the supply temperature *T_Supply* drops below *DHW_Store_Setpoint* + *DHW_Store_Supply_Extra* – *DHW_Supp_Hyst_Down* the burner starts.

When the burner is ON the power is PID-controlled based on *T_Supply* toward *DHW_Store_Setpoint* + *DHW_Store_Supply_Extra*.

The burner is stopped when the supply temperature rises above *DHW_Store_Setpoint* + *DHW_Store_Supply_Extra* + *DHW_Supp_Hyst_Up*.

The demand for the DHW is ended when the store thermostat opens. The pump continues *DHW_Post_Pump_Period* after the DHW demand stopped.

DHW priority

See paragraph “5.2.2.2 DHW mode 1 – Storage with sensor” pag. 34

Relevant variables

Specific Parameters		Level	(Default) Value		Settable	
			°C	°F	°C	°F
DHW_Mode		2: Installer	0		0, 1, 2, 3, 5, 6, 7, 8	
DHW_Store_Setpoint Sets the supply temperature from primary heat exchanger to prepare DHW in the indirect tank.	[°C/°F]	2: User	57	135	40..85	104..185
DHW_Store_Hyst_Down Hysterese to start burner for DHW. Condition: T_Supply below DHW_Supply_Setpoint less DHW_Supp_Hyst_Down.	[°C/°F]	3. Factory	5	9	0..20	0..36
DHW_Store_Hyst_Up Hysterese to stop burner for DHW. Condition: T_Supply above DHW_Supply_Setpoint plus DHW_Supp_Hyst_Up.	[°C/°F]	3. Factory	5	9	0..20	0..36
DHW_Store_Supply_Extra Increases the supply temperature to the indirect tank until DHW_Store_Setpoint + DHW_Store_Supply_Extra.	[°C/°F]	2: Installer	15	27	0..30	0..54
DHW_Priority	[-]		2		0 → Time 1 → Off 2 → On 3 → Parallel	
DHW_Max_Priority_Time Sets the maximum time for either DHW or CH priority.	[min]	2: Installer	60			
DHW_Post_Pump_Period	[sec]	2: Installer	120		10..900	
DHW_PID_P_Store		3. Factory	100		0..1275	
DHW_PID_I_Store		3. Factory	50		0..1275	
DHW_PID_D_Store		3. Factory	0		0..1275	

5.3 Safety and system function

5.3.1 Flame detection (Rev 3.0.0.0)

When during burning the flame is not detected anymore, the gas valve will be closed and the control will perform a post-purge, after which a restart will take place. When the flame disappears three times within one heat demand the control will lockout.

The presence of a flame is measured by an ionization rod. Between this ionization rod and earth an electromagnetic field is present. When a flame is present, the free electrons in the flame flow from the ionization rod to the earth. This flow of electrons is the flame current. The flame current is measured by the control as ionization in uA.

When the flame current is above *Flamerod_Setpoint* + *Flamerod_Hysterese* (1,0uA + 0,5uA) a flame will be present.

When the flame current is below *Flamerod_Setpoint* (1,0uA) the flame will not be present.

5.3.2 Ionization jumper (Rev 3.0.0.0)

The 900 series burner controls are equipped with an ionization-jumper. Depending on the situation where the control is placed it is possible that the jumper should be removed.

Mains voltage 230V	
Phase-Phase network	Standard the ion-jumper should not be placed.
Phase-Neutral network	Standard the ion-jumper should be placed [1) 2)]

Mains voltage 120V	
Phase-Phase network	Not possible.
Phase-Neutral network	Standard the ion-jumper should not be placed [2)]

[1)] It is possible that the ion-jumper should be removed in combination with a HIS, because the HSI can influence the ionization measurement. This is appliance-dependent.

[2)] When the ion-jumper is removed the burner control becomes sensitive to which way phase and neutral are connected.

Therefore check with a multi-meter if on the board mains supply connector the phase (120/230Vac) is connected to line and the neutral is zero. When polarized mains is used it is important to wire phase and neutral correctly during production. In case phase and neutral are reversed, the lack of ionization current will cause a locking error when the burner tries to ignite.

5.3.3 Flame recovery (Rev 3.0.0.0)

When the ionization current is too low, the system responds by increasing the minimal fan speed, in order to keep the flame present. This is done by increasing the minimal fan speed when the ionization current is too low.

Whenever the ionization current is high enough, the minimal fan speed will be decreased again.

When the flame still disappears the minimal fan speed will be increased for the next burn cycle.

- When the flame current is below Flamerod_Setpoint + Flamerod_Delta (1,0uA+0.2uA) the minimal fan speed will be increased.
- When the flame current is above Flamerod_Setpoint + *Flamerod_Delta* + *Flamerod_Delta* * 2 (1,0uA + 0.2uA + 0.4uA) the minimal fan speed will be decreased.

When the flame still disappears the minimal fan speed will be increased for the next burn cycle.

No. of flame losses	Description
0	Minimal fan speed as set in the system
1	In between minimal and ignition fan speed
2	Ignition fan speed

When the system successfully completes a burn cycle the minimal fan speed will be reset to the set minimal fan speed in the system.

5.3.4 Overheat detection (safety limit) (Rev 3.0.0.0)

Overheat is detected using an external overheat thermostat that is placed in series with the gas valve.

When the temperature gets too high the overheat stat opens and the gas valve is closed automatically.

An error message is shown at the display. Details on how to connect the overheat thermostat can be found in the connector description.

The burner always stops when T_Supply is over *STAY_BURNING_TEMP* and starts again when *T_Supply* is under *START_BURNING_TEMP*.

Relevant variables

Specific Parameters	Level	(Default) Value		Settable	
		°C	°F	°C	°F
START_BURNING_TEMP [°C/°F]	3: Factory	90	194	-10...117	14...243
STAY_BURNING_TEMP [°C/°F]	3: Factory	95	203	-10...117	14...243

5.3.5 Sensor availability (Rev 3.0.0.0)

The following sensors can be connected to the control:

Senor	Description
T_Supply	CH supply sensor
T_Return	CH return sensor
T_DHW	DHW out sensor
T_Flue	Flue gas sensor
T_System	Cascade system sensor
T_Outdoor	Outdoor sensor
P_Water_Switch	Water pressure switch
0-10 Volt	0-10 Volt input
P_Flue	Flue pressure switch
Water Flow CH	CH flow sensor
P_Gas	Gas pressure switch
Air Damper	Air Damper switch
Flue switch	Flue switch input
LWCO1	Low water cut off 1
LWCO2	Low water cut off 2
RT switch	Room thermostat input

The following table shows the sensor availability for all CH and DHW control modes. Sensors that are not mentioned in

the table are optionally available for other functions.

	CH mode				
	0	1	2	3	4
T_Supply	M	M	M	M	M
T_Return	-	-	-	-	-
T_DHW	-	-	-	-	-
T_Outdoor	D	M	M	-	
0-10 Volt	-	-	-	-	M
RT switch	M	M	M	M	M

	DHW mode							
	0	1	2	3	5	6	7	8
T_Supply	-	M	M	-	-	M	M	M
T_Return	-	-	-	-	-	D	-	M
T_DHW	D	M	D	M	M	M	D	M
T_Outdoor	-	-	-	-	-	D	D	-
0-10 Volt	-	-	-	-	-	-	-	-
RT switch	-	-	M	-	-	-	-	-

Legend:

M Mandatory
- Optional
D Disabled

The *T_Flue* and *T_Flue_2* sensors do not store the sensor open error.
This is to protect the system going to a blocking state in very cold conditions.

Pump start every 24 hours (Rev 3.0.0.0)
To protect the pump from getting stuck at a certain position it is forced to run for 10 seconds every 24 hours. This is done only for the CH pump at the start-up of the board.

5.3.6 Frost protection (Rev 3.0.0.0)

The frost protection function protects the system from freezing.
The *T_Supply*, *T_Supply_2* and *T_Return* sensors are checked for generating a frost protection demand.

- When any of the sensors drop below *FP_start_pump* the pump is switched on for CH.
- When any of the sensors drop below *FP_start_burn* the burner is started.
- When all of the sensors measure above *FP_stop* the frost protection demand is ended.

When the demand for frost protection is ended the pumps will post-circulate for *CH_Post_Pump_Period*. Relevant variables

Relevant variables

Specific Parameters	Level	(Default) Value		Settable	
		°C	°F	°C	°F
FP_start_pump [°C/°F]	3: Factory	10	50	-10..117	14..243
FP_start_burn [°C/°F]	3: Factory	5	41	-10..117	14..243
E2_FP_stop [°C/°F]	3: Factory	15	59	-10..117	14..243

5.3.6.1 Frost protection

In cascade systems frost protection is active on 3 levels.
[4] Boiler cascade controller
[5] Burner cascade controller
[6] Burner

The start temperatures should be defined so that the cascade handlers are the first to trigger the protection. When there is a CH/DHW call for heat, the frost protection will be overridden and the control will start for CH/DHW. When frost protection stops the pumps go to post purge.
The display may show “Frost protection” when it is activated.

Specific Parameters	Level	(Default) Value		Settable	
		°C	°F	°C	°F
Cascade frost protection [°C/°F] Temperature for frost protection	2: Installer	15	59	10..30	50...86

Frost protection for boiler cascade
The ‘frost protection’ function for a boiler cascade is related to the system sensor temperature.
When the system sensor temperature is below:

Cascade frost protection
The cascade CH/system pump and the general pump of the managing burner in the managing boiler start running.

Frost protection for boiler cascade
The ‘frost protection’ function for a burner cascade is related to the boiler sensor temperatures.
When the boiler sensor temperature or the managing burner supply/return temperature is below:

Cascade frost protection
The cascade CH/system pump and the general pump of the managing burner start running.

Cascade frost protection − 5°C
Cascade heat demand is activated to open the optional air damper, the general pumps of all the burners will be started. Demand with setpoint Cascade frost protection allows the burners to start burning until the lowest of both boiler, managing supply and return temperatures are above *Cascade frost protection + 5°C*.

Frost protection on burner
As last protection the controllers for the burners can force themselves to burn.

NOTE: On systems with an air damper this demand will not be served when the air damper is closed.

If the burner supply/return temperature drops below 5°C (41°F) the burner starts at minimum power and continues burning until the lowest of both supply and return temperatures are above 15°C (59°F).

Frost protection in cascades with air damper

To enable frost protection a demand must be generated on the cascade controller. This is covered by the frost protection and needed because the air damper must be opened by the cascade controller before a burner can start.

5.3.7 Flue temperature protection (Rev 3.0.0.0)

The flue temperature protection function protects against the flue gas reaching too high temperatures. Either a flue gas sensor or a flue switch can be used.

- When the *T_Flue* or *T_Flue_2* sensor measure above the *Max_Flue_Gas_Temp* the control generates a *Flue_Gas_Error*.
- When the Flue_Switch closes the control generates a *Flue_Gas_Error*.

When the control is in a Flue_Gas_Error the fan will run at the minimum fan speed.

Burner power limitation

When a flue gas sensor is connected the control will limit the burner power when the flue gas temperature reaches the set *Max_Flue_Gas_Temp*. The maximum burner power is linearly limited when the flue gas temperature is within *Max_Flue_Gas_Temp* – 5°C and *Max_Flue_Gas_Temp*.

Relevant variables

Specific Parameters	Level	(Default) Value		Settable	
		°C	°F	°C	°F
Max_Flue_Gas_Temp [°C/°F]	3: Factory	100	212	40...130	104...266

5.3.8 Heat exchanger protection: max differential (Rev 3.0.0.0)

To avoid temperature differences that are too large in the primary heat exchanger, the burner load automatically decreases when the Return-Supply temperature differential increases too much.

At maximum burner power the ΔT *Hx_Diff_DeltaT_Min* is limited to 40°C (72°F) and at low burner power a ΔT above 48°C (86°F) (= *Hx_Diff_DeltaT_Min* +8°C) is allowed.

Above ΔT 52°C(94°F) (= *Hx_Diff_DeltaT_Min* +8°C + 5°C) the burner is switched OFF during *Diff_Max_Wait_Time* (settable).

In between 40°C (72°F) and 48°C (86°F) ΔT over the heat exchanger, the burner power is linear limited.

To achieve this the PID output value is linear limited between minimum (@48°C ΔT) and maximum (@40°C ΔT).

However when the calculated PID output for temperature control is already below this limit, this output value remains the current control value.

Relevant variables

Specific Parameters	Level	(Default) Value		Settable	
		°C	°F	°C	°F
HX Diff DeltaT Min [°C/°F]	3: Factory	40	72	10...80	18...144
HX Diff Max Wait Time [sec.]	3: Factory	0		1...255 sec.	

5.3.9 Appliance selection (Rev 3.0.0.0)

The control is designed to store specific parameter sets of different boiler models.

By defining specific setting for different appliance models the same control can be used for a complete product range. Depending on which model the control is applied to, it only will be necessary to change just one single parameter.

When this parameter is changed the following settings are changed:

- Maximal fan speed
- Minimal fan speed
- Ignition speed(*)
- Maximum flue gas temperature

(*) Ignition speed is the same as Pre Purge Speed and Post Purge speed.

The appliance can store 6 appliance type settings.

The following appliances are available (example):

ID	Min. fan speed (rpm)	Ignition fan speed (rpm)	Max fan speed (rpm)	Max flue gas temp.
50	1500	3750	6000	95°C / 203°F
51	1500	3750	6000	95°C / 203°F
52	1500	3750	6000	95°C / 203°F
53	1500	3750	6000	95°C / 203°F
54	1500	3750	6000	95°C / 203°F
55	1500	3750	6000	95°C / 203°F

Relevant variables

Specific Parameters	Level	(Default) Value	Settable
Appliance type [-] Selection for the appliance type	2: Installer	50	50...55

5.3.10 Anti-legionella protection (Rev 3.0.0.0)

Anti-Legionella protection is enabled for DHW modes with an external tank with a sensor (DHW Mode 1).

To prevent legionella a special function is implemented in the

software.

- When DHW Mode 1 is selected the Anti-Legionella protection will be checked on the *T_DHW_0ut* sensor.

This sensor will be named the *Anti_Legionella_Sensor* in the remaining part of the explanation.

At least once every 168 hours (7 days) the *Anti_Legionella_Sensor* must reach a temperature above *Anti_Legionella_Setpoint* for a time specified by *Anti_Legionella_Burn_Time*.

If 7 days have passed and these conditions are not met, the burner is forced to heat-up the system for Anti-Legionella.

When the *Anti_Legionella_Sensor* temperature is below *Anti_Legionella_Setpoint* the control switches ON the pumps, when the *Anti_Legionella_Sensor* temperature is above *Anti_Legionella_Setpoint* + 5°C the control stops the pumps.

When DHW Mode 1 is selected the burner setpoint will be at *Anti_Legionella_Setpoint* + *DHW_Store_Supply_Extra*, for DHW Mode 6&7 the burner setpoint will be at *Anti_Legionella_Setpoint*.

If the supply temperature drops below the burner setpoint the burner is started as well.

The burner is PID controlled towards the burner setpoint. When the supply temperature rises above burner setpoint + *DHW_Supp_Hysterese_Up* the burner is switched OFF.

When the *Anti_Legionella_Sensor* is above *Anti_Legionella_Setpoint* – 3°C for *Anti_Legionella_Burn_Time* the controller goes into post pumping and ends the Anti-Legionella demand. When the controller has powered up, the *Anti_Legionella_Sensor* temperature must reach a temperature of *Anti_Legionella_Setpoint* (for *Anti_Legionella_Burn_Time*) within 2 hours, otherwise the burner is forced into Anti-Legionella demand.

Every time an Anti-Legionella demand has ended the *Anti_Legionella_Active_Counter* is incremented to indicate how many Anti-Legionella actions have been performed. This counter can be found in the screen Boiler History in the epHS diagnostic tool LabVision. Also the Anti Legionella Wait Time is started to delay the next anti legionella cycle.

This diagnostic tool can also override the wait time for Anti-Legionella. When this demand is forced by LabVision, the timer will be set to 0 and Anti-Legionella demand will start immediately. Then the demand must be completed successfully before the wait timer is set again.

The anti-legionella demand has priority over any DHW and CH demand. However when the anti-legionella protection is active and there is no heat or burn demand because the *Anti_Legionella_Sensor* is already at a high enough temperature CH/DHW demand will be accepted as normal.

Relevant variables

Specific Parameters	Level	(Default) Value °C	°F	Settable °C	°F
Anti_Legionella_Setpoint Setpoint for Anti-Legionella demand	3: Factory	60	140	50...90	122...194
Anti_Legionella_Burn_Time [min]	3: Factory	30		5..120	
Anti_Legionella_Wait_Time Wait time for Anti-Legionella demand		120 min after cold start, 168 hr after first successful Anti-Legionella demand			

5.3.11 De-Air sequence (Rev 3.0.0.0)

The De-Air sequence it is a safety function starting at every power ON and is used to remove the air from the heat-exchanger.

The De-Air sequence does not start after a general reset (such as the locking error reset or 24 hour reset).

The display will show “dAir” indicating that the controller is performing the De-Air sequence to purge the heat exchanger of air, by sequencing the circulator OFF and ON. The user can cancel the De-Air sequence when he presses a specific key-button combination from the display.

By default “De-Air” sequence takes around 14 minutes.

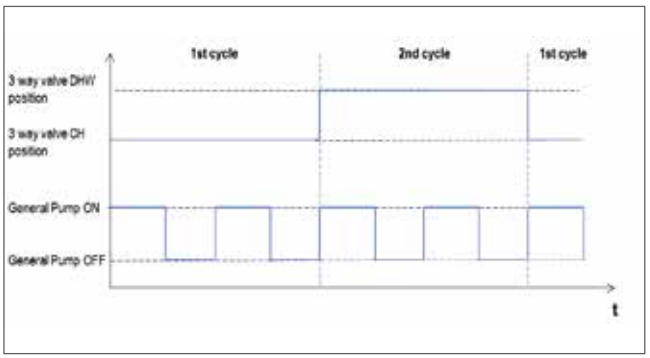
- 1st cycle: the 3 ways valve moves to CH position and the general pump is activated for 10 seconds, deactivated for 10 seconds, activated again for 10 seconds and then deactivated again for 10 seconds (*DAir_Repeation_0n0ff*, which means ON/OFF/ON/OFF each time for 10 seconds = 40 seconds in total).
- 2nd cycle: it starts when 1st cycle is ended. The 3 ways valve is moved to DHW position and repeats the same cycling of the pump (*DAir_Repeation_0n0ff*, which means ON/OFF/ON/OFF each time for 10 seconds = 40 second in total).

This sequence (1st cycles + 2nd cycles) is performed *DAir_Number_Cycles* times (if *DAir_Number_Cycles* is 10 “de-air” sequence lasts (10 x 40) x 2 = 800 seconds).

During De-Air sequence no demand will be served.

When the water pressure is too low or pressure sensor is in error, the De-Air sequence will be suspended until water pressure / sensor pressure is stable again. In that case the De-Air sequence will last longer than the estimated 14 minutes.

The following scheme below shows the behaviour of the 3 way valve and general pump during one whole cycle of De-Air sequence with a *DAir_Repeation_0n0ff* set to 2.



Relevant variables

Specific Parameters	Level	(Default) Value	Range
De_Air_Config 0 = DAir disabled; 1 = DAir enabled.	2: Installer	0	0..1
De_Air_State Current state of the DAir function.	1: User	-	-
DAir_Repeation_ OnOff Number of repeating ON/OFF.	2: Installer	2	0..255
DAir_Number_ Cycles Number of DAir cycles..	2: Installer	10	0..255

5.3.12 Low water cut off (Rev 3.0.0.0)

A Low Water Cut Off (LWCO) sensor can be enabled to detect if there is enough water in the boiler. When this is not the case a non-volatile lockout error is generated.

Relevant variables

Specific Parameters	Level	(Default) Value	Range
Programmable input LWCO 1	3: Factory	0	0 → Disabled 1 → Enabled
Programmable input LWCO 2	3: Factory	0	0 → Disabled 1 → Enabled

5.3.13 Heat exchanger protection (Rev 3.0.0.0)

Heat Exchanger Protection limits the max. heat load based on the heat exchanger flow (CH flow).

To avoid temperature differences that are too large in the primary heat exchanger, the burner load automatically decreases when the CH water flow decreases too much.

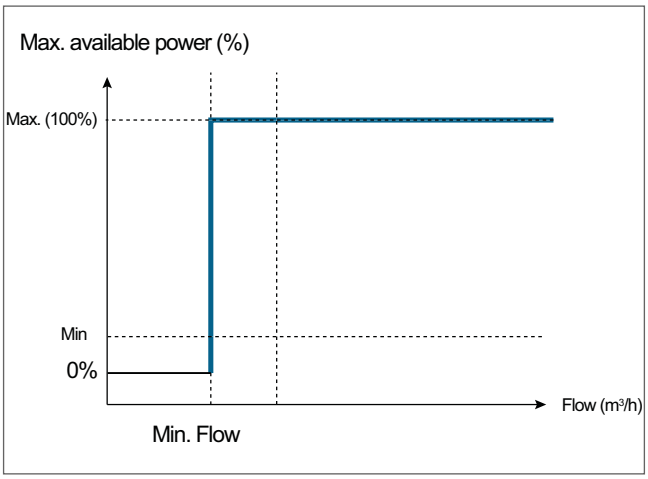
- Below Min_EX_Flow_Rate the burner is stopped.
- Over Min_EX_Flow_Rate the maximum power of the burner is fully available.

In between *Nominal_EX_Flow_Rate* and *Min_EX_Flow_Rate*, the burner power is linear limited.

To achieve this the PID output value is linear limited between *Nominal_EX_Flow_Rate* and *Min_EX_Flow_Rate*.

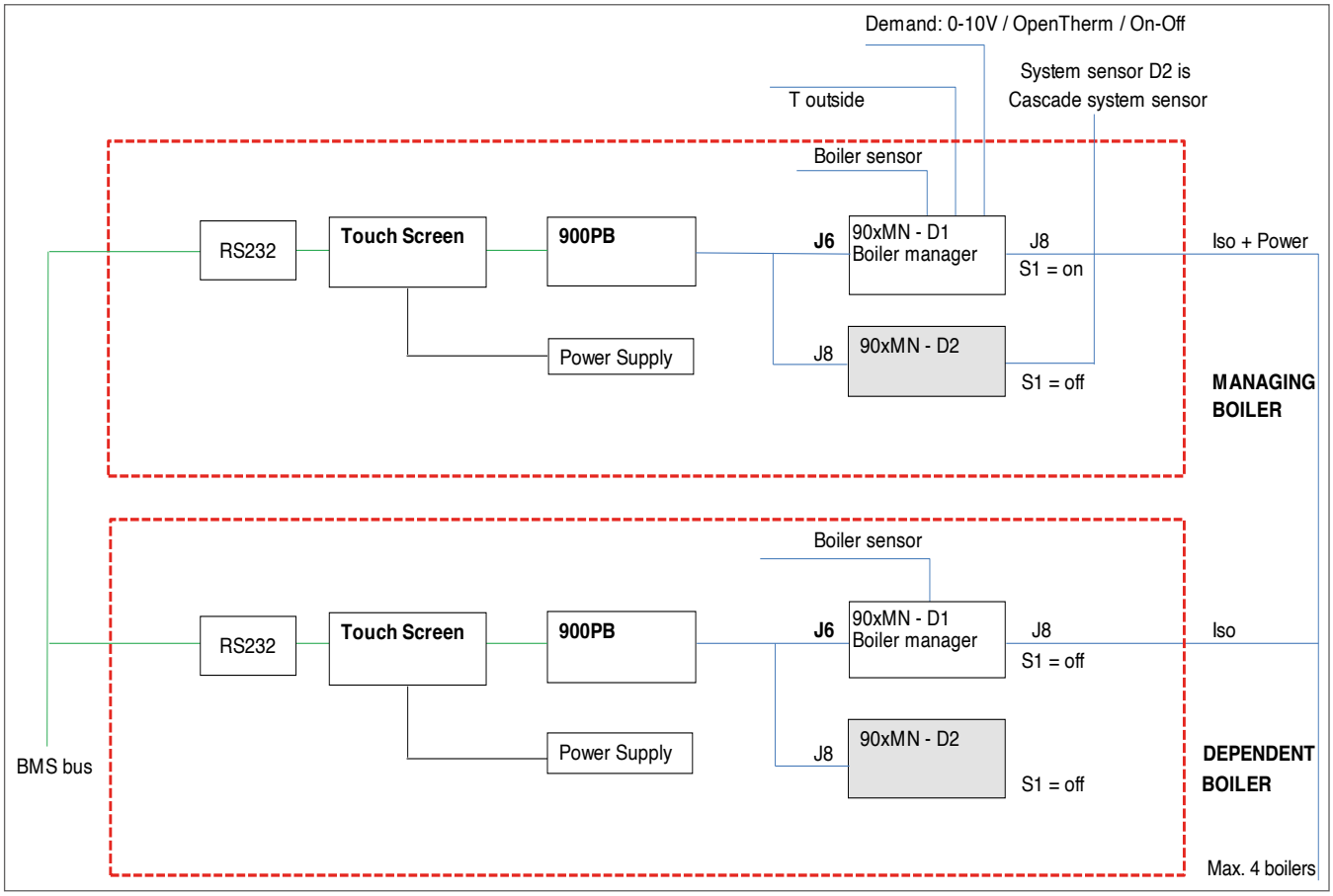
When a demand request is present the level of the flow is evaluated. If the flow is too low (smaller than the *Min_EX_Flow_Rate* parameter) and stays low for at least (*PRE_PURGE_TIME* - 2 seconds), a warning is raised (*LOWEXFLOW_PROTECTION* warning). Although the timeout is limited between a minimum value of 4 seconds and a maximum value of 60 seconds.

In case the flow level is too low the fan will be switched OFF in order to protect the heat exchanger while the pump stays On. When the level of the flow will be again stable for at least 20 seconds the warning status is cleared and the burner will go again in BURN status if a request is still pending. In case the request of demand has been cancelled the burner will go in STANDBY.



6 Boiler cascade

6.1 Extended 4x2 boiler/burner cascade with Touch Screen and Building Management System (BMS)



6.2 Compensation for secondary manifold temperature on single boiler

To compensate the temperature after the manifold an additional system sensor and the boiler cascade controller must be activated.

- The boiler cascade controller on the first burner must be activated by setting parameter 73 to managing boiler.
- The system sensor after the manifold must be connected to the second burner.

6.3 Set Switches for all cascade boards

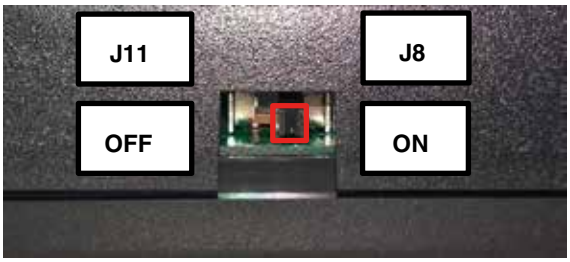
6.3.1 Power off all the boards

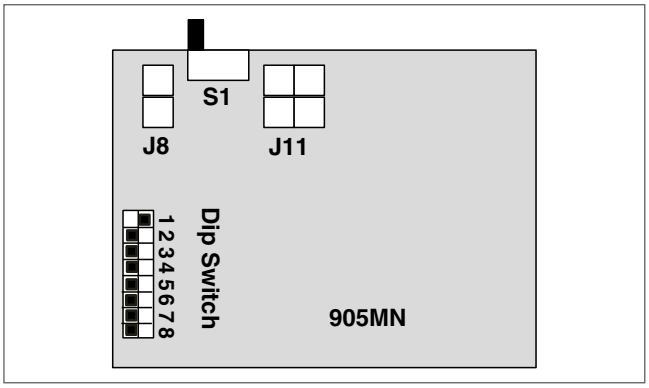
Power off all the boards and set all the switch (S1 and dip switches).

6.3.2 Set AL Power switch S1 and Dip switch for 905MN Managing of Boiler X

Set AL Power Switch S1 in ON position

Set Dip Switch with value 1





6.3.3 Set AL Power switch S1 and Dip switch for 905MN Dependent boards

Set AL Power Switch S1 in OFF position

Set Dip Switch with value 2 or bigger

Dip-switch setting	Burner Operation	LabVision Device Address
	Stand alone burner	100
	1st burner (managing)	100
	2nd burner (depending)	101

6.4 Set the Modules and Boiler Cascade Settings

6.4.1 Cascade of Modules: Set the address for all the modules Boards

Set the dipswitch (as explained in paragraph “6.3.3 Set AL Power switch S1 and Dip switch for 905MN Dependent boards” pag. 43)

6.4.2 Cascade of Modules: Set Number of expected Modules (to do only in the managing of Modules)

By default the number of expected Modules are 8. If less number of Modules are expected set the parameter (*) Number of Units. (e.g. Set 5 if the number of Modules are in total 4, including the managing board)

Menu → Settings → Boiler Settings (password 1200) → Module Cascade Settings → (*) Number of Units

6.4.3 Cascade of Boilers: Set Boiler Address for all the Managing boards

Assign the Boiler Address in the managing boards (that has the dipswitch set to 1).

Menu → Settings → Boiler Settings (password 1200) → Boiler Cascade Settings → (73) Boiler Address

Boiler x	(73) Boiler Address
Boiler Managing	Managing
Boiler Dep 1	Dep. 1
Boiler Dep 2	Dep. 2

6.4.4 Cascade of Boilers: Set Number of expected Boiler (to do only in the managing of Boiler)

By default the number of expected Boiler are 8. If less number of Boilers are expected set the parameter (*) Number of Boilers. (e.g. Set 3 if the boilers in the cascade are 3, including the Managing boiler).

Menu → Settings → Boiler Settings (password 1200) → Boiler Cascade Settings → (*) Number of Boilers

7 System test

FULL TEST: the full boiler system test mode puts all modules in a boiler on the same test mode at the same time.

With a test mode for the whole boiler it becomes possible to test whether external factors such as gas pressure are able to handle the boil-er at full power. This test mode can only be activated from the PB connected to the manager of that boiler. Installer level access is required to activate the test mode.

7.1 System test (Rev 3.0.0.0)

For testing the system at fixed power rates a system test can be activated via the Installer menu or LabVision PC screen. Via the system test the boiler can be started without CH or DHW being present. The system test has priority.

The following modes are available:

System test mode		Description
1	Not active	
1	Fan only	The fan is forced to run at maximum speed without starting the burner.
2	Low power	The burner starts and after the ignition period has finished the burner stays at low power
3	Ignition power	The burner starts and stays at ignition power
4	High power	The burner starts and after the ignition period has finished the burner stays at high power
5	High power limited	The burner starts and after the ignition period has finished the burner stays at high power limited by the CH max. power parameter
6	High limit error test	Simulates the MAX_TEMP_ ERROR
7	Low water cut off 1 error test	Simulates the LWCO_1_ ERROR
8	Low water cut off 2 error test	Simulates the LWCO_2_ ERROR
32	DHW pump on	The DHW pump is on
64	CH pump on	The CH pump is on
128	General pump on	The general pump is on
160	General pump with DHW	The general pump is on with the DHW pump
192	General pump with CH	The general pump is on with the CH pump

Before running the system test modes first check if the heat can also be dissipated.

NOTE: during this mode the supply temperature can be raised above 95°C (203°F). When this temperature is reached the burner will switch off. When the supply temperature cools down to 90°C (194°F) the burner will start again.

During the system test the general and CH pump will on.

As the boiler will run at fixed power rates there is no setpoint control active. Also the flame recovery is not active during system test demand. All other safety functions remain active.

The system test automatically stops after 10 minutes, after this the system continues with normal demand handling. When the system test mode is changed during an active system test, the 10 minute timer is reloaded.

NOTE: for DHW *Mode_7* and DHW *Mode_8* the *Actual_ Flow_Rate* must be higher than *Flow_Rate_Start* in order that the board can go in to system test.

System test for cascade burners with air-damper functionality

When a cascade system is configured with an air-damper system test demand cannot be started before the air-damper output is opened and the air-damper input gives a feedback signal.

When a system test for a depending burner is required first a cascade demand must be started to open the air-damper output before the system test demand is accepted.

7.2 Physical high limit test mode. (100°C +/- 5°C)

7.2.1 Starting the test

To start the physical high limit test the following steps have to be taken.

- Enable the physical high limit test on the 905PB display. Enable menu located at:
  Settings → Boiler Settings → Boiler Parameters → (183) High Limit Test
  Menu only accessible with the factory passcode.
- Start the high limit test on the touchscreen.

After enabling the physical high limit test on the 905PB display the physical high limit test will be enabled for 60 minutes. After 60 minutes the test mode will return to a simulated test.

When the physical high limit test is started the control will temporarily override several safety checks. The following settings are temporarily changed during this test.

Parameter	Update during test.
Stay/Start burning	During the test the stay/start burning temperatures are increased to the high limit safety setting which is set to 115°C
Maximum flue gas tempera-ture	During the test the maximum flue gas temperature is increased to 120°C.
Minimal CH flowrate	During the test the checks on the CH flowrate protection are disabled by decreasing the CH minimal flowrate to 0.0 l/m.

The test mode is limited to a maximum of 5 attempts per 24 hours. At each start of the physical high limit test a test counter will be stored internally in the control. This counter is reset automatically after 24 hours.

7.2.2 Running the test

When the physical high limit test is started the burner runs at high power with a CH pump demand.

The supply temperature will be increased reducing progressively the flowrate with the manual stop valves.

7.2.3 Stopping the test

Test OK:

The test mode is stopped when the high limit sensor of the duplex supply sensor detects the *MAX_TEMP_ERROR*. The *MAX_TEMP_ERROR* is stored in the boiler error history of the module,

The touchscreen shows the highest temperature of the *T_Supply* sensor after the physical high limit test has been activated.

Test stopped by operator: When the test is aborted by the operator the test mode is cleared and the override parameters are restored.

Timeout: When there is no error after 5 minutes the test stops automatically. In this case the blocking error "*HIGH_LIMIT_FAIL*" is active for 30 seconds.

7.2.4 Monitoring of attempts

The amount of test attempts is limited to 5 within 24hrs.

When the attempts counter > 5 the warning "high limit test wait time active" is displayed for the module.

After 24hrs the high limit test attempts are cleared and the warning is removed.

7.2.5 Limitations

The sensor temperature high limit test remains active during this test mode. The setpoint for triggering the *MAX_TEMP_ERROR* lockout on the sensor temperature is set to 115°C – 3°C hysteresis. When the Safety Limit switch does not open during this test the sensor temperature check stops the burner when the temperature increases to over this setpoint. The error codes for both the Safety Limit switch and the sensor temperature check are locking code 15, *MAX_TEMP_ERROR*.

When the physical high limit test is over the settings that were overruled are restored. When the test failed the exchanger flowrate function is still active and expects the actual flowrate to be over the minimum CH flowrate. When this isn't true after the testing period the *LOWEX_FLOW_PROTECTION* error will be stored after the *HIGH_LIMIT_FAIL* error is cleared.

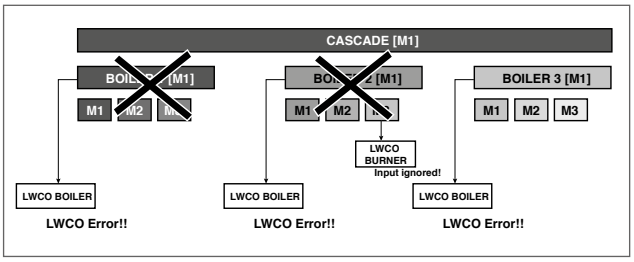
7.3 LWCO Error evaluated at Boiler level

To activate this modality set via Labvision the following parameter in the Managing boards (Boiler X M1):

Prog. Input LWCO1: LWCO1 input (Boiler Level)

If the LWCO Error occurs in Boiler X, in case of demand request the whole Boiler X will not start.

The Next BoilerX+1 will be then called.



7.4 System test in cascades with air damper

To enable system test a demand must be generated on the cascade controller.

This is handled by the PB and needed because the air damper must be opened by the cascade controller before a burner can start.

8 Service reminder

8.1 Service Reminder

The Service Reminder functionality is available on all, except the 900PB00 PCB configuration.

This functionality requires the large EEPROM therefore it will not be available on the 900PB00 PCB configuration.

8.1.1 Service Reminder

The Service Reminder will remind the owner/user of the appliance to service the appliance at a specified *Service_Interval* (factory setting). When service is not done within the specified time, a service reminder will be shown on the screen, alternating with the normal status display.

The *Service_Interval* can be set as the number of burn hours or the number of operational (appliance is powered) hours.

This can be done by setting the *Service_Hour_Counter* (factory) parameter.

8.1.2 Service Overdue logging

When the service reminder has become active, the time it takes before service is actually done is being logged by the 900PB (in hours). This time is called the Service Overdue time. With this log the factory can read back how long service was overdue on the system/appliance which can be useful when handling warranty claims. A maximum of 15 Service moments can be logged by the 900PB, when the log is full it will overwrite the oldest log entry.

Each time the Service Reminder is being reset, a new service moment is counted and the Service Overdue counter will be stored in the log/history.

8.1.3 Service Reminder implementations

There are two types of service reminders: (Normal) Service Reminder and Service Shutdown.

Service Reminder

The (normal) Service Reminder will only show the service reminder message on the screen and will log how many time the ser-vice is overdue, and the appliance will remain fully operational.

Service Shutdown

The Service Shutdown has the same functionality as the Service Reminder but will shut-down the appliance after the specified *Service_Shutdown_Period* (factory setting) after the service reminder became active (message is displayed).

The appliance will shut-down and no demands are handled anymore. This way the owner/user has a warning before the appliance will actually shutdown. Shutting down the appliance is stored in the burner (main) control so disconnecting the display will not enable the appliance. Re-enabling the appliance is only possible by resetting the Service Reminder (Shutdown) which is done by the installer.

NOTE: The Service Shutdown is only available for 850 Platform products systems and is not supported for 900 Platform products (yet).

8.1.4 Resetting the Service Reminder

The Service Reminder (or Shutdown) can be reset by the installer that services the appliance.

When the Service Reminder is being reset, a service moment will be counted and the Service Overdue counter will be stored in the log/history.

It is possible to reset the Service Reminder counters before the Service Reminder was actually set.

This should be done when the appliance was serviced before the Service Reminder was active. This will mean an overdue coun-ter of 0 hours will be stored on the log (which makes sense because the service was not overdue, but ahead of schedule).

8.1.5 Menu's and Parameters

Service Reminder status information can be viewed from the Information menu. Here the installer can also reset the service reminder (accessible by any user-level).

(Sub) Menu item	Description
Service History	View the service history (log). For each service moment the service overdue counter is stored. When the overdue counter is 0 hrs, this means service was done before the service reminder was active. The log is ordered so the most recent service moment is shown first (on top of the list).
Hours since last service / Burn hours since last service	Shows the number of hours (or burn hours) since the last service moment. Depends on the *Service_Hour_Counter* setting (burn or normal hours).
Hours till service / Burn hours till service / Hours till shutdown	Shows the number of hours (or burn hours) until service is required. Depends on the *Service_Hour_Counter* setting (burn or normal hours). When the Service Shutdown function is enabled and the Service Reminder is active, the number of hours until the appliance is shut-down will be shown.
Reset Service Reminder	Reset the Service Reminder (and store service overdue counter in the service history). Installer must first enter the installer password before the service reminder can be reset.

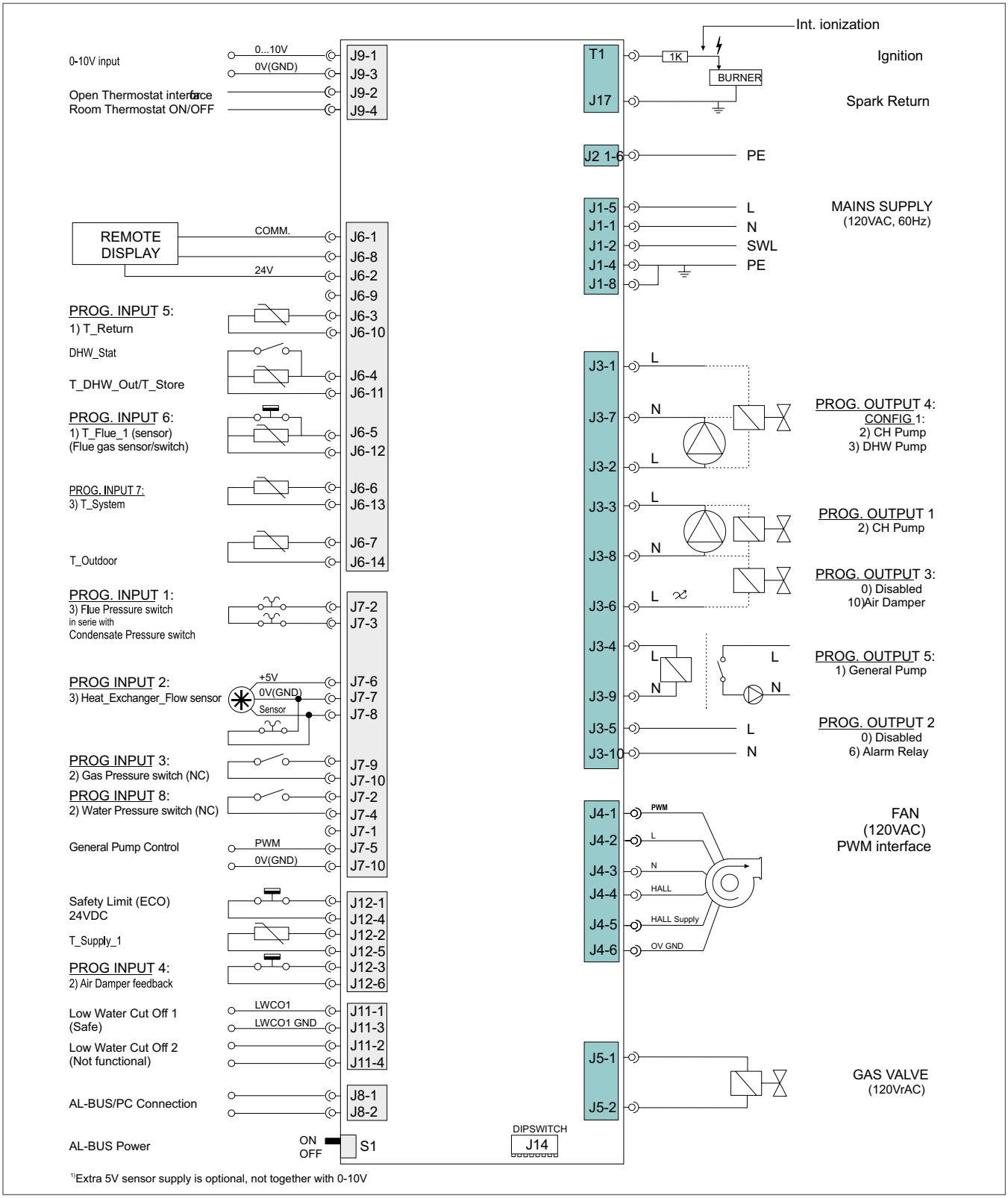
The Service Reminder parameters can be set from the Boiler Settings menu (Service submenu) when logged in as factory user-level.

(Sub) Menu item	Description
Service Hour Counter	Select how the hours until service must be counted. As burner hours or normal (appliance is powered) hours.
Service Interval	Number of hours after the Service Reminder must be shown. When disabled the (entire) Service Reminder functionality will be disabled.
Service Shutdown Period	Number of hours after the appliance must be shut-down when the Service Reminder became active. Time that the appliance is allowed to function with the service reminder active. When disabled, Service Shutdown function is disabled and the appliance will not be shut-down.
Reset Service Reminder	Reset the Service Reminder (and store service overdue counter in the service history).
Clear Service History	Clears the entire service history (number of service moments and the overdue counters).

Appendix A - Connection diagram

A.1 Connection diagram

The following connection diagram is specifically assigned to the 905MN Control:



[1] Extra 5V sensor supply is optional, not together with 0-10V

Appendix J - Connector description for 905mn1x (120vac version)

Connector	Pin	Pin Description
J1 (Molex, Mini-Fit Jr. 5557, 2x4 receptacle with terminals 5556)	1 4 5	Neutral Protective Earth (PE) Line
Mains input	The control is equipped with one fuse, in the Line. The fuse-holder is appropriate for glass fuses of 5x20 mm. The mains cable must be at least 3x0.75mm^2	

Connector	Pin	Pin Description
J2 (Molex, Mini-Fit Jr. 5557, 2x3 receptacle with terminals 5556)	1, 2, 3, 4, 5, 6	Protective Earth (PE)

Connector	Pin	Pin Description
J3 (Molex, Mini-Fit Jr. 5557, 2x5 receptacle with terminals 5556)	1 2 7 3 - 8 4 - 9 5 -10 6	3-way valve direction NC Programmable output 4 - 3-way valve Common neutral Programmable output 1 Programmable output 5 Programmable output 2 Programmable output 3
PUMP AND PROGRAMMABLE OUTPUT	The max. usable output current of a single output of J3 is 2A, cos φ = 0.7. Total combined usable output current of J3 and J4 is 3.5A, cos φ = 0.7. Maximal cable length is 1 meter	

Connector	Pin	Pin Description
J4 (Molex, Mini-Fit Jr. 5557, 2x3 receptacle with terminals 5556)	1 2 3 4 5 6	PWM Line (230VAC) Neutral (230VAC) Hall Hall supply 0V GND
FAN INTERFACE	The max. usable output current of J4 is 2.0A, cos φ = 0.7. Total combined usable output current of J3 and J4 is 3.5A, cos φ = 0.7. Maximal cable length is 1 meter.	

Connector	Pin	Pin Description
J5 (Molex, Mini-Fit Jr. 5557, 2x2 receptacle with terminals 5556)	1 2 3	Gas valve phase Gas valve neutral Ionization
GAS VALVE	The max. usable output current of J5 is 0.25A, cos φ = 0.7. Maximal cable length is 1 meter.	
J6 Molex, Mini-Fit Jr. 5557, 2x7 receptacle with terminals 5556)	2 9 1 - 8 3 - 10 4 - 11 5 - 12 6 - 13 7 - 14	24V supply 0V (GND) Remote control / AL-Bus Programmable input 5 DHW/Store sensor Programmable input 6 Programmable input 7 Outdoor sensor
SENSOR INPUT	NTC's have a resistance of 10k@25°C (77°F) β= 3435 Temp. range NTC is -40°C to 150°C (-40°F to 300°F). All these sensor inputs carry a voltage of 3V3 or 5V. The sensors connected to the control should be free from the appliance earth. The maximum cable length is 1 meter.	
J7 (Molex, Mini-Fit Jr. 5557, 2x5 receptacle with terminals 5556)	1 5 6 2 – 3 2 – 4 7 – 8 9 – 10	5V power supply for multiple input 2-3 PWM out 5V power supply for multiple input 7-8 Programmable input 1 Programmable input 8 Programmable input 2 Programmable input 3
SENSOR		

Connector	Pin	Pin Description
J8 (Molex, Mini-Fit Jr. 5557, 2x1 receptacle with terminals 5556)	1 - 2	AL-BUS connector
AL-BUS CONNECTOR	Connector to connect other communication devices onto the AL-BUS communication bus or PC communication.	
AL-BUS POWER SWITCH	The power ON this AL-BUS can be activated with S1 (the switch on the side): Set to “OFF” position for a controller in a burner cascade or stand-alone appliance. Set to “ON” position only on the controller of the first burner in the managing boiler of a boiler cascade (see architecture diagram for system overview).	

Connector	Pin	Pin Description
J9 (Molex, Mini-Fit Jr. 5557, 2x2 receptacle with terminals 5556)	1 – 3 2 – 4	0…10V input Open thermostat interface or Room thermostat ON/OFF

Connector	Pin	Pin Description
J10 (Molex, Mini-Fit Jr. 5557, 2x4 receptacle with terminals 5556	1 2 5 6	Stepper coil 1 begin Stepper coil 1 end Stepper coil 2 begin Stepper coil 2 end
STEPPER MOTOR		

J11 Molex, Mini-Fit Jr. 5557, 2x2 receptacle with terminals 5556)	1 – 3 2 – 4	Low water cut off 1 Low water cut off 2
LWCO 1 + 2		

Connector	Pin	Pin Description
J12 Molex, Mini-Fit Jr. 5557, 2x3 receptacle with terminals 5556)	1 – 4 2 – 5 3 – 6	Safety limit (ECO) 24VDC T_Supply sensor Programmable input 4

Connector		Pin Description
J17 (Faston female push-on connector 4.8x0.8mm)	1	Spark Return
SPARK RETURN		

Connector	Pin	Pin Description
J18		Programming header
PROGRAMMING HEADER MN	Connector to reprogram the MN processor using an 850US device (Also see J20).	

Connector	Pin	Pin Description
J20		Programming jumper
PROGRAMMING JUMPER MN	When placed during power up of the board the MN microcontroller will go to a state where it is possible that it’s ROM is reprogrammed	

Connector	Pin	Pin Description
J21		Programming jumper
PROGRAMMING JUMPER WD	When placed during power-up of the board the WD microcontroller will go to a state where it is possible that it’s ROM is reprogrammed	

Connector	Pin	Pin Description
J22		Programming header
PROGRAMMING HEADER WD	Connector to re-program the WD processor using an 850US device (Also see J21).	

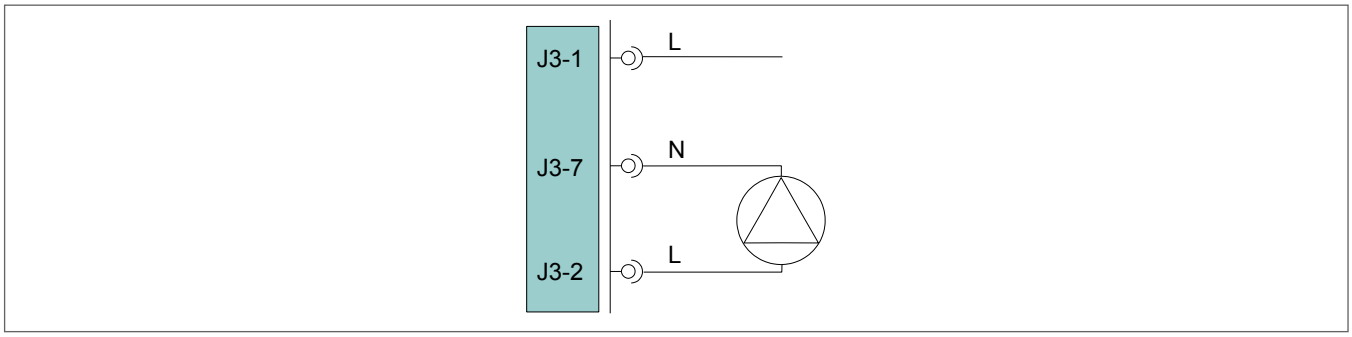
Connector	Pin	Pin Description
J25 (Molex, Micro-Fit 43045, 2x2 receptacle)	1 2 3 4	9V Display communication 24V Ground
EXTERNAL DISPLAY		

Connector	Pin	Pin Description
J28	Ionization header	
IONIZATION HEADER	Connector to place ionization jumper. See 4.2 – Ionization jumper	

A.2 DHW Pump Configuration for 3 way valve output J3 (1-2-7)

This configuration replaces CONFIG. 1 in the 905MN connection diagram (paragraph “A.1 Connection diagram” pag. 47) and is specifically for configuring a DHW Pump on the 3 way valve output.

With the setting “3 way valve” a 3 way valve or optionally a CH pump can be connected to J3 (2-7).
When the setting is changed to “DHW pump” a DHW pump can be connected to J3 (2-7).



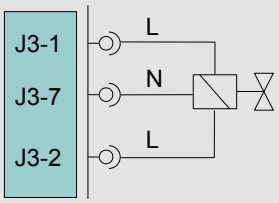
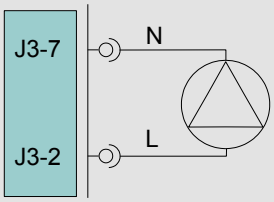
A.3 Output configurations

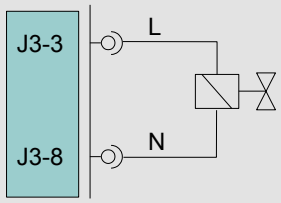
The bold items(*) are the default configuration for CH/DHW pumps, the option shows the settings for a 3 way valve.

J3 - 1	not connected	option: **3-way valve - DHW (3)**(*)
J3 - 2	**DHW pump (3)**(*)	option: **3-way valve - CH (2)**(*)
J3 - 3	**CH/System pump (4)**(*)	
J3 - 4	**General pump / 2 way valve (1)**(*)	
J3 - 5	**Disabled (0)**(*) Alarm (6)	
J3 - 6	**Disabled (0)**(*) Air damper (10)	

A.4 Pump connections (Rev 3.0.0.0)

The burner control can be applied for both heating only and combination (CH and DHW) appliances.
However, many different configurations can be designed to serve this purpose.
Functions of outputs like pumps or valve are not the same for each configuration.
On the other hand it shouldn’t be necessary to change wiring when, for example, a DHW pump is installed later on.

Output	Function	
J3 2 – 7	3-way valve for CH/DHW CH/DHW-pump	**3-way valve:** 
		DHW-pump: 

Output	Function		
J3 3 – 8	Programmable output 1*	CH PUMP	

*Only available for the general pump.

Appendix B - Maximum load on outputs

B.1 Maximum load on outputs (for hardware up to 905MN1x_3Re)

The mains fuse on 905MN is rated at 5AT, but to guarantee reliable operation with enough margin for power fluctuations, the maximum current through all outputs together must always stay below 4A.

Following are two examples of combinations of devices that can be connected:

Device	Max Current	Max Power
Control and gas valve	0,5 A	**60 VA**
General Pump	2,0 A	**240 VA**
Other Pump	Do not connect! → Power externally	
Fan	1,5 A	**180 VA**
Total external load	4 A	**480 VA**

Device	Max Current	Max Power
Control and gas valve	0,5 A	**60 VA**
General Pump	1,0 A	**120 VA**
Other Pump	1,0 A	120 VA
Fan	1,5 A	**180 VA**
Total external load	4 A	**480 VA**

All other devices must be powered externally

B.2 Maximum load on outputs (for hardware 905MN1x_3Rf and up)

Device	Max Current	Max Power
Control and gas valve	0,5 A	**60 VA**
All pumps together	1,5 A	**180 VA**
Fan	2,0 A	**240 VA**
Total external load	4 A	**480 VA**

All other devices must be powered externally.

B.3 Minimum/Maximum load on air damper output (J3-6)

The output J3-6 is a triac controlled output. This output needs a minimum load of approx. 10VA to work correctly and the max load must be limited to 50VA @ supply voltage.

Connection an external relay to this output to be able to switch a higher load is only possible when an additional resistor or load is added to make sure the minimum load requirements are met.

Appendix C - System parameters

C.1 Settings stored in 905PB display

Menu item	Sub item / Parameter	Range	Default Value	Units	User Level
Language	English French Chinese Italian		English		1: User
Unit type	Metric Imperial		Metric	°C, Bar °F, PSI	1: User
Date &Time	Date		-	dd-mm-year	1: User
	Time		-	00:00	1: User
	Time Zone Settings				1: User
	Time Zone Correction	UTC	X		1: User
	Daylight Savings Time	Disabled N,C America, Europe			1: User
	Display Settings				1: User
	Time Notation	24h, 12h	24h		1: User
	Date Order	DMY, MDY, YMD	DMY		1: User
	Day of Month	1-2 digits	2 digits		1: User
	Month	Short-Full text 1-2 digits	2 digits		1: User
	Year	2-4 digits	4 digits		1: User
	Date Separation Character	-, /, .	-		1: User
	Day of Week	Disabled Short Text Full Text	Short Text		1: User
	Seconds	Yes, No	No		1: User
Cascade Mode	Full option (8 module TS/BMS) Basic (16 module ZH)	Full Basic	Full		1: User
	Modbus Address	0..255	1		1: User
	Modbus Stop bits	1 - 2	2		1: User
	Startup Settings	Startup Logo	Default		1: User

C.2 List of Parameters (With Ranges and Default Values)

Parameters are listed base on the reference menu.

Reference Menu
M1 Parameters Menu
M2 Cascaded module configuration menu
M3 Cascaded boiler configuration menu
M4 Appliance configuration menu

Access type
U End user
I Installer
0 Manufacturer

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M1		CH Control	Enable or disable the heating circuit	Enabled/Disabled	Enabled		I	Heating
M1	1	CH mode	Defines the thermal module's various heating operation modes	0…5	0		I	Heating
M1	3	CH set-point	Defines the desired delivery temperature in heating mode (Par. 1) = 0	30...80 (86..176)	60 (140)	°C (°F)	U	Heating
M1	185	Calc. set-point off-set	It is possible to shift the climatic curve up and down. The calculated setpoint can be increased or decreased with a maximum of 10°C	-10…10	0	°C (°F)	I	Heating
M1	109	Comp. T. @ Bas. Outd	Establishes the set-point offset value cal-culated in climatic mode (Par. 1= 1). Offsets the climatic curve in presence of mild outdoor temperatures	Off, -10…10	0		I	Heating
M1	110	CH Min. set-point	Defines the minimum delivery tempera-ture at which the system operates in both heating and DHW mode	20…50 (68...122)	20 (68)	°C (°F)	I	Heating
M1	111	CH Max. set-point	Defines the maximum delivery tempera-ture at which the system operates in both heating and DHW mode	50…90 (122...194)	90 (194)	°C (°F)	I	Heating
M1	190	Outd. Comp. Fact		0…100	0	%	I	Heating
M1	5	Boiler Pump Overrun	Sets the overrun time in seconds of the boiler's circulator during stand-alone op-eration; cascaded operation determines the module's overrun after switch-off due to temperature control	0…900	30	Sec	I	Heating
M1	6	Flue Temp. Limit	Sets the activation temperature when the maximum flue gas temperature is exceeded. When the flue gas temperature is higher than a set value, the module switches off and an error message is gen-erated. When the flue gas temperature is in the interval between (Par. 6) -5°C and Par. 6, the module reduces its power in a linear way until it reaches minimum power when the temperature measured is equal to Par. 6	10…120 (50...248)	100 (212)	°C (°F)	0	General

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M1	7	CH Hystereis Up	Sets the value in degrees beyond the set-point at which the burner switches off for thermoregulation.	0…20 (32...68)	6 (10.8)	°C (°F)	I	Heating
M1	112	CH Hystereis Down	Sets the value in degrees below the set-point at which the burner switches on again for thermoregulation	0…20 (32...68)	6 (10.8)	°C (°F)	I	Heating
M1	9	Anti-cycle Period	Sets the stand-by time before the appliance is switched on again after it switches off due to thermoregulation, independently from the delivery temper-ature dropping below the value indicated in Par. 10. Parameter valid only in stand-alone mode	10…900	180	Sec	I	Heating
M1	10	Anti-cycle Temp. Diff.	Sets the value in degrees below which the burner switches on again notwithstanding from the time spent at Par. 9	0…20 (32...68)	16 (28.8)	°C (°F)	I	Heating
M1	12	Hx diff. Minimum	Sets the value of the temperature difference (Delta T) between the module's delivery and return temperature. For a Delta T value ranging between Par. 12 and (Par. 12) +8°C, the module reduces its power in a linear fashion until it reaches the minimum power. The minimum power is maintained until reaching (Par. 12) +8°C+5°C, after which the module switches off for a period of time equal to the value attributed to Par. 13; at the end of this time interval, the module switches on again	10…60 (50...140)	40 (72)	°C (°F)	O	General
M1	13	Hx Diff. Max. Wait Time	Defines the restart time after reaching the Delta T limit between delivery and return	10…250	10	Sec.	O	Heating
M1	14	Max. Power CH	Sets the heating's % max. power	50…100	100	%		Heating
M1	15	Min. Power CH	Sets the heating's % min. power.	1…30	1	%		Heating
M1	16	CH PID P	Defines the proportional parameter for modulation during heating operation	0…1275	50		O	Heating
M1	17	CH PID I	Defines the modulation integral term during heating operation	0…1275	500		O	Heating
M1	18	CH PID D	Defines the modulation derivative term during heating operation	0…1275	0		O	Heating
M1	19	Design supply Temp	Defines the max. set-point at the minimum outdoor temperature for climatic regulation	30…90 (86...194)	90 (194)	°C (°F)	U	Heating

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M1	20	Design Outdoor Temp	Defines the minimum outdoor temperature to which the maximum set-point can be associated for climatic regulation	-25...25 (-13...77)	-5 (23)	°C (°F)	U	Heating
M1	21	Baseline Supply Temp	Defines the minimum set-point at the maximum outdoor temperature for climatic regulation	30…90 (86...194)	40 (104)	°C (°F)	I	Heating
M1	22	Baseline Outdoor Temp	Defines the maximum minimum outdoor temperature to which the minimum set-point can be associated for climatic regulation	0...30 (32...86)	20 (68)	°C (°F)	I	Heating
M1	23	Design Supply Min. Limit	Limits the minimum value that can be assigned to the set-point in heating mode (does not apply to heating mode 4)	4...82 (39...180)	30 (86)	°C (°F)	I	Heating
M1	24	Design Supply Max. Limit	Limits the maximum value that can be assigned to the set-point in heating mode (does not apply to heating mode 4)	27...90 (81...194)	90 (194)	°C (°F)	I	Heating
M1	25	Warm Weather Shutdn	Defines the temperature at which climatic regulation is switched off	0...35 (32...95)	22 (71,6)	°C (°F)	I	Heating
M1	26	Boost Temp Increment	Establishes the set-point temperature increase delta T, if the heat demand in heating mode is not satisfied after the time interval specified in Par. 27 (applies only to stand-alone mode)	0...30 (32...86)	0 (32)	°C (°F)	I	Heating
M1	27	Boost Time Delay	Defines the time interval after which the setpoint is increased as defined in Par. 26 (applies only to stand-alone mode)	1…120	20	Min.	I	Heating
M1	28	Night Setback Temp	Used in heating mode Par. 1= 2 or 3. Establishes by how many degrees the delivery set-point is reduced when the RT (room thermostat/heat demand) contact is closed	0...30 (32...86)	10 (18)	°C (°F)	I	Heating
M1	195	WWSD Enable	It is possible to enable/ disable the shutdown of the entire system due to high external temperatures, both CH and ZH	Enabled/Disabled	Enabled		I	Heating
		DHW Control	Enable or disable the DHW circuit	Enabled/Disabled	Enabled		I	Heating
M1	35	DHW mode	Establishes the domestic hot water circuit's operation mode. 0 = Disabled 1 = Tank + sensor 2 = Tank + thermostat	0,1,2	0		I	DHW
M1	113	Max. Power DHW	Defines the domestic hot water circuit's % max. power	50...100	50	%	I	DHW
	114	Min. Power DHW	Defines the domestic hot water circuit's % minimum power	1...30	1	%	I	DHW

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M1	36	DHW Tank Hyst. Down	Defines the hysteresis to initiate the domestic hot water demand	0…20 (32...68)	5 (9)	°C (°F)	I	DHW
M1	37	DHW Tank Hyst. Up	Defines the hysteresis to stop the domestic hot water demand	0…20 (32...68)	5 (9)	°C (°F)	I	DHW
M1	38	DHW Tank Supply Extra	Defines the primary circuit's set-point increase in degrees compared to the temperature set for the domestic hot water tank	0...30 (32...86)	15 (27)	°C (°F)	I	DHW
M1	39	DHW Tank Supp Hyst Dn	Defines the primary circuit's restart hysteresis in modes 1 and 2 of domestic hot water (valid both for cascade and stand-alone applications)	0…20 (32...68)	5 (9)	°C (°F)	O	DHW
M1	40	DHW Tank Supp Hyst Up	Defines the primary circuit's shut-off hysteresis in modes 1 and 2 of domestic hot water (valid both for cascade and stand-alone applications)	0…20 (32...68)	5 (9)	°C (°F)	O	DHW
M1	41	DHW Tank Hold Warm	Defines the value of a storage cylinder's delta T required for temperature maintenance. For instance, if set at 3 degrees, when the storage cylinder is at a set-point value minus 3 degrees, the thermal module is switched on at minimum power to maintain the temperature to the set-point plus hysteresis. If this parameter is kept the same as Par. 36, this function is inactive and the thermal module is switched on to the maximum power envisaged for the DHW circuit	0…10 (32...50)	5 (9)	°C (°F)	O	DHW
M1	42	DHW Priority	Defines the priority type: 0 = Time: time priority between the two circuits defined by Par. 43; 1 = Off: priority for CH; 2 = On: priority for DHW; 3 = Parallel: parallel priority managed on the basis of the primary circuit's temperature compared to the heating circuit's set-point	0…3	0 = Time		I	DHW
M1	43	DHW Max. Priority Time	Establishes the time in minutes during which priority is alternatively allocated to the DHW and CH circuits when Par. 43 is set to "time" mode	1…255	60	Min.	I	DHW
M1	44	DHW Pump Overrun	Establishes the overrun time in seconds for the domestic hot water mode with the boiler in stand-alone operation; cascaded operation defines the module's overrun after switch-off due to thermoregulation	0…900	0	Sec.	I	DHW

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M1	45	DHW Tank PID P	Defines the proportional term for modulation during operation of the DHW storage tank	0…1255	100		O	DHW
M1	46	DHW Tank PID I	Defines the integral term for modulation during operation of the DHW storage tank	0…1255	500		O	DHW
M1	47	DHW Tank PID D	Defines the derivative term for modulation during operation of the DHW storage tank	0…1255	0		O	DHW
M1	48	DHW tank set-point	Establishes the DHW storage tank set-point	40...71 (104...160)	50 (122)	°C (°F)	U	DHW
M1	49	DHW Hysteresis Down	“reserved”	0…20 (32...68)	4 (7.2)	°C (°F)	O	DHW
M1	50	DHW Hysteresis Up	“reserved”	0…20 (32...68)	4 (7.2)	°C (°F)	O	DHW
M1	51	DHW Instant PID P	“reserved”	0…1255	100		O	DHW
M1	52	DHW Instant PID I	“reserved”	0…1255	160		O	DHW
M1	53	DHW Instant PID D	“reserved”	0…1255	0		O	DHW
M1	60	Flow Rate Start	“reserved”	0.1…20	1.4	l/min	O	DHW
M1	61	Flow Rate Lo Temp Pwr	“reserved”	0.1…20	1.4	l/min	O	DHW
M1	62	Flow Rate Hi Temp Pwr	“reserved”	0.1…20	1.4	l/min	O	DHW
M1	63	DHW On Off Period	“reserved”	10…60	30	Sec.	O	DHW
M1	64	PreHeat Mode	“reserved”	Off, Comfort, Eco, Anti-Fr	Off		U	DHW
M1	65	PreHeat Mode Eco Setpoint	“reserved”	20...60 (68...140)	30 (86)	°C (°F)	O	DHW
M1	67	PreHeat After Tap Hld Time	“reserved”	0…255	30	Sec.	O	DHW
M1	68	After Tap Hold Time	“reserved”	0…255	120	Sec.	O	DHW
M1	69	PreHeat Hyst Down	“reserved”	0...30 (32...86)	5 (9)	°C (°F)	O	DHW
M1	70	PreHeat Hyst Up	“reserved”	0...30 (32...86)	0	°C (°F)	O	DHW
M1	71	PreHeat Delay Time	“reserved”	0…15	10	Sec	O	DHW
M1	92	Fan Speed Maximum	Defines the number of fan rpm at max. power (it depends on the model)	0…12750	6900	RPM	I	General
M1	93	Fan Speed Minimum	Defines the number of fan rpm at minimum power (it depends on the model).	0…12750	1900	RPM	I	General
M1	94	Fan Speed Ignition	Defines the number of fan rpm when the boiler is switched on (it depends on the model).	0…12750	4500	RPM	I	General
M1	116	Prog. Input 1.	0 = Disabled 1 = Water pressure sensor 2 = CH flow switch 3 = Flue pressure switch.	0,1,2,3	Defined by Par. 97		I	General
M1	117	Prog. Input 2	0 = Disabled 1 = DHW flow sensor 2 = DHW flow switch 3 = CH flow sensor.	0,1,2,3,4	Defined by Par. 97		I	General
M1	118	Prog. Input 3.	0 = Disabled 1 = Drain switch 2 = Gas pressure switch	0,1,2	Defined by Par. 97		I	General

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M1	120	Prog. Input 5	0 = Disabled 1 = T_Return sensor 2 = Extern switch	0,1,2	Defined by Par. 97		I	General
M1	121	Prog. Input 6	0 = Disabled 1 = T_Flue sensor 2 = Flue switch 3 = APS switch	0,1,2,3	Defined by Par. 97		I	General
M1	122	Prog. Input 7	0 = Disabled 1 = T_Flue_2 sensor 2 = T_Flue_2 + Bl. Flue 3 T_System sensor 4 = Blocked Flue switch 5 Cascade Sensor	0,1,2,3,4,5	Defined by Par. 97		I	General
M1	123	Prog. Input 8	0 = Disabled 1 = T_DCW sensor 2 = Water pressure switch	0,1,2	Defined by Par. 97		I	General
M1	188	Prog. Input 9	0 = Disabled 1 = T_DHW sensor 2 = Zone sensor	NA	Defined by Par. 97		I	General
M1	124	Prog. Input RT.	0 = Disabled 1 = Enabled	NA			I	General
M1	125	Prog. Output 1	0) Disabled 1) General Pump 2) CH Pump 3) DHW Pump 4) System Pump 5) Cascade Pump 6) Alarm Relay 7) Filling Valve 8) LPG Tank 9) External Igniter 10) Air Damper 14) Alarm Burner CC 15) Status Burner CC 16) Zone pump 17)Mixing valve open 18)Mixing valve closed 19) Anti-legionella 20) LPG Tank cascade	0,1,2,3,4,5,6,7,8,9,10,14,15,16,17,18,19,20	Defined by Par. 97		I	General
M1	126	Prog. Output 2	0) Disabled 1) General Pump 2) CH Pump 3) DHW Pump 4) System Pump 5) Cascade Pump 6) Alarm Relay 7) Filling Valve 8) LPG Tank 9) External Igniter 10) Air Damper 14) Alarm Burner CC 15) Status Burner CC 16) Zone pump 17) Mixing valve open 18) Mixing valve closed 19) Anti-legionella pump 20) LPG Tank cascade	0,1,2,3,4,5,6,7,8,9,10,14,15,16,17,18,19,20	Defined by Par. 97		I	General

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M1	127	Prog. Output 3	0) Disabled 1) General Pump 6) Alarm Relay 9) External Igniter 10) Air Damper 11) External Igniter 12) Modulating pump	0,1,2,3,4,5,6,7,8,9,10,11,12	Defined by Par. 97		I	General
M1	128	Prog. Output 4	0) Disabled 1) General Pump 2) CH Pump 3) DHW Pump 4) System Pump 5) Cascade Pump 6) Alarm Relay 7) Filling Valve 8) LPG Tank 9) External Igniter 10) Air Damper 14) Alarm Burner CC 15) Status Burner CC 16)Zone pump 17)Mixing valve open 18)Mixing valve closed 19)Anti-legionella 20) LPG Tank cascade	0,1,2,3,4,5,6,7,8,9,10,14,15,16,17,18,19,20	Defined by Par. 97		I	General
M1	187	Prog. Output 5	0) Disabled 1) General Pump 2) CH Pump 3) DHW Pump 4) System Pump 5) Cascade Pump 6) Alarm Relay 7) Filling Valve 8) LPG Tank 9) External Igniter 10) Air Damper 14) Alarm Burner CC 15) Status Burner CC 16) Zone pump 17) Mixing valve open 18) Mixing valve closed 19) Anti-legionella 20) LPG Tank cascade	0,1,2,3,4,5,6,7,8,9,10,14,15,16,17,18,19,20	Defined by Par. 97		I	General
M1	129	Flow Sensor	Defines the type of flow sensor used.	Bitron, Huba: DN8, DN10, DN15, DN15, DN20, DN25	Huba DN25		I	General
M1	130	Flow Scaling Factor	“reserved”	0…25.5	3.2	rpm/l	I	DHW
M1	131	Min Press.	“reserved”	Off, 0.3…5.0	0.1 (1.5)	bar (PSI)	I	DHW
M1	132	Pressure Fill Hyst.	“reserved”	Off, 0.2…5.0	0.5 (7.3)	bar (PSI)	I	DHW
M1	133	Mod. Pump dT	Defines the delta T set for the operation of the modulating circulator.	5...40 (41..104)	15 (59)	°C (°F)	I	General

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M1	134	Mod. Pump Start Time	Defines the time in seconds from the moment the burner is switched on to start the modu-lation of the circulator and obtain the delta T specified in Par. 133.	0…255	120	Sec.	I	General
M1	135	Mod. Pump Type	Defines the PWM circulator model installed. 0 = Wilo 1 = Salmson 2 = Grundfos	0. Wilo Yonos 1. Salmson 2. Grundfos	0= Wilo		I	General
M1	136	Mod. Pump Mode	Defines whether the boiler's circulator oper-ates in modulating mode or at a set speed (as a percentage of maximum speed).	0. On/Off 1. Modulating 2-10 Fixed 20… 100%	ON/OFF		I	General
M1	137	Mod. Pump Min Pwr	Defines the percentage of speed that sets the minimum speed that the circulator can reach during modulation.	0…100	40	%	I	General
M1	139	Dair active	Activates bleeding the system's air. To activate air bleeding, it is necessary to switch on the boiler and change the parameter from "No" to "Yes". Wait for one minute. Switch off and restart. At this stage, when it is restarted the boiler will initiate the automatic bleeding procedure (lasting around 20 minutes). With the parameter set to "Yes", the procedure is carried out each time the boiler is switched off and restarted using its master switch. The value must be set to "No" if you do not wish to initiate the bleeding procedure when the thermal module is switched on.	Yes, No	No		I	General
M1	140	Minimum Flow	Defines the flow rate below which the boiler is switched off. The value varies depending on the model.	0.0...100 (0...26)	50	l/min	I	General
M1	196	HX flow timeout	If the minimum flow rate is not reached within the timeout, error 163 (LOWEXFLOW_ PROTECTION) will be generated which will also cause the end of prepurge.	4...100	18	Sec	I	General
M1	107	Anti-legionella Day	Sets the weekday on which the anti-Legionella procedure is carried out.	Sun…Sat.	Sun	Day	I	DHW
M1	108	Anti-legionella Hour	Sets the time of the day during which the an-ti-Legionella procedure is carried out.	0…23	0	Hour	I	DHW
M1	183	High Limit Test	Enable limit thermostat physical test	Simulated/Physical	Simulated		O	General

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M1	155	Frost Protection	Defines the temperature (detected by the pri-mary sen- sor) below which the thermal mod-ule circulator and the system circulator (with cascade configuration) activate. If the tem-perature of the primary sensor falls another 5 degrees below the value set by Par. 155, then a request to activate the cascade is generated. When the temper- ature of the primary sensor reaches the value defined by Par. 155 increased by 5 degrees, then the request ceases and the cascade returns to stand-by mode.	10...30 (50...86)	15 (59)	°C (°F)	I	General
M1	186	Frost protection outdoor	It defines the intervention temperature of the antifreeze function related to the external probe.	-30...15 (-22...59)	3 (37.4)	°C (°F)	I	General
M1	191	Fan Type	Defines the type of fan installed in the boiler.	0...15	Defined by Par. 97		I	General
M1	193	DHW for all	“reserved”	No...Yes	No		I	DHW
M2	**189**	**Burner address**	It is used to address the module.	Stand-alone (0) Managing (1) Dependent (2…16)	Stand alone (0)		I	DHW
M2		Dipswitch Config.	Enable or disable the dipswitch function.	Enabled/Disabled	Enabled		I	Cascade
M2		Boiler demand disabled	All requests for this boiler are disabled.	Yes/No	No	.	I	Cascade
M2	72	Permit Emergency Mode	Activates the emergency mode. This mode comes on when communication between Managing and the primary circuit’s probe is lost. In this event, if Par. 72 is set to “Yes”, the cascade is initiated, working to the fixed set-point determined by Par. 74.	Yes/No	Yes	.	U	Cascade
M2	74	Emergency Set-point	Set-point active in emergency mode.	20…90 (68...194)	70 (158)	°C (°F).	I	Cascade
M2	75	Delay Per Start Next Mod	Defines the stand-by time in seconds to restart the subsequent cascade module in normal start mode.	5…255	200	Sec.	I	Cascade
M2	76	Delay Per Stop Next Mod	Defines the stand-by time in seconds to switch off the last cascade module on in nor- mal Off mode.	5…255	180	Sec	I	Cascade
M2	142	Delay Quick Start Next	Defines the stand-by time in seconds to restart the next cascade module in quick start mode.	5…255	50	Sec	I	Cascade
M2	143	Delay Quick Stop Next	Defines the stand-by time in seconds to switch off the last cascade module on in Quick Stop mode.	5…255	30	Sec	I	Cascade

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M2	77	Hyst Down Start Module	Defines by how many degrees the temperature measured by the primary circuit's probe must fall below the set-point in order for the sub-sequent module to be started after the time interval set by Par. 75.	0...40 (32...104)	5 (9)	°C (°F)	I	Cascade
M2	78	Hyst Up Stop Module	Defines by how many degrees the tempera-ture measured by the primary circuit's probe must go above the set-point in order for the subsequent module to be switched off after the time interval set by Par. 76.	0...40 (32...104)	4 (7.2)	°C (°F)	I	Cascade
M2	147	Number of Units	Defines the number of modules of which the cascade consists.	1…16 (basic cascade) 1…8 (full cascade)	8		I	Cascade
M2	144	Hyst Down Quick Start	Defines by how many degrees the temperature measured by the primary circuit's probe must go below the set-point in order for the sub-sequent module to be started after the time interval set by Par. 142 (quick-start mode).	0...40 (32...104)	10 (18)	°C (°F)	I	Cascade
M2	145	Hyst Up Quick Stop	Defines by how many degrees the temperature measured by the primary circuit's probe must go above the set-point in order for the sub-sequent module to be switched off after the time interval set by Par. 143 (quick stop mode).	0...40 (32...104)	6 (10.8)	°C (°F)	I	Cascade
M2	146	Hyst Up Stop All	Defines by how many degrees the temperature measured by the primary circuit's probe must go above the set-point in order for all "On" modules to be switched off at the same time.	0...40 (32...104)	8 (14.4)	°C (°F)	I	Cascade
M2	148	Power mode	Defines the cascade operation mode 0 = Disabled 1 = Min burners 2 = Max burners	0,1,2	2		I	Cascade
M2	79	Max. Setp. Offset Down	Defines the maximum decrease in the primary circuit's cascade set-point. Is based on the primary circuit's probe reading.	0...40 (32...104)	4 (7.2)	°C (°F)	I	Cascade
M2	80	Max Setp Offset Up	Defines the maximum increase in the primary circuit's cascade set-point. Is based on the primary circuit's probe reading.	0...40 (32...104)	4 (7.2)	°C (°F)	I	Cascade
M2	81	Start Mod Delay Fact	Defines the time in minutes from the moment the demand is triggered until the activation of the set-point increases or decreases provided for by Par. 79 e 80.	0…60	60	Min.	I	Cascade

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M2	82	Next Module Start Rate	It defines the minimum power for at least one of the modules in the cascade in order for the next module to be switched on (if the other conditions linked to Par. 75 and 77 are met).	10…100	80	%	I	Cascade
M2	83	Next Module Stop Rate	It defines the maximum power for all the modules in the cascade in order for the last module on to be switched off (if the other conditions linked to Par. 76 and 78 are met).	10…100	25	%	I	Cascade
M2	84	Module Rotation Interval	It defines the time interval (in days) after which modules are rotated.	0...30	5	Days	I	Cascade
M2	149	First Module to Start	Establishes the number of the next module to be rotated (this value is automatically updated at each rotation).	1...8	1		I	Cascade
M2	86	PID P	Defines the proportional term to change the setpoint of the cascade module.	0…1275	50		O	Cascade
M2	87	PID I	Defines the integral term to change the set-point of the cascade module.	0…1275	250		O	Cascade
M2	150	PID Slew Rate Up	Defines the speed (in °C/100 ms) with which the set-point of individual modules is in-creased in the event the primary circuit's set-point is not achieved (if the value is set to zero, the change is controlled by the PI of Par. 86 and87 without restrictions).	0…25.5	5		O	Cascade
M2	151	PID Slew Rate Dn	Defines the speed (in °C/100 ms) with which the set-point of individual modules is de-creased in the event the primary circuit's set-point is exceeded (if the value is set to zero, the change is controlled by the PI of Par. 86 and 87 without restrictions).	0…25.5	5		O	Cascade
M2	152	PwrMode2 Min Power	Defines the power value (in percentage terms) against which the average power of all on modules in cascade operation mode must be compared (Par. 148 = 2).	0…100	20	%	I	Cascade
M2	**153**	PwrMode2 Hysteresis	Defines the extra power value (in percentage terms) compared to the average power of all on modules in cascade operation mode (Par. 148 = 2).	0…100	40	%	I	Cascade
M2	154	Post-Pump period	Defines overrun time in seconds at the end of the cascade heat demand.	0…255	30	Sec	I	Cascade
M2	184	N. active burner in DHW	With this setting it is possible to set the num-ber of burners that are used for cascade DHW.	0...16	16		I	Cascade

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M3	73	Boiler Address	Defines the way in which the boiler is man-aged.	Managing, Stand-alone, Dependent	Stand-alone	.	I	Cascade
M3	156	Permit Emergency Mode	Enable/disable emergency mode.	Yes/No	Yes	.	U	Cascade
M3	157	Emergency Set-point	Defines the emergency mode setpoint.	20…90 (68...194)	70 (158)	°C (°F)	I	Cascade
M3	158	Delay Per Start Next Blr.	“reserved”	0…1275	1275	Sec.	I	Cascade
M3	159	Delay Per Stop Next Blr.	(“reserved”)	0…1275	1275	Sec	I	Cascade
M3	160	Delay Quick Start Next	“reserved”	0…1275	400	Sec	I	Cascade
M3	161	Delay Quick Stop Next	“reserved”	0…1275	240	Sec	I	Cascade
M3	162	Hyst Down Start Boiler	“reserved”	0...40 (32...104)	5 (9)	°C (°F)	I	Cascade
M3	163	Hyst Up Start Boiler	“reserved”	0...40 (32...104)	2 (3.6)	°C (°F)	I	Cascade
M3	164	Hyst Down Quick Start	“reserved”	0...40 (32...104)	10 (18)	°C (°F)	I	Cascade
M3	165	Hyst Up Quick Stop	“reserved”	0...40 (32...104)	4 (7.2)	°C (°F)	I	Cascade
M3	166	Hyst Up Stop All	“reserved”	0...60 (32...140)	8 (14.4)	°C (°F)	I	Cascade
M3	167	Number of boilers	“reserved”	1…16 (basic cascade) 1…8 (full cascade)	1		I	Cascade
M3	168	Power Mode	“reserved”	0) Disabled 2) Max burners 3) Balanced burners	2		I	Cascade
M3	169	Max. Setp. Offset Down	Defines the maximum decrease in the primary circuit’s cascade set-point. Is based on the secondary circuit’s probe reading.	0...40 (32...104)	8 (14.4)	°C (°F)	I	Cascade
M3	170	Max Setp Offset Up	Defines the maximum increase in the primary circuit’s cascade set-point. Is based on the secondary circuit’s probe reading.	0...40 (32...104)	8 (14.4)	°C (°F)	I	Cascade
M3	171	Start Mod Delay Fact	Defines the time in minutes from the moment the request is triggered until the activation of the set-point increases or decreases provided for by Par.169 e 170.	0…255	20	Min.	I	Cascade
M3	172	Next Boiler Start Rate	“reserved”	10…100	80	%	I	Cascade
M3	173	Next Boiler Stop Rate	“reserved”	10…100	25	%	I	Cascade
M3	174	Module Rotation Interval	“reserved”	0…30	5	Days	I	Cascade
M3	175	First Boiler to Start	“reserved”	1…8	1		I	Cascade
M3	176	PID P	Defines the proportional term to change the set-point of the cascade module based on the secondary circuit’s temperature.	0…1275	25		O	Cascade

Menu.	Par. No.	Display visualisation	Description	Range	Default setting	UM	Access type	Category
M3	177	PID I	Defines the integral term to change the set-point of the cascade module based on the secondary circuit's temperature.	0…1275	500		O	Cascade
M3	178	PID Slew Rate Up	Defines the speed (in °C/100 ms) with which the set-point of individual modules is in-creased in the event the secondary circuit's set-point not reached (if the value is set to zero, the change is controlled by the PI of Par. 176 and 177 without restrictions).	0…25.5	5		O	Cascade
M3	179	PID Slew Rate Dn	Defines the speed (in °C/100 ms) with which the set-point of individual modules is de-creased in the event the primary circuit's set-point is exceeded (if the value is set to zero, the change is controlled by the PI of Par. 176 and 177 without restrictions).	0…25.5	5		O	Cascade
M3	180	PwrMode2 Min Power	"reserved"	0…100	20		I	Cascade
M3	181	PwrMode2 Min Hysteresis	"reserved"	0…100	40		I	Cascade
M3	182	Post-Pump period	"reserved"	0…255	30		I	Cascade
M4		Appliance model	Defines the boiler model	1…4	3		O	General
M4	98	Appliance settings	Supports uploading the values of Par. 92, 93 and 94 from a set of pre-defined rpm values that identifies the boiler type.	1…85	17		I	General
M4	97	IO Configuraion	Supports uploading the values of Par. from 116 to 128 from a set of pre-defined rpm values that defines the configuration of the boiler's inputs and outputs.	1…53	12		I	General

BOARD	Parameter 97 I/O Configuration	Parameter 98 Appliance
MANAGING	12	NG: 17 (Max 6900rpm Min 1900rpm Ignit 4500rpm) LPG: 18 (Max 6900rpm Min 1900rpm Ignit 4400rpm)
DEPENDENT	13	NG: 17 (Max 6900rpm Min 1900rpm Ignit 4500rpm) LPG: 18 (Max 6900rpm Min 1900rpm Ignit 4400rpm)

Appendix D - NTC sensor curve selection (Rev 3.0.0.0)

The NTC curve of each sensor can be changed between LabVision PC software.
The NTC curve can be selected from a list of pre-defined curves.

Setting	NTC Curve
0	NTC 10K @ 25°C B3435
1	NTC 10K @ 25°C B3977
2	NTC 10K @ 25°C B3760
10	NTC 10K @ 20°C B3457
20	NTC 12K @ 25°C B3740
30	NTC 12K @ 25°C B3970

(*) Duplex safety sensors cannot be adjusted freely.

Appendix E - 5 Error table (Rev. 4.0.905.17114)

In the next tables a description of all different errors is given.

Errors can be divided in three groups:
- Non-volatile locking errors (can only be reset by the reset button).
- Blocking errors (will disappear when error is gone)
- Warnings (will disappear when the warning is gone, also isn't stored in the e2prom)

When the control is in error the pump will be running. This is to prevent the freezing of the Central Heating circuit when the boiler is in error during the winter period. For some non-volatile lockouts the pump will not be running, also see the error tables in this chapter for more details.

E.1 Boiler history and time stamps

Boiler History

Via the Boiler History screen in the LabVision PC software the following history data is shown:
- Successful ignitions
- Failed Ignitions
- Flame Failures
- Hours in Operation
- CH Burner Minutes
- DHW Burner Minutes

Error History

The last 15 lockout and 15 blocking errors are stored in the boiler control. This boiler history can be shown via the Boiler History screen in LabVision or via the installer boiler status menu in one of the advanced epHS displays.

Time Stamp

A time stamp will be added to an error at the moment the error occurs. The time between this error and a new error will be counted. The interval between an error and the previous error is shown as interval time in minutes, hours, days or weeks.
The previous error codes are also shown in LabVision (also see the image on the following page).

Successful ignitions

To prevent wear on the e2prom of the boiler control, the successful ignitions are only saved after 16 successful ignitions. When a power cycle is performed after 15 successful ignitions, these 15 ignitions are not counted.

E.2 Lockout codes

Error no.	Error	Description	Checks	Solutions
0	E2PROM_READ_ERROR	Internal software error		Control board replacement
1	IGNIT_ERROR	Three unsuccessful ignition attempts in a row	a- Check gas supply pressure; b- Check spark and ignitor rod. c- Correct amount of air; d-Check for 120VAC at the gas valve. e- Ensure that the gas valve is functioning properly by checking for changes in gas pressure.	a- If the gas supply pressure is incorrect, it must be adjusted to the correct pressure; b- If spark is not present check for correct ignition electrode position; c- If the combustion air pressure is incorrect, inspect the vent system and eliminate any obstructions; d- If the voltage to the gas valve is not 120Vac the power control board must be replaced.
2	GV_RELAY_ERROR	Failure detected in the GV (Gas Valve) relay	a- Check the integrity of the wire connections between gas valve and control board.	a- If wires are damaged, replace them b- If wires are ok, replace the gas valve or the power control board.
3	SAFETY_RELAY_ERROR	Internal control board error		a- If the error occurs during boiler normal operation, replace the Control board b- If the error occurs at the electrical switching on (by main switch) of the boiler, check high sensor limit (and its wiring) integrity
4	BLOCKING_TOO_LONG	Control had a blocking error for more than 20 hours. This error is caused when any Blocking errors occur and are not corrected automatically. Therefore it causes a Locking error.	a- Press RESET button to display the Blocking error description b- Check error log on touchscreen. c- The blocking error that occurred previous to current locking error will be the cause (i.e.- 163 LowExFlow).	Remove the cause of the Blocking error

Error no.	Error	Description	Checks	Solutions
5	FAN_ERROR_NOT_ RUNNING	Fan is not running after 60 seconds.	a- Check for 120 VAC power connection of the fan. b- Check PWM connection of the fan.	a- If no 120 VAC voltage is present, replace the power control board; b- If no PWM signal is present, replace power control board; c- Replace the fan.
6	FAN_ERROR_TOO_SLOW	Fan runs too slow for more than 60 seconds		
7	FAN_ERROR_TOO_FAST	Fan runs too fast for more than 60 seconds		
8	RAM_ERROR	Internal software error		Control board replacement
9	WRONG_EEPROM_ SIGNATURE	Contents of E2PROM are not up to date		Control board replacement
10	E2PROM_ERROR	Wrong safety parameters in E2PROM		Control board replacement
11	STATE_ERROR	Internal software error		Control board replacement
12	ROM_ERROR	Internal software error		Control board replacement
13	APS_NOT_OPEN	Air pressure switch not working		
14	APS_NOT_CLOSED	Air pressure switch not working		
15	MAX_TEMP_ERROR	The external overheat protection is enabled or the High limit sensor measures a temperature of over 95°C (203°F)	a- Check module water temp. b- Check the pump to verify the flow circulation; c- Check if the valves on hydraulic circuit are open; d- Check the high limit switch.	a- Change the pump or restart it; b- Open the valves on hydraulic circuit; c- Change the high limit switch.
16	FLUE_GAS_ERROR	Flue temperature exceeded the maximum allowable flue temperature		
17	STACK_ERROR	Internal software error		Control board replacement
18	INSTRUCTION_ERROR	Internal software error		Control board replacement
19	ION_CHECK_FAILED	Internal software error		Control board replacement
20	FLAME_OUT_TOO_LATE	Flame still present 10 seconds after closing the gas valve		Replace the gas valve
21	FLAME_BEFORE_IGNIT	Flame is detected before ignition		Replace the gas valve
22	TOO_MANY_FLAME_LOSS	Three flame failures during one demand cycle	a- Check the integrity of the wire connections of the spark and the earth on heat exchanger b- check ionization signal while running	a- If wires are damaged, replace them b- check for proper combustion settings - if correct replace spark/flamerod.
23	CORRUPTED_ERROR_NR	Error code RAM byte was corrupted to an unknown error code		

Error no.	Error	Description	Checks	Solutions
24	FLUE_SWITCH_NOT_ CLOSING	The blocked flue sensor is not closed within 10 minutes		
29	PSM_ERROR	Internal software error		
30	REGISTER_ERROR	Internal software error		Control board replacement
33	LWCO_1_ERROR	Low Water Cut-Off 1 error	a- Check to ensure all valves are open, pump is running. b- Check the wiring between the controller and the LWCO probe.	a- Verify water is in the boiler. b- Verify good connection between control module and low water probe.
34	LWCO_2_ERROR	Low Water Cut-Off 2 error	a- Check to ensure all valves are open, pump is running. b- Check the wiring between the controller and the LWCO probe.	a- Verify water is in the boiler. b- Verify good connection between control module and low water probe.
35	GAS_PRESSURE_ERROR	Gas pressure switch is closed. This can either be the High or Low Gas Pressure Switch.	a- Check gas pressure to ensure it is steady and within the recommended range for the unit. b- Check with as many modules on as possible to ensure supply connections are sized properly.	
36	AIR_DAMPER_LOCKING	Air Damper feedback is not received when the relative output is open for the fourth time.		
37	FLUE_PRESSURE_ LOCKING	Flue pressure switch is closed for the fourth time.	a- Check for obstruction in the flue piping. b- Blocking errors should be recorded prior to the occurrence of this Locking error. c- Check for condensate in the hose connecting the flue pressure switch to ensure it isn't blocked.	

Blocking errors

Error no.	Error	Description	Checks	Solutions
100	WD_ERROR_RAM	Internal software error		Control board replacement

Error no.	Error	Description	Checks	Solutions
101	WD_ERROR_ROM	Internal software error		Control board replacement
102	WD_ERROR_STACK	Internal software error		Control board replacement
103	WD_ERROR_REGISTER	Internal software error		Control board replacement
104	HIGH_LIMIT_FAIL	Physical high limit test failed		Control board replacement
106	REFHI_TOO_HIGH	Internal software error		Control board replacement
107	REFHI_TOO_LOW	Internal software error		Control board replacement
108	REFLO_TOO_HIGH	Internal software error		Control board replacement
109	REFLO_TOO_LOW	Internal software error		Control board replacement
110	REFHI2_TOO_HIGH	Internal software error		Control board replacement
111	REFHI2_TOO_LOW	Internal software error		Control board replacement
112	REFLO2_TOO_HIGH	Internal software error		Control board replacement
113	REFLO2_TOO_LOW	Internal software error		Control board replacement
114	FALSE_FLAME	Flame is detected in a state in which no flame is allowed to be seen		Control board replacement
115	LOW_WATER_PRESSURE_ERROR	Low water pressure error	a- Check system water pressure. b- Ensure that it is above min. recommended pressure (7.5PSI). c- Check the value of the reading of this sensor in the info screen. If the value is not in line with the system pressure check the sensor.	
116	LOW_WATER_PRESSURE_SENSOR	Low water pressure		
117	BLOCKED_DRAIN	Blocked drain switch is active		
118	WD_COMM_ERROR	Watchdog communication error		Control board replacement

Error no.	Error	Description	Checks	Solutions
119	RETURN_OPEN	Return sensor open	a- Check the integrity of the wire connections; b- Check the return temperature sensor.	a- If the wiring is damaged, replace it; b- Verify that the temperature sensor has the correct resistance values. If values are incorrect sensor must be replaced.
120	SUPPLY_OPEN	Supply sensor open	a- Check the integrity of the wire connections; b- Check the supply temperature sensor.	a- If the wiring is damaged, replace it; b- Verify that the temperature sensor has the correct resistance values. If values are incorrect sensor must be replaced.
122	DHW_OPEN	DHW sensor open	a- Check the integrity of the wire connections; b- Check the DHW temperature sensor.	a- If the wiring is damaged, replace it; b- Verify that the temperature sensor has the correct resistance values. If values are incorrect sensor must be replaced.
123	FLUE_OPEN	Flue sensor open		
125	OUTDOOR_OPEN	Outdoor sensor open	a- Check the integrity of the wire connections; b- Check the Outdoor temperature sensor.	a- If the wiring is damaged, replace it; b- Verify that the temperature sensor has the correct resistance values. If values are incorrect sensor must be replaced.
126	RETURN_SHORTED	Return sensor shorted	a- Check the integrity of the wire connections; b- Check the return temperature sensor.	a- If the wiring is damaged, replace it; b- Verify that the temperature sensor has the correct resistance values. If values are incorrect sensor must be replaced.
127	SUPPLY_SHORTED	Supply sensor shorted	a- Check the integrity of the wire connections; b- Check the supply temperature sensor.	a- If the wiring is damaged, replace it; b- Verify that the temperature sensor has the correct resistance values. If values are incorrect sensor must be replaced.

Error no.	Error	Description	Checks	Solutions
129	DHW_SHORTED	DHW sensor shorted	a- Check the integrity of the wire connections; b- Check the DHW temperature sensor.	a- If the wiring is damaged, replace it; b- Verify that the temperature sensor has the correct resistance values. If values are incorrect sensor must be replaced.
130	FLUE_SHORTED	Flue sensor shorted	a- Check the integrity of the wire connections; b- Check the Outdoor temperature sensor.	a- If the wiring is damaged, replace it; b- Verify that the temperature sensor has the correct resistance values. If values are incorrect sensor must be replaced.
132	OUTDOOR_SHORTED	Outdoor sensor shorted	a- Check the integrity of the wire connections; b- Check the Outdoor temperature sensor.	a- If the wiring is damaged, replace it; b- Verify that the temperature sensor has the correct resistance values. If values are incorrect sensor must be replaced.
133	RESET_BUTTON_ERROR	Too many resets in a short time period		
135	T_EXCHANGE_BLOCK_ ERROR	Exchange temperature exceeded 90°C		
141	T_SELECTION3_OPEN	Selection 3 sensor open		
142	T_OPTIONAL1_OPEN	Optional 1 sensor open		
143	T_OPTIONAL2_OPEN	Optional 2 sensor open		
144	T_AMBIENT_OPEN	Ambient sensor open		
145	T_CHIMNEY_CLOSED	Chimney sensor shorted		
155	FLUE_PRESSURE_ERROR	Flue pressure switch is open	a- Check flue for obstructions. Clear if found. b- Check flue pressure to ensure flue has been installed and sized properly. c- Flue pressure switch default to 2.2”wc.	a- Remove any obstructions from the exhaust system; b- Remove any obstruction from condensate discharge and confirm the condensate can flow freely.
156	AIR_DAMPER_ERROR	Air Damper feedback is not received when the relative output is closed		
162	FLUE_BLOCKED	Flue is blocked, demand needs to be stopped with fan at ignition speed, but no error needed to be stored at this time		

Error no.	Error	Description	Checks	Solutions
163	LOWEXFLOW_PROTECTION	Flow is too low, demand needs to be stopped with fan at ignition speed, but no error needed to be stored at this time	a- Flow through the module is below recommended rate. b- Check to ensure module pump is running. c- Verify valves are open. d- Possible air entrapment.	

Warnngs

Error no.	Error	Description	Checks	Solutions
200	CC_LOSS_ COMMUNICATION	Cascade System: Leading burner lost communication with one of the depending burners	a- Check wiring and connections on individual Modules. b- Make sure both controllers in the boiler are powered on. c- Make sure Parameter 147 set to 2. d- Check the position of the S1 switches on the dependent module to make sure it is off.	
201	CC_LOSS_BOILER_COMM	Cascade System: Leading boiler lost communication with one of the depending boilers	a- Check interconnecting wiring between boilers. b- Make sure all boilers are powered on. c- Make sure that Parameter 167 set to proper number of boilers. d- Whichever boiler(s) loses communication with the Master Boiler will enter boiler level emergency mode. e- Check the position of the S1 switches on the managing boiler (on) and on the dependent boiler (off) to make sure they are set properly.	
202	OUTDOOR_WRONG	Outdoor sensor is open or shorted		
203	T_SYSTEM_WRONG	T_System sensor is open or shorted	a- Check connections of the boiler mounted sensor. b- This will cause Module Emergency Mode to activate on that particular boiler. c- Remaining cascade will continue to operate as normal. d- Check the value of the reading of this sensor on the info screen.	
204	T_CASCADE_WRONG	T_Cascade sensor is open or shorted	a- Check connections of the System sensor mounted in the header. b- This will cause Boiler level emergency mode to activate on all boilers in the cascade. c- Check the value of the reading of this sensor on the info screen.	

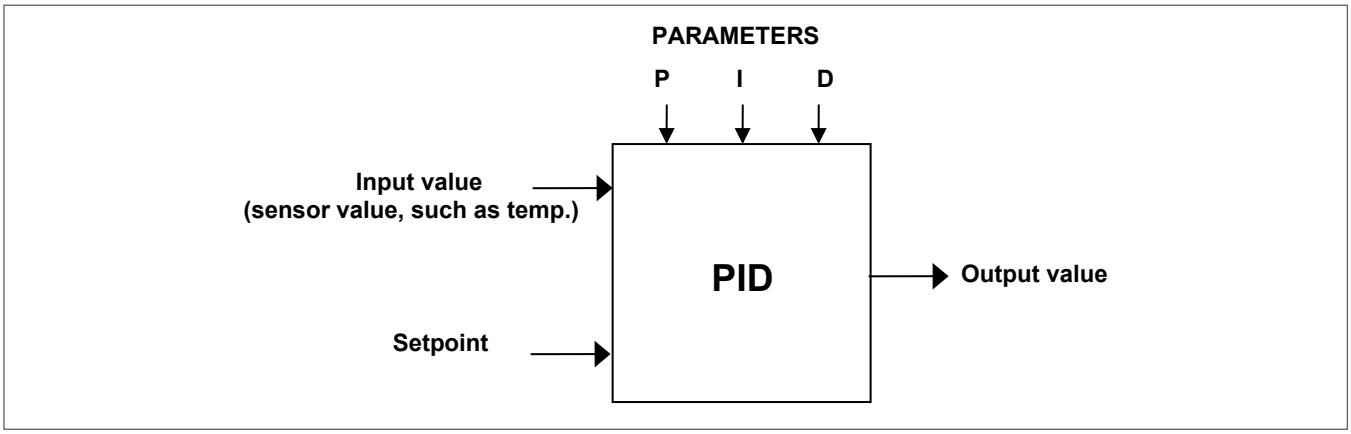
Error no.	Error	Description	Checks	Solutions
205	HIGH_LIMIT_TEST_WAIT_ ACTIVE	Too many physical high limit test attempts within 24 hours.		
206	DHW sensor is open or shorted	Current setopint is higher than 176°F (80°C)		
207	DHW_SENSOR_WRONG	DHW sensor is open or shorted		
208	ZONE_SENSOR_WRONG	Zone sensor is open or shorted		
209	BOILER_DEMAND-DISABLED	All incoming demand is disabled		

Appendix F - PID: Proportional-Integral-Derivative controller

For demand handling a software PID controller is implemented.

The PID controller calculates its output value as a function of the PID parameters, the setpoint and the input. The output can be used to control the fan for regulation of power, or pump for controlling the flow, depending on the application.

Parameters used for the calculation are:



Input value	As input the parameter that needs to be controlled is given. In most cases this is a sensor temperature. This PID controller will then control this input value to the given setpoint.
Setpoint	The setpoint value is the target value to which the input value is controlled to. This must be entered in the same format as the input value.
Output	The output is the target power to control the input value towards the setpoint. The output value can be scaled between a minimum and maximum output so this can be used in a understandable format.

P	The P parameter of the PID-controller is used to adjust the speed of the regulation. With a larger P-factor the regulation is faster, but it is more likely to create overshoot on the regulation. The formula is P_Power = P * Error, where the error is the difference between the setpoint and the actual temperature in 1/32 degree temperature steps. The P is a positive value when the difference (Setpoint > actual temperature) is also positive. This value is a part of the output power. The P is a negative value when the difference is also negative (Setpoint < actual temperature). This means that this part of the output power is negative.
I	The I parameter of the PID-controller is used to adjust the accuracy of the regulation. The I-factor keeps calculating the sum of the error between the input value and the setpoint. This keeps increasing/decreasing the output value. The I-factor is used to eliminate the error between the input value and setpoint that the P-factor cannot regulate. The sum of the error is divided by the I-factor, which means a small I-factor means a faster response on the output. A large I-factor results in a slower response on the output.
D	The D-factor is not enabled in the software.

F.1 Relay-based PID tuning

Relay-based auto tuning is a simple way to tune PID controllers that avoids trial and error, and minimizes the possibility of operating the plant close to the stability limit.

As it turns out, under relay-based feedback PID tuning, most plants oscillate with a modest amplitude fortuitously at the critical frequency.

The procedure is as following:

[7] In order to use relay-based tuning, this tuning mode must be enabled in the software. Set the PID- P parameter to 1, PID- I parameter to 0 and PID- D parameter to 0 when the tuning mode is enabled.

[8] Set offset parameter to the value needed to maintain at set-point for a certain load.

[9] When the input is stable with amplitude d for the PID controller as shown in the figure below, also set PID- P parameter to 0. This will start the relay-based PID tuning Oscillation.

[10] Trim the offSet if necessary to get an symmetric oscillation around set-point.

[11] Record the plant output amplitude a and period P.

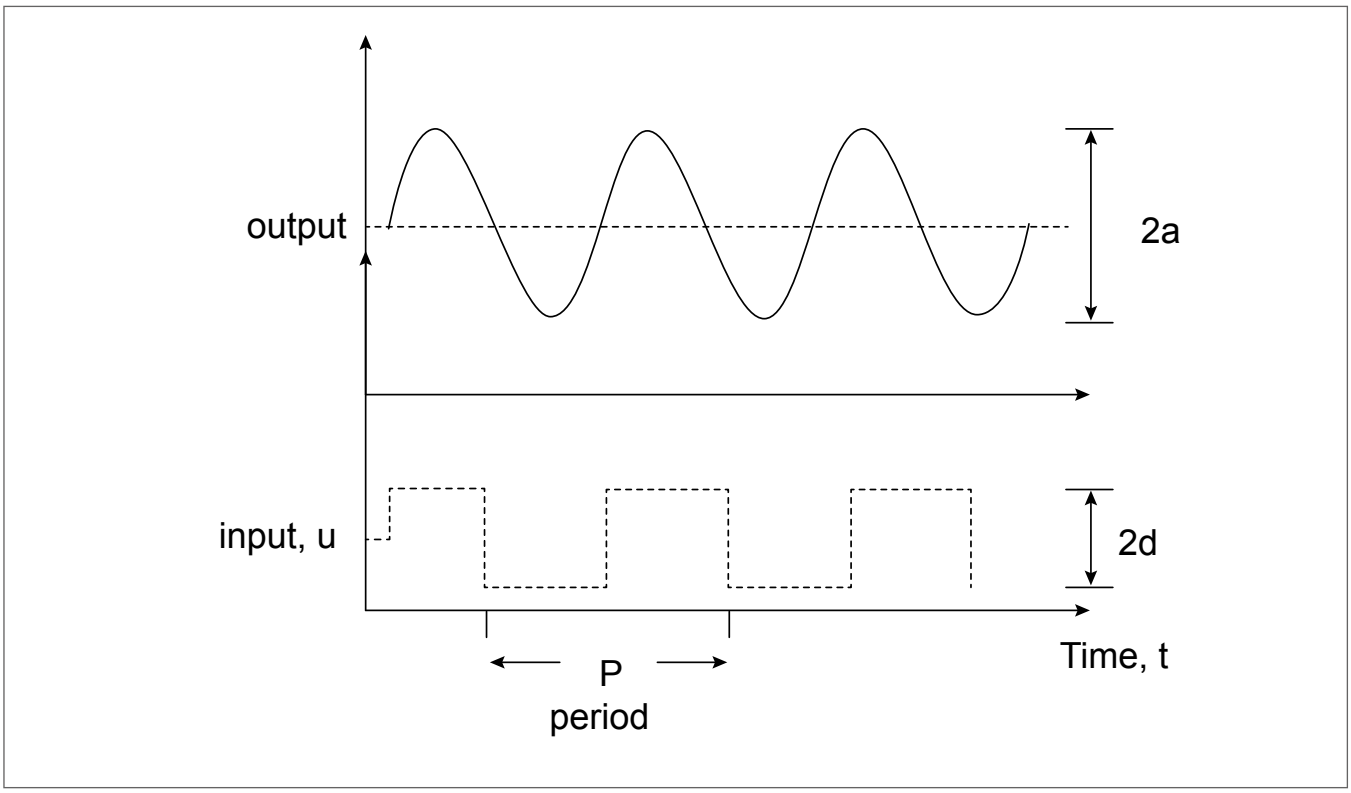
[12] The ultimate period is the observed period (P), while the ultimate gain (Ku) is inversely proportional to the observed amplitude.

$Ku = (4 * h) / (\pi * a)$

h = offSet,

a = amplitude on the input.

P = oscillation period.



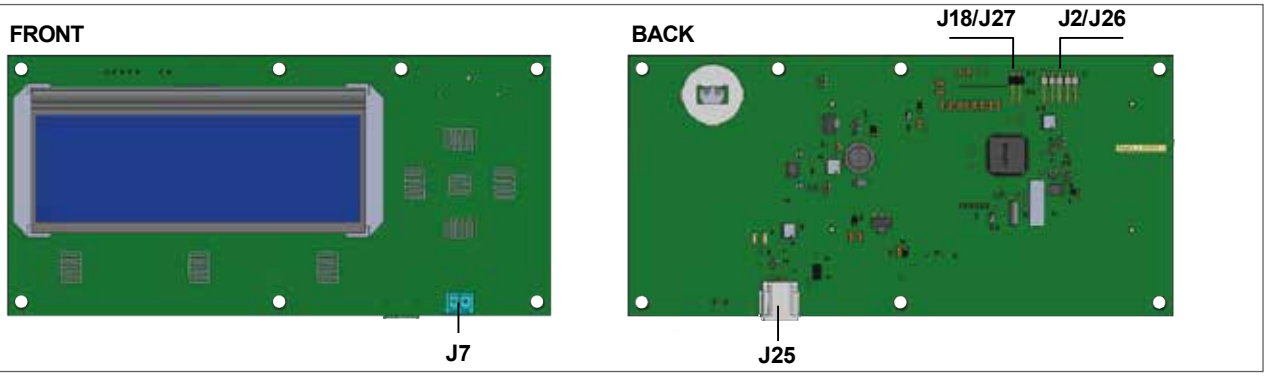
Example:

offSet = 6400, a = 1,3°C, P = 20sec.
Ku = (4 * 6400) / (π * 1,3 * 32) = 196.
PID-D = Ku / 2 = 195 / 2 = ± 100.
PID-I = P / 1,2 = 20 / 1,2 * 100 = ±160.

F.2 905PB05_3R Display

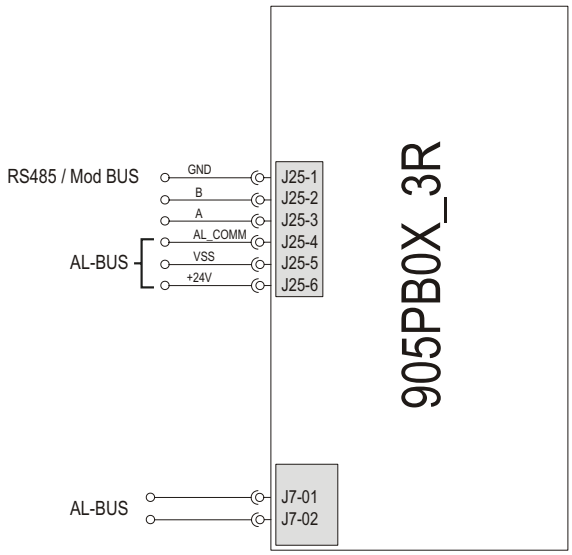
F.2.1 Connectors

The following connectors are present on the 905PB_3R Display:



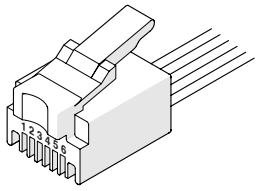
Connector	Mini Combicon	Connector	Modular jack
J1	MCV 1,5-2-G-3,81 (top entry)	J25	6P/6C
		J18/J27 J2/J26	are 2-pin and 5-pin connectors that can be used for programming

F.2.2 Connection diagram



905PB05_3R	
Connector	**Function**
J7	PC interface
J25	Connection to MN control/Modbus

F.2.3 J25 Connector (on 905PB05_3R)



1: GND/VSS
2: ModBus_B (= Data -)
3: ModBus_A (= Data +)
3: AL_Comm
5: VSS — **To 905MN**
6: +24V

J25 Wire Colors:

J25-1: Grey
J25-2: Black
J25-3: Green
J25-4: Yellow
J25-5: Red
J25-6: Blue

Appendix G - Modbus

G.1 Modbus Configuration

The table below summarizes the Modbus configuration details.

Protocol	Modbus RTU.
Default dependent address	Configurable with 900PB or LabVision. Default: 1
Supported Modbus commands	Read Holding registers (03) Write single holding register (06) Write multiple holding registers (10)
Baud rate	9600 bps.
Data Length	8
Parity	None
Stop Bits	1/2, Configurable with 900PB or LabVision. Default: 2 stop bits
Physical layer	RS485 (two wire + optional GND)

G.2 Holding registers

Depending on the type of Modbus software used, the holding register addressing range starts either at 0x0000 or at 0x0001.
If your Modbus software starts addressing from 0x0000 you can use the holding register addresses shown in the table above.
If your Modbus software addressing range starts at 0x0001 then add 1 to the holding register addresses listed in the table above. This is also applicable for the various test tools available for Modbus.

Holding registers that support writing can only be written to when writing is enabled.
Writing can be enabled by setting the 'Write enable' bit in the 'Control register' (Also see chapter "G.4 Control register" and "G.4.1 Write Enable").

G.3 Overview

G.3.1 General Modbus Control/Status registers (95 - 99)

Depending on the type of Modbus software used, the holding register addressing range starts either at 0x0000 or at 0x0001.

Holding register		Access R	Access W	Description	Automatic Conversion	Range
General Modbus Control/Status registers						
95	005F	X		Group number		850 / 900
97	0061	X		Modbus Device type / table		20 = 900PB
98	0062	X	X	Unit selection (see paragraph "G.5 Unit selection" pag. 83 for more details)		Bit0: °C / °F Bit1: bar / psi
99	0063	X	X	Control register (see paragraph "G.4 Control register" pag. 82 for more details)		Bit0: Write Enable. Bit14: Controller reset.

G.3.2 Status Information (100 - 199)

Holding register		Access R	Access W	Description	Automatic Conversion	Range
Status information						
100	0064	X		State		See state table
101	0065	X		Status		See status table
102	0066	X		Error Code		See error list
...				Reserved...		
109				Reserved		
110		X		CH pump	Yes	0/100 or 0..100%
111		X		DHW pump	Yes	0/100 or 0..100%
112		X		General pump	Yes	0/100 or 0..100%
...				Reserved…		
119				Reserved…		
Sensor / Feedback information						
120		X		Supply temperature	Yes	Depending on units °C/°F
121		X		Return temperature	Yes	Depending on units °C/°F
122		X		DHW temperature	Yes	Depending on units °C/°F
123		X		Flue gas temperature	Yes	Depending on units °C/°F
124		X		System (Heat exchanger) temperature (if available)	Yes	Depending on units °C/°F
125		X		Outside temperature (if available)	Yes	Depending on units °C/°F
...				Reserved…		
139				Reserved…		
140		X		Firing Rate (power output)	Yes	0..100%
142		X		Flame (ionization) current	Yes	0..x µA
143		X		Water pressure (if available)	Yes	Depending on units bar/ psi
...				Reserved…		
159				Reserved…		

G.3.3 Dependent Information (300 - 399)

Holding register		Access R	Access W	Description	Automatic Conversion	Range
Dependent 01						
300		X		State		See state table
302		X		Error Code		See error list
303		X		Firing Rate (power output)	Yes	0...100%
...				Reserved…		
305				Reserved…		
Dependent 02						
306		X		State		See state table
308		X		Error Code		See error list
309		X		Firing Rate (power output)	Yes	0...100%
...				Reserved…		
311				Reserved…		
Dependent 03						
312		X		State		See state table
314		X		Error Code		See error list
315		X		Firing Rate (power output)	Yes	0...100%
...				Reserved…		
317				Reserved…		
Dependent 04						
318		X		State		See state table

Holding register	Access R	Access W	Description	Automatic Conversion	Range
320	X		Error Code		See error list
321	X		Firing Rate (power output)	Yes	0...100%
...			Reserved…		
323			Reserved…		
Dependent 05					
324	X		State		See state table
326	X		Error Code		See error list
327	X		Firing Rate (power output)	Yes	0...100%
...			Reserved…		
329			Reserved…		
Dependent 06					
330	X		State		See state table
332	X		Error Code		See error list
333	X		Firing Rate (power output)	Yes	0...100%
...			Reserved…		
335			Reserved…		
Dependent 07					
336	X		State		See state table
338	X		Error Code		See error list
339	X		Firing Rate (power output)	Yes	0...100%
...			Reserved…		
341			Reserved…		
Dependent 08					
342	X		State		See state table
344	X		Error Code		See error list
345	X		Firing Rate (power output)	Yes	0...100%
...			Reserved…		
347			Reserved…		

G.3.4 Settings / Parameters (500 - 599)

Holding register	Access R	Access W	Description	Remarks	Automatic Conversion	Range
Settings / Parameters						
500	X	X	CH mode	NV		0..x
501	X	X	DHW mode	NV		0..x
502	X	X	CH set-point	V	Yes	Depending on units °C/°F
503	X	X	DHW set-point	V	Yes	Depending on units °C/°F
504	X	X	Reset Curve Boiler Design	NV	Yes	Depending on units °C/°F
505	X	X	Reset Curve Boiler Mild Weather	NV	Yes	Depending on units °C/°F
506	X	X	Reset Curve Outdoor Mild Weather	NV	Yes	Depending on units °C/°F
507	X	X	Reset Curve Outdoor Design	NV	Yes	Depending on units °C/°F
508	X	X	Warm Weather Shutdown	NV	Yes	Depending on units °C/°F
509	X	X	Reset Curve Boiler Maximum	NV	Yes	Depending on units °C/°F
510	X	X	Reset Curve Boiler Minimum	NV	Yes	Depending on units °C/°F
511	X	X	Night Setback	NV	Yes	Depending on units °C/°F
...			Reserved…			
599			Reserved…			

REMARKS

NV Non-Volatile means that the parameter is stored in the non-volatile memory (eeprom, flash, etc). These parameters will retain their value after a reset/power cycle. However the parameters have a limited amount of allowed write cycles (10.000 times, average of 2 times per day), which means these parameters cannot be used for dynamic control!

V Volatile, means that the parameter is stored in the volatile memory (RAM). These parameters will lose their value after a reset/power cycle (value will be reset to the last know setting from non-volatile memory). These parameters can be written unlimited and can be used for dynamic control. The Error Log items can be read in blocks of 8 holding registers from error log index 0 to 47 (total 48 error log items).

G.3.5 Service Reminder (1500 – 1550)

The Service Reminder status and settings can be read/written using the following holding registers.
To check if the Service Reminder is active, the *Hours_Till_Service* (1501) holding register should be read.
When the *Hours_Till_Service* value is 0 the service reminder is active.

Holding register		Acces R	Acces W	Description	Automatic Conversion	Range
Service Reminder Counters						
1500		X		Hours since last service (Burn hours or operation hours, depends on the *Service_Hour_Counter* setting).		0…65534 hours.
1501		X		Hours till service is required (Burn hours or operation hours, depends on the *Service_Hour_Counter* setting).		0…Service_Interval
...				Reserved…		
Service Settings						
1530		X	X	Reset Service Reminder.		0…1 (1=Reset).
1531		X	X	Service Hour Counter setting. The counted hours (1500 + 1501) are burn / operation hours.		0=Burn hours, 1=Operation hours.
1532		X	X	Service Interval.		0…25500 hours (Steps of 100 hours).
1533		X	X	Service Shutdown Period (after service reminder is active).		0…25500 hours (Steps of 100 hours).

NOTE: A Overdue counter value of 0xFFFF means that the counter is not available/empty.

G.4 Control register

The control register can be used to gain access to special functions (like writing or controller reset).

Holding register		Access R	Access W	Description	Automatic Conversion	Range
99	0063	X	X	Control register		Bit0: Write Enable. Bit14: Controller reset.

When no Modbus communication (reading or writing) is sensed for more than 4,0 Seconds the control register will be reset / cleared.
The bits will also be reset when undefined bits (i.e. other than bits 0 and 14) are set.

G.4.1 Write Enable

The ‘Write enable’ bit controls if writing to Holding registers is allowed.
‘Write enable’ = 0: Holding registers cannot be written.
‘Write enable’ = 1: Holding registers (that support writing) can be written.
After a write sequence is completed the ‘Write enable’ bit will be automatically cleared. So before each new write action the ‘Write enable’ bit must be set again. After setting the ‘Write enable’ bit, a write action must be done within max 4 seconds, otherwise the bit is cleared and writing is disabled.

Only enable writing when initiating a write command to a holding register. Do not send this command when no write is needed to prevent holding registers from being corrupted.

Controller reset
A controller can only be reset when it is in Lockout (lockout error is set).

When the controller is in lockout, it can be reset by setting bit 14 in the control holding register.
Once the reset is executed the bit will automatically be cleared.

G.5 Unit selection

For easier handling of holding registers, the data format can be changed. The data format that is selected will apply for both reading and writing of data.

Holding register		Access		Description	Automatic Conversion	Range
		R	W			
98	0062	X	X	Unit selection		Bit0: °C / °F. . Bit1: Bar / PSI.

Before you can change the unit selection, you must first enable writing (by setting the 'Write enabled' bit in the 'Control register').
After this you can set the appropriate bits in the 'Unit selection' register.

G.6 Data Types

Modbus communicates using words (the contents of 16bit holding registers).
This means data will be received/send as 16-bit data for each holding register.
Some data types require a higher precision than a whole number (integer), these data types will be multiplied with a factor so the precision is not lost. When the value for that data type is read it must be divided by the same factor to get the real value.
This also applies to writing the value, then the value must first be multiplied by the factor before writing it to the Holding register.

Data type	Resolution	Factor	Unit
Temperature	xxx.x	10	Degrees Celsius / Fahrenheit (°C / °F)
Voltage	xxx.x	10	Volt
Pressure	xxx.x	10	Bar / PSI
Flame current (micro amps)	xxx.x	10	µA
Percentage	xxx.x	10	%

G.7 Examples: How to update a register with a Write request via Modbus

G.7.1 Example of a simple Write command

The following example explains how to update a register with a (simple) write request via Modbus:

Address 900PB	Command simple write	Register to update	New value	Checksum
01h	06h	01F6h	0262h	E8D8h

G.7.2 Example of Command-Sequences for updating the CH setpoint via Modbus

This example explains how to update the CH setpoint from value 60°C to value 61°C in the 900PB Display (Modbus address 01h) and shows the sequence of Modbus commands that have to be written:

Enable write action	Command on modbus	Write from … to… *
Enable the control Register (99) by writing value 1 in the register 99. The register 99 will be cleared after 3 sec. from 900PB, therefore the next write command has to be send within 3 sec.	01h 06h 00h 63h 00h 01h B8h 14h	Modbus-device → 900PB

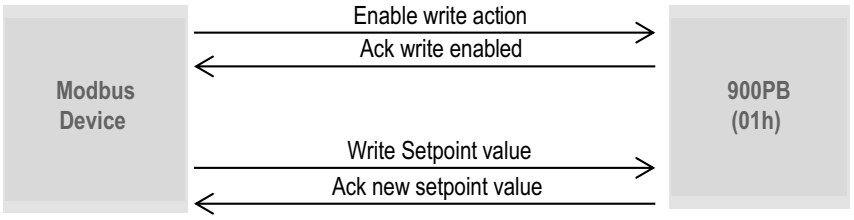
Ack write enabled	Command on modbus	Write from … to… *
The ack for the simple write request is the repetition of the previous request command.	01h 06h 00h 63h 00h 01h B8h 14h	900PB → Modbus Device

Write ch-setpoint value	Command on modbus	Write from … to… *
Simple Write in register 502 (CH-Setpoint) the value 610. Send a request for update the CH- Setpoint at a value of 61°C	01h 06h 01h F6h 02h 62h E8h 8Dh	Modbus Device → 900PB

Ack new ch-setpoint value	Command on modbus	Write from … to… *
The ack for the simple write request is the repetition of the previous request command	01h 06h 01h F6h 02h 62h E8h 8Dh	900PB → Modbus Device

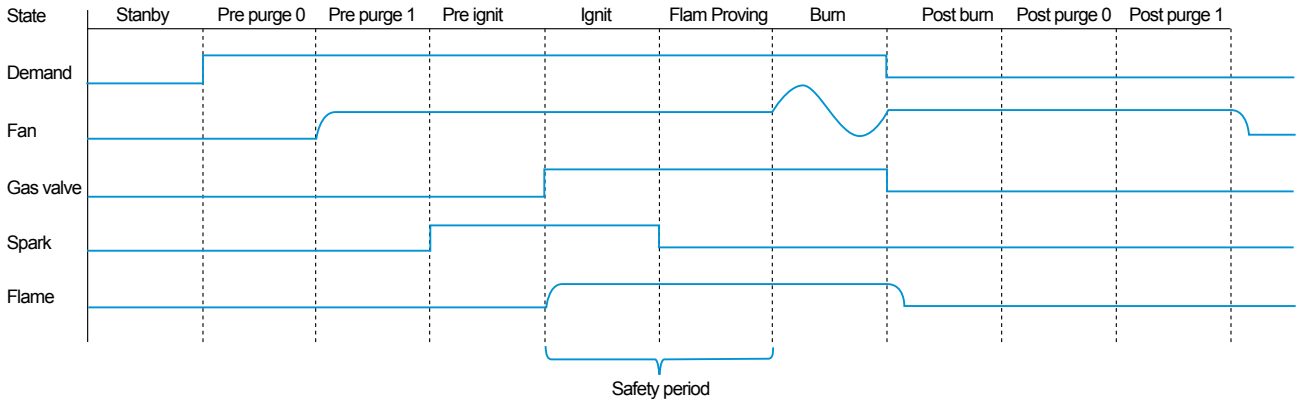
* Also see the scheme on the following page that shows the different writing actions between the Modbus Device and the 900PB .

The following scheme illustrates the examples from the previous paragraph and shows from which device to (another device) the Writing actions take place:



NOTE: Modbus Interface and Diagnostics software is available via ebm-papst Heating Systems B.V.

Appendix H - Safety timing



The following table shows the states of the burner ignition cycle:

Control state	Actions	Setting
Pre purge 0	Fan is not running, Initialize pre-purge 1	0 sec
Pre purge 1	Fan starts at ignition speed	Parameter E2_PRE_PURGE_TIME: 20 sec
Pre ignit	Fan stays at ignition speed Igniter is started	2 sec
Safety period	Ignit State + Flame Proving	5 sec

Control state	Actions	Setting
Ignit	Fan stays at ignition speed The gas valve is opened Igniter stays on	3 sec
Flame proving	Fan stays at ignition speed The gas valve stays opened The igniter is stopped	2 sec
Burn	The fan is modulating The gas valve stays opened	
Post Burn	The fan is set at ignition speed The gas valve is closed Initialize post-purge 0	0 sec
Post purge 0	The fan is set at ignition speed The gas valve is closed	Wait until flame is gone, max 10 sec. Timeout triggers FLAME_OUT_TOO_LATE lock error (20)
Post purge 1	Fan stays at ignition speed	Parameter E2_POST_PURGE_TIME: 10 sec
Standby	Fan is not running, The gas valve is closed Pump post run may be active	

The following table shows the states of the pump when demand is cleared:

State	Actions	Setting
Pump CH	Pump is ON	Parameter E2_CH_POST_PUMP_TIME: 30 sec

During the ignition cycle multiple safety checks are active:

Safety check	Actions	Setting
Flame Before Ignit	If flame is detected during the pre-spark period (Pre ignit) a lockout error occurs	1 sec
Re-ignition	If at the end of the safety period no flame is detected the control will go to post-purge to remove the unburned gas. After this a re-ignition attempt is started following the same cycle. The number of re-ignition attempts is limited to *Max_Ignit_Trials* after which a lockout occurs.	3 trials
Flame out too late	If at the end of the Post purge 0 state the flame is still detected a lockout follows.	10 sec
Flame loss	When a flame is lost during a burn cycle the control will restart the burner. The number of restarts is limited by the *Max_Flame_Trials* setting.	3 trials
Fan supervision	The fan speed is continuously monitored. The following conditions for the fan speed are checked. • The actual fan speed must be within 300RPM of the target fan speed • When in the burn state both the actual and target fan speeds are above 4200RPM, the check on the 300RPM range is not performed.	60 sec

Switch input	Function	Reaction time
Blocked Flue switch (NC) in series with Condensate pressure switch (NC)	The Blocking error *FLUE_PRESSURE_ERROR* (156) is triggered if one of the two inputs is open.	5 sec
LWCO (NC)	*Low_Water_Cut_Off_Error* is triggered. No error is triggered during de-air.	2 sec (20 samples)
Water pressure switch (NC)	The blocking error *LOW_WATER_PRESSURE_ERROR* (115) is triggered when the input is open.	10 sec
Gas pressure switch (NC)	The locking error *GAS_PRESSURE_ERROR* (35) is triggered when the input is open.	Parameter E2_GPS_TIMEOUT: 10 sec
CH flow sensor	The blocking error *LOWEXFLOW_PROTECTION* is triggered if the flow-Rate is lower than parameters E2_MinExFlowRate when the general pump is running. Parameter E2_MinExFlowRate: 50 l/min.	Parameter (E2_PRE_PURGE_TIME - 2)= 18 sec

When the control has a blocking error for too long a locking error is generate:

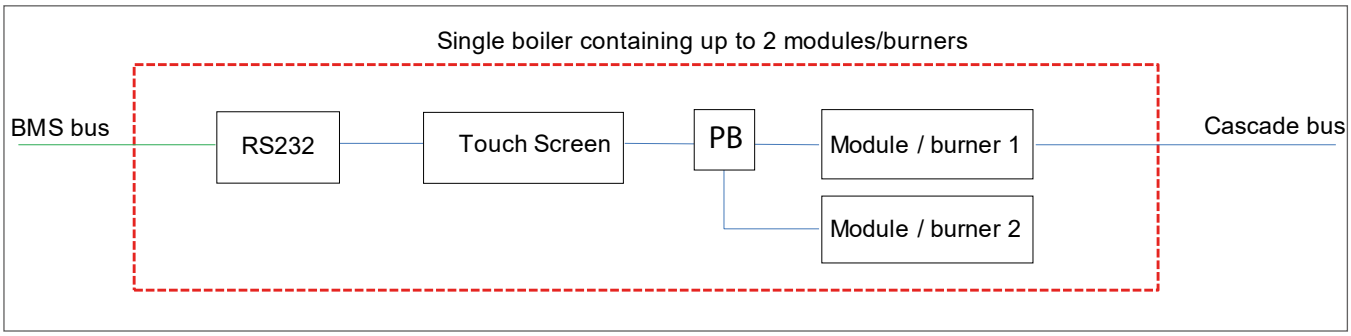
Safety Check	Function	Reaction time
BLOCKING_MAX_PERIOD	A blocking error can remain for a the maximum of a certain period. After that the blocking error is cancel and the lock error *BLOCKING_TOO_LONG* is triggered	1 hour

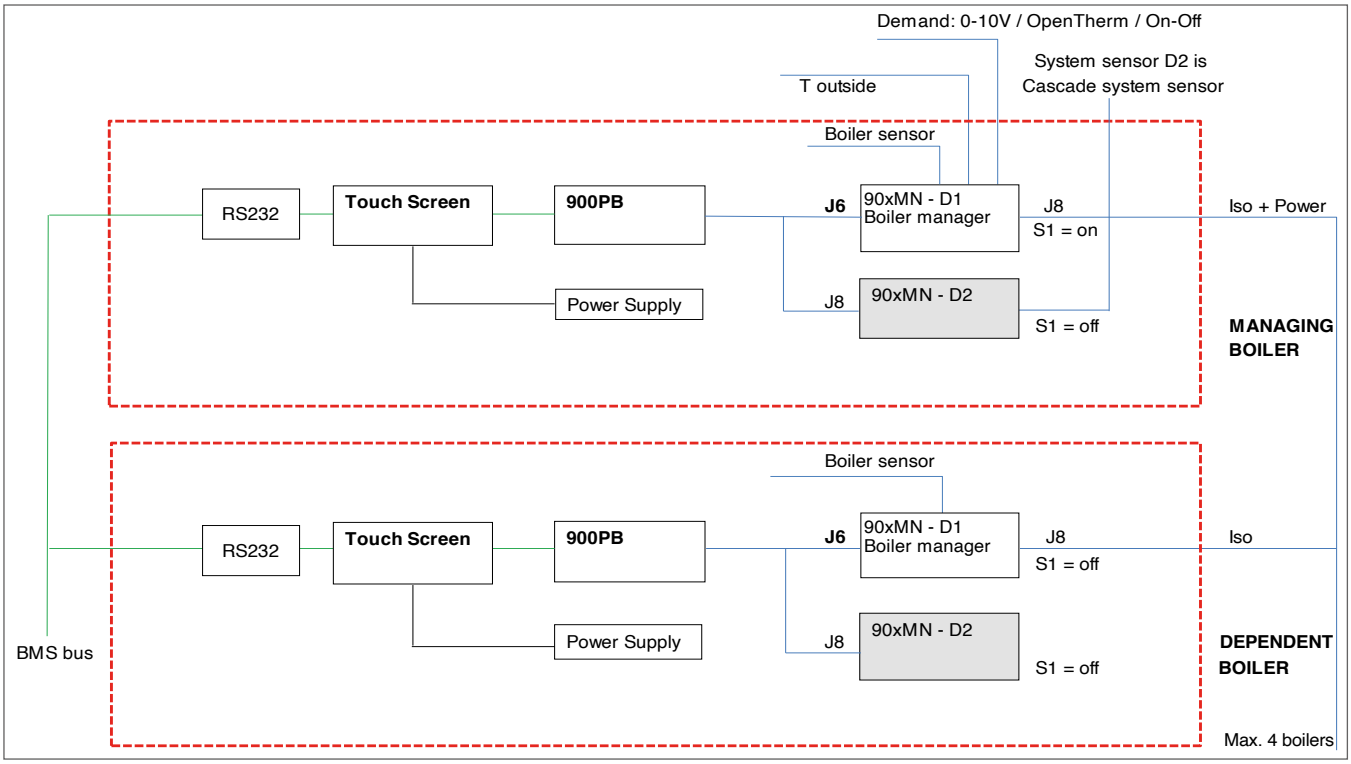
Appendix I - Building Management System (BMS) Registers Specifications

The system is designed to be a cascade of (1..2) burners (modules) which form a stand-alone boiler.

This stand-alone boiler has a Modbus and cascade bus interface so that up to 4 boilers can be cascaded.

On the BMS side the boilers (1..4) all have their own Modbus dependent address so that the BMS bus can be connected to all boilers.





I.1 Modbus

I.1.1 Configuration

The table below summarizes the Slave Modbus configuration details for 900TS.

Protocol	Modbus RTU.
Default dependent address	Boiler 1 Default: 1 Boiler 2 Default: 2 Boiler 3 Default: 3 Boiler 4 Default: 4
Supported Modbus commands	Read Holding registers (03) Write single holding register (06) Write multiple holding registers (10)
Baud rate	9600 bps.
Data Length	8
Parity	None
Stop Bits	Default: 2 stop bits
Physical layer	RS485 (two wire + optional GND)

I.2 Registers

The Cascade Manager controls the cascade of multiple boilers. Each boiler can have up to 8 units/burners available.

I.2.1 Touch screen

Touch screen information and settings.

CLIMATIC CURVE

HR #	Access R	Access W	Description	Range
			Climatic curve status info	
125	X		Outdoor sensor temperature	-50...150°C (-58...302°F)
			Climatic curve settings	
2240	X	X	Reset Curve Boiler Design	0-100°C (32-212°F)
2241	X	X	Reset Curve Boiler Mild Weather	0-100°C (32-212°F)
2242	X	X	Reset Curve Outdoor Mild Weather	0-100°C (32-212°F)
2243	X	X	Reset Curve Outdoor Design	0-100°C (32-212°F)
2244	X	X	Warm Weather Shutdown	0-100°C (32-212°F)
2245	X	X	Reset Curve Boiler Maximum	0-100°C (32-212°F)
2246	X	X	Reset Curve Boiler Minimum	0-100°C (32-212°F)
2247	X	X	Night Setback	0-100°C (32-212°F)

I.2.2 Boiler Cascade Manager

Boiler cascade information and settings.

BOILER CASCADE STATUS (ONLY AVAILABLE ON THE CASCADE MANAGER)

HR #	Access R	Access W	Description	Range
System status info				
502	X	X	Cascade Ch Mode X setpoint	0-100%
2000	X		Power level for entire (boiler) cascade system	0-100%
2001	X		System supply setpoint	0-100%
2020	X		System supply sensor temperature	-50...150°C (-58...302°F)
2021	X		Outdoor sensor temperature	-50...150°C (-58...302°F)
2060	X		Cascade Pump Status	0=Off, 1=On
Boilers available				
2100	X		Boiler 1 available / present	0=No, 1=Yes
2101	X		Boiler 2 available / present	0=No, 1=Yes
2102	X		Boiler 3 available / present	0=No, 1=Yes
2103	X		Boiler 4 available / present	0=No, 1=Yes
Boilers active (heating)				
2132	X		Boiler 1 is active / heating	0=No, 1=Yes
2133	X		Boiler 2 is active / heating	0=No, 1=Yes
2134	X		Boiler 3 is active / heating	0=No, 1=Yes
2135	X		Boiler 4 is active / heating	0=No, 1=Yes
Boiler errors				
2164	X		Boiler 1 has error (one or more modules / burners have an error)	0=No, 1=Yes
2165	X		Boiler 2 has error (one or more modules / burners have an error)	0=No, 1=Yes
2166	X		Boiler 3 has error (one or more modules / burners have an error)	0=No, 1=Yes
2167	X		Boiler 4 has error (one or more modules / burners have an error)	0=No, 1=Yes
Boiler service				
2196	X		Boiler 1 requires service	0=No, 1=Yes
2197	X		Boiler 2 requires service	0=No, 1=Yes
2198	X		Boiler 3 requires service	0=No, 1=Yes
2199	X		Boiler 4 requires service	0=No, 1=Yes

I.3 Module/Burner Cascade Manager

Module/Burner cascade information and settings.

I.3.1 Boiler address

HR #	Access R	Access W	Control Settings	Range
Climatic curve status info				
3110	X	X	Boiler address (1=Cascade / Boiler manager, 2-4=Dependent)	1 - 4

I.3.2 Module/Burner Cascade Status

HR #	Access R	Access W	Description	Range
System status info				
3000	X		Power level for the boiler	0-100%
3001	X		Boiler supply setpoint (calculated)	0-100%
3002	X		Heat demand type	None,CH,DHW
3020	X		Boiler Supply temperature	0-100%
3021	X		DHW temperature	0-100%
3060	X		CH pump running	0=Off, 1=On
3061	X		DHW pump status	0=Off, 1=On
3080	X		Burn hours (total of all unit/burner burn hours)	0-65536hr
Module/Burner available				
3100	X		Module/Burner 1 available / present	0=No, 1=Yes
3101	X		Module/Burner 2 available / present	0=No, 1=Yes
Module/Burner active (heating) (see also holding register contents “I.4.1 Burner/Module 1 Status and Control Registers” pag. 92)				
4000	X		Module/Burner 1 is active / heating	State(*)
4010	X		Module/Burner 2 is active / heating	State(*)
Module/Burner errors (see also holding register contents “I.4.1 Burner/Module 1 Status and Control Registers” pag. 92)				
4001	X		Module/Burner 1 has error	255=No error, x=Error
4101	X		Module/Burner 2 has error	255=No error, x=Error

The State(*) can be divided in the following steps:

Standby: 0 : Initialization
1 : Reset
2 : Standby

Active: 3/4 : Pre Purge
5/6 : (Pre) Ignition
7 : Flame Proving
8/9 : Burn
10/11 : Post Purge

Error: 12 : Error
13 : Alarm
14 : Warning
15 : Burner Boot

I.3.3 Boiler Error Log

The Error Log items can be read in blocks of 8 holding registers from error log index 0 to 47 (total 48 error log items).

NOTE: The error log items are not ordered based on the last occurrence when more than 47 errors are stored!

HR #	Access R	Access W	Description	Range
Last Error Index				
34000 - 34007			Reserved…	
Error Log Index 0				
3400	X		Error Number	See error list.
3401	X		Boiler ID: 0=Stand-Alone, 1=Managing, 2-4=Dependent.	0…4
3402	X		Timestamp: Day Of Week	0…6 = Sunday…Saturday
3403	X		Timestamp: Day Of Month	1…31d
3404	X		Timestamp: Month	1…12m
3405	X		Timestamp: Year	2000…2255y
3406	X		Timestamp: Hour	0...23 (24h notation)
3407	X		Timestamp: Minute	0...59min
Error Log Index 1-46				
3408 - 3775	X		Error Number 2-46	
Error Log Index 47				
3776	X		Error Number	See error list.
3777	X		Boiler ID: 0=Stand-Alone, 1=Managing, 2-4=Dependent.	0…4
3778	X		Timestamp: Day Of Week	0…6 = Sunday…Saturday
3779	X		Timestamp: Day Of Month	1…31d
3780	X		Timestamp: Month	1…12m
3781	X		Timestamp: Year	2000…2255y
3782	X		Timestamp: Hour	0...23 (24h notation)
3783	X		Timestamp: Minute	0...59min

I.3.4 Boiler Service Reminder

The Service Reminder status and settings can be read/ written using the following holding registers.

To check if the Service Reminder is active, the *Hours_Till_Service* holding register should be read.

When the *Hours_Till_Service* value is 0 the service reminder is active.

HR #	Access R	Access W	Description	Range
Service Reminder Counters				
3300	X		Burn Hours since last service	0…65534 hours.
3301	X		Burn Hours till service is required	0…Service_Interval
Service Overdue Counters (history)				
3305	X		Overdue counter 0	0…65534 hours.
3306	X		Overdue counter 1	0…65534 hours.
3307	X		Overdue counter 2	0…65534 hours.

HR #	Access R	W	Description	Range
3308 - 3318	X		Overdue counter 3-13	0…65534 hours.
3319	X		Overdue counter 14	0…65534 hours.
			Service Settings	
3342	X		Service Interval.	0…255 x 100 hours

NOTE: A Overdue counter value of 0xFFFF means that the counter is not available/empty.

I.4 Burner/Module info

Each module/burner present in the boiler has its own set of status information holding registers. Each set has the holding register offset of ((‘Unit/burner Number’ - 1) x 100) + 40000. So Burner 1 starts at holding register 40000, Burner 2 starts at 40100, etc.

I.4.1 Burner/Module 1 Status and Control Registers

HR #	Access R	W	Description	Range
			Module/Burner 1 status info	
4000	X		Current state of the unit/burner.	State(*)
4001	X		Error of the unit/burner.	See manual
4002	X		Module supply setpoint (calculated)	0-100°C (32-212°F)
4003	X		Power level.	0.0 - 100.0%
4006	X		General pump status.	0=Off, 1=On
4009	X		CH Flow rate.	0-255 l/min
4011	X		Actual fan speed.	RPM
4030	X		Supply sensor temperature.	-50...150°C (-58...302°F)
4032	X		Return sensor temperature.	-50...150°C (-58...302°F)
4035	X		Flue sensor temperature.	-50...150°C (-58...302°F)
4052	X		Total burn hours.	0-65536Hours

The State(*) can be divided in the following steps:

Standby:
0 : Initialization
1 : Reset
2 : Standby

Active:
3/4 : Pre Purge
5/6 : (Pre) Ignition
7 : Flame Proving
8/9 : Burn
10/11 : Post Purge

Error:
12 : Error
13 : Alarm
14 : Warning
15 : Burner Boot

I.4.2 Burner/Module 2 Status and Control Registers

HR #	Access R	Access W	Description	Range
			Module/Burner 2-8 status info	
4100 - 4152	X		Burner/Module 2 (see also holding register contents “I.4.1 Burner/Module 1 Status and Control Registers” pag. 92)	

I.5 Data Type

Modbus communicates using words (the contents of 16bit holding registers).

This means data will be received/send as 16-bit data for each holding register.

Some data types require a higher precision than a whole number (integer), these data types will be multiplied with a factor so the precision is not lost. When the value for that data type is read it must be divided by the same factor to get the real value.

This also applies to writing the value, then the value must first be multiplied by the factor before writing it to the Holding register.

Data type	Resolution	Factor	Unit
Temperature	xxx.x	10	Degrees Celsius °C
Voltage	xxx.x	10	Volt
Pressure	xxx.x	10	Bar
Flame current (micro amps)	xxx.x	10	µA
Percentage	xxx.x	10	%

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