1 GENERAL TABLE OF CONTENTS

1 DETAILED TABLE OF CONTENTS

1 DEFINITIONS

DHW = Domestic Hot Water.
AY = generic term used to designate the AY condensing boiler product range, which includes AY 35, AY 50 and AY 100.
Aerothermal appliances = gas-fired heating/cooling appliances intended exclusively for outdoor installation (gas absorption heat pumps GAHP A Plus/GAHP AR Plus, or gas absorption chillers GA ACF/HR/TK/HT/LB), which require proper heat exchange with outdoor air to operate.
GA appliance = GA gas-fired absorption chiller.
GAHP appliance = GAHP gas-fired absorption heat pump.
BMS (Building Management System) = plant or building supervisor controller not supplied by Robur.
TAC = Robur authorized Technical Assistance Centre.
Common water pump = water pump serving a group of generators.
Independent water pump = water pump serving a single generator.
Primary circuit = section of the air conditioning system starting from the generators to the hydraulic separator or heat exchanger (if any).
Secondary circuit = section of the air conditioning system downstream of the hydraulic separator or heat exchanger (if any).
Parallel plumbing configuration = plumbing configuration in which the water inlet to each generator is common.
Series plumbing configuration = plumbing configuration in which all or part of the water flow entering a generator comes from another generator.
External request = generic control device (e.g. thermostat, timer or any other system) equipped with a voltage-free NO contact and used as control to start/stop the GAHP/GA appliance and the AY boiler.
RB100/RB200 devices (Robur Box) = optional interface devices complementary to the DDC control panel, which may be used to broaden its functions (heating/cooling/DHW production service requests and control of system components such as third party generators, diverter valves, water pumps, probes).
GA = generic term used to designate the GA gas absorption chillers product range, which includes ACF60-00, ACF60-00 S, ACF60-00 HR, ACF60-00 HR S, ACF60-00 HT, ACF60-00 HT S, ACF60-00 LB, ACF60-00 LB S, ACF60-00 TK, ACF60-00 TK S.
GAHP Plus = new generation versions of gas absorption heat pumps. Includes the GAHP A Plus, GAHP AR Plus and GAHP GS/WS Plus heat pump product ranges.
GAHP A Plus = generic term used to designate the GAHP A Plus gas absorption heat pump product range, which includes GAHP A Plus, GAHP A Plus S1.
GAHP AR Plus = generic term used to designate the GAHP AR Plus reversible gas absorption heat pump product range, which includes GAHP AR Plus, GAHP AR Plus S1.
Third-party generator = a generator (usually boiler or chiller) that is not produced by Robur, which cannot be controlled directly by the DDC control panel and therefore requires an additional interface device (RB200).
Robur generator = generator (heat pump, boiler or chiller) produced by Robur, controlled by the DDC control panel via CAN bus communication.
Heat generator = equipment (e.g. boiler, heat pump, etc.) for producing heat for heating and DHW.
Base group = set of generators located on the base system.
Separable/separated group = set of generators located on the separable/separated DHW system.
GUE (Gas Utilization Efficiency) = efficiency index of gas heat pumps, equal to the ratio between the thermal energy produced and the energy of the fuel used (relative to LCV, lower calorific value).
2-pipe system = system on whose primary and/or secondary circuit there is only one pair of pipes (supply/return), therefore unable to provide hot and cold water services simultaneously.
4-pipe system = system fitted on both primary and secondary circuits with two pairs of pipes, therefore able to supply two different services simultaneously.
Separable DHW system = part of the primary circuit that can be hydraulically separated from the base system part and operate independently. It can assume two states, depending on the position of the 3-way diverter valve:

- Hydraulically connected to the base system (**included** state): in the included state, this part of the system integrates the heating system.
- Disconnected from the base system (**separate** state): in the separate state, this part of the system is dedicated to DHW production, regardless of the service supplied by the base system.

Separate DHW system = part of the primary circuit for DHW production only, hydraulically permanently disconnected from the base system.
DHW system = system intended for DHW production.
Base system = part of the primary circuit comprising all generators, excluding those that can be hydraulically separated from it by means of a suitable 3-way valve.
Heat system = system intended for the production of hot water for heating and/or DHW.
Cold system = system intended for production of cold water for cooling.
Complement = coordinated control of different types of generators to maximize overall system efficiency.
Power complement = complement mode in which all generators produce power at the same temperature.
Temperature complement = complement mode in which different types of generators can produce power at different temperatures.
"Complement and progressive replacement" operating mode = possible operating mode for a series plumbing configuration in which the outlet setpoint is not compatible in some operating conditions with the operating temperatures of some generators (in particular the GAHP).
"Complement and replacement" operating mode = operating mode in which the temperature setpoint under some operating conditions may not be compatible with the operating temperatures of some generators (in particular, the GAHP heat pumps).
“Complement” operating mode = operating mode in which the setpoint in all operating conditions is compatible with the operating temperatures of all generators.
Heat module = for a Robur generator this is the logic control unit that manages hot water production functions.
Cold module = for a Robur generator this is the logic control unit that manages cold water production functions.
CCI control panel (Comfort Controller Interface) = optional Robur control device which lets you manage up to three modulating GAHP appliances (GAHP A, GAHP GS/WS) of the same type, for heating only.
DDC control panel (Direct Digital Controller) = optional Robur control device to manage one or more Robur appliances in in modulating mode (GAHP heat pumps, AY boilers) or ON/OFF mode (GA chillers).
First start-up = appliance commissioning operation which may only and exclusively be carried out by a TAC.
Service request = signal activating a specific service. Some

service requests may be relayed to the Robur control system in different ways (directly to the DDC control panel or through RB100/RB200 devices).
Service = for Robur control systems, this term is used to identify a specific functionality of the resources managed by the controllers (heating service, DHW service, cooling service, valve service, water pump service, probe service...).
Base DHW service = DHW service obtained with the base system.
Separable/separate DHW service = DHW service obtained with the separable/separate DHW system.
Hybrid system = system consisting of Robur heat pumps and boilers (Robur or third party).
Mixed system = system consisting of Robur appliances and third-party appliances.

2 ADVANTAGES OF GAS ABSORPTION TECHNOLOGY

- ► Very high winter energy efficiency.
- ► High savings on management costs (up to 40%).
- ► Very high reliability due to almost no moving parts.
- ► Avoids an increase in installed electrical power.
- ► Can be combined with third-party boilers or chillers.
- ► Stable and efficient operation even at very low outdoor temperatures (aerothermal versions).
- ► No performance degradation over time.
- ► Uninterrupted power output during defrosting (aerothermal versions).
- ► Thermodynamic circuit free of any scheduled maintenance (maintenance is comparable to that required for a condensing boiler).
- ► Service continuity thanks to modular control.
- ► In geothermal application for space heating, it halves the need for geothermal probes.
- ► No use of refrigerants that are toxic, harmful for the environment or the ozone layer.
- ► Sealed circuit requiring no refrigerant top-up.
- ► No water consumption in cooling mode (no evaporative cooling tower).
- ► Increase in the energy class of the building.
- ► Performance data certified by independent third parties at their laboratories.
- ► The absorption cycle can be powered using various energy carriers such as natural gas, biomethane or hydrogen.
- ► Possibility of access to incentive mechanisms for heat pumps and high-efficiency heating appliances.
- ► Possible sealed circuit warranty extension (labour and spare parts).
- ► Remote monitoring and optimisation via In-Cloud Watcher Monitoring System service.

3 GAS ABSORPTION CYCLE

In the conventional refrigeration cycle (with vapour compression) the process by which the gaseous refrigerant goes from low pressure/low temperature at evaporator outlet to high pressure/high temperature conditions at the condenser inlet is performed by a mechanical compressor (usually driven by an electric motor).
The main difference with the gas absorption cycle is that this same process is performed by means of thermal compression in three main steps:

1. The high-pressure solution is heated by the energy carrier to the point where the refrigerant is released in the gaseous phase at high temperature.
2. Through a spontaneous refrigerant/absorbent reaction, the gaseous refrigerant is absorbed in a low-pressure liquid phase.
3. The pressure of the liquid solution is raised by a pump and the solution is fed back into the generator to repeat the cycle.

The advantages of this thermo-physical process compared to conventional mechanical compression are essentially as follows:

1. Raising the pressure of a liquid requires far less energy (electricity) than compressing a gas.
2. The absorption reaction is highly exothermic and the released heat may be usefully exploited.
3. The energy vector supplying energy to the process is primary energy (natural gas/LPG, but also biomethane) or hydrogen.

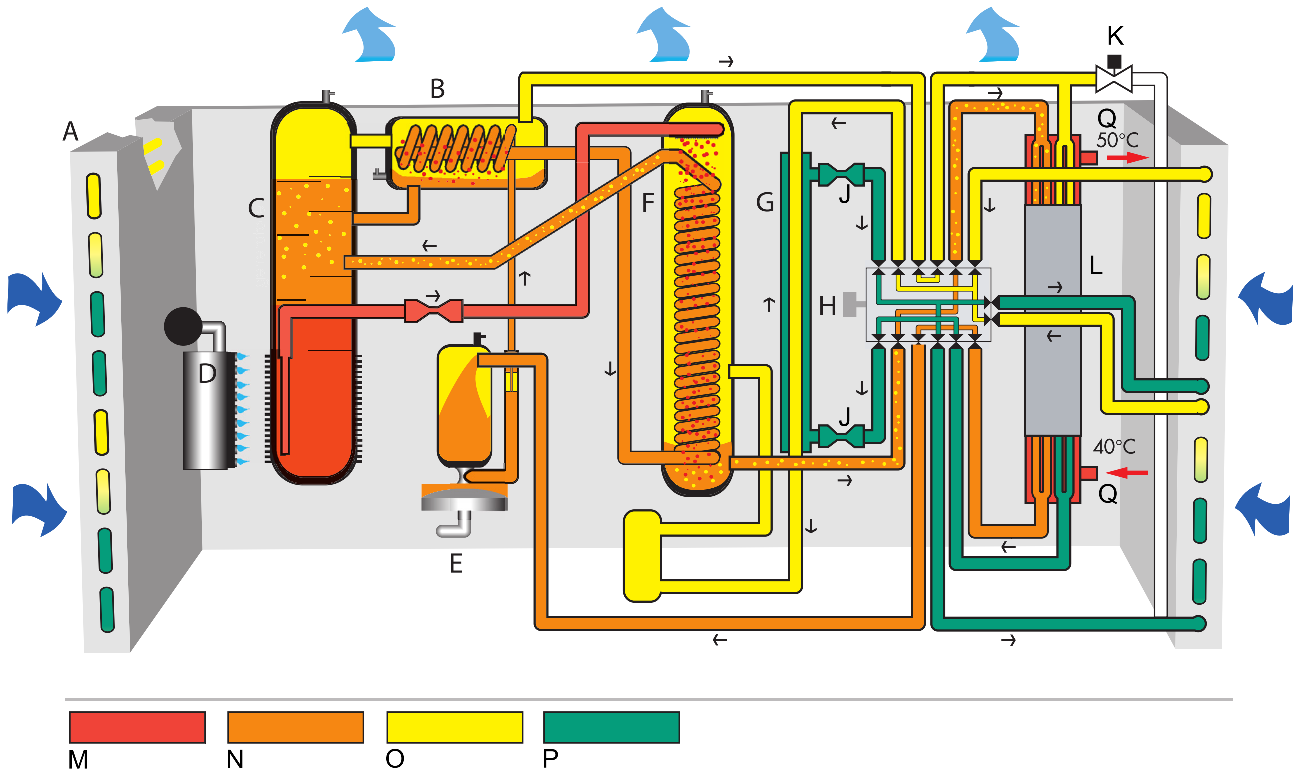
In the gas absorption cycle the refrigerant is ammonia and the absorbent is water.

3.1 DETAILED DESCRIPTION

For a detailed description of the thermodynamic cycle of a GAHP heat pump, please refer to Figure 3.1 *p. 3*, which shows the cooling circuit of a GAHP AR Plus (reversible gas absorption heat pump for alternate production of hot or chilled water) in heating mode.
The multi gas burner (D) is used to heat the absorbent-refrigerant solution causing separation of the two components by evaporation of the refrigerant in the distillation column (C).
In the gas absorption cycle the refrigerant is ammonia and the absorbent is water.
The burner-distillation column assembly (C+D) is called a generator and in absorption heat pumps replaces the compressor typical of electrical heat pumps.
The refrigerant vapour leaving the generator, passing through the rectifier (B), separates from any residual water and enters the shell and tube heat exchanger (L), which, if the appliance is operating in heating mode, takes on the role of the heat pump condenser.
In this part of the cycle, the heat exchanger acts as the refrigerant condenser, which transfers the latent condensation heat to the water of the heating system.
This change of state of the refrigerant, therefore, represents the first useful effect of the thermodynamic cycle.
The refrigerant on outlet of the condensation section passes through a first lamination section (J), a tube-in-tube heat exchanger (G) and a second lamination section (J) where, through successive decreases in pressure and temperature, it is progressively brought to the ideal conditions for changing state again to the gaseous phase.
In the finned coil (A) the refrigerant evaporates by taking heat from the outdoor air.
In this part of the circuit, the heat pump imports into the cycle a portion of aerothermal renewable energy.
The refrigerant used by GAHP heat pumps, ammonia, can evaporate down to -33 °C at ambient pressure.
This thermodynamic characteristic of the refrigerant allows renewable energy to be taken from the air even when its temperature goes down to deep negative values, thus dispensing with the need to have backup boilers.

The ammonia evaporated in the finned coil (A), after overheating in the tube in tube heat exchanger (G), enters the pre-absorber (F) where it meets the atomized absorbent (water) thus giving rise to the actual absorption reaction.
Absorption is an exothermic chemical reaction whereby the emitted thermal energy needs to be removed.
In the pre-absorber (F) this energy is partially used to preheat the water-ammonia solution that is about to go back into the generator.
To complete the absorption reaction, the solution is sent back to the shell and tube heat exchanger (L).
At this stage of the cycle, the heat exchanger allows a considerable amount of thermal energy to be transferred to the heat transfer fluid of the heating system, which constitutes the second useful effect of the thermodynamic cycle.
The water-ammonia solution coming out of the heat exchanger (L) is conveyed by the solution pump (E) back to the generator, passing through the pre-absorber (F) and the rectifier (B) again, where it is preheated, recovering heat from the cycle itself.
In the generator, therefore, the thermodynamic cycle just described restarts.
The inversion valve of the heat pump cycle (H), only provided for GAHP AR Plus units, consists of a mechanical component through which the refrigerant flow is diverted into the circuit.
This operation makes it possible to seasonally reverse the operating mode and produce hot water in the heating season and chilled water in the cooling season.
The defrosting valve (K), provided only for GAHP A Plus and GAHP AR Plus aerothermal heat pumps, allows rapid defrosting of the finned coil, if required, without the need to reverse the refrigeration cycle or switch on electrical auxiliary heaters.
This is because, as shown in Figure 3.1 *p. 3* below, only one of the two energy inputs to the heat exchanger (L) is diverted to the finned coil, namely hot ammonia vapour.
This makes possible a quick ice removal while assuring 50% power to the heating circuit, without markedly altering the appliance's efficiency.

Figure 3.1 *GAHP-AR absorption cycle (heating mode)*



A	Finned coil	G	Tube in tube heat exchanger	N	Ammonia-rich solution
B	Rectifier	H	Cycle inversion valve	O	Ammonia in vapour state
C	Distillation column	J	Lamination valve	P	Ammonia in liquid state
D	Burner	K	Defrosting valve	Q	Heating system water
E	Solution pump	L	Shell and tube heat exchanger		
F	Pre-absorber	M	Ammonia-poor solution		

1 SECTION B CONTENTS

1 SPECIFICATION OF SUPPLY

1.1 GAHP A PLUS

Water-ammonia absorption heat pump, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version, modulating down to 28% of the nominal heat input, condensing, for hot water production up to an outlet temperature of 65 °C (70 °C at 50% of maximum thermal input), for outdoor installation.
Nominal heat output (A7W35): 44,6 kW
GUE efficiency (A7W35): 172 %
Heat input: 26,0 kW
Electrical power absorption nominal: 0,84 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 356 kg
Dimensions: width 904 mm, depth 1264 mm, height 1446 mm

1.2 GAHP A PLUS S1

Water-ammonia absorption heat pump with low-noise brushless modulating fan, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version, modulating down to 28% of the nominal heat input, condensing, for hot water production up to an outlet temperature of 65 °C (70 °C at 50% of maximum thermal input), for outdoor installation.
Nominal heat output (A7W35): 44,6 kW
GUE efficiency (A7W35): 172 %
Heat input: 26,0 kW
Electrical power absorption nominal: 0,77 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 74,0 dB(A)
Sound power Lw (min): 71,0 dB(A)
Weight: 367 kg
Dimensions: width 904 mm, depth 1264 mm, height 1523 mm

2 FEATURES AND TECHNICAL DATA

2.1 FEATURES

2.1.1 Mechanical and thermo-hydraulic components

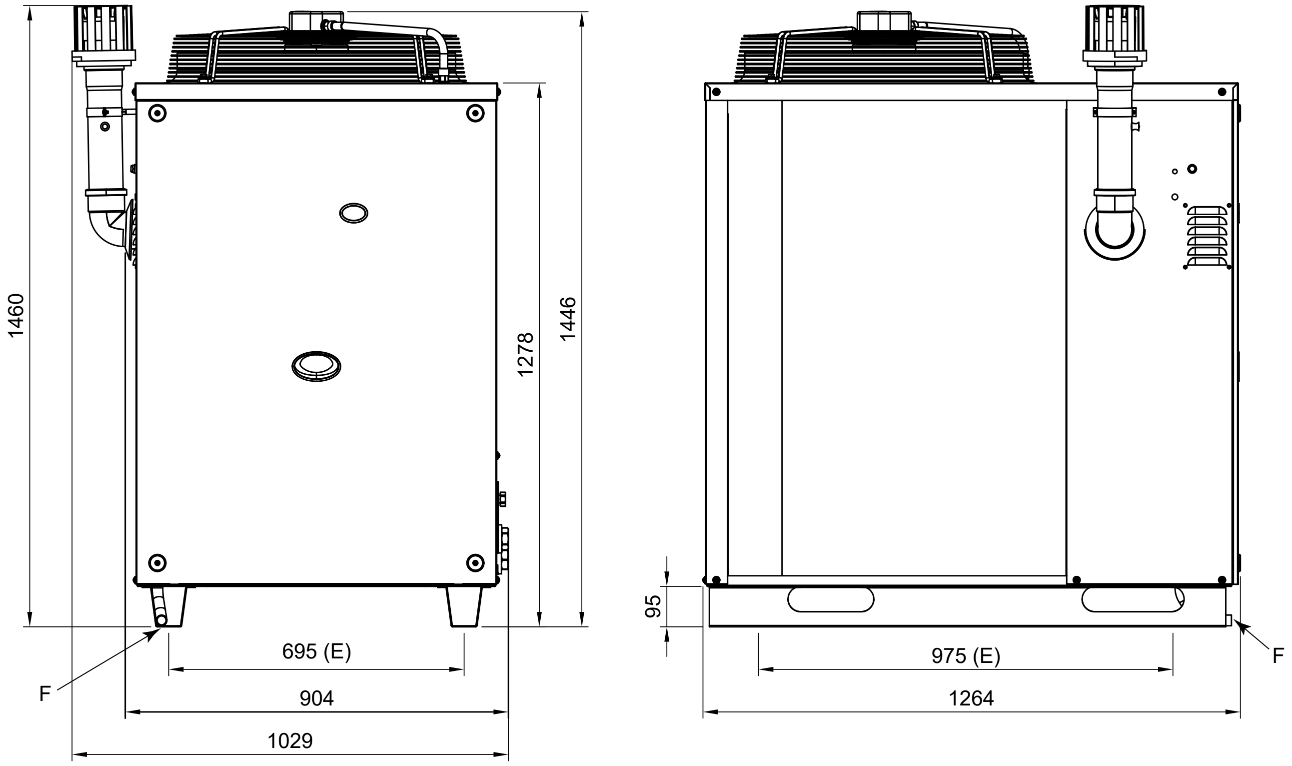
- Steel sealed circuit, externally treated with epoxy paint.
- Sealed combustion chamber (type C) suitable for outdoor installations.
- Metal mesh radiant burner, equipped with ignition electrodes and flame detection, managed by an electronic flame control box.
- Titanium stainless steel shell-and-tube water heat exchanger, externally insulated.
- Stainless steel, shell-and-tube recovery exchanger of flue gas latent heat.
- Air exchanger with finned coil, with steel pipe and aluminium fins.
- Automatic microprocessor-controlled finned coil defrosting valve.
- Low power consumption refrigerant fluid oil pump.
- Modulating premix burner group from 100% to 28% of the nominal heat input.
- Standard or S1 low-noise fan (low power consumption and low noise emission).

2.1.2 Control and safety devices

- Electronic board featuring a microprocessor, LCD, and knob.
- System water flowmeter.
- Generator limit thermostat, with manual reset.
- Flue gas thermostat, with manual reset.
- Generator fins temperature probe.
- Sealed circuit safety relief valve.
- Bypass valve, between high and low-pressure circuits.
- Ionization flame control box.
- Double shutter electric gas valve.
- Condensate drain obstruction sensor.

2.2 DIMENSIONS

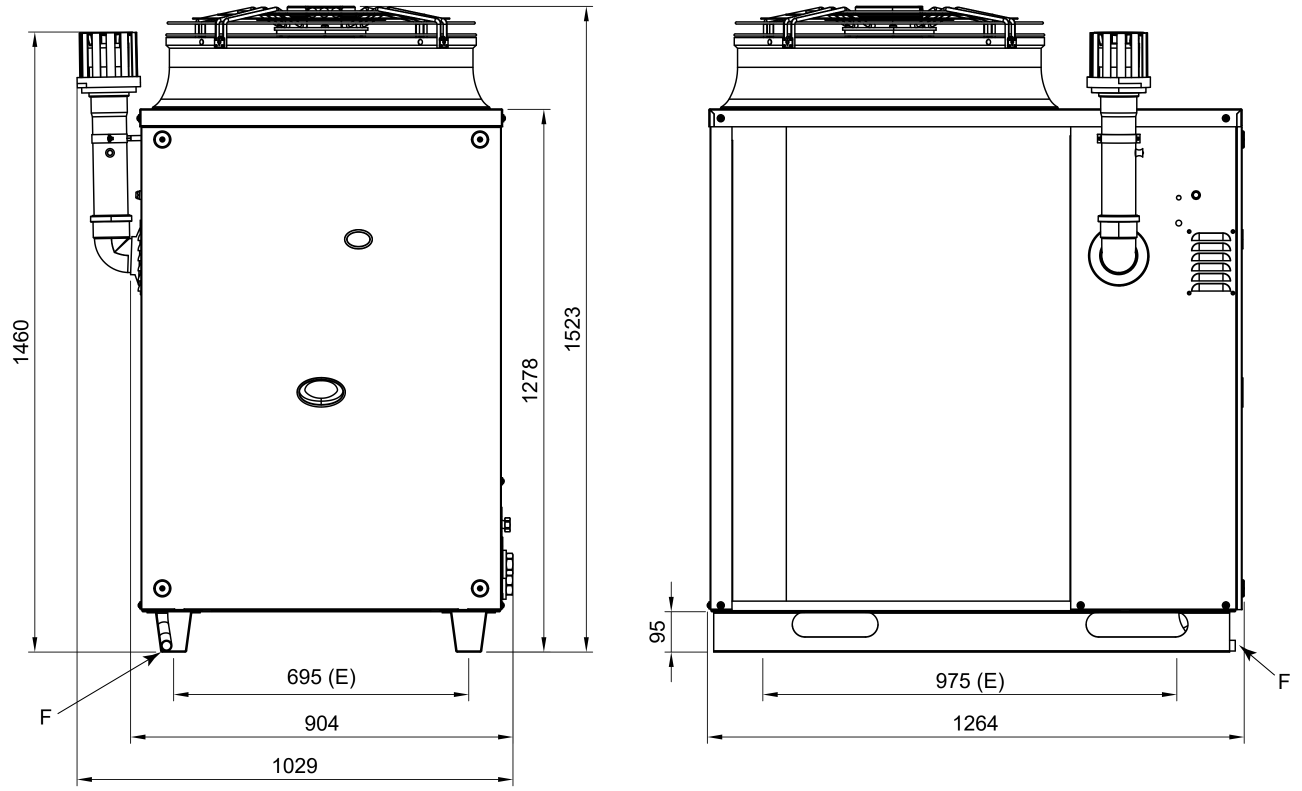
Figure 2.1 *Dimensions (standard fan)*



E Centre distance of holes for vibration damper supports

F Condensate drain connection

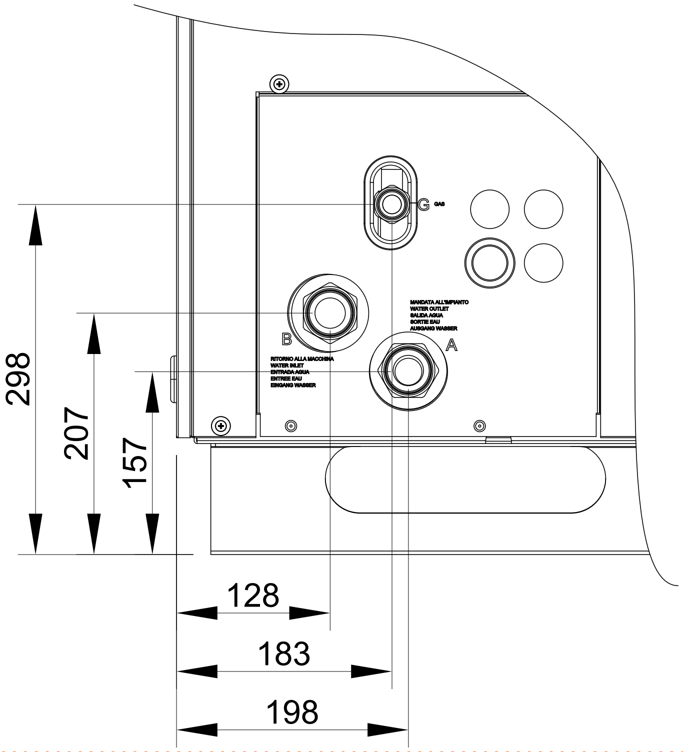
Figure 2.2 *Dimensions (low-noise fan)*



E Centre distance of holes for vibration damper supports

F Condensate drain connection

Figure 2.3 *Service plate - Hydraulic/gas connections detail*



G Gas connection Ø 3/4" F
B Water inlet connection Ø 1 1/4" F
A Water outlet connection Ø 1 1/4" F

2.3 CONTROLS

2.3.1 Control device

The appliance may only work if it is connected to a control device, selected from:

- DDC panel
- CCI panel
- External request

2.3.2 DDC panel

The DDC control panel can manage one or more Robur appliances in modulating mode (GAHP heat pumps, AY boilers) or ON/OFF mode (GA chillers).
DDC control panel 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 water pumps,...).

For more details see Section C01.11.

2.3.3 CCI panel

The CCI control panel can manage up to 3 GAHP appliances in modulating mode (i.e. only GAHP A Plus/GAHP GS/WS Plus for heating only).

For more details see Section C01.11.

2.3.4 External request

The appliance can also be controlled by a generic request device (e.g. thermostat, timer, switch, contactor...) fitted with a voltage-free NO contact. This system only allows basic control (on/off, with a fixed setpoint temperature), thus lacking essential system functions of the DDC/CCI control panel. We recommend using it only for simple applications and with a single appliance.

2.4 TECHNICAL DATA

Table 2.1 *GAHP A Plus technical data*

				GAHP A Plus	GAHP A Plus S1
Heating mode					
Seasonal space heating energy efficiency class (ErP)	medium-temperature application (55 °C)		-	A+	A++
	low-temperature application (35 °C)		-	A+	
Nominal heat output	Outdoor temperature/Water outlet temperature	A7W35	kW	44,6	
GUE efficiency	Outdoor temperature/Water outlet temperature	A7W35	%	172	
Heat input	nominal (1013 mbar - 15 °C)		kW	26,4	
	real		kW	26,0	
Hot water outlet temperature	maximum for heating		°C	65	
	maximum for DHW		°C	70	
Hot water inlet temperature	maximum for heating		°C	55	
	maximum for DHW		°C	60	
	minimum temperature in continuous operation		°C	30 (1)	
Heating water flow	nominal		l/h	2500	
	maximum		l/h	4000	
	minimum		l/h	2000	
Water pressure drop in heating mode	at nominal water flow		bar	0,31 (2)	
Outdoor temperature (dry bulb)	maximum		°C	45	
	minimum		°C	-15 (3)	
Electrical specifications					
Power supply	voltage		V	230	
	type		-	single-phase	
	frequency		Hz	50	
Electrical power absorption	nominal		kW	0,84 (4)	0,77 (4)
	minimum		kW	-	0,45 (4)
Degree of protection	IP		-	25	
Installation data					
Gas consumption	G20 natural gas (nominal)		m^3/h	2,79	
	G25 (nominal)		m^3/h	3,25	
	G25.1 (nominal)		m^3/h	3,25	
	G25.3 (nominal)		m^3/h	3,13	
	G27 (nominal)		m^3/h	3,41	
	G2.350 (nominal)		m^3/h	3,92	
	G30 (nominal)		kg/h	2,09	
	G31 (nominal)		kg/h	2,05	
NO_x emission class			-	6	
Sound power L_W (max)			dB(A)	79,6 (5)	74,0 (5)
Sound power L_W (min)			dB(A)	-	71,0 (5)

(1) In transient operation, lower temperatures are allowed.
(2) For flows other than nominal see Design Manual, Pressure losses Paragraph.
(3) As an option, a version for operation down to -30 °C is available.
(4) ±10% depending on power voltage and absorption tolerance of electric motors.
(5) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614. Data referred to 50 °C outlet temperature.
(6) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614. Data referred to 50 °C outlet temperature.
(7) Overall dimensions excluding flue gas exhaust.
(8) Tolerance ±5%.

				GAHP A Plus	GAHP A Plus S1
sound pressure L_p at 5 metres (max)			dB(A)	57,6 (6)	52,0 (6)
sound pressure L_p at 5 metres (min)			dB(A)	-	49,0 (6)
minimum storage temperature			°C	-30	
maximum water pressure in operation			bar	4,0	
maximum condensate flow			l/h	4,2	
water content inside the appliance			l	4	
Water fitting	type		-	F	
	thread		"	1 1/4	
Gas connection	type		-	F	
	thread		"	3/4	
Flue gas exhaust	diameter (Ø)		mm	80	
	residual head		Pa	90	
type of installation			-	B23P, B33, B53P	
Dimensions	width		mm	904 (7)	
	depth		mm	1264	
	height		mm	1446 (7)	1523
	Packing	width	mm	930	
		height	mm	1489	1523
		depth	mm	1300	
Weight	in operation		kg	356	367
	gross (including packaging)		kg	353	364
Maximum air flow of the fan			m^3/h	11000	
fan residual head			Pa	-	40
General information					
Refrigerating fluid (8)	ammonia R717		kg	7,5	
	water H_2O		kg	10,0	
maximum pressure of the refrigerating circuit			bar	32	

(1) In transient operation, lower temperatures are allowed.
(2) For flows other than nominal see Design Manual, Pressure losses Paragraph.
(3) As an option, a version for operation down to -30 °C is available.
(4) ±10% depending on power voltage and absorption tolerance of electric motors.
(5) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614. Data referred to 50 °C outlet temperature.
(6) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614. Data referred to 50 °C outlet temperature.
(7) Overall dimensions excluding flue gas exhaust.
(8) Tolerance ±5%.

2.4.1 Pressure drops

Table 2.2 *GAHP A Plus pressure drops*

Hot water flow	Heat transfer fluid temperature at outlet		
	35 °C	50 °C	60 °C
	bar	bar	bar
2000 l/h	0,23	0,21	0,19
2500 l/h	0,33	0,31	0,29
3000 l/h	0,46	0,43	0,40
4000 l/h	0,78	0,72	0,67

2.4.2 Performances

Table 2.3 *p. 5* shows the heat output at full load and stable operation, depending on the hot water delivery temperature to the system and outdoor temperature.

Table 2.3 *GAHP A Plus heat output*

Outdoor temperature	Water delivery temperature							
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C	70 °C (1)
	kW	kW	kW	kW	kW	kW	kW	kW
-22 °C	34,8	32,8	30,7	28,7	26,8	25,4	23,9	-
-20 °C	35,2	33,2	31,1	29,1	27,2	25,7	24,2	-
-15 °C	36,1	34,1	32,0	30,1	28,2	26,5	24,7	-
-14 °C	36,3	34,3	32,2	30,3	28,4	26,6	24,9	-
-13 °C	36,6	34,5	32,4	30,5	28,7	26,8	25,0	-
-12 °C	36,8	34,7	32,6	30,7	28,9	27,0	25,1	-
-11 °C	37,1	35,0	32,9	31,0	29,1	27,2	25,3	-
-10 °C	37,6	35,4	33,3	31,3	29,4	27,4	25,5	-
-9 °C	38,1	36,0	33,9	31,8	29,8	27,8	25,8	-
-8 °C	40,3	38,3	36,3	33,5	30,8	28,7	26,7	-
-7 °C	41,3	39,2	37,1	34,3	31,5	29,4	27,3	11,8
-6 °C	41,9	39,7	37,6	34,8	32,0	29,8	27,6	11,9
-5 °C	42,2	40,2	38,1	35,2	32,4	30,1	27,9	12,0
-4 °C	42,5	40,5	38,5	35,7	32,9	30,5	28,2	12,0
-3 °C	42,9	40,9	38,9	36,2	33,4	30,9	28,5	12,1
-2 °C	43,2	41,2	39,3	36,5	33,7	31,2	28,7	12,2

(1) Thermal input reduced to 50%

Outdoor temperature	Water delivery temperature							
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C	70 °C (1)
	kW	kW	kW	kW	kW	kW	kW	kW
-1 °C	43,4	41,6	39,7	37,0	34,2	31,6	29,0	12,3
0 °C	43,7	41,9	40,1	37,4	34,7	32,0	29,3	12,3
1 °C	41,6	41,0	40,4	37,8	35,2	32,4	29,6	12,4
2 °C	44,2	42,5	40,8	38,2	35,6	32,8	29,9	12,5
3 °C	44,4	42,8	41,2	38,7	36,1	33,2	30,3	12,6
4 °C	44,5	43,0	41,5	39,1	36,7	33,7	30,8	12,7
5 °C	44,6	43,2	41,8	39,5	37,3	34,3	31,4	12,8
6 °C	44,6	43,3	42,0	39,9	37,8	34,9	32,0	13,0
7 °C	44,6	43,4	42,3	40,3	38,4	35,4	32,5	13,1
8 °C	44,6	43,5	42,4	40,6	38,8	35,9	33,0	13,3
9 °C	44,6	43,6	42,5	40,9	39,3	36,4	33,5	13,5
10 °C	44,7	43,6	42,5	41,1	39,7	36,8	34,0	13,6
11 °C	44,7	43,6	42,6	41,3	40,0	37,2	34,4	13,8
12 °C	44,7	43,7	42,6	41,5	40,3	37,6	34,8	13,9
13 °C	44,7	43,7	42,7	41,6	40,5	37,9	35,2	14,0
14 °C	44,7	43,7	42,7	41,7	40,6	38,1	35,6	14,1
15 °C	44,7	43,8	42,8	41,8	40,8	38,4	36,0	14,2
20 °C	44,7	43,9	43,0	42,2	41,3	39,5	37,7	14,6
25 °C	44,7	43,9	43,2	42,4	41,6	40,3	39,0	15,0
30 °C	44,7	43,9	43,2	42,5	41,9	40,8	39,8	15,1
35 °C	44,7	43,9	43,2	42,5	41,9	41,1	40,3	15,2

(1) Thermal input reduced to 50%

Table 2.4 *p. 6* shows the GUE at full load and stable operation, depending on the hot water delivery temperature to the system and outdoor temperature.

Table 2.4 *GUE GAHP A Plus*

Outdoor temperature	Water delivery temperature							
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C	70 °C (1)
-22 °C	134	126	118	111	103	98	92	-
-20 °C	136	128	120	112	105	99	93	-
-15 °C	139	131	123	116	108	102	95	-
-14 °C	140	132	124	117	109	102	96	-
-13 °C	141	133	125	117	110	103	96	-
-12 °C	142	134	126	118	111	104	97	-
-11 °C	143	135	127	119	112	105	97	-
-10 °C	145	136	128	121	113	106	98	-
-9 °C	147	138	130	122	115	107	99	-
-8 °C	155	147	140	129	118	111	103	-
-7 °C	159	151	143	132	121	113	105	91
-6 °C	161	153	145	134	123	115	106	92
-5 °C	162	154	147	136	125	116	107	92
-4 °C	164	156	148	137	126	117	108	93
-3 °C	165	157	150	139	128	119	110	93
-2 °C	166	159	151	141	130	120	111	94
-1 °C	167	160	153	142	132	122	112	94
0 °C	168	161	154	144	134	123	113	95
1 °C	160	158	156	145	135	124	114	95
2 °C	170	164	157	147	137	126	115	96
3 °C	171	165	159	149	139	128	117	97
4 °C	171	166	160	150	141	130	119	98
5 °C	171	166	161	152	143	132	121	99
6 °C	172	167	162	154	146	134	123	100
7 °C	172	167	163	155	148	136	125	101
8 °C	172	167	163	156	149	138	127	102
9 °C	172	168	163	157	151	140	129	104
10 °C	172	168	164	158	153	142	131	105
11 °C	172	168	164	159	154	143	132	106
12 °C	172	168	164	160	155	145	134	107
13 °C	172	168	164	160	156	146	136	108
14 °C	172	168	164	160	156	147	137	109
15 °C	172	168	165	161	157	148	138	109
20 °C	172	169	166	162	159	152	145	112

(1) Thermal input reduced to 50%

Outdoor temperature	Water delivery temperature							
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C	70 °C (1)
25 °C	172	169	166	163	160	155	150	115
30 °C	172	169	166	164	161	157	153	116
35 °C	172	169	166	164	161	158	155	117

(1) Thermal input reduced to 50%

Please consider that, according to the actual heating load, the appliance may often need to operate under partial load conditions and in non-stationary operation.

3 DESIGN

Compliance with installation standards

Design and installation must comply with applicable regulations in force, based on the installation Country and site, in matters of safety, design, implementation and maintenance of:

- heating systems
- cooling systems
- gas systems
- flue gas exhaust
- flue gas condensate drain

Design and installation must also comply with the manufacturer's provisions.

3.1 APPLIANCE POSITIONING

Please refer to Section C01.02.

3.2 PLUMBING DESIGN

Please refer to Section C01.03.

3.3 WATER PUMP

The circulation pump (flow and head) must be selected and installed based on pressure drops of plumbing/primary circuit (piping + components + exchange terminals + appliance).
For the appliance's pressure drops refer to Table 2.2 *p. 5*.

Please refer to Section C01.04 for the characteristics of the pumps available as Robur optional.

3.4 SYSTEM WATER QUALITY

Please refer to Section C01.05.

3.5 ANTIFREEZE PROTECTION

Please refer to Section C01.06.

3.6 FUEL GAS SUPPLY

Please refer to Section C01.08.

3.7 FLUE GAS EXHAUST

Compliance with standards

The appliance is approved for connection to a combustion products exhaust duct for the types shown in Table 2.1 *p. 4*.

3.7.1 Flue gas exhaust connection

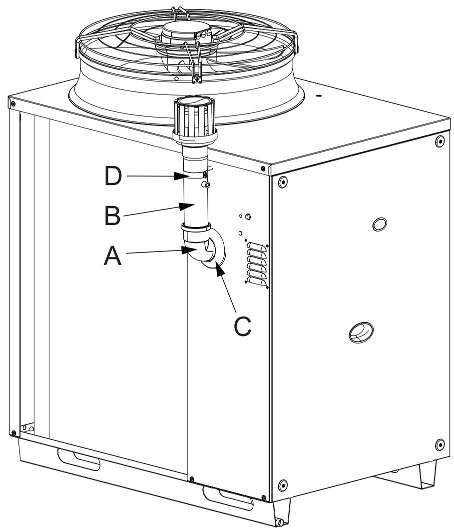
Ø 80 mm (with gasket), on the left, at the top (Figure 3.1 *p. 7*).

3.7.2 Flue gas exhaust kit

The appliance is supplied with flue gas exhaust kit, to be fitted by the installer, including (Figure 3.1 *p. 7*):

1. pipe Ø 80 mm, length 300 mm, with terminal and socket for flue gas analysis
1. support collar
1. 90° elbow Ø 80 mm
1. rain cover

Figure 3.1 *Flue gas exhaust*



A	90° elbow Ø 80 mm	C	Rain cover
B	Pipe Ø 80 mm, length 300 mm, with terminal	D	Collar

3.7.3 Possible flue

If required, the appliance may be connected to a flue appropriate for condensing appliances.

For more details see Section C01.09.

3.8 FLUE GAS CONDENSATE DRAIN

Please refer to Section C01.09.

3.9 ELECTRICAL AND CONTROL CONNECTIONS

Please refer to Section C01.10.

3.10 EXAMPLE DIAGRAMS

Please refer to Section C01.13.

3.11 ACOUSTIC

Please refer to Section C01.14.

1 SPECIFICATION OF SUPPLY

1.1 GAHP AR PLUS

Water-ammonia absorption heat pump, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version, modulating down to 46% of the nominal heat input, reversible, for hot water production up to an outlet temperature of 60 °C (65 °C at 50% of maximum thermal input) and alternatively cold water down to an outlet temperature of 3 °C, for outdoor installation.
Nominal heat output (A7W35): 38,8 kW
GUE efficiency (A7W35): 154 %
Nominal cooling output (A35W7): 16,9 kW
Heat input: 25,2 kW
Electrical power absorption nominal: 0,84 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 363 kg
Dimensions: width 918 mm, depth 1266 mm, height 1446 mm

1.2 GAHP AR PLUS S1

Water-ammonia absorption heat pump with low-noise brushless modulating fan, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version, modulating down to 46% of the nominal heat input, reversible, for hot water production up to an outlet temperature of 60 °C (65 °C at 50% of maximum thermal input) and alternatively cold water down to an outlet temperature of 3 °C, for outdoor installation.
Nominal heat output (A7W35): 38,8 kW
GUE efficiency (A7W35): 154 %
Nominal cooling output (A35W7): 16,9 kW
Heat input: 25,2 kW
Electrical power absorption nominal: 0,77 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 74,0 dB(A)
Sound power Lw (min): 71,0 dB(A)
Weight: 374 kg
Dimensions: width 918 mm, depth 1266 mm, height 1523 mm

2 FEATURES AND TECHNICAL DATA

2.1 FEATURES

2.1.1 Mechanical and thermo-hydraulic components

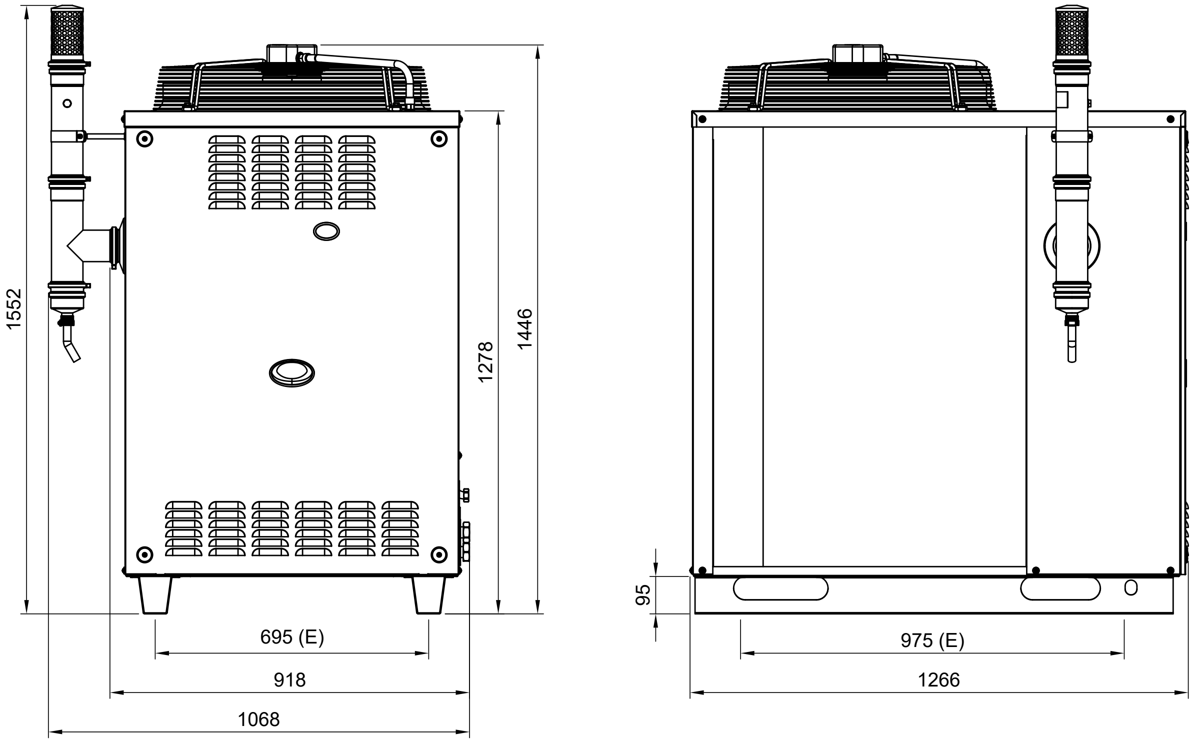
- Steel sealed circuit, externally treated with epoxy paint.
- Sealed combustion chamber (type C) suitable for outdoor installations.
- Metal mesh radiant burner, equipped with ignition electrodes and flame detection, managed by an electronic flame control box.
- Titanium stainless steel shell-and-tube water heat exchanger, externally insulated.
- Air exchanger with finned coil, with steel pipe and aluminium fins.
- Inversion valve on the cooling circuit, for use of the appliance in heating or cooling mode.
- Automatic microprocessor-controlled finned coil defrosting valve.
- Low power consumption refrigerant fluid oil pump.
- Modulating premix burner group from 100% to 46% of the nominal heat input.
- Standard or S1 low-noise fan (low power consumption and low noise emission).

2.1.2 Control and safety devices

- Electronic board featuring a microprocessor, LCD, and knob.
- System water flowmeter.
- Generator limit thermostat, with manual reset.
- Generator fins temperature probe.
- Sealed circuit safety relief valve.
- Bypass valve, between high and low-pressure circuits.
- Ionization flame control box.
- Double shutter electric gas valve.

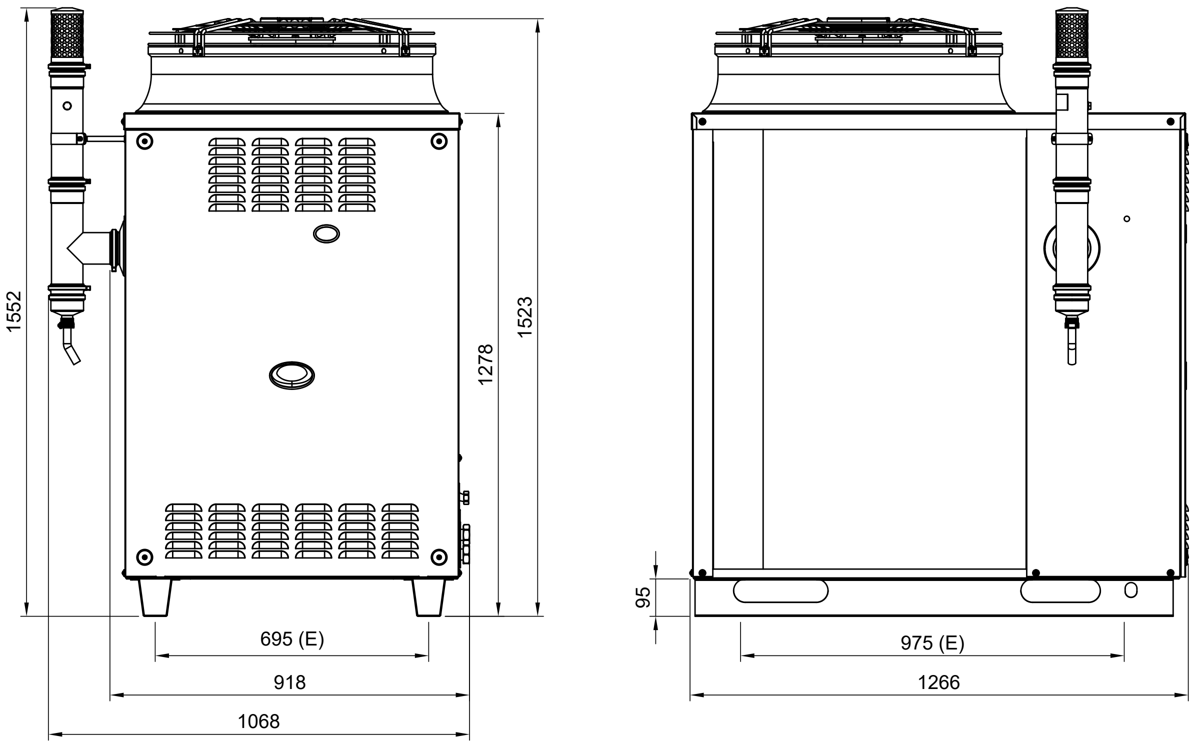
2.2 DIMENSIONS

Figure 2.1 *Dimensions (standard fan)*



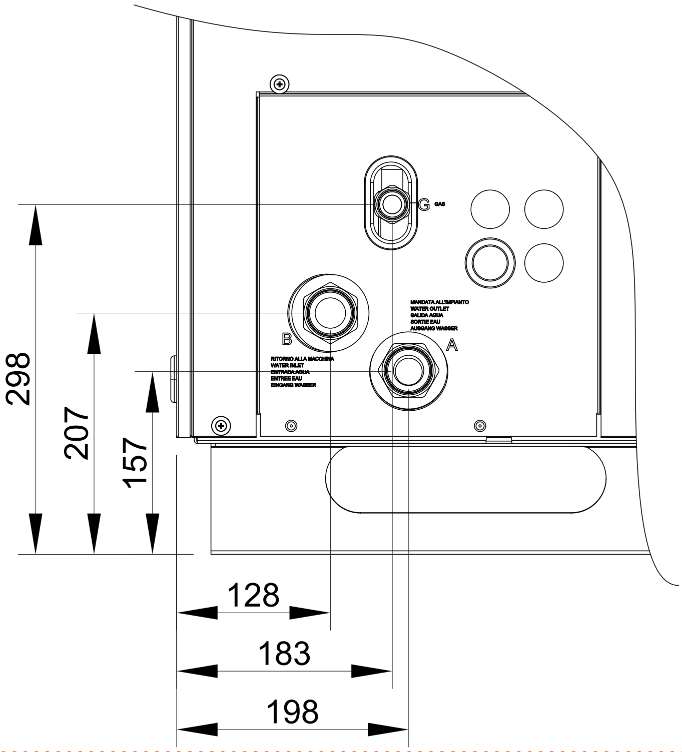
E Centre distance of holes for vibration damper supports

Figure 2.2 *Dimensions (low-noise fan)*



E Centre distance of holes for vibration damper supports

Figure 2.3 *Service plate - Hydraulic/gas connections detail*



G Gas connection Ø 3/4" F
B Water inlet connection Ø 1 1/4" F
A Water outlet connection Ø 1 1/4" F

2.3 CONTROLS

Control device

The appliance may only work if it is connected to a control device, selected from:

- ► DDC panel
- ► External request

2.3.1 DDC panel

The DDC control panel can manage one or more Robur appliances in modulating mode (GA heat pumps, GAHP boilers) or ON/OFF mode (AY chillers).
DDC control panel 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 water pumps,...).

For more details see Section C01.11.

2.3.2 External request

The appliance can also be controlled by a generic request device (e.g. thermostat, timer, switch, contactor...) fitted with a voltage-free NO contact. This system only allows basic control (on/off, with a fixed setpoint temperature), thus lacking essential system functions of the DDC control panel. We recommend using it only for simple applications and with a single appliance.

2.4 TECHNICAL DATA

Table 2.1 *GAHP AR Plus technical data*

				GAHP AR Plus	GAHP AR Plus S1
Heating mode					
Seasonal space heating energy efficiency class (ErP)	medium-temperature application (55 °C)		-	A+	
	low-temperature application (35 °C)		-	A	A+
Nominal heat output	Outdoor temperature/Water outlet temperature	A7W35	kW	38,8	
GUE efficiency	Outdoor temperature/Water outlet temperature	A7W35	%	154	
Heat input	nominal (1013 mbar - 15 °C)		kW	25,7	
	real		kW	25,2	

(1) In transient operation, lower temperatures are allowed.
(2) For flows other than nominal see Design Manual, Pressure losses Paragraph.
(3) As an option, a version for operation down to -30 °C is available.
(4) To be set (on demand) during the first start-up. Default Minimum Temperature = 4,5 °C.
(5) ±10% depending on power voltage and absorption tolerance of electric motors.
(6) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614.
(7) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614. Data referred to 50 °C outlet temperature.
(8) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614. Data referred to 50 °C outlet temperature.
(9) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614.
(10) Overall dimensions excluding flue gas exhaust.
(11) Tolerance ±5%.

				GAHP AR Plus	GAHP AR Plus S1
Hot water outlet temperature	maximum for heating		°C	60	
	maximum for DHW		°C	65	
Hot water inlet temperature	maximum for heating		°C	50	
	maximum for DHW		°C	60	
	minimum temperature in continuous operation		°C	30 (1)	
Heating water flow	nominal		l/h	3040	
	maximum		l/h	3500	
	minimum		l/h	2500	
Water pressure drop in heating mode	at nominal water flow		bar	0,29 (2)	
Outdoor temperature (dry bulb)	maximum		°C	40	
	minimum		°C	-15 (3)	
Cooling mode					
Nominal cooling output	Outdoor temperature/Water outlet temperature	A35W7	kW	16,9	
GUE efficiency	Outdoor temperature/Water outlet temperature	A35W7	%	67	
Cold water temperature (outlet)	minimum		°C	3 (4)	
Cold water temperature (inlet)	maximum		°C	45	
	minimum		°C	8	
Cold water flow	nominal		l/h	2900	
	maximum		l/h	3500	
	minimum		l/h	2500	
Internal pressure drop	at nominal water flow		bar	0,31 (2)	
Outdoor temperature	maximum		°C	45	
	minimum		°C	0	
Electrical specifications					
Power supply	voltage		V	230	
	type		-	single-phase	
	frequency		Hz	50	
Electrical power absorption	nominal		kW	0,84	0,77 (5)
	minimum		kW	-	0,50 (5)
Degree of protection	IP		-	25	
Installation data					
Gas consumption	G20 natural gas (nominal)		m^3/h	2,72	
	G25 (nominal)		m^3/h	3,16	
	G25.1 (nominal)		m^3/h	3,16	
	G25.3 (nominal)		m^3/h	3,09	
	G27 (nominal)		m^3/h	3,32	
	G2.350 (nominal)		m^3/h	3,78	
	G30 (nominal)		kg/h	2,03	
	G31 (nominal)		kg/h	2,00	
NO_x emission class			-	6	
Sound power L_W (max)			dB(A)	79,6 (6)	74,0 (7)
Sound power L_W (min)			dB(A)	-	71,0 (8)
sound pressure L_p at 5 metres (max)			dB(A)	57,6 (9)	52,0 (7)
sound pressure L_p at 5 metres (min)			dB(A)	-	49,0 (7)
maximum water pressure in operation			bar	4,0	
water content inside the appliance			l	3	
Water fitting	type		-	F	
	thread		"	1 1/4	
Gas connection	type		-	F	
	thread		"	3/4	
Flue gas exhaust	diameter (Ø)		mm	80	
	residual head		Pa	90	
type of installation			-	B23P, B33, B53P	

(1) In transient operation, lower temperatures are allowed.
(2) For flows other than nominal see Design Manual, Pressure losses Paragraph.
(3) As an option, a version for operation down to -30 °C is available.
(4) To be set (on demand) during the first start-up. Default Minimum Temperature = 4,5 °C.
(5) ±10% depending on power voltage and absorption tolerance of electric motors.
(6) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614.
(7) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614. Data referred to 50 °C outlet temperature.
(8) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614. Data referred to 50 °C outlet temperature.
(9) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614.
(10) Overall dimensions excluding flue gas exhaust.
(11) Tolerance ±5%.

				GAHP AR Plus	GAHP AR Plus S1
Dimensions	width		mm	918 (10)	
	depth		mm	1266	
	height		mm	1446 (10)	1523 (10)
	Packing	width	mm	930	
		height	mm	1446	1523
		depth	mm	1300	
Weight	in operation		kg	363	374
	gross (including packaging)		kg	361	372
Maximum air flow of the fan			m^3/h	11000	
fan residual head			Pa	-	40
General information					
Refrigerating fluid (11)	ammonia R717		kg	7,6	
	water H_2O		kg	10,0	
maximum pressure of the refrigerating circuit			bar	32	

(1) In transient operation, lower temperatures are allowed.
(2) For flows other than nominal see Design Manual, Pressure losses Paragraph.
(3) As an option, a version for operation down to -30 °C is available.
(4) To be set (on demand) during the first start-up. Default Minimum Temperature = 4,5 °C.
(5) ±10% depending on power voltage and absorption tolerance of electric motors.
(6) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614.
(7) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614. Data referred to 50 °C outlet temperature.
(8) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614. Data referred to 50 °C outlet temperature.
(9) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614.
(10) Overall dimensions excluding flue gas exhaust.
(11) Tolerance ±5%.

2.4.1 Pressure drops

2.4.1.1 Heating

Table 2.2 *GAHP AR Plus pressure drops in heating mode*

Hot water flow	Heat transfer fluid temperature at outlet		
	35 °C	50 °C	60 °C
	bar	bar	bar
2500 l/h	0,22	0,21	0,20
3000 l/h	0,30	0,29	0,28
3500 l/h	0,40	0,38	-

2.4.1.2 Cooling

Table 2.3 *GAHP AR Plus pressure drops in cooling mode*

Cold water flow	Heat transfer fluid temperature at outlet		
	3 °C	7 °C	10 °C
	bar	bar	bar
2500 l/h	0,26	0,24	0,23
3000 l/h	0,35	0,33	0,32
3500 l/h	0,48	0,46	0,45

The data refer to operation with no glycol in water.

2.4.2 Performances

2.4.2.1 Heating

Table 2.4 *p. 5* shows the heat output at full load and stable operation, depending on the hot water delivery temperature to the system and outdoor temperature.

Table 2.4 *GAHP AR Plus heat output*

Outdoor temperature	Water delivery temperature						
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C (1)
	kW	kW	kW	kW	kW	kW	kW
-22 °C	26,2	25,5	24,7	24,6	24,4	-	-
-20 °C	26,8	26,0	25,2	25,0	24,8	-	-
-15 °C	28,2	27,3	26,4	26,0	25,7	-	-
-14 °C	28,5	27,5	26,6	26,2	25,9	-	-
-13 °C	28,8	27,8	26,9	26,5	26,0	-	-
-12 °C	29,1	28,1	27,1	26,7	26,3	-	-
-11 °C	29,4	28,4	27,4	27,0	26,5	-	-
-10 °C	29,7	28,8	27,8	27,3	26,7	26,5	-
-9 °C	30,4	29,4	28,3	27,8	27,2	27,0	-
-8 °C	31,1	30,0	28,8	28,3	27,7	27,5	-
-7 °C	31,8	30,6	29,5	28,9	28,2	28,0	10,0
-6 °C	32,2	31,1	30,1	29,3	28,6	28,2	10,1
-5 °C	32,7	31,7	30,6	29,8	29,0	28,5	10,1
-4 °C	33,1	32,2	31,2	30,3	29,3	28,7	10,2
-3 °C	33,5	32,7	31,8	30,7	29,7	28,9	10,3
-2 °C	34,0	33,2	32,4	31,2	30,0	29,1	10,4
-1 °C	34,4	33,7	33,0	31,7	30,3	29,3	10,5
0 °C	34,9	34,3	33,6	32,2	30,7	29,6	10,6
1 °C	35,4	34,8	34,2	32,7	31,1	29,9	10,7
2 °C	35,8	35,3	34,8	33,2	31,5	30,2	10,8
3 °C	36,3	35,8	35,4	33,7	32,0	30,7	10,9

(1) Thermal input reduced to 50%

Outdoor temperature	Water delivery temperature						
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C (1)
	kW	kW	kW	kW	kW	kW	kW
4 °C	37,0	36,5	36,0	34,3	32,5	31,2	11,1
5 °C	37,7	37,2	36,7	34,9	33,1	31,8	11,2
6 °C	38,3	37,8	37,3	35,5	33,7	32,5	11,4
7 °C	38,8	38,3	37,8	36,0	34,3	33,0	11,6
8 °C	39,2	38,7	38,2	36,4	34,7	33,5	11,8
9 °C	39,4	38,9	38,4	36,7	35,1	34,1	12,1
10 °C	39,6	39,1	38,6	37,0	35,5	34,6	12,3
11 °C	39,7	39,2	38,7	37,2	35,8	35,0	12,6
12 °C	39,8	39,3	38,8	37,4	36,0	35,3	12,7
13 °C	39,9	39,4	38,9	37,6	36,2	35,5	12,8
14 °C	40,0	39,5	39,0	37,7	36,5	35,7	12,9
15 °C	40,1	39,6	39,1	37,9	36,7	35,9	13,0
20 °C	40,3	39,8	39,3	38,3	37,3	36,5	13,2
25 °C	40,4	39,9	39,4	38,6	37,8	37,3	13,5
30 °C	40,6	40,1	39,6	38,8	38,1	37,5	13,6
35 °C	40,6	40,1	39,6	38,8	38,1	37,5	13,7

(1) Thermal input reduced to 50%

Table 2.5 *p. 6* shows the GUE at full load and stable operation in heating mode, depending on the hot water delivery temperature to the system and outdoor temperature.

Table 2.5 *GUE GAHP AR Plus in heating mode*

Outdoor temperature	Water delivery temperature						
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C (1)
-22 °C	104	101	98	98	97	-	-
-20 °C	106	103	100	99	99	-	-
-15 °C	112	108	105	103	102	-	-
-14 °C	113	109	106	104	103	-	-
-13 °C	114	110	107	105	103	-	-
-12 °C	115	112	108	106	104	-	-
-11 °C	117	113	109	107	105	-	-
-10 °C	118	114	110	108	106	105	-
-9 °C	121	117	112	110	108	107	-
-8 °C	123	119	114	112	110	109	-
-7 °C	126	122	117	115	112	111	79
-6 °C	128	124	119	116	114	112	80
-5 °C	130	126	122	118	115	113	81
-4 °C	131	128	124	120	116	114	81
-3 °C	133	130	126	122	118	115	82
-2 °C	135	132	129	124	119	116	83
-1 °C	137	134	131	126	120	116	84
0 °C	139	136	133	128	122	117	84
1 °C	140	138	136	130	123	119	85
2 °C	142	140	138	132	125	120	86
3 °C	144	142	140	134	127	122	87
4 °C	147	145	143	136	129	124	88
5 °C	150	148	146	139	132	126	89
6 °C	152	150	148	141	134	129	91
7 °C	154	152	150	143	136	131	92
8 °C	155	153	151	145	138	133	94
9 °C	156	154	152	146	139	135	96
10 °C	157	155	153	147	141	137	98
11 °C	158	156	154	148	142	139	100
12 °C	158	156	154	149	143	140	101
13 °C	158	156	154	149	144	141	102
14 °C	159	157	155	150	145	142	103
15 °C	159	157	155	150	146	142	103
20 °C	160	158	156	152	148	145	105
25 °C	161	159	157	153	150	148	107
30 °C	161	159	157	154	151	149	108
35 °C	161	159	157	154	151	149	109

(1) Thermal input reduced to 50%

Please consider that, according to the actual heating load, the appliance may often need to operate under partial load conditions and in non-stationary operation.

2.4.2.2 Cooling

Table 2.6 *p. 7* shows the cooling output at full load and in stable operation, depending on the cold water delivery temperature to the system and outdoor temperature.

Table 2.6 *GAHP AR Plus cooling output*

Outdoor temperature	Water delivery temperature	
	7 °C	10 °C
	kW	kW
30 °C	17,8	18,1
35 °C	16,9	17,4
40 °C	15,0	16,0
45 °C	-	13,5

Table 2.7 *p. 7* shows the GUE at full load and stable operation in cooling mode, depending on the cold water delivery temperature to the system and outdoor temperature.

Table 2.7 *GUE GAHP AR Plus in cooling mode*

Outdoor temperature	Water delivery temperature	
	7 °C	10 °C
	%	%
30 °C	71	72
35 °C	67	69
40 °C	60	63
45 °C	-	54

Please consider that, according to the actual cooling load, the appliance may often need to operate under partial load conditions and in non-stationary operation.

3 DESIGN

Compliance with installation standards

Design and installation must comply with applicable regulations in force, based on the installation Country and site, in matters of safety, design, implementation and maintenance of:

- heating systems
- cooling systems
- gas systems
- flue gas exhaust
- flue gas condensate drain

Design and installation must also comply with the manufacturer's provisions.

3.1 APPLIANCE POSITIONING

Please refer to Section C01.02.

3.2 PLUMBING DESIGN

Please refer to Section C01.03.

3.3 WATER PUMP

The circulation pump (flow and head) must be selected and installed based on pressure drops of plumbing/primary circuit (piping + components + exchange terminals + appliance).
For the appliance pressure drops refer to Table 2.2 *p. 5* (in heating mode) and to Table 2.3 *p. 5* (in cooling mode).

Please refer to Section C01.04 for the characteristics of the pumps available as Robur optional.

3.4 SYSTEM WATER QUALITY

Please refer to Section C01.05.

3.5 ANTIFREEZE PROTECTION

Please refer to Section C01.06.

3.6 FUEL GAS SUPPLY

Please refer to Section C01.08.

3.7 FLUE GAS EXHAUST

Compliance with standards

The appliance is approved for connection to a combustion products exhaust duct for the types shown in Table 2.1 *p. 3*.

3.7.1 Flue gas exhaust connection

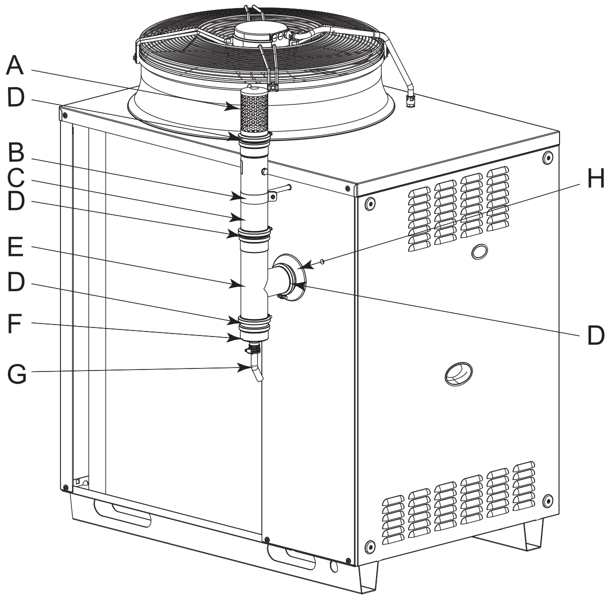
Ø 80 mm (with gasket), on the left, at the top (Figure 3.1 *p. 8*).

3.7.2 Flue gas exhaust kit

The appliance is supplied with flue gas exhaust kit, to be fitted by the installer, including (Figure 3.1 *p. 8*):

1. Ø 80 mm flue gas exhaust pipe, length 350 mm (C)
1. "T" connector (E)
1. condensate trap (F)
1. terminal (A)
1. clamp for fixing pipe (B) to left side panel
4. pipe clamps (D)
1. hose holder and condensate drain hose (G)

Figure 3.1 *Components of flue gas exhaust kit*



A	Terminal	E	T connector
B	Pipe clamp	F	Condensate trap
C	Flue gas exhaust pipe, length 350 mm	G	Hose adaptor + condensate drain pipe
D	Pipe clamp	H	Rain cover

3.7.3 Possible flue

If required, the appliance may be connected to a flue of appropriate type for non-condensing appliances.

For more details see Section C01.09.

3.8 FLUE GAS CONDENSATE DRAIN

Please refer to Section C01.09.

3.9 ELECTRICAL AND CONTROL CONNECTIONS

Please refer to Section C01.10.

3.10 EXAMPLE DIAGRAMS

Please refer to Section C01.13.

3.11 ACOUSTIC

Please refer to Section C01.14.

1 SPECIFICATION OF SUPPLY

1.1 GAHP GS PLUS OUTDOOR VERSION

Water-ammonia absorption heat pump, gas-fired with natural gas, LPG or natural gas/hydrogen mixtures up to 20%, brine-water version, modulating down to 28% of the nominal heat input, condensing, for alternate or simultaneous production of hot water up to an outlet temperature of 65 °C (70 °C at 50% of maximum thermal input) and cold water even at negative temperatures (minimum outlet temperature -5 °C), for outdoor installation.
Nominal heat output (B0W35): 43,0 kW
GUE efficiency (B0W35): 165 %
Power recovered from renewable source (B0W35): 16,9 kW
Heat input: 26,0 kW
Electrical power absorption nominal: 0,41 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 66,1 dB(A)
Weight: 287 kg
Dimensions: width 1056 mm, depth 729 mm, height 1280 mm

1.2 GAHP GS PLUS INDOOR VERSION

Water-ammonia absorption heat pump, gas-fired with natural gas, LPG or natural gas/hydrogen mixtures up to 20%, brine-water version, modulating down to 28% of the nominal heat input, condensing, for alternate or simultaneous production of hot water up to an outlet temperature of 65 °C (70 °C at 50% of maximum thermal input) and cold water even at negative temperatures (minimum outlet temperature -5 °C), for indoor installation.
Nominal heat output (B0W35): 43,0 kW
GUE efficiency (B0W35): 165 %
Power recovered from renewable source (B0W35): 16,9 kW
Heat input: 26,0 kW
Electrical power absorption nominal: 0,41 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 66,1 dB(A)
Weight: 287 kg
Dimensions: width 923 mm, depth 729 mm, height 1280 mm

1.3 GAHP WS PLUS OUTDOOR VERSION

Water-ammonia absorption heat pump, gas-fired with natural gas, LPG or natural gas/hydrogen mixtures up to 20%, water-water version, modulating down to 28% of the nominal heat input, condensing, for alternate or simultaneous production of hot water up to an outlet temperature of 65 °C (70 °C at 50% of maximum thermal input) and cold water down to an outlet temperature of 3 °C, for outdoor installation.
Nominal heat output (W10W35): 45,3 kW
GUE efficiency (W10W35): 174 %
Power recovered from renewable source (W10W35): 19,3 kW
Heat input: 26,0 kW
Electrical power absorption nominal: 0,41 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 66,1 dB(A)
Weight: 287 kg
Dimensions: width 1056 mm, depth 729 mm, height 1280 mm

1.4 GAHP WS PLUS INDOOR VERSION

Water-ammonia absorption heat pump, gas-fired with natural gas, LPG or natural gas/hydrogen mixtures up to 20%, water-water version, modulating down to 28% of the nominal heat input, condensing, for alternate or simultaneous production of hot water up to an outlet temperature of 65 °C (70 °C at 50% of maximum thermal input) and cold water down to an outlet temperature of 3 °C, for indoor installation.
Nominal heat output (W10W35): 45,3 kW
GUE efficiency (W10W35): 174 %
Power recovered from renewable source (W10W35): 19,3 kW
Heat input: 26,0 kW
Electrical power absorption nominal: 0,41 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 66,1 dB(A)
Weight: 287 kg
Dimensions: width 923 mm, depth 729 mm, height 1280 mm

2 FEATURES AND TECHNICAL DATA

2.1 FEATURES

2.1.1 Mechanical and thermo-hydraulic components

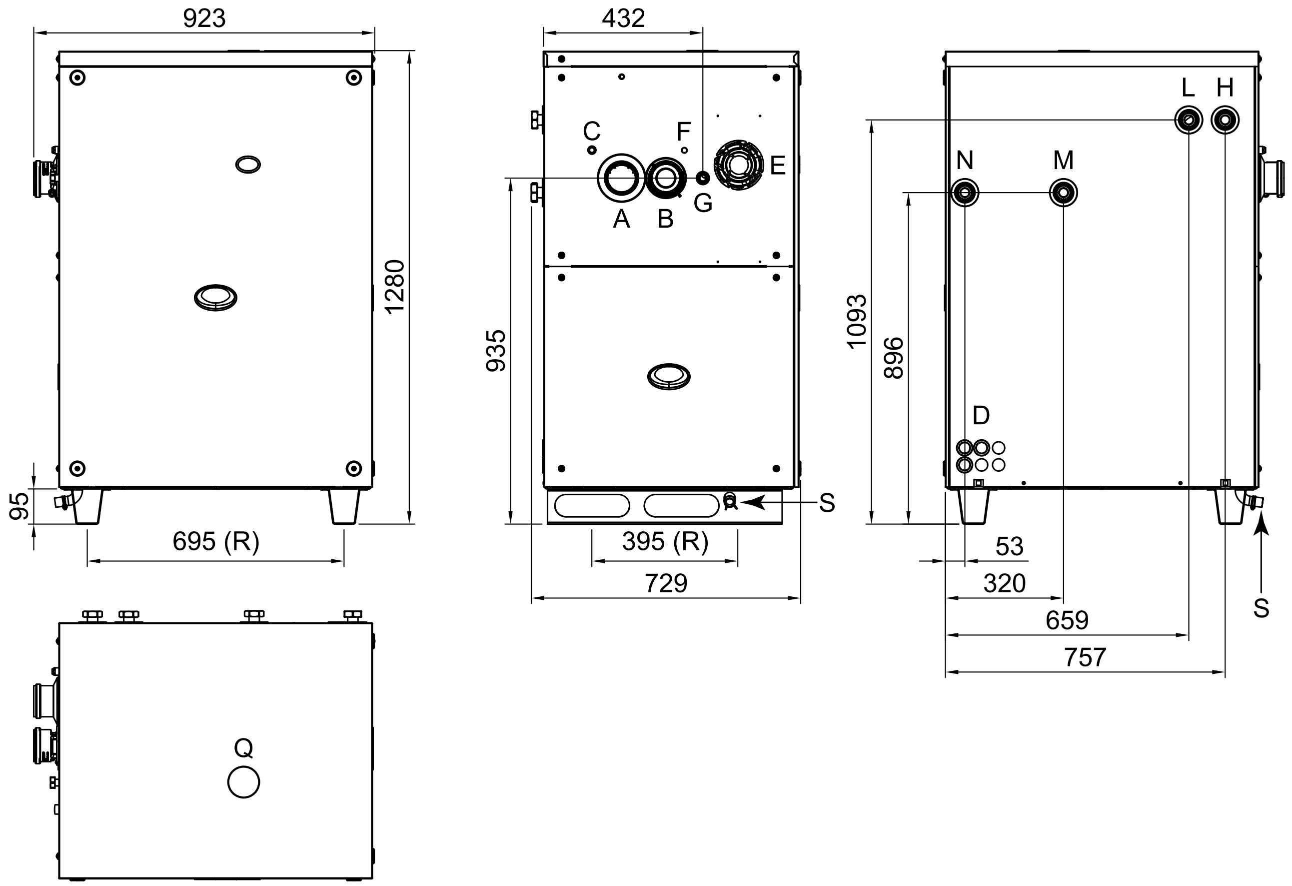
- Steel sealed circuit, externally treated with epoxy paint.
- Sealed combustion chamber (type C) suitable for outdoor installations.
- Metal mesh radiant burner, equipped with ignition electrodes and flame detection, managed by an electronic flame control box.
- Titanium stainless steel shell-and-tube water exchanger (condenser), externally insulated.
- Titanium stainless steel shell-and-tube water exchanger (evaporator), externally insulated.
- Low power consumption refrigerant fluid oil pump.
- Modulating premix burner group from 100% to 28% of the nominal heat input.
- Stainless steel, shell-and-tube recovery exchanger of flue gas latent heat.

2.1.2 Control and safety devices

- Electronic board featuring a microprocessor, LCD, and knob.
- Installation water flow meter (hot side).
- Installation water flow switch (cold side).
- Generator limit thermostat, with manual reset.
- Flue gas thermostat, with manual reset.
- Generator fins temperature probe.
- Sealed circuit safety relief valve.
- Bypass valve, between high and low-pressure circuits.
- Ionization flame control box.
- Double shutter electric gas valve.
- Condensate drain obstruction sensor.

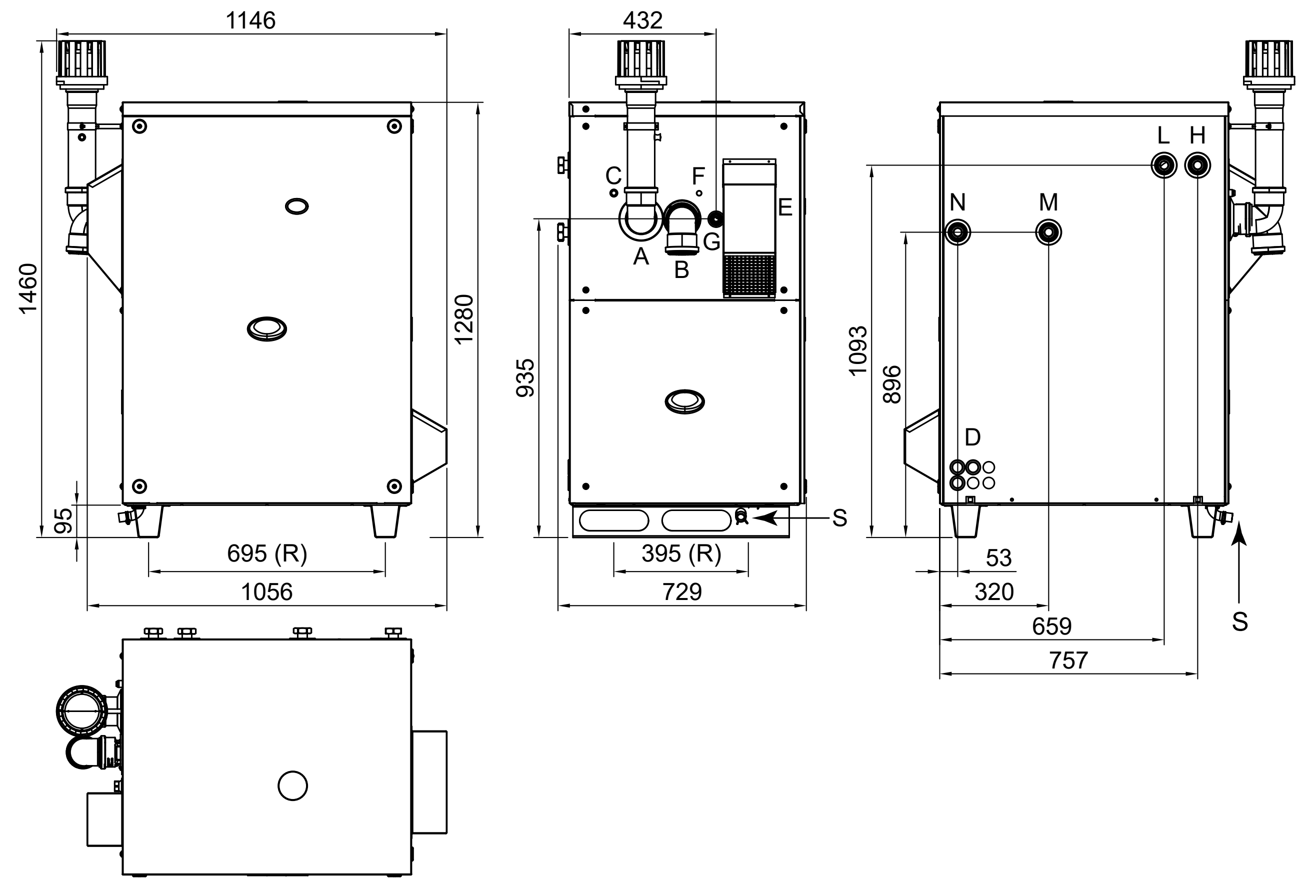
2.2 DIMENSIONS

Figure 2.1 *Indoor GAHP GS/WS Plus dimensions*



A	Flue gas outlet Ø 80 mm		F	Burner on warning light		N	Hot water outlet Ø 1 1/4" F
B	Combustion air intake Ø 80 mm		G	Gas connection Ø 3/4" F		Q	Safety valve drain ducting Ø 1 1/4"
C	Fumes thermostat manual reset		H	Hot water inlet Ø 1 1/4" F		R	Centre distance of holes for vibration damper supports
D	Power supply cables input		L	Renewable source water inlet Ø 1 1/4" F			
E	Ventilation fan		M	Renewable source water outlet Ø 1 1/4" F		S	Condensate drain connection

Figure 2.2 *Outdoor GAHP GS/WS Plus dimensions*



A	Flue gas outlet Ø 80 mm	F	Burner on warning light	N	Hot water outlet Ø 1 1/4" F
B	Combustion air intake Ø 80 mm	G	Gas connection Ø 3/4" F	R	Centre distance of holes for vibration damper supports
C	Fumes thermostat manual reset	H	Hot water inlet Ø 1 1/4" F	S	Condensate drain connection
D	Power supply cables input	L	Renewable source water inlet Ø 1 1/4" F		
E	Ventilation fan	M	Renewable source water outlet Ø 1 1/4" F		

2.3 CONTROLS

Control device

The appliance may only work if it is connected to a control device, selected from:

- ► DDC panel
- ► CCI panel
- ► External request

2.3.1 DDC panel

The DDC control panel can manage one or more Robur appliances in modulating mode (GA heat pumps, GAHP boilers) or ON/OFF mode (AY chillers).
DDC control panel 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 water pumps,...).

For more details see Section C01.11.

2.3.2 CCI panel

The CCI control panel can manage up to 3 GAHP appliances in modulating mode (i.e. only GAHP A Plus/GAHP GS/WS Plus for heating only).

For more details see Section C01.11.

2.3.3 External request

The appliance can also be controlled by a generic request device (e.g. thermostat, timer, switch, contactor...) fitted with a voltage-free NO contact. This system only allows basic control (on/off, with a fixed setpoint temperature), thus lacking essential system functions of the DDC control panel. We recommend using it only for simple applications and with a single appliance. There are two control options: either a heating request or a cooling request.

2.4 TECHNICAL DATA

Table 2.1 *GAHP GS/WS Plus technical data*

				GAHP GS Plus	GAHP WS Plus
Heating mode					
Seasonal space heating energy efficiency class (ErP)	medium-temperature application (55 °C)		-	A++	
	low-temperature application (35 °C)		-	A+	
Nominal heat output	Evaporator inlet temperature/Delivery temperature	B0W35	kW	43,0	-
		W10W35	kW	-	45,3
GUE efficiency	Evaporator inlet temperature/Delivery temperature	B0W35	%	165	-
		W10W35	%	-	174
Heat input	nominal (1013 mbar - 15 °C)		kW	26,4	
	real		kW	26,0	
Hot water outlet temperature	maximum for heating		°C	65	
	maximum for DHW		°C	70	
Hot water inlet temperature	maximum for heating		°C	55	
	maximum for DHW		°C	60	
	minimum temperature in continuous operation		°C	30 (1)	
Heating water flow	nominal (B0W35)		l/h	3000	-
	nominal (W10W35)		l/h	-	3200
	maximum		l/h	4000	
	minimum		l/h	2000	
Water pressure drop in heating mode	at nominal water flow		bar	0,46 (2)	0,52 (2)
Outdoor temperature (dry bulb)	maximum		°C	45	
	minimum		°C	0 (3)	
Renewable source operating conditions					
Power recovered from renewable source	Evaporator inlet temperature/Delivery temperature	B0W35	kW	16,9	-
		W10W35	kW	-	19,3
Renewable source water return temperature	maximum		°C	45	
Renewable source delivery water temperature	minimum		°C	-5	3
Renewable source water flow (with 25% glycol)	nominal (B0W35)		l/h	3020	-
	maximum		l/h	4000	-
	minimum		l/h	2000	-
Renewable source water flow	nominal (W10W35)		l/h	-	2850
	maximum		l/h	-	4700
	minimum		l/h	-	2300
Renewable source pressure drop	at nominal water flow		bar	0,57 (2)	0,40 (2)
Electrical specifications					
Power supply	voltage		V	230	
	type		-	single-phase	
	frequency		Hz	50	
Electrical power absorption	nominal		kW	0,41 (4)	
Degree of protection	IP		-	25	
Installation data					
Gas consumption	G20 natural gas (nominal)		m^3/h	2,79	
	G25 (nominal)		m^3/h	3,25	
	G25.1 (nominal)		m^3/h	3,25	
	G25.3 (nominal)		m^3/h	3,13	
	G27 (nominal)		m^3/h	3,41	
	G2.350 (nominal)		m^3/h	3,92	
	G30 (nominal)		kg/h	2,09	
	G31 (nominal)		kg/h	2,05	
NO_x emission class			-	6	
Sound power L_w (max)			dB(A)	66,1 (5)	
sound pressure L_p at 5 metres (max)			dB(A)	44,1 (6)	
minimum storage temperature			°C	-30	
maximum water pressure in operation			bar	4,0	

(1) In transient operation, lower temperatures are allowed.
(2) For flows other than nominal see Design Manual, Pressure losses Paragraph.
(3) Data referred to the indoor version. For the outdoor version, the minimum ambient air temperature is -15 °C. A special outdoor version is available as an option for operation down to -30 °C.
(4) ±10% depending on power voltage and absorption tolerance of electric motors.
(5) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614; C type installation.
(6) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614; C type installation.
(7) Indoor version only.
(8) Overall dimensions excluding flue gas exhaust. Width indoor version 923 mm.
(9) Overall dimensions excluding flue gas exhaust.
(10) Packaging width for the indoor version is 934 mm.
(11) Packaging height for the indoor version is 1280 mm.
(12) Packaging depth for the indoor version is 746 mm.
(13) Weight of indoor version 307 kg.
(14) Weight of indoor version 301 kg.
(15) Tolerance ±5%.

				GAHP GS Plus	GAHP WS Plus
maximum condensate flow			l/h	4,2	
Water content inside the appliance	hot side		l	4	
	cold side		l	3	
Water fitting	type		-	F	
	thread		"	1 1/4	
Gas connection	type		-	F	
	thread		"	3/4	
safety valve drain ducting connection			"	1 1/4 (7)	
Flue gas exhaust	diameter (Ø)		mm	80	
	residual head		Pa	90	
type of installation			-	C13, C33, C43, C53, C63, C83, B23P, B33	
Dimensions	width		mm	1056 (8)	
	depth		mm	729	
	height		mm	1280 (9)	
	Packing	width	mm	1056 (10)	
		height	mm	1488 (11)	
		depth	mm	1056 (12)	
Weight	in operation		kg	287 (13)	
	gross (including packaging)		kg	281 (14)	
General information					
Refrigerating fluid (15)	ammonia R717		kg	7,0	6,8
	water H_2O		kg	10,0	
maximum pressure of the refrigerating circuit			bar	32	

(1) In transient operation, lower temperatures are allowed.
(2) For flows other than nominal see Design Manual, Pressure losses Paragraph.
(3) Data referred to the indoor version. For the outdoor version, the minimum ambient air temperature is -15 °C. A special outdoor version is available as an option for operation down to -30 °C.
(4) ±10% depending on power voltage and absorption tolerance of electric motors.
(5) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614; C type installation.
(6) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614; C type installation.
(7) Indoor version only.
(8) Overall dimensions excluding flue gas exhaust. Width indoor version 923 mm.
(9) Overall dimensions excluding flue gas exhaust.
(10) Packaging width for the indoor version is 934 mm.
(11) Packaging height for the indoor version is 1280 mm.
(12) Packaging depth for the indoor version is 746 mm.
(13) Weight of indoor version 307 kg.
(14) Weight of indoor version 301 kg.
(15) Tolerance ±5%.

2.4.1 Pressure drops

2.4.1.1 Condenser

Table 2.2 *p. 5* shows the pressure drop data on the condenser side for GAHP GS/WS Plus appliances.

Table 2.2 *GAHP GS/WS Plus pressure drops on the condenser side*

Hot water flow	Heat transfer fluid temperature at outlet		
	35 °C	50 °C	65 °C
	bar	bar	bar
2000 l/h	0,23	0,21	0,19
3000 l/h	0,46	0,43	0,38
3200 l/h	0,52	0,48	0,43
4000 l/h	0,78	0,72	0,64

2.4.1.2 Evaporator

Table 2.3 *p. 5* shows the pressure drop data on the evaporator side for the GAHP GS Plus appliance.

Table 2.3 *GAHP GS Plus pressure drops on the evaporator side*

Cold water flow	Heat transfer fluid temperature at outlet		
	-5 °C	0 °C	5 °C
	bar	bar	bar
2500 l/h	0,43	0,40	0,38
3000 l/h	0,57	0,54	0,52
3500 l/h	0,74	0,70	0,67

The data refer to operation with 25% glycol water.

Table 2.4 *p. 5* shows the pressure drop data on the evaporator side for the GAHP WS Plus appliance.

Table 2.4 *GAHP WS Plus pressure drops on the evaporator side*

Cold water flow	Heat transfer fluid temperature at outlet	
	3 °C	7 °C
	bar	bar
2500 l/h	0,31	0,30
3000 l/h	0,44	0,43
3500 l/h	0,60	0,58

The data refer to operation with no glycol in water.

2.4.2 Performances

2.4.2.1 Heating

Table 2.5 p. 6 shows the heat output at full load and stable operation, depending on the hot water outlet temperature to the system and the cold water inlet temperature from the renewable source for the GAHP GS Plus appliance.

Table 2.5 *GAHP GS Plus heat output*

Evaporator inlet water temperature	Water delivery temperature							
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C	70 °C (1)
	kW	kW	kW	kW	kW	kW	kW	kW
0 °C	43,0	41,7	40,3	38,8	36,7	34,6	32,4	14,0
5 °C	43,6	43,1	41,3	40,3	38,3	36,4	34,0	14,3
10 °C	43,7	43,1	42,3	41,3	39,6	38,3	36,4	16,0
15 °C	43,9	43,6	43,1	42,3	40,9	40,3	38,3	16,5

(1) Thermal input reduced to 50%

Data refer to the hot water delivery temperature to the system (condenser outlet).
Data refer to the cold water return temperature from the renewable source (evaporator inlet).

Table 2.6 p. 6 shows the GUE at full load and stable operation in heating mode, depending on the hot water outlet temperature to the system and the cold water inlet temperature from the renewable source, for the GAHP GS Plus appliance.

Table 2.6 *GUE GAHP GS Plus in heating mode*

Evaporator inlet water temperature	Water delivery temperature							
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C	70 °C (1)
	%	%	%	%	%	%	%	%
0 °C	165	161	155	149	141	133	125	108
5 °C	168	166	159	155	147	140	131	110
10 °C	168	166	163	159	152	147	140	123
15 °C	169	168	166	163	157	155	147	127

(1) Thermal input reduced to 50%

Table 2.7 p. 6 shows the heat output at full load and stable operation, depending on the hot water outlet temperature to the system and the cold water inlet temperature from the renewable source for the GAHP WS Plus appliance.

Table 2.7 *GAHP WS Plus heat output*

Evaporator inlet water temperature	Water delivery temperature							
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C	70 °C (1)
	kW	kW	kW	kW	kW	kW	kW	kW
10 °C	45,3	44,6	43,8	42,9	40,8	38,9	36,9	14,0
15 °C	45,3	44,9	44,4	43,9	41,9	40,0	38,1	14,6
20 °C	45,3	44,9	45,0	45,0	43,0	41,2	39,3	15,1
25 °C	45,3	44,9	45,0	45,0	44,1	42,3	40,5	15,6

(1) Thermal input reduced to 50%

Data refer to the hot water delivery temperature to the system (condenser outlet).
Data refer to the cold water return temperature from the renewable source (evaporator inlet).

Table 2.8 p. 6 shows the GUE at full load and stable operation in heating mode, depending on the hot water outlet temperature to the system and the cold water inlet temperature from the renewable source, for the GAHP WS Plus appliance.

Table 2.8 *GUE GAHP WS heating mode*

Evaporator inlet water temperature	Water delivery temperature							
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C	65 °C	70 °C (1)
	%	%	%	%	%	%	%	%
10 °C	174	172	168	165	157	150	142	108
15 °C	174	173	171	169	161	154	147	112
20 °C	174	173	173	173	166	158	151	116
25 °C	174	173	173	173	170	163	156	120

(1) Thermal input reduced to 50%

Please consider that, according to the actual heating load, the appliance may often need to operate under partial load conditions and in non-stationary operation.

2.4.2.2 Power recovered from renewable source

Cooling performance corresponds to the power recovered from the renewable energy source

In cooling mode, the return temperature from the system corresponds to the inlet temperature of the evaporator, while the water delivery temperature corresponds to the outlet temperature to the thermal energy dissipation system (geothermal probes or heat exchanger).

Table 2.9 p. 7 shows the power recovered from the renewable energy source at full load and stable operation, depending on the hot water outlet temperature to the system and the cold water inlet temperature from the renewable source for the GAHP GS Plus appliance.

Table 2.9 *Power recovered from renewable source GAHP GS Plus*

Evaporator inlet water temperature	Water delivery temperature					
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C
	kW	kW	kW	kW	kW	kW
12 °C	18,2	18,0	18,0	17,6	17,3	16,3
15 °C	18,5	18,3	18,2	18,1	17,8	17,1

Data refer to the hot water delivery temperature to the system (condenser outlet).
Data refer to the cold water return temperature from the renewable source (evaporator inlet).

Table 2.10 *p. 7* shows the GUE at full load and stable operation in cooling mode, depending on the cold water inlet temperature from the system and the hot water outlet temperature to the dissipation system, for the GAHP GS Plus appliance.

Table 2.10 *GUE GAHP GS Plus in cooling mode*

Evaporator inlet water temperature	Water delivery temperature					
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C
	%	%	%	%	%	%
12 °C	70	69	69	68	67	63
15 °C	71	70	70	69	69	66

Table 2.11 *p. 7* shows the power recovered from the renewable energy source at full load and stable operation, depending on the hot water outlet temperature to the system and the cold water inlet temperature from the renewable source for the GAHP WS Plus appliance.

Table 2.11 *Power recovered from renewable source GAHP WS Plus*

Evaporator inlet water temperature	Water delivery temperature					
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C
	kW	kW	kW	kW	kW	kW
12 °C	19,3	18,8	18,1	17,3	15,3	13,3
15 °C	19,3	19,0	18,5	18,0	15,9	14,0

Data refer to the hot water delivery temperature to the system (condenser outlet).
Data refer to the cold water return temperature from the renewable source (evaporator inlet).

Table 2.12 *p. 7* shows the GUE at full load and stable operation in cooling mode, depending on the cold water inlet temperature from the system and the hot water outlet temperature to the dissipation system, for the GAHP WS Plus appliance.

Table 2.12 *GUE GAHP WS Plus in cooling mode*

Evaporator inlet water temperature	Water delivery temperature					
	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C
	%	%	%	%	%	%
12 °C	74	72	69	67	59	51
15 °C	74	73	71	69	61	54

Please consider that, according to the actual heat exchange with the renewable source (or cooling load), the appliance may often operate under partial load conditions and in non-steady operation.

3 DESIGN

Compliance with installation standards

Design and installation must comply with applicable regulations in force, based on the installation Country and site, in matters of safety, design, implementation and maintenance of:

- heating systems
- cooling systems
- gas systems
- flue gas exhaust
- flue gas condensate drain

Design and installation must also comply with the manufacturer's provisions.

3.1 APPLIANCE POSITIONING

Please refer to Section C01.02.

3.2 PLUMBING DESIGN

Please refer to Section C01.03.

3.3 WATER PUMP

The circulation pump (flow and head) must be selected and installed based on pressure drops of plumbing/primary circuit (piping + components + exchange terminals + appliance).
For appliance pressure drops see Paragraph 2.4.1.1 *p. 5* (for condenser side) and Paragraph 2.4.1.2 *p. 5* (for evaporator side).

Please refer to Section C01.04 for the characteristics of the pumps available as Robur optional.

3.4 SYSTEM WATER QUALITY

Please refer to Section C01.05.

3.5 ANTIFREEZE PROTECTION

Please refer to Section C01.06.

3.6 FUEL GAS SUPPLY

Please refer to Section C01.08.

3.7 FLUE GAS EXHAUST

Compliance with standards

The appliance is approved for connection to a combustion products exhaust duct for the types shown in Table 2.1 *p. 4*.

3.7.1 Flue gas exhaust connection

Ø 80 mm (with gasket), on the left side, at the top, side panel (detail A Figures 2.1 *p. 2* and 2.2 *p. 3*).

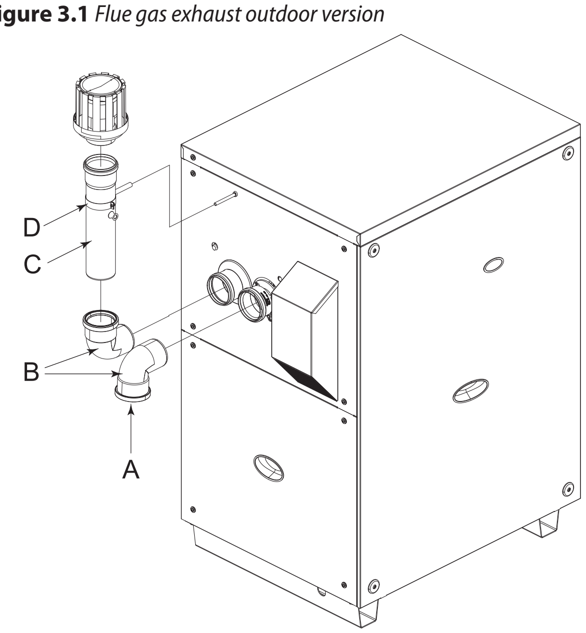
3.7.2 Indoor version

The appliance is supplied in configuration type B63.

3.7.3 Outdoor version

The appliance is supplied complete with air intake and flue gas exhaust kit to be fitted by the installer, shown in Figure 3.1 *p. 8*.

Figure 3.1 *Flue gas exhaust outdoor version*



A Air intake
B 90° elbow Ø 80 mm
C Pipe Ø 80 mm, length 300 mm, with terminal
D Collar

3.7.4 Possible flue

If required, the appliance may be connected to a flue appropriate for condensing appliances.

For more details see Section C01.09.

3.8 FLUE GAS CONDENSATE DRAIN

Please refer to Section C01.09.

3.9 SAFETY VALVE DRAIN (INDOOR VERSION)

Ø 1 1/4", on the upper panel (detail Q Figure 2.1 *p. 2*).

The safety valve drain must be mandatorily ducted outside. Failure to comply with this provision jeopardizes first start-up.

Do not install any shut off device on the drain duct between the safety valve and the outside vent.

3.9.1 Safety valve drain ducting

The drain ducting shall be made in steel pipes (do not use copper or its alloys). Table 3.1 *p. 8* provides sufficient criteria of pipe sizing; alternatively, less compelling sizing is accepted, provided it is compliant with specific applicable norms (the manufacturer cannot be held liable).

Table 3.1 *Safety valve drain ducting*

Diameter	DN	Maximum length (m)
1" 1/4	32	30
2"	50	60

The drain duct must have an initial straight section of at least 30 cm.

Place the drain terminal outside the room, away from doors, windows and aeration vents, and at such a height that any refrigerant leaks cannot be inhaled by any people.

3.10 ELECTRICAL AND CONTROL CONNECTIONS

Please refer to Section C01.10.

3.11 EXAMPLE DIAGRAMS

Please refer to Section C01.13.

3.12 ACOUSTIC

Please refer to Section C01.14.

1 VERSIONS

The GA appliance is available in the following versions:

- ACF, for residential/retail/industrial cooling systems with chilled water down to 3 °C.
- HR with heat recovery exchanger, for residential/retail/industrial cooling systems with chilled water down to 3 °C, plus recovery exchanger hot water up to 75 °C (e.g. DHW production).
- TK, for systems and process applications with chilled water down to 3 °C, in continuous operation all year round.
- HT for very hot climates, for residential/retail/industrial cooling systems with chilled water down to 5 °C, with outdoor air up to 50 °C.
- LB for negative temperatures, for cooling systems with chilled water down to -10 °C (glycol required).

ACF, TK, LB and HT models have 2 water fittings (chilled water inlet/outlet), model HR has 4 water fittings (chilled water and heat recovery exchanger hot water inlet/outlet).
Each version may be supplied with standard or low-noise fan.

2 SPECIFICATION OF SUPPLY

2.1 ACF

Water-ammonia absorption chiller, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version, for cold water production down to an outlet temperature of 3 °C, for outdoor installation.
Nominal cooling output (A35W7): 17,7 kW
Heat input: 25,0 kW
Electrical power absorption nominal: 0,82 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 333 kg
Dimensions: width 880 mm, depth 1266 mm, height 1446 mm

2.2 ACF S

Water-ammonia absorption chiller with low-noise fan, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version, for cold water production down to an outlet temperature of 3 °C, for outdoor installation.
Nominal cooling output (A35W7): 17,7 kW
Heat input: 25,0 kW
Electrical power absorption nominal: 0,87 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 340 kg
Dimensions: width 880 mm, depth 1266 mm, height 1516 mm

2.3 HR

Water-ammonia absorption chiller-heater, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version with heat recovery, for cold water production down to an outlet temperature of 3 °C and simultaneously hot water up to an outlet temperature of 75 °C, for outdoor installation.
Nominal cooling output (A35W7): 17,7 kW
Heat input: 25,0 kW
Recovery unit heat output (A35W40): 14,9 kW
Electrical power absorption nominal: 0,82 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 366 kg
Dimensions: width 880 mm, depth 1266 mm, height 1446 mm

2.4 HR S

Water-ammonia absorption chiller-heater with low-noise fan, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version with heat recovery, for cold water production down to an outlet temperature of 3 °C and simultaneously hot water up to an outlet temperature of 75 °C, for outdoor installation.
Nominal cooling output (A35W7): 17,7 kW
Heat input: 25,0 kW
Recovery unit heat output (A35W40): 14,9 kW
Electrical power absorption nominal: 0,87 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 373 kg
Dimensions: width 880 mm, depth 1266 mm, height 1516 mm

2.5 TK

Water-ammonia absorption chiller, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version for use in process applications, for cold water production down to an outlet temperature of 3 °C, for outdoor installation.
Nominal cooling output (A35W7): 17,7 kW
Heat input: 25,0 kW
Electrical power absorption nominal: 0,82 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 353 kg
Dimensions: width 880 mm, depth 1266 mm, height 1446 mm

2.6 TK S

Water-ammonia absorption chiller with low-noise fan, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version for use in process applications, for cold water production down to an outlet temperature of 3 °C, for outdoor installation.
Nominal cooling output (A35W7): 17,7 kW
Heat input: 25,0 kW
Electrical power absorption nominal: 0,87 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 360 kg
Dimensions: width 880 mm, depth 1266 mm, height 1516 mm

2.7 HT

Water-ammonia absorption chiller, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version for use in areas with high ambient temperature and humidity, for cold water production down to an outlet temperature of 5 °C, for outdoor installation.
Nominal cooling output (A35W7): 17,1 kW
Heat input: 25,0 kW
Electrical power absorption nominal: 0,82 kW

Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 353 kg
Dimensions: width 880 mm, depth 1266 mm, height 1446 mm

2.8 HT S

Water-ammonia absorption chiller with low-noise fan, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version for use in areas with high ambient temperature and humidity, for cold water production down to an outlet temperature of 5 °C, for outdoor installation.
Nominal cooling output (A35W7): 17,1 kW
Heat input: 25,0 kW
Electrical power absorption nominal: 0,87 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 360 kg
Dimensions: width 880 mm, depth 1266 mm, height 1516 mm

2.9 LB

Water-ammonia absorption chiller, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version for refrigeration, for cold water production down to an outlet temperature of -10 °C, for outdoor installation.
Nominal cooling output (A35W-5): 13,3 kW
Heat input: 25,0 kW
Electrical power absorption nominal: 0,82 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 353 kg
Dimensions: width 880 mm, depth 1266 mm, height 1446 mm

2.10 LB S

Water-ammonia absorption chiller with low-noise fan, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, air-water version for refrigeration, for cold water production down to an outlet temperature of -10 °C, for outdoor installation.
Nominal cooling output (A35W-5): 13,3 kW
Heat input: 25,0 kW
Electrical power absorption nominal: 0,87 kW
Power supply: 230 V - 50 Hz single-phase
Sound power Lw (max): 79,6 dB(A)
Weight: 360 kg
Dimensions: width 880 mm, depth 1266 mm, height 1516 mm

3 FEATURES AND TECHNICAL DATA

3.1 FEATURES

Based on the thermodynamic water-ammonia absorption cycle ($H_2O–NH_3$), the appliance produces chilled water using natural gas (or LPG) as the primary energy source and dissipating heat directly to the outdoor air.
The thermodynamic cycle takes place within a hermetically sealed circuit, in welded construction, perfectly tight, factory-tested, which does not require any maintenance or refrigerant top-ups.

3.1.1 Mechanical and thermo-hydraulic components

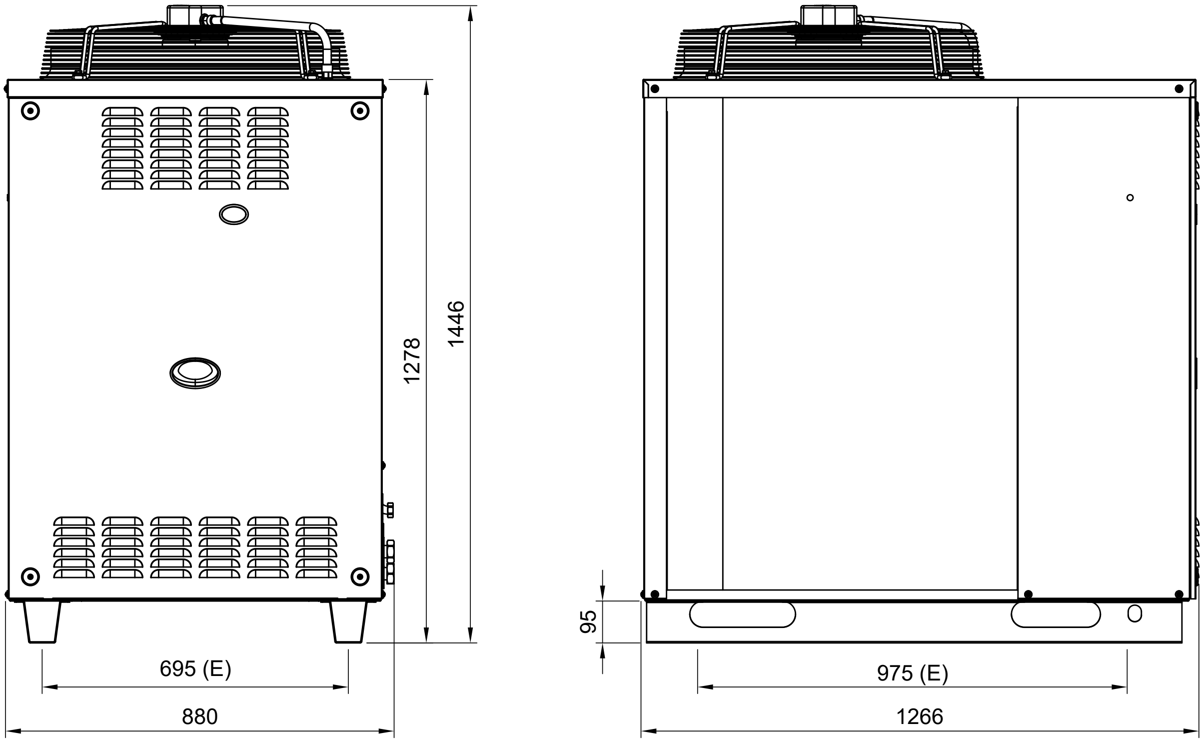
- Steel sealed circuit, externally treated with epoxy paint.
- Sealed combustion chamber (type C) suitable for outdoor installations.
- Metal mesh radiant burner, equipped with ignition electrodes and flame detection, managed by an electronic flame control box.
- Titanium stainless steel shell-and-tube water exchanger (evaporator), externally insulated.
- Air exchanger (condenser) with finned coil, with steel pipe and aluminium fins.
- Low power consumption refrigerant fluid oil pump.
- Variable-flow microprocessor-controlled helicoidal motor-fan.
- Standard or low noise S fan.

3.1.2 Control and safety devices

- Electronic board featuring a microprocessor, LCD, and knob.
- Circuit water flow switch.
- Generator limit thermostat, with manual reset.
- Automatically resettable flue gas thermostat.
- Differential air pressure switch on the combustion circuit.
- Sealed circuit safety relief valve.
- Bypass valve, between high and low-pressure circuits.
- Ionization flame control box.
- Double shutter electric gas valve.
- Heat recovery exchanger water pump relay (HR version only).

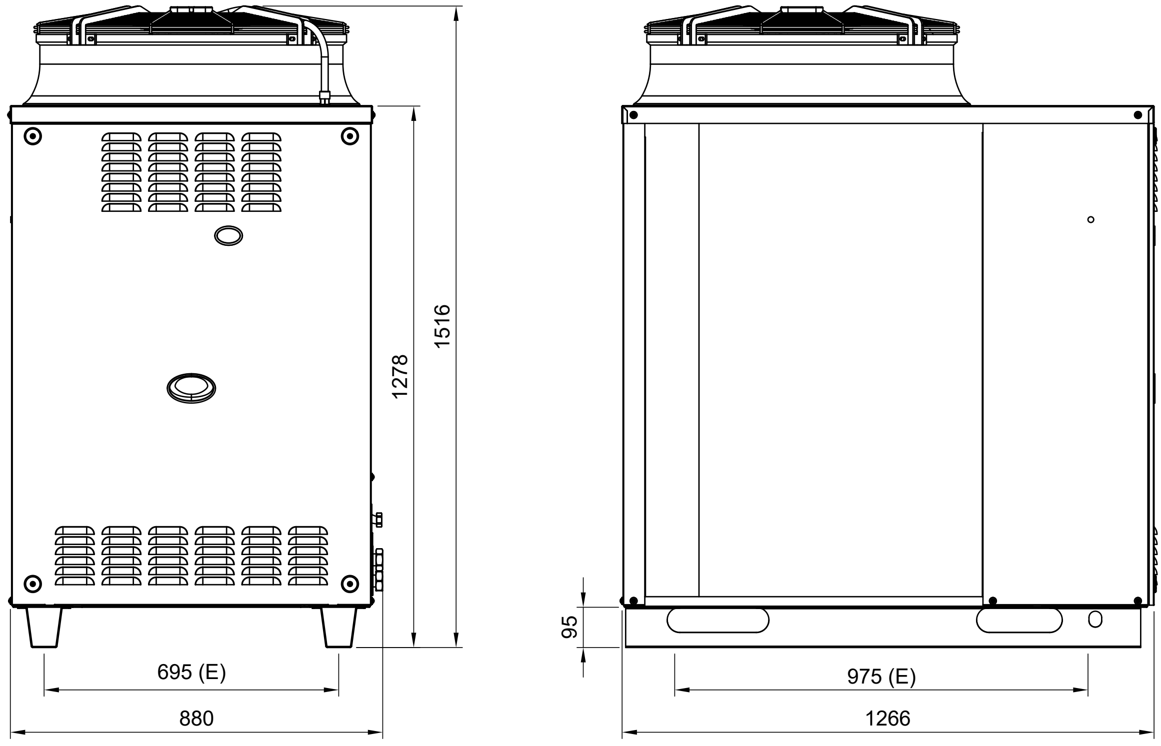
3.2 DIMENSIONS

Figure 3.1 *ACF standard version dimensions*



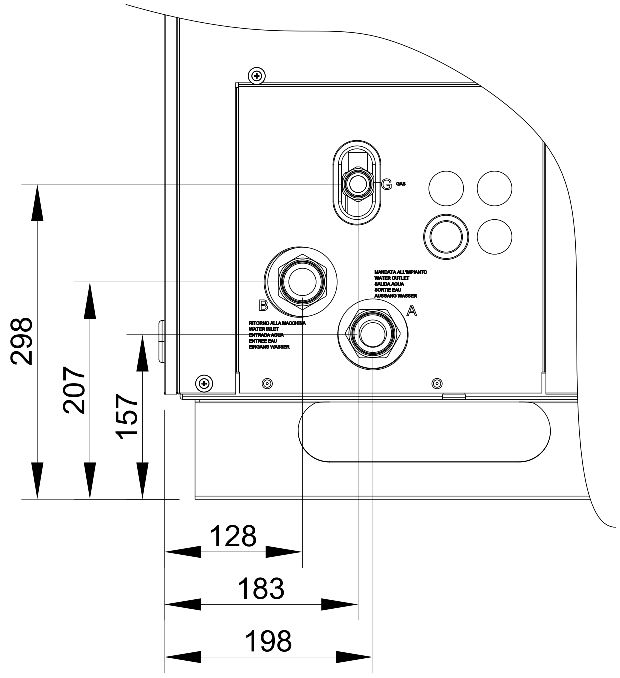
A Centre distance of holes for vibration damper supports

Figure 3.2 *ACF silenced version dimensions*



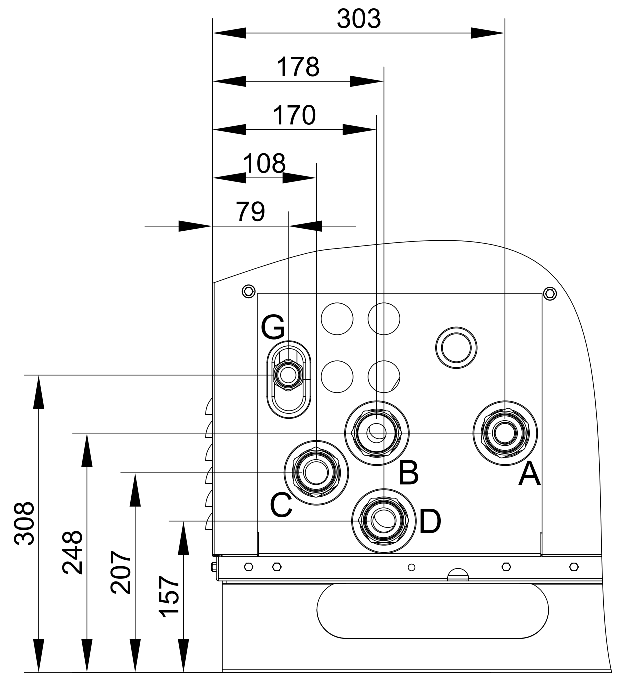
A Centre distance of holes for vibration damper supports

Figure 3.3 *Service plate - Hydraulic/gas connections detail*



G Gas connection Ø 3/4" F
B Water inlet connection Ø 1 1/4" F
A Water outlet connection Ø 1 1/4" F

Figure 3.4 *ACF HR service plate with plumbing and gas connections*



G Gas connection Ø 3/4" F

Chiller: chilled water
C Water inlet connection Ø 1 1/4" F
D Water outlet connection Ø 1 1/4" F

Recovery exchanger: hot water
A Water outlet connection Ø 1 1/4" F
B Water inlet connection Ø 1 1/4" F

3.3 CONTROLS

Control device

The appliance may only work if it is connected to a control device, selected from:

- ► DDC panel
- ► External request

3.3.1 DDC panel

The DDC control panel can manage one or more Robur appliances in modulating mode (GA heat pumps, GAHP boilers) or ON/OFF mode (AY chillers).
DDC control panel 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 water pumps,...).

For more details see Section C01.11.

3.3.2 External request

The appliance can also be controlled by a generic request device (e.g. thermostat, timer, switch, contactor...) fitted with a voltage-free NO contact. This system only allows basic control (on/off, with a fixed setpoint temperature), thus lacking essential system functions of the DDC control panel. We recommend using it only for simple applications and with a single appliance.

3.4 TECHNICAL DATA

Table 3.1 *GA technical data*

				ACF60-00	ACF60-00 HR	ACF60-00 TK	ACF60-00 HT	ACF60-00 LB
Cooling mode								
Nominal cooling output	Outdoor temperature/Water outlet temperature	A35W7	kW	17,7			17,1	-
		A35W-5	kW	-				13,3
Heat input	nominal (1013 mbar - 15 °C)		kW	25,3				
	real		kW	25,0				
Cold water temperature (outlet)	minimum		°C	3 (1)			5	-10
	nominal		°C	7				-5
Cold water temperature (inlet)	maximum		°C	45				
	minimum		°C	8				-7
Cold water flow	nominal		l/h	2770			2675	2600
	maximum		l/h	3500				2900
	minimum		l/h	2500				2300
Water pressure drop in cooling mode	at nominal water flow		bar	0,29 (2)				0,42 (3)
Outdoor temperature	maximum		°C	45			50	45
	minimum		°C	0		-12	0	
Recovery circuit operation								
Recovery unit heat output	Outdoor temperature/Cooling water outlet temperature/Heat recovery exchanger flow rate 1000 l/h	A35W40	kW	-	21,0	-		
Total GUE (40 °C inlet temperature)	Outdoor temperature/Cooling water outlet temperature/Heat recovery exchanger flow rate 1000 l/h	A35W7	%	-	155	-		
Hot water temperature (inlet)	nominal		°C	-	40	-		
Hot water temperature (outlet)	nominal		°C	-	58	-		
Hot water flow	nominal		l/h	-	1000	-		
	maximum		l/h	-	2500	-		
	minimum		l/h	-	0	-		
Electrical specifications								
Power supply	voltage		V	230				
	type		-	single-phase				
	frequency		Hz	50				
Electrical power absorption	nominal		kW	0,82 (4)				
	nominal silenced		kW	0,87 (4)				
Degree of protection	IP		-	X5D				
Installation data								
Gas consumption	G20 natural gas (nominal)		m^3/h	2,68				
	G25 (nominal)		m^3/h	3,11				
	LPG G30/G31 (nominal)		kg/h	1,97				
Sound power L_w (max)			dB(A)	79,6 (5)				
sound power L_w (max) silenced			dB(A)	75,0 (5)				
sound pressure L_p at 5 metres (max)			dB(A)	57,6 (6)				
sound pressure L_p at 5 m (maximum) silenced			dB(A)	53,0 (6)				
maximum water pressure in operation			bar	4,0				
Water content inside the appliance	hot side		l	-	3	-		
	cold side		l	3				
Water fitting	type		-	F				
	thread		"	1 1/4				
Gas connection	type		-	F				
	thread		"	3/4				

(1) To be set (on demand) during the first start-up. Default Minimum Temperature = 4,5 °C.
(2) For flows other than nominal see Design Manual, Pressure losses Paragraph.
(3) The data refer to operation with 40% glycol water. For flows other than the nominal flow, refer to the Design Manual, Paragraph Pressure drops.
(4) ±10% according to the power supply voltage and tolerance on electrical motors consumption. Measured at outdoor temperature of 30 °C.
(5) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614.
(6) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614.
(7) Tolerance ±5%.

				ACF60-00	ACF60-00 HR	ACF60-00 TK	ACF60-00 HT	ACF60-00 LB
Dimensions	width		mm	880				
	depth		mm	1266				
	height		mm	1446				
	silenced height		mm	1516				
	Packing	width	mm	890				
		depth	mm	1300				
		height	mm	1446				
		silenced height	mm	1516				
Weight	in operation		kg	333	366	353		
	gross (including packaging)		kg	331	361	351		
General information								
Refrigerating fluid (7)	ammonia R717		kg	6,8	7,2	7,9	7,1	7,2
	water H_2O		kg	10,0	10,3	10,0	10,5	

(1) To be set (on demand) during the first start-up. Default Minimum Temperature = 4,5 °C.
(2) For flows other than nominal see Design Manual, Pressure losses Paragraph.
(3) The data refer to operation with 40% glycol water. For flows other than the nominal flow, refer to the Design Manual, Paragraph Pressure drops.
(4) ±10% according to the power supply voltage and tolerance on electrical motors consumption. Measured at outdoor temperature of 30 °C.
(5) Sound power values detected in compliance with the intensity measurement methodology set forth by standard EN ISO 9614.
(6) Maximum sound pressure levels in free field, with directivity factor 2, obtained from the sound power level in compliance with standard EN ISO 9614.
(7) Tolerance ±5%.

3.4.1 Pressure drops

3.4.1.1 ACF, HR, TK, HT

Table 3.2 *GA ACF, HR, TK, HT pressure drop*

Cold water flow	Heat transfer fluid temperature at outlet	
	3 °C	7 °C
	bar	bar
2600 l/h	0,27	0,26
2900 l/h	0,33	0,31
3500 l/h	0,48	0,46

The data refer to operation with no glycol in water.

3.4.1.2 LB

Table 3.3 *IF ACF | LB pressure drops*

Cold water flow	Heat transfer fluid temperature at outlet		
	-10 °C	-5 °C	0 °C
	bar	bar	bar
2300 l/h	0,44	0,37	0,30
2600 l/h	0,52	0,42	0,35
2900 l/h	0,55	0,47	0,41

The data refer to operation with 40% glycol water.

3.4.1.3 HR recovery exchanger

Table 3.4 *GA ACF HR heat recover exchanger pressure drop*

Hot water flow	Heat transfer fluid temperatures at inlet		
	30 °C	40 °C	70 °C
	bar	bar	bar
500 l/h	0,01	0,01	0,01
1000 l/h	0,03	0,03	0,03
1500 l/h	0,06	0,06	0,06
2500 l/h	0,16	0,16	0,14

3.4.2 Performances

Please consider that, according to the actual cooling load, the appliance may often need to operate under partial load conditions and in non-stationary operation.

3.4.2.1 ACF

Table 3.5 *p. 6* shows the cooling output at full load and in stable operation, depending on the cold water outlet temperature to the system and the outdoor temperature, referring to the ACF60-00 appliance.

Table 3.5 *GA ACF cooling output*

Outdoor temperature	Water delivery temperature	
	7 °C	10 °C
	kW	kW
30 °C	17,9	18,4
35 °C	17,7	17,2
40 °C	15,6	16,0
45 °C	11,9	14,8

Table 3.6 *p. 6* shows the GUE at full load and stable operation in cooling mode, depending on the cold water outlet temperature to the system and the outdoor temperature, referring to the ACF60-00 appliance.

Table 3.6 *GA ACF GUE*

Outdoor temperature	Water delivery temperature	
	7 °C	10 °C
	%	%
30 °C	72	73
35 °C	71	69
40 °C	62	64
45 °C	47	59

3.4.2.2 TK

Table 3.7 *p. 6* shows the cooling output at full load and in stable operation, depending on the cold water outlet temperature to the system and the outdoor temperature, referring to the ACF60-00 TK appliance.

Table 3.7 *GA ACF TK cooling output*

Outdoor temperature	Water delivery temperature	
	4 °C	7 °C
	kW	kW
-10 °C	20,9	20,9
-5 °C	20,6	20,6
0 °C	20,4	20,4
5 °C	20,1	20,2
10 °C	19,9	19,9
15 °C	19,7	19,7
20 °C	19,3	19,7
25 °C	18,6	19,4
30 °C	16,9	18,8
35 °C	13,8	17,7
40 °C	\	15,8

Table 3.8 *p. 7* shows the GUE at full load and stable operation in cooling mode, depending on the cold water outlet tempera-

ture to the system and the outdoor temperature, referring to the ACF60-00 TK appliance.

Table 3.8 *GA ACF TK GUE*

Outdoor temperature	Water delivery temperature	
	4 °C	7 °C
	%	%
-10 °C	84	84
-5 °C	82	83
0 °C	82	82
5 °C	80	81
10 °C	79	79
15 °C	79	79
20 °C	77	79
25 °C	74	78
30 °C	68	75
35 °C	55	71
40 °C	/	63

3.4.2.3 HT

Table 3.9 *p. 7* shows the cooling output at full load and in stable operation, depending on the cold water outlet temperature to the system and the outdoor temperature, referring to the ACF60-00 HT appliance.

Table 3.9 *GA ACF HT cooling output*

Outdoor temperature	Water delivery temperature	
	7 °C	10 °C
	kW	kW
30 °C	17,5	17,5
35 °C	17,1	17,1
40 °C	15,9	16,6
45 °C	/	15,2

Table 3.10 *p. 7* shows the GUE at full load and stable operation in cooling mode, depending on the cold water outlet temperature to the system and the outdoor temperature, referring to the ACF60-00 HT appliance.

Table 3.10 *GA ACF HT GUE*

Outdoor temperature	Water delivery temperature	
	7 °C	10 °C
	%	%
30 °C	70	70
35 °C	68	68
40 °C	64	66
45 °C	/	61

3.4.2.4 LB

Table 3.11 *p. 7* shows the cooling output at full load and in stable operation, depending on the cold water outlet temperature to the system and the outdoor temperature, referring to the ACF60-00 LB appliance.

Table 3.11 *GA ACF LB cooling output*

Outdoor temperature	Water delivery temperature		
	-10 °C	-5 °C	0 °C
	kW	kW	kW
10 °C	15,2	15,3	15,6
15 °C	15,2	15,3	15,6
20 °C	14,8	15,2	15,6
25 °C	14,1	14,9	15,4
30 °C	13,2	14,2	15,2
35 °C	11,7	13,3	14,4
40 °C	9,6	11,8	13,3

Table 3.12 *p. 7* shows the GUE at full load and stable operation in cooling mode, depending on the cold water outlet temperature to the system and the outdoor temperature, referring to the ACF60-00 LB appliance.

Table 3.12 *GA ACF LB GUE*

Outdoor temperature	Water delivery temperature		
	-10 °C	-5 °C	0 °C
	%	%	%
10 °C	61	61	62
15 °C	61	61	62
20 °C	59	61	62
25 °C	56	60	62
30 °C	53	57	61
35 °C	47	53	57
40 °C	38	47	53

3.4.2.5 HR

Table 3.13 *p. 7* shows the cooling output at full load and in stable operation, depending on the cold water outlet temperature to the system and the outdoor temperature, referring to the ACF60-00 HR appliance.

Table 3.13 *GA ACF HR cooling output*

Outdoor temperature	Water delivery temperature	
	7 °C	10 °C
	kW	kW
30 °C	17,7	18,2
35 °C	17,7	17,2
40 °C	16,8	16,1
45 °C	14,2	15,4

Tables 3.14 *p. 7* and 3.15 *p. 7* show the recoverable heat output at full load and in stable operation, depending on the temperature of the heat transfer fluid at the inlet to the heat recovery exchanger and the outdoor temperature for two reference water flows to the heat recovery exchanger, respectively 1000 l/h (Table 3.14 *p. 7*) and 500 l/h (Table 3.15 *p. 7*), referring to the ACF60-00 HR appliance.
Consider that in the absence of a refrigeration request no recoverable heat output will be available.

Table 3.14 *Recoverable heat output for GA ACF HR with 1000 l/h water flow*

Outdoor temperature	Heat transfer fluid temperature at inlet			
	20 °C	30 °C	40 °C	50 °C
	kW	kW	kW	kW
30 °C	31,3	25,1	19,1	13,2
35 °C	32,0	26,2	21,0	15,5
40 °C	/	28,0	23,0	17,5
45 °C	/	30,0	25,1	19,2

The figures refer to temperature on recovery exchanger inlet, with flow to recovery exchanger of 1000 l/h.

Table 3.15 *Recoverable heat output for GA ACF HR with 500 l/h water flow*

Outdoor temperature	Heat transfer fluid temperature at inlet				
	10 °C	20 °C	30 °C	40 °C	50 °C
	kW	kW	kW	kW	kW
30 °C	27,5	23,0	18,1	13,5	9,3
35 °C	27,9	23,5	19,1	14,9	11,0
40 °C	28,2	24,4	20,1	16,3	12,8
45 °C	28,5	25,0	21,2	18,0	14,9

The figures refer to temperature on recovery exchanger inlet, with flow rate to recovery exchanger of 500 l/h.

The following Tables show the GUE at full load in cooling mode and simultaneous heat recovery in stable operation, depending on the cold water outlet temperature to the system and the outdoor temperature, for two reference water flows to the heat recovery exchanger, respectively 1000 l/h (Table 3.16 *p. 8*) and 500 l/h (Table 3.17 *p. 8*), referring to the ACF60-00 HR appliance.

Table 3.16 *GA ACF HR GUE with heat recovery 1000 l/h return 40 °C*

Outdoor temperature	Water delivery temperature	
	7 °C	10 °C
	%	%
30 °C	147	149
35 °C	155	153
40 °C	159	156
45 °C	157	162

Table 3.17 *GA ACF HR GUE with heat recovery 500 l/h return 40 °C*

Outdoor temperature	Water delivery temperature	
	7 °C	10 °C
	%	%
30 °C	125	127
35 °C	131	128
40 °C	133	130
45 °C	129	133

4 DESIGN

Compliance with installation standards

Design and installation must comply with applicable regulations in force, based on the installation Country and site, in matters of safety, design, implementation and maintenance of:

- heating systems
- cooling systems
- gas systems
- flue gas exhaust
- flue gas condensate drain

Design and installation must also comply with the manufacturer's provisions.

4.1 APPLIANCE POSITIONING

Please refer to Section C01.02.

4.2 PLUMBING DESIGN

Please refer to Section C01.03.

4.3 WATER PUMP

The circulation pump (flow and head) must be selected and installed based on pressure drops of plumbing/primary circuit (piping + components + exchange terminals + appliance).
For appliance pressure drops, see Paragraph 3.4.1 *p. 6*, referring to the specific GA appliance used.

Please refer to Section C01.04 for the characteristics of the pumps available as Robur optional.

4.4 SYSTEM WATER QUALITY

Please refer to Section C01.05.

4.5 ANTIFREEZE PROTECTION

Please refer to Section C01.06.

4.6 FUEL GAS SUPPLY

Please refer to Section C01.08.

4.7 FLUE GAS EXHAUST

The GA appliances have no flue gas exhaust.

4.8 ELECTRICAL AND CONTROL CONNECTIONS

Please refer to Section C01.10.

4.9 EXAMPLE DIAGRAMS

Please refer to Section C01.13.

4.10 ACOUSTIC

Please refer to Section C01.14.

1 SPECIFICATION OF SUPPLY

1.1 AY 35

Modulating condensing boiler with sealed chamber, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, for hot water production up to an outlet temperature of 88 °C, for indoor or outdoor installation, equipped with a high head water pump.
Operating point 80/60: effective power 33,3 kW
Heat input: 34,0 kW
Electrical power absorption nominal: 0,27 kW
Power supply: 230 V - 50 Hz single-phase
Weight: 77 kg
Dimensions: width 497 mm, depth 583 mm, height 1329 mm

1.2 AY 50

Modulating condensing boiler with sealed chamber, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, for hot water production up to an outlet temperature of 88 °C, for indoor or outdoor installation, equipped with a high head water pump.
Operating point 80/60: effective power 49,2 kW
Heat input: 50,0 kW
Electrical power absorption nominal: 0,30 kW
Power supply: 230 V - 50 Hz single-phase
Weight: 91 kg
Dimensions: width 497 mm, depth 583 mm, height 1329 mm

1.3 AY 100

Modulating condensing boiler with sealed chamber, consisting of two independent thermal modules, each with effective power 49,2 kW, gas-fired with natural gas, LPG or natural gas and hydrogen mixtures up to 20%, for hot water production up to an outlet temperature of 88 °C, for indoor or outdoor installation, equipped with independent high head water pumps (one for each thermal module).
Operating point 80/60: effective power 98,4 kW
Heat input: 99,8 kW
Electrical power absorption nominal: 0,59 kW
Power supply: 230 V - 50 Hz single-phase
Weight: 142 kg
Dimensions: width 757 mm, depth 579 mm, height 1329 mm

2 FEATURES AND TECHNICAL DATA

2.1 FEATURES

The AY appliances are condensing boilers suitable for both outdoor and indoor installation, capable of producing hot water up to 88 °C.
The range includes three models: AY 35, AY 50, AY 100.
The boiler casing is approved to resist weathering with particular regard to the action of UV rays.

2.1.1 Mechanical and thermo-hydraulic components

- Integrated spiral single tube stainless steel heat exchanger.
- Premix modulating burner with 1:9 ratio (AY 35), 1:10 (AY 50), 1:20 (AY 100).
- Automatic air vent valve.
- Check valve.
- High efficiency water pump.
- System drain tap.
- Water temperature probes.
- Condensate drain siphon.
- Flue gas exhaust duct with relevant terminal, for type B53P configuration.

In the AY 100 the above components are double.

2.1.2 Control and safety devices

- Flue safety thermal fuse.
- Gas solenoid valve.
- Safety thermostat.

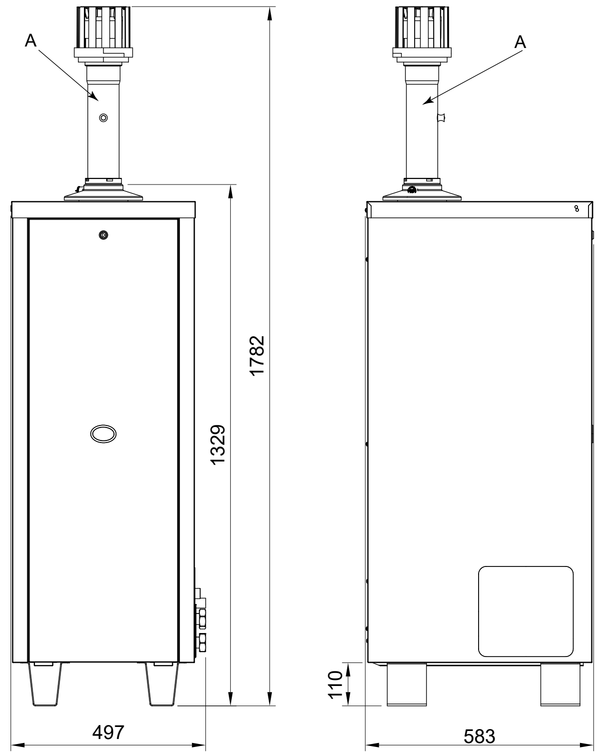
In the AY 100 the above components are double.

- Safety valve (3,5 bar).
- Water differential pressure switch.
- Expansion tank.
- Outdoor temperature probe.

2.2 DIMENSIONS

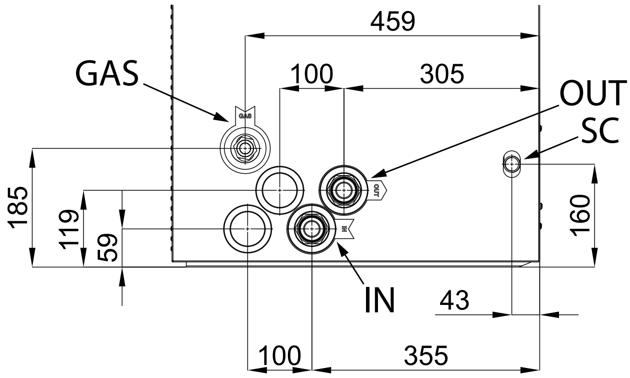
2.2.1 AY 35 and AY 50

Figure 2.1 *AY 35 and AY 50 dimensions*



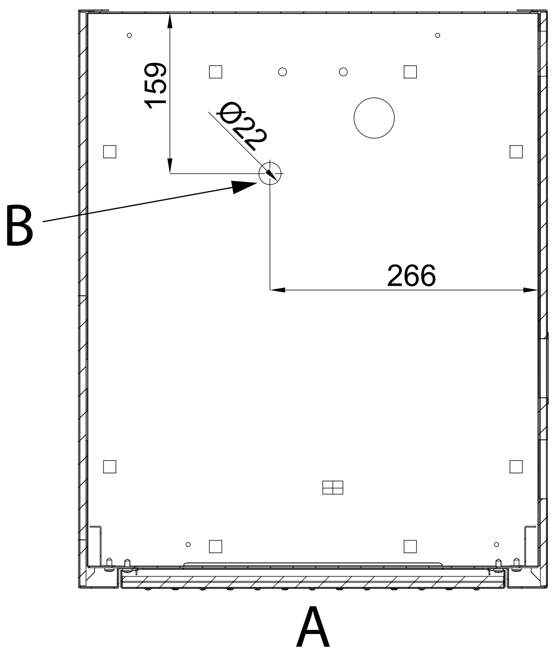
A Flue gas outlet Ø 80 mm

Figure 2.2 *Service plate - Hydraulic/gas connections detail*



OUT Water outlet connection Ø 1 1/4" F
IN Water inlet connection Ø 1 1/4" F
SC Condensate drain connection (outside diameter 25 mm, inside 21 mm)
GAS Gas connection Ø 3/4" M

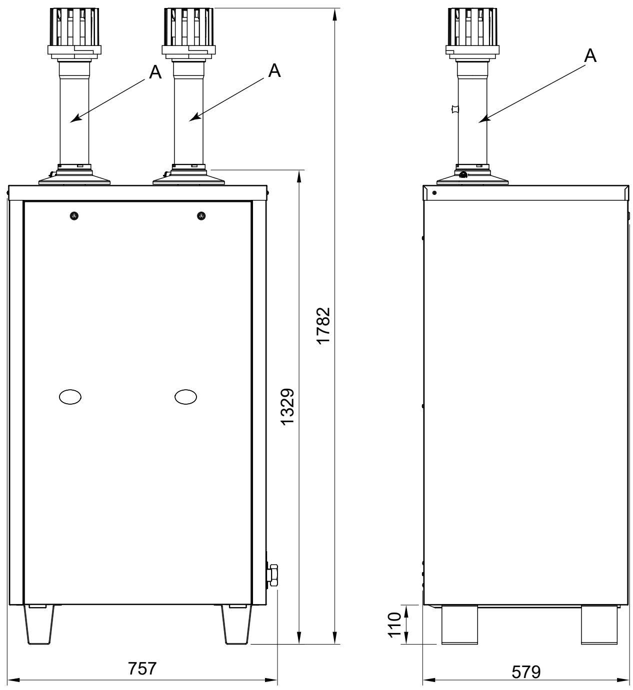
Figure 2.3 *Service plate - Detail of bottom plate*



A AY front panel
B Boiler safety valve drain outside Ø 20 mm, inside Ø 14 mm

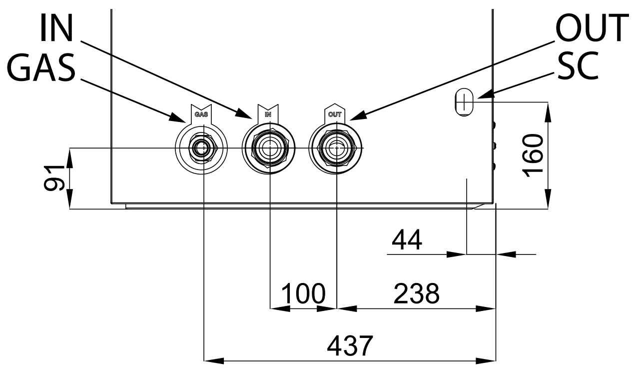
2.2.2 AY 100

Figure 2.4 *AY 100 dimensions*



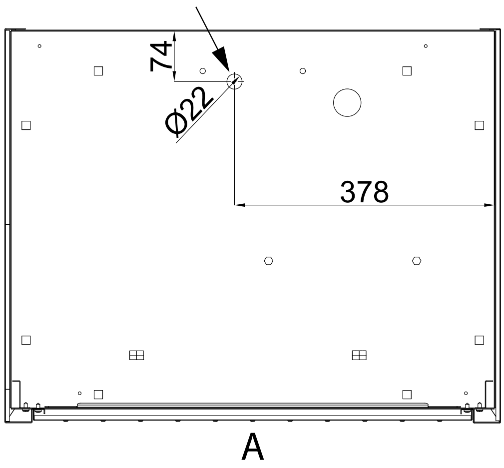
A Flue gas outlet Ø 80 mm

Figure 2.5 *Service plate - Hydraulic/gas connections detail*



OUT Water outlet connection Ø 1 1/2" F
IN Water inlet connection Ø 1 1/2" F
SC Condensate drain connection (outside diameter 25 mm, inside 21 mm)
GAS Gas connection Ø 1" M

Figure 2.6 *Service plate - Detail of bottom plate*



A AY front panel
B Boiler safety valve drain outside Ø 20 mm, inside Ø 14 mm

2.3 CONTROLS

2.3.1 Control device

The appliance may only work if it is connected to a control device, selected from:

- ► DDC panel
- ► External request

2.3.2 DDC panel

The DDC control panel can manage one or more Robur appliances in modulating mode (GA heat pumps, GAHP boilers) or ON/OFF mode (AY chillers).
DDC control panel 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 water pumps,...).

For more details see Section C01.11.

2.3.3 External request

The appliance can also be controlled by a generic request device (e.g. thermostat, timer, switch, contactor...) fitted with a voltage-free NO contact. This system only allows basic control (on/off, with a fixed setpoint temperature), thus lacking essential system functions of the DDC control panel. We recommend using it only for simple applications and with a single appliance.

In the case of the AY 100 appliance, two separate requests must be provided for the two thermal modules that make up the appliance.

2.4 TECHNICAL DATA

Table 2.1 *Technical data*

				AY 35	AY 50	AY 100
Heating mode						
seasonal space heating energy efficiency class (ErP)			-	A		-
Heat input	nominal (1013 mbar - 15 °C)		kW	34,0	50,0	99,8
	minimum		kW	4,1	5,0	
	nominal (1013 mbar - 15 °C) 20%H2NG		kW	32,0	47,0	94,0
	minimum 20%H2NG		kW	3,9	4,8	
Operating point 80/60	Nominal heat input	effective power	kW	33,3	49,2	98,4
		efficiency	%	98,0	97,9	
Operating point 50/30	Nominal heat input	efficiency	%	106,4	106,8	
Operating point Tr = 30 °C	Heat input 30%	efficiency	%	108,6	108,8	
Operating point Tr = 47 °C	Heat input 30%	efficiency	%	102,1	102,8	
Heat losses	to casing in operation		%	0,25	0,10	0,47
	to flue in operation		%	2,40	2,10	
	with burner off		%	0,03	0,05	0,03
Heating water flow	nominal		l/h	2600	2350	4700
	minimum		l/h	1200	1500	
Water pressure drop in heating mode	at nominal water flow		bar	0,57 (1)		
Hot water outlet temperature	maximum		°C	88		
Outdoor temperature (dry bulb)	maximum		°C	45		
	minimum		°C	-25		
Electrical specifications						
Power supply	voltage		V	230		
	type		-	single-phase		
	frequency		Hz	50		
Electrical power absorption	nominal		kW	0,27	0,30	0,59
Degree of protection	IP		-	X5D		
Installation data						

(1) For flows other than nominal see design manual, Paragraph "Pressure losses".
(2) Gas not available for AY 35.
(3) 2 independent flue gas exhausts.
(4) For each of the independent flue gas exhausts.
(5) Overall dimensions excluding flue gas exhaust.

				AY 35	AY 50	AY 100
Gas consumption	G20 natural gas (nominal)		m^3/h	3,60	5,29	10,58
	G25 (nominal)		m^3/h	4,18	6,15	12,30
	G25.1 (nominal)		m^3/h	- (2)	6,14	12,26
	G25.3 (nominal)		m^3/h	4,09	6,01	12,03
	G27 (nominal)		m^3/h	4,39	6,45	12,88
	G2.350 (nominal)		m^3/h	5,00	7,35	14,67
	G30 (nominal)		kg/h	2,68	3,94	7,88
	G31 (nominal)		kg/h	2,64	3,88	7,77
	20%H2NG (nominal)		m^3/h	3,94	5,78	11,56
Water fitting	type		-	F		
	thread		"	1 1/4		1 1/2
Gas connection	type		-	M		
	thread		"	3/4		1
Flue gas exhaust	diameter (Ø)		mm	80		80 (3)
	residual head		Pa	91	100	100 (4)
NO_x emission class			-	6		
Water pump data	Residual pressure head at nominal flow rate	boiler only	bar	0,44		
	nominal flow at the maximum available head		l/h	2600	2350	4700
type of installation			-	B23, B23P, B33, B53		
maximum equivalent length of exhaust duct			m	15	14	14 (4)
maximum water pressure in operation			bar	4,0		
maximum condensate flow			l/h	3,4	5,0	10,0
water content inside the appliance			l	8	11	22
expansion tank volume			l	10		
Dimensions	width		mm	497		757
	depth		mm	583		579
	height		mm	1329 (5)		
Weight	in operation		kg	77	91	142
	gross (including packaging)		kg	76	87	127

(1) For flows other than nominal see design manual, Paragraph "Pressure losses".
(2) Gas not available for AY 35.
(3) 2 independent flue gas exhausts.
(4) For each of the independent flue gas exhausts.
(5) Overall dimensions excluding flue gas exhaust.

2.4.1 Water pump characteristic curves

Figure 2.7 *Characteristic curve of the single water pump with oversized head*

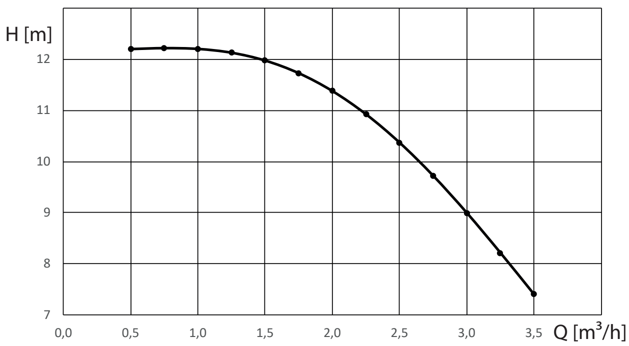
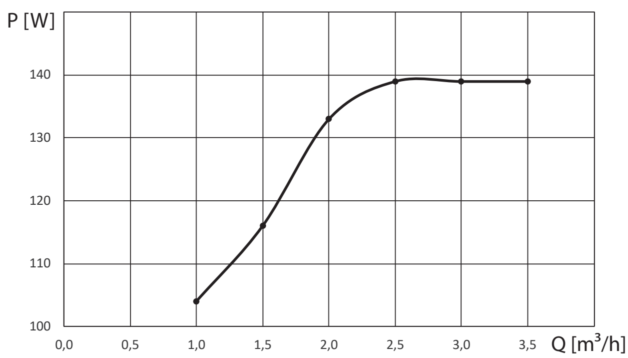


Figure 2.8 *Electrical consumption curve of the single water pump with oversized head*



There are two water pumps in the AY 100 appliance.

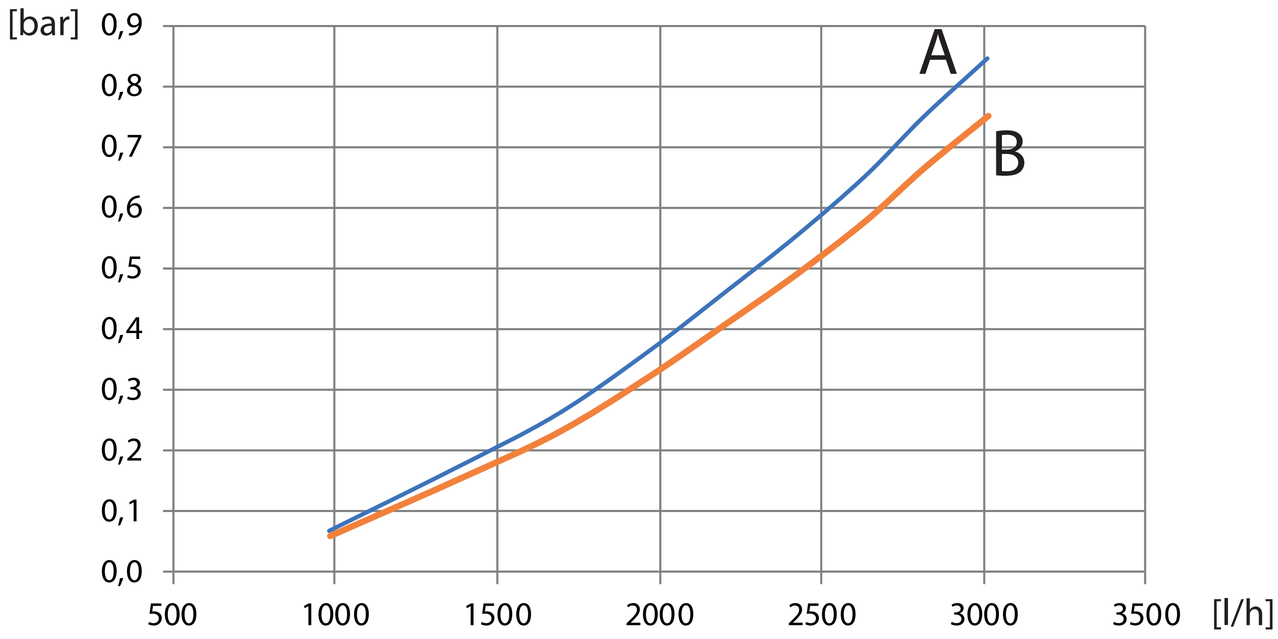
2.4.2 Pressure drops and residual head

Table 2.2 *Nominal flow rate and residual head*

				AY 35	AY 50	AY 100
Installation data						
Water pump data	nominal flow at the maximum available head		l/h	2600	2350	4700
	Residual pressure head at nominal flow rate	boiler only	bar	0,44		

2.4.2.1 AY 35

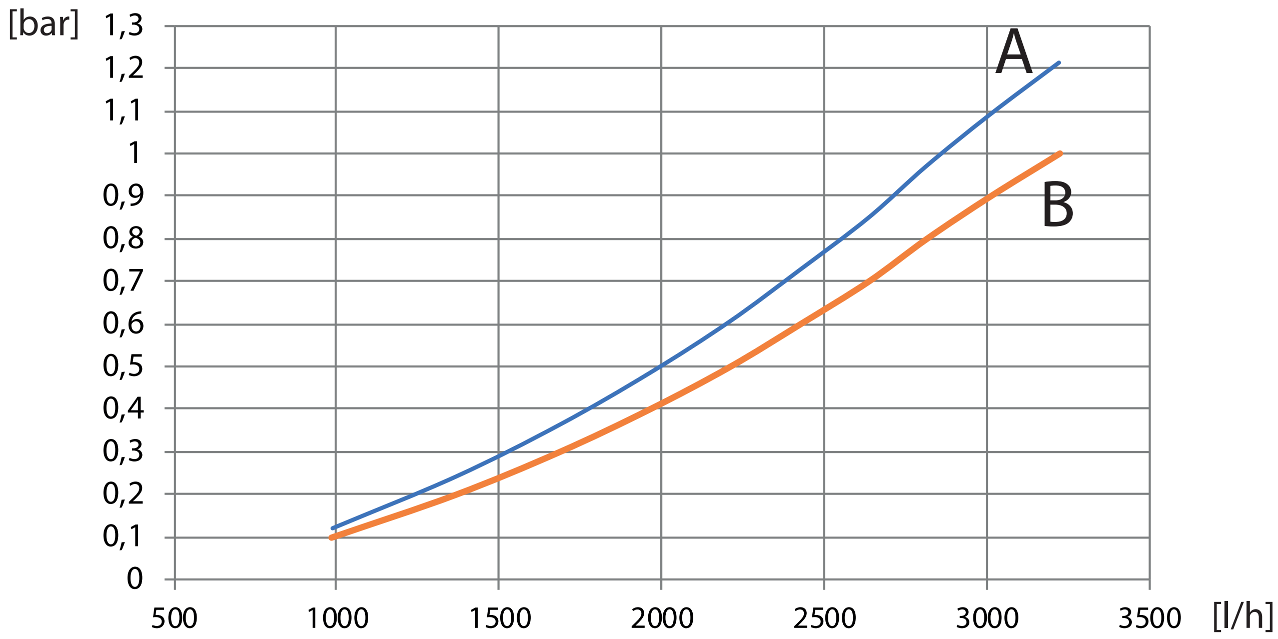
Figure 2.9 *Pressure drop AY 35*



A Boiler pressure drop with 20% glycol water
B Boiler pressure drop with no glycol in water

2.4.2.2 AY 50 and AY 100

Figure 2.10 *Pressure drop AY 50 and AY 100*



A Boiler pressure drop with 35% glycol water
B Boiler pressure drop with no glycol in water

For AY 100 the curve is the same, as the boiler consists of two thermal modules in parallel, each with its own water pump.

3 DESIGN

Compliance with installation standards

Design and installation must comply with applicable regulations in force, based on the installation Country and site, in matters of safety, design, implementation and maintenance of:

- heating systems
- gas systems
- flue gas exhaust
- flue gas condensate drain

Design and installation must also comply with the manufacturer's provisions.

3.1 APPLIANCE POSITIONING

Please refer to Section C01.02.

3.2 PLUMBING DESIGN

Please refer to Section C01.03.

3.3 WATER PUMP

Appliances in the AY range are equipped with high head water pumps, already mounted and wired, the characteristic curve of which is shown in Figure 2.7 *p. 4*.
Pressure drops within the appliance are given in Paragraph 2.4.2 *p. 4*.

3.4 SYSTEM WATER QUALITY

Please refer to Section C01.05.

3.5 ANTIFREEZE PROTECTION

Please refer to Section C01.06.

3.6 FUEL GAS SUPPLY

Please refer to Section C01.08.

3.7 FLUE GAS EXHAUST

Compliance with standards

The appliance is approved for connection to a combustion products exhaust duct for the types shown in Table 2.1 *p. 3*.

3.7.1 Flue gas exhaust connection

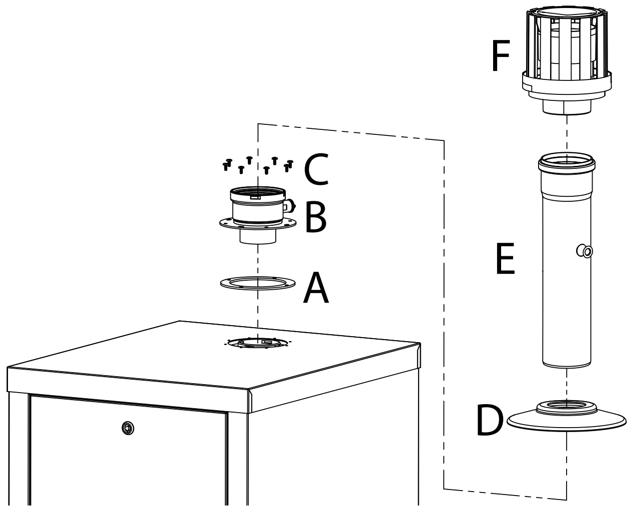
- AY 35: Ø 80 mm
- AY 50: Ø 80 mm
- AY 100: Ø 80 mm (2 independent flue gas exhausts)

on the upper side of the boiler (Paragraph 2.2 *p. 1*).
The combustion air is drawn from the outside of the casing by means of special louvres.

3.7.2 Flue gas exhaust kit

The appliance, supplied in B53P configuration, is standard supplied with a DN80 flue gas kit, to be set up by the installer.
For the AY 100 appliance, the flue gas exhaust kit is double and the kit must be installed on both thermal modules.

Figure 3.1 *Flue gas exhaust kit*



A	Gasket of the flanged socket	D	Rain cover
B	Flanged socket Ø 60/80 mm	E	Flue gas exhaust pipe
C	Fixing screws of the flanged socket	F	Terminal

3.7.3 Possible flue

If required, the appliance may be connected to a flue appropriate for condensing appliances.

For more details see Section C01.09.

3.8 FLUE GAS CONDENSATE DRAIN

Please refer to Section C01.09.

3.9 ELECTRICAL AND CONTROL CONNECTIONS

Please refer to Section C01.10.

3.10 EXAMPLE DIAGRAMS

Please refer to Section C01.13.

3.11 ACOUSTIC

Please refer to Section C01.14.

1 LINK

The Link are gas-fired heating/cooling groups, to supply hot and/or chilled water. Each Link consists of a number of individual gas-fired heating/cooling modules (GAHP/GA/AY modules).

The set of appliances and components is preassembled at the factory, forming a complete hydronic group already prepared to be connected to the system.

2 SPECIFICATION OF SUPPLY

Thanks to the possibility of combining several individual gas-fired heating/refrigeration modules (GAHP/GA/AY modules) on the same Link, a large number of configurations can be realised, with the aim of meeting the specific requirements of the system to be served while avoiding oversizing and consequent energy wastage.
The specifications of supply and the technical data of each Link must therefore be customised to the specific module combination required.
The Link data sheet is available:

- ► on the product configurator, described in Section C01.19
- ► in the documentation supplied with the commercial offer
- ► by sending a request to the Robur technical service or the sales network

The specification of supply of the Link is available on request from the Robur technical service or the authorised distributor for your country.
The composition of the Link can be traced back from its description, as detailed in Paragraph 2.1 *p. 1*.
The types of Link are as follows (Paragraph 2.1 *p. 1*):

- ► Link heat pumps, with at least one GAHP A Plus, GAHP AR Plus, GAHP GS/WS Plus module.
- ► Link condensing boilers, which consists only of AY boilers.
- ► Link chillers, which consists only of GA modules, excluding ACF60-00 HR modules.
- ► Link chiller-heaters, on which GA modules are combined with AY boilers or ACF60-00 HR modules, eventually combined with GA modules.
- ► Link custom, showing non-standard composition and design to meet very specific design requirements.

To be specified in the specification of supply

- ■ The exact composition (number and type of modules) of the Link.
- ■ Details of any versions of the modules making up the Link, if more than one version is available.
- ■ The plumbing configuration (2, 4 or 6-pipe).
- ■ The type and number of modules on the separate circuit.
- ■ Water pumps configuration (with or without).
- ■ For an aerothermal Link, the choice of standard or low-noise fans (S or S1).
- ■ Main technical data for the Link, extracted from the relevant data sheet.

2.1 DESCRIPTION OF THE LINK

Each Link is described by a series of letters and digits that distinguish its composition and configuration. In order:

1. Description and composition of the Link:
   - ■ LINK (always present if several modules are preassembled).
   - ■ (13 to 23 letters) = type of Link according to constituent modules:
     - – CONDENSING BOILERS (if the Link only consist of AY boilers)
     - – HEAT PUMPS (if at least one GAHP A Plus, GAHP AR Plus, GAHP GS/WS Plus module is present on the Link)
     - – CHILLERS (if the Link only consist of GA modules, excluding ACF60-00 HR modules)
     - – CHILLER-HEATERS (if on the Link are present GA modules combined with AY boilers, or ACF60-00 HR modules, eventually combined with GA modules)
   - ■ (3 to 33 letters) = composition of the Link (number of modules followed by module type). Modules are ordered as follows: GAHP A Plus, GAHP AR Plus, GA ACF, ACF60-00 HR, AY 100, AY 50, AY 35. The letter "S" that may be present after the module type identifies the modules that are connected to the separate circuit, which are listed after those connected to the base circuit, with the same sorting criteria for the modules.
2. (2 digits) = nominal cooling output, given by the sum of the nominal cooling outputs of the individual modules. If the Link does not provide cooling, 00 is indicated
3. (3 digits) = nominal heat output, given by the sum of the nominal heat outputs of the individual modules. If the Link does not provide for heating, 00 is indicated
4. (, /4 or /6) = number of pipes, i.e. outlet/inlet manifold pairs (1, 2 or 3)
5. (, S, S1) = fans, standard, low-noise or brushless low-noise (only for aerothermal appliances)
6. (3 letters) = fuel gas
7. (2 letters) = country of destination
8. (2 letters) = water pumps (without or oversized)
9. (6 or 7 letters) = only for Link of GAHP GS/WS Plus heat pumps: outdoor or indoor version

Table 2.1 *p. 2* exemplifies the meaning of the encoding in detail, providing the key for reading any possible composition and configuration, starting from an example.
It should be noted that the number of modules of a specific type on the Link is determined indirectly via the heating and cooling output value, which always identifies only one possible module combination.
The example shows a LINK HEAT PUMPS 1ARH 1CFH 1HRH 1AYH100S 1AYH50S 1AYH35S 52-241 /6 S MET CH WW, which is decoded as follows:

1. (LINK HEAT PUMPS 1ARH 1CFH 1HRH 1AYH100S 1AYH50S 1AYH35S) = Link consisting of (1 GAHP AR Plus, 1 ACF60-00, 1 ACF60-00 HR) on the base circuit and (1 AY 100, 1 AY 50, 1 AY 35) on the separate circuit.
2. (52) = nominal cooling output (A35W7) in kW, resulting from the sum of: 16,9 kW for the GAHP AR Plus module, 17,7 kW for the ACF60-00 module and 17,7 kW for the ACF60-00 HR module.
3. (241) = nominal heat output (A7W35) in kW, resulting from the sum of: 38,8 kW for the module GAHP AR Plus, 21,0 kW for the module ACF60-00 HR, 98,4 kW for the module AY 100, 49,2 kW for the module AY 50 and 33,3 kW for the module AY 35.
4. (/6) = water circuit with three separate pipe pairs (heating/cooling, DHW and heat recovery).
5. (S) = GAHP/GA modules are equipped with a low-noise fan.
6. (MET) = the Link is preset for natural gas supply.
7. (CH) = the country of destination is Switzerland.

8. (WW) = the Link is equipped with oversized water pumps for each module on all circuits (base+separable and recovery).
9. () = not being a Link of GAHP GS/WS Plus this field is empty.

Figure 2.1 *Link description encoding matrix*

LINK	HEAT PUMPS	1ARH 1CFH 1HRH 1AYH100S 1AYH50S 1AYH35S	52	241	/6	S1	MET	CH	WW	
1			2	3	4	5	6	7	8	9

Field 1 – Heat pumps

Module	Label
GAHP A Plus	AHH
GAHP AR Plus	ARH
ACF	CFH
ACF HR	HRH
AY 100	AYH100
AY 50	AYH50
AY 35	AYG35
GAHP GS Plus	GSHH
GAHP WS Plus	WSH
ACF HT	HTH
ACF TK	TKH
ACF LB	LBH

Field 1 – LINK

Code	Series	Description	Composition
FGAA	LINK (+ description + quantities and models for base and any separate circuit)	HEAT PUMPS	A Plus
FGAR		HEAT PUMPS	AR Plus
FGCF		CHILLERS	ACF (no HR)
FGCF		CHILLER-HEATERS	HR
FEEC		CONDENSING BOILERS	AY
FHRE		HEAT PUMPS	HR-AR Plus-AY
FHAR		HEAT PUMPS	HR-AR Plus
FFRE		HEAT PUMPS	HR-AR Plus-ACF-AY
FARC		HEAT PUMPS	AR Plus-ACF
FARE		HEAT PUMPS	AR Plus-AY
FHFE		CHILLER-HEATERS	HR-ACF-AY
FHCF		CHILLER-HEATERS	HR-ACF
FGFE		CHILLER-HEATERS	ACF-AY
FGWS		HEAT PUMPS	WS Plus
FGGS		HEAT PUMPS	GS Plus
FRAE		HEAT PUMPS	AR Plus-A Plus-AY
FRFE		HEAT PUMPS	ACF-AR Plus-AY
FGHA		HEAT PUMPS	HR-A Plus
FAAR		HEAT PUMPS	A Plus-AR Plus
FAAE		HEAT PUMPS	A Plus-AY
FGHE		CHILLER-HEATERS	HR-AY

Field 2 (52) – Cooling output

Module	kW
ACF	17,7
HR	17,7
TK	17,7
HT	17,1
LB	13,3
AR Plus	16,9
GS Plus	16,4
WS Plus	18,7
A Plus	0
AY	0

Field 3 (241) – Heating output

Module	kW
ACF	0
HR	21,0
TK	0
HT	0
LB	0
AR Plus	38,8
A Plus	44,6
AY35	33,3
AY50	49,2
AY100	98,4
WS Plus	45,3
GS Plus	43,0

Field 4 (/6)

Pipes	Description
2 pipes	
4 pipes	/4
4+2 (HR+AY)	/6

Field 5 (S1)

Version	Description
standard	
low-noise	S
brushless	S1

Field 6 (MET)

Gas type	Description
G20	MET
G31	G31

Field 7 (CH)

Description	Country of destination
IT	Italy
DE	Germany
CH	Switzerland
AT	Austria
DK	Denmark
HU	Hungary
RO	Romania
RU	Russia
FA	France Air
FR	France
HR	Croatia
ES	Spain
CZ	Czech Republic
PL	Poland
EN	Generic export
BE	Belgium
NL	Netherlands
GB	United Kingdom

Field 8 (WW) – Water pumps

Type	Description: Link without HR – heating/cooling	Description: Link with HR or GS/WS – heating/cooling	Description: Link with HR or GS/WS – recovery/source
without water pumps	SC	N	N
oversized water pump	CW	W	W

Field 9

Version	Description
only for GS/WS indoor	INDOOR
only for GS/WS outdoor	OUTDOOR

1	2	3	4	5	6	7	8		= FIELD
LINK HEAT PUMPS 1ARH 1CFH 1HRH 1AYH100S 1AYH50S 1AYH35S	52	241	/6	S1	MET	CH	WW		= DESCRIPTION

3 FEATURES AND TECHNICAL DATA

3.1 FEATURES

The Link are gas-fired heating/cooling groups, to supply hot and/or chilled water. Each Link consists of a number of individual gas-fired heating/cooling modules (GAHP/GA/AY modules). The set of appliances and components is preassembled at the factory, forming a complete hydronic group already prepared to be connected to the system.

3.1.1 Application

Each Link, according to its configuration (Link condensing boilers, heat pumps, chillers, chiller-heaters) can simultaneously or alternately provide space heating, cooling, DHW production and heat recovery, according to the needs of each installation, with a considerable extension of heating and cooling output. The various hydronic models are suitable for all heating and cooling systems operating with hot and/or chilled water, with standard terminals (e.g. radiators, fan coils, radiant panels, fan heaters, air handling units, DHW buffer tanks, swimming pool heat exchangers, ...), including process systems (industrial heat exchangers).

3.1.2 Manufacturing features

Each Link, in addition to the GAHP/GA/AY gas-fired heating/cooling modules, consists of:

- outlet/inlet stainless steel hydraulic manifolds, insulated with rigid cups lined with aluminum sheet
- galvanized steel gas outlet manifold
- flexible couplings of individual modules to hydraulic and gas manifolds
- condensate drain manifold (only if there are at least two condensing appliances GAHP A Plus/GAHP GS/WS Plus/AY)
- electrical panel with protection devices (2 electrical panels with more than 6 modules)
- bearing structure with galvanized steel sections

The Link equipped with water pumps are also equipped with a check valve, mounted downstream of each water pump, and a protection for the pump body.

3.1.3 Configuration

The gas heating/cooling modules that make up a Link can be:

- GAHP appliances: absorption heat pumps versions A/AR/GS/WS
- GA appliances, absorption chillers versions ACF/HR/TK/HT/LB
- AY appliances, versions AY 35/AY 50/AY 100, condensing boilers

GAHP and GA appliances can be further distinguished into:

- aerothermal appliances (A, AR, ACF, HR, TK, HT, LB)
- hydrothermal appliances (WS) and geothermal appliances (GS)

The number of modules is variable:

- from 2 to 5 in the case of GAHP/GA only
- from 2 to 7 in the case of GAHP/GA and AY

The Link with aerothermal appliances must be installed exclusively outdoors. In contrast, the others, whether equipped with AY boilers or not, can be installed both outdoors and indoors (using the specific indoor versions).

The aerothermal modules of Links may be in configuration:

- with standard fans
- with silenced fans (S or S1)

As regards the water circuit, the Link can be:

- Without water pumps or with oversize water pumps.
- 2, 4 or 6 pipes, ie 1, 2 or 3 pairs of delivery/return hydraulic collectors/connections for hot and/or cold water, connected as needed.

3.2 LINK COMPOSITION RULES

Online product configurator

The best way to configure a Link for your project is to use the online product configurator described in Section C01.19.

The rules according to which the individual GAHP/GA/AY modules are assembled on the Link are defined below.

- Up to 5 GAHP/GA modules can be provided on the Link.
- Up to 2 boilers AY can be provided on a Link of boilers only.
- Up to 4 AY boilers can be provided on a Link that also includes GAHP/GA modules.
- The total power of the AY boilers provided on the Link can reach up to 205 kW.
- Link with GAHP GS/WS Plus modules do not allow other types of modules.
- If two or more condensing modules (GAHP A Plus, GAHP GS/WS Plus, AY) are included in the Link, the Link is equipped with a condensate drain manifold.
- If there are more than 6 modules on the Link, there are two electrical panels.
- With GA ACF HR modules the Link will necessarily be a 4-pipe version (if there are no modules on the separate circuit) or a 6-pipe version (if there are modules on the separate circuit). The connections for the recovery circuit of the GA ACF HR modules are on the left, except in the case of Link of only GA ACF HR modules where the connections for the recovery circuit are also on the right (Paragraph 3.4 *p. 4*).
- For Link equipped with water pumps, these are always mounted on the inlet pipes and are equipped with check valves.
- If at least one boiler AY is provided on the Link, the Link must be equipped with water pumps.
- Only GAHP A Plus heat pumps or AY boilers can be provided on the separate circuit.
- You can choose the type and number of modules to be connected on the separate circuit (e.g. if there are two AY 50 boilers on the Link, you can choose to connect only one of them on the separate circuit, while the other will be connected on the base circuit).
- If there are 2 AY 100 boilers connected to the same water circuit of 3 GAHP/GA modules, the boilers are placed in line with each other.
- If there are 2 AY 100 boilers and 4 GAHP/GA modules, at least one AY 100 boiler must be connected to the separate circuit.
- In the case of Link of condensing boilers only (maximum 2 AY boilers), reduced depth bases (530 mm) are used.

If the configuration you are interested in is not possible via the online product configurator, you should contact Robur technical service to assess the possibility of a customised configuration.

3.3 CIRCULATING PUMPS

3.3.1 Link without water pumps

If the Link is without circulators, It must be installed on the hydraulic/primary circuit at least one circulation pump, suitably selected and rated (by the designer/installer).
The circulation pump (flow and head) must be selected and installed based on pressure drops of plumbing/primary circuit (piping + components + exchange terminals + appliance).
Refer to Paragraph 3.7.3 *p. 15* for appliance pressure drops.
The Link without water pumps, consisting of mixed modules, i.e., some that produce hot water and others that produce cold water on the same circuit, are equipped with isolation valves on the modules that produce cold water, to prevent water from circulating inside them during heating mode.

If at least one boiler AY is provided on the Link, it is not possible to install the Link without independent water pumps for each module.

3.3.2 Link with water pumps

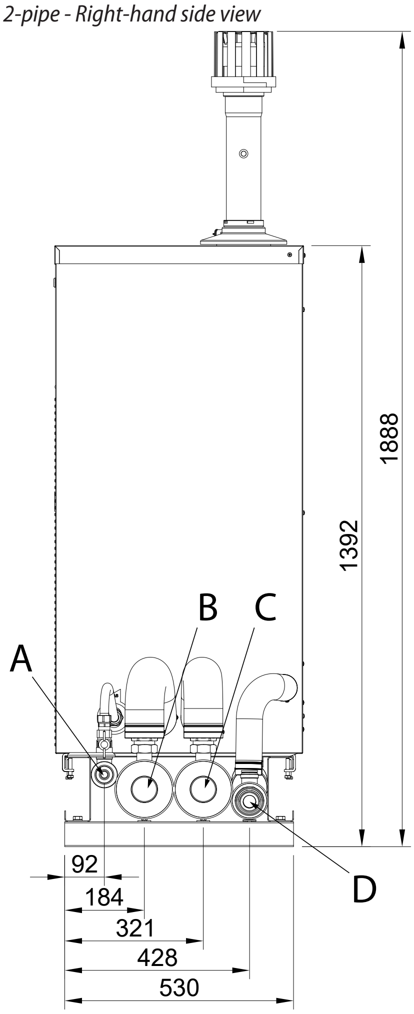
In Link already equipped with water pumps, each individual GAHP/GA/AY module that is part of the Link has an individual, independent, high-efficiency fixed-flow water pump.

The water pumps of the GAHP/GA modules are installed externally and equipped with a special protective cover. For the AY modules, the water pumps are installed inside the module itself.

For the characteristics of the water pumps available for Link, please refer to Section C01.04.

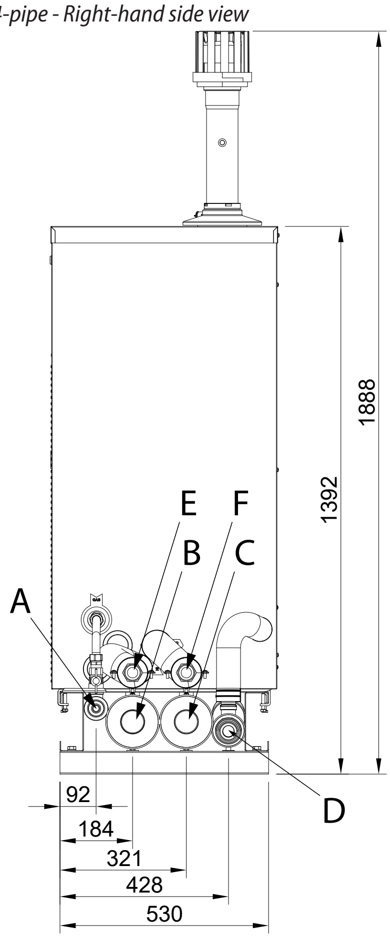
3.4 HYDRAULIC/GAS CONNECTIONS

Figure 3.1 *Position of connections for a Link of condensing boiler only - 2-pipe - Right-hand side view*



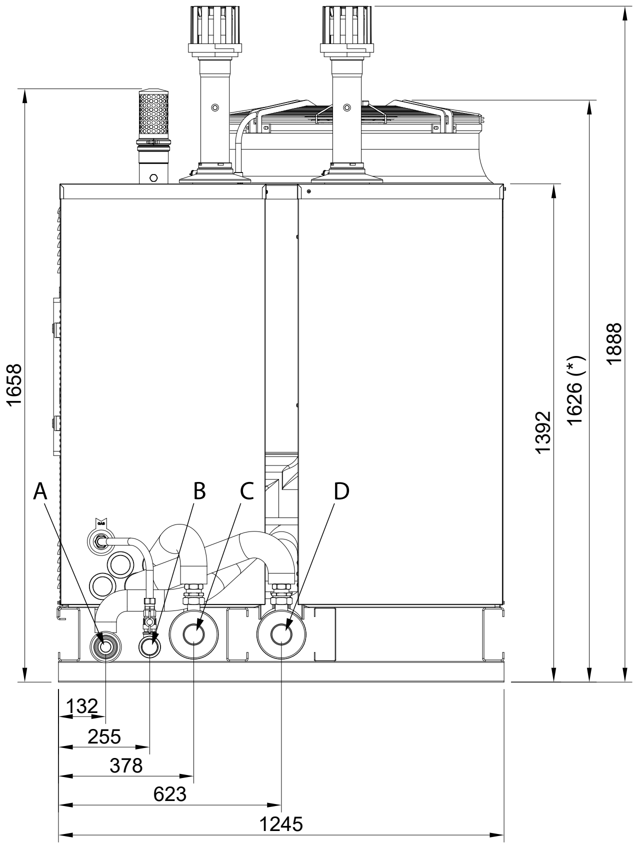
A Gas connection [1 1/2" F]
B Hot water return [2" M]
C Hot water outlet [2" M]
D Condensate drain connection [1" F]. Sloping manifold, must be connected on the right side

Figure 3.2 *Position of connections for a Link of condensing boiler only - 4-pipe - Right-hand side view*



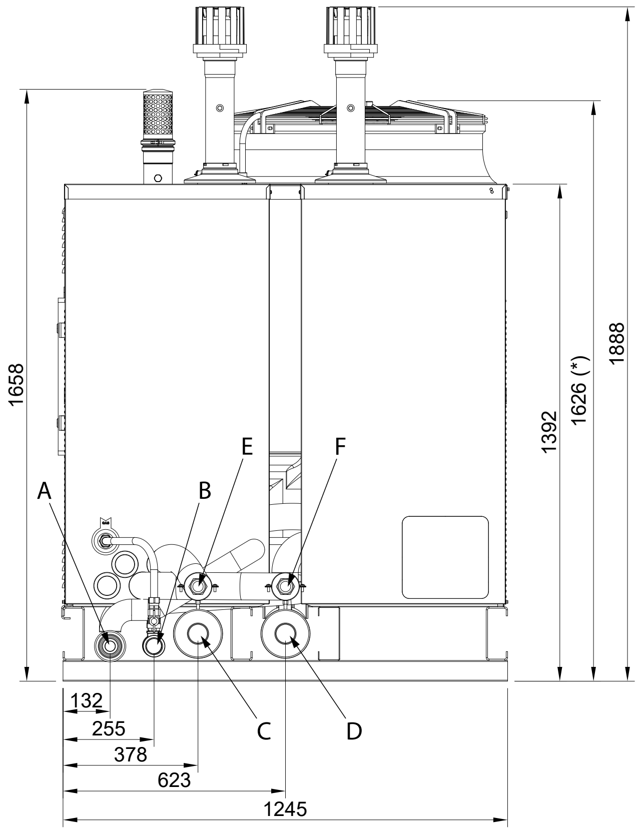
A Gas connection [1 1/2" F]
B Hot water return [2" M]
C Hot water outlet [2" M]
D Condensate drain connection [1" F]. Sloping manifold, must be connected on the right side
E Separate boiler hot water inlet [1 1/4" F for AY 35 and AY 50, 1 1/2" F for AY 100]
F Separate boiler hot water outlet [1 1/4" F for AY 35 and AY 50, 1 1/2" F for AY 100]

Figure 3.3 *Position of connections for a 2-pipe Link - Right-hand side view*



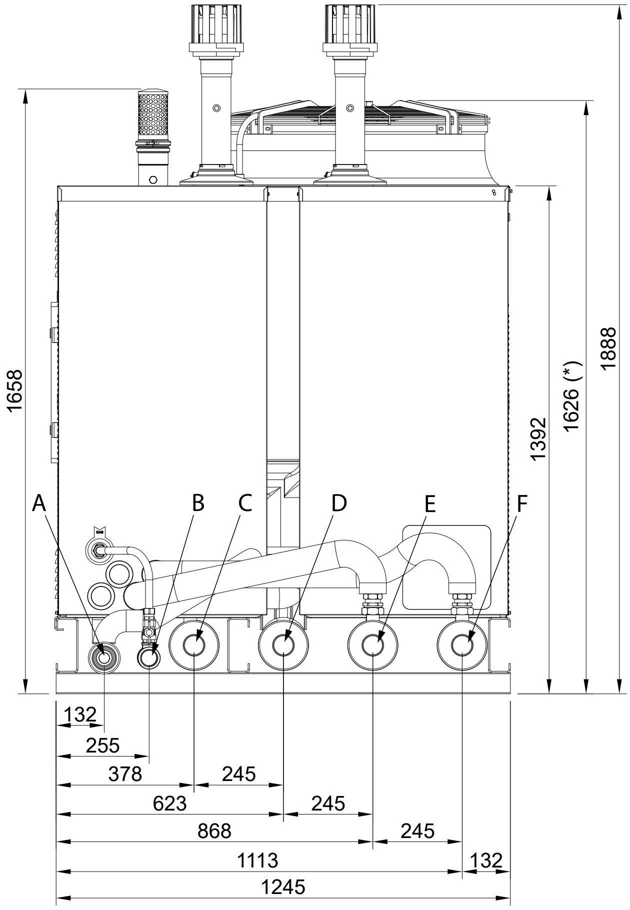
A Condensate drain connection [1" F] (only for Link with more than one condensing module). Sloping manifold, must be connected on the right side
B Gas connection [1 1/2" F]
C Hot/Cold water outlet [2" M]
D Hot/Cold water inlet [2" M]
* The height of standard models is 1562 mm

Figure 3.4 *Position of connections for a 4-pipe Link with a single AY boiler on the separate circuit - Right-hand side view*



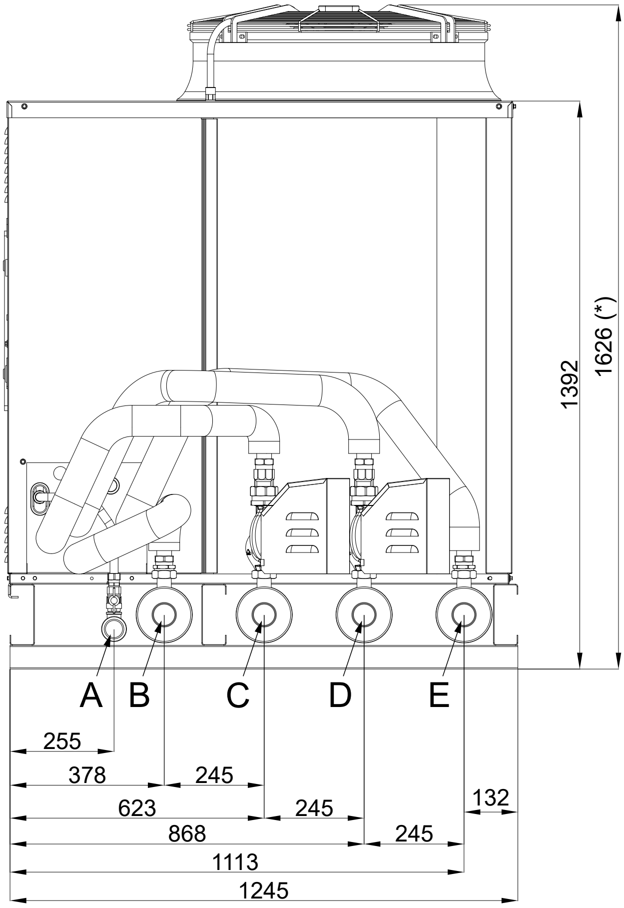
A Condensate drain connection [1" F] (only for Link with more than one condensing module). Sloping manifold, must be connected on the right side
B Gas connection [1 1/2" F]
C Hot/Cold water outlet [2" M]
D Hot/Cold water inlet [2" M]
E Separate boiler hot water outlet [1 1/4" F for AY 35 and AY 50, 1 1/2" F for AY 100]
F Separate boiler hot water inlet [1 1/4" F for AY 35 and AY 50, 1 1/2" F for AY 100]
* The height of standard models is 1562 mm

Figure 3.5 *Position of connections for a 4-pipe Link with several AY boilers on the separate circuit - Right-hand side view*



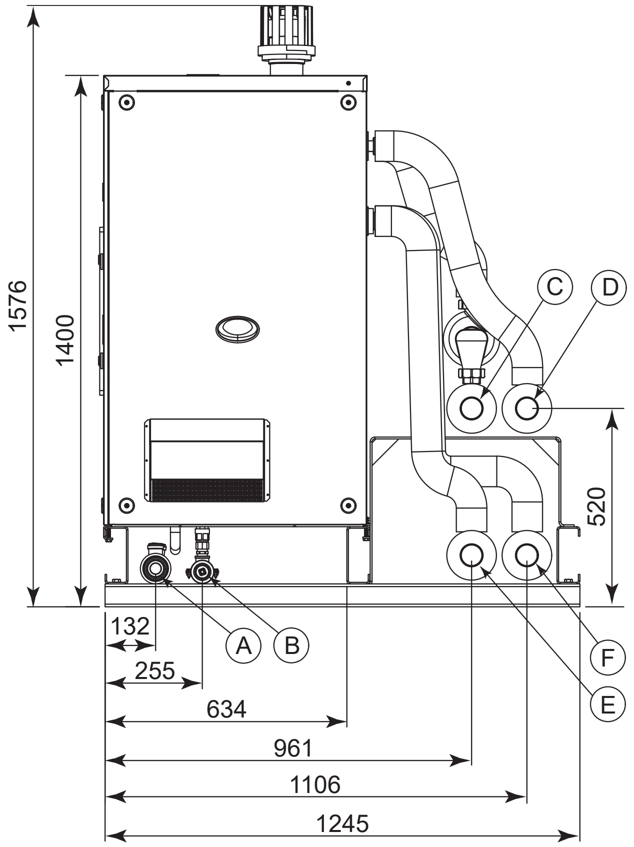
A Condensate drain connection [1" F]. Sloping manifold, must be connected on the right side
B Gas connection [1 1/2" F]
C Hot/Cold water outlet [2" M]
D Hot/Cold water inlet [2" M]
E Separate boilers hot water inlet [2" M]
F Separate boilers hot water outlet [2" M]
* The height of standard models is 1562 mm

Figure 3.6 *Position of connections for a 4-pipe Link of ACF HR only*



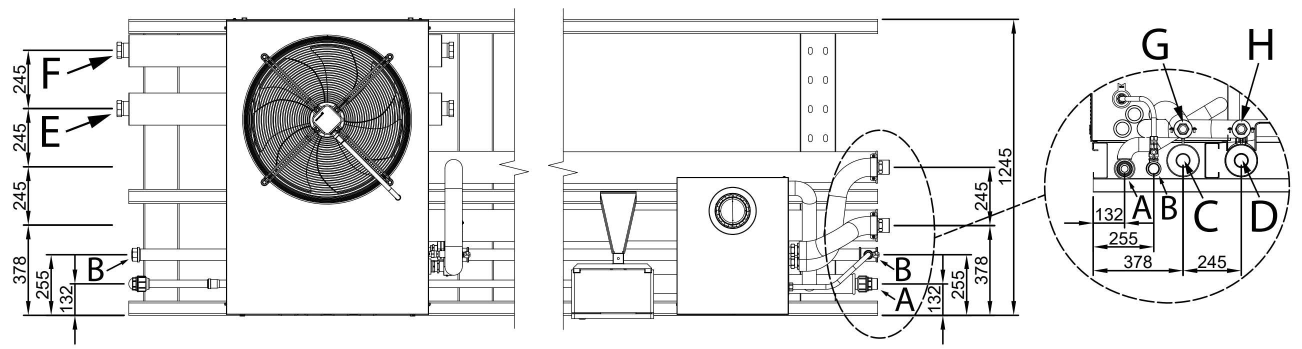
A Gas connection [1 1/2" F]
B Cold water outlet [2" M]
C Cold water inlet [2" M]
D ACF HR heat recovery hot water inlet [2" M]
E ACF HR heat recovery hot water outlet [2" M]
* The height of standard models is 1562 mm

Figure 3.7 *Position of connections for a Link of GAHP GS/WS - Right-hand side view*



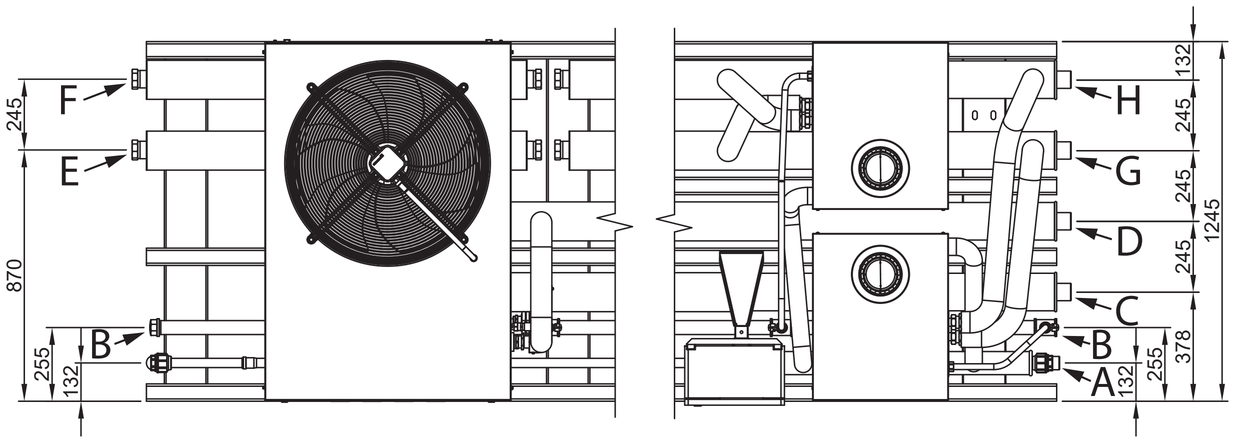
A	Condensate drain connection [1" F]. Sloping manifold, must be connected on the right side	C	Hot water return [2" M]
		D	Cold water inlet [2" M]
		E	Hot water outlet [2" M]
B	Gas connection [1 1/2" F]	F	Cold water outlet [2" M]

Figure 3.8 *Position of connections for a 6-pipe Link with a single AY boiler on the separate circuit - Upper view*



A	Condensate drain connection [1" F] (only for Link with more than one condensing module). Sloping manifold, must be connected on the right side	F	ACF HR heat recovery hot water outlet (left connection only) [2" M]
B	Gas connection [1 1/2" F]	G	Separate boiler hot water inlet [1 1/4" F for AY 35 and AY 50, 1 1/2" F for AY 100]
C	Hot/Cold water outlet [2" M]	H	Separate boiler hot water outlet [1 1/4" F for AY 35 and AY 50, 1 1/2" F for AY 100]
D	Hot/Cold water inlet [2" M]		
E	ACF HR heat recovery hot water inlet (left connection only) [2" M]		

Figure 3.9 *Position of connections for a 6-pipe Link with several AY boilers on the separate circuit - Upper view*



A Condensate drain connection [1" F] (only for Link with more than one condensing module). Sloping manifold, must be connected on the right side
B Gas connection [1 1/2" F]
C Hot/Cold water outlet [2" M]
D Hot/Cold water inlet [2" M]
E ACF HR heat recovery hot water inlet (left connection only) [2" M]
F ACF HR heat recovery hot water outlet (left connection only) [2" M]
G Separate boilers hot water inlet (right-hand connection only) [2" M]
H Separate boilers hot water outlet (right-hand connection only) [2" M]

3.5 DIMENSIONS

The dimensions are given for the maximum footprint configuration. For the specific dimensions of the Link please refer to the technical data sheet (Paragraph 3.7 *p. 14*) or the Robur technical service.

Please refer to Paragraph 3.4 *p. 4* for the depth and detail of hydraulic connections.

Figure 3.10 *Dimensions of a Link with 2 GAHP/GA modules*

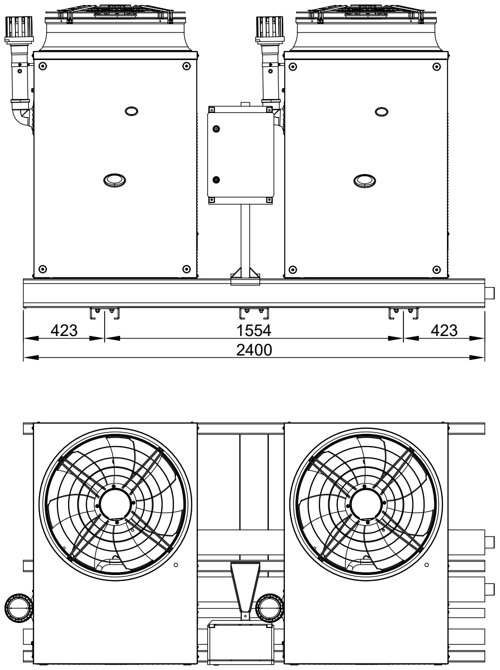


Figure 3.11 *Dimensions of a Link with 3 GAHP/GA modules*

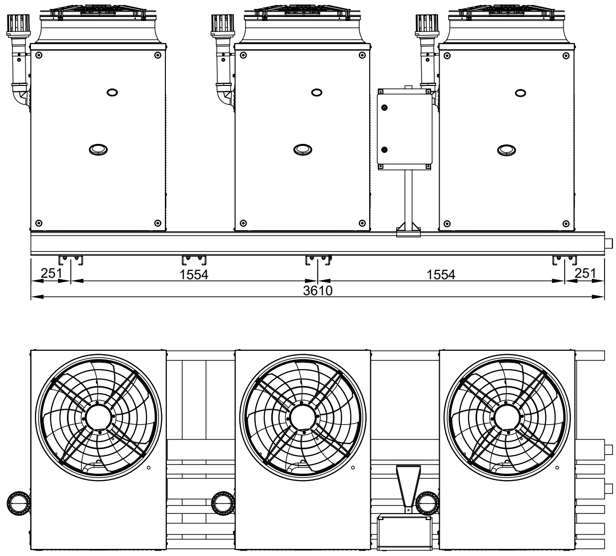


Figure 3.12 *Dimensions of a Link with 4 GAHP/GA modules*

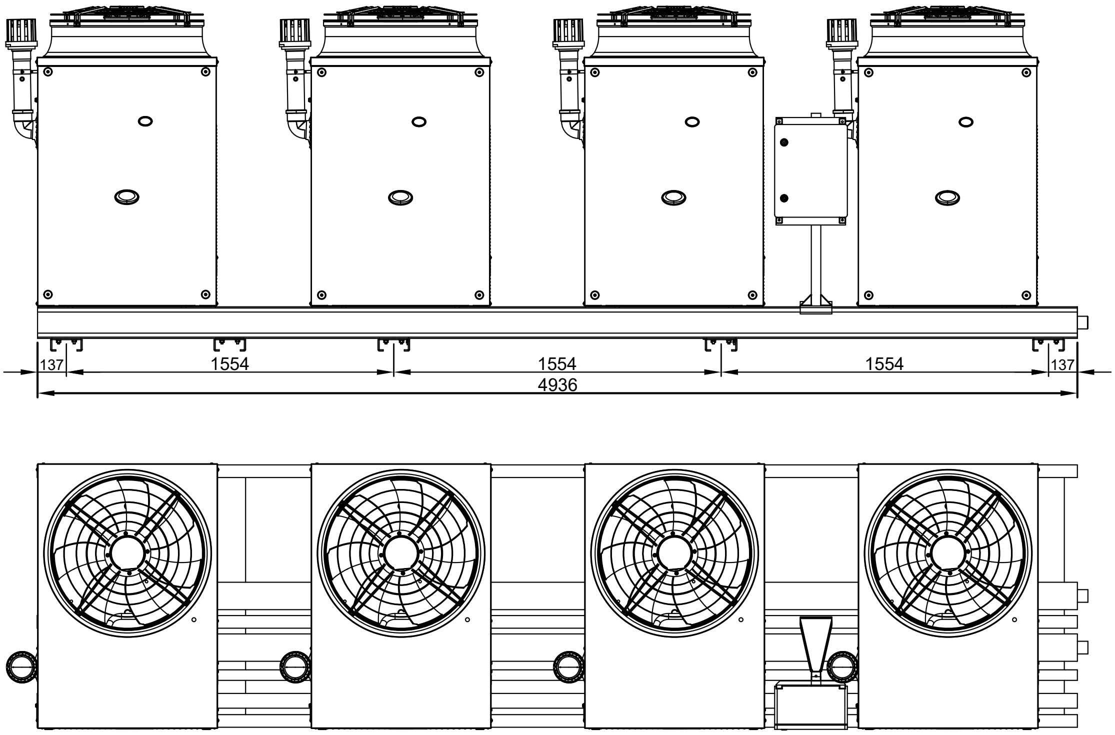


Figure 3.13 *Dimensions of a Link with 5 GAHP/GA modules*

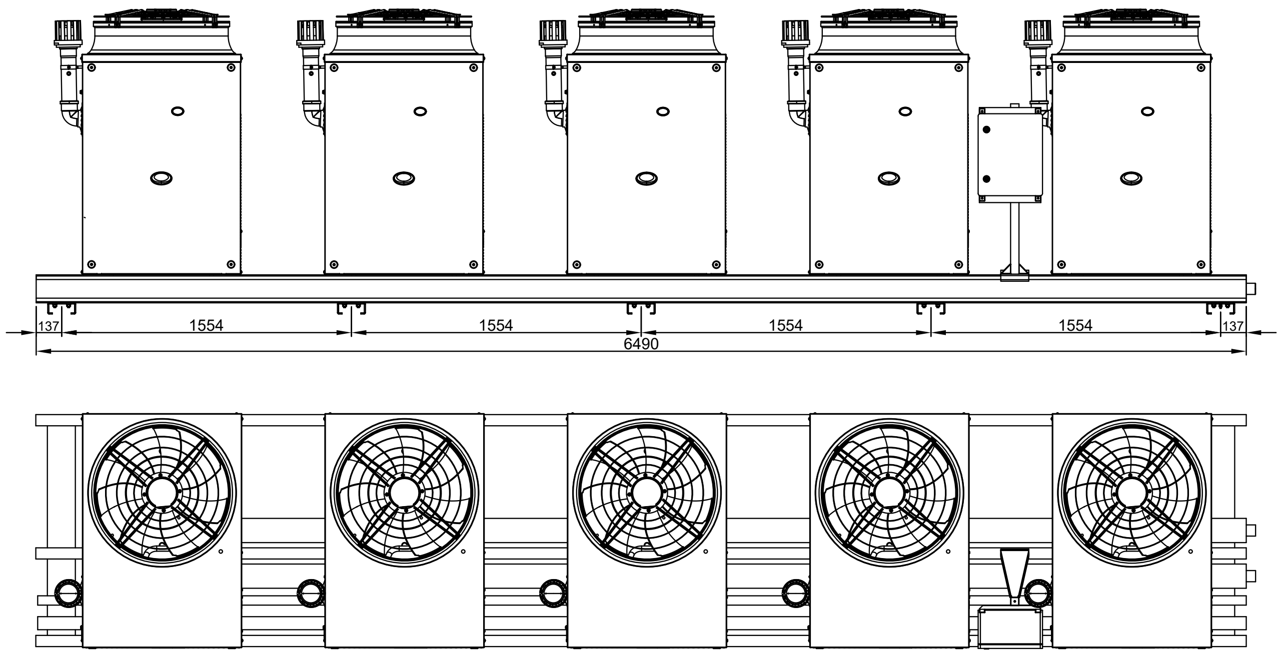


Figure 3.14 *Dimensions of a Link of 2 AY 35/50 condensing boilers*

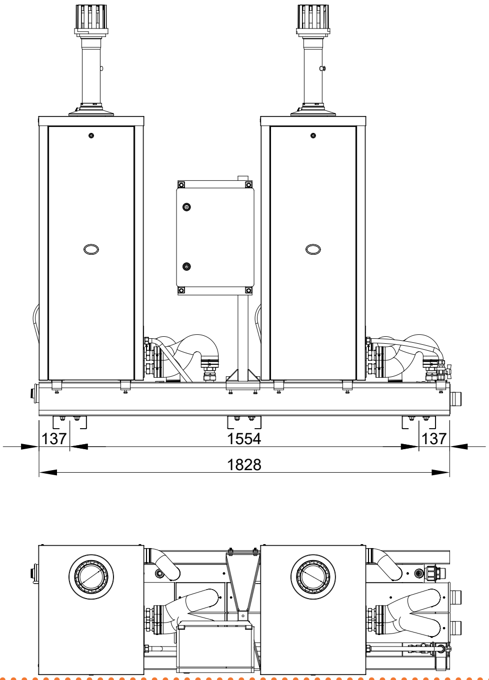


Figure 3.15 *Dimensions of a Link of 1 AY 35/50 + 1 AY 100 condensing boilers*

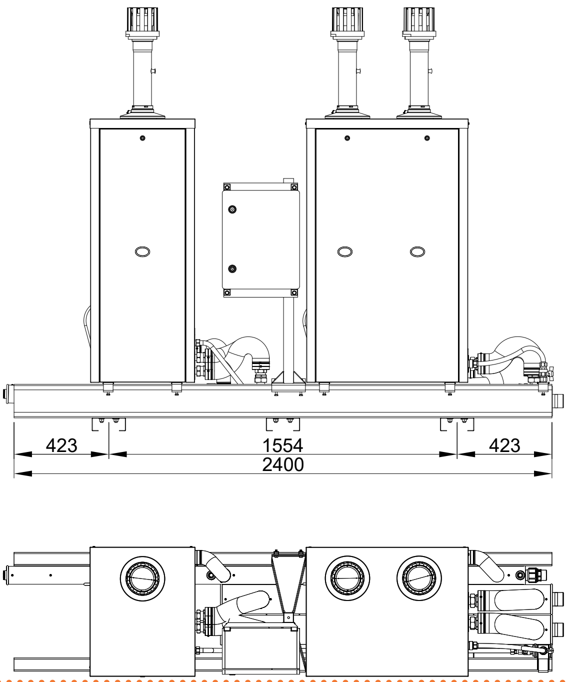


Figure 3.16 *Dimensions of a Link of 2 AY 100 condensing boilers*

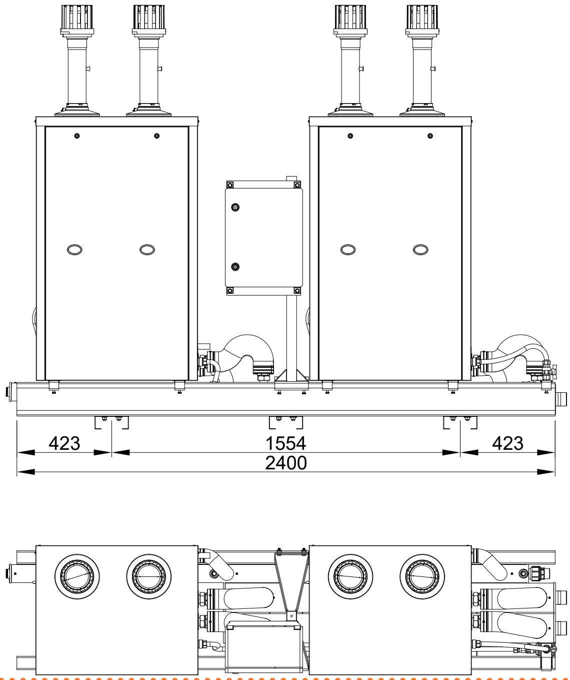


Figure 3.17 *Dimensions of a Link with 1 ACF/A/AR + 1 AY 100 + 1 AY 35/50 - front and top view*

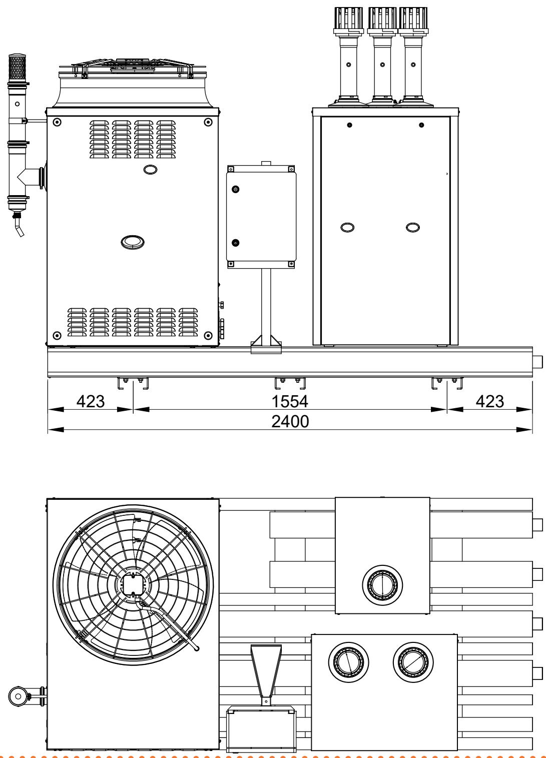


Figure 3.18 *Dimensions of a Link with 1 ACF/A/AR + 1 AY 100 + 2 or 3 AY 35/50 - front and top view*

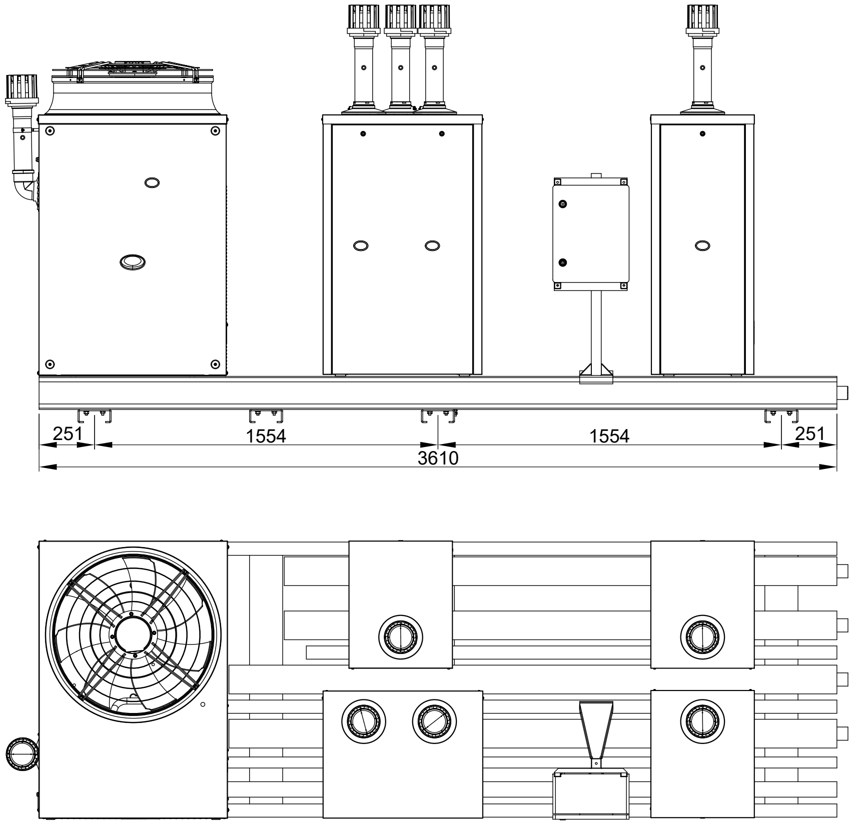


Figure 3.19 *Dimensions of a Link with 2 ACF/A/AR + 2 AY 100 - front and top view*

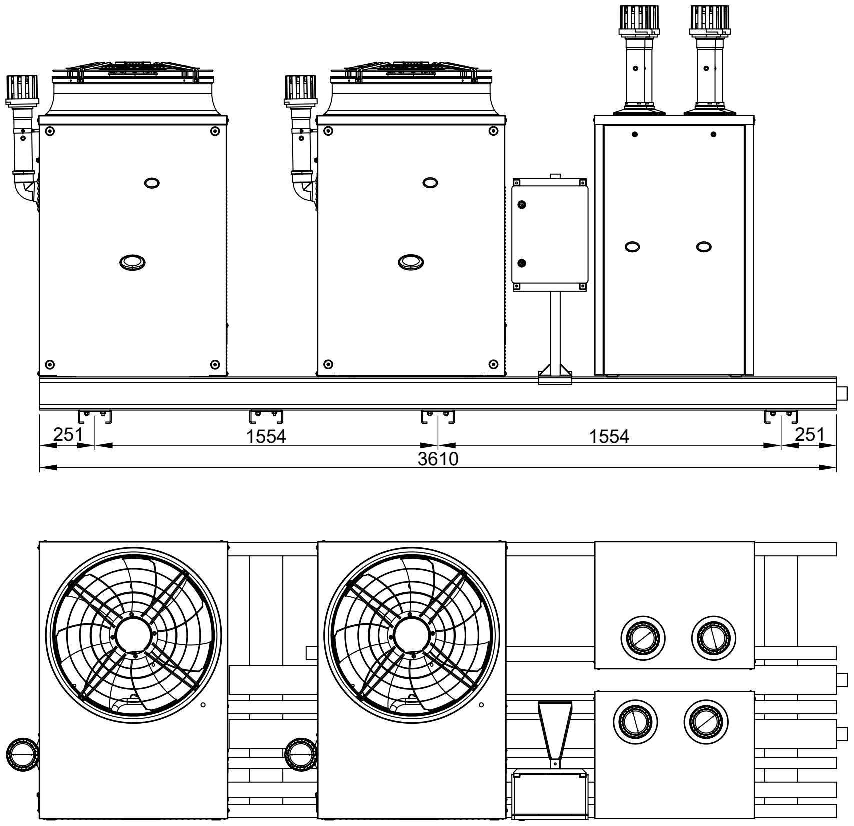
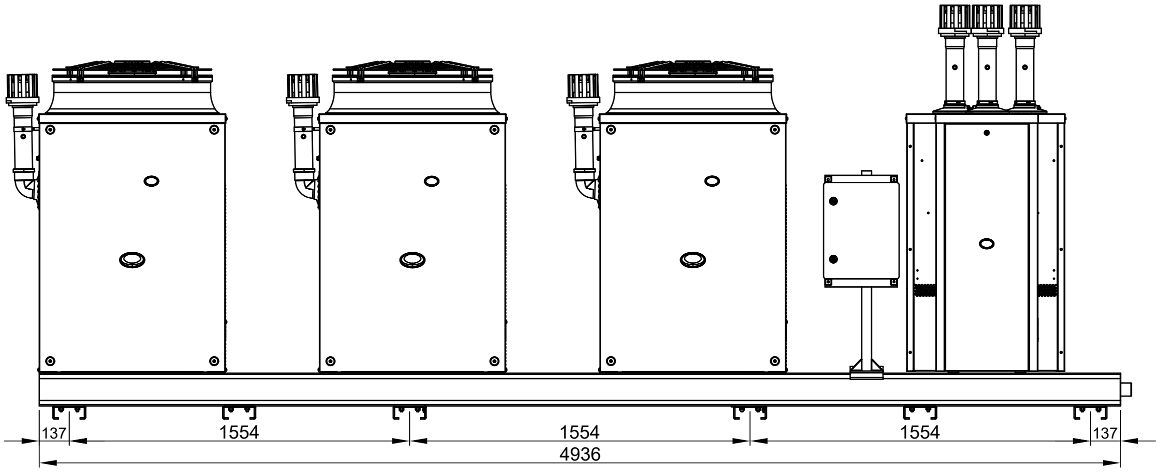


Figure 3.20 *Dimensions of a Link with 3 ACF/A/AR + 1 AY 35/50 + 1 AY 100 - front and top view*



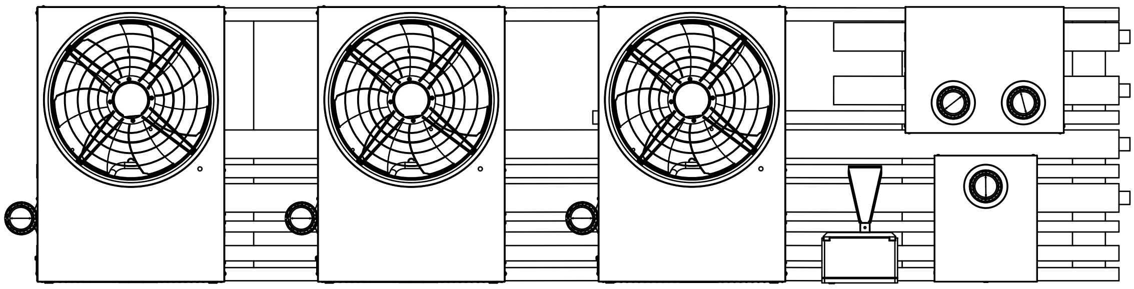
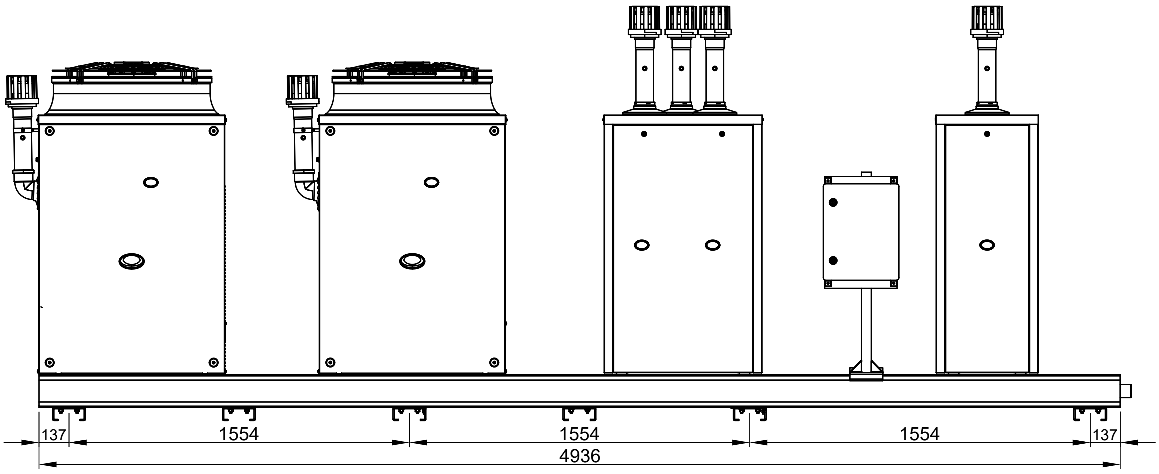


Figure 3.21 *Dimensions of a Link with 2 ACF/A/AR + 2 or 3 AY 35/50 + 1 AY 100 - front and top view*



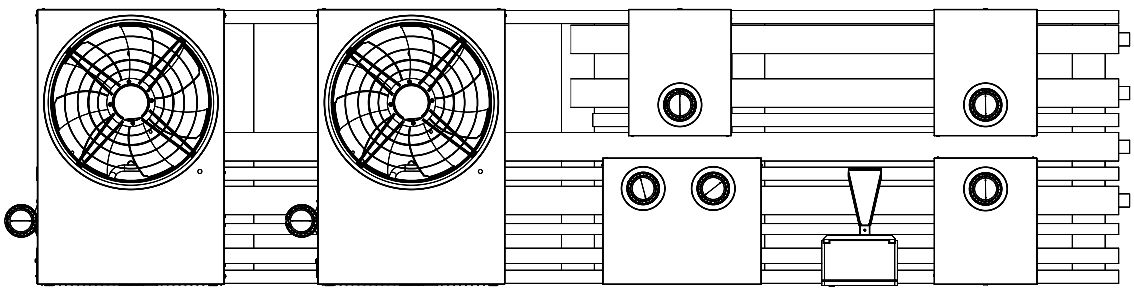


Figure 3.22 *Dimensions of a Link with 3 ACF/A/AR + 3 or 4 AY 35/50 - front and top view*

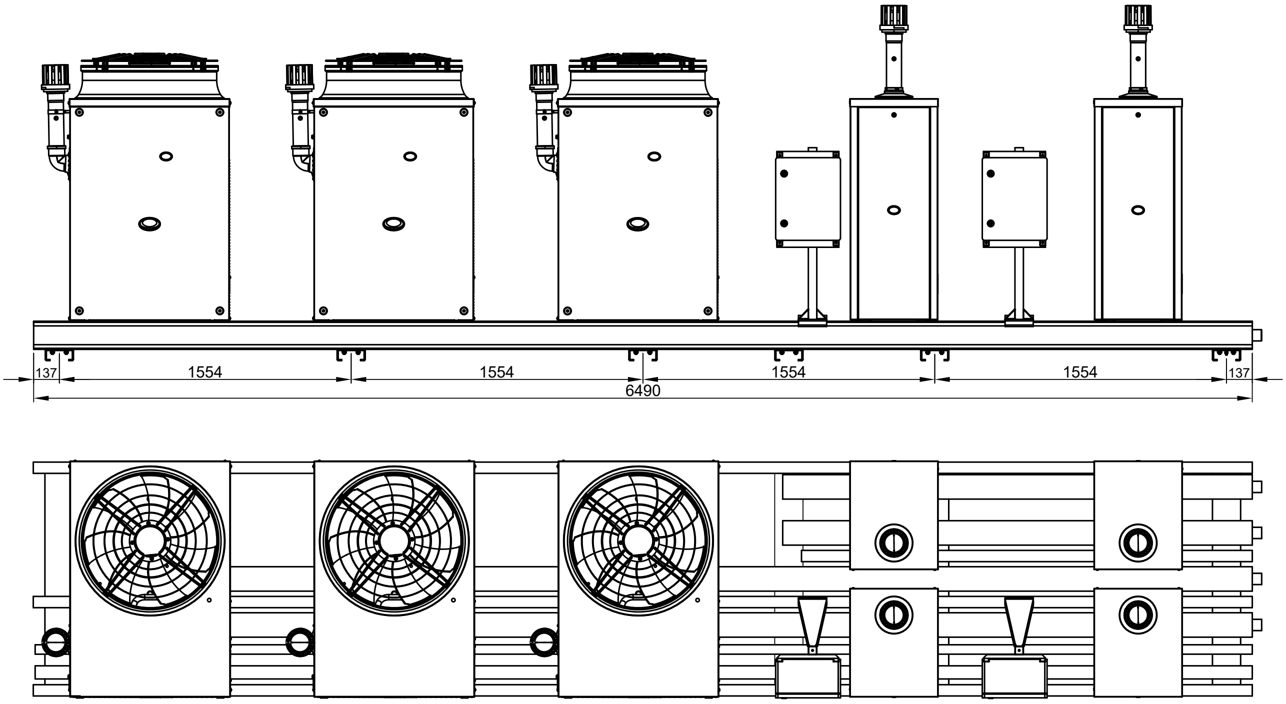


Figure 3.23 *Dimensions of a Link with 3 ACF/A/AR + 2 AY 100 - front and top view*

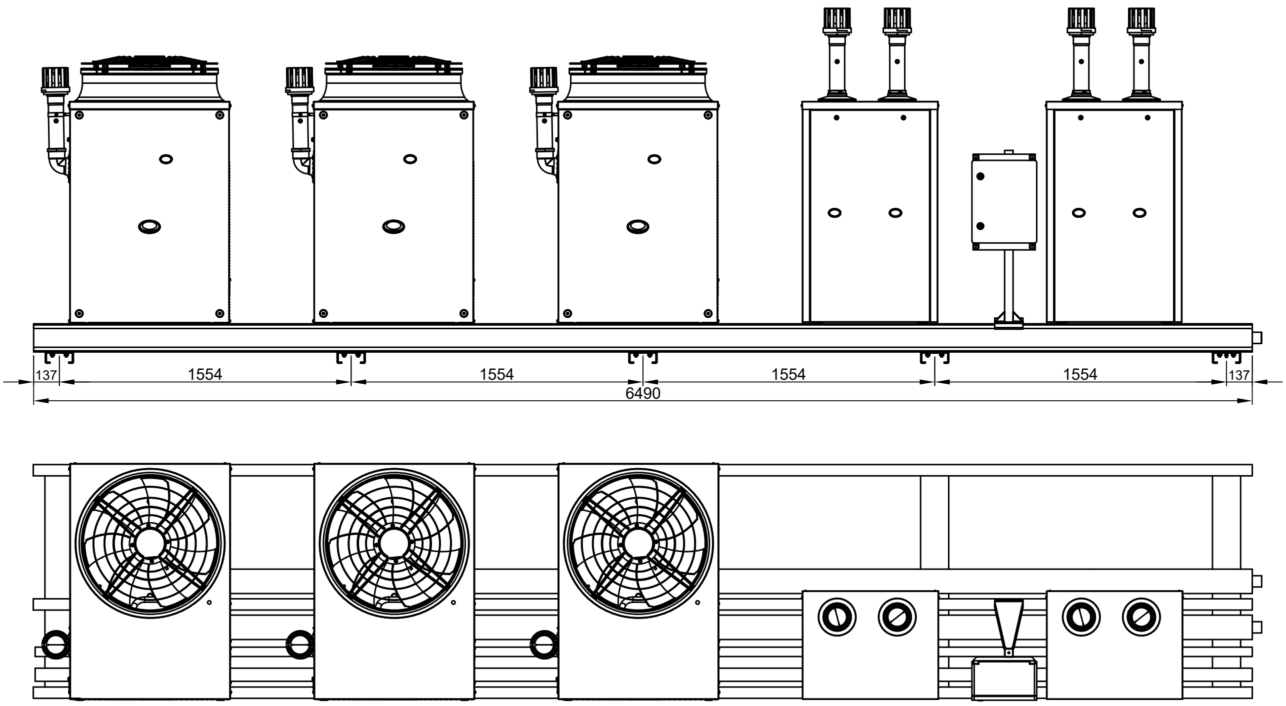
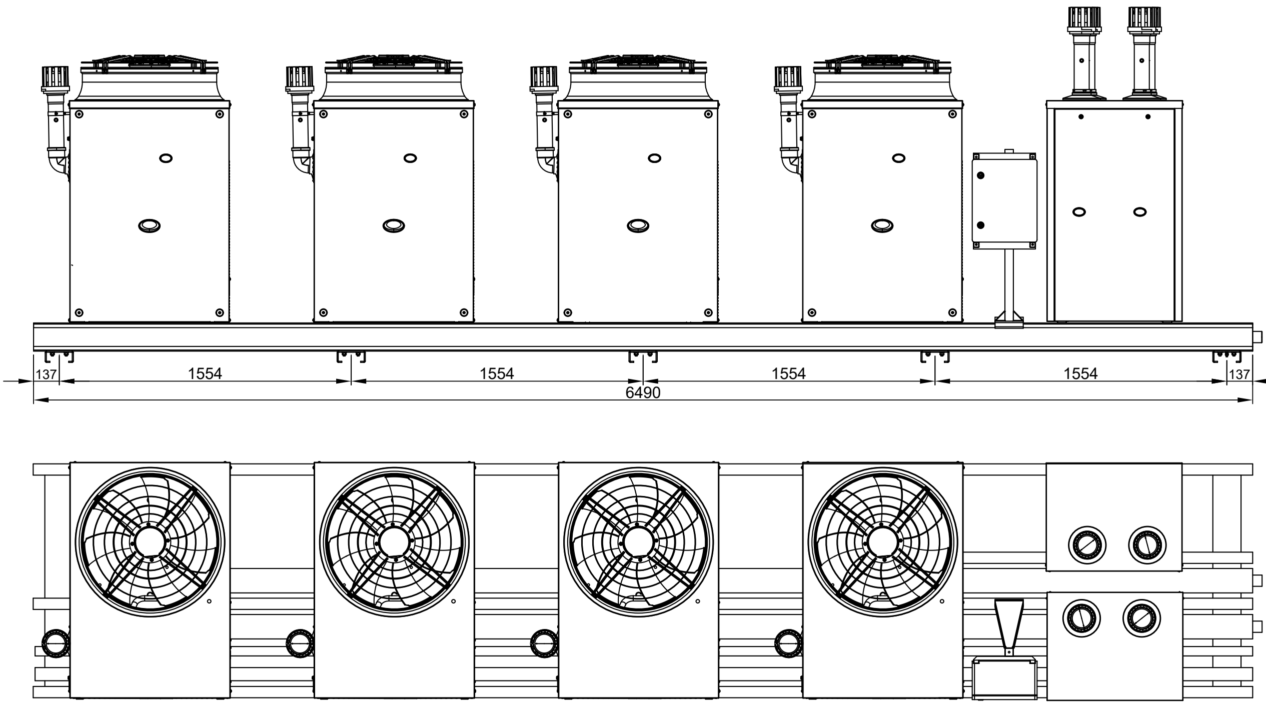


Figure 3.24 *Dimensions of a Link with 4 ACF/A/AR + 1 AY 100 + 1 AY 100S - front and top view*



3.6 CONTROLS

3.6.1 Control device

The Link may only work if it is connected to a control device, selected from:

- DDC panel
- CCI panel

3.6.2 DDC control panel

The DDC control panel can manage one or more Robur appliances in modulating mode (GAHP heat pumps, AY boilers) or ON/OFF mode (GA chillers).
DDC control panel 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 water pumps,...).

For more details see Section C01.11.

3.6.3 CCI control

The CCI control panel can manage up to 3 GAHP appliances in modulating mode (i.e. only GAHP A Plus/GAHP GS/WS Plus for heating only).

For more details see Section C01.11.

3.7 TECHNICAL DATA

Technical data for each Link are customised to the specific module combination required.
The Link data sheet is available:

- on the product configurator, described in Section C01.19
- in the documentation supplied with the commercial offer
- by sending a request to the Robur technical service or the sales network

Please refer to the technical data of the individual GAHP/GA/AY modules making up the Link (available in Section B of the manual) for more details on the characteristics of each individual module.

3.7.1 Protection rating

The Link has a protection rating IP 25.

3.7.2 Hydraulic connections

The configuration of the hydraulic connections depends on the composition of the Link. Refer to Paragraph 3.4 *p. 4*.
The following Table 3.1 *p. 14* shows the dimensions of the hydraulic and condensate drain connections.

Table 3.1 *Connections diameters*

Gas connection	1 1/2" F
Cold/hot water connections	2" M
Condensate drain connection	1" F
Connection of a single AY on the separate circuit	1 1/4" F for AY 35 and AY 50 1 1/2" F for AY 100
Connection of more AY on the separate circuit	2" M
Recovery circuit connection	2" M
AY safety valve drain	outside Ø 20 mm, inside Ø 14 mm

The hydraulic connections of the base circuit (and of the separate circuit, if any) are only provided on the right side of the Link, as is any condensate drain for condensing modules. The hydraulic connections of the recovery circuit, if any, are only provided on the left side of the Link, except for Link of GA ACF HR modules only, where the hydraulic connections of the recovery circuit are also on the right.
Gas connection is always possible on both sides of the Link, ex-

cept for Link of AY boilers only, where the gas connection is only provided on the right side of the Link.

Connect the outlet of each safety valve of any boiler on the Link to a suitable drain. The manufacturer is not liable for any damage caused by the opening of the safety valve in the event of system overpressure.

3.7.3 Pressure drops

The available head at the hydraulic connections of the Link, published in the technical data for Link with independent water pumps, is considered net of the internal pressure drops of the appliances and water manifolds.

Table 3.2 *p. 15* provides the minimum residual head at nominal flow in the configuration with the highest pressure drops.

Table 3.2 *Minimum residual head at nominal flow rate*

	residual head [bar]
Oversize water pumps	0,34
Oversized water pumps (only for the heating circuit of the GAHP WS Plus modules)	0,20

In this way it is possible to perform an immediate preliminary check of the selected independent circulating pump's suitability with respect to the expected system pressure drops:

- ► If the residual head indicated is sufficient, no further checks are necessary.
- ► If the residual head indicated is not sufficient, it will be necessary to calculate the actual pressure drop of the specific Link, based on the information provided in Paragraph 3.7.3.1 *p. 15*, and check the actual head of the water pumps under the design conditions. For more detailed data on the flow rate and head of the water pumps, refer to Section C01.04.

In a Link without water pumps, the primary circuit water pump must be appropriately selected and sized, considering both the pressure drops associated with the individual modules and those resulting from preassembly, calculated on the basis of the information provided in Paragraph 3.7.3.1 *p. 15* below.

3.7.3.1 Preassembled group pressure drop calculation

The pressure drop associated with the specific Link is given by the sum of the pressure drops of the module with the highest pressure drops and those resulting from preassembly.

Please refer to Section B for the pressure drop data of the individual modules in the Link.

Pressure drop associated to preassembly

This value derives from the pressure drop associated with the water manifolds supplied with the preassembled group; it is constant and equal to 0,02 bar.

Module pressure drop

The pressure drop of the individual modules should not be added together; instead, it should be considered in relation to the module with the highest value under the operating conditions. This is because the modules are hydraulically parallel on the manifolds.

3.7.4 Performances

Please refer to Section B for heating/cooling output and GUE efficiency of the individual modules in the Link.

4 DESIGN

4.1 APPLIANCE POSITIONING

Please refer to Section C01.02.

4.2 PLUMBING DESIGN

The system must be designed and realized in a congruent way with the features and functionality of the Link.

For the appropriate system design, the following must be considered:

- ► the properties of the individual heating/cooling appliances (GAHP/GA/AY modules) that make up the Link
- ► the configuration of manifolds and hydraulic connections
- ► the presence (or not) of water pumps

Please refer to Section C01.03.

4.3 WATER PUMP

The Link can be supplied in either a configuration without water pumps or with independent oversized water pumps for each module making up the Link.

For further information please refer to Paragraph 3.3 *p. 4*.

4.4 SYSTEM WATER QUALITY

Please refer to Section C01.05.

4.5 ANTIFREEZE PROTECTION

Please refer to Section C01.06.

4.6 FUEL GAS SUPPLY

Please refer to Section C01.08.

4.7 FLUE GAS EXHAUST

Compliance with standards

The modules that make up a Link are approved for connection to a flue gas exhaust for the types listed in the technical data in Section B relating to the specific module.

4.7.1 Flue gas exhaust connection

The characteristics of the flue gas exhaust connections of the individual modules making up the Link are summarised in Section C01.09.

Please refer to Section B for the position of the flue gas exhaust connection of the individual modules in the Link.

4.7.2 Flue gas exhaust kit

The individual GAHP/AY modules making up the Link are fitted as standard with a flue gas exhaust kit, to be installed by the installer, with the exception of the indoor versions of GAHP GS/WS Plus modules.
Please refer to Section B for more details on the composition of the flue gas exhaust kit of the individual modules in the Link.

4.7.3 Possible flue

If necessary, the Link can be connected to one or more flue(s).

For more details see Section C01.09.

4.8 FLUE GAS CONDENSATE DRAIN

If condensing modules (GAHP A Plus, GAHP GS/WS Plus, AY) are included in the Link, condensate is produced from flue gases, which must be evacuated in compliance with current regulations.

Please refer to Section C01.09.

4.9 ELECTRICAL AND CONTROL CONNECTIONS

Please refer to Section C01.10.

4.10 EXAMPLE DIAGRAMS

Please refer to Section C01.13.

4.11 ACOUSTIC

Please refer to Section C01.14.

1 SECTION C CONTENTS - DESIGN SUGGESTIONS

Section of the Abso Pro design manual	QRCode
Section C01 - Abso Pro design	
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1 SECTION C01 CONTENTS - ABSO PRO DESIGN

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1 SELECTION CRITERIA

The main features of the appliances are summarised below to help you quickly identify the type of appliance that best meets your project needs.
The types of available appliances are divided into:
- Individual GAHP/GA/AY appliances
- Link
- Link and hybrid system

Please refer to Section B for a more detailed description of the characteristics of each appliance.

1.1 INDIVIDUAL APPLIANCES

The individual appliances are further divided into:
- GAHP Plus heat pumps
- GA chillers and chiller-heaters
- AY boilers

Multiple individual appliances can be provided on the same system. Still, it should be noted that choosing a Link offers several advantages in terms of simplifying design and installation, as well as improving control effectiveness.

1.1.1 GAHP Plus heat pumps

Heat pumps in the GAHP Plus range are:
- GAHP A Plus: gas and aerothermal renewable energy absorption heat pump, modulating and condensing, for hot water production up to an outlet temperature of 65 °C (70 °C at 50% of maximum thermal input), for outdoor installation. Nominal heat output (A7W35): 44,6 kW.
- GAHP AR Plus: gas and aerothermal renewable energy absorption heat pump, reversible, for hot water production up to an outlet temperature of 60 °C (65 °C at 50% of maximum thermal input) and alternatively cold water down to a delivery temperature of 3 °C, for outdoor installation. Nominal heat output (A7W35): 38,8 kW. Nominal cooling output (A35W7): 16,9 kW.
- GAHP GS Plus: gas and geothermal renewable energy absorption heat pump, modulating and condensing, for alternate or simultaneous production of hot water up to an outlet temperature of 65 °C (70 °C at 50% of maximum thermal input) and cold water even at negative temperatures (minimum delivery temperature -5 °C), for outdoor or indoor installation. Nominal heat output (B0W35): 43,0 kW.
- GAHP WS Plus: gas and geothermal renewable energy absorption heat pump, modulating and condensing, for alternate or simultaneous production of hot water up to an outlet temperature of 65 °C (70 °C at 50% of maximum thermal input) and cold water down to a delivery temperature of 3 °C, for outdoor or indoor installation. Nominal heat output (W10W35): 45,3 kW.

1.1.2 GA chillers and chiller-heaters

- GA ACF: gas absorption chiller for residential/commercial/industrial cooling systems with chilled water down to 3 °C.
- GA ACF HR: gas absorption chiller-heater with heat recovery exchanger, for residential/commercial/industrial cooling systems with chilled water down to 3 °C, plus hot water from the heat recovery exchanger up to 75 °C (e.g., DHW production).
- GA ACF TK: gas absorption chiller for systems and process applications with chilled water down to 3 °C, in continuous operation all year round.
- GA ACF HT: gas absorption chiller for very hot climates, for residential/commercial/industrial cooling systems with chilled water down to 5 °C, with outdoor air up to 50 °C.
- GA ACF LB: gas absorption chiller for negative temperatures, for refrigeration systems with chilled water down to -10 °C (glycol required).

1.1.3 AY boilers

- AY 35: modulating gas condensing boiler with sealed chamber for hot water production up to a delivery temperature of 88 °C, for indoor or outdoor installation, effective power 33,3 kW.
- AY 50: modulating gas condensing boiler with sealed chamber for hot water production up to a delivery temperature of 88 °C, for indoor or outdoor installation, effective power 49,2 kW.
- AY 100: modulating gas condensing boiler with sealed chamber for hot water production up to a delivery temperature of 88 °C, for indoor or outdoor installation, effective power 98,4 kW.

1.2 LINK AND HYBRID SYSTEM

The Link are gas-fired heating/cooling groups, to supply hot and/or chilled water. Each Link consists of a number of individual gas-fired heating/cooling modules (GAHP/GA/AY modules). The set of appliances and components is preassembled at the factory, forming a complete hydronic group already prepared to be connected to the system.
Thanks to the possibility of combining several individual gas-fired heating/refrigeration modules (GAHP/GA/AY modules) on the same Link, a large number of configurations can be realised, with the aim of meeting the specific requirements of the system to be served while avoiding oversizing and consequent energy wastage.

2 CHOOSING THE HYBRID HEATING SYSTEM

2.1 PREMISE

As known, the calculation of the design heat demand of a building (power) provides the winter peak value on which to size the heating system.
In an installation with boiler only, the result of this calculation actually provides sufficient criteria for selecting the boiler.
In the case of absorption heat pumps, the choice of appliances cannot disregard a more comprehensive system analysis, also involving emission devices, and above all their behaviour at the operating temperatures of heat pumps.
In fact it is essential, for efficient system operation, that the temperatures of terminals are adequate to the specific operative limits of heat pumps, summarised in Table 2.1 *p. 2* below, in particular for return temperatures.

Table 2.1 *Heating and DHW temperature limits*

			GAHP A Plus	GAHP AR Plus	GAHP GS/WS Plus	AY
Heating mode						
Hot water outlet temperature	maximum for heating	°C	65	60	65	-
	maximum for DHW	°C	70	65	70	-
	maximum	°C	-	-	-	88
Hot water inlet temperature	maximum for heating	°C	55	50	55	-
	maximum for DHW	°C	60	60	60	-

Once this indispensable verification has been completed, it is advisable to evaluate a broader selection criterion compared to the pure coverage of winter peak power, aimed both at maximising the economic return of the investment and verifying the indispensable compliance with any legal requirements relating to the use of renewable energy sources, or even the possibility of accessing incentives associated with a minimum efficiency threshold of the system.
The approach aimed at maximising the economic return of the investment involves using absorption heat pumps to cover only part of the building's nominal heat demand (the so-called "base load"), delegating auxiliary boilers to cover the remaining share ("peak load"); the limited number of hours of operation per year at peak load usually reduces the overall contribution of the peak in terms of seasonal energy (and thus in economic terms).
The presence of legal requirements relating to a minimum threshold for the use of renewable energy sources may substantially alter this selection criterion and force the installation of a much larger (if not total) share of heat pumps, depending on the type of building and consumers served.
Even in the absence of a regulatory constraint on the share of renewable energy, the choice of the appliances may be influenced (in the direction of a higher share of heat pumps compared to any auxiliary boilers) by the desire to access incentives, usually related to the efficiency achievable by the generation system or building during the heating season.
It should be emphasised that absorption heat pumps maintain uninterrupted operation even at extremely low outdoor temperatures. Therefore, the role of auxiliary boilers is not that of backup appliances (as in a bivalent system typical of electric heat pumps, i.e. in which the boilers replace the electric heat pumps below a specific outdoor temperature), but is that of complementing the power supplied by the heat pumps, which does not cover the peak load due to a specific design choice.
These different criteria for the choice of appliances are reflected in the choice of the best compromise between the number of heat pumps to be installed and the number of boilers, if any, against the design load of the building.
The assessment is complex and involves a number of parameters, the two main ones being:
- Trend of the actual thermal load in the heating season, which in turn depends on the geographical location of the building to be heated and on its usage profile.
- Operating temperature of the systems, also in relation to the characteristics of the heat pump model to be used.

In order to provide some useful general guidance, below is an analysis based on the calculation models provided by the European Directive 2009/125/EC and related ErP Regulations (Energy Related Products, 811/2013 in particular), as well as the European product standard EN 12309.
The graphs in the following Paragraphs are always in percentage terms with respect to the design power for the building in question (to be determined based on applicable regulations) and therefore are generally valid.
Cases that place themselves in intermediate positions between those proposed should be evaluated through appropriate interpolations, choosing the optimal appliance type allocation each time.
Since the performance of the heat pump is influenced by both the outdoor temperature and the required water outlet temperature, making a rough calculation without resorting to complex calculation software may not be simple. In fact, such software requires the input of a series of data in order to be able to offer a usable result, data which is not always available, because, for example, you simply want to make a rough economic sizing for a possible space heating solution for a building whose construction details have not yet been precisely defined.
The graphs in the following paragraphs, on the other hand, offer a simple way to get an idea of the performance offered by a precise mix of heat pumps and boilers (represented by the percentage of the heat pumps' heat output compared to the system's total heat output, based on design conditions), depending on the climate zone and temperature profile.
For each of the temperature profiles, it is possible to determine, simply by consulting the graph:
- the percentage of energy produced with GAHP
- the seasonal average efficiency (SGUE) of the GAHP alone
- the seasonal average efficiency (SGUE) of the hybrid system with GAHP and auxiliary condensing boilers
- the seasonal average efficiency (SGUE) of the hybrid system with GAHP and auxiliary existing boilers (assumed with 80% efficiency)

It is essential to emphasise once again how different criteria are possible for choosing appliances to assess the best mix between heat pumps and any auxiliary boilers. A correct choice can never disregard a more complete evaluation of the system, which also involves the emission devices, necessarily considering their behaviour at heat pumps' operating temperatures and an evaluation of the targets linked to any performance requirements or linked to the exploitation of renewable energy sources.

The use of diagrams to quickly obtain information about the operation of the system is in no case a substitute for the calculation procedures required by the regulations in force and the relevant conformity checks with respect to all legal requirements for the design of systems or for access to incentives.

2.1.1 The regulation 811/2013

Regulation 811/2013 sets forth:

- Three climate zones (warmer climate, average climate and colder climate).
- A reference building model.
- A typical seasonal temperature trend profile, in terms of bins. Bins represent the number of hours/year for which the system is expected to operate at a given outdoor temperature.

The three climatic zones are identified by the following conditions of reference:

- Athens for warmer climate conditions (outdoor design temperature 2 °C)
- Strasbourg for average climate conditions (outdoor design temperature -10 °C)
- Helsinki for colder climate conditions (outdoor design temperature -22 °C)

2.1.2 The standard EN 12309

For the three climate zones described in Paragraph 2.1.1 *p. 3*, the system operating temperatures are defined within the product standard EN 12309 according to the type of distribution system (underfloor heating, fancoil, radiators, ...).

In particular, four temperature profiles are defined in the standard, each of which may be either fixed or variable outlet temperature according to a heating curve depending on the outdoor temperature (hence on the climate zone).

The four temperature profiles are as follows:

- low temperature, corresponding to a nominal outlet temperature of 35 °C
- medium temperature, corresponding to a nominal outlet temperature of 45 °C
- high temperature, corresponding to a nominal outlet temperature of 55 °C
- very high temperature, corresponding to a nominal outlet temperature of 65 °C

Pay attention to the terminological misalignment between the definitions in standard EN 12309 and Regulation 811/2013

The profile corresponding to an outlet temperature of 55 °C is defined as "high temperature" in EN 12309 (as listed above), while it is defined as "medium temperature" in Regulation 811/2013.

2.2 MEDIUM CLIMATE

Table 2.2 *p. 3* shows the main data from the above-mentioned standards for the average climate (reference Strasbourg, outdoor design temperature -10 °C).

Table 2.2 *Table of medium climate ErP profiles*

Tj [°C]	Hj [h/y]	ΣHj	PLRh(Tj) [%]	Tout,vh [°C]	Tout,h [°C]	Tout,m [°C]	Tout,l [°C]
-10	1	1	100	65	55	45	35
-9	25	26	96	63	54	44	34
-8	23	49	92	62	53	43	34
-7	24	73	88	61	52	43	34
-6	27	100	85	59	50	42	33
-5	68	168	81	58	49	41	33
-4	91	259	77	57	48	41	32
-3	89	348	73	55	47	40	32
-2	165	513	69	54	46	39	31
-1	173	686	65	53	45	39	31
0	240	926	62	51	44	38	30
1	280	1206	58	50	43	37	30
2	320	1526	54	49	42	37	30
3	357	1883	50	47	40	36	29
4	356	2239	46	45	39	35	28
5	303	2542	42	44	38	34	28
6	330	2872	38	42	37	33	27
7	326	3198	35	41	36	33	27
8	348	3546	31	39	34	32	26
9	335	3881	27	37	33	31	25
10	315	4196	23	35	32	30	25
11	215	4411	19	33	31	29	24
12	169	4580	15	32	30	28	24
13	151	4731	12	30	28	27	23
14	105	4836	8	28	27	26	22
15	74	4910	4	26	26	25	22

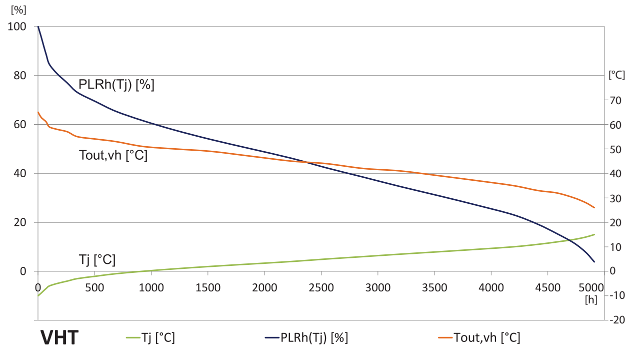
Tj [°C] = bin outdoor temperature
Hj [h/y] = annual hours of operating at outdoor temperature Tj
ΣHj = cumulative annual hours of operating at temperature equal to or lower than Tj
PLRh(Tj) [%] = system partial load factor at outdoor temperature Tj
Tout,vh [°C] = temperature profile for operating at very high temperature
Tout,h [°C] = temperature profile for operating at high temperature
Tout,m [°C] = temperature profile for operating at medium temperature
Tout,l [°C] = temperature profile for operation at low temperature

The graphs in the following figures, for each temperature profile, let you appreciate at a glance the relationship between outdoor temperature, load profile (represented by the power percentage with respect to the design rated power) and system outlet temperature with reference to the number of cumulative hours of operation of the heating system at a given outdoor temperature Tj, for the climate zone considered.

The choice of this reference axis makes it possible to quickly extract useful information for the choice of appliances, as detailed in Paragraph 2.5 *p. 10*.

For the "very high temperature" profile (VHT) see Figure 2.1 *p. 4* below.

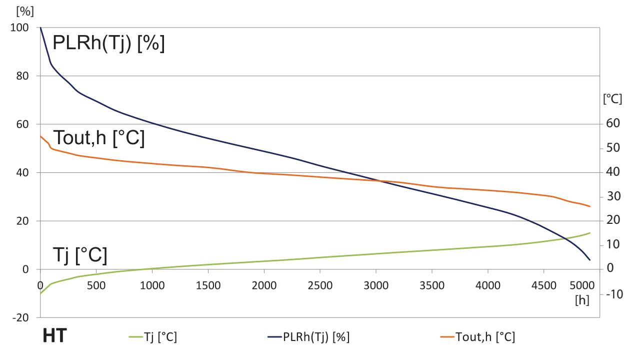
Figure 2.1 *Graph of VHT medium climate ErP profiles*



Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,vh [°C] Temperature profile for very high temperature operation

For the "high temperature" profile (HT) see Figure 2.2 *p. 4* below.

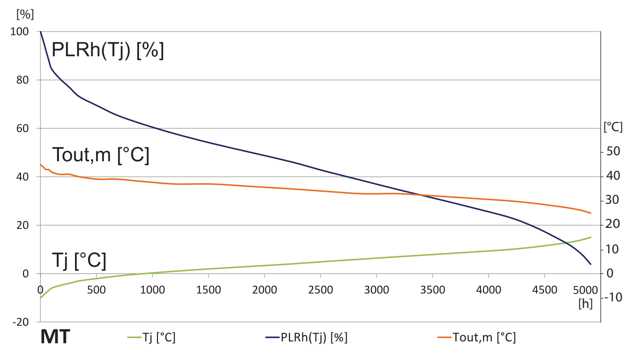
Figure 2.2 *Graph of HT medium climate ErP profiles*



Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,h [°C] Temperature profile for high temperature operation

For the "medium temperature" profile (MT) see Figure 2.3 *p. 4* below.

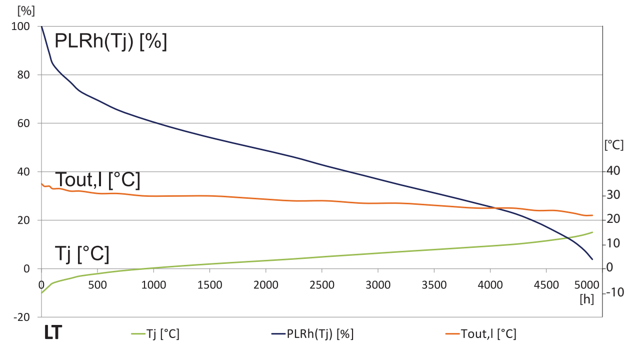
Figure 2.3 *Graph of MT medium climate ErP profiles*



Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,m [°C] Temperature profile for medium temperature operation

For the "low temperature" profile (LT) see Figure 2.4 *p. 4* below.

Figure 2.4 *Graph of LT medium climate ErP profiles*



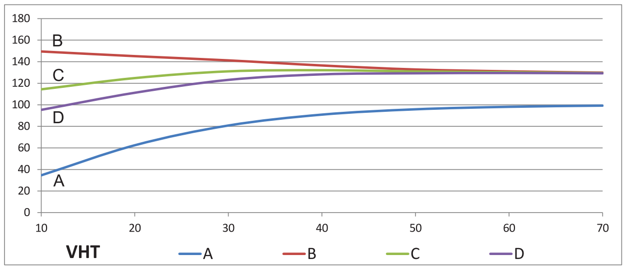
Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,h [°C] Temperature profile for low temperature operation

For each of the profiles, it is possible to determine, on the basis of the share of power covered with GAHP compared to the design power (both referring to the design conditions for the climate zone and the chosen temperature profile):

- the percentage of energy produced with GAHP
- the seasonal average efficiency (SGUE) of the GAHP alone
- the seasonal average efficiency (SGUE) of the hybrid system with GAHP and auxiliary condensing boilers
- the seasonal average efficiency (SGUE) of the hybrid system with GAHP and auxiliary existing boilers (assumed with 80% efficiency)

The graphs in the following figures show these data for the average climate zone and for each of the temperature profiles.
For the "very high temperature" profile (VHT) see Figure 2.5 *p. 4* below.

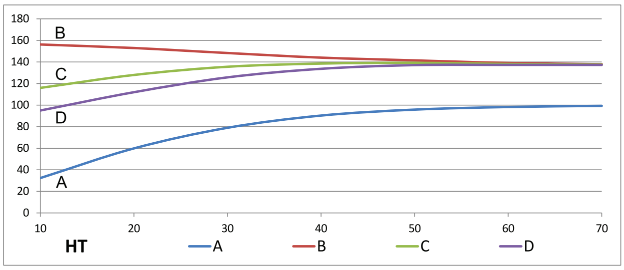
Figure 2.5 *Graph of VHT medium climate ErP energy performance*



In abscissa the power percentage with GAHP compared to the design power (both calculated at A-10W65 conditions)
A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

For the "high temperature" profile (HT) see Figure 2.6 *p. 5* below.

Figure 2.6 *Graph of HT medium climate ErP energy performance*

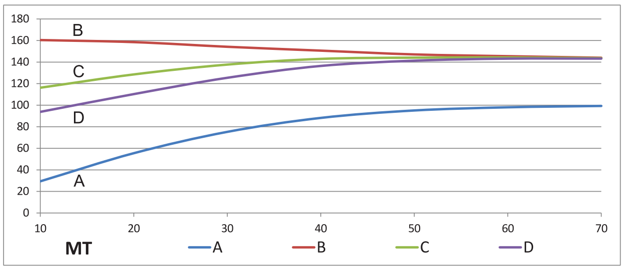


In abscissa the power percentage with GAHP compared to the design power (both calculated at A-10W55 conditions)

A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

For the "medium temperature" profile (MT) see Figure 2.7 *p. 5* below.

Figure 2.7 *Graph of MT medium climate ErP energy performance*

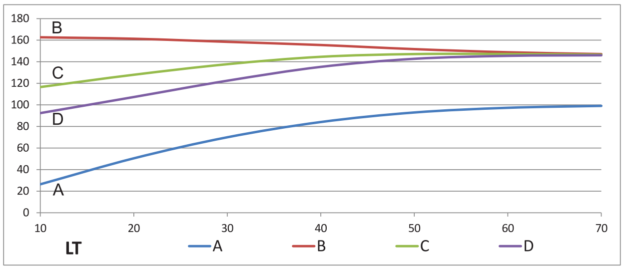


In abscissa the power percentage with GAHP compared to the design power (both calculated at A-10W45 conditions)

A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

For the "low temperature" profile (LT) see Figure 2.8 *p. 5* below.

Figure 2.8 *Graph of LT medium climate ErP energy performance*



In abscissa the power percentage with GAHP compared to the design power (both calculated at A-10W35 conditions)

A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

2.3 HOT CLIMATE

Table 2.3 *p. 5* shows the main data from the above-mentioned standards for the warmer climate (reference Athens, outdoor design temperature 2 °C).

Table 2.3 *Table of hot climate ErP profiles*

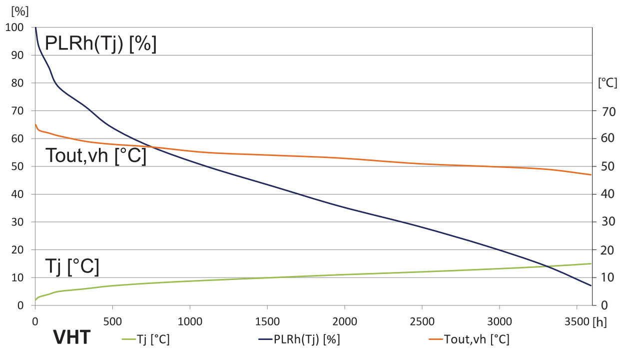
Tj [°C]	Hj [h/y]	ΣHj	PLRh(Tj) [%]	Tout,vh [°C]	Tout,h [°C]	Tout,m [°C]	Tout,l [°C]
2	3	3	100	65	55	45	35
3	22	25	93	62	53	43	34
4	63	88	86	60	51	42	33
5	63	151	79	57	49	41	32
6	175	326	71	55	47	40	31
7	162	488	64	53	46	39	31
8	259	747	57	50	43	37	30
9	360	1107	50	47	41	35	29
10	428	1535	43	44	38	34	28
11	430	1965	36	41	36	32	27
12	503	2468	29	39	34	31	26
13	444	2912	21	36	31	29	25
14	384	3296	14	33	29	27	24
15	294	3590	7	30	26	26	23

Tj [°C] = bin outdoor temperature
Hj [h/y] = annual hours of operating at outdoor temperature Tj
ΣHj = cumulative annual hours of operating at temperature equal to or lower than Tj
PLRh(Tj) [%] = system partial load factor at outdoor temperature Tj
Tout,vh [°C] = temperature profile for operating at very high temperature
Tout,h [°C] = temperature profile for operating at high temperature
Tout,m [°C] = temperature profile for operating at medium temperature
Tout,l [°C] = temperature profile for operation at low temperature

The graphs in the following figures, for each temperature profile, let you appreciate at a glance the relationship between outdoor temperature, load profile (represented by the power percentage with respect to the design rated power) and system outlet temperature with reference to the number of cumulative hours of operation of the heating system at a given outdoor temperature Tj, for the climate zone considered.
The choice of this reference axis makes it possible to quickly extract useful information for the choice of appliances, as detailed in Paragraph 2.5 *p. 10*.

For the "very high temperature" profile (VHT) see Figure 2.9 *p. 6* below.

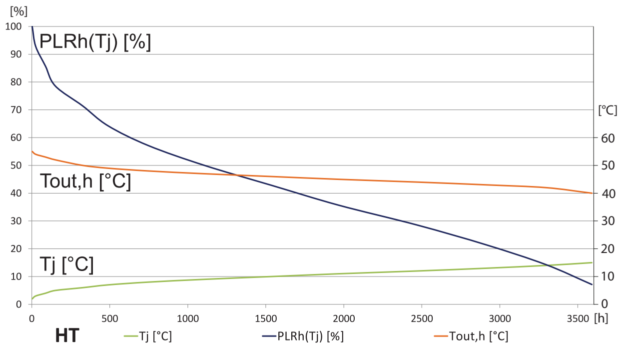
Figure 2.9 *Graph of VHT hot climate ErP profiles*



Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,vh [°C] Temperature profile for very high temperature operation

For the "high temperature" profile (HT) see Figure 2.10 *p. 6* below.

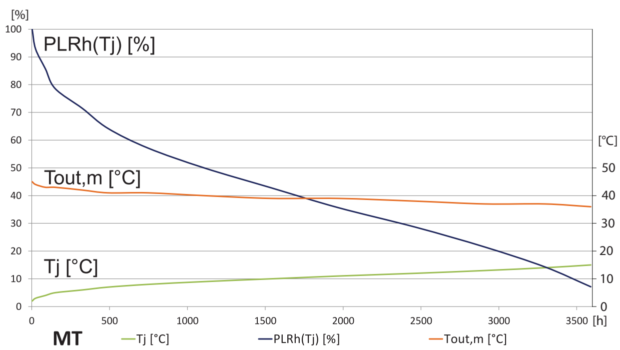
Figure 2.10 *Graph of HT hot climate ErP profiles*



Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,h [°C] Temperature profile for high temperature operation

For the "medium temperature" profile (MT) see Figure 2.11 *p. 6* below.

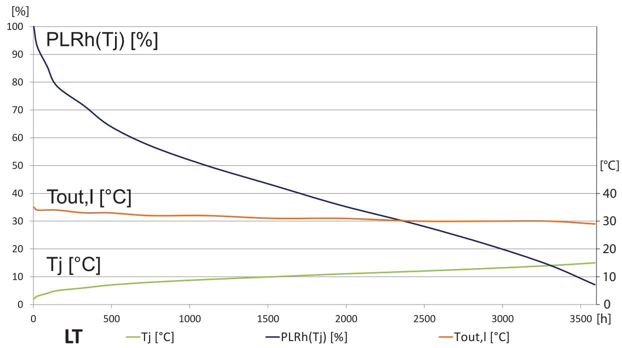
Figure 2.11 *Graph of MT hot climate ErP profiles*



Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,m [°C] Temperature profile for medium temperature operation

For the "low temperature" profile (LT) see Figure 2.12 *p. 6* below.

Figure 2.12 *Graph of LT hot climate ErP profiles*



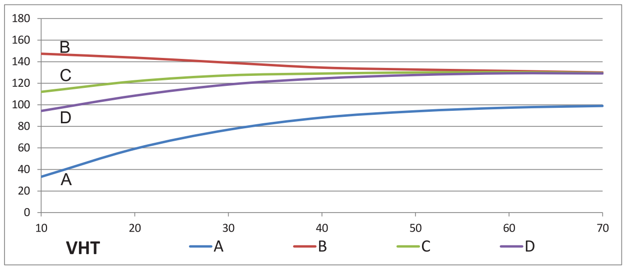
Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,h [°C] Temperature profile for low temperature operation

For each of the profiles, it is possible to determine, on the basis of the share of power covered with GAHP compared to the design power (both referring to the design conditions for the climate zone and the chosen temperature profile):

- the percentage of energy produced with GAHP
- the seasonal average efficiency (SGUE) of the GAHP alone
- the seasonal average efficiency (SGUE) of the hybrid system with GAHP and auxiliary condensing boilers
- the seasonal average efficiency (SGUE) of the hybrid system with GAHP and auxiliary existing boilers (assumed with 80% efficiency)

The graphs in the following figures show these data for the average climate zone and for each of the temperature profiles.
For the "very high temperature" profile (VHT) see Figure 2.13 *p. 6* below.

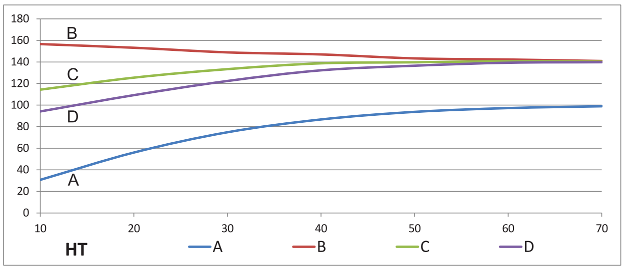
Figure 2.13 *Graph of VHT hot climate ErP energy performance*



In abscissa the power percentage with GAHP compared to the design power (both calculated at A2W65 conditions)
A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

For the "high temperature" profile (HT) see Figure 2.14 *p. 7* below.

Figure 2.14 *Graph of HT hot climate ErP energy performance*

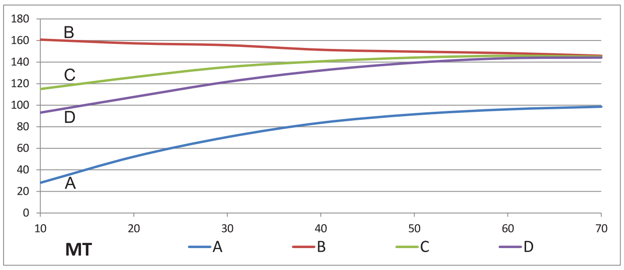


In abscissa the power percentage with GAHP compared to the design power (both calculated at A2W55 conditions)

A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

For the "medium temperature" profile (MT) see Figure 2.15 *p. 7* below.

Figure 2.15 *Graph of MT hot climate ErP energy performance*

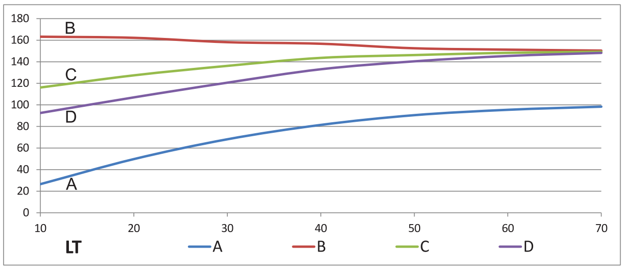


In abscissa the power percentage with GAHP compared to the design power (both calculated at A2W45 conditions)

A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

For the "low temperature" profile (LT) see Figure 2.16 *p. 7* below.

Figure 2.16 *Graph of LT hot climate ErP energy performance*



In abscissa the power percentage with GAHP compared to the design power (both calculated at A2W35 conditions)

A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

2.4 COLD CLIMATE

Table 2.4 *p. 7* shows the main data from the above-mentioned standards for the colder climate (reference Helsinki, outdoor design temperature -22 °C).

Table 2.4 *Table of cold climate ErP profiles*

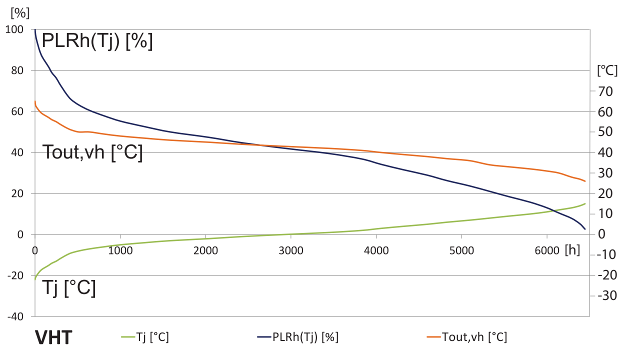
Tj [°C]	Hj [h/y]	ΣHj	PLRh(Tj) [%]	Tout,vh [°C]	Tout,h [°C]	Tout,m [°C]	Tout,l [°C]
-22	1	1	100	65	55	45	35
-21	6	7	97	63	54	44	34
-20	13	20	95	62	53	43	34
-19	17	37	92	61	52	43	33
-18	19	56	89	60	51	42	33
-17	26	82	87	59	50	42	32
-16	39	121	84	58	49	41	32
-15	41	162	82	57	49	41	32
-14	35	197	79	56	48	40	31
-13	52	249	76	55	47	40	31
-12	37	286	74	54	47	39	31
-11	41	327	71	53	46	39	31
-10	43	370	68	52	45	39	30
-9	54	424	66	51	45	38	30
-8	90	514	63	50	44	38	30
-7	125	639	61	50	44	38	30
-6	169	808	58	49	43	37	29
-5	195	1003	55	48	42	36	29
-4	278	1281	53	47	41	36	29
-3	306	1587	50	46	40	35	28
-2	454	2041	47	45	40	35	28
-1	385	2426	45	44	39	34	28
0	490	2916	42	43	38	34	27

Tj [°C]	Hj [h/y]	ΣHj	PLRh(Tj) [%]	Tout,vh [°C]	Tout,h [°C]	Tout,m [°C]	Tout,l [°C]
1	533	3449	39	42	37	33	27
2	380	3829	37	41	37	33	27
3	228	4057	34	40	36	32	26
4	261	4318	32	39	35	31	26
5	279	4597	29	38	34	31	25
6	229	4826	26	37	33	30	25
7	269	5095	24	36	32	30	25
8	233	5328	21	34	31	29	24
9	230	5558	18	33	30	28	24
10	243	5801	16	32	29	27	24
11	191	5992	13	31	28	26	24
12	146	6138	11	30	28	26	24
13	150	6288	8	28	27	25	23
14	97	6385	5	27	26	24	23
15	61	6446	3	26	25	23	23

Tj [°C] = bin outdoor temperature
Hj [h/y] = annual hours of operating at outdoor temperature Tj
ΣHj = cumulative annual hours of operating at temperature equal to or lower than Tj
PLRh(Tj) [%] = system partial load factor at outdoor temperature Tj
Tout,vh [°C] = temperature profile for operating at very high temperature
Tout,h [°C] = temperature profile for operating at high temperature
Tout,m [°C] = temperature profile for medium temperature operating
Tout,l [°C] = temperature profile for operation at low temperature

The graphs in the following figures, for each temperature profile, let you appreciate at a glance the relationship between outdoor temperature, load profile (represented by the power percentage with respect to the design rated power) and system outlet temperature with reference to the number of cumulative hours of operation of the heating system at a given outdoor temperature Tj, for the climate zone considered.
The choice of this reference axis makes it possible to quickly extract useful information for the choice of appliances, as detailed in Paragraph 2.5 *p. 10*.
For the "very high temperature" profile (VHT) see Figure 2.17 *p. 8* below.

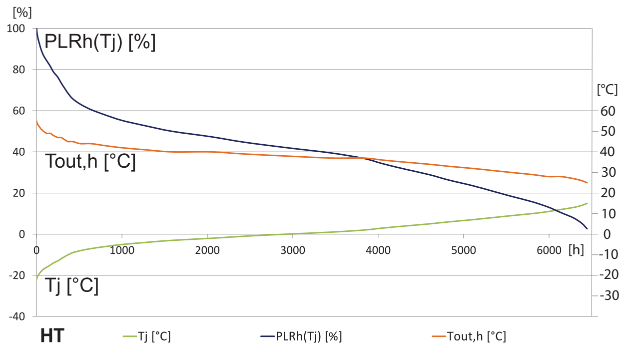
Figure 2.17 *Graph of VHT cold climate ErP profiles*



Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,vh [°C] Temperature profile for very high temperature operation

For the "high temperature" profile (HT) see Figure 2.18 *p. 8* below.

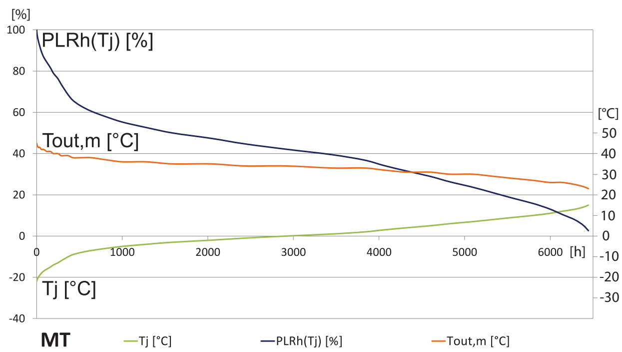
Figure 2.18 *Graph of HT cold climate ErP profiles*



Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,h [°C] Temperature profile for high temperature operation

For the "medium temperature" profile (MT) see Figure 2.19 *p. 8* below.

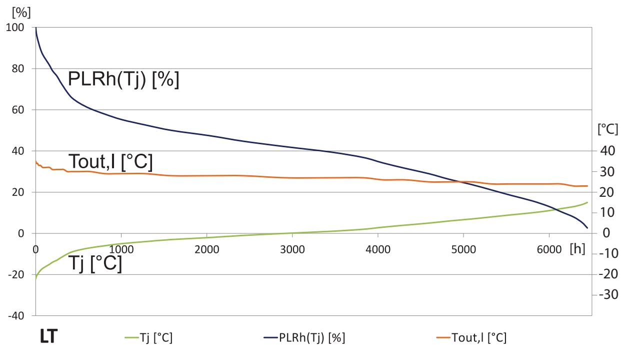
Figure 2.19 *Graph of MT cold climate ErP profiles*



Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,m [°C] Temperature profile for medium temperature operation

For the "low temperature" profile (LT) see Figure 2.20 *p. 9* below.

Figure 2.20 *Graph of LT cold climate ErP profiles*



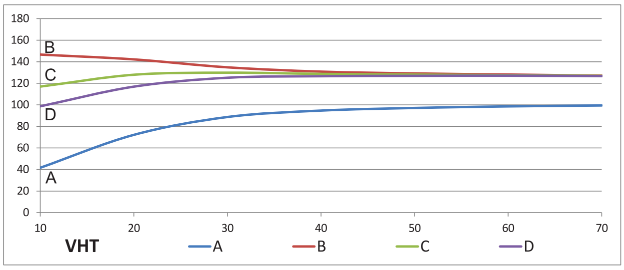
Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
Tout,h [°C] Temperature profile for low temperature operation

For each of the profiles, it is possible to determine, on the basis of the share of power covered with GAHP compared to the design power (both referring to the design conditions for the climate zone and the chosen temperature profile):

- the percentage of energy produced with GAHP
- the seasonal average efficiency (SGUE) of the GAHP alone
- the seasonal average efficiency (SGUE) of the hybrid system with GAHP and auxiliary condensing boilers
- the seasonal average efficiency (SGUE) of the hybrid system with GAHP and auxiliary existing boilers (assumed with 80% efficiency)

The graphs in the following figures show these data for the average climate zone and for each of the temperature profiles.
For the "very high temperature" profile (VHT) see Figure 2.21 *p. 9* below.

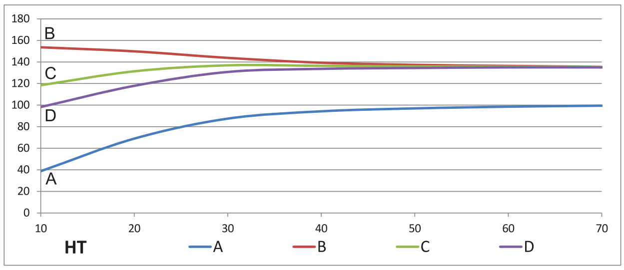
Figure 2.21 *Graph of VHT cold climate ErP energy performance*



In abscissa the power percentage with GAHP compared to the design power (both calculated at A-22W65 conditions)
A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

For the "high temperature" profile (HT) see Figure 2.22 *p. 9* below.

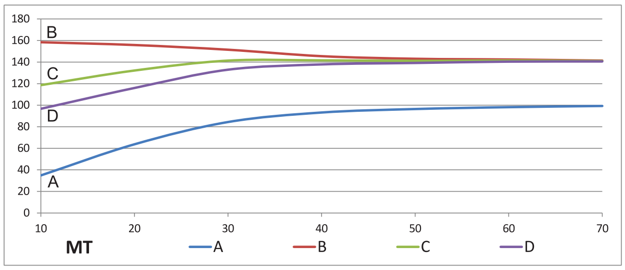
Figure 2.22 *Graph of HT cold climate ErP energy performance*



In abscissa the power percentage with GAHP compared to the design power (both calculated at A-22W55 conditions)
A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

For the "medium temperature" profile (MT) see Figure 2.23 *p. 9* below.

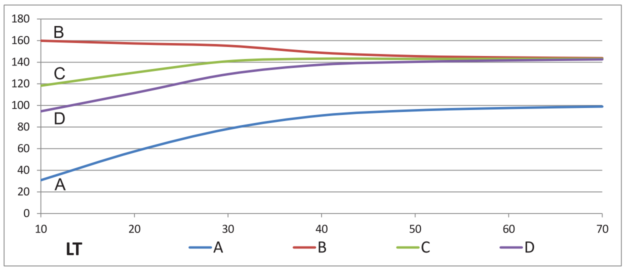
Figure 2.23 *Graph of MT cold climate ErP energy performance*



In abscissa the power percentage with GAHP compared to the design power (both calculated at A-22W45 conditions)
A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

For the "low temperature" profile (LT) see Figure 2.24 *p. 9* below.

Figure 2.24 *Graph of LT cold climate ErP energy performance*



In abscissa the power percentage with GAHP compared to the design power (both calculated at A-22W35 conditions)
A Share of energy produced with GAHP
B SGUE (seasonal GUE) GAHP only
C SGUE (seasonal GUE) GAHP and condensing boilers
D SGUE (seasonal GUE) GAHP and existing boilers (assumed with 80% efficiency)

2.5 EXAMPLE OF HYBRID SYSTEM CHOICE

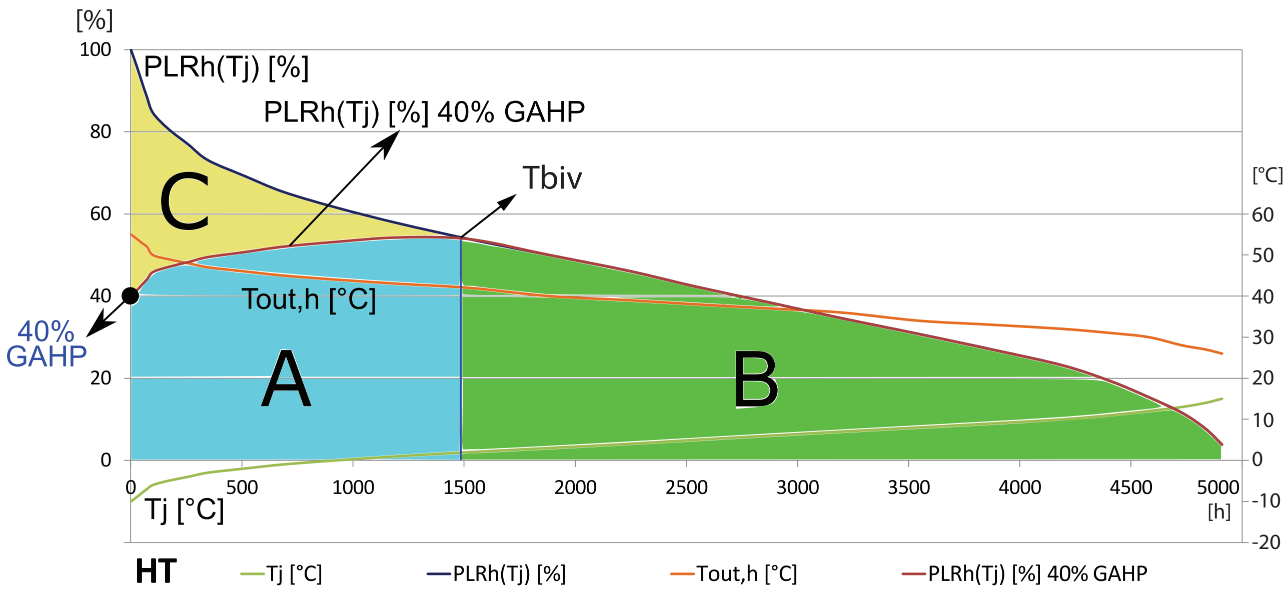
The graphs shown in the previous paragraphs may be used to derive useful information for the choice of the hybrid system, specifically to assess the expected seasonal average efficiency of the generation system and the overall share of energy produced by heat pumps in relation to demand, as a function of the share of the design power covered by heat pumps.

Taking Figure 2.2 *p. 4* and related Figure 2.6 *p. 5* as an example, we assume that GAHP covers 40% of the design load (calculating the power output of the individual heat pump at the design conditions for that climate zone and temperature profile, i.e. in this example A-10W55), leaving the boilers to cover the remaining 60%.

Specifically, in Figure 2.25 *p. 10* we see how in the case in point we have:

- The GAHP system (area A, in blue), which has priority operation, will operate at full power for approximately 30% of the total heating system operating time (4910 hours for the average climate zone, Table 2.2 *p. 3*). During this period, the auxiliary boilers (area C, in yellow) will modulate their output to follow the building's load, as the heat output provided by the GAHP alone is insufficient to meet the building's heat demand.
- For the remaining hours, the GAHP system will operate in partial load mode (area B, in green), autonomously covering the building load (auxiliary boilers off). In this case, the heat output delivered by the GAHP alone is higher than the heat output demand of the building.
- The bivalent outdoor temperature Tj corresponding to the transition between operation at full power (with boilers providing complement) and partial operation of the GAHP (with boilers switched off) will be around 0 °C.

Figure 2.25 *Example of a hybrid system with 40% of the design load covered by GAHP*



Tbiv [°C] Bivalent temperature
Tj [°C] Bin outdoor temperature
PLRh(Tj) [%] System partial load ratio at outdoor temperature Tj
PLRh(Tj) [%] 40% GAHP Partial load ratio covered by GAHP assuming 40% power with GAHP compared to total design power
Tout,h [°C] Temperature profile for high temperature operation
A GAHP operating area at full load
B GAHP operating area at partial load
C Auxiliary boilers operating area

Evaluating the ratio between the sum of areas A and B, which represents the amount of energy covered by GAHP, compared to the total area under the blue curve of PLRh(Tj), which represents the total heat output demand of the building, it is immediately clear that the energy share actually covered by GAHP is much greater than the 40% (which was the initial assumption, i.e. covering 40% of the design power with GAHP), thus covering approximately 90% of the building's total heat output demand.

The fact that the GAHP system mostly delivers more heat output than the building's needs is not a problem as sophisticated control systems are available (see Section C01.11 for more details) that allow the generation system to be managed with appropriate capacity step levels, so as to optimise the energy supply (and consequently the gas consumption) to the building's actual needs.

Using the data shown in Figure 2.6 *p. 5* and referring to the coverage with GAHP of 40% of the design power (value 40 in the abscissa), it is possible to derive further data useful for assessing optimal sizing.

We can indeed derive that under these conditions:

- the GAHP will cover approximately 90% of the building's heat output demand
- The seasonal average efficiency (SGUE) of the GAHP alone will be 144%
- The seasonal average efficiency (SGUE) of the hybrid system with GAHP and auxiliary condensing boilers will be 139%
- The seasonal average efficiency (SGUE) of the hybrid system with GAHP and auxiliary existing boilers (assumed with 80% efficiency) will be 139%

With this method, it is therefore possible to calculate the energy share covered by GAHP as a function of the share of the GAHP's power output to the design rated power, but also to make a first estimation of the expected average seasonal efficiency for both GAHP alone and for hybrid systems, either with condensing boilers or with existing boilers.

First of all, it is therefore necessary to establish the percentage

of power, compared to the actual value of the building's design load (which can be obtained either from rough estimates or from the appropriate calculation software), which allows the criteria defined as an objective to be met (maximising the economic return on investment rather than complying with any legal requirements relating to the use of renewable energy sources rather than accessing incentives related to a minimum efficiency threshold of the system, or other).
From the power obtained in this way, the number of GAHP required for the system can be calculated by dividing this power by the power output of the individual GAHP under the same design conditions (minimum outdoor temperature of the climate zone and the corresponding heating water delivery temperature).
Of course, the calculation is discrete in nature, i.e. the result must then be adapted to an integer number of GAHP.
Intuitively, you can understand how, in colder climates, a higher number of GAHP is needed to cover the same power share, while in warmer climates a lower number is sufficient.

2.5.1 Average zone, very high temperature

Let us assume that we have a heat output demand at design conditions of 400 kW and that we are in an average climate zone with a VHT temperature profile, i.e., very high temperature.
Consequently, the reference design conditions at which to calculate the power output of each individual GAHP will be A-10W65.
If we assume using GAHP A Plus heat pumps for the heating system, the heat output of each GAHP A Plus under design conditions (A-10W65) is 25,5 kW (the performance is shown in Section B11).
Several scenarios open up at this step, depending on the criterion according to which the hybrid system is chosen:

- If the priority is to have the most efficient system, I would choose to cover all the design load with GAHP A Plus heat pumps. Consequently, the number of GAHP A Plus to be installed will be (400/25,5) = 15,7 modules. Consequently, the system will consist of 16 GAHP A Plus. However, this is also the most expensive option.
- If the priority is the best cost/benefit trade-off, I would choose to cover, for example, only 40% of the design load with GAHP A Plus heat pumps, which will still ensure that the heat pumps cover about 90% of the building's heat output demand (as explained in the 2.5 *p. 10* Paragraph above). In this way, (400x0,4/25,5) = 6,3 modules will be sufficient. Consequently, the system would consist of 7 GAHP A Plus and three AY auxiliary boilers, two AY 100 and one AY 50.
- If the priority is to achieve a specific share of renewable energy, appropriate simulations must be carried out, using suitable calculation software, to determine the share of renewable energy that can be achieved with a specific percentage of heat pumps in relation to the design load. Let us assume, for example, that by covering 80% of the design load with GAHP I can meet this requirement. Consequently, the number of GAHP A Plus to be installed will be (400x0,8/25,5) = 12,5 modules. Consequently, the system will consist of 13 GAHP A Plus and one auxiliary AY 100 boiler. This hybrid system will be extremely efficient, but less expensive than one based solely on GAHP A Plus.

Depending on the criteria identified for the choice of the hybrid system, optimal solutions can be identified on a case-by-case basis, which simultaneously achieve the chosen objective and maximise the cost/benefit ratio.

2.5.2 Average zone, high temperature

Let us assume that we have a heat output demand at design conditions of 400 kW and that we are in an average climate zone with an HT temperature profile, i.e., high temperature.
Consequently, the reference design conditions at which to calculate the power output of each individual GAHP will be A-10W55.
If we assume using GAHP A Plus heat pumps for the heating system, the heat output of each GAHP A Plus under design conditions (A-10W55) is 29,4 kW (the performance is shown in Section B11).
Several scenarios open up at this step, depending on the criterion according to which the hybrid system is chosen:

- If the priority is to have the most efficient system, I would choose to cover all the design load with GAHP A Plus heat pumps. Consequently, the number of GAHP A Plus to be installed will be (400/29,4) = 13,6 modules. Consequently, the system will consist of 14 GAHP A Plus. However, this is also the most expensive option.
- If the priority is the best cost/benefit trade-off, I would choose to cover, for example, only 40% of the design load with GAHP A Plus heat pumps, which will still ensure that the heat pumps cover about 90% of the building's heat output demand (as explained in the 2.5 *p. 10* Paragraph above). In this way, (400x0,4/29,4) = 5,4 modules will be sufficient. Consequently, the system would consist of 6 GAHP A Plus and three AY auxiliary boilers, two AY 100 and one AY 50.
- If the priority is to achieve a specific share of renewable energy, appropriate simulations must be carried out, using suitable calculation software, to determine the share of renewable energy that can be achieved with a specific percentage of heat pumps in relation to the design load. Let us assume, for example, that by covering 80% of the design load with GAHP I can meet this requirement. Consequently, the number of GAHP A Plus to be installed will be (400x0,8/29,4) = 10,9 modules. Consequently, the system will consist of 11 GAHP A Plus and one auxiliary AY 100 boiler. This hybrid system will be extremely efficient, but less expensive than one based solely on GAHP A Plus.

Depending on the criteria identified for the choice of the hybrid system, optimal solutions can be identified on a case-by-case basis, which simultaneously achieve the chosen objective and maximise the cost/benefit ratio.

2.5.3 Colder zone, very high temperature

Let us assume that we have a heat output demand at design conditions of 400 kW and that we are in a cold climate zone with a VHT temperature profile, i.e., very high temperature.
Consequently, the reference design conditions at which to calculate the power output of each individual GAHP will be A-22W65.
If we assume using GAHP A Plus heat pumps for the heating system, the heat output of each GAHP A Plus under design conditions (A-22W65) is 23,9 kW (the performance is shown in Section B11).
Several scenarios open up at this step, depending on the criterion according to which the hybrid system is chosen:

- If the priority is to have the most efficient system, I would choose to cover all the design load with GAHP A Plus heat pumps. Consequently, the number of GAHP A Plus to be installed will be (400/23,9) = 16,7 modules. Consequently, the system will consist of 17 GAHP A Plus. However, this is also the most expensive option.
- If the priority is the best cost/benefit trade-off, I would choose to cover, for example, only 40% of the design load with GAHP A Plus heat pumps, which will still ensure that the heat pumps cover about 90% of the building's heat output demand (as explained in the 2.5 *p. 10* Paragraph above). In this way, (400x0,4/23,9) = 6,7 modules will be sufficient. Consequently, the system would consist of 7 GAHP A Plus and three AY auxiliary boilers, two AY 100 and one AY 50.
- If the priority is to achieve a specific share of renewable

energy, appropriate simulations must be carried out, using suitable calculation software, to determine the share of renewable energy that can be achieved with a specific percentage of heat pumps in relation to the design load. Let us assume, for example, that by covering 80% of the design load with GAHP I can meet this requirement. Consequently, the number of GAHP A Plus to be installed will be (400x0,8/23,9) = 13,3 modules. Consequently, the system will consist of 14 GAHP A Plus and one auxiliary AY 100 boiler. This hybrid system will be extremely efficient, but less expensive than one based solely on GAHP A Plus.

Depending on the criteria identified for the choice of the hybrid system, optimal solutions can be identified on a case-by-case basis, which simultaneously achieve the chosen objective and maximise the cost/benefit ratio.

2.5.4 Warmer zone, low temperature

Let us assume that we have a heat output demand at design conditions of 400 kW and that we are in a warm climate zone with an LT temperature profile, i.e., low temperature.

Consequently, the reference design conditions at which to calculate the power output of each individual GAHP will be A2W35.

If we assume using GAHP A Plus heat pumps for the heating system, the heat output of each GAHP A Plus under design conditions (A2W35) is 44,2 kW (the performance is shown in Section B11).

Several scenarios open up at this step, depending on the criterion according to which the hybrid system is chosen:

- If the priority is to have the most efficient system, I would choose to cover all the design load with GAHP A Plus heat pumps. Consequently, the number of GAHP A Plus to be installed will be (400/44,2) = 9,0 modules. Consequently, the system will consist of 9 GAHP A Plus. However, this is also the most expensive option.
- If the priority is the best cost/benefit trade-off, I would choose to cover, for example, only 40% of the design load with GAHP A Plus heat pumps, which will still ensure that the heat pumps cover about 88% of the building's heat output demand (as explained in the 2.5 *p. 10* Paragraph above). In this way, (400x0,4/44,2) = 3,6 modules will be sufficient. Consequently, the system would consist of 4 GAHP A Plus and three AY auxiliary boilers, two AY 100 and one AY 50.
- If the priority is to achieve a specific share of renewable energy, appropriate simulations must be carried out, using suitable calculation software, to determine the share of renewable energy that can be achieved with a specific percentage of heat pumps in relation to the design load. Let us assume, for example, that by covering 60% of the design load with GAHP I can meet this requirement. Consequently, the number of GAHP A Plus to be installed will be (400x0,6/44,2) = 5,4 modules. Consequently, the system will consist of 6 GAHP A Plus and one auxiliary AY 100 boiler. This hybrid system will be extremely efficient, but less expensive than one based solely on GAHP A Plus.

Depending on the criteria identified for the choice of the hybrid system, optimal solutions can be identified on a case-by-case basis, which simultaneously achieve the chosen objective and maximise the cost/benefit ratio.

2.6 HYBRID SYSTEMS: THE TAILOR-MADE SOLUTION

From the previous paragraphs, it can be concluded that it is generally not possible to identify a single criterion for choosing a hybrid system, as the choosing criteria can also be very different, from simply maximising the economic return on the investment, to verifying compliance with any legal requirements concerning the use of renewable energy sources, or the possibility of accessing incentives related to a minimum efficiency threshold of the realised system.

Such different criteria necessarily lead to very different conclusions.

Generally speaking, we can state that for the simple optimisation of the economic return on investment, the optimal result is obtained with a heat output share with GAHP that, under design conditions, lies between 30% and 40%.

For criteria related to possible renewable energy quotas, the advice is to use special calculation software that can quickly check whether the assumed generation system is able to meet the requirement. Usually, these criteria require heat output shares with GAHP, at design conditions, greater than 80%.

For criteria related to the minimum threshold of system efficiency, an initial estimate can be made, as described in Paragraph 2.5 *p. 10*, using the energy performance graphs related to the specific climate zone and to the specific temperature profile considered, based on the heat output share that is estimated to be covered with GAHP, and then verifying them using appropriate calculation software. As can be seen from the graphs, even rather low GAHP heat output shares make it possible to achieve very high levels of system efficiency, even in the case of coupling with existing low-efficiency boilers.

Once the criteria for choosing the hybrid system have been identified, the actual choice of appliances that will be part of it is based on their characteristics, as detailed in Paragraph 1 *p. 1*.

1 APPLIANCE POSITIONING

1.1 WARNINGS

Aggressive substances in the air

Halogenated hydrocarbons containing chlorine and fluorine compounds cause corrosion. The air of the installation site must be free from aggressive substances.

Environmental or operational heavy conditions

Increase the frequency of appliance maintenance and cleaning operations in especially heavy-duty environmental or use conditions (e.g., intensive use of the equipment, brackish environment, etc.).

1.2 AEROTHERMAL APPLIANCES

Do not install the aerothermal appliances indoors

Aerothermal appliances include devices equipped with finned coils and fan, approved for outdoor installation.

- Do not install inside a room, not even if it has openings.
- In no event start the appliance inside a room.

Ventilation of aerothermal appliances

- Aerothermal appliances require a large space, ventilated and free from obstacles, to enable smooth flow of air to the finned coils and free air outlet above the mouth of the fan, with no air recirculation.
- Incorrect ventilation may affect efficiency and cause damage to the appliance.
- The manufacturer shall not be liable for any incorrect choices of the place and setting of installation.

1.3 APPLIANCES SUITABLE FOR INSTALLATION IN A TECHNICAL ROOM

The installation room must meet all requirements set forth by laws, standards and regulations of the Country and place of installation concerning gas appliances and cooling appliances.

Do not install inside a room that has no aeration openings.

Other appliances

Any other gas appliances in the room where GAHP heat pumps are installed must necessarily be type C.

1.3.1 GAHP GS/WS (indoor version) and AY boilers

AY boilers, GAHP GS/WS Plus heat pumps (in the specific indoor version) and their corresponding Link with GAHP GS/WS Plus modules (in the specific indoor version) can be installed indoors.

Do not install the outdoor version of the GAHP GS/WS Plus heat pumps inside a room, not even if it has openings. In no event the outdoor version of GAHP GS/WS Plus heat pumps may be started inside a room.

1.3.1.1 Characteristics of the installation room

- ► The premise must be provided with permanent and sufficiently wide ventilation openings to permit even air flow for ventilation.
- ► Combustion air intake must be ducted from the outside (type C installation).
- ► The appliance's flue gas exhaust must be ducted to the outside. The flue outlet must not be immediately close to openings or air intakes of buildings, and must comply with environmental and safety regulations.

1.4 WHERE TO INSTALL THE APPLIANCE

In general, the appliances:

- ► May be installed at ground level, on a terrace or on a roof, compatibly with their size and weight.
- ► May be only installed out of the dripping line of rain gutters or the like. Do not require protection from weathering.
- ► No obstruction or overhanging structure (e.g. protruding roofs, canopies, balconies, ledges, trees, ...) must interfere with the exhaust flue gas.
- ► The appliances flue gas exhausts must not be immediately close to openings or air intakes of buildings, and must comply with environmental and safety regulations.

In particular, for aerothermal appliances:

- ► They must be installed outside buildings, in an area of natural air circulation.
- ► No obstruction or overhanging structure (e.g. protruding roofs, canopies, balconies, ledges, trees,...) must interfere with the air flowing out from the top of the appliance.
- ► Do not install near the exhaust of flues, chimneys or hot polluted air. In order to work correctly, the appliance needs clean air.

For appliances suitable for indoor installation, please refer to Paragraph 1.3 *p. 1*.

1.5 DEFROSTING WATER DRAINAGE

In winter, for GAHP A Plus/GAHP AR Plus appliances, frost may form on the finned coils and the appliance performs defrosting cycles.
To prevent overflowing and damage provide for a drainage system.

1.6 ACOUSTIC ISSUES

- ► Pre-emptively assess the appliance's sound effect in connection to the site, taking into account that building corners, enclosed courtyards, restricted spaces may amplify the acoustic impact due to the reverberation phenomenon.
- ► In case of appliances suitable for installation in utility room, assess beforehand the appliances' sound effect inside the room and to the adjacent rooms and outside.
- ► In Section C01.14 further advice on acoustic design can be found.

2 MINIMUM CLEARANCE DISTANCES

2.1 DISTANCES FROM COMBUSTIBLE OR FLAMMABLE MATERIALS

Keep the appliance away from combustible or flammable materials or components, in compliance with applicable regulations.

2.2 CLEARANCES AROUND THE APPLIANCE

The minimum clearance distances shown in the following Figures (barring any stricter regulations) are required for safety, operation and maintenance.

2.2.1 Individual GAHP/GA appliances

The distances shown in Figure 2.2 *p. 2* below are valid:

- for GAHP GS/WS Plus appliances
- for aerothermal appliances, in the absence of walls close to the appliance that are higher than the appliance itself
- for aerothermal appliances, in the case of a single wall that is higher than the appliance (Figure 2.1 *p. 2*)

Figure 2.1 *Clearances for a single aerothermal appliance with 1 wall higher than the appliance*

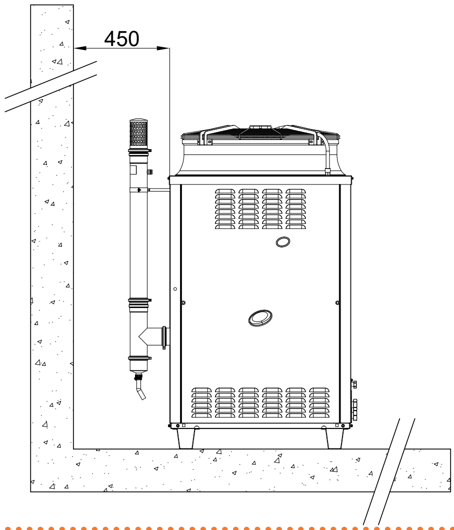
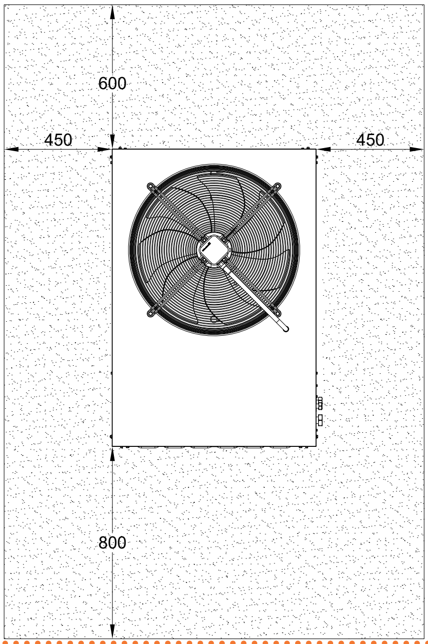
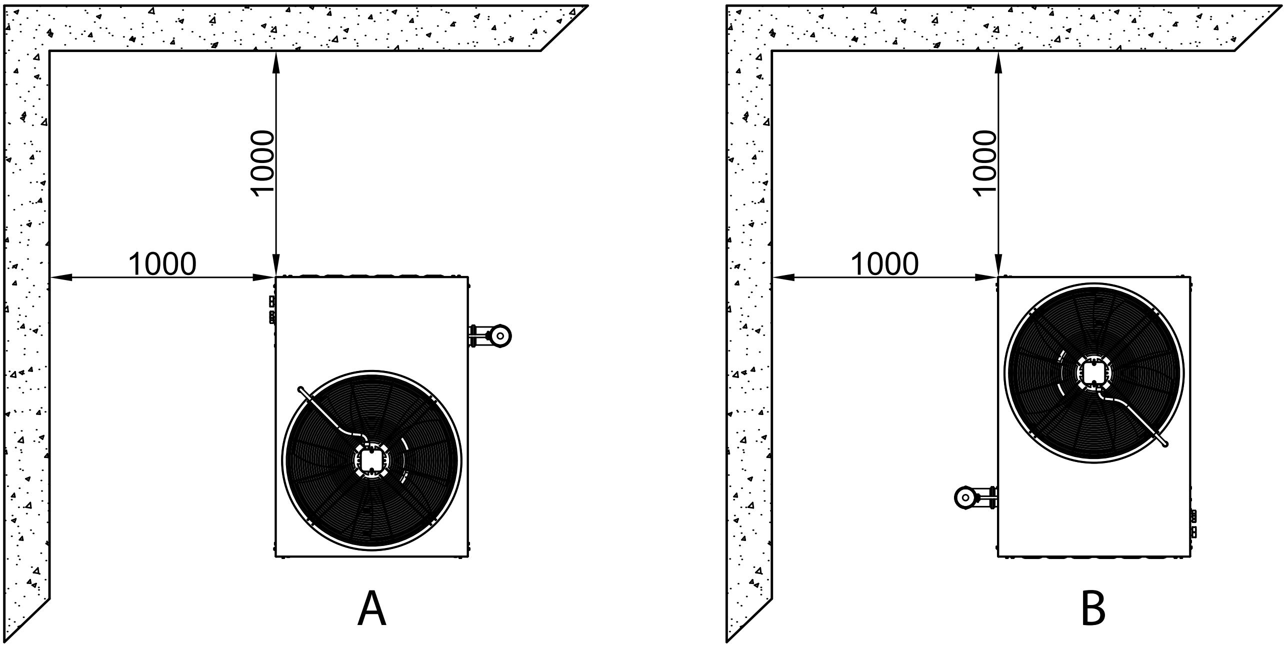


Figure 2.2 *Clearances*



If there are two walls higher than the aerothermal appliance (Figure 2.3 *p. 3*), the distance of the appliance must be increased to 1 m from each wall. If possible, the aerothermal appliance should always be placed with the finned coil facing outwards and not towards the walls.

Figure 2.3 *Clearances for a single aerothermal appliance with 2 walls higher than the appliance*

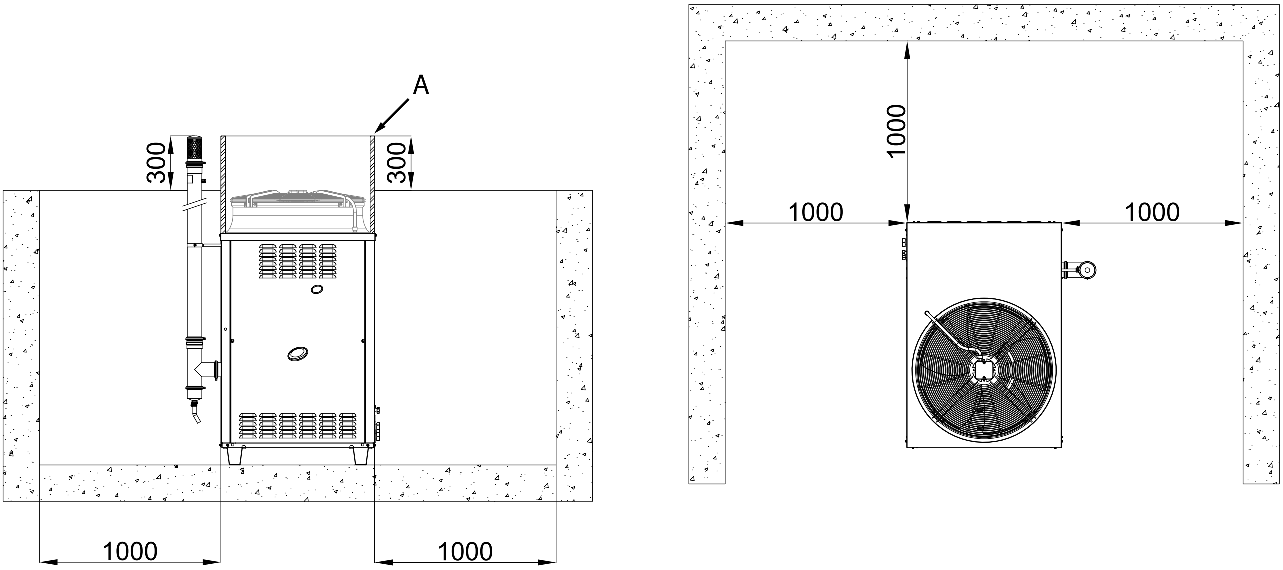


A Optimum positioning B Allowed positioning

If there are three walls higher than the aerothermal appliance (Figure 2.4 *p. 3*), you must:

- keep at least 1 m away from each wall
- orient the finned coil outwards, so as to facilitate air circulation
- extend the flue gas exhaust (for appliances in which it is provided) beyond the wall height by at least 300 mm
- duct the expulsion of air from the fan beyond the height of the walls by at least 300 mm

Figure 2.4 *Clearances for a single aerothermal appliance with 3 walls higher than the appliance*

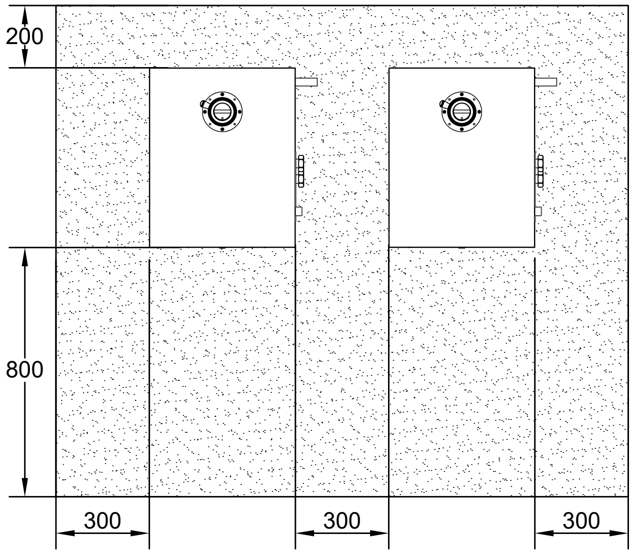


A Ducting of exhaust air from the fan

Installation in trenches (i.e. with the aerothermal appliance surrounded on all four sides by walls) is permitted in accordance with the specific instructions provided by Robur technical service.

2.2.2 AY

Figure 2.5 *Clearances*

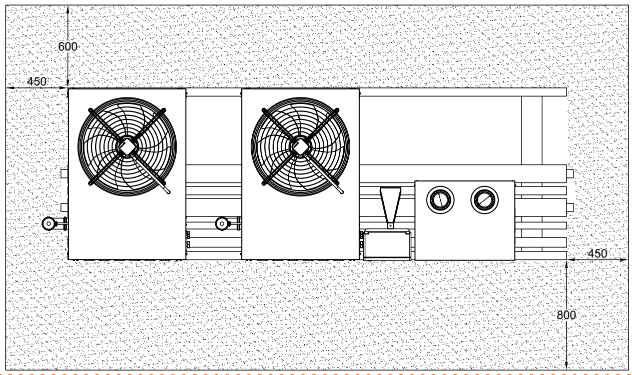


2.2.3 Link

The distances shown in Figure 2.6 *p. 4* below are valid when installing a single Link:

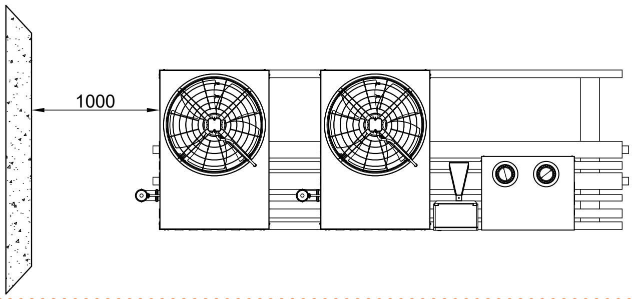
- ► for all Link of GAHP GS/WS Plus or AY modules only
- ► for all aerothermal Link, in the absence of walls near the Link that are higher than the appliance

Figure 2.6 *Clearances*



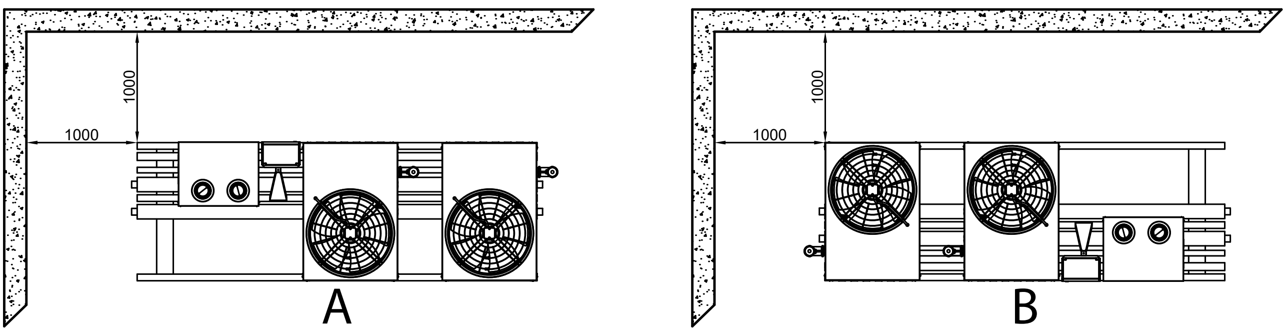
If there is a wall higher than the aerothermal Link (Figure 2.7 *p. 4*), the lateral distance must be increased to 1 m from the wall.

Figure 2.7 *Clearances for a single aerothermal link with 1 wall higher than the appliance*



If there are two walls higher than the aerothermal Link (Figure 2.8 *p. 4*), the distance of the Link must be increased to 1 m from each wall. If possible, the aerothermal Link should always be placed with the finned coil facing outwards and not towards the walls.

Figure 2.8 *Clearances for a single aerothermal link with 2 walls higher than the appliance*



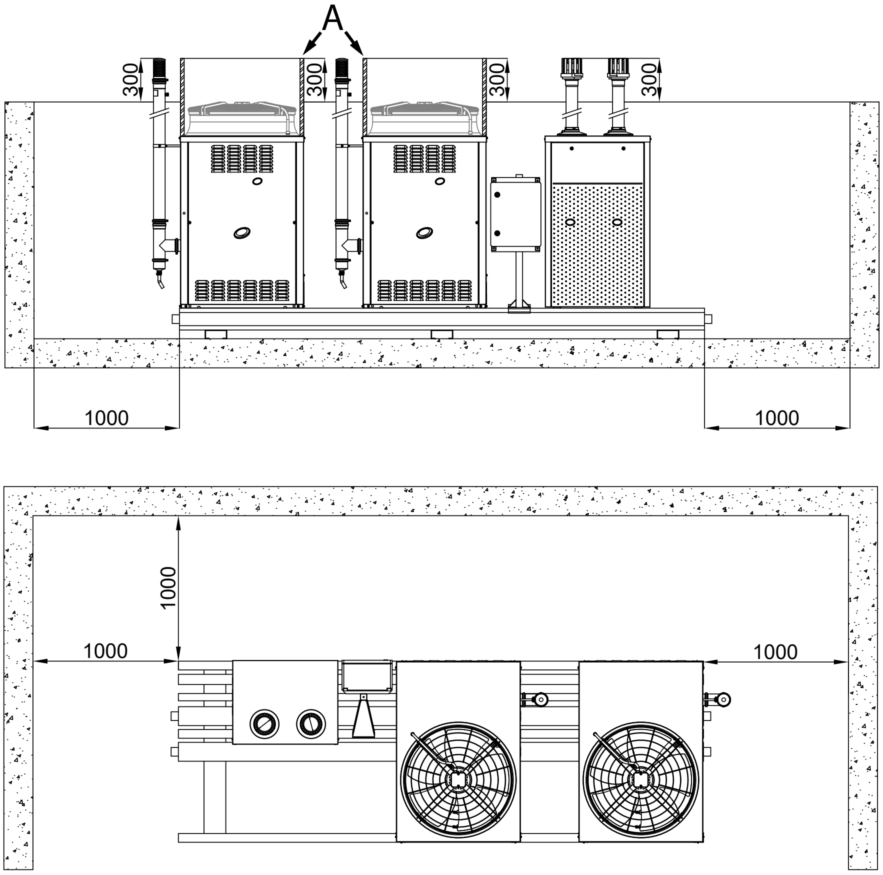
A Optimum positioning

B Allowed positioning

If there are three walls higher than the aerothermal Link (Figure 2.9 *p. 5*), you must:

- ► keep at least 1 m away from each wall
- ► orient the finned coil outwards, so as to facilitate air circulation
- ► extend the flue gas exhaust (for appliances in which it is provided) beyond the wall height by at least 300 mm
- ► duct the expulsion of air from the fan beyond the height of the walls by at least 300 mm

Figure 2.9 *Clearances for a single aerothermal link with 3 walls higher than the appliance*



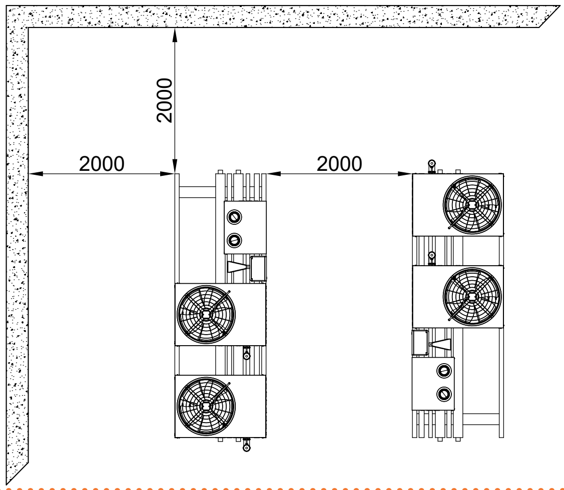
A Ducting of exhaust air from the fan

Installation in trenches (i.e. with the aerothermal Link surrounded on all four sides by walls) is permitted in accordance with the specific instructions provided by Robur technical service.

If there are several aerothermal Link:

- if there are no walls near the Link that are higher than the appliance, refer to Figure 2.6 *p. 4*
- if there is only one wall higher than the Link, refer to Figure 2.7 *p. 4*
- if there are two walls higher than the Link, at least 2 m distance from each wall must be kept (Figure 2.10 *p. 5*)

Figure 2.10 *Clearances for multiple aerothermal links with 2 walls higher than the appliance*



Robur technical service is available for in-depth evaluation of installation situations with specific problems.

3 MOUNTING BASE

3.1 MOUNTING BASE CONSTRUCTIVE FEATURES

Place the appliance on a level flat surface made of fireproof material and able to withstand its weight.

3.2 INSTALLATION AT GROUND LEVEL

Failing a horizontal support base, make a flat, level concrete base, at least 150 mm larger than the appliance on each side.

3.3 INSTALLATION ON TERRACE OR ROOF

- ► The structure of the building must support the total weight of the appliance and the supporting base.
- ► If necessary, provide a maintenance walkway around the appliance.

3.4 ANTI VIBRATION MOUNTINGS

Although the appliance's vibrations are minimal, resonance phenomena might occur in roof or terrace installations.

- ► Use anti-vibration mountings.
- ► Also provide anti-vibration joints between the appliance and water and gas pipes.

1 HYDRAULIC SYSTEM

1.1 DESIGN AND IMPLEMENTATION

The system must be designed and realized in a congruent way with the features and functionality of the single appliance or Link.

Pay particular attention to the variable or constant flow operation of the appliances (Paragraph 1.6 *p. 5*).

For the appropriate system design, the following must be considered:

- the characteristics of individual heating/cooling appliances
- manifold configuration (for Link only) and hydraulic connections
- the presence (or not) of water pumps

The sizing of the hydraulic plumbing and of any water circulation pump must provide the nominal flow required for proper operation of the appliance or Link:

- For individual appliance pressure drop data, please refer to Section B.
- For pressure drop data for Link, please refer to Section B14.
- For water pumps data, please refer to Section C01.04.

When using glycol water, take this into account when selecting the pipe material and calculating the additional pressure drop generated by the presence of glycol (Section C01.06).

1.2 PRIMARY AND SECONDARY CIRCUIT

In many cases it is advisable to divide the hydraulic system into two parts, primary and secondary circuit(s), uncoupled by a hydraulic separator, or possibly by a tank that also acts as inertial volume/buffer tank.

The installation of an inertial volume/buffer tank is always advised and recommended if the system has a low water content. Please refer to Paragraph 1.5 *p. 5* for sizing of Inertial volume/buffer tank.

For further information on the buffer tank and hydraulic separator please refer to Section C01.07.

1.3 DHW CIRCUIT

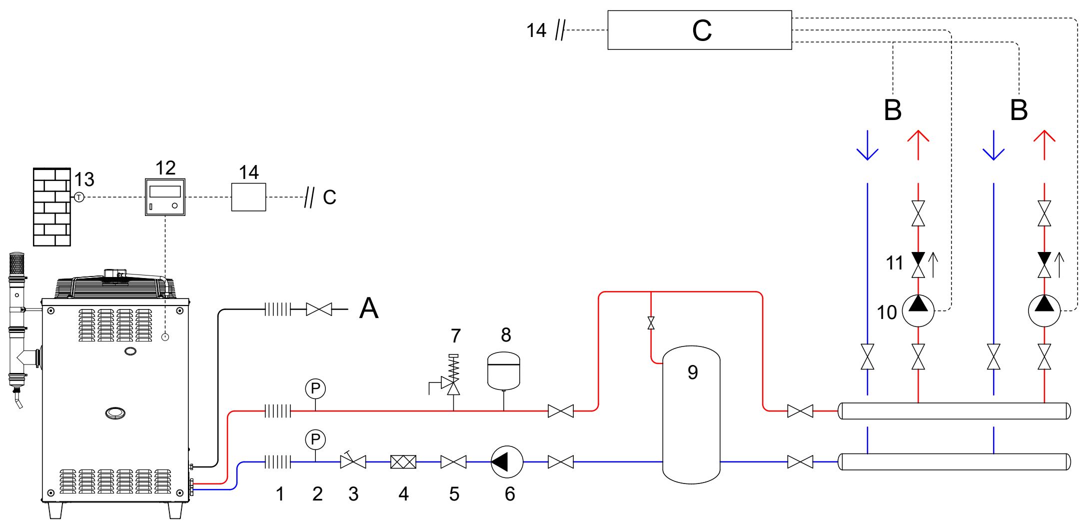
DHW production with Robur appliances can take place via the base DHW circuit or via the separable DHW circuit.
The separable DHW circuit is functional for DHW production using a subset of the generation system, so that the space heating service is not interrupted during DHW production.
Three-way diverting valves must be provided for this purpose (Paragraph 2 *p. 6*) and the pressure drops on this circuit, which typically does not have hydraulic separation as the DHW buffer tanks coil exchangers are fed directly from the primary circuit of the generation system, must be carefully checked.

For further information, please refer to Section C01.12.

1.4 WATER FLOW

The individual GAHP/GA appliances are always supplied without water pumps, which must be selected according to the appliance's characteristics (possibly from those available in the catalogue as options) and the circuit to which it is connected.
Figure 1.1 *p. 1* shows an example of a plumbing diagram for a single aerothermal appliance.

Figure 1.1 *Plumbing diagram for a single GAHP AR Plus for heating and cooling*

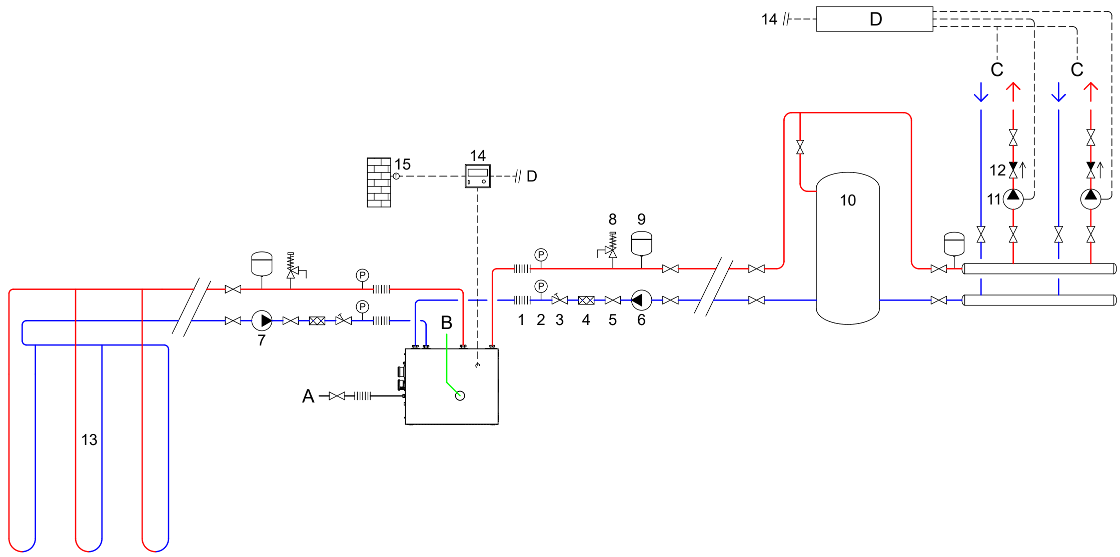


The flow regulation valve must only be used if the pump in the primary circuit is the fixed flow type

A	Gas connection	2	Pressure gauge	9	Buffer tank (and hydraulic separator)
B	Heating/Cooling circuit	3	Flow regulation valve	10	Heating/Cooling circuit water pump
C	Secondary circuit management system	4	Sludge filter	11	Check valve
1	Anti-vibration connection	5	Shut-off valve	12	DDC panel
		6	Primary circuit water pump	13	Outdoor temperature probe
		7	Safety valve	14	Summer/winter selector switch
		8	Expansion tank		

Figure 1.2 *p. 2* shows an example of a plumbing diagram for a single appliance GAHP GS Plus.

Figure 1.2 *GAHP GS plumbing diagram*



The flow regulation valve must only be used if the pump in the primary circuit is the fixed flow type

A Gas connection

B Safety valve drain ducting connection (indoor version only)

C Heating circuit

D Secondary circuit management system

1 Anti-vibration connection

2 Pressure gauge

3 Flow regulation valve

4 Sludge filter

5 Shut-off valve

6 Primary circuit water pump on system side

7 Primary circuit water pump on renewable source side

8 Safety valve

9 Expansion tank

10 Buffer tank (and hydraulic separator)

11 Heating/Cooling circuit water pump

12 Check valve

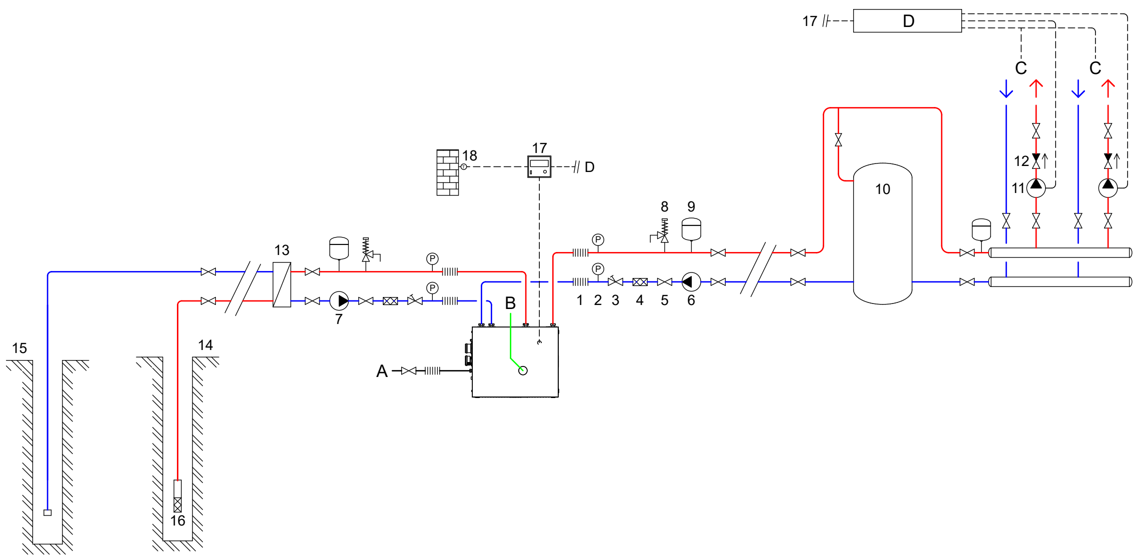
13 Geothermal field probes

14 DDC panel

15 Outdoor temperature probe

Figure 1.3 *p. 2* shows an example of plumbing diagram for an individual GAHP WS Plus unit.

Figure 1.3 *GAHP WS plumbing diagram*



The flow regulation valve must only be used if the pump in the primary circuit is the fixed flow type

A Gas connection

B Safety valve drain ducting connection (indoor version only)

C Heating circuit

D Secondary circuit management system

1 Anti-vibration connection

2 Pressure gauge

3 Flow regulation valve

4 Sludge filter

5 Shut-off valve

6 Primary circuit water pump on system side

7 Primary circuit water pump on renewable source side

8 Safety valve

9 Expansion tank

10 Buffer tank (and hydraulic separator)

11 Heating/Cooling circuit water pump

12 Check valve

13 Heat exchanger

14 Water extraction well

15 Water return well

16 Submersible pump

17 DDC panel

18 Outdoor temperature probe

The primary water pump must be mandatorily con- trolled by the appliance (see Section C01.10 for primary water pump wiring diagrams).

AY boilers are always equipped with independent oversized water pumps (one for each module).
The Link can be:

► already equipped with water pumps for each module (preferred configuration in many applications)

or

► without water pumps, in which case it is required to install at least one common water pump, on the primary circuit (this choice should be carefully evaluated, discussing it in advance with Robur technical service)

If there is at least one AY boiler, it is mandatory to provide Link with water pumps for each individual module.

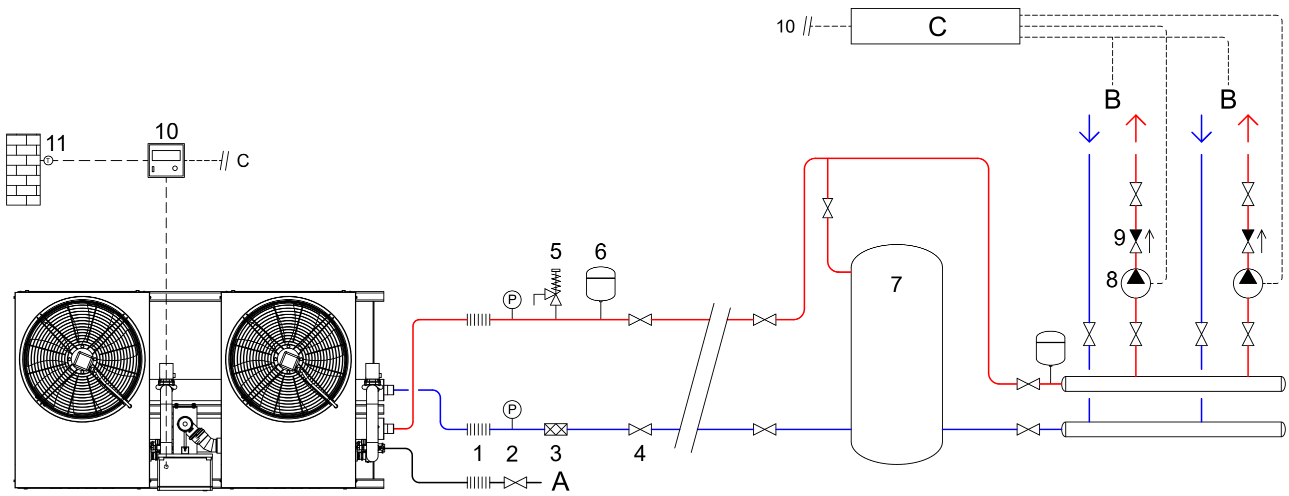
Examples of hydraulic diagrams of Link with independent water pumps are shown in Figure 1.4 *p. 3* and 1.5 *p. 4*.
Examples of hydraulic diagrams of Link without independent water pumps (with common water pump, not supplied with the Link) are shown in Figure 1.6 *p. 4* and 1.7 *p. 5*.

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

Under partial load conditions, it is not therefore possible to ensure the general setpoint is reached and maintained.
With high delivery setpoint, GAHP/GA appliances may exceed their operating limits to offset the mixing that occurs with inactive units.
The solution with common circulating pump is therefore recommended only if the thermal or cooling load applied is constant in any operating condition.
If systems with Link without independent water pumps are to be designed, a prior check with the Robur technical service is always advisable.

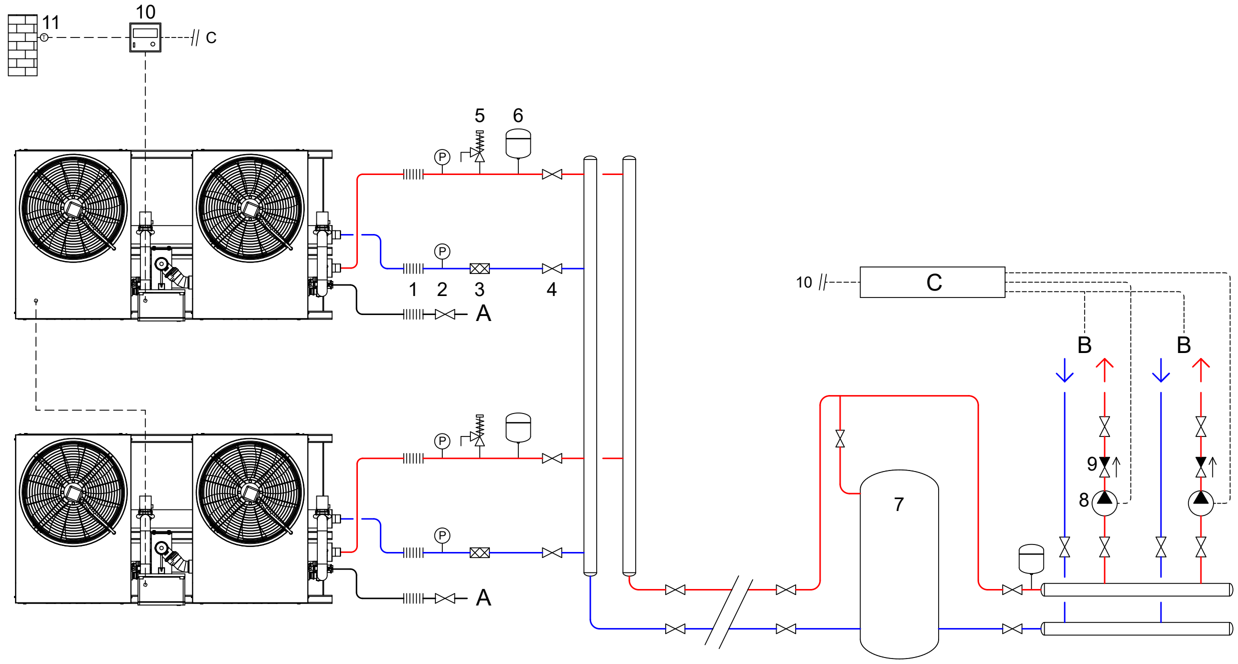
The common primary water pump must mandatorily be controlled by the request on the Link electrical panel (see Section C01.10).

Figure 1.4 *Example of hydraulic system diagram for connection of 1 Link, 2-pipe, with water pumps*



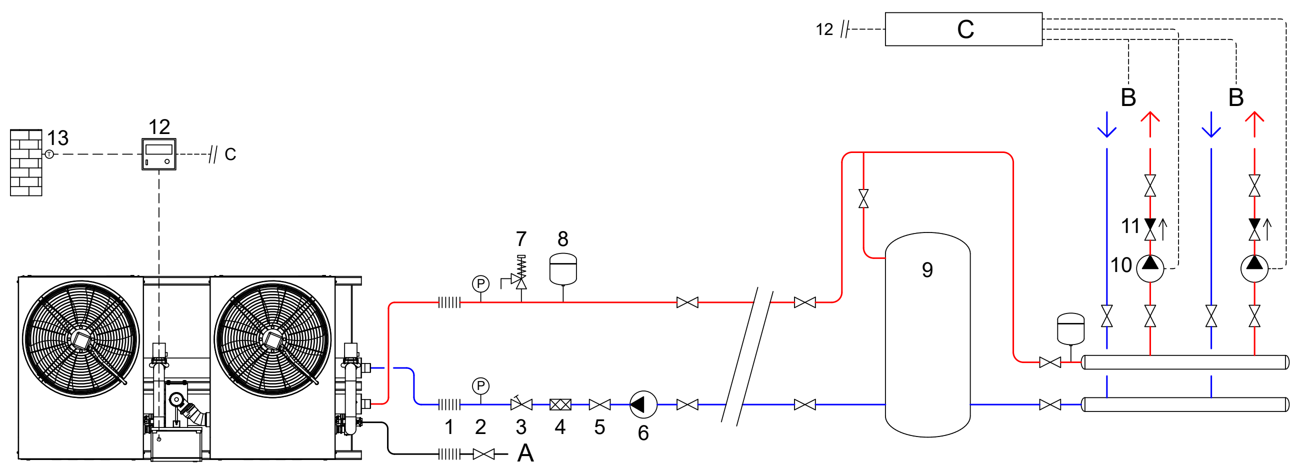
A	Gas connection	3	Sludge filter	8	Heating/Cooling circuit water pump
B	Heating/Cooling circuit	4	Shut-off valve	9	Check valve
C	Secondary circuit management system	5	Safety valve	10	DDC panel
1	Anti-vibration connections	6	Expansion tank	11	Outdoor temperature probe
2	Pressure gauge	7	Buffer tank (and hydraulic separator)		

Figure 1.5 *Example of hydraulic system diagram for connection of 2 Link, 2-pipe, with water pumps*



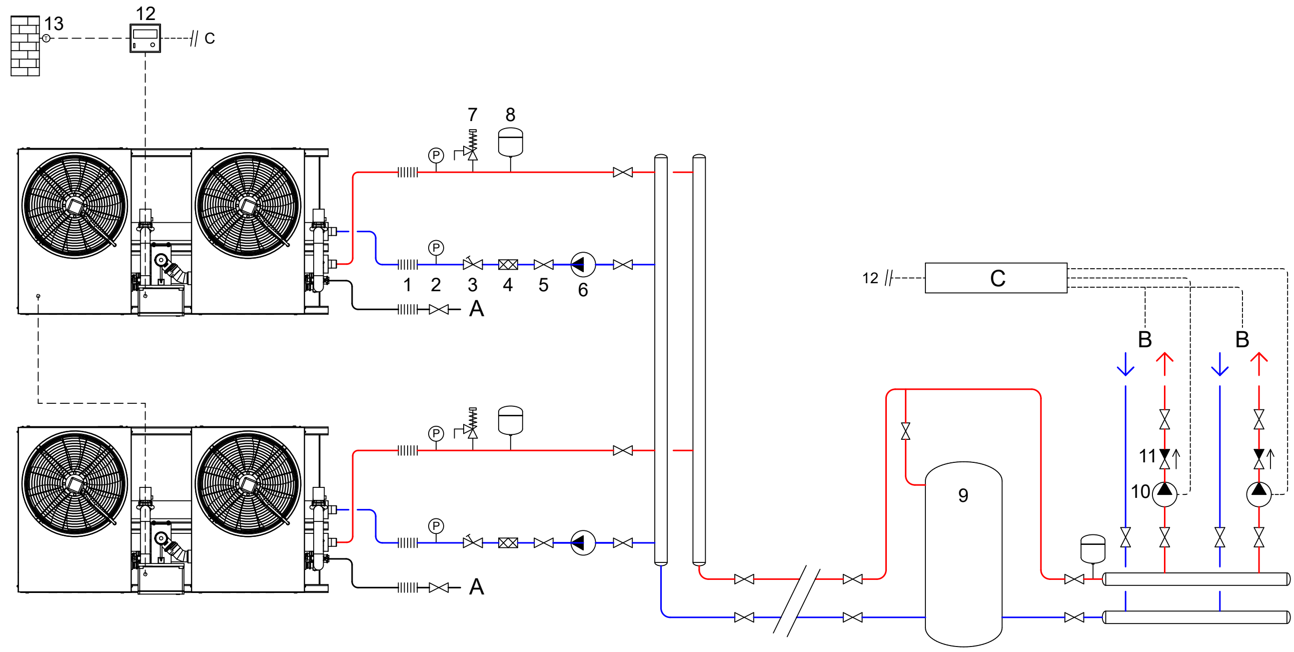
A	Gas connection	3	Sludge filter	8	Heating/Cooling circuit water pump
B	Heating/Cooling circuit	4	Shut-off valve	9	Check valve
C	Secondary circuit management system	5	Safety valve	10	DDC panel
1	Anti-vibration connection	6	Expansion tank	11	Outdoor temperature probe
2	Pressure gauge	7	Buffer tank (and hydraulic separator)		

Figure 1.6 *Example of hydraulic system diagram for connection of 1 Link, 2-pipe, without water pumps*



A	Gas connection	4	Sludge filter	10	Heating/Cooling circuit water pump
B	Heating/Cooling circuit	5	Shut-off valve	11	Check valve
C	Secondary circuit management system	6	Primary circuit water pump	12	DDC panel
1	Anti-vibration connection	7	Safety valve	13	Outdoor temperature probe
2	Pressure gauge	8	Expansion tank		
3	Flow regulation valve	9	Buffer tank (and hydraulic separator)		

Figure 1.7 *Example of hydraulic system diagram for connection of 2 Link, 2-pipe, without water pumps*



A	Gas connection	4	Sludge filter	10	Heating/Cooling circuit water pump
B	Heating/Cooling circuit	5	Shut-off valve	11	Check valve
C	Secondary circuit management system	6	Primary circuit water pump	12	DDC panel
1	Anti-vibration connection	7	Safety valve	13	Outdoor temperature probe
2	Pressure gauge	8	Expansion tank		
3	Flow regulation valve	9	Buffer tank (and hydraulic separator)		

1.5 PRIMARY CIRCUIT WATER CONTENT

A minimum volume of water in the primary circuit must be provided. This volume must be at least 70 litres for each GAHP/GA module, both on the heating/cooling circuit and on the renewable source circuit (only for systems with GAHP GS/WS Plus), to absorb the energy (thermal or cooling) supplied by the module during the switch-off phase.
In order to provide thermal inertia to the system, especially under low load conditions, and optimise performance accordingly, a larger volume of water can be provided, as detailed in Section C01.07.

1.6 CONSTANT OT VARIABLE WATER FLOW

The GAHP A Plus and GAHP GS/WS Plus appliances can operate with constant or variable water flow (only on the hot side), regardless of the ON/OFF or modulating operating mode.
All other individual appliances can only operate with constant water flow.
Link equipped with independent water pumps operate at variable flow, as only the water pumps of the actually active modules are switched on.
The Link without water pumps operates at a constant flow (even if the water pump serving the Link is of the variable flow type). This is because, although it is possible to manually disconnect individual modules from the water circuit (for example, in the case of Link without water pumps consisting of mixed modules, i.e. some that produce hot water and others that produce cold water on the same circuit), it is not possible to dynamically disconnect individual modules of the same type that are not switched on at that moment. For example, it would not be possible to exclude a GAHP A Plus module that is switched off (but not disconnected from the water circuit) from the water circulation by two other GAHP A Plus modules that are switched on and present on the same Link without water pumps. Consequently, a common water pump, even of the variable flow type, would distribute the water flow to all three modules in this example, and not only to those that are actually switched on.

1.7 HYDRAULIC CONNECTIONS

1.7.1 Hydraulic connections

1.7.1.1 Single GAHP/GA/AY

The hydraulic connections of the individual appliances are summarised in the following Table 1.1 *p. 5*:

Table 1.1 *Hydraulic connections of appliances*

Appliance	Hydraulic connections	Condensate drain connection	Boiler safety valve drain connections
GAHP/GA	1 1/4" F	outside 25 mm, inside 21 mm (only on GAHP A Plus and GAHP GS/WS Plus)	-
AY 35/AY 50	1 1/4" F	outside 25 mm, inside 21 mm	outside 20 mm, inside 14 mm
AY 100	1 1/2" F	outside 25 mm, inside 21 mm	outside 20 mm, inside 14 mm

Connect the outlet of the boiler safety valve to a suitable drain. The manufacturer is not liable for any damage caused by the opening of the safety valve in the event of system overpressure.

1.7.1.2 Link

The exact configuration of the hydraulic connections depends on the composition of the Link. Please refer to the technical data sheet of the specific Link or the information in Section B14.
The following Table 1.2 *p. 6* shows the dimensions of the hydraulic and condensate drain connections.

Table 1.2 *Hydraulic connections diameters*

Cold/hot water connections	2" M
Condensate drain connection	1" F
Connection of a single AY on the separate circuit	1 1/4" F for AY 35 and AY 50 1 1/2" F for AY 100
Connection of more AY on the separate circuit	2" M
Recovery circuit connection	2" M
AY safety valve drain	outside Ø 20 mm, inside Ø 14 mm

The hydraulic connections of the base circuit (and of the separate circuit, if any) are only provided on the right side of the Link, as is any condensate drain. The hydraulic connections of the recovery circuit, if any, are only provided on the left side of the Link, except for Link made up only of GA ACF HR modules, where the hydraulic connections of the recovery circuit are also on the right.

Connect the outlet of each safety valve of any boiler on the Link to a suitable drain. The manufacturer is not liable for any damage caused by the opening of the safety valve in the event of system overpressure.

1.7.2 Hydraulic pipes, materials and features

Use pipes for heating/cooling systems, protected from weathering and freezing, insulated for thermal dispersion, with vapour barrier to prevent condensation.

1.7.3 Minimum components of primary plumbing circuit

Always provide, near the appliance:

- on water piping, both outlet and inlet
  2. antivibration joints on water fittings
  2. pressure gauges
  2. isolation ball valves
- on the inlet water piping
  1. separator filter
  1. flow regulation valve, if the circulation pump is with constant flow (only for Link without circulators)
  1. water pump, towards the appliance (only for Link without water pumps)
- on the water outlet pipe (in the absence of AY boilers on the same pipe pair)
  1. safety valve (3,5 bar)
  1. expansion tank

The safety valve and expansion tank must be installed before any isolation valves, so that they cannot be excluded from the system.

Each AY boiler is equipped with its own 10 l internal expansion tank and with a safety valve. Depending on the system water content, assess the need for additional expansion tanks.

For GAHP WS Plus heat pumps with an open circuit, it is always mandatory to use a heat exchanger on the renewable source side.

See Paragraph 1.4 *p. 1* and Section C01.13 for example hydraulic diagrams.

1.8 COOL/HEAT SWITCHING

Reversing the operating mode from heating to cooling mode and vice versa is done internally for GAHP AR Plus reversible aerothermal heat pumps, which nevertheless maintain the same outlet and inlet connections in both modes. Consequently, in the heating mode, water outlet will be hotter than inlet, while in the cooling mode, water outlet will be colder than inlet. Any inversions of the connections to the buffer tank/hydraulic separator, so as to keep the cold water at the bottom and the hot water at the top, in order to avoid undesired mixing, must be foreseen on the system and cannot be managed by the heat pump.
For GAHP GS/WS Plus geothermal and hydrothermal heat pumps, the inversion of the operating mode is purely logical, as the appliances are equipped with two pairs of connections, one for hot water and the other for cold water. Consequently, in cooling mode operation, it is necessary to provide the water circuit with inversion diverter valves external to the heat pumps, capable of inverting the connections between the heating circuit/renewable source and the system, so that cold water (connected to the renewable source in heating mode) is instead sent to the system, and hot water is instead sent to the renewable source. These valves can be controlled directly by GAHP GS/WS Plus heat pumps. Refer to Paragraph 2 *p. 6* for the characteristics of the inversion diverter valves.

2 SPECIFICATIONS OF DIVERTER VALVES

Table 2.1 *p. 7* shows the minimum and maximum flow rate to be assured to Robur units in all operating conditions, hence also during the switching stage of any diverter valves installed on the system.
These flow rates are valid both for DHW separation valves and for hot/cold switching valves.
The valve (hence its kvs indicating pressure drops) must consequently be selected in connection with the required flow rates, so that the indicated flow rate range is complied with even in the switching stage.

Table 2.1 *Diverter valves water flow*

			GAHP GS/WS Plus		GAHP A Plus	AY			GA ACF		GAHP AR Plus
			GAHP WS Plus	GAHP GS Plus		AY 35	AY 50	AY 100		ACF60-00 LB	
Heating mode											
Heating water flow	minimum	l/h	2000		2000	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	minimum	l/h	2300	-	-	-	-	-	-	-	-
	maximum	l/h	4700	-	-	-	-	-	-	-	-
Renewable source water flow (with 25% glycol)	minimum	l/h	-	2000	-	-	-	-	-	-	-
	maximum	l/h	-	4000	-	-	-	-	-	-	-

3 DEFROSTING WATER DRAINAGE

Defrosting

In winter, frost may form on the finned coil of aerothermal heat pumps (GAHP A Plus/GAHP AR Plus) and the appliance automatically performs defrosting cycles.

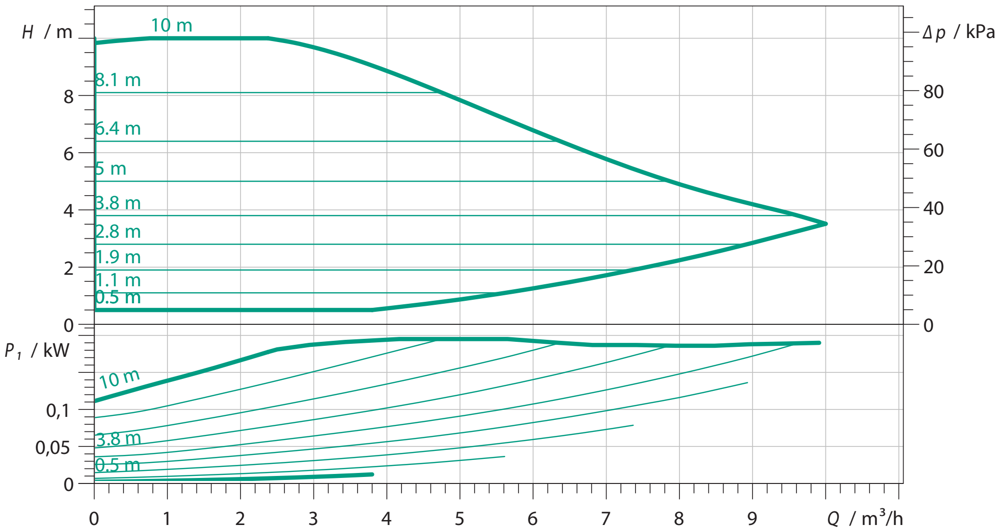
3.1 COLLECTION BASIN AND DRAINAGE SYSTEM

Provide for a collection basin or containment rim and a discharge system of the defrosting water, to avoid overflowing, freezing and damage.

1 INDIVIDUAL APPLIANCES

For individual GAHP Plus/GA appliances, water pumps are always supplied as an option and are all high-efficiency modulating pumps.
Below is the characteristic curve for this pump type.

Figure 1.1 *Oversized pressure head water pump characteristic curves*



For single AY boilers, the water pumps are high-efficiency, fixed-flow types and are already installed and wired inside the appliance. In the AY 100 appliance, there are two water pumps, one for each thermal module.
Below is the characteristic curve for this pump type.

Figure 1.2 *Characteristic curve of the single water pump with oversized head*

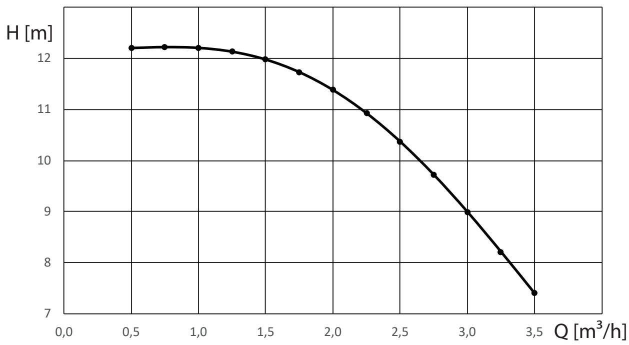
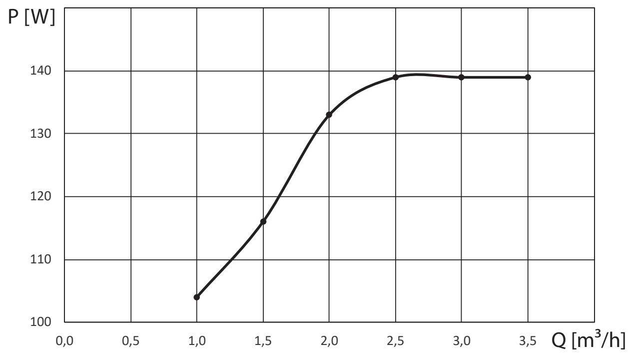


Figure 1.3 *Electrical consumption curve of the single water pump with oversized head*



2 LINK

The Link can be:

- ► already equipped with water pumps for each module (preferred configuration in many applications)

or

- ► without water pumps, in which case it is required to install at least one common water pump, on the primary circuit (this choice should be carefully evaluated, discussing it in advance with Robur technical service)

If there is at least one AY boiler, it is mandatory to provide Link with water pumps for each individual module.

In Link already equipped with water pumps, each individual GAHP/GA/AY module that is part of the Link has an individual, independent, high-efficiency fixed-flow water pump.
The characteristic curve of the water pump is shown in Figure 1.2 *p. 1*.

The water pumps of the GAHP/GA modules are installed externally and equipped with a special protective cover. For the AY modules, the water pumps are installed inside the module itself.

1 SYSTEM WATER CHARACTERISTICS

In order to avoid any scale or deposits on the primary exchanger, the water in the system must be treated in accordance with the applicable standards. This treatment is absolutely essential in cases where there are frequent episodes of water supply or partial or total emptying of the system.

The filling and top-up water bring some amount of calcium into the system. This is attached to the hot parts including the heat exchanger, thus creating pressure drops and thermal insulation on the active parts. This can lead to damage.
If the filling and top-up water of the system is outside the values indicated below, it must be softened and/or chemically treated. Additives may also be added to keep the calcium in solution. Hardness should be checked regularly and recorded on the system logbook.
The choice of the type of treatment must be made according to the characteristics of the water to be treated, the type of plant and the limits of purity required.
Free chlorine or water hardness may damage the appliance.
Adhere to the chemical-physical parameters in Table 1.1 *p. 1* and the regulations on water treatment for residential and industrial heating systems.

Table 1.1 *Chemical and physical parameters of water*

Chemical and physical parameters of water in heating/cooling systems		
Parameter	**Measurement unit**	**Required value**
pH	/	> 7 (1)
Chlorides	mg/l	< 125 (2)
Total hardness ($CaCO_3$)	°f	< 15
	°d	< 8,4
Iron	mg/kg	< 0,5 (3)
Copper	mg/kg	< 0,1 (3)
Aluminium	mg/l	< 1
Langelier's index	/	0-0,4
Harmful substances		
Free chlorine	mg/l	< 0,2 (3)
Fluorides	mg/l	< 1
Sulphides		ABSENT

1 With aluminium or light alloys radiators, pH must also be lower than 8 (in compliance with applicable rules)
2 Value referred to the maximum water temperature of 80 °C
3 In compliance with applicable rules

2 CHOICE OF TREATMENT

The features of the plant water must be as detailed in the 1 *p. 1* section.
The choice of a possible chemical conditioning system or the addition of plant water additives is subject to the designer, depending on the quality of water detected by qualified personnel.
It must always be verified (through the technical office of the company producing the additive) that adding it to the plant water does not cause any such alterations to come out of the required parameters.

3 WATER TOPPING UP

The chemical-physical properties of the system's water may alter over time, resulting in poor operation or excessive topping up.
► Ensure there are no leaks in the installation.
► Periodically check the chemical-physical parameters of the water, particularly in case of automatic topping up.

Chemical conditioning and washing

Water treatment/conditioning or system washing carried out carelessly may result in risks for the appliance, the system, the environment and health.
- Contact specialised firms or professionals for water treatment or system washing.
- Check compatibility of treatment or washing products with operating conditions.
- Do not use aggressive substances for stainless steel or copper.
- Do not leave washing residues.

1 ANTIFREEZE FUNCTION

The individual appliances are equipped with an active antifreeze self-protection system to prevent freezing. The antifreeze function automatically starts the primary water pumps and, if necessary, the burners (heat pumps and boilers only) when the outdoor temperature approaches zero or the temperature measured by the appliance's water probes is below a preset value. The antifreeze function is activated by default for heat modules and deactivated for cold modules.

Electrical and gas continuity

The active antifreeze self-protection is only effective if the power and gas supplies are assured. Otherwise, antifreeze fluid might be required.

GA ACF HR appliances

The GA ACF HR appliances are equipped with an antifreeze function for the cooling circuit (deactivated by default as they are cold modules). In contrast, the recovery circuit does not have an antifreeze function.
The recovery circuit antifreeze protection must therefore be assured with alternative methods if not used (e.g. by adding antifreeze fluid or by starting up the circulation pump with timer or thermostat).

Secondary circuit

Arrange for appropriate measures to prevent water freezing in any secondary side circuits not used in winter (e.g. controlling, by timer or thermostat, the operation of the circulating pumps in that branch of the system).

2 ANTIFREEZE FLUID

Precautions with glycol

<u>The manufacturer disclaims any liability for any damage caused by improper glycol use.</u>

- Always check product suitability and its expiry date with the glycol supplier. Periodically check the product's preservation state.
- Do not use car-grade antifreeze fluid (without inhibitors), nor zinc-coated piping and fittings (incompatible with glycol).
- Glycol modifies water's physical properties (density, viscosity, specific heat, etc.). Size the piping, water pump and thermal generators accordingly.
- With automatic system water filling, a periodic check of the glycol content is required.

When producing DHW by DHW buffer tank, use propylene glycol only.

Please refer to the applicable local regulations for the choice of antifreeze fluid.

The use of toxic antifreeze fluids is forbidden.

Use with chilled water below 3 °C

Glycol may be required in any case if the chilled water outlet temperature is 3 °C or lower.

2.1 TYPE OF ANTIFREEZE GLYCOL

Inhibited type glycol is recommended to prevent oxidation phenomena.

2.2 GLYCOL EFFECTS

Please refer to the specifications of the chosen glycol for the glycol percentage to be used and for the effects of glycol on appliance efficiency and pressure drops.

When using the antifreeze glycol available as a Robur optional, the characteristics can be found in the Instruction sheet enclosed with the optional.

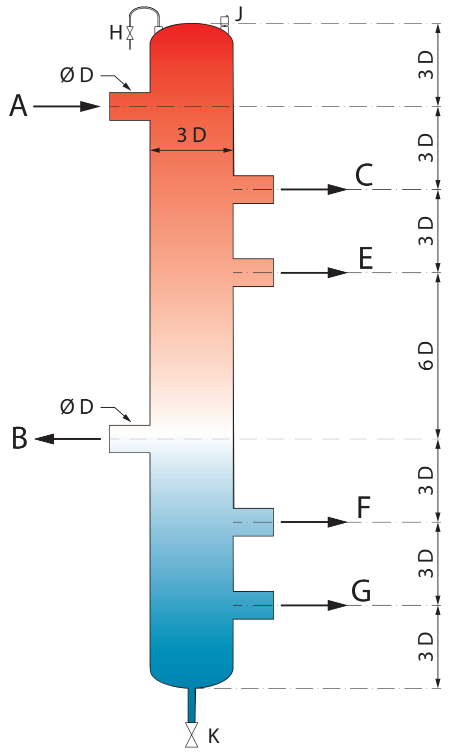
1 HYDRAULIC SEPARATOR

The hydraulic separator is used to make the primary and secondary circuit independent, to prevent interferences and mutual disruptions, especially when the flow rates on the circuits are different.
The separator cannot replace the inertial buffer tank unless it has an adequate volume (Paragraph 2 *p. 2*).
The hydraulic separator should have the following features:

- Maximum water speed in the separator 0,1 m/s
- Maximum inlet/outlet water speed 0,9 m/s
- Branch connections for circuits at higher temperature upwards (for heating applications)
- In case of several deliveries at the same temperature use a single branch connection and create a distribution manifold

Sizing must be carried out on the basis of the maximum flow rate between primary and secondary.
For optimal sizing it is recommended to follow the so-called "3 D" rule, shown in Figure 1.1 *p. 1*.
This is based on the diameter D of the hydraulic separator's connections to define the dimensional features and position of the branch connections, based on multiples of the diameter.
Figure 1.1 *p. 1* shows the use for heating applications.
For conditioning applications, the inlet of the primary circuit should be at the bottom, so that natural circulation does not trigger parasitic mixing phenomena.
Similarly, for conditioning applications, branch connections at lower temperature must be at the bottom and those at higher temperature must be at the top.

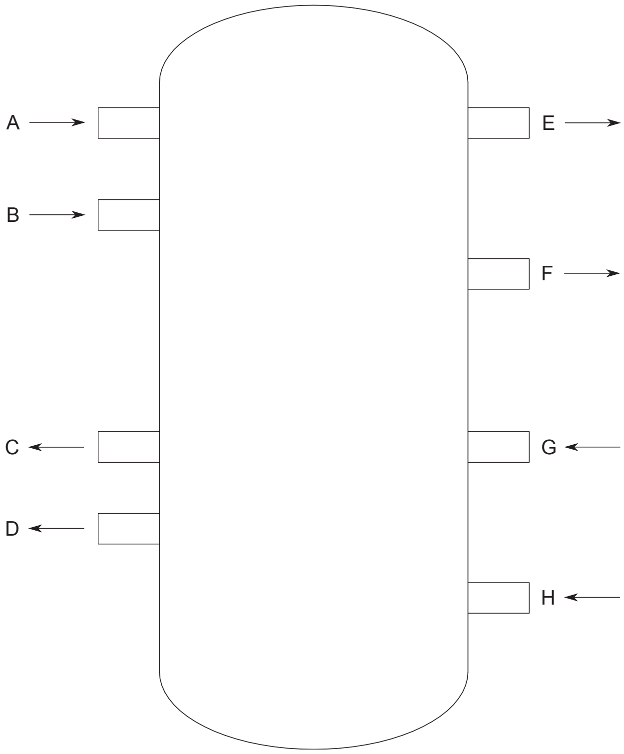
Figure 1.1 *6-connection hydraulic separator*



A	Heating primary circuit outlet	F	High temperature secondary circuit return
B	Hot primary circuit return	G	Low temperature secondary circuit return
C	High temperature secondary circuit outlet	H	Manual air vent
D	Hydraulic connections diameter	J	Automatic air vent
E	Low temperature secondary circuit outlet	K	Sludge purge

If different types of generators are installed on the primary circuit, connected to the same separator, one should refer to Picture 1.2 *p. 1*, related to heating applications.
Branch connections at higher temperature, on inlet or outlet, must be positioned higher, in order to prevent excessively hot water reaches the heat pumps from the boilers.

Figure 1.2 *8-connection hydraulic separator*



A	Boiler primary circuit delivery	F	Low temperature secondary circuit outlet
B	GAHP primary circuit delivery	G	High temperature secondary circuit return
C	Boiler primary circuit return	H	Low temperature secondary circuit return
D	GAHP primary circuit return		
E	High temperature secondary circuit outlet		

2 BUFFER TANK

The buffer tank has the purpose of providing thermal inertia to the system, especially in low load conditions, thus reducing the number of heat generators ON/OFF, particularly significant for the system general efficiency.
In the appropriate plumbing configuration, it may also be used as a hydraulic separator (Paragraph 1 *p. 1*).
The buffer tank may also be used for disposing of thermal and cooling output when the appliance is switched off, to prevent the water temperature from rising or dropping excessively.

The heating or cooling energy accumulated during normal operation of the system, which also depends on the buffer tank capacity, can only be exploited effectively with a control system which, on the basis of the secondary temperature, switches off the generation system and relevant circulating pumps and chokes the water flow on the secondary circuit, for example by means of mixing valves.

Without such a control system, the buffer tank is unable to prevent the appliances from switching off, regardless of the buffer tank size, as soon as the setpoint temperature is reached, and thus cannot store energy, risking a high number of ON/OFF switching, especially at low loads.

For more information on Robur control systems, see Section C01.11.

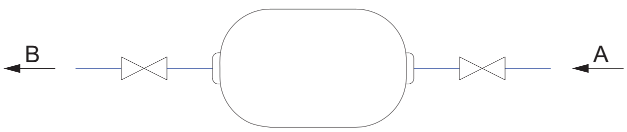
Buffer tanks are divided into:
- in line (2 connections) (Paragraph 2.1 *p. 2*)
- with hydraulic separation (3 or 4 connections) (Paragraph 2.2 *p. 2*)

When used with chilled water, special versions of the buffer tanks must be provided (Paragraph 2.3 *p. 3*).
A minimum volume of water in the primary circuit must be provided. This volume must be at least 70 litres for each GAHP/GA module, both on the heating/cooling circuit and on the renewable source circuit (only for systems with GAHP GS/WS Plus), to absorb the energy (thermal or cooling) supplied by the module during the switch-off phase.
The recommended dimensions for optimising efficiency by reducing the number of ON/OFF switching are however greater:
- single appliance: 300 to 500 litres
- several appliances: from 500 to 1000 litres total

2.1 IN LINE BUFFER TANK

The in line buffer tank, or 2-connection buffer tank, only has the purpose of storing the heating and/or cooling energy.
It must be installed on the inlet to the appliances, preferably before the water pumps.
Figure 2.1 *p. 2* schematically shows an in line buffer tank with 2 connections.

Figure 2.1 *2-connection inertial buffer tank*



A Distribution circuit return (or hydraulic separator)
B Water pump inlet (or Robur appliances)

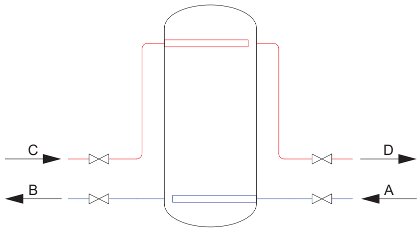
2.2 BUFFER TANK WITH HYDRAULIC SEPARATION

The buffer tank with hydraulic separation performs both functions of thermal buffer tank and hydraulic separator.
There are two types:
- 4 connections
- 3 connections

2.2.1 4 connections

The 4-connection buffer tank represents the most typical case of buffer tank with hydraulic separation functions.
Figure 2.2 *p. 2* shows an example of 4-connection buffer tank installation.

Figure 2.2 *4-connection inertial buffer tank*



A Secondary circuit return
B Primary circuit return
C Primary circuit delivery
D Secondary circuit delivery

One should ensure the selected buffer tank includes certain measures to reduce mixing the water flows inside the tank, consequently altering the temperatures and undermining comfort and efficiency:
- correct sizing (in particular the ratio of height to diameter)
- installation of anti-mixing devices

The main types of anti-mixing devices are:
- anti-mixing baffles (Figure 2.3 *p. 2*)
- conveying pipes (Figure 2.4 *p. 2*)
- diffuser pipes (Figure 2.5 *p. 3*)

Figure 2.3 *Tank with dividing baffles*

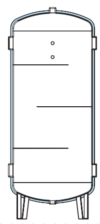
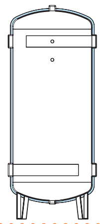


Figure 2.4 *Tank with conveying pipes*



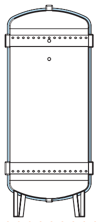


Figure 2.5 *Tank with diffuser pipes*

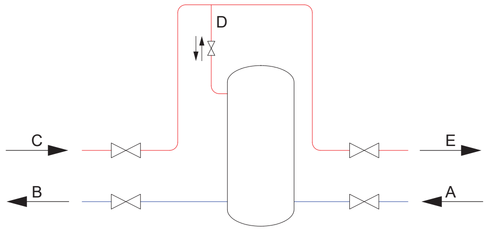
2.2.2 3 connections

The 3-connection buffer tank is actually identical to the more popular 4-connection one, except for the water connection.
A section of pipe, indicated with D in Figure 2.6 *p. 3*, with a large cross-section area (and consequently minimum pressure drop), in which the water can flow alternately in both directions, is realised.
The water flow is:

- towards the inlet of the buffer tank if the primary flow is higher than the secondary flow
- out of the buffer tank if the primary flow is lower than the secondary flow

In order for the buffer tank to also act as a hydraulic separator, it is essential not to close the shut-off valve provided on pipe D, which should only be closed for maintenance operations on the tank itself or to check the temperature arriving at the manifold in the absence of the buffer tank.

Figure 2.6 *3-connection inertial buffer tank*



A Secondary circuit return
B Primary circuit return
C Primary circuit delivery
D Pipe performing hydraulic separation, with shut-off valve
E Secondary circuit delivery

The significant advantage of this configuration, compared to the more popular 4-connection one, lies in the fact that when there are balanced flow rates the water flow is directly transferred from primary to secondary circuit, without mixing inside the buffer tank.
This is particularly useful in high temperature systems, where it is important to reduce temperature drops in order not to undermine the energy efficiency of heat pumps.
This configuration is also possible in cooling, provided the C, D, E sections are positioned at the bottom to better exploit thermal stratification.

2.3 BUFFER TANKS FOR CHILLED WATER

If the buffer tank (of any type) is also to be used for chilled water, it should be checked that it is suitable for this type of use, in order to prevent condensate formation leading to a deterioration of the buffer tank in a short time.

1 GAS CONNECTION

Table 1.1 *Gas connection*

Appliance	Gas connection
GAHP/GA	3/4" F
AY 35/AY 50	3/4" M
AY 100	1" M
Link	1 1/2" F

The connection is located on the right side, at the bottom (see dimensional diagrams of individual appliances or Link in Section B).

For Link, the gas connection can be moved to the left side by moving the blind plug from the left to the right side, except for Link of AY boilers only, where the gas connection is only provided on the right side of the Link.

- ► Install an anti-vibration connection between the appliance and the gas piping.

2 MANDATORY SHUT-OFF VALVE

- ► Provide a gas shut-off valve (manual) on the gas supply line, next to the appliance, in a visible and easy accessible position, to exclude it when required.
- ► Perform connection in compliance with applicable regulations.

3 GAS PIPES SIZING

The gas pipes must not cause excessive pressure drops and, consequently, insufficient gas pressure for the appliance.

4 SUPPLY GAS PRESSURE

This appliance is equipped for a maximum gas supply pressure of 50 mbar.

The appliance's gas supply pressure, both static and dynamic, must comply with the following Tables, with a tolerance of ± 15%.

Non compliant gas pressure may damage the appliance and be hazardous.

The appliance is suitable for the use of fuel gases of group H and/or group E and mixtures of natural gas and hydrogen up to 20% by volume.

Although it is normal for the inlet pressure to decrease during the operation of the appliance, it is important to check that there are no excessive fluctuations in the inlet pressure. In order to limit the extent of these variations, it is necessary to appropriately define the diameter of the gas inlet pipe to be adopted based on the length and pressure drop of the pipe itself, from the gas meter to the appliance.

If fluctuations in the gas distribution pressure happen, it is advisable to insert a special pressure stabiliser upstream of the gas inlet to the appliance. In case of LPG supply, all necessary precautions must be taken to avoid freezing of the combustible gas in case of very low external temperatures.

4.1 GAHP A PLUS, GAHP GS/WS PLUS, GAHP AR PLUS

Table 4.1 *Network gas pressure*

Product category	Country of destination	Gas supply pressure [mbar]							
		G20	G25	G25.1	G25.3	G2.350	G27	G30	G31
$II_{2H3B/P}$	AL, BG, CH, CZ, DK, EE, FI, GR, HR, IT, LT, LV, MK, NO, RO, SE, SI, SK, TR	20						30	
	AT, CH	20						50	
II_{2H3P}	BG, CH, CZ, ES, GB, GR, HR, IE, IT, LT, LV, MK, PT, SI, SK, TR	20							37
	RO	20							30
	AT	20							50
$II_{2ELL3B/P}$	DE	20	20					50	
II_{2Esi3P}	FR	20	25						37
II_{2Er3P}		20	25						37
$II_{2HS3B/P}$	HU	25		25				30	
II_{2E3P}	LU	20							50
I_{2EK}	NL	20			25				
$II_{2EK3B/P}$		20			25			30	
II_{2EK3P}		20			25				30

The appliance gas supply pressure, both static and dynamic, must comply with the values in the Table, with a tolerance of ± 15%.

Product category	Country of destination	Gas supply pressure [mbar]							
		G20	G25	G25.1	G25.3	G2.350	G27	G30	G31
$II_{2E3B/P}$	PL	20						37	
$II_{2ELwLs3B/P}$	PL	20				13	20	37	
$II_{2ELwLs3P}$	PL	20				13	20		37
$I_{2E(S)}$	BE	20	25						
I_{3P}	BE								37
I_{3P}	IS								30
I_{2H}	LV	20							
$I_{3B/P}$	MT, CY							30	
I_{3B}	MT, CY							30	

The appliance gas supply pressure, both static and dynamic, must comply with the values in the Table, with a tolerance of ± 15%.

4.2 GA

Table 4.2 *Network gas pressure*

Product category	Country of destination	Gas supply pressure [mbar]							
		G20	G25	G25.1 (1)	G25.3 (1)	G2.350 (1)	G27 (1)	G30	G31
$II_{2H3B/P}$	AL, BG, CH, CY, CZ, DK, EE, FI, GR, HR, IT, LT, LV, MK, NO, RO, SE, SI, SK, TR	20						30	
	AT, CH	20						50	
	HU	25						30	
II_{2H3P}	AL, BG, CH, CZ, ES, GB, GR, HR, IE, IT, LT, LV, MK, PT, SI, SK, TR	20							37
	RO	20							30
	AT	20							50
$II_{2ELL3B/P}$	DE	20	20					50	
II_{2Esi3P}	FR	20	25						37
II_{2Er3P}	FR	20	25						37
$II_{2HS3B/P}$	HU	25						30	
II_{2E3P}	LU	20							50
$II_{2L3B/P}$	NL							30	
II_{2L3P}	NL								37
$II_{2E3B/P}$	PL	20						37	
$II_{2ELwLs3B/P}$	PL	20						37	
$II_{2ELwLs3P}$	PL	20							37
I_{2E}	PL	20							
$I_{2E(S)}$	BE	20	25						
I_{3P}	BE								37
	IS								30
I_{2H}	LV	20							
$I_{3B/P}$	MT							30	
I_{3B}	MT							30	

The appliance gas supply pressure, both static and dynamic, must comply with the values in the Table, with a tolerance of ± 15%.

1. GA not approved for G25.1, G2.350, G27 gases.

4.3 AY

Table 4.3 *Network gas pressure*

Product category	Country of destination	Gas supply pressure [mbar]							
		G20	G25	G25.1 (1)	G25.3	G2.350	G27	G30	G31
$II_{2H3B/P}$	AL, BG, CY, CZ, DK, EE, FI, GR, HR, IT, LT, MK, NO, RO, SE, SI, SK, TR	20						30	
	AT, CH	20						50	
	HU	25						30	
$II_{2H3B/P}$	HU	25						30	
$II_{2HS3B/P}$	HU			25					
II_{2H3P}	AL, BE, BG, CH, CZ, ES, FR, GB, GR, HR, IE, IT, LT, NL, MK, PL, PT, SI, SK, TR	20							37
	AT, BE, CH, CZ, DE, ES, FR, GB, HU, NL, SK	20							50
	AT, CZ, DE, NL, RO	20							30

The appliance gas supply pressure, both static and dynamic, must comply with the values in the Table, with a tolerance of ± 15%.

1 Gas not available for Caldaia 35 Tech, Caldaia 35 Tech ACS, Caldaria 35 Tech Export, AY 35.

Product category	Country of destination	Gas supply pressure [mbar]							
		G20	G25	G25.1 (1)	G25.3	G2.350	G27	G30	G31
$II_{2ELL3B/P}$	DE	20	20					50	
II_{2ELL3P}		20	20						50
II_{2Esi3P}	FR	20	25						37
$II_{2E(R)3P}$	BE	20							37
$II_{2E(S)3P}$		20							37
II_{2E3P}	LU	20							50
$II_{2E3B/P}$	DE, PL, RO	20						30	
$II_{2ELwLs3B/P}$	PL	20				13	20	30	
$II_{2ELwLs3P}$		20				13	20		37
$II_{2L3B/P}$	RO		25					30	
II_{2L3P}	FR		25						37
	RO		25						37
II_{2EK3P}	NL	20			25				30
$II_{2EK3B/P}$		20			25			30	
I_{2EK}		20			25				
I_{2ELL}	DE	20	20						
$I_{2E(S)}$	BE	20							
$I_{2E(R)}$		20							
I_{2Esi}	FR	20	25						
I_{2H}	AL, AT, BG, CH, CY, CZ, DK, EE, ES, FI, GB, GR, HR, IE, IT, LT, LV, MK, NO, PT, RO, SE, SI, SK, TR	20							
	FR	20							
	HU	25							
I_{2L}	FR		25						
	RO		25						

The appliance gas supply pressure, both static and dynamic, must comply with the values in the Table, with a tolerance of ± 15%.
1 Gas not available for Caldaia 35 Tech, Caldaia 35 Tech ACS, Caldaria 35 Tech Export, AY 35.

4.4 LINK

Table 4.4 *Network gas pressure*

Product category	Country of destination	Gas supply pressure [mbar]							
		G20	G25	G25.1 (1) (2)	G25.3 (2)	G2.350 (2)	G27 (2)	G30	G31
$II_{2H3B/P}$	AL, BG, CH, CY, CZ, DK, EE, FI, GR, HR, IT, LT, MK, NO, RO, SE, SI, SK, TR	20						30	
	AT, CH	20						50	
II_{2H3P}	BG, CH, CZ, ES, GB, GR, HR, IE, IT, LT, MK, PT, SI, SK, TR	20							37
	RO	20							30
	AT	20							50
$II_{2ELL3B/P}$	DE	20	20					50	
II_{2Esi3P}	FR	20	25						37
II_{2Er3P}		20	25						37
$II_{2HS3B/P}$	HU	25		25				30	
II_{2E3P}	LU	20							50
$II_{2EK3B/P}$	NL	20			25			30	
$II_{2E3B/P}$	PL	20						37	
$II_{2ELwLs3B/P}$		20				13	20	37	
$II_{2ELwLs3P}$		20				13	20		37
$I_{2E(R)}$	BE	20							
$I_{2E(S)}$		20							
I_{3P}	BE								37
	IS								30
I_{2H}	LV	20							
$I_{3B/P}$	MT, CY							30	
I_{3B}								30	

The appliance gas supply pressure, both static and dynamic, must comply with the values in the Table, with a tolerance of ± 15%.
1 Gas not available for AY 35.
2 GA not approved for G25.1, G25.3, G2.350, G27 gases.

5 VERTICAL PIPES AND CONDENSATE

- ► If needed, vertical gas pipes must be fitted with siphon and discharge of the condensate that may form inside the pipe.
- ► If needed, insulate the piping.

6 LPG PRESSURE REDUCERS

With LPG the following must be installed:
- ► A first stage pressure reducer, close to the liquid gas tank.
- ► A second stage pressure reducer, close to the appliance.

1 FLUE GAS MANAGEMENT

According to the type of installation allowed, as summarised in Table 1.2 *p. 2*, both individual appliances and individual modules of a Link can be connected to one or more flues.

In the case of indoor appliances (GAHP GS/WS Plus indoor version), it is not allowed to connect multiple appliances to a single flue; each appliance must have its own separate flue gas exhaust.

When sizing a flue serving several appliances, Table 1.1 *p. 1* below summarises the main combustion parameters for each appliance.
When sizing a flue serving several appliances, consider the following:

- The flues must be designed, sized, verified and realized by a qualified firm, with materials and components in accordance with regulations.
- Always provide the necessary sockets for smoke analysis in an accessible position.
- The GAHP A Plus, GAHP GS/WS Plus and AY modules are condensation units and require exhaust of the flue gas with appropriate piping, with forced draft and residual head shown in Table 1.1 *p. 1*.
- The horizontal sections for flue gas exhaust must always be mounted with a downward slope towards the appliance (3° slope = 5 mm per metre of pipe).
- For vertical ducts longer than 1,5 m, a curve and a Tee (Figure 1.1 *p. 2*) for condensate collection and drainage must be provided. The condensate must then be evacuated in accordance with the regulations in force, including that from inside the appliance.

If several forced draft appliances (GAHP A Plus, GAHP GS/WS Plus, GAHP AR Plus and AY) are connected to a single flue, it is obligatory to install a check valve on the exhaust of each. The check valve affects the appliance's operation and must therefore be selected appropriately to ensure correct and safe operation.

In case the check valves are installed outside, an appropriate UV ray protection must be assured (if the valve is in plastic) as well as protection from potential winter freezing of condensate backflow into the siphon.

- GAHP/AY modules with different flue gas exhaust characteristics cannot be connected to the same flue but must be connected to separate and distinct flues.
- The GA modules have no flue gas exhaust.
- It is recommended to insulate the stainless steel flues of GAHP AR Plus appliances.

To avoid corrosion phenomena, convey the GAHP AR Plus acid condensate drain to the base of the flue gas exhaust duct.

Table 1.1 *Characteristics of flue gas exhaust*

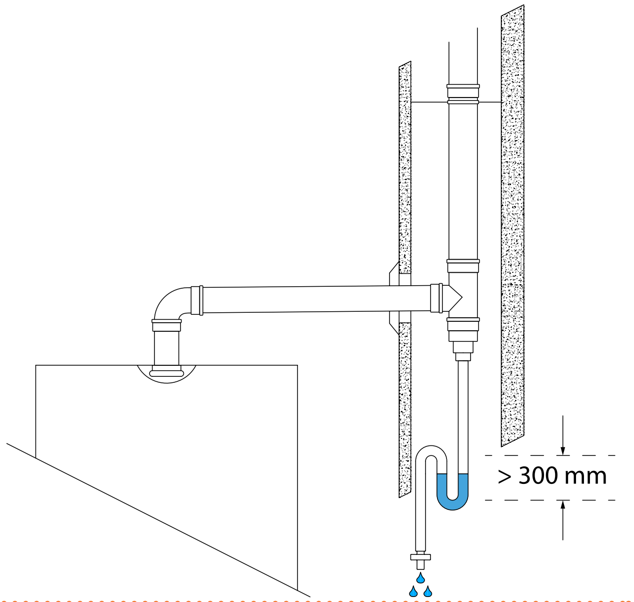
				GAHP A Plus	GAHP AR Plus	GAHP GS/WS Plus	AY			GA ACF
							AY 35	AY 50	AY 100	
Heating mode										
Heat input	real		kW	26,0	25,2	26,0	34,0	50,0	99,8	-
	nominal (1013 mbar - 15 °C) 20%H2NG		kW	-	-	-	32,0	47,0	94,0	-
Cooling mode										
Heat input	real		kW	-	25,2	26,0		-		25,0
Installation data										
Fumes flow rate	Nominal heat input	G20	kg/h	43	42	43	54	80	80 (1)	42
Flue temperature	Nominal heat input	G20	°C	46,0	171,0	46,0	69,4	66,4	66,4	190,0
CO_2 percentage in flue gases	Nominal heat input	G20	%	9,2	9,2	9,2	9,45 ÷ 9,25	9,3 ÷ 9,1	9,3 ÷ 9,1	8,7
		G25	%	9,5	9,1	9,5	9,35 ÷ 9,15	9,3 ÷ 9,1	9,3 ÷ 9,1	8,5
		G25.1	%	10,6	10,5	10,6	- (2)	10.5 ÷ 10.3	10.5 ÷ 10.3	- (2)
		G25.3	%	9,3	9,1	9,3		9,3 ÷ 9,1		- (2)
		G27	%	9,1	9,1	9,1	9,4 ÷ 9,0	9,3 ÷ 9,1	9,3 ÷ 9,1	- (2)
		G2.350	%	9,3	9,2	9,3	9,4 ÷ 9,0	9,3 ÷ 9,1	9,3 ÷ 9,1	- (2)
		G30	%	10,4	9,8	10,4	11,4 ÷ 11,2	11,3 ÷ 11,1	11,3 ÷ 11,1	9,3
		G31	%	10,4	9,7	10,4	10,55 ÷ 10,35	10,3 ÷ 10,1	10,3 ÷ 10,1	9,1
		20%H2NG	%	-	-	-		8,4 ÷ 8,0		-
NO_x emission class			-	6	6	6		6		6
Flue gas exhaust	diameter (Ø)		mm	80	80	80	80	80	80 (3)	-
	residual head		Pa	90	90	90	91	100	100 (4)	-

(1) Data refers to each thermal module.
(2) Gas not available for the appliance.
(3) 2 independent flue gas exhausts.
(4) For each of the independent flue gas exhausts.

Table 1.2 *Type of installation*

		GAHP A Plus	GAHP AR Plus	GAHP GS/WS Plus	AY
Installation data					
type of installation	-	B23P, B33, B53P	B23P, B33, B53P	C13, C33, C43, C53, C63, C83, B23P, B33	B23, B23P, B33, B53

Figure 1.1 *Flue gas condensate drain*



1.1 MAXIMUM DRAIN PIPE LENGTH FOR AY BOILERS

Table 1.3 *Characteristics of flue gas exhaust*

			AY 35	AY 50	AY 100
Installation data					
Flue gas exhaust	residual head	Pa	91	100	100 (1)
	diameter (Ø)	mm	80		80 (2)
maximum equivalent length of exhaust duct		m	15	14	14 (1)

(1) For each of the independent flue gas exhausts.
(2) 2 independent flue gas exhausts.

The maximum exhaust length (or equivalent linear length) is obtained by adding the length of the linear duct to the equivalent length of each additional curve.
The equivalent lengths of linear ducts and curves are given in Table 1.4 *p. 2*.

Table 1.4 *Pressure drop of flue pipes*

	Equivalent length (m)	Pressure drop (Pa)
AY 35		
extension pipe Ø 80 mm, length 1000 mm	1	5,8
elbow 90° Ø 80 mm	1,5	8,7
elbow 45° Ø 80 mm	1,2	7,0
T connector Ø 80 mm	3	17,4
AY 50/AY 100		
extension pipe Ø 80 mm, length 1000 mm	1	7,0
elbow 90° Ø 80 mm	2,5	17,5
elbow 45° Ø 80 mm	1,4	7,8
T connector Ø 80 mm	3	21,0

2 FLUE GAS CONDENSATE DRAIN

Condensing appliances (GAHP A Plus, GAHP GS/WS Plus, AY) produce condensate from combustion flue gas.
The GAHP AR Plus appliances produce condensate from the combustion flue gas only during the cold start-up transient.
The system must be designed in such a way as to prevent condensation from freezing. Before commissioning the appliance, check that the condensate is drained correctly.

Condensate acidity and exhaust regulations

The condensate contains aggressive acid substances. Refer to applicable regulations in force for condensate exhaust and disposal.
If required, install an acidity neutraliser of adequate capacity.

Do not use gutters to discharge the condensate

Do not discharge the condensate in gutters, due to the risk of materials corrosion and ice formation.

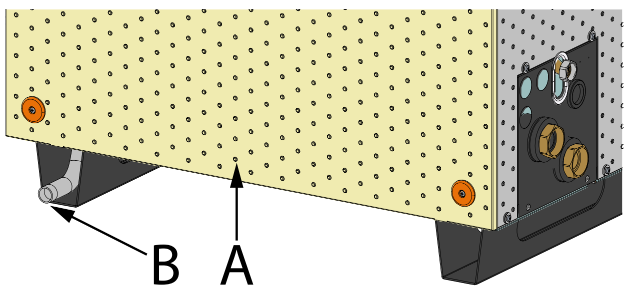
2.1 FLUE GAS CONDENSATE CONNECTION

- The condensate drain hose must be connected to a suitable discharge manifold.
- The junction between the pipe and the manifold must remain visible.
- The connection of the discharge to the sewerage system must be made at atmospheric pressure, i.e. by dripping into a siphoned container connected to the sewerage system.

2.1.1 GAHP A Plus

The fitting for flue gas condensate drain is located on the left side of the appliance (Figure 2.1 *p. 2*).

Figure 2.1 *GAHP A Plus condensate drain*

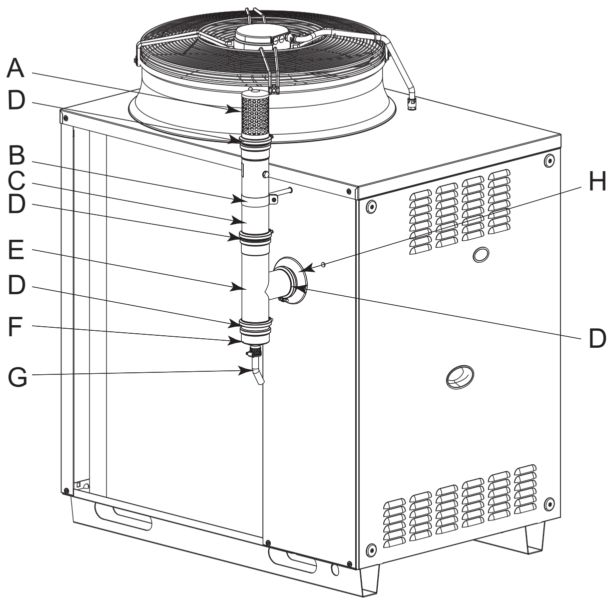


A GAHP A Plus front panel B GAHP A Plus condensate drain

2.1.2 GAHP AR Plus

The fitting for flue gas condensate drain is located on the base of the flue gas exhaust duct (Figure 2.2 *p. 3*).

Figure 2.2 *Components of flue gas exhaust kit*

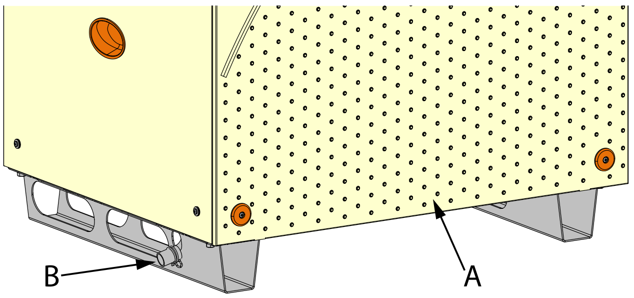


A	Terminal	E	T connector
B	Pipe clamp	F	Condensate trap
C	Flue gas exhaust pipe, length 350 mm	G	Hose adaptor + condensate drain pipe
D	Pipe clamp	H	Rain cover

2.1.3 GAHP GS/WS Plus

The fitting for flue gas condensate drain is located on the left side of the appliance (Figure 2.3 *p. 3*).

Figure 2.3 *GAHP GS/WS Plus condensate drain*



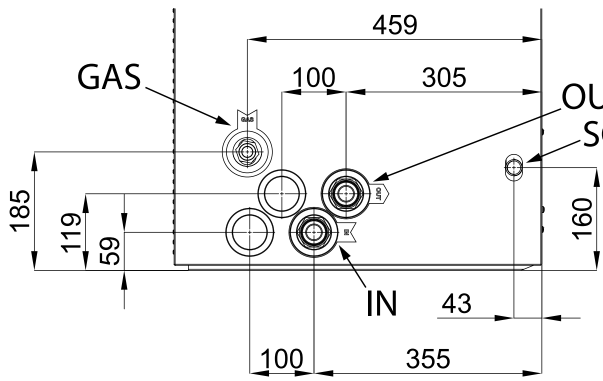
A GAHP GS/WS Plus front panel
B GAHP GS/WS Plus condensate drain

2.1.4 AY

The flue gas condensate drain connection is located on the right side of the appliance at the connection plate.

2.1.4.1 AY 35/AY 50

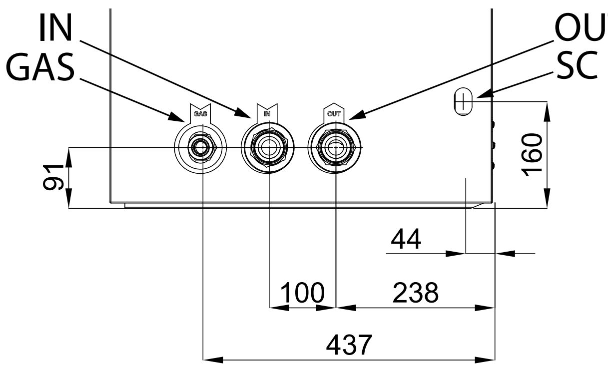
Figure 2.4 *Service plate - Hydraulic/gas connections detail*



OUT Water outlet connection Ø 1 1/4" F
IN Water inlet connection Ø 1 1/4" F
SC Condensate drain connection (outside diameter 25 mm, inside 21 mm)
GAS Gas connection Ø 3/4" M

2.1.4.2 AY 100

Figure 2.5 *Service plate - Hydraulic/gas connections detail*

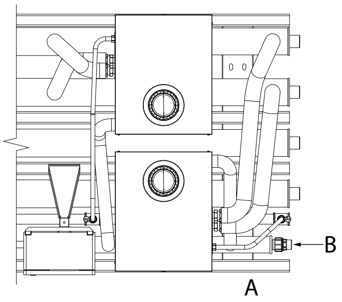


OUT Water outlet connection Ø 1 1/2" F
IN Water inlet connection Ø 1 1/2" F
SC Condensate drain connection (outside diameter 25 mm, inside 21 mm)
GAS Gas connection Ø 1" M

2.1.5 Link

If two or more condensing modules (GAHP A Plus, GAHP GS/WS Plus, AY) are included in the Link, the Link is equipped with a flue gas condensate manifold.
The flue gas condensate drain connection is located on the right side of the Link (Figure 2.6 *p. 4*).

Figure 2.6 *Link condensate drain connection*



A Front of the Link
B Condensate drain connection [1" F] (only for Link with more than one condensing module). Sloping manifold, must be connected on the right side

2.2 FLUE GAS CONDENSATE DRAIN MANIFOLD

To make the condensate drain manifold:

- Size the ducts for the maximum condensate flow (refer to the technical data of the individual appliances, available in Section B), and in any case with a diameter not less than 15 mm.
- Use plastic materials resistant to acidity pH 3-5.
- Provide a minimum slope of 1%, i.e. 1 cm for each metre of length (otherwise a booster pump is required).
- Prevent freezing.
- Dilute, if possible, with domestic waste water (e.g. bathrooms, washing machines, dish washers...), basic and neutralising.

1 ELECTRICAL SYSTEMS

Electrical connections must provide:
- ► power supply (Paragraph 3 *p. 2*)
- ► control system (Paragraph 4 *p. 4*)
- ► water pump (Paragraph 5 *p. 13*)

Earthing

- ■ The appliance must be connected to an effective earthing system, installed in compliance with regulations in force.
- ■ It is forbidden to use gas pipes as earthing.

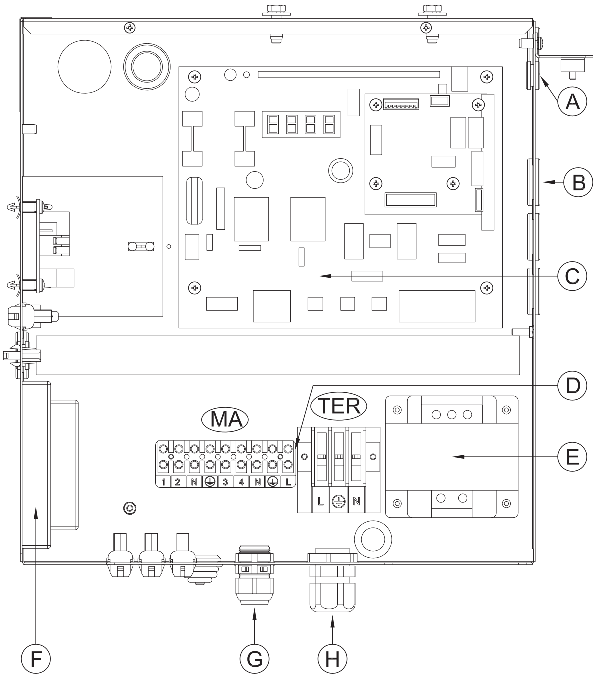
Cable segregation

Keep power cables physically separate from signal ones.

2 ELECTRICAL PANEL

2.1 GAHP/GA

Figure 2.1 *GAHP/GA electrical panel*

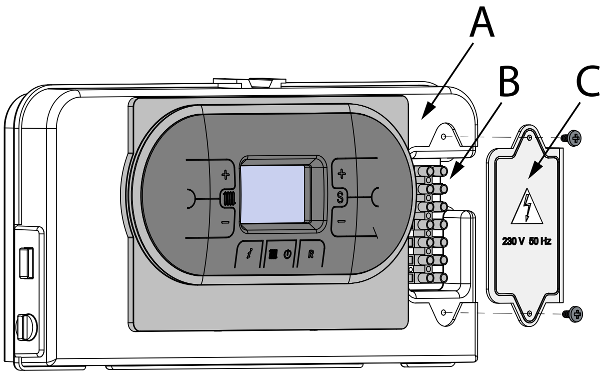


A CAN bus cable gland
B Cable gland for 0-10 V signal of water pump
C Electronic boards
D Terminal blocks
E Transformer 230/24 Vac
F Flame control box
G Pump power supply and control cable gland
H GAHP/GA power supply cable gland

Terminals:
TER terminal block
L-(PE)-N Phase/earth/neutral of GAHP/GA power supply
MA terminal block
N-(PE)-L Neutral/earth/phase of water pump power supply
3-4 Water pump request

2.2 AY

Figure 2.2 *Access to AY terminal block*

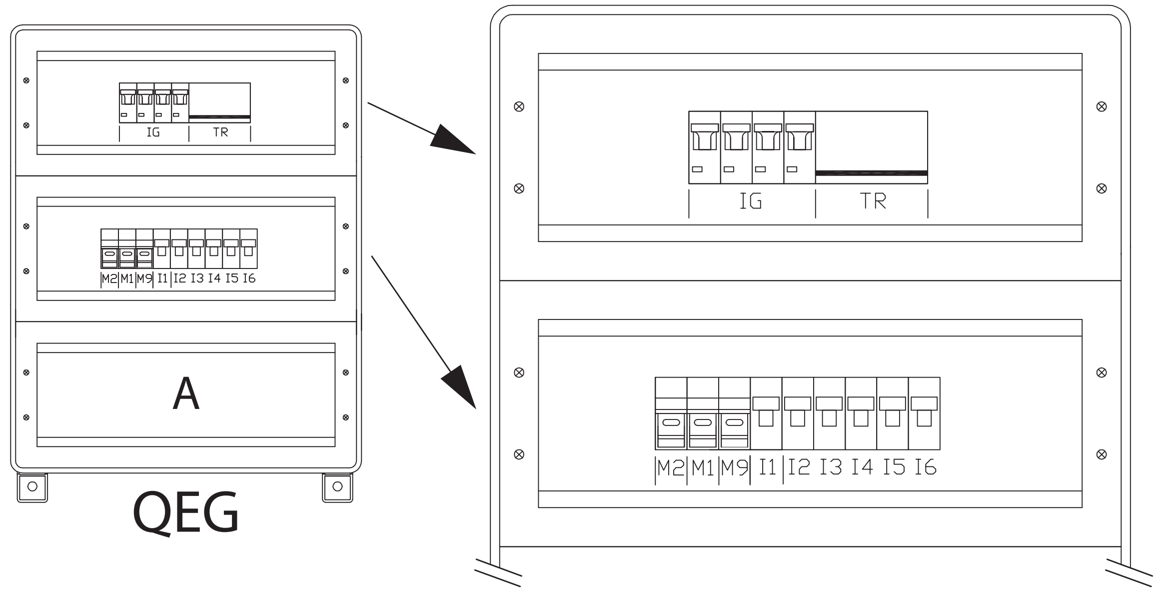


A Electrical panel
B Terminal block
C Plate

2.3 LINK

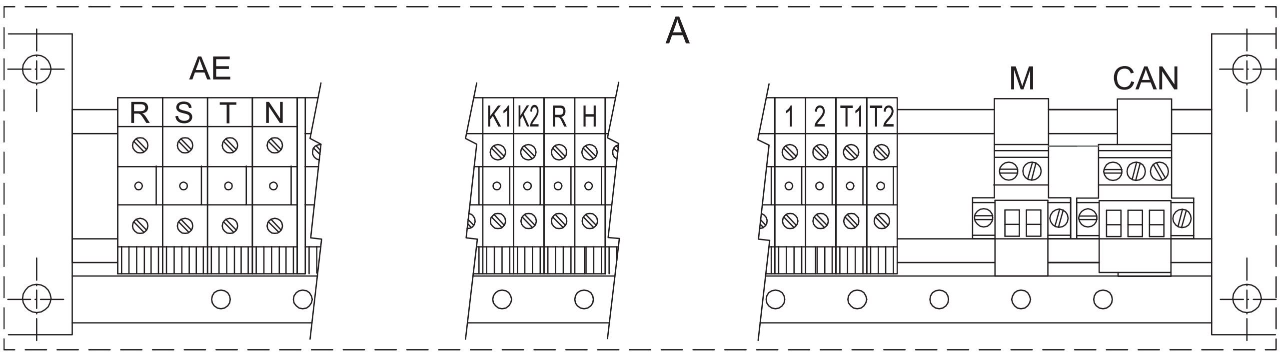
Up to 6 GAHP/GA/AY modules on the Link there is only one electrical panel, detailed in Figure 2.3 *p. 2* below. In the presence of more than 6 GAHP/GA/AY modules on the Link there are two electrical panels, of which the main one (the one in which the electrical connections for power supply and control are to be made) is the one on the left, while the one on the right is dedicated to the AY boilers.

Figure 2.3 *Electrical panel of the Link*



A Blind panel (Figure 2.4 *p. 2* for detail of internal terminal blocks)
I1 Magnetothermic breaker of the "ID00" module
I2 Magnetothermic breaker of the "ID01" module
I3 Magnetothermic breaker of the "ID02" module
I4 Magnetothermic breaker of the "ID03" module
I5 Magnetothermic breaker of the "ID04" module
I6 Magnetothermic breaker of the "ID05" module
IG Electrical panel switch disconnector
TR Transformer 230/24 Vac
M9 Transformer primary fuse
M2 Condensate heating resistance protection fuse
M9 Transformer secondary fuse
QEG Link electrical panel
Note: the components within the electrical panel may have an order and/or position other than the one shown in the figure

Figure 2.4 *Blind panel: detail of internal terminal blocks on DIN rail*



A Blind panel of the Link electrical panel (Figure 2.3 *p. 2*)
AE Power supply input terminals
K1-K2 24 V coil terminals for water pump request (heating/cooling circuit side)
R-H Condensate heating resistor terminals
1-2 24 V coil terminals for water pump request (HR recovery circuit side)
T1-T2 DHW buffer tank thermostat terminals (HR recovery circuit side)
M 2-pole 24 Vac connector for service use
CAN 3-pole connector for CAN bus network connection

3 ELECTRICAL POWER SUPPLY

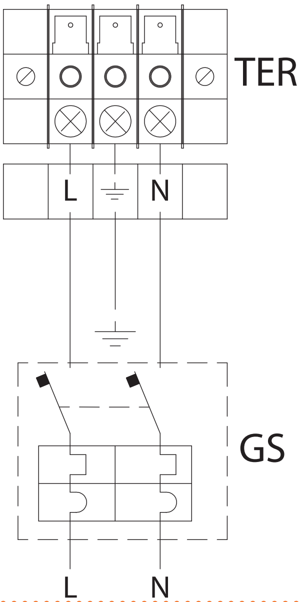
3.1 GAHP/GA

Provide (by the installer) a protected single phase line (230 V 1-N 50 Hz) with:

1. three-pole cable type FG16(O)R 3Gx1,5
1. two-pole switch with 2 x 5 A type T (GS) fuses, or 1 x 10 A magnetothermic breaker

The switches must also provide disconnect capability, with a minimum contact opening of 4 mm.

Figure 3.1 *Power supply connection*



TER Terminal block
L Phase
N Neutral

Components NOT SUPPLIED
GS Main switch

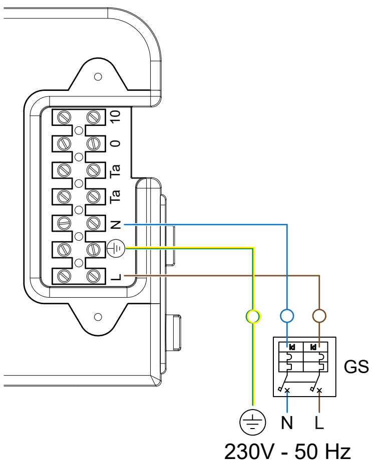
3.2 AY

Provide (by the installer) a protected single phase line (230 V 1-N 50 Hz) with:

1. three-pole cable type FG16(O)R 3Gx1,5
1. two-pole switch with 2 x 2 A type T (GS) fuses, or 1 x 4 A magnetothermic breaker

The switches must also provide disconnect capability, with a minimum contact opening of 3 mm.

Figure 3.2 *Power supply connection*



L Phase
N Neutral

Components NOT SUPPLIED
GS Two-pole switch

3.3 LINK

Electrical protection

The installer must provide a four-pole (three-phase) disconnector GS (Figure 3.3 *p. 3*) or a two-pole (single phase) GS disconnector (Figure 3.4 *p. 3*), in the external electrical power supply panel, with suitable fuses on the phases and a minimum contact opening of 3 mm.

The installation of a fuse on the neutral is not allowed. Indirect contact protection by means of differential switch and overload must be guaranteed by means of a sufficiently dimensioned automatic switch or fuse.

Do not modify the electric panel of the Link, nor add any components inside it (relays, ...).

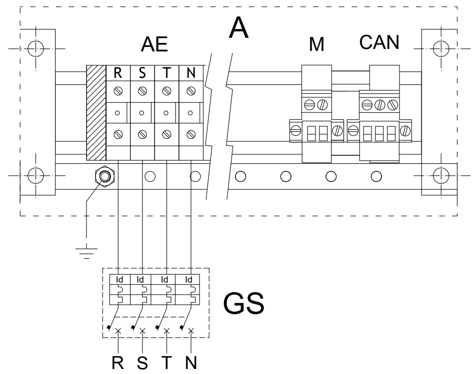
Provide a protected line (by the installer), which may be:

- three-phase 400 V 3N - 50 Hz (Figure 3.3 *p. 3*)

or as an alternative,

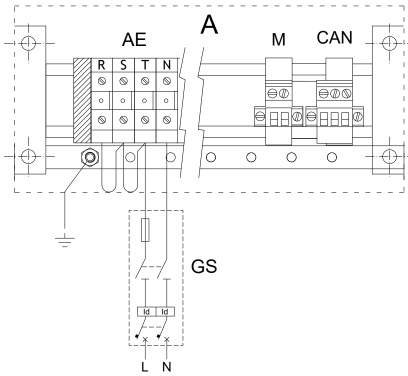
- single-phase 230 V 1N - 50 Hz (Figure 3.4 *p. 3*)

Figure 3.3 *Three phase power supply electrical connection 400 V 3N - 50 Hz*



A Blind panel of the Link electrical panel (Figure 2.3 *p. 2*)
AE Power supply input terminals
GS Three-phase magnetothermic switch
RST Phases
N Neutral

Figure 3.4 *Single phase power supply electrical connection 230 V 1N - 50 Hz*



A Blind panel of the Link electrical panel (Figure 2.3 *p. 2*)
AE Power supply input terminals
GS Bipolar disconnector with suitable fuse and minimum contact opening of 3 mm
L Phase
N Neutral

4 ADJUSTMENT AND CONTROL

Correct and efficient operation of the heating/cooling system cannot be achieved without proper control.
In Section C01.11 the characteristics and operating logic of the control devices available as Robur optional are detailed.

Switching for reversible appliances

Avoid frequently switching between heating and cooling modes for reversible appliances.

4.1 CONTROL SYSTEMS

Separate control systems are provided, each with specific features, components and diagrams:

1. DDC control panel (with CAN bus connection).
2. CCI control panel (with CAN bus connection), only for GAHP A Plus, GAHP GS/WS Plus and for heating only.
3. External request.

For a description of the features of the DDC and CCI control panels, please refer to Section C01.11.
For external requests, please refer to Paragraph 4.6 *p. 11*.

4.2 CAN BUS COMMUNICATION NETWORK

The CAN bus communication network, built using the signal cable of the same name, allows one or more Robur appliances to connect and be controlled remotely using the DDC or CCI control panels.
It entails a certain number of serial nodes, distinguished in:

- intermediate nodes, in variable number
- terminal nodes, always and only two (beginning and end)

Each component of the Robur system, appliance (GAHP, GA, AY,...) or control device (DDC, RB100, RB200,...), corresponds to a node, connected to two more elements (if it is an intermediate node) or to just one other element (if it is a terminal node) through two/one CAN bus cable section/s, forming an open linear communication network (never star- or loop-shaped).

4.3 CAN BUS SIGNAL CABLE

The DDC or CCI control panels are connected to the individual appliances or to the Link using the shielded CAN bus cable in accordance with Table 4.1 *p. 4* (types and maximum permissible distances).
For lengths ≤200 m and up to 4 nodes (e.g. 1 DDC + 3 GAHP), a simple 3x0,75 mm² shielded cable may also be used.

Table 4.1 *CAN bus cable types*

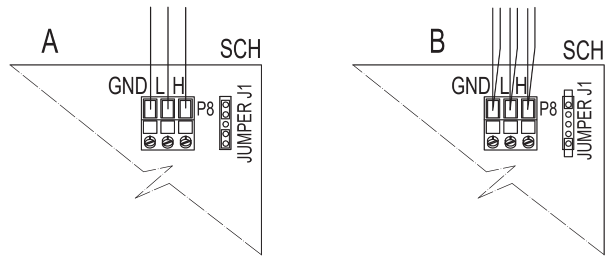
Cable name	Signals / Color			Maximum length	Note
Robur					Optional code OCVO008
ROBUR NETBUS	H = BLACK	L = WHITE	GND = BROWN	450 m	
Honeywell SDS 1620					In all cases the fourth conductor should not be used
BELDEN 3086A	H = BLACK	L = WHITE	GND = BROWN	450 m	
TURCK type 530					
DeviceNet Mid Cable					
TURCK type 5711	H = BLUE	L = WHITE	GND = BLACK	450 m	
Honeywell SDS 2022					
TURCK type 531	H = BLACK	L = WHITE	GND = BROWN	200 m	

4.4 CAN BUS CONNECTION

4.4.1 GAHP/GA

Arrange the J1 Jumpers of the electronic board of the GAHP/GA appliance CLOSED (detail A) if the node is terminal (only one CAN bus cable section connected), or OPEN (detail B) if the node is intermediate (two CAN bus cable sections connected).

Figure 4.1 *Connection of the CAN bus cable to the electronic board (GAHP/GA/IF ACF)*

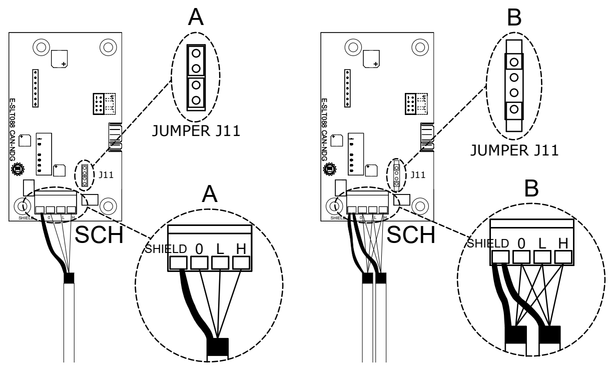


SCH GAHP/GA/IF ACF electronic board
GND Common data
L Data signal LOW
H Data signal HIGH
J1 Onboard CAN bus jumper
A Detail of "terminal node" case (3 wires; J1 = jumper "closed")
B Detail of "intermediate node" case (6 wires; J1 = jumper "open")
P8 CAN port/connector

4.4.2 AY

Arrange the J11 jumpers on the CAN-NDG electronic board of the AY appliance CLOSED (detail A) if the node is terminal (only one CAN bus cable section connected), or OPEN (detail B) if the node is intermediate (two CAN bus cable sections connected).

Figure 4.2 *Connection of the CAN bus cable to the CAN-NDG electronic board*

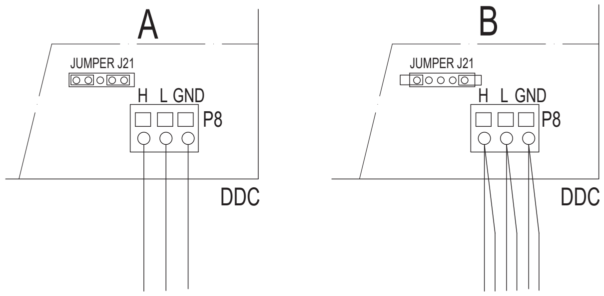


SCH CAN-NDG electronic board for AY appliance
0 Common data
L Data signal LOW
H Data signal HIGH
J11 CAN bus jumper on CAN-NDG board
A Detail of "terminal node" case (3 wires; J11 = jumper "closed")
B Detail of "intermediate node" case (6 wires; J11 = jumper "open")

4.4.3 DDC/CCI panel

Place the J21 Jumpers of the DDC control panel CLOSED (detail A) if the node is terminal (one connected CAN bus cable section only), or OPEN (detail B) if the node is intermediate (two connected CAN bus cable sections).

Figure 4.3 *Connection of the CAN bus cable to the control panel*

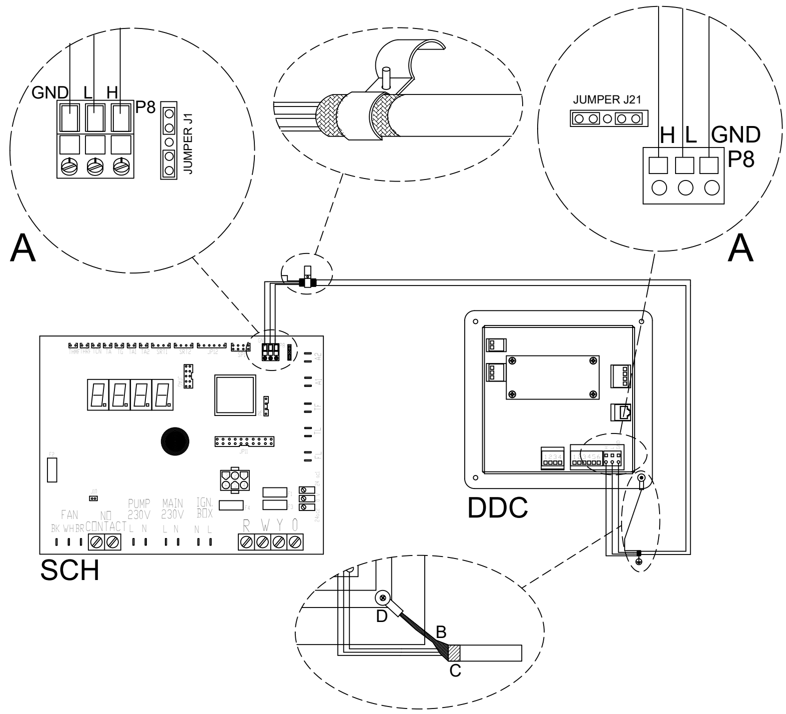


DDC DDC control panel
GND Common data
L Data signal LOW
H Data signal HIGH
J21 CAN bus jumper on DDC board
A Detail of "terminal node" case (3 wires; J21 = jumper "closed")
B Detail of "intermediate node" case (6 wires; J21 = jumper "open")
P8 CAN port/connector

4.5 DDC/CCI CONNECTION

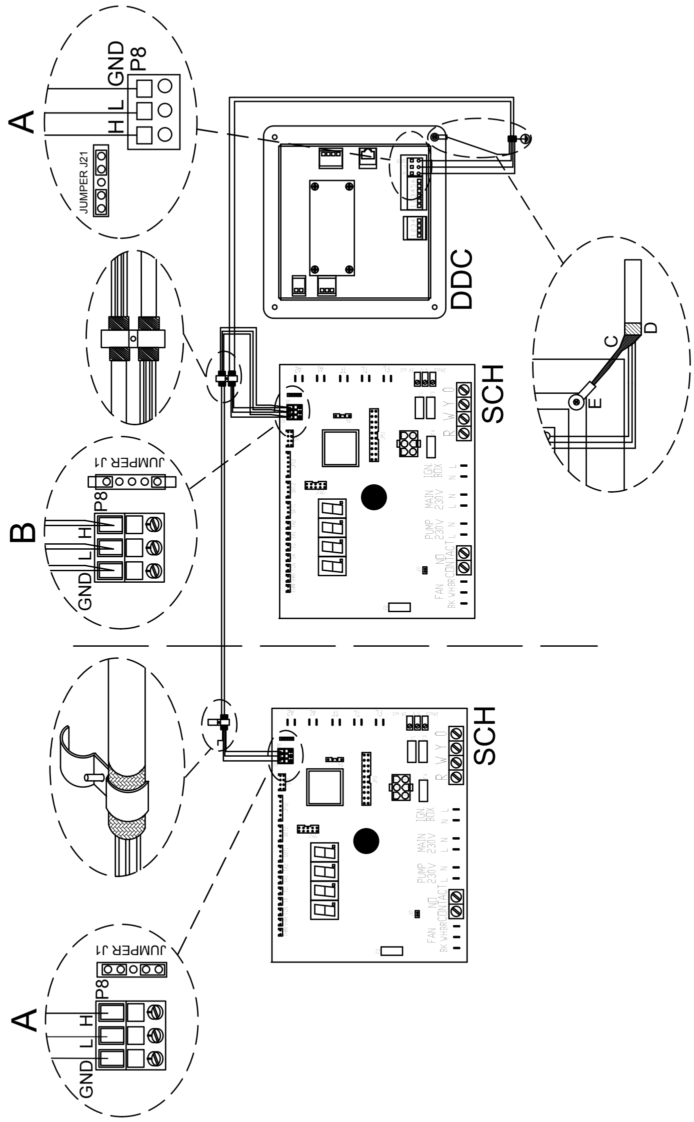
4.5.1 GAHP/GA

Figure 4.4 *CAN bus connection for systems with one appliance*



DDC DDC control panel
SCH S61 electronic board
J1 CAN bus jumper onboard S61
J21 CAN bus jumper on DDC board
H,L,GND Data signal wires (ref. cables table)
A Terminal node connection - (3 wires; J1 and J21 = "closed")
B CAN bus cable shield
C Electrical tape to protect the shield of the CAN bus cable
D Eyelet terminal and fixing screw

Figure 4.5 *CAN bus connection for systems with multiple single appliances*



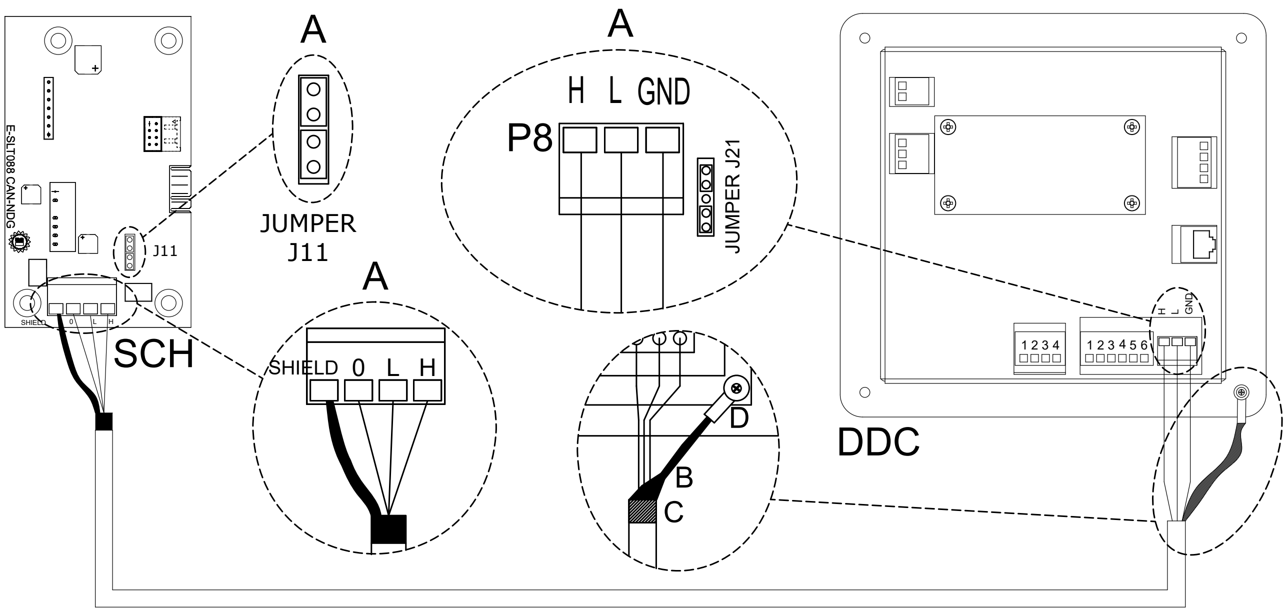
DDC	DDC control panel
SCH	S61 electronic board
J1	CAN bus jumper onboard S61
J21	CAN bus jumper on DDC board
H,L,GND	Data signal wires (ref. cables table)
A	Terminal node connection - (3 wires; J1 and J21 = "closed")
B	Intermediate node connection - (6 wires; J1 and J21 jumpers = "open")
C	CAN bus cable shield
D	Electrical tape to protect the shield of the CAN bus cable
E	Eyelet terminal and fixing screw

4.5.2 AY

The AY boilers leave the factory with the jumpers already positioned for connecting the individual appliance as a terminal node.

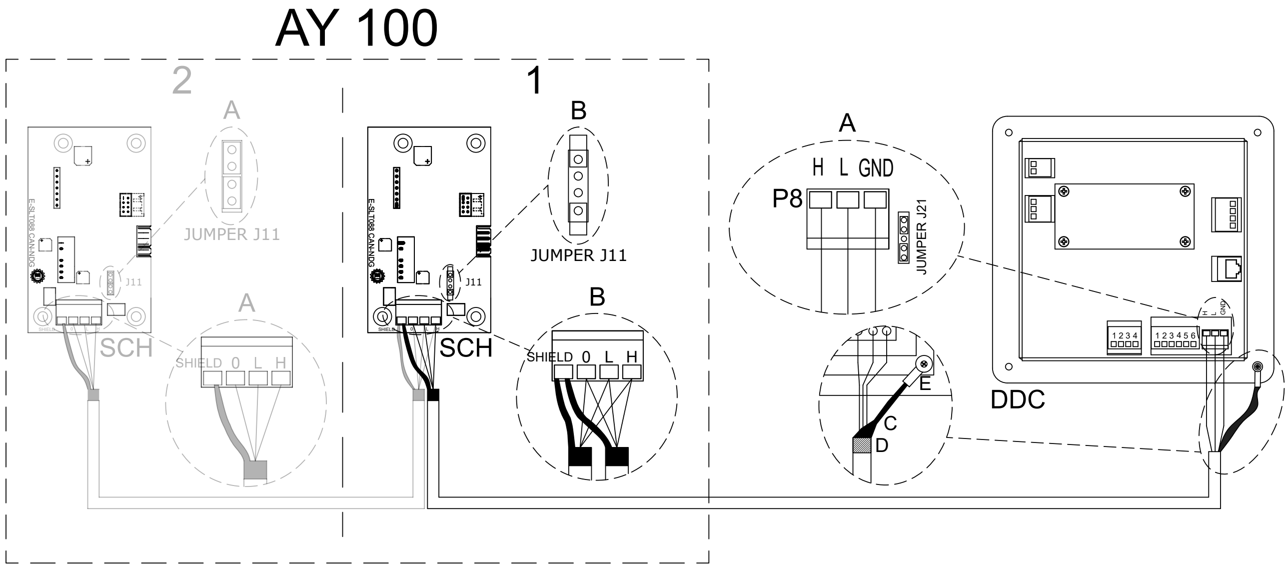
For the AY 100 appliance, the CAN bus connection between the two modules is already factory-made. Consequently, if an individual AY 100 appliance is connected as a terminal node, the connection should only be made on module 1 (right), Figure 4.7 *p. 8*, without changing the position of the J11 jumpers. If one or more AY 100 appliances are to be connected as Intermediate nodes, the CAN-NDG board of module 1 (right) is to be connected to the previous CAN bus node, without changing the position of the J11 jumpers, while the CAN-NDG board of module 2 (left) is to be connected to the next CAN bus node and the J11 jumpers are to be opened accordingly.

Figure 4.6 *CAN bus connection for systems with a single AY 35/AY 50*



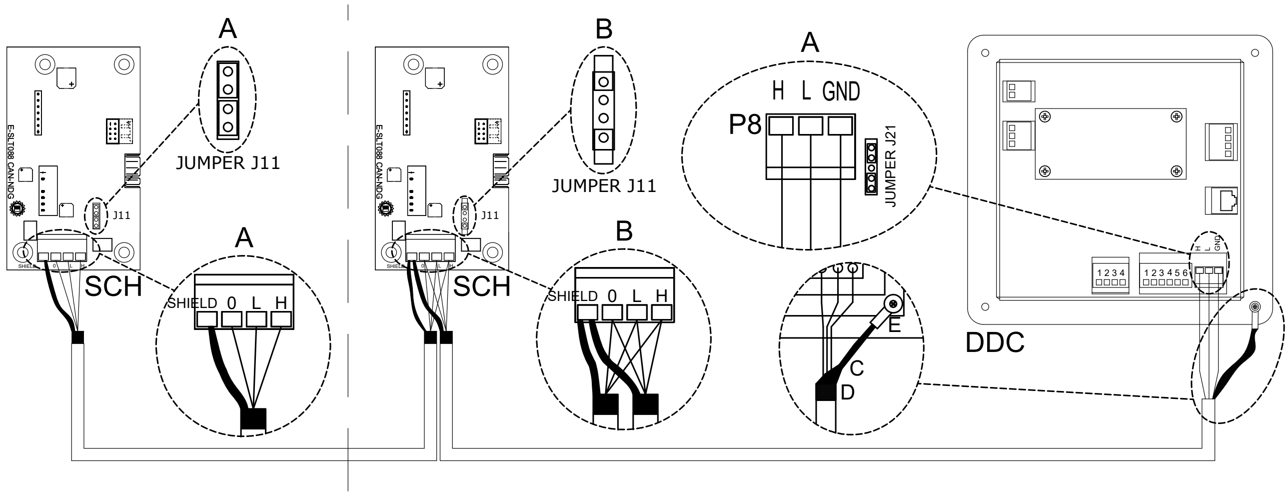
DDC	DDC control panel	0	Common data	B	CAN bus cable shield
SCH	CAN-NDG board	H	Data signal HIGH	C	Electrical tape to protect the shield of the CAN bus cable
J11	CAN bus jumper on CAN-NDG board	L	Data signal LOW	D	Eyelet terminal and fixing screw
J21	CAN bus jumper on DDC control panel	A	Terminal node connection - (3 wires; J11 and J21 = "closed")	P8	CAN port/connector
GND	Common data				

Figure 4.7 *CAN bus connection for systems with a single AY 100*



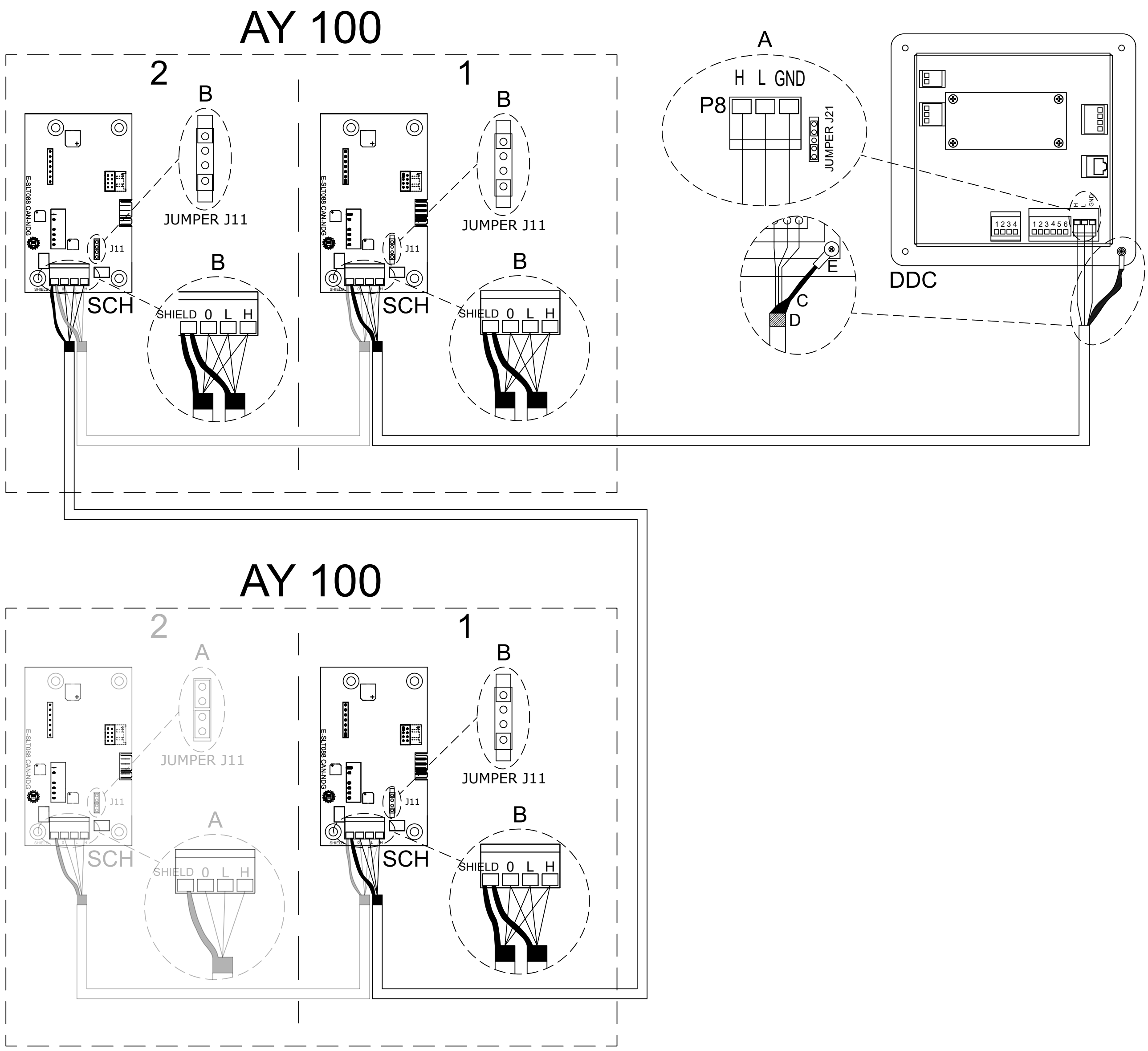
1 Module 1 (right)
2 Module 2 (left)
DDC DDC control panel
SCH CAN-NDG board
J11 CAN bus jumper on CAN-NDG board
J21 CAN bus jumper on DDC control panel
GND Common data
0 Common data
H Data signal HIGH
L Data signal LOW
A Terminal node connection - (3 wires; J11 and J21 = "closed")
B Intermediate node connection - (6 wires; J11 and J21 jumpers = "open")
C CAN bus cable shield
D Electrical tape to protect the shield of the CAN bus cable
E Eyelet terminal and fixing screw
P8 CAN port/connector

Figure 4.8 *CAN bus connection for systems with several individual AY 35/AY 50 appliances*



DDC DDC control panel
SCH CAN-NDG board
J11 CAN bus jumper on CAN-NDG board
J21 CAN bus jumper on DDC control panel
GND Common data
0 Common data
H Data signal HIGH
L Data signal LOW
A Terminal node connection - (3 wires; J11 and J21 = "closed")
B Intermediate node connection - (6 wires; J11 and J21 jumpers = "open")
C CAN bus cable shield
D Electrical tape to protect the shield of the CAN bus cable
E Eyelet terminal and fixing screw
P8 CAN port/connector

Figure 4.9 *CAN bus connection for systems with several individual AY 100 appliances*



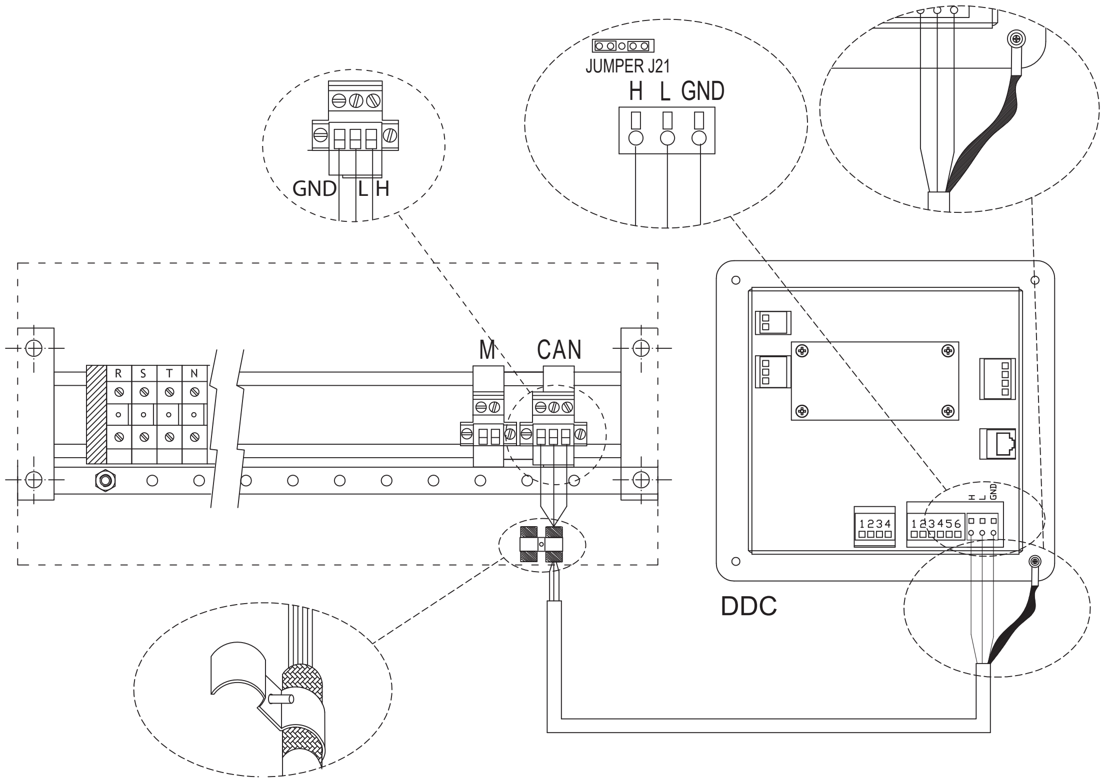
1	Module 1 (right)	0	Common data	C	CAN bus cable shield
2	Module 2 (left)	H	Data signal HIGH	D	Electrical tape to protect the shield of the CAN bus cable
DDC	DDC control panel	L	Data signal LOW	E	Eyelet terminal and fixing screw
SCH	CAN-NDG board	A	Terminal node connection - (3 wires; J11 and J21 = "closed")	P8	CAN port/connector
J11	CAN bus jumper on CAN-NDG board	B	Intermediate node connection - (6 wires; J11 and J21 jumpers = "open")		
J21	CAN bus jumper on DDC control panel				
GND	Common data				

4.5.3 Link

The CAN bus connections between the boards of the individual GAHP/GA/AY modules that make up the individual Link are already factory-made.

Working with AY 100 (which has two thermal modules inside), take care to always operate on internal module 2 (left), as the internal CAN bus connection between module 1 and module 2 is already factory-made and must not be modified.

Figure 4.10 *CAN bus cable connection between 1 DDC/CCI and the Link electrical panel*



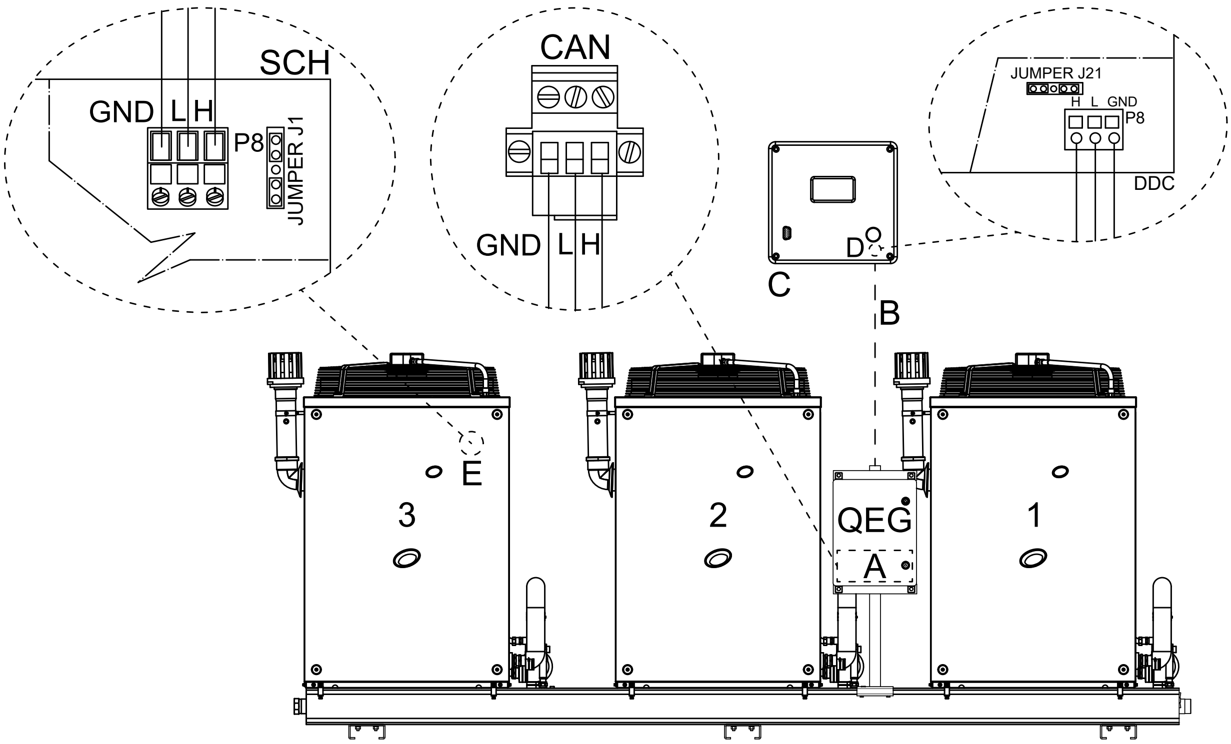
CAN 3-pole connector for CAN bus network connection

DDC CCI/DDC (rear view)

4.5.3.1 1 Link + DDC/CCI configuration

Refer to Figure 4.10 *p. 10* for the connection diagram of the CAN bus cable.

Figure 4.11 *CAN bus connection for systems with a single Link*



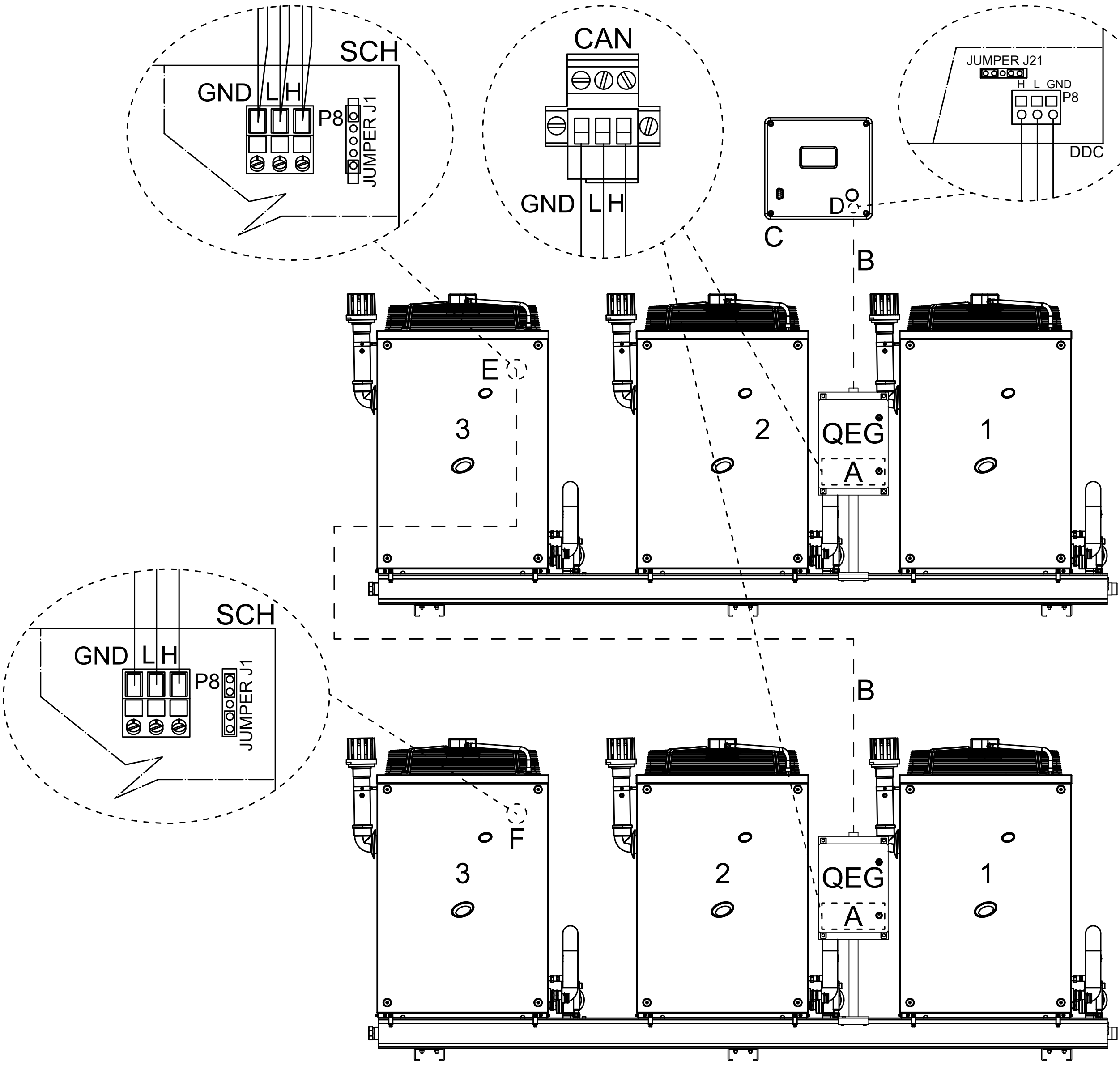
A Blind panel of the Link electrical panel (Figure 2.3 *p. 2*)
B CAN bus cable (not supplied, Table 4.1 *p. 4*)
C DDC/CCI control panel
D Terminal node connection on DDC/CCI (Figure 4.3 *p. 5*, case A)
E Pre-wired terminal node on the last module of the Link (Figure 4.1 *p. 4*, case A)
QEG Link electrical panel
3 Last module of Link (with "ID00")

4.5.3.2 2 Link + DDC configuration

The DDC control panel is connected to the first Link as a terminal node (connection diagram in Figure 4.10 *p. 10*).

In the last module of the first Link (which must be connected to the electrical panel of the next Link), jumpers J1 must be arranged open, as shown in detail B of Figure 4.1 *p. 4*.

Figure 4.12 *Example of a 7-node CAN bus network (1 DDC + 2 Link connected to the same water circuit)*



A Blind panel of the Link electrical panel (Figure 2.3 *p. 2*)
B CAN bus cable (not supplied, Table 4.1 *p. 4*)
C DDC panel
D Terminal node connection on DDC control panel (Figure 4.3 *p. 5*, case A)
E Intermediate node on the last module of the Link (Figure 4.1 *p. 4*, case B)
F Pre-wired terminal node on the last module of the Link (Figure 4.1 *p. 4*, case A)
QEG Link electrical panel
3 Last module of Link (with "ID00")

4.6 EXTERNAL REQUEST

It is required to arrange:

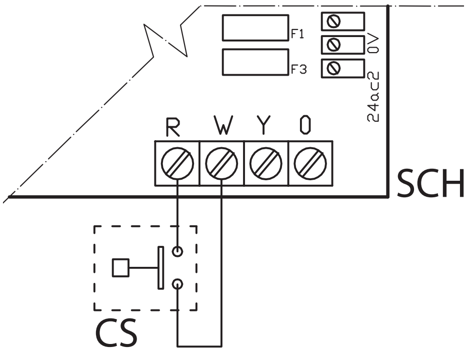
- Request devices (e.g. thermostats, timers, switchs, ...) fitted with voltage-free NO contacts.
- Winter/Summer switching device (only for reversible appliances).

The external request is connected to the electronic board located in the electrical panel inside the appliance (Paragraph 2 *p. 1*).

In the case of Link, control by external request is not possible.

4.6.1 GAHP A Plus

Figure 4.13 *External heating request connection*

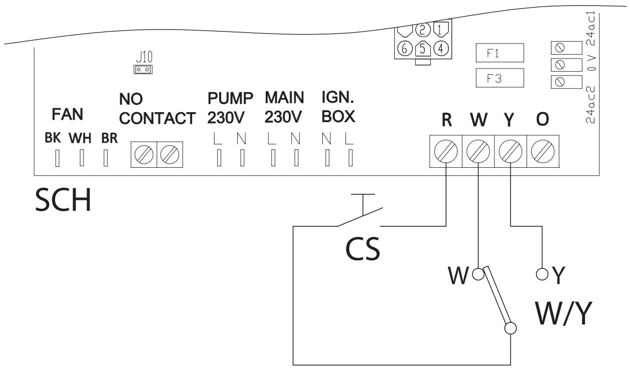


SCH Electronic board
R Common 24 VAC
W Heating request terminal

Components NOT SUPPLIED
CS External request

4.6.2 GAHP AR Plus

Figure 4.14 *External operation requests connection*



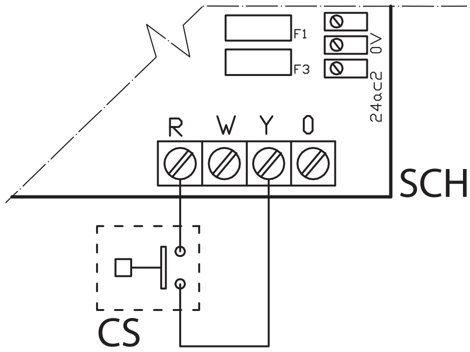
SCH Electronic board
R Common 24 VAC
W Heating request terminal
Y Cooling request terminal

Components NOT SUPPLIED
CS External request
W/Y Heating/Cooling switch (winter/summer)

4.6.3 GAHP GS/WS Plus

See Figure 4.13 *p. 12* for connection of heating request.
See Figure 4.15 *p. 12* below for connection of cooling request.

Figure 4.15 *External cooling request connection*



SCH Electronic board
R Common
Y Cooling request terminal

Components NOT SUPPLIED
CS External request

4.6.4 GA

See Figure 4.15 *p. 12* for connection of cooling request.

4.6.5 AY

The following Table 4.2 *p. 12* summarizes the features associated with the different control devices.

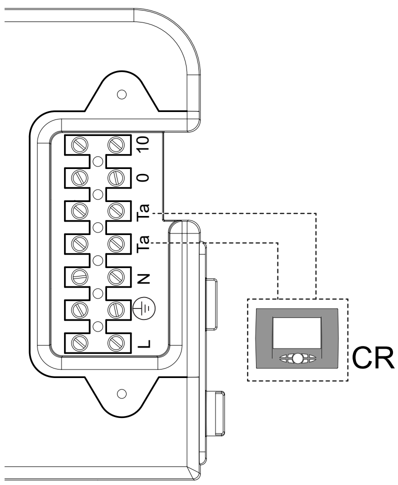
Table 4.2 *Available features depending on controls*

Control devices	Description
External request	Heating at fixed temperature, based on the parameters set on the control panel onboard the boiler. Activation/deactivation based on an external request, connected to the Ta-Ta terminals.
Room thermostat	Heating at fixed temperature, based on the parameters set on the control panel onboard the boiler. Activation/deactivation based on the temperature detected by the room thermostat and its settings.

Use a cable with a cross-section between 0,5 and 1,5 mm^2, with a maximum length of 50 metres.

For the AY 100 appliance, two separate requests must be provided, one for each of the Ta1-Ta2 contacts in the electrical panel, which correspond to the two separate thermal modules of the appliance.

Figure 4.16 *External request connection*



CR External request/room thermostat

4.6.6 Recovery circuit activation request

The recovery heat output (and consequently the activation of the relevant water pump) will only be available when the GA ACF HR chiller is running for the cooling service. It is not possible to activate the GA ACF HR chiller due to the request for recovery heat output.

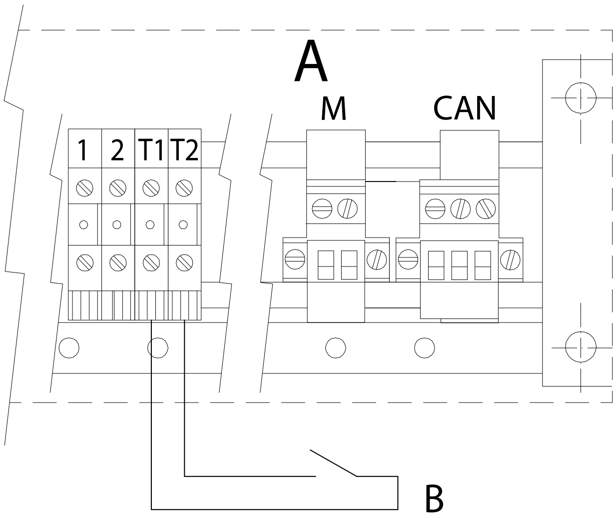
4.6.6.1 GA ACF-HR

If there is a single GA ACF HR, the request for activation of the recovery circuit, coming from a suitable thermostat with adjustable differential placed on the consumer for which the recovery is intended (e.g. the DHW buffer tank), activates the water pump of the recovery circuit via a suitable relay, as detailed in the diagram in Figure 5.9 *p. 18*.

4.6.6.2 Link with HR

To activate the recovery heat output request (only available if at least one GA ACF HR module is present on the Link), it is necessary to connect the contact from a suitable thermostat with adjustable differential placed on the consumer for which the recovery is intended (e.g. the DHW buffer tank) to terminals T1-T2 of the Link electrical panel.

Figure 4.17 *Connection of DHW thermostat for heat recovery circuit activation (Link with HR)*



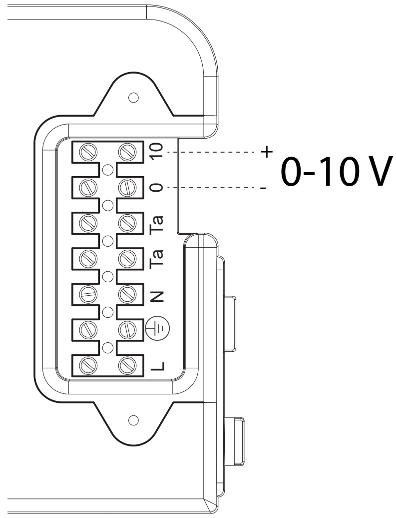
A Blind panel of the Link electrical panel (Figure 2.3 *p. 2*)
B DHW thermostat with adjustable differential for heat recovery circuit activation
T1-T2 DHW buffer tank thermostat terminals (HR recovery circuit side)

4.7 0-10 V INPUT

Control via a 0-10 V signal is an alternative to control via the DDC control panel or an external request.

The 0-10 V signal connection is only available on AY 35 and AY 50 models.
Either the water temperature setpoint or the power value can be communicated alternatively via a 0-10 V analogue signal.
The 0-10 V signal should be connected to the 0-10 terminals as shown in Figure 4.18 *p. 13*.
The cable may not be longer than 30 metres.

Figure 4.18 *0-10 V input connection*



5 WATER PUMP

For individual GAHP/GA appliances, water pumps are always supplied as an option and are all high-efficiency modulating pumps.
For individual AY appliances, the water pumps are high-efficiency, fixed-flow types and are already installed and wired inside the appliance. In the AY 100 appliance, there are two water pumps, one for each thermal module.
The Link can be supplied with high-efficiency, fixed-flow water pumps or without water pumps.

Control of water pump

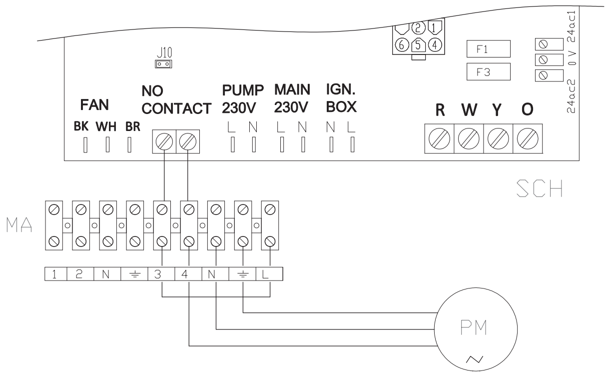
The water pump of the water/primary circuit must mandatorily be controlled by the appliance's electronic boards. It is not admissible to start/stop the pump with no request from the appliance.

5.1 GAHP A PLUS

5.1.1 Constant flow pump

The diagram in Figure 5.1 *p. 14* is for pumps < 700 W. For pumps ≥ 700 W, it is required to add a control relay and arrange jumper J10 OPEN.

Figure 5.1 *Water pump connection (power absorption less than 700W) controlled directly by the appliance's board*



SCH Electronic board
J10 Jumper (1)
N.O. CONTACT NO voltage-free contacts
MA Terminal block of the appliance
L Phase
N Neutral

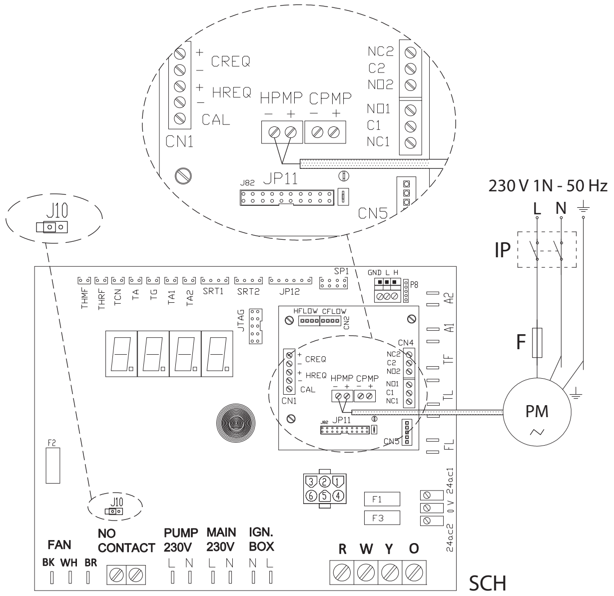
Components NOT SUPPLIED

PM Water pump

Note

1 Jumper J10 must be closed if the installed pump is not an electronic pump. Jumper J10 must be opened if the installed pump is an electronic pump.

Figure 5.2 *Connection of the variable flow pump for GAHP A Plus*

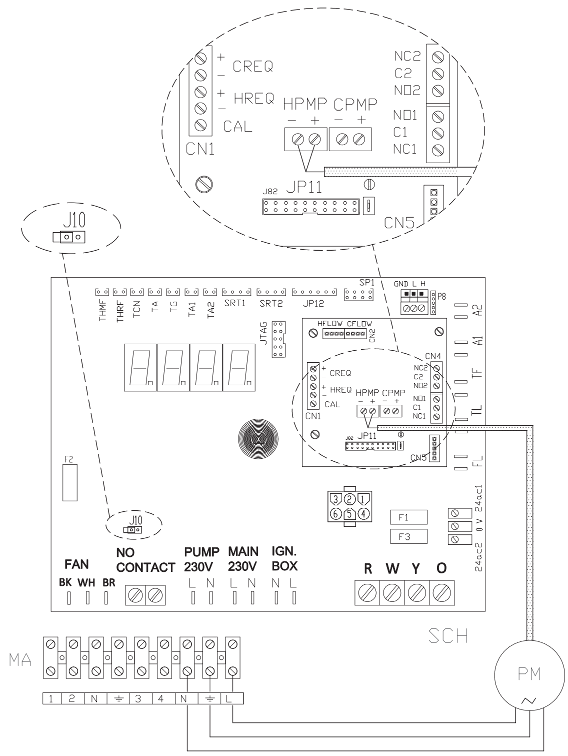


IP Two-position pump power switch
F Fuse
PM Hot water pump (primary circuit)
Pump 0-10 V signal wire colours
black connect to terminal -
red connect to terminal +

5.1.2 Variable flow pump

The variable flow pump, available as OPMP010 option, is factory-supplied with a power supply cable and a signal cable, both 1,8 m long.
For longer lengths, use FG16 3Gx1,5 mm² cable for the power supply and 2x0,75 mm² shielded cable suitable for 0-10 V signals for the signal cable (maximum length of the signal cable 30 m).
Protect the pump power supply line with a two-pole switch with a 2 A delayed fuse (detail IP, Figure 5.2 *p. 14*), or connect it directly to the terminals inside the appliance's electrical panel (detail MA, Figure 5.3 *p. 14*).

Figure 5.3 *Connection of the variable flow pump powered by the GAHP A Plus appliance*



PM Hot water pump (primary circuit)
MA Terminal block of the appliance
Pump 0-10 V signal wire colours
black connect to terminal -
red connect to terminal +

5.2 GAHP AR PLUS

5.2.1 Constant flow pump

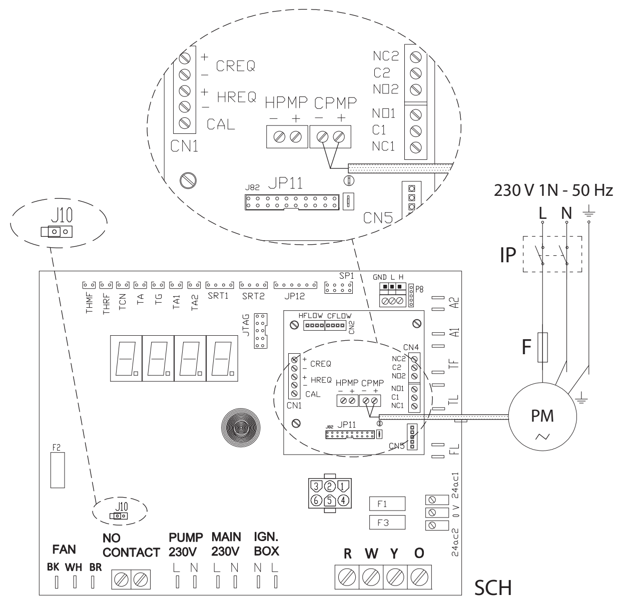
See Paragraph 5.1.1 *p. 13*.

5.2.2 Variable flow pump

The variable flow pump, available as OPMP010 option, is factory-supplied with a power supply cable and a signal cable, both 1,8 m long.
For longer lengths, use FG16 3Gx1,5 mm² cable for the power supply and 2x0,75 mm² shielded cable suitable for 0-10 V signals for the signal cable (maximum length of the signal cable 30 m).
Protect the pump power supply line with a two-pole switch with a 2 A delayed fuse (detail IP, Figure 5.4 *p. 15*), or connect it directly to the terminals inside the appliance's electrical panel (detail MA, Figure 5.5 *p. 15*).

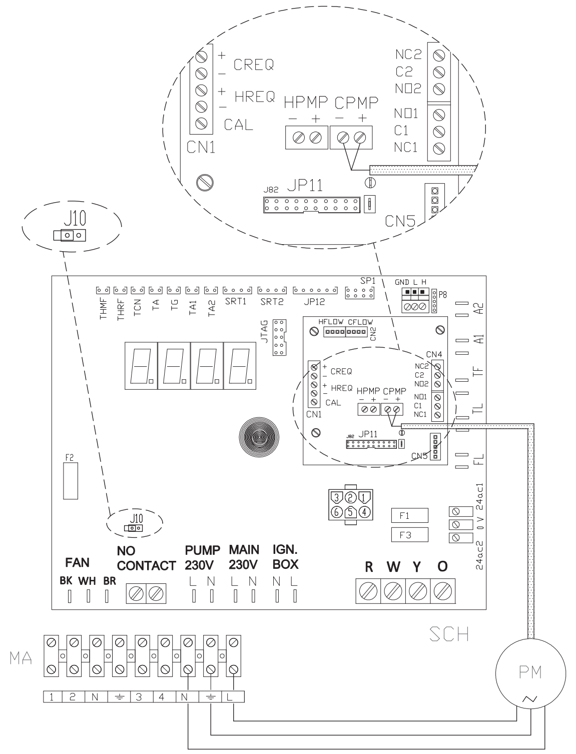
Modulation mode is only available during heating service. During cooling service, the pump operates at a fixed flow rate.

Figure 5.4 *Connection of the variable flow pump for GAHP AR Plus*



IP Two-position pump power switch
F Fuse
PM Water pump (primary circuit)
Pump 0-10 V signal wire colours
black connect to terminal -
red connect to terminal +

Figure 5.5 *Connection of the variable flow pump powered by the GAHP AR Plus appliance*



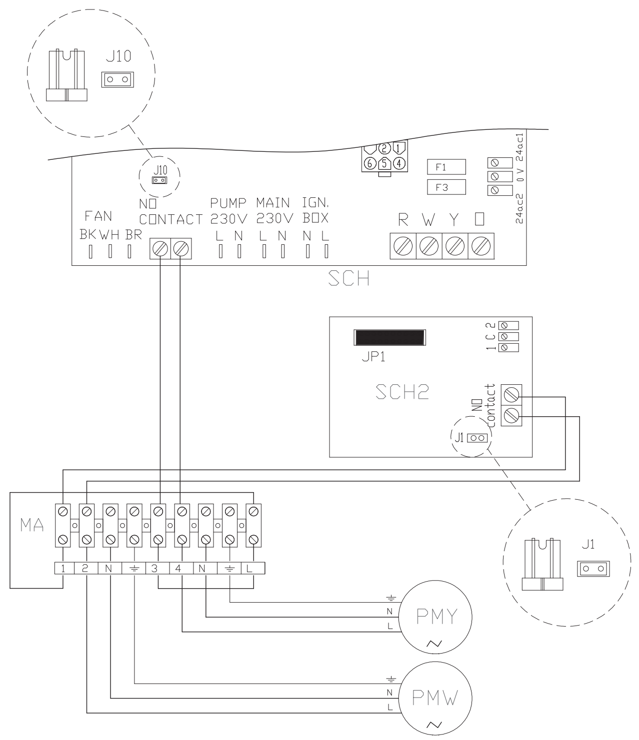
PM Water pump (primary circuit)
MA Terminal block of the appliance
Pump 0-10 V signal wire colours
black connect to terminal -
red connect to terminal +

5.3 GAHP GS/WS PLUS

5.3.1 Constant flow pump

The diagram in Figure 5.6 *p. 16* is for pumps < 700 W. For pumps ≥ 700 W, it is required to add a control relay and arrange jumper J1 (hot side pump) and J10 (cold side pump) OPEN.

Figure 5.6 *Connection of a fixed flow pump for GAHP GS/WS Plus*



SCH Electronic board
SCH2 Electronic board
J10 Cold side pump jumper (1)
J1 Hot side pump jumper (1)
N.O. CONTACT NO voltage-free contacts
MA Terminal block of the appliance
L Phase
N Neutral

Components NOT SUPPLIED
PMW Hot side water pump < 700 W
PMY Cold side water pump < 700 W

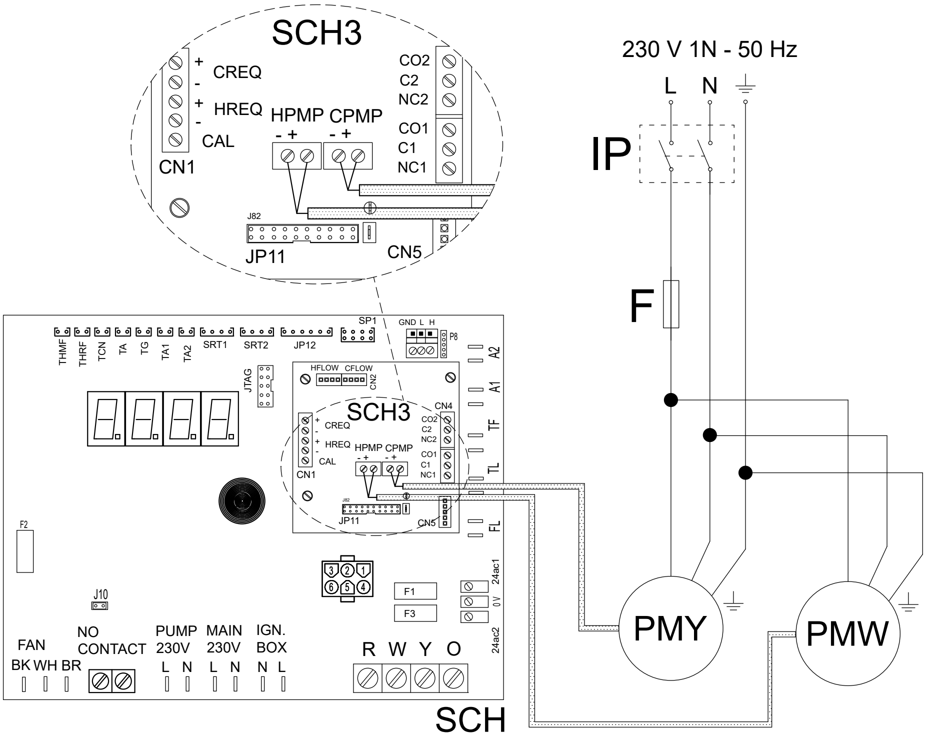
Note
1 Jumpers J10 and J1 must be closed if the installed pump is not an electronic pump.
Jumpers J10 and J1 must be opened if the installed pump is an electronic pump.

5.3.2 Variable flow pump

The variable flow pump, available as OPMP010 option, is factory-supplied with a power supply cable and a signal cable, both 1,8 m long.
For longer lengths, use FG16 3Gx1,5 mm^2 cable for the power supply and 2x0,75 mm^2 shielded cable suitable for 0-10 V signals for the signal cable (maximum length of the signal cable 30 m).
Protect the two pumps' power supply line with a two-pole switch with 2 A delayed fuse (detail IP, Figure 5.7 *p. 17*), or connect it directly to the terminals inside the appliance's electrical board (detail MA, Figure 5.8 *p. 17*).

Only the hot side pump will actually be controlled with variable flow. The cold side pump will in any case be controlled with constant flow.

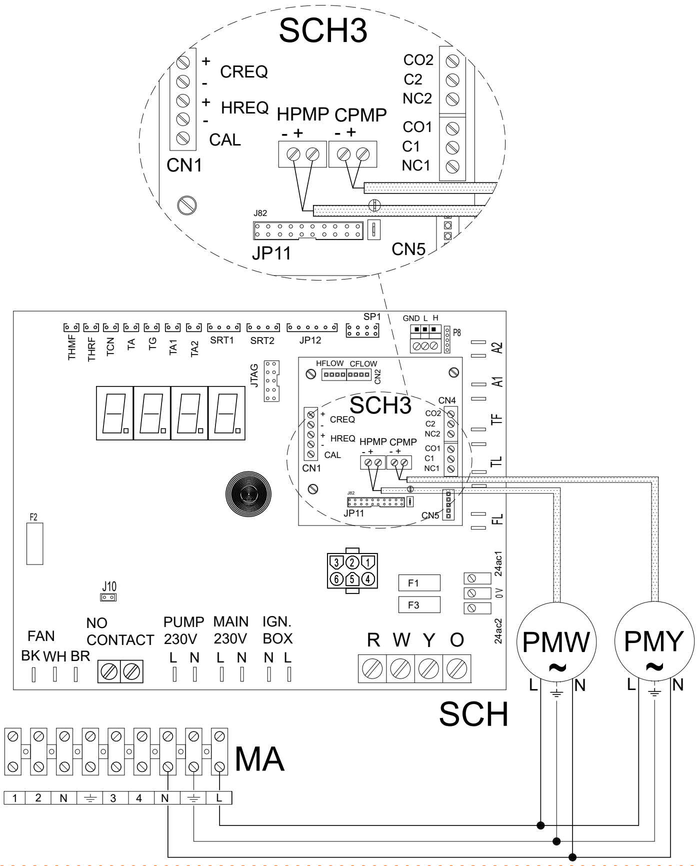
Figure 5.7 *Connection of the variable flow pump for GAHP GS/WS Plus*



IP Two-position pump power switch
F Fuse
PMW Hot side water circulation pump (primary circuit)
PMY Cold side water circulation pump

Pump 0-10 V signal wire colours
black connect to terminal -
red connect to terminal +

Figure 5.8 *Connection of the variable flow pump powered by the GAHP GS/WS Plus appliance*



PMW Hot side water circulation pump (primary circuit)
PMY Cold side water circulation pump
MA Terminal block of the appliance
Pump 0-10 V signal wire colours
black connect to terminal -
red connect to terminal +

5.4 GA

5.4.1 Constant flow pump

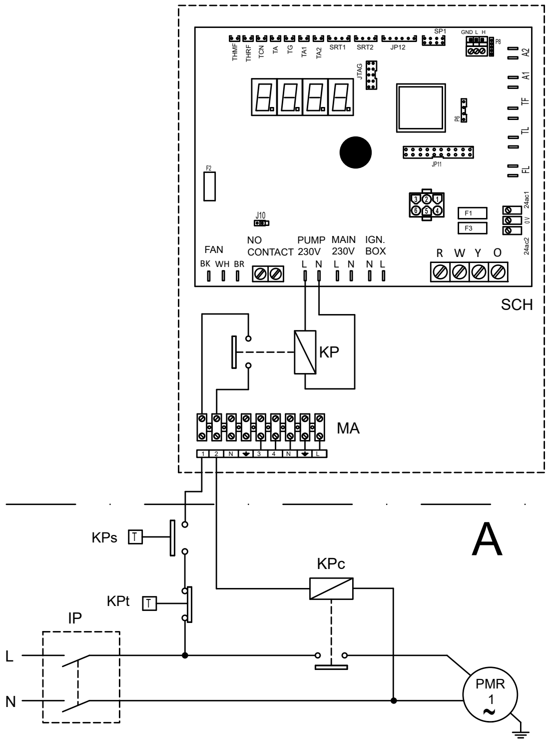
See Paragraph 5.1.1 *p. 13*.

5.4.2 Heat recovery exchanger water pump (only for GA ACF HR)

To be controlled through contacts 1-2 on terminal block MA (Figure 5.9 *p. 18*).

The recovery heat output (and consequently the activation of the relevant water pump) will only be available when the GA ACF HR chiller is running for the cooling service. It is not possible to activate the GA ACF HR chiller due to the request for recovery heat output.

Figure 5.9 *Recovery exchanger pump connection*



A Connections to be made by the installer
KP Relay provided on the appliance for heat recovery exchanger pump request
KPt Thermostat with setpoint calibration of DHW tank (not supplied)
KPs Thermostat calibrated at 35 °C with capillary tube in the lower part of the DHW buffer tank (not supplied) [to be provided if the water flow on the recovery circuit exceeds the nominal value of 1000 l/h]
KPc Two-pole relay for recovery exchanger pump request (not supplied)
IP Two-pole isolation switch for recovery exchanger pump power supply (not supplied)
PMR Recovery exchanger pump (not supplied)

5.5 AY

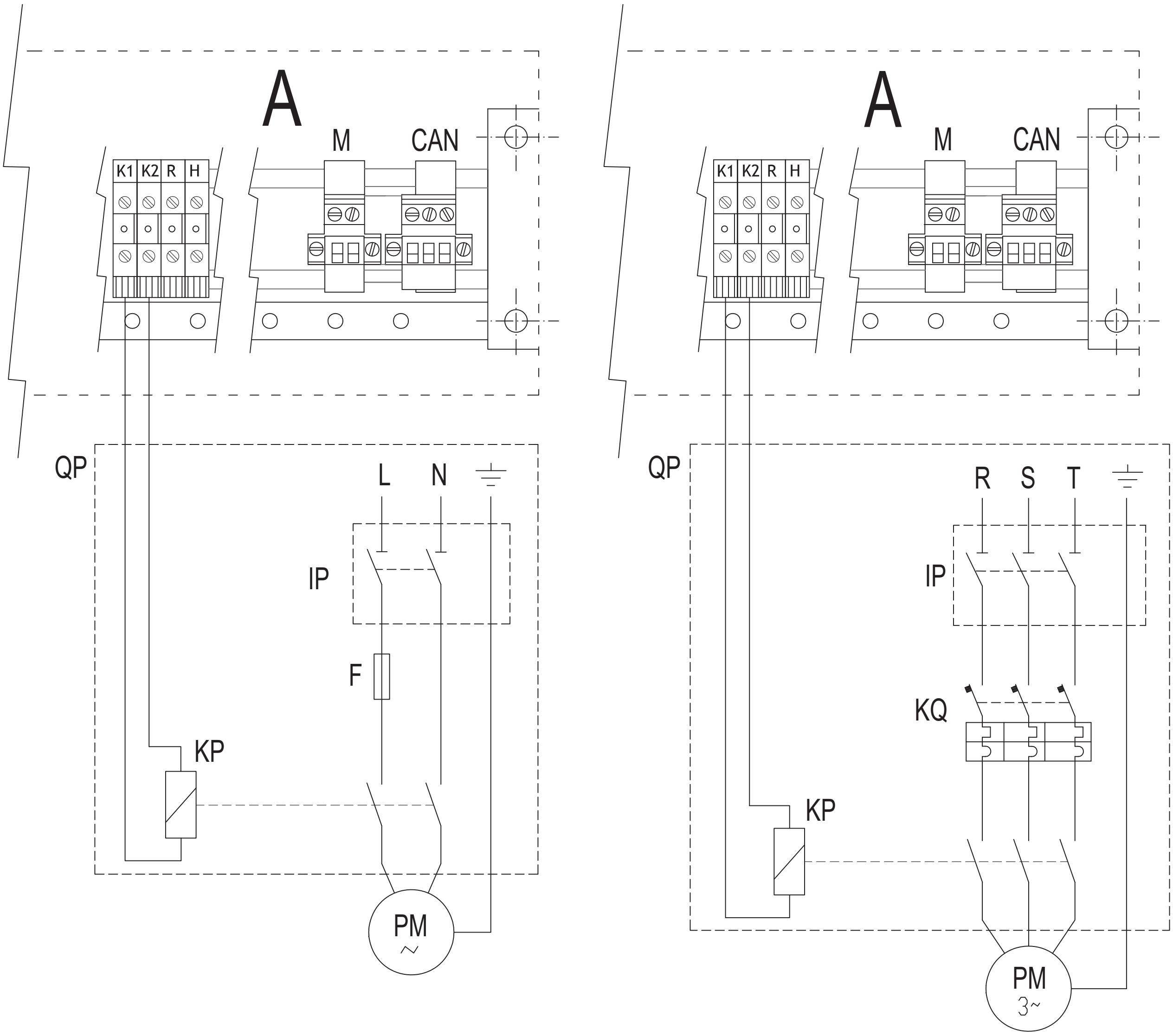
Appliances in the AY range are equipped with high head water pumps, already mounted and wired.

5.6 LINK

In Link with water pumps, the individual independent water pumps (1 or 2 for each GAHP/GA/AY module) are already mounted and pre-wired on board the Link.
In Link without water pumps, electrical connections must be made (both for power supply and control) of the common water water pump of the primary water circuit, as shown in the diagrams in Figures 5.10 *p. 19*, 5.11 *p. 20*.

5.6.1 Common water pump of a link without water pumps

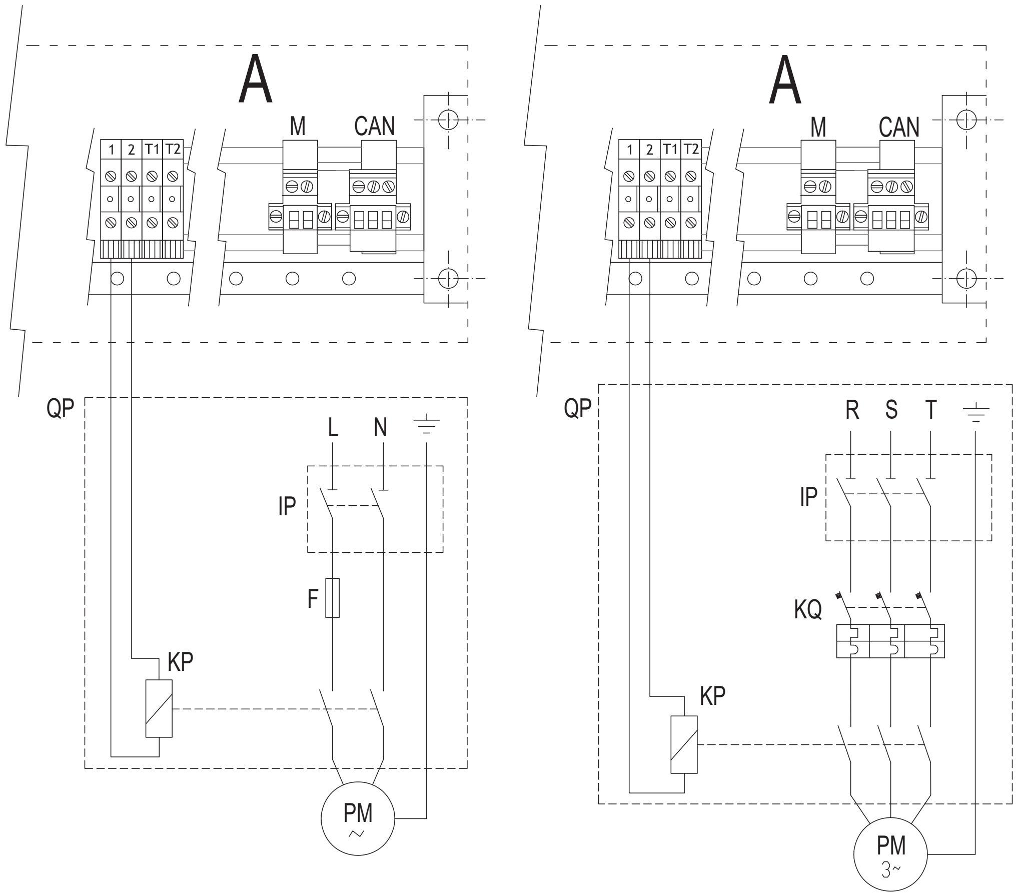
Figure 5.10 *Connection of single- or three-phase water pump directly controlled by the Link (configurations "without water pumps")*



A Blind panel of the Link electrical panel (Figure 2.3 *p. 2*)
F Appropriate fuse for protecting the water pump used
IP Water pump disconnector (not supplied)
K1-K2 24 Vac coil terminals for the common water pump request of the hot/cold circuit of the Link
KP NO relay for controlling the water pump (not supplied)
KQ Appropriate motor protection switch for the water pump used
L Phase of single-phase water pump power supply
N Neutral
PM Primary system water pump (not supplied)
QP Water pump electrical panel (external)
RST Three-phase water pump power supply phases

The terminals for controlling the common water pump of the heat recovery circuit, described in Figure 5.11 *p. 20* below, are only present if at least one GA ACF HR module is present on the Link.

Figure 5.11 *Heat recovery circuit: connection of single- or three-phase water pump directly controlled by the Link (configurations "without water pumps")*



A	Blind panel of the Link electrical panel (Figure 2.3 *p. 2*)	KQ	Appropriate motor protection switch for the water pump used
1-2	24 Vac coil terminals for the common water pump request of the heat recovery circuit of Link with HR	L	Phase of single-phase water pump power supply
F	Appropriate fuse for protecting the water pump used	N	Neutral
IP	Water pump disconnector (not supplied)	PM	Primary system water pump (not supplied)
KP	NO relay for controlling the water pump (not supplied)	QP	Water pump electrical panel (external)
		RST	Three-phase water pump power supply phases

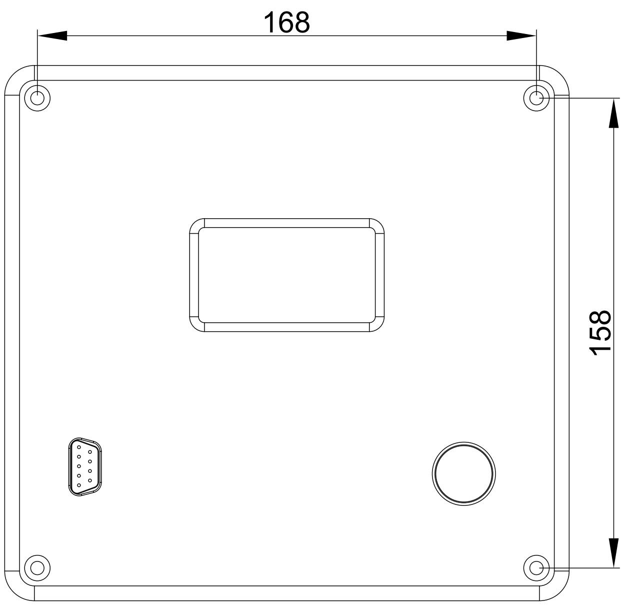
6 DDC PANEL

For a description of the features of the DDC control panel, please refer to Section C01.11.

6.1 INSTALLATION

The DDC control panel is suitable for indoor installation and must be mounted on an electrical panel with a rectangular opening measuring 155x151 mm.
Figure 6.1 *p. 21* indicates the position of the fixing holes.

Figure 6.1 *DDC/CCI front view with fixing dimensions*

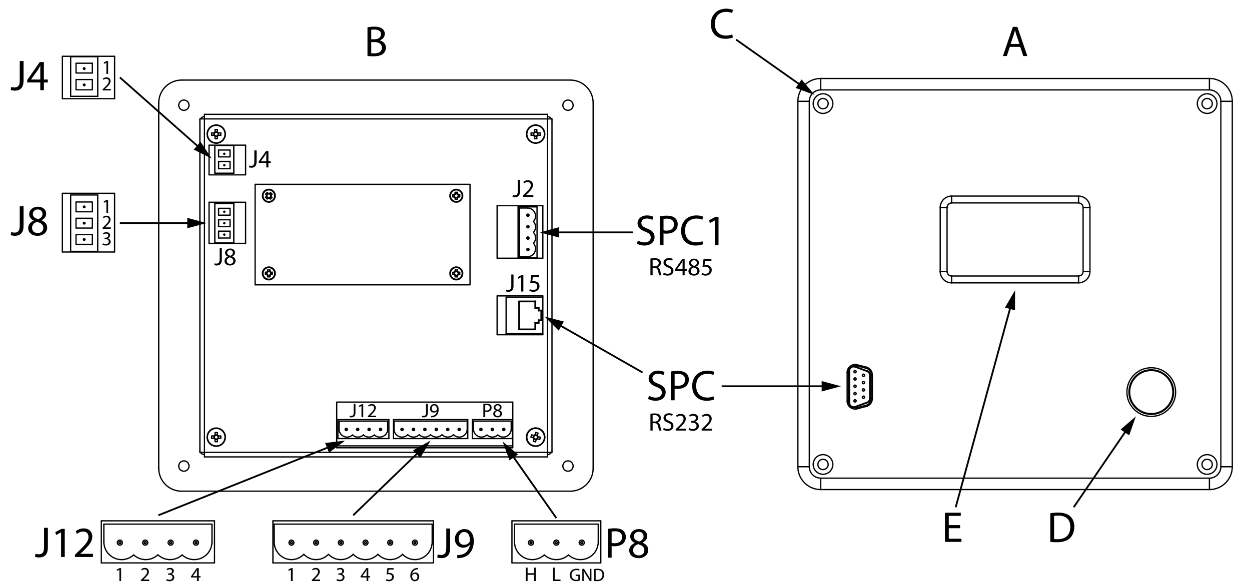


The DDC control panel has an IP20 protection rating and must be installed in premises with an ambient air temperature between 0 °C and 50 °C, away from direct sunlight.

6.2 CONNECTIONS

The DDC control panel provides the connection terminals shown in Figure 6.2 *p. 21*.

Figure 6.2 *Detail of DDC connectors*



A Front view
B Rear view
C Mounting holes
D Knob
E Display
J4 Outdoor (or ambient) temperature probe NTC 10 kΩ - 2-pin terminal block
J8 Output for external alarm systems - 3-pole terminal block, max voltage 24 V AC
1 COM
2 NO
3 NC

J12 24 Vac electrical power supply - 4 pole connector
1 24 Vac
2 0 V AC
3 Safety earthing
J9 External requests - 6-pin socket
1 R (24 V AC output)
2 W (heating request)
3 YY (cooling request)
4 0 (0 V AC)
5 NA (not connected)
6 R (24 V AC output)

P8 CAN bus network socket (orange)
SPC RS232 serial port
- J15, RJ45 port (Modbus / supervision system / monitoring connection)
- DB9 (connection Modbus / BMS / monitoring)

SPC1 J2 port (Modbus RS485 serial connection)
1 A (TXD/RXD +)
2 B (TXD/RXD -)
3 Common (earth and GND)
4 Cable shielding (earth and GND)

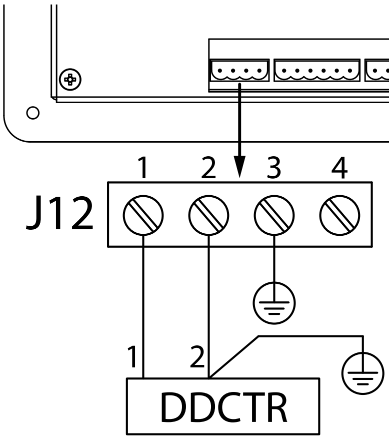
6.2.1 Electrical power supply

The DDC control panel must be supplied by a safety transformer rated at 230/24 Vac - 50/60 Hz with a power rating of not less than 20 VA (not supplied). This transformer must comply with Standard EN 61558-2-6.

Use a 3x0,75 mm² electrical cable and connect it to the terminals

of J12 plug on the bottom left (rear side), respecting the polarity shown in Figure 6.3 *p. 22*.
The maximum specified length for this cable is 1 m.

Figure 6.3 *Electrical power supply of the DDC/CCI control panel*



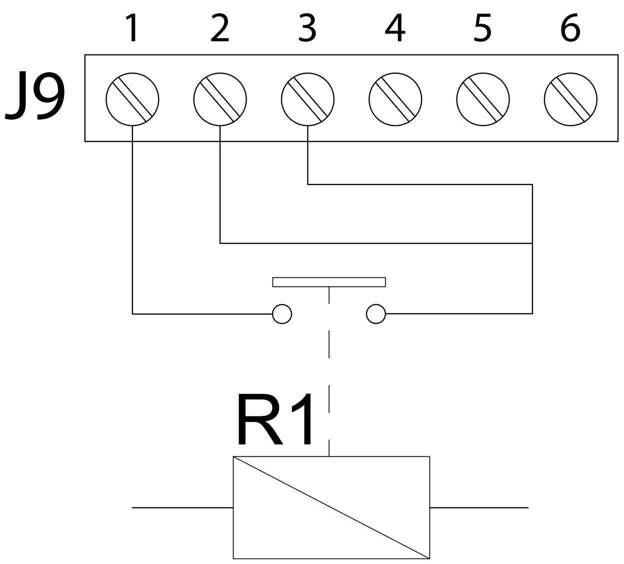
J12 24 Vac electrical power supply - 4 pole connector
1 24 Vac
2 0 V AC
3 Safety earthing
DDCTR Safety transformer 240/24 VAC - 50/60 Hz - minimum 20 VA (not supplied)

6.2.2 Inputs/Outputs

6.2.2.1 External requests

Switching on or off the appliances controlled by the DDC control panel can be managed via a general external request.
To use this feature, you must configure the DDC control panel appropriately and set up the electrical connections as detailed in the following Figures.
Figure 6.4 *p. 22* shows the case of the connection of an external request for a 2-pipe system (alternative heating/cooling).

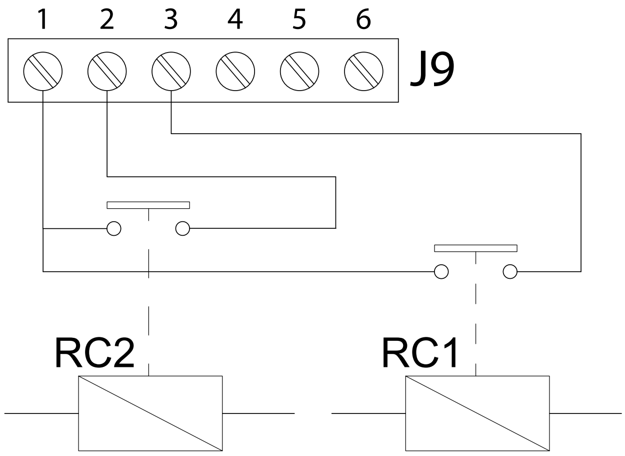
Figure 6.4 *2-pipe system single DDC external request*



Details of J9 socket (Figure 6.2 *p. 21*)
R1 Relay with double insulation for external request for system activation (not supplied)

Figure 6.5 *p. 22* shows the case of the connection of two external requests for a 2-/4-pipe system (alternative or simultaneous heating/cooling).

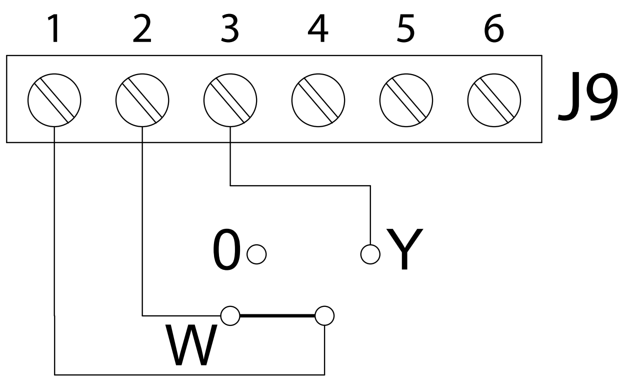
Figure 6.5 *Double DDC external request*



Details of J9 socket (Figure 6.2 *p. 21*)
RC1 Relay for external request for cooling system activation (not supplied)
RC2 Relay for external request for heating system activation (not supplied)

Figure 6.6 *p. 22* shows the case of connecting a 3-position external selector switch for a 2-pipe system (alternative heating/cooling).

Figure 6.6 *DDC 2 pipe external request selector switch*



Details of J9 socket (Figure 6.2 *p. 21*)
Operating mode external selector switch (not supplied)

- Position W to turn heating on
- Position Y to turn cooling on
- Position 0 for system off

6.2.2.2 External alarm signal output

The DDC control panel provides a SELV digital output for activating an external alarm signal (such as a warning light, siren or other device), of the NO/NC type, in the event of an alarm condition (on the units or the water temperature):

► NO is closed if an alarm condition occurs
► NC is opened if an alarm condition occurs

Maximum applicable voltage 24 Vac.
Maximum applicable current 1 A.
Figure 6.7 *p. 23* below shows a connection diagram for SELV type external alarm connected to the NO terminal.
If the connected alarm device is not SELV type, a control relay

must be installed.

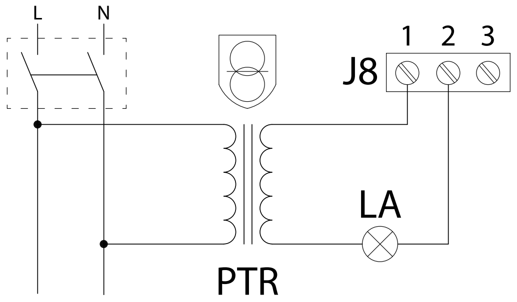


Figure 6.7 *DDC external alarm signal*

L-N Phase/neutral 230 V 1N - 50Hz
PTR Safety transformer (240/24 V AC - 50 Hz)
LA External alarm signalling device (lamp, siren, etc.)
J8 Output for external alarm systems, maximum voltage 24 VAC, maximum current 1 A
1 Common
2 NO
3 NC

6.2.2.3 Outdoor/Ambient temperature probe

Analogue input J4 (Figure 6.2 *p. 21*) is used for the outdoor temperature probe (or room temperature probe). The input is of the resistive type NTC 10 kΩ.
The maximum length of the connecting cable is 100 m.
Figure 9.3 *p. 35* shows the connection diagram.

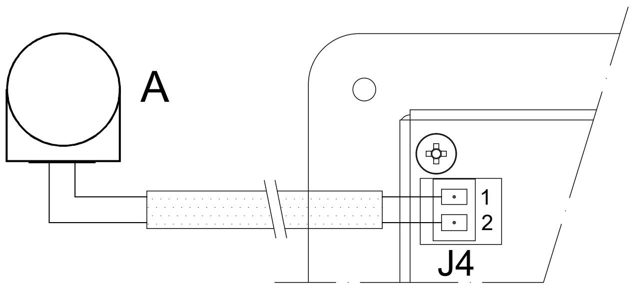


Figure 6.8 *Outdoor probe connection*

A Outdoor temperature probe (or room temperature probe) NTC 10 kΩ
J4 Outdoor temperature probe (or room temperature probe) NTC 10 kΩ - 2-pin plug

6.2.3 CAN bus connections

For the CAN bus connection of the DDC control panel to the appliances, please refer to Paragraph 4.5 *p. 5*.

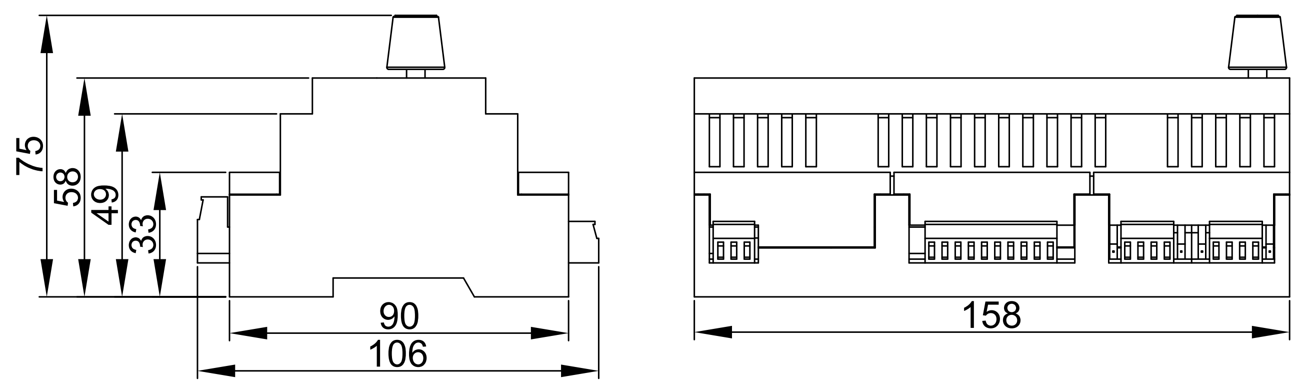
7 RB100

For a description of the features of the RB100 device, please refer to Section C01.11.

7.1 INSTALLATION

The RB100 device is suitable for indoor installation and must be mounted in an electrical panel on a 35 mm DIN rail (EN 60715). The space requirement is equal to 9 modules, as shown in Figure 7.1 *p. 23*.

Figure 7.1 *RB100 device dimensions*

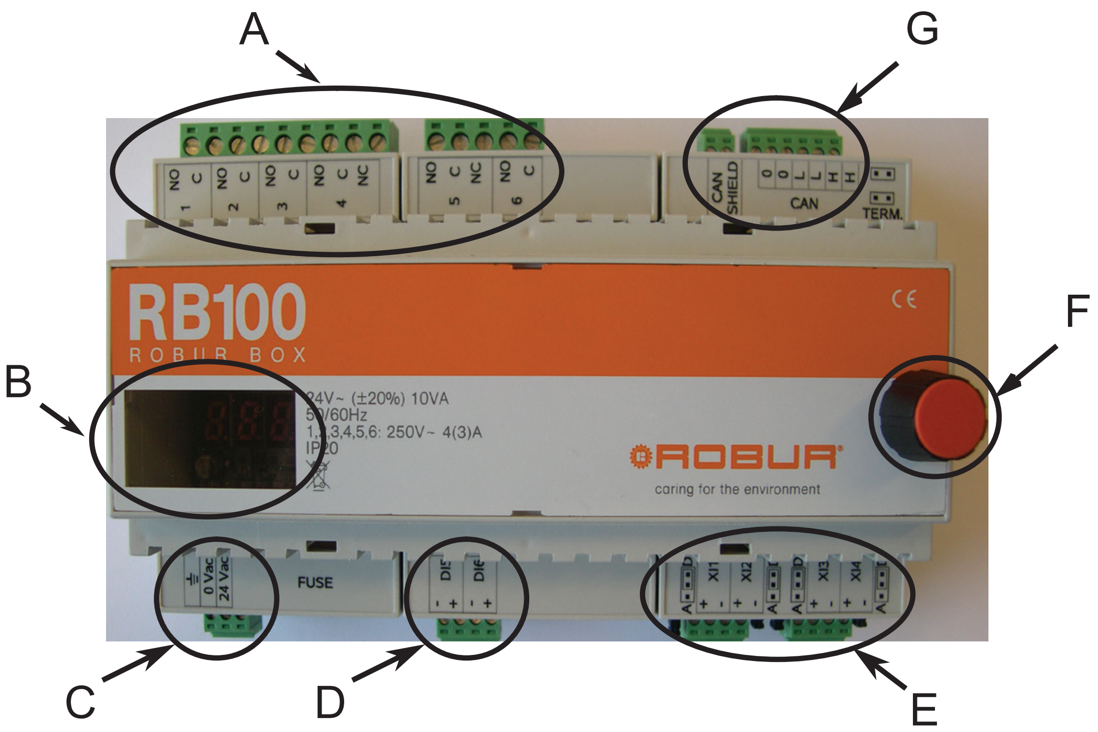


The RB100 device has an IP20 protection rating and must be installed in premises with an ambient air temperature between 0 °C and 50 °C.

7.2 CONNECTIONS

The RB100 device provides the connection terminals shown in Figure 7.2 *p. 24*.

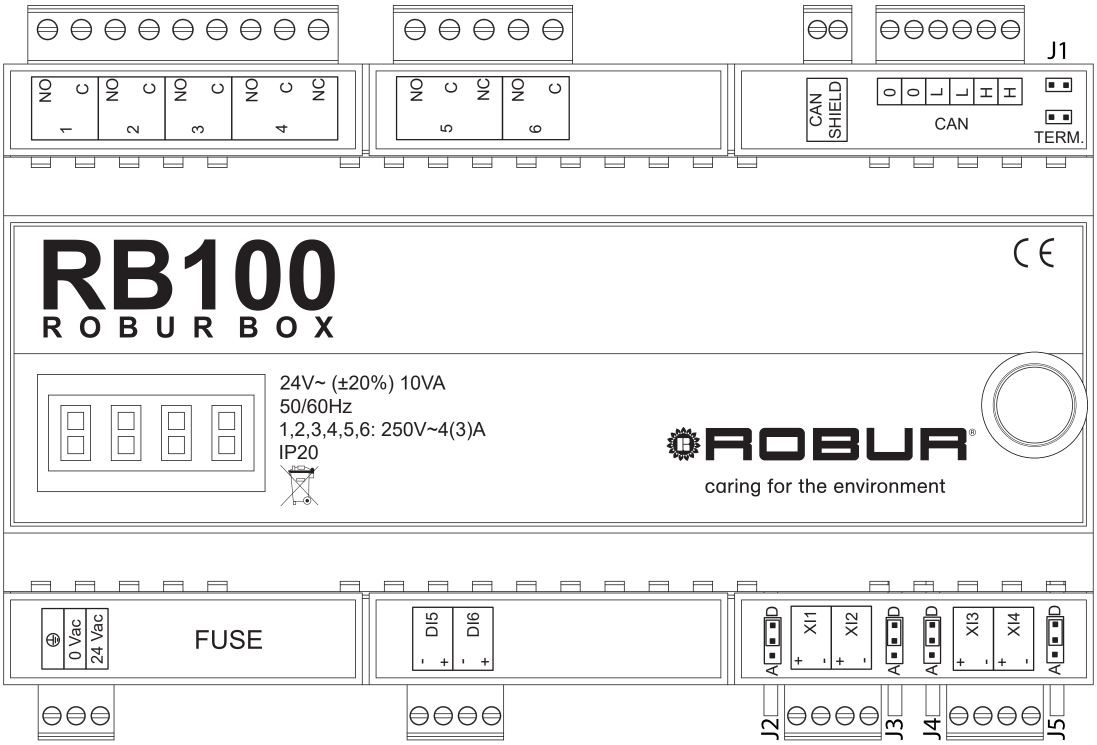
Figure 7.2 *RB100 device connections*



A Output relay
B Display
C 24 V AC power supply
D Limit switch auxiliary contacts input
E Analogue/digital inputs for service requests
F Knob
G CAN bus connection

Figure 7.3 *p. 25* shows the detail of connection terminals.

Figure 7.3 *Detail of RB100 device connections*



A terminals
4 NO/NC contact for valve service

C terminals
Device power supply connector

E terminals
XI1 Analogue/digital input for cooling service request
XI2 Analogue/digital input for heating service request
XI3 Analogue/digital input for DHW0 service request
XI4 Analogue/digital input for DHW1 service request
J2 Input type (analogue/digital) selection jumper for cooling service request
J3 Input type (analogue/digital) selection jumper for heating service request
J4 Input type (analogue/digital) selection jumper for DHW0 service request
J5 Input type (analogue/digital) selection jumper for DHW1 service request

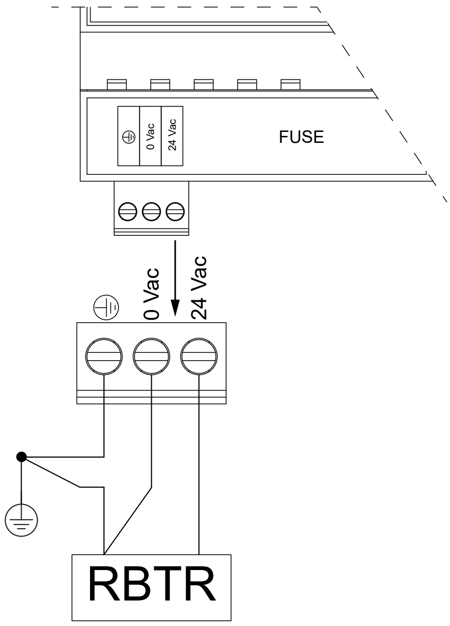
G terminals
CAN SHIELDCAN bus cable shielding terminal block
CAN CAN bus cable terminal block
J1 CAN bus jumpers

Each of the four inputs XI1...XI4 may be configured as either analogue or digital. Configuration must be done both by correctly positioning the jumpers on the board as well as by correctly setting the device configuration parameters.

7.2.1 Electrical power supply

The RB100 device must be supplied by a safety transformer rated at 230/24 Vac - 50/60 Hz with a power rating of not less than 10 VA (not supplied). This transformer must comply with Standard EN 61558-2-6.
Use a 3x0,75 mm² electrical cable and connect it to terminals C (Figure 7.2 *p. 24*), respecting the polarity indicated in Figure 7.4 *p. 25*.
The maximum specified length for this cable is 1 m.

Figure 7.4 *RB100 power supply*



RBTR Safety transformer 230/24 VAC - 50/60 Hz - minimum 10 VA (not supplied)

7.2.2 Inputs/Outputs

7.2.2.1 Service requests analogue inputs

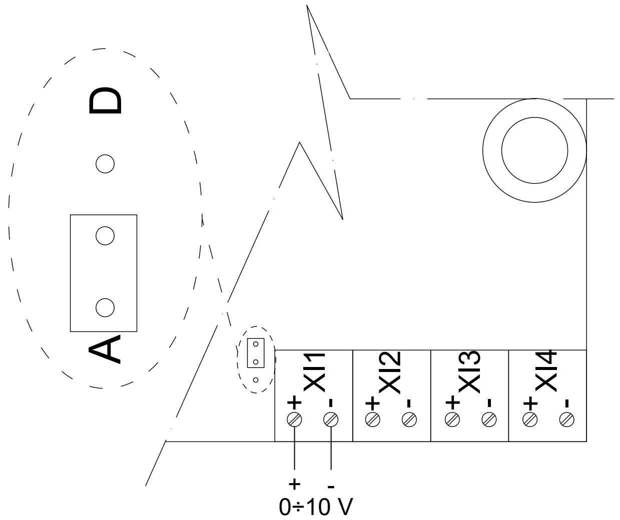
For analogue service request inputs, the input voltage must be between 0 and 10 Vdc.
The maximum length of the connecting cables and their section are detailed in Table 7.1 *p. 26* below.
The cable must be shielded and with shield earthed at one end.

Table 7.1 *RB100/RB200 analogue input cables*

Maximum cable length (m)	Wire cross section (mm^2)
300	1,5
100	0,5

Figure 7.5 *p. 26* details the connecting diagram for input XI1, valid for any analogue input XI1...XI4.

Figure 7.5 *RB100 services requests analogue inputs*



7.2.2.2 Service requests digital inputs

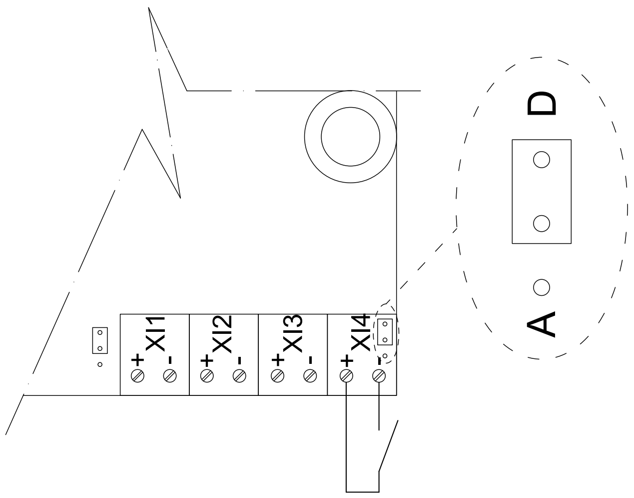
For digital service requests inputs, the external request must have an operating voltage of at least 12 Vdc and must ensure closing with a minimum current of 5 mA.
The maximum length of the connecting cables and their resistance are detailed in Table 7.2 *p. 26* below.
The cable must be shielded and with shield earthed at one end.

Table 7.2 *RB100/RB200 digital input cables*

Max resistance for On (Ω)	Min resistance for Off (Ω)	Maximum cable length (m)
200	50	300

Figure 7.6 *p. 26* details the connecting diagram for input XI4, valid for any digital input XI1...XI4.

Figure 7.6 *RB100 services requests digital inputs*



7.2.2.3 Diverter valves output

The digital output to control the diverter valves is a NO/NC diverter voltage-free contact:

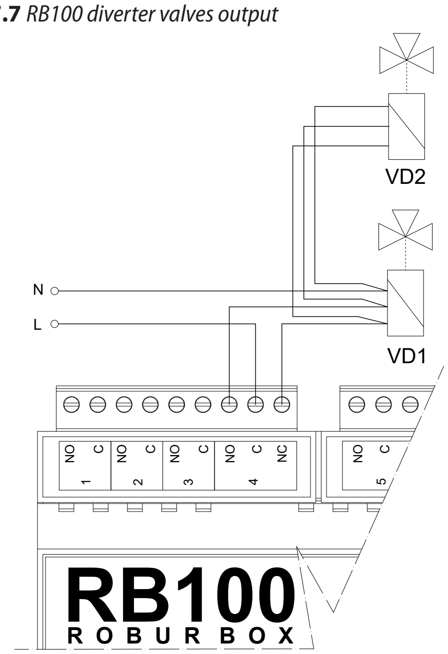
- ► NO is closed when the valves are towards the heating circuit or the separable group
- ► NC is closed when the valves are towards the cooling circuit or the base group

The relay retains its position even in the event of power supply interruption.
Maximum applicable voltage 250 Vac.
Maximum applicable current:

- ► 4 A for resistive loads
- ► 3 A for inductive loads

Maximum cable length 300 m.
Figure 7.7 *p. 26* details the connection diagram for diverter valves.
The diverter valves can be either the on/off type with spring return (in which case only one of the two NO/NC contacts needs to be connected) or the 3-point type.

Figure 7.7 *RB100 diverter valves output*



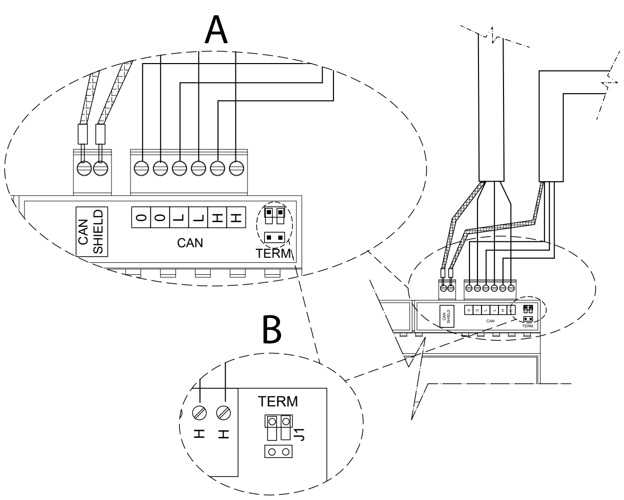
VD1 Actuated 3-way valve on system outlet pipes
VD2 Actuated 3-way valve on system inlet pipes

7.2.3 CAN bus connections

For general concepts on the CAN bus communication network, Paragraph 4.2 *p. 4*.
For CAN bus cable characteristics, Paragraph 4.3 *p. 4*.
The RB100 device can be an intermediate node or a terminal node of the CAN bus network.
If the RB100 device is an **intermediate node**, make the connection as shown in Figure 7.8 *p. 27*.

If the RB100 device is an intermediate node, jumpers J1 (detail B in Figure 7.8 *p. 27*) must be **open**.

Figure 7.8 *RB100/RB200 CAN bus connection for an intermediate node*

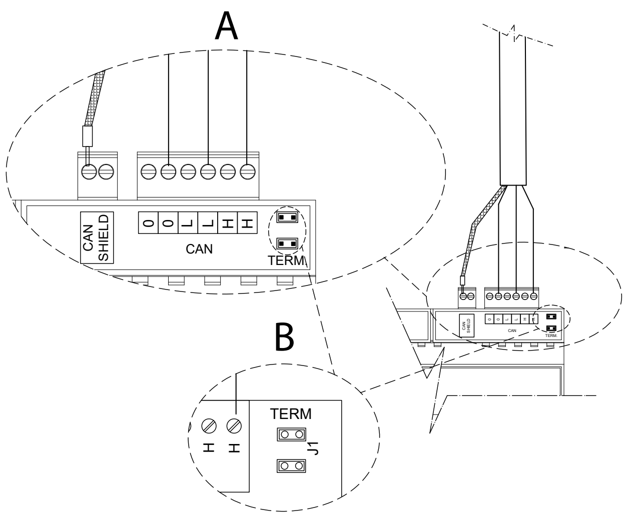


A CAN bus screen connection detail
B Detail of J1 jumpers position

If the RB100 device is a **terminal node**, make the connection as shown in Figure 7.9 *p. 27*.

If the RB100 device is a terminal node, jumpers J1 (detail B in Figure 7.9 *p. 27*) must be **closed**.

Figure 7.9 *RB100/RB200 CAN bus connection for a terminal node*



A CAN bus screen connection detail
B Detail of J1 jumpers position

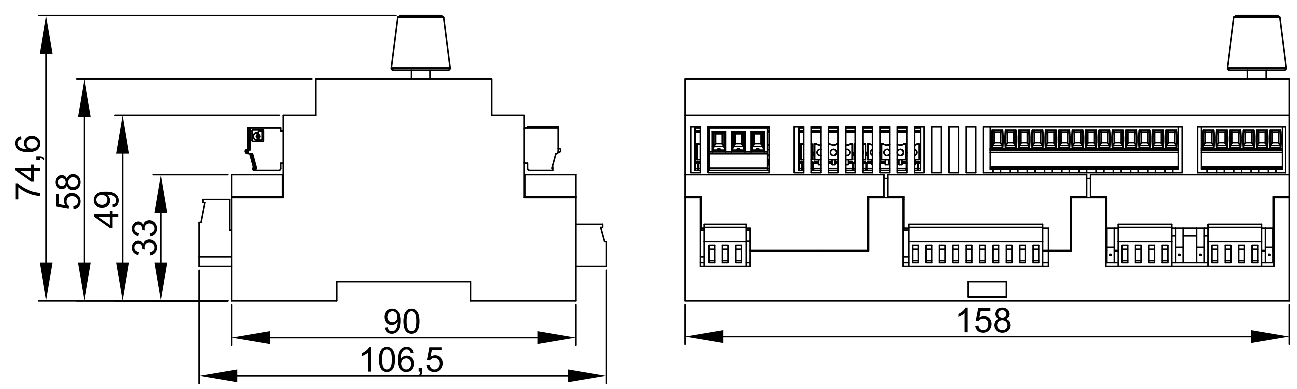
8 RB200

For a description of the features of the RB200 device, please refer to Section C01.11.

8.1 INSTALLATION

The RB200 device is suitable for indoor installation and must be mounted in an electrical panel on a 35 mm DIN rail (EN 60715). The space requirement is equal to 9 modules, as shown in Figure 8.1 *p. 27*.

Figure 8.1 *RB200 device dimensions*



The RB200 device has an IP20 protection rating and must be installed in premises with an ambient air temperature between

0 °C and 50 °C.

8.2 CONNECTIONS

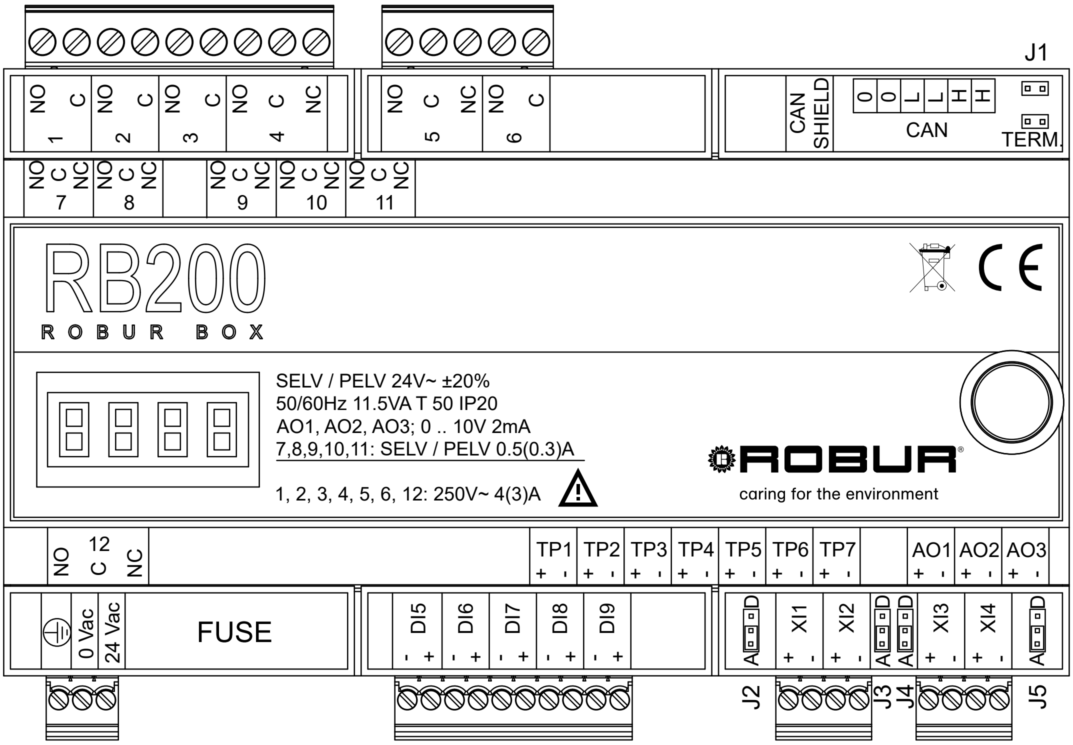
The RB200 device provides the connection terminals shown in Figure 8.2 *p. 28*.

Figure 8.2 *RB200 device connections*

A Output relay
B Display
C 24 V AC power supply
D Limit switch auxiliary contacts input
E Analogue/digital inputs for service requests
F Knob
G CAN bus connection
H Digital inputs for unavailability signals of third-party generators
J Temperature probe inputs
K Analogue outputs for third-party generator setpoint

The following Figures show in detail the connection terminals, divided by lower level (Figure 8.3 *p. 29*) and upper level (Figure 8.4 *p. 30*).

Figure 8.3 *Detail of RB200 device connections on the lower level*



A terminals
1 NO contact for generator 1 water pump or water pump 1 service
2 NO contact for generator 2 water pump or water pump 2 service
3 NO contact for water pump 3 service
4 NO/NC contact for valve 1 service or water pump 4 service
5 NO/NC contact for generator 1 start up
6 NO contact for generator 2 start up

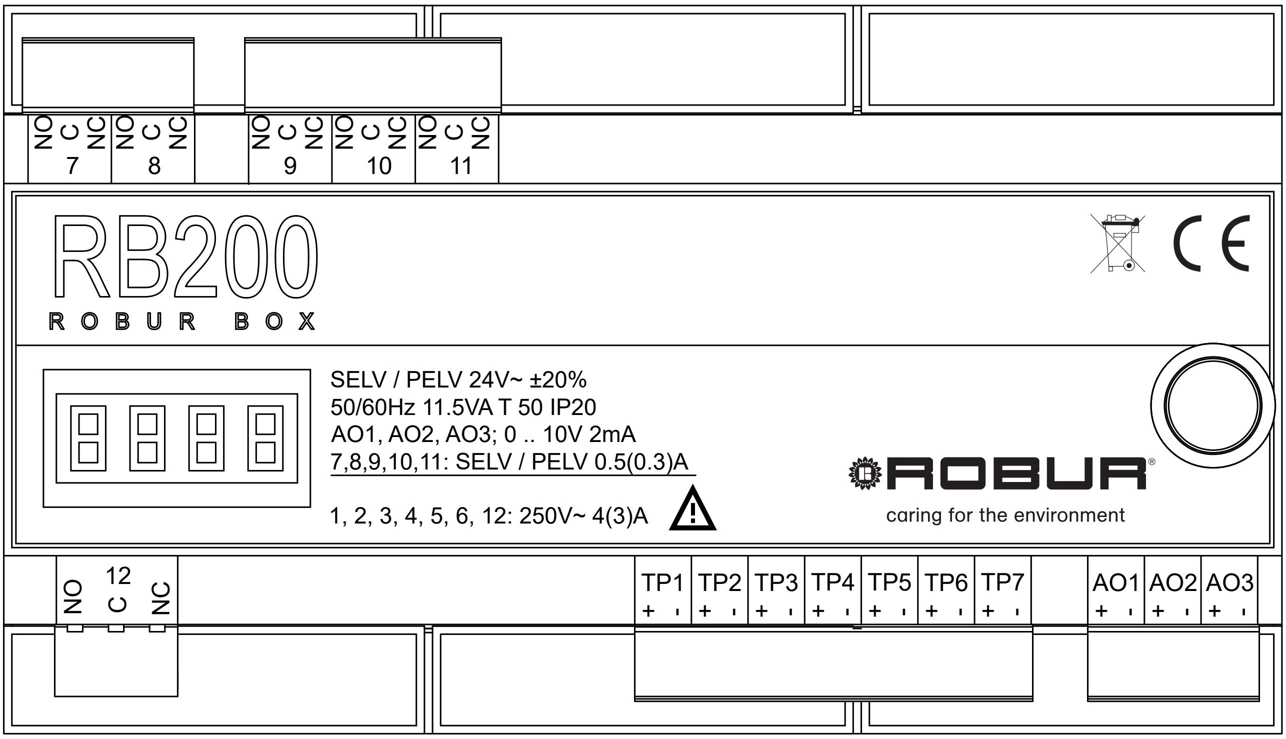
C terminals
Device power supply connector

E terminals
XI1 Analogue/digital input for cooling service request
XI2 Analogue/digital input for heating service request
XI3 Analogue/digital input for DHW0 service request
XI4 Analogue/digital input for DHW1 service request
J2 Input type (analogue/digital) selection jumper for cooling service request
J3 Input type (analogue/digital) selection jumper for heating service request
J4 Input type (analogue/digital) selection jumper for DHW0 service request
J5 Input type (analogue/digital) selection jumper for DHW1 service request

G terminals
CAN SHIELDCAN bus cable shielding terminal block
CAN CAN bus cable terminal block
J1 CAN bus jumpers

H terminals
DI7 Generator 1 alarm input
DI8 Generator 2 alarm input

Figure 8.4 *Detail of RB200 device connections on the upper level*



A terminals
12 NO/NC contact for valve 2 service or water pump 5 service

J terminals
TP1 Temperature probe input for cooling inlet
TP2 Temperature probe input for cooling outlet
TP3 Temperature probe input for heating inlet
TP4 Temperature probe input for heating outlet
TP5 Temperature probe input for separable DHW inlet
TP6 Temperature probe input for separable DHW outlet
TP3 Temperature probe input for GAHP inlet

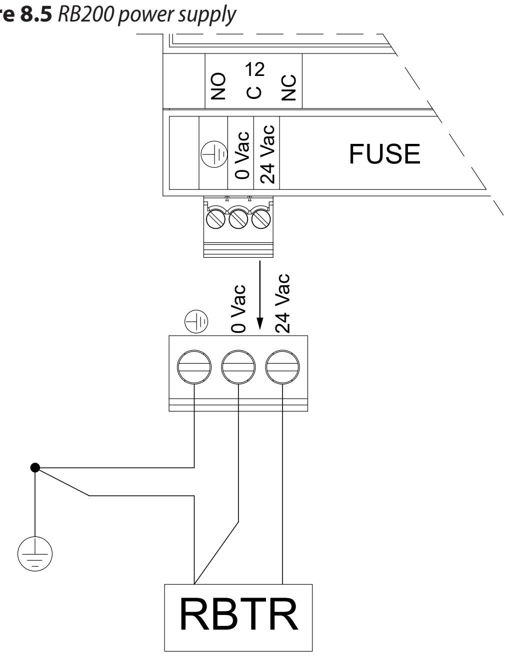
K terminals
AO1 0-10 V output for generator 1 setpoint
AO2 0-10 V output for generator 2 setpoint

Each of the four inputs XI1...XI4 may be configured as either analogue or digital. Configuration must be done both by correctly positioning the jumpers on the board as well as by correctly setting the device configuration parameters.

8.2.1 Electrical power supply

The RB200 device must be supplied by a safety transformer rated at 230/24 Vac - 50/60 Hz with a power rating of not less than 12 VA (not supplied). This transformer must comply with Standard EN 61558-2-6.
Use a 3x0,75 mm² electrical cable and connect it to terminals C (Figure 8.2 *p. 28*), respecting the polarity indicated in Figure 8.5 *p. 30*.
The maximum specified length for this cable is 1 m.

Figure 8.5 *RB200 power supply*



RBTR Safety transformer 230/24 VAC - 50/60 Hz - minimum 12 VA (not supplied)

8.2.2 Inputs/Outputs

The digital outputs (voltage-free contacts) have these features:
- maximum voltage 250 Vac

- maximum current for resistive loads 4 A
- maximum current for inductive loads 3 A

8.2.2.1 Service requests analogue inputs

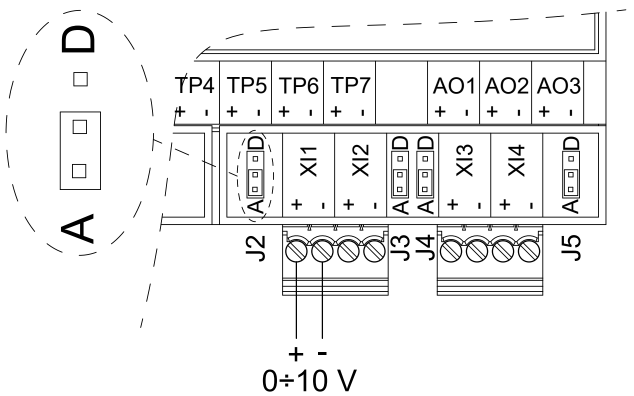
For analogue service request inputs, the input voltage must be between 0 and 10 Vdc.
The maximum length of the connecting cables and their section are detailed in Table 8.1 *p. 31* below.
The cable must be shielded and with shield earthed at one end.

Table 8.1 *RB100/RB200 analogue input cables*

Maximum cable length (m)	Wire cross section (mm^2)
300	1,5
100	0,5

Figure 8.6 *p. 31* details the connecting diagram for input XI1, valid for any analogue input XI1...XI4.

Figure 8.6 *Analogue inputs for RB200 service requests*



8.2.2.2 Service requests digital inputs

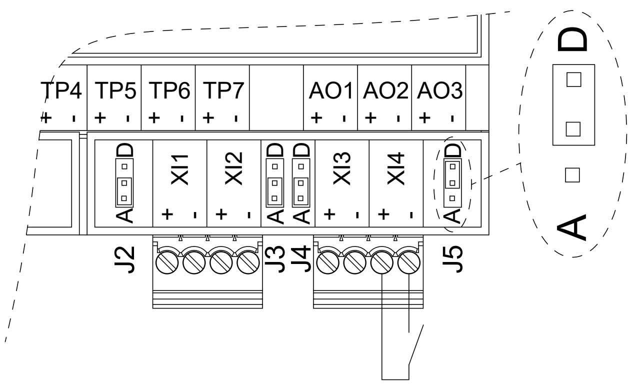
For digital service requests inputs, the external request must have an operating voltage of at least 12 Vdc and must ensure closing with a minimum current of 5 mA.
The maximum length of the connecting cables and their resistance are detailed in Table 7.2 *p. 26* below.
The cable must be shielded and with shield earthed at one end.

Table 8.2 *RB100/RB200 digital input cables*

Max resistance for On (Ω)	Min resistance for Off (Ω)	Maximum cable length (m)
200	50	300

Figure 8.7 *p. 31* details the connecting diagram for input XI4, valid for any digital input XI1...XI4.

Figure 8.7 *Digital inputs for RB200 service requests*



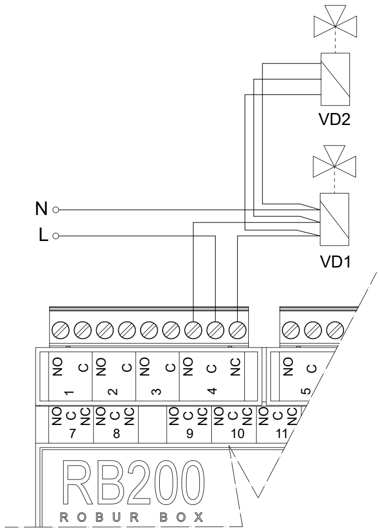
8.2.2.3 Diverter valve outputs

The digital outputs (contact 4 in Figure 8.3 *p. 29* and contact 12 in Figure 8.4 *p. 30*) to control the diverter valves are NO/NC diverter voltage-free contacts:

- 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

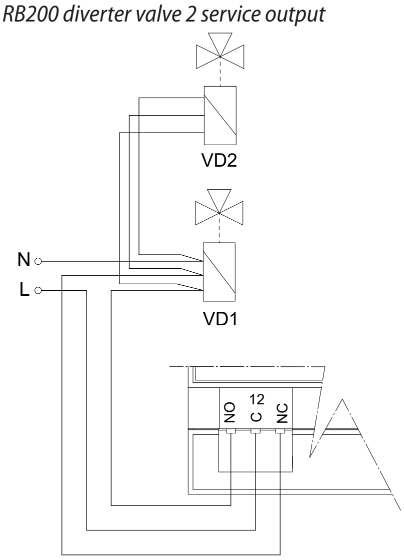
The relay retains its position even in the event of power supply interruption.
Maximum cable length 300 m.
Figures 8.8 *p. 31* and 8.9 *p. 31* show in detail the connection diagram of the diverter valves to each of the two available digital outputs.
The diverter valves can be either the on/off type with spring return (in which case only one of the two NO/NC contacts needs to be connected) or the 3-point type.

Figure 8.8 *RB200 diverter valve 1 service output*



VD1 Actuated 3-way valve on system outlet pipes
VD2 Actuated 3-way valve on system inlet pipes

Figure 8.9 *RB200 diverter valve 2 service output*



VD1 Actuated 3-way valve on system outlet pipes
VD2 Actuated 3-way valve on system inlet pipes

8.2.2.4 Third party generators services

To control third party generators, the following outputs are available for each generator:

- One voltage-free NO contact for ON/OFF generator control (contact 5 for generator 1, contact 6 for generator 2, Figure 8.3 *p. 29*).
- One voltage-free NO contact for ON/OFF generator water pump control (contact 1 for generator 1, contact 2 for generator 2, Figure 8.3 *p. 29*).
- One analogue 0-10 V output for the generator temperature set-point (output AO1 for generator 1, output AO2 for generator 2, see Figure 8.4 *p. 30*).

NO contacts are closed when the system requires switching on the generator or water pump.

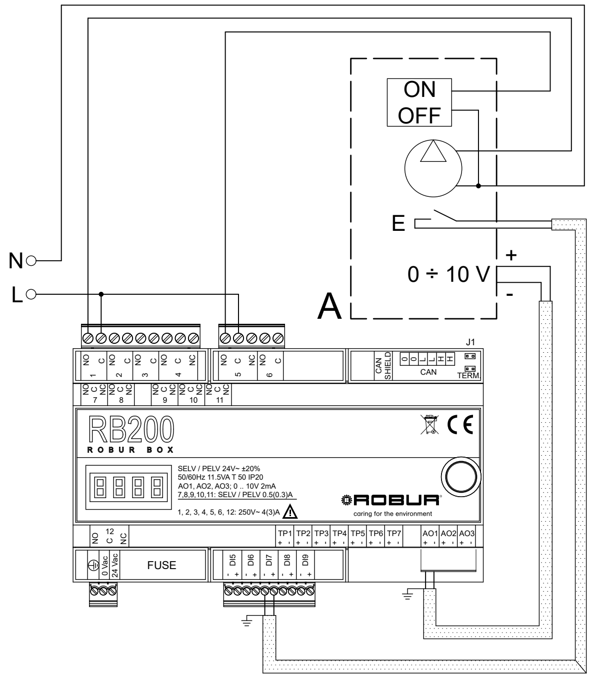
When controlling the switching on/off of third-party appliances, it is always advisable to avoid interrupting the electrical power supply to the appliance. There is often a dedicated input for an on/off signal from an external device, which should be used for connection to the RB200, checking in advance in the documentation of the third-party appliance whether this signal is mains voltage or a voltage-free contact.

For the analogue output the features of the cable to be used are set out in Table 8.1 *p. 31*.
The cable of the analogue output must be shielded with shield earthed at one end.
The following are available for signalling the alarm status of each generator:

- One digital input (voltage-free contact) (contact DI7 for generator 1, contact DI8 for generator 2, Figure 8.3 *p. 29*).

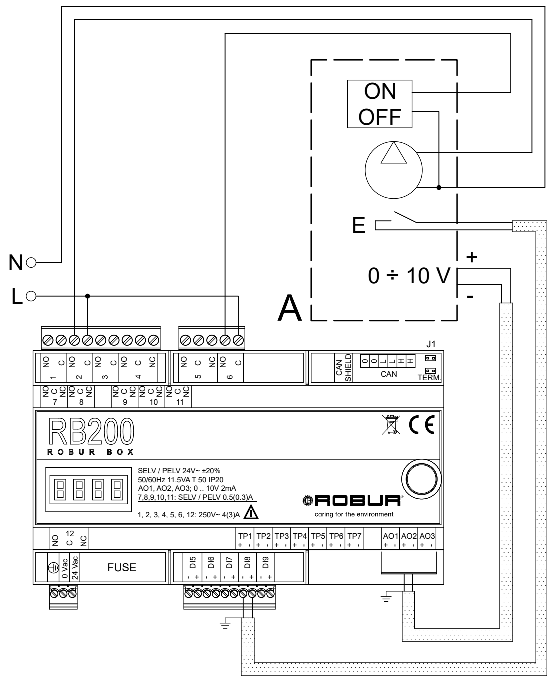
The alarm signal is active when the contact is closed.
The cable of the digital input must be shielded with shield earthed at one end.
For the digital input the features of the cable to be used are set out in Table 8.2 *p. 31*.
Maximum length of input/output cables 300 m.
Figure 8.10 *p. 32* shows the connection diagram for the signals relating to generator 1, whereas Figure 8.11 *p. 32* shows the connection diagram for the signals relating to generator 2.

Figure 8.10 *RB200 generator 1 service connection*



A Third-party generator 1
E Third-party generator alarm output

Figure 8.11 *RB200 generator 2 service connection*



A Third-party generator 2
E Third-party generator alarm output

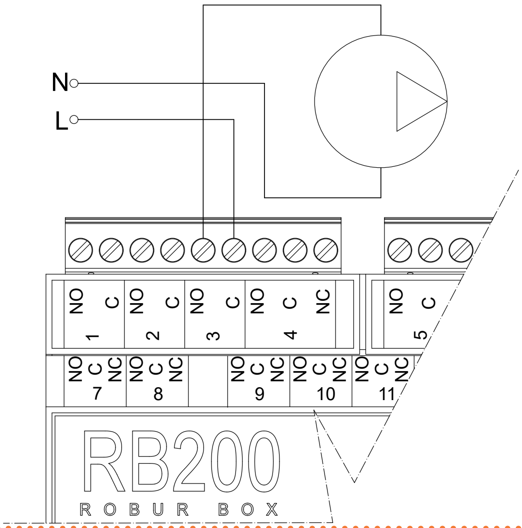
8.2.2.5 Water pumps service outputs

The water pump control outputs are voltage-free NO contacts (contacts 1, 2, 3, 4, 12 for water pump services 1, 2, 3, 4, 5, Figure 8.3 *p. 29*).
NO contacts are closed when the system requires switching on the water pump.
Maximum cable length 300 m.

Some contacts are common to two types of services, which cannot therefore be configured simultaneously on the RB200 device.

Figure 8.12 *p. 33* shows the connection diagram for the water pump 3 service.
For the other water pump services, only the contact to be connected changes.

Figure 8.12 *RB200 water pump 3 service connection*



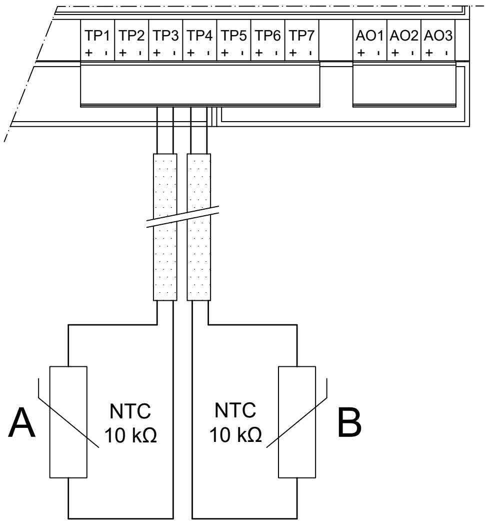
8.2.2.6 Temperature probes inputs

Analogue inputs TP1 - TP7 (Figure 8.4 *p. 30*) are intended for NTC 10 kΩ resistive temperature probes:

- TP1-TP2: Cooling only or 2 pipes cooling/heating manifold probes
- TP3-TP4: Heating only manifold probes
- TP5-TP6: Separable DHW manifold probes
- TP7: GAHP inlet manifold probe

Table 8.1 *p. 31* sets out the features of the connecting cables for the temperature probes.
Figure 8.13 *p. 33* shows an example connection for the heating manifold probes.
For the other temperature probes, only the contact to be connected changes.

Figure 8.13 *RB200 heating temperature probes connection*



A Heating inlet probe B Heating outlet probe

8.2.3 CAN bus connections

For general concepts on the CAN bus communication network, Paragraph 4.2 *p. 4*.
For CAN bus cable characteristics, Paragraph 4.3 *p. 4*.
The RB200 device can be an intermediate node or a terminal node of the CAN bus network.
If the RB200 device is an **intermediate node**, make the connection as shown in Figure 7.8 *p. 27*.

If the RB200 device is an intermediate node, jumpers J1 (detail B in Figure 7.8 *p. 27*) must be **open**.

If the RB200 device is a **terminal node**, make the connection as shown in Figure 7.9 *p. 27*.

If the RB200 device is a terminal node, jumpers J1 (detail B in Figure 7.9 *p. 27*) must be **closed**.

9 CCI PANEL

For a description of the features of the CCI control panel, please refer to Section C01.11.

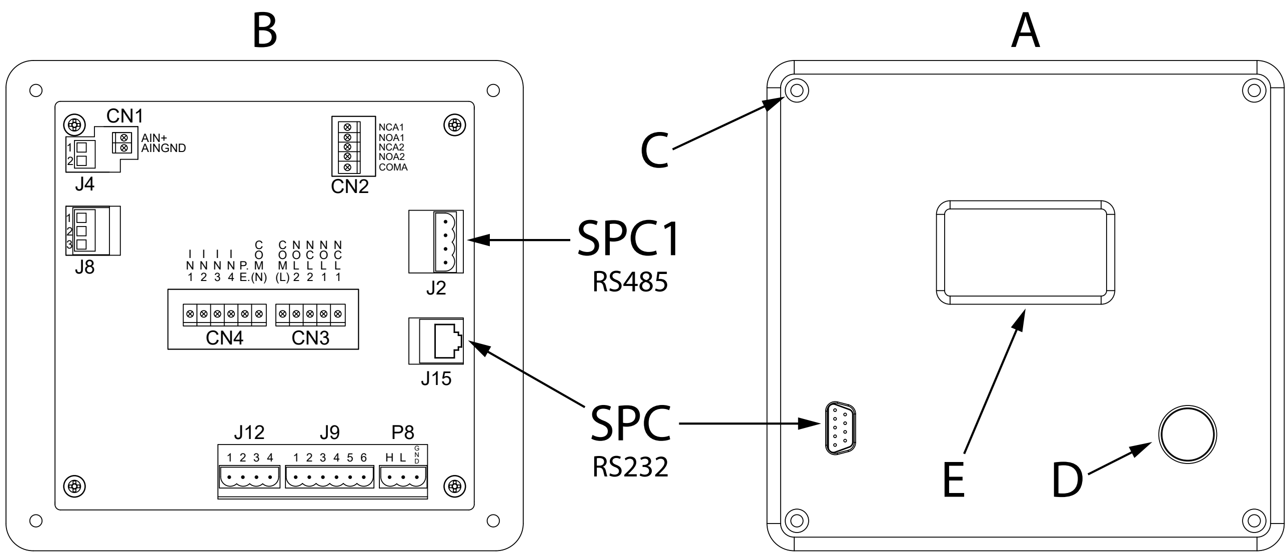
9.1 INSTALLATION

The CCI control panel is suitable for indoor installation and must be mounted on an electrical panel with a rectangular opening measuring 155x151 mm.
Figure 6.1 *p. 21* indicates the position of the fixing holes.
The CCI control panel has an IP20 protection rating and must be installed in premises with an ambient air temperature between 0 °C and 50 °C, away from direct sunlight.

9.2 CONNECTIONS

The CCI control panel provides the connection terminals shown in Figure 9.1 *p. 34*.

Figure 9.1 *CCI panel connections*



A Front view
B Rear view
C Mounting holes
D Knob
E Display
CN1 Setpoint request connections
- AIN+ 0-10 V input for setpoint request
- AINGND Ground reference for AIN+

J4 Delivery or return manifold temperature probe input
CN4 Service request inputs
- IN1 Input (phase 230 V) GAHP start-up request
- IN2 Input (phase 230 V) DHW service request
- IN3 Not used
- IN4 Input (phase 230 V) free cooling request
- P.E. Safety earthing
- COM(N) Reference (neutral 230 V) for inputs IN1-IN4

J9 Auxiliary boiler start-up signal
1 Reference for contact 2
2 Auxiliary boiler active signal input
CN3 Service alarms signal outputs
- COM(L) Common contact
- NOL2 NO contact for impossibility to continue DHW service with GAHP
- NCL2 NC contact for impossibility to continue DHW service with GAHP
- NOL1 NO general alarm contact
- NCL1 NC general alarm contact

J8 First GAHP appliance alarm signal outputs
1 Common contact
2 NC alarm contact for first GAHP
3 NO alarm contact for first GAHP
CN2 Second and third GAHP appliances alarm signal outputs
- COMA Common contact
- NOA2 NO alarm contact for third GAHP
- NCA2 NC alarm contact for third GAHP
- NOA1 NO alarm contact for second GAHP
- NCA1 NC alarm contact for second GAHP

J12 24 Vac electrical power supply - 4 pole connector
1 24 Vac
2 0 V AC
3 Safety earthing
P8 CAN bus network socket (orange)
SPC RS232 serial port
- J15, RJ45 port (Modbus / supervision system / monitoring connection)
- DB9 (connection Modbus / BMS / monitoring)

SPC1 J2 port (Modbus RS485 serial connection)
1 A (TXD/RXD +)
2 B (TXD/RXD -)
3 Common (earth and GND)
4 Cable shielding (earth and GND)

9.2.1 Electrical power supply

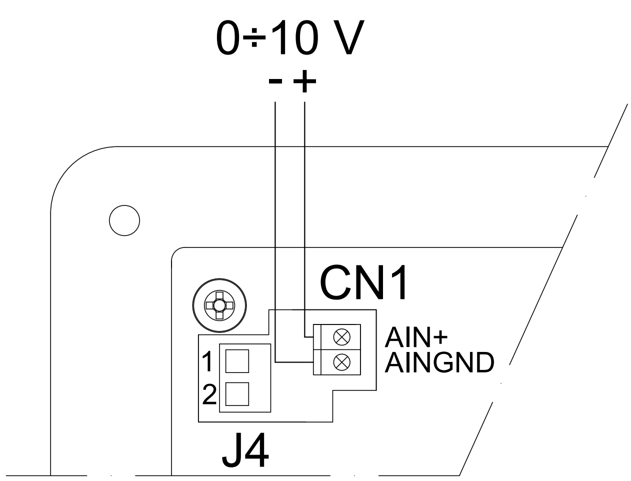
The CCI control panel must be supplied by a safety transformer rated at 230/24 Vac - 50/60 Hz with a power rating of not less than 20 VA (not supplied). This transformer must comply with Standard EN 61558-2-6.
Use a 3x0,75 mm^2 electrical cable and connect it to the terminals of J12 plug on the bottom left (rear side), respecting the polarity shown in Figure 6.3 *p. 22*.
The maximum specified length for this cable is 1 m.

9.2.2 Inputs/Outputs

9.2.2.1 Setpoint request analogue input

CN1 terminal block (Figure 9.1 *p. 34*) is used to connect the 0-10 VDC analogue setpoint request signal from the external control system.
The maximum length of the connecting cables is 10 m.
Figure 9.2 *p. 34* shows the connection diagram.

Figure 9.2 *CCI setpoint request connection*

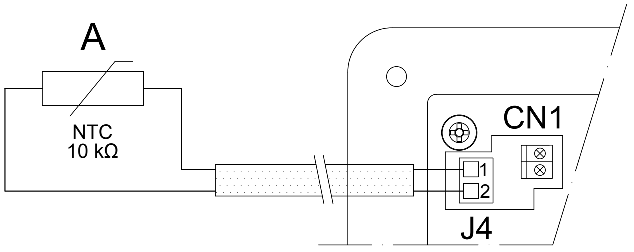


9.2.2.2 Temperature probe input of heating manifold

Analogue input J4 (Figure 9.1 *p. 34*) is used for the heating manifold temperature probe, located on the outlet (or inlet). The

input is of the resistive type NTC 10 kΩ.
The maximum length of the connecting cable is 100 m.
Figure 9.3 *p. 35* shows the connection diagram.

Figure 9.3 *CCI manifold probe connection*



A Temperature probe of the heating manifold (outlet or inlet)

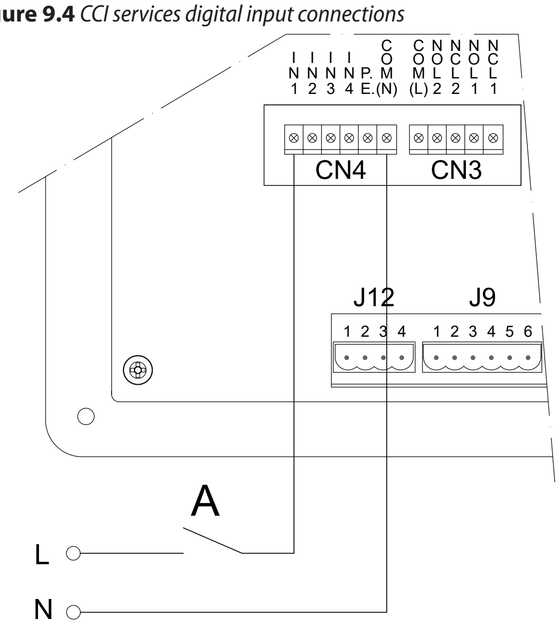
9.2.2.3 External request digital inputs

CN4 terminal block (Figure 9.1 *p. 34*) is used to connect the digital service request signal from the external control system.
The inputs have the following features:

- ► IN1: phase 230 VAC, value 0 V if GAHP is OFF, value 230 V if GAHP is ON.
- ► IN2: phase 230 VAC, value 0 V if heating service, value 230 V if DHW service.
- ► IN3: not used.
- ► IN4: phase 230 VAC, value 0 V if free cooling OFF, value 230 V if free cooling ON.
- ► P.E.: safety earthing.
- ► COM(N): neutral 230 Vac from mains.

The maximum length of the connecting cables is 10 m.
Figure 9.4 *p. 35* shows a connection example for the GAHP start-up contact IN1.
For the other start-up requests, only the contact to be connected changes.

Figure 9.4 *CCI services digital input connections*

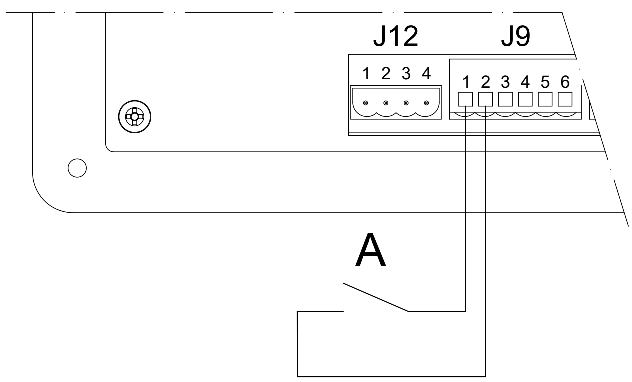


A Request activation from the external control system

9.2.2.4 Auxiliary generator start-up digital input

J9 socket (Figure 9.1 *p. 34*) is used to connect the auxiliary boiler start-up digital signal from the external control system.
The purpose of this contact is to force the GAHP to full power when the external control system activates an auxiliary boiler.
The maximum length of the connecting cables is 10 m.
Figure 9.5 *p. 35* shows the connection diagram.

Figure 9.5 *CCI auxiliary generator digital input connection*



A Auxiliary boiler activation signal from an external control system

9.2.3 CAN bus connections

For the CAN bus connection of the CCI control panel to the appliances, please refer to Paragraph 4.5 *p. 5*.

The CCI control panel cannot be connected:

- ► to GAHP appliances other than GAHP A Plus and GAHP GS/WS Plus, up to a maximum of three
- ► to RB100/RB200 devices
- ► to the DDC control panel

10 OUTDOOR/AMBIENT TEMPERATURE PROBE OSND007

The outdoor temperature probe (available as OSND007 optional) is a passive type remote outdoor temperature probe used as

a reference for climate compensation control.
The probe can also be used as a room temperature probe to detect the temperature inside heated or cooled rooms.
The probe must be used in conjunction with the DDC control panel.
It is not possible to install more than one OSND007 probe per system.

10.1 TECHNICAL SPECIFICATIONS

Figure 10.1 *OSND007 outdoor temperature probe dimensions*

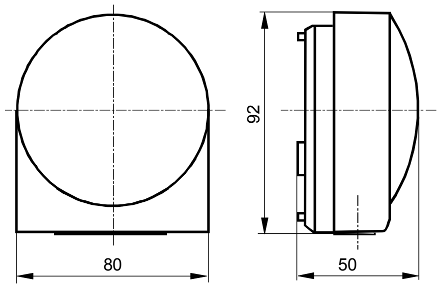
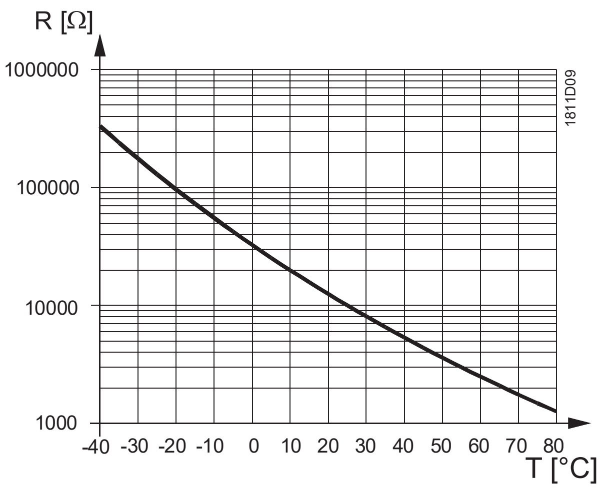


Table 10.1 *OSND007 outdoor temperature probe technical data*

Sensing element	NTC 10k @ 25 °C
Range of use	-40 ÷ +70 °C
Time constant	Ca. 14 min
Protection rating	IP 54

Figure 10.2 *OSND007 resistance values*



R Resistance T Temperature

10.2 INSTALLATION

10.2.1 Use as outdoor temperature probe

Fix the OSND007 outdoor temperature probe on a wall facing north.
Observe a distance of at least 2 metres from heat sources.
Observe a distance of at least 20 meters from sources of electrical noise (power plants, distribution boards, etc.).

10.2.2 Use as room temperature probe

Install the OSND007 probe according to the following guidelines:

- ► Place it inside the heated room, in an area representative of the room temperature, at approximately 1,5 m from the floor, protected from draughts, direct sunlight, and the influence of direct heating sources (lamps, hot air flows, etc.).
- ► Avoid installation on walls bordering the outside, to avoid distortion on the detected temperature and therefore affect system operation. Otherwise, shield the control system by placing a sheet of insulating material (cork, polystyrene or other) between it and the wall.

By following the above guidelines, unwanted starting and stopping of the system can be avoided and optimal comfort in the heated space can be guaranteed.

10.3 CONNECTION

For connecting the OSND007 outdoor probe to the DDC control panel, see Paragraph 6.2.2.3 *p. 23*.

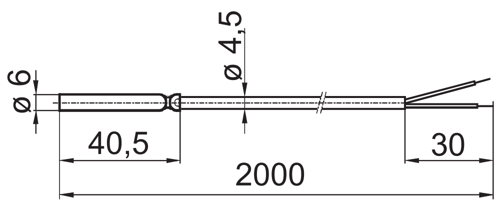
11 OSND004 IMMERSION TEMPERATURE PROBE

11.1 TECHNICAL SPECIFICATIONS

Table 11.1 *OSND004 immersion temperature probe technical data*

Sensing element	NTC 10k @ 25 °C
Range of use	0 ÷ 95 °C
Tolerance	± 0,5 K
Time constant	30 s
Beta value	3977
Cable length	2 m

Figure 11.1 *OSND004 immersion temperature probe dimensions*



11.2 INSTALLATION

The probe must be fixed in a dedicated thermowell, with a length suitable to result immersed in water mass, using thermal paste to ensure a good heat transfer.

11.3 CONNECTION

For connecting the OSND004 probe to the RB200 device, see Paragraph 8.2.2.6 *p. 33*.
For connecting the OSND004 probe to the CCI control panel, see Paragraph 9.2.2.2 *p. 34*.

1 ABSO PRO RANGE CONTROLS AND OPTIONAL ACCESSORIES

For the Abso Pro range, various types of controls are available, depending on the appliance and the required functions.
The appliance may only work if it is connected to a control device, selected from:

1. DDC control panel
2. CCI control panel
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 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 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 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 Plus	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 Plus	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 Plus	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 GA	DDC panel		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 connection of the DDC control panel, see Section C01.10.
Single GAHP Plus/AY	DDC panel		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 connection of the DDC control 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).
Up to 3 GAHP A Plus/ GAHP GS/WS Plus for heating only Link up to 3 GAHP A Plus/GAHP GS/ WS Plus of the same type, for heating only	CCI panel		Modulating management up to a maximum of 3 GAHP A Plus/GAHP GS/WS Plus for heating only, based on the water temperature set on the CCI control panel and the temperature measured by the heating manifold probe. Heating at a fixed water temperature, based on the parameters set on the CCI control panel. Data display and parameters setting. Manifold water temperature probe control. Diagnostics. Errors reset. Possibility to interface with a BMS.For connection of the CCI control panel, see Section C01.10.
Up to 3 GAHP A Plus/ GAHP GS/WS Plus for heating only Link up to 3 GAHP A Plus/GAHP GS/ WS Plus of the same type, for heating only	CCI control panel + external system controller		Modulation management up to a maximum of 3 GAHP A Plus/GAHP GS/WS Plus 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 Plus). Data display and parameters setting. Manifold water temperature probe control. Diagnostics. Errors reset. Possibility to interface with a BMS.For connection of the CCI control panel, see Section C01.10.

Appliance	Control device	Burner	Description
More GAHP/GA/AY Link	DDC panel		Modulating management (of the last GAHP Plus/AY module switched on) and step-by-step management of up to 16 appliances (extendable to 48 using up to 3 DDC modules connected). 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 connection of the DDC control panel, see Section C01.10.

1.1 DDC CONTROL PANEL

The DDC control panel can manage one or more Robur appliances in modulating mode (GAHP heat pumps, AY boilers) or ON/OFF mode (GA chillers).
DDC control panel 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 water pumps,...).
The following Table 1.2 *p. 2* describes the features available with the optional accessories for the DDC control panel.

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.
In-Cloud Monitoring 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

Using the RB100 device, to be combined with the DDC control panel, 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 more information on the RB100 device, please refer to Paragraph 4 *p. 6*.

1.1.2 RB200

Using the RB200 device, to be combined with the DDC control panel, 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 more information on the RB200 device, please refer to Paragraph 5 *p. 6*.

1.1.3 In-Cloud Monitoring System

The In-Cloud Monitoring System collects operating data from appliances connected to the DDC control panel and sends it to the cloud, where it is used for performance analysis and optimisation, which can also be carried out remotely.
The system also allows notifications of any faults on the monitored system to be sent, allowing remote reset.
The data collection device is connected via Modbus protocol to the DDC control panel through the RS 485 port (which will therefore not be available for any other systems that use the Modbus protocol).

For further information on the In-Cloud Monitoring System, please contact Robur technical service.

1.2 CCI CONTROL PANEL

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

1.3 EXTERNAL REQUEST

The appliance can also be controlled by a generic request device (e.g. thermostat, timer, switch, contactor...) fitted with a voltage-free NO contact. This system only allows basic control (on/off, with a fixed setpoint temperature), thus lacking essential system functions of the DDC/CCI control panel. We recommend using it only for simple applications 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 Plus/GAHP GS/WS Plus	CCI + external system controller	OSND004 immersion water temperature probe External system controller

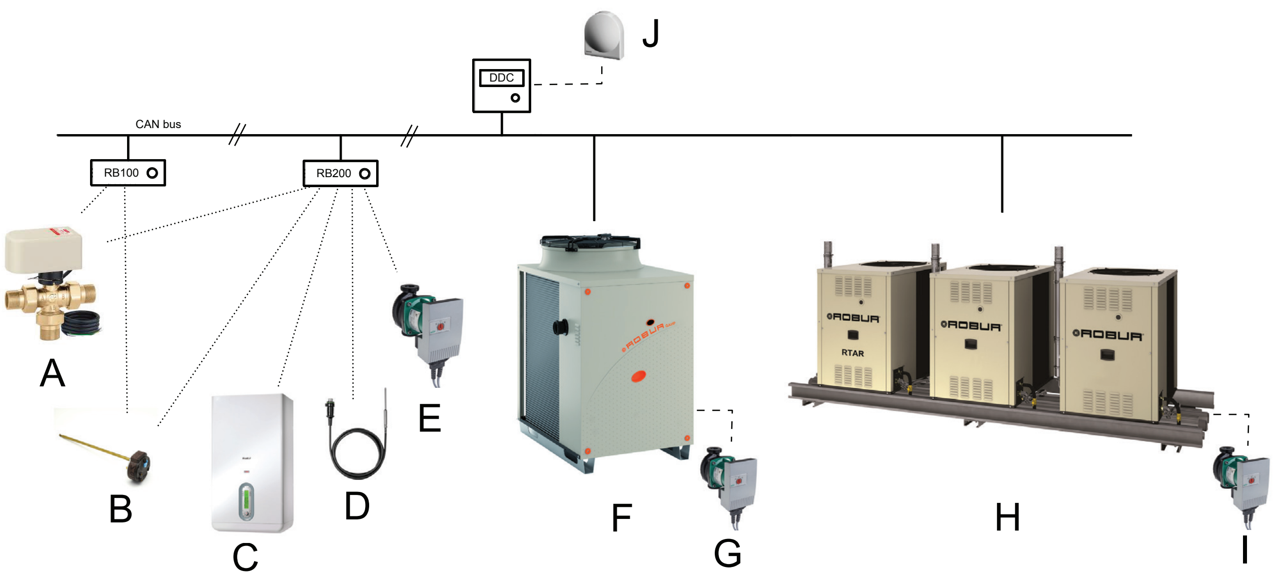
In case of doubt, the Robur technical service is available to identify the most suitable type of control.

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

2 DDC CONTROL PANEL SYSTEM ARCHITECTURE

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

Figure 2.1 *DDC control architecture*



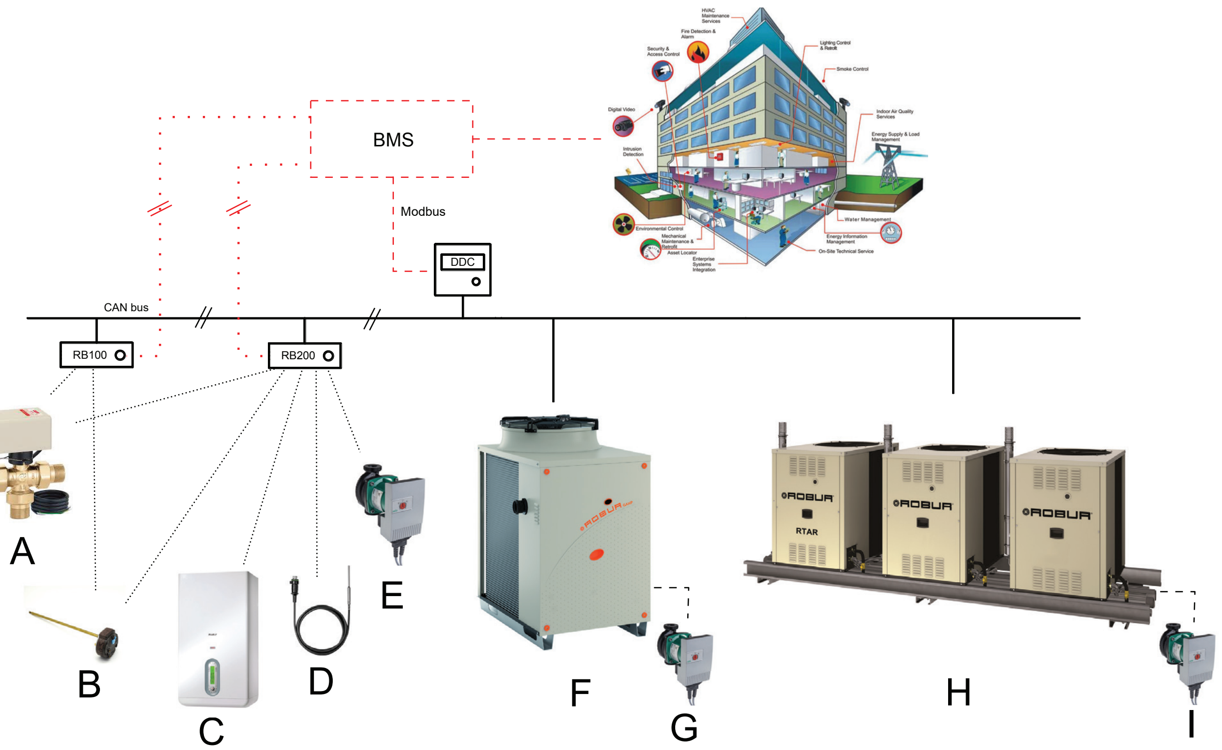
A solid line shows the CAN bus connection between the Robur control devices.
A dotted line shows the connection with analogue/digital signals between the RB100/RB200 devices and the objects that can be controlled with them.
A dashed line shows the connections with analogue/digital signals between DDC 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

The Robur appliances and Robur control devices are always connected via CAN bus connections.
All connections to other devices are made via analogue signals (0-10 V or resistive probe readings) and digital signals.
The diagram shown in Figure 2.2 *p. 4* shows the control system components and the types of connections available when

the DDC control panel and a BMS, SCADA or similar user control system are present.
The connection with the DDC control panel will always be via Modbus protocol, while any analogue/digital signals from the BMS system (functional only if the BMS system does not communicate via Modbus with the DDC control panel) will be connected to the RB100/RB200 devices.
Third-party generators or other system components can be managed by the DDC control panel (using the RB100/RB200 devices) or directly by the BMS system.
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 CONTROL PANEL

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

3.1 MAIN FUNCTIONS

The main functions are:

- Adjustment and control of one (or more) Robur appliances 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 control panel 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 water pumps,...).
Below is a brief description of the main functions of the DDC control panel:

1. The management and control of one (or more) Robur appliances allows you to manage the cascade operation of different types of appliances, giving priority to the most efficient ones.
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

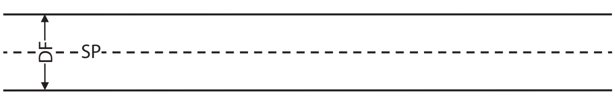
user comfort.

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 allows, both in winter and summer, to supply only the energy required in specific environmental conditions. On the one hand, this avoids wasting energy when the heating/cooling system does not require it. On the other hand, it prevents the appliances from stopping when the exceeded operational limit is reached due to the load applied being too low compared to the temperature set on the DDC control 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 possibility of interfacing with a BMS (or other external supervision and control system) allows the DDC control panel (and the appliances it controls) to be managed via an external device, within more complex and integrated home automation or integrated building/system management systems. In practice, the interface can be implemented either through simple analogue/digital signals or (more comprehensively) through the Modbus protocol, detailed in Paragraph 3.3 *p. 5*.
8. The possibility of coupling to remote monitoring and management systems allows you to collect operating data and any faults from appliances connected to the DDC control panel, remotely modify system settings, receive notifications if faults occur and reset any errors remotely.

3.2 CONTROL AND SETUP

The DDC control panel adjusts the water temperature to maintain it within a range centred on the setpoint.
The width of this band is defined by a parameter (water differential) whose default value is 2 °C (i.e. ±1 K with respect to the setpoint value).
The differential defines the maximum acceptable deviation of water temperature from the setpoint before the control system intervenes.

Figure 3.1 *DDC setpoint and differential*



SP water setpoint DF water differential

To control the system, the DDC control panel manages the switching on and off of the various types of appliances in cascade, adjusting the power supplied to the thermal or cooling load of the system.
For GAHP Plus heat pumps and AY boilers, the last module switched on by the control system can be modulated.
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 control panel can manage the various types of appliances with different logic and parameters.
Within a category, however, appliances have equivalent characteristics.
For all Robur appliances, the categories are already assigned and their properties filled in.
For third-party appliances, this information must be entered based on the characteristics of the specific third-party appliance.
For each category, the **power** of the individual appliance belonging to it is specified.
Each category has a **switch-on priority**, automatically assigned for Robur appliances and user-defined for third-party appliances. This determines the priority of use of appliances belonging to that category.
For each category, the **number of stages** used by the control system is defined, settable in the range from 1 to 10. With independent water pumps, the number of stages typically equals the number of appliances in each category. With common water pumps and high setpoint values, set the number of stages to fewer than the number of appliances. 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 GAHP Plus heat pumps and AY 35 and AY 50 boilers, the last module of the unlocked stage that is switched on is controlled in modulation mode.
- 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 control panel also supports interfacing with external devices via the Modbus RTU protocol in slave mode.
The Modbus protocol can be used to collect the operating data of appliances and systems managed by the DDC control 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 set various operating parameters of the system, such as appliance activation, heating/cooling inversion, setpoint, differential, steps, and operating time slots.

For further information on Modbus mapping implemented in the current version of the DDC control panel, please refer to Paragraph 10.2 *p. 21*.

4 RB100 DEVICE

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:
- analogue type 0-10 V
- digital type (voltage-free contacts)

Requests from external control systems will only be effective if the corresponding service on the DDC control panel is active.

The outputs for driving the valves are digital signals (voltage-free contacts) with the following features:
- maximum voltage 250 Vac
- 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 control panel.

5 RB200 DEVICE

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:
- analogue type 0-10 V
- digital type (voltage-free contacts)

Requests from external control systems will only be effective if the corresponding service on the DDC control panel is active.

The outputs for driving the valves are digital signals (voltage-free contacts) with the following features:
- maximum voltage 250 Vac
- 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 water temperature setpoint of the generator
- 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 control panel.

6 ENGINEERING APPLICATIONS

Through the DDC control panel, combined with the RB100 and RB200 devices if necessary, it is possible to support multiple system configurations.

The control logic resides in the DDC control panel, while the RB100 and RB200 devices act as interface devices 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 setpoints can be set both on the DDC control panel and on the RB100/RB200 devices.

On the DDC control panel, you can also set separate activation time slots for each service.

6.1.1 DDC control panel

The DDC control panel provides two digital inputs for service

requests:
- ► 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 control panel also supports interfacing via Modbus protocol to receive service requests from BMS devices. For further information, see Paragraph 10.2 *p. 21*.

6.1.2 RB100/RB200 devices

The RB100/RB200 devices provide four inputs for service requests, which can be independently configured 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 requests consist of voltage-free contacts, while analogue requests are 0-10 V signals corresponding to the setpoint for the service.
In the case of digital requests, the setpoint for the service is set on the DDC control panel or on the RB100/RB200 device.

Service requests to RB100/RB200 devices do not allow the operating mode to be switched.

6.2 SYSTEM CIRCULATING PUMPS CONTROL

The RB200 device can manage up to five common water pumps (i.e., serving a group of appliances), which are controlled 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

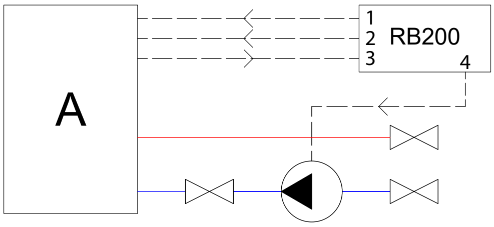
Generally, it is not mandatory to have a water pump on the secondary circuit, and it is not necessary to manage it with the RB200 device. However, if probes are installed on the secondary circuit, it is *recommended* to provide a secondary water pump and configure it on the RB200 device, in order to correctly manage the water flow to the probes themselves, which must be constantly flushed when the system is active.

If third-party appliances are equipped with a directly controlled water pump (i.e. not connected to the RB200 device), then antifreeze protection must be provided by the appliances themselves or appropriate precautions must be taken to protect the system from freezing.

6.3 THIRD PARTY GENERATORS CONTROL

For each RB200 device, up to two third-party generators can be configured and a maximum of eight RB200 devices can be provided for each system.
The signals that the RB200 device can exchange with each third-party generator are shown in Figure 6.1 *p. 7*.

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 will be recorded in the event log of the DDC control panel as a generic error, while details on the type of error will only be available on the generator itself (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 equipped with their controllers for cascade control, it is possible to interface directly with the cascade controller via the RB200 device using the signals described in Figure 6.1 *p. 7*.
In this case, the control system will manage the cascade as if it were a single third-party generator. However, this is not an optimal situation because the cascade controller could generate undesirable behaviour that is not easily predictable.

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 con-

sumers' 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, all of the resistive NTC 10 kΩ type, can be configured on the RB200 device:

- 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

On the RB100 and RB200 devices, two types of valve drive services can be configured:

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

These services are alternative on the RB100 device, while both can 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 Plus		GAHP A Plus	AY			GA ACF		GAHP AR Plus
			GAHP WS Plus	GAHP GS Plus		AY 35	AY 50	AY 100		ACF60-00 LB	
Heating mode											
Heating water flow	minimum	l/h	2000		2000	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	minimum	l/h	2300	-	-	-	-	-	-	-	-
	maximum	l/h	4700	-	-	-	-	-	-	-	-
Renewable source water flow (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), are 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)

For cooling service, only the complement mode is available (both parallel and series plumbing configuration), and it is possible to set the priority between Robur appliances 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 considering 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 the GAHP heat pumps and of the Link, 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.

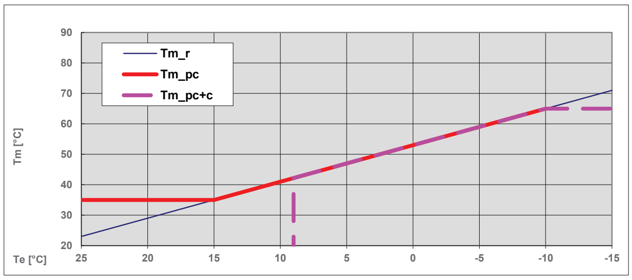
7.1.4 Existing appliances

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 control panel simply according to the efficiency of each type of generator in relation to 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.

Please refer to Table 7.2 *p. 10*, which shows the maximum outlet and inlet temperatures for GAHP heat pumps.

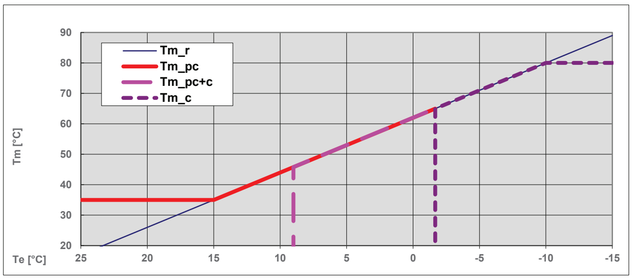
Table 7.2 *Heating and DHW temperature limits*

			GAHP A Plus	GAHP AR Plus	GAHP GS/WS Plus	AY
Heating mode						
Hot water outlet temperature	maximum for heating	°C	65	60	65	-
	maximum for DHW	°C	70	65	70	-
	maximum	°C	-	-	-	88
Hot water inlet temperature	maximum for heating	°C	55	50	55	-
	maximum for DHW	°C	60	60	60	-

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 control panel will then manage situations where the entire thermal load of the building (design output) is covered by the boilers alone. Instead, the GAHP contribute to covering the base load only as long as the required temperatures allow.
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

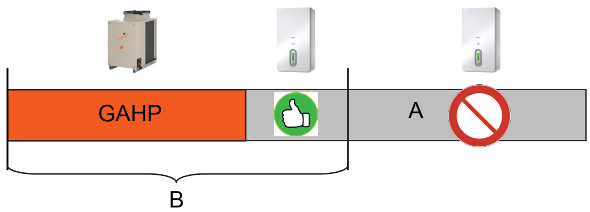
Table 7.3 *Heating curve in heating mode: complement and replacement*

	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 setpoint remains within the operating range of the GAHP, the DDC control panel only activates part of the boilers, so that the total power (GAHP + active boilers) does not exceed the design power; the remaining boilers remain inhibited (Figure 7.3 *p. 10*).

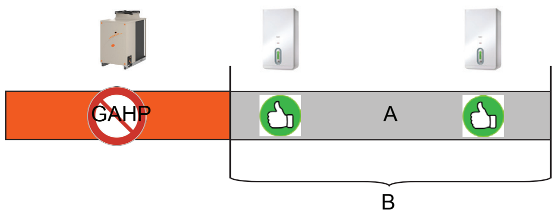
Figure 7.3 *Low temperature operation (integration)*



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.

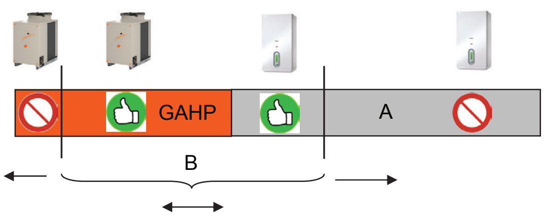
The "complement and replacement" operating mode makes a very simple energy "upgrade" of a building possible: flanking the existing boilers with GAHP in order to cover the base load with them, without touching the boilers themselves in any way, which are left to cover the higher loads, being able to meet 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. 14*.

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, the building must therefore 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 control panel will identify the maximum number of GAHP that can be activated depending on 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 operating mode must also be set in the DDC control panel; in particular, the design thermal load of the building must be defined (which is related to the mobile band B in Figure 7.5 *p. 11*).

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:

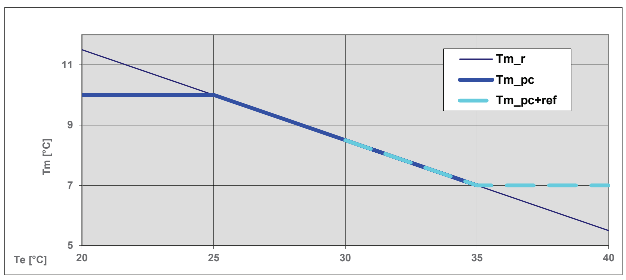
- integration mode (either parallel or series plumbing configuration)
- integration and replacement mode (either parallel or series plumbing configuration)
- integration and progressive replacement mode (series plumbing configuration only)

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

7.6 COOLING: 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 control panel that allows the priority between Robur appliances and third-party chillers to be defined, thereby providing maximum flexibility in assigning the base load to the generators, depending on the specific characteristics of the system.
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 can be achieved by the third-party chiller and the Robur appliances 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 Cooling outlet temperature
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 Cooling outlet temperature

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, under these conditions, can develop a thermal leap well above 10 °C on the system.

8 BLOCK DIAGRAMS OF SYSTEMS FOR CONTROLLING THIRD-PARTY GENERATORS

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. 14*)
- 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.

Third-party generators and system components, such as manifold temperature probes and common water pumps, can only be controlled using the DDC control panel, combined with the RB200 device, as described in Paragraph 1 *p. 1*.

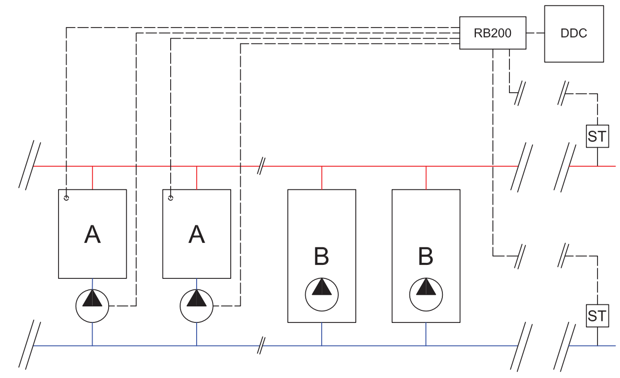
Table 8.1 *p. 12* intentionally refers to the generic secondary S1 (see Paragraph 8.2.1 *p. 14*), without specifying one of the three possible versions, as the combination is possible with any of the three versions. However, the "X" means that the combination cannot be managed by Robur control systems.
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 generator with water pumps controlled by the RB200 device
- a pair of temperature probes on the secondary circuit manifold connected to the RB200 device

Temperature probes connected to the RB200 device are mandatory when using third-party generators.

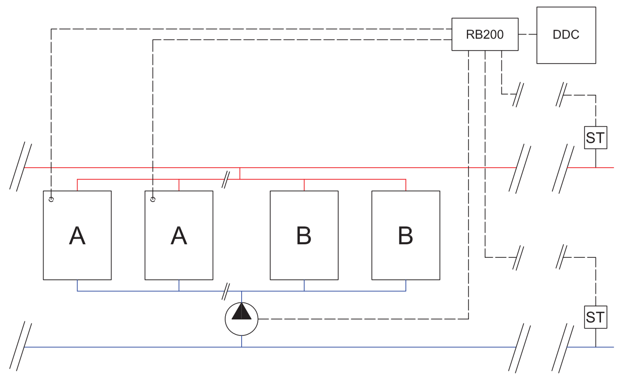
The water pumps of third-party generators are controlled exclusively in on/off mode.

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. 13* shows type P2 primary block, with the following features:

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

Temperature probes connected to the RB200 device are mandatory when using third-party generators.

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

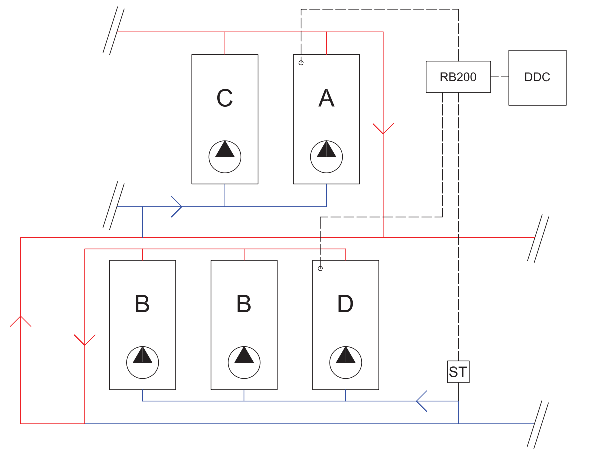
It is not therefore possible to ensure the general setpoint is reached and maintained under any conditions.
With a high outlet setpoint, the GAHP heat pumps may exceed their operating limits to compensate for the mixing that occurs due to inactive appliances. The common water pump configuration should 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
B Robur gas unit heaters
C AY Robur boilers
D Third party chillers
ST GAHP inlet temperature probe

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

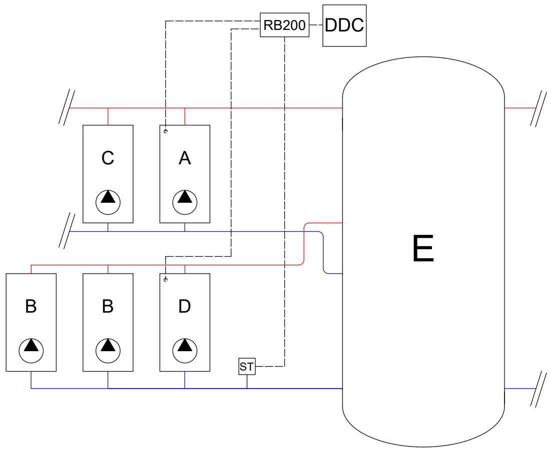
- ► Robur appliances with water pumps controlled by on-board electronics
- ► third-party generators with water pumps controlled by their own on-board electronics
- ► series plumbing configuration
- ► inlet manifold probe for "complement and progressive replacement" function (Paragraph 7.4 *p. 11*)

The temperature probe on the inlet manifold, connected to the RB200 device, 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. 14* 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 temperature probe on the inlet manifold, connected to the RB200 device, 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.

The DDC control panel should receive a signal indicating that the secondary circuit has been deactivated when all deliveries serving it are switched off, ensuring that generation remains active only when there is an actual request.

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

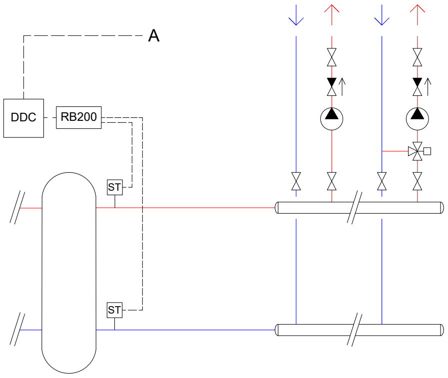
8.2.1 Secondary S1

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*



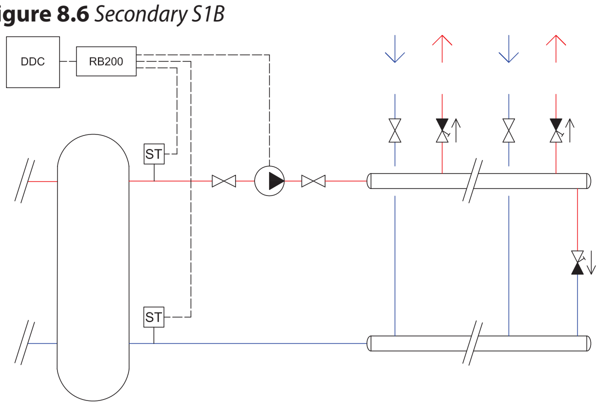
A	Service request signal from secondary circuit management system (not supplied)
ST	Temperature probes on secondary circuit

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 the RB200 device

As explained in Paragraph 8.2 *p. 14*, the user management system should send a digital signal to the DDC control panel to activate or deactivate users, to optimise the operation of the generation system.

Figure 8.6 *Secondary S1B*



ST Temperature probes on secondary circuit

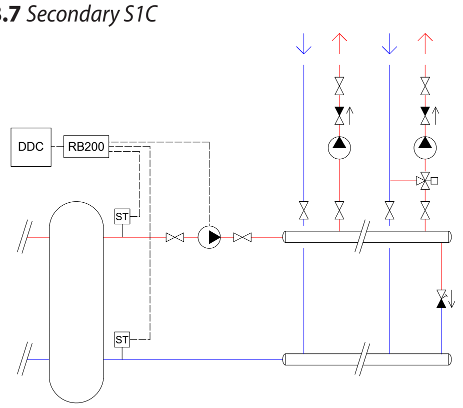
Figure 8.6 *p. 15* shows type S1B secondary block, with the following features:

- 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 the RB200 device

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. 15* 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 by the RB200 device
- hydraulic bypass with balancing valve
- a pair of temperature probes on the secondary circuit manifold connected to the RB200 device

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*

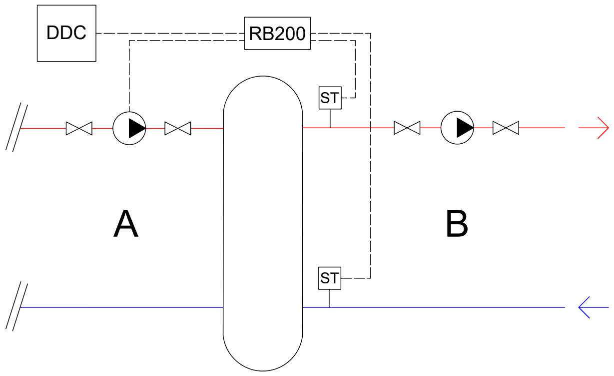


Diagram only applicable for series plumbing configuration with primary type P3 (Paragraph 8.1.3 *p. 13*)

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

The water pump on the tertiary circuit can be controlled using the RB200 device, driving it in parallel with the secondary water pump.

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

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

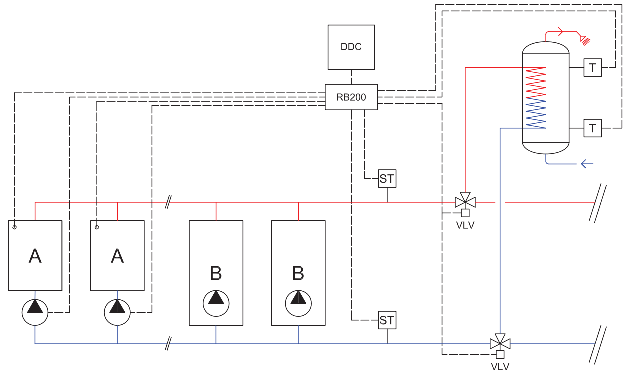
8.3 SEPARABLE CIRCUIT BLOCKS

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

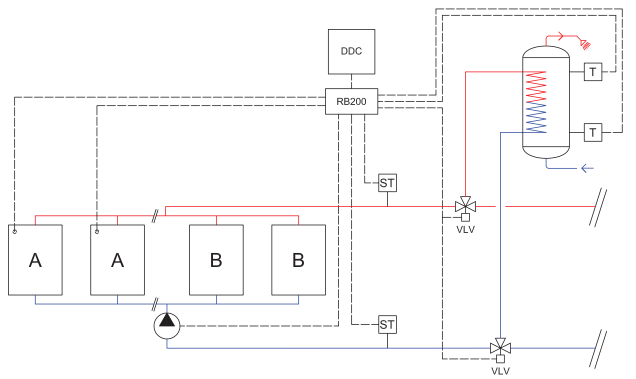
Figure 8.9 *p. 16* shows type A1 separable block, with the following features:
- Robur appliances with water pumps controlled by on-board electronics
- third-party generator with water pumps controlled by the RB200 device
- pair of 3-way diverter valves controlled by the RB200 device
- thermostat(s) in DHW buffer tank for DHW service request
- a pair of temperature probes on the separable circuit manifold connected to the RB200 device

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

Temperature probes connected to the RB200 device are mandatory when using third-party generators.

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. 16* shows type A2 separable block, with the following features:
- Robur appliances and third-party generators with a common water pump controlled by the RB200 device
- pair of 3-way diverter valves controlled by the RB200 device
- thermostat(s) in DHW buffer tank for DHW service request
- a pair of temperature probes on the separable circuit manifold connected to the RB200 device

Temperature probes connected to the RB200 device are mandatory when using third-party generators.

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 a high outlet setpoint, the GAHP heat pumps may exceed their operating limits to compensate for the mixing that occurs due to inactive appliances. 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.

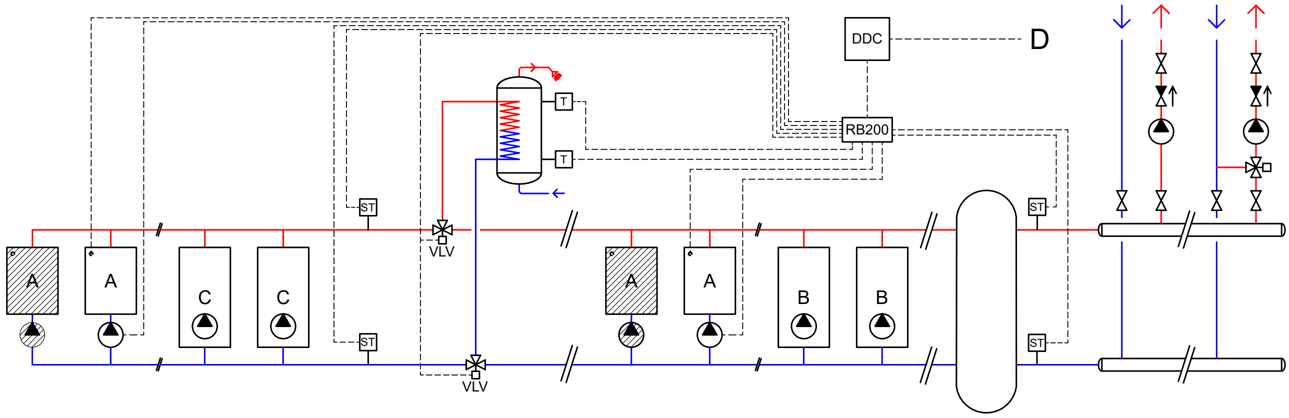
Any water flow modulation must be controlled directly by the circulating pump.

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 respect the original structure of the blocks described in the relevant chapters. Still, they cannot be controlled with a single RB200 device, as (as explained in Paragraph 5 *p. 6*) each RB200 device allows up to two third-party generators to be controlled.

8.4.1 Primary P1 with separable A1 and secondary S1

Figure 8.11 *P1+A1+S1 system*



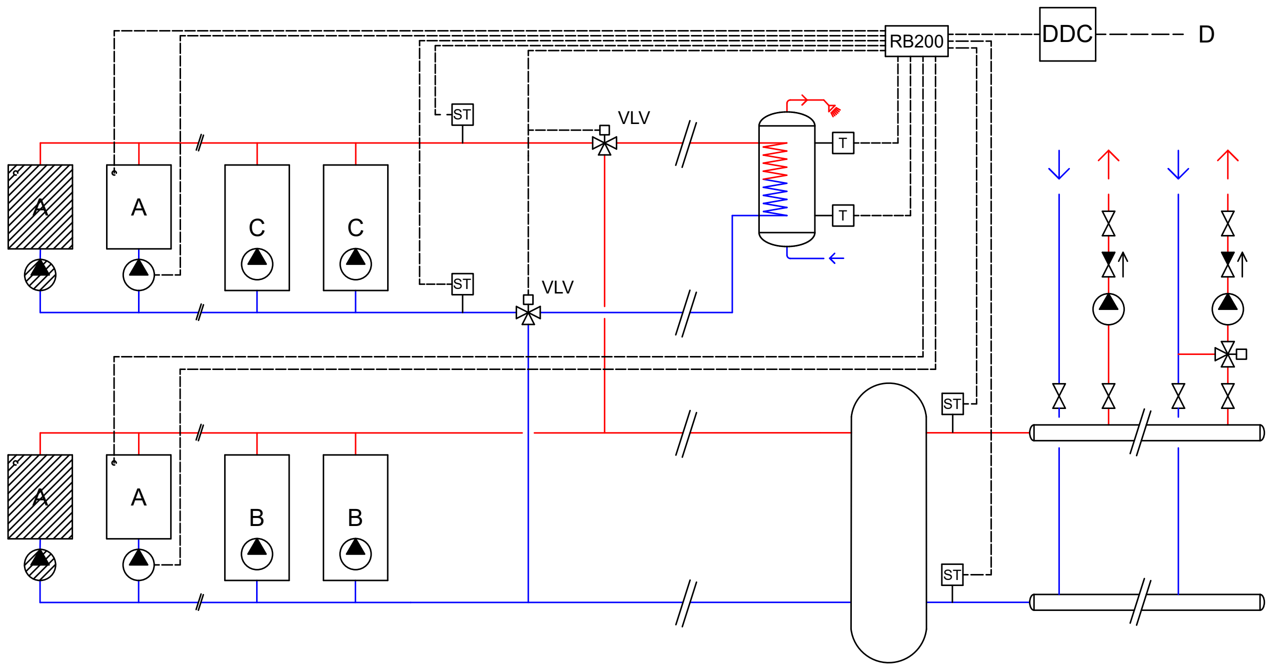
A Third party generators
B Robur gas unit heaters
C GAHP A or AY
D Service request signal from secondary circuit management system (not supplied)
ST Temperature probes of secondary and/or separable circuits
T DHW buffer tank thermostats
VLV Diverter valves

Figure 8.11 *p. 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. 16*).

The probes are placed on both the separable and secondary circuits, and the secondary control system (not supplied) is expected to send a request for operation to the DDC control panel, preventing the generation system from being active while the distribution system is 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. 16*).

In this case, unlike the diagram described in Paragraph 8.4.1 *p. 17*, 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 placed on both the separable and secondary circuits, and the secondary control system (not supplied) is expected to send a request for operation to the DDC control panel, preventing the generation system from being active while the distribution system is off.

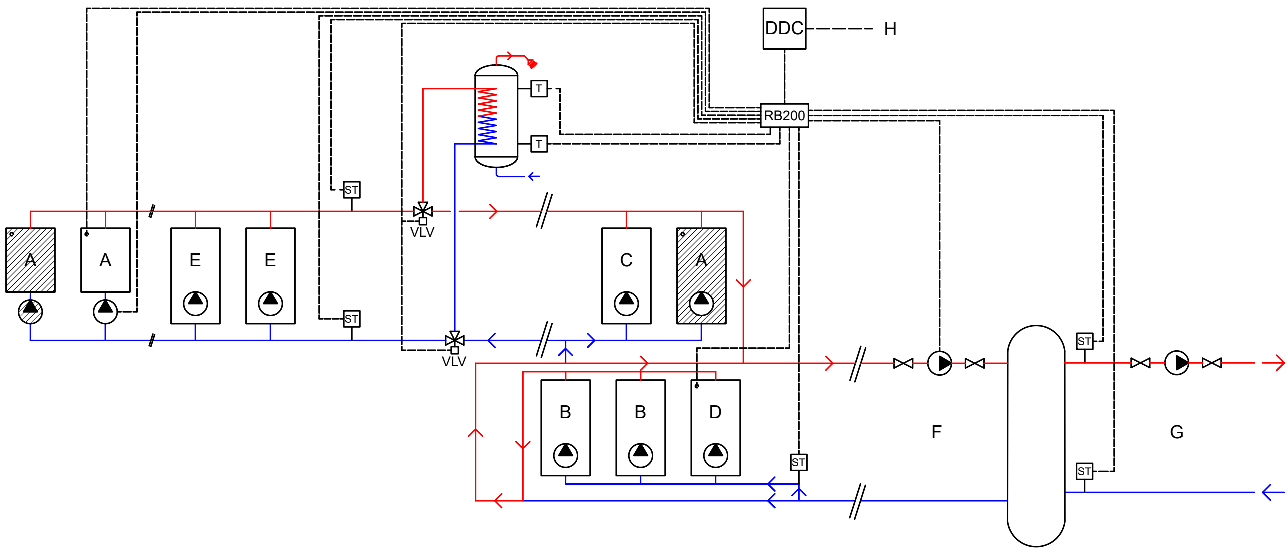
8.4.3 Primary P2 with separable A2 and secondary S1

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. 13*) 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. 16*).

For systems with common water pumps on the generation system, we recommend carefully checking the operating conditions, especially the operating limits of the GAHP/GA appliances, with the help of the Robur technical service.

8.4.4 Primary P3 with separable A1 and secondary S2

Figure 8.13 *P3+A1+S2 system*

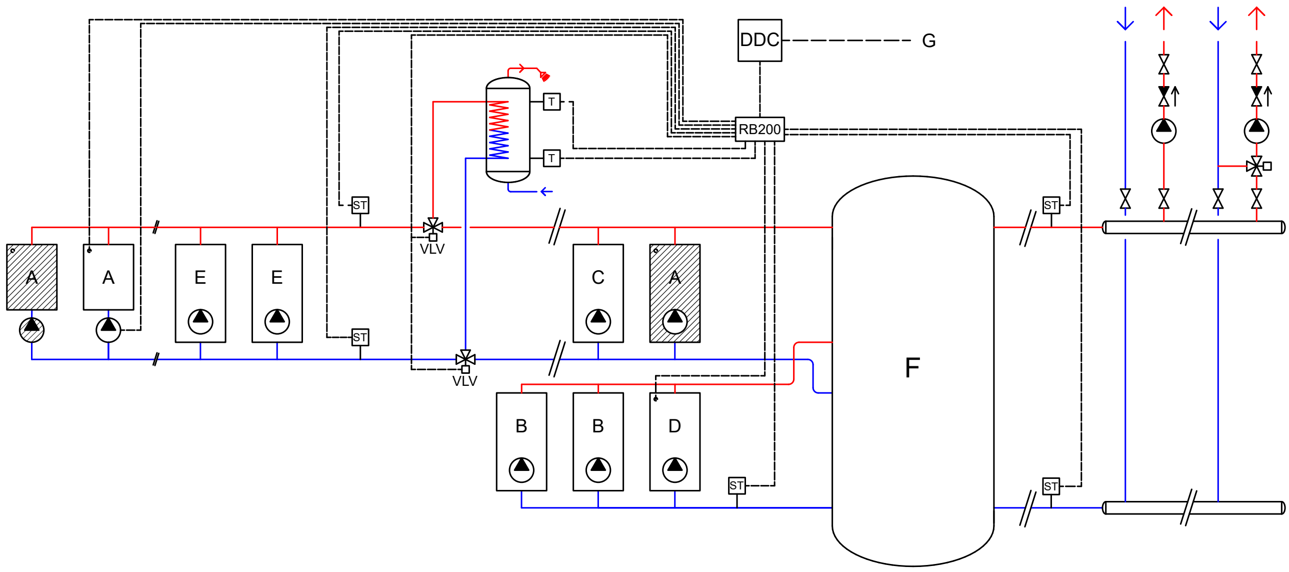


A Third party generators
B Robur gas unit heaters
C AY boilers
D Third party chillers
E GAHP A or AY
F Secondary circuit
G Tertiary circuit
H Service request signal from secondary circuit management system (not supplied)
ST GAHP inlet temperature probe and/or tertiary and/or separable circuit temperature 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. 15*), with the addition (if required) of the separable type A1 (Paragraph 8.3.1 *p. 16*).
The probes are placed on both the separable and secondary circuits (or tertiary if the inertial buffer tank is installed) as well as on the GAHP inlet branch (the latter is only required if you wish to use the "complement and progressive replacement" mode, described in Paragraph 7.4 *p. 11*), and the secondary/tertiary control system (not supplied) is expected to send a request for operation to the DDC control panel, preventing the generation system from being active while the distribution system is off.
The common secondary water pump is controlled via the RB200 device.

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	T	DHW buffer tank thermostats
C	AY00-120 boilers	G	Service request signal from secondary circuit management system (not supplied)	VLV	Diverter valves
D	Third party chillers				

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. 14*) 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. 16*).

The probes are placed on the separable, on the secondary and on the inlet branch to the GAHP (the latter only necessary if you wish to use the "complement and progressive replacement" mode, described in Paragraph 7.4 *p. 11*), and the secondary control system (not supplied) is expected to send a request for operation to the DDC control panel.

9 CCI CONTROL PANEL

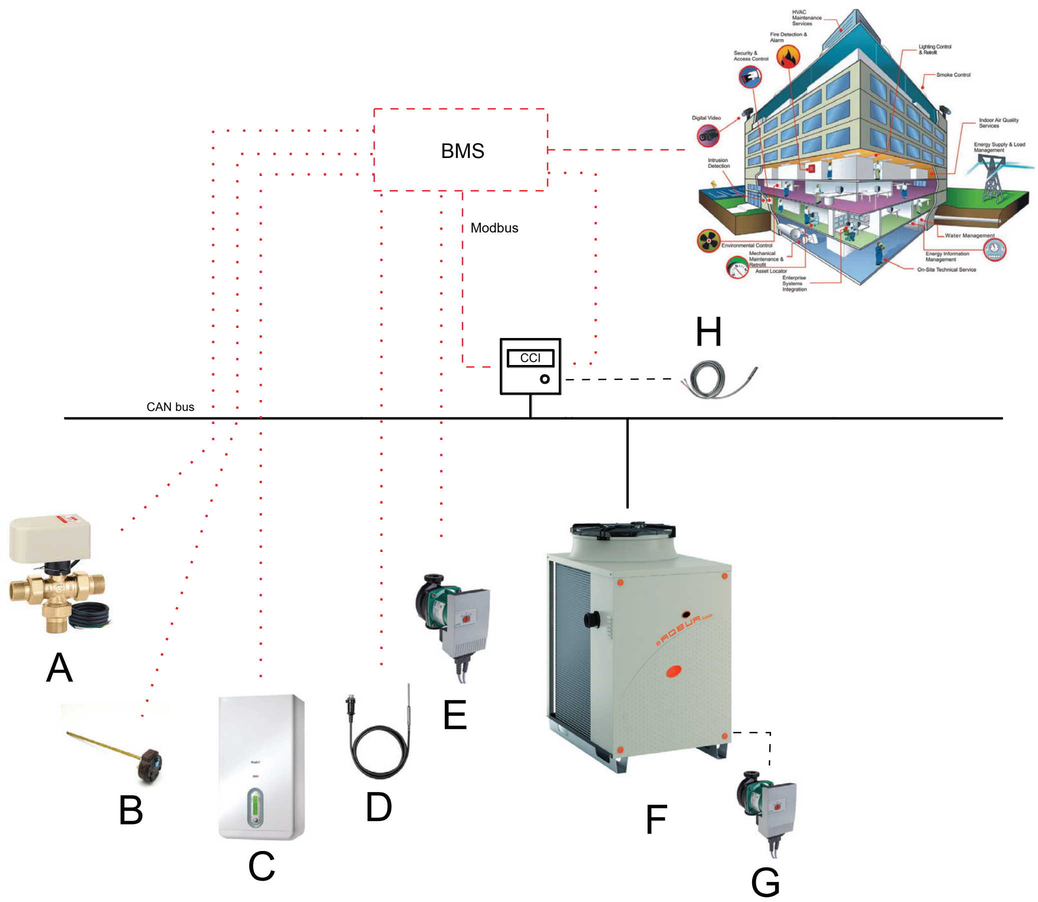
9.1 CCI CONTROL PANEL SYSTEM ARCHITECTURE

The CCI control panel can manage up to three appliances GAHP A Plus or GAHP GS/WS Plus of the same type, in modulating mode (for heating and DHW production) and optional free-cooling (only GAHP GS/WS Plus appliances).

The CCI control panel requires appropriate request signals from an external system, as it is designed to operate in conjunction with a system controller.

The diagram shown in Figure 9.1 *p. 20* shows the control system components and the types of connections available when the CCI control panel and a BMS, SCADA or similar user control system are present.

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

9.2 MAIN FUNCTIONS

The main functions of the CCI control panel are:

1. Adjustment and control of up to three Robur heat pumps (GAHP A Plus or GAHP GS/WS Plus) 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 control panel, coupled to an external system controller, supports the following functions:

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

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

1. The management and control of up to three Robur GAHP A Plus/GAHP GS/WS Plus heat pumps allows the modulating operation of the 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 possibility of interfacing with a BMS (or other external supervision and control system) allows the CCI control panel (and the appliances it controls) to be managed via an external device, within more complex and integrated home au-

tomation or integrated building/system management systems. In practice, the interface can be implemented either through simple analogue/digital signals or (more comprehensively) through the Modbus protocol, detailed in Paragraph 9.3 *p. 21*.

9.3 MODBUS

The CCI control panel also supports interfacing with external devices via the Modbus RTU protocol in slave mode.
The Modbus protocol can be used to collect the operating data of appliances and systems managed by the CCI control 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 set various operating parameters of the system, such as appliance activation, setpoint, and differential.
For further information on Modbus mapping implemented in the current version of the CCI control panel, please refer to Paragraph 10.3 *p. 21*.

9.4 CONTROL AND SETUP

To start the GAHP heat pumps managed by the CCI control panel, an external system controller must activate the request signal on the appropriate input of the CCI control panel.
The water set-point may be fixed or variable.
If a variable setpoint is required, 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 control panel via Modbus (Paragraph 9.3 *p. 21*).
The CCI control panel manages the GAHP heat pumps to adjust the water temperature (measured by the manifold probe connected to the specific input) to the setpoint value.
For heating service, the CCI control panel can modulate the 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 control 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 control panel as for the heating setpoint.
For the DHW service, modulation control is not provided; only on/off mode is available, with the option to specify the number of GAHP heat pumps that can be used for the DHW service, which will be activated at maximum power.

The CCI control panel does not directly manage an auxiliary boiler; instead, it must be managed by the external system controller.

For the free cooling service, by activating the appropriate input for the request, the CCI control panel activates the water pumps on the cold side of the GAHP GS/WS Plus appliances.

For details of the inputs and outputs of the CCI control panel relating to the various services, see Section C01.10.

10 MODBUS MAPPING

Below is some information for Modbus interfacing with the DDC and CCI control panels.
Modbus interfacing with RB100 and RB200 devices is not provided. The relevant data and settings, where available, can be accessed via Modbus from the DDC control 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 DDC CONTROL PANEL

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

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

10.3 CCI CONTROL PANEL

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

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

1 DHW PRODUCTION

Absorption heat pumps may also be used for DHW production, taking into account their specific features, namely:

1. maximum operating temperatures, summarised in Table 1.1 *p. 1* below
2. time required to be fully operational

Table 1.1 *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	-	-

These features are reflected in the need to use the "indirect" (non-instantaneous) mode for DHW production, with a buffer tank that has a suitable exchange surface (tank expressly designed for coupling with heat pumps, Paragraph 2 *p. 1*) and adequate capacity in relation to demand.
For correct operation of heat pumps, it is essential for the exchange surface of the tank to be able to develop a thermal gradient of at least 10 °C in any operating condition.
For the GAHP A and GAHP GS/WS appliances, it is possible to raise the maximum delivery temperature up to 70 °C (maximum return to 60 °C), but halving the thermal input when the temperatures indicated in Table 1.1 *p. 1* are exceeded.
When the power required for DHW is less than 20 kW, it is recommended to provide two independent systems, avoiding the use of GAHP for DHW, as the investment for the DHW buffer tank would not be justified by the savings.

The use of compact buffer tanks for high temperature storage should be avoided.

DHW production in instantaneous mode is not possible.

Use of ACF60-00 HR units for DHW production is only possible in recovery mode. The thermal power is therefore only available in case of simultaneous cooling request. Therefore, the ACF60-00 HR unit cannot be used as the only DHW source.

The permitted number of annual hot/cold inversions of GAHP-AR units is limited. Therefore, the GAHP-AR unit must not be used to meet DHW requests in summer.

2 DHW TANK SIZING

The DHW buffer tank must be sized on the basis of the DHW need established according to design regulations in force.
With regard to the sizing of the exchange coil, the following parameters must be taken into account when coupling it with a GAHP heat pump:

- buffer tank temperature between 45 °C and 50 °C
- coil inlet temperature between 50 °C and 60 °C
- nominal thermal leap 10 °C
- water flow within the operating limits of the GAHP, if the buffer tank is installed on the primary

The minimum recommended surfaces according to buffer tank size are summarised in Table 2.1 *p. 1* below.

Table 2.1 *DHW buffer tank minimum coil surface*

Buffer tank capacity (l)	Coil surface (m2)
300	4,0
400	5,0
500	6,0
800	7,0
1000	8,0

The nominal coil exchange capacity figure published by manufacturers should be used with caution, as this figure usually refers to inlet water at 80 °C and a thermal leap of 20 °C, which is not applicable in the case of heat pumps.

3 DHW SERVICE REQUESTS

DHW service requests may be relayed in two different ways:

- via RB100/RB200 devices via digital or analogue signals (Section C01.10 for the electrical design and Section C01.11 for the description of the operating logic)
- directly to the DDC or CCI panel via Modbus protocol by setting the appropriate registers (Section C1.11) via an external system controller

DHW service requests can be associated with the separation of any separable part of the system, where this has been hydraulically provided for and configured on the relevant control systems.
Temperature control in the DHW tank is performed alternatively with:

- two thermostats in the DHW buffer tank, with adjustable differential, connected directly to RB100/RB200
- temperature probes in the DHW buffer tank, serving an external controller

The DHW production service always has operating priority over the heating service.

3.1 DHW TANK WITH THERMOSTATS

If the DHW buffer tank temperature is controlled by thermostats, it will be necessary to provide two separate thermostats with adjustable differentials, appropriately set to the desired temperatures:

- DHW heating service (or DHW service at reduced temperature)
- anti-legionella disinfection service (or DHW service at comfort temperature)

The digital outputs of these thermostats must be connected to the two digital inputs for DHW available on the RB100/RB200 devices (Section C1.10), setting up the relevant configuration both on the RB100/RB200 devices and on the DDC Panel.

3.2 DHW TANK WITH TEMPERATURE PROBES

If the DHW buffer tank temperature is controlled by means of temperature probes, an external electronic controller must be provided, capable of supplying a 0-10 V signal or a voltage-free contact to the DHW analogue/digital input of the RB100/RB200 devices (Section C01.10), setting the relevant configuration both on the RB100/RB200 devices and on the DDC panel.

The external electronic controller will then take care of both the probe reading and the DHW or anti-legionella service activation logic, including the setpoint and any time schedule.

4 LEGIONELLA DISINFECTION

The Legionella disinfection obligation complies with the regulations in force.

Legionella disinfection may be performed with a number of methods, either physical or chemical.

The most widely used method, despite its poor effectiveness and high energy consumption, remains disinfection by means of thermal shock, which consists of bringing the buffer tank and the distribution and recirculation network to a high temperature (above 55 °C) for at least 1 h.

It is recommended to assure Legionella disinfection with methods other than thermal shock (such as chemical methods, UV lamps or adding ozone) in order to:

- achieve an optimal degree of disinfection (the thermal shock does not operate on system branches where the water is still)
- avoid heavily penalising the efficiency of GAHP appliances

In order to carry out anti-legionella disinfection by means of thermal shock, it may be advisable to have at least one AY or a third-party boiler in the system.

5 INDICATIVE DHW DIAGRAMS

Below are some example diagrams, which are useful to understand the various methods for producing DHW using Robur units.

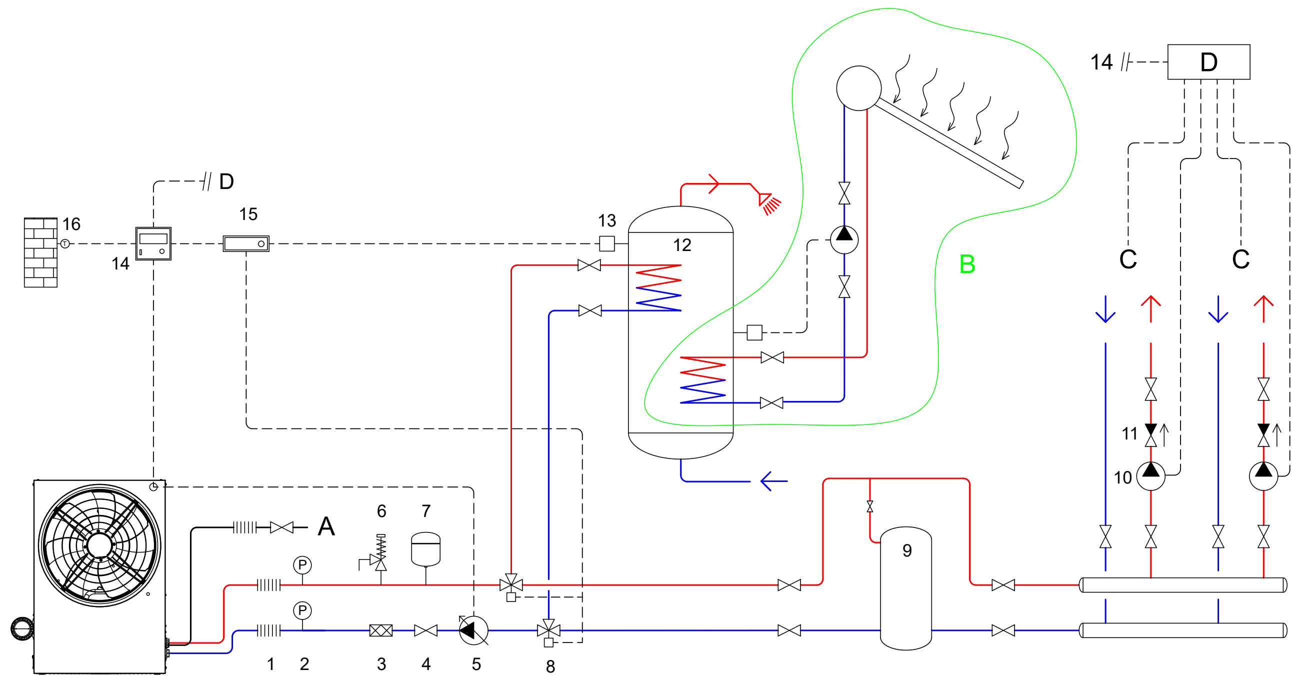
Below are some definitions (taken from Section A01):

- **Separable DHW system** = part of the primary circuit that can be hydraulically separated from the base system part and operate independently. It can assume two states, depending on the position of the three-way diverter valve:
  - Water plumbing connected to the base system (**included** state): in included state this part of the system integrates the space heating service.
  - Disconnected from the base system (**separate** state): in the separate state this part of the system is designated for DHW production, regardless of the service supplied by the base system.
- **Separate DHW system** = part of the primary circuit for the exclusive production of DHW, hydraulically disconnected permanently from the base system.
- **DHW system** = system intended for DHW production.
- **Base system** = part of the primary circuit comprising all generators, excluding those that can be hydraulically separated from it by means of a suitable three-way valve.

5.1 SINGLE GAHP BASE DHW

The diagram shown in Figure 5.1 *p. 3* illustrates the case of a single GAHP A with solar integration in a system for space heating and DHW production only.
Solar thermal integration is useful in the summer season when there are no other heat demands, in order to avoid too short and frequent switching on of the GAHP.
The same schematic diagram is applicable to GAHP GS/WS appliances when used for space heating and DHW production only (provided that the appropriate hydrothermal/geothermal exchange system is in place to supply the renewable thermal energy required to operate the heat pump).

Figure 5.1 *Plumbing diagram for a single GAHP A for heating and base DHW*

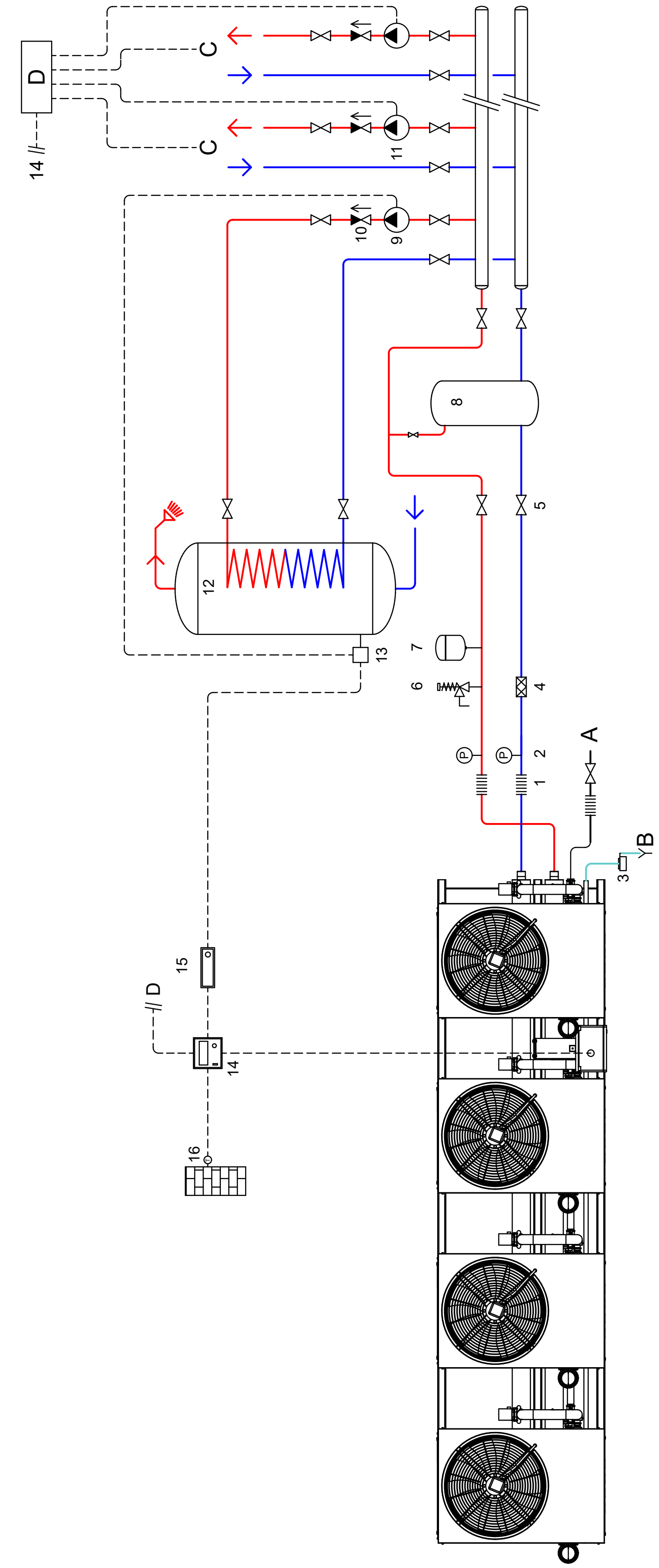


A Gas connection
B Solar thermal integration (not supplied)
C Heating circuit
D Secondary circuit management system
System components:
1 Anti-vibration connection
2 Pressure gauge
3 Sludge filter
4 Shut-off valve
5 Primary circuit water pump (variable flow)
6 Safety valve
7 Expansion tank
8 3-way diverter valves for DHW
9 Buffer tank (and hydraulic separator)
10 Heating circuit water pump
11 Check valve
12 DHW buffer tank
13 Thermostat with adjustable differential for DHW
14 Panel DDC
15 RB100 device
16 Outdoor temperature probe

5.2 MULTI GAHP BASE DHW

The diagram shown in Figure 5.2 *p. 4* illustrates the case of a system with several GAHP A (Link 4AHT heat pumps) in a medium/high power system for space heating and DHW production only.
It is important to point out that in this type of system, with DHW service provided by means of a delivery from the delivery manifold, the manifold itself must always be kept heated in order to meet any DHW demands.
Alternatively, the same thermostat that activates the DHW request must also activate the heating request, so as to switch on the generation system (which will need time to heat up the system's water mass so that the delivery feeding the buffer tank can be fed with water at a sufficient temperature).
The direct connection between the DHW thermostat (detail 13 in Figure 5.2 *p. 4*) and the delivery pump 9 only makes sense if the delivery manifold is actually kept heated at all times. If this is not the case, a system (differential thermostat) should be provided to prevent the start-up of the delivery pump 9 if the temperature difference between the manifold temperature and the temperature in the DHW buffer tank is insufficient for proper heat exchange.
The same schematic diagram is applicable to GAHP GS/WS appliances when used for space heating and DHW production only (provided that the appropriate hydrothermal/geothermal exchange system is in place to supply the renewable thermal energy required to operate the heat pump).

Figure 5.2 *Multi GAHP base DHW*



A Gas connection
B Condensate drain
C Heating circuit
D Secondary circuit management system

System components:

1 Anti-vibration connection
2 Pressure gauge
3 Condensate neutralizer
4 Sludge filter
5 Shut-off valve
6 Safety valve
7 Expansion tank
8 Buffer tank (and hydraulic separator)
9 DHW circuit water pump
10 Check valve
11 Heating circuit water pump
12 DHW buffer tank
13 Thermostat with adjustable differential for DHW
14 Panel DDC
15 RB100 device
16 Outdoor temperature probe

Notes:

- Pump 9 of the DHW circuit must only turn on when the heating system is on

5.3 SEPARABLE DHW

The diagram in Figure 5.3 *p. 5* shows the case of a heating/cooling/DHW system with a Link of heat pumps 2AR 2AY50S 34-174 /4 S consisting of 2 GAHP-AR S reversible heat pumps and 2 separate AY 50 boilers, both connected to the rear manifold pair. Pay attention to the appropriate neutralisation and drainage of condensate in accordance with the applicable standards.
On the separable DHW circuit, there is no safety valve as this is already present inside the AY boiler and also acts on this circuit branch.
DHW production is assured by:

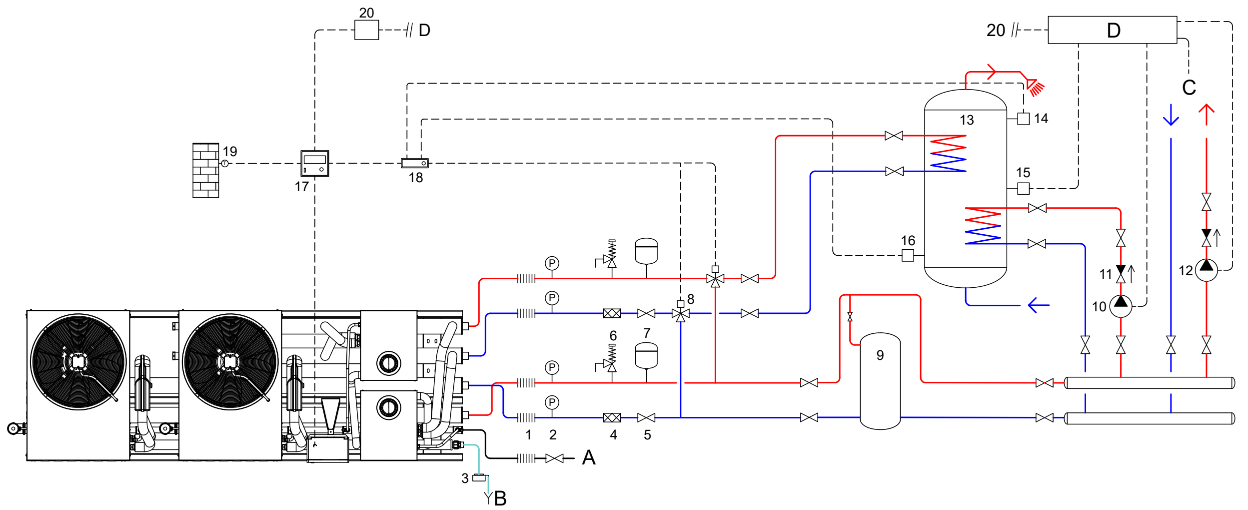
- ► to a preheating delivery from the secondary manifold
- ► to boiler separation

Preheating spillage must only be turned on if:

- ► the temperature in the manifold is suitable for proper heat exchange in the DHW buffer tank
- ► the system is active in heating mode

The winter preheating must be designed to work with a thermal leap greater than 10 °C, so as not to risk excessive heating of the inlet to GAHP, which would result in switching them off due to exceeded operational limit.
It is recommended to provide a system (differential thermostat) to prevent the start-up of the delivery pump 10 if the temperature difference between the manifold temperature and the temperature in the DHW buffer tank is insufficient for proper heat exchange.
If there is a separable DHW request from thermostat 14, the boilers will be switched on with the DHW service setpoint (set on the DDC panel or RB100 device) and the diverter valves 8 will be switched.
The diagram also supports anti-legionella thermal disinfection, again by activating a separable DHW request from thermostat 16, with a dedicated setpoint (set on the DDC panel or RB100), suitably scheduled on the DDC panel.
If the DHW requirement and the heating power are high, one may decide to use a separate preheating tank.
The same schematic diagram is more generally applicable to all systems in which there is at least one boiler (Robur or third-party, for the latter case, see Section C01.11) on the separable circuit.

Figure 5.3 *Plumbing diagram for separable DHW*



A Gas connection
B Condensate drain
C Heating/Cooling circuit
D Secondary circuit management system
System components:
1 Anti-vibration connection
2 Pressure gauge
3 Condensate neutralizer
4 Sludge filter
5 Shut-off valve
6 Safety valve
7 Expansion tank
8 3-way diverter valves for DHW
9 Buffer tank (and hydraulic separator)
10 DHW winter preheating water pump
11 Check valve
12 Heating/Cooling circuit water pump
13 DHW buffer tank
14 Thermostat with adjustable differential for DHW
15 Thermostat with adjustable differential for DHW preheating
16 Thermostat with adjustable differential for Legionella function
17 Panel DDC
18 RB100 device
19 Outdoor temperature probe
20 Summer/winter selector switch

Notes:

- Activation of the DHW preheating pump 10 should only occur if the temperature difference between manifold and buffer tank is sufficient for proper heat exchange on the preheating coil
- DHW preheating pump 10 must be turned off in summer

5.4 SEPARABLE DHW WITH HEAT RECOVERY

The diagram in Figure 5.4 *p. 7* shows the case of a heating/cooling/DHW system with a Link of heat pumps 2AR 2HR 1AY100S 69-216 /6 S, consisting of 2 GAHP-AR S reversible heat pumps, 2 ACF60-00 HR S chiller-heaters with heat recovery and a AY 100 boiler on the separate circuit.

DHW production is assured by:

- to a preheating delivery from the secondary manifold
- to the preheating from the recovery of ACF60-00 HR freely available during summer cooling
- to AY 100 boiler separation

Preheating spillage must only be turned on if:

- the temperature in the manifold is suitable for proper heat exchange in the DHW buffer tank
- the system is active in heating mode

Manual switching of selector switch 21 when switching from heating to cooling will activate the request to the heat recovery exchanger via thermostat 15 and thus carry out preheating with free heat from the heat recovery.

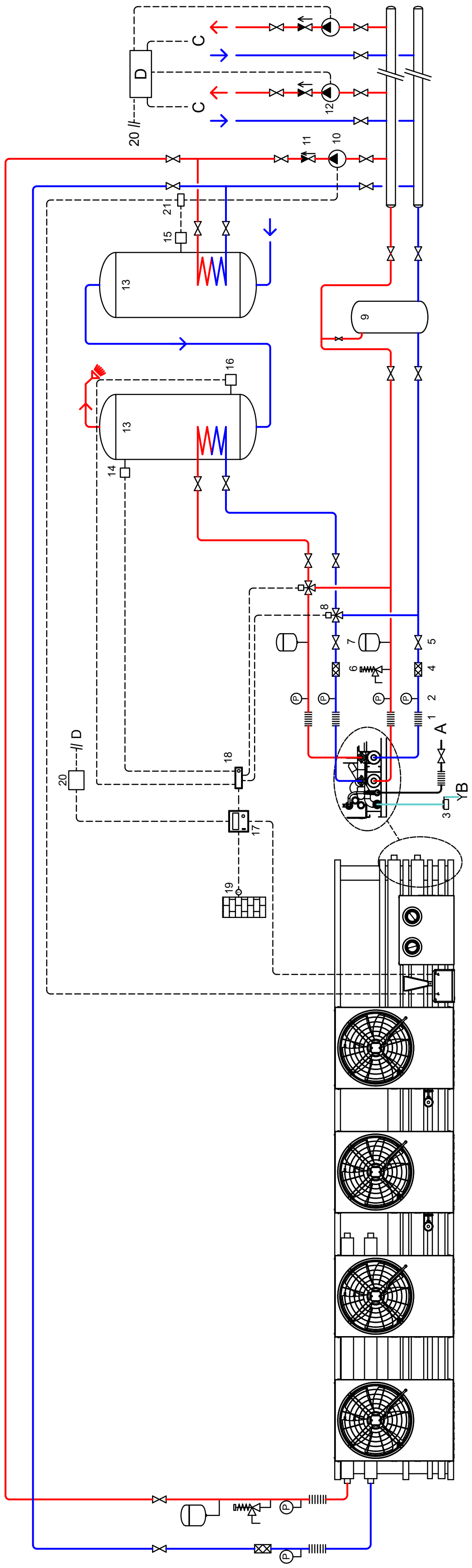
The winter preheating must be designed to work with a thermal leap greater than 10 °C, so as not to risk excessive heating of the inlet to GAHP, which would result in switching them off due to exceeded operational limit.

If there is a separable DHW service request from thermostat 14, the AY 100 boiler will be activated with the setpoint for DHW service (set on the DDC panel or RB100 device) and diverter valves 8 will be switched.

The diagram also supports anti-legionella thermal disinfection, also by activating a separable DHW request from thermostat 17, with a dedicated setpoint (set on the DDC panel or RB100), with a dedicated schedule on the DDC panel.

The same schematic diagram is more generally applicable to all systems in which there is at least one boiler (Robur or third-party, for the latter case, see Section C01.11) on the separable circuit and a ACF60-00 HR chiller-heater.

Figure 5.4 *Plumbing diagram for separable DHW with heat recovery*



- A Gas connection
- B Condensate drain
- C Heating/Cooling circuit
- D Secondary circuit management system

System components:

- 1 Anti-vibration connection
- 2 Pressure gauge
- 3 Condensate neutralizer
- 4 Sludge filter
- 5 Shut-off valve
- 6 Safety valve
- 7 Expansion tank
- 8 3-way diverter valves for DHW
- 9 Buffer tank (and hydraulic separator)
- 10 DHW winter preheating water pump
- 11 Check valve
- 12 Heating/Cooling circuit water pump
- 13 DHW buffer tank
- 14 Thermostat with adjustable differential for DHW
- 15 Thermostat with adjustable differential for DHW preheating
- 16 Thermostat with adjustable differential for Legionella function
- 17 Panel DDC
- 18 RB100 device
- 19 Outdoor temperature probe
- 20 Summer/winter selector switch
- 21 Thermostat signal summer/winter switch

Notes:

- Activation of the DHW preheating pump 10 should only occur if the temperature difference between manifold and buffer tank is sufficient for proper heat exchange on the preheating coil
- DHW preheating pump 10 must be turned off in summer
- The summer/winter selector switch 21 will enable thermostat 15 to activate the heat recovery exchanger request to ACF60-00 HR chiller-heaters in summer

1 PREMISE

Some example plumbing and electrical diagrams of possible applications of the Robur appliances and their controls are shown below.

The diagrams shown are for design purposes only and are not valid for installation purposes.

For more details on plumbing design please refer to Section C01.03. For more details on electrical design refer to Section C01.10.

The Robur technical service is available for customised advice on specific plumbing and control configurations.

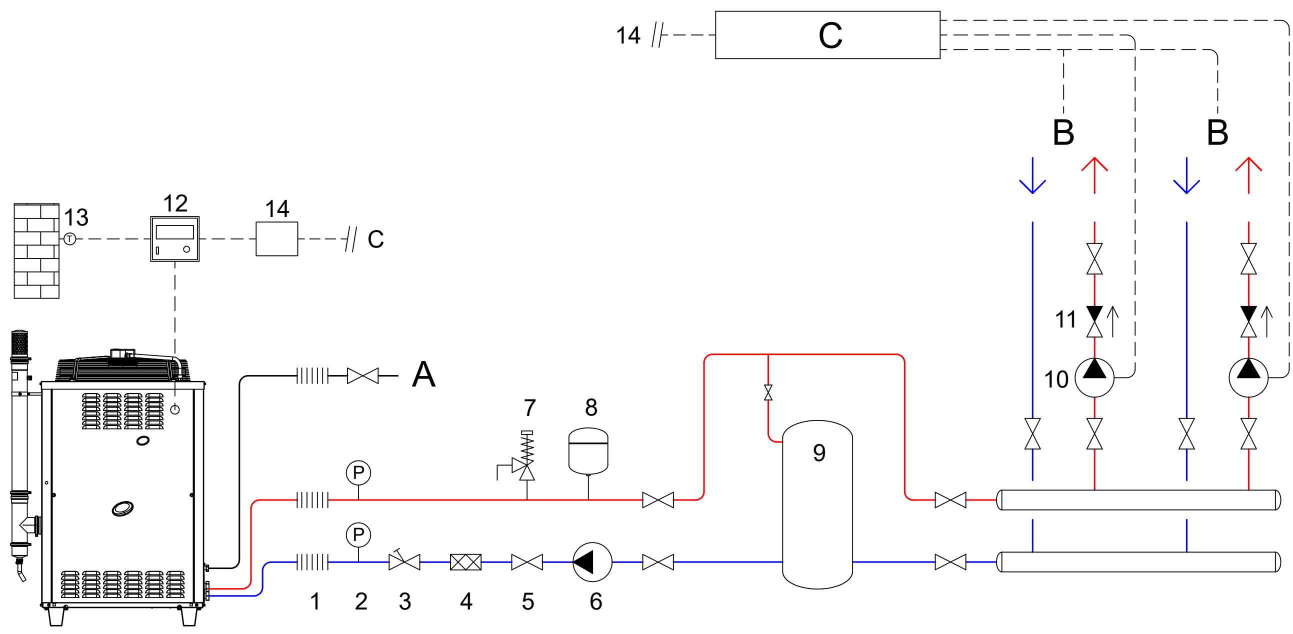
2 HEATING/COOLING WITH GAHP-AR

2.1 DESCRIPTION

The plumbing diagram in Figure 2.1 *p. 1* shows the use of a single GAHP-AR for heating and cooling, coupled to a primary/secondary system with a 3-pipe hydraulic separator.
The control system also includes a secondary circuit management system capable of transmitting a heating/cooling service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits switched off.
The activation signal goes through a summer/winter selector switch as the GAHP-AR is a reversible heat pump and it is therefore necessary that the request comes alternately for either heating or cooling. The DDC configuration must be consistent with this management.

2.2 PLUMBING DIAGRAM

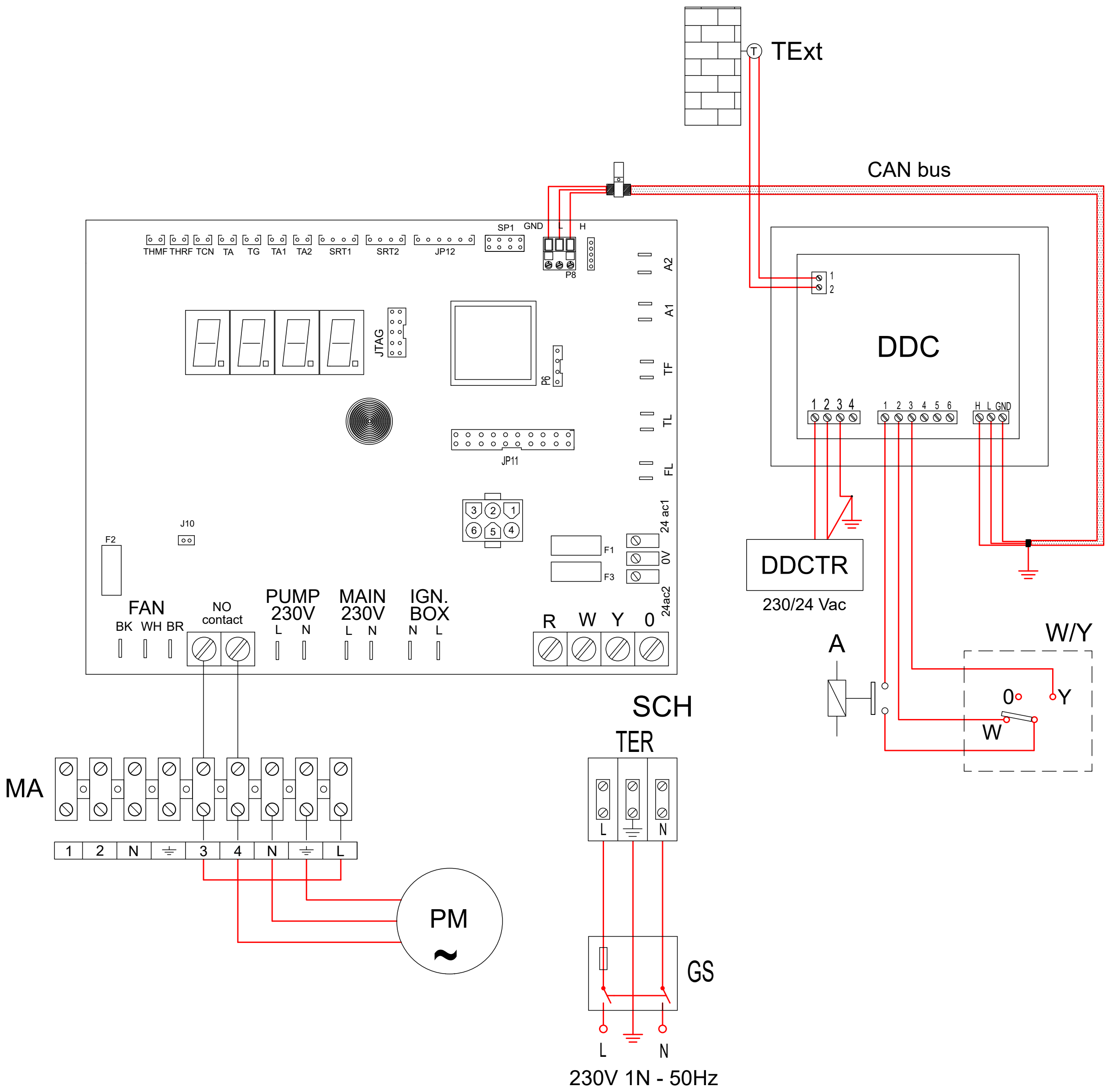
Figure 2.1 *Plumbing diagram for a single GAHP-AR for heating and cooling*



The flow regulation valve must only be used if the pump in the primary circuit is the fixed flow type
A Gas connection
B Heating/Cooling circuit
C Secondary circuit management system
1 Anti-vibration connection
2 Pressure gauge
3 Flow regulation valve
4 Sludge filter
5 Shut-off valve
6 Primary circuit water pump
7 Safety valve
8 Expansion tank
9 Buffer tank (and hydraulic separator)
10 Heating/Cooling circuit water pump
11 Check valve
12 Panel DDC
13 Outdoor temperature probe
14 Summer/winter selector switch

2.3 ELECTRICAL WIRING DIAGRAM

Figure 2.2 *Wiring diagram for a single GAHP-AR for heating and cooling*



A External request
DDC DDC panel
SCH GAHP electronic board
TER terminal block
L-(PE)-N Phase/earth/neutral GAHP power supply
MA terminal block
N-(PE)-L Neutral/earth/phase of water pump power supply
3-4 Water pump request
CAN terminal block
GND Common data
L Data signal LOW
H Data signal HIGH
Components NOT SUPPLIED
DDCTR Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA
PM Water pump < 700 W
TExt Outdoor temperature probe
W/Y Heating/Cooling switch (winter/summer)
- Position W to turn heating on
- Position Y to turn cooling on
- Position 0 for system off

3 HEATING WITH GAHP GS WITH GEOTHERMAL PROBES

3.1 DESCRIPTION

The plumbing diagram in Figure 3.1 *p. 3* shows the use of a single GAHP GS HT for heating, coupled to a primary/secondary system with a 3-pipe hydraulic separator and geothermal probes.
If required by local regulations, a heat exchanger may be placed before the geothermal exchange system to avoid sending any glycol water into the ground.
The geothermal exchange system can be realised with either vertical probes, horizontal exchange systems or energy piles.
The correct design of the geothermal exchange system is critical to the operation and performance of the geothermal heat pump. It is recommended to refer to technicians specialised in the design and implementation of geothermal exchange systems for heat pump applications.

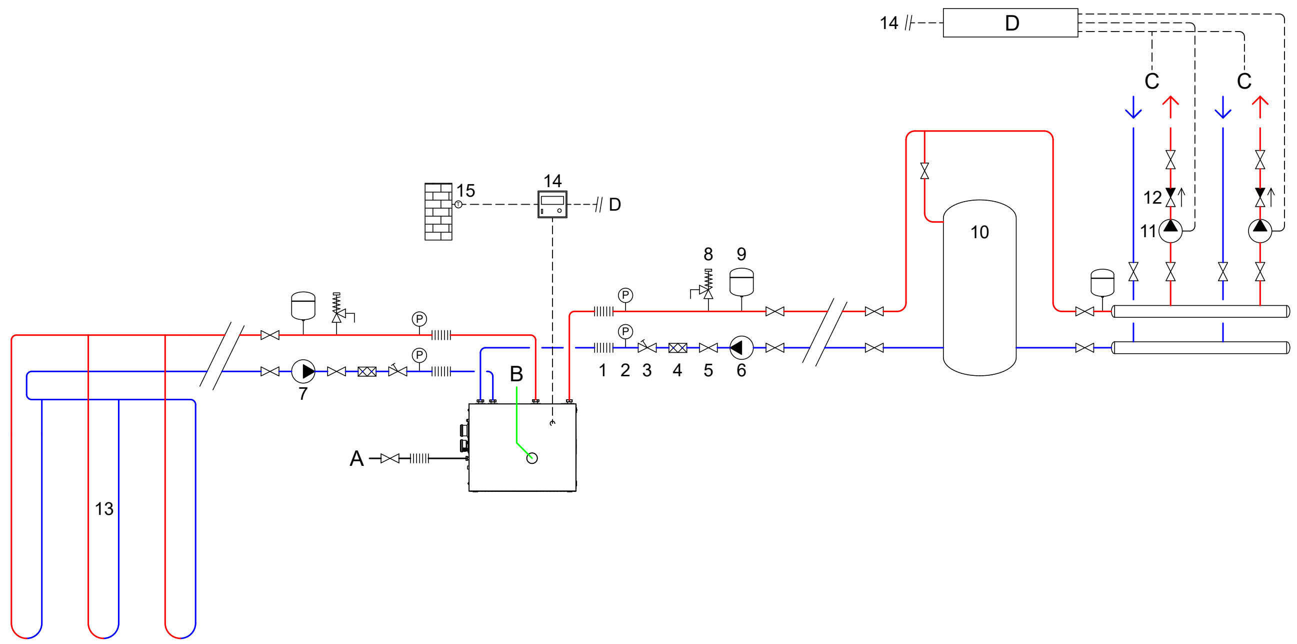
The Robur technical service is available to provide designers of the geothermal system with any information about the GAHP GS HT appliance that may be needed for design purposes.

In the wiring diagram, the water pumps are operated at constant flow. If you wish to operate the water pump at variable flow on the system side (on the renewable source side the water pump is always operated at constant flow) refer to Section C01.10 for the relevant electrical connections.

The control system also includes a secondary circuit management system capable of transmitting a heating service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits switched off.

3.2 PLUMBING DIAGRAM

Figure 3.1 *GAHP GS plumbing diagram*



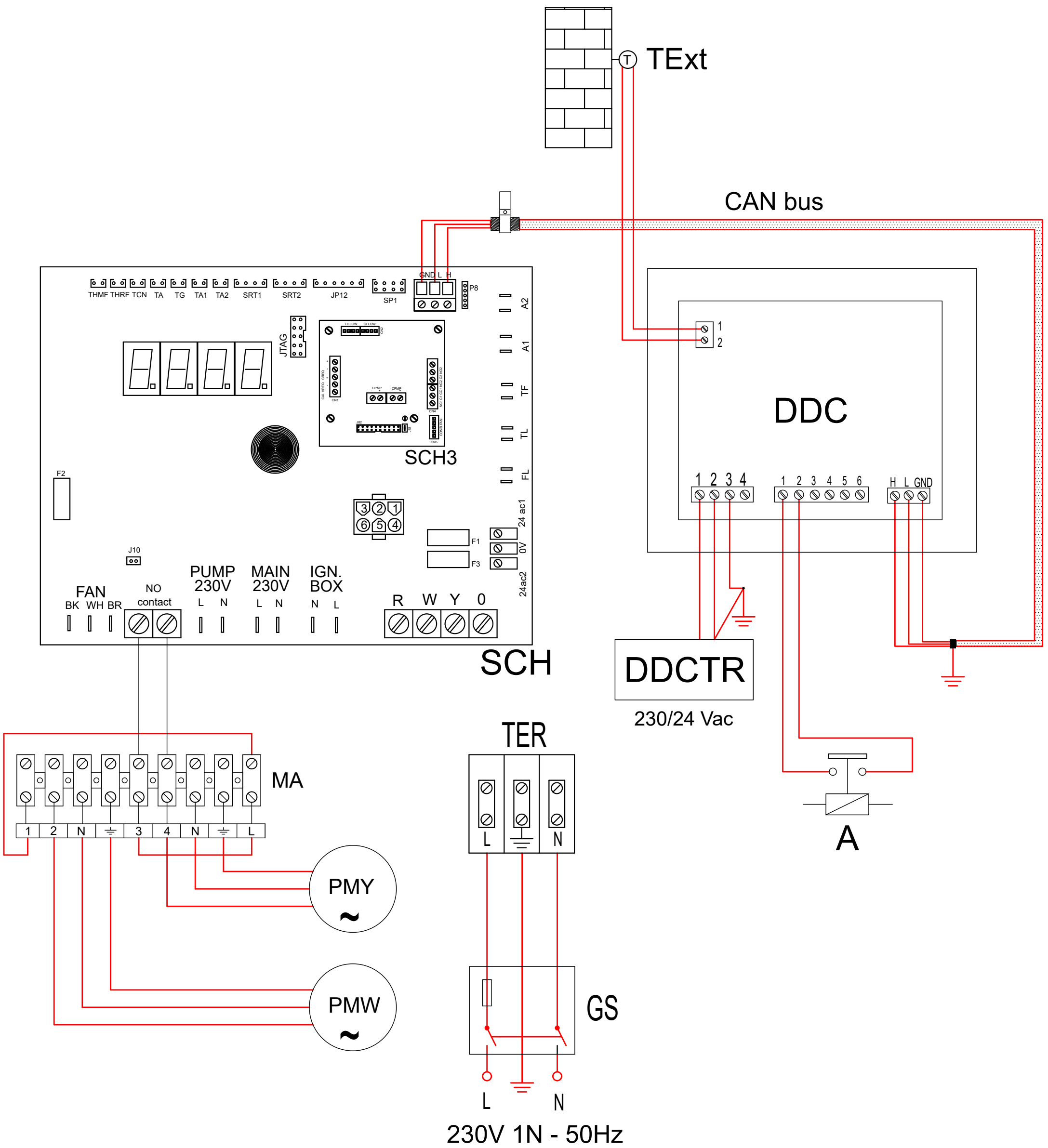
The flow regulation valve must only be used if the pump in the primary circuit is the fixed flow type
A Gas connection
B Safety valve drain ducting connection (indoor version only)
C Heating circuit
D Secondary circuit management system

1 Anti-vibration connection
2 Pressure gauge
3 Flow regulation valve
4 Sludge filter
5 Shut-off valve
6 Primary circuit water pump on system side
7 Primary circuit water pump on renewable source side

8 Safety valve
9 Expansion tank
10 Buffer tank (and hydraulic separator)
11 Heating/Cooling circuit water pump
12 Check valve
13 Geothermal field probes
14 Panel DDC
15 Outdoor temperature probe

3.3 ELECTRICAL WIRING DIAGRAM

Figure 3.2 *Wiring diagram for a single GAHP GS/WS for heating*



A External heating request
DDC DDC panel
SCH GAHP electronic board
TER terminal block
L-(PE)-N Phase/earth/neutral GAHP power supply
MA terminal block
N-(PE)-L Neutral/earth/phase of water pump power supply
1-2 Water pump request on system side
3-4 Water pump request on renewable source side
CAN terminal block
GND Common data
L Data signal LOW
H Data signal HIGH

Components NOT SUPPLIED
DDCTR Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA
TExt Outdoor temperature probe
PMW System-side water pump < 700 W
PMY Renewable source side water pump < 700 W

4 HEATING WITH GAHP WS WITH GROUND WATER

4.1 DESCRIPTION

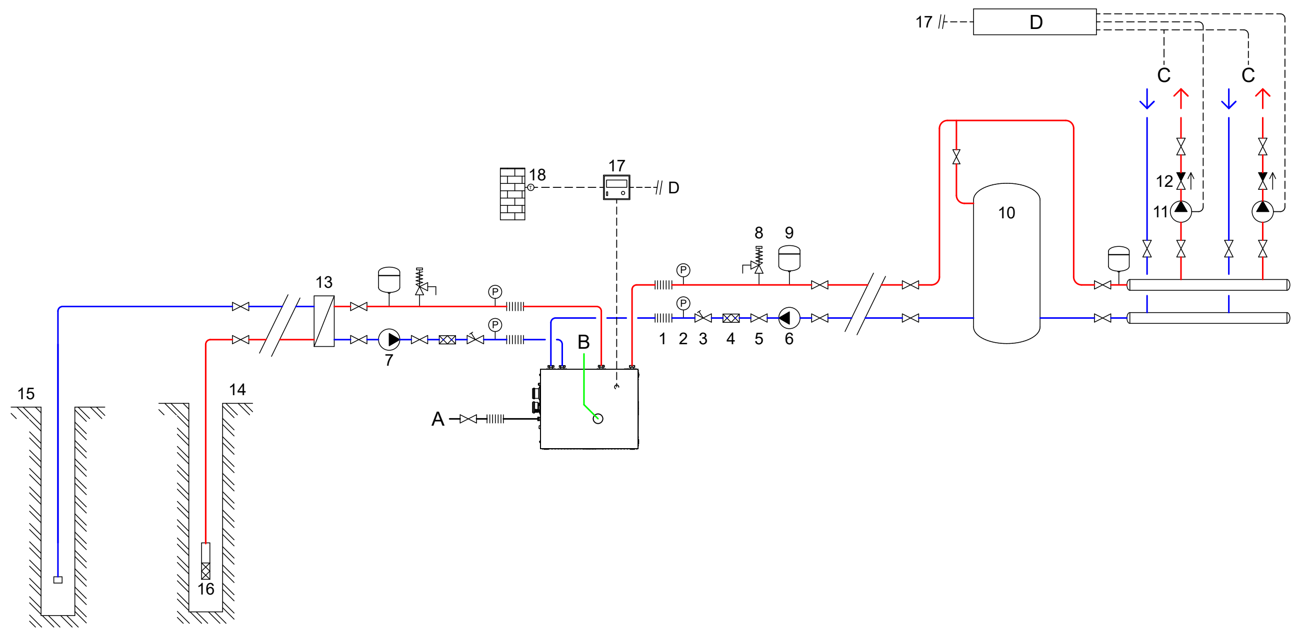
The plumbing diagram in Figure 4.1 *p. 5* shows the use of a single GAHP WS for heating, coupled to a primary/secondary system with a 3-pipe hydraulic separator and energy recovery from ground water with a heat exchanger (mandatory) with water return well.
The exchange system with the hydrothermal energy source can be realised either by means of wells or surface aquifer systems (lakes, rivers). The use of the interposed heat exchanger is however mandatory.
In the case of the construction of water extraction wells, check that the well has the authorisation to draw the required flow for the operation of the GAHP WS heat pump.
The water return well is generally not compulsory, unless otherwise specified in local regulations, which must be complied with.
The Robur technical service is available to provide designers of the exchange system (wells, heat exchangers) with any information about the GAHP WS appliance that may be needed for design purposes.

In the wiring diagram, the water pumps are operated at constant flow. If you wish to operate the water pump at variable flow on the system side (on the renewable source side the water pump is always operated at constant flow) refer to Section C01.10 for the relevant electrical connections.

The control system also includes a secondary circuit management system capable of transmitting a heating service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits switched off.

4.2 PLUMBING DIAGRAM

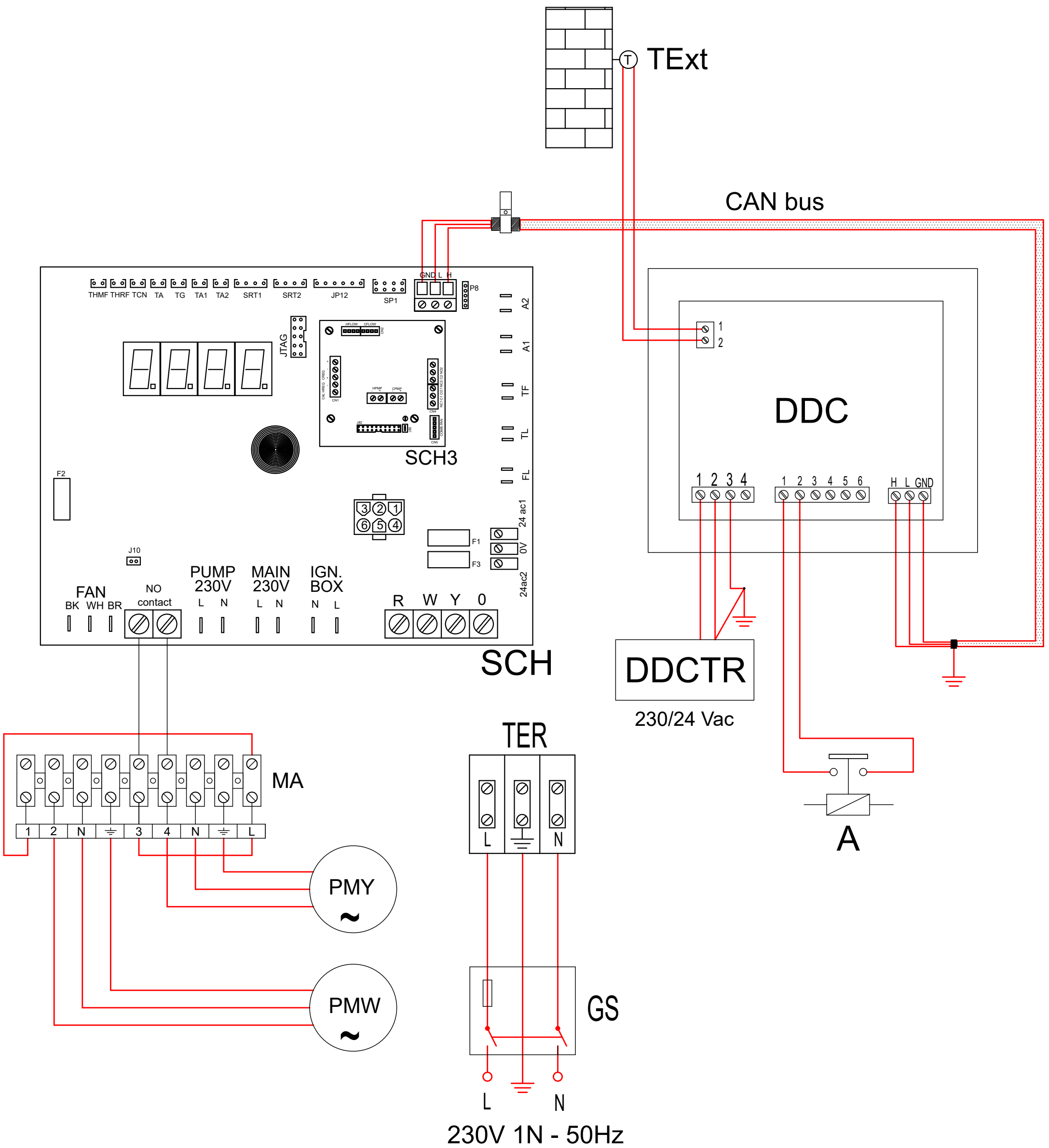
Figure 4.1 *GAHP WS plumbing diagram*



The flow regulation valve must only be used if the pump in the primary circuit is the fixed flow type
A Gas connection
B Safety valve drain ducting connection (indoor version only)
C Heating circuit
D Secondary circuit management system
1 Anti-vibration connection
2 Pressure gauge
3 Flow regulation valve
4 Sludge filter
5 Shut-off valve
6 Primary circuit water pump on system side
7 Primary circuit water pump on renewable source side
8 Safety valve
9 Expansion tank
10 Buffer tank (and hydraulic separator)
11 Heating/Cooling circuit water pump
12 Check valve
13 Heat exchanger
14 Water extraction well
15 Water return well
16 Submersible pump
17 Panel DDC
18 Outdoor temperature probe

4.3 ELECTRICAL WIRING DIAGRAM

Figure 4.2 *Wiring diagram for a single GAHP GS/WS for heating*



A External heating request
DDC DDC panel
SCH GAHP electronic board
TER terminal block
L-(PE)-N Phase/earth/neutral GAHP power supply
MA terminal block
N-(PE)-L Neutral/earth/phase of water pump power supply
1-2 Water pump request on system side
3-4 Water pump request on renewable source side
CAN terminal block
GND Common data
L Data signal LOW
H Data signal HIGH

Components NOT SUPPLIED
DDCTR Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA
TExt Outdoor temperature probe
PMW System-side water pump < 700 W
PMY Renewable source side water pump < 700 W

5 HEATING AND DHW WITH GAHP A

5.1 DESCRIPTION

The plumbing diagram in Figure 5.1 *p. 8* shows the use of a single GAHP A for heating, cooling and base DHW production (with possible solar integration), coupled to a primary/secondary system with a 3-pipe hydraulic separator.
DHW production is done via the base circuit, diverting hot water to the DHW buffer tank via diverter valves based on the DHW service request from a thermostat with adjustable differential, conveniently located in the DHW buffer tank.
Positioning DHW immersion thermostat correctly is important for the proper operation of the system. Positioning the thermostat at the top of the buffer tank will result in shorter operation for DHW production service, as the heat stratifying at the top will deactivate the thermostat more quickly. Positioning the thermostat at the bottom of the buffer tank will result in a longer operation for DHW production service, but the average temperature in the DHW will be higher when the thermostat reaches the switch-off temperature.
The correct setting of the thermostat and its differentials is critical for the system to function properly. Setting the temperature too high means leaving the system permanently blocked on the DHW request, preventing the heating system from delivering service. A too reduced differential will in turn lead to numerous service requests of very short duration, with a significant reduction in overall performance.

Also critical is the correct sizing of the DHW buffer tank and its exchange coil, for which reference should be made to Section C01.12.

In the presence of the solar system (not supplied), it is important that this is upstream of the DHW production system with the GAHP A and can work on the colder inlet water to the buffer tank, in order to optimise its exploitation and ensure that, if the solar system is able to achieve the required temperature on thermostat 13 on its own, there are no activation requests for DHW at the GAHP A.
If DHW and heat output demand are high, a separate preheating tank may be considered.
The presence of the RB100 device allows DHW service requests from the thermostat in the DHW buffer tank to be interfaced with the DDC panel and diverter valves to be switched.
Diverter valves can be either the on/off type with spring return (in which case only one of the two NO/NC contacts needs to be connected) or the 3-point type.

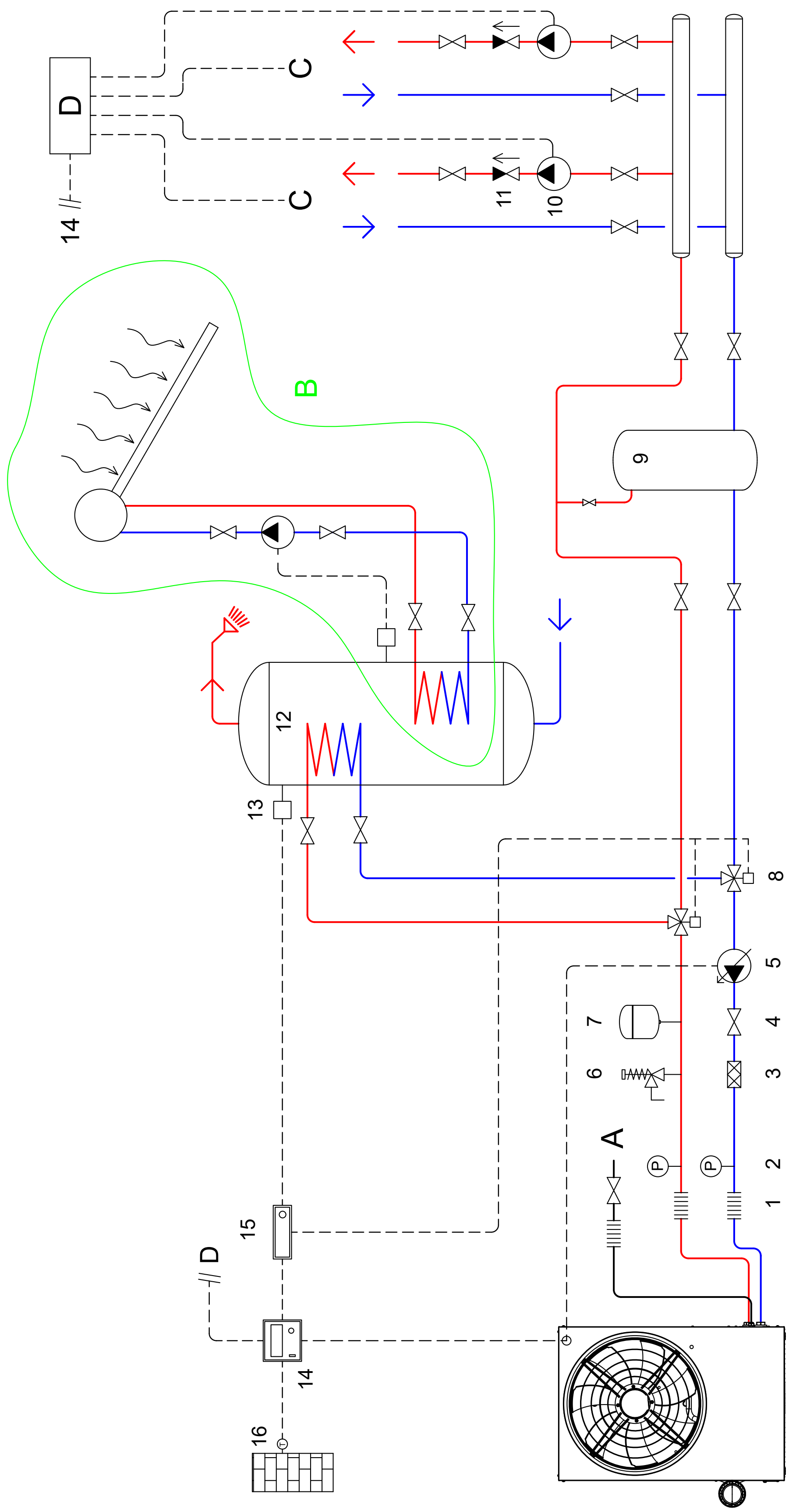
For details on the configuration of CAN bus jumpers on terminal nodes and intermediate nodes of the CAN bus network, please refer to Section C01.10.

In the wiring diagram, the water pump is of the variable flow type. If you wish to operate the water pump at constant flow, please refer to Section C01.10 for the relevant electrical connections.

The control system also includes a secondary circuit management system capable of transmitting a heating service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits switched off.

5.2 PLUMBING DIAGRAM

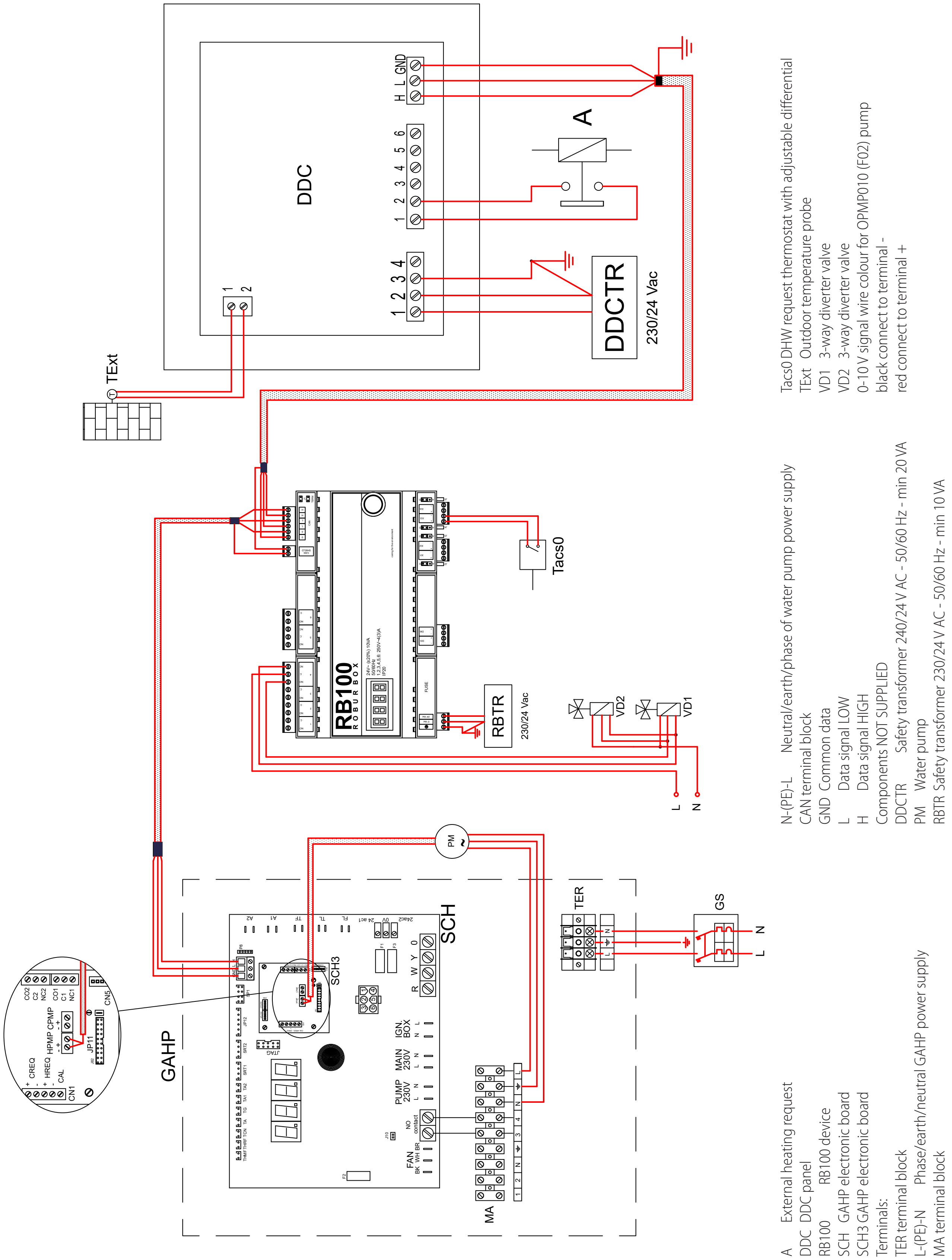
Figure 5.1 *Plumbing diagram for a single GAHP A for heating and base DHW*



A Gas connection
B Solar thermal integration (not supplied)
C Heating circuit
D Secondary circuit management system
System components:
1 Anti-vibration connection
2 Pressure gauge
3 Sludge filter
4 Shut-off valve
5 Primary circuit water pump (variable flow)
6 Safety valve
7 Expansion tank
8 3-way diverter valves for DHW
9 Buffer tank (and hydraulic separator)
10 Heating circuit water pump
11 Check valve
12 DHW buffer tank
13 Thermostat with adjustable differential for DHW
14 Panel DDC
15 RB100 device
16 Outdoor temperature probe

5.3 ELECTRICAL WIRING DIAGRAM

Figure 5.2 *Wiring diagram for a single GAHP A for heating and base DHW*



6 HEATING/COOLING AND SEPARABLE DHW

6.1 DESCRIPTION

The plumbing diagram in Figure 6.1 *p. 11* shows the use of a Link of heat pump 2AR 2AY50S 34-174 /4 S, consisting of 2 GAHP-AR S reversible heat pumps and 2 separate AY 50 boilers, both connected to the rear manifold pair, for heating, cooling and separable DHW production, coupled to a primary/secondary system with a 3-pipe hydraulic separator.
Although there are boilers in the generation system, there is no need to use the RB200 device, as the AY boilers are also Robur and consequently can be controlled directly from the DDC panel via the CAN bus network.
Pay attention to the appropriate neutralisation and drainage of condensate in accordance with the applicable standards.
For this type of system, for heating service, the "complement" and "complement and replacement" modes are available. For cooling and separable DHW production services, only "complement" mode is available.

For further information on integration modes, please refer to Section C01.11.

On the separable DHW circuit, there is no safety valve as this is already present inside the AY boiler and also acts on this circuit branch.
DHW production is done by boiler separation, diverting hot water to the DHW buffer tank by means of diverter valves based on the DHW service request from the thermostats in the DHW buffer tank, distinguished between normal DHW request and DHW request for thermal anti-legionella disinfection.
Preheating pump 10, which is only useful if DHW consumption is high and for systems switched on continuously for heating, will only be switched on if the temperature difference between the buffer tank and manifold is sufficient for proper heat exchange, and must be switched off in the summer season.
The winter preheating must be designed to work with a thermal leap greater than 10 °C, so as not to risk excessive heating of the inlet to GAHP, which would result in switching them off due to exceeded operational limit.
If there is a separable DHW request from thermostat 14, the boilers will be switched on with the DHW service setpoint (set on the DDC panel or RB100 device) and the diverter valves 8 will be switched.
The diagram also supports anti-legionella thermal disinfection, again by activating a separable DHW request from thermostat 16, with a dedicated setpoint (set on the DDC panel or RB100), suitably scheduled on the DDC panel.
If DHW and heat output demand are high, a separate preheating tank may be considered.

DHW production will also be possible while the cooling system is active, thanks to the separation of the boilers, which in the summer season will be permanently separated from the system and dedicated only to DHW production
Positioning DHW immersion thermostats correctly is important for the proper operation of the system. Positioning the thermostat at the top of the buffer tank will result in shorter operation for DHW production service, as the heat stratifying at the top will deactivate the thermostat more quickly. Positioning the thermostat at the bottom of the buffer tank will result in a longer operation for DHW production service, but the average temperature in the DHW will be higher when the thermostat reaches the switch-off temperature.
The correct setting of the thermostat and its differentials is critical for the system to function properly. Setting the temperature too high means leaving the system permanently blocked on the DHW request, preventing the heating system from delivering service. A too reduced differential will in turn lead to numerous service requests of very short duration, with a significant reduction in overall performance.

Also critical is the correct sizing of the DHW buffer tank and its exchange coil, for which reference should be made to Section C01.12.

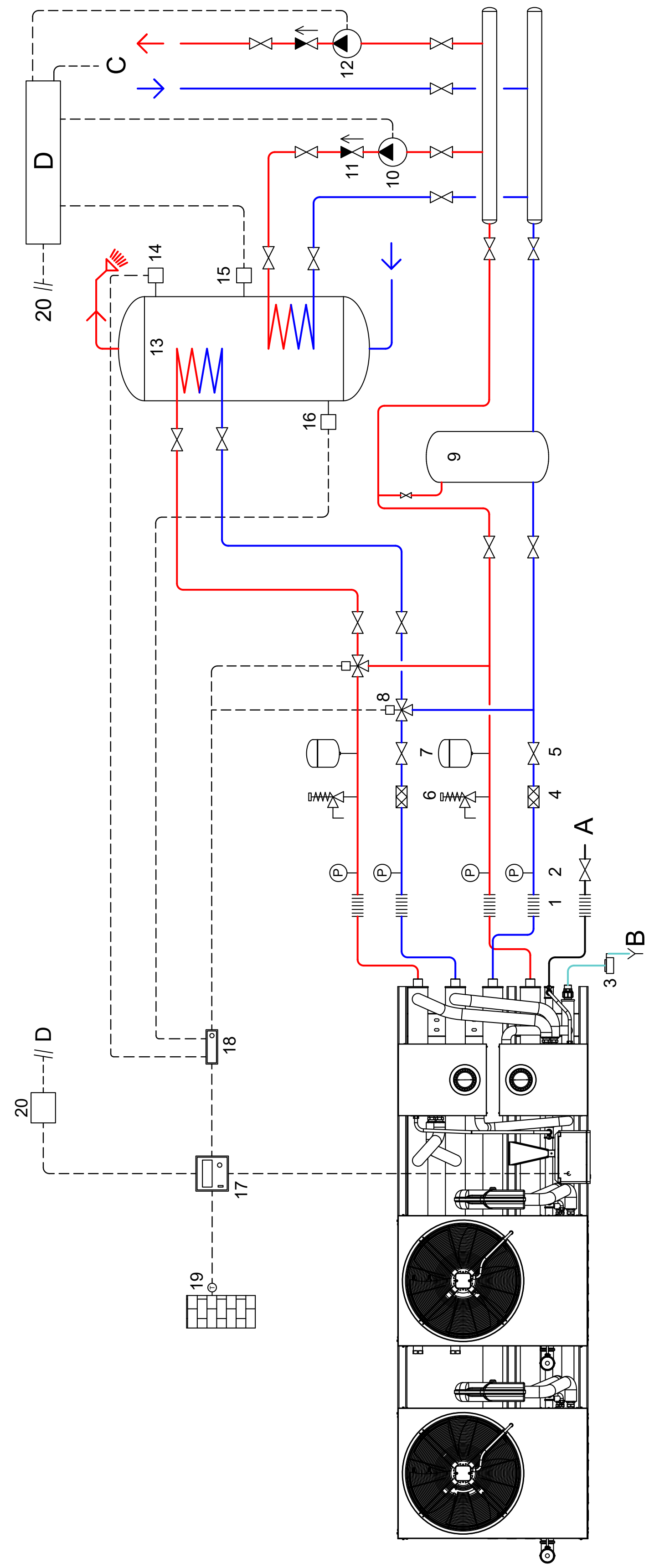
The presence of the RB100 device allows DHW service requests from thermostats in the DHW buffer tank to be interfaced with the DDC panel and diverter valves to be switched.
Diverter valves can be either the on/off type with spring return (in which case only one of the two NO/NC contacts needs to be connected) or the 3-point type.

For details on the configuration of CAN bus jumpers on terminal nodes and intermediate nodes of the CAN bus network, please refer to Section C01.10.

The control system also includes a secondary circuit management system capable of transmitting a heating/cooling service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits switched off.
The activation signal goes through a summer/winter selector switch as the GAHP-AR is a reversible heat pump and it is therefore necessary that the request comes alternately for either heating or cooling. The DDC configuration must be consistent with this management.
Separable DHW production will always be available, whatever the position of the summer/winter selector switch.

6.2 PLUMBING DIAGRAM

Figure 6.1 *Plumbing diagram for separable DHW*



- A Gas connection
- B Condensate drain
- C Heating/Cooling circuit
- D Secondary circuit management system

System components:

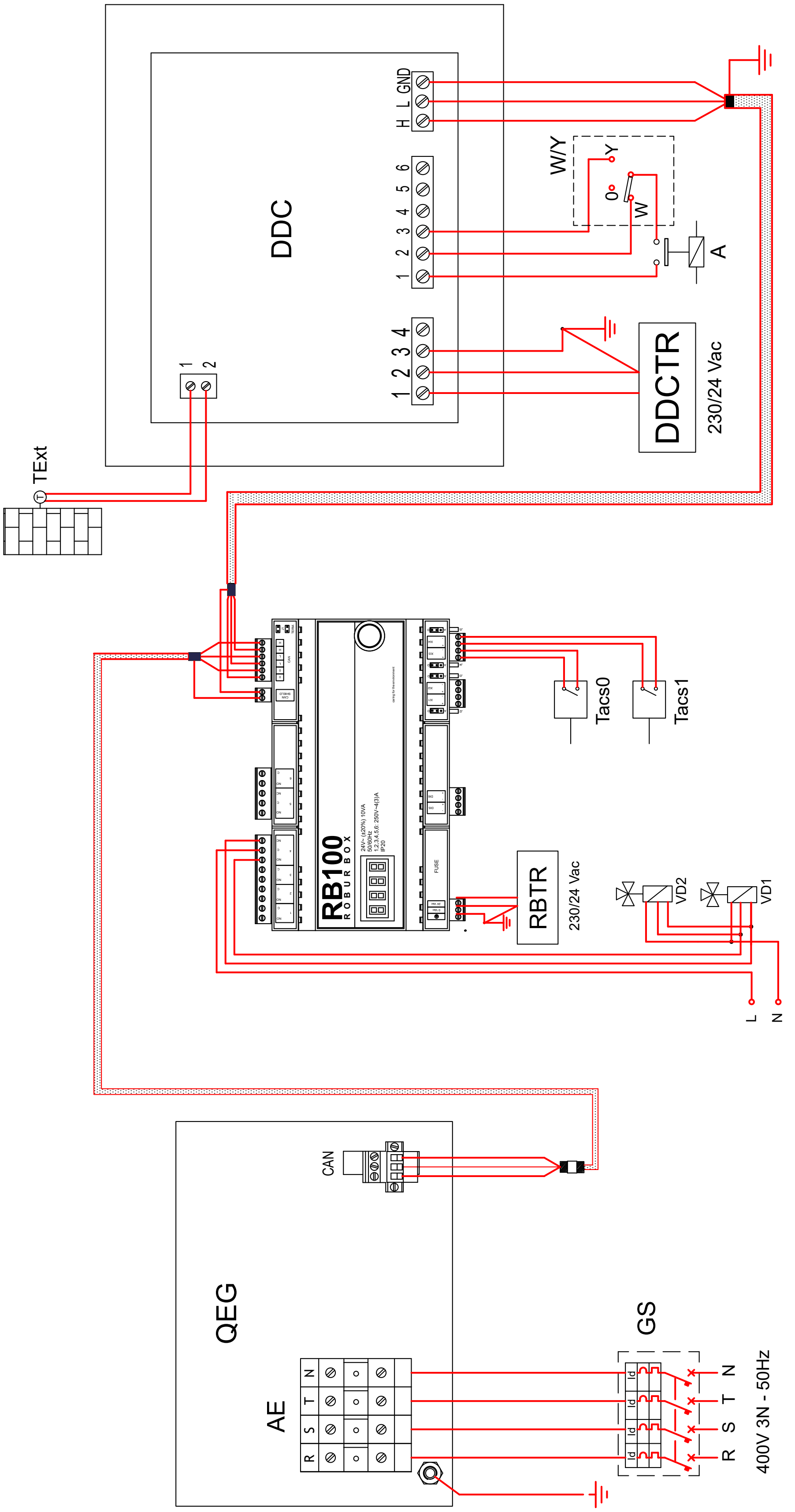
- 1 Anti-vibration connection
- 2 Pressure gauge
- 3 Condensate neutralizer
- 4 Sludge filter
- 5 Shut-off valve
- 6 Safety valve
- 7 Expansion tank
- 8 3-way diverter valves for DHW
- 9 Buffer tank (and hydraulic separator)
- 10 DHW winter preheating water pump
- 11 Check valve
- 12 Heating/Cooling circuit water pump
- 13 DHW buffer tank
- 14 Thermostat with adjustable differential for DHW
- 15 Thermostat with adjustable differential for DHW preheating
- 16 Thermostat with adjustable differential for Legionella function
- 17 Panel DDC
- 18 RB100 device
- 19 Outdoor temperature probe
- 20 Summer/winter selector switch

Notes:

- Activation of the DHW preheating pump 10 should only occur if the temperature difference between manifold and buffer tank is sufficient for proper heat exchange on the preheating coil
- DHW preheating pump 10 must be turned off in summer

6.3 ELECTRICAL WIRING DIAGRAM

Figure 6.2 *Wiring diagram for heating/cooling and separable DHW*



A External request
DDC DDC panel
RB100 RB100 device
QEG Link electrical panel
AE Power supply input terminals
GS Three-phase magnetothermic switch
RST Phases
N Neutral

CAN terminal block
GND Common data
L Data signal LOW
H Data signal HIGH
Components NOT SUPPLIED
DDCTR Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA
RBTR Safety transformer 230/24 V AC - 50/60 Hz - min 10 VA
Tacs0 DHW request thermostat with adjustable differential

Tacs1 Legionella DHW request thermostat with adjustable differential
TExt Outdoor temperature probe
VD1 3-way diverter valve
VD2 3-way diverter valve
W/Y Heating/Cooling switch (winter/summer)
- Position W to turn heating on
- Position Y to turn cooling on
- Position 0 for system off

7 HEATING/COOLING AND SEPARABLE DHW WITH HEAT RECOVERY

7.1 DESCRIPTION

The plumbing diagram in Figure 7.1 *p. 14* shows the use of a Link of heat pumps 2AR 2HR 1AY100S 69-216 /6 S, consisting of 2 reversible GAHP-AR S heat pumps, 2 ACF60-00 HR chiller-heaters with heat recovery and a AY 100 boiler on the separate circuit, for heating, cooling and separable DHW production, with summer heat recovery, coupled to a primary/secondary system with a 3-pipe hydraulic separator.

Although there are boilers in the generation system, there is no need to use the RB200 device, as the AY boilers are also Robur and consequently can be controlled directly from the DDC panel via the CAN bus network.

Pay attention to the appropriate neutralisation and drainage of condensate in accordance with the applicable standards.

For this type of system, for heating service, the "complement" and "complement and replacement" modes are available. For cooling and separable DHW production services, only "complement" mode is available.

For further information on integration modes, please refer to Section C01.11.

On the separable DHW circuit, there is no safety valve as this is already present inside the AY boiler and also acts on this circuit branch.

DHW is produced by separating only the AY 100 boiler, diverting hot water to the DHW buffer tank via diverter valves based on the DHW service request from the thermostats in the DHW buffer tank, distinguishing between normal DHW request and request for thermal anti-legionella disinfection.

Preheating pump 10, which is only useful if DHW consumption is high and for systems switched on continuously for heating, will only be switched on if the temperature difference between the buffer tank and manifold is sufficient for proper heat exchange, and must be switched off in the summer season.

If there is a separable DHW service request from thermostat 14, the AY 100 boiler will be activated with the setpoint for separable DHW service (set on the DDC panel or RB100 device) and diverter valves 8 will be switched.

The diagram also supports anti-legionella thermal disinfection, again by activating a separable DHW request from thermostat 16, with a dedicated setpoint (set on the DDC panel or RB100), suitably scheduled on the DDC panel.

Manual switching of selector switch 21 when switching from heating to cooling will activate the request to the heat recovery exchanger via thermostat 15 and thus carry out preheating with free heat from the heat recovery.

The winter preheating must be designed to work with a thermal leap greater than 10 °C, so as not to risk excessive heating of the inlet to GAHP, which would result in switching them off due to exceeded operational limit.

If the DHW demand and the power available for heat recovery are high, a separate preheating tank should be used.

DHW production will also be possible while the cooling system is active, thanks to the separation of the boiler, which in the summer season will be permanently separated from the system and dedicated only to DHW production, relying on heat recovery to carry out preheating.

Positioning DHW immersion thermostats correctly is important for the proper operation of the system. Positioning the thermostat at the top of the buffer tank will result in shorter operation for DHW production service, as the heat stratifying at the top will deactivate the thermostat more quickly. Positioning the thermostat at the bottom of the buffer tank will result in a longer operation for DHW production service, but the average temperature in the DHW will be higher when the thermostat reaches the switch-off temperature.

The correct setting of the thermostat and its differentials is critical for the system to function properly. Setting the temperature too high means leaving the system permanently blocked on the DHW request, preventing the heating system from delivering service. A too reduced differential will in turn lead to numerous service requests of very short duration, with a significant reduction in overall performance.

Also critical is the correct sizing of the DHW buffer tank and its exchange coil, for which reference should be made to Section C01.12.

The presence of the RB100 device allows DHW service requests from thermostats in the DHW buffer tank to be interfaced with the DDC panel and diverter valves to be switched.

Diverter valves can be either the on/off type with spring return (in which case only one of the two NO/NC contacts needs to be connected) or the 3-point type.

For details on the configuration of CAN bus jumpers on terminal nodes and intermediate nodes of the CAN bus network, please refer to Section C01.10.

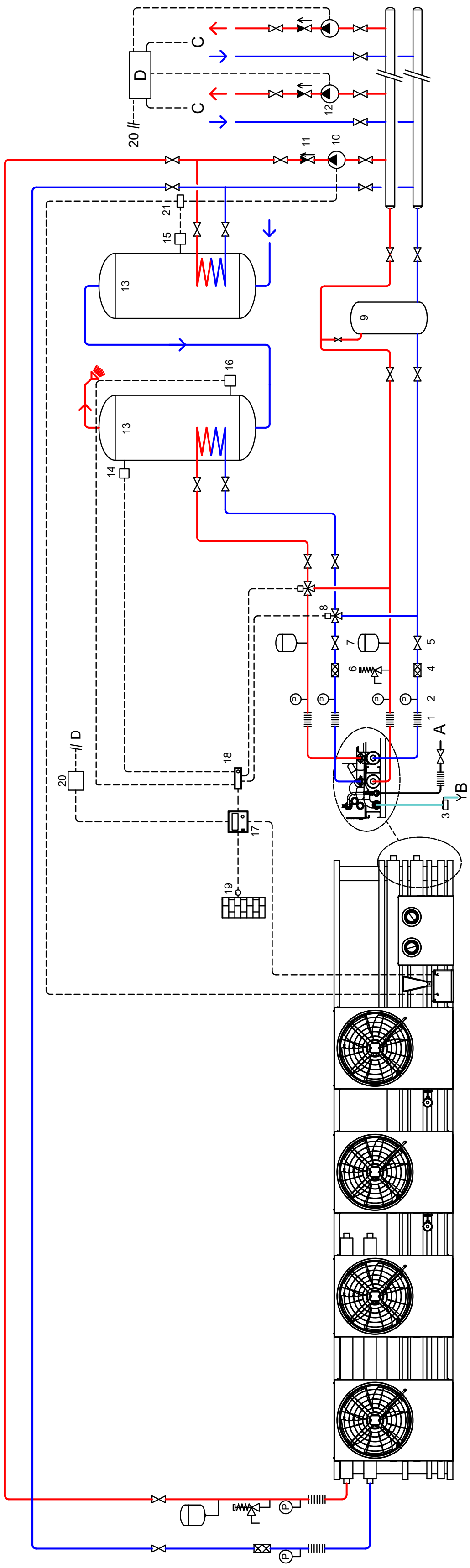
The control system also includes a secondary circuit management system capable of transmitting a heating/cooling service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits switched off.

The activation signal goes through a summer/winter selector switch as the GAHP-AR is a reversible heat pump and it is therefore necessary that the request comes alternately for either heating or cooling. The DDC configuration must be consistent with this management.

Separable DHW production will always be available, whatever the position of the summer/winter selector switch.

7.2 PLUMBING DIAGRAM

Figure 7.1 *Plumbing diagram for separable DHW with heat recovery*



A Gas connection
B Condensate drain
C Heating/Cooling circuit
D Secondary circuit management system

System components:

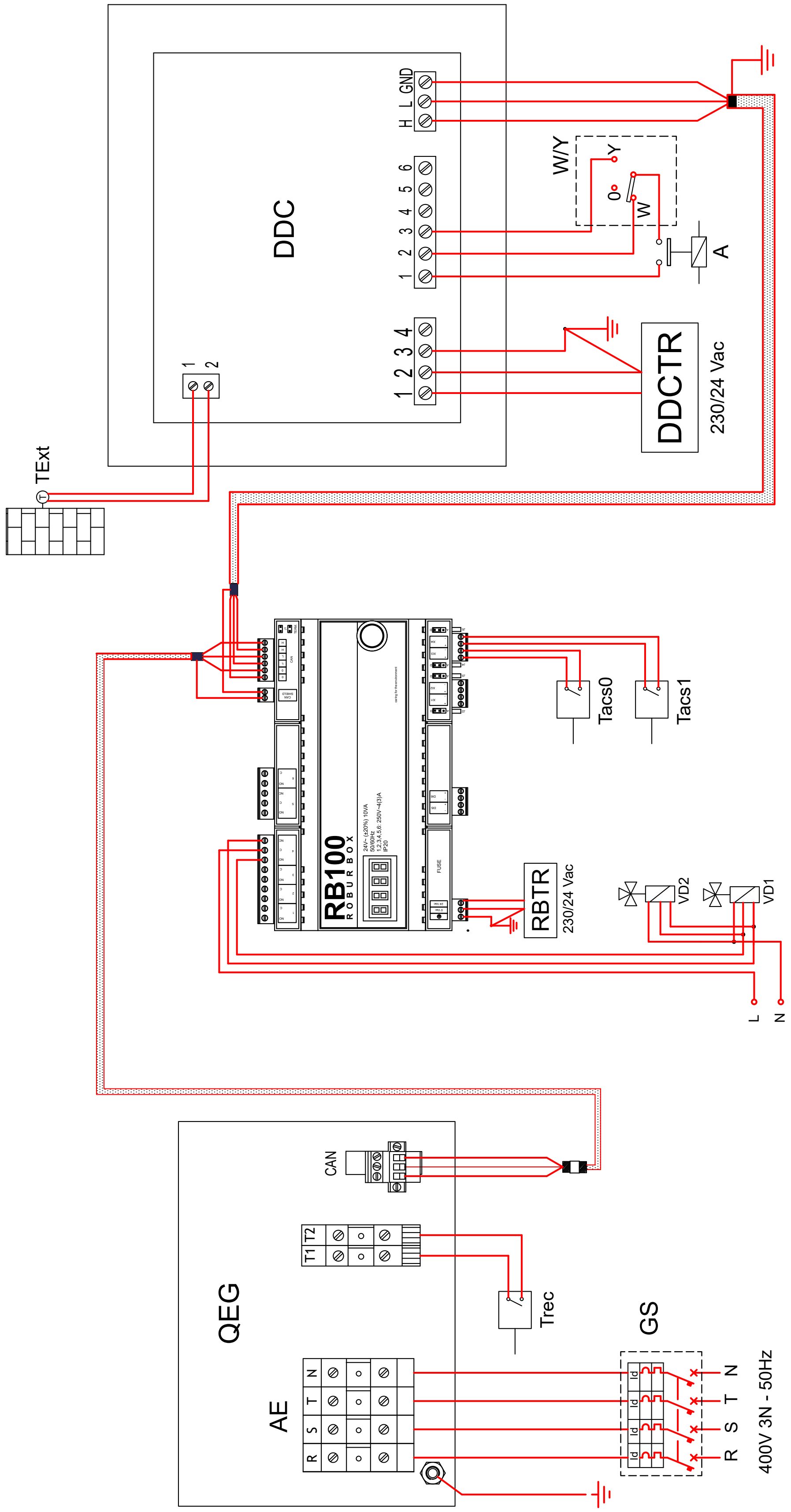
1 Anti-vibration connection
2 Pressure gauge
3 Condensate neutralizer
4 Sludge filter
5 Shut-off valve
6 Safety valve
7 Expansion tank
8 3-way diverter valves for DHW
9 Buffer tank (and hydraulic separator)
10 DHW winter preheating water pump
11 Check valve
12 Heating/Cooling circuit water pump
13 DHW buffer tank
14 Thermostat with adjustable differential for DHW
15 Thermostat with adjustable differential for DHW preheating
16 Thermostat with adjustable differential for Legionella function
17 Panel DDC
18 RB100 device
19 Outdoor temperature probe
20 Summer/winter selector switch
21 Thermostat signal summer/winter switch

Notes:

- Activation of the DHW preheating pump 10 should only occur if the temperature difference between manifold and buffer tank is sufficient for proper heat exchange on the preheating coil
- DHW preheating pump 10 must be turned off in summer
- The summer/winter selector switch 21 will enable thermostat 15 to activate the heat recovery exchanger request to ACF60-00 HR chiller-heaters in summer

7.3 ELECTRICAL WIRING DIAGRAM

Figure 7.2 *Wiring diagram for separable DHW with heat recovery*



A External request
DDC DDC panel
RB100 RB100 device
QEG Link electrical panel
AE Power supply input terminals
GS Three-phase magnetothermic switch
RST Phases
N Neutral
T1-T2 DHW buffer tank thermostat terminals (HR recovery circuit side)

CAN terminal block
GND Common data
L Data signal LOW
H Data signal HIGH
Components NOT SUPPLIED
DDCTR Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA
RBTR Safety transformer 230/24 V AC - 50/60 Hz - min 10 VA
Tacs0 DHW request thermostat with adjustable differential
Tacs1 Legionella DHW request thermostat with adjustable differential

TExt Outdoor temperature probe
Trec DHW request thermostat with adjustable differential for heat recovery circuit activation
VD1 3-way diverter valve
VD2 3-way diverter valve
W/Y Heating/Cooling switch (winter/summer)
- Position W to turn heating on
- Position Y to turn cooling on
- Position 0 for system off

8 HEATING/COOLING WITH MORE THAN 16 MODULES

8.1 DESCRIPTION

The plumbing diagram in Figure 8.1 *p. 17* shows the use of 3 Link of heat pumps 5AR 85-189, consisting of 5 GAHP-AR each, and one Link condensing boilers 2AY100 00-197, consisting of 2 AY 100, for heating and cooling, coupled to a primary/secondary system with a 3-pipe hydraulic separator.
The number of modules is greater than 16 (15 GAHP-AR modules and 4 AY 50 modules, as the DDC panel considers each AY 100 as consisting of two independent AY 50 modules) and consequently two DDC panels are needed to control the system, one of which will be the master of the system and the other will be a slave. By using two slave DDC panels and one master, it will be possible to manage up to a maximum of 32 modules.
Although there are boilers in the generation system, there is no need to use the RB200 device, as the AY boilers are also Robur and consequently can be controlled directly from the DDC panel via the CAN bus network.
Pay attention to the appropriate neutralisation and drainage of condensate in accordance with the applicable standards.
For this type of system, for heating service, the "complement" and "complement and replacement" modes are available, while only the "complement" mode is available for cooling service.

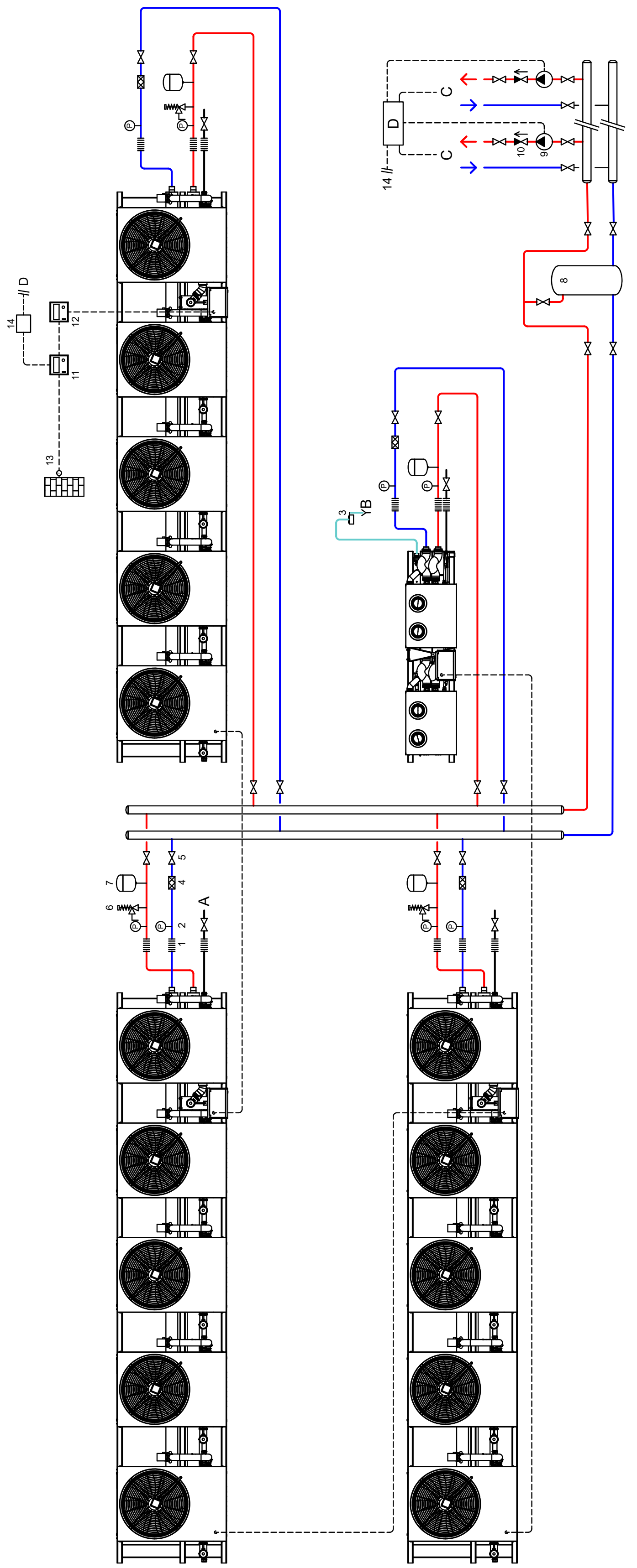
For further information on integration modes, please refer to Section C01.11.

For details on the configuration of CAN bus jumpers on terminal nodes and intermediate nodes of the CAN bus network, please refer to Section C01.10.

The control system also includes a secondary circuit management system capable of transmitting a heating/cooling service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits switched off.
The activation signal goes through a summer/winter selector switch as the GAHP-AR is a reversible heat pump and it is therefore necessary that the request comes alternately for either heating or cooling. The DDC configuration must be consistent with this management.

8.2 PLUMBING DIAGRAM

Figure 8.1 *Plumbing diagram for heating/cooling with more than 16 modules*



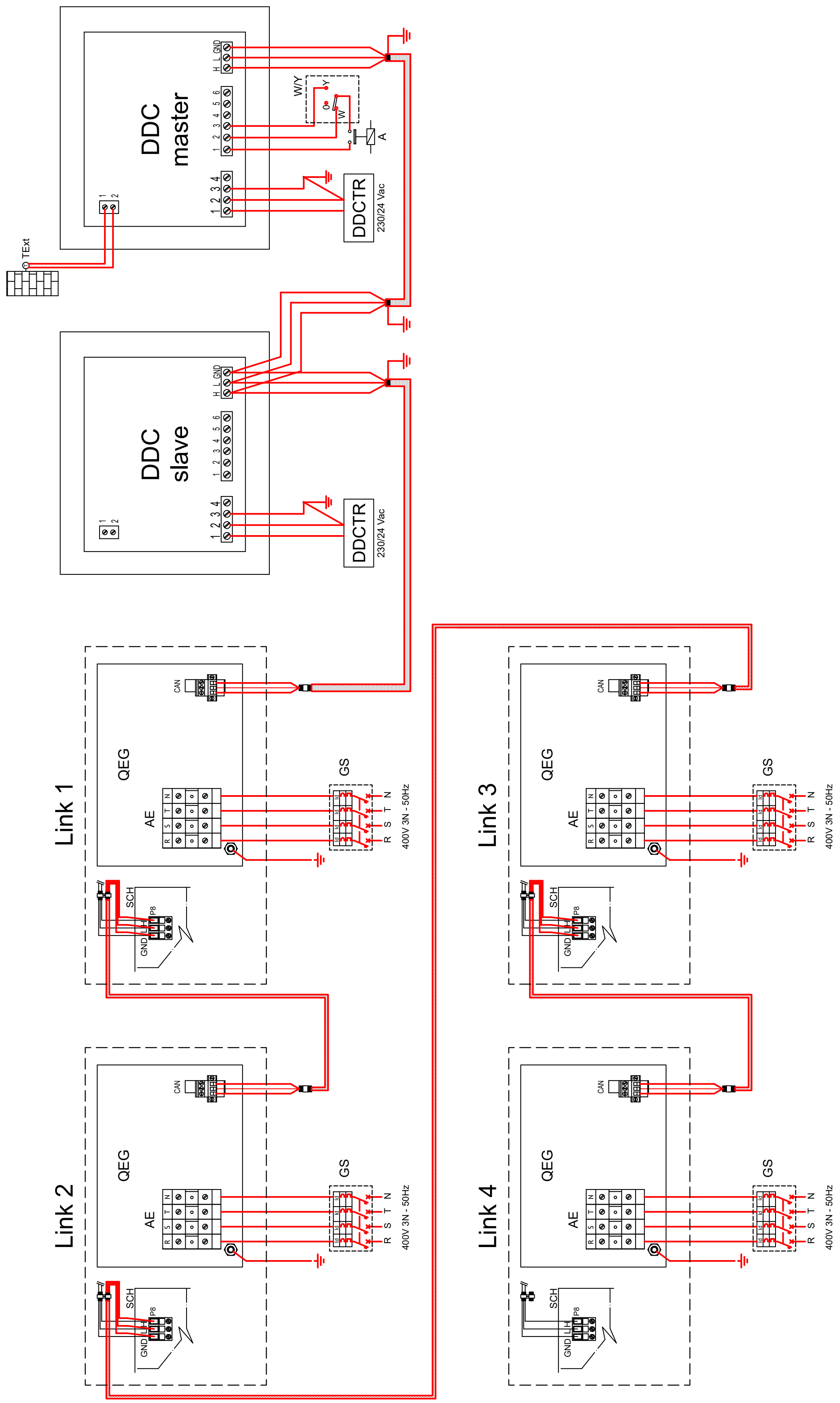
- A Gas connection
- B Condensate drain
- C Heating/Cooling circuit
- D Secondary circuit management system

System components:

- 1 Anti-vibration connection
- 2 Pressure gauge
- 3 Condensate neutralizer
- 4 Sludge filter
- 5 Shut-off valve
- 6 Safety valve
- 7 Expansion tank
- 8 Buffer tank (and hydraulic separator)
- 9 Heating/Cooling circuit water pump
- 10 Check valve
- 11 Master DDC panel
- 12 Slave DDC panel
- 13 Outdoor temperature probe
- 14 Summer/winter selector switch

8.3 ELECTRICAL WIRING DIAGRAM

Figure 8.2 *Wiring diagram for heating/cooling with more than 16 modules*



A External request
DDC master DDC master panel
DDC slave DDC slave panel
QEG Link electrical panel
AE Power supply input terminals
GS Three-phase magnetothermic switch
RST Phases
N Neutral
CAN terminal block
GND Common data
L Data signal LOW
H Data signal HIGH
Components NOT SUPPLIED
DDCTR Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA
TExt Outdoor temperature probe
W/Y Heating/Cooling switch (winter/summer)
- Position W to turn heating on
- Position Y to turn cooling on
- Position 0 for system off

9 HEATING/COOLING WITH THIRD-PARTY INTEGRATION

9.1 DESCRIPTION

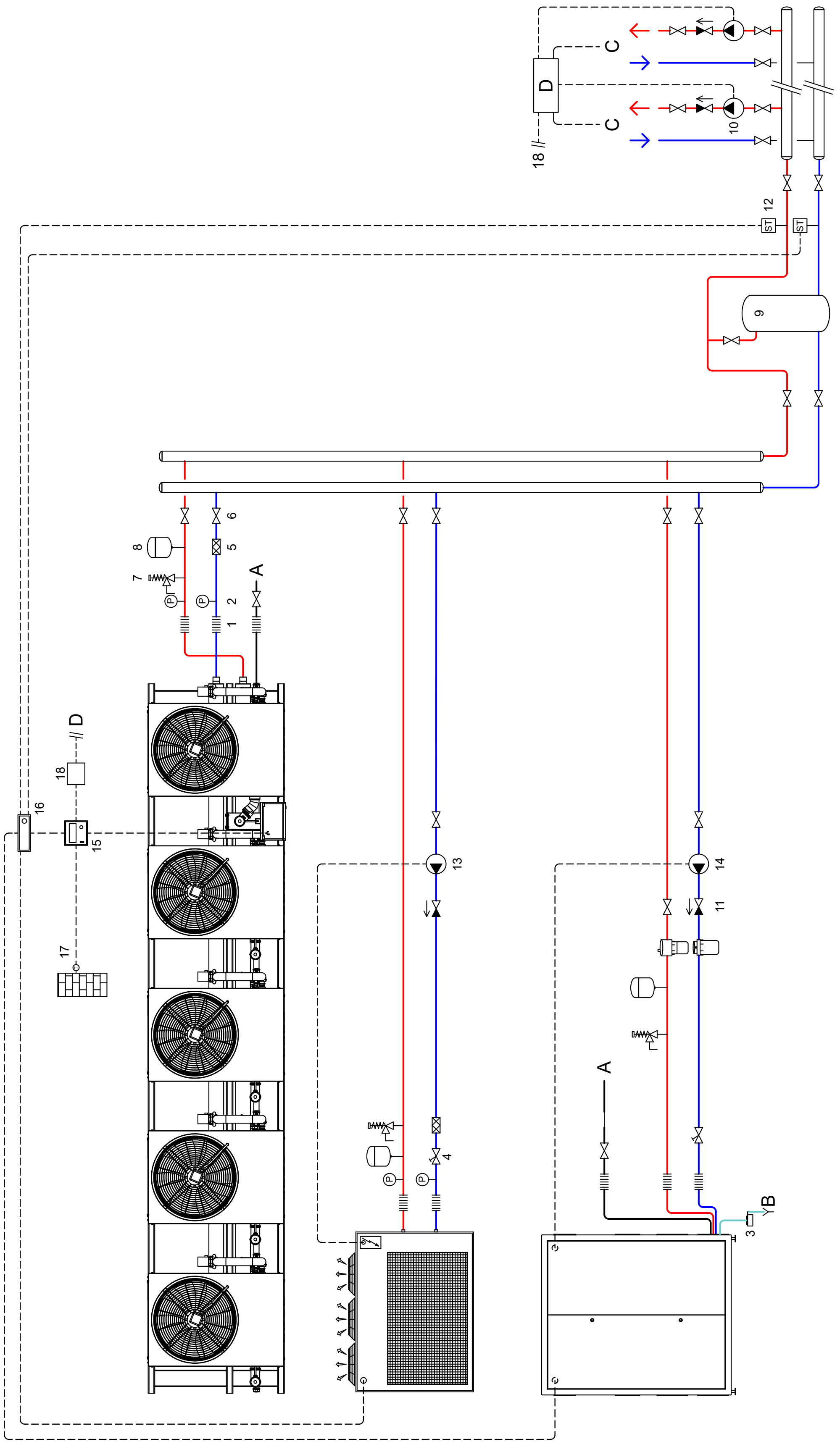
The plumbing diagram in Figure 9.1 *p. 20* shows the use of a Link of heat pumps 5AR 85-189, consisting of 5 GAHP-AR, and third-party appliances (boiler and chiller) for heating and cooling, coupled to a primary/secondary system with a 3-pipe hydraulic separator.
Using the RB200 device allows the third-party appliances and secondary circuit temperature to be controlled.
The water pumps of third-party appliances are controlled independently by the appliances themselves, which will also provide antifreeze protection of their own circuit branch, if needed.
Pay attention to the appropriate neutralisation and drainage of condensate in accordance with the applicable standards.
For this type of system, for heating service, the "complement" and "complement and replacement" modes are available, while only the "complement" mode is available for cooling service.

For further information on integration modes, please refer to Section C01.11.

When controlling the switching on/off of third-party appliances, it is always advisable to avoid interrupting the electrical power supply to the appliance. There is often a dedicated input for an on/off signal from an external device, which should be used for connection to the RB200, checking in advance in the documentation of the third-party appliance whether this signal is mains voltage or a voltage-free contact.
The control system also includes a secondary circuit management system capable of transmitting a heating/cooling service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits switched off.
The activation signal goes through a summer/winter selector switch as the GAHP-AR is a reversible heat pump and it is therefore necessary that the request comes alternately for either heating or cooling. The DDC configuration must be consistent with this management.

9.2 PLUMBING DIAGRAM

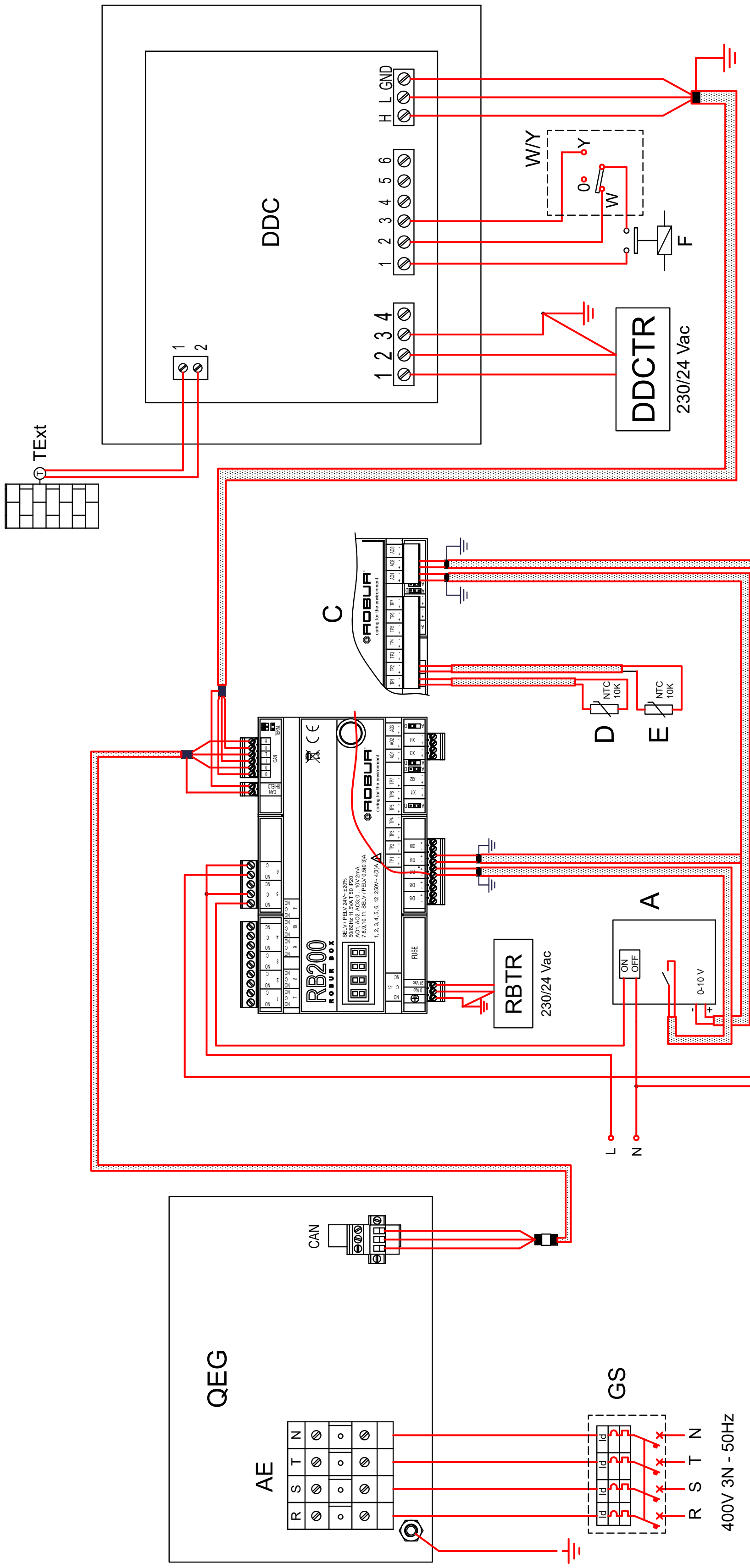
Figure 9.1 *Plumbing diagram for heating/cooling with third-party integration*



A Gas connection
B Condensate drain
C Heating/Cooling circuit
D Secondary circuit management system
System components:
1 Anti-vibration connection
2 Pressure gauge
3 Condensate neutralizer
4 Flow regulation valve
5 Sludge filter
6 Shut-off valve
7 Safety valve
8 Expansion tank
9 Buffer tank (and hydraulic separator)
10 Heating/Cooling circuit water pump
11 Check valve
12 Secondary manifold temperature probes
13 Third-party appliance water pump (boiler)
14 Third-party appliance water pump (chiller)
15 Panel DDC
16 RB200 device
17 Outdoor temperature probe
18 Summer/winter selector switch

9.3 ELECTRICAL WIRING DIAGRAM

Figure 9.2 *Wiring diagram for heating/cooling with third-party integration*



A Third-party generator with its own water pump
B Third-party generator with its own water pump
C Detail of upper RB200 terminal block
D Heating/Cooling manifold inlet temperature probe
E Heating/Cooling manifold outlet temperature probe
F External request
DDC DDC panel
RB200 RB200 device
QEG Link electrical panel

AE Power supply input terminals
GS Three-phase magnetothermic switch
RST Phases
N Neutral
CAN terminal block
GND Common data
L Data signal LOW
H Data signal HIGH
Components NOT SUPPLIED

DDCTR Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA
RBTR Safety transformer 230/24 V AC - 50/60 Hz - 12 VA min
TExt Outdoor temperature probe
W/Y Heating/Cooling switch (winter/summer)
- Position W to turn heating on
- Position Y to turn cooling on
- Position 0 for system off

10 HEATING AND BASE AND SEPARABLE DHW WITH THIRD-PARTY INTEGRATION

10.1 DESCRIPTION

The plumbing diagram in Figure 10.1 *p. 23* shows the use of a Link of heat pump 5AHT 00-207, consisting of 5 GAHP A, and third-party appliances (boilers) for heating and both base and separable DHW, coupled to a primary/secondary system with a 3-pipe hydraulic separator.
Using the RB200 device makes it possible to control the third party units, including the circulating pump of the third party unit on the separable circuit, as well as secondary circuit and separable circuit temperature. The use of the RB200 device allows the control of third-party appliances, including the water pump of the third-party appliance on the separable circuit, and the temperature of both the secondary circuit and the separable circuit.
For third-party appliances whose water pump is controlled by the RB200 device, attention must be paid to the antifreeze protection, as the RB200 is not able to activate the appliance or its water pump for the antifreeze function.
Pay attention to the appropriate neutralisation and drainage of condensate in accordance with the applicable standards.
For this type of system, for heating and base DHW services, the "complement" and "complement and replacement" modes are available. For separable DHW production, only the "complement" mode is available.

For further information on integration modes, please refer to Section C01.11.

DHW production is possible either through the base system, by means of a delivery from the heating manifold, managed by the secondary circuit management system via pump 22 and a suitable temperature probe in the relevant DHW buffer tank, or through the separation of one of the third-party boilers, diverting the hot water to the DHW buffer tank downstream of the preheating by means of diverter valves.
Preheating pump 22, which is only useful if DHW consumption is high and for systems switched on continuously for heating, will only be switched on by the secondary circuit management system if the temperature difference between the buffer tank and manifold is sufficient for proper heat exchange, and must be switched off in the summer season.
If there is a base DHW request from thermostat 16, the whole generation system will adjust its setpoint to meet the higher temperature demand between heating and DHW.
If there is a separable DHW service request from thermostat 15, the third-party boiler on the separable circuit will be switched on with the setpoint for separable DHW service (set on the DDC panel or RB200 device) and diverter valves 9 will be switched.
For anti-Legionella disinfection in a system in which preheating takes place in a buffer tank separate from the one served by the separable system, it is even more recommended to use methods other than thermal shock (such as chemical methods, UV Lamps or the addition of ozone).

The separate DHW preheating tank has been foreseen in the event that the thermal load for DHW is high and it is therefore advisable to use at least part of the heating circuit's thermal output for this service, being able to count on the contribution of renewable energy offered by the heat pumps.
DHW production will also be possible with the space heating system switched off thanks to the separation of the third-party boiler.
Positioning DHW immersion thermostats correctly is important for the proper operation of the system. Positioning the thermostat at the top of the buffer tank will result in shorter operation for DHW production service, as the heat stratifying at the top will deactivate the thermostat more quickly. Positioning the thermostat at the bottom of the buffer tank will result in a longer operation for DHW production service, but the average temperature in the DHW will be higher when the thermostat reaches the switch-off temperature.
The correct setting of the thermostat and its differentials is critical for the system to function properly. Setting the temperature too high means leaving the system permanently blocked on the DHW request, preventing the heating system from delivering service. A too reduced differential will in turn lead to numerous service requests of very short duration, with a significant reduction in overall performance.

Also critical is the correct sizing of the DHW buffer tank and its exchange coil, for which reference should be made to Section C01.12.

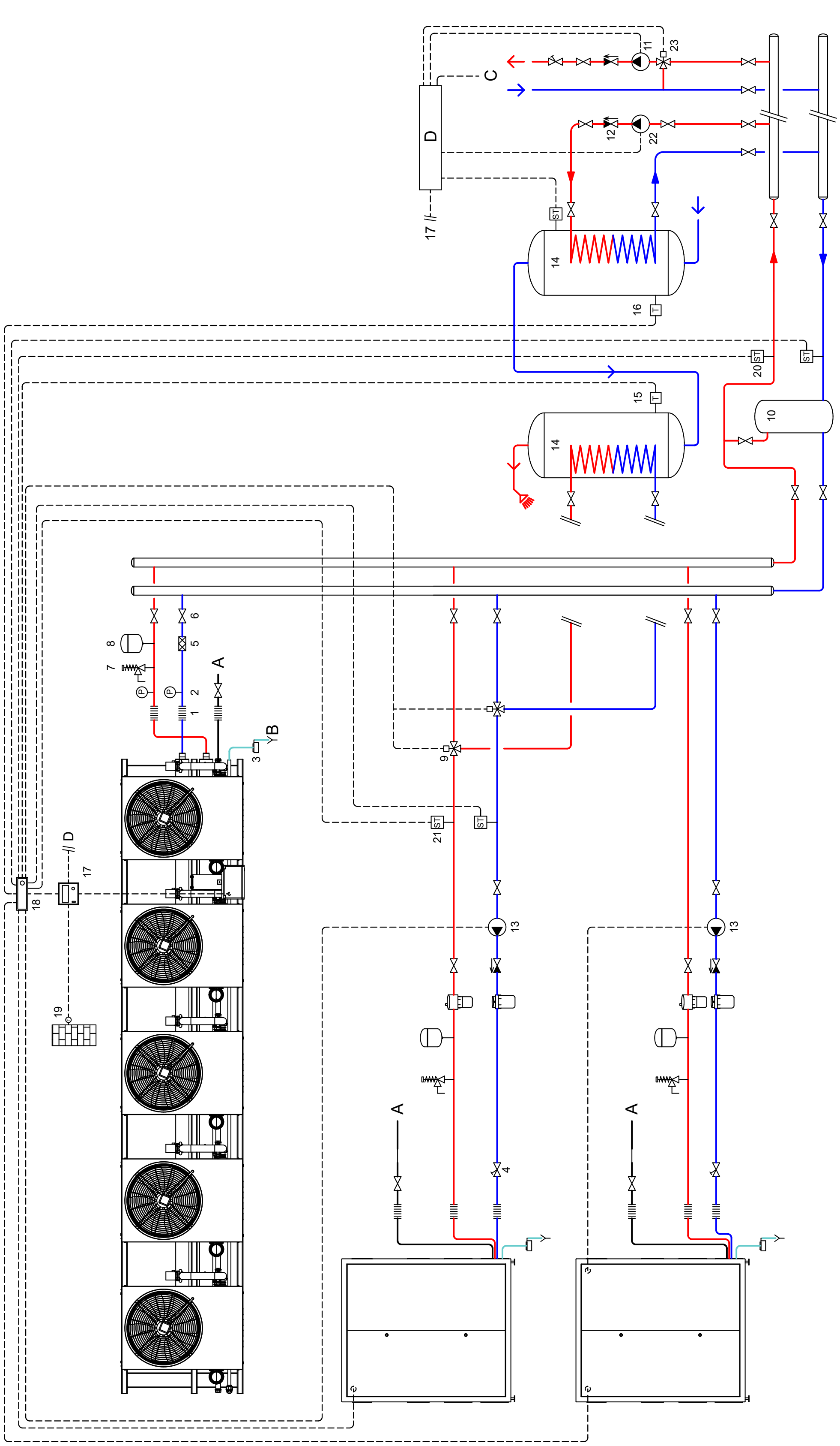
The RB200 device also allows DHW service requests from the thermostats in the DHW buffer tanks to be interfaced with the DDC panel and diverter valves to be switched.
Diverter valves can be either the on/off type with spring return (in which case only one of the two NO/NC contacts needs to be connected) or the 3-point type.

For details on the configuration of CAN bus jumpers on terminal nodes and intermediate nodes of the CAN bus network, please refer to Section C01.10.

When controlling the switching on/off of third-party appliances, it is always advisable to avoid interrupting the electrical power supply to the appliance. There is often a dedicated input for an on/off signal from an external device, which should be used for connection to the RB200, checking in advance in the documentation of the third-party appliance whether this signal is mains voltage or a voltage-free contact.
The control system also includes a secondary circuit management system capable of transmitting a heating service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits switched off.
DHW production will always be available, regardless of the activation status of the heating service request.

10.2 PLUMBING DIAGRAM

Figure 10.1 *Plumbing diagram for heating and base and separable DHW*



- A Gas connection
- B Condensate drain
- C Heating circuit
- D Secondary circuit management system

System components:

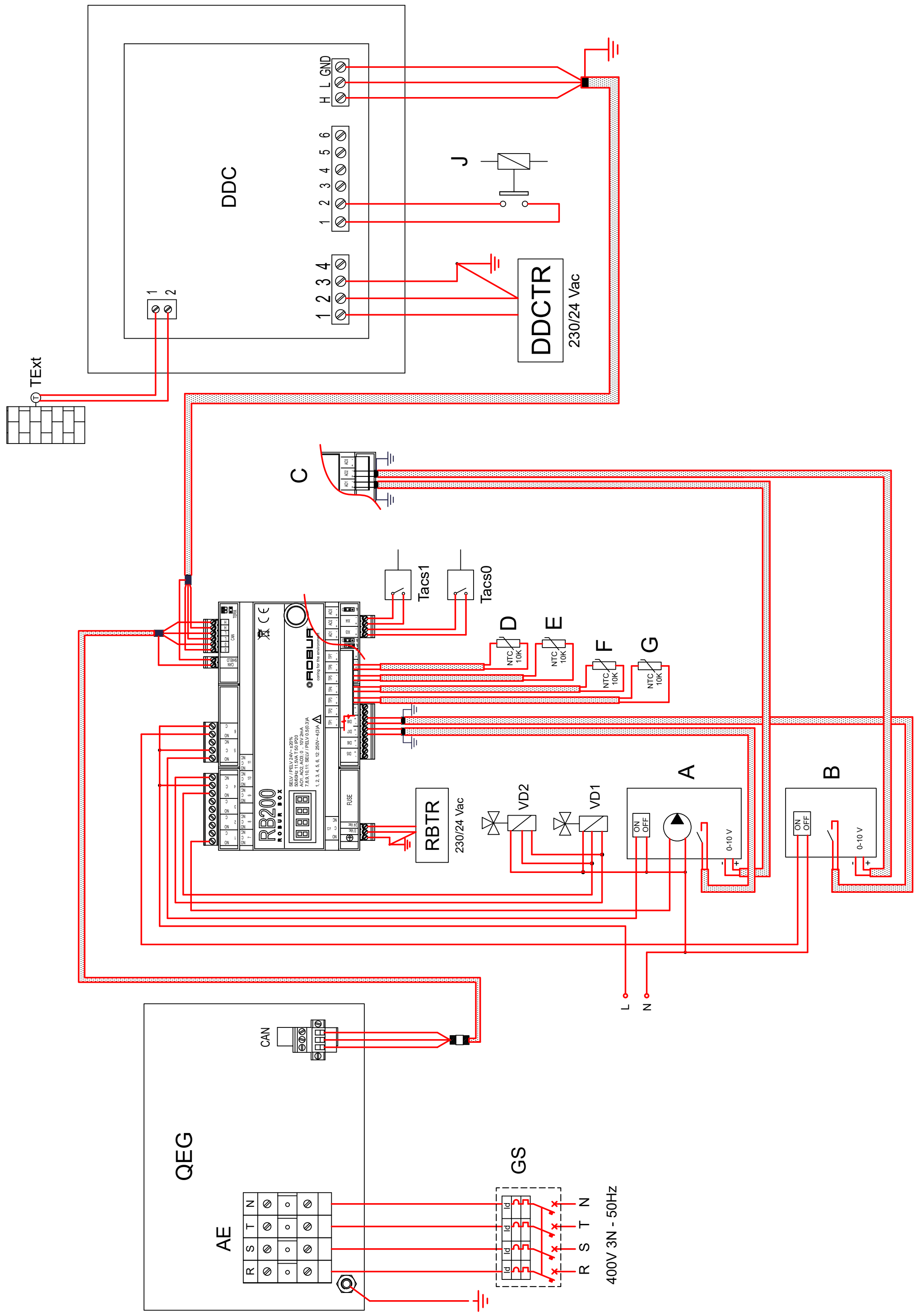
- 1 Anti-vibration connection
- 2 Pressure gauge
- 3 Condensate neutralizer
- 4 Flow regulation valve
- 5 Sludge filter
- 6 Shut-off valve
- 7 Safety valve
- 8 Expansion tank
- 9 3-way diverter valves for DHW
- 10 Buffer tank (and hydraulic separator)
- 11 Heating circuit water pump
- 12 Check valve
- 13 Third-party appliance water pump
- 14 DHW buffer tank
- 15 Thermostat with adjustable differential for separable DHW
- 16 Thermostat with adjustable differential for DHW preheating
- 17 Panel DDC
- 18 RB200 device
- 19 Outdoor temperature probe
- 20 Secondary manifold temperature probes
- 21 Separable manifold temperature probes
- 22 DHW preheating water pump
- 23 3-way mixing valve

Notes:

- DHW preheating pump 22 must be turned off when the heating system is off, or if the temperature difference between manifold and buffer tank is not sufficient for proper heat exchange on the preheating coil

10.3 ELECTRICAL WIRING DIAGRAM

Figure 10.2 *Wiring diagram for heating and base and separable DHW*



A Third-party generator with water pump controlled by RB200
B Third-party generator with its own water pump
C Detail of upper RB200 terminal block
D Separable manifold outlet temperature probe
E Separable manifold inlet temperature probe
F Heating manifold outlet temperature probe
G Heating manifold inlet temperature probe
J External heating request
DDC DDC panel

RB200 RB200 device
QEG Link electrical panel
AE Power supply input terminals
GS Three-phase magnetothermic switch
RST Phases
N Neutral
CAN CAN terminal block
GND Common data
L Data signal LOW

H Data signal HIGH
Components NOT SUPPLIED
DDCTR Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA
RBTR Safety transformer 230/24 V AC - 50/60 Hz - 12 VA min
Tacs0 Base DHW request thermostat with adjustable differential
Tacs1 Separable DHW request thermostat with adjustable differential
TExt Outdoor temperature probe
VD1 3-way diverter valve
VD2 3-way diverter valve

11 SIMULTANEOUS HEATING AND COOLING AND BASE AND SEPARABLE DHW WITH THIRD-PARTY INTEGRATION

11.1 DESCRIPTION

The plumbing diagram in Figure 11.1 *p. 27* shows the use of a Link of heat pumps 3GSHT 49-125/4 (or a Link of heat pumps 3WS 56-132/4), consisting of 3 GAHP GS/WS, and third-party appliances (boilers and chillers) for process applications or applications involving the simultaneous use of hot water and chilled water with the possibility of producing both base and separable DHW, coupled to a primary/secondary system with hydraulic separator and common water pump on the secondary circuit for both the heating circuit and the cooling circuit.
The use of the RB200 device allows the control of third-party appliances, including the third-party appliance water pump on the separable circuit, the temperature of all three circuits (heating, cooling, separable) and the common water pumps on the secondary circuit.
For third-party appliances whose water pump is controlled by the RB200 device, attention must be paid to the antifreeze protection, as the RB200 is not able to activate the appliance or its water pump for the antifreeze function.
Pay attention to the appropriate neutralisation and drainage of condensate in accordance with the applicable standards.
For this type of system, for heating and base DHW services, the "complement" and "complement and replacement" modes are available, while only the "complement" mode is available for separable DHW production and cooling services.
For further information on integration modes, please refer to Section C01.11.
The main advantage of this type of system lies in the possibility of exploiting the simultaneous production of hot water and chilled water by a Link formed by GAHP GS/WS, consequently obtaining very high efficiency values (up to 248%), being able to manage the temperature on both the heating and cooling manifold at the same time, thanks to the presence of a third-party appliance complementing each of the two circuits. In fact, the GAHP GS/WS appliances can only control one of the two temperatures when there is no complement.
As a result, this same system can operate all year round providing both services, with the Link of GAHP GS/WS providing the base load in heating and cooling and third-party appliances stepping in when complement is required.
If the heating and cooling loads are unbalanced in such a way that it is not possible to dissipate (to the heating circuit) or recover (from the cooling circuit) the energy required for the simultaneous operation of all the GAHP GS/WS, the DDC will autonomously switch off the appliances for which load balancing is not possible, activating if necessary the third-party appliances for the service for which there is an energy deficit. This avoids the need for expensive and complex heat exchange systems such as dry-coolers.
DHW production is possible either through the base system, by means of a delivery from the heating manifold, managed by the secondary circuit management system via pump 24 and a suitable temperature probe in the relevant DHW buffer tank, or through the separation of the third-party boiler, diverting the hot water to the DHW buffer tank downstream of the preheating by means of diverter valves.
Preheating pump 24, which is only useful if DHW consumption is high, will only be activated by the secondary circuit management system if the temperature difference between the buffer tank and manifold is sufficient for proper heat exchange.
If there is a base DHW request from thermostat 17, the whole generation system will adjust its setpoint to meet the higher temperature demand between heating and DHW.
If there is a separable DHW service request from thermostat 16, the third-party boiler on the separable circuit will be switched on with the setpoint for separable DHW service (set on the DDC panel or RB200 device) and diverter valves 9 will be switched.
For anti-Legionella disinfection in a system in which preheating takes place in a buffer tank separate from the one served by the separable system, it is even more recommended to use methods other than thermal shock (such as chemical methods, UV Lamps or the addition of ozone).
The separate DHW preheating tank has been foreseen in the event that the thermal load for DHW is high and it is therefore advisable to use at least part of the heating circuit's thermal output for this service, being able to count on the contribution of renewable energy offered by the heat pumps.
DHW production will also be possible with the space heating system switched off thanks to the separation of the third-party boiler.
Positioning DHW immersion thermostats correctly is important for the proper operation of the system. Positioning the thermostat at the top of the buffer tank will result in shorter operation for DHW production service, as the heat stratifying at the top will deactivate the thermostat more quickly. Positioning the thermostat at the bottom of the buffer tank will result in a longer operation for DHW production service, but the average temperature in the DHW will be higher when the thermostat reaches the switch-off temperature.
The correct setting of the thermostat and its differentials is critical for the system to function properly. Setting the temperature too high means leaving the system permanently blocked on the DHW request, preventing the heating system from delivering service. A too reduced differential will in turn lead to numerous service requests of very short duration, with a significant reduction in overall performance.

Also critical is the correct sizing of the DHW buffer tank and its exchange coil, for which reference should be made to Section C01.12.

The RB200 device also allows DHW service requests from the thermostats in the DHW buffer tanks to be interfaced with the DDC panel and diverter valves to be switched.
Diverter valves can be either the on/off type with spring return (in which case only one of the two NO/NC contacts needs to be connected) or the 3-point type.

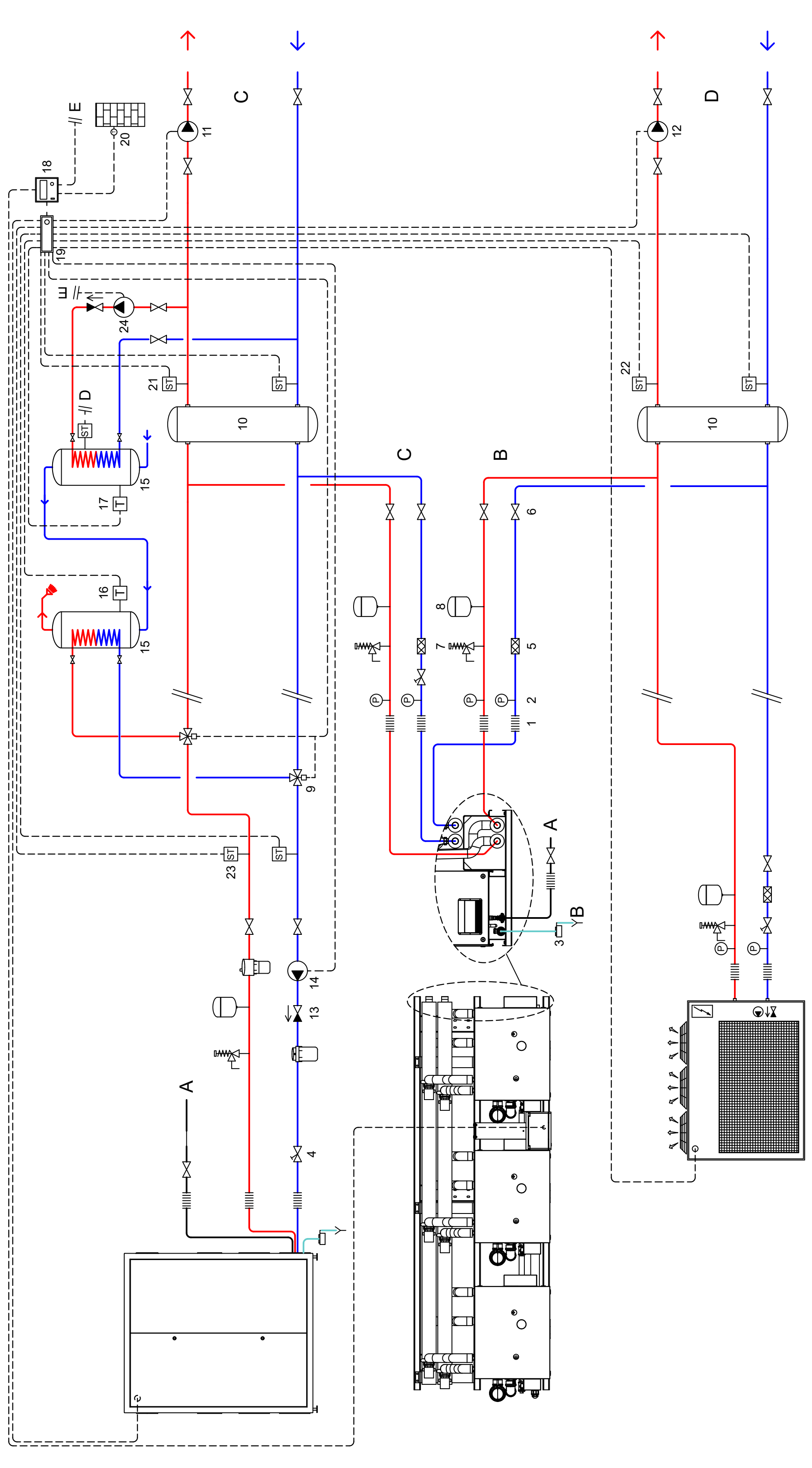
For details on the configuration of CAN bus jumpers on terminal nodes and intermediate nodes of the CAN bus network, please refer to Section C01.10.

When controlling the switching on/off of third-party appliances, it is always advisable to avoid interrupting the electrical power supply to the appliance. There is often a dedicated input for an on/off signal from an external device, which should be used for connection to the RB200, checking in advance in the documentation of the third-party appliance whether this signal is mains voltage or a voltage-free contact.
The control system also includes a secondary circuit management system capable of transmitting a heating/cooling service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distri-

bution circuits switched off.
Two separate and independent requests have been provided because the two heating/cooling circuits can be switched on independently (bearing in mind the considerations regarding simultaneous load shedding already outlined above).
Separable DHW production will always be available, whatever the status of the heating/cooling request contacts.

11.2 PLUMBING DIAGRAM

Figure 11.1 *Plumbing diagram for simultaneous heating and cooling and base and separable DHW with third-party integration*



A Gas connection
B Condensate drain
C Heating circuit
D Cooling circuit
E Secondary circuit management system

System components:

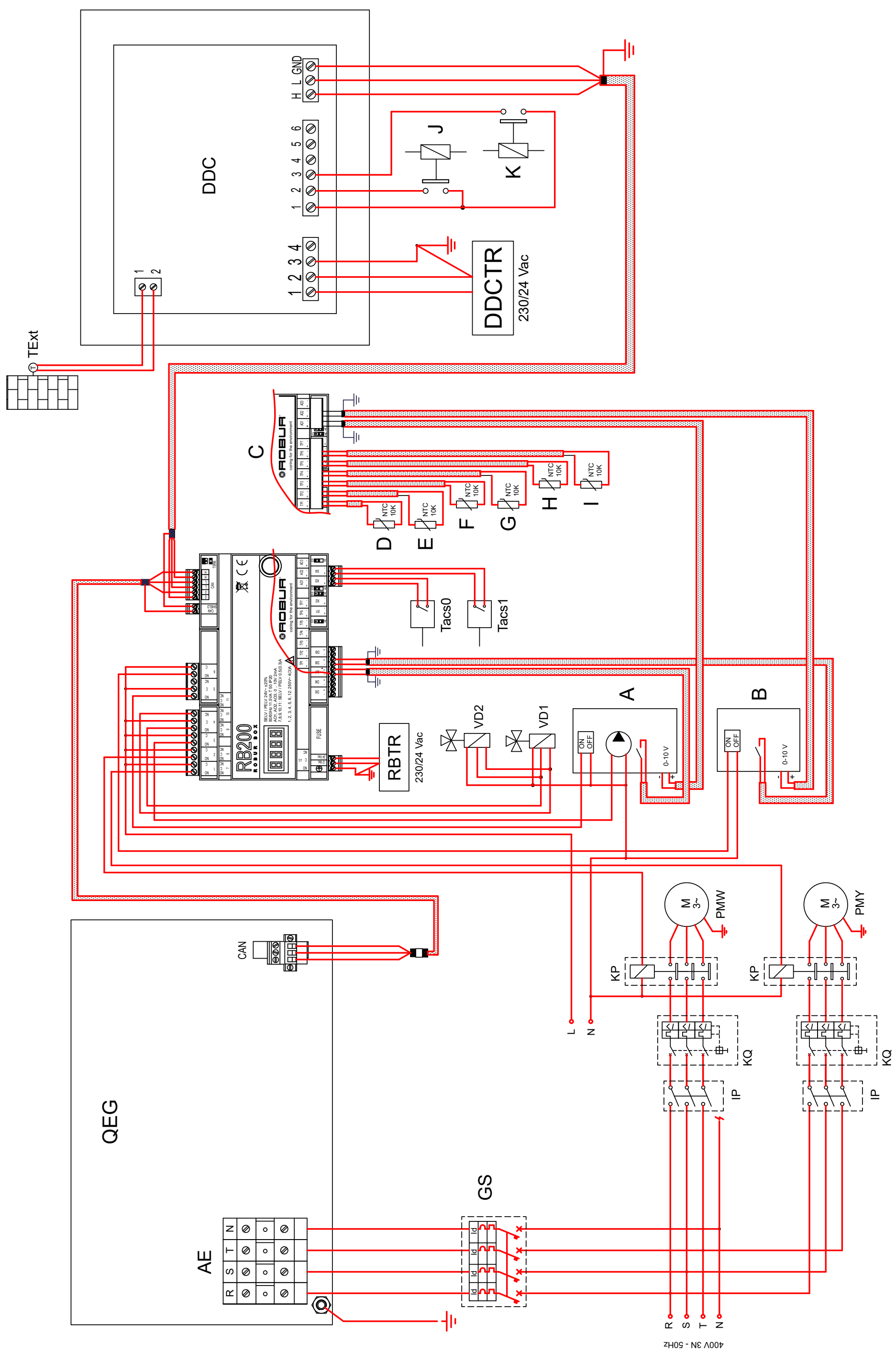
1 Anti-vibration connection
2 Pressure gauge
3 Condensate neutralizer
4 Flow regulation valve
5 Sludge filter
6 Shut-off valve
7 Safety valve
8 Expansion tank
9 3-way diverter valves for DHW
10 Buffer tank (and hydraulic separator)
11 Heating circuit water pump
12 Cooling circuit water pump
13 Check valve
14 Third-party appliance water pump
15 DHW buffer tank
16 Thermostat with adjustable differential for separable DHW
17 Thermostat with adjustable differential for DHW preheating
18 Panel DDC
19 RB200 device
20 Outdoor temperature probe
21 Secondary heating manifold temperature probes
22 Secondary cooling manifold temperature probes
23 Separable manifold temperature probes
24 DHW preheating water pump

Notes:

- DHW preheating pump 24 must be turned off when the heating system is off, or if the temperature difference between manifold and buffer tank is not sufficient for proper heat exchange on the preheating coil

11.3 ELECTRICAL WIRING DIAGRAM

Figure 11.2 *Wiring diagram for simultaneous heating and cooling and base and separable DHW with third-party integration*



A	Third-party generator with water pump controlled by RB200
B	Third-party generator with its own water pump
C	Detail of upper RB200 terminal block
D	Cooling manifold inlet temperature probe
E	Cooling manifold outlet temperature probe
F	Heating manifold inlet temperature probe
G	Heating manifold outlet temperature probe
H	Separable manifold inlet temperature probe
I	Separable manifold outlet temperature probe
J	External heating request
K	External cooling request
DDC	DDC panel

RB200	RB200 device
QEG	Link electrical panel
AE	Power supply input terminals
GS	Three-phase magnetothermic switch
RST	Phases
N	Neutral
	CAN terminal block
GND	Common data
L	Data signal LOW
H	Data signal HIGH
	Components NOT SUPPLIED
DDCTR	Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA

RBTR	Safety transformer 230/24 V AC - 50/60 Hz - 12 VA min
Tacs0	Base DHW request thermostat with adjustable differential
Tacs1	Separable DHW request thermostat with adjustable differential
TExt	Outdoor temperature probe
VD1	3-way diverter valve
VD2	3-way diverter valve
IP	Four-pole pump supply disconnector
KP	Water pump control relay
KQ	400 V AC pump motor protector
PMW	Common water pump of the heating circuit
PMY	Common water pump of the cooling circuit

12 SERIES HEATING (TYPE P4) AND BASE AND SEPARABLE DHW WITH THIRD-PARTY INTEGRATION

12.1 DESCRIPTION

The plumbing diagram in Figure 12.1 *p. 30* shows the use of a Link of heat pumps 5AHT 00-207, consisting of 5 GAHP A, and third-party appliances (boilers) for heating and both base and separable DHW, coupled to a series heating system (type P4, Section C01.11), with a heating loop equipped with a common water pump controlled by RB200 and a 3-pipe hydraulic separator.
Only if the complement and progressive replacement mode is to be used, the GAHP inlet probe must also be installed.
The series installation allows the GAHP to be used on the low-temperature return from the system, even only on a part of the water flow passing through the system, realising an initial increase in temperature with maximum efficiency and then completing the heating up to the required setpoint (which could also be, under the right conditions, beyond the operating limit of the GAHP) thanks to the contribution of the third-party appliances.
The use of the RB200 device allows the control of third-party appliances, including the third-party appliance's water pump on the separable circuit and the heating loop water pump, and of the manifold temperature of both the secondary circuit and the separable circuit, as well as any additional GAHP inlet temperature probe.
For third-party appliances whose water pump is controlled by the RB200 device, attention must be paid to the antifreeze protection, as the RB200 is not able to activate the appliance or its water pump for the antifreeze function.
Pay attention to the appropriate neutralisation and drainage of condensate in accordance with the applicable standards.
For this type of system, for heating and base DHW services, the "complement" and "complement and replacement" modes are available and, if the GAHP inlet probe is also installed, also the "complement and progressive replacement" mode. For separable DHW production, only the "complement" mode is available.

For further information on integration modes, please refer to Section C01.11.

DHW production is possible either through the base system, by means of a delivery from the heating manifold, managed by the secondary circuit management system via pump 24 and a temperature probe in the relevant DHW buffer tank, or through the separation of one of the third-party boilers, diverting the hot water to the DHW buffer tank downstream of the preheating by means of diverter valves.
Preheating pump 24, which is only useful if DHW consumption is high and for systems always active for heating, will only be activated by the secondary circuit management system if the temperature difference between the buffer tank and manifold is sufficient for correct heat exchange, and must be switched off in the summer season.
When there is a request for base DHW from temperature probe 16, the secondary circuit management system will communicate the new setpoint to the generation system to meet the higher temperature request between heating and DHW.
If there is a separate DHW service request by the temperature probe 15, the secondary circuit management system will communicate the request to RB200 and the DDC will switch on the third-party boiler on the separable circuit with the setpoint transmitted by the secondary circuit management system for the separable DHW service and the diverter valves 9 will be switched.

For anti-Legionella disinfection in a system in which preheating takes place in a buffer tank separate from the one served by the separable system, it is even more recommended to use methods other than thermal shock (such as chemical methods, UV Lamps or the addition of ozone).
The separate DHW preheating tank has been foreseen in the event that the thermal load for DHW is high and it is therefore advisable to use at least part of the heating circuit's thermal output for this service, being able to count on the contribution of renewable energy offered by the heat pumps.
DHW production will also be possible with the space heating system switched off thanks to the separation of the third-party boiler.
Positioning DHW temperature probes correctly is important for the proper operation of the system. Positioning the probe at the top of the buffer tank will result in shorter operation for DHW production service, as the heat stratifying at the top will deactivate the thermostat more quickly. Positioning the probe at the bottom of the buffer tank will result in a longer operation for DHW production service, but the average temperature in the DHW will be higher when the probe reaches the setpoint temperature.
The correct setting of the probe setpoints and their differentials are critical for the system to function properly. Setting the temperature too high means leaving the system permanently blocked on the DHW request, preventing the heating system from delivering service. A too reduced differential will in turn lead to numerous service requests of very short duration, with a significant reduction in overall performance.

Also critical is the correct sizing of the DHW buffer tank and its exchange coil, for which reference should be made to Section C01.12.

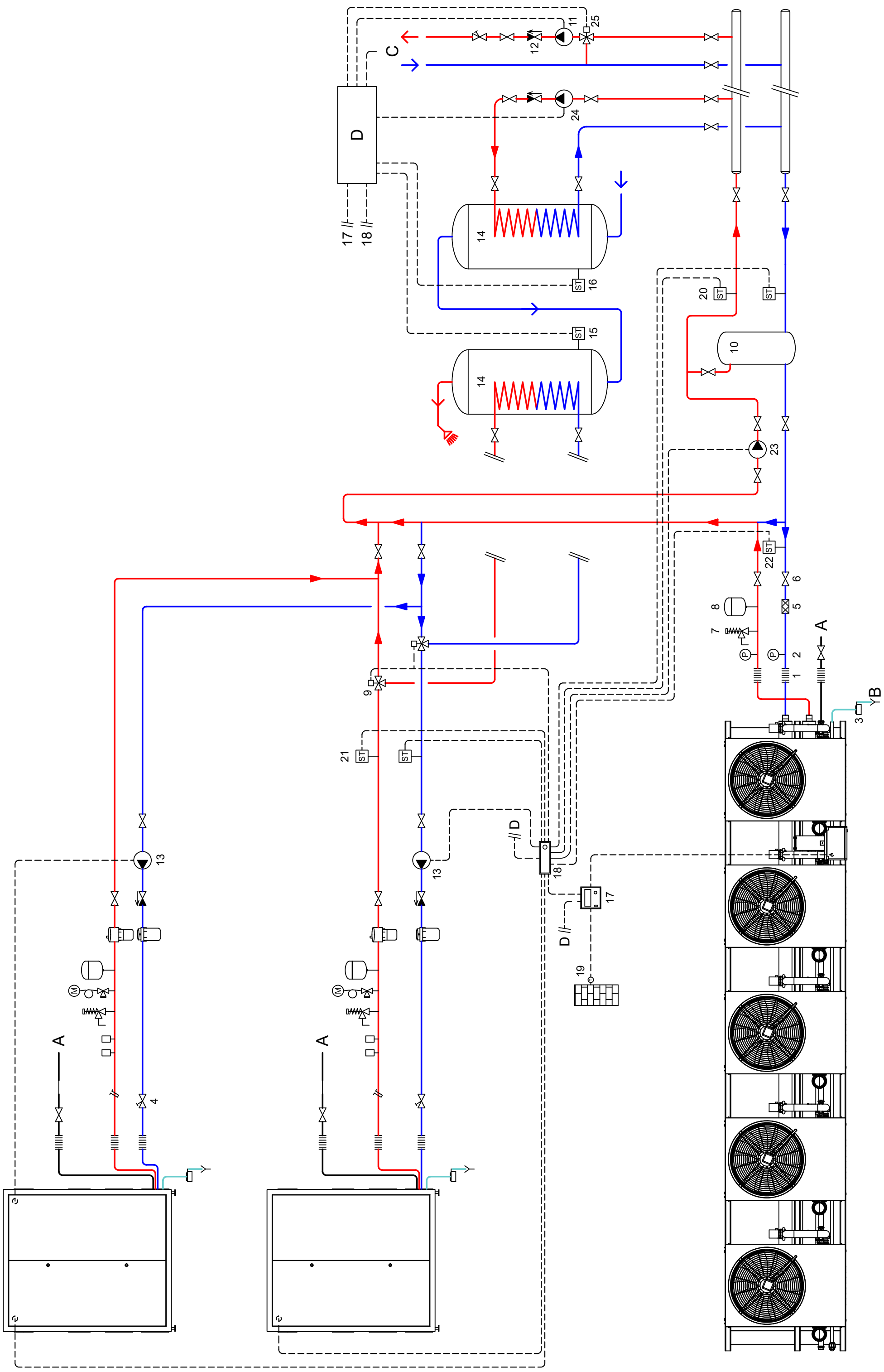
The setpoints for the heating and DHW services (base and separable) are communicated to the RB200 device by the secondary circuit management system via 0-10 V analogue signals. It is possible to configure the RB200 device so that below a certain threshold the signal counts as off of the relevant service, or alternatively to transmit a heating service request on/off signal to the DDC panel based on the request status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits off. The RB200 device will also switch diverter valves in the presence of a separable DHW demand.
Diverter valves can be either the on/off type with spring return (in which case only one of the two NO/NC contacts needs to be connected) or the 3-point type.

For details on the configuration of CAN bus jumpers on terminal nodes and intermediate nodes of the CAN bus network, please refer to Section C01.10.

When controlling the switching on/off of third-party appliances, it is always advisable to avoid interrupting the electrical power supply to the appliance. There is often a dedicated input for an on/off signal from an external device, which should be used for connection to the RB200, checking in advance in the documentation of the third-party appliance whether this signal is mains voltage or a voltage-free contact.
DHW production will always be available, regardless of the activation status of the heating service request.

12.2 PLUMBING DIAGRAM

Figure 12.1 *Plumbing diagram for series heating (type P4) and base and separable DHW*



A Gas connection
B Condensate drain
C Heating circuit
D Secondary circuit management system

System components:

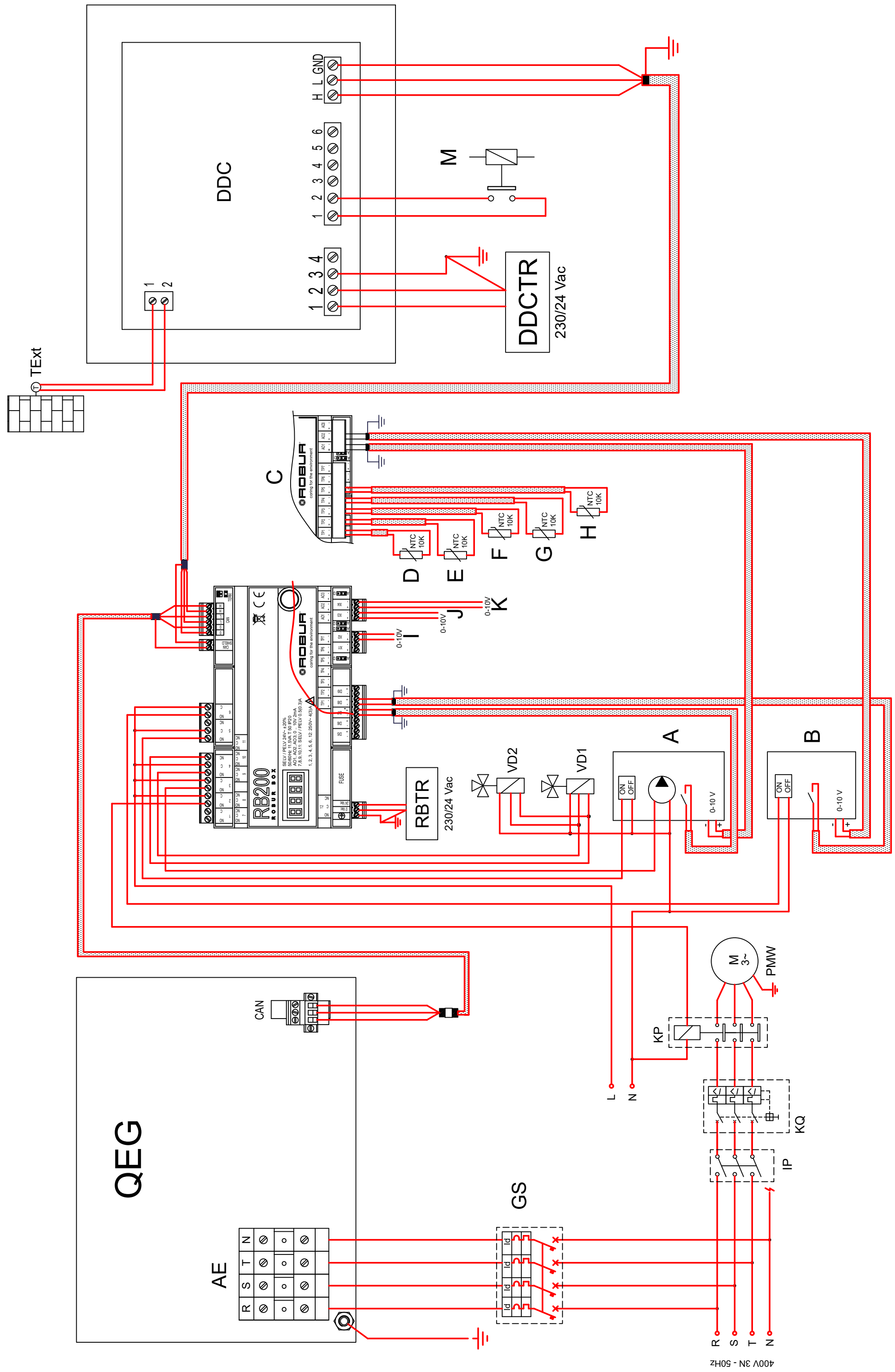
1 Anti-vibration connection
2 Pressure gauge
3 Condensate neutralizer
4 Flow regulation valve
5 Sludge filter
6 Shut-off valve
7 Safety valve
8 Expansion tank
9 3-way diverter valves for DHW
10 Buffer tank (and hydraulic separator)
11 Heating circuit water pump
12 Check valve
13 Third-party appliance water pump
14 DHW buffer tank
15 Separable DHW temperature probe
16 DHW preheating temperature probe
17 Panel DDC
18 RB200 device
19 Outdoor temperature probe
20 Secondary manifold temperature probes
21 Separable manifold temperature probes
22 GAHP inlet temperature probe
23 Heating loop water pump
24 DHW preheating water pump
25 3-way mixing valve

Notes:

- DHW preheating pump 24 must be turned off when the heating system is off, or if the temperature difference between manifold and buffer tank is not sufficient for proper heat exchange on the preheating coil

12.3 ELECTRICAL WIRING DIAGRAM

Figure 12.2 *Wiring diagram for series heating (type P4) and base and separable DHW*



A Third-party generator with water pump controlled by RB200
B Third-party generator with its own water pump
C Detail of upper RB200 terminal block
D Separable manifold outlet temperature probe
E Separable manifold inlet temperature probe
F Heating manifold outlet temperature probe
G Heating manifold inlet temperature probe
H GAHP inlet temperature probe
I 0-10 V heating setpoint input
J 0-10 V DHW0 setpoint input
K 0-10 V DHW1 setpoint input

M External heating request
DDC DDC panel
RB200 RB200 device
QEG Link electrical panel
AE Power supply input terminals
GS Three-phase magnetothermic switch
RST Phases
N Neutral
CAN CAN terminal block
GND Common data
L Data signal LOW

H Data signal HIGH
Components NOT SUPPLIED
DDCTR Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA
RBTR Safety transformer 230/24 V AC - 50/60 Hz - 12 VA min
TExt Outdoor temperature probe
VD1 3-way diverter valve
VD2 3-way diverter valve
IP Four-pole pump supply disconnector
KP Water pump control relay
KQ 400 V AC pump motor protector
PMW Common water pump of the heating circuit

13 SERIES HEATING (TYPE P5) AND BASE DHW WITH THIRD-PARTY INTEGRATION

13.1 DESCRIPTION

The plumbing diagram in Figure 13.1 *p. 33* shows the use of a Link of heat pumps 5AHT 00-207, consisting of 5 GAHP A, and third-party appliances (boilers) for heating and base DHW, coupled to a series heating system (type P5, Section C01.11) and a buffer tank with 4 large connections (e.g. suitable for small district heating networks).
Only if the complement and progressive replacement mode is to be used, the GAHP inlet probe must also be installed.
The series installation allows the GAHP to be used on the low-temperature water withdrawal in the lower part of the buffer tank (the size of which must be such as to allow reasonable stratification of the water, even with the generation system in operation), even only on a part of the water flow that is then processed by the system, realising an initial increase in temperature with maximum efficiency and then completing the heating up to the required setpoint (which could also be, under the right conditions, beyond the operating limit of the GAHP) thanks to the contribution of the third-party appliances that draw precisely from a higher point and deliver into the upper part of the buffer tank.
Using the RB200 device allows the third-party appliances and secondary circuit temperature to be controlled.
Pay attention to the appropriate neutralisation and drainage of condensate in accordance with the applicable standards.
For this type of system, for heating and base DHW services, the "complement" and "complement and replacement" modes are available and, if the GAHP inlet probe is also installed, also the "complement and progressive replacement" mode.

For further information on integration modes, please refer to Section C01.11.

DHW production is done from the heating circuit via the loading pump 20, which will only be activated by the secondary circuit management system if the temperature difference between the DHW buffer tank and the manifold is sufficient for correct heat exchange.
When there is a base DHW request from thermostat 13, the whole generation system will adjust its setpoint to meet the higher temperature demand between heating and DHW.
The diagram also supports anti-legionella thermal disinfection, also by activating a base DHW request from thermostat 14, with a dedicated setpoint (set on the DDC panel or RB200), with a dedicated schedule on the DDC panel.
Since DHW production is carried out exclusively by delivery from the heating manifold, this must be maintained heated for as long as the DHW service is expected to be used.
Positioning DHW immersion thermostats correctly is important for the proper operation of the system. Positioning the thermostat at the top of the buffer tank will result in shorter operation for DHW production service, as the heat stratifying at the top will deactivate the thermostat more quickly. Positioning the thermostat at the bottom of the buffer tank will result in a longer operation for DHW production service, but the average temperature in the DHW will be higher when the thermostat reaches the switch-off temperature.
The correct setting of the thermostat and its differentials is critical for the system to function properly. Setting the temperature too high means leaving the system permanently blocked on the DHW request, altering the temperature from that set for the heating system. A too reduced differential will in turn lead to numerous service requests of very short duration, with a significant reduction in overall performance.

Also critical is the correct sizing of the DHW buffer tank and its exchange coil, for which reference should be made to Section C01.12.

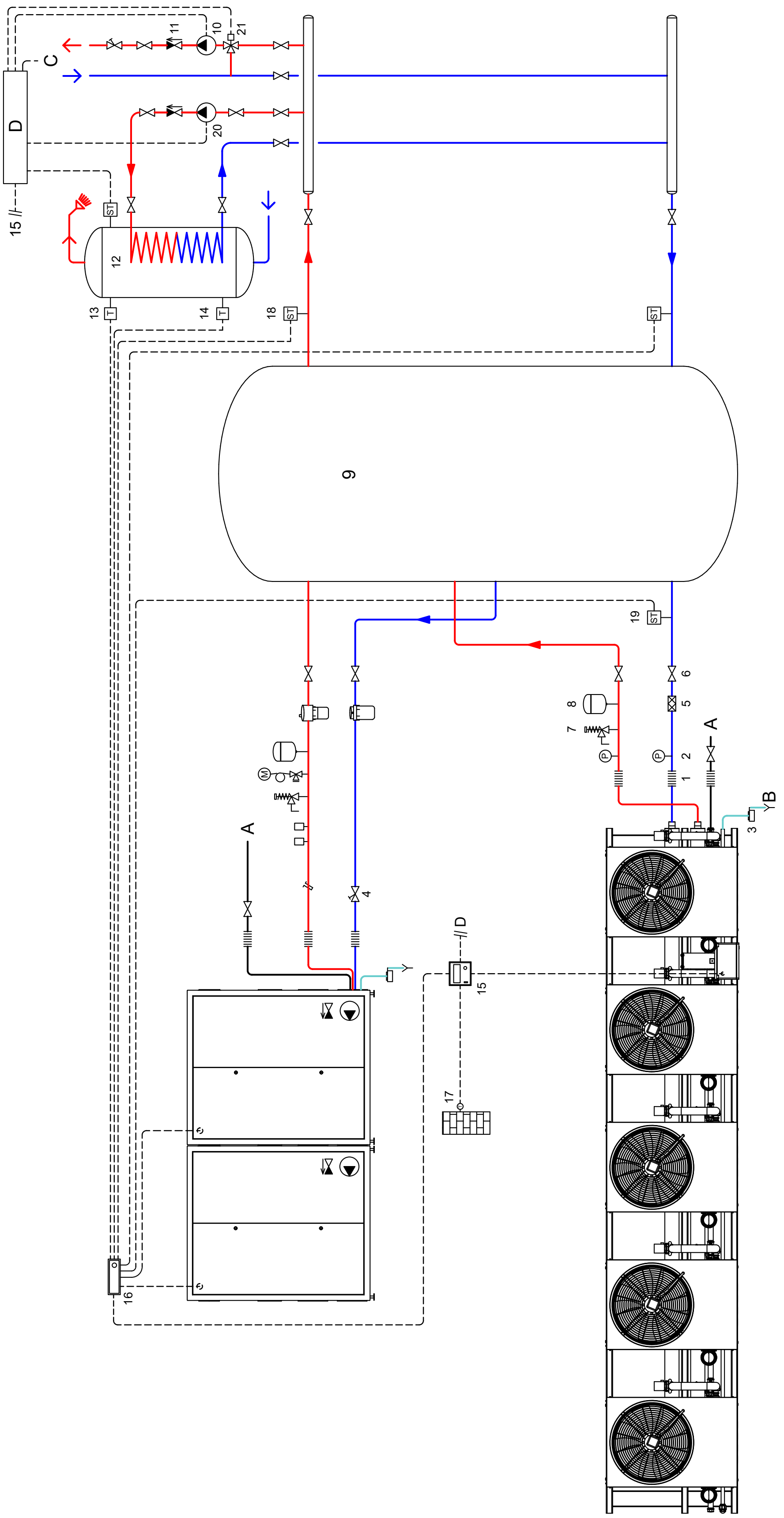
The RB200 device also allows base DHW service requests from thermostats in the DHW buffer tank to be interfaced with the DDC panel.

For details on the configuration of CAN bus jumpers on terminal nodes and intermediate nodes of the CAN bus network, please refer to Section C01.10.

When controlling the switching on/off of third-party appliances, it is always advisable to avoid interrupting the electrical power supply to the appliance. There is often a dedicated input for an on/off signal from an external device, which should be used for connection to the RB200, checking in advance in the documentation of the third-party appliance whether this signal is mains voltage or a voltage-free contact.
The control system also includes a secondary circuit management system capable of transmitting a heating service request activation/deactivation signal to the DDC panel based on the demand status of the consumers. This is extremely useful to prevent the generation system from operating with the distribution circuits switched off.

13.2 PLUMBING DIAGRAM

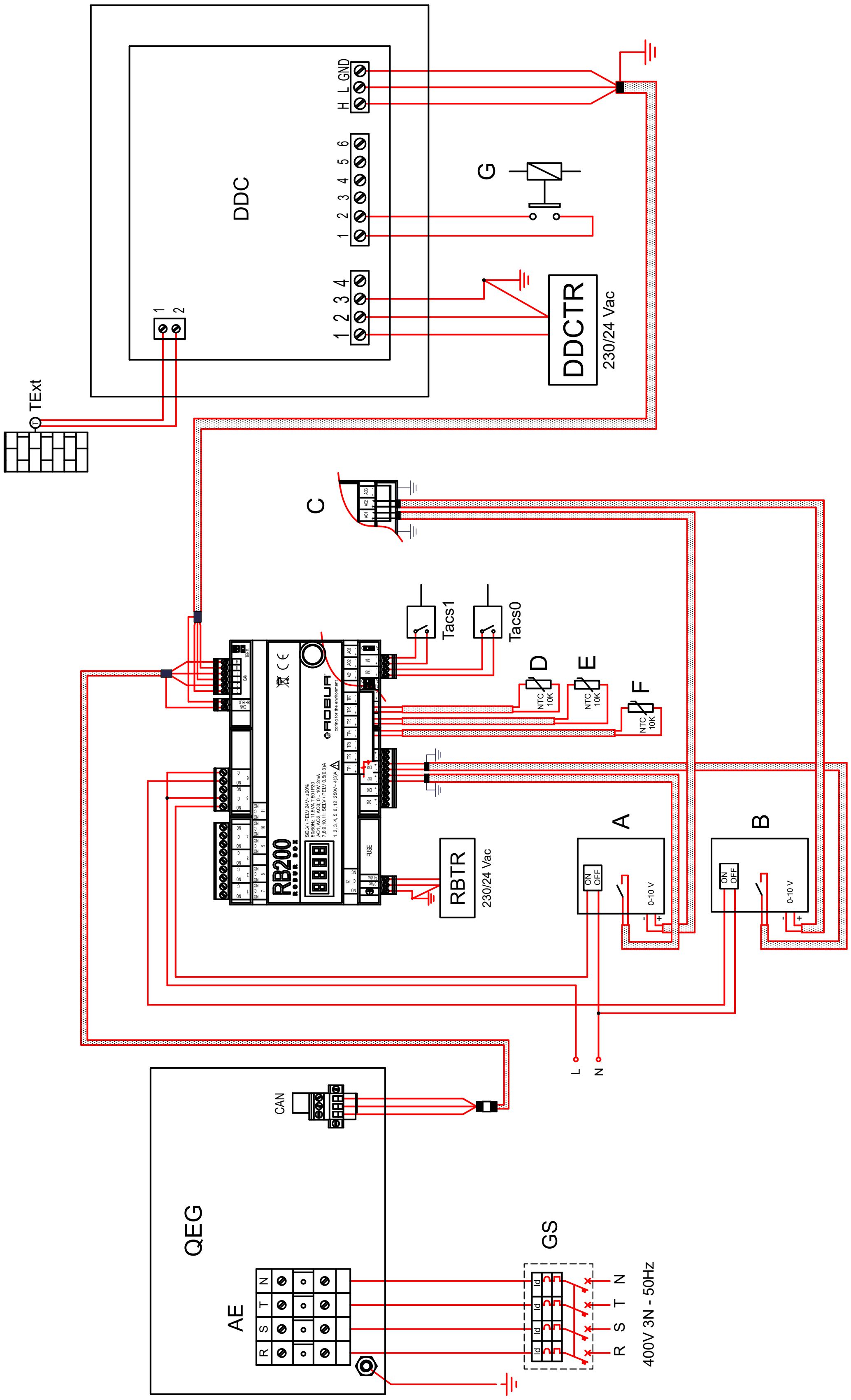
Figure 13.1 *Plumbing diagram for series heating (type P5) and base DHW*



A Gas connection
B Condensate drain
C Heating circuit
D Secondary circuit management system
System components:
1 Anti-vibration connection
2 Pressure gauge
3 Condensate neutralizer
4 Flow regulation valve
5 Sludge filter
6 Shut-off valve
7 Safety valve
8 Expansion tank
9 Buffer tank (and hydraulic separator)
10 Heating circuit water pump
11 Check valve
12 DHW buffer tank
13 Thermostat with adjustable differential for DHW
14 Thermostat with adjustable differential for Legionella function
15 Panel DDC
16 RB200 device
17 Outdoor temperature probe
18 Secondary manifold temperature probe
19 GAHP inlet temperature probe
20 DHW water pump
21 3-way mixing valve

13.3 ELECTRICAL WIRING DIAGRAM

Figure 13.2 *Wiring diagram for series heating (type P5) and base DHW*



A Third-party generator with its own water pump
B Third-party generator with its own water pump
C Detail of upper RB200 terminal block
D Heating manifold outlet temperature probe
E Heating manifold inlet temperature probe
F GAHP inlet temperature probe
G External heating request
DDC DDC panel

RB200 RB200 device
QEG Link electrical panel
AE Power supply input terminals
GS Three-phase magnetothermic switch
RST Phases
N Neutral
CAN CAN terminal block
GND Common data

L Data signal LOW
H Data signal HIGH
Components NOT SUPPLIED
DDCTR Safety transformer 240/24 V AC - 50/60 Hz - min 20 VA
RBTR Safety transformer 230/24 V AC - 50/60 Hz - 12 VA min
Tacs0 DHW request thermostat with adjustable differential
Tacs1 Legionella DHW request thermostat with adjustable differential
TExt Outdoor temperature probe

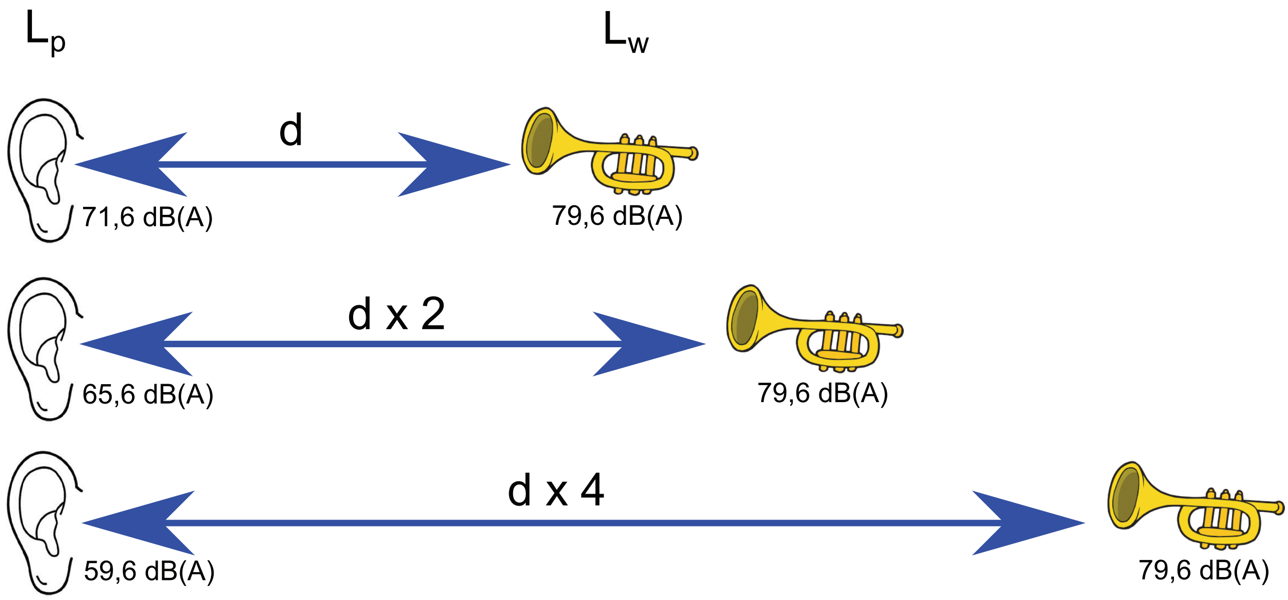
1 ACOUSTIC ISSUES

For all aerothermal appliances for which only outdoor installation is possible, it is essential to assess the acoustic aspects related to the positioning of the units, both for the verification of compliance with any regulatory limits on noise emissions, and for the assessment of the acoustic comfort of the users surrounding the installation site.

2 DEFINITIONS

The measurement unit usually used to express acoustic quantities in the HVAC sector is the dB(A), which is a measurement of sound intensity weighted according to the sensitivity of the human ear (which is higher at low frequencies than at high frequencies).
This is a logarithmic scale, so for example an increase of 3 dB(A) translates into a doubling of the perceived sound intensity.
It is essential to remember the distinction between sound power Lw and sound pressure Lp.
Figure 2.1 *p. 1* lets you intuitively appreciate the difference between sound power Lw and sound pressure Lp.

Figure 2.1 *Sound power and pressure*



d distance of the measuring point from the sound source
Lw [dB(A)] Sound power
Lp [dB(A)] Sound pressure at distance d, with precise positioning of the source

2.1 SOUND POWER LW

Sound power Lw expressed in dB(A) characterises the overall sound emission capacity of the source: it is an intrinsic property of the sound source, independent of the distance from the measuring point.
This value is usually measured in appropriately equipped laboratories and makes it possible to compare different emission sources (appliances).

2.2 SOUND PRESSURE LP

Sound pressure Lp, also expressed in dB(A), on the other hand, is an index of the sound level perceived at a given location and therefore depends on several factors:
- distances of the different sound sources
- directivity factors
- environmental conditions (reverberation)
- background noise

Being a local parameter, it is usually measured on site with a sound level meter.

3 ACOUSTIC ASSESSMENT

Acoustic assessment cannot disregard correct appliance positioning, also in connection with the installation context and the level of naturally occurring background noise (which is higher e.g. in urban settings than in rural settings).
Table 3.1 *p. 2* shows a generic indication of the background noise levels naturally present in some reference environments, expressed as Level of equivalent continuous sound pressure (Leq), which is an average of the sound energy level.
This type of table is established by national and/or local regulations, since they are necessarily affected by lifestyles, climate and architecture of the buildings.

Table 3.1 *Example of background noise levels in reference environments - Leq [dB(A)]*

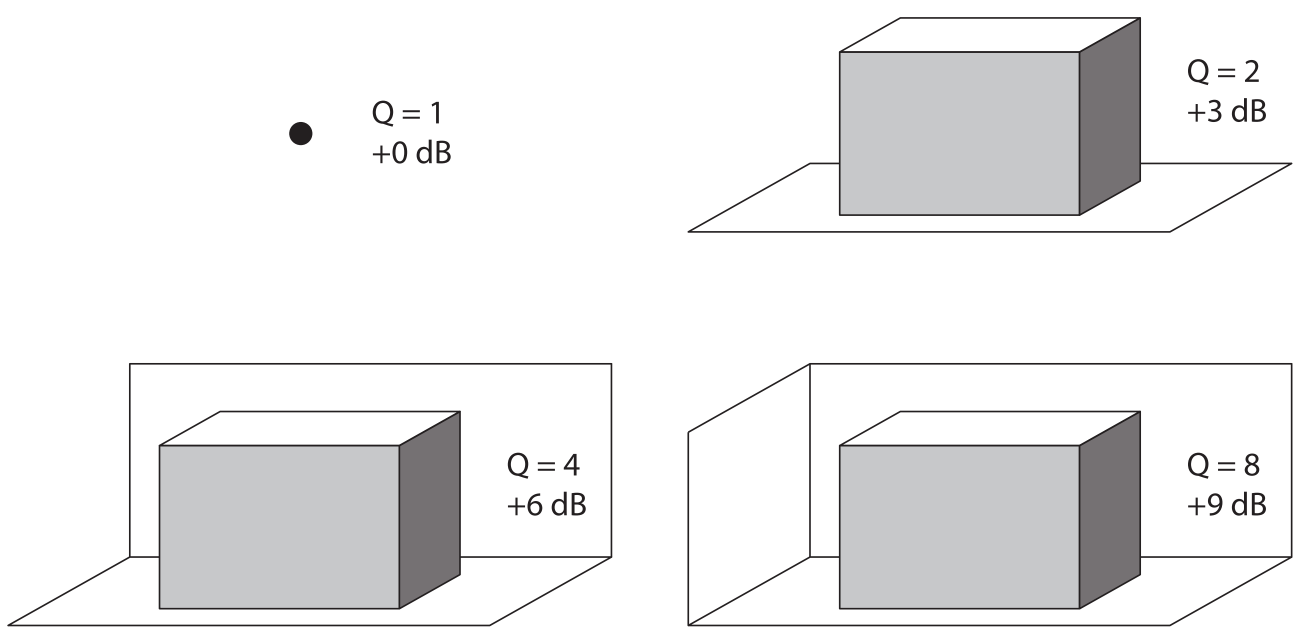
Type of area	Day	Medium	Night
Hospitals, rest areas, protected natural areas	45	40	35
Rural or peripheral residential areas, with low traffic (vehicular/aircraft)	50	45	40
Urban residential areas	55	50	45
Residential and retail areas with medium-high traffic (vehicular/aircraft)	60	55	50
Retail and industrial areas (light industry)	65	60	55
Industrial areas (heavy industry)	65	65	65

Figure 3.1 *p. 2* sets out the sound pressure increase depending on source positioning with respect to any obstacles able to reflect sound.
A sound source sufficiently distant from any obstacle (point source, i.e. directivity factor Q equal to 1) is taken as a reference, which is, however, an absolutely unrealistic case in relation to the actual positioning of the appliances, as they are always at least resting on a flat surface (i.e. directivity factor Q equal to 2 and sound pressure increase of 3 dB(A)).

Sound pressure values for Robur appliances

All sound pressure values published in the technical data tables for Robur appliances (Section B) refer to installation with directivity factor 2, i.e. they already include the 3 dB(A) increase due to positioning the appliance on a flat surface. When comparing with sound pressure values of other manufacturers' appliances, it is essential to check that the directivity factor and the distance to which the sound pressure value refers are the same.

Figure 3.1 *Sound reflection factors*



Q. Directivity factor

It should be considered that acoustic shielding can be combined with visual shielding, which is sometimes required regardless of whether the acoustic aspects are critical or not.

4 OVERALL RESULTING SOUND PRESSURE

The overall sound pressure resulting from the simultaneous presence of several sound sources may be calculated either in a simplified or analytical manner.
In no case, since the dB(A) scale is logarithmic, the calculation can be performed by simply adding up the sound pressure values of the individual appliances.

4.1 SIMPLIFIED CALCULATION

Simplified calculation may only be used if there are two appliances, due to the simplifications it implements.
The difference between the sound pressures Lp between the appliances (<u>both at the same distance and under the same measurement conditions</u>) is taken into account, and based on this, the value indicated in Table 4.1 *p. 3* is added to the highest Lp value.

Table 4.1 *Simplified calculation table of the resulting Lp value*

Difference in dB(A) between L_p figures	dB(A) to be added to the highest L_p value
0÷1	3
2÷3	2
4÷6	1
>6	0

Example of calculation with identical units

Two identical GAHP A HT (sound pressure Lp at 5 metres (max) 57,6 dB(A)) give a resulting total sound pressure Lp of (57,6 + 3 = 60,6 dB(A)) because the difference between the Lp values of the two sound sources is 0 dB and therefore the value to be added to the higher Lp value is 3 dB(A). This in fact, since the dB(A) scale is logarithmic, correctly translates into a doubling of the perceived sound intensity.

Example of calculation with different units

A GAHP A HT S1 (sound pressure Lp at 5 metres (max) 52,0 dB(A)) operating together with a ACF60-00 (sound pressure Lp at 5 metres (max) 57,6 dB(A)) gives a resulting total sound pressure Lp of (57,6 + 1 = 58,6 dB(A)) because the difference between the Lp values of the two sound sources is between 4 and 6 dB(A) and therefore the value to be added to the higher Lp value is 1 dB(A).

4.2 ANALYTICAL CALCULATION

The following formula is to be used for the analytical calculation of the resulting overall sound pressure:

$$L_p = 10\log_{10}\left(\sum_{i=1}^{n} 10^{\frac{(L_p)_i}{10}}\right)$$

Lp is the overall resultant sound pressure level and $(Lp)_i$ is the sound pressure level of the individual sources (<u>all at the same distance and under the same measurement conditions</u>).

Example of calculation

Two GAHP-AR S (sound pressure Lp at 5 metres (max) 53,0 dB(A) each) operating with one GAHP A HT S1 (sound pressure Lp at 5 metres (max) 52,0 dB(A)) lead, applying the above formula, to a total resulting sound pressure of 57,5 dB(A):

$$L_p = 10\log_{10}\left(10^{\frac{53}{10}} + 10^{\frac{53}{10}} + 10^{\frac{52}{10}}\right)$$

1 FIRST START-UP

The purposes of the first start-up, which is always and only to be carried out by an authorised Robur TAC (technical assistance centre), are:

- ensure that the appliances have been correctly installed
- ensure that the appliances can be operated and maintained safely
- set up and configure the appliances correctly

First start-up by the Robur TAC is therefore an indispensable step to ensure the safe and efficient operation of Robur appliances.

1.1 PRELIMINARY CHECKS FOR FIRST START-UP

Upon completing installation, before contacting the TAC the installer must check:

- Water, electrical and gas systems suitable for the required capacities and equipped with all safety and control devices required by the regulations in force.
- Absence of leaks in the water and gas systems.
- Type of gas for which the appliance is designed (natural gas or LPG).
- Gas supply pressure complying with the values required for the appliance.
- Correct operation of the flue exhaust duct.
- Power supply mains complying with the appliance's rating plate data.
- Appliance correctly installed, according to the manufacturer's provisions.
- System installed in a workmanlike manner, according to national and local regulations.

1.2 ABNORMAL OR HAZARDOUS INSTALLATION SITUATIONS

Should any abnormal or hazardous installation situations be found, the TAC shall not perform first start-up and the appliance shall not be commissioned.
These situations may be:

- Appliance installed indoors (excluding GAHP A Indoor, GAHP GS/WS in indoor version and AY boilers).
- Appliance installed indoors without safety valve drain ducting (only for GAHP A Indoor and GAHP GS/WS in indoor version).
- Appliance installations other than type C (only for GAHP A Indoor and GAHP GS/WS indoor version).
- Other gas appliances, not type C, in the installation room (only for GAHP A Indoor and GAHP GS/WS indoor version).
- Failed compliance with minimum clearances.
- Insufficient distance from combustible or flammable materials.
- Conditions that do not warrant access and maintenance in safety.
- Appliance switched on/off with the main switch, instead of the provided control device.
- Appliance defects or faults caused during transport or installation.
- Gas smell.
- Non-compliant mains gas pressure.
- Non-compliant flue gas exhaust.
- Lack of ducting for the fan's exhaust air (only for GAHP A Indoor).
- All situations that may involve operation abnormalities or are potentially hazardous.

1 NORMAL OPERATION

For normal operation of the appliance, once the Robur TAC has completed the first start-up, simply follow the instructions in the installation, use and maintenance manual supplied with the appliance.
If Robur control devices are used to switch on and control the appliance, please refer to the manuals supplied with them for setting operations.
It is important to specify the operating and control requirements of the system as clearly as possible during the first start-up phase, as this allows the Robur TAC to set the adjustment and control systems correctly (if they are in turn provided by Robur), and consequently normal operation will only require minimal changes to the settings already made, drastically reducing the possibility of incorrect settings compromising the efficient operation of the appliance.

2 EFFICIENCY

For greater appliance efficiency:
- Keep the finned coil of the aerothermal appliances clean.
- Set water temperature to the actual system requirement.
- Reduce repeated switch-ons to the minimum (low loads).
- Program appliance activation for actual periods of use.
- Keep water and air filters on plumbing and ventilation systems clean.
- If the use of Link is planned, choose the configuration that provides independent water pumps for each of the modules, so as to ensure that the setpoint is achieved and maintained even under partial load conditions.
- In the case of Link without independent water pumps that are made up of mixed modules, remember to close the isolation valves on the GA ACF modules during the heating operation of the system.
- Avoid changing complex settings, which require specific technical and system engineering knowledge. In such cases, contact Robur TAC.

1 MAINTENANCE

Correct maintenance prevents problems, assures efficiency and keeps running costs low.

Maintenance operations described herein may exclusively be performed by the TAC or skilled maintenance technician.

Any operation on the internal components of the GAHP/GA/AY modules that make up the Link may only be performed by the TAC.

The efficiency checks and every other "check and maintenance operation" (Paragraph 2 *p. 1* and 3 *p. 1*) must be performed with a frequency according to current regulations or, if more restrictive, according to the provisions set forth by the manufacturer, installer or TAC.

Responsibility for efficiency checks, to be carried out for the aims of restricting energy consumption, lies with the system manager.

Environmental or operational heavy conditions

In environmental or operational conditions particularly heavy (for example: heavy-duty use of the appliance, salty environment, etc.), maintenance and cleaning operations must be more frequent.

2 PRE-EMPTIVE MAINTENANCE

For pre-emptive maintenance, comply with the recommendations in Table 2.1 *p. 1*.

		GAHP A	GAHP GS/WS	GA ACF	GAHP-AR
Guidelines for the preventive maintenance operations					
Check of the unit	visually check of the general condition of the unit and of its finned coil	√ (1)	-	√ (1)	√ (1)
	check the correct operation of the device used for monitoring the water flow	√	√	√	√
	check the % value of CO_2	√	√	-	-
	check gas pressure to the burners	-	-	√	√
	check that the condensate drain is clean (If necessary, frequency of the maintenace operation must be increased)	√	√	-	-
	replace the belts after 6 years or 12000 hours of operation	√	√	√	√
	check/restore the pressure of the primary hydronic circuit	-	-	-	-
	check/restore the air pressure inside of the expansion vessel of the primary hydronic circuit	-	-	-	-
	replace the oil pump motor condenser every 3 years or every 10000 operating hours or whenever the condenser capacity is less than 95% of the nominal value	√	√	√	√
Check for every DDC or CCI	check that the plant is able to achieve the setpoint temperature	√	√	√	√
	download the event history	√	√	√	√

(1) It is suggested to clean the finned coil once every 4 years (optimal frequency of the cleaning operation is in any case strongly affected by the installation site). Avoid excessively aggressive cleaning of the finned coil (e.g. high-pressure washer).

3 SCHEDULED ROUTINE MAINTENANCE

3.1 GAHP/GA

For scheduled routine maintenance, perform the operations in Table 3.1 *p. 1*, at least once every 2 years.

		GAHP A	GAHP GS/WS	GA ACF	GAHP-AR
Ordinary scheduled maintenance					
Check of the unit	clean the combustion chamber	√ (1)	√ (1)	√	√ (1)
	clean the burner	√ (1)	√ (1)	√	√ (1)
	clean the ignition and flame sensor electrodes	√	√	√	√
	check that the condensate drain is clean	√	√	-	-

(1) Only in case the analysis of combustion products is non-compliant.

3.2 AY

It is recommended that the following operations and checks be carried out each year:

- ► Combustion circuit functionality and heat exchange control:
  - ■ Burner and flue exhaust duct inspection
  - ■ Cleaning of burner and water/flue exchanger (if applicable)
  - ■ Flame ignition/detection system control
- ► Hydraulic circuit and internal components functionality check:
  - ■ Hydraulic circuit control (pipes, gaskets)

- Expansion tank
- Control and safety devices
- Water temperature probes

► Periodic analysis of combustion, in accordance with regulations in force

1 GAHP A PLUS

Table 8

COMMISSION DELEGATED REGULATION (EU) No 811/2013

Technical parameters for heat pump space heaters and heat pump combination heaters

Model(s):				GAHP A Plus			
Air-to-water heat pump:				yes			
Water-to-water heat pump:				no			
Brine-to-water heat pump:				no			
Low-temperature heat pump:				no			
Equipped with a supplementary heater:				no			
Heat pump combination heater:				no			
Parameters shall be declared for medium-temperature application.							
Parameters shall be declared for average, colder and warmer climate conditions.							
Item	**Symbol**	**Value**	**Unit**	**Item**	**Symbol**	**Value**	**Unit**
AVERAGE CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	31,1	kW	**Seasonal space heating energy efficiency**	η_s	124	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = -7 °C	*Pdh*	27,4	kW	Tj = -7 °C	*PERd*	103	%
Tj = +2 °C	*Pdh*	16,8	kW	Tj = +2 °C	*PERd*	136	%
Tj = +7 °C	*Pdh*	10,9	kW	Tj = +7 °C	*PERd*	130	%
Tj = +12 °C	*Pdh*	4,7	kW	Tj = +12 °C	*PERd*	118	%
T_j = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Bivalent temperature	T_{biv}	-	°C				
Annual energy consumption	Q_{HE}	187	GJ				
COLDER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	28,3	kW	**Seasonal space heating energy efficiency**	η_s	109	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = -7 °C	*Pdh*	17,3	kW	Tj = -7 °C	*PERd*	110	%
Tj = +2 °C	*Pdh*	10,5	kW	Tj = +2 °C	*PERd*	119	%
Tj = +7 °C	*Pdh*	6,8	kW	Tj = +7 °C	*PERd*	115	%
Tj = +12 °C	*Pdh*	3,1	kW	Tj = +12 °C	*PERd*	113	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
T_j = operation limit temperature	*Pdh*	28,3	kW	Tj = operation limit temperature	*PERd*	89	%
For air-to-water heat pumps: Tj = -15 °C (if TOL < -20 °C)	*Pdh*	23,2	kW	For air-to-water heat pumps: Tj = -15 °C (if TOL < -20 °C)	*PERd*	91	%
Bivalent temperature	T_{biv}	-	°C				
Annual energy consumption	Q_{HE}	230	GJ				
WARMER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	37,7	kW	**Seasonal space heating energy efficiency**	η_s	126	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = +2 °C	*Pdh*	37,7	kW	Tj = +2 °C	*PERd*	122	%
Tj = +7 °C	*Pdh*	24,1	kW	Tj = +7 °C	*PERd*	135	%
Tj = +12 °C	*Pdh*	10,9	kW	Tj = +12 °C	*PERd*	125	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Annual energy consumption	Q_{HE}	144	GJ				
Bivalent temperature	T_{biv}	-	°C	For air-to-water heat pumps: Operation limit temperature	*TOL*	-22	°C
				Heating water operating limit temperature	*WTOL*	65	°C
Power consumption in modes other than active mode				Supplementary heater			
Off mode	P_{OFF}	0,000	kW	Rated heat output	*Psup*	-	kW
Thermostat-off mode	P_{TO}	0,021	kW				
Standby mode	P_{SB}	0,005	kW	Type of energy input	monovalent		
Crankcase heater mode	P_{CK}	-	kW				
Other items							
Capacity control	variable			For air-to-water heat pumps: Rated air flow rate, outdoors	—	10000	m³/h
Sound power level, indoors/outdoors	L_{WA}	- / 80	dB	For water- or brine-to-water heat pumps: Rated brine or water flow rate, outdoor heat exchanger	—	-	m³/h
Contact details	Robur SPA, Via Parigi 4/6, I-24040 Zingonia (BG)						

(*) For heat pump space heaters and heat pump combination heaters, the rated heat output *Prated* is equal to the design load for heating *Pdesignh*, and the rated heat output of a supplementary heater *Psup* is equal to the supplementary capacity for heating *sup(Tj)*.

Additional information required by COMMISSION REGULATION (EU) No 813/2013, Table 2:

Emissions of nitrogen oxides:	NO_x	35	mg/kWh

2 GAHP A PLUS S1

Table 8

COMMISSION DELEGATED REGULATION (EU) No 811/2013

Technical parameters for heat pump space heaters and heat pump combination heaters

Model(s):	GAHP A Plus S1
Air-to-water heat pump:	yes
Water-to-water heat pump:	no
Brine-to-water heat pump:	no
Low-temperature heat pump:	no
Equipped with a supplementary heater:	no
Heat pump combination heater:	no
Parameters shall be declared for medium-temperature application.	
Parameters shall be declared for average, colder and warmer climate conditions.	

Item	Symbol	Value	Unit	Item	Symbol	Value	Unit
AVERAGE CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	31,1	kW	**Seasonal space heating energy efficiency**	η_s	125	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = -7 °C	*Pdh*	27,4	kW	Tj = -7 °C	*PERd*	108	%
Tj = +2 °C	*Pdh*	16,8	kW	Tj = +2 °C	*PERd*	137	%
Tj = +7 °C	*Pdh*	10,9	kW	Tj = +7 °C	*PERd*	130	%
Tj = +12 °C	*Pdh*	4,7	kW	Tj = +12 °C	*PERd*	116	%
T_j = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Bivalent temperature	T_{biv}	-	°C				
Annual energy consumption	Q_{HE}	185	GJ				
COLDER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	28,3	kW	**Seasonal space heating energy efficiency**	η_s	111	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = -7 °C	*Pdh*	17,3	kW	Tj = -7 °C	*PERd*	110	%
Tj = +2 °C	*Pdh*	10,5	kW	Tj = +2 °C	*PERd*	124	%
Tj = +7 °C	*Pdh*	6,8	kW	Tj = +7 °C	*PERd*	117	%
Tj = +12 °C	*Pdh*	3,1	kW	Tj = +12 °C	*PERd*	113	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
T_j = operation limit temperature	*Pdh*	28,3	kW	Tj = operation limit temperature	*PERd*	85	%
For air-to-water heat pumps: Tj = -15 °C (if TOL < -20 °C)	*Pdh*	23,2	kW	For air-to-water heat pumps: Tj = -15 °C (if TOL < -20 °C)	*PERd*	89	%
Bivalent temperature	T_{biv}	-	°C				
Annual energy consumption	Q_{HE}	226	GJ				
WARMER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	37,7	kW	**Seasonal space heating energy efficiency**	η_s	128	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = +2 °C	*Pdh*	37,7	kW	Tj = +2 °C	*PERd*	125	%
Tj = +7 °C	*Pdh*	24,1	kW	Tj = +7 °C	*PERd*	136	%
Tj = +12 °C	*Pdh*	10,9	kW	Tj = +12 °C	*PERd*	127	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Annual energy consumption	Q_{HE}	141	GJ				
Bivalent temperature	T_{biv}	-	°C	For air-to-water heat pumps: Operation limit temperature	*TOL*	-22	°C
				Heating water operating limit temperature	*WTOL*	65	°C
Power consumption in modes other than active mode				Supplementary heater			
Off mode	P_{OFF}	0,000	kW	Rated heat output	*Psup*	-	kW
Thermostat-off mode	P_{TO}	0,021	kW				
Standby mode	P_{SB}	0,005	kW	Type of energy input	monovalent		
Crankcase heater mode	P_{CK}	-	kW				
Other items							
Capacity control	variable			For air-to-water heat pumps: Rated air flow rate, outdoors	—	10000	m³/h
Sound power level, indoors/outdoors	L_{WA}	- / 74	dB	For water- or brine-to-water heat pumps: Rated brine or water flow rate, outdoor heat exchanger	—	-	m³/h
Contact details	Robur SPA, Via Parigi 4/6, I-24040 Zingonia (BG)						

(*) For heat pump space heaters and heat pump combination heaters, the rated heat output *Prated* is equal to the design load for heating *Pdesignh* , and the rated heat output of a supplementary heater *Psup* is equal to the supplementary capacity for heating *sup(Tj)* .

Additional information required by COMMISSION REGULATION (EU) No 813/2013, Table 2:

Emissions of nitrogen oxides:	NO_x	35	mg/kWh

3 GAHP AR PLUS

Table 8
COMMISSION DELEGATED REGULATION (EU) No 811/2013
Technical parameters for heat pump space heaters and heat pump combination heaters

Model(s):	GAHP AR Plus
Air-to-water heat pump:	yes
Water-to-water heat pump:	no
Brine-to-water heat pump:	no
Low-temperature heat pump:	no
Equipped with a supplementary heater:	no
Heat pump combination heater:	no
Parameters shall be declared for medium-temperature application.	
Parameters shall be declared for average, colder and warmer climate conditions.	

Item	Symbol	Value	Unit	Item	Symbol	Value	Unit
AVERAGE CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	28,8	kW	**Seasonal space heating energy efficiency**	η_s	120	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = -7 °C	*Pdh*	25,3	kW	Tj = -7 °C	*PERd*	94	%
Tj = +2 °C	*Pdh*	15,5	kW	Tj = +2 °C	*PERd*	131	%
Tj = +7 °C	*Pdh*	10,1	kW	Tj = +7 °C	*PERd*	131	%
Tj = +12 °C	*Pdh*	4,3	kW	Tj = +12 °C	*PERd*	115	%
T_j = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Bivalent temperature	T_{biv}	-	°C				
Annual energy consumption	Q_{HE}	178	GJ				
COLDER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	27,1	kW	**Seasonal space heating energy efficiency**	η_s	105	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = -7 °C	*Pdh*	16,5	kW	Tj = -7 °C	*PERd*	100	%
Tj = +2 °C	*Pdh*	10,0	kW	Tj = +2 °C	*PERd*	119	%
Tj = +7 °C	*Pdh*	6,5	kW	Tj = +7 °C	*PERd*	114	%
Tj = +12 °C	*Pdh*	3,0	kW	Tj = +12 °C	*PERd*	109	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
T_j = operation limit temperature	*Pdh*	27,1	kW	Tj = operation limit temperature	*PERd*	86	%
For air-to-water heat pumps: Tj = -15 °C (if TOL < -20 °C)	*Pdh*	22,2	kW	For air-to-water heat pumps: Tj = -15 °C (if TOL < -20 °C)	*PERd*	84	%
Bivalent temperature	T_{biv}	-	°C				
Annual energy consumption	Q_{HE}	229	GJ				
WARMER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	34,7	kW	**Seasonal space heating energy efficiency**	η_s	121	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = +2 °C	*Pdh*	34,7	kW	Tj = +2 °C	*PERd*	119	%
Tj = +7 °C	*Pdh*	22,2	kW	Tj = +7 °C	*PERd*	132	%
Tj = +12 °C	*Pdh*	10,1	kW	Tj = +12 °C	*PERd*	122	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Annual energy consumption	Q_{HE}	138	GJ				
Bivalent temperature	T_{biv}	-	°C	For air-to-water heat pumps: Operation limit temperature	*TOL*	-22	°C
				Heating water operating limit temperature	*WTOL*	60	°C
Power consumption in modes other than active mode				Supplementary heater			
Off mode	P_{OFF}	0,000	kW	Rated heat output	*Psup*	-	kW
Thermostat-off mode	P_{TO}	0,023	kW				
Standby mode	P_{SB}	0,007	kW	Type of energy input		monovalent	
Crankcase heater mode	P_{CK}	-	kW				
Other items							
Capacity control		variable		For air-to-water heat pumps: Rated air flow rate, outdoors	—	10000	m³/h
Sound power level, indoors/outdoors	L_{WA}	- / 80	dB	For water- or brine-to-water heat pumps: Rated brine or water flow rate, outdoor heat exchanger	—	-	m³/h
Contact details	Robur SPA, Via Parigi 4/6, I-24040 Zingonia (BG)						

(*) For heat pump space heaters and heat pump combination heaters, the rated heat output *Prated* is equal to the design load for heating *Pdesignh*, and the rated heat output of a supplementary heater *Psup* is equal to the supplementary capacity for heating *sup(Tj)*.

Additional information required by COMMISSION REGULATION (EU) No 813/2013, Table 2:

Emissions of nitrogen oxides:	NO_x	35	mg/kWh

4 GAHP AR PLUS S1

Table 8
COMMISSION DELEGATED REGULATION (EU) No 811/2013
Technical parameters for heat pump space heaters and heat pump combination heaters

Model(s):	GAHP AR Plus S1
Air-to-water heat pump:	yes
Water-to-water heat pump:	no
Brine-to-water heat pump:	no
Low-temperature heat pump:	no
Equipped with a supplementary heater:	no
Heat pump combination heater:	no
Parameters shall be declared for medium-temperature application.	
Parameters shall be declared for average, colder and warmer climate conditions.	

Item	Symbol	Value	Unit	Item	Symbol	Value	Unit
AVERAGE CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	28,8	kW	**Seasonal space heating energy efficiency**	η_s	121	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = -7 °C	*Pdh*	25,3	kW	Tj = -7 °C	*PERd*	94	%
Tj = +2 °C	*Pdh*	15,5	kW	Tj = +2 °C	*PERd*	133	%
Tj = +7 °C	*Pdh*	10,1	kW	Tj = +7 °C	*PERd*	132	%
Tj = +12 °C	*Pdh*	4,3	kW	Tj = +12 °C	*PERd*	116	%
T_j = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Bivalent temperature	T_{biv}	-	°C				
Annual energy consumption	Q_{HE}	177	GJ				
COLDER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	27,1	kW	**Seasonal space heating energy efficiency**	η_s	106	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = -7 °C	*Pdh*	16,5	kW	Tj = -7 °C	*PERd*	101	%
Tj = +2 °C	*Pdh*	10,0	kW	Tj = +2 °C	*PERd*	120	%
Tj = +7 °C	*Pdh*	6,5	kW	Tj = +7 °C	*PERd*	116	%
Tj = +12 °C	*Pdh*	3,0	kW	Tj = +12 °C	*PERd*	109	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
T_j = operation limit temperature	*Pdh*	27,1	kW	Tj = operation limit temperature	*PERd*	86	%
For air-to-water heat pumps: Tj = -15 °C (if TOL < -20 °C)	*Pdh*	22,2	kW	For air-to-water heat pumps: Tj = -15 °C (if TOL < -20 °C)	*PERd*	85	%
Bivalent temperature	T_{biv}	-	°C				
Annual energy consumption	Q_{HE}	227	GJ				
WARMER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	34,7	kW	**Seasonal space heating energy efficiency**	η_s	123	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = +2 °C	*Pdh*	34,7	kW	Tj = +2 °C	*PERd*	120	%
Tj = +7 °C	*Pdh*	22,2	kW	Tj = +7 °C	*PERd*	135	%
Tj = +12 °C	*Pdh*	10,1	kW	Tj = +12 °C	*PERd*	122	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Annual energy consumption	Q_{HE}	136	GJ				
Bivalent temperature	T_{biv}	-	°C	For air-to-water heat pumps: Operation limit temperature	*TOL*	-22	°C
				Heating water operating limit temperature	*WTOL*	60	°C
Power consumption in modes other than active mode				Supplementary heater			
Off mode	P_{OFF}	0,000	kW	Rated heat output	*Psup*	-	kW
Thermostat-off mode	P_{TO}	0,021	kW	Type of energy input		monovalent	
Standby mode	P_{SB}	0,005	kW				
Crankcase heater mode	P_{CK}	-	kW				
Other items							
Capacity control	variable			For air-to-water heat pumps: Rated air flow rate, outdoors	—	10000	m³/h
Sound power level, indoors/outdoors	L_{WA}	- / 74	dB	For water- or brine-to-water heat pumps: Rated brine or water flow rate, outdoor heat exchanger	—	-	m³/h
Contact details	Robur SPA, Via Parigi 4/6, I-24040 Zingonia (BG)						

(*) For heat pump space heaters and heat pump combination heaters, the rated heat output *Prated* is equal to the design load for heating *Pdesignh*, and the rated heat output of a supplementary heater *Psup* is equal to the supplementary capacity for heating *sup(Tj)*.

Additional information required by COMMISSION REGULATION (EU) No 813/2013, Table 2:

Emissions of nitrogen oxides:	NO_x	35	mg/kWh

5 GAHP GS PLUS

Table 8
COMMISSION DELEGATED REGULATION (EU) No 811/2013
Technical parameters for heat pump space heaters and heat pump combination heaters

Model(s):				GAHP GS Plus			
Air-to-water heat pump:				no			
Water-to-water heat pump:				no			
Brine-to-water heat pump:				yes			
Low-temperature heat pump:				no			
Equipped with a supplementary heater:				no			
Heat pump combination heater:				no			
Parameters shall be declared for medium-temperature application.							
Parameters shall be declared for average, colder and warmer climate conditions.							
Item	**Symbol**	**Value**	**Unit**	**Item**	**Symbol**	**Value**	**Unit**
AVERAGE CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	37,4	kW	**Seasonal space heating energy efficiency**	η_s	125	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = –7 °C	*Pdh*	32,9	kW	Tj = –7 °C	*PERd*	128	%
Tj = +2 °C	*Pdh*	20,2	kW	Tj = +2 °C	*PERd*	130	%
Tj = +7 °C	*Pdh*	13,1	kW	Tj = +7 °C	*PERd*	128	%
Tj = +12 °C	*Pdh*	5,6	kW	Tj = +12 °C	*PERd*	123	%
T_j = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Annual energy consumption	Q_{HE}	223	GJ				
COLDER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	37,4	kW	**Seasonal space heating energy efficiency**	η_s	124	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = –7 °C	*Pdh*	22,8	kW	Tj = –7 °C	*PERd*	129	%
Tj = +2 °C	*Pdh*	13,8	kW	Tj = +2 °C	*PERd*	128	%
Tj = +7 °C	*Pdh*	9,0	kW	Tj = +7 °C	*PERd*	126	%
Tj = +12 °C	*Pdh*	4,1	kW	Tj = +12 °C	*PERd*	122	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
T_j = operation limit temperature	*Pdh*	37,4	kW	Tj = operation limit temperature	*PERd*	128	%
For air-to-water heat pumps: T_j = –15 °C (if TOL < –20 °C)	*Pdh*	30,7	kW	For air-to-water heat pumps: Tj = –15 °C (if TOL < –20 °C)	*PERd*	128	%
Annual energy consumption	Q_{HE}	268	GJ				
WARMER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	37,4	kW	**Seasonal space heating energy efficiency**	η_s	124	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = +2 °C	*Pdh*	37,4	kW	Tj = +2 °C	*PERd*	128	%
Tj = +7 °C	*Pdh*	23,9	kW	Tj = +7 °C	*PERd*	129	%
Tj = +12 °C	*Pdh*	10,9	kW	Tj = +12 °C	*PERd*	127	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Annual energy consumption	Q_{HE}	145	GJ				
Bivalent temperature	T_{biv}	TOL < $T_{designh}$	°C	For air-to-water heat pumps: Operation limit temperature	*TOL*	-	°C
				Heating water operating limit temperature	*WTOL*	65	°C
Power consumption in modes other than active mode				Supplementary heater			
Off mode	P_{OFF}	0,000	kW	Rated heat output	*Psup*	-	kW
Thermostat-off mode	P_{TO}	0,019	kW				
Standby mode	P_{SB}	0,005	kW	Type of energy input		monovalent	
Crankcase heater mode	P_{CK}	-	kW				
Other items							
Capacity control		variable		For air-to-water heat pumps: Rated air flow rate, outdoors	—	-	m³/h
Sound power level, indoors/outdoors	L_{WA}	- / 66	dB	For water- or brine-to-water heat pumps: Rated brine or water flow rate, outdoor heat exchanger	—	3,0	m³/h
Contact details	Robur SPA, Via Parigi 4/6, I-24040 Zingonia (BG)						

(*) For heat pump space heaters and heat pump combination heaters, the rated heat output *Prated* is equal to the design load for heating *Pdesignh* , and the rated heat output of a supplementary heater *Psup* is equal to the supplementary capacity for heating *sup(Tj)* .

Additional information required by COMMISSION REGULATION (EU) No 813/2013, Table 2:

Emissions of nitrogen oxides:	NO_x	40	mg/kWh

6 GAHP WS PLUS

Table 8

COMMISSION DELEGATED REGULATION (EU) No 811/2013

Technical parameters for heat pump space heaters and heat pump combination heaters

Model(s):	GAHP WS Plus
Air-to-water heat pump:	no
Water-to-water heat pump:	yes
Brine-to-water heat pump:	no
Low-temperature heat pump:	no
Equipped with a supplementary heater:	no
Heat pump combination heater:	no
Parameters shall be declared for medium-temperature application.	
Parameters shall be declared for average, colder and warmer climate conditions.	

Item	**Symbol**	**Value**	**Unit**	**Item**	**Symbol**	**Value**	**Unit**
AVERAGE CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	41,5	kW	**Seasonal space heating energy efficiency**	η_s	127	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = –7 °C	*Pdh*	36,5	kW	Tj = –7 °C	*PERd*	139	%
Tj = +2 °C	*Pdh*	22,4	kW	Tj = +2 °C	*PERd*	135	%
Tj = +7 °C	*Pdh*	14,5	kW	Tj = +7 °C	*PERd*	127	%
Tj = +12 °C	*Pdh*	6,2	kW	Tj = +12 °C	*PERd*	121	%
T_j = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Annual energy consumption	Q_{HE}	243	GJ				
COLDER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	41,5	kW	**Seasonal space heating energy efficiency**	η_s	125	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = –7 °C	*Pdh*	25,3	kW	Tj = –7 °C	*PERd*	135	%
Tj = +2 °C	*Pdh*	15,4	kW	Tj = +2 °C	*PERd*	128	%
Tj = +7 °C	*Pdh*	10,0	kW	Tj = +7 °C	*PERd*	124	%
Tj = +12 °C	*Pdh*	4,6	kW	Tj = +12 °C	*PERd*	119	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
T_j = operation limit temperature	*Pdh*	41,5	kW	Tj = operation limit temperature	*PERd*	142	%
For air-to-water heat pumps: T_j = –15 °C (if TOL < –20 °C)	*Pdh*	34,0	kW	For air-to-water heat pumps: Tj = –15 °C (if TOL < –20 °C)	*PERd*	138	%
Annual energy consumption	Q_{HE}	294	GJ				
WARMER CLIMATE CONDITIONS							
Rated heat output (*)	*Prated*	41,5	kW	**Seasonal space heating energy efficiency**	η_s	126	%
Declared capacity for heating for part load at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance or primary energy ratio for part load at indoor temperature 20 °C and outdoor temperature Tj			
Tj = +2 °C	*Pdh*	41,5	kW	Tj = +2 °C	*PERd*	142	%
Tj = +7 °C	*Pdh*	26,6	kW	Tj = +7 °C	*PERd*	136	%
Tj = +12 °C	*Pdh*	12,0	kW	Tj = +12 °C	*PERd*	125	%
Tj = bivalent temperature	*Pdh*	-	kW	Tj = bivalent temperature	*PERd*	-	%
Annual energy consumption	Q_{HE}	158	GJ				
Bivalent temperature	T_{biv}	TOL < $T_{designh}$	°C	For air-to-water heat pumps: Operation limit temperature	*TOL*	-	°C
				Heating water operating limit temperature	*WTOL*	65	°C
Power consumption in modes other than active mode				Supplementary heater			
Off mode	P_{OFF}	0,000	kW	Rated heat output	*Psup*	-	kW
Thermostat-off mode	P_{TO}	0,019	kW				
Standby mode	P_{SB}	0,005	kW	Type of energy input		monovalent	
Crankcase heater mode	P_{CK}	-	kW				
Other items							
Capacity control		variable		For air-to-water heat pumps: Rated air flow rate, outdoors	—	-	m³/h
Sound power level, indoors/outdoors	L_{WA}	- / 66	dB	For water- or brine-to-water heat pumps: Rated brine or water flow rate, outdoor heat exchanger	—	2,9	m³/h
Contact details	Robur SPA, Via Parigi 4/6, I-24040 Zingonia (BG)						

(*) For heat pump space heaters and heat pump combination heaters, the rated heat output *Prated* is equal to the design load for heating *Pdesignh*, and the rated heat output of a supplementary heater *Psup* is equal to the supplementary capacity for heating *sup(Tj)*.

Additional information required by COMMISSION REGULATION (EU) No 813/2013, Table 2:

Emissions of nitrogen oxides:	NO_x	40	mg/kWh

7 AY 35

Figure 7.1

Table 7

COMMISSION DELEGATED REGULATION (EU) No 811/2013

Technical parameters for boiler space heaters, boiler combination heaters and cogeneration space heaters

Model(s):				AY 35			
Condensing boiler:				yes			
Low-temperature (**) boiler:				no			
B11 boiler:				no			
Cogeneration space heater:		no		If yes, equipped with a supplementary heater:		no	
Combination heater:				no			
Item	**Symbol**	**Value**	**Unit**	**Item**	**Symbol**	**Value**	**Unit**
Rated heat output	*Prated*	33,3	kW	**Seasonal space heating energy efficiency**	η_s	92,7	%
For boiler space heaters and boiler combination heaters: Useful heat output				For boiler space heaters and boiler combination heaters: Useful efficiency			
At rated heat output and high-temperature regime (*)	P_4	33,3	kW	At rated heat output and high-temperature regime (*)	η_4	88,3	%
At 30 % of rated heat output and low-temperature regime (**)	P_1	10,0	kW	At 30 % of rated heat output and low-temperature regime (**)	η_1	97,8	%
Auxiliary electricity consumption				Other items			
At full load	*elmax*	0,088	kW	Standby heat loss	P_{stby}	0,059	kW
At part load	*elmin*	0,017	kW	Ignition burner power consumption	P_{ign}	0	kW
In standby mode	P_{SB}	0,004	kW	Annual energy consumption	Q_{HE}	266,8	GJ
				Sound power level, indoors/outdoors	L_{WA}	- / 52,4	dB

(*) High-temperature regime means 60 °C return temperature at heater inlet and 80 °C feed temperature at heater outlet.

(**) Low temperature means for condensing boilers 30 °C, for low-temperature boilers 37 °C and for other heaters 50 °C return temperature (at heater inlet).

Contact details	Robur SPA, Via Parigi 4/6, I-24040 Zingonia (BG)

Additional information required by COMMISSION REGULATION (EU) No 813/2013, Table 1:

Emissions of nitrogen oxides: NO_x 49 mg/kWh

8 AY 50

Figure 8.1

Table 7

COMMISSION DELEGATED REGULATION (EU) No 811/2013

Technical parameters for boiler space heaters, boiler combination heaters and cogeneration space heaters

Model(s):				AY 50			
Condensing boiler:				yes			
Low-temperature (**) boiler:				no			
B11 boiler:				no			
Cogeneration space heater:			no	If yes, equipped with a supplementary heater:			no
Combination heater:				no			
Item	**Symbol**	**Value**	**Unit**	**Item**	**Symbol**	**Value**	**Unit**
Rated heat output	*Prated*	49,2	kW	**Seasonal space heating energy efficiency**	η_s	93	%
For boiler space heaters and boiler combination heaters: Useful heat output				For boiler space heaters and boiler combination heaters: Useful efficiency			
At rated heat output and high-temperature regime (*)	P_4	49,2	kW	At rated heat output and high-temperature regime (*)	η_4	88,1	%
At 30 % of rated heat output and low-temperature regime (**)	P_1	14,8	kW	At 30 % of rated heat output and low-temperature regime (**)	η_1	98,0	%
Auxiliary electricity consumption				Other items			
At full load	*elmax*	0,113	kW	Standby heat loss	P_{stby}	0,059	kW
At part load	*elmin*	0,017	kW	Ignition burner power consumption	P_{ign}	0	kW
In standby mode	P_{SB}	0,004	kW	Annual energy consumption	Q_{HE}	393,1	GJ
				Sound power level, indoors/outdoors	L_{WA}	- / 52,4	dB

(*) High-temperature regime means 60 °C return temperature at heater inlet and 80 °C feed temperature at heater outlet.

(**) Low temperature means for condensing boilers 30 °C, for low-temperature boilers 37 °C and for other heaters 50 °C return temperature (at heater inlet).

Contact details	Robur SPA, Via Parigi 4/6, I-24040 Zingonia (BG)

Additional information required by COMMISSION REGULATION (EU) No 813/2013, Table 1:

Emissions of nitrogen oxides: NO_x 46 mg/kWh

9 AY 100

Figure 9.1

Table 7

COMMISSION DELEGATED REGULATION (EU) No 811/2013

Technical parameters for boiler space heaters, boiler combination heaters and cogeneration space heaters

Model(s):				AY 100			
Condensing boiler:				yes			
Low-temperature (**) boiler:				no			
B11 boiler:				no			
Cogeneration space heater:			no	If yes, equipped with a supplementary heater:			no
Combination heater:				no			
Item	**Symbol**	**Value**	**Unit**	**Item**	**Symbol**	**Value**	**Unit**
Rated heat output	*Prated*	98,4	kW	**Seasonal space heating energy efficiency**	η_s	93,1	%
For boiler space heaters and boiler combination heaters: Useful heat output				For boiler space heaters and boiler combination heaters: Useful efficiency			
At rated heat output and high-temperature regime (*)	P_4	98,4	kW	At rated heat output and high-temperature regime (*)	η_4	88,1	%
At 30 % of rated heat output and low-temperature regime (**)	P_1	30,0	kW	At 30 % of rated heat output and low-temperature regime (**)	η_1	98,0	%
Auxiliary electricity consumption				Other items			
At full load	*elmax*	0,225	kW	Standby heat loss	P_{stby}	0,100	kW
At part load	*elmin*	0,023	kW	Ignition burner power consumption	P_{ign}	0	kW
In standby mode	P_{SB}	0,004	kW	Annual energy consumption	Q_{HE}	785,3	GJ
				Sound power level, indoors/outdoors	L_{WA}	- / 52,0	dB

(*) High-temperature regime means 60 °C return temperature at heater inlet and 80 °C feed temperature at heater outlet.

(**) Low temperature means for condensing boilers 30 °C, for low-temperature boilers 37 °C and for other heaters 50 °C return temperature (at heater inlet).

Contact details	Robur SPA, Via Parigi 4/6, I-24040 Zingonia (BG)

Additional information required by COMMISSION REGULATION (EU) No 813/2013, Table 1:

Emissions of nitrogen oxides: NO_x 50 mg/kWh

10 DDC PANEL

IT	:	REGOLAMENTO DELEGATO (UE) N. 811/2013 DELLA COMMISSIONE	DISPOSITIVI DI CONTROLLO DELLA TEMPERATURA
EN	:	COMMISSION DELEGATED REGULATION (EU) No 811/2013	TEMPERATURE CONTROLS
FR	:	RÈGLEMENT DÉLÉGUÉ (UE) N o 811/2013 DE LA COMMISSION	RÉGULATEURS DE TEMPÉRATURE
DE	:	DELEGIERTE VERORDNUNG (EU) Nr. 811/2013 DER KOMMISSION	TEMPERATURREGLER
NL	:	GEDELEGEERDE VERORDENING (EU) Nr. 811/2013 VAN DE COMMISSIE	TEMPERATUURREGELAARS
CS	:	NAŘÍZENÍ KOMISE V PŘENESENÉ PRAVOMOCI (EU) č. 811/2013	REGULÁTORY TEPLOTY
PL	:	ROZPORZĄDZENIE DELEGOWANE KOMISJI (UE) NR 811/2013	REGULATORY TEMPERATURY

IT	Il nome o marchio del fornitore	L'identificativo del modello del fornitore	La classe del dispositivo di controllo della temperatura	Il contributo del dispositivo di controllo della temperatura all'efficienza energetica stagionale di riscaldamento d'ambiente in %, arrotondata alla cifra intera più vicina
EN	Supplier's name or trade mark	Supplier's model identifier	The class of the temperature control	The contribution of the temperature control to seasonal space heating energy efficiency in %, rounded to one decimal place
FR	Le nom du fournisseur ou la marque commerciale	La référence du modèle donnée par le fournisseur	La classe du régulateur de température	La contribution du régulateur de température à l'efficacité énergétique saisonnière pour le chauffage des locaux, en %, arrondie à la première décimale
DE	Name oder Warenzeichen des Lieferanten	Modellkennung des Lieferanten	Die Klasse des Temperaturreglers	Beitrag des Temperaturreglers zur jahreszeitbedingten Raumheizungs-Energieeffizienz in Prozent, auf eine Dezimalstelle gerundet
NL	De naam van de leverancier of het handelsmerk	De typeaanduiding van de leverancier	De klasse van de temperatuurregelaar	De bijdrage van de temperatuurregelaar aan de seizoensgebonden energie-efficiëntie voor ruimteverwarming in %, afgerond tot op één decimaal
CS	Název nebo ochranná známka dodavatele	Identifikační značka modelu používaná dodavatelem	Třída regulátoru teploty	Přínos regulátoru teploty k sezonní energetické účinnosti vytápění, vyjádřený v % a zaokrouhlený na jedno desetinné místo
PL	Nazwa dostawcy lub jego znak towarowy	Identyfikator modelu dostawcy	Klasa regulatora temperatury	Udział regulatora temperatury w sezonowej efektywności energetycznej ogrzewania pomieszczeń w %, w zaokrągleniu do jednego miejsca po przecinku

Robur	**DDC**	**III**	**2%**
Robur	**DDC+OSND007**	**VI (AY)** **VII (GAHP/GA)**	**4%**

11 CCI PANEL

IT	:	REGOLAMENTO DELEGATO (UE) N. 811/2013 DELLA COMMISSIONE	DISPOSITIVI DI CONTROLLO DELLA TEMPERATURA
EN	:	COMMISSION DELEGATED REGULATION (EU) No 811/2013	TEMPERATURE CONTROLS
FR	:	RÈGLEMENT DÉLÉGUÉ (UE) N o 811/2013 DE LA COMMISSION	RÉGULATEURS DE TEMPÉRATURE
DE	:	DELEGIERTE VERORDNUNG (EU) Nr. 811/2013 DER KOMMISSION	TEMPERATURREGLER
NL	:	GEDELEGEERDE VERORDENING (EU) Nr. 811/2013 VAN DE COMMISSIE	TEMPERATUURREGELAARS
CS	:	NAŘÍZENÍ KOMISE V PŘENESENÉ PRAVOMOCI (EU) č. 811/2013	REGULÁTORY TEPLOTY
PL	:	ROZPORZĄDZENIE DELEGOWANE KOMISJI (UE) NR 811/2013	REGULATORY TEMPERATURY

IT	Il nome o marchio del fornitore	L'identificativo del modello del fornitore	La classe del dispositivo di controllo della temperatura	Il contributo del dispositivo di controllo della temperatura all'efficienza energetica stagionale di riscaldamento d'ambiente in %, arrotondata alla cifra intera più vicina
EN	Supplier's name or trade mark	Supplier's model identifier	The class of the temperature control	The contribution of the temperature control to seasonal space heating energy efficiency in %, rounded to one decimal place
FR	Le nom du fournisseur ou la marque commerciale	La référence du modèle donnée par le fournisseur	La classe du régulateur de température	La contribution du régulateur de température à l'efficacité énergétique saisonnière pour le chauffage des locaux, en %, arrondie à la première décimale
DE	Name oder Warenzeichen des Lieferanten	Modellkennung des Lieferanten	Die Klasse des Temperaturreglers	Beitrag des Temperaturreglers zur jahreszeitbedingten Raumheizungs-Energieeffizienz in Prozent, auf eine Dezimalstelle gerundet
NL	De naam van de leverancier of het handelsmerk	De typeaanduiding van de leverancier	De klasse van de temperatuurregelaar	De bijdrage van de temperatuurregelaar aan de seizoensgebonden energie-efficiëntie voor ruimteverwarming in %, afgerond tot op één decimaal
CS	Název nebo ochranná známka dodavatele	Identifikační značka modelu používaná dodavatelem	Třída regulátoru teploty	Přínos regulátoru teploty k sezonní energetické účinnosti vytápění, vyjádřený v % a zaokrouhlený na jedno desetinné místo
PL	Nazwa dostawcy lub jego znak towarowy	Identyfikator modelu dostawcy	Klasa regulatora temperatury	Udział regulatora temperatury w sezonowej efektywności energetycznej ogrzewania pomieszczeń w %, w zaokrągleniu do jednego miejsca po przecinku

Robur	**CCI**	**III**	**2%**

12 BUFFER TANKS AND DHW BUFFER TANKS

Table 12.1 *Buffer tanks and DHW buffer tanks technical data sheets*

Item code	Description	Loss (W)	Loss (kWh/24h)	Specific loss (W/K)	Volume (l)	Energy efficiency class
OSRB000	300-litre thermal tank	90	2,24	2,07	270	C
OSRB001	500-litre thermal tank	126	3,02	2,79	476	D
OSRB004	300-litre DHW buffer tank	85	2,03	1,88	263	C
OSRB005	500-litre DHW buffer tank	130	3,13	2,90	470	D
OSRB006	500-litre DHW buffer tank with integrated coil	130	3,13	2,90	470	D

1 WHAT IS THE ONLINE CONFIGURATOR

The online configurator is an online tool designed to allow the configuration of Link of Robur appliances for heating, cooling and DHW production.
This tool allows you to create a preassembled group with the desired heating and cooling output from the individual appliances in the Robur catalogue, consisting of two or more modules chosen from:

- Air/water absorption heat pumps for heating only GAHP A Plus
- Reversible air/water absorption heat pumps for heating or cooling GAHP AR Plus
- Ground/water absorption heat pumps (geothermal) for simultaneous production of hot and cold water GAHP GS Plus.
- Water/water absorption heat pumps (hydrothermal) for simultaneous production of hot and cold water GAHP WS Plus.
- AY outdoor condensing boiler
- GA ACF HR gas absorption chiller-heaters with heat recovery
- GA ACF gas absorption chiller

2 WHAT MAKES IT POSSIBLE

The online configurator enables you to define the optimal solution for your needs by selecting the required models and number of modules, considering relevant variants such as standard or low-noise versions, and determining whether to equip the modules with independent water pumps or not.
The various selections are guided, ensuring that no configuration is created that cannot be manufactured.

Once the required modules have been selected, the online configurator suggests a series of optional accessories to facilitate installation of the specific Link configured.
For the Link, you can generate the technical data sheet, referring to the nominal conditions or specifying the desired design conditions, and find out the relative list price.

3 HOW IT WORKS

The online configurator has two modes of use:

- assisted configuration (recommended mode)
- advanced configuration

3.1 ASSISTED CONFIGURATION

This mode is designed specifically for users who are not familiar with the characteristics and codes of Robur appliances.
In this mode, the user must provide a series of basic data, specifically:

- type of renewable energy to be used (air, water or ground), helpful in choosing the type of heat pump to be installed
- heating and/or cooling output demand
- any need for DHW production
- design conditions to which the above power values refer

In just a few guided steps, the configurator suggests one or more possible combinations, highlighting the relative heating and cooling outputs (under design conditions, if specified) and also highlighting any deviations from the requirements.

By selecting the most suitable combination, the configurator will suggest optional accessories that can be paired with your selection. The configurator will generate a technical data sheet for the Link (referring to the nominal conditions or, if specified, to the design conditions) and provide the list price of the configured Link and any selected optional accessories.

3.2 ADVANCED CONFIGURATION

This mode is designed for more experienced users, who are already familiar with the characteristics and codes of Robur appliances.
The configuration process is the same as described for the assisted configuration (Paragraph 3.1 *p. 1*), with the difference that in this mode the choice of modules on the Link is not based on the specified heating and cooling outputs, but by directly selecting the number and type of modules that must be present on the Link.

4 HOW TO ACCESS

Accessing the online configurator is very simple: go to the dedicated login page .
If you are not registered, you can register to obtain your login credentials.
Registration is swift and will allow all planners and heating engineers to access a guided selection programme for Robur preassembled groups, with helpful information for an accurate technical and economic assessment.

1 SECTION C02 CONTENTS

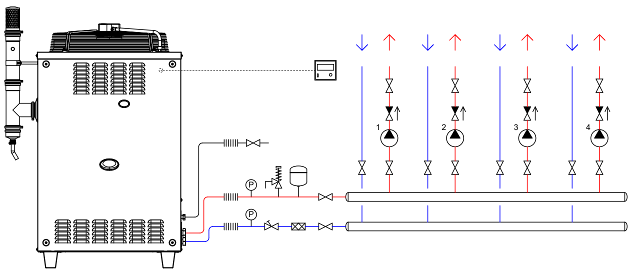
Table 1.1 *ADM - Section C02 - General Design - Contents*

1 FLOW BALANCING

After the sizing of the generating system and the choice of distribution terminals has been completed, it should be carefully evaluated that the system currently designed does not present any interference between the plumbing circuits such as to alter the setpoint in comparison with the regulation systems, resulting in reduced comfort, efficiency and even the life of the components of the system.
Referring to the system shown in Figure 1.1 *p. 1* the following occurs:

- With the system switched off, the pressures of the delivery manifold and return manifold will be identical, so the Δp between the manifolds will be zero.
- When the first delivery is activated, a pressure difference will be created, equal to the pressure drop across the generator. Check valves are essential to prevent the risk of reverse flow on inactive deliveries.
- The activation of subsequent deliveries leads to an increase in water flow on the generator and consequently in pressure drops, with the risk of these becoming so high that the delivery pumps cannot operate properly.

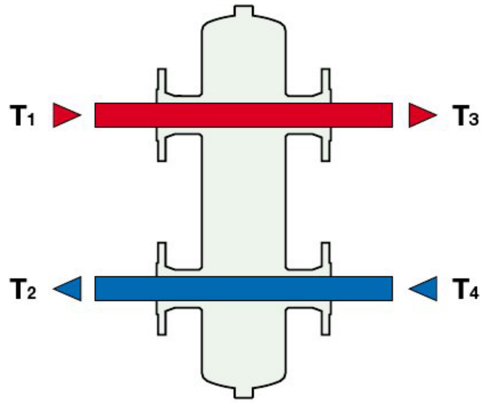
Figure 1.1 *System without an hydraulic separator*



In general these systems characterized by strong imbalances in the flow rates are unlikely to work under the design conditions and therefore to ensure efficiency and comfort.
The hydraulic separator, which was discussed in Section C01.07, is the component usually used to prevent interference between water circuits, precisely because it allows constant operation with zero Δp between manifolds.
However, careful balancing of the water flow between the primary and the secondary must be carefully considered, as inadequate balancing can trigger flow mixing phenomena, resulting in temperature changes.
In the optimal case, the flow rates are perfectly balanced (see Figure 1.2 *p. 1*) and the primary and secondary temperatures are identical (T1=T3 and T2=T4).
Mixing becomes influential when the difference between primary and secondary flow exceeds 10%.
In this case two scenarios may occur:

- primary flow lower than secondary flow (recirculation on secondary)
- primary flow higher than secondary flow (recirculation on primary)

Figure 1.2 *Balanced separator*

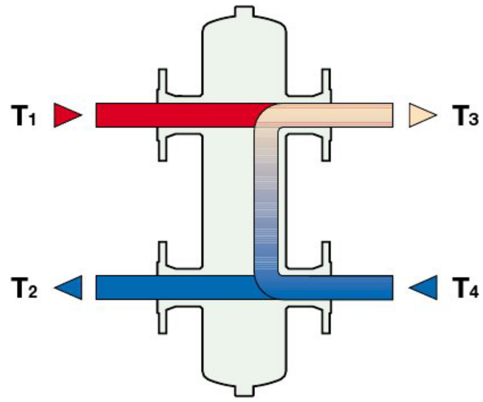


T1	Primary delivery temperature
T2	Primary return temperature
T3	Secondary delivery temperature
T3	Secondary return temperature

1.1 PRIMARY FLOW LOWER THAN SECONDARY FLOW

In this case, as shown in Figure 1.3 *p. 1*, the primary flow rate is lower than that of the secondary and there is partial recirculation of the secondary return flow, with consequent lowering of the delivery temperature T3 to the secondary as a result of mixing.

Figure 1.3 *Primary flow rate lower than secondary flow rate*



T1	Primary delivery temperature
T2	Primary return temperature
T3	Secondary delivery temperature
T3	Secondary return temperature

In this scenario, therefore:

- the secondary outlet temperature T3 is lower than the primary outlet temperature T1
- the inlet temperature of primary T2 and secondary T4 coincide

These are the possible consequences:

- Decreased generation system efficiency due to the higher temperature required to compensate for mixing.
- Potential reduction in comfort for consumers, linked to the lower supply temperature of emission devices, which therefore reduces (even significantly) heat exchange.

This case typically occurs when the secondary circuit works with

a thermal leap lower than the primary circuit.
In the worst-case scenario, the GAHP heat pumps could be operating at maximum temperature, but the users would still feel cold due to inefficient heat exchange caused by the drop in temperature.
Reduced heat exchange could also lead to a reduction in the thermal leap on the secondary circuit, thereby raising the temperature on the inlet and, ultimately, causing the heat pumps to shut down due to exceeding the inlet operational limit.
Table 1.1 *p. 2* shows the maximum temperatures that can be reached by the Robur heat pumps.

Table 1.1 *Heating and DHW temperature limits*

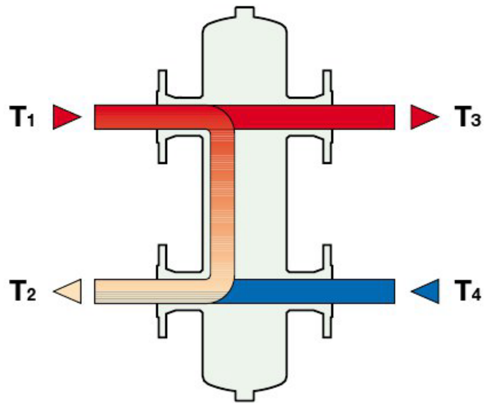
			GAHP A Plus	GAHP AR Plus	GAHP GS/WS Plus	AY
Heating mode						
Hot water outlet temperature	maximum for heating	°C	65	60	65	-
	maximum for DHW	°C	70	65	70	-
	maximum	°C	-	-	-	88
Hot water inlet temperature	maximum for heating	°C	55	50	55	-
	maximum for DHW	°C	60	60	60	-

To calculate the magnitude of the drop in outlet temperature to the secondary, it is sufficient to determine the thermal leap Δt on the secondary, based on the flow rate of the secondary and the heat output generated on the primary, according to the formula:
$Q = m \cdot cp \cdot \Delta t$
where Q is the primary heat output in [kW], m is the secondary water flow in [kg/s], cp is the specific heat of water in [kJ/kg ·°C] and Δt is the secondary thermal leap in [°C].
This thermal leap is added to the return temperature T4 of the secondary to determine the delivery temperature T3 of the secondary.
The same applies to cooling mode, where the room for manoeuvre on temperatures is further restricted by the need to have temperatures low enough to carry out dehumidification, and by the minimum outlet temperature of the Robur appliances, which, except for specific versions for process cooling, cannot fall below 3 °C.

1.2 PRIMARY FLOW HIGHER THAN SECONDARY FLOW

In this case, as shown in Figure 1.4 *p. 2*, the primary flow rate is higher than that of the secondary and there is partial recirculation of the primary return flow, with a consequent increase in the return temperature T2 of primary due to mixing.

Figure 1.4 *Primary flow rate higher than secondary flow rate*



T1	Primary delivery temperature
T2	Primary return temperature
T3	Secondary delivery temperature
T3	Secondary return temperature

In this scenario, therefore:
- the secondary outlet temperature T3 is equal to the primary outlet temperature T1
- the primary inlet temperature T2 is higher than the secondary inlet temperature T4

These are the possible consequences:
- Significant decrease in efficiency of the generation system due to the increase in the primary return temperature.
- Potential blocking of Robur heat pumps due to exceeding the inlet operational limit.
- Serious repercussions on comfort if the heat pumps exceed the operational limit.

This case typically occurs when the secondary circuit works with a thermal leap higher than the primary circuit.
This entails the risk of reaching the inlet temperature limit very quickly (Table 1.1 *p. 2*) and therefore switching off the heat pumps, even though the system is still requesting the service, with serious repercussions for user comfort.
To calculate the magnitude of the increase in the primary return temperature, it is sufficient to determine the thermal leap Δt on the primary, based on the primary flow rate and the heat demand of the secondary, according to the formula:
$Q = m \cdot cp \cdot \Delta t$
Where Q is the power demand by the secondary in [kW], m is the water flow of the primary in [kg/s], cp is the specific heat of water in [kJ/kg ·°C] and Δt is the primary thermal leap in [°C].
This thermal leap is subtracted from the primary delivery temperature T1 to determine the primary return temperature T2.
An absolutely similar but specular discussion can be made for operation in cooling mode.

2 HOW TO MAKE BALANCING

The guidelines to ensure that the system is properly balanced can be summarized as follows:
- Check the nominal water flow of the Robur appliances in the technical data tables (Section B for the specific appliance).

- Please note that in the case of Link equipped with independent water pumps, the water flow on the primary varies substantially in relation to the number of actually active modules.
- Please note that the nominal thermal leap for heating service is approximately twice that for cooling service.
- Check that balancing is carried out for each of the services required by the system (heating, cooling, DHW).
- Co-ordinate the operation between the distribution circuits and the generation system.