

SCI-BEMS

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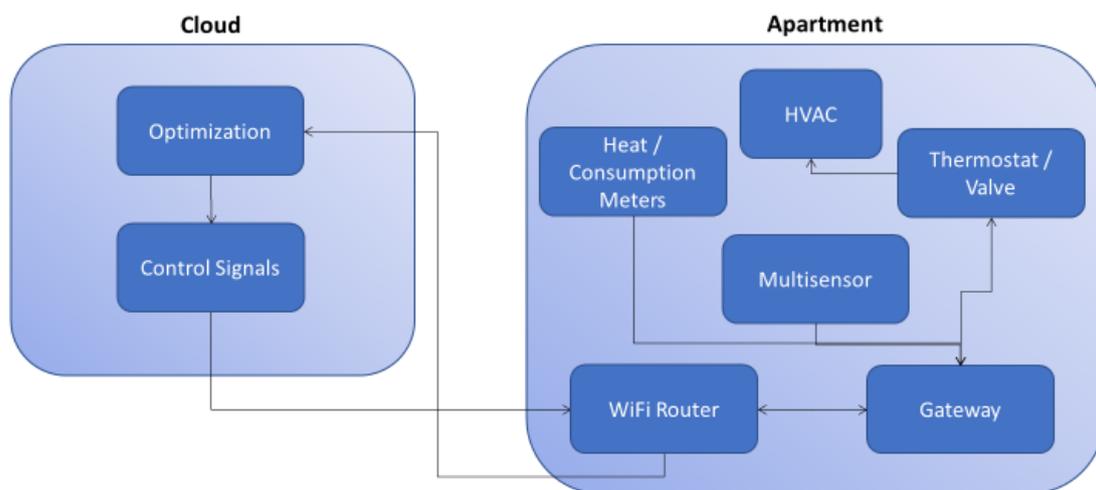


1.1 System description

In order to reduce the energy consumption of a building it is necessary to quantify it, measure the effect on it of certain control actions, and finally enable the required processes for optimal control. For this reason, the SCI-BEMS system must be designed with suitable equipment that can be easily installed & configured for seamless operation.

In essence the system will be able to sense the ambient conditions inside the zone, to capture thermostatic setpoints, to meter the total energy consumption of the zone (electric, heating/cooling were applicable), to capture user occupancy patterns extracted through sensor reading, and provide ad-hoc remote control over specific loads (HVAC, DHW).

For the purposes of the Heat4Cool project, different combinations of equipment installations will be implemented. In the following we concentrate on the instrumentation required to monitor, quantify and ultimately alter the demand required by specific zones, due to their thermal comfort and DHW requirements. This chapter includes extended details about the main ICT systems that will be deployed in the pilots, while a more extended list of equipment, with fewer details per device is reported in Annex That list is included in order to cover potential issues or needs that may arise during the final steps of deployment.



1.2 Configuration of the system

1.2.1 Gateway Configuration

In this section, a complete guide for the proper configuration of the gateway is presented. Starting from the assembly of all the different components that come together with the gateway, the gateway firmware installation and the commissioning of the device into the cloud infrastructure are described, by coupling it with one or more pilot zones as they were defined during the audits.

1.2.1.1 Firmware Installation

1.2.1.1.1 Firmware Download

Download the latest version of the Gateway firmware using the following link:

https://drive.google.com/file/d/1jkOJkY8D1X4_HcXOy_CCNwH_ZFBa_bly/view?usp=sharing

Once the firmware image is downloaded, follow the instructions bellow in order to install it to the gateway's micro SD card.

1.2.1.1.2 Write the image file on the micro SD card

You will need to use an image-writing tool to install the image you have downloaded in your SD card.

1. Download Etcher and install it.
2. Connect an SD card reader to your computer with the SD card inside.
3. Open Etcher and select from your hard drive the image file (.img) downloaded in 1.2.2.1
4. Select the SD card you wish to write your image to.

Review your selections and click 'Flash!' to begin writing data to the SD card.

1.2.1.2 Gateway Assembly

The gateway is comprised of 5 different components:

1. The Raspberry PI 3 Model B +
2. The Z Wave Antenna (RaZberry)
3. The micro SD card
4. The Raspberry PI Case
5. The Power Supply

The core of the device is the Raspberry PI card; therefore, it is crucial that all the peripherals are connected according to this manual to ensure its smooth operation. The following images show how the gateway components should be assembled.



Figure 1. Gateway Components overview.



Figure 2. Attach the Raspberry PI Card on the case back-plate.



Figure 3. Connect the Z Wave Antenna to the Raspberry PI Pin Header.



Figure 4. Attach the case top plate to the assembly.



Figure 5. Connect the casing side plates.



Figure 6. Connect the casing side plates.



Figure 7. Attach the casing top cover.



Figure 8. Insert the microSD card to the relative slot.

IMPORTANT NOTICE

The gateway should not be powered on prior to the installation in its respective zone(s). During its first boot, the device should be connected to the Internet using an Ethernet Cable.

1.2.1.3 Gateway Configuration – Commissioning

In this chapter, all the necessary steps for the appropriate configuration and commissioning of the gateway to the cloud infrastructure are presented and explained. Please install all the necessary third-party software in order for the configuration and commissioning process to run smoothly.

1.2.1.3.1 Required third-party software

1.2.1.3.1.1 Google Chrome Browser

Please follow the [link](#)¹ in order to download and install the latest version of google chrome in the PC used for the gateway configuration. Detailed instructions on how to install this software can be found inside the website.

1.2.1.3.1.2 Gateway IP Detection Software

The following software will allow the commissioner to find the local IP address of the installed gateway.

Please follow the [link](#)² in order to download Angry IP Scanner. Please choose the appropriate version according to your operating system; there are available versions for Windows, Linux and Mac OS PCs. As soon as you install the downloaded file and run Angry IP scanner, the following screen will appear.



Figure 9. Angry IP Scanner screen.

¹ If the link does not work, please navigate to the following page (<https://www.google.com/chrome/>).

² If the link does not work, please navigate to the following page (<https://angryip.org/download>).

Please press the “**Start**” button and wait for the scanning process to be completed. A pop-up window will be shown informing you that the process is finished and a number of connected devices are scanned.

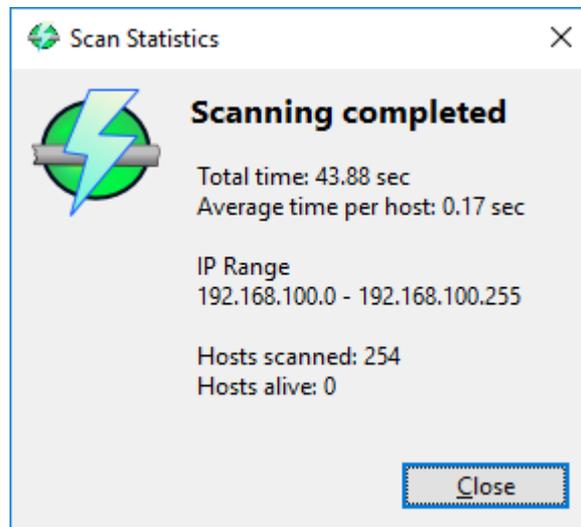


Figure 10. Scan results screen.

In the generated list search for the “**smartbox.local**” Hostname and copy the IP address next to it.

?	192.168.100.148	[n/a]	[n/a]
?	192.168.100.149	[n/a]	[n/a]
?	192.168.100.150	smartbox.local	Raspberry Pi Foundation
?	192.168.100.151	[n/a]	SAMSUNG ELECTRO-MECHANICS
?	192.168.100.152	DESKTOP-IDR2P24	Dell

Figure 11. List of hostnames and IP addresses. The IP address of smartbox.local must be copied.

1.2.1.3.2 Gateway Configuration and Commissioning

1.2.1.3.2.1 Gateway First Boot Instructions

Please follow these steps in order to boot the gateway for its very first time.

1. Connect the gateway to the internet using an Ethernet cable.
The cable connects the Raspberry Pi Ethernet Port to an active Ethernet Wall plug³ or directly to the router.
2. Insert the SD card to the Gateway. (See Figure 8).
The SD card should have the gateway firmware already installed.
3. Start up the Gateway using its power supply and wait at least 2 minutes.

Important Notice

³ The Ethernet plug should provide internet connectivity to the connected device

The steps described in this section are highly strict. Any deviation will possibly affect the communication between the gateway and the cloud.

1.2.1.3.2.2 Open Commissioning App

In order to access the commissioning app, please make sure that the computer that you are using for the commissioning process is connected to the same network as the gateway, and that all the third-party software is also already installed.

1. Open chrome application and navigate to:

http://<IP-address>

For the current example the link should be: <http://192.168.100.150> (See: [1.3.1.2 Gateway IP Detection Software](#)).

2. After some seconds⁴, the commissioning application will open.

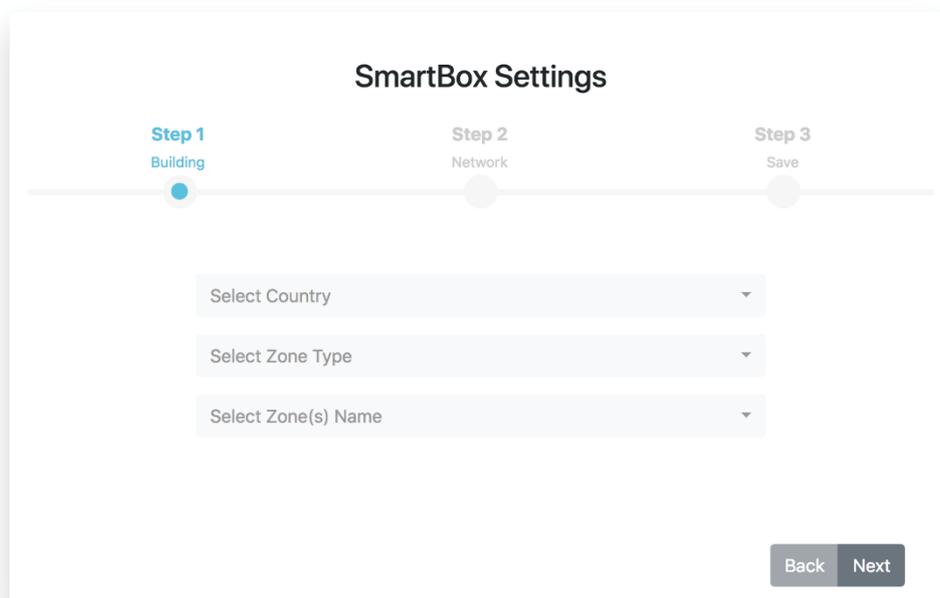


Figure 12. Commissioning App caption. (Gateway is neither commissioned nor configured).

1.2.1.3.2.3 Insert Zone Information for Residential buildings

In Step 1 (Building), all the necessary information concerning the zones that the gateway will be attached to should be inserted.

- In the first input “**Select Country**”, the commissioner has to select the country where the zone/s on which he is currently working are located.
- In the second input “**Select Zone Type**”, please select Residential from the drop-down menu.

⁴ Depends on the internet connection speed

- Once the above inputs are configured, a complete list with the available zone IDs, as defined during the audits, will be available in the third dropdown menu “**Select Zone(s) Name**”. There the commissioner should select *one or more*, zone IDs.

The screenshot shows the 'SmartBox Settings' interface at Step 1, 'Building'. A progress bar at the top has three steps: Step 1 (Building, active), Step 2 (Network), and Step 3 (Save). Below the progress bar are three dropdown menus. The first dropdown is set to 'Greece', the second to 'Residential', and the third to 'TestZone, TestZone2'. At the bottom right, there are 'Back' and 'Next' buttons.

Figure 13. Zone Information passed and validated.

1.2.1.3.2.4 Validation mechanisms

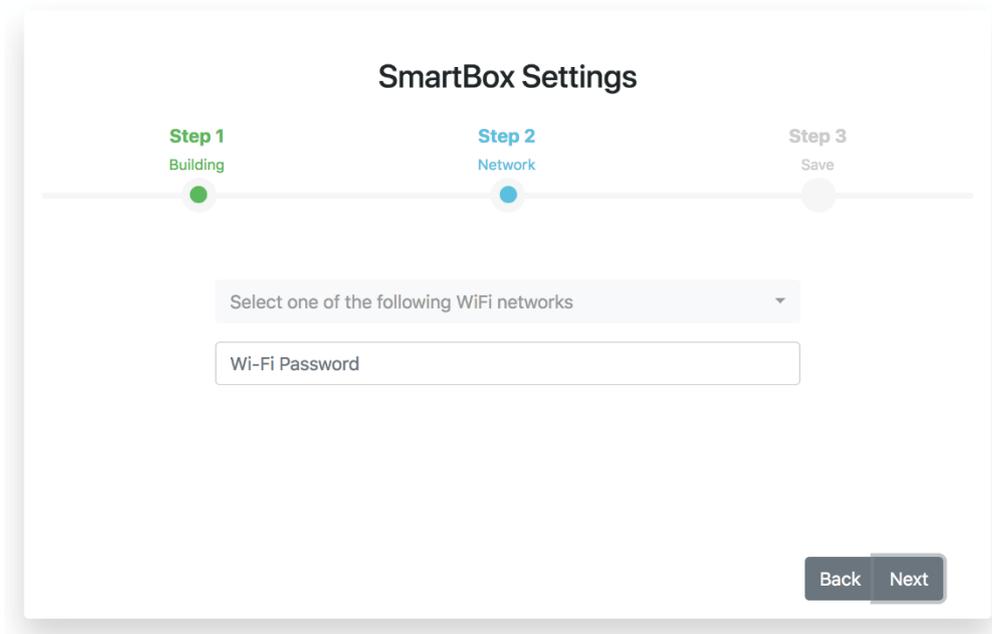
As this information is crucial for the commissioning of the whole solution to the cloud, several different validation mechanisms are running in parallel in order to ensure that all the necessary information is filled out by the commissioner.

The screenshot shows the 'SmartBox Settings' interface at Step 1, 'Building'. A progress bar at the top has three steps: Step 1 (Building, active), Step 2 (Network), and Step 3 (Save). Below the progress bar, a red error message box says 'Please select country.' with a close button (X). Underneath are three dropdown menus: 'Select Country', 'Select Zone Type', and 'Select Zone(s) Name'. At the bottom right, there are 'Back' and 'Next' buttons.

Figure 14. Error message produced by validator.

1.2.1.3.2.5 Network Configuration

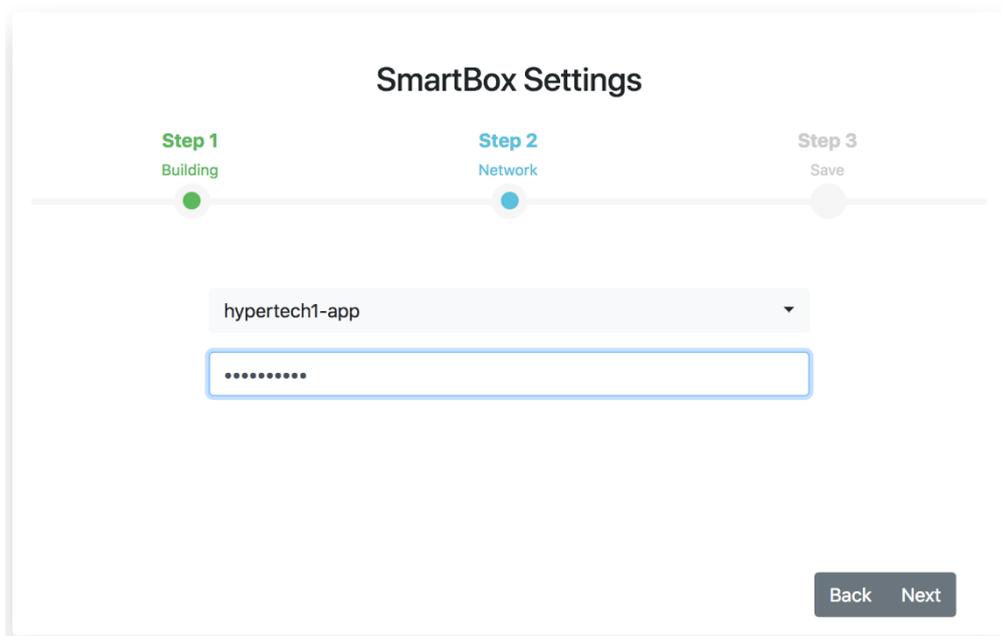
The second step refers to the WiFi configuration of the Gateway.



The screenshot shows the 'SmartBox Settings' interface. At the top, there is a progress bar with three steps: 'Step 1 Building' (green dot), 'Step 2 Network' (blue dot), and 'Step 3 Save' (grey dot). Below the progress bar, there is a dropdown menu labeled 'Select one of the following WiFi networks' and a text input field labeled 'Wi-Fi Password'. At the bottom right, there are 'Back' and 'Next' buttons.

Figure 15. Network Configuration Step.

Here, the user should select the correct Wi-Fi network and insert the password in order for the gateway to access the WLAN network.



The screenshot shows the 'SmartBox Settings' interface. At the top, there is a progress bar with three steps: 'Step 1 Building' (green dot), 'Step 2 Network' (blue dot), and 'Step 3 Save' (grey dot). Below the progress bar, the dropdown menu now shows 'hypertech1-app' and the password field contains several dots. At the bottom right, there are 'Back' and 'Next' buttons.

Figure 16. WLAN data passed to the application.

By clicking “Next”, the network information is validated and if it is correct, the gateway can access the zone’s wireless network.

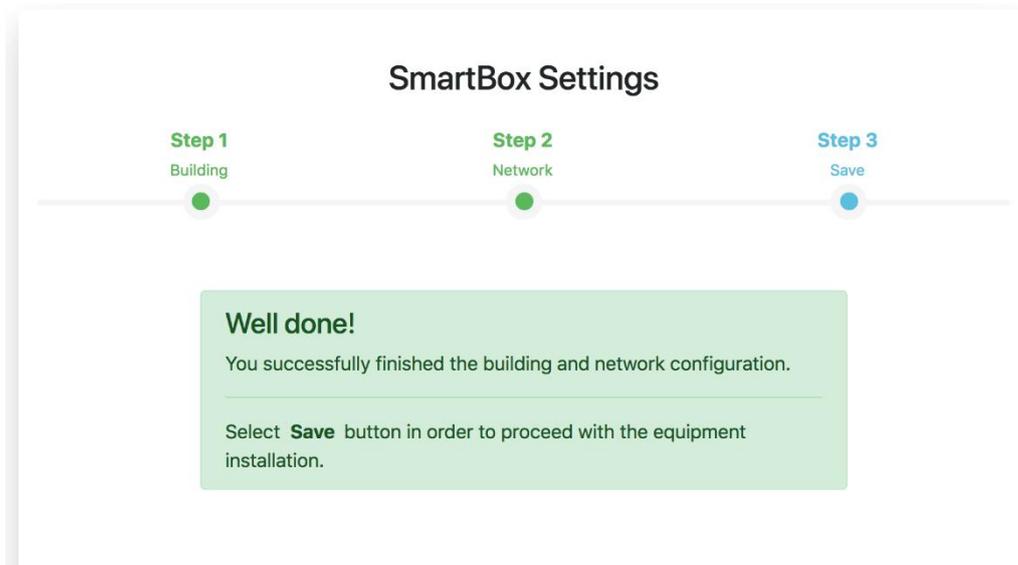


Figure 17. Wi-Fi credentials are correctly passed (The gateway is now connected to the Wi-Fi).

If the Wi-Fi credentials are not correct, or there is any other connectivity issue, the application will show the following error message.

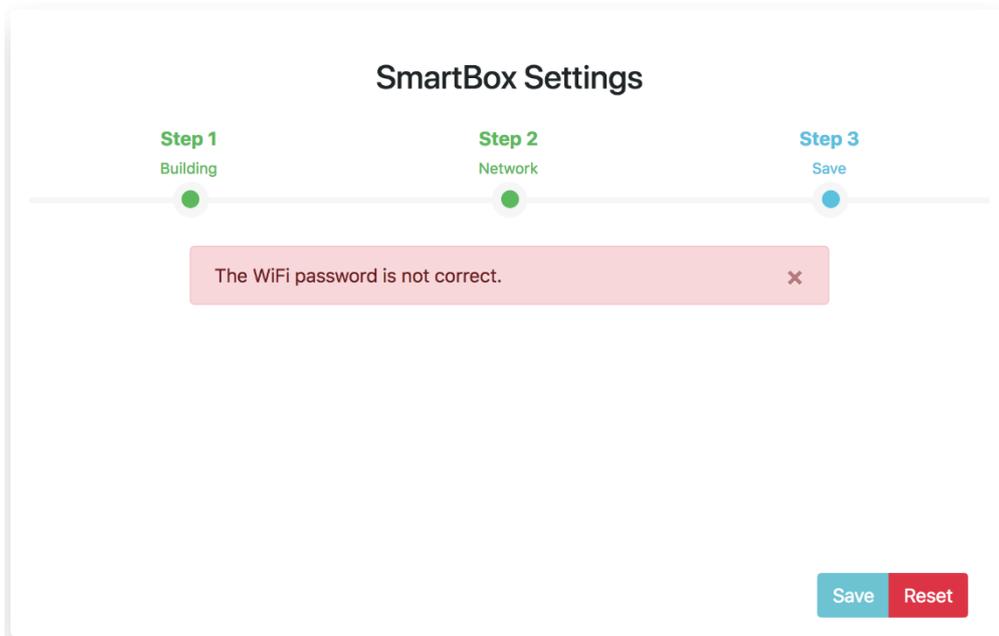


Figure 18. Incorrect credentials given.

In this case, the user should press button “Reset”, to navigate again to the “Step 2” and again press the “Next” button to re-insert Wireless Network credentials.

1.2.1.3.2.6 Save gateway configuration to Cloud

Once both the Building information and Network Configuration are given correctly to the Gateway, the commissioner should click “Save” in order for the Gateway to be safely stored in the cloud. Of course, no personal information such as Wi-Fi credentials will be saved.

Once the procedure completed successfully, the application will be redirected to the “Device Commissioning” view.

1.2.1.4 Gateway shutdown

Gateway is an embedded computer system. This means that improper shutdowns may cause severe problems either to the gateway's software or to its hardware. So, if for any reason the gateway should be shut down please use the http link as shown below to shutdown properly the device.

<http://<ip-address>/smartbox/shutdownNow>

Replace the <ip-address> part with the respective IP of the gateway in question. After 1 minute at least power cable can be removed from the device.

1.2.2 Device Commissioning

The device configuration approach described below is valid for all ZWave and IntesisBox devices that may be installed in the pilot sites.

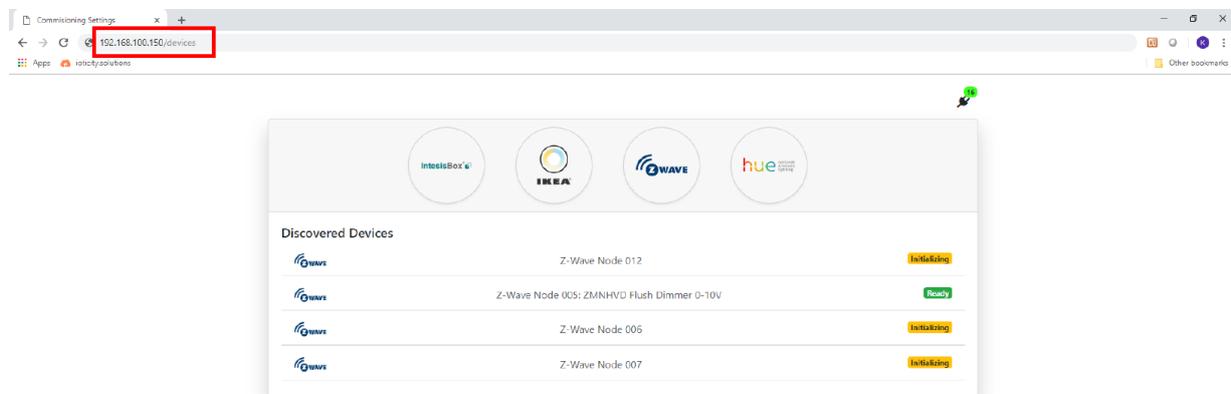


Figure 19. Device Commissioning View. To reach the gateway, the link based on the IP address is used.

Important Notice

This document includes the information needed in order for the selected device to be commissioned to the cloud infrastructure. These instructions are supplementary to the installation and technical manuals provided by device manufacturer.

1.2.2.1 Device Commissioning Overview

The “Device Commissioning” view has three main containers.

1. The “Device Type” container, where all the compatible device types presented. Specifically, the solution is compatible with four different device types.



Figure 20. Compatible Device Types.

- a. **Z-Wave Devices**, including every Z-Wave or Z-Wave Plus devices
- b. **Phillips Hue Devices**, including all the devices that are compatible with the Phillips Hue gateway.
- c. **IKEA Tradfri Devices**, including all smart-lighting products provided by IKEA.
- d. **IntesisBox devices**, including all the WiFi enabled HVAC remote controllers provided by Intesis.

Out of these, only a. and d. are applicable in the Heat4Cool project. By clicking those buttons, the respective bundle initiates the device inclusion mode. Detailed information about the inclusion of each device type can be found below.

2. The “Discovered Devices” container, where all the devices that are currently discovered by the gateway but not commissioned to the network are.

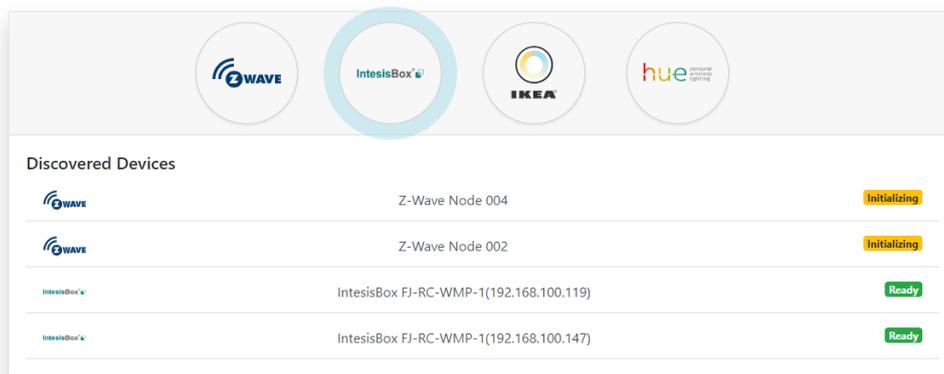


Figure 21. Four new devices discovered by the Gateway.

There are two possible device status for the discovered devices:

- **READY:** the device is ready to be commissioned to the network. The commissioning process of the device will start by clicking its name.
- **INITIALISING:** the gateway is currently gathering basic information for the discovered device. Commissioning process is not available for those devices. The user has to wait for the device to become “ready”.

3. The “Connected Devices” container, where all the already commissioned devices are presented together with their status.

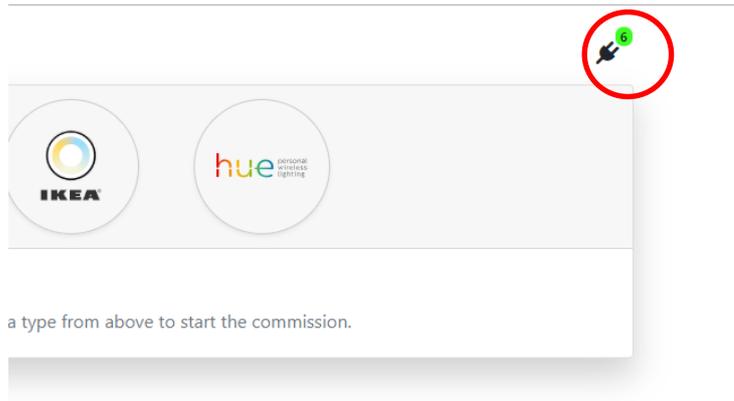


Figure 22. Click the plug at the top right corner to view the "Connected Devices" container.

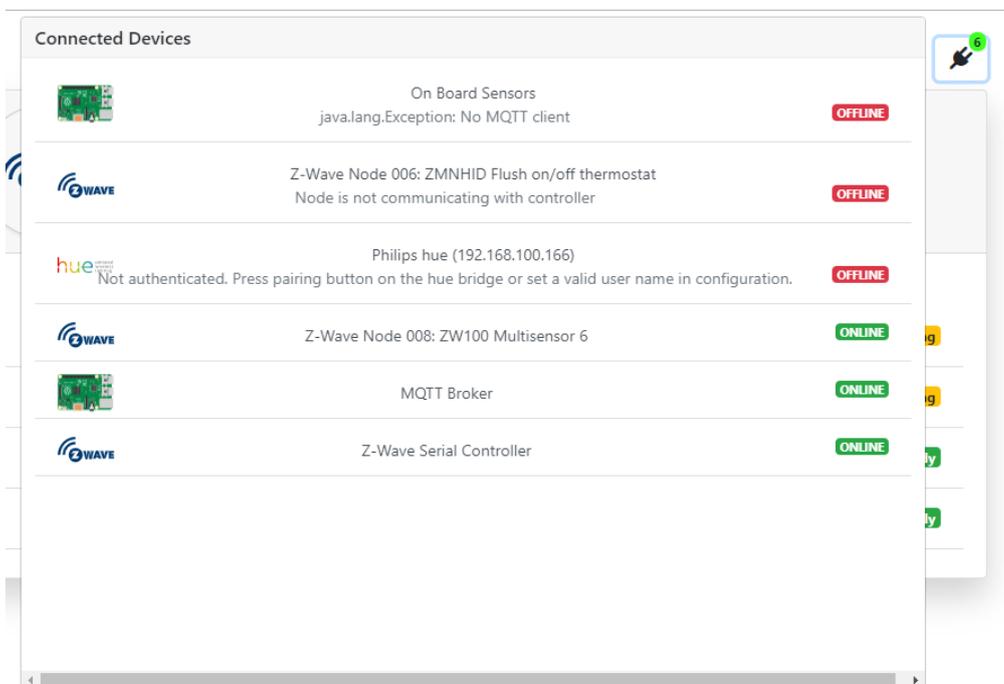


Figure 23. "Connected Devices" container.

1.2.2.2 Device Commissioning Wizard

The Device Commissioning Wizard is the same for every compatible device type and includes all the necessary information that has to be given to each device in order to be properly correlated with its connected loads. ***Please fill out very carefully all the information requested otherwise all the collected data will be useless.***

Important Notice

Do not refresh the page when the Device Commissioning Wizard is visible. This will cause fatal errors to the entire system

1.2.2.2.1 General Information Step

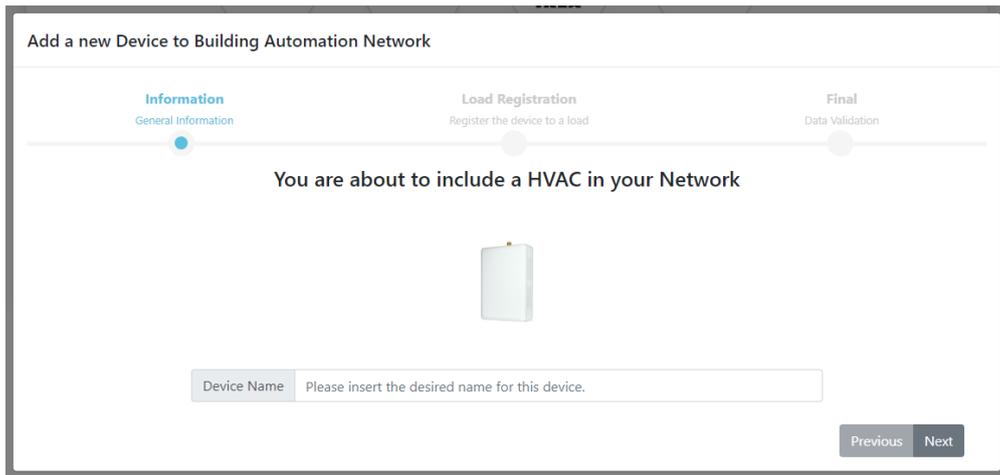


Figure 24. General Information Step (Intesis device is about to be commissioned).

In this step, the gateway provides information about the selected device. For the majority of the devices used. The user should insert a custom (friendly) label for the device. The label should be a name that will help the user to easily identify the installed device.

Click “Next” to continue.

1.2.2.2.2 Load Registration Step

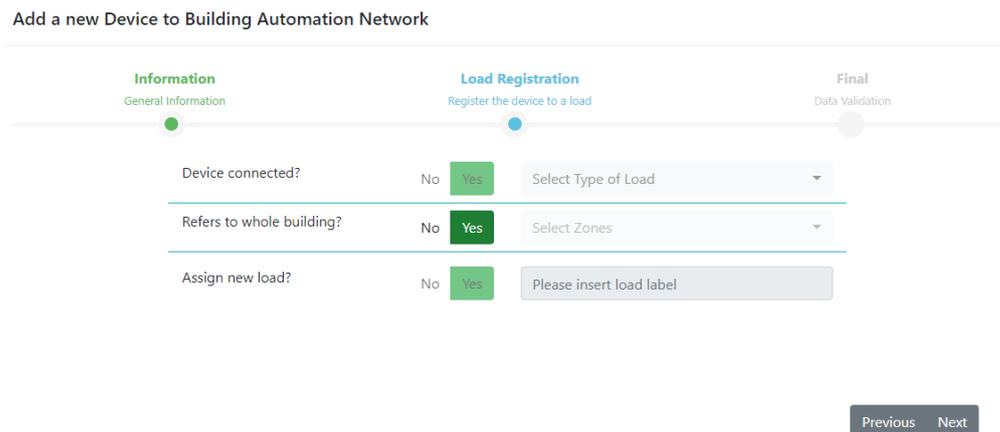


Figure 25. Load Registration Step.

In this step, the user should correlate the discovered device with the appropriate load, by selecting the type of load to which the device is connected, the zone/s where the load is located to, and whether other previously commissioned devices are already correlated with that load.

The procedure includes the following steps:

1. Select one of the available type of loads
 - a. The available options for this selection are dynamically allocated, in accordance to the device that is about to be commissioned. In general, there are 6 different load types:
 - i. **LIGHTING**: refers to every connected device that is connected to the lighting system of the zone. (Smart Lighting Gateway, Smart Light Bulbs, ZWave Dimmers, ZWave Switches, Smart Clamps that are used to measure the energy consumption of a light circuit inside a zone, etc).
 - ii. **HVAC**: Refers to every connected device that is connected with a HVAC system inside the zone/building. (Smart Thermostat, HVAC Remote

Controllers, Smart Switches for electric radiators, Smart Plugs used to meter the energy consumption of a A/C split unit, Smart Clamps, etc).

- iii. **DHW**(Domestic Hot Water): Refers to every connected device that is connected to the Domestic Hot Water System of the zone/building. (Smart Thermostat, Smart Plugs, Smart Switches, Smart Clamps, Smart Flow Meters).
- iv. **TOTAL_ENERGY_METERING**: refers to the connected devices that are used in order to meter the total energy consumption of the zone or the building. (Only Smart Clamp is applicable for this type of load).
- v. **OTHER_LOAD**: refers to any other loads that are going to be metered and controlled inside a zone/building. (Smart Plugs, Smart Switches, Smart Clamps).
- vi. **AMBIENTSENSING**: refers to any sensing device installed inside the zone/building. (Only Multisensor is applicable for this load).
- vii. **PV**: refers to every device correlated to any Photovoltaic installed in the building. (Only Smart Clamp is applicable for this type of load).

2. Select the exact location of the load by using the “Refers to the whole building” option and the “Select Zones” dropdown menu.

Add a new Device to Building Automation Network

Information

General Information

Load Registration

Register the device to a load

Final

Data Validation

Device connected?	No <input type="checkbox"/> Yes <input checked="" type="checkbox"/>	HVAC
Refers to whole building?	No <input checked="" type="checkbox"/> Yes <input type="checkbox"/>	Select Zones
Assign new load?	No <input type="checkbox"/> Yes <input checked="" type="checkbox"/>	SWTC001 SWTC002

Previous
Next

Figure 26. Select one or more of the Applicable Zone ID.

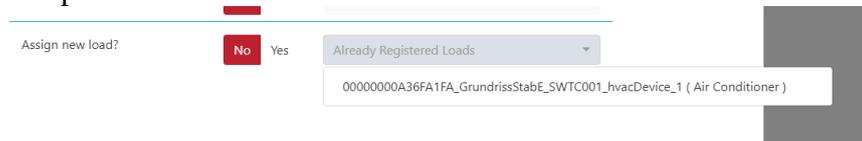
During the location selection, the commissioner will have the ability to select one or more zone IDs. The list of applicable zone IDs in this step is directly coupled if the zone IDs were selected during the gateway configuration/commission. However, in order for the list to become enabled, the user should select “No” at the “Refers to whole building” option.

3. Select Load or Assign new Load, using the selected type of device and Define location. If the user wants to create a new load that will be correlated with this device, “Assign new Load?” should be checked, and a User-friendly label should be insert in the respective field.

Assign new load?	No <input type="checkbox"/> Yes <input checked="" type="checkbox"/>	Please insert load label
------------------	---------------------------------------------------------------------	--------------------------

Figure 27. Register New Load Field.

Otherwise, the user can correlate the device with one of the already configured loads that are of the same type with the selected load and have the same location as well. In this case the user should select “No” at the “Assign new load” option and select one of the available loads that appeared in the relative dropdown menu.



Assign new load? No Yes

Already Registered Loads

00000000A36FA1FA_GrundrissStabE_SWTC001_hvacDevice_1 (Air Conditioner)

Figure 28. List of the already correlated loads.

As an example, let us assume an A/C Split Unit currently installed in the SWTC001, on which the commissioner has already installed a smart plug in order to meter its energy consumption. Let an Intesis device be installed on the same A/C unit that is about to be commissioned to the network. The commissioner should insert the following data into the “Load Registration” step.

1. Type of Load: **HVAC** (The A/C unit is an HVAC device)
2. Refers to whole building?: **No** (The A/C unit located in zone SWTC001)
3. Select Zone(s): **SWTC001**
4. Assign new load: **No** (As a previously commissioned device is already correlated with that load)
5. Already Registered Loads: **Air Conditioner**

Once the Load Registration is successfully completed, click “Next” and “Save” to commit the device into the IoT network.

1.2.2.3 Close Device Commissioning Wizard

If for any reason you want to close the wizard, please use the x button at the top-right corner. To re-discover a device that has been incompletely configured, please press one of the four buttons on the top of the page (IKEA, ZWave, Hue and Intesis) depending on the device type.

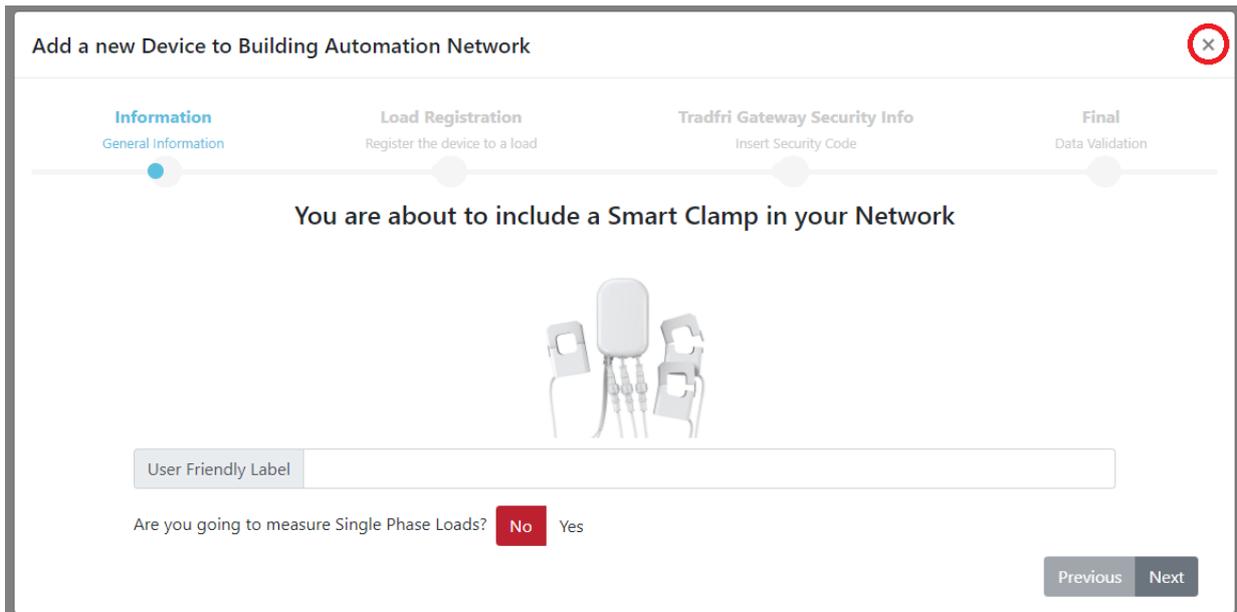


Figure 29. Device Commissioning Wizard Close Button.

1.3 Training and guidelines

In this section we present some installation details for a selection of devices. Please also refer to the devices' accompanying manuals.

1.3.1 Aeotec Home Energy Meter (GEN5)

The device can be installed for three-phase or single-phase load metering. According to the following installation topology, the clamp meter will be measuring a three-phase load. Hence, the three different clamps should be connected to the relative circuit breaker according to the following schematic.

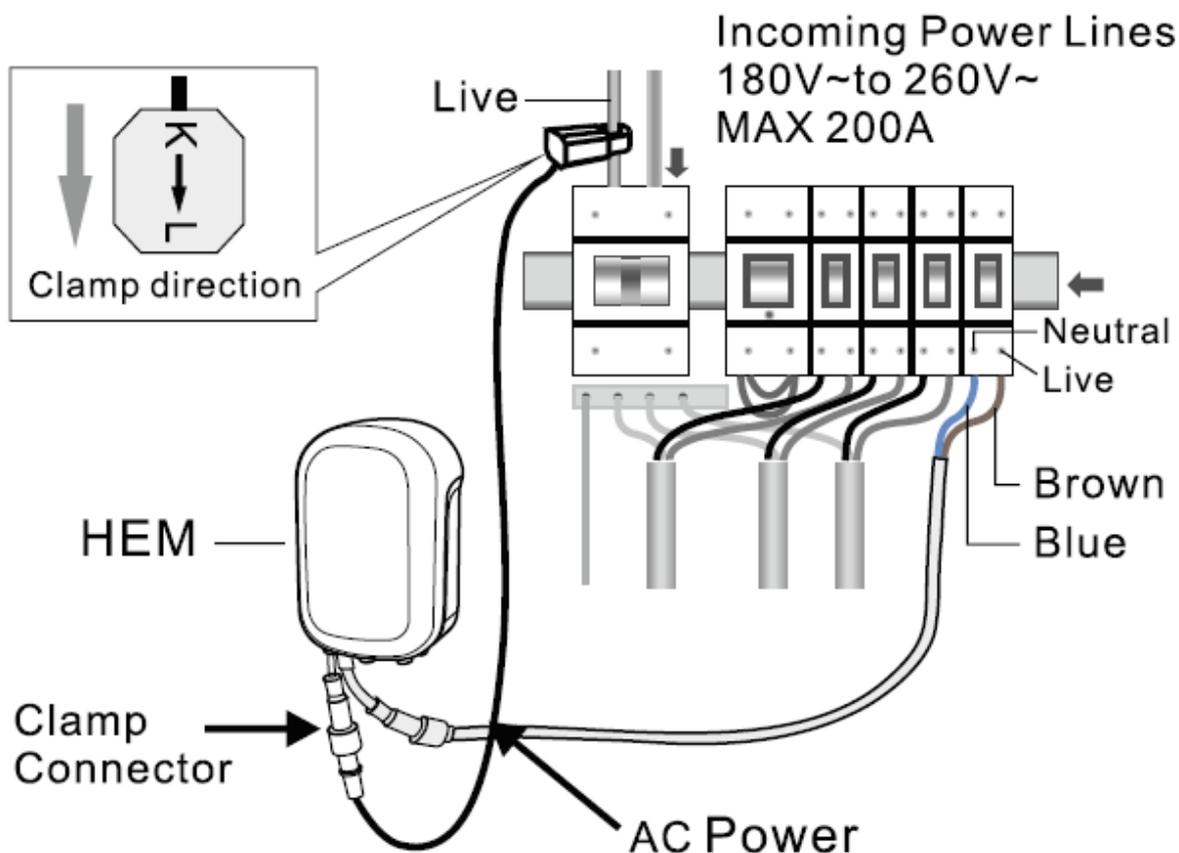


Figure 31. Single-phase installation topology. The above schematic shows how to connect each one of the clamps to its relative load.

1.3.2 MCOHome Fan Coil Thermostat

MCOHome Fan Coil Thermostat (MCOEMH8-FC4) is a Z-Wave enabled device for indoor temperature control (Figure 32). It is mainly applied to a 4-pipe Fan coil system. It can read room temperature and local time, and automatically control fan speed based on the temperature difference. The device is of high reliability and practicability. This product can be included and operated in any Z-Wave network with other Z-Wave certified devices from any other manufacturers. The following information was extracted from the device's manual.



Figure 32. MCO fan coil thermostat.

1.3.2.1 Installation principles and steps

The thermostat is suggested to be installed indoor, a place with around 1.5m height above the floor where represents the average room temperature. It should be away from direct sunlight, any cover, or any heat source, to avoid false signal for temperature control.

CAUTION: Cut off power supply at circuit breaker or fuse before installation to avoid fire, shock or death!

Step 1: Remove the steel frame from the device and secure it onto the junction box with two screws (**Error! Reference source not found.**).

Step 2: Insert all wires into the right terminals and tighten screws. The wiring diagram is shown below (**Error! Reference source not found.**).

Step 3: Attach the wired device on “A” points of the steel frame as shown first, and then push the whole device into junction box.

Step 4: Confirm the device is well mounted, power on and it is ready to operate.

Note: CO--Cool Valve Open, CC--Cool Valve Close, HO--Heat Valve Open, HC--Heat Valve Close.

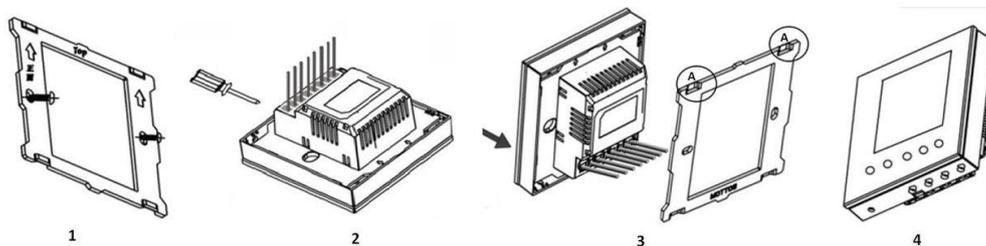


Figure 33. MCO fan coil thermostat installation.

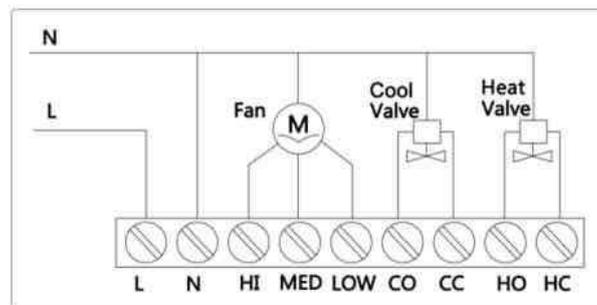


Figure 34. MCO fan coil thermostat wiring.

1.3.2.2 Connecting to the network

Including & Excluding of Z-Wave network

Under the shutdown state, press & hold ∇ to enter interface for inclusion or exclusion of Z-Wave network. Before device included into network, “- -” will display on the screen. Then press ∇ once, device will enter learning mode to get a node ID. If inclusion is success, a node ID will display on the screen in a few seconds. A node ID can always inform us whether the device is in the network or not. Note: Follow the same steps to exclude the device from the network. After inclusion, turn off the device and then turn it on. Now the device is ready to be operated by controller/ gateway in Z-Wave network.

1.3.2.3 Association Group

Thermostat supports 1 association group. A gateway is suggested to associate with this group. Then if any changes happen, such as: temperature, working mode, fan state etc., the thermostat will report to this associated device (gateway). When the detected temperature change $\geq 0.5^{\circ}\text{C}$, device will send unsolicited report to the gateway.

1.3.3 Aeotec Multisensor 6

Aeotec Multisensor 6 has been crafted to power connected lighting using Z-Wave Plus (**Error! Reference source not found.**). It is powered by Aeotec's Gen5 technology. The following information was extracted from the device's manual.

- The Aeon Labs MultiSensor is a routing binary sensor device based on Z-Wave routing slave library V6.51.06.
- Aeotec by Aeon Labs' MultiSensor looks like a motion sensor and it acts like one too. But it's also so much more. Installing this 1 piece of Z-Wave® technology is the same as installing 6 pieces of Z-Wave technology.
- The building control network will immediately understand motion, temperature, humidity, light, Ultraviolet and Vibration readings wherever MultiSensor installed. Those intelligent readings will equate to intelligence automation.
- The Aeon Labs MultiSensor can be powered by battery or by USB with an appropriate adaptor.



Figure 35. Aeotec MultiSensor 6.

1.3.3.1 Installation Principles and Steps

The MultiSensor 6 brings its intelligent readings to many locations inside a dwelling. The inbuilt motion sensor uses light and heat readings to determine motion, sudden light and heating changes can impact the sensor's quality of motion readings. As such, the sensor should not be installed in areas of artificial temperature change. Thus, when selecting a location, it should not be placed beside or near air conditioners, humidifiers, and heaters or directly opposite a window with direct sunlight. The MultiSensor 6 is powered by batteries, hence it should not be installed in a location where the temperature can drop below 0°C / 32°F as this is below the batteries' working point. Selecting a location for the sensor also depends on the layout of any area that will be monitored. Whatever the room or area, it needs to fit within the sensor's effective motion sensing range as described in the following diagrams.

For ceiling installation, the MultiSensor 6 can take measurements within a 3x3x6m / 10x9x18ft range (**Error! Reference source not found.**). If installing MultiSensor 6 in a corner where the wall meets the ceiling it can take measurements within a 2.5x3.5x5m / 8x11x15ft range.

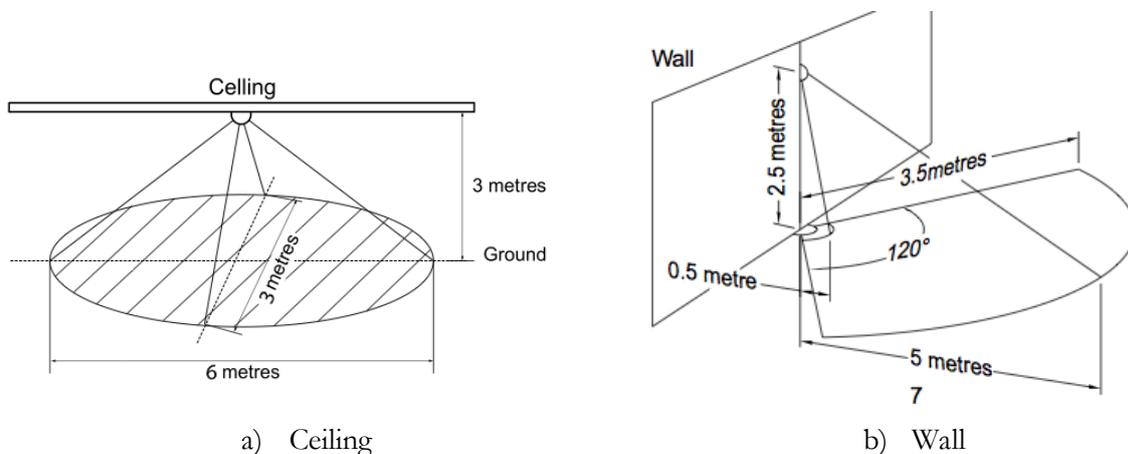


Figure 36. Aetec MultiSensor 6 Installation effective range.

For optimal performance, the MultiSensor 6 should NOT be mounted directly on or near metal framing or other large metallic objects. Large metal objects may weaken the Z-Wave wireless signal. The MultiSensor 6 depends on for communication due to the wireless reflective properties of metal.

MultiSensor Installation

With the MultiSensor 6 as a part of the local Z-Wave network and having determined its installation location, the physical installation needs to proceed. There are 2 ways that the MultiSensor 6 can be mounted on a wall or ceiling. Most simply it can be placed upon a shelf without the need to attach further accessories. The technician can mount the sensor in a corner or against a wall or ceiling by using the Back-Mount Plate. It's also possible to embed the MultiSensor 6 within a ceiling or wall using its Recessor accessory.

To install the MultiSensor 6 (**Error! Reference source not found.**):

Step 1: Using Double-Sided Tape - The surface, on which is planned to be installed Multisensor 6 should adhere to the following conditions: flat, smooth, dry and free of dust and grease.

Step 2: Using screws - Initially two holes should be drilled on the desired location on the wall or ceiling. Then the Back-Mount Arm should be fixed using the provided KA2.5×20mm screws.

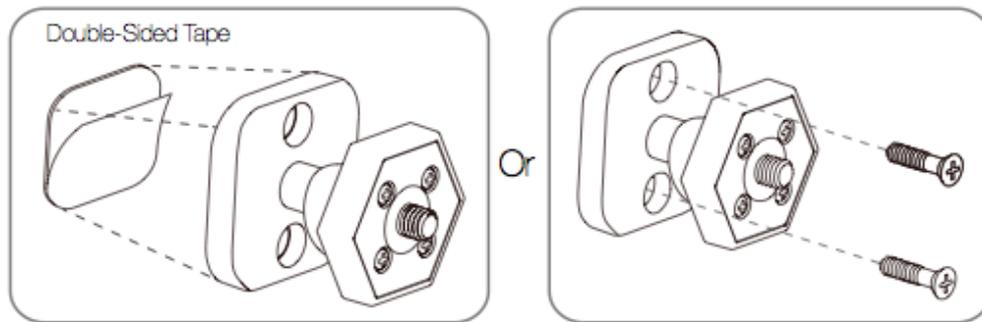


Figure 37. MultiSensor installation.

1.3.3.2 Network configuration

Initially the MultiSensor should be powered on and then use the Z-Wave Gateway to pair Multisensor 6. It should be noted that compatibility and how the sensor shows ultimately depends on the gateway and software integration of products. To achieve this the following steps should be followed:

1. Put the primary Z-Wave gateway into pair mode, the Z-Wave gateway should confirm that it is waiting to add a new device
2. The Action Button should be pressed on the MultiSensor. The LED on Multisensor will blink Green rapidly, followed by a solid Green LED for 1 second for a successful inclusion, or a solid red LED for 1 second for a failed inclusion.
3. The MultiSensor's successful addition to the Z-Wave network can be tested by pressing its Action Button. The button is pressed and the sensor's green LED is solid for a few seconds, then inclusion has been successful. If the green LED blinks when the button is pressed, the inclusion has been unsuccessful and the steps should be repeated from No 1.

1.3.4 Fibaro Radiator Thermostatic Head

The FIBARO Heat Controller is a remotely controlled thermostatic head to control temperature in the room. It measures the temperature and automatically adjust the heat level. It can be mounted without tools on three types of thermostatic radiator valves. Some of its characteristics are the following:

- To be installed on three types of valves: M30 x 1.5, Danfoss RTD-N and Danfoss RA-N,
- Compatible with any Z-Wave or Z-Wave+ Controller,
- Supports Z-Wave network Security Modes: S0 with AES-128 encryption and S2 with PRNG-based encryption,
- Built-in battery recharged through standard micro-USB port,
- Easy installation – no tools required,
- Can use a dedicated temperature sensor,
- Supports heating schedules,
- Automatic calibration,
- Anti-freeze function,
- Decalc function,
- Unconstrained rotation spherical knob to set desired temperature.

1.3.4.1 Installation Principles and Steps

At first launch, follow these steps:

1. Connect the charger to the micro-USB port to charge the device. If you have the temperature sensor:
 - a. Use a coin to open the battery cover by turning it counter-clockwise.
 - b. Remove the sticker underneath the battery.
 - c. Use a coin to close the battery cover by turning it clockwise.
2. Disconnect the charger when the LED ring pulses green (device fully charged). First charging may take up to 3 hours.
3. Dismount your current thermostatic head.
4. Depending on type of your thermostatic valve use the appropriate adaptor (see Figure 38). If you use one of the adapters, double check that it is mounted properly. It should click when putting on the valve, hold tight after installing and not rotate! The device is strongly recommended to be installed in horizontal position only! If the connection is vertical, then the external temperature sensor must be used.

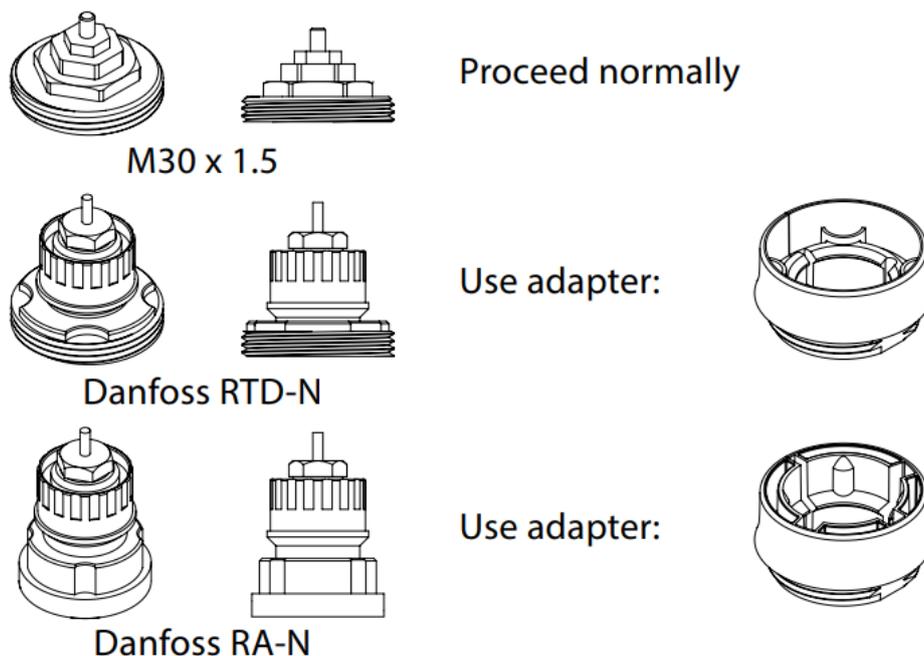
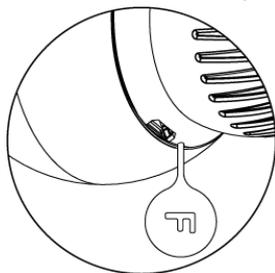
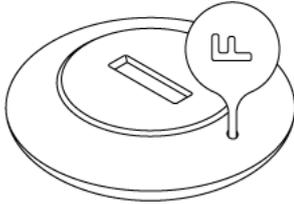


Figure 38. Fibaro Thermostatic Head valve connection adaptors.

5. Mount the device on the valve and tighten it by turning the cap clockwise.
6. Use the included key to click the button.



7. The LED ring will start blinking blue. If you have the temperature sensor click the button on it now. The LED ring will blink green 5 times if the connection was successful. Please do not cover or veil the thermostatic head.



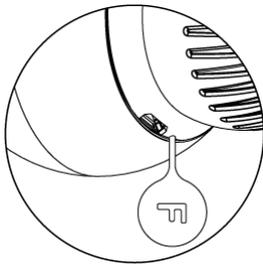
1.3.4.2 Head Calibration

Calibrating the device to your radiator valve is required for proper controlling the temperature. Calibration cannot be performed while the device is being charged. Calibration is performed:

- Automatically, after 10 minutes from turning on if no operation on the device has been made (only at first installation),
- Automatically, after 10 minutes from last state change (only at first installation),
- Manually, using the menu (see below).

To perform calibration using the menu:

1. Use the included key to press and hold the button.



2. Release the button when you see white LED colour.
3. Click the button to confirm the selection.

1.3.4.3 Dismounting the device

Before dismounting, the device must be put in Standby Mode to ensure safe removal. See Standby Mode for more information. To dismount the device:

1. Use the included key to press and hold the button.
2. Release the button when you see cyan LED colour.
3. Click the button to confirm the selection.
4. Turn the cap counter-clockwise and remove adapter if used.
5. Store the device in temperature: -10°C to 25°C.

1.3.4.4 Inclusion Details

To add the device to the Z-Wave network:

1. Make sure the device is within the direct range of your Z-Wave controller.
2. Set the main controller in (security/non-security) add mode (see the controller's manual)
3. Use the included key to quickly triple click the button on the thermostatic head.
4. The LED ring will start blinking white.

5. If you are adding in S2 authenticated mode, type in the device pin code (underlined part of the public key on the label).
6. Wait for the adding process to end.
7. Successful adding will be confirmed by the Z-Wave controller.

To remove the device from the Z-Wave network:

1. Make sure the device is within the direct range of your Z-Wave controller.
2. Set the main controller into remove mode (see the controller’s manual).
3. Use the included key to quickly triple click the button on the thermostatic head.
4. The LED ring will start blinking white.
5. Wait for the removing process to end.
6. Successful removing will be confirmed by the Z-Wave controller.

Further details can be found at <https://manuals.fibaro.com/heat-controller/>.

1.4 Operation of End-Users

In this section we present the end-user/occupant operational details for specific devices controlling the emitter systems within the apartments.

1.4.1 MCO Home Fan Coil Thermostat

Figure 39 shows the different button functionalities and display feature descriptions for the thermostat.

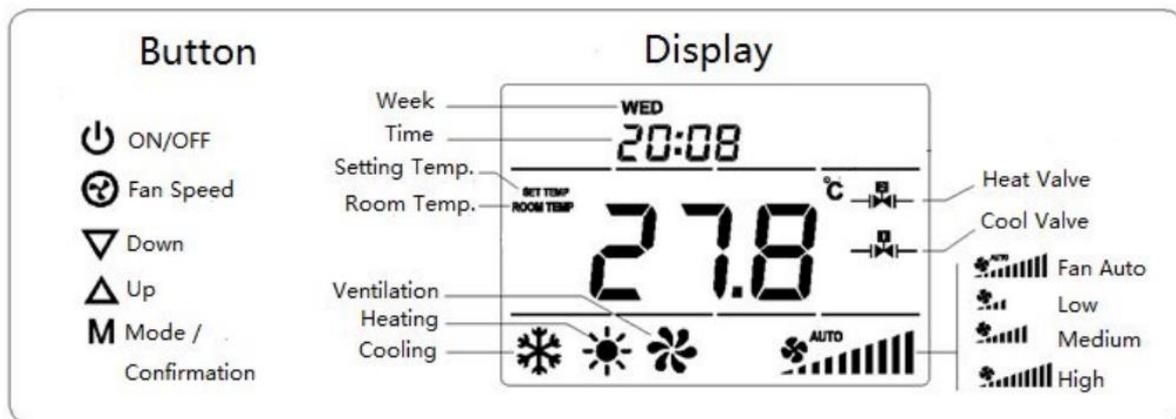


Figure 39. MCOHome Fan Coil Thermostat Control and Display Information.

1.4.1.1 On/Off Setting

When powered off, the thermostat will display “OFF”, press to ON/OFF button to enter the working interface. When working, press the same button to turn off the device, “OFF” displays and all outputs are off.

1.4.1.2 Local Time Setting

Press and hold the M button to enter local time setting. Touch M to switch among Week, Hour and Minute, and then press the UP/DOWN arrows to set the parameters of the flashing item. Press M, or wait for 15s to save the value and return to display.

1.4.1.3 Working Mode Setting

Touch M to enter working mode setting, with the current mode flashing. Press UP/DOWN to switch among Cooling , Heating and Ventilation mode, then press M, or wait for 15s to confirm the choice.

1.4.1.4 Temperature setting

Touch UP/DOWN to set local temperature value. Holding the buttons will increase/decrease values continuously. Press M, or wait for 15s to save and return to room temperature display.

1.4.1.5 Fan Speed setting

In normal display, press the FANSPEED button to switch among the fan speeds: Low, Medium, High, Auto. Then press M, or wait for 15s to confirm the choice. Note that in Ventilation mode, no Auto speed choice is available.

1.4.2 Fibaro Radiator Thermostatic Head

1.4.2.1 Controlling the setpoint temperature

The setpoint temperature can be adjusted on the device (16-24°C). During manual temperature change the LED ring colour corresponds to the temperature set-point. To check and change the temperature on the device:

1. Bring your hand close to the sphere.
2. LED ring will:
 - a. Glow if temperature was set manually,
 - b. Pulse slowly if device is in schedule mode,
 - c. Pulse quickly if device is in override schedule mode.
3. The colour depends on the setpoint temperature as shown below

Z-Wave Mode	Temperature [°C]	Colour
OFF	Valve closed (anti-freeze)	White
	16°C or lower	Blue
	17°C	Azure
	18°C	Cyan
	19°C	Spring green
HEAT	20°C	Green
	21°C	Chartreuse
	22°C	Yellow
	23°C	Orange
	24°C or higher	Red
MANUFACTURER SPECIFIC	Valve fully opened	Magenta

4. Turn the sphere counter-clockwise to lower temperature or turn clockwise to raise the temperature.
5. Remove the hand from the sphere, after 5 seconds LED will fade and new temperature will be set.

1.4.2.2 Battery and charging

The device is equipped with a rechargeable lithium-polymer battery pack that can be charged via micro-USB port using standard 5V charger (not included). When battery is low the LED ring will start to blink red. The device will also report low battery status of itself and dedicated temperature sensor (if paired) to the controller. Make sure you are using certified charger Class

II, which complies with parameters specified in the manual. Do not leave the device unattended while charging. Do not use cables longer than 3 meters for charging the device.

To charge the battery:

1. Connect charger to the micro-USB port.
2. During charging the LED ring will pulse red and valve control will be disabled.
3. When LED starts pulsing green, disconnect the charger.
4. The device will restore its previous operation.