

Cascade Controller - IN780CTR0XSO000

for SAMSUNG ECO HEATING SYSTEMS
[EHS] and HYDRO UNITS [HE/HT]

USER MANUAL
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1. Description and Order Codes

IN780CTROXSO000 Cascade Controller.

Controller for cascaded Samsung EHS air-to-water heat pump systems and Samsung DVM Hydro systems.

ORDER CODE	LEGACY ORDER CODE
IN780CTROXSO000	-

2. Licensing

Distribution license(s) for the IN780CTROXSO000 Cascade Controller:

Order Code	License	Maximum number of heat pumps or Hydro Units	
		Indoor units	Outdoor units
IN780CTROXSO000	XS	8	8

3. General Information

3.1. Intended Use of the User Manual

This manual contains the main features of this Intesis Cascade Controller and the instructions for its appropriate installation, configuration, and operation.

Any person who installs, configures, or operates this cascade controller or any associated equipment should be aware of this manual's contents.

Keep this manual for future reference during the installation, configuration, and operation.

3.2. General Safety Information



IMPORTANT

Follow these instructions carefully. Improper work may seriously harm your health and damage the cascade controller and/or any other equipment connected to it.

Only technical personnel, following these instructions and the country legislation for installing electrical equipment, can install and manipulate this cascade controller.

Install this cascade controller indoors, in a restricted access location, avoiding exposure to direct solar radiation, water, high relative humidity, or dust.

Mount this cascade controller on a DIN rail inside a grounded metallic cabinet, following the instructions in this manual.

All wires (for communication and power supply, if needed) must only be connected to networks with indoor wiring. All communication ports are considered for indoor use and must only be connected to SELV circuits.

Disconnect all systems from power before manipulating and connecting them to the cascade controller.

Use SELV-rated NEC class 2 or limited power source (LPS) power supply.



CAUTION

To avoid earth loops that can damage the cascade controller and/or any other equipment connected to it, we strongly recommend:

- The use of DC power supplies, floating or with the negative terminal connected to earth. **Never use a DC power supply with a positive terminal connected to earth.**
- The use of AC power supplies only if they are floating and not powering any other device.

Use a circuit breaker between the cascade controller and the power supply. Rating: 250 V, 6 A.

Supply the correct voltage to power the cascade controller. The admitted range is detailed in the technical specifications table.

Respect the expected polarity of power and communication cables when connecting them to the cascade controller.

The Intesis Cascade Controller is designed for installation in an enclosure. When the device is mounted outside an enclosure, precautions should be taken to avoid electrostatic discharges to the unit in environments with static levels above 4 kV. When working in an enclosure (e.g., making adjustments, setting switches, etc.), typical anti-static precautions should be observed before touching the unit.

Binary inputs, if present, are potential-free contact. Do not connect any voltage.

3.3. Admonition Messages and Symbols

**CAUTION**

Instruction that must be followed to avoid a potentially hazardous situation that, if not avoided, could result in minor or moderate injury.

**IMPORTANT**

Instruction that must be followed to avoid a risk of reduced functionality and/or damage to the equipment or to avoid a network security risk.

**NOTE**

Additional information which may facilitate installation and/or operation.

**TIP**

Helpful advice and suggestions.

**NOTICE**

Remarkable Information.

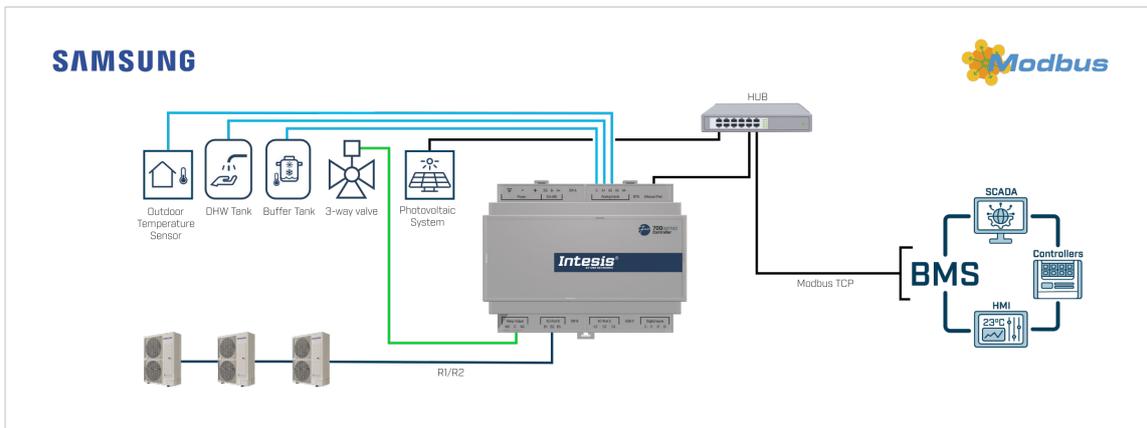
4. Overview



IMPORTANT

This document assumes that the user is familiar with these technologies.

Figure 1. Management of a Samsung EHS installation by the Intesis Cascade Controller



4.1. Inside the Package

ITEMS INCLUDED

- Intesis IN780CTROXSO000 Cascade Controller
- Installation Guide

4.2. Main Features

- Management of up to eight cascaded Samsung EHS air-to-water heat pumps or HE and HT Hydro Units to optimize their performance in cooling and heating modes and domestic hot water production.
- Scan function: Find the air-to-water heat pumps or Hydro Units connected to the R1/R2 bus.
- Energy efficiency: The Intesis Cascade Controller adjusts the operation of multiple heat pumps or Hydro Units according to changing conditions, improving efficiency.
- Heating, cooling, and domestic hot water (DHW) operation.
- Four analog inputs for monitoring tanks and outdoor temperature.
- One relay output to control the 3-way valve.
- Support for photovoltaic systems with Modbus TCP-compatible inverters or power meters.
- Customizable outside temperature-dependent heating curve to adjust the indoor temperature based on outdoor conditions, ensuring comfort and optimizing energy use.
- Rotation function to prioritize the use of units with the lowest run time, optimizing the use of individual units.
- Sequential startup features to optimize system performance and prevent overload conditions.
- Integration with Modbus TCP to monitor the Samsung EHS installation from a BMS, also enabling control of the operation mode and tank setpoint temperatures.

4.3. Cascade Controller General Functionality

The Intesis Cascade Controller controls up to eight Samsung EHS air-to-water heat pumps or Samsung DVM HE/HT Hydro Units in cascade mode to maintain the water temperature in the buffer tanks at the desired setpoint while the heat pumps or Hydro Units provide heating or cooling as efficiently as possible. To do so, the temperature sensors from the heating/cooling tank and the domestic hot water tank are connected to the cascade controller. The Intesis Cascade Controller then responds to the information gathered from these sensors and changes the number of active heat pumps or Hydro Units and their modes accordingly. As mentioned, this is done in the most efficient way possible, resulting in greater energy savings and an overall better system performance. To improve energy efficiency even further, it is also possible to connect a photovoltaic system to the cascade controller and apply its surplus power to one of the installation's tanks.



IMPORTANT

Temperature sensors are not part of the Intesis Cascade Controller and may need to be purchased separately.

Configuration is carried out via the Intesis MAPS configuration tool. This includes the different operating modes: heating, cooling, and domestic hot water production, as well as the assignment of each sensor's function and the configuration of photovoltaic panels. A scan function is available to detect all units currently on the bus.

The following sections provide an overview of the main functionalities of the Intesis Cascade Controller.



NOTICE

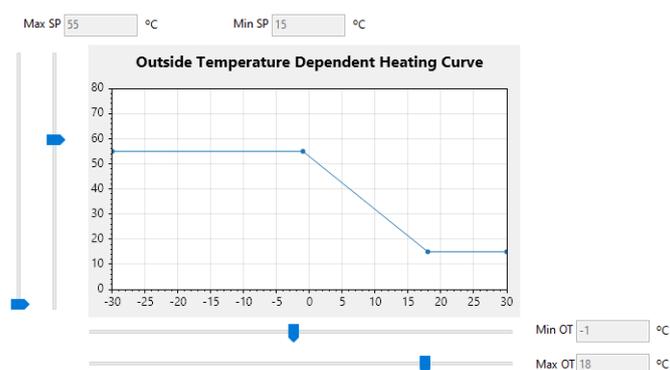
Refer to the [Intesis MAPS Configuration Guide](#) for more information on how to configure these functions.

4.3.1. Heating Operation

For the heating operation, it is possible to use a fixed setpoint or to control the indoor temperature based on the outdoor temperature. The latter is achieved by using an outdoor temperature sensor and defining an outdoor temperature-dependent heating curve, so that a setpoint correction can be applied in response to changes in outdoor temperature. This second option allows to maintain a consistent and comfortable indoor environment while optimizing energy use.

4.3.1.1. Outside Temperature-dependent Heating Curve

The heating curve that can be used as a setpoint method is a graphical representation of the relationship between outdoor temperature and the heating system's required supply temperature. It ensures that the heating system adjusts the heat output as the outdoor temperature changes.



4.3.2. Cooling Operation

The cooling operation is controlled similarly to the heating operation, except that only the fixed setpoint option is used. With this method, if the tank temperature rises too high, the controller will activate one or more outdoor units in cooling mode, provided there is no demand for domestic hot water when the setting for domestic hot water priority over heating/cooling is enabled.

4.3.3. Domestic Hot Water

The Intesis Cascade Controller uses a temperature sensor to monitor domestic hot water production and respond accordingly when the tank temperature drops too low. When that happens, the cascade controller manages the outdoor units available for domestic hot water mode, sequentially turning on as many units as needed until the temperature of the domestic hot water tank closely matches the defined setpoint again.

If the installation is solely for producing domestic hot water, the water flow will be direct. However, if the installation is for both domestic hot water production and space heating or cooling, the installation will include at least one 3-way valve.



NOTE

A 3-way valve is a key component in installations that cover both heating/cooling and domestic hot water production. Its main function is to direct the water flow between the two circuits (heating/cooling and domestic hot water) according to the system's demand.

Depending on the system setup, there are two possible behaviors when this occurs:

- **Systems with a centralized 3-way valve:** The Intesis Cascade Controller controls the 3-way valve directly, switching it to the required position at any time until the corresponding tank temperature reaches the user-defined setpoint.
- **Units with integrated 3-way valves:** The Intesis Cascade Controller activates the outdoor unit(s) serving the domestic hot water tank to operate in domestic hot water mode, with the outdoor unit acting on its valve, as each unit directly controls its integrated 3-way valve.

By default, the Intesis Cascade Controller prioritizes domestic hot water production over heating/cooling. This means that whenever there is a demand for domestic hot water, heating and cooling operations are suspended in favor of domestic hot water. This behavior can be disabled, and individual units without domestic hot water support can be defined. Units identified as such will remain exclusively dedicated to heating or cooling mode, regardless of domestic hot water demand.

4.3.3.1. Electric Heater

Heat pumps or Hydro Units are typically the sole component used for domestic hot water heating, with the number of active units varying according to demand. However, the domestic hot water tank can also have an electric heater installed as an auxiliary component to help with heating in cases where the heat pumps or Hydro Units alone cannot meet the heating demand. In these cases, the electric heater is connected to one of the heat pumps or Hydro Units, and it can be made available to the cascade controller via the Intesis MAPS configuration tool by enabling the electric heater control option on the corresponding unit.



NOTICE

Refer to the [Intesis MAPS Configuration Guide](#) for more information about the electric heater control.

With this option enabled, the cascade controller can then activate the electric heater to help reach the required setpoint. This activation takes place when the following conditions are met:

- Maximum capacity has been reached, i.e., all outdoor units with Domestic hot water support enabled are on.
- All units have been running for more than ten minutes.

Once the electric heater is activated, it will remain active until the capacity drops. This occurs when the pending demand decreases sufficiently, allowing the system to operate at a lower capacity.

4.3.4. Modbus Integration

The Intesis Cascade Controller can be integrated into a Modbus building management system (BMS), with system signals available via Modbus TCP. The heat pump or Hydro Unit operating mode and tank-related setpoint signals can be written and, therefore, controlled from the BMS side. The remaining signals, on the other hand, are read-only and therefore used for monitoring purposes only.

4.3.5. Rotation Function

A key aspect of working with a multiple heat pump or Hydro Unit installation is efficiently distributing the workload to achieve optimal utilization of all units. The Intesis Cascade Controller automatically handles this with its rotation feature, which prioritizes starting the unit with the lowest run time. There are many benefits to this strategy:

- **Balanced wear and tear:** By rotating usage, all heat pumps or Hydro Units experience similar levels of wear and tear, extending their overall lifespan.
- **Increased efficiency:** Prioritizing less frequently used pumps can prevent overworking a single unit and maintain optimal performance and efficiency throughout the system.
- **Reduced maintenance costs:** An evenly distributed operation reduces the risk of breakdowns and repairs.
- **Enhanced reliability:** A balanced system ensures that no single pump is overburdened, improving the reliability and stability of the heating system.

This function works by reading the duration usage of each outdoor unit through the **Operation Hours** signal of each unit. This value is then used to determine the unit priority.

In the event of a malfunction or failure of one heat pump or Hydro Unit, the rotation feature includes a fallback mechanism to switch automatically to an alternate unit. This ensures uninterrupted heating during maintenance or repair. Similarly, if a heat pump or Hydro Unit reports a defrost status, the controller will activate another available unit until the defrost procedure is complete.

4.3.6. Sequential Starting

The Intesis Cascade Controller implements a sequential start function that manages the process of starting multiple heat pumps or Hydro Units in sequence, determining the number of active units required to maintain the desired space heating, cooling, or water temperature setpoints. This feature ensures a controlled and coordinated startup process to optimize system performance and prevent overload conditions. The sequential start is calculated independently for the heating, cooling, and domestic hot water systems, with a PI controller defined for each.



NOTICE

A PI controller (Proportional-Integral controller) is a type of feedback control system that combines proportional control, which reacts to the current error, and integral control, which reacts to the accumulation of past errors, to maintain a desired setpoint.

It is, therefore, possible to define the proportional band and the integral time for the heating operation, the cooling operation, and domestic hot water.

- The **proportional band** defines the error range that allows the controller's output to reach its full capacity.
- The **integral time** determines how quickly the controller corrects accumulated errors over time.



NOTICE

In the context of a PI controller, error refers to the difference between the setpoint and the measured actual value. Refer to the [Intesis MAPS Configuration Guide](#) for more information.

The cascade controller uses these parameters to determine the number of units ON needed for each tank to stay within range in the defined time length.

4.3.7. Photovoltaic (PV) Panels

As the integration of photovoltaic panels into air-to-water heat pump or Hydro Unit installations becomes more common, the Intesis Cascade Controller provides specific options to support them. Communication between the cascade controller and the photovoltaic system is established via Modbus TCP, using a Modbus register. The characteristics of said register can be defined in the Intesis MAPS configuration tool, along with other important parameters such as the conditions under which the cascade controller will take advantage of excess power to avoid losing it to the grid. This power is used to help reach and increase the domestic hot water setpoint or to raise or lower the buffer tank temperature when the domestic hot water setpoint has already been reached or there is no domestic hot water production.



NOTICE

Make sure your photovoltaic system's communication protocol includes the active power Modbus register to confirm its compatibility with the cascade controller. For more information, refer to the manufacturer's documentation.

4.4. Installation Examples

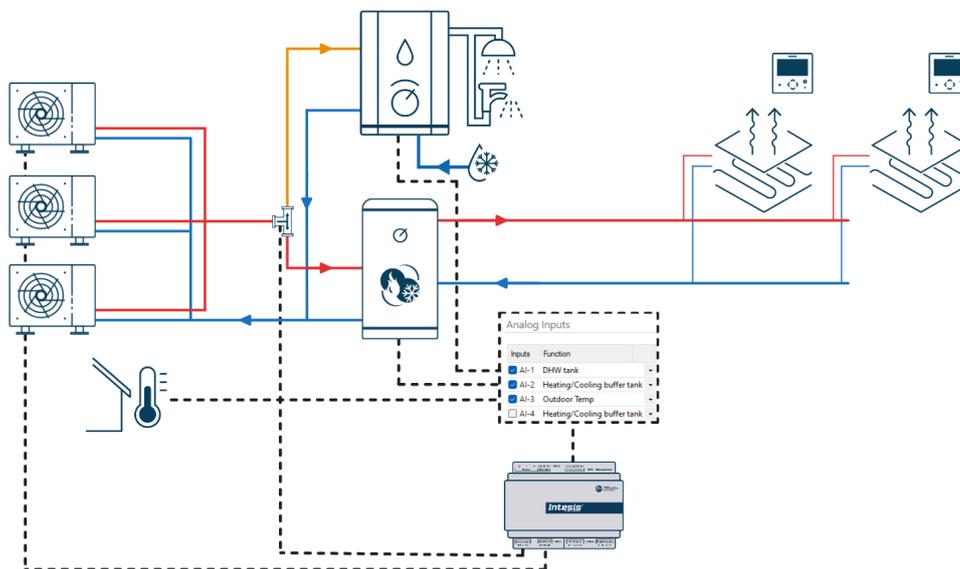
Air-to-water heat pump or Hydro Unit installations are highly versatile and can accommodate a wide range of scenarios. As a result, the scope of the installation adapts to the unique characteristics of each situation. The intended functionality determines which elements are part of the installation and how they interact, with the Intesis Cascade Controller managing their operation to optimize overall performance. Below are some examples of installations and their configuration.



NOTICE

For the reasons described above, the following examples cover only some of the possible installations and are not intended to be a complete list. These examples depict different Samsung EHS combinations only.

4.4.1. Common Heating/Cooling and DHW Production



This installation allows the production of space heating or cooling and domestic hot water, with all the outdoor units' flow being completely managed through the 3-way valve. This allows prioritizing domestic hot water production when it is on demand, diverting the overall production of all outdoor units toward the domestic hot water tank while stopping space heating or cooling production. Different unit types, such as underfloor heating (pictured), radiators, or fan coils, can be used for space heating or cooling. This installation type is suitable for isolated single-family homes, chalets, or hostels.

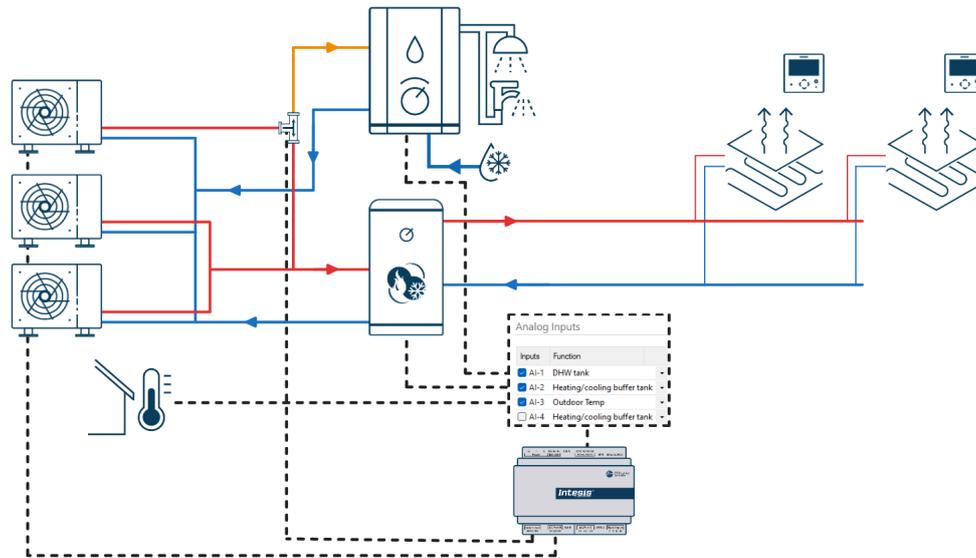
Elements monitored by the cascade controller via analog inputs (sensors)	Elements controlled by the cascade controller	Elements NOT controlled by the cascade controller
<ul style="list-style-type: none"> Domestic hot water tank Heating/cooling buffer tank Outdoor temperature 	<ul style="list-style-type: none"> Heat pumps 3-way valve 	<ul style="list-style-type: none"> Underfloor heating (or any other unit type connected through a secondary circuit).



NOTICE

Outdoor temperature is monitored for heating operation when the **Outside Temperature-dependent Heating Curve** setpoint method is selected. Refer to [Outside Temperature-dependent Heating Curve \(page 6\)](#) for more information.

4.4.2. Heating/cooling with Isolated Domestic Hot Water Production



This variation of the previous installation uses the same elements, but the piping is rearranged to leave a single outdoor unit connected to the 3-way valve. Only this outdoor unit can, then, cover either domestic hot water production or space heating or cooling, depending on the demand. Since the two other outdoor units are directly connected to the heating/cooling buffer tank, they remain exclusively dedicated to space heating or cooling, freed from domestic hot water production. With this modification, the heating or cooling production is therefore unaffected by domestic hot water demand, improving stability. This installation type is usually applied in hostels, gyms, restaurants, nursing homes, or childcare centers.

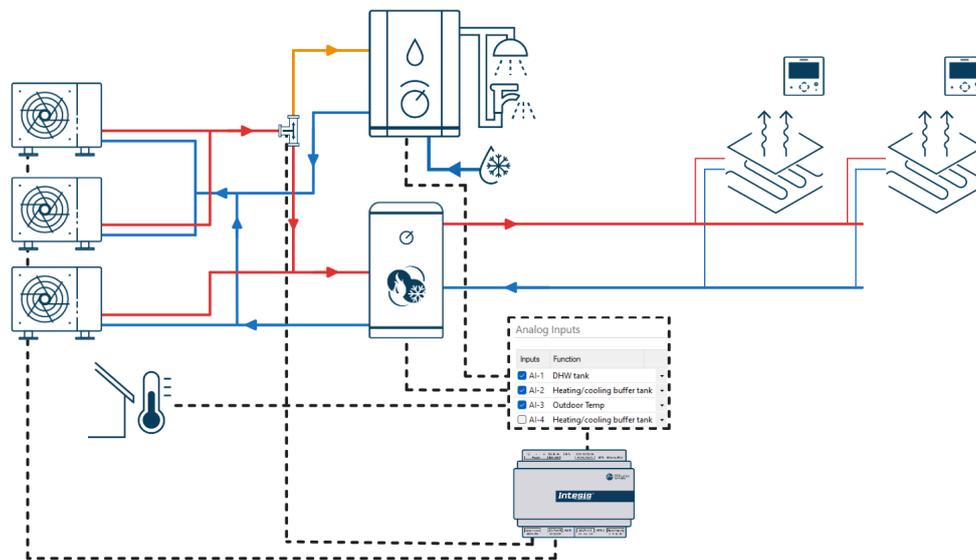
Elements monitored by the cascade controller via analog inputs (sensors)	Elements controlled by the cascade controller	Elements NOT controlled by the cascade controller
<ul style="list-style-type: none"> Domestic hot water tank Heating/cooling buffer tank Outdoor temperature 	<ul style="list-style-type: none"> Heat pumps 3-way valve 	<ul style="list-style-type: none"> Underfloor heating (or any other unit type connected through a secondary circuit).



NOTICE

Outdoor temperature is monitored for heating operation when the **Outside Temperature-dependent Heating Curve** setpoint method is selected. Refer to [Outside Temperature-dependent Heating Curve \(page 6\)](#) for more information.

4.4.3. Heating/cooling and focused Isolated Domestic Hot Water Production



This second variation of the initial example redistributes the assignment of outdoor units, having two of them connected to the 3-way valve. The production of these two units can, then, be directed toward domestic hot water or space heating/cooling, depending on the current demand. The third outdoor unit is exclusively dedicated to heating or cooling production. This option is suitable where domestic hot water demand is higher compared to residential buildings, like for example light commercial buildings, as more workforce is available for domestic hot water production.

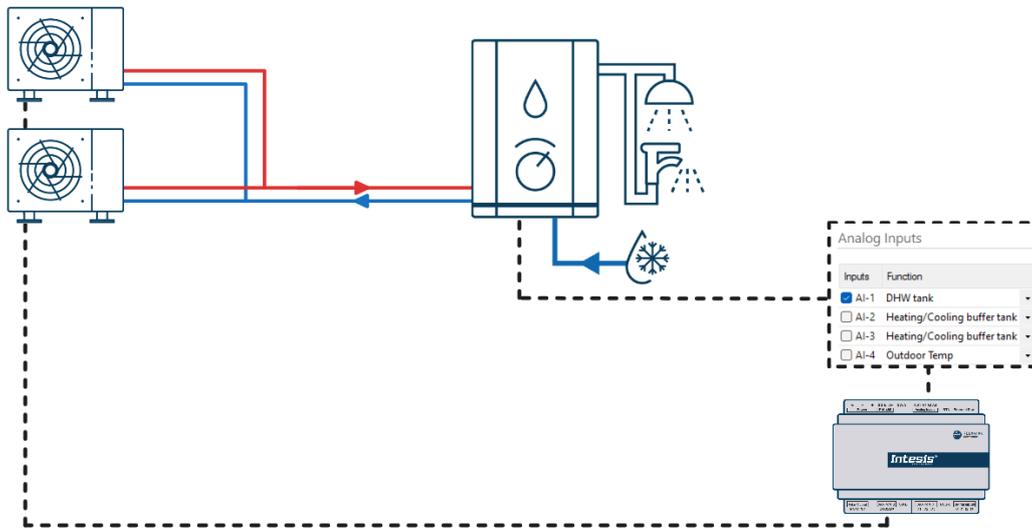
Elements monitored by the cascade controller via analog inputs (sensors)	Elements controlled by the cascade controller	Elements NOT controlled by the cascade controller
<ul style="list-style-type: none"> Domestic hot water tank Heating/cooling buffer tank Outdoor temperature 	<ul style="list-style-type: none"> Heat pumps 3-way valve 	<ul style="list-style-type: none"> Underfloor heating (or any other unit type connected through a secondary circuit).



NOTICE

Outdoor temperature is monitored for heating operation when the **Outside Temperature-dependent Heating Curve** setpoint method is selected. Refer to [Outside Temperature-dependent Heating Curve \(page 6\)](#) for more information.

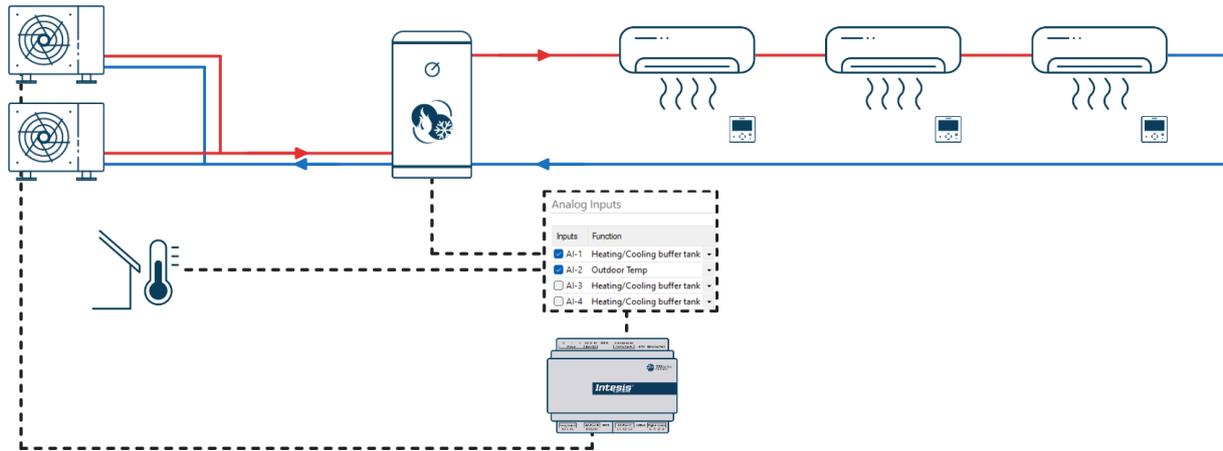
4.4.4. Domestic Hot Water Production Only



This simpler installation type is solely dedicated to domestic hot water production. A 3-way valve is not used here, as the system operates with a single piping circuit. This installation type is not common, but it can be found in retrofitting projects where existing space heating systems might have been retained or in specific applications that could require a dedicated system for domestic hot water production. This could be the case, for example, in large residential buildings or sports centers due to their high demand for domestic hot water.

Elements monitored by the cascade controller via analog inputs (sensors)	Elements controlled by the cascade controller
<ul style="list-style-type: none"> Domestic hot water tank 	<ul style="list-style-type: none"> Heat pumps

4.4.5. Heating/Cooling Only



Another basic case is an installation dedicated solely to space heating and cooling, excluding domestic hot water production. As in the previous example, this system operates with a single piping circuit, so no 3-way valve is used here either. This type of installation can be found in locations that do not require domestic hot water, such as retail stores or supermarkets, or in buildings with an existing alternative domestic hot water source.



NOTICE

Besides the pictured wall-mounted fan coils, other common space heating options are: underfloor heating, low-temperature radiators, and wall or ceiling heating panels.

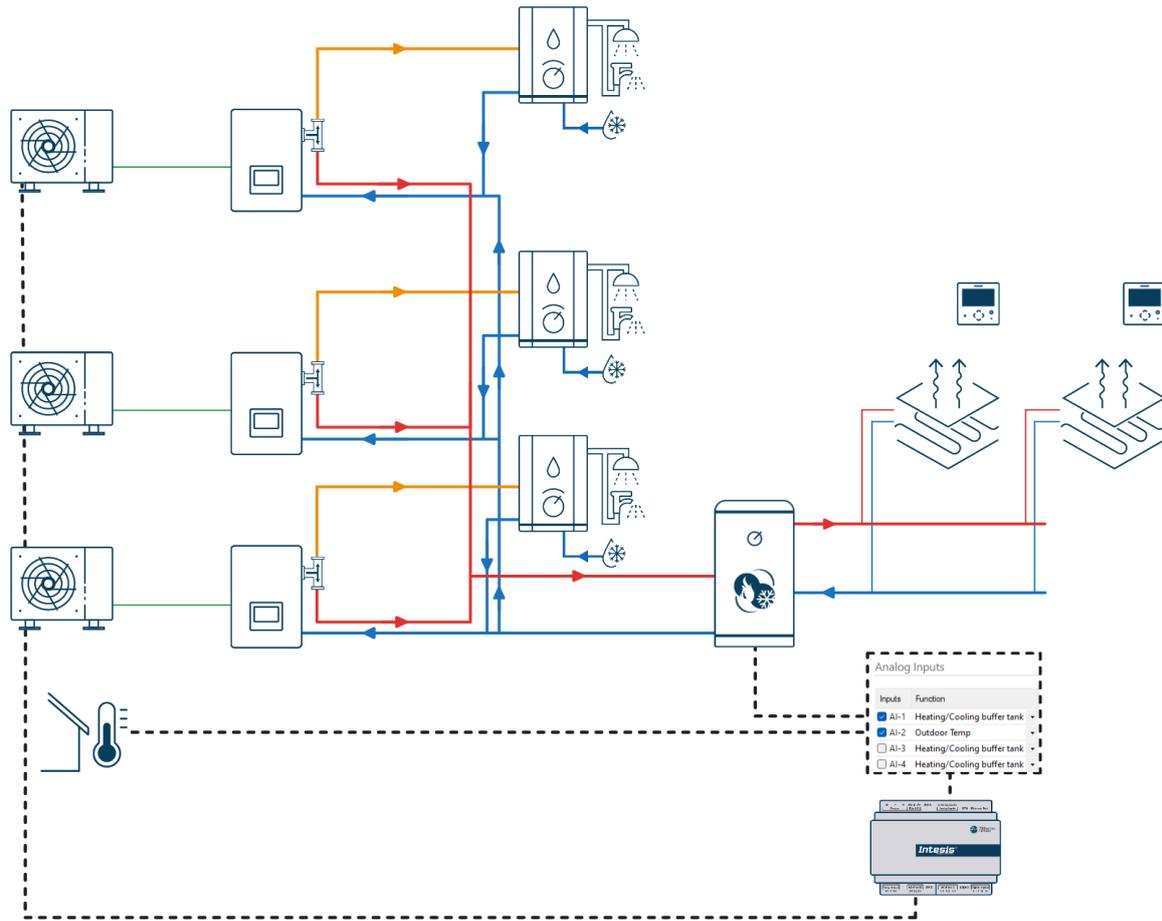
Elements monitored by the cascade controller via analog inputs (sensors)	Elements controlled by the cascade controller	Elements NOT controlled by the cascade controller
<ul style="list-style-type: none"> • Heating/cooling buffer tank • Outdoor temperature 	<ul style="list-style-type: none"> • Heat pumps 	<ul style="list-style-type: none"> • Fan coils (or any other unit type connected through a secondary circuit).



NOTICE

Outdoor temperature is monitored for heating operation when the **Outside Temperature-dependent Heating Curve** setpoint method is selected. Refer to [Outside Temperature-dependent Heating Curve \(page 6\)](#) for more information.

4.4.6. Collective Heating/cooling and individual DHW production



This installation example shows how split solutions work and the role of the cascade controller in such an installation. Split solutions consist of an outdoor unit connected to an indoor hydronic unit that is connected, in turn, to a third-party domestic hot water tank. This configuration enables individual domestic hot water production, as each hydronic unit contains and controls its specific 3-way valve. In this case, since each heat pump controls its own domestic hot water tank, the cascade controller only monitors the common section of the installation, i.e., space heating or cooling. The goal of the cascade controller in this scenario is limited, then, to maintaining the temperature of the heating/cooling buffer tank within the required parameters. To do so, it can only activate units that are currently available, i.e., units that are not producing domestic hot water. This installation type is usually applied to multi-family housing, such as blocks of flats.

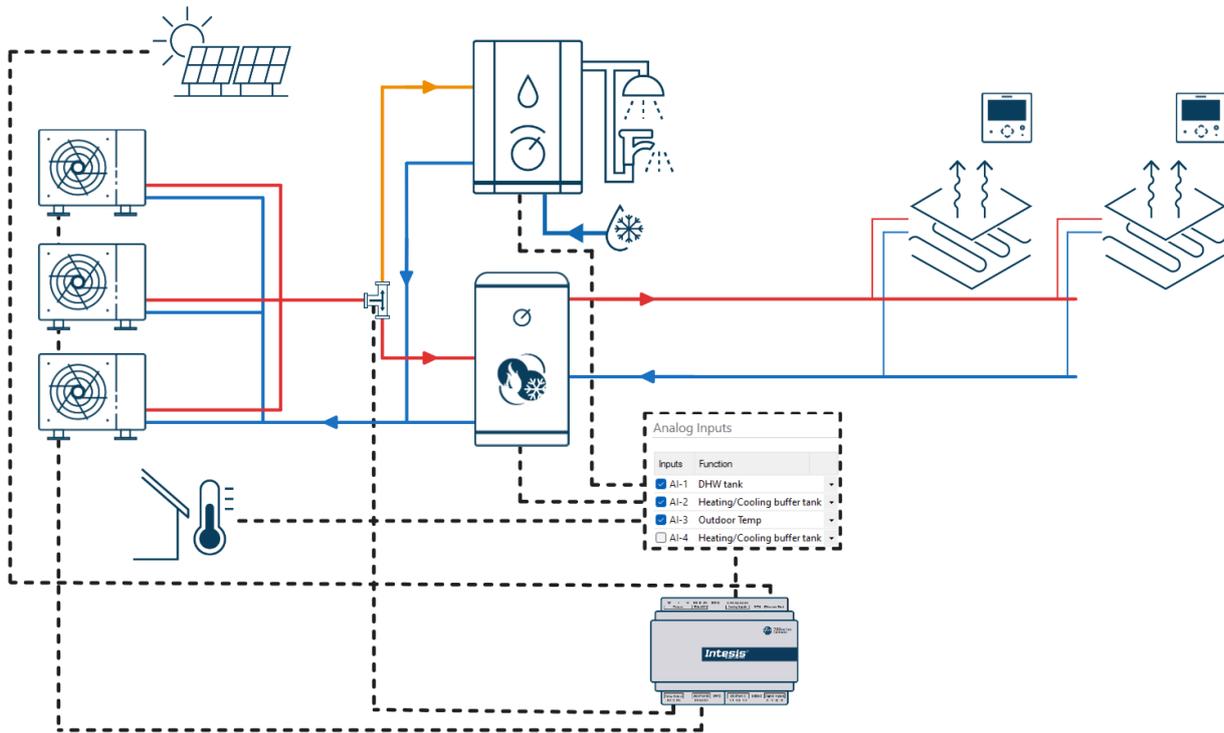
Elements monitored by the cascade controller via analog inputs (sensors)	Elements controlled by the cascade controller	Elements NOT controlled by the cascade controller
<ul style="list-style-type: none"> • Heating/cooling buffer tank • Outdoor temperature 	<ul style="list-style-type: none"> • Heat pumps 	<ul style="list-style-type: none"> • 3-way valves • Underfloor heating (or any other unit type connected through a secondary circuit).



NOTICE

Outdoor temperature is monitored for heating operation when the **Outside Temperature-dependent Heating Curve** setpoint method is selected. Refer to [Outside Temperature-dependent Heating Curve \(page 6\)](#) for more information.

4.4.7. Photovoltaic panel support



As mentioned in [Photovoltaic \(PV\) Panels \(page 9\)](#), the Intesis Cascade Controller provides photovoltaic panel support, utilizing the excess power generated by the panels to increase the setpoint of the domestic hot water tank or, alternatively, the heating/cooling buffer tank, once the domestic hot water setpoint has been reached.

Elements monitored by the cascade controller via analog inputs (sensors)	Elements controlled by the cascade controller	Elements NOT controlled by the cascade controller
<ul style="list-style-type: none"> Domestic hot water tank Heating/cooling buffer tank Outdoor temperature Photovoltaic system 	<ul style="list-style-type: none"> Heat pumps 3-way valve 	<ul style="list-style-type: none"> Underfloor heating (or any other unit type connected through a secondary circuit).



NOTICE

Outdoor temperature is monitored for heating operation when the **Outside Temperature-dependent Heating Curve** setpoint method is selected. Refer to [Outside Temperature-dependent Heating Curve \(page 6\)](#) for more information.

5. Quick Start Guide



IMPORTANT

While the following procedure outlines the fundamental steps for installing, wiring, and configuring the cascade controller, it is crucial to thoroughly review all documentation to prevent errors.

1. Install [Intesis MAPS](#) on your laptop. Use the setup program supplied and follow the instructions given by the installation wizard.
2. Mount the cascade controller at the desired installation site. The cascade controller can only be mounted on a DIN rail. Mounting inside a metallic industrial cabinet grounded to earth is recommended. See [Mounting \(page 18\)](#).
3. Disconnect all systems from power before wiring the cascade controller.
4. Connect the temperature sensors to the port marked as **Analog Inputs** on the cascade controller. See [Connection to the Temperature Sensors \(Analog Inputs\) \(page 23\)](#).
5. In case of a Modbus BMS integration, connect the communication cable from the Modbus network to the port marked as **Ethernet** on the cascade controller. See [Cascade Controller Connectors \(page 19\)](#).
6. In case of a Photovoltaic system integration, connect the communication cable from the photovoltaic system's inverter or power meter to the port marked as **Ethernet** on the cascade controller. See [Cascade Controller Connectors \(page 19\)](#).



NOTICE

In installations with both a Modbus BMS and a photovoltaic system to integrate, use a switch to accommodate both connections.

7. Connect the installation's 3-way valve to the port marked as **Relay Output** on the cascade controller. See [Connection to the 3-way Valve \(Relay Output\) \(page 25\)](#).



NOTICE

This only applies to installations with a centralized 3-way valve.

8. Connect the communication cable from the Samsung system to the port marked as **AC-Port B** on the cascade controller.
9. Power the cascade controller. The supply voltage can be from 12 to 36 VDC or just 24 VAC. Observe the polarity. See [Connection to the Power Supply \(page 22\)](#).
10. Reconnect the systems that were previously disconnected in step 3.
11. Connect the cascade controller to your laptop to configure it with Intesis MAPS. To do so, connect a USB Type-C cable from the laptop to the port marked as **Console** on the cascade controller.
12. Open Intesis MAPS and create a new project by selecting the corresponding project template.
13. Modify the configuration as needed, save it, and send the configuration file to the cascade controller. Consult the [Intesis MAPS guide for the Intesis Cascade Controller](#).
14. Go to the **Diagnostic** tab and check the communication activity between the cascade controller, the BMS, and the Samsung systems. If there is no communication activity, check that all systems are operative, the wiring of all devices is right, and the cascade controller configuration is correct.

6. Hardware

6.1. Mounting

**IMPORTANT**

Before mounting, please ensure that the chosen installation place preserves the cascade controller from direct solar radiation, water, high relative humidity, or dust.

**IMPORTANT**

Ensure the cascade controller has sufficient clearances for all connections when mounted. See [Dimensions \(page 31\)](#).

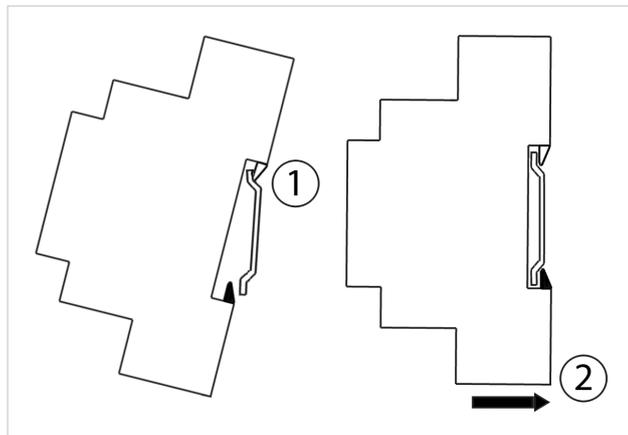
**NOTE**

Mount the cascade controller over a DIN rail, preferably inside a grounded metallic industrial cabinet.

1. Fit the cascade controller's top-side clips in the upper edge of the DIN rail.
2. Press the low side of the cascade controller gently to lock it in the DIN rail.
3. Make sure the cascade controller is firmly fixed.

**NOTE**

For some DIN rails, you may need to use a small screwdriver or similar to pull down the bottom clip to complete step 2.



6.2. Connection



CAUTION

Disconnect all systems from power before manipulating and connecting them to the cascade controller.

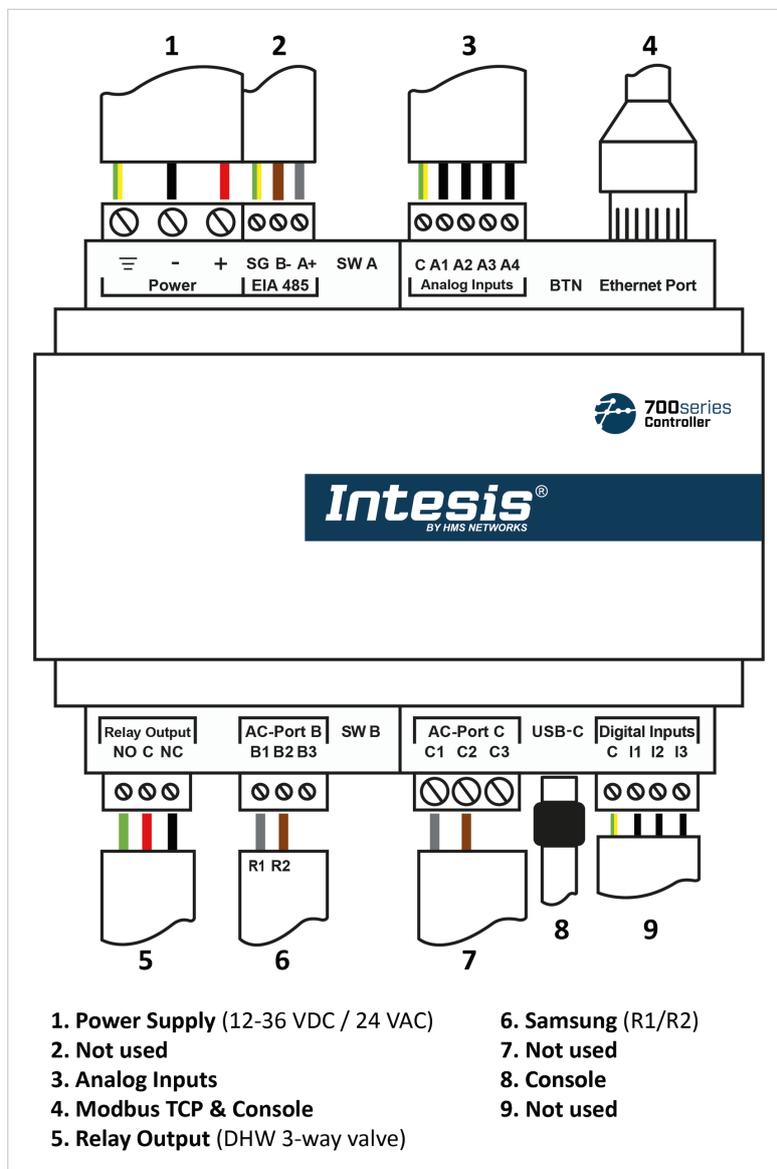


IMPORTANT

Keep communication cables away from power and ground wires.

6.2.1. Cascade Controller Connectors

Figure 2. Wiring diagram



WIRING THE CONNECTORS



IMPORTANT

For all connectors, use solid or stranded wires (twisted or with ferrule).

Cross-section/gauge per terminal:

- One core: 0.2 .. 2.5 mm² / 24 .. 11 AWG
- Two cores: 0.2 .. 1.5 mm² / 24 .. 15 AWG
- Three cores: Not permitted



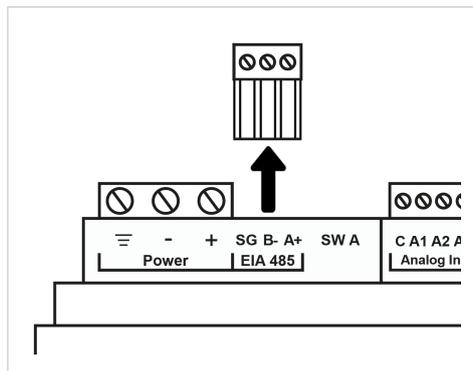
NOTE

To learn more about each port's specifications, see [Technical Specifications](#).



TIP

- Mount the cascade controller in the desired place before wiring it.
- Terminal block connectors can be unplugged to facilitate the wiring process.



COMMUNICATION PORTS

PORT	USAGE	WIRING				
EIA-485	<i>Not used</i>					
Analog Inputs	Thermistor connection for the system's buffer tanks (heating/cooling), domestic hot water tank, and the outdoor temperature	C: Common	A1: Input 1	A2: Input 2	A3: Input 3	A4: Input 4
Ethernet	<p>As a TCP/IP port: Modbus TCP</p> <p>As a console port: Connection to a PC for configuration purposes</p>	<p style="text-align: center;">Ethernet cable (CAT5 or higher)</p> <p style="text-align: center;">When using the building LAN, contact the network administrator and make sure traffic is allowed. When starting up the cascade controller for the first time, DHCP will be enabled for 30 seconds. After that time, the default IP 192.168.100.246 will be set.</p>				
Relay Output	DHW 3-way valve control	NO: Normally Open		C: Common	NC: Normally Closed	
AC-Port B Observe polarity	Samsung bus	B1: R1	B2: R2	B3: <i>Not used</i>		
AC-Port C	<i>Not used</i>					
USB-C	Connection to a PC for configuration purposes	USB Type-C				
Digital Inputs	<i>Not used</i>					

6.2.2. Connection to the Power Supply

The power supply connector is a green pluggable terminal block (three poles) labeled as **Power**.

Apply the voltage within the admitted range and of enough power:

- **For DC:** 12 .. 36 VDC ($\pm 10\%$), 3W - Max: 250 mA
- **For AC:** 24 VAC ($\pm 10\%$), 50-60 Hz, 4.8 W - 200 mA



NOTE

- **Recommended voltage :**24 VDC
- **Operating current at 24 VDC:** Min. 125mA



IMPORTANT

Use a circuit breaker between the cascade controller and the power supply. Rating: 250 V, 6 A.



IMPORTANT

- **When using a DC power supply:** Respect the polarity labeled on the power connector for the positive and negative wires.
- **When using an AC power supply:** Ensure the same power supply is not powering any other device.



IMPORTANT

- Use SELV-rated NEC class 2 or limited power source (LPS) power supply.
- Respect the polarity.
- Connect the cascade controller ground terminal  to the installation grounding.



IMPORTANT

To avoid earth loops that can damage the cascade controller and/or any other equipment connected to it, we strongly recommend:

- The use of DC power supplies, floating or with the negative terminal connected to earth.
- The use of AC power supplies only if they are floating and not powering any other device.



CAUTION

Never use a DC power supply with a positive terminal connected to earth.



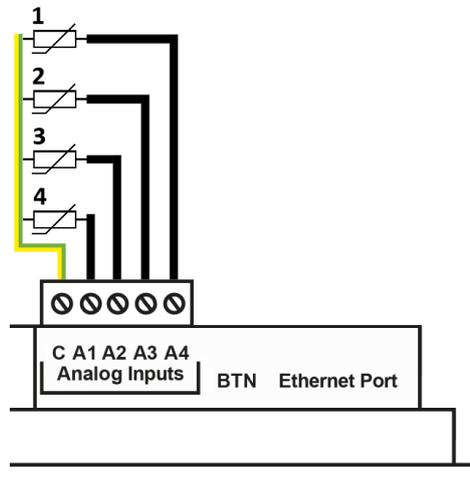
NOTE

See the [Wiring diagram \(page 19\)](#).

6.2.3. Connection to the Temperature Sensors (Analog Inputs)

Connect the temperature sensors to the cascade controller using the **Analog Inputs** port.

Figure 3. Connection of temperature sensors to the cascade controller



1 .. 4: Temperature sensors (heating/cooling buffer tank, DHW tank, and outdoor temperature)

There is no specific order in which the different sensor types must be connected, as each input function is defined in the Intesis MAPS configuration tool. It is also possible to connect more than one tank of the same type as long as this connector has unused inputs.



NOTICE

Refer to the [Intesis MAPS Configuration Guide](#) for more information.

Both PT and NTC thermistor types are supported. The table below lists the currently supported sensors.

Signal Type Measurement	Standard Measuring Range	Offset (°C)	Correction factor
PT1000	-20°C .. +100°C	0	1
PT1000	-50°C .. +500°C	0	1
NTC10K	-25°C .. +100°C	0	1
NTC10K	-40°C .. +125°C	0	1
NTC10K	-50°C .. +150°C	0	1
NTC10K	-55°C .. +150°C	0	1
NTC20K	-55°C .. +175°C	0	1



NOTE

See the [Wiring diagram \(page 19\)](#).

6.2.4. Connection to Modbus TCP

The **Ethernet Port** of the cascade controller has two different purposes:

- Connection to a Modbus TCP BMS.
- Connection to a Modbus TCP-compatible inverter or energy meter from a photovoltaic system.

The connection process is the same in both cases: Connect the Modbus TCP Ethernet cable to the cascade controller's **Ethernet Port**. The correct cable to use depends on where the cascade controller is connected:

- **Connecting directly to a Modbus TCP device:** use a crossover Ethernet UTP/FTP CAT5 or higher cable.
- **Connecting to a hub or switch of the LAN of the building:** use a straight Ethernet UTP/FTP CAT5 or higher cable.



NOTICE

In installations with both a Modbus BMS and a photovoltaic system to integrate, use a switch to accommodate both connections.



NOTE

When commissioning the cascade controller for the first time, DHCP will be enabled for 30 seconds. During that time, if there is a DHCP server, an IP address will be automatically assigned to the cascade controller. After that time, the default IP address 192.168.100.246 will be automatically set.



IMPORTANT

If communicating through the LAN of the building, contact the network administrator and make sure traffic on the used port is allowed through all LAN paths.



NOTE

See the [Wiring diagram \(page 19\)](#).

6.2.5. Connection to the 3-way Valve (Relay Output)

Connect the 3-way valve to the cascade controller using the **Relay Output** connector.



NOTICE

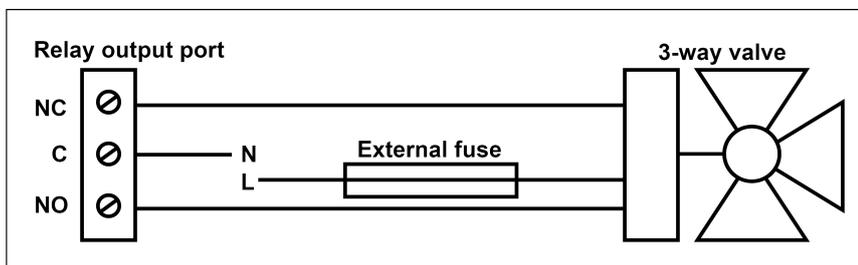
This connection only applies to systems with a centralized 3-way valve. This valve is only required for installations with two separate circuits, one for heating or cooling and the other for domestic hot water. Once connected, the cascade controller controls the 3-way valve directly to divert the flow towards one circuit or the other, depending on the current demand.



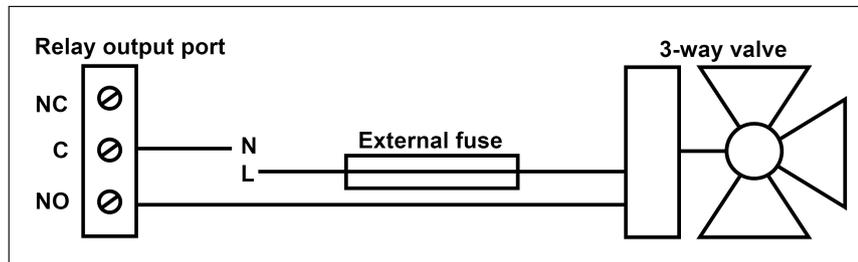
WARNING

It is mandatory to add an external fuse to protect the 3-way circuit:

A) For three wires valve control:



B) For two wires valve control:



- **NC:** Normally closed
- **C:** Common
- **NO:** Normally open
- **N:** Neutral
- **L:** Line



NOTICE

Connection to the 3-way valve may vary depending on the type and manufacturer. Refer to the 3-way valve manufacturer's documentation for more information.



NOTE

See the [Wiring diagram \(page 19\)](#).

6.2.6. Connection to the Samsung Outdoor Unit

Connect the R1/R2 terminals of the Samsung outdoor unit to the cascade controller through the **B1** and **B2** poles of the **AC-Port B**.



IMPORTANT

Observe polarity:

- **B1:** R1
- **B2:** R2
- **B3:** *Not used*



NOTE

See the [Wiring diagram \(page 19\)](#).

6.2.7. Connection to a Computer for Configuration

Use a USB Type-C cable to connect the cascade controller through its **Console** port to a Windows-based computer to configure it with Intesis MAPS.



NOTE

You can use the **Ethernet Port** to connect the cascade controller and the computer instead.



NOTE

To know more about the cascade controller configuration, consult the [Intesis MAPS Configuration Guide](#).

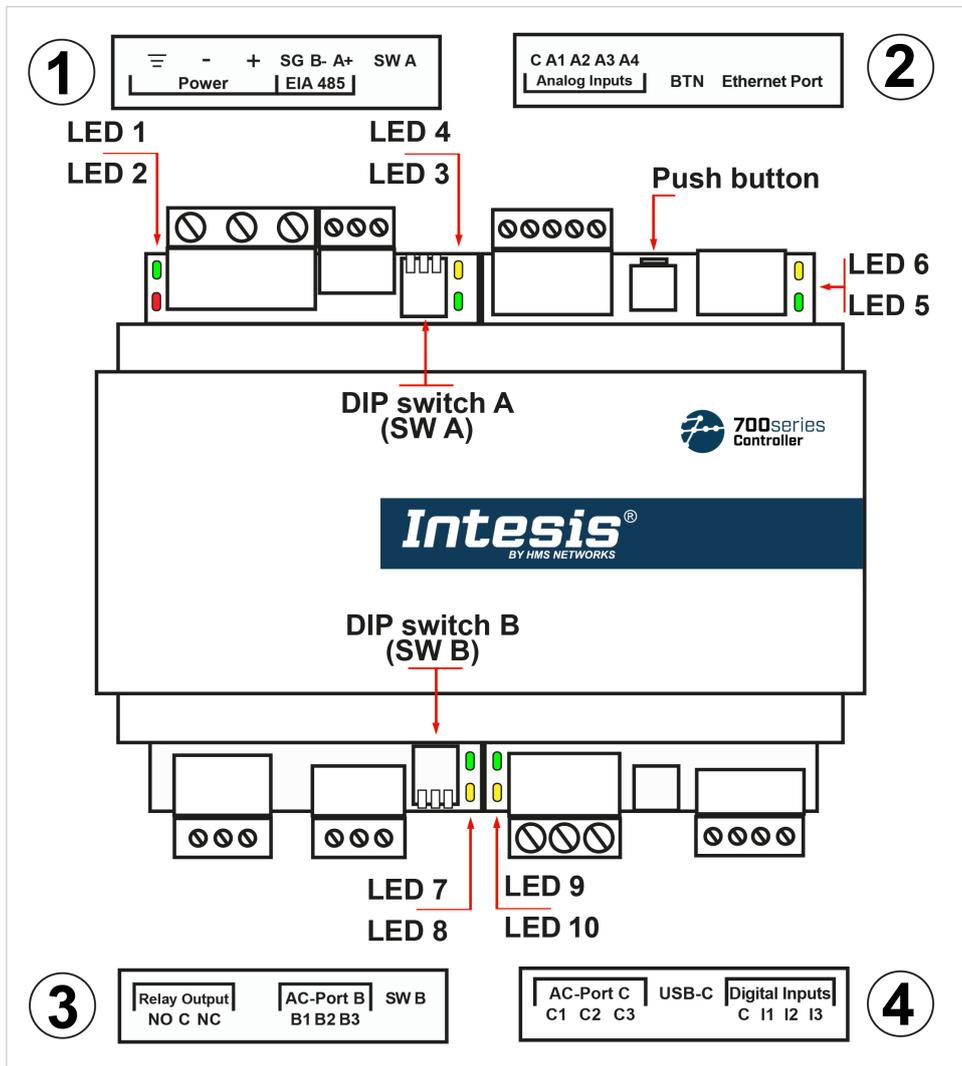


NOTE

See the [Wiring diagram \(page 19\)](#).

6.3. Cascade Controller Layout

Figure 4. Disposition of hardware elements in the cascade controller



Plastic covers numbered in the image as ①, ②, ③, and ④ can be easily disassembled.



NOTE

LEDs and DIP switches are hidden behind the removable plastic covers and can only be accessed by disassembling the covers.

The following sections explain each element in more detail: LEDs, DIP switches, and the push button.

6.4. LED Indicators

Table 1. LEDs location and behavior

Cover	LED	Color	Description
Top side			
Under frontal cover ①	LED 1 (PWR)	Green	Power on (not programmable)
	LED 2 (ERR)	Red	Blinking: Hardware error
	LED 3	Green	Not used
	LED 4	Yellow	Not used
Under frontal cover ②	LED 5	Green	Ethernet link established
	LED 6	Yellow	Ethernet speed
Bottom side			
Under frontal cover ③	LED 7	Green	AC-Port B Tx (RS485)
	LED 8	Yellow	AC-Port B Rx (RS485)
Under frontal cover ④	LED 9	Green	Not used
	LED 10	Yellow	Not used



NOTE

LEDs are hidden behind the four frontal labeled covers (see the figure [Disposition of hardware elements in the cascade controller \(page 27\)](#)). These covers are assembled by pressure, so you just need to pull to remove them.

6.5. DIP Switches

The cascade controller has two DIP switches (see the figure [Disposition of hardware elements in the cascade controller \(page 27\)](#)):

- DIP switch A (SW A): Reserved for future use
- DIP switch B (SW B): Activation or deactivation of the termination resistor (position 1) and activation or deactivation of the polarization of the AC-Port B port, to which the Samsung bus is connected (positions 2 and 3).



NOTICE

To know more, refer to the document [Polarity Issues in RS485 Networks](#).

Position			Description
1	2	3	
OFF	X	X	120 Ω termination inactive
ON	X	X	120 Ω Termination active
X	OFF	OFF	Polarization inactive
X	ON	ON	Polarization active



NOTE

The default positions are:

- **OFF, ON, ON** (120 Ω termination inactive and polarization active)



IMPORTANT

Observe the **ON** indicator on the DIP switch as a reference.

6.6. Push Button

Find the push button at the top side, between the Analog Inputs and the Ethernet connector (see the figure [Disposition of hardware elements in the cascade controller \(page 27\)](#)).



NOTE

The button is hidden and only accessible using a thin object like a paper clip.

Functionality:

RESET FACTORY SETTINGS

1. Press and hold the button.
2. Power on the cascade controller.
3. Wait four seconds.
4. Release the button.

6.7. Technical Specifications

Housing	Plastic, type PC (UL 94 V-0). Color: Light Grey. RAL 7035 Net dimensions (HxWxD): Millimeters: 90 x 106 x 58 mm / Inches: 3.5 x 4.2 x 2.3" Protection: IP20	
Net weight	240 g	
Mounting	DIN rail EN60715 TH35	
Wires (for power supply and low-voltage signals)	Per terminal: solid wires or stranded wires (twisted or with ferrule) Wire cross-section/gauge: One core: 0.2 .. 2.5 mm ² (24 .. 14 AWG) Two cores: 0.2 .. 1.5 mm ² (24 .. 16 AWG) Three cores: Not permitted For distances longer than 3.05 meters (10 feet), use class 2 cables	
Power	1 x Green pluggable terminal block (3 poles) 12 .. 36 VDC +/-10%, 3W - Max: 250 mA 24 VAC +/-10% 50-60 Hz, 50-60 Hz, 4.8 W - 200 mA Recommended: 24 VDC, Min.: 125 mA	
Ethernet	1 x Ethernet 10/100 Mbps RJ45	
EIA 485 Port	1 x Green pluggable terminal block (3 poles) Reserved for future use	
Analog Inputs Port	1 x green pluggable terminal block (5 poles) Common, A1, A2, A3, and A4	
Relay Output	1 x green pluggable terminal block (3 poles) DHW 3-way valve control  NOTE It is mandatory to add an external fuse to protect the 3-way circuit. See Connection to the 3-way Valve (Relay Output) (page 25) .	
AC-Ports	AC-Port B (serial, 3 poles): Samsung bus connection (R1/R2) AC-Port C (serial, 3 poles): Not used	
LEDs	2 x Run (Power/Error) 2 x Port EIA-485 (Not used) 2 x Ethernet Link/Speed	2 x AC-Port B TX/RX 2 x AC-Port C (Not used)
Digital inputs	1 x Green pluggable terminal block (4 poles) Reserved for future use	
Console port	USB Type-C compliant	

DIP switches SW A SW B	2 x DIP switch blocks for EIA-485 serial port configuration:	
	SW A (EIA 485 port)	SW B (AC-Port B port)
	<ul style="list-style-type: none"> Reserved for future use 	Position 1: On: 120 Ω termination active Off: 120 Ω termination inactive (default) Positions 2 and 3: On: Polarization active (default) Off: Polarization inactive
Push button	1 x Push button Factory reset	
Operational temperature	Celsius: -10 .. 70°C Fahrenheit: 14 .. 158°F	
Operational humidity	5 to 95%. No condensation	
Isolation between comm. ports	1000 VDC	

6.8. Dimensions

NET DIMENSIONS (HxWxD)

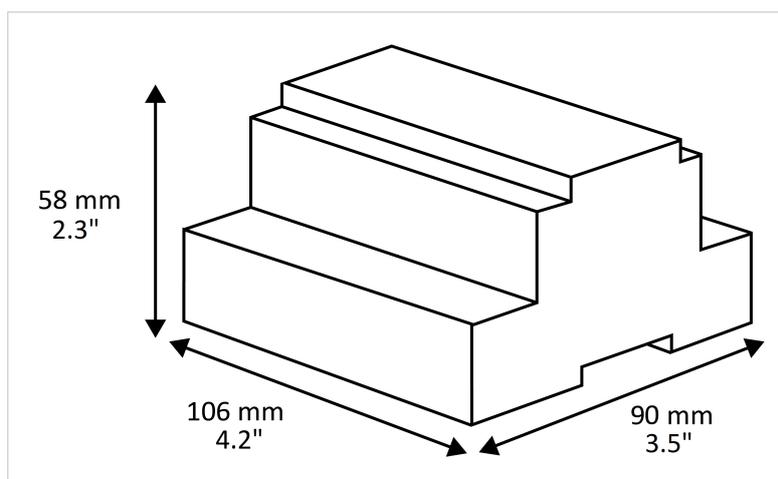
Millimeters: 90 x 106 x 58 mm

Inches: 3.5 x 4.2 x 2.3"



IMPORTANT

Leave enough clear space to wire the cascade controller easily and for the subsequent manipulation of elements.



7. Integration into Modbus TCP Systems

7.1. Modbus Registers

Functions to read Modbus registers	Functions to write Modbus registers
<ul style="list-style-type: none"> • 03 Read Holding Registers • 04 Read Input Registers 	<ul style="list-style-type: none"> • 06 Write Single Register

Modbus register contents are expressed in most significant bit (MSB) .. less significant bit (LSB).

The following tables list all available Modbus registers for the cascade controller.



NOTICE

Read/write parameter terminology:

- **R**: Read-only register.
- **RW**: Read and write register.

Table 2. Cascade controller signals

Register name	Possible values	Modbus address formula	R/W
Heat pump operation mode	0: Heat 1: Cool	0	RW
Heating/Cooling tank actual temperature_AI (x10)	°C	AI[1 .. 4]	R
Heating tank setpoint_AI (x10)	Heat (15 .. 75°C)	AI[5 .. 8]	RW ¹
Cooling tank setpoint_AI (x10)	Cool (5 .. 25°C)	AI[9 .. 12]	RW
Outdoor temperature (x10)	°C	13	R
DHW tank setpoint (x10)	30 .. 75°C	AI[14 .. 17]	RW
DHW tank actual temperature (x10)	°C	AI[18 .. 21]	R
DHW 3-way valve	0: Closed 1: Open	22	RW
Photovoltaic systems	0: Not surcharge 1: Surcharge	23	R
Number of units ON	0 .. 8	26	R
Controller Alarm	0: No error 1: Out of range 2: Temperature sensor is in open loop 3: Temperature has not increased in 30 min. 4: Temperature is not consistent	27	R

¹This signal changes to read-only when the selected **Setpoint method** for the heating operation on MAPS is **dependent heating curve**.

**NOTICE**

The 'AI' suffix in the registers relating to actual temperature and setpoints stands for 'analogue input' and can take one of four possible values, one for each input of the cascade controller. These addresses are reserved to accommodate installations with more than one tank of the same type installed, with the tanks being added sequentially when enabled.

Table 3. Outdoor units signals

Register name	Possible values	Modbus address formula	R/W
OU_xx_Communication Error	0: No error 1: Error	$(\text{OU address}[0..15] \times 2) + 50$	R
OU_xx_Mode Master IDU	0xFF: OU XX: IU	$(\text{OU address}[0..15] \times 2) + 51$	R

**NOTICE**

[0..N] refers to the outdoor unit address in Intesis MAPS, shown in the **OU** column of the Samsung Cascade Controller section of the Signals table.

Table 4. Units signals

Register name	Possible values	Modbus address formula	R/W
On/Off	0: Off 1: On	(IU address[1..8] × 100) + 0	R
Operation Mode	0: Auto 1: Heat 4: Cool	(IU address[1..8] × 100) + 1	R
Unit Error code	0: No Error 100 .. 999: Error	(IU address[1..8] × 100) + 2	R
Communication Status	b0: Exist b1: Ready b2: Data updated b3: Type OK	(IU address[1..8] × 100) + 3	R
Remote control disablement	0: Not disabled 1: Disabled	(IU address[1..8] × 100) + 4	R
Hot Water On/Off	0: Off 1: On	(IU address[1..8] × 100) + 5	R
Hot Water Mode	0: Eco 1: Standby 2: Power 3: Force	(IU address[1..8] × 100) + 6	R
Hot Water Setpoint Temp. (x10°C)	30 .. 70°C	(IU address[1..8] × 100) + 7	R
Hot Water Current Temp. (x10°C)	°C	(IU address[1..8] × 100) + 8	R
Water In Temp (x10°C)	°C	(IU address[1..8] × 100) + 9	R
Water Out Temp (x10°C)	°C	(IU address[1..8] × 100) + 10	R
Water Out Setpoint Temp. (x10°C)	Cool (5 .. 25°C) Heat (15 .. 75°C)	(IU address[1..8] × 100) + 11	R
Operation Hours	0 .. 16777215 hours	(IU address[1..8] × 100) + 12	R
Defrost	00: Released 01: Start 02: On defrost	(IU address[1..8] × 100) + 14	R
Antilegionella	0: Off 1: On	(IU address[1..8] × 100) + 15	R
Electric heater	0: Off 1: On	(IU address[1..8] × 100) + 16	RW
Electric heater Connected	0: No 1: Yes	(IU address[1..8] × 100) + 17	R

**NOTICE**

[1..N] refers to the unit index in Intesis MAPS, as shown in the **Unit ID** column of the Samsung Cascade Controller section of the Signals table.

8. Error Codes

ERROR CODE	DESCRIPTION
101	Hydro Unit/Outdoor Unit communication connection error
108	Setting Address Duplicate error
120	Short- or open-circuit error of the room temperature sensor of the Zone 2 indoor unit (detected only when the room thermostat is used)
121	Short- or open-circuit error of the room temperature sensor of the Zone 1 indoor unit (detected only when the room thermostat is used)
122	EVA Inlet temp sensor error (open/short)
123	EVA Outlet temp sensor error (open/short)
162	EEPROM error
163	EEPROM OPTION SETTING error
177	In hydro box, take place emergency signal error
198	Error of terminal's block thermal fuse (open)
201	Hydro Unit/Outdoor Unit communication error (matching error)
202	Hydro Unit/Outdoor Unit communication error (3 min)
203	Communication error between INVERTER and MAIN MICOM (4 min)
205	Communication error between Outdoor Unit Inv MICOM - Fan Motor MICOM
221	Outdoor temperature sensor error (open/short)
231	COND_OUT main temperature sensor error (open/short)
241	COND_OUT sensor of Outdoor Unit breakaway error
251	Discharge Temperature sensor error (open/short)
262	Discharge sensor breakaway error
266	Comp Top sensor breakaway error
269	Suction sensor breakaway error
276	Compressor Top Temperature sensor error (open/short)
291	High-pressure sensor error (open/short)
296	Low-pressure sensor error (open/short)
308	Suction sensor error (open/short)
320	OLP sensor error
321	EVI Inlet sensor error (open/short)
322	EVI Outlet sensor error (open/short)
381	Outdoor Inverter1 controller PCB overheat
403	Protect for freezing control error
404	Protection of Outdoor Unit when it is overload (during safety start, normal operation state)
407	COMP down due to high-pressure sensor protection control
410	COMP down due to low-pressure sensor protection control
416	COMP down due to discharge temperature
419	Outdoor Unit EEV operation error

ERROR CODE	DESCRIPTION
425	Power source line missing error (only for 3-phase model)
428	COMP down by compression ration control error
436	Protect for freezing burst control error
438	EVI EEV opening error
439	Refrigerant Leakage error (detected when the system is not operated)
440	Forbid heat mode operation when the outdoor temperature is over 43°C
441	Forbid Cooling mode operation when the outdoor temperature is under 10°C
443	No startup due to low pressure
458	Outdoor Unit fan error
461	[Inverter] COMP operating failure
462	All currency control COMP stop or CT2 low currency
463	OLP is overheated
464	[Inverter] IPM over current error
465	Compressor overload error
466	DC LINK over/low voltage error
467	[Inverter] Compressor rotation error
468	[Inverter] Current sensor error
469	[Inverter] DC-LINK voltage sensor error
470	Outdoor Unit EEPROM Read/Write error
471	Outdoor unit EEPROM Read/Write error (OTP error)
474	IPM (IGBT Module) or PFCM temperature sensor error
475	Outdoor Unit BLDC/Fan2 error
483	H/W DC-LINK over voltage error
484	PFC overload error
485	[Inverter] Input current sensor error (open/short)
488	AC input voltage sensor error
500	IPM overheat error for inverter COMP
507	COMP down due to high pressure or high-pressure switch open
536	PHE refrigerant leakage error
554	Gas leak error
563	Indoor Unit mixed install error
590	[Inverter] Data flash error
601	Communication error between the Hydro unit and the wired remote controller
602	Wired remote controller Master/Slave setting error
604	Communication tracking error between the Hydro unit and the wired remote controller
653	Wired remote controller temp sensor error (short/open)
654	Memory (EEPROM) Read/Write error (wired remote controller data error)
702	Error due to closed EEV of indoor unit (1st detection)
703	Error due to open EEV of indoor unit (1st detection)
897	Water tank in sensor error (open/short)

ERROR CODE	DESCRIPTION
899	Zone1 water outlet thermistor error (open/short)
900	Zone2 water outlet thermistor error (open/short)
901	Water inlet (PHE) temperature sensor error (open/short)
902	Water outlet (PHE) temperature sensor error (open/short)
903	Water Outlet (backup heater) temperature sensor error
904	DHW tank temperature sensor error
906	Refrigerant gas inlet (PHE) temperature sensor error (open/short)
907	Error due to pipe rupture protection
908	Error due to freeze prevention (re-operation is possible)
909	Error due to freeze prevention (re-operation is not possible)
910	Water temperature sensor on water outlet pipe is detached
911	Flow switch open error
912	Flow switch close error
913	Six times detection for flow switch error (re-operation is not possible)
914	Error due to incorrect thermostat connection
915	Error on DC fan (non-operating)
916	Mixing sensor short/open
919	Disinfection operation incomplete error
920	FSV SD card data error
973	Water pressure sensor research (open/short)

**NOTE**

Some of these error codes only apply to certain Samsung models. For more information, refer to the documentation for your Samsung model.

**NOTE**

If you detect a non-listed error code, please contact Samsung technical support.