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Design Manual

GAHP-A

Air-Water gas absorption heat pump

platform PRO

Revision: A

Code: D-MNL036

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1 OVERVIEW AND TECHNICAL CHARACTERISTICS

The GAHP-A is a very high efficiency air-water absorption heat pump with a water-ammoniac thermodynamic cycle (NH_3 - H_2O), equipped with fumes condensation heat recovery circuit; it uses the external air as a renewable energy source (on average, 36% of the useful heating power).
The electromechanical components of all GAHP-A absorption heat pump equipment can be reduced to the burner, fan and solution pump. This characteristic of absorption systems reduces power consumption as well as service requirements.
The water-ammoniac thermodynamic employed by the GAHP-A, is implemented in a hermetically-sealed (welded) circuit which does not require coolant top-ups.
GAHP-A heat pumps are produced in the HT and LT versions depending on the maximum required delivery temperature. The maximum delivery temperature for LT units is 55°C and the maximum return temperature is 45°C. The maximum delivery temperature for HT units is 65°C and the maximum return temperature is 55°C. For both versions, the minimum/maximum external air temperatures are -30°C / +45°C. The GAHP-A LT version is thus optimised for plants with radiating panels or fan coils powered with water at temperatures less than or equal to 50°C. The GAHP-A HT version, on the other hand, is optimised for heating plants at medium/high temperatures and can also serve existing radiator installations in case of retrofitting.
The GAHP-A heat pump is designed for outdoors installation.
The GAHP-A unit employs polypropylene flue pipes; The high available head (up to 80 Pa) enables considerable versatility in installation.
The GAHP-A can be supplied in both **silent** and **standard versions.**

Principal benefits

Efficiency: the GAHP-A has peak efficiencies in excess of 165%, is hardly affected by external temperatures, in contrast with traditional electric heat pumps.
Reduced energy consumption: since it consumes only 0.025 kW per 1 kW of heating power, thanks to the use of methane gas or LPG.
No increase in installed electrical power: given the limited electrical draw of each unit (900 W), this enables the implementation of heat pump systems without significantly increasing the overall electrical consumption of the plant. This enables the construction of more simple electrical circuits and also means that the power supply contract need not be changed. It also means that UPS systems can be installed using smaller emergency generators.
Stable operation in extremely low external temperatures: even at outdoors temperatures of -20°C, the GAHP-A unit guarantees efficiencies greater than 100%, and can thus be used to advantage even in especially cold locations without the need for backup systems based on boilers or electrical heaters.
No indoors footprint: the indoors installation typical of traditional boilers is not required, so that the indoors of the building can be dedicated to more rational and profitable uses.
Continuous heating service even during defrost cycles: the formation of ice on the external finned array which occurs in certain operating conditions, automatically starts the defrost cycle which takes a few minutes to complete, during which the unitcontinues providing heat to the internal environment at 50% output, without increasing the thermal or electrical energy consumption.

Specification of supply

GAHP-A LT AIR-WATER ABSORPTION HEAT PUMP

Gas powered air-water condensation heat pump with water-ammoniac cycle, for production of hot water up to a delivery temperature of 55°C, suited for outdoors installation, with water condensation and air evaporation, with methane of LPG gas power, composed of sealed carbon steel heating/cooling circuit and single-rank finned array on three sides, with epoxy powder enamel, titanium steel tube coil condenser heat exchanger, helical fan (with oversize blades for the silent model), fumes side heat recovery circuit, equipped with limit thermostat - overpressure safety valve - fumes thermostat and pressure switch - stainless steel gas mixture burner - electronic controller - flow meter - water flowmeter - flame controller - gas valve - painted galvanised steel panelling - polypropylene fumes and condensation discharges.
Nominal thermal capacity (at burner) 25.70 kW.
Nominal heating power (A7/W35) 38.40 kW.
Power supply 230 V 1N - 50 Hz.
Electrical power absorption 0.90 kW (for silent model: 1.09 kW).
Operating weight 390 kg (for silent model: 400 kg).
Water fittings (out/in) 1 ¼" F.
Gas fitting ¾" F.
Overall dimensions: standard model width/depth (852 mm x 1255 mm), height 1281 mm.
Overall dimensions: silent model width/depth (854 mm x 1256 mm), height 1540 mm.

Specification of supply

GAHP-A HT AIR-WATER ABSORPTION HEAT PUMP
Gas powered air-water condensation heat pump with water-ammoniac cycle, for production of hot water up to a delivery temperature of 65°C, suited for outdoors installation, with water condensation and air evaporation, with methane of LPG gas power, composed of sealed carbon steel heating/cooling circuit and single-rank finned array on three sides, with epoxy powder enamel, titanium steel tube coil condenser heat exchanger, helical fan (with oversize blades for the silent model), fumes side heat recovery circuit, equipped with limit thermostat - overpressure safety valve - fumes thermostat and pressure switch - stainless steel gas mixture burner - electronic controller - flow meter - water flowmeter - flame controller - gas valve - painted galvanised steel panelling - polypropylene fumes and condensation discharges.
Nominal thermal capacity (at burner) 25.70 kW.
Nominal heating power (A7/W50) 35.40 kW.
Power supply 230 V 1N - 50 Hz.
Electrical power absorption 0.90 kW (for silent model: 1.09 kW).
Operating weight 390 kg (for silent model: 400 kg).
Water fittings (out/in) 1 ¼" F.
Gas fitting ¾" F.
Overall dimensions: standard model width/depth (852 mm x 1255 mm), height 1281 mm.
Overall dimensions: silent model width/depth (854 mm x 1256 mm), height 1540 mm.

1.1 TECHNICAL DATA

Table 1.1 – Technical specifications: GAHP-A version LT

			GAHP-A LT
OPERATION WHEN HEATING			
OPERATING POINT A7W50	G.U.E. gas usage efficiency	%	--
	Thermal power	kW	--
OPERATING POINT A7W35	G.U.E. gas usage efficiency	%	165
	Thermal power	kW	41,6
Thermal capacity	Nominal (1013 mbar - 15°C)	kW	25,7
	true peak	kW	25,2
NOx emission class			5
NOx emission		ppm	25
CO emission		ppm	36
Hot water delivery temperature	maximum for heating	°C	55
	maximum for ACS	°C	70
Hot water return temperature	maximum heating	°C	45
	maximum for ACS	°C	60
	minimum	°C	2
Hot water flow rate	nominal	l/h	3000
	maximum	l/h	4000
	minimum	l/h	1000
Hot water pressure drop	nominal water pressure (A7W50)	bar	0,43
Ambient air temperature (dry bulb)	maximum	°C	45
	minimum	°C	-20 (1)
Thermal differential	nominal	°C	10
gas consumption	methane G20 (nominal)	m3/h	2,72
	G30 (nominal)	kg/h	2,03
	G31 (nominal)	kg/h	2,00
ELECTRICAL SPECIFICATIONS			
Power supply	Voltage	V	230
	TYPE		SINGLE PHASE
	Frequency	50 Hz supply	50
Electrical power absorption	nominal	kW	1,09
Degree of protection	IP		X5D
INSTALLATION DATA			
Level of acoustic power		dB(A)	73
Minimum storage temperature		°C	-30
Maximum operating pressure		bar	4
Water content inside the apparatus		l	4
Water fitting	TYPE		F
	thread	" G	1 1/4
Gas fitting	TYPE		F
	thread	" G	3/4
Fume outlet	Size	mm	80
	Residual head	Pa	80
Maximum condensation water flow rate		l/h	4
Size	width	mm	848
	height	mm	1537
	depth	mm	1258
Weight	In operation	kg	400
GENERAL INFORMATION			
INSTALLATION MODE			B23, B53
COOLING FLUID	AMMONIA R717	kg	7
	WATER H2O	kg	10
MAXIMUM PRESSURE OF THE COOLING CIRCUIT		bar	35
METHANE GAS FEED PRESSURE (G20)		mbar	17-25
PED data			

			GAHP-A LT
COMPONENTS UNDER PRESSURE	Generator	l	18,6
	Leveling chamber	l	11,5
	Evaporator	l	3,7
	Cooling volume transformer	l	4,5
	Cooling absorber solution	l	6,3
	Solution pump	l	3,3
TEST PRESSURE (IN AIR)		bar g	55
SAFETY VALVE PRESSURE CALIBRATION		bar g	35
FILLING RATIO		kg of NH3/l	0,146
FLUID GROUP			GROUP 1°

(1) As per EN12309-2 evaluated over the actual thermal capacity. For operating conditions other than nominal, refer to Section 2 SIZING AND CHECKING GAHP-A SYSTEMS → 15.
(2) For capacities other than nominal, refer to the values given in Table 1.3 Pressure drop tables of a single GAHP-A → 9.
(3) PCI 34.02 MJ/m3 (1013 mbar - 15 ° C).
(4) PCI 46.34 MJ/kg (1013 mbar - 15 ° C).
(5) ± 10% depending on power voltage and absorption tolerance of electric motors.
(6) Free field, frontal, directionality factor 2.
(7) Overall dimensions excluding fumes pipes (see Figure 1.1 Size (Standard ventilation) → 10 and Figure 1.2 Size → 11).

Table 1.2 – Technical specifications: GAHP-A version HT

			GAHP-A HT
OPERATION WHEN HEATING			
OPERATING POINT A7W50	G.U.E. gas usage efficiency	%	152
	Thermal power	kW	38,3
OPERATING POINT A7W35	G.U.E. gas usage efficiency	%	--
	Thermal power	kW	--
Thermal capacity	Nominal (1013 mbar - 15°C)	kW	25,7
	true peak	kW	25,2
NOx emission class			5
NOx emission		ppm	25
CO emission		ppm	36
Hot water delivery temperature	maximum for heating	°C	65
	maximum for ACS	°C	70
Hot water return temperature	maximum heating	°C	55
	maximum for ACS	°C	60
	minimum	°C	2
Hot water flow rate	nominal	l/h	3000
	maximum	l/h	4000
	minimum	l/h	1000
Hot water pressure drop	nominal water pressure (A7W50)	bar	0,43
Ambient air temperature (dry bulb)	maximum	°C	45
	minimum	°C	-20 (1)
Thermal differential	nominal	°C	10
gas consumption	methane G20 (nominal)	m3/h	2,72
	G30 (nominal)	kg/h	2,03
	G31 (nominal)	kg/h	2,00
ELECTRICAL SPECIFICATIONS			
Power supply	Voltage	V	230
	TYPE		SINGLE PHASE
	Frequency	50 Hz supply	50
Electrical power absorption	nominal	kW	1,09
Degree of protection	IP		X5D
INSTALLATION DATA			
Level of acoustic power		dB(A)	73

			GAHP-A HT
Minimum storage temperature		°C	-30
Maximum operating pressure		bar	4
Water content inside the apparatus		l	4
Water fitting	TYPE		F
	thread	" G	1 1/4
Gas fitting	TYPE		F
	thread	" G	3/4
Fume outlet	Size	mm	80
	Residual head	Pa	80
Maximum condensation water flow rate		l/h	4
Size	width	mm	848
	height	mm	1537
	depth	mm	1258
Weight	In operation	kg	400
GENERAL INFORMATION			
INSTALLATION MODE			B23, B53
COOLING FLUID	AMMONIA R717	kg	7
	WATER H2O	kg	10
MAXIMUM PRESSURE OF THE COOLING CIRCUIT		bar	35
METHANE GAS FEED PRESSURE (G20)		mbar	17-25
PED data			
COMPONENTS UNDER PRESSURE	Generator	l	18,6
	Leveling chamber	l	11,5
	Evaporator	l	3,7
	Cooling volume transformer	l	4,5
	Cooling absorber solution	l	6,3
	Solution pump	l	3,3
TEST PRESSURE (IN AIR)		bar g	55
SAFETY VALVE PRESSURE CALIBRATION		bar g	35
FILLING RATIO		kg of NH3/l	0,146
FLUID GROUP			GROUP 1°

(1) As per EN12309-2 evaluated over the actual thermal capacity. For operating conditions other than nominal, refer to Section 2 SIZING AND CHECKING GAHP-A SYSTEMS → 15.
(2) For capacities other than nominal, refer to the values given in Table 1.3 Pressure drop tables of a single GAHP-A → 9.
(3) PCI 34.02 MJ/m3 (1013 mbar - 15 ° C).
(4) PCI 46.34 MJ/kg (1013 mbar - 15 ° C).
(5) ± 10% depending on power voltage and absorption tolerance of electric motors.
(6) Free field, frontal, directionality factor 2.
(7) Overall dimensions excluding fumes pipes (see Figure 1.1 Size (Standard ventilation) → 10 and Figure 1.2 Size → 11).

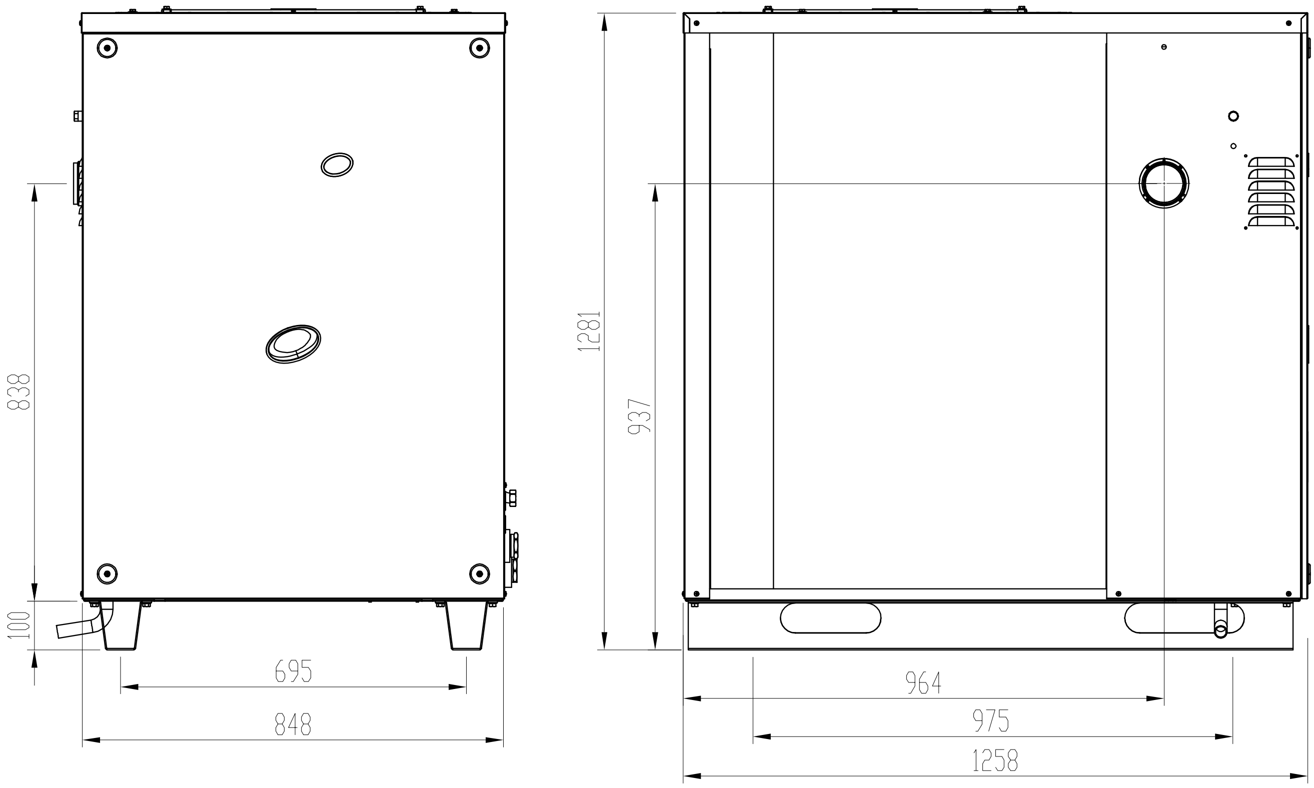
Table 1.3 – Pressure drop tables of a single GAHP-A

PRESSURE DROP OF A SINGLE GAHP-A (versions LT and HT)								
Hot water flow rate	**VECTOR FLUID TEMPERATURE AT OUTLET (T_{hm}) OF GAHP-A**							
	30°C	**35°C**	**40°C**	**45°C**	**50°C**	**55°C**	**60°C**	**65°C**
[l/h]	**[bar]**	**[bar]**	**[bar]**	**[bar]**	**[bar]**	**[bar]**	**[bar]**	**[bar]**
1000	0,07	0,07	0,07	0,07	0,07	0,06	0,06	0,06
1100	0,09	0,08	0,08	0,08	0,08	0,07	0,07	0,07
1200	0,10	0,10	0,09	0,09	0,09	0,09	0,08	0,08
1300	0,11	0,11	0,11	0,10	0,10	0,10	0,09	0,09
1400	0,13	0,12	0,12	0,12	0,11	0,11	0,11	0,10
1500	0,14	0,14	0,13	0,13	0,13	0,12	0,12	0,11
1600	0,16	0,15	0,15	0,15	0,14	0,14	0,13	0,13
1700	0.18	0,17	0,17	0,16	0,16	0,15	0,15	0,14
1800	0.20	0,19	0.18	0.18	0,17	0,17	0,16	0,16
1900	0,21	0,21	0.20	0.20	0,19	0.18	0.18	0,17
2000	0,23	0,23	0,22	0,21	0,21	0.20	0,19	0,19

2100	0,25	0,25	0,24	0,23	0,23	0,22	0,21	0.20
2200	0,28	0,27	0,26	0,25	0,25	0,24	0,23	0,22
2300	0,30	0,29	0,28	0,27	0,27	0,26	0,25	0,24
2400	0,32	0,31	0,30	0,29	0,29	0,28	0,27	0,26
2500	0,35	0,33	0,32	0,32	0,31	0,30	0,29	0,27
2600	0.37	0,36	0,35	0,34	0,33	0,32	0,31	0,29
2700	0,40	0,38	0.37	0,36	0,35	0,34	0,33	0,31
2800	0,42	0,41	0,40	0,39	0,38	0,36	0,35	0,34
2900	0,45	0.44	0,42	0,41	0,40	0,39	0.37	0,36
3000	0,48	0,46	0,45	0.44	0,43	0,41	0,40	0,38
3100	0,51	0,49	0,48	0,46	0,45	0.44	0,42	0,40
3200	0,54	0,52	0,50	0,49	0,48	0,46	0,45	0,43
3300	0,57	0,55	0,53	0,52	0,51	0,49	0,47	0,45
3400	0,60	0,58	0.56	0,55	0,54	0,52	0,50	0,48
3500	0.63	0,61	0,59	0,58	0,57	0,54	0,52	0,50
3600	0,67	0,65	0.62	0,61	0,60	0,57	0,55	0,53
3700	0,70	0,68	0,66	0,64	0.63	0,60	0,58	0.56
3800	0.74	0.71	0,69	0,67	0,66	0.63	0,61	0,58
3900	0,77	0,75	0,72	0.71	0,69	0,66	0,64	0,61
4000	0,81	0,78	0,76	0.74	0,72	0,70	0,67	0,64

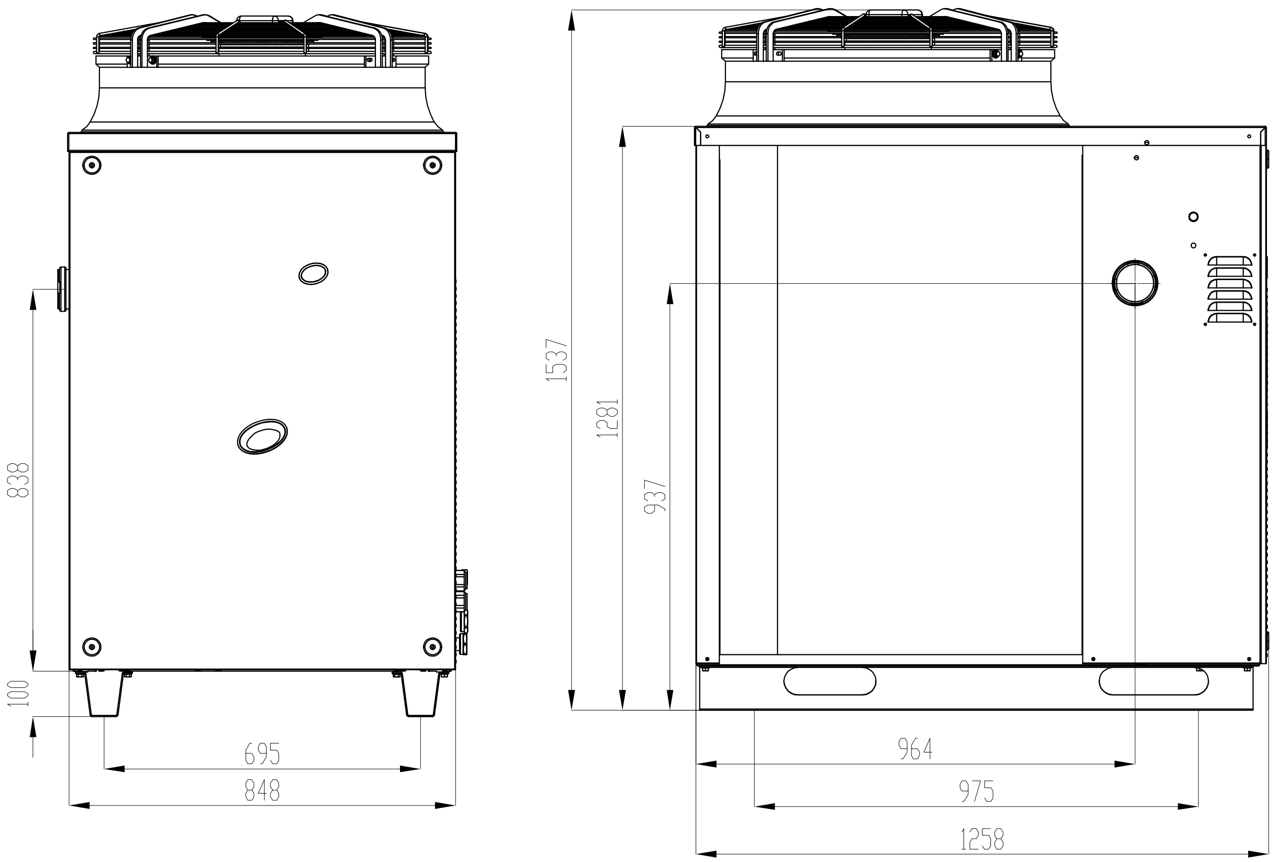
1.2 DIMENSIONS

Figure 1.1 – Size (Standard ventilation)



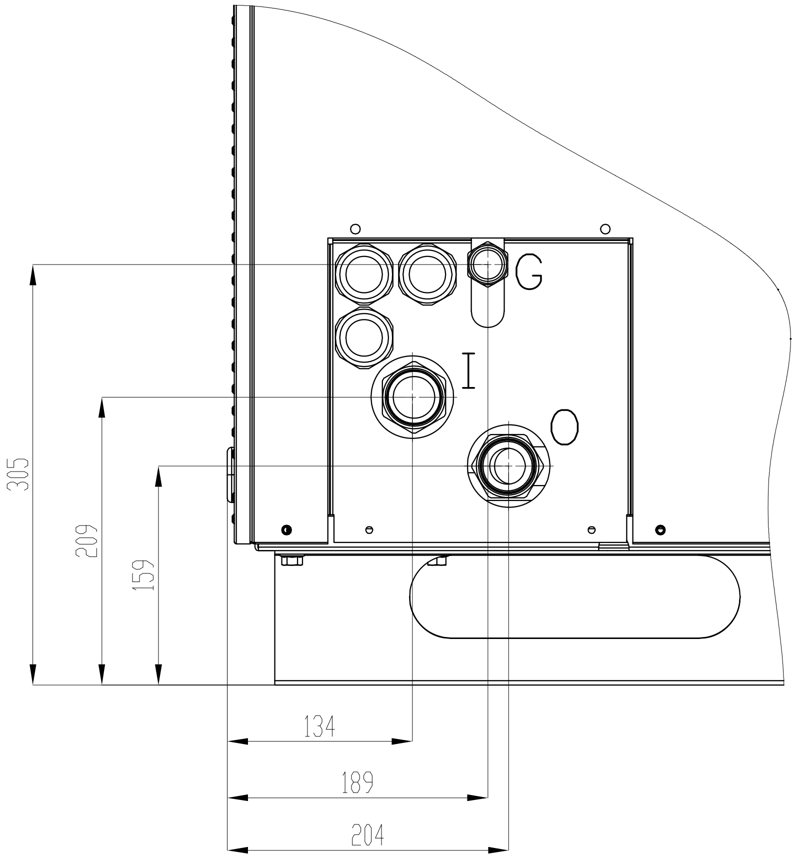
Front and side views (dimensions in mm).

Figure 1.2 – Size



Front and side views (dimensions in mm).

Figure 1.3 – Service plate

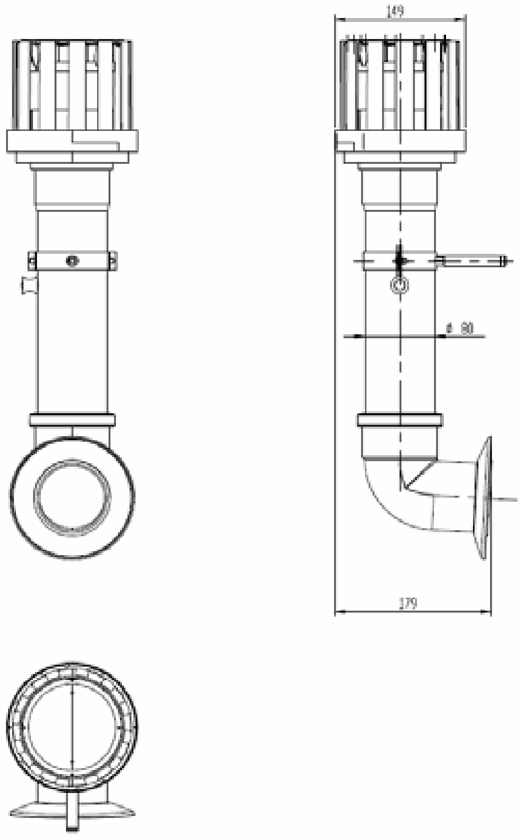


LEGEND

G	Gas fitting Ø ¾" F
I	Inlet water fitting Ø 1¼" F
O	Outlet water fitting Ø 1¼" F

Hydraulic/gas unions detail

Figure 1.4 – Drain outlet



Detail of provided drain outlet.

2 SIZING AND CHECKING GAHP-A SYSTEMS

2.1 DESIGN PARAMETERS

The principal design parameters are the heating power q_h (in kW) for the single GAHP-A unit and its G.U.E. (Gas Utilisation Efficiency) evaluated under design conditions. The G.U.E. is the ratio between the useful heating power and the actual thermal capacity.
The G.U.E. and the heating power q_h of the GAHP-A absorption heat pump are direct functions of the condenser inlet water temperature T_{hr} (return temperature from plant) and the external air temperature T_a, which are both design parameters along with the thermal differential ΔT of the vector fluid. The latter is normally assumed to be 10°C; the minimum and maximum values are equal respectively to 7.5°C (corresponding to a maximum flow rate of 4000 l/h at the nominal thermal power) and 30°C (corresponding to a minimum flow rate of 1000 l/h at the nominal thermal power).
Given the value of ΔT the values of T_{hr} is given automatically by the desired temperature of the water in delivery to the plant, T_{hm}. Once these values have been determined, simply use the refrigeration efficiency tables in Paragraph 2.2 DESIGN PARAMETER TABLES → 15.
These tables give, for each condenser return temperature T_{hr}, the value of the heating power q_h of the GAHP-A as a function of the external air temperature T_a.
Another parameter which should be borne in mind is the maximum condenser return temperature T_{hr} max, set to the value of 55°C (HT version) or 45°C (LT version).

2.2 DESIGN PARAMETER TABLES

Table 2.1 – Unitary heating power GAHP-A version LT

UNITARY HEATING POWER GAHP-A version LT					
EXTERNAL AIR TEMPERATURE (Ta)	WATER DELIVERY TEMPERATURE (T_{hm})				
	35°C	40°C	45°C	50°C	55°C
	WATER RETURN TEMPERATURE (T_{hr})				
	25°C	30°C	35°C	40°C	45°C
	q_h [kW]	q_h [kW]	q_h [kW]	q_h [kW]	q_h [kW]
-20°C	30,3	28,2	26,1	24,1	21,2
-19°C	30,5	28,5	26,4	24,3	21,4
-18°C	30,8	28,7	26,6	24,6	21,7
-17°C	31,0	29,0	26,9	24,8	21,9
-16°C	31,3	29,2	27,1	25,1	22,2
-15°C	31,5	29,5	27,4	25,3	22,4
-14°C	32.0	30,0	27,9	25,8	22,9
-13°C	32,5	30,5	28,4	26,3	23,4
-12°C	33,0	31,0	28,9	26,8	23,9
-11°C	33,5	31,5	29,4	27,3	24,4
-10°C	34,0	32.0	29,9	27,8	24,9
-9°C	34,9	32,8	30,8	28,7	25,8
-8°C	35,7	33,7	31,6	29,5	26,6
-7°C	36,6	34,5	32,4	30,4	27,5
-6°C	37,1	35,2	33,0	30,8	28,1
-5°C	37,7	35,9	33,6	31,3	28,7
-4°C	38,2	36,7	34,2	31,8	29,3
-3°C	38,8	37,4	34,8	32,3	29,9
-2°C	39,3	38,1	35,4	32,8	30,5
-1°C	39,5	38,5	35,9	33,4	31,0
0°C	39,7	38,9	36,4	34,0	31,6
+1°C	39,9	39,3	36,9	34,6	32,1
+2°C	40,1	39,7	37,5	35,3	32,6
+3°C	39,8	39,3	37,2	35,2	32,6
+4°C	39,4	39,0	37,0	35,1	32,6
+5°C	39,1	38,7	36,8	35,1	32,6
+6°C	38,7	38,4	36,5	35,0	32,6
+7°C	38,4	38,0	36,3	34,9	32,6

+8°C	38,4	38,1	36,6	35,3	33,1
+9°C	38,5	38,2	36,8	35,7	33,5
+10°C	38,6	38,3	37,1	36,1	33,9
+11°C	38,6	38,3	37,3	36,5	34.4
+12°C	38,7	38,4	37,6	36,8	34,8
+13°C	38,8	38,5	37,8	37,2	35,2
+14°C	38,8	38,6	38,1	37,6	35,7
+15°C	38,9	38,6	38,3	38,0	36,1

Table 2.2 – GUE GAHP-A unit version LT

GUE GAHP-A version LT					
EXTERNAL AIR TEMPERATURE (Ta)	WATER DELIVERY TEMPERATURE (T_{hm})				
	35°C	40°C	45°C	50°C	55°C
	WATER RETURN TEMPERATURE (T_{hr})				
	25°C	30°C	35°C	40°C	45°C
-20°C	1,201	1,119	1,037	0,955	0,840
-19°C	1,211	1,129	1,047	0,965	0,850
-18°C	1,221	1,139	1,057	0,975	0,860
-17°C	1,231	1,149	1,067	0,985	0,870
-16°C	1,241	1,159	1,077	0,995	0,880
-15°C	1,251	1,169	1,087	1,005	0,890
-14°C	1,271	1,189	1,107	1,025	0,910
-13°C	1,291	1,209	1,127	1,045	0,930
-12°C	1,311	1,229	1,147	1,065	0,950
-11°C	1,331	1,249	1,167	1,085	0,970
-10°C	1,351	1,269	1,187	1,105	0,990
-9°C	1,385	1,303	1,220	1,138	1,023
-8°C	1,418	1,336	1,254	1,172	1,057
-7°C	1,452	1,369	1,287	1,205	1,090
-6°C	1,473	1,398	1,311	1,224	1,114
-5°C	1,495	1,426	1,335	1,243	1,138
-4°C	1,516	1,454	1,358	1,262	1,162
-3°C	1,538	1,483	1,382	1,281	1,186
-2°C	1,559	1,511	1,406	1,300	1,210
-1°C	1,579	1,538	1,436	1,334	1,241
0°C	1,599	1,564	1,467	1,369	1,272
+1°C	1,620	1,591	1,498	1,404	1,303
+2°C	1,641	1,619	1,529	1,440	1,335
+3°C	1,643	1,621	1,537	1,453	1,348
+4°C	1,645	1,623	1,545	1,467	1,360
+5°C	1,648	1,625	1,553	1,481	1,373
+6°C	1,650	1,627	1,561	1,495	1,386
+7°C	1,653	1,629	1,570	1,510	1,400
+8°C	1,655	1,633	1,579	1,525	1,419
+9°C	1,657	1,637	1,588	1,540	1,438
+10°C	1,659	1,640	1,598	1,555	1,456
+11°C	1,661	1,644	1,607	1,570	1,475
+12°C	1,664	1,648	1,616	1,585	1,494
+13°C	1,666	1,651	1,626	1,600	1,513
+14°C	1,668	1,655	1,635	1,615	1,531
+15°C	1,670	1,658	1,644	1,630	1,550

Table 2.3 – Unitary heating power GAHP-A version HT

UNITARY HEATING POWER GAHP-A version HT						
EXTERNAL AIR TEMPERATURE (Ta)	WATER DELIVERY TEMPERATURE (T_{hm})					
	40°C	45°C	50°C	55°C	60°C	65°C
	WATER RETURN TEMPERATURE (T_{hr})					
	30°C	35°C	40°C	45°C	50°C	55°C
	q_h [kW]	q_h [kW]	q_h [kW]	q_h [kW]	q_h [kW]	q_h [kW]

-20°C	31,5	29,6	27,7	25,7	23,7	22,7
-19°C	31,8	29,9	28,0	26,0	23,9	22,9
-18°C	32.0	30,1	28,2	26,2	24,2	23,2
-17°C	32,3	30,4	28,5	26,5	24,4	23,4
-16°C	32,5	30,6	28,7	26,7	24,7	23,7
-15°C	32,8	30,9	29,0	27,0	24,9	23,9
-14°C	33,0	31,1	29,2	27,2	25,2	24,2
-13°C	33,3	31,4	29,5	27,5	25,5	24,4
-12°C	33,5	31,6	29,7	27,7	25,7	24,7
-11°C	33,8	31,9	30,0	28,0	26,0	24,9
-10°C	34,0	32,1	30,2	28,2	26,2	25,2
-9°C	35,0	32,9	30,8	28,7	26,6	25,4
-8°C	36,0	33,7	31,4	29,2	27,0	25,5
-7°C	37,0	34,5	32.0	29,7	27,5	25,7
-6°C	37,4	34,9	32,4	30,2	28,0	26,1
-5°C	37,7	35,2	32,7	30,6	28,5	26,4
-4°C	38,1	35,6	33,1	31,0	29,0	26,8
-3°C	38,5	35,9	33,4	31,4	29,5	27,1
-2°C	38,8	36,3	33,8	31,9	30,0	27,5
-1°C	38,7	36,4	34,2	32.0	29,9	27,6
0°C	38,6	36,6	34,6	32,2	29,8	27,8
+1°C	38,5	36,8	35,0	32,3	29,6	27,9
+2°C	38,4	36,9	35,4	32,5	29,5	28,1
+3°C	38,3	36,9	35,4	32,6	29,8	28,2
+4°C	38,3	36,9	35,4	32,7	30,0	28,3
+5°C	38,3	36,9	35,4	32,8	30,2	28,4
+6°C	38,2	36,8	35,4	32,9	30,5	28,5
+7°C	38,2	36,8	35,4	33,1	30,7	28,5
+8°C	38,2	36,9	35,6	33,3	31,1	29,0
+9°C	38,2	37,0	35,8	33,6	31,5	29,4
+10°C	38,1	37,0	35,9	33,9	31,9	29,8
+11°C	38,1	37,1	36,1	34,2	32,3	30,2
+12°C	38,1	37,2	36,2	34,5	32,7	30,6
+13°C	38,0	37,2	36,4	34,8	33,1	31,0
+14°C	38,0	37,3	36,6	35,1	33,5	31,4
+15°C	38,0	37,3	36,7	35,3	34,0	31,8

Table 2.4 – GUE GAHP-A unit version HT

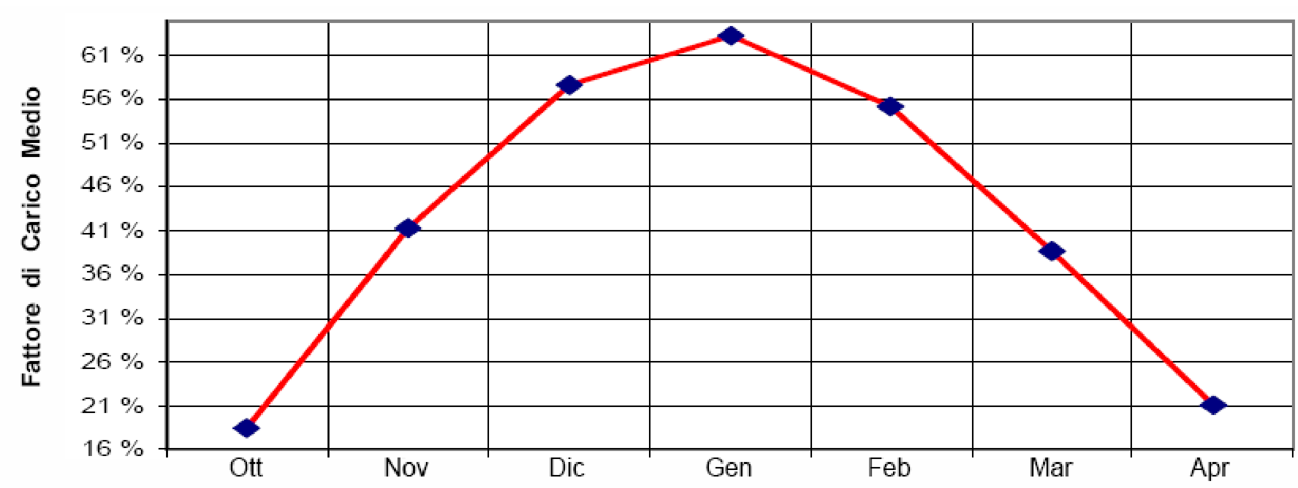
GUE GAHP-A version HT						
EXTERNAL AIR TEMPERATURE (Ta)	**WATER DELIVERY TEMPERATURE (T_{hm})**					
	40°C	45°C	50°C	55°C	60°C	65°C
	WATER RETURN TEMPERATURE (T_{hr})					
	30°C	35°C	40°C	45°C	50°C	55°C
-20°C	1,250	1,175	1,100	1,020	0,940	0,900
-19°C	1,260	1,185	1,110	1,030	0,950	0,910
-18°C	1,270	1,195	1,120	1,040	0,960	0,920
-17°C	1,280	1,205	1,130	1,050	0,970	0,930
-16°C	1,290	1,215	1,140	1,060	0,980	0,940
-15°C	1,300	1,225	1,150	1,070	0,990	0,950
-14°C	1,310	1,235	1,160	1,080	1,000	0,960
-13°C	1,320	1,245	1,170	1,090	1,010	0,970
-12°C	1,330	1,255	1,180	1,100	1,020	0,980
-11°C	1,340	1,265	1,190	1,110	1,030	0,990
-10°C	1,350	1,275	1,200	1,120	1,040	1,000
-9°C	1,390	1,307	1,223	1,140	1,057	1,007
-8°C	1,430	1,338	1,247	1,160	1,073	1,013
-7°C	1,470	1,370	1,270	1,180	1,090	1,020
-6°C	1,484	1,384	1,284	1,197	1,110	1,034
-5°C	1,498	1,398	1,298	1,214	1,130	1,048
-4°C	1,512	1,412	1,312	1,231	1,150	1,062
-3°C	1,526	1,426	1,326	1,248	1,170	1,076
-2°C	1,540	1,440	1,340	1,265	1,190	1,090
-1°C	1,547	1,457	1,366	1,281	1,195	1,105
0°C	1,555	1,474	1,393	1,297	1,201	1,120

+1°C	1,562	1,491	1,420	1,314	1,206	1,135
+2°C	1,570	1,509	1,448	1,330	1,212	1,150
+3°C	1,575	1,519	1,462	1,347	1,231	1,166
+4°C	1,581	1,528	1,476	1,363	1,251	1,183
+5°C	1,586	1,538	1,490	1,380	1,270	1,200
+6°C	1,591	1,548	1,504	1,397	1,291	1,218
+7°C	1,597	1,558	1,519	1,415	1,311	1,236
+8°C	1,602	1,565	1,527	1,428	1,329	1,254
+9°C	1,607	1,571	1,534	1,441	1,348	1,272
+10°C	1,613	1,578	1,542	1,454	1,367	1,290
+11°C	1,618	1,584	1,549	1,467	1,385	1,308
+12°C	1,624	1,590	1,557	1,480	1,404	1,326
+13°C	1,629	1,597	1,565	1,494	1,423	1,344
+14°C	1,634	1,603	1,572	1,507	1,441	1,362
+15°C	1,640	1,610	1,580	1,520	1,460	1,380

2.3 THEORETICAL BASES FOR THE CALCULATION OF GAHP-A INSTALLATIONS

To make the design calculations for GAHP-A one must calculate the heating power q_h of each individual unit at the external design conditions, using the above tables.
For systems with heating powers up to 30÷35 kW, the number of heat pumps is defined directly as one unit.
For systems with greater heating powers, the installed power must be distributed over several machines to be controlled in cascade, with a modular logic.
The following considerations can nonetheless be used to determine the advisability of providing only part of the required load with heat pumps.
Normally, the thermal load requirement typically varies as a function of two effects, seasonal (the major of the two) and daily (secondary). This enables us to distinguish between the basic and peak load requirement.

Figure 2.1 – Load factor



(percentage power requirement as a function of Qh)

The seasonal variation can be expressed using the mean load factor illustrated in Figure 2.1 Load factor → 18, which highlights how the effective power requirement of the system at mean climatic conditions does not generally exceed 65% of the design power rating. The remainder represents an insignificant percentage of the total energy to be delivered to the building during the season, and can hence be provided by less efficient

machines, such as traditional or condensation boilers, without thereby seriously compromising the mean seasonal efficiency.
The system's load factor at the mean climatic conditions F_c can be calculated as follows:

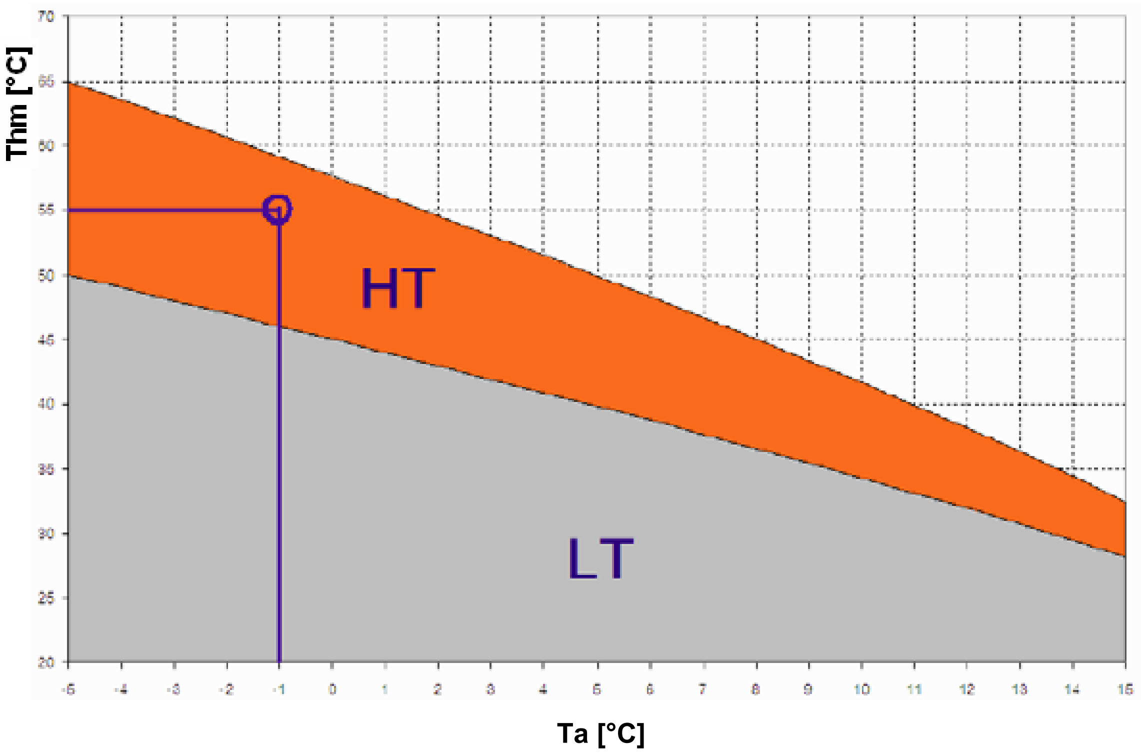
$$F_c = \frac{\dot{Q}_{hm}}{\dot{Q}_h} = \frac{T_i - T_{am}}{T_i - T_a}$$

where:
T_i is the internal air temperature of the heated rooms
T_a is the design external temperature

2.4 SELECTING THE LT OR HT VERSION

The GAHP-A is available in two versions which differ in their maximum vector fluid delivery temperature T_{hm} The LT version is suited to temperatures less than or equal to 50°C, whereas the HT version delivers temperatures greater than 50°C.
In new installations, to reduce energy wastage and promote a rational use of energy, we always recommend reducing the vector fluid's working temperature..
If there is the requirement to provide a domestic hot water supply using the same heat pumps, the HT provides a delivery temperature of 65°C, making it suitable for this purpose if the said temperature is adequate for indirect hot water production.
In existing installations requiring retrofitting, the user must determine the vector fluid's working temperature at the existing terminals (if they are not to be replaced) to determine whether the LT or HT version is more suitable.
Verification of the thermal level of the vector fluid in a plant whose boiler is equipped with climatic curve can be done by inspecting the existing heating plant during any day of winter time operation. The inspection consists in measuring the external air temperature and the corresponding delivery water temperature.
Referring to the graph on Figure 2.2 LT / HT version selection graph → 20 with the measured data enables you to establish which version is more suited to the requirements of the installation.
In the example on Figure 2.2 LT / HT version selection graph → 20, we measure a heating system delivery temperature of 55°C for an external air temperature of -1°C. This leads us to select the HT version, and also indicates that there is no need to refurbish the existing system for its needs to be met by an absorption heat pump system.
Obviously if the measured data result in a point in the grey area, the LT version is more suitable.

Figure 2.2 – LT / HT version selection graph



LEGEND

Ta External air temperature

Thm Water delivery Temperature

If the on-site measurements result in points outside the LT and HT areas, then the existing building system must be refurbished (insulation, improved windows/doors, modification or replacement of the user equipment, increased hours of operation of the system, etc.) if absorption heat pumps are to be used.

3 PLANT DESIGN

3.1 GENERAL DESIGN CRITERIA

Types of plant

GAHP-A absorption heat pumps can be used effectively with all types of hydronic heating plant. Note, however, that since these systems are of very high efficiency, it is advisable to evaluate the use in the winter of vector fluid temperatures T_{hm} in the medium to low range, in other words, in the range 30°C to 50°C. The use of medium high temperatures (50°C to 60°C, or even peaks of 65°C), should be reserved for installations equipped with relatively inefficient heat delivery equipment (such as radiators), for which it is essential not to drop below delivery temperatures of 50°C. To this end, we note the option of reducing the delivery temperature to radiators in three situations: a) increased hours of operation of the heating system; b) reduced energy requirement of the building (improved building insulation); c) modified radiators (increased exchange surfaces).

Inertial volume

The inertial tank, although specifically required, can be usefully included in the circuit as a thermal energy accumulator when the water delivery temperature is less than or equal to 50°C, thus reducing the number of ignition cycles of the units composing the system. The volume in litres of the inertial tank can be determined using the following formula, in which "t" is the accumulation time in seconds, Q_s is the heating power in kW transferred to the accumulation tank in the time "t", ρ is the density of the vector fluid in use, C_p is the specific heat of the water (4.187 kJ/kg K) and ΔT is the thermal differential of the vector fluid expressed in degrees Kelvin (K).

$$V = \frac{\dot{Q}_s}{\rho \cdot C_p \cdot \Delta T} \cdot t \qquad \text{(I)}$$

A simple way of determining the power Q_s, is to select the minimum seasonal load factor F_c and apply it in the following formula:

$$\dot{Q}_s = \dot{Q}_h - \left(\dot{Q}_h \cdot F_c \right) \qquad \text{(kW)}$$

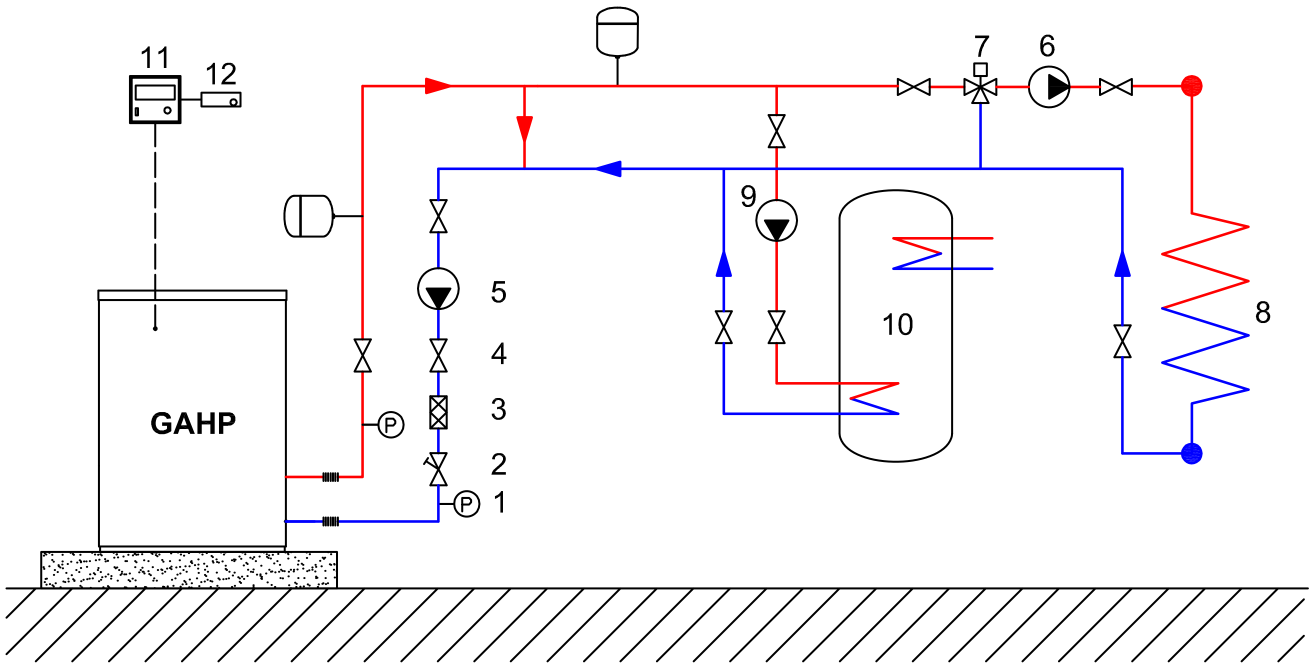
Where the heating power Q_h is the heating power delivered by the installed unit.
Fc is the minimum seasonal load factor calculated using the formula given in Paragraph 2.3 THEORETICAL BASES FOR THE CALCULATION OF GAHP-A INSTALLATIONS → 18.

Production of domestic hot water

Domestic hot water can be provided by GAHP-A, heat pump units, bearing in mind the maximum return temperature to the condenser (55°C for the HT version, 45° for the LT version). One should thus implement an accumulation system with temperature close to the service temperature (e.g. 45°C) or a system with direct heat exchange at the same working temperature. To control the anti-legionella function one must install equipment suited to run the anti-legionella cycle in accordance with applicable legislation.
For the control logic for the above described option, see Paragraph 5.5 CONTROL OF DOMESTIC HOT WATER (DHW) PRODUCTION → 34, regarding control of GAHP-A systems.
In Figure 3.1 Hydraulic schematic for a single GAHP-A → 22 we give an example of a single GAHP-A unit combined with a heating system with radiant panels and domestic

hot water production plant with accumulator. The heat pump, when the domestic hot water service is not required, sends the vector fluid to the system at the user conditions required by the radiant panels (low temperature). When the boiler requires power for domestic hot water production the RB100 system interface (see Paragraph 5 REGULATOR SYSTEM → 31) changes the unit's temperature setpoint. A three-way mixer valve controls the delivery temperature to the radiator coils.

Figure 3.1 – Hydraulic schematic for a single GAHP-A

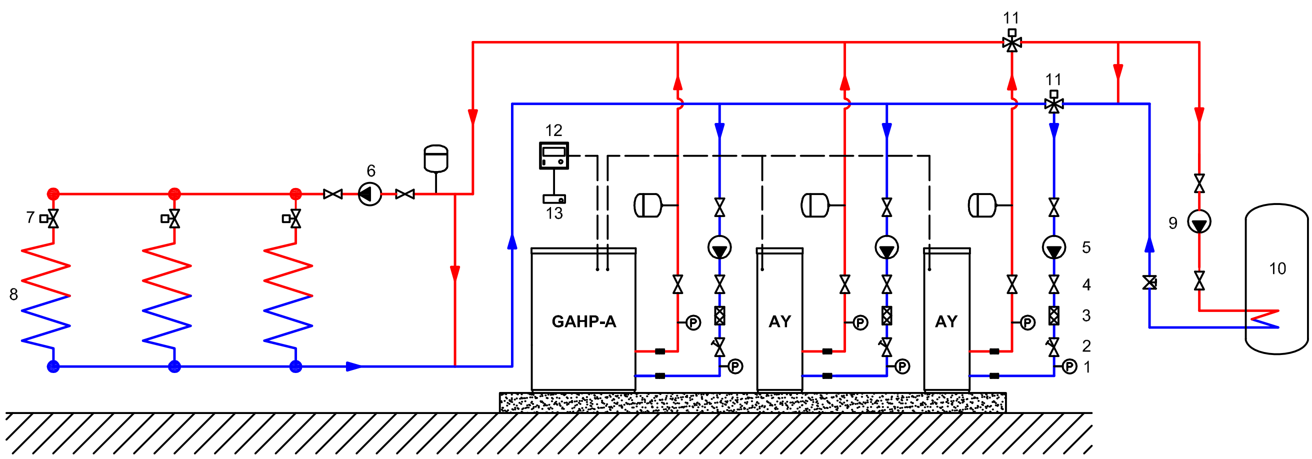


Hydraulic schematic for the use of a single GAHP-A for production of domestic hot water at max 45°C.

In the schematic given in Figure 3.1 Hydraulic schematic for a single GAHP-A → 22 the represented components have the following meanings: "1" pressure gauge; "2" flow regulator valve; "3" water filter; "4" shut-off valve; "5" internal circuit constant rate pump; "6" external service circuit constant rate pump; "7" three-way regulator/mixer valve; "8" heating system services; "9" DHW production external circuit constant rate pump; "10" boiler for DHW production; "11" Direct Digital Controller. "12" RB100 system interface.

In Figure 3.2 Hydraulic schematic for a mixed system → 23 we give anexample of a system composed of a GAHP-A and two Robur AY condensing boilers combined with a heating system with radiant panels and domestic hot water production plant with accumulator.

Figure 3.2 – Hydraulic schematic for a mixed system



Hydraulic schematic for a mixed heating and DHW production system.

In the schematic, the represented components have the following meanings: "1" pressure gauge; "2" flow regulator valve; "3" water filter; "4" shut-off valve; "5" internal circuit constant rate pump; "6" external service circuit variable rate pump; "7" 2-way regulator valve; "8" heating system services; "9" DHW production external circuit constant rate pump; "10" boiler for DHW production; "11" diverter valve for excluding the AY boiler; "12" Direct Digital Controller. "13" RB100 system interface.

Characteristics of the plant water supply

Robur units, by their very nature, do not require evaporator towers to operate. There is thus no need for topping up the water circuit. Furthermore, for the same reason, there are no special requirements or restrictions on the plant water quality, so that one need only refer to the normal values adopted for the physical and chemical properties of vector fluids in traditional heating systems.
You need only observe established standards regarding the treatment of water for heating systems.
The optimal chemical and physical specifications for the water are given in Table 3.1 Chemical and physical parameters of water → 23.

Table 3.1 – Chemical and physical parameters of water

CHEMICAL AND PHYSICAL PARAMETERS OF WATER IN HEATING/COOLING SYSTEMS		
PARAMETER	**OPTIMAL VALUE**	**UNIT OF MEASUREMENT**
pH	6,5 - 8,0	\
Chlorides	< 125	mg/L
Total chlorine	< 5	mg/L
Total hardness ($CaCO_3$)	10 - 15	°F
Iron	< 50	mg/L
Copper	< 3	mg/L
Aluminium	< 3	mg/L
Langelier's index	0	\
SUBSTANCES HAZARDOUS EVEN AT VERY LOW CONCENTRATION		
Free chlorine	ABSENT	
Fluorides	ABSENT	
Sulphides	ABSENT	

Physical and chemical properties of the system water.

3.2 INSTALLATION CRITERIA

- GAHP-A units must be installed outdoors, in an area in which air circulates naturally and which does not require any particular protection from the weather. **GAHP-A units may not under any circumstances be installed indoors.**
- No obstruction or overhanging structure (protruding roofs, eaves, balconies, ledges, trees) may obstruct the flow of air from the top of the appliance GAHP-A, nor the combustion fumes exhaust.
- Do not install the GAHP-A unit in the immediate vicinity of flue outlets, chimneys or other such features, so as to prevent warm or polluted air from being drawn in by the fan via the condenser. In order to function correctly the GAHP-A units must use clean air from the environment.
- GAHP-A units must be installed in such a way that the exhaust fumes outlet is not in the immediate vicinity of any external air inlets of a building. Observe established standards in regard to the discharge of fumes.
- If the GAHP-A unit is to be installed in the vicinity of constructions, make sure that it is out of the way of water dripping from gutters or similar sources.

- The GAHP-A units are homologated for connection of their combustion products evacuation pipe to a flue for direct connection to the exterior of type B_{23} and B_{53}. The units are equipped with a fitting of diameter Ø80 mm (with gasket) at the left side (see Figure 1.1 Size (Standard ventilation) → 10 and Figure 1.2 Size → 11) with vertical outlet. If the type of installation or established legislation requires combustion products to be conveyed away, refer to Table 3.2 Combustion products table → 24 for the dimensions of the duct.

Table 3.2 – Combustion products table

COMBUSTION PRODUCTS TABLE FOR A SINGLE GAHP-A UNIT				
-	UNIT OF MEASUREMENT	NATURAL GAS G20	LPG. G30	LPG. G31
EXHAUST GAS FLOW	kg/h	42	43	48
EXHAUST GAS TEMPERATURE	°C	65	65	65
CARBON DIOXIDE CO_2	%	9,1	10.4	9,1

Fumes flow rate and temperature.

- The flue and its fumes duct may be made in polypropylene and the high available head (80 Pa) enables considerable versatility in installation.
- Each unit is equipped with a condensation discharge system, which must be connected to the drain system by the installer. If local legislation permits, it can be discharged directly into the sewers, otherwise a system to neutralise the condensation before disposal must be installed. Depending on the type of installation it may also be necessary to install a condensation return pump, available on request as an accessory.

Plumbing plant and gas circuit

- The sizing of the plumbing pipes and pump must guarantee the nominal water flow required for correct operation of the GAHP-A unit (for calculation of pressure drops in the appliance GAHP-A, refer to tables of the Paragraph 1.1 TECHNICAL DATA → 7).
- The hydraulic plant may be created using pipes in stainless steel, black steel, copper or crosslinked polyethylene for heating/cooling plants. All water pipes and pipe connections must be adequately insulated in accordance with current regulations, to prevent heat loss and the formation of condensate.
- When rigid pipes are used, in order to prevent the transmission of vibrations, we recommended connecting the water inlet and outlet of the appliance GAHP-A with anti-vibration joints.
- When filling the hydraulic circuit, ensure the minimum water content in the plant, and add, in case of outdoors installation, to the plant water (free of impurities) a quantity of inhibited monoethylene glycol in proportion with the minimum winter temperature in the installation zone (see Table 3.3 Percentage of monoethylene glycol → 25).
- To prevent icing inside the circuit, the GAHP-A units are equipped with antifreeze equipment. This device (antifreeze function) starts the external water circulation pump (if controlled by the GAHP-A unit) and, if necessary, the burner (when necessary). It is therefore necessary to ensure a continuous supply of electricity to the appliance GAHP-A throughout the whole of the winter period. If it is not possible to ensure a continuous supply of electricity and gas to the appliance, use glycol antifreeze of the inhibited monoethylene type.

- If glycol antifreeze is to be used, DO NOT USE galvanised pipes, as they are potentially subject to corrosion in the presence of glycol. Table 3.3 Percentage of monoethylene glycol → 25 following, we give the approximate freezing temperature of the water and consequent increased drop in pressure of the appliance GAHP-A and system circuit as a function of the percentage of monoethylene glycol employed. This Table should be taken into account for the sizing of the pipes and the circulation pump (for calculation of internal pressure drops of the appliance, refer to the Paragraph 1.1 TECHNICAL DATA → 7).
- Nevertheless, it is advisable to consult the technical specifications of the monoethylene glycol used.

Table 3.3 – Percentage of monoethylene glycol

% of MONOETHYLENE GLYCOL	**10**	**15**	**20**	**25**	**30**	**35**	**40**
WATER FREEZING POINT TEMPERATURE	-3°C	-5°C	-8°C	-12°C	-15°C	-20°C	-25°C
PERCENTAGE OF INCREASE IN PRESSURE DROPS	--	6%	8%	10%	12%	14%	16%
LOSS OF EFFICIENCY OF UNIT	--	0,5%	1%	2%	2,5%	3%	4%

Technical data for filling the hydraulic circuit

- The pressure of the gas supplied by the mains must be within the range of 17 and 25 mbar for natural gas (G20), and between 25 and 35 mbar for LPG (whether G30 or G31).
- The gas supply system must be correctly rated for the capacity required by the appliance GAHP-A and must be equipped with all safety and control devices prescribed by current regulations.
- Clean the plant of any waste or process residue before commissioning the units, to prevent the filters blocking and reducing the circulation of water.

3.3 POSITION OF THE APPLIANCE

Lifting the appliance and placing it in position

The GAHP-A unit can be installed at ground level, or on a terrace or roof (if they are able to sustain its "dimensions" and "weight"; see tables of the Paragraph 1.1 TECHNICAL DATA → 7).

The hoist and all accessory equipment (braces, cables, bars) must be of adequate dimensions in relation to the load to be lifted.

Mounting base

Always position the appliance on a flat level surface that is made of fireproof material and able to sustain the weight of the appliance itself.

During winter operation, the appliance, on the basis of temperature and humidity conditions of the outside air, can carry out defrosting cycles that cause the layer of frost/ice on the fan coil to melt.

Take this possibility into consideration, adopting appropriate measures (for example: a “containing” step and channelling of water into a suitable drain) in order to prevent “uncontrolled” spread of water around the appliance and the consequent risk that a layer of ice will form (with the danger of falls on the part of passing people).

Installation at ground level

If a horizontal support base is unavailable (see also "SUPPORTS and LEVELLING" below), it is necessary to create a flat level base in concrete which is larger than the dimensions of the base of the appliance by at least 100-150 mm on each side.

The dimensions of the appliance are given in the Paragraph 1.2 DIMENSIONS → 10.

Provide a “containing” step and a suitable drainage channel for the water.

Installation on a terrace or roof

Position the appliance on a levelled flat surface made of fireproof material (see also "SUPPORTS and LEVELLING" below).

The structure of the building will have to support the weight of the appliance added to the weight of the supporting base.

The weight of the unit is given in tables of the Paragraph 1.1 TECHNICAL DATA → 7.

Create a "containing" step and a suitable drainage channel for the water, providing a gangway around the appliance for maintenance purposes.

Although the appliance produces only moderate vibrations, the use of anti-vibration supports (available as accessories) is especially recommended in rooftop and terrace installations in which resonance phenomena may occur.

In addition, it is advisable to use flexible connections (anti-vibration joints) between the appliance and the hydraulic and gas supply pipes.

Supports and levelling

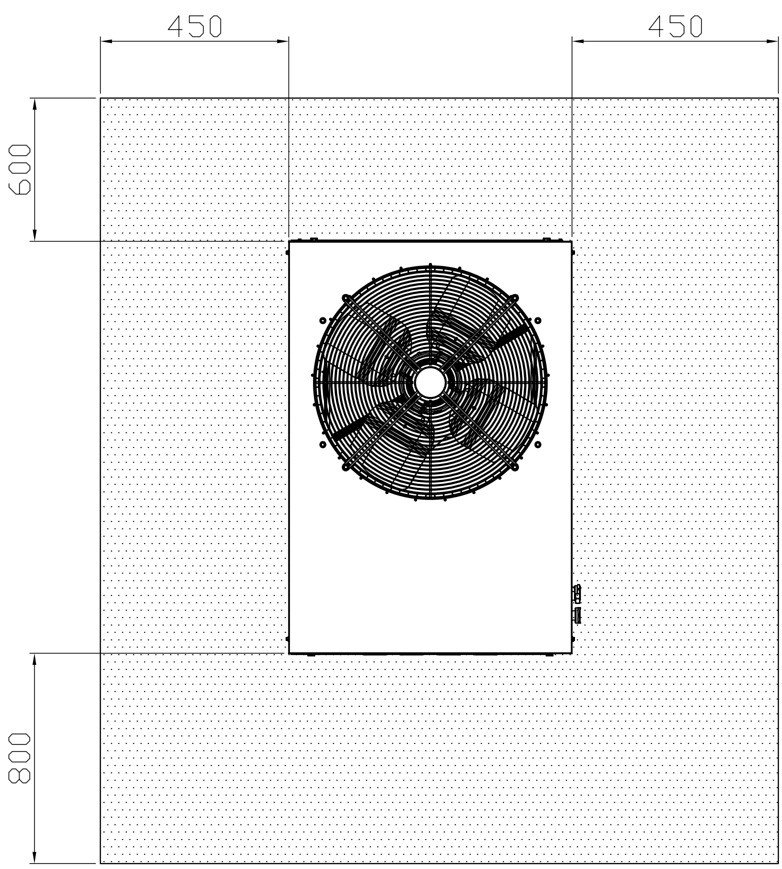
The appliance must be correctly levelled. If necessary, level the appliance with metal shims, placing them appropriately in relation to the mounts; do not use wooden spacers as these degrade quickly.

Clearances

Locate the appliance in such a way as to maintain the minimum specified clearances from combustible surfaces, walls or other equipment, as given in Figure 3.3 Clearances → 27.

Minimum clearances are necessary in order to be able to carry out maintenance operations and to ensure the correct airflow required for heat exchange with the finned coil.

Figure 3.3 – Clearances



Evaluate the noise impact of the GAHP-A unit in relation to the installation site: avoid installing the GAHP-A unit in positions (corners of buildings, etc.) that could amplify its running noise (reverb effect), and always check the consequences of the intended installation position.

3.4 HYDRAULIC PLANT COMPONENTS

The components described below, to be fitted in proximity to the appliance, are illustrated in the typical hydraulic plant schematics in Section "6 PLANT SCHEMATICS → 37":

- ANTIVIBRATION JOINTS in line with the water and gas connections of the appliance.
- MANOMETERS installed in the inlet and outlet water pipes.
- FLOW REGULATION VALVE (shutter or balancing) at the water inlet pipe.
- WATER FILTER at the water inlet pipe, mesh MIN 0.7 mm, MAX 1 mm.
- BALL CHECK VALVE on the water and gas pipes.
- 3 BAR SAFETY VALVE installed in the appliance outlet water pipe.
- EXPANSION TANK on the water outlet pipe.
- PLANT WATER CIRCULATION PUMP on the water inlet pipe, rated for the installation in question.
- Systems for BLEEDING AIR from the water pipes.
- DRAIN COCK on the water pipes.
- PLANT FILLING SYSTEM: if automatic filling systems are used, it is advisable to carry out a seasonal check of the percentage of monoethylene glycol contained in the plant.
- CONDENSATION COLLECTION AND DISPOSAL SYSTEM connected to the condensation drain provided on the unit, complete with eventual neutralisation system as per established legislation and eventual condensate pump.

If more than one GAHP-A unit is connected to a single hydraulic circuit, the following must also be installed:

- WATER CIRCULATION PUMP for each unit, on the water inlet pipe, with delivery towards the GAHP-A unit, rated for the installation in question.
- HYDRAULIC SEPARATOR complete with air bleeder valve and drain tap.
- PLANT WATER CIRCULATION PUMP on the plant delivery pipe, with delivery towards the plant.

4 ELECTRICAL DESIGN

The following specifications must be observed in the electrical power section of the plant:

- Power supply 230 V 1N - 50 Hz.
- The electrical components used for the hookup (circuit breakers, fuses, relays, etc.) must be mounted in an external electrical cabinet located by the installer in the vicinity of the GAHP-A unit.
- If the plant is equipped with a hydraulic separator, take the precautions required to prevent the external circuit water freezing during the winter (for example, control the operation of the external circuit circulation pump with a lock or thermostat).

The electrical connection schematics are given in Section "6 PLANT SCHEMATICS → 37".

4.1 CONNECTION TO THE GAHP-A UNIT

To hook up one or more GAHP-A units, the following will be required:

- A connection cable, FG7(O)R 3Gx1.5.
- An external bipolar circuit breaker with 2 5A type T fuses with minimum airgap 3 mm or a 10 A magnetothermic switch.

4.2 CONNECTING THE CONTROLLER

The unit GAHP-A can be controlled with the accessory Direct Digital Controller (DDC). For a total cable run of ≤ 200 m and up to 5 units connected, use a simple 3x0.75 mm2 shielded cable; otherwise use a CAN-BUS cable as specified by the Honeywell SDS standard, as given below:

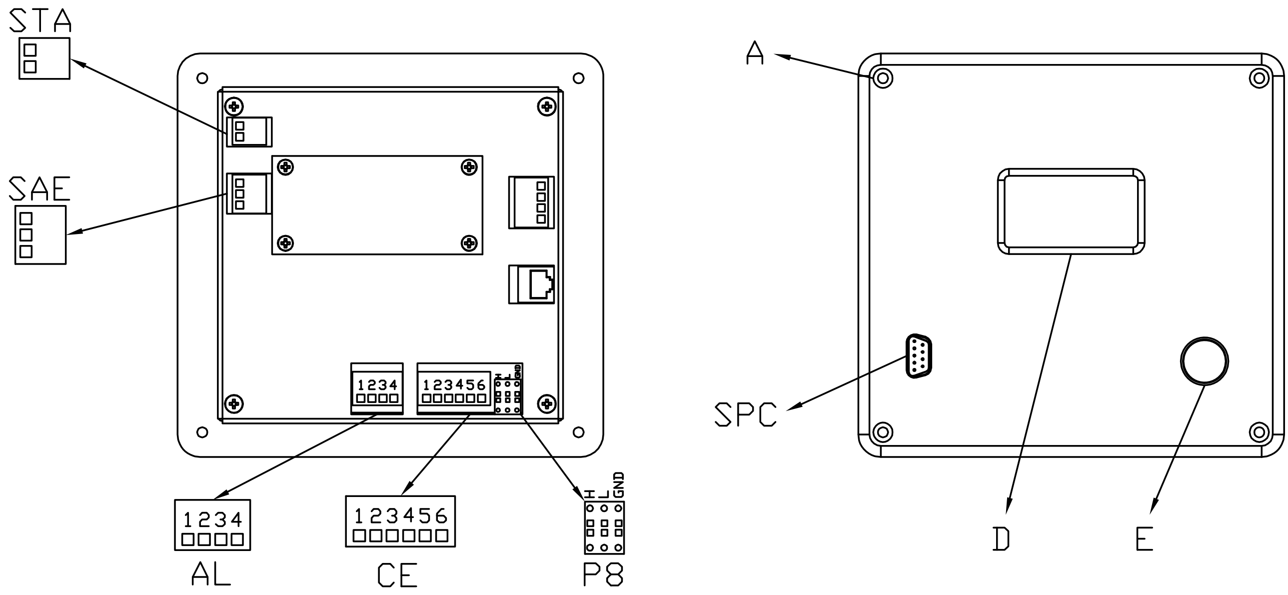
- Robur Netbus (Robur, maximum cable run 450 m).
- Belden 3086A (Honeywell SDS 1620, maximum cable run 450 m).
- Turck 530 (Honeywell SDS 1620, maximum cable run 450 m).
- Turck 5711 (DeviceNet Mid Cable, maximum cable run 450 m).
- Turck 531 (Honeywell SDS 2022, maximum cable run 200 m).

5 REGULATOR SYSTEM

5.1 DIRECT DIGITAL CONTROLLER (DDC)

The fundamental component for the control and regulation of GAHP systems is the Direct Digital Controller (DDC).
The Direct Digital Controller is a device which displays, on a backlit graphic LCD display of 128x64 pixels, all the status, operating and error conditions of each individual unit to which it is linked. The DDC controls water thermostating by controlling the switch-on and switch-off of the units connected to it.
Each DDC is able to control up to sixteen GAHP-A modules, beyond which another DDC must be used in combination with the first to control the system.
For pre-assembled units, the DDC is already supplied as part of the equipment. In the case of single GAHP-A unit, not pre-assembled Robur, the DDC is available as an optional accessory.
The DDC is designed for indoors installation (ambient air temperature in the range 0°C to 50°C), mounted to an electrical cabinet in a hole measuring 155 x 151 mm.
The front of the DDC mounts a graphic display on which all the parameters necessary to control, program and configure the machine are shown (see detail D, Figure 5.1 Direct Digital Control (DDC) → 32); a selector knob (Encoder) used to select options, parameter settings, etc. (detail E, Figure 5.1 Direct Digital Control (DDC) → 32); an RS 232 serial port for connecting the DDC to a PC (see detail SPC, Figure 5.1 Direct Digital Control (DDC) → 32), used for technical service.
The rear of the DDC mounts all the electrical and CAN-BUS connections required for its operation. Furthermore, it also features contacts for additional DDC on/off options using enabling signals from external regulator systems, alarm lamps and buzzers for remote installation, and contacts for connection to an ambient sensor (optional).

Figure 5.1 – Direct Digital Control (DDC)



LEGEND

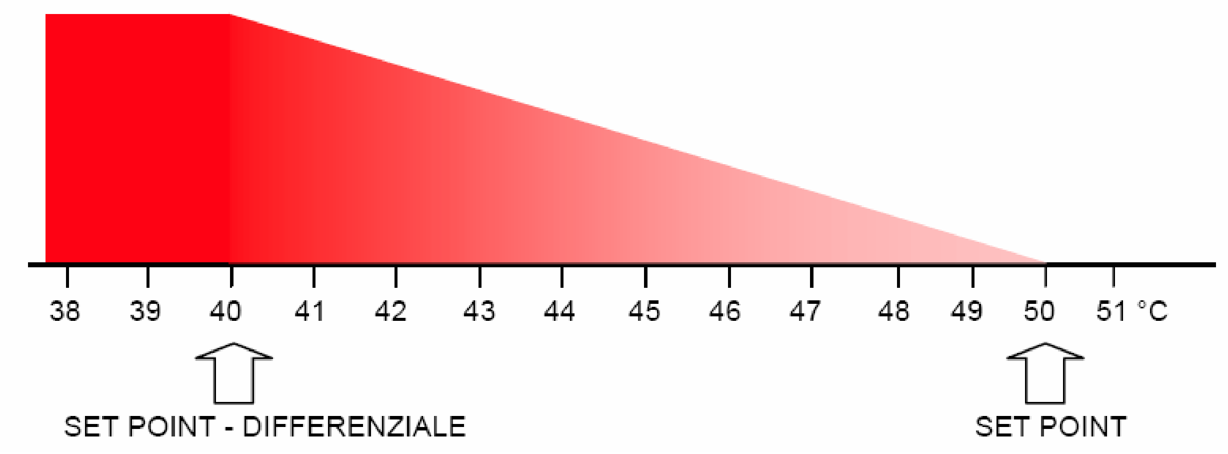
STA ambient temperature probe - 2-pole connector
SAE external alarm systems - 3-pole connector
AL power supply 24 V ac - 4-pole connector
CE external consents - 6-pole connector
P8 CAN BUS network connector (orange)
SPC 232 serial connection to PC - 9-pole connector
A mounting holes DDC
E Encoder
D Display

Front and rear views with detail of electrical connections.

5.2 CONTROL AND REGULATION OF THE GAHP-A SYSTEM

For the control and regulation of the system, install one or more DDC's, which serve to obtain full system diagnostics and control and regulate the operation of the system itself. In particular, they are used to set the winter-time vector fluid differential and setpoint, with the option to control either the delivery or return temperature. The above settings can be made for four daily time bands, with the option of using four different setpoints.
The Robur plant concept, which also includes multiple units, has the certain benefit of enabling completely independent operation of the component modules, so as to deliver the heating power strictly required to handle the real time load, thus preventing frequent operational variations and consequent wasted fuel consumption.
Installation of units in cascade, up to five power steps, is featured on the DDC.

Figure 5.2 – Example of winter operation power steps



The regulation system, during the first daily power on, powers up all modules, which are then gradually switched off starting from the setpoint temperature minus the differential set on the DDC.
The system does not provide for sensors on the plant delivery or return pipes, since the GAHP-A units are equipped with sensors which enable direct measurement on-board of the vector fluid temperature.

5.3 "DEFROSTING"

During normal winter operation, it may happen that the finned array of the unit ices up with the humidity in the air. Contrary to what is the case in "air-water" electric heat pump appliances, the GAHP-A automatically runs a defrost cycle, while continuing to provide heating to the plant (the system does not undergo cycle inversion).
The on-board electronics deviate part of the flow of ammoniac originating from the generator at a temperature close to 80°C to the finned array, thus detaching the layer of ice. The heating power required for the heating plant is still provided by a part of the flow of ammoniac which continues to be sent to the tube coil heat exchanger in which the exchange of heat with the plant water occurs.
Tests run on systems with GAHP-A units have shown that the number of defrosting cycles does not exceed 50 per winter season and that each cycle lasts an average of 3 minutes thanks to the high condensation temperature of the ammoniac. In short, the defrosting cycles do not compromise the overall efficiency of the heat pump.

5.4 "SLIDING TEMPERATURE"

The GAHP-A delivery/return temperature can be regulated continuously as a function of an external parameter controlled by another electronic system. In particular, it may be useful to vary the vector fluid delivery temperature as a function of the external air temperature, or another plant parameter which is significant in the application in question.
This option is provided by the optional RB100 plant interface, connected by a can-bus cable to the DDC. The RB100 can receive a 0 ÷ 10 V digital signal from an electronic regulator, so as to continuously modulate the delivery or return temperature.
The RB100 device has the function of interfacing the requests coming from one or more external control systems with the DDC.

It has the following functions: it controls the connected Robur units with a continuously variable temperature setpoint (sliding temperature) as well as domestic hot water production, which also requires actuation of the three-way diverter valves (see also Paragraph 5.5 CONTROL OF DOMESTIC HOT WATER (DHW) PRODUCTION → 34).
RB100 board dimensions: width 158 mm, depth 74.6 mm height 106.5 mm. The weight of the component is 0.320 kg and it must be mounted to the cabinet on a 35 mm DIN rail (EN 60715).

5.5 CONTROL OF DOMESTIC HOT WATER (DHW) PRODUCTION

The domestic hot water production service can be provided using only the GAHP-A units when the system includes medium to low temperature accumulator boilers (45°C - 48°C) or when the production is handled directly by suitably dimensioned heat exchangers (external circuit delivery temperature 45°C - 48°C).
If the plant is to be equipped with one or more heat pumps in combination with one or more Robur AY condensation boilers, this service can be provided at any temperature of the DHW production boilers (accumulation temperature greater than 50°C), using the AY boilers for this purpose.
In any case, in order to use absorption heat pumps to produce DHW, the controller must be equipped with a DDC and an "RB100" system interface.
If GAHP-A heat pumps are to be used for producing DHW under the above-mentioned conditions (accumulation temperature close to user temperature, max 48°C), the RB100 interface is required to raise the unit's delivery temperature, if this is not already set to the maximum working temperature.
If Robur AY condensing boilers are also to be used, the RB100 module connected with a CAN-BUS cable to the DDC can be used to deviate the vector fluid flow (with appropriate diverter valves, not supplied) to a heat exchanger for direct or accumulation production of DHW.
Once the heating circuit has been deviated to DHW production, the RB100 module modifies the setpoint only of the Robur AY condensing boilers involved in this service. The adjustment of the DHW setpoint of the Robur AY condensing boilers can be done with an ON-OFF analogue signal originated by a thermostat, or by a 0 - 10 V digital signal from an electronic controller.
The advantage of the RB100 unit is that there is no need to include other boilers for DHW production, so that all the Robur AY condensing units can be used, which would otherwise be kept switched off most of the time during the winter.
Clearly the DHW production service has operational priority, so that if the system is operating under maximum design conditions, the boilers dedicated to the dual service will nonetheless be switched from heating mode to DHW production for the duration of the period for which the service is required.
For existing plant for which the user wishes to implement such a remote control system, the firmware must be compatible with the components - contact Robur S.p.A. presales.

5.6 REMOTE CONTROL - “WISE” (WEB INVISIBLE SERVICE EMPLOYEE)

The WISE unit provides remote control of the major functions of the DDC and thus of the Robur units and plant controlled by the latter, over a common cellphone line equipped with WAP browser or using a point-to-point connection with a PC with a PSTN or GSM modem, so as to implement tele-control and teleassistance applications. The system is controlled by means of a web browser, while alarms are sent to the user by SMS.

The WISE device is composed of: n.1 WISE device; n.1 antenna; n.1 RS232 null-modem serial cable for device configuration; n.1 WISE - DDC communications cable with phone plug connection to the rear of the DDC; n.1 CD-ROM.
For existing plant for which the user wishes to implement such a remote control system, the firmware must be compatible with the components - contact Robur S.p.A. presales.

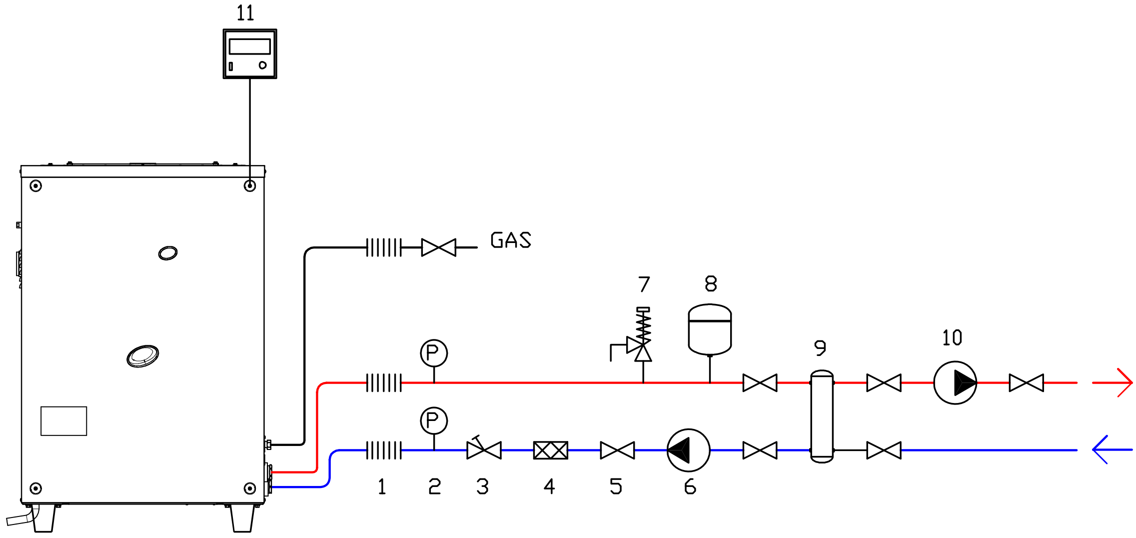
5.7 MOD BUS

The DDC supports interfacing with external equipment (BMS, PLC, SCADA, etc.) via the Modbus RTU protocol.
The Modbus protocol makes it possible to acquire data regarding the operation of the units and the plant controlled by the DDC (temperatures, statuses, counters, etc.).
It can also acquire information regarding alarms, both current and registered in the alarms log.
It can also act on the plant to set a variety of operational parameters such as unit On/Off, hot/cold inversion, setpoints, differentials, power steps, and operating time bands.
The DDC implements the Modbus RTU protocol as a slave device, in the following modes: 19.200 8N1; 19200 8E1; 19200 8N2; 9600 8N1; 9600 8E1; 9600 8N2.
The default modbus address is 1, and can be configured via the DDC's display which supports the following modbus function codes: (01) Read Coil Status; (02) Read Discrete Input; (03) Read Holding Register; (04) Read Input Register; (05) Write Single Coil; (06) Write Single Register; (15) Write Multiple Coil; (16) Write Multiple Register; (23) Read/Write Multiple Register.
The DDC is equipped to support broadcast messages.

6 PLANT SCHEMATICS

6.1 SINGLE GAHP-A HEATING SYSTEM

Figure 6.1 – Plumbing system

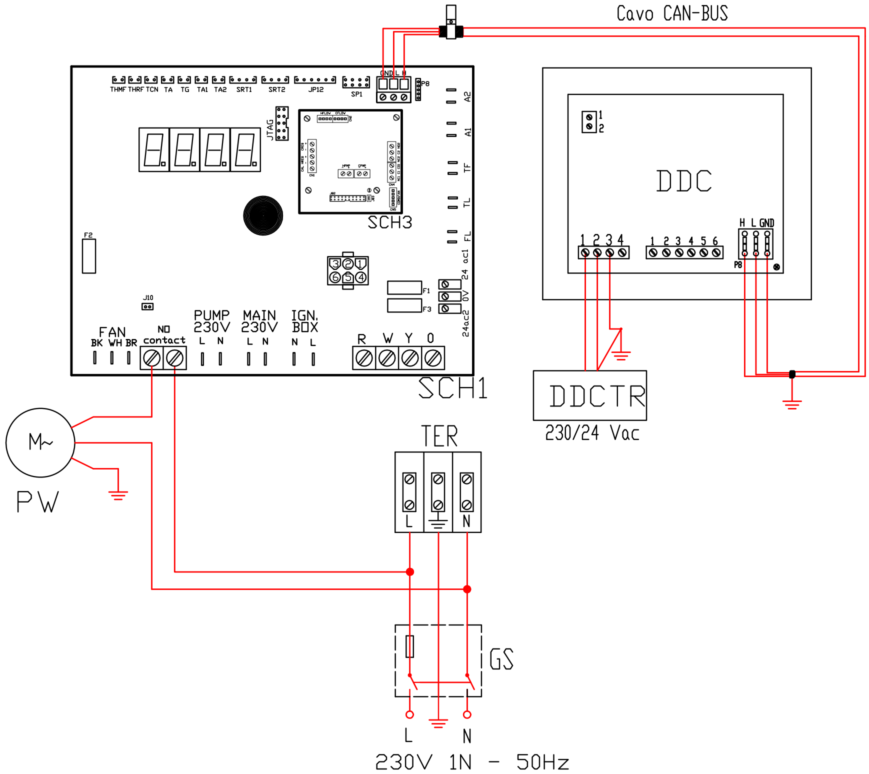


LEGEND

1	Anti-vibration joints
2	Manometer
3	Flow regulator valve
4	Water filter
5	Cut-off valve
6	Water pump (primary circuit)
7	Safety valve 3 bar
8	Expansion tank of the unit
9	Hydraulic separator / inertial tank with 4 attack
10	Water pump (secondary circuit)
11	Direct Digital Controller

Example of hydraulic connection of a single unit.

Figure 6.2 – Electrical system



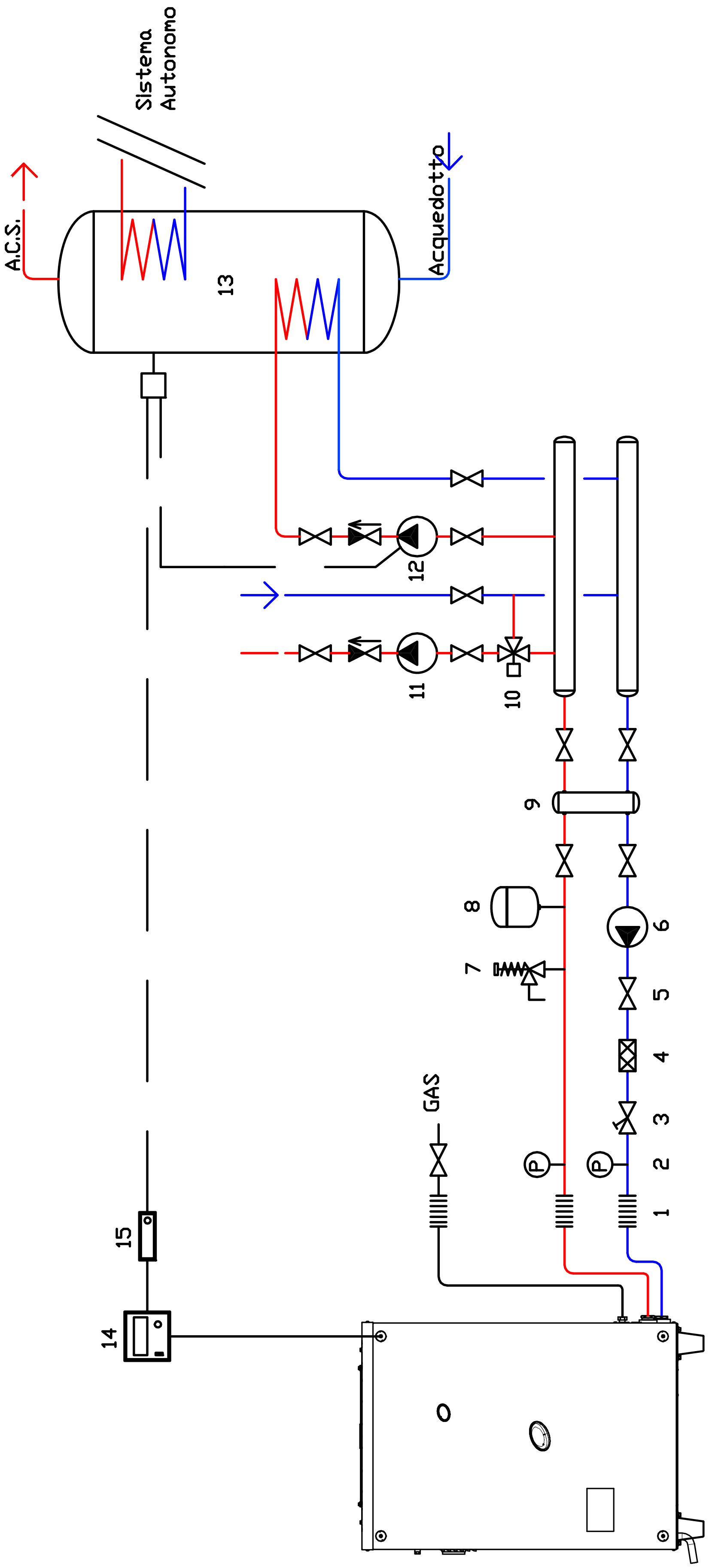
LEGEND

DDCTR	secondary safety transformer SELV 230/24 V AC, 50/60 Hz (not supplied)
PW	plant water pump [230 V AC; less than 700W] (not supplied)
GS	master bipolar breaker with fuse (not supplied)
TER	9-pole on-board terminal block, of unit
DDC	direct digital controller (not supplied)
S60	unit on-board logic
L	line terminal (single phase)
N	Neutral terminal

Example of electrical connection of a single unit.

6.2 SINGLE GAHP-A HEATING AND DHW PRODUCTION SYSTEM

Figure 6.3 – Plumbing system

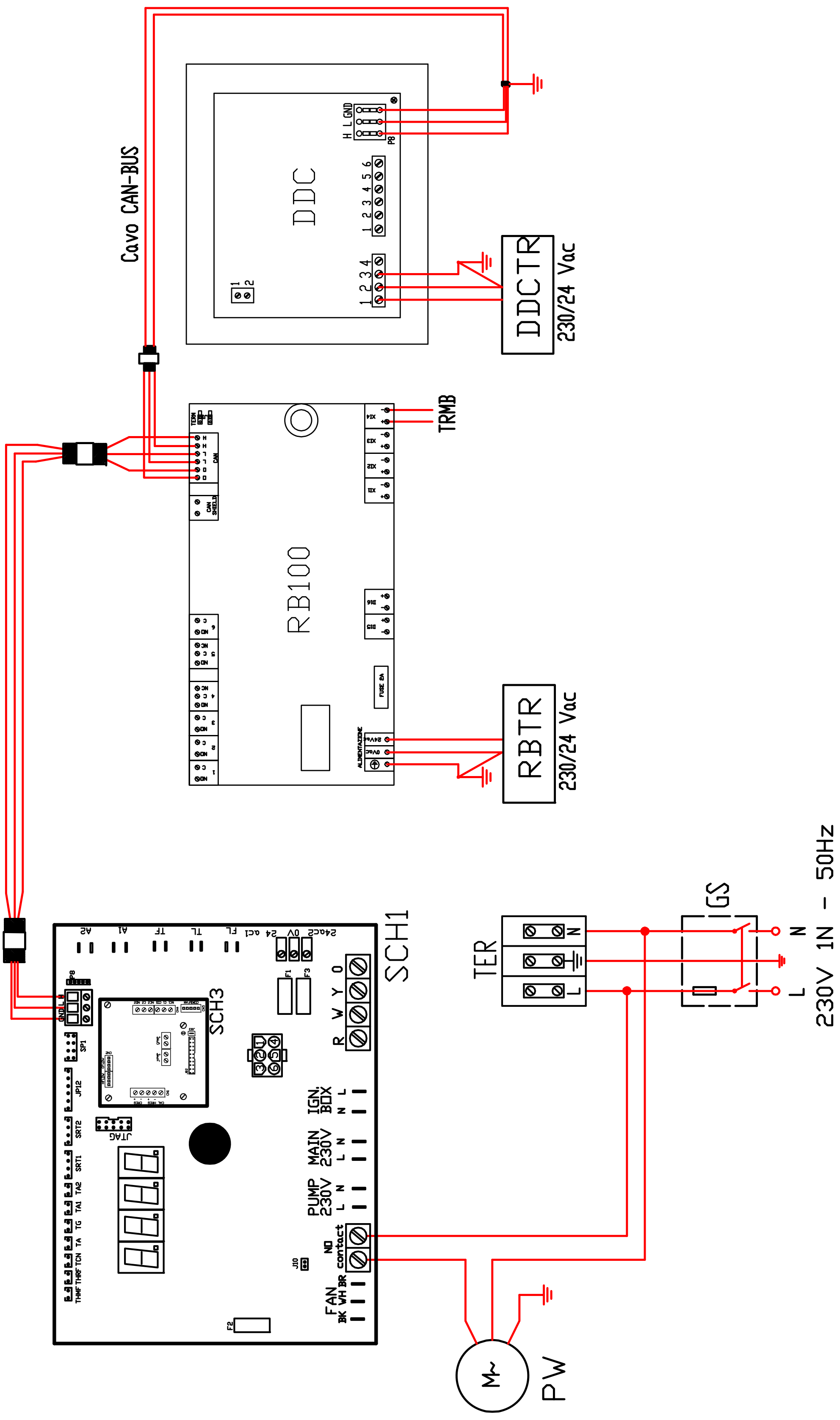


LEGEND

1 Anti-vibration coupling
2 Pressure gauge
3 Flow regulator valve
4 Water filter
5 Shut-off valve
6 Water circulation pump internal circuit
7 Safety valve 3 bar
8 Expansion tank single unit
9 Hydraulic separator
10 3-way mixer valve
11 Water circulation pump heating circuit
12 Water circulation pump DHW circuit
13 DHW accumulation tank, with thermostat (T.max = 45°C)
14 Direct Digital Controller
15 RB100 controller

Example of hydraulic connection of single unit with DHW production.

Figure 6.4 – Electrical system



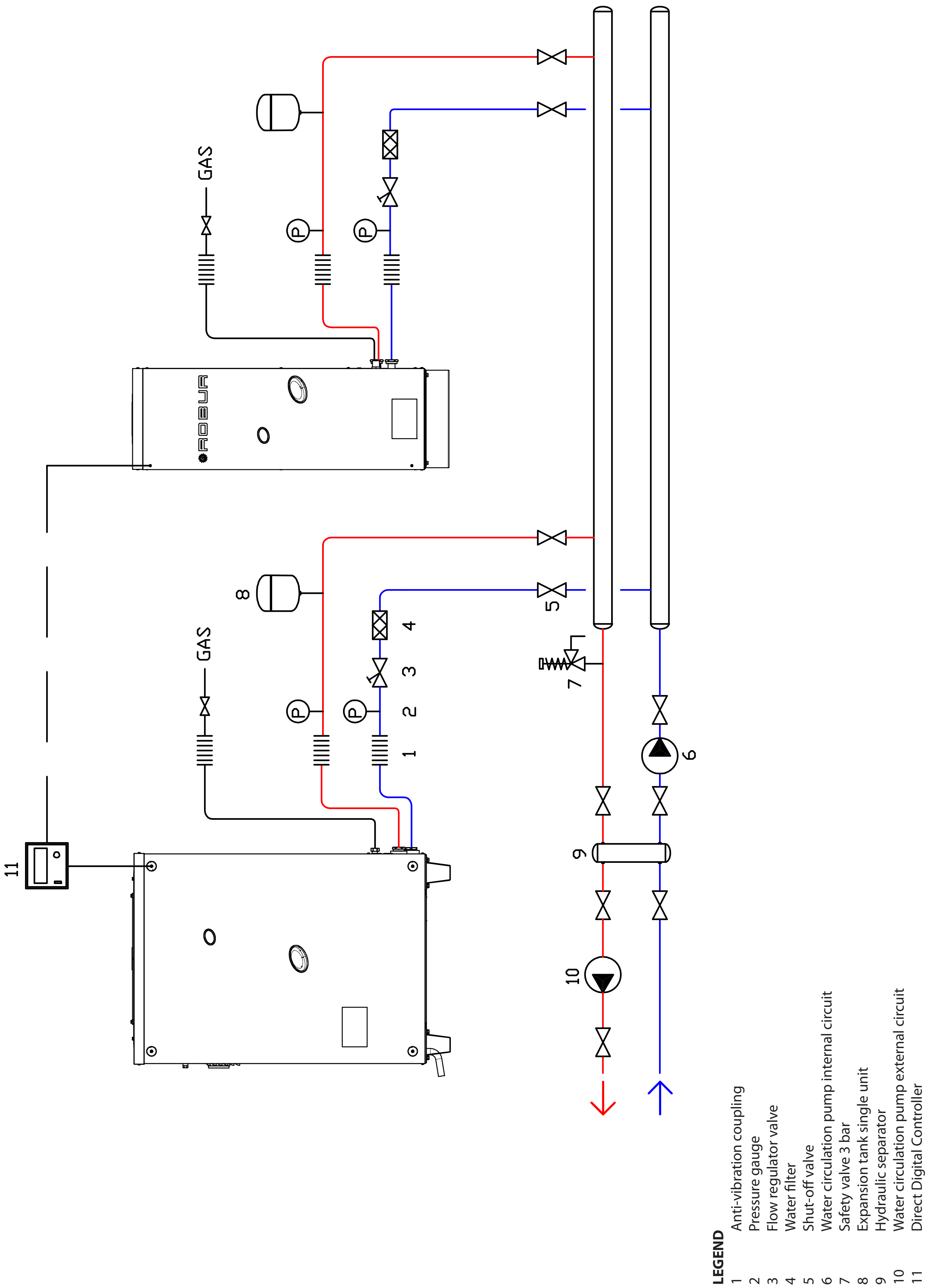
LEGEND

DDCTR	secondary safety transformer SELV 230/24 V AC, 50/60 Hz (not supplied)
RBTR	secondary safety transformer SELV 230/24 V AC, 50/60 Hz (not supplied)
PW	water pump internal circuit [230 V AC; <700W] (non fornita)
GS	master bipolar breaker with fuse (not supplied)
TER	9-pole on-board terminal block, of unit
DDC	Direct Digital Controller (not supplied)
SCH1	unit on-board logic
RB100	Robur Box logic
TRMB	Boiler thermostat
L	line terminal (single phase)
N	Neutral terminal

Example of electrical connection of single unit with DHW production.

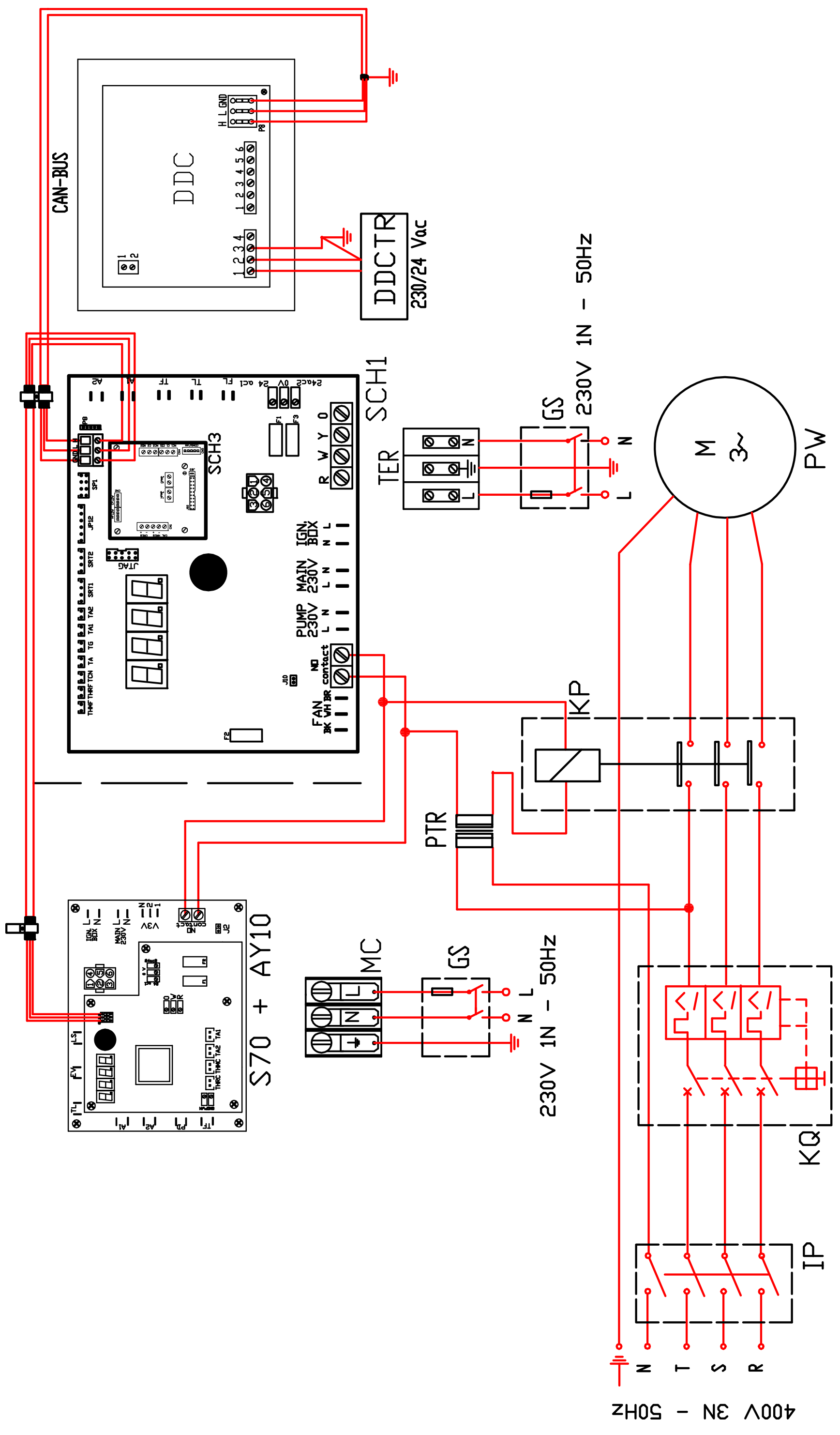
6.3 HEATING SYSTEM WITH SINGLE GAHP-A AND AY CONDENSING UNIT WITH SHARED CIRCULATOR

Figure 6.5 – Plumbing system



Example of hydraulic connection of a single unit with AY00-120 condensing units and shared circulator.

Figure 6.6 – Electrical system



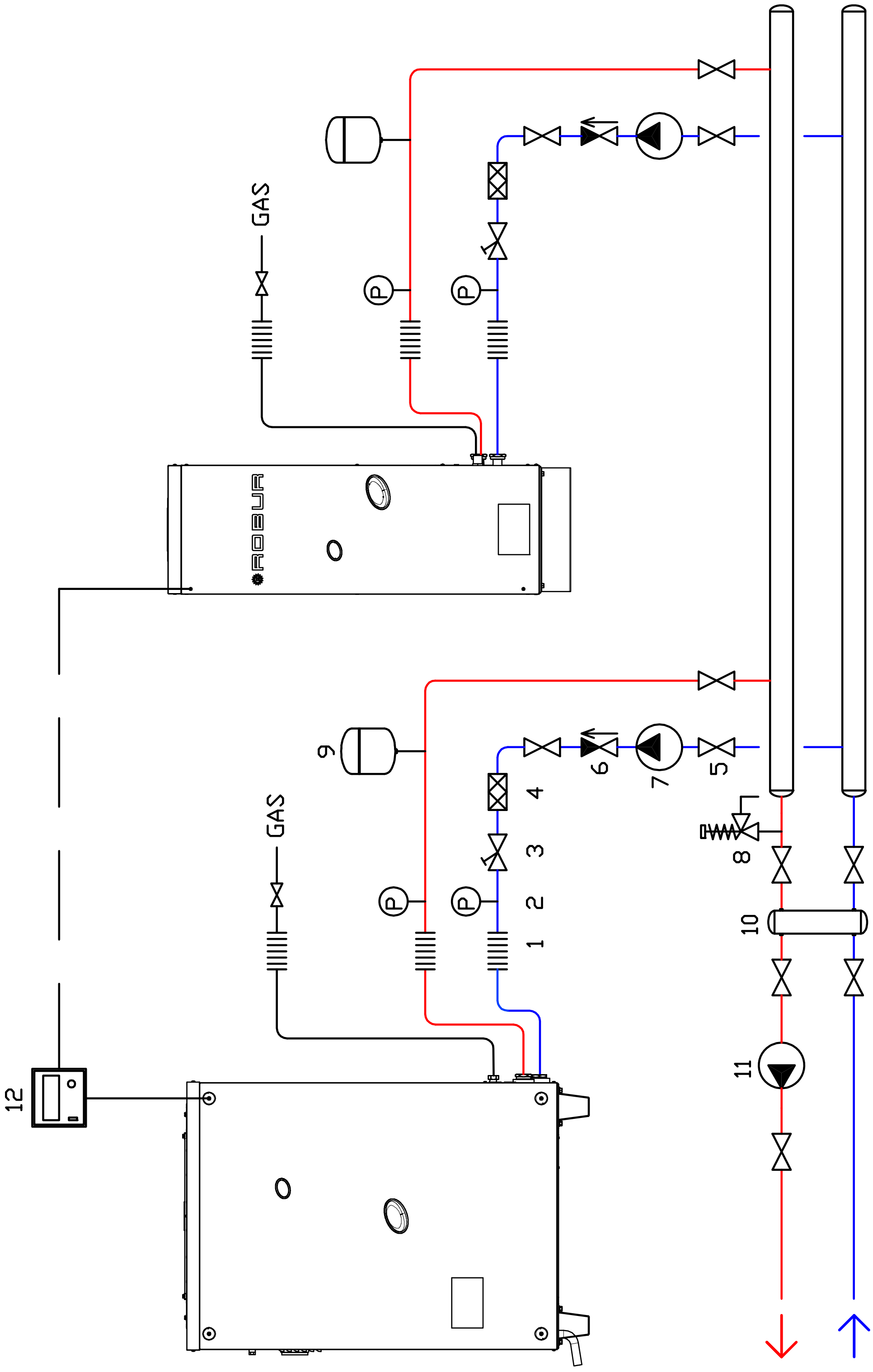
LEGEND

DDCTR	secondary safety transformer SELV 230/24 V AC, 50/60 Hz (not supplied)
PTR	secondary safety transformer SELV (not supplied)
PW	internal circuit water pump [400 V AC] (not supplied)
IP	four-pole pump power breaker (not supplied)
GS	master bipolar breaker with fuse (not supplied)
MC	6-pole horizontal on-board terminal block, AY unit
KP	N.O. relay for water pump control (not supplied)
TER	9-pole on-board terminal block, of unit
DDC	Direct Digital Controller (not supplied)
SCH1	unit on-board logic
KQ	thermal cutout for 400 V AC pump (not supplied)
AY10	AY unit on-board logic
S70	AY unit auxiliary on-board logic
L	line terminal (single phase)
R,S,T	line terminals (three phase)
N	Neutral terminal

Example of electrical connection of a single unit with AY00-120 condensing units and shared circulator.

6.4 HEATING SYSTEM WITH SINGLE GAHP-A AND AY CONDENSING UNIT WITH INDEPENDENT CIRCULATORS

Figure 6.7 – Plumbing system

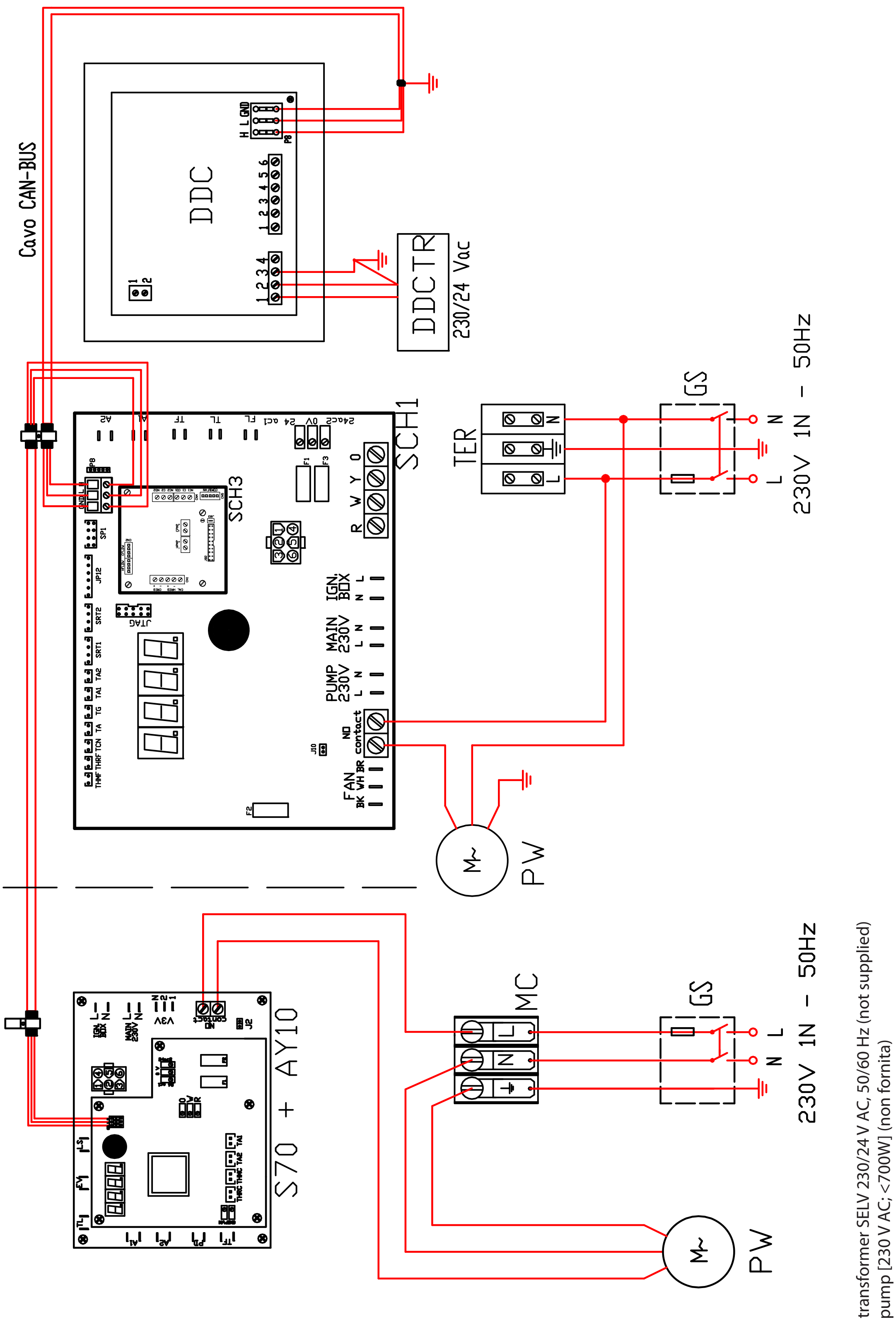


LEGEND

1 Anti-vibration coupling
2 Pressure gauge
3 Flow regulator valve
4 Water filter
5 Shut-off valve
6 Check valve
7 Water circulation pump single unit
8 Safety valve 3 bar
9 Expansion tank single unit
10 Hydraulic separator
11 Water circulation pump external circuit
12 Direct Digital Controller

Example of hydraulic connection of a single unit with AY00-120 condensing units and independent circulators.

Figure 6.8 – Electrical system



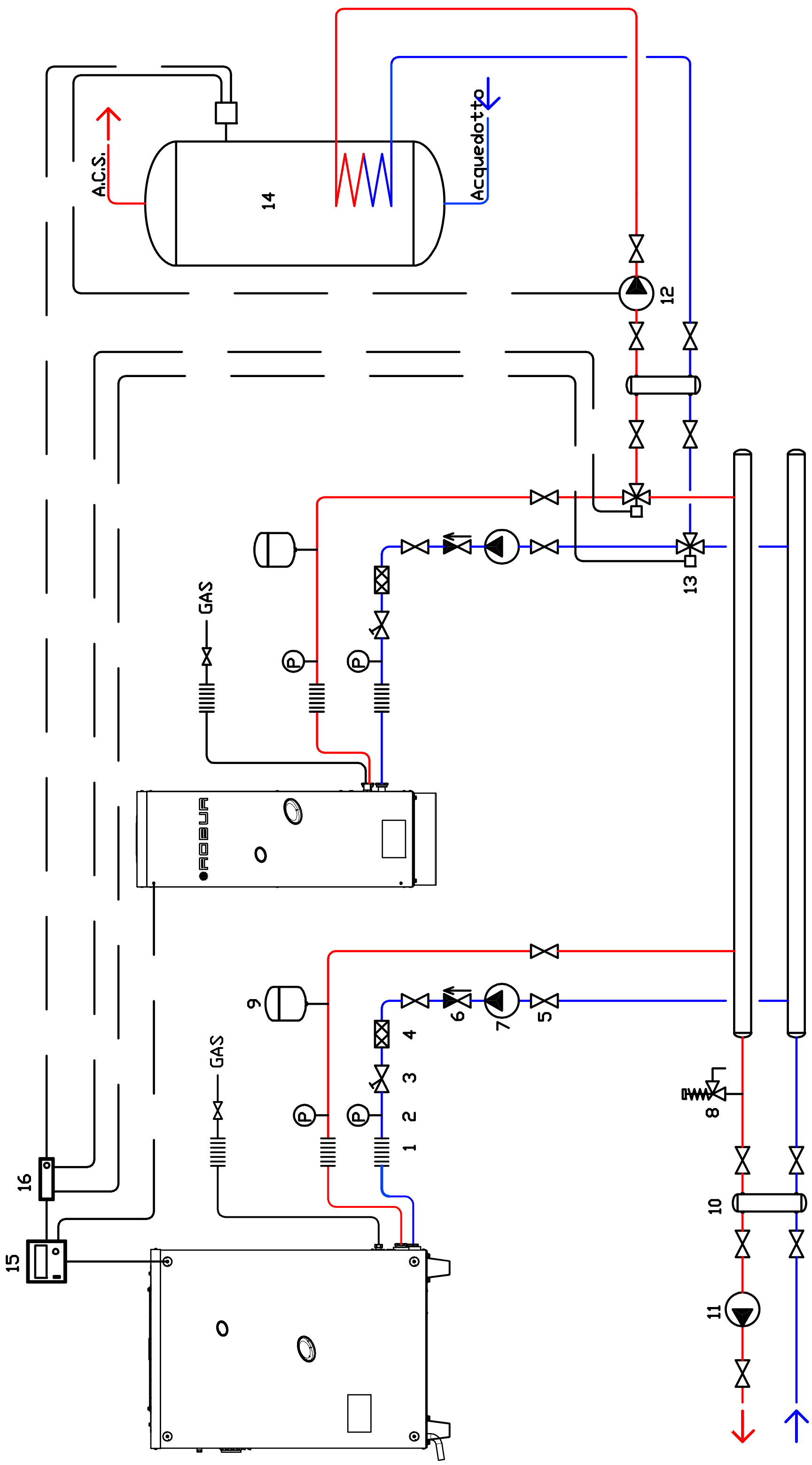
LEGEND

- DDCTR secondary safety transformer SELV 230/24 V AC, 50/60 Hz (not supplied)
- PW single unit water pump [230 V AC; <700W] (non fornita)
- GS master bipolar breaker with fuse (not supplied)
- MC 6-pole horizontal on-board terminal block, AY unit
- TER 9-pole on-board terminal block, of unit
- DDC Direct Digital Controller (not supplied)
- SCH1 Unit on-board logic
- S70 AY unit auxiliary on-board logic
- AY10 AY unit on-board logic
- L line terminal (single phase)
- N Neutral terminal

Example of electrical connection of a single unit with AY00-120 condensing units and independent circulators.

6.5 HEATING AND DHW PRODUCTION SYSTEM WITH SINGLE GAHP-A AND AYCONDENSING UNIT - INDEPENDENT CIRCULATORS

Figure 6.9 – Plumbing system

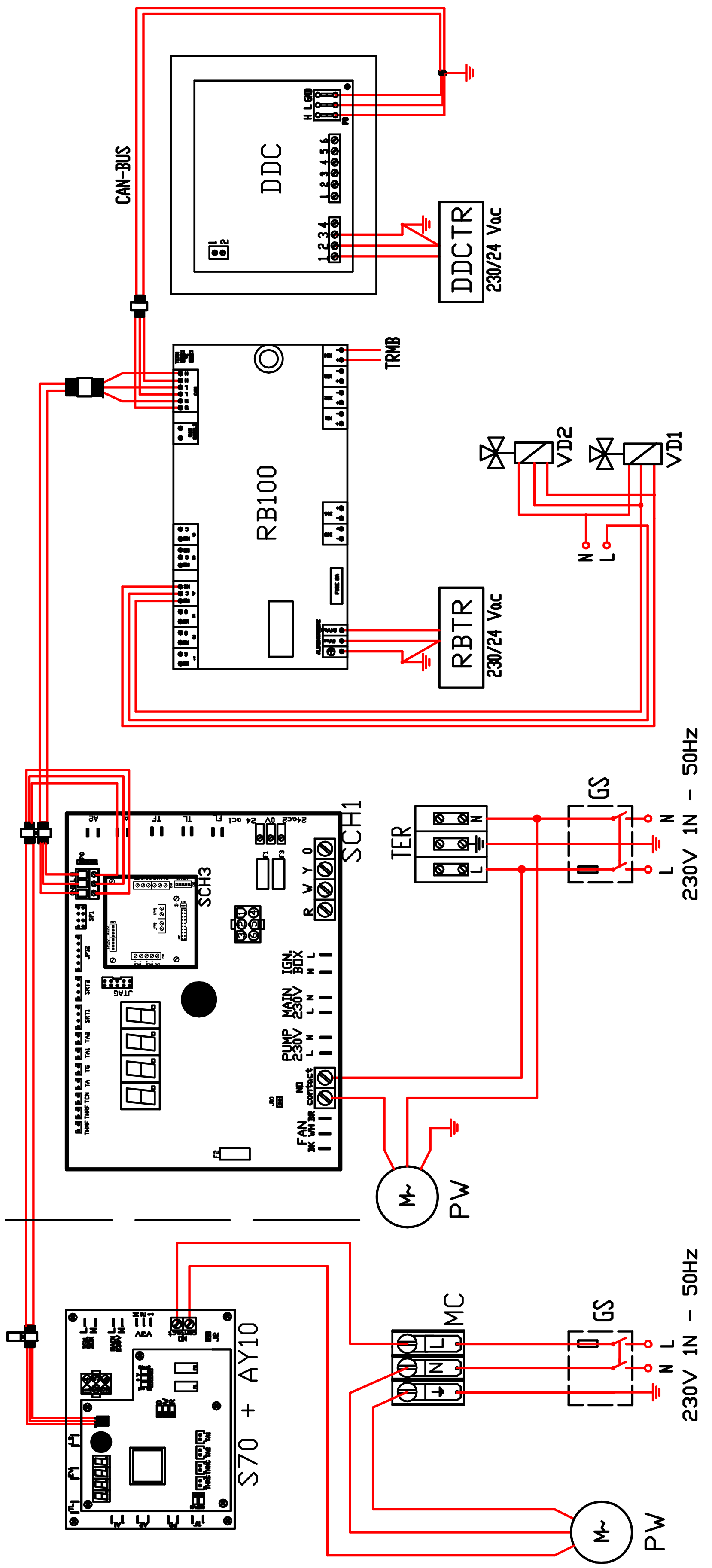


LEGEND

1 Anti-vibration coupling
2 Pressure gauge
3 Flow regulator valve
4 Water filter
5 Shut-off valve
6 Check valve
7 Water circulation pump single unit
8 Safety valve 3 bar
9 Expansion tank single unit
10 Hydraulic separator
11 Water circulation pump external circuit
12 Water circulation pump DHW circuit
13 3-way valve
14 DHW accumulation tank, with thermostat
15 Direct Digital Controller
16 RB100 controller

Example of hydraulic connection of a single unit with AY00-120 condensing units and independent circulators, with DHW production.

Figure 6.10 – Electrical system



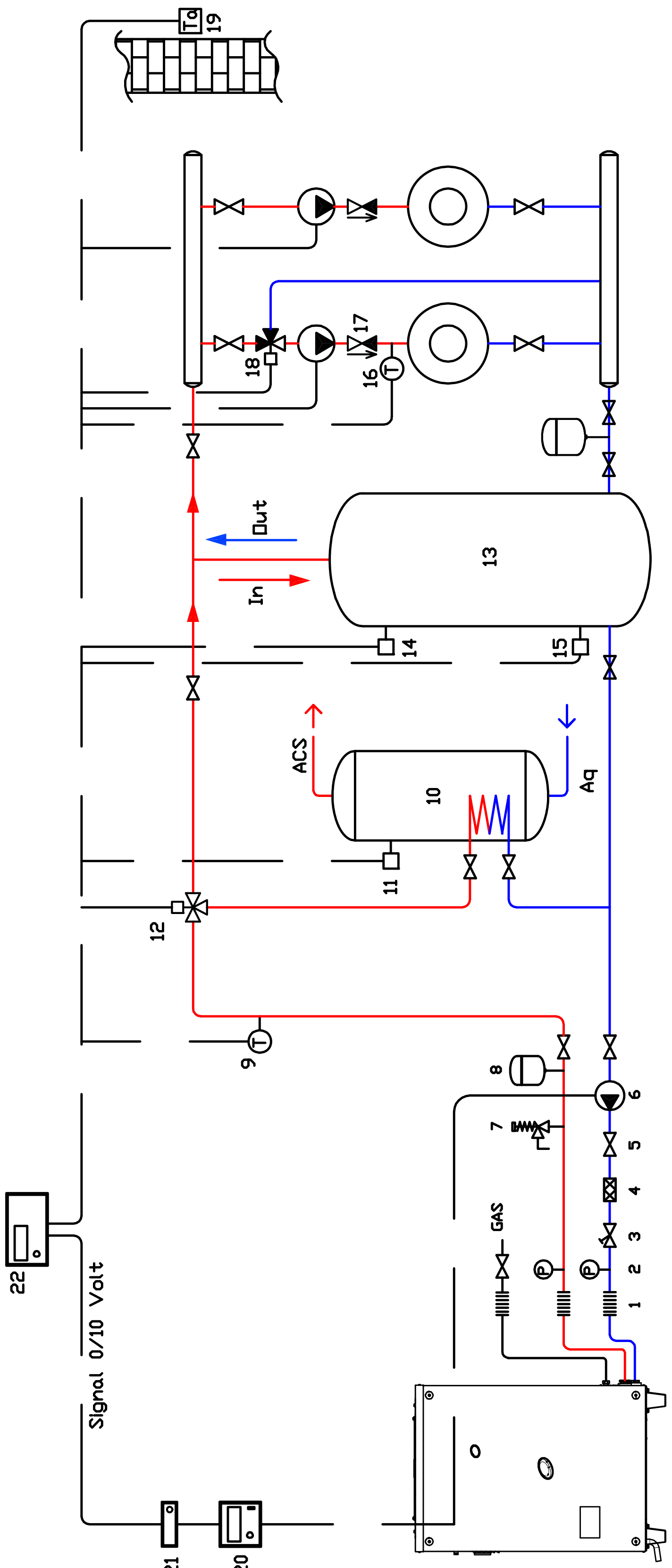
LEGEND

DDCTR	secondary safety transformer SELV 230/24 V AC, 50/60 Hz (not supplied)
RBTR	secondary safety transformer SELV 230/24 V AC, 50/60 Hz (not supplied)
PW	single unit water pump [230 V AC; <700W] (not supplied)
vd1-2	3-way valve (not supplied)
GS	master bipolar breaker with fuse (not supplied)
MC	6-pole horizontal on-board terminal block, AY unit
TER	9-pole on-board terminal block, of unit
DDC	Direct Digital Controller (not supplied)
SCH1	unit on-board logic
RB100	Robur Box logic (not supplied)
TRMB	Boiler Thermostat
AY10	AY unit on-board logic
S70	AY unit auxiliary on-board logic
L	line terminal (single phase)
N	Neutral terminal

Example of electrical connection of a single unit with AY00-120 condensing units and independent circulators, with DHW production.

6.6 SINGLE GAHP-A UNIT HEATING AND DHW PRODUCTION SYSTEM WITH ELECTRONIC SYSTEM CONTROL

Figure 6.11 – Plumbing system

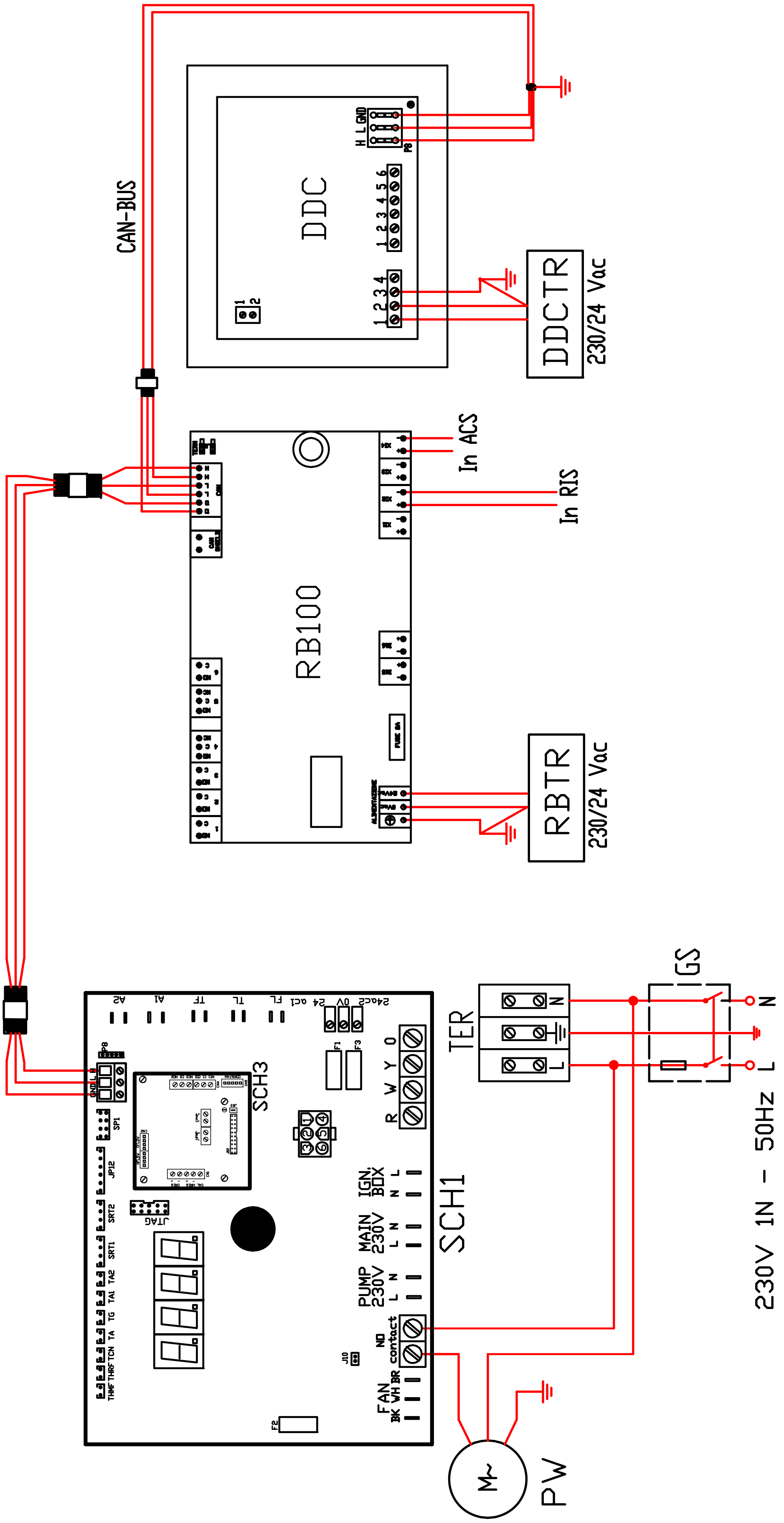


LEGEND

1 Anti-vibration coupling
2 Pressure gauge
3 Flow regulator valve
4 Water filter
5 Shut-off valve
6 Water circulation pump single unit
7 Safety valve 3 bar
8 Expansion tank single unit
9 Temperature sensor internal circuit delivery
10 DHW accumulation tank, with thermostat
11 Temperature probe on DHW accumulation tank
12 3-way valve
13 Inertial tank, 3 fittings
14 Temperature probe on inertial tank
15 Temperature probe on inertial tank
16 Temperature probe on system deliveries
17 Check valve
18 3-way mixer valve for system deliveries
19 External air temperature probe
20 Direct Digital Controller
21 RB100 controller
22 Plant controller system

Example of hydraulic connection of single unit with DHW production and electronic system control.

Figure 6.12 – Electrical system



LEGEND

- DDCTR secondary safety transformer SELV 230/24 V AC, 50/60 Hz (not supplied)
- RBTR secondary safety transformer SELV 230/24 V AC, 50/60 Hz (not supplied)
- PW water pump internal circuit [230 Vac; <700W] (not supplied)
- GS master bipolar breaker with fuse (not supplied)
- TER 9-pole on-board terminal block, of unit
- SCH1 Unit on-board logic
- SCH3 auxiliary controller (Mod10)
- DDC Direct Digital Controller (not supplied)
- RB100 Robur Box logic (otpional)
- In ACS Inlet DHW request (by controller)
- In RIS Inlet heating request (by controller)
- L line terminal (single phase)
- N Neutral terminal

Example of electrical connection of single unit with DHW production and electronic system control.

Robur is dedicated to dynamic progression
in research, development and promotion
of safe, environmentally-friendly, energy-efficiency products,
through the commitment and caring
of its employees and partners.

La Mission Robur

Revision: A Code: D-MNL036 09 MED SDC xxx 20/05/09

caring for the environment

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