SAMSUNG

EHS

Design guide

Contents

1. Introduction

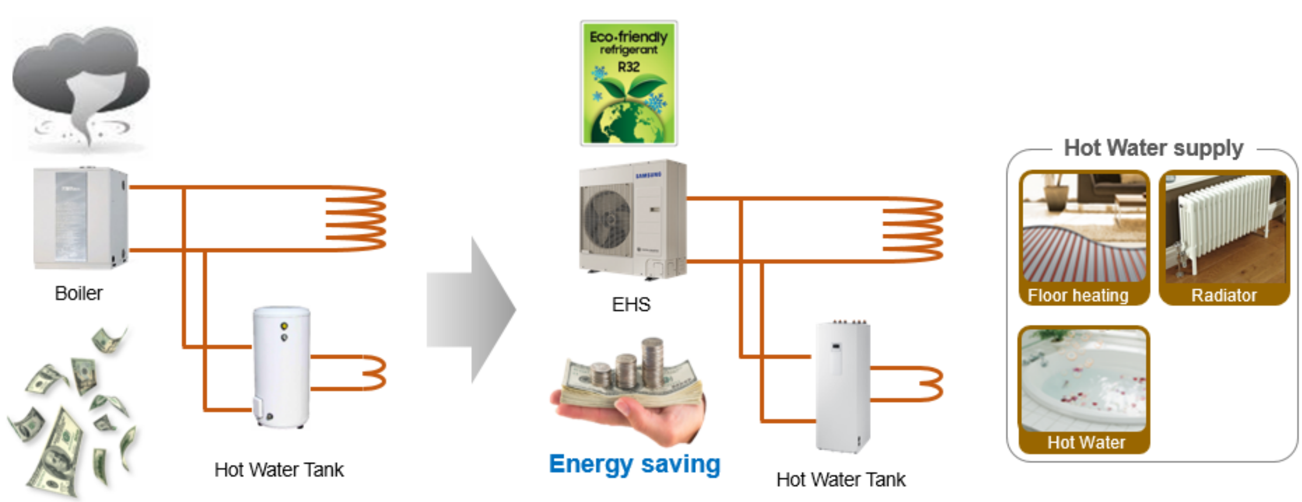
Please note that this document is for guidance only and is not the actual design manual. In practice, construction and plumbing methods may vary according to the projects and local legislation. To complete design and installation of the system, please consult your local design office.

1-1 Why SAMSUNG EHS system?

EHS stands for Eco Heating System.
Conventional boiler systems that use fossil fuel, like oil and gas, to provide heating and hot water are known to have a huge impact on the environment. Their fuel combustion creates harmful air pollution, like Sulfur Dioxide and Nitrogen Dioxide, and significant emissions of greenhouse gases, such as Carbon Dioxide.
SAMSUNG's range of Air to Water Eco Heating System is the culmination of years of research. They provide eco-friendly and energy efficient all-in-one heating, hot water and air conditioning for your home, with an Ozone Depletion Potential of zero and a low Global Warming Potential. They are also simple to install and configure, and their efficient heat pump technology delivers supreme comfort all year round with low operating costs.

You need heat, but the Earth does not.

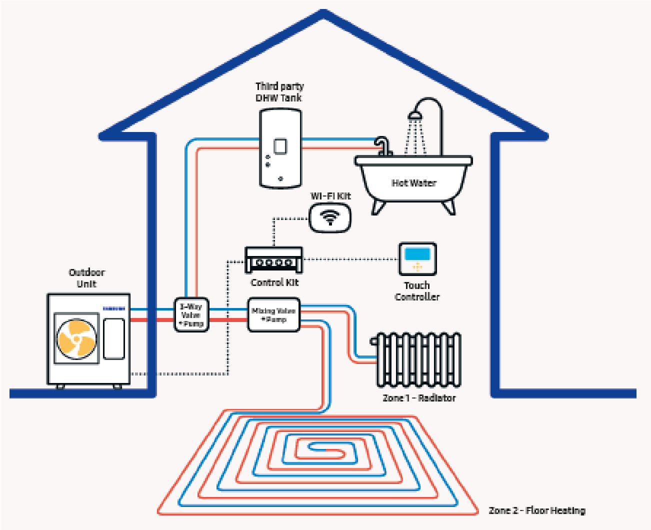
The Eco Heating System is perfect for both.



1-2 Product categories

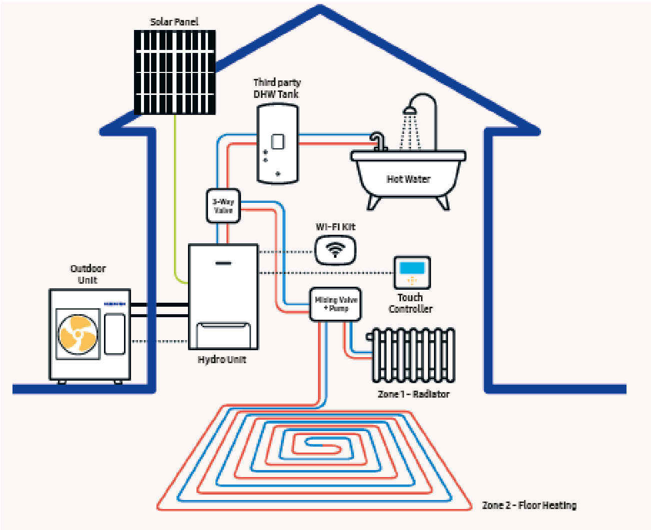
Mono

The EHS Mono can connect to third party equipment such as a Domestic Hot Water (DHW) tank thanks to the Samsung Mono control kit. The Mono Control kit includes a controller, flow sensor, DHW sensor and leaving and return water sensors.



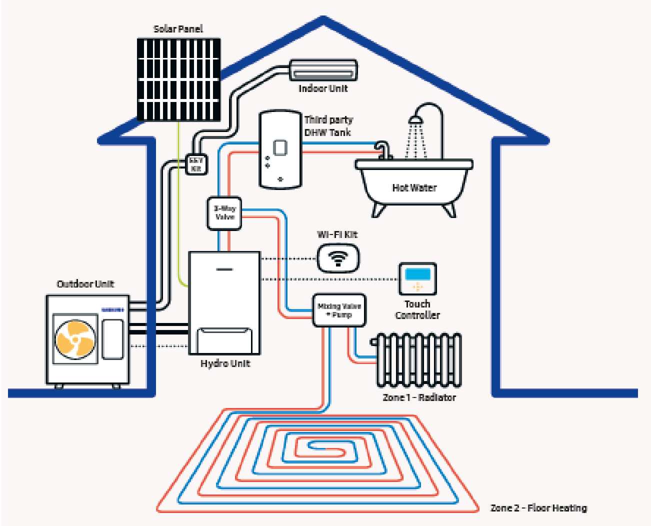
Split

The EHS Split outdoor unit is connected to a wall-mounted Hydro Unit to combine with a third party Domestic Hot Water (DHW) tank to suit all requirements. When used with the Hydro Unit, the Split enables production of domestic hot water and underfloor heating/cooling, and heating of radiators.



TDM Plus

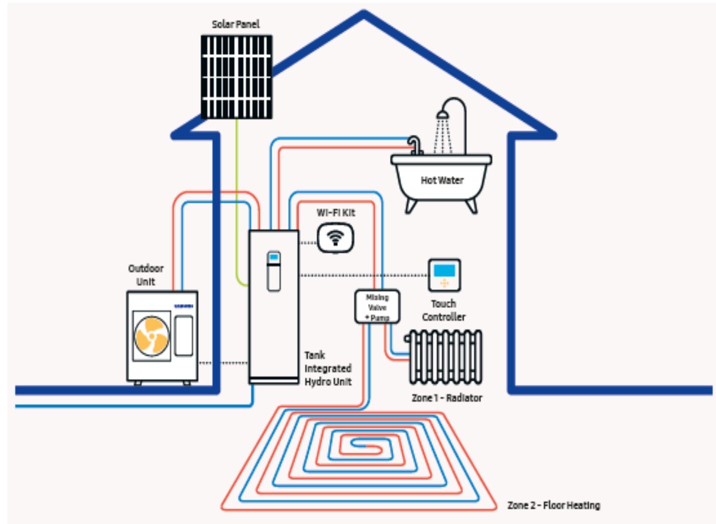
The EHS TDM Plus outdoor unit can connect to a third party Domestic Hot Water (DHW) tank via a wall-mounted Hydro Unit. TDM Plus with a third party connection offers A2W and A2A home climate comfort.



1-2 Product categories

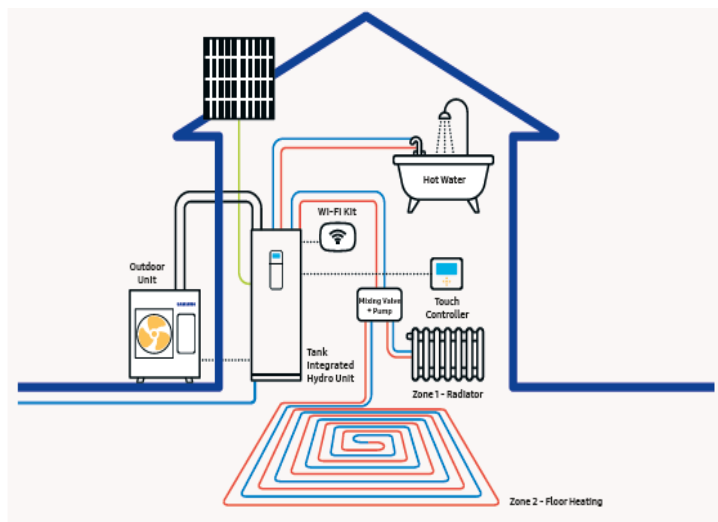
ClimateHub Mono

The ClimateHub Mono configuration has a single outdoor unit that includes the hydronic system, making it easy to install and use. The system's potential can be maximized by connecting to Smart Grid or Solar Power (PV).



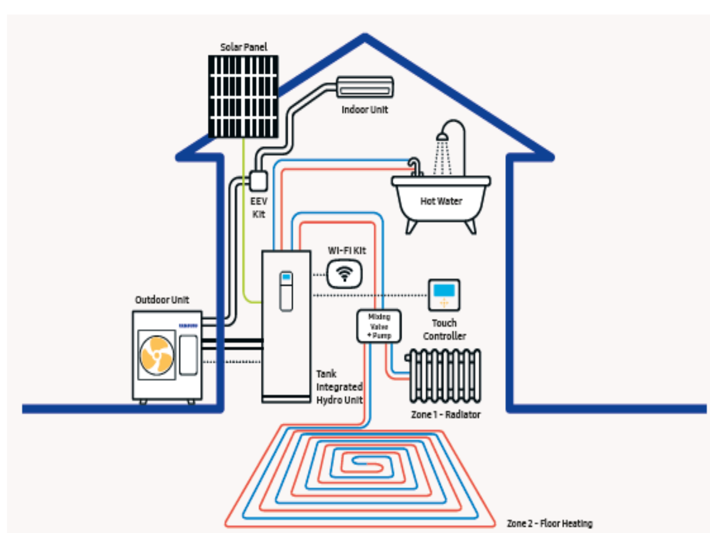
ClimateHub Split

The ClimateHub Split configuration has a single outdoor unit, connected by refrigerant pipes to the tank integrated hydro unit. To maximize its potential, the system can be connected to Smart Grid or Solar Power (PV).



ClimateHub TDM Plus

The TDM Plus system is an 'All-In-One' Air-to-Water (A2W) and Air-to-Air (A2A) system for a complete home climate solution. It enables underfloor heating/cooling and radiator heating, as well as offering A2A cooling with various options for air conditioning.



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1-3 EHS system design process

Design condition check

. Ambient temperature
. Desired water temperature
. Floor heating area
. Number of Tenants
. etc.

Heat load calculation

. Heat Load (peak)
. Cooling Load (peak)

***DHW calculation**

. Water flow appliance
. Daily liter/person per type of building
. DHW & Tank temperature

Product selection

Emitter choice

. *UFH design
 - Floor temperature
. Water piping design
 - Water flow rate
 - Friction loss
. Thermal resistance
. Delta temperature

Radiator selection

. Water temperature
. Delta temperature
* EN 1264 Method & radiator manufacture capacity table

Outdoor unit selection

. Load at design condition
. System *LWT
. Capacity correction factors
. Electric heater choice

FCU selection

. Water temperature
. Delta temperature

A2A unit selection (TDM)

. Load at design condition

* DHW : Domestic Hot Water
* UFH : Under Floor Heating
* LWT : Leaving Water Temperature

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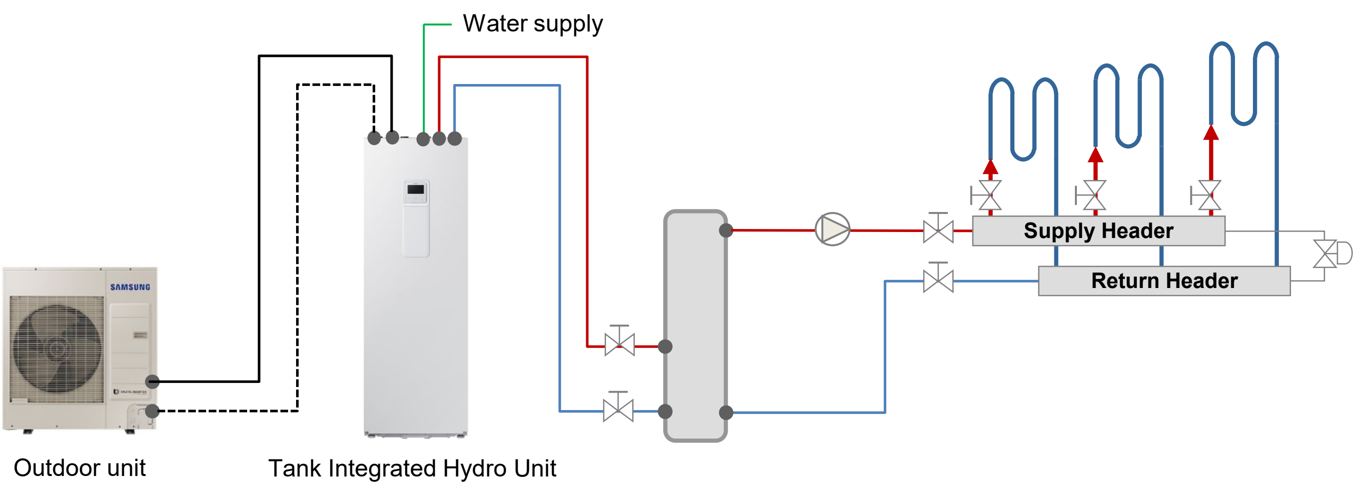
2. Application of SAMSUNG EHS

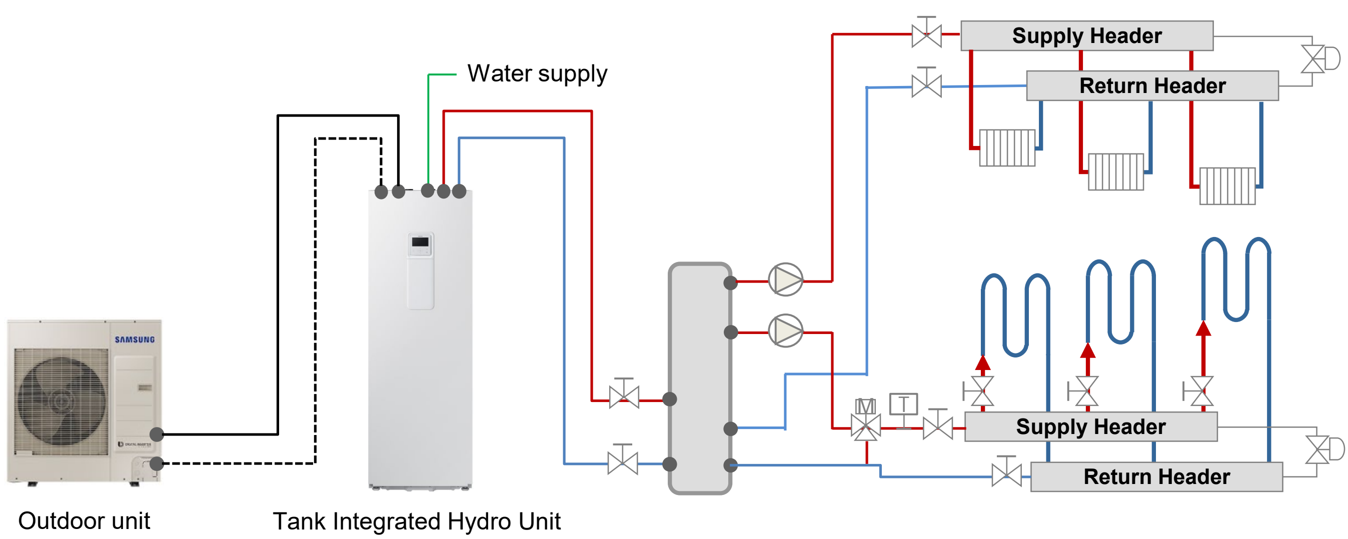
Please note that the following application is for reference only and is not the actual design.
Consult your local design office (Installer) for detailed hydraulic diagrams.

2-1 Space Heating/Cooling System

1) Floor heating only



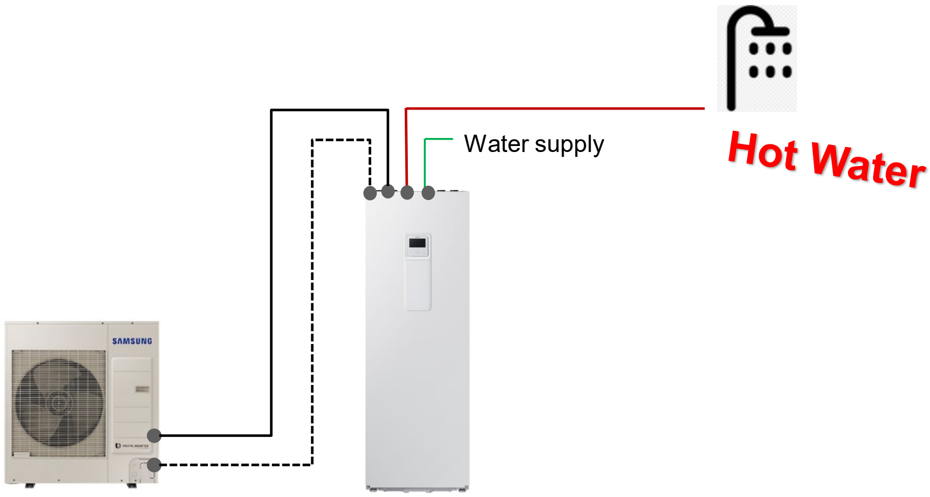
2) Floor heating + Radiator (FCU)



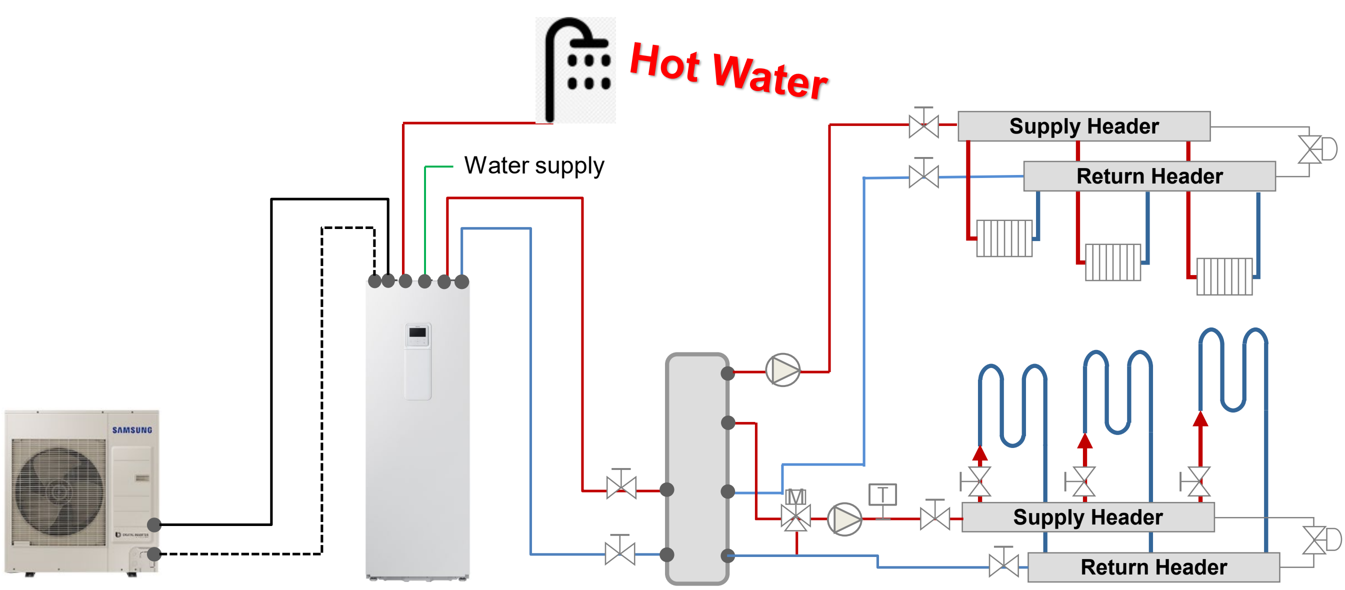
	Water pump		Mixed valve		Stop valve
	Bypass valve		Thermal sensor		3Way valve

2-2 Domestic Hot Water System

1) DHW only



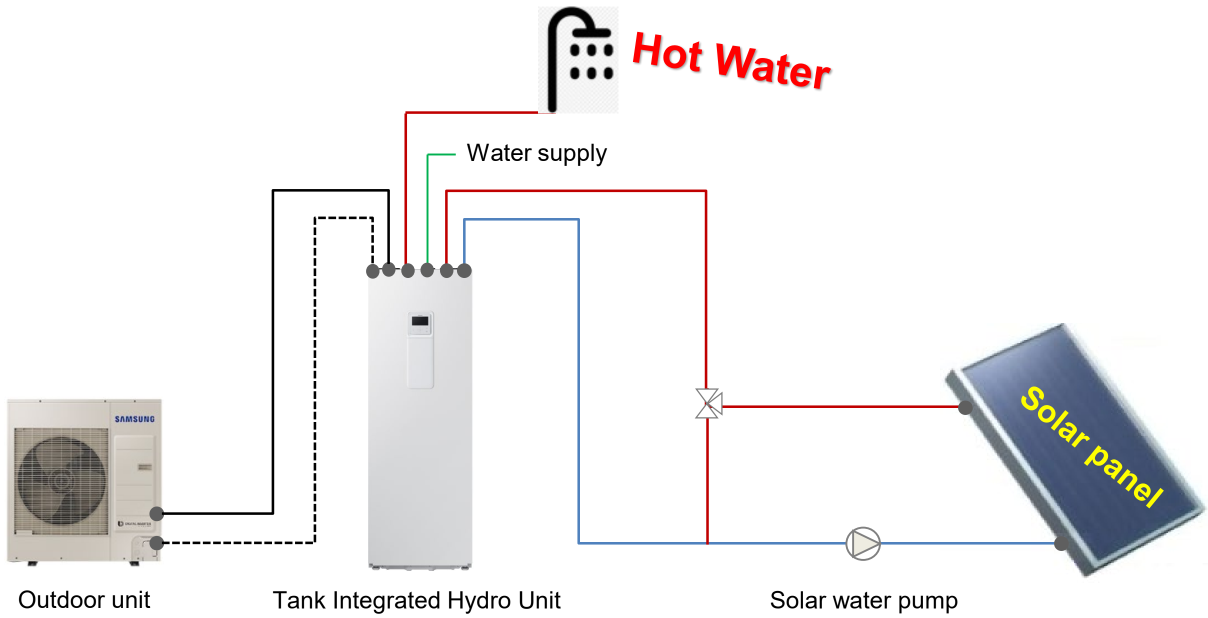
2) DHW + Space Heating/Cooling (Floor heating, Radiator, FCU)



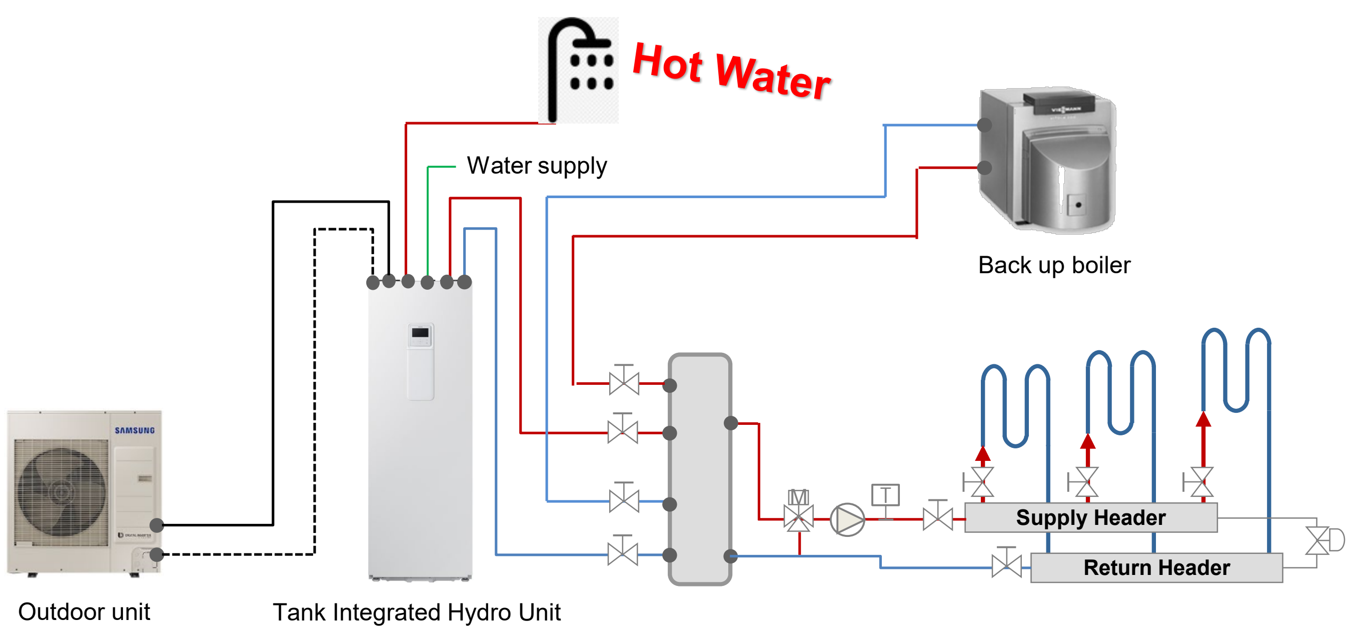
	Water pump		Mixed valve		Stop valve
	Bypass valve		Thermal sensor		3Way valve

2-3 Application with Solar panel and Backup boiler

1) Solar Panel



2) Backup boiler



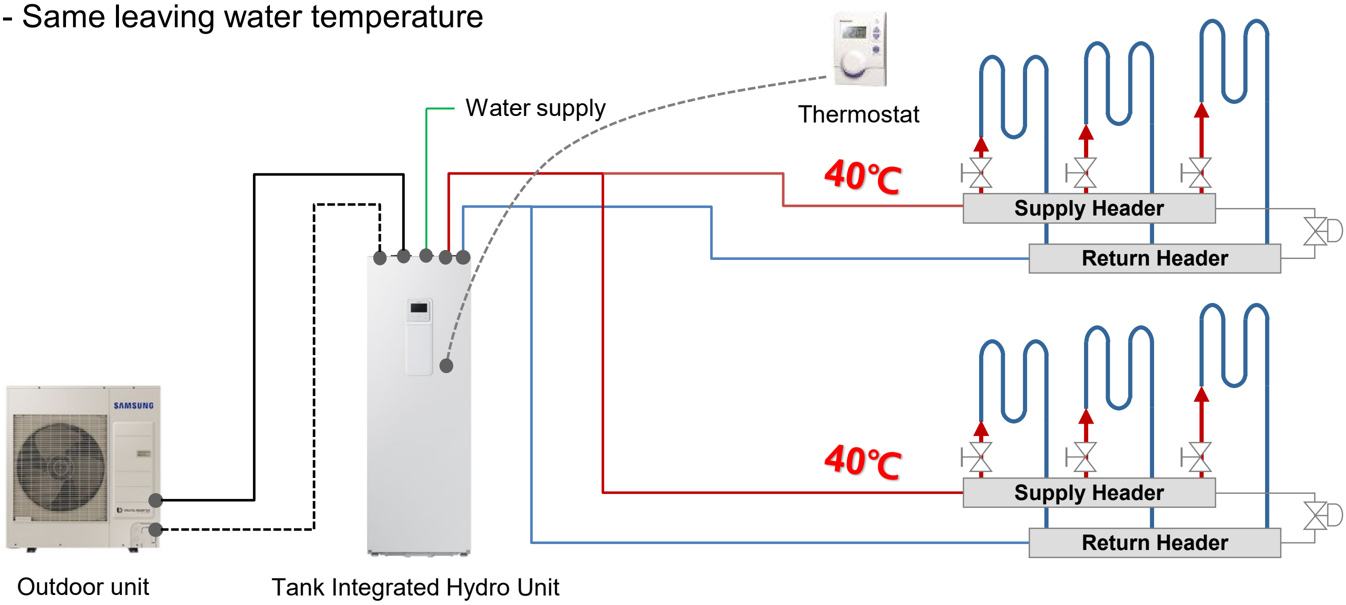
	Water pump		Mixed valve		Stop valve
	Bypass valve		Thermal sensor		3Way valve

2-4 Zone Control by Thermostat

- The FSV #2091 (Floor heating) or #2092 (FCU) should be set to “1” or “2” or “3” or “4”.

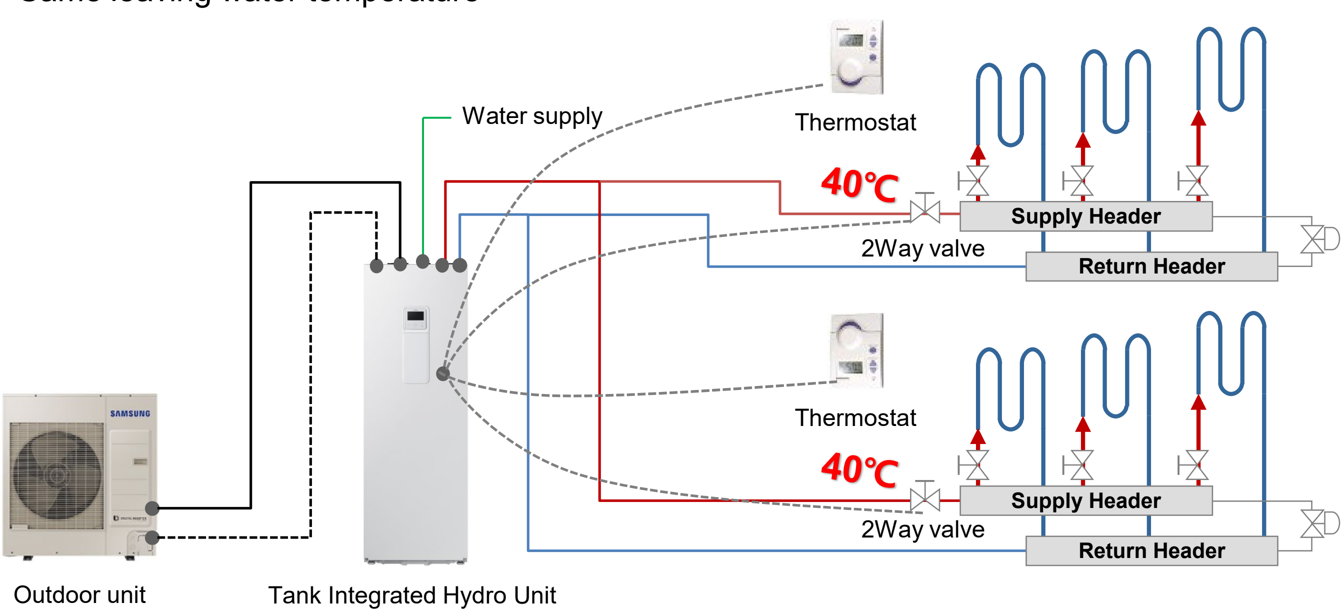
1) One Zone Control

- Same leaving water temperature



2) Two Zone Control by 2Way valve

- Same leaving water temperature

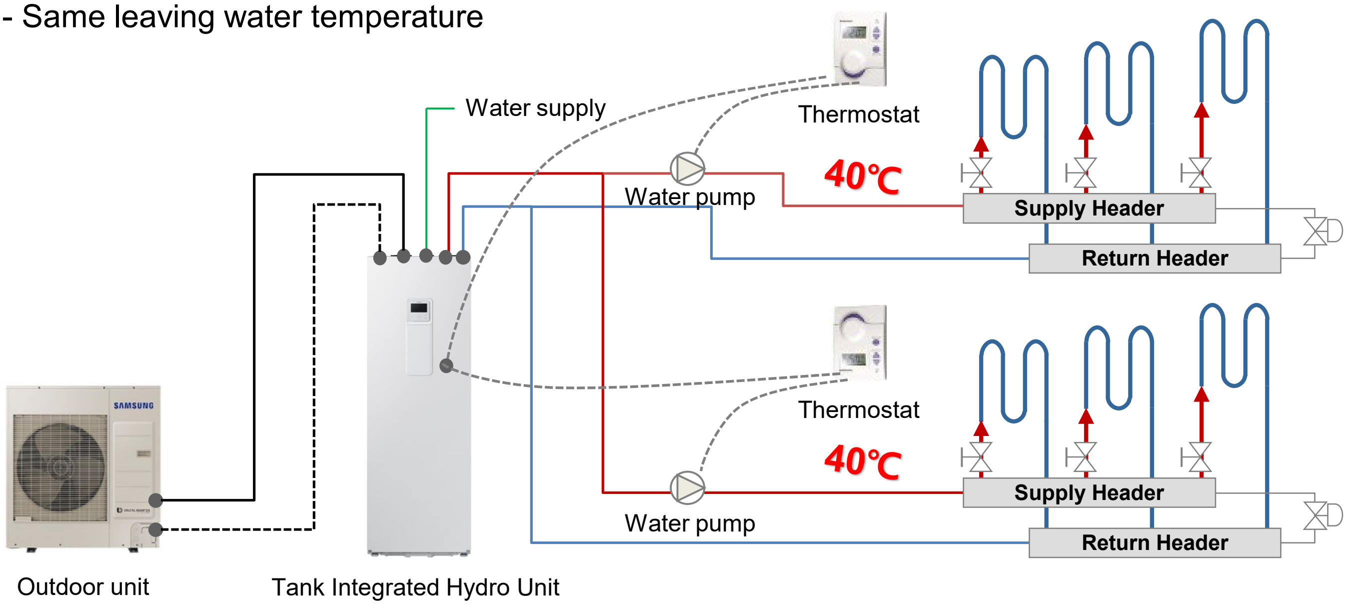


2-4 Zone Control by Thermostat

- The FSV #2091 (Floor heating) or #2092 (FCU) should be set to “1” or “2” or “3” or “4”.

3) Two Zone Control by individual water pump

- Same leaving water temperature

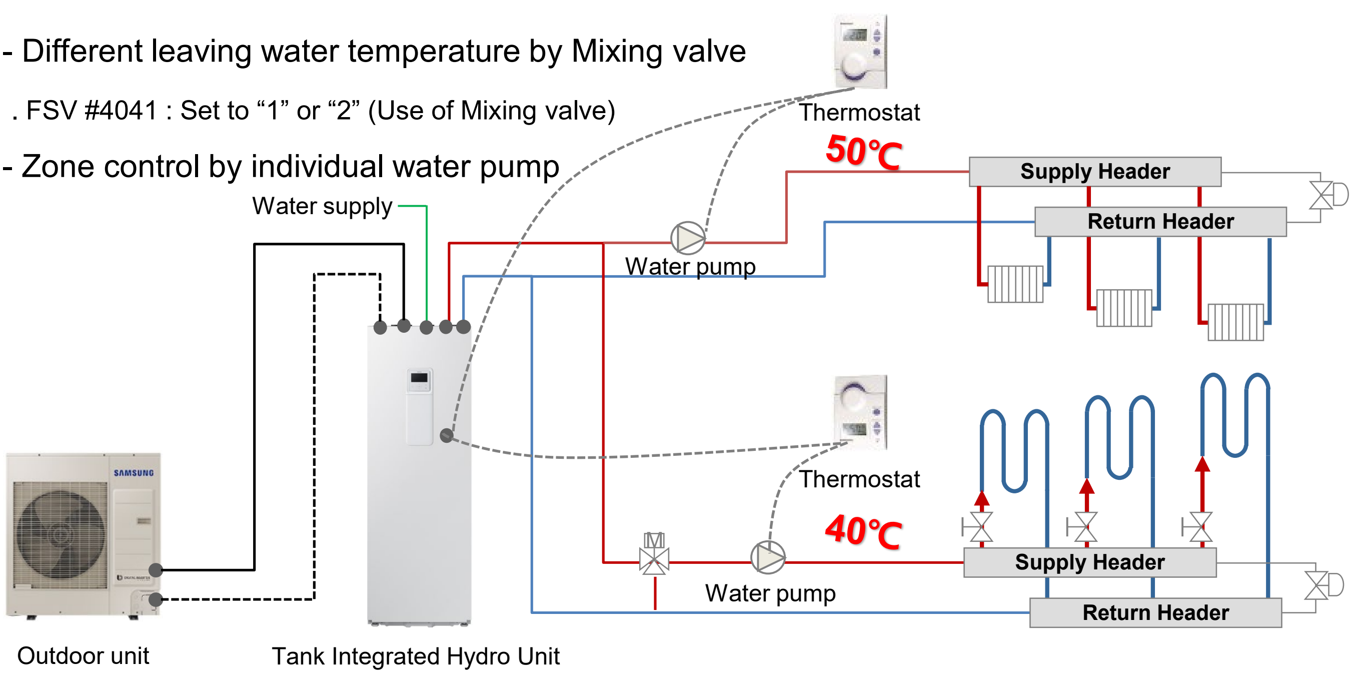


4) Two Zone Control with Mixing valve

- Different leaving water temperature by Mixing valve

. FSV #4041 : Set to “1” or “2” (Use of Mixing valve)

- Zone control by individual water pump

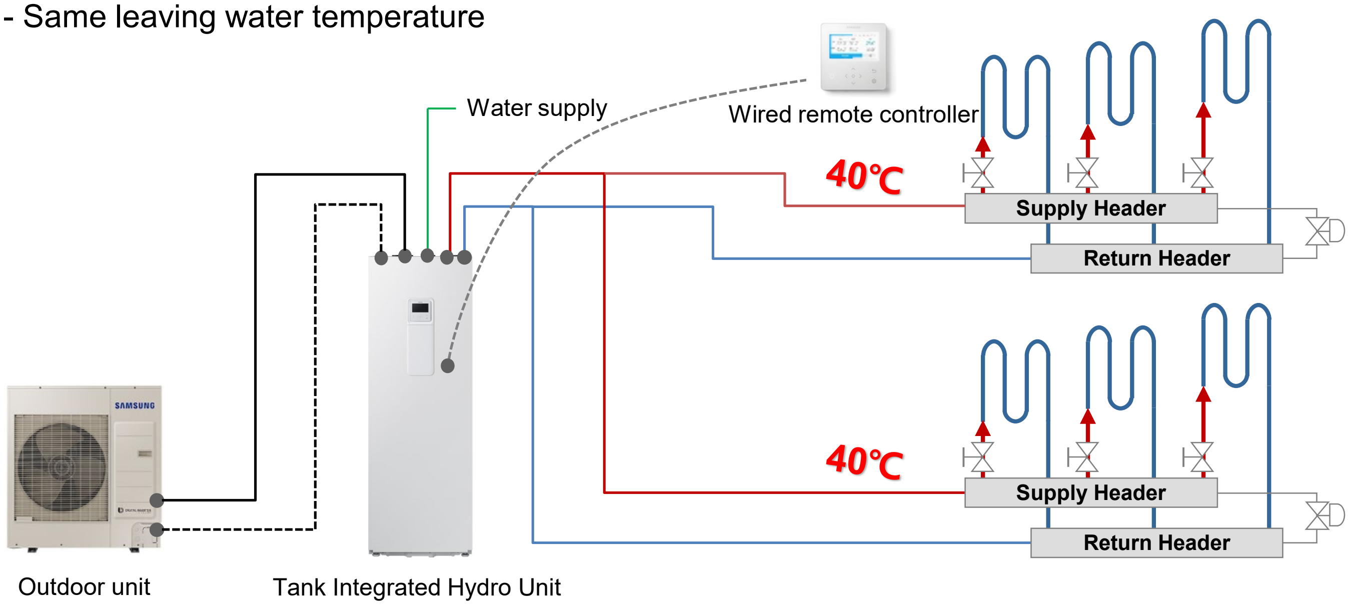


2-5 Zone Control by Wired remote controller

- The FSV #2091 (Floor heating) or #2092 (FCU) should be set to “0”.

1) One Zone Control

- Same leaving water temperature

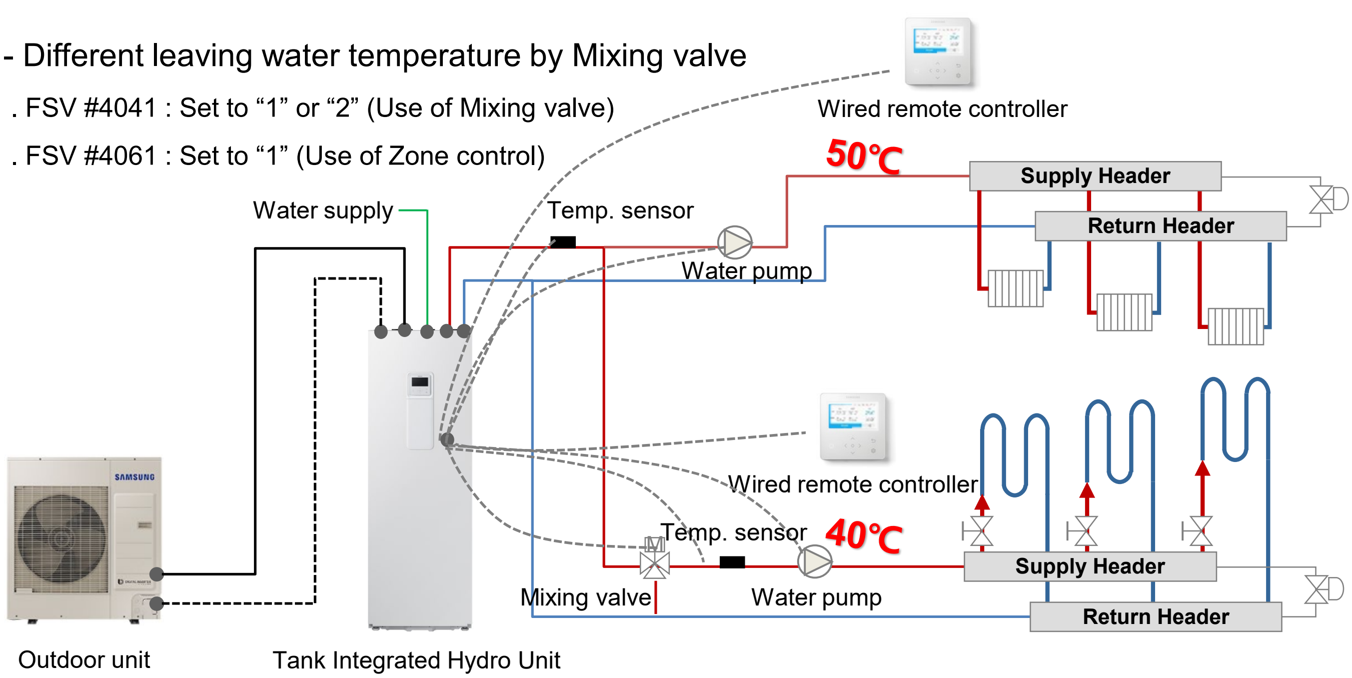


2) Two Zone Control

- Different leaving water temperature by Mixing valve

. FSV #4041 : Set to “1” or “2” (Use of Mixing valve)

. FSV #4061 : Set to “1” (Use of Zone control)



3. Load calculation

Please note that the following guide for load calculation is for reference only.
Consult your local design office (Installer) for detailed load calculation.

3-1 Underfloor heating load

- It is difficult to calculate the exact load because the insulation conditions such as walls, roofs, floors, windows, etc., and the direction and area of the building are all different. The table below is a design standard guide used to calculate underfloor heating load in Korea.

* Tier 1, 2, 3 : It is divided according to the insulation performance standard of the building.

☐ **Heat loss factor by region in Korea (kcal/h·㎡)**

City	Building Types		
	Tier 1	Tier 2	Tier 3
Seoul	68.9	90.9	216.3
Incheon	64.5	84.9	201.7
Daegu	61.8	81.5	193.6
Jeonju	62.1	81.9	194.4
Ulsan	55.7	73.1	172.1
Gwangju	57.8	76	180.1
Busan	51.5	67.5	159.3
Jeju	44.1	57.8	136.2

※ Based on boiler design standard in Korea

- Total heating load (kcal/h)
  = Heating load per area (kcal/h·㎡) x heating area (㎡)

※ It is generally calculated at 105~110% of the above calculation value, taking into account the heat loss of the piping.

→ This is a reference, and the detailed heating load should be calculated considering the characteristics of each site (region).

3-2 Domestic hot water load

- The amount of hot water used varies depending on the type and use of the building. Also, it depends on the usage status, the time variation during the day, and the season. Therefore, sufficient review is required to calculate the amount of hot water.

1) Method by considering number of occupant

- Quantity of water required (liter/hr)

= Number of people x Peak demand per occupant according to type of building

- Domestic hot water load (kW)

= [Quantity of water required (kg/hr) x 4.19 (kJ/kg ℃) x △T (℃)] / 3600

. △T (℃) : Supply hot water temperature – Tap water temperature

Example) House with 4 people, Supply hot water temp. = 45℃ / Tap water temp. = 10℃

* Domestic hot water load (kW) = [(4 x 45) x 4.19 x 35] / 3600

= 7.3 kW

[Wikipedia reference table]

Type of building	Consumption per occupant	Peak demand per occupant	Storage per occupant
	liter/day	liter/hr	liter
Factories	22 - 45	9	5
Hospitals, general	160	30	27
Hotels	90 - 150	45	30
Houses and flats	90 - 150	45	**30**
Offices	22	9	5
Schools, boarding	115	20	25
Schools, day	15	9	5

→ This is a reference, and the detailed domestic hot water load should be calculated considering the characteristics of each site (region).

3-2 Domestic hot water load

2) Method by considering number of equipment

- Quantity of water required (liter/hr)

= Number of equipment x Hot water supply per hour x *Demand Factor

- Domestic hot water load (kW)

= [Quantity of water required (kg/hr) x 4.19 (kJ/kg ℃) x △T (℃)] / 3600

. △T (℃) : Supply hot water temperature – Tap water temperature

[Hot Water Demand per Fixture for Various Types of Buildings, liter/hr]

Fixture type \ Build type	Apartment	Hotel	Office	Private Residence
Basin (lavatory private)	7.6	7.6	7.6	7.6
Basin (lavatory public)	15	30	23	-
Bathtub	76	76	-	76
Dishwasher	57	190-760	-	57
Foot basin	11	11	-	11
Kitchen Sink	38	114	76	38
Laundry, stationary tubs	76	106	-	76
Pantry Sink	19	38	38	19
Shower	114	284	114	114
Service Sink	76	114	76	57
Demand Factor[1)]	0.30	0.25	0.30	0.30
Storage Capacity Factor[2)]	1.25	0.80	2.00	0.70

(Source : ASHRAE Application Handbook, 2011)

3-2 Domestic hot water load

2) Method by considering number of equipment

1) Demand Factor : A Demand Factor is applied to calculate the Maximum Probable Demand, which is the rate at which the heater will generate hot water and is also termed as "the recovery rate or heater capacity". A high demand factor will mean a higher recovery rate or heater size.

2) Storage Capacity Factor : The storage volume of the tank needs adjustment for usable volume to account for the drop in temperature resulting from withdrawal of hot water and continuous entry of cold water in storage tank. The "maximum probable demand" is thus factored by the "storage capacity factor" to determine the "storage tank capacity"

Example) Private Residence, Basin (private lavatory) 2EA, Bathtub 1EA, Dishwasher 1EA
Kitchen sink 2EA, Laundry, stationary tub 1EA, Shower 2EA
Supply hot water temp. = 45℃ / Tap water temp. = 10℃

* Quantity of water required (liter/hr) = [(2 x 7.6) + (1 x 76) + (1 x 57) + (2 x 38)
+ (1 x 76) + (2 x 114)] x 0.3
= 158 liter/hr

* Domestic hot water load (kW) = (158 x 4.19 x 35) / 3600
= 6.4 kW

Cf)

- Water tank volume (liter)
  = Quantity of water required (liter/hr) x Storage Capacity Factor

→ This is a reference, and the detailed domestic hot water load should be calculated considering the characteristics of each site (region).

3-3 Product selection

- Domestic hot water load : 7.3 kW
- Required capacity : 7.3 x 1.1 (*Correction factor) ≒ 8.0 kW
- Leaving water temperature : 45℃
- Outdoor temperature : 7℃

* It may vary depending on the site.

Model	LWT (℃)	25		30		35		40		45		50		55		60		65	
	Tamb (℃)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)
AE060RXEDEG	-20	4.69	1.63	4.56	1.75	4.35	1.97	4.18	2.10	4.01	2.32								
	-15	5.35	1.73	5.20	1.85	4.95	2.08	4.81	2.21	4.67	2.34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
	-10	5.77	1.78	5.61	1.91	5.34	2.15	5.18	2.29	5.02	2.43	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
	-7	5.94	1.66	5.78	1.78	5.50	2.00	5.38	2.26	5.27	2.51	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
	-2	5.78	1.44	5.62	1.55	5.35	1.74	5.15	1.91	4.94	2.08	4.70	2.34	4.45	2.60	4.22	2.89		
	2	5.62	1.23	5.46	1.32	5.20	1.48	4.91	1.57	4.62	1.65	4.39	1.86	4.16	2.06	3.94	2.29		
	7	6.48	1.01	6.30	1.09	6.00	1.22	5.70	1.37	5.40	1.51	5.10	1.66	4.80	1.81	4.53	1.88	4.27	1.95
	10	7.08	1.02	6.88	1.10	6.55	1.23	6.30	1.38	6.04	1.53	5.74	1.73	5.43	1.92	5.16	1.98	4.89	2.04
	15	8.08	1.04	7.85	1.11	7.48	1.25	7.29	1.39	7.10	1.57	6.74	1.77	6.39	1.97	6.07	2.03	5.75	2.09
	20	9.07	1.05	8.82	1.13	8.40	1.27	8.28	1.42	8.16	1.61	7.75	1.81	7.34	2.01	6.98	2.08	6.61	2.14
	LWT (℃)	25		30		35		40		45		50		55		60		65	
	Tamb (℃)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)	HC (kW)	PI (kW)
AE090RXED*G	-20	6.90	2.28	6.71	2.44	6.39	2.74	6.14	2.93	5.90	3.23								
	-15	7.86	2.41	7.64	2.58	7.28	2.90	7.07	3.08	6.87	3.26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
	-10	8.47	2.52	8.23	2.70	7.84	3.04	7.60	3.21	7.37	3.39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
	-7	8.53	2.41	8.30	2.58	7.90	2.90	7.73	3.27	7.56	3.65	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
	-2	8.42	2.14	8.19	2.30	7.80	2.58	7.50	2.83	7.20	3.08	6.84	3.47	6.48	3.85	6.14	4.28		
	2	8.32	1.88	8.09	2.01	7.70	2.26	7.27	2.39	6.84	2.52	6.50	2.84	6.16	3.15	5.84	3.50		
	7	9.72	1.55	9.45	1.66	9.00	1.87	8.80	[illegible]	8.60	2.33	8.30	2.53	8.00	2.73	7.72	2.96	7.44	3.20
	10	10.62	1.57	10.32	1.68	9.83	1.89	9.64	2.12	9.44	2.56	8.97	2.66	8.50	2.95	8.07	3.05	7.65	3.14
	15	12.11	1.59	11.78	1.70	11.22	1.91	11.03	2.13	10.84	2.42	10.30	2.72	9.76	3.02	9.27	3.11	8.78	3.21
	20	13.61	1.61	13.23	1.73	12.60	1.94	12.42	2.18	12.24	2.47	11.63	2.78	11.02	3.09	10.47	3.18	9.91	3.28

HC = 5.40 kW
PI = 1.51 kW

HC = 8.60 kW
PI = 2.33 kW

* TC : Total Heating Capacity

* PI : Power Input

* LWT : Leaving Water Temperature

→ The AE090RXED*G should be selected by referring to the product TDB.

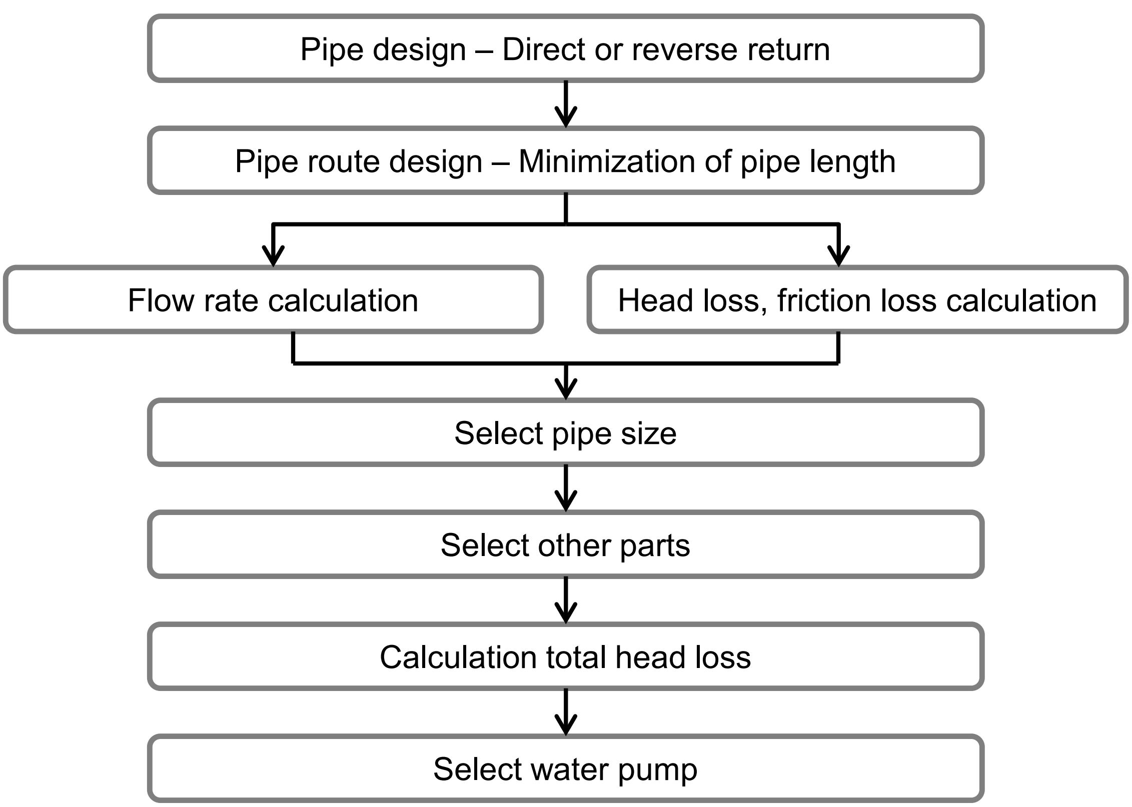
4. Water piping elements design

- When designing a water piping system, the following should be considered :

- Water must be supplied to the required locations according to the needs of each EHS unit.
- Head and friction losses should be kept minimum.
- Water velocity should be properly controlled to avoid water streaming noise, pipe vibration or pipe expansion contraction due to temperature differences.
- Attention should be paid to water management : Impact of the water quality, corrosion prevention, freezing prevention etc.

  * Water quality must be according to EN directive 98/83 EC.
- Enough arrangements should be provided for easy service and maintenance.

✓ Process

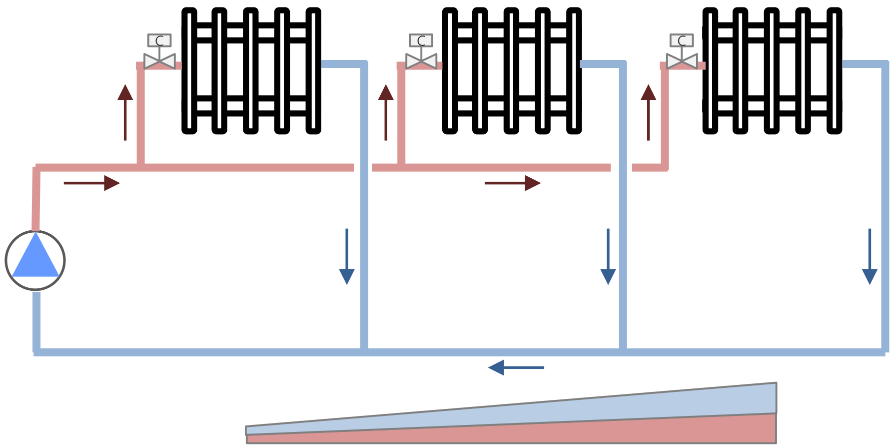


* It may vary depending on the site (region).

4-1 Water piping

1) Direct return piping

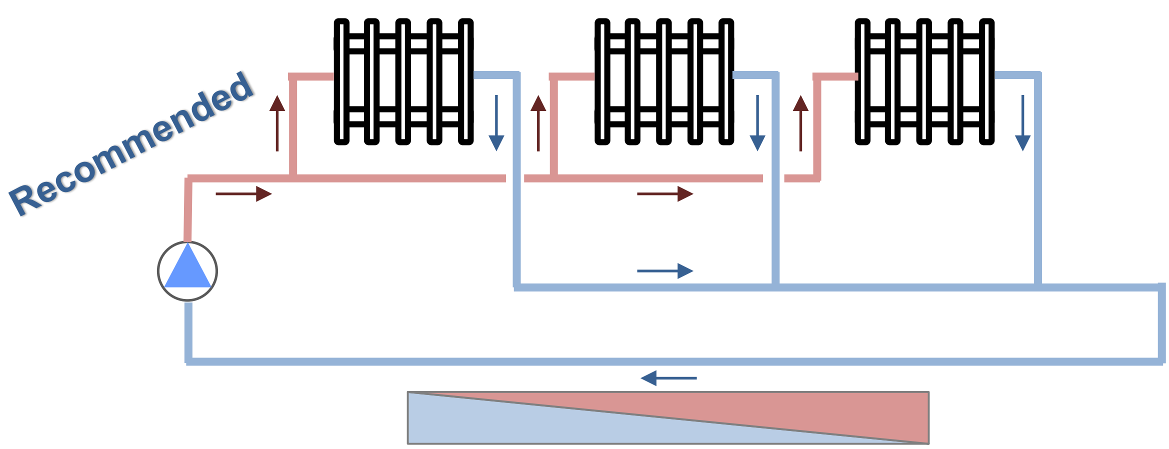
- When it's designed direct return piping, the pressure drops between near and far side from the pump can be different due to different piping length. Because of different friction loss, the water flow rate of heat emitters and load can not be same. It requires to install additional flow control valves near the inlet side of each load to balance water flow.
  (Balancing valve)



Profile of Pressure Drop
between inlet and outlet

2) Reverse return piping

- If the pipe length is the same, it has approximately the same friction loss, which it makes the same flow rate.
  But, this system may also require balancing valves for water flow balance control.



Profile of Pressure Drop
between inlet and outlet

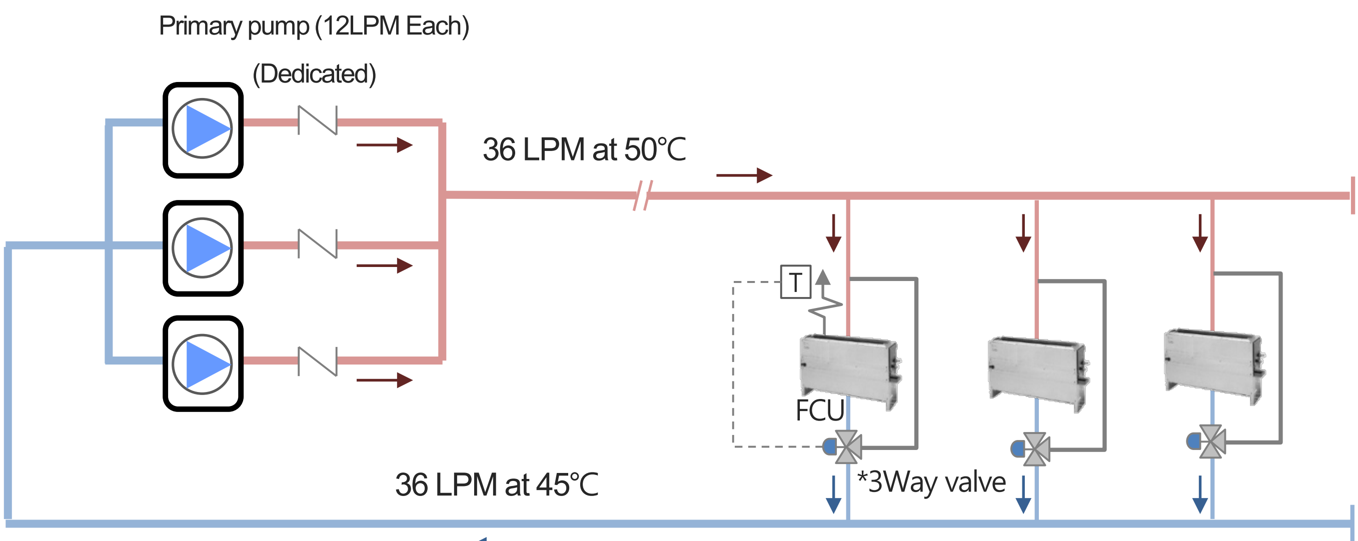
4-2 Water distribution

1) Constant Primary Flow

- The water pumps are constant speed.

For constant flow rate, a 3way valve is placed on the outlet of each coil.

A 3way valve is controlled by the set point of leaving water temperature.

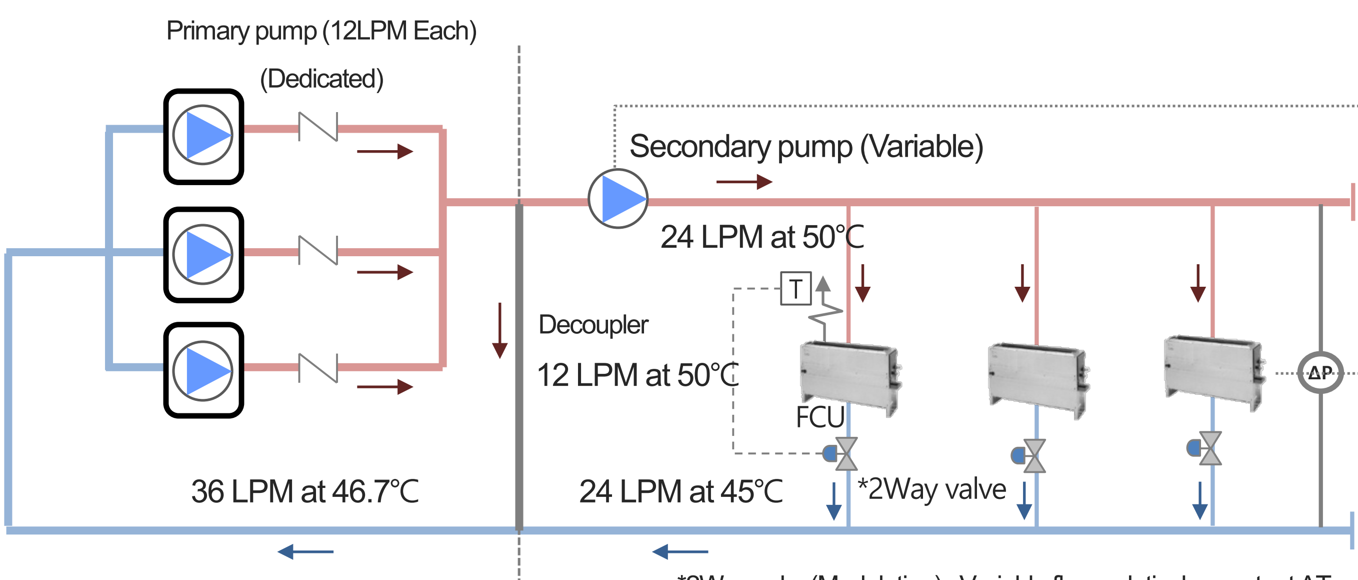


*3Way valve(Modulating) : Constant flow rate, Variable ΔT

2) Primary Secondary Flow

- A decoupler pipe separates the two loop hydronically.

* Primary flow must always be equal to or greater than Secondary flow.



*2Way valve(Modulating) : Variable flow, relatively constant ΔT

4-3 Water pipe selection

- For pipe sizing, the condition of flow rate, velocity, friction loss and materials type are determined previously. Water pump operating cost depends on pressure drop of the system. Small piping makes big pressure drop but big piping raises initial cost. It will be considered life cycle point of view carefully.

1) Piping materials

- Steel, PVC, Copper tube (Typical HVAC application)

(Steel)

(PVC)

(Copper)

2) Water velocity

- The recommended water velocity through the piping is depending on two conditions :
  - Pipe diameter
  - Effect of erosion

✓ Pipe selection guide

Velocity	Reliability
High	Erosion accelerating, vibration and noise
Low	Damaging wear and tear of pipes and fittings Laminar flow reduces the unit efficiency

* Design water velocity must be decided by the design engineer as erosion is a function of time.

4-3 Water pipe selection

[Recommended velocity range]

Pipe diameter		*Velocity range[m/s]
[mm]	[inch]	
125 or more	5 or more	2.1~2.7
50~100	2~4	1.2~2.1
About 25	About 1	0.6~1.2

[Max allowable velocity to minimize erosion]

Running time (hr/year)	Velocity(m/s)
1,500	3.00
2,000	2.90
3,000	2.75
4,000	2.45
6,000	2.15
8,000	1.80

* 1 year = 8,760 hr

→ This is a reference, it may vary slightly depending on the region.

3) Friction loss

- In order to force a fluid through a pipe, pressure is required to overcome the viscous friction forces. Friction loss occurs when water flow through a pipe.

  • By Hazen-Williams Equation
  • By Darcy-Weisbach Equation

4-3 Water pipe selection

[Hazen-Williams Equation]

- The Darcy-Weisbach equation with the Moody diagram are considered to be the most accurate model for estimating frictional head loss in steady pipe flow. Since the approach requires a not so efficient trial and error iteration, an alternative empirical head loss calculation like the Hazen-Williams equation may be preferred.

$$h = 10.67 \times q^{1.85} / \left(C^{1.85} \times d_h^{4.8655}\right)$$

Where,

h = head loss per unit pipe (mAq/m)

C = design coefficient,

determined for the type of pipe or tube

. Cast iron, wrought iron pipes : 80 to 150, with average value 130 and design value 100

. Copper, glass, brass pipes : 120 to 150, with average value 140 and design value 140

q = flow rate (m^3/s)

dh = inside hydraulic diameter (m), dh = 4 x Area / perimeter = 2 x radius (m^2/m)

Pressure drop can be calculated from the head loss by multiplying head loss with the specific weight of water :

p = h γ

Where,

p = pressure loss (N/m^2, Pa)

γ = specific weight (N/m^3)

specific weight of water at 4℃ is 9,810 N/ m^3

4-3 Water pipe selection

[Darcy-Weisbach Equation]

$$h_f = f \cdot \frac{L}{D} \cdot \frac{V^2}{2g}$$

Where,

h_f = head loss due to friction

L = length of the pipe

D = hydraulic diameter of the pipe

(for a pipe of circular section, this equals the internal diameter of the pipe)

V = average velocity of the fluid flow

g = local acceleration due to gravity

f = dimensionless coefficient called the Darcy friction factor.

(It can be found from a Moody diagram)

Given that the head loss hf expresses the pressure loss Δp as the height of a column of fluid, where ρ is the density of the fluid, the Darcy–Weisbach equation can also be written in terms of pressure loss :

$$\Delta p = f \cdot \frac{L}{D} \cdot \frac{\rho V^2}{2}$$

Where the pressure loss due to friction **Δp** is a function of :

the ratio of the length to diameter of the pipe, **L/D**

the density of the fluid, **ρ**

the mean velocity of the flow, **V**, as defined above

a (dimensionless) coefficient of laminar, or turbulent flow, **f**

Since the pressure loss equation can be derived from the head loss equation by multiplying each side by ρ and g.

4-3 Water pipe selection

[Example of dimensioning the water pipes]

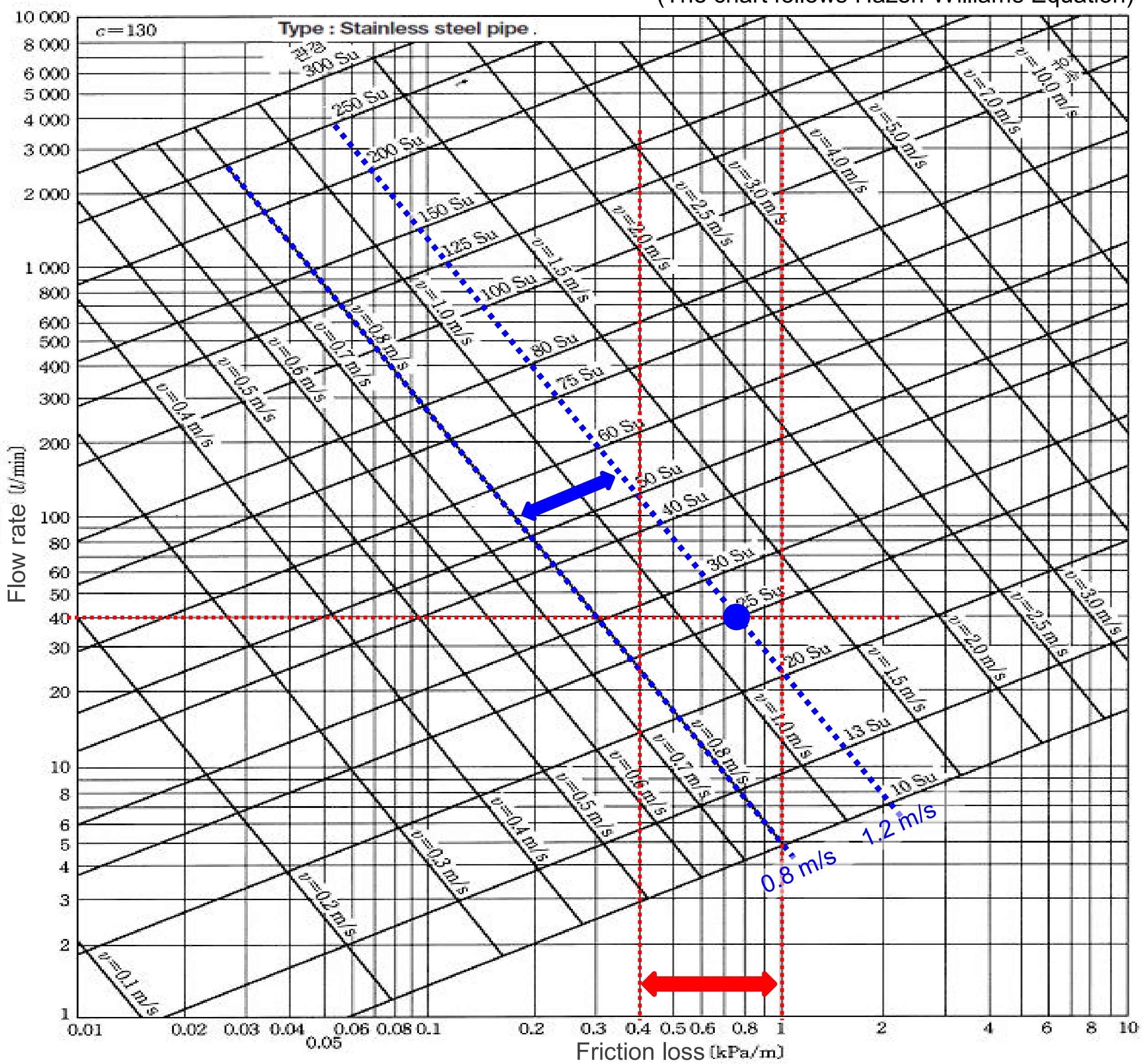
* Condition

- Type : Stainless steel pipe, Water flow : 40 l/min,
  Velocity : 0.8 ~ 1.2 m/s, Friction loss : 0.4 ~ 1.0 kPa/m

* Result

- Pipe diameter : 25A, Velocity : 1.2m/s, Friction loss : 0.75 kPa/m

(The chart follows Hazen-Williams Equation)

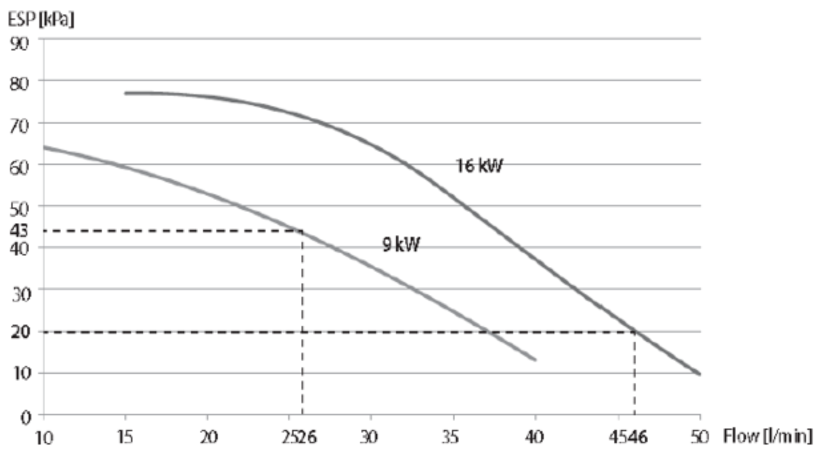


4-4 Additional pump

- The pump have to supply the required water flow rate and head pressure.
- If the pressure loss of total system is more than what the manufacturer guides, additional water pump should be installed in series.

→ When ESP (External Static Pressure) is not enough, additional pump should be installed.

(Example : EHS Split)



Water flow rate
9kW : 26LPM

Water flow rate
16kW : 46LPM

[Water pump selection]

1) Flow rate, 2) Total Head, 3) Power

1) Flow rate

- Sum of required flow rate of each Unit.

2) Total Head

$H_t = H_a + H_p + H_f + H_u$

H_a : Head pressure by level difference
(It is 0 for EHS system because it must be a closed loop system)

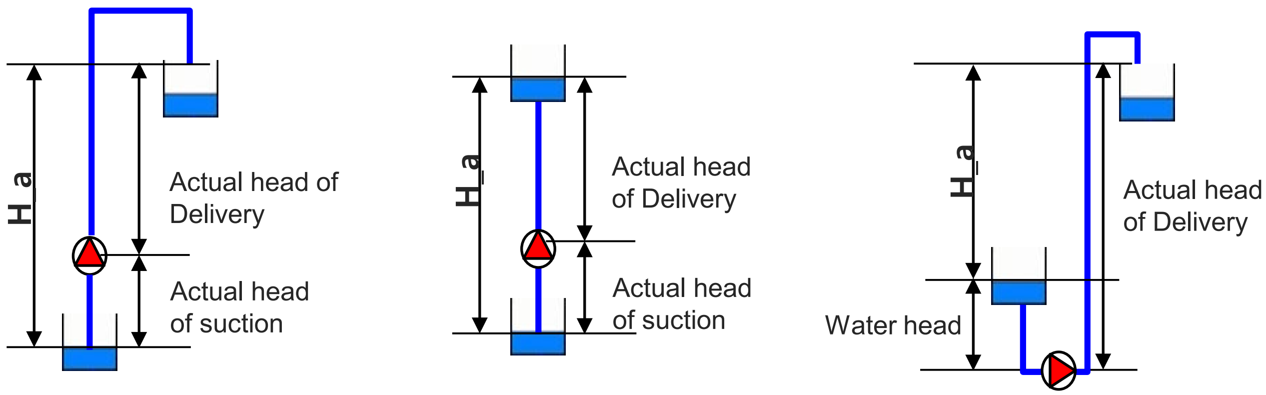
H_p : Friction loss by straight pipes

H_f : Equivalent length of friction loss by fittings

H_u : Friction loss from the condenser / evaporator in the units (PHE of the unit)

4-4 Additional pump

2) Total Head



* Equivalent length of friction loss by fitting [m]

Pipe size	15 A	20 A	25 A	32 A	40 A	50 A	65 A	80 A
Elbow	0.5	0.6	0.9	1.1	1.3	1.6	2.1	3.0
T-connection straight through	0.6	0.6	0.6	0.8	0.9	1.1	1.4	1.7
T-connection through branch	1.0	1.3	1.8	2.3	2.8	3.5	4.2	5.7
Globe valve	4.5	6.5	9.0	11.0	16.0	21.0	26.0	30.0

→ This is a reference, it may vary slightly depending on the region.

3) Power

- Motor power calculation : This value will be used to select motor of water pump.

Power[kW] = q x ρ x g x h / (3.6 x 10^6) / η

q = Flow rate (m3/h)

ρ = Density of fluid (kg/m3), * 1,000 for water

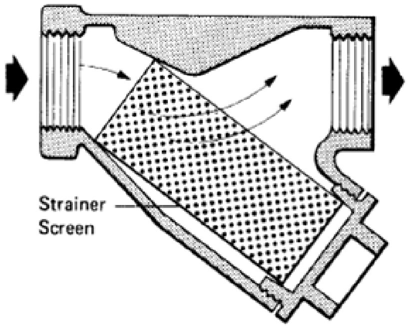
g = Gravity (9.81 m/s2)

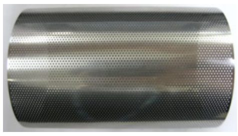
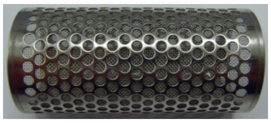
h = Differential head (m)

η = Pump efficiency

4-5 Strainer

- It is to filter the water and protect PHE (Plate Heat Exchanger) against dirt. And, it is recommended to install strainer (50 mesh or more) for each water inlet pipe of PHE.
  Also the strainer must be cleaned after flushing the pipes, and it should be cleaned periodically.
  (Replace strainer when necessary)



Type	Mesh Type	Punching Type	Mixed Type
Feature			
type	Wire	Punching in plate	Wire Type(inner) + Punching Type(outer)
Feature	Filtration area : large Stiffness : bad	Filtration area : small Stiffness : good	Filtration area : large Stiffness : good
Recommendation	△	△	O

4-6 Air vent

- It is to remove air in water pipe.
  And, it should be installed where air can be stuck like bend or else.
  (Example, Highest position of each section)
  → The air can cause *surging or *cavitation and pump can be broken.

*Surging : Vibration and noise caused by the change of discharge pressure or flow rate of the fluid, the operation becomes impossible.

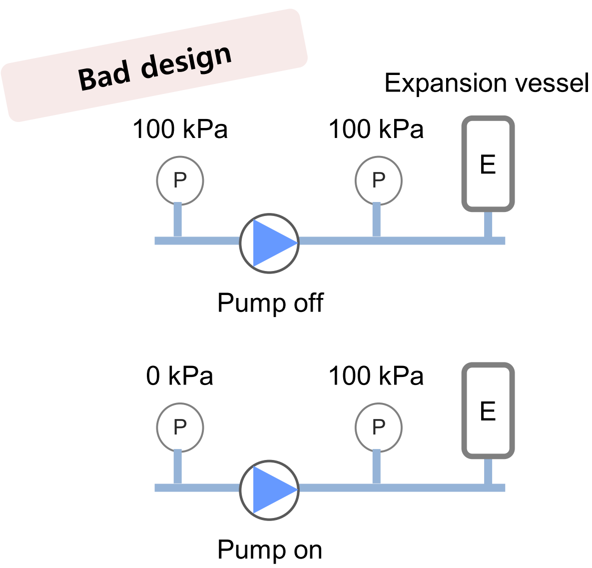
*Cavitation : It means that cavities or bubbles are forming in the liquid that we're pumping. These cavities form at the low pressure or suction side of the pump, causing pump broken.

4-7 Expansion vessel

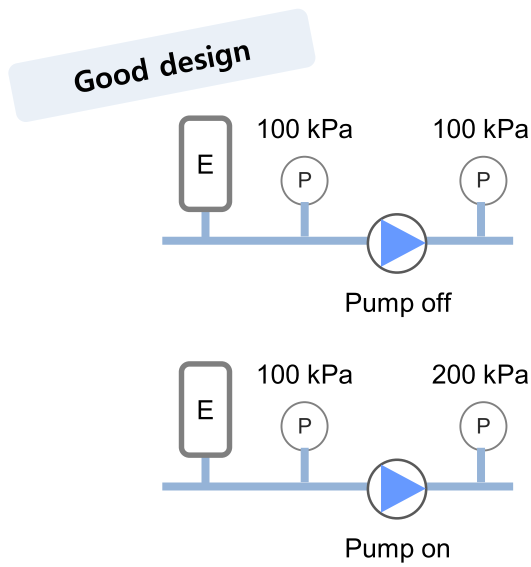
- The purpose of the expansion tank is to maintain system pressure by allowing the water to expand when the water temperature increases in order to prevent pipes from bursting. The tank is partially filled with air, whose compressibility cushions shock caused by water hammer and absorbs excess water pressure caused by thermal expansion.

[Expansion vessel location]

- It is recommend to install the suction side of the water pump.



✓ It is highly likely that air can be sucked into the pipe, causing corrosion, noise, and reduction of pump efficiency.



✓ It should be confirmed that the maximum pressure is lower than the maximum allowable pressure of the piping.

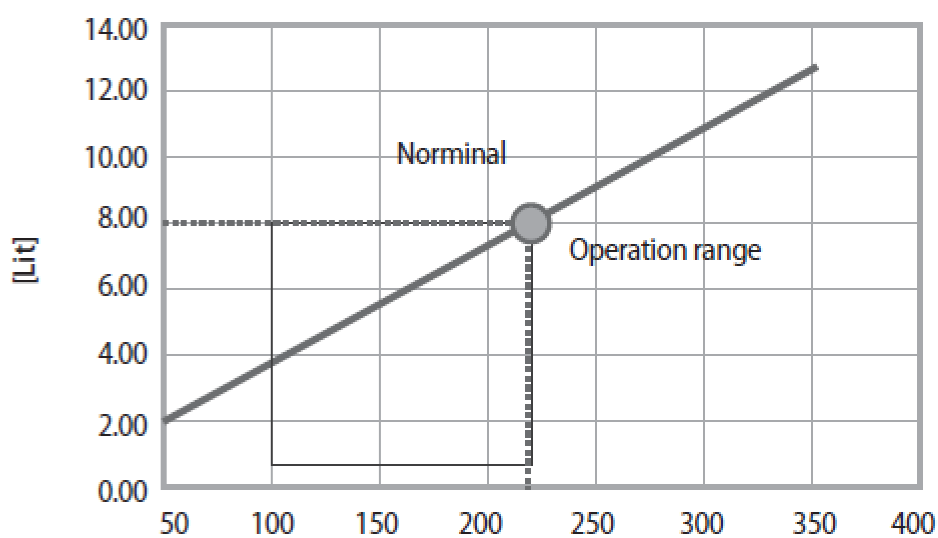
4-7 Expansion vessel

[Setting the pre-pressure of the expansion vessel]

When it is required to change the default pre-pressure of the expansion vessel (1bar), keep in mind the following guidelines:

- Use only dry nitrogen to set the expansion vessel pre-pressure.
- Inappropriate setting of the expansion vessel pre-pressure will lead to malfunction of the system. Therefore, the pre-pressure should only be adjusted by a licensed installer.

(Expansion Vessel capacity, Liter)



Water volume (Liter) in total system including pipes

* Water volume of total system (except tank hydro unit) for reliable performance is minimum 20 liters (AE040/050/060/080/090RX**), 40 liters (AE120/160RX**).

4-7 Expansion vessel

[Setting the pre-pressure of the expansion vessel]

*Installation height difference	Water volume	
	< 220 Liters	> 220 Liters
< 7m	No pre-pressure adjustment required.	Actions required: . Pre-pressure must be decreased, calculate the appropriate value following by “Calculating the pre-pressure of the expansion vessel”. . Check if the water volume is lower than maximum allowed water volume.
> 7m	Actions required: . Pre-pressure must be increased, calculate the appropriate value following by “Calculating the pre-pressure of the expansion vessel”. . Check if the water volume is lower than maximum allowed water volume.	Expansion vessel of the unit too small for the installation.

* Installation height difference:

Height difference(m) between the highest point of the water circuit and the indoor unit.

If the indoor unit is located at the highest point of the installation, the installation height is considered 0m.

✓ Calculating the pre-pressure of the expansion vessel

- The pre-pressure(Pg) to be set depends on the maximum installation height difference(H) and is calculated as below:

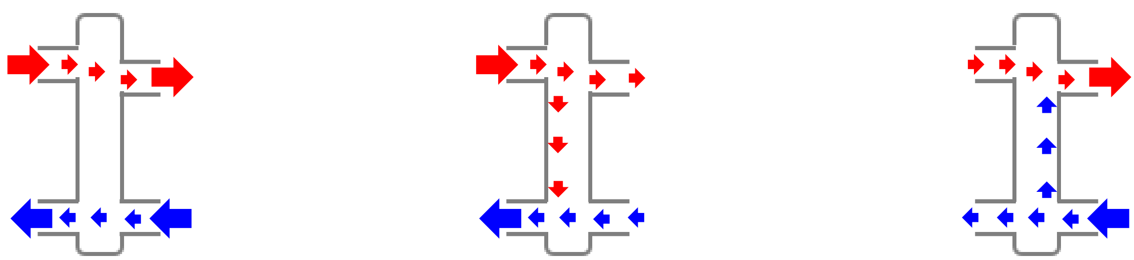
$$Pg=(H/10+0.3)\ \text{bar}$$

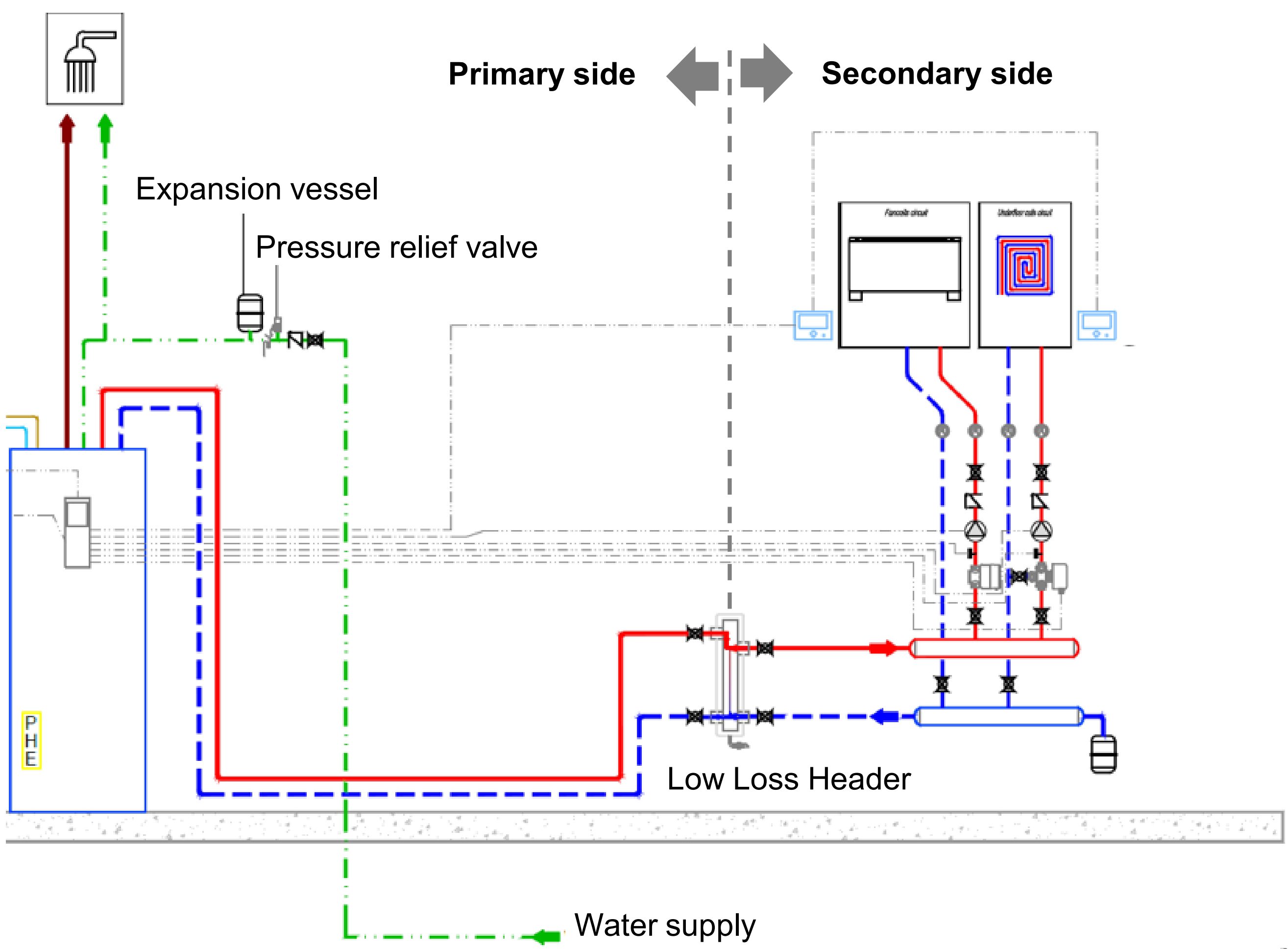
4-8 Low Loss Header

- Low Loss Header maintains the flow balance between the load side (Secondary side) and the boiler side (Primary side) during heating operation, allowing the heating system to maintain stable flow rate.

[Flow Path]

1) Primary flow = Secondary flow 2) Primary flow > Secondary flow 3) Primary flow < Secondary flow



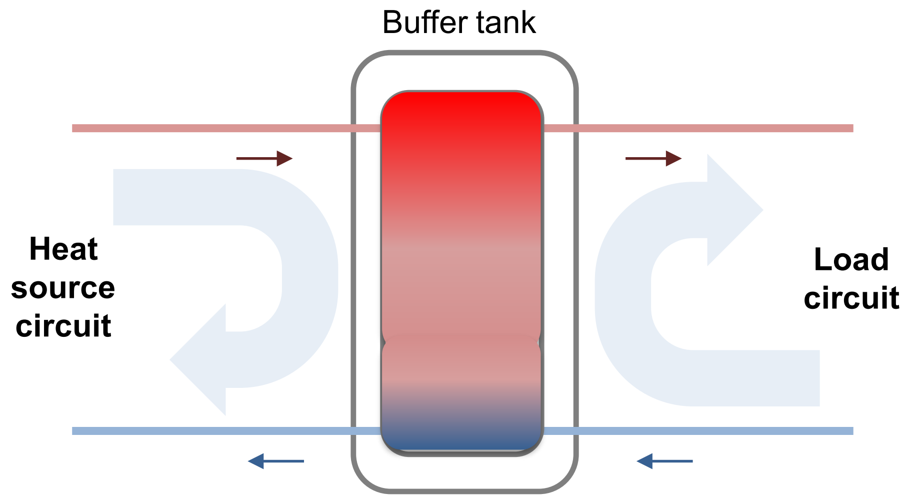


4-9 Buffer tank

- The purpose of the buffer tank is to prevent the frequent operation on/off and to prevent sudden water temperature change.
- It can be installed as needed.

[Buffer tank location]

- It is recommended to install between heat source and load side.



✓ Flow rate to load is greater than flow rate from heat source.

5. Maintenance

5-1 Water quality

- If chilled/heating water is not maintained by following standard, corrosion and scale accumulation may occur. It may decrease not only the performance of heat exchange, but also cause product malfunction due to heat exchanger damage by freezing. Extra care is necessary, and water should be maintained by expert to keep the water within the standard.

* Water quality must be according to EN directive 98/83 EC.

Item		Chilled water system		Heating water system		Effect	
		Circulation water (below 20℃)	Supply water	Circulation water (20℃~60℃)	Supply water	Corrosion	Forming scale
Basic item	pH (25 °C)	6.8~8.0	6.8~8.0	7.0~8.0	7.0~8.0	O	O
	Electric conductivity (mS/m, 25 °C) {μS/cm, 25 °C}	Below 40 {Below 400}	Below 30 {Below 300}	Below 30 {Below 300}	Below 30 {Below 300}	O	O
	Chloride ion (mgCl-/ℓ)	Below 50	Below 50	Below 50	Below 50	O	
	Sulfate ion (mgSO42-/ℓ)	Below 50	Below 50	Below 50	Below 50	O	
	Acid consumption (pH4.8, mgCaCO3/ℓ)	Below 50	Below 50	Below 50	Below 50		O
	Full hardness (mgCaCO3/ℓ)	Below 70	Below 70	Below 70	Below 70		O
	Calcium hardness (mgCaCO3/ℓ)	Below 50	Below 50	Below 50	Below 50		O
	Ion-like silica (mgSiO2/ℓ)	Below 30	Below 30	Below 30	Below 30		O
Reference item	Iron (mgFe/ℓ)	Below 1.0	Below 0.3	Below 1.0	Below 0.3		O
	Copper (mgCu/ℓ)	Below 1.0	Below 0.1	Below 1.0	Below 0.1	O	
	Sulfide ion (mgS2-/ℓ)	Not detected	Not detected	Not detected	Not detected	O	
	Ammonium ion (mgNH4+/ℓ)	Below 1.0	Below 0.1	Below 0.3	Below 0.1	O	
	Chlorine residual (mgCl/ℓ)	Below 0.3	Below 0.3	Below 0.25	Below 0.3	O	
	Free carbon (mgCO2/ℓ)	Below 4.0	Below 4.0	Below 0.4	Below 4.0	O	

5-2 Inspection for normal operation

Item	Standard	Number of inspection	Side effects when inadequate
Forced drainage	Have you set the electric conductivity value properly?	Once a week	Corrosion, water scale or slime may occur
	Is electric conductivity sensor working properly?		
	Is auto valve working properly?		
Water quality inspection	Is water corrupted or have floating particles?	Once a month	
	Is there any red tides?		
	Is the concentration of the anti-freeze being maintained?	Once a year (Before winter season)	-

* Electric conductivity of boiler water : 1.0 ㎲/㎝

▶ Do not cut-off the power supply.

- This may result in water leakage or pipe damage because pump will not operate to prevent freezing. Do not cut-off the power supply for the pump.

▶ Stop the operation with water pipe valve opened.

- Stop the operation with valve opened to make water circulate when the pump operates. If the water does not circulate,
  it may freeze and cause product malfunction due to heat generated on pump.

5-3 Freeze protection

- Freeze protection solutions must use propylene with a toxicity rating of Class 1 as listed in Clinical Toxicology of Commercial Products, 5th Edition.

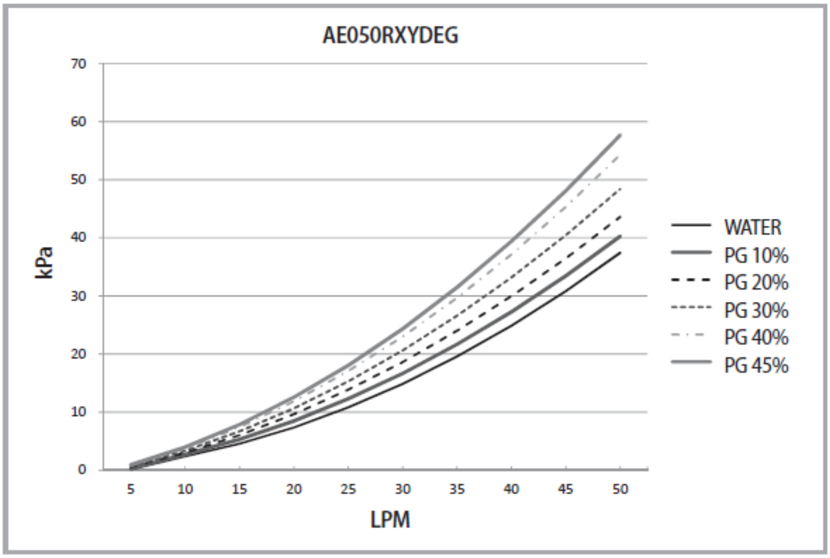
Freezing Points of Propylene Glycol – Water Mixtures			
Propylene Glycol [wt. %]	Freezing Point [°C]	Propylene Glycol [wt. %]	Freezing Point [°C]
0	0	36	-18
10	-3	40	-20
20	-7	43	-23
30	-12	48	-29

* Ethylene glycol is toxic and must not be used in the primary water circuit in case of any cross-contamination of the potable circuit.

[Resistance by glycol concentrate]

- To ensure correct operation and predict the expected performance, Flow and Resistance table can be used and Flow and Resistance characteristic is dependent on glycol concentration.

(Example : EHS Mono 5kW)

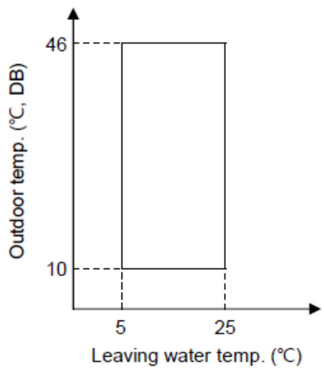


* Refer to the installation manual for each model.

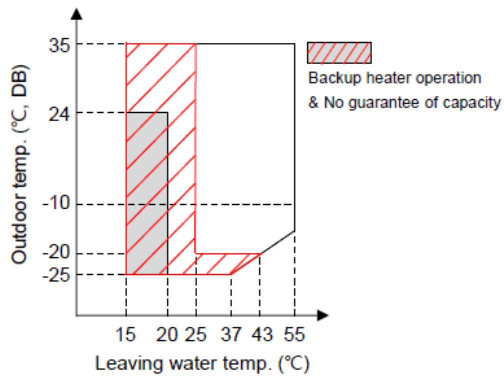
5-4 Operation range

1) Mono / Split

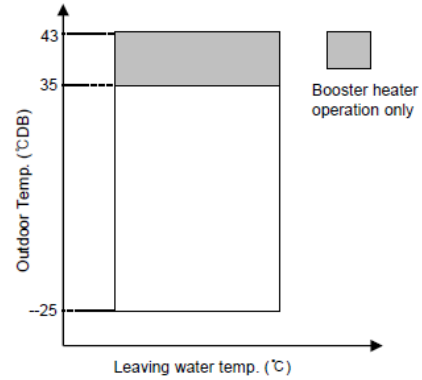
(Cooling)



(Heating)



(DHW)



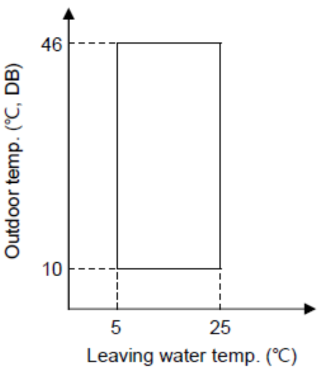
		Water Temperature (℃)		Water Flow Rate (LPM)		Air Temperature (℃)	
		Min	Max	Min	Max	Min	Max
Cooling	Inlet	-	30	12 (7*1)	58 (48*1)	10/-	46/28
	Outlet	5	25				
Heating	Inlet	5	-			-25/-	35/24
	Outlet	25 (15*2)	55				

- *1) Model : 4~9kW
- *2) Backup heater operation

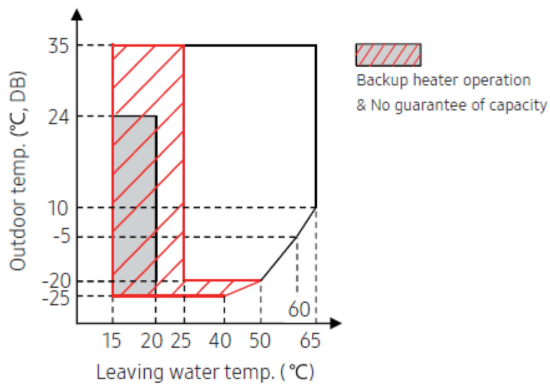
5-4 Operation range

2) ClimateHub Mono / ClimateHub Split

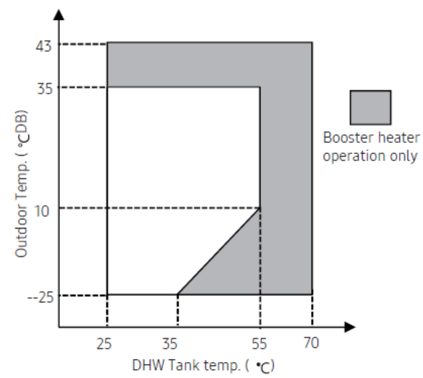
(Cooling)



(Heating)



(DHW)



		Water Temperature (℃)		Water Flow Rate (LPM)		Air Temperature (℃)	
		Min	Max	Min	Max	Min	Max
Cooling	Inlet	-	30	12 (7[*1])	58 (48[*1])	10/-	46/28
	Outlet	5	25				
Heating	Inlet	5	-			-25/-	35/24
	Outlet	25 (15[*2])	65				

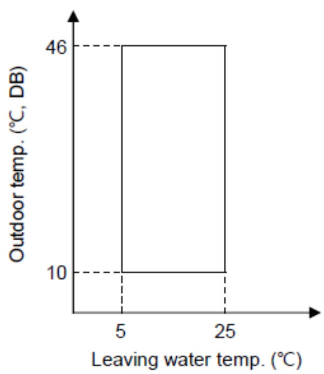
- *1) Model : 4~9kW
- *2) Backup heater operation

5-4 Operation range

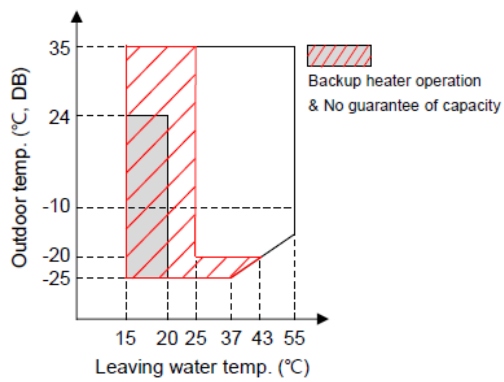
3) TDM Plus

✓ Air to Water

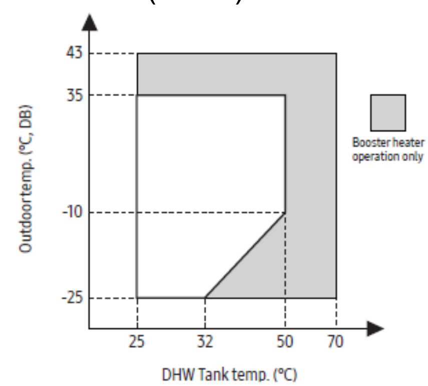
(Cooling)



(Heating)



(DHW)

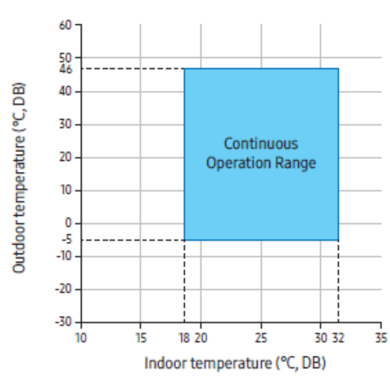


		Water Temperature (℃)		Water Flow Rate (LPM)		Air Temperature (℃)	
		Min	Max	Min	Max	Min	Max
Cooling	Inlet	-	30	12 (7*1)	58 (48*1)	10/-	46/28
	Outlet	5	25				
Heating	Inlet	5	-			-25/-	35/24
	Outlet	25 (15*2)	55				

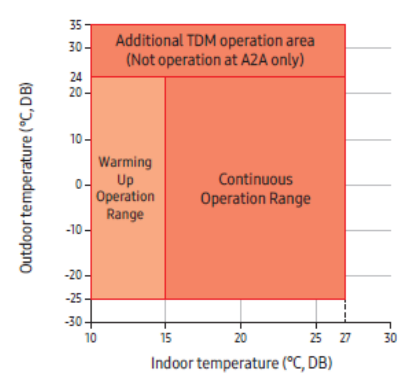
- *1) Model : 4~9kW
- *2) Backup heater operation

✓ Air to Air

(Cooling)



(Heating)

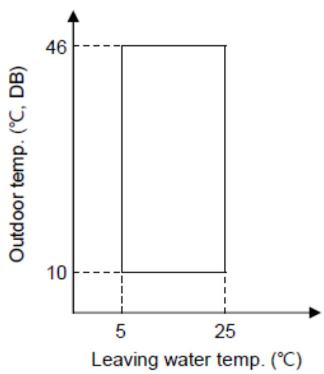


5-4 Operation range

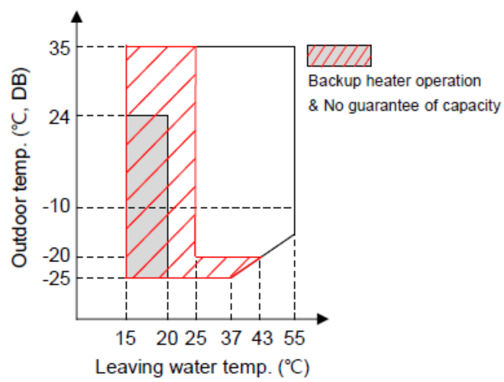
4) ClimateHub TDM Plus

✓ Air to Water

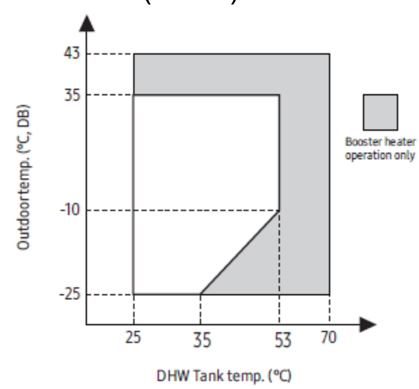
(Cooling)



(Heating)



(DHW)

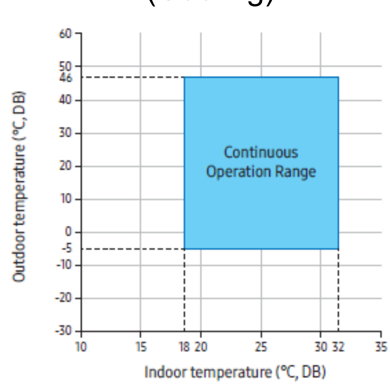


		Water Temperature (℃)		Water Flow Rate (LPM)		Air Temperature (℃)	
		Min	Max	Min	Max	Min	Max
Cooling	Inlet	-	30	12 (7*1)	58 (48*1)	10/-	46/28
	Outlet	5	25				
Heating	Inlet	5	-			-25/-	35/24
	Outlet	25 (15*2)	55				

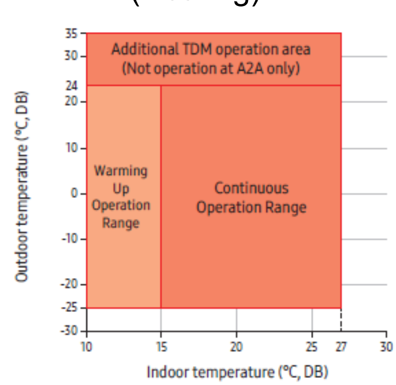
- *1) Model : 4~9kW
- *2) Backup heater operation

✓ Air to Air

(Cooling)



(Heating)



6. Field setting

6-1 FSV (Field Setting Value)

Set the FSV of the product other than the specified models by referring to the FSV label Provided with the manual of the product, and then attach it on the control box's cover.
The FSV values in the table are applied to the specified models.

1) Code 10** : Upper and lower temperature limits of each operation mode of wired remote controller (Heating, Cooling, DHW)

* The values in the following table are just examples for your understanding.

Main Menu (Code)	Sub Menu Function	Description	Sub Code	Step	Unit	AE200(260)RNW*** Default	Min	Max
Remote Controller Setting Range (Code 10✳✳)	Water Outlet Temp for Cooling	Max	✳✳11	1	˚C	25	18	25
		Min	✳✳12	1	˚C	16	5	18
	Room Temp for Cooling	Max	✳✳21	1	˚C	30	28	30
		Min	✳✳22	1	˚C	18	18	28
	Water Outlet Temp for Heating	Max	✳✳31	1	˚C	65	37	65
		Min	✳✳32	1	˚C	25	15	37
	Room Temp for Heating	Max	✳✳41	1	˚C	30	18	30
		Min	✳✳42	1	˚C	16	16	18
	DHW Tank Temp	Max	✳✳51	1	˚C	50	50	70
		Min	✳✳52	1	˚C	40	30	40

* The values may vary depending on the model.

[Space Cooling]

- Water Outlet Temperature for Cooling (#1011, #1012):
  User can change the target water outlet temperature within the range of 5 ~ 25℃ for cooling.
- Room Temperature for Cooling (#1021, #1022):
  User can change the target room temperature within the range of 18 ~ 30℃ for cooling.

[Space Heating]

- Water Outlet Temperature for Heating (#1031, #1032):
  User can change the target water outlet temperature within the range of 15 ~ 65℃ for heating.
- Room Temperature for Heating (#1041, #1042):
  User can change the target room temperature within the range of 16 ~ 30℃ for heating.

[DHW Heating]

- DHW Tank Temperature (#1051, #1052):
  User can change the target tank temperature within the range of 30 ~ 70℃ for DHW heating.

2) Code 20** : Water law design

* The values in the following table are just examples for your understanding.

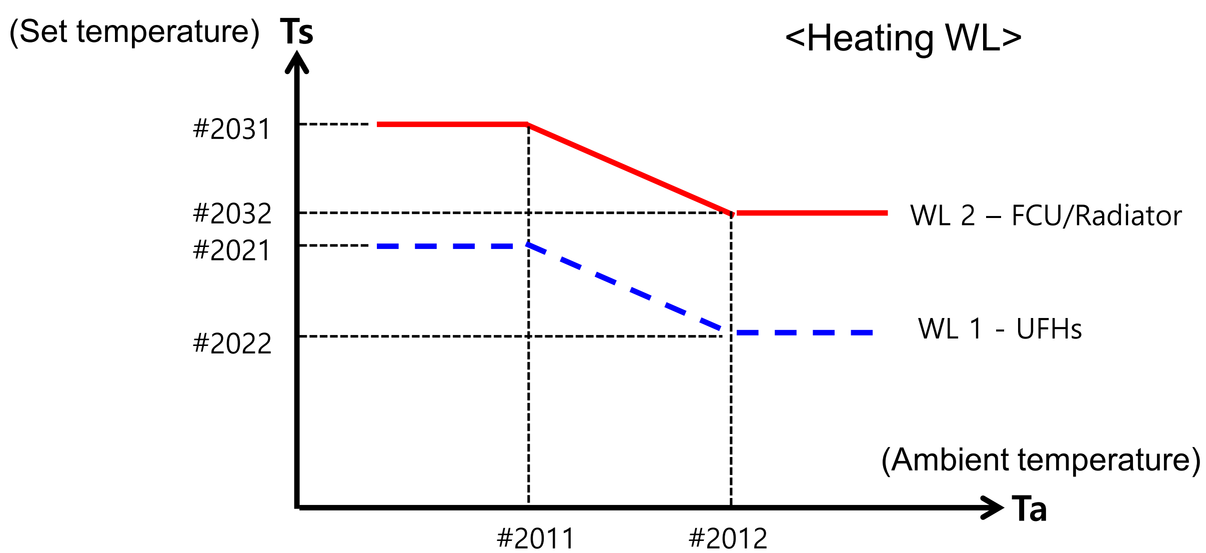
						AE200(260)RNW***		
Main Menu (Code)	Sub Menu Function	Description	Sub Code	Step	Unit	Default	Min	Max
Water Law (Code 20✳✳)	Outdoor Temp for Heating Water Law	Max	✳✳11	1	˚C	-10	-20	5
		Min	✳✳12	1	˚C	15	10	20
	Water Out Temp for WL1 Heating (UFHs)	Max	✳✳21	1	˚C	40	17	65
		Min	✳✳22	1	˚C	25	17	65
	Water Out Temp for WL2 Heating (FCUs)	Max	✳✳31	1	˚C	50	17	65
		Min	✳✳32	1	˚C	35	17	65
	Heating Water Law Selection	WL Type	✳✳41	-	-	1(WL1)	1	2(WL2)
	Outdoor Temp for Cooling Water Law	Max	✳✳51	1	˚C	30	25	35
		Min	✳✳52	1	˚C	40	35	45
	Water Out Temp for WL1 Cooling (UFHs)	Max	✳✳61	1	˚C	25	5	25
		Min	✳✳62	1	˚C	18	5	25
	Water Out Temp for WL2 Cooling (FCUs)	Max	✳✳71	1	˚C	18	5	25
		Min	✳✳72	1	˚C	5	5	25
	Cooing Water Law Selection	WL Type	✳✳81	-	-	1(WL1)	1	2(WL2)
	External Thermostat Application	#1 (UFHs)	✳✳91	1	-	0(No)	0	4
		#2 (FCUs)	✳✳92	1	-	0(No)	0	4
	Wired RC Room Temp Control	#3 (Wired RC)	✳✳93	1	-	4	1	4

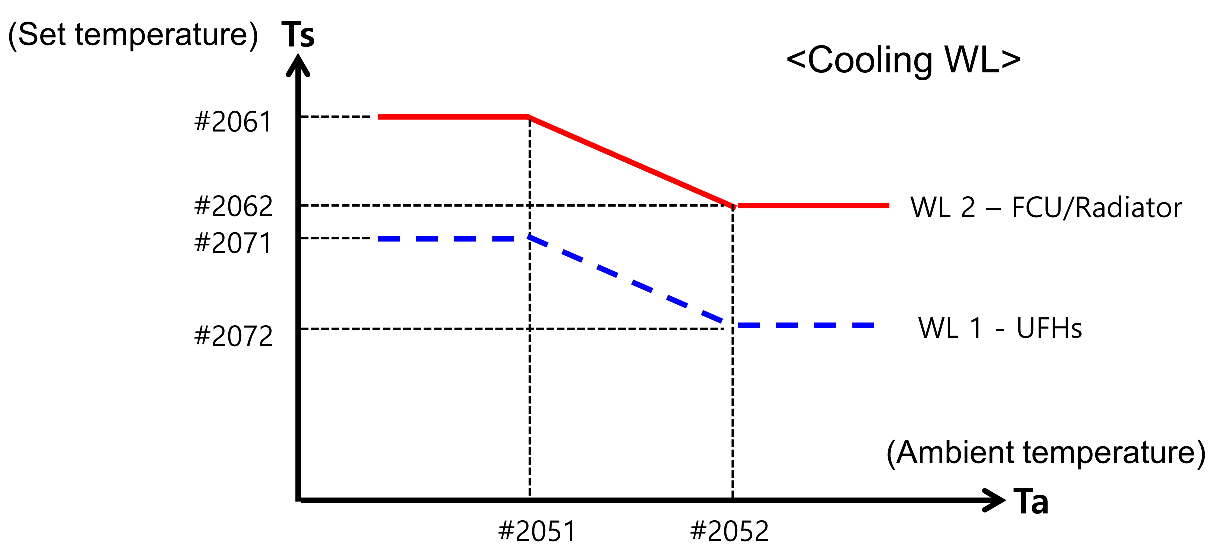
* The values may vary depending on the model.

[Water Law]

- In this mode, the heat pump adjusts both heating or cooling set temperatures related to ambient temperatures.
  This can reduce unnecessary energy consumption through ideal operation of the system.
- This function is controlled through the room sensor of the wired remote controller or via Thermostat control.

* Only heating mode with a target water outlet temperature control can use this function during auto mode.





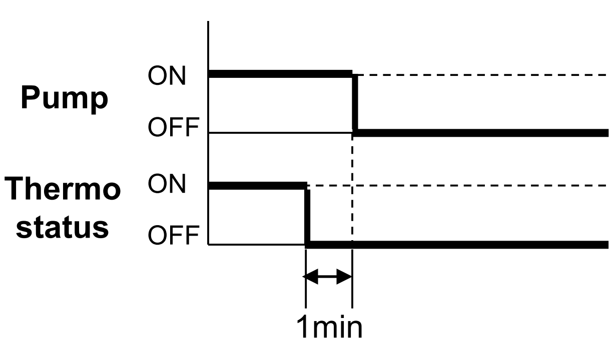
[External Thermostat Application]

- #2091 (UFHs) = “0”, #2092 (FCU) = “0”:
  Disable external thermostat application,
  To use wired remote controller, both of the above settings should be set to “0” simultaneously.
  If not, thermostat controls system.
- #2091 (UFHs) = “1”, #2092 (FCU) = “1”:
  Judgement for Thermo On/Off according to Thermostat signal only,
  If it set to “1”, the compressor can be turned on or off only by the thermostat.
- #2091 (UFHs) = “2~4”, #2092 (FCU) = “2~4”:
  Judgement for Thermo On/Off according to Thermostat signal or Water Law,
  If it set to “2~4”, the compressor can be turned on or off by the thermostat or according to Water Law.

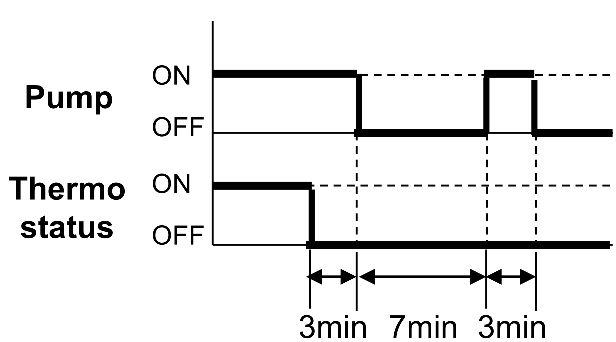
(Example of Thermo On/Off according to system status)

<table>
<tr><th colspan="2">Status by Thermostat</th><th>Thermo On</th><th>Thermo On</th><th>Thermo Off</th><th>Thermo Off</th><th rowspan="2">Pump status during
“Thermo Off”</th></tr>
<tr><th colspan="2">Status by WL</th><th>Thermo On</th><th>Thermo Off</th><th>Thermo On</th><th>Thermo Off</th></tr>
<tr><td rowspan="5">Value of
#2091, #2092</td><td>0</td><td>-</td><td>-</td><td>-</td><td>-</td><td>Not used (Default)</td></tr>
<tr><td>1</td><td>On</td><td>On</td><td>Off</td><td>Off</td><td>Off (*1min delay)</td></tr>
<tr><td>2</td><td rowspan="3">On</td><td rowspan="3">Off</td><td rowspan="3">Off</td><td rowspan="3">Off</td><td>Off (*1min delay)</td></tr>
<tr><td>3</td><td>On</td></tr>
<tr><td>4</td><td>*Repeat 3min On / 7min Off</td></tr>
</table>

(1min delay)



(Repeat 3min On / 7 min Off)



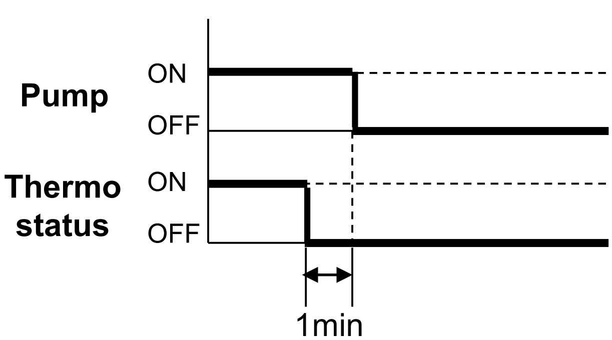
[Wired Remote Controller]

- Control by room temperature sensor of wired remote controller.
- #2093 = “1”:
  Judgement for Thermo On/Off according to room temp sensor of wired RC only,
  If it set to “1”, the compressor can be turned on or off only by room temp sensor.
- #2093 (UFHs) = “2~4”:
  Judgement for Thermo On/Off according to room temp sensor of wired RC or Water Law,
  If it set to “2~4”, the compressor can be turned on or off by room temp sensor or according to Water Law.

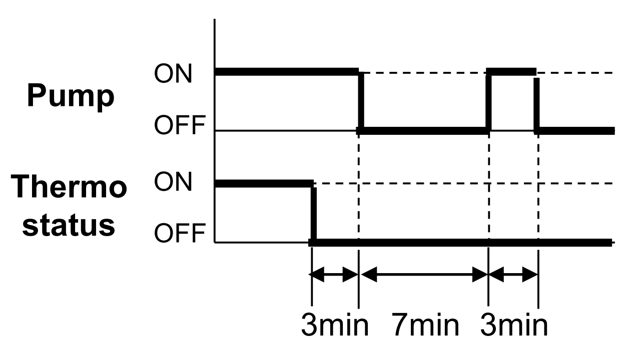
(Example of Thermo On/Off according to system status)

Status by wired RC		Thermo On	Thermo On	Thermo Off	Thermo Off	Pump status during **“Thermo Off”**
Status by WL		Thermo On	Thermo Off	Thermo On	Thermo Off	
Value of #2093	1	On	On	Off	Off	Off (*1min delay)
	2	On	Off	Off	Off	Off (*1min delay)
	3					On
	4					*Repeat 3min On / 7min Off

(1min delay)



(Repeat 3min On / 7 min Off)



3) Code 30** : User’s options for Domestic Hot Water(DHW) tank heating

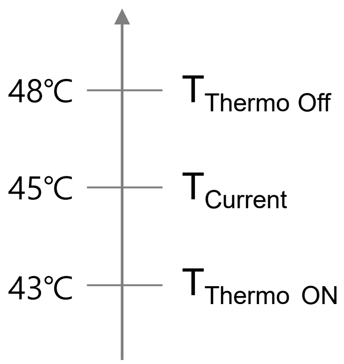
* The values in the following table are just examples for your understanding.

Main Menu (Code)	Sub Menu Function	Description	Sub Code	Step	Unit	AE200(260)RNW*** Default	Min	Max
DHW Tank (Code 30✳✳)	DHW Tank	Application	✳✳11	-	-	1(Yes)	0(No)	2
	Heat Pump	Max Temp	✳✳21	1	˚C	55	45	55
		Stop	✳✳22	1	˚C	0	0	10
		Start	✳✳23	1	˚C	5	5	30
		Min. Space heating Operating Time	✳✳24	1	min	5	1	20
		Max. DHW Operating Time	✳✳25	1	min	30	5	95
		Max. Space heating Operating Time	✳✳26	1	hour	3	0.5	10
	Booster Heater	Application	✳✳31	-	-	1(On)	0(Off)	1
		Delay Time	✳✳32	5	min	20	20	95
		Overshoot	✳✳33	1	˚C	0	0	4
	Disinfection	Application	✳✳41	-	-	1(On)	0(Off)	1
		Interval	✳✳42	1	day	Fri(5)	Sun(0)	All(7)
		Start Time	✳✳43	1	o'clock	23	0	23
		Target Temp	✳✳44	1	˚C	70	40	70
		Duration	✳✳45	1	min	10	5	60
		Max Time	✳✳46	1	hour	8	1	24
	Forced DHW Operation	Timer OFF Function	✳✳51	-	-	0(No)	0	1(Yes)
		Timer Duration	✳✳52	1	(x10) min	6	3	30
	Solar Panel / DHW Thermostat	H/P Combination	✳✳61	1	-	0(No)	0	2
	Direction of DHW valve	DHW Tank	✳✳71	-	-	0(Room)	0	1(Tank)
	Energy metering	BUH 1 step capacity	✳✳81	1	kW	2	1	6
		BUH 2 step capacity	✳✳82	1	kW	2	0	6
		BSH capacity	✳✳83	1	kW	3	1	6

* The values may vary depending on the model.

[DHW Application]

- The FSV #3011 should be set to “1” or “2” to use DHW function.
- #3011 = “1”:
  The DHW operation starts based on the Thermo On temperature.
- #3011 = “2”:
  The DHW operation starts based on the Thermo Off temperature.

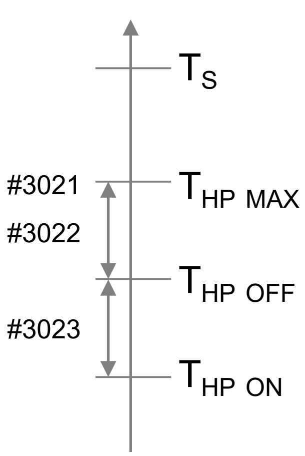


For example,
When the current temperature becomes 45℃ under the conditions that the Thermo On temperature is 43℃ and the Thermo Off temperature is 48℃, the DHW turns off if FSV #3011 is set to “1” and DHW turns on if FSV #3011 is set to “2”.

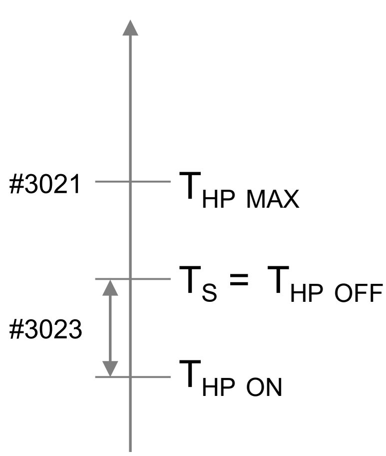
[Thermo On/Off control during DHW mode]

- #3021 : Max temperature available through a Heat Pump ($T_{HP\ MAX}$)
- #3022 : Temperature difference with $T_{HP\ MAX}$ for Thermo Off
- #3023 : Temperature difference between $T_{HP\ OFF}$ and $T_{HP\ ON}$ for Thermo On

Case 1) $T_S > T_{HP\ MAX}$



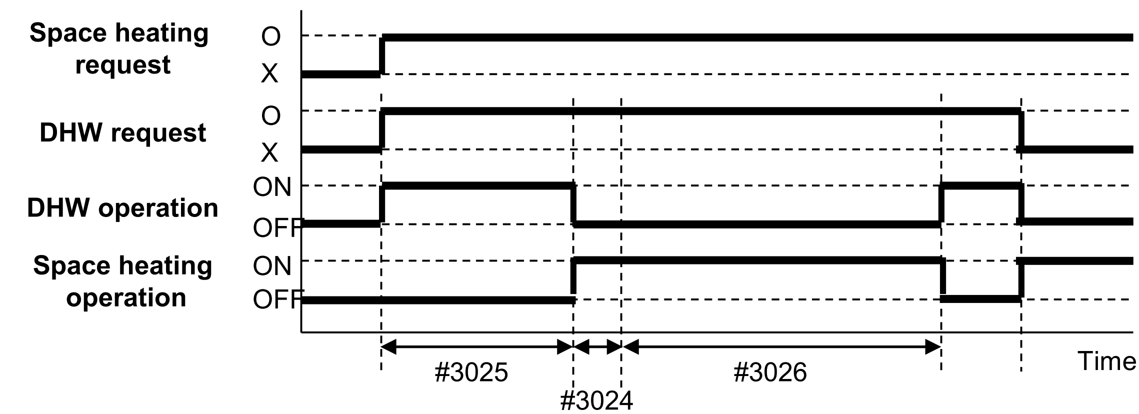
Case 2) $T_S < T_{HP\ MAX}$



T_S : Set temperature
$T_{HP\ MAX}$: Max temperature available through a Heat Pump
$T_{HP\ ON}$: Temperature for start (Heat Pump On)
$T_{HP\ OFF}$: Temperature for stop (Heat Pump Off)

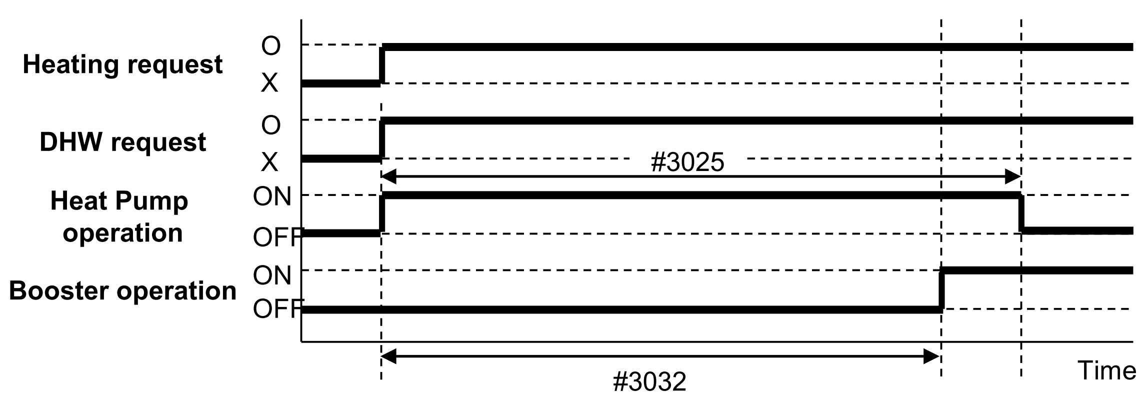
[Time variation control of DHW and Space heating mode]

- #3024 : Minimum time for Space heating operation
- #3025 : Maximum time for DHW operation
- #3026 : Maximum time for Space heating operation after DHW operation
- Maximum operation time is applied only when both DHW and Space heating request operation. DHW or Space heating operates continuously until reaching at target temperature without time limitation in the single operation.



[Time variation control of Heat Pump and Booster heater]

- #3025 : Maximum time for DHW operation
- #3032 : Delay time for activation of Booster heater
- The FSV #4022 for booster heater priority should be set to “0 (Both)” or “2 (Booster)” to use booster heater. If not (Backup heater priority), the booster heater can be operated in case of no backup heater demand.



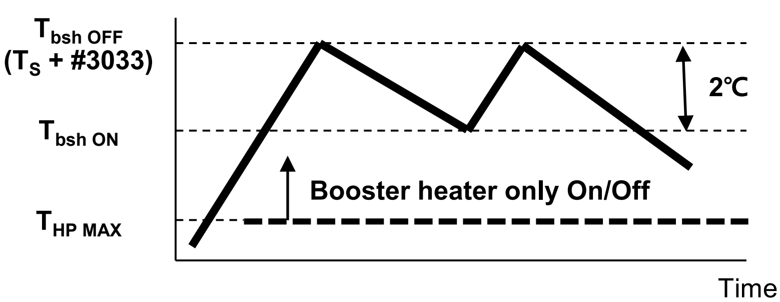
[Booster heater variables for controlling DHW Tank]

- The FSV #3031 should be set to “1 (On)” to use booster heater as an additional heat source for DHW tank.
- Booster heater startup delay timer (#3032):
  In case of DHW request, this timer will delay the operation of booster heater compared to heat pump.
  . In “Power/Force” DHW mode, the delay timer will be neglected, and the booster heater starts immediately.
  . In “Economic” DHW mode, the DHW heating will be conducted only with Heat pump.
  . The FSV #3032 should be smaller than the maximum heat pump operation time (#3025).
  If the delay time is set too high, it might take very long time for DHW heating.

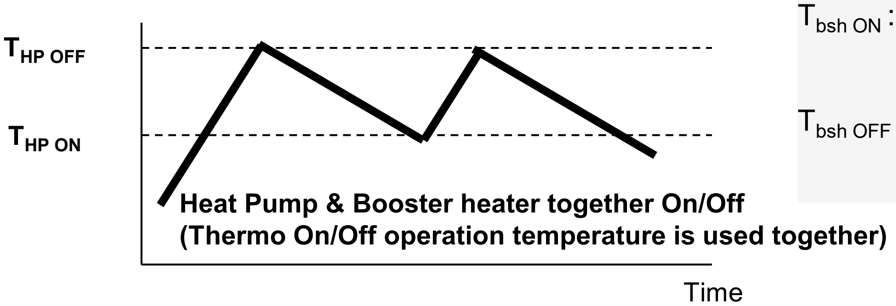
[Thermo On/Off control of Heat Pump and Booster heater]

- #3033 : Temperature (Overshoot) value for Booster heater control

Case 1) Set temperature of DHW > $T_{HP\ MAX}$



Case 2) Set temperature of DHW ≤ $T_{HP\ MAX}$



T_S : Set temperature

$T_{HP\ MAX}$: Max temperature available through a Heat Pump

$T_{HP\ ON}$: Temperature for start (Heat Pump On)

$T_{HP\ OFF}$: Temperature for stop (Heat Pump Off)

$T_{bsh\ ON}$: Temperature at which the booster heater starts to operate

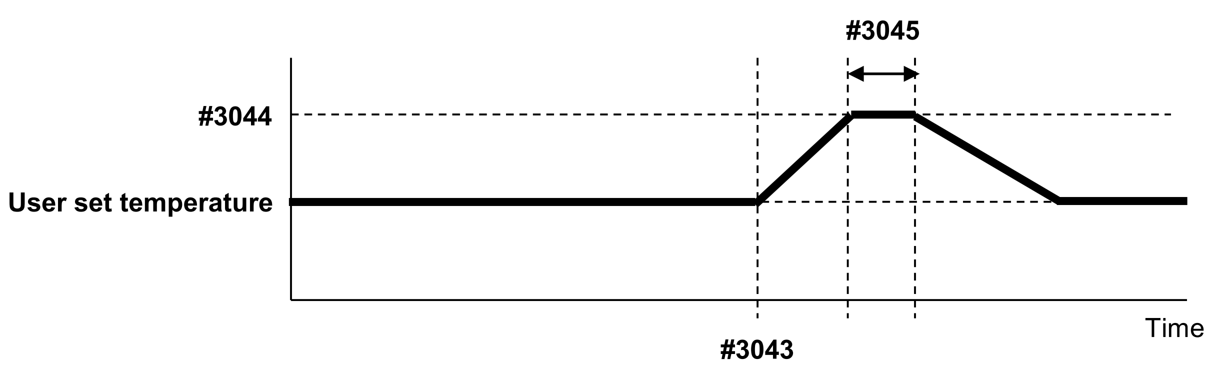
$T_{bsh\ OFF}$: Temperature at which the booster heater stops to operate

[Disinfection Function]

- The FSV #3041 should be set to “1 (On)” to use disinfection function.
- #3042 : Day when disinfection is performed
- #3043 : Starting time (0 ~ 24hr)
- #3044 : Target tank temperature
- #3045 : Duration which satisfy the target temperature for disinfection

* Disinfection function is available only when a booster heater is connected.

* Check tank capacity, booster heater capacity if disinfection operation does not work normally over the maximum operation time. (E919 error)



[Forced DHW by User’s Input]

- Forced DHW mode shall be working depending on timer setting.
- #3051 : Set whether to use a timer for forced DHW function
- #3052 : Set time for forced DHW operation

[Solar panel / DHW Thermostat Application]

- #3061 : Set when configuring applications that use Solar panel or DHW Thermostat
  . When using Solar panel, set the FSV #3061, “1”.
  . Solar panel and Heat Pump are able to operate simultaneously except DHW mode.
  . When using DHW Thermostat, set the FSV #3061, “2”.

[Water flow direction by 3Way valve for DHW]

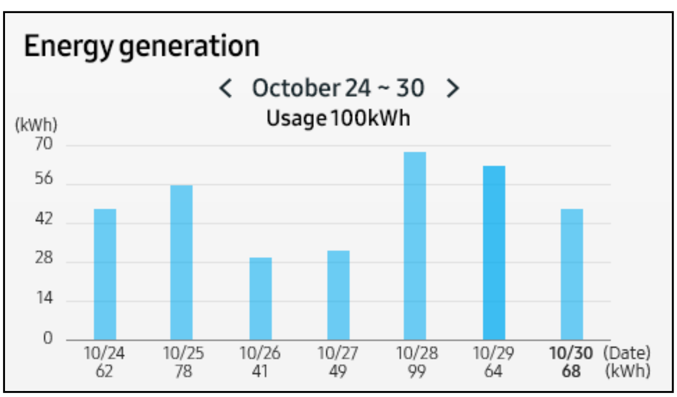
- #3071 : Set direction of water flow between room and DHW Tank
  . #3071 = “1”: Room (Based on Normal Close Valve)
  . #3071 = “2”: DHW Tank (Based on Normal Close Valve)

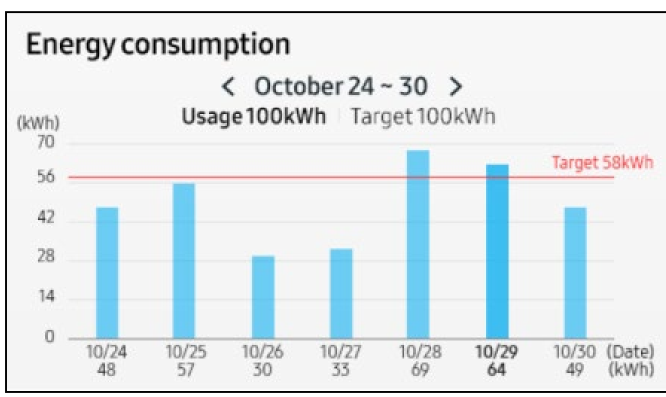
[Energy metering]

- #3081 : Set the FSV #308* according to heater (BUH, BSH) capacity to check energy information of system

* In order to accurately indicate energy metering, it must be set.

(Energy monitoring using wired remote controller, MWR-WW10N)





4) Code 40** : User's options for heating devices including internal backup heater and external boiler

* The values in the following table are just examples for your understanding.

Main Menu (Code)	Sub Menu Function	Description	Sub Code	Step	Unit	AE200(260)RNW*** Default	Min	Max
Heating (Code 40✳✳)	Heat Pump	DHW / Heating Priority	✳✳11	-	-	0(DHW)	0	1 (Heating)
		Outdoor Temp for Priority	✳✳12	1	˚C	0	-15	20
		Heating Off	✳✳13	1	˚C	35	14	35
	Backup Heater	Application	✳✳21	-	-	0(No)	0	2
		BUH / BSH Priority	✳✳22	1	-	2(BSH)	0(Both)	2(BSH)
		Cold weather compensation	✳✳23	-	-	1(Yes)	0(No)	1
		Threshold Temp	✳✳24	1	˚C	0	-25	35
		Defrost Backup Temp.	✳✳25	5	˚C	15	10	55
	Backup Boiler	Application	✳✳31	-	-	0(No)	0	1(Yes)
		Boiler Priority	✳✳32	-	-	0(No)	0	1(Yes)
		Threshold Temp	✳✳33	1	˚C	-15	-20	5
	Mixing Valve	Application	✳✳41	1	-	0(No)	0	2
		Target ΔT(Heating)	✳✳42	1	˚C	10	5	15
		Target ΔT(Cooling)	✳✳43	1	˚C	10	5	15
		Control factor	✳✳44	1	-	2	1	5
		Control interval	✳✳45	1	min	2	1	30
		Running Time	✳✳46	3	(x10) sec	9	6	24
	Inverter Pump	Application	✳✳51	-	-	1(Yes)	0	2
		Target ΔT	✳✳52	1	˚C	5	2	8
		Control factor	✳✳53	1	-	2	1	3
	Zone Control	Application	✳✳61	-	-	0(No)	0	1(Yes)

* The values may vary depending on the model.

[Heat Pump Variables for Space Heating]

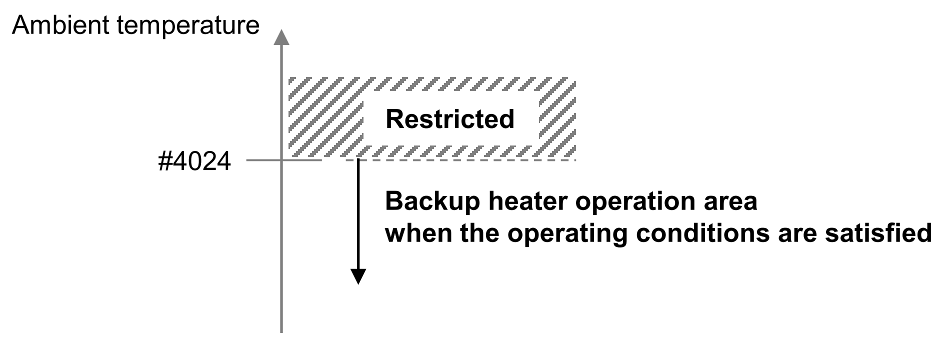
- #4011 : Set priority when both DHW and Heating are required at the same time
- #4012 : Reference temperature for control
- #4013 : Outdoor temperature at which the Heat Pump stops
- The FSV #4011 for DHW priority is set to “0 (DHW)” as a default.
  Space heating gets a priority by setting FSV #4011 “1”, but this is only valid when the outdoor temperature is lower than the specified temperature defined by FSV #4012.

Priority	Condition	Operation
DHW (#4011 = “0”)	-	Regardless of the current mode of operation, the DHW mode takes a priority (DHW and Heating mode are operated alternately by FSV #3025, #3026)
Heating (#4011 = “1”)	Outdoor temperature < FSV #4012	Regardless of the current mode of operation, it only works to Heating mode
	Outdoor temperature ≥ FSV #4012	It is same as when the DHW mode has a priority

[Backup Heater Variables for Space Heating]

- #4021 : Whether to use the Backup heater
- #4022 : Priority between Booster heater and Backup heater
- #4023 : Whether to use energy saving control related to Backup heater
- #4024 : Threshold temperature for control of Backup heater
- #4025 : Temperature at which Backup heater turns on during defrost mode
- The FSV #4021 should be set to “1 (2-stage heater)” or “2 (1-stage heater)” to use electric backup heater in hydro unit as an additional heat source.

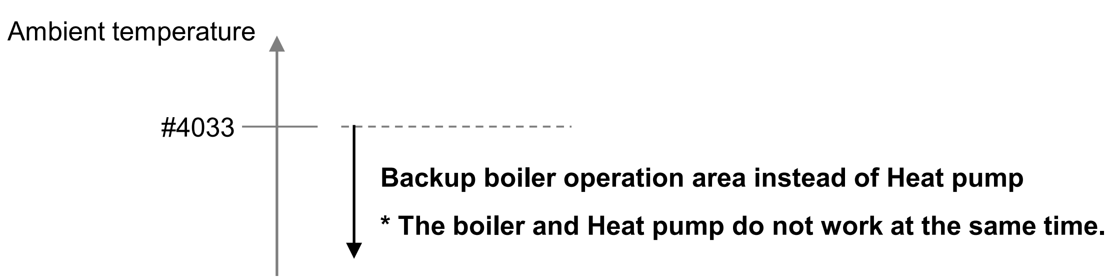
- The FSV #4022 for backup heater priority should be set to "0 (Both)" or "1 (Backup heater)" to use backup heater. If not (Booster heater priority), the backup heater can be operated in case of no booster heater demand.
- #4023 = "1":
  The backup heater operation is restricted to save energy in the threshold temperature range.



- The threshold temperature for backup heater operation during defrost mode to prevent cold draft because of chilled water can be controlled by adjusting FSV #4025 of water outlet temperature, backup heater will be turned on.

[External Backup Boiler for Space Heating]

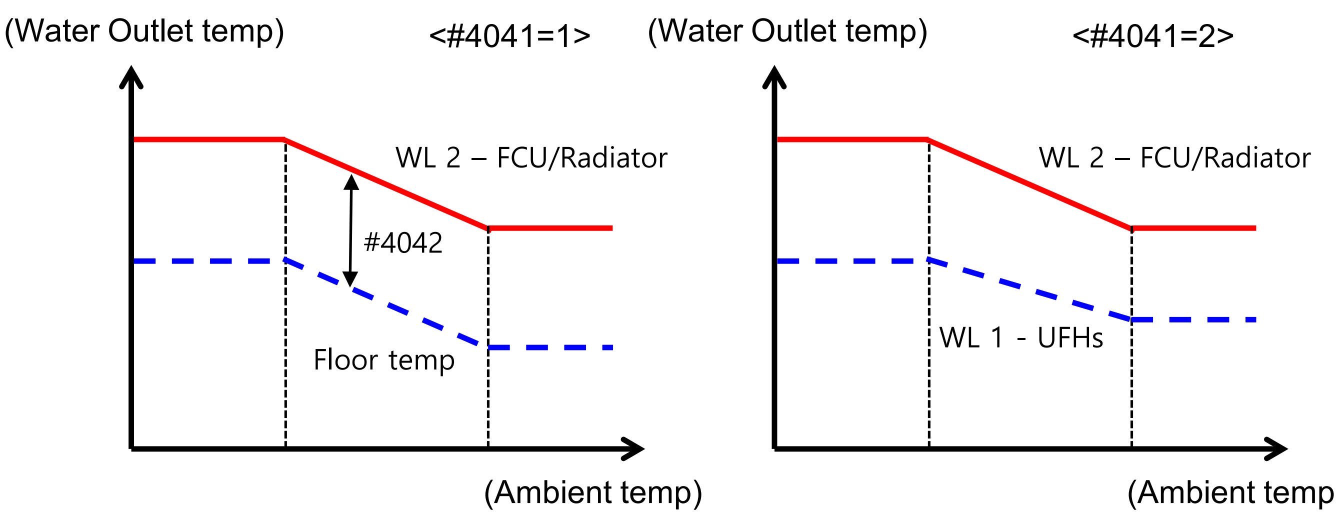
- The FSV #4031 should be set to "1 (Yes)" to use a backup boiler as an additional heat source.
- #4031 : Whether to use the Backup boiler
- #4032 : Priority between Heat Pump and Backup boiler
- #4033 : Threshold temperature for control of Backup boiler
- To compensate the lowered heat pump heating performance under very cold weather conditions, the backup boiler operates instead of heat pump under the threshold temperature.



[Mixing valve Installation]

- The FSV #4041 should be set to “1” or “2” to use a mixing valve.
- #4041 = “1”:
  Controlled based on the temperature difference (#4042, #4043)
- #4041 = “2”
  Controlled based on the temperature difference of the Water Law value
- #4042 : Temperature difference for mixing valve control in Heating mode
- #4043 : Temperature difference for mixing valve control in Cooling mode

Ex) Heating mode



- #4044 : Control weighting
- #4045 : Control interval
- #4046 : Running time of Mixing valve
- As the value of #4044 increases and the value of #4045 decreases, the control speed increases.
- When using mixing valve, the FSV #4046 should be matched with mixing valve running time characteristic.

[Inverter Pump Control]

- The FSV #4051 should be set to “1” or “2” to use inverter pump control.
- #4051 = “1” : Use (Maximum output 100%)
- #4051 = “2” : Use (Maximum output 70%)
- #4052, #4053 : Control factor for Inverter pump control
- Inverter pump control

. Output signal of Inverter pump in heating mode (%)

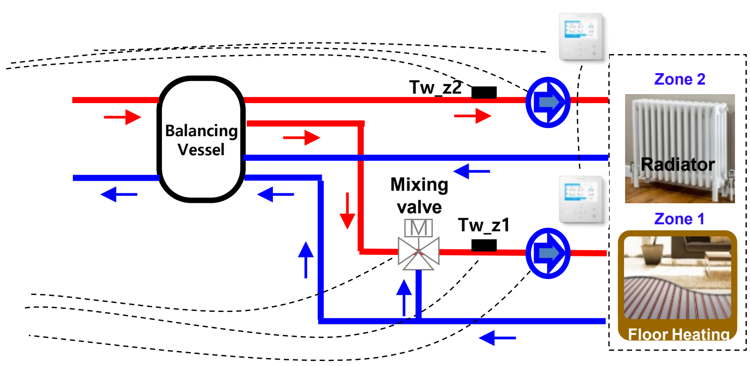
= Current Inverter pump output (%) + (*Tw2 – *Tw1 – #4052) * #4053

* Tw1 : Water Inlet temperature (℃)
* Tw2 : Water Outlet temperature (℃)

[Zone Control]

- The FSV #4061 should be set to “1” to use zone control.

* Set when using zone control using Samsung wired remote controller (MWR-WW10N).
It does not require to set when using 3rd party thermostat.
* MIM-E03CN (Mono Control kit) model does not support this zone control function.



* Zone 1 and Zone 2 can be set to different temperatures.

5) Code 50** : User's options for extra functions

* The values in the following table are just examples for your understanding.

Main Menu (Code)	Sub Menu Function	Description	Sub Code	Step	Unit	AE200(260)RNW*** Default	Min	Max
Others (Code 50✳✳)	Outing Mode	Water Out Temp for Cooling	✳✳11	1	˚C	25	5	25
		Room Temp for Cooling	✳✳12	1	˚C	30	18	30
		Water Out Temp for Heating	✳✳13	1	˚C	15	15	55
		Room Temp for Heating	✳✳14	1	˚C	16	16	30
		Auto Cooling WL1 Temp	✳✳15	1	˚C	25	5	25
		Auto Cooling WL2 Temp	✳✳16	1	˚C	25	5	25
		Auto Heating WL1 Temp	✳✳17	1	˚C	15	15	55
		Auto Heating WL2 Temp	✳✳18	1	˚C	15	15	55
		Target Tank Temp	✳✳19	1	˚C	30	30	70
	DHW Saving	Temp Difference	✳✳21	1	˚C	5	0	40
		Saving Mode	✳✳22	-	-	0	0	1
		Thermo On Temp During Saving Mode	✳✳23	1	˚C	25	0	40
	TDM Variable (TDM Only)	Priority Maximum Operation Time	✳✳31	5	min	30	10	90
		Non Priority Minimum Operation Time	✳✳32	1	min	5	3	60
		A2A / DHW Priority	✳✳33	1	-	0 (A2A)	0	1 (DHW)
	Peak Power Control	Application	✳✳41	-	-	0 (No)	0	1 (Yes)
		Select forced off parts	✳✳42	1	-	0 (All)	0	3
		Using input voltage	✳✳43	-	-	1 (High)	0 (Low)	1
	Frequency Ratio Control		✳✳51	-	-	0 (No)	0	1 (Yes)
	PV Control	Application	✳✳81	-	-	0 (No)	0	1 (Yes)
		Setting Temp Shift Value (Cooling)	✳✳82	0.5	˚C	2	1	20
		Setting Temp Shift Value (Heating)	✳✳83	0.5	˚C	2	1	50
	Smart Grid Control	Application	✳✳91	-	-	0 (No)	0	1 (Yes)
		Setting Temp Shift Value (Heating)	✳✳92	0.5	˚C	2	1	50
		Setting Temp Shift Value (DHW)	✳✳93	0.5	˚C	5	1	40
		DHW Mode	✳✳94	-	-	0	0 (Standard)	1 (Power)

* The values may vary depending on the model.

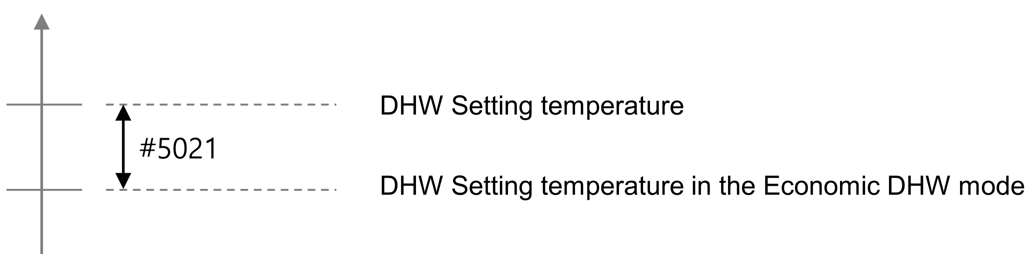
[Outing Mode]

- When activating the Outing mode, the setting temperature of system can be lowered to the Field Setting Value (FSV) to minimize the operation during absence.
- #5011 ~ #5019 : Set temperature values in Outing mode (Space heating and cooling, Water law, DHW, Room temperature)

[Economic DHW Heating]

- This is to save energy by lowering the target DHW temperature.
  . It is activated in the Economic DHW mode of wired remote controller.
- #5021 : Control factor for DHW setting temperature in the Economic DHW mode
- #5022 : Economic DHW mode
- #5023 : Control factor for Thermo On in the Economic DHW mode

* The #5023 may be applied when the FSV #5022 is set to “1”.



[TDM Variable]

- This is only for TDM plus model.
- #5031 : Maximum operation time of priority mode
- #5032 : Minimum operation time of Non priority mode
- #5033 : Set priority between *A2A IDU and *A2W IDU (Hydro unit)

* A2A IDU : Heat delivery from Outdoor Air to Indoor Air
* A2W IDU : Heat delivery from Outdoor Air to Indoor Water

(Example of operation according to operation mode)

- In case of A2A & A2W operation is “On” simultaneously

* A2A and A2W modes can not operate at the same time.

Operation Mode	A2A	Cool	Heat	Cool	Heat	
	A2W	Cool	Cool	Heat	Floor heating	DHW
Operation Priority	A2A	A2A cool A2W cool	① A2A heat A2W limited	A2A cool A2W heat/DHW (only by **BUH/BSH**)	A2A heat A2W floor heat	A2A heat A2W DHW
	A2W	A2A cool A2W cool	A2A heat A2W limited	② A2A cool A2W heat/DHW	A2A heat A2W floor heat	A2A heat A2W DHW

- Case ① : A2A Heating mode and A2W Cooling mode, A2A has a priority

. A2A IDUs can be operated to Heating mode, but A2W IDU (Hydro unit) can not be operated to Cooling mode for efficient use of the system.

- Case ② : A2A Cooling mode and A2W Heating/DHW mode, A2W has a priority

. A2W IDU (Hydro unit) can be operated to Heating/DHW mode, and A2A IDUs also can be operated to Cooling mode. (It is operated alternately according to the priority.)

[Peak Power Control]

- The FSV #5041 should be set to “1” to use peak power control.
- #5041 : Whether to use the peak power control
- #5042 : Set the available items
- #5042 = “1” : Only Compressor (Heat Pump) is available
- #5042 = “2” : Only Booster Heater (BSH) is available
- #5042 = “3” : Nothing is available

(Example)

#5042	Compressor	Backup heater	Booster heater
0 (Default)	Permitted	Forced off	Permitted
1	Permitted	Forced off	Forced off
2	Forced off	Forced off	Permitted
3	Forced off	Forced off	Forced off

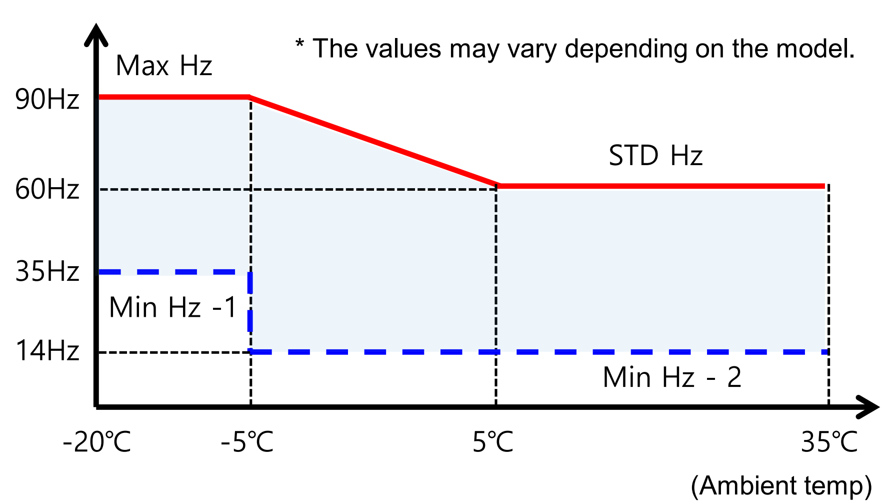
- #5043 : Set the input contact voltage
- #5043 = “0” : The input contact voltage is “High”
- #5043 = “1” : The input contact voltage is “Low”
- Applying the control when voltage of input contact is “high” is default.
  It allows the input contact voltage to be applied “Low” by using the FSV #5043.

[FR (Frequency Ratio) Control]

- The FSV #5051 should be set to “1” to use FR control.
- This is to limited the maximum frequency of the compressor in heat pump.
- #5041 : Whether to use the FR control
- It uses a DC voltage of 0 ~10V.

Voltage (V)	FR
0.0 ≤ V≤ 1.0 (Min Hz)	50%
1.0 ≤ V≤ 2.0	60%
2.0 ≤ V≤ 3.0	70%
3.0 ≤ V≤ 4.0	80%
4.0 ≤ V≤ 5.0	90%
5.0 ≤ V≤ 6.0 (STD Hz)	100%
6.0 ≤ V≤ 7.0	110%
7.0 ≤ V≤ 8.0	120%
8.0 ≤ V≤ 8.5	130%
8.5 ≤ V≤ 9.0	140%
9.0 ≤ V≤ 10.0 (Max Hz)	150%

(Example)

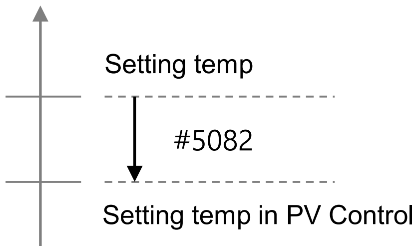


[PV (Photovoltaics) Control]

- The FSV #5081 should be set to “1” to use PV control.
- This is for energy saving by using the solar energy.
* This function is activated only for the Outing mode and DHW mode.
* It can not be used at the same time as Peak power control.
- #5081 : Whether to use the PV control
- #5082 : Set the temperature offset value in Cooling mode
- #5083 : Set the temperature offset value in Heating mode

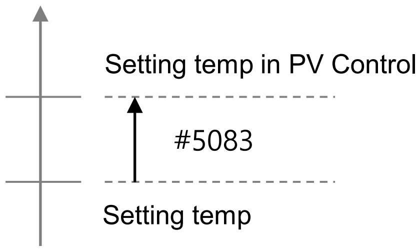
(Cooling mode in Outing mode)

- Room setting temperature = Setting temperature – #5082
- Water outlet setting temperature = Setting temperature - #5082
- Setting temperature by Water law = Setting temperature - #5082



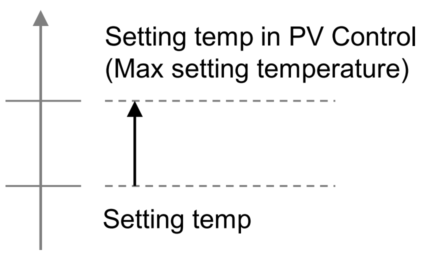
(Heating mode in Outing mode)

- Room setting temperature = Setting temperature + #5083
- Water outlet setting temperature = Setting temperature + #5083
- Setting temperature by Water law = Setting temperature + #5083



(DHW mode)

- When the PV control is activated, it operates regardless of the Outing mode.
- DHW setting temperature = Max setting temperature of DHW mode



[Smart Grid Control]

- The FSV #5091 should be set to “1” to use Smart Grid control.

* MIM-E03CN (Mono Control Kit) model does not support this function.

- #5091 : Whether to use the Smart Grid control
- #5092 : Set the temperature offset value in Heating mode
- #5093 : Set the temperature offset value in DHW mode
- #5094 : DHW mode setting in Mode4
  . #5094 = “0”: Standard mode, the setting temperature is 55℃
  . #5094 = “1”: Power mode, the setting temperature is 70℃

(Operation mode for Smart Grid)

Operation Mode	SG Ready Signal 1 (#1,2 Pin)	SG Ready Signal 2 (#3,4 Pin)	Product Operation
Mode1	1 (Short)	0 (Open)	Forced Thermo off operation
Mode2	0 (Open)	0 (Open)	Normal operation
Mode3	0 (Open)	1 (Short)	1 Step-up operation
Mode4	1 (Short)	1 (Short)	2 Step-up operation

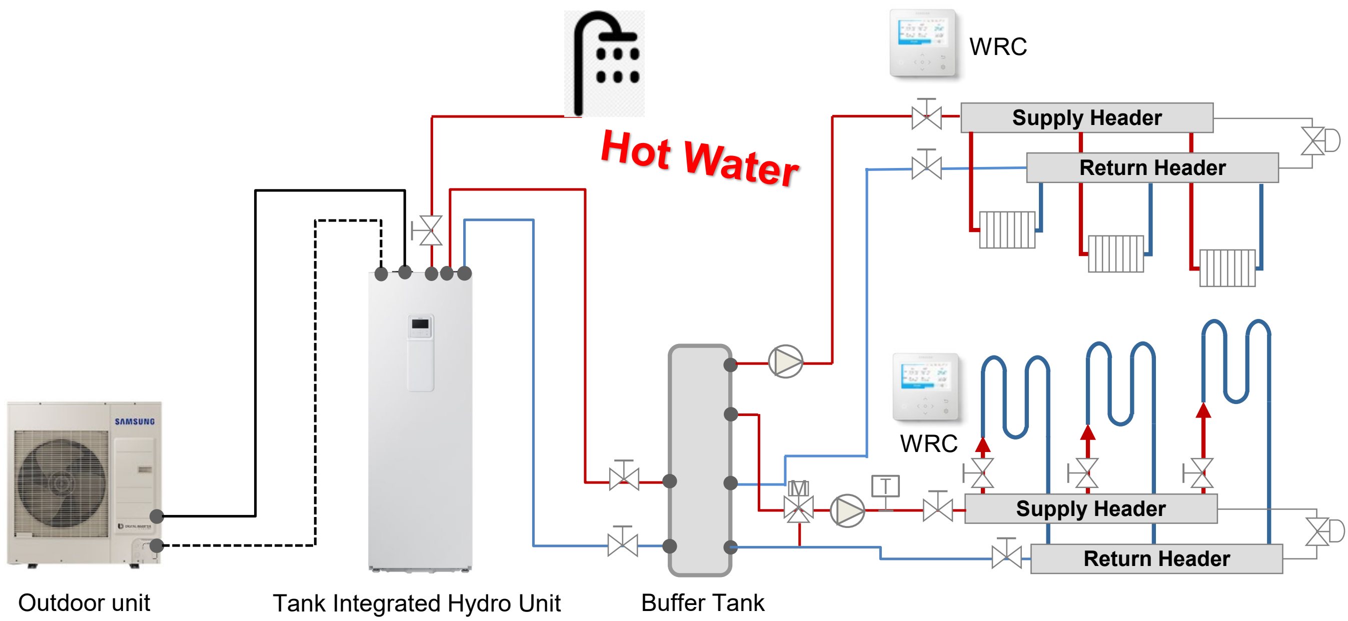
- Mode1 : Forced Thermo off of all system
- Mode2 : Normal operation
- Mode3 :
  . Heating mode (Room / Water outlet / Water law) = Setting temperature + #5092
  . DHW mode = Setting temperature + #5093
- Mode4 :
  . Heating mode (Room) = Setting temperature + #5092 + 3℃
  . Heating mode (Water outlet) = Setting temperature + #5092 + 5℃
  . Heating mode (Water law) = Setting temperature + #5092 + 5℃
  . DHW mode : It operates according to the setting in #5094.

6-2 Example of FSV setting

Please note that the following guide for FSV setting is for reference only.

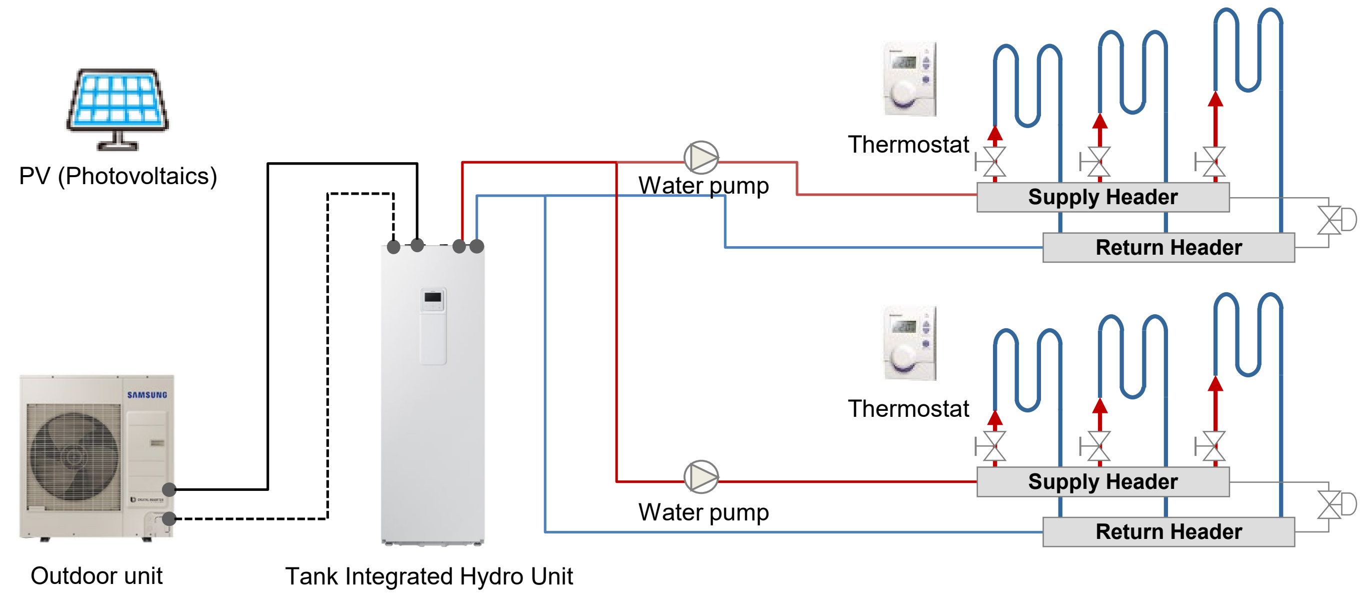
Consult your local design office (Installer) for detailed FSV setting.

[DHW + Space Heating/Cooling with Samsung wired remote controller]



Function	FSV setting
- **DHW** . The DHW operation starts based on the Thermo On temperature.	- #3011 : "1"
- **Disinfection**	- #3041 : "1"
- **2 Zone control by Samsung wired remote controller**	- #4061 : "1"
- **Mixing valve** . Controlled based on the temperature difference (#4042, #4043)	- #4041 : "1"
- **Thermo off control** . It is determined by Water law or Set temp of WRC . Water pump stops during Thermo off	- #2093 : "2"

[DHW + Space Heating/Cooling with 3rd party Thermostat]



Function	FSV setting
- **DHW** . The DHW operation starts based on the Thermo Off temperature.	- #3011 : "2"
- **Disinfection**	- #3041 : "1"
- **External Thermostat Application (UFH)** . The Thermo off is determined by Water law or Thermostat signal . Water pump operates like below during Thermo off Repeat 3min On / 7min Off	- #2091 : "4"
- **Booster heater** . Capacity : 3kW	- #3083 : "3"
- **PV (Photovoltaics) control**	- #5081 : "1"

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THANK YOU