1 ABSO PRO RANGE CONTROLS AND OPTIONAL ACCESSORIES

Different types of control are provided for the Abso Pro range, depending on the appliance and the desired functionality.
The appliance may only work if it is connected to a control device, selected from:

1. DDC control
2. CCI control
3. external request

The following Table 1.1 *p. 1* shows an overview of the functionality that can be obtained depending on the controls used.

Table 1.1 *Available features depending on controls*

Appliance	Control device	Burner	Description
Single GAHP/GA	External request		Heating and cooling with fixed water temperature on the basis of the parameters set on the appliance board. Activation/deactivation based on an external request, connected to the appropriate terminals on the appliance board (Section C01.10).
Single GAHP/GA	Room thermostat		Heating and cooling with fixed water temperature on the basis of the parameters set on the appliance board. Activation/deactivation based on the air temperature detected by the room thermostat and its settings. The thermostat must be connected to the appropriate terminals on the appliance board (Section C01.10).
Single GAHP/GA	Chronothermostat		Heating and cooling with fixed water temperature on the basis of the parameters set on the appliance board. Activation/deactivation based on the time program set on the chronothermostat and the air temperature detected by the chronothermostat and its settings. The chronothermostat must be connected to the appropriate terminals on the appliance board (Section C01.10).
Single GAHP/GA	DDC		Appliance management in ON/OFF mode. Data display and parameters setting. Time programming. Heating curve control. Diagnostics. Errors reset. Possibility of interfacing via Modbus with other management systems. Possibility of coupling with remote monitoring and management systems.For the connection of the DDC panel, see Section C01.10.
Single AY	External request		Heating with fixed water temperature on the basis of the parameters set on the appliance board. Activation/deactivation based on an external request, connected to the appropriate terminals on the appliance board (Section C01.10).
Single AY	Room thermostat		Heating with fixed water temperature on the basis of the parameters set on the appliance board. Activation/deactivation based on the air temperature detected by the room thermostat and its settings. The thermostat must be connected to the appropriate terminals on the appliance board (Section C01.10).
Single AY	Chronothermostat		Heating with fixed water temperature on the basis of the parameters set on the appliance board. Activation/deactivation based on the time program set on the chronothermostat and the air temperature detected by the chronothermostat and its settings. The chronothermostat must be connected to the appropriate terminals on the appliance board (Section C01.10).
Single AY	DDC		Appliance management in modulation. Data display and parameters setting. Time programming. Heating curve control. Diagnostics. Errors reset. Possibility of interfacing via Modbus with other management systems. Possibility of coupling with remote monitoring and management systems.For the connection of the DDC panel, see Section C01.10.
Up to 3 GAHP A/GAHP GS/WS for heating only Link up to 3 GAHP A/GAHP GS/WS of the same type, for heating only	CCI		Modulation management up to a maximum of 3 GAHP A/GAHP GS/WS for heating only, based on the water temperature set on the CCI panel and the temperature measured by the heating manifold probe. Heating with fixed water temperature, based on the parameters set on the CCI panel. Data display and parameters setting. Manifold water temperature probe control. Diagnostics. Errors reset. Possibility to interface with a BMS.For the connection of the CCI panel, see Section C01.10.
Up to 3 GAHP A/GAHP GS/WS for heating only Link up to 3 GAHP A/GAHP GS/WS of the same type, for heating only	CCI + external system controller		Modulation management up to a maximum of 3 GAHP A/GAHP GS/WS for heating and possible DHW production. Heating with variable water temperature based on the parameters set on the external system controller. Possible free cooling (only for GAHP GS/WS). Data display and parameters setting. Manifold water temperature probe control. Diagnostics. Errors reset. Possibility to interface with a BMS.For the connection of the CCI panel, see Section C01.10.
More GAHP/GA/AY Link	DDC		Step modulation management of up to 16 appliances (extendable up to 48 by using up to 3 DDCs connected together). Data display and parameters setting. Time programming. Heating curve control. Diagnostics. Errors reset. Possibility of interfacing via Modbus with other management systems. Possibility of coupling with remote monitoring and management systems.For the connection of the DDC panel, see Section C01.10.

1.1 DDC CONTROLLER

The DDC control is able to manage one or more Robur appliances in ON/OFF mode (GAHP heat pumps, GA chillers) or modulating mode (AY boilers).
DDC functionality may be extended with auxiliary Robur devices RB100 and RB200 (e.g. service requests, DHW production, third party generator control, probe control, system valves or circulating pumps, ...).
Table 1.2 *p. 2* below describes the functionality that can be achieved with the optional extras available for DDC control.

Table 1.2 *Additional features available with DDC options*

Control device	Description
OSND007 outdoor temperature probe	Allows detecting the outdoor temperature and, by setting the heating curve on the DDC, obtaining a variable outlet temperature depending on the outdoor temperature. The probe can also be used as a room temperature probe for automatic heating curve adaptation.
RB100	Allows service requests (heating, cooling, DHW) from external control systems to be interfaced. Allows diverter valves for space heating/DHW or heating/cooling inversion to be managed.
RB200	Allows service requests (heating, cooling, DHW) from external control systems to be interfaced. Allows diverter valves for space heating/DHW and/or heating/cooling inversion to be managed. Allows third-party generators to be interfaced. Allows manifold temperature probes to be interfaced. Allows common water pumps to be interfaced.
Monitoring and remote control system	Allows real-time appliance operating data to be collected and stored in the cloud. Allows data and operating faults to be logged and analysed in order to increase performance and improve system management. Allows remote modification of control system and appliance settings to optimise efficiency. Allows notifications of any active errors on the system to be received and remotely reset.

1.1.1 RB100

Via the RB100 device, to be combined with the DDC, you can manage:

- Digital service requests (heating, cooling, DHW0 and DHW1 service).
- 0-10 V analogue service requests (heating, cooling, DHW0 and DHW1 service).
- Thermostats (typically for DHW).
- Diverter valves for DHW circuit separation or heating/cooling inversion, both on/off with spring return and 3-point type.

For further information on the RB100 device, please refer to Paragraph 4 *p. 6*.

1.1.2 RB200

Via the RB200 device, to be combined with the DDC, you can manage:

- Digital service requests (heating, cooling, DHW0 and DHW1 service).
- 0-10 V analogue service requests (heating, cooling, DHW0 and DHW1 service).
- Thermostats (typically for DHW).
- Diverter valves for DHW circuit separation or heating/cooling inversion, both on/off with spring return and 3-point type.
- Manifold temperature probes (heating, cooling, separable DHW and inlet to GAHP).
- Third-party generators.
- Common system water pumps.

For further information on the RB200 device refer to Paragraph 5 *p. 6*.

1.1.3 Monitoring and remote control system

The purpose of the monitoring and remote control system is to collect operating data from the appliances connected to the DDC panel to which the monitoring system itself is connected, and to send it to the cloud, where they are made available via an appropriate Interface for analysis regarding both operating status and performance optimisation.
The availability of data for more than one season of operation allows easy comparisons with operation in the previous year, so that the impact of any changes in settings can be detected even over medium to long time horizons.
The interface provided by the remote control site also allows you to act on the system itself, appropriately modifying its settings in order to optimise the level of efficiency, based on the performance data collected by the monitoring system, being able to observe the effect of the changes in real time.
The system also takes care of automatically notifying any active faults on the monitored system, allowing them to be reset remotely and, where necessary, a timely intervention by maintenance personnel following a precise identification of the problem (and any necessary spare parts), reducing the unavailability of the system considerably.
The data collection device is connected via the Modbus protocol to the DDC panel via the RS 485 port (which will therefore not be available for any other systems using the Modbus protocol) and transmits the data, via appropriate secure protocols, to the cloud server, using an internet connection via LAN, WiFi or GSM.
The cloud management interface is available via a browser and is profiled by user type, so that only those authorised can operate the system settings and the data of each system are in turn only visible to those authorised for that system.

1.2 CCI CONTROL

The CCI control can manage up to 3 GAHP appliances in modulating mode (only GAHP A/GAHP GS/WS).
No other accessories can be associated with the CCI control (except the manifold temperature probe, available as OSND004 optional, which is required for operation).
For optimal operation, the CCI controller should be coupled with an external system controller capable of sending the appropriate service requests to the CCI controller.

1.3 EXTERNAL REQUEST

The appliance may also be controlled with a generic request device (e.g. thermostat, timer, switch, contactor...) fitted with voltage-free NO contact. This system only provides elementary control (on/off, with fixed setpoint temperature), thus without the important functions of the DDC/CCI control. It is advisable to possibly limit its use to simple applications only and with a single appliance.

External request operation is not available for Link.

1.4 ABSO PRO CONTROL SYSTEMS SELECTION GUIDE

The following Table 1.3 *p. 3* lists the main types of service required and the control device that best meets the need.

Table 1.3 *Abso Pro control systems selection guide*

Service	Control device	Other required devices
Heating Cooling	DDC	OSND007 outdoor temperature probe
Heating/Cooling and base DHW	DDC + RB100	OSND007 outdoor temperature probe DHW thermostats with adjustable differential
Heating/Cooling and separable DHW	DDC + RB100	OSND007 outdoor temperature probe DHW thermostats with adjustable differential On/off diverter valves with spring return or 3-point type
Heating/Cooling and summer/winter inversion valves	DDC + RB100	OSND007 outdoor temperature probe On/off diverter valves with spring return or 3-point type
Heating/Cooling with integration of third-party generators	DDC + RB200	OSND007 outdoor temperature probe OSND004 immersion water temperature probes (two probes for each heating/cooling manifold)
Heating/Cooling with integration of third-party generators and base DHW	DDC + RB200	OSND007 outdoor temperature probe DHW thermostats with adjustable differential OSND004 immersion water temperature probes (two probes for each heating/cooling/DHW manifold)
Heating/Cooling with integration of third-party generators and separable DHW	DDC + RB200	OSND007 outdoor temperature probe DHW thermostats with adjustable differential On/off diverter valves with spring return or 3-point type OSND004 immersion water temperature probes (two probes for each heating/cooling/DHW manifold)
Modulating heating up to 3 GAHP A/GAHP GS/WS	CCI + external system controller	OSND004 immersion water temperature probe External system controller

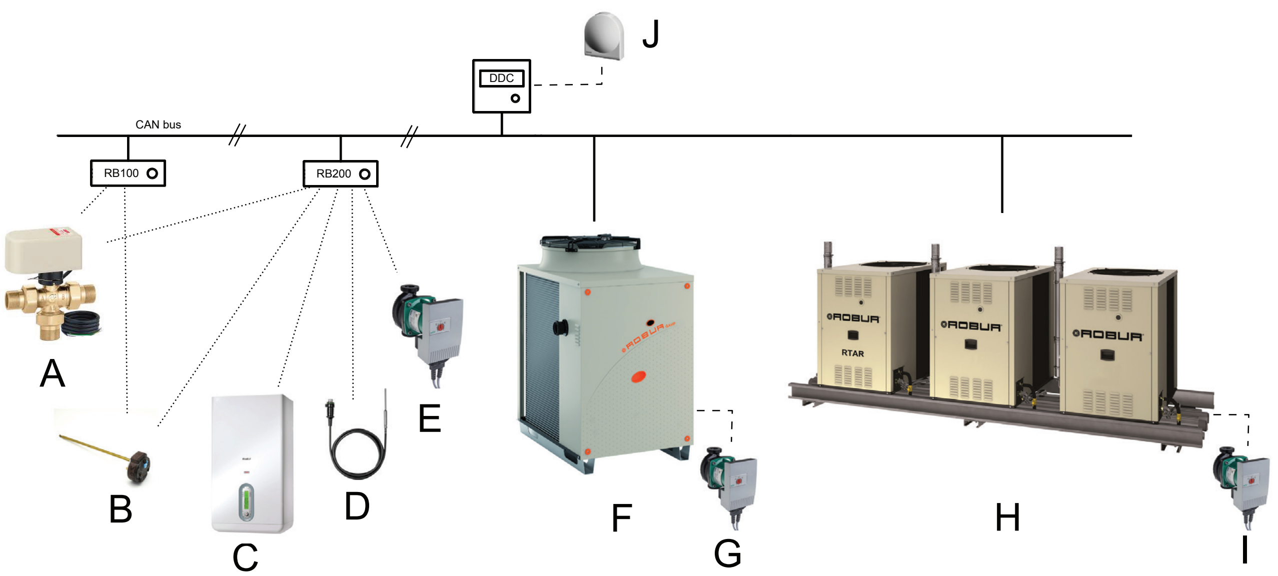
Sections C01.12 and C01.13 show example hydraulic diagrams of Robur control system applications to meet different service requirements.

In case of doubt, the Robur technical service is available to identify the most suitable type of control.

2 DDC CONTROL ARCHITECTURE

The diagram in Figure 2.1 *p. 3* shows the elements of the Robur control system based on the DDC panel and the type of connections available.

Figure 2.1 *DDC control architecture*



A solid line shows the CAN bus connection between the Robur control devices.
A dotted line shows the connection with analogue/digital signals between the RB100/RB200 devices and the objects that can be controlled with them.
A dashed line shows the connections with analogue/digital signals between DDC and OSND007 outdoor temperature probe and the water pumps of Robur appliances, which must be managed by the appliances' internal electronic boards.

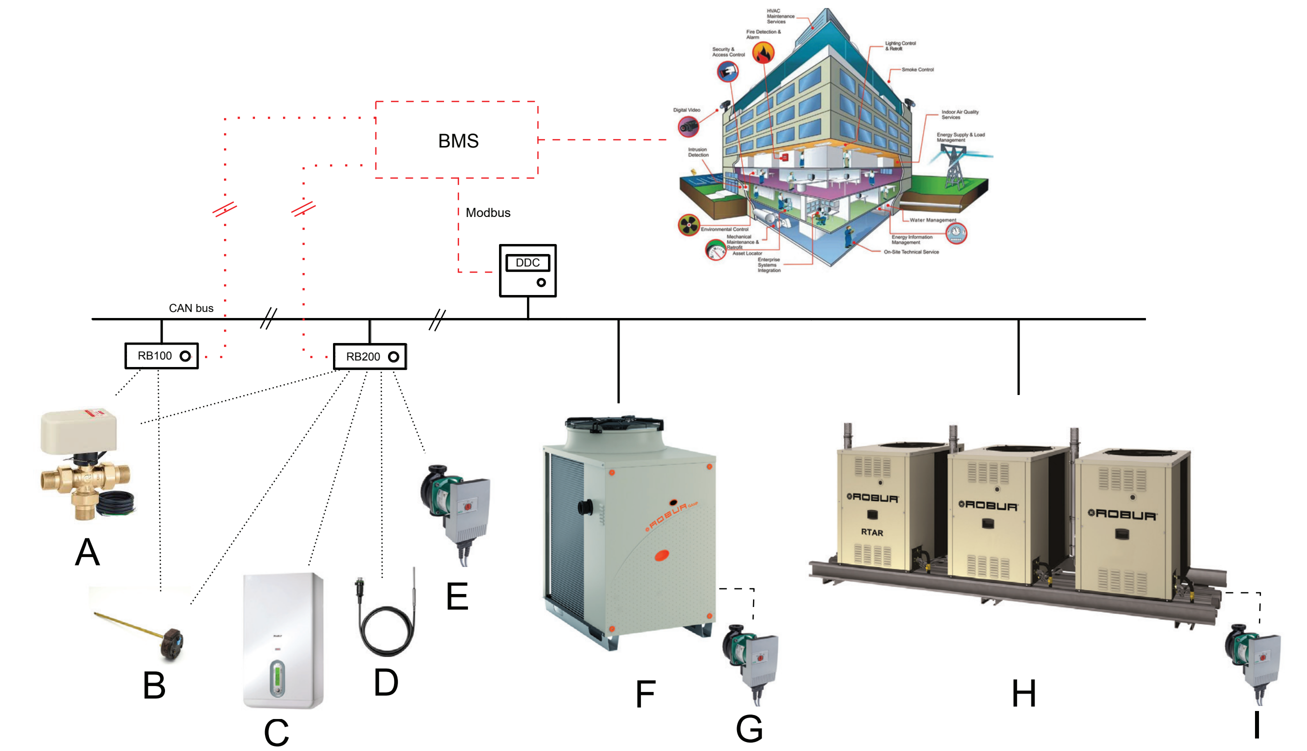
- A Three-way diverter valves of the on/off spring return or 3-point type
- B Thermostats with adjustable differential
- C Third party generators
- D Manifold temperature probes
- E Common system water pumps
- F Single GAHP/GA/AY
- G Single unit water pumps
- H Link Robur
- I Link Robur water pumps (independent or common)
- J OSND007 outdoor temperature probe

Robur appliances and Robur control devices are always connected to each other via CAN bus connections.
All connections towards other devices are effected via analogue signals (0-10 V or resistive probe readings) and digital signals.

The diagram in Figure 2.2 *p. 4* shows the control system elements and the type of connections available in the presence of the DDC panel and a user control system such as BMS, SCADA and similar.

The connection with the DDC panel will always be via Modbus protocol, while any analogue/digital signals from the BMS system (only useful if the BMS system does not communicate via Modbus with the DDC panel) will be connected to the RB100/RB200 devices.
Third-party generators or other system components may be controlled by the DDC panel (via the RB100/RB200 devices) or directly by the BMS.
The control of consumers is always managed by the BMS system.
The OSND007 outdoor temperature probe is not used in this case as it is assumed that the setpoint is communicated directly from the BMS system.

Figure 2.2 *Control architecture with BMS*



A solid line shows the CAN bus connection between the Robur control devices.
A dotted line shows the connection with analogue/digital signals between the RB100/RB200 devices and the objects that can be controlled with them.
A dashed line shows the connections with analogue/digital signals between DDC and OSND007 outdoor temperature probe and the water pumps of Robur appliances, which must be managed by the appliances' internal electronic boards.
A red dashed line shows the Modbus connection between the DDC panel and the user control system (BMS, SCADA, etc.).
A red dotted line shows the connection with analogue/digital signals between the user control system and the RB100/RB200 devices.

A Three-way diverter valves of the on/off spring return or 3-point type
B Thermostats with adjustable differential
C Third party generators
D Manifold temperature probes
E Common system water pumps
F Single GAHP/GA/AY
G Single unit water pumps
H Link Robur
I Link Robur water pumps (independent or common)

3 DDC

The DDC control is able to manage one or more Robur appliances in ON/OFF mode (GAHP heat pumps, GA chillers) or modulating mode (AY boilers).
Each individual DDC Panel is able to manage up to 16 units
Up to 3 DDC panels may be coupled to control up to 48 units.

3.1 MAIN FUNCTIONS

The main functions are:

- Adjustment and control of one (or more) Robur units of the absorption line (GAHP, GA, AY).
- Data display and parameters setting.
- Time programming.
- Heating curve control.
- Diagnostics.
- Errors reset.
- Possibility to interface with a BMS.
- Possibility of coupling with remote monitoring and management systems.

DDC functionality may be extended with auxiliary Robur devices RB100 and RB200 (e.g. service requests, DHW production, third party generator control, probe control, system valves or circulating pumps, ...).
Below is a brief description of the main functions of the DDC panel:

1. Adjustment and control of one (or more) unitsRobur makes it possible to manage cascade operation of the various types of appliance, using the more efficient ones with priority.
2. Values view and parameters setting allow you to optimize the adjustment parameters in order to best exploit the efficiency of the absorption technology, while safeguarding user comfort.
3. The hourly programming makes it possible to turn the generation system on only if an actual service request is expected, preventing fuel waste.
4. The heating curve management makes it possible, for both

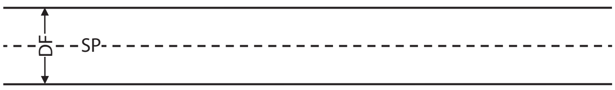
winter and summer seasons, to deliver only the energy actually required in specific environmental conditions. This on one hand avoids wasting energy when the heating/cooling system does not require it, and on the other hand prevents appliances from exceeded operational limit shutdown, due to the applied load being too low compared to the temperature set on the DDC panel.

5. Diagnostics lets you know at any time the operating status, warnings or errors of appliances and identify the possible causes of any malfunctions, as well as manage a log of recorded events.
6. The error reset lets you restore appliance availability following resolution of an error that involved shutdown by the control system.
7. The BMS interfacing option (or other external supervision and control system) makes it possible to manage the DDC panel (and the appliances controlled by it) via an external device, within more complex and integrated home automation or building/plant management systems. In practice, the interfacing can be realised either through simple analogue/digital signals, or (in a more complete way) through the Modbus protocol, detailed in Paragraph 3.3 *p. 5*.
8. The possibility of coupling with remote monitoring and management systems makes it possible to collect operating data and any faults of the appliances connected to the DDC, remotely modify system settings, receive notifications in the event of faults and be able to reset any errors remotely.

3.2 CONTROL AND SETUP

The DDC controls the water temperature with the aim of keeping it within a range centred on the setpoint.
The width of this range is defined by a parameter (water differential) whose default is 2 °C (i.e. ± 1 K with respect to the setpoint).
The purpose of the differential is to define the maximum acceptable deviation of water temperature from the set-point, before the control system intervenes.

Figure 3.1 *DDC setpoint and differential*



SP water setpoint DF water differential

To make the regulation, the DDC manages switch-on and switch-off in cascade mode of the different types of machines available, adapting the power supplied to the system thermal or cooling load.
Only for AY boilers, it is possible to modulate a single boiler (the last one switched on by the control).
It is possible to choose whether to regulate the delivery or the return temperature.
Up to four daily time slots may be set, possibly using different values for the set-point.

3.2.1 Regulation of the cascade

Depending on their type, appliances are assigned to **categories** with different properties, so that the DDC can manage the various appliance types with different logic and parameters.
However, the units within a category have equivalent features.
For all Robur appliances, the categories are already assigned and their properties filled in.
For third-party appliances, this information must instead be set based on the characteristics of the specific third-party unit.
For each category, the **power** of the individual unit belonging to it is specified.
Each category is associated with a **turn-on priority**, automatically assigned for Robur appliances and user-defined for third-party units, which determines the priority of use of the units belonging to that category.
For each category the **number of stages** used by the control system is defined, which can be set in the range from 1 to 10. With independent water pumps, the number of stages is normally equal to the number of units in each category. With common water pumps and high setpoint values, set an appropriate number of stages, less than the number of units. It is always recommended to set the heating curve.
Four additional parameters must be defined for each category, in order to adapt as much as possible the regulation to the specific features of the category:

- **Locking time**, which allows waiting for stable operation of a stage before allowing the energy lack to be calculated (and thus switch on the next stage).
- **Release integral**, which represents the energy lack beyond which the next stage of the category is unlocked.
- **Reset integral**, which represents the excess energy beyond which the previous stage of the category is switched off and the previously unlocked stage is locked.
- **Minimum switch-on time**, which prevents a stage from being kept on for too short a time.

The operation of the control algorithm can be summarised by the following rules:

- At a given time, the controller works with some stages released and the remaining ones locked.
- The first stage of the category with highest priority is never locked.
- All locked stages are always switched off; all released stages, except the last one, are always switched on; the last released stage is switched on or off when the water temperature, respectively falling or rising, exits the differential band.
- In the case of AY 35 and AY 50 boilers, the last unlocked stage that is switched on is managed in modulation.
- A locked stage is unlocked (and switched on) if the area representing the energy deficit, calculated from the expiry of the locking time, reaches the value of the release integral.
- An unlocked stage is locked (and the previous stage is switched off) if the excess energy reaches the inhibition integral setting.

3.3 MODBUS

The DDC panel also supports interfacing with external devices via Modbus RTU protocol in slave mode.
With the Modbus protocol it is possible to acquire information concerning the operation data of the units and systems managed by the DDC (temperatures, statuses, meters, etc.).
It can also acquire information regarding alarms, both current and registered in the alarms log.
Finally, it is possible to act on the system to set various operating parameters such as appliance switch on, heating/cooling inversion, setpoint, differential, steps, and operation time slots.
For further information on the Modbus Mapping implemented in the current version of the DDC panel, please refer to Paragraph 10.3 *p. 21*.

4 RB100

4.1 MAIN FUNCTIONS

The RB100 device has the purpose of:
- interfacing requests from external control systems (heating, cooling service, DHW0 and DHW1)
- provide actuation signal for switching valves (for DHW or heating/cooling inversion)

The requests from external control systems may be:
- 0-10 V analogue type
- digital type (voltage-free contacts)

The requests from external control systems are only effective if the relevant service is active on the DDC.

The outputs for driving the valves are digital signals (voltage-free contacts) with the following features:
- maximum voltage 250 V AC
- maximum current for resistive loads 4 A
- maximum current for inductive loads 3 A

The RB100 device can only be used in combination with the DDC panel.

5 RB200

5.1 MAIN FUNCTIONS

The RB200 device has the purpose of:
- interfacing requests from external control systems (heating, cooling service, DHW0 and DHW1)
- actuate switching valves (for DHW or heating/cooling inversion)
- interface third party generators
- interface system temperature probes
- interface common circulating pumps

The requests from external control systems may be:
- 0-10 V analogue type
- digital type (voltage-free contacts)

The requests from external control systems are only effective if the relevant service is active on the DDC.

The outputs for driving the valves are digital signals (voltage-free contacts) with the following features:
- maximum voltage 250 V AC
- maximum current for resistive loads 4 A
- maximum current for inductive loads 3 A

The inputs/outputs to control third party generators may be:
- a digital output (voltage-free contact) to switch on the generator
- a digital output (voltage-free contact) to control the generator circulating pump
- a 0-10 V analogue output for the generator water temperature setpoint
- a digital input (voltage-free contact) for the generator alarm signal

The system temperature probes must be of the resistive NTC 10 kΩ type and can be:
- manifold delivery and return probes cooling only or 2 pipes cooling/heating
- manifold delivery and return probes heating only
- manifold delivery and return probes for separable DHW
- GAHP inlet manifold probe

Common water pumps are controlled via digital outputs (voltage-free contacts) and can be:
- secondary circulating pump cooling only or 2 pipes cooling/heating
- primary circulating pump heating only
- separable primary circulating pump
- secondary circulating pump cooling only or 2 pipes cooling/heating
- secondary circulating pump heating only

The RB200 device can only be used in combination with the DDC panel.

6 ENGINEERING APPLICATIONS

Through the DDC panel, if required combined with the RB100 and RB200 devices, multiple system configurations can be supported.
The control logic resides in the DDC panel, while the RB100 and RB200 devices act as interfaces for inputs and outputs to the system components.

6.1 MANAGEMENT OF SERVICE REQUESTS

The service requests make it possible to interface devices fitted on the system (e.g. thermostats) as well as external control devices (BMS).
These requests may be:
- digital signals (voltage-free contacts)
- analogue signals (0-10 V)
- transmitted via Modbus RTU protocol

The following services may be managed through these requests:
- heating service
- cooling service
- base DHW service
- separable DHW service

The service set-points may be set either on the DDC or on the RB100/RB200 devices.
On the DDC, it is also possible to set separate activation time slots for each service.

6.1.1 DDC

The DDC panel provides <u>two digital inputs</u> for service request:
- cooling service request (RY contact)
- heating service request (RW contact)

The same inputs may be used to switch operating mode in 2-pipe hot/cold systems.

The DDC panel also supports interfacing via Modbus protocol to receive service requests from BMS devices. For further information see Paragraph 10.3 *p. 21*.

6.1.2 RB100/RB200

The RB100/RB200 devices provide four service request inputs, independently configurable as analogue (0-10 V) or digital:
- heating service
- cooling service
- DHW0 service
- DHW1 service

DHW services are independently configurable as base DHW or separable DHW.
Digital type requests consist of voltage-free contacts, whereas analogue type requests are 0-10 V signals corresponding to the set-point for the service.
In the case of digital service requests, the service setpoint is set on the DDC panel or the RB100/RB200 device.

The service requests to RB100/RB200 devices do not involve switching the operating mode.

6.2 SYSTEM CIRCULATING PUMPS CONTROL

RB200 can be used to manage up to five common water pumps (i.e. serving a group of units), driven in on/off mode. Any modulation must be managed independently by the water pumps themselves (e.g. constant ΔT or Δp).
The following types of circulating pumps may be controlled:
- cooling or 2-pipe heating/cooling primary common water pump
- heating primary common water pump
- separable primary common water pump
- cooling or 2-pipe heating/cooling secondary common water pump
- heating secondary common water pump

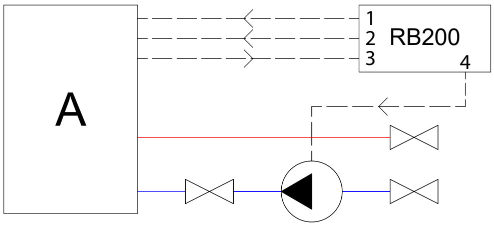
In general, it is not obligatory to have a circulating pump on the secondary circuit and it is not obligatory to control it with RB200. If there are probes installed on the secondary circuit, however, it is *recommended* to install a secondary circulating pump and configure it on RB200, to correctly control flushing of the probes, as they must be constantly flushed when the system is active.

If the third party units are fitted with directly controlled circulating pump (i.e. not connected to RB200), then the antifreeze protection must be assured by the third party units, or the appropriate precautions must be taken to protect the system from freezing.

6.3 THIRD PARTY GENERATORS CONTROL

Up to two third-party generators can be configured for each RB200, and a maximum of eight RB200 devices can be provided for each system.
Figure 6.1 *p. 7* shows the signals that RB200 is able to exchange with each third party generator.

Figure 6.1 *Third party generators control*



A third party generators
1 Generator on/off digital output
2 0-10 V analogue output for temperature setpoint (where the generator is arranged to receive it)
3 Digital input for generator error/unavailability (where the generator makes it available)
4 Digital output for controlling independent generator water pump (if installed and if not driven by the generator itself)

All the combinations of the aforementioned signals are possible to control the generator, according to its features.

Refer to the third party generator manufacturer for the features of the signals required to control it.

Manifold temperature probes

When third party generators are involved, the manifold temperature probes must be installed and configured for the part of the system in which the generators are present.

Third party generator errors and settings

If the third-party generator error/unavailability signal is available, the event is recorded in the DDC panel event history as a generic error, whereas the details on the type of error are only available on the generator (if provided by the manufacturer).
Any customisations of the generator settings in terms of regulation dynamics and any temperature lags compared to the system setpoint must be set directly on the generator regulator.

Controller for control in cascade of several third party generators

If there are several third party generators fitted with their own controller for control in cascade, it is possible to interface directly with the cascade controller via RB200 through the signals described in Figure 6.1 *p. 7*. In this case the control system manages the cascade as if it were a single third party generator. However, this is not an optimal situation because the cascade controller might generate undesirable and not easily foreseeable behaviour.

6.4 MANIFOLD TEMPERATURE PROBE CONTROL

The management of manifold temperature probes is particularly useful if you want to control the temperature (delivery or return) that is actually distributed from the manifolds to the consumers, ensuring that the setpoint set at the point closest to the consumers' withdrawal is respected.
This allows the control system to automatically compensate for

any mixing that alters water temperatures, at the cost of a decrease in efficiency due to mixing, which should be avoided as far as possible.
In the absence of the manifold temperature probes, control is based on the average of the temperatures (delivery or return) read by the water temperature probes on board the appliance, for appliances in which there is actually water circulation, which prevents the control system from knowing what is happening on the distribution manifolds and compensating for any mixing.
The following manifold temperature probes may be configured on the RB200 device, all of the resistive type NTC 10 kΩ:

- heating delivery and return
- cooling delivery and return
- separable DHW delivery and return
- GAHP inlet (only used for "complement and progressive replacement" control mode, Paragraph 7.4 *p. 11*)

Manifold temperature probes are required:

- with third-party generators
- for hydraulic systems with generators in series
- if system control is to be carried out on the secondary circuit

The temperature probes that can be managed are exclusively related to the manifolds of the heat/cold/DHW systems. Under no circumstances is it possible to manage delivery probes.

Water flow on the manifold probes must always be assured when the relevant system (hot/cold/DHW) is on.

6.5 VALVE SERVICES

Two types of valve driving services may be configured on the RB100 and RB200 devices:

- heating/cooling switching valves
- base/separable switching valves

These services are alternative on the RB100 device, whereas both may be used independently on the RB200 device.
The digital output to control the diverter valves is a NO/NC diverter voltage-free contact:

- NO is closed when the valves are towards the heating circuit or the separable group
- NC is closed when the valves are towards the cooling circuit or the base group

Diverter valves can be either the on/off type with spring return or the 3-point type.
The diverter valves must be such as to assure to Robur generators the flow rates set out in Table 6.1 *p. 8* under all operating conditions (including the switching stage).

Table 6.1 *Diverter valves water flow*

			GAHP GS/WS		GAHP A	AY			GA ACF		GAHP-AR
			GAHP WS	GAHP GS HT		AY 35	AY 50	AY 100		ACF60-00 LB	
Heating operation											
Heating water flow	minimum	l/h	1400		1400	1200	1500	1500	-	-	2500
	maximum	l/h	4000		4000	-	-	-	-	-	3500
Cooling mode											
Cold water flow	minimum	l/h	-	-	-	-	-	-	2500	2300	2500
	maximum	l/h	-	-	-	-	-	-	3500	2900	3500
Renewable source operating conditions											
Renewable source water flow rate	minimum	l/h	2300	-	-	-	-	-	-	-	-
	maximum	l/h	4700	-	-	-	-	-	-	-	-
Renewable source water flow rate (with 25% glycol)	minimum	l/h	-	2000	-	-	-	-	-	-	-
	maximum	l/h	-	4000	-	-	-	-	-	-	-

7 INTEGRATION METHODS

The control methods for mixed heating/cooling systems, i.e. consisting of Robur appliances and third-party generators (boilers and/or chillers) will be detailed below.
Integration modes for heating are also available for AY boilers.
Three different methods are available for the space heating service (integration between heat pumps and boilers):

- integration mode (either parallel or series plumbing configuration)
- integration and replacement mode (either parallel or series plumbing configuration)
- integration and progressive replacement mode (series plumbing configuration only)

Only the integration mode is available for the conditioning service (either parallel or series plumbing configuration), and it is possible to set the priority between Robur systems and third party chillers.

7.1 WHY INTEGRATE

Unlike other types of heat pumps (essentially aerothermal), where complement is mainly for reasons of heat pump efficiency loss, since at particularly low outdoor temperatures the efficiency of the heat pump, referred to primary energy, is lower than that of a condensing boiler and consequently, it is necessary to provide a generator that replaces the heat pumps as a whole (as is the case with many hybrid systems), for GAHP heat pumps, complement is driven by other reasons, in consideration of the fact that these are able to operate in all operating conditions with higher efficiency than a condensing boiler.
The objective is to have the highest overall efficiency of the generation system and, thanks to the GAHP heat pump characteristics, this is achieved without ever having to switch off the heat pump due to low efficiency.
The main reasons for evaluating the integration of GAHP/GA and boilers (Robur AY or third-party) and chillers are:

- economic aspects
- availability of space
- availability of electric power
- upgrading existing generators without replacing them

7.1.1 Economic aspects

The purchase cost is lower for a boiler, which is less efficient, than for a GAHP. Consequently, to optimise the economic investment, GAHP are often used to cover only the base load of space heating and boilers are used to cover the peak load, while still achieving a very good overall system efficiency.

For further information, please refer to Section C01.01.

Added to this are evaluations related to the presence of possible incentives linked to the presence of heat pumps in the generation system, whose ceilings may be insufficient to cover a generation system consisting entirely of heat pumps. In this case, another criterion for the economic optimisation of the investment is to install the share of GAHP that allows for the maximum incentive, and cover the remaining power share with boilers.

7.1.2 Available space

Especially in the case of high power systems, the limited space available for installation may make it impossible to realise the whole generation system with GAHP, especially when aerothermal. In this case, the possibility of installing auxiliary boilers, which need much less space than the corresponding power covered with GAHP, makes it possible to realise generation systems that are still efficient while respecting the constraints on available installation space.
Thanks to integration, it is also possible to realise generation systems in which the GAHP are located outdoors and the boilers in the technical room, or the whole generation system is located outdoors, freeing up indoor space for other, more value-added uses.

For the dimensions of GAHP and Link appliances, please refer to Section B.

7.1.3 Electric power availability

If a cooling generation system is to be set up and only a limited amount of electrical power is available to supply it, GA absorption chillers, being gas-fired, can be an excellent means of achieving the required cooling output without a significant increase in the contracted capacity, by supplementing electric chillers.
In this case, the control system allows the electric chiller groups to be set as the priority and leave the GA absorption chillers to cover peak loads, or vice versa, depending on the cost-effectiveness of the energy carriers.
The same is possible for space heating, where GAHP absorption heat pumps could cover the base load and electrical heat pumps would step in to cover peak loads, limiting the electrical draw required compared to an all-electric solution.

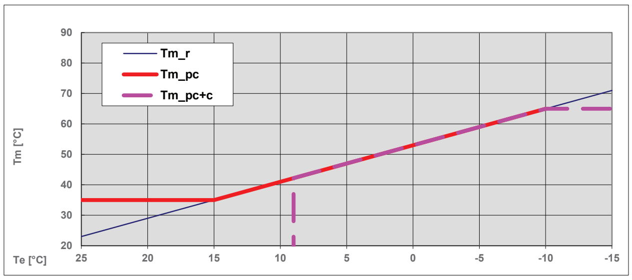
7.1.4 Existing appliances

If you do not want to modify the existing heating plant and machine room, but simply want to add GAHP heat pumps in order to achieve a simple and effective increase in overall efficiency, even a very significant one, integration offers the simplest and most cost-effective solution, also due to the fact that existing boilers and GAHP heat pumps share the same energy carrier.

7.2 HEATING: INTEGRATION

This operating mode allows managing heating systems consisting of both GAHP and boilers where in all operating conditions the required setpoint (fixed or variable) is compatible with the operating range of all generators.
Therefore, no operating conditions are envisaged for this mode where such a high setpoint is required that the GAHP must be excluded.
The power contribution of each generator will then be managed by the DDC panel simply according to the efficiency of each type of generator against the system load.
The integration mode is possible either in parallel or series plumbing configurations, even at different operative temperatures by type of generator, as long as remaining within the permitted operating range of the individual generators.
In this operating mode, it is therefore assumed that the total installed power (GAHP + boilers) is equal to the maximum thermal load of the building.
Figure 7.1 *p. 9* shows an example of heating curve set-up to illustrate this operating mode.
For higher outdoor temperatures, the GAHP alone cover the low load required by the system, at low outlet temperatures. As outdoor temperatures decrease, the load increases and higher outlet temperatures are required.
GAHP appliances and boilers will therefore work in parallel at the same temperature, with GAHP appliances active at full power and the boilers complementing the power according to the load.

Figure 7.1 *Heating curve in heating mode: complement*



Te Outdoor temperature
Tm Outlet temperature for heating
Tm_r Delivery temperature required by the system (linear heating curve)
Tm_pc Required outlet temperature for sole GAHP
Tm_pc+c Required outlet temperature for GAHP + auxiliary boilers

Table 7.1 *Heating curve in heating mode: complement*

	Te [°C]	Tm [°C]
1st point	-10	65
2nd point	15	35
Tmax GAHP	-10	65
Tmin	15	35
Tmax boiler	-10	65

Te Outdoor temperature
Tm Outlet temperature for heating

This operating mode is set out by the European regulation 811/2013 and is explained in Section C1.01.

In addition to the outlet setpoint, it is very important to check that the return temperature of the system (function of the actual thermal exchange) is compatible with the operating range of the GAHP: if the delta between outlet and inlet is too low, even with outlet temperatures far from the operating limit, the GAHP will stop due to inlet temperature too high and will no longer contribute to covering the total load, contrary to the system sizing design.

Refer to Table 7.2 *p. 10* showing the maximum outlet and inlet temperatures for GAHP in heating mode.

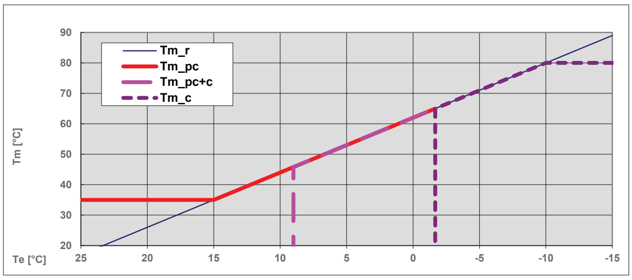
Table 7.2 *Heating temperature limits*

			GAHP A	GAHP-AR	GAHP GS/WS	AY
Heating operation						
Hot water outlet temperature	maximum for heating	°C	65	-	65	-
	maximum	°C	-	60	-	88
Hot water inlet temperature	maximum for heating	°C	55	-	55	-
	maximum	°C	-	50	-	-

7.3 HEATING: INTEGRATION AND REPLACEMENT

This operating mode allows managing heating systems consisting of both GAHP and boilers where the operating conditions entail the possibility of the setpoint required by the heating curve exceeding the maximum temperatures achievable by the GAHP (Table 7.2 *p. 10*).
The DDC panel will therefore handle situations where the building's entire thermal load (design power) is covered by the boilers alone, while the GAHP contribute to covering the base load only as long as allowed by the required temperatures.
Clearly, in these systems the total installed power (GAHP + boilers) is higher than the maximum power required by the building (design power).
Figure 7.2 *p. 10* shows an example of heating curve set-up to illustrate this operating mode.
For high outdoor temperatures, the system will work at low load and low temperature with the GAHP units only (Tm_pc section).
As the outdoor temperature decreases, the system load increases: GAHP and boilers will work together at the same temperature, with the GAHP at full power and the boilers following the load (Tm_pc+c section).
By further decreasing the outdoor temperature, below a specific value, the required outlet temperature will be higher than the one achievable by GAHP, which will therefore be switched off: space heating will then be provided solely by the boilers (Tm_c section).

Figure 7.2 *Heating curve in heating mode: complement and replacement*



Te Outdoor temperature
Tm Outlet temperature for heating
Tm_r Delivery temperature required by the system (linear heating curve)
Tm_pc Required outlet temperature for sole GAHP
Tm_pc+c Required outlet temperature for GAHP + auxiliary boilers
Tm_c Delivery temperature required for boilers alone

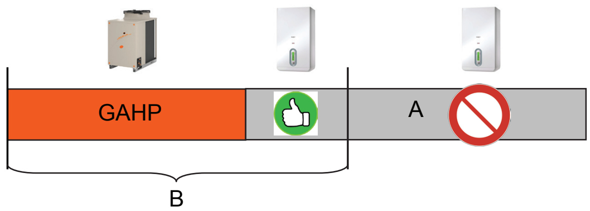
Table 7.3 *Heating curve in heating mode: complement and replacement*

	Te [°C]	Tm [°C]
1st point	-10	80
2nd point	15	35
Tmax GAHP	-2	65
Tmin	15	35
Tmax boiler	-10	80

Te Outdoor temperature
Tm Outlet temperature for heating

As long as the required temperature remains within the operating range of the GAHP, the DDC panel makes only a part of the boilers available for activation, such that the total heat output (GAHP + active boilers) does not exceed the design heat output; the remaining boilers remain inhibited (Figure 7.3 *p. 10*).

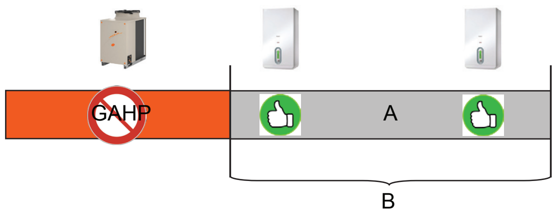
Figure 7.3 *Low temperature operation (integration)*



A Auxiliary boilers B Design power

As the temperature rises above the admissible limits for the GAHP, their operation is inhibited and the boilers alone meet the entire heat demand (Figure 7.4 *p. 10*).

Figure 7.4 *High temperature operation (replacement)*



A Auxiliary boilers B Design power

The switchover from low-temperature operation ("complement" step) to high-temperature operation ("replacement" step) will take place as soon as the actual outlet temperature or inlet temperature of one of the GAHP reaches its operating limit (Table 7.2 *p. 10*). Automatic restore of the GAHP availability will take place as soon as allowed by operating conditions.

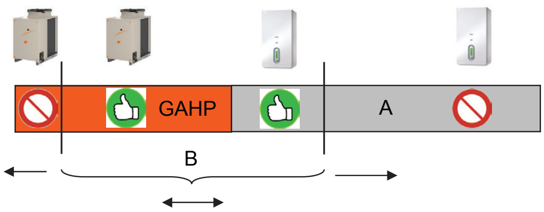
The "complement and replacement" operating mode makes a very simple energy "upgrade" of a building possible: flanking the existing boilers with GAHP in order to cover the base load with them, without touching the boilers themselves in any way, which are left to cover the higher loads, being able to meet the building's whole heat output demand independently at all times.

7.4 HEATING: INTEGRATION AND PROGRESSIVE REPLACEMENT

This operating mode requires a series plumbing configuration between GAHP and boilers, in accordance with the block diagrams in Paragraphs 8.1.3 *p. 13* and 8.1.4 *p. 13*.

This operating mode allows realising a temperature increase by successive steps, i.e. to obtain overall outlet temperatures above the operating limits of the GAHP while not inhibiting them (as long as possible), by integrating the temperature with the boilers.
Unlike the "complement and replacement" mode, this mode seeks to favour the use of the GAHP as much as possible before the definitive switch over to boilers alone, which will occur when the return temperature from the system (and not the required outlet temperature) becomes incompatible with the GAHP operating limits (Table 7.2 *p. 10*).
In the "complement and replacement" mode, in fact, as soon as one of the GAHP reaches the operating limit condition, all GAHP are inhibited until the temperatures fall within the operating limits.
For the complement and progressive replacement mode to be effective, it is therefore necessary for the building to develop a high thermal leap (well above 10 °C) when the required outlet temperature exceeds the operating limits of the GAHP.

Figure 7.5 *Progressive replacement operation*



A Auxiliary boilers B Design power

The DDC panel will identify the maximum number of GAHP that can be activated according to the operating conditions.
To do this, the temperature probes of the supply and return manifolds and the temperature probe dedicated to the return to the GAHP only (temperature that may be different from the temperature of the return manifold of the system, as only part of the system's flow can be used for the first heating step with the GAHP) are required.
Some additional parameters specific to this mode of operation must also be set in the DDC panel; in particular, the design thermal load of the building (which is related to the moving band B in Figure 7.5 *p. 11*) must be defined.

7.5 DHW

For the base DHW service, the same integration modes are available as for the heating service, already described in the previous Paragraphs:

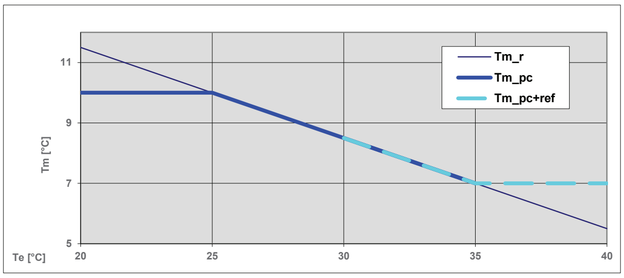
- ► integration mode (either parallel or series plumbing configuration)
- ► integration and replacement mode (either parallel or series plumbing configuration)
- ► integration and progressive replacement mode (series plumbing configuration only)

Only the complement mode (Paragraph 7.2 *p. 9*) is available for the separable DHW production service.

7.6 CONDITIONING: INTEGRATION

This operating mode makes it possible to manage cooling systems in which GAHP heat pumps, GA chillers and third-party chillers are present.
The required setpoint (fixed or variable) must be compatible with the temperature limits of all generators installed in the system.
For this operating mode, a parameter is available on the DDC to define the priority between Robur units and third party chillers, in order to assure maximum flexibility in the choice of the generators in charge of the base load, according to the system specific features.
In the case of cooling, the third-party chillers might cover the base load (hence active in the Tm_pc section of the heating curve in Figure 7.6 *p. 11*), whereas Robur chillers are only active to cover peak loads (Tm_pc+ref section), or vice versa.
Figure 7.6 *p. 11* shows an example of heating curve set-up to illustrate this operating mode.
In this case, the minimum temperature that may be reached by the third party chiller and by the Robur units is the same, and corresponds to the minimum temperature request of the system.
For the first operation section (section Tm_pc), the chillers chosen to cover the base load are able to cover the requirement on their own.
As the outdoor temperature rises, so does the system load and lower temperatures are required; the base chillers and the peak ones are therefore working in parallel at the same temperature (section Tm_pc+ref), with base chillers at full power and peak ones keeping up with the load.

Figure 7.6 *Heating curve in cooling complement mode*



Te Outdoor temperature
Tm Outlet temperature for heating
Tm_r Delivery temperature required by the system (linear heating curve)
Tm_pc Required delivery temperature for active chillers on base load
Tm_pc+ref Required delivery temperature for active chillers on base load and active chillers on peak load

Table 7.4 *Heating curve in cooling complement mode*

	Te [°C]	Tm [°C]
1st point	25	10
2nd point	35	7
Tmax GAHP/GA	25	10
Tmin	35	7

Te Outdoor temperature
Tm Outlet temperature for heating

7.7 PLUMBING CONFIGURATIONS AND INTEGRATION METHODS

The integration methods described above may be used either with series or parallel plumbing configurations, with the exception of the integration and progressive replacement mode, which requires mandatory series configuration.

The series configuration is advantageous when the system, under high thermal load, requires a temperature above the GAHP operating limits and at the same time can develop a thermal leap well above 10 °C on the system under such conditions.

8 SYSTEM BLOCK DIAGRAMS FOR THIRD PARTY UNIT CONTROL

In order to provide a more general representation of the control possibilities of third-party generators and other system components (manifold temperature probes, common water pumps, diverter valves) made possible by Robur control systems, a block diagram is shown below, subdivided by:

- primary circuit (Paragraph 8.1 *p. 12*)
- secondary circuit (Paragraph 8.2 *p. 13*)
- separable circuit (Paragraph 8.3 *p. 15*)

Table 8.1 *p. 12* sets out the permitted combinations between system blocks.

Table 8.1 *System block combinations*

Circuit	Plumbing configuration	Primary	Secondary	
			Separable A1	Separable A2
Primary	Parallel circuit	P1	S1	X
		P2	X	S1
	Series	P3	S2	X
		P4	S1	X

X. Pairing not managed by Robur control systems.

The control of third-party generators and system components such as manifold temperature probes and common water pumps is only possible by using the DDC panel together with the RB200 device, as described in Paragraph 1 *p. 1*.

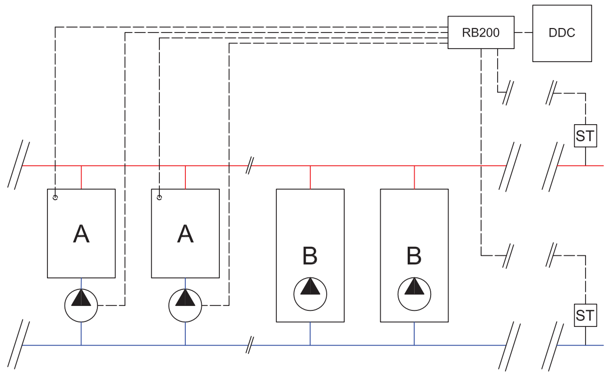
Table 8.1 *p. 12* intentionally refers to the generic secondary S1 (see Paragraph 8.2.1 *p. 14*), without specifying one of the three possible versions, as the combination is possible with any of the three versions. However, the "X" means that the combination cannot be managed by Robur control systems.
Paragraph 8.4 *p. 16* sets out some example diagrams of possible combinations.

8.1 PRIMARY CIRCUIT BLOCKS

Below is a series of system configurations of possible primary circuits supported by Robur control systems.

8.1.1 Primary P1

Figure 8.1 *Primary P1*



A Third party generators
B Robur gas unit heaters
ST Temperature probes on secondary circuit

Figure 8.1 *p. 12* shows type P1 primary block, with the following features:

- Robur appliances with water pumps controlled by on-board electronics
- third-party generators with water pumps controlled via RB200
- a pair of temperature probes on the secondary circuit manifold connected to RB200

The temperature probes connected to RB200 are mandatory if third party generators are installed.

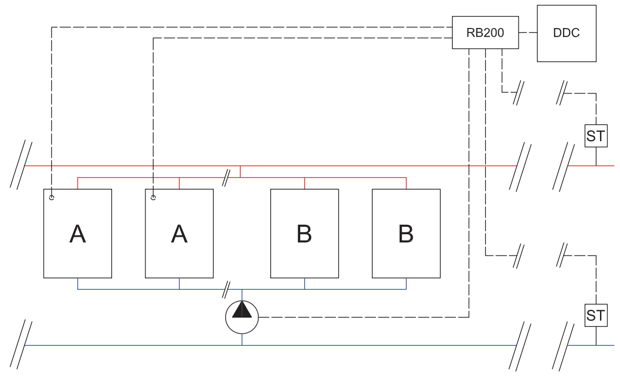
The water pumps of third-party units are only controlled in on/off mode.

Any water flow modulation must be controlled directly by the circulating pumps.

"Complement" (Paragraph 7.2 *p. 9*) and "Complement and replacement" (Paragraph 7.3 *p. 10*) modes are possible with this hydraulic layout for space heating and DHW with base system. For the air conditioning function, only the “integration” mode described in Paragraph 7.6 *p. 11* is available.

8.1.2 Primary P2

Figure 8.2 *Primary P2*



A Third party generators
B Robur gas unit heaters
ST Temperature probes on secondary circuit

Figure 8.2 *p. 12* shows type P2 primary block, with the following features:

- Robur appliances and third-party generators with common water pump controlled via RB200
- a pair of temperature probes on the secondary circuit manifold connected to RB200

The temperature probes connected to RB200 are mandatory if third party generators are installed.

The common circulating pump does not allow the water flow to bypass generators that are temporarily turned off from normal cascade control.

It is not therefore possible to ensure the general setpoint is reached and maintained under any conditions.

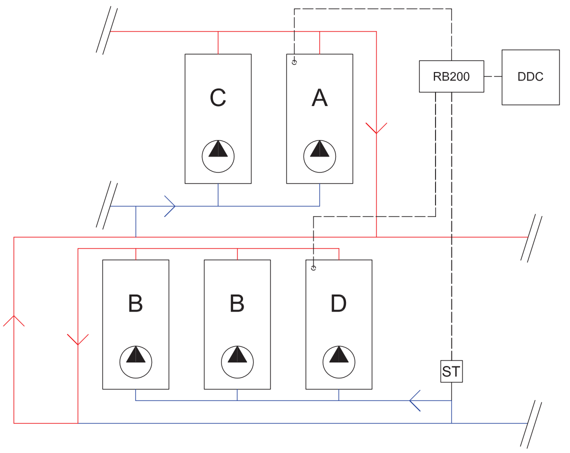
With high outlet setpoints, GAHP appliances may exceed their operating limits to compensate for mixing with inactive units. The common water pump configuration should therefore be carefully considered in these cases, with the support of the Robur technical service.

The common water pump is only controlled in on/off mode.

"Complement" (Paragraph 7.2 *p. 9*) and "Complement and replacement" (Paragraph 7.3 *p. 10*) modes are possible with this hydraulic layout for space heating and DHW with base system.
For the air conditioning function, only the “integration” mode described in Paragraph 7.6 *p. 11* is available.

8.1.3 Primary P3

Figure 8.3 *Primary P3*



A	Third party generators	D	Third party chillers
B	Robur gas unit heaters	ST	GAHP inlet temperature probe
C	AY Robur boilers		

Figure 8.3 *p. 13* shows type P3 primary block, with the following features:

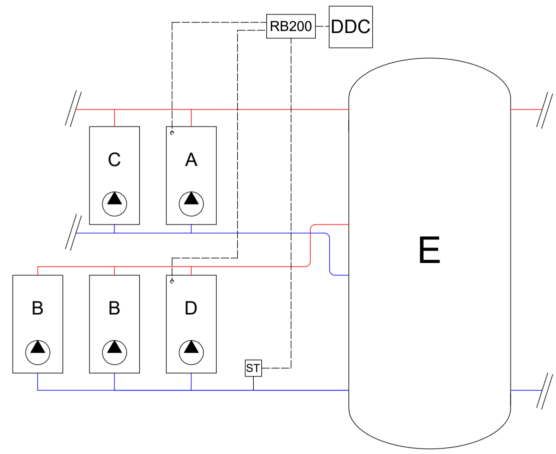
- Robur appliances with water pumps controlled by on-board electronics
- third-party generators with water pumps controlled by their own on-board electronics
- series plumbing configuration
- inlet manifold probe for "complement and progressive replacement" function (Paragraph 7.4 *p. 11*)

The return manifold temperature probe, connected to RB200, is mandatory for the "complement and progressive replacement" function.

"Complement" (Paragraph 7.2 *p. 9*) and "Complement and replacement" (Paragraph 7.3 *p. 10*) and "Complement and progressive replacement" (Paragraph 7.4 *p. 11*) modes are possible with this hydraulic layout for space heating and DHW with base system.
For the air conditioning function, only the “integration” mode described in Paragraph 7.6 *p. 11* is available.

8.1.4 Primary P4

Figure 8.4 *Primary P4*



A	Third party generators	D	Third party chillers
B	Robur gas unit heaters	E	Large size stratified buffer tank
C	AY Robur boilers	ST	GAHP inlet temperature probe

Figure 8.4 *p. 13* shows type P4 primary block, with the following features:

- Robur appliances with water pumps controlled by on-board electronics
- third-party generators with water pumps controlled by their own on-board electronics
- series plumbing configuration to serve a large stratified buffer tank
- inlet manifold probe for "complement and progressive replacement" function (Paragraph 7.4 *p. 11*)

The return manifold temperature probe, connected to RB200, is mandatory for the "complement and progressive replacement" function.

"Complement" (Paragraph 7.2 *p. 9*) and "Complement and replacement" (Paragraph 7.3 *p. 10*) and "Complement and progressive replacement" (Paragraph 7.4 *p. 11*) modes are possible with this hydraulic layout for space heating and DHW with base system.
For the air conditioning function, only the “integration” mode described in Paragraph 7.6 *p. 11* is available.
The presence of the inertial storage tank of a large size and, therefore, able to appropriately stratify the heat even when the system is operating at full power, is a necessary condition so that the hot water flows at different temperatures from the boilers and heat pumps do not mix. Any mixing could in fact raise the return temperature to the heat pumps outside the operating limits.

8.2 SECONDARY CIRCUIT BLOCKS

Below is a series of system configurations of possible secondary circuits supported by Robur control systems.
It should be noted that in the diagrams shown, the hydraulic separator (which also acts as a buffer tank, as described in Section C01.07) is always provided, as the residual head of the on-board water pumps (if present) is often not sufficient for distribution to the consumers.
Please also note that the functions of the control systems do not include controlling the delivery circuits to the users.

It is important for the DDC panel to receive a signal that the secondary circuit is switched off if all the deliveries serving it are switched off so that the generation is only active when there is an actual request.

This simple arrangement allows the overall efficiency to be further and consistently optimised.

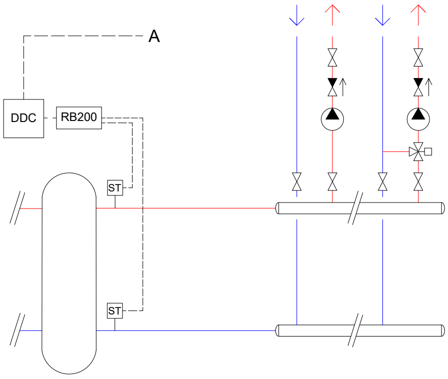
8.2.1 Secondary S1

This type of secondary circuit is divided into three versions: S1A, S1B and S1C.

In all three variants, the temperature probes are required in the following cases:

- presence of third-party generators managed by the Robur control systems
- primary system in series configuration

Figure 8.5 *Secondary S1A*



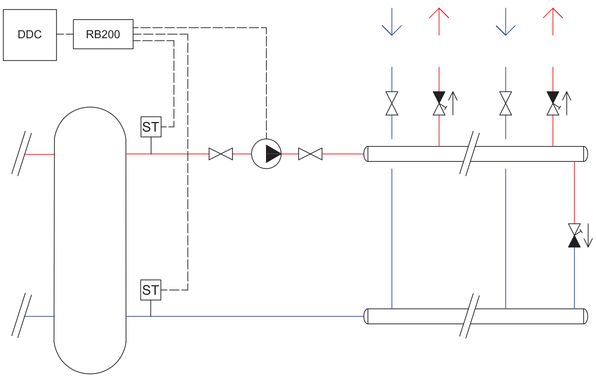
A Service request signal from secondary circuit management system (not supplied)
ST Temperature probes on secondary circuit

Figure 8.5 *p. 14* shows type S1A secondary block, with the following features:

- common manifold with deliveries and check valves
- dedicated water pumps for each delivery, not managed by the Robur control systems
- a pair of temperature probes on the secondary circuit manifold connected to RB200

As set out in Paragraph 8.2 *p. 13*, a digital on/off signal from the user management system should be connected to the DDC panel in order to optimise the operation of the generation system.

Figure 8.6 *Secondary S1B*



ST Temperature probes on secondary circuit

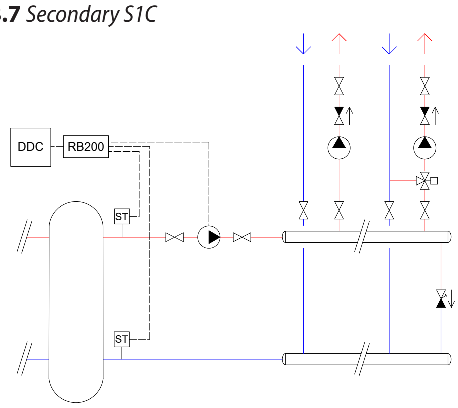
Figure 8.6 *p. 14* shows type S1B secondary block, with the following features:

- common manifold with deliveries and balancing valves
- common water pump controlled via RB200
- hydraulic bypass with balancing valve
- a pair of temperature probes on the secondary circuit manifold connected to RB200

The common water pump is only controlled in on/off mode.

Any water flow modulation must be controlled directly by the circulating pump.

Figure 8.7 *Secondary S1C*



ST Temperature probes on secondary circuit

Figure 8.7 *p. 14* shows type S1C secondary block, with the following features:

- common manifold with deliveries and check valves
- dedicated water pumps for each delivery, not managed by the Robur control systems
- common water pump controlled via RB200
- hydraulic bypass with balancing valve
- a pair of temperature probes on the secondary circuit manifold connected to RB200

The common water pump is only controlled in on/off mode.

Any water flow modulation must be controlled directly by the circulating pump.

8.2.2 Secondary S2

Secondary circuit type S2 includes an additional common water pump upstream of the hydraulic separator (if any) (called secondary pump); for this reason, if the separator is actually provided, the downstream water pump is called tertiary. Secondary circuit type S2 must be used in combination with primary circuit type P3 (described in Paragraph 8.1.3 *p. 13*).

Figure 8.8 *Secondary S2*

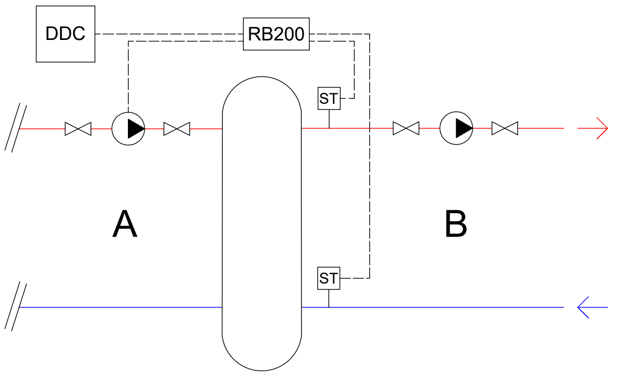


Diagram only applicable for series plumbing configuration with primary type P3 (Paragraph 8.1.3 *p. 13*)

A Secondary circuit
B Tertiary circuit
ST Temperature probes on tertiary circuit

Figure 8.8 *p. 15* shows type S2 secondary block, with the following features:

- secondary water pump controlled via RB200
- tertiary water pump (only with a hydraulic separator)
- hydraulic separator (optional)
- a pair of temperature probes on the secondary circuit manifold connected to RB200

The tertiary circuit circulator can be controlled via RB200, controlled in parallel to the secondary circulator.

The common water pump is only controlled in on/off mode.

Any water flow modulation must be controlled directly by the circulating pump.

8.3 SEPARABLE CIRCUIT BLOCKS

Below is a series of system configurations for possible separable circuits for production of domestic hot water and space heating alternatively, supported by Robur control systems.

Only the "integration" mode described in Paragraph 7.2 *p. 9* is available for separable systems.

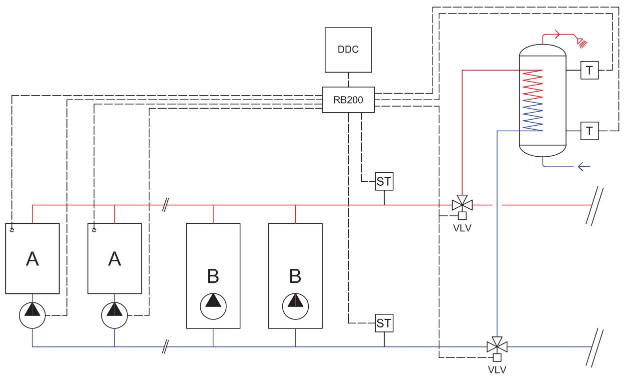
In no case may reversible or 4-pipe Robur generators be used on the separable system.

The correct design of both the water circuit (in particular the diverter valves) and the heat exchange in the DHW buffer tank, which must be able to correctly transmit the heat output from the part of the generation system that is separated, is essential for the proper operation of the separable circuit.

For further information on DHW production, please refer to Section C01.12.

8.3.1 Separable A1

Figure 8.9 *Separable A1*



A Third party generators
B GAHP A or AY
ST Temperature probes on separable circuit
T DHW buffer tank thermostats
VLV Diverter valves

Figure 8.9 *p. 15* shows type A1 separable block, with the following features:

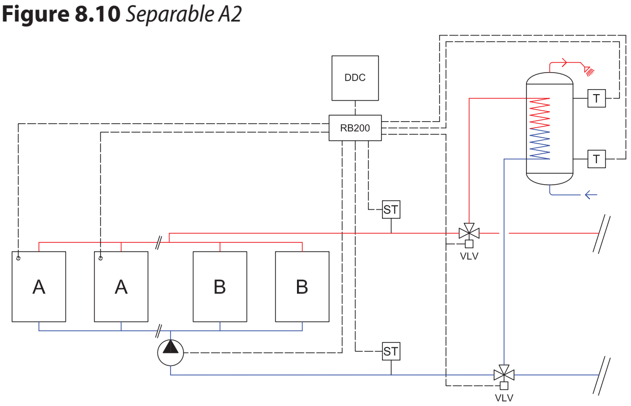
- Robur appliances with water pumps controlled by on-board electronics
- third-party generators with water pumps controlled via RB200
- pair of 3-way diverter valves controlled via RB200
- thermostat(s) in DHW buffer tank for DHW service request
- a pair of temperature probes on the separable circuit manifold connected to RB200

For the characteristics of 3-way diverter valves, please refer to Paragraph 6.5 *p. 8*.

The temperature probes connected to RB200 are mandatory if third party generators are installed.

8.3.2 Separable A2

Figure 8.10 *Separable A2*



A Third party generators
B GAHP A or AY00-120
ST Temperature probes on separable circuit
T DHW buffer tank thermostats
VLV ON/OFF type diverting valves

Figure 8.10 *p. 15* shows type A2 separable block, with the following features:

- Robur appliances and third-party generators with common water pump controlled by RB200
- pair of 3-way diverter valves controlled via RB200
- thermostat(s) in DHW buffer tank for DHW service request
- a pair of temperature probes on the separable circuit manifold connected to RB200

The temperature probes connected to RB200 are mandatory if third party generators are installed.

The common circulating pump does not allow the water flow to bypass generators that are temporarily turned off from normal cascade control.

It is not therefore possible to ensure the general setpoint is reached and maintained under any conditions.
With high outlet setpoints, GAHP appliances may exceed their operating limits to compensate for mixing with inactive units. The common water pump configuration should therefore be carefully considered in these cases, with the support of the Robur technical service.

The common water pump is only controlled in on/off mode.

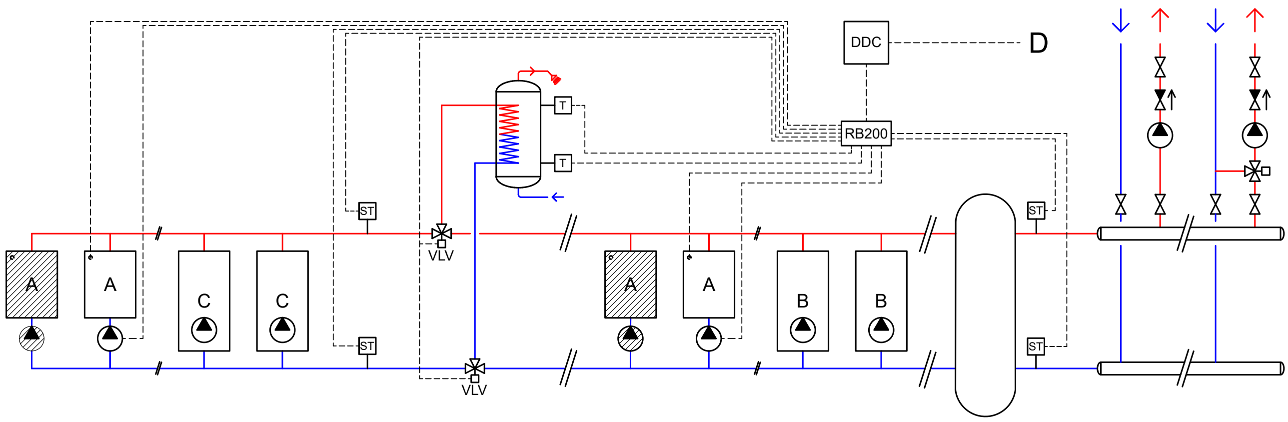
Any water flow modulation must be controlled directly by the circulating pump.

8.4 INDICATIVE BLOCK DIAGRAMS

For the secondary type S1, any of the three versions S1A, S1B or S1C can be used (Paragraph 8.2.1 *p. 14*). For simplicity, only the S1A variant is shown in the figures.
The shaded generators are shown to comply with the original block structure described in the relevant chapters, but cannot be controlled with a single RB200, because (as illustrated in Paragraph 5 *p. 6*) each RB200 makes it possible to control up to two third party units.

8.4.1 Primary P1 with separable A1 and secondary S1

Figure 8.11 *P1+A1+S1 system*

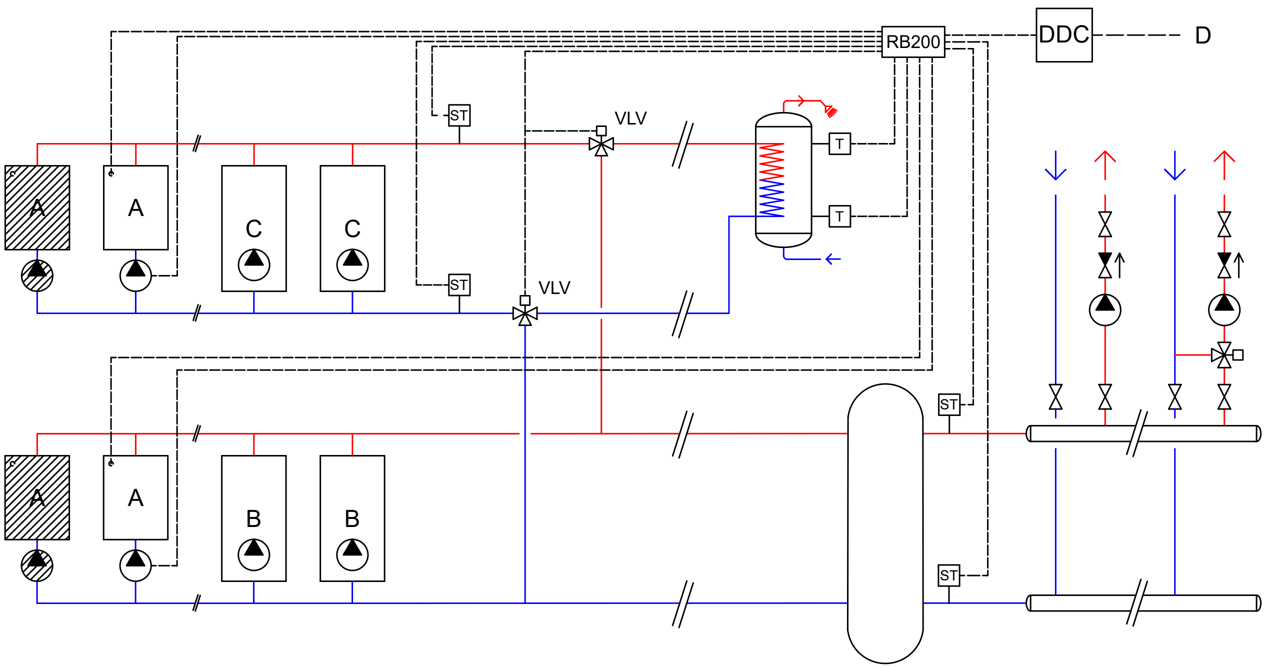


A Third party generators
B Robur gas unit heaters
C GAHP A or AY
D Service request signal from secondary circuit management system (not supplied)
ST Temperature probes of secondary and/or separable circuits
T DHW buffer tank thermostats
VLV Diverter valves

Figure 8.11 *p. 16* shows a general diagram for a system resulting from the coupling, according to the rules set out in Paragraph 8 *p. 12*, of the primary type P1 (Paragraph 8.1.1 *p. 12*) with the secondary type S1A (Paragraph 8.2.1 *p. 14*), with the addition (if required) of the separable type A1 (Paragraph 8.3.1 *p. 15*).
The probes are located both on the separable and secondary circuit, and the secondary control system (not supplied) is expected to communicate a request to the DDC panel to operate, in order to avoid the generation system being active but the distribution system being off.

8.4.2 Primary P1 with separable A1 and secondary S1 in 4-pipe configuration

Figure 8.12 *P1+A1+S1 system in 4-pipe configuration*



A Third party generators
B Robur gas unit heaters
C GAHP A or AY
D Service request signal from secondary circuit management system (not supplied)
ST Temperature probes of secondary and/or separable circuits
T DHW buffer tank thermostats
VLV Diverter valves

Figure 8.12 *p. 17* shows a general diagram for a system resulting from the coupling, according to the rules set out in Paragraph 8 *p. 12*, of the primary type P1 (Paragraph 8.1.1 *p. 12*) with the secondary type S1A (Paragraph 8.2.1 *p. 14*), with the addition (if required) of the separable type A1 (Paragraph 8.3.1 *p. 15*).
In this case, unlike the diagram described in Paragraph 8.4.1 *p. 16*, the diagram is in a 4-pipe plumbing configuration (i.e. the primary circuit type P1 and the separable type A1 have two separate pairs of pipes, which can be unified if necessary thanks to the action of the three-way valves, which also allow the separation of the separable type A1 on the DHW circuit).
The probes are located both on the separable and secondary circuit, and the secondary control system (not supplied) is expected to communicate a request to the DDC panel to operate, in order to avoid the generation system being active but the distribution system being off.

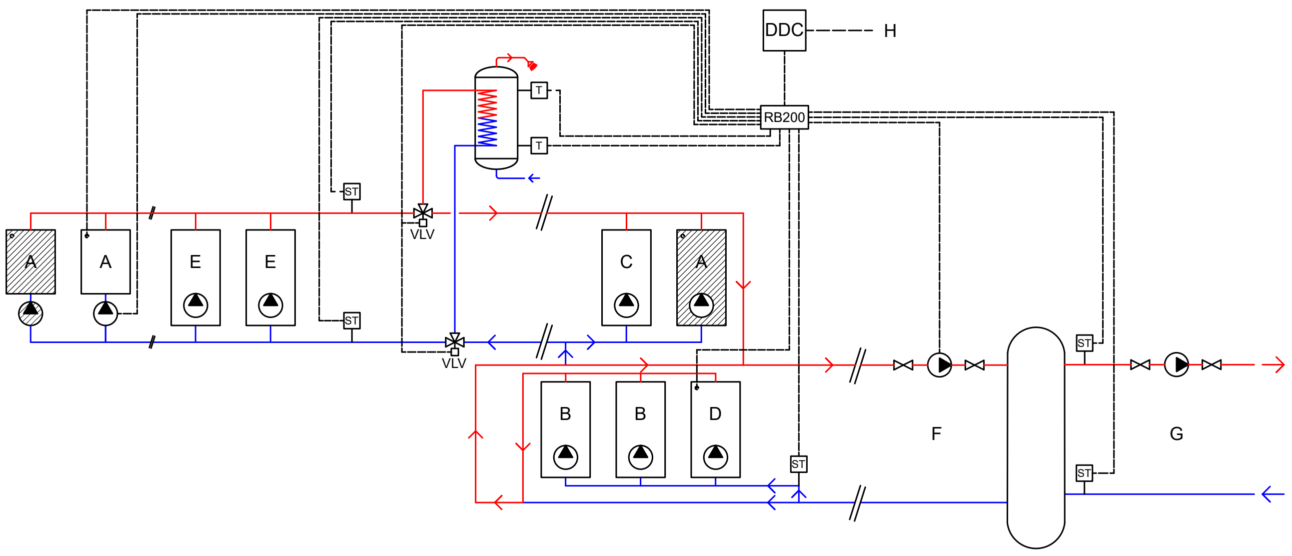
8.4.3 Primary P2 with separable A2 and secondary S1

It is possible to design a system resulting from the coupling, according to the rules set out in Paragraph 8 *p. 12*, of the primary type P2 (Paragraph 8.1.2 *p. 12*) with the secondary type S1A (Paragraph 8.2.1 *p. 14*), with the addition (if needed) of the separable type A2 (Paragraph 8.3.2 *p. 15*).

For the realisation of systems with common water pumps on the generation system, a careful evaluation of the operating conditions is recommended, with particular regard to the operating limits of the GAHP/GA appliances, with the support of the Robur technical service.

8.4.4 Primary P3 with separable A1 and secondary S2

Figure 8.13 *P3+A1+S2 system*

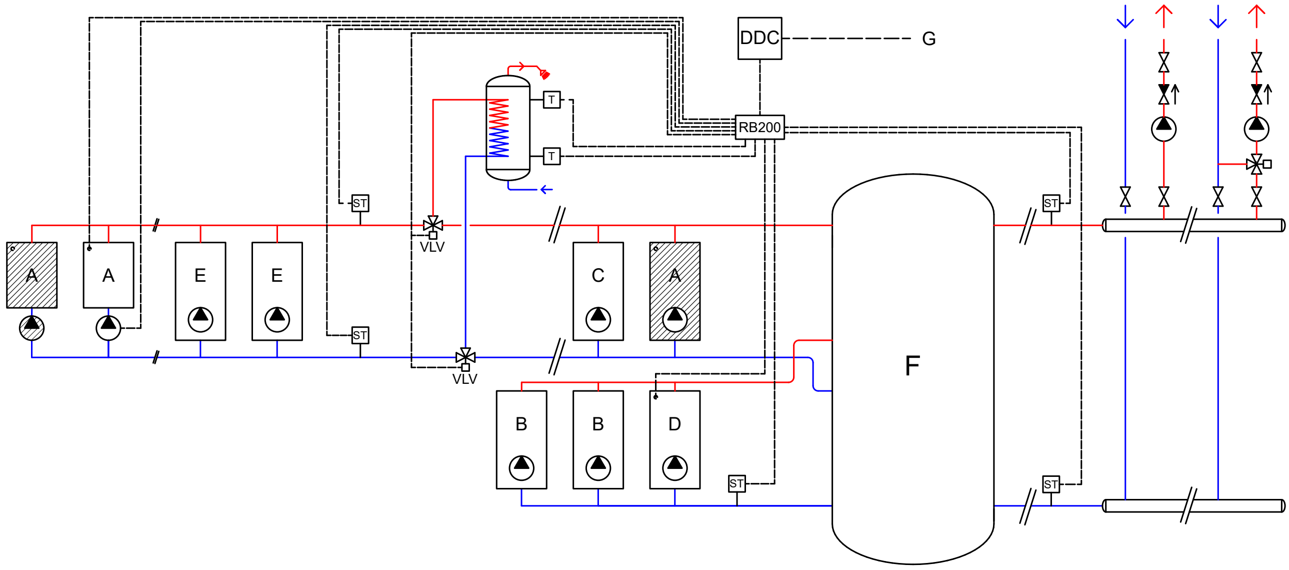


A Third party generators
B Robur gas unit heaters
C AY boilers
D Third party chillers
E GAHP A or AY
F Secondary circuit
G Tertiary circuit
H Service request signal from secondary circuit management system (not supplied)
ST GAHP inlet temperature probe and/or tertiary and/or separable circuit temperature probes
T DHW buffer tank thermostats
VLV Diverter valves

Figure 8.13 *p. 18* shows a general diagram for a system resulting from the coupling, according to the rules set out in Paragraph 8 *p. 12*, of the primary type P3 (Paragraph 8.1.3 *p. 13*) with the secondary type S2 (Paragraph 8.2.2 *p. 14*), with the addition (if required) of the separable type A1 (Paragraph 8.3.1 *p. 15*).
The probes are located both on the separable and secondary circuit (or tertiary if the inertial buffer tank is installed) as well as on the GAHP inlet branch (the latter is only required if the "complement and progressive replacement" mode, described in Paragraph 7.4 *p. 11*, is to be used), and the secondary/tertiary control system (not supplied) is expected to communicate a request to the DDC panel to operate, in order to avoid the generation system being active but the distribution system being off.
The common circulating pump of the secondary circuit is controlled by RB200.

8.4.5 Primary P4 with separable A1 and secondary S1

Figure 8.14 *P4+A1+S1 system*



A	Third party generators	E	GAHP A or AY00-120	ST	GAHP inlet temperature probe and/or tertiary and/or separable circuit temperature probes
B	Robur gas unit heaters	F	Large size stratified buffer tank		
C	AY00-120 boilers	G	Service request signal from secondary circuit management system (not supplied)	T	DHW buffer tank thermostats
D	Third party chillers			VLV	Diverter valves

Figure 8.14 *p. 19* shows a general diagram for a system resulting from the coupling, according to the rules set out in Paragraph 8 *p. 12*, of the primary type P4 (Paragraph 8.1.4 *p. 13*) with the secondary type S1A (Paragraph 8.2.1 *p. 14*), with the addition (if required) of the separable type A1 (Paragraph 8.3.1 *p. 15*).

The probes are located both on the separable and secondary circuit as well as on the GAHP inlet branch (the latter is only required if the "complement and progressive replacement" mode, described in Paragraph 7.4 *p. 11*, is to be used), and the secondary control system (not supplied) is expected to communicate a request to the DDC panel to operate.

9 CCI

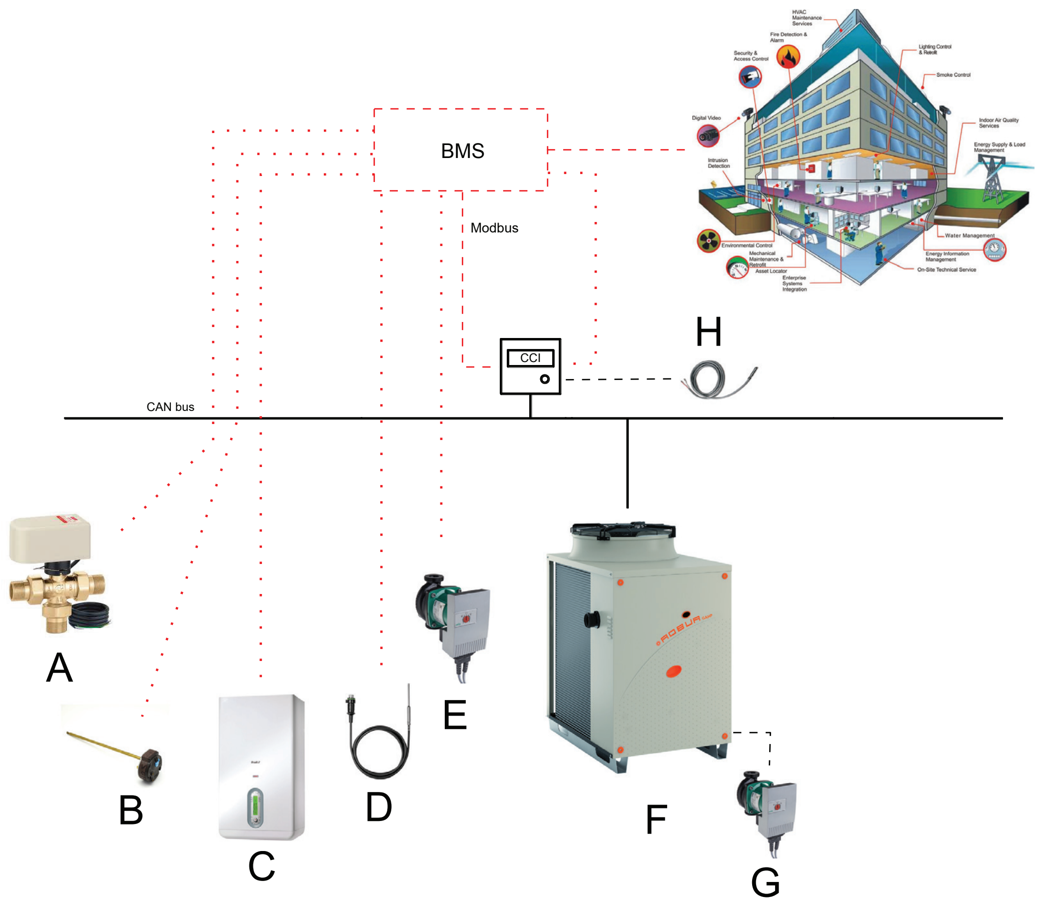
9.1 CCI CONTROL ARCHITECTURE

The CCI control is able to control the appliances, from a single unit up to three GAHP A or GAHP GS/WS units of the same type, in modulating mode (for heating and DHW production) and any free-cooling (GAHP GS/WS units only).

The CCI panel needs to receive the appropriate request signals from an external control system as it is designed for operation in combination with a system controller.

The diagram in Figure 9.1 *p. 20* shows the control system elements and the type of connections available in the presence of the CCI panel and a user control system such as BMS, SCADA and similar.

Figure 9.1 *BMS control architecture with CCI*



A solid line shows the CAN bus connection between the Robur control devices and the appliances.
A dashed line shows the connections with analogue/digital signals between the CCI panel and the manifold temperature probe and the water pumps of Robur appliances, which must be managed by the appliances' internal electronic boards.
A red dashed line shows the Modbus connection between the CCI panel and the user control system (BMS, SCADA, etc.).
A red dotted line shows the connection with analogue/digital signals between the user control system, the CCI panel and other devices in the system.

- A Three-way diverter valves of the on/off spring return or 3-point type
- B Thermostats with adjustable differential
- C Third party generators
- D Temperature probes
- E Circulating pumps
- F Single GAHP A or GAHP GS/WS, up to three, of the same type
- G Single unit water pumps
- H Manifold water temperature probe

The connection with the CCI panel will always be via Modbus protocol, while any analogue/digital signals from the BMS system (only useful if the BMS system does not communicate via Modbus with the CCI panel) will be connected directly to the CCI. It is not possible to use the DDC panel or RB100/RB200 devices with the CCI panel.

9.2 MAIN FUNCTIONS

The main functions of the CCI panel are:

1. Adjustment and control of up to three Robur appliances (GAHP A or GAHP GS/WS) of the same type, with modulation control of the appliances.
2. Data display and parameters setting.
3. Manifold water temperature probe interface.
4. Diagnostics.
5. Errors reset.
6. Possibility to interface with a BMS.

The CCI panel in combination with an external system controller supports the following functions:

- ► heating
- ► DHW production
- ► free cooling (GAHP GS/WS appliances only)

Below is a brief description of the main functions of the CCI panel:

1. Management and control of up to three units Robur GAHP A/GAHP GS/WS allows modulation operation of supported appliance types.
2. Values view and parameters setting allow you to optimize the adjustment parameters in order to best exploit the efficiency of the absorption technology, while safeguarding user comfort.
3. Interfacing for the manifold water temperature probe makes it possible to know exactly the actual temperature on the manifold feeding the fixtures, and to use this reading as feedback to optimise control.
4. Diagnostics lets you know at any time the operating status, warnings or errors of the appliances and identify the possible causes of any malfunctions, as well as manage a log of recorded events.
5. The error reset lets you restore appliance availability following resolution of an error that involved shutdown by the control system.
6. The BMS interfacing option (or other external supervision and control system) makes it possible to manage the CCI panel (and the appliances controlled by it) via an external device, within more complex and integrated home automation or building/plant management systems. In practice, the

interfacing can be realised either through simple analogue/digital signals, or (in a more complete way) through the Modbus protocol, detailed in Paragraph 9.3 *p. 21*.

9.3 MODBUS

The CCI panel also supports interfacing with external devices via Modbus RTU protocol in slave mode.
Using the Modbus protocol, it is possible to collect information on the operating data of the appliances and systems managed by the CCI panel (temperatures, statuses, meters, etc.).
It can also acquire information regarding alarms, both current and registered in the alarms log.
Finally, it is possible to act on the system to set various operating parameters such as appliance switch on, setpoint, differential.
For further information on the Modbus Mapping implemented in the current version of the CCI panel, please refer to Paragraph 10.2 *p. 21*.

9.4 CONTROL AND SETUP

In order to have the GAHP appliances managed by the CCI panel switched on, an external system controller must activate the request signal on the appropriate input of the CCI panel.
The water set-point may be fixed or variable.
If a variable setpoint is desired, it must be transmitted by the external system controller via the 0-10 V signal connected to the appropriate input, or received by the CCI panel via Modbus (Paragraph 9.3 *p. 21*).

The CCI panel manages the GAHP in order to adjust the water temperature (measured by the manifold probe connected to the specific input) to the setpoint value.
For the space heating service, the CCI panel is able to modulate power as follows:

- up to 50% for a single GAHP
- up to 30% of the total power with two or three GAHP

Below the minimum modulation threshold, the CCI panel manages the appliances in on/off mode, either directly or via the external system controller.
If there is a DHW request, the DHW setpoint can also in this case be fixed or variable.
If the setpoint is to be variable, the same rules apply for its transmission to the CCI panel as for the space heating setpoint.
For DHW service, there is no modulation control, but only on/off, being able to specify the number of GAHP appliances that can be used for DHW service, which will be activated at maximum power.

The CCI panel does not directly manage an auxiliary boiler, which must be controlled by the external system controller.

For free cooling service, by activating the appropriate demand input, the CCI merely activates the water pumps on the cold side of the GAHP GS/WS appliances.
For details of the CCI panel inputs and outputs relating to the various services, see Section C01.10.

10 MODBUS MAPPING

Below is some information for Modbus interfacing with DDC and CCI panels.
Modbus interfacing with RB100 and RB200 devices is not provided. The relevant data and settings, where available, are accessible via Modbus from the DDC panel.

10.1 MAIN FUNCTIONS

The following main functions are obtained via Modbus protocol interface:

- reading system outlet and return temperatures
- reading the active setpoint on the system for the specific service (heating/cooling/ DHW)
- reading the general alarm status
- reading the digital status of each individual appliance (on/off, alarm, flame status, etc.)
- reset alarms, including flame lockout
- reading temperatures and analogue values of the appliance
- set switch on/off of services (heating/cooling/DHW)
- summer/winter switching
- set activation and heating curve parameters

10.2 CCI

The document with the Modbus mapping can be requested from the Robur technical service.

The FW version of the CCI panel must be specified, as Modbus mapping depends on the FW version.

10.3 DDC

The document with the Modbus mapping can be requested from the Robur technical service.

The FW version of the DDC panel must be specified, as Modbus mapping depends on the FW version.